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PROGRESSIVE REHABILITATION AND CLOSURE PLAN

AGRIPOWER AUSTRALIA LIMITED
CONJUBOY DIATOMACEOUS EARTH PROJECT (ML 10279)

EA NUMBER: EPML00392513
EA HOLDERS: GREENVALE SILICON PTY LTD AND DIATOMACEOUS EARTH INVESTMENTS PTY LTD
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PART A – REHABILITATION PLANNING PART

1 PROJECT PLANNING

1.1 BASELINE INFORMATION

The Conjuboy Diatomaceous Earth Project (hereafter "Project") comprises Mining Lease (ML) 10279, Mineral Development Licences (MDL) 325 and 326, and Exploration Permits for Minerals (EPM) 13236, 13995, 19573 and 25110. The holder of all tenements within the Project is Greenvale Silicon Pty Ltd (80%) and Diatomaceous Earth Investments Pty Ltd (20%).

The tenement subject to this Progressive Rehabilitation and Closure Plan (PRC Plan) is ML 10279, which was granted over a "whole surface area" of 133.066 hectares. It is located near Conjuboy in the Charters Towers Region local government area and was granted in 2003 for the mining of diatomaceous earth (DE).

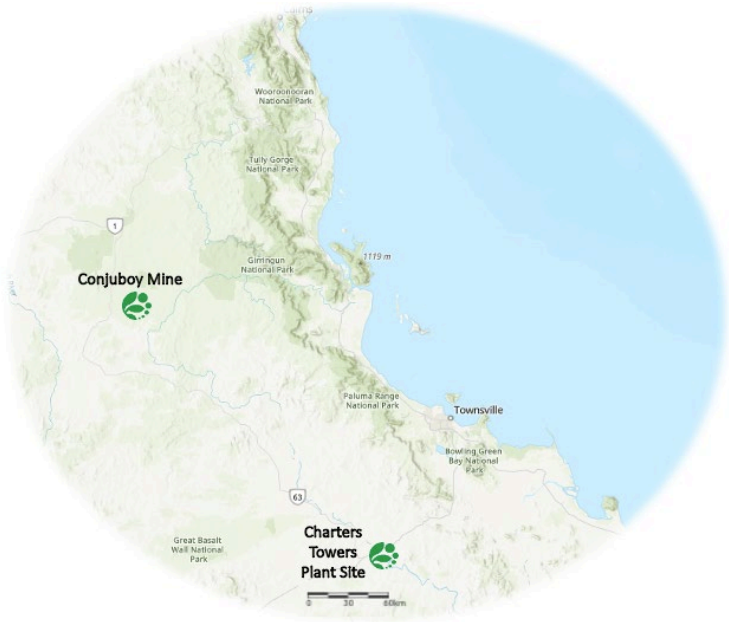


Figure 1 – Conjuboy Mine and Processing Plant Location

1.1.1 Topography

The ML is surrounded by gently sloping lava plains of McBride Basalt (olivine basalt) which are locally dissected. Elevation within the ML area ranges between 500 and 550m. The ML10279 is located on an area covered sporadically with a thin layer (up to 2m) of basalt which covers a laterally persistent sedimentary layer of Diatomite, which to the south has been eroded to uncover an area known as "Greasy Plain".

1.1.2 Climate

The climate of the area is typical of monsoonal northern Australia with most rain falling in the months of December to March, followed by a dry winter. Mean annual rainfall for Conjuboy Station (30061 – 1964-2020) is 663mm. The area is often referred to as the dry tropics or semi-arid sub-tropics.

1.1.3 Geological setting

The lease area lies on the margins of a basalt dome of about 5,000km^2 that forms the McBride Plateau.

The dome comprises numerous basalt lavas that flowed radially outward from 164 volcanic centres. The volcanic centres range from low hills formed by eroded plugs to well preserved cones with craters. The site is adjacent to a low basalt wall that represents the southernmost extension of the lava flows. Lacustrine sediments, including diatomaceous earth were deposited prior to the basalt emplacement. Quaternary Alluvial deposits (clays) occupy dissected areas.

The basement rocks are exposed south of the McBride basalt margin. They include Early Proterozoic to Paleozoic schist, gneiss, migmatite, granite, mafic intrusive rocks, and metamorphosed volcanic and sedimentary rocks. Cambro-Ordovician granite (the Ringwood Park Microgranite) is the only basement lithology cropping out within the southern parts of the Conjuboy MDLs 325 and 326. Figure 2 Geology and cadastre surrounding the Conjuboy Project, shows the local geology in the ML area.

Lacustrine claystone, sandstone and conglomerate occupy a shallow, irregular basin of lake sediments extending about 100km^2. Basalt flows are thought to have dammed ancient drainage features to form the lake. The lake sediments which rest directly on basement rocks were subsequently buried by later basalt flows which have preserved these sedimentary deposits from erosion.

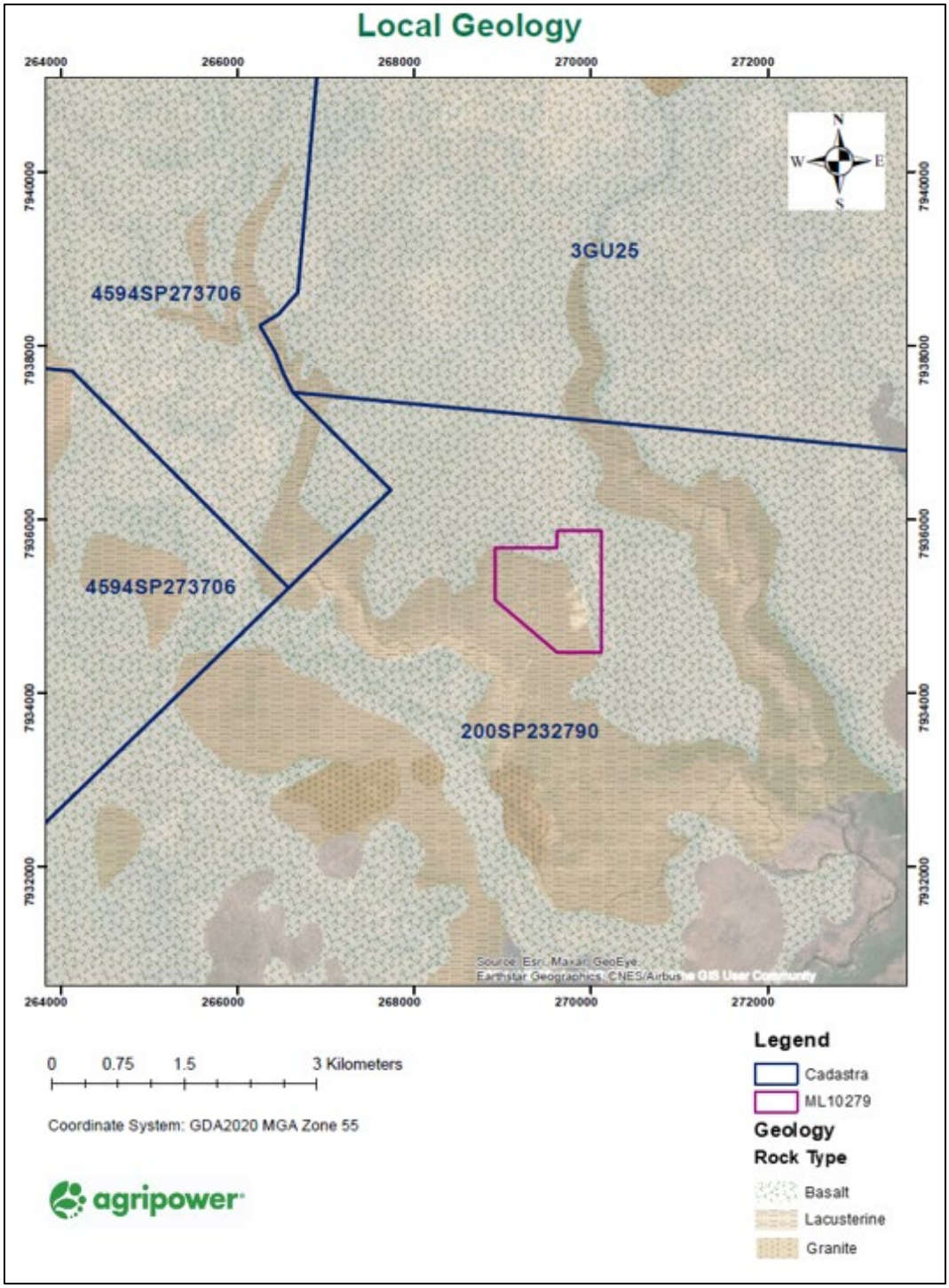


Figure 2 Geology and cadastre surrounding the Conjuboy Project

1.1.4 Site Hydrology and Fluvial Networks

The site is within the catchment of Wyandotte Creek and flows into Dry River, a tributary of the Burdekin River. Drainage from the lease area is dendritic and during the wet season, ephemeral water flows into Wyandotte Creek via the unnamed tributary. The waterways on the lease area are first order streams which form a second order tributary of Wyandotte Creek. The first order streams have relatively small catchment and are bounded by a basalt wall to the north and east. Flow in the intermittent creeks is dependent on seasonal rain and is unlikely to persist after rain events. Downstream surface water uses include agriculture, potable water and recreational uses.

The dry tropics are characterized by episodic summer rainfall, with most of the annual river flow occurring in a short period of time, after which rivers typically contract into a series of waterholes of varying permanence and hydrologic connectivity. The waterways are mostly ephemeral, only flowing after largely unpredictable rainfall and runoff, ceasing to flow within days, supporting aquatic organisms whose life cycles are adapted to these conditions. Surface flow in stream order waterways 1 to 3 will almost certainly be largely ephemeral, especially in areas where sand may be the dominant substrate. However, intermittent pools would possibly persist on some of the more significant waterways (stream order 4 and above) particularly at locations which may have less permeable clay and rock substrates.

1.1.5 Groundwater Levels and Properties

Groundwater is primarily used for watering stock and irrigation of fodder crops. The Conjuboy-Gilldale area and principally the open pit region on ML10279 contains groundwater of variable quality due to prolonged contact with localised rock units. Groundwater permeates through geological horizons as aquifers and are differentiated from each other as separate/ semi-separate aquifers.

Groundwater at the Conjuboy Project is divided between two discernible semi-disconnected aquifers. The primary aquifer which is essentially unconsolidated and porous decomposed basalt and the secondary body which behaves more as an aquitard within lacustrine sediments. This aquitard forms the mineral body mined from the Gilldale pit on ML10279. Aquifer layers are listed from the surface down in Table 1 and depicted in Figure 3.

Hydrogeological properties of geological units and chemistry from various government environmental reports have reported for aquifers in the Greenvale aquifer of pH 7.9 and conductivity 1582 µS/cm (50th percentile).

Groundwater ages vary between 5 to 120 years, these ages have been allocated to the McBride Basalt.

Table 1: Hydrogeological properties of geological units chemistry

Aquifer/Aquitard Layer	Description
BASALT (0- 22 L/Sec)	• Very little to no water (compared to that hosted in sedimentary rock and alluvium) • Weathered and fissured Basalt (1- 22 L/Sec) • Vesicle or fissure hosted water- Hard water • Intra Basalt layer alluvium- secondary and fed from vesical hosted water and fractures within the basalt.
LACUSTRINE SEDIMENTS (DE) (~1-18 L/Sec Indicative value with modal supply likely less than 1 litre a second in the actual diatomite)	• Hosted in pore space fill and separated by swelling clays. • Localised trapping from ionic dissolution (e.g. Limonitic staining). • Water hosted in DE maybe secondary to Basaltic groundwater. • Hosted in Cracks and fissures within diatomite- small disjointed aquifers or interstitial though as a whole the diatomite exists as an impermeable barrier or aquitard.

1.1.6 Basalt Aquifers

Basaltic groundwater usually yields moderately saline groundwater, of typical basaltic composition, being dominated by HCO_3 with even cations. The basalts, as with other fractured rock aquifers, are vulnerable to contamination. This is because rapid recharge from the surface limits the filtering and protecting chemical environment of the soil layer. The storage capacity of a fracture zone may also be hydrologically isolated so that accumulated contaminants are unable to disperse.

Bore reports suggest the strips of alluvium around the streams are of low salinity, NaCl chemistry suggesting an alluvial origin is unlikely. However, small yields of saline Na-Ca-HCO_3 groundwater can be obtained from local fractured basement trap rock at depth, though some of the granite extrusions produced no water showing a lack of fractures and fissures present at least locally.

Basalts of this region are Mg-HCO_3 dominant and of moderate size, consisting of two large basalt tablelands, with a combined area of 9,876km^2, in the Upper Burdekin Sub-basin. The tablelands are divided by trap rocks of the Greenvale Craton Zone. The aquifer system is mostly deep to very deep, extending from 28m to 86m, with 65 per cent of the bores being attributed to basalt, with the rest mostly granite. The data record for the area are however considered limited. The recorded salinity is usually moderate to occasionally low, being between 779µS/cm and 1,550µS/cm. Most of the samples, including all the basalts, are moderate in salinity and dominated by HCO_3 with evenly distributed cations.

1.1.7 Lacustrine Sediment Aquifers

Information on groundwater hosted in Diatomaceous Earth deposits is limited as most of the work has been done on investigations into the use of DE for improving water quality than as a natural host. Diatomaceous earth has been described as an aquitard (aquiclude) or barrier to groundwater in most instances.

Diatomite is known to be highly porous, but its permeability is limited, owing to its very fine-grained nature. Although the diatomite deposit will become saturated by recharge events, it is not considered to represent a significant aquifer unit and is unlikely to permit further vertical infiltration of groundwater. It is considered that the mining operation will not change the chemistry of the groundwater due to the low permeability and neutral nature of the Diatomite.

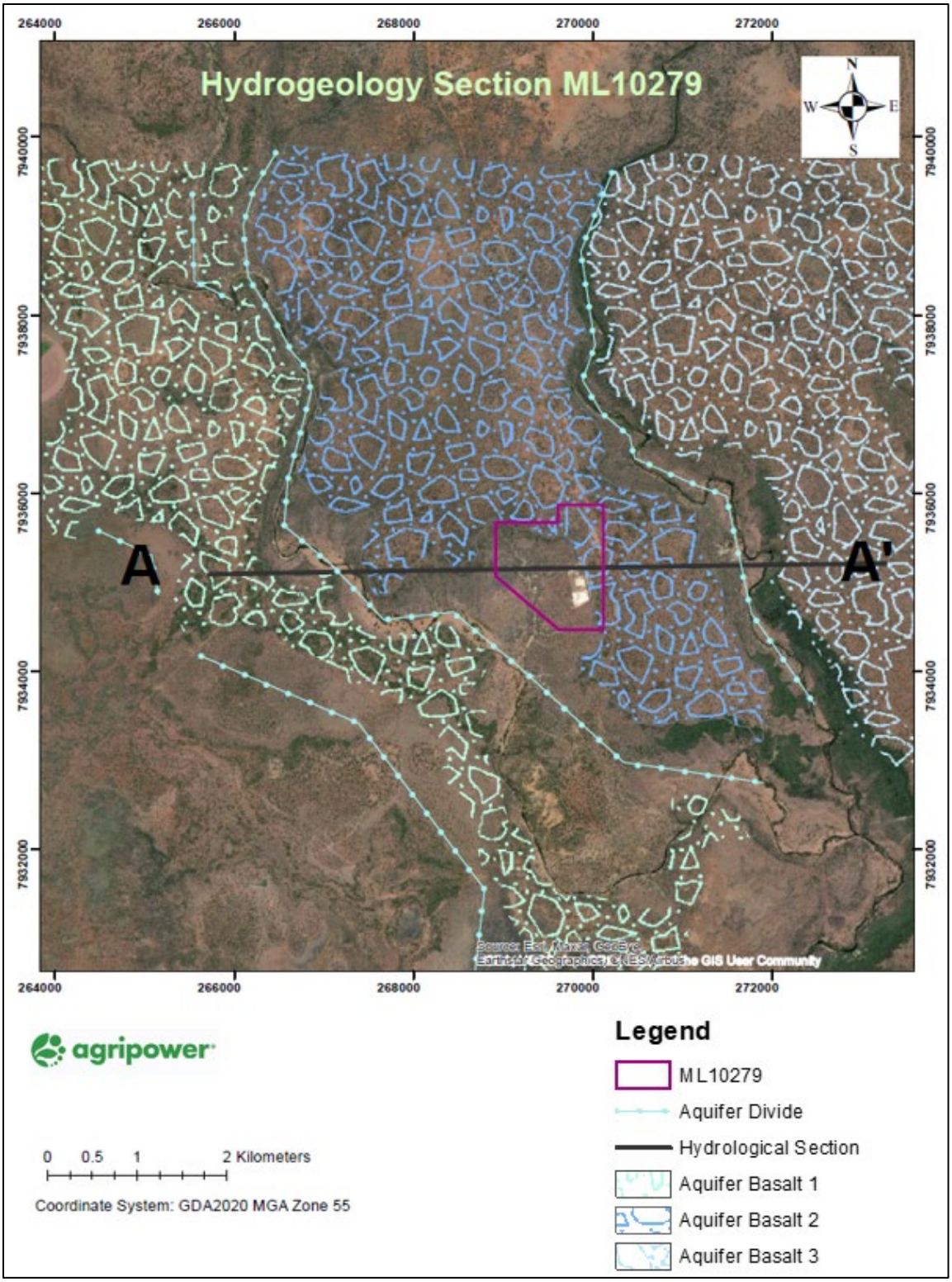


Figure 3 Hydrogeological section location, and aquifers on the Conjuboy Project (ML10279)

1.1.8 Soil Types and Properties

The pre-disturbance soil mapping of the lease area include:

- Red Ferrosol (A1) – red clay soils on basalt (very dark brown, very slightly stony light firm clay),
- Red Ferrosol/Rudosol (A2) – stony red clay soils on basalt (very dark brown very slightly stony light soft clay),
- Black Vertosol (B1) – Dark cracking clay (dark grey stone-free medium very strong clay),
- Tenosol/Calcarosol (C1) – Shallow grey silt loam under tea trees (light greyish brown weak silt loam),
- Red Vertosol (D1) – Red/brown cracking clay (very dark brown, very slightly stony light very strong clay) and
- Tenosol (E1) – greyish brown weak silt loam.

Salvageable surface soils exist on site (30-40cm thick) are collected and stockpiled on site ready to be used in rehabilitation. Some subsoils are sodic and potentially dispersive and are unsuitable for use in rehabilitation and should not be exposed unnecessarily. The distribution of soil types is shown in Figure 4.

The physical description of those soil units (as described in Appendix 3 and reproduced in Table 2 below) will be used to dictate the depth of topsoil to be stripped prior to disturbance for pit development.

Table 2 Topsoil stripping depth by soil type

Soil Unit	Topsoil depth (m)	Topsoil attributes	Subsoil colour
A1	0.1	Very dark brown clay loam	Soil becomes red brown
A2	0.1	Very dark brown clay loam	Soil becomes red brown
B1	0.3	Very dark greyish brown/Black cracking clay	Colour change is difficult to judge. Use total depth as indicator.
C1	0.15	Light greyish brown to greyish brown clay silt	Diatomaceous earth (white)
D1	0.3	Very dark brown to reddish brown clay	Colour change is difficult to judge. Use total depth as indicator.
E1	0	Greyish brown silt loam over white diatomaceous earth	Not to be striped and stored

Topsoil is stripped to depth (using above guidance) using a dozer or loader.

The polygons for each soil type have been measured and the recommended stripping depth applied to determine whether soil availability will meet topsoil rehabilitation cover estimate (refer Section 5.1.3).

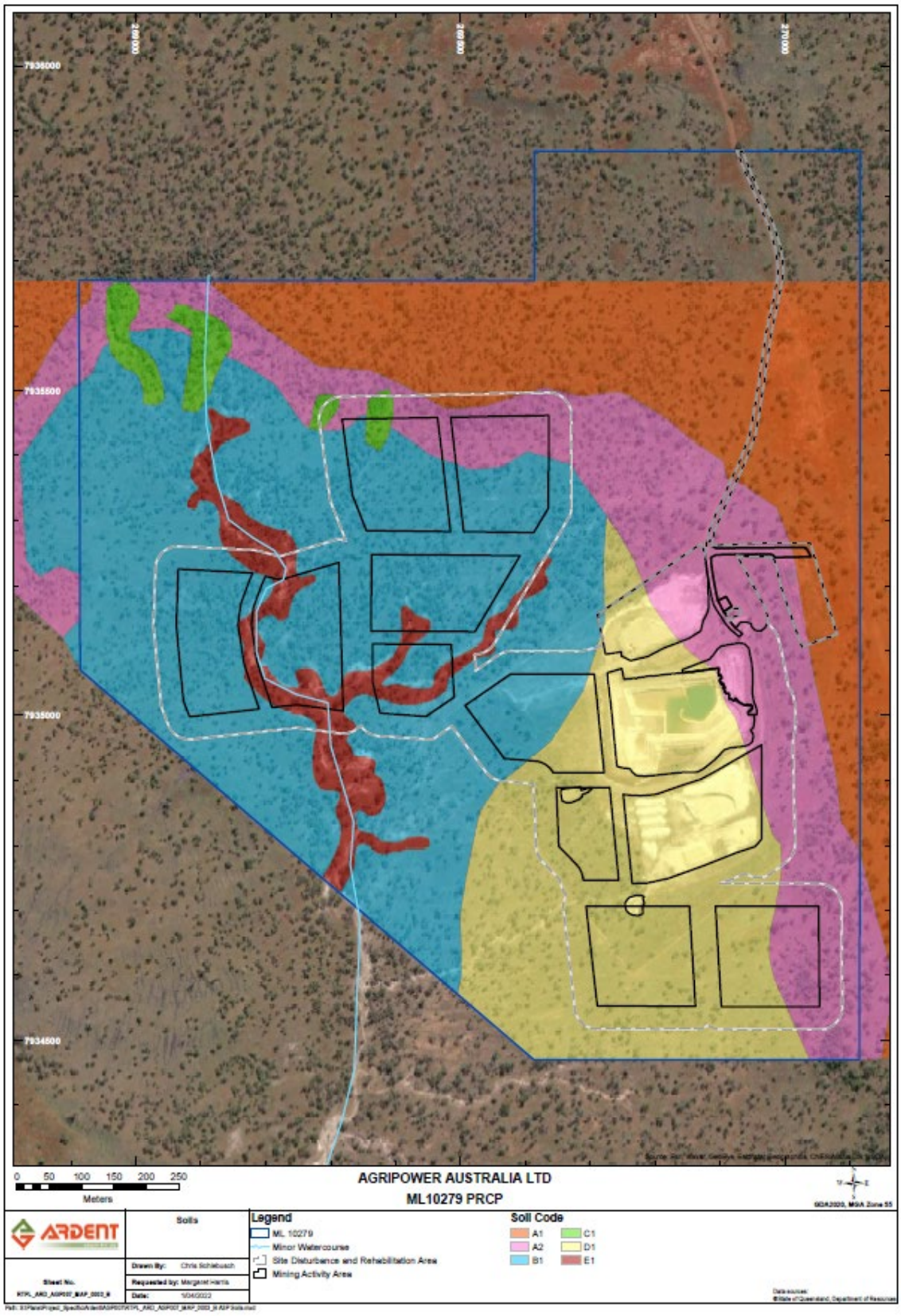


Figure 4: Soil Types over ML 10279

1.1.9 Land Stability

The area is used for cattle grazing on native pastures. There was evidence of soil degradation associated with that land use in the form of accelerated erosion along cattle tracks, watercourse bank damage and severe treading where soils were wet on the pre-mining land surface. Wyandotte Creek has a mean annual stream bank erosion rate of up to 0.5t/yr and mean annual sediment load of up to 50t/ha/yr.

No major structural geology features were observed in and around the open pit. The diatomite is finely bedded but this is almost tabular and flat dipping. The predominant structural features are sub vertical sedimentary dykes. These are probably neptunean dykes and are infilled with various angular clasts and Leonardite, calcrete and dolomite. These vary in thickness from a few millimeters up to 30 cm.

All major structures observed in the open pit were mapped during the pit inspection, with the following results;

- 93% of all structures observed where dykes;
- These dykes range in dip from 55° to 90° but are generally steep with an average dip of 84°;
- These dykes appear to have a random strike orientation;
- The remaining 7% of the observed structure was jointing, with one structure showing indications of micro faulting.

The combination of flat dipping bedding in the diatomite along with sub-vertical dykes is favourable from a geotechnical point of view. No structures were observed that could cause instability by undercutting the faces.

The field strength estimates summarised below are for the C unit, as units A and B are poorly exposed and would be mostly removed during pre-strip;

- The UCS is estimated to be between 3 and 10 MPa. This value is based on standard field strength estimating techniques (Hoek & Bray, 1974);
- The base friction angle is estimated at between 20° and 30°;
- The cohesion was estimated using the Rocscience package, Roclab (2013). For the low confining stresses expected at shallow depth, Roclab predicts a cohesion of 53 kPa and a friction angle of 43°.
- However, field estimates of friction angle are much lower than this and the material appears to have a relatively high cohesion, in the range of 0.2 to 1.0 MPa;
- The rock mass quality was estimated using the Geological Strength Index to be 30.

Testing of the basaltic lava cap is unnecessary, as this is a very high strength material and would only fail along discontinuities in a shallow, open pit scenario.

1.1.10 Agricultural Land Class

The Department of Agriculture and Fisheries define the ML10279 area as Agricultural Land Class "B", which is defined as "Limited crop land that is suitable for a narrow range of current and potential crops due to severe limitations, but is highly suitable for pastures. Land may be suitable for cropping with engineering or agronomic improvements" *(https://www.business.qld.gov.au/industries/farms-fishing-forestry/agriculture/agribusiness/agricultural-land-audit/land-classes)*. The baseline assessment (Appendix 3) characterises the area as suitable for low intensity grazing (LIG) and that rehabilitation of mining disturbances will be able to return to this use following rehabilitation.

1.1.11 Vegetation Communities and Ecological Data

ML10279 lies within the Kidston/Undara-Toomba Basalt provinces of the Einasleigh Uplands bioregion, east of the Great Dividing Range. An open narrow-leaved ironbark (*Eucalyptus crebra*) woodland with grass understory has developed on the McBride Basalt plains in the north of the lease area. In the dissected areas on alluvial and colluvial deposits, open Mt Molloy Box (*Eucalyptus leptophleba*) woodland with a grassy understory is dominant.

The regional ecosystems (RE) within the lease area are all no concern at present (NC) status:

- RE 9.3.2 Mt Molloy Box on alluvium
- RE 9.8.1 Ironbark on red soil plains and rocky rises
- RE 9.3.10 Mountain Coolibah, Black Tea Tree and springs on black soil plains

Grass understory is the native pasture used for grazing in the area of the ML10279. No threatened ecological communities are considered to occur within the ML10279 boundary. No mapped essential habitat or flora trigger map/species record occur within the ML10279 area.

1.1.12 Fauna Presence and Populations

Pre-disturbance field investigations observed native and introduced species over the lease area, including 2 reptiles, 16 birds and 6 mammals. An aquatic ecology survey was also undertaken in the ephemeral creeks. Habitat diversity within the lease area is low and can be broadly described as eucalypt woodland with a shrub and grass understory. The floristic and structural differences between the RE's described above are small and unlikely to constitute discrete habitat types and are unlikely to constitute critical habitat for any fauna species. Notable habitat structures within the woodland complex include rock screes and hollow-bearing trees. The features are common on a local and regional scale. Wyandotte Creek downstream of the lease area has some permanent pools which that provides refugia for aquatic organisms in the semi-arid environment.

Appendix 7 includes a copy of the pre-disturbance fauna investigation, the updated conservation status of those species observed (as separate revised Table 3.7 of Appendix 7) and WildNet reports for species, conservation significant species and pest species lists for the ML area and buffer.

1.1.13 Pre-mining Land Use

The pastoral holding is used for grazing of beef cattle on native pastures. The zoning is/was rural. The land suitability of the area proposed for pit excavation is assessed as unsuitable for cultivation but suitable for grazing based on QDME (1995) criteria.

1.1.14 Landholders

ML 10279 (133 ha) is entirely within the Wyandotte Property boundary, a Grazing Homestead Perpetual Lease, Lot 200 on SP232790 (37,520 ha). The landholders are E. J. and M. J. Masterson. The landholders breed, fatten and sell beef cattle on the property and in some areas irrigate fodder-growing paddocks (lucerne and sorghum). A compensation agreement exists with this holder pursuant to the requirements of the *Mineral Resources Act 1989.*

1.2 PROJECT DESCRIPTION

This PRC Plan relates to the mining activities on ML 10279, operated by Greenvale Silicon Pty Ltd which is a wholly owned subsidiary of Agripower Australia Limited.

The Conjuboy Diatomaceous Earth Project is located approximately 48 kilometres north of Greenvale and approximately 210 kilometres northwest of Townsville, in Far North Queensland (Figure 5), in the Charters Towers Regional Council.

The mine's primary activity encompasses the extraction of Diatomaceous Earth (DE) for testing and trials in Agriculture and also for sales. DE is a very high source of "Plant Available Silicon" (PAS) and is certified for use in organic agriculture in Australia, India, USA and European Union.

The project operation is a simple excavation, crush / screen and stockpile of the target ore profile which is transported by road to the processing facility located at Charters Towers.

The Diatomite bearing horizon reaches up to 25m thick locally, thinning to 10m in the west and south. The site within ML 10279 is estimated to contain 55 million cubic metres of JORC diatomite resources suitable for processing.

1.3 TENURES TO WHICH PRC PLAN RELATES

The Conjuboy Diatomaceous Earth Project comprises of ML 10279, Mineral Development Licence (MDL) 325 and MDL 326, and Exploration Permits for Minerals (EPMs) 13236, EPM 25110, EPM 19573 and EPM 13995.

Details of the ML, which is the subject of this PRC Plan, are outlined in Table 3.

Table 3: Tenement Information

Tenement	Area	Original Grant Date	Most Recent Term Sought	Status	Term End Date
ML 10279	133 ha	28 /10/2004	50 years	Granted	27/10/2054

ML10279 is located over pre-requisite tenure (MDL 325) which is held by Greenvale Silicon Pty Ltd (80%) and Diatomaceous Earth Investments Pty Ltd (20%).

The MDL's were granted on 1st May 2001 over an area of 3,562.5 hectares and has been maintained in good standing since that date. The MDL 325 adjoins MDL 326 and EPM 13236, EPM 25110, EPM 19573 and EPM 13995, which are all held in the same percentages by the same parties. The location of these tenements is shown in Figure 5.

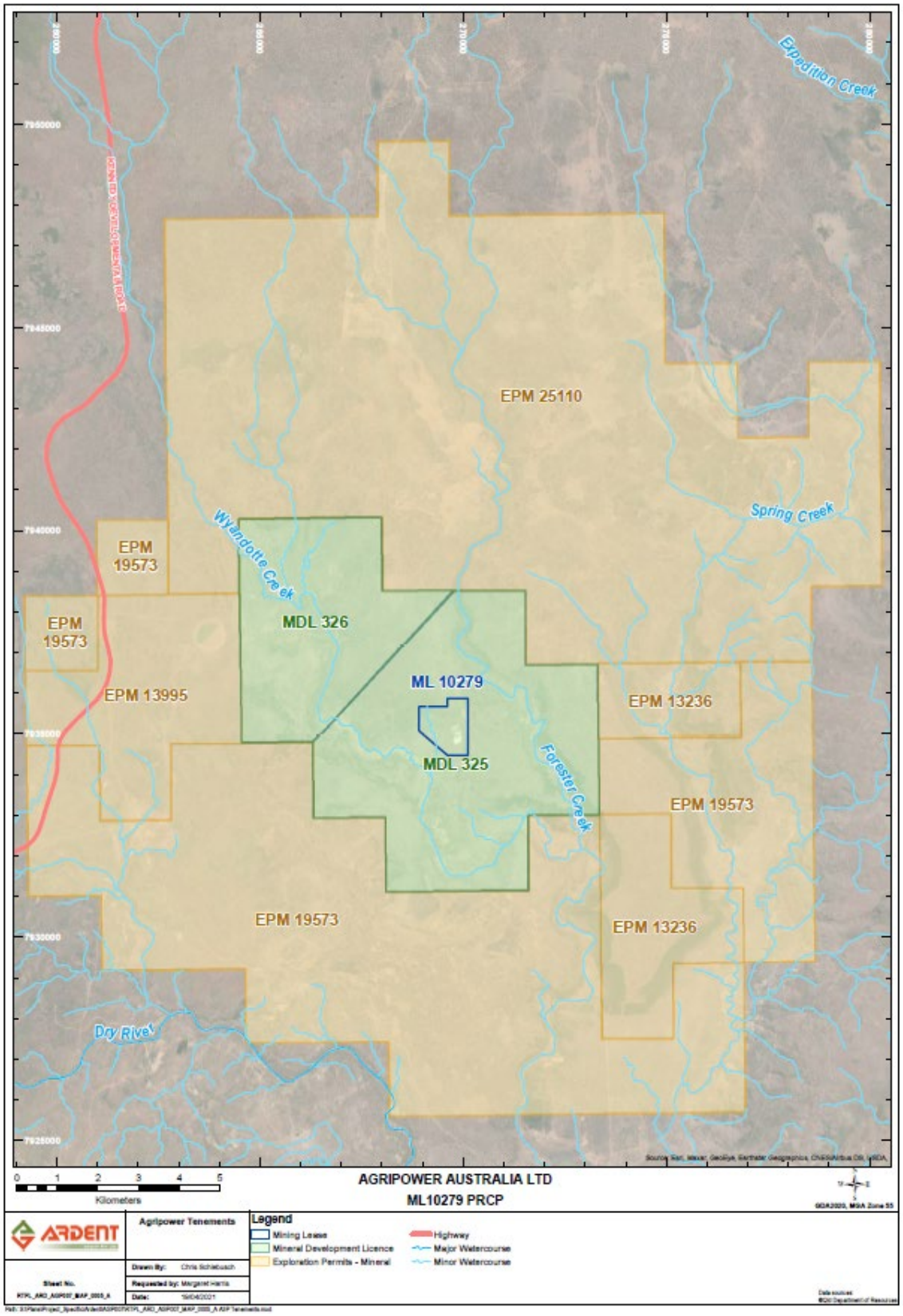


Figure 5 Location of Conjuboy Project Tenements

1.3.1 Relevant Activities and Primary Mine Features

The relevant activity for ML 10279 is mining, which is authorised under Environmental Authority (EA) EPML00392513. The Environmentally Relevant Activity (ERA) on ML 10279 is ERA 21. The primary mine features on the ML include the areas described below and illustrated in Figure 6.

1.3.1.1 Roads, tracks and park-up areas

Access from the designated lease access road to the activity area within ML 10279 is via a 15m wide unsealed all weather road. The expected life of mine disturbance for access roads is 3.71 hectares. There are currently no agreements with the landholder in respect of retention of site roads.

1.3.1.2 Overburden and waste dumps

The overburden stockpile volume generated by the excavation activities is estimated to be 3m per pit area. The progression of activities will maintain a rolling total at any one time, but the life of mine disturbance for this mine feature is expected to be 2.74 hectares.

Topsoil stockpiles generated in excavation preparation are expected to be overlaid on the overburden dump footprint but have a distinct operational area of approximately 0.9 hectares.

1.3.1.3 Ore stockpiles/drying pads

The campaign style mining operation requires the temporary stockpiling of ore that over a short time will be removed to the Charters Towers processing facility. The size of these temporary ore stockpiles is 1.1 hectares with a life of mine disturbance for this feature expected to be 1.1 hectares. This footprint will be superseded by future pit development and rehabilitated as required.

1.3.1.4 Water management structures

For offsite water quality protection, a small settlement traps are located downstream of the activity area. The settlement traps are currently less than 0.15 hectares with a life of mine disturbance for this feature expected to be 0.15 hectares.

1.3.1.5 Open pits

The open pit excavation footprint for the safe removal of ore includes internal access ramps, safety bund and pit fence, walls and pit floor. In order to proceed on a progressive mine development and rehabilitation program, the five pit groups will be developed as smaller excavations which help speed up backfilling operations as part of the ongoing rehabilitation at the site. A total of five pit group excavations are expected for the life of mine disturbance at 200,000 tonnes per annum (tpa) operation. The pit fence will remain to exclude stock from the operational and rehabilitation areas within the initial mine activity area and is expected to be extended to enclose active areas until mine closure. Its perimeter is the enclosed mine activity area. The operational safety bund will extend with the pit perimeter for each pit until its removal is safe to do so. The total footprint for open pits over the life of mine is 27.45 hectares. Working pit will be less than 3.05 hectares at any one time.

Figure 6: Location of Primary Mine Features

The pit excavations adopted the following geotechnical design parameters based off safety in design criteria:

- Bench Face Angle (BFA) of 20° has been adopted into design.
- Berm width = 5m
- Bench height = 2.5m

These design parameters yield an inter-ramp slope angle of 15°. These slope design parameters are considered conservative given the local slope performance and exposures of DE in the river cuttings (Wyandotte Creek). The design criteria for safe mine operations were:

Zone	BFA	Berm Width	Bench Height
Soil and A horizon	30°	4m	3m
B and C1	40°	4m	3m
C2-C6	80°	3m	6m
Main Pit Ramp	60° below ramp	3m	6m

The compensation agreement with the landholder includes retention of a perimeter fence for a minimum of 4 years. The fence will be removed following 4 year achievement of cover. Posts will be removed and wire removed at the achievement of stability and revegetation milestones and no additional works required.

1.3.1.6 Minor fuel storage (10Kl) and designated service area

The majority of refuelling and maintenance occurs off site, however a designated area for emergency servicing has been made. The total for this temporary feature for life of mine disturbance is 0.03 hectares.

1.3.1.7 Cleared areas between pits and stockpiles

The extraction pit perimeters and transition areas between stockpiled materials will become disturbed to varying degrees throughout the life of mine. A conservative estimate of these areas is provided for the life of mine at 21.51 hectares. The pit group configurations will require access between working pit and pit areas under rehabilitation for the transfer of waste for backfilling. The cleared area within each pit group will be rehabilitated as the integration of final contours of backfilled materials for the pit group are completed. The integration of the pit group perimeter with the natural contour will occur subsequent to the end of use of pit access roads. The integration of backfilled pit level and natural contours will require slopes of up to 18°.

1.3.2 Duration of Relevant Activities

The total project life could be in excess of 50 years. It is anticipated that mining will continue in small campaigns up until 2022 for a 200,000 tpa operation. At this rate, each campaign will be carried out over a 3-4 month period each year, during the dry season only. The mine will be on 'care and maintenance' when mining is not being conducted. Table 4 is the provisional mine sequence upon which this PRC Plan is based.

Table 4 Provisional Mine Sequence

Pit Group	Pit	Mine Start	Mine End	Backfilled	Rehabilitation complete
Pit 1	1A	2022	2025	2027	2035
	1B	2025	2028	2030	
	1C	2028	2029	2031	
	1D	2029	2031	2033	
Pit 2	2A	2029	2033	2035	2041
	2B	2033	2036	2038	
Pit 3	3A	2036	2039	2041	2044
	3B	2039	2040	2042	
Pit 4	4A	2040	2042	2044	2048
	4B	2042	2044	2046	
Pit 5	5A	2044	2046	2048	2053
	5B	2046	2049	2051	

Rehabilitation of the mined area will be on a continuous basis only once each area has been mined to its economic limit. Once this occurs, the stripped overburden from that pit and the proceeding development pit can be placed directly back into the open pit, when it has been deemed safe to do so. Pit development beyond Table 4 is subject to future PRC Plan and Schedule amendments.

1.4 LAND OUTCOME IDENTIFICATION

1.4.1 DESIGN FOR CLOSURE

The land outcome identified in EPML00392513 for the entire ML10279 area is Low Intensity Grazing ('LIG'). The final landform design proposed for the relevant activities are as outlined below.

1.4.1.1 Roads, tracks and park-up areas

Access tracks within ML10279 will be ripped and seeded and returned to use as LIG.

1.4.1.2 Overburden and waste dumps

Overburden will be stabilized for the duration of surface storage and returned to the mine excavation as backfill when safe to do so. Overburden surface storage footprint will be ripped, topsoiled and seeded and returned to use as LIG.

1.4.1.3 Ore stockpiles/drying pads

Ore stockpiles/drying pads will be ripped, topsoiled and seeded and returned to use as LIG.

1.4.1.4 Water management structures

The sediment settling traps will be maintained throughout the rehabilitation of the site to settle sediment laden runoff whilst rehabilitated areas achieve stability milestones. The structure will be removed and seeded to return to use as LIG.

1.4.1.5 Open pits

Active pits will be progressively backfilled using overburden throughout mining. Material will be returned in reverse sequence and the surface contoured, spread with stored topsoil and seeded. Pit walls will be made safe.

A schematic of the final profile is shown below in Figure 7.

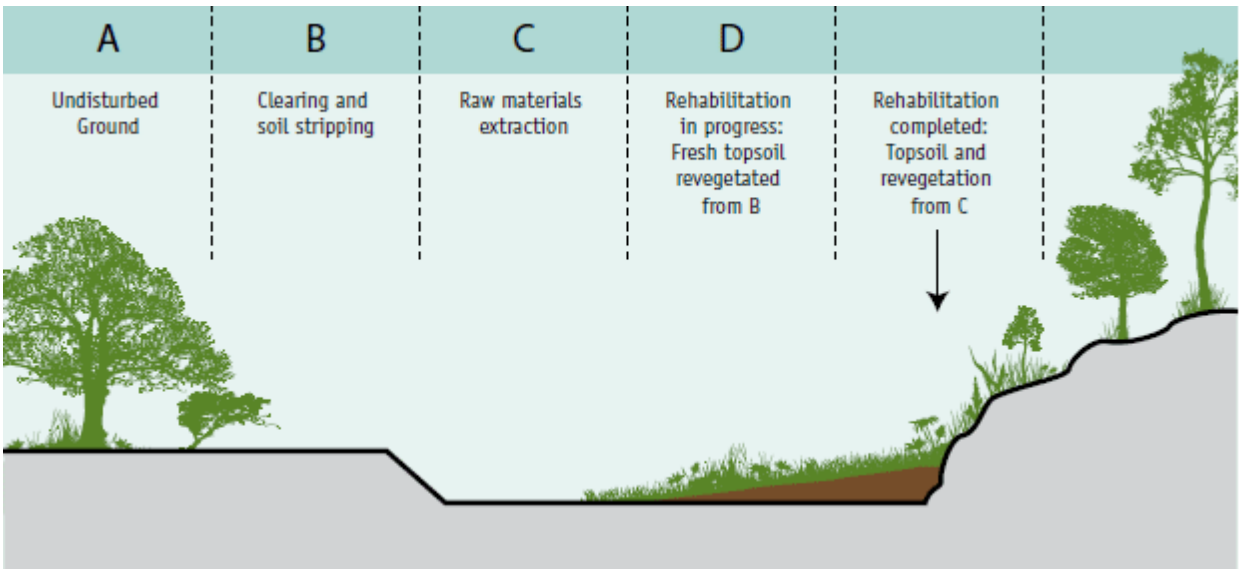


Figure 7: Schematic of pit backfilling and rehabilitation

1.4.1.6 Minor fuel storage (10Kl) and designated service area

While fuel is only stored on ML10279 for the duration of the mining campaigns.

Any and all excess stored fuel will be removed from site upon closure. Surface materials will be tested and scraped and either bioremediated via in situ landfarming methods (Environmental Protection Authority (NSW), 2014) or if suitable, disposed of at a suitable facility to receive that waste. The fuel and designated service area will be ripped, topsoiled and seeded and returned to use as LIG.

1.4.1.7 Cleared areas between pits and stockpiles

Cleared areas (such as walls between pits and batter slopes that integrate to the natural contours) disturbed throughout mine development will be reprofiled, topsoiled, ripped and seeded to return to use as LIG.

1.4.1.8 Undisturbed land

The land surrounding the relevant activities is used for LIG. The fenced area within ML10279 is referred to as the Initial Mine Activity Area it contains both undisturbed and disturbed land.

1.4.2 STATUS OF EXISTING REHABILITATION

There have been no completed rehabilitation works on the site. However, stabilisation of stockpiled materials, such as overburden and topsoil are an operational requirement and have been completed on a continual basis in previous years.

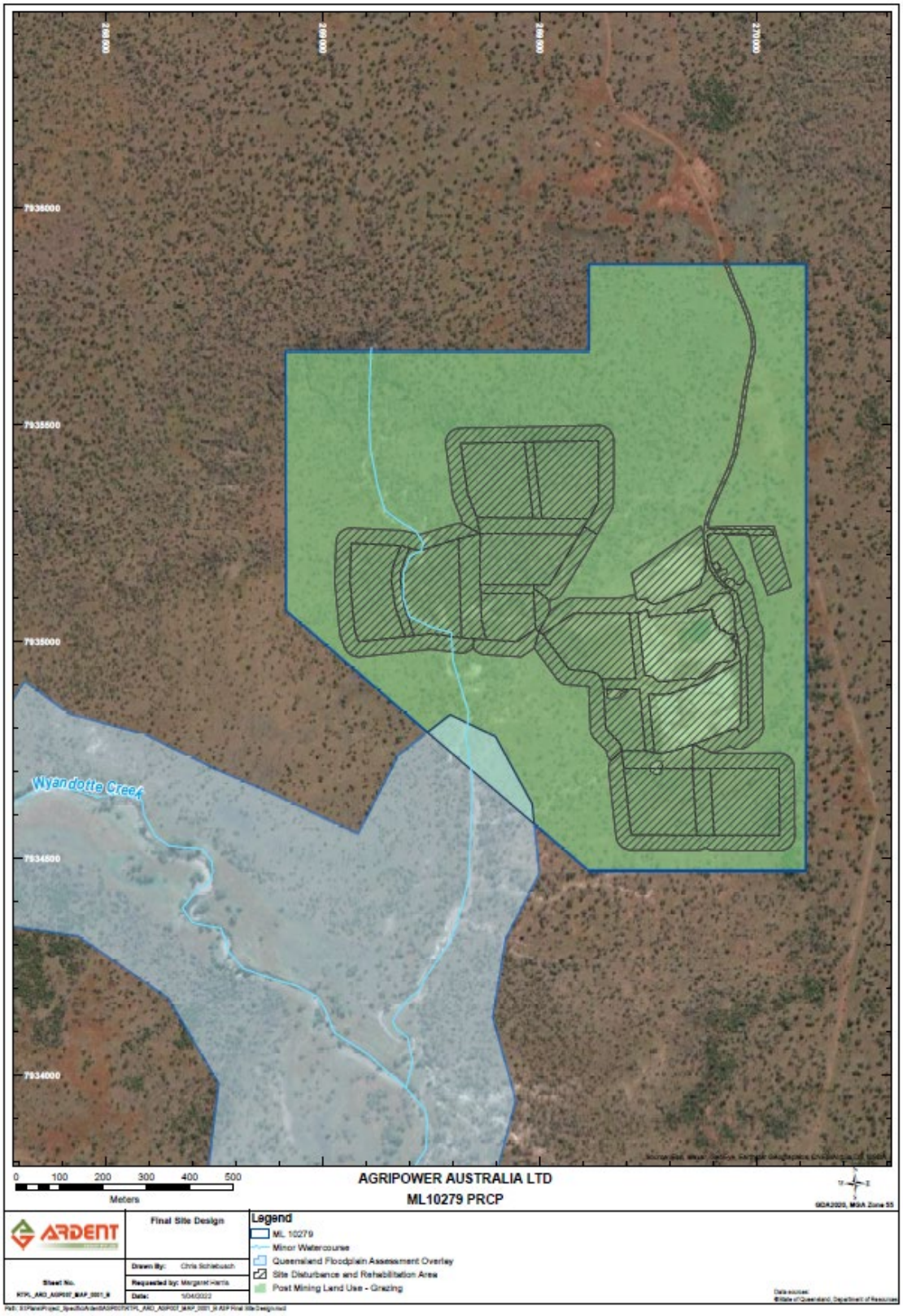


Figure 8: Final Site Design for PMLU Grazing

1.5 REHABILITATION PLANNING

1.5.1 Rehabilitation Areas to be Transitioned from LOD

Table 5 identifies the relevant activities on the mine site, the predicted duration of each activity, the site and extent and the potential for the relevant activities to be progressively rehabilitated.

Table 5 Rehabilitation areas and availability of progressive rehabilitation

Rehabilitation Area	Relevant Activity	ID Code	Duration of Relevant Activity	Progressive Rehabilitation Possible	Justification for Timing
Extraction pits	Open pits	RA5	Life of mine	Yes	Pit locations will fluctuate over life of mine. Final footprint will be rehabilitated following cessation of operations.
	Cleared areas between pits and stockpiles	RA2	Life of mine	Yes	Reprofiling and pit backfilling works will require additional areas over the life of mine. Pit perimeter and adjacent areas will be rehabilitated sequentially with the pit groups.
	Overburden and waste dumps Temporary stockpiles	RA3	Life of mine	Yes	Stockpile locations will fluctuate with pit excavation. Final footprint will be rehabilitated following cessation of operations.
Processing	Roads, tracks and park up areas	RA1	Life of mine	No	Required until cessation of operations and rehabilitation activities.
	Ore stockpile/drying pad	RA3	Life of mine	No	Required until cessation of operations. *Included in pit footprint
	Minor bunded fuel storage and designated service area	RA6	Life of mine	No	Required until cessation of operations.
Settling pond	Water management structure	RA4	Life of mine	No	Settling ponds required for water quality protection until other relevant activities meet stability milestone criteria

2 COMMUNITY CONSULTATION

2.1 DETAILS OF CONSULTATION IN DEVELOPING THIS PRC PLAN

2.1.1 Stakeholder Identification

The primary stakeholders identified for the project at the time of application were:

- the landholders of the MLA area and access road connection from Kennedy Developmental Road,
- the local government authority – then Dalrymple Shire Council (Charters Towers Regional Council),
- State Government Authorities responsible for mining – the Department of Natural Resources and Mines and Environmental Protection Agency (as they were in 2003).

The nearest township, Greenvale, is over 40km southeast of ML10279. The entire locality (6,126km^2) has a population of 232 people (2016 Census).

The application for ML10279 and the accompanying EA (mining approvals) was made in 2003 and the site has been operational since the grant in October 2004.

2.1.2 Community Consultation Register

The Post-Mining Land Use (PMLU) proposed and accepted in the mining approvals and forming the basis of compensation hearings and agreements agreed to in the Land and Environment Court is low intensity grazing (LIG). The information in Table 6 has been obtained from the application processes.

Table 6 Community Consultation Register

DATE OF CONSULTATION	COMMUNITY MEMBER/ STAKEHOLDER	TYPE OF CONSULTATION	INFORMATION PROVIDED	LAND USE OUTCOME PRESENTED	COMMITMENTS/OUTCOMES OF ENGAGEMENT
February 2003	Regional community	Advertisements in the Greenvale Gazette (28/2/03), Townsville Bulletin (25/2/03) of the environmental authority application	EA application materials including EMOS	LIG	No public comment received
February 2003	Mr Henry Daniel, Gilldale Station	Environmental Authority Application notice	EA application materials including EMOS	LIG	Compensation Agreement (December 2003) with mine access landholder and neighbour, Mr Daniel of Gilldale Station (23/12/03), addressing the requirement for installation of all-weather gravel road of 20 metres and cattle grids where access cuts through existing fencing, annual financial compensation for loss of land grazing potential during mine grant period, installation of water supply and power supply to pumping equipment. In 2012 Mr. Daniels sold Gilldale Station (Lot 3GU25) to Mr. Peter Prentice who is still the current landholder. Mr. Daniels passed away in 2013. Actions taken prior to sale.
	Mr Edward Masterson Wyandotte Station and his legal representative	Environmental Authority Application notice	EA application materials including EMOS	LIG	Compensation Agreement (28/10/2003) with mining lease area landholder Mr Masterson - Rehabilitation of a strip is to occur when mining is completed on that strip (within two years); • Vegetation must be established consisting of the same or similar grass species and within the range of density of cover of that of the immediate

DATE OF CONSULTATION	COMMUNITY MEMBER/ STAKEHOLDER	TYPE OF CONSULTATION	INFORMATION PROVIDED	LAND USE OUTCOME PRESENTED	COMMITMENTS/OUTCOMES OF ENGAGEMENT
	at Townsville PO Box				surrounding areas adjoining the mined area, not disturbed by mining. (Indian cooch or like introduced grass must not be used. It is noted that Indian cooch is a prevalent species in the area and may be difficult to now control). • Proactive action must be taken to harvest and sow native seeds (i.e. Mitchell grass, Blue grass and Kangaroo grass) for the purposes of rehabilitation of the areas disturbed by mining such that rehabilitation to natural state of each area mine is effected within four (4) years of completion of mining of that area, taking into account weather, rainfall, drought and acts of God. • Fencing of rehabilitated areas in a manner that will exclude cattle, kangaroo and feral animals from inhabiting the area. Fencing must remain for a minimum period of four (4) years. • Rehabilitation of areas disturbed by mining activities to a stable landform free of pits or depressions from mining activities, similar to that of surrounding areas not disturbed by mining. The wishes of the landholder on rehabilitation technique have been incorporated into the principles adopted in the drafting of this PRC Plan.
	Dalrymple Shire Council, Charters Towers	Environmental Authority Application notice	EA application materials including EMOS	LIG	Dalrymple Shire Council made no submission on the MLA or EA application
20/2/2003 to 21/3/2003	Regional community	Public display of mining	EA application materials	LIG	No submissions on the MLA or EA application were received

DATE OF CONSULTATION	COMMUNITY MEMBER/ STAKEHOLDER	TYPE OF CONSULTATION	INFORMATION PROVIDED	LAND USE OUTCOME PRESENTED	COMMITMENTS/OUTCOMES OF ENGAGEMENT
		approvals applications at Environmental Protection Agency Townsville District Office; Office of the Mining Registrar, Charters Towers	including EMOS		
2003-2020	Mr Masterson	Ad hoc landholder discussions	Access and activities	LIG	No alteration to proposed land use outcome raised.

2.2 DETAILS OF ONGOING CONSULTATION ON REHABILITATION

2.2.1 Objectives for Community Consultation

As the Project approaches the initial rehabilitation activities for the site, a series of engagement phases will be initiated with the primary stakeholders for the project.

The objective of this engagement will be to inform the stakeholders of the near future and long-term activities on the site to gauge their level of interest and any local experience and knowledge inputs to the methodology for rehabilitation.

2.2.2 Methods of Engagement

Informal communications with the landholder have been the nature of consultation and issue resolution from the initial development proposal to date. A more structured information exchange will develop as the rehabilitation processes commence.

The consultation activities will include:

- Ad hoc contact points and one on one meetings where current activities and near future events can be exchanged such as mining, exploration and general access provisions.
- Primary stakeholder letters to present information on the project and timeframes for activities;
- Regulatory authority information to report on project progress.
- Media releases to inform the wider community in the event of significant milestones that may have interest to the local region as well as archived material via the company website on developments.
- Website https://www.agripower.com.au/mining includes frequently asked questions (FAQ) and has over 50,000 site visits.
- E-Newsletter (2017, 2018 and 2019) historically used for promotion of silica product and company information but is established and available to include rehabilitation data.

2.2.3 Consultation frequency

The following table outlines the consultation program for this PRC Plan.

Table 7: Consultation Plan for PRC Plan

Activity	Purpose	Task	Timing
Landholder letters	Invite landholder to one on one meeting prior to initiation of rehabilitation works	Draft and send letter to landholder	Q3 2022
Landholder meetings	Inform the landholder of upcoming rehabilitation works and design	Face to face (where possible) exchange of information and request for feedback prior to commencement of works	3 months prior to works.
Website updates	Inform wider community of project developments and to host FAQ and to update for questions arising from contacts on that site	Keep website current	Quarterly consideration of new information/questions.
E-newsletter	Include annual rehabilitation milestones to wider community	Include updated data for each annual publication	Annual
Regulatory authority information	Maintain contact with key state government stakeholders to keep project developments understood	Phone call to delegates on project status	Annual
Statutory reporting	Fulfil reporting obligations under PRC Plan	Compile and present annual report to DES	Annual

Information exchanges with the landholder will include the final landform design implementation and rate. Success of rehabilitation trials and progress toward milestone criteria will also be shared. Any issues arising will be managed through a process of:

- Regular communication.
- Feedback and follow-up on issues raised.
- Close out of issues raised with the stakeholder recorded.

3 POST-MINING LAND USE ('PMLU')

The agreed post-mining land use for the whole of ML 10279 has been defined as Low Intensity Grazing (LIG).

This outcome is supported by baseline assessment of soil, water and vegetation and included explicitly in the EA for ML10279.

3.1 CONSISTENCY OF PMLU AND COMMUNITY OUTCOMES

The landholder has explicitly required that the land disturbed by mining on their property be returned to the use of grazing, consistent with the remainder of their property and that the land is stable to support that use.

3.2 CONSISTENCY OF PMLU AND PLANNED GOVERNMENT LAND OUTCOMES

The Dalrymple Shire Council planning scheme (2006) had identified the land over which ML10279 is located as "rural". The Charters Towers Regional Town Plan Zone Map (2019) has the same zone designation.

The Queensland agricultural land audit has identified the active pit area as secondary use – mining.

The surrounding area is characterised as "production from relatively natural environments" and a secondary use as "grazing native vegetation". ML10279 area is classified as Agricultural Land Class B meaning it has limited crop land potential. At the time of the ML10279 application (2002), the proposed land outcome for all disturbances on ML10279 was low intensity grazing.

4 NON-USE MANAGEMENT AREAS

4.1 STATEMENT OF WHY NUMA IS NOT APPLICABLE

The Conjuboy Diatomaceous Earth Project has defined low intensity grazing post mining land use for all mining disturbances. There have been no non-use management areas (NUMA) described or anticipated for the entire mining lease area.

The mining process does not involve the excavation, storage or exposure of acid producing materials and does not include any mineral processing which causes the concentration of contaminants, so that the post-mining landforms are all able to be made safe, non-polluting and maintain a water quality consistent with the proposed PLMU of low intensity grazing.

The rehabilitated mine pits are not located within a flood plain.

5 REHABILITATION MANAGEMENT METHODOLOGY

The following section summarises the baseline and operational information gathered that relates to the rehabilitation methods selected for each relevant activity to achieve the PLMU of low intensity grazing.

The assembled information has been reproduced in the appendices to this plan, with the relevant outcomes extracted in the sections below.

The whole site and all relevant activities have been designated as suitable for achieving a PLMU of low intensity grazing, the methods for each and the applicable source information is listed in Table 8 below.

Table 8 Relevant Activity, rehabilitation method and source information

Relevant Activity/Rehabilitation Area	Rehabilitation Method	Source information
RA 1 Roads, tracks and park up areas	The ML area has a short section of earthen road connecting to the lease access. The proposed rehabilitation method to return the surface disturbance to the PMLU is to resurface with minor earthworks, final trim to ensure runoff does not concentrate and deep rip to encourage soil moisture and recolonization of native pasture grasses. There has been no formal agreement with the landholder executed for the retention of this disturbance.	***Appendix 3*** Soil Assessment ***Appendix 7*** Flora and Fauna Assessment and Revegetation Information
RA 2 Cleared Areas	Between Pit Group Areas: Bulk push to adjacent pits prior to backfilling with available overburden for final pit contour. Reshaping to landform with slope consistent with stability for PMLU being less than 10° (DSITI and DNRM, 2015). Deep rip of final surface to encourage surface roughness to increase soil moisture and to decrease erodibility. Direct seeding with native grass and tree/shrub mix and fertilizer application to ensure quick revegetation. Pit Group Perimeter Areas: Pit perimeter reshaping and trim to achieve landform with slope consistent with landform stability to meet PMLU being less than 18° or 1:3. Land suitable for grazing – Class VI can be described as having the general criteria of slopes that do not exceed 33% (18°) with low erodibility and quickly revegetated (Emery, 1986) and water erosion limitation on land class 4 suitability for beef cattle grazing can be achieved at slopes of	***Appendix 3*** Soil Assessment ***Appendix 5*** Final Landform Design Information ***Appendix 7*** Flora and Fauna Assessment and Revegetation Information

Relevant Activity/Rehabilitation Area	Rehabilitation Method	Source information
	20-45% on non-sodic rigid soils (Department of Minerals and Energy, 1995). A vertical height of 10m has been adopted to improve stability outcomes (Department of Minerals and Energy, 1995). A groundcover density of >90% is also recommended.	
RA 3 Overburden, ore stockpile and drying pad	The overburden and waste dumps are designed to be medium term structures destined for backfill within the pit as mining progresses and backfill operations are safe to be conducted. As such it is the footprint of the area designated for temporary storage that requires rehabilitation when the area is no longer required for surface storage. The proposed rehabilitation method for the site to return to the PMLU is the bulk push of stockpiled material into the adjacent pit (for reshaping within that domain) in a sequence reversing that of excavation so as to maintain a profile generally consistent with the pre-mining order (i.e. overburden, sub-soils and lastly topsoil). The surface should not have exposed subsoils remaining as their likely sodic nature will reduce the rehabilitation outcomes. Reshaping to landform with slope consistent with stability for PMLU being less than 10° (the topographic attribute determinant of land classification is safe machinery movement which is achievable on up to 14° (DSITI and DNRM, 2015) Deep rip of final surface to encourage surface roughness to increase soil moisture and to decrease erodibility. Direct seeding with native grass and tree/shrub mix and fertilizer application if required.	***Appendix 3*** Soil Assessment ***Appendix 5*** Final Landform Design Information ***Appendix 7*** Flora and Fauna Assessment and Revegetation Information

Relevant Activity/Rehabilitation Area	Rehabilitation Method	Source information
RA 4 Water management structure	When final landform earthworks and revegetation is assessed as successful, the remaining water within the storage will be drained and sediments removed to void. The dam retaining wall will be removed. Reshaping to achieve landform with slope consistent with landform stability to meet PMLU being less than 10° (DSITI and DNRM, 2015). Direct seeding of tree/shrub species and fertilizer application will be completed.	***Appendix 7*** Flora and Fauna Assessment and Revegetation Information
RA 5 Open pits	Backfill progressively over final operating years to achieve free draining levels graded into the existing contours. Structural works for water management allowing for safe surface carriage of water where level transitions are necessary. Installation of contour berms at 45-60m intervals on backfilled pit slopes. Direct seeding with native grass and tree/shrub mix and fertilizer application if required. Maintain fence around mine working area for 4 years until completion criteria are satisfied.	***Appendix 5*** Final Landform Design Information ***Appendix 7*** Flora and Fauna Assessment and Revegetation Information
RA 6 Minor fuel storage and designated service area	Removal from site of all structures and storage units from the footprint following end of bulk earthworks. Assessment of areas of potential contamination to be completed and where necessary completion of bioremediate of lightly ripped surface or if necessary, removal of contaminated materials from site to a suitably licensed facility to receive hydrocarbon contaminated soils.	***Appendix 7*** Flora and Fauna Assessment and Revegetation Information

Relevant Activity/Rehabilitation Area	Rehabilitation Method	Source information
	Minor earthworks to trim the surface to a slope consistent with achieving PMLU being less than 10° (DSITI and DNRM, 2015). Deep rip of final surface to encourage surface roughness to increase soil moisture and to decrease erodibility. Direct seeding with native grass and tree/shrub mix and fertilizer application if required.	

5.1 General Rehabilitation Practices

5.1.1 Hydrogeological implications

Appendix 1 contains reproductions of the baseline assessment of the site including a description of the hydrogeological setting of ML10279. Figure 9 shows a schematic of the backfilled pit within the geological landscape.

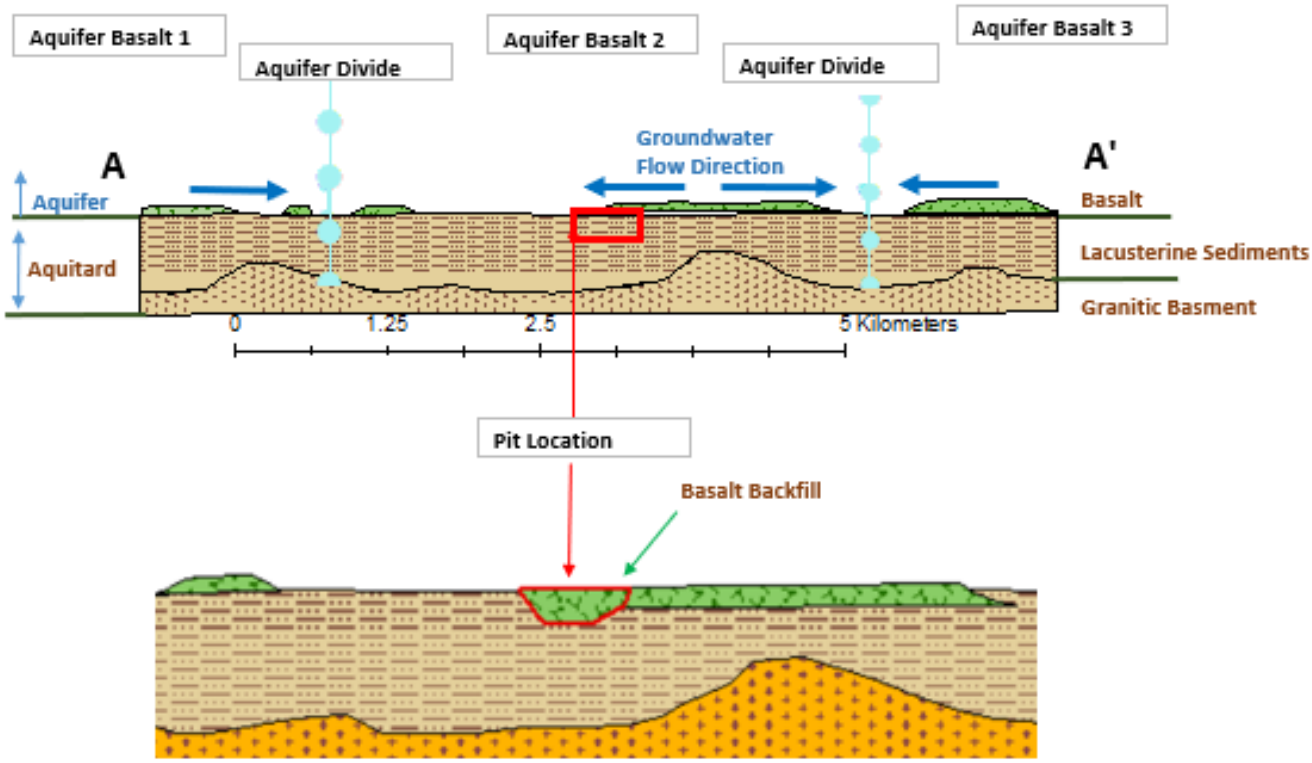


Figure 9 Cross Section of geology and aquifer.

Backfill of the pit will be formed from the local basalt and lacustrine sediment overburden replacing the diatomaceous earth and clay that forms the relatively imperviable aquitard below the water table.

At the pit location groundwater occurs in quantities to be described as an aquifer to several metres before clay levels in the underlying diatomite become relatively impermeable as indicated in the figure below.

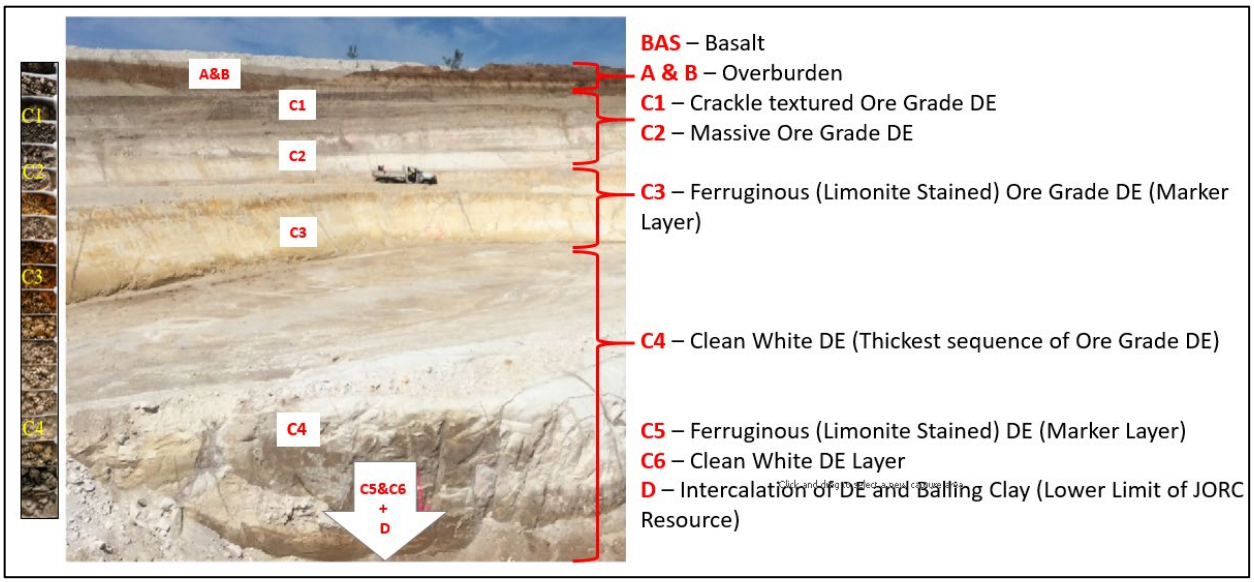


Figure 10 Lithology of the Gilldale pit showing diatomaceous earth and clay.

The target ore zone has been characterised as an aquitard. The backfilled material will be largely within C6 ore zone (i.e. diatomaceous earth) at least 2 metres from the ore zone floor. It is not expected that there will be vertical infiltration through the backfilled material into the underlying basalt aquifer but will behave consistent with the other surrounding basaltic overburden material.

It is highly unlikely that the backfilled pit will affect groundwater chemistry or supply to the immediate surrounding area. As the backfill material is made up of existing locally occurring basaltic overburden, groundwater intrusion is expected to have the same effect as what is currently occurring on the surrounding countryside.

The diatomaceous earth layer that may become saturated by recharge events is not considered to represent a significant aquifer unit and unlikely to permit further vertical infiltration of groundwater. It is considered that the mining operation will not change the chemistry of the groundwater due to the low permeability and neutral nature of the diatomaceous earth. The mining activity does not appear likely to intersect the local, primary groundwater host.

Figure 11 shows the nearest groundwater dependent ecosystem (GDE) of record at 7.45km west of the pit extent with an elevation of 521m. The pit development and rehabilitation will not have an effect on this location due to the aquifer divides that occur between the pits and this location. Adjacent landholder bores for agricultural supply are more likely to have effect on the mapped GDE area.

Model of post-rehabilitation ponding shows that it is not likely to have surface water accumulating on the backfilled pit area (refer Figure 12).

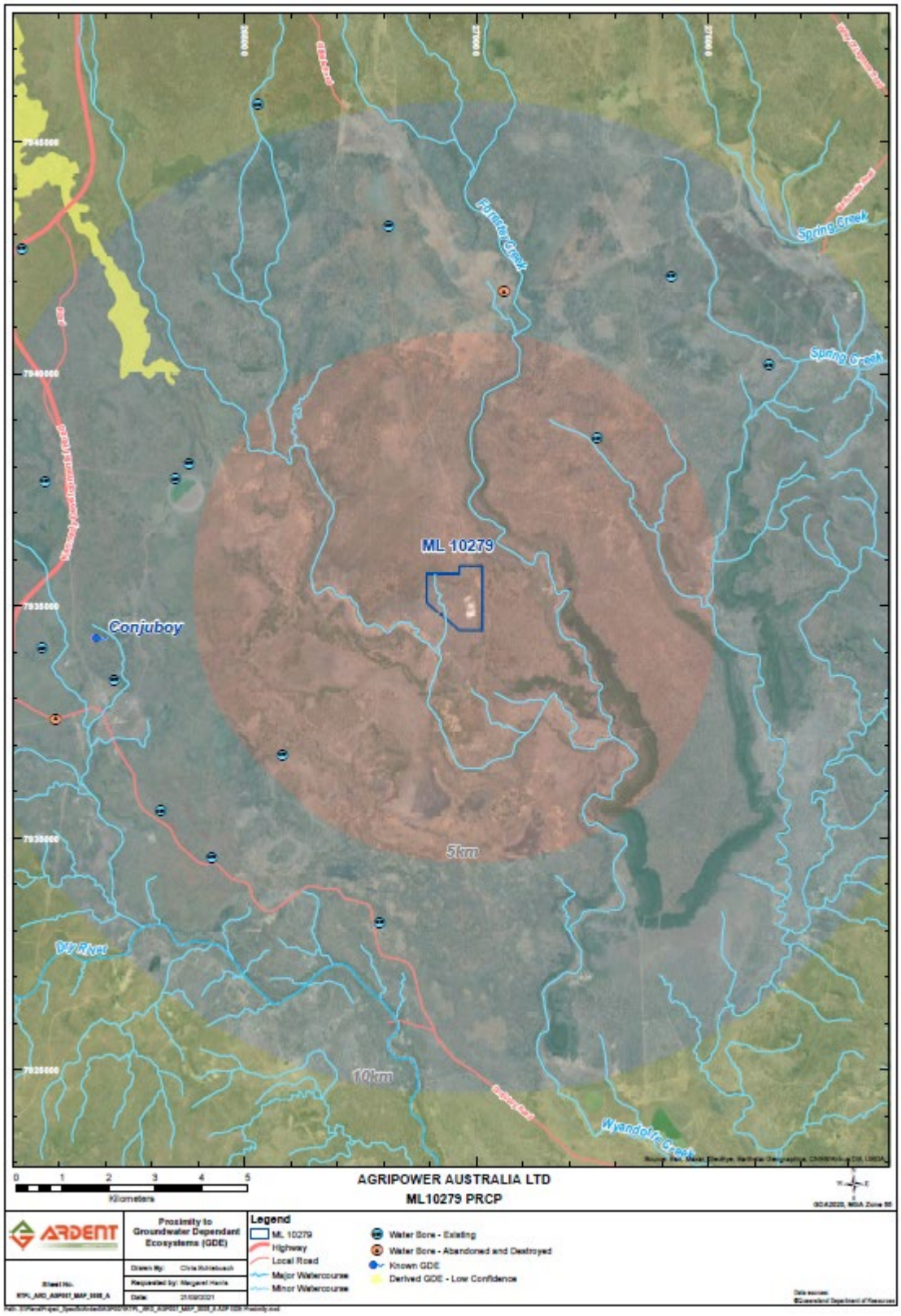


Figure 11 Groundwater Dependent Ecosystem proximity to ML10279

5.1.2 Flooding implications

Wyandotte Creek stream gauging station (120117A) historical data suggests that in most years the summer flow peaks range from 10,000 to 25,000ML and it is expected that these flows would not inundate the site. However, extreme monthly flows in excess of 50,000 ML may inundate the site.

Appendix 2 contains the excerpts of the original EMOS relating to these data regarding flooding. The records of NRME stream discharge for Wyandotte Creek show 1981 as the only year during its operation to approach the stream volume mentioned in the EMOS. The rainfall events of that period were less than 1% AEP, however a model of the 1% AEP at the ML shows that inundation would not impinge the current or proposed pit extent.

The current Flood hazard area – Level 1 - Queensland floodplain assessment overlay extends into the southwestern border of ML10279 area. No disturbances are planned for that area. Flooding is not expected to have impact on rehabilitation success.

The final landform design drainage analysis for Pit Group areas in 3D Dig shows that the backfilled pits will be free draining in the landscape as shown in Figure 12 below.

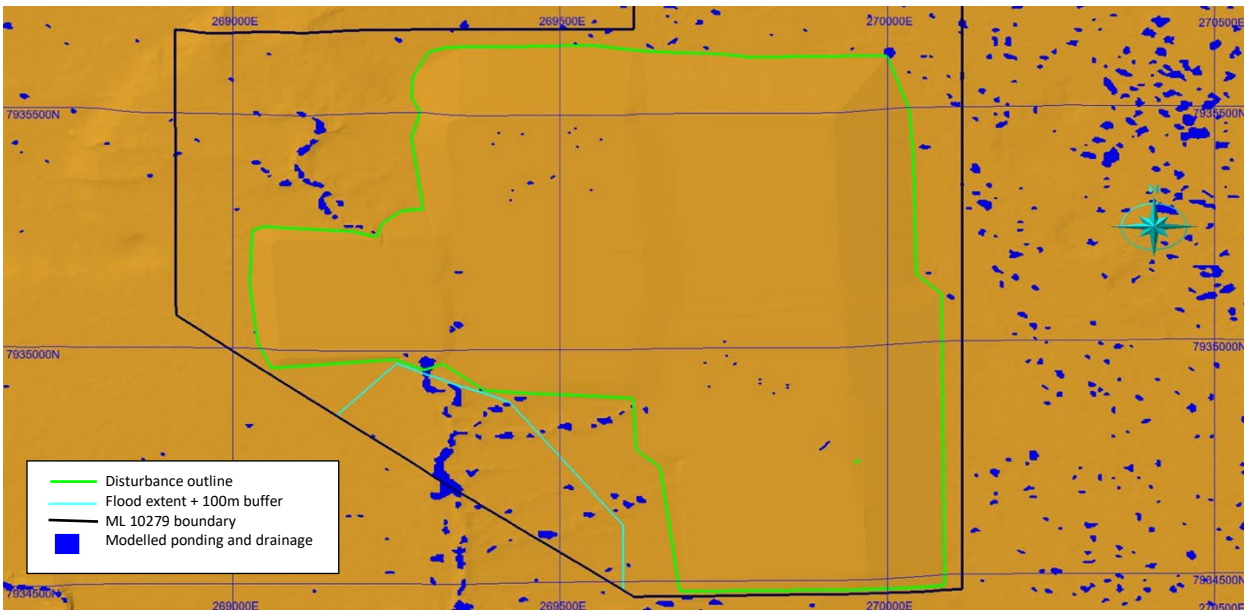


Figure 12: Drainage and ponding of final landform footprint

Note: Natural ponding in areas not disturbed (Black – ML10279 boundary, Green – Modelled Area of total known disturbance (life of mine), Blue – Ponding and drainage)

Following a revision of the maximum mine disturbance areas at any one time, the proposed mine footprint remains wholly within the area modelled in Appendix 5 and the outcomes are reasonable to rely on for this PRCP. Figure 13 shows the proposed footprint within the modelled extent.

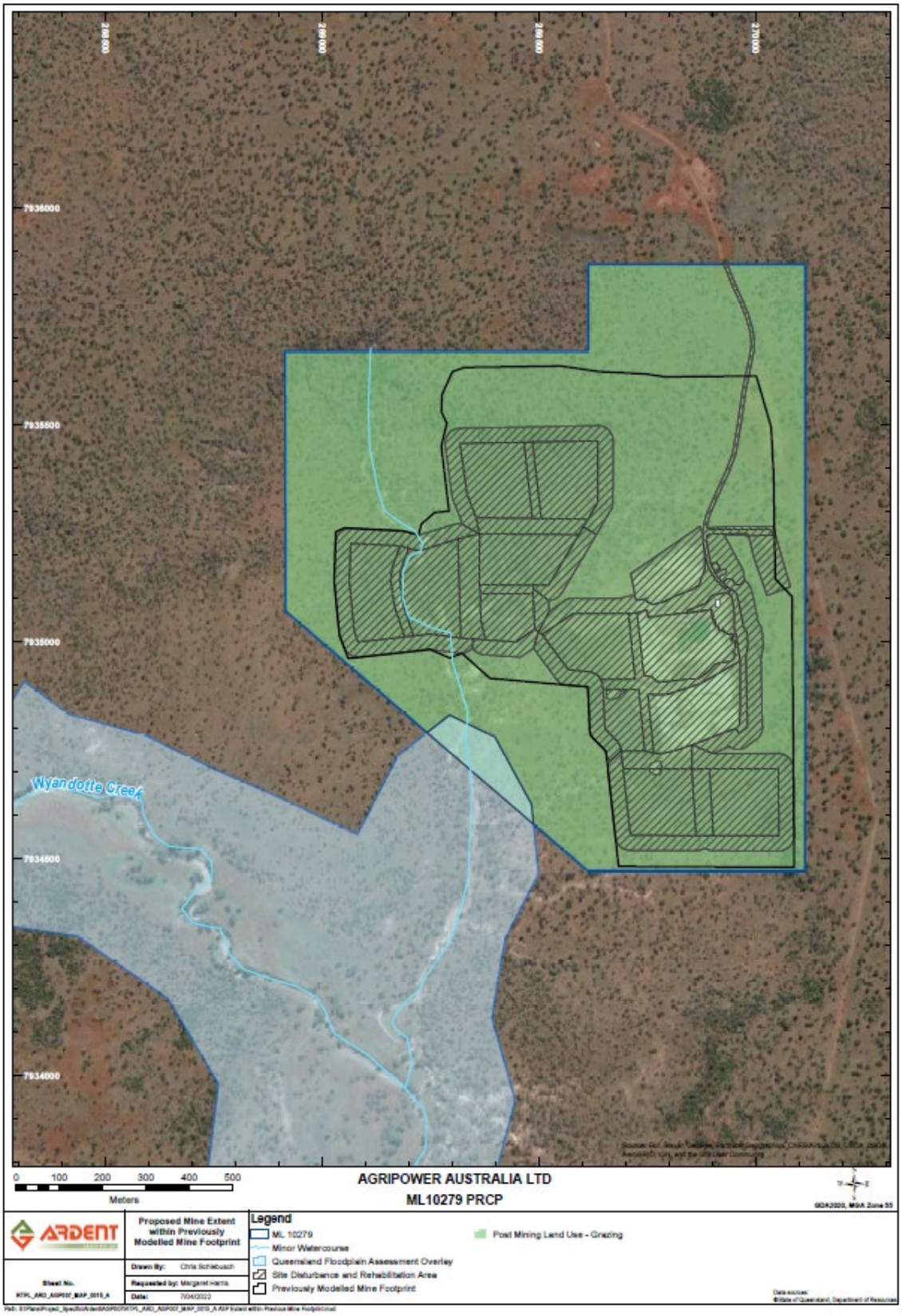


Figure 13: Proposed mine extent within previously modelled mine footprint

5.1.3 Soil use implications

The soil assessment (Appendix 3) identified that some soils identified "have physical or chemical limitations in the subsoils (B1 and D1) and it will be necessary to ensure that this subsoil does not become mixed with topsoil during stripping operations". The impact of mixed topsoil/subsoil will render the rehabilitation media less productive and a potentially unstable surface treatment. As a result, overburden and topsoil are stockpiled separately on site.

The identified soils within the Mine Activity Area disturbed by excavation pits are predominantly D1 and B1. A2 materials will be used directly to backfill as it is unsuitable for surface rehabilitation media. The limited extent of E1 and A1 soils have not been used to calculate topsoil yield. The following information pertaining to these soils' suitability for rehabilitation and estimated quantity.

Mapping Unit A2 – Red Ferrosol

- Unsuitable for rehabilitation due to basalt cobbles and boulders (60-90%)
- Encountered in road access and easternmost extent of Pit Group 1, northern extent of Pit Group 5 and stockpile areas.

Mapping Unit B1 – Black Earth

- Topsoil depth 30cm to be salvaged for rehabilitation works.
- 0-30cm Exchangeable Sodium Percentage (ESP) range 1-2% on acidic to neutral soil would not indicate application of gypsum.
- Moderate Cation Exchange Capacity (CEC)
- Overlays sodic soils from 30-100cm. Overburden to be stored separately from salvage topsoil to avoid mixing.

Mapping Unit D1 – Red Vertosol

- Topsoil depth 30cm to be salvaged for rehabilitation works.
- 0-30cm ESP range 1-5% on acidic to neutral soil would not indicate application of gypsum for use at surface.
- Moderate CEC
- Overlays sodic subsoils from 30-100cm. Overburden to be stored separately from salvage topsoil to avoid mixing.

The assessment identifies suitable resources that can be salvaged and recommends stripping depths for each soil unit but does not instruct separation of the units, only exclusive stockpiling of subsoils. The instructed restoration is the reinstatement of the soil profile when backfilling the excavation in the order it was removed overburden, then subsoils and finally topsoil.

The only specific instruction on "capping" is in the instance of exposure of exposed sodic soils, that they should be covered with salvaged surface soil and revegetated. An erosion and sediment control plan should be progressively implemented throughout mine life. The B1 and D1 subsoils show ESP results of up to 9% which would require amelioration if exposed on the final landform profile. Rates of application would be implemented as per Table 13.

The out of pit storage of overburden which includes potentially sodic material (in the 30cm-1m interval of B1 and D1 soils) is only a factor in the early stages of development (i.e. Pit Group 1). As the backfilling program progresses at the rate of pit development, overburden, including potentially sodic material will be returned to pit for reprofiling. The highest ESP for sub soils was 17.9% which was at a single location. This falls in the light to moderate range of sodicity hazard (Food and Agriculture Organisation, 1988).

The LongPaddock subsoil dispersibility report (included in Appendix 3 of the PRCP) for the location that includes the ML area is mapped as non-dispersive. The proposed management of encountered sodic subsoils is separate stockpiling from topsoil, deep placement within backfilled pit areas and if present, treatment with gypsum prior to the application of topsoil.

The operational volume of topsoil stockpiled in 2017 was 7,250BCM which would be sufficient to apply 15cm to the first 4.8ha of disturbance. Subsequent topsoil harvesting from mine expansion will yield estimated volumes in Table 9. No topsoil replacement depth was recommended in the assessment, but the project has adopted 15cm for the purposes of rehabilitation planning.

Table 9 Topsoil yield by soil type for disturbance footprint

Class	AREA (ha)	AREA (m2)	Depth of soil type (m)	Yield (m3)
A1	1.04	10,365	0.10	1,036.5
A2	10.04	100,419	0.10	10,041.9
C1	0.38	3,773	0.15	565.95
D1	18.8	188,026	0.30	56,407.8
E1	2.89	28,917	0	0
B1	20.24	202,406	0.3	60,721.8
All soil total				**128,774**

When the yield total is compared with the topsoil requirement to achieve a minimum 15cm cover over all disturbances (Table 9 of the PRC Planning Part), this exceeds the demand.

Details of the required volume of topsoil to prepare site disturbances for revegetation area presented in Table 10.

Table 10 Topsoil required for site surface disturbance

Site	Area (ha)	Area (m2)	Thickness (m)	Volume (m3)
Footprint excl roads, area between current & new stockpiles	31.5	314,574.01	0.15	47,186
Area between stockpile footprints	21.5	214,493.62	0.15	32,174
Total	53			**79,360**

Sequence of soil preparation and how it is achieved

1. Topsoil to be stripped over surface and stockpiled separately from subsoil storage.
2. Stored topsoil to be kept to a minimum height (<2m)
3. Stored free from traffic and erosive agents.
4. Stockpile to be sown with cover grass seed from revegetation mix and maintained weed free until use in backfilling and surface revegetation.
   - Topsoil stockpiles should be used in order of creation, that is oldest stockpiles should be used first.
   - Initial pit areas to be removed to stockpile area (Figure 14 reproduced Figure 4 from current Plan of Operations) to be used in backfilling sequence.
   - Later topsoil yield can be applied directly to backfilled pit areas and sown with revegetation mix directly.
   - A minor stockpile to be maintained from final pit (Pit 5) to use in that pit's backfilling and surface revegetation.

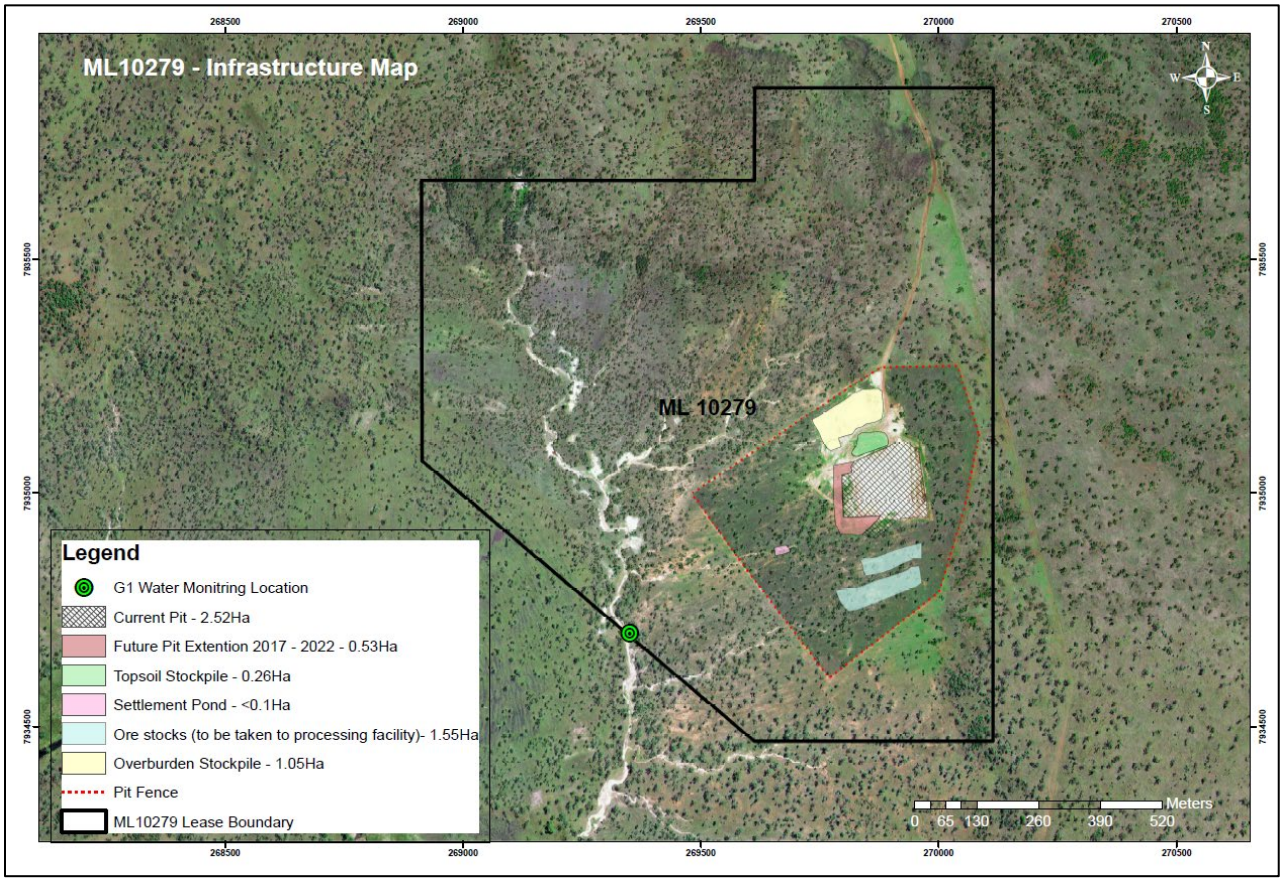


Figure 14 Topsoil and Overburden stockpiles from initial pit development (Plan of Operations)

Subsequent management techniques to achieve a stable condition

Sodic subsoils may be encountered in any of the five pits based on soil survey results. Application of gypsum prior to spreading of topsoil will be assessed via either a field assessment method for dispersion (Sugar Research Australia, n.d.) or by laboratory analysis to confirm effective application rate.

Upslope diversions that have been installed for operational activities will remain in place following backfilling to reduce risk of erosion on newly established surfaces.

Slopes will be contour ripped following topsoil application and prior revegetation seeding.

Sediment controls will be applied on slopes at intervals of 30-60m depending on final grade of backfilled pit area while vegetation cover is establishing.

Sediment controls may be reinstalled following any slow establishment or reseeding if indicated at the 12-month post-seeding.

No specific fertiliser treatment has been recommended for the establishment of native pasture (See section 5.1.8 on revegetation), however yields may be improved for *Themeda* and *Astrebla sp.* and with low nitrogen fertiliser applications of 50kg/ha if cover development performance is poor. Success of revegetation species strike rate will depend on weed-free rehabilitation media and N soil levels.

Pre-mining erosion rates were reported as 0.5t/year for the Wyandotte Creek area (See section 1.1.7 and Appendix 3).

5.1.4 Waste Characterisation and implication

The nature of diatomite within the reserve for extraction is understood to have no acid generating potential. The chemical nature of the diatomaceous earth is constant across the entire exploration target and mine development area. The basin containing the diatomite deposit has a shallow consistent base and does not have any/many ridges or high spots in it. The diatomite basin is cut by both Wyandotte and Spring Creek's and these paleochannels have eroded the lacustrine diatomite from some areas of the resource. However, no major erosion of the lacustrine diatomite layers occurs near ML10279 and the target area.

There are no intrusions or "waste" material replacing the diatomite under the basalt cover in ML10279 and near the target area.

Confirmation sampling of the basalt materials, diatomite from target ore zones and overburden material was undertaken to verify this understanding of the target area. The full results of acid generation analysis and water leachable metals are presented in Appendix 4.

All materials sampled have a negative acid production potential and net acid generation rate of <0.1kg H_2SO_4/t. The water leachable metals for all materials are lower than the receiving water quality standards set for the site in Schedule C – Table 2 Receiving water contaminant limits.

In light of these results no specific waste (overburden or exposed ore) treatment is proposed in the rehabilitation design.

No placement restrictions arise from the chemical character of the waste material. The placement order (reverse of extraction) is sufficient to support the reinstatement of the backfilled landform.

5.1.5 Landform design and implication

The final landform design has been informed by the long term mine plan development model. Copies of stepwise development for Pit Group Areas are included in Appendix 5. The principles applied to the final landform include:

- the backfilling of excavated voids using the overburden materials from active mining areas so as to minimise the total disturbed area at any one time and reduce total materials handling throughout operations.
- Creation of a water shedding surface on the backfilled void.
- Creation of landform slopes that allow the return of land to PMLU of low intensity grazing.
- Backfilled void slopes integrated with the pre-disturbance mine contours.

The contours of the pre-mining landscape include a step down to the resource location which determines the grade direction for the post-mining landform design.

Based on the engineered design, the slope lengths for backfilled pits over a >300m area are less than 5 degrees.

Slopes will include contour berms at 45 to 60 m intervals respectively to reduce erosion potential. Contour berms will be within the design length of 1500m as per Soil Conservation Guideline for Queensland (Department of Science, Information Technology and Innovation, 2015) to reduce risk of failure.

Batter slopes that integrate the backfilled pit with natural contours will be constructed as each pit group is completed. Slopes of not more than 10m height of 18° will be installed.

Stability risks

The primary risks associated with the slope length relate to the early establishment of vegetation and erosion rates. By reducing the velocity of water on the bare slopes using contour banks and placed sediment controls, the chance of improved vegetative cover is increased. A grassed drain will be installed to divert runoff from eroding the reprofiled landform before the revegetation milestones can be achieved. The drain will need to maintain function for at least 4 years until the rehabilitated landform reaches the vegetation cover milestones. The drain will discharge via level spreader onto adjacent undisturbed land within the ML.

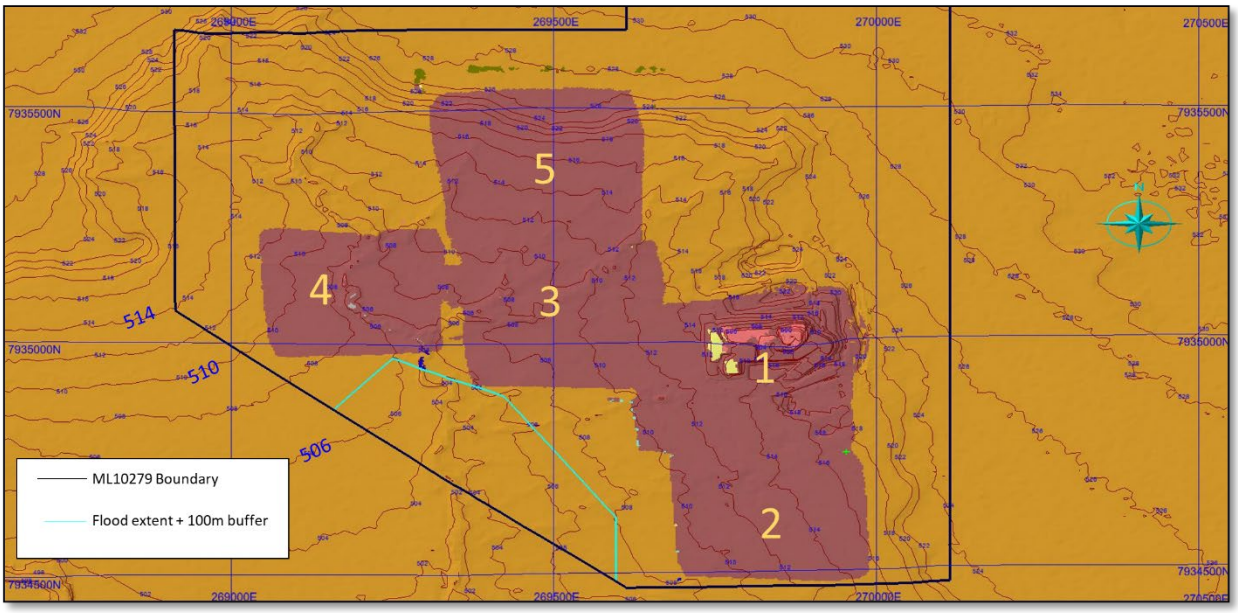


Figure 15 Modelled Pit Group footprint overlay on pre-mining contours

The sequence of mining (Pit Group 1 to Pit Group 5) in a stepwise manner to allow for the surface placement of ore and waste until the receiving void is safe to receive wastes directly. The waste of Pit 1A will be stockpiled to the north of the excavation in a balance stockpile. Pit 1B waste returned to Pit 1A will be placed to uniform depth with initial campaign wastes following. Commencement of Pit 1C will initiate backfilling of Pit 1B. The surface stockpile of waste will be exhausted by this stage and direct placement of waste to Pit 1C and Pit 1D will commence at the initiation of Pit 2A and so forth. At the completion of a Pit Group (consisting of up to 4 smaller pits in one group), the adjoining pit wall will be dozed to create a continuous contour landscape. Backfilled material integrity is expected to be enhanced by the retention of internal wall divisions between pit developments.

Table 11 Modelled mine waste volumes by Pit Group Area placed into backfill

Volume ('000 m³)	Pit 1	Pit 2	Pit 3	Pit 4	Pit 5	Stockpile Volume	Extra for Rehab	Totals
Dumped Trucked Volume	616	268	229	245	793	0	451	2,604
Dumped Dozed Volume	481	93	0	45	643	0	0	1,263
Stockpile Rehandle	0	0	0	0	0	650	0	650
Loose Volume into Backfill	1,097	361	229	290	1,437	650	451	4,519

Scope and assessment criteria of geotechnical assessment

The scope of assessment for a geotechnical engineer is to prepare a geotechnical assessment of the final slope status, geometry (<10°), condition and engineering characteristics, such as material strength, assessment of failure mechanisms and acceptability of failure based on consequence and probability, factor of safety over the life of slope.

The final landform design basis for the Pit Group footprint meets the design criteria of slopes of <10 degrees for backfilled materials and water-shedding (non-ponding) landform. The cross-sections below illustrate the slope and drainage analysis of the design meeting the criteria. The cross-section images include the pre-mine profile, void exhaustion profile and backfilled and reprofiled lines through Pit Groups 1, 3 and 4, Pit Groups 3 and 5 in Appendix 5.

5.1.6 Cover Design

There are no processing or mine waste generated requiring a capping cover on ML10279. Sodic soil management is described in section 5.1.3 above.

5.1.7 Water Management

Environmental values (EVs) reflect the uses and values of water. EVs for Burdekin Basin waters have been identified and most fresh waters in the Burdekin River Basin include EVs for stock watering, farm supply, recreation, aquatic ecosystems and cultural and spiritual values. Draft Water Quality Objectives (WQOs) have been prepared for review and consultation for the Burdekin Basin (DSITI, 2017).

The application process for ML 10279 identified the downstream water uses as the environmental values and included receiving water quality standards under which the mine has operated. Table 12 below includes the criteria for Schedule C – Table 2 of the EA are considered to set the closure standard in the absence of published WQOs for the Burdekin River Basin – Upper Burdekin River sub-catchment waters. The baseline assessment for Water is included as Appendix 6.

Table 12 Surface Water Quality standards

Parameter	Units	Limit Type	Contaminant Limits (EA)
Total dissolved solids	mg/L	Maximum	4000
pH	pH units	Acceptable range	6.5-9.0
Turbidity	mg/L	Maximum	10% seasonal mean
Sulphate	mg/L	Maximum	1000
Fluoride	mg/L	Maximum	2
Cadmium	mg/L	Maximum	0.01
Mercury	mg/L	Maximum	0.002
Arsenic	mg/L	Maximum	0.5
Copper	mg/L	Maximum	1
Chromium	mg/L	Maximum	1.0
Lead	mg/L	Maximum	0.1
Nickel	mg/L	Maximum	1.0
Zinc	mg/L	Maximum	20

The closure design has no watercourse diversions or long-term management requirements, infiltration or seepage interventions, dewatering requirements or on-going water management and reduction or treatment requirements.

Catchment management targets include minimum 70% late dry season groundcover on grazing land (NQ Dry Tropics, 2016).

5.1.8 Revegetation Plan

The aim of the revegetation plan is to achieve a stable, self-sustaining groundcover of native pasture species, free from weeds and invasive introduced grasses in a density and richness consistent with the surrounding landholding.

The species mix is targeted to achieve groundcover at percentages which can conserve soil stability and species density and richness of the surrounding land and be exclusive of the noxious weeds of the region to meet the landholder's expectation of resumption of a grazing land use over the ML area.

Appendix 7 includes the baseline flora and fauna survey reports and some information relating to the successful treatment and timing of revegetation of native pasture species recommended by DPI. The pre-disturbance surveys conducted in 2002 identified the following regional ecosystems in the area of the ML RE. 9.3.2 and RE9.8.1. Limited areas of RE 9.3.10 were identified but only associated with watercourse margins, which are not being disturbed by the activity.

The key flora species for the disturbed area revegetation are a mix including:
Native pasture species mix:

a. *Heteropogon contortus*
b. *Heteropogon triticeus*
c. *Themeda triandra*
d. *Grewia retusifolia*

At an initial seeding rate of not less than 3kg/hectare/species for which fertiliser application to promote growth will be established in revegetation trials.

As per the landholder requirements, the following native pasture species will also be included in the reseeding mix:

- *Astrebla sp* (Mitchell grass)
- *Dichanthium sericium* (Queensland bluegrass)

at an initial seeding rate of 1kg/hectare/species (Scattini, 2008) and (Phelps, 2008) which are expected to improve strike rate by the inclusion of low N fertiliser.

Native tree and shrub mix including:

a. *Petalostigma pubescens*
b. *Ficus opposita*
c. *Diospyos geminata*
d. *Hakea arboescens*
e. *Brachychiton diversifolius*
f. *Corymbia erythophloia*
g. *Corymbia dallachiana*
h. *Eucalyptus leptophleba*
i. *Eucalytpus crebra*

At an initial seeding rate of not less than 200g/hectare/species which do not require fertiliser to establish growth.

The strike rate of the native pasture seed mixes will be subject to trials on the initial landform area to determine if proportions, success and survival are achieved over successive years (See section 6.3.1.3).

Any areas within the landform that accumulates water, may also include:

a. *Carissa ovata,*
b. *Capparis umbonata*
c. *Indigofera linnea*
d. *Lomandra multiflora*
e. *Melaluca braceata*

The preference is that native species seeds are collected from the site itself or adjacent landholdings. It may be desirable to apply low nitrogen fertilizer (50kg/ha) on pastures targeted for seed harvesting as it may increase seed head yield.

Weed control measures will be essential to manage the successful establishment of native grazing pasture and has been identified as a protection of habitat integrity in the baseline fauna assessment.

The weeds of concern include:

a. Parthenium weed
b. Noogoora burr
c. Prickly acacia
d. American rat's tail grass
e. Giant Paramatta grass
f. Lantana

The landholder had specific requirements for the exclusion of Indian cooch (*Bothriochloa pertusa*) from the rehabilitation area.

Revegetation seeding timing for the native pastures are to be planned for Autumn when temperatures and soil moisture are ideal.

Establishment of 75-85% groundcover on <10° slope is considered sustainable for the soil type and post-mining land use of grazing according to (NSWDPI, 2005) and consistent with the timeseries LongPaddock Forage Report for Lot 200 on SP232790 in Appendix 3.

Fencing that is operationally installed for the protection of livestock is to be retained for 4 years after the final seeding and growth on disturbed areas to allow for resilience in the pasture before cattle are admitted, as per the landholder's request.

Topsoil sourced from the site stripped prior to disturbance is the proposed rehabilitation media. The recommended topsoil stripping rates for rehabilitation is commonly 10cm and up to 30cm depending upon soil group. A topdressing depth of 15cm uniformly across the backfilled excavation profile will allow for contour ripping and surface establishment of groundcover species.

The final landform design with a moderate slope (between 5-11°) on moderate to high erodibility soils (loams and self-mulching black earths) would need to maintain 75- 85% groundcover to sustain a soil loss of <2t/ha/yr under a use of grazing (NSWDPI, 2005). Establishment of at least 90% groundcover on 18° slope (ie steep as described by (Emery, 1986)) is considered sustainable for the soil type and post-mining land use of grazing according to (NSWDPI, 2005).

Where sodic soil exposure at surface is identified, gypsum application will be included in the surface treatment, prior to revegetation. Following an Exchangeable Sodium Percentage assessment, gypsum will be applied at the rates as follows:

Table 13 A guide to the rate of gypsum application required according to the degree of dispersion (sodicity), exchangeable sodium percentage and pH of the soil

Dispersive behaviour or sodicity rating	Exchangeable sodium percentage (ESP %)	Gypsum application rate on neutral to acid soils (t/ha)	Gypsum application rate on alkaline soils (t/ha)
Slight	6–10	0–1.5	1.0–2.5
Moderate	10–15	2.5	5.0
Severe	>15	5.0	5.03

Source: https://www.agric.wa.gov.au/dispersive-and-sodic-soils/managing-dispersive-sodic-soils

Reference sites for revegetation assessments

Location of reference sites considered to be representative of the ML disturbance areas but within the ML perimeter are located as follows:

- Site characteristics considered representative of the 133ha ML area based on vegetation cover, slope, soil characteristics. RE is largely uniform across the site and land use outcome is grazing and not RE dependent.

  Analogue site 1: Soil group B1
  Analogue site 2: Soil group D1

Data to be collected from each analogue site:
Soil:
- Slope;
- topsoil depth;
- subsoil sodicity;
- erosion estimate (rill count and volume estimation).

Vegetation:
- species count;
- cover percentage;
- form distribution (groundcover/mid-storey/canopy);
- weed percentage;
- habitat features.

Vegetation transects

Vegetation transects will consist of a modified BioCondition survey using fixed 100 m x 50 m vegetation transects will be established and monitored throughout the Project Area with the following information recorded in regards to vegetation structure:

- RE;
- Canopy species and relative abundance;
- Canopy minimum, maximum and average height;
- Crown cover;
- Shrub species and relative abundance;
- Shrub average height;
- Shrub canopy cover;
- Weed cover;
- Ground cover;
- Ground layer species and individual percentage cover;
- Percentage cover of bare ground and organic material.

5.1.9 Tailings Storage Facilities

This project has no tailings storage facilities.

5.1.10 Voids

All voids will be backfilled with native materials from the mining activity. Final landform profiles are described in Section 5.1.5. The voids are located above the floodplain and have been designed to be free draining surfaces.

The revegetation of backfilled surfaces using native pastures are expected to achieve stability at the cover identified in the revegetation plan (Section 5.1.8) and for the final landform maximum slope of 10°.

5.2 MILESTONES TO BE TRANSITIONED

Significant events or steps required to achieve PMLU from the EA include the receiving water contaminant limits presented in Schedule C – Table 2 to be adopted as milestone criteria. The location for assessment should include that identified in Schedule C - Table 1 of EPML00392513 (page 6).

5.3 MILESTONES TO BE DEVELOPED

5.3.1 General rehabilitation milestones applicable to any disturbance areas

The following milestones are applicable to any of the disturbance areas and are enumerated in sequence of application and expected achievement.

Table 14 Rehabilitation Milestones

Milestone Reference	Rehabilitation Milestone	Milestone Criteria
RM1	Removal of infrastructure and storage vessels	a) All buildings demolished and removed
RM2	Landform reprofiling and trim complete	a) Surface contours reinstated and integrated with adjacent undisturbed land with maximum slope of 18° for batter slopes of 35m to a maximum height of 10m. b) Light ripping to improve infiltration c) Surface drainage does not concentrate flow d) Sediment controls installed
RM3	Surface treatment	a) Soil used from topsoil stockpiled for use as rehabilitation media and is weed-free prior to use and assess N level in stored soil. b) Topsoil applied over whole footprint area to thickness of not less than 15cm. c) Ameliorants and fertilizer applied according to recommendations arising from rehabilitation trials.
RM4	Revegetation (native pasture grazing)	a) Seeding of native pasture species mix including: *a. Heteropogon contortus* *b. Heteropogon triticeus* *c. Themeda triandra* *d. Grewia retusifolia* At a rate of not less than 3kg/hectare/species. Landholder species of: e. *Astrebla sp* (Mitchell grass) f. *Dichanthium sericium* (Queensland bluegrass) At an initial seeding rate of 1kg/hectare/species b) Seeding native tree and shrub mix including: *a. Petalostigma pubescens* *b. Ficus opposite* *c. Diospyos geminate* *d. Hakea arboescens* *e. Brachychiton diversifolius* *f. Corymbia erythophloia* *g. Corymbia dallachiana* *h. Eucalyptus leptophleba* *i. Eucalytpus crebra* At a rate of not less than 200g/hectare/species. c) Achieve groundcover projective foliage cover of >75% of analogue site for successive years (excluded from grazing). d) Strike rate of native grass seeding to be recorded.

Milestone Reference	Rehabilitation Milestone	Milestone Criteria
RM5	Achievement of surface requirements	a) Achieve native species dominance for groundcover of >75% similarity of analogue site for successive years on slopes of 10° or less. b) Achieve native species dominance for groundcover of >90% similarity of analogue site for successive years on batter slopes of 18°. c) Assessment of weed contribution to total groundcover to be <10%. d) No active rill or gully development across reinstated surface.
RM6	Achievement of post-mining land use to stable condition for grazing	a) Certification from a suitably qualified person that the area has achieved stable condition. b) Surface stability to be less than 0.5t/ha/annum loss through erosion. c) Groundcover has achieved >75% of analogue site for slopes of 10° and >90% for slopes between 10-18°. d) Surface water quality sampled (DES, 2017) from the area complies with the following: a. Total dissolved solids <4000 mg/L b. pH between 6.5-9.0 c. Turbidity (mg/L) +10% of seasonal mean d. Fluoride <2 mg/L e. Cadmium <0.01 mg/L f. Mercury <0.002 mg/L g. Arsenic <0.5 mg/L h. Copper <1 mg/L i. Chromium <1 mg/L j. Lead <0.1 mg/L k. Nickel <1 mg/L l. Zinc <20 mg/L e) A contaminated land survey carried out by an appropriately qualified person indicates that no contamination unsuitable for the PMLU is occurring. f) Certification of no weed and pest species abundance identified in the rehabilitated areas are no greater than at reference sites by a suitably qualified person.

5.3.2 Relevant Activity Specific Milestones

5.3.2.1 Roads, tracks and park up areas

Milestone Reference	Rehabilitation Milestone	Milestone Criteria
RM7	Surface preparation of road	a) Deep rip along recontoured surface b) Surface suitable for native grass re-establishment without topsoil placement (based on trial outcomes)

5.3.2.2 Overburden and waste dumps and Ore stockpile/drying pad

Milestone Reference	Rehabilitation Milestone	Milestone Criteria
RM8	Removal of stored materials	a) Waste/overburden/ore removed from footprint area to pit
RM9	Achievement of surface requirements	a) Certification by a suitably qualified person that no sodic materials have been exposed nor remain at surface (if excavated) or have been treated with gypsum application.

5.3.2.3 Water management structure

Milestone Reference	Rehabilitation Milestone	Milestone Criteria
RM10	Removal of retaining structure	a) Drainage of water stored. b) Drying of sediments therein c) Removal of retaining wall and sediments to pit

5.3.2.4 Open pits

Milestone Reference	Rehabilitation Milestone	Milestone Criteria
RM11	Backfill of pits	a) Backfilling of ore/ waste/overburden to pit. b) All major earthworks within pit footprint complete. c) Batter slopes meet final design specifications. d) Installation of contour berms on backfilled landform. e) Installation of upslope drainage for pit perimeter areas to provide erosion protection on slopes prior to vegetation cover criteria met.
RM12	Achievement of post-mining land use to stable condition for grazing	a) Backfilled pits assessed as geotechnically stable by a suitably qualified geotechnical engineer so that no slumping is observed or expected in placed material.

Milestone Reference	Rehabilitation Milestone	Milestone Criteria
		b) Stability assessment includes final slope status and geometry (<10° for backfilled pits and <18° for batter slopes), condition and engineering characteristics and assessment of failure mechanisms. c) Final landform slope lengths and angles consistent with landform design criteria.

6 RISK ASSESSMENT

AS ISO 31000:2018 *Risk Management – Guidelines* (Standards Australia, 2018) describes risk assessment as the overall process of risk identification, risk analysis, risk evaluation and risk treatment. Each of these aspects must be included in the risk assessment in the rehabilitation planning part.

6.1 Identification, Risk Assessment and Management of Closure Issues

The systematic identification and management of mine closure risks is part of the overall site risk management process.

The purpose of this section is to undertake a high-level risk assessment which identifies the potential risks associated with the period following rehabilitation and mine closure. The scope covers risks to the successful achievement of PMLU - Grazing. Potential health and safety hazards that may affect site workers were not assessed as part of this risk assessment process as generally there are no site workers following mine closure.

A risk assessment has been undertaken in accordance with the principles outlined in ISO31000:2018 taking into account the areas of impact, events and their causes and potential consequences for the period following mine closure. An assessment of likelihood and consequence of associated risks have been made based to determine unmitigated risk. Definitions of likelihood and consequence of the risk are shown in Table 15 and Table 16. Table 17 demonstrates how the overall risk level is determined. Proposed mitigation measures are specified. The residual risk based on effective and ongoing implementation of the mitigation measures was then determined.

Table 15: Likelihood Definition

Likelihood	Definition
Almost Certain; >90%; (5)	Greater than 90% likelihood of occurring. Has happened, will probably happen during the mine life and there is no reason to suspect it won't happen in the post-closure period.
Likely; 30% - 90%; (4)	Likelihood of occurring is equal to or more than 30% and less than 90%. This consequence is not uncommon in the mining industry/local area
Possible 10-29%; (3)	Likelihood of occurring is equal to or more than 10% and less than 30%. There is a possibility of this risk occurring as it has occurred before (albeit infrequently) in the mining industry/local area
Unlikely; 3% - 9% (2)	Likelihood of occurring is more than or equal to 3% and less than 10%. There are no specific circumstances to suggest this could happen.
Improbable; <3%; (1)	Likelihood of occurring is less than 3%. It would require a substantial change in circumstances to create an environment for this to occur, and even then, this is a rare occurrence.

Table 16: Consequence Definition

Consequence Type	Insignificant (1)	Minor (2)	Moderate (3)	High (4)	Major (5)
PMLU not being achieved	Lasting days or less; affecting small area (metres); groundcover affected with no loss of stability.	Lasting weeks; affecting limited area (tens of metres); groundcover affected on rehabilitated surfaces only and/or land slip of rehabilitated surface/profile or one incident of surface water quality deterioration.	Lasting months; affecting extended area (hundreds of metres); groundcover affected within Mine Activity Area only and/or erosion or slumping of rehabilitated surface/profile or successive incidents of surface water quality deterioration.	Lasting years; affecting area on ML area beyond the Mine Activity Area and undisturbed land; landform failure requiring remobilisation of rehabilitation efforts. Off lease impacts potential to cause environmental harm.	Permanent impact; affecting area beyond ML area and landholder property, reducing productivity of affected land permanently.

Table 17: Risk Level Matrix

Likelihood	Consequence Scale				
	Insignificant (1)	Minor (2)	Moderate (3)	High (4)	Major (5)
Almost Certain; >90%; (5)	5 (Medium)	10 (Significant)	15 (Significant)	20 (High)	25 (High)
Likely; 30% - 90%; (4)	4 (Medium)	8 (Medium)	12 (Significant)	16 (High)	20 (High)
Possible 10-29%; (3)	3 (Low)	6 (Medium)	9 (Medium)	12 (Significant)	15 (Significant)
Unlikely; 3% - 9% (2)	2 (Low)	4 (Medium)	6 (Medium)	8 (Medium)	10 (Significant)
Improbable; <3%; (1)	1 (Low)	2 (Low)	3 (Low)	4 (Medium)	5 (Medium)

The risk assessment outcome, including proposed mitigation measures are shown in Table 18. The table is presented with each rehabilitation area (RA) identified separately where an event is unique to its circumstance or listed where an event may apply regardless of location.

Table 18: Risk Assessment of Mine Closure

C = Consequence L= Likelihood R = Risk

RISK TO PMLU OUTCOME			Unmitigated Risk			Residual Risk			
RA	Cause	Event	C	L	R	Mitigation	C	L	R
1/2/3/4/5/6	Weed invasion of rehabilitated areas	Groundcover of native pastures fails	3	4	12	• Complete weed eradication from topsoil stockpile prior to use. • Ensure fertilizer use is low release to allow native species to out compete weeds. • Keep weed hygiene measures in place for entire rehabilitation activity schedule. • Consider weed control on areas adjacent to the Mine Activity Area. • Selective weed eradication on revegetated areas based on weed type and control susceptibility.	2	3	6
	Extended drought event		3	3	9	• Exclude stock until establishment of regrowth. • Reseed area in the first available wet season following extended drought.	2	3	9
	Unrestricted livestock access prior to RM5 achievement		4	4	16	• Maintain Mine Activity Area fence until RM5 criteria are met.	2	2	4
	Native fauna access prior to RM5 achievement		4	3	12	• Maintain Mine Activity Area fence until RM5 criteria are met. • Install tree guards around base of immature tree/shrubs in critical areas (slopes and slope toes).	2	3	6
	Vehicle access prior to RM5 achievement		3	3	9	• Install safety bund to restrict access to backfilled pit. • Install ramp bund. • Maintain Mine Activity Area fence until RM5 criteria are met.	2	1	2
	Exposure of contaminated or sodic soil at surface		3	2	6	• Inspection by suitably qualified person of potentially contaminated or exposed areas prior to reshaping and confirmation post-shaping • Installation of runoff controls to limit the potential for erosive events.	2	2	4
	Low native pasture seed strike rate		3	3	9	• Implementing findings of revegetation trials for seed mix with best strike rate.	2	3	6

RISK TO PMLU OUTCOME			Unmitigated Risk			Residual Risk			
RA	Cause	Event	C	L	R	Mitigation	C	L	R
						• Monitoring of groundcover over successive years to commence remedial actions at the soonest possible season. • Reseed as required for improved strike rate. • Increase seeding of landholder preferred species of *Astrebla sp* and *Dichanthium sericium*.			
	Bushfire event alters surface cover		2	3	6	• Following a failed recovery season, reseed area with native pasture species mix. • Recommence groundcover monitoring assessment.	2	3	6
	Flooding event alters surface cover		3	2	6	• Following a failed recovery season, reseed area with native pasture species mix. • Recommence groundcover monitoring assessment.	3	2	6
	Unsuitable seed blend used for ground conditions (microrelief)		3	3	9	• Reseed area with either RE9.3.10 mix if inundation or persistent water accumulation or increase seeding of landholder preferred species of *Astrebla sp* and *Dichanthium sericium*.	2	3	6
9	Soil loss from topsoiled areas	Instability of regraded surface	3	3	9	• Installation of runoff controls to limit the potential for erosive events. • Confirmation of final profile <10° over backfilled and topsoiled areas. • Maintain Mine Activity Area fence until RM5 criteria are met.	2	2	4
	Slumping of placed materials on slope		3	3	9	• Confirmation of final profile <10° over backfilled and topsoiled areas. • Where placed material meets in situ materials key into slope and install water management to direct runoff to dedicated structures and away from placed materials.	2	2	4
	Water management installations fail		3	3	9	• Maintain water management installations throughout rehabilitation schedule and annually prior to each wet season. • Inspect status of installations following wet season.	2	2	4
	Stock access damages topsoiled areas		3	3	9	• Maintain Mine Activity Area fence until RM5 criteria are met.	2	1	2

RISK TO PMLU OUTCOME			Unmitigated Risk			Residual Risk			
RA	Cause	Event	C	L	R	Mitigation	C	L	R
2/3/6	Exposure of sodic materials in the profile	Reprofiled landform failure	3	2	6	• Inspection by suitably qualified person of potentially contaminated or exposed areas prior to reshaping and confirmation post-shaping • Installation of runoff controls to limit the potential for erosive events.	2	2	4
	Final landform design angle or slope length is not suitable for material used at time of rehabilitation		3	3	9	• Geotechnical assessment to confirm available material can be installed as stable and if not include benching to final profile to decrease slope angle and length.	2	2	4
	Groundwater intrusion weakens backfilled material geotechnical competency		2	2	4	• Pit hydrogeological assessment and closure model recommendations implemented	2	1	2
	Gully formation on rehabilitated surface changing site water dynamics		3	2	6	• Geotechnical assessment of pit wall stability • Implementation of recommendations of geotechnical assessment. • Installation of further water management controls to preserve rehabilitation.	2	2	4
1/6	Exposure of contaminated or sodic soil at surface	Water quality fails to meet criteria	3	2	6	• Contaminated land assessment prior to closure • Removal of sodic materials at surface for burial in pit • Monitoring of water quality downstream throughout rehabilitation and closure period	2	2	4
	Surface application of gypsum on rehabilitation area washes into watercourse altering pH		2	2	4	• Rip gypsum into surface prior to topsoiling and/or seeding. • Monitoring of water quality downstream throughout rehabilitation and closure period.	2	1	2
	Groundcover failure results in sediment laden runoff from rehabilitation area		3	3	9	• Implementing findings of revegetation trials for seed mix with best strike rate • Monitoring of groundcover over successive years. • Reseed as required for improved strike rate.	2	2	4

RISK TO PMLU OUTCOME			Unmitigated Risk			Residual Risk			
RA	Cause	Event	C	L	R	Mitigation	C	L	R
						• Install temporary sediment control fences.			
	Surface expression of groundwater at altered landform profile causes runoff to watercourse.		2	2	4	• Installation of temporary sediment control fences and seeding of location with RE9.3.10 species to increase water uptake and decrease runoff. • Monitoring of water quality downstream throughout rehabilitation and closure period.	2	1	2
1/2/3/4/5/6	Failure of successive years achievement of native pasture grass.	Rehabilitation not self-sustaining for grazing	3	3	9	• Monitoring trial locations and applying revised methodologies to final landform at scale.	2	2	4
	Failure to achieve water quality criteria over successive wet seasons		3	3	9	• Include upstream water quality sampling to provide a reasonable local alternative to the Schedule C Table 2 water quality limits.	3	1	3
	Failure to achieve groundcover rate within 5 years after seeding		3	3	9	• Increase seeding of landholder preferred species of *Astrebla sp* and *Dichanthium sericium*.	2	2	4
	Failure for successive years to achieve erosion loss limit of 0.5t/ha/annum		3	3	9	• Include analogue site assessment of erosion loss rates to provide a reasonable temporal alternative to the single point baseline assessment. • Reinspect sodic soil surface expression and apply ameliorant treatment.	3	2	6

The majority of the risks identified were rated as being associated with risks at medium level based on the unmitigated risk. The significant/high unmitigated risks identified within the scope of the risk assessment related to entry to the rehabilitation area by stock or native fauna and weed infestation. These risks were then reduced to low or medium once the mitigation measures were implemented.

It should be noted that the above risk assessment is high level. It should also be highlighted that the residual risk is based on the effective and ongoing implementation of the mitigation measures documented in Table 18.

6.2 Risk Treatment Plan

The bases for selection of the various risk treatments are recorded in Table 19 below. The risk mitigations are presented in approximate sequence of application for each cause. It is possible that early treatments may be sufficient for risk eradication and that the full range of options may not be necessary for the mitigative effect to be completed.

Table 19: Risk Treatment Selection

RISK TO PMLU OUTCOME		Treatment of Risk			
Cause	Mitigation	Selection rationale	Responsibility	Actions and Performance measures	Reporting/Monitoring/Timing
Groundcover of native pastures fails					
Weed invasion of rehabilitated areas	Complete weed eradication from topsoil stockpile prior to use.	timely application of control in rehabilitation schedule	Operations manager	Apply suitable herbicide to weed infested areas seasonally	Record weed status of stockpiled soils prior to re-spreading on regraded landforms
	Ensure fertilizer use is low release to allow native species to out compete weeds.	meets native species recommended outcome	Rehabilitation manager	Source suitable fertiliser for use throughout rehabilitation period	Record rate of use and weed emergence
	Apply weed hygiene measures for entire rehabilitation activity schedule.	protection of surrounding environment	Rehabilitation manager	Keep operational weed hygiene measures in place for entire rehabilitation activity schedule.	Record equipment and maintain hygiene records
	Consider weed control on areas adjacent to the Mine Activity Area.	cost-benefit in post-closure period	Operations manager	Engage in discussions with landholder about coordinated weed control measures	Implement prior to rehabilitation period completion

RISK TO PMLU OUTCOME		Treatment of Risk			
Cause	Mitigation	Selection rationale	Responsibility	Actions and Performance measures	Reporting/Monitoring/Timing
	Selective weed eradication on revegetated areas based on weed type and control susceptibility.	protection of surrounding environment	Rehabilitation manager	Surveillance of rehabilitation areas for weed emergence	Record weed emergence
Extended drought event	Exclude stock until establishment of regrowth.	timely application of control in rehabilitation schedule	Rehabilitation manager	Engage in discussions with landholder about maintaining perimeter fence.	Maintain fence for at least 4 years
	Reseed area in the first available wet season following extended drought.	cost-benefit in post-closure period	Rehabilitation manager	Check rainfall records for Greenvale regional area to confirm conditions	Record rate of application of seed and timing
Unrestricted livestock access prior to RM5 achievement	Maintain Initial Mine Activity Area fence until RM5 criteria are met.	timely application of control in rehabilitation schedule	Rehabilitation manager	Engage in discussions with landholder about maintaining perimeter fence.	Implement prior to rehabilitation period completion
Native fauna access prior to RM5 achievement	Maintain Initial Mine Activity Area fence until RM5 criteria are met.	timely application of control in rehabilitation schedule	Rehabilitation manager	Engage in discussions with landholder about maintaining perimeter fence.	Implement prior to rehabilitation period completion
	Install tree guards around base of immature tree/shrubs in critical areas (slopes and slope toes).	cost-benefit in post-closure period	Rehabilitation manager	Observations of growth and groundcover to include signs of predation on emerging vegetation	Photo-monitoring of emerging tree/shrubs
Vehicle access prior to RM5 achievement	Install safety bund to restrict access to backfilled pit.	timely application of control in	Rehabilitation manager	Final landform design plan/schematic to include	Photo-monitoring of installed feature

RISK TO PMLU OUTCOME		Treatment of Risk			
Cause	Mitigation	Selection rationale	Responsibility	Actions and Performance measures	Reporting/Monitoring/Timing
		rehabilitation schedule		location and materials for installation	
	Install ramp bund.	timely application of control in rehabilitation schedule	Rehabilitation manager	Final landform design plan/schematic to include location and materials for installation	Photo-monitoring of installed feature
	Maintain Initial Mine Activity Area fence until RM5 criteria are met.	timely application of control in rehabilitation schedule	Rehabilitation manager	Engage in discussions with landholder about maintaining perimeter fence.	Implement prior to rehabilitation period completion
Exposure of contaminated or sodic soil at surface	Inspection by suitably qualified person of potentially contaminated or exposed areas prior to reshaping and confirmation post-shaping	protection of surrounding environment	Rehabilitation manager	Engage person with soil qualifications to prepare inspection report. Implement report recommendations in rehabilitation works	Record implemented works and sampling results where recommended.
	Installation of runoff controls to limit the potential for erosive events.	timely application of control in rehabilitation schedule	Rehabilitation manager	Final landform design plan/schematic to include location and materials for installation	Photo-monitoring of installed feature
Low native pasture seed strike rate	Implementing findings of revegetation trials for seed mix with best strike rate.	timely application of control in rehabilitation schedule	Rehabilitation manager	Source suitable native seed supply for use throughout rehabilitation period	Record rate of application of seed and timing

RISK TO PMLU OUTCOME		Treatment of Risk			
Cause	Mitigation	Selection rationale	Responsibility	Actions and Performance measures	Reporting/Monitoring/Timing
	Monitoring of groundcover over successive years to commence remedial actions at the soonest possible season.	timely application of control in rehabilitation schedule	Rehabilitation manager	Engage suitably qualified person to review seasonal monitoring data to determine actions required to improve strike rate	record implemented works and sampling results where recommended.
	Reseed as required for improved strike rate.	cost-benefit in post-closure period	Rehabilitation manager	Reseed at locations requiring remedial works	Record implemented works and sampling results where recommended.
	Increase seeding of landholder preferred species of *Astrebla sp* and *Dichanthium sericium*.	cost-benefit in post-closure period	Rehabilitation manager	Engage in discussions with landholder about preferred seeding species for remedial works	Records implemented works and sampling results where recommended
Bushfire event alters surface cover	Following a failed recovery season, reseed area with native pasture species mix.	cost-benefit in post-closure period	Rehabilitation manager	Undertake monitoring in a suitable recovery period and recommendations about reseeding options	Record implemented works and sampling results where recommended.
	Recommence groundcover monitoring assessment.	cost-benefit in post-closure period	Rehabilitation manager	Engage suitably qualified person to undertake monitoring	Record monitoring and analysis of revegetation trend
Flooding event alters surface cover	Following a failed recovery season, reseed area with native pasture species mix.	cost-benefit in post-closure period	Rehabilitation manager	Undertake monitoring in a suitable recovery period and recommendations about reseeding options	Record implemented works and sampling results where recommended.
	Recommence groundcover monitoring assessment.	cost-benefit in post-closure period	Rehabilitation manager	Engage suitably qualified person to undertake monitoring	Record monitoring and analysis of revegetation trend

RISK TO PMLU OUTCOME		Treatment of Risk			
Cause	Mitigation	Selection rationale	Responsibility	Actions and Performance measures	Reporting/Monitoring/Timing
Unsuitable seed blend used for ground conditions (microrelief)	Reseed area with either RE9.3.10 mix if inundation or persistent water accumulation or increase seeding of landholder preferred species of *Astrebla sp* and *Dichanthium sericium.*	cost-benefit in post-closure period	Rehabilitation manager	Reseed at locations requiring remedial works	Record implemented works and sampling results where recommended.
Instability of regraded surface					
Soil loss from topsoiled areas	Installation of runoff controls to limit the potential for erosive events.	timely application of control in rehabilitation schedule	Rehabilitation manager	Final landform design plan/schematic to include location and materials for installation	Photo-monitoring of installed feature
	Confirmation of final profile <10° over backfilled and topsoiled areas.	timely application of control in rehabilitation schedule	Rehabilitation manager	Measure profiles as installed, prior to topsoiling and revegetating final landforms	Photo-monitoring of completed earthworks
	Maintain Mine Activity Area fence until RM5 criteria are met.	timely application of control in rehabilitation schedule	Rehabilitation manager	Engage in discussions with landholder about maintaining perimeter fence.	Implement prior to rehabilitation period completion
Slumping of placed materials on slope	Confirmation of final profile <10° over backfilled and topsoiled areas.	timely application of control in rehabilitation schedule	Rehabilitation manager	Measure profiles as installed, prior to topsoiling and revegetating final landforms	Photo-monitoring of completed earthworks

RISK TO PMLU OUTCOME		Treatment of Risk			
Cause	Mitigation	Selection rationale	Responsibility	Actions and Performance measures	Reporting/Monitoring/Timing
	Where placed material meets in situ materials key into slope and install water management to direct runoff to dedicated structures and away from placed materials.	timely application of control in rehabilitation schedule	Rehabilitation manager	Final landform design plan/schematic to include areas for keying and locations for installation of water management structures	Photo-monitoring of completed earthworks
Water management installations fail	Maintain water management installations throughout rehabilitation schedule and annually prior to each wet season.	timely application of control in rehabilitation schedule	Rehabilitation manager	Engage suitably qualified person to undertake inspection of water management installations throughout rehabilitation schedule	Record implemented works and sampling results where recommended.
	Inspect status of installations following wet season.	timely application of control in rehabilitation schedule	Rehabilitation manager	Engage suitably qualified person to undertake inspection of water management installations until closure approved	Record implemented works and sampling results where recommended.
Stock access damages topsoiled areas	Maintain Mine Activity Area fence until RM5 criteria are met.	timely application of control in rehabilitation schedule	Rehabilitation manager	Engage in discussions with landholder about maintaining perimeter fence.	Implement prior to rehabilitation period completion
Reprofiled landform failure					
Exposure of sodic materials in the profile	Inspection by suitably qualified person of potentially contaminated or exposed areas prior to reshaping and confirmation post-shaping	timely application of control in rehabilitation schedule	Rehabilitation manager	Engage person with soil qualifications to prepare inspection report. Implement report recommendations in rehabilitation works	Record implemented works and sampling results where recommended.

RISK TO PMLU OUTCOME		Treatment of Risk			
Cause	Mitigation	Selection rationale	Responsibility	Actions and Performance measures	Reporting/Monitoring/Timing
	Installation of runoff controls to limit the potential for erosive events.	timely application of control in rehabilitation schedule	Rehabilitation manager	Final landform design plan/schematic to include location and materials for installation	Photo-monitoring of installed feature
Final landform design angle or slope length is not suitable for material used at time of rehabilitation	Geotechnical assessment to confirm available material can be installed as stable and if not include benching to final profile to decrease slope angle and length.	timely application of control in rehabilitation schedule	Rehabilitation manager	Engage suitably qualified person to undertake geotechnical assessment of final landform design and material competency	Implement recommendations prior to commencing rehabilitation works.
Groundwater intrusion weakens backfilled material geotechnical competency	Pit hydrogeological assessment and closure model.	cost-benefit in operational period	Operations manager	Engage suitably qualified person to undertake monitoring	Implement recommendations prior to commencing rehabilitation works.
Gully formation on rehabilitated surface changing site water dynamics	Geotechnical assessment of pit wall stability	timely application of control in rehabilitation schedule	Rehabilitation manager	Engage suitably qualified person to undertake geotechnical assessment of final landform design and material competency	Implement recommendations prior to commencing rehabilitation works.
	Implementation of recommendations of geotechnical assessment.	timely application of control in rehabilitation schedule	Rehabilitation manager	Final landform design plan/schematic to include location and materials for installation of recommendations	Implement recommendations prior to commencing rehabilitation works.

RISK TO PMLU OUTCOME		Treatment of Risk			
Cause	Mitigation	Selection rationale	Responsibility	Actions and Performance measures	Reporting/Monitoring/Timing
	Installation of further water management controls to preserve rehabilitation.	timely application of control in rehabilitation schedule	Rehabilitation manager	Final landform design plan/schematic to include location and materials for installation	Photo-monitoring of installed feature
Water quality fails to meet criteria					
Exposure of contaminated or sodic soil at surface	Contaminated land assessment prior to closure	timely application of control in rehabilitation schedule	Rehabilitation manager	Engage person with soil qualifications to prepare inspection report. Implement report recommendations in rehabilitation works	Record implemented works and sampling results where recommended.
	Removal of sodic materials at surface for burial in pit	timely application of control in rehabilitation schedule	Rehabilitation manager	Quantify and record location of burial and treatment applied if any.	Photo-monitoring of completed earthworks
	Monitoring of water quality downstream throughout rehabilitation and closure period	timely application of control in rehabilitation schedule	Rehabilitation manager	Engage suitably qualified person to undertake monitoring each wet season	Record monitoring and analysis of water quality trend
Surface application of gypsum on rehabilitation area washes	Rip gypsum into surface prior to topsoiling and/or seeding.	timely application of control in rehabilitation schedule	Rehabilitation manager	Apply gypsum to treatment areas prior to application of topsoil	Records implemented works and rates of application

RISK TO PMLU OUTCOME		Treatment of Risk			
Cause	Mitigation	Selection rationale	Responsibility	Actions and Performance measures	Reporting/Monitoring/Timing
into watercourse altering pH	Monitoring of water quality downstream throughout rehabilitation and closure period.	timely application of control in rehabilitation schedule	Rehabilitation manager	Engage suitably qualified person to undertake monitoring each wet season	Record monitoring and analysis of water quality trend
Groundcover failure results in sediment laden runoff from rehabilitation area	Implementing findings of revegetation trials for seed mix with best strike rate	timely application of control in rehabilitation schedule	Rehabilitation manager	Source suitable native seed supply for use throughout rehabilitation period	Record rate of application of seed and timing
	Monitoring of groundcover over successive years.	cost-benefit in post-closure period	Rehabilitation manager	Engage suitably qualified person to review seasonal monitoring data to determine actions required to improve strike rate	record implemented works and sampling results where recommended.
	Reseed as required for improved strike rate.	cost-benefit in post-closure period	Rehabilitation manager	Reseed at locations requiring remedial works	Record implemented works and sampling results where recommended.
	Install temporary sediment control fences.	timely application of control in rehabilitation schedule	Rehabilitation manager	Final landform design plan/schematic to include location and materials for installation	Photo-monitoring of installed features
Surface expression of groundwater at altered	Installation of temporary sediment control fences	cost-benefit in the post-closure period	Rehabilitation manager	Final landform design plan/schematic to include location and materials for installation	Photo-monitoring of installed features

RISK TO PMLU OUTCOME		Treatment of Risk			
Cause	Mitigation	Selection rationale	Responsibility	Actions and Performance measures	Reporting/Monitoring/Timing
landform profile causes runoff to watercourse.	seeding of location with RE9.3.10 species to increase water uptake and decrease runoff.	cost-benefit in the post-closure period	Rehabilitation manager	Engage in discussions with landholder about watercourse seeding species for remedial works	Photo-monitoring of emerging tree/shrubs
	Monitoring of water quality downstream throughout rehabilitation and closure period.	timely application of control in rehabilitation schedule	Rehabilitation manager	Engage suitably qualified person to undertake monitoring each wet season	Record monitoring and analysis of water quality trend
Rehabilitation not self-sustaining for grazing					
Failure of successive years achievement of native pasture grass.	Monitoring trial locations and applying revised methodologies to final landform at scale.	timely application of control in rehabilitation schedule	Rehabilitation manager	Implement best trial outcome strategy and recommendations	Record monitoring of rehabilitated landform and analysis of revegetation trend
Failure to achieve water quality criteria over successive wet seasons	Include upstream water quality sampling to provide a reasonable local alternative to the Schedule C Table 2 water quality limits.	cost-benefit in the operational period	Operations manager	Engage suitably qualified person to undertake monitoring each wet season	Record monitoring and analysis of water quality trend for revision of target water quality prior to prior to final rehabilitation works
Failure to achieve groundcover rate within 5 years after seeding	Increase seeding of landholder preferred species of *Astrebla sp* and *Dichanthium sericium*.	cost-benefit in the post-closure period	Rehabilitation manager	Engage in discussions with landholder about preferred seeding species for remedial works	Records implemented works and sampling results where recommended

RISK TO PMLU OUTCOME		Treatment of Risk			
Cause	Mitigation	Selection rationale	Responsibility	Actions and Performance measures	Reporting/Monitoring/Timing
Failure for successive years to achieve erosion loss limit of 0.5t/ha/annum	Include analogue site assessment of erosion loss rates to provide a reasonable temporal alternative to the single point baseline assessment.	cost-benefit in the operational period	Operations manager	Engage suitably qualified person to undertake monitoring in the operational period	Record monitoring and erosion rate for analogue site for revision of target erosion rate prior to final rehabilitation works
	Reinspect sodic soil surface expression and apply ameliorant treatment.	cost-benefit in the post-closure period	Rehabilitation manager	Engage person with soil qualifications to prepare inspection report. Implement report recommendations in remediation works	Records implemented works and rates of application

6.3 Rehabilitation Trials

Two rehabilitation trials have been considered necessary to support the rehabilitation milestones. The first trial is a seed mix strike success rate on topsoiled landform, the second is direct seeding to ripped road surfaces.

6.3.1 Trial 1 – Seed Mix Strike Rate

6.3.1.1 Objective

To determine whether the ratio and combination of seeds for native pasture revegetation can achieve the desired groundcover and diversity on the rehabilitated landform and to determine the success rate of germination for the seed types consistent with the RE 9.3.2 and RE 9.8.1 grasses with and without the use of a low nitrogen fertiliser. Depending on the underlying subsoil sodicity characteristics, ameliorants may also be applied.

6.3.1.2 Design

On backfilled, profiled and topsoiled in pit slope initiate revegetation with the native pasture seed mix on plots with a variety of proportions and fertilizer application (low nitrogen fertilizer at a rate of less than 50kg/ha). The native grasses requested by the landholder will not be incorporated in the trial as their proportion in mixed seed is supported by common practice/grazing advice.

Trial 1 location selected for the backfilled and reprofiled Pit 1 available in year 2030. The underlying land characteristics will be backfilled pit as per sequence in rehabilitation method with topsoil spread of 15cm and overall slope of 8°. The seed mix will be applied with and without fertiliser as per trial. No previous trials have been carried out on site.

6.3.1.3 Detail

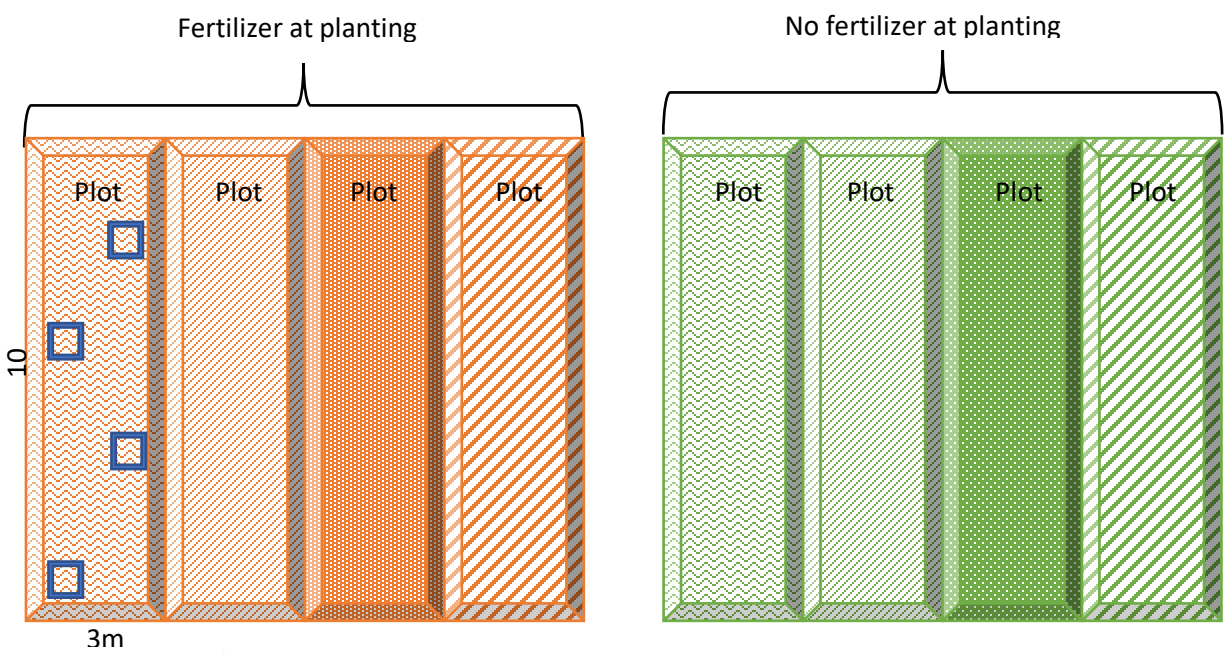
The rehabilitated pit area designated for trial of seed mix (3kg/species/hectare) should be strip prepared into 3m x 10m plots for planting in Autumn in the following proportions:

Table 20 Species Strike Rate Trial proportion and treatment

Plot	Native grass species	Percentage by weight	Fertilizer
1	*Heteropogon contortus*	50	At planting
	Heteropogon triticeus	10	
	Themeda triandra	30	
	Grewia retusifolia	10	
2	*Heteropogon contortus*	25	At planting
	Heteropogon triticeus	25	
	Themeda triandra	25	
	Grewia retusifolia	25	
3	*Heteropogon contortus*	40	At planting
	Heteropogon triticeus	10	
	Themeda triandra	40	
	Grewia retusifolia	10	
4	*Heteropogon contortus*	30	At planting
	Heteropogon triticeus	10	

Plot	Native grass species	Percentage by weight	Fertilizer
	Themeda triandra	50	
	Grewia retusifolia	10	
5	*Heteropogon contortus*	50	NIL
	Heteropogon triticeus	10	
	Themeda triandra	30	
	Grewia retusifolia	10	
6	*Heteropogon contortus*	25	NIL
	Heteropogon triticeus	25	
	Themeda triandra	25	
	Grewia retusifolia	25	
7	*Heteropogon contortus*	40	NIL
	Heteropogon triticeus	10	
	Themeda triandra	40	
	Grewia retusifolia	10	
8	*Heteropogon contortus*	30	NIL
	Heteropogon triticeus	10	
	Themeda triandra	50	
	Grewia retusifolia	10	

A trial plot layout to example such as below:



6.3.1.4 Data and monitoring

The trial will require the following data to be collected at inception:

- Depth of topsoil, slope and soil moisture estimate.
- Photo location of surface preparation.
- Rainfall record for week commencing trial.
- Daily temperature.
- Any weed populations within the trial area and treatment date.
- Full description of seed mix proportion and quantity used for each plot.

Quarterly monitoring of trial plots for the following data:

- Date of emergence of seedlings and identification when possible
- Photographic record of rate of growth
- Quadrat measurements (1m x1m) for 4 samples per plot:
    - Density of groundcover (Meat and Livestock Australia Ltd, 2019)
    - Species diversity (count of species both as planted and natural recruitment of other species) (Habich, 2001)
    - Successful germination and growth.
    - Weed invasion.
    - Obvious damage or intrusion.

6.3.1.5 Timing

Trial to commence on in pit revegetation before Autumn 2032 and continue monitoring for not less than 2 wet seasons (2035).

6.3.1.6 Success

Where a treatment yields the target groundcover of 75% or greater and <10% weed cover it will be deemed suitable for use in final site in pit rehabilitation. Failure to produce representation of any particular species will be analysed in relation to its seeding proportion and fertilizer application and seasonality. Similarity with a selected reference/analogue site will also be a criterion.

Limitations for Trial 1 include the germination conditions at time of assessment of trial plots may not be representative of conditions for main rehabilitation areas and locally sourced seeds may not be consistently available between trial initiation and each rehabilitation effort.

6.3.2 Trial 2 – Direct seeding success

6.3.2.1 Objective

To determine whether species mix will establish at a rate consistent with grazing land use on trafficked surface without topsoil.

6.3.2.2 Design

Deep rip former stockpile area of not less than 2 x 20 metre section and apply native grass seed mix at 3kg/species and 2 sections with deep ripping and no seed application.

6.3.2.3 Detail

Locate area no longer used for mining activities within the Mine Activity Area (ie fenced from stock access) for surface treatment of deep ripping and seeding in alternate strips at full width.

In season (Autumn) apply seed mix of

- *Heteropogon contortus*
- *Heteropogon triticeus*
- *Themeda triandra*
- *Grewia retusifolia*

At a rate of 3kg/ha per species to 2 non-consecutive sections of 20m x 5m width and apply no seed mix to the intervening sections. Gypsum to be applied at one section of ripped and seeded and one section of ripped only.

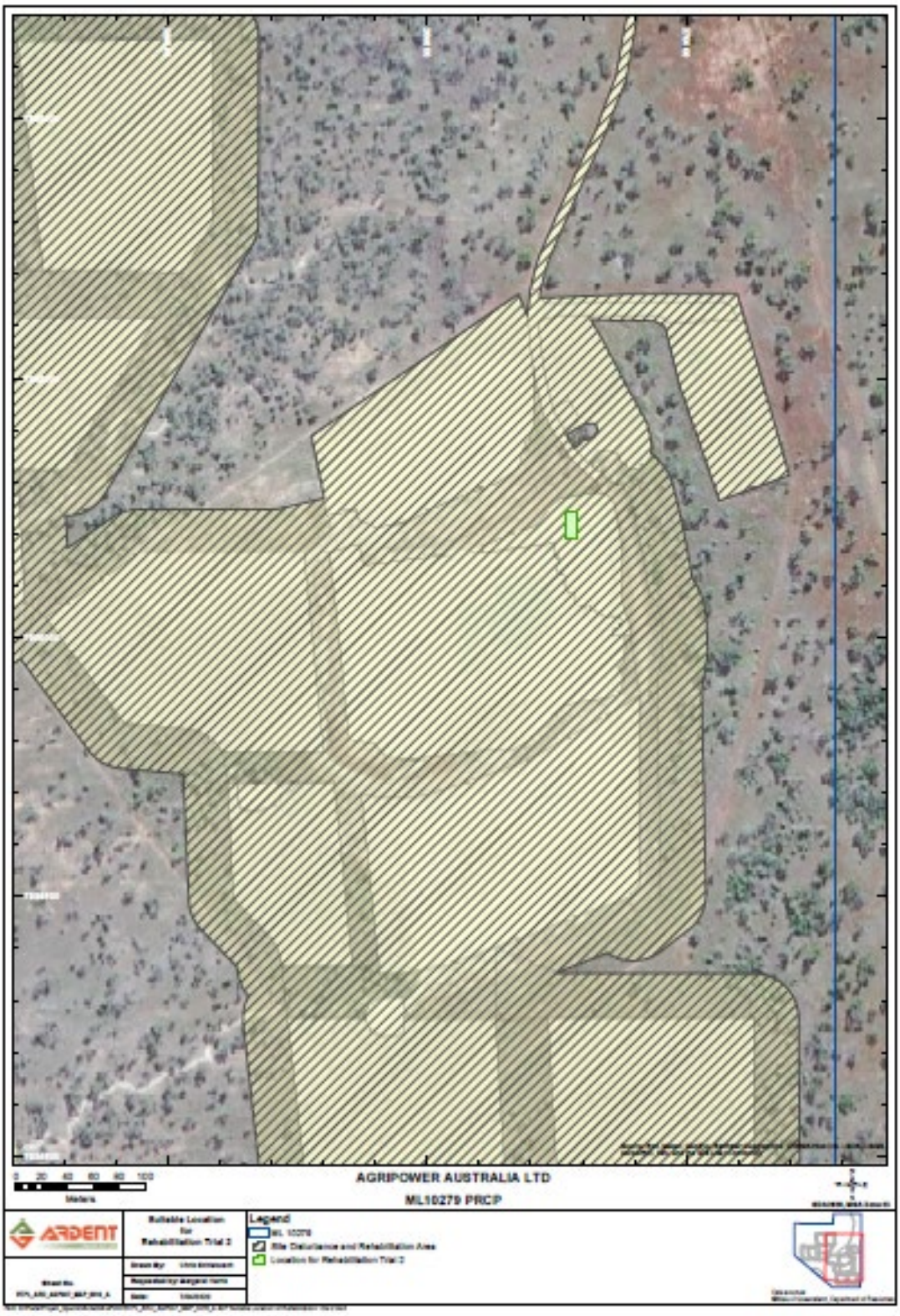


Figure 16: Suitable location for rehabilitation trial 2

6.3.2.4 Data and monitoring

The trial will require the following data to be collected at inception:

- Depth of ripping
- Photo location of surface preparation (gypsum/no gypsum)
- Rainfall record for week commencing trial
- Daily temperature
- Any weed populations within the trial area and treatment date.
- Full description of seed mix proportion and quantity.

Quarterly monitoring of trial plots for the following data:

- Date of emergence of seedlings and identification when possible
- Photographic record of rate of growth
- Quadrat measurements (1m x1m) for 4 samples per plot:
    - Density of groundcover
    - Species diversity
    - successful germination and growth
    - Weed invasion

6.3.2.5 Timing

Trial to commence on road surface before Autumn 2035 and continue monitoring for not less than 2 wet seasons (2037).

6.3.2.6 Success

Where a treatment yields the target groundcover of 75% or greater and <10% weed cover it will be deemed successful for use in final site access road rehabilitation.

7 MONITORING AND MAINTENANCE

The program of monitoring and maintenance of the milestones and milestone criteria are presented in **Table 21**.

Table 21: Rehabilitation Milestone and Criteria Monitoring Program

Milestone Reference	Rehabilitation Milestone	Milestone Criteria	Schedule of Monitoring	Schedule of analysis and reporting	Review	Method of monitoring
RM1	Removal of infrastructure and storage vessels	a) All buildings demolished or removed	Once at completion of actions	First year post closure	NA	Photo of location with date
RM2	Landform reprofiling and trim complete	a) Surface contours reinstated and integrated with adjacent undisturbed land with maximum slope of 18° for batter slopes of 35m to a maximum height of 10m. b) Light ripping to improve infiltration c) Surface drainage does not concentrate flow d) Sediment controls installed	Once at completion of actions	First year post closure	NA NA Annual following installation Annual following installation	Clinometer reading for every 100m of slope Photo of location with date Drone photo of location annually in wet season Photo of location with date
RM3	Surface treatment	a) Soil used from topsoil stockpiled for use as rehabilitation media and is weed-free prior to use and assess N level in stored soil.	Once at completion of actions	First year post closure	NA	Photo of location with date Stockpiled soil sample analysed for Nitrate Nitrogen at laboratory

Milestone Reference	Rehabilitation Milestone	Milestone Criteria	Schedule of Monitoring	Schedule of analysis and reporting	Review	Method of monitoring
		b) Topsoil applied over whole footprint area to thickness of not less than 15cm. c) Ameliorants and fertilizer applied according to recommendations arising from rehabilitation trials.			NA NA	Topsoil depth measurement every 100m of slope Record of actions and amount applied
RM4	Revegetation (native pasture grazing)	a) Seeding of native pasture species mix including: *a. Heteropogon contortus* *b. Heteropogon triticeus* *c. Themeda triandra* *d. Grewia retusifolia* At a rate of not less than 3kg/hectare/species.	Once at completion of actions	First year post closure	Following trial outcomes	Record of actions and amount applied
		b) Seeding native tree and shrub mix including: *a. Petalostigma pubescens* *b. Ficus opposite* *c. Diospyos geminate* *d. Hakea arboescens* *e. Brachychiton diversifolius* *f. Corymbia erythophloia* *g. Corymbia dallachiana* *h. Eucalyptus leptophleba* *i. Eucalytpus crebra* At a rate of not less than 200g/hectare/species.	Once at completion of actions	First year post closure	NA	Record of actions and amount applied

Milestone Reference	Rehabilitation Milestone	Milestone Criteria	Schedule of Monitoring	Schedule of analysis and reporting	Review	Method of monitoring
		c) Achieve groundcover projective foliage cover of >75% of analogue site for successive years (excluded from grazing).	Quarterly from completion of action	Annual until successive years achievement	NA	Groundcover assessment (Meat and Livestock Australia Ltd, 2019) (Meat and Livestock Australia Ltd, 2019)
		d) Strike rate of native grass seeding to be recorded.	Quarterly from completion of action	Annual until greater than 50% cover achievement	Reseed if unsuccessful germination in first year	Photo of location with date
RM5	Achievement of surface requirements	a) Achieve native species dominance for groundcover of >75% similarity of analogue site for successive years on slopes of 10° or less. b) Achieve native species dominance for groundcover of >90% similarity of analogue site for successive years on batter slopes of 18°.	Annual commencing second year following seeding	Annual until successive years achievement	If analogue site is destroyed or significantly affected by landholder activities	(Habich, 2001) abundance similarity data gathering.
		c) Assessment of weed contribution to total groundcover to be <10%.	Annual commencing second year following seeding	Annual until greater than 50% native pasture species cover achievement	Treatment if >10% measured	Groundcover assessment (Meat and Livestock Australia Ltd, 2019)
		d) No active rill or gully development across reinstated surface.	Annual commencing second year following seeding	Annual until greater than 50% native pasture	Treatment if gullies >1 measured or rilling of >10/100m	Reinstated slope measurement/transect photography to allow determination of soil loss

Milestone Reference	Rehabilitation Milestone	Milestone Criteria	Schedule of Monitoring	Schedule of analysis and reporting	Review	Method of monitoring
				species cover achievement		
RM6	Achievement of post-mining land use to stable condition for grazing	a) Certification from a suitably qualified person that the area has achieved stable condition.	Once after successive years of achievement of groundcover >75%	First year following achievement of groundcover milestone		Statement from suitably qualified person
		b) Surface stability to be less than 0.5t/ha/annum loss through erosion.	Once after successive years of achievement of groundcover >75%	Annual until successive years achievement		Reinstated slope and transect photography to allow determination of soil loss
		c) Groundcover has achieved >75% analogue site for successive years for slopes of 10° and >90% for slopes between 10-18°.	Annual commencing second year following seeding	Annual until successive years achievement	If analogue site is destroyed or significantly affected by landholder activities	Groundcover assessment (Meat and Livestock Australia Ltd, 2019)
		d) Surface water quality from the area complies with the following: i. Total dissolved solids <4000 mg/L	Annual commencing second year	Annual until greater than 50% native pasture	Alternate milestone values	Undisturbed upstream samples taken at the same time to provide background comparison

Milestone Reference	Rehabilitation Milestone	Milestone Criteria	Schedule of Monitoring	Schedule of analysis and reporting	Review	Method of monitoring
		ii. pH between 6.5-8.5 iii. Suspended solids <25 mg/L iv. Total nitrogen <370 µg/L v. Total phosphorous <70 µg/L vi. Chlorophyll-a <5µg/L vii. Dissolved oxygen between 85-110% viii. Conductivity <540µS/cm ix. Sulphate <3mg/L	following seeding	species cover achievement		to milestone values using (DES, 2017) Sampling method
		e) A contaminated land survey carried out by an appropriately qualified person indicates that no contamination unsuitable for the PMLU is occurring.	Once after second year following seeding	First year following achievement of groundcover milestone		Statement from suitably qualified person
		f) Certification of no weed and pest species abundance identified in the rehabilitated areas are no greater than at reference sites by a suitably qualified person.	Once after successive years of achievement of groundcover >75%			
RM7	Surface preparation of road	a) Deep rip along recontoured surface	Once at completion of actions	First year post closure	NA	Photo of location with date

Milestone Reference	Rehabilitation Milestone	Milestone Criteria	Schedule of Monitoring	Schedule of analysis and reporting	Review	Method of monitoring
		b) Surface suitable for native grass reestablishment without topsoil placement	Once at completion of actions	First year post closure	Trial outcomes indicate surface preparatio n must include topsoil	Photo of location with date
RM8	Removal of stored materials	a) Waste/overburden/ore removed from footprint area to pit	Once at completion of actions	First year post closure	NA	Photo of location with date
RM9	Achievement of surface requirements	a) Certification by a suitably qualified person that no sodic materials have been exposed nor remain at surface (if excavated) or have been treated with gypsum application.	Once at completion of actions	First year post closure	NA	Statement from suitably qualified person supported by ESP analysis of grab sample of surface material if suspected sodic exposure
RM10	Removal of retaining structure	a) Drainage of water stored.	Once at completion of actions	First year post closure	NA	Photo of location with date
		b) Drying of sediments therein	Once at completion of actions			
		c) Removal of retaining wall and sediments to pit	Once at completion of actions			
RM11	Backfill of pit	a) Backfilling of ore waste/overburden to pit b) All major earthworks within pit footprint complete	Once at completion of actions	First year post closure	NA	Photo of location with date

Milestone Reference	Rehabilitation Milestone	Milestone Criteria	Schedule of Monitoring	Schedule of analysis and reporting	Review	Method of monitoring
		c) Batter slopes meet final design specifications d) Installation of contour berms on backfilled landform e) Installation of upslope drainage for pit perimeter areas to provide erosion protection on slopes prior to vegetation cover criteria met	Once at completion of actions	First year post closure		
RM12	Achievement of post-mining land use to stable condition for grazing	a) Backfilled pits assessed as geotechnically stable by a suitably qualified geotechnical engineer so that no slumping is observed or expected in placed material.			NA	Statement from suitably qualified person
		b) Stability assessment includes final slope status and geometry (<10° for backfilled pits and <18° for batter slopes), condition and engineering characteristics and assessment of failure mechanisms.			NA	Statement from suitably qualified person
		c) Final landform slope lengths and angles consistent with landform design criteria			NA	Photo of location with date

8 References

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Appendix 1: HYDROGEOLOGICAL INFORMATION

Appendix 1
Hydrogeology

The Greenvale ML is situated within the headwaters of the Burdekin River. About 25km east of the Conjuboy homestead, the upper Burdekin River changes direction: from flowing essentially westerly to flowing southwards. The main drainage system in the ML region is the Dry River, which flows southeast into the Burdekin. Wyandotte and Forester Creeks are tributaries of the Dry River. Wyandotte Creek is the only creek that drains the ML area.

The hydrogeological regime of the ML area appears to be controlled by:

- *Unconfined fractured rock aquifers within the McBride basalt flows;*
- *Confined aquifers in the flow-top breccias and interflow sediments;*
- *Possible groundwater reservoirs within lava tubes of the McBride basalts;*
- *Groundwater discharging from the base of the basalts into Spring, Forester and Wyandotte Creeks and the Dry River;*
- *Confined fractured rock aquifers within the basement crystalline rocks beneath the basalt; and*
- *Unconfined aquifers associated with the Dry River valley.*

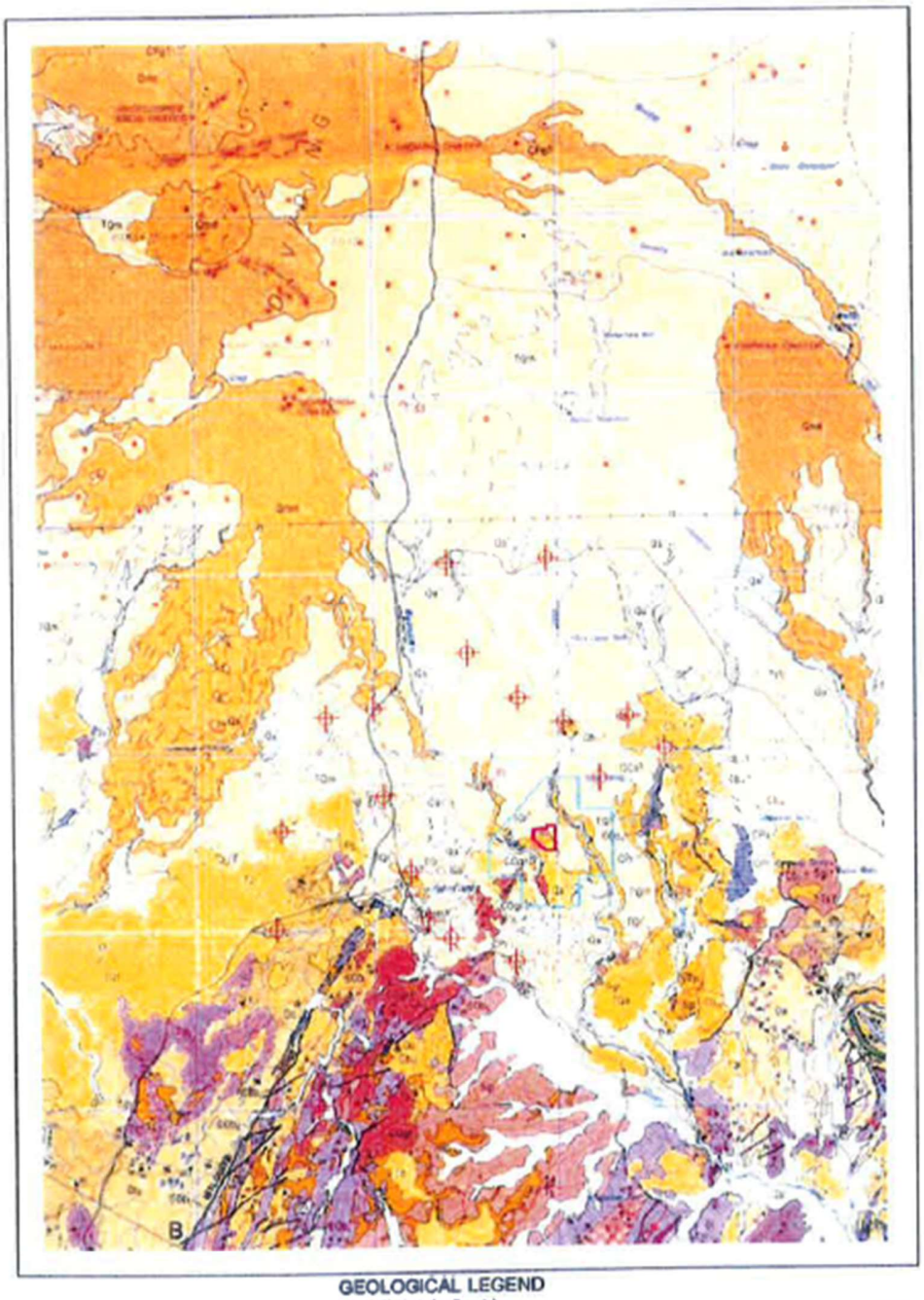
The Greenvale area is not a declared subartesian groundwater area. Consequently, no licences or permits are required for the drilling and construction of water bores. There is also no requirement for landholders or drilling contractors to lodge groundwater records with NRM. A search of the NRM groundwater database for the area revealed that:

- *There is not formal log information for bores in the area;*
- *Only the depth of bores is generally known;*
- *Regular standing water levels are not measured by landholders; and*
- *Only very limited groundwater quality data exist.*

There is no reliable historical evidence of seasonal variations in either unconfined or confined aquifers in the area. See Figure 2 for location of bores around the Greenvale ML.

Diatomite is known to be highly porous, but its permeability is limited, owing to its very fine-grained nature. Although the diatomite deposit will become saturated by recharge events, it is not considered to represent a significant aquifer unit and is unlikely to permit further vertical infiltration of groundwater. It is considered that the mining operation will not change the chemistry of the groundwater due to the low permeability and neutral nature of the diatomaceous earth. Therefore, no conditions have been proposed for groundwater. Instead the ADEJV will monitor soil contamination levels (see section 4.6.4).

Extract from the EMOS 2002.



GEOLOGICAL LEGEND

(selected units only)

PALAEOZOIC ROCKS	COgr Ringwood Park Microgranite pink microgranite and biotite granite Cbr1 Bally Knob Volcanics pink to brown rhyolitic ignimbrite	**TERTIARY AND QUATERNARY SEDIMENTS**	TQl Undifferentiated claystone, minor sandstone, lacustrine deposits, diatomite shown with superscript d TQm Unassigned Olivine Basalt Qa Clay, silt, sand, gravel, floodplain alluvium superscript c indicates clay

Registered Water Bore

MDL

ENVIRONMENTAL & LICENSING PROFESSIONALS PTY LTD

DRAWN PA	Figure 2 Assessment of Hydrology and Hydrogeology Geological Map Greenvale Diatomite Deposit
CHECKED RS	
DATE November 2002	
CADD AC4	Australian Diatomaceous Earth Pty Ltd

LATER HYDROGEOLOGICAL INFORMATION

Investigations into groundwater in the unconsolidated geology and basalt caps at Gilldale and Conjuboy properties discerned 3 to 4 semi-disconnected aquifers.

Aquifer Layers are listed from Surface down:

- Basalt cap (0 L/Sec)
  - Very little to no water
- Weathered and fissured Basalt (1- 22 L/Sec)
  - Vesicle or fissure hosted water- Hard water
  - Intra Basalt layer alluvium- secondary and fed from vesical hosted water and fractures within the basalt.
- Alluvial lake Sediments (DE) (~1-2 L/Sec Indicative value)
  - Hosted in pore space fill and swelling clays.
  - May have localised trapped high salinity in areas.
- Meta-sediments (0– 18 L/Sec)
  - Hosted in Cracks and fissures within metamorphosed country rocks and granite- small disjointed aquifers.

Diatomaceous earth has been described as being an aquiclude in some instances, though on inspection of drill holes at the Gilldale pit, diatomite appeared to be hosting the groundwater or at least retarding its conductivity.

Recharge

Groundwater in the basalts may occur in both vesicular and fractured rock, and the degree of weathering may influence the storage capacity and behaves as an unconfined aquifer system, with recharge occurring locally. Horizontal hydraulic conductivity is greater than the vertical hydraulic conductivity, groundwater in recent tertiary flows is more likely to be stored within fresh or weathered vesicular layers, including palaeosols. Modelled residence times for groundwater in the basalt to be 5 to 120 years.

The common mode for basalt aquifer system occurrence is from lava flows with interbedded material of both weathered sedimentary and extrusive pyroclastic material making the storage and porosity polymodal. The porosity of unfractured volcanic rock varies from <1% for dense basalt to >85% for pumice. Typically, dense basalt such as around the Cunjuboy area has a porosity of 1- 10% and vesicular basalts 10- 20%.

Basalt deposits usually yield moderately saline groundwaters, of typical basaltic composition, being dominated by HCO3 with even cations. The basalts, as with other fractured rock aquifers, are vulnerable to contamination. This is because rapid recharge from the surface limits the filtering and protecting chemical environment of the soil layer. The storage capacity of a fracture zone may also be hydrologically isolated so that accumulated contaminants are unable to disperse.

Historic bores and recent drill hole logging of basalt samples onsite at Gilldale for the resource model provided much of the data in this report, which included;

- Quantity of Aquifers
- Groundwater levels

- Aquifer material

Anecdotal information on comparative areas that host similar groundwater conditions suggests the combined groundwater seepage from portions of the modelled Basaltic area investigated to be within the range of about 1 ML/day to 1.5 ML/day.

Groundwater flow paths from head values (figure # below) calculated from head values based off elevations in basalt flows. Natural springs in the area indicate differential flow within the basaltic unit to occur under the hard cap into the weathered (Saprolite) zone and within alluvial sand fans of metamorphic and granitic origin, out flow from the weathered edges of basalt flow outcrops feed the creeks and the wetlands of the area.

Modelling for Darcy Flow and Direction in figure # provided below the best indication for drill locations, this model is based on using surface flow, topography and basalt depth as the most obvious course to locate paleochannels where groundwater is likely to flow to and be found.

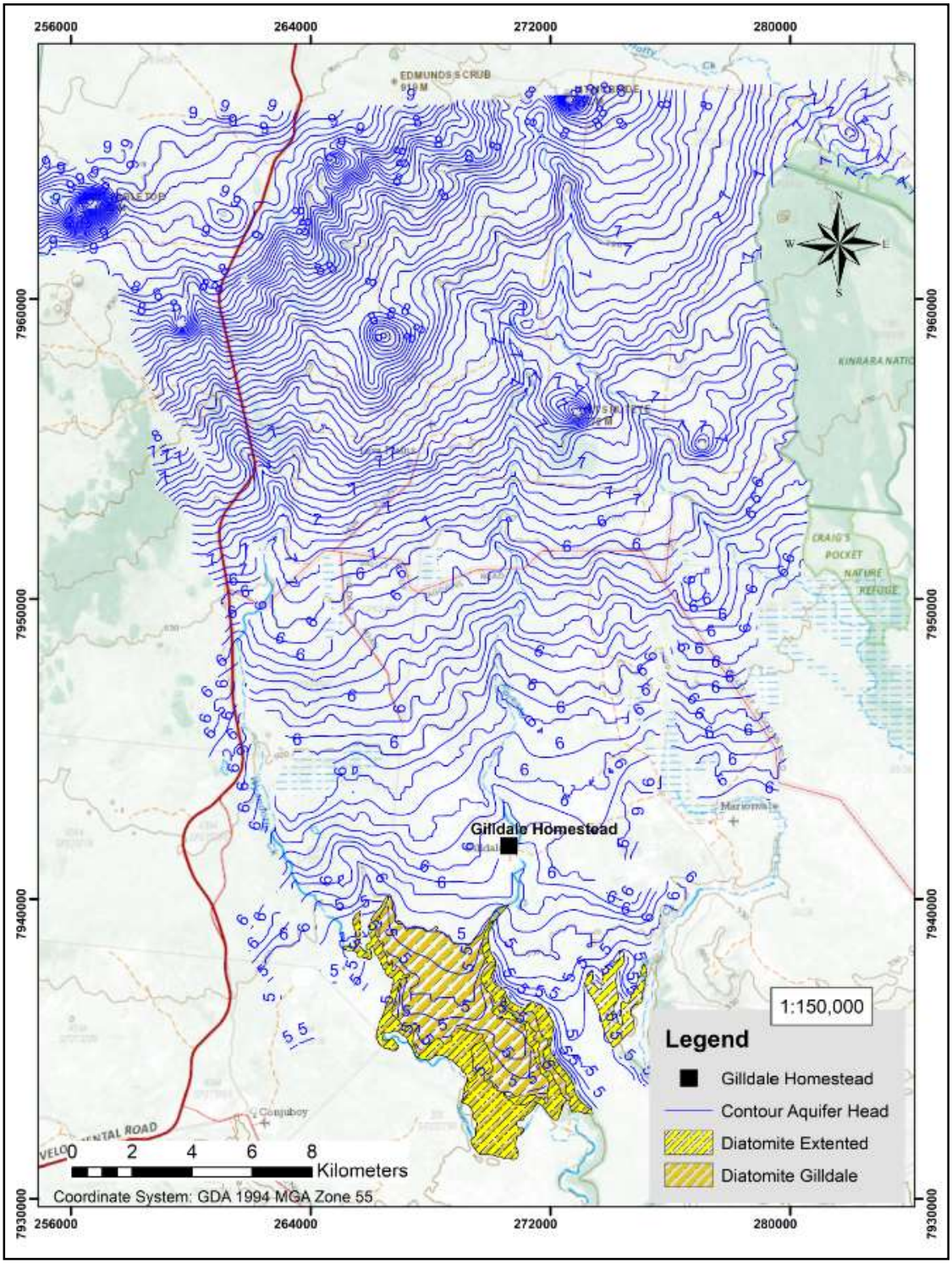


Figure 1 Groundwater Head Value contours for basaltic aquifer (including Diatomite) Gilldale.

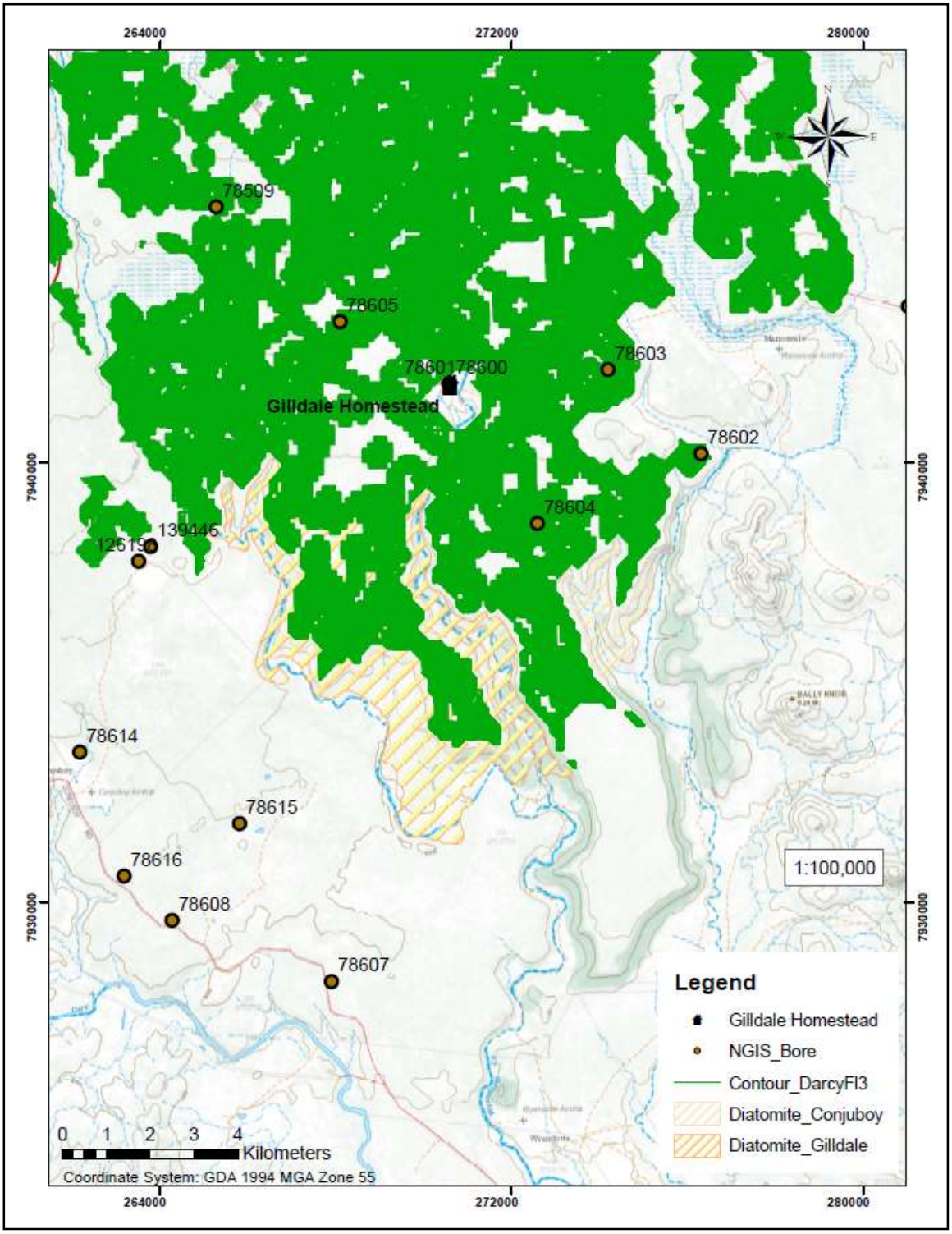


Figure 2 Indicated groundwater locations contoured in light green based on Darcy modelling.

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Appendix 2: FLOODING INFORMATION

5.2 Runoff

The accuracy of estimation of runoff or discharge from rainfall measurements depends on the time scale being considered (Shaw, 1988)[6]. Generally the inter-relationship between rainfall and runoff for short periods, say hours, in any catchment is complex, but if it is considered on an annual basis, a straight line correlation is usually obtained. The size of the catchment being considered also affects the relationship.

The Coefficient of Runoff depends on the average slope of the catchment and the land cover in the catchment. Table 5.5 shows published Coefficients of Runoff for average slopes of 1%.

Table 5.5: Coefficients of Runoff for Average Slopes of 1% (Adapted from Interim Stormwater Standards Committee, 1958)

Land Cover	Coefficient of Runoff
Bare ground, rock, pavement, roofs, city areas fully built	0.85
Rocky, clayey or non-absorbent soil with scanty herbage	0.70
Open forest or grassed land, cereal crops	0.55
Average grassed timbered land of medium soil texture	0.45
Heavily timbered country, closely cultivated land and gardens	0.34
Sand	0.19

As the majority of Wyandotte Creek catchment may be described as rocky, or clayey with non-absorbent soil and scanty herbage, the appropriate Coefficient of Runoff for the catchment is 0.70.

In view of the size and location of both catchments, it is reasonable to assume that both the amount and intensity of rainfall is constant across the catchment.

The discharge in any stream is the accumulated runoff from the stream's catchment. Discharge is directly proportional to runoff and the discharge at any time can be calculated using the rainfall received in the time interval. Thus, discharge (D) can be calculated using a modified form of the catchment using the Lloyd-Davies (1906)[7] equation:

$$D = C\, r_t\, A$$

where: C = Coefficient of Runoff

i = rainfall intensity

A = Area of catchment

No data on rainfall intensity are available for the Conjuboy area, however the above relationship may be used to assess the likely runoff from the MDL when mining commences.

[6] Shaw, E.M., (1988). Hydrology in Practice (Second edition). Van Nostrand Reinhold International.
[7] Lloyd-Davies, D.E., (1906). The elimination of storm water from sewerage systems. Proceedings of the Institute of Civil Engineers, Volume 164, 41-67.

5.3 Stream Flow

NRM installed and operated a stream gauging station (GS 120117A) on Wyandotte Creek from 1970 until 1988. The location of GS 120117A is shown on Drawing No 2. The data for GS 120117A have been obtained from the NRM Watershed website.

The mean monthly flow for the period of record at GS 120117A is presented graphically in Figure 5.1 below.

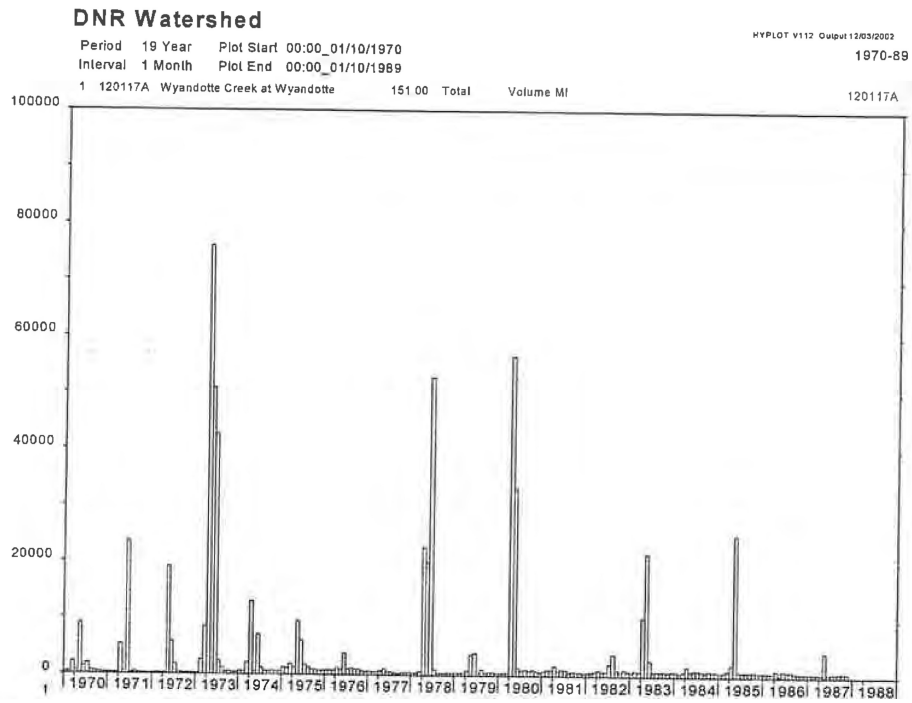


Figure 5.1: Mean monthly flow in ML at GS 120117A
(source NRM Watershed website)

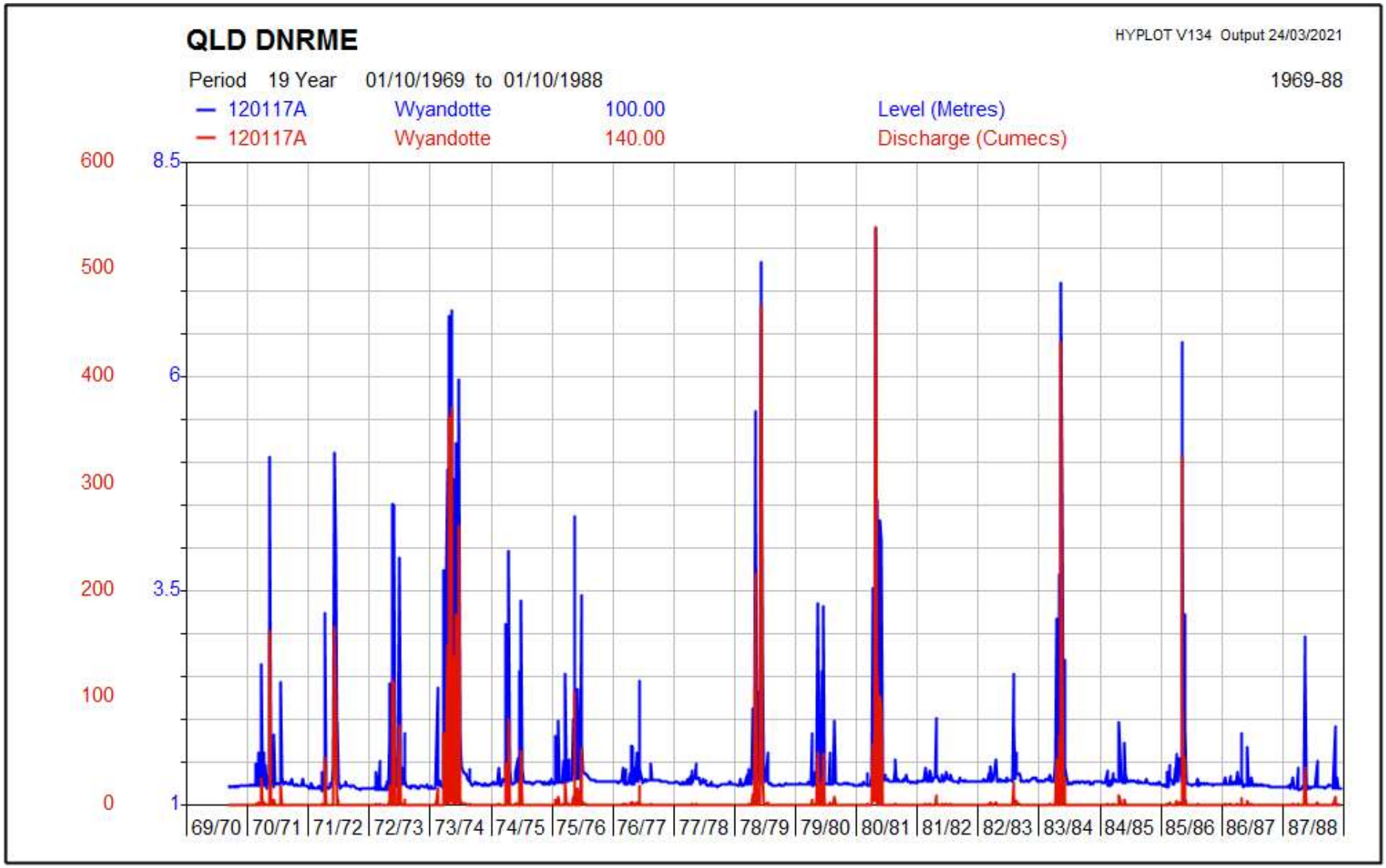
It can be seen from Figure 1 that, in most years, summer monthly flows generally range from around 10 000 to 25 000ML. It is expected that flows such as these would not inundate the mining site.

In exceptionally wet years extreme monthly flows in excess of 50 000ML have been recorded. Inundation of the mining site can be expected in these years.

5.4 Surface Water Quality

NRM sampled the surface water from Wyandotte Creek at GS 120117A whilst it was in operation. Table 5.6 shows summary statistics of major ionic species that are likely to be impactèd by the mining operation.

It can be seen from Table 5.6 that the historical physico-chemical surface water quality of the Wyandotte Creek catchment is excellent.


QLD DNRME
HYPLOT V134 Output 24/03/2021
Period 19 Year 01/10/1969 to 01/10/1988
1969-88
120117A Wyandotte 100.00 Level (Metres)
120117A Wyandotte 140.00 Discharge (Cumecs)
600
500
400
300
200
100
0
8.5
6
3.5
1
69/70
70/71
71/72
72/73
73/74
74/75
75/76
76/77
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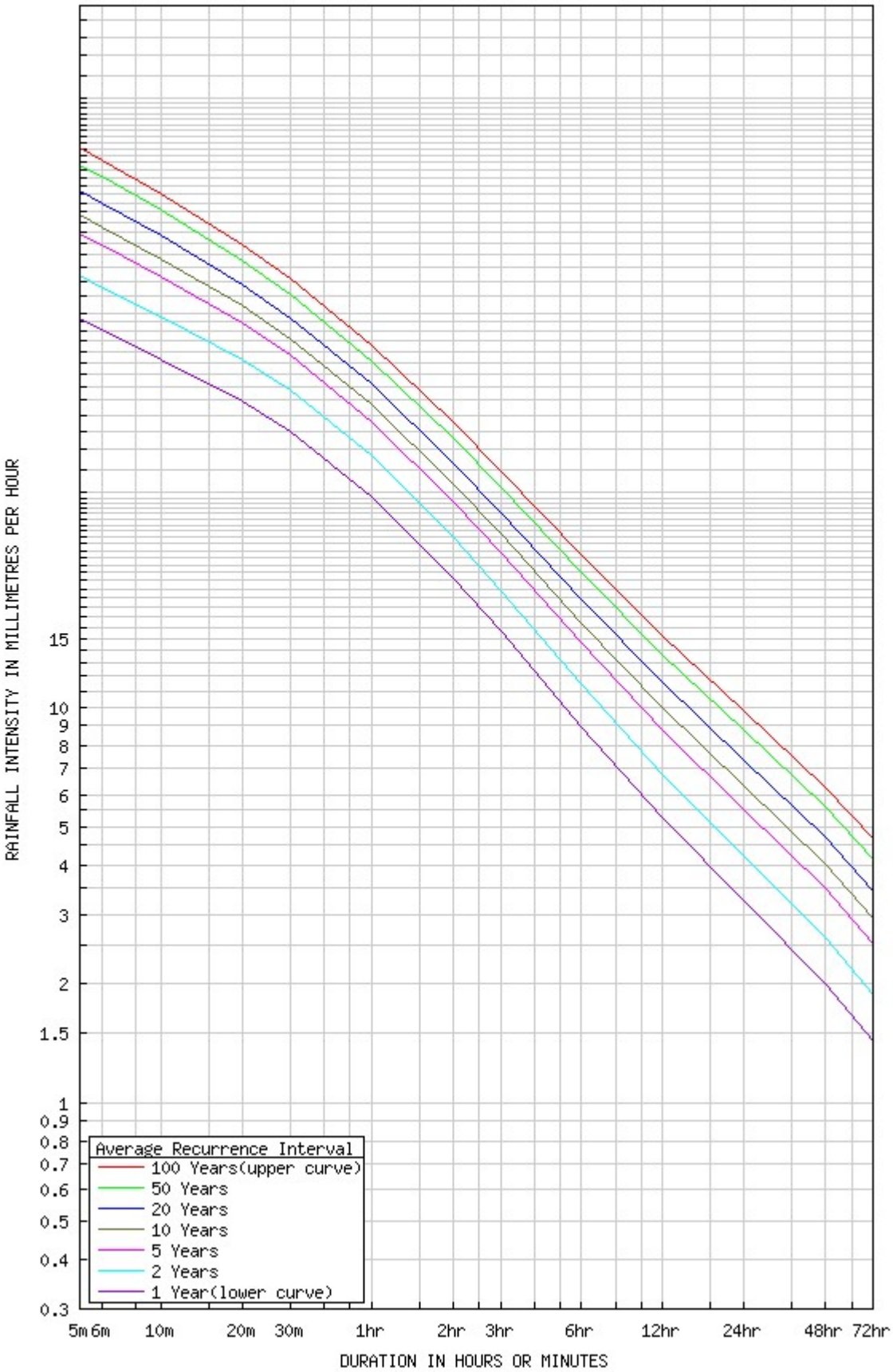
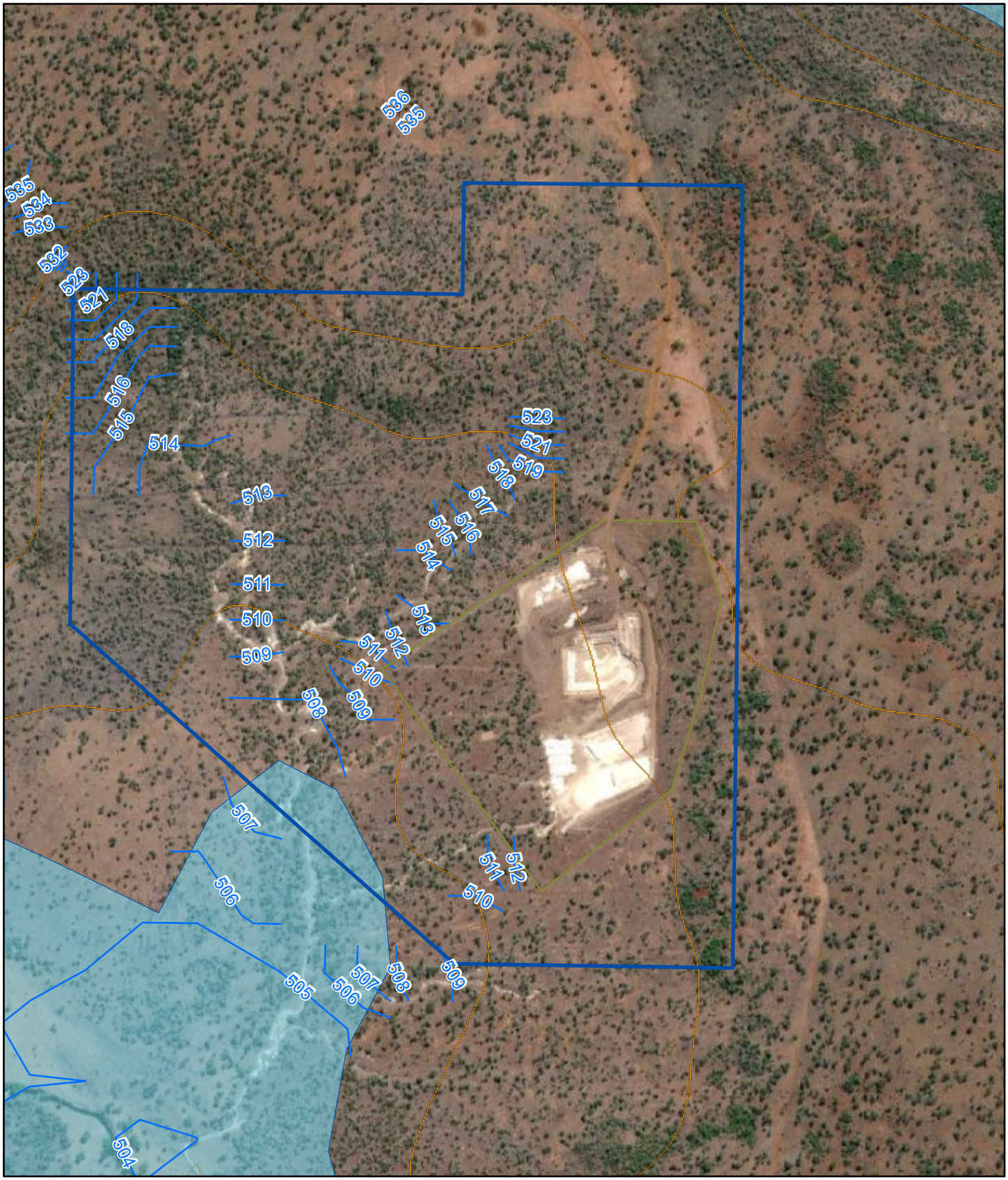
86/87
87/88


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

QFAO overlay



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0 0.07 0.15 0.3 mi

0 0.13 0.25 0.5 km

Contour

- Index
- Intermediate
- ML 10279
- ML10279 PRCP Fenceline
- SMEC Burdekin 100m 100yr Peak WSL Contours
- Qld Floodplain Assessment Overlay 2013

© State of Queensland (Department of Natural Resources and Mines), 2016, Esri Community Maps Contributors, QPWS, Esri, HERE, Garmin, METI/NASA, USGS, Maxar

Web AppBuilder for ArcGIS

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Appendix 3: SOIL AND LAND USE ASSESSMENT AND INFORMATION

Conjuboy Diatomite Project
Baseline Studies

Natural Resource Assessments

ENVIRONMENTAL CONSULTANTS

Chapter 2. Soils

1. INTRODUCTION

According to the terms of reference (received 7 August 2000) on which the original NRA proposal was based (dated 11 August 2000), the following tasks were required

- Conduct a soils/land capability assessment to include a review, description and mapping of the soils in the project area. Samples to be collected from holes to a depth of 40 cm, at 0 cm, 20 cm and 40 cm. Sample locations agreed upon with ELP. Soil edaphic and contamination parameters to include physical and chemical characteristics that may influence erosion potential, the land rehabilitation program, and the quality of water leaving the site.

These tasks related to the proposed bulk sampling work in the MDL with a disturbance area of approximately 56 ha. Following increases to the proposed project area and the move to a ML application, the scope was redefined and the following changes were agreed to the overall scope (record of conversation with Richard Smith, 26 July 2001).

- Soil sampling will not be carried out at fixed depths, but will reflect natural variations in horizon depth.
- Contamination analysis would not be performed as ELP anticipated that the local geochemistry would not have lead to high background concentrations of metals.
- A rapid assessment of the haul route would be carried out to identify any soil-related issues present that may require specific management.

The work carried out addresses the agreed scope and provides information that can be used to prepare an EMOS for the proposed mining operation.

2. METHODOLOGY

The soils investigation was undertaken cognisant of the *Guidelines for Agricultural Land Evaluation in Queensland* (QDPI, 1990) and *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland – Land Suitability Assessment and Determination of Post-mining Land Use* (QDME, 1995). To assist in determining acceptable post-mining land use options, an understanding of pre-mining land resources and suitability is essential. This report seeks to provide information on existing land/soil resources, determine the likely post-mining land suitability, and suggest management options for minimising impacts.

The investigation involved the following tasks:

- a review of available soils and land resource information prior to commencement of fieldwork
- definition of approximate mapping units by air photo interpretation prior to commencement of fieldwork
- a field soil survey to confirm the map unit type and boundaries and describe land and soil resources
- characterisation of soils in terms of physical and chemical properties relevant to soil management and land suitability
- determination of the quality and quantity of soil resources available for use in rehabilitation
- assessment of pre-mining land suitability and potential likely impacts on post-mining suitability
- production of soil resources and land suitability maps.

The following sections provide more detail on the methods employed to achieve these tasks.

2.1 Review of Existing Information

A literature search for published land resources information covering the Conjuboy Project and surrounding area was undertaken and relevant publications obtained. This literature included the following publications:

- *Land Resources of the Einasleigh – Atherton Dry Tropics* (QDPI - Grundy and Bryde, 1989). Soil associations within soil landscape units and suitability mapped at 1:250,000 covering the project area.
- *Cropping Potential in the Eastern Etheridge Shire Area, North Queensland* (QDPI - Kent and Shepherd, 1984). Land resources and capability/suitability mapping at 1:100,000 adjacent to the project area (but covering landscape units present in the project area).
- *Agricultural Land Suitability of Herberton Shire* (QDPI - Grundy and Reid, 1986). Land resources and suitability mapping at 1:250,000 adjacent to the project area (but covering landscape units present in the project area).
- *Land Resources of the Ravenshoe – Mt Garnet Area North Queensland*, Vol 1 (QDPI - Heiner and Grundy, 1994). Soils and UMAs mapped at 1:100,000 adjacent to the project area (but covering landscape units present in the project area).

- *Land Resources of the Ravenshoe – Mt Garnet Area North Queensland*, Vol 2 (DNR - Grundy and Heiner, 1999). Land attributes and suitability mapped at 1:125,000 adjacent to the project area (but covering landscape units present in the project area).
- *Einasleigh 1:250,000 Geological Series Explanatory Notes to accompany Einasleigh 1:250,000 Geological Map Sheet SE 55-9, Second Edition* (QDME – Withnall and Grimes, 1995). Geology mapped at 1:250,000 covering the project area.

2.2 Aerial Photograph Interpretation

Stereo pairs of aerial photographs (approximately 1:25,000) covering the proposed project area were examined to determine key topographical features and vegetation/textural boundaries. Several landscape units were identified and existing soil and land resource information was consulted to determine likely soil types/attributes associated with these. Field surveys were planned to check boundary positions and to describe the soils present on site.

2.3 Soil Survey

The soil survey of the proposed Conjuboy Diatomite Project ML was conducted on 21 to 23 May 2002 inclusive by Andrew Butler of NRA. The study area was approximately 150 ha. The field survey component was undertaken with reference to Gunn *et al* (1988). Free survey techniques were used to determine the distribution of soil mapping units. Free survey was used as it allows flexibility in site selection and provides a more accurate result than grid survey techniques when time is limited. It also allowed effort to be concentrated on the proving of soil boundaries between soils of different quality in terms of re-use, the main purpose of the survey.

As recommended by the QDME guidelines, survey intensity was varied according to planned disturbance with more survey effort afforded to areas that are to be disturbed by mining.

Soil profiles were examined in auger borings and/or hand excavated pits. Approximately 25% of the profiles were described in detail. Soils were very hard and stony in places and prevented deep penetration with hand excavation. In general, soils were excavated by hand to about 50 cm and augering was used to obtain deeper samples. Where possible, profiles were examined to a depth of at least 1 m or until underlying parent material or diatomaceous earth was intercepted. Soils were described using standard terminology as documented in McDonald *et al* (1990). A total of 32 soil observations were made. The level of survey intensity was sufficient to satisy a scale of 1:21,000.

The general soil resources along the proposed haul route were assessed from observations of the soil surface, existing resource information and aerial photography. In particular, soil properties that may affect construction and maintenance of the haul route were noted. No samples were taken. This assessment was carried out on 23 May 2002.

2.4 Soil Analysis

A total of 36 soil samples was collected during the survey. All samples were analysed for pH (1:5 water), EC (1:5 water), chloride, cation exchange capacity (CEC) and exchangeable sodium percentage (ESP). In addition, 7 surface samples from representative profiles were also analysed for organic carbon (%), sulphur (MCP), phosphorus (Colwell), exchangeable potassium, calcium and magnesium, nitrate N and micronutrients (B, Mn, Fe, Zn, Cu). Soil analysis was carried out by Incitec Ltd, a NATA accredited laboratory.

Slaking and dispersion characteristics were determined on selected samples by NRA using a modified Emerson Dispersion test (Loveday and Pyle, 1973).

2.5 Land Suitability Assessment

Land capability assessment was that method relied upon historically with land suitability now the preferred method for the mining industry (QDME, 1995). Land capability classification is recommended for studies where evaluation for a wide range of agricultural uses is required at a small scale (1:250,000 or smaller) (QDPI, 1990). The land capability scheme in use in Land Capability assessment has historically been used in the mining industry for describing the capacity of land resources to sustain a broad range of land uses (both agricultural and non-agricultural). Land suitability assessment is recommended for studies where more specific information at medium or larger scales (1: 100 000 or larger) is required (QDPI, 1990). Land suitability assessments define the capacity of the land resources to sustain particular forms of land use, for example peanuts, maize or pasture. The rankings (land suitability classes) can be applied to small land units and are more useful in determining post-mining land use options than land capability assessment (QDME 1995).

Five land suitability classifications have been defined for use in Queensland, with suitability decreasing progressively from Class 1 to 5. QDME (1995) presents a summation of the suitability classes (based on QDPI, 1990) and also includes descriptors for a *Conservation* use. The suitability classes are briefly summarised below:

Class 1	Agriculture	*Suitable land with negligible limitations* (QDPI, 1990).
	Conservation	These areas possess significant conservation benefits (pre-mining) capable of being returned (post-mining) (QDME, 1995).
Class 2	Agriculture	*Suitable land with minor limitations* (QDPI, 1990).
	Conservation	These areas are suited to conservation use in that a significant component of the pre-mining benefit can be restored post-mining however, there will be some loss of value (QDME, 1995)
Class 3	Agriculture	*Suitable land with moderate limitations* (QDPI, 1990).
	Conservation	These areas possess significant conservation benefits (pre-mining) but restoration of values may not be feasible. These areas could however be restored to a form of conservation use which provides an alternative conservation benefit (QDME, 1995).
Class 4	Agriculture	*Marginal land which is presently considered unsuitable due to severe limitations* (QDPI, 1990).
	Conservation	These areas possess limited conservation value (pre-mining) and/or are incapable of being returned (post-mining), however, may be restored to provide a stable form of use which does not impact on surrounding conservation values (QDME, 1995).
Class 5	Agriculture	*Unsuitable land with extreme limitations* (QDPI, 1990).
	Conservation	These areas contain no significant conservation values (QDME, 1995).

In this report suitability assessments have been made for a range of land uses including conservation. These have been nominated with reference to published reports (particularly Grundy and Heiner 1999 for arable agriculture and QDME, 1995 for extensive grazing and conservation uses) and observations of the land uses surrounding the study area. The assessments are based on field observations, the results of laboratory analyses, and information detailed in published reports.

3. RESULTS AND DISCUSSION

3.1 Existing Land Use

The survey area and much of the surrounding land is used for extensive grazing on native pasture. It is understood that some irrigated fodder cropping (lucerne) has been carried out on Wyandotte Station (using a centre pivot). This area was not examined and it is not known what soil type is used for fodder production.

3.2 Existing Resource Information

With reference to Grundy and Bryde (1989), the following soils were mapped in and around the study area and along the proposed haul route.

Soil Landscape Unit	Mapping Unit	Dominant Great Soil Group	Associated Great Soil Group
Soils of Dissected Plateaux on Basalt	EDB	Euchrozem	Lithosol
Soils of Dissected Plateaux on Basalt	BEDB	Black Earth	[Stony] Krasnozem
Soils of Basalt Lava Plains	SKLB	[Stony] Krasnozem	[Stony] Euchrozem
Soils of Basalt Lava Plains	SBLB	[Stony] Black Earth	[Stony] Brown Clay
Soils of Basalt Lava Plains	BCLB	Brown Clay	[Stony] Xanthozem
Soils of Alluvial Plains on Basaltic Alluvium	BEAL	Black Earth	Grey Clay, Brown Clay

With reference to Kent and Shepherd (1984) the following soils were mapped in an area adjacent (to the immediate south west) to the project area.

Land Resource Area	Dominant Soils and Landform
Red Basaltic Soils	Red structured earths on gently undulating basalt plains or plateaux with low stony flow scarps (severe stoniness)
Dark Basaltic Soils	Dark cracking clays on local alluvial-colluvial plains; areas with low stony flow scarps (little or no stone to severe stoniness)

With reference to Heiner and Grundy (1994), the following soils occupy similar landscape positions on similar parent material to those found in the study area.

Soil Landscape Unit	Mapping Unit	Great Soil Group	Australian Soil Classification
Soils derived from Tertiary-Quarternary Basaltic Rocks. Level to gently undulating rises.	Ironbark (Ib)	Euchrozem	Eutrophic, Red Ferrosol
	Millstream (Ms)	Xanthozem	Mesotrophic, Brown Ferrosol
Soils derived from Basaltic Quarternary Alluvia. Level to gently undulating plains.	Sooty (St)	Black Earth	Self-mulching, Black Vertosol
	Caesar (Cs)	Grey Clay	Self-mulching, Grey Vertosol

3.3 Preliminary Mapping

Several preliminary mapping units were derived from air photo interpretation and with reference to relevant publications. These were used as the basis for the field survey. The mapping units identified are summarised below.

Mapping Unit	Description	Possible soil types
Basalt Plateau	Uniform open woodland vegetation with relatively uniform tone. This same unit dominates the proposed haul route	Red/Brown Ferrosols
Basalt Wall	Dark tones associated with the edge of the basalt plateau, outcrops of basalt likely	Shallow Red Ferrosols
Colluvial Slope	Base of the basalt wall possibly dominated by colluvial material including basalt boulders	Red Ferrosols
Dark Gullies	Depressions in the basalt wall with closed canopy vegetation	Vertosols
Flats	Low lying areas of alluvium/colluvium between the Colluvial Slope and the Creek Zone	Vertosols
Creek Zone	Areas of white along or adjacent to the creek lines	Exposed diatomaceous earth

3.4 Soil Resources Identified in the Proposed Lease Area

A total of 6 mapping units were identified over the site. A description of the soils and their properties are provided in Table 2.1. Some of the soils found were similar to those expected, but some of the soils do not appear to have been previously mapped in the vicinity (though similar soils occur in the region). The distribution of the mapping units is shown on Figure 2. Some of the soils have physical or chemical limitations in the subsoil (mapping units B1 and D1) and it will be necessary to ensure that this subsoil does not become mixed with topsoil during stripping operations. More detail is provided in the recommendations. The survey area was slightly different to the proposed MLA, but soils in the unsurveyed area are likely to be mapped as A1 (Basalt Plateau).

Results of laboratory analyses and a summary table (Table A) are provided in Appendix A. Slaking and dispersion results are provided in Appendix B.

Representative profiles descriptions for each mapping unit are provided in Sections 3.4.1 – 3.4.6.

Table 2.1: Major attributes of the mapping units on the proposed Lease Area

Mapping Unit (previously recorded codes in brackets)	Major distinguishing attributes and properties that may affect their use in rehabilitation	Landform Pattern or Landscape Position	Australian Classification (Great Soil Group equivalent in brackets)
A1 (Ib)[1]	Brown or red strongly pedal clay loam or light strongly pedal clay surface horizon over red pedal subsoil with increasing basalt coarse fragments. Basalt stones (200-600 mm) or boulders (600 mm – 2 m) may be present at the soil surface (up to 40%) or may be present throughout the profile. Hand excavation below 40 cm is difficult. These soils are slightly acid to neutral and apart from their stoniness, they have good soil physical characteristics. There will be few limitations for use of this soil in rehabilitation.	Flat to gently sloping basalt plateau	Red Ferrosol (Euchrozem)
A2 (Ib)[1]	Soil not described, but similar to A1. Soil surface dominated by basalt cobbles and boulders 60-90%. This unit also contains adjacent soils associated with colluvium at the base of the basalt wall. Although slightly different, they were not extensive and were not mapped out. They were of similar suitability to A2 soils being limited by up to 60% cobles and stones at the soil surface and rockiness in the profile. These soils have a thin black weakly pedal sandy clay loam surface layer over black strongly pedal clay loam horizon layer over apedal red light to medium clay. These soils are slightly acid to neutral and apart from their stoniness, they have good soil physical characteristics. High stone content may limit the use of these soils in rehabilitation.	Basalt wall/scarp and associated colluvium	Red Ferrosol/Rudosol ([Stony] Euchrozem/Lithosol)
B1 (St)[1]	Cracking clay with strong self mulching surface over black neutral pedal medium clay A horizon over alkaline black or grey pedal B horizon (where present) commonly with calcareous segregations. Underlain by diatomaceous earth at 30 cm to >1 m depth. Some of these soils have subsoil salinity and sodicity below 30 cm (or sometimes at greater depth). The presence of this increase in salt is not readily recognised in the field. If this soil is mixed with topsoil, topsoil quality will be degraded and rehabilitation may be hindered. The subsoils may be dispersive (though this was not confirmed). This property causes clay in the soil to be easily suspended and removed by percolating water. If subsoils are dispersive, they may be prone to erosion (particularly gully erosion) if exposed.	Flat to gently inclined alluvial/colluvial plains	Black Vertosol (Black Earth)

Mapping Unit (previously recorded codes in brackets)	Major distinguishing attributes and properties that may affect their use in rehabilitation	Landform Pattern or Landscape Position	Australian Classification (Great Soil Group equivalent in brackets)
C1 (not previously recorded, affinities with BMAL) [2]	Shallow grey silt loam to medium clay mixed with or overlying (calcareous) diatomaceous earth within 30 cm. Occasionally mottled in surface (in deeper soils). Soils in seepage lines such as these tend to accumulate salts, particularly if vegetation is removed. The surface soils at Conjuboy were not regarded as saline. Topsoil is thin, but likely to contain seed reserves of value in rehabilitation.	Base of basalt wall, associated with seepage areas	Tenosol/Calcarosol (No Suitable Group)
D1 (Not previously recorded, affinites with GRAL) [2]	Cracking clay with thin dark or red granular crust over black strongly pedal light clay A horizon over neutral or alkaline strongly pedal light clay red subsoil with calcareous segregations. Grading to brown calcareous medium clay over diatomaceous earth at approximately 1 m. May be shallower near drainage lines. Some of these soils have subsoil salinity and sodicity below 30 cm. The presence of this increase in salt is not readily recognised in the field. If this soil is mixed with topsoil, topsoil quality will be degraded and rehabilitation may be hindered. The subsoils may be dispersive (though this was not confirmed) and will be prone to erosion on exposure.	Flat to gently inclined alluvial/colluvial plains	Red Vertosol (Red-Brown Earth)
E1 (Not previously recorded)	White, cream (occasionally banded with yellow) exposed diatomaceous earth. Very poor quality soils of little or no value for rehabilitation.	Drainage lines or banks and gullies below the basalt wall	Tenosol? (No Suitable Group)

[1] Codes given in Heiner and Grundy (1994)

Ib = Ironbark

St = Sooty

[2] Codes given in Grundy and Bryde (1989)

BMAL = Black earth [with *Melaleuca bracteata*] on Alluvial Plains on Basaltic Alluvium

GRAL = Grey clay – red-brown earth complex on Alluvial Plains on Basaltic Alluvium

3.4.1 Unit A1

Description

Observation Points:	S1, S2, S3, S4
Landform:	Flat lava plateau slope 0°.
Coarse Fragments:	Many 60 mm – 2 m basalt cobbles to boulders
Dominant Vegetation	Narrow Leaf Ironbark dominant with Mt Molloy Box, Ghost Gum and Red Bloodwood forming an open woodland. A grass understory of Kangaroo Grass and Black Spear Grass
Australian Classification:	Red Ferrosol
Great Soil Group:	Euchrozem
Plate/s:	1 & 2

Representative Soil Profile (S1)

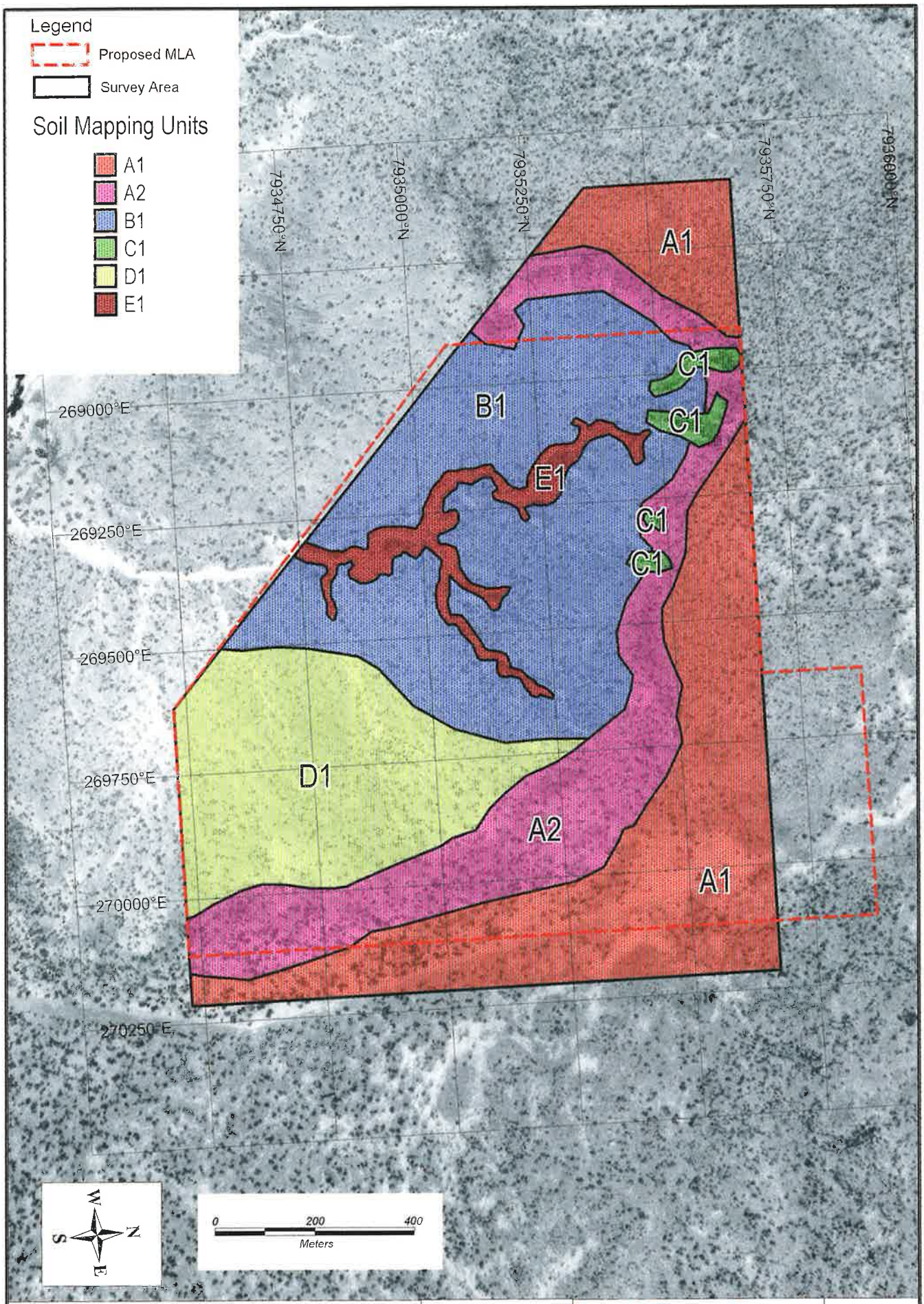
0-2 cm	Very dark brown (10 YR 2/2) very slightly stony (2-6 mm) light clay of firm consistence with strong 2-5 mm granular or polyhedral structure.
2-9 cm	Very dark brown (10 YR 2/2) very slightly stony (2-6 mm) light clay of very firm consistence with strong 20-50 mm polyhedral structure.
9-25 cm	Dark reddish brown (5 YR 3/3) stony (2-6 mm) light clay of firm consistence with strong 20-50 mm sub-angular blocky structure.
25-37 cm	Reddish brown (5YR 4/4) moderately stony (6-20 mm) light clay of weak consistence.

Refusal at base of profile due to weathered basalt.

3.4.2 Unit A2

Description

Observation Points:	S5, S6
Landform:	Lava scarp and colluvial footslope 15°.
Coarse Fragments:	Abundant 60 mm – 2 m basalt cobbles to boulders
Dominant Vegetation	Narrow Leaf Ironbark dominant with Mt Molloy Box, Ghost Gum and Red Bloodwood forming an open woodland. A grass understory of Kangaroo Grass and Black Spear Grass
Australian Classification:	Red Ferrosol
Great Soil Group:	Euchrozem
Plate/s:	3



PROJECT: Conjuboy Diatomite Project
TITLE: Distribution of soil mapping units

JOB NO: 235001.02
DATE: Sep 2002
SOURCE: NRA

Natural Resource Assessments

Figure: 2

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Representative Soil Profile (S5)

0-1 cm	Very dark brown (10 YR 2/2) very slightly stony (2-6 mm) light clay of soft consistence with strong <2 mm granular structure.
1-9 cm	Dark reddish brown (5 YR 3/3) moderately stony (6-60 mm) light clay of firm to very firm consistence with strong 20-50 mm sub-angular blocky structure breaking to polyhedral.
9-15 cm	Reddish brown (5 YR 4/3) moderately stony light clay of very firm consistence.

Refusal at base of profile due to weathered basalt.

A2 Salvage Depth and Soil Management

This area is not expected to be disturbed and soils are of little value due to the high stone content.

3.4.3 Unit B1

Description

Observation Points:	S9, S10, S11, S12, S13, S14, S15B, S18, S19, S23, S26, S28, S30
Landform:	Simple slope 1-3°.
Coarse Fragments:	Few basalt stones
Dominant Vegetation	Widely to very widely spaced Mt Molloy Box and Ghost Gum woodland. Occasional occurrence of Beefwood, Quinine Bush and Conkerberry with an extensive cover of Kangaroo Grass, Black Spear Grass and an unidentified grass (*Dichanthium* sp).
Australian Classification:	Black Vertosol
Great Soil Group:	Black Earth
Plate/s:	4

Representative Soil Profile (S28)

0-2 cm	Surface reddish sandy crust.
2-13 cm	Dark grey (10 YR 3/1) stone free medium clay of very strong consistence with strong 20-50 mm blocky structure.
13-27 cm	Very dark greyish brown (10 YR 3/2) stone free medium clay of very strong consistence with strong 20-50 mm blocky structure. 2% calcareous segregations.
27-75 cm	Dark greyish brown (10 YR 4/2) stone free medium clay of very strong consistence with strong 20-50 mm sub-angular blocky to prismatic structure. Slickensides. 10% calcareous segregations.
75 cm +	Greyish brown (10 YR 5/2) stone free mixed soil and diatomaceous earth containing calcareous segregations.

3.4.4 Unit C1

Description

Observation Points:	S16, S17
Landform:	Simple slope 10°.
Coarse Fragments:	Common basalt stones to boulders
Dominant Vegetation	Exclusive canopy layer of Black Tea Trees
Australian Classification:	Tenosol/Calcarosol
Great Soil Group:	(No Suitable Group)
Plate/s:	5

Representative Soil Profile (S16)

0-13 cm	Light greyish brown to greyish brown (10YR 5/2 – 6/2) silt loam of weak consistence with weak sub-angular blocky structure. 10% cemented diatomaceous earth (or travatine) and 10% calcareous segregations.
13 cm +	White diatomaceous earth with calcareous segregations.

3.4.5 Unit D1

Description

Observation Points:	S7, S8, S20, S21, S22, S24, S25, S27B
Landform:	Simple slope 1-3°.
Coarse Fragments:	Few basalt stones
Dominant Vegetation	Widely to very widely spaced Mt Molloy Box and Ghost Gum woodland. Occasional occurrence of Beefwood, Quinine Bush and Conkerberry with an extensive cover of Kangaroo Grass, Black Spear Grass and an unidentified grass (*Dichanthium* sp).
Australian Classification:	Red Vertosol
Great Soil Group:	Red Brown Earth
Plate/s:	6, 7

Representative Soil Profile (S20)

0-2 cm	Surface reddish sandy crust.
2-12 cm	Very dark brown (10 YR 2/2) very slightly stony (2-6 mm) light clay of very strong consistence with strong 20-50 mm blocky structure.
12-40 cm	Reddish brown (2.5 YR 4/4) with few greyish brown (10YR 4/2) mottles . Stone free light clay of very strong consistence with strong 20-50 mm columnar structure. Slickensides.
40-70 cm	Reddish brown (5 YR 4/3) stone free medium clay of very strong consistence with strong 20-50 mm sub-angular blocky to prismatic structure. 1% calcareous segregations.
70 - 80 cm	Brown to dark brown (7.5 YR 4/2) stone free moderately calcareous medium clay.
80 cm +	White diatomaceous earth.

3.4.6 Unit E1

Description

Observation Points: S15A

Landform: Flat, top of creek bank

Coarse Fragments: None

Dominant Vegetation Widely to very widely spaced Mt Molloy Box and Ghost Gum woodland. Occasional occurrence of Boxthorn, Black Tea Tree, Quinine Bush and Conkerberry with a groundcover of Kangaroo Grass and Black Spear Grass.

Australian Classification: Tenosol

Great Soil Group: (No Suitable Group)

Plate/s: 8

Representative Soil Profile (S15A)

0-5 cm	Greyish brown (10YR 5/ – 6/2) silt loam of weak consistence with weak sub-angular blocky structure.
5 cm +	White (10YR 8/2) with some yellow banding. Calcareous diatomaceous earth.

3.5 Soil Stripping and Handling Recommendations

The surface soil is where the majority of soil biota exist. These biota are critical in maintaining soil physical and chemical fertility. Surface soils also contains a valuable seed bank. It is important during soil stripping and storage operations that surface soil be removed and stored separately from subsoils and unwanted overburden. During restoration at the end of the campaign, the soil profile should be re-instated in the same order in which it was removed (unwanted over burden first, then subsoil and lastly topsoil). The following table gives some guidance for recognising the base of the topsoil for each mapping unit to aid stripping operations.

Table 2.2: Summary of main soil attributes

Soil Unit	Soil Type	Location	Approximate topsoil depth (cm)	Diagnostic Subsoil Features
A1	Red clay soils on basalt	Flat basalt plateau	10	Soil becomes more red than brown.
A2	Stony red clay soils on basalt	Basalt wall/scarp	10	Soil becomes more red than brown.
B1	Dark cracking clay	Flats above creek	30 (based on laboratory data). Do not collect subsoil	Difficult to judge, sometimes subsoil is much harder and blocky. Advice is to strip and store surface 30 cm separately from deeper material.
C1	Shallow grey silt loam under Tea Trees	Heads of drainage lines in basalt walls	15	Diatomaceous earth is exposed below topsoil.
D1	Red/brown cracking clay	Flats above creek	30 (based on laboratory data). Do not collect subsoil	Difficult to judge, sometimes subsoil is much harder and blocky. Advice is to strip and store surface 30 cm separately from deeper material.
E1				No recoverable resources

Due to the nature of the operation (campaign mining of small pits), it is unlikely to be necessary or practical to separately strip and store soils of different types. Where possible soil salvaged for use in rehabilitation should not be stockpiled but directly placed on the restored landform. Where it is not possible to practice direct placement, stockpiles should be:

- kept to a minimum height (<2 m)
- strategically located in terms of final end use and protection from deterioration *eg* free of traffic and erosive agents.
- if soil is to be stockpiled for more for more than 6 weeks the soil should be sown with the vegetation proposed to be used in rehabilitation. At the Conjuboy Project it is critical that weeds, such as parthenium, are not permitted to colonise soil stockpiles.

3.6 Land Suitability Assessments

Pre-mining Land Suitability assessments have been carried out using information and suitability criteria in Grundy and Heiner (1999) and QDME (1995). This information is summarised in Table 2.3. This assessment shows that only mapping units D1 and B1 are marginally suitable for arable or forage cropping. Most of the area is suitable for grazing.

It is our understanding that, during mining, material will be removed to a depth of up to 20 m. After processing, as much as 75% of this material will be returned to the pit as process tailings (mostly clay). This will result in a depressed post-mining landform (by approximately 5 m). This will make these areas unsuitable for cultivation of any kind. However, the areas involved are small and, from what we understand of the proposed operation, the areas to be mined will be adjacent to the basalt wall (an area unsuited to cultivation). It appears that the area marginally suitable for cultivation will be smaller post-mining, but it should remain contiguous.

It should be possible to rehabilitate all other land disturbed by the operation to its original suitability. It is assumed that only Mapping Units B1, C1, D1, E1 will be affected by active mining. The anticipated post-mining land suitability classes of these mapping units within the area affected by extraction are provided in Table 2.4. Outside the areas affected by extraction, post-mining land suitability classes remain as shown in Table 2.3.

3.7 Soil Resources Along the Haul Route

Soil observations were made along part of the proposed haul route. Aerial photographs of the rest of the route were examined. The soils along the haul route were mostly comprised mapping unit A1 (Red Ferrosol) under open Ironbark Woodland. Isolated patches of two other soils were found, mostly in slight depressions. As the areas were mostly about 10 m across, it would have been impossible to map these out with accuracy from the aerial photograph. One of the soils found is similar to that mapped as B1, a black cracking clay. This soil did however commonly contain stones and boulders. These soils appeared to be poorly drained and deep cattle hoof imprints were noted. In wet conditions, tracks on these soils may become rutted and access may be affected. On drying, these soils will become extremely hard and any imperfections created in wet conditions will remain. The other soil noted was similar to that mapped elsewhere on McBride Basalt as "Millstream" (a brown or yellow coloured Brown Ferrosol or Xanthozem) and is likely to behave similarly to the red soils of mapping unit A1.

Table 2.3: Pre-mining Land Suitability classes of the Land Units within the proposed Lease Area

Mapping Unit	Suitability for a Range of Land Use Activities and main limitations[3]									
	Peanuts[1]	Sorghum[1]	Maize[1]	Soy-beans[1]	Mung-beans[1]	Forage Sorghum[1]	Stylo pasture[1]	Grass-legume pasture[1]	Grazing[2]	Conservation[2]
A1	5 r	5 r	5 r	5 r	5 r	5 r	4 r	4 r	2 r	2
A2	5 r	5 r	5 r	5 r	5 r	5 r	5 r	5 r	3 r	2
B1	4 x, p	4 x	4 x	4 x	4 x	4 x	3 n_d, s_a	3 n_d, s_a	3 n_d, s_a	2
C1	5 w, x	5 w, x	5 w, x	5 w, x	5 w, x	5 w, x	5 w, x	5 w, x	4 m?, w	3
D1	4 w, r, p	3 w, e	3 s_a, w, e	3 w, r, e	3 s_a, w, r, e	3 w	3 n_d	3 n_d	3 n_d	2
E1	5 e, x	5 e, x	5 e, x	5 e, x	5 e, x	5 e, x	5 e, x	5 e, x	5 e, x	2

[1] – Based on information and criteria in Grundy and Heiner (1999)

[2] – Based on criteria in QDME (1995)

[3] – Limitation codes: r = rockiness, n_d = soil nutrition, s_a = salinity, x = complexity, p = soil physical condition, w = wetness, e = water erosion, m = moisture

Shaded areas are class 4 and 5 which are regarded as being unsuitable for the designated land use.

Table 2.4: Post-mining Land Suitability classes of the Land Units in areas affected by extraction within the proposed Lease Area

Mapping Unit	Suitability for a Range of Land Use Activities								
	Peanuts	Sorghum	Maize	Soy-beans	Mung-beans	Forage Sorghum	Stylo pasture	Grass-legume pasture	Grazing
B1	5	5	5	5	5	5	5	5	3
C1	5	5	5	5	5	5	5	5	4
D1	5	5	5	5	5	5	5	5	3
E1	5	5	5	5	5	5	5	5	5

4. SUMMATION

4.1 Soil Resources

Salvageable surface soil exists on-site and should be collected for use in rehabilitation (refer Table 2.2).

Some subsoils are sodic (potentially dispersive). Not only should they not be collected for use in rehabilitation, wherever possible they should not be exposed (refer Table 2.2).

Should regrading of pit walls be undertaken (for final landform), care not to expose sodic subsoils is required. If sodic soils were exposed (worse case scenario) then they should be covered with salvaged surface soil and revegetated.

An Erosion and Sediment Control Plan (ESCP) for the project (mine site and haul route) should be prepared prior to the final mine design stage. This ESCP should be progressively implemented during construction and the structures maintained throughout mine life (pre-wet season and post-wet season maintenance check/reparation).

4.2 Land Resources

The majority of the study area is suitable for grazing.

Post-mine land suitability of some small areas of land will be less than that prior to mining. The depressions resulting from backfilling of mined pits will be unsuitable for cultivation. It appears that the area marginally suitable for cultivation will be smaller post-mining, but it should remain contiguous. It should be possible to rehabilitate all other areas disturbed by the operations to its pre-mine land suitability.

Plates

Plate 2.1: Typical soil surface and vegetation – Mapping Unit A1

Plate 2.2: Typical soil surface and vegetation – Mapping Unit A1

Plate 2.3: Typical landscape – Mapping Unit A2

Plate 2.4: Typical vegetation on Black Vertosols – Mapping Unit B1

Note: less dense grass cover than D1.

Plate 2.5: Severe cattle treading (poaching) – Unit C1 (Observation Site 17)

Plate 2.6: Mapping Unit D1 – subsoil structural units and soil surface

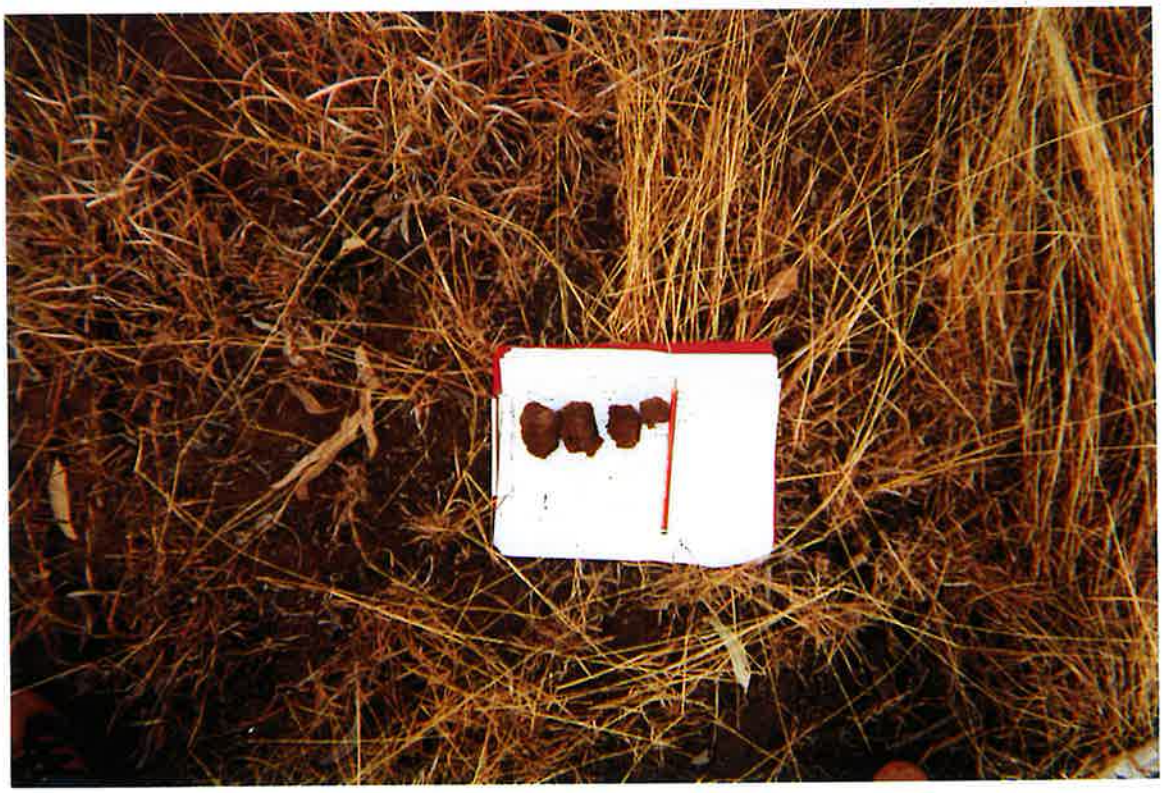

Plate 2.7: Typical vegetation – Mapping Unit D1

Plate 2.8: Mapping Unit E1 (Site 15a)

Plate 3.3: RE 9.3.10 – Mountain Coolibah, Black Tea Tree and springs on black soil plains

Appendix A:
Soil Analysis Results

1. **Table A: Summary of Laboratory Results**
2. **Soil Analysis Reports**

Table A: Summary of Laboratory Results

Site	Sample Depth	pH (1:5 Water)	pH (1:5 CaCl2)	Buffer pH*	Organic Carbon %C	Nitrate Nitrogen mg/kg	Sulfur (MCP) mg/kg	Phosphorus (Colwell) mg/kg	Potassium (Amm.Ac.) meq/100g	Calcium (Amm.Ac.) meq/100g	Magnesium (Amm.Ac.) meq/100g	Aluminium (KCl) meq/100g	Sodium (Amm.Ac.) meq/100g	Chloride mg/kg	Electrical Conduct. dS/m	Copper (DTPA) mg/kg	Zinc (DTPA) mg/kg	Manganese (DTPA) mg/kg	Iron (DTPA) mg/kg	Boron (Hot CacL2) mg/kg	Liming Requirement 6.5	Cation Exch. Cap. Meq/100g	Calcium/Magnesium Ratio	Aluminium Saturation %	Sodium% of cations (ESP)	elec. Conductivity (se) dS/m
1	0-10	6.50	5.70		2.7	1.6	7	74	2.41	14.12	7.59		0.04	20	0.06	2	2.4	36	124	1		24.16	1.86		0.15	0.5
1	10-25	6.60	5.50										0.04	5	0.03							21.64			0.19	0.2
2	0-10	6.50	5.60										0.05	5	0.04							23.32			0.20	0.3
6	0-10	7.10	6.30										0.05	10	0.05							28.15			0.18	0.3
6	18-30	6.30	5.20										0.11	10	0.02							31.46			0.34	0.2
7	0-10	6.50	5.40										0.08	10	0.03							13.00			0.58	0.3
7	20-40	7.00	5.60										0.70	5	0.02							23.32			2.99	0.2
9	0-10	6.30	5.10	6.00	0.8	0.6	4	2	0.16	7.91	8.04	0.02	0.19	5	0.02	0.9	<0.1	26	26	0.3	2.8	16.32	0.98	0.1	1.17	0.2
9	35-45	6.70	5.10									0.04	0.60	5	0.01							25.36		0.2	2.37	0.1
9	70-90	7.40	6.20										0.39	5	0.02							35.88			1.09	0.1
11	0-10	6.40	4.90	5.80	0.8	1	5	2	0.3	11.14	12.24	0.09	0.90	5	0.03	1.5	<0.1	24	44	0.5	4	24.67	0.91	0.4	3.65	0.2
11	40-50	8.10	7.40										6.78	735	0.49							45.02			15.06	3.1
11	80-100	8.40	7.80										8.79	1430	0.92							48.92			17.97	5.7
14	0-10	6.80	5.70										0.46	10	0.03							30.71			1.51	0.2
14	25-35	7.00	5.60										0.79	5	0.02							36.05			2.19	0.1
15A	0-10	8.30	7.70										0.04	5	0.11							52.21			0.07	1.0
15B	0-10	6.70	5.80										0.20	5	0.03							47.15			0.43	0.2
15B	40-50	6.70	5.70										0.27	5	0.02							51.51			0.52	0.1
16	0-10	8.80	8.10		0.8	1	2	8	0.54	20.18	18.72		0.81	5	0.1	0.4	0.1	2	7	0.7		10.25	1.08		2.01	0.6

Site	Sample Depth	pH (1:5 Water)	pH (1:5 CaCl2)	Buffer pH*	Organic Carbon %C	Nitrate Nitrogen mg/kg	Sulfur (MCP) mg/kg	Phosphorus (Colwell) mg/kg	Potassium (Amm.Ac.) meq/100g	Calcium (Amm.Ac.) meq/100g	Magnesium (Amm.Ac.) meq/100g	Aluminium (KCl) meq/100g	Sodium (Amm.Ac.) meq/100g	Chloride mg/kg	Electrical Conduct. dS/m	Copper (DTPA) mg/kg	Zinc (DTPA) mg/kg	Manganese (DTPA) mg/kg	Iron (DTPA) mg/kg	Boron (Hot CacL2) mg/kg	Liming Requirement 6.5	Cation Exch. Cap. Meq/100g	Calcium/Magnesium Ratio	Aluminium Saturation %	Sodium% of cations (ESP)	elec. Conductivity (se) dS/m
19	0-10	7.00	6.00										0.47	5	0.04							33.58			1.40	0.3
19	35-40	7.60	6.30										1.30	5	0.04							37.74			3.44	0.2
20	0-10	6.50	5.40		0.9	0.8	5	2	0.4	6.6	6.73		0.13	5	0.03	1.5	<0.1	32	34	0.5		13.87	0.98		0.96	0.2
20	20-30	6.90	5.40										1.12	15	0.04							22.72			4.94	0.3
20	40-70	8.40	7.60										3.17	330	0.25							32.45			9.76	1.8
20	70-80	8.80	8.20										5.40	685	0.51							58.21			9.28	3.2
27	0-10	7.00	6.20		1.2	1.1	6	5	0.47	14.23	8.22		0.06	10	0.04	0.8	0.2	5	16	0.8		22.98	1.73		0.25	0.3
27	10-30	7.30	6.30										0.20	5	0.02							24.14			0.83	0.2
27	30-50	7.70	6.90										0.38	5	0.05							32.91			1.17	0.3
27	50-70	8.80	8.10										1.20	10	0.13							45.03			2.67	0.9
27	75-85	8.90	8.20										2.31	80	0.17							55.39			4.18	1.1
28	0-10	7.70	7.00		0.7	0.7	4	2	0.47	26.75	9.85		0.06	5	0.05	0.8	<0.1	2	8	1		37.14	2.72		0.17	0.3
28	15-25	8.10	7.40						0.32	26.38	11.05		0.12	5	0.12							37.87	2.39		0.30	0.3
28	35-70	8.60	7.90										0.74	10	0.12							52.01			1.42	0.8
28	80-90	8.70	8.10										2.46	180	0.24							56.60			4.35	1.5
29	0-10	8.30	7.60										0.09	5	0.09							35.53			0.26	0.7
29	25-35	8.50	7.80										0.28	5	0.1							56.63			0.47	0.6

SOIL ANALYSIS REPORT

Incitec Ltd
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PO BOX 5678
CAIRNS
QLD 4870

Phone		Fax	
Nearest Town		Postcode	
Distance to Town		Direction to Town	
Australian Map Grid Ref	. .	Average Annual Rainfall	mm

SOIL SAMPLE AND SITE INFORMATION:

Sampling depth(cm)	0-10	Surface	Months of Fallow	
Sampling depth(cm)	-	Deep	Age of cultivation	yrs
			Drainage	
Paddock area		ha	Stubble/Trash	
Soil type			Tillage	
Slope			Irrigation	
Soil profile depth	m			
Reasons for sampling	1.			
	2.			

PRODUCTION INFORMATION:

			yrs mths
Main species to be fertilized		Age established	-
Variety		Root stock(Hort)	
Previous best yield		Plant population	ha
Yield last year		Canopy radius(Hort)	m
Vigour of growth		Grain protein	
Row/tree spacing(Hort)	m X m	Legume content	
Row spacing(Grain/Cotton)		Stock type	
Interrow treatment		Stock number	
Stage in Crop Cycle(Sugar Cane)			
Method of fertilizer placement:			
1.	2.	3.	

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NATA Accredited Laboratory Number: 1292

Registered Signatory
P.M. Ferguson
Patricia Ferguson
Laboratory Analyst

The Laboratory is not associated with the sampling process.
Samples are analysed as received after drying at 40°C.

Results of Analysis

PADDOCK NAME	235001.02
ORDER NUMBER	615067
PRODUCT	SQ 2002/062 SOIL
SAMPLE BAG NUMBER SURFACE	OBS-1A
CORRESPONDING DEEP SOIL BAG No	
DATE OF SAMPLING	27/05/02
DATE RECEIVED	04/06/02
DATE OF REPORT	11/06/02

Soil colour (Munsell)	Brown
Soil texture	Clay Loam
pH(1:5 Water)	6.5
pH(1:5 CaCl2)	5.7
Organic Carbon %C	2.7
Nitrate Nitrogen mg/kg	1.6
Sulfur (MCP) mg/kg	7
Phosphorus(Colwell) mg/kg	74
Potassium(Amm.Ac.)meq/100g	2.41
Calcium (Amm.Ac.) meq/100g	14.12
Magnesium(Amm.Ac.)meq/100g	7.59
Sodium (Amm Ac.) meq/100g	0.04
Chloride mg/kg	20
Electrical Conduct. dS/m	0.06
Copper (DTPA) mg/kg	2.0
Zinc (DTPA) mg/kg	2.4
Manganese (DTPA) mg/kg	36
Iron (DTPA) mg/kg	124
Boron (Hot CaCl2) mg/kg	1.0

Calculations

Cation Exch. Cap. meq/100g	24.16
Calcium/Magnesium Ratio	1.86
Elec.Conductivity(se) dS/m	0.5
Sodium% of cations(ESP)	0.15

Methods, Calculations outlined overpage.

FOR INTERPRETATION OF THESE RESULTS,
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NARELLE JAGER

Other Relevant Comments

Report # g0241428

* Denote "NATA Accreditation Does Not Cover Performance Of This Service".

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CAIRNS
QLD 4870

RECEIVED 13 JUN 2002

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Direction to Town
Australian Map Grid Ref . .
Average Annual Rainfall mm

SOIL SAMPLE AND SITE INFORMATION:

Sampling depth(cm)	10-25 Surface	Months of Fallow	
Sampling depth(cm)	- Deep	Age of cultivation	yrs
		Drainage	
Paddock area	ha	Stubble/Trash	
Soil type		Tillage	
Slope		Irrigation	
Soil profile depth	m		
Reasons for sampling	1.		
	2.		

PRODUCTION INFORMATION:

			yrs mths
Main species to be fertilized		Age established	-
Variety		Root stock(Hort)	
Previous best yield		Plant population	ha
Yield last year		Canopy radius(Hort)	m
Vigour of growth		Grain protein	
Row/tree spacing(Hort)	m X m	Legume content	
Row spacing(Grain/Cotton)		Stock type	
Interrow treatment		Stock number	
Stage in Crop Cycle(Sugar Cane)			

Method of fertilizer placement:
1. 2. 3.

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Number: 1292

Registered Signatory
Patricia Ferguson
Laboratory Analyst

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Other Relevant Comments

Results of Analysis

PADDOCK NAME	235001.02
ORDER NUMBER	615067
PRODUCT	SQ 2002/305 SOIL
SAMPLE BAG NUMBER SURFACE	OBS-1B
CORRESPONDING DEEP SOIL BAG No	
DATE OF SAMPLING	27/05/02
DATE RECEIVED	04/06/02
DATE OF REPORT	07/06/02

Soil texture	Light Clay
pH(1:5 Water)	6.6
pH(1:5 CaCl2)	5.5
Sodium (Amm Ac.) meq/100g	0.04
Chloride mg/kg	5
Electrical Conduct. dS/m	0.03

Calculations

Cation Exch. Cap. meq/100g	21.64
Sodium% of cations(ESP)	0.19
Elec.Conductivity(se) dS/m	0.2

Methods, Calculations outlined overpage.

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Report # g0241429

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QLD 4870

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Nearest Town
Postcode
Distance to Town
Direction to Town
Australian Map Grid Ref . .
Average Annual Rainfall mm

SOIL SAMPLE AND SITE INFORMATION:

Sampling depth(cm) 0-10 Surface
Sampling depth(cm) - Deep
Paddock area ha
Soil type
Slope
Soil profile depth m
Reasons for sampling 1.
2.

Months of Fallow
Age of cultivation yrs
Drainage
Stubble/Trash
Tillage
Irrigation

PRODUCTION INFORMATION:

Main species to be fertilized
Variety
Previous best yield
Yield last year
Vigour of growth
Row/tree spacing(Hort) m X m
Row spacing(Grain/Cotton)
Interrow treatment
Stage in Crop Cycle(Sugar Cane)
Method of fertilizer placement:
1. 2. 3.

yrs mths
Age established -
Root stock(Hort)
Plant population ha
Canopy radius(Hort) m
Grain protein
Legume content
Stock type
Stock number

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Laboratory Analyst

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Other Relevant Comments

Report # g0241430

Form No. 804 (Rev.6)

Results of Analysis

PADDOCK NAME	235001.02
ORDER NUMBER	615067
PRODUCT	SQ 2002/305 SOIL
SAMPLE BAG NUMBER SURFACE	OBS-2A
CORRESPONDING DEEP SOIL BAG No	
DATE OF SAMPLING	27/05/02
DATE RECEIVED	04/06/02
DATE OF REPORT	07/06/02

Soil texture	Light Clay
pH(1:5 Water)	6.5
pH(1:5 CaCl2)	5.6
Sodium (Amm Ac.) meq/100g	0.05
Chloride mg/kg	5
Electrical Conduct. dS/m	0.04

Calculations

Cation Exch. Cap. meq/100g	23.32
Sodium% of cations(ESP)	0.20
Elec.Conductivity(se) dS/m	0.3

Methods, Calculations outlined overpage.

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Direction to Town
Australian Map Grid Ref . .
Average Annual Rainfall mm

SOIL SAMPLE AND SITE INFORMATION:

Sampling depth(cm) 0-10 Surface
Sampling depth(cm) - Deep
Paddock area ha
Soil type
Slope
Soil profile depth m
Reasons for sampling 1.
2.

Months of Fallow
Age of cultivation yrs
Drainage
Stubble/Trash
Tillage
Irrigation

PRODUCTION INFORMATION:

Main species to be fertilized
Variety
Previous best yield
Yield last year
Vigour of growth
Row/tree spacing(Hort) m X m
Row spacing(Grain/Cotton)
Interrow treatment
Stage in Crop Cycle(Sugar Cane)
Method of fertilizer placement:
1. 2. 3.

Age established yrs mths -
Root stock(Hort)
Plant population ha
Canopy radius(Hort) m
Grain protein
Legume content
Stock type
Stock number

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Laboratory Analyst

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Other Relevant Comments

Results of Analysis

PADDOCK NAME	235001.02
ORDER NUMBER	615067
PRODUCT	SQ 2002/305 SOIL
SAMPLE BAG NUMBER SURFACE	OBS-6A
CORRESPONDING DEEP SOIL BAG No	
DATE OF SAMPLING	27/05/02
DATE RECEIVED	04/06/02
DATE OF REPORT	11/06/02

Soil texture	Light Clay
pH(1:5 Water)	7.1
pH(1:5 CaCl2)	6.3
Sodium (Amm Ac.) meq/100g	0.05
Chloride mg/kg	10
Electrical Conduct. dS/m	0.05

Calculations

Cation Exch. Cap. meq/100g	28.15
Sodium% of cations(ESP)	0.18
Elec.Conductivity(se) dS/m	0.3

Methods, Calculations outlined overpage.

FOR INTERPRETATION OF THESE RESULTS,
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Australian Map Grid Ref	. .	Average Annual Rainfall	mm

SOIL SAMPLE AND SITE INFORMATION:

Sampling depth(cm)	18-30	Surface	Months of Fallow	
Sampling depth(cm)	-	Deep	Age of cultivation	yrs
			Drainage	
Paddock area		ha	Stubble/Trash	
Soil type			Tillage	
Slope			Irrigation	
Soil profile depth	m			
Reasons for sampling	1.			
	2.			

PRODUCTION INFORMATION:

			yrs mths
Main species to be fertilized		Age established	-
Variety		Root stock(Hort)	
Previous best yield		Plant population	ha
Yield last year		Canopy radius(Hort)	m
Vigour of growth		Grain protein	
Row/tree spacing(Hort)	m X m	Legume content	
Row spacing(Grain/Cotton)		Stock type	
Interrow treatment		Stock number	
Stage in Crop Cycle(Sugar Cane)			

Method of fertilizer placement:
1. 2. 3.

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NATA Accredited Laboratory Number: 1292

Registered Signatory
Patricia Ferguson
Laboratory Analyst

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Samples are analysed as received after drying at 40°C.

Other Relevant Comments

Report # g0241432

Form No. 804 (Rev.6)

Results of Analysis

PADDOCK NAME	235001.02
ORDER NUMBER	615067
PRODUCT	SQ 2002/305 SOIL
SAMPLE BAG NUMBER SURFACE	OBS-6B
CORRESPONDING DEEP SOIL BAG No	
DATE OF SAMPLING	27/05/02
DATE RECEIVED	04/06/02
DATE OF REPORT	11/06/02

Soil texture	Light Clay
pH(1:5 Water)	6.3
pH(1:5 CaCl2)	5.2
Sodium (Amm Ac.) meq/100g	0.11
Chloride mg/kg	10
Electrical Conduct. dS/m	0.02

Calculations

Cation Exch. Cap. meq/100g	31.46
Sodium% of cations(ESP)	0.34
Elec.Conductivity(se) dS/m	0.2

Methods, Calculations outlined overpage.

FOR INTERPRETATION OF THESE RESULTS,
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NARELLE JAGER

SOIL ANALYSIS REPORT

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QLD 4870

Phone | Fax
Nearest Town | Postcode
Distance to Town | Direction to Town
Australian Map Grid Ref . . | Average Annual Rainfall mm

SOIL SAMPLE AND SITE INFORMATION:

Sampling depth(cm)	0-10	Surface	Months of Fallow	
Sampling depth(cm)	-	Deep	Age of cultivation	yrs
			Drainage	
Paddock area		ha	Stubble/Trash	
Soil type			Tillage	
Slope			Irrigation	
Soil profile depth	m			
Reasons for sampling	1.			
	2.			

PRODUCTION INFORMATION:

			yrs mths
Main species to be fertilized		Age established	-
Variety		Root stock(Hort)	
Previous best yield		Plant population	ha
Yield last year		Canopy radius(Hort)	m
Vigour of growth		Grain protein	
Row/tree spacing(Hort)	m X m	Legume content	
Row spacing(Grain/Cotton)		Stock type	
Interrow treatment		Stock number	
Stage in Crop Cycle(Sugar Cane)			

Method of fertilizer placement:
1. 2. 3.

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Number: 1292

Registered Signatory
Patricia Ferguson
Laboratory Analyst

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Samples are analysed as received after drying at 40°C.

Other Relevant Comments

Form No. 804 (Rev.6)

Results of Analysis

PADDOCK NAME	235001.02
ORDER NUMBER	615067
PRODUCT	SQ 2002/305 SOIL
SAMPLE BAG NUMBER SURFACE	OBS-7A
CORRESPONDING DEEP SOIL BAG No	
DATE OF SAMPLING	27/05/02
DATE RECEIVED	04/06/02
DATE OF REPORT	11/06/02

Soil texture	Sandy Clay Loam
pH(1:5 Water)	6.5
pH(1:5 CaCl2)	5.4
Sodium (Amm Ac.) meq/100g	0.08
Chloride mg/kg	10
Electrical Conduct. dS/m	0.03

Calculations

Cation Exch. Cap. meq/100g	13.00
Sodium% of cations(ESP)	0.58
Elec.Conductivity(se) dS/m	0.3

Methods, Calculations outlined overpage.

FOR INTERPRETATION OF THESE RESULTS,
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NARELLE JAGER

Report # g0241433

SOIL ANALYSIS REPORT

Incitec Ltd
A.B.N. 41 010 767 263
Paringa Road, Gibson Island, Murarrie
P.O. Box 140, Morningside, Qld 4170
Tel: (07) 3867 9300
Website: www.incitecfertilizers.com.au

NUTRIENT ADVANTAGE

NATURAL RESOURCE ASSESS.
PO BOX 5678
CAIRNS
QLD 4870

Phone | Fax
Nearest Town | Postcode
Distance to Town | Direction to Town
Australian Map Grid Ref . . | Average Annual Rainfall mm

SOIL SAMPLE AND SITE INFORMATION:

Sampling depth(cm)	20-40 Surface	Months of Fallow	
Sampling depth(cm)	- Deep	Age of cultivation	yrs
		Drainage	
Paddock area	ha	Stubble/Trash	
Soil type		Tillage	
Slope		Irrigation	
Soil profile depth	m		
Reasons for sampling	1.		
	2.		

PRODUCTION INFORMATION:

			yrs mths
Main species to be fertilized		Age established	-
Variety		Root stock(Hort)	
Previous best yield		Plant population	ha
Yield last year		Canopy radius(Hort)	m
Vigour of growth		Grain protein	
Row/tree spacing(Hort)	m X m	Legume content	
Row spacing(Grain/Cotton)		Stock type	
Interrow treatment		Stock number	
Stage in Crop Cycle(Sugar Cane)			
Method of fertilizer placement:			
1.	2.	3.	

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NATA Accredited Laboratory Number: 1292

Registered Signatory
Patricia Ferguson
Laboratory Analyst

The Laboratory is not associated with the sampling process.
Samples are analysed as received after drying at 40°C.

Other Relevant Comments

Results of Analysis

PADDOCK NAME	235001.02
ORDER NUMBER	615067
PRODUCT	SQ 2002/305 SOIL
SAMPLE BAG NUMBER SURFACE	OBS-7B
CORRESPONDING DEEP SOIL BAG No	
DATE OF SAMPLING	27/05/02
DATE RECEIVED	04/06/02
DATE OF REPORT	11/06/02

Soil texture	Light Clay
pH(1:5 Water)	7.0
pH(1:5 CaCl2)	5.6
Sodium (Amm Ac.) meq/100g	0.70
Chloride mg/kg	5
Electrical Conduct. dS/m	0.02

Calculations

Cation Exch. Cap. meq/100g	23.32
Sodium% of cations(ESP)	2.99
Elec.Conductivity(se) dS/m	0.2

Methods, Calculations outlined overpage.

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Report # g0241434

SOIL ANALYSIS REPORT

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Distance to Town		Direction to Town	
Australian Map Grid Ref	. .	Average Annual Rainfall	mm

SOIL SAMPLE AND SITE INFORMATION:

Sampling depth(cm)	0-10 Surface	Months of Fallow	
Sampling depth(cm)	- Deep	Age of cultivation	yrs
		Drainage	
Paddock area	ha	Stubble/Trash	
Soil type		Tillage	
Slope		Irrigation	
Soil profile depth	m		
Reasons for sampling	1.		
	2.		

PRODUCTION INFORMATION:

			yrs mths
Main species to be fertilized		Age established	-
Variety		Root stock(Hort)	
Previous best yield		Plant population	ha
Yield last year		Canopy radius(Hort)	m
Vigour of growth		Grain protein	
Row/tree spacing(Hort)	m X m	Legume content	
Row spacing(Grain/Cotton)		Stock type	
Interrow treatment		Stock number	
Stage in Crop Cycle(Sugar Cane)			
Method of fertilizer placement:			
1.	2.	3.	

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Number: 1292

Registered Signatory
Patricia Ferguson
Laboratory Analyst

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Results of Analysis

PADDOCK NAME	235001.02
ORDER NUMBER	615067
PRODUCT	SQ 2002/062 SOIL
SAMPLE BAG NUMBER SURFACE	OBS-9A
CORRESPONDING DEEP SOIL BAG No	
DATE OF SAMPLING	27/05/02
DATE RECEIVED	04/06/02
DATE OF REPORT	11/06/02

Soil colour (Munsell)	Dark Grey Brown
Soil texture	Coarse Sandy Clay Loam
pH(1:5 Water)	6.3
pH(1:5 CaCl2)	5.1
*Buffer pH	6.0
Organic Carbon %C	0.8
Nitrate Nitrogen mg/kg	0.6
Sulfur (MCP) mg/kg	4
Phosphorus(Colwell) mg/kg	2
Potassium(Amm.Ac.)meq/100g	0.16
Calcium (Amm.Ac.) meq/100g	7.91
Magnesium(Amm.Ac.)meq/100g	8.04
Aluminium (KCl) meq/100g	0.02
Sodium (Amm Ac.) meq/100g	0.19
Chloride mg/kg	5
Electrical Conduct. dS/m	0.02
Copper (DTPA) mg/kg	0.9
Zinc (DTPA) mg/kg	<0.1
Manganese (DTPA) mg/kg	26
Iron (DTPA) mg/kg	26
Boron (Hot CaCl2) mg/kg	0.3

Calculations

Liming Requirement 6.5	2.8
Cation Exch. Cap. meq/100g	16.32
Calcium/Magnesium Ratio	0.98
Aluminium Saturation %	0.1
Elec.Conductivity(se) dS/m	0.2
Sodium% of cations(ESP)	1.17

Methods, Calculations outlined overpage.

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Other Relevant Comments

Report # g0241435

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Form No. 804 (Rev.6)

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Nearest Town		Postcode	
Distance to Town		Direction to Town	
Australian Map Grid Ref	. .	Average Annual Rainfall	mm

SOIL SAMPLE AND SITE INFORMATION:

Sampling depth(cm)	35-45	Surface	Months of Fallow	
Sampling depth(cm)	-	Deep	Age of cultivation	yrs
			Drainage	
Paddock area		ha	Stubble/Trash	
Soil type			Tillage	
Slope			Irrigation	
Soil profile depth	m			
Reasons for sampling	1.			
	2.			

PRODUCTION INFORMATION:

			yrs mths
Main species to be fertilized		Age established	-
Variety		Root stock(Hort)	
Previous best yield		Plant population	ha
Yield last year		Canopy radius(Hort)	m
Vigour of growth		Grain protein	
Row/tree spacing(Hort)	m X m	Legume content	
Row spacing(Grain/Cotton)		Stock type	
Interrow treatment		Stock number	
Stage in Crop Cycle(Sugar Cane)			
Method of fertilizer placement:			
1.	2.	3.	

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Registered Signatory
Patricia Ferguson
Laboratory Analyst

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Other Relevant Comments

Results of Analysis

PADDOCK NAME	235001.02
ORDER NUMBER	615067
PRODUCT	SQ 2002/305 SOIL
SAMPLE BAG NUMBER SURFACE	OBS-9B
CORRESPONDING DEEP SOIL BAG No	
DATE OF SAMPLING	27/05/02
DATE RECEIVED	04/06/02
DATE OF REPORT	11/06/02

Soil texture	Medium Clay
pH(1:5 Water)	6.7
pH(1:5 CaCl2)	5.1
Aluminium (KCl) meq/100g	0.04
Sodium (Amm Ac.) meq/100g	0.60
Chloride mg/kg	5
Electrical Conduct. dS/m	0.01

Calculations

Cation Exch. Cap. meq/100g	25.36
Aluminium Saturation %	0.2
Sodium% of cations(ESP)	2.37
Elec.Conductivity(se) dS/m	0.1

Methods, Calculations outlined overpage.

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Report # g0241436

Form No. 804 (Rev.6)

SOIL ANALYSIS REPORT

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Tel: (07) 3867 9300
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QLD 4870

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Nearest Town | Postcode
Distance to Town | Direction to Town
Australian Map Grid Ref . . | Average Annual Rainfall mm

SOIL SAMPLE AND SITE INFORMATION:

Sampling depth(cm) 70-90 Surface | Months of Fallow
Sampling depth(cm) - Deep | Age of cultivation yrs
Drainage
Paddock area ha | Stubble/Trash
Soil type | Tillage
Slope | Irrigation
Soil profile depth m
Reasons for sampling 1.
2.

PRODUCTION INFORMATION: yrs mths

Main species to be fertilized | Age established -
Variety | Root stock(Hort)
Previous best yield | Plant population ha
Yield last year | Canopy radius(Hort) m
Vigour of growth | Grain protein
Row/tree spacing(Hort) m X m | Legume content
Row spacing(Grain/Cotton) | Stock type
Interrow treatment | Stock number
Stage in Crop Cycle(Sugar Cane)
Method of fertilizer placement:
1. 2. 3.

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Registered Signatory
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Laboratory Analyst

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Other Relevant Comments

Report # g0241437

Form No. 804 (Rev.6)

Results of Analysis

PADDOCK NAME	235001.02
ORDER NUMBER	615067
PRODUCT	SQ 2002/305 SOIL
SAMPLE BAG NUMBER SURFACE	OBS-9C
CORRESPONDING DEEP SOIL BAG No	
DATE OF SAMPLING	27/05/02
DATE RECEIVED	04/06/02
DATE OF REPORT	11/06/02

Soil texture	Medium Clay
pH(1:5 Water)	7.4
pH(1:5 CaCl2)	6.2
Sodium (Amm Ac.) meq/100g	0.39
Chloride mg/kg	5
Electrical Conduct. dS/m	0.02

Calculations

Cation Exch. Cap. meq/100g	35.88
Sodium% of cations(ESP)	1.09
Elec.Conductivity(se) dS/m	0.1

Methods, Calculations outlined overpage.

FOR INTERPRETATION OF THESE RESULTS,
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SOIL ANALYSIS REPORT

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Distance to Town		Direction to Town	
Australian Map Grid Ref	. .	Average Annual Rainfall	mm

SOIL SAMPLE AND SITE INFORMATION:

Sampling depth(cm)	0-10	Surface	Months of Fallow	
Sampling depth(cm)	-	Deep	Age of cultivation	yrs
			Drainage	
Paddock area		ha	Stubble/Trash	
Soil type			Tillage	
Slope			Irrigation	
Soil profile depth	m			
Reasons for sampling	1.			
	2.			

PRODUCTION INFORMATION:

			yrs mths
Main species to be fertilized		Age established	-
Variety		Root stock(Hort)	
Previous best yield		Plant population	ha
Yield last year		Canopy radius(Hort)	m
Vigour of growth		Grain protein	
Row/tree spacing(Hort)	m X m	Legume content	
Row spacing(Grain/Cotton)		Stock type	
Interrow treatment		Stock number	
Stage in Crop Cycle(Sugar Cane)			

Method of fertilizer placement:
1. 2. 3.

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Number: 1292

Registered Signatory
Patricia Ferguson
Laboratory Analyst

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Results of Analysis

PADDOCK NAME	235001.02
ORDER NUMBER	615067
PRODUCT	SQ 2002/062 SOIL
SAMPLE BAG NUMBER SURFACE	OBS-11A
CORRESPONDING DEEP SOIL BAG No	
DATE OF SAMPLING	27/05/02
DATE RECEIVED	04/06/02
DATE OF REPORT	11/06/02

Soil colour (Munsell)	Dark Grey Brown
Soil texture	Medium Clay
pH(1:5 Water)	6.4
pH(1:5 CaCl2)	4.9
*Buffer pH	5.8
Organic Carbon %C	0.8
Nitrate Nitrogen mg/kg	1.0
Sulfur (MCP) mg/kg	5
Phosphorus(Colwell) mg/kg	2
Potassium(Amm.Ac.)meq/100g	0.30
Calcium (Amm.Ac.) meq/100g	11.14
Magnesium(Amm.Ac.)meq/100g	12.24
Aluminium (KCl) meq/100g	0.09
Sodium (Amm Ac.) meq/100g	0.90
Chloride mg/kg	5
Electrical Conduct. dS/m	0.03
Copper (DTPA) mg/kg	1.5
Zinc (DTPA) mg/kg	<0.1
Manganese (DTPA) mg/kg	24
Iron (DTPA) mg/kg	44
Boron (Hot CaCl2) mg/kg	0.5

Calculations

Liming Requirement 6.5	4.0
Cation Exch. Cap. meq/100g	24.67
Calcium/Magnesium Ratio	0.91
Aluminium Saturation %	0.4
Elec.Conductivity(se) dS/m	0.2
Sodium% of cations(ESP)	3.65

Methods, Calculations outlined overpage.

FOR INTERPRETATION OF THESE RESULTS,
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Other Relevant Comments

Report # g0241438

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Form No. 804 (Rev.6)

SOIL ANALYSIS REPORT

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NUTRIENT ADVANTAGE

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PO BOX 5678
CAIRNS
QLD 4870

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Nearest Town		Postcode	
Distance to Town		Direction to Town	
Australian Map Grid Ref	. .	Average Annual Rainfall	mm

SOIL SAMPLE AND SITE INFORMATION:

Sampling depth(cm)	40-50	Surface	Months of Fallow	
Sampling depth(cm)	-	Deep	Age of cultivation	yrs
			Drainage	
Paddock area		ha	Stubble/Trash	
Soil type			Tillage	
Slope			Irrigation	
Soil profile depth	m			
Reasons for sampling	1.			
	2.			

PRODUCTION INFORMATION:

			yrs mths
Main species to be fertilized		Age established	-
Variety		Root stock(Hort)	
Previous best yield		Plant population	ha
Yield last year		Canopy radius(Hort)	m
Vigour of growth		Grain protein	
Row/tree spacing(Hort)	m X m	Legume content	
Row spacing(Grain/Cotton)		Stock type	
Interrow treatment		Stock number	
Stage in Crop Cycle(Sugar Cane)			

Method of fertilizer placement:
1. 2. 3.

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Number: 1292

Registered Signatory
Patricia Ferguson
Laboratory Analyst

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Samples are analysed as received after drying at 40°C.

Other Relevant Comments

Results of Analysis

PADDOCK NAME	235001.02
ORDER NUMBER	615067
PRODUCT	SQ 2002/305 SOIL
SAMPLE BAG NUMBER SURFACE	OBS-11B
CORRESPONDING DEEP SOIL BAG No	
DATE OF SAMPLING	27/05/02
DATE RECEIVED	04/06/02
DATE OF REPORT	11/06/02

Soil texture	Medium Clay
pH(1:5 Water)	8.1
pH(1:5 CaCl2)	7.4
Sodium (Amm Ac.) meq/100g	6.78
Chloride mg/kg	735
Electrical Conduct. dS/m	0.49

Calculations

Cation Exch. Cap. meq/100g	45.02
Sodium% of cations(ESP)	15.06
Elec.Conductivity(se) dS/m	3.1

Methods, Calculations outlined overpage.

FOR INTERPRETATION OF THESE RESULTS,
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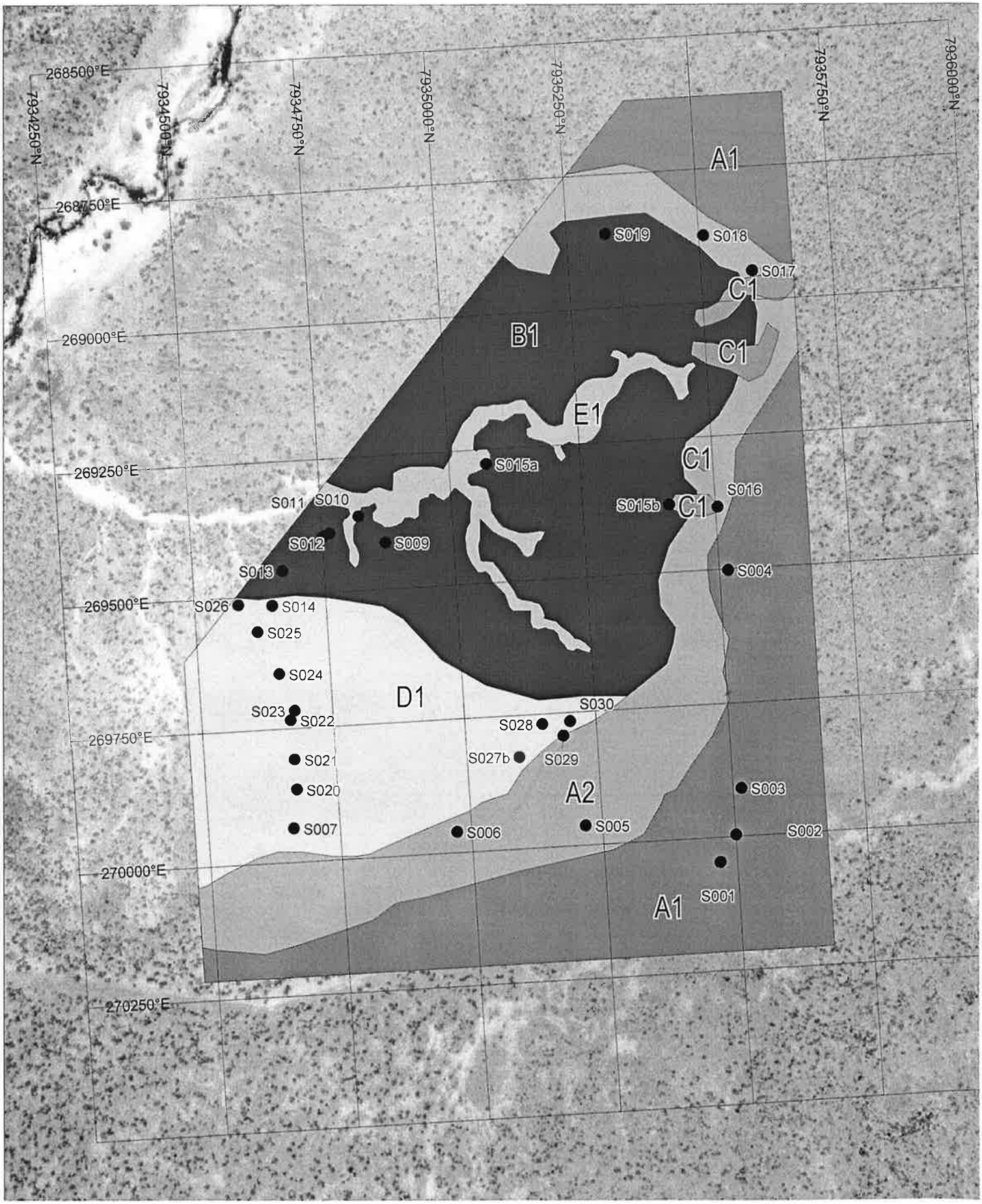
Report # g0241439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SOIL ANALYSIS REPORT

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Nearest Town		Postcode	
Distance to Town		Direction to Town	
Australian Map Grid Ref	. .	Average Annual Rainfall	mm

SOIL SAMPLE AND SITE INFORMATION:

Sampling depth(cm)	80-**	Surface	Months of Fallow	
Sampling depth(cm)	-	Deep	Age of cultivation	yrs
			Drainage	
Paddock area		ha	Stubble/Trash	
Soil type			Tillage	
Slope			Irrigation	
Soil profile depth	m			
Reasons for sampling	1.			
	2.			

PRODUCTION INFORMATION:

			yrs mths
Main species to be fertilized		Age established	-
Variety		Root stock(Hort)	
Previous best yield		Plant population	ha
Yield last year		Canopy radius(Hort)	m
Vigour of growth		Grain protein	
Row/tree spacing(Hort)	m X m	Legume content	
Row spacing(Grain/Cotton)		Stock type	
Interrow treatment		Stock number	
Stage in Crop Cycle(Sugar Cane)			

Method of fertilizer placement:
1. 2. 3.

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Registered Signatory
Patricia Ferguson
Laboratory Analyst

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Samples are analysed as received after drying at 40°C.

Other Relevant Comments

Form No. 804 (Rev.6)

Results of Analysis

PADDOCK NAME	235001.02
ORDER NUMBER	615067
PRODUCT	SQ 2002/305 SOIL
SAMPLE BAG NUMBER SURFACE	OBS-11C
CORRESPONDING DEEP SOIL BAG No	
DATE OF SAMPLING	27/05/02
DATE RECEIVED	04/06/02
DATE OF REPORT	11/06/02

Soil texture	Medium Clay
pH(1:5 Water)	8.4
pH(1:5 CaCl2)	7.8
Sodium (Amm Ac.) meq/100g	8.79
Chloride mg/kg	1430
Electrical Conduct. dS/m	0.92

Calculations

Cation Exch. Cap. meq/100g	48.92
Sodium% of cations(ESP)	17.97
Elec.Conductivity(se) dS/m	5.7

Methods, Calculations outlined overpage.

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Report # g0241440

SOIL ANALYSIS REPORT

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Nearest Town		Postcode	
Distance to Town		Direction to Town	
Australian Map Grid Ref	. .	Average Annual Rainfall	mm

SOIL SAMPLE AND SITE INFORMATION:

Sampling depth(cm)	0-10	Surface	Months of Fallow	
Sampling depth(cm)	-	Deep	Age of cultivation	yrs
			Drainage	
Paddock area		ha	Stubble/Trash	
Soil type			Tillage	
Slope			Irrigation	
Soil profile depth	m			
Reasons for sampling	1.			
	2.			

PRODUCTION INFORMATION:

				yrs mths
Main species to be fertilized			Age established	-
Variety			Root stock(Hort)	
Previous best yield			Plant population	ha
Yield last year			Canopy radius(Hort)	m
Vigour of growth			Grain protein	
Row/tree spacing(Hort)	m X	m	Legume content	
Row spacing(Grain/Cotton)			Stock type	
Interrow treatment			Stock number	
Stage in Crop Cycle(Sugar Cane)				

Method of fertilizer placement:
1. 2. 3.

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Registered Signatory
Patricia Ferguson
Laboratory Analyst

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Other Relevant Comments

Form No. 804 (Rev.6)

Results of Analysis

PADDOCK NAME	235001.02
ORDER NUMBER	615067
PRODUCT	SQ 2002/305 SOIL
SAMPLE BAG NUMBER SURFACE	OBS-14A
CORRESPONDING DEEP SOIL BAG No	
DATE OF SAMPLING	27/05/02
DATE RECEIVED	04/06/02
DATE OF REPORT	11/06/02

Soil texture	Medium Clay
pH(1:5 Water)	6.8
pH(1:5 CaCl2)	5.7
Sodium (Amm Ac.) meq/100g	0.46
Chloride mg/kg	10
Electrical Conduct. dS/m	0.03

Calculations

Cation Exch. Cap. meq/100g	30.71
Sodium% of cations(ESP)	1.51
Elec.Conductivity(se) dS/m	0.2

Methods, Calculations outlined overpage.

FOR INTERPRETATION OF THESE RESULTS, PLEASE CONTACT YOUR DEALER:
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NARELLE JAGER

Report # g0241441

SOIL ANALYSIS REPORT

Incitec Ltd
A.B.N. 41 010 767 263
Paringa Road, Gibson Island, Murarrie
P.O. Box 140, Morningside, Qld 4170
Tel: (07) 3867 9300
Website: www.incitecfertilizers.com.au

NUTRIENT ADVANTAGE

NATURAL RESOURCE ASSESS.
PO BOX 5678
CAIRNS
QLD 4870

Phone
Fax
Nearest Town
Postcode
Distance to Town
Direction to Town
Australian Map Grid Ref . .
Average Annual Rainfall mm

SOIL SAMPLE AND SITE INFORMATION:

Sampling depth(cm) 25-35 Surface
Sampling depth(cm) - Deep
Paddock area ha
Soil type
Slope
Soil profile depth m
Reasons for sampling 1.
2.

Months of Fallow
Age of cultivation yrs
Drainage
Stubble/Trash
Tillage
Irrigation

PRODUCTION INFORMATION:

Main species to be fertilized
Variety
Previous best yield
Yield last year
Vigour of growth
Row/tree spacing(Hort) m X m
Row spacing(Grain/Cotton)
Interrow treatment
Stage in Crop Cycle(Sugar Cane)
Method of fertilizer placement:
1. 2. 3.

yrs mths
Age established -
Root stock(Hort)
Plant population ha
Canopy radius(Hort) m
Grain protein
Legume content
Stock type
Stock number

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NATA Accredited Laboratory
Number: 1292

Registered Signatory
Patricia Ferguson
Laboratory Analyst

The Laboratory is not associated with the sampling process.
Samples are analysed as received after drying at 40°C.

Other Relevant Comments

Report # g0241442

Form No. 804 (Rev.6)

Results of Analysis

PADDOCK NAME	235001.02
ORDER NUMBER	615067
PRODUCT	SQ 2002/305 SOIL
SAMPLE BAG NUMBER SURFACE	OBS-14B
CORRESPONDING DEEP SOIL BAG No	
DATE OF SAMPLING	27/05/02
DATE RECEIVED	04/06/02
DATE OF REPORT	11/06/02

Soil texture	Medium Clay
pH(1:5 Water)	7.0
pH(1:5 CaCl2)	5.6
Sodium (Amm Ac.) meq/100g	0.79
Chloride mg/kg	5
Electrical Conduct. dS/m	0.02

Calculations

Cation Exch. Cap. meq/100g	36.05
Sodium% of cations(ESP)	2.19
Elec.Conductivity(se) dS/m	0.1

Methods, Calculations outlined overpage.

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SOIL ANALYSIS REPORT

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Nearest Town		Postcode	
Distance to Town		Direction to Town	
Australian Map Grid Ref	. .	Average Annual Rainfall	mm

SOIL SAMPLE AND SITE INFORMATION:

Sampling depth(cm)	0-10	Surface	Months of Fallow	
Sampling depth(cm)	-	Deep	Age of cultivation	yrs
			Drainage	
Paddock area		ha	Stubble/Trash	
Soil type			Tillage	
Slope			Irrigation	
Soil profile depth	m			
Reasons for sampling	1.			
	2.			

PRODUCTION INFORMATION:

			yrs mths
Main species to be fertilized		Age established	-
Variety		Root stock(Hort)	
Previous best yield		Plant population	ha
Yield last year		Canopy radius(Hort)	m
Vigour of growth		Grain protein	
Row/tree spacing(Hort)	m X m	Legume content	
Row spacing(Grain/Cotton)		Stock type	
Interrow treatment		Stock number	
Stage in Crop Cycle(Sugar Cane)			

Method of fertilizer placement:
1. 2. 3.

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Number: 1292

Registered Signatory
Patricia Ferguson
Laboratory Analyst

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Samples are analysed as received after drying at 40°C.

Other Relevant Comments

Form No. 804 (Rev.6)

Results of Analysis

PADDOCK NAME	235001.02
ORDER NUMBER	615067
PRODUCT	SQ 2002/305 SOIL
SAMPLE BAG NUMBER SURFACE	OBS-15A
CORRESPONDING DEEP SOIL BAG No	
DATE OF SAMPLING	27/05/02
DATE RECEIVED	04/06/02
DATE OF REPORT	11/06/02

Soil texture	Silty Loam
pH(1:5 Water)	8.3
pH(1:5 CaCl2)	7.7
Sodium (Amm Ac.) meq/100g	0.04
Chloride mg/kg	5
Electrical Conduct. dS/m	0.11

Calculations

Cation Exch. Cap. meq/100g	52.21
Sodium% of cations(ESP)	0.07
Elec.Conductivity(se) dS/m	1.0

Methods, Calculations outlined overpage.

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Report # g0241443

SOIL ANALYSIS REPORT

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QLD 4870

Phone | Fax
Nearest Town | Postcode
Distance to Town | Direction to Town
Australian Map Grid Ref . . | Average Annual Rainfall mm

SOIL SAMPLE AND SITE INFORMATION:

Sampling depth(cm)	0-10 Surface	Months of Fallow	
Sampling depth(cm)	- Deep	Age of cultivation	yrs
		Drainage	
Paddock area	ha	Stubble/Trash	
Soil type		Tillage	
Slope		Irrigation	
Soil profile depth	m		
Reasons for sampling	1.		
	2.		

PRODUCTION INFORMATION:

			yrs mths
Main species to be fertilized		Age established	-
Variety		Root stock(Hort)	
Previous best yield		Plant population	ha
Yield last year		Canopy radius(Hort)	m
Vigour of growth		Grain protein	
Row/tree spacing(Hort)	m X m	Legume content	
Row spacing(Grain/Cotton)		Stock type	
Interrow treatment		Stock number	
Stage in Crop Cycle(Sugar Cane)			

Method of fertilizer placement:
1. 2. 3.

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Registered Signatory
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Laboratory Analyst

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Other Relevant Comments

Report # g0241444

Form No. 804 (Rev.6)

Results of Analysis

PADDOCK NAME	235001.02
ORDER NUMBER	615067
PRODUCT	SQ 2002/305 SOIL
SAMPLE BAG NUMBER SURFACE	OBS-15B
CORRESPONDING DEEP SOIL BAG No	
DATE OF SAMPLING	27/05/02
DATE RECEIVED	04/06/02
DATE OF REPORT	11/06/02

Soil texture	Medium Clay
pH(1:5 Water)	6.7
pH(1:5 CaCl2)	5.8
Sodium (Amm Ac.) meq/100g	0.20
Chloride mg/kg	5
Electrical Conduct. dS/m	0.03

Calculations

Cation Exch. Cap. meq/100g	47.15
Sodium% of cations(ESP)	0.43
Elec.Conductivity(se) dS/m	0.2

Methods, Calculations outlined overpage.

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SOIL ANALYSIS REPORT

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SOIL SAMPLE AND SITE INFORMATION:

Sampling depth(cm)	40-50	Surface	Months of Fallow	
Sampling depth(cm)	-	Deep	Age of cultivation	yrs
			Drainage	
Paddock area		ha	Stubble/Trash	
Soil type			Tillage	
Slope			Irrigation	
Soil profile depth	m			
Reasons for sampling	1.			
	2.			

PRODUCTION INFORMATION:

			yrs mths
Main species to be fertilized		Age established	-
Variety		Root stock(Hort)	
Previous best yield		Plant population	ha
Yield last year		Canopy radius(Hort)	m
Vigour of growth		Grain protein	
Row/tree spacing(Hort)	m X m	Legume content	
Row spacing(Grain/Cotton)		Stock type	
Interrow treatment		Stock number	
Stage in Crop Cycle(Sugar Cane)			

Method of fertilizer placement:
1. 2. 3.

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Registered Signatory
Patricia Ferguson
Laboratory Analyst

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Other Relevant Comments

Form No. 804 (Rev.6)

Results of Analysis

PADDOCK NAME	235001.02
ORDER NUMBER	615067
PRODUCT	SQ 2002/305 SOIL
SAMPLE BAG NUMBER SURFACE	OBS-15C
CORRESPONDING DEEP SOIL BAG No	
DATE OF SAMPLING	27/05/02
DATE RECEIVED	04/06/02
DATE OF REPORT	11/06/02

Soil texture	Medium Clay
pH(1:5 Water)	6.7
pH(1:5 CaCl2)	5.7
Sodium (Amm Ac.) meq/100g	0.27
Chloride mg/kg	5
Electrical Conduct. dS/m	0.02

Calculations

Cation Exch. Cap. meq/100g	51.51
Sodium% of cations(ESP)	0.52
Elec.Conductivity(se) dS/m	0.1

Methods, Calculations outlined overpage.

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Report # g0241445

SOIL ANALYSIS REPORT

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Distance to Town
Direction to Town
Australian Map Grid Ref . .
Average Annual Rainfall mm

SOIL SAMPLE AND SITE INFORMATION:

Sampling depth(cm) 0-10 Surface
Sampling depth(cm) - Deep
Paddock area ha
Soil type
Slope
Soil profile depth m
Reasons for sampling 1.
2.

Months of Fallow
Age of cultivation yrs
Drainage
Stubble/Trash
Tillage
Irrigation

PRODUCTION INFORMATION:

Main species to be fertilized
Variety
Previous best yield
Yield last year
Vigour of growth
Row/tree spacing(Hort) m X m
Row spacing(Grain/Cotton)
Interrow treatment
Stage in Crop Cycle(Sugar Cane)
Method of fertilizer placement:
1. 2. 3.

yrs mths
Age established -
Root stock(Hort)
Plant population ha
Canopy radius(Hort) m
Grain protein
Legume content
Stock type
Stock number

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Registered Signatory
Patricia Ferguson
Laboratory Analyst

The Laboratory is not associated with the sampling process.
Samples are analysed as received after drying at 40°C.

Other Relevant Comments

Results of Analysis

PADDOCK NAME 235001.02
ORDER NUMBER 615067
PRODUCT SQ 2002/062 SOIL
SAMPLE BAG NUMBER SURFACE OBS-16A
CORRESPONDING DEEP SOIL BAG No
DATE OF SAMPLING 27/05/02
DATE RECEIVED 04/06/02
DATE OF REPORT 11/06/02

Soil colour (Munsell)	Dark Grey Brown
Soil texture	Medium Clay
pH(1:5 Water)	8.8
pH(1:5 CaCl2)	8.1
Organic Carbon %C	0.8
Nitrate Nitrogen mg/kg	1.0
Sulfur (MCP) mg/kg	2
Phosphorus(Colwell) mg/kg	8
Potassium(Amm.Ac.)meq/100g	0.54
Calcium (Amm.Ac.) meq/100g	20.18
Magnesium(Amm.Ac.)meq/100g	18.72
Sodium (Amm Ac.) meq/100g	0.81
Chloride mg/kg	5
Electrical Conduct. dS/m	0.10
Copper (DTPA) mg/kg	0.4
Zinc (DTPA) mg/kg	0.1
Manganese (DTPA) mg/kg	2
Iron (DTPA) mg/kg	7
Boron (Hot CaCl2) mg/kg	0.7

Calculations

Cation Exch. Cap. meq/100g	40.25
Calcium/Magnesium Ratio	1.08
Elec.Conductivity(se) dS/m	0.6
Sodium% of cations(ESP)	2.01

Methods, Calculations outlined overpage.

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Report # g0241446

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Form No. 804 (Rev.6)

SOIL ANALYSIS REPORT

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P.O. Box 140, Morningside, Qld 4170
Tel: (07) 3867 9300
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NUTRIENT ADVANTAGE

NATURAL RESOURCE ASSESS.
PO BOX 5678
CAIRNS
QLD 4870

Phone		Fax	
Nearest Town		Postcode	
Distance to Town		Direction to Town	
Australian Map Grid Ref	. .	Average Annual Rainfall	mm

SOIL SAMPLE AND SITE INFORMATION:

Sampling depth(cm)	0-10	Surface	Months of Fallow	
Sampling depth(cm)	-	Deep	Age of cultivation	yrs
			Drainage	
Paddock area		ha	Stubble/Trash	
Soil type			Tillage	
Slope			Irrigation	
Soil profile depth	m			
Reasons for sampling	1.			
	2.			

PRODUCTION INFORMATION:

			yrs mths
Main species to be fertilized		Age established	-
Variety		Root stock(Hort)	
Previous best yield		Plant population	ha
Yield last year		Canopy radius(Hort)	m
Vigour of growth		Grain protein	
Row/tree spacing(Hort)	m X m	Legume content	
Row spacing(Grain/Cotton)		Stock type	
Interrow treatment		Stock number	
Stage in Crop Cycle(Sugar Cane)			

Method of fertilizer placement:
1. 2. 3.

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Registered Signatory
Patricia Ferguson
Laboratory Analyst

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Samples are analysed as received after drying at 40°C.

Other Relevant Comments

Report # g0241447

Form No. 804 (Rev.6)

Results of Analysis

PADDOCK NAME	235001.02
ORDER NUMBER	615067
PRODUCT	SQ 2002/305 SOIL
SAMPLE BAG NUMBER SURFACE	OBS-19A
CORRESPONDING DEEP SOIL BAG No	
DATE OF SAMPLING	27/05/02
DATE RECEIVED	04/06/02
DATE OF REPORT	11/06/02

Soil texture	Medium Clay
pH(1:5 Water)	7.0
pH(1:5 CaCl2)	6.0
Sodium (Amm Ac.) meq/100g	0.47
Chloride mg/kg	5
Electrical Conduct. dS/m	0.04

Calculations

Cation Exch. Cap. meq/100g	33.58
Sodium% of cations(ESP)	1.40
Elec.Conductivity(se) dS/m	0.3

Methods, Calculations outlined overpage.

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SOIL ANALYSIS REPORT

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QLD 4870

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Distance to Town
Direction to Town
Australian Map Grid Ref . .
Average Annual Rainfall mm

SOIL SAMPLE AND SITE INFORMATION:

Sampling depth(cm) 35-40 Surface
Sampling depth(cm) - Deep
Paddock area ha
Soil type
Slope
Soil profile depth m
Reasons for sampling 1.
2.

Months of Fallow
Age of cultivation yrs
Drainage
Stubble/Trash
Tillage
Irrigation

PRODUCTION INFORMATION:

Main species to be fertilized
Variety
Previous best yield
Yield last year
Vigour of growth
Row/tree spacing(Hort) m X m
Row spacing(Grain/Cotton)
Interrow treatment
Stage in Crop Cycle(Sugar Cane)
Method of fertilizer placement:
1. 2. 3.

yrs mths
Age established -
Root stock(Hort)
Plant population ha
Canopy radius(Hort) m
Grain protein
Legume content
Stock type
Stock number

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Registered Signatory
Patricia Ferguson
Laboratory Analyst

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Samples are analysed as received after drying at 40°C.

Other Relevant Comments

Report # g0241448

Form No. 804 (Rev.6)

Results of Analysis

PADDOCK NAME	235001.02
ORDER NUMBER	615067
PRODUCT	SQ 2002/305 SOIL
SAMPLE BAG NUMBER SURFACE	OBS-19B
CORRESPONDING DEEP SOIL BAG No	
DATE OF SAMPLING	27/05/02
DATE RECEIVED	04/06/02
DATE OF REPORT	11/06/02

Soil texture	Medium Clay
pH(1:5 Water)	7.6
pH(1:5 CaCl2)	6.3
Sodium (Amm Ac.) meq/100g	1.30
Chloride mg/kg	5
Electrical Conduct. dS/m	0.04

Calculations

Cation Exch. Cap. meq/100g	37.74
Sodium% of cations(ESP)	3.44
Elec.Conductivity(se) dS/m	0.2

Methods, Calculations outlined overpage.

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SOIL ANALYSIS REPORT

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Phone		Fax	
Nearest Town		Postcode	
Distance to Town		Direction to Town	
Australian Map Grid Ref	. .	Average Annual Rainfall	mm

SOIL SAMPLE AND SITE INFORMATION:

Sampling depth(cm)	0-10	Surface	Months of Fallow	
Sampling depth(cm)	-	Deep	Age of cultivation	yrs
			Drainage	
Paddock area		ha	Stubble/Trash	
Soil type			Tillage	
Slope			Irrigation	
Soil profile depth	m			
Reasons for sampling	1.			
	2.			

PRODUCTION INFORMATION:

			yrs mths
Main species to be fertilized		Age established	-
Variety		Root stock(Hort)	
Previous best yield		Plant population	ha
Yield last year		Canopy radius(Hort)	m
Vigour of growth		Grain protein	
Row/tree spacing(Hort)	m X m	Legume content	
Row spacing(Grain/Cotton)		Stock type	
Interrow treatment		Stock number	
Stage in Crop Cycle(Sugar Cane)			

Method of fertilizer placement:
1. 2. 3.

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Number: 1292

Registered Signatory
Patricia Ferguson
Laboratory Analyst

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Results of Analysis

PADDOCK NAME	235001.02
ORDER NUMBER	615067
PRODUCT	SQ 2002/062 SOIL
SAMPLE BAG NUMBER SURFACE	OBS-20A
CORRESPONDING DEEP SOIL BAG No	
DATE OF SAMPLING	27/05/02
DATE RECEIVED	04/06/02
DATE OF REPORT	11/06/02

Soil colour (Munsell)	Dark Grey Brown
Soil texture	Clay Loam
pH(1:5 Water)	6.5
pH(1:5 CaCl2)	5.4
Organic Carbon %C	0.9
Nitrate Nitrogen mg/kg	0.8
Sulfur (MCP) mg/kg	5
Phosphorus(Colwell) mg/kg	2
Potassium(Amm.Ac.)meq/100g	0.40
Calcium (Amm.Ac.) meq/100g	6.60
Magnesium(Amm.Ac.)meq/100g	6.73
Sodium (Amm Ac.) meq/100g	0.13
Chloride mg/kg	5
Electrical Conduct. dS/m	0.03
Copper (DTPA) mg/kg	1.5
Zinc (DTPA) mg/kg	<0.1
Manganese (DTPA) mg/kg	32
Iron (DTPA) mg/kg	34
Boron (Hot CaCl2) mg/kg	0.5

Calculations

Cation Exch. Cap. meq/100g	13.87
Calcium/Magnesium Ratio	0.98
Elec.Conductivity(se) dS/m	0.2
Sodium% of cations(ESP)	0.96

Methods, Calculations outlined overpage.

FOR INTERPRETATION OF THESE RESULTS,
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Other Relevant Comments

Report # g0241449

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Distance to Town
Direction to Town
Australian Map Grid Ref . .
Average Annual Rainfall mm

SOIL SAMPLE AND SITE INFORMATION:

Sampling depth(cm)	20-30	Surface	Months of Fallow	
Sampling depth(cm)	-	Deep	Age of cultivation	yrs
			Drainage	
Paddock area		ha	Stubble/Trash	
Soil type			Tillage	
Slope			Irrigation	
Soil profile depth	m			
Reasons for sampling	1.			
	2.			

PRODUCTION INFORMATION:

			yrs mths
Main species to be fertilized		Age established	-
Variety		Root stock(Hort)	
Previous best yield		Plant population	ha
Yield last year		Canopy radius(Hort)	m
Vigour of growth		Grain protein	
Row/tree spacing(Hort)	m X m	Legume content	
Row spacing(Grain/Cotton)		Stock type	
Interrow treatment		Stock number	
Stage in Crop Cycle(Sugar Cane)			

Method of fertilizer placement:
1. 2. 3.

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Number: 1292

Registered Signatory
Patricia Ferguson
Laboratory Analyst

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Samples are analysed as received after drying at 40°C.

Other Relevant Comments

Results of Analysis

PADDOCK NAME	235001.02
ORDER NUMBER	615067
PRODUCT	SQ 2002/305 SOIL
SAMPLE BAG NUMBER SURFACE	OBS-20B
CORRESPONDING DEEP SOIL BAG No	
DATE OF SAMPLING	27/05/02
DATE RECEIVED	04/06/02
DATE OF REPORT	11/06/02

Soil texture	Light Clay
pH(1:5 Water)	6.9
pH(1:5 CaCl2)	5.4
Sodium (Amm Ac.) meq/100g	1.12
Chloride mg/kg	15
Electrical Conduct. dS/m	0.04

Calculations

Cation Exch. Cap. meq/100g	22.72
Sodium% of cations(ESP)	4.94
Elec.Conductivity(se) dS/m	0.3

Methods, Calculations outlined overpage.

FOR INTERPRETATION OF THESE RESULTS,
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NARELLE JAGER

Report # g0241450

Form No. 804 (Rev.6)

SOIL ANALYSIS REPORT

Incitec Ltd
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Paringa Road, Gibson Island, Murarrie
P.O. Box 140, Morningside, Qld 4170
Tel: (07) 3867 9300
Website: www.incitecfertilizers.com.au

NUTRIENT ADVANTAGE

NATURAL RESOURCE ASSESS.
PO BOX 5678
CAIRNS
QLD 4870

Phone		Fax	
Nearest Town		Postcode	
Distance to Town		Direction to Town	
Australian Map Grid Ref	. .	Average Annual Rainfall	mm

SOIL SAMPLE AND SITE INFORMATION:

Sampling depth(cm)	40-70	Surface	Months of Fallow	
Sampling depth(cm)	-	Deep	Age of cultivation	yrs
			Drainage	
Paddock area		ha	Stubble/Trash	
Soil type			Tillage	
Slope			Irrigation	
Soil profile depth	m			
Reasons for sampling	1.			
	2.			

PRODUCTION INFORMATION:

			yrs mths
Main species to be fertilized		Age established	-
Variety		Root stock(Hort)	
Previous best yield		Plant population	ha
Yield last year		Canopy radius(Hort)	m
Vigour of growth		Grain protein	
Row/tree spacing(Hort)	m X m	Legume content	
Row spacing(Grain/Cotton)		Stock type	
Interrow treatment		Stock number	
Stage in Crop Cycle(Sugar Cane)			

Method of fertilizer placement:
1. 2. 3.

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NATA Accredited Laboratory
Number: 1292

Registered Signatory
Patricia Ferguson
Laboratory Analyst

The Laboratory is not associated with the sampling process.
Samples are analysed as received after drying at 40°C.

Other Relevant Comments

Form No. 804 (Rev.6)

Results of Analysis

PADDOCK NAME	235001.02
ORDER NUMBER	615067
PRODUCT	SQ 2002/305 SOIL
SAMPLE BAG NUMBER SURFACE	OBS-20C
CORRESPONDING DEEP SOIL BAG No	
DATE OF SAMPLING	27/05/02
DATE RECEIVED	04/06/02
DATE OF REPORT	11/06/02

Soil texture	Light Clay
pH(1:5 Water)	8.4
pH(1:5 CaCl2)	7.6
Sodium (Amm Ac.) meq/100g	3.17
Chloride mg/kg	330
Electrical Conduct. dS/m	0.25

Calculations

Cation Exch. Cap. meq/100g	32.45
Sodium% of cations(ESP)	9.76
Elec.Conductivity(se) dS/m	1.8

Methods, Calculations outlined overpage.

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Report # g0241451

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Direction to Town
Australian Map Grid Ref . .
Average Annual Rainfall mm

SOIL SAMPLE AND SITE INFORMATION:

Sampling depth(cm) 70-80 Surface
Sampling depth(cm) - Deep
Paddock area ha
Soil type
Slope
Soil profile depth m
Reasons for sampling 1.
2.

Months of Fallow
Age of cultivation yrs
Drainage
Stubble/Trash
Tillage
Irrigation

PRODUCTION INFORMATION:

Main species to be fertilized
Variety
Previous best yield
Yield last year
Vigour of growth
Row/tree spacing(Hort) m X m
Row spacing(Grain/Cotton)
Interrow treatment
Stage in Crop Cycle(Sugar Cane)
Method of fertilizer placement:
1. 2. 3.

yrs mths
Age established -
Root stock(Hort)
Plant population ha
Canopy radius(Hort) m
Grain protein
Legume content
Stock type
Stock number

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Registered Signatory
Patricia Ferguson
Laboratory Analyst

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Other Relevant Comments

Results of Analysis

PADDOCK NAME	235001.02
ORDER NUMBER	615067
PRODUCT	SQ 2002/305 SOIL
SAMPLE BAG NUMBER SURFACE	OBS-20D
CORRESPONDING DEEP SOIL BAG No	
DATE OF SAMPLING	27/05/02
DATE RECEIVED	04/06/02
DATE OF REPORT	11/06/02

Soil texture	Medium Clay
pH(1:5 Water)	8.8
pH(1:5 CaCl2)	8.2
Sodium (Amm Ac.) meq/100g	5.40
Chloride mg/kg	685
Electrical Conduct. dS/m	0.51

Calculations

Cation Exch. Cap. meq/100g	58.21
Sodium% of cations(ESP)	9.28
Elec.Conductivity(se) dS/m	3.2

Methods, Calculations outlined overpage.

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Report # g0241452

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Australian Map Grid Ref	. .	Average Annual Rainfall	mm

SOIL SAMPLE AND SITE INFORMATION:

Sampling depth(cm)	0-10	Surface	Months of Fallow	
Sampling depth(cm)	-	Deep	Age of cultivation	yrs
			Drainage	
Paddock area		ha	Stubble/Trash	
Soil type			Tillage	
Slope			Irrigation	
Soil profile depth	m			
Reasons for sampling	1.			
	2.			

PRODUCTION INFORMATION:

			yrs mths
Main species to be fertilized		Age established	-
Variety		Root stock(Hort)	
Previous best yield		Plant population	ha
Yield last year		Canopy radius(Hort)	m
Vigour of growth		Grain protein	
Row/tree spacing(Hort)	m X m	Legume content	
Row spacing(Grain/Cotton)		Stock type	
Interrow treatment		Stock number	
Stage in Crop Cycle(Sugar Cane)			
Method of fertilizer placement:			
1.	2.	3.	

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Registered Signatory
Patricia Ferguson
Laboratory Analyst

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Other Relevant Comments

Results of Analysis

PADDOCK NAME	235001.02
ORDER NUMBER	615067
PRODUCT	SQ 2002/062 SOIL
SAMPLE BAG NUMBER SURFACE	OBS-27A
CORRESPONDING DEEP SOIL BAG No	
DATE OF SAMPLING	27/05/02
DATE RECEIVED	04/06/02
DATE OF REPORT	11/06/02

Soil colour (Munsell)	Dark Brown
Soil texture	Light Clay
pH(1:5 Water)	7.0
pH(1:5 CaCl2)	6.2
Organic Carbon %C	1.2
Nitrate Nitrogen mg/kg	1.1
Sulfur (MCP) mg/kg	6
Phosphorus(Colwell) mg/kg	5
Potassium(Amm.Ac.)meq/100g	0.47
Calcium (Amm.Ac.) meq/100g	14.23
Magnesium(Amm.Ac.)meq/100g	8.22
Sodium (Amm Ac.) meq/100g	0.06
Chloride mg/kg	10
Electrical Conduct. dS/m	0.04
Copper (DTPA) mg/kg	0.8
Zinc (DTPA) mg/kg	0.2
Manganese (DTPA) mg/kg	5
Iron (DTPA) mg/kg	16
Boron (Hot CaCl2) mg/kg	0.8

Calculations

Cation Exch. Cap. meq/100g	22.98
Calcium/Magnesium Ratio	1.73
Elec.Conductivity(se) dS/m	0.3
Sodium% of cations(ESP)	0.25

Methods, Calculations outlined overpage.

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QLD 4870

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Direction to Town
Australian Map Grid Ref . .
Average Annual Rainfall mm

SOIL SAMPLE AND SITE INFORMATION:

Sampling depth(cm) 10-30 Surface
Sampling depth(cm) - Deep
Paddock area ha
Soil type
Slope
Soil profile depth m
Reasons for sampling 1.
2.

Months of Fallow
Age of cultivation yrs
Drainage
Stubble/Trash
Tillage
Irrigation

PRODUCTION INFORMATION:

Main species to be fertilized
Variety
Previous best yield
Yield last year
Vigour of growth
Row/tree spacing(Hort) m X m
Row spacing(Grain/Cotton)
Interrow treatment
Stage in Crop Cycle(Sugar Cane)
Method of fertilizer placement:
1. 2. 3.

Age established yrs mths -
Root stock(Hort)
Plant population ha
Canopy radius(Hort) m
Grain protein
Legume content
Stock type
Stock number

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Registered Signatory
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Laboratory Analyst

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Other Relevant Comments

Report # g0241454

Form No. 804 (Rev.6)

Results of Analysis

PADDOCK NAME 235001.02
ORDER NUMBER 615067
PRODUCT SQ 2002/305 SOIL
SAMPLE BAG NUMBER SURFACE OBS-27B
CORRESPONDING DEEP SOIL BAG No
DATE OF SAMPLING 27/05/02
DATE RECEIVED 04/06/02
DATE OF REPORT 11/06/02

Soil texture	Light Clay
pH(1:5 Water)	7.3
pH(1:5 CaCl2)	6.3
Sodium (Amm Ac.) meq/100g	0.20
Chloride mg/kg	5
Electrical Conduct. dS/m	0.02

Calculations

Cation Exch. Cap. meq/100g	24.14
Sodium% of cations(ESP)	0.83
Elec.Conductivity(se) dS/m	0.2

Methods, Calculations outlined overpage.

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SOIL SAMPLE AND SITE INFORMATION:

Sampling depth(cm)	30-50	Surface	Months of Fallow	
Sampling depth(cm)	-	Deep	Age of cultivation	yrs
			Drainage	
Paddock area		ha	Stubble/Trash	
Soil type			Tillage	
Slope			Irrigation	
Soil profile depth	m			
Reasons for sampling	1.			
	2.			

PRODUCTION INFORMATION:

			yrs mths
Main species to be fertilized		Age established	-
Variety		Root stock(Hort)	
Previous best yield		Plant population	ha
Yield last year		Canopy radius(Hort)	m
Vigour of growth		Grain protein	
Row/tree spacing(Hort)	m X m	Legume content	
Row spacing(Grain/Cotton)		Stock type	
Interrow treatment		Stock number	
Stage in Crop Cycle(Sugar Cane)			
Method of fertilizer placement:			
1.	2.	3.	

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Registered Signatory
Patricia Ferguson
Laboratory Analyst

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Other Relevant Comments

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Results of Analysis

PADDOCK NAME	235001.02
ORDER NUMBER	615067
PRODUCT	SQ 2002/305 SOIL
SAMPLE BAG NUMBER SURFACE	OBS-27C
CORRESPONDING DEEP SOIL BAG No	
DATE OF SAMPLING	27/05/02
DATE RECEIVED	04/06/02
DATE OF REPORT	11/06/02

Soil texture	Medium Clay
pH(1:5 Water)	7.7
pH(1:5 CaCl2)	6.9
Sodium (Amm Ac.) meq/100g	0.38
Chloride mg/kg	5
Electrical Conduct. dS/m	0.05

Calculations

Cation Exch. Cap. meq/100g	32.91
Sodium% of cations(ESP)	1.17
Elec.Conductivity(se) dS/m	0.3

Methods, Calculations outlined overpage.

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Report # g0241455

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SOIL SAMPLE AND SITE INFORMATION:

Sampling depth(cm) 50-70 Surface | Months of Fallow
Sampling depth(cm) - Deep | Age of cultivation yrs
Drainage
Paddock area ha | Stubble/Trash
Soil type | Tillage
Slope | Irrigation
Soil profile depth m
Reasons for sampling 1.
2.

PRODUCTION INFORMATION: yrs mths

Main species to be fertilized | Age established -
Variety | Root stock(Hort)
Previous best yield | Plant population ha
Yield last year | Canopy radius(Hort) m
Vigour of growth | Grain protein
Row/tree spacing(Hort) m X m | Legume content
Row spacing(Grain/Cotton) | Stock type
Interrow treatment | Stock number
Stage in Crop Cycle(Sugar Cane)
Method of fertilizer placement:
1. 2. 3.

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Registered Signatory
Patricia Ferguson
Laboratory Analyst

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Samples are analysed as received after drying at 40°C.

Other Relevant Comments

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Results of Analysis

PADDOCK NAME 235001.02
ORDER NUMBER 615067
PRODUCT SQ 2002/305 SOIL
SAMPLE BAG NUMBER SURFACE OBS-27D
CORRESPONDING DEEP SOIL BAG No
DATE OF SAMPLING 27/05/02
DATE RECEIVED 04/06/02
DATE OF REPORT 11/06/02

Soil texture	Fine Sandy Clay
pH(1:5 Water)	8.8
pH(1:5 CaCl2)	8.1
Sodium (Amm Ac.) meq/100g	1.20
Chloride mg/kg	10
Electrical Conduct. dS/m	0.13

Calculations

Cation Exch. Cap. meq/100g	45.03
Sodium% of cations(ESP)	2.67
Elec.Conductivity(se) dS/m	0.9

Methods, Calculations outlined overpage.

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Report # g0241456

SOIL ANALYSIS REPORT

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Distance to Town		Direction to Town	
Australian Map Grid Ref	. .	Average Annual Rainfall	mm

SOIL SAMPLE AND SITE INFORMATION:

Sampling depth(cm)	75-85	Surface	Months of Fallow	
Sampling depth(cm)	-	Deep	Age of cultivation	yrs
			Drainage	
Paddock area		ha	Stubble/Trash	
Soil type			Tillage	
Slope			Irrigation	
Soil profile depth	m			
Reasons for sampling	1.			
	2.			

PRODUCTION INFORMATION:

			yrs mths
Main species to be fertilized		Age established	-
Variety		Root stock(Hort)	
Previous best yield		Plant population	ha
Yield last year		Canopy radius(Hort)	m
Vigour of growth		Grain protein	
Row/tree spacing(Hort)	m X m	Legume content	
Row spacing(Grain/Cotton)		Stock type	
Interrow treatment		Stock number	
Stage in Crop Cycle(Sugar Cane)			

Method of fertilizer placement:
1. 2. 3.

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Number: 1292

Registered Signatory
Patricia Ferguson
Laboratory Analyst

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Samples are analysed as received after drying at 40°C.

Other Relevant Comments

Results of Analysis

PADDOCK NAME	235001.02
ORDER NUMBER	615067
PRODUCT	SQ 2002/305 SOIL
SAMPLE BAG NUMBER SURFACE	OBS-27E
CORRESPONDING DEEP SOIL BAG No	
DATE OF SAMPLING	27/05/02
DATE RECEIVED	04/06/02
DATE OF REPORT	11/06/02

Soil texture	Medium Clay
pH(1:5 Water)	8.9
pH(1:5 CaCl2)	8.2
Sodium (Amm Ac.) meq/100g	2.31
Chloride mg/kg	80
Electrical Conduct. dS/m	0.17

Calculations

Cation Exch. Cap. meq/100g	55.39
Sodium% of cations(ESP)	4.18
Elec.Conductivity(se) dS/m	1.1

Methods, Calculations outlined overpage.

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SOIL ANALYSIS REPORT

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Distance to Town		Direction to Town	
Australian Map Grid Ref	. .	Average Annual Rainfall	mm

SOIL SAMPLE AND SITE INFORMATION:

Sampling depth(cm)	0-10	Surface	Months of Fallow	
Sampling depth(cm)	-	Deep	Age of cultivation	yrs
			Drainage	
Paddock area		ha	Stubble/Trash	
Soil type			Tillage	
Slope			Irrigation	
Soil profile depth	m			
Reasons for sampling	1.			
	2.			

PRODUCTION INFORMATION:

			yrs mths
Main species to be fertilized		Age established	-
Variety		Root stock(Hort)	
Previous best yield		Plant population	ha
Yield last year		Canopy radius(Hort)	m
Vigour of growth		Grain protein	
Row/tree spacing(Hort)	m X m	Legume content	
Row spacing(Grain/Cotton)		Stock type	
Interrow treatment		Stock number	
Stage in Crop Cycle(Sugar Cane)			
Method of fertilizer placement:			
1.	2.	3.	

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Registered Signatory
Patricia Ferguson
Laboratory Analyst

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Results of Analysis

PADDOCK NAME	235001.02
ORDER NUMBER	615067
PRODUCT	SQ 2002/062 SOIL
SAMPLE BAG NUMBER SURFACE	OBS-28A
CORRESPONDING DEEP SOIL BAG No	
DATE OF SAMPLING	27/05/02
DATE RECEIVED	04/06/02
DATE OF REPORT	11/06/02

Soil colour (Munsell)	Dark Brown
Soil texture	Medium Clay
pH(1:5 Water)	7.7
pH(1:5 CaCl2)	7.0
Organic Carbon %C	0.7
Nitrate Nitrogen mg/kg	0.7
Sulfur (MCP) mg/kg	4
Phosphorus(Colwell) mg/kg	2
Potassium(Amm.Ac.)meq/100g	0.47
Calcium (Amm.Ac.) meq/100g	26.75
Magnesium(Amm.Ac.)meq/100g	9.85
Sodium (Amm Ac.) meq/100g	0.06
Chloride mg/kg	5
Electrical Conduct. dS/m	0.05
Copper (DTPA) mg/kg	0.8
Zinc (DTPA) mg/kg	<0.1
Manganese (DTPA) mg/kg	2
Iron (DTPA) mg/kg	8
Boron (Hot CaCl2) mg/kg	1.0

Calculations

Cation Exch. Cap. meq/100g	37.14
Calcium/Magnesium Ratio	2.72
Elec.Conductivity(se) dS/m	0.3
Sodium% of cations(ESP)	0.17

Methods, Calculations outlined overpage.

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Other Relevant Comments

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SOIL SAMPLE AND SITE INFORMATION:

Sampling depth(cm)	15-25 Surface	Months of Fallow	
Sampling depth(cm)	- Deep	Age of cultivation	yrs
		Drainage	
Paddock area	ha	Stubble/Trash	
Soil type		Tillage	
Slope		Irrigation	
Soil profile depth	m		
Reasons for sampling	1.		
	2.		

PRODUCTION INFORMATION:

			yrs mths
Main species to be fertilized		Age established	-
Variety		Root stock(Hort)	
Previous best yield		Plant population	ha
Yield last year		Canopy radius(Hort)	m
Vigour of growth		Grain protein	
Row/tree spacing(Hort)	m X m	Legume content	
Row spacing(Grain/Cotton)		Stock type	
Interrow treatment		Stock number	
Stage in Crop Cycle(Sugar Cane)			

Method of fertilizer placement:
1. 2. 3.

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Registered Signatory
P. McFerg
Patricia Ferguson
Laboratory Analyst

The Laboratory is not associated with the sampling process. Samples are analysed as received after drying at 40°C.

Other Relevant Comments

g0241459

Report # g0241459

Form No. 804 (Rev.6)

Results of Analysis

PADDOCK NAME	235001.02
ORDER NUMBER	615067
PRODUCT	SQ 2002/305 SOIL
SAMPLE BAG NUMBER SURFACE	OBS-28B
CORRESPONDING DEEP SOIL BAG No	
DATE OF SAMPLING	27/05/02
DATE RECEIVED	04/06/02
DATE OF REPORT	14/06/02

Soil texture	Medium Clay
pH(1:5 Water)	8.1
pH(1:5 CaCl2)	7.4
Potassium(Amm.Ac.)meq/100g	0.32
Calcium (Amm.Ac.) meq/100g	26.38
Magnesium(Amm.Ac.)meq/100g	11.05
Sodium (Amm Ac.) meq/100g	0.12
Chloride mg/kg	5

Calculations

Calcium/Magnesium Ratio	2.39
Elec.Conductivity(se) dS/m	0.3
Sodium% of cations(ESP)	0.30
Cation Exch. Cap. meq/100g	37.87

Methods, Calculations outlined overpage.

FOR INTERPRETATION OF THESE RESULTS, PLEASE CONTACT YOUR DEALER:
BACCOUNT
GIBSON ISLAND LAB

OR YOUR INCITEC AREA MANAGER
NARELLE JAGER

SOIL ANALYSIS REPORT

Incitec Ltd
A.B.N. 41 010 767 263
Paringa Road, Gibson Island, Murarrie
P.O. Box 140, Morningside, Qld 4170
Tel: (07) 3867 9300
Website: www.incitecfertilizers.com.au

NUTRIENT ADVANTAGE

NATURAL RESOURCE ASSESS.
PO BOX 5678
CAIRNS
QLD 4870

Phone		Fax	
Nearest Town		Postcode	
Distance to Town		Direction to Town	
Australian Map Grid Ref	. .	Average Annual Rainfall	mm

SOIL SAMPLE AND SITE INFORMATION:

Sampling depth(cm)	35-70	Surface	Months of Fallow	
Sampling depth(cm)	-	Deep	Age of cultivation	yrs
			Drainage	
Paddock area		ha	Stubble/Trash	
Soil type			Tillage	
Slope			Irrigation	
Soil profile depth	m			
Reasons for sampling	1.			
	2.			

PRODUCTION INFORMATION:

Main species to be fertilized		Age established	yrs mths -
Variety		Root stock(Hort)	
Previous best yield		Plant population	ha
Yield last year		Canopy radius(Hort)	m
Vigour of growth		Grain protein	
Row/tree spacing(Hort)	m X m	Legume content	
Row spacing(Grain/Cotton)		Stock type	
Interrow treatment		Stock number	
Stage in Crop Cycle(Sugar Cane)			

Method of fertilizer placement:
1. 2. 3.

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NATA Accredited Laboratory
Number: 1292

Registered Signatory
Patricia Ferguson
Laboratory Analyst

The Laboratory is not associated with the sampling process.
Samples are analysed as received after drying at 40°C.

Other Relevant Comments

Form No. 804 (Rev.6)

Results of Analysis

PADDOCK NAME	235001.02
ORDER NUMBER	615067
PRODUCT	SQ 2002/305 SOIL
SAMPLE BAG NUMBER SURFACE	OBS-28C
CORRESPONDING DEEP SOIL BAG No	
DATE OF SAMPLING	27/05/02
DATE RECEIVED	04/06/02
DATE OF REPORT	11/06/02

Soil texture	Medium Clay
pH(1:5 Water)	8.6
pH(1:5 CaCl2)	7.9
Sodium (Amm Ac.) meq/100g	0.74
Chloride mg/kg	10
Electrical Conduct. dS/m	0.12

Calculations

Cation Exch. Cap. meq/100g	52.01
Sodium% of cations(ESP)	1.42
Elec.Conductivity(se) dS/m	0.8

Methods, Calculations outlined overpage.

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GIBSON ISLAND LAB

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NARELLE JAGER

Report # g0241460

SOIL ANALYSIS REPORT

Incitec Ltd
A.B.N. 41 010 767 263
Paringa Road, Gibson Island, Murarrie
P.O. Box 140, Morningside, Qld 4170
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Website: www.incitecfertilizers.com.au

NUTRIENT ADVANTAGE

NATURAL RESOURCE ASSESS.
PO BOX 5678
CAIRNS
QLD 4870

Phone		Fax	
Nearest Town		Postcode	
Distance to Town		Direction to Town	
Australian Map Grid Ref	. .	Average Annual Rainfall	mm

SOIL SAMPLE AND SITE INFORMATION:

Sampling depth(cm)	80-90	Surface	Months of Fallow	
Sampling depth(cm)	-	Deep	Age of cultivation	yrs
			Drainage	
Paddock area		ha	Stubble/Trash	
Soil type			Tillage	
Slope			Irrigation	
Soil profile depth	m			
Reasons for sampling	1.			
	2.			

PRODUCTION INFORMATION:

			yrs mths
Main species to be fertilized		Age established	-
Variety		Root stock(Hort)	
Previous best yield		Plant population	ha
Yield last year		Canopy radius(Hort)	m
Vigour of growth		Grain protein	
Row/tree spacing(Hort)	m X m	Legume content	
Row spacing(Grain/Cotton)		Stock type	
Interrow treatment		Stock number	
Stage in Crop Cycle(Sugar Cane)			

Method of fertilizer placement:
1. 2. 3.

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NATA Accredited Laboratory Number: 1292

Registered Signatory
Patricia Ferguson
Laboratory Analyst

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Other Relevant Comments

Results of Analysis

PADDOCK NAME	235001.02
ORDER NUMBER	615067
PRODUCT	SQ 2002/305 SOIL
SAMPLE BAG NUMBER SURFACE	OBS-28D
CORRESPONDING DEEP SOIL BAG No	
DATE OF SAMPLING	27/05/02
DATE RECEIVED	04/06/02
DATE OF REPORT	11/06/02

Soil texture	Medium Clay
pH(1:5 Water)	8.7
pH(1:5 CaCl2)	8.1
Sodium (Amm Ac.) meq/100g	2.46
Chloride mg/kg	180
Electrical Conduct. dS/m	0.24

Calculations

Cation Exch. Cap. meq/100g	56.60
Sodium% of cations(ESP)	4.35
Elec.Conductivity(se) dS/m	1.5

Methods, Calculations outlined overpage.

FOR INTERPRETATION OF THESE RESULTS, PLEASE CONTACT YOUR DEALER:
BACCOUNT
GIBSON ISLAND LAB

OR YOUR INCITEC AREA MANAGER
NARELLE JAGER

Report # g0241461

Form No. 804 (Rev.6)

SOIL ANALYSIS REPORT

Incitec Ltd
A.B.N. 41 010 767 263
Paringa Road, Gibson Island, Murarrie
P.O. Box 140, Morningside, Qld 4170
Tel: (07) 3867 9300
Website: www.incitecfertilizers.com.au

NUTRIENT ADVANTAGE

NATURAL RESOURCE ASSESS.
PO BOX 5678
CAIRNS
QLD 4870

Phone		Fax	
Nearest Town		Postcode	
Distance to Town		Direction to Town	
Australian Map Grid Ref	. .	Average Annual Rainfall	mm

SOIL SAMPLE AND SITE INFORMATION:

Sampling depth(cm)	0-10	Surface	Months of Fallow	
Sampling depth(cm)	-	Deep	Age of cultivation	yrs
			Drainage	
Paddock area		ha	Stubble/Trash	
Soil type			Tillage	
Slope			Irrigation	
Soil profile depth	m			
Reasons for sampling	1.			
	2.			

PRODUCTION INFORMATION:

			yrs mths
Main species to be fertilized		Age established	-
Variety		Root stock(Hort)	
Previous best yield		Plant population	ha
Yield last year		Canopy radius(Hort)	m
Vigour of growth		Grain protein	
Row/tree spacing(Hort)	m X m	Legume content	
Row spacing(Grain/Cotton)		Stock type	
Interrow treatment		Stock number	
Stage in Crop Cycle(Sugar Cane)			

Method of fertilizer placement:
1. 2. 3.

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NATA Accredited Laboratory
Number: 1292

Registered Signatory
P. Ferguson
Patricia Ferguson
Laboratory Analyst

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Samples are analysed as received after drying at 40°C.

Other Relevant Comments

Form No. 804 (Rev.6)

Results of Analysis

PADDOCK NAME	235001.02
ORDER NUMBER	615067
PRODUCT	SQ 2002/305 SOIL
SAMPLE BAG NUMBER SURFACE	XOBS-29A
CORRESPONDING DEEP SOIL BAG No	
DATE OF SAMPLING	27/05/02
DATE RECEIVED	04/06/02
DATE OF REPORT	11/06/02

Soil texture	Light Clay
pH(1:5 Water)	8.3
pH(1:5 CaCl2)	7.6
Sodium (Amm Ac.) meq/100g	0.09
Chloride mg/kg	5
Electrical Conduct. dS/m	0.09

Calculations

Cation Exch. Cap. meq/100g	35.53
Sodium% of cations(ESP)	0.26
Elec.Conductivity(se) dS/m	0.7

Methods, Calculations outlined overpage.

FOR INTERPRETATION OF THESE RESULTS,
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BACCOUNT
GIBSON ISLAND LAB

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NARELLE JAGER

Report # g0241462

SOIL ANALYSIS REPORT

Incitec Ltd
A.B.N. 41 010 767 263
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P.O. Box 140, Morningside, Qld 4170
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NUTRIENT ADVANTAGE

NATURAL RESOURCE ASSESS.
PO BOX 5678
CAIRNS
QLD 4870

Phone
Fax
Nearest Town
Postcode
Distance to Town
Direction to Town
Australian Map Grid Ref . .
Average Annual Rainfall mm

SOIL SAMPLE AND SITE INFORMATION:

Sampling depth(cm) 25-35 Surface
Sampling depth(cm) - Deep
Paddock area ha
Soil type
Slope
Soil profile depth m
Reasons for sampling 1.
2.

Months of Fallow
Age of cultivation yrs
Drainage
Stubble/Trash
Tillage
Irrigation

PRODUCTION INFORMATION:

Main species to be fertilized
Variety
Previous best yield
Yield last year
Vigour of growth
Row/tree spacing(Hort) m X m
Row spacing(Grain/Cotton)
Interrow treatment
Stage in Crop Cycle(Sugar Cane)
Method of fertilizer placement:
1. 2. 3.

Age established yrs mths -
Root stock(Hort)
Plant population ha
Canopy radius(Hort) m
Grain protein
Legume content
Stock type
Stock number

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NATA Accredited Laboratory Number: 1292

Registered Signatory
Patricia Ferguson
Laboratory Analyst

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Samples are analysed as received after drying at 40°C.

Other Relevant Comments

Report # g0241463

Form No. 804 (Rev.6)

Results of Analysis

PADDOCK NAME	235001.02
ORDER NUMBER	615067
PRODUCT	SQ 2002/305 SOIL
SAMPLE BAG NUMBER SURFACE	OBS-29B
CORRESPONDING DEEP SOIL BAG No	
DATE OF SAMPLING	27/05/02
DATE RECEIVED	04/06/02
DATE OF REPORT	11/06/02

Soil texture	Medium Clay
pH(1:5 Water)	8.5
pH(1:5 CaCl2)	7.8
Sodium (Amm Ac.) meq/100g	0.28
Chloride mg/kg	5
Electrical Conduct. dS/m	0.10

Calculations

Cation Exch. Cap. meq/100g	56.63
Sodium% of cations(ESP)	0.49
Elec.Conductivity(se) dS/m	0.6

Methods, Calculations outlined overpage.

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NARELLE JAGER

METHODS OF SOIL ANALYSIS

	Incitec Method	
Soil Colour	SLM 101	- visual assessment of moist soil against Munsell colour chart.
Soil Texture	SLM 101	- field texture techniques of Northcote.
pH (1:5 water)	SLM 102	- 1 to 5, soil to water dilution, stirred, stand 1 hour and read while stirring, using combination electrode.
pH (1:5 Ca Cl_2)	SLM 116	- 1 to 5, soil 0.01M Calcium Chloride, Stirred, read using combination electrode.
Buffer pH	SLM 115	- Mehlich buffer - 1:1 soil:water or 1/2 hour add buffer to 1:2 soil solution, stand 1 hour, read while stirring.
Organic Carbon	SLM 111	- Walkley and Black, using H_2SO_4 and $K_2Cr_2O_7$ in 1:100 dilution, measured colormetrically.
Nitrate Nitrogen	SLM 104	- 1:5 soil to water, intermittent stirring over 1 hour, centrifuged nitrate measured colormetrically in segmented flow analyser.
Ammonium Nitrogen	SLM 118	- 1:5 soil to solution of 2M KCL plus 0.05M H_2SO_4 - 1 hour shake centrifuged - measured on segmented flow.
Sulfur (MCP)	SLM 110	- 1:5 soil to solution of 0.01 M Ca $(H_2PO_4)_2$, end-over-end for 16 hour shake, centrifuge, measured on ICP AES as phosphate extractable sulfur (sulfate).
Sulfur (KCl-40)	SLM 121	- 3:20 soil to solution of 0.25 M KCl heated @ 40°C for 3 hours. Solution is filtered, measured on ICP
Phosphorous (Colwell)	SLM 108	- 1:100 soil to solution of 0.5 M $NaHCO_3$ end-over-end 16 hour shake, centrifuge, measured colormetrically in segmented flow analyser.
Phosphorous (Bray)	SLM 122	- 1.4:10, soil to solution of 0.03M NH_4F/0.024M HCl reciprocating shaker, for precisely 60 seconds, filtered immediately, measured colormetrically in segmented flow analyser.
Phosphorous (Lactate)	SLM 123	- 1:50 soil to solution of 0.005M $C_6H_{10}CaO_6$ shaken by Orbital shaker for 90 minutes. Measured colormetrically.
Phosphorous (Olsen)	SLM 124	- 1:20 soil to solution of 0.5 M Sodium Bicarbonate at pH 8.5, end-over-end 30 minute shake. Measured colormetrically in segmented flow analyser.
Phosphorous (BSES)	SLM 109	- 1:200 soil:solution of 0.01 N H_2SO_4, end-over-end 16 hour shake, centrifuge, measured colormetrically in segmented flow analyser.
Potassium Calcium Magnesium, Sodium	SLM 105	- 1:10 neutral, normal ammonium acetate, 1/2 hour vigorous shake, centrifuged, measured on ICP AES.
Potassium (Colwell)	SLM 126	- 1:100 soil to solution of 0.5M $NaHCO_3$ end-over-end - 16 hour shake - centrifuged measured on Atomic Absorption Spectrophotometer.
Aluminium	SLM 112	- 1:10 soil to solution of 1M KCL, 1 hour vigorous shake, centrifuged, measured on Atomic Absorption Spectrophotometer.
Chloride	SLM 104	- 1:5, soil to water, intermittent stirring over 1 hour, centrifuged and chloride measured colormetrically in segmented flow analyser.
Electrical Conductivity	SLM 103	- 1:5 soil to water, stirred, stand 1 hour and read by conductivity meter.
Copper, Zinc Manganese, Iron	SLM 106	- 1:2 soil:solution of DTPA, triethanomaline and Ca Cl_2 1/2 hour vigorous shake, centrifuged, measured on ICP AES.
Boron	SLM 107	- 1:2 soil:solution of hot 0.01M Ca Cl_2, refluxed for 10 minutes, centrifuged, measured on ICP AES.

CALCULATIONS

Cation exchange capacity = sum of K, Ca, Mg, Na and Al (if present).

Calcium/Magnesium ratio = Ca÷Mg

Aluminium saturation $= \frac{\text{Al} \times 100}{\text{Cation exchange capacity}}$

Sodium % (ESP) $= \frac{\text{Na} \times 100}{\text{Cation exchange capacity}}$

Elec. conductivity of saturated extract (equiv) is based on conversions of EC (1:5) and soil texture class, to give more accurate assessment of soil salinity hazard (R.J. Shaw et al. QDPI).

CONDITIONS OF SALE OF SOIL, PLANT TISSUE, PLANT SAP AND WATER ANALYSIS

1. DEFINITIONS:
"Company" hereinafter stated is Incitec Ltd.
2. ACCEPTANCE:
The Company hereby reserves the right to refuse to accept requests for Soil, Plant Tissue, Plant Sap and Water analyses at any time prior to analysis being carried out. Analysis shall be carried out on such samples as may be accepted by the Company using such laboratory procedures as the Company considers appropriate. The date of analysis shall be the date on which the analysis is completed by the Company in it's laboratory.
3. WARRANTIES/LIMITATIONS OF LIABILITY:
The Company warrants that the services supplied hereto shall comply with the description and specification as set out in Company brochures or other product documentation published by the Company. All services are supplied subject to this warranty only and all other warranties, whether expressed or implied, are hereby excluded (subject however to any over-riding provisions of the Trade Practices Act 1974 or other Statute). Any other liability arising out of the supply of the services or the rendering of the services, however arising and whether for consequential loss or otherwise including any liability whatsoever the Company may otherwise have by virtue of any representation, warranty, conditions or term whether expressed or implied by law is hereby excluded. Any liability which may be implied by over-riding provisions of the Trade Practices Act 1974 or other Statue hereinafter enacted, shall be limited to the extent that is lawful to do so at the option of the Company, to the rendering again of the services provided and in particular shall not extend to consequential loss or damage and shall be condition upon the purchaser within thirty (30) days of delivery making a written claim to the Company setting out in full particulars of such claim and where possible returning to the Company sufficient information regarding the rendering of the services to enable a proper investigation of the matter.
4. RECOMMENDATIONS
It is a condition of any recommendations given pursuant to the results of any analysis supplied by the Company that the samples upon which the analyses were conducted are representative of the area from which samples came and hence are indicative of soil type and soil structure for which the recommendations are made. As agronomic circumstances and practices vary substantially from place to place and from time to time and as such circumstances and practices are outside the controls of the Company, any recommendations which may be made by the Company are based on general and reasonably anticipated conditions and circumstances and the Company cannot and does not warrant or otherwise guarantee the results of any agronomic recommendations given as a result of the analysis carried out and therefore, subject to any statutory rights, any advice, recommendations, information, assistance or services provided by the Company in relation to the analytical services hereby rendered is given in good faith and is believed by the Company to be appropriate and reliable, however, any liability arising out of or in respect of any such advice, recommendations, information, assistance or services provided by the Company in rendering the analytical services is hereby expressly excluded.
5. DELAY:
All orders for soil, plant tissue, plant sap and water analysis shall be accepted by the Company without responsibility for loss or damage to samples or delays in performance or failure to carry out analyses for any reason whatsoever. The Company will make all reasonable efforts to have the analytical services rendered to the purchaser on or before the date agreed between the parties as the delivery date, but the Company shall be under no responsibility or liability whatsoever should delivery not be made on or before that date.
6. INTELLECTUAL-PROPERTY
No right or licence is granted to the purchaser of these analytical services for any patent, copyright, registered design or other industrial or intellectual property whatsoever and the use acknowledges that all such intellectual property and confidential information shall remain the property of the Company and shall not be used or disclosed to any party unless expressly authorised by the Company.
7. GOVERNING LAW:
This contract shall be governed and construed in accordance with the law in force in the State of Queensland in the Commonwealth of Australia.
8 PRICE:
Prices charged will be at the price ruling at the date of the supply of the services unless otherwise agreed in writing. Any price indications or price lists are subject to alteration to price ruling at the supply date.
9. PAYMENT
Unless otherwise expressly agreed in writing the terms of payment shall be as per invoice. The purchaser is not entitled to withhold any of the payment or to reduce payment on the grounds of counterclaims which are disputed by the Company. Should the purchaser not pay within the time stipulated on the invoice or as otherwise agreed, the Company shall be entitled to charge an overdue account fee as liquidated damages at the rate shown on the front of the invoice. If the purchaser makes default in any payment or commits any act of bankruptcy or bring an incorporated company passes a resolution for winding up (except for the purposes of reconstruction) or a petition is presented for its winding up, the Company may without prejudice to its own rights, either suspend further delivered, alter payment terms or terminate this contract forthwith by written notice to the purchaser. The Company may require cash payments or satisfactory security for future deliveries if the purchaser's financial responsibility becomes unsatisfactory to the Company.
10 NOTICES:
Any notice required to be given shall be in writing and shall be deemed to be properly service if delivered personally, sent by ordinary prepaid mail or sent by telex or facsimile machine to the other party at its last known address. The date of the service of the notice sent by mail shall be deemed to be duly served at the time when in due course the postage would have been delivered.

Appendix B:
Slaking and Dispersion Results

Slaking and Dispersion Results

Sample	Dispersion		Slaking	
	2 hrs	20 hrs	2 hrs	20 hrs
OBS 1, 0-10	0, 0, 0	0, 0, 0	0, 0, 0	-
OBS 1, 10-25	0, 0, 0	0, 0, 0	3, 3, 2	-
OBS 2, 0-10	0, 0, 0	0, 0, 0	0, 0, 1	-
OBS 6, 0-10	0, 0, 0	0, 0, 0	1, 1, 1	-
OBS 6, 18-30	0, 0, 0	0, 0, 0	3, 3, 3	-
OBS 7, 0-10	0, 0, 0	0, 0, 0	0, 1, 0	-
OBS 7, 20-40	0, 0, 0	0, 0, 0	1, 2, 3	-
OBS 9, 0-10	0, 0, 0	0, 0, 0	3, 2, 2	-
OBS 9, 35-45	0, 0, 0	0, 0, 0	3, 3, 2	-
OBS 9, 70-90	0, 0, 0	0, 0, 0	2, 2, 2	-
OBS 11, 0-10	0, 0, 0	0, 0, 0	0, 1, 0	-
OBS 11, 40-50	0, 0, 0	1, 0, 0	3, 3, 2	-
OBS 11, 80-100	0, 0, 0	0, 0, 0	3, 3, 3	-
OBS 14, 0-10	0, 0, 0	0, 0, 0	1, 1, 0	-
OBS 14, 25-35	0, 0, 0	0, 0, 0	1, 2, 1	-
OBS 15a, 0-10	0, 0, 0	0, 0, 0	0, 0, 0	-
OBS 15b, 0-10	0, 0, 0	0, 0, 0	0, 0, 0	-
OBS 15b, 40-50	0, 0, 0	0, 0, 0	2, 3, 3	-
OBS 16, 0-10	0, 0, 0	0, 0, 0	3, 2, 2	-
OBS 19, 0-10	0, 0, 0	0, 0, 0	1, 2, 1	-
OBS 19, 35-40	0, 0, 0	0, 0, 0	2, 2, 1	-
OBS 20, 0-10	0, 0, 0	0, 0, 0	1, 1, 1	-
OBS 20, 20-30	0, 0, 0	0, 0, 0	2, 2, 2	-
OBS 20, 40-70	0, 0, 0	0, 0, 0	2, 3, 3	-
OBS 20, 70-80	0, 0, 0	0, 0, 0	3, 3, 3	-
OBS 27, 0-10	0, 0, 0	0, 0, 0	1, 0, 0	-
OBS 27, 10-30	0, 0, 0	0, 0, 0	2, 2, 2	-
OBS 27, 30-50	0, 0, 0	0, 0, 0	1, 2, 2	-
OBS 27, 50-70	0, 0, 0	0, 0, 0	3, 2, 2	-
OBS 27, 75-85	0, 0, 0	0, 0, 0	3, 3, 3	-
OBS 28, 0-10	0, 0, 0	0, 0, 0	0, 0, 1	-
OBS 28, 15-25	0, 0, 0	0, 0, 0	1, 0, 0	-
OBS 28, 35-70	0, 0, 0	0, 0, 0	3, 3, 2	-
OBS 28, 80-90	0, 0, 0	0, 0, 0	3, 3, 3	-
OBS 29, 0-10	0, 0, 0	0, 0, 0	3, 1, 1	-
OBS 29, 25-35	0, 0, 0	0, 0, 0	1, 2, 2	-

FORAGE REPORT: GROUND COVER

http://www.longpaddock.qld.gov.au/forage *March 12, 2021* *Lot on Plan: 200SP232790,3GU25* *Label: noLabel*

Queensland Government

Introduction

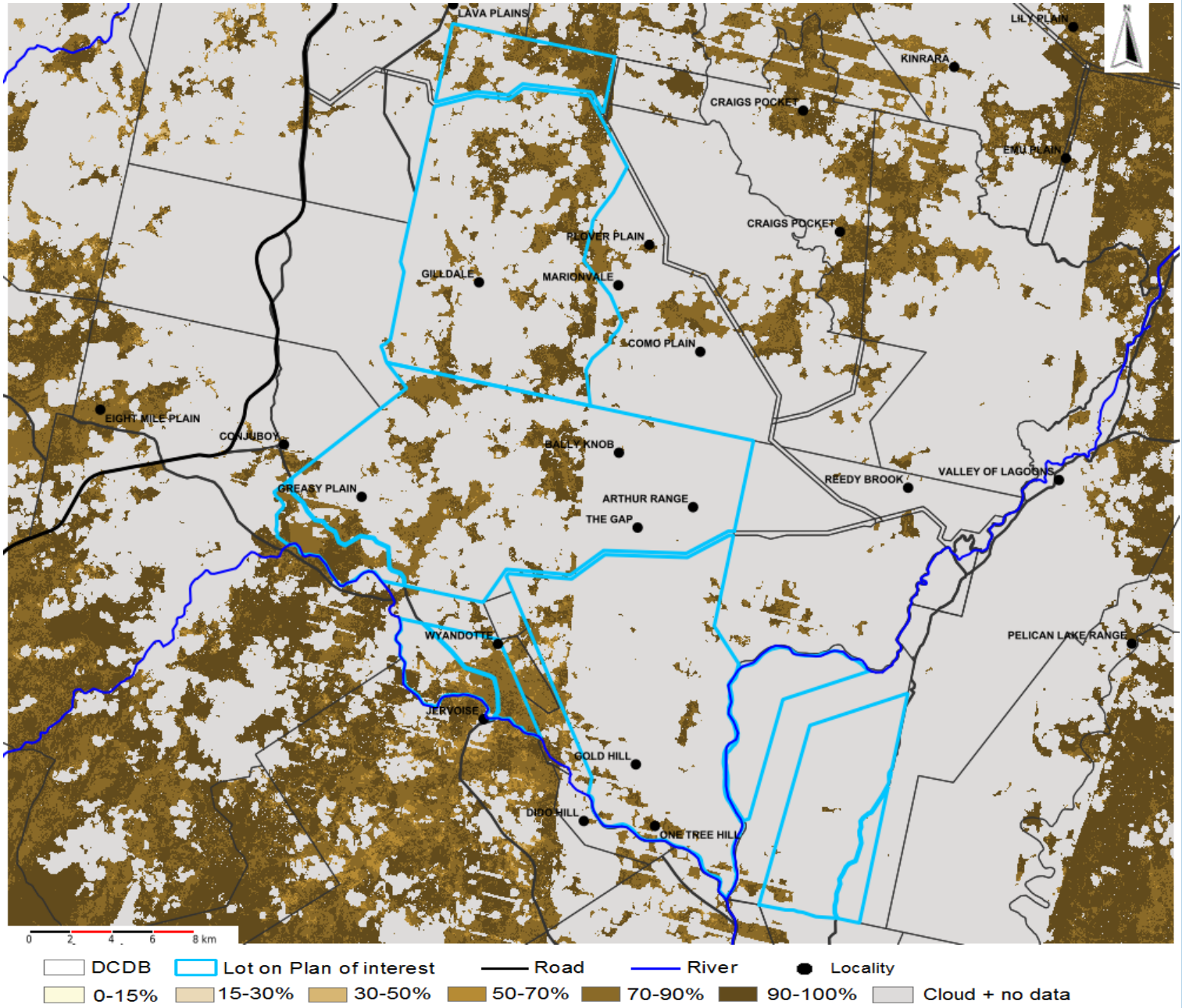
This report presents three ground cover information products: (i) a ground cover map for the chosen month; (ii) a minimum ground cover map for the period 1990 to 2016; and, (iii) a graph showing the historical time series of seasonal ground cover. The maps and historical time series graph are generated from the ground cover products which are produced by the Queensland Government's Remote Sensing Centre using Landsat satellite image data from the United States Geological Survey.

Background information of the Lot on Plan

Latitude/longitude: -18.68/144.89
Total land area : 52928 ha
Long-term annual mean temperature : 23.0 °C
Last 12-month rainfall : 1086.5 mm
Local government: Charters Towers Regional
Average woody vegetation cover: 15.2%
Long-term annual mean rainfall : 682.7 mm
Last month rainfall: 247.7 mm

Location map

Ground cover map (The image is for March 2019)



Ground cover map summary

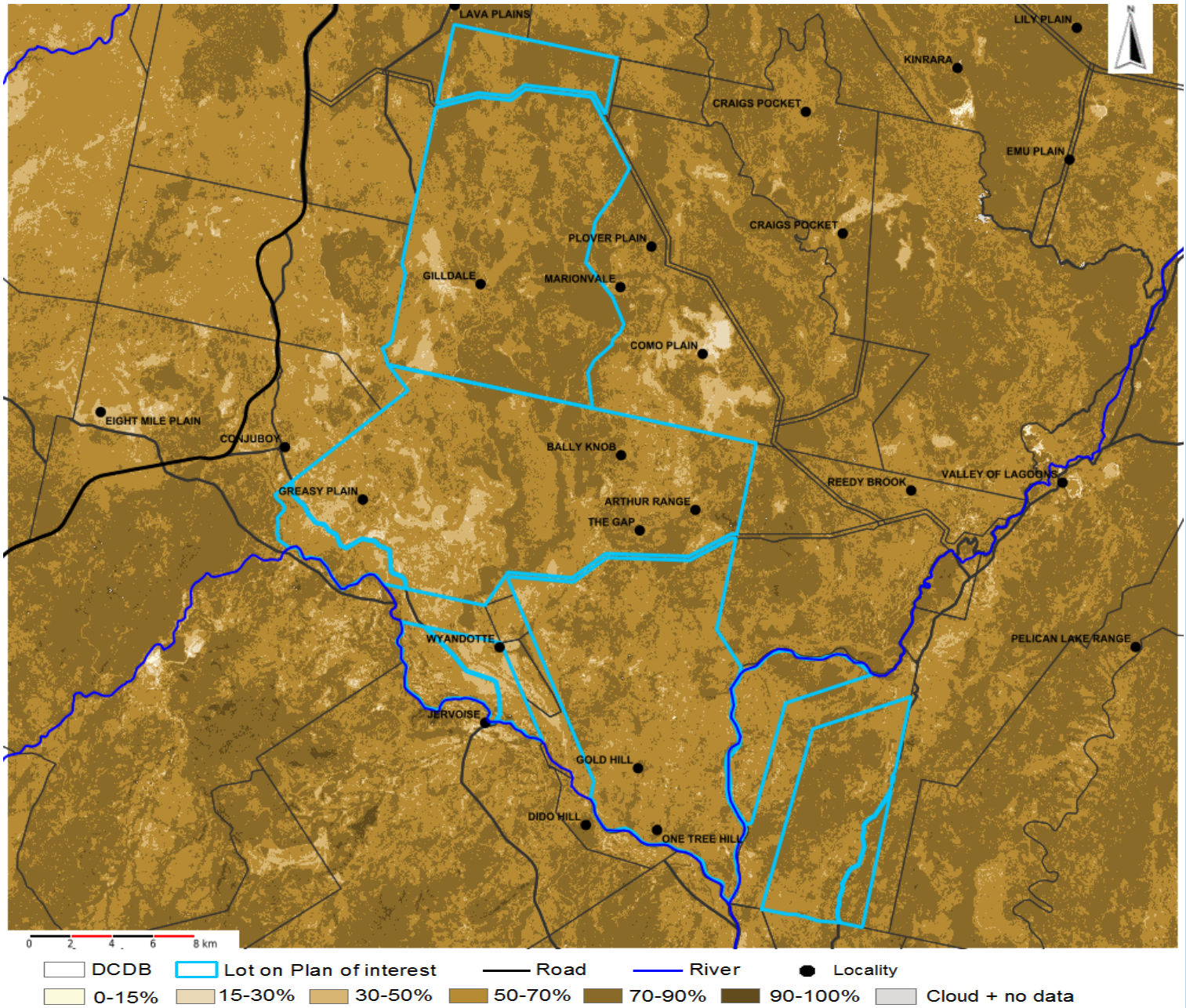
The monthly ground cover map shows the level of ground cover for areas on the Lot on Plan with less than 60% tree cover. The image is for March 2019. The percentage of the total area of the Lot on Plan for 6 ranges of ground cover levels are summarised below:

Cover levels	<15%	15 - 30%	30 - 50%	50 - 70%	70 - 90%	>90%
Percentage out of the total area	0.0	0.0	0.3	3.1	54.7	41.9

FORAGE REPORT: GROUND COVER

Queensland Government

Minimum ground cover map for 1990 to 2016



Minimum ground cover map summary

The minimum ground cover map shows the lowest level of cover for the Lot on Plan which has been measured in the period 1986 to 2016. This map is useful for showing areas that may be vulnerable to low ground cover. The percentage of the total area of the Lot on Plan for 6 ranges of minimum ground cover levels are summarised below:

Cover levels	<15%	15 - 30%	30 - 50%	50 - 70%	70 - 90%	>90%
Percentage out of the total area	0.0	0.1	5.8	52.3	41.7	0.1

Disclaimer

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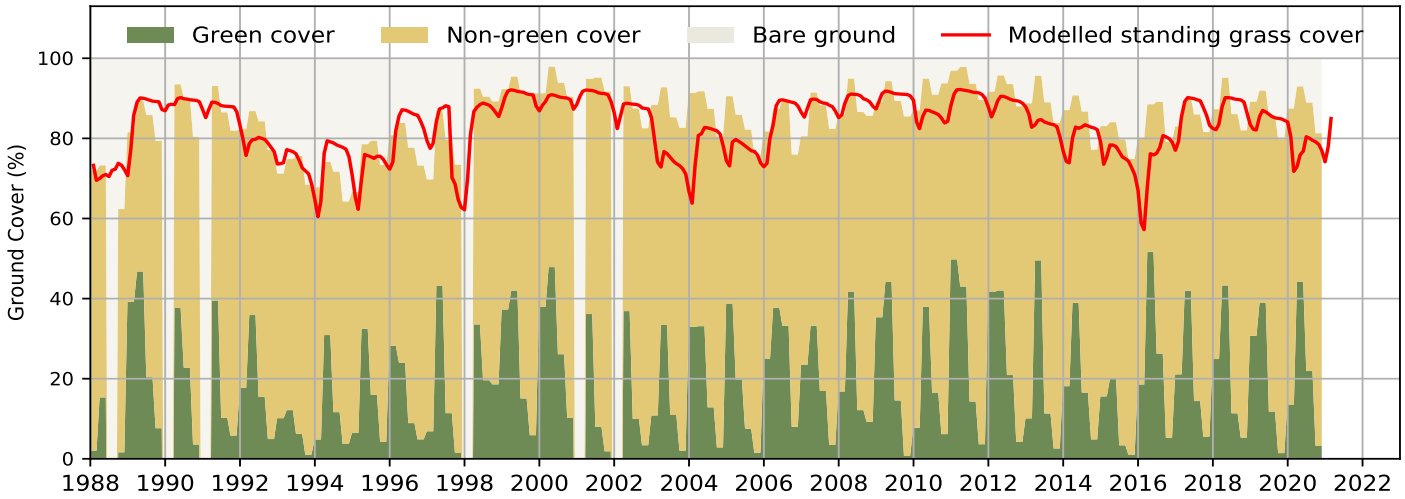
FORAGE REPORT: GROUND COVER

http://www.longpaddock.qld.gov.au/forage *March 12, 2021* *Lot on Plan: 200SP232790,3GU25* *Label: noLabel*

Queensland Government

Seasonal ground cover time series graph



About the seasonal ground cover time series graph

The time series graph shows the seasonal levels of ground cover for the Lot on Plan from 1988 to present. The ground cover level is also separated in the green and non-green components of the total level of ground cover. Gaps may occur on the graph where there was insufficient satellite data to derive a valid seasonal estimate of ground cover (e.g. due to persistent cloud over a season). The solid red line on the graph represents modelled seasonal average standing grass cover for the Lot on Plan. This is derived from the AussieGRASS model. It is included to provide an indication of the amount of the measured ground cover that is likely to be standing grass cover. The satellite-derived estimates of ground cover include all cover components, and therefore does not distinguish between standing grass cover and litter on the ground, particularly in the non-green component.

FORAGE REPORT: ERODIBLE SOILS

Queensland Government

Introduction

This report contains three maps of overall soil erodibility (map 1), surface soil stability (map 2) and subsoil erodibility (map 3).

This information was produced specifically for the Burdekin catchment and Fitzroy NRM region. The red cross on the map shows your location within the catchment.

Soil erodibility on these maps is the likelihood that a particular soil is susceptible to erosion.

The maps were produced for regional or sub-catchment investigations, for example comparing soils in major tributaries of rivers and not at a property scale. The maps were produced at a scale of 1:250,000 at this scale 1cm represents 2.5km.

Location map

About the maps

These maps were developed to characterise soils into increasing degrees of erosion vulnerability using a limited set of locally relevant soil properties. The actual extent to which a soil erodes is also influenced by non-soil factors such as land cover, landscape position, climate and land management practices. These factors are not included in these maps.

When considering the soils vulnerability to erosion, both surface soil stability and subsoil erodibility need to be considered. For example, some soils have protective stable surface soils overlying erodible subsoils while other soils have erodible surface soils over erodible subsoils. The table below describes the overall soil erodibility as shown in map 1, in terms of locations of surface soil stability (map 2) and subsoil erodibility (map 3). As you move to the right of the table the potential erodibility of the surface soil increases, correspondingly as you move down the table the potential erodibility of the subsoil increases. As such soils in the bottom right of the table have the potential to be more erodible than those soils in the top left. The colour in each cell corresponds with the legend colours of each map.

Information on soil erosion is available from www.qld.gov.au/environment/land/soil.

A userguide is available for download from https://publications.qld.gov.au/dataset/burdekin-digital-soils-mapping-bdsm. GIS data in the form of 90m raster of overall, surface and subsoil erodibility is available for free download from Queensland Government Data portal at www.data.qld.gov.au.

Surface soil stability (Map 2)

Increasing surface soil erodibility →

Subsoil dispersibility (Map 3) — **Increasing subsoil erodibility ↓**

	Moderately stable surface soils	Non-cohesive surface soils	Dispersive surface soils	Highly erodible surface soils
Rock	Loamy to clayey soils over rock	Sandy massive surface soils over rock	Weakly dispersive clay soils	Clayey soils that erode and/or slake readily
Non-dispersive subsoils	Loamy to clayey soils over non-dispersive subsoils	Sandy massive surface soils over non-dispersive subsoils		Clayey surface soils that erode and/or slake over weakly dispersive subsoils
Weakly dispersive subsoils	Loamy to clayey soils over weakly dispersive clay subsoils	Sandy massive surface soils over weakly dispersive subsoils		
Moderately dispersive subsoils	Loamy to clayey soils over moderately dispersive clay subsoils	Sandy massive surface soils over moderately dispersive subsoils	Moderately dispersive clay soils	Clayey surface soils that erode and/or slake over moderately dispersive subsoils
Highly dispersive subsoils	Loamy to clayey soils over highly dispersive clay subsoils	Sandy massive surface soils over highly dispersive subsoils	Dispersive loamy or clayey surface soils over highly dispersive clay subsoils	Clayey surface soils that erode and/or slake over highly dispersive subsoils

Disclaimer

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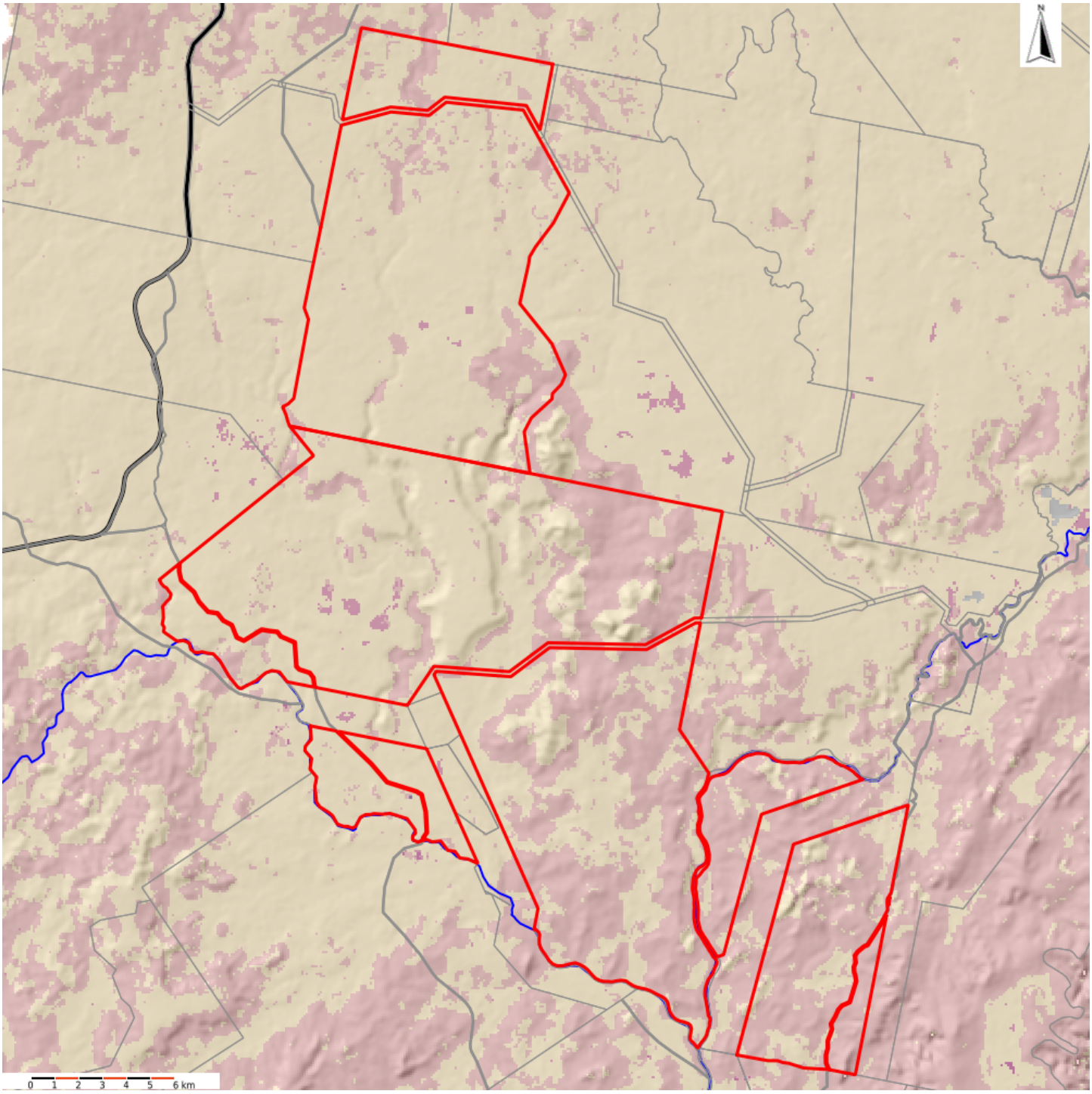
Overall soil erodibility

Soils have been ranked into five broad categories of erodibility (very low to very high). They have been derived from a combination of surface soil stability and subsoil erodibility. The table on the first page shows the possible combinations. Using the Table in the About the Maps section and Maps 2 and 3, you can determine the soils likely to occur.

Map 1 - Overall soil erodibility ranking



- Not assessed
- Very low erosion vulnerability
- Low erosion vulnerability
- Moderate erosion vulnerability
- High erosion vulnerability
- Very high erosion vulnerability

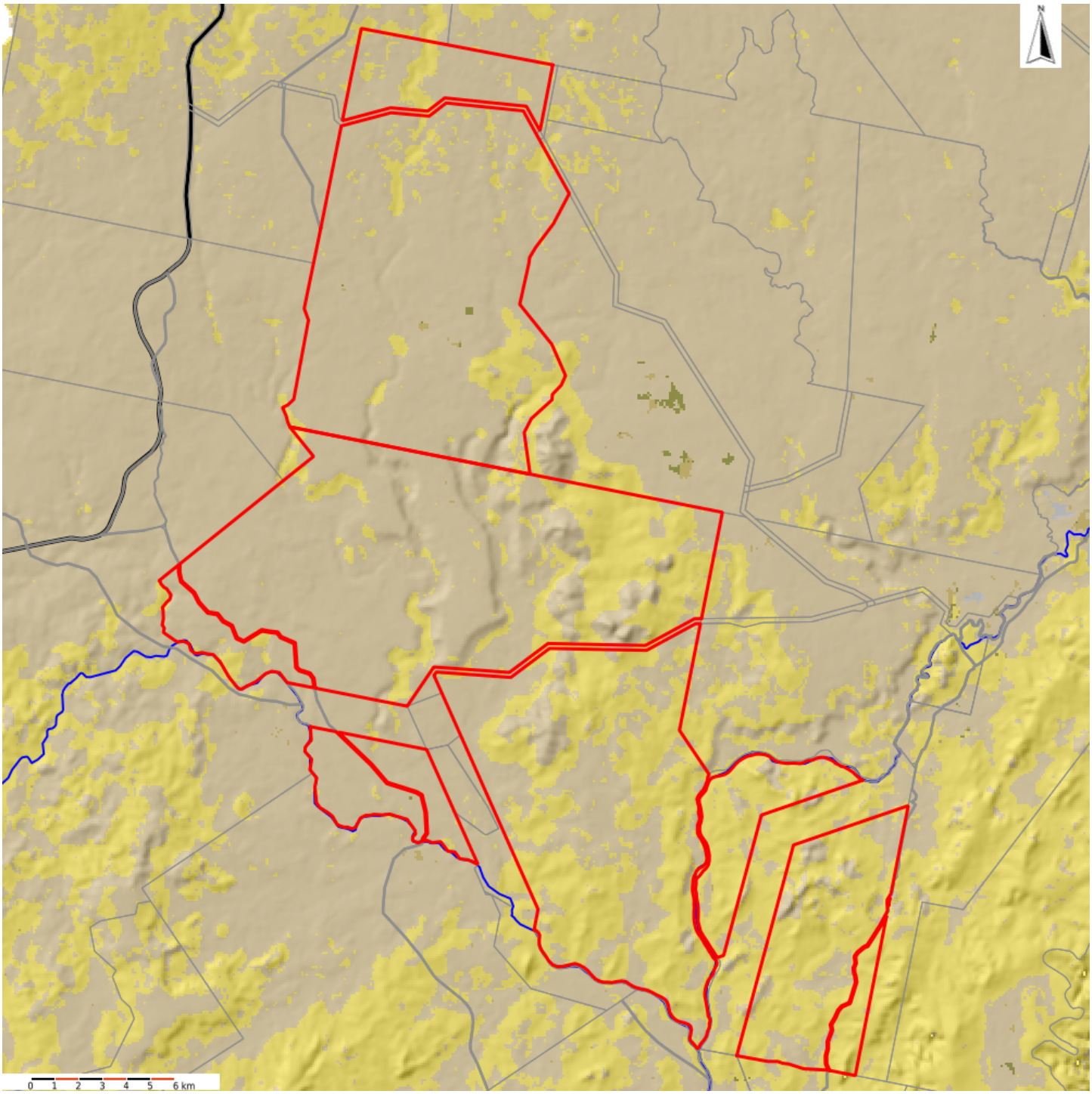
DCDB Rivers Roads Selected property/Lot on Plan

Surface soil

The surface soils have been classified into the following four categories. These categories generally relate to increasing surface soil erodibility:

1. Moderately stable surface soils are usually structured and resilient to degradation .
2. Non-cohesive surface soils are sandy soils that are not structured or only weakly so and non-cohesive. These soils are easily eroded.
3. Dispersive surface soils are loamy or clayey soils that are sodic, hardsetting and are likely to disperse in water.
4. Highly erodible surface soils are clayey soils that are sodic and dominated by shrink/swell clays that readily disperse.

Map 2 - Surface soil stability



Not assessed

Moderately stable surface soils

Non-cohesive surface soils

Dispersive surface soils

Highly erodible surface soils

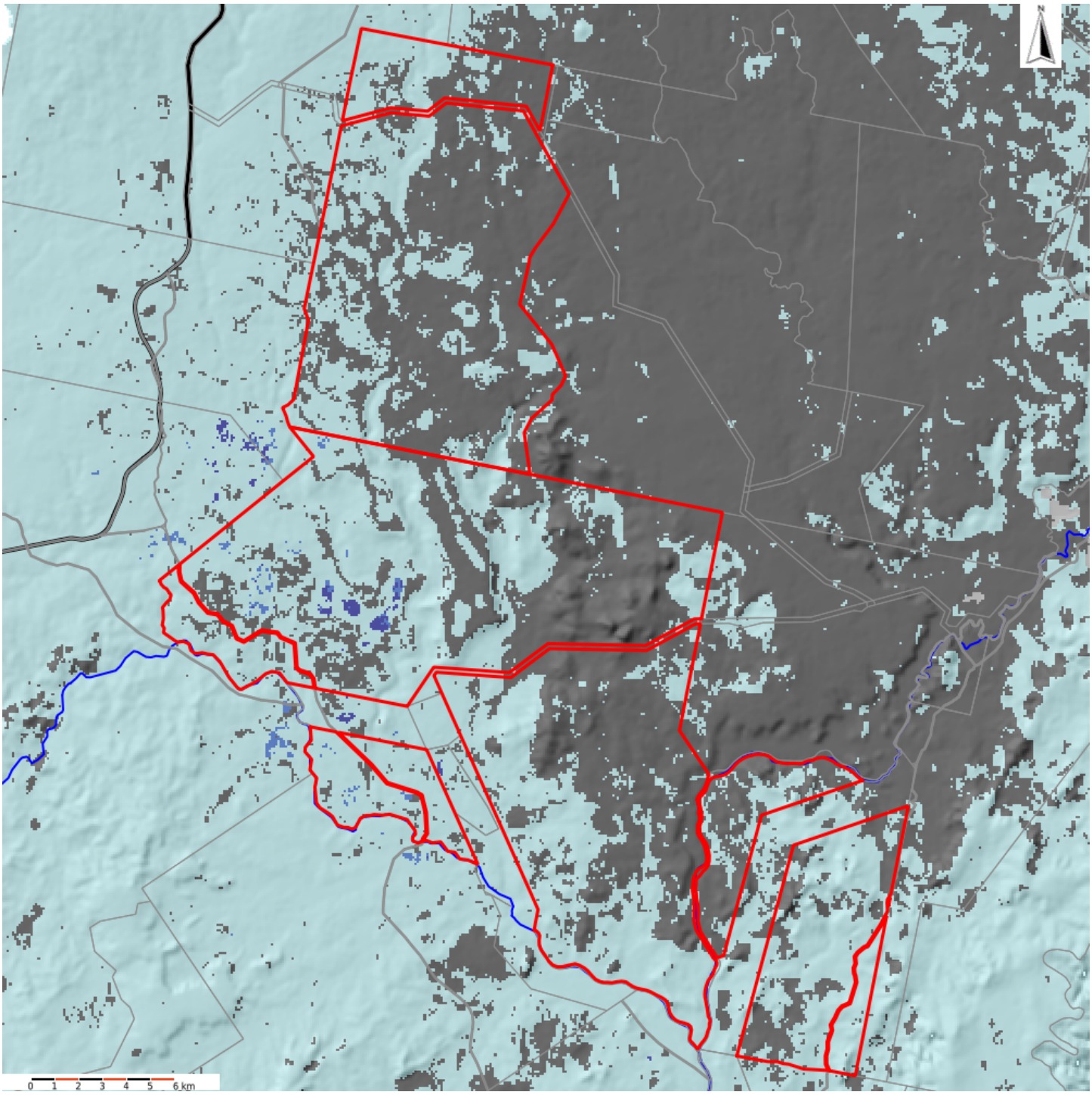
DCDB Rivers Roads Selected property/Lot on Plan

Subsoil

The subsoils have been classified into the following four categories:

1. Non-dispersive subsoils that are non-sodic or only weakly sodic and are unlikely to disperse.
2. Weakly dispersive subsoils are sodic subsoils that are saline or dominated by carbonate nodules that prevent these subsoils from dispersing readily.
3. Dispersive subsoils are sodic subsoils that disperse readily.
4. Highly dispersive subsoils are sodic subsoils that are also dominated by magnesium ions that enhance the dispersive affect.

Map 3 - Subsoil dispersibility



Not assessed
Non-dispersive subsoils
Weakly dispersive subsoils
Moderately dispersive subsoils
Highly dispersive subsoils
Rock
DCDB
Rivers
Roads
Selected property/Lot on Plan

PROGRESSIVE REHABILITATION AND CLOSURE PLAN
AGRIPOWER AUSTRALIA LTD

Appendix 4: WASTE CHARACTERISATION INFORMATION

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2109949**	Page	: 1 of 7
Client	: **ARDENT GROUP**	Laboratory	: Environmental Division Brisbane
Contact	: MR RICHARD DAVIS	Contact	: Customer Services EB
Address	: 159 Musgrave Road Redhill Brisbane 4059	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: 07 3368 1033	Telephone	: +61-7-3243 7222
Project	: Agripower	Date Samples Received	: 13-Apr-2021 11:55
Order number	: ----	Date Analysis Commenced	: 15-Apr-2021
C-O-C number	: ----	Issue Date	: 23-Apr-2021 15:39
Sampler	: ----		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 7		
No. of samples analysed	: 7		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Mark Hallas	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Satishkumar Trivedi	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Satishkumar Trivedi	Senior Acid Sulfate Soil Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

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

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

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

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

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

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

- EA031 (Saturated Paste pH): NATA accreditation does not cover the performance of this service.
- EA032 (Saturated Paste EC): NATA accreditation does not cover the performance of this service.
- Samples xxx have been crushed prior to preparation and analysis.
- Samples have been crushed prior to preparation and analysis.
- ASS: EA029 (SPOCAS): Laboratory determinations of ANC needs to be corroborated by effectiveness of the measured ANC in relation to incubation ANC. Unless corroborated, the results of ANC testing should be discounted when determining Net Acidity for comparison with action criteria, or for the determination of the acidity hazard and required liming amounts.
- ASS: EA013 (ANC) Fizz Rating: 0- None; 1- Slight; 2- Moderate; 3- Strong; 4- Very Strong; 5- Lime.
- ASS: EA029 (SPOCAS): Liming rate is calculated and reported on a dry weight basis assuming use of fine agricultural lime ($CaCO_3$) and using a safety factor of 1.5 to allow for non-homogeneous mixing and poor reactivity of lime. For conversion of Liming Rate from kg/t dry weight to kg/m3 in-situ soil, multiply reported results x wet bulk density of soil in t/m3.

Analytical Results

Sub-Matrix: **ASLP LEACHATE** (Matrix: **WATER**)			Sample ID	B7	B8	OB5	OB10	DE2E
			Sampling date / time	08-Apr-2021 00:00	08-Apr-2021 00:00	08-Apr-2021 00:00	08-Apr-2021 00:00	08-Apr-2021 00:00
Compound	CAS Number	LOR	Unit	EB2109949-001	EB2109949-002	EB2109949-003	EB2109949-004	EB2109949-005
				Result	Result	Result	Result	Result
EG020W: Water Leachable Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	<0.001	**0.001**	**0.004**	**0.001**	**0.001**
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	**0.015**	**0.039**	**0.041**	**0.019**	**0.012**
Copper	7440-50-8	0.001	mg/L	**0.031**	**0.039**	**0.040**	**0.010**	**0.013**
Lead	7439-92-1	0.001	mg/L	**0.005**	**0.035**	**0.042**	**0.008**	**0.009**
Nickel	7440-02-0	0.001	mg/L	**0.086**	**0.105**	**0.040**	**0.015**	**0.003**
Zinc	7440-66-6	0.005	mg/L	**0.016**	**0.019**	**0.017**	**0.008**	<0.005
EG035W: Water Leachable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

Analytical Results

Sub-Matrix: ASLP LEACHATE (Matrix: WATER)			Sample ID	DE5S	DE7	----	----	----
			Sampling date / time	08-Apr-2021 00:00	08-Apr-2021 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EB2109949-006	EB2109949-007	--------	--------	--------
				Result	Result	----	----	----
EG020W: Water Leachable Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	**0.002**	**0.003**	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	----	----	----
Chromium	7440-47-3	0.001	mg/L	**0.017**	**0.027**	----	----	----
Copper	7440-50-8	0.001	mg/L	**0.017**	**0.046**	----	----	----
Lead	7439-92-1	0.001	mg/L	**0.010**	**0.023**	----	----	----
Nickel	7440-02-0	0.001	mg/L	**0.004**	**0.008**	----	----	----
Zinc	7440-66-6	0.005	mg/L	<0.005	**0.027**	----	----	----
EG035W: Water Leachable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	----	----	----

Analytical Results

Sub-Matrix: ROCK (Matrix: SOIL)			Sample ID	B7	B8	----	----	----
			Sampling date / time	08-Apr-2021 00:00	08-Apr-2021 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EB2109949-001	EB2109949-002	--------	--------	--------
				Result	Result	----	----	----
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-56.7	-32.7	----	----	----
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	9.1	8.0	----	----	----
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	----	----	----
NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	<0.1	----	----	----
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	57.3	33.0	----	----	----
ANC as CaCO3	----	0.1	% CaCO3	5.8	3.4	----	----	----
Fizz Rating	----	0	Fizz Unit	2	1	----	----	----
EA029-G: Retained Acidity								
HCl Extractable Sulfur (20Be)	----	0.020	% S	<0.020	<0.020	----	----	----
EA031: pH (saturated paste)								
ø pH (Saturated Paste)	----	0.1	pH Unit	8.1	7.7	----	----	----
EA032: Electrical Conductivity (saturated paste)								
ø Electrical Conductivity (Saturated Paste)	----	1	µS/cm	215	169	----	----	----
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.02	0.01	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	<10	<10	----	----	----
EG020T: Total Metals by ICP-MS								
Arsenic	7440-38-2	0.1	mg/kg	0.7	0.7	----	----	----
Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	----	----	----
Chromium	7440-47-3	0.1	mg/kg	16.0	30.7	----	----	----
Copper	7440-50-8	0.1	mg/kg	25.6	23.2	----	----	----
Nickel	7440-02-0	0.1	mg/kg	115	146	----	----	----
Lead	7439-92-1	0.1	mg/kg	2.3	2.9	----	----	----
Zinc	7440-66-6	0.5	mg/kg	47.6	41.7	----	----	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	----	----	----
EN60: ASLP Leaching Procedure - Inorganics/Non-Volatile Organics (Glass Vessel)								
Final pH	----	0.1	pH Unit	8.1	8.1	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	OB5	OB10	DE2E	DE5S	DE7
			Sampling date / time	08-Apr-2021 00:00	08-Apr-2021 00:00	08-Apr-2021 00:00	08-Apr-2021 00:00	08-Apr-2021 00:00
Compound	CAS Number	LOR	Unit	EB2109949-003	EB2109949-004	EB2109949-005	EB2109949-006	EB2109949-007
				Result	Result	Result	Result	Result
EA009: Net Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-103	-62.4	-7.8	-1.6	-3.1
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	8.9	9.0	8.0	7.2	7.1
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	103	62.4	8.1	2.8	3.7
ANC as CaCO3	----	0.1	% CaCO3	10.5	6.4	0.8	0.3	0.4
Fizz Rating	----	0	Fizz Unit	2	2	1	0	0
EA029-G: Retained Acidity								
HCl Extractable Sulfur (20Be)	----	0.020	% S	<0.020	<0.020	<0.020	<0.020	<0.020
EA031: pH (saturated paste)								
ø pH (Saturated Paste)	----	0.1	pH Unit	8.5	8.1	8.4	7.8	7.8
EA032: Electrical Conductivity (saturated paste)								
ø Electrical Conductivity (Saturated Paste)	----	1	µS/cm	1340	1040	357	165	1160
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	24.5	25.2	42.5	45.5	37.1
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	<0.01	<0.01	0.01	0.04	0.02
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	<10	<10	<10	<10	620
EG020T: Total Metals by ICP-MS								
Arsenic	7440-38-2	0.1	mg/kg	1.3	1.8	0.3	0.8	0.8
Cadmium	7440-43-9	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium	7440-47-3	0.1	mg/kg	12.3	9.5	3.9	3.6	4.2
Copper	7440-50-8	0.1	mg/kg	15.5	15.7	5.1	7.5	9.5
Nickel	7440-02-0	0.1	mg/kg	11.2	9.8	1.0	1.1	1.4
Lead	7439-92-1	0.1	mg/kg	15.5	12.8	5.7	4.4	3.8
Zinc	7440-66-6	0.5	mg/kg	3.9	3.9	0.8	0.7	3.6
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
EN60: ASLP Leaching Procedure - Inorganics/Non-Volatile Organics (Glass Vessel)								

Analytical Results

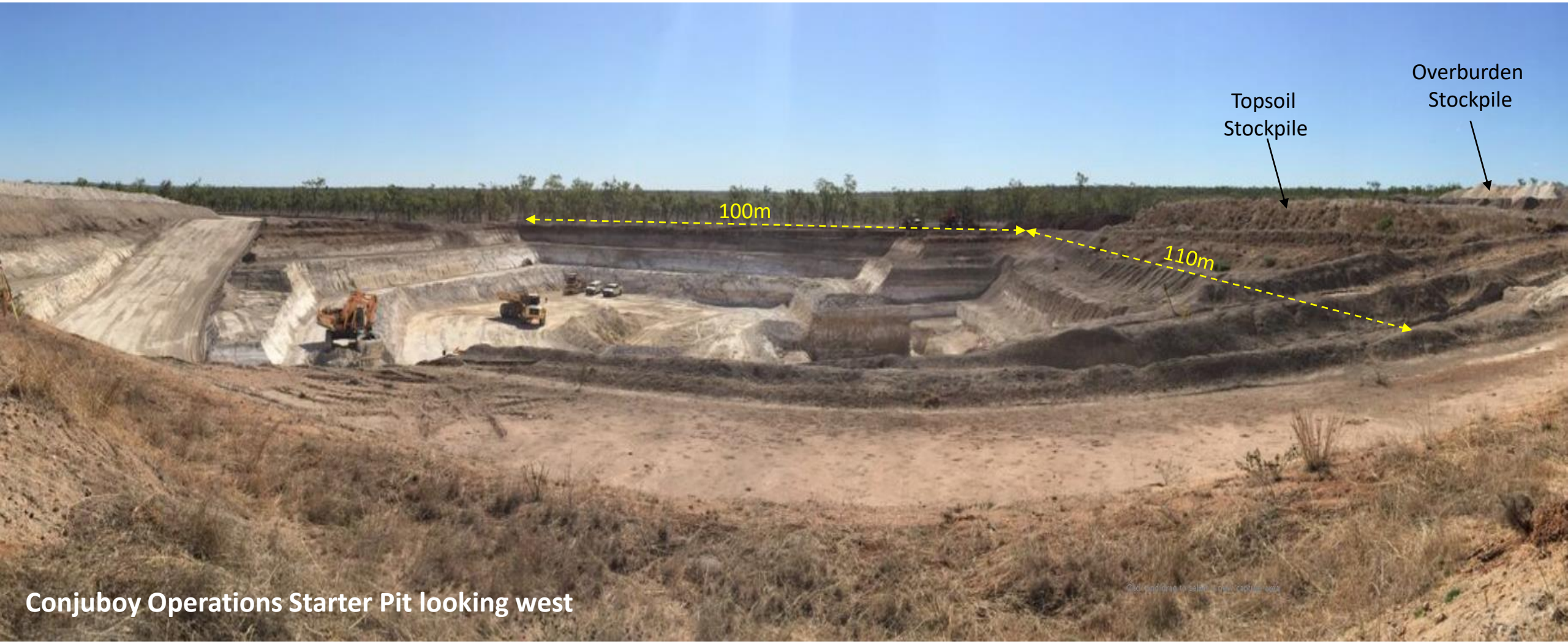
Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	OB5	OB10	DE2E	DE5S	DE7
			Sampling date / time	08-Apr-2021 00:00	08-Apr-2021 00:00	08-Apr-2021 00:00	08-Apr-2021 00:00	08-Apr-2021 00:00
Compound	CAS Number	LOR	Unit	EB2109949-003	EB2109949-004	EB2109949-005	EB2109949-006	EB2109949-007
				Result	Result	Result	Result	Result
EN60: ASLP Leaching Procedure - Inorganics/Non-Volatile Organics (Glass Vessel) - Continued								
Final pH	----	0.1	pH Unit	**9.3**	**8.7**	**9.1**	**8.5**	**8.5**

PROGRESSIVE REHABILITATION AND CLOSURE PLAN
AGRIPOWER AUSTRALIA LTD

Appendix 5: LANDFORM DESIGN INFORMATION

Conjuboy Operations – ML10279
Rehabilitation Program

Greenvale Silicon Pty Ltd
ACN 097 148 680



Conjuboy Operations Starter Pit looking west

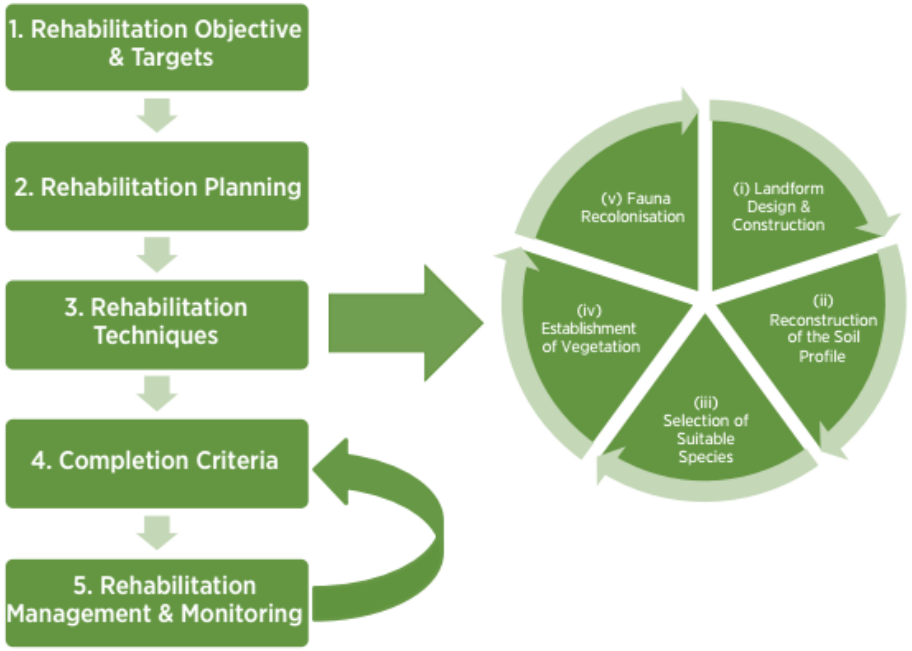
Conjuboy Operations – ML10279
Rehabilitation Program – Aims and Processes

Restoring the environment to it's natural state.

Rehabilitation at the Conjuboy Operation is carried out progressively as soon as practicable as the open pit develops and it is safe to do so (determined to be at 3Ha as per Environmental Authority EPML00392513). It includes the progressive rehabilitation of any significant disturbance to create a structurally stable landform capable of future productive use and environmental sustainability. The Rehabilitation involves returning the land to it's natural state (similar to that which exists prior to mining) through strict, well researched strategies of revegetation and the regeneration of natural ecosystems.

Rehabilitation at the Conjuboy Operation involves a comprehensive process of overburden and topsoil stockpiling, land re-contouring, seeding and regeneration.

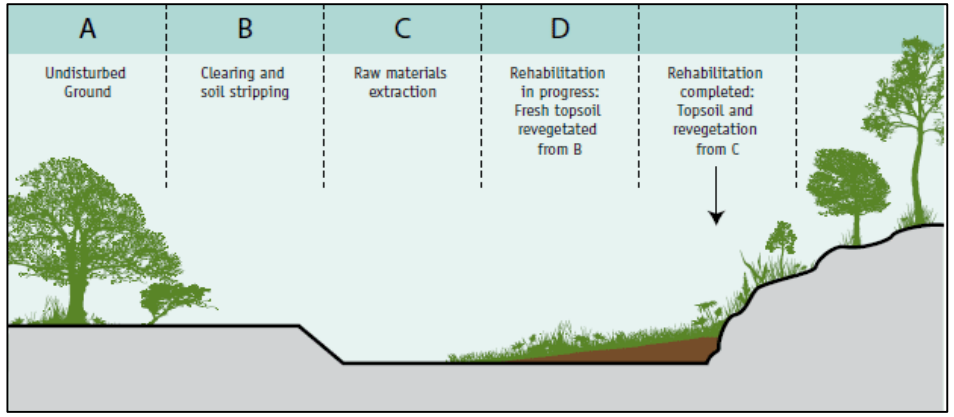
Topsoil and overburden are stripped off the top of the ore horizon as the open pit develops. This topsoil and overburden are stockpiled separately close to the open pit in a safe and optimal manner according to best practice guidelines.



Conjuboy Operations – ML10279
Rehabilitation Program – Techniques and Justification

Rehabilitation Technique

The set-up of the Conjuboy Operation open pit, its overburden stockpiles and topsoil stockpiles have been strategically located to ensure the optimal and safest rehabilitation strategy can be carried out at the operation.



The overburden stockpile has been located tangentially (to the North) of the open pit and within 100m of the old mining face. The topsoil stockpile is located directly next to the pit (to the North).

Once the open pit has reached the a safe operating size (3Ha) and as per the EPML00392513 overburden will be pushed back into the pit via a dozer. The full length of the dozer push will be less than 100m from North to South (from stockpile to pit). At this stage, once the pit is big enough, overburden can be placed directly into the open void during pre-stripping activities.

Rehabilitation Technique Justification

The set up and execution of continuous rehabilitation via a dozer push at the Conjuboy Operation is the most cost effective, quickest and best practice option for the Operation.

No expensive trucks and shovels are required to remove and place the overburden stockpiles into the open void and the unconsolidated overburden is easily pushed back into the pit via a dozer.

Final Landform and Final Land Use

Once the open pit develops and the mining face has been determined to be far enough ahead of the rehabilitation area, the stockpiled overburden is pushed back into the open pit with a dozer. The slopes are then re-contoured to less than 10 degrees to control surface runoff and to ensure a stable slope remains. Topsoil is then spread to a depth of 150 millimetres before the area is contour ripped, fertilised and seeded with local native bush species comprising grasses, groundcovers, shrubs and trees.

Conjuboy Operations – ML10279
Rehabilitation Program – Year 1 of 5

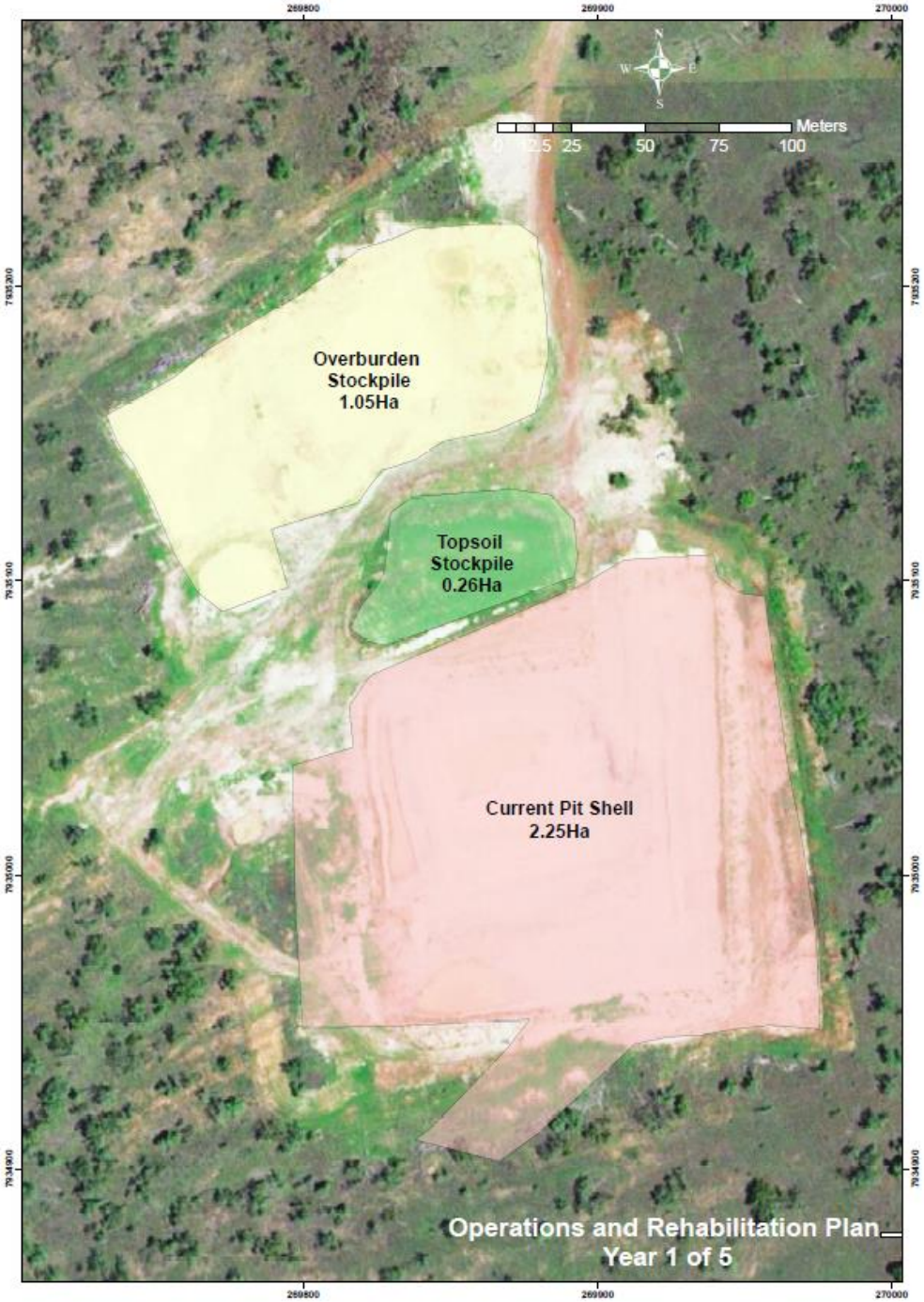
Total Lease Area -	133Ha
Total Disturbed Area -	4.13Ha
Percentage of Lease Area Disturbed -	3.1%

Total area of Significant Disturbance - Pit Shell Area= 2.25Ha
Percentage of Significant Disturbance of Total Lease Area = 1.7%

Operations Plan

- Mining will continue from current pit extents
- Ore stocks will be removed from Mine to Plant site
- No further overburden or topsoil removed and stockpiled
- No rehabilitation as work plan still operating in open pit extents

Total Area Rehabilitated – 0 Ha



Conjuboy Operations – ML10279
Rehabilitation Program – Year 2 of 5

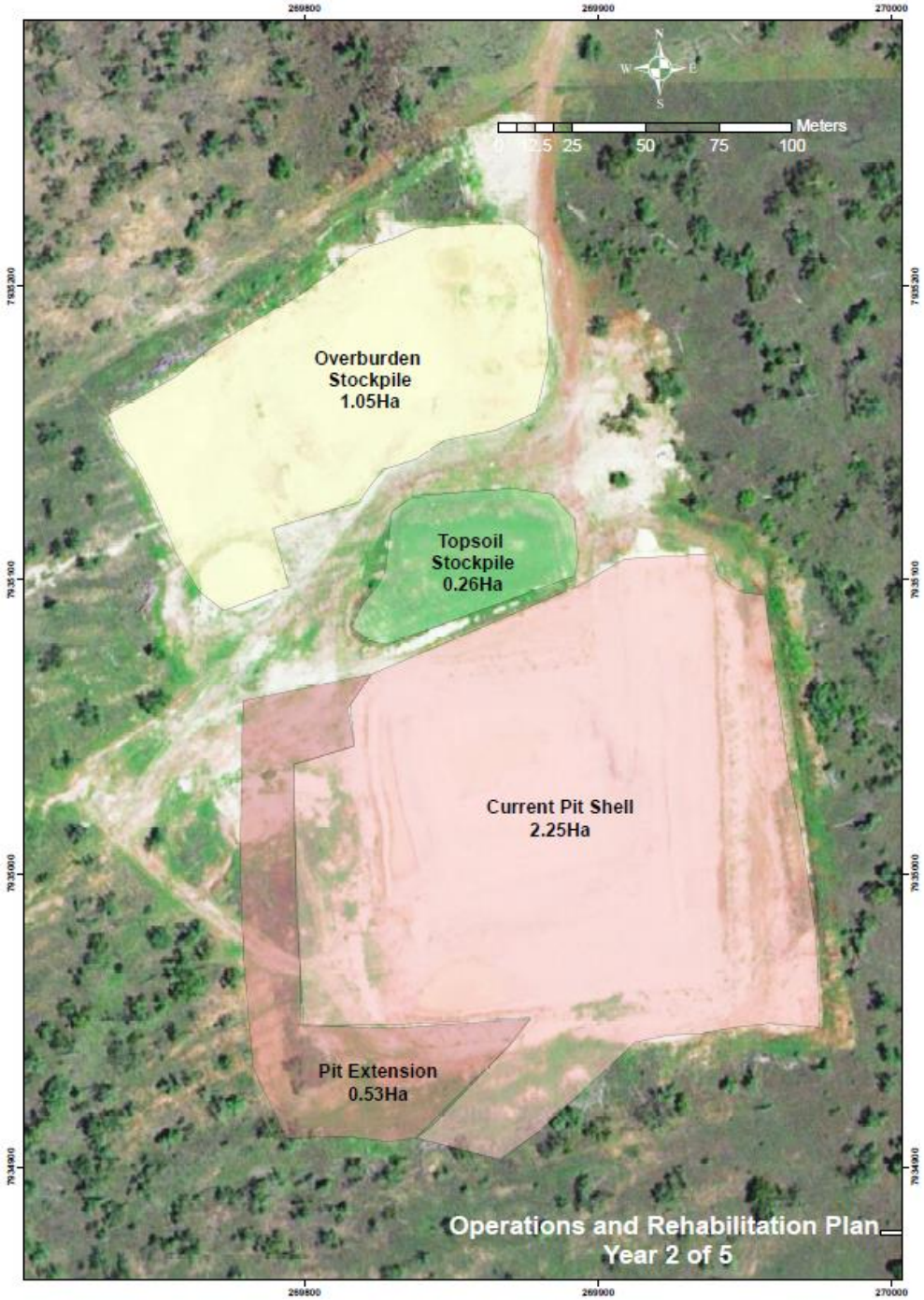
Total Lease Area -	133Ha
Total Disturbed Area -	4.66Ha
Percentage of Lease Area Disturbed -	3.5%

Total area of Significant Disturbance - Pit Shell Area= 2.78Ha
Percentage of Significant Disturbance of Total Lease Area = 2.1%

Operations Plan

- A further 0.53Ha of clearing will occur to east of mining pit
- Topsoil will be removed and stockpiled on current topsoil stockpile
- Overburden will be removed and stockpiled on current overburden stockpile
- Mining of ore will continue from expanded open pit
- Ore stocks will be removed from Mine to Plant site
- No rehabilitation as work plan still operating in open pit extents

Total Area Rehabilitated – 0 Ha



Conjuboy Operations – ML10279
Rehabilitation Program – Year 3 of 5

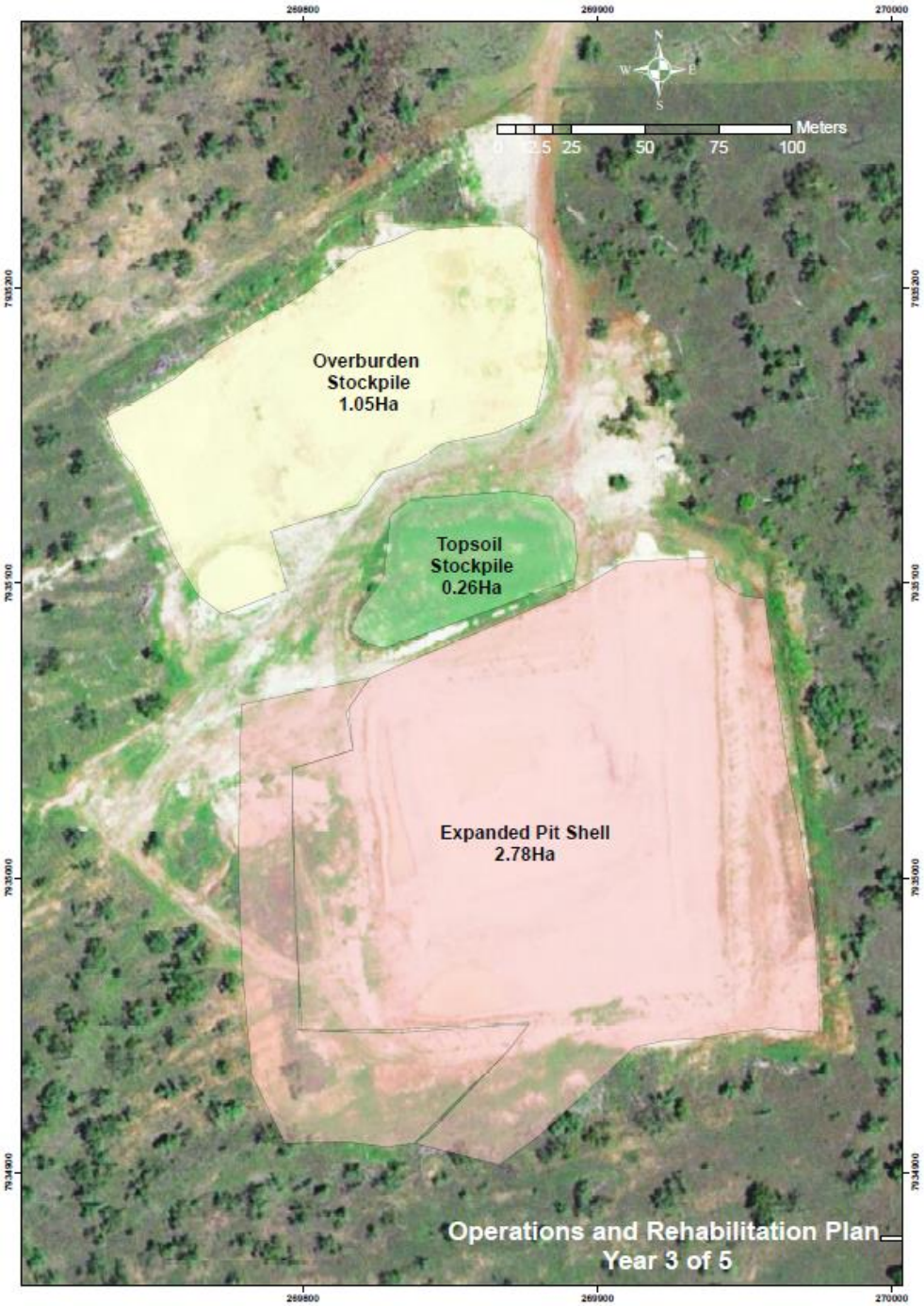
Total Lease Area -	133Ha
Total Disturbed Area -	4.66Ha
Percentage of Lease Area Disturbed -	3.5%

Total area of Significant Disturbance - Pit Shell Area= 2.78Ha
Percentage of Significant Disturbance of Total Lease Area = 2.1%

Operations Plan

- Mining of ore will continue from expanded open pit
- Ore stocks will be removed from Mine to Plant site
- No further overburden or topsoil removed and stockpiled
- No rehabilitation as work plan still operating in open pit extents

Total Area Rehabilitated – 0 Ha



Conjuboy Operations – ML10279
Rehabilitation Program – Year 4 of 5

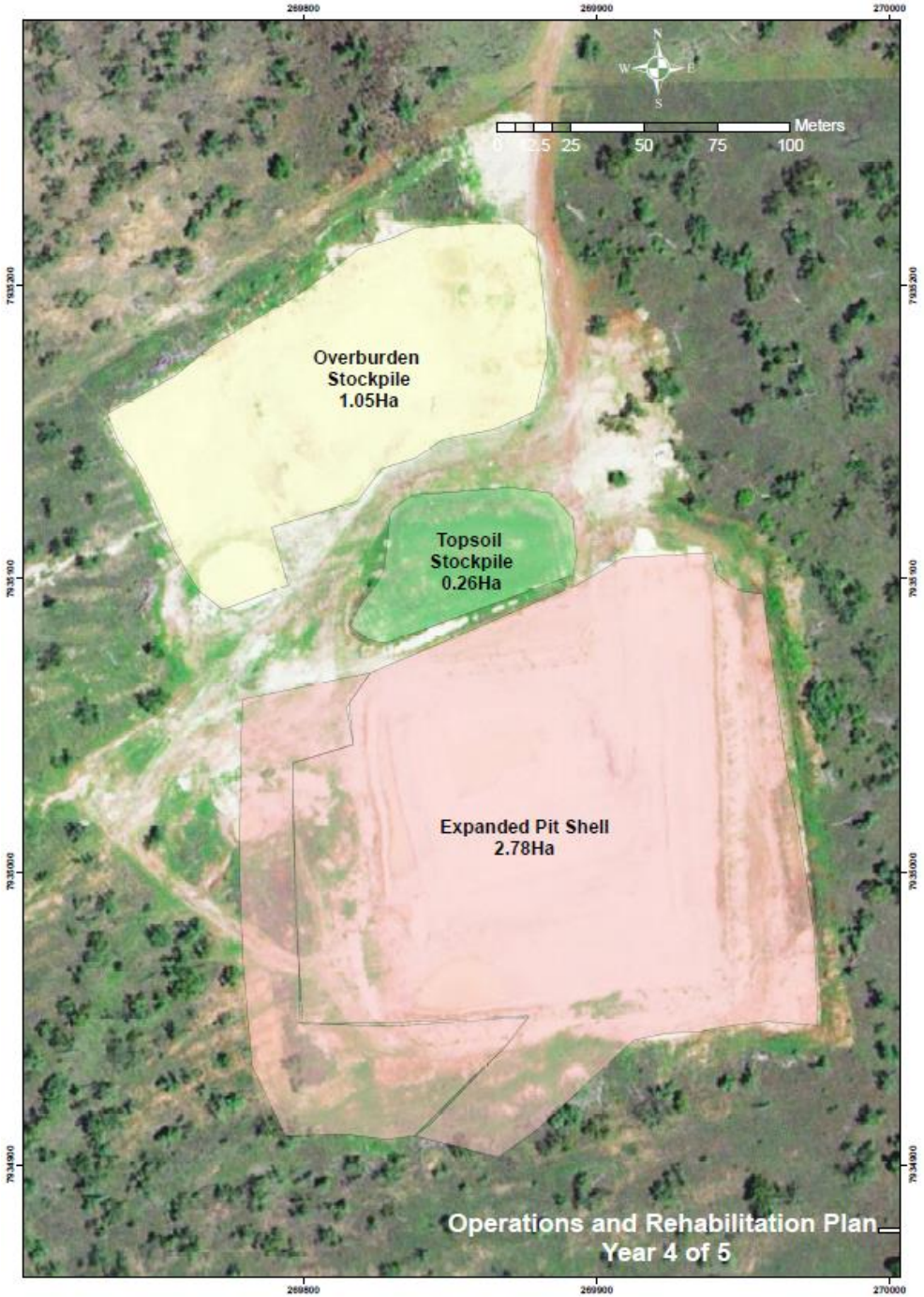
Total Lease Area -	133Ha
Total Disturbed Area -	4.66Ha
Percentage of Lease Area Disturbed -	3.5%

Total area of Significant Disturbance - Pit Shell Area= 2.78Ha
Percentage of Significant Disturbance of Total Lease Area = 2.1%

Operations Plan

- Mining of ore will continue from expanded open pit
- Ore stocks will be removed from Mine to Plant site
- No further overburden or topsoil removed and stockpiled
- No rehabilitation as work plan still operating in open pit extents

Total Area Rehabilitated – 0 Ha



Conjuboy Operations – ML10279
Rehabilitation Program – Year 5 of 5

Total Lease Area -	133Ha
Total Disturbed Area -	4.66Ha
Percentage of Lease Area Disturbed -	3.5%

Total area of Significant Disturbance - Pit Shell Area= 2.78Ha
Percentage of Significant Disturbance of Total Lease Area = 2.1%

Operations Plan

- Mining of ore will continue from expanded open pit
- Ore stocks will be removed from Mine to Plant site
- No further overburden or topsoil removed and stockpiled
- No rehabilitation as work plan still operating in open pit extents

Total Area Rehabilitated – 0 Ha

Conjuboy Operations – ML10279
Rehabilitation Program – Following Years (outside of PoOPS scope)

Total Lease Area -	133Ha
Total Disturbed Area -	4.66Ha
Percentage of Lease Area Disturbed -	3.5%

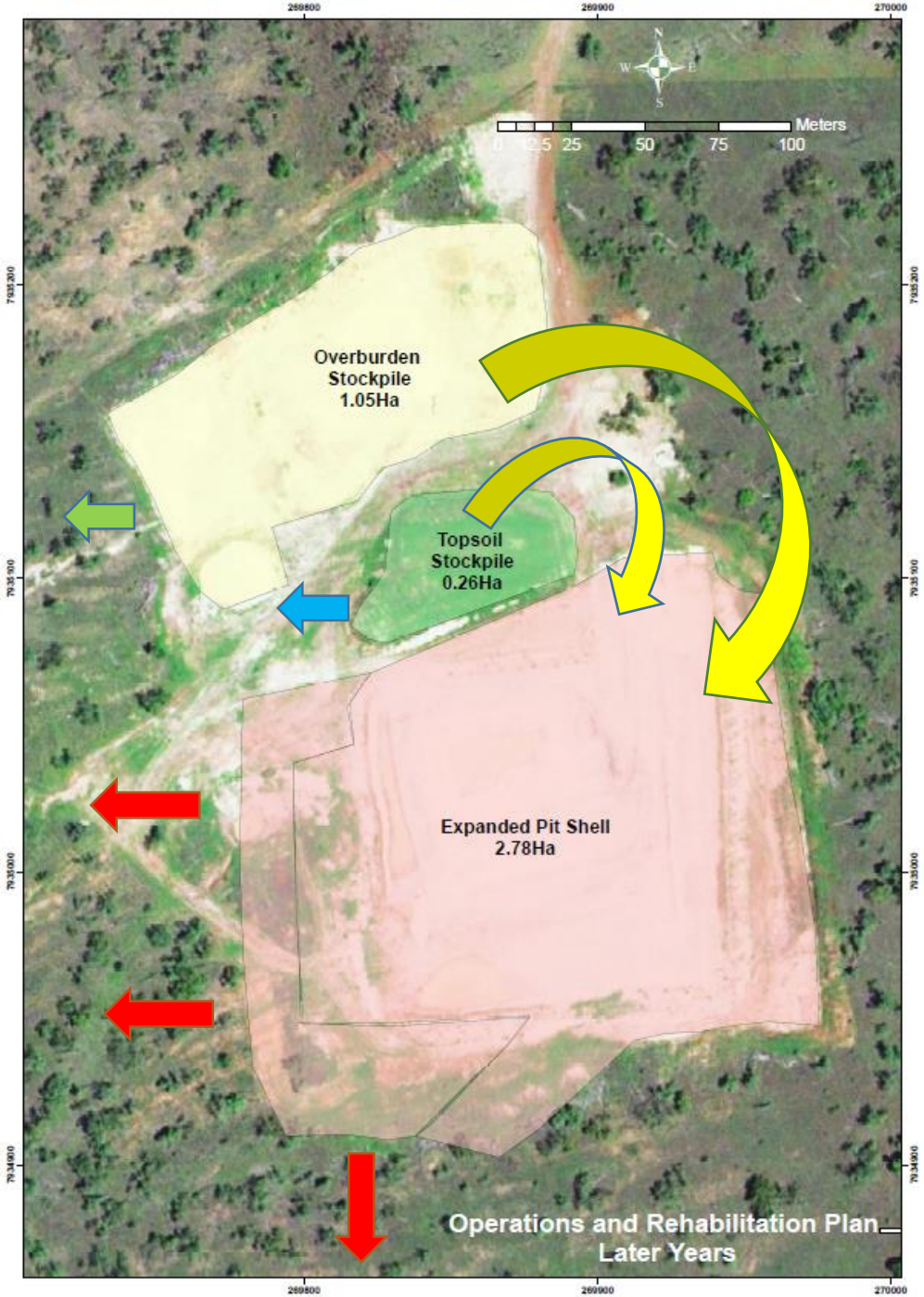
Total area of Significant Disturbance - Pit Shell Area= 2.78Ha
Percentage of Significant Disturbance of Total Lease Area = 2.1%

Operations Plan

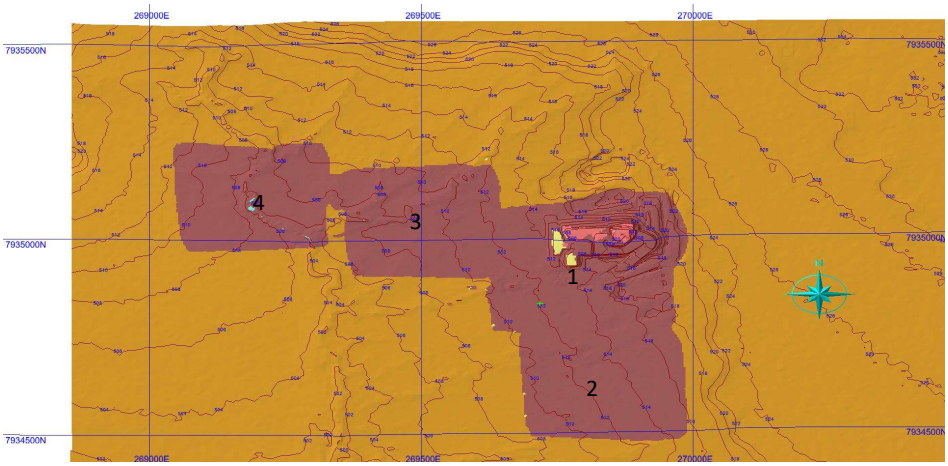
- Pit expansion in later years of operation (>3Ha) – Red Arrows
- Ore stocks will be removed from Mine to Plant Site
- Overburden or topsoil removed and stockpiled as pit expands – Green and Blue Arrows

- As pit expands and the longwall is developed the overburden and topsoil is pushed back into the back end of the open pit (approx. 100m push length with a dozer) – Yellow Arrows

Total Area Rehabilitated – Ongoing as longwall develops. Push length remains at 100m



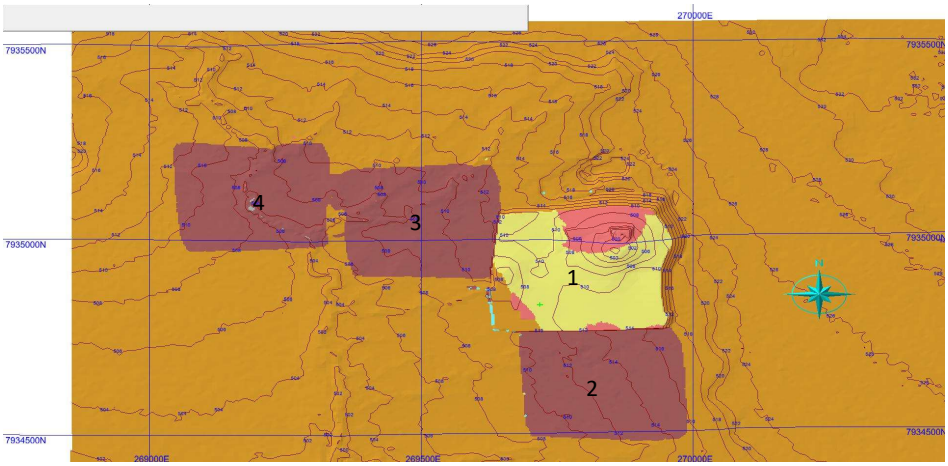
Start Position



1

Pit 1
Waste (to 1m below C1-2 roof)

Volume (m³)	Pit 1
Waste	474,363
C1-2	114,670
C3	226,362
C4	342,953
C5	142,569
C6	40,987
Totals	1,341,904

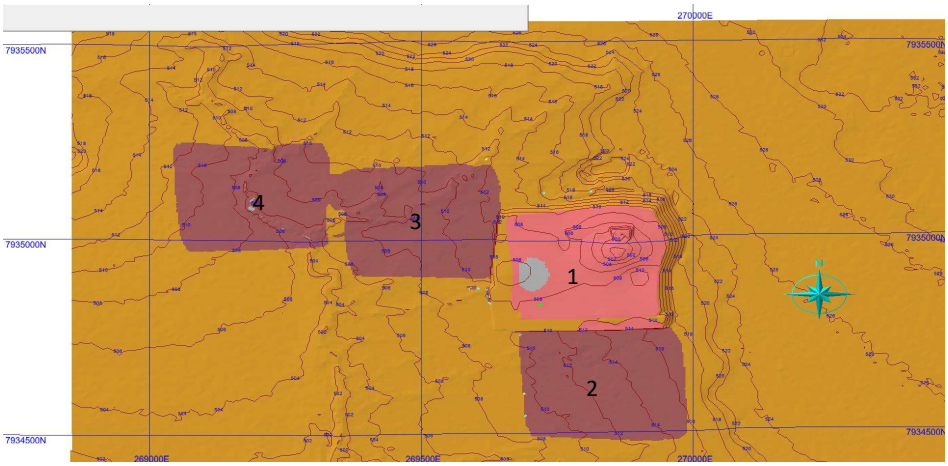


1

2

Pit 1
C1-2 Ore

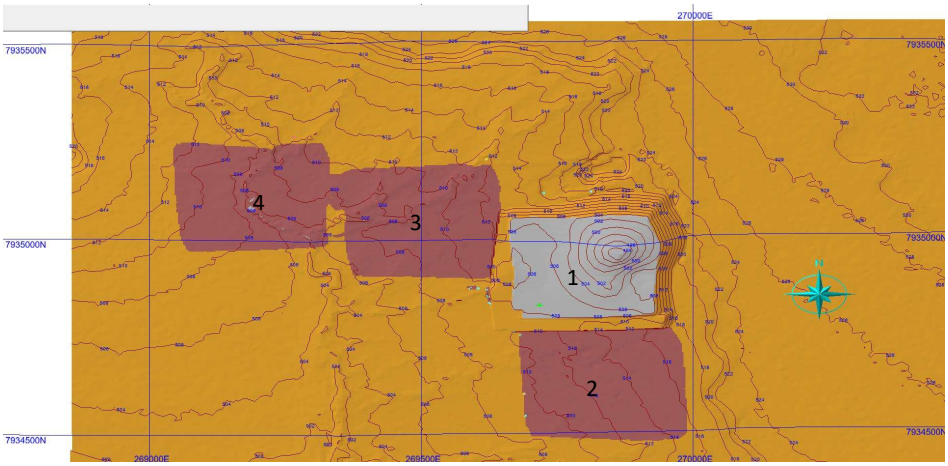
Volume (m³)	Pit 1
Waste	474,363
C1-2	114,670
C3	226,362
C4	342,953
C5	142,569
C6	40,987
Totals	1,341,904



3

Pit 1
C3 Ore

Volume (m³)	Pit 1
Waste	474,363
C1-2	114,670
C3	226,362
C4	342,953
C5	142,569
C6	40,987
Totals	1,341,904

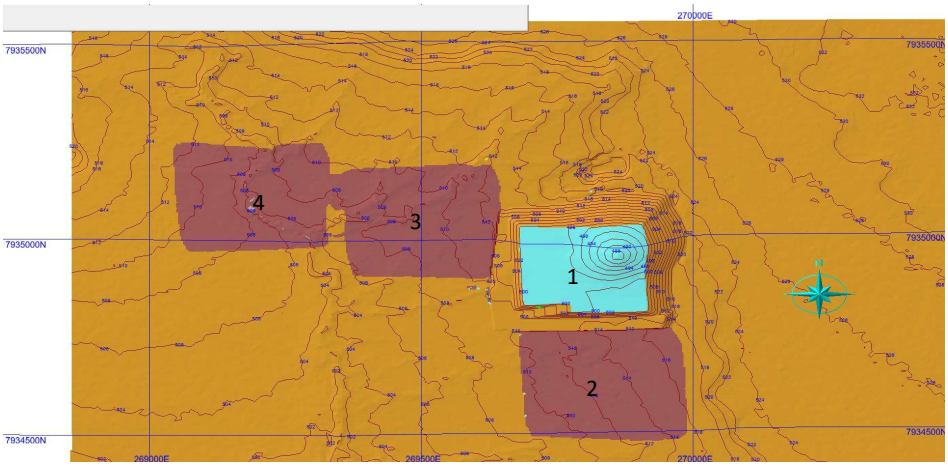


2

4

Pit 1
C4 Ore

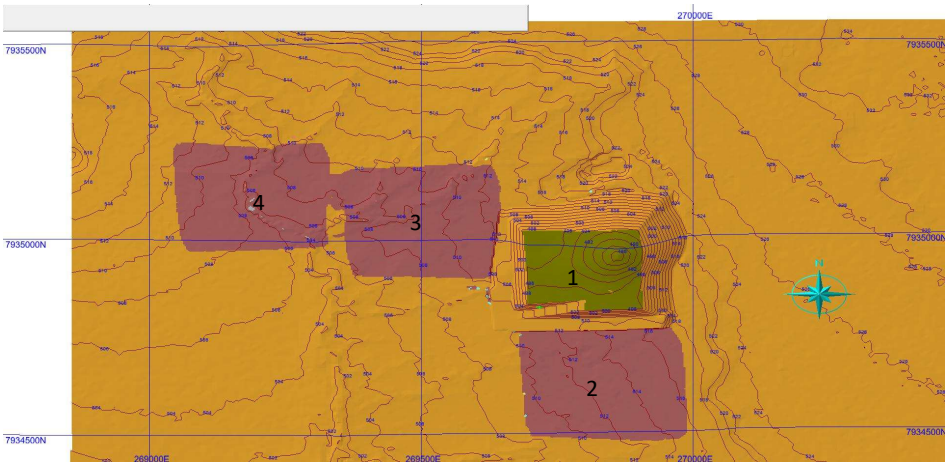
Volume (m³)	Pit 1
Waste	474,363
C1-2	114,670
C3	226,362
C4	342,953
C5	142,569
C6	40,987
Totals	1,341,904



5

Pit 1
C5 Ore

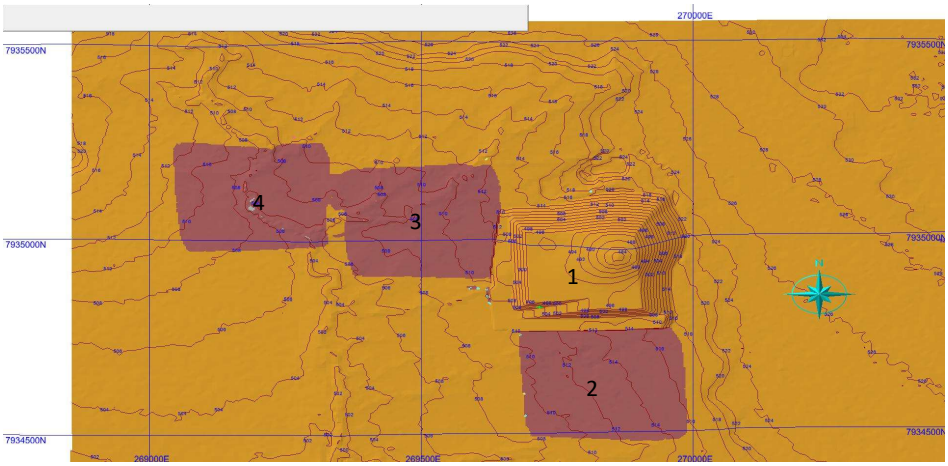
Volume (m³)	Pit 1
Waste	474,363
C1-2	114,670
C3	226,362
C4	342,953
C5	142,569
C6	40,987
Totals	1,341,904



6

Pit 1
C6 Ore (to 2m above C6 floor)

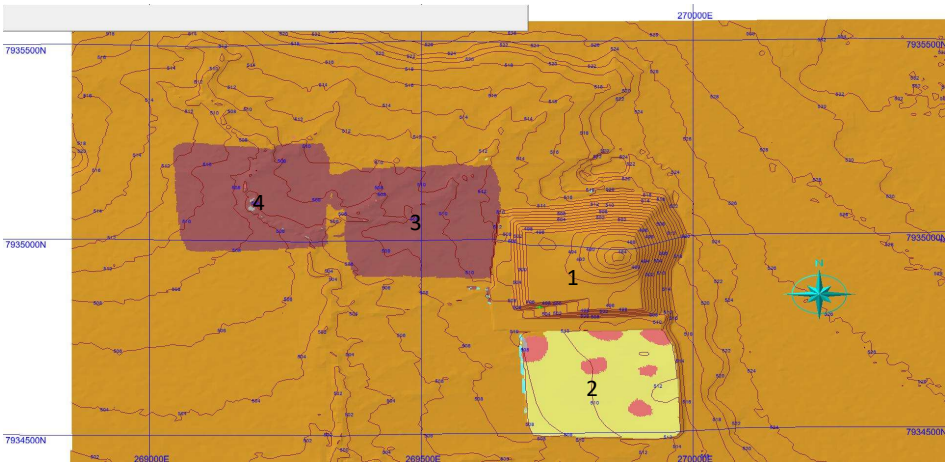
Volume (m³)	Pit 1
Waste	474,363
C1-2	114,670
C3	226,362
C4	342,953
C5	142,569
C6	40,987
Totals	1,341,904



7

Pit 2
Waste (to 1m below C1-2 roof)

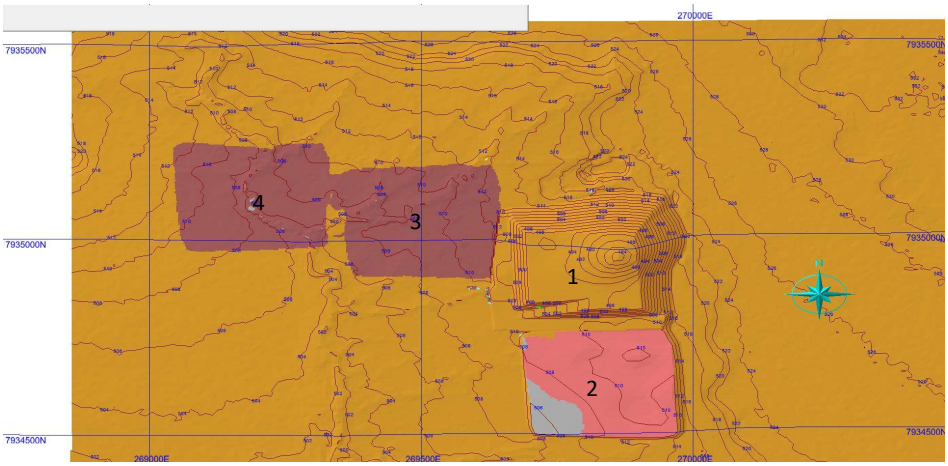
Volume (m³)	Pit 2
Waste	206,561
C1-2	81,766
C3	120,968
C4	393,493
C5	161,355
C6	45,129
Totals	1,009,272



8

Pit 2
C1-2 Ore

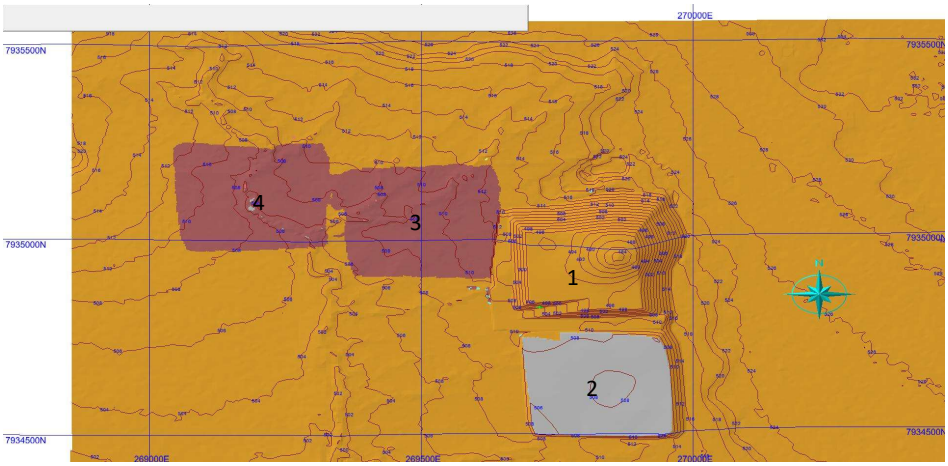
Volume (m³)	Pit 2
Waste	206,561
C1-2	81,766
C3	120,968
C4	393,493
C5	161,355
C6	45,129
Totals	1,009,272



9

Pit 2
C3 Ore

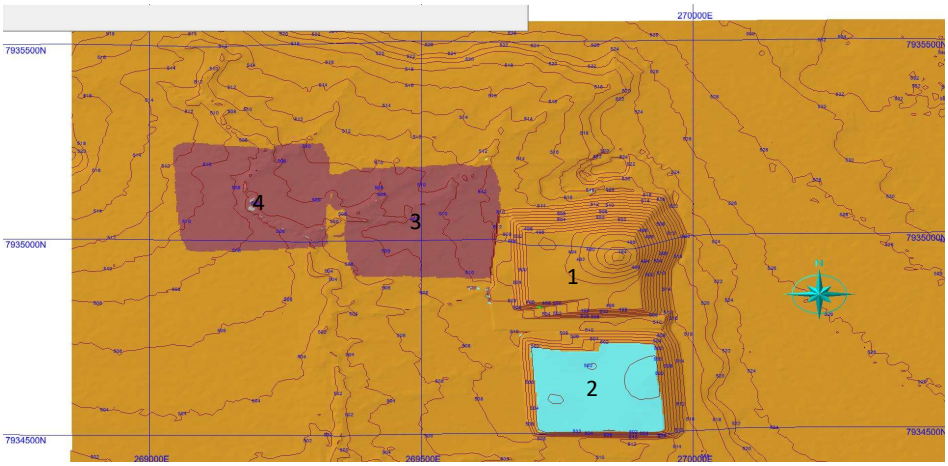
Volume (m³)	Pit 2
Waste	206,561
C1-2	81,766
C3	120,968
C4	393,493
C5	161,355
C6	45,129
Totals	1,009,272



10

Pit 2
C4 Ore

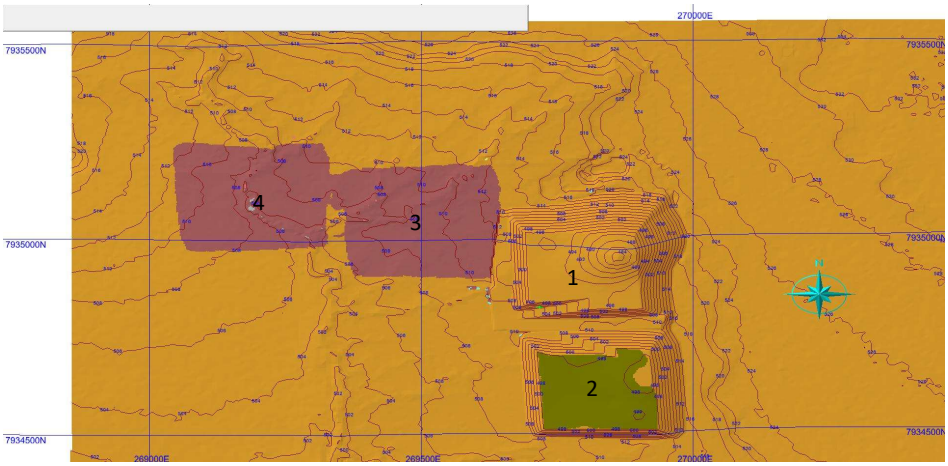
Volume (m³)	Pit 2
Waste	206,561
C1-2	81,766
C3	120,968
C4	393,493
C5	161,355
C6	45,129
Totals	1,009,272



11

Pit 2
C5 Ore

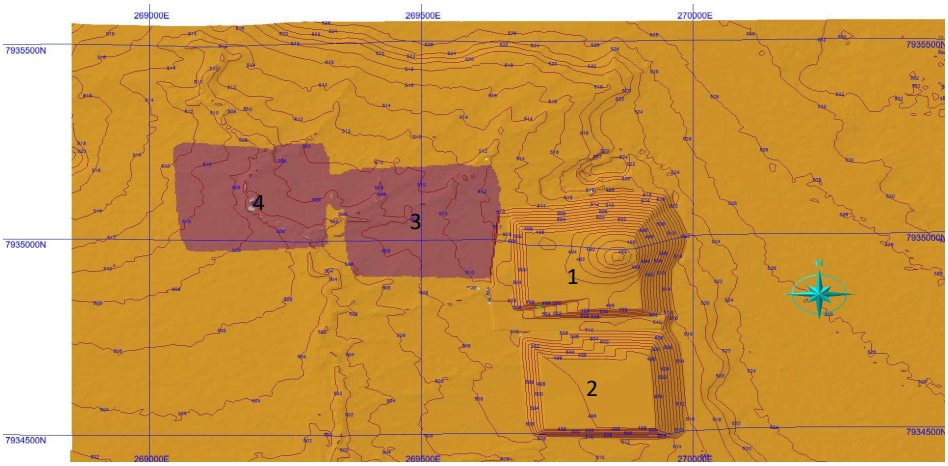
Volume (m³)	Pit 2
Waste	206,561
C1-2	81,766
C3	120,968
C4	393,493
C5	161,355
C6	45,129
Totals	1,009,272



12

Pit 2
C6 Ore (to 2m above C6 floor)

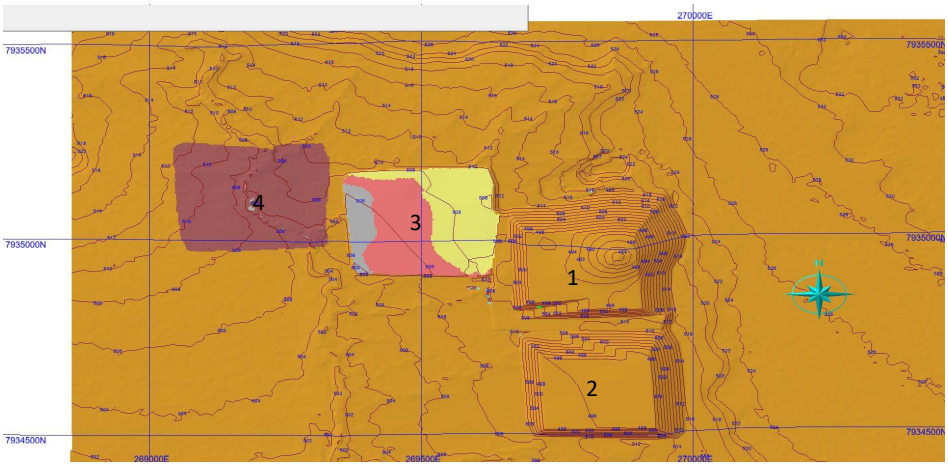
Volume (m³)	Pit 2
Waste	206,561
C1-2	81,766
C3	120,968
C4	393,493
C5	161,355
C6	45,129
Totals	1,009,272



13

Pit 3
Waste (to 1m below C1-2 roof)

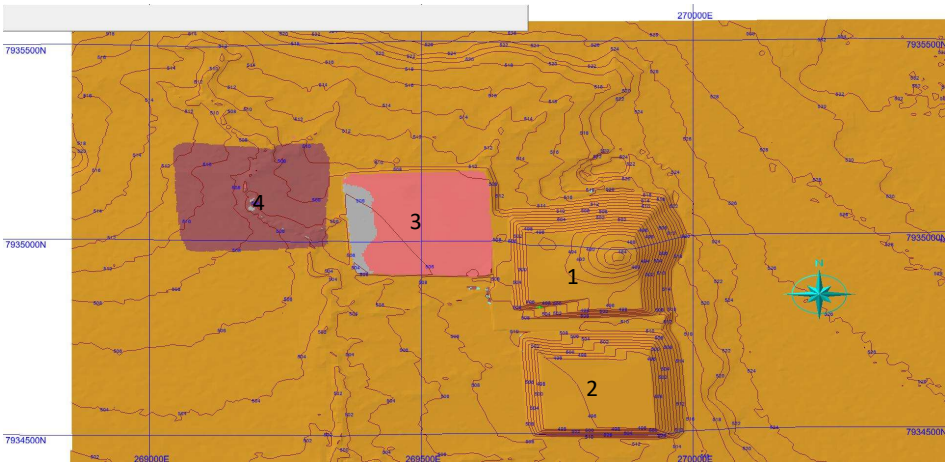
Volume (m³)	Pit 3
Waste	176,591
C1-2	22,839
C3	119,004
C4	265,356
C5	166,484
C6	45,873
Totals	796,147



14

Pit 3
C1-2 Ore

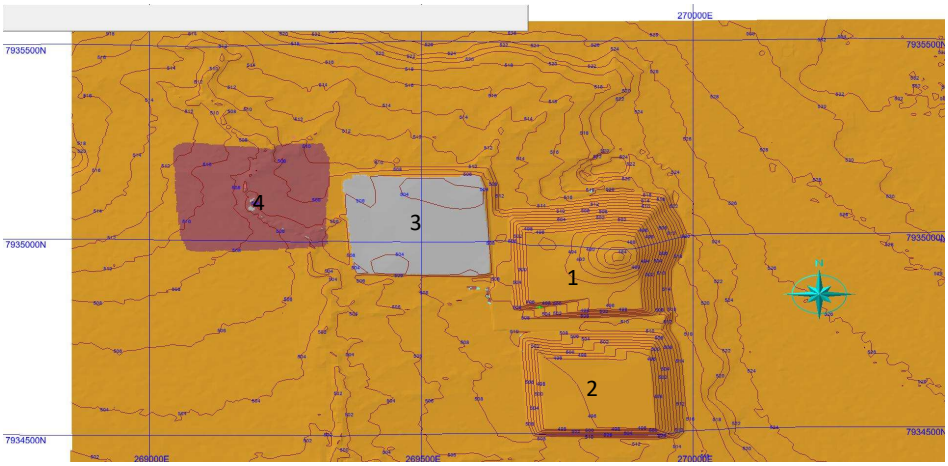
Volume (m³)	Pit 3
Waste	176,591
C1-2	22,839
C3	119,004
C4	265,356
C5	166,484
C6	45,873
Totals	796,147



15

Pit 3
C3 Ore

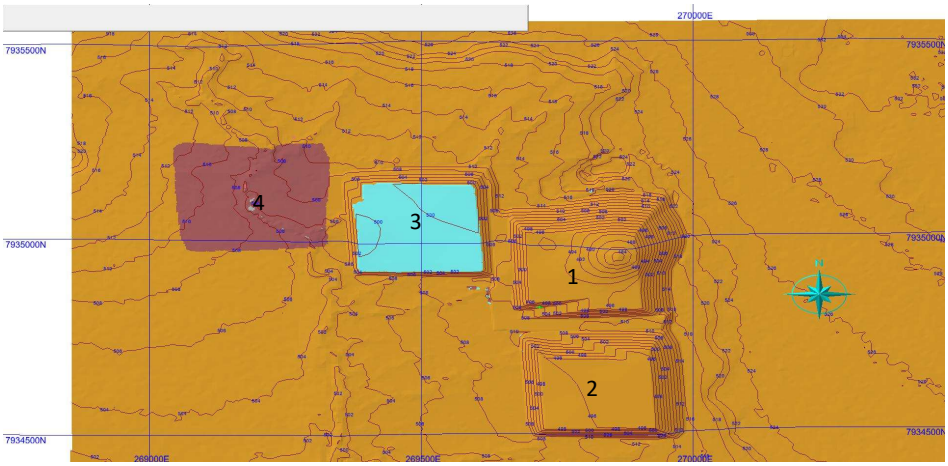
Volume (m³)	Pit 3
Waste	176,591
C1-2	22,839
C3	119,004
C4	265,356
C5	166,484
C6	45,873
Totals	796,147



16

Pit 3
C4 Ore

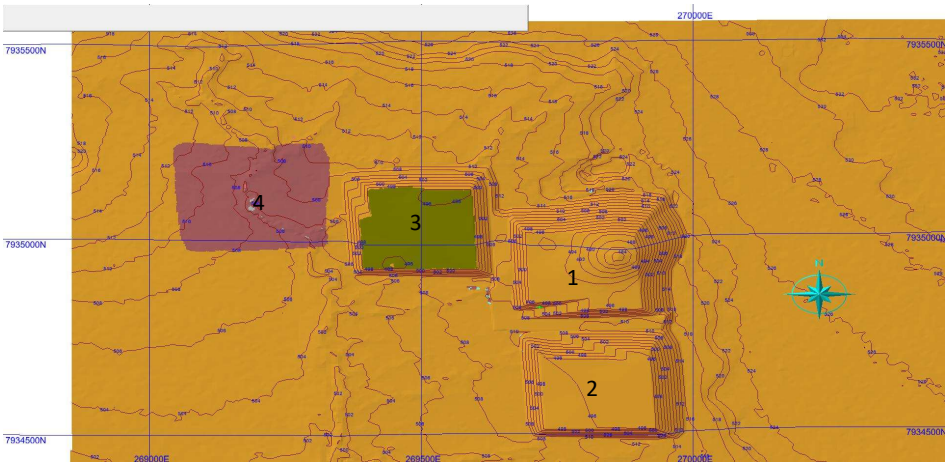
Volume (m³)	Pit 3
Waste	176,591
C1-2	22,839
C3	119,004
C4	265,356
C5	166,484
C6	45,873
Totals	796,147



17

Pit 3
C5 Ore

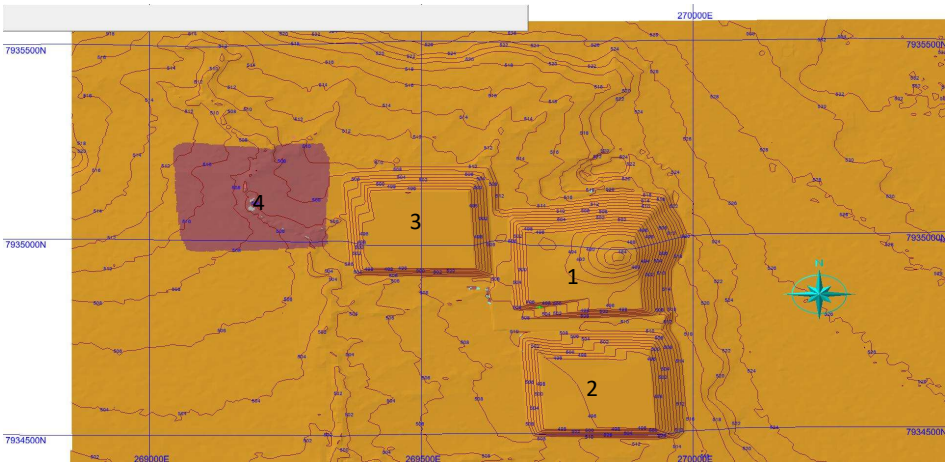
Volume (m³)	Pit 3
Waste	176,591
C1-2	22,839
C3	119,004
C4	265,356
C5	166,484
C6	45,873
Totals	796,147



18

Pit 3
C6 Ore (to 2m above C6 floor)

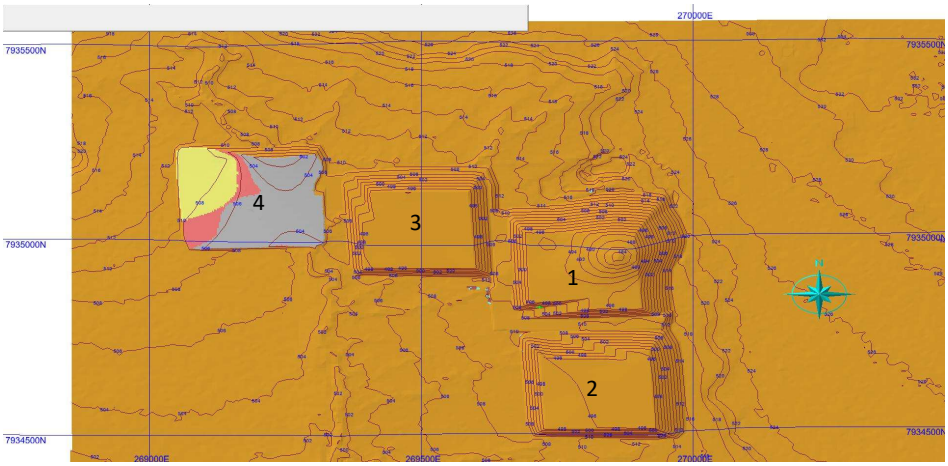
Volume (m³)	Pit 3
Waste	176,591
C1-2	22,839
C3	119,004
C4	265,356
C5	166,484
C6	45,873
Totals	796,147



19

Pit 4
Waste (to 1m below C1-2 roof)

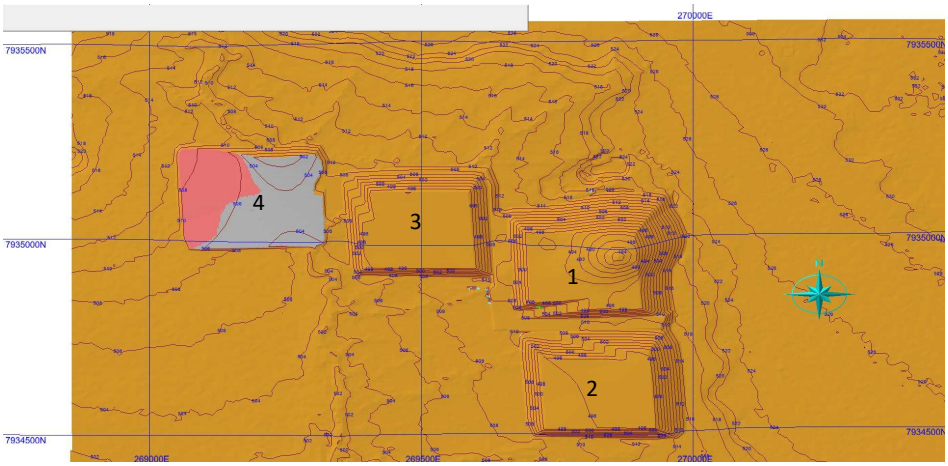
Volume (m³)	Pit 4
Waste	188,690
C1-2	14,204
C3	28,371
C4	238,547
C5	180,400
C6	18,103
Totals	668,315



20

Pit 4
C1-2 Ore

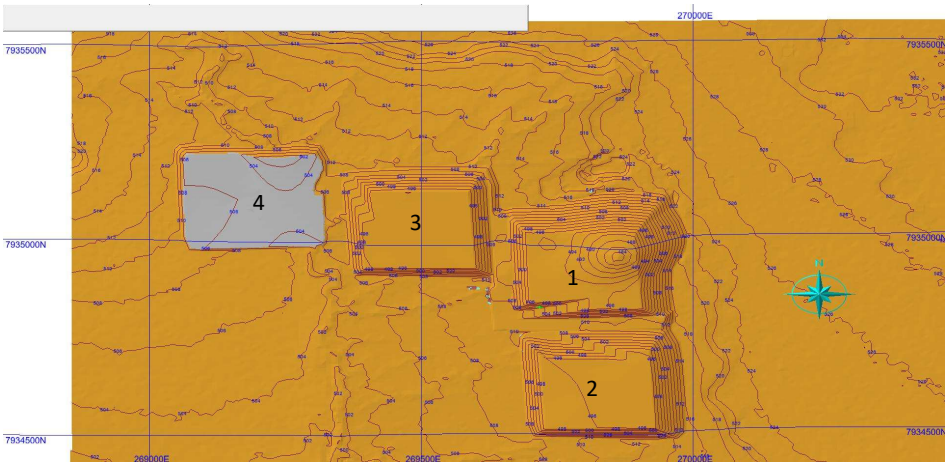
Volume (m³)	Pit 4
Waste	188,690
C1-2	14,204
C3	28,371
C4	238,547
C5	180,400
C6	18,103
Totals	668,315



21

Pit 4
C3 Ore

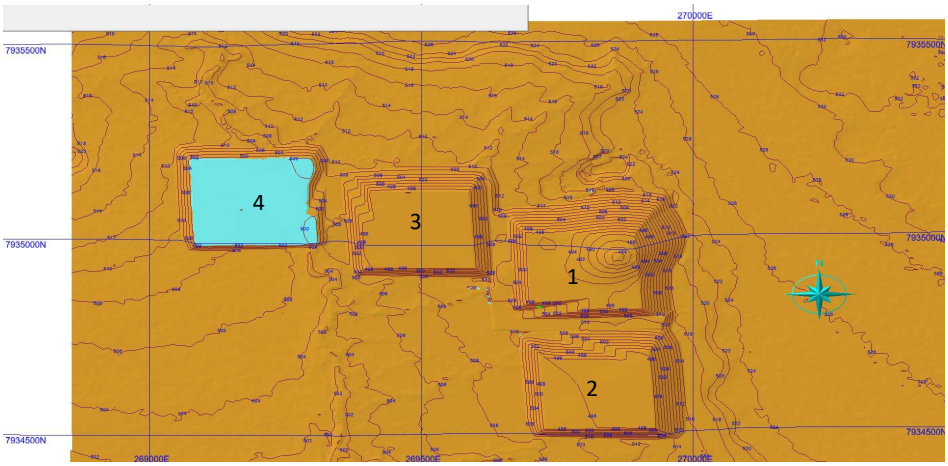
Volume (m³)	Pit 4
Waste	188,690
C1-2	14,204
C3	28,371
C4	238,547
C5	180,400
C6	18,103
Totals	668,315



22

Pit 4
C4 Ore

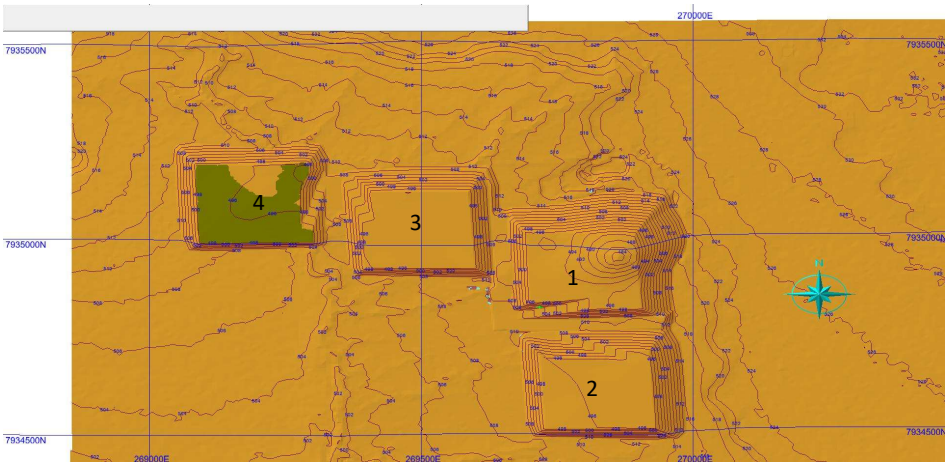
Volume (m³)	Pit 4
Waste	188,690
C1-2	14,204
C3	28,371
C4	238,547
C5	180,400
C6	18,103
Totals	668,315



23

Pit 4
C5 Ore

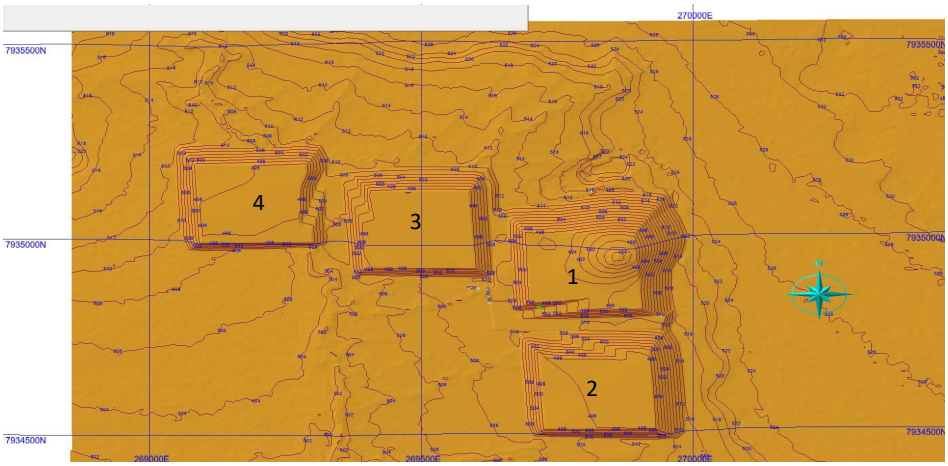
Volume (m³)	Pit 4
Waste	188,690
C1-2	14,204
C3	28,371
C4	238,547
C5	180,400
C6	18,103
Totals	668,315



24

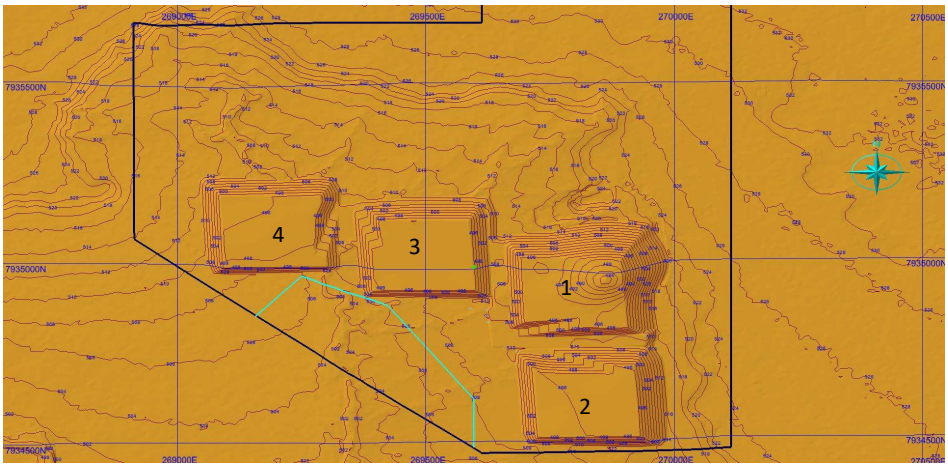
Pit 4
C6 Ore (to 2m above C6 floor)

Volume (m³)	Pit 4
Waste	188,690
C1-2	14,204
C3	28,371
C4	238,547
C5	180,400
C6	18,103
Totals	668,315

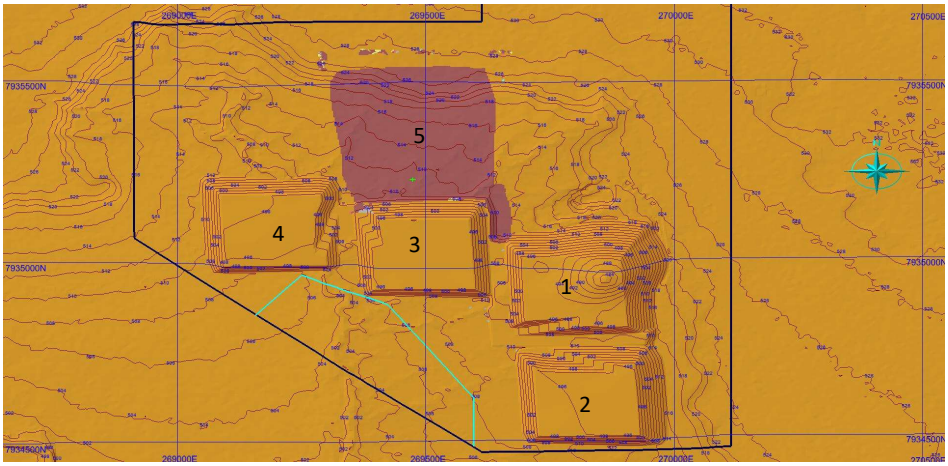


25

Pit 5 Inclusive



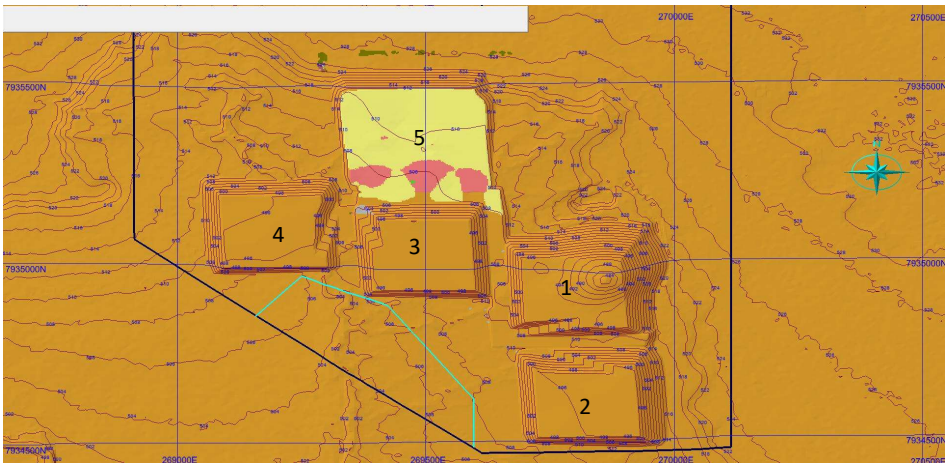
26



27

Pit 5
Waste (to 1m below C1-2 roof)

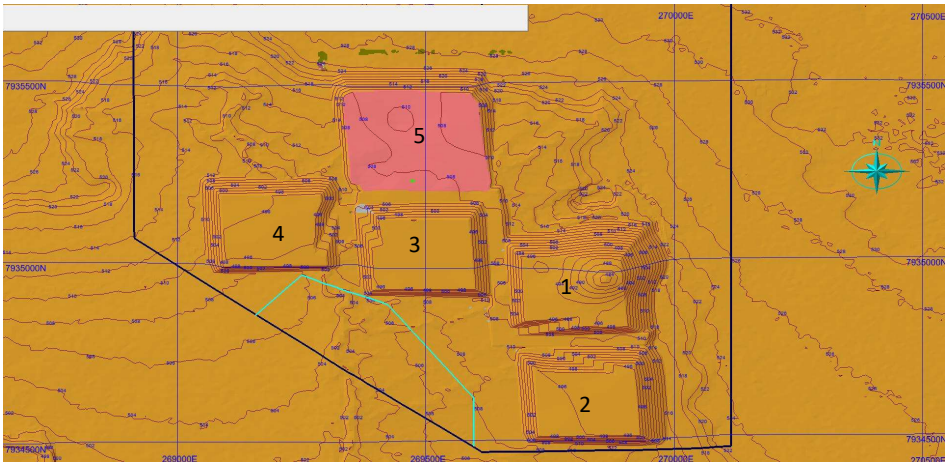
Volume (m³)	Pit 5
Waste	610,325
C1-2	103,372
C3	271,174
C4	374,654
C5	151,197
C6	33,600
Totals	1,544,322



28

Pit 5
C1-2 Ore

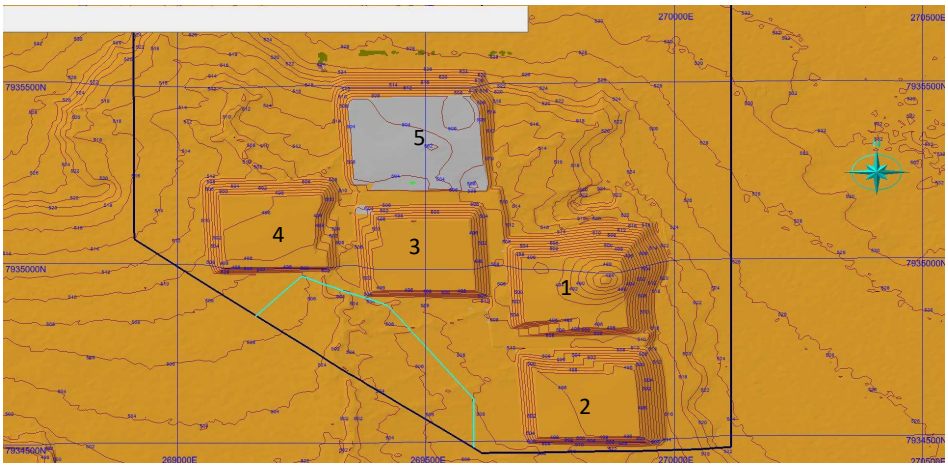
Volume (m³)	Pit 5
Waste	610,325
C1-2	103,372
C3	271,174
C4	374,654
C5	151,197
C6	33,600
Totals	1,544,322



29

Pit 4
C3 Ore

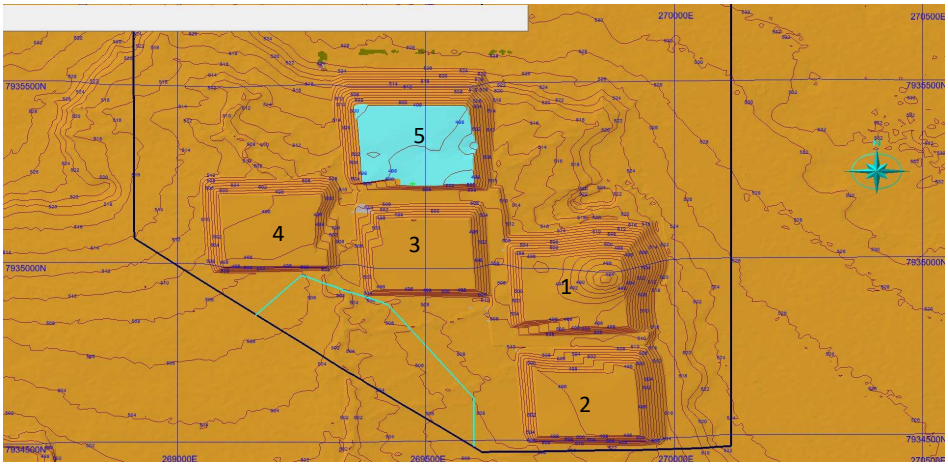
Volume (m³)	Pit 5
Waste	610,325
C1-2	103,372
C3	271,174
C4	374,654
C5	151,197
C6	33,600
Totals	1,544,322



30

Pit 4
C4 Ore

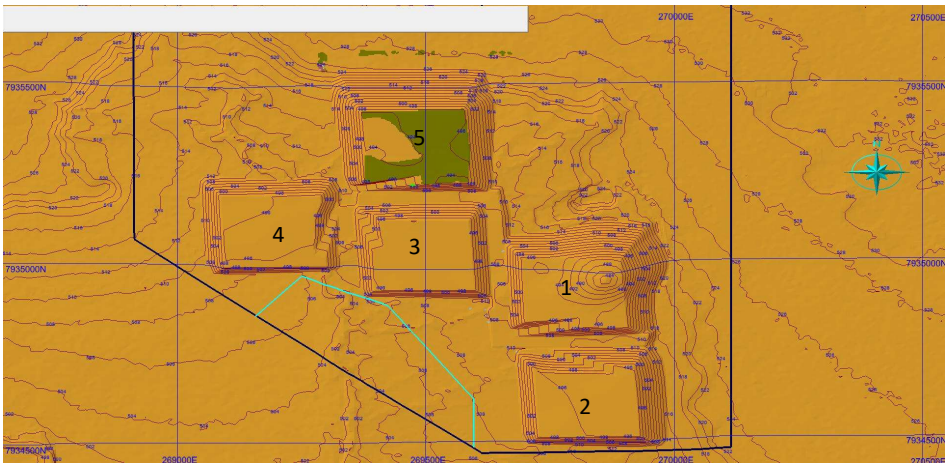
Volume (m³)	Pit 5
Waste	610,325
C1-2	103,372
C3	271,174
C4	374,654
C5	151,197
C6	33,600
Totals	1,544,322



31

Pit 4
C5 Ore

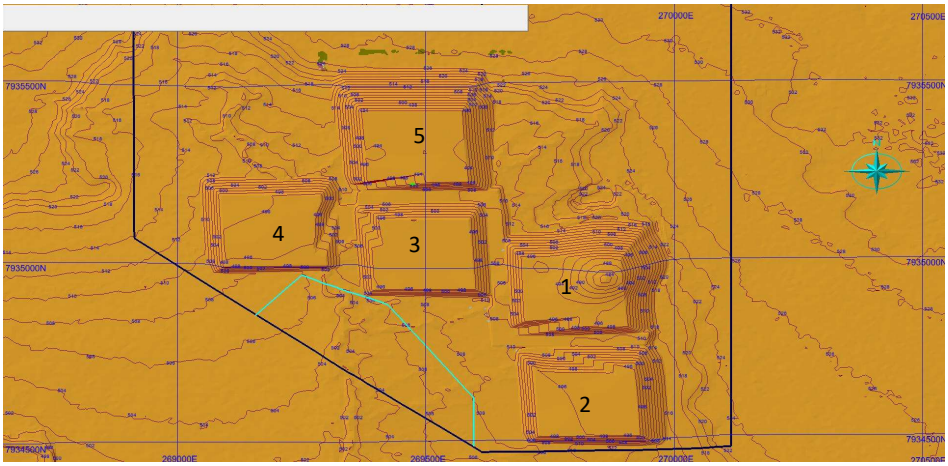
Volume (m³)	Pit 5
Waste	610,325
C1-2	103,372
C3	271,174
C4	374,654
C5	151,197
C6	33,600
Totals	1,544,322



32

Pit 4
C6 Ore (to 2m above C6 floor)

Volume (m³)	Pit 5
Waste	610,325
C1-2	103,372
C3	271,174
C4	374,654
C5	151,197
C6	33,600
Totals	1,544,322



33

Table of Volumes

Volume (m³)	Pit 1	Pit 2	Pit 3	Pit 4	Pit 5	Totals
Waste	474,363	206,561	176,591	188,690	610,325	1,656,530
C1-2	114,670	81,766	22,839	14,204	103,372	336,851
C3	226,362	120,968	119,004	28,371	271,174	765,879
C4	342,953	393,493	265,356	238,547	374,654	1,615,003
C5	142,569	161,355	166,484	180,400	151,197	802,005
C6	40,987	45,129	45,873	18,103	33,600	183,692
Totals	1,341,904	1,009,272	796,147	668,315	1,544,322	5,359,960
Note 1 :- Waste floor is 1m below roof of C1-2						
Note 2 :- Pit floor is 2m above floor of C6						
Waste dumped	616,672	268,529	229,568	245,297	793,423	2,153,489

Reference :- Volumes 20210412.xlsx

34

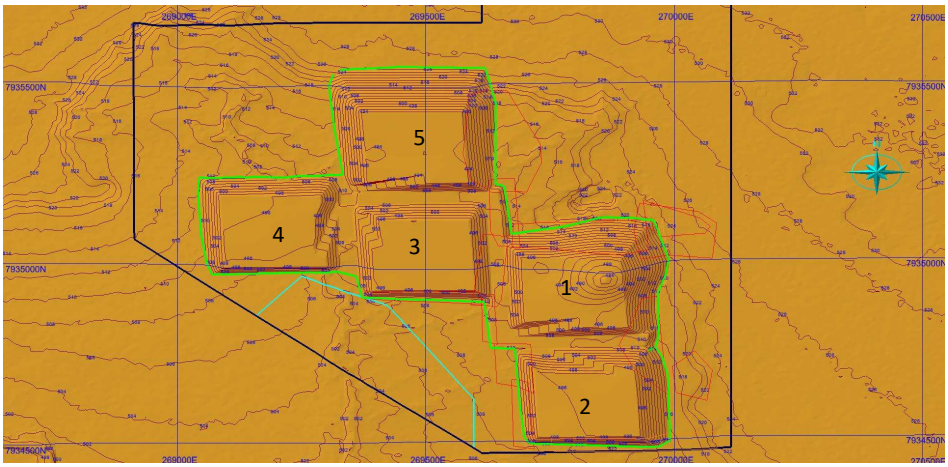
Ponding in Pits if let un-rehabilitated.

- The next set of images have been provided to illustrate that if the pits were left un-rehabilitated, there would be ponding.

35

The green line indicates the extent of disturbance for the 5 pits with no rehab.

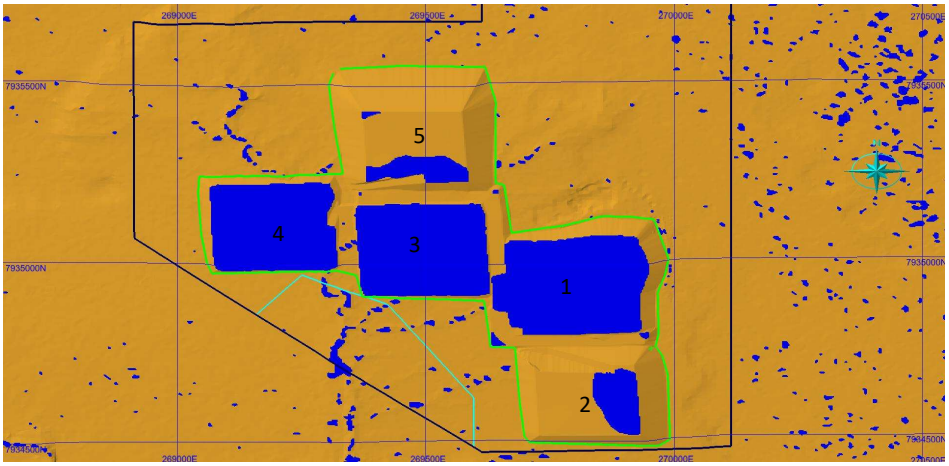
Final Surface



36

Final Surface- No backfilling

The drainage analysis in 3D Dig indicates there is ponding in each pit.



37

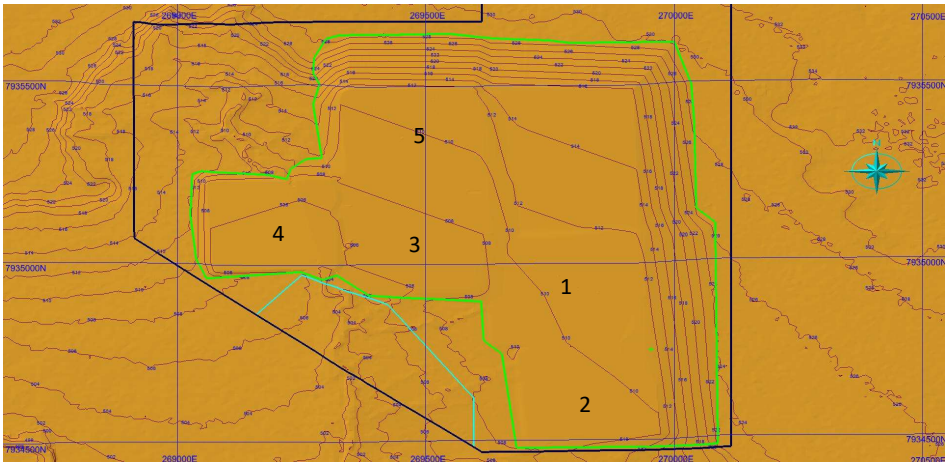
Ponding in Final Surface.

- The next set of images have been provided to illustrate that the final surface is free draining and non-ponding.

38

The green line indicates the extent of disturbance for the final pit design.

Final Surface

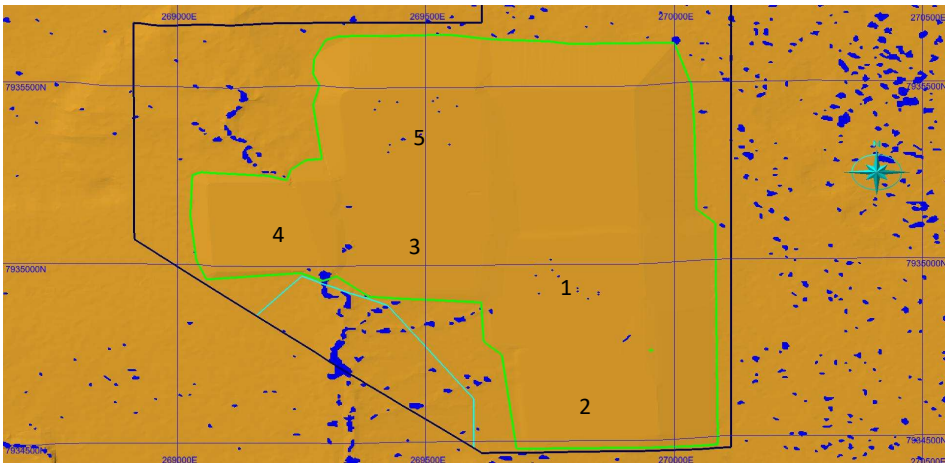


Reshape logic part 04D.bit

39

The drainage analysis in 3D Dig indicates that there is no ponding in the final surface and that the surface is free draining.

Final Surface



Reshape logic part 04D.bit

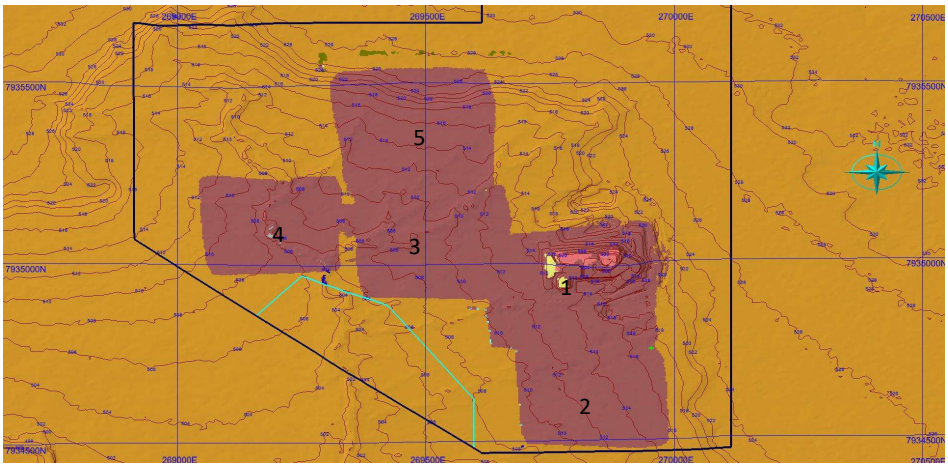
40

Indicative Staging to illustrate progressive rehabilitation of the pits.

- The next set of images have been provided to illustrate a provisional schedule of extraction and progressive rehabilitation.

41

Start Position.



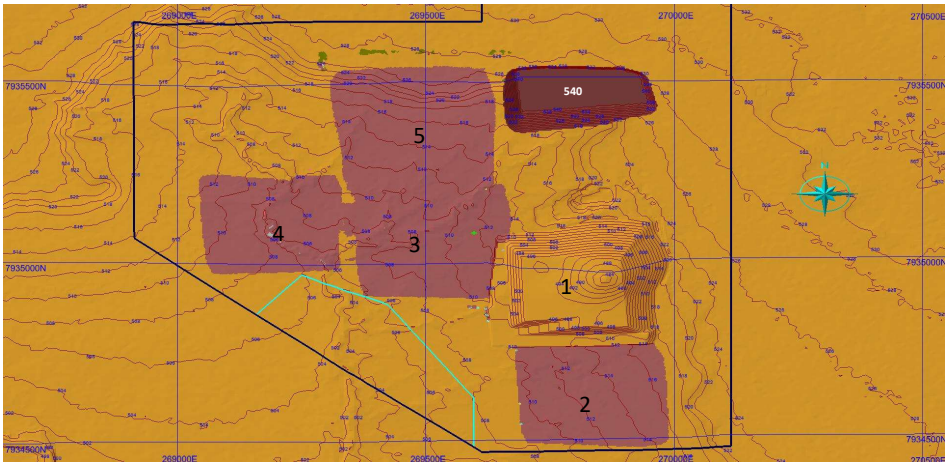
Staging Step 00.bit

42

Step 01

In Step 01, Pit 1 has been mined.
Volume of Waste = 474.4 Kbcm.
Volume dumped = 616.7 Klcm.

The waste from Pit 1 has been stockpiled to the north of Pit 1.
It has been placed further than the dozer push limit that is seen in Step XX.
Ore is assumed to be stockpiled pit-side and processed off site.



Staging Step 01.bit

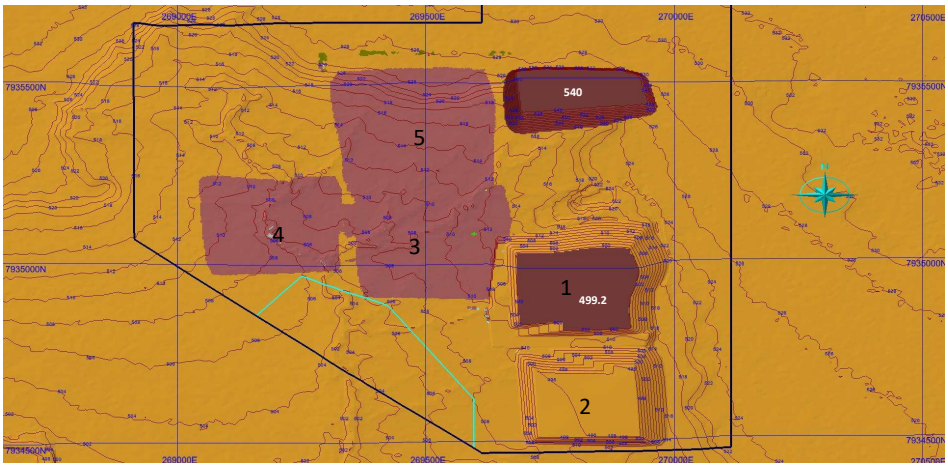
43

Step 02

In Step 02, Pit 2 has been mined.
Volume of Waste = 206.6 Kbcm.
Volume dumped = 268.5 Klcm.

The waste from Pit 2 has been placed in the base of Pit 1.

Ore is assumed to be stockpiled pit-side and processed off site.

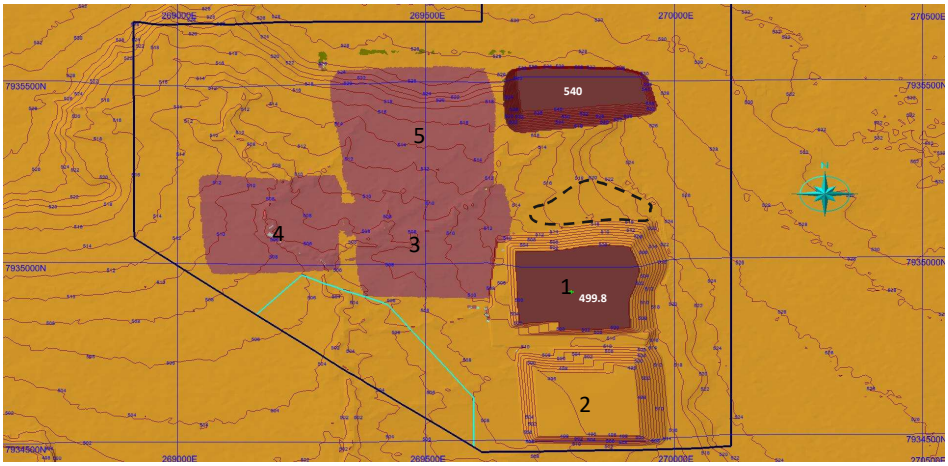


Staging Step 02.bit

44

Step 03

In Step 03, the previously stockpiled waste has been placed into Pit 1.
Volume of Waste = 34.2 Klcm.
Volume dumped = 268.5 Klcm.

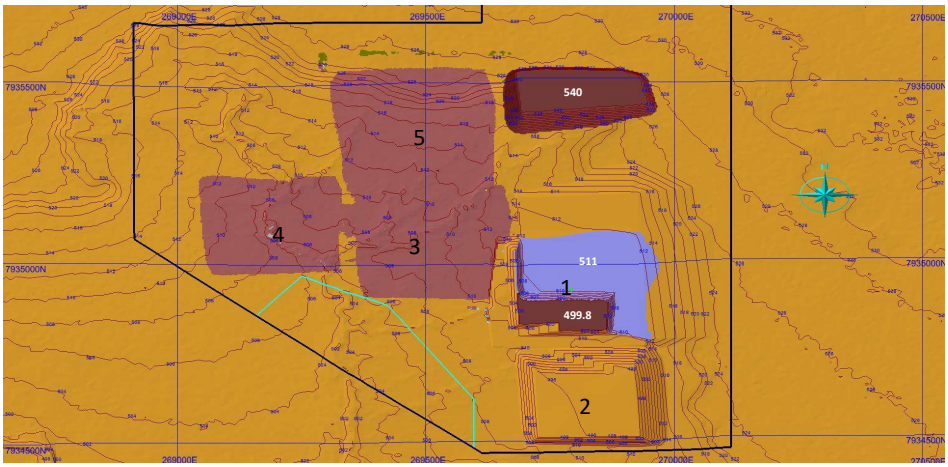


Staging Step 03.bit

45

Step 04

In Step 04 I have dozer pushed the Eastern and Northern extents of Pit 1 as shown in the image below.
Volume - Insitu Waste Dozed = 370.2 Klcm.
Volume dumped = 481.3 Klcm.



Staging Step 04.bit

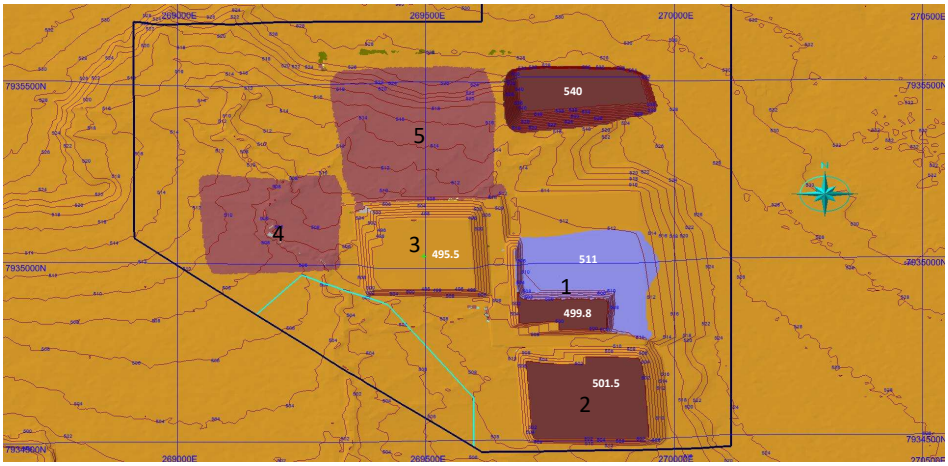
46

Step 05

In Step 05, Pit 3 has been mined.
Volume of Waste = 176.6 Kbcm.
Volume dumped = 229.6 Klcm.

The waste from Pit 3 has been placed in the base of Pit 2.

Ore is assumed to be stockpiled pit-side and processed off site.



Staging Step 05.bit

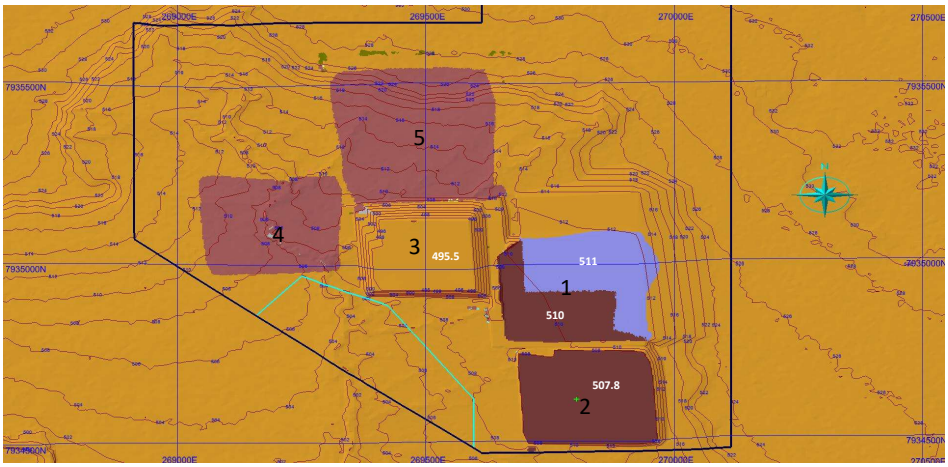
47

Step 06

In Step 06, the waste that was stockpiled in Step 01 has now been placed back into both Pit 1 and Pit 2.

Volume dumped = 229.6 Klcm.

Pit 1 has now reached the final reshaped surface.

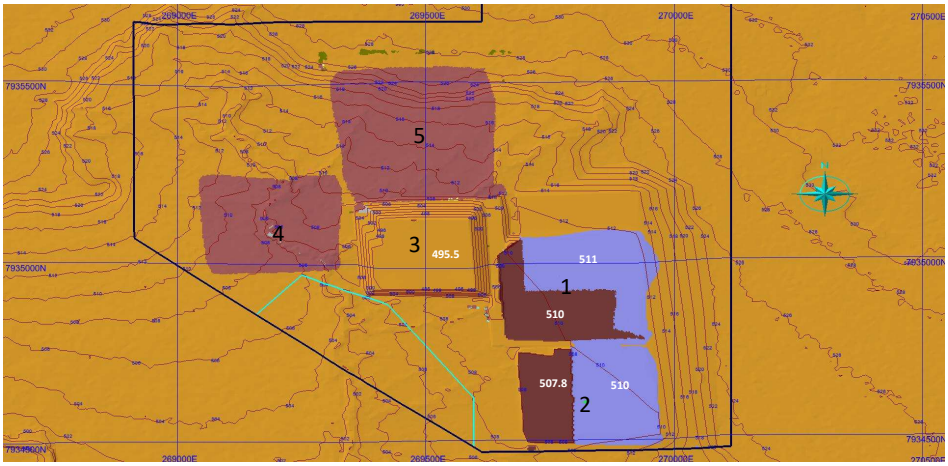


Staging Step 06.bit

48

Step 07

In Step 07 I have dozer pushed the Eastern extent of Pit 2 as shown in the image below.
Volume - Insitu Waste Dozed = 71.7 Klcm.
Volume dumped = 93.2 Klcm.



Staging Step 07.bit

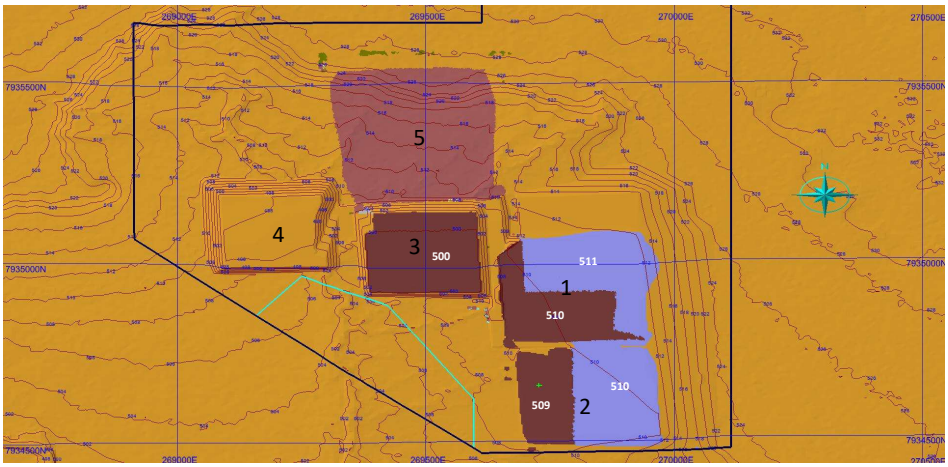
49

Step 08

In Step 08, Pit 4 has been mined.
Volume of Waste = 188.7 Kbcm.
Volume dumped = 245.3 Klcm.

The waste from Pit 4 has been placed inside Pit 2 to reach the rehab level in Pit 2, and the remainder has been placed in Pit 3.

Ore is assumed to be stockpiled pit-side and processed off site.



Staging Step 08.bit

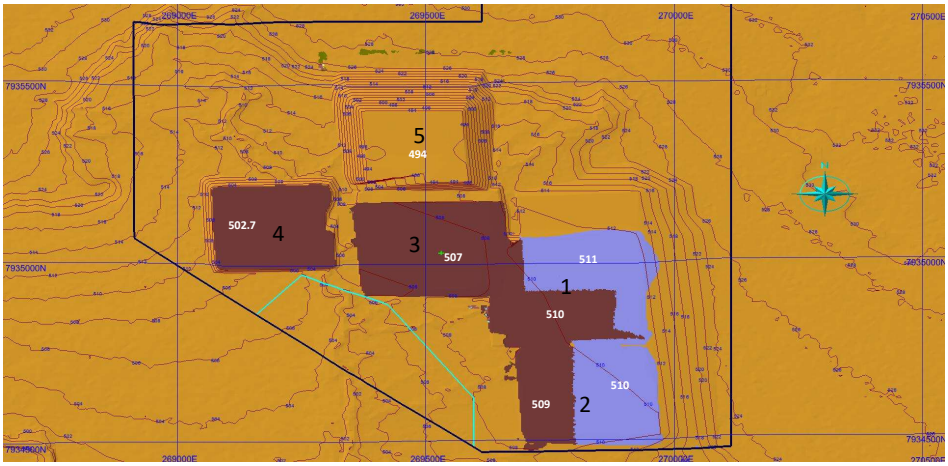
50

Step 09

In Step 09, Pit 5 has been mined.
Volume of Waste = 610.3 Kbcm.
Volume dumped = 793.4 Klcm.

The waste from Pit 4 has been placed inside Pit 3 to reach the rehab level in Pit 3, and the remainder has been placed in Pit 4.

Ore is assumed to be stockpiled pit-side and processed off site.

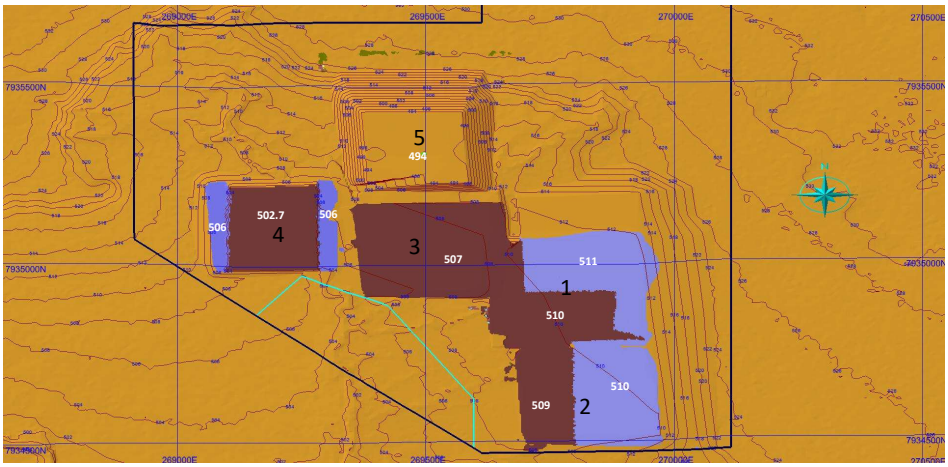


Staging Step 09.bit

51

Step 10

In Step 10 I have dozer pushed the edges of Pit 4 as shown in the image below.
Volume - Insitu Waste Dozed = 34.8 Klcm.
Volume dumped = 45.2 Klcm.

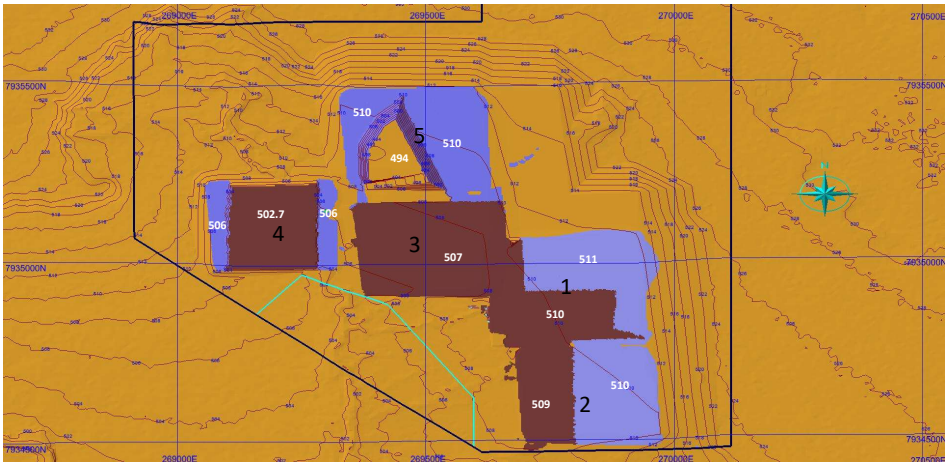


Staging Step 10.bit

52

In Step 11 I have dozer pushed the edges of Pit 5 as shown in the image below.
Volume - Insitu Waste Dozed = 495.1 Klcm.
Volume dumped = 643.7 Klcm.

Step 11

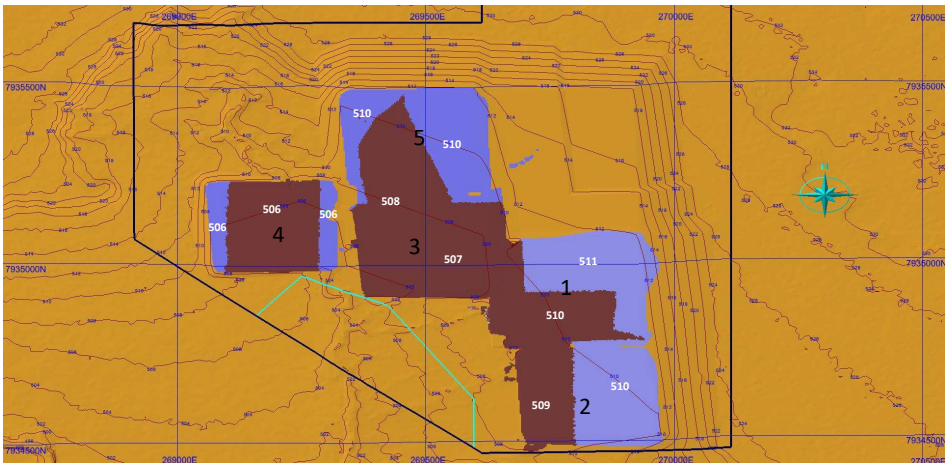


Staging Step 11.bit

53

In Step 11 dozer pushed the edges of Pit 5 as shown in the image below.
Volume - Insitu Waste Dozed = 495.1 Klcm.
Volume dumped = 643.7 Klcm.

Step 12



Staging Step 12.bit

54

Table 1 – Project Volumes

Table 1A - Prime Volume Moved by Trucks

Volume (m³)	Pit 1	Pit 2	Pit 3	Pit 4	Pit 5	Stockpile Rehandle	Extra for Rehab	Totals
Waste	474,363	206,561	176,591	188,690	610,325	0	347,286	2,003,816
C1-2	114,670	81,766	22,839	14,204	103,372	0	0	336,851
C3	226,362	120,968	119,004	28,371	271,174	0	0	765,879
C4	342,953	393,493	265,356	238,547	374,654	0	0	1,615,003
C5	142,569	161,355	166,484	180,400	151,197	0	0	802,005
C6	40,987	45,129	45,873	18,103	33,600	0	0	183,692
Total for Trucking	1,341,904	1,009,272	796,147	668,315	1,544,322	0	347,286	5,707,246

Table 1B - Prime Volume Moved by Dozers

Volume (m³)	Pit 1	Pit 2	Pit 3	Pit 4	Pit 5	Stockpile Rehandle	Extra for Rehab	Totals
Dozer Push Volumes	370,227	71,657		34,768	495,127			971,779

Table 1C - Rehandle of Stockpiles moved by Trucks

Volume (m³)	Pit 1	Pit 2	Pit 3	Pit 4	Pit 5	Stockpile Rehandle	Extra for Rehab	Totals
Stockpile Rehandle						650,866		650,866

Table 1D - Project Total Volumes Moved

Volume (m³)	Pit 1	Pit 2	Pit 3	Pit 4	Pit 5	Stockpile Rehandle	Extra for Rehab	Totals
Prime Volume Trucked Waste	474,363	206,561	176,591	188,690	610,325	0	347,286	2,003,816
Prime Volume Trucked Ore	867,541	802,711	619,556	479,625	933,997	0	0	3,703,430
Prime Volume Dozed	370,227	71,657	0	34,768	495,127	0	0	971,779
Stockpile Rehandle	0	0	0	0	0	650,866	0	650,866
Project Total	1,712,131	1,080,929	796,147	703,083	2,039,449	650,866	347,286	7,329,891

Table 1D - Project Total Volumes Placed into the Backfill

Volume (m³)	Pit 1	Pit 2	Pit 3	Pit 4	Pit 5	Stockpile Rehandle	Extra for Rehab	Totals
Dumped Trucked Volume	616,672	268,529	229,568	245,297	793,423	0	451,472	2,604,961
Dumped Dozed Volume	481,295	93,154	0	45,198	643,665	0	0	1,263,313
Stockpile Rehandle	0	0	0	0	0	650,866	0	650,866
Loose Volume Into Backfill	1,097,967	361,683	229,568	290,495	1,437,088	650,866	451,472	4,519,139

Prime volume to be moved by trucks = 5.7 Mbcm

Prime volume to be moved by dozers = 0.97 Mbcm

Rehandle volume to be moved by trucks = 0.65 Mbcm

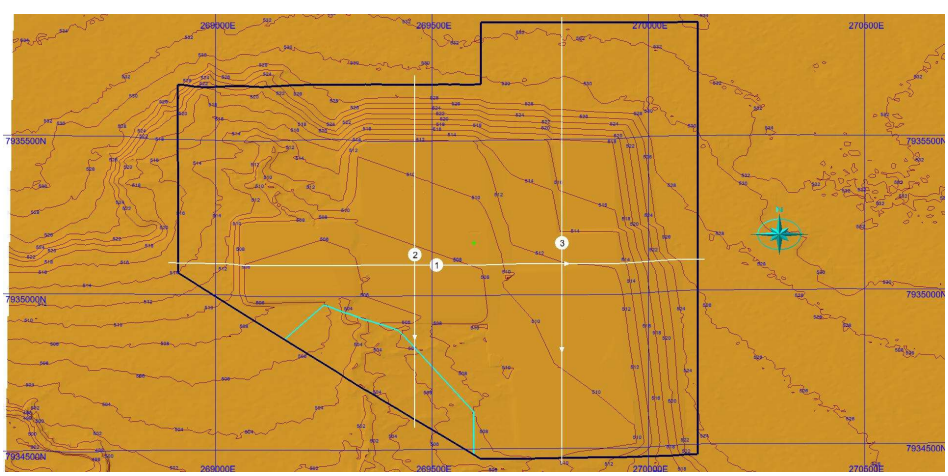
Project volume to be moved by trucks and dozers = 7.33 Mbcm

Swelled volume to be placed into the backfill = 4.52 Mlcm (Based upon swell of 1.3)

Reference :- Volumes 20210412.xlsx

55

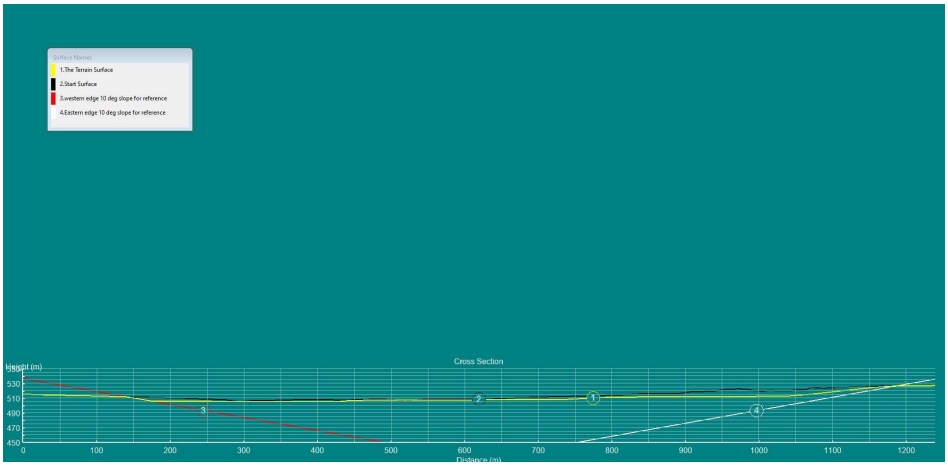
Location of 3 Cross Sections



Staging Step 12.bit

56

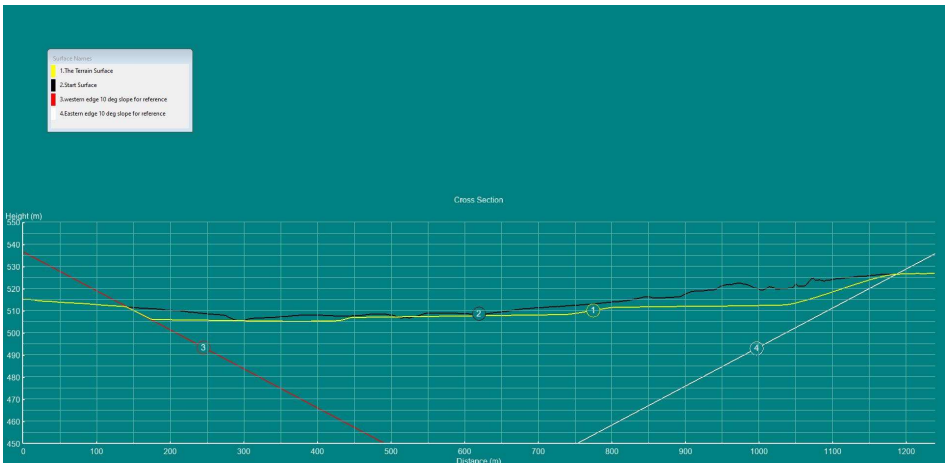
Cross Section 1
Vertical Exaggeration = 1



Staging Step 12.bit

57

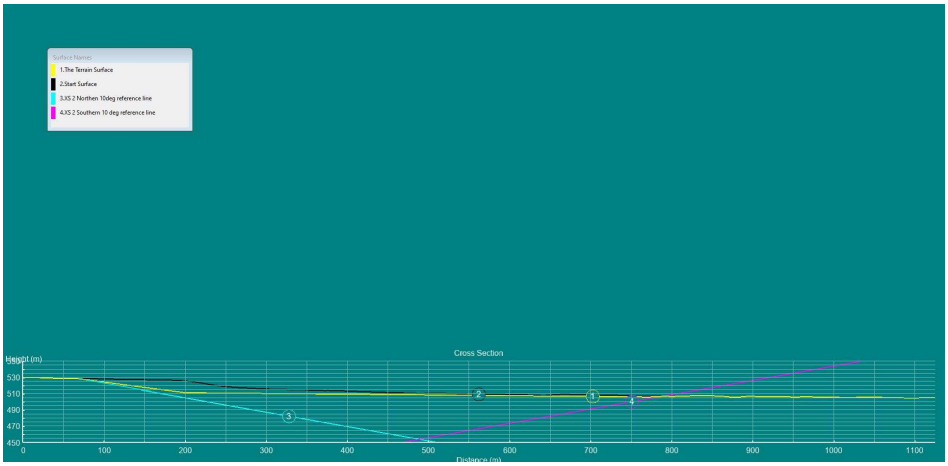
Cross Section 1
Vertical Exaggeration = 3



Staging Step 12.bit

58

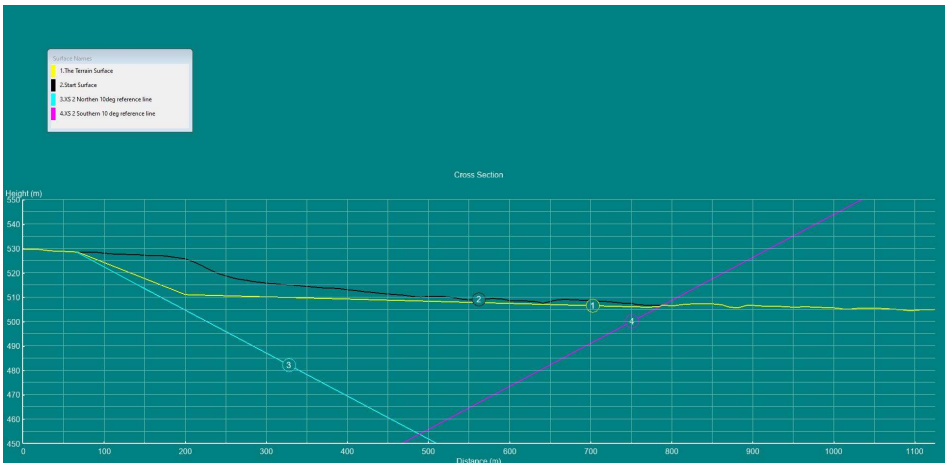
Cross Section 2
Vertical Exaggeration = 1



Staging Step 12.bit

59

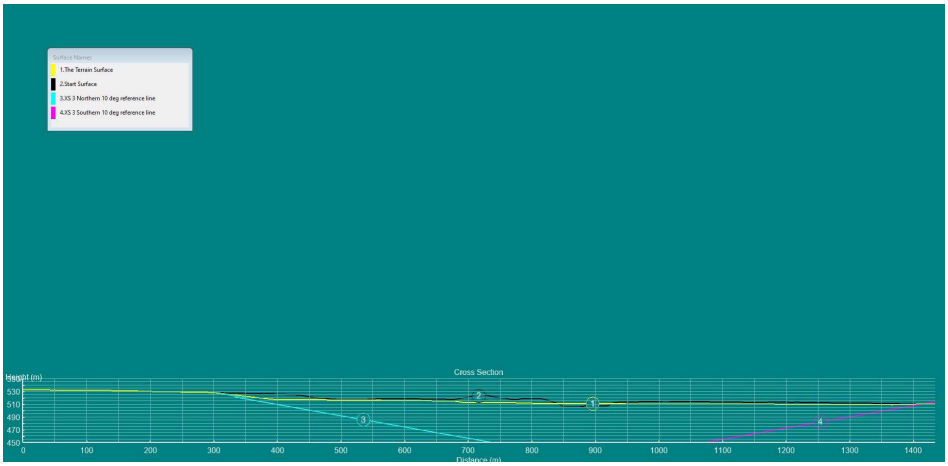
Cross Section 2
Vertical Exaggeration = 3



Staging Step 12.bit

60

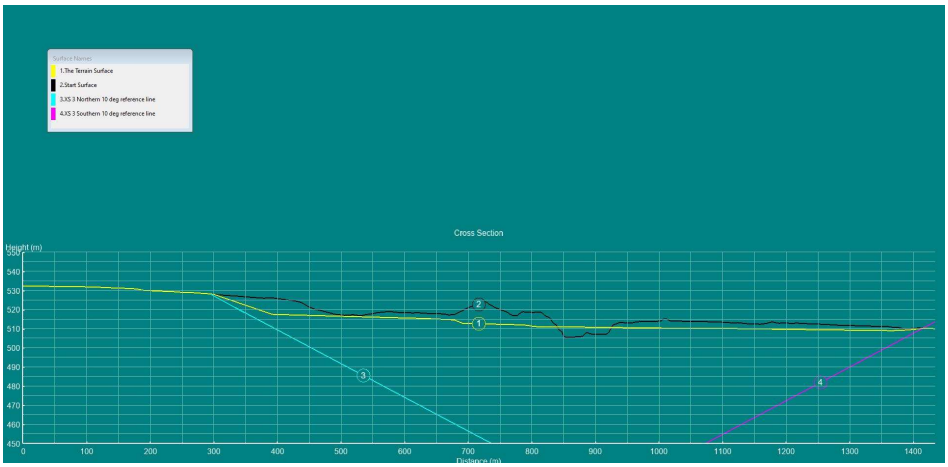
Cross Section 3
Vertical Exaggeration = 1



Staging Step 12.bit

61

Cross Section 3
Vertical Exaggeration = 3



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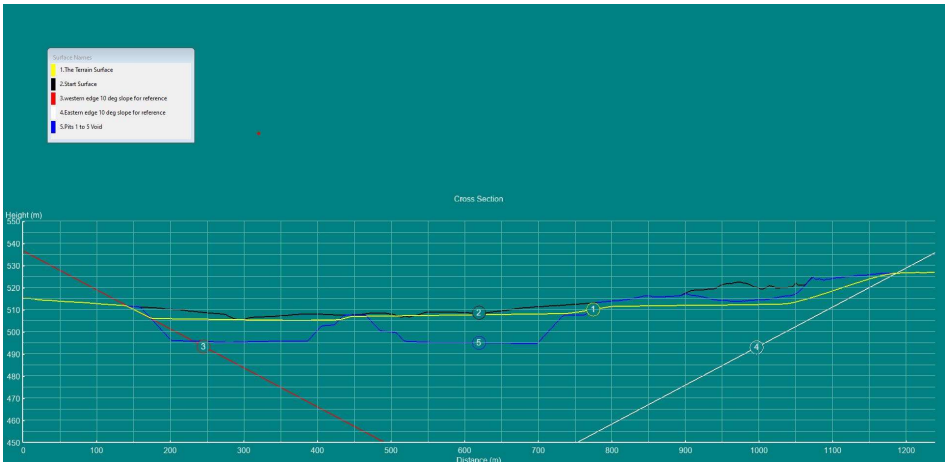

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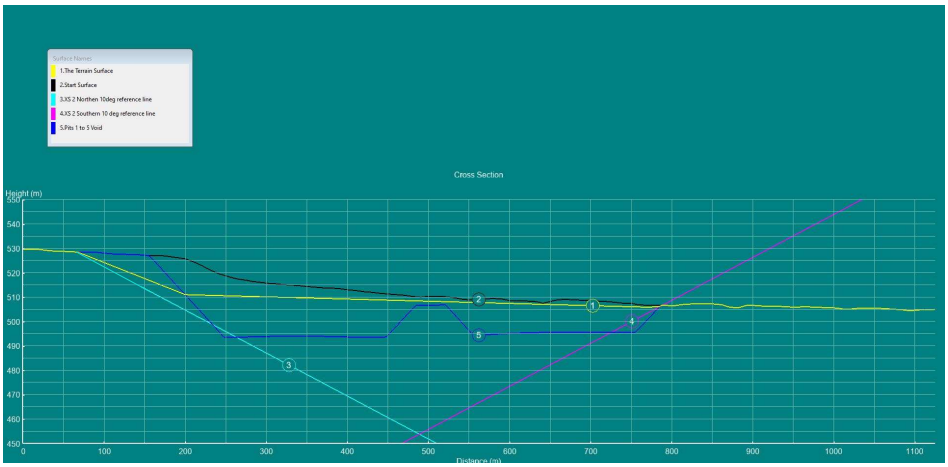

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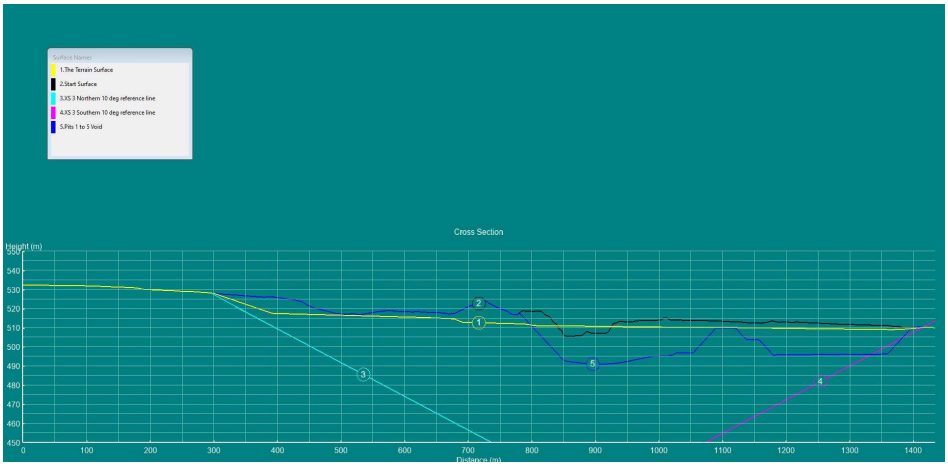

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PROGRESSIVE REHABILITATION AND CLOSURE PLAN
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Appendix 6: WATER RESOURCE INFORMATION

Chapter 5.
Report on Groundwater and Surfacewater Resources and Prospects

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Prepared for

Natural Resource Assessments Pty Ltd

1. INTRODUCTION

Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) was engaged by Natural Resource Assessments Pty Ltd (NRA) to undertake an assessment of the surface water and groundwater resources in the area of the proposed open-pit diatomite mining lease on Wyandotte Station in North Queensland. Australian Diatomaceous Earth Pty Ltd (ADE) will develop the diatomite deposit.

Conjuboy Station and other grazing properties in the area rely almost exclusively on groundwater for stock raising. Small and unreliable dams collect rain and surface water and augment the water supply.

This investigation into the local water resources was requested to ensure that any groundwater utilised for mine processing was additional to that used by the Station, and that any of the proposed mining activities did not impact adversely on the on-going agricultural land use and the local environment.

2. OBJECTIVES AND SCOPE OF WORK

The objectives of the project were to:

1) identify the extent, type and number of aquifers
2) identify the potential impacts of a proposed mine on the groundwater and current land use
3) identify potential water sources for the project
4) address the surface water resources of the area—in particular runoff quantities, drainage patterns, stream flow, percolation and infiltration rates, recommendations for appropriate surface water sampling and the impacts likely to occur from extraction of the proposed bulk sample.

In order to achieve these objectives, the following work was undertaken:

- review of existing geological and groundwater data
- discussion of the Conjuboy Diatomite project's expectations in terms of required yields and additional groundwater locations
- an inspection of all existing bore and spring sites on and near the MLA
- field assessment of landform and geomorphological aspects of the Conjuboy area
- assessment of local water bore data from Department of Natural Resources and Mines (NRM) records
- discussion with the ADE staff at Conjuboy;
- assessment of groundwater quality analyses and field groundwater quality parameters
- a desktop assessment of the surface water hydrology.

The information, assistance and time provided by landholders in the area, and drilling and water quality data and previous hydrogeological reports provided by NRM, are gratefully acknowledged and were critical to this project.

3. PHYSICAL SETTING

3.1 Location

The Conjuboy Mining Lease Application (MLA) is centred on 144°49'E 18°40'S. The property is located about 220km northwest of Charters Towers, 225km WNW of Townsville, and 215km southwest of Cairns. The MLA is about 8km east of Conjuboy homestead, within a larger current MDL. Access is via the Gregory Development Highway.

3.2 Physiography

The Conjuboy MLA is at an elevation of about 530 m and lies on the southern margins of a basalt dome of about 5 000 km^2 that forms the McBride Plateau. The centre of the dome reaches an elevation of 1 028 m. The dome comprises numerous basalt lavas that flowed radially outward from 164 volcanic centres. The volcanic centres range from low hills formed by eroded plugs to well-preserved cones with craters.

As the lava flows progressed further from their volcanic centres, the basalt lava degassed and became less viscous. The resulting landform consists of horizontal blocky basalt that is only lightly incised by gullies. Both vehicular and walking access across the old flows is difficult owing to the basalt blocks.

Around its margins, where the basalt is locally only 5 m thick, surface drainage features are separated by, and run parallel to, basalt flows. Basalt flow fronts present low, but distinctive 'jump ups' in the generally subdued topography.

The MLA itself is immediately adjacent a low basalt wall that represents the southernmost extension of the lava flows. It is located on a topographic feature known as Greasy Plain - an area of heavy dark clayey soil (see Drawing No 2). Greasy Plain is located on the fringe of the southern extent of the basalt lava flow and has developed by intensive in situ chemical weathering of the underlying clayey Tertiary to Quaternary rocks, some of which are diatomaceous. It is around 5m lower in elevation than the basalt flow.

3.3 Climate

Conjuboy experiences a relatively humid tropical climate, with hot wet summers and warm dry winters. The Bureau of Meteorology recording station at Mt Surprise, 80 km to the northwest, is the nearest to Conjuboy. Data from Mt Surprise are given in Table 5.1, which shows average monthly rainfall, maximum and minimum temperatures, and evaporation. Average annual rainfall is about 790 mm. Most rain falls from November to March. Very little rainfall is received during the remainder of the year.

Average daytime temperatures vary from around 20-35°C in summer to 10-25°C during the winter. The highest recorded daytime temperatures vary from 42°C in summer to –2.5°C in winter.

Table 5.1: Climate Statistics for Mt Surprise

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Rainfall (mm)	206.3	204.8	115.4	29.8	14.8	14.3	7.1	4.6	5.3	18.9	56.4	116.0
Average Maximum Temperature (°C)	33.2	32.3	31.7	30.7	28.5	26.6	26.4	28.5	31.3	34.2	35.1	34.7
Average Minimum Temperature (°C)	20.9	20.9	19.4	16.7	13.4	10.5	9.6	10.6	13.8	17.2	19.7	20.6
Average Evaporation (mm)*	161.2	126	145.7	117	114.5	105	105.4	142.6	183	226.3	195	198.4

From Table 5.1, it can be seen that average monthly evaporation exceeds average monthly rainfall for all but two months most of the year. This has important implications for grazing properties in the area as surface water storages are particularly susceptible to losses via evaporation.

3.4 Geology

The Conjuboy area is covered by the EINASLEIGH 1:250 000 sheet SE55-9.

The region was first comprehensively mapped by the Bureau of Mineral Resources (BMR) in the 1950s and described by White in 1962[1]. In 1970s and 80s, the BMR and Geological Survey of Queensland (GSQ) remapped the Georgetown Province. The new map and explanatory notes were published in 1995[2]. The geology of the Conjuboy area is shown on Drawing No. 1 and reflected in Table 5.2.

The Conjuboy diatomite deposit occurs on the southern margin of the McBride Basalt Province within the Georgetown Region[3].

The regional geology can be divided into three major units:

- Cainozoic olivine basalt;
- Cainozoic lake sediments;
- Proterozoic and Middle Paleozoic metamorphic and igneous basement rocks.

[1] White, D.A., (1962), Einasleigh 1:250,000 Geological Series, Explanatory Notes and Map, Bureau of Mineral Resources, Geology and Geophysics, Canberra.

[2] Withnall, I.W., & Grimes, K.G., (1995), Einasleigh second edition 1:250,000 Geological Series - Explanatory Notes, Department of Minerals and Energy, Queensland.

[3] Bain, J.H.C., & Draper, J.J., (1997), North Queensland Geology. AGSO Bulletin 240/Queensland Geology 9, Canberra & Brisbane.

Basement rocks

Basement rocks are exposed south of the McBride basalt margin. They include Early Proterozoic to Palaeozoic schist, gneiss, migmatite, granite, mafic intrusive rocks, and metamorphosed volcanic and sedimentary rocks.

Cambro-Ordovician granite (the Ringwood Park Microgranite) is the only basement lithology cropping out within the Conjuboy MDL. It is exposed along the southern parts of the lease area. The rock is a foliated pink equigranular to porphyritic microgranite and biotite granite.

Cainozoic lake sediments

Lacustrine claystone, sandstone and conglomerate occupy a shallow, irregular basin of lake sediments extending about 100 km^2. Basalt flows are thought to have dammed ancient drainage features to form the lake—similar to a number of local present day examples.

The lake sediments, which rest directly on basement rocks, were subsequently buried by later basalt flows.

Table 5.2: Summary of Regional Stratigraphy

Age	Geological Unit	Description	Thickness (m)	Occurrence
Quaternary	Kinrara Basalt	Olivine basalt	unknown	30 km NE of Conjuboy. The lavas flowed into the Burdekin R valley.
Tertiary-Quaternary	undivided McBride Basalt Group	Olivine basalt	up to 500 in centre of dome	Conjuboy is on southern margin of a 5 000 km^2 basalt dome.
Tertiary	unnamed	Claystone, diatomite, minor sandstone; lake deposits	irregular; diatomite is 20 m thick	Exposed in Wyandotte, Forester and Spring Creeks.
Late Palaeozoic	NQ Igneous Province	Intrusive dacite & rhyolite	unknown	Minor outcrops near Dry River, SSW of MDL.
Early Palaeozoic	Dido Tonalite	Batholith; foliated grey hornblende-biotite tonalite & quartz-diorite	unknown	Southern parts of MDL and extends south of Conjuboy.
	Lucky Creek Metamorphics	Biotite gneiss, quartzite, amphibolite; intermediate-mafic volcaniclastics; chlorite schist, phyllite	unknown	S of Conjuboy.
	Ringwood Park Microgranite	Porphyritic microgranite	unknown	Intrudes Balcooma Mylonite Zone.
	Balcooma Metamorphics;	Rhyolitic metavolcanics, metsediments	unknown	SW of Conjuboy; east of Balcooma Mylonite Zone.
Proterozoic	Einasleigh Metamorphics	Biotite gneiss & schist, calc-silicate gneiss, leucogneiss, migmatite, granite gneiss, amphibolite	unknown	West of Conjuboy; around the western flanks of the McBride Basalt dome; west of the Balcooma Mylonite Zone.

Exposed in Wyandotte, Forester and Spring Creeks are beds of poorly cemented kaolinitic diatomite, intercalated with the lake clays and sands. The diatomite is underlain by clay.

There is an alternative explanation to basalt damming. As occurs elsewhere in North Queensland, the basalt flows may have exploited topographic depressions in the lake sediment basin—drainage lines or slight downwarps. The modern creeks now follow the former drainage divides that were not covered by basalt.

Olivine basalt

Late Tertiary to Quaternary basaltic rocks crop out extensively across parts of North Queensland. The McBride Basalt Province is one of the three main basalt provinces of the area, and it comprises a large basaltic dome about 80 km across and nearly 500 m thick. Within the dome 164 volcanic centres have been recognised, including many lava and cinder cones and craters.

Most of the basalts range in age from 2.7 to 0.5 million years old, but a few are <40 000 years old. Tourists would be familiar with one of the younger basalts, the Undara Basalt, dated at 190 000 years. Of the younger flows, the Kinrara Basalt (70 000 to 50 000 years) is the nearest to Conjuboy: The Kinrara Crater is about 30 km NNE of the Conjuboy deposit.

Structure

The major regional structural trend of the rocks around the MDL is SSW-NNE. Beneath the McBride basalt dome, the major structural trend remains NNE. This is the trend of the Balcooma Mylonite Zone and also the Burdekin Fault, 30km SE of the Conjuboy MLA.

The Conjuboy MLA is underlain mainly by Tertiary basalt from the early part of the McBride Basalt Group. This obscures much of the structure. However, numbers of volcanic centres within the basalt dome align with a NNE trend. One major lineament is formed by a series of unnamed craters parallel to the Kennedy Developmental Road which align with the Undara and Murronga Craters. Lava from the Murronga Crater flowed SSW for 25 km, extending this lineament to the margins of the basalt dome, where it aligns with major mylonite zones cutting the Einasleigh Metamorphics. Together, these features form a NNE-SSW-trending lineament 100km long.

The Conjuboy MLA lies close to the strike extension of another major regional structure, the Balcooma Mylonite Zone. The Zone separates predominantly Proterozoic gneisses and schists of the Einasleigh Metamorphics from Early Palaeozoic metavolcanic and metasedimentary rocks and granitoids.

The Zone, which is the locus for a string of deformed gold and base metal deposits, has a regional NNE trend and passes beneath the McBride basalts. The Pleistocene Kinrara Crater lies directly on its strike extension.

A subordinate fracture direction is SE-NW. In the Conjuboy area, the basalt appears to have flowed SSE or southeasterly. The Dry River follows a major SE-trending lineament that marks the local limit of basalt. Lava from the Kinrara Crater also flowed towards the southeast into the Burdekin River.

4. HYDROGEOLOGICAL REGIME

The hydrogeological regime of the Conjuboy area appears to be controlled by:

- unconfined fractured rock aquifers within the McBride basalt flows;
- confined aquifers in flow-top breccias and interflow sediments.
- possible groundwater reservoirs within lava tubes of the McBride basalts;
- groundwater discharging from the base of the basalts into Spring, Forester and Wyandotte Creeks and the Dry River;
- confined fractured rock aquifers within the basement crystalline rocks beneath the basalt; and
- unconfined aquifers associated with alluvium in the Dry River valley.

The contribution and relative importance of each of these hydrogeological entities is discussed in detail below.

4.1 Previous Investigations and Groundwater Data

Previous hydrogeological investigations in the area are few. In 2001, AGE analysed pump test data from a newly drilled bore on behalf of Conjuboy Station. This analysis provides the only estimates of the aquifer parameters Transmissivity (T) for the basalt aquifer in the area.

The Conjuboy area is not a declared subartesian groundwater area. Consequently no licences or permits are required for the drilling and construction of water bores. There is also no requirement on landholders or drilling contractors to lodge groundwater records with NRM. A search of the NRM groundwater database for the area revealed that:

- There is no formal strata log information for bores in the area;
- Only the depth of the bores is generally known;
- Regular standing water levels are not measured by landholders; and
- Only very limited groundwater quality data exist.

4.2 Aquifers at Conjuboy

Based on the geology of the Conjuboy area and the limited historical groundwater data available, a number of different aquifers have been identified.

Basalt aquifers

The basalt flows could be a very good source of water. Compare western Victoria, where much of Geelong's water supply derives from similar-aged basalts underlying the Western Plains.

The basalt rock matrix itself is not permeable—the centres of lava flows are generally impervious (porosity <1% and hydraulic conductivity about 10^{-10} m/s)[4], but large flow tubes like those at Undara would act as superb water reservoirs. Other causes of high permeability in young basalts are gas vents, or vesicles, produced by volcanic gases escaping from the lava. These are locally known as 'honeycomb' basalt. Vesicular basalt has a porosity of 5% and a hydraulic conductivity of between 10^{-9} and 10^{-8} m/s.

Boundaries between flows are usually permeable, as are brecciated flow tops and bottoms. Buried soils, and gravels deposited by streams on lava landscapes, and later covered by new flows, could also be aquifers. Interbeds are known to have porosities of 20% and hydraulic conductivities between 10^{-8} and 10^{-5} m/s. Withnall & Grimes[2] have reported that good quality water can be obtained from sandy unconsolidated material beneath the basalts.

Secondary permeability in basalt is developed along fractures, and particularly good secondary permeability is afforded by columnar jointed flows. For fractured basalt, typical porosity and hydraulic conductivity are 10% and 10^{-9} to 10^{-5} m/s, respectively.

On a large scale, the permeability of basalt is anisotropic. Within any basalt flow the permeability is normally greatest in the direction of highest original dip of the flows.

Aquifers in the basement rocks

Unfractured metamorphic and plutonic rocks rarely have porosities >2%. Because the intercrystalline pore sizes in igneous and metamorphic rocks are tiny and are usually not interconnected, the primary permeabilities of these rocks are extremely small. Hydraulic conductivities are in the range of 10^{-14} to 10^{-10} m/s.

Although appreciable fracture permeability can occur within a few hundred metres of the ground surface, hydraulic conductivities for *fractured* igneous and metamorphic rocks range from 10^{-8} to 10^{-4} m/s. Note, however, that small joints can become clogged by clays and other weathering products, an important consideration in areas of intense tropical weathering and deep soil profile development.

The basement rocks south of Conjuboy occupy a position adjacent to the Balcooma Mylonite Zone. The mylonite itself would be tight, but fault and joint development along associated structures might provide opportunities for a fracture-related groundwater source.

As noted above, the Kinrara Crater lies on the NNE strike extension of the Balcooma Mylonite Zone. This suggests that the Pleistocene lavas have exploited a fundamental basement structural lineament. At depth, below the basalt, a significant water reservoir may occupy fractures associated with this Zone.

Aquifers in the diatomite

Diatomite is known to be highly porous but its permeability is limited owing to its very fine-grained nature. Although the diatomite deposits will become saturated by recharge events, it is considered that they do not represent a significant aquifer unit.

[4] Freeze,R.A., & Cherry, J.A., (1979), Groundwater. Prentice-Hall Inc., New Jersey.

Aquifers in the unconsolidated creek sediments

Unconfined aquifers may exist within the alluvium along Dry River. As there are few known bores in the alluvium the nature and extent of these aquifers cannot be assessed.

The relatively pervious Quaternary alluvial sands occupying the channels of larger creeks form a potential recharge system for the fractured rock aquifers of the basement rocks, where these units are traversed by the streams.

4.3 Recharge and Groundwater Flow

The primary mechanism of recharge of the basalts and the basement fractured rock aquifers is direct infiltration of rainfall.

Some recharge of the basement fractured rock aquifers occurs via slow release of water stored in the alluvium associated with the major creeks. However, from observations made during this investigation, it appears that the storage and transmission of groundwater in alluvium, and therefore recharge via this mechanism, is limited. Although recharge from the alluvium should not be disregarded, the limited aerial extent and thickness of the alluvium precludes adequate storage of groundwater. Down valley flow within the alluvium probably removes groundwater before there is sufficient time for recharge to occur. Few rock bars exist in the major watercourses to impede down valley flow.

Although no measured permeability data exist for either the alluvium of Dry River, a visual assessment suggests that the permeability is moderate.

The lack of historical water level data for most of the bores in the Conjuboy area do not allow an accurate assessment of groundwater flow paths for the property. From measurements made in selected bores around the MLA, anecdotal evidence and a visual assessment of the hydrogeological regime, the following trends are apparent.

- Standing water levels in most bores rarely vary from 5 to 10 metres below ground level.
- Incident rainfall on the basalt rapidly infiltrates the basalt plains. No reliable standing water level data exist with which to estimate the percentage of incident rainfall that will result in recharge. Experience in similar terrains suggests that recharge rates of between 3 to 5% of incident rainfall will apply.
- Recharging groundwater percolates vertically through the basalt until it reaches the underlying clay sequence.
- The groundwater in the thin basalt flow immediately north of Greasy Plain discharges around the margins of the basalt onto the plain itself.
- Seepage lines occur (A. Butler, NRA, pers. comm.) where spring discharge flows are concentrated in locally more permeable sections at the base of the basalt flow.
- The underlying clay is of low permeability and is unlikely to permit further vertical infiltration of groundwater as evidenced by the indurated clayey nature of the beds of Wyandotte and Forester Creeks.

Based on these observations it is assessed that groundwater flows in a southerly direction at more or less the same gradient as the topography (about 0.01 or 1%).

4.4 Groundwater Level Behaviour

Regular standing water level measurements are not made in the bores in the area, mainly because the headworks and pumping equipment in the bores preclude easy access to the water table. There is no reliable historical evidence of seasonal variations in either unconfined or confined aquifers in the area.

4.5 Existing Bores

Data on existing bores were obtained from NRM's groundwater database. Table 5.3 shows summary statistics of the bores near the Conjuboy MLA.

Subsurface information is scarce as drilling logs have next to no information (see Table 5.3). The most likely aquifer unit being exploited by each of the production bores was assessed from its location, depth and the published geology of the area.

Table 5.3: Summary of Regional of Bore Data

Station	NRM Registered No.	Easting	Northing	Depth (m)	Discharge Rate (m^3/day)	Standing Water Level (m)	Likely Aquifer Unit
Lava Plains	78509	265200	7945600	53.34	109	8.8[1]	McBride Basalt
Lava Plains	78510	264100	7950800	24.38	109	ns	McBride Basalt
Spring Creek	78532	256900	7920000	ns	TRICKLE	ns	Balcooma Metavolcanics
Spring Creek	78533	256900	7921200	ns	GOOD	ns	Balcooma Metavolcanics
Gildale	78601	270500	7941600	36.00	DRY	ns	Tertiary lake seds
Gildale	78602	276200	7950800	43.00	1090	ns	Tertiary lake seds
Gildale	78603	274100	7941900	36.57	86	ns	Tertiary lake seds
Gildale	78604	272500	7938400	ns	ns	ns	Tertiary lake seds
Gildale	78605	268000	7943000	ns	ns	ns	Tertiary lake seds
Gildale	78606	269600	7951000	67.05	109	ns	McBride Basalt
Wyandotte	78607	267800	7928000	38.4	ns	ns	Dido Tonalite
Wyandotte	78608	264200	7929400	ns	ns	ns	Ringwood Park Microgranite
Conjuboy	78614	262100	7933200	ns	ns	ns	McBride Basalt
Conjuboy	78615	265700	7931600	12.19	87	ns	Ringwood Park Microgranite
Conjuboy	78616	263100	7930400	36.57	26	ns	Ringwood Park Microgranite
Conjuboy	78617	260000	7942500	ns	GOOD	ns	McBride Basalt
Conjuboy	78618	260600	7937500	ns	109	ns	Einasleigh Metamorphics
Conjuboy	78619	254900	7935600	18.00	ns	ns	Einasleigh Metamorphics
Conjuboy	78620	254600	7930000	60.96	GOOD	ns	Einasleigh Metamorphics
Conjuboy	78621	257400	7942000	ns	POOR	ns	McBride Basalt
Conjuboy – Figtree bore	Not assigned	262338	7933203	26	2,168	3.95[1]	McBride Basalt

[1]no date given, ns = not stated

It can be seen from Table 5.3 that:

- most of the bores are quite shallow;
- the bores exploit a variety of aquifers;
- two bores report shallow standing water levels (<10m);
- variable groundwater supplies may be obtained from aquifers in the McBride Basalt (eg. Figtree Bore); and
- more detailed regional data are needed to be confident about the groundwater potential of the Conjuboy area.

The Figtree Bore on Conjuboy Station was drilled by Delais Drilling and is not registered in the NRM groundwater database. The bore comprises 200mm nominal diameter casing to a depth of 17m. The bore is not cased from 17m to the total depth of 26m. The 200mm casing is slotted in the interval 6 to 17m in the basalt.

A constant rate test was undertaken to assess the hydraulic parameters of the aquifer. A summary of the analysis is provided in Table 5.4 below.

Table 5.4: Summary of Analysis of Pumping Test Data

Bore	Pumping Rate 'Q' (m^3/day)	Standing water level (mbTOC)	Depth of Slotted casing (mbns)	Maximum Drawdown* (m)	Transmissivity 'T' (m^2/day)	Method of Analysis
Figtree	2,168	6.0	5-17	2.8	1,713	Hantush

Notes: mbns - metres below top of casing
*drawdown - decrease in potentiometric surface

The constant rate test data and analysis indicates that the aquifer is unconfined and receives leakage from overlying aquifers. The test data indicate a transmissivity value, which averages about 1,713m^2/day.

4.6 Groundwater Quality

Records of groundwater quality form the bores in the area are almost non-existent. Bores with Registered Numbers (RN) 78604 and 78605 were reported to be salty. Both are exploiting Tertiary lake sediments. It is likely that these bores are exchanging groundwater with deeper fractured rock aquifers.

RNs 78606 and 78616 have electrical conductivity (EC) measurements of 600 to 800µS/cm, indicating that the groundwater from them is of low salinity and should be chemically suitable for most purposes. These bores exploit basalt aquifers and the groundwater is considered to be typical of the basalt in the area. The EC of the groundwater from White Tank bore (RN 78509) was 1,100µS/cm during the field inspection.

5. SURFACE WATER HYDROLOGY

The Conjuboy Diatomite MLA is situated within the headwaters of the Burdekin River. About 25 km east of Conjuboy homestead, the upper Burdekin River changes direction: from flowing essentially westerly to flowing southwards. The MDL straddles several tributary drainages of the upper Burdekin River. The main drainage system in the MLA area is the Dry River, which flows southeast into the Burdekin. Wyandotte and Forester Creeks are northern tributaries of the Dry River and are the main creeks that drain the MDL area.

Published 1:100 000 and 1:250 000 topographic maps were used to define the boundaries of Wyandotte and Forester Creek catchments (See Drawing 2).

Soil types were assessed from the Atlas of Australian Soils (Isbell et al., 1968)[5]. A brief evaluation of the geology and soil types, as they relate to runoff, was undertaken. A catchment and flow analysis was carried out to assess the relative rainfall and runoff characteristics of both Wyandotte and Forester Creek catchments.

5.1 Catchment Characteristics and Drainage

Wyandotte Creek catchment is roughly 15km from east to west and 40km from north to south and has a total area of 520km^2. Two creeks contribute to Wyandotte Creek catchment – Wyandotte Creek and Forester Creek. Both commence at elevations of around 1000m in Great Dividing Range and flow roughly southward and are part of the much more extensive Burdekin River catchment.

The creeks are incised into Greasy Plain to a depth of around 5m. The bed of both consists of moderately hard indurated clayey material. The banks consist of dark grey to chocolate coloured clay in which desiccation cracks are evident. Travertine, a secondary limestone, often infills the desiccation cracks.

The southern extent of Wyandotte Creek catchment is the confluence of the two creeks. This boundary is at an elevation of about 480m. The MDL extends outside of the catchment but the proposed MLA is wholly contained between the two creeks approximately 3km northwest of the confluence.

Wyandotte Creek catchment slopes gently from the Great Dividing Range to its southern boundary. The predominant vegetation within the catchment consists of open Eucalypt forest. Claystone, diatomite, minor sandstone and lake deposits underlie this area. Low viscosity flood basalts within the Burdekin catchment formed extensive relatively flat rocky plains owing to fracturing of the basalt in the near surface - for example the land north of Greenvale. The flood basalts filled the existing stream channels when extruded. Differential erosion and weathering of the softer surrounding sediments has resulted in basalt walls and an inverted topography in places.

Clayey soils are dominant and they are interspersed with basalt blocks (Isbell et al., 1968). The soil in this area has been formed from geologically rapid chemical weathering of basalt lavas, which emanated from volcanic vents further to the north. They are referred to as soils with duplex profiles by Isbell et al., (1968). Within the MDL the soils have no A_2 horizon. The average gradient of the slopes in the Wyandotte Creek catchment is 0.01 (or 1%).

[5] Isbell, R.F., Webb, A.A., and Murtha, G.G, (1968). Atlas of Australian Soils. Commonwealth Scientific and Industrial Research Organisation.

5.2 Runoff

The accuracy of estimation of runoff or discharge from rainfall measurements depends on the time scale being considered (Shaw, 1988)[6]. Generally the inter-relationship between rainfall and runoff for short periods, say hours, in any catchment is complex, but if it is considered on an annual basis, a straight line correlation is usually obtained. The size of the catchment being considered also affects the relationship.

The Coefficient of Runoff depends on the average slope of the catchment and the land cover in the catchment. Table 5.5 shows published Coefficients of Runoff for average slopes of 1%.

Table 5.5: Coefficients of Runoff for Average Slopes of 1% (Adapted from Interim Stormwater Standards Committee, 1958)

Land Cover	Coefficient of Runoff
Bare ground, rock, pavement, roofs, city areas fully built	0.85
Rocky, clayey or non-absorbent soil with scanty herbage	0.70
Open forest or grassed land, cereal crops	0.55
Average grassed timbered land of medium soil texture	0.45
Heavily timbered country, closely cultivated land and gardens	0.34
Sand	0.19

As the majority of Wyandotte Creek catchment may be described as rocky, or clayey with non-absorbent soil and scanty herbage, the appropriate Coefficient of Runoff for the catchment is 0.70.

In view of the size and location of both catchments, it is reasonable to assume that both the amount and intensity of rainfall is constant across the catchment.

The discharge in any stream is the accumulated runoff from the stream's catchment. Discharge is directly proportional to runoff and the discharge at any time can be calculated using the rainfall received in the time interval. Thus, discharge (D) can be calculated using a modified form of the catchment using the Lloyd-Davies (1906)[7] equation:

$$D = C\, r_t\, A$$

where: C = Coefficient of Runoff

i = rainfall intensity

A = Area of catchment

No data on rainfall intensity are available for the Conjuboy area, however the above relationship may be used to assess the likely runoff from the MDL when mining commences.

[6] Shaw, E.M., (1988). Hydrology in Practice (Second edition). Van Nostrand Reinhold International.
[7] Lloyd-Davies, D.E., (1906). The elimination of storm water from sewerage systems. Proceedings of the Institute of Civil Engineers, Volume 164, 41-67.

5.3 Stream Flow

NRM installed and operated a stream gauging station (GS 120117A) on Wyandotte Creek from 1970 until 1988. The location of GS 120117A is shown on Drawing No 2. The data for GS 120117A have been obtained from the NRM Watershed website.

The mean monthly flow for the period of record at GS 120117A is presented graphically in Figure 5.1 below.

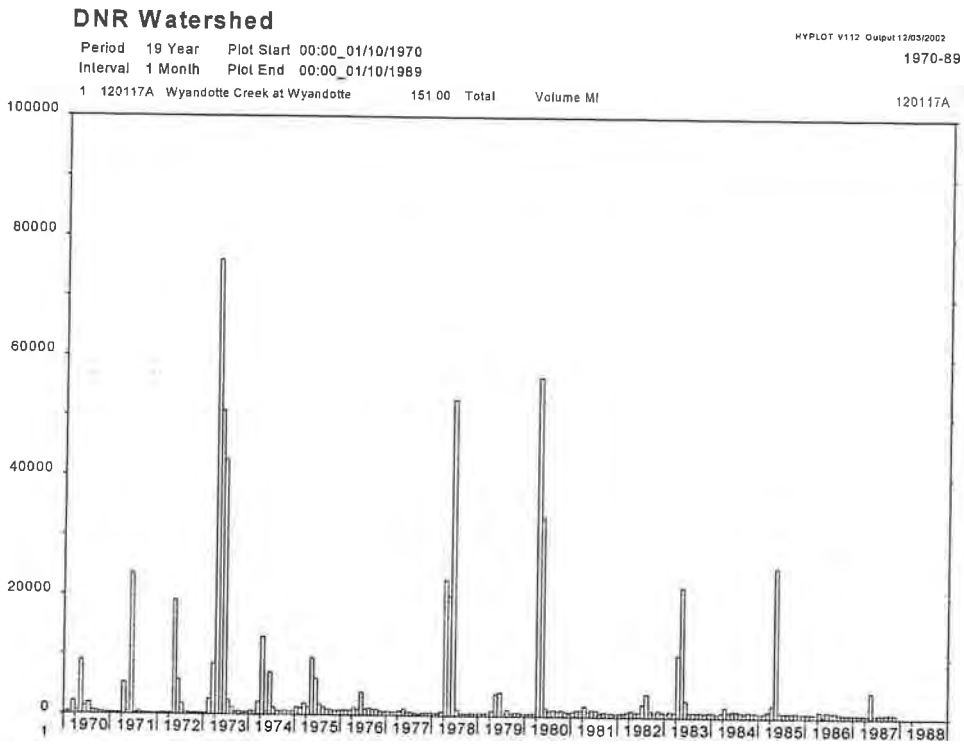


Figure 5.1: Mean monthly flow in ML at GS 120117A
(source NRM Watershed website)

It can be seen from Figure 1 that, in most years, summer monthly flows generally range from around 10 000 to 25 000ML. It is expected that flows such as these would not inundate the mining site.

In exceptionally wet years extreme monthly flows in excess of 50 000ML have been recorded. Inundation of the mining site can be expected in these years.

5.4 Surface Water Quality

NRM sampled the surface water from Wyandotte Creek at GS 120117A whilst it was in operation. Table 5.6 shows summary statistics of major ionic species that are likely to be impacted by the mining operation.

It can be seen from Table 5.6 that the historical physico-chemical surface water quality of the Wyandotte Creek catchment is excellent.

When mining commences the water quality and, in particular, the turbidity of the water in Wyandotte Creek should be maintained at the minimum practical level at all stages during construction and processing.

Table 5.6: Chemical Analyses of Major Ionic Species
(data from 37 samples at GS1120117A)

Parameter		Minimum	Median	Maximum
Discharge	m^3/s	0.082	0.273	1280
pH		7.4	8.5	8.8
EC	µS/cm	315	720	800
Turbidity	NTU	1	4	38
SO_4	mg/L	2	3	7
Calcium (Ca)	mg/L	17	25	40
Magnesium (Mg)	mg/L	22	62	74
Sodium (Na)	mg/L	23	42	48
Potassium (K)	mg/L	1.6	7.2	8.8
Total Alkalinity (as $CaCO_3$)	mg/L	125	389.5	424
Chloride (Cl)	mg/L	8.2	26	74
Nitrate (NO_3)	mg/L	0.2	0.5	4.3
Filtered Iron (Fe)	mg/L	0.02	0.02	0.3
Fluoride (F)	mg/L	0.05	0.1	0.4
Silica	mg/L	15	34	60

It is recommended that ADE should use the site of former GS 120117A as its primary surface water quality monitoring station. The following surface water quality sampling regime is recommended.

- Measurements of water pH and turbidity should be made at weekly intervals and the results should be recorded.
- Water should be collected and analysed for a selection of parameters as shown in Table 5.6 above, on a monthly basis for the first twelve months of operation. This will permit ADE to construct a database of water quality parameters both before and during mining.
- The water quality data should be reviewed after twelve months of operation.

5.5 Water Resource Impacts of Diatomite Mining

Based on the desktop analysis and field inspection, impacts have been assessed as follows.

- The only water resource impacts of diatomite mining at the Conjuboy site will be increases in turbidity of the surface water, and perhaps contamination due to fuel and other chemical spills in Wyandotte Creek.
- The groundwater within the thin basalt layers immediately to the north of Greasy Plain will only impact on the mining operation during and for a short time after the wet season.
- The final shape and size of the void left after mining has not been determined at this stage. It will fill from groundwater discharging from the base of the basalt wall.
- It is unlikely that the volume of groundwater in the final void will have a major impact on the groundwater resources of the region.
- The mining operation itself will have little or no impact on the surrounding aquifers.

In order to minimise the impact of silt movement and increases in turbidity and contamination of the surface water, it is recommended that:

1) Fuel and oil should be stored and washing of hand tools is to be carried out in an earth-bunded area. This should minimise the ingress of potentially contaminating fuel, oil, grease and other contaminants to the pit. Trucks should be washed down off-site.

2) As a component of erosion and sediment control measures, silt trapping fences are to be placed at spacing of 10m in disturbed areas to effectively minimise sediment ingress into the pit and surrounding watercourses. Silt trapping fences must be maintained in good order throughout the project. Should it be necessary to remove the silt trapping fences to permit vehicle access etc, the fences should be reinstated as soon as possible.

3) Ausorb (a proprietary oil-absorbing chemical (or similar) is to be used to contain any oil spills on-site. Visibly contaminated soil may be lifted up and removed to a site designated for the disposal of hydrocarbons as soon as possible following the incident. Alternatively *in situ* remediation may be appropriate. Records detailing the time and date, nature and extent of the incident are to be kept in the site's environmental management register. Any disposal of contaminated soil will require prior approval from the Environmental Protection Authority.

AUSTRALASIAN GROUNDWATER AND ENVIRONMENTAL CONSULTANTS PTY LTD

Reviewed by:

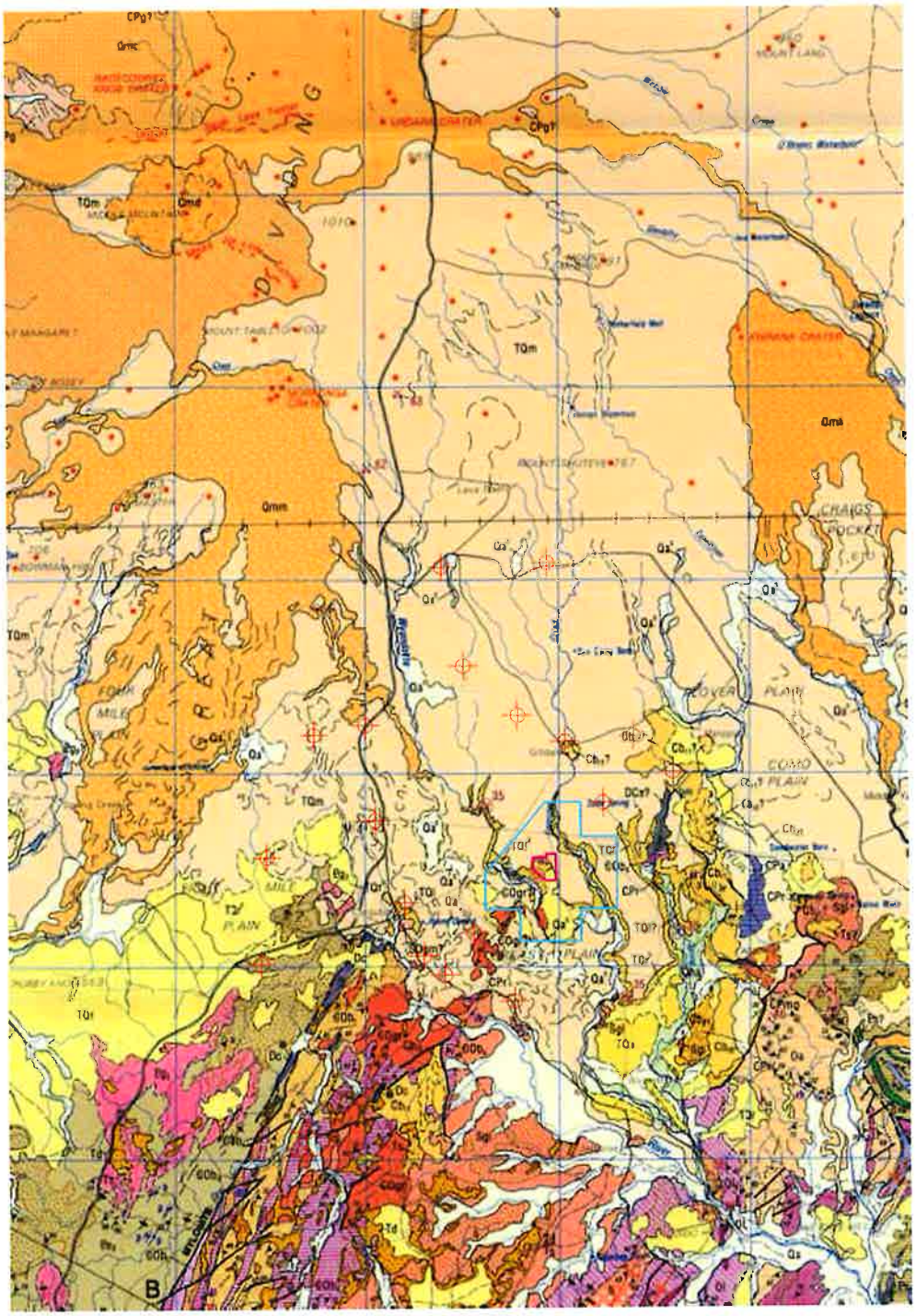
ROB LAIT

Regional Manager/Principal Hydrogeologist

GEOFF HODGSON

Hydrogeologist

Drawings



GEOLOGICAL LEGEND

((selected units only)

PALAEOZOIC ROCKS	COgr	Ringwood Park Microgranite pink microgranite and biotite granite	**TERTIARY AND QUATERNARY SEDIMENTS**	TQl	Undifferentiated claystone, minor sandstone, lacustrine deposits, diatomite shown with superscript d
	Cbr1	Bally Knob Volcanics pink to brown rhyolitic ignimbrite		TQm	Unassigned Olivine Basalt
				Qa	Clay, silt, sand, gravel, floodplain alluvium superscript c indicates clay

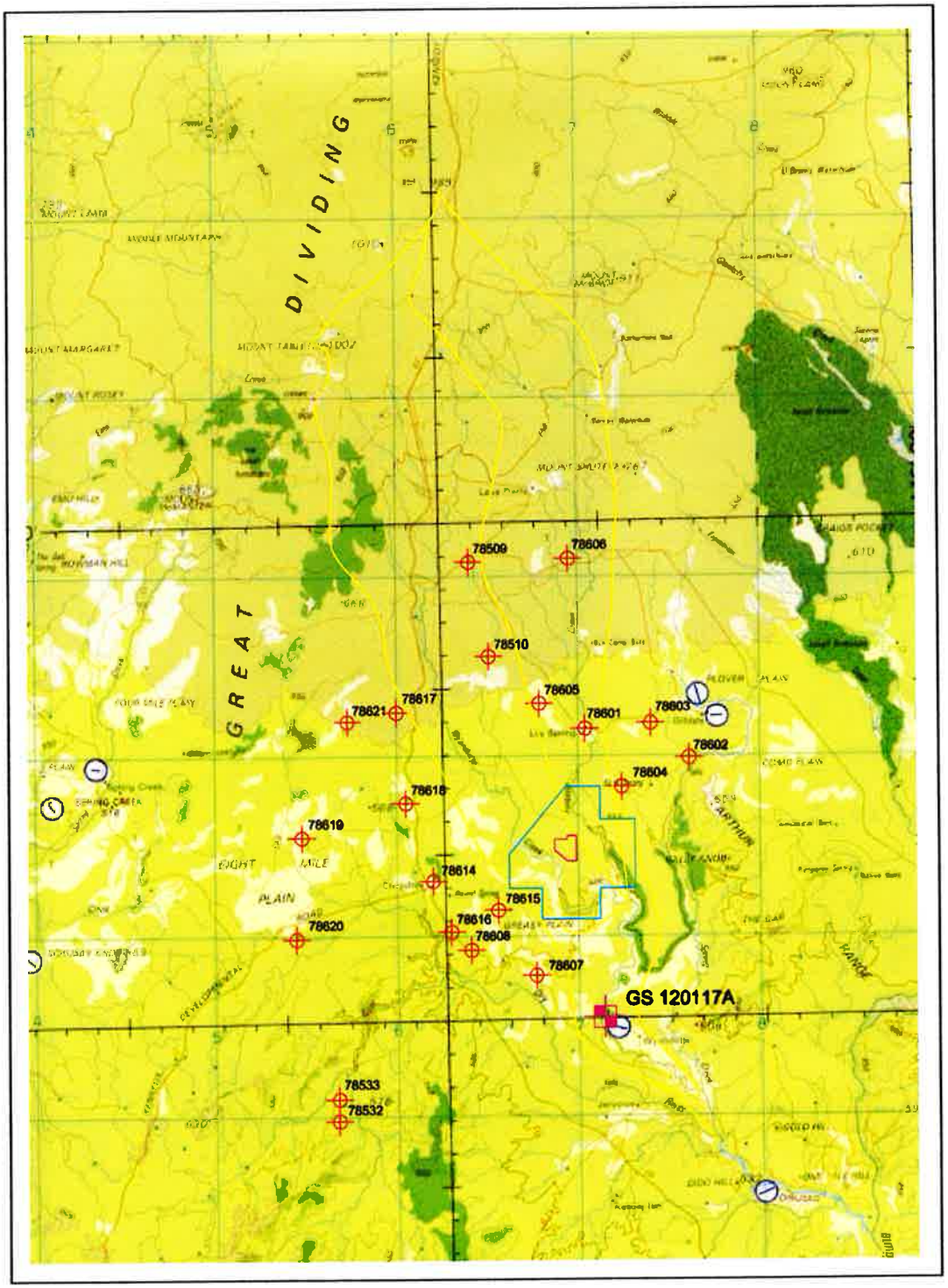
Registered Water Bore

MDL

AUSTRALASIAN GROUNDWATER & ENVIRONMENTAL CONSULTANTS PTY LTD
7/289 ABBOTSFORD RD BOWEN HILLS QLD 4006 AUSTRALIA

TITLE: ASSESSMENT OF HYDROLOGY AND HYDROGEOLOGY
CONJUBOY DIATOMITE DEPOSIT
GEOLOGICAL MAP

CLIENT: Natural Resource Assessments | OFFICE: Innisfail
DRAWN BY: JST | SCALE: 1:250,000 | PROJECT No: NG118 | DRAWING No: 1
APPROVED BY: | DATE: June 2002



78614 Water Bore with Registered Number

Catchment boundary

MDL

MLA

AUSTRALASIAN GROUNDWATER & ENVIRONMENTAL CONSULTANTS PTY LTD
7/200 ABBOTSFORD RD BOWEN HILLS QLD 4006 AUSTRALIA

TITLE: ASSESSMENT OF HYDROLOGY AND HYDROGEOLOGY
CONJUBOY DIATOMITE DEPOSIT
TOPOGRAPHIC MAP

CLIENT: Natural Resource Assessments | OFFICE: Innisfail
DRAWN BY: JST | SCALE: 1:250,000 | PROJECT No: NG118 | DRAWING No: 2
APPROVED BY: | DATE: June 2002

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PROGRESSIVE REHABILITATION AND CLOSURE PLAN
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Appendix 7: FLORA AND FAUNA ASSESSMENT, WILDNET REPORTS AND REVEGETATION INFORMATION

Chapter 3. Flora and Fauna

1. INTRODUCTION

A vegetation survey and a fauna assessment were commissioned for the Conjuboy Diatomite Project baseline study. The purpose of these studies was to assess the environment values of the area and to provide background information suitable for the preparation of an EMOS. This report documents the outcomes of the vegetation and fauna studies conducted at the proposed mine lease and along the approximate route of the proposed haul route.

The scope of the vegetation survey was to:

- provide vegetation mapping of indicative regional ecosystems (vegetation communities)
- describe the vegetation noting any species of significance
- assess the flora for local and regional significance
- discuss weed management issues together with recommendations for plants to be used in site rehabilitation.

The scope of the fauna assessment was to:

- assess the likelihood of any significant fauna species occurring in the area from a desktop review of literature and database searches
- conduct a field investigation over a two day period to document observed fauna species and assess habitat integrity and significance
- assess the requirement for, and nature of further studies, based on desktop investigations and field inspections.

2. VEGETATION SURVEY

2.1 Methodology

2.1.1 Desktop study

To facilitate the flora and fauna investigations the site was divided into 6 areas based on aerial photograph interpretation of topography and vegetation. These areas are described as follows.

- Basalt Plateau - curves from the northern edge to the eastern edge of the proposed lease area and includes the haul route, it is very stony on the surface (stones to boulders).
- Basalt Wall - the face of the basalt flow, it is dominated by cobbles, stones and boulders.
- Colluvial Slope - the area at the bottom of the Basalt Wall, it has a lower gradient and is dominated by basalt cobbles and stones.
- Tea Tree Gullies - seepage areas in the basalt wall, dominated by groves of *Melaleuca bracteata*.
- Flats - the area between the Colluvial Slope and the creek zone, an area of transported sediments over diatomaceous earth.
- Watercourse - 0 to 10 m from the creek bed proper.

Plant species likely to occur in the study sites were identified with reference to the following materials:

- Brooker and Kleinig (1994) *Field Guide to Eucalypts: volume 3, Northern Australia.*
- Sattler and Williams (1999) *The Conservation Significance of Queensland's Bioregional Ecosystems.*
- Other flora studies conducted by NRA in the region.
- A HERBRECS search of plant species was conducted through the Queensland Herbarium to determine Rare and Threatened species previously recorded from the Conjuboy area. The search area was 26600E 793300N to 27100E 793700N (UTM AGD 66). The search results are attached in Appendix C.

2.1.2 Fieldwork

Walk-through surveys were carried out in the early dry season (on 21 to 23 May 2002) to ground-truth vegetation communities identified from aerial photographs. The dominant canopy, mid-storey and ground species were noted and a rating was given to the more common species according to their apparent abundance in the community. The rating uses a scale called the DAFOR scale (based on the initial letter for each rating).

- Dominant
- Abundant
- Frequent
- Occasional
- Rare

Other readily identifiable species present at the site were listed, however many plant species could not be identified due to lack of flowering or fruiting material. Obvious natural and anthropogenic disturbances were recorded.

2.1.3 Mapping of Flora – Regional Ecosystems

Dominant canopy species noted during site investigations were used to define the Regional Ecosystem (RE) that most closely corresponded to the community present at the site. Vegetation is described using the RE codes and descriptions of Sattler and Williams (1999). The conservation status of the REs was established as follows (Sattler and Williams 1999).

- REs with >30% of their original extent are classified as "not of concern"
- REs with 10-30% of their original extent remaining are classified as "of concern"
- REs with less than 10% of their original extent are considered endangered.

2.1.4 Significant Flora Species

Species lists compiled from site investigations and HERBRECS were compared against species listed as Protected Wildlife in the Queensland *Nature Conservation (Wildlife) Regulation* 1994 and the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999.

2.1.5 Weeds

The Queensland *Rural Lands Protection Act* 1985 requires land managers to control certain declared weeds. Declared weed species were identified and this report presents recommended control measures. Other weed species known to occur or likely to occur in the proposed mine lease area or along the haul route are listed, and recommended control measures are presented. In particular, reference is made to priority weeds listed in Dalrymple Shire Council's Management Plan: Control of Declared Plants and Animals within the Dalrymple Shire (1999).

2.1.6 Rehabilitation

Lists of species for use in rehabilitation were prepared based upon observations made during site investigations. Selection of native species was made on the following criteria:

- the species to be used in rehabilitation must be recorded from the site
- the mix must include grass, shrub and canopy species
- the mix should include species which produce fruit and nectar for birds.

2.2 Results

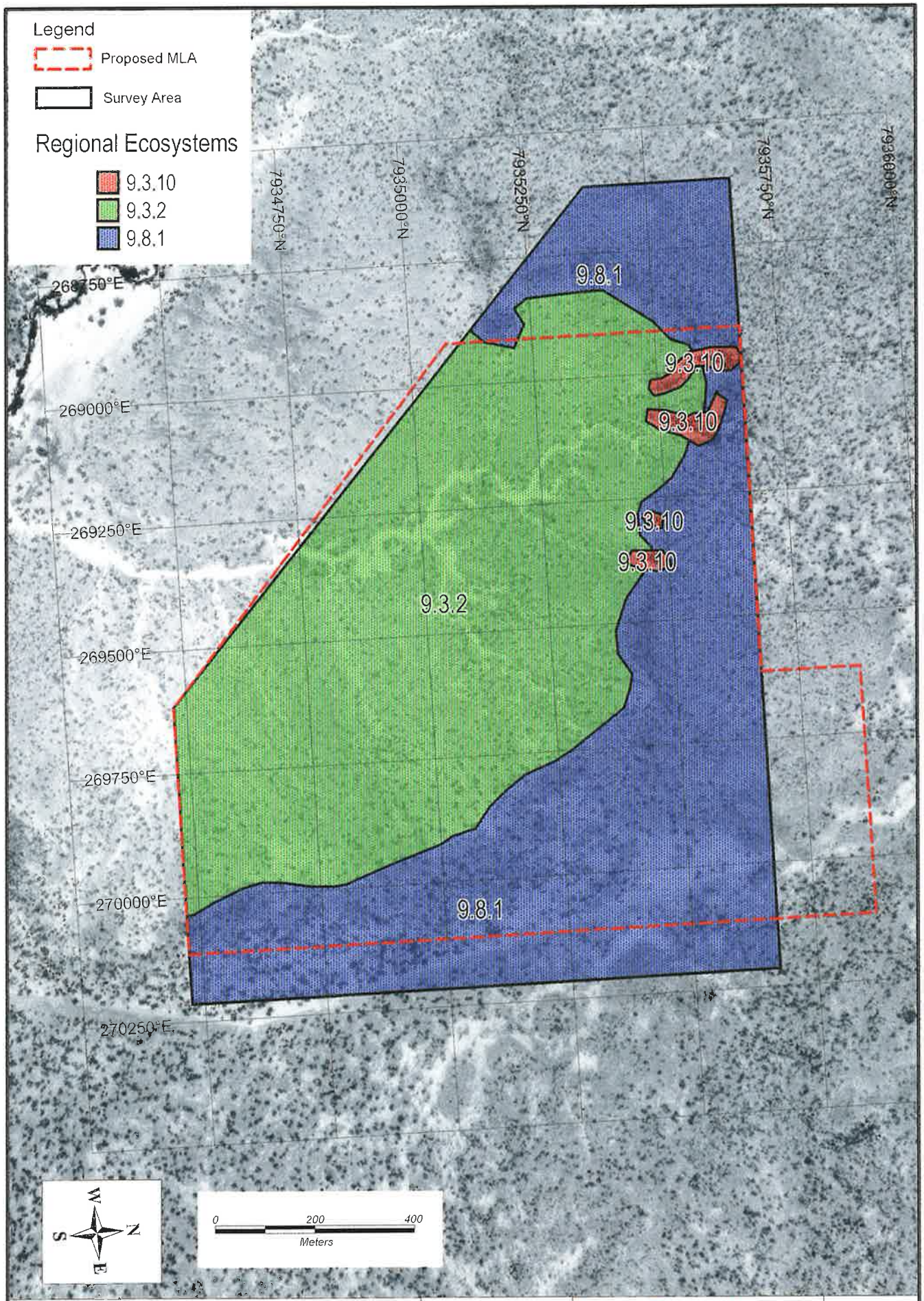
2.2.1 Mapping of Flora – Regional Ecosystems

Two vegetation communities dominate the survey area (Figure 3). The survey area was slightly different to the proposed MLA, but the RE and vegetation information for the northern part of the survey area will be similar, if not identical, to the unsurveyed area (RE 9.8.1). The plains surrounding and including the creek zone are dominated by the RE 9.3.2 (Mt Molloy Box on alluvium, Plate 1). The basalt wall and plateau, and the proposed haul route are dominated by the RE 9.8.1 (Ironbark on red soil plains and rocky rises, Plate 2). Neither of these vegetation communities are of concern at present. Black Tea Tree Gullies (RE 9.3.10: Mountain Coolibah, Black Tea Tree and springs on black soil plains, Plate 3) are a discrete vegetation community associated with seepages along the basalt wall. Although the Regional Ecosystem they represent is not of concern at present, disturbance of these communities should be avoided because of their locally restricted distribution. The vegetation communities encountered are described in Table 3.1.

2.2.2 Significant Flora Species

No Rare, Vulnerable or Endangered species (as listed in the *Nature Conservation (Wildlife) Regulation 1994* and the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999) were identified during site investigations. The HERBRECS database search identified one plant of conservation significance. *Brachychiton albidus* is a rare plant (as listed in the *Nature Conservation (Wildlife) Regulation 1994*) noted from the area but was not encountered during the survey.

A full list of plant species found during field surveys is presented in Appendix C. None of the plant species encountered on the proposed mine lease area or the approximate proposed haul route are specifically listed the Queensland *Nature Conservation (Wildlife) Regulation* 1994, except as in "A plant indigenous to Australia, other than a presumed extinct, endangered, vulnerable or rare plant, is a common plant." (Schedule 5 Part 2).



PROJECT: Conjuboy Diatomite Project
TITLE: Distribution of vegetation areas

JOB NO: 235001.07
DATE: Sep 2002
SOURCE: NRA

Natural Resource Assessments

Figure: 3

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Table 3.1: Vegetation Description and Regional Ecosystems identified at the Conjuboy Diatomite Project Mine Lease

Mine Lease areas	Vegetation Description	RE (Sattler & Williams 1999)	RE Description	Conservation Status	Comments
Basalt Plateau	Narrow Leaf Ironbark dominant with Mt Molloy Box, Ghost Gum and Red Bloodwood forming an open woodland. A grass understory of Kangaroo Grass and Black Spear Grass with Dogs Balls frequently encountered amongst the grass.	9.8.1	*Eucalyptus crebra* or *E. whitei* woodland on red basalt soils.	No concern at present	Scattered clusters of basalt boulders and cobbles. Trees separated by one to three crown diameters.
Basalt Wall	Mt Molloy Box, Narrow Leaf Ironbark, Ghost Gum and Red Bloodwood forming an open woodland. A dispersed shrub layer of Quinine Bush and Conkerberry with a groundcover of Kangaroo Grass, Black Spear Grass and Giant Spear Grass.	9.8.1 to 9.3.2	*Eucalyptus crebra* or *E. whitei* woodland on red basalt soils to *Eucalyptus leptophleba* woodland on alluvial terraces and in drainage depressions.	No concern at present	Extensive occurrence of basalt cobbles. Narrow Leaf Ironbarks occur near the top of the wall.
Colluvial Slope	Widely spaced Mt Molloy Box and Ghost Gum emergents with small Red Bloodwood trees forming a low open woodland. A dispersed shrub layer of Quinine Bush and Conkerberry with a groundcover of Dogs Balls, Kangaroo Grass, Black Spear Grass and Giant Spear Grass.	9.3.2	*Eucalyptus leptophleba* woodland on alluvial terraces and in drainage depressions.	No concern at present	Extensive occurrence of basalt cobbles. Vegetation generally undifferentiated from the Basalt Wall vegetation.
Tea Tree Gullies	Exclusive canopy layer of Black Tea Trees with a bare rocky understory / groundlayer.	9.3.10	Mountain Coolibah, Black Tea Tree and springs on black soil plains.	No concern at present	In a seepage gully. *Melaleuca bracteata* form a dense closed canopy.
Flats	Widely to very widely spaced Mt Molloy Box and Ghost Gum woodland. Occasional occurrence of Beefwood, Quinine Bush and Conkerberry with an extensive cover of Kangaroo Grass, Black Spear Grass and an unidentified grass (*Dichanthium* sp).	9.3.2	*Eucalyptus leptophleba* woodland on alluvial terraces and in drainage depressions.	No concern at present	On Black and Red Clay Soils derived from transported materials over diatomaceous earth. Trees widely spaced separated by 3-5 crown diameters.
Watercourse	Widely to very widely spaced Mt Molloy Box and Ghost Gum woodland. Occasional occurrence of Boxthorn, Black Tea Tree. Quinine Bush and Conkerberry with a groundcover of Kangaroo Grass and Black Spear Grass.	9.3.2	*Eucalyptus leptophleba* woodland on alluvial terraces and in drainage depressions.	No concern at present	Creek bank vegetation generally undifferentiated from the Flats vegetation. Creek bed lined with diatomaceous earth.

2.2.3 Significant Weeds and Weed Control Measures

Declared Weeds

Of the exotic species identified within the proposed mine lease area, Noogoora Burr (*Xanthium pungens*) is the only Declared weed (class P3) under the provisions of the Queensland *Rural Lands Protection Act* 1985 and a proposed class 2 pest plant under the *Land Protection (Pest and Stock Route Management) Bill* 2001. Under the Act, its numbers and/or distribution are to be reduced state-wide. Control of this species should be a priority of the Conjuboy Diatomite Project weed control program.

The Queensland Department of Natural Resources has prepared a Pest Fact Sheet for *Xanthium pungens* that provides recommended control measures. A copy of this Pest Fact Sheet is presented in Appendix D. Control of this species should follow procedures laid out in this document. This weed was only observed in isolated instances on the Flats. However given the time of the year and the general lack of rain, this may not provide an accurate indication of the true extent of Noogoora Burr in the proposed mine lease area. Provisions should be made to address this potential weed problem (especially after rains) should it prove to be widespread. Otherwise point spraying of isolated plants and groups of plants should be undertaken.

Other Weed Species

The Dalrymple Shire Council's Pest Management Plan (Control of Declared Plants and Animals within the Dalrymple Shire 1999), provides a table of significant pest plants. These, and other significant weed species noted during site investigations, are discussed in Appendix E.

Parthenium Weed (*Parthenium hysterophorus*) is known to occur in the nearby Dry River and is of concern to the local landholders and Shires. This plant is a serious agricultural and environmental weed and care should be taken to ensure its exclusion or, if it is encountered, its control and elimination. The elimination of Parthenium weed, once established, may prove impracticable. Therefore, prevention of its introduction warrants specific management attention and continued vigilance. Parthenium is most likely to be encountered after a wet period.

Given the potential for existing weeds to proliferate and new weeds to be brought in and to establish it is important that a weed management plan be drawn up for the proposed mine lease area and the associated haul route. The weed management plan should address the following:

- ensure existing weeds are controlled or eradicated as determined by state legislation and local by-laws and in accordance with best practice
- ensure that strategies are put in place to prevent the entry and eradication of any new weed
- establishment of a monitoring program to identify potential and existing weed problems
- the concerns of local landholders and government bodies.

Rehabilitation

The following Tables (3.2 – 3.6) list recommended tree, shrub and grass species to be used for rehabilitation of disturbed areas on the proposed mine lease. The DAFOR scale is used to indicate the relative importance of different species in the community and hence during rehabilitation. Seed of native species for use in rehabilitation should be collected from site wherever possible and, if not possible, from local plants.

Table 3.2: Species for use in rehabilitation of the Basalt Plateau (RE 9.8.1)

Growth Form	Species*
Groundcover	*Heteropogon contortus* [D]
	Heteropogon triticeus [O]
	Themeda triandra [D]
	Grewia retusifolia [A]
Shrubs and Small Trees	*Petalostigma pubescens* [A]
	Ficus opposita [O]
	Diospyros geminata [O]
	Hakea arborescens [F]
	Brachychiton diversifolius [R]
Trees	*Corymbia erythrophloia*
	Corymbia dallachiana [A]
	Eucalyptus leptophleba [A]
	Eucalyptus crebra [D]

* DAFOR scale is used to indicate relative importance of species.

Table 3.3: Species for use in rehabilitation of the Basalt Wall and Colluvial Slope (RE 9.3.2 & 9.8.1)

Growth Form	Species*
Groundcover	*Cymbopogon bombycinus* [I]
	Heteropogon contortus [D]
	Heteropogon triticeus [F]
	Themeda triandra [D]
	Grewia retusifolia [A]
	Indigofera linnaei [O]
	Lomandra multiflora [O]
Shrubs and Small Trees	*Petalostigma pubescens* [A]
	Carissa ovata [F]
	Capparis umbonata [O]
	Ficus opposita [O]
	Diospyros geminata [O]
	Hakea arborescens [A]
Trees	*Corymbia erythrophloia* [A]
	Corymbia dallachiana [A]
	Eucalyptus leptophleba [A]

* DAFOR scale is used to indicate relative importance of species.

Table 3.4: Species for rehabilitation of the Tea Tree Gully (RE 9.3.10)

Growth Form	Species*
Groundcover	-
Shrubs and Small Trees	*Melaleuca bracteata* [D]
Trees	-

* DAFOR scale is used to indicate relative importance of species.

Table 3.5: Species for rehabilitation of the Flats (RE 9.3.2)

Growth Form	Species*
Groundcover	*Heteropogon contortus* [D]
	Heteropogon triticeus [O]
	Themeda triandra [D]
	Grewia retusifolia [A]
	Neptunia amplexicaulis [A]
Shrubs and Small Trees	*Carissa ovata* [F]
	Grevillea parallela [O]
	Petalostigma pubescens [A]
	Hakea arborescens [F]
Trees	*Corymbia dallachyana* [D]
	Eucalyptus leptophleba [A]
	Grevillea striata [O]

* DAFOR scale is used to indicate relative importance of species.

Table 3.6: Species for use in rehabilitation along the Watercourse (RE 9.3.2)

Growth Form	Species*
Groundcover	*Heteropogon contortus* [D]
	Heteropogon triticeus [O]
	Themeda triandra [D]
Shrubs and Small Trees	*Melaleuca bracteata* [F]
	Ficus opposita [O]
	Bursaria incana [O]
Trees	*Corymbia erythrophloia* [A]
	Corymbia dallachiana [A]
	Eucalyptus leptophleba [D]

* DAFOR scale is used to indicate relative importance of species.

It is understood that material will be excavated to a depth of up to 20 m during mining. After processing, as much as 75% of this material will be returned to the pit as process tailings (mostly clay). This will result in a depressed final landform (5 m depression). The clay tailings may also create an impermeable layer that inhibits vertical water movement and root penetration. If this were to occur, it is not certain it would have a significant effect on drainage in this area as the surrounding diatomaceous earth conducts water very well (*pers. comm.* Rob Lait (AGE), 20 June 2002). As a precaution it may be advisable to rehabilitate any resulting drainage depression with vegetation elements from current drainage lines (*eg* Black Tea Tree and Boxthorn) as well as with Mt Molloy Box.

3. FAUNA ASSESSMENT

3.1 Methodology

3.1.1 Desktop Study

The desktop study involved a review of published material and searches of available databases/archives. This assessment was used to document known records for the study area and identify the potential presence of protected fauna species. Protected fauna are defined primarily as those species listed in the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999 and Queensland *Nature Conservation (Wildlife) Regulation* 1994. The results of the desktop study were used to focus rapid field assessments. Literature consulted during the desktop assessment included:

- Search of the Queensland Museum Database between 266000E, 793300N & 27100E, 793700N (UTM AGD 66)
- Search of the Environment Australia EPBC Database
- Search of the Birds Australia Database
- Search of the Directory of Important Wetlands Database
- Review of the following texts: Sattler and Williams (1999), Wilson and Knowles (1988), Cogger (1992), Slater *et al.* (1989), Churchill (1998), Strahan (1995) and Duncan *et al.* (1999).

3.1.2 Fieldwork

A field investigation of the site was conducted on the 21st and 22nd of May 2002 in conjunction with the vegetation and soil surveys. The range of habitat types existing at the site was identified and an assessment was made of:

- habitat integrity
- local and regional significance of habitats
- habitat connectivity.

The rapid assessment fauna surveys included opportunistic sightings, scat analysis, audio identification (*eg* bird and frog calls), and spotlighting over a two day (1 night) period. Dedicated assessments were made of the likely presence of these protected fauna species determined during the desktop study.

3.1.3 Interpretation and Documentation

Using the habitat assessment and field observation data acquired during the fieldwork, refinements were made to the list of potentially occurring protected fauna species established during the desktop study. Likely impacts on these species were analysed based on the known ecology of the species.

3.2 Results

3.2.1 *Protected and Significant Fauna Species*

A total of 30 protected fauna species was identified as potentially occurring at the Conjuboy Diatomite Project site (Table 3.7). Protected fauna species are those species that are protected by legislation. A further 3 fauna species, regarded as being under threat on a regional scale but not protected by legislation, were identified as potentially occurring in the study area (Table 3.7 *see* species labelled 'S = Significant'). The three Significant (S) species are of concern because they have suffered large range contractions or are very poorly known but suspected to be rare or threatened. The absence of these species from legislation reflects a lack of published information and/or a time lag between knowledge of their status and its inclusion in relevant legislation. The basis for their mention in this report is summarised in Appendix F (Table F1).

No protected or significant fauna species were observed during field surveys. Fauna species observed during field inspections are described in Appendix F (Table F2). More comprehensive fauna inventories are only possible through higher intensity field surveys.

Fauna listed in the *Nature Conservation (Wildlife) Regulation* 1994 are protected under the *Nature Conservation Act* 1992. Subject to Section 93 (Aborigines' and Torres Strait Islanders' right to take *etc* protected wildlife), it is an offence to take protected animals other than under:

(a) a conservation plan applicable to the animal; or

(b) licence, permit or authority issued or given under a regulation; or

(c) an exemption under a regulation.

The management principles of protected wildlife include the protection of the protected wildlife's habitat. Section 73 provides that protected wildlife is to be managed to:

(a)
- (iii) identify and reduce or remove the effects of threatening processes relating to the wildlife; and
- (iv) identify the wildlife's critical habitat and conserve it to the greatest possible extent.

The *Commonwealth Environment Protection and Biodiversity Conservation Act* 1999 Section 3 (1) (a) – (c) includes:

(a) provision for the protection of the environment, especially those aspects of the environment that are matters of national environmental significance; and

(b) promotion of ecologically sustainable development through the conservation and ecologically sustainable use of natural resources; and

(c) promotion of conservation of biodiversity.

"*National environmental significance*" as identified in Chapter 2, Part 3, Division 1 of the Act includes:

(a) a listed threatened species included in the:
- (i) extinct in the wild category
- (ii) critically endangered category
- (iii) endangered category
- (iv) vulnerable category.

The species identified as "S" in Table 3.7 have no legislative protection. It is recommended however that they be regarded as potentially important elements in the environment and that suitable protection measures for these species are implemented.

Table 3.7: Protected and significant fauna species that have the potential to occur in the Conjuboy study area.

EPBC = Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999

QNCR = Queensland *Nature Conservation (Wildlife) Regulation* 1994

Note: no species listed in Table 3.7 were observed during this field study

Species	Common Name	EPBC 1999	QNCR 1994
Reptiles			
Egernia rugosa	Yakka Skink	V	V
Lygisaurus rococo	Chillagoe Litter-skink		R
Lerista ameles	Limbless Fine-lined Slider		R
Lerista cinerea	Vine-thicket Fine-lined Slider		R
Lerista wilkinsi	Two-toed Fine-lined Slider		R
Ctenotus zebrilla	Cape York Fine-snouted Ctenotus		R
Furina barnardi	Yellow-naped Snake		R
Ramphotyphlops broomi	Blind Snake		R
Simoselaps warro	Burrowing Snake		R
Acanthophis antarcticus	Common Death Adder		R
Birds			
Lophoictinia isura	Square-tailed Kite		R
Haliaeetus leucogaster	White-bellied Sea-Eagle	Migratory and Marine Protected Species	
Accipiter novaehollandiae	Grey Goshawk		R
Erythrotriorchis radiatus	Red Goshawk	V	E
Falco hypoleucos	Grey Falcon		R
Ninox rufa	Rufous Owl		R
Tyto novaehollandiae kimberli	Masked Owl	V	V
Hirundapus caudacutus	White-throated Needletail	Migratory and Marine Protected Species	
Melithreptus gularis	Black Chinned Honeyeater		R
Poephila cincta	Black-throated Finch	V	V
Neochmia ruficauda ruficauda	Star Finch	E	E
Neochmia phaeton	Crimson Finch	V	V
Erythrura gouldiae	Gouldian Finch	E	E
Myiagra cyanoleuca	Satin Flycatcher	Migratory and Marine Protected Species	
Melithreptus gularis	Black-chinned Honeyeater		R

Species	Common Name	EPBC 1999	QNCR 1994
Mammals			
Dasyurus hallucatus	Northern Quoll		S
Phascogale tapoatafa	Brush-tailed Phascogale		S
Pseudocheirus peregrinus	Common Ringtail Possum		S
Petrogale mareeba	Mareeba Rock Wallaby		R
Macroderma gigas	Ghost Bat		V
Hipposideros diadema	Diadem Horseshoe-bat		R
Hipposideros semoni	Greater Wart-nosed Horseshoe-bat	E	V
Chalinolobus picatus	Little Pied Bat		R
SUMMARY		E = 3 V = 5 Migratory and Marine Protected Species = 3	E = 3 V = 6 R = 18 S = 3

Conservation Codes: E, Endangered; V, Vulnerable; R, Rare; S, significant species not listed under Queensland (QNCR 1994) or Commonwealth (*EPBC* 1999) legislation (see Methods for definition of significant fauna, Table 1).

3.2.2 *Habitat Integrity*

Habitat diversity within the study area is low and can be broadly described as an open eucalypt woodland with a shrub and grass understorey. From a fauna habitat perspective, the floristic and structural differences described for the vegetation communities in the flora section of this report are small and are unlikely to constitute discrete habitat types.

Noteable habitat structures within this woodland complex included rock screes and the high potential for hollow-bearing trees. These features are common on both a local and regional scale. A noteable omission within the study area was the lack of a distinguishable riparian zone. These areas typically form focal points for fauna within the open woodland complexes. Habitat integrity across the site was generally moderate with signs of past disturbance in the form of cattle grazing and fire. This appears to have contributed to accelerated erosion along cattle tracks, watercourse bank damage and severe treading/poaching where soils are wet. Habitat types found within the study area are common both locally and regionally and are unlikely to constitute critical habitat for any fauna species. Good habitat connectivity exists between the study site and surrounds.

Conservation of Fauna Values

Impacts on fauna species, including protected and significant fauna species are likely to be low given the:

- small total area of disturbance
- proposal to stagger the disturbance/operational regime on a temporal scale
- proposal to disturb areas in a progressive pattern, allowing the potential for progressive rehabilitation
- high connectivity with similar surrounding habitat types and the high representation of similar habitat types on both a local and regional scale.

Conservation of protected and significant fauna involves protection of habitat which, for all the species shown in Table 3.7, includes the general eucalypt woodland habitat that occupies the entire site. Management of significant fauna habitat can therefore be carried out so that it complements the vegetation protection measures discussed for the vegetation communities.

Protecting fauna habitat means:

- minimising area of disturbance
- protection of tall, hollow-bearing trees. This should include inspecting hollow-bearing trees prior to clearing and either: a) removing fauna and/or b) remove hollow-bearing trees at night time when there is a lower likelihood of fauna occupying roost/nest site.
- protecting habitat integrity through weed control
- rehabilitating disturbed areas with minimal delay following disturbance.

3.2.3 Recommendations for Further Studies

Low levels of impact are expected on fauna assemblages within the study area. Additional fauna studies are unlikely to contribute additional information to the conservation of existing fauna and are therefore not recommended. However, areas to be disturbed should be inspected for hollow-bearing trees prior to clearing and appropriate mitigation measures undertaken as discussed in this report (*see* Conservation of Fauna Values).

Plates

Plate 3.1: RE 9.3.2 - Mt Molloy Box on alluvium

Plate 3.2: RE 9.8.1 – Ironbark on red soil plains and rocky rises

Plate 3.3: RE 9.3.10 – Mountain Coolibah, Black Tea Tree and springs on black soil plains

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Appendix C:
Herbrecs Search Results and Flora Species List

Family_Name	Status	Botanical_Name	Label
Myrtaceae		Eucalyptus leptophleba F.Muell.	64K SW to SSW of Mt Garnet.□ Monsoon forest; in red basaltic soil area.
Fabaceae		Crotalaria aridicola Domin	
Fabaceae		Crotalaria aridicola Domin	
Caesalpiniaceae		Senna sophera (L.) Roxb. var. sophera	
Fabaceae		Crotalaria aridicola Domin	
Erythroxylaceae		Erythroxylum ellipticum R.Br. ex Benth.	
Solanaceae		Solanum parvifolium R.Br.	
Apiaceae		Trachymene bivestita (Domin) L.A.S.Johnson var. bivestita	
Poaceae		Aristida sciuroides Domin	near Lynd Station.□ Tussocky perennial 4.5 ft high with dense, spike-like narrow long inflorescence.
Poaceae		Aristida warburgii Mez	N of the Lynd.□ Eucalyptus forest on granite sand.□ Green tufts with oblique to straggling culms.
Poaceae		Brachiaria holosericea subsp. velutina (R.D.Webster) B.K.Simon	Near Lynd Station.□ Common in gritty soil on slope of small hill in Eucalyptus argillacea community. Slender, erect annual to 1ft high with silky hairy spikelets.
Cyperaceae		Fimbristylis sieberiana Kunth	
Poaceae	*	Paspalum dilatatum Poir.	Near Conjuboy Station.□ Common in red basaltic soils. Tussocky, dense perennial 3-4ft high.
Euphorbiaceae		Petalostigma pubescens Domin	
Mimosaceae		Acacia gonoclada F.Muell.	
Mimosaceae		Acacia hemignosta F.Muell.	
Mimosaceae		Acacia disparrima subsp. calidestris M.W.McDonald & Maslin	
Portulacaceae		Calandrinia arenicola Syeda	
Myrtaceae		Eucalyptus shirleyi Maiden	North of Lynd.□ Crooked tree of 7 m with crooked spreading and descending branches; bark blackish, hard, rough and deeply furrowed; leaves glaucous.

Euphorbiaceae	Phyllanthus carpentariae Muell.Arg.	
Myrtaceae	Melaleuca nervosa (Lindl.) Cheel	
Poaceae	Brachiaria reptans (L.) C.A.Gardner & C.E.Hubb.	Near Conjuboy Station.□ Common near spring in podsolic soil.□ Semi-prostrate, branching annual to 2ft high with very small spikelets.
Poaceae	Arundinella setosa Trin.	
Myrtaceae	Eucalyptus orgadophila Maiden & Blakely	65K SW to SSW of Mt Garnet.□ In Monsoon Forest.□ Glaucous gumtop bark.
Myrtaceae	Corymbia setosa subsp. pedicellaris K.D.Hill & L.A.S.Johnson	Oakland Park Station Upper Copperfield River.□ Open sandy ridges.□ Bark bloodwood type, friable, yellowish.
Fabaceae	Gastrolobium grandiflorum F.Muell.	
Fabaceae	Indigastrum parviflorum (B.Heyne ex Wight & Arn.) Schrire	
Zygophyllaceae	Tribulopis angustifolia R.Br.	
Amaranthaceae	Gomphrena lanata R.Br.	
Convolvulaceae	Ipomoea gracilis R.Br.	
Poaceae	Elionurus citreus (R.Br.) Munro ex Benth.	
Cyperaceae	Cyperus bifax C.B.Clarke	
Poaceae	Aristida ingrata Domin	N of the Lynd.□ Erect, compact, dull green tufts 1-1.2 m.
Cyperaceae	Cyperus difformis L.	
Mimosaceae	Acacia lazaridis Pedley	
Myrtaceae	Eucalyptus leptophleba F.Muell.	65K SW to SSW of Mt Garnet.□ In monsoon forest.
Rubiaceae	Everistia vacciniifolia forma crassa S.T.Reynolds & R.J.F.Hend.	
Myrtaceae	Corymbia citriodora (Hook.) K.D.Hill & L.A.S.Johnson subsp. citriodora	CA 65km South West to SSW of Mt Garnet.□ In monsoon forest.
Myrtaceae	Corymbia confertiflora (F.Muell.) K.D.Hill & L.A.S.Johnson	CA 65K South West to SSW of Mt Garnet in Monsoon Forest.
Mimosaceae	Acacia lazaridis Pedley	
Fabaceae	Lamprolobium fruticosum Benth.	
Fabaceae	Daviesia flava Pedley	

Poaceae	*	Eragrostis cilianensis (All.) Vignolo ex Janch.	40 miles north of Conjuboy.
Convolvulaceae		Ipomoea eriocarpa R.Br.	
Sterculiaceae	R	Brachychiton albidus Guymer	
Campanulaceae		Pratia concolor (R.Br.) Domin	
Celastraceae		Denhamia pittosporoides subsp. angustifolia Jessup	
Pittosporaceae		Pittosporum spinescens (F.Muell.) L.W.Cayzer, Crisp & I.Telford	
Poaceae		Aristida lazaridis B.K.Simon	7M N of Conjuboy Station.□ Occasional on red basaltic soil with Eucalyptus crebra and Themeda australis.□ Tussocky, erect perennial 4 ft high with large, spreading panicle.
Poaceae		Bothriochloa bladhii (Retz.) S.T.Blake subsp. bladhii	
Poaceae		Chrysopogon fallax S.T.Blake	
Poaceae		Cymbopogon bombycinus (R.Br.) Domin	
Poaceae		Digitaria divaricatissima (R.Br.) Hughes	7 miles N of Conjuboy Station.□ Occasional on red basaltic soil with Themeda australis.□ Erect, tussocky perennial 3ft 6in high.
Poaceae	*	Eragrostis cilianensis (All.) Vignolo ex Janch.	7 miles north of Conjuboy Station.□ Occasional on red, basaltic soils with Themeda australis in disturbed ground.□ Tufted, branched annual 2ft high. Foliage unpleasantly aromatic.
Poaceae		Heteropogon triticeus (R.Br.) Stapf	
Mimosaceae		Acacia julifera subsp. gilbertensis Pedley	
Pittosporaceae		Bursaria incana Lindl.	
Malvaceae		Abelmoschus moschatus subsp. tuberosus (Span.) Borss.Waalk.	
Fabaceae	*	Crotalaria spectabilis Roth	
Asclepiadaceae	*	Asclepias curassavica L.	
Poaceae		Eulalia aurea (Bory) Kunth	
Poaceae		Eriochloa crebra S.T.Blake	Conjuboy Station.□ On grey, heavy textured self mulching soil.□ Tufted, erect perennial 2-3ft high.

Poaceae		Iseilema macratherum Domin	
Poaceae		Capillipedium parviflorum (R.Br.) Stapf	
Asteraceae		Calotis scapigera Hook.	
Proteaceae		Grevillea mimosoides R.Br.	
Poaceae		Bothriochloa bladhii (Retz.) S.T.Blake subsp. bladhii	
Asteraceae		Flaveria australasica Hook.	
Poaceae		Sporobolus sessilis B.K.Simon	Conjuboy Station.□ Growing as a weed in homestead lawn. Wiry, tufted perennial to 18in high.
Poaceae		Eriachne glabrata (Maiden) W.Hartley	
Poaceae		Paspalum distichum L.	Conjuboy Station.□ Growing in water and dominating bank of drain-water channel.□ Semi-prostrate perennial forming a dense mat over water with erect flowering culms to 1ft high.
Poaceae		Digitaria bicornis (Lam.) Roem. & Schult.	4 miles north of Conjuboy Station.□ Occasional on red, stony soil on basalt.□ Semi-erect, branched annual with erect flowering culms 18in high and rooting from lower nodes.
Poaceae	*	Chloris gayana Kunth	Conjuboy Station.□ Common on grey, heavy-textured soil on basalt. Tufted, erect perennial to 4ft high, rooting at lower nodes.
Poaceae		Brachyachne convergens (F.Muell.) Stapf	Conjuboy Station.□ Common in grey soil on heavy texture.□ Semi-prostrate annual with erect flowering culms 18in to 2ft high.
Poaceae		Brachiaria gilesii (Benth.) Chase	4 miles north of Conjuboy Station.□ Common, often dominant in patches on red, stony soil on basalt.□ Semi-erect, hairy annual rooting from lower nodes with erect flowering culms 9in high.
Poaceae		Sorghum plumosum (R.Br.) P.Beauv. var. plumosum	
Poaceae		Chloris divaricata R.Br.	Conjuboy Station.□ Occasional on grey soil of heavy texture. Erect, tufted grass 3ft high.

Poaceae		Dichanthium sericeum (R.Br.) A.Camus subsp. sericeum	
Poaceae	*	Echinochloa colona (L.) Link	Conjuboy Station.□ Common near water in depressions on grey soil of heavy texture.□ Semi-prostrate or erect annual to 2ft high.
Poaceae		Echinochloa telmatophila P.W.Michael & Vickery	Conjuboy Station.□ Dominating sandy bank of permanent waterhole.□ Tall, dense, tussocky perennial 5-6ft high.
Poaceae	*	Eleusine indica (L.) Gaertn.	Conjuboy Station.□ Common near water on creek bank.□ Robust, branched, tussocky perennial to 1ft high.
Asteraceae		Pterocaulon sphacelatum (Labill.) F.Muell.	
Convolvulaceae		Ipomoea polymorpha Roem. & Schult.	
Poaceae		Eriochloa crebra S.T.Blake	Conjuboy Station.□ Occasional in grey soil of heavy texture.□ Tufted, erect perennial, 2-3ft high.
Fabaceae		Indigofera glandulosa Willd.	
Mimosaceae		Neptunia gracilis Benth. forma gracilis	
Mimosaceae		Acacia galioides Benth.	
Myrtaceae		Eucalyptus leptophleba F.Muell.	2M ESE of Conjuboy Station.□ Common on stony skeletal soil on basalt.□ Straggly tree 40-50ft high; grey, box-type bark.
Thymelaeaceae		Pimelea haematostachya F.Muell.	
Myrtaceae		Corymbia erythrophloia (Blakely) K.D.Hill & L.A.S.Johnson	27M S of Mt Garnet-Normanton Rd.□ Tree 5m high; dark grey/brown tessellated bark to about 2in, then smooth yellowish.

Table C: Flora Species List

Family	Species	Common Name	Status[1]	RE 9.8.1	RE 9.3.2	RE 9.3.10
APOCYNACEAE	*Carissa ovata*	Currant Bush		✓	✓	
ASTERACEAE	**Tridax procumbens*			✓		
	**Xanthium pungens*	Noogoora Burr	P3		✓	
BIGNONIACEAE	*Dolichandrone heterophylla*	Lemon Wood			✓	
BORAGINACEAE	*Trichodesma zeylanicum*	Camel Bush		✓		
CAPPARACEAE	*Capparis lasiantha*	Supplejack				✓
	Capparis umbonata	Native Pomegranate		✓		
CARYOPHYLLACEAE	*Polycarpaea corymbosa*	Copper Bush		✓		
CELASTRACEAE	*Maytenus cunninghamii*	Yellowberry Bush		✓		
	Siphonodon pendulus				✓	
CONVOLVULACEAE	*Ipomoea eriocarpa*	a Morning Glory		✓		
CUCURBITACEAE	*Mukia maderaspatana*	Red cucumber		✓		
EBENACEAE	*Diospyros geminata*	Native Ebony		✓		✓
EUPHORBIACEAE	*Breynia oblongifolia*	Breynia				✓
	Euphorbia sp.			✓		
	Euphorbia tannensis	Desert Spurge		✓		
	Petalostigma pubescens	Quinine Bush		✓	✓	
FABACEAE	*Cajanus marmoratus*				✓	
	Cajanus scarabaeoides			✓	✓	
	Crotalaria brevipes	a Rattlepod			✓	
	Crotalaria montana	a Rattlepod		✓	✓	
	Indigofera linifolia	Round Pod Indigo		✓		
	Indigofera linnaei	Birdsville Indigo		✓	✓	
	**Stylosanthes hamata*	Caribbean Stylo		✓	✓	
	Stylosanthes sp	Stylo		✓	✓	
	Tephrosia juncea	Tephrosia		✓		
	Trifolium dubium			✓		
	Uraria lagopodioides				✓	
FLACOURTIACEAE	*Homalium brachybotrys*	Hard Boxwood		✓		
MALVACEAE	*Sida cordifolia*	Flannel Weed			✓	
MIMOSACEAE	*Acacia bidwillii*				✓	
	**Acacia farnesiana*	Mimosa		✓	✓	
	Acacia victoriae	Gundabluie		✓		
	Neptunia amplexicaulis	Selenium Weed		✓	✓	
MORACEAE	*Ficus opposita*	Fig		✓		✓
MYOPORACEAE	*Myoporum montanum*	Boobialla		✓		
MYRTACEAE	*Corymbia citriodora*	Lemon Scented Gum		✓		
	Corymbia dallachiana	Cabbage Gum		✓	✓	
	Corymbia erythrophloia	Red Bloodwood		✓	✓	
	Eucalyptus crebra	Grey Ironbark		✓		
	Eucalyptus leptophleba	Molloy Red Box		✓	✓	
	Melaleuca bracteata	Black Tea Tree			✓	✓
ORCHIDACEAE	*Cymbidium canaliculatum*	Black Orchid	C	✓	✓	✓
PITTOSPORACEAE	*Bursaria incana*	Box Thorn			✓	

POACEAE	*Cymbopogon bombycinus*	Lemon Scented Grass	✓	✓	
	Dichanthium sp	Bluegrass		✓	
	Digitaria bicornis	Hairy Finger Grass	✓	✓	
	Eragrostis sp.		✓	✓	
	Heteropogon triticeus	Giant Spear Grass	✓	✓	
	**Melinis repens*	Red Natal	✓	✓	
	Sporobolus australasicus	Australian Dropseed	✓	✓	
	**Themeda quadrivalvis*	Grader Grass	✓	✓	
	Themeda triandra	Kangaroo Grass	✓	✓	✓
PROTEACEAE	*Grevillea parallela*	Silver Oak		✓	
	Grevillea striata	Beefwood		✓	
	Hakea arborescens	Tree Hakea	✓	✓	
SANTALACEAE	*Santalum lanceolatum*	Australian Sandalwood	✓		
SMILACACEAE	*Eustrephus latifolius*	Wombat Berry	✓	✓	✓
STERCULIACEAE	*Brachychiton diversifolius*	Kurrajong	✓		
	Waltheria indica	Waltheria	✓		
TILIACEAE	*Grewia retusifolia*	Dogs Balls	✓	✓	
VITACEAE	*Cayratia trifoliata*		✓		
XANTHORRHOEACEAE	*Lomandra multiflora*		✓	✓	

* Indicates an introduced species.

[1] Status of the species under Queensland legislation.

C - Common Protected Wildlife (*Queensland Nature Conservation Act* 1992)

P3 - Class P3 declared weed (*Rural Lands Protection Act 1985*)

Appendix E:
Weeds and Recommended Control Measures

Weeds and Recommended Control Measures

The table below presents weed species known to occur or have the potential to occur (field survey, Dalrymple Shire Council (Pest) Management Plan, 1999) within the proposed mine lease area. Control methodologies are provided based on recommendations provided in DNR Pest Factsheets or within the Dalrymple Shire (Pest) Management Plan. Application of chemical control should be in accordance with product specifications.

Weed management should involve integrated control that includes:

- minimising the area of disturbance.
- timing chemical control for when plants are actively growing, but prior to seed set
- rehabilitating disturbed areas as soon as possible following disturbance
- quarantine measures which minimise the risk of introducing new weeds to the site. These may involve
  - cleaning of machinery, tools and other work gear prior to arrival on site
  - use of clean straw, tea-tree mulch or other seed-free medium as a mulch

Species Name	Common Name	Noted During Site Investigation?	*Rural Lands Protection Act* 1985	Priority of the Dalrymple Shire (Pest) Management Plan[1]	Prevention and Control Measures (Sources: Dalrymple Shire (Pest) Management Plan 1999, DNR Pest Fact Sheets)
Acacia nilotica	Prickly Acacia	No	P2	B, C	Refer to DNR Pest Fact Sheet (Appendix D)
Agave sisalana	Sisal Hemp	No	-	B, C, G	Contact the Dalrymple Shire Environmental Officer on (07) 4787 5600
Bryophyllum spp	Mother of Millions	No	P4	B, C, G	Refer to DNR Pest Fact Sheet (Appendix D)
Cryptostegia grandiflora	Rubbervine	No	P3	B, C, D, F	Refer to DNR Pest Fact Sheet (Appendix D)
Eichornia crassipes	Water Hyacinth	No	P3	C, E, F	Refer to DNR Pest Fact Sheet (Appendix D)
Eriocereus martinii	Harrisia Cactus	No	P3	B, C, F	Refer to DNR Pest Fact Sheet (Appendix D)
Jatropha gossypifolia	Bellyache Bush	No	-	B, C, G	Refer to DNR Pest Fact Sheet (Appendix D)
Lantana camara	Lantana	No	-	C, D, E, F, G, H	Refer to DNR Pest Fact Sheet (Appendix D)
Parkinsonia aculeata	Parkinsonia	No	P3	B, C	Refer to DNR Pest Fact Sheet (Appendix D)
Parthenium hysterophorus	Parthenium Weed	No	P3	B, C, D, F, H	Refer to DNR Pest Fact Sheet (Appendix D)

Species Name	Common Name	Noted During Site Investigation?	*Rural Lands Protection Act* 1985	Priority of the Dalrymple Shire (Pest) Management Plan[1]	Prevention and Control Measures (Sources: Dalrymple Shire (Pest) Management Plan 1999, DNR Pest Fact Sheets)
Pistia stratiotes	Water Lettuce	No	P3	A	Refer to DNR Pest Fact Sheet (Appendix D)
Prosopis spp	Prickly Mesquite	No	P2 & P3	B	Refer to DNR Pest Fact Sheet (Appendix D)
Ricinus communis	Castor-oil Plant	No	-	B, C, D, G	Refer to DNR Pest Fact Sheet (Appendix D)
Salvinia molesta	Salvinia	No	P3	A, F	Refer to DNR Pest Fact Sheet (Appendix D)
Solanum torvum	Devils Fig	No	-	C, E, G, H	Contact the Dalrymple Shire Environmental Officer on (07) 4787 5600
Sporobolus pyramidalis and S. natalensis	Giant Rats Tail Grass	No	P2	A	Refer to DNR Pest Fact Sheet (Appendix D)
Stachytarpheta spp	Snakeweed	No	-	B, C, E, G, H	Refer to DNR Pest Fact Sheet (Appendix D)
Thevetia peruviana	Captain Cook Tree	No	-	B, G	Contact the Dalrymple Shire Environmental Officer on (07) 4787 5600
Tribulus terrestris	Caltrop	No	-	B, C, E, G	Contact the Dalrymple Shire Environmental Officer on (07) 4787 5600
Xanthium pungens	Noogoora Burr	Yes	P3	-	Refer to DNR Pest Fact Sheet (Appendix D)
Ziziphus mauritiana	Chinee Apple	No	P3	B, C, H	Refer to DNR Pest Fact Sheet (Appendix D)

[1] Dalrymple Shire Control Definitions:

A: Total eradication
B: Eradication of isolated infestations
C: Containment/Prevention from spreading
D: Control in buffer zone circumstances
E: Extension and Education
F: Biological control
G: Environmental Weed requiring control
H: Integrated Pest Management

Appendix F:
Fauna Significance and Species

Table F1: Significant Species of the Study Area and the Reason for their Significance Nomination.

Species	Reason for significance	Source
Northern Quoll, *Dasyurus hallucatus*	Australia-wide decline and ecological susceptibility to population extinction	Braithwaite and Griffiths 1994 S. Burnett (James Cook University, Townsville) unpublished data
Brush-tailed Phascogale, *Phascogale tapoatafa*	Extreme rarity and ecological susceptibility to population extinction	S. Burnett unpublished data
Common Ringtail, *Pseudocheirus peregrinus*	Widespread decline throughout north Queensland and Cape York	John Winter (Acting Threatened Species Coordinator, EPA, Atherton)

Table F2: Fauna Species Observed During Field Investigations of the Conjuboy Study Area.

Species	Common Name
Reptiles	
Carlia jarnoldae	Lined Rainbow-skink
Diporiphora australis/bilineata	Eastern Two-lined Dragon
Birds	
Dromaius novaehollandiae	Emu
Milvus migrans	Black Kite
Aquila audax	Wedge-tailed Eagle
Grus rubicundra	Brolga
Ardeotis australis	Australian Bustard
Ocyphaps lophotes	Crested Pigeon
Eolophus roseicapillus	Galah
Platycercus adscitus	Pale-headed Rosella
Dacelo novaeguineae	Blue-winged Kookaburra
Coracina novaehollandiae	Black-faced Cuckoo-shrike
Rhipdura leucophyrs	Willy Wagtail
Gerygone fusca	Western Gerygone
Artamus minor	Little Woodswallow
Struthidea cinerea	Apostle-bird
Cractiticus nigrogularis	Pied Butcherbird
Corvus orru	Torresian Crow
Mammals	
Bettongia tropica	Rufous Bettong
Oryctolagus cuniculus	Rabbit*
Vulpes vulpes	Fox*
Felis catus	Cat*
Canis familiarus/lupus	Dog*/ Dingo
Bos taurus	Cattle*

* = Introduced species.

Species	Common Name	EPBC 1999	QNCR 1994
Reptiles			
Egernia rugosa	Yakka skink	V	V
Lysgisaurus rococo	Chillagoe Litter-skink		NT
Lerista ameles	Limbless Fine-lined Slider		V
Lerista cinerea	Vine-thicket Fine-lined Slider		V
Lerista wilkinsi	Two-toed Fine-lined Slider		C
Ctenotus zebrilla	Cape York Fine-snouted Ctenotus		C
Furina barnardi	Yellow-naped snake		C
Ramphotyphlops broomi	Blind snake		
Simoselaps warro	Burrowing Snake		
Acanthophis antarcticus	Common Death Adder		V
Birds			
Lophoictinia isura	Square-tailed kite		C
Haliaeetus leucogaster	White-bellied Sea Eagle	Migratory and Marine Protected Species	C
Accipiter novahollandiae	Grey Goshawk		C
Erythrotriorchloris radiatus	Red Goshawk	V	E
Falco hypoleucos	Grey Falcon	V	V
Ninox rufa	Rufous Owl		NT
Tyto novaehollandiae kimberli	Masked Owl	V	C
Hirundapus caudacutus	White-throated Needletail	V and Migratory and Marine Protected Species	V
Poephila cinta	Black-throated Finch	E	C
Neochmia rufiauda ruficauda	Star Finch	E	C
Neochmia phaeton	Crimson Finch	E	C
Erythrura gouldiae	Gouldian Finch	E	E
Mylagra cyanoleuca	Satin Flycatcher	Migratory and Marine Protected Species	SL
Melthithreptus gularis	Black-chinned Honeyeater		C
Mammals			
Dasyurus hallucatus	Northern Quoll	E	C
Phascogale tapoatafa	Brush-tailed Phascogale	V	C
Pseudocheirus peregrinus*	Common Ringtail Possum		LC
Petrogale mareeba	Mareeba Rock Wallaby		C
Macroderma gigas	Ghost Bat	V	E
Hipposideros diadema	Diadem Horseshoe-Bat	E	NT

Species	Common Name	EPBC 1999	QNCR 1994
Hipposideros semoni	Greater Wart-nosed Horseshoe-bat	V	E
Chalinolobus picatus	Little Pied Bat		C
EPBC STATUS SUMARY		QNCR STATUS SUMMARY	
E= Endangered = 6 V = Vulnerable = 8 Migratory and marine protected species = 3		E = Endangered = 4 V = Vulnerable = 6 NT = near threatened = 3 C = least concern = 15 SC= Special Least Concern = 1	

* *not Pseudocheirus peregrinus occidentalis*

Source of updated conservation status

Species Profiles (SPRAT) (environment.gov.au)

Species - Conservation status of Queensland wildlife | Open Data Portal | Queensland Government

WildNet Records
Conservation Significant Species List

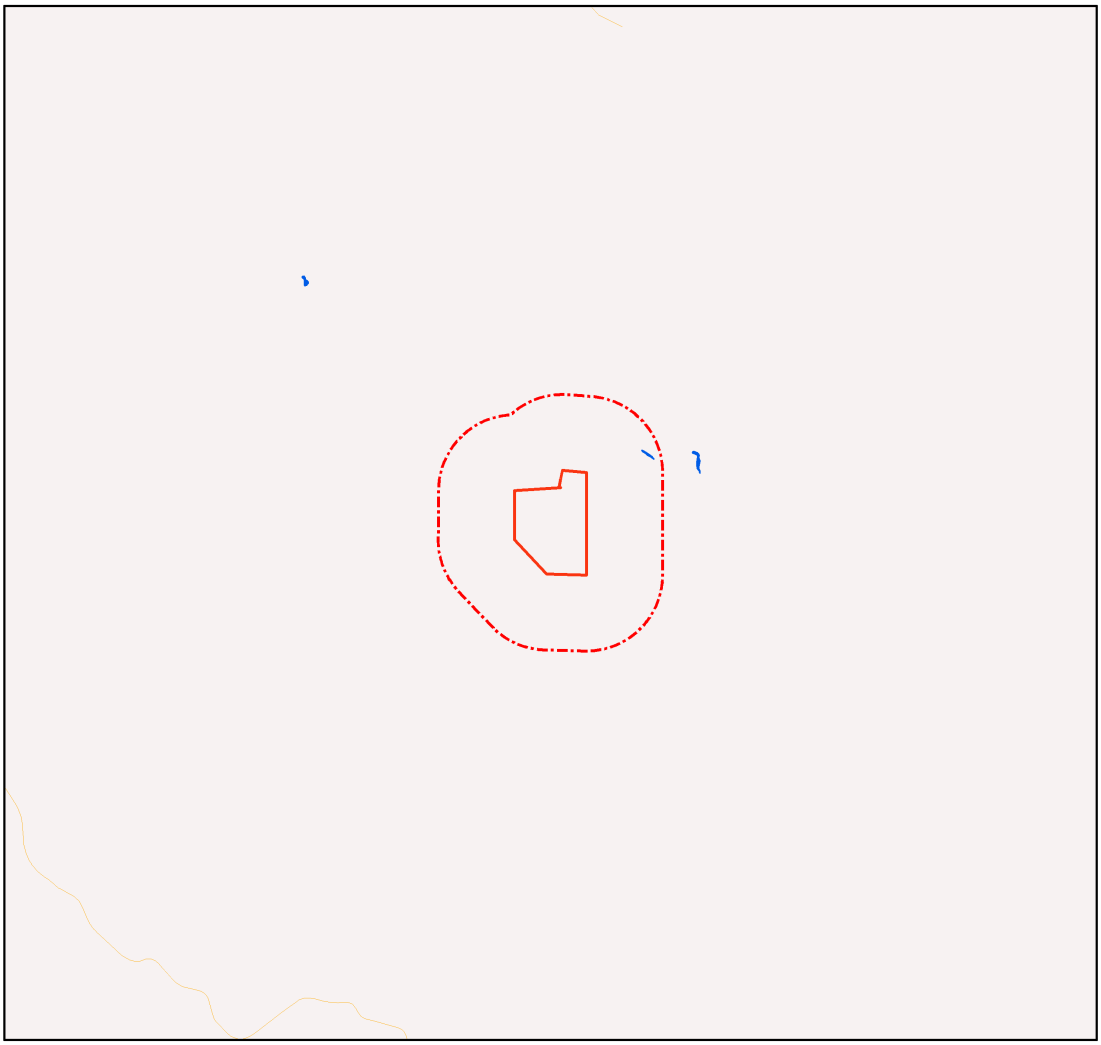
For the selected area of interest 104.11ha

Current as at 11/08/2021

WildNetCSSpeciesList

Queensland Government

Map 1. Locality Map



Locality Map

Legend

- 1 kilometre buffer
- polygon
- Towns
- Highway
- Connector
- Street/Local Road
- Reservoirs
- Lakes
- National Park (Scientific)
- National Park
- National Park (CYPAL)
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- Resources Reserve
- Forest Reserve
- State Forest
- Timber Reserve
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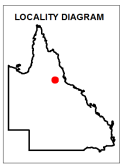

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Summary Information

The following table provides an overview of the area of interest .

Table 1. Area of interest details

Size (ha)	104.11
Local Government(s)	Charters Towers Regional
Bioregion(s)	Einasleigh Uplands
Subregion(s)	Undara - Toomba Basalts
Catchment(s)	Burdekin

Protected Area(s)
No estates or reserves are located within the area of interest.

World Heritage Area(s)
No World Heritage Areas are located within the area of interest.

Ramsar Area(s)
No Ramsar Areas are located within the area of interest.

Conservation Significant Species List

Introduction

This report is derived from a spatial layer generated from the WildNet database managed by the Department of Environment and Science. The layer which is generated weekly contains the WildNet wildlife records that are not classed as erroneous or duplicate, that have a location precision equal to or less than 10000 metres and do not have a count of zero.

Conservation significant species are species listed:

- as threatened or near threatened under the Nature Conservation Act 1992;
- as threatened under the *Environment Protection and Biodiversity Conservation Act 1999* or
- migratory species protected under the following international agreements:
  - Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention)
  - China-Australia Migratory Bird Agreement
  - Japan-Australia Migratory Bird Agreement
  - Republic of Korea-Australia Migratory Bird Agreement

The WildNet dataset is constantly being enhanced and the taxonomic and status information revised. If a species is not listed in this report, it does not mean it doesn't occur there and listed species may also no longer inhabit the area. It is recommended that you also access other internal and external data sources for species information in your area of interest (Refer Links and Support).

Table 2 lists the species recorded within the area of interest and its one kilometre buffer.

Table 2. Conservation significant species recorded within the area of interest and its one kilometre buffer

No species found within the area of interest.

Taxon Id: Unique identifier of the taxon from the WildNet database.

NCA: Queensland conservation status of the taxon under the *Nature Conservation Act 1992* (Least Concern (C), Critically Endangered (CR), Endangered (E), Extinct (EX), Near Threatened (NT), Extinct in the Wild (PE), Special Least Concern (SL), and Vulnerable (V)).

EPBC: Australian conservation status of the taxon under the *Environment Protection and Biodiversity Conservation Act 1999* (Conservation Dependent (CD), Critically Endangered (CE), Endangered (E), Extinct (EX), Vulnerable (V), and Extinct in the Wild (XW)).

Specimens: The number of specimen-backed records of the taxon.

Records: The total number of records of the taxon.

Last record: Date of latest record of the taxon.

Links and Support

Other sites that deliver species information from the WildNet database include:

- Species profile search - access species information approved for publication including species names, statuses, notes, images, distribution maps and records
- Species lists - generate species lists for Queensland protected areas, forestry areas, local governments and areas defined using coordinates
- Biomaps - view biodiversity information, including WildNet records approved for publication, and generate reports
- Queensland Globe - view spatial information, including WildNet records approved for publication
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Please direct queries about this report to the WildNet Team.

Other useful sites for accessing Queensland biodiversity data include:

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WildNet Records
Pest List

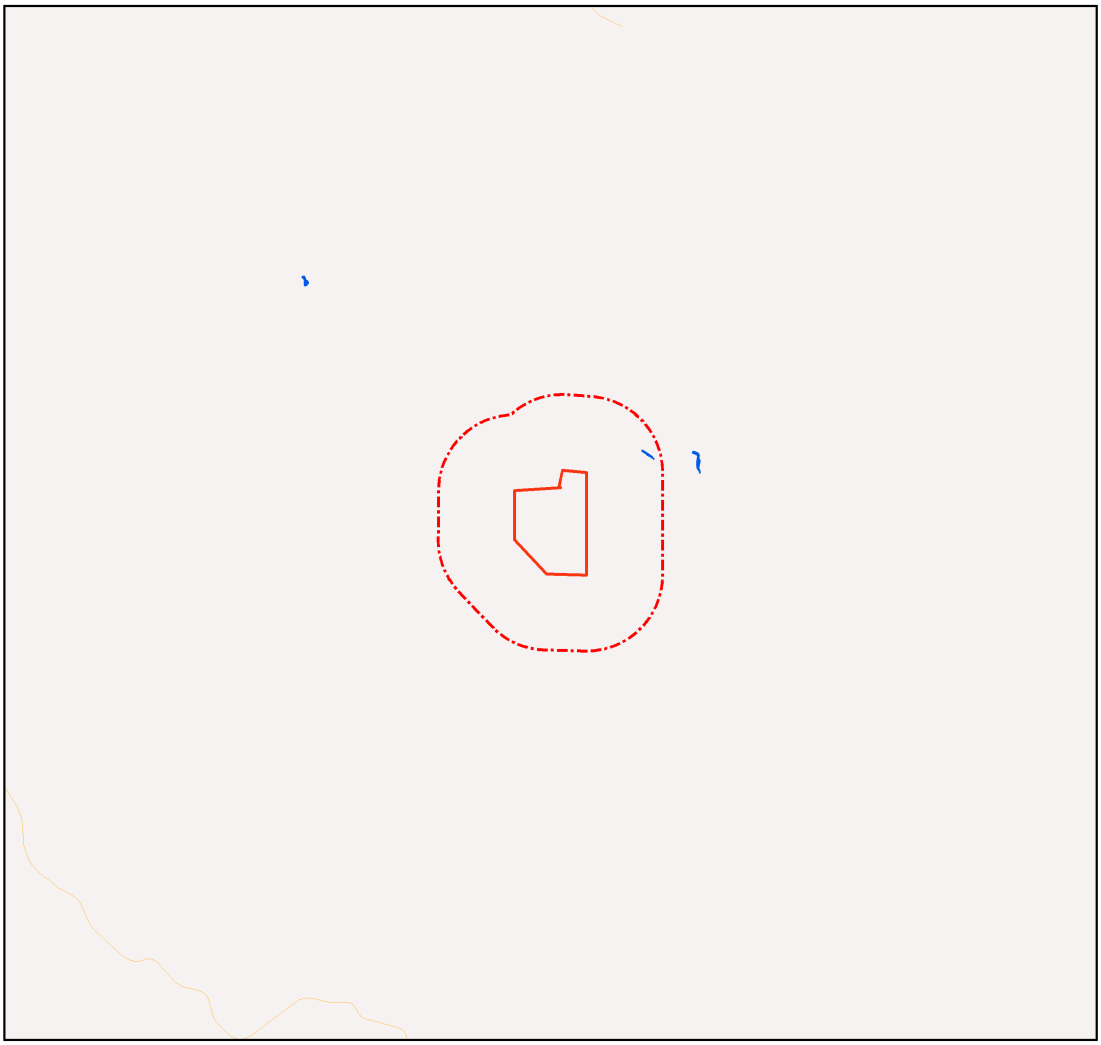
For the selected area of interest 104.11ha

Current as at 11/08/2021

WildNetPestList

Queensland Government

Map 1. Locality Map



Locality Map

Legend

- 1 kilometre buffer
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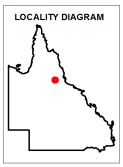

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Pest List

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Species Data

Contextual location information is presented in Map 1.

A summary of the pests recorded within the area of interest and its one kilometre buffer is presented in Table 2.

Table 2. Pests recorded within the area of interest and its one kilometre buffer

No pests found within the area of interest and its one kilometre buffer.

Species table headings and codes

Taxon Id: Unique identifier of the taxon from the WildNet database.

Specimens: The number of specimen-backed records of the taxon.

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Last record: Date of latest record of the taxon.

Endemicity: The endemicity code for the taxon (Introduced (Intranational) (IA), Introduced (International) (II), Introduced (Unknown), Exotic (Intranational) (XA), Exotic (International) (XI) and Exotic (Unknown) (XU)).

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WildNet Records
Species List

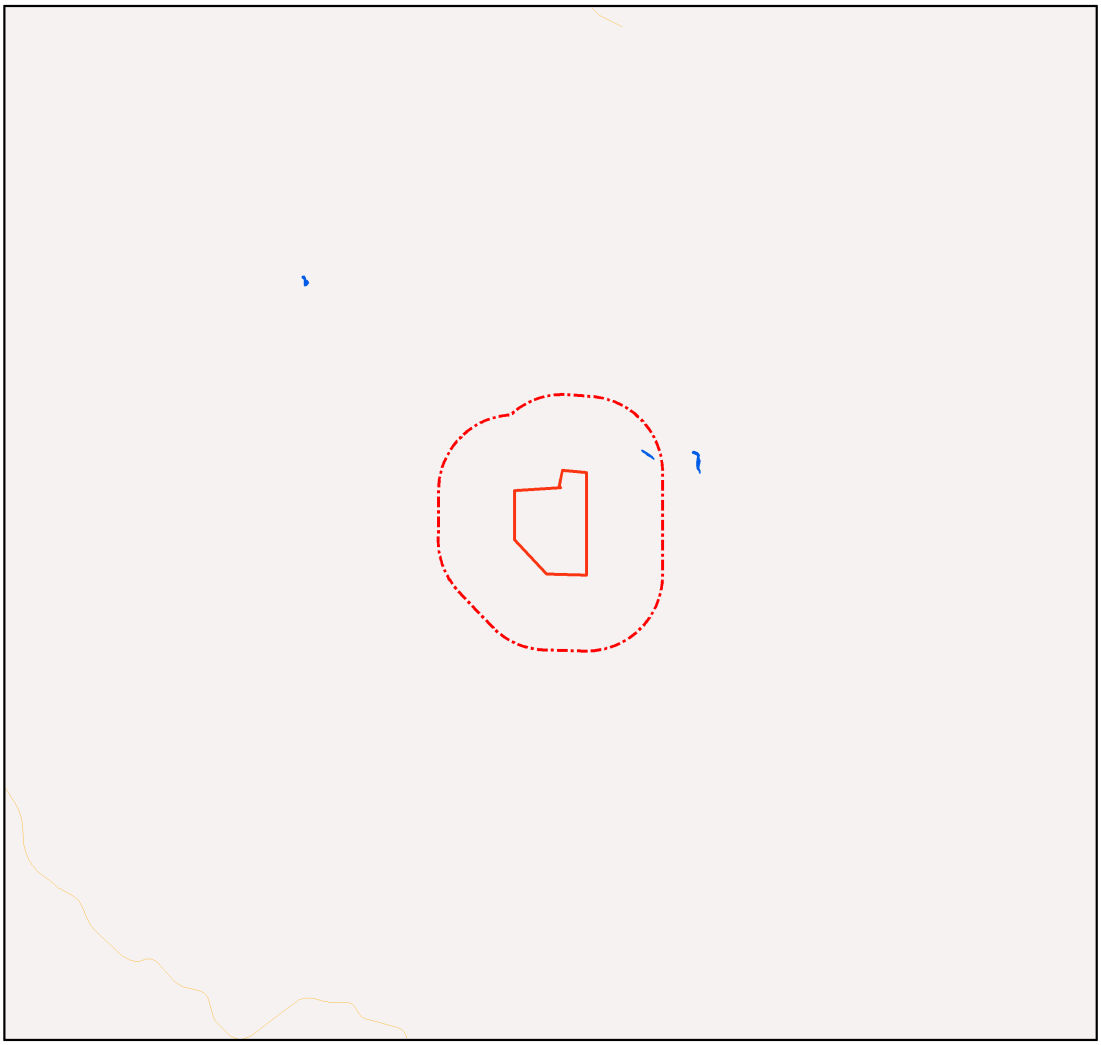
For the selected area of interest 104.11ha

Current as at 11/08/2021

WildNetSpeciesList

Queensland Government

Map 1. Locality Map



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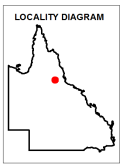

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Protected Area(s)
No estates or reserves are located within the area of interest.

World Heritage Area(s)
No World Heritage Areas are located within the area of interest.

Ramsar Area(s)
No Ramsar Areas are located within the area of interest.

Species List

Introduction
This report is derived from a spatial layer generated from the WildNet database managed by the Department of Environment and Science. The layer which is generated weekly contains the WildNet wildlife records that are not classed as erroneous or duplicate, that have a location precision equal to or less than 10000 metres and do not have a count of zero.

The WildNet dataset is constantly being enhanced and the taxonomic and status information revised. If a species is not listed in this report, it does not mean it doesn't occur there and listed species may also no longer inhabit the area. It is recommended that you also access other internal and external data sources for species information in your area of interest (Refer Links and Support).

Table 2 lists the animals recorded within the area of interest and its one kilometre buffer.

Table 3 lists the plants recorded within the area of interest and its one kilometre buffer.

Table 4 lists the fungi recorded within the area of interest and its one kilometre buffer.

Table 5 lists the protists recorded within the area of interest and its one kilometre buffer.

Table 2. Animals recorded within the area of interest and its one kilometre buffer

No species found within the area of interest and its one kilometre buffer.

Table 3. Plants recorded within the area of interest and its one kilometre buffer

No species found within the area of interest and its one kilometre buffer.

Table 4. Fungi recorded within the area of interest and its one kilometre buffer

No species found within the area of interest and its one kilometre buffer.

Table 5. Protists recorded within the area of interest and its one kilometre buffer

No species found within the area of interest and its one kilometre buffer.

Species table headings and codes

Taxon Id: Unique identifier of the taxon from the WildNet database.

NCA: Queensland conservation status of the taxon under the *Nature Conservation Act 1992* (Least Concern (C), Critically Endangered (CR), Endangered (E), Extinct (EX), Near Threatened (NT), Extinct in the Wild (PE), Special Least Concern (SL), and Vulnerable (V)).

EPBC: Australian conservation status of the taxon under the *Environment Protection and Biodiversity Conservation Act 1999* (Conservation Dependent (CD), Critically Endangered (CE), Endangered (E), Extinct (EX), Vulnerable (V), and Extinct in the Wild (XW)).

Specimens: The number of specimen-backed records of the taxon.

Records: The total number of records of the taxon.

Last record: Date of latest record of the taxon.

Links and Support

Other sites that deliver species information from the WildNet database include:

- Species profile search - access species information approved for publication including species names, statuses, notes, images, distribution maps and records
- Species lists - generate species lists for Queensland protected areas, forestry areas, local governments and areas defined using coordinates
- Biomaps - view biodiversity information, including WildNet records approved for publication, and generate reports
- Queensland Globe - view spatial information, including WildNet records approved for publication
- Qld wildlife data API - access WildNet species information approved for publication such as notes, images and records etc.
- Wetland*Maps* - view species records, survey locations etc. approved for publication
- Wetland*Summary* - view wildlife statistics, species lists for a range of area types, and access WildNet species profiles
- WildNet wildlife records - published - Queensland - spatial layer of WildNet records approved for publication generated weekly
- Generalised distribution and densities of Queensland wildlife - Queensland species distributions and densities generalised to a 10 km grid resolution
- Conservation status of Queensland wildlife - access current lists of priority species for Queensland including nomenclature and status information
- Queensland Confidential Species - the list of species flagged as confidential in the WildNet database.

Please direct queries about this report to the WildNet Team.

Other useful sites for accessing Queensland biodiversity data include:

- Useful wildlife resources
- Queensland Government Data
- Atlas of Living Australia (ALA)
- Online Zoological Collections of Australian Museums (OZCAM)
- Australia's Virtual Herbarium (AVH)
- Protected Matters Search Tool

Disclaimer

Whilst every care is taken to ensure the accuracy of the information provided in this report, the Queensland Government, to the maximum extent permitted by law, makes no representations or warranties about its accuracy, reliability, completeness, or suitability, for any particular purpose and disclaims all responsibility and all liability (including without limitation, liability in negligence) for all expenses, losses, damages (including indirect or consequential damage) and costs which the user may incur as a consequence of the information being inaccurate or incomplete in any way and for any reason.