CENTURION NORTH

Progressive Rehabilitation and Closure Plan

Prepared for: Department of Environment, Science and Innovation

Prepared by: Peabody Energy Australia Pty Ltd

EA and PRCP Schedule holder: Centurion Coal Mining Pty Ltd

Tenure number: ML 1790 and ML 70495

Version: 001

Date of Submission: 13 September 2024

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GLOSSARY of TERMS and ABBREVIATIONS

Key terms and abbreviations, and associated definitions used in this report are listed below.

Term / abbreviation	Description
2D / 3D	2-dimensional / 3-dimensional
3P grasses	Perennial, productive and palatable
AEP	Annual exceedance probability
AMD	Acid and Metalliferous Drainage (AMD). Includes acid/acidic drainage (AD), pH-neutral and metalliferous drainage (NMD) and sulphide-derived saline drainage (SD) – and/or any combination of these.
AMWU	Australian Manufacturing Workers' Union
ASC	Australian Soil Classification
bcm	Bank cubic meter. One cubic meter of material as it lies in the natural bank state.
Biodiversity Act	Biodiversity Act 2004 (Queensland)
BMC	BHP Mitsui Coal Pty Limited
BOM	Bureau of Meteorology (Australia)
CCP	Community Consultation Plan
CEC	Cation exchange capacity
CFMEU	Construction, Forestry, Mining and Energy Union
CHPP	Coal handling and preparation plant
C-RES	BHP cost-neutral organization. (BMC's community-related Local Buying Program is delivered in a strategic partnership between BHP and *C-RES).*
CSIRO	Commonwealth Scientific and Industrial Research Organisation (Australia)
DAWE	Department of Agriculture, Water and Environment (Australia)
DEM	Digital elevation model
DESI	Department of Environment, Science and Innovation (Queensland) (The Administrating Authority)
DM	Dry matter (with reference to vegetation)
DoR	Department of Resources (Queensland)
DSI	Detailed site investigation
DSITI	Department of Science, Information Technology and Innovation (Queensland)
DTMR	Department of Transport and Main Roads (Queensland)
EA	Environmental Authority (in terms of the Environmental Protection Act 1994, Queensland)
EC	Electrical conductivity
EIS	Environmental Impact Statement
EMP	Environmental Management Plan
EP Act	Environmental Protection Act 1994 (Queensland)
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
ERA	Environmentally relevant activities
ESP	Exchangeable sodium percentage
ETU	Electrical Trades Union
FCCM	Fort Cooper Coal Measures
FOS	Factor of safety
GL	Goonyella Lower coal seam
GM	Goonyella Middle coal seam

GLOSSARY of TERMS and ABBREVIATIONS

Key terms and abbreviations, and associated definitions used in this report are listed below.

Term / abbreviation	Description
GP	Goonyella P coal seam
Ha	Hectares
Interburden	Non-carbonaceous or carbonaceous mine waste located between coal seams. In this report the term 'overburden' shall be used to define overburden and interburden.
IRC	Isaac Regional Council
km	Kilometer
lcm	Loose cubic meter. One cubic meter of material which has been disturbed and has swelled as a result of movement
LGA	Local Government Area
LOA	Life-of-asset
LOD	Land outcomes document
LOM	Life-of-mine
LSA	Land suitability assessment
MERFP Act	Mineral and Energy Resources (Financial Provisioning) Act 2018 (Queensland)
Mine waste	Material comprising overburden, ± coarse/fine reject (dewatered), ± waste coal. Sometimes called 'mineral waste' or 'mining waste'.
ML	Mining Lease
MLES	Matter of local environmental significance
MNES	Matter of national environment significance
MCM	Moranbah Coal Measures
MSES	Matter of state environmental significance
NAF	Non-acid forming
NC Act	Nature Conservation Act 1992 (Queensland)
NEPM	National environment protection measure
NNTT	National Native Title Tribunal - an independent body established under the Native Title Act 1993 in Australia as a special measure for the advancement and protection of Aboriginal and Torres Strait Islander peoples.
NUMA	Non-use management area
Overburden	Non-carbonaceous or carbonaceous mineral waste located above (overburden proper) or between (interburden) coal seams. Carbonaceous overburden is generated during mining of non-ore material and may be represented by sedimentary units (non-coal) rich in organic carbon. Carbonaceous overburden does not include coarse reject, seam floor, seam roof or coal partings. Overburden reports to spoils dumps.
Overburden stockpile	Out-of-pit landform containing mine waste (also referred to as a spoil dump or waste dump)
PAF	Potentially acid forming
PMLU	Post-mining land use
PRC plan	Progressive Rehabilitation and Closure Plan (in terms of the Environmental Protection Act 1994 (Queensland)
PRCP Guideline	Progressive Rehabilitation and Closure Plan Guideline (November 2019) (DES, Queensland)
PSI	Preliminary site investigation

GLOSSARY of TERMS and ABBREVIATIONS

Key terms and abbreviations, and associated definitions used in this report are listed below.

Term / abbreviation	Description
RA	Rehabilitation area. As defined in the PRCP Guideline: a rehabilitation area, for a post-mine land use, means an area of land in the post-mine land use to which e rehabilitation milestone for the post-mining use relates.
RE	Regional ecosystems
Reject	Waste material produced during coal washing, separated from run-of-mine (ROM) coal in the coal handling and preparation plant (CHPP). Can be separated and disposed as fine rejects (tailings) and coarse reject, or co-disposed as mixed plant reject which is a mixture of coarse reject and 'dewatered' fine reject
Remnant coal	In-situ coal that remains exposed on the pit walls (highwall) and/or pit floor. Remnant coal can be ore grade or waste coal. Remnant coal can be fresh, oxidized or coked (heat affected).
ROM	Run-of-mine
RM	Rehabilitation milestone. As defined in the PRCP Guideline: a rehabilitation milestone, for the rehabilitated land, means each significant event or step necessary to rehabilitate the land to a stable condition (section 115 of the *EP Act*).
RRR	Residual risk rating (with reference to the risk assessment)
Qld	Queensland
SEVT	Semi-evergreen vine thicket
SMART	Specific, measurable, achievable, reasonable/relevant, time-specific
Spoil	Mine waste comprising non-ore (non-ROM) material such as overburden and waste coal. Within this report, unless stated otherwise, spoil is assessed as a whole (bulk material) with no distinction made between carbonaceous and non-carbonaceous overburden.
SPR	Source-pathway-receptor
TDS	Total dissolved solids
TEC	Threatened ecological communities
Waste coal	Sub-economical coal that reports to the spoil dumps as waste. Waste coal can be fresh or oxidised. All oxidised and coked (cindered) coal is waste.
WQOs	Water Quality Objectives
WW	Wards Well

1. INTRODUCTION

Stanmore SMC Pty Ltd (SMC) is a wholly owned subsidiary of Stanmore Resources Ltd (Stanmore). SMC is the holder of mining leases (ML) 1790, ML 4752, ML 70443 and ML 70495, together referred to as the Wards Well MLs. The Wards Well MLs are situated in Bowen Basin, central Queensland, approximately 40 to 60 km north of Moranbah, as shown in *Figure 1***.**

Stanmore acquired BHP Mitsui Coal Pty Ltd (BMC), formerly a subsidiary of BHP Group Limited (BHP), on 3 May 2022. BMC was renamed as SMC on 11 May 2022. The Wards Well MLs were held by BMC prior to the acquisition.

The Wards Well MLs are subject to an environmental authority (EA) with environmentally relevant activities (ERAs) listed in the EA. A Progressive Rehabilitation and Closure Plan (PRC plan / PRCP) schedule for Wards Well MLs was originally approved by the Department of Environment and Science (DES) on 31/01/2022.

DES approved an amendment to the Wards Well EA and PRCP schedule on 29 April 2024, which authorised additional exploration activities.

Details of the EA and PRCP schedule are:

- Environmental Authority and PRCP schedule Holder: Centurion Coal Mine Pty Ltd
- Environmental Authority Number: P-EA-100658735 (03 September 2024)
- PRCP Schedule Number: P-PRCP-100669070_V1
- Land description ML 1790, ML 70495, ML 70443, ML 4752

It is proposed to de-amalgamate the Wards Well MLs as SMC is proposing to transfer ML 1790 and ML 70495 to Centurion Coal Mining Pty Ltd (Centurion) a wholly owned subsidiary of Peabody Energy Australia Pty Ltd (ACN 096 909 410) with the overall parent company being Peabody Energy Corporation (Peabody), with these two MLs hereafter referred to as the Centurion North MLs (also 'Centurion North'). ML 4752 and ML 70443 will continue to be held by SMC and are hereafter referred to as the Lancewood MLs (also 'Lancewood').

It is noted that realignment of the boundaries of the Wards Well MLs was approved by the Department of Resources on 12/03/2024 and subsequently updated on the Department mapping system. The overall size and shape of the combined Wards Well MLs was unchanged by the internal boundary realignment. This PRC plan describes the realigned ML boundaries, except where noted.

This PRC plan has been prepared for the Centurion North MLs:

- in accordance with the amendments promulgated via the Mineral and Energy Resources (Financial Provisioning) Act 2018 (*MERFP Act*) to the Environmental Protection Act 1994 (*EP Act*).
- on the basis that environmentally relevant activities (ERAs) listed on the Wards Well EA (Appendix 1) will be apportioned to the Centurion North MLs where those ERAs are currently listed on the EA for the MLs.
- to meet the requirements of the Progressive Rehabilitation and Closure Plan Guideline (PRCP Guideline).

This PRC plan refers to the Wards Well MLs (also 'Wards Well') in the context of historical or background information that formed part of the original PRC plan application in February 2021 that resulted in the current approved PRCP schedule. However, this PRC plan has been modified to remove reference to activities that will not form part of the Centurion North MLs. Appendices to this PRC plan are the same as those that supported the original PRC plan application, and therefore reference the original Wards Well MLs. Never-the-less these appendices continue to provide relevant and useful information to support this PRC plan.

The EA for the Wards Well MLs was the land outcome document (LOD) for the approved PRP schedule.

This PRC plan comprises two parts:

- **Section A:** Rehabilitation planning part – provides information about the site, the rehabilitation plans, and evidence and justification to support the development of the proposed PRCP schedule; and
- **Section B:** PRCP schedule – includes maps of rehabilitation and closure outcomes for the site and tables of time-based milestones.

This PRC plan also includes **Section C: Appendices**, which provides key information and specialist studies used to support development of this plan.

PRCP for exploration activities

The current EA and PRCP schedule allow for bulk sample and other exploration activities at Wards Well. However, bulk sample activities (box cut, bulk sample, underground and associated infrastructure) are not proposed on the Centurion North MLs at this time and therefore this PRC plan does not describe rehabilitation of bulk sample activities. The rehabilitation activities described in this PRC plan relate solely to the exploration activities as proposed for de-amalgamation of the approved current EA.

The uncertain nature of the outcomes of the exploration activities and the potential requirement for a future amendment process have been taken into consideration in development of the PRCP schedule.

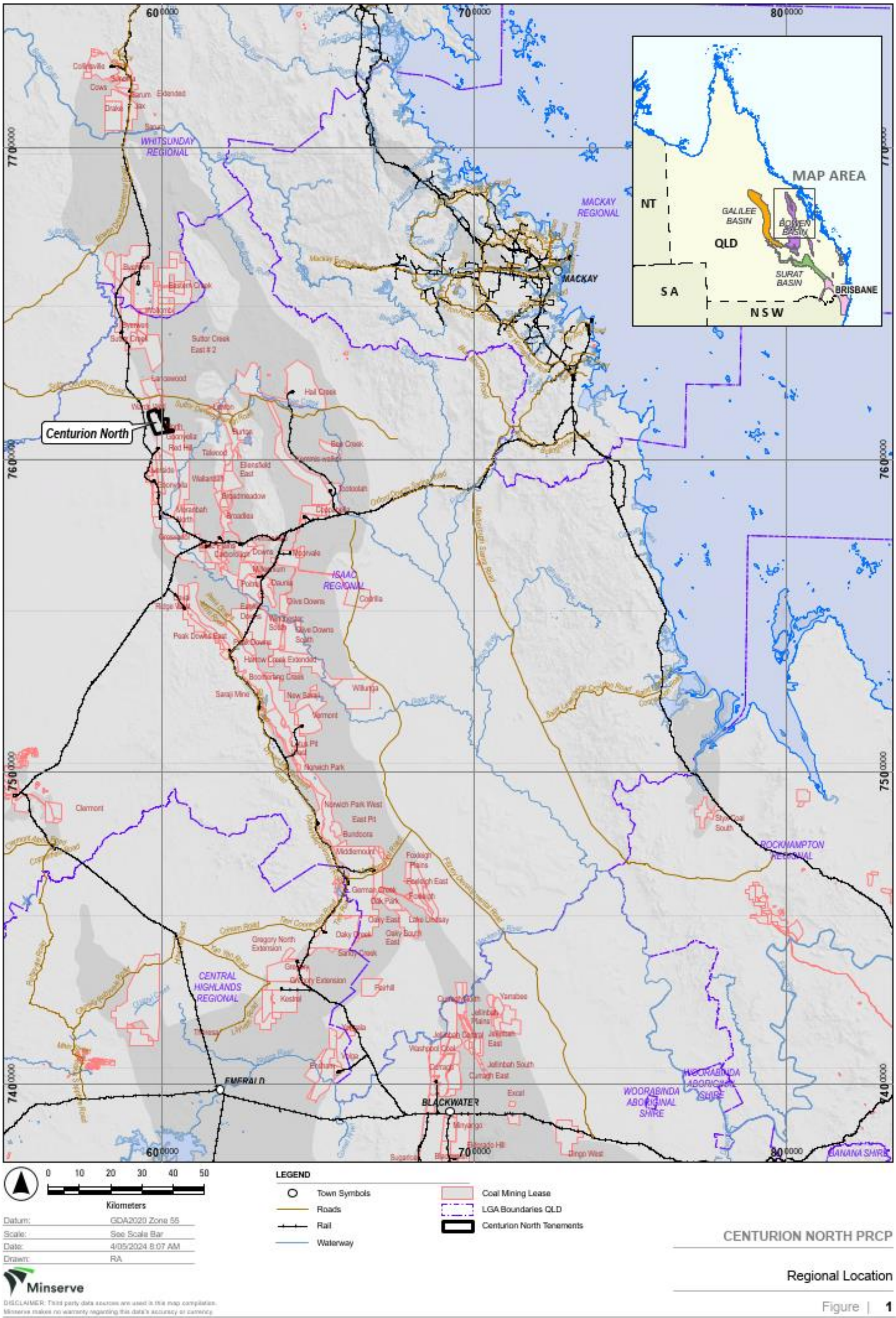


Figure 1 Regional Location map

2. SECTION A: REHABILITATION PROJECT PLANNING

Legislative Requirement

In accordance with Section 126C(1)(b) and (c)(ii) of the *EP Act*, the rehabilitation planning part of the PRC plan must include a description of:

- each resource tenure, including the area of each tenure;
- the relevant activities to which the application relates;
- the likely duration of the relevant activities; and
- how and where the relevant activities are to be carried out, including maps.

PRCP Guideline

The following spatial information must be submitted as part of the PRC plan:

- the location and maximum extent of disturbance footprint for the mine life;
- the PMLUs and NUMAs for the area within the resource tenures; and
- any sensitive receptors.

In addition to the list above, the PRC plan must include spatial information outlining the rehabilitation and improvement areas that correspond to the proposed PRCP schedule. The spatial information must show the locations of the rehabilitation and improvement areas for a 10-year period (minimum).

All spatial information must be prepared and submitted in accordance with the guideline '*Spatial Information Submission' (ESR/2018/4337).*

2.1 Project description

Centurion North is located within the northern region of the Bowen Basin approximately 30 kilometres (km) south of Glenden and approximately 150km south-west of Mackay in Central Queensland (Qld). It is located immediately to the north of the existing Centurion Mine (owned and operated by Peabody) and approximately 50km north of Moranbah (*Figure 1*).

Suttor Development Road is a public road that runs east-west to the north of Centurion North. Site access is either via Red Hill Road from the south and/or Suttor Development Road.

Centurion North covers approximately 3,471 hectares (ha) and is identified as a hard coking coal resource.

EA EPPR00668513 limits activity at Wards Well to bulk sample exploration and other exploration activities. Exploration drilling and seismic surveys have been occurring since the 1970s. It is anticipated that exploration drilling will continue on the Centurion North MLs in accordance with the EA and PRC schedule requirements (or subsequent amendments) until a sufficient understanding of the resource is gained, further informing bulk sample exploration and future mining operations.

2.1.1 Mining tenements

Details of the Wards Well MLs are provided in **Table 1** along with the location and boundaries of these MLs shown in **Figure 2**.

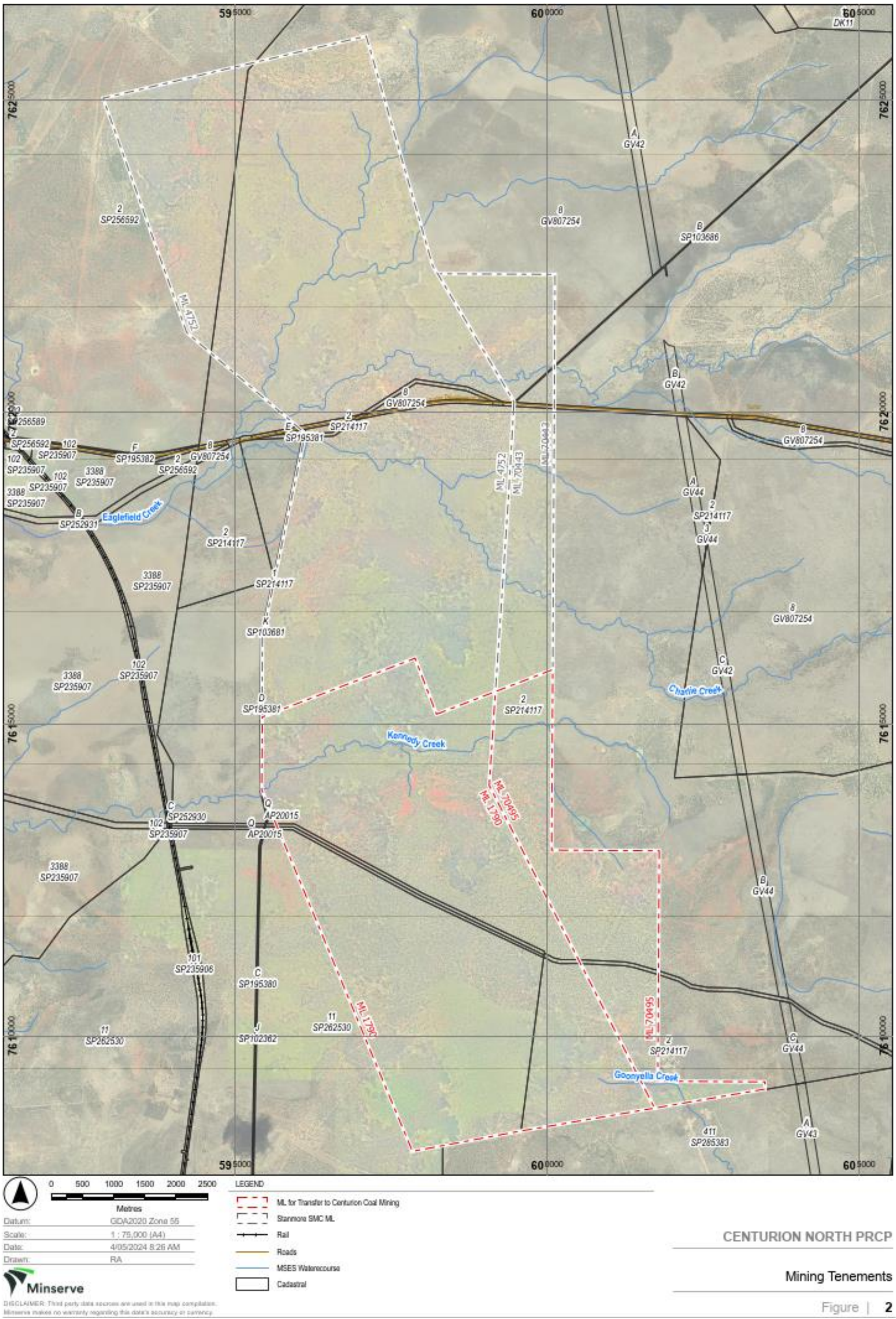


Figure 2 Mining tenements

Table 1 Wards Well mining tenements

Mining Lease	Name	EA holder	Purpose	Area (ha)
ML 4752	Lancewood	Stanmore SMC PTY LTD	Mining for coal and mineral hydrocarbons	4,027.2
ML 1790	Wards Well (part of Centurion North)	Stanmore SMC PTY LTD	Mining for coal and mineral hydrocarbons	2,722.8
ML 70443	Wards Well East (part of Lancewood)	Stanmore SMC PTY LTD	Mining coal	611.4
ML 70495	Wards Well South-east (part of Centurion North)	Stanmore SMC PTY LTD	Mining coal	747.8
			Total area	**8,109.20**

2.1.2 Primary mine features and infrastructure on-site

The main features and infrastructure approved within the EA for Wards Well are summarised in **Table 2** and illustrated in **Figure 3. Table 2** identifies whether the mine features and infrastructure are applicable to the Centurion North MLs. Activities that are not applicable do not form part of this PRC plan and PRCP schedule.

Table 2 Primary mine features and infrastructure at Wards Well, as approved within the EA

Mine domain	Mine feature name	Applicability to the Centurion North MLs
Exploration activities	Drill holes and pads LOX line drilling 3D seismic survey program Access roads & tracks	Drill holes and pads are authorised on the Centurion North MLs. Lox line drilling and 3D seismic survey program are not currently authorised on the Centurion North MLs. Some additional access tracks required where existing tracks are not suitable.
Exploration box-cut area	Box-cut pit	Not applicable
Combined bulk sample area	Overburden stockpile Topsoil stockpiles Run-of-mine (ROM) coal stockpile Water management infrastructure, including mine water dam and stormwater dam	Not applicable
Underground	Underground exploration drive	Not applicable
Dams	Mine water dam Stormwater dam	Not applicable

Mine domain	Mine feature name	Applicability to the Centurion North MLs
Ancillary infrastructure	Industrial area and workshop Administration area Laydown areas Roads and tracks Exploration camp accommodation including sewage treatment plant	Not applicable, other than roads and tracks to support drill holes and pads (moved to Exploration activities domain)

Historical exploration drilling and seismic surveys are shown in the final site design map (**Figure 23**), as well as included in the hectares in the PRCP schedule.

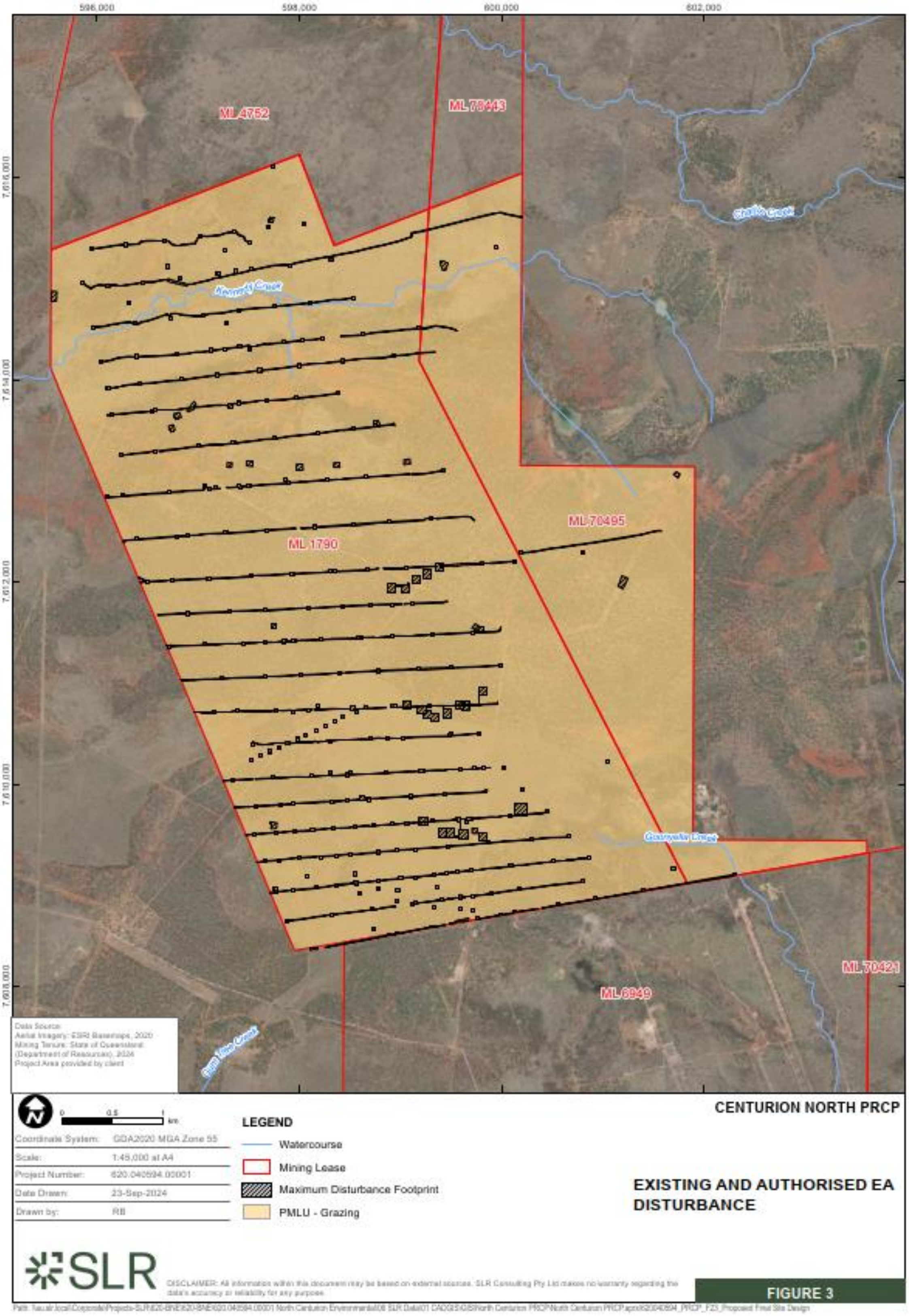


Figure 3 Existing and Authorised EA Disturbance

2.1.3 Type of mining operation

Wards Well, at the time of preparation of this PRC plan, is a greenfield mine site with some historic and approved exploration drilling and seismic activities. Exploration bulk sampling activities are currently authorised on the Lancewood MLs under the EA and PRCP schedule (but have not commenced).

Ongoing exploration drilling and environmental data assessment is planned to continue on the Centurion North MLs for the evaluation of an underground operation to be accessed from the adjacent Centurion ML (ML6949). The Centurion North MLs are intended to be transferred to the holder of the Centurion ML under a commercial arrangement between SMC and Peabody.

2.1.4 Proposed duration of the operation

Exploration activities have been occurring at Wards Well since the 1970s, with BMC (previous EA holder) having conducted exploration drilling and seismic surveys since 2010. Centurion plans to continue exploration drilling activities on the Centurion North MLs where these are authorised under the EA.

2.2 Baseline information

PRCP Guideline (Section 3.1)

In addition to the legislative requirements, the following information about the site, where relevant, is considered necessary by the administering authority (as per section 126C(1)(j) of the *EP Act*) to decide whether to approve the PRCP schedule:

- site topography (locally and regionally);
- climate (general and specific (rain, evaporation, temperatures)) including long-term projections;
- geological setting;
- site hydrology and fluvial networks;
- groundwater levels and properties;
- soil types, properties, and productivity;
- land stability (pre-existing land degradation/erosion and predisposition to ongoing stability issues);
- vegetation communities and ecological data (including existing regional ecosystem mapping);
- fauna presence and populations;
- pre-mining land use; and
- identification of underlying landholders.

PRC plans must include any baseline information collected as part of an EIS process or original EA application. If this information is unavailable, the reasons should be explained in this section of the rehabilitation planning part.

Any expansion to an existing site must demonstrate how it has been designed for closure. The rehabilitation/improvement planning must include data from when mining first commenced up until planned surrender. The provisions of the *EP Act* include an exceptional circumstance for when land is available for rehabilitation.

Much of the baseline information presented in this section is relevant to Wards Well, which encompasses both Lancewood and Centurion North, and therefore remains relevant.

2.2.1 Site topography

The regional topography of the Bowen Basin is dominated by flat to gently sloping landforms and low rolling hills.

The Wards Well MLs topographical features are consistent with the regional landscape and consist of level plains and gently undulating plains and rises. The slope across the majority of the site is between 1-2%, sloping gently towards the southwest (**Figure *4***). Steeper slopes up to 11% exist in the far north and on the south-eastern parts of the site. Within the footprint of the Wards Well area, the highest ground elevations lie within the north-west (about RL380) with the lowest in the middle of the area toward the western boundary (about RL310).

The area encompasses two shallow valleys, associated with Eaglefield Creek (the closest creek to the box-cut area) and Kennedy Creek (located in the southern half of the lease).

Figure 4 General site topography at Wards Well

2.2.2 Climate

Wards Well is located in a semi-arid area with warm dry winters and hot humid summers. Weather data was collected at the Moranbah Water Treatment Plant (Station No. 034038) between 1972 and 2012 and since 2012 it has been collected at the Moranbah Airport (Station No. 034035). The Moranbah weather stations are located about 60km south of Wards Well.

2.2.2.1 Temperature

Maximum temperatures range from 24°C in June/July to 35°C in December/January, with minimum temperatures ranging from 9°C in July to 22°C in January[1&2].

2.2.2.2 Rainfall

Although rainfall occurs throughout the year, it is more prevalent in the summer months (December, January and February) (**Table 3**).

[1] Accessed from the Bureau of Meteorology (1972-2012)
[2] Accessed from www.willyweather.com.au (2012-2020)

Table 3 Moranbah monthly average rainfall

Month	Station no. 034038 (mm)	Station no. 034035 (mm)
January	103.8	88.0
February	100.7	100.5
March	55.4	92.6
April	36.4	23.8
May	34.5	30.1
June	22.1	16.7
July	18.0	28.0
August	25.0	9.0
September	9.1	8.3
October	35.7	24.0
November	69.3	38.3
December	103.9	55.3
Annual	**613.9**	**514.6**

2.2.2.3 Evaporation

The evaporation rate is highest in the summer months - mean daily rate of 8.2mm in January, and lowest in the cooler months - mean daily rate of 3.6mm in June. The annual average rate of evaporation is 2,372.5mm, which greatly exceeds the annual rainfall; a characteristic of semi-arid environments.

2.2.2.4 Wind

The region tends to have winds of low velocity (less than 10km/hr) with the prevailing wind direction predominantly from the north and north-east during spring and summer and from the south-east during autumn and winter.

Wind records for Moranbah for January-April show an easterly predominance of moderate strength (1-20km/h), with easterlies dominating during May-July with some south-easterly influence. Easterly winds predominate for August and December which tend north to north-easterly from October-December.

2.2.3 Geological setting

Wards Well is located within the Bowen Basin in Central Queensland. The Bowen Basin is part of a connected group of Permian-Triassic basins in eastern Australia that includes the Sydney and Gunnedah

Basins. The Bowen Basin contains large reserves of Permian coals, which have been mined on a large scale by open-cut and underground methods since the 1970s.

The Wards Well deposit is situated on the north-western margin of the Bowen Basin, west of the Nebo Synclinorium and on the southern side of the Collinsville Shelf. The Wards Well deposit dips broadly eastwards at between 2 to 5 degrees, with local steepening in places. In the district the Bowen Basin is characterised by typical basin-fill fluvial (and some marine) sediments, comprising mudstones, siltstones, sandstones and coal seams. Both normal and thrust faults are present.

2.2.3.1 Coal seams

The following two major coal bearing geological formations of Permian age occur in the Wards Well area:

- Fort Cooper Coal Measures (FCCM); and
- Moranbah Coal Measures (MCM).

The MCM is comprised of three coal seam groups (listed in stratigraphic order from youngest to oldest):

- Goonyella P (GP) seam;
- Goonyella Middle (GM) seam; and
- Goonyella Lower (GL) seam.

2.2.4 Site hydrology and fluvial networks

The Centurion North MLs are located within the Burdekin and Fitzroy Basins. The boundary between the two basins crosses the south-eastern corner of Centurion North MLs. The basins, as they relate to Centurion North MLs, are as follows:

- **Burdekin Basin** – Majority of ML1790 and northern portion of ML70495. The portion of the site within the Burdekin Basin is contained within the Suttor River Sub-basin and the Upper Suttor River catchment. The ephemeral Eaglefield, Kennedy and Charlie creeks (**Figure 5**) and their tributaries, drain the Centurion North area and Lancewood MLs within the Burdekin Basin to the west. These creeks drain into the Suttor River, which in turn runs to the north and into Lake Dalrymple (130km to the north-west) and the Burdekin River.
- **Fitzroy Basin** – South-east corner of ML1790 and the southern half of ML70495 (in total, approximately 515ha). The portion of the site within the Fitzroy Basin is contained within the Isaac River Sub-basin and Isaac Northern Rivers catchment. This portion of Wards Well drains toward Goonyella Creek, whose headwaters are located in ML1790.

Figure 6 [3] illustrates the location of the basins and mining leases.

[3] https://qldglobe.information.qld.gov.au/ (accessed November 2020)

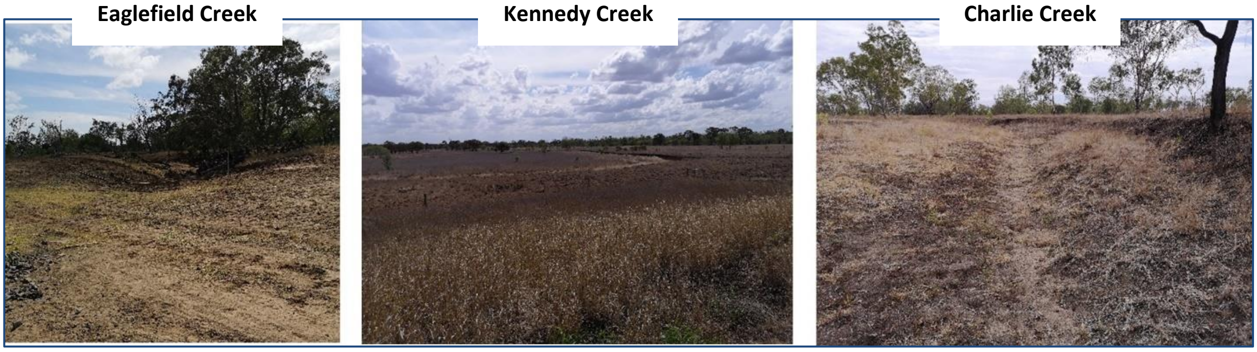


Figure 5 **Ephemeral Eaglefield, Kennedy and Charlie creeks and their tributaries that drain the Wards Well area within the Burdekin Basin to the west.**

The environmental values and water quality objectives established for the Burdekin and Fitzroy Basins under the Queensland Environment Protection (Water and Wetland Biodiversity) Policy (2019) are documented in the following:

- NQ Dry Tropics 2016, Burdekin Region Water Quality Improvement Plan 2016, NQ Dry Tropics, Townsville; and
- Isaac River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (Part).

The environmental values identified for the Upper Suttor River are summarised in **Table 4**.

Table 4 **Water environmental values for the Wards Well area**

Basin	Catchment	Aquatic ecosystems	Irrigation	Farm use	Stock watering	Aquaculture	Human consumption	Primary recreation	Secondary recreation	Visual recreation	Raw drinking water	Industrial use	Cultural and spiritual
Burdekin (Draft)	Upper Suttor River – Surface Waters	✓	-		✓	-	✓	✓	✓	✓	✓	✓	✓
	Upper Suttor River – Groundwaters	-	✓	✓	✓	-	-	-	-	-	✓	✓	-
Fitzroy	Isaac Northern Tributaries – Surface Waters	✓	✓	✓	✓	-	✓	✓	✓	✓	✓	✓	✓

	Isaac – Groundwaters	✓	✓	✓	✓	-	-	✓	-	-	✓	-	✓

Note: The Environmental values provided within the NQ Dry Tropics 2016, Burdekin Region Water Quality Improvement Plan 2016 are draft only.

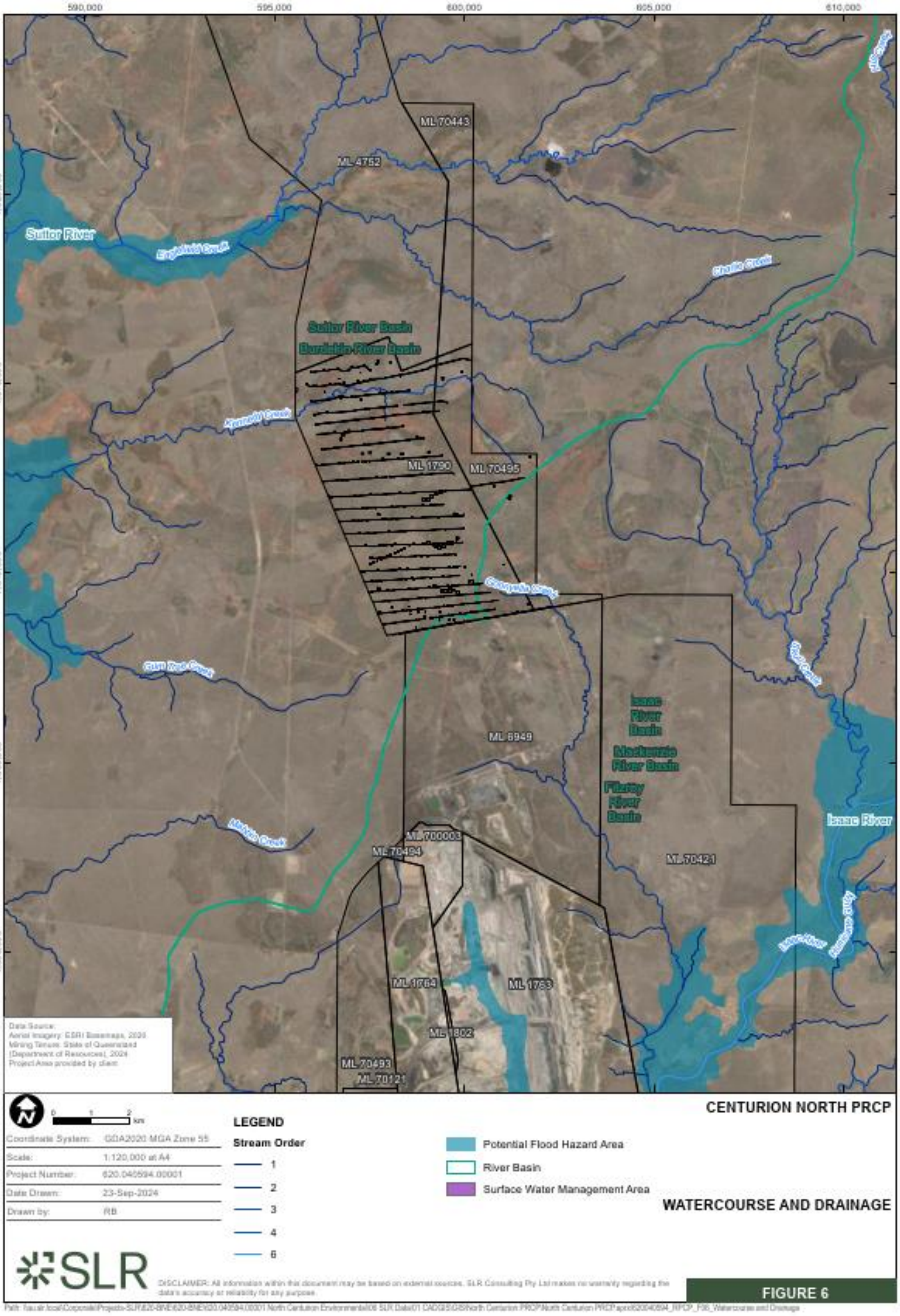


Figure 6 Watercourses and Drainage

summary of watercourses and dams located within and immediately surrounding the Wards Well MLs are summarised in **Table 5**.

No fourth order streams or above, or diversions, are present within the Wards Well mining leases.

Table 5 Summary of Wards Well watercourses and dams

Watercourse	Perennially	Hierarchy	Stream order	Comment
Burdekin Basin				
Eaglefield Creek	Non-perennial	Minor	3	Runs east to west across ML4752 and ML70443 to the north of Suttor Creek Development Road. To the west of the investigation area the stream classification changes to a Hierarchy of Major and a Stream Order of 4.
Charlie Creek	Non-perennial	Minor	2	Runs south-east to north-west across ML70443 and ML4752 to the south of Suttor Development Road. Drains into Eaglefield Creek to the west of ML1790.
Kennedy Creek	Non-perennial	Minor	2	Runs east to west across ML70495 and ML1790. Two minor first order streams drain into the creek from the south. Drains into Eaglefield Creek approximately 10km to the west of the investigation area.
Unnamed	Non-perennial	Minor	1	Runs east to west across ML70443 to the south of Suttor Development Road and drains into Charlie Creek on ML1790.
Unnamed	Non-perennial	Minor-Major	1-2-3	Multiple unnamed drainage lines draining the northern portion of ML4752 and to the north-east of the investigation area. Generally, run north-east to south-west across ML4752 to the north of Suttor Development Road. Drains into Eaglefield Creek to the west of ML4752.
Lake Dalrymple/Burdekin Falls Dam	-	-	-	Located approximately 130km to the north-west of the site.
Farm dams	-	-	-	Numerous small farm water supply dams are present within and immediately surrounding Wards Well.
Fitzroy Basin				
Goonyella Creek	Non-perennial	Minor	1	Headwaters located in the south-eastern corner of ML1790, running to the east along the southern boundary of ML70495 before turning south and draining into the Isaac River.

Watercourse	Perennially	Hierarchy	Stream order	Comment
Burton Gorge Dam	Permanent	-	-	Located on the Isaac River approximately 15km to the east of the investigation area.
Farm dams	-	-	-	Numerous small farm water supply dams are present within and immediately surrounding the investigation area.

2.2.5 Groundwater levels and properties

A hydrogeological assessment and development of pre- and post-mining hydrogeological conceptual models has been undertaken to support the PRC plan[4] and is contained in **Appendix 2**. Hydrogeological information summarised within this PRC plan is extracted from this assessment.

The groundwater levels and properties for the identified hydrostratigraphic units at Wards Well include the following:

- **Quaternary alluvium** – is located in alluvial sediments associated with Eaglefield, Charlie and Kennedy creek river systems. Quaternary alluvium is also located on older floodplain sediments and alluvial flats. These aquifers are considered porous media aquifers with groundwater occurring within the media pore spaces and are generally unconfined. The depth and availability of the Quaternary alluvium aquifer is likely to be variable and dependant on weather conditions. Therefore, this aquifer is not typically targeted for groundwater extraction at Wards Well. Ecosystems along the creek lines that are potentially groundwater dependent, may be associated with this aquifer. Typical thicknesses of the quaternary alluvium aquifers are believed to be between 15 and 25m.
- **Tertiary strata** – comprises of vesicular basalt flows following Tertiary palaeochannels incised into the Permian Basement. This strata is the predominant aquifer targeted by groundwater extraction bores used for stock watering in the proximity of Wards Well. The typical Total Dissolved Solid (TDS) range between 480 and 2,900mg/L, which is suitable for stock watering; however, it has limited suitability for other beneficial uses such as irrigation, domestic, recreation or drinking water. Groundwater within basalt is a second porosity aquifer with groundwater transmitted through fractures and joints. Low permeability sediment deposits, weathering horizons between basalt flows and low permeability basalts within the centre of the flows, compartmentalise the aquifer. Typical groundwater levels for the Tertiary strata are between 6 and 60m below ground surface, with flow typically from north-east to south-west across Wards Well.
- **Permian strata** – comprises of siltstone, sandstone, calcareous, carbonaceous shales and coal. This aquifer is not expected to be a significant aquifer at Wards Well. The Permian strata is identified primarily as a porosity aquifer in the sandstone units and a secondary porosity aquifer in the shales, siltstone and coal units. The occurrence of the aquifer is variable depending on the interconnection of fractures, faulting and extent of porous sediments. The aquifer is generally considered to be a confined aquifer with lower permeability overburden rocks acting as a confining unit to groundwater in the coal seams. Existing data indicates the water levels are between 6.8 and 42.1m below ground and has a higher salinity than those within the Tertiary strata. This aquifer is generally not targeted for beneficial use due to salinity and low recharge rates.

[4] Golder (2020): Wards Well Mine PRCP Hydrogeological Conceptual Model. Ref. No. 20360652-001-R-RevA

A baseline hydrogeological conceptual model [4] illustrating the above hydrostratigraphic units and groundwater flows is illustrated in **Figure 7.**

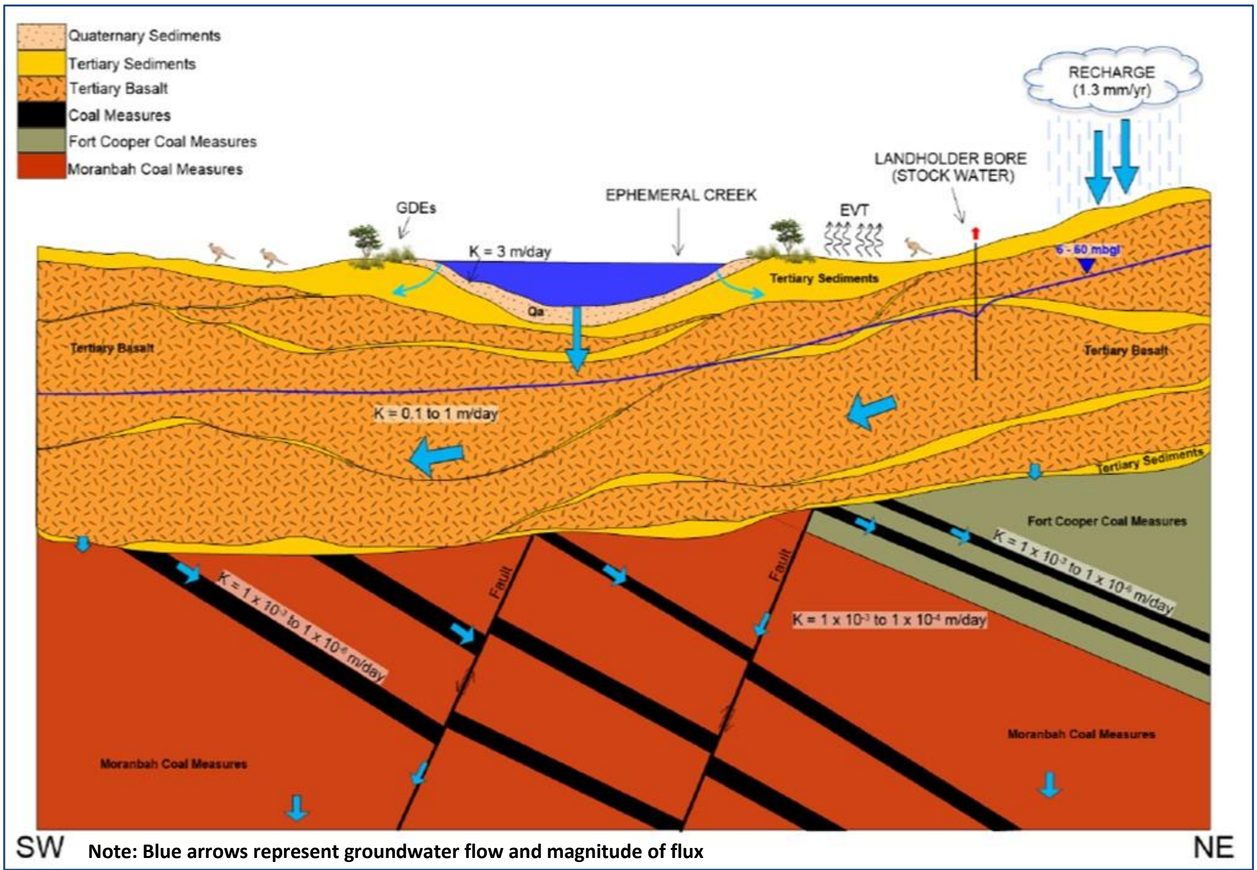


Figure 7 **Wards Well baseline hydrogeological conceptual model (Golder, 2020)**

The environmental values for groundwater established for the Upper Suttor and Isaac Connors Groundwaters under the Queensland Environment Protection (Water and Wetland Biodiversity) Policy (2019) are summarised in **Table 5**. The Highlands Underground Water Area (Burdekin Basin) and the Isaac Connors Groundwater Management Area (Fitzroy Basin) intersect the southern portions of ML 1790 and ML 70495 (**Figure 8)** [5]. The approved box-cut and bulk sampling area is not contained within the groundwater management areas.

There are 16 registered groundwater bores within 10km of the box-cut (both on and off lease), which were listed as existing[6]. Two of the 16 bores were listed for monitoring purposes. The usage for remaining 14 existing bores was not listed, however is expected to be for stock watering or monitoring. Registered bores within 10km of the proposed bulk sample activities on the Lancewood MLs are shown on **Appendix 2**, Figure 10.

[5] Accessed from https://qldglobe.information.qld.gov.au/ (November 2020)

[6] DNRME (2020): Queensland Groundwater Database, accessed via https://www.data.qld.gov.au/dataset/groundwater-database-queensland

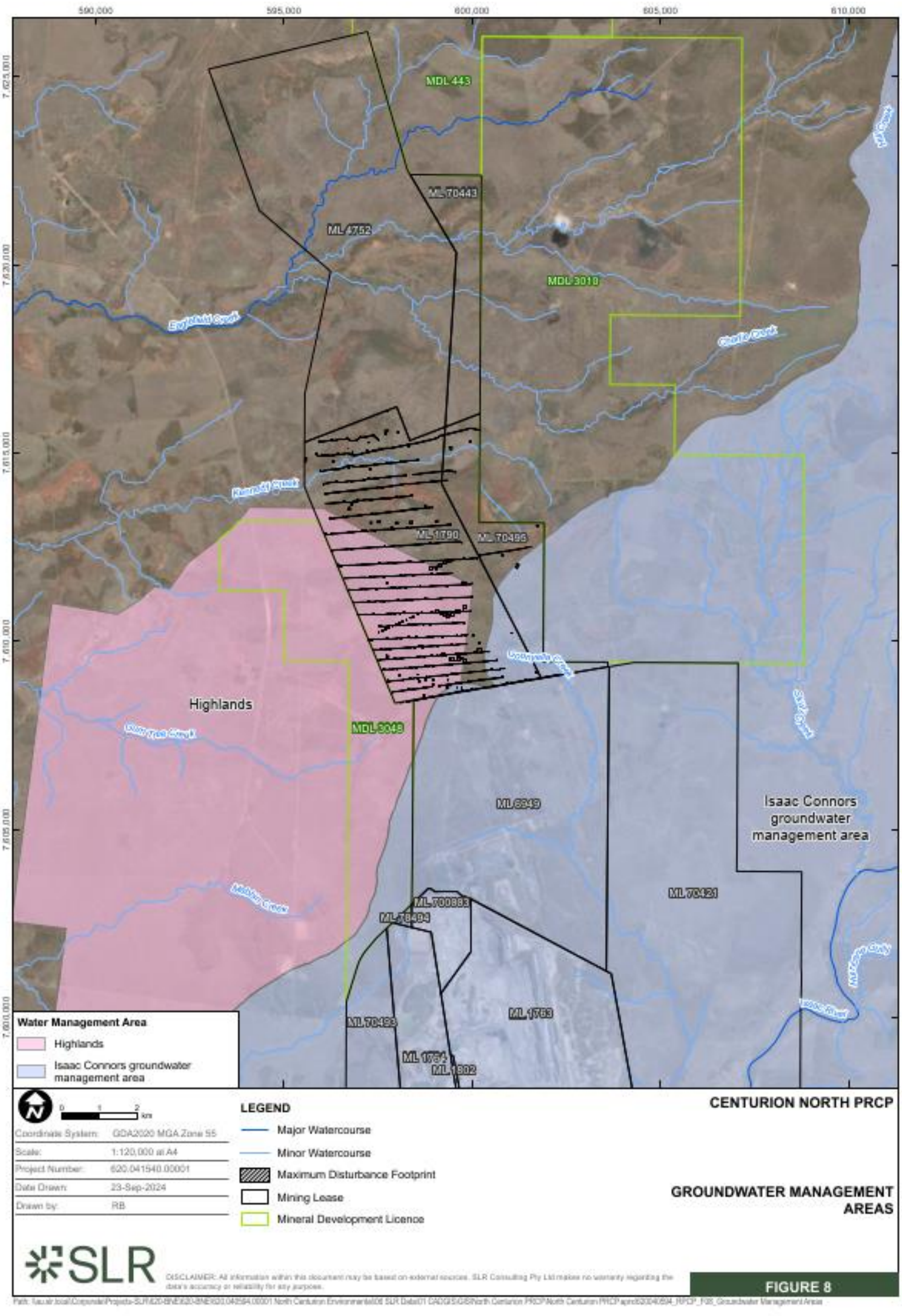


Figure 8 **Groundwater management areas**

Groundwater monitoring of the Tertiary aquifers has been undertaken since 2011 for parameters specified within the EA, including a range of metals, total recoverable hydrocarbons, pH, electrical conductivity and alkalinity. As mining operations have not commenced at Wards Well, the groundwater monitoring results are indicative of background concentrations. Locations of the existing monitoring bores are shown on **Appendix 2**, Figure 3.

The existing groundwater data, collected by BMC and SMC, indicates that selected analytes may be present at background concentrations above the Water Quality Objectives (WQOs) for the Burdekin and/or Fitzroy Basins. Therefore, site-specific trigger levels and closure criteria will need to be developed in consideration of the 2021 Department of Environment and Science (DES) "*Using monitoring data to assess groundwater quality and potential environmental impacts – Version 2".*

2.2.6 Soil types, properties and productivity

A soil resources and pre-mining assessment of agricultural land suitability was undertaken in 2011 to determine soil type and properties to understand baseline soil characteristics and suitable rehabilitation resources (**Appendix 5**)[8]. The scale of survey at Wards Well was 1:25,000 for planned disturbed areas and up to 1:50,000 for planned undisturbed areas, equivalent to a high intensity soil survey (McKenzie *et al,* 2008). Soil types were identified according to the Australian Soil Classification (ASC). A follow-up site observation of the surface condition was undertaken in 2020; this focussed on soil characteristics within the planned box-cut area.

During the 2011 soil survey, site access challenges prohibited machinery access to sample and examine soil profiles in the planned box-cut area. These access challenges were again identified during the 2020 observation. During the 2020 observation, an assessment was completed on vegetation communities, surface condition and topsoil physical characteristics, with comparisons made to soils that have been examined in more detail adjacent to the area. Light self-mulching clays were identified in the A1 horizon in the box-cut area with surface cracking present. This is consistent with Vertosols identified in the adjacent area during the 2011 assessment, at sites 85, 86 and 87[7].

Both the survey and observation found Vertosols, Sodosols, Dermosols and Kandosols to be present (**Figure 9)**. A summary of physical properties of these soil types is described in **Table 6**, with the associated rehabilitation-related chemical properties (from a productivity perspective) provided in **Table 7**. All soil types within the Centurion North area support a pre-mining land use of grazing.

Table 6 Soil types within the Centurion North area

Australian Soil Classification	Properties	Area (%)	Area (ha)
Vertosol	Occurring on plains/floodplains and mafic volcanic rocks Brown, Grey and Black, greater than 35% clay content, self-mulching over Basalt Soils may become saline to epihypersodic with depth Moderately to well drained and are generally alkaline to very alkaline with depth	17%	575
Dermosol	Occuring on low angle pediments with low shrublands, to surrounding Vertosol plains Red, Brown Light to Medium Clays, well-structured and well drained	23%	781

[7] Sinclair Knight Merz (26 June 2012): Wards Well Mine Project: Soil Survey. Version A, ref. no. QE09811

Australian Soil Classification	Properties	Area (%)	Area (ha)
	Dispersion potential Poor drainage and low overall fertility		
Kandosol	Occurring on level to gently undulating plains often in association with ferricrete deposits Red Sandy Loams and Medium Clays Often very deep (>3m) and clay-rich Good surface drainage Good pasture soil with low to moderate fertility	53%	1,786
Sodosol	Occurring on alluvial and part-colluvial deposits, as well as igneous, sedimentary and metamorphic rocks Sodic Duplex and Gradational Brown Loams Dispersive, hard setting and prone to erosion Good surface drainage and poor subsoil drainage Sodosol areas are grazed at Wards Well but erosion is present	7%	245

Table 7 Rehabilitation-related chemical properties and productivity of soil types found within the Centurion North area

Parameter	Unit	Vertosol	Dermosol	Kandosol	Sodosol
pH_{water}	N/A	7.8 - 8.6	7.2 - 7.8	6.7 - 7.5	Sodosols - minimal disturbance; hence data has not been included
EC_{water}	dS/m	0.1 - 0.66	0.025 - 0.15	0.014 - 0.034	
Plant Available Water Content	mm	125 - 450	100 - >125	>125	
Organic carbon	%	5.1	1.4	3.6	
CEC	cmol/kg	57 - 72.4	8.1 - 20.3	17.4 - 31	
ESP	%	0 - 12	5 - 11	0 – 5	
Ca/Mg ratio	N/A	1.1 - 2.1	0.8 - 1.2	1.2 - 1.7	
Productivity	-	Predominant soil type in the region. Soil properties sufficient to support grasses and native trees	Suitable for rehabilitation for cattle grazing on flat to gentle slopes	Suitable for rehabilitation of steeper slopes due to good soil structure	

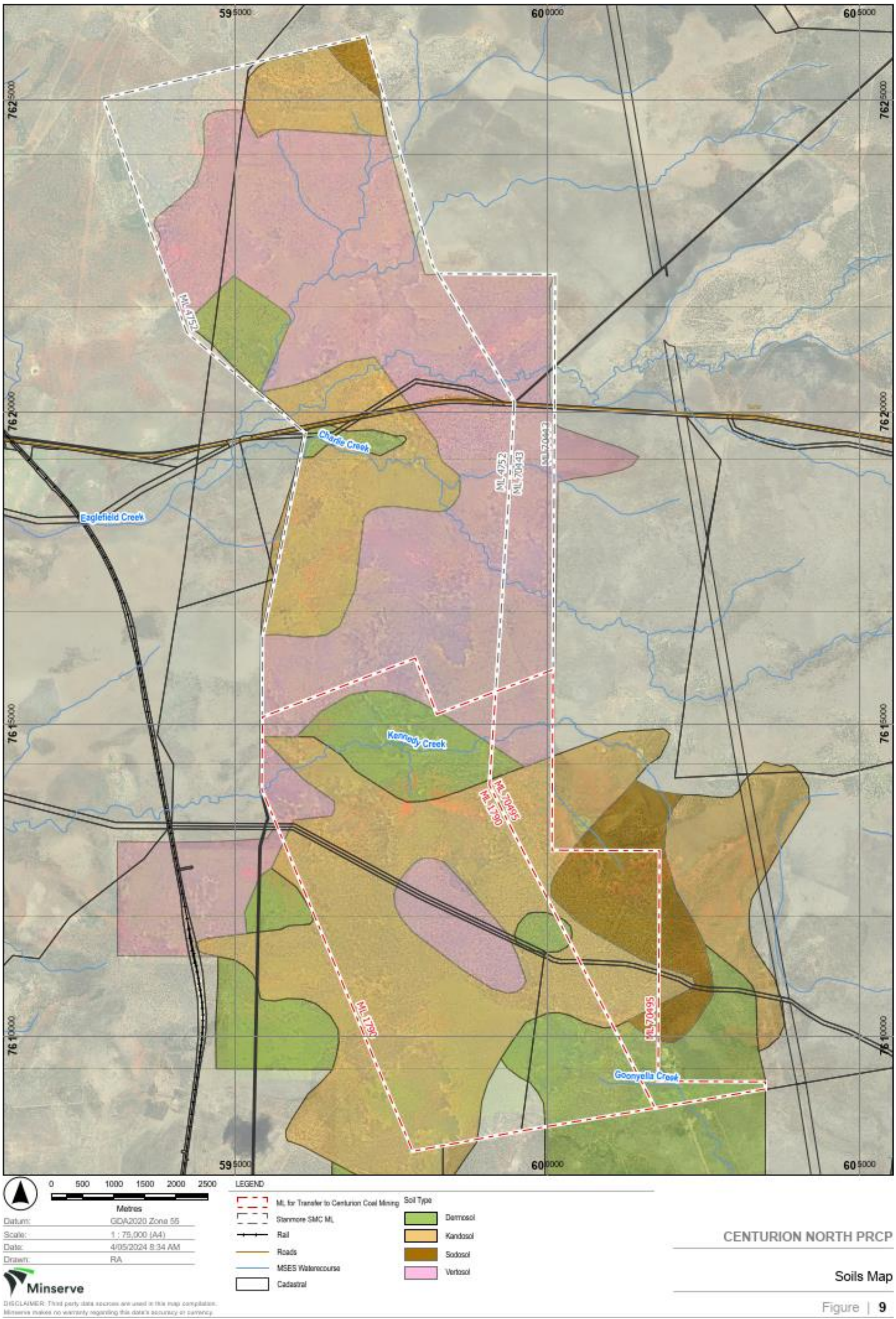


Figure 9 **Soils map**

Figure 10 illustrates various areas in Wards Well that are characteristic of the local soil types and associated vegetation.

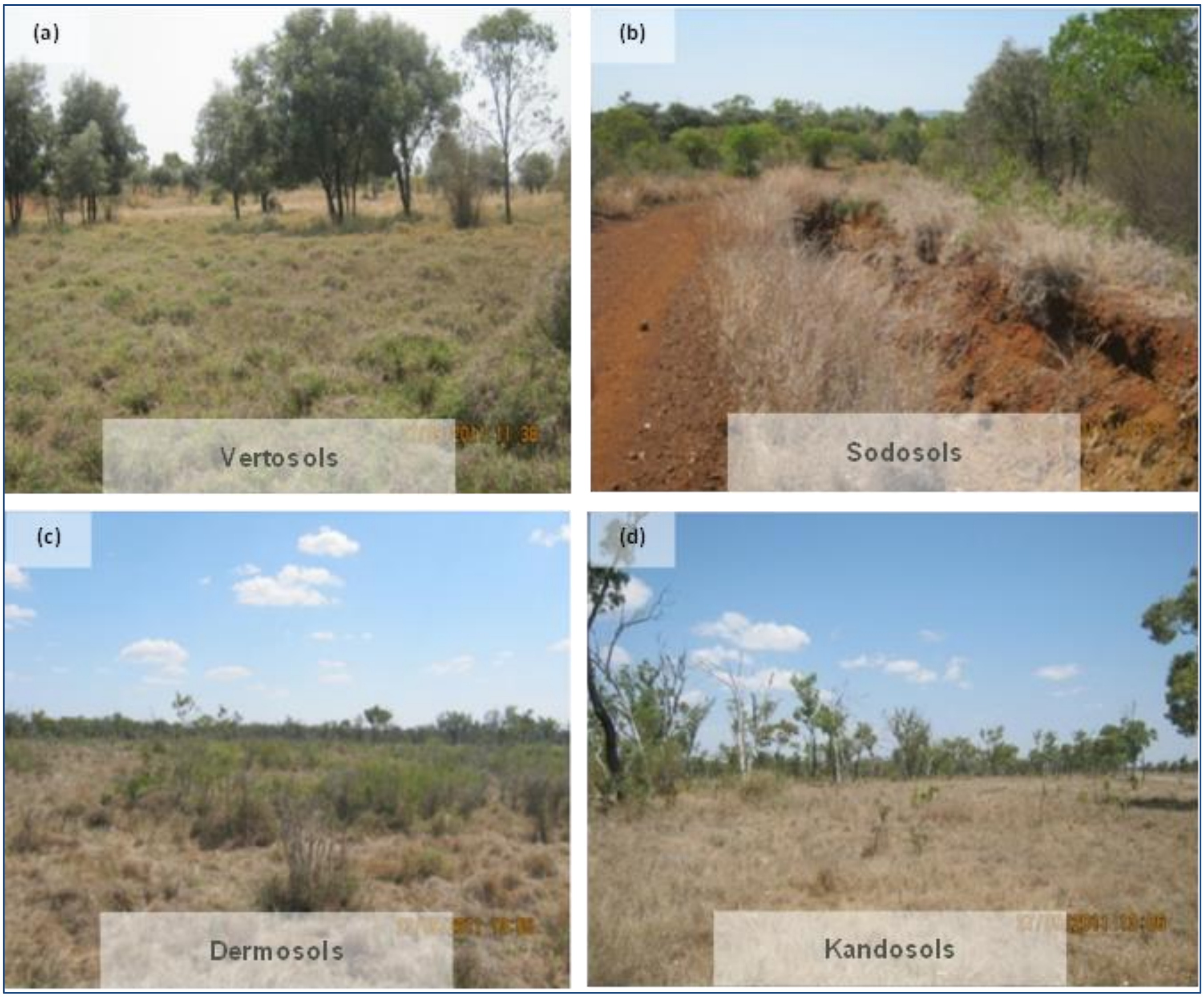


Figure 10 **Areas in Wards Well that are characteristic of the local soil types and vegetation - a) Brigalow and grasslands with cattle grazing on cracking clay Vertosols; b) Ironbark, Brigalow and erosion-prone areas on Sodosols; c) Low shrubs and grassland with cattle grazing on Dermosols and d) Open grasslands with remnant vegetation and cattle grazing on Kandosols.**

2.2.7 Land stability

The regional topography is dominated by flat to gently sloping landforms which is consistent with the landscape at Wards Well. In the context of land stability, erosion is isolated to areas of the landscape where land use has exposed soil types with limited erosion resistance. Pre-mining surface erosion in drainage areas and creek crossings is evident across the site and is mainly associated with existing grazing activities and historically cleared areas. During the soil survey, erosion was noted at 16 of the 98 sample locations and on all four soil types.

Erosion was most prevalent on Sodosols in the north-east of Lancewood MLs and will have a tendency to be unstable if not ameliorated post-disturbance. Stream bank erosion was also identified within drainage lines, and sheet erosion on land adjacent to dirt tracks (see Figure 11).

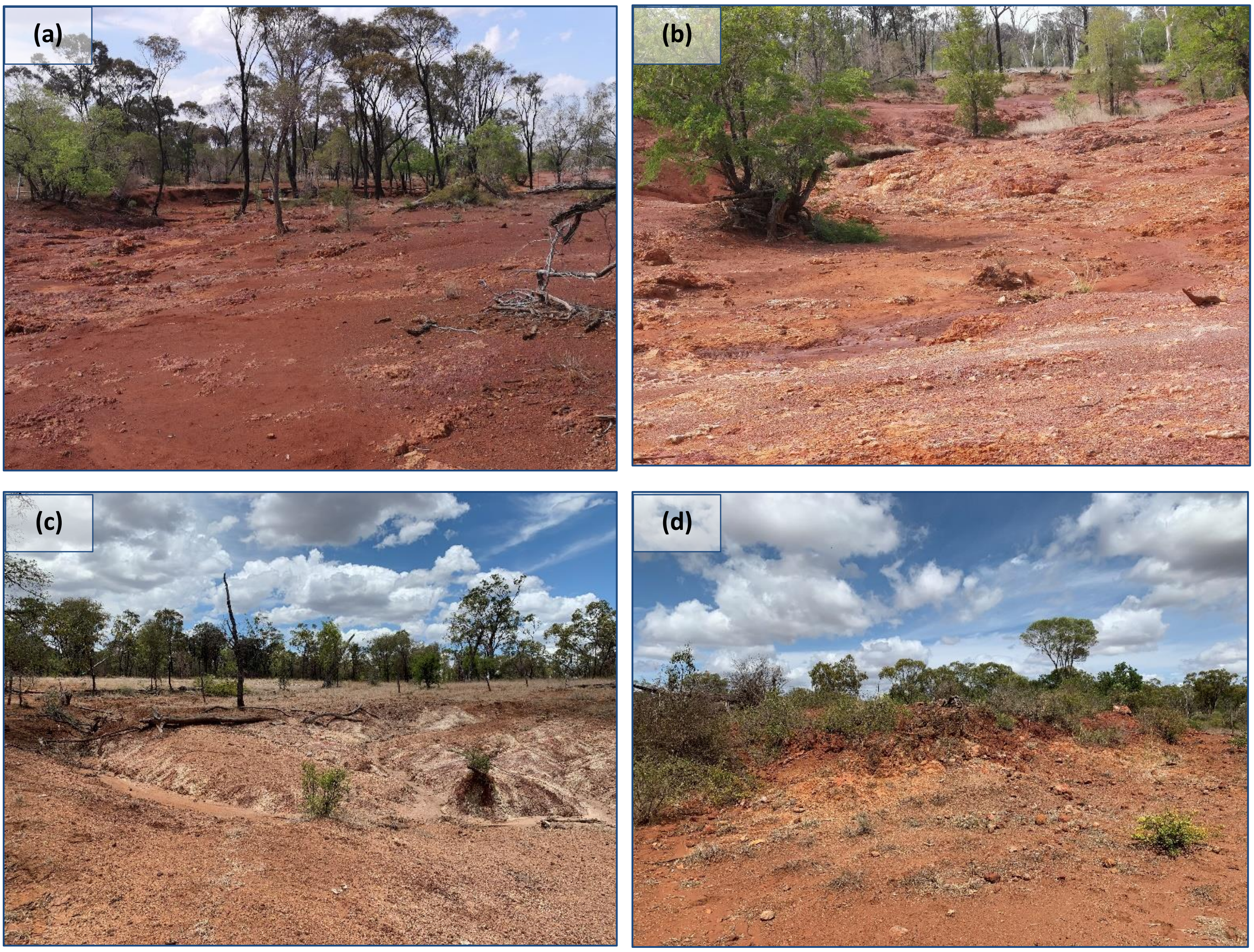


Figure 11 ***Evidence of surface erosion due to existing grazing activities and historical land clearance in the Wards Well area*** **- a) Sheet erosion adjacent to creek; b) Stream bank erosion; c) Sheet erosion leading to flow concentrating features; and d) Stream bank erosion.**

2.2.8 Vegetation communities and ecological data

2.2.8.1 Vegetation communities

The vegetation communities at Wards Well comprises a mix of non-remnant pasture, remnant vegetation and regrowth vegetation.

Disturbance due to historical land uses, including grazing, have created a mosaic of intact and regrowth communities at varying stages of maturity which are interspersed with non-remnant areas. The area north of Suttor Development Road is dominated by remnant natural grasslands and *Eucalyptus orgadophila* open grassy woodlands on basalt derived soils, most of which has been highly disturbed due to grazing.

The western boundary contains lateritic jump-up areas and the far northern boundary contains Acacia thickets and Eucalypt woodlands on weathered Tertiary surfaces. Brigalow dominated forest/woodland communities are also scattered throughout the area north of Suttor Development Road.

Vegetation south of Suttor Development Road is also dominated by natural grasslands and *Eucalyptus orgadophila* open grassy woodlands on basalt derived soils, much of which is in remnant condition. The southern area is dominated by a mosaic of *Eucalyptus crebra* and *Eucalyptus populnea* woodlands on weathered Tertiary surfaces, with small pockets of semi-evergreen vine thicket (SEVT) and sections of Brigalow dominated woodlands on the southern boundary.

Waterways that traverse the northern and central portion of the study area support fringing riparian Eucalypt communities.

The ground-truthed vegetation communities recorded at Wards Well and the associated Regional Ecosystems (RE), and the remnant or regrowth status is listed in **Table 8** (**Appendix 3**)[8]. The remainder of the vegetation recorded in the Wards Well study area is represented as non-remnant (**Appendix 3**).

Table 8 Vegetation communities ground-truthed within the Wards Well area

RE	Short description	Biodiversity status[1]	Condition	Area (ha)
11.3.1	*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains	Endangered	Remnant	11.1
			Mature regrowth	51.6
11.3.25	*Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines	Of concern	Remnant	79.9
11.3.3	*Eucalyptus coolabah* woodland on alluvial plains	Of concern	Remnant	4.4
11.3.3a	*Melaleuca bracteata* woodland. On alluvial plains. Riverine wetland or fringing riverine wetland	Of concern	Remnant	34.1
11.4.8	*Eucalyptus cambageana* woodland to open forest with *Acacia harpophylla* or *A. argyrodendron* on Cainozioc clay plains	Endangered	Remnant	39.0
			Mature regrowth	56.1
11.4.9	*Acacia harpophylla* shrubby woodland with *Terminalia oblongata* on Cainozioc clay plains	Endangered	Remnant	48.2
			Mature regrowth	252.1

[8] Ecological Australia (10 June 2016): Wards Well/Lancewood Brigalow TEC Assessment

RE	Short description	Biodiversity status[1]	Condition	Area (ha)
11.5.3	*Eucalyptus populnea* ± *E. melanophlois* ± *Corymnbia clarksoniana* woodland on Cainozioc sandy plains and/or remnant surfaces	No concern at present	Remnant	429.4
			Mature regrowth	81.8
11.5.3b	*Eucalyptus populnea* on closed depressions	No concern at present	Remnant	40.3
11.5.9	*Eucalyptus crebra* woodland on Cainozioc sand plains and/or remnant surfaces	No concern at present	Remnant	1,361.0
			Mature regrowth	106.5
11.5.15	Semi-evergreen vine thicket on Tertiary surfaces	Endangered	Remnant	57.5
11.7.1x	Semi-evergreen vine thicket	Of concern	Regrowth	5.2
11.7.2	*Acacia spp*. woodland on Cainozioc lateritic duricrust. Scarp retreat zone.	No concern at present	Remnant	11.8
11.8.11	*Dichanthium sericeum* grassland on Cainozioc igneous rocks	Of concern	Remnant	1,661.8
11.8.11a	*Melalueca bracteata* woodland drainage depressions. Occurs in drainage depressions	Of concern	Remnant	9.5
11.8.5	Eucalyptus orgadophila open woodland on Cainozioc igneous rocks	No concern at present	Remnant	1,166.2
			Mature regrowth	42.0
11.8.15	*Eucalyptus populnea* woodland on Cainozioc igneous rocks	Endangered	Remnant	9.3
11.9.2	*Eucalyptus melanophloia* and/or *E. orgadophila* woodland on Cainozioc fine grained sediments	No concern at present	Remnant	65.0
11.9.5	*Acaia harphphylla* and/or *Casuarina cristata* open forest with semi-evergreen vine thicket understorey	Endangered	Remnant	18.7
			Mature regrowth	204.1

RE	Short description	Biodiversity status[1]	Condition	Area (ha)
11.9.7	*Eucalyptus populnea* woodland on Cainozioc fine grained sediments	Of concern	Remnant	8.4
			Mature regrowth	8.7
11.9.7a	*Eucalyptus populnea* shrubby woodland on Cainozioc fine grained sediments	Of concern	Remnant	25.3
11.9.9	*Eucalyptus crebra* grassy woodland on Cainozioc fine grained sediments	No concern at present	Remnant	92.0
-	Brigalow regrowth	-	-	394.4
-	Eucalypt regrowth	-	-	86.5

[1] Vegetation Management Act 1999 (VM Act)

Additional terrestrial ecology surveys were undertaken across the MLs in 2024. The surveys identifies a total of approximately 3,729 ha of remnant vegetation and 441 ha of mature regrowth was ground-truthed within the MLs. A summary of REs, associated vegetation condition class and area is provided in Table 9. REs recorded within the MLs comprised:

- 3,728.58 ha of remnant vegetation;
- 441.23 ha of mature regrowth vegetation;
- 1,018.80 ha non-remnant vegetation, comprising:
- 269.82 ha of non-remnant young woody regrowth vegetation; and
- 748.98 ha of non-remnant (other vegetation).

Endangered (VM Act class) communities were associated with Cainozoic sand plains (land zone 5) and undulating country on fine grained sedimentary rocks (land zone 9) within the MLs.

Of Concern (VM Act class) REs were located along riparian corridors (land zone 3) and Cainozoic basalt plains (land zone 8) within the MLs.

The extent of remnant vegetation throughout the MLs was largely consistent with DoR Vegetation Management mapping (DoR, 2021a). Inconsistencies between DoR mapped and ground-truthed vegetation extents within the MLs include:

- heterogenous polygons were observed to contain fewer RE types than mapped in some instances, and in other instances more RE types were recorded than mapped by DoR.
- some areas mapped by DoR as non-remnant were observed to support remnant and regrowth vegetation.

Table 9 Ground-truthed REs within the Study Area

RE	RE description	RE type	Biodiversity status	VM Act class	Broad Vegetation Group (BVG) (1:1M)	Extent within Study Area (ha)
11.3.25d	*Eucalyptus tereticornis, E. camaldulensis* and *Melaleuca bracteata* woodland fringing drainage lines	Remnant	Of concern	Least concern	22c	30.54
11.5.3	*Eucalyptus brownii* woodland on Cainozoic sand plains and/or remnant surfaces	Remnant	No concern at present	Least concern	17a	170.11
		Mature regrowth	No concern at present	Least concern	17a	29.64
		Non-remnant: young woody regrowth	NA	NA	NA	29.91
11.5.15	Semi-evergreen vine thicket on Cainozoic sand plains and/or remnant surfaces	Remnant	Endangered	Least concern	7a	32.02
		Mature regrowth	Endangered	Least concern	7a	3.99
		Non-remnant: young woody regrowth	NA	NA	NA	114.58
11.5.16	*Acacia harpophylla* open forest in depressions on Cainozoic sand plains and remnant surfaces	Remnant	Endangered	Endangered	25a	196.66
		Mature regrowth	Endangered	Endangered	25a	221.16

RE	RE description	RE type	Biodiversity status	VM Act class	Broad Vegetation Group (BVG) (1:1M)	Extent within Study Area (ha)
		Non-remnant: young woody regrowth	NA	NA	NA	122.48
11.5.17	*Eucalyptus tereticornis* and *E. camaldulensis* woodland in depressions on Cainozoic sand plains and remnant surfaces	Remnant	Endangered	Endangered	34d	4.16
11.5.9c	*Eucalyptus crebra +/- Corymbia intermedia +/- E. moluccana +/- C. dallachiana woodland.* Occurs on Cainozoic sandplains formed on plateaus and broad crests of hills and ranges. Soils are generally deep red earths.	Remnant	No concern at present	Least concern	18b	2119.64
		Mature regrowth	No concern at present	Least concern	18b	35.35
		Non-remnant: young woody regrowth	NA	NA	NA	34.66
11.7.1x1	Semi-evergreen vine thicket on the slopes and scarps of rocky residual ranges with Cainozoic lateritic duricrust.	Remnant	Of concern	Least concern	7a	10.67
11.7.2	Acacia spp. woodland on Cainozoic lateritic duricrust. Scarp retreat zone	Remnant	No concern at present	Least concern	24a	3.50

RE	RE description	RE type	Biodiversity status	VM Act class	Broad Vegetation Group (BVG) (1:1M)	Extent within Study Area (ha)
11.8.11	*Dichanthium sericeum* grassland on Cainozoic igneous rocks.	Remnant	Of concern	Of concern	30b	741.57
11.8.5	*Eucalyptus orgadophila* open woodland on Cainozoic igneous rocks	Remnant	No concern at present	Least concern	11a	421.79
		Mature regrowth	No concern at present	Least concern	11a	20.19
11.9.5	*Acacia harpophylla and/or Casuarina cristata* open forest to woodland on fine-grained sedimentary rocks	Mature regrowth	Endangered	Endangered	25a	99.48
Non-remnant	Cleared paddocks and disturbed areas dominated by introduced pasture grasses such as *Cenchrus ciliaris*	non-remnant: other vegetation	NA	NA	NA	320.95

2.2.8.2 Category B environmental sensitive areas – endangered regional ecosystems

Under the *EP Act*, all REs with a biodiversity status as Endangered are classified as a Category B Environmentally Sensitive Areas (ESA).

Requirements for managing impacts to Category B ESAs are included in the EA and PRCP schedule. Condition PRCP4 requires: *"Rehabilitation of areas disturbed in Category B Environmentally Sensitive Area or within 500m of a Category B Environmentally Sensitive Area must commence as soon as practicable to the extent that erosion impacts are minimised and be completed as soon as practicable but no longer than three (3) months after completion of the disturbance activity"*.

Figure 1 of the proposed de-amalgamated EA shows mapping of Category B ESAs associated with Endangered REs as approved under the EA and includes a 500m shaded buffer area.

Exploration activities have been designed to avoid, where possible Category B ESAs, or have implemented management actions to reduce impacts such as minimising ground impacts by slashing or accessing each proposed drill site utilising existing tracks wherever possible. Where new tracks are required, tracks will be positioned to cause the least environmental impact.

2.2.8.3 Threatened ecological communities

Three threatened ecological communities (TECs) listed as Matters of National Significance (MNES) under the *Environment Protection and Biodiversity Conservation Act 1999* (the EPBC Act) were ground-truthed within the Wards Well area (**Appendix 3**) and (**Appendix 4**), and included:

- Brigalow (*Acacia harpophylla* dominated and co-dominated) Threatened Ecological Community (Brigalow TEC);
- Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin (Best quality);
- Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin (Good quality) and/or
- Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions (SEVT TEC).

The Brigalow TEC was identified in small patches across the Wards Well MLs, within a total area of 91.2ha (**Figure 12**). Natural Grasslands dominate the centre and north of the Wards Well MLs - patches meeting the key diagnostic and condition threshold of the TEC in good quality were identified within an area of 234.0 ha and best quality within 552.4 ha (**Figure 12**). SEVT TEC was identified in small patches in the south, within an area of 57.5 ha (**Appendix 4**) (**Figure 12**)[16].

For exploration activities, areas of Brigalow and SEVT TEC are subject to management measures to reduce impacts. However, the impact of clearing activities is inherently diminished in Natural Grassland TEC areas and opportunities exist to further minimise disturbance through managed slashing.

2.2.8.4 Threatened flora

The threatened flora species *Dichanthium queenslandicum*, which is currently listed as Endangered under the EPBC Act and Vulnerable under the Nature Conservation Act 1992 (NC Act), was previously identified in Natural Grassland habitat within the Wards Well MLs.

There are no specific requirements in the Wards Well EA or PRCP schedule for inclusion of threatened flora species in the rehabilitation planning.

Additional terrestrial ecology surveys were undertaken across the MLs in 2024. The surveys identified the likelihood of occurrence assessment identified two threatened flora species that are known to occur within the MLs. The species include:

- *Dichanthium queenslandicum* – Endangered under the EPBC Act and Nature Conservation Act 1992 (NC Act).

- *Digitaria porrecta* – Near Threatened under the NC Act.

Dichanthium Queenslandicum

1,800 tussocks of this species were identified within the northern part of the MLs in association with areas of remnant bluegrass grasslands and open woodlands on basalt plains with low weed abundance.

Preferred habitat mapped for the species within the MLs includes:

- Areas of remnant bluegrass grasslands and open woodlands on basalt plains with low weed abundance (RE 11.8.11 and 11.8.5) where records of D. queenslandicum were present within the ML.

Digitaria Porrecta

71 tussocks were identified within the northern and central eastern part of the ML in associations with areas of remnant bluegrass grasslands and open woodlands on basalt plains with low weed abundance.

Preferred habitat mapped for the species within the Project Area and greater Study Area includes:

- Areas of remnant bluegrass grasslands and open woodlands on basalt plains with low weed abundance (RE 11.8.11 and 11.8.5) where records of D. porrecta were present within the Study Area.

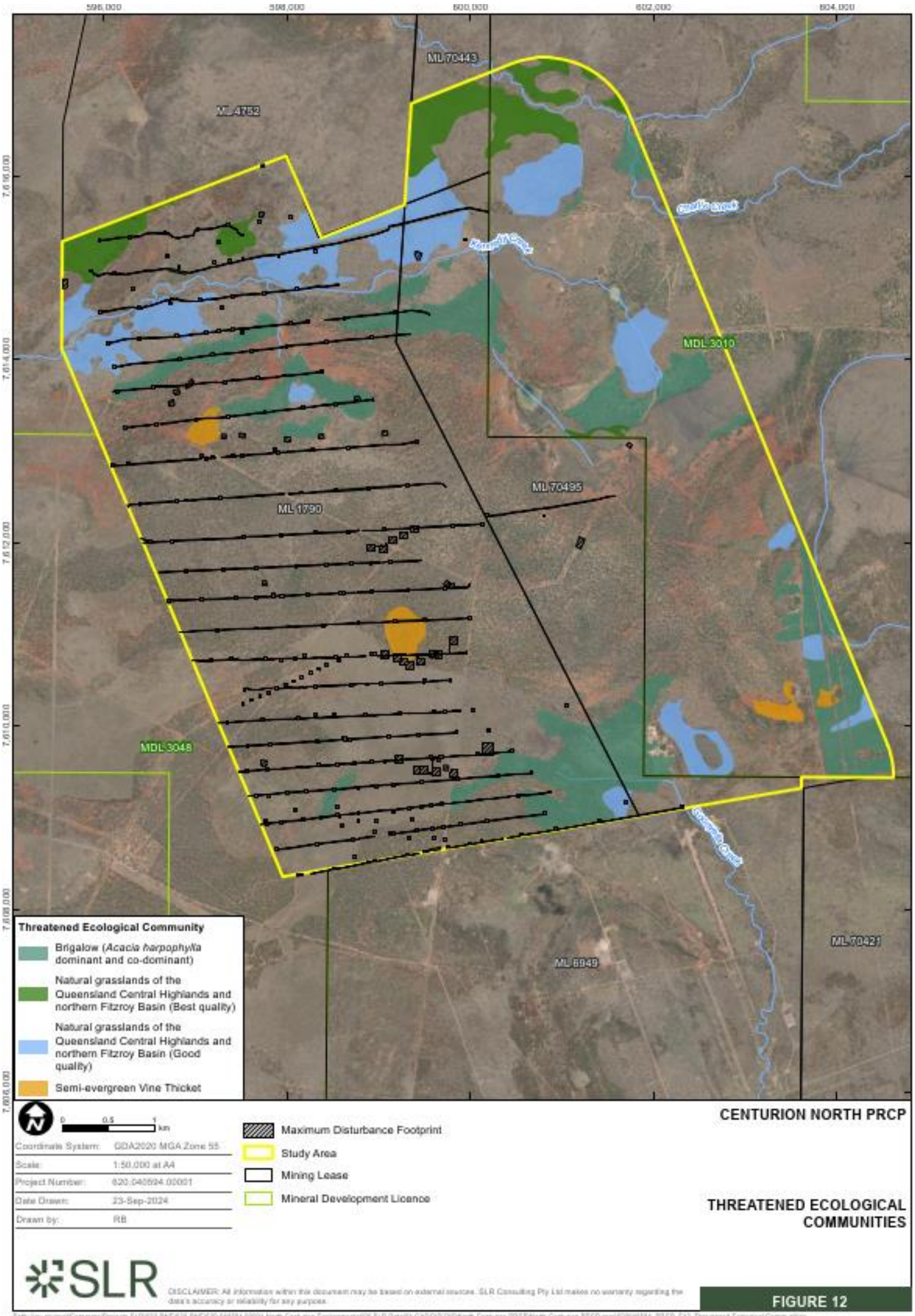


Figure 12 TEC mapping

2.2.9 Fauna presence and populations

A desktop and field based ecological assessment was undertaken to identify the potential presence of native and introduced fauna populations at Wards Well[9] (**Appendix 4**).

There were 19 threatened fauna species and 11 migratory species listed under the *EPBC Act* and/or *NC Act* returned from initial desktop searches that may occur within the Wards Well area. The likelihood of occurrence of each of these species was assessed based on each species known distribution, habitat quality and species occurrence within the region. The results of the likelihood of occurrence assessment are summarised in **Table 10**. The results returned two threatened fauna species as likely to occur, two threatened mammal species with potential to occur, four migratory species with potential to occur, and eight declared pest species under the *Biosecurity Act 2014* as potentially occurring within the wards well study area.

There are no specific requirements in the Wards Well EA or PRCP schedule for inclusion of fauna habitat planning in the rehabilitation planning.

Table 10 Fauna populations within the Wards Well area

Species name	Common name	Status	Likelihood of occurrence
Threatened species			
Geophaps scripta	Squatter Pigeon	Vulnerable EPBC Act and NC Act	Likely
Denisonia maculata	Ornamental Snake	Vulnerable EPBC Act and NC Act	Likely
Phascolarctos cinereus	Koala	Vulnerable EPBC Act and NC Act	Potential
Petauroides volans	Greater Glider	Vulnerable EPBC Act and NC Act	Potential
Migratory species			
Apus pacificus	Fork-tailed Swift	Migratory	Potential
Hirundapus caudacutus	White Throated Needletail	Migratory	Potential
Monarcha melanopsis	Black Faced Monarch	Migratory	Potential
Plegadis falcinellus	Glossy Ibis	Migratory	Potential
Introduced species			
-	Feral deer	Restricted invasive	Potential

[9] Ecological Australia (18 August 2017): Wards Well Coal Project – Ecological Assessment Report. Project No. 17BRIECO-4089

Species name	Common name	Status	Likelihood of occurrence
Capra hircus	Goat	Restricted invasive	Potential
Felis catus	Cat	Restricted invasive	Potential
Mus musculus	House mouse	Other invasive	Potential
Oryctolagus cuniculus	Rabbit	Restricted invasive	Potential
Bufo marinus	Cane toad	Other invasive	Potential
Sus scrofa	Pig	Restricted invasive	Potential
Vulpes	Red fox	Restricted invasive	Potential

Additional terrestrial ecology surveys were undertaken across the MLs in 2024. The surveys identified the likelihood of occurrence assessment identified two threatened fauna species and one conservation significant species that are known to occur within the MLs. Given the presence of mapped habitat within the MLs, these species are also considered known to occur. The species include:

- Koala (*Phascolarctos cinereus*) – Endangered under the EPBC Act and NC Act.
- Short-beaked echidna (*Tachyglossus aculeatus*) – Special least concern under the NC Act.
- Squatter pigeon (southern) (*Geophaps scripta scripta*) – Vulnerable under the EPBC Act and the NC Act.

An additional threatened fauna species was assessed as likely to occur within the Study Area and Project Area, including:

- *White-throated needletail (Hirundapus caudacutus) – Vulnerable under the EPBC Act and the NC Act.*

2.2.9.1.1 Koala

Individuals were identified from two BAR locations within the central western and central parts of the MLs. All records were in areas of *Eucalyptus crebra* woodland and *Eucalyptus brownii* woodland (RE 11.5.9c).

Koala habitat within the MLs has been mapped as either preferred, suitable or marginal habitat, with guidance from *A review of koala habitat assessment criteria and methods* (Youngentob et al., 2021).

Preferred habitat mapped for the species within the MLs includes:

- Areas of remnant riparian eucalypt woodland RE 11.3.25d with locally important koala trees (LIKTs) present with high moisture content (*E. tereticornis and E. camaldulensis*) and connectivity to other areas of preferred habitat.

Suitable habitat mapped for the species within the MLs includes:

- Areas of remnant and mature regrowth eucalypt woodland REs 11.5.3, 11.5.9c, 11.8.5 and 11.5.17 providing abundant LIKTs (*E. brownii, E. crebra and E. tereticornis*) where koalas were recorded within the MLs.

Marginal habitat mapped for the species within the ML includes:

- Areas of remnant and regrowth brigalow dominated communities RE 11.5.16 and 11.9.5 providing few LIKTs (E. cambageana) and ancillary habitat trees (A. harpophylla) that provide limited feeding resources but may facilitate dispersal to other areas of suitable and preferred habitat.

2.2.9.1.2 Short-beaked Echidna

One individual was identified with the central part of the ML. This record was recorded in remnant *Eucalyptus crebra* woodland (RE 11.5.9c). Scats attributable to the species were also recorded in multiple locations in remnant vegetation within the MLs.

Short-beaked echidna habitat within the MLs has been mapped as either suitable or marginal habitat.

Suitable habitat mapped for the species within MLs includes:

- Areas of remnant and mature regrowth woodland REs providing habitat features such as large woody debris, shrubby areas and logs suitable for short-beaked echidna.

Marginal habitat mapped for the species within the MLs includes:

- Areas of grasslands and young woody regrowth vegetation providing limited habitat features such as large woody debris, shrubby areas and logs suitable for short-beaked echidna and provides dispersal habitat between areas of preferred habitat.

2.2.9.1.3 Squatter Pigeon (southern)

A total of 65 squatter pigeon (southern) individuals were recorded across the MLs. Records were in proximity to dams where there were trees nearby to disperse into when startled. Wooded areas with tree cover had lower levels of grass productivity with mid-dense to sparse ground cover. These areas are likely to be more suitable for squatter pigeon (southern) foraging habitat.

Squatter pigeon (southern) habitat within the MLs has been mapped as either preferred, suitable or marginal habitat with guidance from the DCCEEW species profile (DotE, 2022).

Preferred habitat mapped for the species within the MLs includes:

- Areas within 1 km of permanent water source suitable for breeding, that are areas of remnant and mature regrowth eucalypt woodland REs suitable for foraging.

Suitable habitat mapped for the species within the MLs includes:

- Areas within 3 km of permanent water source that are areas of remnant and mature regrowth eucalypt woodland REs suitable for foraging.

Marginal habitat mapped for the species within the MLs includes:

- Dispersal habitat which includes non-remnant areas within 3km of a permanent water source.

2.2.9.1.4 White-throated Needletail

White-throated needletail was not detected during the field surveys, however, has been previously recorded nearby (approximately 20 km) the MLs (ALA, 2024) and is considered likely to occur. Suitable habitat for the species includes a broad range of vegetation communities that support feeding resources in which they fly in the airspace above. No areas of emergent trees with hollows in woodlands or tall trees at the edges of clearing were observed within the MLs.

Marginal habitat mapped for the species within the MLs includes:

- All areas that provide aerial space above suitable for foraging.

2.2.9.2 Migratory Fauna

The likelihood of occurrence assessment identified two migratory fauna species that are likely to occur within the ML, including:

- Fork-tailed swift (*Apus pacificus*) – Migratory under the EPBC Act and Special least concern under the NC Act.
- Oriental cuckoo (*Cuculus optatus*) - Migratory under the EPBC Act and Special least concern under the NC Act.

An additional two migratory fauna species were assessed as likely to occur within the MLs. These species include glossy ibis (*Plegadis falcinellus*) and Latham's snipe (*Gallinago hardwickii*) (Migratory under the EPBC Act and Special least concern under the NC Act).

2.2.9.2.1 Fork-tailed Swift

Fork-tailed swift was not detected during the field surveys, however, has been previously recorded nearby (approximately 20 km) the MLs (ALA, 2024) and is considered likely to occur. Suitable habitat for the species include a broad range of vegetation communities that support feeding resources in which they fly in the airspace above.

Marginal habitat mapped for the species within the MLs includes:

- All areas that provide aerial space above suitable for foraging.

2.2.9.2.2 Oriental Cuckoo

Oriental cuckoo was not detected during the field surveys, however, has been previously recorded approximately 17 to 25 km from the MLs (BMA, 2014; ALA, 2024) and is considered likely to occur. The species does not breed in Australia. Suitable habitat for the species' only includes intermittent roosting and foraging habitat (DotE, 2015). Suitable habitat for the species includes a broad range of vegetation communities that support feeding and dispersal of the species. Therefore, oriental cuckoo habitat within the MLs has been mapped as marginal habitat with guidance from the *Referral guideline for 14 birds listed as migratory species under the EPBC Act* (DotE, 2015).

Marginal habitat mapped for the species within the ML includes:

- All areas of remnant and regrowth woodland communities that intermittently provide roosting, feeding and dispersal opportunities.

2.2.9.3 Pest Fauna

Five pest fauna species were recorded within the MLs. Four of these species were listed as restricted matters under the Biosecurity Act, including:

- Cane toad (*Rhinella marina*).
- Cat (*Felis catus*) – Category 3, 4 and 6 restricted matter.
- Wild dogs (*Canis lupus*) – Category 3, 4 and 6 restricted matter.

- European rabbit (*Oryctolagus cuniculus*) – Category 3, 4, 5, and 6 restricted matter.
- Feral pig (*Sus scrofa*) – Category 3, 4, and 6 restricted matter.

Pest fauna species have varying adverse impacts on the environment. Pigs are known to contribute to habitat degradation by damaging the banks of wetlands, creek lines and gilgai, uprooting vegetation, causing soil erosion, spreading weeds and browsing/grazing native flora. Evidence of habitat degradation caused by pig rooting was observed within the Study Area including damage around gilgai as well as within SEVT vegetation.

Carnivorous pest fauna such as feral cats and dingos and opportunistic carnivores such as feral pigs, are known to directly predate native fauna. In addition, cane toads outcompete native amphibians and are toxic to animals such as ornamental snake that predate upon them.

2.2.10 Pre-mining land use

The pre-mining land use of the area is cattle grazing. Some areas have previously been subject to vegetation clearing. Farm infrastructure such as water tanks, property water pipelines, windmills, bores, water troughs, feed troughs and dams are located throughout the area (**Figure 13**):

a) cattle and feed stations; and

b) windmills for livestock watering.

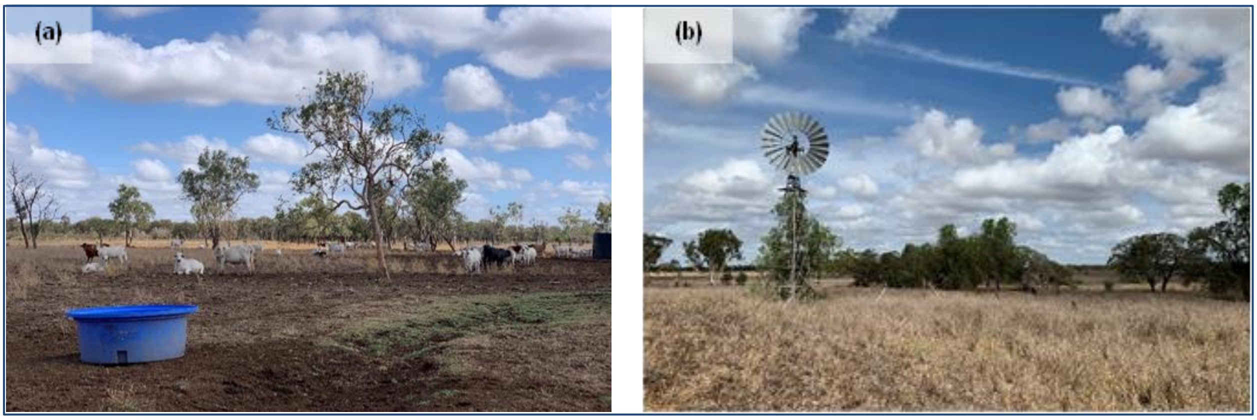


Figure 13 Evidence of existing cattle grazing-related land uses at Wards Well

Existing soil erosion is evident across the Wards Well area and is mainly associated with existing land use grazing activities; this includes evidence of historically cleared drainage lines and creeks (i.e. gully erosion) (**Figure 11 (a)** and **13(b)**).

The pre-mining land suitability classification for grazing of Wards Well, according to the DSITI & DNRM (2015) Guidelines for Agricultural Land Evaluation in Queensland[10] and the soil survey[7], is Class 2 for areas of Kandosol soil (i.e. suitable with minor limitations), and Class 3 for the Sodosol, Vertosol and Dermosol soil areas (i.e. suitable with moderate limitations). Class 2 land suitability covers approximately 53% of the Wards Well site and Class 3 covers the remaining 47% of the site[7].

[10] DSITI & DNRM (2015) Guidelines for agricultural land evaluation in Queensland, second edition, The State of Queensland (prepared by Department of Science, Information Technology and Innovation and Department of Natural Resources and Mines), Brisbane

2.2.11 Underlying landholders

The underlying landholders for the Wards Well leases are shown in **Table 11**, and illustrated in **Figure 14**.

Table 11 Underlying landholders for the Wards Well project area.

Mining Lease	Property	Landholder
ML 4752	Lancewood Lenton Downs	Pini family Mason family
	Dabin Holding	Stanmore SMC Pty Ltd
ML 1790	Dabin Holding Denham Park	Stanmore SMC Pty Ltd Stanmore SMC Pty Ltd
ML 70443	Dabin Holding Lenton Downs	Stanmore SMC Pty Ltd Mason family
ML 70495	Dabin Holding	Stanmore SMC Pty Ltd

2.3 Design for closure

This PRC plan has been developed to proactively manage progressive rehabilitation of the Centurion North site to a stable PMLU, aiming to minimise long-term management requirements as well as associated closure costs. Importantly, a focused design for closure underpins all sections of this plan from:

- the proposed exploration methods to development of the rehabilitation knowledge base (baseline information);
- engagement with relevant stakeholders to define suitable PMLUs;
- defining and implementing rehabilitation practices to identify risks that could influence achievement of milestone criteria; and
- demonstrating successful rehabilitation through defined site monitoring to develop a feasible PRCP schedule.

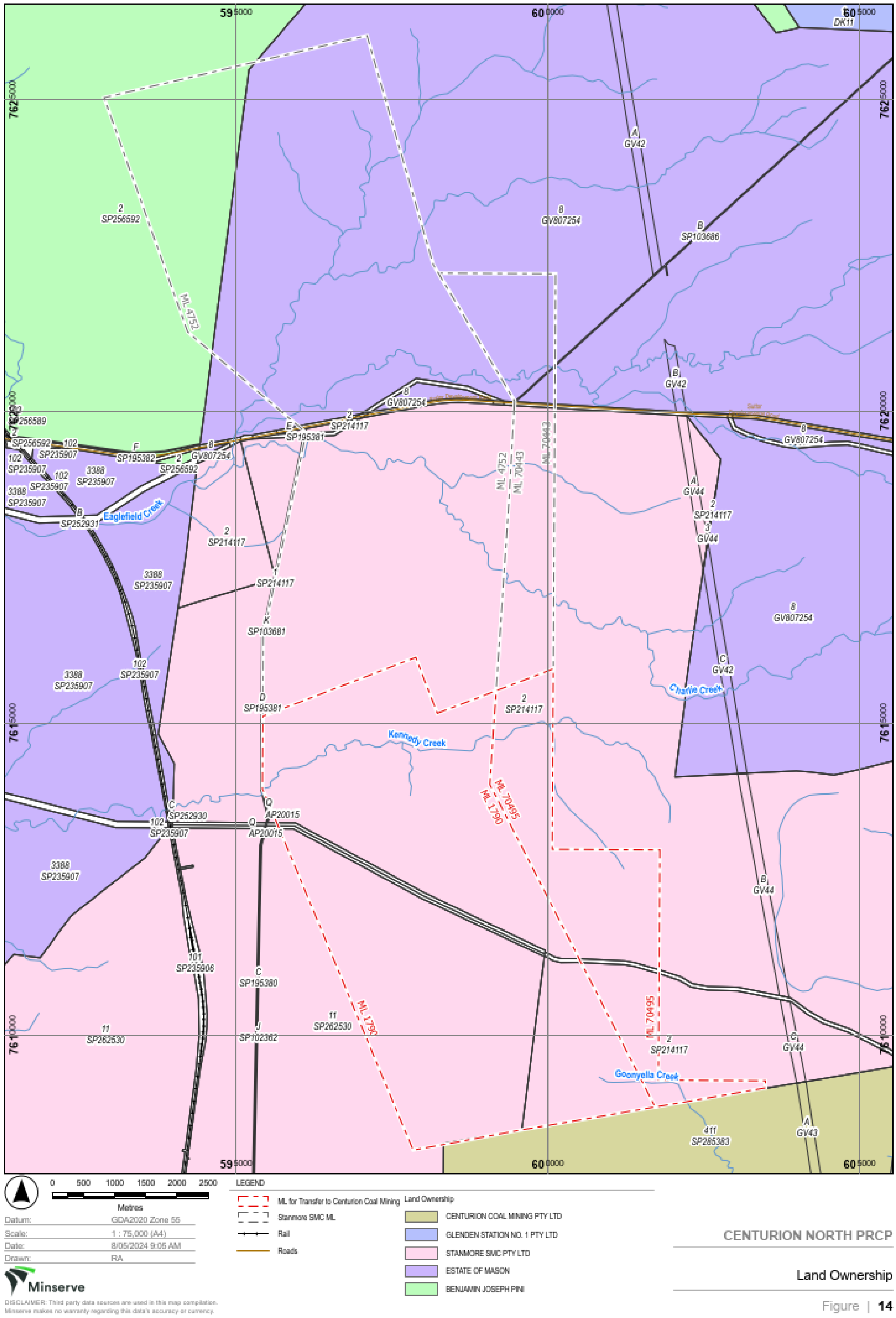


Figure 14 Land ownership

2.4 Rehabilitation and improvement planning

Legislative Requirement

In accordance with sections 126C(1)(b) and (c)(ii) of the *EP Act*, the rehabilitation planning part must include:

- identification of all relevant activities on the mine site;
- the predicted duration of each of the relevant activities proposed for the mine site;
- the size/extent of the relevant activities; and
- whether the different relevant activities can be progressively rehabilitated.

PRC Plan Guideline (Section 3.1)

Under section 126C(1)(j) of the *EP Act,* PRC plans must also include the following details about any existing rehabilitation already completed at the time of submission of the proposed PRC plan:

- a description of the rehabilitation works previously carried out;
- when the rehabilitation works commenced and were completed; and
- whether the rehabilitation has been applied for or approved as progressively certified under the *EP Act.*

2.4.1 Relevant activities

The relevant activities at Centurion North that will require rehabilitation are provided in **Table 12**. This table also provides the predicted duration of each activity from when the activity commences i.e. where topsoil is stripped, until it is available for rehabilitation.

Exploration drill areas will be progressively rehabilitated once drilling is complete.

Table 12 Relevant activities requiring rehabilitation at Wards Well

Relevant activity	Predicted duration	Size (ha)	Availability for progressive rehabilitation
Exploration drilling area (RA1)			
Exploration drilling pads and tracks	2021-2036	145	Areas to be progressively rehabilitated during this time period once pad and tracks are no longer required

∗EA indicates 1.8ha, which is the surface area of the box-cut floor

2.4.2 Rehabilitation areas and milestones

The activities in **Table 12** are grouped by rehabilitation area (RA). A rehabilitation area is defined in the PRCP Guideline as "*an area of land in the post-mine land use to which a rehabilitation milestone for the post-mining use relates*". A rehabilitation milestone (RM) for the rehabilitated land, *means each significant event or step necessary to rehabilitate the land to a stable condition (section 115 of the EP Act)1. EP Act*

The RAs and RMs for Centurion North are referred to throughout this PRC plan and are summarised in **Table 13.** (These are further illustrated in **Figure 24**, and detailed in the PRCP schedule).

Table 13 Rehabilitation areas (RAs) and rehabilitation milestones (RMs) for Wards Well

Rehabilitation area (RA)		Rehabilitation milestone (RM)	
		RM1	Infrastructure decommissioning and removal
		RM2	Remediation of contaminated land
		RM3	Landform development and reshaping
		RM4	Surface preparation
RA1	Exploration drilling area	RM5	Revegetation (cattle grazing)
		RM6	Achievement of surface requirements (cattle grazing)
		RM7	Achievement of post-mining land use to a stable condition (cattle grazing)

2.4.3 Existing rehabilitation

Rehabilitation of drill pads, tracks and seismic has occurred at Centurion North. **Figure 15** shows a drill site before (a) and after rehabilitation (b), which included the following standard Wards Well rehabilitation activities:

- Removing hole casings from drill holes;
- Draining any existing water from associated mud sumps;
- Backfilling drill chips in the drill hole and/or the associated mud sump;
- Blocking drill holes, and cementing surface hole where necessary;
- Covering and levelling drill pad area to allow for settlement, and then covering with topsoil;
- Removing all rubbish, casings and/or fencing from the site;
- Re-shaping and levelling the drill pad area;
- Ripping associated tracks to promote regrowth;
- Re-spreading topsoil (previously removed from the site) over the area;
- Contour ripping immediately after topsoil placement to control erosion; and
- Seeding the area.

The existing rehabilitation of drill sites – and the subsequent trajectory towards achievement of milestone criteria, has been determined based on a combination of aerial imagery analysis before and after approved drilling programs, as well as by field visits which have indicated the self-regeneration of pastures on rehabilitated drill sites (**Figure 15**)b.

No rehabilitation areas have applied for progressive certification under the *EP Act*.

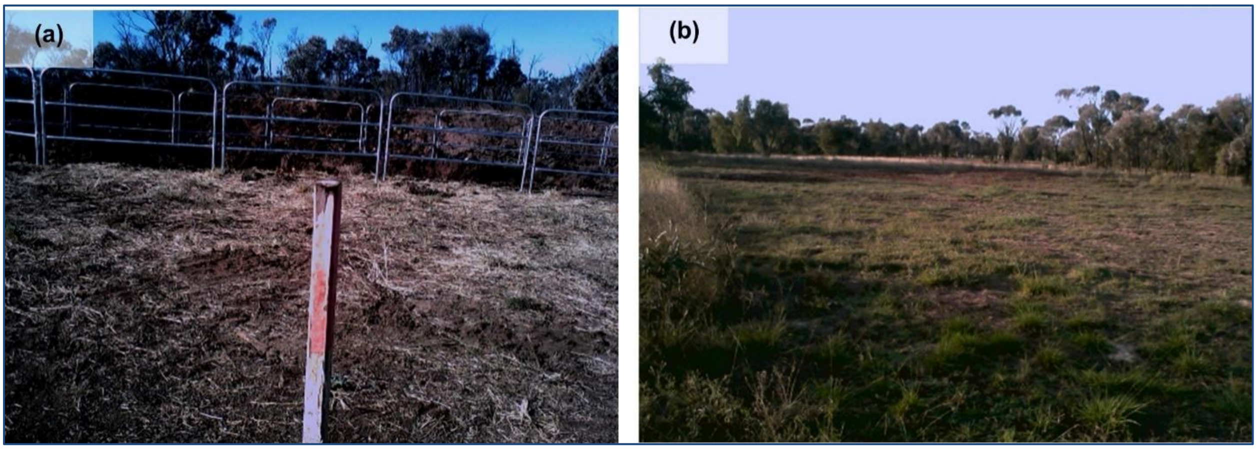


Figure 15 **Wards Well drill site DB12 before and after rehabilitation**

2.4.4 Seismic activities

No further seismic activities are currently planned for Centurion North.

3. COMMUNITY CONSULTATION

Legislative Requirement

In accordance with section 126C(1)(c)(iii) and (iv) of the *EP Act*, the rehabilitation planning part of the PRC plan must include:

- details of the consultation undertaken by the applicant in developing the proposed PRC plan; and
- details of how the applicant will undertake ongoing consultation in relation to the rehabilitation to be carried out under the plan.

PRCP Guideline (Section 3.5)

In developing the proposed PRC plan, the community should at least be engaged on the plan for the mine, PMLUs or NUMAs, areas of disturbance, rehabilitation and management methods, progressive rehabilitation, and closure timeframes. Ongoing community consultation should continue throughout the stages of the mine life so that progressive rehabilitation and the socio-economic and environmental impacts related to mine closure can be discussed with the community.

Community consultation carried out through different processes (such as an EIS) may be used to address the requirements in section 126C(1)(c) of the *EP Act*. The details of this consultation must be provided in the rehabilitation planning part of the proposed PRC plan).

PRC plans are still required to meet the legislative requirements in section 126C(1)(c) of the *EP Act*. All proposed PRC plans must contain a community consultation plan regardless of whether the site has an existing EA.

3.1 Consultation to date

Land within the Wards Well MLs was acquired in 2007. Further compensation agreements on other land parcels were executed in 2011 - 2012. Engagement with the affected landowners was undertaken to develop compensation, leasing and agistment agreements. This included advice that:

- in the near term, exploration activities were the only activities planned;
- underground mine was proposed for some time in the future; and
- until land was required for exploration or mining, it would be available for cattle grazing within the terms of the agistment agreements and leases.

Consultation has been undertaken for the Wards Well MLs, which incorporates the Lancewood MLs and Centurion North MLs and therefore remains relevant.

In essence, the outcome of consultation during the acquisition processes was that landowners and cattle would be excluded from affected areas whilst land disturbance was occurring, and the land would then be rehabilitated, and the landform returned to a state suitable for cattle grazing. The existing use for grazing (managed under agistment agreements and leases) has been discussed with directly-affected landholders as part of regular meetings between SMC and these stakeholders.

Consultation undertaken as part of the application for the original PRC plan and PRCP schedule preparation for Wards Well includes the following:

1. Meeting with Isaac Regional Council (IRC) about Wards Well's approved activities, PRC planning process and PMLUs; providing a presentation for Council's information, and an invitation for further discussion with Council about their involvement in future PRC plan consultations.

2. Writing to the three landholders that own or lease land within the MLs to provide a project update and information about the approved activities and PMLUs under Wards Well's EA; inviting feedback; and discussing ongoing engagement regarding the form of landholder involvement in future PRC planning consultations.

3. Writing to Widi People who are the Traditional Owners of land within ML1790 and ML70495 to provide an update on Wards Well and information on approved activities and PMLUs within the MLs.

4. Writing to utility owners and the owners of overlapping tenures (mining and gas exploration) within the Wards Well MLs to advise that a PRC plan was being prepared, and to let them know that further engagement in future stages of Wards Well's development will be undertaken.

5. Writing to other interested stakeholders including adjacent landholders, IRC and government representatives to advise that a PRC plan was being prepared; provide information about Wards Well's progressive rehabilitation and approved PMLUs; and invite stakeholders to contact SMC if they would like to discuss the PRC plan or obtain more information.

3.2 Community consultation register

A community consultation register has been provided as part of the application for the original PRC plan and PRCP schedule in compliance with section 126C(1)(c)(iii) of the *EP Act* and includes:

- identification of each community member/stakeholder;
- all recorded previous engagements with the community;
- consultation date(s);
- description of consultation type (e.g. letters, meetings and communication strategies);
- information provided to the community;
- issues raised/discussed;
- how issues raised and the outcomes of engagement have been considered in decision-making; and
- commitments made by the applicant.

The stakeholders identified as part of this register are considered as having a genuine, demonstrable and legitimate interest in Wards Well's ongoing rehabilitation and closure planning. Relevant stakeholders identified for Wards Well's PRC planning and the proposed exploration program are provided in

Table *14*.

The complete community consultation register provided in **Appendix 6**, and will be a live instrument that will be updated for recording future consultation on Centurion North PRC plan.

Table 14 Key stakeholders identified as part of the Wards Well's community consultation register

Stakeholders	Details	Interests
Affected stakeholders		
Traditional owners - Widi People	The Widi People (whose claim was recognised by the NNTT (National Native Title Tribunal) in 2015) are the Traditional Owners of land to the east of Wards Well, with a small area of land within ML1790 and ML70495 within the Widi People's claim area.	• Cultural heritage impacts. • Impacts on Native Title. • Potential for impacts on the cultural landscape or connections to Country. • Post-mining land use and landform / landscape. • Environmental management / stewardship. • Employment and business opportunities in exploration, environmental management and monitoring, rehabilitation.
Affected landowners and lessees	SMC has agreements with three landholders within the Wards Well MLs – two landowners and two lessees of land owned by BMC. Land within the MLs is used for grazing. Compensation Agreements are in place for properties within the MLs. The two landholder properties do not overlap the Centurion North MLs; however they remain stakeholders.	• Access to land owned by SMC whilst not required for mining purposes. • Future access to and ownership of lands. • Compensation for impacts on land use. • Water access – water allocations, water pipelines. • Environmental management / stewardship. • PMLU and landform/landscape.
Utility owners • Powerlink • Aurizon • Sunwater • DTMR	Utility owners with assets within Wards Well MLs include Powerlink (electricity transmission), Sunwater (Burdekin water supply pipeline and Eungella water pipelines), Aurizon (rail infrastructure) and DTMR (Suttor Development Road and an unformed road). SMC engages with utility owners as required, i.e. through issue-specific or transactional engagement. Implementation of the PRC plan will require update to agreements with utility owners. Some infrastructure assets may not be located on the Centurion North MLs; however utility owners remain as stakeholders.	• Impact on assets/asset value. • Remediation of impacts on assets. • Service disruptions and mitigations. • Crossing/interface agreements.
Owners of overlapping tenures • Arrow Energy	Arrow Energy have overlapping tenures with the Centurion North MLs (for coal seam gas production). Relationships with overlapping tenures owners are managed as part of statutory and commercial processes.	• Any impacts on the use or availability of land within overlapping tenures. • Water access. • Access to land owned by SMC whilst not required for mining purposes. • Crossing/interface agreements.

Stakeholders	Details	Interests
Adjacent private landholders	To the east and west of Wards Well MLs, SMC owns land which is used as a buffer to manage the potential for conflicting land uses. Peabody's North Goonyella mine adjoins the southern boundary of the mining lease. Land owned by private landowners is located to the west and east. Land uses on adjacent land holdings include grazing and mining.	• Environmental management / stewardship. • PMLU and landform/landscape. • Access to land owned by BMC whilst not required for mining purposes. • Rehabilitation schedule. • Future access to and ownership of lands.
Local Government • Isaac Regional Council	Isaac Regional Council is the local government and planning authority for the Isaac LGA which encompasses some 58,000km^2 and 17 distinct and diverse communities.	• Local job opportunities. • Economic and community sustainability and transformation (towards post-mining). • Environmental stewardship. • Effects of on Council services and infrastructure e.g. changes to infrastructure agreements, water supply or road maintenance. • Mine rehabilitation progress. • Management of closure impacts on employment and businesses. • Accordance of SMC rehabilitation plans with local and regional planning goals.
Interested stakeholders		
Other nearby landholders	Several landholders are located within a 5-6km radius around Wards Well. SMC has established relationships with landholders to the south and east of Wards Well.	• Post-mining land use and landform/landscape. • Access to land owned by SMC. • Rehabilitation schedule. • Future access to and ownership of lands.
Jangga People	The Jangga People (whose claim was recognised in 2012) are the Traditional Owners of land to the west of Wards Well's MLs.	• Potential for impacts on the cultural landscape or connections to Country. • PMLU and landform / landscape. • Employment and business opportunities in exploration, environmental management and monitoring, rehabilitation.
Stanmore employees and contractors	Centurion North does not have an established on-site workforce. Exploration and land management functions are performed by contractors. Other SMC personnel will be interested in closure planning if they perceive that it may affect their employment security.	• Job opportunities. • Loss of jobs with closure. • Closure planning in context with other mining industry changes e.g.

Stakeholders	Details	Interests
Unions	Unions with members who are employed by SMC include the Construction, Forestry, Mining and Energy Union (CFMEU), the Australian Manufacturing Workers' Union (AMWU) and the Electrical Trades Union (ETU). SMC maintains relationships with unions with respect to enterprise bargaining agreements, working conditions and workplace health and safety.	technology advances, autonomous haulage. • Workers' conditions. • Sustainability of communities that are dependent on mining.
Businesses	SMC has processes to identify small, local businesses as well business owned by traditional owners. Stanmore seeks to promote vendor growth through improving working capital in a timely manner, i.e. favorable payment terms.	• Opportunities to participate in supply chain (e.g. exploration, environmental management, rehabilitation). • Economic transformation (towards post-mining). • Economic and community sustainability. • Loss of supply opportunities with closure.
Community members and groups	SMC is strongly affiliated with the communities of Moranbah and nearby smaller regional towns (in the Isaac LGA).	• Local job opportunities. • Local business opportunities. • Community and regional sustainability. • Environmental management. • Future use of mined land. • With closure of an operation, loss of jobs and supply opportunities. • Rehabilitation schedules.
Queensland Government	State government representatives and agencies with an interest in PRC planning include: • Office of the Minister for Resources • Office of the Minister for Environment, Great Barrier Reef, Science and Innovation • Member for Burdekin • Member for Gregory • Shadow Minister for Resources and Critical Minerals • Department of Resources (DoR) - Deputy Director-General Georesources • DESI – PRCP Team and Emerald Business Centre	• Legislative compliance. • Resource development. • Employment opportunities. • Public interest. • Environmental management. • Financial assurance. • Environmental risk identification and management. • Future land use and landform. • Company responses to stakeholder views.
Federal Government	The Department of Climate Change, Energy, the Environment and Water (DCCEEW) is the lead agency for environmental protection at Commonwealth level.	

3.3 Ongoing consultation

3.3.1 Consultation objectives, engagement type and frequency

A dedicated Community Consultation Plan (CCP) has been compiled for Wards Well's PRC planning[11] (**Appendix 6**). This plan documents the iterative consultation process to be followed to enable ongoing engagement with relevant stakeholders (**Table 15**) and will form the basis for consultation on Centurion North.

Table 15 Process to be followed for ongoing community consultation for the Centurion North PRCP

Consultation objective	Develop strong and cooperative stakeholder relationships with affected stakeholders to enable their informed consideration of PRC plans and identification of shared value and/or beneficial future land uses	
Stakeholders	**Engagement type**	**Consultation frequency**
• Landowners and lessees within the MLs • Traditional owners – Widi People and Jangga People • Adjacent private landholders • Isaac Regional Council • Utility owners – Powerlink, Aurizon, Sunwater, DTMR • Owners of overlapping tenures – Arrow Energy, Anglo American	Advise affected stakeholders in writing when the PRC plan is approved and provide a copy of the PRC plan for their information	One-off
	Provide information in writing to all affected stakeholders on PRC plan progress, and invite affected stakeholders' feedback on: the approved PMLU e.g. rehabilitation methods which would optimize future grazing opportunities areas where land disturbance through approved exploration activities are proposed i.e. any particular values in certain areas rehabilitation methods, schedule and milestones	Initially on commencement of rehabilitation; subsequent consultation to be defined thereafter
	Meet with directly affected and adjacent landholders, Widi People and Jangga People to provide an update on the Centurion North concept plan, communicate progress with rehabilitation against the PRC plan schedule, and discuss any other items of interest (e.g. particular values pertaining to disturbed areas, or shared value initiatives).	Ongoing engagement process
	As part of biannual meetings with IRC (or as determined with Council), provide an update on the status of the EA (approved activities and PMLUs), the PRC plan and concept plan (as progressed), and progress with rehabilitation against the PRC plan schedule, and forecast upcoming PRC plan consultations for other SMC assets.	Bi-annual
	Notify affected stakeholders in writing when an EA amendment application for further exploration has commenced, providing information on the scope and location of the activities for which the amendment is sought, seeking feedback on the proposed updated rehabilitation schedule, disturbance footprint and proposed PMLUs to be included in the PRC plan/amendment accompanying the EA amendment application, and advising on how to access information about the EA amendment notification process.	One-off

[11] BHP (December 2020): PRCP Wards Well Community Consultation Plan

Consultation objective	Develop strong and cooperative stakeholder relationships with affected stakeholders to enable their informed consideration of PRC plans and identification of shared value and/or beneficial future land uses	
Stakeholders	**Engagement type**	**Consultation frequency**
	Meet with Widi People and Jangga People to provide an update on Centurion North and proposed disturbance areas / activities for which an EA amendment is sought. With Widi People, this will include consultation on cultural heritage management requirements, rehabilitation species, methods and timeframes. This consultation may also identify Traditional Owners' interest in and capacity for involvement in rehabilitation works.	Ongoing engagement process
	Meet with DTMR to develop an Infrastructure Plan and update/develop agreements, if required, with terms and conditions tailored to the planned exploration / mining activity as part of a future EA amendment application process.	Meetings as required
	Through correspondence and/or meetings, co-operate with Powerlink, Sunwater and Aurizon to develop interface agreements, if required, with terms and conditions tailored to the planned exploration/ mining activity as part of a future EA amendment application process.	One-off process
Consultation objective	**Demonstrate transparency regarding SMC's PRC intentions and timeframes to local communities**	
Stakeholders	Engagement type	Consultation frequency
Moranbah and Glenden community members and groups	Using SMC's website and community forums such as interagency meetings, partnership meetings and community and business networks, provide community updates on PRC planning (Centurion North-specific and portfolio wide) and advise community members of progress towards further exploration and development of Centurion North.	Ongoing engagement process
	Via Smart Transformations Advisory Committee members, CSIRO Local Voices pulse surveys and/or PRC plan-specific workshops or focus groups, seek the involvement of community members and groups in articulating community aspirations for rehabilitation of SMC operations, PMLUs and economic transformation.	One-off process
SMC employees, contractors and unions	Via internal SMC communications, provide regular updates on PRC planning (Centurion North-specific and portfolio wide) and updates on the Centurion North concept planning process.	Ongoing engagement process
Young people	Share accessible information (e.g. on-line or printed learning resources) with Moranbah and Glenden schools and community organisations (e.g. Moranbah Youth and Community Centre and Youth Advisory Committee) to enable young people to understand mine planning and rehabilitation planning and implementation.	One-off
Local businesses and suppliers	Via the Moranbah Traders Association, provide updates on PRC planning (Wards Well-specific and portfolio wide), including	One-off

Consultation objective	Develop strong and cooperative stakeholder relationships with affected stakeholders to enable their informed consideration of PRC plans and identification of shared value and/or beneficial future land uses	
Stakeholders	**Engagement type**	**Consultation frequency**
	rehabilitation plans and progress, approved PMLUs and potential future supply opportunities.	
Elected representatives and Government agencies	Provide updates via letter and/or meeting on PRC planning to: • Office of the Minister for Resources (Queensland) • Office of the Minister for Environment, Great Barrier Reef, Science and Innovation (Queensland) • Office of the Minister for Resources and Critical Minerals • Member for Burdekin (Queensland Parliament) • Member for Gregory (Queensland Parliament) • Member for Capricornia (Australian Parliament) • DES PRCP Team and Emerald Business Centre • Deputy Director-General Georesources, DoR • Assistant Secretary Assessments and Governance Branch, DCCEEW	As requested, or as agreed with individual representatives /agencies

Consultation objective	**Incorporate community objectives and aspirations for land use and landform planning post-mining in future plans for** Centurion North**.**	
Stakeholders	Engagement type	Consultation frequency
Traditional Owners and Indigenous businesses	Meet with Traditional Owners and Indigenous businesses to understand business capabilities and communicate the pipeline of opportunities relating to rehabilitation work and land management (portfolio-wide).	One-off
	In cooperation with Traditional Owners including Widi People, Jangga People and other First Nations within Isaac LGA, plan and implement an Indigenous business capability development program to match rehabilitation opportunities, if this is required.	One-off
Isaac Regional Council	Meet with IRC to understand Council's strategic analysis and planning for Isaac LGA and the Centurion North project area as relevant, to identify objectives to be considered as part of future PRC planning for Wards Well.	Annually, or as agreed with Council
	Share the results of SMC research and industry partnership projects relevant to rehabilitation with Council.	One-off, or as agreed with Council
	Participate in Council-led initiatives which aim to harness social value from mine closure and rehabilitation planning, and/or work towards from economic transformation.	As invited
Local businesses and suppliers	Share information on local supply opportunities relevant to rehabilitation implementation and hold a workshop/s for interested businesses, to	One-off process

Consultation objective	Develop strong and cooperative stakeholder relationships with affected stakeholders to enable their informed consideration of PRC plans and identification of shared value and/or beneficial future land uses	
Stakeholders	**Engagement type**	**Consultation frequency**
	identify and develop local capabilities for involvement in rehabilitation work.	

3.3.2 Consultation objectives, engagement type and frequency

Information to be released as part of ongoing community consultation will include:

- Rationale and scope for PRC Plan and PRCP Schedule;
- Approved activities and PMLUs for Centurion North;
- On-site activities and areas of disturbance;
- Proposed rehabilitation methods, schedule and milestones; and/or
- Opportunities for community consultation as part of the PRC Plan's implementation.

Where required, communication tools could include:

- A holding statement for general enquiries;
- Frequently asked questions and answers (FAQs) and a PRC Planning fact sheet available to support consultation activities;
- Face-to-face and virtual meetings; and/or
- Updates and fact sheets about PRC Planning.

3.3.3 Addressing feedback and comments

As noted in the PRCP Guideline, in addition to the annual return requirements that relate to EAs, if a PRC Plan applies to the activities, the annual return must also include an evaluation of the effectiveness of the PRC Plan, including the environmental management carried out under the PRCP Schedule, for the year to which the annual return relates.

Centurion will monitor and report on the progress and outcomes of progressive rehabilitation activities against rehabilitation milestones provided in the PRCP Schedule. This monitoring will aim to demonstrate a successful rehabilitation trajectory towards achievement of the approved PMLU, and/or to inform corrective action where required, which will be reported as part of annual returns.

Information about rehabilitation progress will also be delivered as part of the consultation methods detailed in **Table 15,** and any feedback will be considered in subsequent updates of this PRC Plan.

The PRC Plan Community Consultation Register will also be updated as community consultation activities outlined in **Table 15** are completed. Feedback recorded in the Community Consultation Register will be considered in framing and detailing future PRC Plan amendments for Wards Well.

The above is also documented as part of the Community Consultation Register (**Appendix 6**).

Relationship with PRCP Schedule

Consultation was undertaken for the original PRC plan application and will continue as per the process documented in the CCP. Achievement of the PMLU of cattle grazing is consistent with the outcome of consultation completed to date.

4. POST-MINING LAND USES

Legislative Requirement

In accordance with section 126C(1)(d) of the *EP Act*, the rehabilitation planning part of the PRC Plan must state the extent to which each post-mining land use for land identified in the PRCP schedule for the plan is consistent with:

1. the outcome of consultation with the community in developing the plan, and
2. any strategies or plans for the land of a local government, the State or the Commonwealth.

PRCP Guideline (Section 3.2)

A PMLU is defined under section 112 of the *EP Act* as the purpose for which the land will be used after all relevant activities for the PRC Plan carried out on the land have ended. Relevant activity for a PRC plan is defined in the *EP Act* as the relevant activities to be carried out on land the subject of the plan. It is not the intention of this definition to include third-party activities or assets that continue to exist once mining activities have ceased, such as third- party pipeline easements, power easements or overlapping tenures for other EAs.

The rehabilitation planning part of the PRC plan must include a detailed description of the nominated PMLU(s) for the site. The description must include (where relevant), but is not limited to:

- a description of the use of the land;
- if applicable, the specific vegetation types (e.g. RE 13.2.9) or land suitability classification (e.g. Class 4);
- identification of any permanent or essential management infrastructure to be included as part of the PMLU; and
- completion criteria for measuring whether the PMLU has be successfully achieved.

Where a PMLU has been previously addressed in a land outcome document and is able to be transitioned into the PRCP schedule, the holder is not required to complete the information requirements under section 126C(1)(j) of the *EP Act* in this section for those PMLUs.

However, the legislative requirements under section 126C(1)(d) of the *EP Act* still apply. All PMLUs transitioned into the PRCP schedule must still meet the requirements of a PMLU explained in this section, particularly that the PMLU can be rehabilitated to a stable condition.

4.1 Nominated PMLUs

Cattle grazing is approved in the PRCP schedule as the only PMLU for the site.

The EA acceptance criteria, as they existed prior to approval of the PRCP schedule, for the PMLU of cattle grazing (

Table 16) were transitioned to the milestone criteria in the PRCP schedule for the final milestone of achieving the post-mining land use to a stable condition. The approved PRCP schedule has cattle grazing PMLU for all rehabilitation areas.

Table 16 Wards Well EA post-mine land use objectives, indicators and acceptance criteria for cattle grazing

Goal	Objective	Indicator	Acceptance criteria
Safe to humans and wildlife	Safety hazards in rehabilitation are not significantly different to surrounding unmined landscapes subject to the same land use	Hazard assessment	No significant difference
Stable	Rehabilitation is geotechnically stable	Factor of safety	≥1.5
	Rehabilitation is erosionally stable	Extent, slope gradient and groundcover	1. Groundcover >50% 2. 70% of slopes ≤20%
Non-polluting	Rainfall runoff from rehabilitation achieves relevant water quality objectives for receiving waters	pH EC Turbidity	Not significantly different to upstream values
	Deep drainage from rehabilitation achieves relevant water quality objectives for groundwater	EC	Not significantly different to: a) the EPP (Water) schedule documents water quality objectives for relevant groundwater chemistry zones; or b) local water quality objectives developed in accordance with the Queensland Water Quality Guidelines
Able to sustain an agreed post-mining land use	Rehabilitation is suitable for sustainable cattle grazing	Land suitability assessment for cattle grazing	Land suitability class ≤3 or not different from pre-mining class if ≥4 Assessment completed in accordance with *LSA Framework for Open-Cut Coal Mine Rehabilitation 2018. (A rule-set for land suitability assessment of sustainable beef cattle grazing on land rehabilitated after open-cut coal mining in the Bowen Basin Queensland*) unless otherwise agreed in writing between the Administrating Authority and the environmental authority holder[12]

[12] It is noted that this LSA Framework, as referenced in the EA, is a draft document and may be refined over time as site knowledge is refined.

Goal	Objective	Indicator	Acceptance criteria
		Leucaena stem density	<250 stems >2m height per ha (1 per 40m^2), mean total area

4.1.1 Grazing land suitability

The assessment of pre-mining and post-mining land suitability for cattle grazing, as specified in the PRCP schedule, is based on the 'Rule-set for land suitability assessment of cattle grazing on coal mine rehabilitation[13] (hereafter referred to as the grazing rule-set).

The land use limitations in the grazing rule-set identified for cattle grazing have been selected from the comprehensive list provided in the Queensland Land Evaluation Guidelines based on:

- The target PMLU of sustainable cattle grazing;
- The regional-scale of application across the Bowen Basin; and
- Diagnostic attributes that can be readily correlated to mapping units at potential mapping scales of 1:50,000 and larger.

Table 17 provides further detail on the specific indicators for assessing land suitability class of the grazing ruleset. The Class 1 to Class 2 boundary represents the attribute level at which the limitation starts to affect productivity; and the Class 3 to Class 4 boundary determines whether the rehabilitation is suitable or not and therefore able to sustain an agreed PMLU of grazing as required under the PRCP schedule.

It is important for long-term sustainable grazing land management on rehabilitated lands to plan for the establishment and maintenance of good condition pastures. The rehabilitation planning and revegetation process is therefore based on sowing preferred pasture species aligned to the associated rehabilitation soils and land topography. The ongoing assessment of pasture condition, after the revegetation process, is used to assess the condition of the pasture and guide ongoing maintenance and management of pastures on rehabilitated lands. The pasture condition milestones are described in further detail in Section 7.

[13] Short, T. (2020): A rule-set for land suitability assessment of sustainable beef cattle grazing on land rehabilitated after open-cut coal mining in the Bowen Basin, Queensland Highlands Environmental, Emerald

Table 17 Land suitability ruleset for cattle grazing on rehabilitation at Centurion North

Limitation	Indicator	Units	Suitability class				
			1	2	3	4	5
Water availability	PAWC in ERD	mm/0.6d	> 75	75 - 60	< 60 - 45	< 45 - 30	< 30
Nutrient supply	P in 0.1m	mg / kg	> 20	20 - 14	< 14 - 8	< 8 - 4	< 4
	pH in 0.1m	pH units	7.3 – 6.6	*< 6.6. – 6.0 or > 7.3 – 8.0*	< 6.0 – 5.5 or > 8.0 – 8.5	< 5.5 – 5.0 or > 8.5 – 9.0	< 5.0 or > 9.0
Soil physical factors	Surface soil structure	variable	Fine (peds < 10mm)	Coarse (peds > 10mm)	Surface crust	Very hard setting	Massive
Salinity	EC in ERD	dS/m	< 2	2 - < 4	4 - < 10	10 - < 16	≥ 16
Rockiness	Fragments on surface	%	< 5	5 - 10	10 - 30	30 - 60	> 60
Topography (slope)	Gradient, surface	%	< 5	5 - < 10	10 - < 15	15 - < 20	≥ 20
	Vertical interval, surface	m	Nil ripping furrows	Regular ripping furrows < 0.2m	Regular ripping furrows > 0.2 – 0.4m	Regular ripping furrows > 0.4 – 0.6m	Regular ripping furrows > 0.6m
Water erosion, surface soil	Slope (ESP in 0.1m <6)	%	< 5	5 - 8	> 8 - 12	> 12 - 18	> 18
	Slope (ESP in 0.1m > 6 - < 14)	%	< 3	3 - 6	> 6 - 10	> 10 - 12	> 12
	Slope (ESP in 0.1m > 14)	%	< 1	1 - 2	> 2 - 4	> 4 - 6	> 6
Sub-soil erosion	ESP at 0.5m	%	< 7	7 - 14	> 14 - 23	> 23 - 34	> 34
Potentially acid forming materials	pH < 4.5	pH units	Not likely to be present within 5m of surface	Not likely to be present within 3m of surface	Not likely to be present within 2m of surface	Present immediately below root zone (0.9 – 0.6m)	Present within root zone (surface 0.6m)

4.2 Community Consultation

Achievement of the PMLU of cattle grazing is consistent with the outcome of consultation completed to date (Section 3).

4.3 Regional planning integration

The PMLU at Wards Well, and consequently Centurion North, considers the pre-mining land use, neighbouring land use and EA conditions. Existing land use in the area is primarily grazing of beef cattle. Some areas have been subject to cultivation (ploughing) and clearing. Wards Well and the neighbouring beef cattle stations also feature remnant woodland vegetation with farm infrastructure such as water tanks, windmills, troughs, and dams located throughout the area.

Under the Isaac Regional Planning Scheme (2021), Wards Well is located in a 'rural' zone, which includes uses such as grazing, farming, forestry, tourism and extractive industries. Land use performance outcomes for this rural zone include ensuring development:

(a) is consistent with the rural character of the locality;

(b) supports the primary rural function of the zone;

(c) protects rural, natural and scenic values of the locality.

In addition, the Queensland Government, via its Mackay, Isaac and Whitsunday Regional Plan (2021), maps Wards Well in a 'regional landscape and rural production area', which includes land used for agriculture, water catchment, traditional uses, conservation areas and native forests.

The defined uses in both plans are consistent with the PMLUs approved for Wards Well in the PRCP schedule.

Relationship with PRCP schedule
Due to the limited disturbance caused by the approved mining activities as well as minimal changes to the pre-mining landform, the PMLU will be cattle grazing. This is consistent with the pre-mining land use. The acceptance criteria for cattle grazing are the milestone criteria for achieving the PMLU in the PRCP schedule.

The information in this section is relevant to the following highlighted **Rehabilitation Areas (RAs)** and **Rehabilitation Milestones (RMs)** in the PRCP schedule						
RA1						
RM1	RM2	RM3	RM4	RM5	RM6	RM7

The following **Milestone Criteria** will demonstrate achievement of PMLU to a stable condition:	
RM7	• A hazard assessment has been completed by an appropriately qualified person to confirm safety hazards in rehabilitation are not significantly different to surrounding unmined landscapes subject to the same land use. • Groundcover >50%. • Rainfall runoff from the area is not significantly different to upstream values for the following: pH, EC and turbidity.

	– • Land suitability class ≤3, or not different from pre-mining class if ≥4. The assessment is to be conducted by an appropriately qualified person and completed in accordance with LSA Framework for Open-Cut Coal Mine Rehabilitation 2018 (A rule-set for land suitability assessment of sustainable beef cattle grazing on land rehabilitated after open-cut coal mining in the Bowen Basin Queensland) unless otherwise agreed in writing between the administering authority and the environmental authority holder. For RM7(d) if the land suitability class is assessed as not different from pre-mining class if ≥4 for all or a portion of a rehabilitation area, an assessment of reference sites must be carried out to determine if the limitation/s resulting in the class of ≥4 is consistent with that of reference sites. • Certification by an appropriately qualified person that pasture meets a pasture condition rating ≤3, based on the Pasture Condition Assessment Table as per Stocktake: Balancing Supply and Demand (https://futurebeef.com.au/workshops/sustainable-grazing/stocktake-balancing-supply-demand/), as provided in **Table 30**.

5. NON-USE MANAGEMENT AREAS

Legislative Requirement

In accordance with sections 126C(1)(d), (g) and (h) of the *EP Act*, for each proposed non-use management area, the rehabilitation planning part of the PRC plan must:

- state the reasons the applicant considers the area cannot be rehabilitated to a stable condition;
- include copies of reports or other evidence relied on by the applicant for each proposed non-use management area;
- state the extent to which the proposed non-use management area is consistent with the outcome of consultation with the community in developing the plan; and
- state the extent to which the non-use management area is consistent with any strategies or plans for the land of a local government, the State or the Commonwealth.

PRCP Guideline (Section 3.3)

A NUMA is defined in the *EP Act* as an area of land the subject of a PRC plan that cannot be rehabilitated to a stable condition after all relevant activities for the PRC plan carried out on the land have ended. Proposed NUMAs must be justified under the criteria set out in section 126D(2) of the *EP Act*.

The rehabilitation planning part of the PRC plan must also include:

a) information demonstrating that the proposed footprint of each NUMA is as small as practicable;

b) an assessment of the NUMA location options, having regard to the constraint of the resource location, with an analysis of the potential environmental harm and sensitivity of the surrounding environment of each option;

c) a description of the proposed location of each NUMA and the environmental values of the surrounding environment; and

d) evidence showing how the proposed location will prevent or minimise environmental harm.

In accordance with section 126D(1)(c) of the *EP Act*, the applicant must develop and implement management milestones within the PRCP schedule which achieve best practice management and minimise environmental harm for any NUMAs contained in the proposed PRC plan. As part of the development of management milestones, the applicant must conduct a NUMA specific risk assessment to identify and quantify risks and associated controls. The risk assessment should have an overarching goal of identifying and controlling any significant risks to the community and the environment.

The proposed PRC plan must include a detailed description of the nominated NUMA(s) for the site. The description must include, but is not limited to:

- description of the land at surrender;
- any relevant safety features; and
- completion criteria for measuring whether the NUMA has achieved sufficient improvement.

Where a NUMA has already been identified in a land outcome document and is able to be transitioned into the PRCP schedule, the applicant is not required to comply with sections 126C(1)(g) or (h) or 126D(2) or (3) of the *EP Act.* NUMAs transitioned into the PRCP schedule are not required to complete the information requirements under section 126C(1)(j) of the *EP Act* in this section for those NUMAs. However, the legislative requirements under section 126C(1)(d) of the *EP Act* still apply.

Where a NUMA has not been pre-approved and is proposed as part of the transition into the PRC plan, the applicant must include all of the requirements identified in this section.

5.1 Nominated NUMAs

There are no NUMAs planned for Centurion North.

5.2 Management methods

Not applicable. There are no NUMAs planned for Centurion North.

5.3 Community considerations

Not applicable. There are no NUMAs planned for Centurion North.

5.4 Regional planning integration

Not applicable. There are no NUMAs planned for Centurion North.

Relationship with PRCP schedule
Not applicable. There are no NUMAs planned for Centurion North.

6. VOIDS IN FLOODPLAINS

Legislative Requirement

In accordance with section 126D(3) of the *EP Act*, if land the subject of the proposed PRCP schedule will contain a void situated wholly or partly in a flood plain, the schedule must provide for the rehabilitation of the land to a stable condition.

PRCP Guideline (Section 3.4)

Section 41C of the EP Regulation states the decision considerations for a void situated wholly or partly in a flood plain. A void is considered to be located in a flood plain if the flood plain modelling shows that, when all relevant activities carried out on the land have ended, the land is the same height as, or lower than, the level modelled as the peak water level 0.1% AEP for a relevant watercourse under the guideline Australian Rainfall and Runoff (2019)(ARR).

Where a land outcome document has a pre-approved land outcome for a void with a location specified, flood plain modelling is not required. If a void has been identified as a NUMA in a land outcome document but the location is not identified, the applicant is required to carry out flood plain modelling in accordance with this section of the guideline. While the provision in the *EP Act* relating to voids located within a floodplain having to rehabilitate to a stable condition does not apply, the PRC plan must include how the proposed location of the void minimises risks to the environment. Therefore, the flood plain modelling is required to support the assessment of the proposed location of the void.

If there are no land outcomes identified in a land outcome document, the applicant is required to carry out flood plain modelling in accordance with this section of the guideline.

Relevance to Centurion North

There current Environmental Authority does not contemplate any residual voids to be left on the Centurion North MLs.

7. REHABILITATION AND MANAGEMENT METHODOLGY

Legislative Requirement

In accordance with section 126C(1)(e) and (i), the rehabilitation planning part of the PRC plan must:

- For each proposed post-mining land use for land, state the proposed methods or techniques for rehabilitating the land to a stable condition in a way that supports the rehabilitation milestones under the proposed PRCP schedule; and
- For each proposed non-use management area, state the proposed methodology for achieving best practice management of the area to support the management milestones under the proposed PRCP schedule for the area.

PRCP Guideline (Section 3.6)

The proposed rehabilitation or management methodologies will underpin the development of the milestone criteria and support how the proposed PMLU will be achieved, or the NUMA will be managed. As per section 126C(1)(j) of the *EP Act,* the administering authority requires information describing how the proposed rehabilitation or management methodologies have been developed and will be implemented.

This section identifies a number of studies or reports that must be provided in the proposed PRC plan. If any of the required information outlined below is not relevant to the specific operation, the applicant must provide justification in the PRC plan outlining why the information is not required.

Information contained in this section was based on information developed for the Wards Well MLs, which incorporate the Centurion North MLs, and hence remain relevant. However, the only activity type that is approved on the Centurion NorthMLs is exploration drilling and tracks and therefore reference to other activity types (e.g. bulk sample and underground activities) has been removed from this PRC plan.

7.1 General rehabilitation practices

PRCP Guideline (Section 3.6.1)

This section outlines the range of information that the administering authority considers is necessary to underpin the development of the rehabilitation or management methodologies applicable to new and existing mines for most domains. The applicant must include the information as appendices to the rehabilitation planning part.

7.1.1 Hydrogeology

Assess the hydrogeology of the site and all connected strata and develop a conceptual model of the mine site's groundwater systems. This information must be integrated into the design of rehabilitation strategies and choice of PMLU or NUMA.

As detailed in **Section 2.2.5**, there are three hydrostratigraphic units identified at Wards Well, namely the Quaternary alluvium, Tertiary and Permian strata aquifers.

Recharge of the Quaternary alluvium and Tertiary strata aquifers is expected to only occur after heavy rainfall in the wet season, which creates flows within the ephemeral creeks and flooding.

Due to the compartmentalised nature of the basalt aquifer, recharge from groundwater flows from surrounding regional aquifers is not expected to be significant. Predominant recharge of the basalt aquifers is expected to be from overlying quaternary alluvium aquifers and infiltration at basalt outcrops. Recharge of the Permian strata is likely to be driven by downward seepage or through flow from overlying/adjacent aquifers; infiltration at outcrop locations; and leakage between aquifers through faults or other structural discontinuities.

Primary discharge mechanisms in the Quaternary alluvium and Tertiary strata groundwater systems include evapotranspiration; through flow into adjacent or underlying aquifers; and groundwater extraction. Discharge from the Permian strata is likely to occur through down gradient flow into Permian - Triassic strata; flow into adjacent aquifers; seepage into underlying aquifers through structural discontinuities; and groundwater extraction (such as dewatering).

Groundwater investigations at Wards Well to date have focused on the Tertiary strata, which are the aquifers predominantly targeted for groundwater use (stock watering). These aquifers are sodium chloride dominated with total dissolved solid concentrations ranging between 480 and 2,900mg/L. Only limited groundwater data collected during exploration activities is available for the Permian aquifers. Review of available data indicated the salinity of the Permian aquifers is expected to be significantly higher than that within the overlying basalt aquifers.

The potentiometric surface for the Tertiary basalt aquifer has been assessed using data from on-site monitoring bores and available registered bores. The general flow direction at Wards Well in the Tertiary basalts is from the northeast to the southwest. The potentiometric surface of the Tertiary strata is illustrated in **Figure 16**.

A review of the registered groundwater bores within 10km of the Lancewood box-cut identified a total of 16 bores, which were listed as existing (**Appendix 2**). Two of the 16 were listed for monitoring purposes. The usage of the remaining 14 existing bores was not listed, however is expected to be for stock watering or monitoring purposes.

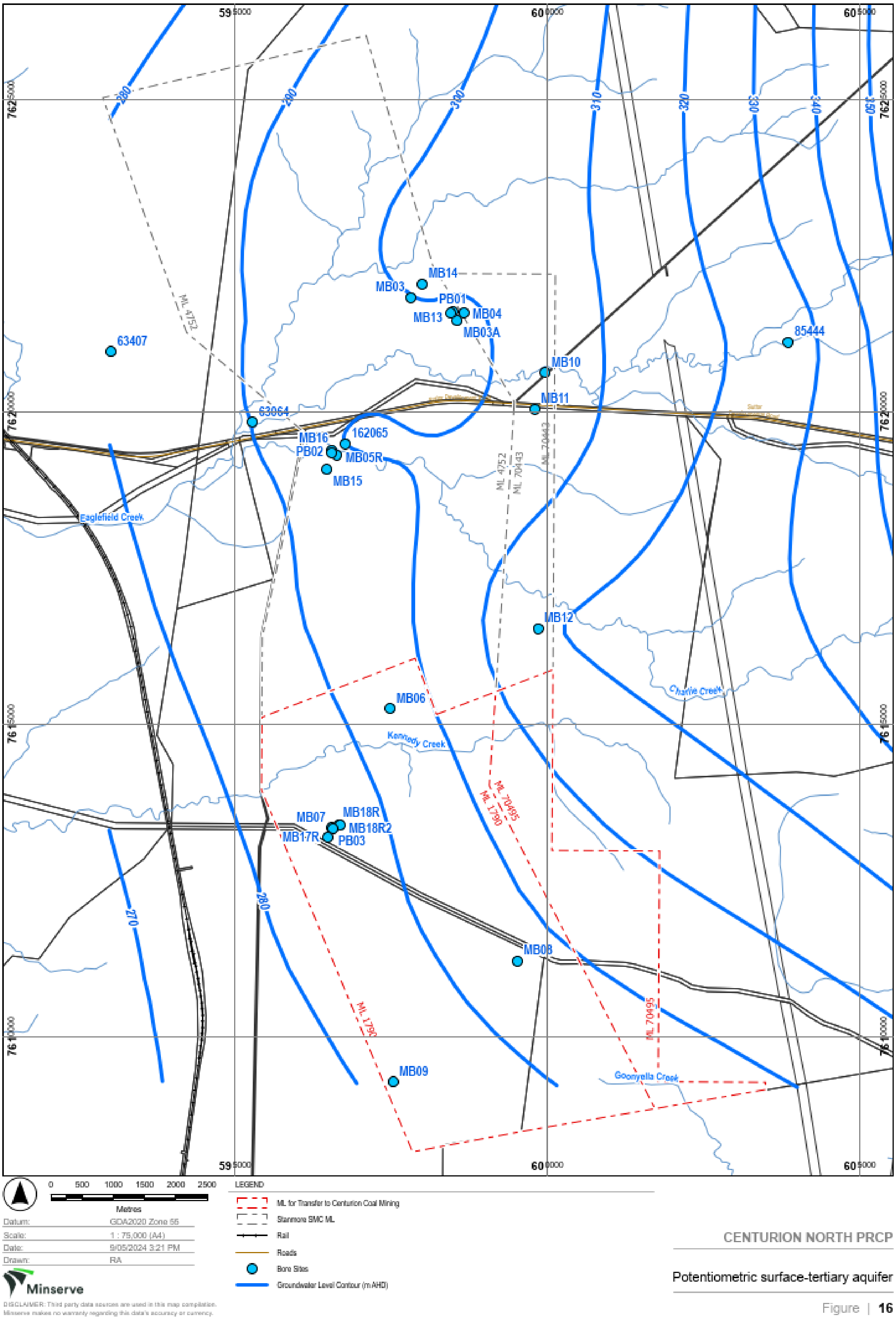


Figure 16 **Potentiometric surface-tertiary**

Relationship with PRCP schedule
The current Environmental Authority does not contemplate any significant excavation on the Centurion North MLs and, as such, impacts on local groundwater use and groundwater dependent ecosystems are expected to be negligible.

The information in this section is relevant to the following highlighted **Rehabilitation Areas** and **Rehabilitation Milestones** in the PRCP schedule						
RA1						
RM1	RM2	RM3	RM4	RM5	RM6	RM7

The following **Milestone Criteria** will demonstrate achievement of the Rehabilitation Milestones:	
RM2	• All contamination is remediated or removed from site in accordance with relevant legislation • A contaminated land survey is carried out by a suitably qualified person confirming the land does not present an unacceptable risk to proposed future land uses or the environment

7.1.2 Flooding

PRCP Guideline (Section 3.6.1)

Section 3.4 of this guideline requires flood plain modelling for the purpose of voids located within a flood plain being rehabilitated to a stable condition. In addition to this, the applicant must also assess the flooding susceptibility and influence across the site. If flooding is a consideration, develop a hydrologic model of the catchment and a hydraulic model of the proposed mining area. Knowledge of flooding is integral to the rehabilitation planning process, including the placement and design of mine domains.

The activities currently approved under the Environmental Authority will result in negligible change to final landform from the original topography.

An assessment of flood susceptibility has been used to inform a risk-based approach to determine basis for this flood assessment.

In addition to the final landform described above, the assessment of flood susceptibility identified the following:

- The DoR flood mapping (**Figure 17**) indicates only limited impact to the ML surface area from a 1% AEP flood event.
- The approved activities do not require diversion or interruption of creeks or streams; and
- There are no fourth order or higher streams present on the Wards Well area.

Based on the above, the final landform will not adversely alter pre-mining flows and the identified risk associated with flooding is low (see Section 8, Risk Assessment), therefore further flood modelling is not required.

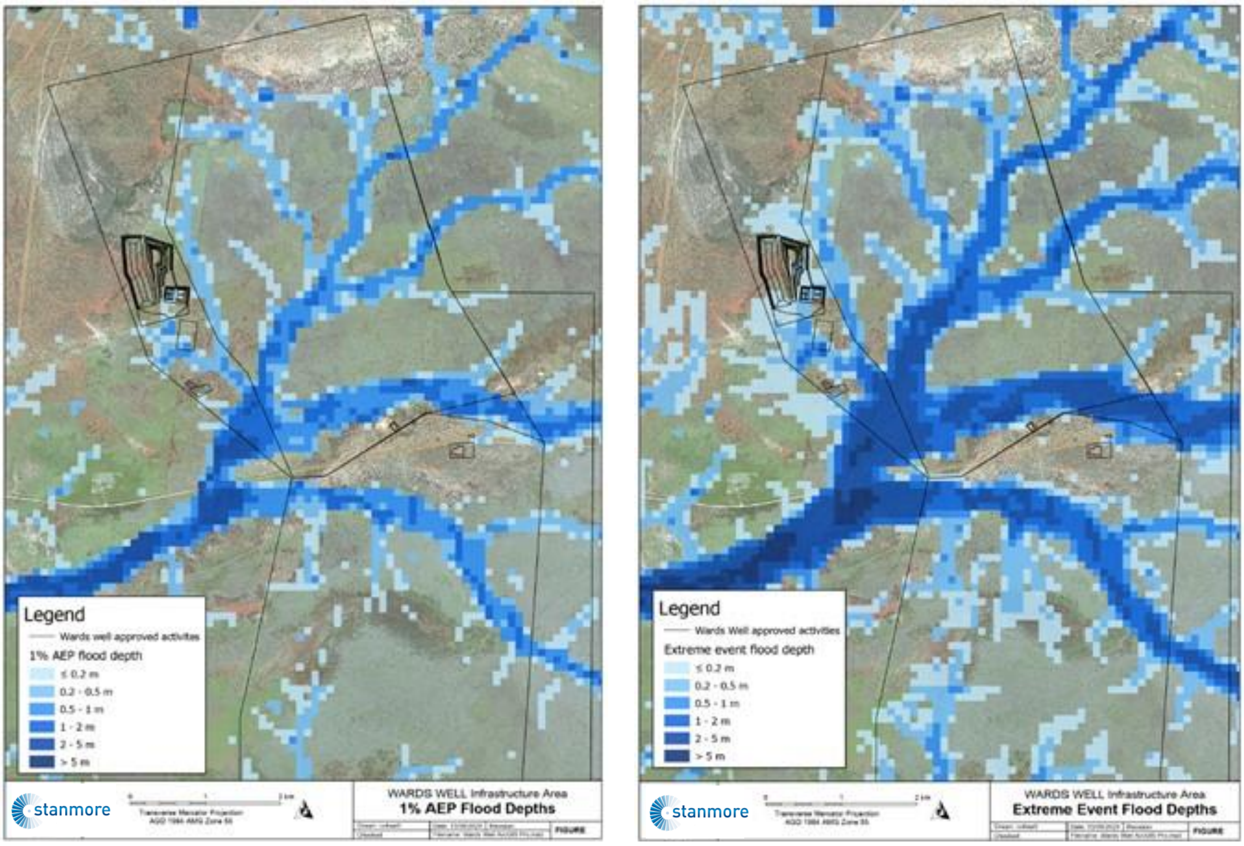


Figure 17 DoR 1% AEP flood depths (left) and extreme event flood depths (right)

Relationship with PRCP schedule
The final post-mining landform will not alter pre-mining water flows. The risk of flooding after closure has been deemed low.

The information in this section is not relevant to the **Rehabilitation Areas** and **Rehabilitation Milestones** in the Centurion North PRCP schedule						
RA1						
RM1	RM2	RM3	RM4	RM5	RM6	RM7

The following **Milestone Criteria** will demonstrate achievement of the Rehabilitation Milestones:	
RM3	• Landform is reshaped to be free-draining with slopes ≤ 5% and consistent with the surrounding topography

7.1.3 Waste characterisation

Not relevant to the Rehabilitation Areas or Milestones for Centurion North.

7.1.4 Soil and capping material

PRCP Guideline (Section 3.6.1)

The rehabilitation and management methodology should include that soil assessment activities are supplemented by additional surveys conducted at appropriate intervals to assess soil resources in planned disturbance areas. In addition to the assessment of soils, the proposed rehabilitation methodologies in the rehabilitation planning part must also address topsoil management. Topsoil management must ensure sufficient topsoil quantity and quality is available to support the proposed PMLU. The available soil resources and capping material should be assessed prior to the commencement of operations.

7.1.4.1 Topsoil stripping

Areas approved for disturbance that will require stripping of topsoil for re-use in rehabilitation include exploration drill pads, potentially tracks. Specific recommendations for topsoil stripping at Centurion North are summarised in **Table 18.** However, as topsoils stripping activities at Centurion North are limited to exploration drill pads and tracks it is unlikely that topsoil stockpiles will be required, as topsoil is replaced after drilling is completed.

Table 18 Recommended topsoil stripping depths and stockpile heights for Centurion North

Soil	Soil concept	Recommendations
Vertosol	Soils with high clay content, and when dry, crack to a considerable depth	Typical: 200mm Maximum stockpile height: 2m
Dermosol	Texture contrast soils with moderately to strongly structured usually clayey B2 horizons	Typical: 200mm Maximum stockpile height: 2m
Kandosol	Very deep (>3m) clay-rich soils	Typical: 500mm Maximum stockpile height: 2m
Sodosol	Texture contrast soils, with clayey sodic subsoils and dispersive properties	Typical: 100mm Maximum stockpile height: 2m These soils occupy a small portion of the site – stripping should be avoided in favour of deeper stripping on other, better soils

Topsoil volumes for exploration drilling are not calculated as the topsoil is stockpiled at each individual drill pad and replaced at the end of drilling.

7.1.4.2 Topsoil management

Topsoil stockpiles will have a maximum height of 2m to reduce soil degradation.

Compaction of topsoil will be minimised where possible by avoiding the use of machinery, such as graders or watercarts, on stockpiles. All stockpiles shall remain in a free-draining location to avoid long-term soil saturation. The stockpile surface will be left in a coarsely textured condition to promote infiltration and aeration and to minimise erosion until vegetation is established. Where necessary, silt fences or vegetation (from clearing operations) will be installed around topsoil stockpiles as a form of erosion and sediment control.

7.1.4.3 Topsoil application

Topsoil will be replaced where needed to achieve the PMLU of cattle grazing. All the stockpiled topsoil will be used as part of the rehabilitation activities. The following measures will be considered when applying topsoil during rehabilitation:

- Spread topsoil at an average thickness of 200mm. Re-spreading on the contour will aid runoff control and increase moisture retention for subsequent plant growth;
- Level topsoil to an even surface and avoid a compacted or over-smooth finish;
- Rip across the contour in preparation for sowing – this will leave the soil surface in a roughened condition creating a 'key' between the soil and underlying material; and
- Minimise vehicle traffic entering the area once topsoil is spread.

7.1.4.4 Amelioration requirements

The parameters provided in **Table 19** are critical nutrient sufficiency ranges for pasture plant nutrition in Queensland[14, 15,16]. These ranges are designed for rehabilitation to a PMLU of cattle grazing, to promote establishment of pasture species to support >50% surface cover. Topsoil characterisation results detailed in Section 2.2.6 indicate the stockpiled Vertosol and Dermosol soils may have potential to be dispersive. An assessment of the stockpiled soil characteristics will be completed by an appropriately qualified person to determine amelioration requirements to meet the ranges in **Table 19**. It is noted that topsoil will bev replaced at exploration drill pads following completion of drilling and hence it may not be necessary to ameliorate the topsoil.

Based on these parameters, amelioration products and application rates will be determined for Wards Well prior to rehabilitation surface preparation commencing. These products could include fertilisers, biosolids and physical amendments such as gypsum.

[14] Hazelton P and Murphy B (2007) Interpreting Soil Test Results, CSIRO Publishing, Melbourne.

[15] Baker D and Eldershaw V (1993) Interpreting Soil Analysis for Agricultural Land Use in Queensland, Queensland Department of Primary Industries, Brisbane.

[16] Hall R (2008) Soil Essentials – Managing your farm's primary asset, CSIRO Publishing, Melbourne.

Table 19 Recommended sufficiency levels for rehabilitation materials at Wards Well

Parameter	Unit	Ranges
pH_{water}	N/A	6.0 - 8.0
$pH_{chloride}$	N/A	5.0 – 8.0
EC_{water}	dS/m	<0.9
EC_{sat}	dS/m	<4
Chloride	mg/kg	<300
Organic carbon	%	1 - 3
N nitrate	mg/kg	>10
N ammonia	mg/kg	N/A
P	mg/kg	8 - >20
S	mg/kg	>10
CEC	cmol/kg	>12
ESP	%	<6

Parameter	Unit	Ranges
Ca/Mg ratio	N/A	>4
Ca	cmol/kg	5 – 10
	%	65 - 80
Mg	cmol/kg	1 – 3
	%	10 - 15
K	cmol/kg	0.3 – 0.7
	%	1 - 5
Na	cmol/kg	0.3 – 0.7
	%	0 - 1
Zn	mg/kg	0.5 – 5
Cu	mg/kg	0.3 – 5
Fe	mg/kg	2 – 100
Mn	mg/kg	2 – 50
B	mg/kg	1 – 2
Mo	mg/kg	2

Relationship with PRCP schedule
The soil survey and topsoil management methodologies ensure that there is suitable quantity and quality of growth media available to support a PMLU of cattle grazing.

The information in this section is relevant to the following highlighted **Rehabilitation Areas** and **Rehabilitation Milestones Reference** in the PRCP schedule						
RA1						
RM1	RM2	RM3	RM4	RM5	RM6	RM7

	The following **Milestone Criteria** will demonstrate achievement of the Rehabilitation Milestones:
RM4	• Topsoil is placed an average thickness of 200mm • An assessment of soil and growth media characteristics is completed by an appropriately qualified person, and amelioration and other treatments required identified • Ameliorant and physical treatments are applied as identified, if required for RA1

7.1.5 Landform design

PRCP Guideline (Section 3.6.1)

The final landform design must be based on the proposed PMLUs and NUMAs and demonstrate that the land will be safe and structurally stable.

Landform design considers both the landform structures such as the void and dumps, but also the landform development and reshape of all relevant activity areas after removal of infrastructure and wastes, and prior to placement of topsoil.

The following approved activities at Wards Well have negligible impact on the pre-mining landform:

- Exploration drilling;
- Clearing for access roads & tracks.

7.1.5.1 Landform structures

All relevant activities detailed in Section 2 are considered as landform structures for the purposes of determining the landform design (**Table 20**).

Table 20 Landform structures for Centurion North

Landform structure	Area extent on the surface (ha)	Landform design and rehabilitation
Exploration drilling and tracks	145	• Area will be reshaped to be free-draining and blend in with surrounding topography

Removal of infrastructure (Section 7.5) and contaminated land assessment requirements (Section 7.5.2) will be completed where required, prior to reshaping of the final landform. After reshaping of the final landform, topsoil is spread over the areas and revegetated.

7.1.5.2 Erosion assessment

The majority of the site is undisturbed with only minimal variance in the final landform from the pre-mining landform for 1% of the total site area. The final landform design is approximately 0.6m above pre-mining landform in this area with low slope angles. Soil will also be assessed and amended to promote establishment of pasture species and limit dispersion potential (Section 7.1.4.4). The landform erosion risk is therefore low and further erosion assessments are not a requirement for Wards Well.

7.1.5.3 Slope profile design

Individual exploration drill pads will have maximum slopes of 5%, similar to the natural topography.

7.1.5.4 Hydrological and hydrogeological assessments

The majority of the site will remain undisturbed. Hydrological and hydrogeological risks associated with the approved activities have therefore been evaluated as low, and are unlikely to impact on the final landform.

7.1.5.5 Waste placement strategy

There are no specific requirements.

7.1.5.6 Specific landform requirements

There are no specific requirements.

7.1.5.7 Monitoring of control measures

No control measures, such as liners or seepage collection systems, will be used on-site.

7.1.5.8 Long-term landform stability

The majority of the site is undisturbed Topsoil will be replaced over the disturbed area and revegetated with a pasture seed mix to re-establish a land use of cattle grazing. The landform erosion risk therefore has been assessed as low and modelling of long-term stability is not required.

7.1.5.9 Quality assurance / quality control

The proposed actions referenced in **Table 23** are the key controls that will be put in place to manage the landform risks associated with achieving the PMLU. Quality assurance and quality control activities are built into all necessary execution and verification activities of these controls. Monitoring and reporting processes verify controls and ensure that controls are executed effectively (refer to Section 8).

7.1.5.10 Trial methodology

As the landform design is low risk, no trial methodology is proposed.

Relationship with PRCP schedule
The approved activities result in only minor disturbance and minor changes in the final landform from the pre-mining topography.

The information in this section is relevant to the following highlighted **Rehabilitation Areas** and **Rehabilitation Milestones** in the PRCP schedule:						
RA1						
RM1	RM2	RM3	RM4	RM5	RM6	RM7

The following **Milestone Criteria** will demonstrate achievement of the Rehabilitation Milestones:
RM3 • Landform is reshaped to be free-draining with slopes ≤ 5% and consistent with the surrounding topography

7.1.6 Cover design

PRCP Guideline (Section 3.6.1)

A cover design is required for the surface treatment of a mine landform or other waste material. Hence, the cover system design must be appropriate for the type(s) of waste the project will generate and reflect a risk-based approach. Where waste has the potential for AMD, neutral mine drainage or saline mine drainage, an appropriate cover system must be designed.

The cover design should include:

- identification and specification of the objectives of the cover system;
- a detailed description of the design including the thickness of each layer;
- a detailed description of construction methodology including any proposed staging of the cover system;
- a quantitative assessment that identifies the location and quantity of proposed capping material available on-site; and
- proposed QA/QC for the construction of the cover system including the timely implementation of corrective actions where deviations from the design are identified.

This is not applicable to activities authorised on the Centurion North MLs.

Relationship with PRCP schedule
There is no environmental risk associated with any material remaining on-site and potential contaminants; therefore no cover designs are required.

7.1.7 Water Management

PRCP Guideline (Section 3.6.1)

The rehabilitation planning part must include a description of the following:

- a description of the contaminants that pose a risk to environmental values of the receiving environment;
- source, pathway and fate of contaminants that have the potential to impact environmental values;
- infiltration and seepage intervention and collection controls;
- surface water diversions and long-term management requirements;
- dewatering requirements;
- ongoing water management and reduction requirements (i.e. treatment).

Water management will be undertaken to minimise the potential for release of contaminants to the surrounding environment. With regard to the exploration activities authorised on the Centurion North MLs, there is negligible risk to receiving waters. At exploration drill pads, small sumps may be used for temporary storage of water during drilling. These will be removed following completion of drilling activities, and rehabilitated as part of the drill pad rehabilitation.

7.1.8 Revegetation

PRCP Guideline (Section 3.6.1)

The revegetation plan must propose activities that will establish self-sustaining vegetation communities that are appropriate for the intended PMLU (e.g. natural ecosystems, grazing, forestry and some agricultural and other land uses). Revegetation should, therefore, not only establish a ground cover, but also, in some domains, establish associated fauna habitat and other ecological services.

The rehabilitation planning part must include details of the site preparation required for rehabilitation activities.

7.1.8.1 Revegetation objectives

The PRCP schedule requires all areas disturbed by mining activities to be rehabilitated to a stable condition suitable for cattle grazing. The required objectives and acceptance criteria for a PMLU of cattle grazing at Wards Well (and hence Centurion North) are listed in the PRCP schedule.

Cattle grazing can be achieved with the materials available for rehabilitation. Section 7.1.4 discusses the types of topsoils at Wards Well as they relate to a post-mining land use of cattle grazing. Section 4.1 further discusses land suitability requirements for cattle grazing (**Table 17**).

Based on the final landform, the topsoil materials available for rehabilitation and the pre-mining land use suitability assessment, a PMLU of cattle grazing is able to be achieved through revegetation activities associated with pasture seeding and additional soil amelioration if required.

7.1.8.2 Revegetation species and seed mixes for a cattle grazing PMLU

Prior to approval of the PRCP schedule, there were no requirements listed in the EA for inclusion of any species of conservation significance or fauna habitat and/or use of analogue sites for the purpose of a PMLU of cattle grazing. Nonetheless, the species mix for revegetating pastures for a PMLU of cattle grazing at Wards Well has been developed based on selecting a combination of both native and exotic pasture grasses listed as perennial, productive and palatable (3P) - these are suited to the topsoils at Wards Well and have either been previously recorded at Wards Well or have been recorded within up to 30km in the surrounding environment of Wards Well. Importantly, native Bluegrass (*Dichanthium sericeum*), Black Spear grass (*Heteropogon contortus*) and native Mitchell grass species (*Astrebla* spp.) that dominate the surrounding natural grasslands, have been included in the seed mix. In addition, exotic pasture species occurring in the surrounding environment have also been included to provide a representative mixed native/exotic grazing pasture to support a PMLU of cattle grazing.

Table 21 lists the revegetation pasture species and recommended sowing rates for a PMLU of cattle grazing at Centurion North. Species availability may fluctuate from year to year and unavailable species would be substituted with other species listed in this table. All pasture seed mixes would include 5 kg/ha of Shirohie millet (*Echinochloa esculenta*) or similar as a cover crop for soil protection, i.e. minimisation of erosion.

No sowing or use of Leucaena is proposed at Centurion North, and Leucaena detected anywhere on the rehabilitation areas will be required to be controlled in accordance with weed management activities.

Table 21 Recommended species list and sowing rates for a mixed native/exotic pasture for sustainable beef cattle grazing on Centurion North soils during rehabilitation

Common name	Scientific name	Sowing rate (kg/ha)	Comment
Queensland Bluegrass	*Dichanthium sericeum*	6	3P grass
Buffel grass	*Cenchrus ciliaris**	4^{c}	3P grass
Stylo^{s}	*Stylosanthes scabra**	2	Legume requires specific rhizobium inoculum strain CB1650
Black spear grass	*Heteropogon contortus*	5	3P grass
Mitchell grasses	Bull Mitchell grass (*Astrebla squarrosa*), Curly Mitchell grass (*Astrebla lappacea*) and Hoop	3	3P grass

Common name	Scientific name	Sowing rate (kg/ha)	Comment
	Mitchell Grass (*Astrebla elymoides*)		
Cover crop	*(e.g. Echinochloa esculenta*)*	5	Cover crop for soil protection
Total		**25**	

*Notes *exotic species, [C] assumes seed is coated, if not coated, use half prescribed rate, [S] must be sown within 28 days of inoculation*

7.1.8.3 Establishing and managing revegetation

Both the native and exotic pasture species selected are cognisant of grazing best management practices. A good condition pasture will have a high percentage of 3P grasses and a high frequency of legumes and a low number of weeds.

Pasture seed mixes will be targeted for planting between September and March. Seed quality will be ascertained prior to planting to ensure highest potential for seed strike and vegetation establishment. A friable or crumbly seed bed will be created by ripping on contour followed by direct planting of seed using agricultural equipment. Surface ripping may not be required in all disturbance areas where a suitable seed bed already exists e.g. exploration access tracks and seismic grid lines. As detailed in Section 7.1.4.4, amelioration products and application rates will be determined prior to rehabilitation surface preparation commencing.

The rehabilitation planning and revegetation process is based on sowing preferred 3P pasture species aligned to the associated rehabilitation soils and land topography. As mentioned in Section 3, the ongoing assessment of pasture condition - after the revegetation process, is used to assess the condition of the pasture and guide ongoing maintenance and management of pastures on rehabilitated lands (further detail on monitoring is provided in Section 9).

Scientific evidence supports groundcover [17], including vegetation, as a surrogate for erosion risk in coal mine rehabilitation, with 50% being a conservative target for most slope gradients (less than 20% slope gradient[18,19,20,21]). For these reasons, rehabilitation must achieve and maintain a groundcover greater than 50% to adequately mitigate erosion risk and prevent land degradation.

7.1.8.4 Topsoil

There is sufficient topsoil on-site to respread over the disturbed areas. Topsoil treatments and depth for rehabilitation are detailed in Section 7.1.4.

Relationship with PRCP schedule
Vegetation species to be used will be suitable for soil type and support a post-mining land use of cattle grazing.

[17] Note: Groundcover refers to anything in contact with the soil surface, e.g. rocks, stones, sticks, leaves, grass, hay, etc.

[18] So, W, Sheridan, G, Loch, R, Carroll, C, Willgoose, G, Short, M and Grabski A 1998 Post-mining landscape parameters for erosion and water quality control, ACARP Project Numbers C4011 and C5009, Australian Coal Research Limited, Brisbane

[19] Loch, R 2000 Effects of vegetation cover on runoff and erosion under simulated rain and overland flow on a rehabilitated site on the Meandu Mine, Tarong, Queensland, Australian Journal of Soil Research, vol. 38, pp 299-312

[20] Carroll, C and Tucker, A 2000 Effects of pasture cover on soil erosion and water quality on central Queensland coal mine rehabilitation, Tropical Grasslands, vol. 34, pp 254-262

[21] Carroll, C, Merton, L and Burger, P 2000 Impact of vegetative cover and slope on runoff, erosion, and water quality for field plots on a range of soil and spoil materials on central Queensland coal mines, Australian Journal of Soil Research, vol. 38, pp.313-327.

The information in this section is relevant to the following highlighted **Rehabilitation Areas** and **Rehabilitation Milestones** in the PRCP schedule:						
RA1						
RM1	RM2	RM3	RM4	RM5	RM6	RM7

The following **Milestone Criteria** will demonstrate achievement of the Rehabilitation Milestones:	
RM5	• Completed seeding in accordance with recommended pasture mix (grasses, cover crop and legumes), and seeding rates (up to 25kg/ha)
RM6	• Pasture condition rating ≤3, based on the Pasture Condition Assessment Table as per Stocktake: Balancing Supply and Demand (https://futurebeef.com.au/workshops/sustainable-grazing/stocktake-balancing-supply-demand/), as provided in Table 33, including: – Preferred pasture species (3P grasses) diversity ≥2 species – Preferred pasture (3P grasses) % DM yield ≥10% – Annual grass DM yield % <70% – Undesirable grasses and other weeds % DM yield <80% – Crown cover (3P grasses) – at worst, moderate to low density and some plants dead
RM7	• Groundcover >50% • Land suitability class ≤3, or not different from pre-mining class if ≥4. The assessment is to be conducted by an appropriately qualified person and completed in accordance with LSA Framework for Open-Cut Coal Mine Rehabilitation 2018 (A rule-set for land suitability assessment of sustainable beef cattle grazing on land rehabilitated after open-cut coal mining in the Bowen Basin Queensland) unless otherwise agreed in writing between the administering authority and the environmental authority holder. • Fore RM7(e) if the land suitability class is assessed as not different from pre-mining class if ≥4 for all or a portion of a rehabilitation area, an assessment of reference sites must be carried out to determine if the limitation/s resulting in the class of ≥4 is consistent with that of reference sites. • Certification by an appropriately qualified person that pasture meets a pasture condition rating ≤3, based on the Pasture Condition Assessment Table as per Stocktake: Balancing Supply and Demand (https://futurebeef.com.au/workshops/sustainable-grazing/stocktake-balancing-supply-demand/), as provided in **Table 30**.

7.2 Tailings storage facility

PRCP Guideline (Section 3.6.2)

The tailings require characterisation to determine the geochemistry, rheology and geotechnical parameters that influence the rehabilitation or management strategies and the capacity of the site to support revegetation.

The design for a TSF must include relevant elements:

a) lining of TSF (i.e. embankments and base of structure)

b) leak detection systems

c) cellular design of TSF
d) seepage collection systems
e) design storage allowance
f) spillway location
g) designing TSF for progressive rehabilitation.

Relationship with PRCP schedule
No tailings storage facilities are proposed on Centurion North MLs.

7.3 Voids

PRCP Guideline (Section 3.6.3)

The information requirements of this domain are dependent on the nature of the proposed PMLU or NUMA for the void. For mine sites with voids, the rehabilitation planning part must include a void closure plan, which includes options for minimising final void area and volume; final void dimensions; pit wall geotechnical and geochemical stability, final slope angles, void hydrology, groundwater modelling, water balance and predicted long-term water quality.

A geotechnical report should focus on how the void will achieve post-closure slopes that will exhibit stability characteristics consistent with the planning and design of the post-closure mine void.

If floodwaters are likely to move over backfilled material, an assessment of the hydraulic properties must be conducted to assess whether instability may occur.

The rehabilitation and management strategies in the plan must include the supervision, verification and auditing of engineering works carried out to achieve the post-closure void landform, to ensure construction is consistent with the geotechnical design.

The rehabilitation and management strategy must also include confirmation that the post-closure landform demonstrates the level of stability as specified by the design.

Relevance to Centurion North

No final voids are proposed on Centurion North.

7.3.1 Mining final void

No final void remains.

7.3.2 Final void dimensions

No final void remains.

7.3.3 Final void wall stability

No final void remains.

7.3.4 Final void wall angles

No final void remains.

7.3.5 Void hydrology

No final void remains.

7.3.6 Design plan

No final void remains.

7.3.7 Rehabilitation and management strategies

No final void remains.

7.4 Underground mining

PRCP Guideline (Section 3.6.4)

For underground mining operations, the rehabilitation planning part must include:

- a geotechnical study;
- an assessment of groundwater interactions and potential lowering of groundwater levels;
- the development of a hydrogeological conceptual model;
- subsidence analysis and modelling and a subsidence vegetation/habitat impact assessment;
- consideration of how potential entries to underground workings will be sealed (i.e. through some form of capping or back filling);
- how surface ponding and cracking will be mitigated; and
- identification of post-closure stabilisation of underground workings in order to manage the potential for unplanned surface subsidence and unplanned ground collapse such as sinkholes and pot holing.

Relevance to Centurion North

The current Environmental Authority does not contemplate any underground mining activity on the Centurion North MLs.

7.5 Built infrastructure

PRCP Guideline (Section 3.6.5)

The administering authority's expectation of rehabilitation relating to built infrastructure is that it will be decommissioned, demolished, salvaged and/or disposed of unless it is being formally retained by the landholder to achieve an appropriate PMLU.

The rehabilitation planning part must include:

g) Identification of infrastructure that will be decommissioned and the methods for decommissioning.
h) A description of infrastructure that will remain post rehabilitation and the identification of ongoing maintenance requirements.
i) Evidence of agreement for any infrastructure that will have ownership transferred.

7.5.1 Decommissioning, demolition and removal

Currently, there are no agreements in place for retention of infrastructure by a post mining land owner / holder, but these may be sought in the future if the infrastructure may benefit the post-mining land use.

The infrastructure associated with the approved mining activities (**Table 22**) will be decommissioned and removed from site prior to surrender except where agreed in writing by the post-mining land-owner/holder. It is anticipated that future EA amendments will be sought for further exploration programs and mining operations and some mining infrastructure may be required beyond the current approved exploration activities. This will be incorporated in any future amendments of the PRC plan and PRCP schedule. Further detail on the rehabilitation stages after decommissioning of the infrastructure, such as landform reshape, surface preparation, revegetation and monitoring are covered in the relevant sections.

On-site infrastructure, used solely for grazing purposes (i.e. not related to mining), such as water tanks, property water pipelines, windmills, water troughs, feed troughs and dams will remain to support the post-mining land use.

Table 22 Infrastructure associated with the approved Wards Well activities

Infrastructure	
Exploration	• Drill holes

7.5.1.1 Exploration

Decommissioning of the exploration drill holes will include:

- Assessment of the drill hole to determine if it is required to be sealed;
- Sealing, if required;
- Backfilling drill cuttings into the hole or sump;
- Removing hole collar below the ground level; and
- Removal of all waste products and rubbish.

7.5.2 Contaminated land assessment

In accordance with the EA conditions C16, F1, F2 and F3, spillage of any wastes, contaminants or other materials must be cleaned up as quickly as practicable, stored in accordance with relevant standards and handled in a way that prevents environmental harm. Although contamination at Centurion North is unlikely, a contaminated land assessment will be completed on exploration drill pads, where a risk of contamination may have occurred.

The assessment, if required, will include a Preliminary Site Investigation (PSI) prior to the completion of the approved activities, to identify if any areas require further Detailed Site Investigation (DSI). The investigations will be undertaken in accordance with the National Environment Protection (Assessment of Site Contamination) Measure or equivalent in place at the time of investigation. Where the PSI identifies a requirement for further investigation a targeted DSI will be undertaken to confirm and characterise areas of concern. If contamination is identified, the potential risks will be assessed and, where required, remediation will be undertaken and/or a site management plan developed.

A contaminated land survey will be undertaken to confirm that no contamination unsuitable for the post-mining land use is present.

Relationship with PRCP schedule
The EA requires all infrastructure constructed for the approved activities, must be removed from the site prior to surrender and any spills and releases to be cleaned up and the area remediated.

The information in this section is relevant to the following highlighted **Rehabilitation Areas** and **Rehabilitation Milestones** in the PRCP schedule:						
RA1						
RM1	RM2	RM3	RM4	RM5	RM6	RM7

The following **Milestone Criteria** will demonstrate achievement of the Rehabilitation Milestones:	
RM1	• All services disconnected • All built and service infrastructure demolished and removed (except where agreed in writing by the post-mining land owner/holder) • All concrete, bitumen and aggregate removed • All waste and rubbish removed • All exploration drill holes decommissioned
RM2	• All contamination is remediated or removed from site in accordance with relevant legislation • A contaminated land survey is carried out by a suitably qualified person confirming the land does not present an unacceptable risk to proposed future land uses or the environment

7.6 Summary of key rehabilitation and management practices

Figure 18 summarises the Centurion North rehabilitation milestones. Exploration drilling is rehabilitated progressively throughout the timeline of exploration activities.

In support of this figure, **Table 23** further details the key rehabilitation activities for RA1 at Centurion North. The rehabilitation activities drive achievement of the Centurion North rehabilitation milestones and inform the associated PRCP schedule.

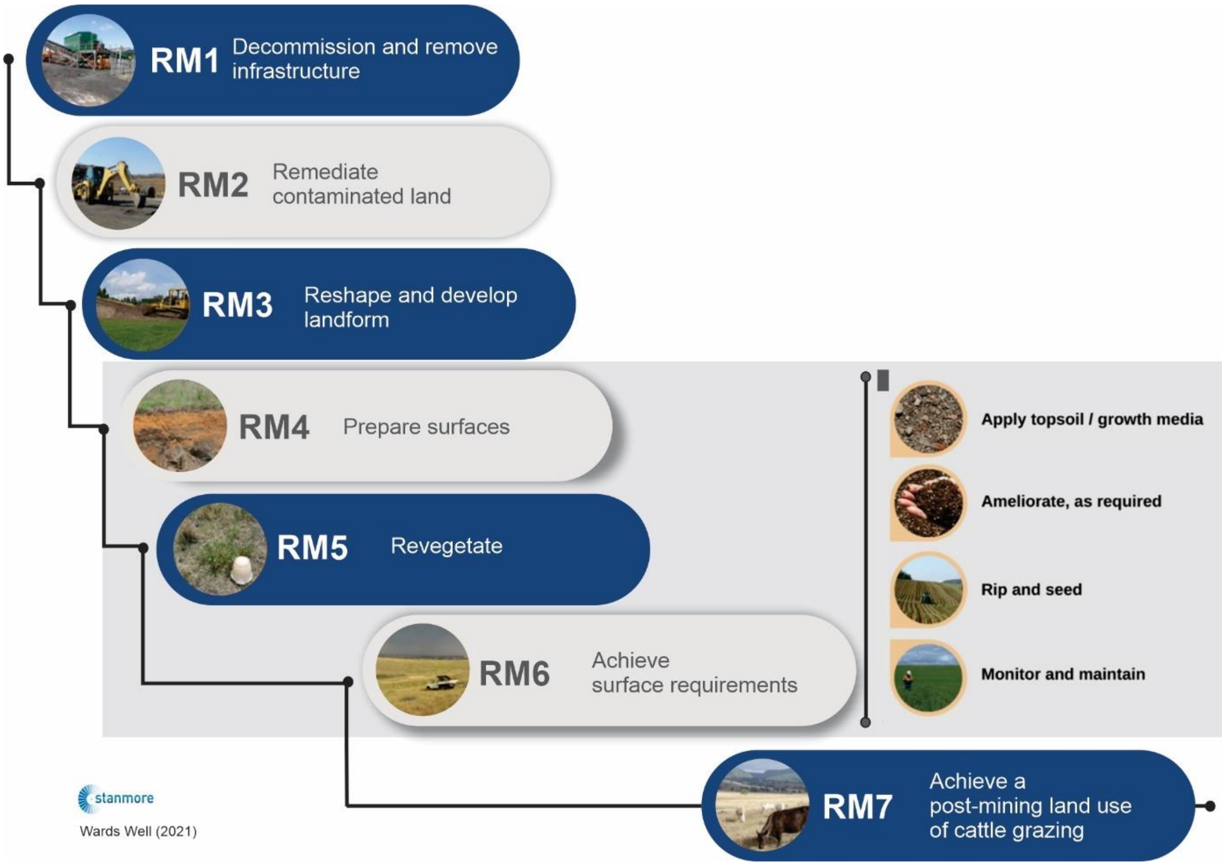


Figure 18 Summary of key rehabilitation and management practices for Centurion North

Table 23 Key rehabilitation activities identified to drive achievement of Centurion North's rehabilitation milestones

Rehabilitation area	Relevant activities	Area (ha)	Rehabilitation activities (to drive achievement of Rehabilitation Milestones)	Rehabilitation timing	Rehabilitation milestones

RA1	Exploration drill holes and tracks	145	• Decommission drill holes:
			  ◦ Assess if the drill hole needs to be sealed by an appropriately qualified person, and seal if required
			  ◦ Backfill drill cuttings into the hole or sump
			  ◦ Cut collar below ground level
			• Remove rubbish
			• Undertake assessment for contaminated land and remediate if required
			• Reshape the landform to be free-draining and blend to merge in with the surrounding topography
			• Spread all topsoil stripped from the area back over the area
			• Rip across contour
			• Seed
			• Undertake monitoring and maintenance to demonstrate achievement of a cattle grazing PMLU
				• Rehabilitation will be completed progressively as drilling is completed
				• Seeding of all legacy drill holes and tracks (unless required for future access) to be completed by 2026
				• Seeding of all new drilling to be completed by 2031
					RM1
					RM2
					RM3
					RM4
					RM5
					RM6
					RM7

8. RISK ASSESSMENT

Legislative Requirement

In accordance with section 126C(1)(f) of the *EP Act*, the rehabilitation planning part of the PRC plan must identify the risks of a stable condition for land described as a post-mining land use not being achieved, and how the applicant intends to manage or minimise the risks.

8.1 Identifying, assessing and treating risks

PRCP Guideline (Section 3.7)

As per section 126C(1)(j) of the *EP Act*, the administering authority considers it necessary for the proposed PRC plan to contain a risk assessment of all proposed NUMAs. The risk assessment must be carried out to identify the risks of the NUMA causing environmental harm and not being safe and structurally stable and detail how the applicant intends to manage and minimise the identified risks.

The 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.

Information requirements in this section apply to all applicants whether or not they are an existing EA holder. Existing holders may have the required information available from previously submitted plans/reports/applications that, if still valid, can be used in the PRC plan.

8.1.1 Risk methodology

A risk-based approach to the Centurion North PRC planning has been undertaken (**Figure 19**).

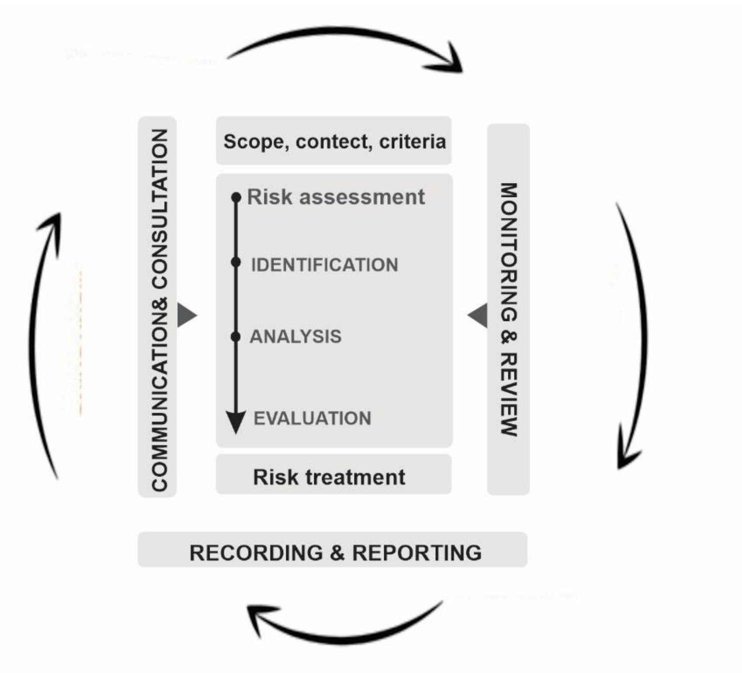


Figure 19 **ISO 3100-compliant risk-based approach followed for the Centurion North PRCP**

8.2 Risk identification

The risk event - a stable condition for land described as a post-mining land use not being achieved, was assessed per ISO 31000 methodology described in **Figure 19** above (the full risk assessment is included in **Appendix 10**), where stable condition is defined as per section 111A of the *EP Act*:

- The land is safe and structurally stable;
- There is no environmental harm being caused by anything on or in the land; and
- The land can sustain a PMLU.

For Centurion North the PMLU being assessed is cattle grazing as per the PRCP schedule**.**

A number of scenarios were identified in the risk identification process related to a stable condition for the land described as the PLMU not being achieved:

- Landform failure;
- Alteration of hydrogeological conditions;
- Alteration of surface water systems;
- Alteration of flood hydrology;
- Insufficient, inadequate or inappropriate soil and capping material required for rehabilitation activities;
- Insufficient identification and management of waste characterisation;
- Inadequate and/or inappropriate revegetation;
- Stability failure of rehabilitated void (noting that this is not applicable to centurion North);
- Stability failure of underground mine workings (noting that this is not applicable to centurion North); and
- Deterioration of built infrastructure conditions.

8.2.1 Risk analysis, evaluation and relevant treatments

The table included in **Appendix 10** provides the full detail of risk analysis, risk evaluation and risk treatment for these scenarios. Worst case outcomes where assessed for each scenario, preventative and mitigating controls identified and from there a residual risk rating was calculated. The applied likelihood and severity tables, as well as the outcomes of the residual risk rating (RRR) heat map ratings matrix are provided in **Figure 20**.

LIKELIHOOD TABLE			
Uncertainty	**Frequency**	**Likelihood Factor**	**Guidance**
Highly Likely	Likely to occur within a 1 year period.	**3**	Event is expected to occur > 80% of the time during a 5 year planning cycle.
Likely	Likely to occur within a 1 - 5 year period.	**1**	Event is expected to occur 60% to 80% of the time during a 5 year planning cycle.
Probable	Likely to occur within a 5 - 20 year period.	**0.3**	Event is expected to occur 30% to 60% of the time during a 5 year planning cycle.
Unlikely	Likely to occur within a 20 - 50 year period.	**0.1**	Event is expected to occur 10% to 30% of the time during a 5 year planning cycle.
Highly Unlikely	Not likely to occur within a 50 year period.	**0.03**	Event is expected to occur < 10% of the time during a 5 year planning cycle.

SEVERITY TABLE		
Severity Level	Descriptor	Severity Factor
5	Severe impact to the environment and where recovery of ecosystem function takes 10 years or more;	1000
4	Serious impact to the environment, where recovery of ecosystem function takes between 3 and up to 10 years or	300
3	Substantial impact to the environment, where recovery of ecosystem function takes between 1 and up to 3 years	100
2	Measureable but limited impact to the environment, where recovery of ecosystem function takes less than 1 year	30
1	Minor, temporary impact to the environment, where the ecosystem recovers with little intervention	10

			Severity level	S1	S2	S3	S4	S5
			Severity Factor	10	30	100	300	1000
	Likelihood	Likehood Factor	Timeframe	Residual Risk Calculation (with controls in place and effective)				
Likelihood	Highly Likely	3	Within 1 year	30	90	300	900	3000
	Likely	1	Within 1-5 years	10	30	100	300	1000
	Probable	0.3	Within 5-20 years	3	9	30	90	300
	Unlikely	0.1	Within 20-50 years	1	3	10	30	100
	Highly Unlikely	0.03	Within 50 years	0.3	0.9	3	9	30

Figure 20 Likelihood and severity tables, with resulting residual risk rating (RRR) heat map

With controls in place and implemented effectively, the RRR for the identified risk scenarios of this risk event is deemed to be low (RRR of 3 or lower).

The risk treatments for each scenario that are necessary for achieving a stable condition for the land described as the PLMU are shown below in **Table 24**.

Table 24 Necessary risk treatments identified to achieve a stable condition for the PMLU

Aspect	Risk treatment
Risk event: Landform failure	
Reasons for selecting treatment option	• Method will achieve a stable condition. • Final landform is similar to pre-mining landform.
Responsibility for plan: • Approval • Implementation	• EA Holder. • Exploration team
Proposed actions	• Minimise height and slope gradients of landform structures. • Landform structures reshaped and blended in with surrounding topography. • Surface cover including vegetation to provide erosion resistance.
Resource requirements	• Landform design. • Available material inventory. • Equipment capabilities. • Survey/LiDAR. • Rehabilitation monitoring data.

Aspect	Risk treatment
Performance measures and constraints	• Tracking against milestone criteria.
Reporting and monitoring requirements	• Analysis of final landform against design. • Rehabilitation monitoring.
Risk timing and scheduling	• From commencement of rehabilitation to final achievement of PMLU.
Risk event: Alteration of hydrogeological conditions	
Reasons for selecting treatment option	• AMD issues not identified. • Hydrogeological conceptual model indicates low potential for impacts to groundwater quality, groundwater use or for long-term changes to hydrogeological condition.
Responsibility for plan: • Approval • Implementation	• EA Holder. • Exploration team.
Proposed actions	• All imported hazardous materials are to be stored and used in accordance with the requirements of EA. • At the completion of operations, all imported hazardous materials and infrastructure that have the potential to release contaminants to groundwater will be removed from site. • Groundwater and ecosystem monitoring to be undertaken in accordance with EA conditions.
Resource requirements	• Not applicable.
Performance measures and constraints	• Tracking against milestone criteria.
Reporting and monitoring requirements	• Rehabilitation monitoring. • Reporting under existing EA requirements.
Risk timing and scheduling	• From commencement of rehabilitation to final achievement of PMLU.
Risk event: Alteration of surface water systems	
Reasons for selecting treatment option	• AMD issues not identified. • No alteration of the alignment of drainage lines or creeks.
Responsibility for plan: • Approval • Implementation	• EA Holder. • Exploration team.
Proposed actions	• All imported hazardous materials and to be stored and used in accordance with EA conditions.

Aspect	Risk treatment
	• Surface water monitoring to be undertaken opportunistically when sufficient water is available in the ephemeral creeks and in accordance with EA conditions. • Monitoring of surrounding ecosystems will be undertaken in accordance with EA conditions. • Rehabilitation of disturbed areas will be undertaken after the completion of operations.
Resource requirements	• Not applicable.
Performance measures and constraints	• Tracking against milestone criteria and WQO.
Reporting and monitoring requirements	• Monitoring when surface water flows are available. • Reporting under existing EA requirements.
Risk timing and scheduling	• From commencement of rehabilitation to final achievement of PMLU.
Risk event: Alteration of flood hydrology	
Reasons for selecting treatment option	• No alteration of the alignment of drainage lines or creeks.
Responsibility for plan: • Approval • Implementation	• EA Holder. • Exploration team.
Proposed actions	• Assessment of flooding risks evaluated prior to commencement of operations. Note assessment has confirmed low risk. • Final landforms are to be located, designed and constructed to minimise impact to flooding regimes and to withstand reasonably assessed flooding risks. • Monitoring of surrounding ecosystems to be undertaken in accordance with EA conditions.
Resource requirements	• Not applicable.
Performance measures and constraints	• Tracking against milestone criteria.
Reporting and monitoring requirements	• Rehabilitation monitoring. • Reporting under existing EA requirements.
Risk timing and scheduling	• From commencement of rehabilitation to final achievement of PMLU.
Risk event: Insufficient, inadequate or inappropriate soil and capping material required for rehabilitation activities	
Reasons for selecting treatment option	• Enables utilisation of site resources for greatest chance of stable condition being achieved.
Responsibility for plan: • Approval	• EA Holder. • Exploration team.

Aspect	Risk treatment
• Implementation	
Proposed actions	• Undertake rehabilitation planning and preparation in accordance with the specific requirements for soil, seed and management for a cattle grazing PMLU. • Management of topsoil stripping and application during rehabilitation. • Topsoil assessment by an appropriately qualified person to determine if ameliorant and fertiliser requirements are required. • Ameliorants and fertilisers applied, if required.
Resource requirements	• Topsoil inventory. • Survey/LiDAR. • Topsoil assessment. • Rehabilitation monitoring data.
Performance measures and constraints	• Tracking against milestone criteria.
Reporting and monitoring requirements	• Topsoil assessment. • Rehabilitation monitoring.
Risk timing and scheduling	• From planning of soil stripping to final achievement of PMLU.
Risk event: Insufficient or poor waste characterisation (not relevant to Centurion North)	
Reasons for selecting treatment option	• Not applicable.
Responsibility for plan: • Approval • Implementation	• Not applicable.
Proposed actions	• Not applicable.
Resource requirements	• Not applicable.
Performance measures and constraints	• Not applicable.
Reporting and monitoring requirements	• Not applicable.
Risk timing and scheduling	• Not applicable.
Risk event: Inadequate and/or inappropriate revegetation	
Reasons for selecting treatment option	• Proposed seed mix has worked successfully in cattle grazing PMLU rehabilitation at other sites.
Responsibility for plan: • Approval	• EA Holder. • Exploration team.

Aspect	Risk treatment
• Implementation	
Proposed actions	• Management of topsoil stripping and application during rehabilitation. • Topsoil assessment by an appropriately qualified person to determine if ameliorant and fertiliser requirements for planned seed mix are required. • Ameliorants and fertilisers applied, if required. • Management of seed selection and quality. • Plant at optimal time of year.
Resource requirements	• Topsoil inventory. • Topsoil assessment. • Rehabilitation monitoring data.
Performance measures and constraints	• Tracking against milestone criteria.
Reporting and monitoring requirements	• Rehabilitation monitoring.
Risk timing and scheduling	• From planning of soil stripping to final achievement of PMLU.
Risk event: Stability failure of rehabilitated void (not relevant to Centurion North)	
Reasons for selecting treatment option	• Not applicable.
Responsibility for plan: • Approval • Implementation	• Not applicable.
Proposed actions	• Not applicable.
Resource requirements	• Not applicable.
Performance measures and constraints	• Not applicable.
Reporting and monitoring requirements	• Not applicable.
Risk timing and scheduling	• Not applicable.
Risk event: Stability failure of underground mine workings (not relevant to Centurion North)	
Reasons for selecting treatment option	• Not applicable.
Responsibility for plan: • Approval • Implementation	• Not applicable.
Proposed actions	• Not applicable.

Aspect	Risk treatment
Resource requirements	• Not applicable.
Performance measures and constraints	• Not applicable.
Reporting and monitoring requirements	• Not applicable.
Risk timing and scheduling	• Not applicable.
Risk event: Deterioration of built infrastructure land conditions	
Reasons for selecting treatment option	• Minimise or prevent contamination.
Responsibility for plan: • Approval • Implementation	• EA Holder. • Exploration team.
Proposed actions	• Clean up and remediate contamination during operational period. • Undertake PSI contaminated land assessment post-mining to identify any areas requiring further DSI. • Remediate any contamination. • A contaminated land survey is carried out by a suitably qualified person confirming no contamination.
Resource requirements	• Infrastructure inventory. • Contaminated land assessments. • Final contaminated land survey. • Rehabilitation monitoring data.
Performance measures and constraints	• Tracking against milestone criteria.
Reporting and monitoring requirements	• Contaminated land assessments. • Final contaminated land survey. • Rehabilitation monitoring.
Risk timing and scheduling	• From the commencement of all activities to final achievement of PMLU.

Due to the limited disturbance area and minimum elevation of the final landform, the rehabilitation outcomes are considered low-risk and no rehabilitation trials will be conducted.

9. MONITORING AND MAINTENANCE

To demonstrate achievement of the RMs, as they relate to achieving a PMLU of cattle grazing, a combination of the following approaches will be used (**Table 25**):

- Rehabilitation reporting requirements (RM1 to RM5); and
- Ongoing rehabilitation monitoring (RM6 and RM7), comprising desktop and field-based assessments and associated reporting (**Figure 21**).

Table 25 Rehabilitation milestones with relevant reporting requirements

Milestone reference	Rehabilitation milestone	Milestone criteria	Reporting requirements
RM1	Infrastructure decommissioning and removal	a) All services disconnected. b) All built and service infrastructure demolished and removed. c) All concrete, bitumen and aggregate removed. d) All waste and rubbish removed. e) All exploration drill holes decommissioned.	• Undertake visual inspections. • Document inspections.
RM2	Remediation of contaminated land	a) All contamination is remediated or removed from site in accordance with relevant legislation. b) A contaminated land survey is carried out by a suitably qualified person confirming the land does not present an unacceptable risk to proposed future land uses or the environment.	• Documentation by a suitably qualified person confirming the land does not present an unacceptable risk to proposed future land uses or the environment.
RM3	Landform development and reshaping	b) Landform is reshaped to be free-draining with slopes ≤ 5% and consistent with the surrounding topography.	• Survey/LiDAR of landform. • Analyse final landform against design.
RM4	Surface preparation	a) Topsoil is placed an average thickness of 200mm. b) An assessment of soil and growth media characteristics is completed by an appropriately qualified person and amelioration and other treatments required identified. c) Ameliorant and physical treatments are applied as identified.	• Survey/LiDAR of surface and extent after topsoil is placed. • Document topsoil depth. • Document soil assessment. • Document soil ameliorants and physical treatments applied.

Milestone reference	Rehabilitation milestone	Milestone criteria	Reporting requirements
RM5	Revegetation (cattle grazing)	a) Completed seeding in accordance with recommended pasture mix (grasses, cover crop and legumes), and seeding rates (up to 25kg/ha).	• Document seed mix, planting rates and areas.
RM6	Achievement of surface requirements (cattle grazing)	a) Pasture condition rating ≤3, including: • Preferred pasture species (3P grasses) diversity ≥2 species; • Preferred pasture (3P grasses) % DM yield ≥10%; • Annual grass DM yield % <70%; • Undesirable grasses and other weeds % DM yield <80%; and • Crown cover (3P grasses) – at worst, moderate to low density and some plants dead.	• Undertake rehabilitation monitoring as per Sections 9.
RM7	Achievement of post-mining land use to a stable condition (cattle grazing)	a) A hazard assessment has been completed by an appropriately qualified person to confirm safety hazards in rehabilitation are not significantly different to surrounding unmined landscapes subject to the same land use. b) n/a. c) Groundcover >50%. d) Rainfall runoff from the area is not significantly different to upstream values for the following: pH, EC and turbidity. e) n/a. f) Land suitability class ≤3, or not different from pre-mining class if ≥4. The assessment is to be conducted by an appropriately qualified person in accordance with LSA Framework for Open-Cut Coal Mine Rehabilitation 2018 (A rule-set for land suitability assessment of sustainable beef cattle grazing on land rehabilitated after open-cut coal mining in the Bowen Basin Queensland) unless otherwise agreed in writing between the administering authority and the environmental authority holder. For RM7(f), if the land suitability class is assessed as not different from pre-mining class if ≥4 for all or a portion of a rehabilitation area, an assessment of reference sites must be carried out to determine if the limitation/s resulting in the class of ≥4 is consistent with that of reference sites.	• Undertake rehabilitation monitoring as per Sections 9.

Milestone reference	Rehabilitation milestone	Milestone criteria	Reporting requirements
		g) Certification by an appropriately qualified person that pasture meets a pasture condition rating ≤3.	

9.1.1 Analogue sites and grazing PMLU monitoring

Monitoring of analogue or reference sites is not a requirement of the current EA and is not included in the Centurion North rehabilitation monitoring program (unless identified as being required as per RM7(f) (**Table 25**)).

Monitoring of cattle grazing will be assessed against:

- The pasture condition criteria for RM6 and RM7(g) (**Table 25**), which is based on standard methods for assessing pasture condition consistent with industry guidelines[22]; and
- The land suitability assessment based on the grazing rule-set[13] criteria for RM7(f) (**Table 25**).

9.1.2 Rehabilitation monitoring phases

Permanent monitoring plots will be established at the start of the rehabilitation monitoring program. These same plots will also be assessed at the same location during all subsequent phases of the ongoing rehabilitation monitoring.

This rehabilitation monitoring program has been designed to demonstrate achievement of surface requirements (RM6) and post-mining land use to a stable condition (RM7); and follows a phased approach to ensure greater accuracy and efficiency in data collection and analysis. There are three main phases to the rehabilitation monitoring program including 'initial', 'minor', and 'major', as illustrated in **Figure 21**. Opportunistic monitoring is also conducted in addition to each monitoring phase (**Figure 21**).

[22] Stocktake: Balancing Supply and Demand https://futurebeef.com.au/workshops/sustainable-grazing/stocktake-balancing-supply-demand/#why-choose-stocktake

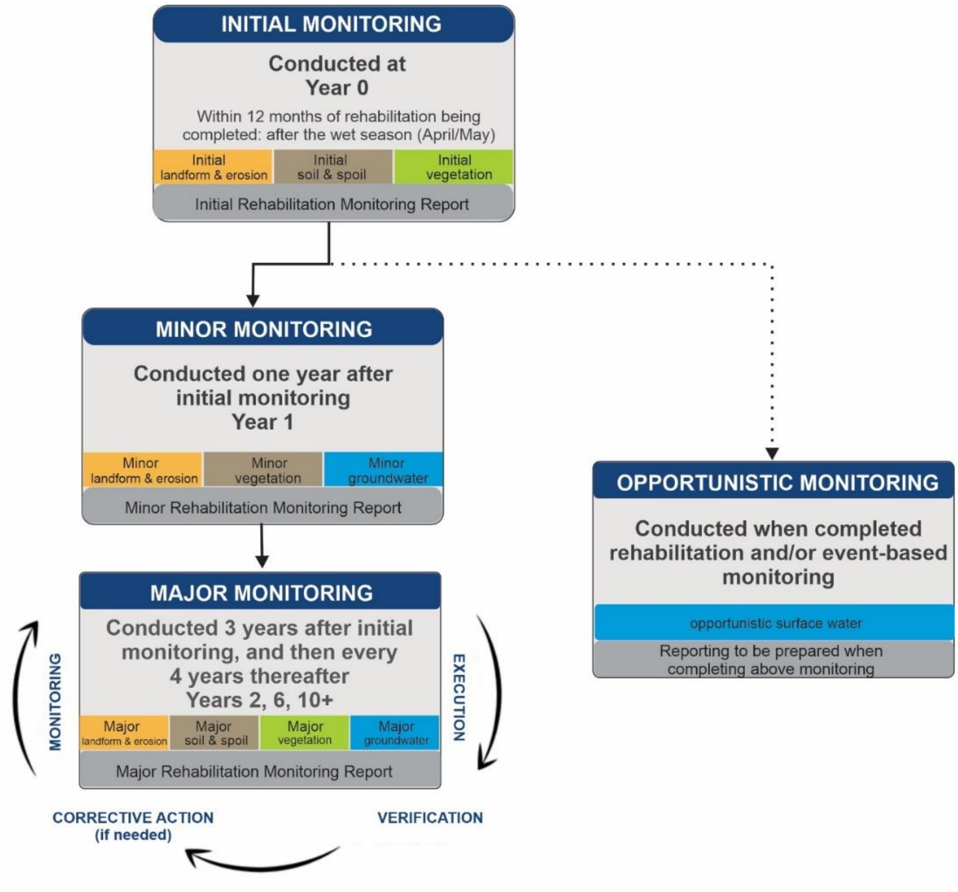


Figure 21 Flow diagram of the Centurion North rehabilitation monitoring program

The ongoing and consistent phased approach of the monitoring program ensures that there is continual monitoring of the rehabilitation parameters against the milestone criteria up to the point of the surrender of the EA. **Table 26** describes how the monitoring schedule progresses over the PRCP period during the phases of monitoring, and includes the parameters monitored during each phase. This allows assessment of the performance and trajectory of the rehabilitation against milestone criteria and accounts for the influence of seasonal variations and extreme weather events over time.

Table 26 Rehabilitation parameters measured during rehabilitation monitoring phases

Rehabilitation parameters	Rehabilitation				
	Year 0	Year 1	Year 2	Year 6	Year 10+
Landform stability	Initial	Minor	Major	Major	Major
Erosion	Initial	Minor	Major	Major	Major
Soil and spoil	Initial	-	Major	Major	Major
Groundcover	Initial	Minor	Major	Major	Major
Invasive plants	Initial	Minor	Major	Major	Major

Rehabilitation parameters	Rehabilitation				
	Year 0	Year 1	Year 2	Year 6	Year 10+
Pasture species Richness	Initial	Minor	Major	Major	Major
Pasture yield and quality	-	-	Major	Major	Major
Pasture condition	-	-	Major	Major	Major
Grazing Land Suitability Assessment	-	-	-	Major	Major

9.2 Initial monitoring method

Initial monitoring will be undertaken at newly established rehabilitation monitoring sites to categorise the site, develop baseline data and identify any risks to rehabilitation success.

Early detection and rectification of drainage and run-off issues can prevent more widespread erosion issues that can lead to rehabilitation failure.

The following aspects of rehabilitation will be assessed during initial monitoring:

- Landform and erosion;
- Soils and spoils; and
- Vegetation.

9.2.1 Desktop monitoring

Prior to commencing any field monitoring work, LiDAR data and aerial imagery will be used to:

- Develop a Digital Elevation Slope Model to assess the landform design;
- Identify potential erosion areas for field validation; and
- Plan the locations to establish permanent, fixed monitoring plots using the following criteria:
  - Representative of rehabilitation slope and PMLU; and
  - Accessibility (vehicle access preferred).

9.2.2 Field monitoring

Field monitoring will be undertaken at the permanent, fixed plot field monitoring sites established as part of the initial desktop monitoring.

9.2.2.1 Landform and erosion

Field based landform and erosion monitoring will focus on assessing initial areas of erosion identified through the desktop assessment.

Whilst the rehabilitated landforms at Centurion North are not complex and the risks associated with instability and erosion are low, provisions for field-based erosion monitoring have been included in the program for any potential areas of erosion identified during desktop analysis.

The field survey involves establishing an erosion monitoring transect by running a 50m tape perpendicular to the slope and across the erosional activity identified during the LiDAR analysis.

9.2.2.2 Soil and spoil

Surface sampling of topsoil refers to the layer at 0 – 10cm; and sub-surface sampling of underlying spoils refers to layers at 10 – 30cm, 30 – 60cm and 90 – 100cm.

Data acquired from soil and spoil monitoring will be analysed by an appropriately qualified person and consider the grazing ruleset. This will be used to establish initial characteristics of the rehabilitated soil profile for trend analysis of these fixed points over time.

The soil and spoil analysis parameters are provided in **Table 27**.

Table 27 Soil and soil analysis parameters for Wards Well's monitoring programs

Category	Analyte	Purpose of analyte	Depth		Monitoring phase	
			Surface	Sub-surface	Initial	Major
Acidity / alkalinity	pH	Identify anomalies that may affect plant growth and sustainability.	ü	ü	ü	ü
Salinity	EC	Identify leaching profile. High salinity can lead to poor vegetation germination and establishment, reduced plant growth and vigour.	ü	ü	ü	ü
	Chloride	Identify leaching profile. High chloride can lead to poor vegetation germination and establishment, reduced plant growth and vigour.	ü	ü	ü	ü
Exchangeable cations	Cation exchange capacity (CEC)	Major factor in soil fertility. Controls soil stability, nutrient availability and buffers soil's chemical properties.	ü	ü	ü	ü
	Exchangeable cations	Exchangeable Calcium is linked to soil stability. High levels of exchangeable Magnesium can cause clay dispersion, instability when wet and hard setting.	ü	ü	ü	ü
	Exchangeable Sodium Percentage (ESP)	ESP is a measure of the dominance of sodium ions on the soil's cation exchange complex. Sodicity in soils can lead to slaking and dispersion which impact soil structure and stability.	ü	ü	ü	ü

Category	Analyte	Purpose of analyte	Depth		Monitoring phase	
			Surface	Sub-surface	Initial	Major
Organic matter	Organic carbon	An indicator of soil nutrient stores and a contributor to improvements in soil structure. Changes through time in organic carbon are a key indicator of rehabilitation success.	ü	-	ü	ü
Major elements	Total Nitrogen	Indicator of soil nutrient store and is also a major plant nutrient.	ü	-	ü	ü
	Extractable Phosphorous (Colwell method)	Indicator of Phosphorous readily available to plants.	ü	-	ü	ü
	Total Phosphorous	Indicator of total store of Phosphorous, some of which is readily available. Key indicator of potential for long-term success or failure of rehabilitation.	ü	-	ü	ü
	Potassium	Important plant nutrient.	ü	-	ü	ü
	Total Sulphur	Indicator of potential for development of Acid Metalliferous Drainage.	ü	-	ü	ü
	Sulphate	Important plant nutrient, and can be an indicator of development of Acid and Metalliferous Drainage.	ü	-	ü	ü
	Calcium	Important plant nutrient.	ü	-	ü	ü
	Magnesium	Important plant nutrient.	ü	-	ü	ü
Trace elements	Manganese	Trace element with minor importance for vegetation success.	ü	-	ü	ü
	Iron	Trace element with minor importance for vegetation success.	ü	-	ü	ü
	Zinc	Trace element important for vegetation success.	ü	-	ü	ü
	Copper	Trace element important for vegetation success.	ü	-	ü	ü
Metals	For example: Se, Zn, and Hg	Metals that have been identified as occurring at elevated levels during material characterisation analysis should be tested during monitoring.	ü	ü	ü	ü

Category	Analyte	Purpose of analyte	Depth		Monitoring phase	
			Surface	Sub-surface	Initial	Major
Physical parameters	Particle size (PSA)	Soil texture strongly affects water entry and storage. Soil texture will impact erosion and vegetation success, and should be considered when planning species mixes for planting.	ü	ü	ü	-
	Emerson aggregate test	Indicator of clay dispersion. Should be interpreted in conjunction with ESP and EC data.	ü	ü	ü	-
Field analysis	Soil profile characteristics	Horizon depths, Field colour, Field texture, Structure, Root density and depth, Soil plant available water capacity (PAWC – initial only).	ü	ü	ü	-

9.2.2.3 Vegetation

As initial monitoring is conducted within 12 months of rehabilitation being completed, vegetation establishment is expected to be limited. Initial vegetation monitoring consists of identifying germinants present at the time of monitoring to species level, where possible, to assess the relative germination success rates of each species in the rehabilitation seed mix.

9.2.2.4 Groundwater

Groundwater monitoring will include ongoing monitoring of the existing groundwater monitoring network. The groundwater monitoring network will be reviewed to ensure sufficient monitoring bores to assess up-gradient potential source areas and down gradient areas. This monitoring network will be used for the collection of post-mining groundwater data and to provide information that will allow for the assessment of future trends of key groundwater indicators.

9.3 Minor monitoring methods

The minor monitoring methodology has been designed to maintain a replicable record of rehabilitation condition, and to quickly identify and resolve issues.

In addition to the existing permanent fixed monitoring points, any new erosion areas that are identified through desktop and field analysis will also be included in the already established monitoring activities. The following aspects will be assessed during the minor monitoring:

- Landform and erosion; and
- Vegetation.

9.3.1 Desktop monitoring

Prior to commencing any field monitoring work, LiDAR data and aerial imagery will be used to:

- Update the Digital Elevation Slope Model;
- Identify new areas of potential sedimentation and/or ponding; and

- Identify new areas of erosion for field validation.

9.3.2 Field monitoring

9.3.2.1 Landform and erosion

For erosion areas identified through the desktop assessment as well as the existing permanent fixed monitoring plots, the following data is recorded:

- Coordinates of erosion point;
- Photo details - coordinates and direction of photos;
- Estimated topsoil coverage of the surrounding rehabilitated area;
- Type of erosional process identified (i.e. sheet erosion, rill erosion, gully erosion, tunnel erosion);
- Evaluation of the severity of the erosion based on previous photographs or knowledge of the area;
- Estimated size of erosional form (using a tape measure to record width and depth); and
- State of erosion[23] (**Table 28**).

Table 28 States of erosion

State of erosion	Description
Active	• One or both of the following conditions apply: • Evidence of sediment movement • Sides and/or floors of erosion form are relatively bare of vegetation
Partly stabilised	• Evidence of some active erosion and some evidence of stabilisation
Stabilised	• One or both of the following conditions apply: • No evidence of sediment movement • Sides and/or floors of erosion form are revegetated

9.3.2.2 Soils and spoil

Soils and spoils baseline sampling is undertaken during the initial phase (refer to Section 9.2.2) and then compared to baseline again during the major monitoring phases (refer to Section 9.4). It is not included in the minor monitoring phase. Only surface conditions are considered in the minor monitoring.

9.3.2.3 Vegetation

Minor monitoring shall be undertaken at the fixed plots established during initial phases of monitoring. The following vegetation parameters are monitored:

- Groundcover;
- Invasive plants; and

[23] McDonald R, Isbell R, Speight J, Walker J and Hopkins M (2009) 'Australian Soil and Land Survey Field Handbook, CSIRO

- Pasture species richness.

9.4 Major monitoring methods

The major monitoring methodology has been designed to provide a detailed assessment of rehabilitation performance. In addition to the existing permanent fixed monitoring points, any new erosion areas that are identified through desktop and field analysis will also be included in monitoring activities. Its purpose is to identify any risks to rehabilitation success and to evaluate the progress of rehabilitation towards milestone criteria and the PMLU of cattle grazing.

The following aspects of rehabilitation will be assessed during major monitoring:

- Landform and erosion;
- Soil and spoil;
- Vegetation (including pasture condition); and
- Grazing Land Suitability Assessment.

9.4.1 Desktop monitoring

Prior to commencing any field monitoring work, a desktop review is to be undertaken including:

- Review of previous rehabilitation monitoring reports to understand historic conditions;
- Update the Digital Elevation Slope Model to compare against previous models and detect any changes in landform over time (e.g. settlement/subsidence); and
- Identify new areas of erosion for field validation.

9.4.2 Field monitoring

9.4.2.1 Landform and erosion

Field based landform and erosion monitoring will focus on assessing erosion at the existing permanent fixed monitoring plots as well as areas identified through the desktop assessment.

9.4.2.2 Soil and spoil

Soil and spoil data acquired from major monitoring is shown in **Table 28** and will be analysed by an appropriately qualified person and consider the grazing rule-set (refer **Table 17**). This data will provide an indication of performance of these parameters at fixed monitoring points over time. Evaluation of rehabilitation performance will consider soil and spoil data to inform trend to achieving milestone criteria or remediation action if required.

9.4.2.3 Vegetation

Ongoing major vegetation monitoring is to take place at the permanently, fixed field monitoring plots established during the initial phase. Vegetation monitoring includes assessment of the following parameters:

- Groundcover;
- Invasive plants;
- Pasture species richness; and
- Pasture condition.

Pasture condition (yield and quality as well as species richness)

The pasture analysis includes an assessment of pasture species richness, yield and quality, and pasture condition. Pasture yield is assessed using percentage dry matter (DM) yield for preferred pasture species as well as the proportion of DM yield for other intermediate species, annual grasses, undesirable grasses and weeds. Pasture condition is assessed by measuring the percentage DM yield, health and diversity of preferred pasture species. Preferred pasture species are identified as perennial grasses that are productive and palatable (3P grasses) to stock. A list of common preferred, other intermediate and undesirable pasture species is provided in **Table 29**.

An overall assessment of pasture condition is undertaken at the first major monitoring assessment at year 2, and every four years thereafter. This initially allows at least two seasons after seeding for pasture species to establish.

Table 29 Preferred, intermediate and undesirable pasture species

Preferred species		Other intermediate species		Other undesirable species	
Scientific name	**Common name**	**Scientific name**	**Common name**	**Scientific name**	**Common name**
Cenchrus ciliaris	Buffel Grass	*Bothriochloa decipiens*	Pitted Bluegrass	*Aristida spp.*	Wire Grasses
Heteropogon contortus	Black Spear Grass	*Cynodon dactylon*	Green Couch	*Sporobolus spp.*	Native Rat's Tail Grasses
Dichanthium sericeum	Queensland Bluegrass	*Panicum decompositum*	Native millet	*Chloris divaricata*	Slender Chloris
Astrebla squarrosa, A. appacea, A. elymoides	Bull Mitchell Curly Mitchell Hoop Mitchell	*Cymbopogon refractus*	Barbwire Grass		

Pasture monitoring is undertaken within three quadrats at each of the existing monitoring sites. Pasture is removed from the quadrat by cutting vegetation to approximately 50mm in height and weighing in the field. It is important to record total sample weight for the quadrat and then separate the sample into preferred pasture species (3P), other pasture species, annual grasses, undesirable grass species and weeds. These are all weighed separately to collect data on initial weight and determine the overall percentage DM yield. Results of each plot are averaged to attain an overall pasture condition rating score for each site.

Pasture condition rating criteria is listed in **Table 30**. Importantly the pasture condition can be assessed at any time pasture species area identifiable, preferably post wet season. The pasture is assessed against the milestone criteria for pasture condition listed in RM6 and RM7(g) (**Table 25**) which is based on standard methods for assessing pasture condition consistent with industry guidelines.

Table 30 Pasture condition assessment table (criteria to assign pasture rankings)

Condition rating	Condition indicators				
	Preferred pasture species		Annual grass % DM yield	Undesirable grasses and other weeds % DM Yield	Preferred pasture species diversity
	% DM yield	Crown cover			
1	> 80 %	Dense and plants healthy	< 20 %	< 20 %	> 5 species
2	60 – 80 %	High to moderate density and some plants unhealthy	20 – 40 %	20 – 30 %	3 – 5 species
3	10 – 60 %	Moderate to low density and some plants dead	40 – 70 %	30 – 80 %	2 – 3 Species
4	< 10 %	Sparse and many plants dead	> 70 %	> 80 %	0 or 1 species

9.4.2.4 Grazing land suitability assessment

An assessment of land suitability, based on the grazing ruleset, is undertaken to demonstrate achievement of RM7(f) for a PMLU of cattle grazing, at the following monitoring times:

- During major monitoring in Year 6 (second time major monitoring is undertaken) to allow time for vegetation to establish; and
- Each scheduled major monitoring from Year 10+ until the rehabilitation succeeds in meeting the milestone criteria.

(Refer to Section 4.1 for more details on the land suitability methodology for the grazing ruleset for a PMLU of cattle grazing).

9.5 Achieving monitoring across the PRCP schedule

For final rehabilitation, it is planned that RM6 – achievement of surface requirements for cattle grazing (pasture condition rating of ≤3), is possible within a 10-year timeframe from revegetation. There are a number of factors which can influence the successful establishment of pastures on post-mined land including soils and landform, soil management and amelioration, species selection, sowing rates, and sowing timing plus rainfall. The revegetation plan has considered these elements, and allows a period up to 10 years to achieve RM6 for seasonal rainfall variation to successfully establish a pasture suitable for a PMLU of cattle grazing at Centurion North. For seismic areas requiring return to native vegetation, 5 years will be sufficient to achieve RM6. This is due to minimal disturbance from seismic activities, allowing vegetation to regenerate from the existing root ball as solid will not be disturbed for the majority of seismic activities.

Achievement of post-mining land use to a stable condition for cattle grazing (RM7), is planned within a 15-year timeframe from revegetation. Achieving RM7 relies on successfully achieving RM6 within 10 years, accounting for seasonal variation of rainfall. An additional 5 years has been allowed for achievement of RM7 to demonstrate the ongoing sustainability of the PMLU for cattle grazing through additional rehabilitation monitoring data associated with landform, erosion, soils, vegetation, pastures, and surface water (Section 9.2).

9.6 Maintenance

Maintenance will be implemented when monitoring identifies issues with the rehabilitation, or milestone criteria are not being met. In order to select the most appropriate remedial actions, the likely cause would be assessed. Contributing factors may be related to:

- Climatic conditions (i.e. droughts);
- Weed presence;
- Poor drainage design;
- Insufficient vegetation cover;
- Influence of adjacent land use; and/or
- Soil type.

Required rehabilitation actions are to be entered into a work management system for actioning.

9.7 Data analysis and reporting

Rehabilitation monitoring data will be collected and analysed by appropriately qualified and experienced persons and assessed against the milestone criteria. The data will be analysed to identify changes and trends, as well as map the trajectory of rehabilitation to identify whether it is on track to achieve the rehabilitation milestones or requires remedial actions or maintenance.

The rehabilitation data will be stored and processed within internal geospatial and document management systems.

9.8 Quality assurance and quality control

The quality assurance and quality control (QA/QC) process to be followed as part of Centurion North ongoing rehabilitation monitoring is illustrated in **Figure 22** The process provides for initial execution of the rehabilitation in accordance with the rehabilitation measures, followed by verification of how this execution was undertaken (again, according to these measures). Based on the verification outcomes, allowance is made for implementation of corrective action and/or maintenance, as needed.

The rehabilitated areas as well as corrected and/or maintenance areas then undergo further rehabilitation monitoring; and subsequent execution of the rehabilitation measures.

This process allows for a repetitive execution-verification-monitoring QA/QC approach, to ensure rehabilitation areas progress on a trajectory towards achievement of milestone criteria and eventual certification.

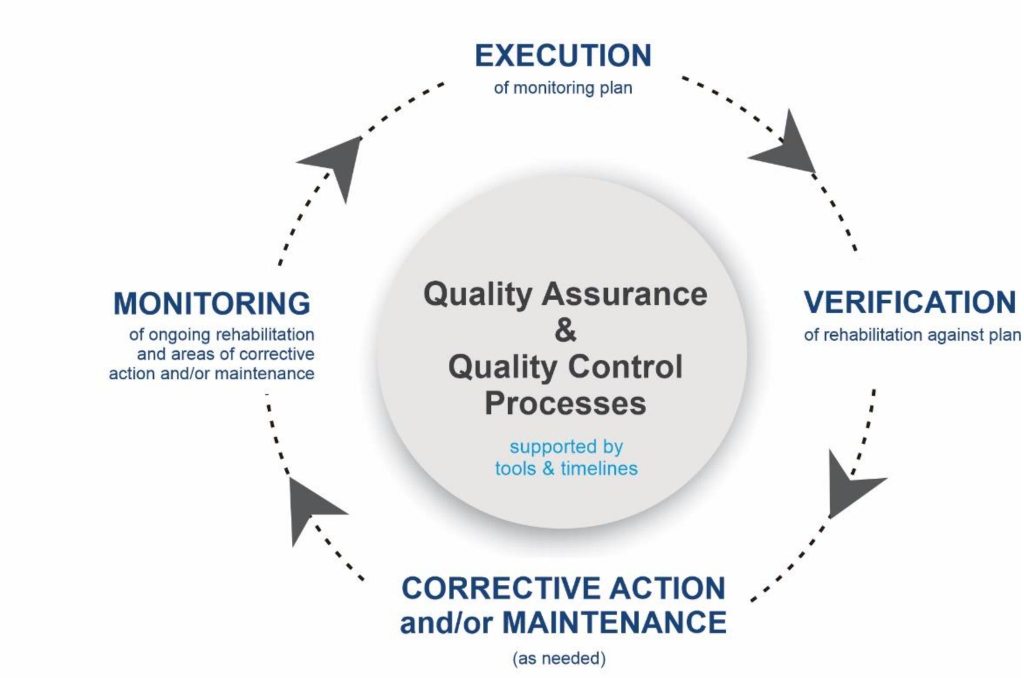


Figure 22 Quality assurance/quality control process to be followed for ongoing rehabilitation monitoring at Centurion North

Relationship with PRCP schedule
The rehabilitation monitoring program is designed to track rehabilitation performance over time to identify compliance to milestone criteria and ensure continuous improvement in rehabilitation methodologies.

10. SECTION B: PRCP SCHEDULE

Legislative Requirement

In accordance with section 126D(1) of the EP Act, the PRCP schedule in the PRC Plan must:

j) describe the area of each resource tenure either a post-mining land use or non-use management area, and
k) for each post-mining land use state:
   i. each rehabilitation milestone required to achieve a stable condition, and
   ii. when each rehabilitation milestone is to be achieved, and
l) for each non-use management area state:
   i. each management milestone, and
   ii. when each management milestone is to be achieved, and
m) include maps showing the land mentioned in (a), (b) and (c).

10.1 Final site design

The final site design for Centurion North, including maximum disturbance, tenure boundaries, the PMLU and the extreme event flood plain, is shown in **Figure 23**.

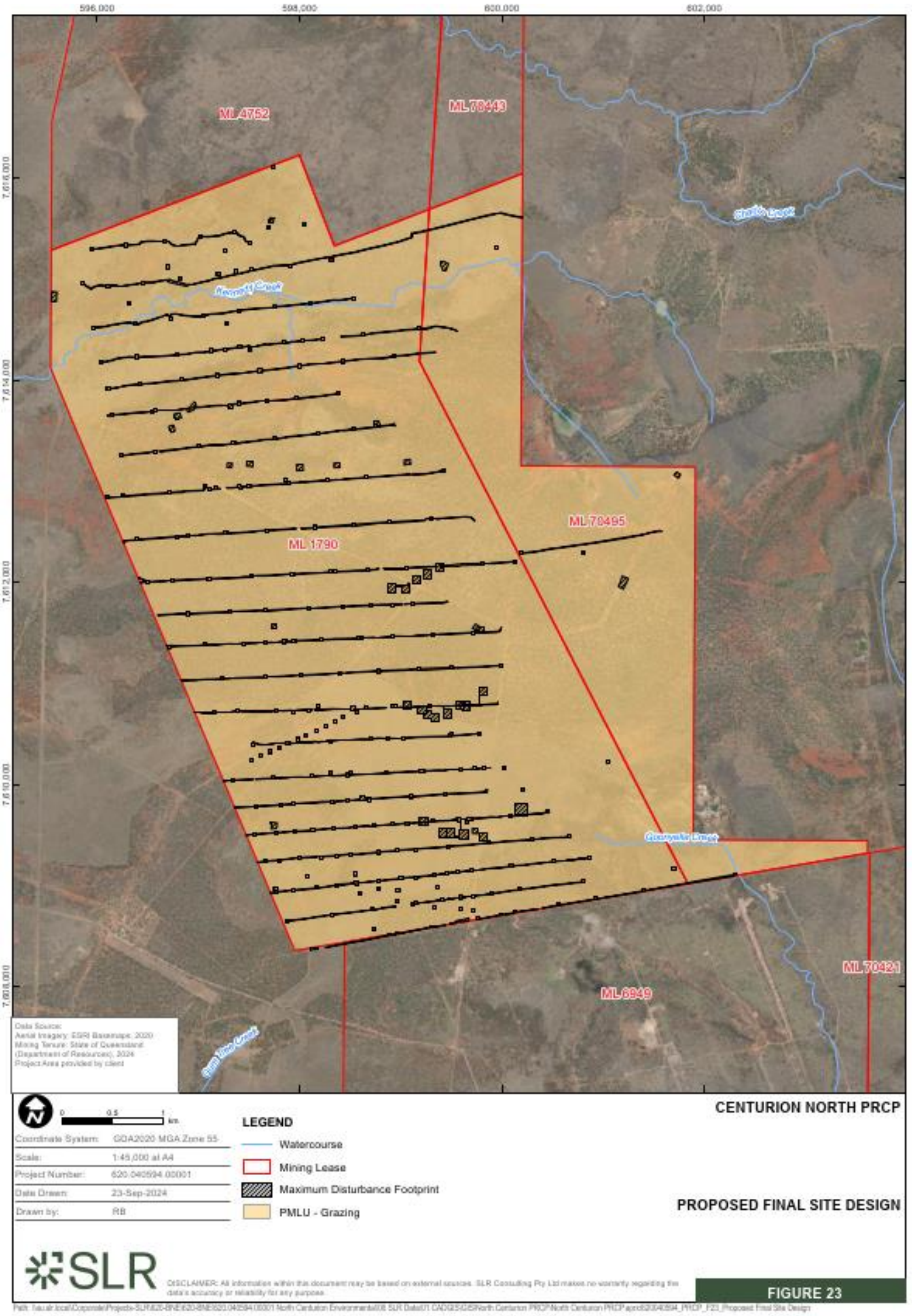


Figure 23 **Centurion North final site design**

10.2 Post-mining land use milestones

The Centurion North rehabilitation areas and relevant rehabilitation milestones are shown in **Table 31**. These are illustrated in the reference map provided in Section 10.4.

Table 31 Centurion North rehabilitation areas and relevant rehabilitation milestones

Rehabilitation area	Relevant activities	PMLU	Relevant rehabilitation milestones
RA1 (formerly RA5)	Exploration drilling and associated tracks	Cattle grazing	RM1 RM2 RM3 RM4 RM5 RM6 RM7

The rehabilitation milestones and milestone criteria for Centurion North are shown in **Table 32**.

Table 32 Centurion North rehabilitation milestones and milestone criteria

Milestone reference	Rehabilitation milestone	Milestone criteria
RM1	Infrastructure decommissioning and removal	a) All services disconnected. b) All built and service infrastructure demolished and removed (except where agreed in writing by the post-mining land owner/holder). c) All concrete, bitumen and aggregate removed. d) All waste and rubbish removed. e) All exploration drill holes decommissioned.
RM2	Remediation of contaminated land	a) All contamination is remediated or removed from site in accordance with relevant legislation. b) A contaminated land survey is carried out by a suitably qualified person confirming the land does not present an unacceptable risk to proposed future land uses or the environment.
RM3	Landform development and reshaping	a) Landform is reshaped to be free-draining with slopes ≤ 5% and consistent with the surrounding topography.
RM4	Surface preparation	a) Topsoil is placed an average thickness of 200mm. b) An assessment of soil and growth media characteristics is completed by an appropriately qualified person[1], and amelioration and other treatments required identified. c) Ameliorant and physical treatments are applied as identified in RM4(b).

<table>
<tr><th>Milestone reference</th><th>Rehabilitation milestone</th><th>Milestone criteria</th></tr>
<tr><td>RM5</td><td>Revegetation (cattle grazing)</td><td>
a) Completed seeding in accordance with the recommended pasture mix (grasses, cover crop and legumes) of Table RM5 – Recommended Pasture Mix, and seeding rates (up to 25kg/ha).

Table RM5 – Recommended Pasture Mix
<table>
<tr><th>Common name</th><th>Scientific name</th><th>Sowing rate (kg/ha)</th></tr>
<tr><td>Queensland Bluegrass</td><td>Dichanthium sericeum</td><td>6</td></tr>
<tr><td>Buffel grass</td><td>Cenchrus ciliaris</td><td>4</td></tr>
<tr><td>Stylo</td><td>Stylosanthes scabra</td><td>2</td></tr>
<tr><td>Black spear grass</td><td>Heteropogon contortus</td><td>5</td></tr>
<tr><td>Mitchell grasses</td><td>Bull Mitchell grass (Astrebla squarrosa), Curly Mitchell grass (Astrebla lappacea) and Hoop Mitchell Grass (Astrebla elymoides)</td><td>3</td></tr>
<tr><td>Shirohie millet</td><td>Echinochloa esculenta</td><td>5</td></tr>
<tr><td></td><td>TOTAL</td><td>25</td></tr>
</table>
</td></tr>
<tr><td>RM6</td><td>Achievement of surface requirements (cattle grazing)</td><td>
a) Pasture condition rating ≤3, based on the Pasture Condition Assessment Table as per Stocktake: Balancing Supply and Demand (https://futurebeef.com.au/workshops/sustainable-grazing/stocktake-balancing-supply-demand/), as provided in Table 33 including:
• Preferred pasture species (3P grasses[2]) diversity ≥2 species;
• Preferred pasture (3P grasses[2]) % DM yield ≥10%;
• Annual grass DM yield % <70%;
• Undesirable grasses and other weeds % DM yield <80%; and
• Crown cover (3P grasses[2]) – at worst, moderate to low density and some plants dead.

3P grasses: native and naturalised exotic grass species that are perennial, palatable, and productive plants to stock.
</td></tr>
</table>

Milestone reference	Rehabilitation milestone	Milestone criteria
RM7*	Achievement of post-mining land use to a stable condition (cattle grazing)	a) A hazard assessment has been completed by an appropriately qualified person[1] to confirm safety hazards in rehabilitation are not significantly different to surrounding unmined landscapes subject to the same land use. b) n/a c) Groundcover[3] >50%. d) Rainfall runoff from the area is not significantly different to upstream values for the following: pH, EC and turbidity. e) n/a. f) Land suitability class ≤3, or not different from pre-mining class if ≥4, as per **Table RM7 – Land Suitability Rule-Set (Cattle Grazing)**. The assessment is to be conducted by an appropriately qualified person[1] and completed in accordance with LSA Framework for Open-Cut Coal Mine Rehabilitation 2018 (A rule-set for land suitability assessment of sustainable beef cattle grazing on land rehabilitated after open-cut coal mining in the Bowen Basin Queensland) unless otherwise agreed in writing between the administering authority and the environmental authority holder. For RM7(f), if the land suitability class is assessed as not different from pre-mining class if ≥4 for all or a portion of a rehabilitation area, an assessment of reference sites[4] must be carried out to determine if the limitation/s resulting in the class of ≥4 is consistent with that of reference sites. g) Certification by an appropriately qualified person[1] that pasture meets a pasture condition rating ≤3, based on the Pasture Condition Assessment Table as per Stocktake: Balancing Supply and Demand, as provided in **Table 30**. [3]***Groundcover***: *to anything in contact with the soil surface, for example, rocks, stones, sticks, leaves, grass, hay* [4]***Reference site***: *representative undisturbed grazing land adjacent to the disturbance areas*

Table RM7 – Land Suitability Rule-Set (Cattle Grazing)

Limitation	Indicator	Units	Suitability class				
			1	2	3	4	5
Water availability	PAWC in ERD	mm/0.6d	> 75	75 - 60	< 60 - 45	< 45 - 30	< 30
Nutrient supply	P in 0.1m	mg / kg	> 20	20 - 14	< 14 - 8	< 8 - 4	< 4
	pH in 0.1m	pH units	7.3 – 6.6	*< 6.6. – 6.0 or > 7.3 – 8.0*	< 6.0 – 5.5 or > 8.0 – 8.5	< 5.5 – 5.0 or > 8.5 – 9.0	< 5.0 or > 9.0

Milestone reference	Rehabilitation milestone	Milestone criteria							
		Soil physical factors	Surface soil structure	variable	Fine (peds < 10mm)	Coarse (peds > 10mm)	Surface crust	Very hard setting	Massive
		Salinity	EC in ERD	dS/m	< 2	2 - < 4	4 - < 10	10 - < 16	≥ 16
		Rockiness	Fragments on surface	%	< 5	5 - 10	10 - 30	30 - 60	> 60
		Topography (slope)	Gradient, surface	%	< 5	5 - < 10	10 - < 15	15 - < 20	≥ 20
			Vertical interval, surface	m	Nil ripping furrows	Regular ripping furrows < 0.2m	Regular ripping furrows > 0.2 – 0.4m	Regular ripping furrows > 0.4 – 0.6m	Regular ripping furrows > 0.6m
		Water erosion, surface soil	Slope (ESP in 0.1m <6)	%	< 5	5 - 8	> 8 - 12	> 12 - 18	> 18
			Slope (ESP in 0.1m > 6 - < 14)	%	< 3	3 - 6	> 6 - 10	> 10 - 12	> 12
			Slope (ESP in 0.1m > 14)	%	< 1	1 - 2	> 2 - 4	> 4 - 6	> 6
		Sub-soil erosion	ESP at 0.5m	%	< 7	7 - 14	> 14 - 23	> 23 - 34	> 34
		Potentially acid forming materials	pH < 4.5	pH units	Not likely to be present within 5m of surface	Not likely to be present within 3m of surface	Not likely to be present within 2m of surface	Present immediately below root zone (0.9 – 0.6m)	Present within root zone (surface 0.6m)

10.3 Non-use management area milestones

Not applicable to Centurion North as there are no NUMAs.

10.4 Reference maps

The Centurion North reference map showing the rehabilitation areas is shown in **Figure 24**.

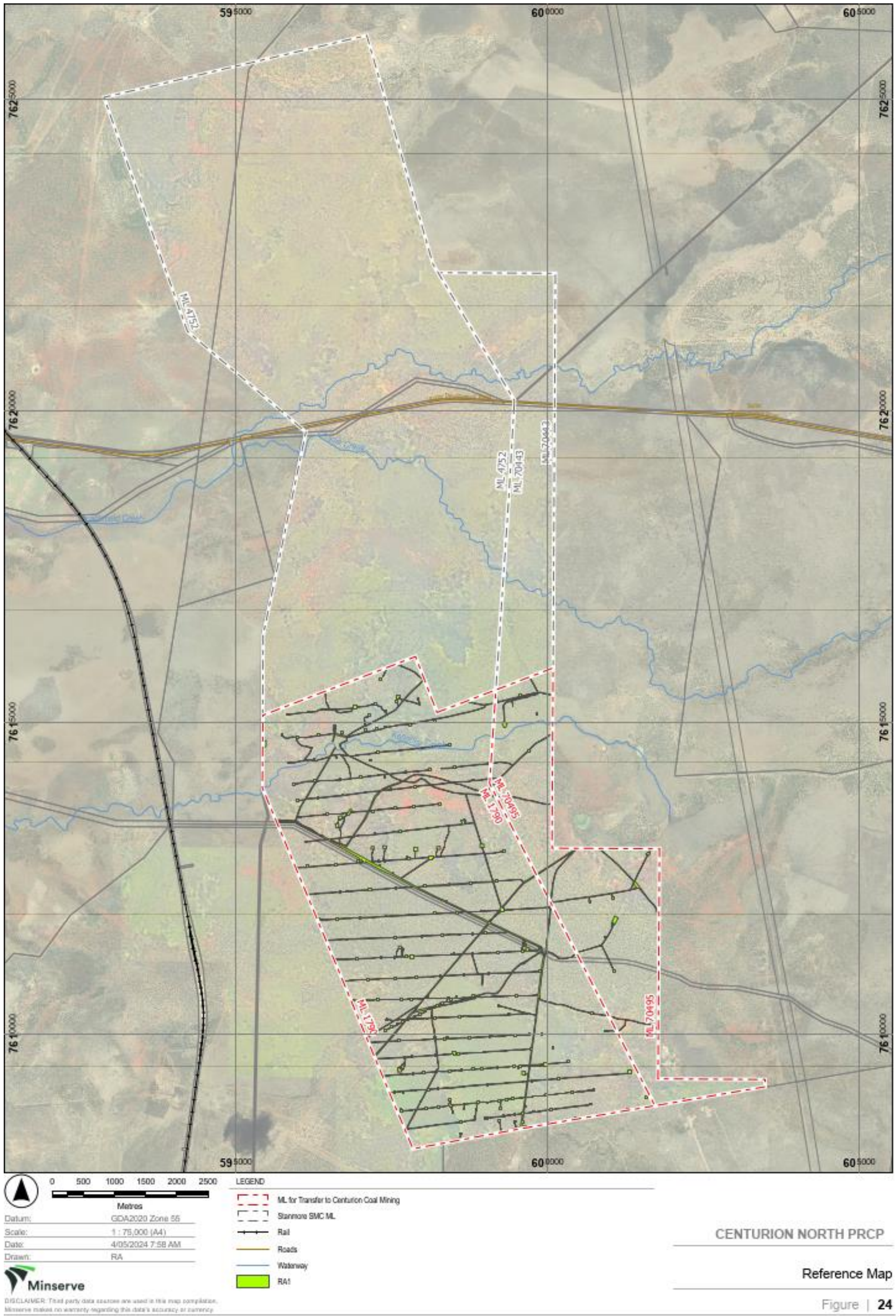

595000
600000
605000
7625000
7620000
7615000
7610000
ML 4752
ML 70443
ML 70495
ML 1790
0 500 1000 1500 2000 2500
Metres
Datum: GDA2020 Zone 55
Scale: 1 : 75,000 (A4)
Date: 4/05/2024 7:58 AM
Drawn: RA
Minserve
DISCLAIMER: Third party data sources are used in this map compilation. Minserve makes no warranty regarding this data's accuracy or currency.
LEGEND
ML for Transfer to Centurion Coal Mining
Stanmore SMC ML
Rail
Roads
Waterway
RA1
CENTURION NORTH PRCP
Reference Map
Figure | 24

Figure 24 Centurion North reference map

10.5 Schedule

The schedule is based on the land being rehabilitated as soon as practicable after the land becomes available, as required under section 126D(4) of the *EP Act.*

Rehabilitation milestones RM1, RM2, RM3, RM4 and RM5 will be completed in the same time period, while completion of RM6 and RM7 is dependent on varying weather seasonality and undesirable weather periods. Achievement of rehabilitation milestones RM6 and RM7 will be demonstrated prior to the scheduled date if possible.

The proposed PRCP schedule is provided on the following pages.

POST MINING LAND USES (PMLU)														
Rehabilitation area	**RA1**													
Distrubance description	Exploration – drilling and associated tracks													
Total size of rehabilitation area (ha)	145													
Commencement of first milestone RM1	10/12/2021													
PMLU	Cattle grazing													
Date area is available	10/12/21	10/12/28												
Cumulative area available (ha)	19	145												
Milestone completed by	**Milestone completed by**													
	10/12/26	10/12/31	10/12/36	10/12/41	10/12/46									
Milestone Reference	**Cumulative area achieved (ha)**													
RM1	19	145												
RM2	19	145												
RM3	19	145												
RM4	19	145												
RM5	19	145												
RM6			19	145										
RM7				19	145									

11. REFERENCES

The following references have been used to support development of the PRC Plan:

Anderson, I.C. (1991): The Development of Formulas for the Estimation of Coal Pillar Strength in Australian Coal Mines. Master of Engineering, the University of New South Wales, School of Mining Engineering

Baker D and Eldershaw V (1993) Interpreting Soil Analysis for Agricultural Land Use in Queensland, Queensland Department of Primary Industries, Brisbane.

BHP (15 January 2021): Preliminary Site Investigation Wards Well Mine

BHP Coal (August 2020): Guideline for Climate Change Adaptation in Mine Water Planning and Hydrological Assessments – BHP Queensland. Ref. no. CTD-WTR-GLD-001

BHP (December 2020): Environmental Geochemical Characterisation and Risk Assessment of Mineral Waste

BHP (November 2020): Wards Well Exploration Adit Subsidence Evaluation

BHP (26 April 2020): Progressive Rehabilitation and Closure Plan BMC Wards Well – DES Pre-Notification Memo.

BHP (2017): Industry benchmarking of average Queensland approval timeframes (unpublished BHP internal report).

Carroll, C. and Tucker, A .(2000): Effects of pasture cover on soil erosion and water quality on central Queensland coal mine rehabilitation, Tropical Grasslands, vol. 34, pp 254-262.

Carroll, C., Merton, L., and Burger, P. (2000): Impact of vegetative cover and slope on runoff, erosion, and water quality for field plots on a range of soil and spoil materials on central Queensland coal mines, Australian Journal of Soil Research, vol. 38, pp.313-327.

Ecological Australia (10 June 2016): Wards Well/Lancewood Brigalow TEC Assessment

Ecological Australia (18 August 2017): Wards Well Coal Project – Ecological Assessment Report. Project No. 17BRIECO-4089

DNRME (2020): Queensland Groundwater Database, accessed via https://www.data.qld.gov.au/dataset/groundwater-database-queensland

DSITI (2017). Using monitoring data to assess groundwater quality and potential environmental impacts. Version 1. Department of Science, Information Technology and Innovation (DSITI), Queensland Government, Brisbane

DSITI & DNRM (2015) Guidelines for agricultural land evaluation in Queensland, second edition, The State of Queensland (prepared by Department of Science, Information Technology and Innovation and Department of Natural Resources and Mines), Brisbane

Golder (2020): Wards Well Mine PRCP Hydrogeological Conceptual Model. Ref. No. 20360652-001-R-RevA

Hazelton, P. and Murphy, B. (2007): Interpreting Soil Test Results, CSIRO Publishing, Melbourne.

Hall, R. (2008): Soil Essentials – Managing your farm's primary asset, CSIRO Publishing, Melbourne.

Isaac Regional Council Planning Scheme (February 2021)

Loch, R 2000 Effects of vegetation cover on runoff and erosion under simulated rain and overland flow on a rehabilitated site on the Meandu Mine, Tarong, Queensland, Australian Journal of Soil Research, vol. 38, pp 299-312

McDonald R, Isbell R, Speight J, Walker J and Hopkins M (2009) 'Australian Soil and Land Survey Field Handbook, CSIRO

McKenzie N, Grundy M, Webster R and Ringrose-Voase A (2008) 'Guidelines for Surveying Soil and Land Resources', 2nd edn, CSIRO

National Environment Protection Council (NEPC) (1999): National Environment Protection (Assessment of Site Contamination) Measure (Rev: 2013)

Queensland Department of Environment and Science (March 2021): Progressive Rehabilitation and Closure Plan Guideline, Queensland Government, Brisbane

Queensland Department of Environment and Science (4 February 2021): Environmental Authority EPPR00668513

Queensland Department of Environment and Science (30 June 2020): Progressive Rehabilitation and Closure Plan Transition Notice. Ref. EPPR00668513

Queensland Department of Local Government and Planning (February 2012): Mackay, Isaac and Whitsunday Regional Plan

Queensland Department of Minerals and Energy (1995): Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland – Land Suitability Assessment Techniques. Environmental Protection Agency, Brisbane

Queensland Department of Resources (14 July 2021): Special Conditions for Renewal of Mining Lease 1790 and 4752 (references 31503 and 301480)

Short, T. (2020): A rule-set for land suitability assessment of sustainable beef cattle grazing on land rehabilitated after open-cut coal mining in the Bowen Basin, Queensland Highlands Environmental, Emerald

Sinclair Knight Merz (26 June 2012): Wards Well Mine Project: Soil Survey. Version A, ref. no. QE09811

So, W, Sheridan, G, Loch, R, Carroll, C, Willgoose, G, Short, M and Grabski A 1998 Post-mining landscape parameters for erosion and water quality control, ACARP Project Numbers C4011 and C5009, Australian Coal Research Limited, Brisbane

University of New South Wales (1995): UNSW Pillar Design Procedure

Williams, D.J. (2015): Bulking and Subsequent Self-Weight and Saturation Settlements, and Geotechnical Stability, of Deep Coal Mine Spoil Piles (ACARP C19022)

The following online resources were also used:

Bureau of Meteorology (1972-2012)

www.willyweather.com.au (2012-2020)

https://qldglobe.information.qld.gov.au/ (accessed November 2020)

https://environment.des.qld.gov.au/management/water/quality-guidelines/sampling-manual

https://longpaddock.qld.gov.au/qld-future-climate/data-info/tern/

Stocktake: Balancing Supply and Demand:

https://futurebeef.com.au/workshops/sustainable-grazing/stocktake-balancing-supply-demand/#why-choose-stocktake

12. APPENDICES

List of Appendices	
Appendix 1	Environmental Authority EA (P-EA-100658735) (3 September 2024)
Appendix 2	Golder Associates (23 December 2020): Wards Well Mine – PRCP Hydrogeological Conceptual Model. Ref. No. 20360652-001-R-RevA
Appendix 3	Ecological Australia (10 June 2016): Wards Well/Lancewood Brigalow TEC Assessment
Appendix 4	Ecological Australia (18 August 2017): Wards Well Coal Project – Ecological Assessment Report. Project No. 17BRIECO-4089
Appendix 5	Sinclair Knight Merz (26 June 2012): Wards Well Mine Project: Soil Survey. Version A, ref. no. QE09811
Appendix 6	BHP (February 2021): Wards Well PRCP Community Consultation Plan and Stakeholder Register
Appendix 7	NOT USED
Appendix 8	BHP (10 February 2021): Preliminary Site Investigation Wards Well Mine
Appendix 9	NOT USED
Appendix 10	Wards Well PRCP Risk Assessment
Appendix 11	NOT USED

APPENDIX 1
ENVIRONMENTAL AUTHORITY EA (P-EA-100658735) (3 SEPTEMBER 2024)

Permit

Environmental Protection Act 1994

Environmental authority P-EA-100658735

This environmental authority is issued by the administering authority under Chapter 5 of the Environmental Protection Act 1994.

Environmental authority number: P-EA-100658735

Environmental authority takes effect on 3 September 2024

The anniversary date of this environmental authority is the same day each year and remains 15 September. The payment of the annual fee will be due each year on this day.

An annual return will be due each year on 01 April.

Environmental authority holder(s)

Name(s)	Registered address
Centurion Coal Mining Pty Ltd	Level 14, 31 Duncan Street, Fortitude Valley QLD 4006

Environmentally relevant activity and location details

Environmentally relevant activity/activities	Location(s)
Ancillary 08 - Chemical Storage 1: Storing a total of 50t or more of chemicals of dangerous goods class 1 or class 2, division 2.3 under subsection (1)(a)	ML70495, ML1790
Schedule 3 09: A mining activity involving drilling, costeaning, pitting or carrying out geological surveys causing significant disturbance	ML70495, ML1790

Additional information for applicants

<u>Environmentally relevant activities</u>

The description of any environmentally relevant activity (ERA) for which an environmental authority (EA) is issued is a restatement of the ERA as defined by legislation at the time the EA is issued. Where there is any inconsistency between that description of an ERA and the conditions stated by an EA as to the scale, intensity or manner of carrying out an ERA, the conditions prevail to the extent of the inconsistency.

An EA authorises the carrying out of an ERA and does not authorise any environmental harm unless a condition stated by the EA specifically authorises environmental harm.

A person carrying out an ERA must also be a registered suitable operator under the *Environmental Protection Act 1994* (EP Act).

Contaminated land

It is a requirement of the EP Act that an owner or occupier of contaminated land give written notice to the administering authority if they become aware of the following:

- the happening of an event involving a hazardous contaminant on the contaminated land (notice must be given within 24 hours); or
- a change in the condition of the contaminated land (notice must be given within 24 hours); or
- a notifiable activity (as defined in Schedule 3) having been carried out, or is being carried out, on the contaminated land (notice must be given within 20 business days);

that is causing, or is reasonably likely to cause, serious or material environmental harm.

For further information, including the form for giving written notice, refer to the Queensland Government website www.qld.gov.au, using the search term 'duty to notify'.

Take effect

Please note that, in accordance with section 200 of the EP Act, an EA has effect:

a) if the authority is for a prescribed ERA and it states that it takes effect on the day nominated by the holder of the authority in a written notice given to the administering authority-on the nominated day; or

b) if the authority states a day or an event for it to take effect-on the stated day or when the stated event happens; or

c) otherwise-on the day the authority is issued.

However, if the EA is authorising an activity that requires an additional authorisation (a relevant tenure for a resource activity, a development permit under the *Sustainable Planning Act 2009* or an SDA Approval under the *State Development and Public Works Organisation Act 1971*), this EA will not take effect until the additional authorisation has taken effect.

If this EA takes effect when the additional authorisation takes effect, you must provide the administering authority written notice within 5 business days of receiving notification of the related additional authorisation taking effect.

If you have incorrectly claimed that an additional authorisation is not required, carrying out the ERA without the additional authorisation is not legal and could result in your prosecution for providing false or misleading information or operating without a valid environmental authority.

Cate Puschmann

Department of Environment and Science
Delegate of the administering authority
Environmental Protection Act 1994

Date issued: 12 Septmeber 2024

Enquiries:
Business Centre Coal
Department of Environment and Science
Phone: (07) 4987 9320
Email: crmining@des.qld.gov.au

Privacy statement

Pursuant to section 540 of the EP Act, the Department is required to maintain a register of certain documents and information authorised under the EP Act. A copy of this document will be kept on the public register. The register is available for inspection by members of the public who are able take extracts, or copies of the documents from the register. Documents that are required to be kept on the register are published in their entirety, unless alteration is required by the EP Act. There is no general discretion allowing the Department to withhold documents or information required to be kept on the public register. For more information on the Department's public register, search 'public register' at www.qld.gov.au. For queries about privacy matters please email privacy@des.qld.gov.au or telephone 13 74 68.

Obligations under the *Environmental Protection Act 1994*

In addition to the requirements found in the conditions of this environmental authority, the holder must also meet their obligations under the EP Act, and the regulations made under the EP Act. For example, the holder must comply with the following provisions of the Act:

- general environmental duty (section 319)
- duty to notify environmental harm (section 320-320G)
- offence of causing serious or material environmental harm (sections 437-439)
- offence of causing environmental nuisance (section 440)
- offence of depositing prescribed water contaminants in waters and related matters (section 440ZG)
- offence to place contaminant where environmental harm or nuisance may be caused (section 443)

Other permits required

This permit only provides an approval under the Environmental Protection Act 1994. In order to lawfully operate you may also require permits / approvals from your local government authority, other business units within the department and other State Government agencies prior to commencing any activity at the site. For example, this may include permits / approvals with your local Council (for planning approval), the Department of Transport and Main Roads (to access state controlled roads), the Department of Resources (to clear vegetation), and the Department of Agriculture and Fisheries (to clear marine plants or to obtain a quarry material allocation).

Conditions of environmental authority

Schedule A: General	
Condition number	**Condition**
A1	**Prevent and/or minimise likelihood of environmental harm** In carrying out the environmentally relevant activities, the environmental authority holder must take all reasonable and practicable measures to prevent and/or to minimise the likelihood of environmental harm being caused. Any environmentally relevant activity, that, if carried out incompetently, or negligently, may cause environmental harm, in a manner that could have been prevented, shall be carried out in a proper manner in accordance with the conditions of this authority. *Note: This authority authorises the environmentally relevant activity. It does not authorise environmental harm unless a condition contained within this authority explicitly authorises that harm. Where there is no condition or the authority is silent on a matter, the lack of a condition or silence shall not be construed as authorising harm.*
A2	**Maintenance of measures, plant and equipment** The environmental authority holder must ensure: a) that all measures, plant and equipment necessary to ensure compliance with the conditions of this environmental authority are installed; b) that such measures, plant and equipment are maintained in a proper condition; and c) that such measures, plant and equipment are operated in a proper manner.
A3	No change, replacement or alteration of any plant or equipment is permitted if the change, replacement or alteration increases, or is likely to substantially increase, the risk of unlawful environmental harm caused by the mining activities.
A4	**Monitoring** Record, compile and keep for a minimum of **five (5) years** all monitoring results required by this environmental authority and make available for inspection all or any of these records upon request by the administering authority.
A5	Where monitoring is a requirement of this environmental authority, ensure that a competent person(s) conducts all monitoring.
A6	**Record Keeping** Unless otherwise specified by a condition of this environmental authority and records must be: a) kept for a period of 5 years and; b) b) provided to the administering authority upon request and in the format required.

A7	**Notification of emergencies, incidents and exceptions** All reasonable actions are to be taken to minimise environmental harm, or potential environmental harm, resulting from any emergency, incident or circumstances not in accordance with the conditions of this environmental authority.
A8	As soon as practicable after becoming aware of any emergency, incident or information about circumstances which results or may result in environmental harm not in accordance with the conditions of this environmental authority, the administering authority must be notified in writing.
A9	Not more than **ten (10) business days** following the initial notification of an emergency, incident or information about circumstances which result or may result in environmental harm, written advice must be provided to the administering authority in relation to: a) proposed actions to prevent a recurrence of the emergency or incident; b) the outcomes of actions taken at the time to prevent or minimise environmental harm; and c) proposed actions to respond to the information about circumstances which result or may result in environmental harm.
A10	As soon as practicable, but not more than **six (6) weeks** following the initial notification of an emergency, incident or information about circumstances which result or may result in environmental harm, environmental monitoring must be performed and written advice must be provided of the results of any such monitoring performed to the administering authority.
A11	The notification of emergencies, incidents or circumstances (incident) which result or may result in environmental harm in accordance with condition **A9** must include but not be limited to the following: a) the holder of the environmental authority; b) the location of the incident; c) the number of the environmental authority; d) the name and telephone number of the designated contact person; e) the time of the incident; f) the time the holder of the environmental authority became aware of the incident; g) the suspected cause of the incident; h) the environmental harm caused, threatened, or suspected to be caused by the incident; and i) actions taken to prevent any further incident and mitigate any environmental harm caused by the incident.
A12	**Mining activities – general** All land subject to mining activities must be rehabilitated to a non-polluting, safe, stable and self-sustaining landform.
A13	Contaminants must not be released to the receiving environment unless they are in accordance with the contaminant limits authorised by this environmental authority.

A14	This environmental authority does not authorise environmental harm unless a condition contained within the authority explicitly authorises that harm. Where there is no condition or the authority is silent on a matter, the lack of a condition or silence shall not be construed as authorising harm.
A15	The only mining activities to be carried out under this environmental authority are the mining activities defined within the parameters in **Table 1 (Mining Activities)** and identified in **Figures 1 to 5** attached to this environmental authority. *Note: Variation of mining activities to those identified within the conceptual designs is considered to be in accordance with these conditions as long as the variation is not significantly different to the conceptual design or causes a significant increase in environmental harm.*
A16	**Definitions** Words and phrases used throughout this environmental authority are defined in the Definitions section of this authority. Where a definition for a term used in this environmental authority is sought and the term is not defined within this environmental authority, the definitions in the *Environmental Protection Act 1994,* its regulations and policies must be used.
A17	**Conditions** The conditions of this environmental authority are in force until a surrender of the authority is accepted pursuant to the *Environmental Protection Act 1994*. The conditions apply unless an amendment is approved pursuant to the *Environmental Protection Act 1994*.

Table 1 (Mining Activities)

Mine Domain	Mine Feature Domain	Location (GDA94)	Maximum Disturbance Area	Constraints
Exploration activities	Drill holes and pads	As per Figure 1	1400 metres squared per drill pad	Total disturbed area must not exceed 1.4 ha
	Historic holes and pads	As per Figure 1	3000 metres squared per drill pad	Quantity: 310 drill holes
Ancillary Infrastructure	Roads and tracks	As per Figure 1		Scale and intensity

Schedule B: Air	
Condition number	**Condition**
B1	**Dust nuisance** Subject to conditions **B2** and **B3** of this environmental authority, the release of dust or particulate matter or both resulting from the mining activity must not cause an environmental nuisance, at any sensitive or commercial place.
B2	When requested by the administering authority, dust and particulate monitoring must be undertaken within a reasonable and practicable timeframe nominated by the administering authority to investigate any complaint (which is neither frivolous nor vexatious nor based on mistaken belief in the opinion of the authorised officer) of environmental nuisance at any sensitive or commercial place, and the results must be notified within **14 days** to the administering authority following completion of monitoring.
B3	If the environmental authority holder can provide evidence through monitoring that the following limits are not being exceeded then the holder is not in breach of **B1**: a) dust deposition of 120 milligrams per square metre per day, averaged over one month, when monitored in accordance with AS 3580.10.1 *Methods for sampling and analysis of ambient air – Determination of particulates – Deposited matter – Gravimetric method* of 1991 (or more recent editions), or b) a concentration of particulate matter with an aerodynamic diameter of less than 10 micrometre (µm) (PM_{10}) suspended in the atmosphere of 50 micrograms per cubic metre over a 24 hour averaging time, at a sensitive or commercial place downwind of the operational land, when monitored in accordance with i. Particulate matter – Determination of suspended particulate PM_{10} high-volume sampler with size-selective inlet – Gravimetric method, when monitored in accordance with AS 3580.9.6 *Methods for sampling and analysis of ambient air – Determination of suspended particulate matter – PM_{10} high volume sampler with size-selective inlet – Gravimetric method* of 1990 (or more recent editions); and ii. any alternative method of sampling PM_{10}, which may be permitted by the *Air Quality Sampling Manual* as published from time to time by the administering authority.
B4	If monitoring indicates exceedance of the relevant limits in condition **B3**, then the environmental authority holder must: a) address the complaint including the use of appropriate dispute resolution if required; and b) immediately implement dust abatement measures so that emissions of dust from the activity do not result in further environmental nuisance.

Schedule C: Water	
Condition number	**Condition**
C1	**Contaminant release** Contaminants that will or have the potential to cause environmental harm must not be released directly or indirectly to any waters.
C2	**Water reuse** Water contaminated by mining activity may be piped or trucked or transferred by some other means that does not contravene the conditions of this authority during periods of dry weather for the purpose of supplying stock water to directly adjoining properties owned by the environmental authority holder or a third party and subject to compliance with the quality release limits specified in **Table 2 (Stock water release limits)**.
C3	Water contaminated by mining activity may be piped or trucked or transferred by some other means that does not contravene the conditions of this authority during periods of dry weather for the purpose of supplying irrigation water to directly adjoining properties owned by the environmental authority holder or a third party and subject to compliance with quality release limits in **Table 3 (Irrigation water release limits)**.

Table 2 (Stock water release limits)

Quality characteristic	Units	Minimum	Maximum
pH	pH units	6.5	8.5
Electrical Conductivity	µS/cm	N/A	5000

Table 3 (Irrigation water release limits)

Quality characteristic	Units	Minimum	Maximum
pH	pH units	6.5	8.5
Electrical Conductivity	µS/cm	N/A	TBD [Note 1]

[Note 1] A site-specific value to be determined in accordance with ANZECC & ARMCANZ (2000) Irrigation Guidelines

C4	Water contaminated by mining activity may be piped or trucked off the mining lease for the purpose of supplying water to a third party for purpose of construction and/or road maintenance in accordance with the conditions of this environmental authority.

C5	If the responsibility of water contaminated by mining activities (the water) is given or transferred to another person in accordance with conditions **C2, C3 or C4**: a) the responsibility of the water must only be given or transferred in accordance with a written agreement (the third party agreement); and b) include in the third party agreement a commitment from the person utilising the water to use water in such a way as to prevent environmental harm or public health incidences and specifically make the persons aware of the General Environmental Duty (GED) under section 319 of the *Environmental Protection Act 1994*, environmental sustainability of the water disposal and protection of environmental values of waters.
C6	**Water general** All determinations of water quality must be: a) performed by a person or body possessing appropriate experience and qualifications to perform the required measurements; b) made in accordance with methods prescribed in the latest edition of the administering authority's Water Quality Sampling Manual; c) collected from the monitoring locations identified within this environmental authority, within 10 hours of each other where possible; d) carried out on representative samples; and e) laboratory testing must be undertaken using a laboratory accredited (e.g. NATA) for the method of analysis being used. *Note: Condition **C6** requires the Water Quality Manual to be followed and where it is not followed because of exceptional circumstances this should be explained and reported with the results.*
C7	**Temporary interference with waterways** Temporarily destroying native vegetation, excavating, or placing fill in a watercourse, lake or spring necessary for and associated with mining activity must be undertaken in accordance with Department of Environment and Resource Management *Guideline - Activities in a Watercourse, Lake or Spring associated with Mining Activities*.
C8	**Saline drainage** The holder of this environmental authority must ensure proper and effective measures are taken to avoid or otherwise minimise the generation and/or release of saline drainage.
C9	**Acid rock drainage** The holder of this environmental authority must ensure proper and effective measures are taken to avoid or otherwise minimise the generation and/or release of acid rock drainage.
C10	**Stormwater and water sediment controls** An erosion and sediment control plan must be developed by an appropriately qualified person and implemented for all stages of the exploration and mining activities on the site to minimise erosion and the release of sediment to waters and contamination of stormwater.
C11	The maintenance and cleaning of any vehicles, plant or equipment must not be carried out in areas from which contaminants can be released into any receiving waters.

C12	Any spillage of wastes, contaminants or other materials must be cleaned up as quickly as practicable to minimise the release of wastes, contaminants or materials to any stormwater drainage system or receiving waters.

Schedule D: Acoustic	
Condition number	**Condition**
D1	**Noise and Vibration** Subject to conditions **D2** and **D3**, noise from the mining activity must not cause an environmental nuisance at any sensitive or commercial place.
D2	When requested by the administering authority, noise monitoring must be undertaken within a reasonable and practicable timeframe nominated by the administering authority to investigate any complaint (which is neither frivolous nor vexatious nor based on mistaken belief in the opinion of the authorised officer) of environmental nuisance at any sensitive or commercial place, and the results must be notified within **14 days** to the administering authority following completion of monitoring.
D3	If the environmental authority holder can provide evidence through monitoring that the limits defined in **Table 4 (Noise Limits)**, are not being exceeded then the holder is not in breach of condition **D1**. Monitoring must include: a) $L_{A,\ max\ adj,\ T}$; b) relevant background sound level; c) the level and frequency of occurrence of impulsive or tonal noise; d) atmospheric conditions including wind speed and direction; and e) location, date and time of recording.
D4	If monitoring indicates exceedance of the limits in **Table 4 (Noise Limits)**, then the environmental authority holder must: a) address the complaint including the use of appropriate dispute resolution if required; and b) immediately implement noise abatement measures so that emissions of noise from the activity do not result in further environmental nuisance.
D5	The method of measurement and reporting of noise levels must comply with the latest edition of the administering authority's *Noise Measurement Manual*.

Table 4 (Noise Limits)

Noise Levels dB(A)	Monday to Sunday (including public holidays)		
	7am-6pm	6pm-10pm	10pm-7am
	Noise measured at a 'sensitive or commercial place'		
$L_{A10,\ adj,\ 10mins}$	B/G + 5	B/G + 5	B/G + 3
$L_{A1,\ adj,\ 10mins}$	B/G + 10	B/G + 10	B/G + 5

Note: Where "Background" means background sound pressure level measured in accordance with the latest edition of the administering authority's Noise Measurement Manual. ***Table 6 (Noise Limits)*** *does not purport to set operating hours for the mining activities.*

Schedule E: Waste	
Condition number	**Condition**
E1	**Storage of tyres** Scrap tyres stored awaiting disposal or transport for take-back and recycling, or waste- to-energy options must be stored in stable stacks and at least 10 metres from any other scrap tyre storage area, or combustible or flammable material, including vegetation.
E2	All reasonable and practicable fire prevention measures must be implemented, including removal of grass and other materials within a 10 metre radius of the scrap tyre storage area.
E3	Where possible and practical, cleared vegetation must be mulched and/or replaced in rehabilitated areas. Cleared vegetation may be burnt as a last resort and only if there is minimal risk of causing nuisance to the neighbouring sensitive receptors. *Note: This condition does not exempt the environmental authority holder from obtaining any approval required under other legislation to conduct a burn.*
E4	General waste must not be burnt or be allowed to burn on the licensed site unless permitted by the administering authority. *Note: This condition does not exempt the environmental authority holder from obtaining any approval required under other legislation to conduct a burn.*
E5	All regulated waste removed from the site must be removed by a person who holds a current approval to transport such waste under the provisions of the *Environmental Protection Act 1994*.
E6	Regulated waste must only be removed to a facility licensed under the *Environmental Protection Act 1994* to receive such waste.

Schedule F: Land	
Condition number	**Condition**
F1	**Preventing contaminant release to land** Contaminants must not be released to land in manner which constitutes nuisance, material or serious environmental harm.
F2	**Storage and Spillage of Chemicals and Flammable or Combustible Liquids** All flammable or combustible liquids must be contained within an on-site containment system and controlled in a manner that prevents environmental harm and maintained in accordance with the current version of AS 1940 - Storage and handling of flammable and combustible liquids.
F3	Spillage of all flammable and combustible liquids must be controlled in a manner that prevents environmental harm.
F4	**Topsoil** Topsoil must be strategically stripped ahead of exploration activity and stockpiled no more than 2 metres in height to preserve topsoil bio-organic integrity.
F5	**Exploration** The environmental authority holder is authorised to carry out exploration activities listed in Table 1 in and within 500m of any Category B Environmentally Sensitive Area. When carrying out exploration activities in and within 500m of any Category B Environmentally Sensitive Area the holder of the environmental authority must do so in accordance with conditions **F6 to F22**.
F6	In carrying out exploration activities on mining leases (ML) ML1790 and ML70495, all reasonable and practicable measures must be taken to prevent or minimise the likelihood of environmental harm being caused to any Category B Environmentally Sensitive Area (ESA).
F7	Exploration activities undertaken must be consistent with **Figures 1 to 4** attached to this environmental authority.
F8	Exploration activities undertaken must be consistent with Control Strategies as outlined in Section 3 of the Environmental Management Plan for Wards Well, 2012.
F9	The operational area of individual drill sites must not exceed 1400 square metres.
F10	The construction of sumps must not exceed 12 square metres.
F11	Drill holes are to be a maximum of 400mm in diameter.
F12	Existing access and fence line tracks must be used wherever possible. New tracks must be constructed to a width of less than 5 metres.

F13	Authorised track construction involving blade clearing of established ground cover vegetation and/or clearing of mature trees is to be minimised in accordance with condition **F13**.
F14	All new tracks are to be recorded with GPS in GDA94 coordinate system and records kept of their location and made available to the administering authority on request.
F15	Tracks should not be used when soil is saturated and prone to displacement or erosion by vehicle movement.
F16	All equipment such as earthmoving and drilling equipment must be used in a manner which prevents the spread of weeds and minimises unnecessary disturbance of topsoil and ground cover vegetation.
F17	Prior to entering the project area, all vehicles, machinery and equipment must be washed down in accordance with the latest version of the Queensland Department of Parks, Recreation, Sport and Racing (or its successor) checklist for clean down procedures.
F18	Campsites must not be established within a Category B Environmentally Sensitive Area or within 500m of a Category B Environmentally Sensitive Area.
F19	Sediment control barriers installed on ML1790 and ML70495 should be made of non-organic material to prevent the spread of weeds. *Note: For example, synthetic sediment fencing is to be used.*
F20	Rehabilitation of areas disturbed in Category B Environmentally Sensitive Area or within 500m of a Category B Environmentally Sensitive Area must commence as soon as practicable to the extent that erosion impacts are minimised, and be completed as soon as practicable but no longer than **three (3) months** after completion of the disturbance activity.
F21	An annual report must be prepared and submitted with each annual return. The report must include a map showing the location of completed drill holes authorised by this environmental authority, and include full details of progressive rehabilitation works completed to demonstrate compliance with condition **F21** of this environmental authority. *Note: Progressive rehabilitation refers to pad by pad rehabilitation as practical.*
F22	**Prescribed environmental matters – matters of State environmental significance** Impacts to matters of State environmental significant (MSES) as a result of carrying out exploration activities must only occur to the maximum extent stated in Table F1 – Authorised residual impacts to MSES' and consistent with general exploration activities depicted in Figure 3 'Authorised impacts to MSES Regulated Vegetation' and Figure 4 'Authorised impacts to MSES Protected Wildlife Habitat'.
F23	All impacts to MSES must be determined, documented, and mapped by an appropriately qualified person.

F24	Records of impacts to MSES in condition F24 must be kept for the life of the environmental authority and include: a) The size and extent of impact; and b) Details about the condition of the MSES (e.g. dominant vegetation and remnant status); and c) A determination of whether the impact is a significant residual impact.
F25	**PRCP Schedule** Rehabilitation of the disturbed land must be carried out in accordance with the approved Progressive Rehabilitation and Closure Plan (PRCP) schedule for this environmental authority.
F26	**Surrender** The holder must meet the conditions and rehabilitation milestones under the PRCP schedule prior to the surrender of the environmental authority.

Table F1 'Authorised residual impact to prescribed environmental matters'

Prescribed environmental matters – matter of State environmental significance (MSES)	Location of impact	Offset requirements under Environmental Offsets Act 2014	Maximum extent of impact (ha)
Regulated vegetation – Endangered or Of Concern Regional Ecosystem			
Grassland Regional Ecosystem (11.8.11)	In accordance with Figure 3	No	0.28
Sparse Regional Ecosystem (11.3.4, 11.4.2)	In accordance with Figure 3	No	0
Dense / Mid Dense Regional Ecosystem (11.3.1, 11.9.5)	In accordance with Figure 3	No	0
Regulated Vegetation – Located in the defined distance from the defining banks of a watercourse			
Grassland Regional Ecosystem (11.8.11)	In accordance with Figure 3	No	0
Sparse Regional Ecosystem (11.3.4, 11.4.2)	In accordance with Figure 3	No	0
Dense / Mid Dense Regional Ecosystem (11.3.1)	In accordance with Figure 3	No	0
Protected Wildlife Habitat – Essential habitat for an endangered or vulnerable animal or plant			
Dichanthium queenslandicum (King Blue Grass)	In accordance with Figure 4	No	0.28
Protected Wildlife Habitat – A habitat for endangered or vulnerable wildlife or Special Least Concern animal			
Squatter Pigeon	In accordance with Figure 4	No	1.43
Grey Falcon	In accordance with Figure 4	No	1.50
Fork Tailed Swift	In accordance with Figure 4	No	1.50
Koala	In accordance with Figure 4	No	1.17
Greater Glider	In accordance with Figure 4	No	0.88
Short Beaked Echidna	In accordance with Figure 4	No	1.50
Ornamental Snake	In accordance with Figure 4	No	0.09

Schedule G: Community	
Condition number	**Condition**
G1	All complaints received must be recorded including investigations undertaken, conclusions formed and action taken. This information must be made available to the administering authority on request.
G2	The holder of this environmental authority must record the following details for all complaints received and provide this information to the administering authority on request: a) name, address and contact number for complainant (if not available; record 'not identified'); b) time and date of complaint; c) investigations undertaken; d) conclusions formed; e) actions taken to resolve complaint; f) any abatement measures implemented; and g) person responsible for resolving the complaint.
G3	When requested by the administering authority, the environmental authority holder must undertake relevant specified monitoring within a reasonable and practicable timeframe nominated by the administering authority to investigate any complaint of environmental harm at any sensitive place or commercial place. The results of the investigation (including an analysis an interpretation of the monitoring results) and abatement measures implemented must be provided to the administering authority within **fourteen (14) days** of completion of the investigation.

END OF CONDITIONS

Definitions

Key terms and/or phrases used in this document are defined in this section. Environmental authority holders should note that where a term is not defined, the definition in the *Environmental Protection Act 1994*, its regulations or environmental protection policies must be used. If a word remains undefined it has its ordinary meaning.

Accepted engineering standards in relation to dams, means those standards of design, construction, operation and maintenance that are broadly accepted within the profession of engineering as being good practice for the purpose and application being considered. In the case of dams, the most relevant documents would be publications of the Australian National Committee on Large Dams (ANCOLD), guidelines published by Queensland government departments, and relevant Australian and New Zealand Standards.

Acid rock drainage means any contaminated discharge emanating from a mining activity formed through a series of chemical and biological reactions, when geological strata is disturbed and exposed to oxygen and moisture as a result of mining activity.

Administering authority is the agency or department that administers the environmental authority provisions under the *Environmental Protection Act 1994*.

Airblast overpressure means energy transmitted from the blast site within the atmosphere in the form of pressure waves. The maximum excess pressure in this wave, above ambient pressure is the peak airblast overpressure measured in decibels linear (dBL).

Annual exceedance probability or AEP means the probability that at least one event in excess of a particular magnitude will occur in any given year.

ANZECC means the Australian and New Zealand Guidelines for Fresh Marine Water Quality 2000

Appropriately qualified person means a person who has professional qualifications, training, skills or experience relevant to the nominated subject matter and can give authoritative assessment, advice and analysis on performance relative to the subject matter using the relevant protocols, standards, methods or literature.

Assessed or assessment by a suitably qualified and experienced person in relation to a consequence assessment of a dam, means that a statutory declaration has been made by that person and, when taken together with any attached or appended documents referenced in that declaration, all of the following aspects are addressed and are sufficient to allow an independent audit of the assessment:

a) exactly what has been assessed and the precise nature of that determination;
b) the relevant legislative, regulatory and technical criteria on which the assessment has been based;
c) the relevant data and facts on which the assessment has been based, the source of that material, and the efforts made to obtain all relevant data and facts; and
d) the reasoning on which the assessment has been based using the relevant data and facts, and the relevant criteria.

Authority means an environmental authority or a development approval.

Bed and banks for a waters, river, creek, stream, lake, lagoon, pond, swamp, wetland or dam means land over which the water of the waters, lake, lagoon, pond, swamp, wetland or dam normally flows or that is normally covered by the water, whether permanently or intermittently; but does not include land adjoining or adjacent to the bed and banks that is from time to time covered by floodwater.

Blasting means the use of explosive materials to fracture:

a) rock, coal and other minerals for later recovery; or
b) structural components or other items to facilitate removal from a site or for reuse.

Certification or certified by a suitably qualified and experienced person in relation to a design plan or an annual report regarding dams, means that a statutory declaration has been made by that person and, when taken together with any attached or appended documents referenced in that declaration, all of the following aspects are addressed and are sufficient to allow an independent audit at any time:

a) exactly what is being certified and the precise nature of that certification

b) the relevant legislative, regulatory and technical criteria on which the certification has been based

c) the relevant data and facts on which the certification has been based, the source of that material, and the efforts made to obtain all relevant data and facts

d) the reasoning on which the certification has been based using the relevant data and facts, and the relevant criteria.

Chemical means:

a) an agricultural chemical product or veterinary chemical product within the meaning of the *Agricultural and Veterinary Chemicals Code Act 1994 (Commonwealth)*; or

b) a dangerous good under the dangerous goods code; or

c) a lead hazardous substance within the meaning of the *Workplace Health and Safety Regulation 1997*; or

d) a drug or poison in the Standard for the Uniform Scheduling of Drugs and Poisons prepared by the Australian Health Ministers' Advisory Council and published by the Commonwealth; or

e) any substance used as, or intended for use as:

  i. a pesticide, insecticide, fungicide, herbicide, rodenticide, nematocide, miticide, fumigant or related product; or

  ii. a surface active agent, including, for example, soap or related detergent; or

  iii. a paint solvent, pigment, dye, printing ink, industrial polish, adhesive, sealant, food additive, bleach, sanitiser, disinfectant, or biocide; or

  iv. a fertiliser for agricultural, horticultural or garden use; or

f) a substance used for, or intended for use for:

  i. mineral processing or treatment of metal, pulp and paper, textile, timber, water or wastewater; or

  ii. manufacture of plastic or synthetic rubber.

Commercial place means a work place used as an office or for business or commercial purposes, which is not part of the mining activity and does not include employees accommodation or public roads.

Construction or constructed in relation to a dam includes building a new dam and modifying or lifting an existing dam, but does not include investigations and testing necessary for the purpose of preparing a design plan.

Contaminate means to render impure by contact or mixture.

Contaminated means the substance has come into contact with a contaminant.

Contaminant can be

a) a gas, liquid or solid; or

b) an odour; or

c) an organism (whether alive or dead), including a virus; or

d) energy, including noise, heat, radioactivity and electromagnetic radiation; or

e) a combination of contaminants.

Dam means a land-based structure or a void that contains, diverts or controls flowable substances, and includes any substances that are thereby contained, diverted or controlled by that land-based structure or void and associated works.

Design plan is a document setting out how all identified consequence scenarios are addressed in the planned design and operation of a regulated structure.

Design storage allowance or DSA means the minimum storage required in a dam at the first of November each year in order to meet the hydraulic performance requirements.

Disturbance of land includes:

a) compacting, removing, covering, exposing or stockpiling of earth;
b) removal or destruction of vegetation or topsoil or both to an extent where the land has been made susceptible to erosion;
c) carrying out mining within a watercourse, waterway, wetland or lake;
d) the submersion of areas by tailings or hazardous contaminant storage and dam/structure walls;
e) temporary infrastructure, including any infrastructure (roads, tracks, bridges, culverts, dam/structures, bores, buildings, fixed machinery, hardstand areas, airstrips, helipads etc.) which is to be removed after the mining activity has ceased; or
f) releasing of contaminants into the soil, or underlying geological strata.

However, the following areas are not included when calculating areas of disturbance:

a) areas off lease (e.g. roads or tracks which provide access to the mining lease);
b) areas previously disturbed which have achieved the rehabilitation outcomes;
c) by agreement with the administering authority, areas previously disturbed which have not achieved the rehabilitation objective(s) due to circumstances beyond the control of the mine operator (such as climatic conditions);
d) areas under permanent infrastructure. Permanent infrastructure includes any infrastructure (roads, tracks, bridges, culverts, dam/structures, bores, buildings, fixed machinery, hardstand areas, airstrips, helipads etc.) which is to be left by agreement with the landowner; or
e) disturbance that pre-existed the grant of the tenure.

Effluent means treated waste water released from sewage treatment plants.

Environmental authority means an environmental authority granted in relation to an environmentally relevant activity under the *Environmental Protection Act 1994*.

Environmental authority holder means the holder of this environmental authority.

Environmentally relevant activity means an environmentally relevant activity as defined under section 18 of the *Environmental Protection Act 1994*.

Flowable substance means matter or a mixture of materials that can flow under any conditions potentially affecting that substance. Constituents of a flowable substance can include water, other liquids fluids or solids, or a mixture that includes water and any other liquids fluids or solids either in solution or suspension.

General waste means waste other than regulated waste.

Hazard in relation to a dam as defined, means the potential for environmental harm resulting from the collapse or failure of the dam to perform its primary purpose of containing, diverting or controlling flowable substances.

Hazard category means a category, either low significant or high, into which a dam is assessed as a result of the application of tables and other criteria in the Site Water Management Technical Guideline for Environmental Management of Exploration and Mining in Queensland (DME 1995).

Hydraulic performance means the capacity of a regulated dam to contain or safely pass flowable substances based on the probability (AEP) of performance failure specified for the relevant hazard category in the *Site Water Management Technical Guideline for Environmental Management of Exploration and Mining in Queensland* (DME 1995).

Infrastructure means water storage dams, roads and tracks, buildings and other structures built for the purpose of mining activities but does not include other facilities required for the long-term management of mining impacts or the protection of potential resources. Such other facilities include dams, waste rock dumps, voids, or ore stockpiles and buildings as well as other structures whose ownership can be transferred and which have a residual beneficial use for the next owner of the mining leases or the background land owner.

$\mathbf{L_{A10,\ adj,\ 10\ mins}}$ means the A-weighted sound pressure level, (adjusted for tonal character and impulsiveness of the sound) exceeded for 10% of any 10 minute measurement period, using Fast response.

$\mathbf{L_{A1,\ adj,\ 10\ mins}}$ means the A-weighted sound pressure level, (adjusted for tonal character and impulsiveness of the sound) exceeded for 1% of any 10 minute measurement period, using Fast response.

Land in the "land schedule" of this document means land excluding waters and the atmosphere.

Mandatory reporting level or MRL means a warning and reporting level determined in accordance with the criteria in the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (Version 4, 10 April 2014) (EM635)* published by the administering authority.

Mature trees means any tree relevant to the tenure that is classified as a commercial sized tree by the *Code of Practice for Native Forest Timber Production 2002*

mg/L means milligrams per litre.

Native vegetation means vegetation that occurs naturally in a certain area.

Mining operations authorised activities-

a) Including mine construction, resource extraction, mineral processing, mine site management, rehabilitation and decommissioning.
b) Excluding exploration activities detailed in the current ERC.
    i. Exploration activities do not include activities involved in the combined bulk sampling area.

Operational land means the land associated with the project for which this environmental authority has been issued.

Peak particle velocity or ppv means a measure of ground vibration magnitude which is the maximum rate of change of ground displacement with time, usually measured in millimetres/second (mm/s).

Progressive rehabilitation means rehabilitation (defined below) undertaken progressively or a staged approach to rehabilitation as mining operations are ongoing.

Receiving environment, in relation to an activity that causes or may cause environmental harm, means the part of the environment to which the harm is, or may be, caused. The receiving environment includes (but is not limited to):

a) a watercourse;

b) groundwater;

c) land; and

d) sediments.

Receiving waters means the waters into which this environmental authority authorises releases of mine affected water.

Regulated dam means any dam in the significant or high hazard category as assessed using the *Site Water Management Technical Guideline for Environmental Management of Exploration and Mining in Queensland* (DME 1995).

Regulated waste is defined in the *Environmental Protection Regulation 2008*.

Rehabilitation means the process of reshaping and revegetating land to restore it to a stable landform and in accordance with the acceptance criteria set out in this environmental authority and, where relevant, includes remediation of contaminated land.

Representative means a sample set that covers the variance in monitoring or other data due to either natural changes or operational phases of the mining activities.

Saline drainage is the movement of waters, contaminated with salt(s), as a result of the mining activity.

Scheme fund means the scheme fund established under section 24 of the *Mineral and Energy Resources (Financial Provisioning) Act 2018*.

Self-sustaining means an area of land which has been rehabilitated and has maintained the required acceptance criteria without human intervention for a period nominated by the administering authority.

Sensitive place means:

a) a dwelling, residential allotment, mobile home or caravan park, residential marina or other residential premises; or

b) a motel, hotel or hostel; or

c) an educational institution; or

d) a medical centre or hospital; or

e) a protected area; or

f) a public park or gardens.

Sewage means the used water of persons to be treated at a sewage treatment plant.

Stable in relation to land, means land form dimensions are or will be stable within tolerable limits now and in the foreseeable future. Stability includes consideration of geotechnical stability, settlement and consolidation allowances, bearing capacity (trafficability), erosion resistance and geochemical stability with respect to seepage, leachate and related contaminant generation.

Stormwater means all surface water runoff from rainfall.

Suitably qualified and experienced person in relation to dams means one who is a Registered Professional Engineer of Queensland (RPEQ) under the provisions of the Professional Engineers Act 2002, OR registered as a National Professional Engineer (NPER) with the Institution of Engineers Australia, OR holds equivalent professional qualifications to the satisfaction of the administering authority for the Act; AND the administering authority for the Act is satisfied that person has knowledge, suitable experience and demonstrated expertise in relevant fields, as set out below:

a) knowledge of engineering principles related to the structures, geomechanics, hydrology, hydraulics, chemistry and environmental impact of dams
b) a total of five years of suitable experience and demonstrated expertise in at least four of the following categories, with the 'geomechanics of dams' category being compulsory:
    i. geomechanics of dams with particular emphasis on stability, geology and geochemistry
    ii. investigation, design or construction of dams
    iii. operation and maintenance of dams
    iv. hydrology with particular reference to flooding, estimation of extreme storms, water management or meteorology
    v. hydraulics with particular reference to sediment transport and deposition, erosion control, beach processes
    vi. hydrogeology with particular reference to seepage, groundwater
    vii. solute transport processes and monitoring thereof
    viii. dam safety

The Act means the *Environmental Protection Act 1994*.

Waste as defined in section 13 of the *Environmental Protection Act 1994*.

Waste and resource management hierarchy has the meaning given by section 9 of the *Waste Reduction and Recycling Act 2011*.

Water quality means the chemical, physical and biological condition of water.

Waters includes all or any part of a river, stream, lake, lagoon, pond, swamp, wetland, unconfined surface water, unconfined water in natural or artificial watercourses, bed and banks of a watercourse, dams, non-tidal or tidal waters (including the sea), stormwater channel, stormwater drain, roadside gutter, stormwater run-off, and groundwater.

µg/L means micrograms per litre.

µS/cm means microsiemens per centimetre.

END OF DEFINITIONS

Figure 1: Location of Exploration and Mineral Development Activities

Figure 2: Wards Well Mining Tenements

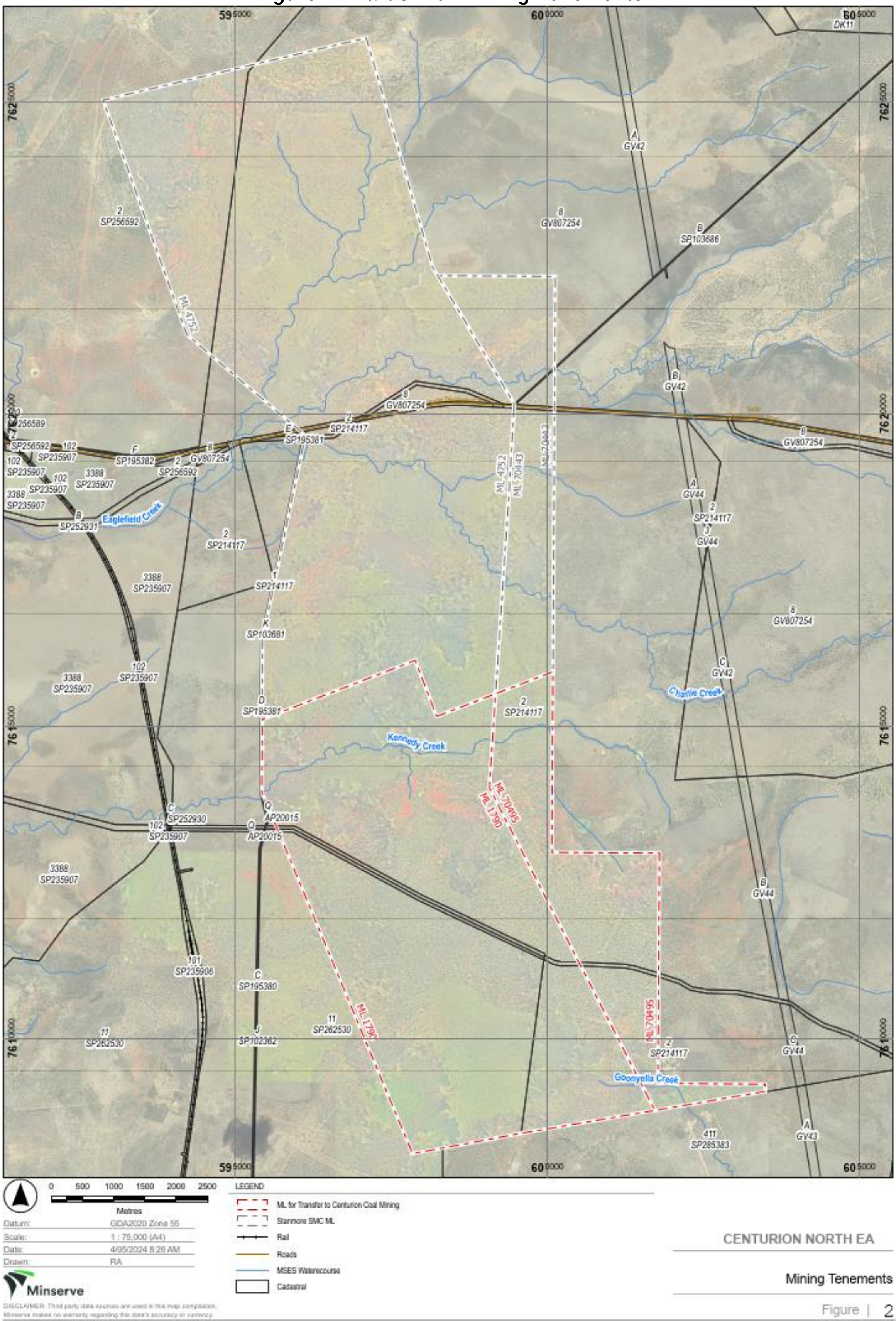


Figure 3: Authorised impacts to MSES Regulated Vegetation

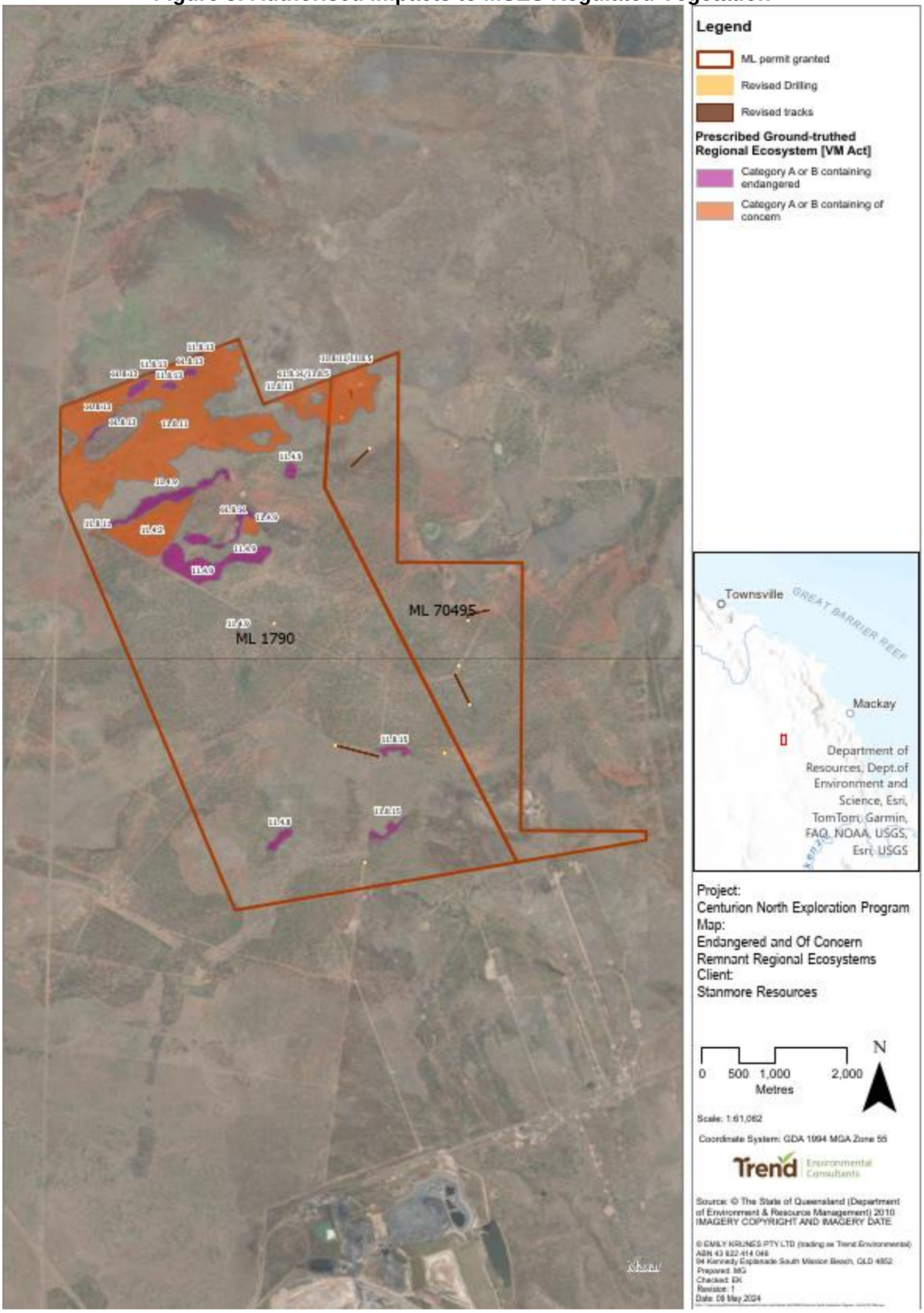
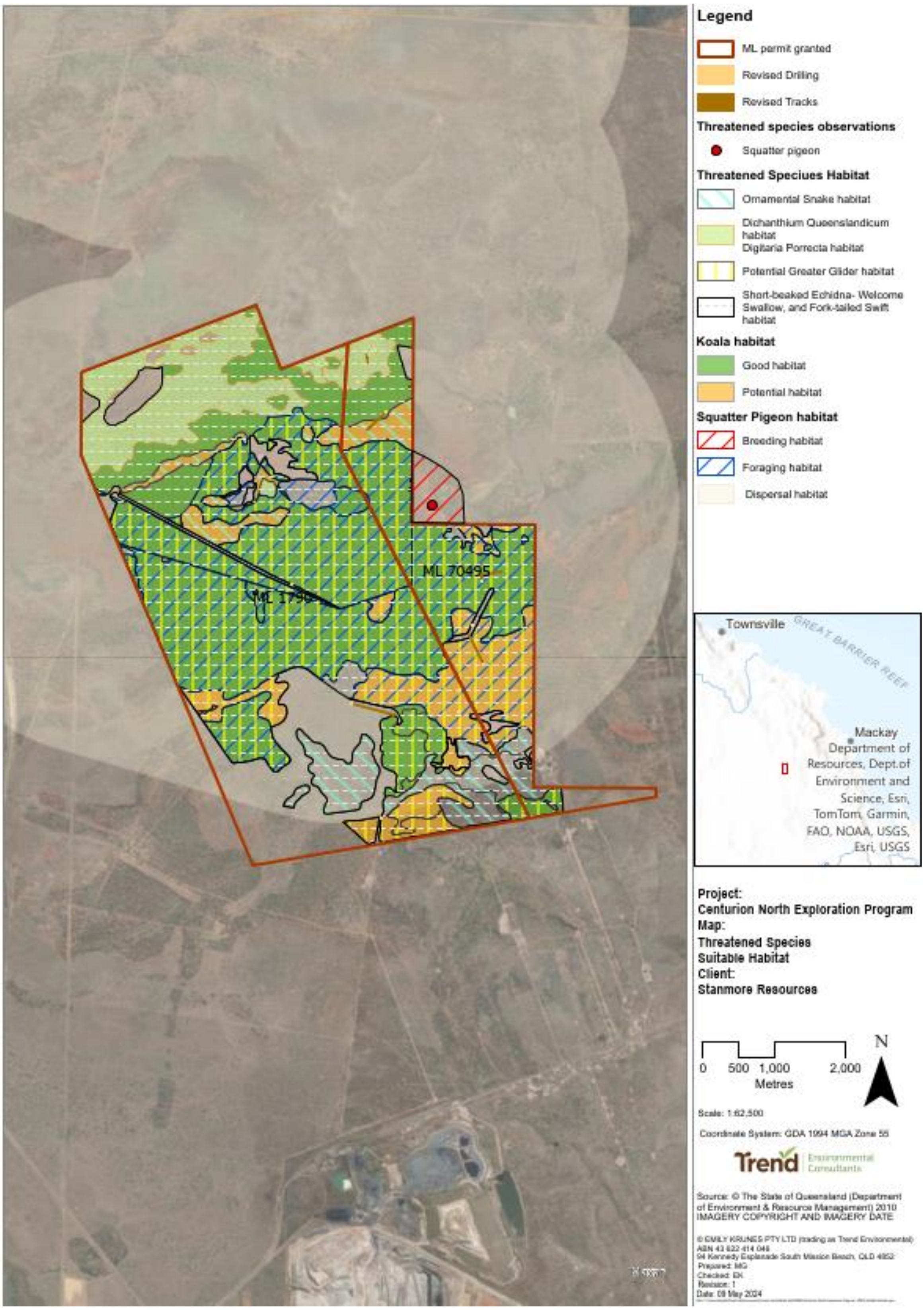


Figure 4: Authorised impacts to MSES Protected Wildlife Habitat



END OF ENVIRONMENTAL AUTHORITY

Notice

Environmental Protection Act 1994

Correction of a clerical or formal error in an environmental authority

This statutory notice is issued by the administering authority[1] *to advise you that your environmental authority has been amended under section 211 of the* Environmental Protection Act 1994 *to correct a clerical or formal error.*

Centurion Coal Mining Pty Ltd
Level 14, 31 Duncan Street
Fortitude Valley QLD 4006
By email transmission only
Email: mgibbons@peabodyenergy.com

Our reference: P-EA-100658713

Attention: Marianne Gibbons

Amendment of an environmental authority to correct a clerical or formal error

1. Permit details

Environmental authority number P-EA-100658713 dated 3/09/2024.

Land description: ML1790, ML70495.

2. Amendment

The administering authority has become aware that there is a formal error on the environmental authority that requires correction. These corrections are minor in nature and will not adversely impact your or anyone else's interests. As a result, the following amendments have been made to your environmental authority:

The company name Stanmore SMC Pty Ltd was changed to Centurion Coal Mining Pty Ltd. The registered address was changed from Level 32, 12 Creek Street, Brisbane City, QLD 4100 to Level 14, 31 Duncan Street, Fortitude Valley QLD 4006.

The amended environmental authority is enclosed with this notice

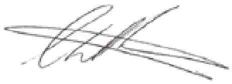
3. Human rights

A human rights assessment was carried out in relation to this decision/action, and it was determined that:

No human rights were engaged by the decision / action.

Should you have any questions in relation to this notice, please contact Business Centre Coal on telephone (07) 4987 9320.

[1] The Department of Environment and Science is the administering authority under the *Environmental Protection Act 1994*.

Signature	Date
	11 September 2024

Cate Puschmann
Department of Environment and Science
Delegate of the administering authority
Environmental Protection Act 1994

Enquiries:
Business Centre Coal
PO Box 3028, Emerald QLD 4720
Phone: (07) 4987 9320
Email: CRMining@des.qld.gov.au

APPENDIX 2
GOLDER ASSOCIATES (23 DECEMBER 2020): WARDS WELL MINE – PRCP HYDROGEOLOGICAL CONCEPTUAL MODEL. REF. NO. 20360652-001-R-REVA

GOLDER

REPORT

Wards Well Mine - Progressive Rehabilitation and Closure Plan

Hydrogeological Conceptual Model

Submitted to:

Matthew Chenery
Water Planning Team
480 Queen Street
Brisbane, QLD 4000
Australia

Submitted by:

Golder Associates Pty Ltd
147 Coronation Drive, Milton, Queensland 4064, Australia

+61 7 3721 5400

20360652-001-R-Rev0

23 December 2020

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1.0 INTRODUCTION

Golder Associates Pty Ltd (Golder) was commissioned by BHP Billiton Mitsui Coal Pty Ltd (BMC) to develop a qualitative hydrogeological conceptual model (HCM) for the Wards Well site, which will inform the site Progressive Rehabilitation and Closure Plan (PRCP). The HCM addresses hydrogeology requirements described within the Department of Environment and Science (2019) Guideline – Progressive Rehabilitation and Closure Plans (PRC Plans). The information provided herein will be used to assist in development of the PRCP associated with Environmental Authority (EA) number EPPR00668513 for the Wards Well Mine.

2.0 BACKGROUND

The Wards Well mine (the site) is situated in the north-western reaches of the Bowen Basin, approximately 30 km south of the town of Glenden and to the north of the North Goonyella Mine.

The Department of Environment and Science issued a Guidelines for Progressive Rehabilitation and Closure Plans (PRCP) on 1 November 2019 (Guideline). The PRCP is a fundamental element of the Queensland Government's Mined Land Rehabilitation Policy. Holders of an existing EA are notified by the administering authority to develop and submit a PRCP to the Department of Environment and Science. The PRCP replaces the rehabilitation requirements in an EA and defines progressive rehabilitation plans throughout the life of the mine.

3.0 SCOPE OF WORK

Golder has been tasked with the compilation and interpretation of groundwater conditions at Wards Well to support the development of the PRCP. The following are the primary objectives to address hydrogeological requirements described within the DES (2019) Guideline:

- Objective 1: Undertake a baseline conceptual hydrogeological assessment.
- Objective 2: Complete a qualitative risk assessment of post mining hydrogeological conditions.

A review of historical data and reports has been completed using information provided to Golder by BMC supplemented with publicly available data and maps.

Objective 1 includes the development of a baseline hydrogeological conceptual model (BHCM). A hydrogeological conceptual model is a descriptive representation of a groundwater system that incorporates knowledge and interpretation of the geological, hydrological and hydrogeological conditions (Anderson and Woessner, 1992; Barnett et al., 2012). The conceptual model works to consolidate the hydrogeological understanding of key processes, such as recharge and discharge, and the influence of boundaries and stresses that may be present in the system. For the purposes of this project, the hydrogeological conceptual model will include a detailed summary of each of the system components and main hydrogeological processes. The BHCM represents the baseline conditions of the Wards Well site prior to mining and is presented both schematically and with detailed written descriptions of each of the system components.

Objective 2 includes a qualitative risk assessment, which estimates potential impacts to the groundwater system as a result of the mining activities described in the Environmental Authority (EA). The risk assessment has been carried out as per the AS ISO 31000:2018 Risk Management – Guidelines (Standards Australia, 2018) and includes the following steps:

1) Risk identification,
2) Risk analysis,
3) Risk evaluation, and

4) Risk treatment.

The most probable scenario at the point of mine closure (i.e. the scenario with the highest likelihood of occurrence) has been defined based on expert opinion. An exposure pathway assessment has been completed for that most probable closure scenario, which defines the complete and incomplete pathways to qualitatively evaluate likely impacts to the relevant identified receptors.

4.0 LEGISLATIVE FRAMEWORK

The primary legislative requirements relating to the project are summarised below.

Environmental Protection Act 1994

The *Environmental Protection Act 1994* (Qld) (EP Act) was put in place to protect Queensland's environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends.

The EP Act states that any undertaking of an environmentally relevant activity (ERA), such as resource activities (mining or petroleum and gas), requires an Environmental Authority (EA). The EA describes legislative requirements and conditions requiring the holder to conduct the ERA in an environmentally responsible manner. The Wards Well mine development is subject to conditions described in EA EPPR00668513 issued by the Department of Environment and Heritage Protection (now Department of Environment and Science), which took effect on 25 January 2018. Under EA EPPR00668513, the approved activities at Wards Well include the following:

- Exploration and drilling: drill holes and pads, LOX line drilling, and 3D seismic survey program,
- Exploration box cut,
- Underground exploration entry point and in seam sampling,
- Mine water dam and stormwater dam,
- Mineral extraction and processing: topsoil stockpiles and overburden dump (temporary, to be used to backfill box cut with the exception of approximately 1.5 m high stockpile of residual matter),
- Run of mine and product stockpile (up to 250,000 tonnes),
- Ancillary infrastructure: industrial area/workshop, administration, petroleum storage, laydown areas, sewage treatment and roads, and
- Accommodation within an exploration fly camp.

Under the EA, any exploration activities on mining leases (ML) ML4752, ML1790, ML70443 and ML70495 must be carried out using all reasonable and practical measures to prevent or minimise the likelihood of environmental harm being cause to any Environmentally Sensitive Area (ESA).

Mineral and Energy Resources (Financial Provisioning) Act 2018

In an effort to improve rehabilitation and financial assurance outcomes in the resources sector, the Queensland Government has released the *Mineral and Energy Resources (Financial Provisioning) Act 2018* (Qld) (MERFP Act). The MERFP Act was passed on 30 November 2018 and established the following key changes in legislation:

1) The MERFP Act replaces the financial assurance arrangements for resource activities under the Environmental Protection Act 1994 with a new financial provisioning scheme,

2) Changes how the estimated rehabilitation cost for an environmental authority (EA) is calculated, and

3) Amends the EP Act to introduce new requirements for the progressive rehabilitation and closure of mined land.

A critical element of the Queensland Government's Mined Land Rehabilitation Policy is the Progressive Rehabilitation and Closure Plan (PRCP). Under new legislation, EA applicants are required to develop and submit a proposed PRC plan as part of their application. The MERFP Act also describes transitional provisions for the application of the PRC plan requirement concerning existing mines. Holders of an existing EA are issued with a notice specifying a start date by which a PRCP must be developed and submitted to the Department of Environment and Science (the administering authority). Such a notice was issued to BMC for the Wards Well project, stating that the EA holder much submit a proposed PRC plan to the administering authority by 26 February 2021.

The primary purposes of the PRCP are as follows:

- To require the holder of an EA to plan for how and where activities will be carried out on land in a way that maximises the progressive rehabilitation of the land to a stable condition and
- To provide for the condition to which the holder must rehabilitate the land before the EA may be surrendered.

Water Act 2000

The *Water Act 2000* (Qld) (Water Act) is the primary legislation surrounding the sustainable management of water and the management of impacts on underground water. The Water Act is enacted under a water planning framework, which is used to sustainably manage and allocate water resources in Queensland. Water resource plans (WRPs) are developed based on technical assessments using environmental, economic, social, hydrologic and cultural data to determine the amount and type of water available so that water can be shared sustainably. WRPs include specification of Groundwater Management Areas (GMAs), which have been established for the protection and management of underground water resources.

The majority of the Wards Well site is located within sub-catchment area E in the eastern portion of the Water Plan (Burdekin Basin) 2007 area. Sub-catchment area E is not a defined water management zone within the Burdekin Basin. However, there is a declared underground water area intersecting the south western portion of the site: Highlands Underground Water Area (CAS2055). Section 1046(1) of the Water Act states that declared underground water areas may be subject to the following regulations:

- Regulate the taking of, or interfering with, underground water; and
- State the types of works for taking or interfering with underground water that are assessable development or accepted development of the Planning Act.

Water Regulation 2016[1], which describes the relevant legislation surrounding declared underground water areas, states that the Highlands Underground Water Area does not require water entitlement, water permit or seasonal water assignment notice for stock or domestic purposes or a prescribed activity. Prescribed activities in the context of mining operations include:

- Washing down equipment, plant, or vehicles,

[1] Water Regulation 2016 is a supplemental piece of legislation which prescribes administrative and operations matters for the Water Act 2000.

- Supplying water for temporary camps or living quarters for staff, for example, for operating toilets, showers, kitchens, or laundries,
- Construction works, infrastructure or plant that are temporary and reasonably necessary for, or incidental to, carrying on mining under a mining lease granted under the Mineral Resources Act,
- Constructing, but not maintaining, roads with the area of a mineral development licence, or mining lease, granted under the Mineral Resources Act,
- The following activities in relation to pumps, wells, or bores –
  - Constructing or drilling (including site establishment and rehabilitation and drill bit lubrication),
  - Proving supply,
  - Testing water quality,
  - Flushing out
- Rehabilitation of riparian land.

Any dewatering requirements occurring within the bounds of the Highlands Underground Water Area will be subject to obtainment of a water entitlement, water permit or seasonal water assignment notice.

The south eastern portion of the Wards Well site falls within the Isaac Connors GMA as defined by the Water Resource (Fitzroy Basin) Plan 2011 (Fitzroy Basin WRP). The Isaac Connors GMA consists of two groundwater units:

- Unit 1 – Quaternary alluvium aquifers
- Unit 2 – Subartesian aquifers (all aquifers other than those classified as Unit 1)

Surface water resources in the southern portion of the Wards Well site also fall into the Isaac Connors Water Management Area under the Fitzroy Basin WRP.

Environmental Protection Policy (Water and Wetland Biodiversity) 2019

The purpose of the Environmental Protection Policy (Water and Wetland Biodiversity) 2019 (EPP) is to protect Queensland's waters while supporting ecologically sustainable development. The policy replaces previous legislation [Environmental Protection (Water) Policy 2009] but does not contain any significant policy changes from expired legislation. The purpose of the EPP is to achieve the following:

- Identify environmental values or waters and wetlands to be enhanced or protected
- Identify management goals for waters
- State water quality guidelines and water quality objectives (WQOs) for enhancing or protecting the environmental values of waters
- Providing a framework for making consistent, equitable and informed decisions about waters, and
- Monitoring and reporting of the condition of waters.

The majority of the Wards Well site lies within the Suttor Catchment of the Burdekin Basin, which currently lacks established environmental values (EVs) and WQOs. However, a Water Quality Improvement Plan (WQIP) has been established for the Burdekin Dry Tropics Natural Resource Management (NRM) region, which supports and guides decision making and investment around protection of local ecosystems as they relate to water quality. The plan addresses human activities in the region which have the potential to have a major influence on regional water quality (NQ Dry Tropics, 2016). The WQIP has been developed to address requirements for Healthy Waters Management Plans (HWMP) specified in Section 24 of the EPP.

Draft EVs for groundwater resources within the Suttor Catchment of the Burdekin Basin described in the WQIP include the following:

- Irrigation
- Farm water supply
- Stock water
- Drinking water
- Industrial use

Guidelines for EVs of groundwater associated with aquatic ecosystems are currently being developed and as such are not included in the above list (NQ Dry Tropics, 2016).

The southern portion of the site lies within the Fitzroy Basin WRP. Groundwater resources in the southern portion of the site are subsequently scheduled under the EPP as Isaac Groundwaters of the Isaac River Sub-basin of the Fitzroy Basin water plan (WQ1301) and are subject to EVs and WQOs outlined in this plan.

The following EVs are associated with groundwaters within the Isaac River Sub-basin:

- Aquatic ecosystems
- Irrigation
- Farm water supply
- Stock water
- Primary Recreation
- Drinking Water
- Industrial Use
- Cultural and spiritual values

The EPP prescribes water quality guidelines (quantitative measures or statements of indicators) for the protection of EVs of groundwater. Water quality guidelines are decided based on site specific documents for water, such as the NQ Dry Tropics WQIP, or other published information including the Australian and New Zealand guidelines for fresh and marine water quality (ANZECC & ARMCANZ, 2018), the Australian drinking water guidelines (ADWG) (NHMRC, 2011), and Guidelines for managing risks in recreational waters (NHMRC, 2008).

Water management areas are displayed in Figure 1.

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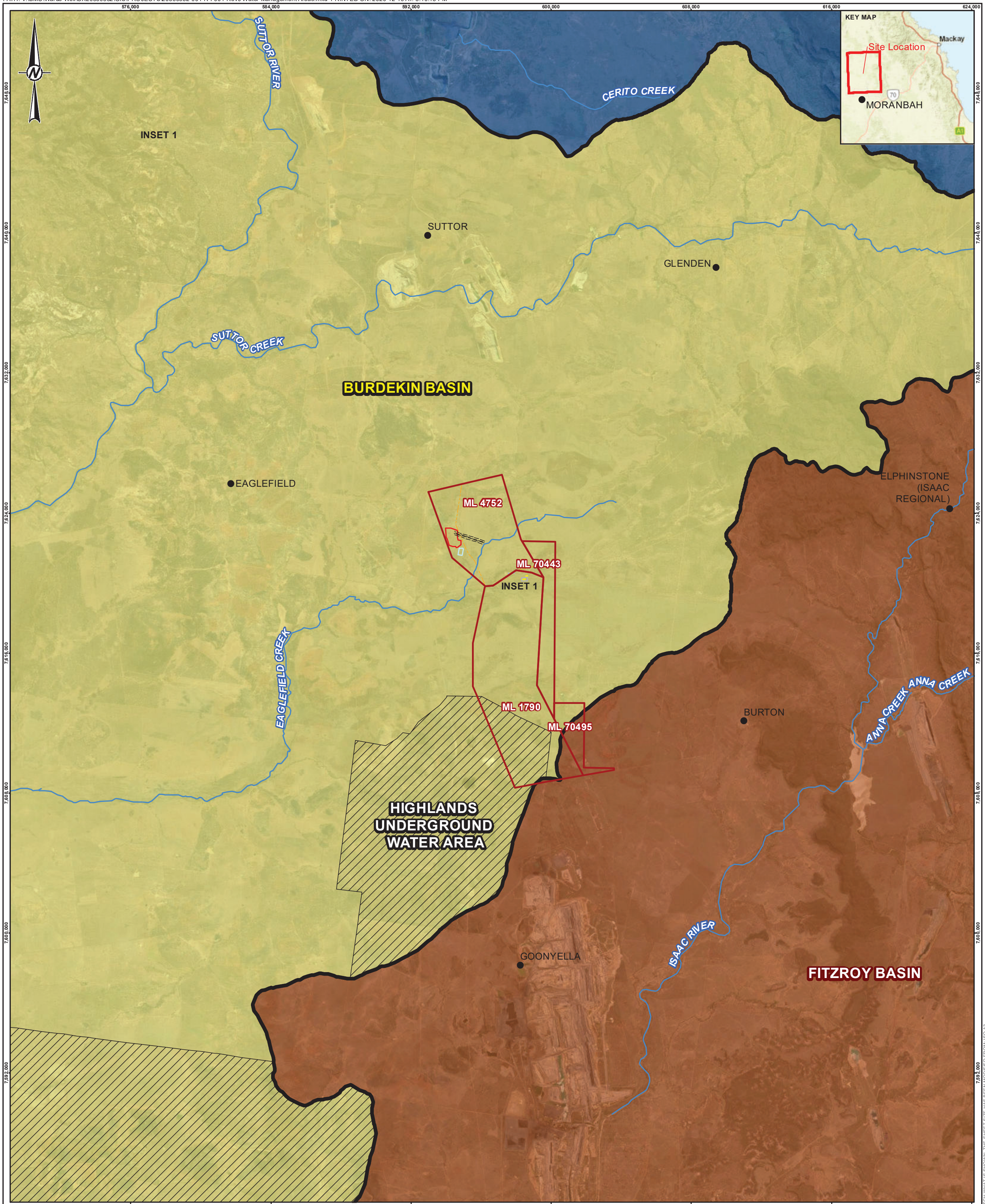

LEGEND

- Place Names

Watercourse

- Major

Wards Well EA Approved Activities

- Administrative Area
- Box Cut Area
- Industrial Area
- Seismic Investigation Area
- Storm Water Dam
- Underground Exploration

- Declared Underground Water Areas
- Catchment Boundary

Water Plan Catchments

Subcatchment

- Bowen River
- Isaac-Connors Rivers
- Suttor River

Coordinate System: GDA 1994 MGA Zone 55
Projection: Transverse Mercator
Datum: GDA 1994

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NOTE(S)
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REFERENCE(S)
1. Place Names, Watercourse, Mining Lease Tenements: © State of Queensland (Department of Natural Resources, Mines and Energy) 2019 - 2020 **2.** Water Plan Catchments, Declared Underground Water Areas: © State of Queensland (Department of Natural Resources, Mines and Energy) 2020 **3.** Wards Well EA Approved Activities: BMC, 2020

CLIENT
BHP BILLITON MITSUI COAL PTY LTD (BMC)

CONSULTANT

GOLDER

DD-MM-YYYY	16-12-2020
DESIGNED	HG
PREPARED	HG
REVIEWED	TRE
APPROVED	TRE

PROJECT
WARDS WELL MINE PROGRESSIVE REHABILITATION AND CLOSURE PLAN - HYDROGEOLOGICAL CONCEPTUAL MODEL

TITLE
WATER MANAGEMENT AREAS

PROJECT NO.	CONTROL	REV.	FIGURE
20360652	001	0	1

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5.0 EXISTING ENVIRONMENT

5.1 Location and Land Use

The Wards Well project site is located near the western extent of the Bowen Basin in Central Queensland, approximately 50 km northwest of Moranbah. The project area comprises four mining leases, including: ML1790, ML4752, ML70443, and ML 70495. The majority of the exploration activities, including the box cut and underground bulk sampling areas fall within the Lancewood Mining Lease (ML4752).

The site location is displayed in Figure 3.

Spatial land use data was acquired from the Department of Environment and Science (DES, 2020) to assess primary land use types in the vicinity of the Wards Well site. Land use in the proposed exploration areas is primarily production from relatively natural environments, including grazing native vegetation, with some localised areas of intensive uses, including residential and farm infrastructure. A statistical breakdown of land use by proportional area is provided in Table 1.

Table 1: Land use within 10 km of exploration box cut

Land Use (Tertiary)	Percent Total Area (%)
Grazing Native Vegetation	99.01
Marsh / wetland (production)	0.66
Farm buildings / infrastructure	0.08
Water storage – intensive use / farm dams	0.08
Mines	0.08
Other minimal use	0.06
Rural residential without agriculture	0.03
Tailings	0.01

Note: Land use is classified according to the Australian Land Use and Management Classification (ALUMC) for the Burdekin NRM Region (DES, 2020)

5.2 Climate

The Central Queensland climate is classified as semi-arid and is characterised by warm, dry winters and hot, humid summers. Almost all rainfall occurs during the wet season, between the months of November and April (BOM, 2020a). Daily rainfall records since 2012 are available from the Moranbah Airport weather station (No. 34035), located approximately 50 km south of the site. The yearly distribution of average monthly rainfall is presented in Figure 2. The average annual rainfall (using rainfall data from 2012 to 2020) is approximately 529 millimetres per year (mm/yr).

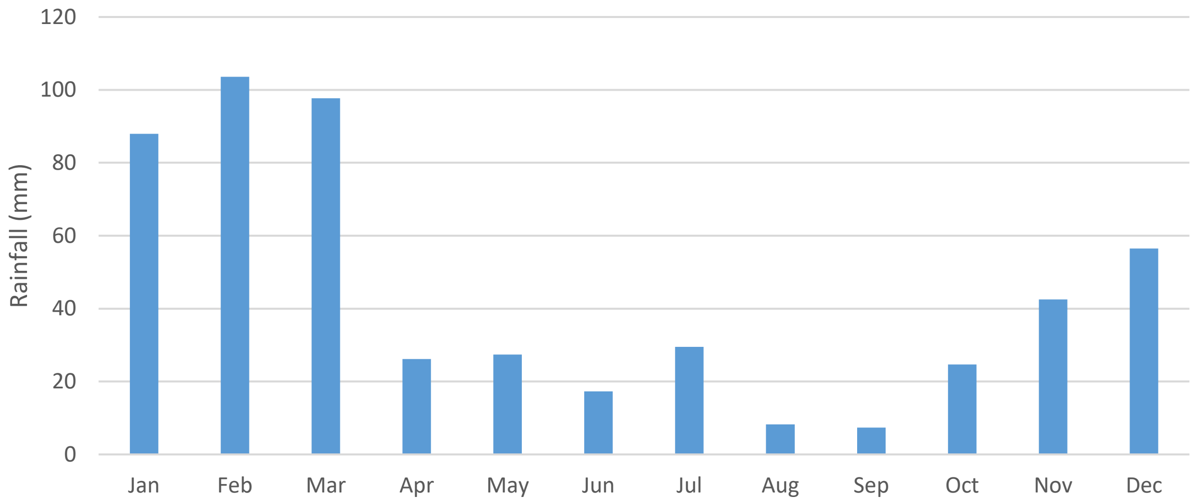
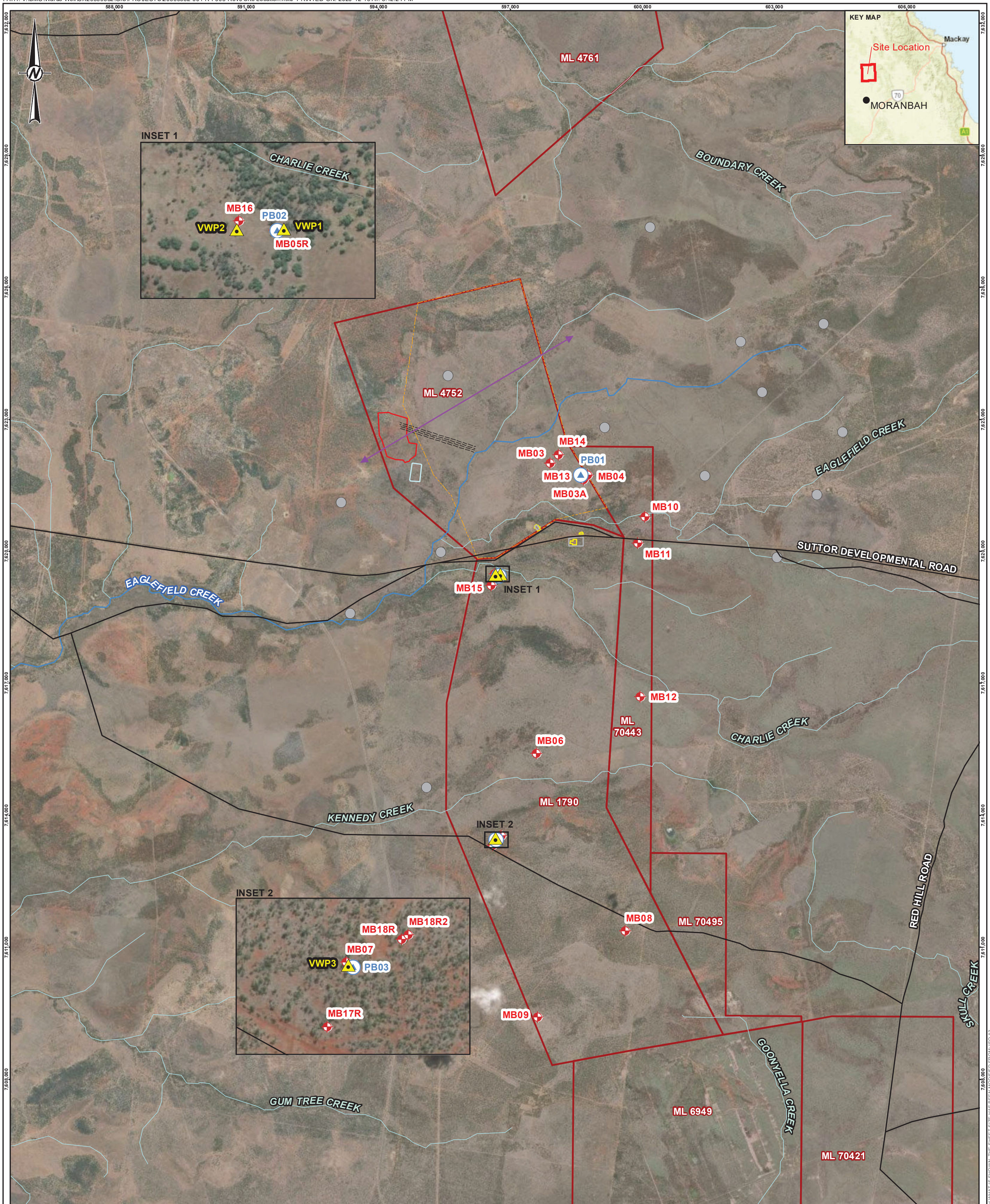


Figure 2: Average monthly rainfall over the period 2012 to 2020 (station number 34035, BOM 2020a)



LEGEND

- Monitoring Bore
- Pumping Bore
- VWP
- Registered Bore
- Roads and Tracks

Watercourse
- Major
- Minor
- Conceptual Cross-Section

Wards Well EA Approved Activities
- Administrative Area
- Box Cut Area
- Industrial Area
- Seismic Investigation Area
- Storm Water Dam
- Underground Exploration
- Mining Lease Tenement

Coordinate System: GDA 1994 MGA Zone 55
Projection: Transverse Mercator
Datum: GDA 1994

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1:80,000 @ A3 METRES

NOTE(S)
Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

REFERENCE(S)
1. Roads and Tracks, Watercourse, Topography, Mining Lease Tenements: © State of Queensland (Department of Natural Resources, Mines and Energy) 2019 - 2020
2. Registered Bores: Bureau of Meteorology Groundwater Bore Database, 2020
3. Wards Well EA Approved Activities: BMC, 2020

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PROJECT
WARDS WELL MINE PROGRESSIVE REHABILITATION AND CLOSURE PLAN - HYDROGEOLOGICAL CONCEPTUAL MODEL

CONSULTANT
GOLDER

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DESIGNED	HG
PREPARED	HG
REVIEWED	TRE
APPROVED	TRE

TITLE
SITE LOCATION

PROJECT NO.	CONTROL	REV.	FIGURE
20360652	001	0	3

5.3 Topography and Drainage

The topography of the project area generally slopes from the north west to south east, with elevations typically ranging between RL 300 and RL 380 m. Topographic highs occur in the north west of the mining lease, near the location of the exploration box cut. Two shallow valleys associated with Eaglefield Creek and Kennedy Creek run broadly east to west through the central portion of the mining lease area, sloping to the west.

Three major creek systems exist within the project area, including Eaglefield Creek in the north, Charlie Creek in the centre and Kennedy Creek in the south. The creeks and associated tributaries are ephemeral, with flow occurring only after periods of intense rainfall during wetter summer months. These creek systems discharge towards the Suttor River, which is situated to the west of the mining lease.

The southern portion of the site is located on the edge of the Fitzroy Basin, within the Upper Isaac River catchment fresh waters. The headwaters of Goonyella Creek are located in the south eastern portion of ML1790, with surface water flowing south towards the Isaac River.

Ephemeral creeks and associated tributaries are displayed in Figure 3**.**

6.0 BASELINE HYDROGEOLOGICAL CONCEPTUAL MODEL

6.1 Desktop Review

A conceptual understanding of the existing hydrogeological environment at the Wards Well site was developed through a desktop review of existing reports and data. The desktop review included information provided in Table 2.

Table 2: Reviewed information and sources

Topic	Data	Source
Environmental Legislation	■ Progressive Rehabilitation and Closure Plan Notice (2020) ■ Environmental Authority (EA) – EPPR00668513 (2018)	Provided to Golder by BMC, September 2020
Historic Reports	■ Wards Well Environmental Impact Study, Groundwater Assessment (AGE, 2012) ■ Geochemical Assessment of Potential Coal Reject and Spoil Materials, Wards Well Project (RGS Terrenus, 2012) ■ Summary Report – Assessment of Groundwater Monitoring Bore BHP Wards Well (4T Consultants, 2019) ■ Wards Well Project Groundwater Monitoring Network Review (SLR, 2019) ■ Prediction of Water Inflows to Broadmeadow Mine and Recommended Pumping Capacity (Seedsman Geotechnics, 2015) ■ Wards Well Planned Hydro Geophysics Requirements (BHP, 2017)	Provided to Golder by BMC, September 2020
	■ Wards Well Water Management Options Assessment (Golder, 2017)	Historic Golder Report, accessed from Golder archives.

Topic	Data	Source
Mine Operations	■ BMC Wards Well FY18-FY22 Plan of Operations (BMC, 2017)	Provided to Golder by BMC, September 2020
Background Data	■ Groundwater level data: 2016 to 2019 (Standing water levels and logger data) ■ Groundwater quality data: 2016 to 2019 ■ VWP Data: 2012	Provided to Golder by BMC, September 2020
Spatial Data	Shapefile: ■ WW_Approved_Activities.shp	Provided to Golder by BMC, September 2020
	Geodatabase: ■ Detailed Surface Geology and Structures (QLD) (2018) ■ Regional Geology 1985 – Bowen Basin (2003)	DNRME, Accessed via QSpatial (http://qldspatial.information.qld.gov.au/catalogue/)
	■ GDE Database – Burdekin River Region: Terrestrial, Subterranean and Aquatic (2020)	Bureau of Meteorology (BOM), accessed via the GDE Atlas (http://www.bom.gov.au/water/groundwater/gde/map.shtml)
	Tabular Data: ■ Groundwater Database – Queensland (2020)	DNRME, Accessed via QSpatial (http://qldspatial.information.qld.gov.au/catalogue/

6.2 Geological Setting

6.2.1 Regional setting

The Wards Well site is located on the Collinsville Shelf, near the western reaches of the Bowen Basin in Central Queensland. The Collinsville Shelf has a shallow, easterly dip between 2 to 5 degrees with localised steepening. The Bowen Basin is part of a connected group of Permian-Triassic basins spanning across eastern Australia, including the Sydney and Gunnedah Basins, and is characterised by a thick Permian-Triassic succession of siliciclastics succeeded by coal measures (Withnall & Cranfield, 2013).

6.2.2 Depositional Setting

The depositional setting of the project area comprises Quaternary alluvial and poorly consolidated sediments and basalt flows of the Tertiary Suttor Formation unconformably overlying Permian age strata.

Quaternary Sediments

The Quaternary sediments consist of sand, clay and silt of varying content that have been unconformably deposited in an eroded, valley-fill environment associated with creeks and drainage channels. The deposits are likely irregular in thickness and lensoidal in nature. Alluvial sediments have been mapped on 1:250 000 scale geology maps and are associated with Eaglefield and Charlie Creek in the north of the site and Kennedy Creek in the south.

Tertiary Strata

The Tertiary strata comprise four major basalt flows intercalated with pyroclastic ash flow and ash fall tuffs, volcanic breccias, clays, muds, lignites and unconsolidated fine to coarse grained sand and gravels. Basalt flows originated from local eruption vents, with the thickest basalt accumulations (up to 60 m thick) occurring in palaeochannels downgradient of the vents. Basalt thickness tends to reduce in the upper reaches of the palaeochannels to the east and north of the Wards Well mining leases and eventually the occurrences of basalt discontinue. To the west, basalts plunge below a thick veneer of Tertiary sediments and eventually discontinue at an unknown distance to the northwest mine lease boundary. To the south the basalt flows are increasingly interbedded with Tertiary clay and sand. Sediment deposits are heterogeneous with clay, silt and sand content varying laterally with depth (Golder, 2017).

Permian Strata

The underlying Permian strata comprises the Fort Cooper Coal Measures (FCCM) and Moranbah Coal Measures (MCM) which generally dip to the east at the Wards Well site. The FCCM unconformably underlies the Tertiary sediments and is typically massive, coarse grained sandstone, fine to medium grained sandstone, dark grey siltstone, carbonaceous shale and mudstone and coal seams with tuffaceous claystone bands.

The MCM conformably underlies the FCCM and comprises low ash coal seams, laminated claystones, siltstones, interbedded siltstones/sandstones and massive sandstones. There are nine coal seams within the MCM, three of which are economically viable, including:

- Goonyella Upper (GU) seam,
- Goonyella Middle (GM) seam, and
- Goonyella Lower (GL) seam.

The ‘target’ seam for the Wards Well project is the Goonyella Middle seam, which is continuous throughout the project area. The seam ranges in thickness from four to eight metres and is situated at depths of 130 m below ground in the west to 690 m down dip in the east (AGE, 2012).

Geological Structures

Two main fault sets have been identified at the project site during previous site investigations: normal faults striking east-west with a vertical displacement of approximately five to ten metres, and thrust faults striking north-south with approximately three metre upthrust to the east. Exploration drilling also intersected a number of normal and thrust faults located throughout the mining lease areas (AGE, 2012).

Detailed solid geology and surface geology is displayed in Figure 4 and Figure 5, respectively. Geological structures are included on Figure 4.

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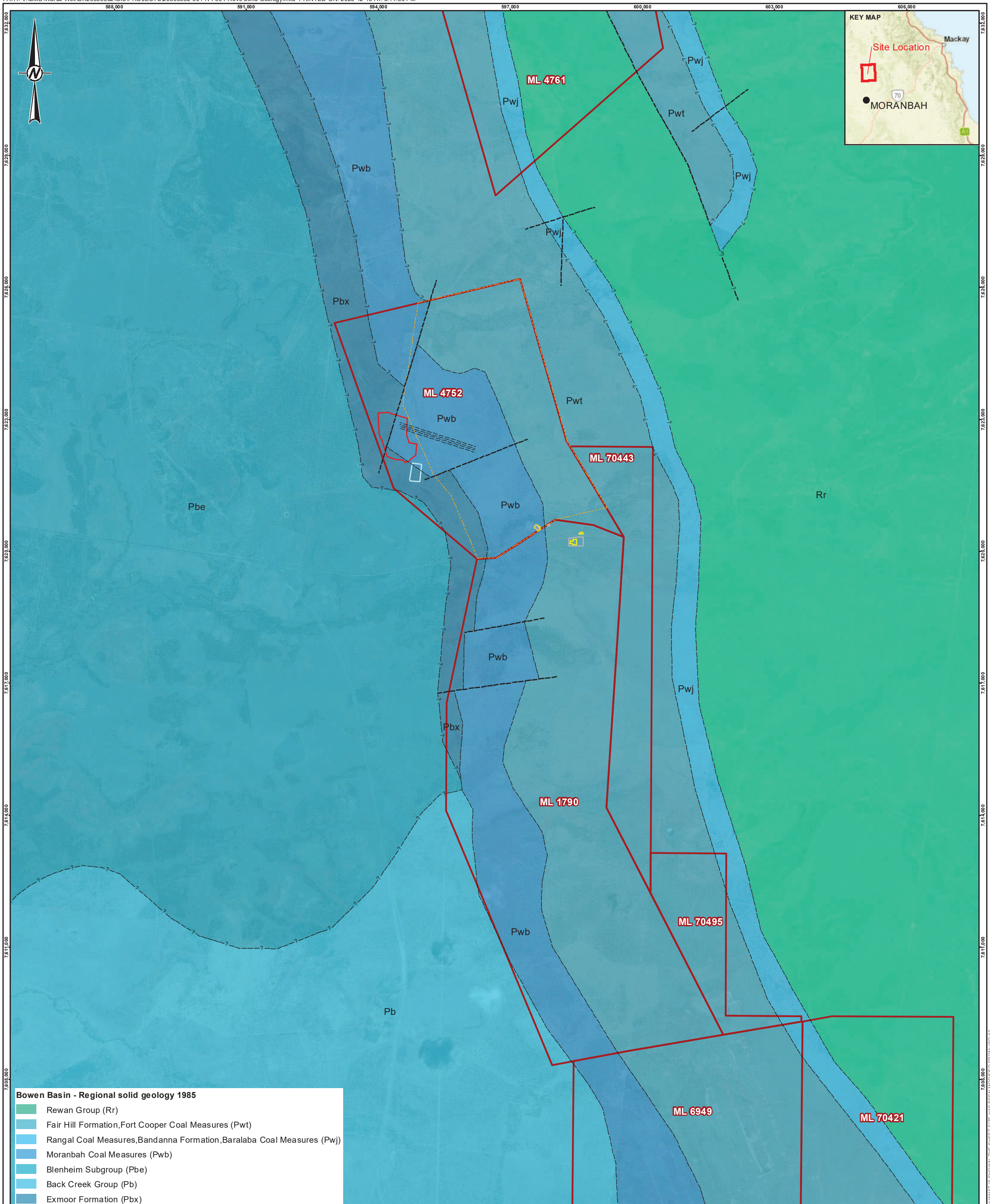

LEGEND

Wards Well EA Approved Activities

- Administrative Area
- Box Cut Area
- Industrial Area
- Seismic Investigation Area
- Storm Water Dam
- Underground Exploration

Bowen Basin - Regional structure 1985

- Fault Approximate
- Fault Inferred
- Geological Boundary Approximate
- Geological Boundary Inferred
- Mining Lease Tenement

Coordinate System: GDA 1994 MGA Zone 55
Projection: Transverse Mercator
Datum: GDA 1994

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NOTE(S)
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REFERENCE(S)
1. Bowen Basin Solid Geology and Structures, Mining Lease Tenements: © State of Queensland (Department of Natural Resources, Mines and Energy) 2003 - 2020
2. Wards Well EA Approved Activities: BMC, 2020

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PROJECT
WARDS WELL MINE PROGRESSIVE REHABILITATION AND CLOSURE PLAN - HYDROGEOLOGICAL CONCEPTUAL MODEL

TITLE
SOLID GEOLOGY AND STRUCTURES

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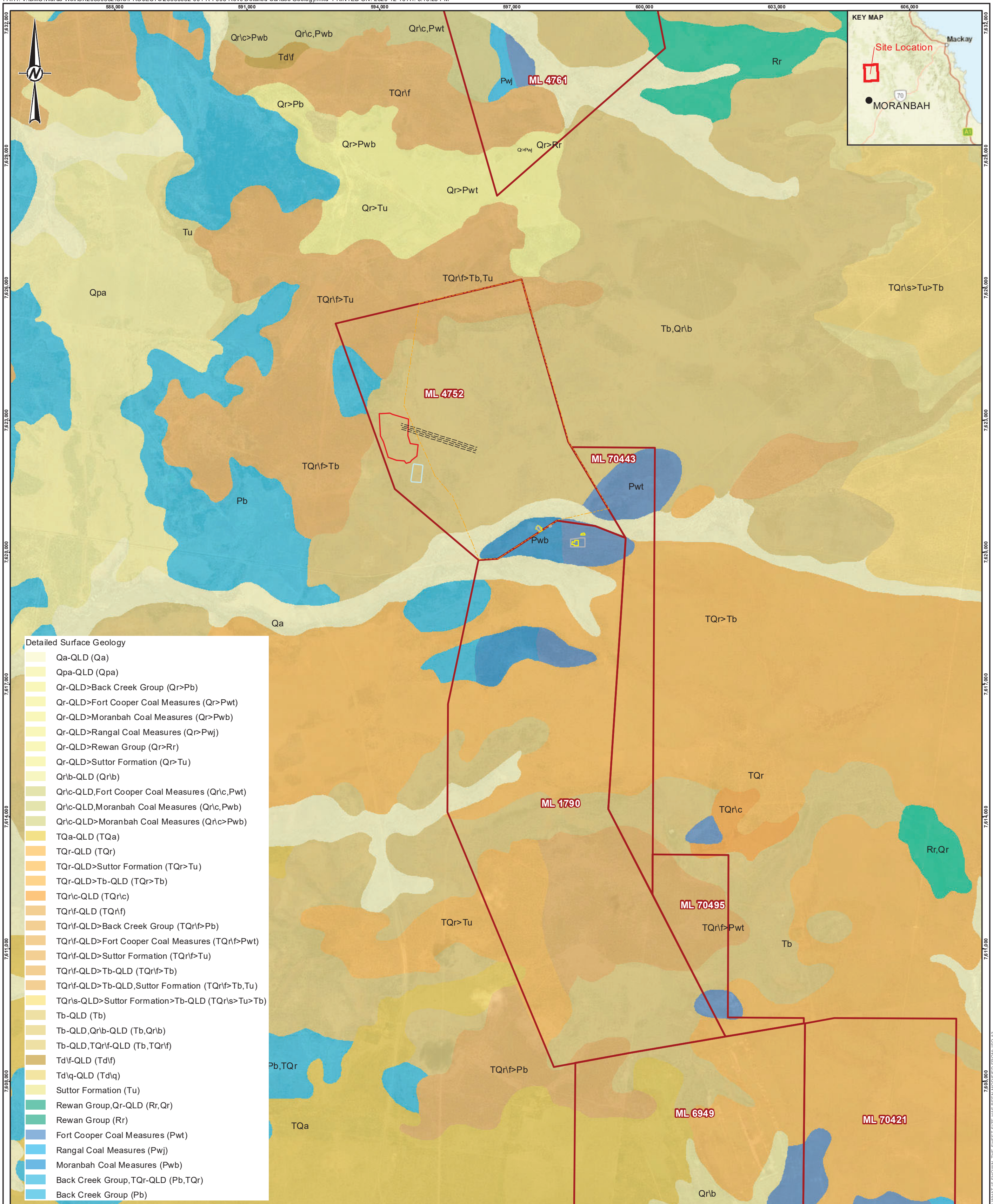

LEGEND

Wards Well EA Approved Activities

- Administrative Area
- Box Cut Area
- Industrial Area
- Seismic Investigation Area
- Storm Water Dam
- Underground Exploration
- Mining Lease Tenement

Coordinate System: GDA 1994 MGA Zone 55
Projection: Transverse Mercator
Datum: GDA 1994

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NOTE(S)
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REFERENCE(S)
1. Bowen Basin Detailed Surface Geology, Mining Lease Tenements: © State of Queensland (Department of Natural Resources, Mines and Energy) 2018 - 2020
2. Wards Well EA Approved Activities: BMC, 2020

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PROJECT
WARDS WELL MINE PROGRESSIVE REHABILITATION AND CLOSURE PLAN - HYDROGEOLOGICAL CONCEPTUAL MODEL

CONSULTANT

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TITLE
DETAILED SURFACE GEOLOGY

PROJECT NO.	CONTROL	REV.	FIGURE
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6.3 Hydrogeological Setting

Previous exploration drilling campaigns and investigative reports have been reviewed to describe the hydrogeological setting at the Wards Well Site. The following summary is derived from the Wards Well Environmental Impact Study (EIS) Groundwater Assessment (AGE, 2012), the Wards Well Water Management Opportunities Assessment Report (Golder, 2017) and the Underground Water Impact Report – For Authority to Prospect 1103 for Consultation (Arrow, 2012).

6.4 Hydrostratigraphy

Three hydro-stratigraphic units have been identified at the Wards Well site:

- Quaternary alluvium,
- Tertiary strata, and
- Permian strata.

The occurrence and continuity of these aquifers varies throughout the mining lease area. A baseline hydrogeological conceptual model (BHCM) is presented in Figure 6. The BHCM is a schematic cross section displaying the key hydrogeological system components and the main hydrogeological processes occurring at the Wards Well site. The BHCM is loosely based on the cross-section location displayed in Figure 3 . The following sections will discuss each of the aquifer systems in further detail.

6.4.1 Quaternary Alluvium

The Quaternary alluvium aquifer is composed of alluvial sediments associated with major river systems and older sediments associated with floodplains and alluvial flats. The Quaternary alluvial deposits are generally associated with Eaglefield Creek and Charlie Creek towards the north of the project area and Kennedy Creek in the south. The Quaternary alluvium is classed as a porous media aquifer where groundwater occurs within the voids between individual grain particles and is generally unconfined (Arrow, 2012).

Extensive investigations of the properties of the alluvial aquifers have not been undertaken to date. However, regional investigations of the Quaternary alluvial aquifers indicate that the aquifer thickness is typically between 15 m and 25 m and groundwater flow direction generally follows the topographic profile (Arrow, 2012).

6.4.2 Tertiary Strata

The primary source of groundwater at the Wards Well site occurs within the Tertiary strata, comprising a set of vesicular basalt flows following Tertiary palaeochannels incised into the Permian basement. The Tertiary basalt aquifer is classed as a secondary porosity aquifer, where groundwater is typically stored and transmitted through fractures, joints, and discontinuities within the rock mass (Arrow, 2012). The aquifer is compartmentalised due to the presence of low permeability sediment deposits and weathering horizons developed between basalt flows. Additionally, low permeable massive basalts in the centre of basalt flows typically separate the high permeable vesicular basalts, which develop at the top and bottom of the basalt flow (Golder, 2017). In most areas the basalt is underlain by a clay layer of variable thickness, however, in some areas the basalt is in direct connection with underlying Permian units.

Groundwater levels in the basalt aquifer typically range between 6 m and 60 m below the ground surface, with groundwater flow in the Tertiary strata (basalts and sediments) flowing from the northeast to the southwest of the project site. Groundwater quality in the basalts is mainly sodium chloride dominated water with Total Dissolved Solids (TDS) concentrations ranging between 480 and 2900 mg/L.

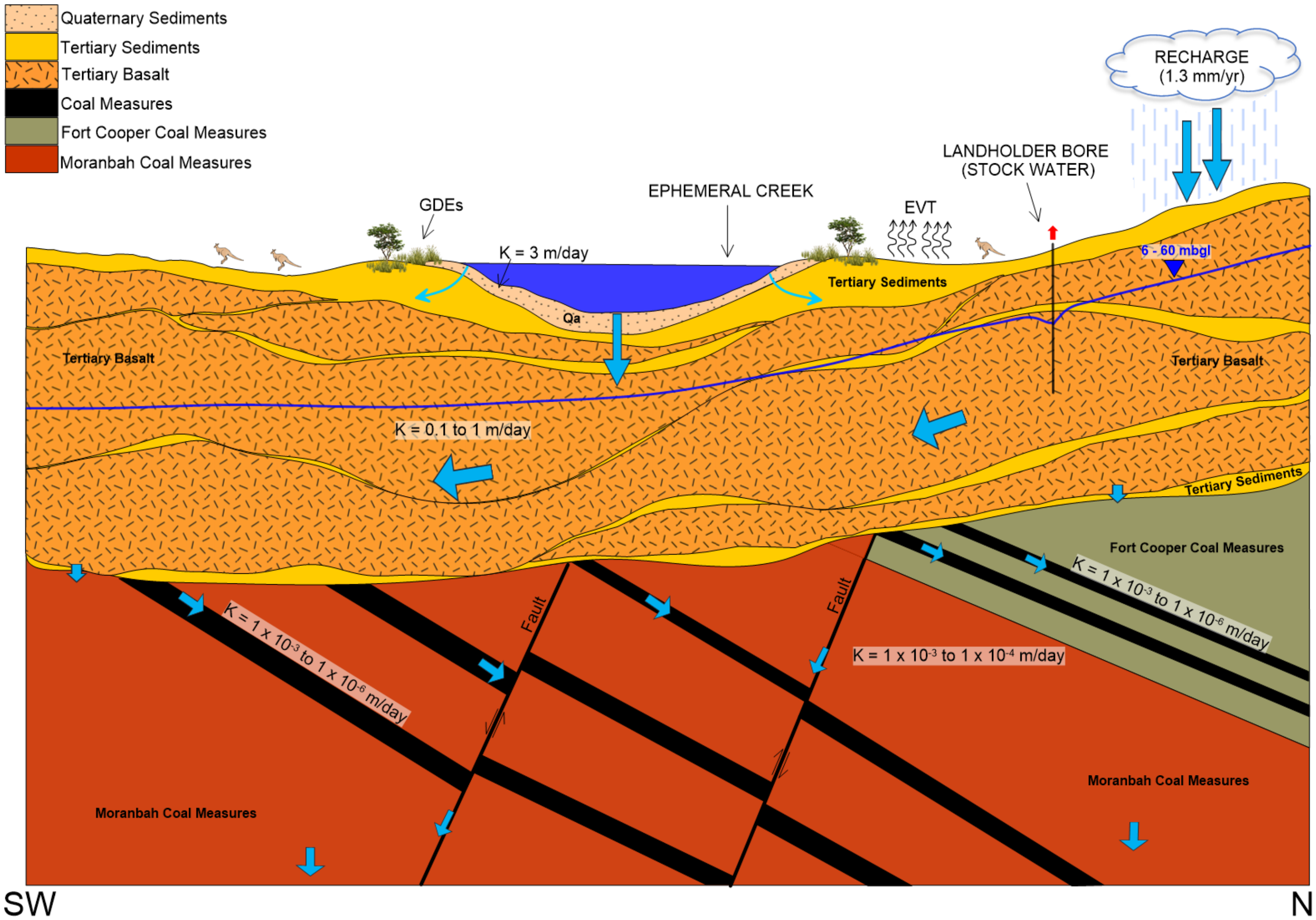


Figure 6: Baseline Hydrogeological Conceptual Model (BHCM) *Blue arrows show likely groundwater flow directions, with the size of the arrow reflecting the magnitude of groundwater flux.*

6.4.3 Permian Strata

The Permian strata generally comprises siltstone, sandstone, calcareous and carbonaceous shales and coal. Limited investigation into the hydraulic properties of the Permian strata indicate that the unit is not expected to be a significant aquifer at the project site. However, regional investigations into the hydrogeological properties of the Permian strata identified primary porosity aquifers in the sandstone units and secondary porosity aquifers in the shales, siltstones, and coal units. The secondary porosity aquifers, where water flow is primarily through fractures, joints, and discontinuities in the rock mass, are generally the most dominant. In the coal measure sequences of the Permian strata, the jointed sandstone overburden and interburden is locally important for storage and transmittal of groundwater (Arrow, 2012).

The occurrence and depth of the Permian aquifers varies depending on the depth, extent, and interconnection of fractures on a local scale and faulting on a regional scale as well as the depth and lateral extent of porous sediments. Previous investigations have indicated water levels ranging from 6.8 m to 42.1 m below the ground level (AGE, 2012). Groundwater drained from the GM seam aquifer is expected to be higher salinity than that of the Tertiary basalts (Golder, 2017).

6.5 Structural Influence on Groundwater Flow

Primary groundwater flow within and between hydrostratigraphic units is likely driven by the presence of geological structures, such as fractures, joints and faults, which have been encountered at the Wards Well site. Locations of regional fault systems located within the mine lease areas are displayed in Figure 4.

In the Tertiary strata, vesicular zones contributing to primary porosity are typically discontinuous and therefore do not provide the primary conduit for water flow. However, pore spaces within the vesicular basalt flows do provide space for groundwater storage. Therefore, groundwater is likely transmitted through fractures and contact surfaces between basalt flows (AGE, 2012).

Within the Permian strata, overburden units are generally of low permeability and may act as a confining unit to groundwater within the coal seams. The drainable porosity of the Permian units is therefore secondary in nature and primarily contributed by joints and bedding partings. Additionally, permeability is thought to be higher along thrust faults intersecting the Permian overburden rocks. Broad scale northeast, northwest and north-northwest to north trending structural zones are inferred to occur within the Permian strata across the Wards Well site by previous studies using drilling data and interpretation of geomagnetic survey data (Golder, 2017).

6.6 Hydraulic Parameters

The hydraulic properties of the three primary hydrostratigraphic units have been estimated through field testing and regional studies completed within the vicinity of the Wards Well site.

Quaternary Alluvium

Investigations of hydraulic proprieties of the Quaternary alluvium within the Wards Well mining lease have not been completed to date. However, hydraulic tests were completed by Golder (2005) in the Suttor Creek alluvium, approximately 35 km to the north of the Wards Well mining lease. The hydraulic conductivity value derived from the Suttor Creek alluvium was approximately 3 m/d (which is a representative value for the cleaner sand layers). This unit is likely similar in composition to the alluvium found at the project site, which is associated with Eaglefield, Charlie and Kennedy Creeks. As the clay content increases locally then hydraulic conductivity can be expected to decrease to values in the order of $1x10^{-1}$ to $1x10^{-3}$ m/d.

Regional studies of the alluvial sediments in the Bowen Basin indicate values of horizontal and vertical conductivity values of up to 20 m/d and 2 m/d, respectively (Arrow, 2012). These upper estimates would reflect testing in localised coarser grained sand and gravel.

Tertiary Sediments

Hydraulic conductivity values for the Tertiary sediments of the Suttor Formation have been derived from a single 100-day constant rate discharge test conducted on a sand layer encountered in Pumping Bore 03 (PB03) in 2012. The location of this pumping bore is presented in Figure 3. Hydraulic conductivity values are presented in Table 3.

Table 3: Pumping Test Data Analysis PB03 (AGE, 2012)

Test Bore	Observation Bore	Distance from Pumping Well (m)	Assumed Aquifer Thickness (m)	Analysis Method*	Calculated Transmissivity (m^2/d)	Approximate Hydraulic Conductivity (m/d)	Storage Coefficient
PB03	PB03	NA	6	1	4.2	0.7	NA
				2	4.5	0.8	NA
	MB07	16		1	2.3	0.4	0.007
				2	5	0.8	NA
	MB18R	128		1	1.9	0.3	0.00007
				2	3.7	0.6	NA
	MB18R2	146		1	2.1	0.3	0.0001
				2	4.4	0.7	NA

Note: *Analysis Method 1 refers to Cooper-Jacob. Analysis method 2 refers to Theis-Jacob Recovery.

The values derived from the pumping test at PB03 are generally in agreement with estimates for sandy sediments of the Suttor Formation found to the south in the Isaac River Palaeochannel deposits east of the Goonyella-Riverside complex. Silt and clay layers frequently observed in boreholes across the southern half of the Wards Well mining lease area are expected to have hydraulic conductivity values several orders of magnitude less but similar storage coefficients (Golder, 2017).

Tertiary Basalts

Hydraulic conductivity estimates for the Tertiary basalt aquifer were completed by Streamline Hydro in 2012. The tests comprised one 100-day constant rate discharge test conducted in Pumping Bore 01 (PB01) and one 90-day constant rate discharge test conducted in Pumping Bore 02 (PB02). The locations of the pumping bores are presented in Figure 3. PB01 was completed in an approximately 140 m thick sequence of mostly fresh basalts in the northern part of the Wards Well site. Geological and geophysical logs of bores in this area show little occurrence of sediment deposition between basalt layers. PB02 intersects approximately 75 m of slightly weathered basalts.

The test results were previously reported by AGE Consultants in 2012. A summary of test results for PB01 and PB02 is provided in Table 4.

Table 4: Pumping Test Data Analysis PB01 and PB02 (AGE, 2012)

Test Bore	Observation Bore	Distance from Pumping Well (m)	Assumed Aquifer Thickness (m)	Analysis Method*	Calculated Transmissivity (m^2/d)	Approximate Hydraulic Conductivity (m/d)	Storage Coefficient
PB01	PB01	NA	44	1	27	0.6	NA
				2	27.1	0.6	NA
	MB03	723		1	106	2.4	0.0006
				2	104	2.4	NA
	MB03A	139		1	21	0.5	0.001
				2	19.9	0.5	NA
	MB04	176		1	21.5	0.5	0.0008
				2	21.3	0.5	NA
	MB13	22		1	21.2	0.5	0.05
				2	30.4	0.7	NA
	MB14	674		1	34.1	0.8	0.0001
				2	39.2	0.9	NA
PB02	PB02	NA	41	1	0.6	0.01	NA
				2	1.4	0.03	NA
	MB05R	18		1	0.6	0.01	0.00002
				2	2.6	0.06	NA
	MB15	287		1	15.8	0.4	0.00006
				2	12.3	0.3	NA

Note: *Analysis Method 1 refers to Cooper-Jacob. Analysis method 2 refers to Theis-Jacob Recovery.

Local and regional testing of the hydraulic properties of the basalts indicate highly variable aquifer transmissivity, with values typically in the range of 20 to 100 m^2/day but with localised exceedances of 500 m^2/day (Golder, 2017). The variability in aquifer transmissivity is likely due to heterogeneity of the Tertiary strata resulting from regional geological depositional history and the intensity, size, and interconnectivity of fractures within individual basalt flows.

Permian Strata

Hydraulic properties of the Permian overburden and coal seams have been investigated at a local and regional scale. Previous Golder reports produced for the Wards Well mining lease indicate permeability of the Permian overburden rocks in the range of 1 x 10^{-3} m/day and 1 x 10^{-4} m/day (Golder, 2017).

Permeability of the coal seams within the mining lease area has been determined from packer testing conducted by SKM, reported in AGE, 2012. Packer testing was completed for coal seams between 100 m and 550 m below ground level (m bgl). Estimated permeability values range from 1 x 10^{-3} m/day to 1 x 10^{-6} m/day. The most common permeability values encountered during testing were in the range of 2 x 10^{-5} m/day and 4 x 10^{-4} m/day, which are considered relatively low in comparison to typical values for the Bowen Basin (AGE, 2012).

Hydraulic testing of Permian coal seams and overburden rocks has also been completed for nearby mine sites, including the Goonyella Broadmeadows Complex as well as the Red Hill mining lease. Interpreted hydraulic conductivity of Permian strata reported from the site and surrounding areas are summarised in Table 5.

Table 5: Hydraulic Properties of the Permian Strata

Area of Investigation	Permian Strata Investigated	Hydraulic Conductivity (m/day)	Source
GBMC+ (Goonyella No2)	GM Seam	0.003 to 0.034	URS, 2013
GBMC (Airstrip Box cut)	GL Seam	0.06 to 0.47	
GBMC (Goonyella Ramp 8)	GL Seam	0.01 to 0.1	
	Interburden	2 x 10^{-5} to 0.33	
Red Hill (EIS Study Area)	Interburden	2 x 10^{-6} to 3 x 10^{-5}	
GBMC	GU Seam	0.01	Golder, 2016
GBMC	GM Seam	0.01	
GBMC	GL Seam	0.01	
GBMC	Overburden, Interburden and Underburden	8 x 10^{-4}	
Wards Well Mining Lease	Coal Seams (undifferentiated)	0.001 to 1 x 10^{-6} #	AGE, 2012

Notes: +GBMC refers to Goonyella Broadmeadow Complex

#Hydraulic conductivity values provided by AGE (2012) cover entire range of testing depth (100 m to 550 m bgl).

Permeability values estimated for the overburden are generally lower than those of the coal seams, with overburden rocks acting as a confining unit to groundwater in the coal seams. Additionally, hydraulic conductivity in the overburden is likely higher along thrust faults, which occur throughout the Wards Well mining lease area.

Coal seam permeability values generally decrease with depth, which is likely a function of overburden pressure compressing the fractures and cleats associated with the secondary porosity features that primarily conduct groundwater movement within the coal seams.

6.7 Groundwater Level Variations

Groundwater level data was provided for site monitoring bores and VWPs by BMC. Groundwater monitoring bore and VWP locations are displayed in Figure 3. The groundwater monitoring network construction details are provided in APPENDIX A.

Groundwater level data from VWPs was available between February and May 2012. Monitoring bore data was available from select bore locations between 2017 and 2019. Groundwater level variations between 2012 and 2019 were compiled into a hydrograph, displayed in Figure 7. The hydrograph indicates that vertical hydraulic gradients are primarily downward (i.e. the basalt heads are consistently higher than the coal seam heads in similar areas), with groundwater flowing from the Quaternary and Tertiary strata into the underlying Permian strata. Minor variations in hydraulic gradients are observed in VWP 3, where there is a localised upward gradient observed in Tip 4. The location of VWP3 is likely influenced by local heterogeneity in geological units, however the exact cause of the localised upward gradient is unclear. Overall, the system displays downward vertical gradients, which have been assumed in the conceptual model.

Figure 7 shows a distinct decrease in groundwater level observed at MB13, for the period between July 2018 and July 2019. This decrease in groundwater level is unusual compared to nearby monitoring locations screened in similar strata, however, not enough information is available to determine the cause of the decrease. It may be reasonable to assume the data for MB13 is not representative of the system as a whole.

A potentiometric surface for the Tertiary aged basalt aquifer (Figure 8) has been created using BMC groundwater level data as well as data from nearby registered bores acquired from the Queensland Groundwater Database (DNRME, 2020). The water level data used to produce the potentiometric surface is a snapshot of historical water levels measured in site monitoring bores and local registered bores associated with the basalt aquifer. General flow direction in the basalts is from the northeast to the southwest of the Wards Well site.

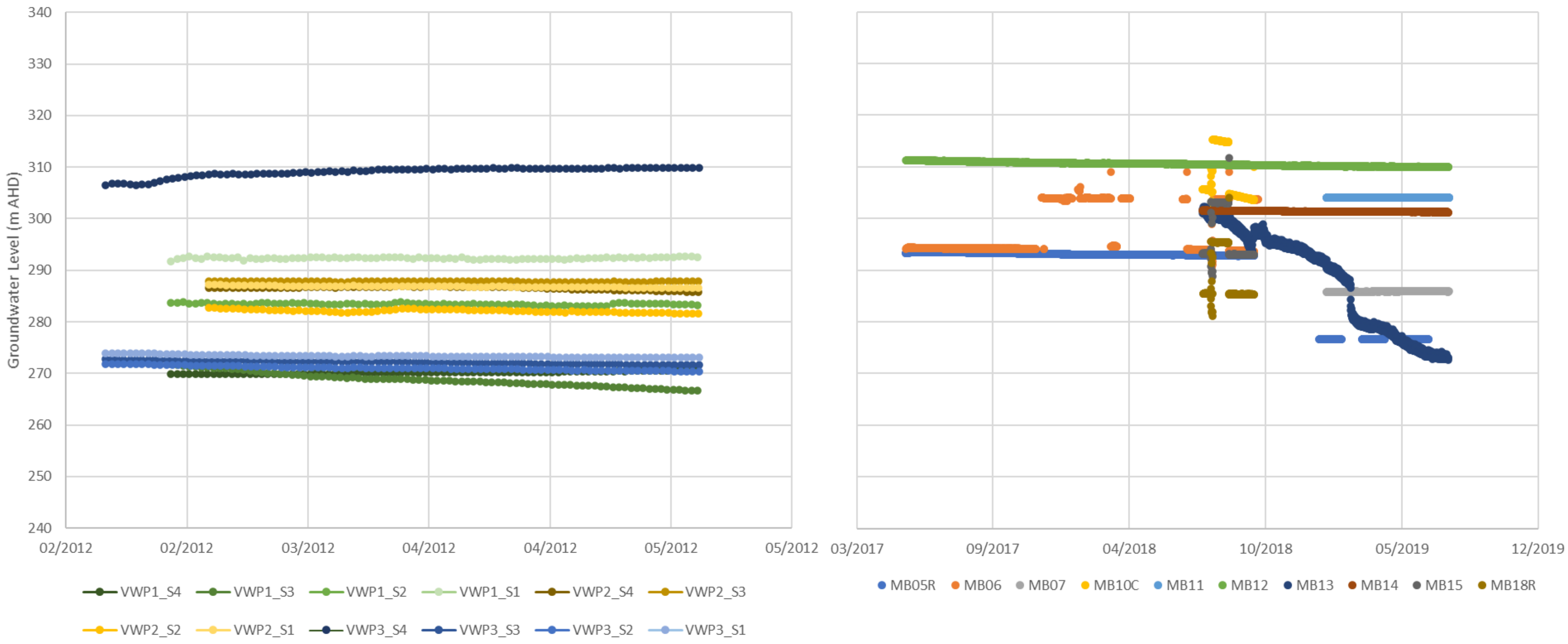
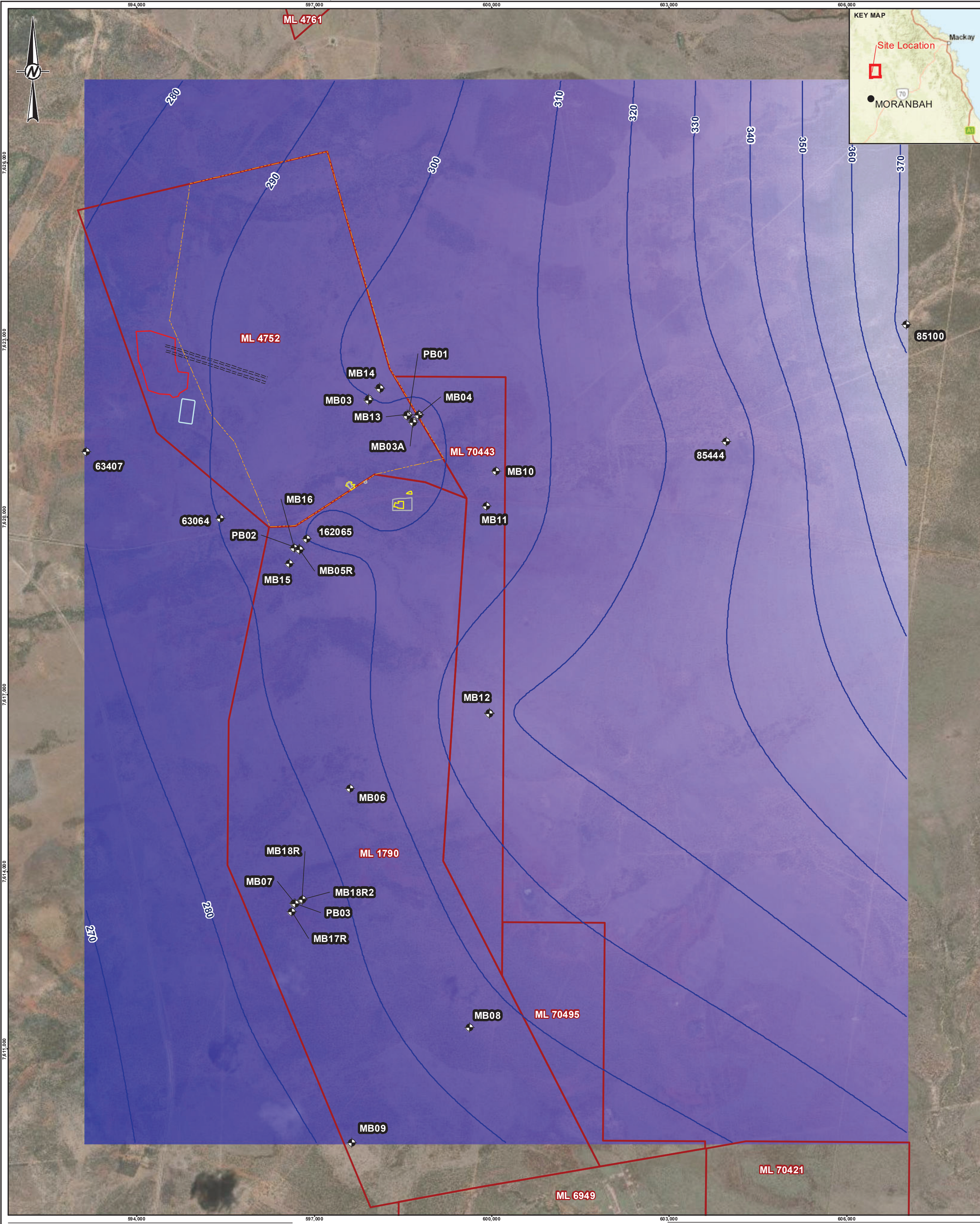


Figure 7: Groundwater Level Hydrographs. VWPs tapping Permian strata are shown on the graph to the left and monitoring bores tapping basalt and sediments shown on the right.

PATH: V:\BMC\Wards Well\CX20360562\GIS\PROJECTS\20360652-001-R-F008-Rev0 Potentiometric Surface - Tertiary1.mxd PRINTED ON: 2020-12-14 AT: 4:44:10 PM



LEGEND

- Bores used to create potentiometric surface

Wards Well EA Approved

- Administrative Area
- Box Cut Area
- Industrial Area
- Seismic Investigation Area
- Storm Water Dam
- Underground Exploration
- Groundwater Level Contour (m AHD)

- Mining Lease Tenement

Groundwater Elevation (m AHD)

High : 373

Low : 267

Coordinate System: GDA 1994 MGA Zone 55
Projection: Transverse Mercator
Datum: GDA 1994

0 500 1,000 1,500 2,000

1:60,000 @ A3 METRES

NOTE(S)

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

REFERENCE(S)

1. Queensland Groundwater Database (background data for creation of potentiometric surface): © State of Queensland (Department of Natural Resources, Mines and Energy) 2020
2. Wards Well EA Approved Activities: BMC, 2020

CLIENT

BHP BILLITON MITSUI COAL PTY LTD (BMC)

PROJECT

WARDS WELL MINE PROGRESSIVE REHABILITATION AND CLOSURE PLAN - HYDROGEOLOGICAL CONCEPTUAL MODEL

CONSULTANT

GOLDER

DD-MM-YYYY	14-12-2020
DESIGNED	HG
PREPARED	HG
REVIEWED	TRE
APPROVED	TRE

TITLE

POTENTIOMETRIC SURFACE - TERTIARY BASALT AQUIFER

PROJECT NO.	CONTROL	REV.	FIGURE
20360652	001	0	8

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ISO A3

25mm

0

6.8 Aquifer Recharge and Discharge

Recharge to the Quaternary and Tertiary sediment deposits at the Wards Well site is believed to occur only after intense storms during the wet season have provided sufficient runoff to cause flash flooding and ephemeral flow in the higher reaches of the Suttor Creek and its tributaries. Due to the compartmentalisation of basalt aquifers underlying the Wards Well site, recharge is likely to occur from rainfall infiltration in rocky outcrop areas and through vertical seepage from overlying aquifers rather than through groundwater flow from basalt aquifers of regional extent (Golder, 2017).

Recharge to the Permian strata is likely to occur through rainfall infiltration and overland flow in rock outcrop and sub-crop areas as well as from downward seepage or through flow from overlying or adjacent aquifers. Additionally, leakage between aquifers may occur through faults or other structural discontinuities in overburden and interburden sediments (Arrow, 2012).

AGE Consultants (2012) estimated a plausible range of groundwater recharge rates for the basalt aquifer within the Wards Well mining lease area using a spreadsheet method developed by CSIRO. The two methods applied for the estimation of groundwater recharge values include the following:

- Groundwater chloride mass balance (GCMB) and
- Method of last resort (MOLR)

A summary of the estimated recharge values is provided in Table 6.

Table 6: Estimated annual recharge rate for the Wards Well and Lancewood mining leases (AGE, 2012)

Parameter	GCMB	MOLR
Mean (mm/year)	1.3	1.2
Minimum (mm/year)	0.6	0.1
Maximum (mm/year)	2.3	24
Areal Recharge Estimate (m^3/year) [based on mean]	8.8	8.1

Note: GCMB – Groundwater Chloride Mass Balance method, MOLR – Method of Last Resort

Primary discharge mechanisms in the Quaternary and Tertiary strata may include evapotranspiration and throughflow into adjacent or underlying aquifers as well as groundwater extraction in areas where these aquifers are used for water supply. Discharge from the Permian strata is likely to occur through downgradient flow into Permian - Triassic strata, throughflow into adjacent aquifers (outcropping or sub-cropping coal seams) or seepage into underlying aquifers through structural discontinuities. Discharge may also occur through groundwater extraction from the Permian strata due to mining activities (such as dewatering) (Arrow, 2012).

6.9 Groundwater Quality

The Wards Well mining lease falls on the boundary between the Burdekin and Fitzroy Basins in Central Queensland. Aquifers within this region have been categorized into groundwater chemistry zones using background ranges of water quality to establish appropriate groundwater quality guidelines for the region. The majority of the project area falls within the Suttor River catchment, located in the eastern portion of the Burdekin Basin. The alluvial groundwaters associated with the Suttor River catchment are generally high salinity (up to 6,600 µS/cm) sodium chloride dominated, although fresher groundwater can be found near streams and in small sub-catchment areas. Groundwater from the Tertiary sediment aquifers in the Burdekin

Basin range from moderate to high salinity while groundwater in the underlying Eastern Bowen Coal Measures (including the FCCM and MCM) is typically of high to very high salinity (McNeil et al., 2018).

Local investigations of groundwater quality have been undertaken for the Tertiary basalts and Permian aquifers within the Wards Well mining lease. Groundwater in the basalts was found to be basically sodium chloride dominated with Total Dissolved Solids (TDS) concentrations ranging between 480 to 2900 mg/L, based on the results collected from 13 monitoring bores between 2015 and 2019. A piper plot of the data collected from this time period is provided in Figure 9.

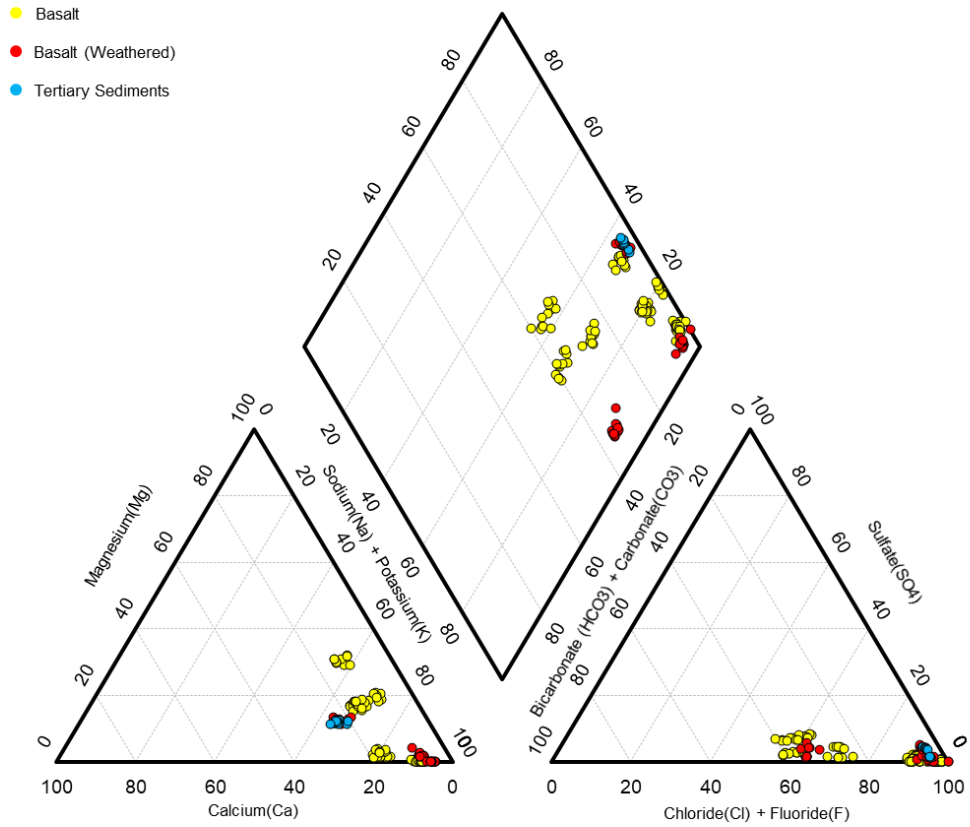


Figure 9: Piper Plot - Tertiary Basalts Water Quality

Water quality data from monitoring bores with screens installed in the coal measures are currently unavailable. However, chemistry results of grab samples collected from open exploration bores during November to December in 2011 indicate that groundwater in the coal measures is likely significantly higher in salinity when compared to samples collected in the basalt aquifer. It is noted that the grab samples were likely mixed with water partially from the coal measures and partially from the basalt aquifer (Golder, 2017).

6.10 Environmental Values

Combined environmental values associated with groundwaters within the Wards Well mining lease include the following:

- Aquatic ecosystems (Fitzroy Basin)
- Irrigation (Burdekin Basin, Fitzroy Basin)
- Farm water supply (Burdekin Basin, Fitzroy Basin)
- Stock water (Burdekin Basin, Fitzroy Basin)

- Primary Recreation (Fitzroy Basin)
- Drinking Water (Burdekin Basin, Fitzroy Basin)
- Industrial Use (Burdekin Basin, Fitzroy Basin)
- Cultural and spiritual values (Fitzroy Basin)

A study area has been established to determine the potential impacts to relevant EVs of groundwater within 10 km of the exploration box cut area. As the study area is located entirely within the Burdekin Basin, draft EVs of groundwater derived in the WQIP (NQ Dry Tropics, 2016) will apply. EVs for groundwater associated with the Fitzroy Basin WRP are outside of the 10 km buffer and are therefore not applicable.

Although aquatic ecosystems are excluded from the Burdekin Basin WQIP (NQ Dry Tropics, 2012) list of EVs associated with groundwaters, the document states the following in reference to aquatic ecosystem guidelines: "Generally these guidelines should apply to quality both of surface water and groundwater since the environmental values they protect relate to above-ground uses…An important exception is for the protection of underground aquatic ecosystems and their novel fauna…given their high conservation value the groundwater upon which they depend should be given the highest level of protection." Therefore, Groundwater Dependent Ecosystems (GDEs) have been included in the evaluation of EVs of groundwater within the vicinity of exploration activities.

EVs associated with groundwaters under the Burdekin Basin WQIP (including aquatic ecosystems as mentioned above) are described in the context of exploration activities in the following subsections.

6.10.1 Groundwater Use

A local search of groundwater users within a 10 km radius of the proposed exploration box cut was performed using the Queensland Groundwater Database (DNRME, 2020). The search discovered 25 groundwater bores within 10 km of the exploration box cut, 16 of which are classified as existing facilities. Two of these registered bores are listed as being utilised for Sub-Artesian monitoring. The role of the remaining 14 bores is unknown, however most are likely in use for stock watering purposes based on original bore names (e.g. "Pearce Dam Bore"). Aquifer data is available for 13 of the 16 existing bores. Twelve of the 13 bores are installed within the basalts or Tertiary sediments aquifer and one (1) is within the Blackwater Group.

As the primary land use within 10 km of the exploration buffer is related to grazing native vegetation, it is assumed that the registered landholder bores would be used primarily for stock water and to a lesser extent farm water supply and drinking water. Groundwater quality from site monitoring bores has been compared to ANZECC (2000) guidelines for livestock drinking water as well as ADWG (2018) for health and aesthetics. Groundwater was found to be generally suitable for use as stock watering but primarily unsuitable for drinking due to exceedances related to aesthetics guidelines. Historical groundwater samples compared to guidelines are presented in APPENDIX B. As there are no industrial or irrigated agricultural areas indicated within the buffer zone, EVs of groundwater used for industry and irrigation would not be applicable to this area.

Registered groundwater bores within 10 km of the exploration box cut are displayed in Figure 10.

6.10.2 Groundwater Dependent Ecosystems

To determine the potential impacts of mining operations on local GDEs, a search for GDEs within 10 km of the exploration box cut location was conducted using data from the GDE Atlas (BOM, 2020b). Terrestrial and aquatic GDE types were discovered within 10 km of the exploration area.

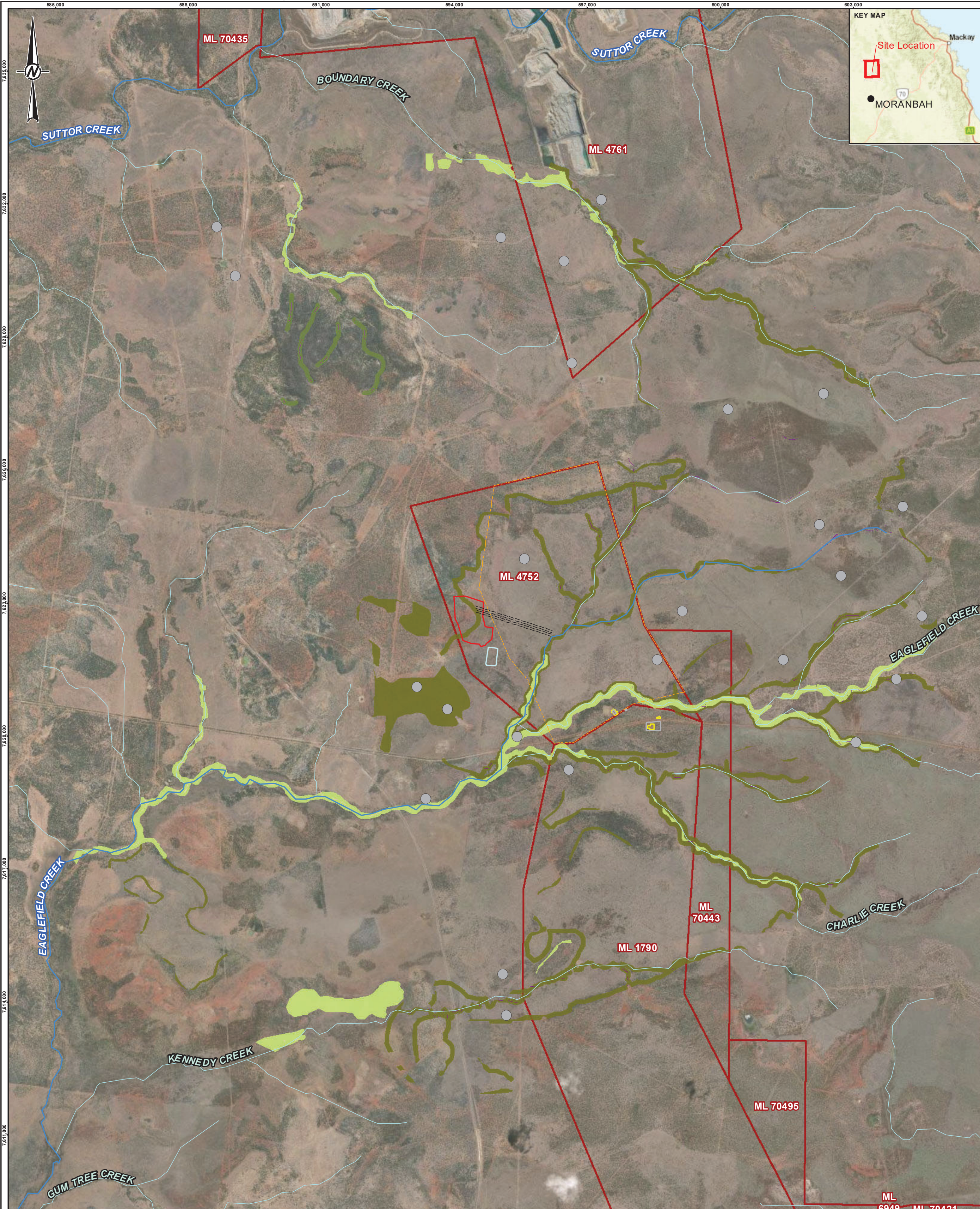
Aquatic GDEs discovered within the 10 km search radius include riverine wetlands associated with unconfined alluvial, basalt and sedimentary rock aquifers. Groundwater recharge to these systems is predominantly through local infiltration. Aquatic GDEs in this area are classified as having low to high potential for interaction with groundwater, based on regional studies.

Terrestrial GDEs discovered within the search area include riverine wetlands, vegetation, and riparian vegetation ecosystem types. Terrestrial GDEs are associated with unconfined aquifers associated with alluvia, basalt, and sedimentary rocks. Groundwater recharge to these systems is predominantly through local infiltration. Based on regional studies, Terrestrial GDEs are classed as having a low, moderate or high potential for interaction with groundwater, which identifies the likelihood of the ecosystem being dependent on a connection to groundwater.

Notably, a terrestrial GDE with high potential to rely on interacting with groundwater is directly overlying the location of the exploration box cut. The ecosystem type is described as a “treed regional ecosystem within 50 metres of the basalt plains and hills contact zone with fresh, intermittent flow” (BOM, 2020b). The Queensland State Government has mapped the riparian vegetation associated with this GDE as a non-remnant regional ecosystem, which is not associated with a threatened ecological community (The State of Qld, 2019).

The likely presence of GDEs within the vicinity of exploration activities is indicative that EVs of groundwater related to aquatic ecosystems, as prescribed in the Burdekin Basin WQIP, should be considered for the study area.

The distribution of GDEs within 10 km of the exploration box cut is displayed in Figure 10.



LEGEND

- GW Bore (Registered)

Watercourse

- Major
- Minor

Wards Well EA Approved Activities

- Administrative Area
- Box Cut Area
- Industrial Area
- Seismic Investigation Area
- Storm Water Dam
- Underground Exploration
- Mining Lease Tenement

GDE (Aquatic)

- High potential GDE - from regional studies
- Moderate potential GDE - from regional studies
- Low potential GDE - from regional studies

GDE (Terrestrial)

- High potential GDE - from regional studies
- Moderate potential GDE - from regional studies
- Low potential GDE - from regional studies

Coordinate System: GDA 1994 MGA Zone 55
Projection: Transverse Mercator
Datum: GDA 1994

0 1,000 2,000 3,000
1:80,000 @ A3 METRES

NOTE(S)

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

REFERENCE(S)

1. Groundwater Dependent Ecosystems: Burearu of Meteorology, GDE Atlas, 2020
2. Watercourses, Mining Tenements and Registered Groundwater Bores: © State of Queensland (Department of Natural Resources, Mines and Energy) 2003 - 2020
3. Wards Well EA Approved Activities: BMC, 2020

CLIENT
BHP BILLITON MITSUI COAL PTY LTD (BMC)

PROJECT
WARDS WELL MINE PROGRESSIVE REHABILITATION AND CLOSURE PLAN - HYDROGEOLOGICAL CONCEPTUAL MODEL

CONSULTANT
GOLDER

DD-MM-YYYY	16-12-2020
DESIGNED	HG
PREPARED	HG
REVIEWED	TRE
APPROVED	TRE

TITLE
GROUNDWATER DEPENDENT ECOSYSTEMS AND REGISTERED GROUNDWATER BORES WITHIN 10 KM OF EXPLORATION BOX CUT

PROJECT NO.	CONTROL	REV.	FIGURE
20360652	001	0	10

7.0 QUALITATIVE RISK ASSESSMENT

The Guideline (Department of Environment and Science, 2019) states that a Progressive Rehabilitation and Closure plan “must include a risk assessment identifying the risks of a stable condition for land not being achieved and how the applicant intends to manage or minimise the identified risks”. In addition, “the risk assessment must be carried out to identify the risks of the NUMA (non-use management area) causing environmental harm and not being safe and structurally stable and detail how the applicant intends to manage and minimise the identified risks” (126C(1)(j), EP Act).

The risk identification should involve assessment of risk source, areas of impacts, events and their causes and their potential consequences. Also, a “comprehensive list of risks based on events, which may impede, enhance, delay or accelerate the rehabilitation of a land to a stable condition or the potential for environmental harm and inability of a NUMA being safe and structurally stable”.

In order to meet these requirements Golder has developed a qualitative risk assessment of the likely impact that approved EA mining activities may have on the groundwater system. The risk assessment involves three main stages:

- Identification and defining main system elements in post mining phase.
- Development of a qualitative hydrogeological conceptual model for post-mining conditions.
- Understanding likely risks under post-mining conditions.

In theory the evolution of the mine site can be divided into several phases (Figure 11):

- Pre-mining phase – current conditions (“steady state”), Section 6.0
- Mine development transient phase – the phase in which the box cut, underground sampling tunnel and any other mine infrastructures are under development, groundwater level declines gradually as the mining activity proceeds (transient).
- Operational phase - a new “steady state” in which the natural and operating mine elements are in “equilibrium”.
- Post-mining transient phase – the box cut, underground openings are gradually backfilled, and groundwater starts to recover (transient).
- Post-closure phase – the mine site is completely closed, and a new hydrogeological “equilibrium” develops (“steady state”).

For any risk assessment it is important to define the temporal and spatial scale of investigation. In this report Golder presents the most likely post-mining scenario (Figure 11). The impact of the mine over a larger time scale (more than hundreds to thousands of years after mine closure) is not discussed and assessed in this report (see Figure 11). Also, since risk assessment time and spatial scales are in close relationship (the longer the time, the larger the scale of impact is), Golder investigated the impact only in the close vicinity of the site (within several kilometres of the site).

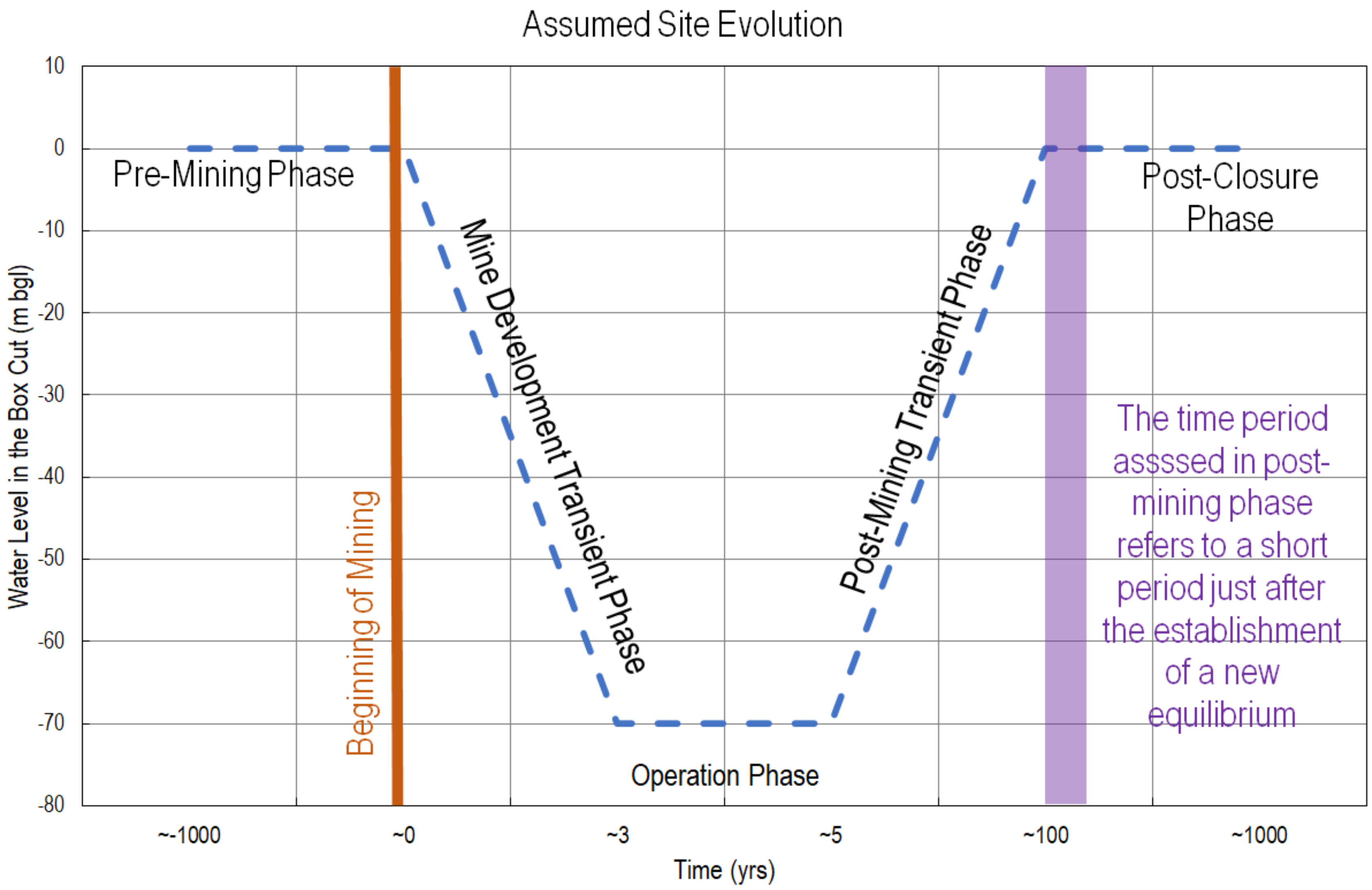


Figure 11: Assumed temporal evolution of the site (time scale is provisional). The purple rectangle shows the time period of the assessment presented in this report.

7.1 Identification of system elements

Any impact assessment is the subject of uncertainty. Uncertainty means a lack or limitation of relevant knowledge and can be grouped into the following categories:

- Uncertainties over the future states of the system studied
- Uncertainty in the models (conceptual, mathematical and numerical)
- Parameter uncertainty
- Uncertainty about human behaviour

As no residual voids will be present after site closure, and there will be no long-term/on-going chemical storage or other waste disposal at the site, a qualitative hydrogeological conceptual model is deemed to be suitable for the development of the site's PRCP. This means that a qualitative assessment should focus on the likely future state(s) of the site under post-mining conditions (first bullet point above). Since numerical model development is not warranted for the PRCP, model and parameter uncertainty are not considered in this report. Also, the most likely scenario assumes that human behaviour/activity in the study area will not undergo any changes in the near future.

Based on these assumptions Golder developed the qualitative post-mining representation on the basis of the BHCM (Baseline Hydrogeological Conceptual Model, Section 6.0, Figure 6). The workflow developed assumes the following:

- The BHCM accurately represents the dominant hydrological, geological and hydrogeological conditions under post-mining conditions away from the site, and conditions are not different from that of the pre-mining BHCM.
- The near site area includes all remaining elements (see below) of the mine in post-closure phase.
- The interaction of the mine elements and the BHCM will result in a new hydrogeological "equilibrium" condition which defines the conditions for post-mining risk assessment.

The BHCM is presented in detail in Section 6.0 and visually displayed in Figure 6.

The remaining mine infrastructure considered in the post-mining risk assessment are as follows:

- Box cut and associated backfill material.
- Underground entry and in-seam sampling, and associated backfill material.

These two elements have potential to interact with the existing hydrogeological regime during post-closure of the mine.

It is assumed that all other mine infrastructures are fully or mostly removed and decommissioned from the site, including:

- Exploration holes
- LOX line drilling
- Topsoil, overburden and ROM coal stockpile
- Water sump
- Mine and stormwater dam

- Infrastructure (industrial area, workshop, administration area, fuel and lubricant storage, lay down/maintenance area, sewage treatment area, roads and tracks)
- Accommodation area.

It is assumed that these elements present no potential to interact with the post-closure hydrogeological regime.

7.2 Post-mining hydrogeological conceptual model

The schematic representation of the recommended post-mining qualitative HCM is shown in Figure 12. The natural elements of the concept are described in Section 6.0, while the near field elements (remaining mine infrastructure) are listed in Section 7.1.

The likely main hydrogeological processes assumed on the site can be summarised as follows (Figure 12):

- The box cut material is recharged from the unsaturated zone and the basalt aquifer.
- The two sources of recharge to the box cut may mix establishing a new blended water quality. This water then moves downward according to the downward vertical hydraulic gradient.
- At the horizon of the basalt – Permian aquifer interface it is assumed that low salinity basalt water mixes with more saline Permian water resulting in a transient water quality between these two end members.
- Also, it is likely that water of Permian origin may not upwell into the basalt layers due to its higher salt concentration and density and lower hydraulic heads. It is expected that the mixing zone will remain very close to the basalt-Permian interface.
- The box cut may partially be discharged to the southwest, back into the basalt aquifer according to the local horizontal hydraulic gradient.
- A small portion of backfill water may mix with more saline Permian water and through the backfilled underground excavation. Coal seams and faults may intrude at larger depth according to the current vertical gradient. It is likely that this basalt water intrusion may locally dilute the more saline Permian groundwater.

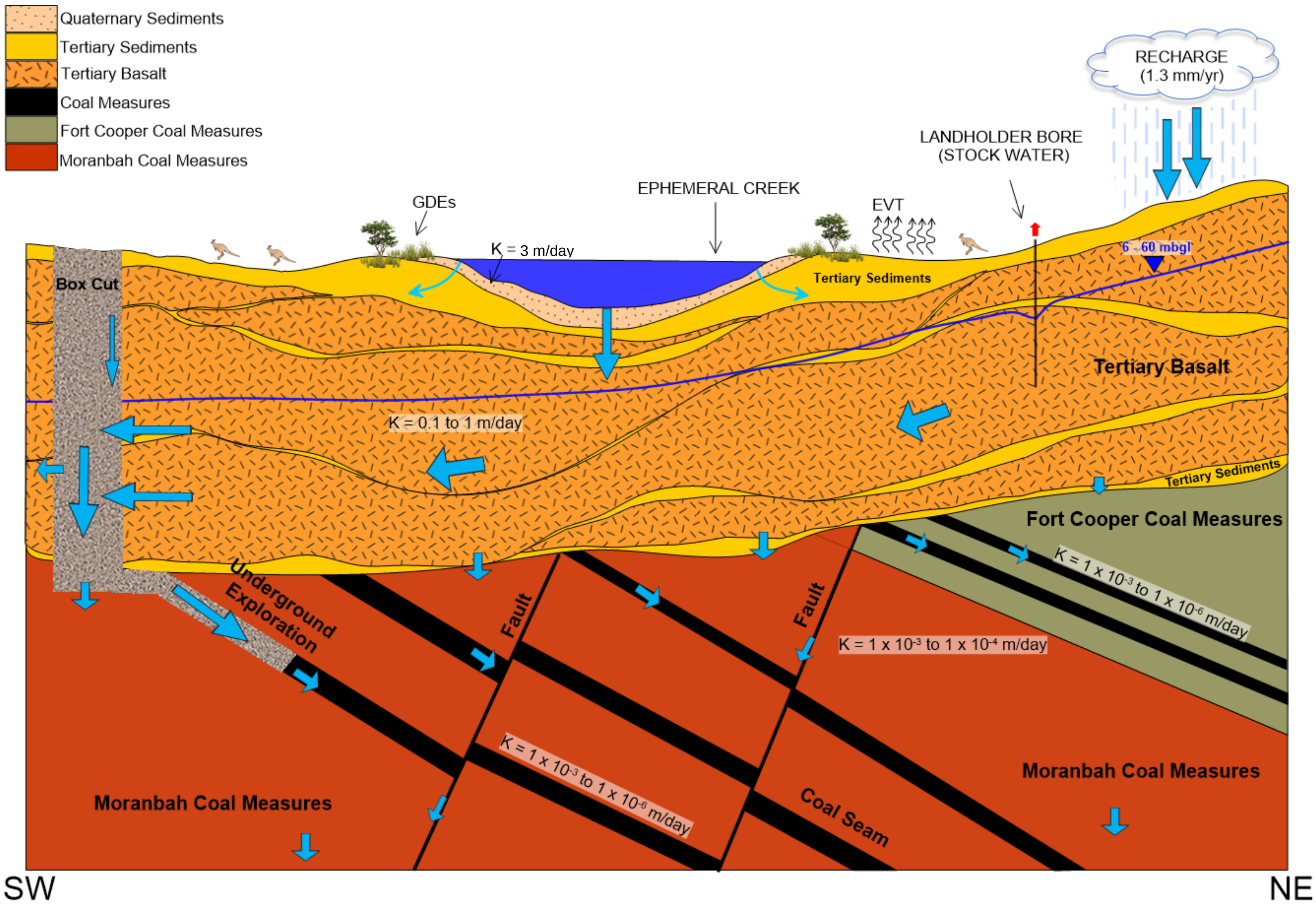


Figure 12: Qualitative hydrogeological conceptualisation of the post-mining conditions. *Blue arrows show likely groundwater flow directions, with the size of the arrow reflecting the magnitude of groundwater flux.*

7.3 Qualitative risk assessment under post-mining conditions

In any risk assessment there are two methods to assess potential pathways between source and receptors:

- Top-down approach: the pathway analysis starts with the identification of potential impacts (for instance regulatory limits) and then through pathway analysis it tries to map potential sources of impact.
- Bottom-up approach: the complete pathways are developed from the source to identify potential impacts at the receptors.

In this report the second option (bottom-up) has been selected to identify potential connected pathways and undertake exposure pathway assessment.

Based on the most likely post-mining HCM (where the hydraulic gradient in the moderate permeability backfill material returns relatively quickly to a new equilibrium as a result of recharge from the basalt) it can be assumed that the dominant direction of the hydraulic gradient will remain downward resulting in downward water flow from the basalt to the Permian formations. It is likely that the better-quality basalt groundwater will dominate the water quality in the backfill material as the much higher permeability of the basalt (see Section 6.6) will lead to higher rates of inflow. Also, any unlikely contamination caused by the operational phase of the mine will move downward through the backfill and will be highly diluted by the voluminous basaltic water. In addition, the post-mining HCM suggests that the saline, poor quality Permian waters will not move upward, closer to the surface, since the local vertical gradient directs groundwater flow downward and the Permian coal seam groundwater will remain to be of poorer quality characterised by higher salinity and density.

Also, the small footprint of the proposed operations and limited depth of the box cut (70m below ground surface) will limit the inflow of groundwater to the backfilled void and therefore will have minimal disturbance to the regional basalt groundwater levels. As the void will be backfilled it will not act as a long-term sink for the basalt aquifer. Further, the compartmentalised nature of the basalt flows will also tend to limit the spatial propagation of drawdown during operations or under the post-closure scenario. As the basalt is unconfined and readily recharged by seasonal rainfall infiltration, it is expected that any drawdown during operations will rapidly recover during the post-closure period (especially when the backfilling of the void occurs). As such no impacts on local groundwater use (registered bores in use) is expected. In addition, since the post-mining HCM indicates no change in groundwater level and groundwater quality, local groundwater dependent ecosystems are unlikely to be impacted after mine closure.

Evaluation of Risk to Environmental Values

The PRCP guideline states that the AS ISO 31000:2018 Risk Management – Guidelines (Standards Australia, 2018) must be applied for the process of risk assessment in rehabilitation planning. To meet this requirement, a risk matrix for evaluation of likelihood, consequence, and level of risk to EVs of groundwater near exploration activities has been completed. A description of relevant EVs of groundwater within 10 km of the exploration box cut are provided in Section 6.10. The adopted risk matrix used in assessing risk as a function of likelihood and consequence is presented in Figure 13. The completed risk matrix is displayed in Table 7.

		CONSEQUENCE				
		1 Minor	2 Measurable but Limited	3 Substantial	4 Serious	5 Severe
LIKELIHOOD	5 Almost Certain	Moderate 5	High 10	Extreme 15	Extreme 20	Extreme 25
	4 Likely	Moderate 4	High 8	High 12	Extreme 16	Extreme 20
	3 Possible	Low 3	Moderate 6	High 9	High 12	Extreme 15
	2 Unlikely	Low 2	Moderate 4	Moderate 6	High 8	High 10
	1 Rare	Low 1	Low 2	Low 3	Moderate 4	Moderate 5

Figure 13: Adopted risk matrix: likelihood vs. consequence

Table 7: Risk Matrix

Environmental Value	Source-Receptor Pathway	Likelihood	Consequence	Overall Risk
Aquatic Ecosystems (GDEs)	No change in groundwater level and groundwater quality is indicated in the post-mining HCM. Therefore, there is no complete pathway for degradation of GDEs due to mining or exploration activities.	1 (Rare) – No complete pathway between source (exploration activities including box cut) and receptor (GDEs) has been identified.	1 (Minor) – Any potential changes to shallow groundwater level or quality associated with GDEs would be temporary.	1 (Low)
Landholder Groundwater Use: Agriculture (Stock Water) and Farm Water Supply	As the box cut void will be backfilled, it will not act as a long-term sink for the basalt aquifer. Limited drawdown that may occur during operations will recover rapidly during the post-closure period. No complete pathway between landholder bores has been identified in the post-mining HCM.	1 (Rare) – No complete pathway between source (exploration activities including box cut) and receptor (stock and farm water supply bores) has been identified.	1 (Minor) – Groundwater systems near exploration activities will recover rapidly in post-mining conditions, after box cut is backfilled.	1 (Low)

Note: only relevant environmental values of groundwater identified in Section 6.10 have been addressed for the qualitative risk assessment.

8.0 CONCLUSIONS

Based on the knowledge gained from the baseline hydrogeological conceptual model, and considering that the small box cut void and coal sampling zones will be backfilled prior to closure, it has been assessed that there is a very low risk (contamination, water level and quality change) of the proposed operations causing any long-term permanent impacts to the basalt or Quaternary aquifer water quality or groundwater levels. The compartmentalised nature of the basalt flows will also limit the spatial propagation of drawdown during operations. Further, an exposure pathway assessment has determined that there are no complete pathways from the backfilled void to nearby groundwater users or GDEs, as current and future hydraulic gradients will remain downwards.

9.0 IMPORTANT INFORMATION

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

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APPENDIX A

Wards Well Groundwater Monitoring Network Construction Details

Bore ID	Installation Type	Coordinates*		Surface Elevation (m AHD**)	Screen Top Elevation (m AHD)	Screen Base Elevation (m AHD)	Screened Unit
		Easting	Northing				
MB03	Open Standpipe	597925.07	7621998.61	317.394	267.7	255.7	Basalt
MB03A	Open Standpipe	598676.78	7621620.44	324.198	188.2	176.2	Basalt
MB04	Open Standpipe	598774.09	7621735.12	325.76	186.8	177.8	Basalt
MB05R	Open Standpipe	596746.19	7619459.28	303.27	170.3	164.3	Basalt
MB06	Open Standpipe	597605.70	7615404.28	314.62	235.1	229.1	Basalt (weathered)
MB07	Open Standpipe	596666.66	7613468.67	311.91	248.9	242.9	Basalt
MB08	Open Standpipe	599625.26	7611360.25	335.89	267.9	264.9	Basalt
MB09	Open Standpipe	597636.22	7609408.33	323.26	274.3	271.3	Basalt
MB10	Open Standpipe	600074.08	7620779.23	320.71	218.7	203.7	Basalt
MB11	Open Standpipe	599910.19	7620190.93	319.7	204.7	198.7	Basalt
MB12	Open Standpipe	599965.54	7616688.78	322.4	291.4	288.4	Basalt
MB13	Open Standpipe	598576.56	7621731.84	325.69	198.7	180.7	Basalt (weathered)
MB14	Open Standpipe	598107.00	7622196.00	317.67	247.4	235.4	Basalt
MB15	Open Standpipe	596585.00	7619217.00	303.31	173.3	164.3	Basalt
MB16	Open Standpipe	596665.22	7619479.51	311.52	185.3	173.3	Basalt
MB17R	Open Standpipe	596622.82	7613321.01	312.67	247.7	244.7	Basalt
MB18R	Open Standpipe	596791.82	7613519.67	312.66	222.7	216.7	Tertiary Sediments (sand)
MB18R2	Open Standpipe	596807.12	7613530.89	312.68	234.7	228.7	Basalt (weathered)
PB01	Pumping Bore	598598.17	7621735.58	325.78	225.2	187.1	Basalt
PB02	Pumping Bore	596750.26	7619458.96	303.03	187.6	157.6	Basalt (weathered)
PB03	Pumping Bore	596679.15	7613457.74	311.91	236.7	230.7	Tertiary Sediments

Bore ID	Installation Type	Coordinates*		Surface Elevation (m AHD**)	Screen Top Elevation (m AHD)	Screen Base Elevation (m AHD)	Screened Unit
		Easting	Northing				
							(clayey sand)
VWP1_S1	Vibrating Wire Piezometer	596765	7619461	303.31	-9.2	-9.2	Overburden
VWP1_S2					-30.2	-30.2	Goonyella Upper 0
VWP1_S3					-142.2	-142.2	Goonyella Middle 0
VWP1_S4					-208.2	-208.2	Goonyella Lower 8
VWP2_S1	Vibrating Wire Piezometer	596658.37	7619459.05	302.98	103	102	Overburden
VWP2_S2					90	90	Goonyella Lower 8
VWP2_S3					73	73	Interburden
VWP2_S4					57.5	57.5	Goonyella Lower 10
VWP2_S1	Vibrating Wire Piezometer	596669.03	7613459.80	311.84	146.4	146.4	Interburden
VWP2_S2					105.84	105.84	Goonyella Middle 0
VWP2_S3					79.84	79.84	Goonyella Lower 3
VWP2_S4					47.84	47.84	Goonyella Lower 8

Note: *Coordinates in AGD84, Zone 55. **m AHD refers to metres Australian Height Datum

APPENDIX B

Groundwater Quality Table

Sample ID	Sampled Date Time	Heavy Metals: Aluminium	Antimony	Arsenic	Barium	Boron	Chromium	Copper	Iron	Mercury	Molybdenum	Nickel	Selenium	Silver	Uranium	Zinc	PAH: Naphthalene
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
ADWG 2018 Aesthetic								**1**	**0.3**							**3**	
ADWG 2018 Health			0.003	0.01	2	4		2		0.001	0.05	0.02	0.01	0.1	0.017		
ANZECC 2000 Livestock Drinking Water		5		0.5		5	1	0.4		0.002	0.15	1	0.02		0.2	20	
MB05R	30/05/2015	<0.05	<0.005	0.002	0.09	0.13	<0.001	0.001	<0.05	<0.0001	<0.005	0.001	<0.001	<0.005	<0.05	0.012	<0.02
MB05R	13/08/2015	<0.05	<0.005	<0.001	0.07	0.16	<0.001	0.002	<0.05	<0.0001	0.005	0.001	<0.001	<0.005	<0.005	0.022	<0.02
MB05R	26/11/2015	<0.05	<0.005	<0.001	0.06	0.14	0.009	0.003	<0.05	<0.0001	0.005	0.005	<0.001	<0.005	<0.005	0.033	<0.01
MB05R	23/03/2016	<0.05	<0.005	<0.001	0.07	0.07	<0.001	<0.001	<0.05	<0.0001	<0.005	<0.001	<0.001	<0.005	<0.005	0.037	<0.01
MB05R	7/06/2016	<0.01	<0.001	<0.001	0.075	0.16	<0.001	<0.001	<0.05	<0.0001	0.005	<0.001	<0.01	<0.001	<0.001	0.008	<0.005
MB05R	13/09/2016	0.07	<0.005	<0.001	0.07	0.14	<0.001	<0.001	<0.05	<0.0001	<0.005	0.002	<0.001	<0.005	<0.005	0.005	<0.01
MB05R	2/11/2016	<0.01	<0.001	<0.001	0.123	0.14	<0.001	<0.001	<0.05	<0.0001	0.004	0.001	<0.01	<0.001	<0.001	0.016	<0.1
MB05R	14/02/2017	0.01	<0.001	<0.001	0.071	0.15	<0.001	<0.001	<0.05	<0.0001	0.006	0.001	<0.01	<0.001	<0.001	0.005	<0.1
MB05R	16/05/2017	<0.01	<0.001	<0.001	0.075	0.17	<0.001	<0.001	<0.05	<0.0001	0.005	<0.001	<0.01	<0.001	<0.001	<0.005	<0.1
MB05R	20/04/2018	<0.01	<0.001	<0.001	-	-	-	-	0.14	<0.0001	0.005	-	<0.01	<0.001	-	-	<0.1
MB05R	26/07/2018	<0.01	0.002	0.001	-	-	-	-	0.05	<0.0001	0.006	-	<0.01	<0.001	-	-	<0.1
MB05R	25/01/2019	<0.01	<0.001	<0.001	-	-	-	-	0.06	<0.0001	0.006	-	<0.01	<0.001	-	-	<5
MB05R	22/07/2019	<0.01	<0.001	<0.001	-	-	-	-	<0.05	<0.0001	0.006	-	<0.01	<0.001	-	-	<5
MB06	28/05/2015	<0.05	<0.005	<0.001	<0.02	<0.05	0.001	0.004	<0.05	<0.0001	<0.005	<0.001	<0.001	<0.005	<0.05	0.013	<0.02
MB06	12/08/2015	<0.05	<0.005	<0.001	<0.02	0.05	<0.001	0.001	<0.05	<0.0001	<0.005	<0.001	<0.001	<0.005	<0.005	0.006	<0.02
MB06	25/11/2015	<0.05	<0.005	<0.001	<0.02	<0.05	0.006	0.008	<0.05	<0.0001	<0.005	0.004	<0.001	<0.005	<0.005	0.016	<0.01
MB06	24/03/2016	<0.05	<0.005	<0.001	<0.02	<0.05	<0.001	0.002	<0.05	<0.0001	<0.005	<0.001	<0.001	<0.005	<0.005	0.023	<0.01
MB06	8/06/2016	0.01	<0.001	<0.001	0.004	<0.05	<0.001	0.001	<0.05	<0.0001	0.002	<0.001	<0.01	<0.001	<0.001	0.007	<0.005
MB06	15/09/2016	0.37	<0.005	<0.001	<0.02	<0.05	<0.001	<0.001	<0.05	<0.0001	<0.005	<0.001	<0.001	<0.005	<0.005	0.01	<0.01
MB06	3/11/2016	<0.01	<0.001	<0.001	0.004	<0.05	<0.001	<0.001	<0.05	<0.0001	0.002	<0.001	<0.01	<0.001	<0.001	0.009	<0.1
MB06	17/05/2017	0.02	<0.001	<0.001	0.013	<0.05	<0.001	<0.001	<0.05	<0.0001	0.002	<0.001	<0.01	<0.001	<0.001	<0.005	<0.1
MB06	20/04/2018	0.01	<0.001	<0.001	-	-	-	-	<0.05	<0.0001	0.002	-	<0.01	<0.001	-	-	<0.1
MB06	27/06/2018	<0.01	<0.001	<0.001	-	-	-	-	<0.05	<0.0001	0.002	-	<0.01	<0.001	-	-	<0.1
MB06	25/01/2019	0.02	<0.001	<0.001	-	-	-	-	<0.05	<0.0001	0.002	-	<0.01	<0.001	-	-	<5
MB06	22/07/2019	<0.01	<0.001	<0.001	-	-	-	-	<0.05	<0.0001	0.002	-	<0.01	<0.001	-	-	<5
MB07	28/05/2015	<0.05	<0.005	0.001	<0.02	0.39	<0.001	0.011	<0.05	<0.0001	<0.005	0.002	<0.001	<0.005	<0.05	0.06	<0.02
MB07	11/08/2015	<0.05	<0.005	<0.001	<0.02	0.51	<0.001	0.006	<0.05	<0.0001	<0.005	0.001	<0.001	<0.005	<0.005	0.048	<0.02
MB07	24/11/2015	<0.05	<0.005	<0.001	<0.02	0.48	0.008	0.001	<0.05	<0.0001	<0.005	0.004	<0.001	<0.005	<0.005	0.005	<0.01
MB07	23/03/2016	<0.05	<0.005	<0.001	<0.02	0.36	<0.001	0.004	<0.05	<0.0001	<0.005	<0.001	<0.001	<0.005	<0.005	0.099	<0.01
MB07	8/06/2016	<0.01	<0.001	<0.001	0.006	0.42	<0.001	0.003	<0.05	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	0.035	<0.005
MB07	15/09/2016	<0.05	<0.005	<0.001	<0.02	0.36	<0.001	0.002	<0.05	<0.0001	<0.005	<0.001	<0.001	<0.005	<0.005	0.029	<0.01
MB07	2/11/2016	<0.01	<0.001	<0.001	0.02	0.37	<0.001	0.005	<0.05	<0.0001	<0.001	<0.001	<0.01	0.004	<0.001	0.033	<0.1
MB07	17/05/2017	<0.01	<0.001	<0.001	0.008	0.41	<0.001	0.002	<0.05	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	0.026	<0.1
MB07	21/04/2018	<0.01	<0.001	<0.001	-	-	-	-	<0.05	<0.0001	<0.001	-	<0.01	<0.001	-	-	<0.1
MB07	27/07/2018	<0.01	<0.001	<0.001	-	-	-	-	<0.05	<0.0001	<0.001	-	<0.01	<0.001	-	-	<0.1
MB07	24/01/2019	<0.01	<0.001	<0.001	-	-	-	-	<0.05	<0.0001	<0.001	-	<0.01	0.001	-	-	<5
MB07	23/07/2019	0.04	<0.001	<0.001	-	-	-	-	<0.05	<0.0001	<0.001	-	<0.01	<0.001	-	-	<5
MB08	28/05/2015	<0.05	<0.005	<0.001	0.14	0.71	<0.001	0.001	0.08	<0.0001	<0.005	<0.001	<0.001	<0.005	<0.05	0.008	<0.02
MB08	12/08/2015	<0.05	<0.005	<0.001	0.14	0.91	<0.001	0.003	0.19	<0.0001	<0.005	0.001	<0.001	<0.005	<0.005	0.014	<0.02
MB08	25/11/2015	<0.05	<0.005	<0.001	0.14	0.71	0.009	0.007	0.06	<0.0001	<0.005	0.007	<0.001	<0.005	<0.005	0.039	<0.01
MB08	23/03/2016	<0.05	<0.005	<0.001	0.13	0.72	<0.001	0.002	0.23	<0.0001	<0.005	0.004	<0.001	<0.005	<0.005	0.056	<0.01
MB08	8/06/2016	<0.01	<0.001	<0.001	0.074	0.95	<0.001	0.008	<0.05	<0.0001	<0.001	0.001	<0.01	<0.001	0.006	0.043	<0.005
MB08	14/09/2016	0.08	<0.005	<0.001	0.15	0.69	<0.001	<0.001	<0.05	<0.0001	<0.005	<0.001	<0.001	<0.005	<0.005	0.003	<0.01
MB08	2/11/2016	<0.01	<0.001	<0.001	0.15	0.73	<0.001	0.002	0.08	<0.0001	<0.001	<0.001	<0.01	0.001	<0.001	0.012	<0.1
MB08	17/05/2017	<0.01	<0.001	<0.001	0.159	0.75	<0.001	0.001	0.18	<0.0001	0.001	<0.001	<0.01	<0.001	<0.001	0.008	<0.1
MB08	21/04/2018	<0.01	<0.001	<0.001	-	-	-	-	<0.05	<0.0001	<0.001	-	<0.01	<0.001	-	-	<0.1
MB08	27/07/2018	<0.01	<0.001	<0.001	-	-	-	-	<0.05	<0.0001	<0.001	-	<0.01	<0.001	-	-	<0.1
MB08	24/01/2019	<0.01	<0.001	<0.001	-	-	-	-	<0.05	<0.0001	<0.001	-	<0.01	<0.001	-	-	<5
MB08	23/07/2019	<0.01	<0.001	<0.001	-	-	-	-	<0.05	<0.0001	<0.001	-	<0.01	<0.001	-	-	<5
MB09	29/05/2015	<0.05	<0.005	<0.001	0.07	0.87	0.003	0.003	<0.05	<0.0001	<0.005	0.005	<0.001	<0.005	<0.05	0.026	<0.02
MB09	12/08/2015	<0.05	<0.005	<0.001	0.08	1.1	0.003	0.001	<0.05	<0.0001	<0.005	0.004	<0.001	<0.005	0.006	0.015	<0.02
MB09	25/11/2015	<0.05	<0.005	<0.001	0.08	1	0.009	0.002	<0.05	<0.0001	<0.005	0.006	<0.001	<0.005	0.005	0.013	<0.01
MB09	23/03/2016	<0.05	<0.005	<0.001	0.05	0.95	<0.001	<0.001	<0.05	<0.0001	<0.005	0.008	<0.001	<0.005	<0.005	<0.001	<0.01
MB09	8/06/2016	<0.01	<0.001	<0.001	0.146	0.76	<0.001	0.002	0.06	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	0.01	<0.005
MB09	14/09/2016	<0.05	<0.005	<0.001	0.06	0.93	<0.001	0.003	<0.05	<0.0001	<0.005	0.003	<0.001	<0.005	0.005	0.01	<0.01
MB09	2/11/2016	<0.01	<0.001	<0.001	0.082	0.93	<0.001	0.005	<0.05	<0.0001	<0.001	0.002	<0.01	<0.001	0.006	0.023	<0.1
MB09	17/05/2017	<0.01	<0.001	<0.001	0.08	0.96	<0.001	0.013	<0.05	<0.0001	<0.001	0.001	<0.01	<0.001	0.006	0.039	<0.1
MB09	21/04/2018	<0.01	<0.001	<0.001	-	-	-	-	<0.05	<0.0001	<0.001	-	<0.01	<0.001	-	-	<0.1
MB09	27/07/2018	<0.01	<0.001	<0.001	-	-	-	-	<0.05	<0.0001	<0.001	-	<0.01	<0.001	-	-	<0.1
MB09	24/01/2019	0.03	<0.001	<0.001	-	-	-	-	<0.05	<0.0001	<0.001	-	<0.01	<0.001	-	-	<5
MB09	23/07/2019	<0.01	<0.001	<0.001	-	-	-	-	<0.05	<0.0001	<0.001	-	<0.01	<0.001	-	-	<5

Sample ID	Sampled Date Time	Sample Quality Parameters: Electrical Conductivity @ 25°C	pH (Lab)	Total Dissolved Solids @180°C (Filtered)	Sodium	Potassium	Calcium	Magnesium	Chloride	Sulfate as SO4 - Turbidimetric	Sulphate (as SO4)	Bicarbonate Alkalinity (as CaCO3)	Carbonate Alkalinity (as CaCO3)	Hydroxide Alkalinity (as CaCO3)	Total Alkalinity (as CaCO3)	Total Suspended Solids
		uS/cm	pH_Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
ADWG 2018 Aesthetic			**6.5-8.5**	**600**	**180**				**250**		**250**					
ADWG 2018 Health																
ANZECC 2000 Livestock Drinking Water							1000				1000					
MB05R	30/05/2015	1900	7.9	**1000**	**290**	2.9	45	3	**520**	<5	<5	89	<10	<10	89	3.6
MB05R	13/08/2015	2100	8.1	**1100**	**300**	3.6	56	4.4	**560**	5.9	5.9	91	<10	<10	91	<1
MB05R	26/11/2015	2100	7.8	**1400**	**300**	3.2	59	4.2	**540**	6.8	6.8	91	<10	<10	91	2.6
MB05R	23/03/2016	2000	7.9	**1200**	**320**	3.3	68	5	**560**	6.5	6.5	90	<10	<10	90	11
MB05R	7/06/2016	2110	7.92	**1180**	**347**	4	67	5	**631**	20	20	84	<1	<1	84	8
MB05R	13/09/2016	2100	8.2	**1200**	**310**	6.2	64	5.1	**530**	6.5	6.5	100	<10	<10	100	250
MB05R	2/11/2016	1970	7.61	**1270**	**337**	3	62	5	**625**	19	19	92	<1	<1	92	<5
MB05R	14/02/2017	2070	7.52	**1200**	**343**	3	59	5	**614**	21	21	83	<1	<1	83	770
MB05R	16/05/2017	2160	7.8	**1290**	**354**	3	61	5	**599**	21	21	89	<1	<1	89	465
MB05R	20/04/2018	2030	7.69	**1210**	**350**	4	58	5	**612**	19	19	83	<1	<1	83	6
MB05R	26/07/2018	2100	7.86	**1220**	**338**	3	65	5	**663**	20	20	82	<1	<1	82	9
MB05R	25/01/2019	2010	7.75	**1190**	**310**	3	59	5	**652**	19	19	87	<1	<1	87	<5
MB05R	22/07/2019	2140	7.92	**1310**	**328**	3	63	5	**659**	20	20	91	<1	<1	91	<5
MB06	28/05/2015	960	**8.5**	500	170	1.6	12	1.5	190	6	6	180	<10	<10	190	1.6
MB06	12/08/2015	900	8.4	490	**180**	2	11	1.6	190	6.3	6.3	180	<10	<10	180	7.2
MB06	25/11/2015	980	8.2	490	170	1.7	12	1.5	200	6	6	190	<10	<10	190	6.4
MB06	24/03/2016	970	**8.5**	480	**180**	2	13	2.2	190	6.1	6.1	180	<10	<10	190	15
MB06	8/06/2016	1000	8.47	556	**197**	2	13	3	212	19	19	156	17	<1	173	<5
MB06	15/09/2016	980	8.4	510	**180**	1.8	13	2	190	6.5	6.5	180	<10	<10	190	<1
MB06	3/11/2016	1050	8.38	**606**	**200**	2	16	5	246	18	18	169	14	<1	182	<5
MB06	17/05/2017	1000	8.37	552	**200**	2	12	2	195	19	19	177	3	<1	180	<5
MB06	20/04/2018	946	8.33	559	**198**	2	12	2	194	19	19	167	5	<1	172	<5
MB06	27/06/2018	963	8.46	547	**187**	2	12	2	208	19	19	161	14	<1	175	<5
MB06	25/01/2019	959	8.36	536	**180**	2	12	3	212	27	27	171	12	<1	183	<5
MB06	22/07/2019	982	8.46	518	**184**	2	11	2	209	19	19	187	10	<1	197	<5
MB07	28/05/2015	3100	7.8	**1800**	**390**	7.3	89	47	**920**	<5	<5	120	<10	<10	120	3.1
MB07	11/08/2015	2800	8.1	**2000**	**390**	7.9	89	52	**920**	<5	<5	120	<10	<10	120	4.8
MB07	24/11/2015	3100	7.8	**2100**	**380**	7.4	88	52	**900**	<5	<5	120	<10	<10	120	4.2
MB07	23/03/2016	3000	8.1	**2000**	**400**	5.7	92	54	**880**	<5	<5	120	<10	<10	120	6.6
MB07	8/06/2016	3120	8.11	**1770**	**427**	7	89	55	**940**	10	10	112	<1	<1	112	9
MB07	15/09/2016	3000	8.1	**1800**	**380**	8.8	89	53	**710**	<5	<5	130	<10	<10	130	13
MB07	2/11/2016	2900	7.98	**1870**	**420**	7	90	55	**956**	11	11	120	<1	<1	120	10
MB07	17/05/2017	3160	7.94	**2000**	**457**	7	88	55	**898**	9	9	116	<1	<1	116	<5
MB07	21/04/2018	2920	7.68	**1780**	**430**	8	80	56	**868**	9	9	112	<1	<1	112	<5
MB07	27/07/2018	2980	7.88	**1670**	**410**	8	91	56	**952**	9	9	113	<1	<1	113	11
MB07	24/01/2019	3020	7.88	**1780**	**409**	8	82	57	**940**	17	17	178	<1	<1	178	<5
MB07	23/07/2019	3100	8.01	**1840**	**394**	7	86	51	**964**	8	8	124	<1	<1	124	6
MB08	28/05/2015	2900	8.1	**1600**	**420**	10	49	57	**680**	18	18	440	<10	<10	440	2.8
MB08	12/08/2015	2600	**8.5**	**1600**	**420**	10	47	62	**690**	18	18	400	24	<10	420	2.9
MB08	25/11/2015	3100	8.1	**1700**	**430**	9.7	65	61	**730**	20	20	390	<10	<10	390	30
MB08	23/03/2016	2800	8.2	**1500**	**390**	7.7	44	59	**680**	16	16	420	<10	<10	420	6.4
MB08	8/06/2016	3560	8.28	**1970**	**486**	6	107	140	**768**	137	137	651	<1	<1	651	17
MB08	14/09/2016	2900	8.4	**1600**	**440**	13	50	70	**580**	19	19	410	10	<10	420	4.8
MB08	2/11/2016	2710	8.32	**1610**	**458**	10	52	68	**730**	58	58	428	12	<1	440	10
MB08	17/05/2017	3000	8.47	**1650**	**494**	11	51	69	**705**	64	64	396	36	<1	432	10
MB08	21/04/2018	2920	8.06	**1660**	**483**	12	48	74	**700**	63	63	426	<1	<1	426	18
MB08	27/07/2018	2940	8.38	**1660**	**456**	12	55	72	**745**	65	65	433	15	<1	448	8
MB08	24/01/2019	2940	8.11	**1630**	**430**	11	52	66	**763**	56	56	447	<1	<1	447	<5
MB08	23/07/2019	3030	8.13	**1660**	**452**	11	54	67	**752**	66	66	483	<1	<1	483	12
MB09	29/05/2015	3600	7.9	**2000**	**460**	6.6	77	120	**760**	46	46	740	<10	<10	740	64
MB09	12/08/2015	3200	8.4	**2100**	**520**	8.1	96	150	**750**	46	46	720	32	<10	750	14
MB09	25/11/2015	3700	7.9	**2200**	**430**	5.7	100	130	**720**	46	46	860	<10	<10	860	5.9
MB09	23/03/2016	3500	8.1	**2100**	**440**	7	72	130	**740**	47	47	770	<10	<10	770	30
MB09	8/06/2016	2930	8.46	**1560**	**451**	11	53	66	**726**	55	55	358	31	<1	389	17
MB09	14/09/2016	3600	8.2	**2100**	**500**	8.9	81	150	**650**	48	48	710	<10	<10	710	2.1
MB09	2/11/2016	3280	8.13	**2110**	**495**	6	98	141	**789**	138	138	731	<1	<1	731	<5
MB09	17/05/2017	3500	8.36	**2050**	**530**	6	103	142	**743**	142	142	594	26	<1	620	6
MB09	21/04/2018	3570	8.04	**2060**	**507**	7	99	147	**753**	141	141	743	<1	<1	743	6
MB09	27/07/2018	3550	8.12	**2000**	**488**	6	113	146	**805**	132	132	725	<1	<1	725	7
MB09	24/01/2019	3570	8.02	**1960**	**465**	6	106	133	**815**	140	140	737	<1	<1	737	24
MB09	23/07/2019	3730	7.51	**2070**	**472**	6	108	134	**796**	138	138	857	<1	<1	857	16

Sample ID	Sampled Date Time	Total Petroleum Hydrocarbons: TRH C6 - C9 Fraction	TRH C10 - C14 Fraction	TRH C15 - C28 Fraction	TRH C29 - C36 Fraction	TRH+C10 - C36 (Sum of total) (Lab Reported)	TRH C6 - C10 Fraction F1	TRH C6 - C10 Fraction Less BTEX F1	TRH >C10 - C16 Fraction F2	TRH >C10 - C16 Fraction Less Naphthalene F2	TRH >C16 - C34 Fraction F3	TRH >C34 - C40 Fraction F4
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
ADWG 2018 Aesthetic												
ADWG 2018 Health												
ANZECC 2000 Livestock Drinking Water												
MB05R	30/05/2015	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB05R	13/08/2015	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB05R	26/11/2015	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB05R	23/03/2016	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB05R	7/06/2016	<0.02	<0.05	<0.1	<0.05	<0.05	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB05R	13/09/2016	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB05R	2/11/2016	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB05R	14/02/2017	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB05R	16/05/2017	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB05R	20/04/2018	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB05R	26/07/2018	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB05R	25/01/2019	<20	<50	<100	<50	<50	<20	<20	<100	<100	<100	<100
MB05R	22/07/2019	<20	<50	<100	<50	<50	<20	<20	<100	<100	<100	<100
MB06	28/05/2015	0.04	<0.05	<0.1	<0.1	<0.1	0.04	0.02	<0.05	<0.05	<0.1	<0.1
MB06	12/08/2015	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB06	25/11/2015	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB06	24/03/2016	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB06	8/06/2016	<0.02	<0.05	<0.1	<0.05	<0.05	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB06	15/09/2016	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB06	3/11/2016	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB06	17/05/2017	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB06	20/04/2018	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB06	27/06/2018	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB06	25/01/2019	<20	<50	<100	<50	<50	<20	<20	<100	<100	<100	<100
MB06	22/07/2019	<20	<50	<100	<50	<50	<20	<20	<100	<100	<100	<100
MB07	28/05/2015	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB07	11/08/2015	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB07	24/11/2015	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB07	23/03/2016	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB07	8/06/2016	<0.02	<0.05	<0.1	<0.05	<0.05	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB07	15/09/2016	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB07	2/11/2016	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB07	17/05/2017	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB07	21/04/2018	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB07	27/07/2018	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB07	24/01/2019	<20	370	<100	<50	370	<20	<20	380	380	<100	<100
MB07	23/07/2019	<20	<50	<100	<50	<50	<20	<20	<100	<100	<100	<100
MB08	28/05/2015	<0.02	<0.05	<0.1	<0.1	<0.1	0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB08	12/08/2015	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB08	25/11/2015	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB08	23/03/2016	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB08	8/06/2016	<0.02	<0.05	<0.1	<0.05	<0.05	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB08	14/09/2016	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB08	2/11/2016	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB08	17/05/2017	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB08	21/04/2018	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB08	27/07/2018	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB08	24/01/2019	<20	<50	<100	<50	<50	<20	<20	<100	<100	<100	<100
MB08	23/07/2019	<20	<50	<100	<50	<50	<20	<20	<100	<100	<100	<100
MB09	29/05/2015	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB09	12/08/2015	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB09	25/11/2015	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB09	23/03/2016	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB09	8/06/2016	<0.02	<0.05	<0.1	<0.05	<0.05	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB09	14/09/2016	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB09	2/11/2016	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB09	17/05/2017	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB09	21/04/2018	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB09	27/07/2018	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB09	24/01/2019	<20	<50	<100	<50	<50	<20	<20	<100	<100	<100	<100
MB09	23/07/2019	<20	<50	<100	<50	<50	<20	<20	<100	<100	<100	<100

Sample ID	Sampled Date Time	Heavy Metals															PAH
		Aluminium	Antimony	Arsenic	Barium	Boron	Chromium	Copper	Iron	Mercury	Molybdenum	Nickel	Selenium	Silver	Uranium	Zinc	Naphthalene
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
ADWG 2018 Aesthetic								**1**	**0.3**							**3**	
ADWG 2018 Health			0.003	0.01	2	4		2		0.001	0.05	0.02	0.01	0.1	0.017		
ANZECC 2000 Livestock Drinking Water		5		0.5		5	1	0.4		0.002	0.15	1	0.02		0.2	20	
MB10	29/05/2015	<0.05	<0.005	<0.001	<0.02	<0.05	<0.001	0.001	<0.05	<0.0001	<0.005	0.001	<0.001	<0.005	<0.05	0.007	<0.02
MB10	13/08/2015	<0.05	<0.005	<0.001	<0.02	0.07	<0.001	<0.001	<0.05	<0.0001	<0.005	<0.001	<0.001	<0.005	<0.005	0.005	<0.02
MB10	25/11/2015	<0.05	<0.005	<0.001	0.02	<0.05	0.008	0.001	<0.05	<0.0001	<0.005	0.004	<0.001	<0.005	<0.005	0.015	<0.01
MB10	22/03/2016	<0.05	<0.005	<0.001	<0.02	<0.05	<0.001	<0.001	<0.05	<0.0001	<0.005	<0.001	<0.001	<0.005	<0.005	0.005	<0.01
MB10	8/06/2016	0.01	<0.001	<0.001	0.018	<0.05	<0.001	0.002	<0.05	<0.0001	0.002	<0.001	<0.01	<0.001	<0.001	0.01	<0.005
MB10	13/09/2016	<0.05	<0.005	<0.001	0.08	<0.05	<0.001	<0.001	<0.05	<0.0001	<0.005	<0.001	<0.001	<0.005	<0.005	0.002	<0.01
MB10	1/11/2016	<0.01	<0.001	<0.001	0.025	0.06	<0.001	<0.001	<0.05	<0.0001	0.003	<0.001	<0.01	<0.001	<0.001	<0.005	<0.1
MB10	14/02/2017	<0.01	<0.001	<0.001	0.063	<0.05	<0.001	<0.001	<0.05	<0.0001	0.003	<0.001	<0.01	<0.001	<0.001	<0.005	<0.1
MB10	16/05/2017	0.01	<0.001	<0.001	0.059	0.06	<0.001	<0.001	<0.05	<0.0001	0.003	<0.001	<0.01	<0.001	<0.001	<0.005	<0.1
MB10	19/04/2018	<0.01	<0.001	<0.001	-	-	-	-	<0.05	<0.0001	0.003	-	<0.01	<0.001	-	-	<0.1
MB10	26/07/2018	<0.01	<0.001	<0.001	-	-	-	-	<0.05	<0.0001	0.002	-	<0.01	<0.001	-	-	<0.1
MB10	24/01/2019	0.03	<0.001	<0.001	-	-	-	-	<0.05	<0.0001	0.003	-	<0.01	<0.001	-	-	<5
MB10	22/07/2019	<0.01	<0.001	<0.001	-	-	-	-	<0.05	<0.0001	0.002	-	<0.01	<0.001	-	-	<5
MB11	29/05/2015	<0.05	<0.005	0.001	<0.02	0.08	<0.001	<0.001	<0.05	<0.0001	<0.005	<0.001	<0.001	<0.005	<0.05	0.012	<0.02
MB11	13/08/2015	<0.05	<0.005	<0.001	<0.02	0.07	<0.001	0.002	<0.05	<0.0001	<0.005	<0.001	<0.001	<0.005	<0.005	0.011	<0.02
MB11	26/11/2015	<0.05	<0.005	0.001	<0.02	0.05	0.007	0.005	<0.05	<0.0001	<0.005	0.004	<0.001	<0.005	<0.005	0.032	<0.01
MB11	22/03/2016	<0.05	<0.005	<0.001	<0.02	<0.05	<0.001	<0.001	<0.05	<0.0001	<0.005	<0.001	<0.001	<0.005	<0.005	0.01	<0.01
MB11	8/06/2016	<0.01	<0.001	<0.001	0.016	0.06	<0.001	0.002	<0.05	<0.0001	0.002	<0.001	<0.01	<0.001	<0.001	0.015	<0.005
MB11	13/09/2016	<0.05	<0.005	<0.001	0.03	0.06	<0.001	0.002	<0.05	<0.0001	<0.005	<0.001	<0.001	<0.005	<0.005	0.015	<0.01
MB11	1/11/2016	<0.01	<0.001	<0.001	0.013	0.07	<0.001	0.001	<0.05	<0.0001	0.002	<0.001	<0.01	<0.001	<0.001	0.009	<0.1
MB11	14/02/2017	<0.01	<0.001	0.001	0.025	0.07	<0.001	<0.001	<0.05	<0.0001	0.002	<0.001	<0.01	<0.001	<0.001	0.006	<0.1
MB11	16/05/2017	<0.01	<0.001	<0.001	0.02	0.08	<0.001	<0.001	<0.05	<0.0001	0.002	<0.001	<0.01	<0.001	<0.001	<0.005	<0.1
MB11	19/04/2018	<0.01	<0.001	<0.001	-	-	-	-	<0.05	<0.0001	0.003	-	<0.01	<0.001	-	-	<0.1
MB11	26/07/2018	<0.01	<0.001	0.001	-	-	-	-	<0.05	<0.0001	0.002	-	<0.01	<0.001	-	-	<0.1
MB11	24/01/2019	0.02	<0.001	<0.001	-	-	-	-	<0.05	<0.0001	0.002	-	<0.01	<0.001	-	-	<5
MB11	23/07/2019	<0.01	<0.001	<0.001	-	-	-	-	<0.05	<0.0001	0.002	-	<0.01	<0.001	-	-	<5
MB12	28/05/2015	<0.05	<0.005	<0.001	0.07	0.19	<0.001	0.007	<0.05	<0.0001	<0.005	0.001	<0.001	<0.005	<0.05	0.03	<0.02
MB12	12/08/2015	<0.05	<0.005	<0.001	0.07	0.22	<0.001	0.003	<0.05	<0.0001	<0.005	<0.001	<0.001	<0.005	<0.005	0.023	<0.02
MB12	25/11/2015	<0.05	<0.005	<0.001	0.06	0.21	0.008	<0.001	0.06	<0.0001	<0.005	0.005	<0.001	<0.005	<0.005	0.005	<0.01
MB12	24/03/2016	<0.05	<0.005	<0.001	0.06	0.09	<0.001	0.005	<0.05	<0.0001	<0.005	<0.001	<0.001	<0.005	<0.005	0.063	<0.01
MB12	9/06/2016	<0.01	<0.001	<0.001	0.064	0.21	<0.001	0.002	<0.05	<0.0001	0.002	<0.001	<0.01	<0.001	<0.001	0.026	<0.005
MB12	15/09/2016	<0.05	<0.005	<0.001	0.05	0.23	<0.001	0.008	<0.05	<0.0001	<0.005	0.002	<0.001	<0.005	<0.005	0.051	<0.01
MB12	2/11/2016	<0.01	<0.001	<0.001	0.06	0.19	<0.001	0.004	<0.05	<0.0001	0.002	<0.001	<0.01	<0.001	<0.001	0.019	<0.1
MB12	17/05/2017	<0.01	<0.001	<0.001	0.068	0.21	<0.001	<0.001	<0.05	<0.0001	0.002	<0.001	<0.01	<0.001	<0.001	0.012	<0.1
MB12	20/04/2018	<0.01	<0.001	<0.001	-	-	-	-	<0.05	<0.0001	0.003	-	<0.01	<0.001	-	-	<0.1
MB12	26/07/2018	<0.01	<0.001	<0.001	-	-	-	-	<0.05	<0.0001	0.003	-	<0.01	<0.001	-	-	<0.1
MB12	25/01/2019	<0.01	<0.001	<0.001	-	-	-	-	<0.05	<0.0001	0.002	-	<0.01	<0.001	-	-	<5
MB12	22/07/2019	<0.01	<0.001	<0.001	-	-	-	-	<0.05	<0.0001	0.003	-	<0.01	<0.001	-	-	<5
MB13	29/05/2015	<0.05	<0.005	<0.001	<0.02	0.05	<0.001	0.006	<0.05	<0.0001	<0.005	0.002	<0.001	<0.005	<0.05	0.014	<0.02
MB13	12/08/2015	<0.05	<0.005	<0.001	<0.02	0.06	<0.001	<0.001	<0.05	<0.0001	<0.005	<0.001	0.017	<0.005	<0.005	0.003	<0.02
MB13	25/11/2015	<0.05	<0.005	<0.001	0.02	<0.05	0.008	0.003	<0.05	<0.0001	<0.005	0.004	<0.001	<0.005	<0.005	0.012	<0.01
MB13	22/03/2016	<0.05	<0.005	<0.001	<0.02	<0.05	<0.001	0.001	<0.05	<0.0001	<0.005	<0.001	<0.001	<0.005	<0.005	0.006	<0.01
MB13	7/06/2016	0.01	<0.001	<0.001	0.006	<0.05	<0.001	0.002	<0.05	<0.0001	0.002	<0.001	<0.01	<0.001	<0.001	0.007	<0.005
MB13	13/09/2016	0.1	<0.005	<0.001	0.05	<0.05	<0.001	0.002	<0.05	<0.0001	<0.005	<0.001	<0.001	<0.005	<0.005	0.004	<0.01
MB13	1/11/2016	0.01	<0.001	<0.001	0.005	<0.05	<0.001	<0.001	<0.05	<0.0001	0.002	<0.001	<0.01	<0.001	<0.001	0.006	<0.1
MB13	14/02/2017	<0.01	<0.001	<0.001	0.023	0.05	<0.001	0.002	<0.05	<0.0001	0.002	<0.001	<0.01	<0.001	<0.001	0.01	<0.1
MB13	16/05/2017	0.01	<0.001	<0.001	0.01	0.06	<0.001	0.002	<0.05	<0.0001	0.002	<0.001	<0.01	<0.001	<0.001	<0.005	<0.1
MB13	19/04/2018	<0.01	0.002	<0.001	-	-	-	-	<0.05	<0.0001	0.002	-	<0.01	<0.001	-	-	<0.1
MB13	26/07/2018	<0.01	<0.001	<0.001	-	-	-	-	<0.05	<0.0001	0.002	-	<0.01	<0.001	-	-	<0.1
MB13	24/01/2019	0.03	<0.001	<0.001	-	-	-	-	<0.05	<0.0001	0.002	-	<0.01	<0.001	-	-	<5
MB13	22/07/2019	<0.01	<0.001	<0.001	-	-	-	-	<0.05	<0.0001	0.003	-	<0.01	<0.001	-	-	<5

Sample ID	Sampled Date Time	Sample Quality Parameters															Total Petroleum Hydrocarbons										
		Electrical Conductivity @ 25°C	pH (Lab)	Total Dissolved Solids @180°C (Filtered)	Sodium	Potassium	Calcium	Magnesium	Chloride	Sulfate as SO4 - Turbidimetric	Sulphate (as SO4)	Bicarbonate Alkalinity (as CaCO3)	Carbonate Alkalinity (as CaCO3)	Hydroxide Alkalinity (as CaCO3)	Total Alkalinity (as CaCO3)	Total Suspended Solids	TRH C6 - C9 Fraction	TRH C10 - C14 Fraction	TRH C15 - C28 Fraction	TRH C29 - C36 Fraction	TRH+C10 - C36 (Sum of total) (Lab Reported)	TRH C6 - C10 Fraction F1	TRH C6 - C10 Fraction Less BTEX F1	TRH >C10 - C16 Fraction F2	TRH >C10 - C16 Fraction Less Naphthalene F2	TRH >C16 - C34 Fraction F3	TRH >C34 - C40 Fraction F4
		uS/cm	pH_Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
ADWG 2018 Aesthetic			**6.5-8.5**	**600**	**180**				**250**		**250**																
ADWG 2018 Health																											
ANZECC 2000 Livestock Drinking Water							1000				1000																
MB10	29/05/2015	2600	7.4	**1400**	**430**	2.5	38	<0.5	**790**	<5	<5	37	<10	<10	37	3.9	<0.02	<0.05	<0.1	<0.1	<0.1	0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB10	13/08/2015	2300	7.2	**1400**	**420**	2.7	36	<0.5	**790**	<5	<5	20	<10	<10	20	2.2	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB10	25/11/2015	2600	7.4	**1500**	**420**	2.9	36	<0.5	**760**	<5	<5	39	<10	<10	39	3.7	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB10	22/03/2016	2600	7.9	**1400**	**420**	3.3	39	0.5	**740**	<5	<5	35	<10	<10	35	5	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB10	8/06/2016	2590	7.83	**1440**	**447**	2	40	2	**810**	<1	<1	42	<1	<1	42	23	<0.02	<0.05	<0.1	<0.05	<0.05	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB10	13/09/2016	2600	7.6	**1500**	**440**	2.6	39	0.9	**690**	<5	<5	36	<10	<10	36	84	<0.02	<0.05	<0.1	0.4	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB10	1/11/2016	2470	7.87	**1420**	**460**	2	38	<1	**838**	<1	<1	52	<1	<1	52	62	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB10	14/02/2017	2640	7.94	**1450**	**478**	2	38	<1	**821**	<1	<1	54	<1	<1	54	128	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB10	16/05/2017	2690	7.68	**1540**	**505**	2	38	<1	**794**	<1	<1	38	<1	<1	38	109	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB10	19/04/2018	2530	7.47	**1460**	**488**	3	36	1	**799**	1	1	42	<1	<1	42	6	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB10	26/07/2018	2570	7.74	**1440**	**468**	4	42	<1	**843**	<1	<1	42	<1	<1	42	5	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB10	24/01/2019	2770	8	**1610**	**466**	3	46	2	**915**	3	3	49	<1	<1	49	<5	<20	<50	<100	<50	<50	<20	<20	<100	<100	<100	<100
MB10	22/07/2019	2690	7.59	**1580**	**463**	2	40	2	**865**	1	1	45	<1	<1	45	<5	<20	<50	<100	<50	<50	<20	<20	<100	<100	<100	<100
MB11	29/05/2015	2000	6.9	**1100**	**330**	2.5	24	<0.5	**590**	<5	<5	29	<10	<10	29	2.5	0.03	<0.05	<0.1	<0.1	<0.1	0.03	<0.02	<0.05	<0.05	<0.1	<0.1
MB11	13/08/2015	2100	**3.4**	**1000**	**340**	2.8	24	<0.5	**610**	<5	<5	<20	<10	<10	<20	1.9	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB11	26/11/2015	2100	7.2	**1200**	**320**	2.9	24	<0.5	**570**	<5	<5	28	<10	<10	28	3.9	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB11	22/03/2016	2000	7.9	**1100**	**360**	3	28	<0.5	**560**	<5	<5	28	<10	<10	28	3.9	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB11	8/06/2016	2060	7.63	**1110**	**360**	2	26	<1	**652**	<1	<1	31	<1	<1	31	15	<0.02	<0.05	<0.1	<0.05	<0.05	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB11	13/09/2016	2100	8	**1200**	**370**	2.8	28	0.6	**530**	<5	<5	29	<10	<10	29	7.2	<0.02	<0.05	<0.1	<0.1	0.4	<0.02	<0.02	<0.05	<0.05	0.3	<0.1
MB11	1/11/2016	1980	7.7	**1200**	**380**	2	28	<1	**666**	<1	<1	35	<1	<1	35	23	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB11	14/02/2017	2090	7.98	**1160**	**384**	2	26	<1	**675**	<1	<1	29	<1	<1	29	15	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB11	16/05/2017	2130	7.41	**1180**	**392**	2	26	<1	**618**	1	1	29	<1	<1	29	9	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB11	19/04/2018	2020	7.27	**1150**	**389**	3	25	<1	**629**	1	1	60	<1	<1	60	<5	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB11	26/07/2018	2010	7.01	**1130**	**359**	2	28	<1	**670**	8	8	24	<1	<1	24	5	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB11	24/01/2019	2110	7.53	**1190**	**357**	2	29	1	**708**	3	3	36	<1	<1	36	<5	<20	<50	<100	<50	<50	<20	<20	<100	<100	<100	<100
MB11	23/07/2019	2050	7.18	**1150**	**360**	4	26	<1	**666**	<1	<1	30	<1	<1	30	22	<20	<50	<100	<50	<50	<20	<20	<100	<100	<100	<100
MB12	28/05/2015	1200	8	**640**	170	3.1	32	21	230	12	12	280	<10	<10	280	7.1	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB12	12/08/2015	1300	**8.5**	**640**	**180**	3.4	32	24	230	12	12	260	10	<10	270	3.5	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB12	25/11/2015	1200	8.3	**660**	170	3.2	30	25	230	11	11	280	<10	<10	290	<1	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB12	24/03/2016	1200	8.4	**640**	170	5.1	35	25	220	12	12	250	<10	<10	250	5.7	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB12	9/06/2016	1230	**8.5**	**680**	**184**	3	37	26	234	37	37	229	26	<1	255	7	<0.02	<0.05	<0.1	<0.05	<0.05	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB12	15/09/2016	1400	8.3	**740**	**190**	5.5	40	28	**270**	13	13	260	<10	<10	260	2.2	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB12	2/11/2016	1160	8.33	**675**	**184**	3	36	25	236	38	38	262	11	<1	273	<5	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB12	17/05/2017	1300	**8.51**	**717**	**198**	3	33	25	224	39	39	240	25	<1	266	<5	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB12	20/04/2018	1180	8.12	**681**	**189**	3	32	26	221	39	39	243	<1	<1	243	12	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB12	26/07/2018	1210	8.24	**681**	179	3	36	26	245	38	38	247	<1	<1	247	6	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB12	25/01/2019	1220	8.04	**688**	175	3	35	24	**250**	38	38	258	<1	<1	258	<5	<20	<50	<100	<50	<50	<20	<20	<100	<100	<100	<100
MB12	22/07/2019	1240	8.2	**692**	175	3	35	23	245	37	37	280	<1	<1	280	8	<20	<50	<100	<50	<50	<20	<20	<100	<100	<100	<100
MB13	29/05/2015	1600	8.4	**770**	**260**	2	13	<0.5	**480**	<5	<5	31	<10	<10	34	2.9	0.04	<0.05	<0.1	<0.1	<0.1	0.04	0.02	<0.05	<0.05	<0.1	<0.1
MB13	12/08/2015	1600	7.1	**780**	**280**	2.3	13	<0.5	**500**	<5	<5	<20	<10	<10	<20	<1	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB13	25/11/2015	1600	7.8	**780**	**260**	2.3	13	<0.5	**490**	<5	<5	37	<10	<10	37	6	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB13	22/03/2016	1600	**8.5**	**750**	**300**	2.4	18	<0.5	**470**	<5	<5	31	<10	<10	34	1.4	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB13	7/06/2016	1570	7.89	**837**	**282**	2	12	<1	**487**	7	7	34	<1	<1	34	<5	<0.02	<0.05	<0.1	<0.05	<0.05	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB13	13/09/2016	1600	7.8	**790**	**280**	2.3	14	<0.5	**370**	<5	<5	32	<10	<10	32	9	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB13	1/11/2016	1500	8.25	**870**	**281**	2	13	<1	**492**	6	6	68	<1	<1	68	9	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB13	14/02/2017	1570	8.24	**878**	**297**	2	12	<1	**492**	3	3	35	<1	<1	35	7	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB13	16/05/2017	1630	7.69	**900**	**311**	2	12	<1	**469**	5	5	39	<1	<1	39	<5	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB13	19/04/2018	1510	7.65	**891**	**299**	2	12	<1	**464**	6	6	36	<1	<1	36	5	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB13	26/07/2018	1550	7.82	**849**	**275**	2	14	<1	**502**	6	6	44	<1	<1	44	10	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB13	24/01/2019	1590	8.02	**963**	**284**	2	14	<1	**529**	7	7	38	<1	<1	38	7	<20	<50	<100	<50	<50	<20	<20	<100	<100	<100	<100
MB13	22/07/2019	1610	7.74	**886**	**290**	2	14	<1	**518**	5	5	36	<1	<1	36	<5	<20	<50	<100	<50	<50	<20	<20	<100	<100	<100	<100

		Heavy Metals															PAH
		Aluminium	Antimony	Arsenic	Barium	Boron	Chromium	Copper	Iron	Mercury	Molybdenum	Nickel	Selenium	Silver	Uranium	Zinc	Naphthalene
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
ADWG 2018 Aesthetic								1	0.3							3	
ADWG 2018 Health			0.003	0.01	2	4		2		0.001	0.05	0.02	0.01	0.1	0.017		
ANZECC 2000 Livestock Drinking Water		5		0.5		5	1	0.4		0.002	0.15	1	0.02		0.2	20	
Sample ID	Sampled Date Time																
MB14	29/05/2015	<0.05	<0.005	0.002	0.91	0.05	<0.001	0.006	<0.05	<0.0001	<0.005	0.002	<0.001	<0.005	<0.05	0.055	<0.02
MB14	12/08/2015	<0.05	<0.005	0.002	1.1	0.06	<0.001	0.003	<0.05	<0.0001	<0.005	<0.001	<0.001	<0.005	<0.005	0.031	<0.02
MB14	25/11/2015	<0.05	<0.005	0.002	1.1	<0.05	0.009	0.005	<0.05	<0.0001	<0.005	0.005	<0.001	<0.005	<0.005	0.027	<0.01
MB14	22/03/2016	<0.05	<0.005	0.002	1	<0.05	<0.001	<0.001	<0.05	<0.0001	<0.005	<0.001	<0.001	<0.005	<0.005	0.022	<0.01
MB14	7/06/2016	<0.01	<0.001	0.001	1.1	<0.05	<0.001	<0.001	<0.05	<0.0001	<0.001	<0.001	<0.01	<0.001	<0.001	0.012	<0.005
MB14	13/09/2016	<0.05	<0.005	0.002	1.1	<0.05	<0.001	<0.001	<0.05	<0.0001	<0.005	0.002	<0.001	<0.005	<0.005	0.006	<0.01
MB14	1/11/2016	<0.01	<0.001	0.002	0.998	<0.05	<0.001	<0.001	<0.05	<0.0001	<0.001	0.001	<0.01	<0.001	<0.001	0.006	<0.1
MB14	14/02/2017	0.02	<0.001	0.002	1.1	0.05	<0.001	<0.001	<0.05	<0.0001	<0.001	0.001	<0.01	<0.001	<0.001	0.011	<0.1
MB14	16/05/2017	<0.01	<0.001	0.002	1.1	0.06	<0.001	<0.001	<0.05	<0.0001	<0.001	0.001	<0.01	<0.001	<0.001	<0.005	<0.1
MB14	20/04/2018	<0.01	<0.001	0.002	-	-	-	-	<0.05	<0.0001	<0.001	-	<0.01	<0.001	-	-	<0.1
MB14	26/07/2018	<0.01	<0.001	0.002	-	-	-	-	<0.05	<0.0001	<0.001	-	<0.01	<0.001	-	-	<0.1
MB14	24/01/2019	0.01	<0.001	0.001	-	-	-	-	<0.05	<0.0001	<0.001	-	<0.01	<0.001	-	-	<5
MB14	22/07/2019	<0.01	<0.001	<0.001	-	-	-	-	<0.05	<0.0001	<0.001	-	<0.01	<0.001	-	-	<5
MB15	30/05/2015	<0.05	<0.005	0.002	0.03	0.15	<0.001	0.003	<0.05	<0.0001	<0.005	0.002	<0.001	<0.005	<0.05	0.067	<0.02
MB15	13/08/2015	<0.05	<0.005	0.002	0.04	0.15	<0.001	<0.001	<0.05	<0.0001	<0.005	0.001	<0.001	<0.005	<0.005	0.015	<0.02
MB15	26/11/2015	<0.05	<0.005	0.002	0.03	0.14	0.008	0.006	<0.05	<0.0001	<0.005	0.006	<0.001	<0.005	<0.005	0.07	<0.01
MB15	23/03/2016	<0.05	<0.005	0.002	0.03	0.06	<0.001	<0.001	<0.05	<0.0001	<0.005	<0.001	<0.001	<0.005	<0.005	0.057	<0.01
MB15	7/06/2016	0.02	<0.001	0.002	0.045	0.14	<0.001	<0.001	<0.05	<0.0001	0.002	<0.001	<0.01	<0.001	<0.001	0.011	<0.005
MB15	14/09/2016	<0.05	<0.005	0.002	0.04	0.12	<0.001	<0.001	<0.05	<0.0001	<0.005	0.002	<0.001	<0.005	<0.005	0.021	<0.01
MB15	2/11/2016	<0.01	<0.001	0.002	0.055	0.13	<0.001	<0.001	<0.05	<0.0001	0.002	0.001	<0.01	<0.001	<0.001	0.016	<0.1
MB15	14/02/2017	<0.01	<0.001	0.002	0.042	0.16	<0.001	<0.001	<0.05	<0.0001	0.002	0.001	<0.01	<0.001	<0.001	0.01	<0.1
MB15	16/05/2017	0.02	<0.001	0.002	0.044	0.16	<0.001	0.004	<0.05	<0.0001	0.002	0.001	<0.01	<0.001	<0.001	0.031	<0.1
MB15	20/04/2018	<0.01	<0.001	0.002	-	-	-	-	<0.05	<0.0001	0.002	-	<0.01	<0.001	-	-	<0.1
MB15	26/07/2018	<0.01	0.003	0.001	-	-	-	-	<0.05	<0.0001	0.002	-	<0.01	<0.001	-	-	<0.1
MB15	25/01/2019	<0.01	<0.001	<0.001	-	-	-	-	<0.05	<0.0001	0.002	-	<0.01	<0.001	-	-	<5
MB15	22/07/2019	<0.01	<0.001	<0.001	-	-	-	-	<0.05	<0.0001	0.002	-	<0.01	<0.001	-	-	<5
MB18R	28/05/2015	<0.05	<0.005	0.003	0.13	0.45	<0.001	<0.001	<0.05	<0.0001	<0.005	0.002	<0.001	<0.005	<0.05	0.052	<0.02
MB18R	11/08/2015	<0.05	<0.005	0.002	0.14	0.55	<0.001	0.003	<0.05	<0.0001	<0.005	0.002	<0.001	<0.005	<0.005	0.03	<0.02
MB18R	24/11/2015	<0.05	<0.005	0.002	0.15	0.49	0.01	0.001	<0.05	<0.0001	<0.005	0.007	<0.001	<0.005	<0.005	0.024	<0.01
MB18R	23/03/2016	<0.05	<0.005	0.002	0.14	0.46	<0.001	<0.001	<0.05	<0.0001	<0.005	<0.001	<0.001	<0.005	<0.005	0.048	<0.01
MB18R	8/06/2016	<0.01	<0.001	0.003	0.022	0.48	<0.001	<0.001	0.15	<0.0001	0.002	<0.001	<0.01	<0.001	<0.001	0.026	<0.005
MB18R	15/09/2016	<0.05	<0.005	0.001	0.15	0.42	<0.001	<0.001	<0.05	<0.0001	<0.005	0.002	<0.001	<0.005	<0.005	0.067	<0.01
MB18R	2/11/2016	<0.01	<0.001	0.002	0.141	0.44	<0.001	<0.001	<0.05	<0.0001	0.002	<0.001	<0.01	<0.001	<0.001	0.031	<0.1
MB18R	21/04/2017	<0.01	<0.001	0.001	-	-	-	-	<0.05	<0.0001	0.002	-	<0.01	<0.001	-	-	<0.1
MB18R	17/05/2017	<0.01	<0.001	0.003	0.14	0.45	<0.001	<0.001	0.11	<0.0001	0.002	<0.001	<0.01	<0.001	<0.001	0.007	<0.1
MB18R	27/07/2018	<0.01	<0.001	0.002	-	-	-	-	<0.05	<0.0001	0.002	-	<0.01	<0.001	-	-	<0.1
MB18R	24/01/2019	<0.01	<0.001	<0.001	-	-	-	-	<0.05	<0.0001	0.002	-	<0.01	<0.001	-	-	<5
MB18R	23/07/2019	<0.01	<0.001	<0.001	-	-	-	-	<0.05	<0.0001	0.002	-	<0.01	<0.001	-	-	<5
MB18R2	28/05/2015	<0.05	<0.005	0.003	0.02	0.41	<0.001	<0.001	0.3	<0.0001	<0.005	<0.001	<0.001	<0.005	<0.05	0.01	<0.02
MB18R2	11/08/2015	<0.05	<0.005	0.003	0.03	0.6	<0.001	0.001	0.46	<0.0001	<0.005	0.002	<0.001	<0.005	<0.005	0.017	<0.02
MB18R2	24/11/2015	<0.05	<0.005	<0.001	0.03	0.55	0.008	0.001	<0.05	<0.0001	<0.005	0.005	<0.001	<0.005	<0.005	0.007	<0.01
MB18R2	23/03/2016	<0.05	<0.005	0.003	0.03	0.45	<0.001	0.001	0.3	<0.0001	<0.005	<0.001	<0.001	<0.005	<0.005	0.05	<0.01
MB18R2	8/06/2016	<0.01	<0.001	0.002	0.158	0.45	<0.001	0.002	<0.05	<0.0001	0.002	0.001	<0.01	<0.001	<0.001	0.025	<0.005
MB18R2	14/09/2016	0.07	<0.005	0.002	0.06	0.45	<0.001	<0.001	0.13	<0.0001	<0.005	0.001	<0.001	<0.005	<0.005	0.027	<0.01
MB18R2	2/11/2016	<0.01	<0.001	0.002	0.056	0.44	<0.001	<0.001	0.07	<0.0001	0.002	0.001	<0.01	<0.001	<0.001	0.033	<0.1
MB18R2	17/05/2017	<0.01	<0.001	0.003	0.023	0.45	<0.001	<0.001	0.07	<0.0001	0.002	<0.001	<0.01	<0.001	<0.001	0.02	<0.1
MB18R2	21/04/2018	<0.01	<0.001	0.003	-	-	-	-	<0.05	<0.0001	0.002	-	<0.01	<0.001	-	-	<0.1
MB18R2	27/07/2018	<0.01	<0.001	0.003	-	-	-	-	<0.05	<0.0001	0.002	-	<0.01	<0.001	-	-	<0.1
MB18R2	24/01/2019	<0.01	<0.001	0.002	-	-	-	-	0.06	<0.0001	0.001	-	<0.01	<0.001	-	-	<5
MB18R2	23/07/2019	<0.01	<0.001	0.001	-	-	-	-	<0.05	<0.0001	0.001	-	<0.01	<0.001	-	-	<5

		Sample Quality Parameters														
		Electrical Conductivity @ 25°C	pH (Lab)	Total Dissolved Solids @180°C (Filtered)	Sodium	Potassium	Calcium	Magnesium	Chloride	Sulfate as SO4 - Turbidimetric	Sulphate (as SO4)	Bicarbonate Alkalinity (as CaCO3)	Carbonate Alkalinity (as CaCO3)	Hydroxide Alkalinity (as CaCO3)	Total Alkalinity (as CaCO3)	Total Suspended Solids
		uS/cm	pH_Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
ADWG 2018 Aesthetic			6.5-8.5	600	180				250		250					
ADWG 2018 Health																
ANZECC 2000 Livestock Drinking Water							1000				1000					
Sample ID	Sampled Date Time															
MB14	29/05/2015	4300	7.4	2700	610	6.4	130	5.6	1400	5	5	35	<10	<10	35	7.7
MB14	12/08/2015	4500	7.5	2700	640	7.1	120	5.9	1400	5.1	5.1	34	<10	<10	34	2.7
MB14	25/11/2015	4300	7.6	2900	640	6.9	120	6.2	1300	<5	<5	40	<10	<10	40	11
MB14	22/03/2016	4100	7.6	2800	660	6.9	130	6.1	1300	<5	<5	33	<10	<10	33	100
MB14	7/06/2016	4280	7.61	2560	688	6	134	6	1310	15	15	36	<1	<1	36	80
MB14	13/09/2016	4200	7.8	2600	660	7	130	6.2	1200	5.1	5.1	37	<10	<10	37	32
MB14	1/11/2016	3840	7.4	2470	662	5	128	6	1290	14	14	41	<1	<1	41	32
MB14	14/02/2017	4360	7.36	2570	725	6	128	7	1370	14	14	35	<1	<1	35	86
MB14	16/05/2017	4280	7.39	2520	725	6	123	6	1240	14	14	34	<1	<1	34	23
MB14	20/04/2018	4230	7.32	2550	741	6	122	7	1310	14	14	34	<1	<1	34	7
MB14	26/07/2018	4300	7.59	2430	690	6	137	7	1370	15	15	37	<1	<1	37	14
MB14	24/01/2019	4250	7.36	2420	678	6	130	6	1390	15	15	39	<1	<1	39	<5
MB14	22/07/2019	4410	7.66	2630	687	6	134	6	1380	14	14	38	<1	<1	38	<5
MB15	30/05/2015	1700	7.7	950	250	3	47	4.5	470	<5	<5	83	<10	<10	83	51
MB15	13/08/2015	1800	8	950	260	3.2	48	5.4	480	<5	<5	80	<10	<10	80	12
MB15	26/11/2015	1800	8	1000	250	3.1	46	5.1	450	<5	<5	84	<10	<10	84	10
MB15	23/03/2016	1700	7.9	1000	260	2.8	49	5.3	450	<5	<5	76	<10	<10	76	41
MB15	7/06/2016	1820	8.01	1110	289	3	53	6	551	8	8	78	<1	<1	78	249
MB15	14/09/2016	1800	8	1000	270	5.1	52	6.1	450	<5	<5	85	<10	<10	85	190
MB15	2/11/2016	1690	7.79	1030	278	3	52	6	546	7	7	88	<1	<1	88	70
MB15	14/02/2017	1770	7.72	1060	291	3	49	6	532	6	6	81	<1	<1	81	581
MB15	16/05/2017	1810	7.88	1080	302	3	50	6	504	7	7	82	<1	<1	82	663
MB15	20/04/2018	1700	7.7	1030	285	4	46	7	512	6	6	81	<1	<1	81	22
MB15	26/07/2018	1740	7.84	1020	274	3	53	7	547	7	7	78	<1	<1	78	17
MB15	25/01/2019	1700	7.77	1000	258	3	48	7	547	8	8	88	<1	<1	88	<5
MB15	22/07/2019	1800	7.96	1110	283	3	54	7	552	7	7	82	<1	<1	82	<5
MB18R	28/05/2015	4000	7.8	2800	460	8.1	160	44	1200	29	29	84	<10	<10	84	110
MB18R	11/08/2015	3600	8	2700	490	10	160	48	1200	25	25	80	<10	<10	80	24
MB18R	24/11/2015	4100	7.8	3000	470	8.6	150	49	1200	26	26	83	<10	<10	83	280
MB18R	23/03/2016	3800	7.8	2600	490	7.8	160	47	1200	24	24	77	<10	<10	77	220
MB18R	8/06/2016	3800	7.98	2360	477	7	143	49	1120	76	76	86	<1	<1	86	<5
MB18R	15/09/2016	4000	8	2700	520	9.3	160	51	1100	25	25	81	<10	<10	81	160
MB18R	2/11/2016	3770	7.73	2560	540	8	165	51	1230	77	77	84	<1	<1	84	135
MB18R	21/04/2017	3940	7.53	2550	562	9	149	54	1160	73	73	75	<1	<1	75	8
MB18R	17/05/2017	4080	7.87	2660	578	8	156	51	1170	74	74	82	<1	<1	82	160
MB18R	27/07/2018	3940	7.88	2400	527	9	166	53	1240	69	69	76	<1	<1	76	26
MB18R	24/01/2019	3950	7.59	2380	502	8	156	49	1270	66	66	84	<1	<1	84	<5
MB18R	23/07/2019	4080	7.79	2420	523	8	161	49	1230	74	74	84	<1	<1	84	7
MB18R2	28/05/2015	3800	7.6	2600	450	8.1	150	44	1100	26	26	93	<10	<10	93	14
MB18R2	11/08/2015	3400	8	2600	480	9.9	150	49	1100	26	26	89	<10	<10	89	12
MB18R2	24/11/2015	3700	8	2800	450	8.7	110	48	1100	26	26	53	<10	<10	53	5.1
MB18R2	23/03/2016	3600	7.8	2900	480	8.3	150	49	1100	25	25	86	<10	<10	86	13
MB18R2	8/06/2016	4000	7.95	2420	512	8	153	47	1200	74	74	76	<1	<1	76	215
MB18R2	14/09/2016	3800	8	2400	460	10	150	52	930	26	26	100	<10	<10	100	1.2
MB18R2	2/11/2016	3480	7.75	2360	486	8	150	51	1150	78	78	107	<1	<1	107	5
MB18R2	17/05/2017	3800	7.94	2330	532	8	142	50	1040	80	80	91	<1	<1	91	245
MB18R2	21/04/2018	3660	7.66	2320	517	10	136	53	1080	74	74	86	<1	<1	86	8
MB18R2	27/07/2018	3670	7.94	2210	482	9	152	52	1150	71	71	88	<1	<1	88	14
MB18R2	24/01/2019	3640	7.59	2230	470	8	141	50	1160	62	62	98	<1	<1	98	<5
MB18R2	23/07/2019	3780	7.82	2320	498	8	152	50	1140	75	75	97	<1	<1	97	7

		Total Petroleum Hydrocarbons										
		TRH C6 - C9 Fraction	TRH C10 - C14 Fraction	TRH C15 - C28 Fraction	TRH C29 - C36 Fraction	TRH+C10 - C36 (Sum of total) (Lab Reported)	TRH C6 - C10 Fraction F1	TRH C6 - C10 Fraction Less BTEX F1	TRH >C10 - C16 Fraction F2	TRH >C10 - C16 Fraction Less Naphthalene F2	TRH >C16 - C34 Fraction F3	TRH >C34 - C40 Fraction F4
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
ADWG 2018 Aesthetic												
ADWG 2018 Health												
ANZECC 2000 Livestock Drinking Water												
Sample ID	Sampled Date Time											
MB14	29/05/2015	0.03	<0.05	<0.1	<0.1	<0.1	0.03	<0.02	<0.05	<0.05	<0.1	<0.1
MB14	12/08/2015	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB14	25/11/2015	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB14	22/03/2016	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB14	7/06/2016	<0.02	<0.05	<0.1	<0.05	<0.05	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB14	13/09/2016	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB14	1/11/2016	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB14	14/02/2017	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB14	16/05/2017	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB14	20/04/2018	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB14	26/07/2018	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB14	24/01/2019	<20	<50	<100	<50	<50	<20	<20	<100	<100	<100	<100
MB14	22/07/2019	<20	<50	<100	<50	<50	<20	<20	<100	<100	<100	<100
MB15	30/05/2015	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB15	13/08/2015	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB15	26/11/2015	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB15	23/03/2016	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB15	7/06/2016	<0.02	<0.05	<0.1	<0.05	<0.05	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB15	14/09/2016	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB15	2/11/2016	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB15	14/02/2017	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB15	16/05/2017	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB15	20/04/2018	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB15	26/07/2018	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB15	25/01/2019	<20	<50	<100	<50	<50	<20	<20	<100	<100	<100	<100
MB15	22/07/2019	<20	<50	<100	<50	<50	<20	<20	<100	<100	<100	<100
MB18R	28/05/2015	<0.02	<0.05	<0.1	<0.1	<0.1	0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB18R	11/08/2015	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB18R	24/11/2015	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB18R	23/03/2016	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB18R	8/06/2016	<0.02	<0.05	<0.1	<0.05	<0.05	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB18R	15/09/2016	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB18R	2/11/2016	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB18R	21/04/2017	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB18R	17/05/2017	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB18R	27/07/2018	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB18R	24/01/2019	<20	<50	<100	<50	<50	<20	<20	<100	<100	<100	<100
MB18R	23/07/2019	<20	<50	<100	<50	<50	<20	<20	<100	<100	<100	<100
MB18R2	28/05/2015	0.04	<0.05	<0.1	<0.1	<0.1	0.04	0.03	<0.05	<0.05	<0.1	<0.1
MB18R2	11/08/2015	0.03	<0.05	<0.1	<0.1	<0.1	0.03	0.02	<0.05	<0.05	<0.1	<0.1
MB18R2	24/11/2015	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB18R2	23/03/2016	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
MB18R2	8/06/2016	<0.02	<0.05	<0.1	<0.05	<0.05	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB18R2	14/09/2016	0.04	<0.05	<0.1	<0.1	<0.1	0.04	0.04	<0.05	<0.05	<0.1	<0.1
MB18R2	2/11/2016	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB18R2	17/05/2017	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB18R2	21/04/2018	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB18R2	27/07/2018	<0.02	<0.05	<0.1	<0.1	<0.1	<0.02	<0.02	<0.1	<0.1	<0.1	<0.1
MB18R2	24/01/2019	<20	<50	<100	<50	<50	<20	<20	<100	<100	<100	<100
MB18R2	23/07/2019	<20	<50	<100	<50	<50	<20	<20	<100	<100	<100	<100

	Heavy Metals															PAH
	Aluminium	Antimony	Arsenic	Barium	Boron	Chromium	Copper	Iron	Mercury	Molybdenum	Nickel	Selenium	Silver	Uranium	Zinc	Naphthalene
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
ADWG 2018 Aesthetic							**1**	**0.3**							**3**	
ADWG 2018 Health		0.003	0.01	2	4		2		0.001	0.05	0.02	0.01	0.1	0.017		
ANZECC 2000 Livestock Drinking Water	5		0.5		5	1	0.4		0.002	0.15	1	0.02		0.2	20	
Sample ID **Sampled Date Time**																
Statistical Summary																
Number of Results	162	162	162	110	110	110	110	162	162	162	110	162	162	110	110	162
Number of Detects	24	3	51	90	86	16	63	20	0	71	51	1	3	6	101	0
Minimum Concentration	<0.01	<0.001	<0.001	0.004	<0.05	<0.001	<0.001	<0.05	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.005
Minimum Detect	0.01	0.002	0.001	0.004	0.05	0.001	0.001	0.05	ND	0.001	0.001	0.017	0.001	0.005	0.002	ND
Maximum Concentration	0.37	<0.005	0.003	1.1	1.1	0.01	0.013	0.46	<0.0001	0.006	0.008	0.017	<0.005	<0.05	0.099	<5
Maximum Detect	0.37	0.003	0.003	1.1	1.1	0.01	0.013	0.46	ND	0.006	0.008	0.017	0.004	0.006	0.099	ND
Average Concentration	0.018	0.0013	0.00095	0.14	0.28	0.0015	0.0021	0.039	0.00005	0.0022	0.0015	0.0033	0.0013	0.0046	0.021	0.42
Median Concentration	0.01	0.0005	0.0005	0.05	0.145	0.0005	0.001	0.025	0.00005	0.0025	0.0005	0.005	0.0005	0.0025	0.014	0.05
Standard Deviation	0.031	0.00099	0.00076	0.28	0.29	0.0025	0.0024	0.054	0	0.0011	0.0017	0.0025	0.001	0.0076	0.019	0.91
Number of Guideline Exceedances	0	66	0	0	0	0	0	3	0	0	0	1	0	13	0	0
Number of Guideline Exceedances(Detects (	0	1	0	0	0	0	0	3	0	0	0	1	0	0	0	0
% of Detects at or above Guidelines	0	1	0	0	0	0	0	2	0	0	0	1	0	0	0	0
% of Results Below Guidelines or Non-Detec	100	99	100	100	100	100	100	98	100	100	100	99	100	100	100	100

	Sample Quality Parameters														
	Electrical Conductivity @ 25°C	pH (Lab)	Total Dissolved Solids @180°C (Filtered)	Sodium	Potassium	Calcium	Magnesium	Chloride	Sulfate as SO4 - Turbidimetric	Sulphate (as SO4)	Bicarbonate Alkalinity (as CaCO3)	Carbonate Alkalinity (as CaCO3)	Hydroxide Alkalinity (as CaCO3)	Total Alkalinity (as CaCO3)	Total Suspended Solids
	uS/cm	pH_Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
ADWG 2018 Aesthetic		**6.5-8.5**	**600**	**180**				**250**		**250**					
ADWG 2018 Health															
ANZECC 2000 Livestock Drinking Water						1000				1000					
Sample ID **Sampled Date Time**															
Statistical Summary															
Number of Results	162	162	162	162	162	162	162	162	162	162	162	162	162	162	162
Number of Detects	162	162	162	162	162	162	131	162	125	125	160	19	0	160	126
Minimum Concentration	900	3.4	480	170	1.6	11	<0.5	190	<1	<1	<20	<1	<1	<20	<1
Minimum Detect	900	3.4	480	170	1.6	11	0.5	190	1	1	20	3	ND	20	1.2
Maximum Concentration	4500	8.51	3000	741	13	166	150	1400	142	142	860	36	<10	860	770
Maximum Detect	4500	8.51	3000	741	13	166	150	1400	142	142	860	36	ND	860	770
Average Concentration	2575	7.9	1541	390	5.1	69	30	727	25	25	165	4.2	2.3	167	41
Median Concentration	2595	7.9	1440	393	4	52	6.15	695	12	12	86	0.5	0.5	86	7
Standard Deviation	1030	0.49	700	138	2.9	48	39	332	33	33	194	6.2	2.2	197	108
Number of Guideline Exceedances	0	8	151	154	0	0	0	140	0	0	0	0	0	0	0
Number of Guideline Exceedances(Detects (	0	8	151	154	0	0	0	140	0	0	0	0	0	0	0
% of Detects at or above Guidelines	0	5	93	95	0	0	0	86	0	0	0	0	0	0	0
% of Results Below Guidelines or Non-Detec	100	95	7	5	100	100	100	14	100	100	100	100	100	100	100

	Total Petroleum Hydrocarbons										
	TRH C6 - C9 Fraction	TRH C10 - C14 Fraction	TRH C15 - C28 Fraction	TRH C29 - C36 Fraction	TRH+C10 - C36 (Sum of total) (Lab Reported)	TRH C6 - C10 Fraction F1	TRH C6 - C10 Fraction Less BTEX F1	TRH >C10 - C16 Fraction F2	TRH >C10 - C16 Fraction Less Naphthalene F2	TRH >C16 - C34 Fraction F3	TRH >C34 - C40 Fraction F4
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
ADWG 2018 Aesthetic											
ADWG 2018 Health											
ANZECC 2000 Livestock Drinking Water											
Sample ID **Sampled Date Time**											
Statistical Summary											
Number of Results	162	162	162	162	162	162	162	162	162	162	162
Number of Detects	7	1	0	1	2	10	5	1	1	1	0
Minimum Concentration	<0.02	<0.05	<0.1	<0.05	<0.05	<0.02	<0.02	<0.05	<0.05	<0.1	<0.1
Minimum Detect	0.03	370	ND	0.4	0.4	0.02	0.02	380	380	0.3	ND
Maximum Concentration	<20	370	<100	<50	370	<20	<20	380	380	<100	<100
Maximum Detect	0.04	370	ND	0.4	370	0.04	0.04	380	380	0.3	ND
Average Concentration	1.6	6.2	8.1	4.1	6.2	1.6	1.6	10	10	8.1	8.1
Median Concentration	0.01	0.025	0.05	0.05	0.05	0.01	0.01	0.05	0.05	0.05	0.05
Standard Deviation	3.7	30	18	9.2	30	3.7	3.7	34	34	18	18
Number of Guideline Exceedances	0	0	0	0	0	0	0	0	0	0	0
Number of Guideline Exceedances(Detects (	0	0	0	0	0	0	0	0	0	0	0
% of Detects at or above Guidelines	0	0	0	0	0	0	0	0	0	0	0
% of Results Below Guidelines or Non-Detec	100	100	100	100	100	100	100	100	100	100	100

APPENDIX C

Important Information

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APPENDIX 3
ECOLOGICAL AUSTRALIA (10 JUNE 2016): WARDS WELL/LANCEWOOD BRIGALOW TEC ASSESSMENT

Taryn Shears
Specialist Exploration Geology - Validation
BHP Billiton
Brisbane, QLD 4000

ECO LOGICAL AUSTRALIA PTY LTD
ABN 87 096 512 088
www.ecoaus.com.au

10 June 2016

Dear Taryn,

RE: Wards Well/Lancewood Brigalow TEC Assessment

A field survey has been conducted to verify the presence, extent and condition of a potential area of Brigalow (*Acacia harpophylla*) vegetation within the Wards Well project area. The potential occurrence of Brigalow vegetation was previously identified during baseline ecological assessments undertaken across the area in 2010. The area of Brigalow vegetation (from herein referred to as the target area) is located within the northern portion of the Wards Well / Lancewood Mining Lease (ML 4752) (the study area) (**Figure 1)**.

The purpose of the field survey was to identify any potential State and Federal approval triggers and requirements that may be associated with exploration activities currently proposed within the target area. Specifically, the survey was undertaken to:

- confirm whether the vegetation constitutes a Threatened Ecological Community (TEC) under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- determine whether the vegetation classifies as a Category B Environmentally Sensitive Area (ESA) under the *Environmental Protection Act 1994* (EP Act)

The following sections outline the methodology of the assessment as well as the results. Recommendations have been provided based on the outcomes of the assessment.

Methodology

A desktop assessment of relevant environmental documents, databases and maps was initially undertaken to identify the likelihood of the TEC as well as Category B ESA to occur within the study area. A targeted field survey was then undertaken on the 26^{th} May 2016 to validate whether the TEC and / or Category B ESA were present. The field survey involved:

- Diagnostic and condition assessments for Brigalow (*Acacia harpophylla* dominant and co-dominant) TEC in accordance with the criteria and thresholds in the Approved Conservation Advice (Threatened Species Scientific Committee (TSSC), 2013)

- BioCondition Assessments in accordance with the Queensland Herbarium assessment manual *"A Condition Assessment Framework for Biodiversity in Queensland"* (version 2.2) to determine condition of the vegetation

- Regional Ecosystem (RE) Assessments in accordance with the Queensland Herbarium methodology (Nelder *et al.* 2012) to verify the structure and RE classification of the vegetation

- Quaternary vegetation assessments in accordance with the Queensland Herbarium methodology (Nelder *et al.* 2012) to validate the Regional Ecosystem (RE) classification and extent of vegetation communities

The location of all field survey sites are shown in **Figure 2.**

<u>Results</u>

Category B ESA

Under the *Environmental Protection Regulation 2008*, Endangered REs as defined in the Regional Ecosystem Description Database (REDD) are classified as Category B Environmentally Sensitive Areas (ESA). The results of the field survey identified one Endangered RE, RE 11.4.8 within the middle of the target area (**Figure 3**). The Endangered RE was also located just outside the boundary of the study area (to the east).

The Endangered RE within the target area was ground-truthed to occupy an area of approximately 1 ha and was found to comprise the same structural and compositional features as RE 11.4.8 that is described in REDD. The area was identified as remnant and BioCondition assessments scored the area within the second highest condition category (category 2 – functional biodiversity condition).

The balance of the target area was found to comprise predominantly Brigalow regrowth. BioCondition scores for the regrowth vegetation were within the lowest condition category (category 4 - dysfunctional biodiversity condition). In addition, canopy height (average 7.5 m) was recorded to be well below the typical height for Brigalow REs (approximately 15 m), key dominant species from Brigalow REs were absent and weed incursion was high. Due to these factors the regrowth vegetation within the target area is not considered to include the compositional or structural components that are required to meet the definition of this Brigalow RE listed in REDD. As such the vegetation is not considered to be an Endangered RE and therefore is not considered to be a Category B ESA.

Table 1 Error! Reference source not found. describes the ground-truthed Endangered REs within the target area, whilst **Figure 3** illustrates the Endangered RE within and adjacent to the target area.

Table 1: Ground-truthed Endangered REs within the target area

RE	REDD Short Description	VM Act Class / Biodiversity Status	Condition
11.4.8	*Eucalyptus cambageana* woodland to open forest with *Acacia harpophylla* or *A. argyrodendron* on Cainozoic clay plains	Endangered / Endangered	Remnant

Threatened Ecological Communities

Three TECs were identified in the desktop assessment as potentially occurring within the study area, including:

- Brigalow (*Acacia harpophylla* dominant and co-dominant)
- Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin
- Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandwear Bioregions

The field survey identified only Brigalow dominated vegetation within the target area, which is one of the key diagnostic criteria for the Brigalow TEC. Whilst the Queensland State RE mapping identified a semi-evergreen vine thicket dominant community (RE 11.8.13) within the target area, this was confirmed to be incorrect during field investigation.

To determine whether the Brigalow dominated vegetation met all of the key diagnostic criteria and condition thresholds for the Brigalow TEC, 13 Brigalow TEC assessments were undertaken across and directly adjacent to the target area. The findings of these assessments are provided within **Attachment 1**.

Results of the TEC assessments indicate that only one patch of vegetation within the target area meets the classification for the Brigalow TEC. The remnant Brigalow vegetation analogous to RE 11.4.8 (also Category B ESA) was found to meet all diagnostic, structure and patch size criteria for the Brigalow TEC. The area also met the required condition thresholds as weed incursion was recorded at only 20% of the total ground cover. Another area of similar composition and condition ground-truthed just outside of the study area was also found to meet the Brigalow TEC criteria.

The remaining regrowth areas within the target area were found to be of a sufficient patch size; however all areas fell below the required condition threshold for Brigalow TEC due to high weed incursion. In these areas, weed incursion occupied between 60 – 90% of the ground cover.

Overall, only two discrete patches of vegetation classify as the Brigalow TEC, with only one of these patches occurring within the target area, occupying an area of 1 ha (refer to **Figure 4** and **Attachment 2**).

<u>Significant Impact Assessment</u>

Potential impacts to the Brigalow TEC were assessed in accordance with the Matters of National Environmental Significance Significant Impact Guidelines 1.1. This assessment identified that the clearing will not have a significant impact due the very minor loss of TEC and no reduction in the TECs extent of occurrence and area of occupancy (**Table 2**).

Table 2 Significant impact assessment

Criteria	Significant impact	Reason
Reduce the extent of an ecological community	No	The clearing will result in the loss of one patch of Brigalow which is approximately 1 ha. The extent of occurrence of the TEC will not be reduced as a result of this activity.
Fragment or increase fragmentation of an ecological community,	No	The clearing will not fragment

for example by clearing vegetation for roads or transmission lines		any patches of Brigalow
Adversely affect habitat critical to the survival of an ecological community	No	The clearing will result in the loss of one patch of Brigalow which is approximately 1 ha. The extent of occurrence and area of occupancy of the TEC will not be reduced as a result of this activity.
Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns	No	The activity will result in minor impacts that will not affect the viability of other TEC patches in the area.
Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting	No	Remaining patches of Brigalow will not be impacted by the activity.
Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to: • assisting invasive species, that are harmful to the listed ecological community, to become established, or • causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community	No	Remaining patches of Brigalow will not be impacted by the activity. These areas are currently highly disturbed and do not meet the TEC criteria.
Interfere with the recovery of an ecological community.	No	The clearing will result in a very minor loss (1 ha) of Brigalow TEC.

Conclusion & Recommendations

The field surveys have confirmed a 1 ha patch of Brigalow TEC within the target area. This area was also ground-truthed as an Endangered RE and a Category B ESA. Another area of Brigalow TEC and Category B ESA was identified outside of the target area but in close proximity to the study area.

Clearing of the 1 ha patch of Brigalow TEC within the target area is unlikely to be a significant impact, therefore, potential impacts can be self-assessable and referral to the Department of the Environment is not required.

The balance of Brigalow regrowth vegetation within the target area was assessed to be in poor condition and did not contain the necessary compositional or structural components to be classified as an Endangered RE. In addition, the regrowth vegetation was found to not meet the Brigalow TEC criteria due to the high weed incursion recorded across the area.

It is recommended that where possible, measures are undertaken to avoid and / or minimise impacts to the identified areas of the Brigalow TEC / Category B ESA.

Where disturbance within Category B ESA is unavoidable, all exploration activities are to be conducted in accordance with Conditions of the Wards Well Environmental Authority (MIN100496707).

If you have any questions about any aspect of the above information, please contact me on (07) 3503 7194.

Yours sincerely,

Liz Fisher

Senior Ecologist

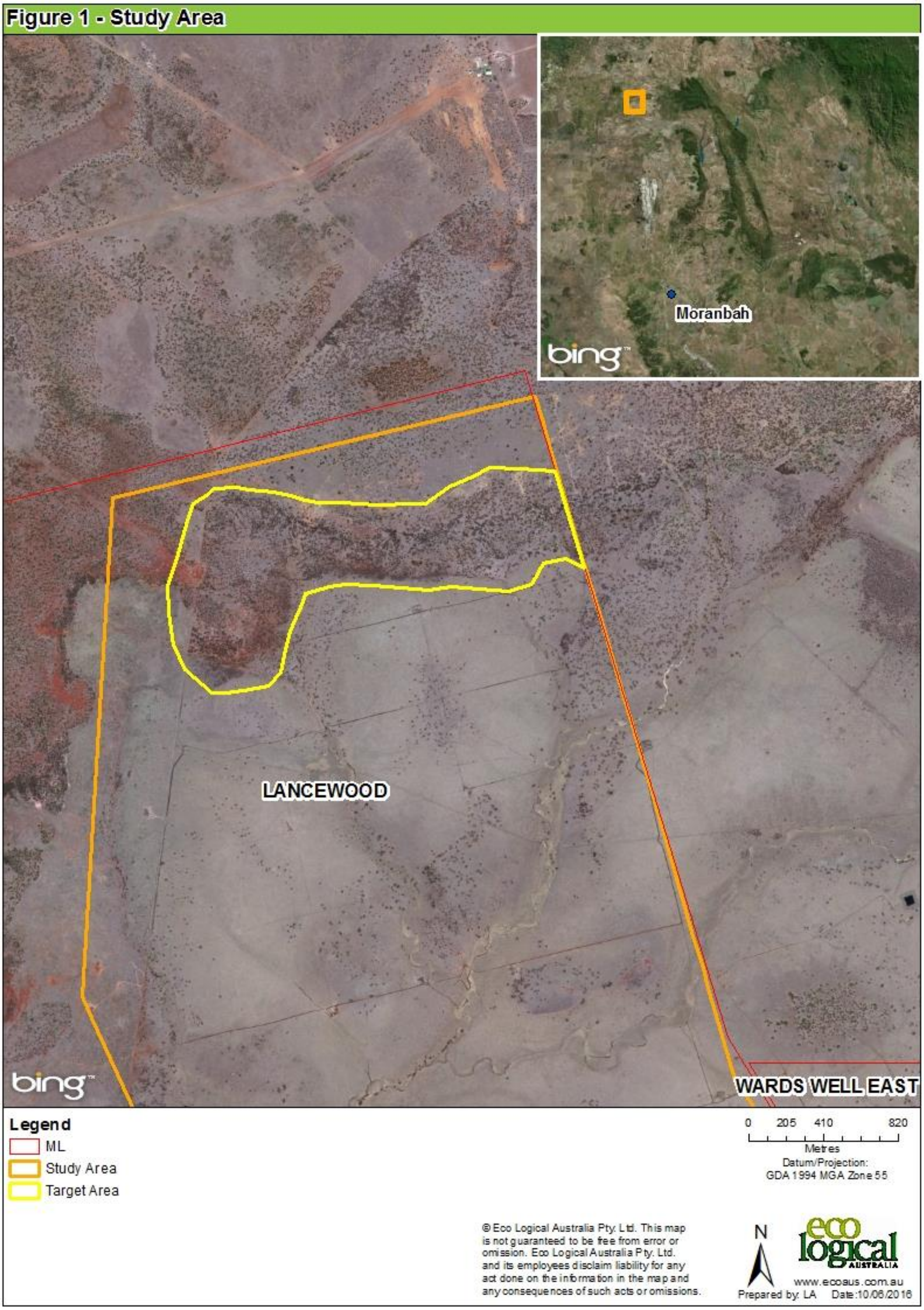

Figure 1 - Study Area

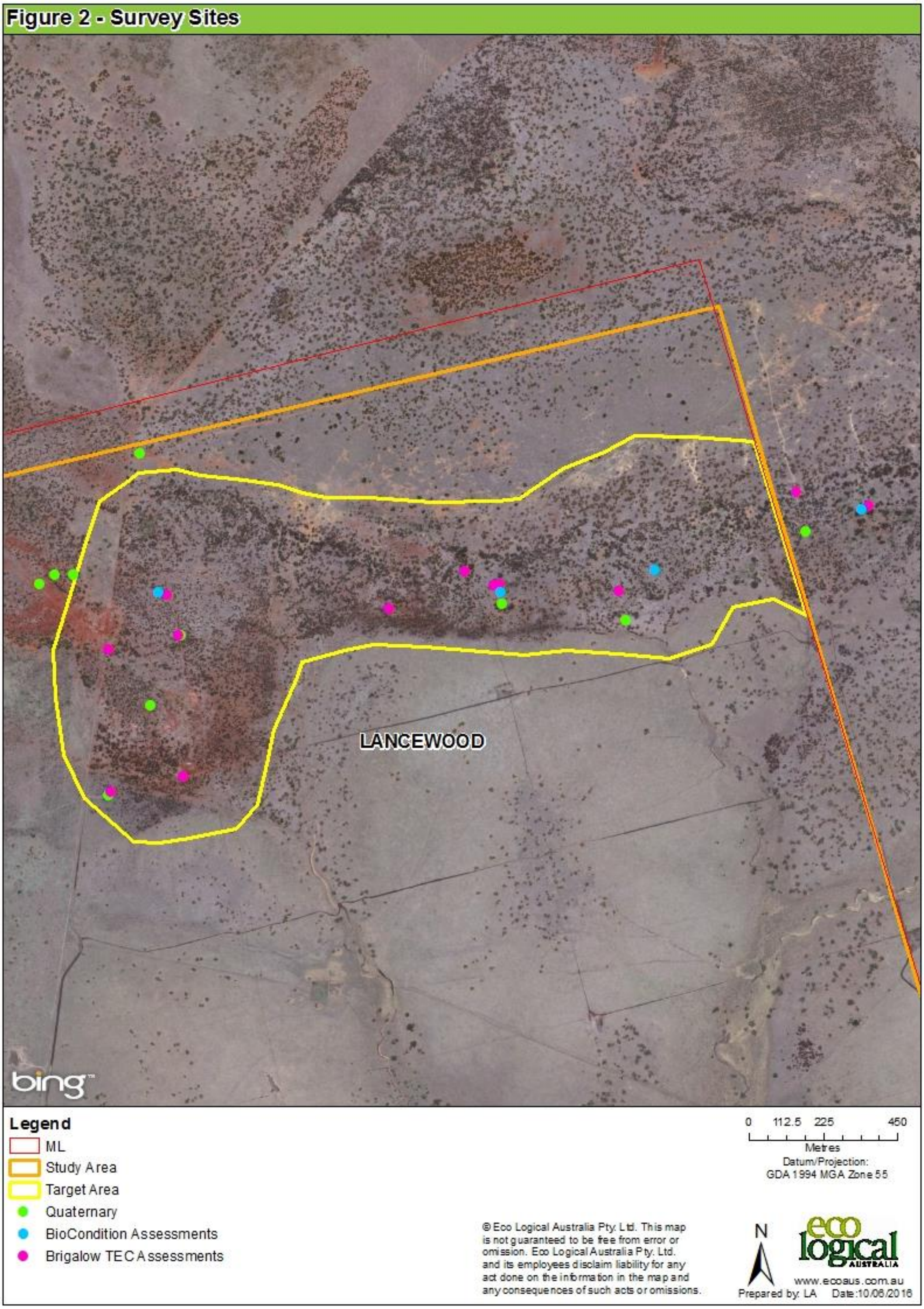

Figure 2 - Survey Sites

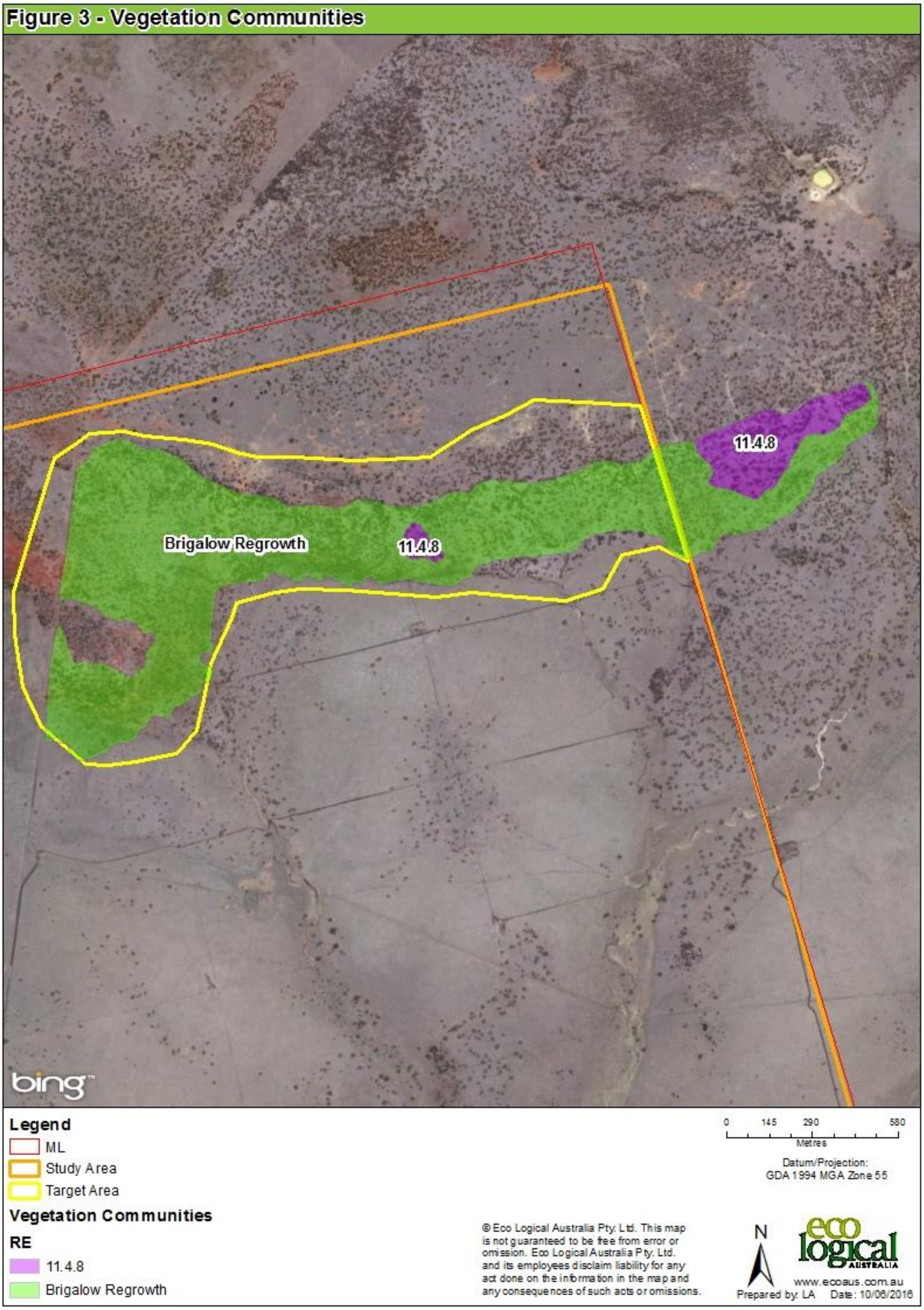

Figure 3 - Vegetation Communities

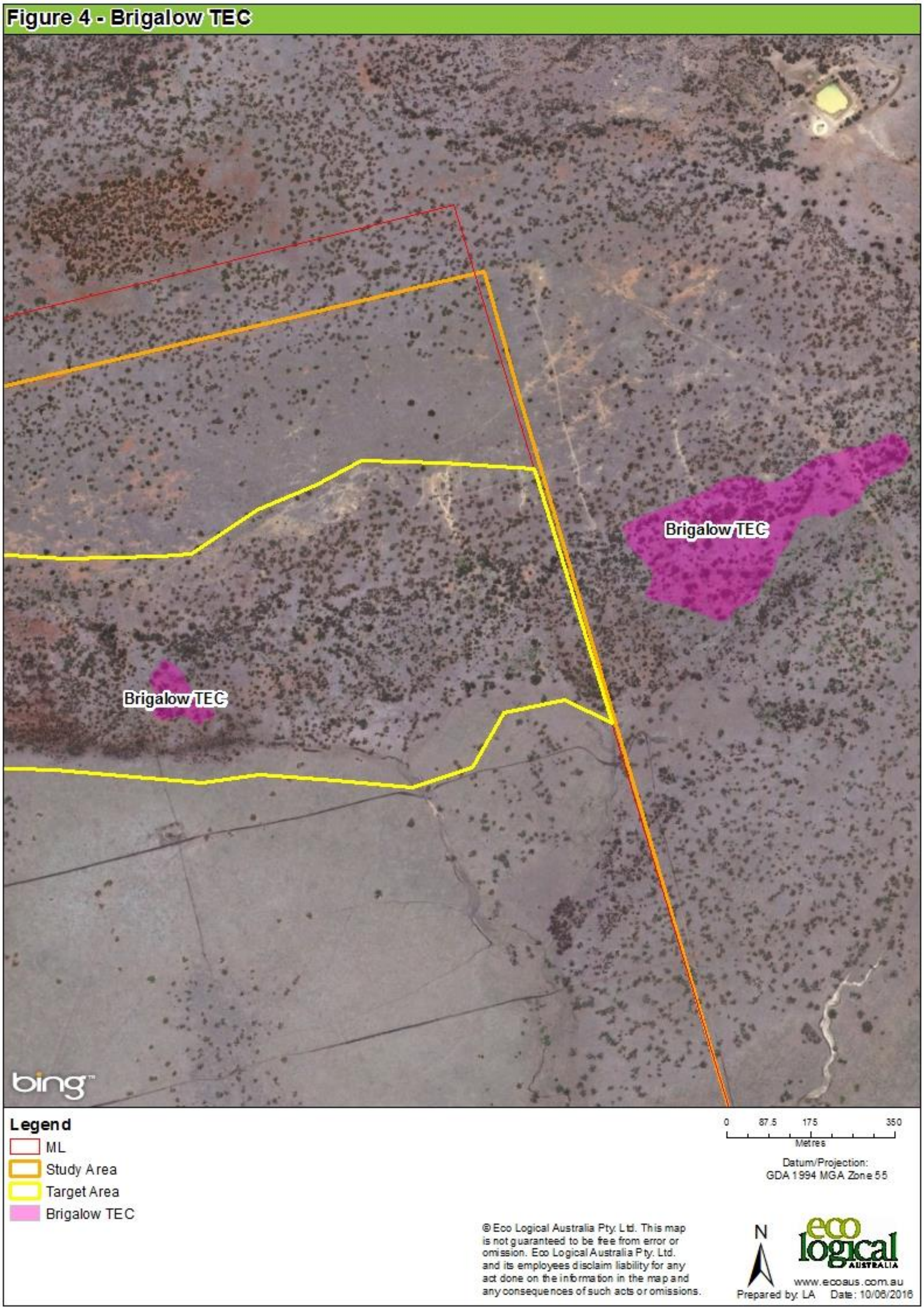

Figure 4 - Brigalow TEC

Attachment 1 – Brigalow TEC Assessments

Survey Site	RE	Tree Layer	Age	Patch Size	Weed Cover
1	-	Dominant	5-15 yrs	>0.5 ha	80
2	-	Dominant	5-15 yrs	>0.5 ha	70
3	-	Dominant	>15 yrs	<0.5 ha	70
4	11.4.8	Co-dominant	>15 yrs	>0.5 ha	20
5	-	Dominant	5-15 yrs	>0.5 ha	60
6	-	Dominant	5-15 yrs	>0.5 ha	65
7	-	Dominant	5-15 yrs	>0.5 ha	60
8	-	Dominant	5-15 yrs	>0.5 ha	60
9	11.4.8	Co-dominant	>15 yrs	>0.5 ha	20
10	-	Dominant	5-15 yrs	>0.5 ha	80
11	-	Dominant	5-15 yrs	>0.5 ha	60
12	-	Dominant	5-15 yrs	>0.5 ha	70
13	-	Dominant	5-15 yrs	>0.5 ha	90

Attachment 2 – Representative Photos Brigalow TEC

APPENDIX 4
ECOLOGICAL AUSTRALIA (18 AUGUST 2017): WARDS WELL COAL PROJECT – ECOLOGICAL ASSESSMENT REPORT. PROJECT NO. 17 BRIECO-4089

Wards Well Coal Project

Ecological Assessment Report

Prepared for
BHP

18 August 2017

DOCUMENT TRACKING

Item	Detail
Project Name	Wards Well Coal Project – Ecological Assessment Report
Project Number	17BRIECO-4089
Project Manager	Liz Fisher 07 3503 7194 3/471 Adelaide Street, Brisbane QLD 4000
Prepared by	Renee Whitchurch
Reviewed by	Liz Fisher
Approved by	Ailsa Kerswell
Status	DRAFT
Version Number	1
Last saved on	18 August 2017
Cover photo	Top left: Natural Grasslands; Top Right: *Accipiter fasciatus* (Brown Goshawk); Bottom Left: Brigalow woodlands; Bottom right: *Dichanthium setosum (*Bluegrass) taken by Renee Whitchurch and Jessie McCudden, June 2017

This report should be cited as 'Eco Logical Australia 2017. *Wards Well Coal Project – Ecological Assessment Report*. Prepared for BHP.'

ACKNOWLEDGEMENTS

This document has been prepared by Eco Logical Australia Pty Ltd

Contents

List of figures

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Abbreviations

Abbreviation	Description
EHP	Department of Environment and Heritage Protection
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
ESA	Environmentally Sensitive Area
GES	General Ecological Significance
ML	Mining Lease
NC Act	*Nature Conservation Act 1992*
RE	Regional Ecosystem
REDD	Regional Ecosystem Description Database
SEVT	Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions
TEC	Threatened Ecological Community
VM Act	*Vegetation Management Act 1999*

Executive summary

An ecological assessment has been undertaken to identify and quantify ecological values located within the proposed Wards Well Coal Project disturbance area. This information is required to assist in determining legislative constraints associated with exploration works for the Wards Well Coal Project.

The ecological assessment included a desktop review of available ecological databases and mapping and a field survey to validate and ground-truth the findings of the desktop assessment. The field survey consisted of quaternary surveys to identify vegetation communities, site condition assessments, Threatened Ecology Community (TEC) assessments and targeted habitat assessments for threatened fauna species, including Greater Glider (*Petauroides volans*), Koala (*Phascolarctos cinereus*) and microchiropteran bats.

A number of ecological values were identified within the proposed disturbance area. These include the identification of three TECs. Brigalow (*Acacia harpophylla* dominant and co-dominant) TEC was ground-truthed within an area of 91.2 ha, Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin (Natural Grasslands) TEC was ground-truthed within an area of 786.4 ha and Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions TEC was ground-truthed within an area of 57.3 ha. Category B Environmentally Sensitive Areas (ESAs) are defined as Regional Ecosystems (REs) which have an Endangered Biodiversity status. REs meeting the definition of Category B ESA were ground-truthed within an area of 828.4 ha.

Dichanthium queenslandicum is currently listed as Endangered under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) and a total of 813 ha of habitat for the species was identified within the study area. In addition to threatened flora habitat, habitat for four threatened fauna species was also identified. Habitat for Koala, listed as Vulnerable under the EPBC Act and *Nature Conservation Act 1992* (NC Act) was ground-truthed within an area of 1,911.5 ha, habitat for Greater Glider listed as Vulnerable under the EPBC Act and Vulnerable under the NC Act was ground-truthed within an area of 315.2 ha, Squatter Pigeon listed as Vulnerable under the EPBC Act and Vulnerable under the NC Act was ground-truthed within an area of 171.2 ha and habitat for Ornamental Snake, listed as Vulnerable under the EPBC Act and NC Act was ground-truthed within an area of 213.6 ha. An additional area of 1,774.7 ha was found to contain MSES values associated with Regulated Vegetation, connectivity and watercourses.

The ecological values detailed above are located across the proposed disturbance area, interspersed with areas of non-remnant and regrowth vegetation which are not environmentally constrained. It is recommended that exploration works are limited to areas outside of identified and mapped ecological values. Where this is not possible additional management and mitigation measures may be employed to avoid and reduce impacts. Where there is the potential for residual impacts, regulatory requirements should be carefully considered prior to activities commencing.

1 Introduction

1.1 Project Background

BHP are currently preparing to undertake exploration activities within the Wards Well Coal Project area. The Wards Well Coal Project is located north of the Red Hill Mine Project as well as the existing Goonyella Riverside and Broadmeadow Mine complex, approximately 50 km north of Moranbah and 135 km south-west of Mackay.

Exploration activities have previously been undertaken across the Wards Well Coal Project area, for which a referral under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) was submitted. The referral was for an exploration program across the three adjoining tenements (ML1790, ML4752 and EPC1061) involving 55 drill pads, approximately 42 km of seismic survey lines and associated exploration activities such as tracks. The project received a referral decision notice "not a controlled action if undertaken in a particular manner" on the 1 March 2011 by the Commonwealth Department of the Environment (DoE) (EPBC 2011/5820). This allowed for the program to proceed and specifically permitted the disturbance of the Threatened Ecological Community (TEC) *Natural Grasslands of the Queensland and Central Highlands and the northern Fitzroy Basin* and listed threatened grass species. Disturbance was permitted in accordance with specified disturbance limits and management actions.

Environmental Authority (EA) EPPR00668513 was also granted under the *Environmental Protection Act 1994* (EP Act) to permit exploration drilling & 3D seismic across ML4752, ML1790, ML70443 and ML70495. Works are permitted in accordance with the specified maximum disturbance areas, constraints and conditions outlined in the EA. This includes permitted disturbance to Category B Environmentally Sensitive Areas (ESAs) as per the designed exploration program disturbance footprint included in the EA.

Previous exploration activities have disturbed xx ha [BHP to advise] of the approved disturbance limit for the Grassland TEC consistent within the 2011 EPBC Act referral determination. If additional disturbance above the disturbance limit is required and/or other MNES have the potential to be significantly impacted, then further assessment and/or approvals may be required. Furthermore, the current EA may not be valid due to the potential inconsistencies between the approved exploration program under the EA and the proposed exploration activities. As such, disturbance associated with the proposed exploration activity may not be covered or only partially covered under existing approvals. This ecological assessment has been prepared to identify and quantify ecological values located within the study area as well as associated legislative constraints for consideration in upcoming exploration activities.

1.2 Objectives and Scope of Work

The objective of this assessment is to validate the ecological values within the project area, using both desktop and field verified data, to assist in the identification of ecological constraints for exploration activities.

Specifically, the scope of works included:

- Confirming the presence and absence of Commonwealth and State significant species and associated habitats
- Validating the habitat values of the study area, particularly in relation to supporting significant species such as Koala (Phascolarctos cinereus), Greater Glider (Petauroides volans),

Ornamental Snake (Denisonia maculata), Squatter Pigeon (Geophaps scripta scripta) and microchiropteran bats.
- Confirming the extent of Regulated Vegetation, including vegetation analogous to Endangered Regional Ecosystems
- Assessing the condition and extent of Commonwealth listed Threatened Ecological Communities (TECs)
- Determining the quality of vegetation communities present, including identification of weed and pest infestations
- Assessing the landscape values including corridor functions
- Determining the associated legislative constraints for identified ecological values
- Recommending measures to avoid, mitigate and manage potential impacts associated exploration activities

1.3 Study Area Description

The Wards Well Coal Project area encompasses approximately 8,343.1 ha of land, formally described as Lot 8 on GV807254 and Lot 2 on SP214117, which are covered under the Wards Well Mining Leases (ML) ML4752, ML1790 and Exploration Coal Permit (EPC) EPC1016 (project area). The exploration activities will be designed to enhance the understanding of the coal resource for potential mining activities. The focus of the ecological assessment is within the proposed seismic area (study area), which encompasses 7,145 ha and overlays a significant proportion of the MLs and EPC (**Figure 1**).

The study area is predominantly vegetated and consists of a mixture of intact and regrowth woodland communities as well as natural grasslands. Cattle grazing is the predominant land use across the study area as well as in the surrounding area. The Goonyella Mine is located south of the study area. Suttor Development Road intersects the northern portion of the study area. Various minor watercourses also traverse the study area.

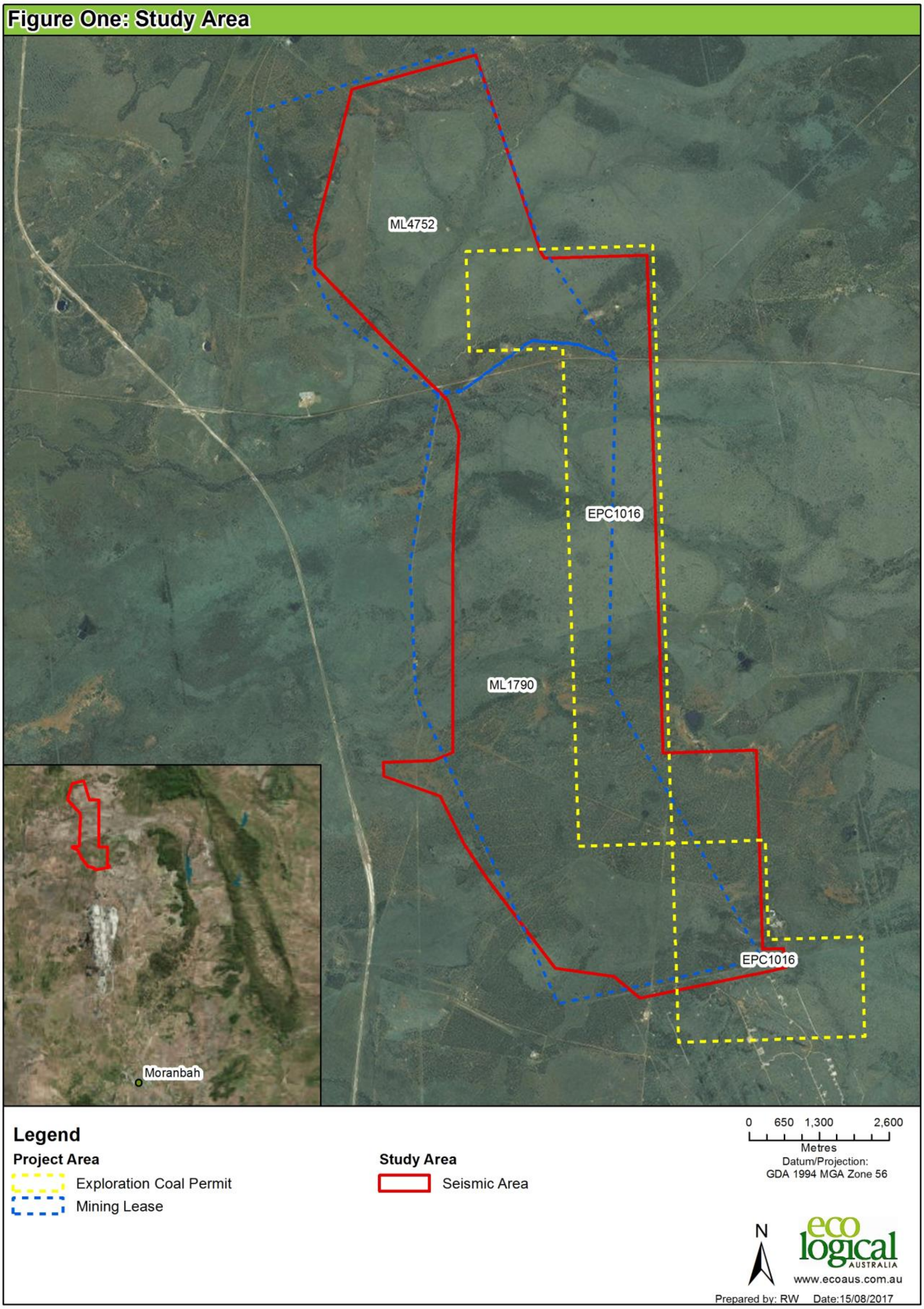

Figure 1: Study Area

2 Methods

2.1 Desktop Assessment

The desktop assessment involved reviewing the relevant environmental documents, databases, maps and legislation (Federal, State and Local) to identify potential ecological values that may occur within the study area. This included the following documents, databases and maps:

- Wards Well / Lancewood Environmental Baseline Survey (SKM 2010)
- Protected Matters Search Tool (PMST) Report (central coordinate of -21.547; 147.949; 20km buffer)
- Wildnet database (central coordinate of -21.547; 147.949; 30km buffer)
- Atlas of living Australia (ALA) species search (central coordinate of -21.547; 147.949; 30km buffer)
- Environmentally Sensitive Areas Map
- Protected Plants Flora Survey Trigger Map
- Regional Ecosystem (RE) mapping version 9.0
- Queensland geological digital data (DNRM, 2012)
- Isaac-Comet land-systems mapping (CSIRO, 1967)
- Essential Habitat mapping version 4.18
- Referrable Wetland mapping
- Wetland Protection Area mapping
- *Vegetation Management Act 1999* (VM Act) watercourse data
- VM Act wetland data
- Matters of State Environmental Significant (MSES) mapping
- Aerial imagery
- Historical aerial imagery (QImagery)

Preliminary vegetation mapping of the study area was also undertaken to further refine the results of the desktop assessment and to provide indicative survey sites to guide field survey effort and ensure sufficient stratification of sampling sites across the study area. Preliminary vegetation mapping was based on mapped RE, geology, land-systems mapping and previous field survey data in conjunction with Aerial Photographic Interpretation (API). API using historical aerial imagery was utilised to differentiate between areas of natural and derived grassland within the study area. Preliminary vegetation mapping involved delineating the study area into assessment units, which are homogenous assessment units defined by a unique RE and broad condition state (i.e. non-remnant, regrowth or remnant). This was done in accordance with the Guide to Determining Terrestrial Habitat Quality (Version 1.2).

Preliminary vegetation mapping and survey sites where uploaded onto a Differential GPS device (Trimble) to assist with navigation during the field survey.

2.2 Field Survey

The field survey was undertaken over ten days, from the 13 to 22 June 2017 to collect additional and more detailed information on the relevant potential ecological values identified from the desktop assessment. The field survey was undertaken by three qualified ecologists and included a flora, fauna and targeted habitat assessment. Survey sites are illustrated in **Figure 2** and **Figure 3.**

Targeted surveys for threatened grass species were also undertaken over eight days between the 19 and 26 April 2017. The methodology and associated results are outlined in the Wards Well Pre-clearance Report (ELA, 2017).

2.2.1 Flora Assessment

The flora assessment consisted of ground-truthing the preliminary vegetation mapping across the study area as well as validating the presence of Regulated Vegetation, TECs and Category B ESAs. Data on vegetation characteristics (floristic and structural form), ecological condition and extent of the vegetation communities, including RE and TEC classification was collected via three methodologies – site condition assessments, quaternary surveys and TEC assessments.

<u>Site Condition Assessment</u>

Site condition assessments were undertaken within the study area in accordance with the *Guide to determining terrestrial habitat quality* (DEHP 2014, Version 1.2). Site condition assessments involved the collection of the following 13 site based attributes within a 100 m x 50 m nested sampling plot:

- Recruitment of woody perennial species
- Native tree species richness
- Native shrub species richness
- Native grass species richness
- Native forb species richness
- Tree canopy height
- Tree canopy cover
- Shrub canopy cover
- Native perennial grass cover
- Organic litter cover
- Number of large trees
- Coarse woody debris abundance
- Non-native plant cover

In total 35 site condition assessments were conducted across the study area (**Figure 2**).

<u>Quaternary Assessments</u>

Quaternary surveys were conducted to validate the extent, classification and condition of ground-truthed vegetation communities and habitat types within the study area. Quaternary surveys were undertaken in accordance with the '*Methodology for Survey and Mapping of Regional Ecosystems and Vegetation Communities in Queensland'* (Nelder *et. al.,* 2012). At each survey point, the following information was recorded:

- RE classification
- Vegetation condition (remnant, high-value regrowth, regrowth, non-remnant)

RE classification was determined based on the vegetation, soil and landform characteristics identified in the field, geological mapping for the region and the Regional Ecosystem Description Database (REDD).

Condition status for woody vegetation was evaluated utilising the definitions of remnant vegetation under the VM Act.

A total of 249 quaternary surveys were conducted across the study area (Error! Reference source not found.).

TEC Assessments

TEC assessments were undertaken to confirm the presence of TECs identified during the desktop assessment, namely:

- Brigalow (*Acacia harpophylla dominated and co-dominated*) Threatened Ecological Community (Brigalow TEC)
- Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin (Natural Grassland TEC)
- Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nadewar Bioregions (SEVT TEC)

Brigalow TEC assessments were undertaken to identify vegetation communities meeting the key diagnostic and condition threshold criteria as described in the Commonwealth Approved Conservation Advice (TSSC, 2013). The assessment consisted of collecting the following data at various sites within Brigalow vegetation:

- Dominance or co-dominance of Brigalow
- Brigalow listed RE
- Exotic perennial cover
- Age of community
- Patch size

Natural Grassland TEC assessments were undertaken in areas preliminary mapped as naturally derived grassland to identify areas meeting the key diagnostic and condition threshold criteria as described in the Commonwealth Listing Advice (TSSC, 2008). The assessment consisted of collecting the following data at various sites within natural grassland communities:

- Tree canopy cover
- Presence of listed indicator species in the ground layer
- Assessment against condition thresholds (**Table 1)**

Table 1: Condition classes for the Natural Grassland TEC

	Best quality	Good quality
Patch size	At least 1 ha	At least 5 ha
Grasses	At least 4 native perennial grass species from the list of perennial native grass indicator species	At least 3 native perennial grass species from the list of perennial native grass indicator species
Tussock cover	At least 200 native grass tussocks	At least 200 native grass tussocks
Woody shrub cover	Total projected canopy cover of shrubs is < 30%	Total projected canopy cover of shrubs is < 50%
Introduced species	Perennial non-woody introduced species are < 5% of the total projected plant cover	Perennial non-woody introduced species are < 30% of the total projected plant cover

There are currently no key diagnostic criteria or condition thresholds for the Semi-evergreen Vine Thicket (SEVT) TEC, however, the Commonwealth Listing Advice (TSSC, 2001) details REs that comprise the TEC. Therefore assessments for SEVT consisted of ground truthing RE mapping (quaternary surveys as above) and assigning any REs that are known to comprise the TEC as SEVT.

REs included in the SEVT TEC, the short description as per the REDD and the Biodiversity status of each RE are provided in **Table 2**.

Table 2: REs included in the SEVT TEC

RE	Short description	Biodiversity status
11.3.11	Semi-evergreen vine thicket on alluvial plains	Endangered
11.4.1	Semi-evergreen vine thicket ± *Casuarina cristata* on Cainozoic clay plains	Endangered
11.5.15	Semi-evergreen vine thicket on Cainozoic sand plains and/or remnant surfaces	Endangered
11.8.13	Semi-evergreen vine thicket and microphyll vine forest on Cainozoic igneous rocks	Endangered
11.9.4	Semi-evergreen vine thicket or *Acacia harpophylla* with a semi-evergreen vine thicket understorey on fine-grained sedimentary rocks	Endangered
11.11.18	Semi-evergreen vine thicket on old sedimentary rocks with varying degrees of metamorphism and folding	Endangered
11.2.3	Microphyll vine forest ("beach scrub") on sandy beach ridges and dune swales	Of concern
11.8.3	Semi-evergreen vine thicket on Cainozoic igneous rocks	Of concern
11.8.6	Macropteranthes leichhardtii thicket on Cainozoic igneous rocks	Of concern
11.9.8	Macropteranthes leichhardtii thicket on fine grained sedimentary rocks	Endangered

A total of 35 Brigalow TEC and 112 Natural Grassland TEC assessments were conducted across the study area (Error! Reference source not found.). Quaternary surveys were used to identify vegetation communities analogous to SEVT TEC listed REs.

2.2.2 Fauna Assessment

The fauna assessment consisted of nocturnal searches (spotlighting), bat detection and habitat assessments to determine the actual or likely presence/absence of targeted threatened, migratory and pest species and their habitats. The target species are species listed under the EPBC Act or *Nature Conservation Act 1992* (NC Act) considered likely or potential to occur within the study area based on the desktop assessment and preliminary vegetation mapping results. This included threatened reptile, bird and mammal species, namely Ornamental Snake, Squatter Pigeon and , Koala,Greater Glider.

Fauna assessments were undertaken within REs that were considered to contain important macro and micro habitat features for the targeted species. Areas with the following habitat features were assessed for the target species:

- Koala and Greater Glider: Eucalypt woodlands containing koala food trees and hollow bearing trees
- Ornamental Snake: Brigalow woodlands containing cracking clays and gilgais
- Squatter Pigeon: areas within landzones 5 and 7 near permanent water bodies

The fauna assessment was designed to include appropriate detection methods for identified target species, which are discussed further in the sections below.

Targeted habitat assessments

Targeted habitat assessments were conducted for Squatter Pigeon, Koala, Greater Glider, microchiropteran bats and Ornamental Snake to quantify the presence and extent of habitat within the study area. The assessments also provide sufficient data for species habitat index scoring as per the Guide of Determining Terrestrial Habitat Quality. Habitat assessments were species specific and included identifying the presence of key values such as:

- Habitat condition (i.e. remnant or regrowth)
- Presence of foraging resources
- Presence of water
- Soil type
- Occurrence of species specific habitat features (i.e. deep cracking clays, gilgai, tree hollows)
- Species specific threat presence and severity

A total of 13 Squatter Pigeon, 10 Koala and 15 Ornamental Snake habitat assessments were conducted across the study area (Error! Reference source not found.).

Areas that contained an abundance of tree hollows suitable for species such as Greater Glider and microchiropteran bats were also recorded (**Figure 2**).

Spotlighting Searches

Spotlighting searches targeting Greater Glider and Koala were undertaken across four nights (15 to 18 June) within areas where suitable micro-habitat features occurred (i.e. tree hollows and foraging resources).

In total 20 person hours of surveying was undertaken across the study area, consisting of both vehicle and on-foot spotlighting searches. Spotlighting surveys were conducted in a new area each night where micro-habitat features were identified (**Figure 3**). Spotlighting searches undertaken meet the recommended spotlighting survey guidelines (DSEWPC 2011)

Acoustic Bat Detection

Acoustic bat detection using Songmeter SM3 devices targeting microchiropteran bats was undertaken across four nights (16 to 19 June). Two devices were deployed across four consecutive nights and placed in different locations across the study area to increase the likelihood of call detection (**Figure 3**).

Passive acoustic detection techniques are used to identify the use of areas by microchiropteran bats, which can then be followed up by appropriate level of trapping if threatened species are potentially detected. Detection devices were placed in natural flyways or suspected bat foraging areas, to optimize the potential recordings. A total of six detection nights were undertaken across the study area.

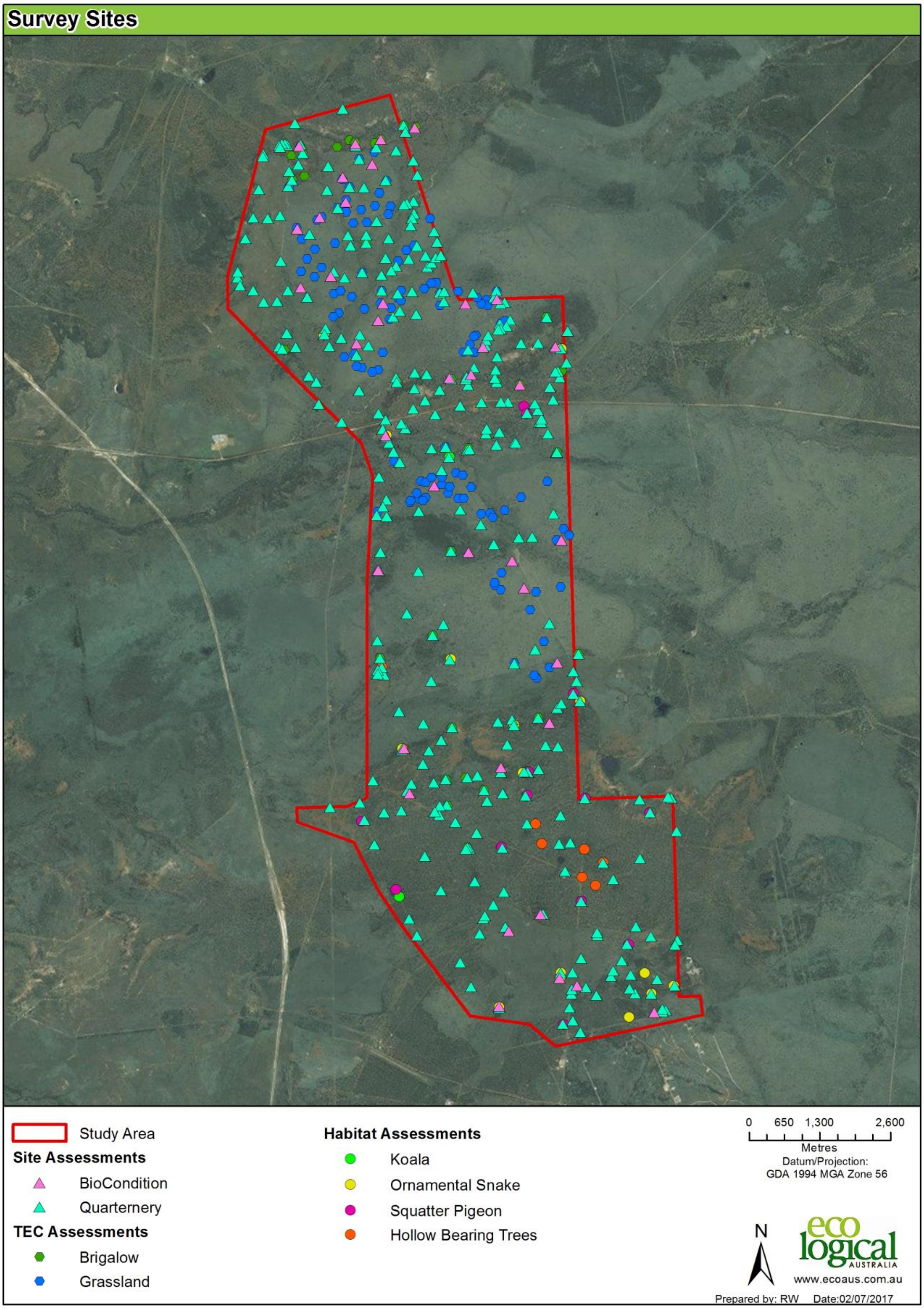

Figure 2: Survey Sites

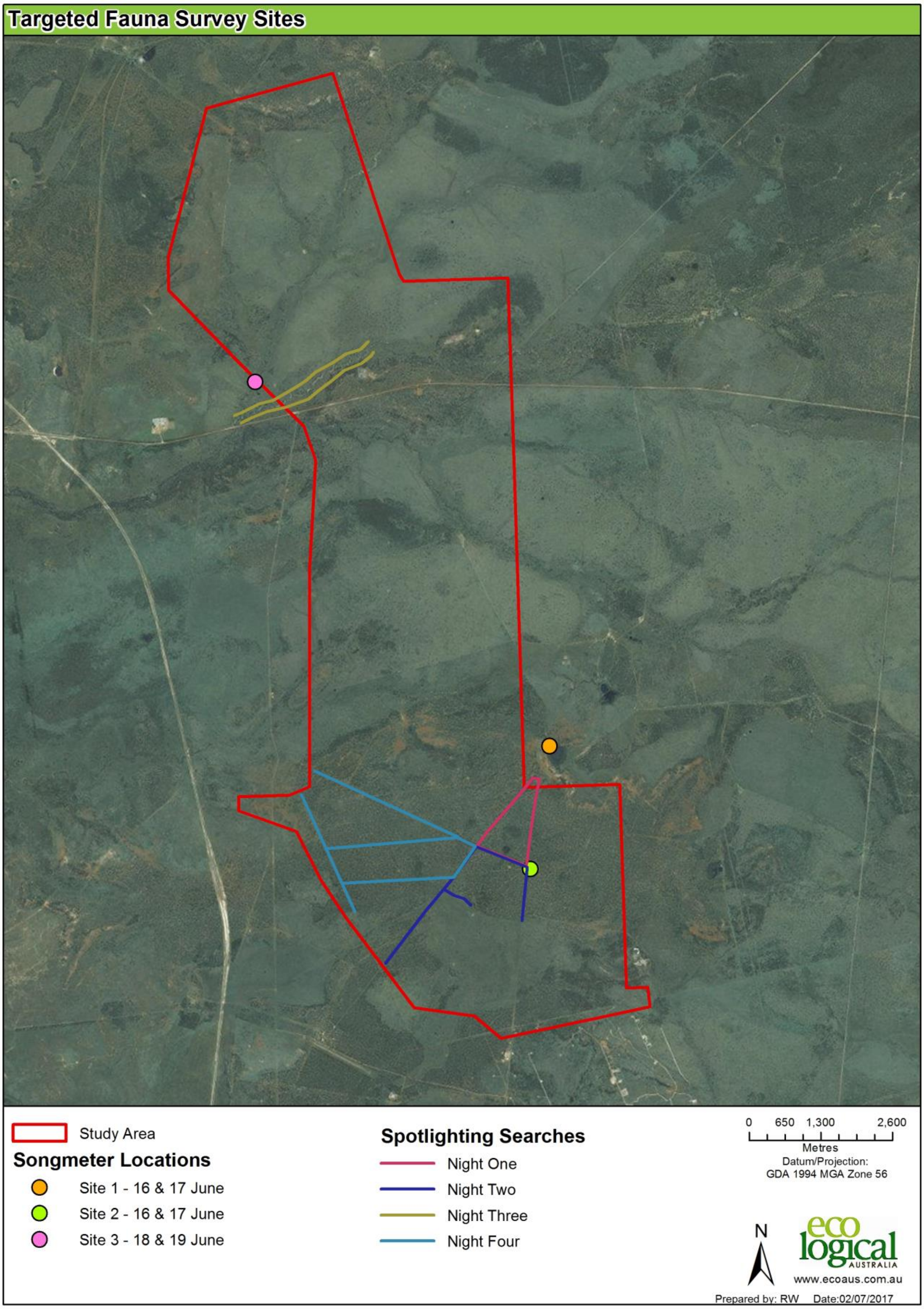

Figure 3: Targeted Fauna Survey Sites

2.3 Data Analysis

2.3.1 Bat Call Analysis

Analysis of all bat calls collected during the survey period was undertaken by a qualified specialist, Greg Ford of Balance Environmental. A total of four nights of recordings were analysed from three different areas across the study area. The format and content of the analysis summary reports complies with nationally accepted standards for the interpretation and reporting of Anabat data (Reardon, 2003).

2.3.2 GIS Analysis

Spatial data collected during the field survey was imported into ArcView GIS (Version 10.2) and analysed against preliminary vegetation mapping. Where necessary, vegetation community and habitat boundaries were refined and/or verified using the collected spatial data to produce final ground-truthed mapping. TEC condition thresholds associated with patch size were also confirmed through GIS analysis of the final ground-truthed mapping.

Final ground-truthed mapping was then used to undertake site context assessments to provide a quantitative assessment of the landscape values of the study area as well as an overall condition score in accordance with the Guide to determining Terrestrial Habitat Quality (Version 1.2) (**Section 2.3.2**).

Site context assessment

Landscape-scale attributes were assessed within a 'Fragmented Landscape', as per the Guide to determining Terrestrial Habitat Quality (Version 1.2). Attributes calculated included:

- Patch Size
- Connectedness
- Context
- Ecological corridors

The spatial layers used to assess the site context attributes were:

- Ground-truthed vegetation mapping of the study area (ELA, 2017)
- Regulated Vegetation Mapping (Version 9.0)

2.3.3 Habitat quality scoring

Habitat quality scoring was conducted in accordance with the Guide to determining Terrestrial Habitat Quality (Version 1.2). This involved accumulating the average site condition and site context scores for each relevant assessment unit and dividing the total against the maximum score for the ecosystem type (i.e. woodland = maximum score of 106). Where relevant, species habitat index scoring was included in the calculations.

Benchmark data to complete the comparison value assessment for the site condition assessment was sourced from Queensland Herbarium prepared benchmarks for each assessment unit's ground-truthed RE (or closest RE benchmark within the same Broad Vegetation Group). Where multiple field survey sites were assessed for one assessment unit, habitat quality scores were averaged.

2.4 Survey Limitations

Flora

It should be noted that the detectability of plants and the ability to accurately identify plants to species level may vary greatly with the time of year, prevailing climatic conditions and the presence of reproductive material (e.g. flowers, fruit, and seed capsules). Specifically, native grass species can be difficult to identify due to seasonality. For this reason, pre-clearance surveys for threatened grass species were conducted prior to this survey when conditions were more optimal. However, results of both surveys should not be regarded as conclusive evidence that certain protected plants do not occur within the study area.

Fauna

All fauna assessments are subject to inherent limitations in the detection success of targeted species. These limitations often result in a degree of false-absence records (i.e. a species is present, but not detected). It is important, therefore, that the limitations to surveys are identified and the survey results are viewed with these constraints in mind.

The general limitations to the fauna assessment conducted in the study area may include the following:

- Species with large home ranges may not be present in this part of their home range during the survey.
- The difficulty detecting certain species during the survey period (e.g. cryptic species and species present in the study area in low densities).
- Biological factors such as sex, age-class, and breeding biology, which may influence species' habitat use and detectability during different times of year.

In addition to these limitations, the survey was undertaken during the winter months, which provided less optimal conditions and/or timing to detect some fauna groups. The target reptile and mammal species are generally more active in the warmer months, which increases the likelihood of detection.

In response to the abovementioned limitations the fauna assessment with a suitable survey effort was designed to ensure every chance of detecting target species where present. For species not detected, habitat assessments were undertaken to determine the value of the study area for supporting such species i.e. absence of a species was not assumed because it was not detected.

3 Results

3.1 Survey Conditions

The weather conditions leading up to and at the time of the survey are shown in **Table 3**. Data was obtained from recordings taken at the Moranbah Airport, located 50 km south of the Project area.

Table 3: Weather conditions preceding and during the field survey

Date	Temperature (^{0}C)		Total Rainfall (mm)	Max Wind Speed (km/h)
	Mean minimum	Mean Maximum		
March 2017	21.5	33.5	257.8	100
April 2017	14.6	28.4	0.00	57
May 2017	13.7	26.2	101.2	50
13/06/2017	6.8	24.0	0.00	35
14/06/2017	8.2	23.5	0.00	43
15/06/2017	9.7	NA	0.00	NA
16/06/2017	10.4	24.8	0.00	33
17/06/2017	9*.4	25.9	0.00	24
18/06/2017	8.7	26.2	0.00	39
19/06/2017	7.1	24.3	0.00	37
20/06/2017	7.0	24.7	0.00	41
21/06/2017	7.8	24.2	0.00	37
22/06/2017	4.5	23.9	0.00	33

3.2 Floristic Values

3.2.1 Vegetation Communities

The study area is currently mapped by the Department of Environment and Heritage Protection (EHP) as a mosaic of Category B remnant vegetation and Category X non-remnant areas. Ground-truthing of vegetation communities across the study area revealed numerous inaccuracies in current mapping, including the extent of remnant vegetation as well as the identification and classification of RE types.

The study area was found to comprise predominantly remnant and regrowth vegetation, within which 21 vegetation communities were ground-truthed (**Table 4**, **Figure 4**). Disturbance due to historical land uses including grazing have created a mosaic of intact and regrowth communities at varying stages of maturity which are interspersed with non-remnant areas.

The study area north of Suttor Development Road is dominated by natural grasslands and *Eucalyptus orgadophila* open woodlands on basalt derived soils, most of which has been highly disturbed due to grazing. The western boundary contains lateritic jump-up areas and the far northern boundary contains Acacia thickets and Eucalypt woodlands on tertiary surfaces. Brigalow dominated woodland communities are also scattered throughout the area north of Sutttor Development Road. Vegetation south of Suttor

Development Road is also dominated by natural grasslands and *E. orgadophila* open woodlands on basalt derived soils, much of which is in remnant condition. The southern area is dominated by a mosaic of *Eucalyptus crebra* and *Eucalyptus populnea* woodlands on tertiary surfaces, with small pockets of semi-evergreen vine thicket and sections of Brigalow dominated woodlands on the southern boundary. Waterways that traverse both the northern and central portion of the study area also support fringing riparian Eucalypt communities.

Table 4: Vegetation communities ground-truthed within the study area

RE	Short Description	Biodiversity Status	Condition	Area (ha)
11.3.1	*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains	Endangered	Remnant	11.1
			Mature Regrowth	51.6
11.3.25	*Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines	Of concern	Remnant	79.9
11.3.3	*Eucalyptus coolabah* woodland on alluvial plains	Of concern	Remnant	4.4
11.3.3a	*Melaleuca bracteata* woodland. On alluvial plains. Riverine wetland or fringing riverine wetland	Of concern	Remnant	34.1
11.4.8	*Eucalyptus cambageana* woodland to open forest with *Acacia harpophylla or A. argyrodendron* on Cainozoic clay plains	Endangered	Remnant	39.0
			Mature Regrowth	56.1
11.4.9	*Acacia harpophylla* shrubby woodland with *Terminalia oblongata* on Cainozoic clay plains	Endangered	Remnant	48.2
			Mature Regrowth	252.1
11.5.3	*Eucalyptus populnea ± E. melanophloia ± Corymbia clarksoniana* woodland on Cainozoic sand plains and/or remnant surfaces	No concern at present	Remnant	429.4
			Mature Regrowth	81.8
11.5.3b	*Eucalyptus populnea* on closed depressions	No concern at present	Remnant	40.3
11.5.9	*Eucalyptus crebra* woodland on Cainozoic sand plains and/or remnant surfaces	No concern at present	Remnant	1,361.9
			Mature Regrowth	106.5
11.5.15	Semi-evergreen vine thicket on Tertiary surfaces	Endangered	Remnant	57.5
11.7.1x	Semi-evergreen vine thicket	Of concern	Regrowth	5.2
11.7.2	*Acacia* spp. woodland on Cainozoic lateritic duricrust. Scarp retreat zone	No concern at present	Remnant	11.8
11.8.11	*Dichanthium sericeum* grassland on Cainozoic igneous rocks	Of concern	Remnant	1,661.8
11.8.11a	*Melaleuca bracteata* woodland drainage depressions. Occurs in drainage depressions.	Of concern	Remnant	9.5
11.8.5	*Eucalyptus orgadophila* open woodland on Cainozoic igneous rocks	No concern at present	Remnant	1,166.2
			Mature Regrowth	42.0

RE	Short Description	Biodiversity Status	Condition	Area (ha)
11.8.15	*Eucalyptus populnea* woodland on Cainozoic igneous rock	Endangered	Remnant	9.3
11.9.2	*Eucalyptus melanophloia* and/or *Eucalyptus orgadophila* woodland on Cainozoic fine grained sediments	No concern at present	Remnant	65.0
11.9.5	*Acacia harpophylla* and/or *Casuarina cristata* open forest with semi-evergreen vine thicket understorey	Endangered	Remnant	18.7
			Mature Regrowth	204.1
11.9.7	*Eucalyptus populnea* woodland on Cainozoic fine grained sediments	Of concern	Remnant	8.4
			Mature Regrowth	8.7
11.9.7a	*Eucalyptus populnea* shrubby woodland on Cainozoic fine grained sediments	Of concern	Remnant	25.3
11.9.9	*Eucalyptus crebra* grassy woodland on Cainozoic fine grained sediments	No concern at present	Remnant	92.0
-	Brigalow regrowth	-		394.4
-	Eucalypt regrowth	-		86.5

3.2.2 Category B ESAs

Under the *Environmental Protection Regulation 2008*, REs with an Endangered Biodiversity status as defined in the REDD are classified as Category B ESAs. The current Queensland Environmentally Sensitive Areas map identifies several patches of Category B ESA throughout the study area (Error! Reference source not found.).

Field survey confirmed the presence of Category B ESA within the study area, with ground-truthed Category B ESA found to comprise a total area of 747.5 ha, significantly exceeding the mapped extent of 70 ha (**Table 5**, **Figure 5)**. Category B ESA within the study area was found to be analogous to RE11.3.1, RE11.4.8, RE11.4.9, RE11.5.15, RE11.8.15 and RE11.9.5 all of which have an endangered Biodiversity status. Condition ranged from remnant to mature regrowth. These endangered vegetation communities where identified in large contiguous patches and smaller fragments throughout the entire study area.

Table 5: Category B ESA vegetation identified within the study area

RE	Short Description	VM Act status	Biodiversity Status	Area (ha)
11.3.1	*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains	Endangered	Endangered	62.7
11.4.8	*Eucalyptus cambageana* woodland to open forest with *Acacia harpophylla or A. argyrodendron* on Cainozoic clay plains	Endangered	Endangered	95.0
11.4.9	*Acacia harpophylla* shrubby woodland with *Terminalia oblongata* on Cainozoic clay plains	Endangered	Endangered	300.2

RE	Short Description	VM Act status	Biodiversity Status	Area (ha)
11.5.15	Semi-evergreen vine thicket on Tertiary surfaces	Endangered	Endangered	57.5
11.8.15	*Eucalyptus populnea* woodland on Cainozoic igneous rock	Endangered	Endangered	9.3
11.9.5	*Acacia harpophylla* and/or *Casuarina cristata* open forest with semi-evergreen vine thicket understorey	Endangered	Endangered	222.8
			Total Category B ESA:	**747.5**

3.2.3 Threatened Ecological Communities

Three TECs were identified in the desktop assessment as potentially occurring within the study area, including:

- Brigalow (*Acacia harpophylla* dominant and co-dominant)
- Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin (Natural Grasslands)
- Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions (SEVT)

Field survey confirmed the presence of all three TECs within the study area (**Figure 5**).

Vegetation meeting the key diagnostic criteria for the Brigalow TEC were identified as the listed Brigalow REs RE11.3.1, RE11.4.8, RE11.4.9 and RE11.9.5 with *Acacia harpophylla* (Brigalow) dominant or co-dominant within the canopy. However, only a few patches of these vegetation communities were found to meet the condition thresholds of the TEC, namely to be > 15 years old, > 0.5 ha in area and have an exotic perennial plant coverage of < 50% (**Appendix E**). A total of 91.2 ha of Brigalow TEC was identified across the study area.

Vegetation meeting the key diagnostic criteria for the Natural grasslands TEC was identified as RE11.8.11 within the study area. Assessment against the condition thresholds identified Natural Grassland TEC of good and best quality, predominantly within the northern and central portion of the study area (**Appendix I**). Good quality Natural Grassland TEC within the study area was found to occur in patches of > 5 ha, comprise at least three native perennial indicator species as described in the Commonwealth Listing Advice and has a perennial non-woody introduced species cover of < 30%. Best quality Natural Grassland TEC within the study area was found to occur in patches >1 ha, comprise of at least four native perennial indicator species and has a perennial non-woody introduced species cover or < 5%. A total of 552.4 ha of best and 234.0 ha of good quality natural grassland TEC was identified across the study area.

Small areas of SEVT were identified as RE11.5.15. These REs were identified within scattered patches across the study area encompassing a total 57.3 ha. There are currently no key diagnostic characteristics or condition thresholds for the SEVT TEC, so the entirety of the mapped RE comprises the TEC.

3.2.4 Threatened Flora

Desktop assessment identified nine threatened flora species that may occur within the study area. One species, *Dichanthium queenslandicum* has previously been recorded within the study area. Seven species were assessed as potentially occurring due to suitable habitat within the study area and records in the surrounding area. These species include *Dichanthium setosum, Digitaria porrecta*, *Samadera* *bidwillii, Kelita uncinella, Bertya opponens, Bertya pedicellata* and *Cerbera dumicola*. One species was assessed as unlikely to occur; *Cycas ophiolitica* (**Appendix J**).

Extensive targeted surveys were undertaken within the study area which identified a substantial population of *Dichanthium queenslandicum.* The identification of *Dichanthium queenslandicum* was confirmed by the Queensland Herbarium. *Dichanthium queenslandicum* occurs in natural grassland communities identified as RE11.8.11 that are present throughout the northern and central portion of the study area.

A localised population of *Dichanthium setosum* were also identified within the study area during targeted surveys and confirmed by the Queensland Herbarium (ELA 2017). *Dichanthium setosum* also occurs in natural grassland communities identified as RE11.8.11. Detailed information on the results of grassland pre-clearance surveys of the study area is contained in the Wards Well Pre-clearance Report (ELA, 2017)

None of the other species listed above were identified within the study area.

3.2.5 Weeds

Desktop assessment identified seven weeds listed as Restricted Invasive Plants under the *Biosecurity Act 2014* as potentially occurring within the study area (**Table 6**).

Table 6: Declared weeds identified during desktop assessment as potentially occurring within the study area

Species name	Common name	Restricted Invasive Plant	Biosecurity Act
Acacia nilotica subsp. *Indica*	Prickly Acacia	✓	Category 5
Cryptostegia grandiflora	Rubber Vine	✓	Category 5
Jatropha gossypiifolia	Cotton-leaved Physic-Nut	✓	Category 5
Lantana camara	Lantana	✓	Category 5
Parkinsonia aculeata	Parkinsonia	✓	Category 5
Parthenium hysterophorus	Parthenium	✓	Category 5
Vachellia nilotica	Prickly Acacia	✓	Category 5

Of the seven listed weed species identified as potentially occurring only Parthenium was identified within the study area. In addition, Biosecurity Act Category 5 declared weed, *Harrisia* spp. (Harrisia Cactus), was also recorded within the study area.

Parthenium was recorded in moderate to high abundance at several locations across the study area, however, as it is an annual species it may be more widespread and abundant at particular times of year. Harrisia Cactus was recorded in isolated occurrences. In addition, the non-declared exotic species *Cenchrus ciliaris* (Buffel Grass) dominated the ground layer across large portions of the study area.

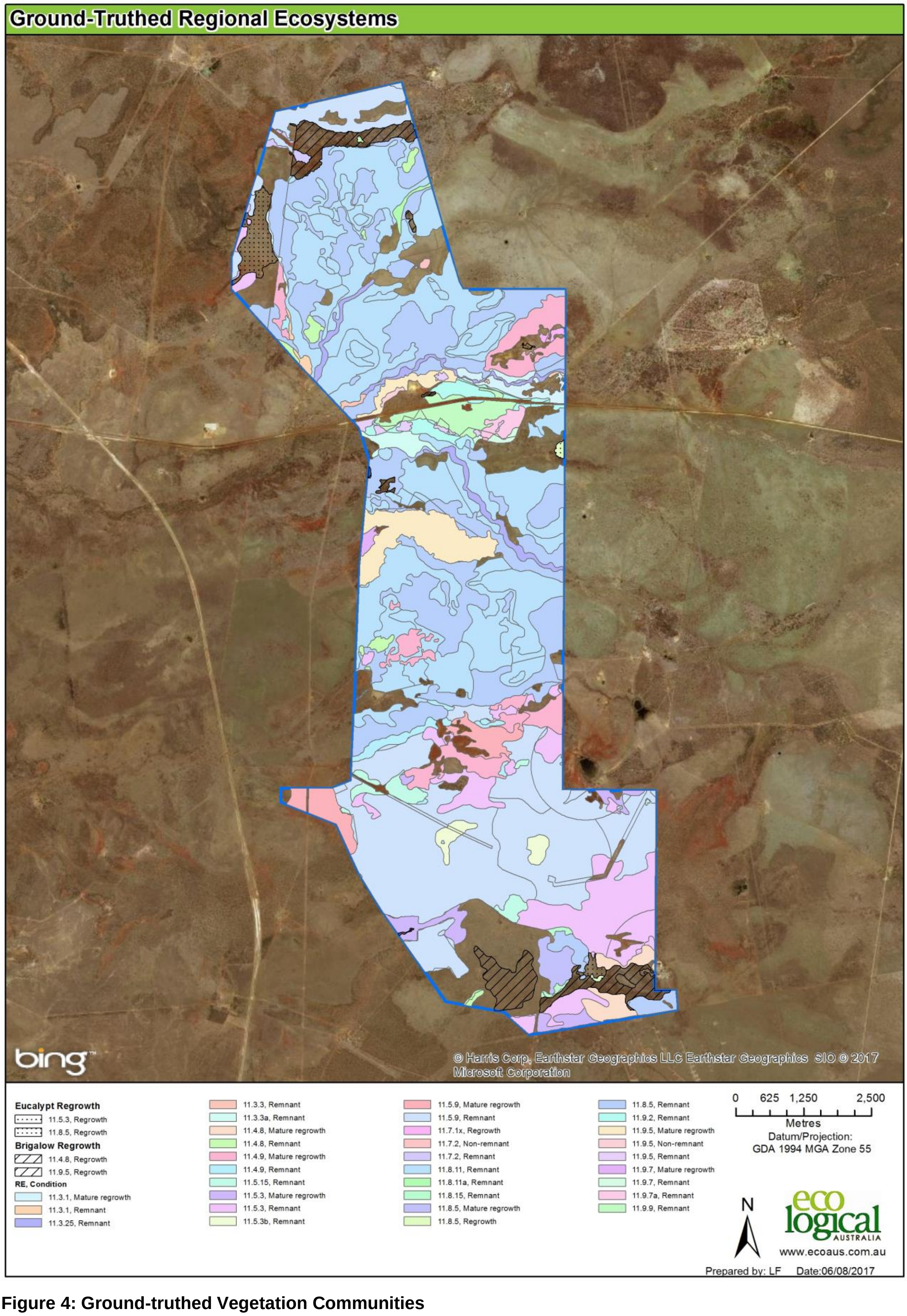

Figure 4: Ground-truthed Vegetation Communities

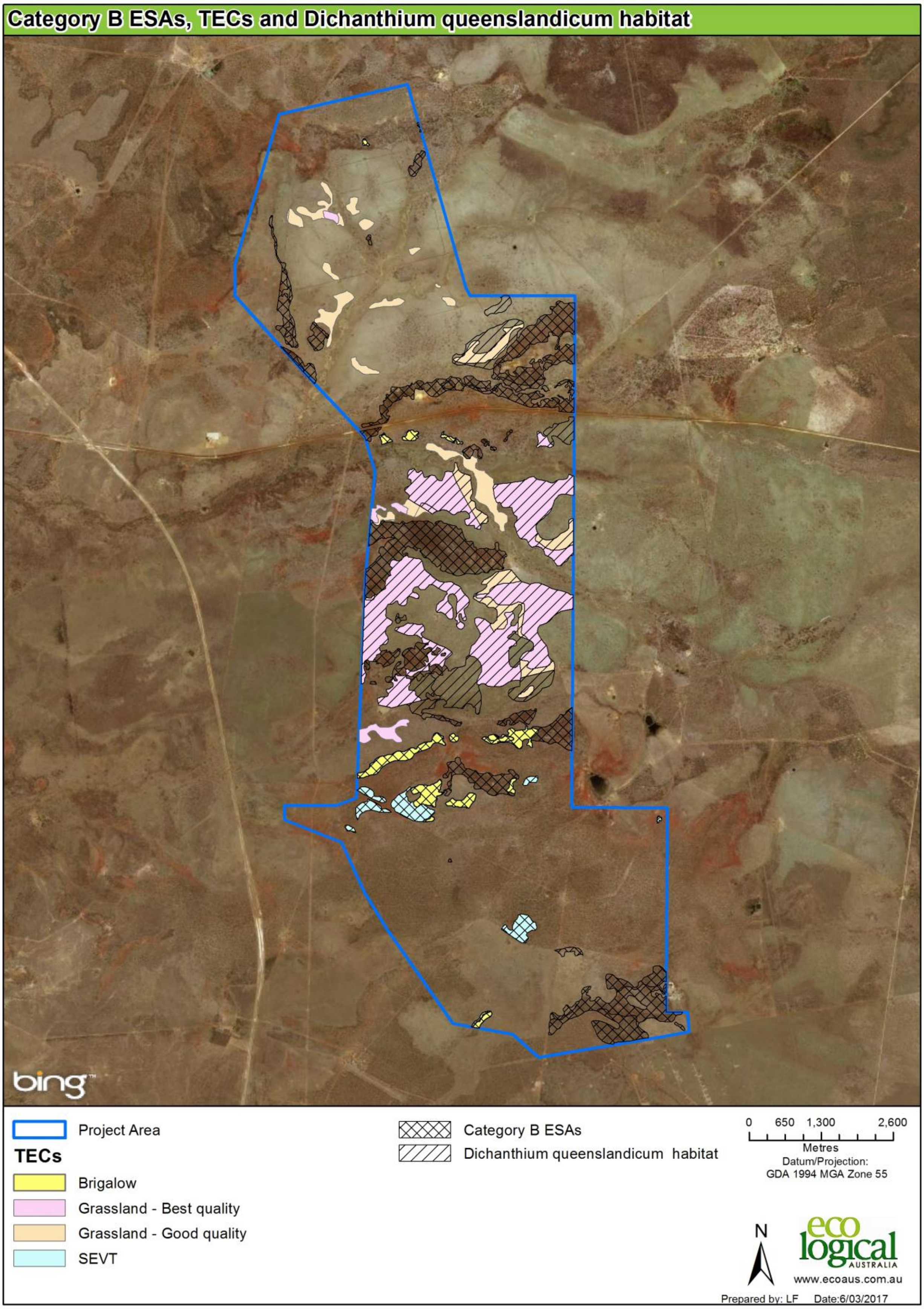

Figure 5: Category B ESAs, TECs and *Dichanthium queenslandicum* and *D. setosum* habitat

3.3 Habitat Values

3.3.1 Habitat Types

Seven broad habitat types were identified as occurring within the study area. These habitats provide a range of resources for native fauna species, including threatened species as discussed in **Section 3.4.1**. The following sections outline the condition and values of each habitat type.

- Fringing riparian forest
- Dry Eucalypt woodland
- Brigalow woodland containing ephemeral gilgais
- Brigalow woodland without ephemeral gilgais
- Natural grasslands
- SEVT
- Acacia open forest

Fringing Riparian Forest

Fringing Riparian Forest habitat is associated with Kennedy, Charlie and Eaglefield Creeks that cross the project area in the centre and north (**Figure 6**). Habitat in these areas was found to contain a sparse canopy of *Eucalyptus camaldulensis* (River Red Gum) and *Melaleuca* sp. and reduced sub-canopy layer. With a low abundance of Koala food trees, canopy connectivity and hollow bearing trees, these areas provide moderate habitat values for arboreal species such as Koala and Greater Glider.

The creeks within the project area were mostly dry during the survey. Water resources are important habitat features for many bat and bird species. The ephemeral nature of the creeks are likely to provide resources during the wet season, however they provide low habitat values for species that require permanent water sources, such as the Squatter Pigeon.

Dry Eucalypt Woodland and Regrowth

Dry Eucalypt Woodland dominates the southern section of the study area and is predominantly in remnant condition, with some areas of mature regrowth and regrowth (**Figure 6**). *Eucalyptus crebra* and *E. populnea* dominate the canopy, both of which are Koala food trees. Habitat values for the Koala are good in the southern section, providing both foraging resources and connectivity. Within the remnant areas, the canopy layer cover is high with a large number of hollow bearing trees in some parts, providing shelter and foraging resources for Greater Glider, hollow roosting bats and nesting birds.

A dense sub-canopy layer was also present in parts of the Eucalypt woodlands in the south, providing good quality habitat for bats and birds, with high structural complexity for foraging. Similar habitat resources were recorded within the mature regrowth and regrowth areas; however due to the younger age of these areas, a mature canopy layer was absent.

The ground layer was found to be moderately complex providing habitat resources for ground-dwelling species. Permanent water resources are available in the form of dams are located in the south, this in conjunction with a complex ground cover provides ideal habitat for Squatter Pigeon and other ground-dwelling birds, reptiles and mammals.

Brigalow woodland and regrowth containing ephemeral gilgais

Brigalow woodland on deep cracking clays and containing ephemeral gilgais was identified predominantly within the southern and northern portion of the study area (**Figure 6**). This habitat has a moderate structural complexity consisting of a moderately dense canopy layer, a sparse sub-canopy layer and an extremely sparse shrub layer. This level of structural complexity provides suitable foraging and nesting habitat for numerous woodland birds. However, the low number of hollow bearing trees within this habitat means there is limited sheltering, nesting and breeding habitat for hollow dependent birds, arboreal mammals and microbats.

This habitat also contains a relatively complex ground layer, consisting of moderate grass cover, large amounts of woody debris, moderate amounts of leaf litter and a high number of soil cracks. These features provide optimal foraging resources, shelter, breeding refuges and basking areas for numerous reptile species, including the threatened species Ornamental Snake. The presence of ephemeral gilgais within this habitat also provides optimal habitat for amphibians, which in turn provides optimal foraging habitat for snakes, including Ornamental Snake. Water was observed in a number of gilgais during the June survey, indicating these areas can provide suitable habitat into the dry season.

Brigalow woodland and regrowth without ephemeral gilgais

Brigalow woodland without ephemeral gilgais was identified throughout the study area in remnant, mature regrowth and regrowth condition (**Figure 6**). The habitat has a varied structural complexity depending on condition state. Remnant areas supported a relatively complex structure, with moderate canopy cover, a sparse shrub layer and a complex ground layer, comprising moderate to dense grass cover, a moderate abundance of fallen woody debris, a moderate amount of leaf litter and few or absent soil cracks. This level of structural complexity provides suitable foraging and nesting habitat for numerous woodland birds, mammals and reptiles. However, the low number of hollow bearing trees within this habitat means there is limited sheltering, nesting and breeding habitat for hollow dependent birds, arboreal mammals and microbats.

Similar habitat resources were recorded within the mature regrowth and regrowth areas; however due to the younger age of these areas, the canopy layer was less well developed. A more simplistic ground layer in mature regrowth and regrowth areas is likely to only contain suitable habitat for generalist reptiles, amphibians and mammals.

Natural grasslands

Natural grassland habitat occurs predominantly in the central and northern portions of the study area (**Figure 6**). The habitat has a simple structure, with an absent or very sparse canopy and shrub layers and moderate to dense grass cover. Although structural complexity is low, this habitat still provides foraging and nesting resources for woodland birds, as well as foraging and dispersal habitat for species preferring more open grassland habitats. However, the absence of hollow bearing trees within this habitat means there is no sheltering, nesting and breeding habitat for hollow dependent birds, arboreal mammals and microbats. Some grassland areas have a high proportion of exotic species, limiting their value as foraging habitat for herbivorous mammals.

SEVT

SEVT habitat occurs in scattered patches across the study area (**Figure 6**). This habitat was found to have a dense, low canopy and tangled understorey of vines and shrubs. The ground layer was relatively simplistic, with bare ground interspersed with scattered grasses and forbs. This habitat provides foraging and nesting resources for woodland birds and small mammals.

Acacia Open Forest

Small areas dominated by stands of *Acacia* sp. were present in the north and north-west section of the project area. A tall canopy layer and moderate shrub layer provides good habitat for foraging and nesting bird species. Whilst the sparse ground-cover and lateritic soils are a preferred foraging habitat feature of Squatter Pigeon.

3.3.2 Essential Habitat

Current Essential Habitat mapping shows two small areas of essential habitat for *Dichanthium queenslandicum* mapped within the north-east corner of the study area. Field survey confirmed the presence of *Dichanthium queenslandicum* within the study area; however ground-truthing of habitat types revealed suitable habitat for the species that far exceeds the current mapped extent of Essential Habitat for the species.

Essential habitat for protected wildlife is defined under the Vegetation Management Act. It is defined as a category A area (vegetation offset area), a category B area (remnant vegetation) or category C area (high-value regrowth vegetation) shown on the regulated vegetation management map:

1) That has at least 3 essential habitat factors for the protected wildlife that must include any essential habitat factors that are stated as mandatory for the protected wildlife in the essential habitat database; or
2) In which the protected wildlife, at any stage of its life cycle, is located.

A total of 813 ha of Essential Habitat for *Dichanthium queenslandicum* occurs within the study area. The area of essential habitat was defined based on extensive meander surveys which were undertaken across the study area to identify the presence of threatened grass species. Further information is available in the Wards Well Pre-clearance Report (ELA, 2017).

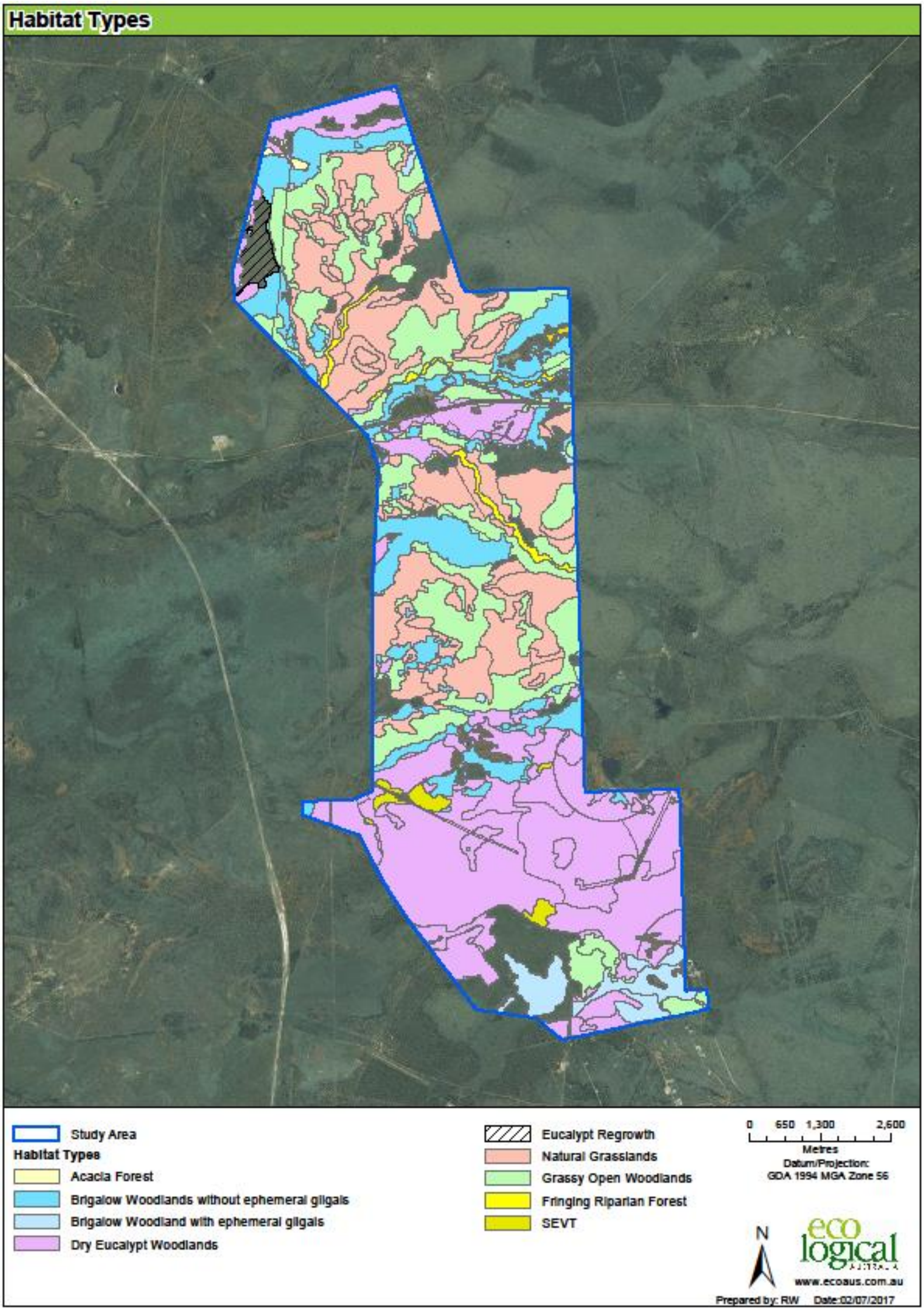

Figure 6: Habitat Types

3.4 Fauna Values

3.4.1 Threatened Species

Desktop assessment identified 19 threatened fauna species and 11 migratory species that may occur within the study area. The likelihood of occurrence of each species was assessed based on the species' known distribution, habitat quality within the study area, species occurrence within the region and species occurrence within the study area. Based on these criteria two species, Squatter Pigeon and Ornamental Snake, were assessed as likely to occur. Two mammals (Koala and Greater Glider) were assessed as potentially occurring within the study area. Four migratory birds (Fork-tailed Swift, White Throated Needletail, Black Faced Monarch and Glossy Ibis) were also assessed as potentially occurring within the study area. A full likelihood of occurrence assessment is provided in **Appendix J.**

No threatened species were recorded during field surveys, however, habitat for species considered likely or potentially occurring was ground-truthed within the study area. A description of the potential extent and utilisation, as well as current observed threats for these species within the study area is provided below.

Squatter Pigeon

Squatter Pigeon is listed as vulnerable under both the EPBC Act and Queensland NC Act. Breeding habitat for this species occurs on stony rises occurring on sandy or gravelly soils and in close (<1 km) proximity to water. Foraging habitat includes remnant or regrowth open-forest to sparse, open-woodland dominated by *Eucalyptus, Corymbia, Acacia* or *Callitris* species, on sandy or gravelly soils and in close proximity to water (<3 km). Previous Squatter Pigeon records also exist within 13 km of the project area.

Squatter Pigeon habitat was ground-truthed within an area of 171.2 ha that was identified to contain essential microhabitat features (**Figure 7**).

Koala

Koala is listed as vulnerable under both the EPBC Act and Queensland NC Act. Suitable habitat for Koala was identified within remnant Eucalypt woodlands in the southern portion of the study area. Koala habitat was ground-truthed within an area of 1,911.5 ha that was found to contain a high proportion of known Koala food tree species (**Figure 7**). Targeted Koala habitat assessments identified small areas of fringing riparian forest and adjacent floodplain Eucalypt forest, as well as eucalypt woodland habitat to contain a high proportion (> 75%) of Koala food tree species within the canopy layer. Fringing riparian habitat and adjacent floodplains contained the known Koala food tree species River Red Gum (*Eucalyptus camaldulensis*) whilst open woodland areas were dominated by Narrow Leaved Ironbark (*Eucalyptus crebra*) and Poplar Box (*Eucalyptus populnea*).

Quality of Koala habitat within the project disturbance footprint has been assessed using the Commonwealth Koala habitat assessment tool (Error! Reference source not found.). A score of 5 out of a potential maximum of 10 was obtained for the study area. This score is reflective of the availability of habitat, the limited presence of key threats, a level of regional habitat connectivity, but a lack of important recovery habitat.

Greater Glider

Greater Glider is listed as vulnerable under both the EPBC Act and Queensland NC Act. The species is largely restricted to eucalypt forests and woodlands that have a high abundance of tree hollows, which it requires for daytime shelter. Suitable habitat for the Greater Glider was identified within the remnant Eucalypt woodlands in the southern portion of the study area where a high density of hollows were recorded in some parts. Greater Glider habitat was ground-truthed within an area of 315.2 ha that was found to contain a high proportion of tree hollows (**Figure 7**).

Ornamental Snake

Ornamental Snake is listed as vulnerable under both the EPBC Act and Queensland NC Act. Suitable habitat for Ornamental Snake was identified within remnant, mature regrowth and regrowth RE11.4.8 and RE11.4.9 Brigalow woodland within the southern and northern portion of the study area. Multiple records also exists within 5 km of the project area. Ornamental Snake habitat was ground-truthed within an area of 213.6 ha that was identified to contain essential microhabitat features such as deep cracking clay soils and gilgai formations, which provide shelter and suitable habitat for the species main form of prey, frogs (**Figure 7**). Additional areas of clay soil and Brigalow vegetation within the study area were found to lack the essential microhabitat features required to support Ornamental Snake.

Migratory birds

Four migratory birds were assessed as potentially occurring within the project area. Fork-tailed Swift and White-throated Needletail are almost exclusively aerial however may roost in woodlands with dense foliage and tree hollows. Black Faced Monarch may use eucalypt woodlands and semi-evergreen vine thicket, however this habitat is considered marginal and likely to be used only when on passage. The Glossy Ibis may use large dams within the project area when on passage.

Habitat for potential migratory species within the project area is marginal and is considered not to be an ecological constraint. Migratory birds are not discussed further in this report.

Microchiropteran BatsSix nights of acoustic bat detection data was analysed by specialist Greg Ford (Appendix K). At least 11 and possibly 13 species were recorded during the surveys, mostly contributed by *Chaerephon jobensis* and the unresolved species group of *Chalinolobus nigrogriseus / Scotorepens greyii / S. sanborni*.

No threatened bat species were recorded during the survey. Habitat for potential threatened bats is marginal and considered not to be an ecological constraint and these species are not discussed further.

3.4.2 Pests

Desktop assessment identified eight declared pest species under the Biosecurity Act as potentially occurring within the study area (**Table 7**).

Table 7: Declared pests identified during desktop assessment as potentially occurring within the study area

Species name	Common name
-	Feral Deer
Capra hircus	Goat
Felis catus	Cat
Mus musculus	House Mouse
Oryctolagus cuniculus	Rabbit
Bufo marinus	Cane Toad
Sus scrofa	Pig
Vulpes vulpes	Red Fox

Of the eight declared pest species identified as potentially occurring within the study area, three were recorded during the field survey. These included Rabbit (*Oryctolagus cuniculus*), Cat (*Felis catus*) and Cane Toad (*Bufo marinus*). Evidence of Pigs (*Sus scrofa*) was observed (i.e. rooting), tracks of Feral

Dogs (*Canis lupus*) or Red Fox (*Vulpes vulpes*) were also observed. Based on habitat resources and condition it is also expected that the study area contains House Mouse (*Mus musculus*).

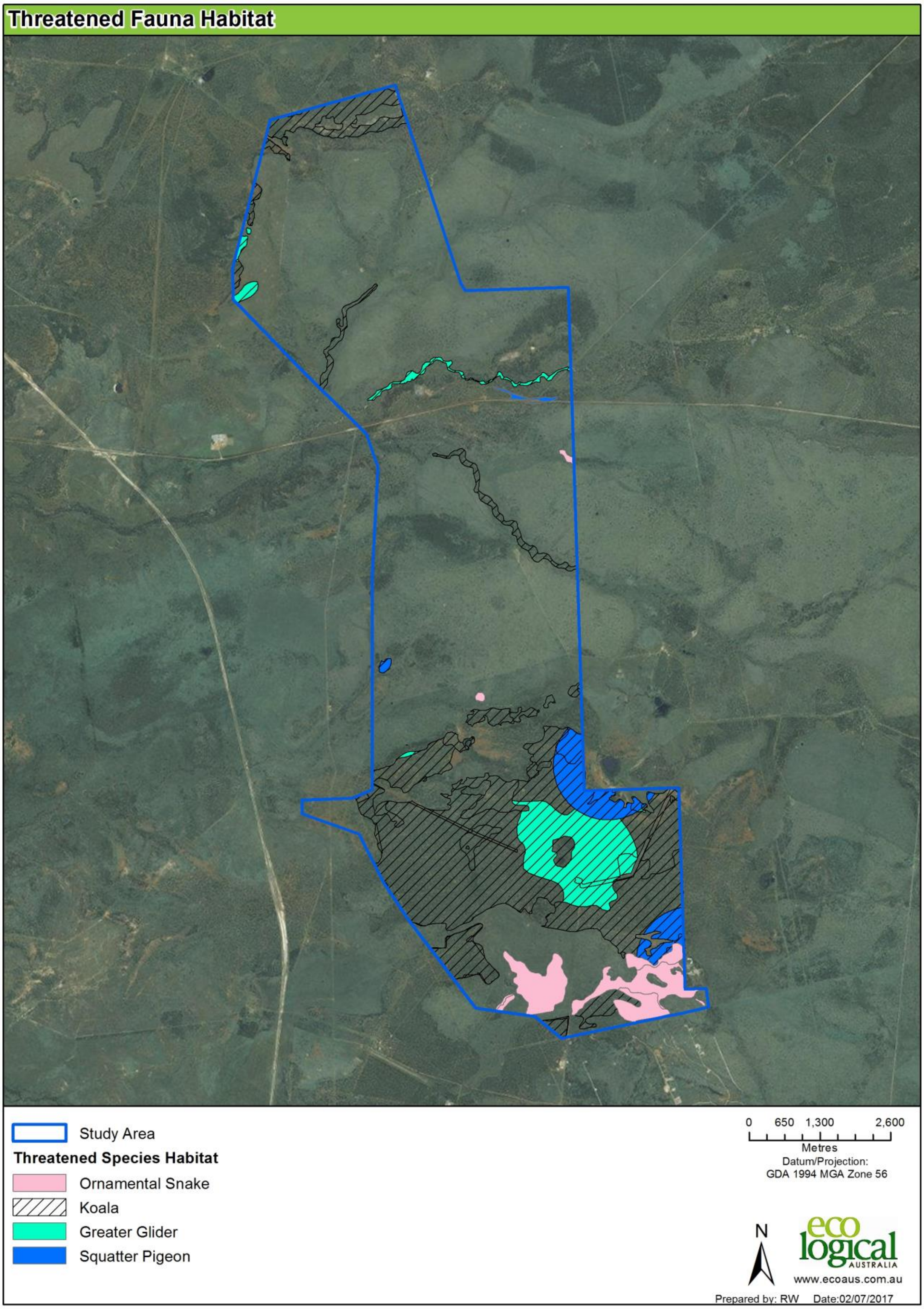

Figure 7: Threatened Fauna Habitat

3.5 Landscape Values

3.5.1 Wetlands and Watercourses

Kennedy, Charlie and Eaglefield Creeks cross the project area in the centre and north, and all are mapped on the VM Act watercourse and drainage feature map. There are no wetlands associated with these creek lines. No watercourse or wetland values shown on the VM Act wetland maps or Wetland Protection Area maps were identified within the study area.

Brigalow habitat containing gilgais do provide some wetland values; however due to the ephemeral nature of the gilgais, the values are provided periodically and for short durations during high rainfall conditions.

3.5.2 Context and Connectivity

The landscape surrounding the study area is heavily fragmented due to widespread clearing activity from historical land uses including agriculture and current mining operations. Suttor Development Road, Red Hill Road and the Goonyella Riverside Mine rail corridor are also significant barriers to connectivity within the landscape. Context and connectivity values of the study area are therefore considered moderate to low. This assessment is supported by the low to moderate site context scores evaluated as part of the Habitat Quality Assessment of the study area (refer to **Appendix D**).

The values that are present within and around the project area include:

- Kennedy, Charlie and Eaglefield Creeks, which cross the project area in the north and centre provide riparian corridors to the west, connecting to the Suttor River
- Vegetation to the west is relatively fragmented, however riparian corridors provide connectivity to large areas of vegetation that are further afield including Nairana National Park, and large patches of vegetation in the north
- The southern portion of the project area provides a contiguous patch of vegetation. This is connected through Goonyella Creek which ends within the Brigalow woodland communities near the southern boundary and provides a riparian corridor to the south and east, connecting to the Isaac River. This also connects to habitat areas in the east, onto Homevale National Park
- Whilst the grasslands that dominate the north and centre of the project area are remnant, these areas only provide connectivity for more mobile species, such as macropods and birds

4 Ecological constraints

4.1 Commonwealth

Field survey identified a number of ecological values within the study area which are currently protected as Matters of National Environmental Significance (MNES) under Commonwealth EPBC Act. These include TECs and habitat for threatened flora and fauna species (**Figure 8**).

The following sections provide an overview of protected values and associated constraint level. In areas of overlapping values, the highest constraint level takes precedence.

TECs

Three TECs were ground-truthed within the project area. Brigalow TEC was identified in small patches across the site, within a total area of 91.2 ha. . Natural grasslands dominate the centre and north of the project area, and patches meeting the key diagnostic and condition threshold of the TEC in good quality were identified within an area of 234.0 and best quality within 552.4 ha . SEVT TEC was identified in small patches in the south of the project area, within an area of 57.5 ha.

For exploration activities, areas of Brigalow and SEVT TEC are considered highly constrained as disturbance through clearing activities would be required. However, the severity of clearing activities is inherently diminished in Natural Grassland TEC areas and opportunities exist to further minimise disturbance through managed slashing. As such these areas are considered moderately constrained for exploration activities.

A significant impact assessment should be undertaken in accordance with the Commonwealth Significant Impact Guidelines (Version 1.1) prior to any disturbance to MNES. Where impacts are deemed likely to be significant, the project is required to be referred to the Commonwealth for assessment.

Threatened flora and fauna

The threatened flora species *Dichanthium queenslandicum,* which is currently listed as endangered under the EPBC Act and vulnerable under the NC Act, was identified in large populations in natural grassland habitat within the study area. Additionally, flora species *Dichanthium setosum*, which is currently listed as Vulnerable under the EPBC Act was also identified within isolated areas.

Suitable habitat for the threatened fauna species Koala, Greater Glider, Squatter Pigeon and Ornamental Snake was also identified within the study area. Koala is currently listed as vulnerable under both the EPBC Act and Queensland NC Act. Suitable habitat for Koala was ground-truthed within an area of 1,911.5 ha of remnant Eucalypt woodlands in the south, along riparian corridors and in the far north.. Greater Glider is listed as Vulnerable under the EPBC Act and NC Act. Suitable habitat for Greater Glider was ground-truthed within an area of 315.2 ha where there was a high abundance of tree hollows. Squatter Pigeon is currently listed as Vulnerable under the EPBC Act and NC Act. Suitable habitat for Squatter Pigeon was ground-truthed within an area of 171.2 ha where sparse or open scrub with sandy or gravelly soil was located within 3 km of permanent water. Ornamental Snake is listed as vulnerable under both the EPBC Act and Queensland NC Act. Suitable habitat for Ornamental Snake was identified within remnant, mature regrowth and regrowth RE11.4.8 Brigalow woodland occupying an area of 213.6 ha within the southern portion of the study area.

As with the Natural Grassland TEC, the severity of clearing activities is inherently diminished in the grassland habitat supporting *Dichanthium queenslandicum* and *Dichanthium setosum,* and opportunities exist to further minimise disturbance through managed slashing and onsite weed hygiene protocols.

Similarly, the severity of clearing activities in Greater Glider, Squatter Pigeon, Ornamental Snake and Koala habitat can be reduced if these activities avoid removal of key habitat features that are important to the species i.e. canopy trees, hollow bearing trees and understorey microhabitat features. As such areas of threatened species habitat are considered moderately constrained for exploration activities.

A significant impact assessment should be undertaken in accordance with the Commonwealth Significant Impact Guidelines (Version 1.1) prior to any disturbance to MNES. Where impacts are deemed likely to be significant, the project is required to be referred to the Commonwealth for assessment. Additional State approval and permit requirements may also be required for species also listed under the NC Act (**Section 4.2**).

4.2 State

Field survey identified a number of ecological values within the study area which are currently protected under Queensland environmental legislation. These include threatened species listed under the NC Act and Category B ESAs, protected under the *Environment Protection Regulation 2008*. In addition, ecological values recognised as Matters of State Environmental Significance (MSES) that are regulated under the *Environmental Offsets Act 2014* (EO Act) were also identified within the study area (**Figure 8**).

The following sections provide an overview of protected values and associated constraint level. In areas of overlapping values, the highest constraint level takes precedence.

Threatened flora and fauna

As discussed in **Section 4.1** above, 1,911.5 ha of suitable habitat for Koala, 315.2 ha for Greater Glider, 171.2 ha for Squatter Pigeon and 213.6 ha of suitable habitat for Ornamental Snake was identified within the study area. In addition, 1,661.8 ha of habitat for *Dichanthium queenslandicum* was identified within the northern and central portions of the study area.

Legislative constraints associated with these threatened species would be addressed initially at a Commonwealth level. As such the same level of constraint at a Commonwealth level is applicable for threatened species habitat protected at a State level for exploration activities. However, additional permitting considerations would be triggered under the Queensland protected plant framework for disturbance to *Dichanthium queenslandicum.*

Under the framework, a protect plant permit is required for the taking of any protected plants listed under the NC Act. Taking includes actions of plucking, gathering and cutting and would therefore extend to the slashing of grassland areas. Assessment of residual impacts on protected plants following the development of management and rehabilitation strategies, and submission of required permits should be undertaken prior to disturbance of threatened grass habitat.

Category B ESAs

Category B ESAs are defined as REs with an Endangered Biodiversity status. A total of 828.4 ha Category B ESA was ground-truthed within the study area. Category B ESA was identified as RE11.3.1, RE11.4.8, RE11.4.9, RE11.9.5 and RE11.5.15 and occurs throughout the study area.

Approval to clear Cat B ESA has been granted under the current EA for Wards Well. However this approval is based on previously mapped extents of Cat B ESA, and any additional areas identified in this survey may trigger an EA amendment. Disturbance on Category B ESAs is listed as a scenario where a substantial increase in the risk of environmental harm is considered likely. Proposed amendments resulting in a substantial increase in the risk of environmental harm can trigger a major amendment assessment under the EP Act. As such for exploration activities, these areas are considered highly constrained.

MSES

Regulated Vegetation containing Endangered REs, Of Concern REs, essential habitat or adjacency to mapped watercourses are MSES values. Protected wildlife habitat and remnant areas supporting connectivity values are also MSES values within the study area. The majority of MSES values overlaps with other ecological values protected under Commonwealth and State legislation. The additional area of MSES values that is regulated under the EO Act encompasses 1,774.7 ha of the study area.

MSES are regulated under the EO Act through the provision of offset conditions only as a result of an assessment trigger. As such these areas are considered to be moderately constrained for exploration activities. If a State approval mechanisms is triggered for exploration activities within the study area i.e. under the EP Act or NC Act, a significant impact assessment should be undertaken in accordance with the Queensland Significant Residual Impact Guideline prior to any disturbance to MSES.

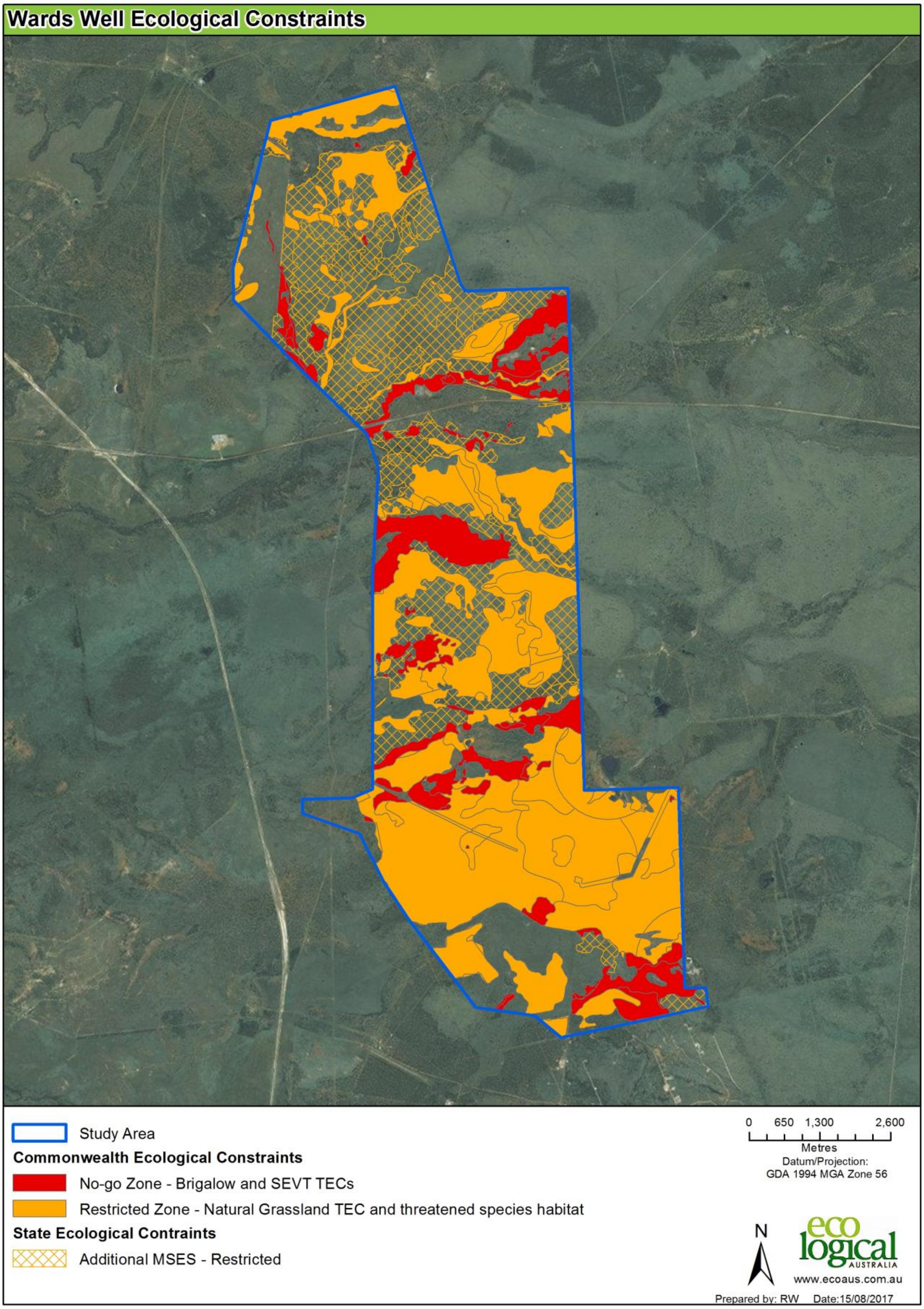

Figure 8: Ecological Constraints

5 Mitigation and Management

5.1 Introduction

The study area contains several Commonwealth and State significant ecological values including TECs, Category B ESAs, threatened species and associated habitats. Any potential future impacts on these values can be reduced and compensated through the implementation of measures to avoid, minimise, mitigate and offset (in that order) impacts associated with the project. A mitigation strategy that employs this hierarchy should be implemented to reduce the potential impacts of any future proposed activities and where possible, avoid a net-loss of habitat, especially for threatened species and TECs within the study area.

Key elements of an effective control strategy are further described below.

5.2 Avoidance Measures

Impacts to environmental values should be avoided as far as practicable by preferentially locating drill pads and associated infrastructure outside of areas containing mapped values. Where it is not possible to completely avoid disturbance to environmental values within the Project area, consideration should be given to the nature of the environmental value. Disturbance should occur preferentially in areas of lower ecological value. Mapped Category B ESA, Brigalow TEC and SEVT are not to be disturbed until the appropriate approvals are in place.

5.3 Minimisation Measures

Where avoidance of clearing and disturbance is not possible due to other constraints, efforts should be made to minimise impacts on ecological values by adopting general management measures across the study area including:

- Minimising the disturbance footprint as much as possible
- Placing buffers between disturbance areas and areas of retained vegetation
- Clearly demarcating the extent of vegetation clearing and areas to be retained prior to the commencement of clearing activities
- Ensuring designated access tracks are utilised wherever possible to prevent additional disturbance
- Reducing speed limits along access tracks to minimise the potential for collision with native fauna

Management measures to be employed when disturbing or clearing Koala and Greater Glider habitat include:

- Avoiding disturbance to Eucalypt canopy trees or regrowth
- Avoiding disturbance to hollow bearing trees
- Utilising a spotter-catcher prior to clearing activities being undertaken. If Koalas or Greater Gliders are identified in the area, clearing activity to be postponed until they have left the area
- Low speed limits to be enforced when travelling within habitat areas
- Strict equipment and vehicle wash down procedures

Management measures to be employed when disturbing or clearing Ornamental Snake habitat include:

- Limit ground disturbance as much as possible, including driving on established tracks to avoid ground compaction
- Utilising a spotter-catcher prior to clearing activities being undertaken
- Avoid conducting works during period of peak reptile activity (September – May)
- Avoid conducting works while water is present in gilgais
- Pruning of vegetation permitted
- No clearing of access tracks or repeat vehicle / equipment traverses (compaction of soils)
- No filling of gilgais with road base gravel, mats, etc
- No removal of fallen woody debris
- No surface scraping

Management measures to be employed when disturbing or clearing Squatter Pigeon habitat include:

- Avoid undertaking seismic activities during optimal breeding times between April and October (when food sources are most abundant)
- Avoid impacts to permanent water sources such as farm dams
- Preventing weeds from being introduced and outcompeting with native grasses
- Utilising a spotter-catcher prior to clearing activities being undertaken
- Low speed limits to be enforced when travelling within habitat areas

Management measures to be employed when disturbing or clearing Natural Grasslands include:

- Limit ground disturbance as much as possible, including driving on established tracks to avoid ground compaction
- Implement strict vehicle wash down procedures to limit spread of weeds
- Slashing permitted during non-flowering times (generally July to October)
- No clearing of access tracks or repeat vehicle / equipment traverses (compaction of soils)
- No covering of ground with road base gravel, mats, etc
- No surface scraping

If management measures are unable to be complied with in areas of identified Koala, Greater Glider, Squatter Pigeon, Ornamental Snake and *Dichanthium queenslandicum, Dichanthium setosum* habitat, or Natural Grassland TEC and areas of MSES value, disturbance should not occur until further assessment of potential impacts has been undertaken.

5.4 Mitigation Measures

Where potential impacts still exists following implementing avoidance and minimisation strategies, mitigation measures should be undertaken to further assist in reducing the severity of impacts. These measures are usually outlined in management plans and should include but not be limited to:

- Implementing sensitive clearing techniques where practicable (e.g. trimming branches wherever possible rather than tree removal, selective tree removal rather than broad scale clearing, ‘vibrating’ hollow-bearing trees prior to felling)
- Ensuring appropriate measures are implemented to reduce fauna entrapment in the trenches and open excavation areas (e.g. reducing the amount of open trench, providing ramps at regular intervals) and undertaking regular inspections of the trenches for fauna
- Implementing erosion and sediment control measures
- Managing water quality and water runoff
- Managing noise, dust and light levels

6 Summary and Conclusion

An ecological assessment has been undertaken to identify and quantify ecological values located within the proposed Wards Well Coal Project disturbance area. This information is required to assist in determining legislative constraints associated with exploration works for the Wards Well Coal Project. This assessment involved both a desktop and field assessment that targeted potential Commonwealth and State values that could constrain the area for future development.

Table 8: Summary of ecological assessment key finding

Ground-truthed ecological value	Area (ha)
Brigalow (*Acacia harpophylla* dominant and co-dominant) TEC	91.2
Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin (Natural Grasslands) TEC	Good – 234.0
	Best – 552.4
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions TEC	57.3
Category B ESA	828.4
Dichanthium queenslandicum habitat	813.0
Koala habitat	1,911.5
Ornamental Snake habitat	213.6
Greater Glider	315.2
Squatter Pigeon	171.2
Additional areas of MSES value	1,774.7

The ecological values detailed above are located across the proposed disturbance area, interspersed with areas of non-remnant and regrowth vegetation which are not environmentally constrained. It is recommended that exploration works are limited to areas outside of identified and mapped ecological values. Where works are required to be undertaken within mapped ecological values, appropriate environmental approvals must be sought and mitigation and management measures employed to limit impacts as far as practicable.

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URS (2013). Red Hill Mining Lease – Flora Survey Report, prepared for BM Alliance Coal Operations Pty Ltd

Appendix A Habitat Quality Scoring Tables

Site Condition Scoring Table

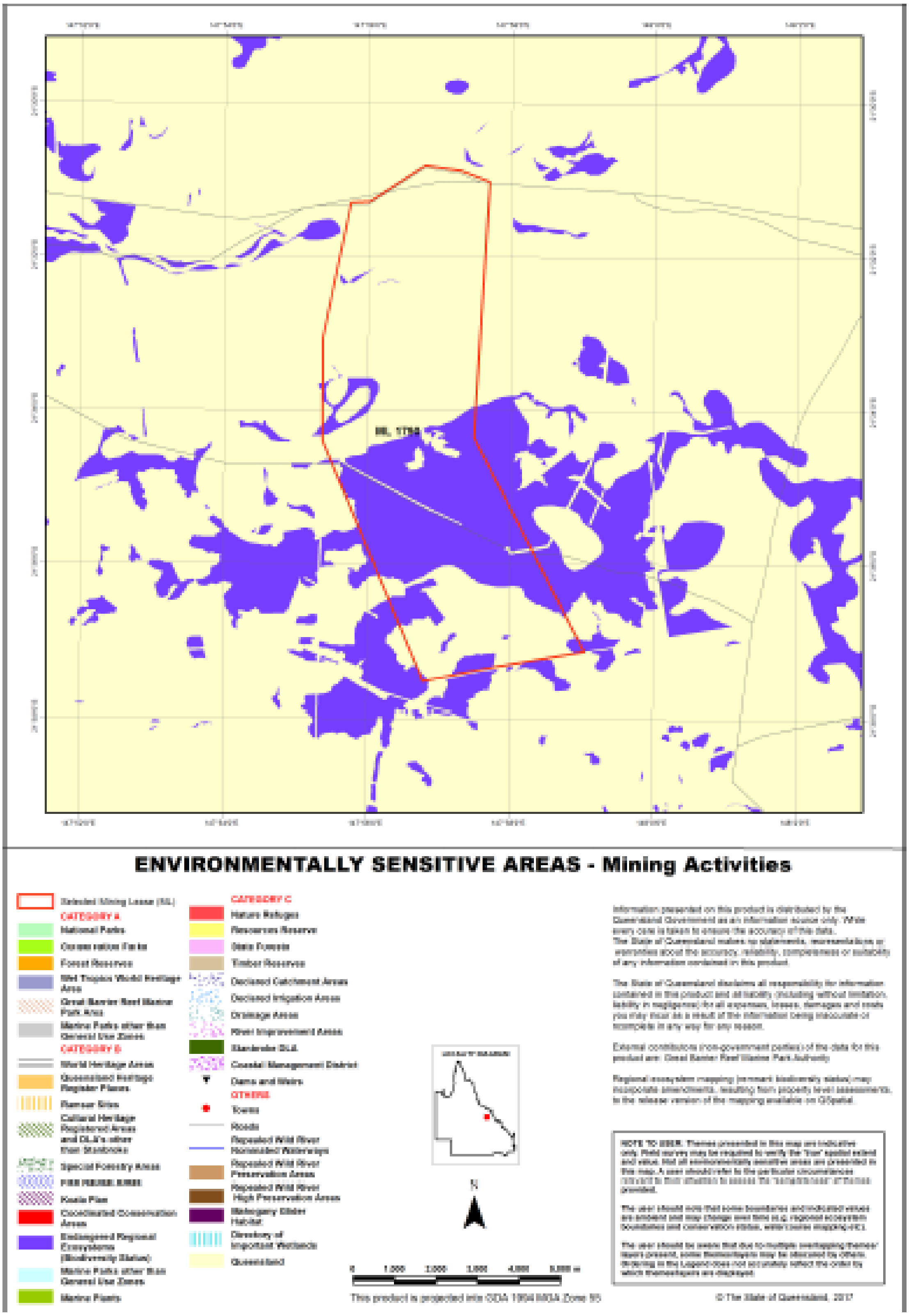
Indicator	Description	Score
1. Recruitment of woody perennial species	<20% of canopy species present as regeneration	0
	≥20 -75 of canopy species present as regeneration	3
	≥75% of canopy species present as regeneration	5
2. Native plant species richness (trees, shrubs, grasses, forbs)	<25% of benchmark number of species within each life-form	0
	≥25% to 90% of benchmark number of species within each life-form	2.5
	>90% of benchmark number of species within each life-form	5
3. Tree canopy height	<25% of benchmark height	0
	≥25% to 70% of benchmark height	3
	≥70% of benchmark height	5
4. Tree canopy cover	<10% of benchmark	0
	≥10% and <50% of benchmark	2
	≥50% to ≤200% of benchmark	5
	>200% of benchmark	3
5. Shrub canopy cover	<10% of benchmark shrub cover	0
	<50% or >200% of benchmark shrub cover	3
	≥50% to ≤200% of benchmark shrub cover	5
6. Native perennial grass cover	<10% of benchmark perennial grass cover	0
	≥10 to 50% of benchmark perennial grass cover	1
	>50 to 90% of benchmark perennial grass cover	3
	>90% of benchmark perennial grass cover	5
7. Organic litter cover	<10% of benchmark organic litter	0
	<50% or >200% of benchmark organic litter	3
	≥50% to ≤200% of benchmark organic litter	5
8. Large trees	No large trees present	0
	0 to 50% of benchmark large trees	5
	>50% to 100% of benchmark of large trees	10
	>benchmark number of large trees	15

Indicator	Description	Score
9. Coarse woody debris (CWD)	<10% of benchmark number or total length of CWD	0
	<50% or >200% of benchmark number or total length of CWD	2
	≥50% or ≤200% of benchmark number or total length of CWD	5
10. Weed cover	>50% weed cover	0
	>25 to 50% weed cover	3
	≥5 to 25% weed cover	5
	<5% weed cover	10

Site Context Scoring Table

Indicator	Description	Score
11. Size of patch *(measured only in fragmented landscapes)*	<5 ha	0
	5-25 ha	2
	26-100 ha	5
	101-200 ha	7
	>200 ha	10
12. Connectivity *(measured only in fragmented landscapes)*	The assessment unit is not connected using any of the below descriptions	0
	The assessment unit adjoins with adjacent remnant vegetation along ≥10% to <50% of its perimeter	2
	The assessment unit adjoins with adjacent remnant vegetation along 50% to 75% of its perimeter	4
	The assessment unit adjoins with adjacent remnant vegetation along >75% of its perimeter; or includes >500 ha remnant vegetation	5
13. Context *(measured only in fragmented landscapes)*	<10% remnant vegetation within 1km radius	0
	≥10% to 30% remnant vegetation within 1km radius	2
	≥30% to 75% remnant vegetation within 1km radius	4
	>75% remnant vegetation within 1km radius	5
15. Ecological Corridors	Not within state, bioregional, regional or sub-regional corridors	0
	Sharing a common boundary within state, bioregional, regional or sub-regional corridors	4
	Within (whole or part) a state, bioregional, regional or sub-regional corridors	6

Appendix B Environmentally Sensitive Areas



Appendix C Koala Habitat Assessment Results

Attribute	Score	Inland	Score	Evidence
Koala occurrence	+2 (high)	Evidence of one or more koalas within the last 5 years.	0	Closest Koala record is in Moranbah, approximately 45 km south of the study area.
	+1 (medium)	Evidence of one or more koalas within 2 km of the edge of the impact area within the last 10 years.		
	0 (low)	None of the above.		
Vegetation composition	+2 (high)	Has forest, woodland or shrubland with emerging trees with 2 or more known koala food tree species, **OR** 1 food tree species that alone accounts for >50% of the vegetation in the relevant strata.	2	Woodlands containing > 75 % of Koala food tree species occur in the southern part of the study area. Up to 2 known Koala food trees are present in the south, however are absent from the majority of the study area.
	+1 (medium)	Has forest, woodland or shrubland with emerging trees with only 1 species of known koala food tree present.		
	0 (low)	None of the above.		
Habitat connectivity	+2 (high)	Area is part of a contiguous landscape ≥ 1000 ha.	2	Vegetation within the impact area is not well connected to adjacent remnant vegetation.
	+1 (medium)	Area is part of a contiguous landscape < 1000 ha, but ≥ 500 ha.		
	0 (low)	None of the above.		
Key existing threats	+2 (high)	Little or no evidence of koala mortality from vehicle strike or dog attack at present in areas that score 1 or 2 for koala occurrence. Areas which score 0 for koala occurrence and have no dog or vehicle threat present	1	Wild dogs have been recorded within the study area.
	+1 (medium)	Evidence of infrequent or irregular koala mortality from vehicle strike or dog attack at present in areas that score 1 or 2 for koala occurrence, OR Areas which score 0 for koala occurrence and are likely to have some degree of dog or vehicle threat present.		
	0 (low)	Evidence of frequent or regular koala mortality from vehicle strike or dog attack in the study area at present, OR Areas which score 0 for koala occurrence and have a significant dog or vehicle threat present.		
Recovery value	+2 (high)	Habitat is likely to be important for achieving the interim recovery objectives for the relevant context, as outlined in Table 1.	0	Suitable habitat for Koala within the study area is limited to the south of the area with little connectivity and is unlikely to be important habitat for the species within the region. The proposed activity will not lead to removal of important habitat refuges for the species during droughts or periods of extreme heat and will not impact on the quality, extent and connectivity of habitat surrounding these refuges.
	+1 (medium)	Uncertain whether the habitat is important for achieving the interim recovery objectives for the relevant context, as outlined in Table 1.		
	0 (low)	Habitat is unlikely to be important for achieving the interim recovery objectives for the relevant context, as outlined in Table 1.		
		TOTAL SCORE	5	A limited area of suitable Koala was identified within the study area. Key threats such as dog attack are present, indicating that habitat within the project area is not of a high quality.

Appendix D Habitat Quality Assessment Data

Site attribute	RE 11.4.8					RE 11.4.9						RE 11.3.1		RE 11.9.5				RE 11.5.15	
	WWB30	WB1	WB3	WWB32	WWB35	WWB13	WWB16	WWB8	WWB15	WB2	WB4	WWB9	WWB11	WWB28	WWB29	WWB12	WWB10	WWB14	WWB33
Recruitment of woody perennial species	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Native plant species richness: trees	2.5	5	2.5	2.5	5	2.5	2.5	0	2.5	2.5	2.5	5	5	5	5	5	5	2.5	0
Native plant species richness: shrubs	2.5	2.5	2.5	0	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	0	5	5	5	2.5	0	0
Native plant species richness: grasses	2.5	2.5	2.5	2.5	2.5	5	5	0	2.5	2.5	2.5	0	2.5	2.5	0	2.5	2.5	5	5
Native plant species richness: forbs	5	5	2.5	2.5	5	2.5	5	2.5	5	2.5	0	5	2.5	2.5	5	2.5	5	2.5	2.5
Tree canopy height	5	3	5	3	5	5	5	3	5	3	3	5	5	3	3	5	5	5	5
Tree canopy cover	5	2	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Shrub canopy cover	3	3	5	0	3	3	3	5	5	5	0	3	0	3	3	3	3	5	5
Native perennial grass cover	1	0	0	1	0	0	1	0	0	0	0	0	1	0	0	1	0	5	5
Organic litter cover	5	5	5	3	5	5	5	3	5	3	5	3	3	5	5	5	5	5	3
Large trees	0	10	15	0	10	5	5	5	5	0	0	10	5	5	5	15	15	5	5
Coarse woody debris	2	2	2	5	5	5	0	2	2	0	0	2	0	5	5	5	5	2	5
Weed cover	0	5	5	0	0	0	3	0	3	0	0	0	0	0	0	5	0	5	5
Total site condition attributes	**38.5**	**50.0**	**57.0**	**29.5**	**53.0**	**45.5**	**47.0**	**33.0**	**47.5**	**31.0**	**25.5**	**45.5**	**34.0**	**46.0**	**46.0**	**64.0**	**58.0**	**52.0**	**50.5**
Fragmented – Patch size	5	5	0	5	0	5	10	5	5	5	5	5	2	7	7	0	5	2	0
Fragmented – Connectivity	2	5	5	0	0	5	2	4	4	5	5	4	5	4	4	5	2	4	5
Fragmented – Context	2	5	5	2	0	4	5	2	4	5	5	4	4	2	2	4	4	5	4
Ecological Corridors	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total site context attributes	**9**	**15**	**10**	**7**	**0**	**14**	**17**	11	**13**	**15**	**15**	**13**	**11**	**13**	**13**	**9**	**11**	**11**	**9**
Habitat Quality Score	**47.5**	**65.0**	**67.0**	**36.5**	**53.0**	**59.5**	**64.0**	**44.0**	**60.5**	**46.0**	**40.5**	**58.5**	**45.0**	**59.0**	**59.0**	**73.0**	**69.0**	**63.0**	**59.5**
Threats to species	7			7	7	7	7		7										
Quality and availability of food and foraging habitat	10			5	5	5	5		5										
Quality and availability of shelter	5			1	5	1	1		1										
Species mobility capacity	7			7	1	7	7		4										
Role of site location to species overall population in the state	1			1	1	1	1		1										
Total species habitat index score	**30**			**21**	**19**	**21**	**21**		**18**										

Appendix E Brigalow TEC Assessment Results

Survey site	RE	Tree layer	Age (years)	Patch size	Weed cover (%)	Key diagnostic criteria	Condition threshold criteria
A1	11.4.9	Dominant	>15yrs	<0.5ha	0	Pass	Fail
A2	11.4.8	Co-dominant	5-15yrs	>0.5ha	60	Fail	Fail
A3	11.4.7	Dominant	>15yrs	>0.5ha	60	Pass	Fail
A4	11.4.9	Dominant	>15yrs	>0.5ha	30	Pass	Pass
A5	11.4.9	Dominant	>15yrs	>0.5ha	10	Pass	Pass
A6	11.4.9	Dominant	>15yrs	>0.5ha	20	Pass	Pass
A7	11.4.9	Dominant	>15yrs	>0.5ha	10	Pass	Pass
A8	11.4.9	Dominant	>15yrs	>0.5ha	10	Pass	Pass
A9	11.4.9	Dominant	>15yrs	>0.5ha	60	Pass	Fail
A10	11.4.9	sub-dominant	5-15yrs	>0.5ha	40	Fail	Pass
A11	11.4.9	Dominant	>15yrs	>0.5ha	20	Pass	Pass
A12	11.4.9	Dominant	>15yrs	>0.5ha	60	Pass	Fail
A13	11.4.9	Dominant	>15yrs	<0.5ha	20	Pass	Fail
A14	11.4.9	Co-dominant	>15yrs	>0.5ha	40	Pass	Pass
A15	11.4.9	Co-dominant	>15yrs	>0.5ha	80	Pass	Fail
A16	11.4.9	Dominant	>15yrs	>0.5ha	60	Pass	Fail
A17	11.4.9	Dominant	>15yrs	>0.5ha	5	Pass	Pass
A18	11.4.9	Dominant	>15yrs	>0.5ha	5	Pass	Pass
A19	11.4.9	Dominant	>15yrs	>0.5ha	60	Pass	Fail
A20	11.3.1	Dominant	>15yrs	>0.5ha	70	Pass	Fail
A21	11.3.1	Dominant	>15yrs	>0.5ha	60	Pass	Fail
A22	11.9.5	Dominant	>15yrs	>0.5ha	5	Pass	Pass
A23	11.4.9	Dominant	>15yrs	>0.5ha	60	Pass	Fail
A24	11.9.5	Dominant	>15yrs	>0.5ha	60	Pass	Fail
A25	11.4.9	Dominant	>15yrs	>0.5ha	70	Pass	Fail
A26	11.9.5	Dominant	5-15yrs	>0.5ha	90	Fail	Fail
A27	11.4.8	Dominant	>15yrs	>0.5ha	60	Pass	Fail
A28	11.4.8	Dominant	>15yrs	>0.5ha	60	Pass	Fail

Survey site	RE	Tree layer	Age (years)	Patch size	Weed cover (%)	Key diagnostic criteria	Condition threshold criteria
A29	11.4.9	Dominant	>15yrs	>0.5ha	90	Pass	Fail
A30	11.4.8	sub-dominant	>15yrs	>0.5ha	90	Fail	Fail
A31	11.9.5	Dominant	5-15yrs	>0.5ha	90	Fail	Fail
A32	11.3.1	Dominant	>15yrs	>0.5ha	90	Pass	Fail
A33	11.4.8	Dominant	>15yrs	>0.5ha	55	Pass	Fail
A34	11.4.9	Dominant	5-15yrs	>0.5ha	70	Fail	Fail

Appendix F Squatter Pigeon Habitat Assessment Results

Survey site	Soil Type	RE	Canopy Cover (%)	Bare Ground (%)	Distance to Water (km)
SP1	Silty sand	11.5.9	40	10	3
SP2	Silty sand	11.5.3	50	20	1.5
SP3	Silty sand	11.5.3	35	30	0.8
SP4	Silty sand	11.5.9	25	33	1.8
SP5	Red silty sand	11.5.9	40	35	2.0
SP6	Silty sand	11.5.9	35	20	1.7
SP7	Silty sand	11.5.9	30	45	0.6
SP8	Silty sand	11.5.9	35	10	0.2
SP9	Silty sand	11.5.9	35	35	1.5
SP10	Silty sand	11.5.3	25	40	1.2
SP11	Loam	11.5.3	20	15	0.1
SP12	Silty sand	11.9.2	15	35	0.4
SP13	Silty sand	11.9.7	25	35	0.6

Appendix G Koala Habitat Assessment Results

Survey site	Koala presence	Koala food tree presence	Koala food tree dominance
K1	No	1 species	> 75 %
K2	No	2 species	> 75 %
K3	No	2 species	> 75 %
K4	No	1 species	21 – 50%
K5	No	1 species	51 – 75 %
K6	No	0 species	na
K7	No	1 species	> 75%
K8	No	1 species	> 75%
K9	No	2 species	51 - 75 %
K10	No	1 species	> 75%

Appendix H Ornamental Snake Habitat Assessment Results

Survey site	Gilgais	Soil cracks	Water	Aquatic vegetation	Fallen woody debris
OS1	Absent	Present	Absent	No	Nil
OS2	Present	Absent	Absent	Yes	Common
OS3	Present	Absent	Absent	No	Occasional
OS4	Absent	Absent	Absent	No	Occasional
OS5	Present	Present	Absent	Yes	Common to Abundant
OS6	Present	Present	Absent	No	Common to Abundant
OS7	Absent	Absent	Absent	No	Occasional to Common
OS8	Present	Present	Absent	No	Occasional to Common
OS9	Present	Present	Absent	No	Rare to Occasional
OS10	Present	Absent	Absent	No	Common
OS11	Present	Present	Present	Yes	Occasional to Common
OS12	Present	Present	Absent	No	Rare to Occasional
OS13	Present	Absent	Absent	No	Abundant
OS14	Present	Present	Absent	No	Abundant
OS15	Present	Present	Absent	No	Common to Abundant

Appendix I Natural Grassland TEC Assessment Results

Survey site	RE	Patch size	Tussock count	Shrub cover (%)	Weed cover (%)	Number of listed grass species
WWTEC1	11.8.11	>5 ha	>200	<30%	>30%	3
WWTEC2	11.8.11	>5 ha	>200	<30%	>30%	3
WWTEC3	11.8.11	>5 ha	>200	<30%	5-30%	3
WWTEC4	11.8.11	>5 ha	>200	<30%	5-30%	4
WWTEC5	N/A	1-5 ha	< 200	<30%	>30%	0
WWTEC6	11.8.11	>5 ha	>200	<30%	5-30%	4
WWTEC7	11.8.11	>5 ha	>200	<30%	>30%	3
WWTEC8	11.8.11	>5 ha	>200	<30%	>30%	4
WWTEC9	11.8.11	>5 ha	>200	<30%	>30%	2
WWTEC10	11.8.11	>5 ha	>200	<30%	5-30%	5
WWTEC11	11.8.11	>5 ha	>200	<30%	>30%	4
WWTEC12	11.8.11	>5 ha	>200	<30%	<5%	3
WWTEC13	11.8.11	>5 ha	>200	<30%	5-30%	3
WWTEC14	11.8.11	>5 ha	>200	<30%	>30%	2
WWTEC15	11.8.11	>5 ha	>200	<30%	>30%	3
WWTEC16	11.8.11	>5 ha	>200	<30%	>30%	3
WWTEC17	11.8.11	1-5 ha	>200	<30%	5-30%	4
WWTEC18	11.8.11	>5 ha	>200	<30%	>30%	2
WWTEC19	11.8.11	>5 ha	>200	<30%	5-30%	3
WWTEC20	11.8.11	>5 ha	>200	<30%	>30%	3
WWTEC21	11.8.11	>5 ha	>200	<30%	>30%	0
WWTEC22	11.8.11	>5 ha	>200	<30%	>30%	4
WWTEC23	11.8.11	> 5ha	>200	<30%	>30%	2
WWTEC24	11.8.11	>5 ha	>200	<30%	>30%	2
WWTEC25	11.8.11	>5 ha	>200	<30%	5-30%	4
WWTEC26	11.8.11	>5 ha	>200	<30%	>30%	0
WWTEC27	11.8.11	>5 ha	>200	<30%	>30%	3
WWTEC28	11.8.11	>5 ha	>200	<30%	>30%	2
WWTEC29	11.8.11	>5 ha	>200	<30%	>30%	0

Survey site	RE	Patch size	Tussock count	Shrub cover (%)	Weed cover (%)	Number of listed grass species
WWTEC30	11.8.11	>5 ha	>200	<30%	>30%	3
WWTEC31	11.8.11	>5 ha	>200	<30%	>30%	3
WWTEC32	11.8.11	>5 ha	>200	<30%	>30%	2
WWTEC33	11.8.11	>5 ha	>200	<30%	>30%	3
WWTEC34	11.8.11	1-5 ha	>200	<30%	5-30%	4
WWTEC35	11.8.11	>5 ha	>200	<30%	>30%	3
WWTEC36	11.8.11	>5 ha	>200	<30%	5-30%	3
WWTEC37	11.8.11	>5 ha	>200	<30%	5-30%	4
WWTEC38	11.8.11	>5 ha	>200	<30%	>30%	2
WWTEC39	11.8.11	>5 ha	>200	<30%	>30%	3
WWTEC40	11.8.11	>5 ha	>200	<30%	>30%	4
WWTEC41	11.8.11	1-5 ha	>200	<30%	5-30%	4
WWTEC42	11.8.11	>5 ha	>200	<30%	>30%	3
WWTEC43	11.8.11	>5 ha	>200	<30%	>30%	3
WWTEC44	11.4.9	>5 ha	>200	<30%	>30%	3
WWTEC45	11.8.11	>5 ha	>200	<30%	>30%	4
WWTEC46	11.8.11	>5 ha	>200	<30%	>30%	3
WWTEC47	11.8.11	1-5 ha	>200	<30%	5-30%	4
WWTEC48	11.8.11	>5 ha	>200	<30%	>30%	2
WWTEC49	11.8.11	1-5 ha	>200	<30%	5-30%	3
WWTEC50	11.8.11	>5 ha	>200	<30%	>30%	3
WWTEC51	11.8.11	1-5 ha	>200	<30%	>30%	4
WWTEC52	11.8.11	>5 ha	>200	<30%	>30%	1
WWTEC53	11.8.11	>5 ha	>200	<30%	>30%	3
WWTEC54	11.8.11	>5 ha	>200	<30%	5-30%	4
WWTEC55	11.8.11	>5 ha	>200	<30%	5-30%	3
WWTEC56	11.8.11	>5 ha	>200	<30%	>30%	2
WWTEC57	11.8.11	>5 ha	>200	<30%	>30%	4
WWTEC58	11.8.11	>5 ha	>200	<30%	>30%	6
WWTEC59	11.8.11	>5 ha	>200	<30%	>30%	4
WWTEC60	11.8.11	1-5 ha	>200	<30%	>30%	3
WWTEC61	11.8.11	>5 ha	>200	<30%	>30%	3

Survey site	RE	Patch size	Tussock count	Shrub cover (%)	Weed cover (%)	Number of listed grass species
WWTEC62	11.8.11	>5 ha	>200	<30%	>30%	3
WWTEC63	11.8.11	>5 ha	>200	<30%	>30%	2
WWTEC64	11.8.11	1-5 ha	>200	<30%	5-30%	4
WWTEC65	11.8.11	1-5 ha	>200	<30%	>30%	3
WWTEC66	11.8.11	>5 ha	>200	<30%	>30%	2
WWTEC67	11.8.11	>5 ha	>200	<30%	>30%	3
WWTEC68	11.8.11	1-5 ha	>200	<30%	5-30%	3
WWTEC69	11.8.11	>5 ha	>200	<30%	>30%	1
WWTEC70	11.8.11	>5 ha	>200	<30%	>30%	2
WWTEC71	11.8.11	1-5 ha	>200	<30%	5-30%	4
WWTEC72	11.8.11	>5 ha	>200	<30%	<5%	0
WWTEC73	11.8.11	>5 ha	>200	<30%	<5%	4
WWTEC74	11.8.11	>5 ha	>200	<30%	5-30%	3
WWTEC75	11.8.11	>5 ha	>200	<30%	5-30%	5
WWTEC76	11.8.11	>5 ha	>200	<30%	<5%	4
WWTEC77	11.8.11	>5 ha	>200	<30%	5-30%	0
WWTEC78	11.8.11	>5 ha	>200	<30%	<5%	5
WWTEC79	11.8.11	>5 ha	>200	<30%	<5%	4
WWTEC80	11.8.11	>5 ha	>200	<30%	<5%	4
WWTEC81	11.8.11	>5 ha	>200	<30%	<5%	5
WWTEC82	11.8.11	>5 ha	>200	<30%	5-30%	4
WWTEC83	11.8.11	>5 ha	>200	<30%	5-30%	4
WWTEC84	11.8.11	>5 ha	>200	<30%	<5%	0
WWTEC85	11.8.11	>5 ha	>200	<30%	<5%	0
WWTEC86	11.8.11	>5 ha	>200	<30%	<5%	5
WWTEC87	11.8.11	>5 ha	>200	<30%	5-30%	5
WWTEC88	11.8.11	>5 ha	>200	<30%	<5%	4
WWTEC89	11.8.11	>5 ha	>200	<30%	<5%	0
WWTEC90	11.8.11	1-5 ha	>200	<30%	>30%	1
WWTEC91	11.8.11	>5 ha	>200	<30%	<5%	7
WWTEC92	11.8.11	>5 ha	>200	<30%	<5%	5
WWTEC93	11.8.11	>5 ha	>200	<30%	5-30%	4

Survey site	RE	Patch size	Tussock count	Shrub cover (%)	Weed cover (%)	Number of listed grass species
WWTEC94	11.8.11	>5 ha	>200	<30%	<5%	6
WWTEC95	11.8.11	1-5 ha	>200	<30%	>30%	3
WWTEC96	11.8.11	1-5 ha	>200	<30%	>30%	2
WWTEC97	11.8.11	>5 ha	>200	<30%	<5%	4
WWTEC98	11.8.11	>5 ha	>200	<30%	<5%	6
WWTEC99	11.8.11	>5 ha	>200	<30%	<5%	6
WWTEC100	11.8.11	>5 ha	>200	<30%	>30%	3
WWTEC101	11.8.11	>5 ha	>200	<30%	5-30%	3
WWTEC102	11.8.11	>5 ha	>200	<30%	>30%	0
WWTEC103	11.8.11	>5 ha	>200	<30%	<5%	7
WWTEC104	11.8.11	>5 ha	>200	<30%	5-30%	4
WWTEC105	11.8.11	>5 ha	>200	<30%	<5%	6
WWTEC106	11.8.11	>5 ha	>200	<30%	5-30%	4
WWTEC107	11.8.11	>5 ha	>200	<30%	<5%	0
WWTEC108	11.8.11	>5 ha	>200	<30%	5-30%	0
WWTEC109	11.8.11	>5 ha	>200	<30%	<5%	4
WWTEC110	11.8.11	>5 ha	>200	<30%	<5%	0
WWTEC111	11.8.11	>5 ha	>200	<30%	<5%	4
WWTEC112	11.8.11	>5 ha	>200	<30%	5-30%	3

Appendix J Likelihood of Occurrence Table

Species Name	Common Name	NC Act	EPBC Act	Wildnet / ALA Records*	Likelihood	Distribution & Habitat**	Justification
Threatened Birds							
Calidris ferruginea	Curlew Sandpiper		CE		**Unlikely**	Usual habitat is intertidal mudflats of estuaries, lagoons, mangroves channels, dams, floodwaters and inland lakes.	Suitable coastal habitat is not present within the study area.
Erythrotriorchis radiatus	Red Goshawk	E	V		**Unlikely**	The Red Goshawk is sparsely dispersed across 15% of coastal and sub-coastal Australia. Recent records in Queensland suggest that both southern and northern Queensland birds are in existing national parks or state forests with a strongholds in north-east Queensland and eastern Cape York Peninsula. The species is mainly associated with regional ecosystems at risk with rugged terrain in southern and northern Queensland. Nesting habitat has been defined as a stand of tall trees within 1km of permanent water.	Study area does not contain suitable habitat for the species, specifically extensive vegetated tracts of mosaic communities, and the presence of permanent water i.e. large river systems.
Geophaps scripta scripta	Squatter Pigeon (Southern Subspecies)	V	V	✓	**Likely**	Habitat is defined as open forests, dominated by Eucalyptus, Corymbia, Acacia or Callitris species, vegetation communities which are remnant or regrowth and within 3 km of a water source. These areas also have well-draining soils to allow the Squatter Pigeon to breed in shallow depressions, generally after heavy rainfall.	Suitable habitat was ground truthed during the survey. Records exist near site.
Neochmia ruficauda ruficauda	Star Finch		E		**Unlikely**	The distribution of the Star Finch Is poorly known but thought to only occur in central Queensland. It is a sedentary species that forms small foraging flocks in grasslands and grassy woodlands near permanent water.	Study area does not contain suitable permanent water sources
Poephila cincta cincta	Black-throated Finch (Southern)		E		**Unlikely**	Distribution is now restricted and known from two areas near Townsville. The Black-throated Finch (southern) occurs mainly in grassy, open woodlands and forests, typically dominated by Eucalyptus, Corymbia and Melaleuca, and occasionally in tussock grasslands or other habitats (for example freshwater wetlands), often along or near watercourses, or in the vicinity of water.	Marginal habitat on site however there are no records in area and population now severely fragmented

Species Name	Common Name	NC Act	EPBC Act	Wildnet / ALA Records*	Likelihood	Distribution & Habitat**	Justification
Rostratula australis	Australian Painted Snipe		E		**No**	The Australian Painted Snipe generally inhabits shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans.	Suitable wetland habitat is not present within the study area
Tyto novaehollandiae kimberli	Masked Owl		V		**Unlikely**	Distribution not well known, three sub-populations. Masked Owl has been recorded from riparian forest, rainforest, open forest, Melaleuca swamps and the edges of mangroves, as well as along the margins of sugar cane fields	Suitable coastal habitat is not present and the study area is outside of the species known distribution.
Migratory Birds							
Apus pacificus	Fork-Tailed Swift		Mi	✓	**Potential**	Migrant to Australia between October and late April. The Fork-tailed Swift is predominantly aerial and occurs over inland areas and occasionally above the foothills in coastal areas with dry and open habitat. They can also occur over low scrub, heathland, saltmarsh and riparian woodlands.	Species has been recorded nearby and potentially flies over the study area.
Cuculus optatus	Oriental Cuckoo		Mi	✓	**Unlikely**	Inhabits monsoonal rainforest, vine thickets, wet sclerophyll forest or open Casuarina, Acacia or Eucalyptus woodlands. Frequently at edges or ecotones between habitat types.	Preferred rainforest and mangrove habitat not present within study area.
Gallinago hardwickii	Latham's Snipe		Mi		**No**	The Latham's Snipe prefers freshwater wetlands, soft moist ground or shallow flooded areas and has a large altitudinal range, up to 2000 m.	Suitable wetland habitat was not identified within the study area.
Hirundapus caudacutus	White-throated Needletail	SL	Mi	✓	**Potential**	The White-throated Needletail is almost exclusively aerial. They almost always forage aerially, at heights up to 'cloud level', above a wide variety of habitats ranging from heavily treed forests to open habitats, such as farmland, heathland or mudflats. Found to roost in tree hollows in tall trees on ridge-tops, on bark or rock faces.	Marginal roosting habitat within the study area and records in area
Hydroprogne caspia	Caspian Tern	SL	Mi		**No**	Habitat usually coastal, prefers sheltered estuaries, inlets, bays with muddy or sandy shores. Also extends well inland on temporary floodwater, large rivers, reservoirs, sewerage ponds	No suitable habitat exists onsite
Monarcha melanopsis	Black-faced Monarch	SL	Mi	✓	**Potential**	The Black-faced Monarch is found in rainforests, eucalypt woodlands, coastal scrub and damp gullies. It may be found in more open woodland when migrating.	Species may be found within Eucalypt woodlands found onsite when migrating, records in area

Species Name	Common Name	NC Act	EPBC Act	Wildnet / ALA Records*	Likelihood	Distribution & Habitat**	Justification
Motacilla flava	Yellow Wagtail		Mi		**Unlikely**	Open country near swamps, salt marshes, sewerage ponds, grassed surrounds to airfields, bare ground; occasionally on drier inland plains.	Marginal habitat, no records in area
Pandion haliaetus	Osprey		Mi		**No**	Adult Eastern Ospreys are mostly resident or sedentary around breeding territories. Eastern Ospreys occur in littoral and coastal habitats and terrestrial wetlands of tropical and temperate Australia and offshore islands. They are mostly found in coastal areas but occasionally travel inland along major rivers, particularly in northern Australia. They require extensive areas of open fresh, brackish or saline water for foraging.	Suitable habitat including extensive areas of open fresh, brackish or saline water for foraging was not identified within the study area.
Plegadis falcinellus	Glossy Ibis		Mi	✓	**Potential**	The Glossy Ibis' preferred habitat for foraging and breeding are fresh water marshes at the edges of lakes and rivers, lagoons, flood-plains, wet meadows, swamps, reservoirs. May use drainage lines and creeks on site during wet season.	Species may use dams or drainage lines found on site, records in area
Rhipidura rufifrons	Rufous Fantail		Mi		**Unlikely**	In east and south-east Australia, the Rufous Fantail mainly inhabits wet sclerophyll forests, often in gullies dominated by eucalypts such as Tallow-wood (Eucalyptus microcorys), Mountain Grey Gum. When on passage a wider range of habitats are used, including dry eucalypt forests and woodlands	Species may be found within Eucalypt woodlands found onsite when migrating, no records in area
Symposiachrus trivirgatus	Spectacled Monarch		Mi		**No**	The Spectacled Monarch prefers thick understorey in rainforests, wet gullies and waterside vegetation, as well as mangroves.	No suitable habitat
Mammals							
Dasyurus hallucatus	Northern Quoll		E		**Unlikely**	The Northern Quoll is known to occur as far south as Gracemere and Mt Morgan, south of Rockhampton, as far north as Weipa in Queensland and extends as far west into central Queensland to the vicinity of Carnarvon Range National Park. The Northern Quoll occupies a diversity of habitats across its range which includes rocky areas, eucalypt forest and woodlands, rainforests, sandy lowlands and beaches, shrubland, grasslands and desert	Preferred habitat for the species, including rugged, rocky habitat is limited within the study area.

Species Name	Common Name	NC Act	EPBC Act	Wildnet / ALA Records*	Likelihood	Distribution & Habitat**	Justification
Macroderma gigas	Ghost Bat		V		**Unlikely**	They currently occupy habitats ranging from the arid Pilbara to tropical savanna woodlands and rainforests. During the daytime they roost in caves, rock crevices and old mines. Foraging areas are centred on average 1.9 km from daytime roosts.	Requires roosting sites such as deep caves or abandoned mine shafts, suitable habitat does not occur within study area.
Nyctophilus corbeni	Corben's Long Eared Bat		V		**Unlikely**	Throughout inland Queensland, the species habitat is dominated by various eucalypt and bloodwood species and is most abundant in vegetation with a distinct canopy and a dense cluttered shrub layer. The South-eastern Long-eared Bat is thought to roost solitarily under loose bark, and in the crevices and hollows of trees. Suitable foraging and roosting habitat will then include mature woodland stands with loose bark and tree hollows.	Small areas of suitable habitat occur within the study area. Bat call analysis did not detect *Nyctophilus* sp. There are no records within 20 mkm
Petauroides volans	Greater Glider		V	✓	**Potential**	The greater glider is restricted to eastern Australia, occurring from the Windsor Tableland in north Queensland through to central Victoria. The greater glider is an arboreal nocturnal marsupial, largely restricted to eucalypt forests and woodlands. It is typically found in highest abundance in taller, montane, moist eucalypt forests with relatively old trees and abundant hollows	Areas of potential habitat exist within the southern area, with records in the wider area (45 km)
Phascolarctos cinereus	Koala		V	✓	**Potential**	Koala distribution extends along the east coast of Australia, as far north as the wet tropics and Einasleigh Uplands. Koalas naturally inhabit a range of temperate, sub-tropical and tropical forest, woodland and semi-arid communities dominated by Eucalyptus species	Areas of potential habitat exist within the southern area, with records in the wider area (45 km)
Ornithorhynchus anatinus	Platypus	SL		✓	**No**	Inhabits freshwater streams, lakes, shallow reservoirs and farm dams. Prefers areas with steep, vegetated banks in which to burrow; entrances concealed by overhanging vegetation.	No suitable habitat
Tachyglossus aculeatus	Short-beaked Echidna	SL		✓	**Likely**	All terrestrial habitats except intensively managed farmland	Suitable habitat, records in area
Reptiles							

Species Name	Common Name	NC Act	EPBC Act	Wildnet / ALA Records*	Likelihood	Distribution & Habitat**	Justification
Egernia rugosa	Yakka Skink		V		**Unlikely**	Isolated populations occur throughout sub-humid to semi-arid areas in the interior of Queensland from St George in the south, to Coen and Cape York Peninsula in the north. The species is known from rocky outcrops, sand plain areas and dense ground vegetation, in association with open dry sclerophyll forest (ironbark) or woodland, Brigalow forest and open shrub land. Habitat for the Yakka Skink is often found in association with common woodland and open forest types such as Brigalow, Mulga, Bendee, Lancewood, Belah, Poplar Box and Ironbark. The species lives in colonies around these microhabitat features and commonly digs tunnels beneath the debris.	Suitable habitat, no records in area
Elseya albagula	Southern Snapping Turtle		CE		**No**	The white-throated snapping turtle is only found in the Burnett, Fitzroy, Raglan and Mary river drainages of south-east Queensland. It prefers permanent flowing water habitats where there are suitable shelters and refuges (e.g. fallen trees).	No suitable habitat
Furina dunmalli	Dunmall's Snake		V		**Unlikely**	Dunmall's Snake is found from near the Queensland border throughout the Brigalow Belt South and Nandewar bioregions, and as far south as Ashford in New South Wales. As it utilises micro habitat features such as fallen timber and ground litter for shelter, distribution is highly fragmented due to agricultural activities limiting available habitat within the Brigalow Belt Bioregion.	Suitable habitat, no records in area
Lerista allanae	Allan's Lerista		E		**Unlikely**	Allan's Lerista is only known from black soil downs in the Brigalow Belt North Bioregion in Queensland, between Clermont and Capella. The species was found in association with Mountain Coolabah / Red Bloodwood open woodlands and Black Tea-tree. These sites were mapped as Regional Ecosystem 11.8.5 and 11.8.11.	Suitable habitat, no records in area
Rheodytes leukops	Fitzroy River Turtle		V		**No**	The Fitzroy River Turtle is only found in flowing streams and permanent waterbodies within the Fitzroy River catchment, Queensland.	No suitable habitat

Species Name	Common Name	NC Act	EPBC Act	Wildnet / ALA Records*	Likelihood	Distribution & Habitat**	Justification
Denisonia maculata	Ornamental Snake	V	V	✓	**Likely**	The species core distribution occurs within the drainage system of the Fitzroy and Dawson Rivers. The species is known to prefer woodlands and open forests associated with moist areas, particularly gilgai mounds and depressions and is likely to be found in Brigalow, Gidgee, or Coolabah dominated vegetation communities, or pure grassland associated with gilgais. Preferred habitat is also defined as areas which favour prey, including Burrowing Frog species and a number of tree frog species.	Suitable habitat identified within the study area supporting gilgai microrelief, records in area
Flora							
Bertya opponens			V	✓	**Potential**	Bertya opponens has been recorded growing in a variety of community types including mixed shrubland, lancewood woodland, mallee woodland, eucalypt/acacia open forest with shrubby understorey, eucalypt/callitris open woodland and semi-evergreen vine-thicket. Record 10 km east of study area.	Suitable habitat within the study area, records in area; however flora surveys did not detect the species within the study area.
Bertya pedicellata		NT		✓	**Potential**	Rocky hillsides in eucalypt forest or woodland, Acacia woodland or shrubland and open heathland or vine thicket communities. Soils are recorded mostly as skeletal to shallow sandy, sandy clay or clay loams overlaying rhyolite, trachyte or sandstone substrates. Record 7 km west of site.	Suitable habitat within the study area, records in area; however flora surveys did not detect the species within the study area.
Cerbera dumicola		NT		✓	**Potential**	Records have been found within non-remnant modified open grassland which was dominated by a dense layer of Buffel grass with *Cerbera dumicola* observed as shrub species growing one to three metres in height. Record 20 km south of site.	Suitable habitat within the study area, records in area; however flora surveys did not detect the species within the study area.

Species Name	Common Name	NC Act	EPBC Act	Wildnet / ALA Records*	Likelihood	Distribution & Habitat**	Justification
Cycas ophiolitica			E		**Unlikely**	Grows on hills and slopes in sparse, grassy open forest at altitude ranges from 80–400 m above sea level. Although this species reaches its best development on red clay soils near Marlborough, it is more frequently found on shallow, stony, infertile soils, which are developed on sandstone and serpentinite, and is associated with species such as *Corymbia dallachiana*, *C. erythrophloia*, *C. xanthope* and *Eucalyptus fibrosa*. Also been found on mudstone in association with *Corymbia dallachiana*, *C. erythrophloia* and *Eucalyptus crebra*, and on alluvial loams with *Corymbia intermedia*, *Eucalyptus drepanophylla* and *E. tereticornis*	Marginal habitat within the study area and no records in surrounding area.
Dichanthium queenslandicum		V	E	✓	**Known**	Grows on heavy black cracking clays in tussock grasslands on basalt downs. Often associated with RE 11.8.11. Records within study area (ELA 2017, ALA 2017).	Species previously recorded within the study area, and confirmed during 2017 pre-clearance survey (ELA 2017).
Dichanthium setosum		V			**Known**	Species usually occurs in grasslands with underlying basaltic geology and often associated with RE11.8.11 which occurs within the study area. Records within study area (ELA 2017)	)Species confirmed during April 2017 pre-clearance survey (ELA 2017)
Digitaria porrecta		NT		✓	**Potential**	Grows on heavy black cracking clays in tussock grasslands on basalt downs. Often associated with RE 11.8.11. Records adjacent to study area (ALA 2017)	Previous records adjacent to the study area, suitable habitat. Extensive pre-clearance surveys across suitable habitat did not detect the species.
Kelita uncinella		E		✓	**Potential**	Kelita uncinella is known only from the vicinity of the Newlands coal mine about 130 km west of Mackay in Queensland. It grows on the slopes of tertiary plateaux (or ‘jump-ups’), appearing to prefer south-facing slopes (Bean, 2010)	Suitable habitat, records in area; however flora surveys did not detect the species within the study area.
Samadera bidwillii			V		**Potential**	Species commonly occurs in lowland rainforest, however is also known to occur in open forest and woodland on lithosols, skeletal soils, loam soils, sands, silts and sands with clay subsoils	Suitable habitat, no records in area; however flora surveys did not detect the species within the study area.

* Records obtained from Atlas of Living Australia (ALA) and Wildnet Databases. Records after 1980 and within 50 km of the study area included.

** Information on species habitat and distribution obtained from Species Profile and Threats Database (DoE 2017), unless referenced otherwise.

Appendix K Bat Call Analysis Report (Greg Ford)

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APPENDIX 5
SINCLAIR KNIGHT MERZ (26 JUNE 2012): WARDS WELL MINE PROJECT: SOIL SURVEY. VERSION A, REF. NO. QE09811

SINCLAIR KNIGHT MERZ

SKM

bhpbilliton

BHP Mitsui Coal

Wards Well Mine Project

  

WARDS WELL: SOIL SURVEY

- Soil Survey
- Version A
- 26 June 2012

BHP Mitsui Coal

Wards Well Mine Project

WARDS WELL: SOIL SURVEY

- Version A
- 26 June 2012

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Contents

Figures

Tables

Document history and status

Revision	Date issued	Reviewed by	Approved by	Date approved	Revision type
A	26/6/2012	T. Rohde	N. Carey	26/6/2012	Preliminary Draft

Distribution of copies

Revision	Copy no	Quantity	Issued to
A	1	1	R. Pidgeon, J. Storey (BMC)

Printed:	26 June 2012
Last saved:	26 June 2012 11:14 AM
File name:	I:\QENV2\Projects\QE09811\Project Technical Studies\004 Land Resources\Reporting\Submitted_20120626\QE09811_SoilRptDRAFT_11April2012.docx
Author:	Timothy Rohde
Project manager:	Timothy Rohde
Name of organisation:	BMA
Name of project:	Wards Well Mine Project
Name of document:	Wards Well: Soil Survey
Document version:	Version A
Project number:	QE09811

1. Introduction

SKM was commissioned by BHP Bilition Mitsu Coal Pty Ltd (BMC) to undertake a soil survey assessing soil classes for Good Quality Agricultural Land (GQAL) (DPI/DHLGP, 1993), Land Suitability for cropping and grazing (DPI, 1990 and DME, 1995) and Strategic Cropping Land (DERM, 2011 and DERM, 2012). This is to form part of the Environmental Impact Statement (EIS) to support the development application for the project. The proposed mine project includes a multi-seam underground coal mine, a Coal Handling and Preparation Plant (CHPP) and Mine Industrial Areas (MIAs) and other industrial areas including a rail line loop and aeroplane runway. The Project is expected to produce up to 15 million tonnes per annum (Mtpa) of high quality hard coking coal product for the export market over a life of approximately 30 years.

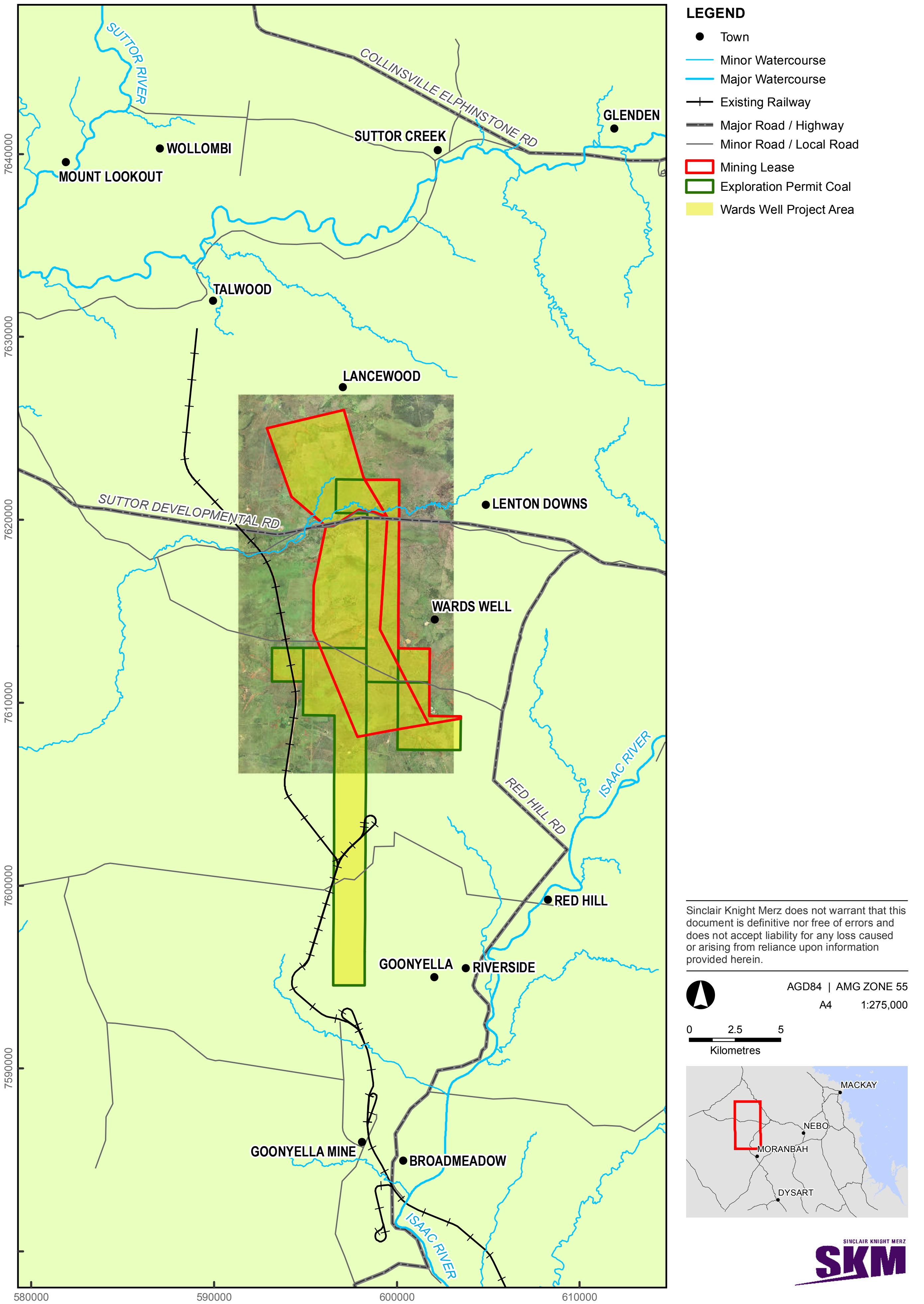
The Wards Well project will inevitable include ground disturbance. Soil resources will be impacted by the mining operations. Development of the underground mine and infrastructure including, dams, roads, hardstands and storages all have the potential to impact on the local soil resource. To ensure sufficient soil resources are available for post-mining rehabilitation, it is important that all suitable natural soil reserves are identified and recovered ahead of this disturbance. If not adequately managed, impacts within the project site may also cause impacts further downstream through the sedimentation of watercourses, especially if saline and / or sodic soils are encountered. Disturbance to the ground surface and landscape character may also reduce the agricultural suitability of land with the project site or downstream.

1.1. Project Location

The Project area is located within the northern region of the Bowen Basin approximately 30 kilometres south of Glenden (further via road network) and approximately 150 kilometres southwest of Mackay, Queensland. The project site is located within the Belyando Shire. A locality map showing the project site in a regional context is provided in **Figure 1-1**, the Project area is located immediately to the north of the existing North Goonyella Mine.

The region contains rich thermal and metallurgical coal resources at depth, and several open-cut and underground mines operating nearby supply both domestic and export markets. BMA mines, including Peak Downs (some 50 km south), have been operating since 1968. Other regional industries include beef cattle grazing and limited cropping.

WARDS WELL PROJECT LOCATION



WARDS WELL MINE PROJECT - EIS
SOILS AND LAND SUITABILITY BASELINE SURVEY

FIGURE 1

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1.2. Project Site

The project is comprised of land that is to be disturbed by the project and surrounding land which will not be disturbed by the project, consisting of 12,006.5 ha, which has been divided into key areas of disturbance for assessment purposes. The key areas of disturbance are described as follows:

- **Disturbance.** This area consists of XX ha or XX % of the project site. The mine infrastructure supporting Wards Well will be located along the western boundary of the Wards Well mining lease area and include:
  - Underground entries and underground mine (including subsidence);
  - Mine water storage facilities;
  - Accommodation camps;
  - Run-of-mine (ROM), Raw and Product coal stockpiles;
  - CHPP;
  - Two mine industrial areas (MIAs).
  - Rail loop and train load out facility;
  - Dry reject disposal area;
  - Gas pre-treatment plant;
  - On-site gas fired power plant;
  - Power supply;
  - Air strip Haul and access roads; and
  - Wards Well Airstrip.
- **Undisturbed Areas**. The area consists of XX ha or X % of the project site. The undisturbed areas are defined as all areas not used for surface infrastructure or not impacted by subsidence from the underground mine operation

1.3. Study Objectives

To assist BMC with operational soil and land management, a soil resources and pre-mining assessment of agricultural land suitability was undertaken. The major objectives of the soil and land suitability assessment, according to the projects Terms of Reference (ToRs), were to:

- **Objective 1. Classify and determine the soil types within the project site**. To satisfy Objective 1, the soil taxonomic classification system used was the Australia Soil Classification (ASC) system. The system is routinely used as the soil classification system in Australia. The scale of mapping used in the project area was 1:25,000 for planned disturbed areas and up to 1:50,000 for planned undisturbed areas across the overall site.
- **Objective 2**. **Assess the pre-mining Land Suitability classes within the project site.** To satisfy Object 2, *the Guidelines for Agricultural land Evaluation in Queensland* (DPI, 1990 and DERM, 1995)) were used. This includes a standard list of limitations for assessing agricultural land suitability in Queensland.
- **Objective 3**. **Assess the pre-mining Agricultural Land Classes (ALC) with the project site.** To satisfy Objective 3, the *Planning Guidelines: Identification of Good Quality Agricultural Land* was used (DPI/DHLGP, 1993). The guidelines define four classes of agricultural land.
- **Objective 4**. **Assess the pre-mining Good Quality Agricultural Land (GQAL) classes within the project site.** To satisfy Objective 4 the *Planning Guidelines: Identification of Good Quality Agricultural Land* was used (DPI/DHLGP, 1993). The guideline sets conditions for land in terms of limitations, rating and ability of the land to maintain a sustainable level of agricultural productivity.
- **Objective 5**. **Assess the pre-mining Strategic Cropping Land (SCL) within the project site and provide soil management recommendations for management.** To satisfy Objective 5, the relevant guideline applied was the *Protecting Queensland's strategic cropping land; Proposed criteria for identifying strategic cropping land* (DERM, 2011). This guideline allows for on ground assessment of the project site against the criteria that will define the extent of strategic cropping at a reconnaissance level.
- **Objective 6**. **Assess the suitability of topsoil for future rehabilitation including the identification of unfavourable soil in the project site.**
- **Objective 7. Assess the potential erosion rates for various scenarios during the construction, and operational phases of the project.**

1.4. Desktop Study

There are several existing surveys that have information relating to soils and land suitability that are relevant to the Project. The first soil and land suitability work in the survey area was completed by CSIRO who mapped land system boundaries (Gunn et al., 1967) and described soil types. Bourne and Tuck (1993) described agricultural management units (AMU's) for the Central highlands region of Queensland that includes the Project area. Other work relevant to the area includes the CSIRO Land Systems mapping (Story et al., 1967).

In addition to the publications described above, the following maps have been used to describe soils, topsoil thickness and land suitability as part of initial desktop review:

- DERM (2011a) Strategic Cropping Land – Trigger Mapping;
- DERM (2010) Good Quality Agricultural Land Mapping;
- National Resource Information Centre (1991) Australian Soil Classification digital map. Mapped by McKenzie and Hook (1992) using soil descriptions provided in the Atlas of Australian Soils (Northcote et. al., 1968); and
- CSIRO digital map interpreted from Northcote et al., (1960-1968) 'Atlas of Australian Soils'.

1.5. Field Sampling Method

The survey has been designed to provide sufficient information on land resources to allow the determination of land suitability, SCL, soil erosion potential, rehabilitation potential and storm water runoff quality consistent with the methods set out by the Queensland DPI (1990), Shields and Williams (1991) and DME (1995). Fieldwork investigations were conducted over the period 15 to 24 August 2011. Soil was described at 98 sample locations with a further 384 observation sites corresponding to an overall soil mapping and sampling scale of 1:25,000.

An assessment has been made of land suitability for grazing and cropping using the Land Resources Branch (1990) system which is considered the most appropriate for this survey and forms the basis for GQAL assessment as well as selection criterion for SCL.

A free survey technique (Gunn et al 1988) has been used to verify mapped soil types and assign boundaries to each. Free survey is a commonly used method in broader scale agricultural lands as it enables flexibility in site selection (over grid mapping techniques), to achieve a more accurate and time effective result. The survey focused on areas that are likely to be affected by mining operations, although sampling beyond planned disturbance areas has also been undertaken to enable soil units to be extended into the adjoining areas not proposed for future mining activity. Generally sampling and profile inspection points have been positioned to characterise all landform elements and soil units.

Ground truthing of mapped soil types was required for the following reasons:

- The dominant soil from each unit may occupy a very limited area (perhaps 20%) within that unit. Any analysis based on an interpretation of the dominant soil is therefore of restricted value;
- It is normal for there to be a very large variation within each map unit. Some units have up to 20 soils listed. It is common for the within unit variation to be as great as the between unit variation;
- As a consequence, it is essential to use the range of soils and their interpreted values when making judgements on soil character and behaviour for any area;
- Many landscape processes (e.g. erosion, salinisation etc.) do not correlate in a simple way (if at all) with the Australian Soil Atlas units because the description of soils is based on profile morphology. Profile morphology may have a poor or complex relationship with soil processes. Furthermore, landscape processes required more information before even synoptic predictions can be made; and
- The spatial arrangement of soils within a landscape may have an overriding impact on landscape processes (e.g. erodible soils along stream banks).

Details regarding the compliance of the survey density with the current recommended sampling densities are summarised in **Table 1-1**.

- **Table 1-1 Compliance with Current Requirements**

Item	Recommendations	Actual	Compliance
Total number of locations assessed	4 to 16 per 100 ha	MLA Area: 5,089.17 ha	Yes
Survey Scale	1:25,000	206 locations assessed which represents 4 locations per 100 ha	Yes
Detailed Sites	10-30 %	1:24,705	Yes
Sites subject to laboratory Analysis	1-5%	51 out of 206 locations which represents approximately 40% of the survey points	Yes

1.6. Soil Description

Profile descriptions have been described with due regard to the Australian Soil and Land Survey Field Handbook (MacDonald et al., 1990), the Australian Soil Classification (Isbell, 1996) and Munsell soil colour charts. Profiles were sampled using a hand auger and where possible profiles at cuttings, excavated pits and eroded channels were recorded.

Major soil characteristics were determined from examination of soil profile morphology for the attributes presented in **Table 1-2**. Physical properties such as permeability and drainage characteristics were inferred from profile morphological characteristics such as concretions, depth to rock, observed root depth, colour and mottling. Slope, landform, vegetation, land condition were also described at inspection points.

- **Table 1-2 Australian Soil Classification Descriptors**

Descriptor	Application
Horizon depth	Weathering characteristics, soil development
Field Colour	Permeability, susceptibility to dispersion / erosion
Field Texture Grade	Erodibility, hydraulic conductivity, moisture retention, root penetration
Boundary Distinctions and Shape	Erosional / Dispositional status, textural grade
Consistence Force	Structural stability, dispersion, ped formation
Structure Pedality Grade	Soil structure, root penetration, permeability, aeration
Structure Ped and Size	Soil structure, root penetration, permeability, aeration
Stones – Amount and Size	Water holding capacity, weathering status, erosional / dispositional character

1.7. Sampling and Laboratory Analysis

Assessment of GQAL, Land Suitability and SCL included laboratory analysis of 1-2 kg of sample collected during the site soil survey. DME (1995) Guidelines suggest a sampling density of between 4 and 16 sample points per 100 ha for a 1:25,000 scale survey depending on pre existing resource information as well as the local knowledge and experience of the surveyor. Further, the guideline also recommends that between 1% and 5% of all sites are sampled and subject to laboratory analysis and that between 10% and 30% of sites are described in detail (i.e. field profile morphological description). The survey has included 98 description locations with samples taken from 16 locations collected through the soil profile at each horizon roughly corresponding to 0 mm, 300 mm and 600 mm depth. In total 46 samples have been analysed by the NATA accredited ALS Laboratories, for chemical and physical characterisation as specified in **Table 1-3**. Of these samples, 27 were analysed for Particle Size Distribution (PSD) and 32 samples analysed for aggregate stability.

- **Table 1-3 Physical and Chemical Laboratory Analysis**

Test	Soils Analysed	Reason for Inclusion
Chemical Analysis		
pH, Electrical Conductivity and Chloride Content	Surface and subsoil	pH is regarded as a useful indicator of other soil properties (e.g. values >8.5 usually indicate high exchangeable sodium levels and the presence of carbonates) and of the need for amendment with lime. Some plants tolerate a wide range of pH, while some are sensitive to acidity and some to alkalinity. The availability of some nutrients will be affected by soil pH. The measure of EC is used as a means of appraising soil salinity. The electrical conductance increases with soluble salt content and thus allows simple interpretation of readings. Plants vary considerable in their tolerance to salt The chloride anion is usually present in soil in association with sodium and is an important constituent of many salty soils. Its high mobility makes it a valuable indicator of the direction of

Test	Soils Analysed	Reason for Inclusion
		salt and water movement, and it can be specifically toxic to some plants.
Carbonate Content	Surface and subsoil	Carbonate may exist in soil as predominately either calcite or dolomite. Its presence, which may vary from trace amounts to high percentages of the soil, is of significance because of its effect on the general physical condition, especially on consistence. When present in large amounts as fine-earth carbonate it can modify soil texture. It can constitute a potential source of calcium for the replacement of exchangeable sodium, thus improve stability.
Cation Exchange Capacity and Exchangeable Ca, Mg, Na (Cations)	Surface and subsoil	The amounts and relative proportions of the exchangeable cations in soil have important effects on both physical and chemical properties. High levels of exchangeable sodium cause dispersion and increased swelling, reducing water movement and affecting near surface aeration whereas exchangeable calcium flocculates colloids and will reduce swelling tendencies. Excessively high or low concentrations of one or the other of the cations may result in nutritional disturbances to germinating plants. Exchangeable cations are held in the soil at negatively charged surfaces and are exchanged by all 'strong' cations. The total amount that can be held is designated the cation exchange capacity.
Soluble Ca, Mg, Na, K, CO_3, HCO_3, SO_4	Surface and subsoil	Knowledge of soluble cations and anions and their relative proportions is valuable in assessing saline and alkaline soils and their response to various treatments. Chloride is usually the principal anion in extracts of soil and it is specifically toxic to some plants. Other anions may also be toxic to plants. Bicarbonate is a normal constituent of saline and sodic soil extracts. Both CO3 and HCO3 have a tendency to precipitate the divalent cations Ca and Mg, resulting in an increase in the ratio of Na to Ca-Mg in the soil solution. This favours the absorption of Na by the exchange complex and the development of unfavourable sodic-soil conditions.
Phosphorous, Nitrogen, Potassium	Surface soil	If the amount of phosphorous in soil is too small then yield is jeopardised, but increasing reserves to very high levels is an unnecessary expense. Thus the concept of a critical level in soil is necessary.
Organic Matter	Surface soil	Organic matter is important in maintaining soil structure, in slightly increasing the soil's water holding capacity and holding a small store of N, P, S and trace elements in organic forms. These cannot be taken up directly by plant roots but have first to be converted by soil microbes to inorganic (ionic) forms identical to those supplied in fertilisers.
Total digest for molybdenum, manganese, iron, copper, zinc, boron, chloride, sodium and cobalt.	Surface and subsoil	Although only required in small amounts, trace elements (or micronutrients) are essential for plant growth. These nutrients often act as catalysts in chemical reactions. It is possible to have toxicities of trace elements, as well as deficiencies. A deficiency may reduce plant growth. An excess of a trace element, although not common, may be toxic to the plant and may cause an imbalance, reduced yield, impaired quality or increased susceptibility to disease.
Bicarbonate Extractable Phosphorus (P)	Surface soil	Defines the very soluble (also termed available of labile) phosphorus in soils.
Physical Analysis		
Particle Size Distribution (PSD)	Subsoil	Defines the relative amounts of silt, clay and sand in the sample
PAWC	Derived empirically for surface and subsoil	Where the plant available water capacity is marginal or requires more detailed evaluation than estimations from morpholocical attributes, then PAWC analysis has been undertaken. Some Brigalow scrub soils may fall into this category.
Aggregate Stability	Surface and	This classifies the behaviour of soil aggregates, when immersed, and their coherence in water. Testing is done only on soils with suitable aggregates. Sands and gravels are usually unsuitable

Test	Soils Analysed	Reason for Inclusion
(Emerson Aggregate Test)	subsoil	for the test. The soils are divided into seven classes on the basis of their coherence in water, with one further class being distinguished by the presence of calcium-rich materials. Typically Class i and 2 soils are highly likely to pollute stormwater of exposed to rainfall or flowing water of any kind. Treatment of these soils with gypsum will most likely be required. Class 3 and 5 soils disturbed by cut and fill operations or construction traffic are highly likely to pollute stormwater, i.e. cause turbid run-off. Chemical stabilisation will likely be required. Any Emerson Class 1, 2, 3 and 5 subsoils that are to be revegetated and need to be covered with a non-dispersive topsoil as soon as possible.

1.8. Report Structure

This technical report is presenting the following:

- The methodology used to assess the land quality of the project area
- The findings of the desktop assessment
- The findings of the field survey in regards to:
– The description of the soils as per the Australian Soil Classification (ASC).
– The ground truthing of the ASC orders as mapped in the desktop study.
– The determination of the erosion susceptibility of the surface and subsurface soil.
– The prediction of likely SCL areas and QGAL.
- A discussion of the results in relation to the mitigation and rehabilitation measures for the project.

2. Geomorphology

This section provides a description of the soil origins and landform of the project area based on existing published data and survey results. The soil logs are provided in **Appendix A** and tabulated laboratory results in **Appendix B**. The ALS laboratory documents are provided as **Appendix C**.

The geomorphology of the project area has been deduced from the following resources:

- R.H. Gunn and H.A. Nix in the 1:1,000,000 mapping Geomorphic Categories and Land Units of the Fitzroy Region, Queensland, Australia (1977);
- Gunn, RH, Galloway, RW, Pedley, L and Fitzpatrick, EA (1967) Lands of the Nogoa-Belyando Area, Queensland. Land Research Series No. 18, CSIRO, Melbourne;
- Atlas of Australian Soils (Northcote et al, 1960-68). Digital Map published by CSIRO; and
- Geoscience Australia (2002) 1:1,000,000 electronic vector mapping data of surface geology.

R.H Gunn et al (1967) have described the relief of the Nogoa-Belyando Area where the project is located. After the formation of extensive basalt sheets in early Tertiary times, prolonged erosion etched out areas of softer rocks to form lowlands while leaving harder rocks standing up as scarps and hill masses. Later in the Tertiary, erosion attacked these higher areas and covered the adjacent lowlands with detrital deposits ranging from conglomerate and sandstone to clay. The result was a gently undulating Tertiary land surface that was depositional over extensive lowland areas and erosional on limited higher areas. Deep weathering associated with this landscape produced the Tertiary weathered zone with laterite overlying mottled and pallid zones.

Subsequently the Tertiary land surface and weathered zone were partially eroded and in places removed entirely. This erosion resulted in the development of a soil catena and associated vegetation types on a wide range of rocks, particularly the Tertiary sediments.

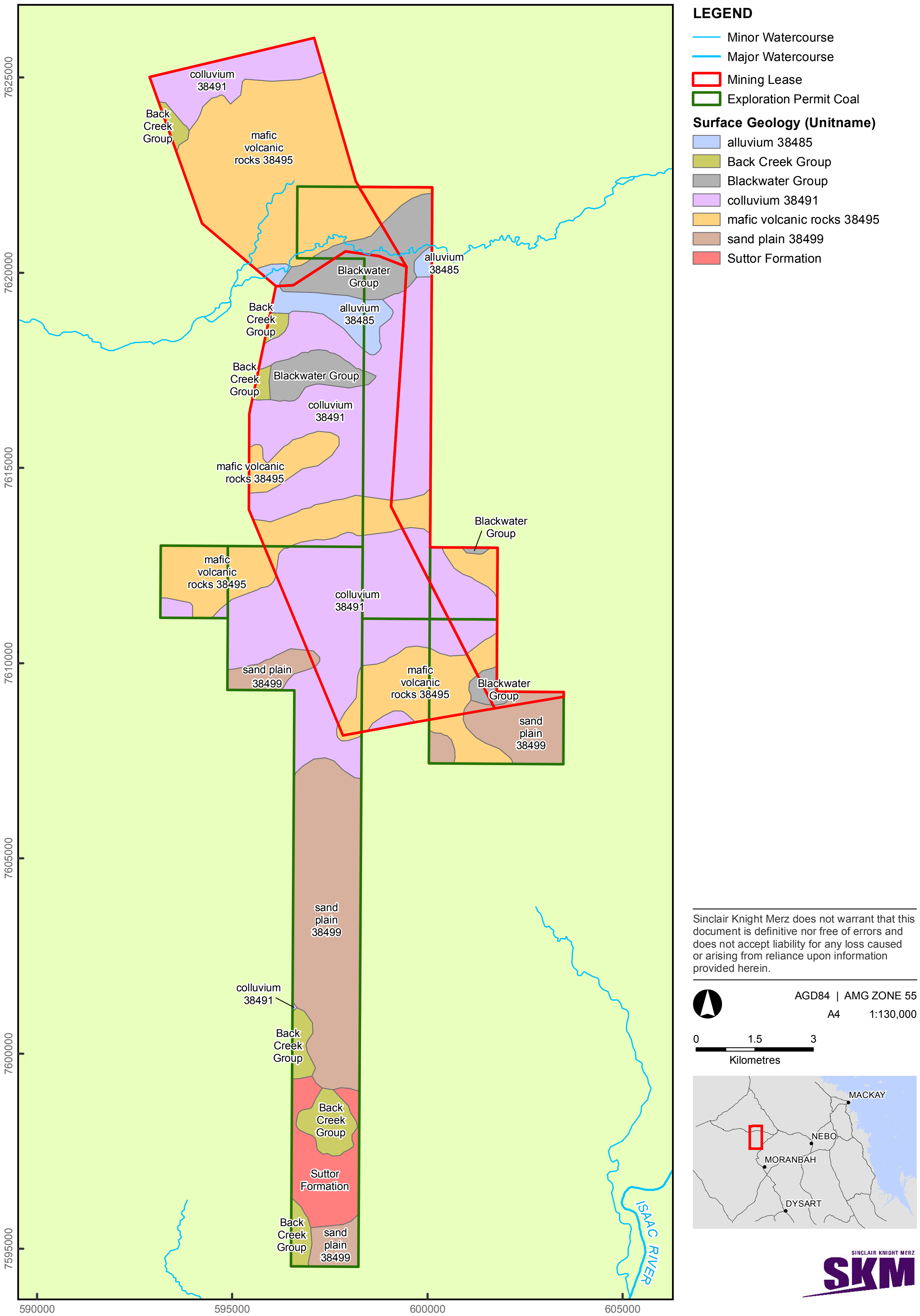
Table 2-1 provides a comparison of published geomorphology descriptions in the project area along with geology and Australian Soil Classification (ASC) found during the field survey. A map showing surface geology is provided in **Figure 2-1**.

- **Table 2-1 Comparison of Published Geomorphology Descriptions in Project Area**

Part of Site	RH Gunn and HA Nix (1977)	Northcote et al (1960 – 1968)	Geology and Soils
North	Lowlands (stable) and occasional low tabular hills on basalt giving rise to sedimentary soil mainly on basalt:	Gently to broadly undulating plains interrupted by some stony ridges, basalt flow scarps, broad low hill crests, or occasional low conical hills: dominant soils are shallow to moderately deep dark grey or dark brown cracking clays.	Mafic volcanic rocks, Alluvium, Colluvium, Blackwater Group (Sandstone, siltstone, shale, mudstone, coal, tuff, conglomerate).

Part of Site	RH Gunn and HA Nix (1977)	Northcote et al (1960 – 1968)	Geology and Soils
Central	May Downs - Dark self mulching deep clay (≥ 90 cm).	Ug5.12 Ug5.16	Kandosol, Vertosol, Sodosol (minimal inclusion).
	Minor Arcturus – Dark self-mulching moderately shallow clays (60-90 cm).	Ug 5.12 Ug5.14	
	Teviot – Dark self mulching moderately deep to deep clay soils.	Ug5.12 Ug5.14 Ug5.22	
	Lowlands (erosional) and occasional low tabular hills on basalt giving rise to Red earths:	Gently undulating lands with broad ridge crests and low rises. Loamy or occasionally sandy red earths.	Mafic volcanic rocks, Colluvium.
	Dunrobin – Deep loamy red earths.	Gn2.12 Gn2.11	Kandosol, Vertosol, Dermosol, Sodosol.
	Minor Struan – Deep loamy yellow earths.	Gn2.22 Gn2.21 Gn2.62	
	Annandale – Deep sandy red earths.	Gn2.12 Gn2.11	
Southern	Gently undulating stable plans giving rise to transported weathered materials:	Level or very gently undulating clay plains with slight to moderate (1-2 ft) gilgai microrelief, occasionally stronger (2-4 ft). Where the unit is adjacent to major streams many small braided channels occur and the area is subject to flooding. Dominant soils are deep grey clays.	Sand Plain (Sand plain, may include some residual alluvium; sand dominant, gravel, clay).
	Natal – Dark self mulching deep clays, neutral to strongly alkaline throughout.	Ug5.24 Ug5.16	Vertosol, Dermosol.
	Logan – Dark self mulching deep clays, neutral to strongly alkaline at or near surface, slightly to strongly acid at depth, gypseous.	Ug5.24 Ug5.16	

SURFACE GEOLOGY



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WARDS WELL MINE PROJECT - EIS
SOILS AND LAND SUITABILITY BASELINE SURVEY

FIGURE 2

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3. Soil Units

The Survey has found Vertosols, Sodosols, Dermosols and Kandosols to be present in the project area. The nature and occurrence of the soils in the Project area is described in **Table 3-1**.

- **Table 3-1 Soil Types**

Australian Soil Classification	Description	Area (%)	Area (ha)
Vertosol	Brown, Grey and Black, greater than 35% clay content, self mulching over Basalt	38%	4,466
Sodosol	Sodic Duplex and Gradational Brown Loams	5%	545
Dermosol	Red, Brown Clays, well structured and well drained	20%	2,355
Kandosol	Red Sandy Loams	37%	4,299

A map showing the survey sample locations and Australian Soil Classification (ASC) is provided in **Figure 3-1**.

All soil test results are provided in **Appendix B** and **Appendix C**.

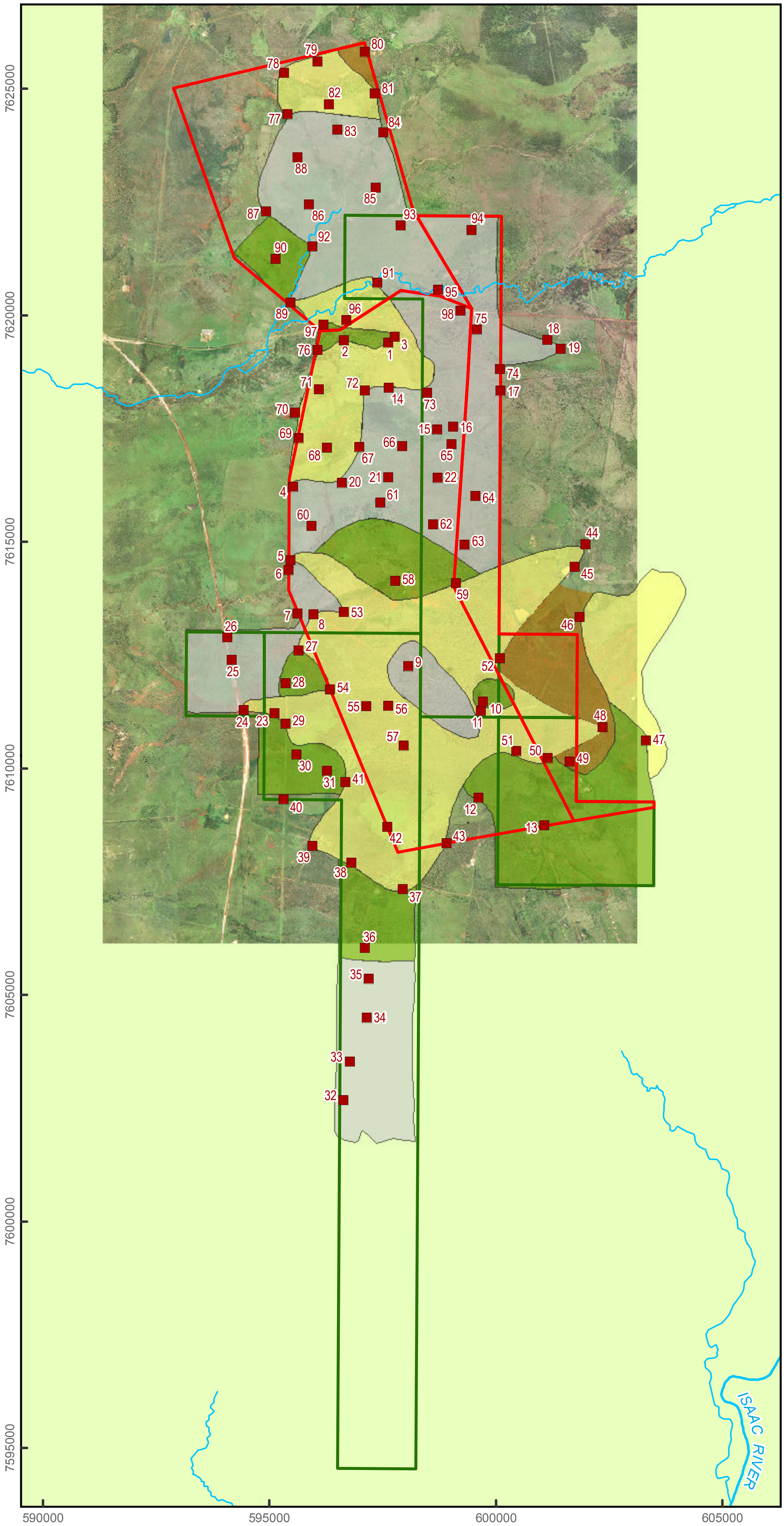
3.1. Vertosol

Vertosols (**Table 3-2**) generally occupy undulating plains and extensive floodplains of inland streams, and are derived from alluvial clayey sediments, shales, mudstones, limestone, and basalts. They are characterised by high clay content, and when dry, crack to a considerable depth (McKenzie et al., 2004).

Vertosols cover 4,466km (38%) of the project area. The observed Vertosols display characteristic features: occurrence on plains/floodplains and mafic volcanic rocks. They have a strongly developed structure and high clay content and the majority of these soils in the region are used for grazing.

Figure 3-2 presents a soil profile description for a Vertosol (site 6). These cracking clays generally consist of very dark brown to dark greyish black medium to heavy clays (**Table 3-3**). These soils are moderately to well drained and are generally alkaline and become very alkaline with depth. These soils may also become saline to epihypersodic with depth.

SAMPLE LOCATIONS AND AUSTRALIAN SOIL CLASSIFICATION



LEGEND

- Sample Locations
- Minor Watercourse
- Major Watercourse
- Mining Lease
- Exploration Permit Coal

Australian Soil Classification

- Dermosol
- Kandasol
- Sodosol
- Vertosol

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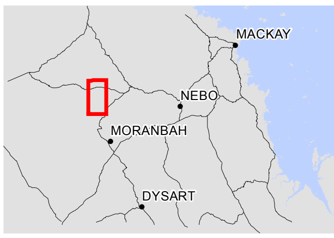

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WARDS WELL MINE PROJECT - EIS
SOILS AND LAND SUITABILITY BASELINE SURVEY

FIGURE 3

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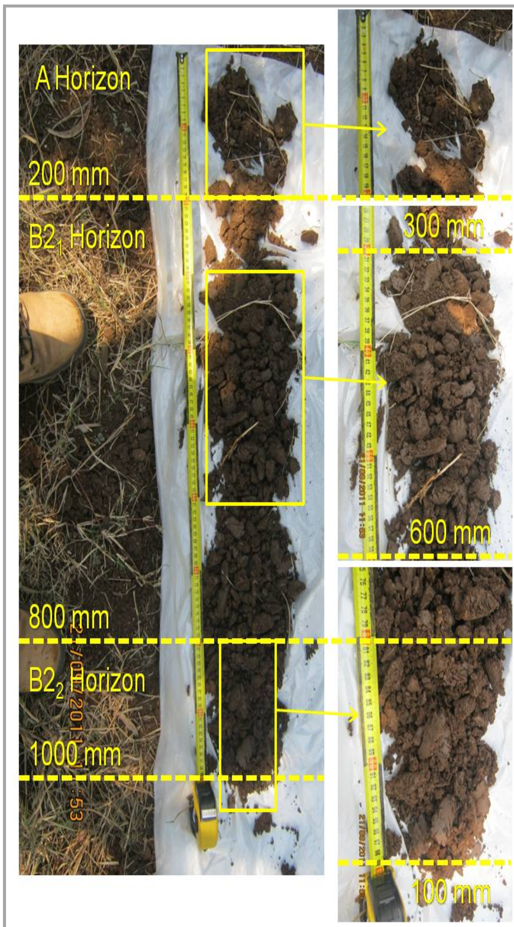
▪ **Table 3-2 Vertosol: Representative Description and Management (Site 6)**

Soil	Vertosol
AMG Reference	0595544, 7614553
Site No	6
Landform Element	Creek bank
Landform Pattern	≤ 1% old flood plain
Slope %	1%
Microrelief	Nil
Drainage	Good
Surface Condition	Cracking clay, fine grain, self mulching
Land Condition	Buffel grass, Brigalow
Land Use	Grazing
Major Vegetation Form and Type	Extensively cleared with open areas of Buffel grass
Sample for analysis	0-100 mm, 200-300 mm, 800-900 mm
General Comments	Overall good fertility, saline at 800-900mm reducing cropping potential, alkaline pH below 100mm
Recommended Topsoil Strip Depth	Topsoil can be stripped to a maximum 500mm where topsoil is deep however some Vertosols in centre of site are saline at 200mm and should not be striped below this depth
Land Suitability Summary	Cropping: 4 Grazing: 3
Preferred Rehabilitation Application	Vertosols where the salt bulge is at depth (below 800mm) have good structure and high moisture storage potential and would readily germinate and support both grasses & native trees. Vertosols with high salinity have high ESPs making them prone to dispersion and are not suited to rehabilitation application due to high erosion potential



A1 0-200mm. Medium Clay, 10YR 3/3, Cracking clay, fine grain, self mulching, Not Coherent, consistence 2, well drained, no inclusions, Clear, Even boundary

B2$_1$ 200-800mm. Medium Clay, 10YR 4/2, ≤ 2% Manganese nodules, Weak, Coherent, consistence 2, Gradual, Even boundary

B2$_2$ 800-1000+ mm. Medium Clay, 7.5YR 3/4, ≤ 2% Manganese nodules and soft lime nodules, Weak, Coherent, consistence 2, Gradual, Even boundary

- **Figure 3-2 3 Vertosol: Profile (Site 6)**

- **Table 3-3 Vertosol: Particle Size Distribution (Site 6)**

Depth	Silt %	Clay %	Sand %	Gravel %	Unified Soil Classification
>200 - <300 mm	12	68	12	8	Medium Clay

Major Chemical and Physical characteristics are summarised in **Table 3-4**. The following summary comments apply to Vertosol soil found within the project area:

- Good overall fertility;
- Becoming sodic and saline below 300mm which limits plant rooting depth and PAWC;
- Desirable pH range;
- Excellent levels of nitrates, phosphorus and metals; and
- Soil has good structure at surface (high organic matter, high Ca compared to Mg) but can become dispersive below 300mm.

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Table 3-4 Vertosol: Soil Chemistry (Site 6)

Analyte	Unit	Soil Sufficiency (Baker and Eldershaw, 1993)	> 100 mm	>200 - <300 mm	>800 - <900 mm	Comment
pH Value	pH Unit		7.8	8.6	8.6	neutral tending alkaline
Electrical Conductivity	mS/cm	<0.8	0.107	0.137	0.659	Low in surface, moderate at 800mm
Sulfate as SO4 2-	mg/kg	8	20	<10	120	High, low at 200mm
Chloride	mg/kg	800	<10	<10	1000	low in surface, high at 800mm
ExchCalcium	meq/100g	2	37.3	37.2	33.7	Very high
ExchMagnesium	meq/100g	2	17.4	24.7	30.2	Very high
Exch Potassium	meq/100g	0.2	2.2	0.5	0.1	high at surface, low below 300
Exch Sodium	meq/100g		0.2	2.4	8.4	sodic at 800
CEC	meq/100g	>5	57	64.8	72.4	High
ESP		<6%	0%	4%	12%	Dispersive at 800mm
Ca/Mg ratio		<0.5	2.1	1.5	1.1	Good structure due to high Ca
Bicarbonate Alkalinity as CaCO3	mg/kg		254	470	444	
Boron	mg/kg	>1-4	<50			
Cobalt	mg/kg		66			
Copper	mg/kg	0.4	38			Very high
Iron	mg/kg		69600			
Manganese	mg/kg		1290			Very high
Molybdenum	mg/kg	5	<2			
Zinc	mg/kg	0.8	76			Very high
Bicarbonate Extractable P	mg/kg		42			High
Nitrite + Nitrate as N (Sol.)	mg/kg		19.8			
Total Kjeldahl Nitrogen as N	mg/kg		2630			
Total Nitrogen as N	mg/kg	1500mg/kg	2650			High
Total Phosphorus as P	mg/kg	200mg/kg	494			High
Organic Matter	%	>1.5%	5.1			

3.2. Sodosol

Sodosols are widely distributed in eastern Queensland and are associated with dry climates. They are formed on alluvial and part-colluvial deposits, as well as igneous, sedimentary and metamorphic rocks (McKenzie et al., 2004). They are characterised by a strong texture contrast between topsoil and subsoil, with clayey, sodic (ESP of over 6% in the upper 0.2 m of the B

Horizon) and often highly dispersive subsoils (Isbell 2002) (**Table 3-5**). The relatively impermeable subsoil which inhibits plant root penetration, hard-setting topsoils and susceptibility to tunnel and gully erosion all pose significant management issues.

Sodosols comprise 545ha (5%) of the project area. Where exposed in road cuttings and creek banks, some Sodosols showed evidence of deep erosion and various stages of rilling and gullying. The subsoils (B Horizon) of Sodosols are susceptible to collapse and transport, and readily disperse under sustained water application.

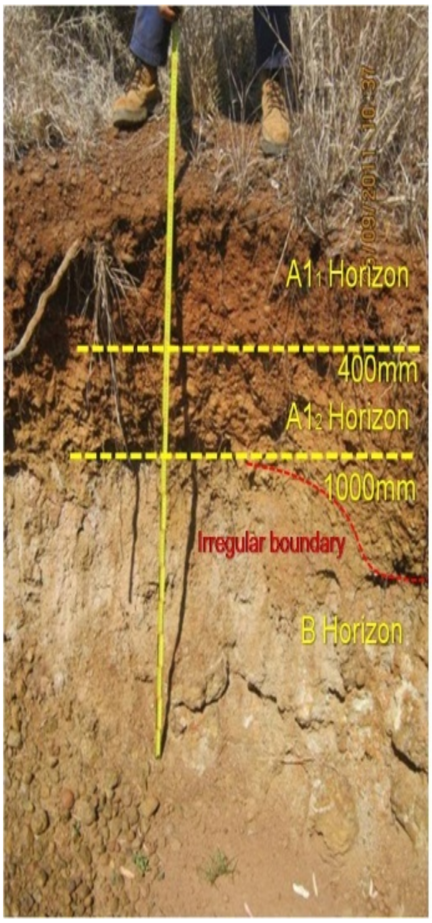
Figure 3-3 presents a soil profile description for a Sodosol (Site 49). These Sodic Duplex and Gradational Brown Loams have a strong textural contrast between the A and B Horizons (**Table 3-6**).

▪ Table 3-5 Sodosol Representative Description and Management (Site 49)

Soil	Sodosol
AMG Reference	0601753E, 7610328N
Site No	49
Landform Element	Upper slope
Landform Pattern	Flat / gently undulating plains
Slope %	0%
Microrelief	Nil
Drainage	Good surface / poor subsoil
Surface Condition	Gravelly
Land Condition	Extensive erosion (≤ 50% of sample area)
Land Use	Grazing
Major Vegetation Form and Type	Ironbark, brigalow, spear grass, bohenia
Sample for analysis	INSERT
General Comments	Erosion was present in around 50% of the land surrounding the sample point
Recommended Topsoil Stripping Depth	200mm if required for rehabilitation
Land Suitability Summary:	Cropping: 5 Grazing: 4
Preferred Rehabilitation Application	Use of this soil should be avoided in rehabilitation due to high erosion potential

▪ Table 3-6 Sodosol: Particle Size Distribution (Site 49)

Depth	Silt %	Clay %	Sand %	Gravel %	Unified Soil Classification
INSERT					



A1 0-400mm. Light Clay, 2.5YR 3/4, coarse fraction 80%, weak, weakly pedal, coherent, consistence 2, good drainage, no inclusions, clear/even boundary

A1$_2$ 400-1000mm. Light Clay, 7.5YR 4/6, coarse fraction 80%, no inclusions Weak, Weakly Pedal, Coherent, poor drainage, consistence 2, Clear, Irregular boundary

B2$_1$ 650-1000mm. Medium/heavy clay, 10YR 5/3, Grey / orange mottles, Weak, Weakly Pedal, Coherent, consistence 2, poor drainage, base of horizon not encountered.

- **Figure 3-3 Sodosol: Profile (Site 49)**

Major Chemical and Physical characteristics are summarised in **Table 3-7**. The following summary comments apply to Sodosol soil found within the project area:

- To be completed after additional soil sampling
- The soil profile display a characteristic texture contrast between the A and B horizons. The upper B horizon contains mottles which may indicate waterlogging due to hardsetting of the dispersive B horizon. This boundary may also act as a barrier to crop root penetration.

- **Table 3-7 Sodosol: Soil Chemistry (Site 49)**

Analyte	Unit	Soil Sufficiency (Baker and Eldershaw, 1993)	> 100 mm	>200 - <300 mm	>800 - <900 mm	Comment
pH Value	pH Unit					
Electrical Conductivity	mS/cm	<0.8				

Analyte	Unit	Soil Sufficiency (Baker and Eldershaw, 1993)	> 100 mm	>200 - <300 mm	>800 - <900 mm	Comment
Sulfate as SO4 2-	mg/kg	8				
Chloride	mg/kg	800				
ExchCalcium	meq/100g	2				
ExchMagnesium	meq/100g	2				
Exch Potassium	meq/100g	0.2				
Exch Sodium	meq/100g					
CEC	meq/100g	>5				
ESP		<6%				
Ca/Mg ratio		<0.5				
Bicarbonate Alkalinity as CaCO3	mg/kg					
Boron	mg/kg	>1-4				
Cobalt	mg/kg					
Copper	mg/kg	0.4				
Iron	mg/kg					
Manganese	mg/kg					
Molybdenum	mg/kg	5				
Zinc	mg/kg	0.8				
Bicarbonate Extractable P	mg/kg					
Nitrite + Nitrate as N (Sol.)	mg/kg					
Total Kjeldahl Nitrogen as N	mg/kg					
Total Nitrogen as N	mg/kg	1500mg/kg				
Total Phosphorus as P	mg/kg	200mg/kg				
Organic Matter	%	>1.5%				

3.3. Dermosol

Dermosols lack a strong texture contrast between the A and B horizons, are not calcareous throughout, and have moderately to strongly structured B2 horizons. The B2 horizons are usually clayey and do not have a free-iron oxide content greater than 5%. In arid zones, Dermosols mainly occur on low angle pediments with low shrublands, extending from mesas with ferricrete in varying degrees of denundation, to surrounding Vertosol plains (**Table 3-8**).

Dermosols cover 2355ha (20%) of the Project area.

Figure 3-4 presents a soil profile description for a Dermosol (Site 28). These Red, Brown Light to Medium Clays are well structured and poorly drained (**Table 3-9**).

- **Table 3-8 Dermosol: Representative Description and Management (Site 28)**

Soil	Brown Dermosol
AMG Reference	595477E, 7612063N
Site No	28
Landform Element	Gently undulating
Landform Pattern	Bottom of slope (1-2%)
Slope %	1%
Microrelief	Nil
Drainage	Imperfect/poor
Surface Condition	Hardpacked, non-cracking clay
Land Condition	Good, small shrubs, grassland, some Ironbark
Land Use	Grazing
Major Vegetation Form and Type	Extensively cleared leaving small shrubs, Grassland, Some Ironbark
Sample for analysis	0-100 mm, 200-300 mm, 700-800 mm
General Comments	Low fertility, suitable for pasture
Recommended Topsoil Stripping Depth	< 200mm on Dermosols with high sodicity at shallow depth. Otherwise Dermosols can be stripped to base of topsoil
Land Suitability Summary:	Cropping: Class 4 Grazing: Class 4
Preferred Rehabilitation Application	Only suitable for flat to gentle slopes (<3%) to avoid excessive erosion due to dispersive erosion potential. Soil suitable for grazing on native pastures

A1 0-100mm. Light Clay, 7.5YR 4/4, Weak, Weakly Pedal /Apedal, consistence 2, imperfect drainage, no inclusions, clear, even boundary

B21 100-400mm. Medium Clay, 7.5Yr 4/4, ≤ 2% White mottles, Weak, Strongly Pedal, Coherent, poor drainage, consistence 2, clear, even boundary

B22 400+ mm. Medium Clay, 7.5YR 3/3, White / Black mottles, Firm / Very Firm, Strongly Pedal, Coherent, consistence 3/4, poor drainage, base of horizon not encountered.

- **Figure 3-4 Dermosol: Profile (Site 28)**

- **Table 3-9 Dermsol: Particle Size Distribution (Site 28)**

Depth	Silt %	Clay %	Sand %	Gravel %	Unified Soil Classification
>0 - <100 mm	15	37	46	2	Light Clay
>700 - <800 mm	11	47	41	1	Medium Clay

Major Chemical and Physical characteristics are summarised in **Table 3-10**. The following summary comments apply to Sodosol soil found within the project area:

- Low overall fertility;
- Becoming sodic and dispersive below 200mm;
- Desirable pH range; and

- Soil has poor structure at surface (low organic matter, apedal) and becomes dispersive below 200mm. Other Dermsols tested were dispersive below 700mm.

- **Table 3-10 Dermosol: Soil Chemistry (Site 28)**

Analyte	Unit	Soil Sufficiency (Baker and Eldershaw, 1993)	> 100 mm	>200 - <300 mm	>700 - <800 mm	Comment
pH Value	pH Unit		7.3	7.8	7.2	Neutral
Electrical Conductivity	mS/cm	<0.8	0.15	0.049	0.025	low
Sulfate as SO4 2-	mg/kg	8	50	10	<10	High at surface, low at depth
Chloride	mg/kg	800	40	20	20	low
ExchCalcium	meq/100g	2	6.4	8.1	3.8	Adequate
ExchMagnesium	meq/100g	2	5.4	9.9	3.6	moderate
Exch Potassium	meq/100g	0.2	2.4	<0.1	<0.1	high in surface, low at depth
Exch Sodium	meq/100g		0.8	2.2	0.7	Sodic
CEC	meq/100g	>5	15.1	20.3	8.1	low
ESP		<6%	5%	11%	9%	Dispersive below 200mm
Ca/Mg ratio		<0.5	1.2	0.8	1.1	
Bicarbonate Alkalinity as CaCO3	mg/kg		152	254	127	
Boron	mg/kg	>1-4	<50			
Cobalt	mg/kg		58			
Copper	mg/kg	0.4	36			Very high
Iron	mg/kg		61000			
Manganese	mg/kg		1560			Very high
Molybdenum	mg/kg	5	<2			
Zinc	mg/kg	0.8	50			Very high
Bicarbonate Extractable P	mg/kg		<2			Very Low
Nitrite + Nitrate as N (Sol.)	mg/kg		35.3			
Total Kjeldahl Nitrogen as N	mg/kg		760			
Total Nitrogen as N	mg/kg	1500mg/kg	800			low
Total Phosphorus as P	mg/kg	200mg/kg	198			low
Organic Matter	%	>1.5%	1.4			

3.4. Kandosol

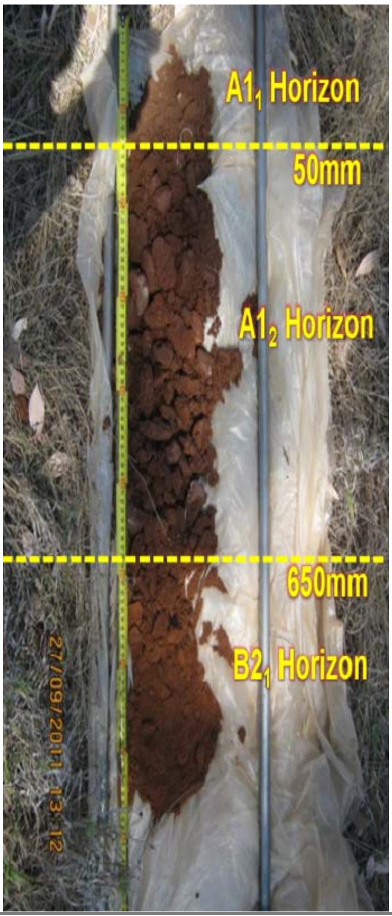
Kandosols are found on extensive, level to gently undulating plains and on mesas, often in association with ferricrete deposits. Parent materials are quartz-rich, often being sedimentary rocks, and their alteration products, and derived alluvium. They are often very deep (>3 m) and clay-rich and only relatively small areas of Kandosols are used for extensive agriculture in Australia (mainly in western Australia and New South Wales). The majority of Kandosols are used for sparse grazing of sheep and cattle on native pastures growing on low fertility soils (McKenzie et al., 2004) (**Table 3-11**).

Kandosols comprise 4,299ha (37%) of the Project area.

Figure 3-5 presents a soil profile description for a Kandosol (Site 69). These Red Sandy Loams are well structured and tend to be poorly drained at depth (**Table 3-12**).

Table 3-11 Kandosol: Representative Description and Management (Site 69)

Soil	Kandosol
AMG Reference	0595767E, 7617473N
Site No	69
Landform Element	Top of rise
Landform Pattern	Gently undulating plain
Slope %	1%
Microrelief	Nil
Drainage	Good at surface / poor at depth
Surface Condition	Hardpacked
Land Condition	Good, some vegetation clearance
Land Use	Grazing
Major Vegetation Form and Type	Extensively cleared Poplar Box, Morton Bay Ash
Sample for analysis	0-50 mm, 200-300 mm, 800-900 mm
General Comments	In general this soil is a good pasture soil however it's low to moderate fertility makes it unsuitable for cropping
Recommended Topsoil Stripping Depth	Can be stripped to B horizon boundary which is maximum of 1500mm however generally is less than 400mm depth
Land Suitability Summary:	Cropping: Class 3 Grazing: Class 2
Preferred Rehabilitation Application	Can be used on steeper slopes due to good soil structure. May be possible for grazing on improved pastures provided further soil testing shows moderate fertility levels



$A1_1$ 0-50mm. Sandy Clay Loam, 2.5 YR 3/3, Very weak/weak, weakly pedal, coherant, consistence 1/2, good drainage, no inclusions, sharp boundary

$A1_2$ 50-650mm. Medium Clay, 2.5YR 2.5/4, Ironstone and grey mottles, Firm, highly pedal, massive, poor drainage, consistence 3, sharp boundary

$B2_1$ 650-1000mm. Sandy clay loam, 2.5YR 3/6, Very weak/weak, weakly pedal, coherant, consistence 1, poor drainage, base of horizon not encountered.

- **Figure 3-5 Kandosol: Profile (Site 69)**

- **Table 3-12 Kandosol: Particle Size Distribution (Site 69)**

Depth	Silt %	Clay %	Sand %	Gravel %	Unified Soil Classification
>200-<300	12	54	32	2	Medium Clay

Major soil chemical and physical characteristics are described in **Table 3-13**. The following summary comments apply to Kandosol soil found within the project area:

- Moderate overall fertility (high levels of nitrogen, adequate phosphorus and metals, low sulphate at surface and low/moderate CEC);
- Good soil structure; and
- Desirable pH range.

Table 3-13 Kandosol: Soil Chemistry (Site 69)

Analyte	Unit	Soil Sufficiency (Baker and Eldershaw, 1993)	>0 - <50 mm	>200 - <300 mm	>800 - <900 mm	Comment
pH Value	pH Unit		6.7	7.5	7.5	neutral
Electrical Conductivity	mS/cm	<0.8	0.034	0.014	0.026	low
Sulfate as SO4 2-	mg/kg	8	<10	<10	30	low at surface, high at depth
Chloride	mg/kg	800	20	<10	10	very low
ExchCalcium	meq/100g	2	10.6	13.7	17	Moderate
ExchMagnesium	meq/100g	2	6.4	11.1	12.6	Moderate
Exch Potassium	meq/100g	0.2	0.3	<0.1	<0.1	Very low
Exch Sodium	meq/100g		<0.1	0.4	1.4	non sodic
CEC	meq/100g	>5	17.4	25.3	31	low to moderate
ESP		<6%	0	2%	5%	non dispersive
Ca/Mg ratio		<0.5	1.7	1.2	1.3	no physcial problems indicated
Bicarbonate Alkalinity as CaCO3	mg/kg		114	63	51	
Boron	mg/kg	>1-4	<50			
Cobalt	mg/kg		58			
Copper	mg/kg	0.4	26			Very high
Iron	mg/kg		76700			
Manganese	mg/kg		1170			Very high
Molybdenum	mg/kg	5	<2			
Zinc	mg/kg	0.8	28			Very High
Bicarbonate Extractable P	mg/kg		80			Very High
Nitrite + Nitrate as N (Sol.)	mg/kg		1.7			
Total Kjeldahl Nitrogen as N	mg/kg		1640			
Total Nitrogen as N	mg/kg	1500mg/kg	1640			not limiting
Total Phosphorus as P	mg/kg	200mg/kg	400			High
Organic Matter	%	>1.5%	3.6			

4. Agricultural Land Suitability

Land use suitability of the project area in reference to broadscale rain-fed cropping and grazing has been assessed in accordance with Attachment 2 of Land Suitability Assessment Techniques in the Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland (DME, 1995).

4.1. Existing Land Use Patterns

The majority of the project area is used for cattle grazing on buffel and native grasses which were in good condition at the time of survey. Vegetation within the project area comprises natural bush of Poplar Box, Bloodwood, Ironbark, Acacia, Wattle, and Brigalow.

The project area has low mean annual rainfall of between 500-800mm/year (BOM 2007) and rainfall can be unreliable and long droughts are common. Such unreliable and insufficient rainfall presents a significant limitation to sustained cropping in this area. No cropping was observed during the survey.

4.2. Methodology

The methodology used to identify agricultural suitability in this survey follows guidelines established by Land Resources Branch (1989), which is the basis for land suitability Assessment (DME, 1995). Land suitability assessments for each soil type have been undertaken for cropping and grazing land uses.

Land suitability classification is based on specific land uses assessed using the classes shown in **Table 4-1** (based on Shields and Williams, 1991 and DME, 1995).

- **Table 4-1 Land Suitability Classes**

Class	Suitability Description
Class 1	Suitable land with negligible limitations and is highly productive requiring only simple management practices
Class 2	Suitable land with minor limitations which either reduce production or require more than simple management practices to sustain the use
Class 3	Suitable land with moderate limitations – Land which is moderately suited to a proposed use but which requires significant inputs to ensure sustainable use
Class 4	Marginal land with severe limitations on land use requiring major inputs to ensure sustainability. Such inputs may outweigh the returns from the land.
Class 5	Unsuitable land with extreme limitations that precludes its use.

The land suitability classification identifies the types and severity of limiting factors for each land use on the different soil types present. **Appendix D** presents graphs used for analysis for determination of land suitability for cropping and grazing.

Land suitability class is determined by the highest ranking limiting factor or a combination of a number of factors. The soils have been assessed against the following limiting factors defined by DME (1995) which determine crop and grazing suitability class:

- Plant available water capacity;
- Nutrient deficiency;
- Salinity;
- Soil physical factors;
- Erosion;
- Workability;
- Microrelief;
- Flooding;
- Wetness;
- Topography; and
- Rockiness.

Normally, only the most severe two or three limiting factors would determine suitability and the remainder become irrelevant.

4.2.1. Plant Available Water Capacity

Plant available water capacity (PAWC) is a significant soil property in this locality as cropping is based on fallow storage of moisture in the soil profile. PAWC is the moisture stored in the soil profile that is available to the plant and is classically defined as the moisture present between field capacity and permanent wilting point (15 bar). **Table 4-2** shows the criteria which DME (1995) proposed for assessment of the moisture availability limitation for crops in this region

- **Table 4-2 PAWC: Land Suitability for Cropping / Grazing (DME, 1995)**

Limiting Factor	1	2	3	4	5
Moisture	PAWC >125 mm	PAWC 100-125 mm	PAWC 75-100 mm	PAWC 50-75 mm	PAWC <50 mm

Soil water storage assessment for Land Suitability Assessment was based on estimated PAWC derived from the following surrogate values:

- **PAWC ≥ 150 mm –** alkaline to neutral pH throughout, Chloride anion (Cl-) <600 ppm (mg/kg) within 90 cm of surface and Exchangeable sodium percentage (ESP) < 15 within 90 cm of surface.
- **PAWC 125 – 150 mm -** alkaline to neutral pH throughout, Cl- <600 ppm (mg/kg) within 90 cm of surface and ESP < 15 within 90 cm of surface, > 15 cm to salt bulge with EC ≥ 900 ppm (1343 ppm).
- **PAWC 75 –125 mm -** alkaline to neutral pH throughout, Cl- <600 ppm (mg/kg) within 90 cm of surface and ESP < 15 within 90 cm of surface, > 15 cm to salt bulge with EC ≥ 900 ppm (1343 ppm), Duplex soils with subsoil becoming sodic (ESP 6-14) within 60 cm of surface but not strongly sodic (ESP ≥ 15) within 90 cm of surface.
- **PAWC ≤50 - ≤ 75 mm -** alkaline to neutral pH throughout, Cl- <600 ppm (mg/kg) within 90 cm of surface and ESP < 15 within 90 cm of surface, Duplex soils with subsoil becoming sodic (ESP 6-14) within 60 cm of surface but not strongly sodic (ESP ≥ 15) within 45 cm of surface.

Effective rooting depth is defined as the depth to which approximately 90% of plant roots will extract water. It is normally limited either by the presence of underlying rock or other hard materials or by chemical or physical attributes within the subsoil that restrict root growth (QDPI, 1990). Field morphology observations and chemical data used included soil texture and barriers to root growth such as high sodium, gravel, poor soil structure, high electrical conductivity and chloride.

4.2.2. Nutrient Deficiency

Shields and Williams (1991) states that soil nutrient deficiency has not been recognised as a major problem for crop production on traditionally cultivated soils in the Central Highlands. The levels of nutrient deficiency found in this survey are similarly not considered severe.

4.2.3. Salinity

This refers to the reduction in dry matter yield as a result of soluble salt (usually influenced by chloride concentration and measured by electrical conductivity) in the soil profile. It also contributes to reduced water availability limitation.

4.2.4. Soil Physical factors

This limitation deals with conditions which determine sufficient seed contact with moist soil to prevent desiccation prior to germination and establishment. One such condition applies to clay soils which have narrow moisture content suitable for cultivation, as they are susceptible to compaction and smearing when wetter than the plastic limit. Trafficability is also limited by high clay content and moisture retention on the clay soils. It is only a minor limitation here. With a grazing use, physical factors refer more to restrictions in the establishment and vigour of pastures as a result of soil surface condition and are typically related to size of surface aggregates which affects tendencies to seal and hardset. Overall within the survey area, the extensive development of Buffel and Spear Grass indicates that soil physical factors are generally not limiting to pasture establishment.

4.2.5. Erosion

The risk of soil loss from water erosion magnifies with increased slope gradient combined with water velocity when land is devoid of vegetation. Erosion was noted at 16 of the 98 sample locations and on all four soil types. Erosion was most severe on Sodosols in the northeast of the Project area and these soils will have a high risk of erosion if exposed. Elsewhere erosion was noted within creek systems and adjacent dirt tracks where water runoff from the track has cut into adjacent land.

Slope limits for determining erosion risk and suitability class according to DME (1995) are provided in **Table 4-3**.

- **Table 4-3 Erosion Limitations for Cattle grazing – Effects of Slope (DME, 1995)**

Land Suitability Class	1	2	3	4	5
Cracking Clays	<3% slope	Slopes 3-6%	Slopes 6-9%	Slopes 9-15%	
Sodic rigid soils	<1% slope	Slopes 1-3%	Slopes 3-6%	Slopes 6-12%	>45%
Non-sodic rigid soils	<3% slope	Slopes 3-12%	Slopes 12-20%	Slopes 20-45%	

4.2.6. Workability, Flooding and Wetness

Drainage conditions of the soil solumn were noted during the soil survey **(Appendix A)**. There was little evidence of poor drainage and water logging suggesting that flooding, workabaility and wetness would add little discernable weighting to overall land suitability.

4.2.7. Microrelief and Rockiness

Microrelief and rockiness was not noted in the Project area (refer to **Appendix A** – soil logs). Microrelief refers to relief up to a few metres about the plane of the land surface (McDonald et al. 1984b). Melonholing caused by the shrinking/swelling properties of clay rich Vertosols can present a limitation to cropping due to an uneven cultivation surface and impeded trafficability of machinery.

4.2.8. Topography

Topography is assessed in terms of slope and micro-relief. Slope may limit the effective and safe use of machinery and contribute to erosion hazard. Topography has been assessed by desktop using a 1 m contour digital elevation model for the site.

4.3. Results

Table 4-4 summarises the analytic criteria used to assign a class number presented in **Table 4-1**. DME (1995) presents thresholds for each of the identified analytic criteria. Table 4-6 summarises land suitability analysis determined from laboratory analysis (refer to **Appendix D** for graphical representation of laboratory analysis relevant to determination of land suitability for cropping and grazing).

Summary of findings here – are the soils suitable for cropping and grazing?

Table 4-4 Land Suitability Class Criteria

Limiting Factor	Diagnostic Criteria		Comment
Plant available water capacity	Cropping Grazing	▪ pH; ▪ Cl- anion concentration; ▪ ESP; and ▪ EC.	Table 2.3 from DME (1995)
Nutrient deficiency	Cropping	▪ Bicarbonate P; and ▪ Exchangeable K	Table 2.2 and Table 2.3 from DME (1995)
	Grazing	▪ Bicarbonate P.	
Salinity	Cropping Grazing	▪ EC; and ▪ Cl- anion concentration.	
Soil physical factors	Cropping Grazing	▪ Soil texture; and ▪ Ped size.	
Erosion	Cropping Grazing	▪ Sodocity; and ▪ Slope.	
Workabaility	Cropping	▪ Soil texture; and ▪ Ped size.	
	Grazing	Not applicable / no criteria.	
Susceptibility to flooding	Cropping Grazing	▪ Flood return period.	
Microrelief	Cropping Grazing	▪ Presence / absence and size of meloholes.	
Wetness	Cropping Grazing	▪ Geomorphology; and ▪ ESP.	
Topography	Cropping Grazing	▪ Presence / Absence of gullies.	
Rockiness	Cropping Grazing	▪ Boulder, Cobbles, Gravel %	

4.3.1. Plant available water capacity

PAWC suitability range estimates for observed soil orders in this survey area are shown in **Table 4-5** summarised based on soil order. Land suitability class ratings for each site subjected to laboratory analsysis is presented in **Table 4-6**.

- **Table 4-5 Estimated Plant Rooting Depth, PAWC and Land Suitability Class**

Soil Order	Concept	Estimated Effective Rooting Depth (mm)	PAWC (mm)	Limitation Level
Vertosol	Soils with high clay content, and when dry, crack to a considerable depth	200->1000	450-125	1-2
Dermosol	Texture contrast soils with moderately to strongly structured usually clayey B2 horizons.	700->1000	100-> 125	2-3
Kandosol	Very deep (>1 m) and clay-rich	>1000	>125	1
Sodosol	INSERT	INSERT	INSERT	INSERT

4.3.2. Nutrient deficiency

The Vertosols in the Project area generally had high levels of nutrients with one exception, WW60 which contained low levels of phosphorus and nitrogen. The Dermosols generally had low fertility levels in particular low levels of phosphorus and nitrogen. The Kandosols had variable levels of nutrients with limitations between 1 and 4 for grazing however these soils generally had moderate to good levels of fertility for cropping purposes with limitation levels between 1 and 2.

Comment on Sodosol

Table 4-6 presents land suitability ratings for cropping and grazing derived from laboratory analysis.

4.3.3. Salinity

Increasing salinity in the soil profile (below 200 mm) was evidenced in some Vertosols and Dermosols (WW6, WW9 and WW15 - **Figure A 4 (b, c, d)**, **Figure A 1 (b, c, d)** and **Figure A 10 (b, c, d)**) respectively) in the central part of the Project area and this attribute has been incorporated into effective rooting depth estimations which directly affects PAWC and hence suitability. However, the remaining four Vertosol sample locations had low salt contents. In addition one Dermosol sample WW13 contained marginally high chloride content at 700mm depth (**Figure A 11 (c)**).

Comment on Sodosol

Refer to **Appendix D** for EC profiles from laboratory analysis. **Table 4-6** presents land suitability ratings for cropping and grazing derived from laboratory analysis.

4.3.4. Soil Physical Factors

As discussed in **Section 4.2.4** there were no identified limiting soil physical factors with the project area. **Table 4-6** presents land suitability ratings for cropping and grazing derived from laboratory analysis.

4.3.5. Erosion

Based on these slope limits presented in **Table 4-3**, none of the sample locations have any limitation with regard to water erosion however laboratory results show that some Vertosols and Dermosols in the Project area are sodic and are susceptible to erosion via dispersion as discussed in **Section 8.1**. The Sodosols also present a high erosion risk due to likely high sodium content relative to total cation exchange capacity.

Comment on Sodosol

Table 4-6 presents land suitability ratings for cropping and grazing derived from laboratory analysis.

4.3.6. Workability, Flooding and Wetness

There was little evidence of poor drainage and water logging suggesting that flooding, workabaility and wetness would add little discernable weighting to overall land suitability.

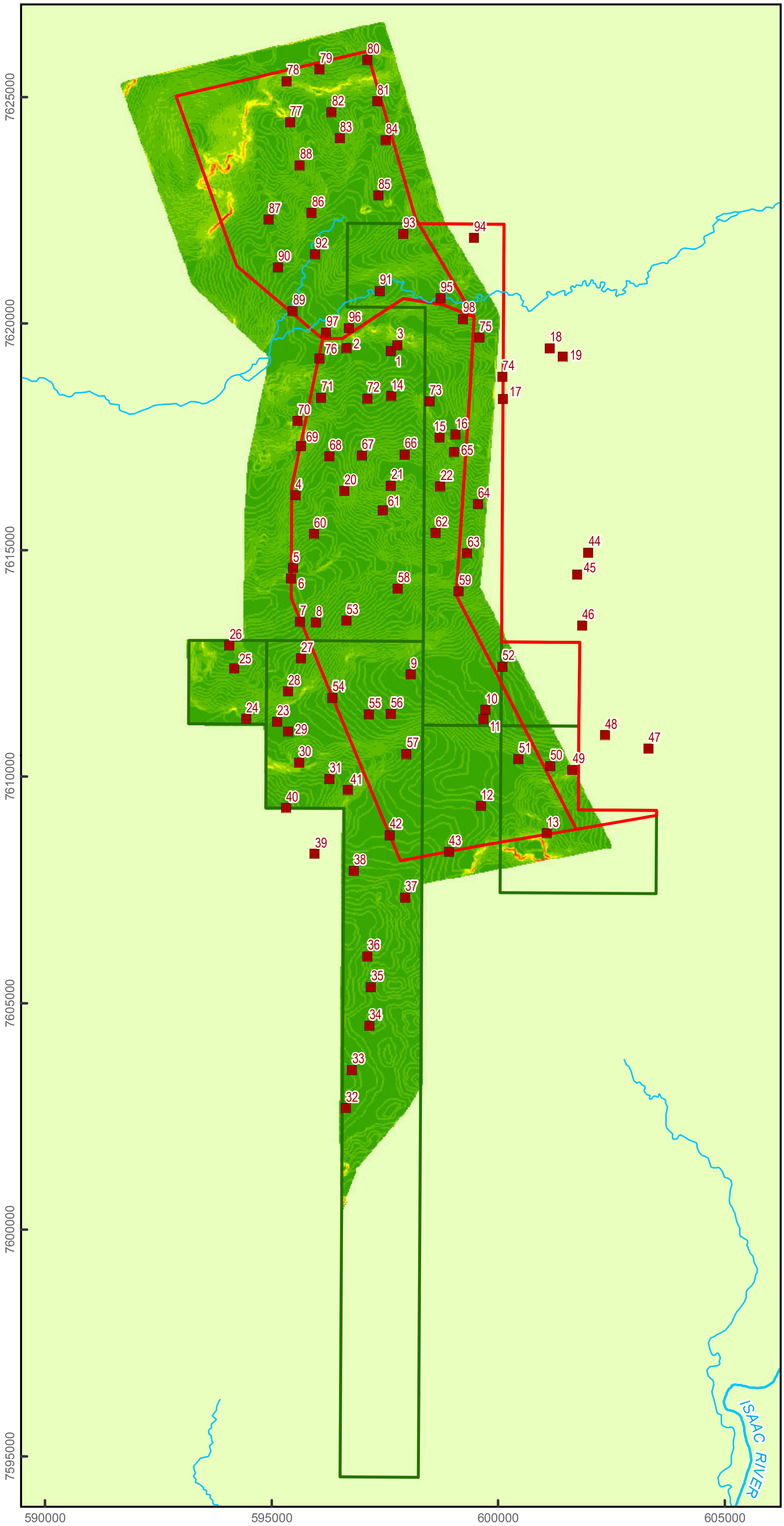
4.3.7. Microrelief and Rockiness

Micro-relief was not found to be a limiting factor during the field survey (refer to **Appendix A**).

4.3.8. Topography

The site consists of level plains and gently undulating plains and rises with slope across the majority of the site between 1-2%. Steeper slopes up to 11% exist in the far north of the site on Kandosols and on the southeast part of the site on Dermosols. These steeper slopes will present a limitation to cropping in these areas but are suitable for grazing. The map showing slope in the Project area is provided in **Figure 4-1**.

SLOPE



LEGEND

- Sample Locations
- Minor Watercourse
- Major Watercourse
- Mining Lease
- Exploration Permit Coal

Slope (by percent rise)

- 0 - 1%
- 1 - 3%
- 3 - 5%
- 5 - 7%
- 7 - 10%
- 10 - 13%
- 13 - 17%
- 17 - 21%
- 21 - 28%

AGD84 | AMG ZONE 55

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0 1.5 3

Kilometres

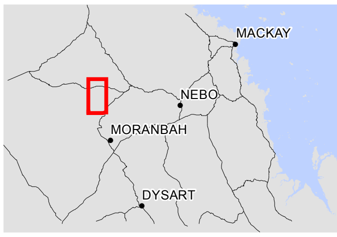

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FIGURE 4

Table 4-6 Land Suitability Assessment: Cropping and Grazing

Soil	Site	Sample Depth (mm)	PAWC (m)	Nutrient Deficiency (n)	pH (1:5)	Salinity (s)	Physical Factors (p)	Erosion (e)	Workability (k)	Microrelief (g)	Flooding (f)	Wetness (w)	Topo	Rock (g)	Ranking Cropping		Ranking Grazing	
Vertosol		0-100		1	1	1	2	2	3	1	2		1	1	4(m) 3(k)		4(m) 3(k)	
	15	300-400	4 (<75 mm) ESP	-	3	2	2	2	3	1	2	1	-	-	4(m) 3(k)	4	4(m) 3(k)(pH)	4
		900-1000		-	3	4	2	2	3	1	2		-	-	4(m) 4(s)		4(m) 4(s)	
	22	0-100	4 (<75 mm) ESP	1	2	1	2	1	1	1	1	1	1	1	4 (m)	4	4(m) 2(pH)	4
		0-100		1	1	1	1	1	2	1	2		1	1	2(k) (f)		2(k) (f)	
	9	200-300	1	-	1	1	1	1	2	1	2	1	-	-	2(k) (f)	2	2(k) (f)	2
		800-900		-	1	1	1	1	2	1	2		-	-	2(k) (f)		2(k) (f)	
		0-100		1	2	2	2	1	1	1	2		1	1	4(m) 2(s)		4(m) 2(pH) (s)	
	6	200-300	4 (<75 mm) ESP	-	3	2	2	1	1	1	2	1	-	-	4(m) 2(s)	4	4(m) 2(pH) (s)	4
		800-900		-	3	3	2	1	1	1	2		-	-	4(m) 2(s)		4(m) 2(pH) (s)	
		0-50		1	2	1	2	1	2	1	2		1	1	2(p) (k) (f)		2(pH) (p) (k) (f)	
	75	400-500	1	-	3	1	2	1	2	1	2	1	-	-	2(p) (k) (f)	2	3(pH) (p) (k) (f)	4
		900-1000		-	4	2	2	1	2	1	2		-	-	2(p) (k) (f)		4(pH) (p) (k) (f)	
		0-50		1	2	1	2	1	2	1	2		1	1	2(p) (k) (f)		2(pH) (p) (k) (f)	
	94	200-300	1	-	3	1	2	1	2	1	2	1	-	-	2(p) (k) (f)	2	3(pH) (p) (k) (f)	3
		600-700		-	3	1	2	1	2	1	2		-	-	2(p) (k) (f)		3(pH) (p) (k) (f)	

Soil	Site	Sample Depth (mm)	PAWC (m)	Nutrient Deficiency (n)	pH (1:5)	Salinity (s)	Physical Factors (p)	Erosion (e)	Workability (k)	Microrelief (g)	Flooding (f)	Wetness (w)	Topo	Rock (g)	Ranking Cropping		Ranking Grazing	
		0-20		4	2	1	3	1	3		1	1	1	1	4(n) 3(p) 3(k)		4(n) 3(p) 3(k)	
	60	20-300	1	-	2	1	3	1	3	1	1	1	-	-	3(p) 3(k)	4	3(p) 3(k)	4
		700-800		-	3	1	3	1	3		1	1	-	-	3(p) 3(k)		3(p) 3(k) 3(pH)	
		0-100		2	2	2	1	3	2		2	1	1	1	2(n) (s) (k) (f) 3(e)		2(n) (pH) (s) (k) (f) 3(e)	
	28	200-300	1	4	2	1	1	3	2	1	2	1	-	-	2(n) (s) (k) (f) 3(e) 4(n)	4	2(n) (pH) (s) (k) (f) 3(e) (4n)	4
		700-800		4	2	1	1	3	2		2	1	-	-	2(n) (s) (k) (f) 3(e) 4(n)		2(n) (pH) (s) (k) (f) 3(e) 4(n)	
		0-100		2	2	1	4	1	2		1	1	1	1	2(n) 4(m) (p)		2(n) (pH) 4(m) (p)	
	36	200-300	4 (<75 mm) ESP	4	4	2	4	1	2	1	1	1	-	-	2(k) 4(m) (n) (p)	4	2(k) 4(m) (n) (pH) (p)	4
Dermosol		700-800		4	4	3	4	1	2		1	1	-	-	2(k) 4(m) (n) (p)		2(k) 4(m) (n) (pH) (p)	
	10	0-100	1	2	1	1	2	1	1	1	1	1	1	1	2(n) (p)	4	2(n) (p)	4
		500-600		4	1	1	2	1	1	-	1	1	-	-	4(n) (p)		4(n) (p)	
		0-50		1	1	1	1	2	1	1	2	1	2	1	3(m) 2(e) (f)		3(m) 2(e) (f)	
		200-300		-	1	1	1	2	1	-	2	1	-	-	3(m) 2(e) (f)		3(m) 2(e) (f)	
	13	700-800	3 (75-125 mm) ESP, EC, Cl	-	3	3	1	2	1	-	2	1	-	-	3(m) 2(e) (f) (s)	3	3(m) 2(e) (f) (pH) (s)	3
		1000-1100			1	1	1	2	1	-	2	1	-	-	3(m) 2(e) (f) (s)		3(m) 2(e) (f) (pH) (s)	

Soil	Site	Sample Depth (mm)	PAWC (m)	Nutrient Deficiency (n)	pH (1:5)	Salinity (s)	Physical Factors (p)	Erosion (e)	Workability (k)	Microrelief (g)	Flooding (f)	Wetness (w)	Topo	Rock (g)	Ranking Cropping		Ranking Grazing	
	47	0-100	1	2	2	1	3	2	1	1	1	1	1	1	3(p) 2(n) (p) (e)	3	3(p) 2(n) (pH) (p) (e)	3
Kandosol	69	0-50	4 (<75 mm) ESP	1	2	1	2	1	2	1	1	1	1	1	4(m) 2(p) (k)	4	4(m) 2(pH) (p) (k)	4
		200-300		-	2	1	2	1	2	-	1	1	-	-	4(m) 2(p) (k)		4(m) 2(pH) (p) (k)	
		800-900		-	2	1	2	1	2	-	1	1	-	-	4(m) 2(p) (k)		4(m) 2(pH) (p) (k)	
	23	0-100	4 (<75 mm) ESP	2	1	2	1	1	2	1	1	1	1	1	4(m) 2(s) (k)	4	4(m) 2(s) (k)	4
		300-400		-	1	1	1	1	2	-	1	1	-	-	4(m) 2 (k)		4(m) 2 (k)	
		900-1000		-	2	1	1	1	2	-	1	1	-	-	4(m) 2 (k)		4(m) 2 (k)	
	38	0-50	4 (<75 mm) ESP	2	1	1	2	1	1	1	1	1	1	1	4(m) 2(p)	4	4(m) 2(p) (pH)	4
		500-600		-	2	1	2	1	1	-	1	1	-	-	4(m) 2(p)		4(m) 2(p) (pH)	
	44	0-100	4 (<75 mm) ESP	1	1	1	3	1	2	1	1	1	1	1	4(m) 3(p) 2(k)	4	4(m) 3(p) 2(k)	4
		100-200		-	1	1	3	1	2	-	1	1	-	-	4(m) 3(p) 2(k)		4(m) 3(p) 2(k)	
		500-600		-	1	1	3	1	2	-	1	1	-	-	4(m) 3(p) 2(k)		4(m) 3(p) 2(k)	
INSERT Sodosol																		

4.3.9. Pre-mining Land Suitability for Cropping and Grazing

The pre-mining land suitability classification for cropping and grazing of the project area, in accordance with the DERM requirements (DME, 1995) is shown in **Figure 4-2** for cropping and **Figure 4-3** for grazing. **Table 4-7** summarises the pre-mining assessment.

- **Table 4-7 Pre-mining Land Suitability Classes**

Land Class	Description	Pre-mining Area (ha)	
1	Not present in the project area	0	
2	Vertosols - Soils with high clay content, and when dry, crack to a considerable depth *Suitable land with minor limitations which either reduce production or require more than simple management practices to sustain the use*	INSERT	
3	Dermosol - Texture contrast soils with moderately to strongly structured usually clayey B2 horizons. *Suitable land with moderate limitations – Land which is moderately suited to a proposed use but which requires significant inputs to ensure sustainable use*	INSERT	
4	Vertosol – as above Dermosol – as above Kandosol - Very deep (>1 m) and clay-rich *Marginal land with severe limitations on land use requiring major inputs to ensure sustainability. Such inputs may outweigh the returns from the land.*	Vertosol Dermosol Kandosol	INSERT INSERT INSERT
5	Not present in project area	0	
TOTAL		INSERT	

LAND SUITABLE FOR CROPPING

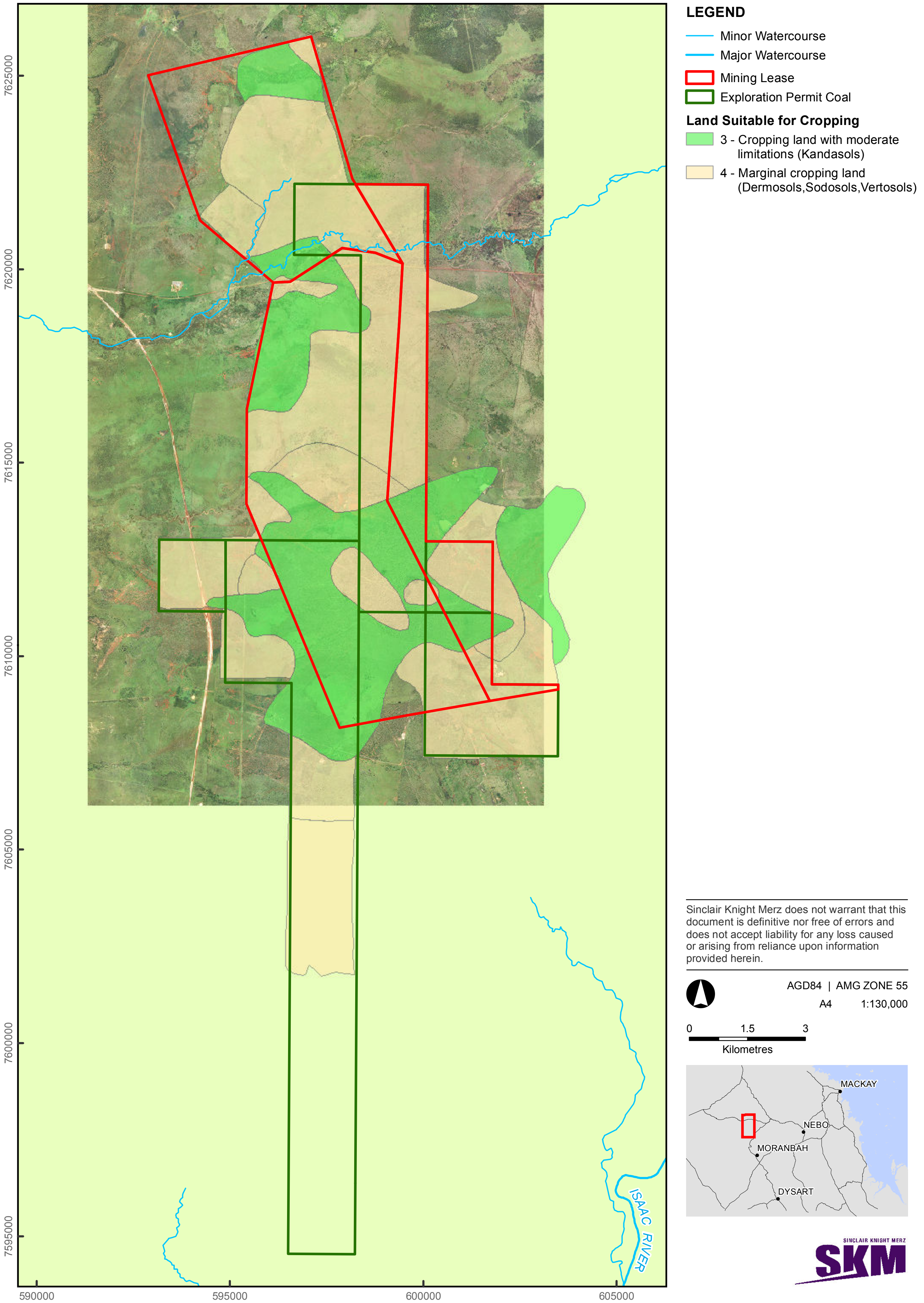

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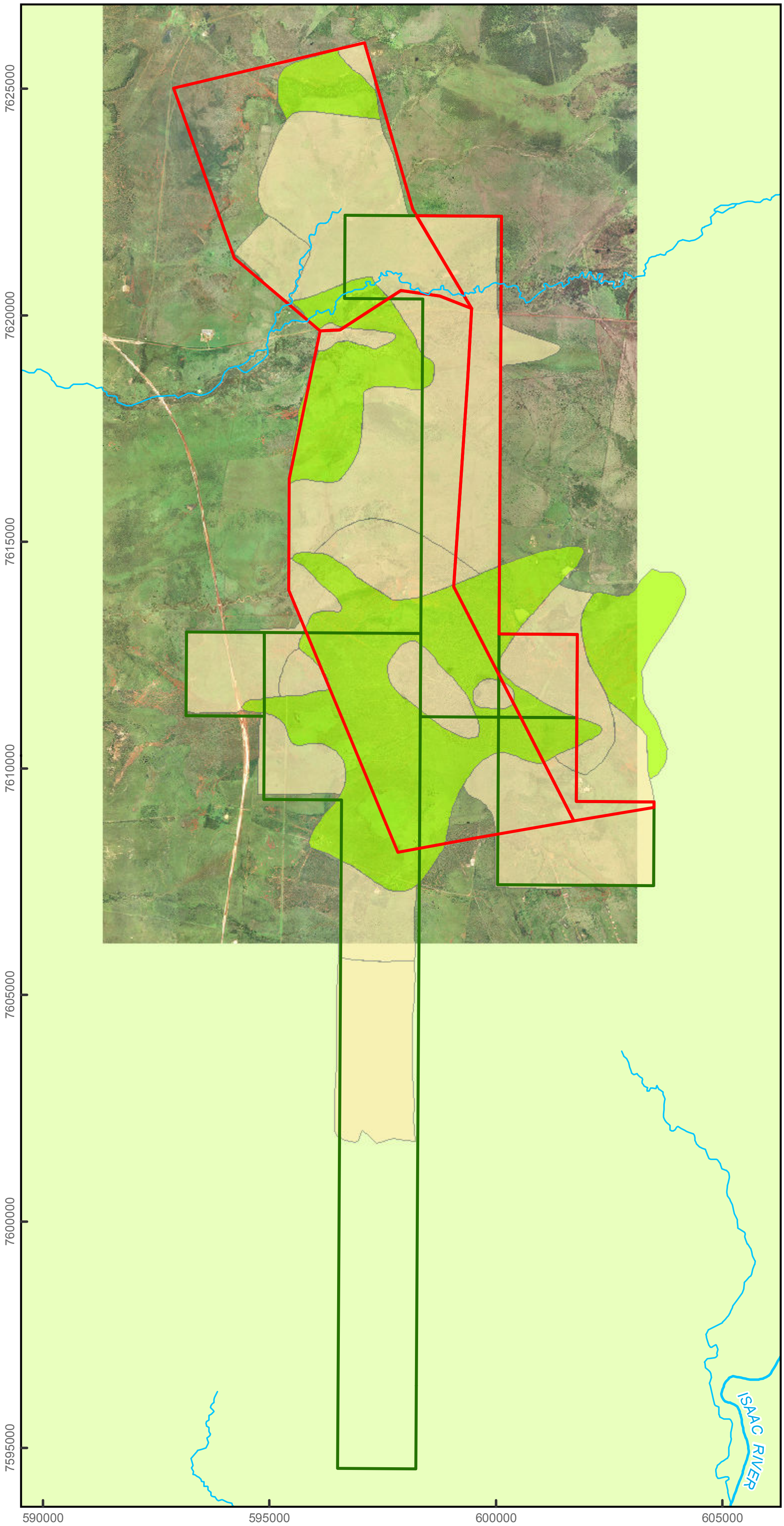
FIGURE 6

LAND SUITABLE FOR GRAZING



LEGEND

- Minor Watercourse
- Major Watercourse
- Mining Lease
- Exploration Permit Coal

Land Suitable for Grazing

- 2 - Suitable grazing land with minor limitations (Kandasols)
- 3 - Suitable grazing land with moderate limitations (Dermosols,Sodosols,Vertosols)

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Kilometres

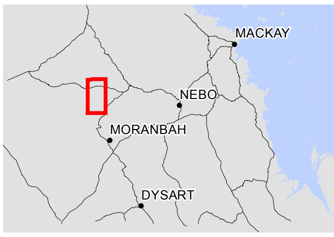

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FIGURE 7

5. Good Quality Agricultural Land

5.1. Method

The project area was also assessed against the Agricultural Land Class (ALC) system, which is used to identify potential Good Quality Agricultural Land (GQAL) in accordance with the *Guidelines for the identification of Good Quality Agricultural Land* (DPI / DLGP, 1993). Agricultural land is defined as land used for crop or animal production, but excluding intensive animal uses (i.e. feelots and piggeries). GQAL is land which is capable of sustainable use for agriculture, with a reasonable level of inputs, and without causing degradation of land or other natural resources.

The DPI / DLGP (1993) guidelines have been introduced to provide local authorities and development proponents with a system to identify areas of good quality agricultural land for planning and project approval purposes. Descriptions of the agricultural land classes are provided in **Table 5-1**.

- **Table 5-1 Scheme for Classifying Agricultural Land (DPI / DLGP, 1993)**

Class	Name		Description
A	Arable land (Crop land)		Land that is suitable for current and potential crops with limitations to production which range from none to moderate level.
B	Limited arable land (Limited crop land)		Land that is marginal for current and potential crops due to severe limitations; and suitable for pastures. Engineering and / or agronomic improvements may be required before the land is considered suitable for cropping.
C	Pastoral land		Land that is only suitable for improved or native pastures due to limitations which preclude continuous cultivation for crop production; but some areas may tolerate a short period of ground disturbance for pasture establishment.
		C1	Land suitable for improved pastures. In some circumstances may be considered as good quality agricultural land.
		C2	Land suitable for native pastures.
		C3	Land suitable for limited grazing of native pastures.
D	Non-agricultural land		Land not suitable for agricultural uses due to extreme limitations. This may be undisturbed land with significant habitat, conservation and / or catchment values or land that may be unsuitable because of very steep slopes, shallow soils, rocky outcrops or poor drainage.

The ALC classification system combines land suitability system assessments for a number of specific land utilisation types into a single land classification (refer to **Section 4** for land suitability assessment). The correlation between ALC and land suitability is summarised in **Table 5-2**.

Table 5-2 Land Suitability Ranking and Agricultural Land Class Correlation

Land Suitability Ranking	Description	ALC
1	Suitable land with negligible limitations and is highly productive requiring only simple management practices	A
2	Suitable land with minor limitations which either reduce production or require more than simple management practices to sustain the use	A
3	Suitable land with moderate limitations – Land which is moderately suited to a proposed use but which requires significant inputs to ensure sustainable use	A
4	Marginal land with severe limitations on land use requiring major inputs to ensure sustainability. Such inputs may outweigh the returns from the land.	B or C1 and C2
5	Unsuitable land with extreme limitations that precludes its use.	C3 or D

5.2. Results

In the local area, the Department of Primary Industries and Fisheries (DPI&F) consider Class A Land in all areas to be good quality agricultural land. In addition, the DPI&F considers that some areas of Class B marginal crop land (where agricultural land is scarce) and better quality Class C1 (land suitable for improved pastures where pastoral industries predominate) may also be considered to be good quality agricultural land.

The existing GQAL mapping for the project area is summarised in **Table 5-3**. Existing broadscale mapping for the project area shows that the project area falls within A, C1, C2 and C3 categories with no indication of Class B or Class D. It is accepted that the mapping scale used to identify these areas was quite small and proponents of major projects are required to investigate GQAL at a higher mapping intensity. Accordingly, this survey within the project area has identified INSERT text based on revised mapping (**Figure 5-1** and **Table 5-4**).

Overall the project will impact only minor areas of GQAL Class A and of Class C1 land as underground mining requiring limited surface disturbance is proposed.

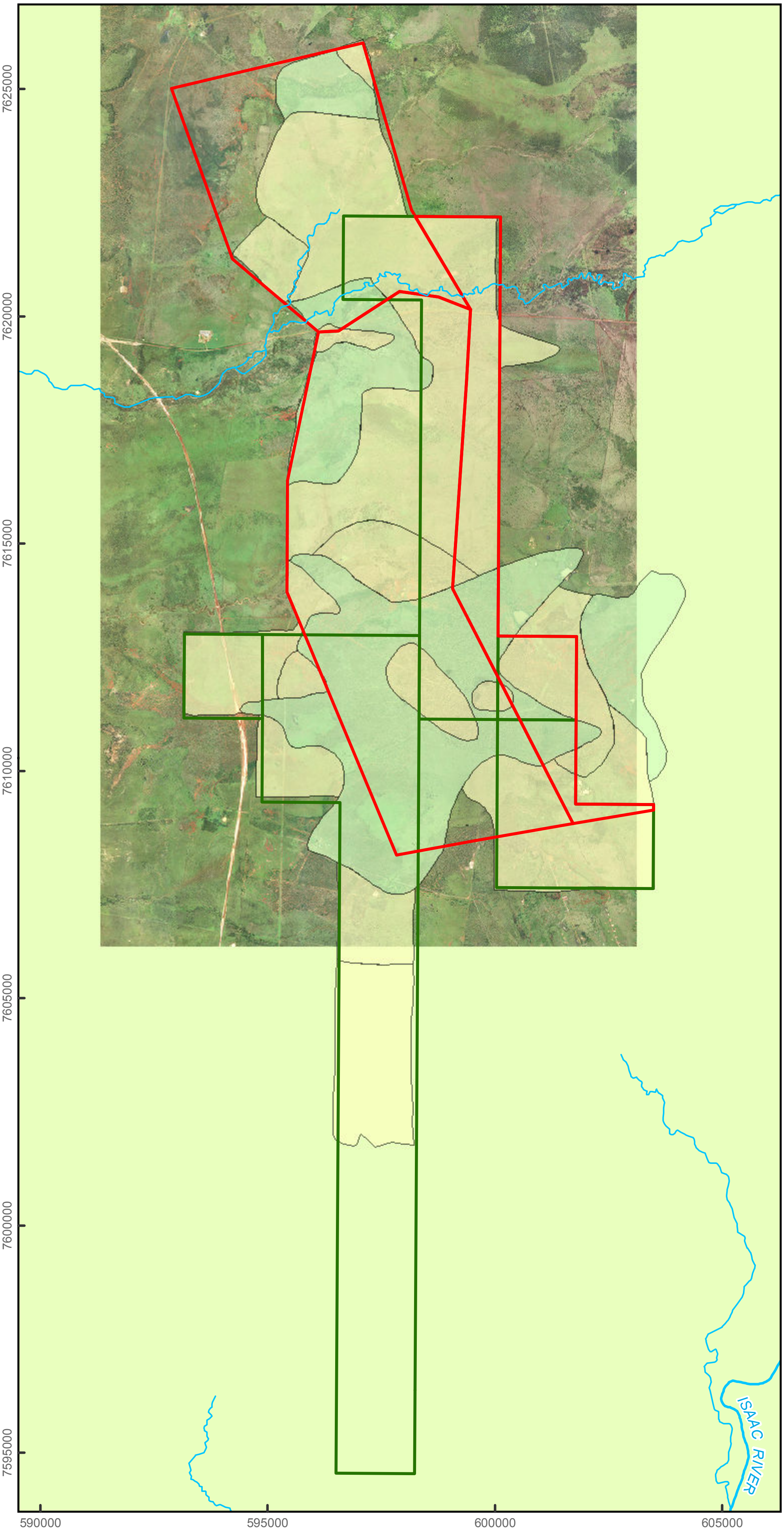
Table 5-3 Existing and Revised Land Class Areas

Class	Existing DERM Mapping (ha)		Revised Mapping (ha)	
A – Crop Land	5,850		INSERT	
B – Limited Crop Land	None		INSERT	
C – Pasture Land	C1	1,338	C1	0
	C2	4,172	C2	INSERT
	C3	646	C3	0
D – Non-agricultural Land	None		INSERT	

Table 5-4 ALC and GQAL

Australian Soil Classification	Cropping land Suitability Rating	Grazing Land Suitability rating	Equivalent ALC	GQAL	Area (ha)
Vertosol	4	4	C2	No	INSERT
	2	2	A	Yes	NSERT
	2	4	A	Yes	NSERT
	2	3	A	Yes	NSERT
Dermosol	4	4	C2	No	NSERT
	3	3	A-B	Yes - marginal	NSERT
Kandosol	4	4	C2	No	NSERT
Sodosol	INSERT	NSERT	NSERT	NSERT	NSERT

REVISED GOOD QUALITY AGRICULTURAL LAND CLASSIFICATIONS



LEGEND

- Minor Watercourse
- Major Watercourse
- Mining Lease
- Exploration Permit Coal

Revised GQAL

- C1 - Grazing on improved pastures
- C3 - Limited grazing on native pastures

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Kilometres

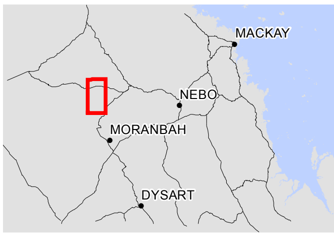

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FIGURE 8

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6. Strategic Cropping Land

This section discusses the land use suitability of the Project area in terms Strategic Cropping Land (SCL).

6.1. Method

DERM have proposed criteria for identifying strategic cropping land in the document *Protecting Queensland's strategic cropping land - Proposed criteria for identifying strategic cropping land* (DERM 2011). The criteria were developed to reliably and consistently identify Queensland's best cropping land—land that is suitable for a range of crops in most seasons.

This document is currently under public consultation and the outcomes of the review may affect the assessment made in this section. The criteria relevant for the Project area are described in **Table 6-1**.

- **Table 6-1 Summary of Criteria for Identifying SCL (DERM, 2011)**

Criteria	Criteria and Thresholds – Western Cropping Land
Slope	≤3%
Rockiness	≤20% for rocks >60 mm diameter
Gildi microrelief	<50% of land surface being gilgai microrelief of >500 mm in depth
Soil depth	≥600 mm
Soil wetness	Has favourable drainage (no waterlogged layers within 300 mm of the ground surface).
Soil pH	For non-rigid soils, the soil at 300 mm and 600 mm soil depth must be greater than pH 5.0. For rigid soils, the soil at 300 mm and 600 mm soil depth must be within the range of pH 5.1 to pH 8.9, inclusive.
Salinity	Chloride content <800 mg/kg within 600 mm of the soil surface
Soil water storage	≥100 mm to a soil depth or soil physico-chemical limitation of ≤1000 mm

Slope for the sample locations has been computed using a 90 m Digital Elevation Model. Rockiness and Gilgai microrelief were not encountered at any sample locations.

Soil water storage assessment was based on estimated PAWC according to soil texture class (measured in mm per cm of soil) as defined by CSIRO (2008) as shown in **Table 6-2**. PAWC estimated from the Land Suitability assessment was used as cross check to the DERM (2011) criteria.

- **Table 6-2 Criteria for Estimating PAWC (DERM, 2011)**

Texture Class	Estimated PAWC (mm water / cm soil)
Sand	0.5
Sandy Loam to Clay	0.8 – 1.2
Heavy Clay	1.5 – 2.0

6.2. Results

Figure 6-1 shows potential mapped SCL within the existing project area.

Comparison of the field investigation results with SCL assessment guidelines identified 7 of the 16 sites (with laboratory results) to be Strategic Cropping Land. **Table 6-3** shows a comparison of the 16 laboratory soil samples with the criteria and indicates whether the criteria were met along with the qualification as SCL. The letter P indicates a pass and F indicates a fail of the criteria. Individual sample SCL assessments are presented as **Appendix E**.

Table 6-3 Summary Assessment of SCL

ID	Assessment	ASC
9	P	Vertosol
15	F	
22	P	
6	F	
75	P - marginal	
94	F	
60	P	Dermosol
28	P	
36	F	
10	P	
13	F	
47	P	
69	F	Kandosol
23	F	
44	F	
38	F	
		INSERT Sodosol

Discussion comparing and contrasting the LS and SCL rating here. They don't agree / why not? Reclassification?

- **Figure 6-1 Mapped potential SCL**

7. Post Mine Land Suitability

A key determining factor of post-mine land suitability is the configuration of coal seams in regards to depth of overburden removal required. As overburden increases in volume by about 30% after excavation, the depth of overburden to be removed is a very significant factor in height and gradients of post-mining landforms. In addition, factors influencing changes in land suitability include changed physical, chemical and biological properties of soil, changes in slope and slope length and changes in soil depth and the quality of the underlying spoil.

All sites which are not disturbed by mining activates will remain the same agricultural suitability as the pre-mining class. The main parameter determining post mining agricultural suitability, as with land capability, is steepness of slope and quality of material used as top dressing in rehabilitation. The majority of disturbance associated with mining will be related to underground subsidence. Subsidence will not likely impact post-mining land suitability and access. The majority of the disturbed post-mining landform consists of slopes of 10 degrees and will be covered in low to moderate quality top dressing. These factors should result in an agricultural suitability class 5. The flatter slopes should result in rehabilitation class 4 lands. The steep high walls and voids should also be class 5.

The exact location and nature of mine infrastructure has not been decided yet. The mine industrial area (MIA) will be constructed on flat ground with minimum surface preparation prior to construction. It is not expected that the agricultural and suitability class in the MIA will be altered post closure.

A return to previous uses such as grazing is feasible provided conservative spoil placement designs are implemented and sound topsoil stripping and management practices are undertaken.

The most important rehabilitation outcomes in the region are aimed at ensuring: a beneficial post-mining landuse; stable landforms; and the preservation of downstream water quality.

The following possible post-mining land use options exist:

- **Rain fed Cropping -** It is considered unlikely that any areas would be suitable for sustainable rain fed cropping mainly due to rainfall and soil limitations.
- **Cattle Grazing -** A return to grazing is feasible beneath most rehabilitated infrastructure areas as well as rehabilitated mine and spoil areas. Limits to grazing use are likely on elevated features such as rejects dumps and tailings dams; however these structures will make up a very small percentage of the total mining and operational areas.
- **Bushland Use -** Many mines in the Bowen Basin have a stated aim of native bushland use at completion of rehabilitation after mining has ceased. Given the climatic limitations in the

region, this is a feasible option for final use of the project site. Extensive clearing for grazing purposes has occurred over the majority of the project site, hence a reversion to a bushland scenario will offer some support for improving biodiversity values in the area. A return to bushland for some mine domains such as on reject dumps is therefore an appropriate option and in line with sustainable development concepts.

8. Erosion Potential and Control

This section discusses the erosion potential of the soils following site clearance and provides erosion control management guidance to minimise the risk of soil degradation and impacts to downstream watercourses.

8.1. Soil Erosion Potential – Sodic Soils

The presence of excessive amounts of exchangeable sodium (relative to the other exchangeable cations) reverses the process of aggregation and causes soil aggregates to disperse into their constituent individual soil particles. This is known as deflocculation and occurs in sodic soils.

Sodicity or Exchangeable Sodium Percentage (ESP) is a measure of the proportion of sodium ions present in a soil; it is expressed as a percentage as:

$$ESP = \frac{\text{Exchanable Sodium}}{\textit{Cation Exchange Capacity}} \qquad \textbf{Q1}$$

Sodicity has a significant effect on the physical properties of a soil. At high sodicity, soils have a tendency to lose aggregation and to develop clay dispersion, impermeability, surface crusting and poor aeration.

When ESP values are medium to high (6 to > 15) and Mg/Ca ratio >1, there is a greater susceptibility to dispersion (Baker 1991). Non-saline soils ($EC_{1:5}$ <400 µS/cm) which are sodic are also more likely to disperse. However in general, soil ESP exceeding 6% warrant consideration as potentially dispersible soils which will influence surface structure and water movement.

The results of the field work show that several sample locations are likely to contain soils that are susceptible to erosion by dispersion which are shown in **Table 8-1** and ESP according to depth at all sample locations is presented for each sample location in **Appendix D**.

From **Table 8-1** the following summary statements can be made with respect to erosion potential:

- **Vertosols –** Moderate to high erosion potential of subsoil below 300 mm depth;
- **Dermosols –** Moderate dispersion potential below 200 mm depth. High erosion potential below 700 mm depth;
- **Kandosols –** Low to moderate erosion potential of subsoil below 500 mm; and
- Sodosols – INSERT

Land preparation for mining activities will involve vegetation clearance and topsoil stripping exposing these areas of dispersive subsoil which could potentially lead to surface crusting and soil loss through dispersion, sheet wash erosion and gullying (even on gentle gradients where topsoil is thin). In some cases, the sodic layer is close to the soil surface, therefore it is important to identify topsoil stripping depth and avoid mixing of topsoil and subsoil which could degrade agricultural land. Some sodic soils may also be prone to tunnel erosion in which the subsoil material is suspended in water percolating through it, gradually removing soil and forming a pipe or tunnel. These tunnels eventually collapse and form a gully that can advance rapidly even on gentle slopes. Once exposed, preventing further degradation of subsoil is expensive and success rates are low.

Table 8-1 Erosion Susceptibility

Soil	Site	Sample Depth (mm)	EC	Exchangeable Sodium	CEC	ESP (approximate)	Exchangeable Calcium	Exchangeable Magnesium	Mg:Ca Ratio	Emerson Aggregate Rating	Susceptibility to Erosion
		Units	µS / cm	meq / 100 g	meq / 100 g	%	meq / 100 g	meq / 100 g	-	-	
Vertosol	15	0-100	0.58	0.7	54.5	1.3	33.2	20	0.6	5	Moderately erosion potential at depth > 900 mm
		300-400	0.278	7	60.6	11.5	30.2	23.2	0.76	-	
		900-1000	0.989	11.4	61.5	18.5	24.8	25.1	1.01	6	
	22	0-100	0.062	<0.1	82.8	<0.12	69.3	12.7	0.18	5	No erosion potential
	9	0-100	0.031	0.8	23.1	3.5	7.8	13.9	1.8	5	Erosion potential below 200 mm
		200-300	0.134	1.7	23.2	7.3	7.2	13.9	1.9	-	
		800-900	0.631	4.4	25	17.6	5.8	14.6	2.5	6	
	6	0-100	0.107	0.2	57	0.4	37.3	17.4	0.5	5	Moderate erosion potential at depth > 800 mm
		200-300	0.137	2.4	64.8	3.7	37.2	24.7	0.7	5	
		800-900	0.659	8.4	72.4	11.6	33.7	30.2	0.9		
	75	0-50	0.041	0.3	75.4	0.4	47	27.4	0.6	5	No erosion potential
		400-500	0.052	3.1	81.6	3.8	47.5	30.9	0.7	-	
		900-1000	0.097	2.8	55.3	5.1	31.3	21.2	0.7	5	
	94	0-50	0.073	<0.1	85	<0.11	66.7	17	0.3	5	No erosion potential
		200-300	0.083	0.2	89.9	0.2	73.4	15.9	0.2	-	
		600-700	0.07	0.3	60.6	0.5	50.1	10.1	0.2	4	
	60	0-20	0.042	0.1	67.2	0.1	42.6	23.4	0.5	5	No erosion potential
		20-300	0.02	0.6	70.4	0.9	45.7	23.9	0.5	-	
		700-800	0.087	0.7	86.8	0.8	61.1	25	0.4	5	
Dermosol	28	0-100	0.15	0.8	15.1	5.3	6.4	5.4	0.8	3	Erosion potential at
		200-300	0.049	2.2	20.3	10.8	8.1	9.9	1.2	-	

Soil	Site	Sample Depth (mm)	EC	Exchangeable Sodium	CEC	ESP (approximate)	Exchangeable Calcium	Exchangeable Magnesium	Mg:Ca Ratio	Emerson Aggregate Rating	Susceptibility to Erosion
		Units	µS / cm	meq / 100 g	meq / 100 g	%	meq / 100 g	meq / 100 g	-	-	
		700-800	0.025	0.7	8.1	8.6	3.8	3.6	0.9	3	depth > 200 mm
	36	0-100	0.028	0.8	17.4	4.6	9.2	7.1	0.8	5	Erosion potential at depth > 700 mm
		200-300	0.199	1.6	33.6	4.8	21.8	10	0.5	-	
		700-800	0.345	5.6	35	16.0	15	14.4	1.0	3	
	10	0-100	0.008	<0.1	2.4	<4.1	1.8	0.5	0.3	5	No erosion potential
		500-600	0.009	<0.1	2.1	<4.8	1.3	0.7	0.5	6	
	13	0-50	0.055	<0.1	22.4	<0.45	15.4	5.8	0.4	5	No erosion potential
		200-300	0.09	0.8	28.1	2.8	18	8.6	0.5	5	
		700-800	0.672	7	48.6	14.4	26.5	14.7	0.6	-	
		1000-1100	0.007	<0.1	1.8	<5.55	1	0.7	0.7	-	
	47	0-100	0.012	0.3	15.7	1.9	8.8	6.5	0.7	5	No erosion potential
Kandosol	69	0-50	0.034	<0.1	17.4	<0.57	10.6	6.4	0.6	3	No erosion potential
		200-300	0.014	0.4	25.3	1.6	13.7	11.1	0.8	-	
		800-900	0.026	1.4	31	4.5	17	12.6	0.7	3	
	23	0-100	0.142	0.2	3.9	5.1	2.3	1	0.4	5	Low erosion potential at depth > 500 mm
		300-400	0.045	<0.1	3.2	<3.1	1.8	1	0.6	-	
		900-1000	0.026	0.1	3.2	3.1	1.4	1.5	1.1	6	
	38	0-50	0.03	<0.1	5.6	<1.8	3.2	1.8	0.6	3	Low erosion potential at depth > 500 mm
		500-600	0.02	0.1	3	3.3	1.4	1.3	0.9	5	
	44	0-100	0.077	0.2	3.7	5.4	1.9	1.3	0.7	5	Low erosion potential at depth > 500 mm
		100-200	0.008	<0.1	2.8	<3.6	1.5	1.2	0.8	6	
		500-600	0.005	<0.1	3	<3.3	0.8	2.1	2.6		

Soil	Site	Sample Depth (mm)	EC	Exchangeable Sodium	CEC	ESP (approximate)	Exchangeable Calcium	Exchangeable Magnesium	Mg:Ca Ratio	Emerson Aggregate Rating	Susceptibility to Erosion
		Units	µS / cm	meq / 100 g	meq / 100 g	%	meq / 100 g	meq / 100 g	-	-	
INSERT Sodosol											

8.2. Hillslope Erosion

In addition to soil dispersion associated with sodic soils, sections of the project area are likely to be susceptible to hillslope erosion. Sheet and rill erosion rates on hillslopes are largely a function of soil type, rainfall intensity, land cover and slope.

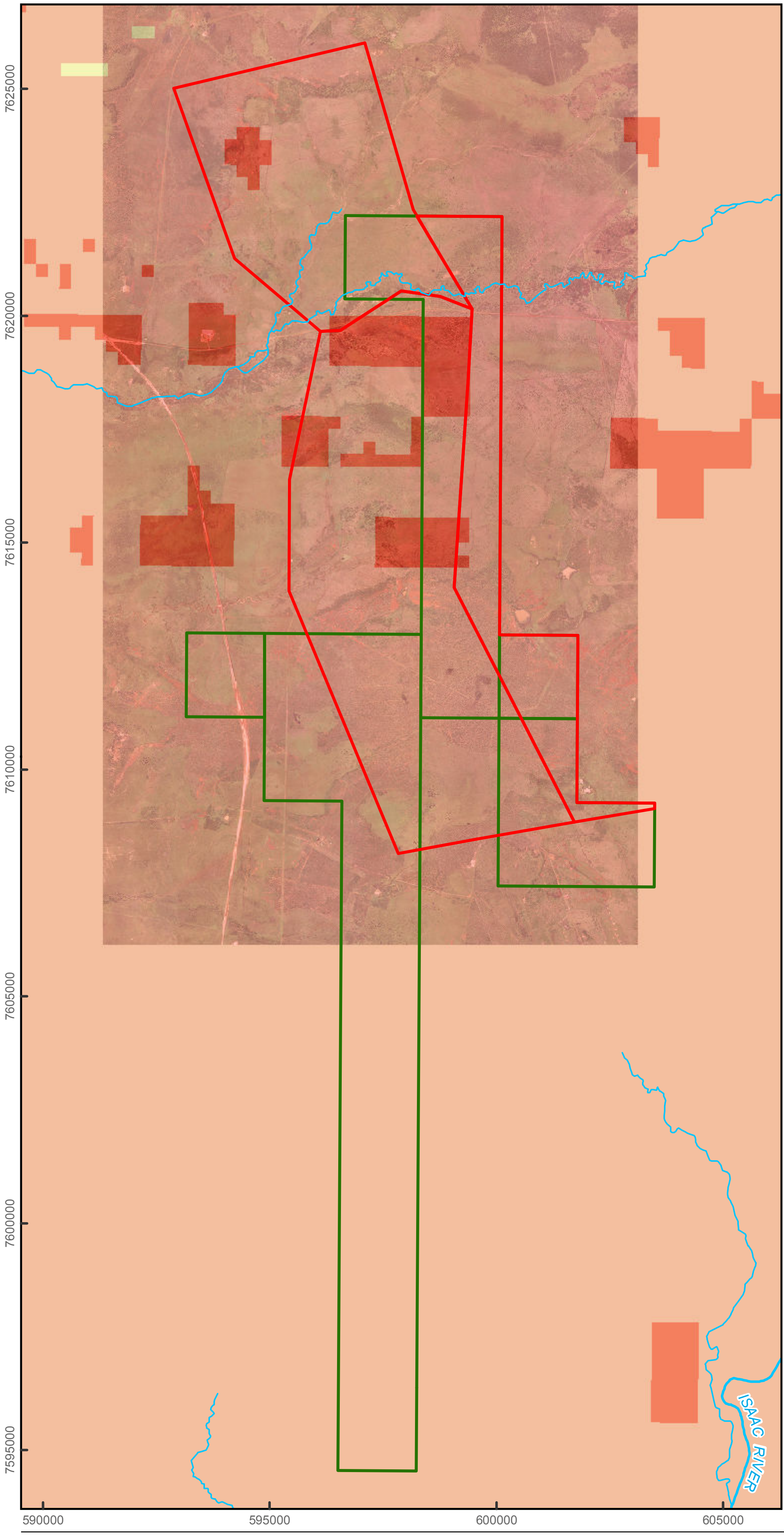
A hillslope erosion map of Australia showing erosion values in tonnes per hectare per year (t/ha/yr) has been produced as a product of the *Water-borne erosion and sediment transport project* conducted by the *National Land and Water Resources Audit* (NLWRA), 2001. The methodology used to produce this map is detailed in **Appendix F**. **Figure 8-1** shows estimated erosion ratings for the project area based on NLWRA (2001) model. Erosion ratings (as used in Australian Agriculture Assessment 2001 reporting) are categorised as High (>10 t/ha/yr), Medium (between 0.5 and 10 t/ha/yr) and Low (<0.5 t/ha/yr). **Figure 8-1** shows that the majority of the project area falls within the medium erosion potential category:

- **Low (<0.5 t/ha/yr)** = 0 ha
- **Medium (0.5 and 10 t/ha/yr)** = 11,079.8 ha
- **High (>10 t/ha/yr)** = 926.7 ha

Potential impacts from the project on current land use are considered as follows:

- Dispersion of topsoil through loss of organic matter, increased sodium to calcium ratios (if dust-suppression water is dominated by sodium), and mechanical degradation of soil aggregates (through traffic movement on topsoils);
- Reduced moisture retention (through reduction in pore space from soil compaction) especially in subsoils;
- Reduced infiltration through compaction of subsoils, dispersed topsoil leading to hard setting and decreased water availability;
- Increased root penetration resistance (through compaction of subsoils) and therefore decreased plant water availability;
- Increased erosion levels through dispersion of topsoil and reduced infiltration through subsoils;
- Loss of topsoil (and resultant loss in fertility) through stripping, storage and replacement; and
- Increased penetration resistance through surface crusting (dispersion of topsoil).

PREDICTED HILLSLOPE EROSION RATE (t/ha/yr)



LEGEND

- Minor Watercourse
- Major Watercourse
- Mining Lease
- Exploration Permit Coal

Predicted Hillslope Erosion (t/ha/yr)

- Low: 0 - 0.5
- Medium: 0.5 - 10
- High: 10 - 100

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0 1.5 3

Kilometres

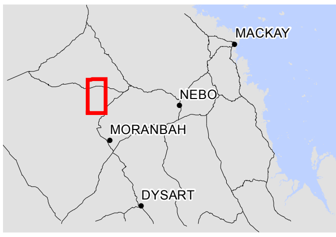

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FIGURE 9

8.3. Erosion Control

Erosion control measures should be incorporated into an Erosion and Sediment Control Plan to be implemented through the life of the project. Erosion controls specific to areas of the proposed mine are summarised in **Table 8-2**. Training will be provided for all staff with responsibility for topsoil stripping, stockpile and management and mine rehabilitation.

The design parameters for the construction of erosion control work such as rock armoured or grass lined waterways will be in accordance with sound engineering and soil conservation earthworks principles. A number of variables should be taken into consideration such as time of concentration, rainfall intensity, soil erosivity, gradient, scour velocities and flow estimations.

Prior to clearing, the limits of disturbance will be marked by pegs placed at intervals on each side of the disturbed area. All operations will be planned to ensure that there is no damage to any trees outside the area being cleared.

Land disturbance will be minimised by clearing the smallest practical area of land ahead of rehabilitation and coal recovery activities and leaving this disturbed for the shortest possible time. Disturbed areas should be stabilised as quickly as practical and progressive revegetation should be undertaken and erosion and sediment control measures employed, that are consistent with the practices described in the Technical Guidelines for Environmental Management for Exploration and Mining in Queensland (DME, 1995).

Table 8-2 Erosion Control for Mining Activities

Area	Control Measures
Areas cleared of vegetation	▪ Restrict clearing to areas essential for the works; ▪ Windrow vegetation debris along the contour; ▪ Minimise length of time soil is exposed; ▪ Divert run-off from undisturbed areas away from the works; and ▪ Direct run-off from cleared areas to sediment dam.
Exposed subsoils	▪ Minimise length of time subsoil is exposed; and ▪ Direct run-off from exposed areas to sediment dam/
Spoil dumps	▪ Direct all run-off from dumps to sediment dams; ▪ Avoid placement of sodic waste material on final external batters; ▪ Control surface drainage to minimise the formation of active gullies; ▪ Use soil and rock mulching to armour long slopes; and ▪ Direct run-off from rehabilitated areas to sediment dams.
Topsoil stockpiles	▪ Revegetate stockpile as soon as possible; ▪ If stockpile to be retained for retained for a period of more than 6 months, the stockpile will be deep ripped and revegetated with application of an appropriate fertiliser; ▪ Stockpiles located in areas away from drainage lines or windy areas in order to minimise the risk of soil and wind erosion; ▪ Dispersive soils (particularly Sodosols) will be stockpiled separately (if to be used in rehabilitation); ▪ Topsoil stockpiles to have an embankment grade of approximately 1V:4H (to limit the potential for erosion of the outer pile face);

Area	Control Measures
	▪ Construction of stockpiles with a “rough” surface condition to reduce erosion hazard, improve drainage and promote revegetation; and ▪ Construction of stockpiles by dozers rather than scrapers to minimise structural degradation.
Residual Voids	▪ Progressive backfilling during operations; ▪ Regrade treatments for erosion and geotechnically unstable voids; ▪ Use of rock mulch to control erosion; and ▪ Apply seed and fertiliser as necessary to ensure rapid re-establishment of pasture and native trees.

Dams, Banks and Creek Crossings	▪ Leave useful water storages to support grazing use;
	▪ Rehabilitate any dam not required post mining by:
	  ▪ Regrading embankments;
	  ▪ Capping any residual saline material;
	  ▪ Replace topsoil;
	  ▪ Rip on the contour; and
	  ▪ Seed.

Infrastructure	▪ Provide protection in drains (e.g. Rip rap, grass) where water velocity may cause scouring; ▪ Confine traffic to maintained tracks and roads; ▪ Install sediment traps, silt fences, hay bales where necessary to control sediment; and ▪ Rehabilitate disturbed areas around construction sites promptly.
Access Roads	▪ Surface drainage will be optimised and stabilised; ▪ Cross-fall drainage structures and mitre drainage will be implemented for the entire length of the roads; ▪ Crowning may be necessary on steeper sections of the roads; ▪ Outfall drainage will be constructed where roads traverses small fill batter areas, and in-fall drainage where roads traverse larger fill batter areas; ▪ Road runoff will be intercepted at regular intervals to reduce runoff velocity in each mitre drain. Drain spacing will not exceed 50 metre; and ▪ Mitre drains will be constructed so that water from the internal haul road is directed to the in-pit sediment control structures or the out-of-pit sediment basins.

8.3.1. Rehabilitation of Eroded Areas

Once extraction works are completed, the land surface will be constructed in accordance with the proposed final landform levels and progressively rehabilitated.

Streams will be restored with adequate controls to minimise the erosion within the restored section of creek, and controls to prevent the migration of any erosion upstream or downstream. Rock-lined channels will be constructed to form the channel surface. Key design elements of channel establishment works will include:

- The channel will be designed to convey the 100-ARI storm event, assuming that the catchment is partially vegetated;
- The channels will be generally trapezoidal in shape with 3:1 (H:V) bank batters and a base width of two metres;
- Natural curves and meanders will be used instead of straight lines to reflect natural stream characteristics;

- The channel will be rock-lined with rip rap and will include the placement of adequately sized rocks above a filter layer of suitable geotextile; and
- Soil will be packed between rocks to allow sedges and grasses to be established within the channel for long-term channel stabilisation.

9. Topsoil Management

This section discusses the selective handling of spoil and topsoil cover material with measures proposed to achieve successful in site rehabilitation outcomes.

9.1. Topsoil Stripping Management

All areas which may be programmed for disturbance may require stripping of topsoil for reuse in rehabilitation programs. Specific recommendations for topsoil stripping are summarised in **Table 9-1**. A map of topsoil stripping depths across the site is presented as **Figure 9-1**.

Table 9-1 Topsoil Stripping Guide

Soil	Soil Concept	Recommendations
Vertosol	Soils with high clay content, and when dry, crack to a considerable depth	**Typical :** 200mm **Maximum Depth :** 800-900 mm **Max. Stockpile Height:** 3 m. Depth to the salt bulge and dispersive soil is variable in these soils. In general they can be stripped to 200mm depth however could as deep as 800-900 mm depending on depth to salt profile (refer to **Table 8-1)**.
Dermosol	Texture contrast soils with moderately to strongly structured usually clayey B2 horizons.	**Typical :** 200 mm **Maximum Depth :** 1000 mm **Max. Stockpile Height:** 3 m Some Dermosols have dispersive subsoils at variable depths. It is important not to strip below the topsoil layer within these soils to avoid mixting of of the dispersive subsoil.
Kandosol	Very deep (>3 m) clay-rich soils	**Typical :** 500mm **Maximum Depth :**1000 mm **Max. Stockpile Height:** 3 m Kandosols can be stripped to the base of the topsoil horizon
Sodosol	Texture contrast soils, with clayey sodic subsoils and dispersive properties	**Typical :** 100 mm **Maximum Depth :** 1000 mm **Max. Stockpile Height:** 3m These soils occupy a small portion of the site - it is recommended that stripping of this soil be avoided in favour of deeper stripping on other better soils if possible

The basic principle in determining useable depths of topsoil for rehabilitation is its quality in comparison to the spoil requiring rehabilitation and as such the quality of topsoil must exceed that of the spoil. While this may seem obvious, there are situations where additional problems have been created with the inappropriate use of topsoil. In addition, spoil can be expected to improve with years of exposure, leaching and plant colonisation and in some cases may provide better coverage than very poor topsoil after an appropriate time-span.

- **Figure 9-1 Topsoil Stripping Depth**

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Often, Brigalow soils in Central Queensland (Bourne and Tuck 1993) are sodic and saline at depth. The Vertosols at Wards Well soils tend to display such tendencies with the depth to the salt accumulation layer (or salt bulge) variable but usually within the subsoil below 800mm however in certain areas it is within the topsoil below 200mm. Such topsoil/subsoil is therefore not recommended for reuse in rehabilitation, not only because of salt but also the associated sodic conditions predisposing coarse hard setting behaviour.

Overall, the area includes considerable reserves of topsoil that may be used in mine rehabilitation programs. As a guide, all topsoil used in rehabilitation should be applied to a thickness of at least 250 mm. This provides sufficient depth for ripping, should follow-up maintenance work be required. Soils placed to 150 mm or less can be significantly contaminated by spoil when a single pass of deep ripping occurs.

Suitable topsoil should be stripped for use in the rehabilitation program prior to mining disturbance. The topsoil should either be stockpiled until suitable re-contoured areas are available, or respread immediately across the area to be rehabilitated. In the project area, the topsoil resources present should be more than adequate for the rehabilitation of the spoil dumps and other disturbed areas. It should be noted that when mine development occurs, small topsoil test pits should be dug at close spacing e.g. say on a 100 m grid to better determine the stripping depth in advance of the box cut. This will provide the dozer operators with an understanding of the actual depth of stripping required in the particular area.

Stockpiling of topsoil will be necessary initially as most rehabilitation is normally unavailable until after a period of time. Stockpiles will be managed so that:

- Soil types with significantly different properties will be stockpiled separately;
- Locations are recorded using gps and data recorded relating to the soil type and volume on a database
- Managed by the mine operator; and
- Stockpile surfaces are ripped and seeded (if natural revegetation does not provide adequate cover).

9.2. Topsoil Stripping and Stockpile Management

Soil stripping and stockpiling is important for soil and water management at a mine during both the operational and rehabilitation phases. The stockpiles need to be managed to minimise erosion and loss of valuable topsoil for rehabilitation, and also to ensure the topsoil is maintained in a condition which supports the most rapid stabilisation of the site during rehabilitation.

The following measures should be adopted for soil stripping and stockpiling:

- Soils should be stripped in a slightly moist condition (neither too dry nor wet) thus reducing dust generation and deterioration in topsoil quality;
- Topsoil should be stockpiled only when disturbed areas are not available for immediate rehabilitation; and
- Soil stockpiles should be constructed to minimise the stockpile area in a discrete three metre-high (maximum) pile, with a working face battered down at 30 degrees.

9.3. Topsoil Application During Rehabilitation

The following measures should be considered when applying topsoil during rehabilitation:

- Soil will be re-spread in the reverse sequence to its removal, so that the organic layer, containing any seed or vegetation, is returned to the surface. Topsoil will be spread to a minimum depth of 100 mm on 3:1 or steeper slopes and to a minimum depth of 50 mm on flatter slopes. Re-spreading on the contour will aid runoff control and increase moisture retention for subsequent plant growth.
- Handle topsoil at an optimum moisture content to reduce damage to soil structure – this will provide a higher standard of revegetation and lower maintenance requirements.
- Re-spread topsoil in the reverse sequence to its removal so that the organic layer, containing any seed or vegetation, is returned to the surface.
- Spread topsoil at a minimum depth of 250 mm.
- Spread topsoil along the contour of re-graded spoil by dumping at the top of slopes and grading downwards and across the contour – thus aiding runoff control, minimising erosion and increasing moisture retention.
- Level topsoil to an even surface and avoid a compacted or over-smooth finish
- Incorporate topsoil into the overburden or waste rock by contour cultivation with a tyned implement in preparation for sowing – this will leave the soil surface in a roughened condition creating a 'key' between the soil and the spoil.
- Stop any vehicle traffic entering the area once topsoil is spread.
- Re-spread topsoil will be levelled to achieve an even surface, while avoiding a compacted or an over-smooth finish.
- Gypsum and/or lime may be applied to the final surface using broadcasting machinery immediately prior to sowing. The ameliorants will be incorporated to a nominal depth of 300 mm.

Site preparation will be undertaken to ensure rapid establishment and growth of vegetation. Topsoil will be spread along the contour of regraded overburden to minimise erosion by dumping at the top of slopes and grading downwards and across the contour.

Once the topsoil is spread, vehicle traffic will be prevented from entering the area. If necessary, some areas will remain without topsoil after final regrading, although these areas will then be sown to fulfil the revegetation objectives.

After topsoil spreading, all topsoiled areas will be contour-ripped to an indicative depth of 400 to 500 mm to create a ‘key’ between the soil and replaced overburden. To minimise erosion, ripping will be undertaken on the contour. Contour banks will be constructed where ripping in the above manner is insufficient to prevent erosion. Rip lines and contour banks will be directed to the closest watercourse.

A sterile cover crop (oats and/or Japanese millet) may be applied to assist with initial soil stabilisation and used in different ratios according to the season.

9.4. Reuse of Competent Spoil

The management and re-use of the topsoil (and subsoil identified as suitable for rehabilitation purposes) - otherwise called competent spoil - for rehabilitation purposes is to be undertaken in accordance with the *Code of Environmental Compliance - Mining Lease Projects* (DERM., January 2001) conditions as follow:

Competent spoil should be stripped and stockpiled separately during clearing. When the topsoil and associated subsoils have been identified as suitable for re-use for rehabilitation purposes, the topsoil should also be stripped and stockpiled separately.

- Competent spoil is to be removed and stockpiled prior to carrying out any mining activity.
- The mixing and erosion of competent spoil with overburden stockpiles should be prevented or minimised.
- Competent spoil and overburden are to be stored in separate stockpiles.
- Silt fencing or bunding is to be installed around the stockpiles
- A temporary cover crop or grass is to be established and maintained on the competent spoil stockpiles
- Competent spoil should be stored in stockpiles no more than 2 m high to retain seed germination potential.
- Where practical the competent spoil stockpiles should be re-used within 12 months of storage.

- The placement of competent spoil needs to be assessed based on the landscape position the topsoil was stripped from (Vertosols in lower slope areas and where water accumulation may occur, Dermosols in lower to medium slope areas, Chromosols in steeper slope areas).
- A competent spoil register should be developed to record the origin, stockpile locations and volumes and future placement areas details.

10. Conclusion

This study has identified and mapped the broad soil types and characterised topsoils and subsoils material within the project area. Based on existing literature and findings of the field survey and review of the analytical data, the study area contains a number of different soils derived from sedimentary and alluvial parents.

Some of the subsoils are alkaline and sodic and therefore dispersive. They will require specific management techniques to control the erosion potential following the commencement of the stripping activities and during the mine life cycle until rehabilitation is undertaken.

The topsoil and subsoils also has some limitations in regards to use as growth medium, including pH, sodicity and moisture holding capacity.

Rehabilitation planning should take into consideration these soils characteristics as the soils deemed competent spoil are to form the substrate for future re-vegetation programs.

Selection of re-vegetation strategies should be trial tested and adjusted to enable the selection of a sustainable re-vegetation program of the disturbed areas.

It is anticipated that topsoil and subsoils (the competent spoil) will be available for use in rehabilitation is appropriately handled during stripping and stockpiling operations. Depth limitations exist in some soils, and slope gradient may impact the stripping activities on steeper slopes.

Based on the literature review and field survey results the following settings have been confirmed for the study area:

- Land Suitability for Cropping
- Land Suitability for Grazing
- GQAL
- SCL

Large portions of the disturbed areas and spoil piles are therefore anticipated to be rehabilitated to either:

- Class 3 beef cattle grazing
- Class 4 cropping
- Nature conservation areas

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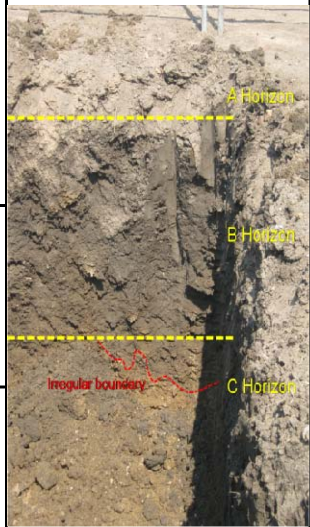
Appendix A Soil Logs

Project: Wards Well **Job Number** QE9811	**Date:** 20/9/2011	**Location:** 1 (DB02) **Oberservation Type:** P	**Coordinates:** 0597742, 7619573

Natural Vegetation: Popular Box, mixed Woodland

Land Use: Grazing

Topography: Flat (< 0.5%)	**Surface Rock % (> 60mm dia):** Nil	**Erosion:** Nil	**Drainage:** Restricted
Remarks:		**ASC Mapped:** Vertosol	**ASC Ground Truth:** Dermosol



Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-20	SiCL	Not recorded	10YR 3/4	None		Cracking coarse self mulching (coarse angular)	Weak, Coherent	2	Not recorded	Gradual, Even	$A1_p$	No sample
20-1400	SiMC	Not recorded	10YR 3/1	None		-	Strong, Coherent	2	Not recorded	Clear, Irregular	$B2_1$	No sample
1400-1500	LC	Not recorded	7.5YR 5/3	> 50% soft $CaCO_3$		-	Not recorded	3, $CaCO_3$ = 1	Not recorded	Base of horizon not encountered	B3	No sample

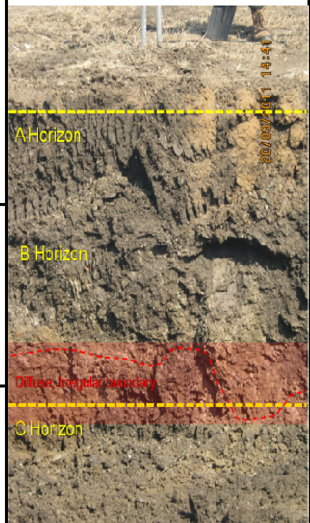
Project: Wards Well
Job Number QE9811
Date: 20/9/2011
Location: 1 (DB01) **Oberservation Type:** P
Coordinates: 0596764, 7619633

Natural Vegetation: Popular Box, mixed Woodland

Land Use: Grazing

Topography: Flat (< 0.5%)
Surface Rock % (> 60mm dia): Nil
Erosion: Nil
Drainage: Restricted

Remarks:
ASC Mapped: Vertosol
ASC Ground Truth: Dermosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-20	SiCL	Not recorded	10YR 3/4	None		Cracking coarse self mulching (coarse angular)	Strong, Coherent	2	Not recorded	Gradual, Even	$A1_p$	No sample
20-1400	SiMC	Not recorded	10YR 3/1	None		-	Strong, Coherent	2	Not recorded	Diffuse, Irregular	$B2_1$	No sample
1400-1500	LC	Not recorded	7.5YR 5/3	> 50% soft $CaCO_3$		-	Not recorded	3, $CaCO_3$ = 1	Not recorded	Base of horizon not encountered	B3	No sample

Project: Wards Well **Job Number** QE9811	**Date:** 20/9/2011	**Location:** 3 (DB2a) **Oberservation Type:** P	**Coordinates:** 597891, 7619704

Natural Vegetation: Popular Box, > 70% pasture


Land Use:

Topography: Gentle undulating plain, low position	**Surface Rock % (> 60mm dia):** < 1%	**Erosion:** Nil	**Drainage:** Vey Slow
Remarks:		**ASC Mapped:** Vertosol	**ASC Ground Truth:** Dermosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-400	FSL	Not recorded	10YR 3/4	None	Photograph of Profile not taken	Hard setting	Coherent, Massive	2	Not recorded	Sharp, Even	$A1_p$	No sample
400-900+	SiC	≤ 10%	7.5YR 3/4	≤ 5% Manganese nodules, ≤ 10% Gray Mottles		-	Strong, Coherent	4	Not recorded	Base of horizon not encountered	$B2_1$	No sample

Project: Wards Well
Job Number QE9811
Date: 21/9/2011
Location: 4 (BDB14) **Oberservation Type:** A
Coordinates: 595643, 7616394

Natural Vegetation: Grassland Cleared, Mt Cool Brigalow Scatter

Land Use: Grazing

Topography: 1 - 1.5%
Surface Rock % (> 60mm dia): Nil
Erosion: Nil
Drainage: Imperfect, well drained

Remarks: Soil profile ≤ field capacity
ASC Mapped: Vertosol
ASC Ground Truth: Brown Vertosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-20	LMC	Nil	5YR 3/3	Nil		Granular cracking mulch	Strong, Coherent	2	Not recorded	Sharp, Even	A1	No sample
20-1000	MC	Nil	5YR 3/3	Nil		-	Strong, Coherent	2	Not recorded	Base of horizon not encountered	$B2_1$	No sample

Project: Wards Well
Job Number QE9811
21/9/2011

Location: 5 **Oberservation Type:** P

Coordinates: 595587,7614777

Natural Vegetation: Reed River Box, Bohemia (sml), buffel grass, ERERE

Land Use: Grazing

Topography: Low ridges (≤ 2 - 4%)

Surface Rock % (> 60mm dia): ≤ 30%

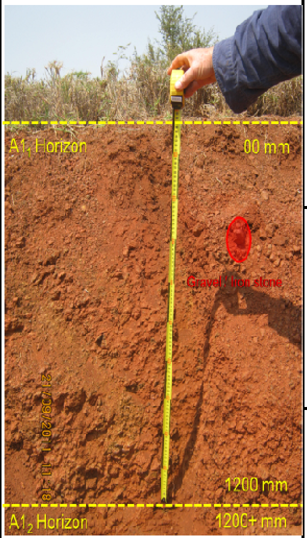
Erosion: Nil

Drainage: Well drained

Remarks:

ASC Mapped: Vertosol

ASC Ground Truth: Kandosol

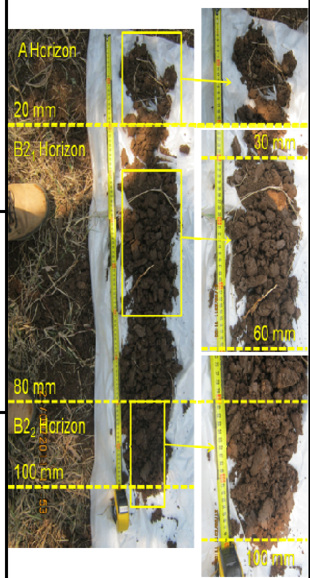
Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-1200	CL	≤ 80%	2.5YR 3/6	Gravel		≥ 60% Gravel	Strong, Coherent, Massive	5	Not recorded	Clear, Even	$A1_1$	No sample
1200+	CL	≤ 40%	5YR 4/6	Gravel		-	Strong, Coherent, Massive	5	Not recorded	Base of horizon not encountered	$A1_2$	No sample

Project: Wards Well **Job Number** QE9811	**Date:** 21/9/2011	**Location:** 6 **Oberservation Type:** A	**Coordinates:** 0595544, 7614553

Natural Vegetation: Buffel grass, Brigalow


Land Use: Gazing

Topography: ≤ 1% old flood plain	**Surface Rock % (> 60mm dia):** Nil	**Erosion:** Nil	**Drainage:** Well drained clay
Remarks:		**ASC Mapped:** Vertosol	**ASC Ground Truth:** Vertosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-200	MC	Not recorded	10YR 3/3	Nil		Cracking clay, fine grain, self mulching	Not Coherent, Mulch	2	Not recorded	Clear, Even	A1	0-10 mm
200-800	MC	Not recorded	10YR 4/2	≤ 2% Manganese nodules		-	Weak, Coherent	2	Not recorded	Gradual, Even	$B2_1$	20-30 mm
800-1000+	MC	Not recorded	7.5YR 3/4	≤ 2% Manganese nodules and soft lime nodules		-	Weak, Coherent	2	Not recorded	Gradual, Even	$B2_2$	80-90 mm

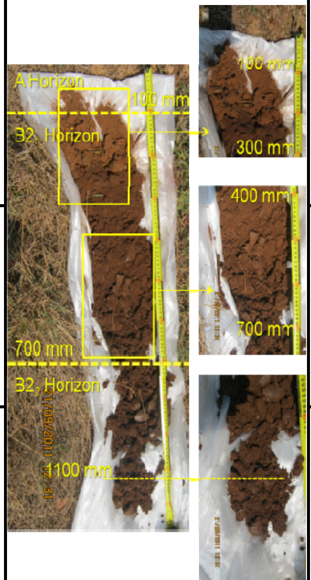
Project: Wards Well
Job Number QE9811
Date: 21/9/2011
Location: 7 **Oberservation Type:** A
Coordinates: 595743,7613598

Natural Vegetation: Grass, SL Ironbark, Bloodwood, Eucalypt Popular Box

Land Use: Grazing

Topography: Crest, low broad ridge (≤ 1%)
Surface Rock % (> 60mm dia): Nil
Erosion: Nil
Drainage: Well drained

Remarks:
ASC Mapped: Vertosol
ASC Ground Truth: Brown Vertosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-100	SiC	Not recorded	5YR 3/4	Nil		Firm hardsetting, weak cracking	Very Firm, Coherent, Massive	4	Not recorded	Clear, Even	A1	No sample
100-700	MC	Not recorded	2.5YR 4/4	Nil		-	Firm, Coherent, Massive	3	Not recorded	Gradual, Even	B2$_1$	No sample
700-1000+	MC	≤ 5%	2.5Yr 3/4	Manganese nodules and trace carbonate		-	Firm, Coherent, Massive	3	Not recorded	Base of horizon not encountered	B2$_2$	No sample

Project: Wards Well
Job Number QE9811

Date: 21/9/2011

Location: 8 **Oberservation Type:** P

Coordinates: 0596097, 7613577

Natural Vegetation: Ironbark, Buffel grass, Popular box, Brigalow, ERERE, Bohenia

Land Use: Grazing

Topography: ≤ 1% Top of broad ridge

Surface Rock % (> 60mm dia): Nil

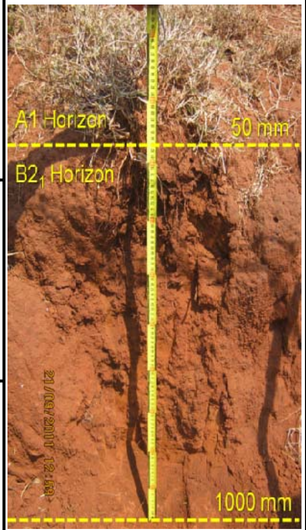
Erosion: Heavily eroded along fence line

Drainage: Not recorded

Remarks:

ASC Mapped: Vertosol

ASC Ground Truth: Kandosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-50	SiC	Not recorded	Not recorded	Slight OM build up		Hard setting, non-cracking	Not Coherent	≤1	Not recorded	Gradual, Even	A1	No sample
50-1000+	SiC	Not recorded	2.5YR 3/6	Manganese nodules		-	Very Firm, Coherent, Massive	4	Not recorded	Base of horizon not encountered	$B2_1$	No sample

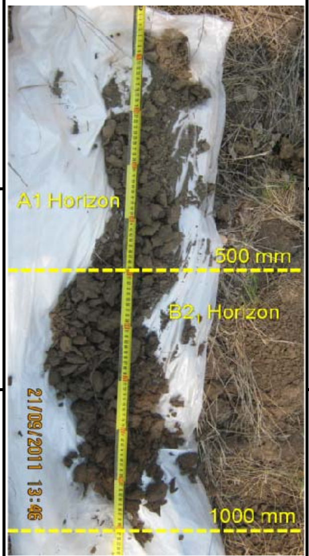
Project: Wards Well
Job Number QE9811
Date: 21/9/2011
Location: 9 **Oberservation Type:** A
Coordinates: 598188, 7612435

Natural Vegetation: popular box, Open woodland


Land Use: grazing

Topography: ≤ 1%
Surface Rock % (> 60mm dia): Nil
Erosion: Nil
Drainage: Poor

Remarks:
ASC Mapped: Kandosol
ASC Ground Truth: Brown Vertosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-500	MC	Not recorded	10YR 4/2	Nil		Crusty, cracking	Very Firm, Coherent, Massive	4	Not recorded	Diffuse, Irregular	A1	0-100 mm, 200-300 mm
500-1000+	MC	Not recorded	10YR 3/3	Yellow, subtle grey mottes		-	Very Firm, Coherent, Massive	4	Not recorded	Base of horizon not encountered d	$B2_1$	800-900 mm

Project: Wards Well **Job Number** QE9811	**Date:** 21/9/2011	**Location:** 10 **Oberservation Type:** A	**Coordinates:** 0599832, 7611654

Natural Vegetation: Spear Grass, Acacia (various), Very few Ironbak, Mixed redland earth vegetation


Land Use: Grazing

Topography: ≤ 1%	**Surface Rock % (> 60mm dia):** Nil	**Erosion:** Nil	**Drainage:** Very well drained
Remarks:		**ASC Mapped:** Kandosol	**ASC Ground Truth:** Brown Dermosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-350	SL	Nil	7.5YR 3/3	Nil		Sand, firm	Loose, Not Coherent	1	Not recorded	Gradual, Even	$A1_1$	0-100
350-1000+	SCL$^-$	Nil	7.5YR 4/4	Some mottles		-	Loose, Not Coherent	1	Not recorded	Gradual Even	$A1_2$	500-600
1000-1100+	SCL$^-$	Nil	5YR 5/5	Nil		-	Loose, Weakly Coherent, Massive	1	Not recorded	Base of horizon not encountered	$A1_3$	1000-1100

Project: Wards Well
Job Number QE9811

Date: 21/9/2011

Location: 11 **Oberservation Type:** P

Coordinates: 0599757

Natural Vegetation: Spear Grass, Acacia (various), Very few Ironbak, Mixed redland earth vegetation

Land Use: Grazing

Topography: Flat (≤ 0.5%)

Surface Rock % (> 60mm dia): Nil

Erosion: Nil

Drainage: Very well drained

Remarks:

ASC Mapped: Kandosol

ASC Ground Truth: Red Kandosol

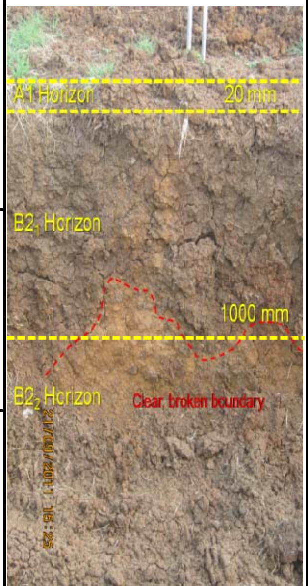
Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-500	SL	Nil	7.5YR 3/3	Nil		Firm, sandy	Loose, Weakly Coherent, Massive	1	Not recorded	Gradual, Even	$A1_{1P}$	No sample
500-1500	SCL	Nil	7.5YR 4/4	Nil		-	Loose, Weakly Coherent, Massive	1	Not recorded	Gradual, Even	$A1_2$	No sample

Project: Wards Well **Job Number** QE9811	**Date:** 21/9/2011	**Location:** 12 **Oberservation Type:** P	**Coordinates:** 599737, 7609528

Natural Vegetation: Brigalow, regrowth, Dandelion

Land Use: Grazing

Topography: ≤ 1%	**Surface Rock % (> 60mm dia):** Nil	**Erosion:** Nil	**Drainage:** Imperfect
Remarks: Hard cracking, flat alluvial plain		**ASC Mapped:** Kandosol	**ASC Ground Truth:** Demosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-20	MC / HC	Nil	10YR 4/3	Nil		Self mulching, ctracking clay	Weakly Coherent, Surface mulch	2	Not recorded	Clear, Even	$A1_P$	No sample
20-1000	MC / HC	Nil	10Yr 4/4	Nil		-	Weak, Coherent, Highly pedal	2	Not recorded	Clear, Broken	$B2_1$	No sample
1000+	MC / HC	Nil	7.5YR 4/6	Some grey mottles present		-	Firm, Coherent, Highly pedal	3	Not recorded	Base of horizon not encountered	$B2_2$	No sample

Project: Wards Well **Job Number** QE9811	**Date:** 21/9/2011	**Location:** 13 **Oberservation Type:** A	**Coordinates:** 601185, 7608926

Natural Vegetation: Brigalow, Black butt

Land Use: Grazing

Topography: ≤ 1%

Surface Rock % (> 60mm dia): Nil

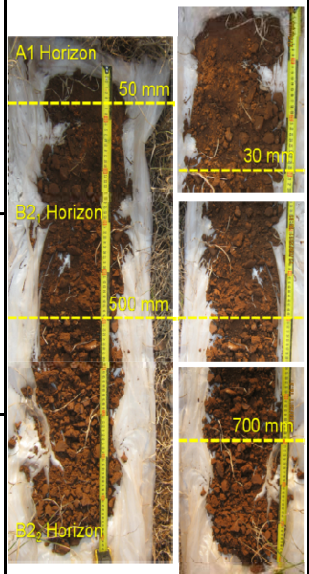
Erosion: Nil

Drainage: Poor

Remarks: Hard soil, normal Gilgai landsurface, sample location in depression

ASC Mapped: Kandosol

ASC Ground Truth: Brown Dermosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-50	SL	Nil	10YR 4/3	Nil		Firm, crusting, non-cracking	Loose / Weak, Apedal	2	Not recorded	Gradual	A1	0-500 mm, 200-300 mm
50-500	SL	Nil	10YR 3/3	Manganese nodules and yellow mottling		-	Loose / Weak, Weakly pedal	1	Not recorded	Gradual	B2$_1$	700-800 mm
500+	MC / HC	Nil	5YR 4/3	Ironstone and Manganese nodules		-	Loose / Weak, Weakly pedal	2	Poor	Gradual	B2$_2$	1000-1100mm

Project: Wards Well **Job Number** QE9811	**Date:** 22/9/2011	**Location:** 14 **Oberservation Type:** A	**Coordinates:** 0597754, 761859

Natural Vegetation: Buffel grass, Acacia, Mt Coolabah (scattered), bohenia, Brigalow on uphill margin


Land Use: Grazing

Topography: ≤ 1%, Top of alluvial plain	**Surface Rock % (> 60mm dia):** Nil	**Erosion:** Nil	**Drainage:** Imperfect, poorly drained clay
Remarks:		**ASC Mapped:** Vertosol	**ASC Ground Truth:** Vertosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-50	MC	Nil	10YR 3/1	Nil		Coarse, self-mulching, hard setting	Weak, Coherent, Highly pedal	2	Not recorded	Gradual, Even	A1	No sample
50-200	MC	1-3%	10YR 3/1	Carbonate nodules (white and red)		-	Weak, Coherent, Highly pedal	2	Not recorded	Gradual, Even	$B2_1$	No sample
200-1000+	MC	Nil	10YR 3/1	Mottling and carbonate nodules		-	Sub-angular, blocky	4	Not recorded	Base of horizon not encountered	$B2_2$	No sample

Project: Wards Well
Job Number QE9811
Date: 22/9/2011
Location: 15 **Oberservation Type:** A
Coordinates: 598820, 7617662

Natural Vegetation: Medium density Ironbark, Acacia, Buffel grass, Brigalow

Land Use: Grazing

Topography: Not recorded
Surface Rock % (> 60mm dia):
Erosion: Nil
Drainage: Nil

Remarks:
ASC Mapped: Vertosol
ASC Ground Truth: Brown Vertosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-100	SiC	Nil	7.5YR 3/2	Nil		Surface cracking, self-mulching, fine angular	Very Firm, Highly Pedal	4	Not recorded	Diffuse, Even	A1	0-100 mm
100-800	LC / MC	Nil	7.5YR 3/2	Some carbnate nodules		-	Very Firm, Highly Pedal	4	Not recorded	Clear, Even	$B2_1$	300-400 mm
800-1000+	MC	Nil	5YR 3/4	Some carbonate nodules		-	Very Firm, Highly Pedal	4	Not recorded	Base of horizon not encountered	$B2_2$	900-1000 mm

Project: Wards Well

Job Number QE9811

Date: 22/9/2011

Location: 16 **Oberservation Type:** P

Coordinates: 599176,7617728

Natural Vegetation: Buffel grass, Acacia, River Gum

Land Use: Grazing

Topography: Undulating (1-2%)

Surface Rock % (> 60mm dia): Nil

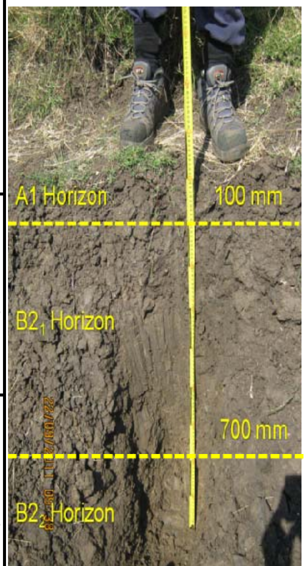
Erosion: Visible signs of erosion

Drainage: Well drained

Remarks: Creek bed

ASC Mapped: Vertosol

ASC Ground Truth: Vertosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-100	LC	Nil	7.5YR 2.5/1			No cracking, self-mulching crust	Weak, Weakly Pedal, Coherent	1	Not recorded	Gradual, Clear	A1	No sample
100-700	MC	≤ 30%	7.5YR 2.5/1	5-10 mm diameter gravel, some mottles		-	Weak, Weakly Pedal, Coherent	1	Not recorded	Gradual, Clear	$B2_1$	No sample
700-1000+	MC	≤ 30%	7.5YR 3/1	5-10 mm diameter gravel, some mottles		-	Weak, Weakly Pedal, Coherent	1	Not recorded	Base of horizon not encountered	$B2_2$	No sample

Project: Wards Well
Job Number QE9811
Date: 22/9/2011
Location: 17 **Oberservation Type:** A
Coordinates: 600217,7618517

Natural Vegetation: Open Popular box Woodlands

Land Use: Grazing

Topography: ≤ 1%
Surface Rock % (> 60mm dia): Nil
Erosion: Nil
Drainage: Imperfect

Remarks:
ASC Mapped: Vertosol
ASC Ground Truth: Brown Vertosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-50	LC	Nil	5YR 3/2	Carbonate nodules		Self mulching	Weak, Highly Pedal, Coherent	2	Not recorded	Gradual	A1	No sample
50-100	MC	Nil	5YR 3/2	Nil		-	Firm, Highly Pedal, Coherent	3	Not recorded	Gradual	$B2_1$	No sample
100-1000	MC	Nil	10YR 4/4	Nil		-	Very Firm, Highly Pedal, Coherent	4	Not recorded	Base of horizon not encountered	$B2_2$	No sample

Project: Wards Well
Job Number QE9811

Date: 22/9/2011

Location: 18 **Oberservation Type:** A

Coordinates: 0601253, 7619639

Natural Vegetation: Brigalow (regrowth), Buffel grass, Bohenia

Land Use: Grazing

Topography: Flat

Surface Rock % (> 60mm dia): Nil

Erosion: Nil

Drainage: Imperfect

Remarks:b Gilgai in area

ASC Mapped: Kandosol

ASC Ground Truth: Brown Vertosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-200	LC	Nil	7.5Yr 3/2	Nil		non-cracking, self mulching	Very Weak, Apedal	1	Not recorded	Gradual, Even	A1	No sample
200-1000+	MC	≤ 20%	7.5Yr 3/1	Mottling anb carbonate nodules		-	Weak, Weakly Pedal, Coherent	2	Not recorded	Gradual, Even	$B2_1$	No sample

Project: Wards Well
Job Number QE9811

Date: 22/9/2011

Location: 19 **Oberservation Type:** A

Coordinates: 601547, 7619445

Natural Vegetation: Brigalow (regrowth), Buffel grass, Bohenia


Land Use: Grazing

Topography: Flat (≤ 1%)

Surface Rock % (> 60mm dia): Nil

Erosion: Nil

Drainage: Imperfect

Remarks:b Gilgai in area

ASC Mapped: Vertosol

ASC Ground Truth: Brown Vertosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-200	LC	Nil	7.5Yr 3/2	Nil		non-cracking, self mulching	Very Weak, Apedal	1	Not recorded	Gradual, Even	A1	No sample
200-1000+	MC	≤ 20%	7.5Yr 3/1	Mottling anf carbomate nodules		-	Weak, Highly Pedal, Coherent	2	Not recorded	Gradual, Even	$B2_1$	No sample

Project: Wards Well **Job Number** QE9811	**Date:** 22/9/2011	**Location:** 20 **Oberservation Type:** P	**Coordinates:** 596723, 7616485

Natural Vegetation: Acacia and Grassland


Land Use: Grazing

Topography: 1-2%	**Surface Rock % (> 60mm dia):** Nil	**Erosion:** Nil	**Drainage:** Well drained clay
Remarks:		**ASC Mapped:** Vertosol	**ASC Ground Truth:** Vertosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-50	MC	Nil	7.5YR 3/1	Nil		Self-mulching crust	Weak, Highly Pedal, Coherent	2	Not recorded	Gradual, Even	$A1_P$	No sample
50-1000+	HC	≤ 5% Gravel	10YR 3/2	Nil		-	Very Firm, Weakly Pedal / Massive, Coherent	4	Not recorded	Base of horoizon not encountered	$B2_1$	No sample

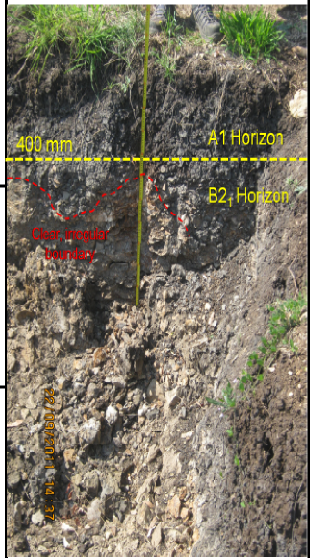
Project: Wards Well
Job Number QE9811
Date: 22/9/2011
Location: 21 **Oberservation Type:** P
Coordinates: 597748,7616602

Natural Vegetation: Moreton Bay Ash, Buffel Grass

Land Use: Grazing

Topography: 1-2%
Surface Rock % (> 60mm dia): Nil
Erosion: Nil
Drainage: well drained midslope site

Remarks:
ASC Mapped: Vertosol
ASC Ground Truth: Vertosol



Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-400	MC	Nil	7.5YR 3/2	Nil		self-mulching cracking clay	Very Firm, Highly Pedal, Coherent	4	poor	Clear, Irregular	$A1_P$	No sample
400+	SC	80-90%	10YR 3/2	Large sandstone fragments, mottles of white / yellow / orange		-	Very Firm, Highly Pedal, Coherent	4	poor	Base of horizon not encountered	$B2_1$	No sample

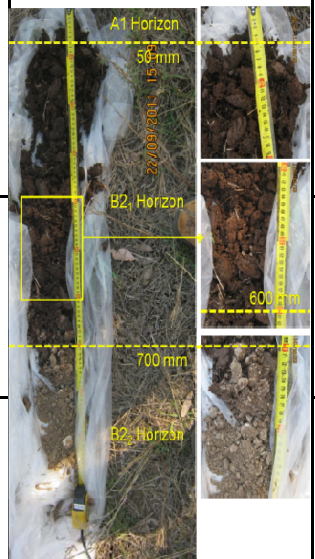
Project: Wards Well
Job Number QE9811
Date: 22/9/2011
Location: 22 **Oberservation Type:** A
Coordinates: 598838, 7616587

Natural Vegetation: Popular Box, Buffel Grass

Land Use: Grazing

Topography: Flat / Table top
Surface Rock % (> 60mm dia): Nil
Erosion: Nil
Drainage: Restricted / Poor

Remarks:
ASC Mapped: Vertosol
ASC Ground Truth: Brown Vertosol

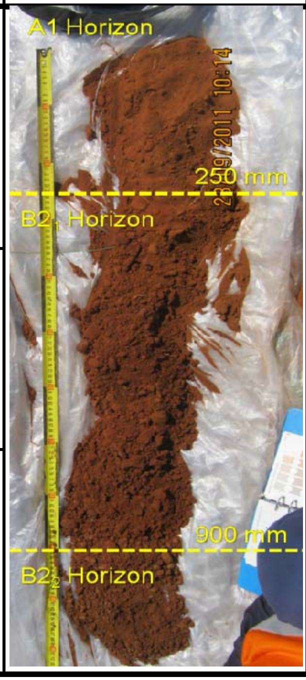
Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-50	LC	Nil	7.5YR 3/3	Nil		Self-mulching cracking clay	Very Weak, Weakly pedal / Apedal,	1	Restricted	Gradual, Even	A1	0-100 mm
50-700	MC	Nil	7.5YR 2.5/2	Carbonate nodules, White mottling		-	Weak, Stonger then weakly pedal, Coherent	2	Poor	Clear, Even	B2$_1$	200-400 mm
700-1000+	SLC	Nil	10YR 4/4	Distinct white / yellow / red mottling		-	Very Firm, Strongly Pedal, Coherent	4	Poor	Clear, Even	B2$_2$	800-900 mm

Project: Wards Well **Job Number** QE9811	**Date:** 23/9/2011	**Location:** 23 **Oberservation Type:** A	**Coordinates:** 0595233, 7611393

Natural Vegetation: Iron Bark, Spear Grass

Land Use: Grazing

Topography: Close to top of slope (1-2%)	**Surface Rock % (> 60mm dia):** Nil	**Erosion:** Nil	**Drainage:** Restricted
Remarks:		**ASC Mapped:** Kandosol	**ASC Ground Truth:** Kandosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-250	SL	Nil	5YR 4/4	Nil		Hard-setting	Very Weak, Apedal	1	Not recorded	Clear Even	A1	0-100 mm
250-900	FSCL	≤ 5%	5YR 3/4	Drak gray / black mottles		-	Very Weak, Apedal / Weakly Coherent	1	Not recorded	Gradual Even	B2$_1$	300-400 mm
900-1000+	FSCL	≤ 80%	5YR 3/4	Nil		-	Very Weak, Apedal / Weakly Coherent	1	Not recorded	Base of horizon not encountered	B2$_2$	900-1000 mm

Project: Wards Well **Job Number** QE9811	**Date:** 23/9/2011	**Location:** 24 **Oberservation Type:** A	**Coordinates:** 594552,7611459

Natural Vegetation: Spear Grass, Ironbark

Land Use: Grazing / Railway easment

Topography: Close to top of slope (1-2%)	**Surface Rock % (> 60mm dia):** Nil	**Erosion:** Nil	**Drainage:** Restricted
Remarks:		**ASC Mapped:** Kandosol	**ASC Ground Truth:** Kandosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-300	SL	Nil	2.5YR 4/6	Nil		Hard packed, hard-setting	Very Weak, Apedal	1	Well	Gradual, Even	$A1_{1P}$	No sample
300-900	LC	Nil	5YR 3/6	Nil		-	Very Weak, Apedal / Weakly Coherent	1	Poor	Gradual, Even	$B2_1$	No sample
900+	FSCL	≤ 5%	2.5YR 2.5/4	Some mottling present		-	Very Weak, Apedal / Weakly Coherent	1	Poor	Base of horizon not encountered	$B2_2$	No sample

Project: Wards Well
Job Number QE9811
Date: 23/9/2011
Location: 25 **Oberservation Type:** A
Coordinates: 594285, 7612574

Natural Vegetation: Spear Grass, Bohenia, Acacia (cleared)

Land Use: Grazing

Topography: Old Alluvial Plain (1-2%)
Surface Rock % (> 60mm dia): Nil
Erosion: Nil
Drainage: Poorly drained

Remarks:
ASC Mapped: Vertosol
ASC Ground Truth: Vertosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-20	LC / MC	Nil	10YR 2/2	Slight red / yellow mottling		Self-mulching	Firm, Strongly Pedal, Coherent	3	Not recorded	Clear, Even	A1	No sample
20-80	MC	Nil	10YR 3/2	Red mottles, White and orange nodules		-	Firm, Strongly Pedal, Coherent	3	Not recorded	Clear, Even	$B2_1$	No sample
850-1000	MC	Nil	7.5YR 3/2	Red mottles, White and orange nodules		-	Weak, Strongly Pedal, Coherent	2	Not recorded	Base of horizon not encountered	$B2_2$	No sample

Project: Wards Well **Job Number** QE9811	**Date:** 23/9/2011	**Location:** 26 **Oberservation Type:** A	**Coordinates:** 594184, 7613072

Natural Vegetation: Cleared regrowth, Acacia

Land Use: Grazing

Topography: ≤ 1%	**Surface Rock % (> 60mm dia):** Nil	**Erosion:** Nil	**Drainage:** Well drained
Remarks:		**ASC Mapped:** Vertosol	**ASC Ground Truth:** Brown Vertosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-20	LC	Nil	10YR 3/4	Nil		Hard-setting, black cracking clay	Weak, Strongly pedal, Coherent	2	Not recorded	Clear, Even	A1	No sample
20-1000+	MC	Nil	10YR 3/4	White and Black nodules		-	Very Firm, Strongly pedal, Coherent	4	Not recorded	Base of horiozon not encountered	$B2_1$	No sample

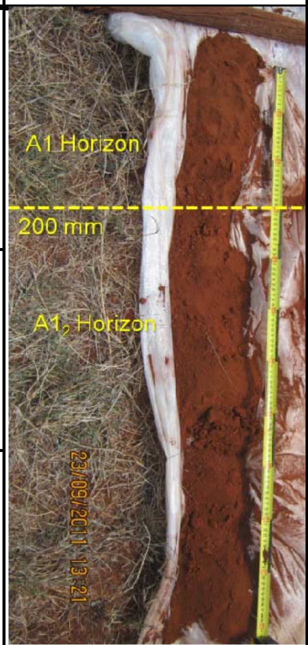
Project: Wards Well
Job Number QE9811
Date: 23/0/2011
Location: 27 **Oberservation Type:** A
Coordinates: 0595765, 7612785

Natural Vegetation: Buffel grass, Cleared regrowth, Popular box, Acacia, Wattle


Land Use: Grazing

Topography: Flat / Middle of Ridge (≤ 1%)
Surface Rock % (> 60mm dia): Nil
Erosion: Nil
Drainage: Well drained

Remarks:
ASC Mapped: Kandosol
ASC Ground Truth: Kandosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-200	SL	Nil	2.5YR 2.5/4	Nil		Firm, hard packed	Loose, Apedal	0	Very well drained	Diffuse, Even	A1	No sample
800-1000	SC	Nil	2.5 YR 2.5/4	Nil		-	Loose / Weak, Weakly pedal	1	Very well drained	Base of horizon not encountered	A1$_2$	No sample

Field Survey Staff: Sinclair Knight Merz

Project: Wards Well **Job Number** QE9811	**Date:** 23/9/2011	**Location:** 28 **Oberservation Type:** A	**Coordinates:** 595477, 7612063

Natural Vegetation: Small shrubs, Grassland, Some Ironbark

Land Use: Grazing

Topography: Bottom of slope (1-2%)	**Surface Rock % (> 60mm dia):** Nil	**Erosion:** Nil	**Drainage:** Restricted
Remarks: Area has been previously cleared		**ASC Mapped:** Kandasol	**ASC Ground Truth:** Brown Dermosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-100	LC	Nil	7.5YR 4/4	Nil		Hardpacked, non-cracking clay	Weak, Weakly Pedal /Apedal	1	imperfect	Clear, Even	A1	0-100 mm
100-400	MC	Nil	7.5Yr 4/4	White mottles		-	Weak, Strongly Pedal, Coherent	2	poor	Clear, Even	$B2_1$	200-300 mm
400+	MC	Nil	7.5YR 3/3	White / Black mottles		-	Firm / Very Firm, Strongly Pedal, Coherent	3 / 4	poor	Base of horizon not encountered	$B2_2$	700-800 mm

Project: Wards Well **Job Number** QE9811	**Date:** 23/9/2011	**Location:** 29 **Oberservation Type:** A	**Coordinates:** 0595478, 7611172

Natural Vegetation: Ironbark, Acacia, Bohenia, Buffel grass, some Popular box

Land Use: Grazing

Topography: ≤ 1% (Table top)	**Surface Rock % (> 60mm dia):** Nil	**Erosion:** Nil	**Drainage:** Imperfect / Well
Remarks:		**ASC Mapped:** Kandosol	**ASC Ground Truth:** Kandosol

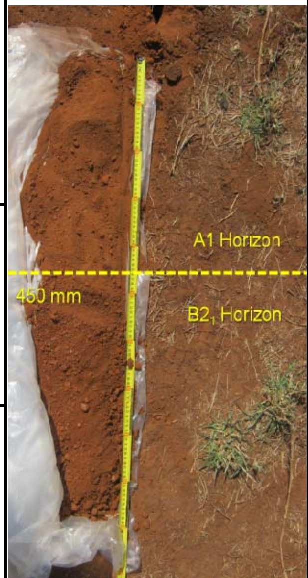
Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-50	SCL	Nil	5YR 3/3	Nil		Hard setting	Very Weak, Weakly Pedal / Apedal	1	Not recorded	Gradual, Clear	A1	No sample
50-400	SCL	Nil	5YR 3/4	Ironstone and orange / red mottles		-	Very Weak / Weak, Weakly Pedal, Slightly Coherent	2	Not recorded	Gradual, Clear	$B2_1$	No sample
400-1000+	LC / MC	Nil	2.5YR 2.5/4	Ironstone and orange / red mottles		-	Weak, Stronger then Weakly Pedal, Mildly Coherent	2	Not recorded	Base of horizon not encountered	$B2_2$	No sample

Project: Wards Well **Job Number** QE9811	**Date:** 23/9/2011	**Location:** 30 **Oberservation Type:** A	**Coordinates:** 595717, 7610486

Natural Vegetation: Cleared, Buffel Grass, Small shrubs

Land Use: Grazing

Topography: Flat plain (1%)	**Surface Rock % (> 60mm dia):** Nil	**Erosion:** Nil	**Drainage:** Well drained
Remarks: Near creek line		**ASC Mapped:** Kandasol	**ASC Ground Truth:** Kandosol

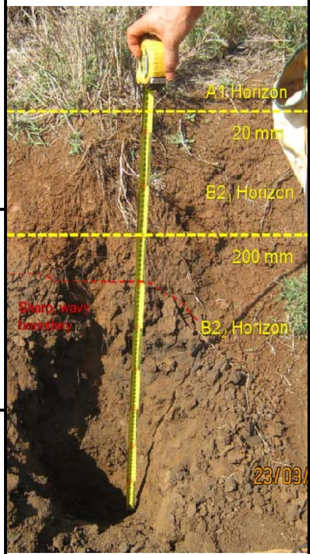
Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-450	SL	Nil	2.5YR 3/4	Nil		Hard setting surface	Loose, Apedal	0	Well drained	Gradual, Even	A	No sample
450-1000+	SL	Nil	5YR 4/6	Ironstone		-	Weak, Weakly Pedal, Weakly Coherent	1	Well drained	Base of horizon not encountered	$B2_1$	No sample

Project: Wards Well **Job Number** QE9811	**Date:** 23/9/2011	**Location:** 31 **Oberservation Type:** P	**Coordinates:** 0596389, 7610125

Natural Vegetation: Buffel Grass, Acacia, Brigalow


Land Use: Grazing

Topography: Creek bed (≤ 1%)	**Surface Rock % (> 60mm dia): Nil**	**Erosion:** Approx 10% of area eroded	**Drainage:** Restricted
Remarks:		**ASC Mapped:** Kandosol	**ASC Ground Truth:** Dermosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-20	SCL	Nil	10YR 4/4	Nil		Hard-setting clay	Weak / Very Weak, Weakly pedal, Coherent	1	Well drained	Clear, Even	A1	No sample
20-200	LC	Nil	10YR 3/6	Nil		-	Weak, Weakly pedal, Coherent	2	Well drained	Sharp, Wavy	B2$_1$	No sample
200-1000+	HC	Nil	10YR 3/3	Ironstone		-	Very Firm, Weakly Pedal / Massive, Coherent	4	Well drained	Base of horizon not encountered	B2$_2$	No sample

Project: Wards Well
Job Number QE9811
Date: 24/9/2011
Location: 32 **Oberservation Type:** A
Coordinates: 0596753, 7602859

Natural Vegetation: Cleared Speargrass, Brigalow regrowth, Acacia


Land Use: Grazing

Topography: Flat, Melonholes throughout
Surface Rock % (> 60mm dia): Nil
Erosion: ≤ 5% of site
Drainage: Well drained

Remarks:
ASC Mapped: Vertosol
ASC Ground Truth: Grey Vertosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-150	LC	Nil	10YR 3/2	Nil		Self-mulching cracking black clay	Very firm, Highly pedal, Coherent	4	Imperfect	Sharp, Even	A1	No sample
150-450	MC	Nil	10YR 3/3	Oange / red motttles		-	Very firm, Highly pedal, Coherent	4	Imperfect	Sharp, Even	$B2_1$	No sample
450-1000+	MC	Nil	10YR 3/4	Carbonate nodules, Ironstone		-	Very firm, Highly pedal, Coherent	4	Imperfect	Base of horizon not encountered	$B2_2$	No sample

Project: Wards Well
Job Number QE9811
Date: 27/9/2011
Location: 33 **Oberservation Type:** A
Coordinates: 596891, 7603704

Natural Vegetation: Cleared vegetation, Spear Grass


Land Use: Grazing

Topography: Flat (≤ 1%), Melonholes present
Surface Rock % (> 60mm dia): Nil
Erosion: Evidence of erosion (≤ 5%)
Drainage: Well drained

Remarks:
ASC Mapped: Vertosol
ASC Ground Truth: Brown Vertosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-150	LC / MC	Nil	10YR 3/2	Nil		Self-mulching cracking clay	Very firm, Highly Pedal, Coherent	4	Not recorded	Diffuse, Even	A1	No sample
150-550	MC	Nil	10YR 3/3	Orange / red mottles		-	Very firm, Highly Pedal, Coherent	4	Not recorded	Diffuse, Even	$B2_1$	No sample
550-1000+	MC	Nil	10YR 3/4	Carbonate nodules, Ironstone. Red / orange mottles		-	Very firm, Highly Pedal, Coherent	4	Not recorded	base of horizon not encountered	$B2_2$	No sample

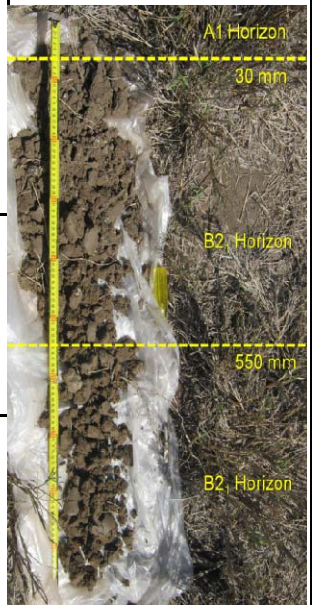
Project: Wards Well
Job Number QE9811
Date: 24/9/2011
Location: 34 **Oberservation Type:** A
Coordinates: 597267, 7604679

Natural Vegetation: Cleared, Buffel Grass, regrowth of Acacia


Land Use: Nil

Topography: Flat undulating, Melon holes
Surface Rock % (> 60mm dia): Nil
Erosion: ≤ 5%
Drainage: Imperfect

Remarks:
ASC Mapped: Vertosol
ASC Ground Truth: Brown Vertosol



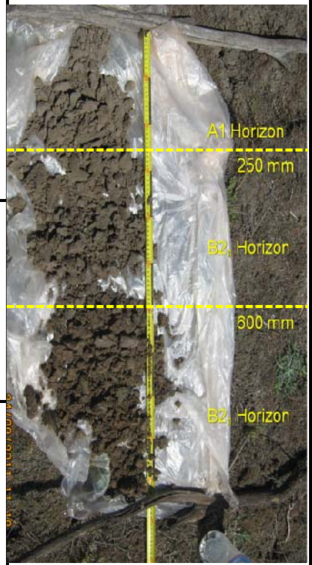
Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-30	MC	Nil	10YR 3/2	Nil		Self-mulching cracking clay	Very Firm, Highly Pedal, Coherent	4	Not recorded	Diffuse, Even	A1	No sample
50-550	MC	Nil	10YR 4/2	Carbonate nodules, Red mottles		-	Firm, Highly Pedal, Coherent	3	Not recorded	Diffuse, Even	B2$_1$	No sample
550+	MC	Nil	10YR 4/2	Tree roots intercepted		-	Weak, Highly Pedal, Coherent	2	Not recorded	Base of horizon not encoutered	B2$_1$	No sample

Project: Wards Well **Job Number** QE9811	**Date:** 24/9/2011	**Location:** 35 **Oberservation Type:** A	**Coordinates:** 597310, 7605530

Natural Vegetation: Buffel Grass,

Land Use: Grazing

Topography: Melonholes (≤ 1%)	**Surface Rock % (> 60mm dia):** Nil	**Erosion:** Nil	**Drainage:** Imperfect
Remarks: Sample from within melonhole		**ASC Mapped:** Vertosol	**ASC Ground Truth:** Vertosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-250	LC	Nil	10YR 4/1	Nil		self-mulching, craking clay	Firm, Highly Pedal, Coherent	3	Imperfect	Gradual, Even	A1	No sample
250-600	MC	Nil	10YR 4/2	White / Brown / Orange / Red mottles		-	Very Firm, Highly Pedal, Coherent	4	Imperfect	Clear, Even	$B2_1$	No sample
600-1000+	MC	Nil	10YR 5/2	Orange / Brown mottles		-	Very Firm, Highly Pedal, Coherent	4	Imperfect	Base of horizon not encountered	$B2_2$	No sample

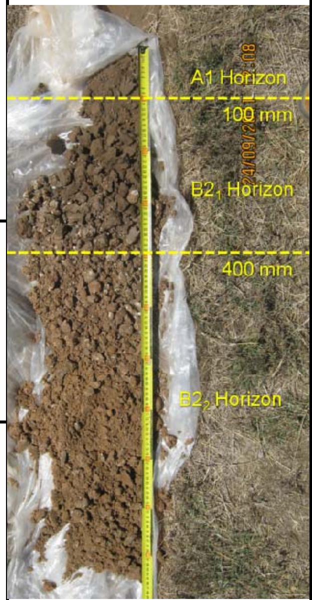
Field Survey Staff: Sinclair Knight Merz

Project: Wards Well **Job Number** QE9811	**Date:** 24/9/2011	**Location:** 36 **Oberservation Type:** A	**Coordinates:** 0597230, 7606211

Natural Vegetation: Cleared Buffel Grass, Popular box on edge of site

Land Use: Grazing

Topography: Near top ridge line (≤ 1%)	**Surface Rock % (> 60mm dia):** Nil	**Erosion:** Nil	**Drainage:** Restricted
Remarks:		**ASC Mapped:** Vertosol	**ASC Ground Truth:** Brown Dermosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-100	SCL	Nil	7.5YR 3/2	Nil		Hard-setting	Firm, Highly Pedal, Coherent	4	Not recorded	Diffuse, Even	A1	0-100 mm
100-400	LC / MC	Nil	7.5Yr 3/2	Carbonate nodules, Ironstone		-	Firm, Highly Pedal, Coherent	4	Not recorded	Gradual, Even	B2$_1$	200-300 mm
400-1000+	MC	Nil	7.5YR 4/3	Carbonate nodules		-	Firm, Highly Pedal, Coherent	3	Not recorded	Base of horizon not encountered	B2$_2$	700-800 mm

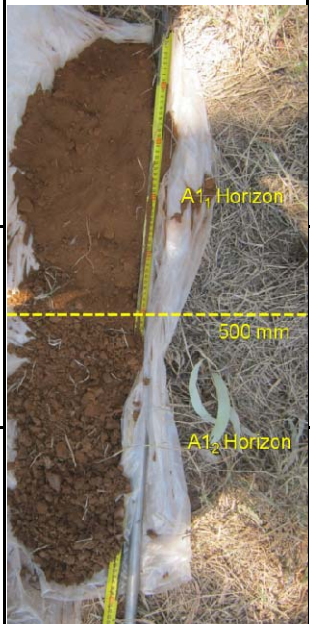
Project: Wards Well
Job Number QE9811
Date: 24/9/2011
Location: 37 **Oberservation Type:** A
Coordinates: 598062, 7607510

Natural Vegetation: Buffel Grass, Brigalow


Land Use: Grazing

Topography: ≤ 1%
Surface Rock % (> 60mm dia): Nil
Erosion: Nil
Drainage: Not recorded

Remarks: Edge of vegetation, roots ≤ 200 mm
ASC Mapped: Kandosol
ASC Ground Truth: Kandosol

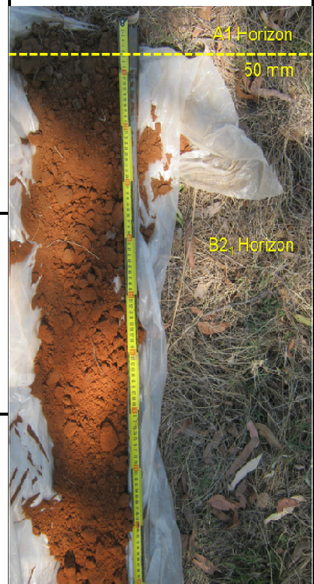
Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-500	SL	Nil	2.5YR 4/5	Nil		Hard-setting, non-cracking	Loose, Apedal	0	Well drained	Sharp, Even	A1	No sample
500-1000+	LC	Nil	7.5YR 4/4	Ironstone		-	Weak / Firm, Stronger then Weakly Pedal, Coherent	2	Well drained	Base of horizon not encountered	$A1_2$	No sample

Project: Wards Well **Job Number** QE9811	**Date:** 24/9/2011	**Location:** 38 **Oberservation Type:** A	**Coordinates:** 0396927, 7608097

Natural Vegetation: Cleared Buffel Grass, Moreton Bay Ash, Acacia, Ironbark

Land Use: Airstrip, Road

Topography: Flat	**Surface Rock % (> 60mm dia):** Nil	**Erosion:** Nil	**Drainage:** Very well drained
Remarks:		**ASC Mapped:** Kandosol	**ASC Ground Truth:** Kandosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-50	SCL$^-$	Nil	7.5YR 2.5/3	Nil		Sandy, Firm	Weak, Weakly Pedal, Coherent	2	Not recorded	Gradual, Even	A1$_1$	0-50 mm
50-1000+	LC	Nil	5YR 4/4	Some Ironstone		-	Weak, Weakly Pedal, Coherent	1	Not recorded	Base of horizon not encountered	B2$_1$	500-600 mm

Project: Wards Well
Job Number QE9811

Date: 24/9/2011

Location: 39 **Oberservation Type:** A

Coordinates: 596067, 7608471

Natural Vegetation: Moreton Bay Ash, Ironbark

Land Use: Grazing and Air strip

Topography: ≤ 1%

Surface Rock % (> 60mm dia): Nil

Erosion: Nil

Drainage: Well drained

Remarks:

ASC Mapped: Vertosol

ASC Ground Truth: Kandosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-100	SL	Nil	5YR 4/4	Nil		Sandy	Loose, Apedal	0	Not recorded	Gradual, Even	A1	No sample
100-1000+	LC	Nil	5YR 4/6	Brown mottles		-	Very Weak, Weakly Pedal, Coherent	1	Not recorded	Base of horizon not encountered	B2$_1$	No sample

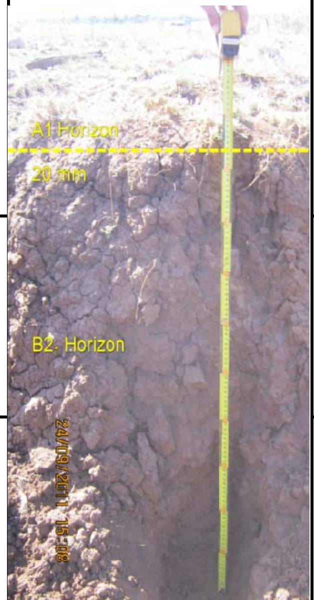
Project: Wards Well
Job Number QE9811
Date: 24/9/2011
Location: 40 **Oberservation Type:** P
Coordinates: 0595434, 7609489

Natural Vegetation: Cleared Grassland, Regrowth of Ironbark and Acacia

Land Use: Grazing

Topography: Flat alluvial floodplain
Surface Rock % (> 60mm dia): Nil
Erosion: ≤ 10%
Drainage: Restricted

Remarks:
ASC Mapped: Vertosol
ASC Ground Truth: Dermosol

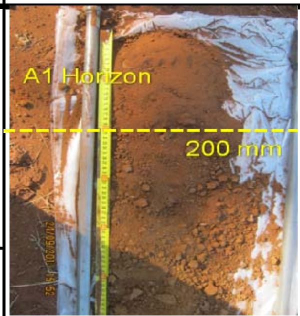
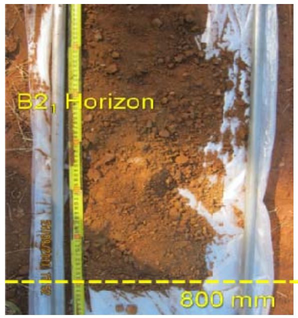
Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-20	LC	Nil	10YR 3/4	Nil		self-mulching	Weak, Strongly Pedal, Coherent	2	Not recorded	Clear, Even	A1	No sample
20-1000	MC	Nil	10YR 4/4	White, Yellow nodules, Ironstone		-	Firm, Strongly Pedal, Coherent	3	Not recorded	Base of horizon not encountered	$B2_1$	No sample

Project: Wards Well **Job Number** QE9811	**Date:** 41	**Location:** 41 **Oberservation Type:** A	**Coordinates:** 596794, 7609884

Natural Vegetation: Ironbar, Buffel Grass

Land Use:

Topography: 1-2%, Midslope	**Surface Rock % (> 60mm dia):** ≤ 1%	**Erosion:** ≤ 5%	**Drainage:** Not recorded
Remarks:		**ASC Mapped:** Kandosol	**ASC Ground Truth:** Kandosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-200	SL	≤ 5%	2.5YR 4/4	Small Gravel (1-2 mm), ≤ 5%		Sandy	Very Weak, Apedal	1	Well drained	Diffuse, Even	A1	No sample
200-800	SL	≤ 5%	2.5YR 4/6	Medium Gravel (1-2 mm), ≤ 5%		-	Weak, Weakly Pedal, Coherent	2	Well drained	Sharp, Even	$B2_1$	No sample
800+	LC	≤ 50% Horizon contain Samprolite (country rock) and is considered to be a transition layer	5YR 5/6	Medium - Large Gravel (1-2 mm), ≤ 50%		-	Very Strong, Strongly Pedal, Coherent	6	Well drained	-	B3	No sample

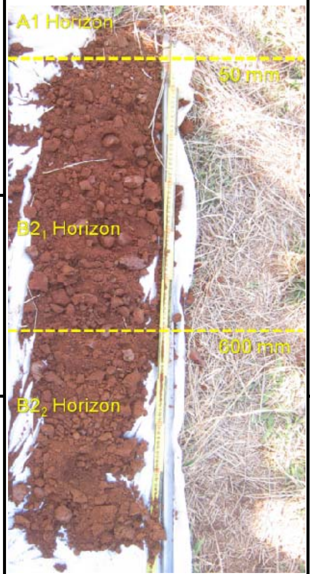
Project: Wards Well
Job Number QE9811
Date: 24/9/2011
Location: 42 **Oberservation Type:** A
Coordinates: 0897721, 7608886

Natural Vegetation: Cleared, Buffel Grass, Regrowth, Bohenia

Land Use: Grazing

Topography: Flat
Surface Rock % (> 60mm dia): Nil
Erosion: Nil
Drainage: Restricted

Remarks:
ASC Mapped: Kandosol
ASC Ground Truth: Kandosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-50	SCL	Nil	5YR 3/4	Nil		Firm, hardset sand	Weak, Weakly Pedal, Coherent	2	Not recorded	Diffuse, Even	A1	No sample
50-600	LC	Nil	2.5YR 3/4	Ironstone		-	Weak / Firm, Stronger then Weakly Pedal, Coherent	2	Not recorded	Diffuse, Even	B2$_1$	No sample
600+	MC	Nil	4YR 3/4	Black mottles		-	Weak / Firm, Stronger then Weakly Pedal, Coherent	2	Not recorded	Base of horizon not encountered	B2$_2$	No sample

Project: Wards Well
Job Number QE9811

Date: 24/9/2011

Location: 43 **Oberservation Type:** A

Coordinates: 599031, 7608521

Natural Vegetation: Ironbark, Spear Grass

Land Use: Grazing

Topography: ≤1%

Surface Rock % (> 60mm dia): Nil

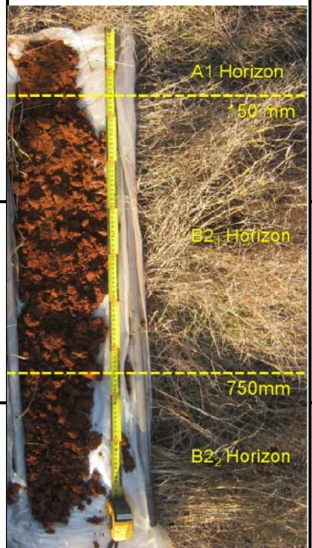
Erosion: Nil

Drainage: No recorded

Remarks:

ASC Mapped: Kandosol

ASC Ground Truth: Kandosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-150	SL	Nil	2.5YR 3/3	Nil		Firm sand	Very Weak, Weakly Pedal, Coherent	1	Well drained	Gradual, Even	A1	No sample
150-750	SCL	Nil	5YR 3/4	Nil		-	Weak, Stonger then Weakly Pedal, Coherent	2	Imperfect	Diffuse, Even	B2$_1$	No sample
750+	MC	Nil	2.5YR 3/4	Yellow mottles		-	Weak / Firm, Highly Pedal, Coherent	2 / 3	Poor drainage	Base of horizon not encountered	B2$_2$	No sample

Project: Wards Well
Job Number QE9811
Date: 25/9/2011
Location: 44 **Oberservation Type:** A
Coordinates: 0602107, 7615125

Natural Vegetation: Spear Grass, Bottle tree, Bohenia, Ironbark, Brigalow


Land Use: Grazing

Topography: Flat, ≤ 1%, top of ridge
Surface Rock % (> 60mm dia): ≤ 10%
Erosion: Nil
Drainage: Poorly drained

Remarks:
ASC Mapped: Vertosol
ASC Ground Truth: Kandosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-100	SL	20-30%	10YR 3/6	Nil		Gravely, hard-setting	Loose / Very Weak, Apedal	0 / 1	Not recorded	Clear, Even	A1	0-100 mm
100-200	SL	30%	10YR 4/4	Nil		-	Very Weak, Weakly Pedal	1	Not recorded	Clear, Even	B2$_1$	100-200 mm
200-800	SCL	80%	10YR 4/6	Yellow mottles		-	Weak, Highly Pedal, Coherent	1 / 2	Not recorded	Base of Horizon not encountered	B2$_2$	500-600 mm

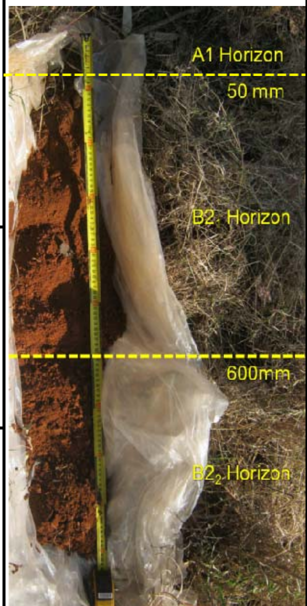
Project: Wards Well
Job Number QE9811
Date: 25/9/2011
Location: 45 **Oberservation Type:** A
Coordinates: 601862, 7614637

Natural Vegetation: Brigalow, Ironbark, Prickly Pear, Spear Grass, Acacia

Land Use: Grazing

Topography: ≤ 5%
Surface Rock % (> 60mm dia): Nil
Erosion: Nil
Drainage: Not recorded

Remarks:
ASC Mapped: Vertosol
ASC Ground Truth: Kandosol

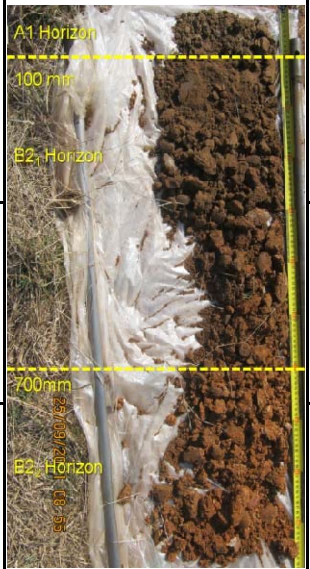
Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-50	SCL	≤ 5%	7.5YR 3/3	Nil		Sandy, Firm, Small gravel (2 - 5 mm) ≤ 5%	Very Weak, Apedal	1	Not recorded	Gradual, Even	A1	No sample
50-600	LC	≤ 2% Ironstone	7.5YR 3/4	Ironstone		-	Weak, Weakly Pedal, Coherent	2	Not recorded	Gradual, Even	$B2_1$	No sample
600-1000+	LC	≤ 5% Gravel	2.5YR 3/4	Gravel		-	Weak, Stronger then Weakly Pedal, Coherent	2	Not recorded	Base of horizon not encountered	$B2_2$	No sample

Project: Wards Well **Job Number** QE9811	**Date:** 25/9/2011	**Location:** 46 **Oberservation Type:** A	**Coordinates:** 0601972, 7613518

Natural Vegetation: Brigalow, Spear Grass, some Ironbark


Land Use: Grazing

Topography: Flat (old aluvial flood plain)	**Surface Rock % (> 60mm dia):** Nil	**Erosion:** Nil	**Drainage:** Poor
Remarks:		**ASC Mapped:** Kandosol	**ASC Ground Truth:** Sodosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-100	LC	≤ 10%	10YR 3/2	Nil		hard-setting	Firm, Hghly Pedal, Coherent	3	Not recorded	Diffuse, Even	A1	No sample
100-700	MC	≤ 5% Ironstone	10YR 2/2	Ironstone		-	Very Firm, Highly Pedal, Coherent	4	Not recorded	Gradual, Even	B2$_1$	No sample
700-1000+	MC	Nil	7.5YR 6/8	Orange / red / white mottles, Carbonate nodules		-	Very Firm, Highly Pedal, Coherent	4	Not recorded	Base of horizon not encountered	B2$_2$	No sample

Project: Wards Well
Job Number QE9811

Date: 25/9/2011

Location: 47 **Oberservation Type:** A

Coordinates: 603431, 7610795

Natural Vegetation: Spear Grass, Brigalow regrowth, some Eucalypt


Land Use: Grazing

Topography:

Surface Rock % (> 60mm dia): Nil

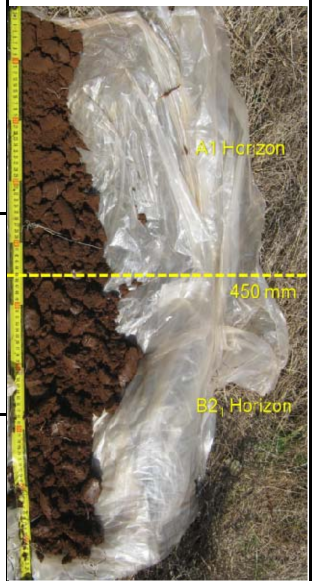
Erosion: Nil

Drainage: Not recorded

Remarks: Thick grass cover, cleared paddock

ASC Mapped: Kandosol

ASC Ground Truth: Red Demosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-450	LC	Nil	7.5YR 3/3	Brown / orange mottles		hard-setting	Ver Weak / Weak, Stronger then Weakly Pedal, Coherent	1 / 2	Not recorded	Gradual, Even	A1	0-100 mm
450-1000	MC	≤ 5%	2.5YR 3/4	Orange / yellow mottles, Ironstone		-	Firm, Highly Pedal, Coherent	3	Not recorded	Base of horizon not encountered	$B2_1$	450-1000 mm

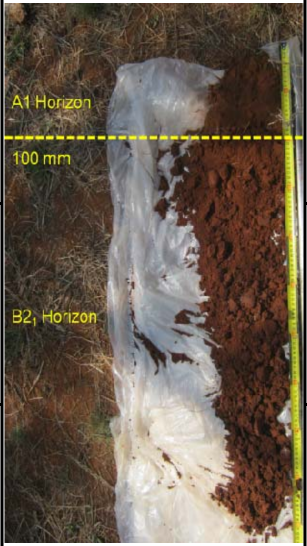
Project: Wards Well **Job Number** QE9811	**Date:** 25/9/2011	**Location:** 48 **Oberservation Type:** A	**Coordinates:** 0602476, 7611095

Natural Vegetation: Buffel Grass, Ironbark



Land Use: Grazing

Topography: ≤ 1%	**Surface Rock % (> 60mm dia):** Nil	**Erosion:** Nil	**Drainage:** Well drained
Remarks:		**ASC Mapped:** Kandosol	**ASC Ground Truth:** Kandosol

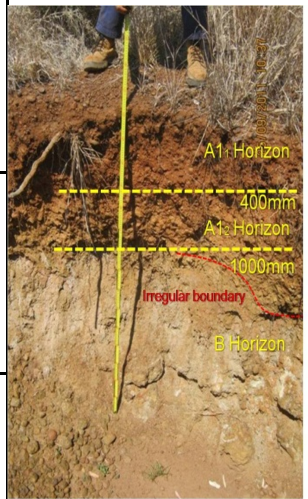
Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-100	SCL	Nil	2.5YR 3/4	Nil		Firm sand	Very Weak, Apedal	1	Not recorded	Gradual, Even	A1	No sample
100-1000+	SCL	≤ 5%	2.5YR 3/6	Ironstone		-	Weak, Stronger then Weakly Pedal, Coherent	2	Not recorded	Base of horizon not encountered	B21	No sample

Project: Wards Well **Job Number** QE9811	**Date:** 25/09/11	**Location:** 49 **Oberservation Type:** E	**Coordinates:** 0601753, 7610328

Natural Vegetation: Ironbark, brigalow, spear, bohenia

Land Use: Grazing

Topography: 1% near top	**Surface Rock % (> 60mm dia):** 50%	**Erosion:** Extensive (≤ 50% of sample area)	**Drainage:** Poor
Remarks: Taken in erosion channel of gravel ridge		**ASC Mapped:** Kandosol	**ASC Ground Truth:** Sodosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-400	LC	80%	2.5YR 3/4	Nil		Hard gravel	Weak, Weakly Pedal, Coherent	2	Good	Clear, Even	$A1_1$	No sample
400-1000	LC	80%	7.5YR 4/6	Nil		-	Weak, Weakly Pedal, Coherent	2	Good	Clear, Irregular	$A1_2$	No sample
>1000	MC / HC	Nil	10YR 5/3	Grey / orange mottles		-	Weak, Weakly Pedal, Coherent	2	Poor	Base of horizon not encountered	$B2_1$	No sample

Project: Wards Well
Job Number QE9811
Date: 25/9/2011
Location: 50 **Oberservation Type:** A
Coordinates: 601263, 7610410

Natural Vegetation: Buffell grass, ironbark, poplar box

Land Use:

Topography: 1-2% mid slope
Surface Rock % (> 60mm dia): Nil
Erosion: Nil
Drainage: Not recorded

Remarks: Similar to 27 & 24
ASC Mapped: Kandosol
ASC Ground Truth: Kandosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-100	SiC	1-5%	7.5YR 3/4	Nil		sandy-hard	Loose, Apedal	0	Not recorded	Gradual, Even	$A1_1$	No sample
100-600	LC	Nil	7.5YR 3/4	Nil		-	Loose, Apedal	0	Not recorded	Gradual, Even	$B2_1$	No sample
600-1000+	MC	Nil	7.5YR 4/4	Ironstone		-	Weak, weakly pedal	2	Not recorded	Base of horizon not encountered	$B2_2$	No sample

Project: Wards Well
Job Number QE9811

Date: 25/9/2011

Location: 51 **Oberservation Type:** A

Coordinates: 0600568, 7610562

Natural Vegetation: Buffell grass, ironbark

Land Use:

Topography: Flat

Surface Rock % (> 60mm dia): Nil

Erosion: Nil

Drainage: Good

Remarks: Similar to 38, 39, 48

ASC Mapped: Kandosol

ASC Ground Truth: Kandosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-200	SiC	Nil	7.5 YR 25/2	Nil		Hard packed	Very weak, Weakly pedal	1	Not recorded	Clear, Sharp	A1	No sample
>200	LC	Nil	5YR 3/3	Ironstone		-	Very weak, Weakly pedal	1	Not recorded	Base of horizon not encountered	$B2_1$	No sample

Field Survey Staff:

Project: Wards Well **Job Number** QE9811	**Date:** 25/9/2011	**Location:** 52 **Oberservation Type:** A	**Coordinates:** 600207, 7612608

Natural Vegetation: Ironbark, Moreton bay Ash

Land Use:

Topography: <1%	**Surface Rock % (> 60mm dia):** Nil	**Erosion:** Nil	**Drainage:** Good
Remarks: Tree roots up to 400mm		**ASC Mapped:** Kandosol	**ASC Ground Truth:** Kandosol

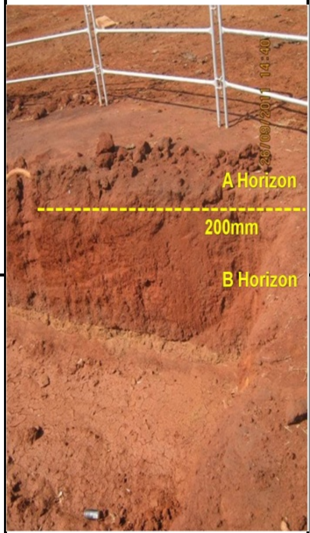
Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-150	SiC	Nil	7.5 YR 3/3	Nil		Hard packed	Very weak, Weakly pedal, Coherant	1	Not recorded	Gradual	A1	No sample
150-550	LC	Nil	10YR 3/3	Orange mottles		-	Very weak, Weakly pedal, Coherant	1	Not recorded	Sharp	$B2_1$	No sample
550- >1000	LC	≤ 50% 0-15 mm	10YR 3/6	Ironstone		-	Weak, Weakly pedal	1	Not recorded	Base of horizon not encountered	$B2_2$	No sample

Project: Wards Well **Job Number** QE9811	**Date:** 26/9/2011	**Location:** 53 **Oberservation Type:** P	**Coordinates:** 596761, 7613627

Natural Vegetation: Ironbark, Eucalyptus, Morton Bay Ash


Land Use:


Topography: <1% flat	**Surface Rock % (> 60mm dia):** Nil	**Erosion:** Nil	**Drainage:** Not recorded
Remarks: Drill pad		**ASC Mapped:** Vertosol	**ASC Ground Truth:** Kandosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-200	SCL	0-1%	2.5YR 3/4	Ironstone		Hard packed	Very weak, Weakly pedal, Coherant	1	Good	Diffuse	$A1_p$	No sample
200 - >1000	LC/MC	Nil	2.5YR 2.5/4	Ironstone		Coherent / Massive	Weak, Weakly pedal, Coherant	2	Good	Diffuse	$B2_1$	No sample

Project: Wards Well
Job Number QE9811
Date: 26/9/2011
Location: 54 **Oberservation Type:** A
Coordinates: 596761, 7613627

Natural Vegetation: Ironbark, Bohenia, Buffell, Morton Bay Ash


Land Use: Grazing

Topography: <1% near top of rise
Surface Rock % (> 60mm dia): Nil
Erosion: Nil
Drainage: Good
Remarks: Brown surface
ASC Mapped: Kandosol
ASC Ground Truth: Kandosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-450	MC	Nil	10YR 2/2	Nil		Hard packed	Weak, Non-pedal	2	Not Recorded	Gradual	A1	No sample
450-1000+	SCL	10-20%	7.5YR 3/3	Ironstone		-	Very weak, weakly pedal	1	Not Recorded	Base of horizon not encountered	$B2_1$	No sample

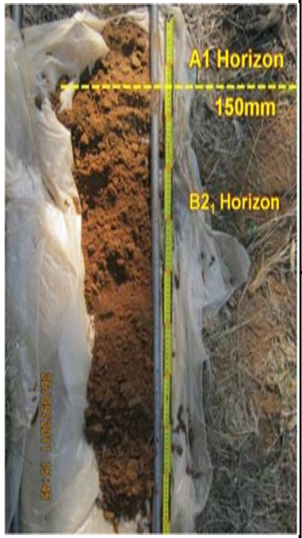
Project: Wards Well
Job Number QE9811
Date: 26/9/2011
Location: 55 **Oberservation Type:** A
Coordinates: 597258, 7611552

Natural Vegetation: Ironbark, Speargrass, Morton Bay Ash

Land Use: Grazing

Topography: <1% flat
Surface Rock % (> 60mm dia): Nil
Erosion: Nil
Drainage: Not recorded

Remarks:
ASC Mapped: Kandosol
ASC Ground Truth: Kandosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-150	SL	Nil	7.5YR 3/4	Nil		Sandy Firm	Very weak, Apedal, Coherant	1	Good	Gradual	A1	No sample
150 - >1000	SCL	Nil	7.5YR 3/4	Black / orange mottles at 950mm		-	Weak, Weakly pedal, Coherant	1 / 2	Not Recorded	Base of horizon not encountered	$B2_1$	No sample

Project: Wards Well **Job Number** QE9811	**Date:** 26/9/2011	**Location:** 56 **Oberservation Type:** P	**Coordinates:** 0597741, 7611566

Natural Vegetation: Ironbark, Speargrass, Morton Bay Ash

Land Use: Grazing

Topography: Flat possible tabletop	**Surface Rock % (> 60mm dia):** Nil	**Erosion:** Nil	**Drainage:** Poor
Remarks: Located on drill pad		**ASC Mapped:** Kandosol	**ASC Ground Truth:** Kandosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-100	SCL	Nil	5YR 3/3	Nil		Hard packed	Very weak, Apedal, Coherant	1	Poor	Gradual	$A1_P$	No sample
100 - >1000	LC	Nil	2.5YR 3/4	Some Ironstone		-	Very weak, Highly pedal	1	Poor	Base of horizon not encountered	$B2_1$	No sample
>1000	LC	20%									$B2_2$	No sample

Project: Wards Well
Job Number QE9811

Date: 26/9/2011

Location: 57 **Oberservation Type:** A

Coordinates: 0598090, 7610680

Natural Vegetation: **Buffel Grass, Ironbark**

Land Use: Grazing

Topography: <1%

Surface Rock % (> 60mm dia): Nil

Erosion: Nil

Drainage: Good

Remarks:

ASC Mapped: Kandosol

ASC Ground Truth: Kandosol

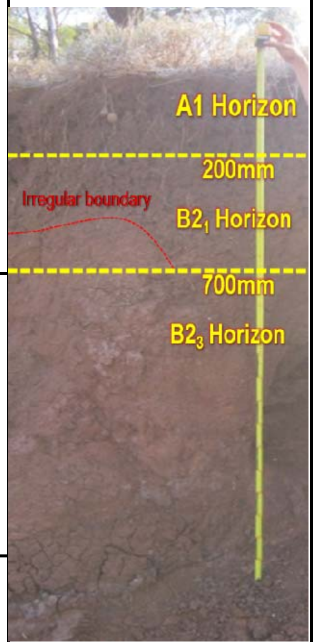
Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-300	LC	Nil	5YR 3/3	Nil		Hard packed	Very weak, Weakly pedal	1	Not recorded	Gradual	A1	No sample
300-1000	LC/MC	Nil	5YR 3/4	Ironstone		-	Very weak, Weakly pedal	1	Not recorded	Base of horizon not encountered	$B2_1$	No sample

Project: Wards Well **Job Number** QE9811	**Date:** 26/9/2011	**Location:** 58 **Oberservation Type:** A	**Coordinates:** 597898, 7614327

Natural Vegetation: Buffel Grass, Ironbark

Land Use: Creek, grazing

Topography: <1%	**Surface Rock % (> 60mm dia):** Nil	**Erosion:** Heavily eroded (90% of land)	**Drainage:** Good
Remarks: Location is in creekbank, dry and heavily eroded (at 180cm surface is brittle/rocky		**ASC Mapped:** Vertosol	**ASC Ground Truth:** Demosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-200	LC/MC	Nil	7.5YR 2.5/3	Nil		Non cracking	Very weak, Weakly pedal, Coherant	1	Not recorded	Gradual, Clear	$A1_P$	No sample
200-700	MC	<5%	5YR 3/3	Ironstone		-	Very firm, Highly pedal, Coherant	4	Not recorded	Not recorded	$B2_1$	No sample
700 - >1000	MC	50% is 5-15mm	7.5YR 2.5/3	Ironstone			Very firm, Highly pedal. Transition layer from B to C. Profile predominately B	4	Not recorded	Base of horizon not encountered	$B2_3$	No sample

Project: Wards Well
Job Number QE9811

Date: 26/9/2011

Location: 59 **Oberservation Type:** A

Coordinates: 599246, 7614274

Natural Vegetation: Dense mature Brigalow, Buffel Grass


Land Use: grazing

Topography: <1% flat

Surface Rock % (> 60mm dia): 5-10%

Erosion: Nil to slight

Drainage: Good

Remarks: No livestock, some kangaroos

ASC Mapped: Vertosol

ASC Ground Truth: Kandosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-100	SCL	1-5%	5YR 4/4	Nil		Not recorded	Very weak, Weakly pedal, Coherant	1	Good	Gradual	A1	No sample
100- >1000	LC	Nil	7.5YR 4/4	White mottles		-	Weak, Weakly pedal, Coherant	2	Poor	Gradual	$B2_1$	No sample

Project: Wards Well
Job Number QE9811

Date: 27/9/2011

Location: 60 **Oberservation Type:** A

Coordinates: 0596050, 7615539

Natural Vegetation: Cleared in places, Buffel Grass, Brigalow

Land Use: grazing

Topography: <1% paleo channel

Surface Rock % (> 60mm dia): Nil

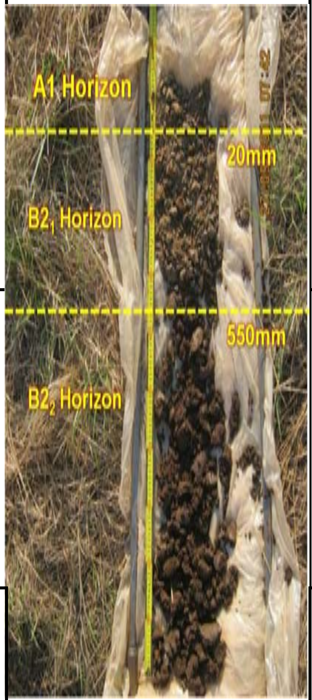
Erosion: Nil

Drainage: Poor

Remarks: Sample location is next to proposed drill pad

ASC Mapped: Vertosol

ASC Ground Truth: Vertosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-20	LC	Nil	7.5YR	Nil		Self Mulching	Very firm, Highly pedal	4	Not recorded	Sharp	A1	0-20 mm
20-550	MC	Nil	7.5YR 3/4	Nil		-	Firm, Highly pedal	3	Poor	Sharp	B2$_1$	20-300 mm
550-1000	SiC	40%	7.5YR 3/3	White/grey mottles and some yellow mottles		-	Very weak, Highly pedal	1	Good	Base of horizon not encountered	B2$_2$	700-800 mm

Project: Wards Well
Job Number QE9811

Date: 27/9/2011

Location: 61 **Oberservation Type:** A

Coordinates: 597565, 7616055

Natural Vegetation: Bohemia, Brigalow, Buffel Grass

Land Use:

Topography: < 1%

Surface Rock % (> 60mm dia): Nil

Erosion: Nil

Drainage: Poor

Remarks: Alluvial floodplain, wet clay at 20mm

ASC Mapped: Vertosol

ASC Ground Truth: Vertosol

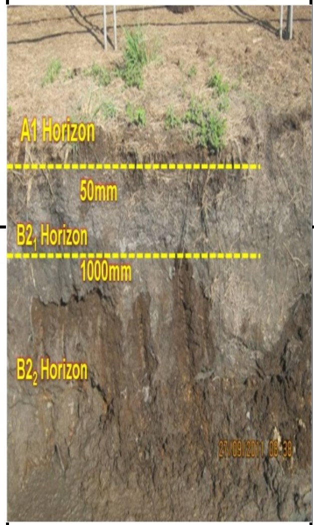
Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-20	LC	Nil	7.5YR 4/4	Nil		Self Mulching	Firm, Highly pedal	1 / 2	Good	Gradual	A1	No sample
20- >1000	MC	1-2% 15mm	7.5YR 3/4	Orange / white mottles		-	Firm, Highly pedal	2	Poor	Base of horizon not encountered	B2$_1$	No sample

Project: Wards Well **Job Number** QE9811	**Date:** 27/9/2011	**Location:** 62 **Oberservation Type:** A	**Coordinates:** 0598732, 7615564

Natural Vegetation: Morton Bay Ash, Buffel Grass

Land Use: grazing

Topography: <1%	**Surface Rock % (> 60mm dia):** Nil	**Erosion:** Nil	**Drainage:** Not recorded
Remarks: Sample location is next to proposed drill pad		**ASC Mapped:** Vertosol	**ASC Ground Truth:** Vertosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-50	LC	Nil	7.5YR 4/4	Nil		Self Mulching	Very weak, Weakly pedal	1	Good	Not recorded	$A1_P$	No sample
50-1000	MC	≤ 5%	7.5YR 3/3	Black / orange mottling		-	Weak / firm, Weakly pedal	2 / 3	Poor	Sharp	$B2_1$	No sample
>1000	SCL	≤ 40%	10YR 5/4	Yellow /orange mottles		-	Very weak / Weak, Weakly pedal	1 / 2	Not recorded	Base of horizon not encountered	$B2_2$	No sample

Project: Wards Well
Job Number QE9811

Date: 27/9/2011

Location: 63 **Oberservation Type:** E

Coordinates: 0599433, 7615112

Natural Vegetation: Site cleared leaving Buffel Grass with Brigalow on edge with occasional Poplar box and Morton Bay Fig

Land Use: Grazing

Topography: Flat alluvial plain

Surface Rock % (> 60mm dia): Nil

Erosion: Nil

Drainage: Not recorded

Remarks:

ASC Mapped: Vertosol

ASC Ground Truth: Vertosol

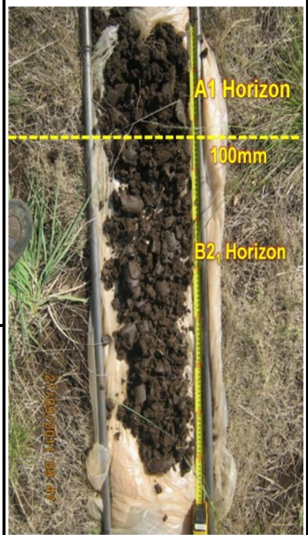
Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-100	LC	Nil	10YR 3/4	Nil		Self Mulching	Very firm	4	Poor	Gradual	A_{1P}	No sample
100 - >1800	MC	Massive rock structure	7.5YR 3/3	Orange/brown and white mottling		-	Weak / Firm, weakly pedal	4	Poor	Sharp	$B2_{3.}$ This is a B / C horizon (transitional)	No sample

Project: Wards Well **Job Number** QE9811	**Date:** 27/9/2011	**Location:** 64 **Oberservation Type:** A	**Coordinates:** 0599669, 7616198

Natural Vegetation: Buffel Grass, Morten Bay Grass

Land Use: Grazing

Topography: On top of ridge	**Surface Rock % (> 60mm dia):** Nil	**Erosion:** Nil	**Drainage:** Poor
Remarks:		**ASC Mapped:** Vertosol	**ASC Ground Truth:** Vertosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-100	MC	Nil	10YR 3/4	Nil		Self Mulching	Very firm, highly pedal	4	Poor	Gradual, Even	A1	No sample
100 - >1000	MC / HC	Nil	10YR 3/3	Orange/brown and white mottling		-	Very firm, highly pedal	4	Poor	Base of horizon not encountered	$B2_1$	No sample

Project: Wards Well
Job Number QE9811
Date: 27/9/2011
Location: 65 **Oberservation Type:** A
Coordinates: 599143, 7617345

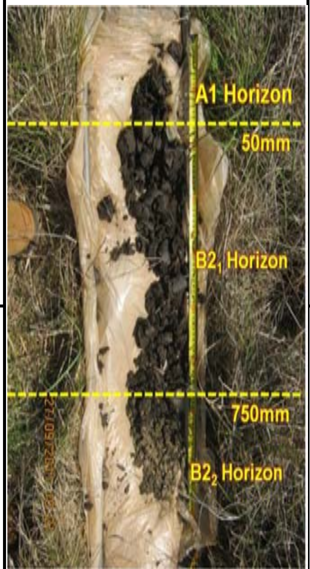
Natural Vegetation: Vegetation clearing leaving Buffel Grass



Land Use: Grazing

Topography: 1-2% bottom of slope
Surface Rock % (> 60mm dia): Nil
Erosion: Nil
Drainage: Poor

Remarks: Stiff Clay, auger difficult to advance, tree roots to 500mm
ASC Mapped: Vertosol
ASC Ground Truth: Vertosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-50	MC	Nil	7.5 YR 3/2	Nil		Self Mulching	Firm, Highly pedal, Coherent	3	Poor	Gradual	A1	No sample
50-750	MC / HC	Nil	10YR 3/2	Fine Ironstone (≥ 2 mm)		-	Firm/Very firm, Highly pedal, Coherent	3 / 4	Poor	Gradual	B2$_1$	No sample
750- >1000	SiC	40 -50%	7.5YR 3/3	White/grey mottling at 750			Very Weak, Stronger then Weakly Pedal, Coherent	1		sharp	B2$_2$	

Project: Wards Well **Job Number** QE9811	**Date:** 27/9/2011	**Location:** 66 **Oberservation Type:** A	**Coordinates:** 0598053, 7617293

Natural Vegetation: Brigalow, Bohemia, Acacia, Morton Bay Ash

Land Use: Grazing

Topography: 1% near top	**Surface Rock % (> 60mm dia):** Nil	**Erosion:** Nil	**Drainage:** Poor
Remarks:		**ASC Mapped:** Vertosol	**ASC Ground Truth:** Vertosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-50	MC	Nil	10 YR 3/2	Nil		Self Mulching, cracking	Very firm, highly pedal	4	Not recorded	Sharp	A1	No sample
50-950	MC	Nil	10YR 3/2	Fine Ironstone gravel (≥ 2 mm)		-	Very firm, highly pedal	4	Not recorded	Sharp	B2$_1$	No sample
950- >1000	SiC	50%	10YR 4/3	White/grey mottling		-	Very weak, weakly pedal	1	Not recorded	Base of horizon not encountered	B2$_2$	No sample

Project: Wards Well **Job Number** QE9811	**Date:** 27/9/2011	**Location:** 67 **Oberservation Type:** A	**Coordinates:** 0598053, 7617293

Natural Vegetation: Cleared, vegetation Buffel grass, acacia


Land Use: Grazing

Topography: <1%	**Surface Rock % (> 60mm dia):** Nil	**Erosion:** Nil	**Drainage:** Poor
Remarks: Large cracks in surface layer		**ASC Mapped:** Vertosol	**ASC Ground Truth:** Vertosol

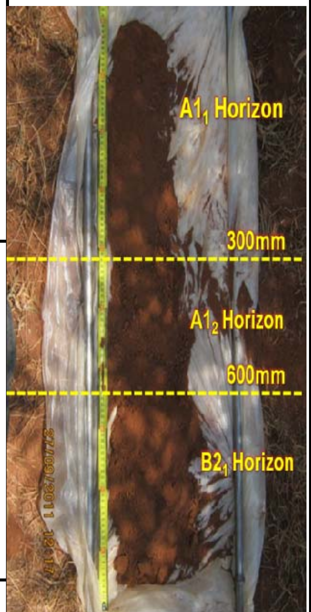
Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-50	MC	Nil	10YR 3/3	Nil		Self Mulching, cracking	Very firm, highly pedal, massive	4	Poor	Gradual	A1	No sample
50-1000	MC	Nil	10YR 3/3	Orange/black mottles		-	Very firm, highly pedal, massive	4	Poor	Base of horizon not encountered	$B2_1$	No sample

Project: Wards Well **Job Number** QE9811	**Date:** 27/9/2011	**Location:** 68 **Oberservation Type:** A	**Coordinates:** 0596388, 7617258

Natural Vegetation: Brigalow, Buffel Grass, 1 Poplar Box


Land Use: Grazing

Topography: 1% mid slope	**Surface Rock % (> 60mm dia):** Nil	**Erosion:** Nil	**Drainage:** Good
Remarks: 600-1000 is hard digging		**ASC Mapped:** Vertosol	**ASC Ground Truth:** Kandosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-300	SCL	Nil	2.5 YR 2.5/4	Nil		Hard packed	Firm, weakly pedal	3	Not recorded	Gradual	A1$_1$	No sample
300-600	SCL	5%	2.5YR 3/4	Nil		-	Weak, weakly pedal	2	Not recorded	Dradual	A1$_2$	No sample
600-1000	SCL	Nil	2.5YR 2.5/4	Nil		-	Weak, weakly pedal	2	Not recorded	Base of horizon not encountered	B2$_1$	No sample

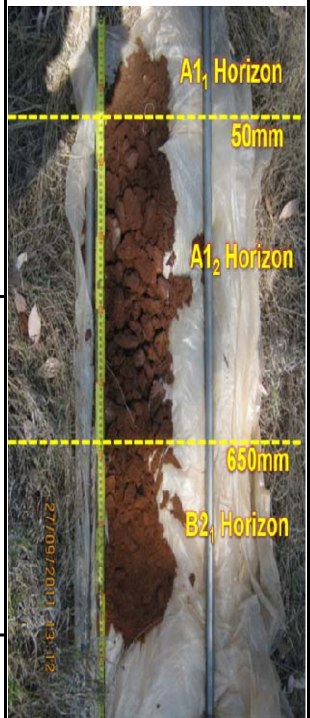
Project: Wards Well
Job Number QE9811
Date: 27/9/2011
Location: 69 **Oberservation Type:** A
Coordinates: 0595767, 7617473

Natural Vegetation: Poplar Box, Morton Bay Ash


Land Use: Grazing

Topography: Top of Peak
Surface Rock % (> 60mm dia): Nil
Erosion: Nil
Drainage: Not recorded

Remarks: 600-1000 is hard digging
ASC Mapped: Vertosol
ASC Ground Truth: Kandosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-50	SCL	Nil	2.5 YR 3/3	Nil		Hard packed	Very weak/weak, weakly pedal, coherant	1 / 2	Good	Sharp	A1$_1$	0-50 mm
50-650	MC	Nil	2.5YR 2.5/4	Ironstone and grey mottles		-	Firm, highly pedal, massive	3	Poor	Sharp	A1$_2$	200-300 mm
650-100	SCL	Nil	2.5YR 3/6	Nil		-	Very weak/weak, weakly pedal, coherant	1	Not recorded	Base of horizon not encountered	B1$_1$	800-900 mm

Project: Wards Well

Job Number QE9811

Date: 27/9/2011

Location: 70 **Observation Type:** A

Coordinates: 0595691, 7618036

Natural Vegetation: Some spear Acacia

Land Use: None

Topography: Top of rocky ridge

Surface Rock % (> 60mm dia): Nil

Erosion: Nil

Drainage: Nil

Remarks: Bore terminated at 100mm due to refusal on hard clay

ASC Mapped: Vertosol

ASC Ground Truth: Kandosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-100	SCL	Nil	2.5 YR 2.5/4	Black and yellow mottles		Rocky outcrops	Very firm	4	Poor	Sharp	$A1_1$	No sample

Project: Wards Well
Job Number QE9811

Date: 27/9/2011

Location: 71 **Oberservation Type:** A

Coordinates: 0596210, 7618561

Natural Vegetation: Buffel Grass, Brigalow, Poplar Box, Eucalypt

Land Use: Grazing

Topography: Flat

Surface Rock % (> 60mm dia): Nil

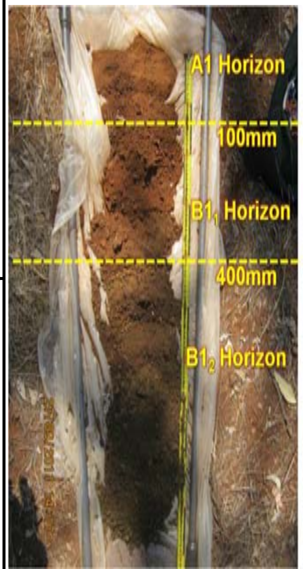
Erosion: Nil

Drainage: Good

Remarks:

ASC Mapped: Vertosol

ASC Ground Truth: Kandosol

Depth (mm)	**Texture**	**Coarse Fraction**	**Munsell Colour**	**Inclusion**	**Photograph**	**Surface Soil Con.**	**Pedality**	**Consistence**	**Drainage**	**Boundaries**	**Horizons**	**Sample**
0-100	LC	Nil	2.5 YR 3/3	Nil		Self mulching	Weak, Apedal	2	Not recorded	Gradual	$A1_1$	No sample
100-400	SC	5%	5YR 3/3	Ironstone		-	Very weak, weakly pedal	1	Not recorded	Sharp	$B1_1$	No sample
400-1000	SCL	50%	7.5YR 2.5/2	Many ironstone gravels		-	Very weak, weakly pedal	1	Not recorded	Base of horizon not encountered	$B2_1$	No sample

Project: Wards Well

Job Number QE9811

Date: 27/9/2011

Location: 72 **Oberservation Type:** A

Coordinates: 0597226, 7618527

Natural Vegetation: Cleared vegetation with some Bohemia, Brigalow

Land Use: Grazing

Topography: <1%

Surface Rock % (> 60mm dia): Nil

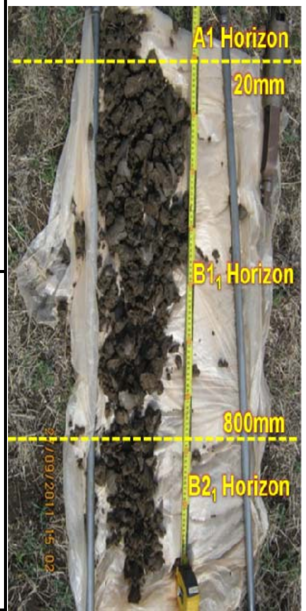
Erosion: Nil

Drainage: Not recorded

Remarks: Hard digging

ASC Mapped: Vertosol

ASC Ground Truth: Vertosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-20	LC	Nil	10 YR 3/3	Nil		Hard cracking clay, self mulching	Weak, weakly pedal	2	Good	Gradual	A1$_1$	No sample
20-800	MC / HC	1%	10YR 3/3	Black and white mottles (ironstone)		-	Very firm, strongly pedal	4	Poor	Gradual	B2$_1$	No sample
800- >1000	MC / HC	Nil	10YR 3/6	Yellow/orange mottles and ironstone		-	Very firm, strongly pedal	4	Poor	Base of horizon not encountered	B2$_1$	No sample

Project: Wards Well
Job Number QE9811

Date: 27/9/2011

Location: 73 **Oberservation Type:** A

Coordinates: 0598601, 7618470

Natural Vegetation: Spear grass, Blue Gum

Land Use: Grazing

Topography: Creek bed

Surface Rock % (> 60mm dia): Nil

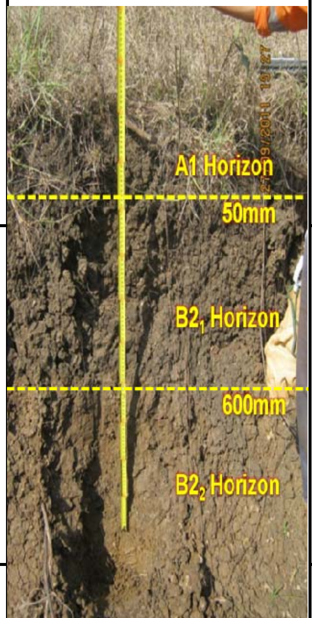
Erosion: 20%

Drainage: Not recorded

Remarks: Creek bank

ASC Mapped: Vertosol

ASC Ground Truth: Vertosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-50	LC	Nil	10YR 3/1	Nil		Self mulching	Loose	0	Not recorded	Gradual	$A1_{1P}$	No sample
50-600	LC / MC	5%	10YR 3/2	White mottles between 150-200mm		-	Very Firm, Strongly Pedal, Coherent	4	Not recorded	Abrupt	$B2_1$	No sample
600- >1000	LC / MC	5%	10YR 4/3	Ironstone		-	Weak, weakly pedal, massive	2	Poor	Base of horizon not encountered	$B2_2$	No sample

Project: Wards Well
Job Number QE9811

Date: 27/9/2011

Location: 74 **Oberservation Type:** A

Coordinates: 0600207, 7619004

Natural Vegetation: Bufffel (cleared) , Bohemia, Brigalow

Land Use: Grazing

Topography: 1% near bottom of slope

Surface Rock % (> 60mm dia): Nil

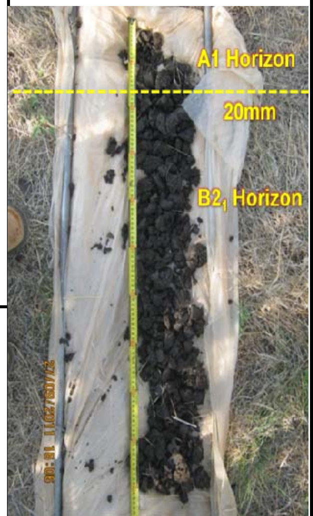
Erosion: Nil

Drainage: Near creek bottom of slope

Remarks: Hard digging

ASC Mapped: Vertosol

ASC Ground Truth: Vertosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-20	LC	Nil	10YR 3/3	Nil		Self mulching, hard cracking clays	Weak, Weakly pedal, Massive	2	Good	Gradual	A1$_1$	No sample
20-1000	MC	1%	10YR 3/3	Black and white mottles			Very firm, stonrgly pedal, Massive	4	Poor	Abrupt	B2$_1$	No sample

Project: Wards Well **Job Number** QE9811	**Date:** 27/9/2011	**Location:** 75 **Oberservation Type:** A	**Coordinates:** 0599700, 7619872

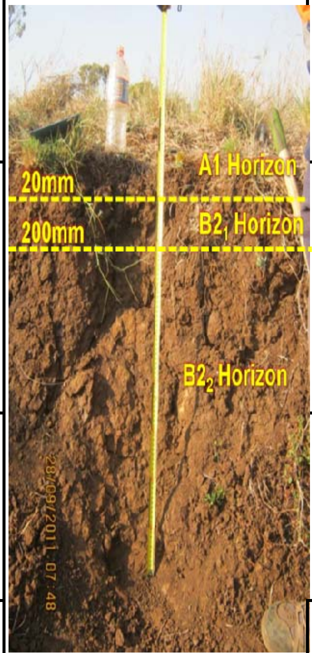
Natural Vegetation: Morton Bay Ash, Poplar Box, Brigalow

Land Use: Grazing

Topography: 1% top of ridge (tabletop)	**Surface Rock % (> 60mm dia):** Nil	**Erosion:** Nil	**Drainage:**
Remarks: Hard digging		**ASC Mapped:** Vertosol	**ASC Ground Truth:** Vertosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-50	LC	Nil	10YR 4/1	Nil		Self mulching, hard cracking clay	Weak / firm, highly pedal, massive	2-3	Poor	Gradual	A1$_1$	0-50 mm
50-750	MC	Nil	10YR 4/1	white mottles		-	Very firm, highly pedal, massive	4	Poor	Sharp	B2$_1$	400-500 mm
750 - >1000	LC/MC	Nil	Not recorded	white/grey mottles		-	Fine, sub-angular, r	3	No recorded	Base of horizon not encountered	B2$_2$	900-1000 mm

Project: Wards Well **Job Number** QE9811	**Date:** 28/9/2011	**Location:** 76 **Oberservation Type:** E	**Coordinates:** 0599700, 7619872
Natural Vegetation: Buffel Grass, Briglow, Blue Gum, Acacia  		**Land Use:** Grazing 	
Topography: 1% bottom of creek	**Surface Rock % (> 60mm dia):** Nil	**Erosion:** High 30%	**Drainage:** Not recorded
Remarks: In creek cutting		**ASC Mapped:** Vertosol	**ASC Ground Truth:** Demosol

Depth (mm)	**Texture**	**Coarse Fraction**	**Munsell Colour**	**Inclusion**	**Photograph**	**Surface Soil Con.**	**Pedality**	**Consistence**	**Drainage**	**Boundaries**	**Horizons**	**Sample**
0-20	LC	Nil	7.5YR 3/4	Nil		Self mulching, hard cracking clay	Very firm	4	Good	Sharp	$A1_{1P}$	No sample
20-200	MC	2%	10YR 3/4	Orange/black mottles		-	Very firm, highly pedal	4	Poor	Gradual	$B2_1$	No sample
200-1400+	MC	5%	10YR 3/6	Ironstone		-	Very firm, highly pedal	4	Poor	Gradual	$B2_2$	No sample

Project: Wards Well

Job Number QE9811

Date: 28/9/2011

Location: 77 **Oberservation Type:** A

Coordinates: 0595518, 7624627

Natural Vegetation: Buffel Grass, Briglow

Land Use: Grazing

Topography: <1%

Surface Rock % (> 60mm dia): Nil

Erosion: Nil

Drainage: Good

Remarks:

ASC Mapped: Kandasol

ASC Ground Truth: Kandosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-250	SL	10%	5YR 3/4	Nil		Sandy, firm, non-cracking	Very weak, weakly pedal, massive	1	Good	Sharp	$A1_1$	No sample
250- >1000	SCL	Nil	5YR 3/4	White/black mottles, yellow mottles at 300mm		-	Very weak, weakly pedal, massive	1	Good	Gradual	$B2_1$	No sample

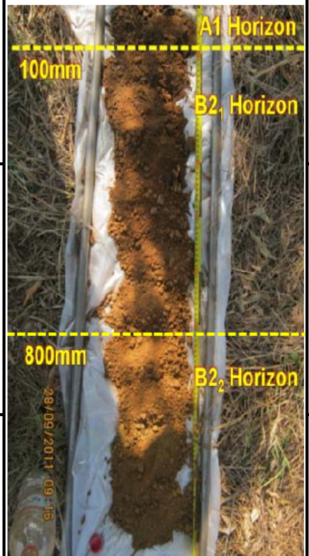
Project: Wards Well **Job Number** QE9811	**Date:** 28/9/2011	**Location:** 78 **Oberservation Type:** A	**Coordinates:** 0595448, 7625536

Natural Vegetation: Ironbark, Buffel Grass



Land Use: Grazing

Topography: Top of ridge	**Surface Rock % (> 60mm dia):** Nil	**Erosion:** Nil	**Drainage:** Good
Remarks: Coarse fraction is black/red when broken		**ASC Mapped:** Kandasol	**ASC Ground Truth:** Kandosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-100	SCL	20%	7.5YR 3/3	Nil		Self mulching	Very weak, weakly pedal	1	Not recorded	Gradual	$A1_1$	No sample
100-800	SCL	50%	7.5YR 4/4	Nil		-	Very weak, weakly pedal	1	Good	Gradual	$B2_1$	No sample
800 - >1000	SCL	60%	10YR 4/6	Nil		-	Very weak, weakly pedal	1	Not recorded	Base of horizon not encountered	$B2_2$	No sample

Project: Wards Well **Job Number** QE9811	**Date:** 28/9/2011	**Location:** 79 **Oberservation Type:** A	**Coordinates:** 0596176, 7625794

Natural Vegetation: Ironbark

Land Use: Grazing

Topography: <1%	**Surface Rock % (> 60mm dia):** Nil	**Erosion:** Nil	**Drainage:** Not recorded
Remarks: Coarse fraction is black/red when broken		**ASC Mapped:** Kandasol	**ASC Ground Truth:** Kandosol

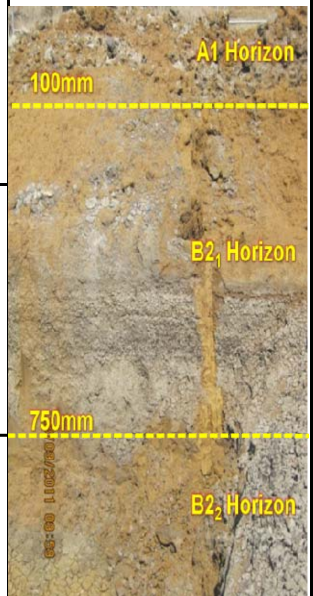
Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-150	SL	Nil	5YR 3/3	Nil		Hard packed sandy	Very weak, non-pedal	1	Good	Gradual	$A1_1$	No sample
150-950	SCL	Nil	2.5YR 4/4	Nil		-	Very weak, weakly pedal, massive	1	Good	Sharp	$B2_1$	No sample
950- >1000	SCL	Nil	5YR 4/4	Ironstone		-	Very weak, weakly pedal, massive	1	Poor	Base of horizon not encountered	$B2_2$	No sample

Project: Wards Well **Job Number** QE9811	**Date:** 28/9/2011	**Location:** 80 **Oberservation Type:** P	**Coordinates:** 0597227, 7626006

Natural Vegetation: Buffel grass, Ironbark

Land Use: Grazing

Topography: Top of ridge	**Surface Rock % (> 60mm dia):** Nil	**Erosion:** Nil	**Drainage:** Not recorded
Remarks:		**ASC Mapped:** Kandasol	**ASC Ground Truth:** Sodosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-100	SL	Nil	10YR 3/3	Nil		Hard packed fine gravel	Very weak, non pedal, massive	2	Good	Gradual	$A1_{1P}$	No sample
100-750	SCL	Nil	10YR 4/6	Ironstone		-	Weak, weakly pedal, massive	2	Poor	Sharp, Irregular	$B2_1$	No sample
750 - >1000	MC/HC	Nil	10YR 5/4	Grey mottles		-	Very firm, weakly pedal, massive	4	Poor	Base of horizon not encountered	$B2_2$	No sample

Project: Wards Well **Job Number** QE9811	**Date:** 28/9/2011	**Location:** 81 **Oberservation Type:** P	**Coordinates:** 0597444, 7625089

Natural Vegetation: Buffel grass, Brigalow, Poplar Box

Land Use: Grazing

Topography: Flat former alluvial floodplain	**Surface Rock % (> 60mm dia):** Nil	**Erosion:** Nil	**Drainage:** Poor
Remarks:		**ASC Mapped:** Kandasol	**ASC Ground Truth:** Vertosol

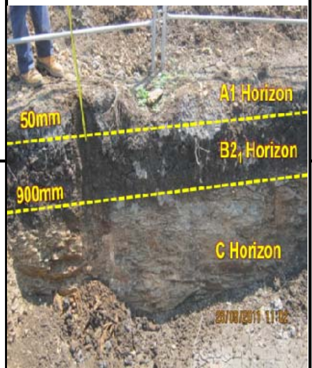
Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-50	MC	Nil	10YR 3/3	Nil		Hard cracking	Firm, Weakly pedal, Massive	3	Good	Gradual	$A1_1$	No sample
50-700	MC	Nil	10YR 3/2	Ironstone		-	Firm, Weakly pedal, Massive	3	Poor	Sharp	$B2_1$	No sample
700- >1000	SL	Nil	10YR 4/3	White, grey, orange mottles		-	Very weak, Apedal	1	Good	Base of horizon not encountered	$B2_2$	No sample

Project: Wards Well **Job Number** QE9811	**Date:** 28/9/2011	**Location:** 82 **Oberservation Type:** P	**Coordinates:** 0596439, 7624851

Natural Vegetation: Cleared vegetation, some Morton Bay Ash, Brigalow and Poplar Box

Land Use: Grazing

Topography: <1%	**Surface Rock % (> 60mm dia):** Nil	**Erosion:** Nil	**Drainage:** Poor
Remarks:		**ASC Mapped:** Kandasol	**ASC Ground Truth:** Vertosol

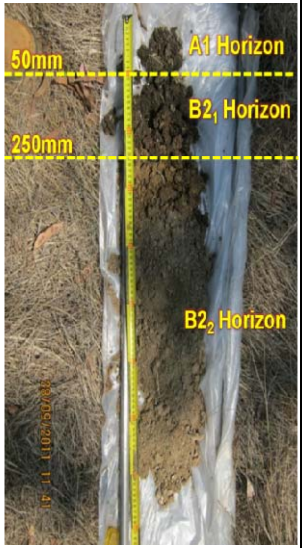
Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-50	LC/MC	Nil	10YR 2/2	Nil		Self mulching	Weak	2	Good	Gradual	$A1_{1P}$	No sample
50-900	MC	Nil	10YR 3/3	Ironstone		-	Weak	2	Poor	Sharp	$B2_1$	No sample
900-1000	SC	Massive	10YR 4/3	White, grey, orange mottles		-	Massive, Rock	1	Poor	Base of horizon not encountered	C	No sample

Project: Wards Well **Job Number** QE9811	**Date:** 28/9/2011	**Location:** 83 **Oberservation Type:** A	**Coordinates:** 0596439, 7624851

Natural Vegetation: Cleared vegetation, some Morton Bay Ash, Brigalow and Poplar Box

Land Use: Grazing

Topography: Flat tabletop (1-2% of flat)	**Surface Rock % (> 60mm dia):** Nil	**Erosion:** Nil	**Drainage:** Poor
Remarks:		**ASC Mapped:** Vertosol	**ASC Ground Truth:** Vertosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-50	LC	Nil	7.5YR 3/2	Nil		Self mulching, non-cracking	Weak	2	not recorded	Gradual	A1$_1$	No sample
50-250	MC/HC	Nil	10YR 3/3	Ironstone			Very firm, massive	4	not recorded	Sharp	B2$_1$	No sample
250-800	SL	Nil	7.5YR 3/4	Yellow mottles at 250mm			Very weak	1	Not recorded	Base of horizon not encountered	B2$_2$	No sample

Project: Wards Well
Job Number QE9811

Date: 28/9/2011

Location: 84 **Oberservation Type:** E

Coordinates:

Natural Vegetation: Cleared vegetation, some Morton Bay Ash, Brigalow and Poplar Box

Land Use: Grazing

Topography: Low lying creek bed

Surface Rock % (> 60mm dia): Nil

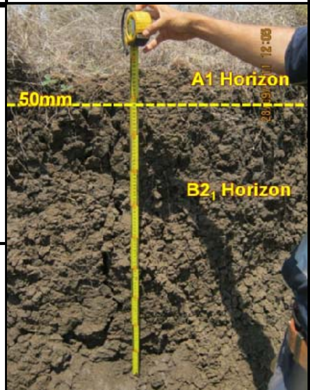
Erosion: 20%

Drainage: Not recorded

Remarks:

ASC Mapped: Vertosol

ASC Ground Truth: Vertosol



Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-50	SC	10%	10YR 3/2	Nil		Self mulching	Weak, highly pedal, massive	2	Good	Sharp	A1$_{1P}$	No sample
50 - >1000	MC	Nil	10YR 3/3	Ironstone		-	Very firm, highly pedal, massive	4	Poor	Base of horizon not encountered	B2$_1$	No sample

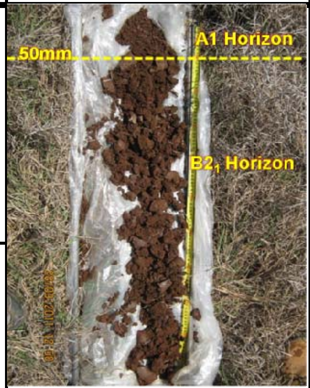
Project: Wards Well
Job Number QE9811
Date: 28/9/2011
Location: 85 **Oberservation Type:** A
Coordinates: 0597468, 7623012

Natural Vegetation: Cleared. Buffel Grass, ironbark, Bohemia, Poplar Box


Land Use: Grazing

Topography: 1% new top of range
Surface Rock % (> 60mm dia): Nil
Erosion: 20%
Drainage: Good

Remarks:
ASC Mapped: Vertosol
ASC Ground Truth: Brown Vertosol

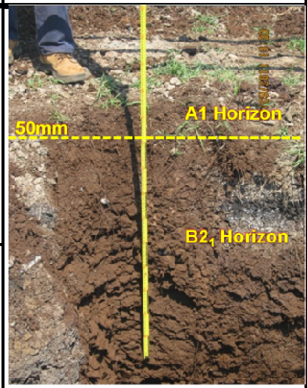
Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-50	LC	Nil	5YR 3/4	Nil		Self mulching	Firm, weakly pedal	3	Not recorded	Gradual	$A1_1$	No sample
50 - >1000	MC	Nil	5YR 3/4	Ironstone		-	Weak, highly pedal	2	Not recorded	Base of horizon not encountered	$B2_1$	No sample

Project: Wards Well **Job Number** QE9811	**Date:** 28/9/2011	**Location:** 86 **Oberservation Type:** P	**Coordinates:** 0595998, 7622629

Natural Vegetation: Cleared Poplar Box

Land Use: Grazing

Topography: 1-2%	**Surface Rock % (> 60mm dia):** Nil	**Erosion:** Nil	**Drainage:** Not recorded
Remarks:		**ASC Mapped:** Vertosol	**ASC Ground Truth:** Vertosol

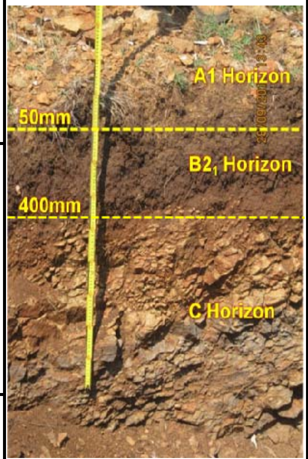
Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-50	LC	Nil	7.5YR 3/3	Nil		Hard cracking clay	Weak, strongly pedal	2	Not recorded	Gradual	A1$_{1P}$	No sample
50 - >1000	MC	5-10%	7.5YR 3/4	Ironstone and orange/brown mottles		-	Very firm, highly pedal	4	Not recorded		B2$_1$	No sample

Project: Wards Well **Job Number** QE9811	**Date:** 28/9/2011	**Location:** 87 **Oberservation Type:** P	**Coordinates:** 0595048, 7622481

Natural Vegetation: Brigalow, Poplar Box (dead)

Land Use: Grazing

Topography: <1%	**Surface Rock % (> 60mm dia):** Nil	**Erosion:** Nil	**Drainage:** Not recorded
Remarks: Dead trees		**ASC Mapped:** Vertosol	**ASC Ground Truth:** Dermosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-20	SC	1%	7.5YR 2.5/3	White mottles		Non-cracking clay	Very firm, massive	4	Good	Sharp	$A1_{1P}$	No sample
20-400	LC/MC	0%	7.5YR 3/3	Ironstone		-	Weak/firm	2-3	Poor	Sharp	$B2_1$	No sample
400 - >1000	Rock	100%		Massive Rock		-	Massive	4	Poor	Base of horizon not encountered	C	No sample

Project: Wards Well
Job Number QE9811

Date: 28/9/2011

Location: 88 **Oberservation Type:** P

Coordinates: 0595737, 7623676

Natural Vegetation: Cleared

Land Use: Grazing

Topography:

Surface Rock % (> 60mm dia): Nil

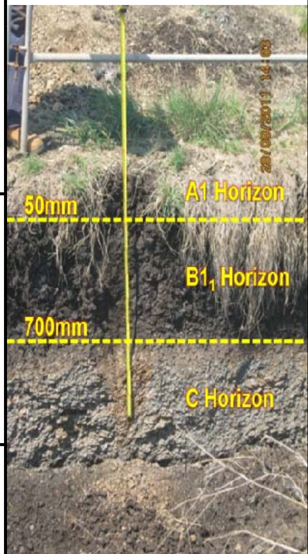
Erosion: Nil

Drainage: Not recorded

Remarks:

ASC Mapped: Vertosol

ASC Ground Truth: Dermosol

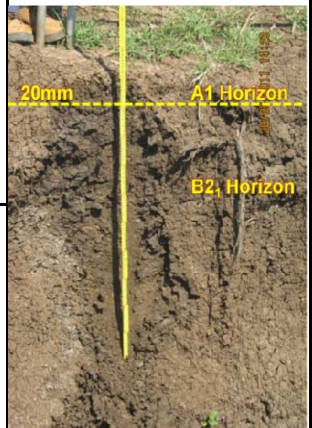
Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-50	HC	1%	10YR 4/2	Nil		Very hard cracking clay	Very firm, highly pedal, massive	4	Good	Sharp	$A1_{1P}$	No sample
50-700	MC	0%	10YR 3/2	White mottles			firm, highly pedal, massive	3	Poor	Sharp	$B2_1$	No sample
700 - >1000	Hard rock layer	100%	Not recorded	Yellow/grey			Massive	4	Poor	Base of horizon not encountered	C	No sample

Project: Wards Well **Job Number** QE9811	**Date:** 28/9/2011	**Location:** 89 **Oberservation Type:** P	**Coordinates:** 0595582, 7620461

Natural Vegetation: Eucalypts

Land Use: Grazing

Topography: <1% high area between creeks	**Surface Rock % (> 60mm dia):** Nil	**Erosion:** Nil	**Drainage:** Not recorded
Remarks: Between creeks		**ASC Mapped:** Vertosol	**ASC Ground Truth:** Vertosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-20	LC/MC	1%	10YR 3/3	Nil		Self mulching, roots	Firm/very firm, strongly pedal, massive	3-4	Good	Gradual	$A1_{1P}$	No sample
20- >1000	LC/MC	Nil	10YR 4/3	Grey mottles with roots and Ironstone		-	Firm, strongly pedal, massive	3	Poor	Base of horizon not encountered	$B2_1$	No sample

Project: Wards Well
Job Number QE9811

Date: 28/9/2011

Location: 90 **Oberservation Type:** P

Coordinates: 0595253, 7621429

Natural Vegetation: Ironbark, Poplar Box, Brigalow, Mountain Coolabah

Land Use: Grazing

Topography: <1% high area between creeks

Surface Rock % (> 60mm dia): Nil

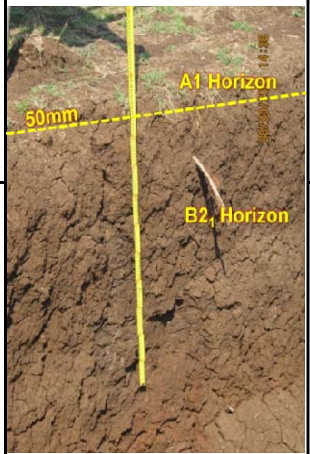
Erosion: Nil

Drainage: Not recorded

Remarks: Good grass cover

ASC Mapped: Vertosol

ASC Ground Truth: Dermosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-50	MC	Nil	10YR 3/3	Nil		Cracking clay, sel-mulching	Firm / very firm, strongly pedal	3-4	Good	Gradual	$A1_{1P}$	No sample
50-1050	LC	Nil	10YR 3/4	Red mottles and Ironstone		-	Firm, strongly pedal	3	Poor	Base of horizon not encountered	$B2_1$	No sample

Project: Wards Well
Job Number QE9811

Date: 28/9/2011

Location: 91 **Oberservation Type:** P

Coordinates: 0597501, 7620905

Natural Vegetation: Poplar Box, brigalow, Eucalypts, Acacias

Land Use: Grazing

Topography: Creek bed

Surface Rock % (> 60mm dia): Nil

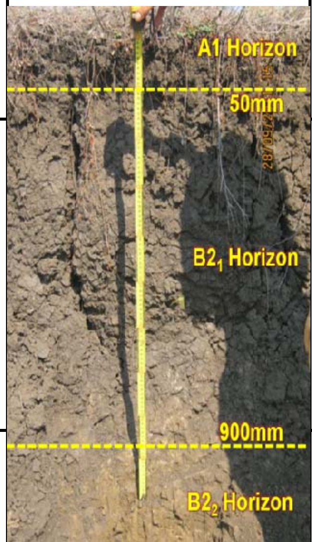
Erosion: 20-30%

Drainage: Not recorded

Remarks: Dry creekbed

ASC Mapped: Vertosol

ASC Ground Truth: Vertosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-50	LC	Nil	10YR 4/2	Nil		Hard cracking clay	Firm, strongly pedal, massive	3	Well	Sharp	$A1_{1P}$	No sample
50-900	LC/MC	Nil	10YR 4/2	Carbonate, Ironstone, brown maroon gravel		-	Weak, strongly pedal, massive	2	Poor	Sharp	$B2_1$	No sample
900 - >1000	MC	Nil	10YR 4/3	Grey gravel, carbonate		-	Very weak/weak, strongly pedal, massive	1-2		Base of horizon not encountered	$B2_1$	No sample

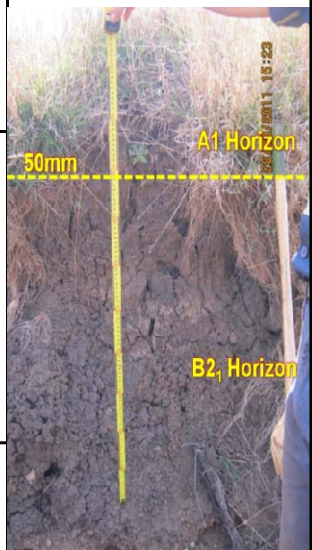
Project: Wards Well **Job Number** QE9811	**Date:** 28/9/2011	**Location:** 92 **Oberservation Type:** P	**Coordinates:** 0596076, 7621714

Natural Vegetation: Sparse Eucalypts

Land Use: Grazing

Topography: Creek bank	**Surface Rock % (> 60mm dia):** Nil	**Erosion:** 10-20%	**Drainage:**
Remarks: Dry creekbed		**ASC Mapped:** Vertosol	**ASC Ground Truth:** Dermosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-50	MC	Nil	10YR 4/3	Ironstone		Self mulching	Very firm, strongly pedal, massive	4	Well	Sharp	$A1_1$	No sample
50-1000	MC	Nil	10YR 3/3	Carbonate		-	Weak/firm, strongly pedal, massive	2-3	Poor	Sharp	$B2_1$	No sample
1000-1050	White rocks	60/70%	10YR 4/3	Grey gravel, carbonate		-	Weak, Massive	3-4	Not recorded	Base of horizon not encountered	C	No sample



Project: Wards Well
Job Number QE9811

Date: 28/9/2011

Location: 93 **Oberservation Type:**

Coordinates: 598022, 7622167

Natural Vegetation: vegetaion cleared, some Poplar box

Land Use: Grazing

Topography: 1-2%

Surface Rock % (> 60mm dia): Nil

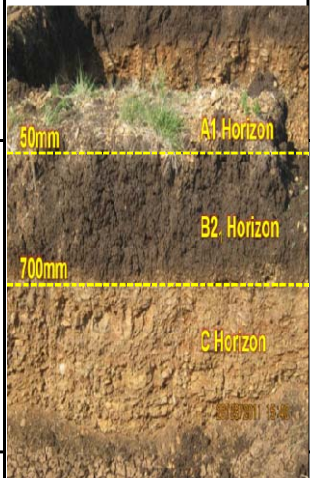
Erosion: Nil

Drainage:

Remarks: Dry creekbed

ASC Mapped: Vertosol

ASC Ground Truth: Vertosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-50	LC	Nil	10YR 3/4	Nil		Self mulching	Weak/firm, strongly pedal, massive	2 / 3	Well	Sharp	$A1_{1P}$	No sample
50-700	MC	Nil	10YR 3/3	Orange gravel		-	Weak, strongly pedal, massive	2	Poor	Sharp	$B2_1$	No sample
700- >1000	Rocks	60/70%	10YR 4/3			-	Weak, Massive	3 / 4	None	Base of horzon not encountered	C	No sample

Project: Wards Well **Job Number** QE9811	**Date:** 28/9/2011	**Location:** 94 **Oberservation Type:** A	**Coordinates:** 0599580, 7622074

Natural Vegetation: Morton Bay Ash

Land Use: Grazing

Topography: 1-2%	**Surface Rock % (> 60mm dia):** Nil	**Erosion:** Nil	**Drainage:**
Remarks: Long grass up to 1.2m		**ASC Mapped:** Vertosol	**ASC Ground Truth:** Vertosol

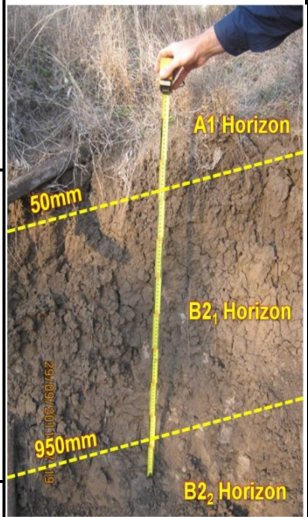
Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-50	LC	Nil	10YR 3/2	Nil		Self mulching	Weak, strongly pedal	2	Good	Sharp	$A1_1$	0-50 mm
50-400	MC	Nil	10YR 3/1	Carbonate		-	Very firm, strongly pedal	4	Poor	Sharp	$B2_1$	200-300 mm
400->1000	SL	Nil	10YR 4/1	Carbonate at 400mm		-	Very weak, non pedal	1	Good	Base of horizon not encountered	$B2_2$	600-700 mm

Project: Wards Well **Job Number** QE9811	**Date:** 29/9/2011	**Location:** 95 **Oberservation Type:** E	**Coordinates:** 0598841, 7620747

Natural Vegetation: Brigalow, Blue Gum, Buffel and Spear Grass, some Ironbark

Land Use: Grazing

Topography: 1-2% in creek bed	**Surface Rock % (> 60mm dia):** Nil	**Erosion:** 20%	**Drainage:** Good
Remarks: In creek bed		**ASC Mapped:** Vertosol	**ASC Ground Truth:** Vertosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-50	LC	Nil	10YR 3/2	Carbonate gravels		Self mulching crust	Very firm, strongly pedal	4	Not recorded	Sharp	A1$_1$	No sample
50-950	LC	Nil	10YR 3/3	Carbonate gravels		-	Very firm, strongly pedal	4	Not recorded	Gradual	B2$_1$	No sample
950- >1000	MC	Nil	10YR 4/2	Ironstone gravels		-	Firm, strongly pedal	3	Not recorded	Base of horizon not encountered	B2$_2$	No sample

Project: Wards Well
Job Number QE9811

Date: 29/9/2011

Location: 96 **Oberservation Type:** E

Coordinates: 0596817, 7620084

Natural Vegetation: Brigalow, Spear Grass

Land Use: Grazing

Topography: 1% near top of ridge

Surface Rock % (> 60mm dia): 5%

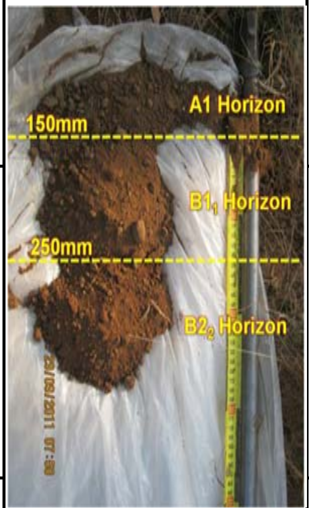
Erosion: Nil

Drainage: Good

Remarks: Located on rocky ridge, auger hit hard rock twice

ASC Mapped: Vertosol

ASC Ground Truth: Kandosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-150	SL	50%	7.5YR 3/4	Black and yellow gravels		Hard packed gravel	Very weak, non pedal	1	Good	Sharp	$A1_1$	No sample
150-250	Sl	50%	5YR 4/4	Ironstone gravel			Very weak, non pedal	1	Good	Sharp	$B2_1$	No sample
250+	Rock								Poor		$B2_2$	No sample

Project: Wards Well
Job Number QE9811

Date: 29/9/2011

Location: 97 **Oberservation Type:** A

Coordinates: 0596317, 7619984

Natural Vegetation: Poplar Box, Buffel Grass

Land Use: Grazing

Topography: 1% near bottom of slope

Surface Rock % (> 60mm dia): Nil

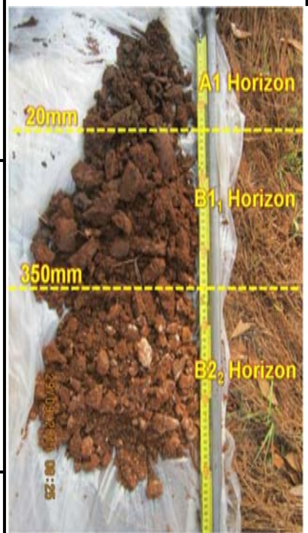
Erosion: Nil

Drainage: Nil

Remarks:

ASC Mapped: Vertosol

ASC Ground Truth: Dermosol

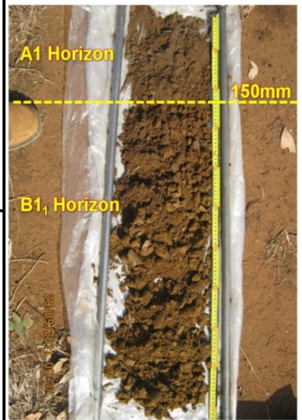
Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-20	LC-MC	Nil	5YR 3/4	Nil		Firm cracking surface	Very firm, strongly pedal, massive	4	Good	Sharp	$A1_1$	No sample
20-350	MC	Nil	5YR 4/6	Ironstone & carbonate gravels		-	Weak/firm, strongly pedal	2-3	Poor	Sharp	$B2_1$	No sample
350-600	Sandy clay	70%	5YR 4/6	Carbonate		-	Very weak, weakly pedal	1	Good	Base of horizon not encountered	$B2_2$	No sample

Project: Wards Well **Job Number** QE9811	**Date:** 29/9/2011	**Location:** 98 **Oberservation Type:** A	**Coordinates:** 0599337, 7620288

Natural Vegetation: Poplar Box

Land Use: Grazing

Topography: <1%	**Surface Rock % (> 60mm dia):** Nil	**Erosion: Nil**	**Drainage:** Not recorded
Remarks:		**ASC Mapped:** Vertosol	**ASC Ground Truth:** Dermosol

Depth (mm)	Texture	Coarse Fraction	Munsell Colour	Inclusion	Photograph	Surface Soil Con.	Pedality	Consistence	Drainage	Boundaries	Horizons	Sample
0-150	SL	Nil	10YR 4/3	Nil		Sandy firm	Very weak, weakly pedal	1	Good	Sharp	$A1_1$	No sample
150- >1000	LC	Nil	7.5YR 5/6	Ironstone & orange gravels		-	Fine, strongly pedal, massive	3	Poor	Base of horizon not encountered	$B2_1$	No sample

Appendix B Tabulated Laboratory Results

QEO9811 400 Wards Well - Land Resources

Analyte	Units	Soil Sufficiency Criteria	LOR	WW6	WW6	WW6	WW9	WW9	WW9	WW10	WW10	WW13	WW13	WW13	WW13	WW15	WW15	WW15	WW22	WW23	WW23	WW23	WW28	WW28	WW28	WW36	WW36	WW36
				0-100	200-300	800-900	0-100	200-300	800-900	0-100	500-600	0-50	200-300	700-800	1000-1100	0-100	300-400	900-1000	0-100	0-100	300-400	900-1000	0-100	200-300	700-800	0-100	200-300	700-800
				Vertosol			Vertosol			Dermosol		Dermosol				Vertosol			Vertosol	Kandosol			Dermosol			Dermosol		
Inorganics																												
pH Value	pH Unit	6-7.5	0.1	7.8	8.6	8.6	5.8	5.2	4.5	6.5	6.4	7.3	8	8.8	5.8	7.6	8.8	8.3	7.8	6.1	6.2	6.6	7.3	7.8	7.2	6.9	9	9.9
Electrical Conductivity @ 25°C	mS/cm	<0.8	1	0.107	0.137	0.659	0.031	0.134	0.631	0.008	0.009	0.055	0.09	0.672	0.007	0.058	0.278	0.989	0.062	0.142	0.045	0.026	0.15	0.049	0.025	0.028	0.199	0.345
Moisture Content (dried @ 103°C)	%		1	18.4	18.5	20.1	7.2	12.3	17.7	6.1	7.1	8.6	13.5	15.2	9.7	15.6	18.9	20.1	20.4	3.6	7.2	7.6	3.9	13.6	12.2	4.5	7.3	8.8
Sulfate as SO4 2-	mg/kg	8mg/kg	10	20	<10	120	10	40	<10	<10	<10	<10	<10	140	<10	10	70	530	<10	20	30	10	50	10	<10	<10	20	30
Chloride	mg/kg	800	10	<10	<10	1000	10	2350	1240	<10	<10	<10	<10	890	<10	30	200	1630	20	80	20	20	40	20	20	10	10	<10
Soil Classification based on Particle Size																												
Clay (<2 µm)	%		1		68				69	21		46		60	23	74		82	80		33		37		47	36		32
Silt (2-60 µm)	%	Ideal is Clay <40% and C. Sand <40%	1		12				23	6		29		19	7	17		12	13		9		15		11	6		8
Sand (0.06-2.00 mm)	%		1		12				8	73		21		13	70	9		6	7		55		46		41	57		60
Gravel (>2mm)	%		1		8				<1	<1		4		8	<1	<1		<1	<1		3		2		1	1		<1
Cobbles (>6cm)	%		1		<1				<1	<1		<1		<1	<1	<1		<1	<1		<1		<1		<1	<1		<1
Soluble Major Cations																												
Calcium	mg/kg		10	50	20	40	<10	<10	20	<10	<10	30	20	30	<10	10	<10	50	60	40	<10	<10	<10	<10	<10	<10	10	<10
Magnesium	mg/kg		10	20	<10	30	<10	<10	40	<10	<10	<10	<10	30	<10	<10	<10	40	<10	20	<10	<10	<10	<10	<10	<10	<10	<10
Sodium	mg/kg		10	20	170	760	20	120	600	<10	<10	10	70	760	<10	50	320	1160	<10	30	10	20	80	40	20	30	210	360
Potassium	mg/kg	500	10	40	<10	<10	<10	<10	<10	<10	<10	30	<10	<10	<10	<10	<10	<10	<10	60	20	<10	110	<10	<10	<10	<10	<10
Exchangeable Cations																												
Exchangeable Calcium	meq/100g		0.1	37.3	37.2	33.7	7.8	7.2	5.8	1.8	1.3	15.4	18	26.5	1	33.2	30.2	24.8	69.3	2.3	1.8	1.4	6.4	8.1	3.8	9.2	21.8	15
Exchangeable Calcium	meq. %	65-80%		65%	57%	47%	34%	31%	23%	75%	62%	69%	64%	55%	56%	61%	50%	40%	84%	59%	56%	44%	42%	40%	47%	53%	65%	43%
Exchangeable Magnesium	meq/100g		0.1	17.4	24.7	30.2	13.9	13.9	14.6	0.5	0.7	5.8	8.6	14.7	0.7	20	23.2	25.1	12.7	1	1	1.5	5.4	9.9	3.6	7.1	10	14.4
Exchangeable Magnesium	meq. %	10-15%		31%	38%	42%	60%	60%	58%	21%	33%	26%	31%	30%	39%	37%	38%	41%	15%	26%	31%	47%	36%	49%	44%	41%	30%	41%
Exchangeable Potassium	meq/100g		0.1	2.2	0.5	0.1	0.6	0.5	<0.1	0.1	<0.1	1.1	0.7	0.4	<0.1	0.5	0.1	0.2	0.8	0.5	0.3	0.1	2.4	<0.1	<0.1	0.3	<0.1	<0.1
Exchangeable Potassium	meq. %	1-5%		4%	1%	0.1%	3%	2%	<0.1	4%	<0.1	5%	2%	1%	<0.1	1%	0.2%	0.3%	1%	13%	9%	3%	16%	<0.1	<0.1	2%	<0.1	<0.1
Exchangeable Sodium	meq/100g		0.1	0.2	2.4	8.4	0.8	1.7	4.4	<0.1	<0.1	<0.1	0.8	7	<0.1	0.7	7	11.4	<0.1	0.2	<0.1	0.1	0.8	2.2	0.7	0.8	1.6	5.6
Exchangeable Sodium	meq. %	0-1%		0%	4%	12%	3%	7%	18%	<0.1	<0.1	<0.1	3%	14%	<0.1	1%	12%	19%	<0.1	5%	<0.1	3%	5%	11%	9%	5%	5%	16%
Cation Exchange Capacity	meq/100g	>5	0.1	57	64.8	72.4	23.1	23.2	25	2.4	2.1	22.4	28.1	48.6	1.8	54.5	60.6	61.5	82.8	3.9	3.2	3.2	15.1	20.3	8.1	17.4	33.6	35
ESP				0%	4%	12%	3%	7%	18%	0	0	0	3%	14%	0	1%	12%	19%	0	5%	0	3%	5%	11%	9%	5%	5%	16%
Alkalinity																												
Total Alkalinity as CaCO3	mg/kg		1	254	470	444	63	38	<1	51	38	203	368	558	51	178	432	140	216	51	25	51	152	254	127	102	558	1130
Bicarbonate Alkalinity as CaCO3	mg/kg		1	254	470	444	63	38	<1	51	38	203	368	507	51	178	381	140	216	51	25	51	152	254	127	102	456	419
Carbonate Alkalinity as CaCO3	mg/kg		1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	51	<1	<1	51	<1	<1	<1	<1	<1	<1	<1	<1	<1	102	711
Total Metals																												
Boron	mg/kg	>1-4	50	<50			<50			<50		<50				<50			<50	<50			<50			<50		
Cobalt	mg/kg		2	66			20			5		24				66			33	14			58			7		
Copper	mg/kg	0.4	5	38			16			<5		28				35			39	9			36			8		
Iron	mg/kg		50	69600			28800			12000		81500				57000			53800	37600			61000			13500		
Manganese	mg/kg		5	1290			182			202		820				732			1160	548			1560			376		
Molybdenum	mg/kg	5	2	<2			<2			<2		<2				<2			<2	<2			<2			<2		
Zinc	mg/kg	0.8	5	76			19			<5		34				42			52	7			50			8		
Nutrients																												
Bicarbonate Extractable P	mg/kg			42			12			<2		55				34			16	5			<2			<2		
Nitrite + Nitrate as N (Sol.)	mg/kg		0.1	19.8			4.1			0.2		1.6				3.1			4.8	42.9			35.3			1.1		
Total Kjeldahl Nitrogen as N	mg/kg		20	2630			770			180		1170				1010			1820	240			760			420		
Total Nitrogen as N	mg/kg	1500mg/kg	20	2650			770			180		1170				1010			1820	280			800			420		
Total Phosphorus as P	mg/kg	200mg/kg	2	494			164			53		477				209			222	114			198			93		
Organic Matter	%	>1.5%	0.5	5.1			2.2			<0.5		2.8				3			3.9	<0.5			1.4			1.9		

Salintiy impedement to rooting depth

Soil nutrient deficiency

Dispersive soil

QEO9811 400 Wards Well - Land Resources				WW38	WW38	WW44	WW44	WW44	WW47	WW60	WW60	WW60	WW69	WW69	WW69	WW75	WW75	WW75	WW94	WW94	WW94
Analyte	Units	Soil Sufficiency Criteria	LOR	0-50	500-600	0-100	100-200	500-600	0-100	0-20	20-300	700-800	0-50	200-300	800-900	0-50	400-500	900-1000	0-50	200-300	600-700
				Kandosol		Kandosol			Dermosol	Vertosol			Kandosol			Vertosol			Vertosol		
Inorganics																					
pH Value	pH Unit	6-7.5	0.1	6.5	7.1	6.3	6.4	6.2	6.6	7.2	7.6	8.7	6.7	7.5	7.5	7.4	8.7	9	7.6	8.4	8.9
Electrical Conductivity @ 25°C	mS/cm	<0.8	1	0.03	0.02	0.077	0.008	0.005	0.012	0.042	0.02	0.087	0.034	0.014	0.026	0.041	0.052	0.097	0.073	0.083	0.07
Moisture Content (dried @ 103°C)	%		1	8.6	3.7	2.6	6.2	9.3	12	13.3	26.4	17.5	8.5	17.1	14.7	15.6	26.4	14.1	10	25.4	10.6
Sulfate as SO4 2-	mg/kg	8mg/kg	10	<10	<10	30	<10	<10	<10	<10	<10	<10	<10	<10	30	20	10	20	<10	<10	<10
Chloride	mg/kg	800	10	20	20	80	<10	<10	<10	10	<10	<10	20	<10	10	10	<10	20	<10	<10	<10
Soil Classification based on Particle Size																					
Clay (<2 µm)	%		1		35	28		21	53	70		26		54		70	75		70		19
Silt (2-60 µm)	%	Ideal is Clay	1		7	9		17	17	22		22		12		22	16		23		41
Sand (0.06-2.00 mm)	%	<40% and C.	1		54	52		18	28	8		19		32		8	9		7		21
Gravel (>2mm)	%	Sand <40%	1		4	11		44	2	<1		33		2		<1	<1		<1		19
Cobbles (>6cm)	%		1		<1	<1		<1	<1	<1		<1		<1		<1	<1		<1		<1
Soluble Major Cations																					
Calcium	mg/kg		10	<10	<10	10	<10	<10	<10	20	<10	40	10	<10	<10	20	<10	<10	60	90	50
Magnesium	mg/kg		10	<10	<10	<10	<10	<10	<10	<10	<10	20	<10	<10	<10	<10	<10	<10	10	10	10
Sodium	mg/kg		10	<10	20	40	<10	<10	10	<10	20	50	<10	20	30	20	80	140	<10	10	30
Potassium	mg/kg	500	10	30	<10	20	<10	<10	<10	10	<10	<10	10	<10	<10	<10	<10	<10	10	<10	<10
Exchangeable Cations																					
Exchangeable Calcium	meq/100g		0.1	3.2	1.4	1.9	1.5	0.8	8.8	42.6	45.7	61.1	10.6	13.7	17	47	47.5	31.3	66.7	73.4	50.1
Exchangeable Calcium	meq. %	65-80%		57%	47%	51%	54%	27%	56%	63%	65%	70%	61%	54%	55%	62%	58%	57%	78%	82%	83%
Exchangeable Magnesium	meq/100g		0.1	1.8	1.3	1.3	1.2	2.1	6.5	23.4	23.9	25	6.4	11.1	12.6	27.4	30.9	21.2	17	15.9	10.1
Exchangeable Magnesium	meq. %	10-15%		32%	43%	35%	43%	70%	41%	35%	34%	29%	37%	44%	41%	36%	38%	38%	20%	18%	17%
Exchangeable Potassium	meq/100g		0.1	0.6	0.2	0.2	<0.1	<0.1	0.1	1.1	0.2	<0.1	0.3	<0.1	<0.1	0.6	0.1	<0.1	1.1	0.3	<0.1
Exchangeable Potassium	meq. %	1-5%		11%	7%	5%	<0.1	<0.1	1%	2%	0.3%	<0.1	2%	<0.1	<0.1	1%	0.1%	<0.1	1%	0.3%	<0.1
Exchangeable Sodium	meq/100g		0.1	<0.1	0.1	0.2	<0.1	<0.1	0.3	0.1	0.6	0.7	<0.1	0.4	1.4	0.3	3.1	2.8	<0.1	0.2	0.3
Exchangeable Sodium	meq. %	0-1%		<0.1	3%	5%	<0.1	<0.1	2%	0%	1%	1%	<0.1	2%	5%	0%	4%	5%	<0.1	0%	0%
Cation Exchange Capacity	meq/100g	>5	0.1	5.6	3	3.7	2.8	3	15.7	67.2	70.4	86.8	17.4	25.3	31	75.4	81.6	55.3	85	89.9	60.6
ESP				0	3%	5%	0	0	2%	0%	1%	1%	0	2%	5%	0%	4%	5%	0	0%	0%
Alkalinity																					
Total Alkalinity as CaCO3	mg/kg		1	63	76	63	25	38	51	140	216	306	114	63	51	140	228	317	228	254	317
Bicarbonate Alkalinity as CaCO3	mg/kg		1	63	76	63	25	38	51	140	216	306	114	63	51	140	228	266	228	254	292
Carbonate Alkalinity as CaCO3	mg/kg		1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	51	<1	<1	25
Total Metals																					
Boron	mg/kg	>1-4	50	<50		<50			<50	<50			<50			<50			<50		
Cobalt	mg/kg		2	6		32			52	183			58			46			40		
Copper	mg/kg	0.4	5	7		13			34	60			26			26			36		
Iron	mg/kg		50	21500		48800			71600	57200			76700			42300			53000		
Manganese	mg/kg		5	513		1010			1180	2660			1170			732			1100		
Molybdenum	mg/kg	5	2	<2		<2			<2	<2			<2			<2			<2		
Zinc	mg/kg	0.8	5	<5		11			35	194			28			60			65		
Nutrients																					
Bicarbonate Extractable P	mg/kg			8		12			<2	2			80			13			39		
Nitrite + Nitrate as N (Sol.)	mg/kg		0.1	1.3		0.2			0.4	2.3			1.7			2.9			4.3		
Total Kjeldahl Nitrogen as N	mg/kg		20	740		260			630	1230			1640			1120			1210		
Total Nitrogen as N	mg/kg	1500mg/kg	20	740		260			630	1230			1640			1120			1210		
Total Phosphorus as P	mg/kg	200mg/kg	2	188		224			280	202			400			135			311		
Organic Matter	%	>1.5%	0.5	2.1		1.2			2.4	2.3			3.6			2.5			2.2		

Salintiy impedement to rooting depth

Soil nutrient deficiency

Dispersive soil

Appendix C ALS Laboratory Documents

Fridge - 250gr

SKM Sinclair Knight Merz Pty Ltd
PO Box 2500
Malvern, VIC 3144
ABN 37 001 024 095
Ph: +61 3 9248 3100
Fx: +61 3 9248 3364

CHAIN OF CUSTODY &

LAB: Aust. Lab. Services Pty Ltd (ALS)
ADDRESS: 32 Shand Street Stafford
PHONE: 07 3243 7222
FAX:

PROJECT #: QEO9811.400
PROJECT NAME: Wards Well - Land Resources
SAMPLE COLLECTOR'S NAME: Angus Thompson / Timothy Rohde
LAB JOB #:

PRELIM. RESULTS BY: ☐ VERBAL ☐ FAX ☑ EMAIL
FINAL REPORT BY:
SEND TO EMAIL ADDRESS(ES):
Sampler: trohde @skm.com.au
Proj Mgr: rjanssen @skm.com.au
LAB QUOTE REF: BQ
SKM ORDER No:

METHOD CODE & ANALYSIS REQUIRED

150g Bag Bag

	SAMPLE ID	DEPTH (metres)	LAB #	MATRIX: WATER	MATRIX: SOIL	MATRIX: AIR	MATRIX: SLUDGE	PRESERVATION METHOD: ICE	PRESERVATION METHOD: ACID-IFIED	PRESERVATION METHOD: OTHER	PRESERVATION METHOD: NONE	SAMPLING DATE	No. OF CONTAINERS	Moisture (EA055)	1:5 Soil Water Extract (EN/34)	Conductivity (EA010)	pH 1:5 (EA002)	Ca, Mg, Na, K (NT-1S)	Chloride and Sulfate (NT-2S	Alkalinity (ED037)	CEC and Ex. Cation (ED007)	Emerson Class	PSD (with hydrometer)	Total N and Total P (NT-11S)	OM (EP004)	Total Metals by ICP/MS (B, Cu, Co, Fe, Mn, Mo, Zn) (EG005T)	COMMENTS (see below) (1) (2) (3)
1	WW6	0-10	1		x							21-Sep-11	1	x	x	x	x	x	x	x	x	x		x	x	x	☐ ☐ ☐
2	WW6	20-30	2		x							21-Sep-11	1	x	x	x	x	x	x	x	x	x	x				☐ ☐ ☐
3	WW6	80-90	3		x							21-Sep-11	1	x	x	x	x	x	x	x	x						☐ ☐ ☐
4	WW9	0-100	4		x							21-Sep-11	1	x	x	x	x	x	x	x	x	x		x	x	x	☐ ☐ ☐
5	WW9	200-300	5		x							21-Sep-11	1	x	x	x	x	x	x	x	x						☐ ☐ ☐
6	WW9	800-900	6		x							21-Sep-11	1	x	x	x	x	x	x	x	x	x	x				☐ ☐ ☐
7	WW10	0-100	7		x							21-Sep-11	1	x	x	x	x	x	x	x	x	x	x	x	x	x	☐ ☐ ☐
8	WW10	500-600	8		x							21-Sep-11	1	x	x	x	x	x	x	x	x						☐ ☐ ☐
9	WW10	1000-1100	9		x							21-Sep-11	1	x	x	x	x	x	x	x	x	x	x				☐ ☐ ☐
10	WW13	0-50	10		x							21-Sep-11	1	x	x	x	x	x	x	x	x	x	x	x	x	x	☐ ☐ ☐
11	WW13	20-30	11		x							21-Sep-11	1	x	x	x	x	x	x	x	x						☐ ☐ ☐
12	WW13	70-80	12		x							21-Sep-11	1	x	x	x	x	x	x	x	x	x	x				☐ ☐ ☐
13	WW15	0-10	13		x							22-Sep-11	1	x	x	x	x	x	x	x	x	x	x	x	x	x	☐ ☐ ☐
14	WW15	30-40	14		x							22-Sep-11	1	x	x	x	x	x	x	x	x						☐ ☐ ☐
15	WW15	90-100	15		x							22-Sep-11	1	x	x	x	x	x	x	x	x	x	x				☐ ☐ ☐
16	WW22	0-100	16		x							22-Sep-11	1	x	x	x	x	x	x	x	x	x	x	x	x	x	☐ ☐ ☐
17	WW22	200-400	SNR		x							22-Sep-11	1	x	x	x	x	x	x	x	x						☐ ☐ ☐
18	WW22	800-900	SNR		x							22-Sep-11	1	x	x	x	x	x	x	x	x	x	x				☐ ☐ ☐
19	WW23	0-100	17		x							23-Sep-11	1	x	x	x	x	x	x	x	x	x		x	x	x	☐ ☐ ☐
20	WW23	300-400	18		x							23-Sep-11	1	x	x	x	x	x	x	x	x		x				☐ ☐ ☐
21	WW23	900-1000	19		x							23-Sep-11	1	x	x	x	x	x	x	x	x	x					☐ ☐ ☐
22	WW28	0-100	20		x							23-Sep-11	1	x	x	x	x	x	x	x	x	x	x	x	x	x	☐ ☐ ☐
23	WW28	200-300	21		x							23-Sep-11	1	x	x	x	x	x	x	x	x						☐ ☐ ☐
24	WW28	700-800	22		x							23-Sep-11	1	x	x	x	x	x	x	x	x	x	x				☐ ☐ ☐
	TOTALS			0	24	0	0							24	24	24	24	24	24	24	24	16	13	8	8	8	

Environmental Division
Brisbane
Work Order
EB1121537
Telephone : +61-7-3243 7222

HW

Relinquished by (SIGN/PRINT):	Date	Time	Received by (SIGN/PRINT):	Date	Time		
Tim Rohde of SKM	17/10		Matt McCabe of ALS	17/10/11	15:20	Custody Seals Intact?	Yes No
Relinquished by (SIGN/PRINT): of	Date	Time	Received by (SIGN/PRINT): of	Date	Time	Sample Receipt Temp.	°C

Additional Comments/Instructions:
Please send copies of all correspondance to -rjanssen@globalskm.com
Please Send Invoice to rjanssen@globalskm.com

QEO9811_CoC_13Oct2011.xlsx

SKM

Sinclair Knight Merz Pty Ltd
PO Box 2500
Malvern, VIC 3144
ABN 37 001 024 095

Ph: +61 3 9248 3100
Fx: +61 3 9248 3364

CHAIN OF CUSTODY &

LAB: Aust. Lab. Services Pty Ltd (ALS)
ADDRESS: 32 Shand Street Stafford
PHONE: 07 3243 7222
FAX:

PROJECT # QEO9811.400
PROJECT NAME Wards Well - Land Resources
SAMPLE COLLECTOR'S NAME Angus Thompson / Timothy Rohde
LAB JOB #

PRELIM. RESULTS BY: ☐ VERBAL ☐ FAX ☑ EMAIL
FINAL REPORT BY:
SEND TO EMAIL ADDRESS(ES):
Sampler: trohde @skm.com.au
Proj Mgr: rjanssen @skm.com.au
LAB QUOTE REF:
SKM ORDER No:

METHOD CODE & ANALYSIS REQUIRED

	SAMPLE ID	DEPTH (metres)	LAB #	MATRIX: WATER	SOIL	AIR	SLUDGE	PRESERVATION METHOD: ICE	ACID-IFIED	OTHER	NONE	SAMPLING DATE	No. OF CONTAINERS	Moisture (EA055)	1:5 Soil Water Extract (EN/34)	Conductivity (EA010)	pH 1:5 (EA002)	Ca, Mg, Na, K (NT-1S)	Chloride and Sulfate (NT-2S	Alkalinity (ED037)	CEC and Ex. Cation (ED007)	Emerson Class	PSD (with hydrometer)	Total N and Total P (NT-11S)	OM (EP004)	Total Metals by ICP/MS (B, Cu, Co, Fe, Mn, Mo, Zn) (EG005T)	COMMENTS	(1)	(2)	(3)
25	WW36	0-100	~~23~~		x							24-Sep-11	1	x	x	x	x	x	x	x	x	x	x	x	x	x		☐	☐	☐
26	WW36	200-300	~~24~~		x							24-Sep-11	1	x	x	x	x	x	x	x	x							☐	☐	☐
27	WW36	700-800	~~25~~		x							24-Sep-11	1	x	x	x	x	x	x	x	x	x	x					☐	☐	☐
28	WW38	0-50	~~26~~		x							24-Sep-11	1	x	x	x	x	x	x	x	x	x		x	x	x		☐	☐	☐
29	WW38	500-600	~~27~~		x							24-Sep-11	1	x	x	x	x	x	x	x	x	x	x					☐	☐	☐
	Intentionally blank																											☐	☐	☐
30	WW44	0-100	~~28~~		x							25-Sep-11	1	x	x	x	x	x	x	x	x	x	x	x	x	x		☐	☐	☐
31	WW44	100-200	~~29~~		x							25-Sep-11	1	x	x	x	x	x	x	x	x							☐	☐	☐
32	WW44	500-600	~~30~~		x							25-Sep-11	1	x	x	x	x	x	x	x	x	x	x					☐	☐	☐
33	WW47	0-100	~~31~~		x							26-Sep-11	1	x	x	x	x	x	x	x	x	x	x	x	x	x		☐	☐	☐
34	WW47	450-1000	~~SNR~~		x							27-Sep-11	1	x	x	x	x	x	x	x	x	x	x					☐	☐	☐
	Intentionally blank																											☐	☐	☐
35	WW60	0-20	~~32~~		x							27-Sep-11	1	x	x	x	x	x	x	x	x	x	x	x	x	x		☐	☐	☐
36	WW60	20-300	~~33~~		x							27-Sep-11	1	x	x	x	x	x	x	x	x							☐	☐	☐
37	WW60	700-800	~~34~~		x							27-Sep-11	1	x	x	x	x	x	x	x	x	x	x					☐	☐	☐
38	WW69	0-50	~~35~~		x							27-Sep-11	1	x	x	x	x	x	x	x	x	x		x	x	x		☐	☐	☐
39	WW69	200-300	~~36~~		x							27-Sep-11	1	x	x	x	x	x	x	x	x		x					☐	☐	☐
40	WW69	800-900	~~37~~		x							27-Sep-11	1	x	x	x	x	x	x	x	x	x						☐	☐	☐
41	WW75	0-50	~~38~~		x							27-Sep-11	1	x	x	x	x	x	x	x	x	x	x	x	x	x		☐	☐	☐
42	WW75	400-500	~~39~~		x							27-Sep-11	1	x	x	x	x	x	x	x	x		x					☐	☐	☐
43	WW75	900-1000	~~40~~		x							27-Sep-11	1	x	x	x	x	x	x	x	x	x						☐	☐	☐
44	WW94	0-50	~~41~~		x							28-Sep-11	1	x	x	x	x	x	x	x	x	x	x	x	x	x		☐	☐	☐
45	WW94	200-300	~~42~~		x							29-Sep-11	1	x	x	x	x	x	x	x	x							☐	☐	☐
[illegible]	WW94	600-700	~~43~~		x							30-Sep-11	1	x	x	x	x	x	x	x	x	x	x					☐	☐	☐
																												☐	☐	☐
	TOTALS			0	22	0	0							22	22	22	22	22	22	22	22	16	14	8	8	8				

(see below)

Emerson Class / PSD: 60 holders bag, new castle bag

Relinquished by (SIGN/PRINT):	Date	Time	Received by (SIGN/PRINT):	Date	Time		
of SKM	17/10		of			Custody Seals Intact?	Yes / No
[illegible]	Date	Time	Received by (SIGN/PRINT): of	Date	Time	Sample Receipt Temp.	°C

Additional Comments/Instructions:
Please send copies of all correspondance to - rjanssen@globalskm.com
Please Send Invoice to rjanssen@globalskm.com

SKM

Sinclair Knight Merz Pty Ltd
PO Box 2500
Malvern, VIC 3144
ABN 37 001 024 095

Ph: +61 3 9248 3100
Fx: +61 3 9248 3364

CHAIN OF COUNSTODY &

LAB: Aust. Lab. Services Pty Ltd (ALS)
ADDRESS: 32 Shand Street Stafford
PHONE: 07 3243 7222
FAX:

PROJECT # QEO9811.400
PROJECT NAME Wards Well - Land Resources
SAMPLE COLLECTOR'S NAME Angus Thompson / Timothy Rohde
LAB JOB #

PRELIM. RESULTS BY: ☐ VERBAL ☐ FAX ☑ EMAIL

FINAL REPORT BY:

SEND TO EMAIL ADDRESS(ES):
Sampler: trohde @skm.com.au
Proj Mgr: rjanssen @skm.com.au

LAB QUOTE REF:
SKM ORDER No:

METHOD CODE & ANALYSIS REQUIRED

	SAMPLE ID	DEPTH (metres)	LAB #	MATRIX: WATER	MATRIX: SOIL	MATRIX: AIR	MATRIX: SLUDGE	PRESERVATION METHOD: ICE	PRESERVATION METHOD: ACID-IFIED	PRESERVATION METHOD: OTHER	PRESERVATION METHOD: NONE	SAMPLING DATE	No. OF CONTAINERS														COMMENTS	(1)	(2)	(3)
47	WW18	80-90	~~44~~		x								1														Retain sample / no analysis	☐	☐	☐
48	WW18	not marked	~~45~~		x								1														Retain sample / no analysis	☐	☐	☐
49	WW18	20-40	~~46~~		x								1														Retain sample / no analysis	☐	☐	☐
50	WW32	20-100	~~47~~		x								1														Retain sample / no analysis	☐	☐	☐
51	WW32	70-80	~~48~~		x								1														Retain sample / no analysis	☐	☐	☐
52	WW32	0-10	~~49~~		x																						Retain sample / no analysis	☐	☐	☐
53	WW52	30-40	~~50~~		x								1														Retain sample / no analysis	☐	☐	☐
54	WW52	0-10	~~51~~		x								1														Retain sample / no analysis	☐	☐	☐
55	WW52	70-80	~~52~~		x								1														Retain sample / no analysis	☐	☐	☐
56	WW35	30-40	~~53~~		x								1														Retain sample / no analysis	☐	☐	☐
57	WW35	80-90	~~54~~		x								1														Retain sample / no analysis	☐	☐	☐
58	WW35	0-10	~~55~~		x																						Retain sample / no analysis	☐	☐	☐
59	WW4	200-300	~~56~~		x								1														Retain sample / no analysis	☐	☐	☐
60	WW4	700-800	~~57~~		x								1														Retain sample / no analysis	☐	☐	☐
61	WW4	0-100	~~58~~		x								1														Retain sample / no analysis	☐	☐	☐
62	WW78	~~280-380~~	~~59~~		x								1														Retain sample / no analysis	☐	☐	☐
63	WW78	200-400	~~60~~		x								1														Retain sample / no analysis	☐	☐	☐
64	WW78	900-1000	~~61~~		x								1														Retain sample / no analysis	☐	☐	☐
65	WW32		~~SNR~~										1															☐	☐	☐
66	WW22	200-1000	~~62~~										1															☐	☐	☐
67	WW22	300-400	~~63~~					EXTRAS					1															☐	☐	☐
68	WW47	600-700	~~64~~										1															☐	☐	☐
													1															☐	☐	☐
													1															☐	☐	☐
																												☐	☐	☐
		TOTALS		0	18	0	0							0	0	0	0	0	0	0	0	0	0	0	0	0				

Relinquished by (SIGN/PRINT):	Date	Time	Received by (SIGN/PRINT):	Date	Time		
Tim Rohde of SKM	17/10		of			Custody Seals Intact?	Yes / No
Relinquished by (SIGN/PRINT): of	Date	Time	Received by (SIGN/PRINT): of	Date	Time	Sample Receipt Temp.	°C

Additional Comments/Instructions:
Please send copies of all correspondance to - rjanssen@globalskm.com
Please Send Invoice to rjanssen@globalskm.com

SAMPLE RECEIPT NOTIFICATION (SRN)

Comprehensive Report

Work Order	: **EB1121537**		
Client	: **SINCLAIR KNIGHT MERZ**	Laboratory	: Environmental Division Brisbane
Contact	: R JANSSEN	Contact	: Dean Sullivan
Address	: P O BOX 312 FLINDERS LANE MELBOURNE VIC AUSTRALIA 8009	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: rjanssen@globalskm.com	E-mail	: dean.sullivan@alsglobal.com
Telephone	: +61 03 8668 3000	Telephone	: +61 7 3243 7144
Facsimile	: +61 03 8668 3001	Facsimile	: +61 7 3243 7218
Project	: QEO9811 400 Wards Well - Land Resources	Page	: 1 of 5
Order number	: ----		
C-O-C number	: ----	Quote number	: ES2010SINKNI0337 (EN/003/10)
Site	: ----		
Sampler	: A Thompson/T Rohde	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement

Dates

Date Samples Received	: 17-OCT-2011	Issue Date	: 19-OCT-2011 13:25
Client Requested Due Date	: 26-OCT-2011	Scheduled Reporting Date	: **26-OCT-2011**

Delivery Details

Mode of Delivery	: Carrier	Temperature	: 24,24.1,24.3,24°C
No. of coolers/boxes	: 4 MEDIUM	No. of samples received	: 64
Security Seal	: Intact.	No. of samples analysed	: 43

General Comments

- This report contains the following information:
  - Sample Container(s)/Preservation Non-Compliances
  - Summary of Sample(s) and Requested Analysis
  - Requested Deliverables
- **Samples received in appropriately pretreated and preserved containers.**
- **Breaches in recommended extraction / analysis holding times have occurred.**
- **Please be advised that samples WW22-200-400; WW22-800-900 and WW47-450-100 were not received.**
- **Emerson Aggregate analysis will be subcontracted to Golder Associates.**
- **The recommended extraction time for organic carbon/matter; sulphate; pH; Conductivity; chloride; moisture on soil samples is 7 days from the date of sampling.**
- Discounted Package Prices apply only when specific ALS Group Codes ('W', 'S', 'NT' suites) are referenced on COCs.
- Please direct any turn around / technical queries to the laboratory contact designated above.
- Please direct any queries related to sample condition / numbering / breakages to Matt Goodwin.
- Analytical work for this work order will be conducted at ALS Brisbane and ALS Newcastle.
- Sample Disposal - Aqueous (14 days), Solid (90 days) from date of completion of work order.

Sample Container(s)/Preservation Non-Compliances

All comparisons are made against pretreatment/preservation AS, APHA, USEPA standards.

- **No sample container / preservation non-compliance exist.**

Summary of Sample(s) and Requested Analysis

Some items described below may be part of a laboratory process neccessary for the execution of client requested tasks. Packages may contain additional analyses, such as the determination of moisture content and preparation tasks, that are included in the package.

If no sampling time is provided, the sampling time will default to 15:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory for processing purposes and will be shown bracketed without a time component.

Matrix: **SOIL**

Laboratory sample ID	*Client sampling date / time*	*Client sample ID*	(On Hold) SOIL No analysis requested	SOIL - EA002 pH (1:5)	SOIL - EA010 (solids): Electrical Conductivity (1:5) Electrical Conductivity (1:5)	SOIL - EA150H Particle Sizing by Hydrometer	SOIL - ED007 CEC / Exchangeable Cations (ED007)	SOIL - ED037 Alkalinity in Soil	SOIL - EG005T (solids) Total Metals by ICP-AES	SOIL - EME-SOL (Subcontracted) Emerson Aggregate Testing on soil samples
EB1121537-001	21-SEP-2011 15:00	WW6 0-10		✓	✓		✓	✓	✓	✓
EB1121537-002	21-SEP-2011 15:00	WW6 20-30		✓	✓	✓	✓	✓		✓
EB1121537-003	21-SEP-2011 15:00	WW6 80-90		✓	✓		✓	✓		
EB1121537-004	21-SEP-2011 15:00	WW9 0-100		✓	✓		✓	✓	✓	✓
EB1121537-005	21-SEP-2011 15:00	WW9 200-300		✓	✓		✓	✓		
EB1121537-006	21-SEP-2011 15:00	WW9 800-900		✓	✓	✓	✓	✓		✓
EB1121537-007	21-SEP-2011 15:00	WW10 0-100		✓	✓	✓	✓	✓	✓	✓
EB1121537-008	21-SEP-2011 15:00	WW10 500-600		✓	✓		✓	✓		
EB1121537-009	21-SEP-2011 15:00	WW13 1000-1100		✓	✓	✓	✓	✓		✓
EB1121537-010	21-SEP-2011 15:00	WW13 0-50		✓	✓	✓	✓	✓	✓	✓
EB1121537-011	21-SEP-2011 15:00	WW13 20-30		✓	✓		✓	✓		
EB1121537-012	21-SEP-2011 15:00	WW13 70-80		✓	✓	✓	✓	✓		✓
EB1121537-013	22-SEP-2011 15:00	WW15 0-10		✓	✓	✓	✓	✓	✓	✓
EB1121537-014	22-SEP-2011 15:00	WW15 30-40		✓	✓		✓	✓		
EB1121537-015	22-SEP-2011 15:00	WW15 90-100		✓	✓	✓	✓	✓		✓
EB1121537-016	22-SEP-2011 15:00	WW22 0-100		✓	✓	✓	✓	✓	✓	✓
EB1121537-019	23-SEP-2011 15:00	WW23 0-100		✓	✓		✓	✓	✓	✓
EB1121537-020	23-SEP-2011 15:00	WW23 300-400		✓	✓	✓	✓	✓		
EB1121537-021	23-SEP-2011 15:00	WW23 900-1000		✓	✓		✓	✓		✓
EB1121537-022	23-SEP-2011 15:00	WW28 0-100		✓	✓	✓	✓	✓	✓	✓
EB1121537-023	23-SEP-2011 15:00	WW28 200-300		✓	✓		✓	✓		
EB1121537-024	23-SEP-2011 15:00	WW28 700-800		✓	✓	✓	✓	✓		✓
EB1121537-025	24-SEP-2011 15:00	WW36 0-100		✓	✓	✓	✓	✓	✓	✓
EB1121537-026	24-SEP-2011 15:00	WW36 200-300		✓	✓		✓	✓		
EB1121537-027	24-SEP-2011 15:00	WW36 700-800		✓	✓	✓	✓	✓		✓
EB1121537-028	24-SEP-2011 15:00	WW38 0-50		✓	✓		✓	✓	✓	✓
EB1121537-029	24-SEP-2011 15:00	WW38 500-600		✓	✓	✓	✓	✓		✓
EB1121537-030	25-SEP-2011 15:00	WW44 0-100		✓	✓	✓	✓	✓	✓	✓
EB1121537-031	25-SEP-2011 15:00	WW44 100-200		✓	✓		✓	✓		
EB1121537-032	25-SEP-2011 15:00	WW44 500-600		✓	✓	✓	✓	✓		✓
EB1121537-033	26-SEP-2011 15:00	WW47 0-100		✓	✓	✓	✓	✓	✓	✓
EB1121537-035	27-SEP-2011 15:00	WW60 0-20		✓	✓	✓	✓	✓	✓	✓
EB1121537-036	27-SEP-2011 15:00	WW60 20-300		✓	✓		✓	✓		
EB1121537-037	27-SEP-2011 15:00	WW60 700-800		✓	✓	✓	✓	✓		✓

			(On Hold) SOIL No analysis requested	SOIL - EA002 pH (1:5)	SOIL - EA010 (solids): Electrical Conductivity (1:5) Electrical Conductivity (1:5)	SOIL - EA150H Particle Sizing by Hydrometer	SOIL - ED007 CEC / Exchangeable Cations (ED007)	SOIL - ED037 Alkalinity in Soil	SOIL - EG005T (solids) Total Metals by ICP-AES	SOIL - EME-SOL (Subcontracted) Emerson Aggregate Testing on soil samples
EB1121537-038	27-SEP-2011 15:00	WW69 0-50		✓	✓		✓	✓	✓	✓
EB1121537-039	27-SEP-2011 15:00	WW69 200-300		✓	✓	✓	✓	✓		
EB1121537-040	27-SEP-2011 15:00	WW69 800-900		✓	✓		✓	✓		✓
EB1121537-041	27-SEP-2011 15:00	WW75 0-50		✓	✓	✓	✓	✓	✓	✓
EB1121537-042	27-SEP-2011 15:00	WW75 400-500		✓	✓	✓	✓	✓		
EB1121537-043	27-SEP-2011 15:00	WW75 900-1000		✓	✓		✓	✓		✓
EB1121537-044	28-SEP-2011 15:00	WW94 0-50		✓	✓	✓	✓	✓	✓	✓
EB1121537-045	29-SEP-2011 15:00	WW94 200-300		✓	✓		✓	✓		
EB1121537-046	30-SEP-2011 15:00	WW94 600-700		✓	✓	✓	✓	✓		✓
EB1121537-047	[17-OCT-2011]	WW18 80-900	✓							
EB1121537-048	[17-OCT-2011]	WW18	✓							
EB1121537-049	[17-OCT-2011]	WW18 20-40	✓							
EB1121537-050	[17-OCT-2011]	WW32 20-100	✓							
EB1121537-051	[17-OCT-2011]	WW32 70-80	✓							
EB1121537-052	[17-OCT-2011]	WW32 0-10	✓							
EB1121537-053	[17-OCT-2011]	WW52 30-40	✓							
EB1121537-054	[17-OCT-2011]	WW52 0-10	✓							
EB1121537-055	[17-OCT-2011]	WW52 70-80	✓							
EB1121537-056	[17-OCT-2011]	WW35 30-40	✓							
EB1121537-057	[17-OCT-2011]	WW35 80-90	✓							
EB1121537-058	[17-OCT-2011]	WW35 0-10	✓							
EB1121537-059	[17-OCT-2011]	WW4 200-300	✓							
EB1121537-060	[17-OCT-2011]	WW4 700-800	✓							
EB1121537-061	[17-OCT-2011]	WW4 0-100	✓							
EB1121537-062	[17-OCT-2011]	WW78 0-100	✓							
EB1121537-063	[17-OCT-2011]	WW78 300-400	✓							
EB1121537-064	[17-OCT-2011]	WW78 900-1000	✓							
EB1121537-066	[17-OCT-2011]	WW22 200-1000	✓							
EB1121537-067	[17-OCT-2011]	WW22 300-400	✓							
EB1121537-068	[17-OCT-2011]	WW22 600-700	✓							

Matrix: **SOIL**

Laboratory sample ID	*Client sampling date / time*	*Client sample ID*	SOIL - EP004 Organic Matter in Soil (Walkley Black)	SOIL - NT-11S Total N + Total P	SOIL - NT-1S Major Cations (Ca, Mg, Na, K)	SOIL - NT-2S Major Anions (Cl, SO4)
EB1121537-001	21-SEP-2011 15:00	WW6 0-10	✓	✓	✓	✓
EB1121537-002	21-SEP-2011 15:00	WW6 20-30			✓	✓
EB1121537-003	21-SEP-2011 15:00	WW6 80-90			✓	✓
EB1121537-004	21-SEP-2011 15:00	WW9 0-100	✓	✓	✓	✓
EB1121537-005	21-SEP-2011 15:00	WW9 200-300			✓	✓
EB1121537-006	21-SEP-2011 15:00	WW9 800-900			✓	✓
EB1121537-007	21-SEP-2011 15:00	WW10 0-100	✓	✓	✓	✓
EB1121537-008	21-SEP-2011 15:00	WW10 500-600			✓	✓
EB1121537-009	21-SEP-2011 15:00	WW13 1000-1100			✓	✓
EB1121537-010	21-SEP-2011 15:00	WW13 0-50	✓	✓	✓	✓
EB1121537-011	21-SEP-2011 15:00	WW13 20-30			✓	✓
EB1121537-012	21-SEP-2011 15:00	WW13 70-80			✓	✓
EB1121537-013	22-SEP-2011 15:00	WW15 0-10	✓	✓	✓	✓
EB1121537-014	22-SEP-2011 15:00	WW15 30-40			✓	✓
EB1121537-015	22-SEP-2011 15:00	WW15 90-100			✓	✓
EB1121537-016	22-SEP-2011 15:00	WW22 0-100	✓	✓	✓	✓
EB1121537-019	23-SEP-2011 15:00	WW23 0-100	✓	✓	✓	✓
EB1121537-020	23-SEP-2011 15:00	WW23 300-400			✓	✓
EB1121537-021	23-SEP-2011 15:00	WW23 900-1000			✓	✓
EB1121537-022	23-SEP-2011 15:00	WW28 0-100	✓	✓	✓	✓
EB1121537-023	23-SEP-2011 15:00	WW28 200-300			✓	✓
EB1121537-024	23-SEP-2011 15:00	WW28 700-800			✓	✓
EB1121537-025	24-SEP-2011 15:00	WW36 0-100	✓	✓	✓	✓
EB1121537-026	24-SEP-2011 15:00	WW36 200-300			✓	✓
EB1121537-027	24-SEP-2011 15:00	WW36 700-800			✓	✓
EB1121537-028	24-SEP-2011 15:00	WW38 0-50	✓	✓	✓	✓
EB1121537-029	24-SEP-2011 15:00	WW38 500-600			✓	✓
EB1121537-030	25-SEP-2011 15:00	WW44 0-100	✓	✓	✓	✓
EB1121537-031	25-SEP-2011 15:00	WW44 100-200			✓	✓
EB1121537-032	25-SEP-2011 15:00	WW44 500-600			✓	✓
EB1121537-033	26-SEP-2011 15:00	WW47 0-100	✓	✓	✓	✓
EB1121537-035	27-SEP-2011 15:00	WW60 0-20	✓	✓	✓	✓
EB1121537-036	27-SEP-2011 15:00	WW60 20-300			✓	✓
EB1121537-037	27-SEP-2011 15:00	WW60 700-800			✓	✓
EB1121537-038	27-SEP-2011 15:00	WW69 0-50	✓	✓	✓	✓
EB1121537-039	27-SEP-2011 15:00	WW69 200-300			✓	✓
EB1121537-040	27-SEP-2011 15:00	WW69 800-900			✓	✓
EB1121537-041	27-SEP-2011 15:00	WW75 0-50	✓	✓	✓	✓
EB1121537-042	27-SEP-2011 15:00	WW75 400-500			✓	✓
EB1121537-043	27-SEP-2011 15:00	WW75 900-1000			✓	✓
EB1121537-044	28-SEP-2011 15:00	WW94 0-50	✓	✓	✓	✓

			SOIL - EP004 Organic Matter in Soil (Walkley Black)	SOIL - NT-11S Total N + Total P	SOIL - NT-1S Major Cations (Ca, Mg, Na, K)	SOIL - NT-2S Major Anions (Cl, SO4)
EB1121537-045	29-SEP-2011 15:00	WW94 200-300			✓	✓
EB1121537-046	30-SEP-2011 15:00	WW94 600-700			✓	✓

Requested Deliverables

MR TIMOTHY ROHDE

- *AU Certificate of Analysis - NATA (COA)	Email	trohde@skm.com.au
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	trohde@skm.com.au
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	trohde@skm.com.au
- A4 - AU Sample Receipt Notification - Environmental (SRN)	Email	trohde@skm.com.au
- Attachment - Report (SUBCO)	Email	trohde@skm.com.au
- Chain of Custody (CoC) (COC)	Email	trohde@skm.com.au
- EDI Format - ENMRG (ENMRG)	Email	trohde@skm.com.au
- EDI Format - ESDAT (ESDAT)	Email	trohde@skm.com.au
- EDI Format - XTab (XTAB)	Email	trohde@skm.com.au

R JANSSEN

- *AU Certificate of Analysis - NATA (COA)	Email	rjanssen@globalskm.com
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	rjanssen@globalskm.com
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	rjanssen@globalskm.com
- A4 - AU Sample Receipt Notification - Environmental (SRN)	Email	rjanssen@globalskm.com
- A4 - AU Tax Invoice (INV)	Email	rjanssen@globalskm.com
- Attachment - Report (SUBCO)	Email	rjanssen@globalskm.com
- Chain of Custody (CoC) (COC)	Email	rjanssen@globalskm.com
- EDI Format - ENMRG (ENMRG)	Email	rjanssen@globalskm.com
- EDI Format - ESDAT (ESDAT)	Email	rjanssen@globalskm.com
- EDI Format - XTab (XTAB)	Email	rjanssen@globalskm.com

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **EB1121537**	Page	: 1 of 20
Client	: **SINCLAIR KNIGHT MERZ**	Laboratory	: Environmental Division Brisbane
Contact	: MR TIMOTHY ROHDE	Contact	: Dean Sullivan
Address	: P O BOX 312 FLINDERS LANE MELBOURNE VIC AUSTRALIA 8009	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: trohde@skm.com.au	E-mail	: dean.sullivan@alsglobal.com
Telephone	: +61 03 8668 3000	Telephone	: +61 7 3243 7144
Facsimile	: +61 03 8668 3001	Facsimile	: +61 7 3243 7218
Project	: QEO9811 400 Wards Well - Land Resources	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 17-OCT-2011
Sampler	: A Thompson/T Rohde	Issue Date	: 26-OCT-2011
Site	: ----		
		No. of samples received	: 64
Quote number	: EN/003/10	No. of samples analysed	: 43

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA
WORLD RECOGNISED
ACCREDITATION

NATA Accredited Laboratory 825

This document is issued in accordance with NATA accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

Signatories

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

Signatories	*Position*	*Accreditation Category*
Dianne Blane	Laboratory Supervisor	Newcastle
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

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

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

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

- **EG005T (Total Metals): Sample EB1121537-030 (WW44 0-100) shows poor duplicate result due to sample heterogeneity. Confirmed by visual confirmation.**

Analytical Results

Sub-Matrix: **SOIL**

Compound	CAS Number	LOR	Unit	WW6 0-10	WW6 20-30	WW6 80-90	WW9 0-100	WW9 200-300
Client sampling date / time				21-SEP-2011 15:00	21-SEP-2011 15:00	21-SEP-2011 15:00	21-SEP-2011 15:00	21-SEP-2011 15:00
				EB1121537-001	EB1121537-002	EB1121537-003	EB1121537-004	EB1121537-005
EA150: Particle Sizing								
+75µm	----	1	%	----	18	----	----	----
+150µm	----	1	%	----	17	----	----	----
+300µm	----	1	%	----	15	----	----	----
+425µm	----	1	%	----	13	----	----	----
+600µm	----	1	%	----	12	----	----	----
+1180µm	----	1	%	----	10	----	----	----
+2.36mm	----	1	%	----	8	----	----	----
+4.75mm	----	1	%	----	6	----	----	----
+9.5mm	----	1	%	----	<1	----	----	----
+19.0mm	----	1	%	----	<1	----	----	----
+37.5mm	----	1	%	----	<1	----	----	----
+75.0mm	----	1	%	----	<1	----	----	----
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	7.8	8.6	8.6	5.8	5.2
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	107	137	659	31	134
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	18.4	18.5	20.1	7.2	12.3
EA150: Soil Classification based on Particle Size								
Clay (<2 µm)	----	1	%	----	68	----	----	----
Silt (2-60 µm)	----	1	%	----	12	----	----	----
Sand (0.06-2.00 mm)	----	1	%	----	12	----	----	----
Gravel (>2mm)	----	1	%	----	8	----	----	----
Cobbles (>6cm)	----	1	%	----	<1	----	----	----
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	37.3	37.2	33.7	7.8	7.2
Exchangeable Magnesium	----	0.1	meq/100g	17.4	24.7	30.2	13.9	13.9
Exchangeable Potassium	----	0.1	meq/100g	2.2	0.5	0.1	0.6	0.5
Exchangeable Sodium	----	0.1	meq/100g	0.2	2.4	8.4	0.8	1.7
Cation Exchange Capacity	----	0.1	meq/100g	57.0	64.8	72.4	23.1	23.2
ED037: Alkalinity								
Total Alkalinity as CaCO3	----	1	mg/kg	254	470	444	63	38
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/kg	254	470	444	63	38
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/kg	<1	<1	<1	<1	<1
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	20	<10	120	10	40

Analytical Results

Sub-Matrix: **SOIL**

Compound	CAS Number	LOR	Unit	WW6 0-10	WW6 20-30	WW6 80-90	WW9 0-100	WW9 200-300
			Client sampling date / time	21-SEP-2011 15:00	21-SEP-2011 15:00	21-SEP-2011 15:00	21-SEP-2011 15:00	21-SEP-2011 15:00
				EB1121537-001	EB1121537-002	EB1121537-003	EB1121537-004	EB1121537-005
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/kg	<10	<10	**1000**	**10**	**2350**
ED093S: Soluble Major Cations								
Calcium	7440-70-2	10	mg/kg	**50**	**20**	**40**	<10	<10
Magnesium	7439-95-4	10	mg/kg	**20**	<10	**30**	<10	<10
Sodium	7440-23-5	10	mg/kg	**20**	**170**	**760**	**20**	**120**
Potassium	7440-09-7	10	mg/kg	**40**	<10	<10	<10	<10
EG005T: Total Metals by ICP-AES								
Boron	7440-42-8	50	mg/kg	<50	----	----	<50	----
Cobalt	7440-48-4	2	mg/kg	**66**	----	----	**20**	----
Copper	7440-50-8	5	mg/kg	**38**	----	----	**16**	----
Iron	7439-89-6	50	mg/kg	**69600**	----	----	**28800**	----
Manganese	7439-96-5	5	mg/kg	**1290**	----	----	**182**	----
Molybdenum	7439-98-7	2	mg/kg	<2	----	----	<2	----
Zinc	7440-66-6	5	mg/kg	**76**	----	----	**19**	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	**19.8**	----	----	**4.1**	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	**2630**	----	----	**770**	----
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	**2650**	----	----	**770**	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	**494**	----	----	**164**	----
EP004: Organic Matter								
Organic Matter	----	0.5	%	**5.1**	----	----	**2.2**	----

Analytical Results

Sub-Matrix: **SOIL**

Compound	CAS Number	LOR	Unit	WW9 800-900	WW10 0-100	WW10 500-600	WW13 1000-1100	WW13 0-50
Client sampling date / time				21-SEP-2011 15:00	21-SEP-2011 15:00	21-SEP-2011 15:00	21-SEP-2011 15:00	21-SEP-2011 15:00
				EB1121537-006	EB1121537-007	EB1121537-008	EB1121537-009	EB1121537-010
EA150: Particle Sizing								
+75µm	----	1	%	7	70	----	67	22
+150µm	----	1	%	5	58	----	52	8
+300µm	----	1	%	3	34	----	30	6
+425µm	----	1	%	2	18	----	19	6
+600µm	----	1	%	<1	8	----	13	5
+1180µm	----	1	%	<1	2	----	5	4
+2.36mm	----	1	%	<1	<1	----	<1	4
+4.75mm	----	1	%	<1	<1	----	<1	4
+9.5mm	----	1	%	<1	<1	----	<1	4
+19.0mm	----	1	%	<1	<1	----	<1	<1
+37.5mm	----	1	%	<1	<1	----	<1	<1
+75.0mm	----	1	%	<1	<1	----	<1	<1
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	4.5	6.5	6.4	5.8	7.3
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	631	8	9	7	55
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	17.7	6.1	7.1	9.7	8.6
EA150: Soil Classification based on Particle Size								
Clay (<2 µm)	----	1	%	69	21	----	23	46
Silt (2-60 µm)	----	1	%	23	6	----	7	29
Sand (0.06-2.00 mm)	----	1	%	8	73	----	70	21
Gravel (>2mm)	----	1	%	<1	<1	----	<1	4
Cobbles (>6cm)	----	1	%	<1	<1	----	<1	<1
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	5.8	1.8	1.3	1.0	15.4
Exchangeable Magnesium	----	0.1	meq/100g	14.6	0.5	0.7	0.7	5.8
Exchangeable Potassium	----	0.1	meq/100g	<0.1	0.1	<0.1	<0.1	1.1
Exchangeable Sodium	----	0.1	meq/100g	4.4	<0.1	<0.1	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	25.0	2.4	2.1	1.8	22.4
ED037: Alkalinity								
Total Alkalinity as CaCO3	----	1	mg/kg	<1	51	38	51	203
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/kg	<1	51	38	51	203
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/kg	<1	<1	<1	<1	<1
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	<10	<10	<10	<10	<10

Analytical Results

Sub-Matrix: **SOIL**

Compound	CAS Number	LOR	Unit	WW9 800-900	WW10 0-100	WW10 500-600	WW13 1000-1100	WW13 0-50
Client sampling date / time				21-SEP-2011 15:00	21-SEP-2011 15:00	21-SEP-2011 15:00	21-SEP-2011 15:00	21-SEP-2011 15:00
				EB1121537-006	EB1121537-007	EB1121537-008	EB1121537-009	EB1121537-010
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/kg	**1240**	<10	<10	<10	<10
ED093S: Soluble Major Cations								
Calcium	7440-70-2	10	mg/kg	**20**	<10	<10	<10	**30**
Magnesium	7439-95-4	10	mg/kg	**40**	<10	<10	<10	<10
Sodium	7440-23-5	10	mg/kg	**600**	<10	<10	<10	**10**
Potassium	7440-09-7	10	mg/kg	<10	<10	<10	<10	**30**
EG005T: Total Metals by ICP-AES								
Boron	7440-42-8	50	mg/kg	----	<50	----	----	<50
Cobalt	7440-48-4	2	mg/kg	----	**5**	----	----	**24**
Copper	7440-50-8	5	mg/kg	----	<5	----	----	**28**
Iron	7439-89-6	50	mg/kg	----	**12000**	----	----	**81500**
Manganese	7439-96-5	5	mg/kg	----	**202**	----	----	**820**
Molybdenum	7439-98-7	2	mg/kg	----	<2	----	----	<2
Zinc	7440-66-6	5	mg/kg	----	<5	----	----	**34**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	----	**0.2**	----	----	**1.6**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	----	**180**	----	----	**1170**
EK062: Total Nitrogen as N (TKN + NOx)								
^ **Total Nitrogen as N**	----	20	mg/kg	----	**180**	----	----	**1170**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	----	**53**	----	----	**477**
EP004: Organic Matter								
Organic Matter	----	0.5	%	----	<0.5	----	----	**2.8**

Analytical Results

Sub-Matrix: **SOIL**

Compound	CAS Number	LOR	Unit	WW13 20-30	WW13 70-80	WW15 0-10	WW15 30-40	WW15 90-100
Client sampling date / time				21-SEP-2011 15:00	21-SEP-2011 15:00	22-SEP-2011 15:00	22-SEP-2011 15:00	22-SEP-2011 15:00
				EB1121537-011	EB1121537-012	EB1121537-013	EB1121537-014	EB1121537-015
EA150: Particle Sizing								
+75µm	----	1	%	----	20	8	----	5
+150µm	----	1	%	----	18	5	----	3
+300µm	----	1	%	----	15	3	----	1
+425µm	----	1	%	----	13	2	----	<1
+600µm	----	1	%	----	12	1	----	<1
+1180µm	----	1	%	----	10	<1	----	<1
+2.36mm	----	1	%	----	8	<1	----	<1
+4.75mm	----	1	%	----	5	<1	----	<1
+9.5mm	----	1	%	----	<1	<1	----	<1
+19.0mm	----	1	%	----	<1	<1	----	<1
+37.5mm	----	1	%	----	<1	<1	----	<1
+75.0mm	----	1	%	----	<1	<1	----	<1
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	8.0	8.8	7.6	8.8	8.3
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	90	672	58	278	989
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	13.5	15.2	15.6	18.9	20.1
EA150: Soil Classification based on Particle Size								
Clay (<2 µm)	----	1	%	----	60	74	----	82
Silt (2-60 µm)	----	1	%	----	19	17	----	12
Sand (0.06-2.00 mm)	----	1	%	----	13	9	----	6
Gravel (>2mm)	----	1	%	----	8	<1	----	<1
Cobbles (>6cm)	----	1	%	----	<1	<1	----	<1
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	18.0	26.5	33.2	30.2	24.8
Exchangeable Magnesium	----	0.1	meq/100g	8.6	14.7	20.0	23.2	25.1
Exchangeable Potassium	----	0.1	meq/100g	0.7	0.4	0.5	0.1	0.2
Exchangeable Sodium	----	0.1	meq/100g	0.8	7.0	0.7	7.0	11.4
Cation Exchange Capacity	----	0.1	meq/100g	28.1	48.6	54.5	60.6	61.5
ED037: Alkalinity								
Total Alkalinity as CaCO3	----	1	mg/kg	368	558	178	432	140
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/kg	368	507	178	381	140
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/kg	<1	51	<1	51	<1
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	<10	140	10	70	530

Analytical Results

Sub-Matrix: **SOIL**

Compound	CAS Number	LOR	Unit	WW13 20-30	WW13 70-80	WW15 0-10	WW15 30-40	WW15 90-100
			Client sampling date / time	21-SEP-2011 15:00	21-SEP-2011 15:00	22-SEP-2011 15:00	22-SEP-2011 15:00	22-SEP-2011 15:00
				EB1121537-011	EB1121537-012	EB1121537-013	EB1121537-014	EB1121537-015
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/kg	<10	**890**	**30**	**200**	**1630**
ED093S: Soluble Major Cations								
Calcium	7440-70-2	10	mg/kg	**20**	**30**	**10**	<10	**50**
Magnesium	7439-95-4	10	mg/kg	<10	**30**	<10	<10	**40**
Sodium	7440-23-5	10	mg/kg	**70**	**760**	**50**	**320**	**1160**
Potassium	7440-09-7	10	mg/kg	<10	<10	<10	<10	<10
EG005T: Total Metals by ICP-AES								
Boron	7440-42-8	50	mg/kg	----	----	<50	----	----
Cobalt	7440-48-4	2	mg/kg	----	----	**66**	----	----
Copper	7440-50-8	5	mg/kg	----	----	**35**	----	----
Iron	7439-89-6	50	mg/kg	----	----	**57000**	----	----
Manganese	7439-96-5	5	mg/kg	----	----	**732**	----	----
Molybdenum	7439-98-7	2	mg/kg	----	----	<2	----	----
Zinc	7440-66-6	5	mg/kg	----	----	**42**	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	----	----	**3.1**	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	----	----	**1010**	----	----
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	----	----	**1010**	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	----	----	**209**	----	----
EP004: Organic Matter								
Organic Matter	----	0.5	%	----	----	**3.0**	----	----

Analytical Results

Sub-Matrix: **SOIL**

Compound	CAS Number	LOR	Unit	WW22 0-100	WW23 0-100	WW23 300-400	WW23 900-1000	WW28 0-100
Client sampling date / time				22-SEP-2011 15:00	23-SEP-2011 15:00	23-SEP-2011 15:00	23-SEP-2011 15:00	23-SEP-2011 15:00
				EB1121537-016	EB1121537-019	EB1121537-020	EB1121537-021	EB1121537-022
EA150: Particle Sizing								
+75µm	----	1	%	6	----	55	----	45
+150µm	----	1	%	4	----	43	----	38
+300µm	----	1	%	2	----	29	----	26
+425µm	----	1	%	<1	----	22	----	18
+600µm	----	1	%	<1	----	18	----	13
+1180µm	----	1	%	<1	----	12	----	7
+2.36mm	----	1	%	<1	----	3	----	2
+4.75mm	----	1	%	<1	----	<1	----	<1
+9.5mm	----	1	%	<1	----	<1	----	<1
+19.0mm	----	1	%	<1	----	<1	----	<1
+37.5mm	----	1	%	<1	----	<1	----	<1
+75.0mm	----	1	%	<1	----	<1	----	<1
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	7.8	6.1	6.2	6.6	7.3
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	62	142	45	26	150
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	20.4	3.6	7.2	7.6	3.9
EA150: Soil Classification based on Particle Size								
Clay (<2 µm)	----	1	%	80	----	33	----	37
Silt (2-60 µm)	----	1	%	13	----	9	----	15
Sand (0.06-2.00 mm)	----	1	%	7	----	55	----	46
Gravel (>2mm)	----	1	%	<1	----	3	----	2
Cobbles (>6cm)	----	1	%	<1	----	<1	----	<1
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	69.3	2.3	1.8	1.4	6.4
Exchangeable Magnesium	----	0.1	meq/100g	12.7	1.0	1.0	1.5	5.4
Exchangeable Potassium	----	0.1	meq/100g	0.8	0.5	0.3	0.1	2.4
Exchangeable Sodium	----	0.1	meq/100g	<0.1	0.2	<0.1	0.1	0.8
Cation Exchange Capacity	----	0.1	meq/100g	82.8	3.9	3.2	3.2	15.1
ED037: Alkalinity								
Total Alkalinity as CaCO3	----	1	mg/kg	216	51	25	51	152
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/kg	216	51	25	51	152
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/kg	<1	<1	<1	<1	<1
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	<10	20	30	10	50

Analytical Results

Sub-Matrix: **SOIL**

			Client sample ID	WW22 0-100	WW23 0-100	WW23 300-400	WW23 900-1000	WW28 0-100
			Client sampling date / time	22-SEP-2011 15:00	23-SEP-2011 15:00	23-SEP-2011 15:00	23-SEP-2011 15:00	23-SEP-2011 15:00
Compound	CAS Number	LOR	Unit	EB1121537-016	EB1121537-019	EB1121537-020	EB1121537-021	EB1121537-022
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/kg	20	80	20	20	40
ED093S: Soluble Major Cations								
Calcium	7440-70-2	10	mg/kg	60	40	<10	<10	<10
Magnesium	7439-95-4	10	mg/kg	<10	20	<10	<10	<10
Sodium	7440-23-5	10	mg/kg	<10	30	10	20	80
Potassium	7440-09-7	10	mg/kg	<10	60	20	<10	110
EG005T: Total Metals by ICP-AES								
Boron	7440-42-8	50	mg/kg	<50	<50	----	----	<50
Cobalt	7440-48-4	2	mg/kg	33	14	----	----	58
Copper	7440-50-8	5	mg/kg	39	9	----	----	36
Iron	7439-89-6	50	mg/kg	53800	37600	----	----	61000
Manganese	7439-96-5	5	mg/kg	1160	548	----	----	1560
Molybdenum	7439-98-7	2	mg/kg	<2	<2	----	----	<2
Zinc	7440-66-6	5	mg/kg	52	7	----	----	50
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	4.8	42.9	----	----	35.3
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	1820	240	----	----	760
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	1820	280	----	----	800
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	222	114	----	----	198
EP004: Organic Matter								
Organic Matter	----	0.5	%	3.9	<0.5	----	----	1.4

Analytical Results

Sub-Matrix: **SOIL**

Compound	CAS Number	LOR	Unit	WW28 200-300	WW28 700-800	WW36 0-100	WW36 200-300	WW36 700-800
Client sampling date / time				23-SEP-2011 15:00	23-SEP-2011 15:00	24-SEP-2011 15:00	24-SEP-2011 15:00	24-SEP-2011 15:00
				EB1121537-023	EB1121537-024	EB1121537-025	EB1121537-026	EB1121537-027
EA150: Particle Sizing								
+75µm	----	1	%	----	41	53	----	57
+150µm	----	1	%	----	35	40	----	44
+300µm	----	1	%	----	25	21	----	23
+425µm	----	1	%	----	18	12	----	12
+600µm	----	1	%	----	13	7	----	6
+1180µm	----	1	%	----	6	3	----	2
+2.36mm	----	1	%	----	2	<1	----	<1
+4.75mm	----	1	%	----	<1	<1	----	<1
+9.5mm	----	1	%	----	<1	<1	----	<1
+19.0mm	----	1	%	----	<1	<1	----	<1
+37.5mm	----	1	%	----	<1	<1	----	<1
+75.0mm	----	1	%	----	<1	<1	----	<1
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	7.8	7.2	6.9	9.0	9.9
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	49	25	28	199	345
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	13.6	12.2	4.5	7.3	8.8
EA150: Soil Classification based on Particle Size								
Clay (<2 µm)	----	1	%	----	47	36	----	32
Silt (2-60 µm)	----	1	%	----	11	6	----	8
Sand (0.06-2.00 mm)	----	1	%	----	41	57	----	60
Gravel (>2mm)	----	1	%	----	1	1	----	<1
Cobbles (>6cm)	----	1	%	----	<1	<1	----	<1
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	8.1	3.8	9.2	21.8	15.0
Exchangeable Magnesium	----	0.1	meq/100g	9.9	3.6	7.1	10.0	14.4
Exchangeable Potassium	----	0.1	meq/100g	<0.1	<0.1	0.3	<0.1	<0.1
Exchangeable Sodium	----	0.1	meq/100g	2.2	0.7	0.8	1.6	5.6
Cation Exchange Capacity	----	0.1	meq/100g	20.3	8.1	17.4	33.6	35.0
ED037: Alkalinity								
Total Alkalinity as CaCO3	----	1	mg/kg	254	127	102	558	1130
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/kg	254	127	102	456	419
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/kg	<1	<1	<1	102	711
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	10	<10	<10	20	30

Analytical Results

Sub-Matrix: **SOIL**

Compound	CAS Number	LOR	Unit	WW28 200-300	WW28 700-800	WW36 0-100	WW36 200-300	WW36 700-800
			Client sampling date / time	23-SEP-2011 15:00	23-SEP-2011 15:00	24-SEP-2011 15:00	24-SEP-2011 15:00	24-SEP-2011 15:00
				EB1121537-023	EB1121537-024	EB1121537-025	EB1121537-026	EB1121537-027
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/kg	**20**	**20**	**10**	**10**	<10
ED093S: Soluble Major Cations								
Calcium	7440-70-2	10	mg/kg	<10	<10	<10	**10**	<10
Magnesium	7439-95-4	10	mg/kg	<10	<10	<10	<10	<10
Sodium	7440-23-5	10	mg/kg	**40**	**20**	**30**	**210**	**360**
Potassium	7440-09-7	10	mg/kg	<10	<10	<10	<10	<10
EG005T: Total Metals by ICP-AES								
Boron	7440-42-8	50	mg/kg	----	----	<50	----	----
Cobalt	7440-48-4	2	mg/kg	----	----	**7**	----	----
Copper	7440-50-8	5	mg/kg	----	----	**8**	----	----
Iron	7439-89-6	50	mg/kg	----	----	**13500**	----	----
Manganese	7439-96-5	5	mg/kg	----	----	**376**	----	----
Molybdenum	7439-98-7	2	mg/kg	----	----	<2	----	----
Zinc	7440-66-6	5	mg/kg	----	----	**8**	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	----	----	**1.1**	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	----	----	**420**	----	----
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	----	----	**420**	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	----	----	**93**	----	----
EP004: Organic Matter								
Organic Matter	----	0.5	%	----	----	**1.9**	----	----

Analytical Results

Sub-Matrix: **SOIL**

Compound	CAS Number	LOR	Unit	WW38 0-50	WW38 500-600	WW44 0-100	WW44 100-200	WW44 500-600
Client sampling date / time				24-SEP-2011 15:00	24-SEP-2011 15:00	25-SEP-2011 15:00	25-SEP-2011 15:00	25-SEP-2011 15:00
				EB1121537-028	EB1121537-029	EB1121537-030	EB1121537-031	EB1121537-032
EA150: Particle Sizing								
+75µm	----	1	%	----	54	62	----	61
+150µm	----	1	%	----	41	52	----	60
+300µm	----	1	%	----	26	37	----	57
+425µm	----	1	%	----	18	29	----	56
+600µm	----	1	%	----	14	24	----	55
+1180µm	----	1	%	----	9	19	----	52
+2.36mm	----	1	%	----	4	11	----	44
+4.75mm	----	1	%	----	<1	3	----	24
+9.5mm	----	1	%	----	<1	<1	----	<1
+19.0mm	----	1	%	----	<1	<1	----	<1
+37.5mm	----	1	%	----	<1	<1	----	<1
+75.0mm	----	1	%	----	<1	<1	----	<1
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	6.5	7.1	6.3	6.4	6.2
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	30	20	77	8	5
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	8.6	3.7	2.6	6.2	9.3
EA150: Soil Classification based on Particle Size								
Clay (<2 µm)	----	1	%	----	35	28	----	21
Silt (2-60 µm)	----	1	%	----	7	9	----	17
Sand (0.06-2.00 mm)	----	1	%	----	54	52	----	18
Gravel (>2mm)	----	1	%	----	4	11	----	44
Cobbles (>6cm)	----	1	%	----	<1	<1	----	<1
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	3.2	1.4	1.9	1.5	0.8
Exchangeable Magnesium	----	0.1	meq/100g	1.8	1.3	1.3	1.2	2.1
Exchangeable Potassium	----	0.1	meq/100g	0.6	0.2	0.2	<0.1	<0.1
Exchangeable Sodium	----	0.1	meq/100g	<0.1	0.1	0.2	<0.1	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	5.6	3.0	3.7	2.8	3.0
ED037: Alkalinity								
Total Alkalinity as CaCO3	----	1	mg/kg	63	76	63	25	38
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/kg	63	76	63	25	38
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/kg	<1	<1	<1	<1	<1
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	<10	<10	30	<10	<10

Analytical Results

Sub-Matrix: **SOIL**

Compound	CAS Number	LOR	Unit	WW38 0-50	WW38 500-600	WW44 0-100	WW44 100-200	WW44 500-600
Client sampling date / time				24-SEP-2011 15:00	24-SEP-2011 15:00	25-SEP-2011 15:00	25-SEP-2011 15:00	25-SEP-2011 15:00
				EB1121537-028	EB1121537-029	EB1121537-030	EB1121537-031	EB1121537-032
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/kg	20	20	80	<10	<10
ED093S: Soluble Major Cations								
Calcium	7440-70-2	10	mg/kg	<10	<10	10	<10	<10
Magnesium	7439-95-4	10	mg/kg	<10	<10	<10	<10	<10
Sodium	7440-23-5	10	mg/kg	<10	20	40	<10	<10
Potassium	7440-09-7	10	mg/kg	30	<10	20	<10	<10
EG005T: Total Metals by ICP-AES								
Boron	7440-42-8	50	mg/kg	<50	----	<50	----	----
Cobalt	7440-48-4	2	mg/kg	6	----	32	----	----
Copper	7440-50-8	5	mg/kg	7	----	13	----	----
Iron	7439-89-6	50	mg/kg	21500	----	48800	----	----
Manganese	7439-96-5	5	mg/kg	513	----	1010	----	----
Molybdenum	7439-98-7	2	mg/kg	<2	----	<2	----	----
Zinc	7440-66-6	5	mg/kg	<5	----	11	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	1.3	----	0.2	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	740	----	260	----	----
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	740	----	260	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	188	----	224	----	----
EP004: Organic Matter								
Organic Matter	----	0.5	%	2.1	----	1.2	----	----

Analytical Results

Sub-Matrix: **SOIL**

Compound	CAS Number	LOR	Unit	WW47 0-100	WW60 0-20	WW60 20-300	WW60 700-800	WW69 0-50
Client sampling date / time				26-SEP-2011 15:00	27-SEP-2011 15:00	27-SEP-2011 15:00	27-SEP-2011 15:00	27-SEP-2011 15:00
				EB1121537-033	EB1121537-035	EB1121537-036	EB1121537-037	EB1121537-038
EA150: Particle Sizing								
+75µm	----	1	%	29	8	----	50	----
+150µm	----	1	%	24	6	----	49	----
+300µm	----	1	%	16	4	----	48	----
+425µm	----	1	%	12	3	----	47	----
+600µm	----	1	%	8	2	----	45	----
+1180µm	----	1	%	5	2	----	41	----
+2.36mm	----	1	%	2	<1	----	33	----
+4.75mm	----	1	%	<1	<1	----	22	----
+9.5mm	----	1	%	<1	<1	----	8	----
+19.0mm	----	1	%	<1	<1	----	<1	----
+37.5mm	----	1	%	<1	<1	----	<1	----
+75.0mm	----	1	%	<1	<1	----	<1	----
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	6.6	7.2	7.6	8.7	6.7
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	12	42	20	87	34
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	12.0	13.3	26.4	17.5	8.5
EA150: Soil Classification based on Particle Size								
Clay (<2 µm)	----	1	%	53	70	----	26	----
Silt (2-60 µm)	----	1	%	17	22	----	22	----
Sand (0.06-2.00 mm)	----	1	%	28	8	----	19	----
Gravel (>2mm)	----	1	%	2	<1	----	33	----
Cobbles (>6cm)	----	1	%	<1	<1	----	<1	----
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	8.8	42.6	45.7	61.1	10.6
Exchangeable Magnesium	----	0.1	meq/100g	6.5	23.4	23.9	25.0	6.4
Exchangeable Potassium	----	0.1	meq/100g	0.1	1.1	0.2	<0.1	0.3
Exchangeable Sodium	----	0.1	meq/100g	0.3	0.1	0.6	0.7	<0.1
Cation Exchange Capacity	----	0.1	meq/100g	15.7	67.2	70.4	86.8	17.4
ED037: Alkalinity								
Total Alkalinity as CaCO3	----	1	mg/kg	51	140	216	306	114
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/kg	51	140	216	306	114
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/kg	<1	<1	<1	<1	<1
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	<10	<10	<10	<10	<10

Analytical Results

Sub-Matrix: **SOIL**

Compound	CAS Number	LOR	Unit	WW47 0-100	WW60 0-20	WW60 20-300	WW60 700-800	WW69 0-50
Client sampling date / time				26-SEP-2011 15:00	27-SEP-2011 15:00	27-SEP-2011 15:00	27-SEP-2011 15:00	27-SEP-2011 15:00
				EB1121537-033	EB1121537-035	EB1121537-036	EB1121537-037	EB1121537-038
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/kg	<10	10	<10	<10	20
ED093S: Soluble Major Cations								
Calcium	7440-70-2	10	mg/kg	<10	20	<10	40	10
Magnesium	7439-95-4	10	mg/kg	<10	<10	<10	20	<10
Sodium	7440-23-5	10	mg/kg	10	<10	20	50	<10
Potassium	7440-09-7	10	mg/kg	<10	10	<10	<10	10
EG005T: Total Metals by ICP-AES								
Boron	7440-42-8	50	mg/kg	<50	<50	----	----	<50
Cobalt	7440-48-4	2	mg/kg	52	183	----	----	58
Copper	7440-50-8	5	mg/kg	34	60	----	----	26
Iron	7439-89-6	50	mg/kg	71600	57200	----	----	76700
Manganese	7439-96-5	5	mg/kg	1180	2660	----	----	1170
Molybdenum	7439-98-7	2	mg/kg	<2	<2	----	----	<2
Zinc	7440-66-6	5	mg/kg	35	194	----	----	28
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	0.4	2.3	----	----	1.7
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	630	1230	----	----	1640
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	630	1230	----	----	1640
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	280	202	----	----	400
EP004: Organic Matter								
Organic Matter	----	0.5	%	2.4	2.3	----	----	3.6

Analytical Results

Sub-Matrix: **SOIL**

Compound	CAS Number	LOR	Unit	WW69 200-300	WW69 800-900	WW75 0-50	WW75 400-500	WW75 900-1000
Client sampling date / time				27-SEP-2011 15:00	27-SEP-2011 15:00	27-SEP-2011 15:00	27-SEP-2011 15:00	27-SEP-2011 15:00
				EB1121537-039	EB1121537-040	EB1121537-041	EB1121537-042	EB1121537-043
EA150: Particle Sizing								
+75µm	----	1	%	33	----	6	6	----
+150µm	----	1	%	29	----	4	3	----
+300µm	----	1	%	21	----	2	2	----
+425µm	----	1	%	16	----	1	1	----
+600µm	----	1	%	12	----	<1	<1	----
+1180µm	----	1	%	6	----	<1	<1	----
+2.36mm	----	1	%	2	----	<1	<1	----
+4.75mm	----	1	%	<1	----	<1	<1	----
+9.5mm	----	1	%	<1	----	<1	<1	----
+19.0mm	----	1	%	<1	----	<1	<1	----
+37.5mm	----	1	%	<1	----	<1	<1	----
+75.0mm	----	1	%	<1	----	<1	<1	----
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	7.5	7.5	7.4	8.7	9.0
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	14	26	41	52	97
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	17.1	14.7	15.6	26.4	14.1
EA150: Soil Classification based on Particle Size								
Clay (<2 µm)	----	1	%	54	----	70	75	----
Silt (2-60 µm)	----	1	%	12	----	22	16	----
Sand (0.06-2.00 mm)	----	1	%	32	----	8	9	----
Gravel (>2mm)	----	1	%	2	----	<1	<1	----
Cobbles (>6cm)	----	1	%	<1	----	<1	<1	----
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	13.7	17.0	47.0	47.5	31.3
Exchangeable Magnesium	----	0.1	meq/100g	11.1	12.6	27.4	30.9	21.2
Exchangeable Potassium	----	0.1	meq/100g	<0.1	<0.1	0.6	0.1	<0.1
Exchangeable Sodium	----	0.1	meq/100g	0.4	1.4	0.3	3.1	2.8
Cation Exchange Capacity	----	0.1	meq/100g	25.3	31.0	75.4	81.6	55.3
ED037: Alkalinity								
Total Alkalinity as CaCO3	----	1	mg/kg	63	51	140	228	317
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/kg	63	51	140	228	266
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/kg	<1	<1	<1	<1	51
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	<10	30	20	10	20

Analytical Results

Sub-Matrix: **SOIL**

Compound	CAS Number	LOR	Unit	WW69 200-300	WW69 800-900	WW75 0-50	WW75 400-500	WW75 900-1000
			Client sampling date / time	27-SEP-2011 15:00	27-SEP-2011 15:00	27-SEP-2011 15:00	27-SEP-2011 15:00	27-SEP-2011 15:00
				EB1121537-039	EB1121537-040	EB1121537-041	EB1121537-042	EB1121537-043
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/kg	<10	**10**	**10**	<10	**20**
ED093S: Soluble Major Cations								
Calcium	7440-70-2	10	mg/kg	<10	<10	**20**	<10	<10
Magnesium	7439-95-4	10	mg/kg	<10	<10	<10	<10	<10
Sodium	7440-23-5	10	mg/kg	**20**	**30**	**20**	**80**	**140**
Potassium	7440-09-7	10	mg/kg	<10	<10	<10	<10	<10
EG005T: Total Metals by ICP-AES								
Boron	7440-42-8	50	mg/kg	----	----	<50	----	----
Cobalt	7440-48-4	2	mg/kg	----	----	**46**	----	----
Copper	7440-50-8	5	mg/kg	----	----	**26**	----	----
Iron	7439-89-6	50	mg/kg	----	----	**42300**	----	----
Manganese	7439-96-5	5	mg/kg	----	----	**732**	----	----
Molybdenum	7439-98-7	2	mg/kg	----	----	<2	----	----
Zinc	7440-66-6	5	mg/kg	----	----	**60**	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	----	----	**2.9**	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	----	----	**1120**	----	----
EK062: Total Nitrogen as N (TKN + NOx)								
^ Total Nitrogen as N	----	20	mg/kg	----	----	**1120**	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	----	----	**135**	----	----
EP004: Organic Matter								
Organic Matter	----	0.5	%	----	----	**2.5**	----	----

Analytical Results

Sub-Matrix: SOIL			Client sample ID	WW94 0-50	WW94 200-300	WW94 600-700	----	----
			Client sampling date / time	28-SEP-2011 15:00	29-SEP-2011 15:00	30-SEP-2011 15:00	----	----
Compound	CAS Number	LOR	Unit	EB1121537-044	EB1121537-045	EB1121537-046	----	----
EA150: Particle Sizing								
+75µm	----	1	%	4	----	36	----	----
+150µm	----	1	%	2	----	34	----	----
+300µm	----	1	%	1	----	32	----	----
+425µm	----	1	%	<1	----	32	----	----
+600µm	----	1	%	<1	----	30	----	----
+1180µm	----	1	%	<1	----	26	----	----
+2.36mm	----	1	%	<1	----	19	----	----
+4.75mm	----	1	%	<1	----	8	----	----
+9.5mm	----	1	%	<1	----	<1	----	----
+19.0mm	----	1	%	<1	----	<1	----	----
+37.5mm	----	1	%	<1	----	<1	----	----
+75.0mm	----	1	%	<1	----	<1	----	----
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	7.6	8.4	8.9	----	----
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	73	83	70	----	----
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1.0	%	10.0	25.4	10.6	----	----
EA150: Soil Classification based on Particle Size								
Clay (<2 µm)	----	1	%	70	----	19	----	----
Silt (2-60 µm)	----	1	%	23	----	41	----	----
Sand (0.06-2.00 mm)	----	1	%	7	----	21	----	----
Gravel (>2mm)	----	1	%	<1	----	19	----	----
Cobbles (>6cm)	----	1	%	<1	----	<1	----	----
ED007: Exchangeable Cations								
Exchangeable Calcium	----	0.1	meq/100g	66.7	73.4	50.1	----	----
Exchangeable Magnesium	----	0.1	meq/100g	17.0	15.9	10.1	----	----
Exchangeable Potassium	----	0.1	meq/100g	1.1	0.3	<0.1	----	----
Exchangeable Sodium	----	0.1	meq/100g	<0.1	0.2	0.3	----	----
Cation Exchange Capacity	----	0.1	meq/100g	85.0	89.9	60.6	----	----
ED037: Alkalinity								
Total Alkalinity as CaCO3	----	1	mg/kg	228	254	317	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/kg	228	254	292	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/kg	<1	<1	25	----	----
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	<10	<10	<10	----	----

Analytical Results

Sub-Matrix: **SOIL**

Compound	CAS Number	LOR	Unit	WW94 0-50	WW94 200-300	WW94 600-700	----	----
			Client sampling date / time	28-SEP-2011 15:00	29-SEP-2011 15:00	30-SEP-2011 15:00	----	----
				EB1121537-044	**EB1121537-045**	**EB1121537-046**	**----**	**----**
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	10	mg/kg	<10	<10	<10	----	----
ED093S: Soluble Major Cations								
Calcium	7440-70-2	10	mg/kg	**60**	**90**	**50**	----	----
Magnesium	7439-95-4	10	mg/kg	**10**	**10**	**10**	----	----
Sodium	7440-23-5	10	mg/kg	<10	**10**	**30**	----	----
Potassium	7440-09-7	10	mg/kg	**10**	<10	<10	----	----
EG005T: Total Metals by ICP-AES								
Boron	7440-42-8	50	mg/kg	<50	----	----	----	----
Cobalt	7440-48-4	2	mg/kg	**40**	----	----	----	----
Copper	7440-50-8	5	mg/kg	**36**	----	----	----	----
Iron	7439-89-6	50	mg/kg	**53000**	----	----	----	----
Manganese	7439-96-5	5	mg/kg	**1100**	----	----	----	----
Molybdenum	7439-98-7	2	mg/kg	<2	----	----	----	----
Zinc	7440-66-6	5	mg/kg	**65**	----	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	**4.3**	----	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	20	mg/kg	**1210**	----	----	----	----
EK062: Total Nitrogen as N (TKN + NOx)								
^ **Total Nitrogen as N**	----	20	mg/kg	**1210**	----	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	2	mg/kg	**311**	----	----	----	----
EP004: Organic Matter								
Organic Matter	----	0.5	%	**2.2**	----	----	----	----

Certificate of Analysis

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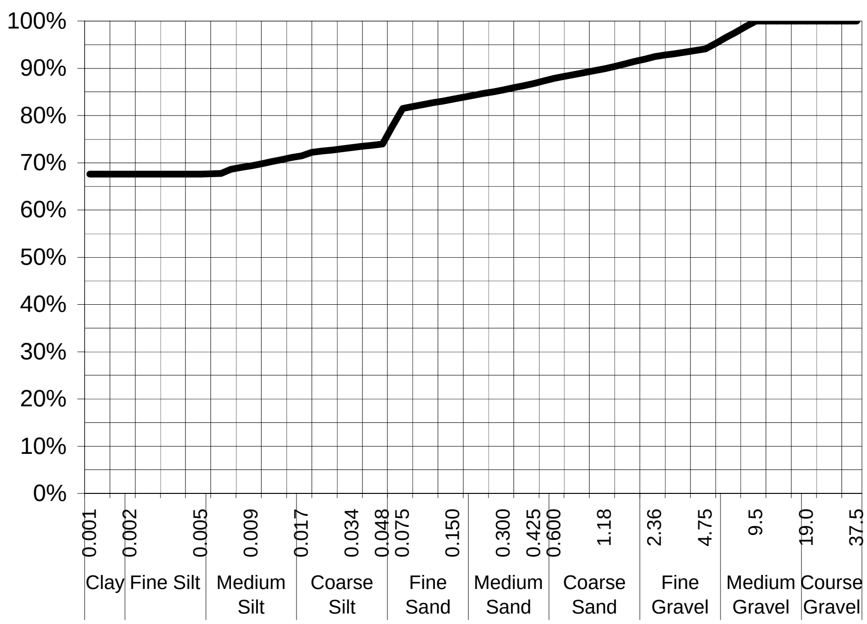
ALS Environmental

Newcastle, NSW

CLIENT:	Timothy Rohde	**DATE REPORTED:**	26-Oct-2011
COMPANY:	Sinclair Knight Merz	**DATE RECEIVED:**	17-Oct-2011
ADDRESS:	P O Box 312 Flinders Lane Melbourne, Vic Australia 8009	**REPORT NO:**	EB1121537-002 / PSD
PROJECT:	QEO9811 400 Wards Well - Land Resources	**SAMPLE ID:**	WW6 20-30

Particle Size Distribution



Particle Size (mm)	Percent Passing
19.0	100%
9.5	100%
4.75	94%
2.36	92%
1.18	90%
0.600	88%
0.425	87%
0.300	85%
0.150	83%
0.075	82%
Particle Size (microns)	
48	74%
34	73%
17	71%
9	69%
5	68%
3	68%
1	68%

Samples analysed as received.

Median Particle Size (mm)	#N/A

Sample Comments:

Analysed: 20-Oct-11

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description: Clay silt and fine sand

Dispersion Method Shaker

Test Method: AS1289.3.6.2/AS1289.3.6.3

Hydrometer Type ASTM E100

Soil Particle Density 2.65 g/cm^3 Assumed

NATA Accreditation: 825 Site: Newcastle
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Dianne Blane
Laboratory Supervisor, Newcastle
Authorised Signatory

Certificate of Analysis

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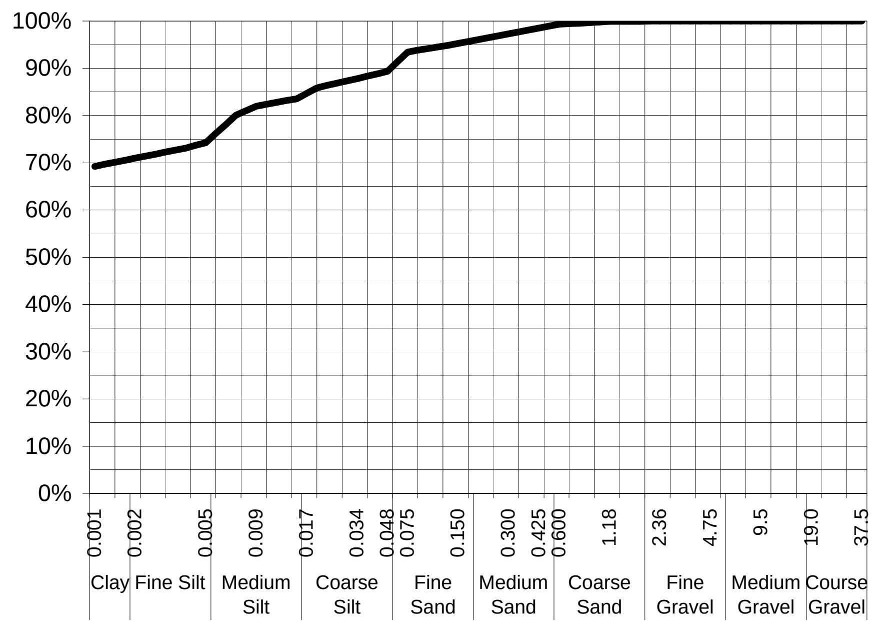
COMPANY:	Sinclair Knight Merz	**DATE RECEIVED:**	17-Oct-2011
ADDRESS:	P O Box 312 Flinders Lane Melbourne, Vic Australia 8009	**REPORT NO:**	EB1121537-006 / PSD
PROJECT:	QEO9811 400 Wards Well - Land Resources	**SAMPLE ID:**	WW9 800-900

Particle Size Distribution



Particle Size (mm)	Percent Passing
19.0	100%
9.5	100%
4.75	100%
2.36	100%
1.18	100%
0.600	99%
0.425	99%
0.300	97%
0.150	95%
0.075	93%
Particle Size (microns)	
48	89%
34	88%
17	85%
9	82%
5	74%
3	73%
1	69%

Samples analysed as received.

Median Particle Size (mm)	#N/A

Sample Comments:		**Analysed:**	20-Oct-11
Loss on Pretreatment	NA	**Limit of Reporting:**	1%
Sample Description:	Clay silt and fine sand	**Dispersion Method**	Shaker
Test Method:	AS1289.3.6.2/AS1289.3.6.3	**Hydrometer Type**	ASTM E100
Soil Particle Density	2.65 g/cm^3 Assumed		

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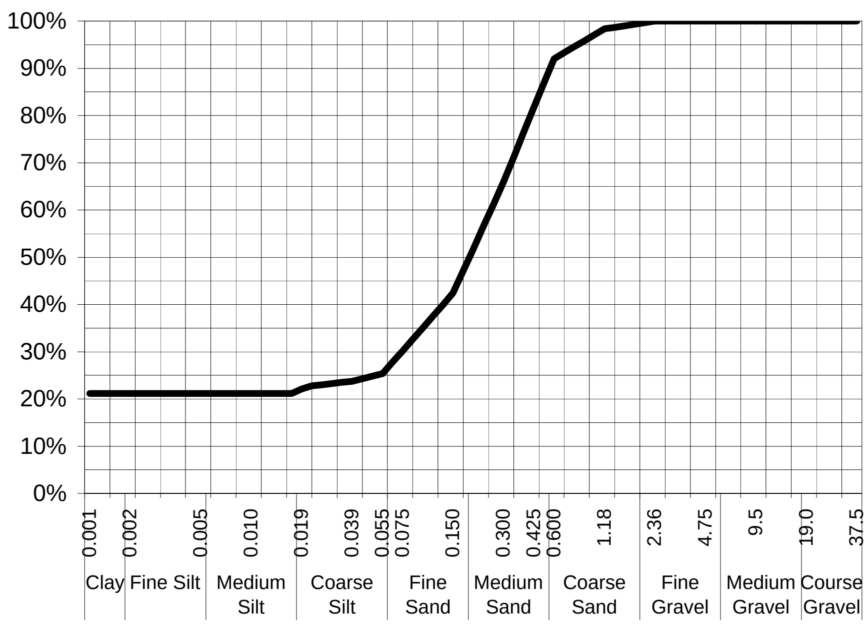
ALS Environmental

Newcastle, NSW

CLIENT:	Timothy Rohde	**DATE REPORTED:**	26-Oct-2011
COMPANY:	Sinclair Knight Merz	**DATE RECEIVED:**	17-Oct-2011
ADDRESS:	P O Box 312 Flinders Lane Melbourne, Vic Australia 8009	**REPORT NO:**	EB1121537-007 / PSD
PROJECT:	QEO9811 400 Wards Well - Land Resources	**SAMPLE ID:**	WW10 0-100

Particle Size Distribution



Particle Size (mm)	Percent Passing
19.0	100%
9.5	100%
4.75	100%
2.36	100%
1.18	98%
0.600	92%
0.425	82%
0.300	66%
0.150	42%
0.075	30%
Particle Size (microns)	
55	25%
39	24%
19	22%
10	21%
5	21%
4	21%
1	21%

Samples analysed as received.

Median Particle Size (mm)	0.150

Sample Comments:		**Analysed:**	20-Oct-11
Loss on Pretreatment	NA	**Limit of Reporting:**	1%
Sample Description:	Medium fine sand and clay	**Dispersion Method**	Shaker
Test Method:	AS1289.3.6.2/AS1289.3.6.3	**Hydrometer Type**	ASTM E100

Soil Particle Density 2.65 g/cm^3 Assumed

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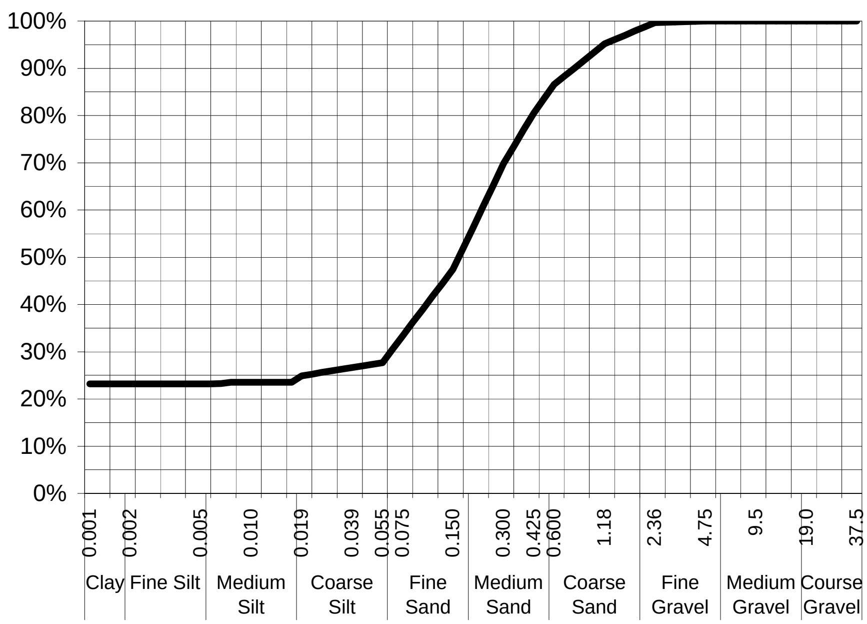
ALS Environmental

Newcastle, NSW

CLIENT:	Timothy Rohde	**DATE REPORTED:**	26-Oct-2011
COMPANY:	Sinclair Knight Merz	**DATE RECEIVED:**	17-Oct-2011
ADDRESS:	P O Box 312 Flinders Lane Melbourne, Vic Australia 8009	**REPORT NO:**	EB1121537-009 / PSD
PROJECT:	QEO9811 400 Wards Well - Land Resources	**SAMPLE ID:**	WW13 1000-1100

Particle Size Distribution



Particle Size (mm)	Percent Passing
19.0	100%
9.5	100%
4.75	100%
2.36	100%
1.18	95%
0.600	87%
0.425	81%
0.300	70%
0.150	47%
0.075	33%
Particle Size (microns)	
55	28%
39	27%
19	25%
10	24%
5	23%
4	23%
1	23%

Samples analysed as received.

Median Particle Size (mm)	0.150

Sample Comments:

Analysed: 20-Oct-11

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description: Medium fine sand and clay

Dispersion Method Shaker

Test Method: AS1289.3.6.2/AS1289.3.6.3

Hydrometer Type ASTM E100

Soil Particle Density 2.65 g/cm^3 Assumed

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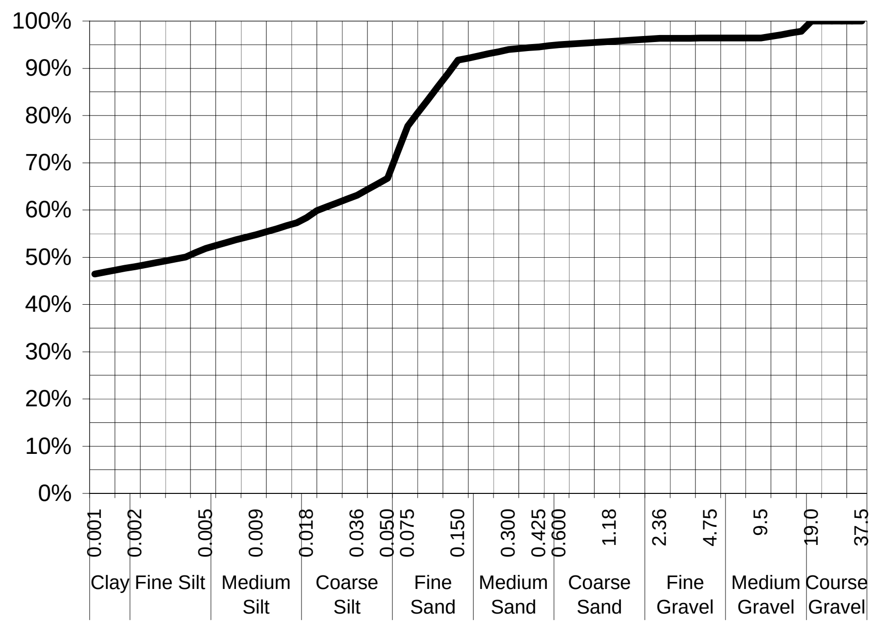
ALS Environmental

Newcastle, NSW

CLIENT:	Timothy Rohde	**DATE REPORTED:**	26-Oct-2011
COMPANY:	Sinclair Knight Merz	**DATE RECEIVED:**	17-Oct-2011
ADDRESS:	P O Box 312 Flinders Lane Melbourne, Vic Australia 8009	**REPORT NO:**	EB1121537-010 / PSD
PROJECT:	QEO9811 400 Wards Well - Land Resources	**SAMPLE ID:**	WW13 0-50

Particle Size Distribution



Particle Size (mm)	Percent Passing
19.0	100%
9.5	96%
4.75	96%
2.36	96%
1.18	96%
0.600	95%
0.425	95%
0.300	94%
0.150	92%
0.075	78%
Particle Size (microns)	
50	67%
36	63%
18	58%
9	55%
5	52%
3	50%
1	46%

Samples analysed as received.

Median Particle Size (mm)	0.004

Sample Comments:

Analysed: 20-Oct-11

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description: Clay silt, fine sand and vegetation

Dispersion Method Shaker

Test Method: AS1289.3.6.2/AS1289.3.6.3

Hydrometer Type ASTM E100

Soil Particle Density 2.65 g/cm^3 Assumed

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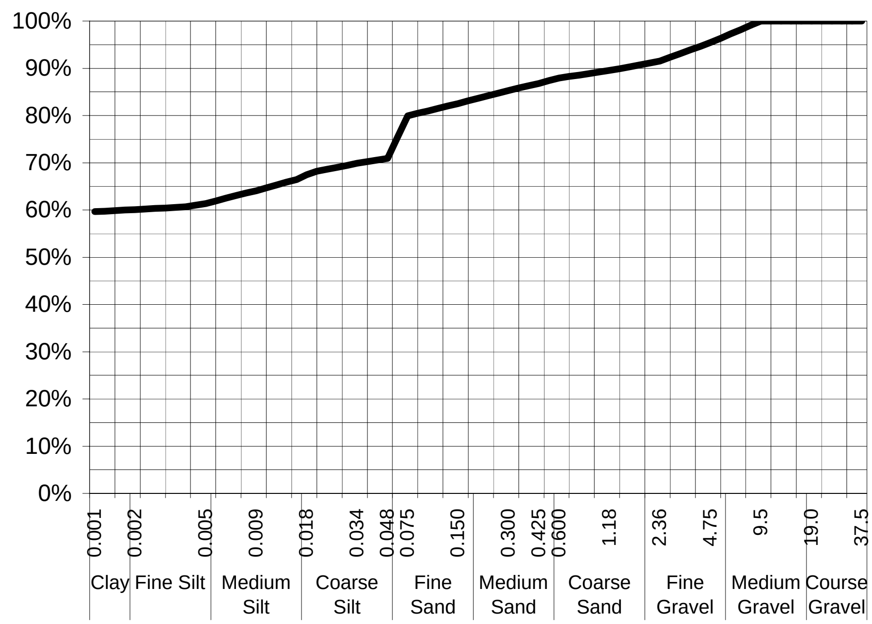
COMPANY:	Sinclair Knight Merz	**DATE RECEIVED:**	17-Oct-2011
ADDRESS:	P O Box 312 Flinders Lane Melbourne, Vic Australia 8009	**REPORT NO:**	EB1121537-012 / PSD
PROJECT:	QEO9811 400 Wards Well - Land Resources	**SAMPLE ID:**	WW13 70-80

Particle Size Distribution



Particle Size (mm)	Percent Passing
19.0	100%
9.5	100%
4.75	95%
2.36	92%
1.18	90%
0.600	88%
0.425	87%
0.300	85%
0.150	83%
0.075	80%
Particle Size (microns)	
48	71%
34	70%
18	67%
9	64%
5	61%
3	61%
1	60%

Samples analysed as received.

Median Particle Size (mm)	#N/A

Sample Comments:		**Analysed:**	20-Oct-11
Loss on Pretreatment	NA	**Limit of Reporting:**	1%
Sample Description:	Clay silt and fine sand	**Dispersion Method**	Shaker
Test Method:	AS1289.3.6.2/AS1289.3.6.3	**Hydrometer Type**	ASTM E100

Soil Particle Density 2.65 g/cm^3 Assumed

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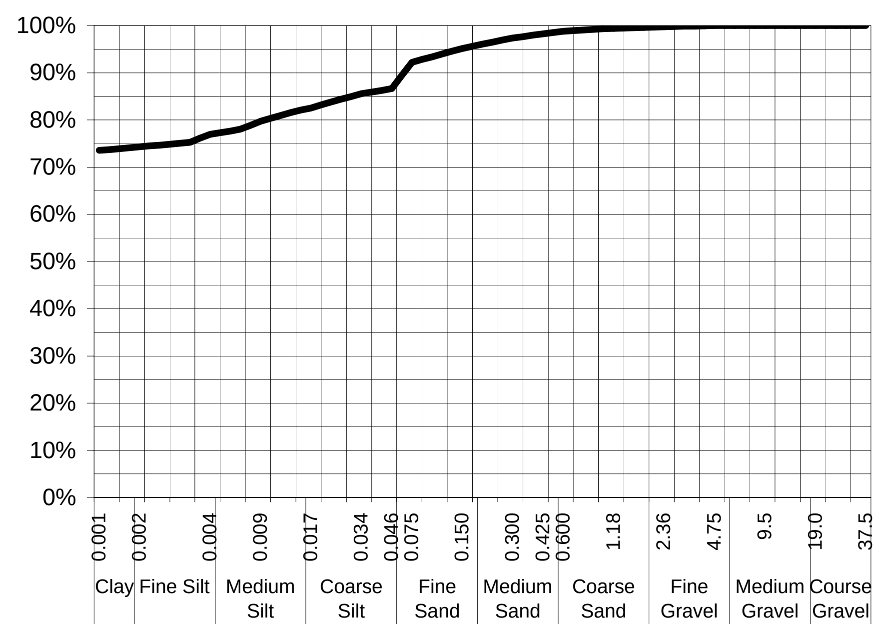
COMPANY:	Sinclair Knight Merz	**DATE RECEIVED:**	17-Oct-2011
ADDRESS:	P O Box 312 Flinders Lane Melbourne, Vic Australia 8009	**REPORT NO:**	EB1121537-013 / PSD
PROJECT:	QEO9811 400 Wards Well - Land Resources	**SAMPLE ID:**	WW15 0-10

Particle Size Distribution



Particle Size (mm)	Percent Passing
19.0	100%
9.5	100%
4.75	100%
2.36	100%
1.18	99%
0.600	99%
0.425	98%
0.300	97%
0.150	95%
0.075	92%
Particle Size (microns)	
46	87%
34	86%
17	82%
9	80%
4	77%
3	75%
1	74%

Samples analysed as received.

Median Particle Size (mm)	#N/A

Sample Comments:		**Analysed:**	20-Oct-11
Loss on Pretreatment	NA	**Limit of Reporting:**	1%
Sample Description:	Clay silt and vegetation	**Dispersion Method**	Shaker
Test Method:	AS1289.3.6.2/AS1289.3.6.3	**Hydrometer Type**	ASTM E100
Soil Particle Density	2.65 g/cm^3 Assumed		

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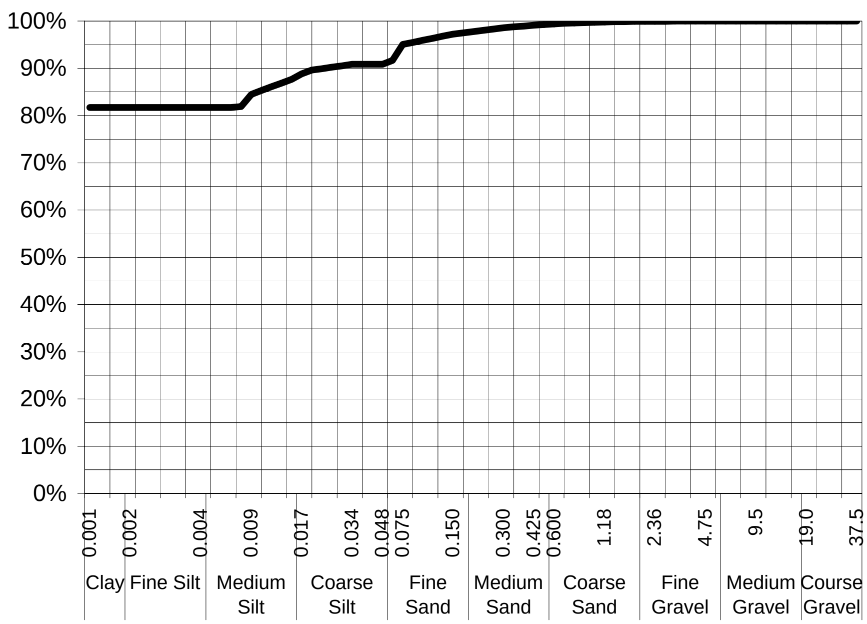
COMPANY:	Sinclair Knight Merz	**DATE RECEIVED:**	17-Oct-2011
ADDRESS:	P O Box 312 Flinders Lane Melbourne, Vic Australia 8009	**REPORT NO:**	EB1121537-015 / PSD
PROJECT:	QEO9811 400 Wards Well - Land Resources	**SAMPLE ID:**	WW15 90-100

Particle Size Distribution



Particle Size (mm)	Percent Passing
19.0	100%
9.5	100%
4.75	100%
2.36	100%
1.18	100%
0.600	99%
0.425	99%
0.300	99%
0.150	97%
0.075	95%
Particle Size (microns)	
48	91%
34	91%
17	89%
9	84%
4	82%
3	82%
1	82%

Samples analysed as received.

Median Particle Size (mm)	#N/A

Sample Comments:		**Analysed:**	20-Oct-11
Loss on Pretreatment	NA	**Limit of Reporting:**	1%
Sample Description:	Clay silt	**Dispersion Method**	Shaker
Test Method:	AS1289.3.6.2/AS1289.3.6.3	**Hydrometer Type**	ASTM E100
Soil Particle Density	2.65 g/cm^3 Assumed		

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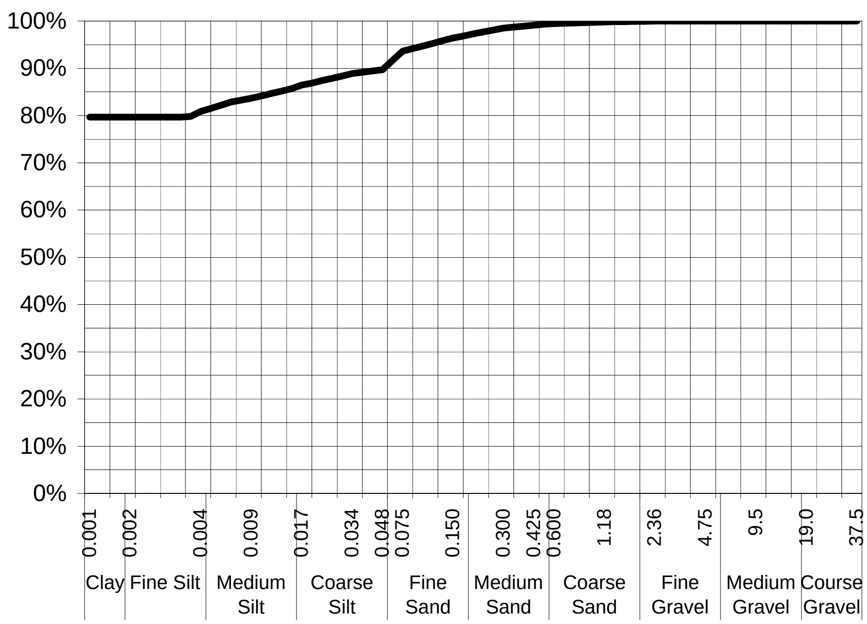
COMPANY:	Sinclair Knight Merz	**DATE RECEIVED:**	17-Oct-2011
ADDRESS:	P O Box 312 Flinders Lane Melbourne, Vic Australia 8009	**REPORT NO:**	EB1121537-016 / PSD
PROJECT:	QEO9811 400 Wards Well - Land Resources	**SAMPLE ID:**	WW22 0-100

Particle Size Distribution



Particle Size (mm)	Percent Passing
19.0	100%
9.5	100%
4.75	100%
2.36	100%
1.18	100%
0.600	99%
0.425	99%
0.300	99%
0.150	96%
0.075	94%
Particle Size (microns)	
48	90%
34	89%
17	86%
9	84%
4	81%
3	80%
1	80%

Samples analysed as received.

Median Particle Size (mm)	#N/A

Sample Comments:

Analysed: 20-Oct-11

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description: Clay silt

Dispersion Method Shaker

Test Method: AS1289.3.6.2/AS1289.3.6.3

Hydrometer Type ASTM E100

Soil Particle Density 2.65 g/cm^3 Assumed

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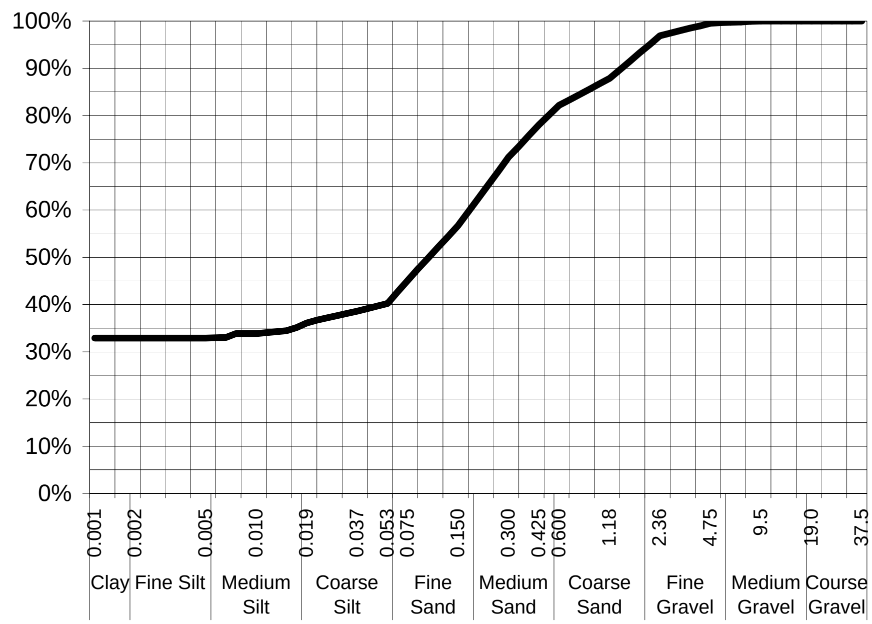
COMPANY:	Sinclair Knight Merz	**DATE RECEIVED:**	17-Oct-2011
ADDRESS:	P O Box 312 Flinders Lane Melbourne, Vic Australia 8009	**REPORT NO:**	EB1121537-020 / PSD
PROJECT:	QEO9811 400 Wards Well - Land Resources	**SAMPLE ID:**	WW23 300-400

Particle Size Distribution



Particle Size (mm)	Percent Passing
19.0	100%
9.5	100%
4.75	100%
2.36	97%
1.18	88%
0.600	82%
0.425	78%
0.300	71%
0.150	57%
0.075	45%
Particle Size (microns)	
53	40%
37	39%
19	36%
10	34%
5	33%
3	33%
1	33%

Samples analysed as received.

Median Particle Size (mm)	0.075

Sample Comments:

Analysed: 20-Oct-11

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description: Medium fine sand and clay

Dispersion Method Shaker

Test Method: AS1289.3.6.2/AS1289.3.6.3

Hydrometer Type ASTM E100

Soil Particle Density 2.65 g/cm^3 Assumed

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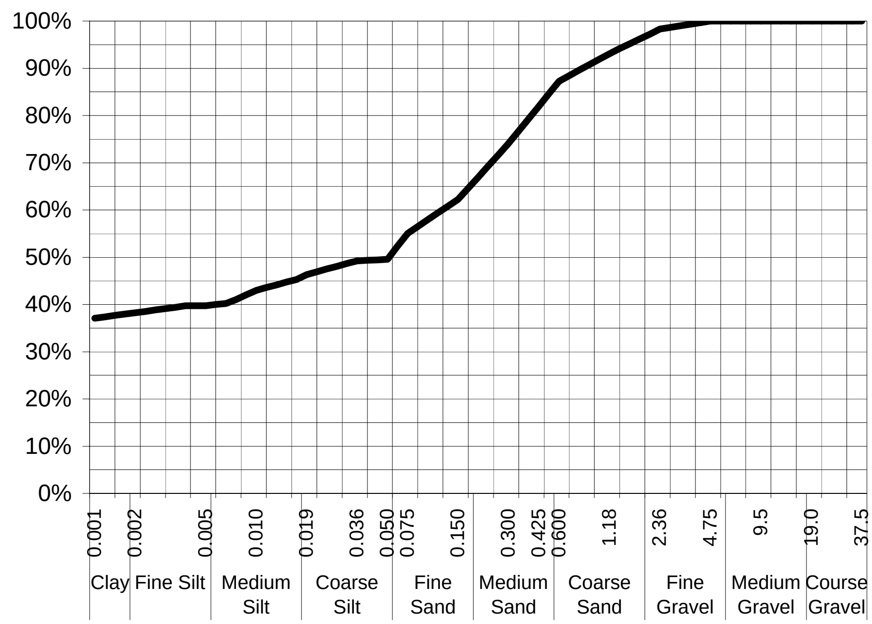
COMPANY:	Sinclair Knight Merz	**DATE RECEIVED:**	17-Oct-2011
ADDRESS:	P O Box 312 Flinders Lane Melbourne, Vic Australia 8009	**REPORT NO:**	EB1121537-022 / PSD
PROJECT:	QEO9811 400 Wards Well - Land Resources	**SAMPLE ID:**	WW28 0-100

Particle Size Distribution



Particle Size (mm)	Percent Passing
19.0	100%
9.5	100%
4.75	100%
2.36	98%
1.18	93%
0.600	87%
0.425	82%
0.300	74%
0.150	62%
0.075	55%
Particle Size (microns)	
50	50%
36	49%
19	46%
10	43%
5	40%
3	40%
1	37%

Samples analysed as received.

Median Particle Size (mm)	0.050

Sample Comments:

Analysed: 20-Oct-11

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description: Medium fine sand, silty clay and vegetation

Dispersion Method Shaker

Test Method: AS1289.3.6.2/AS1289.3.6.3

Hydrometer Type ASTM E100

Soil Particle Density 2.65 g/cm^3 Assumed

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COMPANY:	Sinclair Knight Merz	**DATE RECEIVED:**	17-Oct-2011
ADDRESS:	P O Box 312 Flinders Lane Melbourne, Vic Australia 8009	**REPORT NO:**	EB1121537-024 / PSD
PROJECT:	QEO9811 400 Wards Well - Land Resources	**SAMPLE ID:**	WW28 700-800

Particle Size Distribution

Particle Size (mm)	Percent Passing
19.0	100%
9.5	100%
4.75	100%
2.36	99%
1.18	94%
0.600	87%
0.425	82%
0.300	75%
0.150	65%
0.075	59%
Particle Size (microns)	
50	55%
37	53%
19	53%
10	51%
5	49%
3	49%
1	47%

Samples analysed as received.

Median Particle Size (mm)	0.008

Sample Comments:

Analysed: 20-Oct-11

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description: Medium fine sand and silty clay

Dispersion Method Shaker

Test Method: AS1289.3.6.2/AS1289.3.6.3

Hydrometer Type ASTM E100

Soil Particle Density 2.65 g/cm^3 Assumed

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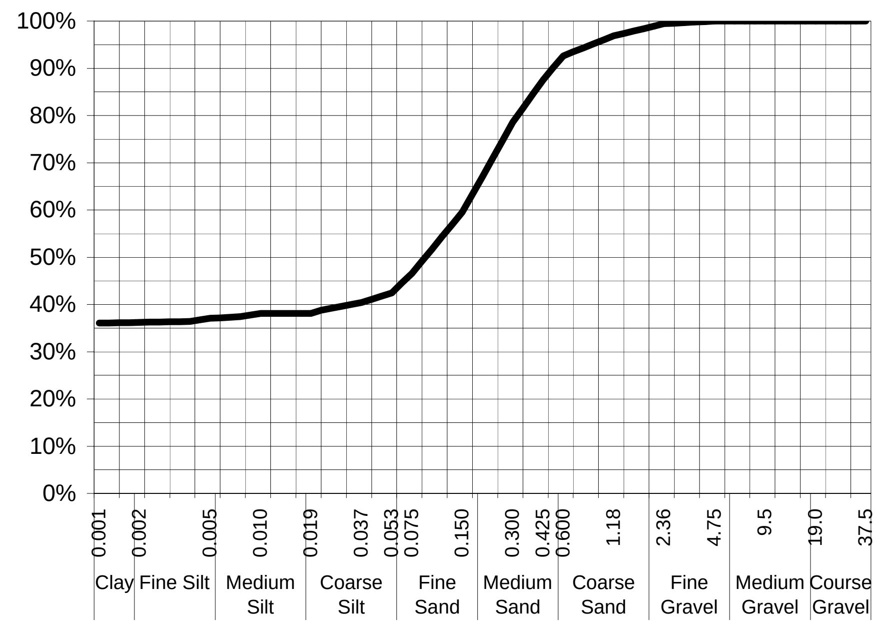
COMPANY:	Sinclair Knight Merz	**DATE RECEIVED:**	17-Oct-2011
ADDRESS:	P O Box 312 Flinders Lane Melbourne, Vic Australia 8009	**REPORT NO:**	EB1121537-025 / PSD
PROJECT:	QEO9811 400 Wards Well - Land Resources	**SAMPLE ID:**	WW36 0-100

Particle Size Distribution



Particle Size (mm)	Percent Passing
19.0	100%
9.5	100%
4.75	100%
2.36	99%
1.18	97%
0.600	93%
0.425	88%
0.300	79%
0.150	60%
0.075	47%
Particle Size (microns)	
53	42%
37	40%
19	38%
10	38%
5	37%
3	36%
1	36%

Median Particle Size (mm)	0.075

Samples analysed as received.

Sample Comments:		**Analysed:**	20-Oct-11
Loss on Pretreatment	NA	**Limit of Reporting:**	1%
Sample Description:	Medium fine sand, clay and vegetation	**Dispersion Method**	Shaker
Test Method:	AS1289.3.6.2/AS1289.3.6.3	**Hydrometer Type**	ASTM E100
Soil Particle Density	2.65 g/cm^3 Assumed		

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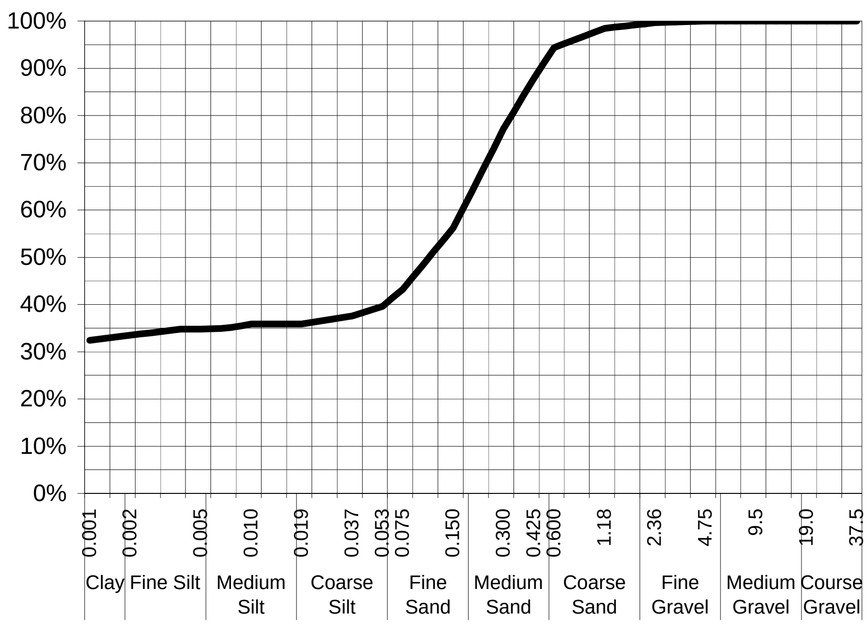
COMPANY:	Sinclair Knight Merz	**DATE RECEIVED:**	17-Oct-2011
ADDRESS:	P O Box 312 Flinders Lane Melbourne, Vic Australia 8009	**REPORT NO:**	EB1121537-027 / PSD
PROJECT:	QEO9811 400 Wards Well - Land Resources	**SAMPLE ID:**	WW36 700-800

Particle Size Distribution



Particle Size (mm)	Percent Passing
19.0	100%
9.5	100%
4.75	100%
2.36	100%
1.18	98%
0.600	94%
0.425	88%
0.300	77%
0.150	56%
0.075	43%
Particle Size (microns)	
53	40%
37	38%
19	36%
10	36%
5	35%
3	35%
1	32%

Samples analysed as received.

Median Particle Size (mm)	0.075

Sample Comments:

Analysed: 20-Oct-11

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description: Medium fine sand and clay

Dispersion Method Shaker

Test Method: AS1289.3.6.2/AS1289.3.6.3

Hydrometer Type ASTM E100

Soil Particle Density 2.65 g/cm^3 Assumed

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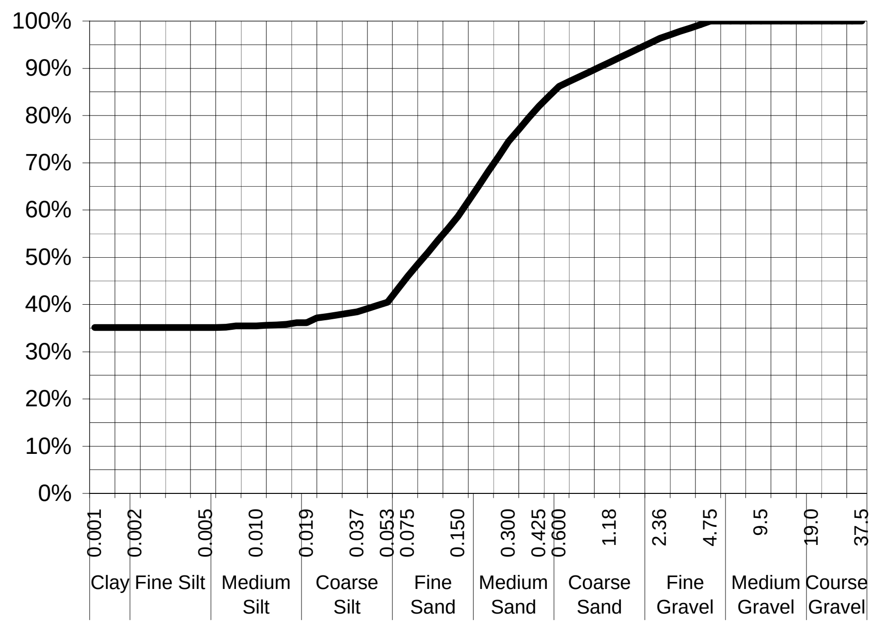
COMPANY:	Sinclair Knight Merz	**DATE RECEIVED:**	17-Oct-2011
ADDRESS:	P O Box 312 Flinders Lane Melbourne, Vic Australia 8009	**REPORT NO:**	EB1121537-029 / PSD
PROJECT:	QEO9811 400 Wards Well - Land Resources	**SAMPLE ID:**	WW38 500-600

Particle Size Distribution



Particle Size (mm)	Percent Passing
19.0	100%
9.5	100%
4.75	100%
2.36	96%
1.18	91%
0.600	86%
0.425	82%
0.300	75%
0.150	59%
0.075	46%
Particle Size (microns)	
53	40%
37	38%
19	36%
10	35%
5	35%
3	35%
1	35%

Samples analysed as received.

Median Particle Size (mm)	0.075

Sample Comments:

Analysed: 20-Oct-11

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description: Medium fine sand and clay

Dispersion Method Shaker

Test Method: AS1289.3.6.2/AS1289.3.6.3

Hydrometer Type ASTM E100

Soil Particle Density 2.65 g/cm^3 Assumed

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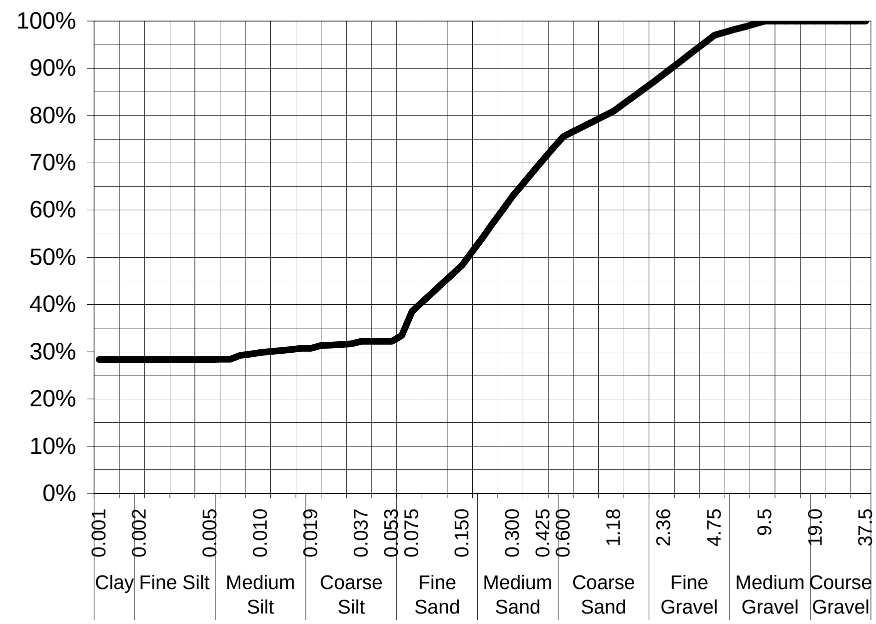
COMPANY:	Sinclair Knight Merz	**DATE RECEIVED:**	17-Oct-2011
ADDRESS:	P O Box 312 Flinders Lane Melbourne, Vic Australia 8009	**REPORT NO:**	EB1121537-030 / PSD
PROJECT:	QEO9811 400 Wards Well - Land Resources	**SAMPLE ID:**	WW44 0-100

Particle Size Distribution



Particle Size (mm)	Percent Passing
19.0	100%
9.5	100%
4.75	97%
2.36	89%
1.18	81%
0.600	76%
0.425	71%
0.300	63%
0.150	48%
0.075	39%
Particle Size (microns)	
53	32%
37	32%
19	31%
10	30%
5	28%
4	28%
1	28%

Samples analysed as received.

Median Particle Size (mm)	0.150

Sample Comments:		**Analysed:**	20-Oct-11
Loss on Pretreatment	NA	**Limit of Reporting:**	1%
Sample Description:	Medium fine sand and clay	**Dispersion Method**	Shaker
Test Method:	AS1289.3.6.2/AS1289.3.6.3	**Hydrometer Type**	ASTM E100
Soil Particle Density	2.65 g/cm^3 Assumed		

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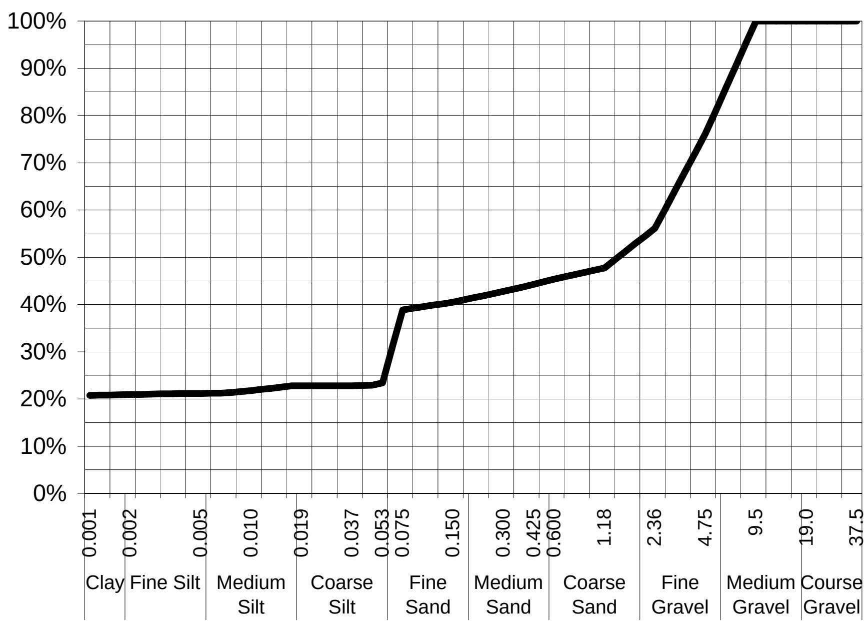
COMPANY:	Sinclair Knight Merz	**DATE RECEIVED:**	17-Oct-2011
ADDRESS:	P O Box 312 Flinders Lane Melbourne, Vic Australia 8009	**REPORT NO:**	EB1121537-032 / PSD
PROJECT:	QEO9811 400 Wards Well - Land Resources	**SAMPLE ID:**	WW44 500-600

Particle Size Distribution



Particle Size (mm)	Percent Passing
19.0	100%
9.5	100%
4.75	76%
2.36	56%
1.18	48%
0.600	45%
0.425	44%
0.300	43%
0.150	40%
0.075	39%
Particle Size (microns)	
53	23%
37	23%
19	23%
10	22%
5	21%
3	21%
1	21%

Samples analysed as received.

Median Particle Size (mm)	1.180

Sample Comments:		**Analysed:**	20-Oct-11
Loss on Pretreatment	NA	**Limit of Reporting:**	1%
Sample Description:	Gravel, silty clay and fine sand	**Dispersion Method**	Shaker
Test Method:	AS1289.3.6.2/AS1289.3.6.3	**Hydrometer Type**	ASTM E100

Soil Particle Density 2.65 g/cm^3 Assumed

NATA Accreditation: 825 Site: Newcastle
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Dianne Blane
Laboratory Supervisor, Newcastle
Authorised Signatory

Certificate of Analysis

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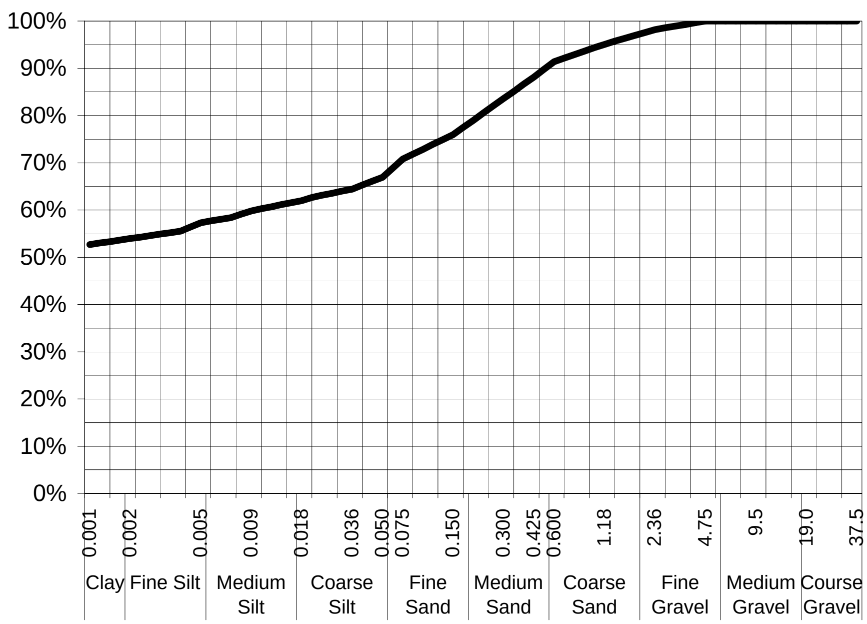
ALS Environmental

Newcastle, NSW

CLIENT:	Timothy Rohde	**DATE REPORTED:**	26-Oct-2011
COMPANY:	Sinclair Knight Merz	**DATE RECEIVED:**	17-Oct-2011
ADDRESS:	P O Box 312 Flinders Lane Melbourne, Vic Australia 8009	**REPORT NO:**	EB1121537-033 / PSD
PROJECT:	QEO9811 400 Wards Well - Land Resources	**SAMPLE ID:**	WW47 0-100

Particle Size Distribution



Particle Size (mm)	Percent Passing
19.0	100%
9.5	100%
4.75	100%
2.36	98%
1.18	95%
0.600	91%
0.425	88%
0.300	84%
0.150	76%
0.075	71%
Particle Size (microns)	
50	67%
36	64%
18	62%
9	60%
5	57%
3	56%
1	53%

Samples analysed as received.

Median Particle Size (mm)	#N/A

Sample Comments:

Analysed: 20-Oct-11

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description: Clay silt and medium fine sand

Dispersion Method Shaker

Test Method: AS1289.3.6.2/AS1289.3.6.3

Hydrometer Type ASTM E100

Soil Particle Density 2.65 g/cm^3 Assumed

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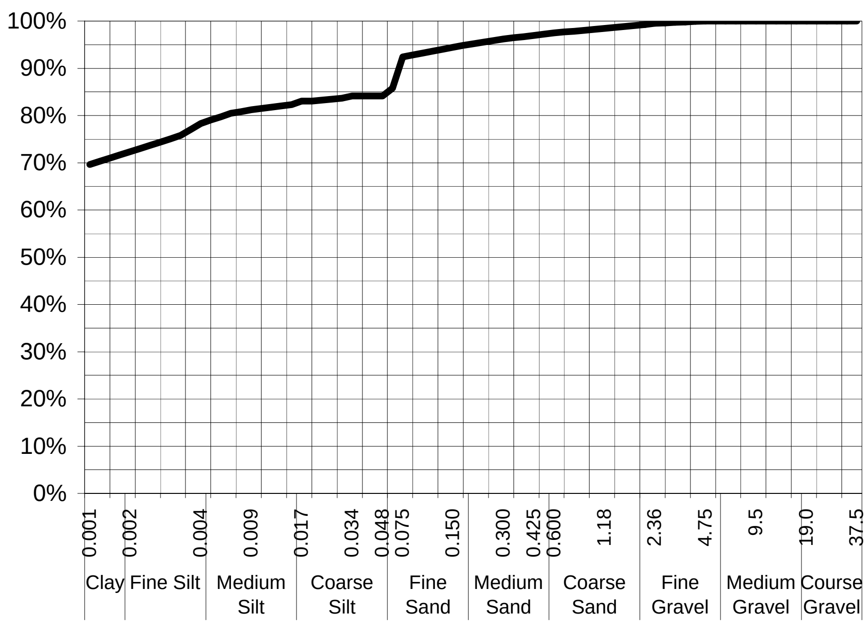
CLIENT:	Timothy Rohde	**DATE REPORTED:**	26-Oct-2011
COMPANY:	Sinclair Knight Merz	**DATE RECEIVED:**	17-Oct-2011
ADDRESS:	P O Box 312 Flinders Lane Melbourne, Vic Australia 8009	**REPORT NO:**	EB1121537-035 / PSD
PROJECT:	QEO9811 400 Wards Well - Land Resources	**SAMPLE ID:**	WW60 0-20

Particle Size Distribution



Particle Size (mm)	Percent Passing
19.0	100%
9.5	100%
4.75	100%
2.36	100%
1.18	98%
0.600	97%
0.425	97%
0.300	96%
0.150	94%
0.075	92%
Particle Size (microns)	
48	84%
34	84%
17	83%
9	81%
4	78%
3	76%
1	70%

Samples analysed as received.

Median Particle Size (mm)	#N/A

Sample Comments:		**Analysed:**	20-Oct-11
Loss on Pretreatment	NA	**Limit of Reporting:**	1%
Sample Description:	Clay silt and vegetation	**Dispersion Method**	Shaker
Test Method:	AS1289.3.6.2/AS1289.3.6.3	**Hydrometer Type**	ASTM E100

Soil Particle Density 2.65 g/cm^3 Assumed

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ALS Environmental

Newcastle, NSW

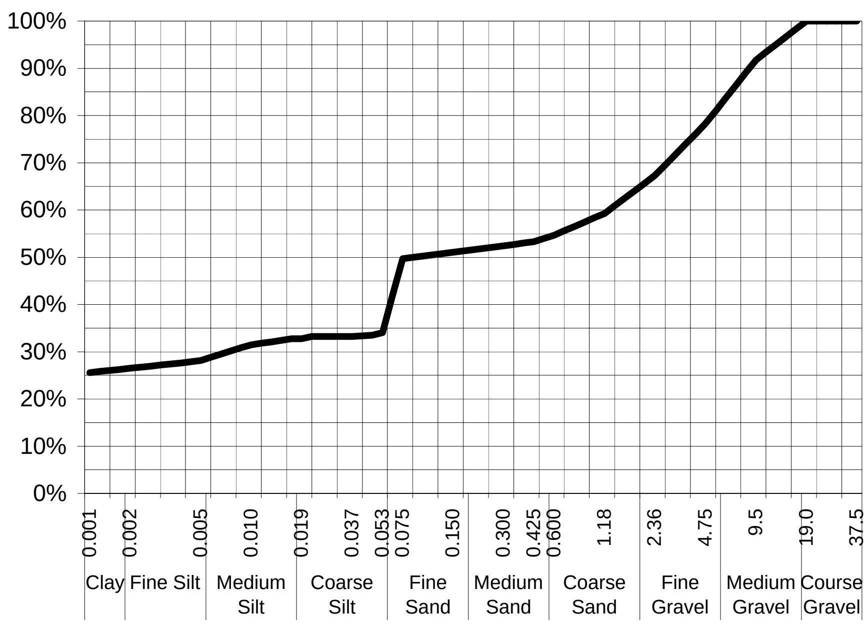
CLIENT: Timothy Rohde | **DATE REPORTED:** 26-Oct-2011

COMPANY: Sinclair Knight Merz | **DATE RECEIVED:** 17-Oct-2011

ADDRESS: P O Box 312 Flinders Lane, Melbourne, Vic Australia 8009 | **REPORT NO:** EB1121537-037 / PSD

PROJECT: QEO9811 400 Wards Well - Land Resources | **SAMPLE ID:** WW60 700-800

Particle Size Distribution



Particle Size (mm)	Percent Passing
19.0	100%
9.5	92%
4.75	78%
2.36	67%
1.18	59%
0.600	55%
0.425	53%
0.300	52%
0.150	51%
0.075	50%
Particle Size (microns)	
53	34%
37	33%
19	33%
10	31%
5	28%
3	28%
1	26%

Median Particle Size (mm)	0.075

Samples analysed as received.

Sample Comments:

Analysed: 20-Oct-11

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description: Clay silt, gravel and coarse sand

Dispersion Method Shaker

Test Method: AS1289.3.6.2/AS1289.3.6.3

Hydrometer Type ASTM E100

Soil Particle Density 2.65 g/cm^3 Assumed

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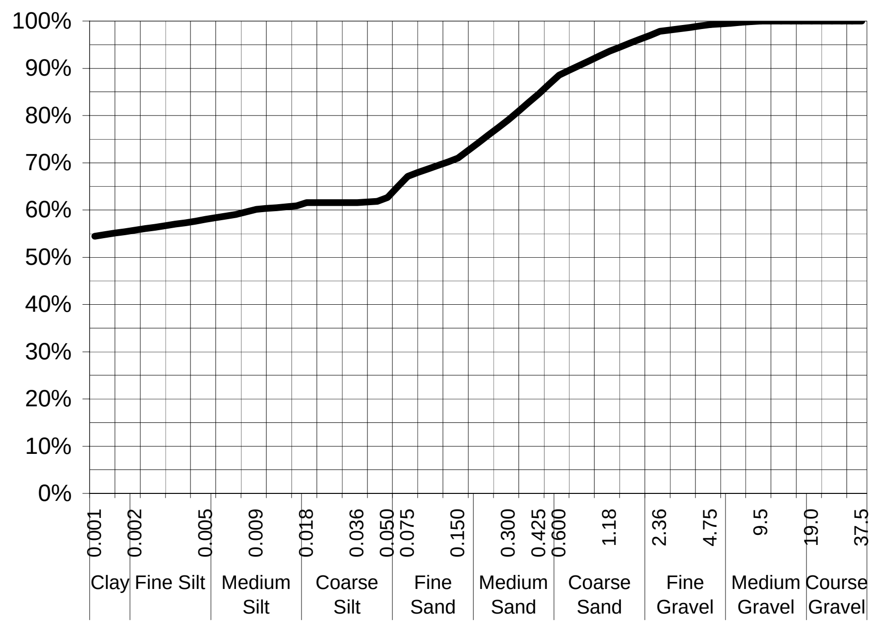
CLIENT:	Timothy Rohde	**DATE REPORTED:**	26-Oct-2011
COMPANY:	Sinclair Knight Merz	**DATE RECEIVED:**	17-Oct-2011
ADDRESS:	P O Box 312 Flinders Lane Melbourne, Vic Australia 8009	**REPORT NO:**	EB1121537-039 / PSD
PROJECT:	QEO9811 400 Wards Well - Land Resources	**SAMPLE ID:**	WW69 200-300

Particle Size Distribution



Particle Size (mm)	Percent Passing
19.0	100%
9.5	100%
4.75	99%
2.36	98%
1.18	94%
0.600	89%
0.425	85%
0.300	79%
0.150	71%
0.075	67%
Particle Size (microns)	
50	63%
36	62%
18	62%
9	60%
5	58%
3	57%
1	54%

Median Particle Size (mm)	#N/A

Samples analysed as received.

Sample Comments:		**Analysed:**	20-Oct-11
Loss on Pretreatment	NA	**Limit of Reporting:**	1%
Sample Description:	Clay silt and medium fine sand	**Dispersion Method**	Shaker
Test Method:	AS1289.3.6.2/AS1289.3.6.3	**Hydrometer Type**	ASTM E100
Soil Particle Density	2.65 g/cm^3 Assumed		

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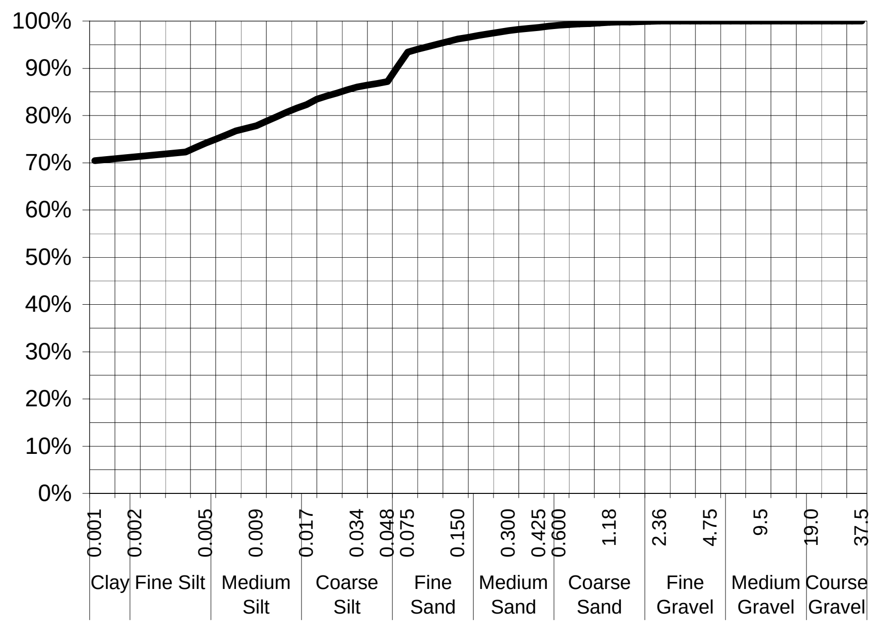
CLIENT:	Timothy Rohde	**DATE REPORTED:**	26-Oct-2011
COMPANY:	Sinclair Knight Merz	**DATE RECEIVED:**	17-Oct-2011
ADDRESS:	P O Box 312 Flinders Lane Melbourne, Vic Australia 8009	**REPORT NO:**	EB1121537-041 / PSD
PROJECT:	QEO9811 400 Wards Well - Land Resources	**SAMPLE ID:**	WW75 0-50

Particle Size Distribution



Particle Size (mm)	Percent Passing
19.0	100%
9.5	100%
4.75	100%
2.36	100%
1.18	100%
0.600	99%
0.425	99%
0.300	98%
0.150	96%
0.075	93%
Particle Size (microns)	
48	87%
34	86%
17	82%
9	78%
5	74%
3	72%
1	70%

Samples analysed as received.

Median Particle Size (mm)	#N/A

Sample Comments:

Analysed: 20-Oct-11

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description: Clay silt and vegetation

Dispersion Method Shaker

Test Method: AS1289.3.6.2/AS1289.3.6.3

Hydrometer Type ASTM E100

Soil Particle Density 2.65 g/cm^3 Assumed

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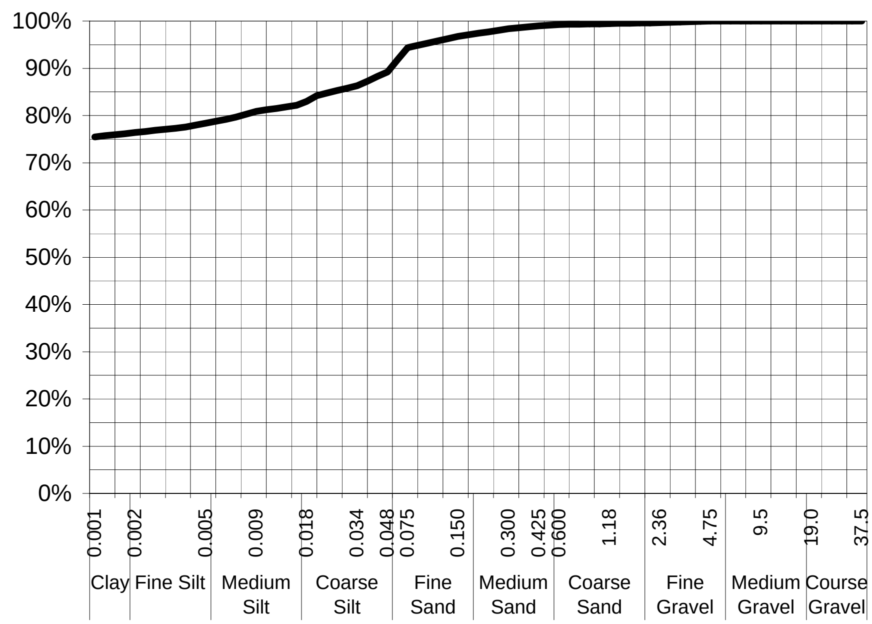
CLIENT:	Timothy Rohde	**DATE REPORTED:**	26-Oct-2011
COMPANY:	Sinclair Knight Merz	**DATE RECEIVED:**	17-Oct-2011
ADDRESS:	P O Box 312 Flinders Lane Melbourne, Vic Australia 8009	**REPORT NO:**	EB1121537-042 / PSD
PROJECT:	QEO9811 400 Wards Well - Land Resources	**SAMPLE ID:**	WW75 400-500

Particle Size Distribution



Particle Size (mm)	Percent Passing
19.0	100%
9.5	100%
4.75	100%
2.36	100%
1.18	99%
0.600	99%
0.425	99%
0.300	98%
0.150	97%
0.075	94%
Particle Size (microns)	
48	89%
34	86%
18	83%
9	81%
5	78%
3	78%
1	75%

Samples analysed as received.

Median Particle Size (mm)	#N/A

Sample Comments:		**Analysed:**	20-Oct-11
Loss on Pretreatment	NA	**Limit of Reporting:**	1%
Sample Description:	Clay silt	**Dispersion Method**	Shaker
Test Method:	AS1289.3.6.2/AS1289.3.6.3	**Hydrometer Type**	ASTM E100
Soil Particle Density	2.65 g/cm^3 Assumed		

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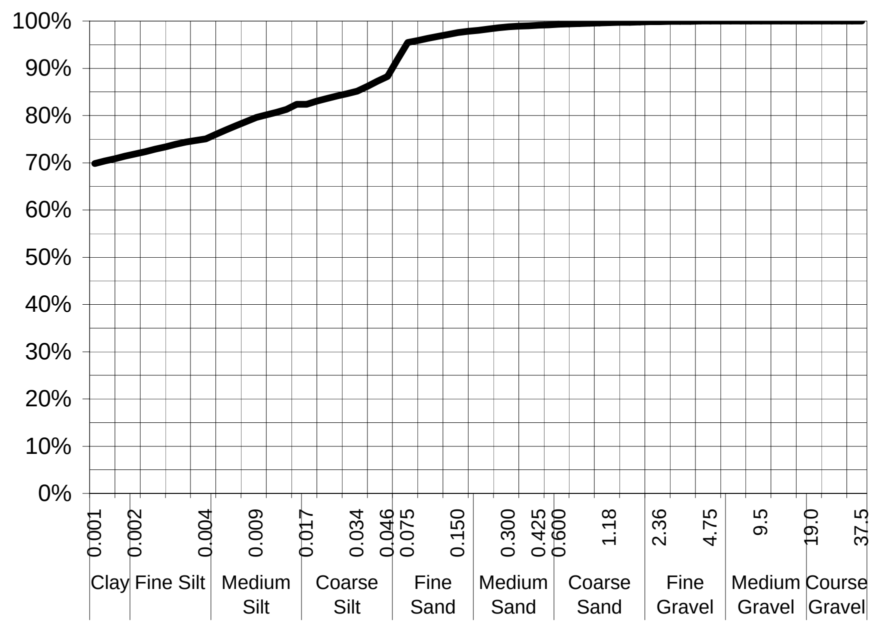
CLIENT:	Timothy Rohde	**DATE REPORTED:**	26-Oct-2011
COMPANY:	Sinclair Knight Merz	**DATE RECEIVED:**	17-Oct-2011
ADDRESS:	P O Box 312 Flinders Lane Melbourne, Vic Australia 8009	**REPORT NO:**	EB1121537-044 / PSD
PROJECT:	QEO9811 400 Wards Well - Land Resources	**SAMPLE ID:**	WW94 0-50

Particle Size Distribution



Particle Size (mm)	Percent Passing
19.0	100%
9.5	100%
4.75	100%
2.36	100%
1.18	100%
0.600	99%
0.425	99%
0.300	99%
0.150	98%
0.075	95%
Particle Size (microns)	
46	88%
34	85%
17	82%
9	80%
4	75%
3	74%
1	70%

Samples analysed as received.

Median Particle Size (mm)	#N/A

Sample Comments:		**Analysed:**	20-Oct-11
Loss on Pretreatment	NA	**Limit of Reporting:**	1%
Sample Description:	Clay silt and vegetation	**Dispersion Method**	Shaker
Test Method:	AS1289.3.6.2/AS1289.3.6.3	**Hydrometer Type**	ASTM E100

Soil Particle Density 2.65 g/cm^3 Assumed

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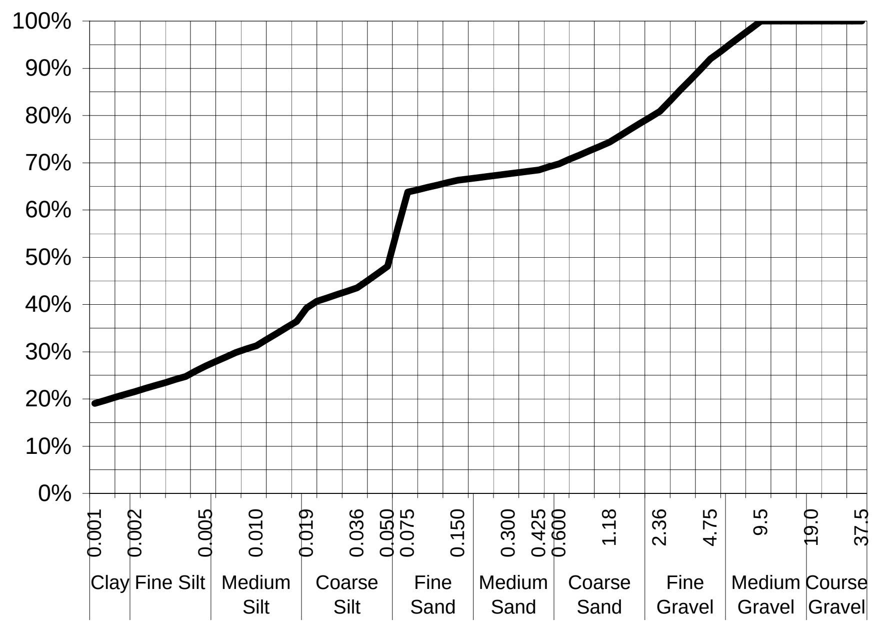
ALS Environmental

Newcastle, NSW

CLIENT:	Timothy Rohde	**DATE REPORTED:**	26-Oct-2011
COMPANY:	Sinclair Knight Merz	**DATE RECEIVED:**	17-Oct-2011
ADDRESS:	P O Box 312 Flinders Lane Melbourne, Vic Australia 8009	**REPORT NO:**	EB1121537-046 / PSD
PROJECT:	QEO9811 400 Wards Well - Land Resources	**SAMPLE ID:**	WW94 600-700

Particle Size Distribution



Particle Size (mm)	Percent Passing
19.0	100%
9.5	100%
4.75	92%
2.36	81%
1.18	74%
0.600	70%
0.425	68%
0.300	68%
0.150	66%
0.075	64%
Particle Size (microns)	
50	48%
36	44%
19	39%
10	31%
5	27%
4	25%
1	19%

Median Particle Size (mm)	0.050

Samples analysed as received.

Sample Comments:		**Analysed:**	20-Oct-11
Loss on Pretreatment	NA	**Limit of Reporting:**	1%
Sample Description:	Silt clay, coarse sand and gravel	**Dispersion Method**	Shaker
Test Method:	AS1289.3.6.2/AS1289.3.6.3	**Hydrometer Type**	ASTM E100
Soil Particle Density	2.65 g/cm^3 Assumed		

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Laboratory Supervisor, Newcastle
Authorised Signatory

Environmental Division

QUALITY CONTROL REPORT

Work Order	: **EB1121537**	Page	: 1 of 10
Client	: **SINCLAIR KNIGHT MERZ**	Laboratory	: Environmental Division Brisbane
Contact	: MR TIMOTHY ROHDE	Contact	: Dean Sullivan
Address	: P O BOX 312 FLINDERS LANE MELBOURNE VIC AUSTRALIA 8009	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: trohde@skm.com.au	E-mail	: dean.sullivan@alsglobal.com
Telephone	: +61 03 8668 3000	Telephone	: +61 7 3243 7144
Facsimile	: +61 03 8668 3001	Facsimile	: +61 7 3243 7218
Project	: QEO9811 400 Wards Well - Land Resources	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Site	: ----		
C-O-C number	: ----	Date Samples Received	: 17-OCT-2011
Sampler	: A Thompson/T Rohde	Issue Date	: 26-OCT-2011
Order number	: ----		
		No. of samples received	: 64
Quote number	: EN/003/10	No. of samples analysed	: 43

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

NATA
WORLD RECOGNISED ACCREDITATION

NATA Accredited Laboratory 825

This document is issued in accordance with NATA accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

Signatories

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

Signatories	*Position*	*Accreditation Category*
Dianne Blane	Laboratory Supervisor	Newcastle
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

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

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

Key :
- Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
- 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
- RPD = Relative Percentage Difference
- # = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR:- No Limit; Result between 10 and 20 times LOR:- 0% - 50%; Result > 20 times LOR:- 0% - 20%.

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EA002 : pH (Soils) (QC Lot: 2005966)									
EB1121537-001	WW6 0-10	EA002: pH Value	----	0.1	pH Unit	7.8	7.8	0.0	0% - 20%
EB1121537-028	WW38 0-50	EA002: pH Value	----	0.1	pH Unit	6.5	6.5	0.0	0% - 20%
EA002 : pH (Soils) (QC Lot: 2005976)									
EB1121537-038	WW69 0-50	EA002: pH Value	----	0.1	pH Unit	6.7	6.8	0.0	0% - 20%
EA002 : pH (Soils) (QC Lot: 2005984)									
EB1121537-002	WW6 20-30	EA002: pH Value	----	0.1	pH Unit	8.6	8.6	0.0	0% - 20%
EB1121537-015	WW15 90-100	EA002: pH Value	----	0.1	pH Unit	8.3	8.2	0.0	0% - 20%
EA002 : pH (Soils) (QC Lot: 2006001)									
EB1121537-037	WW60 700-800	EA002: pH Value	----	0.1	pH Unit	8.7	8.7	0.0	0% - 20%
EA010: Conductivity (QC Lot: 2005968)									
EB1121537-001	WW6 0-10	EA010: Electrical Conductivity @ 25°C	----	1	µS/cm	107	110	2.8	0% - 20%
EB1121537-028	WW38 0-50	EA010: Electrical Conductivity @ 25°C	----	1	µS/cm	30	26	14.3	0% - 20%
EA010: Conductivity (QC Lot: 2005978)									
EB1121537-038	WW69 0-50	EA010: Electrical Conductivity @ 25°C	----	1	µS/cm	34	33	3.0	0% - 20%
EA010: Conductivity (QC Lot: 2005986)									
EB1121537-002	WW6 20-30	EA010: Electrical Conductivity @ 25°C	----	1	µS/cm	137	136	0.7	0% - 20%
EB1121537-015	WW15 90-100	EA010: Electrical Conductivity @ 25°C	----	1	µS/cm	989	1010	2.1	0% - 20%
EA010: Conductivity (QC Lot: 2006003)									
EB1121537-037	WW60 700-800	EA010: Electrical Conductivity @ 25°C	----	1	µS/cm	87	83	4.7	0% - 20%
EA055: Moisture Content (QC Lot: 2006028)									
EB1121537-004	WW9 0-100	EA055-103: Moisture Content (dried @ 103°C)	----	1.0	%	7.2	7.0	3.7	No Limit
EB1121537-011	WW13 20-30	EA055-103: Moisture Content (dried @ 103°C)	----	1.0	%	13.5	14.4	6.5	0% - 50%
EA055: Moisture Content (QC Lot: 2006029)									
EB1121537-026	WW36 200-300	EA055-103: Moisture Content (dried @ 103°C)	----	1.0	%	7.3	7.1	3.9	No Limit
EB1121537-033	WW47 0-100	EA055-103: Moisture Content (dried @ 103°C)	----	1.0	%	12.0	12.1	0.0	0% - 50%
ED007: Exchangeable Cations (QC Lot: 2006014)									
EB1121537-001	WW6 0-10	ED007: Exchangeable Calcium	----	0.1	meq/100g	37.3	36.3	2.5	0% - 20%
		ED007: Exchangeable Magnesium	----	0.1	meq/100g	17.4	17.5	0.9	0% - 20%
		ED007: Exchangeable Potassium	----	0.1	meq/100g	2.2	2.2	0.0	0% - 20%
		ED007: Exchangeable Sodium	----	0.1	meq/100g	0.2	0.2	0.0	No Limit
EB1121537-009	WW13 1000-1100	ED007: Exchangeable Calcium	----	0.1	meq/100g	1.0	1.0	0.0	0% - 50%
		ED007: Exchangeable Magnesium	----	0.1	meq/100g	0.7	0.7	0.0	No Limit
		ED007: Exchangeable Potassium	----	0.1	meq/100g	<0.1	<0.1	0.0	No Limit
		ED007: Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	0.0	No Limit

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
ED007: Exchangeable Cations (QC Lot: 2006015)									
EB1121537-023	WW28 200-300	ED007: Exchangeable Calcium	----	0.1	meq/100g	8.1	8.8	8.0	0% - 20%
		ED007: Exchangeable Magnesium	----	0.1	meq/100g	9.9	10.8	8.7	0% - 20%
		ED007: Exchangeable Potassium	----	0.1	meq/100g	<0.1	<0.1	0.0	No Limit
		ED007: Exchangeable Sodium	----	0.1	meq/100g	2.2	2.4	7.1	0% - 20%
EB1121537-031	WW44 100-200	ED007: Exchangeable Calcium	----	0.1	meq/100g	1.5	1.5	0.0	0% - 50%
		ED007: Exchangeable Magnesium	----	0.1	meq/100g	1.2	1.2	0.0	0% - 50%
		ED007: Exchangeable Potassium	----	0.1	meq/100g	<0.1	<0.1	0.0	No Limit
		ED007: Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	0.0	No Limit
ED007: Exchangeable Cations (QC Lot: 2006016)									
EB1121537-044	WW94 0-50	ED007: Exchangeable Calcium	----	0.1	meq/100g	66.7	65.5	1.8	0% - 20%
		ED007: Exchangeable Magnesium	----	0.1	meq/100g	17.0	17.0	0.0	0% - 20%
		ED007: Exchangeable Potassium	----	0.1	meq/100g	1.1	1.1	0.0	0% - 50%
		ED007: Exchangeable Sodium	----	0.1	meq/100g	<0.1	<0.1	0.0	No Limit
ED037: Alkalinity (QC Lot: 2005970)									
EB1121537-001	WW6 0-10	ED037: Total Alkalinity as CaCO3	----	1	meq/kg	254	254	0.0	0% - 20%
EB1121537-028	WW38 0-50	ED037: Total Alkalinity as CaCO3	----	1	meq/kg	63	63	0.0	0% - 20%
ED037: Alkalinity (QC Lot: 2005980)									
EB1121537-038	WW69 0-50	ED037: Total Alkalinity as CaCO3	----	1	meq/kg	114	114	0.0	0% - 20%
ED037: Alkalinity (QC Lot: 2005988)									
EB1121537-002	WW6 20-30	ED037: Total Alkalinity as CaCO3	----	1	meq/kg	470	470	0.0	0% - 20%
EB1121537-015	WW15 90-100	ED037: Total Alkalinity as CaCO3	----	1	meq/kg	140	140	0.0	0% - 20%
ED037: Alkalinity (QC Lot: 2006005)									
EB1121537-037	WW60 700-800	ED037: Total Alkalinity as CaCO3	----	1	meq/kg	306	306	0.0	0% - 20%
ED040S: Soluble Major Anions (QC Lot: 2005967)									
EB1121537-001	WW6 0-10	ED040S: Sulfate as SO4 2-	14808-79-8	10	mg/kg	20	20	0.0	No Limit
EB1121537-028	WW38 0-50	ED040S: Sulfate as SO4 2-	14808-79-8	10	mg/kg	<10	<10	0.0	No Limit
ED040S: Soluble Major Anions (QC Lot: 2005977)									
EB1121537-038	WW69 0-50	ED040S: Sulfate as SO4 2-	14808-79-8	10	mg/kg	<10	<10	0.0	No Limit
ED040S: Soluble Major Anions (QC Lot: 2005985)									
EB1121537-002	WW6 20-30	ED040S: Sulfate as SO4 2-	14808-79-8	10	mg/kg	<10	<10	0.0	No Limit
EB1121537-015	WW15 90-100	ED040S: Sulfate as SO4 2-	14808-79-8	10	mg/kg	530	570	7.4	0% - 20%
ED040S: Soluble Major Anions (QC Lot: 2006002)									
EB1121537-037	WW60 700-800	ED040S: Sulfate as SO4 2-	14808-79-8	10	mg/kg	<10	<10	0.0	No Limit
ED045G: Chloride Discrete analyser (QC Lot: 2005972)									
EB1121537-001	WW6 0-10	ED045G: Chloride	16887-00-6	10	mg/kg	<10	<10	0.0	No Limit
EB1121537-028	WW38 0-50	ED045G: Chloride	16887-00-6	10	mg/kg	20	20	0.0	No Limit
ED045G: Chloride Discrete analyser (QC Lot: 2005982)									
EB1121537-038	WW69 0-50	ED045G: Chloride	16887-00-6	10	mg/kg	20	20	0.0	No Limit

Sub-Matrix: **SOIL**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report					
				LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
ED045G: Chloride Discrete analyser (QC Lot: 2005989)									
EB1121537-002	WW6 20-30	ED045G: Chloride	16887-00-6	10	mg/kg	<10	<10	0.0	No Limit
EB1121537-015	WW15 90-100	ED045G: Chloride	16887-00-6	10	mg/kg	1630	1620	0.9	0% - 20%
ED045G: Chloride Discrete analyser (QC Lot: 2006006)									
EB1121537-037	WW60 700-800	ED045G: Chloride	16887-00-6	10	mg/kg	<10	<10	0.0	No Limit
ED093S: Soluble Major Cations (QC Lot: 2005969)									
EB1121537-001	WW6 0-10	ED093S: Calcium	7440-70-2	10	mg/kg	50	60	0.0	No Limit
		ED093S: Magnesium	7439-95-4	10	mg/kg	20	20	0.0	No Limit
		ED093S: Sodium	7440-23-5	10	mg/kg	20	30	0.0	No Limit
		ED093S: Potassium	7440-09-7	10	mg/kg	40	30	0.0	No Limit
EB1121537-028	WW38 0-50	ED093S: Calcium	7440-70-2	10	mg/kg	<10	<10	0.0	No Limit
		ED093S: Magnesium	7439-95-4	10	mg/kg	<10	<10	0.0	No Limit
		ED093S: Sodium	7440-23-5	10	mg/kg	<10	<10	0.0	No Limit
		ED093S: Potassium	7440-09-7	10	mg/kg	30	30	0.0	No Limit
ED093S: Soluble Major Cations (QC Lot: 2005979)									
EB1121537-038	WW69 0-50	ED093S: Calcium	7440-70-2	10	mg/kg	10	10	0.0	No Limit
		ED093S: Magnesium	7439-95-4	10	mg/kg	<10	<10	0.0	No Limit
		ED093S: Sodium	7440-23-5	10	mg/kg	<10	<10	0.0	No Limit
		ED093S: Potassium	7440-09-7	10	mg/kg	10	10	0.0	No Limit
ED093S: Soluble Major Cations (QC Lot: 2005987)									
EB1121537-002	WW6 20-30	ED093S: Calcium	7440-70-2	10	mg/kg	20	<10	0.0	No Limit
		ED093S: Magnesium	7439-95-4	10	mg/kg	<10	<10	0.0	No Limit
		ED093S: Sodium	7440-23-5	10	mg/kg	170	160	0.0	0% - 50%
		ED093S: Potassium	7440-09-7	10	mg/kg	<10	<10	0.0	No Limit
EB1121537-015	WW15 90-100	ED093S: Calcium	7440-70-2	10	mg/kg	50	60	20.0	No Limit
		ED093S: Magnesium	7439-95-4	10	mg/kg	40	40	0.0	No Limit
		ED093S: Sodium	7440-23-5	10	mg/kg	1160	1200	3.8	0% - 20%
		ED093S: Potassium	7440-09-7	10	mg/kg	<10	<10	0.0	No Limit
ED093S: Soluble Major Cations (QC Lot: 2006004)									
EB1121537-037	WW60 700-800	ED093S: Calcium	7440-70-2	10	mg/kg	40	40	0.0	No Limit
		ED093S: Magnesium	7439-95-4	10	mg/kg	20	20	0.0	No Limit
		ED093S: Sodium	7440-23-5	10	mg/kg	50	40	0.0	No Limit
		ED093S: Potassium	7440-09-7	10	mg/kg	<10	<10	0.0	No Limit
EG005T: Total Metals by ICP-AES (QC Lot: 2005948)									
EB1121537-001	WW6 0-10	EG005T: Cobalt	7440-48-4	2	mg/kg	66	58	12.8	0% - 20%
		EG005T: Molybdenum	7439-98-7	2	mg/kg	<2	<2	0.0	No Limit
		EG005T: Copper	7440-50-8	5	mg/kg	38	33	14.4	No Limit
		EG005T: Manganese	7439-96-5	5	mg/kg	1290	1130	13.0	0% - 20%
		EG005T: Zinc	7440-66-6	5	mg/kg	76	63	18.5	0% - 50%
		EG005T: Boron	7440-42-8	50	mg/kg	<50	<50	0.0	No Limit

Sub-Matrix: **SOIL**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report					
				LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EG005T: Total Metals by ICP-AES (QC Lot: 2005948) - continued									
EB1121537-001	WW6 0-10	EG005T: Iron	7439-89-6	50	mg/kg	69600	63600	9.0	0% - 20%
EB1121537-030	WW44 0-100	EG005T: Cobalt	7440-48-4	2	mg/kg	32	29	10.4	0% - 50%
		EG005T: Molybdenum	7439-98-7	2	mg/kg	<2	<2	0.0	No Limit
		EG005T: Copper	7440-50-8	5	mg/kg	13	15	11.0	No Limit
		EG005T: Manganese	7439-96-5	5	mg/kg	1010	1270	# 22.4	0% - 20%
		EG005T: Zinc	7440-66-6	5	mg/kg	11	13	15.6	No Limit
		EG005T: Boron	7440-42-8	50	mg/kg	<50	<50	0.0	No Limit
		EG005T: Iron	7439-89-6	50	mg/kg	48800	48500	0.6	0% - 20%
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 2005971)									
EB1121537-001	WW6 0-10	EK059G: Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	19.8	20.0	1.2	0% - 20%
EB1121537-028	WW38 0-50	EK059G: Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	1.3	1.2	9.4	0% - 50%
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 2005981)									
EB1121537-038	WW69 0-50	EK059G: Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	1.7	1.4	15.8	0% - 50%
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 2006017)									
EB1121537-001	WW6 0-10	EK061G: Total Kjeldahl Nitrogen as N	----	20	mg/kg	2630	2160	19.4	0% - 20%
EB1121537-030	WW44 0-100	EK061G: Total Kjeldahl Nitrogen as N	----	20	mg/kg	260	220	13.9	0% - 50%
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 2006018)									
EB1121537-001	WW6 0-10	EK067G: Total Phosphorus as P	----	2	mg/kg	494	528	6.5	0% - 20%
EB1121537-030	WW44 0-100	EK067G: Total Phosphorus as P	----	2	mg/kg	224	221	1.5	0% - 20%
EP004: Organic Matter (QC Lot: 2007396)									
EB1121434-001	Anonymous	EP004: Organic Matter	----	0.5	%	<0.5	<0.5	0.0	No Limit
EB1121532-001	Anonymous	EP004: Organic Matter	----	0.5	%	2.8	2.6	10.0	No Limit
EP004: Organic Matter (QC Lot: 2007397)									
EB1121537-030	WW44 0-100	EP004: Organic Matter	----	0.5	%	1.2	1.1	0.0	No Limit

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **SOIL**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EA002 : pH (Soils) (QCLot: 2005966)								
EA002: pH Value	----	0.1	pH Unit	----	5.2 pH Unit	100	97	103
EA002 : pH (Soils) (QCLot: 2005976)								
EA002: pH Value	----	0.1	pH Unit	----	5.2 pH Unit	100	97	103
EA002 : pH (Soils) (QCLot: 2005984)								
EA002: pH Value	----	0.1	pH Unit	----	5.2 pH Unit	99.8	97	103
EA002 : pH (Soils) (QCLot: 2006001)								
EA002: pH Value	----	0.1	pH Unit	----	5.2 pH Unit	100	97	103
EA010: Conductivity (QCLot: 2005968)								
EA010: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	196 µS/cm	99.5	85	115
EA010: Conductivity (QCLot: 2005978)								
EA010: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	196 µS/cm	95.4	85	115
EA010: Conductivity (QCLot: 2005986)								
EA010: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	196 µS/cm	90.3	85	115
EA010: Conductivity (QCLot: 2006003)								
EA010: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	196 µS/cm	92.3	85	115
ED007: Exchangeable Cations (QCLot: 2006014)								
ED007: Exchangeable Calcium	----	0.1	meq/100g	<0.5	1.39 meq/100g	94.6	70	130
ED007: Exchangeable Magnesium	----	0.1	meq/100g	<0.5	0.79 meq/100g	94.5	70	130
ED007: Exchangeable Potassium	----	0.1	meq/100g	<0.5	0.18 meq/100g	74.8	70	130
ED007: Exchangeable Sodium	----	0.1	meq/100g	<0.5	0.41 meq/100g	90.9	70	130
ED007: Cation Exchange Capacity	----	0.1	meq/100g	----	2.71 meq/100g	94.8	70	130
ED007: Exchangeable Cations (QCLot: 2006015)								
ED007: Exchangeable Calcium	----	0.1	meq/100g	<0.5	1.39 meq/100g	96.3	70	130
ED007: Exchangeable Magnesium	----	0.1	meq/100g	<0.5	0.79 meq/100g	91.0	70	130
ED007: Exchangeable Potassium	----	0.1	meq/100g	<0.5	0.18 meq/100g	71.8	70	130
ED007: Exchangeable Sodium	----	0.1	meq/100g	<0.5	0.41 meq/100g	86.8	70	130
ED007: Cation Exchange Capacity	----	0.1	meq/100g	----	2.71 meq/100g	93.8	70	130
ED007: Exchangeable Cations (QCLot: 2006016)								
ED007: Exchangeable Calcium	----	0.1	meq/100g	<0.5	1.39 meq/100g	93.0	70	130
ED007: Exchangeable Magnesium	----	0.1	meq/100g	<0.5	0.79 meq/100g	91.5	70	130
ED007: Exchangeable Potassium	----	0.1	meq/100g	<0.5	0.18 meq/100g	78.5	70	130
ED007: Exchangeable Sodium	----	0.1	meq/100g	<0.5	0.41 meq/100g	87.2	70	130
ED007: Cation Exchange Capacity	----	0.1	meq/100g	----	2.71 meq/100g	92.8	70	130

Sub-Matrix: **SOIL**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
				Result	Concentration	LCS	Low	High
ED037: Alkalinity (QCLot: 2005970)								
ED037: Total Alkalinity as CaCO3	----	1	meq/kg	<1	200 meq/kg	95.0	85	115
ED037: Alkalinity (QCLot: 2005980)								
ED037: Total Alkalinity as CaCO3	----	1	meq/kg	<1	200 meq/kg	95.0	85	115
ED037: Alkalinity (QCLot: 2005988)								
ED037: Total Alkalinity as CaCO3	----	1	meq/kg	<1	200 meq/kg	95.0	85	115
ED037: Alkalinity (QCLot: 2006005)								
ED037: Total Alkalinity as CaCO3	----	1	meq/kg	<1	200 meq/kg	95.0	85	115
ED040S: Soluble Major Anions (QCLot: 2005967)								
ED040S: Sulfate as SO4 2-	14808-79-8	10	mg/kg	<10	238 mg/kg	94.5	77	125
ED040S: Soluble Major Anions (QCLot: 2005977)								
ED040S: Sulfate as SO4 2-	14808-79-8	10	mg/kg	<10	238 mg/kg	99.1	77	125
ED040S: Soluble Major Anions (QCLot: 2005985)								
ED040S: Sulfate as SO4 2-	14808-79-8	10	mg/kg	<10	238 mg/kg	93.2	77	125
ED040S: Soluble Major Anions (QCLot: 2006002)								
ED040S: Sulfate as SO4 2-	14808-79-8	10	mg/kg	<10	238 mg/kg	92.4	77	125
ED045G: Chloride Discrete analyser (QCLot: 2005972)								
ED045G: Chloride	16887-00-6	10	mg/kg	<10	5000 mg/kg	99.9	81	125
ED045G: Chloride Discrete analyser (QCLot: 2005982)								
ED045G: Chloride	16887-00-6	10	mg/kg	<10	5000 mg/kg	# 11000	81	125
ED045G: Chloride Discrete analyser (QCLot: 2005989)								
ED045G: Chloride	16887-00-6	10	mg/kg	<10	5000 mg/kg	110	81	125
ED045G: Chloride Discrete analyser (QCLot: 2006006)								
ED045G: Chloride	16887-00-6	10	mg/kg	<10	5000 mg/kg	111	81	125
ED093S: Soluble Major Cations (QCLot: 2005969)								
ED093S: Calcium	7440-70-2	10	mg/kg	<10	----	----	----	----
ED093S: Magnesium	7439-95-4	10	mg/kg	<10	----	----	----	----
ED093S: Sodium	7440-23-5	10	mg/kg	<10	----	----	----	----
ED093S: Potassium	7440-09-7	10	mg/kg	<10	----	----	----	----
ED093S: Soluble Major Cations (QCLot: 2005979)								
ED093S: Calcium	7440-70-2	10	mg/kg	<10	----	----	----	----
ED093S: Magnesium	7439-95-4	10	mg/kg	<10	----	----	----	----
ED093S: Sodium	7440-23-5	10	mg/kg	<10	----	----	----	----
ED093S: Potassium	7440-09-7	10	mg/kg	<10	----	----	----	----
ED093S: Soluble Major Cations (QCLot: 2005987)								
ED093S: Calcium	7440-70-2	10	mg/kg	<10	----	----	----	----
ED093S: Magnesium	7439-95-4	10	mg/kg	<10	----	----	----	----

Sub-Matrix: **SOIL**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
				Result	Concentration	LCS	Low	High
ED093S: Soluble Major Cations (QCLot: 2005987) - continued								
ED093S: Sodium	7440-23-5	10	mg/kg	<10	----	----	----	----
ED093S: Potassium	7440-09-7	10	mg/kg	<10	----	----	----	----
ED093S: Soluble Major Cations (QCLot: 2006004)								
ED093S: Calcium	7440-70-2	10	mg/kg	<10	----	----	----	----
ED093S: Magnesium	7439-95-4	10	mg/kg	<10	----	----	----	----
ED093S: Sodium	7440-23-5	10	mg/kg	<10	----	----	----	----
ED093S: Potassium	7440-09-7	10	mg/kg	<10	----	----	----	----
EG005T: Total Metals by ICP-AES (QCLot: 2005948)								
EG005T: Boron	7440-42-8	50	mg/kg	<50	----	----	----	----
EG005T: Cobalt	7440-48-4	2	mg/kg	<2	24.49 mg/kg	94.1	87	125
EG005T: Copper	7440-50-8	5	mg/kg	<5	54.68 mg/kg	95.3	89	125
EG005T: Iron	7439-89-6	50	mg/kg	<50	15500 mg/kg	129	79	130
EG005T: Manganese	7439-96-5	5	mg/kg	<5	135.6 mg/kg	90.4	88	120
EG005T: Molybdenum	7439-98-7	2	mg/kg	<2	8.06 mg/kg	109	78.8	121.2
EG005T: Zinc	7440-66-6	5	mg/kg	<5	103.88 mg/kg	95.2	86	124
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 2005971)								
EK059G: Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	<0.1	2.5 mg/kg	104	70	130
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 2005981)								
EK059G: Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	<0.1	2.68 mg/kg	98.3	70	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 2006017)								
EK061G: Total Kjeldahl Nitrogen as N	----	20	mg/kg	<20	534 mg/kg	78.1	70	118
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 2006018)								
EK067G: Total Phosphorus as P	----	2	mg/kg	<2	75 mg/kg	106	70	130
EP004: Organic Matter (QCLot: 2007396)								
EP004: Organic Matter	----	0.5	%	<0.5	2.3 %	97.4	85	115
EP004: Organic Matter (QCLot: 2007397)								
EP004: Organic Matter	----	0.5	%	<0.5	2.3 %	97.4	85	115

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **SOIL**

				Matrix Spike (MS) Report			
				Spike	Spike Recovery (%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EG005T: Total Metals by ICP-AES (QCLot: 2005948)							
EB1121537-004	WW9 0-100	EG005T: Cobalt	7440-48-4	50 mg/kg	89.8	70	130
		EG005T: Copper	7440-50-8	50 mg/kg	93.8	70	130
		EG005T: Manganese	7439-96-5	50 mg/kg	96.3	70	130
		EG005T: Zinc	7440-66-6	50 mg/kg	92.6	70	130
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 2005971)							
EB1121537-004	WW9 0-100	EK059G: Nitrite + Nitrate as N (Sol.)	----	2.0 mg/kg	111	70	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 2006017)							
EB1121537-004	WW9 0-100	EK061G: Total Kjeldahl Nitrogen as N	----	500 mg/kg	107	70	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 2006018)							
EB1121537-004	WW9 0-100	EK067G: Total Phosphorus as P	----	100 mg/kg	93.8	70	130

Environmental Division

INTERPRETIVE QUALITY CONTROL REPORT

Work Order	: **EB1121537**	Page	: 1 of 25
Client	: SINCLAIR KNIGHT MERZ	Laboratory	: Environmental Division Brisbane
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Project	: QEO9811 400 Wards Well - Land Resources	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Site	: ----		
C-O-C number	: ----	Date Samples Received	: 17-OCT-2011
Sampler	: A Thompson/T Rohde	Issue Date	: 26-OCT-2011
Order number	: ----		
		No. of samples received	: 64
Quote number	: EN/003/10	No. of samples analysed	: 43

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Interpretive Quality Control Report contains the following information:

- Analysis Holding Time Compliance
- Quality Control Parameter Frequency Compliance
- Brief Method Summaries
- Summary of Outliers

Analysis Holding Time Compliance

The following report summarises extraction / preparation and analysis times and compares with recommended holding times. Dates reported represent first date of extraction or analysis and precludes subsequent dilutions and reruns. Information is also provided re the sample container (preservative) from which the analysis aliquot was taken. Elapsed period to analysis represents number of days from sampling where no extraction / digestion is involved or period from extraction / digestion where this is present. For composite samples, sampling date is assumed to be that of the oldest sample contributing to the composite. Sample date for laboratory produced leachates is assumed as the completion date of the leaching process. Outliers for holding time are based on USEPA SW 846, APHA, AS and NEPM (1999). A listing of breaches is provided in the Summary of Outliers.

Holding times for leachate methods (excluding elutriates) vary according to the analytes being determined on the resulting solution. For non-volatile analytes, the holding time compliance assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These soil holding times are: Organics (14 days); Mercury (28 days) & other metals (180 days). A recorded breach therefore does not guarantee a breach for all non-volatile parameters.

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA002 : pH (Soils)								
Snap Lock Bag WW6 - 0-10, WW10 - 0-100,	WW9 - 0-100, WW13 - 0-50	**21-SEP-2011**	**19-OCT-2011**	28-SEP-2011	×	**25-OCT-2011**	19-OCT-2011	×
Snap Lock Bag WW6 - 20-30, WW9 - 200-300, WW10 - 500-600, WW13 - 20-30,	WW6 - 80-90, WW9 - 800-900, WW13 - 1000-1100, WW13 - 70-80	**21-SEP-2011**	**21-OCT-2011**	28-SEP-2011	×	**25-OCT-2011**	21-OCT-2011	×
Snap Lock Bag WW15 - 0-10,	WW22 - 0-100	**22-SEP-2011**	**19-OCT-2011**	29-SEP-2011	×	**25-OCT-2011**	19-OCT-2011	×
Snap Lock Bag WW15 - 30-40,	WW15 - 90-100	**22-SEP-2011**	**21-OCT-2011**	29-SEP-2011	×	**25-OCT-2011**	21-OCT-2011	×
Snap Lock Bag WW23 - 0-100,	WW28 - 0-100	**23-SEP-2011**	**19-OCT-2011**	30-SEP-2011	×	**25-OCT-2011**	19-OCT-2011	×
Snap Lock Bag WW23 - 300-400, WW28 - 200-300,	WW23 - 900-1000, WW28 - 700-800	**23-SEP-2011**	**21-OCT-2011**	30-SEP-2011	×	**25-OCT-2011**	21-OCT-2011	×
Snap Lock Bag WW36 - 0-100,	WW38 - 0-50	**24-SEP-2011**	**19-OCT-2011**	01-OCT-2011	×	**25-OCT-2011**	19-OCT-2011	×
Snap Lock Bag WW36 - 200-300, WW38 - 500-600	WW36 - 700-800,	**24-SEP-2011**	**21-OCT-2011**	01-OCT-2011	×	**25-OCT-2011**	21-OCT-2011	×
Snap Lock Bag WW44 - 0-100		**25-SEP-2011**	**19-OCT-2011**	02-OCT-2011	×	**25-OCT-2011**	19-OCT-2011	×
Snap Lock Bag WW44 - 100-200,	WW44 - 500-600	**25-SEP-2011**	**21-OCT-2011**	02-OCT-2011	×	**25-OCT-2011**	21-OCT-2011	×
Snap Lock Bag WW47 - 0-100		**26-SEP-2011**	**19-OCT-2011**	03-OCT-2011	×	**25-OCT-2011**	19-OCT-2011	×
Snap Lock Bag WW60 - 0-20, WW75 - 0-50	WW69 - 0-50,	**27-SEP-2011**	**19-OCT-2011**	04-OCT-2011	×	**25-OCT-2011**	19-OCT-2011	×

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA002 : pH (Soils) - Continued								
Snap Lock Bag WW60 - 20-300, WW69 - 200-300, WW75 - 400-500,	WW60 - 700-800, WW69 - 800-900, WW75 - 900-1000	**27-SEP-2011**	**21-OCT-2011**	04-OCT-2011	×	**25-OCT-2011**	21-OCT-2011	×
Snap Lock Bag WW94 - 0-50		**28-SEP-2011**	**19-OCT-2011**	05-OCT-2011	×	**25-OCT-2011**	19-OCT-2011	×
Snap Lock Bag WW94 - 200-300		**29-SEP-2011**	**21-OCT-2011**	06-OCT-2011	×	**25-OCT-2011**	21-OCT-2011	×
Snap Lock Bag WW94 - 600-700		**30-SEP-2011**	**21-OCT-2011**	07-OCT-2011	×	**25-OCT-2011**	21-OCT-2011	×

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA010: Conductivity								
Snap Lock Bag WW6 - 0-10, WW10 - 0-100,	WW9 - 0-100, WW13 - 0-50	**21-SEP-2011**	**19-OCT-2011**	28-SEP-2011	×	**25-OCT-2011**	16-NOV-2011	✓
Snap Lock Bag WW6 - 20-30, WW9 - 200-300, WW10 - 500-600, WW13 - 20-30,	WW6 - 80-90, WW9 - 800-900, WW13 - 1000-1100, WW13 - 70-80	**21-SEP-2011**	**21-OCT-2011**	28-SEP-2011	×	**25-OCT-2011**	18-NOV-2011	✓
Snap Lock Bag WW15 - 0-10,	WW22 - 0-100	**22-SEP-2011**	**19-OCT-2011**	29-SEP-2011	×	**25-OCT-2011**	16-NOV-2011	✓
Snap Lock Bag WW15 - 30-40,	WW15 - 90-100	**22-SEP-2011**	**21-OCT-2011**	29-SEP-2011	×	**25-OCT-2011**	18-NOV-2011	✓
Snap Lock Bag WW23 - 0-100,	WW28 - 0-100	**23-SEP-2011**	**19-OCT-2011**	30-SEP-2011	×	**25-OCT-2011**	16-NOV-2011	✓
Snap Lock Bag WW23 - 300-400, WW28 - 200-300,	WW23 - 900-1000, WW28 - 700-800	**23-SEP-2011**	**21-OCT-2011**	30-SEP-2011	×	**25-OCT-2011**	18-NOV-2011	✓
Snap Lock Bag WW36 - 0-100,	WW38 - 0-50	**24-SEP-2011**	**19-OCT-2011**	01-OCT-2011	×	**25-OCT-2011**	16-NOV-2011	✓
Snap Lock Bag WW36 - 200-300, WW38 - 500-600	WW36 - 700-800,	**24-SEP-2011**	**21-OCT-2011**	01-OCT-2011	×	**25-OCT-2011**	18-NOV-2011	✓
Snap Lock Bag WW44 - 0-100		**25-SEP-2011**	**19-OCT-2011**	02-OCT-2011	×	**25-OCT-2011**	16-NOV-2011	✓
Snap Lock Bag WW44 - 100-200,	WW44 - 500-600	**25-SEP-2011**	**21-OCT-2011**	02-OCT-2011	×	**25-OCT-2011**	18-NOV-2011	✓
Snap Lock Bag WW47 - 0-100		**26-SEP-2011**	**19-OCT-2011**	03-OCT-2011	×	**25-OCT-2011**	16-NOV-2011	✓
Snap Lock Bag WW60 - 0-20, WW75 - 0-50	WW69 - 0-50,	**27-SEP-2011**	**19-OCT-2011**	04-OCT-2011	×	**25-OCT-2011**	16-NOV-2011	✓
Snap Lock Bag WW60 - 20-300, WW69 - 200-300, WW75 - 400-500,	WW60 - 700-800, WW69 - 800-900, WW75 - 900-1000	**27-SEP-2011**	**21-OCT-2011**	04-OCT-2011	×	**25-OCT-2011**	18-NOV-2011	✓
Snap Lock Bag WW94 - 0-50		**28-SEP-2011**	**19-OCT-2011**	05-OCT-2011	×	**25-OCT-2011**	16-NOV-2011	✓
Snap Lock Bag WW94 - 200-300		**29-SEP-2011**	**21-OCT-2011**	06-OCT-2011	×	**25-OCT-2011**	18-NOV-2011	✓
Snap Lock Bag WW94 - 600-700		**30-SEP-2011**	**21-OCT-2011**	07-OCT-2011	×	**25-OCT-2011**	18-NOV-2011	✓

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA055: Moisture Content								
Snap Lock Bag WW6 - 0-10, WW6 - 80-90, WW9 - 200-300, WW10 - 0-100, WW13 - 1000-1100, WW13 - 20-30,	WW6 - 20-30, WW9 - 0-100, WW9 - 800-900, WW10 - 500-600, WW13 - 0-50, WW13 - 70-80	**21-SEP-2011**	----	----	----	**19-OCT-2011**	05-OCT-2011	×
Snap Lock Bag WW15 - 0-10, WW15 - 90-100,	WW15 - 30-40, WW22 - 0-100	**22-SEP-2011**	----	----	----	**19-OCT-2011**	06-OCT-2011	×
Snap Lock Bag WW23 - 0-100, WW23 - 900-1000, WW28 - 200-300,	WW23 - 300-400, WW28 - 0-100, WW28 - 700-800	**23-SEP-2011**	----	----	----	**19-OCT-2011**	07-OCT-2011	×
Snap Lock Bag WW36 - 0-100, WW36 - 700-800, WW38 - 500-600	WW36 - 200-300, WW38 - 0-50,	**24-SEP-2011**	----	----	----	**19-OCT-2011**	08-OCT-2011	×
Snap Lock Bag WW44 - 0-100, WW44 - 500-600	WW44 - 100-200,	**25-SEP-2011**	----	----	----	**19-OCT-2011**	09-OCT-2011	×
Snap Lock Bag WW47 - 0-100		**26-SEP-2011**	----	----	----	**19-OCT-2011**	10-OCT-2011	×
Snap Lock Bag WW60 - 0-20, WW60 - 700-800, WW69 - 200-300, WW75 - 0-50, WW75 - 900-1000	WW60 - 20-300, WW69 - 0-50, WW69 - 800-900, WW75 - 400-500,	**27-SEP-2011**	----	----	----	**19-OCT-2011**	11-OCT-2011	×
Snap Lock Bag WW94 - 0-50		**28-SEP-2011**	----	----	----	**19-OCT-2011**	12-OCT-2011	×
Snap Lock Bag WW94 - 200-300		**29-SEP-2011**	----	----	----	**19-OCT-2011**	13-OCT-2011	×
Snap Lock Bag WW94 - 600-700		**30-SEP-2011**	----	----	----	**19-OCT-2011**	14-OCT-2011	×

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA150: Particle Sizing								
Snap Lock Bag WW6 - 20-30, WW10 - 0-100, WW13 - 0-50,	WW9 - 800-900, WW13 - 1000-1100, WW13 - 70-80	**21-SEP-2011**	---	19-MAR-2012	----	**24-OCT-2011**	19-MAR-2012	✓
Snap Lock Bag WW15 - 0-10, WW22 - 0-100	WW15 - 90-100,	**22-SEP-2011**	---	20-MAR-2012	----	**24-OCT-2011**	20-MAR-2012	✓
Snap Lock Bag WW23 - 300-400, WW28 - 700-800	WW28 - 0-100,	**23-SEP-2011**	---	21-MAR-2012	----	**24-OCT-2011**	21-MAR-2012	✓
Snap Lock Bag WW36 - 0-100, WW38 - 500-600	WW36 - 700-800,	**24-SEP-2011**	---	22-MAR-2012	----	**24-OCT-2011**	22-MAR-2012	✓
Snap Lock Bag WW44 - 0-100,	WW44 - 500-600	**25-SEP-2011**	---	23-MAR-2012	----	**24-OCT-2011**	23-MAR-2012	✓
Snap Lock Bag WW47 - 0-100		**26-SEP-2011**	---	24-MAR-2012	----	**24-OCT-2011**	24-MAR-2012	✓
Snap Lock Bag WW60 - 0-20, WW69 - 200-300, WW75 - 400-500	WW60 - 700-800, WW75 - 0-50,	**27-SEP-2011**	---	25-MAR-2012	----	**24-OCT-2011**	25-MAR-2012	✓
Snap Lock Bag WW94 - 0-50		**28-SEP-2011**	---	26-MAR-2012	----	**24-OCT-2011**	26-MAR-2012	✓
Snap Lock Bag WW94 - 600-700		**30-SEP-2011**	---	28-MAR-2012	----	**24-OCT-2011**	28-MAR-2012	✓

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA150: Soil Classification based on Particle Size								
Snap Lock Bag WW6 - 20-30, WW10 - 0-100, WW13 - 0-50,	WW9 - 800-900, WW13 - 1000-1100, WW13 - 70-80	**21-SEP-2011**	---	19-MAR-2012	----	**24-OCT-2011**	19-MAR-2012	✓
Snap Lock Bag WW15 - 0-10, WW22 - 0-100	WW15 - 90-100,	**22-SEP-2011**	---	20-MAR-2012	----	**24-OCT-2011**	20-MAR-2012	✓
Snap Lock Bag WW23 - 300-400, WW28 - 700-800	WW28 - 0-100,	**23-SEP-2011**	---	21-MAR-2012	----	**24-OCT-2011**	21-MAR-2012	✓
Snap Lock Bag WW36 - 0-100, WW38 - 500-600	WW36 - 700-800,	**24-SEP-2011**	---	22-MAR-2012	----	**24-OCT-2011**	22-MAR-2012	✓
Snap Lock Bag WW44 - 0-100,	WW44 - 500-600	**25-SEP-2011**	---	23-MAR-2012	----	**24-OCT-2011**	23-MAR-2012	✓
Snap Lock Bag WW47 - 0-100		**26-SEP-2011**	---	24-MAR-2012	----	**24-OCT-2011**	24-MAR-2012	✓
Snap Lock Bag WW60 - 0-20, WW69 - 200-300, WW75 - 400-500	WW60 - 700-800, WW75 - 0-50,	**27-SEP-2011**	---	25-MAR-2012	----	**24-OCT-2011**	25-MAR-2012	✓
Snap Lock Bag WW94 - 0-50		**28-SEP-2011**	---	26-MAR-2012	----	**24-OCT-2011**	26-MAR-2012	✓
Snap Lock Bag WW94 - 600-700		**30-SEP-2011**	---	28-MAR-2012	----	**24-OCT-2011**	28-MAR-2012	✓

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation: Date extracted	Due for extraction	Evaluation	Analysis: Date analysed	Due for analysis	Evaluation
ED007: Exchangeable Cations							
Soil Glass Jar - Unpreserved WW6 - 0-10, WW6 - 20-30, WW6 - 80-90, WW9 - 0-100, WW9 - 200-300, WW9 - 800-900, WW10 - 0-100, WW10 - 500-600, WW13 - 1000-1100, WW13 - 0-50, WW13 - 20-30, WW13 - 70-80	**21-SEP-2011**	**21-OCT-2011**	19-MAR-2012	✓	**21-OCT-2011**	19-MAR-2012	✓
Soil Glass Jar - Unpreserved WW15 - 0-10, WW15 - 30-40, WW15 - 90-100, WW22 - 0-100	**22-SEP-2011**	**21-OCT-2011**	20-MAR-2012	✓	**21-OCT-2011**	20-MAR-2012	✓
Soil Glass Jar - Unpreserved WW23 - 0-100, WW23 - 300-400, WW23 - 900-1000, WW28 - 0-100, WW28 - 200-300, WW28 - 700-800	**23-SEP-2011**	**21-OCT-2011**	21-MAR-2012	✓	**21-OCT-2011**	21-MAR-2012	✓
Soil Glass Jar - Unpreserved WW36 - 0-100, WW36 - 200-300, WW36 - 700-800, WW38 - 0-50, WW38 - 500-600	**24-SEP-2011**	**21-OCT-2011**	22-MAR-2012	✓	**21-OCT-2011**	22-MAR-2012	✓
Soil Glass Jar - Unpreserved WW44 - 0-100, WW44 - 100-200, WW44 - 500-600	**25-SEP-2011**	**21-OCT-2011**	23-MAR-2012	✓	**21-OCT-2011**	23-MAR-2012	✓
Soil Glass Jar - Unpreserved WW47 - 0-100	**26-SEP-2011**	**21-OCT-2011**	24-MAR-2012	✓	**21-OCT-2011**	24-MAR-2012	✓
Soil Glass Jar - Unpreserved WW60 - 0-20, WW60 - 20-300, WW60 - 700-800, WW69 - 0-50, WW69 - 200-300, WW69 - 800-900, WW75 - 0-50, WW75 - 400-500, WW75 - 900-1000	**27-SEP-2011**	**21-OCT-2011**	25-MAR-2012	✓	**21-OCT-2011**	25-MAR-2012	✓
Soil Glass Jar - Unpreserved WW94 - 0-50	**28-SEP-2011**	**21-OCT-2011**	26-MAR-2012	✓	**21-OCT-2011**	26-MAR-2012	✓
Soil Glass Jar - Unpreserved WW94 - 200-300	**29-SEP-2011**	**21-OCT-2011**	27-MAR-2012	✓	**21-OCT-2011**	27-MAR-2012	✓
Soil Glass Jar - Unpreserved WW94 - 600-700	**30-SEP-2011**	**21-OCT-2011**	28-MAR-2012	✓	**21-OCT-2011**	28-MAR-2012	✓

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
ED037: Alkalinity								
Snap Lock Bag WW6 - 0-10, WW10 - 0-100,	WW9 - 0-100, WW13 - 0-50	**21-SEP-2011**	**19-OCT-2011**	19-MAR-2012	✓	**26-OCT-2011**	19-MAR-2012	✓
Snap Lock Bag WW6 - 20-30, WW9 - 200-300, WW10 - 500-600, WW13 - 20-30,	WW6 - 80-90, WW9 - 800-900, WW13 - 1000-1100, WW13 - 70-80	**21-SEP-2011**	**21-OCT-2011**	19-MAR-2012	✓	**26-OCT-2011**	19-MAR-2012	✓
Snap Lock Bag WW15 - 0-10,	WW22 - 0-100	**22-SEP-2011**	**19-OCT-2011**	20-MAR-2012	✓	**26-OCT-2011**	20-MAR-2012	✓
Snap Lock Bag WW15 - 30-40,	WW15 - 90-100	**22-SEP-2011**	**21-OCT-2011**	20-MAR-2012	✓	**26-OCT-2011**	20-MAR-2012	✓
Snap Lock Bag WW23 - 0-100,	WW28 - 0-100	**23-SEP-2011**	**19-OCT-2011**	21-MAR-2012	✓	**26-OCT-2011**	21-MAR-2012	✓
Snap Lock Bag WW23 - 300-400, WW28 - 200-300,	WW23 - 900-1000, WW28 - 700-800	**23-SEP-2011**	**21-OCT-2011**	21-MAR-2012	✓	**26-OCT-2011**	21-MAR-2012	✓
Snap Lock Bag WW36 - 0-100,	WW38 - 0-50	**24-SEP-2011**	**19-OCT-2011**	22-MAR-2012	✓	**26-OCT-2011**	22-MAR-2012	✓
Snap Lock Bag WW36 - 200-300, WW38 - 500-600	WW36 - 700-800,	**24-SEP-2011**	**21-OCT-2011**	22-MAR-2012	✓	**26-OCT-2011**	22-MAR-2012	✓
Snap Lock Bag WW44 - 0-100		**25-SEP-2011**	**19-OCT-2011**	23-MAR-2012	✓	**26-OCT-2011**	23-MAR-2012	✓
Snap Lock Bag WW44 - 100-200,	WW44 - 500-600	**25-SEP-2011**	**21-OCT-2011**	23-MAR-2012	✓	**26-OCT-2011**	23-MAR-2012	✓
Snap Lock Bag WW47 - 0-100		**26-SEP-2011**	**19-OCT-2011**	24-MAR-2012	✓	**26-OCT-2011**	24-MAR-2012	✓
Snap Lock Bag WW60 - 0-20, WW75 - 0-50	WW69 - 0-50,	**27-SEP-2011**	**19-OCT-2011**	25-MAR-2012	✓	**26-OCT-2011**	25-MAR-2012	✓
Snap Lock Bag WW60 - 20-300, WW69 - 200-300, WW75 - 400-500,	WW60 - 700-800, WW69 - 800-900, WW75 - 900-1000	**27-SEP-2011**	**21-OCT-2011**	25-MAR-2012	✓	**26-OCT-2011**	25-MAR-2012	✓
Snap Lock Bag WW94 - 0-50		**28-SEP-2011**	**19-OCT-2011**	26-MAR-2012	✓	**26-OCT-2011**	26-MAR-2012	✓
Snap Lock Bag WW94 - 200-300		**29-SEP-2011**	**21-OCT-2011**	27-MAR-2012	✓	**26-OCT-2011**	27-MAR-2012	✓
Snap Lock Bag WW94 - 600-700		**30-SEP-2011**	**21-OCT-2011**	28-MAR-2012	✓	**26-OCT-2011**	28-MAR-2012	✓

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
ED040S : Soluble Sulfate by ICPAES								
Snap Lock Bag WW6 - 0-10, WW10 - 0-100,	 WW9 - 0-100, WW13 - 0-50	**21-SEP-2011**	**19-OCT-2011**	28-SEP-2011	×	**26-OCT-2011**	16-NOV-2011	✓
Snap Lock Bag WW6 - 20-30, WW9 - 200-300, WW10 - 500-600, WW13 - 20-30,	 WW6 - 80-90, WW9 - 800-900, WW13 - 1000-1100, WW13 - 70-80	**21-SEP-2011**	**21-OCT-2011**	28-SEP-2011	×	**26-OCT-2011**	18-NOV-2011	✓
Snap Lock Bag WW15 - 0-10,	 WW22 - 0-100	**22-SEP-2011**	**19-OCT-2011**	29-SEP-2011	×	**26-OCT-2011**	16-NOV-2011	✓
Snap Lock Bag WW15 - 30-40,	 WW15 - 90-100	**22-SEP-2011**	**21-OCT-2011**	29-SEP-2011	×	**26-OCT-2011**	18-NOV-2011	✓
Snap Lock Bag WW23 - 0-100,	 WW28 - 0-100	**23-SEP-2011**	**19-OCT-2011**	30-SEP-2011	×	**26-OCT-2011**	16-NOV-2011	✓
Snap Lock Bag WW23 - 300-400, WW28 - 200-300,	 WW23 - 900-1000, WW28 - 700-800	**23-SEP-2011**	**21-OCT-2011**	30-SEP-2011	×	**26-OCT-2011**	18-NOV-2011	✓
Snap Lock Bag WW36 - 0-100,	 WW38 - 0-50	**24-SEP-2011**	**19-OCT-2011**	01-OCT-2011	×	**26-OCT-2011**	16-NOV-2011	✓
Snap Lock Bag WW36 - 200-300, WW38 - 500-600	 WW36 - 700-800,	**24-SEP-2011**	**21-OCT-2011**	01-OCT-2011	×	**26-OCT-2011**	18-NOV-2011	✓
Snap Lock Bag WW44 - 0-100		**25-SEP-2011**	**19-OCT-2011**	02-OCT-2011	×	**26-OCT-2011**	16-NOV-2011	✓
Snap Lock Bag WW44 - 100-200,	 WW44 - 500-600	**25-SEP-2011**	**21-OCT-2011**	02-OCT-2011	×	**26-OCT-2011**	18-NOV-2011	✓
Snap Lock Bag WW47 - 0-100		**26-SEP-2011**	**19-OCT-2011**	03-OCT-2011	×	**26-OCT-2011**	16-NOV-2011	✓
Snap Lock Bag WW60 - 0-20, WW75 - 0-50	 WW69 - 0-50,	**27-SEP-2011**	**19-OCT-2011**	04-OCT-2011	×	**26-OCT-2011**	16-NOV-2011	✓
Snap Lock Bag WW60 - 20-300, WW69 - 200-300, WW75 - 400-500,	 WW60 - 700-800, WW69 - 800-900, WW75 - 900-1000	**27-SEP-2011**	**21-OCT-2011**	04-OCT-2011	×	**26-OCT-2011**	18-NOV-2011	✓
Snap Lock Bag WW94 - 0-50		**28-SEP-2011**	**19-OCT-2011**	05-OCT-2011	×	**26-OCT-2011**	16-NOV-2011	✓
Snap Lock Bag WW94 - 200-300		**29-SEP-2011**	**21-OCT-2011**	06-OCT-2011	×	**26-OCT-2011**	18-NOV-2011	✓
Snap Lock Bag WW94 - 600-700		**30-SEP-2011**	**21-OCT-2011**	07-OCT-2011	×	**26-OCT-2011**	18-NOV-2011	✓

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
ED045G: Chloride Discrete analyser								
Snap Lock Bag WW6 - 0-10, WW10 - 0-100,	WW9 - 0-100, WW13 - 0-50	**21-SEP-2011**	**19-OCT-2011**	28-SEP-2011	×	**26-OCT-2011**	16-NOV-2011	✓
Snap Lock Bag WW6 - 20-30, WW9 - 200-300, WW10 - 500-600, WW13 - 20-30,	WW6 - 80-90, WW9 - 800-900, WW13 - 1000-1100, WW13 - 70-80	**21-SEP-2011**	**21-OCT-2011**	28-SEP-2011	×	**26-OCT-2011**	18-NOV-2011	✓
Snap Lock Bag WW15 - 0-10,	WW22 - 0-100	**22-SEP-2011**	**19-OCT-2011**	29-SEP-2011	×	**26-OCT-2011**	16-NOV-2011	✓
Snap Lock Bag WW15 - 30-40,	WW15 - 90-100	**22-SEP-2011**	**21-OCT-2011**	29-SEP-2011	×	**26-OCT-2011**	18-NOV-2011	✓
Snap Lock Bag WW23 - 0-100,	WW28 - 0-100	**23-SEP-2011**	**19-OCT-2011**	30-SEP-2011	×	**26-OCT-2011**	16-NOV-2011	✓
Snap Lock Bag WW23 - 300-400, WW28 - 200-300,	WW23 - 900-1000, WW28 - 700-800	**23-SEP-2011**	**21-OCT-2011**	30-SEP-2011	×	**26-OCT-2011**	18-NOV-2011	✓
Snap Lock Bag WW36 - 0-100,	WW38 - 0-50	**24-SEP-2011**	**19-OCT-2011**	01-OCT-2011	×	**26-OCT-2011**	16-NOV-2011	✓
Snap Lock Bag WW36 - 200-300, WW38 - 500-600	WW36 - 700-800,	**24-SEP-2011**	**21-OCT-2011**	01-OCT-2011	×	**26-OCT-2011**	18-NOV-2011	✓
Snap Lock Bag WW44 - 0-100		**25-SEP-2011**	**19-OCT-2011**	02-OCT-2011	×	**26-OCT-2011**	16-NOV-2011	✓
Snap Lock Bag WW44 - 100-200,	WW44 - 500-600	**25-SEP-2011**	**21-OCT-2011**	02-OCT-2011	×	**26-OCT-2011**	18-NOV-2011	✓
Snap Lock Bag WW47 - 0-100		**26-SEP-2011**	**19-OCT-2011**	03-OCT-2011	×	**26-OCT-2011**	16-NOV-2011	✓
Snap Lock Bag WW60 - 0-20, WW75 - 0-50	WW69 - 0-50,	**27-SEP-2011**	**19-OCT-2011**	04-OCT-2011	×	**26-OCT-2011**	16-NOV-2011	✓
Snap Lock Bag WW60 - 20-300, WW69 - 200-300, WW75 - 400-500,	WW60 - 700-800, WW69 - 800-900, WW75 - 900-1000	**27-SEP-2011**	**21-OCT-2011**	04-OCT-2011	×	**26-OCT-2011**	18-NOV-2011	✓
Snap Lock Bag WW94 - 0-50		**28-SEP-2011**	**19-OCT-2011**	05-OCT-2011	×	**26-OCT-2011**	16-NOV-2011	✓
Snap Lock Bag WW94 - 200-300		**29-SEP-2011**	**21-OCT-2011**	06-OCT-2011	×	**26-OCT-2011**	18-NOV-2011	✓
Snap Lock Bag WW94 - 600-700		**30-SEP-2011**	**21-OCT-2011**	07-OCT-2011	×	**26-OCT-2011**	18-NOV-2011	✓

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
ED093S: Soluble Major Cations								
Snap Lock Bag WW6 - 0-10, WW10 - 0-100,	WW9 - 0-100, WW13 - 0-50	**21-SEP-2011**	**19-OCT-2011**	19-MAR-2012	✓	**26-OCT-2011**	19-MAR-2012	✓
Snap Lock Bag WW6 - 20-30, WW9 - 200-300, WW10 - 500-600, WW13 - 20-30,	WW6 - 80-90, WW9 - 800-900, WW13 - 1000-1100, WW13 - 70-80	**21-SEP-2011**	**21-OCT-2011**	19-MAR-2012	✓	**26-OCT-2011**	19-MAR-2012	✓
Snap Lock Bag WW15 - 0-10,	WW22 - 0-100	**22-SEP-2011**	**19-OCT-2011**	20-MAR-2012	✓	**26-OCT-2011**	20-MAR-2012	✓
Snap Lock Bag WW15 - 30-40,	WW15 - 90-100	**22-SEP-2011**	**21-OCT-2011**	20-MAR-2012	✓	**26-OCT-2011**	20-MAR-2012	✓
Snap Lock Bag WW23 - 0-100,	WW28 - 0-100	**23-SEP-2011**	**19-OCT-2011**	21-MAR-2012	✓	**26-OCT-2011**	21-MAR-2012	✓
Snap Lock Bag WW23 - 300-400, WW28 - 200-300,	WW23 - 900-1000, WW28 - 700-800	**23-SEP-2011**	**21-OCT-2011**	21-MAR-2012	✓	**26-OCT-2011**	21-MAR-2012	✓
Snap Lock Bag WW36 - 0-100,	WW38 - 0-50	**24-SEP-2011**	**19-OCT-2011**	22-MAR-2012	✓	**26-OCT-2011**	22-MAR-2012	✓
Snap Lock Bag WW36 - 200-300, WW38 - 500-600	WW36 - 700-800,	**24-SEP-2011**	**21-OCT-2011**	22-MAR-2012	✓	**26-OCT-2011**	22-MAR-2012	✓
Snap Lock Bag WW44 - 0-100		**25-SEP-2011**	**19-OCT-2011**	23-MAR-2012	✓	**26-OCT-2011**	23-MAR-2012	✓
Snap Lock Bag WW44 - 100-200,	WW44 - 500-600	**25-SEP-2011**	**21-OCT-2011**	23-MAR-2012	✓	**26-OCT-2011**	23-MAR-2012	✓
Snap Lock Bag WW47 - 0-100		**26-SEP-2011**	**19-OCT-2011**	24-MAR-2012	✓	**26-OCT-2011**	24-MAR-2012	✓
Snap Lock Bag WW60 - 0-20, WW75 - 0-50	WW69 - 0-50,	**27-SEP-2011**	**19-OCT-2011**	25-MAR-2012	✓	**26-OCT-2011**	25-MAR-2012	✓
Snap Lock Bag WW60 - 20-300, WW69 - 200-300, WW75 - 400-500,	WW60 - 700-800, WW69 - 800-900, WW75 - 900-1000	**27-SEP-2011**	**21-OCT-2011**	25-MAR-2012	✓	**26-OCT-2011**	25-MAR-2012	✓
Snap Lock Bag WW94 - 0-50		**28-SEP-2011**	**19-OCT-2011**	26-MAR-2012	✓	**26-OCT-2011**	26-MAR-2012	✓
Snap Lock Bag WW94 - 200-300		**29-SEP-2011**	**21-OCT-2011**	27-MAR-2012	✓	**26-OCT-2011**	27-MAR-2012	✓
Snap Lock Bag WW94 - 600-700		**30-SEP-2011**	**21-OCT-2011**	28-MAR-2012	✓	**26-OCT-2011**	28-MAR-2012	✓

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EG005T: Total Metals by ICP-AES								
Snap Lock Bag WW6 - 0-10, WW10 - 0-100,	WW9 - 0-100, WW13 - 0-50	21-SEP-2011	21-OCT-2011	19-MAR-2012	✓	22-OCT-2011	19-MAR-2012	✓
Snap Lock Bag WW15 - 0-10,	WW22 - 0-100	22-SEP-2011	21-OCT-2011	20-MAR-2012	✓	22-OCT-2011	20-MAR-2012	✓
Snap Lock Bag WW23 - 0-100,	WW28 - 0-100	23-SEP-2011	21-OCT-2011	21-MAR-2012	✓	22-OCT-2011	21-MAR-2012	✓
Snap Lock Bag WW36 - 0-100,	WW38 - 0-50	24-SEP-2011	21-OCT-2011	22-MAR-2012	✓	22-OCT-2011	22-MAR-2012	✓
Snap Lock Bag WW44 - 0-100		25-SEP-2011	21-OCT-2011	23-MAR-2012	✓	22-OCT-2011	23-MAR-2012	✓
Snap Lock Bag WW47 - 0-100		26-SEP-2011	21-OCT-2011	24-MAR-2012	✓	22-OCT-2011	24-MAR-2012	✓
Snap Lock Bag WW60 - 0-20, WW75 - 0-50	WW69 - 0-50,	27-SEP-2011	21-OCT-2011	25-MAR-2012	✓	22-OCT-2011	25-MAR-2012	✓
Snap Lock Bag WW94 - 0-50		28-SEP-2011	21-OCT-2011	26-MAR-2012	✓	22-OCT-2011	26-MAR-2012	✓
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Snap Lock Bag WW6 - 0-10, WW10 - 0-100,	WW9 - 0-100, WW13 - 0-50	21-SEP-2011	19-OCT-2011	19-MAR-2012	✓	26-OCT-2011	19-MAR-2012	✓
Snap Lock Bag WW15 - 0-10,	WW22 - 0-100	22-SEP-2011	19-OCT-2011	20-MAR-2012	✓	26-OCT-2011	20-MAR-2012	✓
Snap Lock Bag WW23 - 0-100,	WW28 - 0-100	23-SEP-2011	19-OCT-2011	21-MAR-2012	✓	26-OCT-2011	21-MAR-2012	✓
Snap Lock Bag WW36 - 0-100,	WW38 - 0-50	24-SEP-2011	19-OCT-2011	22-MAR-2012	✓	26-OCT-2011	22-MAR-2012	✓
Snap Lock Bag WW44 - 0-100		25-SEP-2011	19-OCT-2011	23-MAR-2012	✓	26-OCT-2011	23-MAR-2012	✓
Snap Lock Bag WW47 - 0-100		26-SEP-2011	19-OCT-2011	24-MAR-2012	✓	26-OCT-2011	24-MAR-2012	✓
Snap Lock Bag WW60 - 0-20, WW75 - 0-50	WW69 - 0-50,	27-SEP-2011	19-OCT-2011	25-MAR-2012	✓	26-OCT-2011	25-MAR-2012	✓
Snap Lock Bag WW94 - 0-50		28-SEP-2011	19-OCT-2011	26-MAR-2012	✓	26-OCT-2011	26-MAR-2012	✓

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Snap Lock Bag WW6 - 0-10, WW10 - 0-100,	WW9 - 0-100, WW13 - 0-50	21-SEP-2011	21-OCT-2011	19-MAR-2012	✓	21-OCT-2011	19-MAR-2012	✓
Snap Lock Bag WW15 - 0-10,	WW22 - 0-100	22-SEP-2011	21-OCT-2011	20-MAR-2012	✓	21-OCT-2011	20-MAR-2012	✓
Snap Lock Bag WW23 - 0-100,	WW28 - 0-100	23-SEP-2011	21-OCT-2011	21-MAR-2012	✓	21-OCT-2011	21-MAR-2012	✓
Snap Lock Bag WW36 - 0-100,	WW38 - 0-50	24-SEP-2011	21-OCT-2011	22-MAR-2012	✓	21-OCT-2011	22-MAR-2012	✓
Snap Lock Bag WW44 - 0-100		25-SEP-2011	21-OCT-2011	23-MAR-2012	✓	21-OCT-2011	23-MAR-2012	✓
Snap Lock Bag WW47 - 0-100		26-SEP-2011	21-OCT-2011	24-MAR-2012	✓	21-OCT-2011	24-MAR-2012	✓
Snap Lock Bag WW60 - 0-20, WW75 - 0-50	WW69 - 0-50,	27-SEP-2011	21-OCT-2011	25-MAR-2012	✓	21-OCT-2011	25-MAR-2012	✓
Snap Lock Bag WW94 - 0-50		28-SEP-2011	21-OCT-2011	26-MAR-2012	✓	21-OCT-2011	26-MAR-2012	✓
EK067G: Total Phosphorus as P by Discrete Analyser								
Snap Lock Bag WW6 - 0-10, WW10 - 0-100,	WW9 - 0-100, WW13 - 0-50	21-SEP-2011	21-OCT-2011	19-MAR-2012	✓	21-OCT-2011	19-MAR-2012	✓
Snap Lock Bag WW15 - 0-10,	WW22 - 0-100	22-SEP-2011	21-OCT-2011	20-MAR-2012	✓	21-OCT-2011	20-MAR-2012	✓
Snap Lock Bag WW23 - 0-100,	WW28 - 0-100	23-SEP-2011	21-OCT-2011	21-MAR-2012	✓	21-OCT-2011	21-MAR-2012	✓
Snap Lock Bag WW36 - 0-100,	WW38 - 0-50	24-SEP-2011	21-OCT-2011	22-MAR-2012	✓	21-OCT-2011	22-MAR-2012	✓
Snap Lock Bag WW44 - 0-100		25-SEP-2011	21-OCT-2011	23-MAR-2012	✓	21-OCT-2011	23-MAR-2012	✓
Snap Lock Bag WW47 - 0-100		26-SEP-2011	21-OCT-2011	24-MAR-2012	✓	21-OCT-2011	24-MAR-2012	✓
Snap Lock Bag WW60 - 0-20, WW75 - 0-50	WW69 - 0-50,	27-SEP-2011	21-OCT-2011	25-MAR-2012	✓	21-OCT-2011	25-MAR-2012	✓
Snap Lock Bag WW94 - 0-50		28-SEP-2011	21-OCT-2011	26-MAR-2012	✓	21-OCT-2011	26-MAR-2012	✓

Matrix: **SOIL**

Evaluation: ✘ = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EP004: Organic Matter								
Snap Lock Bag WW6 - 0-10, WW10 - 0-100,	WW9 - 0-100, WW13 - 0-50	**21-SEP-2011**	**25-OCT-2011**	28-SEP-2011	✘	**25-OCT-2011**	22-NOV-2011	✓
Snap Lock Bag WW15 - 0-10,	WW22 - 0-100	**22-SEP-2011**	**25-OCT-2011**	29-SEP-2011	✘	**25-OCT-2011**	22-NOV-2011	✓
Snap Lock Bag WW23 - 0-100,	WW28 - 0-100	**23-SEP-2011**	**25-OCT-2011**	30-SEP-2011	✘	**25-OCT-2011**	22-NOV-2011	✓
Snap Lock Bag WW36 - 0-100,	WW38 - 0-50	**24-SEP-2011**	**25-OCT-2011**	01-OCT-2011	✘	**25-OCT-2011**	22-NOV-2011	✓
Snap Lock Bag WW44 - 0-100		**25-SEP-2011**	**25-OCT-2011**	02-OCT-2011	✘	**25-OCT-2011**	22-NOV-2011	✓
Snap Lock Bag WW47 - 0-100		**26-SEP-2011**	**25-OCT-2011**	03-OCT-2011	✘	**25-OCT-2011**	22-NOV-2011	✓
Snap Lock Bag WW60 - 0-20, WW75 - 0-50	WW69 - 0-50,	**27-SEP-2011**	**25-OCT-2011**	04-OCT-2011	✘	**25-OCT-2011**	22-NOV-2011	✓
Snap Lock Bag WW94 - 0-50		**28-SEP-2011**	**25-OCT-2011**	05-OCT-2011	✘	**25-OCT-2011**	22-NOV-2011	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(where) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **SOIL**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Alkalinity in Soil	ED037	6	43	**14.0**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Cations - soluble by ICP-AES	ED093S	6	43	**14.0**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Chloride Soluble By Discrete Analyser	ED045G	6	43	**14.0**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Electrical Conductivity (1:5)	EA010	6	43	**14.0**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Exchangeable Cations	ED007	5	43	**11.6**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Major Anions - Soluble	ED040S	6	43	**14.0**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Moisture Content	EA055-103	4	40	**10.0**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Nitrite and Nitrate as N (NOx)- Soluble by Discrete Analyser	EK059G	3	16	**18.8**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Organic Matter	EP004	3	29	**10.3**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
pH (1:5)	EA002	6	43	**14.0**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
TKN as N By Discrete Analyser	EK061G	2	16	**12.5**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Metals by ICP-AES	EG005T	2	16	**12.5**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Phosporus By Discrete Analyser	EK067G	2	16	**12.5**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Laboratory Control Samples (LCS)							
Alkalinity in Soil	ED037	4	43	**9.3**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Chloride Soluble By Discrete Analyser	ED045G	8	43	**18.6**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Electrical Conductivity (1:5)	EA010	4	43	**9.3**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Exchangeable Cations	ED007	3	43	**7.0**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Major Anions - Soluble	ED040S	4	43	**9.3**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Nitrite and Nitrate as N (NOx)- Soluble by Discrete Analyser	EK059G	2	16	**12.5**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Organic Matter	EP004	2	29	**6.9**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
pH (1:5)	EA002	4	43	**9.3**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
TKN as N By Discrete Analyser	EK061G	1	16	**6.3**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Metals by ICP-AES	EG005T	1	16	**6.3**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Phosporus By Discrete Analyser	EK067G	1	16	**6.3**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Method Blanks (MB)							
Alkalinity in Soil	ED037	4	43	**9.3**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Cations - soluble by ICP-AES	ED093S	4	43	**9.3**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Chloride Soluble By Discrete Analyser	ED045G	4	43	**9.3**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Electrical Conductivity (1:5)	EA010	4	43	**9.3**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Exchangeable Cations	ED007	3	43	**7.0**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Major Anions - Soluble	ED040S	4	43	**9.3**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Nitrite and Nitrate as N (NOx)- Soluble by Discrete Analyser	EK059G	2	16	**12.5**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Organic Matter	EP004	2	29	**6.9**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
TKN as N By Discrete Analyser	EK061G	1	16	**6.3**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Total Metals by ICP-AES	EG005T	1	16	**6.3**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement

Matrix: **SOIL**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Method Blanks (MB) - Continued							
Total Phosporus By Discrete Analyser	EK067G	1	16	**6.3**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Matrix Spikes (MS)							
Nitrite and Nitrate as N (NOx)- Soluble by Discrete Analyser	EK059G	1	15	**6.7**	**5.0**	✓	ALS QCS3 requirement
TKN as N By Discrete Analyser	EK061G	1	16	**6.3**	**5.0**	✓	ALS QCS3 requirement
Total Metals by ICP-AES	EG005T	1	16	**6.3**	**5.0**	✓	ALS QCS3 requirement
Total Phosporus By Discrete Analyser	EK067G	1	16	**6.3**	**5.0**	✓	ALS QCS3 requirement

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
pH (1:5)	EA002	SOIL	(APHA 21st ed., 4500H+) pH is determined on soil samples after a 1:5 soil/water leach. This method is compliant with NEPM (1999) Schedule B(3) (Method 103)
Electrical Conductivity (1:5)	EA010	SOIL	(APHA 21st ed., 2510) Conductivity is determined on soil samples using a 1:5 soil/water leach. This method is compliant with NEPM (1999) Schedule B(3) (Method 104)
Moisture Content	EA055-103	SOIL	A gravimetric procedure based on weight loss over a 12 hour drying period at 103-105 degrees C. This method is compliant with NEPM (2010 Draft) Schedule B(3) Section 7.1 and Table 1 (14 day holding time).
Particle Size Analysis (Sieving)	EA150	SOIL	Particle Size Analysis by Sieving according to AS1289.3.6.1 - 1995
Particle Size Analysis by Hydrometer	EA150H	SOIL	Particle Size Analysis by Hydrometer according to AS1289.3.6.3 - 2003
Exchangeable Cations	ED007	SOIL	Rayment & Higginson (1992) Method 15A1. Cations are exchanged from the sample by contact with Ammonium Chloride. They are then quantitated in the final solution by ICPAES and reported as meq/100g of original soil. This method is compliant with NEPM (1999) Schedule B(3) (Method 301)
Alkalinity in Soil	ED037	SOIL	APHA 21st ed., 2320 B Alkalinity is determined and reported on a 1:5 soil/water leach.
Major Anions - Soluble	ED040S	SOIL	In-house. Soluble Anions are determined off a 1:5 soil / water extract by ICPAES.
Chloride Soluble By Discrete Analyser	ED045G	SOIL	The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride.in the presence of ferric ions the librated thiocynate forms highly-coloured ferric thiocynate which is measured at 480 nm APHA 21st edition 4500-Cl- E.
Cations - soluble by ICP-AES	ED093S	SOIL	APHA 21st ed., 3120; USEPA SW 846 - 6010 (ICPAES) Water extracts of the soil are analyzed for major cations by ICPAES. The ICPAES technique ionises samples in a plasma, emitting a characteristic spectrum based on metals present. Intensities at selected wavelengths are compared against those of matrix matched standards. This method is compliant with NEPM (1999) Schedule B(3)
Total Metals by ICP-AES	EG005T	SOIL	(APHA 21st ed., 3120; USEPA SW 846 - 6010) (ICPAES) Metals are determined following an appropriate acid digestion of the soil. The ICPAES technique ionises samples in a plasma, emitting a characteristic spectrum based on metals present. Intensities at selected wavelengths are compared against those of matrix matched standards. This method is compliant with NEPM (1999) Schedule B(3)
Nitrite and Nitrate as N (NOx)- Soluble by Discrete Analyser	EK059G	SOIL	APHA 21st ed., 4500 NO3- F. Combined oxidised Nitrogen (NO2+NO3) in a water extract is determined by Cadmium Reduction, and direct colourimetry by Discrete Analyser.
TKN as N By Discrete Analyser	EK061G	SOIL	APHA 21st ed., 4500-Norg-D Soil samples are digested using Kjeldahl digestion followed by determination by Discrete Analyser.
Total Nitrogen as N (TKN + NOx) By Discrete Analyser	EK062G	SOIL	APHA 21st ed., 4500 Norg/NO3- Total Nitrogen is determined as the sum of TKN and Oxidised Nitrrogen, each determined seperately as N.
Total Phosporus By Discrete Analyser	EK067G	SOIL	APHA 21st ed., 4500 P-B&F This procedure involves sulfuric acid digestion and quantification using Discrete Analyser.
Emerson Aggregate Testing	EME-SOL	SOIL	Emerson Aggregate Testing per AS1289.3.8.1 performed by Subcontrator Laboratory.
Organic Matter	EP004	SOIL	AS1289.4.1.1 - 1997., Dichromate oxidation method after Walkley and Black. This method is compliant with NEPM (1999) Schedule B(3) (Method 105)

Preparation Methods	Method	Matrix	Method Descriptions
Exchangeable Cations Preparation Method	ED007PR	SOIL	Rayment & Higginson (1992) method 15A1. A 1M NH4Cl extraction by end over end tumbling at a ratio of 1:20. There is no pretreatment for soluble salts. Extracts can be run by ICP for cations.
TKN/TP Digestion	EK061/EK067	SOIL	APHA 21st ed., 4500 Norg- D; APHA 21st ed., 4500 P - H. Macro Kjeldahl digestion.

Preparation Methods	*Method*	*Matrix*	*Method Descriptions*
1:5 solid / water leach for soluble analytes	EN34	SOIL	10 g of soil is mixed with 50 mL of distilled water and tumbled end over end for 1 hour. Water soluble salts are leached from the soil by the continuous suspension. Samples are settled and the water filtered off for analysis.
Hot Block Digest for metals in soils sediments and sludges	EN69	SOIL	USEPA 200.2 Mod. Hot Block Acid Digestion 1.0g of sample is heated with Nitric and Hydrochloric acids, then cooled. Peroxide is added and samples heated and cooled again before being filtered and bulked to volume for analysis. Digest is appropriate for determination of selected metals in sludge, sediments, and soils. This method is compliant with NEPM (1999) Schedule B(3) (Method 202)
Organic Matter	EP004-PR	SOIL	AS1289.4.1.1 - 1997., Dichromate oxidation method after Walkley and Black. This method is compliant with NEPM (1999) Schedule B(3) (Method 105)

Summary of Outliers

Outliers : Quality Control Samples

The following report highlights outliers flagged in the Quality Control (QC) Report. Surrogate recovery limits are static and based on USEPA SW846 or ALS-QWI/EN/38 (in the absence of specific USEPA limits). This report displays QC Outliers (breaches) only.

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **SOIL**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Duplicate (DUP) RPDs							
EG005T: Total Metals by ICP-AES	EB1121537-030	WW44 0-100	**Manganese**	7439-96-5	22.4 %	0-20%	**RPD exceeds LOR based limits**
Laboratory Control Spike (LCS) Recoveries							
ED045G: Chloride Discrete analyser	2371166-001	----	**Chloride**	16887-00-6	11000 %	81-125%	**Recovery greater than upper control limit**
ED045G: Chloride Discrete analyser	2371166-023	----	**Chloride**	16887-00-6	1.0 %	81-125%	**Recovery less than lower control limit**

- **For all matrices, no Method Blank value outliers occur.**
- **For all matrices, no Matrix Spike outliers occur.**

Regular Sample Surrogates

- **For all regular sample matrices, no surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

This report displays Holding Time breaches only. Only the respective Extraction / Preparation and/or Analysis component is/are displayed.

Matrix: **SOIL**

Method		*Extraction / Preparation*			*Analysis*		
Container / Client Sample ID(s)		*Date extracted*	*Due for extraction*	***Days overdue***	*Date analysed*	*Due for analysis*	***Days overdue***
EA002 : pH (Soils)							
Snap Lock Bag WW6 - 0-10, WW10 - 0-100,	WW9 - 0-100, WW13 - 0-50	19-OCT-2011	28-SEP-2011	**21**	25-OCT-2011	19-OCT-2011	**6**
Snap Lock Bag WW6 - 20-30, WW9 - 200-300, WW10 - 500-600, WW13 - 20-30,	WW6 - 80-90, WW9 - 800-900, WW13 - 1000-1100, WW13 - 70-80	21-OCT-2011	28-SEP-2011	**23**	25-OCT-2011	21-OCT-2011	**4**
Snap Lock Bag WW15 - 0-10,	WW22 - 0-100	19-OCT-2011	29-SEP-2011	**20**	25-OCT-2011	19-OCT-2011	**6**
Snap Lock Bag WW15 - 30-40,	WW15 - 90-100	21-OCT-2011	29-SEP-2011	**22**	25-OCT-2011	21-OCT-2011	**4**
Snap Lock Bag WW23 - 0-100,	WW28 - 0-100	19-OCT-2011	30-SEP-2011	**19**	25-OCT-2011	19-OCT-2011	**6**
Snap Lock Bag WW23 - 300-400, WW28 - 200-300,	WW23 - 900-1000, WW28 - 700-800	21-OCT-2011	30-SEP-2011	**21**	25-OCT-2011	21-OCT-2011	**4**

Matrix: **SOIL**

Method Container / Client Sample ID(s)		Extraction / Preparation Date extracted	Due for extraction	Days overdue	Analysis Date analysed	Due for analysis	Days overdue
EA002 : pH (Soils) - Analysis Holding Time Compliance							
Snap Lock Bag WW36 - 0-100,	WW38 - 0-50	19-OCT-2011	01-OCT-2011	**18**	25-OCT-2011	19-OCT-2011	**6**
Snap Lock Bag WW36 - 200-300, WW38 - 500-600	WW36 - 700-800,	21-OCT-2011	01-OCT-2011	**20**	25-OCT-2011	21-OCT-2011	**4**
Snap Lock Bag WW44 - 0-100		19-OCT-2011	02-OCT-2011	**17**	25-OCT-2011	19-OCT-2011	**6**
Snap Lock Bag WW44 - 100-200,	WW44 - 500-600	21-OCT-2011	02-OCT-2011	**19**	25-OCT-2011	21-OCT-2011	**4**
Snap Lock Bag WW47 - 0-100		19-OCT-2011	03-OCT-2011	**16**	25-OCT-2011	19-OCT-2011	**6**
Snap Lock Bag WW60 - 0-20, WW75 - 0-50	WW69 - 0-50,	19-OCT-2011	04-OCT-2011	**15**	25-OCT-2011	19-OCT-2011	**6**
Snap Lock Bag WW60 - 20-300, WW69 - 200-300, WW75 - 400-500,	WW60 - 700-800, WW69 - 800-900, WW75 - 900-1000	21-OCT-2011	04-OCT-2011	**17**	25-OCT-2011	21-OCT-2011	**4**
Snap Lock Bag WW94 - 0-50		19-OCT-2011	05-OCT-2011	**14**	25-OCT-2011	19-OCT-2011	**6**
Snap Lock Bag WW94 - 200-300		21-OCT-2011	06-OCT-2011	**15**	25-OCT-2011	21-OCT-2011	**4**
Snap Lock Bag WW94 - 600-700		21-OCT-2011	07-OCT-2011	**14**	25-OCT-2011	21-OCT-2011	**4**
EA010: Conductivity							
Snap Lock Bag WW6 - 0-10, WW10 - 0-100,	WW9 - 0-100, WW13 - 0-50	19-OCT-2011	28-SEP-2011	**21**	----	----	----
Snap Lock Bag WW6 - 20-30, WW9 - 200-300, WW10 - 500-600, WW13 - 20-30,	WW6 - 80-90, WW9 - 800-900, WW13 - 1000-1100, WW13 - 70-80	21-OCT-2011	28-SEP-2011	**23**	----	----	----
Snap Lock Bag WW15 - 0-10,	WW22 - 0-100	19-OCT-2011	29-SEP-2011	**20**	----	----	----
Snap Lock Bag WW15 - 30-40,	WW15 - 90-100	21-OCT-2011	29-SEP-2011	**22**	----	----	----
Snap Lock Bag WW23 - 0-100,	WW28 - 0-100	19-OCT-2011	30-SEP-2011	**19**	----	----	----
Snap Lock Bag WW23 - 300-400, WW28 - 200-300,	WW23 - 900-1000, WW28 - 700-800	21-OCT-2011	30-SEP-2011	**21**	----	----	----

Matrix: **SOIL**

Method Container / Client Sample ID(s)		Extraction / Preparation Date extracted	Due for extraction	Days overdue	Analysis Date analysed	Due for analysis	Days overdue
EA010: Conductivity - Analysis Holding Time Compliance							
Snap Lock Bag WW36 - 0-100,	WW38 - 0-50	19-OCT-2011	01-OCT-2011	**18**	----	----	----
Snap Lock Bag WW36 - 200-300, WW38 - 500-600	WW36 - 700-800,	21-OCT-2011	01-OCT-2011	**20**	----	----	----
Snap Lock Bag WW44 - 0-100		19-OCT-2011	02-OCT-2011	**17**	----	----	----
Snap Lock Bag WW44 - 100-200,	WW44 - 500-600	21-OCT-2011	02-OCT-2011	**19**	----	----	----
Snap Lock Bag WW47 - 0-100		19-OCT-2011	03-OCT-2011	**16**	----	----	----
Snap Lock Bag WW60 - 0-20, WW75 - 0-50	WW69 - 0-50,	19-OCT-2011	04-OCT-2011	**15**	----	----	----
Snap Lock Bag WW60 - 20-300, WW69 - 200-300, WW75 - 400-500,	WW60 - 700-800, WW69 - 800-900, WW75 - 900-1000	21-OCT-2011	04-OCT-2011	**17**	----	----	----
Snap Lock Bag WW94 - 0-50		19-OCT-2011	05-OCT-2011	**14**	----	----	----
Snap Lock Bag WW94 - 200-300		21-OCT-2011	06-OCT-2011	**15**	----	----	----
Snap Lock Bag WW94 - 600-700		21-OCT-2011	07-OCT-2011	**14**	----	----	----
EA055: Moisture Content							
Snap Lock Bag WW6 - 0-10, WW6 - 80-90, WW9 - 200-300, WW10 - 0-100, WW13 - 1000-1100, WW13 - 20-30,	WW6 - 20-30, WW9 - 0-100, WW9 - 800-900, WW10 - 500-600, WW13 - 0-50, WW13 - 70-80	----	----	----	19-OCT-2011	05-OCT-2011	**14**
Snap Lock Bag WW15 - 0-10, WW15 - 90-100,	WW15 - 30-40, WW22 - 0-100	----	----	----	19-OCT-2011	06-OCT-2011	**13**
Snap Lock Bag WW23 - 0-100, WW23 - 900-1000, WW28 - 200-300,	WW23 - 300-400, WW28 - 0-100, WW28 - 700-800	----	----	----	19-OCT-2011	07-OCT-2011	**12**
Snap Lock Bag WW36 - 0-100, WW36 - 700-800, WW38 - 500-600	WW36 - 200-300, WW38 - 0-50,	----	----	----	19-OCT-2011	08-OCT-2011	**11**

Matrix: **SOIL**

Method Container / Client Sample ID(s)		Extraction / Preparation Date extracted	Due for extraction	Days overdue	Analysis Date analysed	Due for analysis	Days overdue
EA055: Moisture Content - Analysis Holding Time Compliance							
Snap Lock Bag WW44 - 0-100, WW44 - 500-600	WW44 - 100-200,	----	----	----	19-OCT-2011	09-OCT-2011	**10**
Snap Lock Bag WW47 - 0-100		----	----	----	19-OCT-2011	10-OCT-2011	**9**
Snap Lock Bag WW60 - 0-20, WW60 - 700-800, WW69 - 200-300, WW75 - 0-50, WW75 - 900-1000	WW60 - 20-300, WW69 - 0-50, WW69 - 800-900, WW75 - 400-500,	----	----	----	19-OCT-2011	11-OCT-2011	**8**
Snap Lock Bag WW94 - 0-50		----	----	----	19-OCT-2011	12-OCT-2011	**7**
Snap Lock Bag WW94 - 200-300		----	----	----	19-OCT-2011	13-OCT-2011	**6**
Snap Lock Bag WW94 - 600-700		----	----	----	19-OCT-2011	14-OCT-2011	**5**
ED040S : Soluble Sulfate by ICPAES							
Snap Lock Bag WW6 - 0-10, WW10 - 0-100,	WW9 - 0-100, WW13 - 0-50	19-OCT-2011	28-SEP-2011	**21**	----	----	----
Snap Lock Bag WW6 - 20-30, WW9 - 200-300, WW10 - 500-600, WW13 - 20-30,	WW6 - 80-90, WW9 - 800-900, WW13 - 1000-1100, WW13 - 70-80	21-OCT-2011	28-SEP-2011	**23**	----	----	----
Snap Lock Bag WW15 - 0-10,	WW22 - 0-100	19-OCT-2011	29-SEP-2011	**20**	----	----	----
Snap Lock Bag WW15 - 30-40,	WW15 - 90-100	21-OCT-2011	29-SEP-2011	**22**	----	----	----
Snap Lock Bag WW23 - 0-100,	WW28 - 0-100	19-OCT-2011	30-SEP-2011	**19**	----	----	----
Snap Lock Bag WW23 - 300-400, WW28 - 200-300,	WW23 - 900-1000, WW28 - 700-800	21-OCT-2011	30-SEP-2011	**21**	----	----	----
Snap Lock Bag WW36 - 0-100,	WW38 - 0-50	19-OCT-2011	01-OCT-2011	**18**	----	----	----
Snap Lock Bag WW36 - 200-300, WW38 - 500-600	WW36 - 700-800,	21-OCT-2011	01-OCT-2011	**20**	----	----	----
Snap Lock Bag WW44 - 0-100		19-OCT-2011	02-OCT-2011	**17**	----	----	----

Matrix: **SOIL**

Method Container / Client Sample ID(s)		Extraction / Preparation Date extracted	Due for extraction	Days overdue	Analysis Date analysed	Due for analysis	Days overdue
ED040S : Soluble Sulfate by ICPAES - Analysis Holding Time Compliance							
Snap Lock Bag WW44 - 100-200,	WW44 - 500-600	21-OCT-2011	02-OCT-2011	**19**	----	----	----
Snap Lock Bag WW47 - 0-100		19-OCT-2011	03-OCT-2011	**16**	----	----	----
Snap Lock Bag WW60 - 0-20, WW75 - 0-50	WW69 - 0-50,	19-OCT-2011	04-OCT-2011	**15**	----	----	----
Snap Lock Bag WW60 - 20-300, WW69 - 200-300, WW75 - 400-500,	WW60 - 700-800, WW69 - 800-900, WW75 - 900-1000	21-OCT-2011	04-OCT-2011	**17**	----	----	----
Snap Lock Bag WW94 - 0-50		19-OCT-2011	05-OCT-2011	**14**	----	----	----
Snap Lock Bag WW94 - 200-300		21-OCT-2011	06-OCT-2011	**15**	----	----	----
Snap Lock Bag WW94 - 600-700		21-OCT-2011	07-OCT-2011	**14**	----	----	----
ED045G: Chloride Discrete analyser							
Snap Lock Bag WW6 - 0-10, WW10 - 0-100,	WW9 - 0-100, WW13 - 0-50	19-OCT-2011	28-SEP-2011	**21**	----	----	----
Snap Lock Bag WW6 - 20-30, WW9 - 200-300, WW10 - 500-600, WW13 - 20-30,	WW6 - 80-90, WW9 - 800-900, WW13 - 1000-1100, WW13 - 70-80	21-OCT-2011	28-SEP-2011	**23**	----	----	----
Snap Lock Bag WW15 - 0-10,	WW22 - 0-100	19-OCT-2011	29-SEP-2011	**20**	----	----	----
Snap Lock Bag WW15 - 30-40,	WW15 - 90-100	21-OCT-2011	29-SEP-2011	**22**	----	----	----
Snap Lock Bag WW23 - 0-100,	WW28 - 0-100	19-OCT-2011	30-SEP-2011	**19**	----	----	----
Snap Lock Bag WW23 - 300-400, WW28 - 200-300,	WW23 - 900-1000, WW28 - 700-800	21-OCT-2011	30-SEP-2011	**21**	----	----	----
Snap Lock Bag WW36 - 0-100,	WW38 - 0-50	19-OCT-2011	01-OCT-2011	**18**	----	----	----
Snap Lock Bag WW36 - 200-300, WW38 - 500-600	WW36 - 700-800,	21-OCT-2011	01-OCT-2011	**20**	----	----	----
Snap Lock Bag WW44 - 0-100		19-OCT-2011	02-OCT-2011	**17**	----	----	----

Matrix: **SOIL**

Method Container / Client Sample ID(s)		Extraction / Preparation Date extracted	Due for extraction	Days overdue	Analysis Date analysed	Due for analysis	Days overdue
ED045G: Chloride Discrete analyser - Analysis Holding Time Compliance							
Snap Lock Bag WW44 - 100-200,	WW44 - 500-600	21-OCT-2011	02-OCT-2011	**19**	----	----	----
Snap Lock Bag WW47 - 0-100		19-OCT-2011	03-OCT-2011	**16**	----	----	----
Snap Lock Bag WW60 - 0-20, WW75 - 0-50	WW69 - 0-50,	19-OCT-2011	04-OCT-2011	**15**	----	----	----
Snap Lock Bag WW60 - 20-300, WW69 - 200-300, WW75 - 400-500,	WW60 - 700-800, WW69 - 800-900, WW75 - 900-1000	21-OCT-2011	04-OCT-2011	**17**	----	----	----
Snap Lock Bag WW94 - 0-50		19-OCT-2011	05-OCT-2011	**14**	----	----	----
Snap Lock Bag WW94 - 200-300		21-OCT-2011	06-OCT-2011	**15**	----	----	----
Snap Lock Bag WW94 - 600-700		21-OCT-2011	07-OCT-2011	**14**	----	----	----
EP004: Organic Matter							
Snap Lock Bag WW6 - 0-10, WW10 - 0-100,	WW9 - 0-100, WW13 - 0-50	25-OCT-2011	28-SEP-2011	**27**	----	----	----
Snap Lock Bag WW15 - 0-10,	WW22 - 0-100	25-OCT-2011	29-SEP-2011	**26**	----	----	----
Snap Lock Bag WW23 - 0-100,	WW28 - 0-100	25-OCT-2011	30-SEP-2011	**25**	----	----	----
Snap Lock Bag WW36 - 0-100,	WW38 - 0-50	25-OCT-2011	01-OCT-2011	**24**	----	----	----
Snap Lock Bag WW44 - 0-100		25-OCT-2011	02-OCT-2011	**23**	----	----	----
Snap Lock Bag WW47 - 0-100		25-OCT-2011	03-OCT-2011	**22**	----	----	----
Snap Lock Bag WW60 - 0-20, WW75 - 0-50	WW69 - 0-50,	25-OCT-2011	04-OCT-2011	**21**	----	----	----
Snap Lock Bag WW94 - 0-50		25-OCT-2011	05-OCT-2011	**20**	----	----	----

Outliers : Frequency of Quality Control Samples

The following report highlights breaches in the Frequency of Quality Control Samples.

- **No Quality Control Sample Frequency Outliers exist.**

Craig Bryant

From: Hutchinson, Andrew (SKM) <AHutchinson@globalskm.com>
Sent: Monday, 7 November 2011 11:52 AM
To: Dean Sullivan
Cc: Bryn Stephens; Matthew Goodwin; Samples Brisbane; Rohde, Timothy (SKM)
Subject: RE: Additional Sampling Wards Well EB1121537
Attachments: image001.jpg

Dean

Yeah sorry I had changed some of the sample labels in my spreadsheet to make them all in mm (as some were in cm).

So to confirm, ALS sample numbers for EK080 Bicarbonate Extractable P are:

1, 4, 7, 10, 13, 16, 19, 22, 25, 28, 30, 33, 35, 38, 41, 44
1 → 16

Cheers
Andy

Environmental Division
Brisbane
Work Order
EB1123397
Telephone : + 61-7-3243 7222
MM

From: Dean Sullivan [mailto:Dean.Sullivan@alsglobal.com]
Sent: Monday, 7 November 2011 10:56 AM
To: Hutchinson, Andrew (SKM)
Cc: Rohde, Timothy (SKM)
Subject: RE: Additional Sampling Wards Well

Hi Andy,

Just to clarify:
These samples IDs line up with ALS IDs – 4, 7, 16, 19, 22, 25, 28, 30, 33, 35, 38, 41, 44; and sample 1 do you mean WW6 – 0-10 and sample 10 is it WW13 – 0-500?

Cheers,

How was your customer experience? **Please send us your feedback**
Dean Sullivan
BUSINESS DEVELOPMENT OFFICER
ALS | Environmental
Address
32 Shand St, Stafford, Qld 4053
PHONE +61 7 3243 7222
MOBILE +61 (0) 417 173 443
FAX +61 7 3243 7218
Winner of the inaugural CARE Award 2011 – Sustainable Technology & Innovation:
Reduction in Sample Volumes – Improving quality, safety, efficiency and sustainability in environmental practices

CAREAWARD 2011 WINNER

www.alsglobal.com
P Please consider the environment before printing this email.

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **EB1123397**	Page	: 1 of 6
Client	: **SINCLAIR KNIGHT MERZ**	Laboratory	: Environmental Division Brisbane
Contact	: MR ANDREW HUTCHINSON	Contact	: Dean Sullivan
Address	: LEVEL 5, 33 KING WILLIAM ST ADELAIDE SA, AUSTRALIA 5000	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: ahutchinson@globalskm.com	E-mail	: dean.sullivan@alsglobal.com
Telephone	: +61 08 8424 3800	Telephone	: +61 7 3243 7144
Facsimile	: +61 08 8424 3810	Facsimile	: +61 7 3243 7218
Project	: QEO9811 400 Wards Well-Land Resources	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 07-NOV-2011
Sampler	: A.Thompson/T.Rohde	Issue Date	: 14-NOV-2011
Site	: ----		
		No. of samples received	: 16
Quote number	: EN/003/10	No. of samples analysed	: 16

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

This document is issued in accordance with NATA accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

WORLD RECOGNISED ACCREDITATION

Signatories

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

Signatories	*Position*	*Accreditation Category*
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

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

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

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

Analytical Results

Sub-Matrix: SOIL			Client sample ID	WW6 0-10	WW9 0-100	WW10 0-100	WW13 0-50	WW15 0-10
			Client sampling date / time	21-SEP-2011 15:00	21-SEP-2011 15:00	21-SEP-2011 15:00	21-SEP-2011 15:00	22-SEP-2011 15:00
Compound	CAS Number	LOR	Unit	EB1123397-001	EB1123397-002	EB1123397-003	EB1123397-004	EB1123397-005
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	2	mg/kg	**42**	**12**	<2	**55**	**34**

Analytical Results

Sub-Matrix: SOIL			Client sample ID	WW22 0-100	WW23 0-100	WW28 0-100	WW36 0-100	WW38 0-50
			Client sampling date / time	22-SEP-2011 15:00	23-SEP-2011 15:00	23-SEP-2011 15:00	24-SEP-2011 15:00	24-SEP-2011 15:00
Compound	CAS Number	LOR	Unit	EB1123397-006	EB1123397-007	EB1123397-008	EB1123397-009	EB1123397-010
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	2	mg/kg	16	5	<2	<2	8

Analytical Results

Sub-Matrix: SOIL			Client sample ID	WW44 0-100	WW47 0-100	WW60 0-20	WW69 0-50	WW75 0-50
			Client sampling date / time	25-SEP-2011 15:00	26-SEP-2011 15:00	27-SEP-2011 15:00	27-SEP-2011 15:00	27-SEP-2011 15:00
Compound	CAS Number	LOR	Unit	EB1123397-011	EB1123397-012	EB1123397-013	EB1123397-014	EB1123397-015
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	2	mg/kg	**12**	<2	**2**	**80**	**13**

Analytical Results

Sub-Matrix: SOIL			Client sample ID	WW94 0-50	----	----	----	----
			Client sampling date / time	28-SEP-2011 15:00	----	----	----	----
Compound	CAS Number	LOR	Unit	EB1123397-016	----	----	----	----
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Bicarbonate Ext. P (Colwell)	----	2	mg/kg	**39**	----	----	----	----

INTERPRETIVE QUALITY CONTROL REPORT

Work Order	: **EB1123397**	Page	: 1 of 5
Client	: SINCLAIR KNIGHT MERZ	Laboratory	: Environmental Division Brisbane
Contact	: MR ANDREW HUTCHINSON	Contact	: Dean Sullivan
Address	: LEVEL 5, 33 KING WILLIAM ST ADELAIDE SA, AUSTRALIA 5000	Address	: 32 Shand Street Stafford QLD Australia 4053
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Telephone	: +61 08 8424 3800	Telephone	: +61 7 3243 7144
Facsimile	: +61 08 8424 3810	Facsimile	: +61 7 3243 7218
Project	: QEO9811 400 Wards Well-Land Resources	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Site	: ----		
C-O-C number	: ----	Date Samples Received	: 07-NOV-2011
Sampler	: A.Thompson/T.Rohde	Issue Date	: 14-NOV-2011
Order number	: ----		
		No. of samples received	: 16
Quote number	: EN/003/10	No. of samples analysed	: 16

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Interpretive Quality Control Report contains the following information:

- Analysis Holding Time Compliance
- Quality Control Parameter Frequency Compliance
- Brief Method Summaries
- Summary of Outliers

Analysis Holding Time Compliance

The following report summarises extraction / preparation and analysis times and compares with recommended holding times. Dates reported represent first date of extraction or analysis and precludes subsequent dilutions and reruns. Information is also provided re the sample container (preservative) from which the analysis aliquot was taken. Elapsed period to analysis represents number of days from sampling where no extraction / digestion is involved or period from extraction / digestion where this is present. For composite samples, sampling date is assumed to be that of the oldest sample contributing to the composite. Sample date for laboratory produced leachates is assumed as the completion date of the leaching process. Outliers for holding time are based on USEPA SW 846, APHA, AS and NEPM (1999). A listing of breaches is provided in the Summary of Outliers.

Holding times for leachate methods (excluding elutriates) vary according to the analytes being determined on the resulting solution. For non-volatile analytes, the holding time compliance assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These soil holding times are: Organics (14 days); Mercury (28 days) & other metals (180 days). A recorded breach therefore does not guarantee a breach for all non-volatile parameters.

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method		Sample Date	Extraction / Preparation			Analysis		
Container / Client Sample ID(s)			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK080: Bicarbonate Extractable Phosphorus (Colwell)								
Soil Glass Jar - Unpreserved WW6 0-10, WW10 0-100,	WW9 0-100, WW13 0-50	**21-SEP-2011**	**----**	----	----	**11-NOV-2011**	19-MAR-2012	✓
Soil Glass Jar - Unpreserved WW15 0-10,	WW22 0-100	**22-SEP-2011**	**----**	----	----	**11-NOV-2011**	20-MAR-2012	✓
Soil Glass Jar - Unpreserved WW23 0-100,	WW28 0-100	**23-SEP-2011**	**----**	----	----	**11-NOV-2011**	21-MAR-2012	✓
Soil Glass Jar - Unpreserved WW36 0-100,	WW38 0-50	**24-SEP-2011**	**----**	----	----	**11-NOV-2011**	22-MAR-2012	✓
Soil Glass Jar - Unpreserved WW44 0-100		**25-SEP-2011**	**----**	----	----	**11-NOV-2011**	23-MAR-2012	✓
Soil Glass Jar - Unpreserved WW47 0-100		**26-SEP-2011**	**----**	----	----	**11-NOV-2011**	24-MAR-2012	✓
Soil Glass Jar - Unpreserved WW60 0-20, WW75 0-50	WW69 0-50,	**27-SEP-2011**	**----**	----	----	**11-NOV-2011**	25-MAR-2012	✓
Soil Glass Jar - Unpreserved WW94 0-50		**28-SEP-2011**	**----**	----	----	**11-NOV-2011**	26-MAR-2012	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(where) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **SOIL**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Bicarbonate Extractable P (Colwell)	EK080	2	17	**11.8**	**10.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Method Blanks (MB)							
Bicarbonate Extractable P (Colwell)	EK080	1	17	**5.9**	**5.0**	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
Bicarbonate Extractable P (Colwell)	EK080	SOIL	Rayment & Higginson (1992) Method 9B1 Phosphorus is extracted from the soil using 0.5M $NaHCO_3$ at a 1:100 soil:solution ratio and determined by FIA.

Summary of Outliers

Outliers : Quality Control Samples

The following report highlights outliers flagged in the Quality Control (QC) Report. Surrogate recovery limits are static and based on USEPA SW846 or ALS-QWI/EN/38 (in the absence of specific USEPA limits). This report displays QC Outliers (breaches) only.

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

- **For all matrices, no Method Blank value outliers occur.**
- **For all matrices, no Duplicate outliers occur.**
- **For all matrices, no Laboratory Control outliers occur.**
- **For all matrices, no Matrix Spike outliers occur.**

Regular Sample Surrogates

- **For all regular sample matrices, no surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

This report displays Holding Time breaches only. Only the respective Extraction / Preparation and/or Analysis component is/are displayed.

- **No Analysis Holding Time Outliers exist.**

Outliers : Frequency of Quality Control Samples

The following report highlights breaches in the Frequency of Quality Control Samples.

- **No Quality Control Sample Frequency Outliers exist.**

Golder Associates

BRISBANE LABORATORY

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PO Box 2034 Mansfield DC QLD 4122
Phone:(07) 3343 3166 Fax:(07) 3849 4705
www.golder.com.au

TEST RESULTS

Client :	ALS Environmental Brisbane	Report No. :	R11625
Address :	32 Shand Street, Stafford	Job No. :	117634002/4
Project :	Delivered Samples	Date Received :	20/10/2011
Batch No. :	EB1121537	Sampled by :	Client

EMERSON CLASSIFICATION

Reg'n No.	Sample No.	Sample ID	Description	Emerson Classification Number
11305725	1	WW6 0-10 21/09/2011	(CH) Silty CLAY, dark brown	5
11305726	2	WW6 20-30 21/09/2011	(CH) Silty CLAY, dark brown	5
11305727	4	WW9 0-100 21/09/2011	(CH) Silty CLAY, dark brown	5
11305728	6	WW9 800-900 21/09/2011	(CH) Silty CLAY, dark brown	6
11305729	7	WW10 0-100 21/09/2011	(CI) Silty CLAY, dark brown	5
11305730	9	WW10 1000-1100 21/09/2011	(CI) Silty CLAY, brown	6
11305731	10	WW13 0-50 21/09/2011	(CI) Silty CLAY, dark brown	5
11305732	12	WW13 70-80 21/09/2011	(CH) Silty CLAY, dark brown	5
11305733	13	WW15 0-10 22/09/2011	(CH) Silty CLAY, dark brown	5
11305734	15	WW15 90-100 22/09/2011	(CH) Silty CLAY, dark brown	6
11305735	16	WW22 0-100 22/09/2011	(CH) Silty CLAY, dark brown	5
11305736	19	WW23 0-100 23/09/2011	(CI) Silty CLAY, brown	5
11305737	21	WW23 900-1000 23/09/2011	(CI) Silty CLAY, brown	6
11305738	22	WW28 0-100 23/09/2011	(CI) Silty CLAY, dark brown	3
11305739	24	WW28 700-800 23/09/2011	(CI) Silty CLAY, dark brown	3
11305740	25	WW36 0-100 24/09/2011	(CI) Silty CLAY, dark brown	5
11305741	27	WW36 700-800 24/09/2011	(CH) Silty CLAY, brown	3
11305742	28	WW38 0-50 24/09/2011	(CI) Silty CLAY, brown	3
11305743	29	WW38 500-600 24/09/2011	(CH) Silty CLAY, red brown	5
11305744	30	WW44 0-100 25/09/2011	(CI) Silty CLAY, brown	5
11305745	32	WW44 500-600 25/09/2011	(CH) Silty CLAY, red brown	6
11305746	33	WW47 0-100 26/09/2011	(CI) Silty CLAY, dark brown	5
11305747	35	WW60 0-20 27/09/2011	(CI) Silty CLAY, dark brown	5
11305748	37	WW60 700-800 27/09/2011	(CI) Silty CLAY, dark brown	5
11305749	38	WW69 0-50 27/09/2011	(CI) Silty CLAY, dark brown	3
11305750	40	WW69 800-900 27/09/2011	(CI) Silty CLAY, brown	3
11305751	41	WW75 0-50 27/09/2011	(CI) Silty CLAY, brown	5
11305752	43	WW75 900-1000 27/09/2011	(CI) Silty CLAY, dark brown	5
11305753	44	WW94 0-50 28/09/2011	(CI) Silty CLAY, dark brown	5
11305754	46	WW94 600-700 30/09/2011	(CI) Silty CLAY, dark brown	4

Remarks : Deionised water at 20 °C used in Emerson Class test.

Test Procedure : AS 1289 3.8.1

Prepared by NF   Checked by GH

This document is issued in accordance with NATA's accreditation requirements.

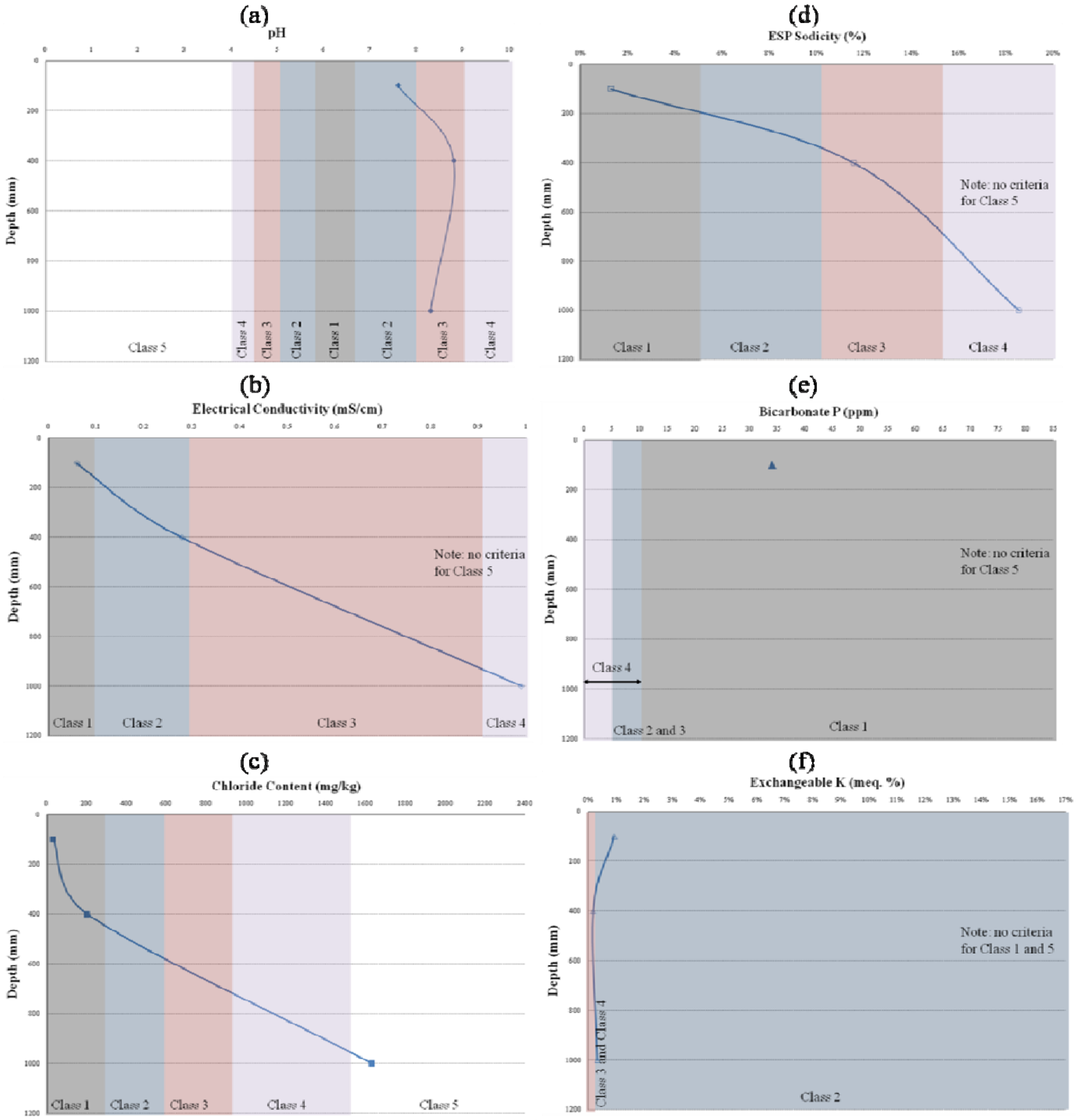
NATA

Nhn 28/10/11

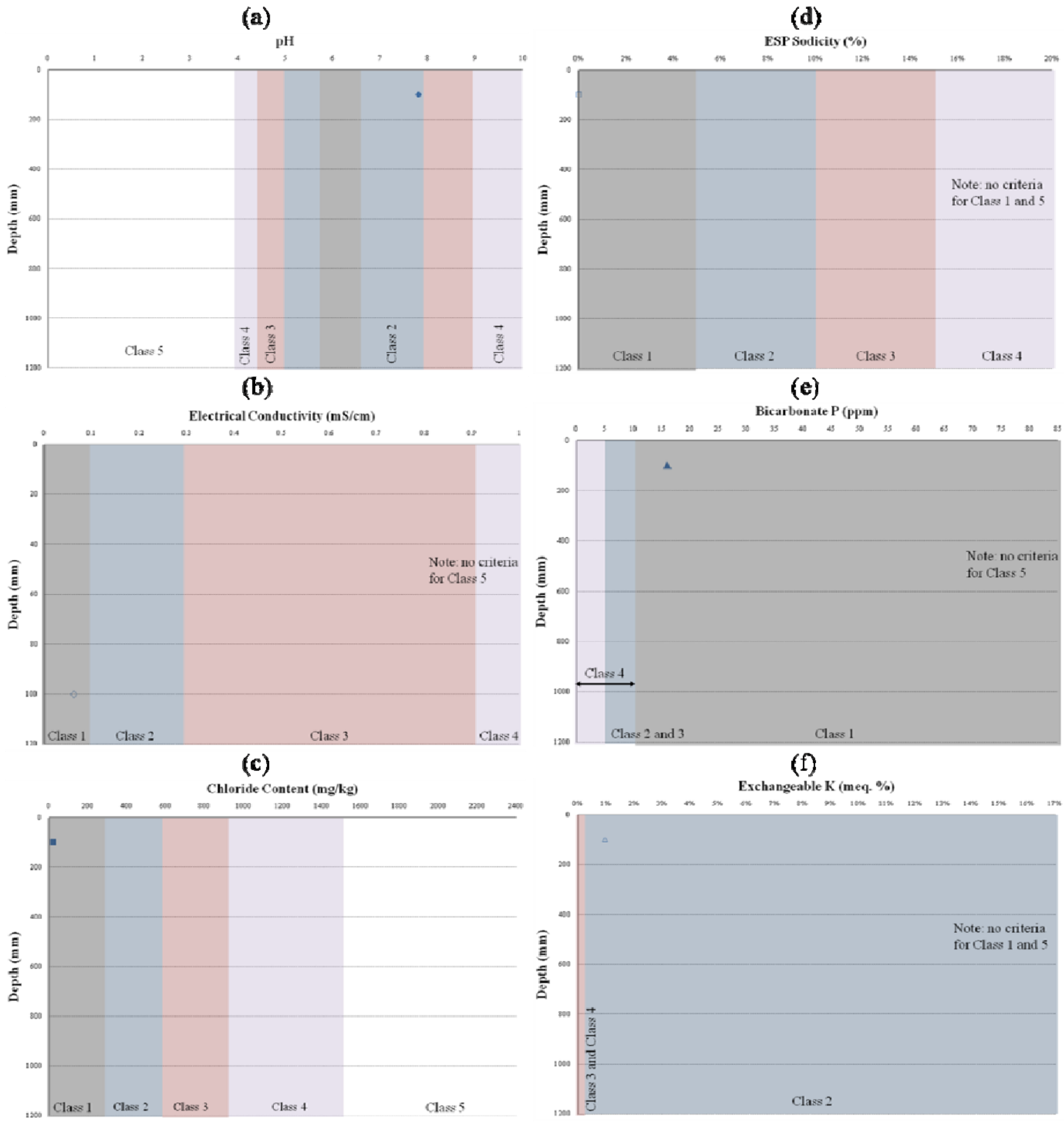
Nick Farrer
Approved Signatory

Senior Technical Officer
NATA Accred. No. : 1961

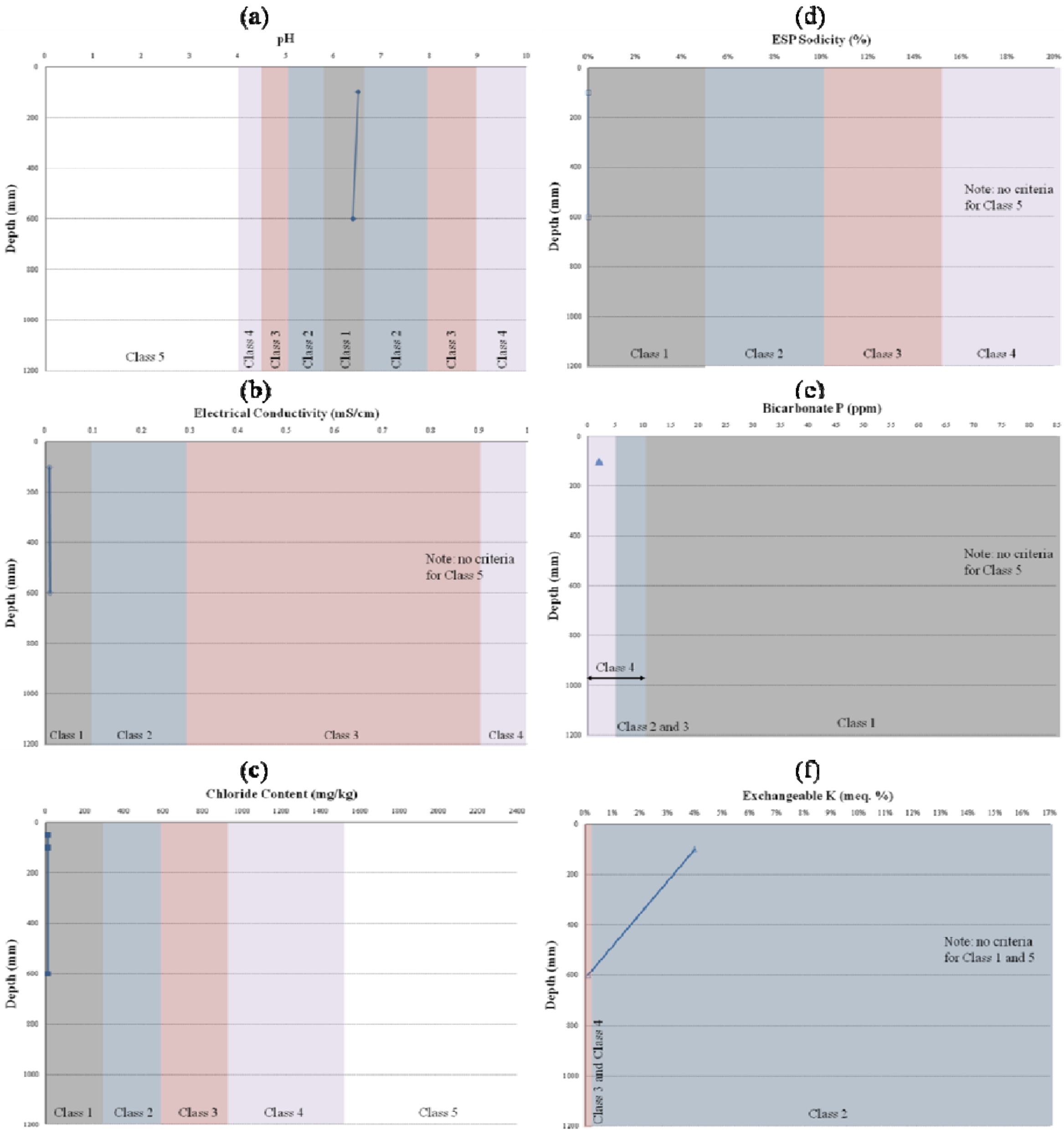
Appendix D Land Suitability Assessment



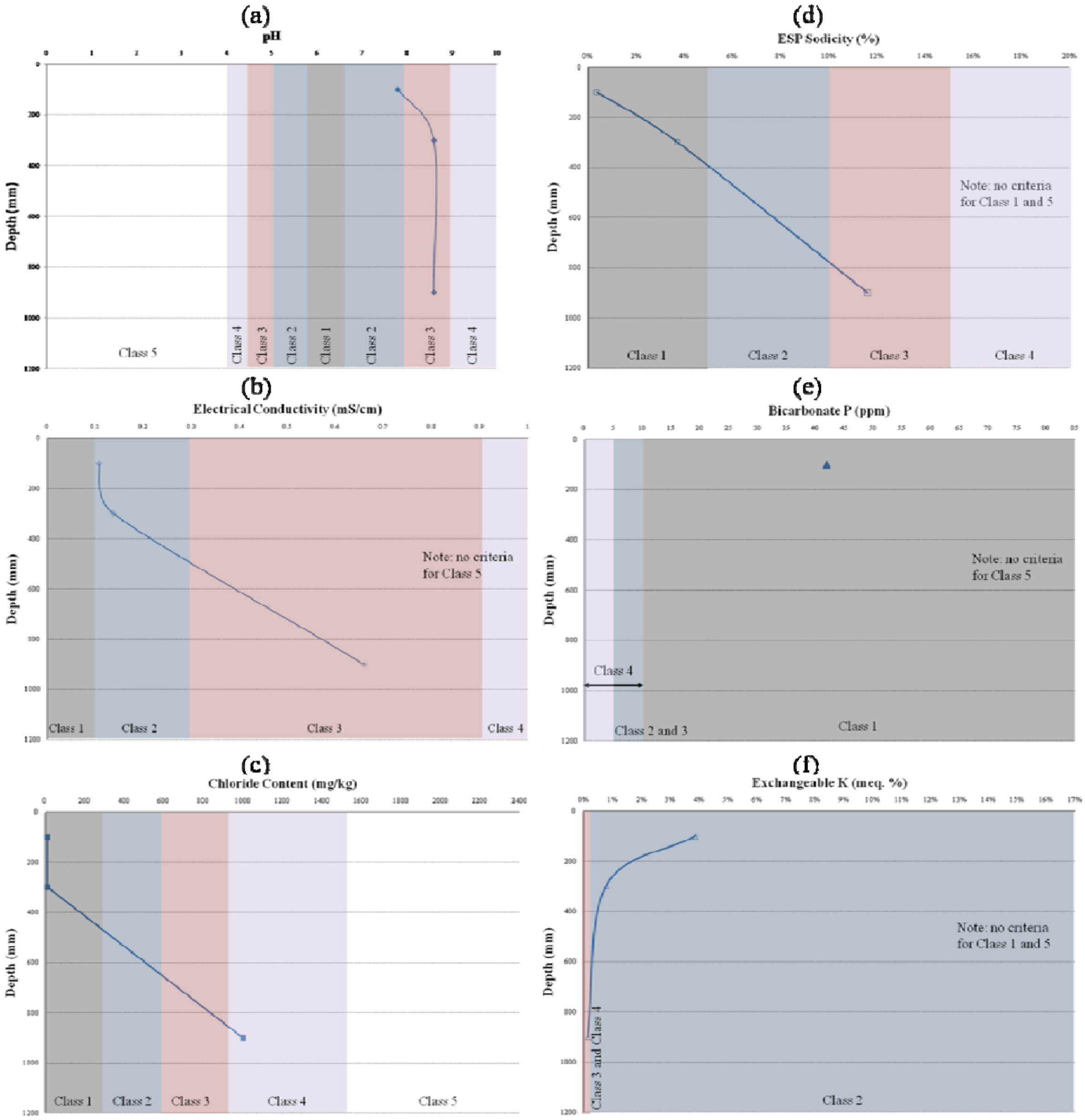
- **Figure A 1 Vertosol: Site 15 (a) pH, (b) Electrical conductivity, (c) Chloride content, (d) ESP. (e) Bicarbonate P, and (f) Exchangeable K**



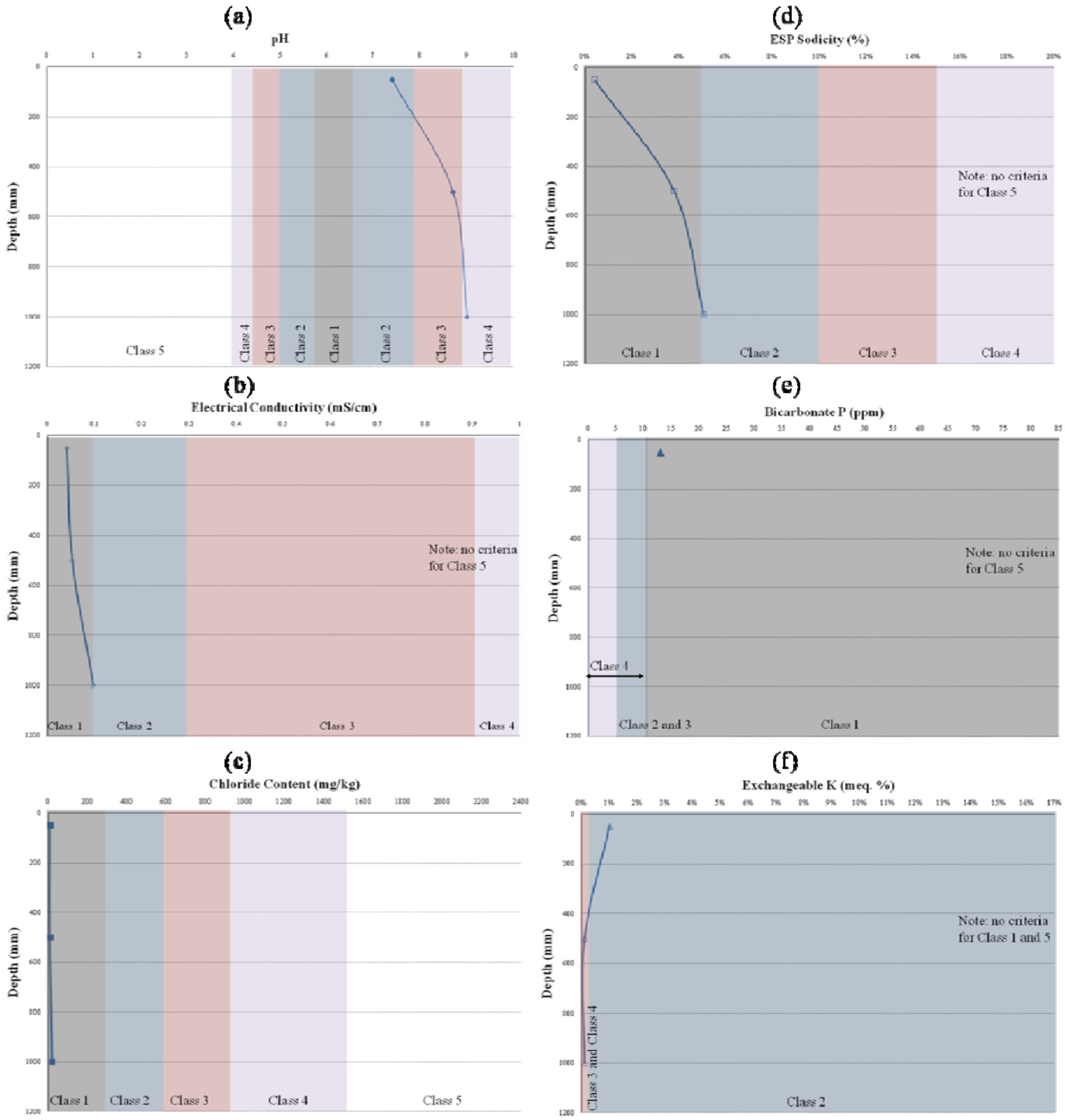
- **Figure A 2 Vertosol: Site 22 (a) pH, (b) Electrical conductivity, (c) Chloride content, (d) ESP. (e) Bicarbonate P, and (f) Exchangeable K**



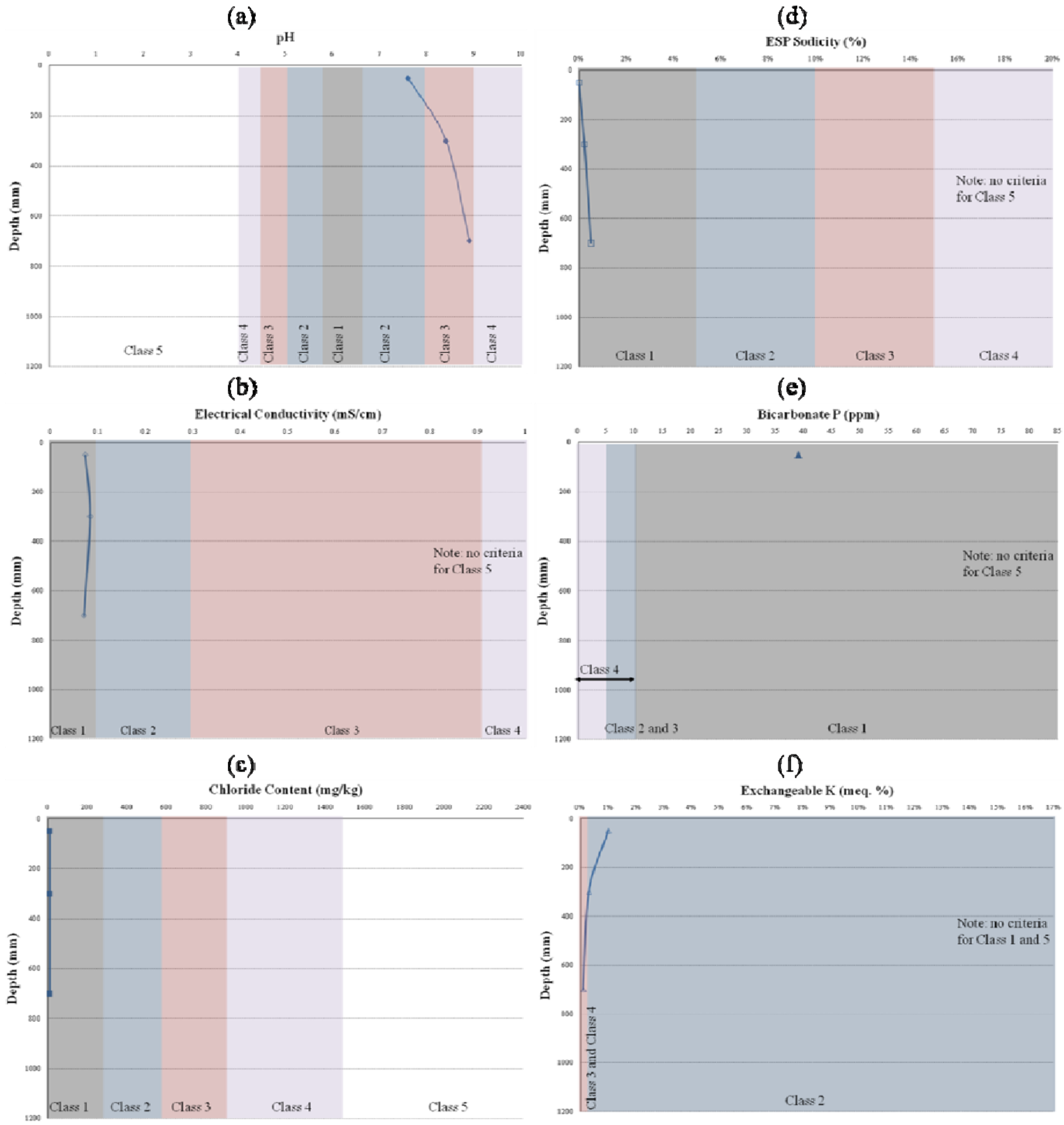
▪ **Figure A 3 Vertosol: Site 9 (a) pH, (b) Electrical conductivity, (c) Chloride content, (d) ESP. (e) Bicarbonate P, and (f) Exchangeable K**



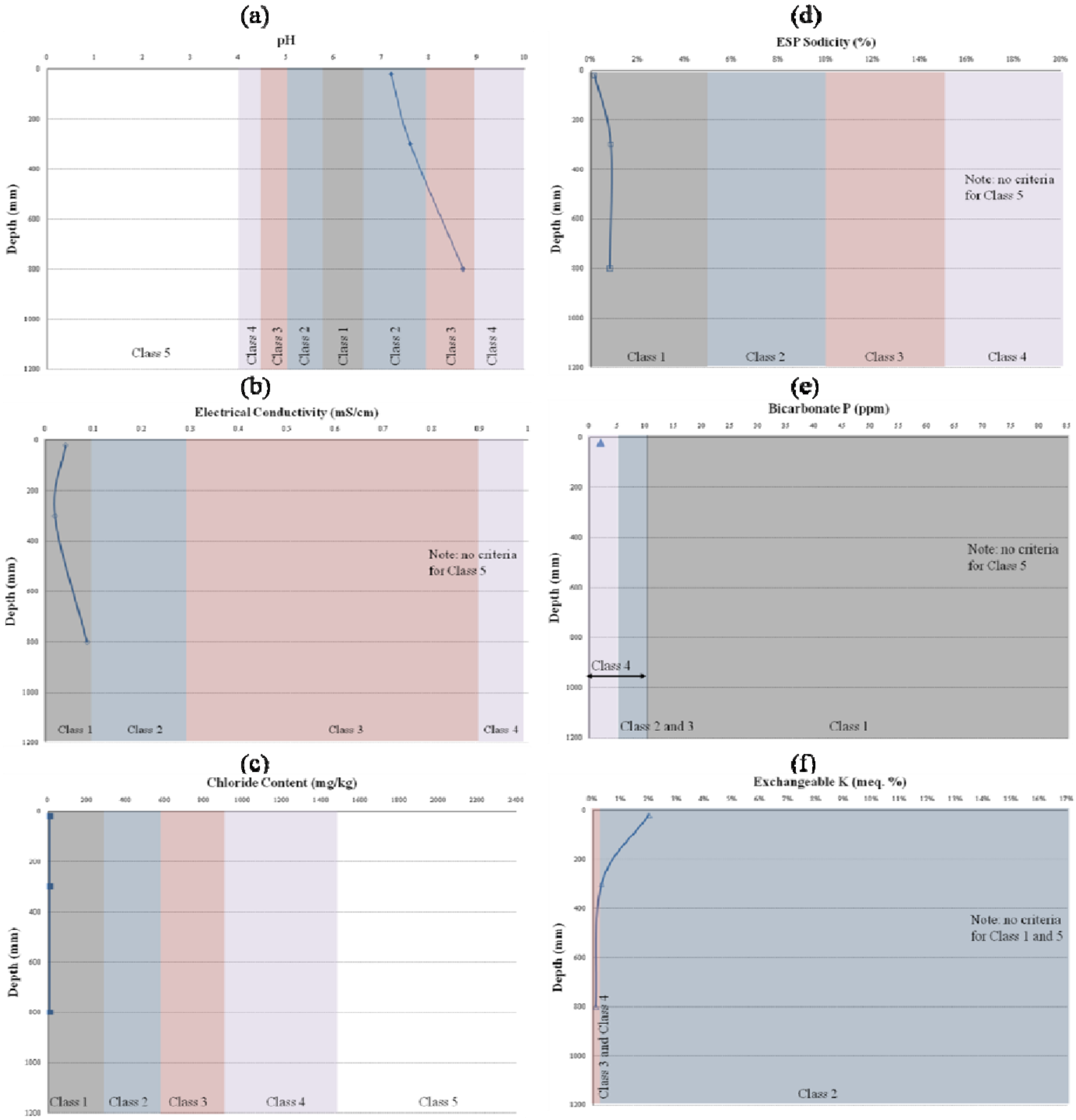
- **Figure A 4 Vertosol Site 6 (a) pH, (b) Electrical conductivity, (c) Chloride content, (d) ESP. (e) Bicarbonate P, and (f) Exchangeable K**



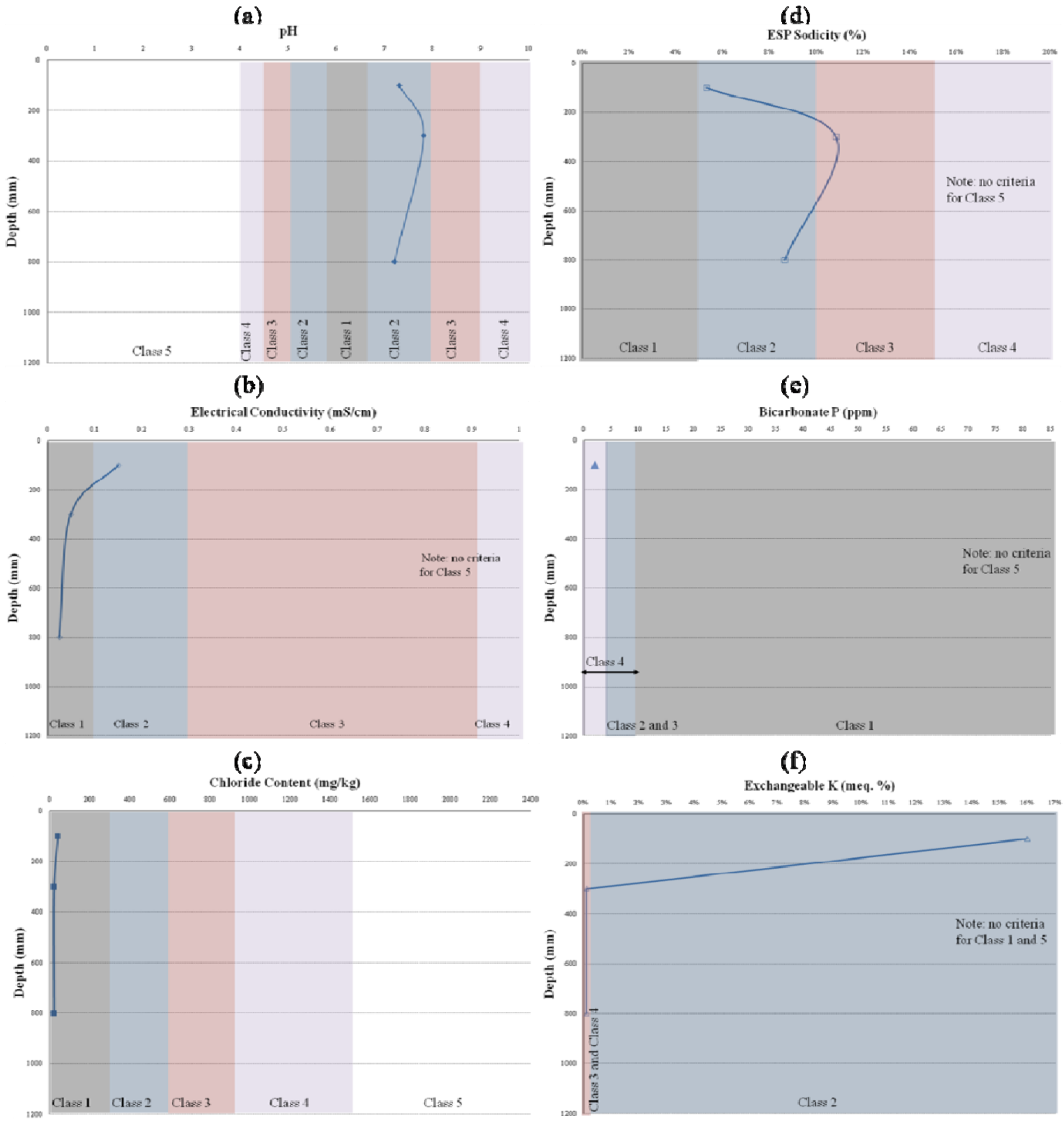
- **Figure A 5 Vertosol: Site 75 (a) pH, (b) Electrical conductivity, (c) Chloride content, (d) ESP. (e) Bicarbonate P, and (f) Exchangeable K**



- **Figure A 6 Vertosol: Site 94 (a) pH, (b) Electrical conductivity, (c) Chloride content, (d) ESP. (e) Bicarbonate P, and (f) Exchangeable K**



- **Figure A 7 Vertosol: Site 60 (a) pH, (b) Electrical conductivity, (c) Chloride content, (d) ESP. (e) Bicarbonate P, and (f) Exchangeable K(a) pH, (b) Electrical conductivity, (c) Chloride content, (d) ESP. (e) Bicarbonate P, and (f) Exchangeable K**



- **Figure A 8 Dermosol: Site 28 (a) pH, (b) Electrical conductivity, (c) Chloride content, (d) ESP. (e) Bicarbonate P, and (f) Exchangeable K**

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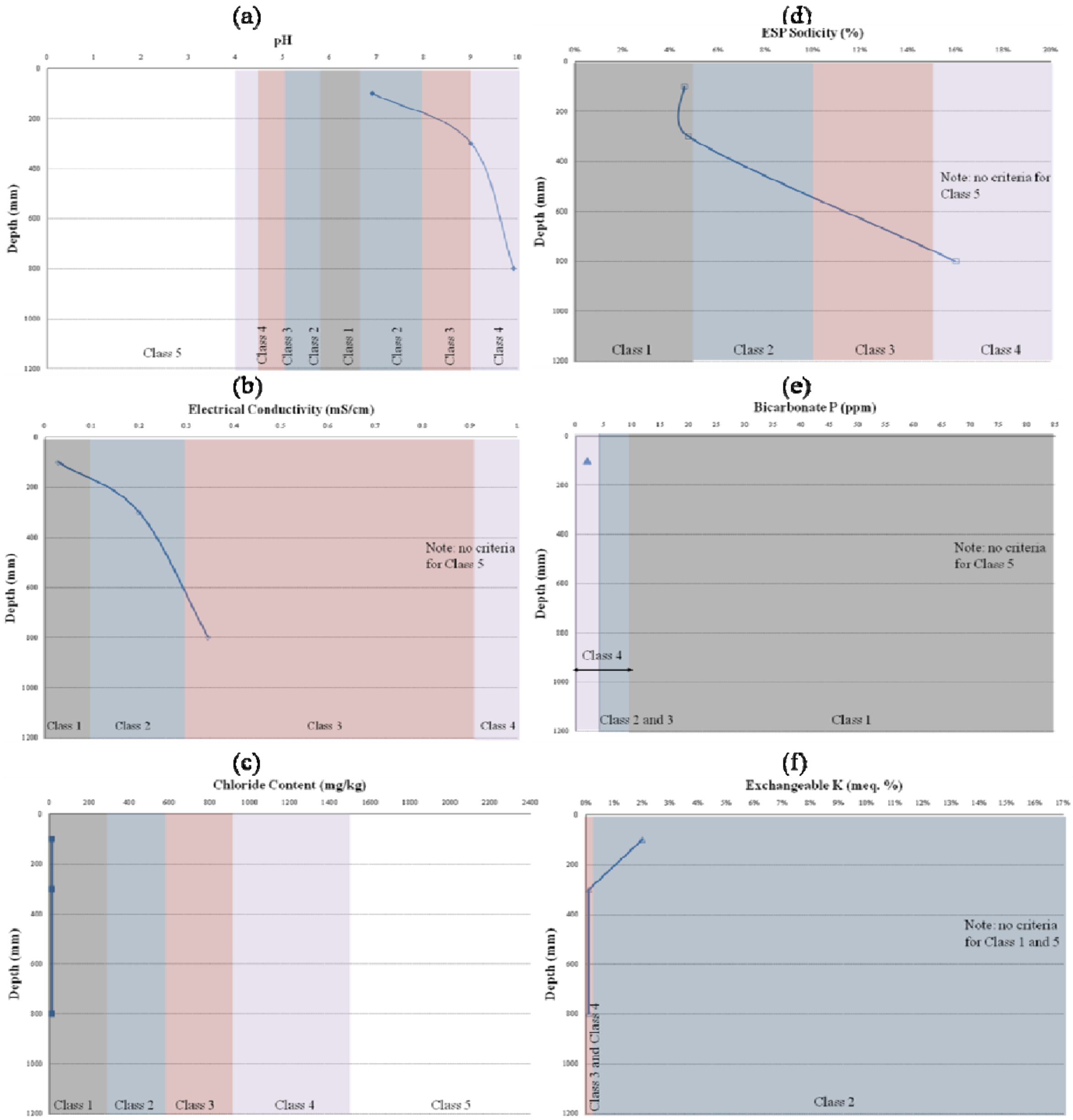
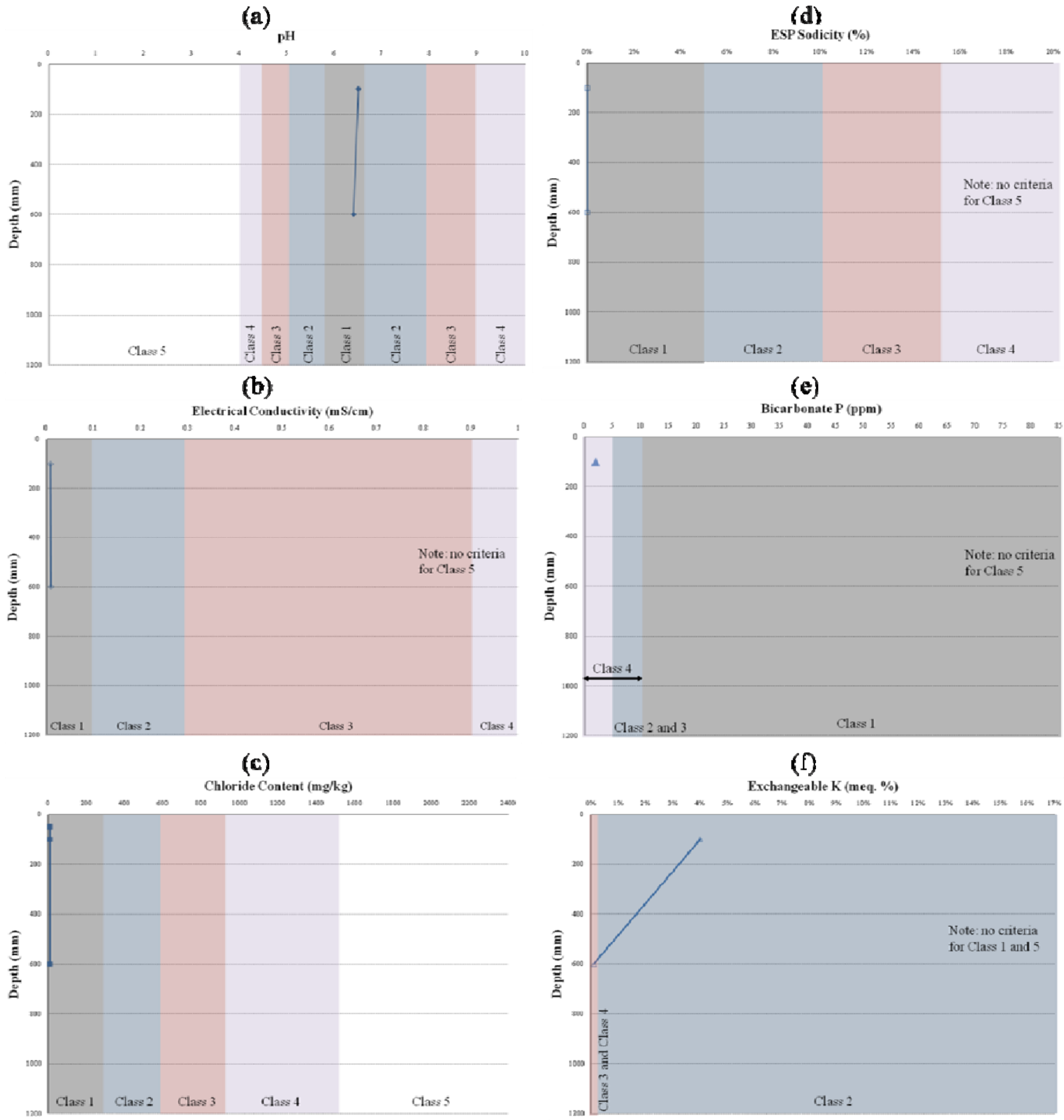
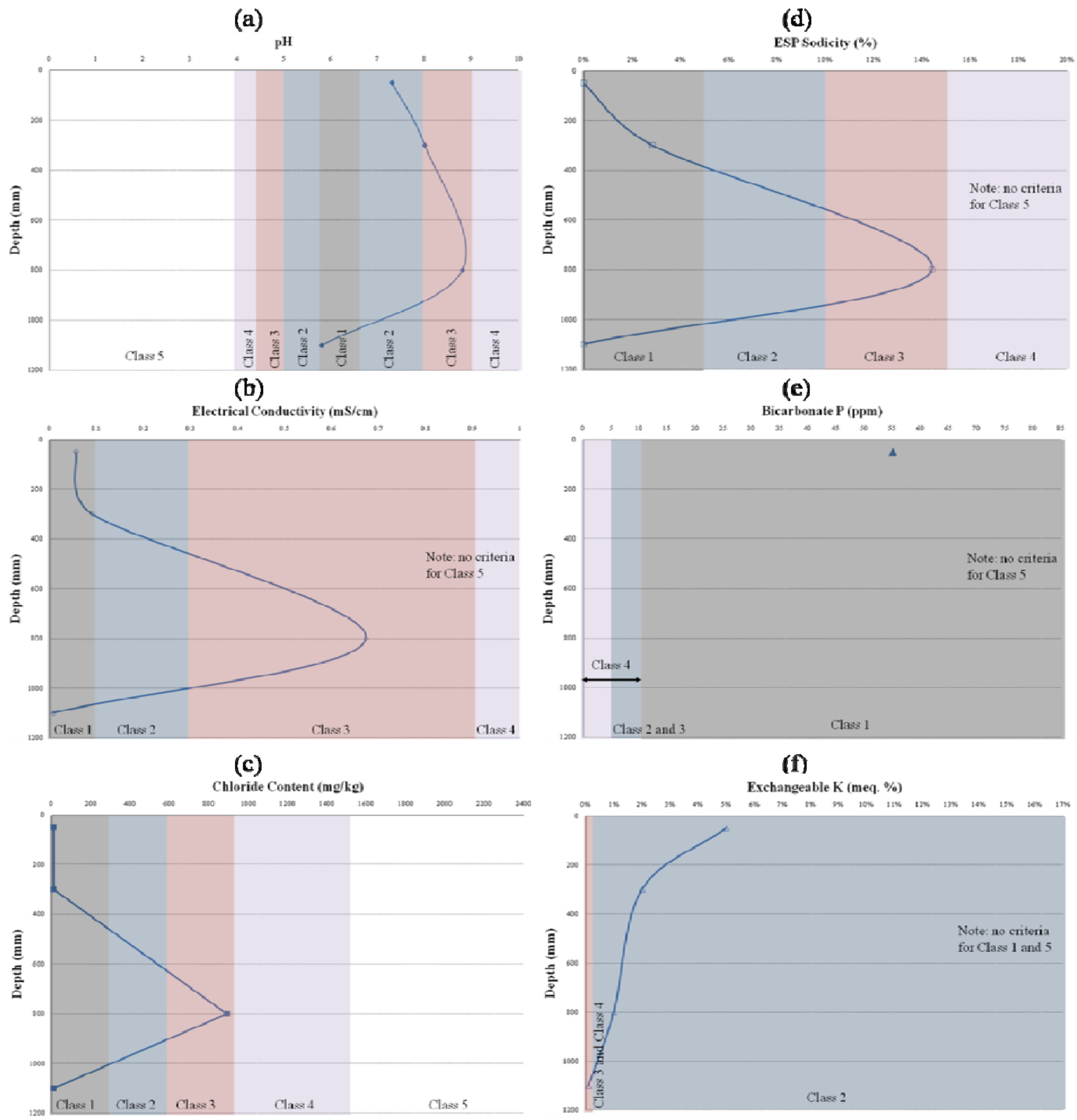


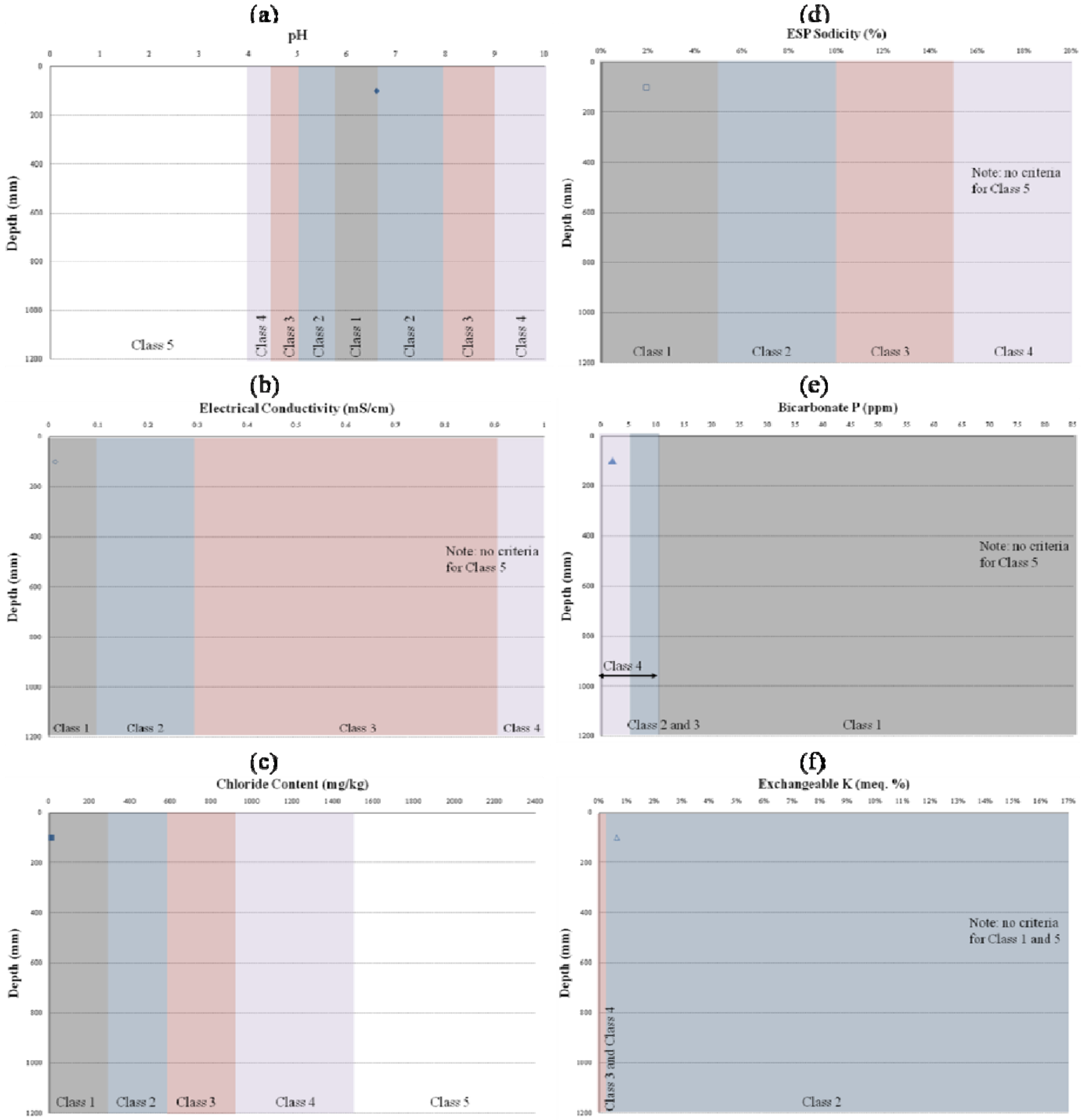
- **Figure A 9 Dermosol: Site 36 (a) pH, (b) Electrical conductivity, (c) Chloride content, (d) ESP. (e) Bicarbonate P, and (f) Exchangeable K**



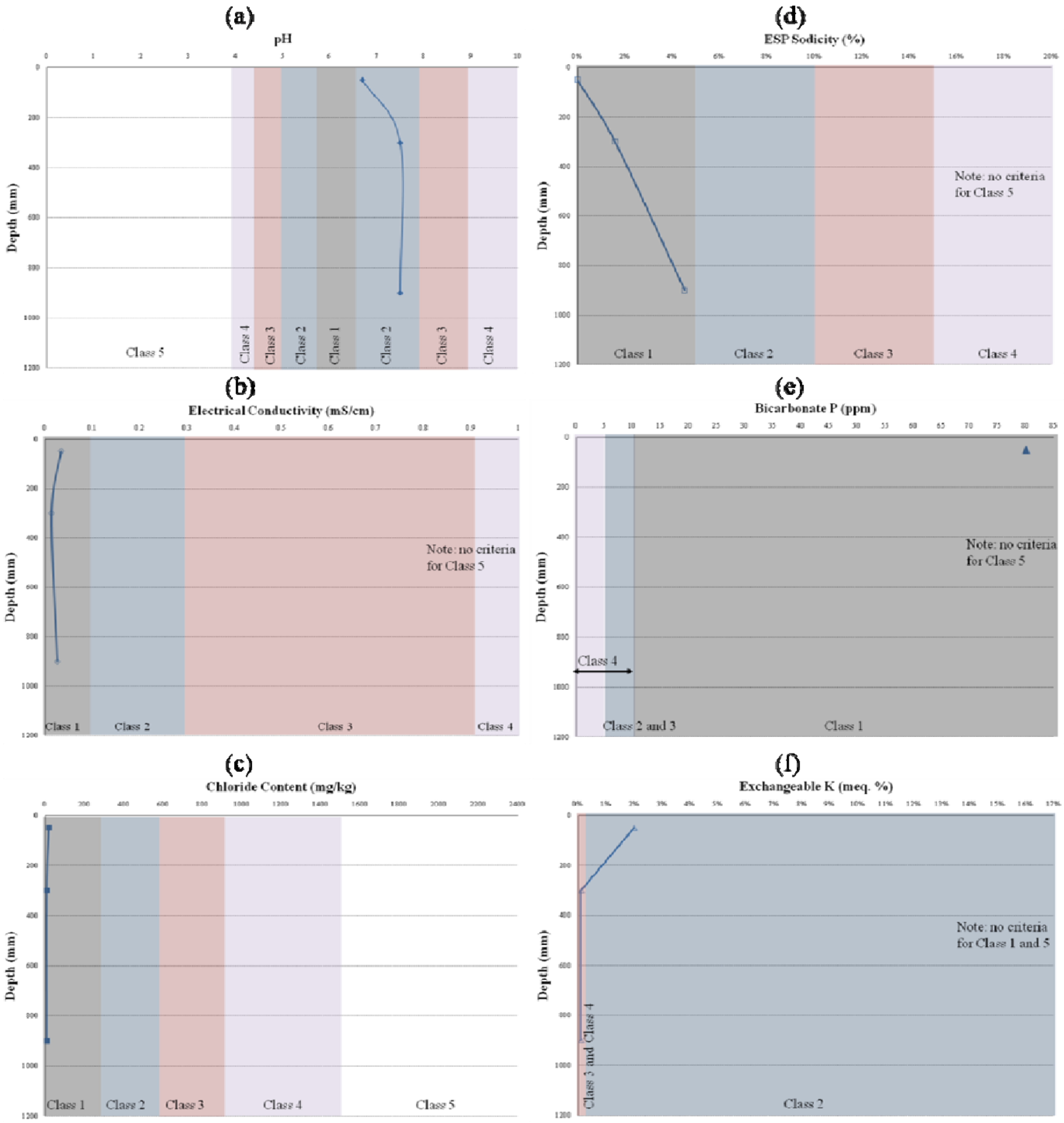
- **Figure A 10 Dermosol: Site 10 (a) pH, (b) Electrical conductivity, (c) Chloride content, (d) ESP. (e) Bicarbonate P, and (f) Exchangeable K**



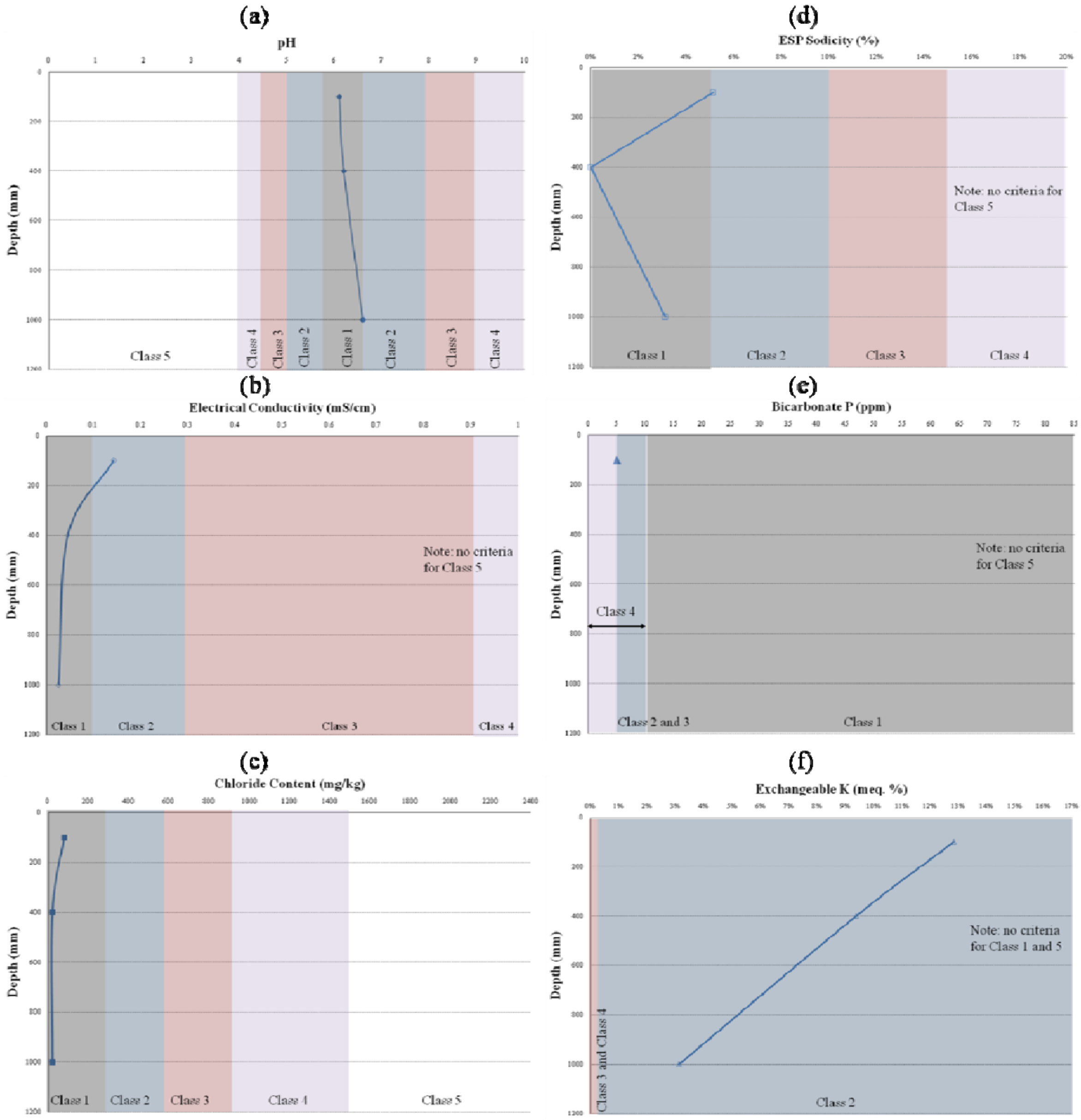
- **Figure A 11 Dermosol: Site 13 (a) pH, (b) Electrical conductivity, (c) Chloride content, (d) ESP. (e) Bicarbonate P, and (f) Exchangeable K**



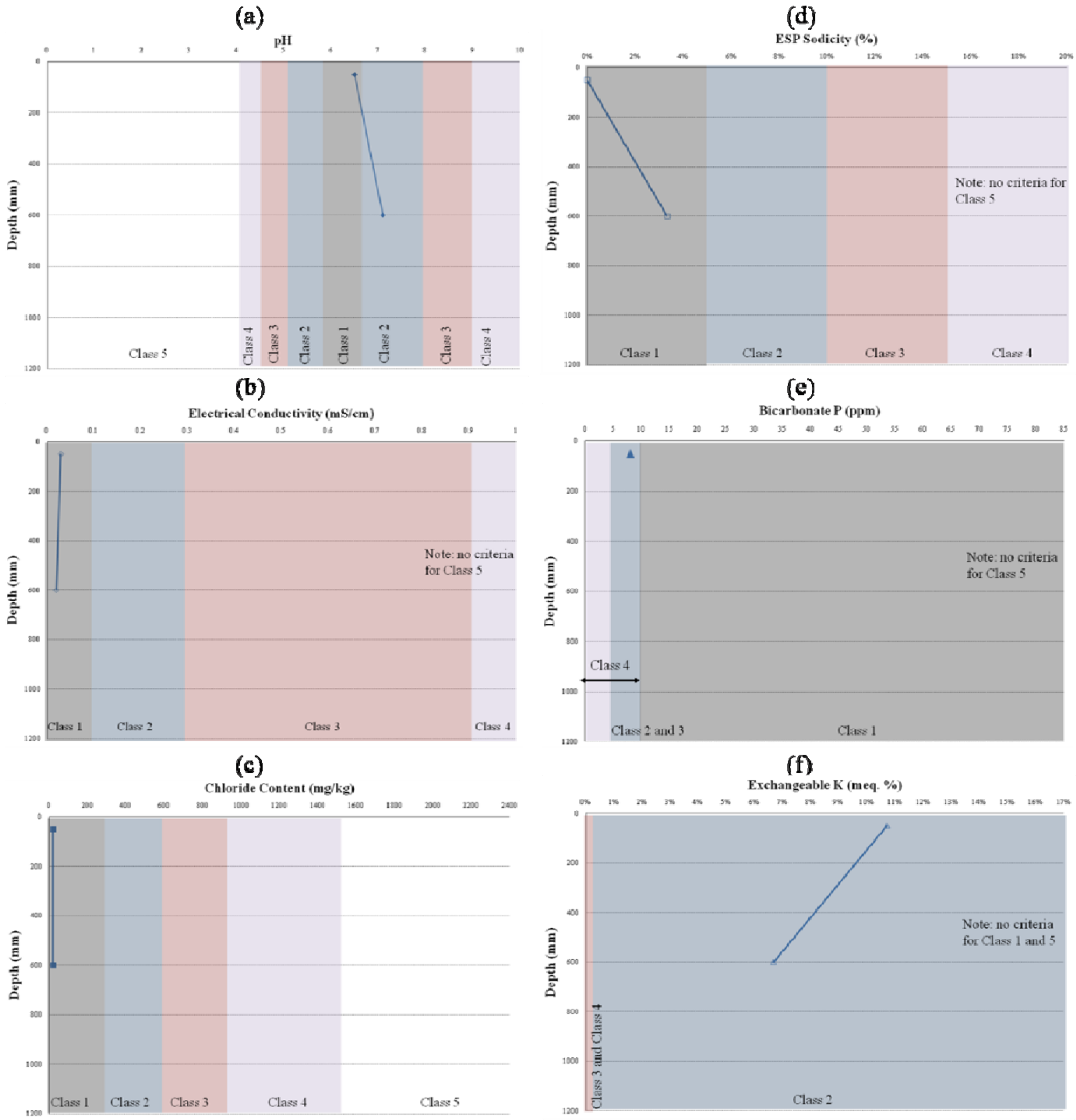
- **Figure A 12 Dermosol: Site 47 (a) pH, (b) Electrical conductivity, (c) Chloride content, (d) ESP. (e) Bicarbonate P, and (f) Exchangeable K**



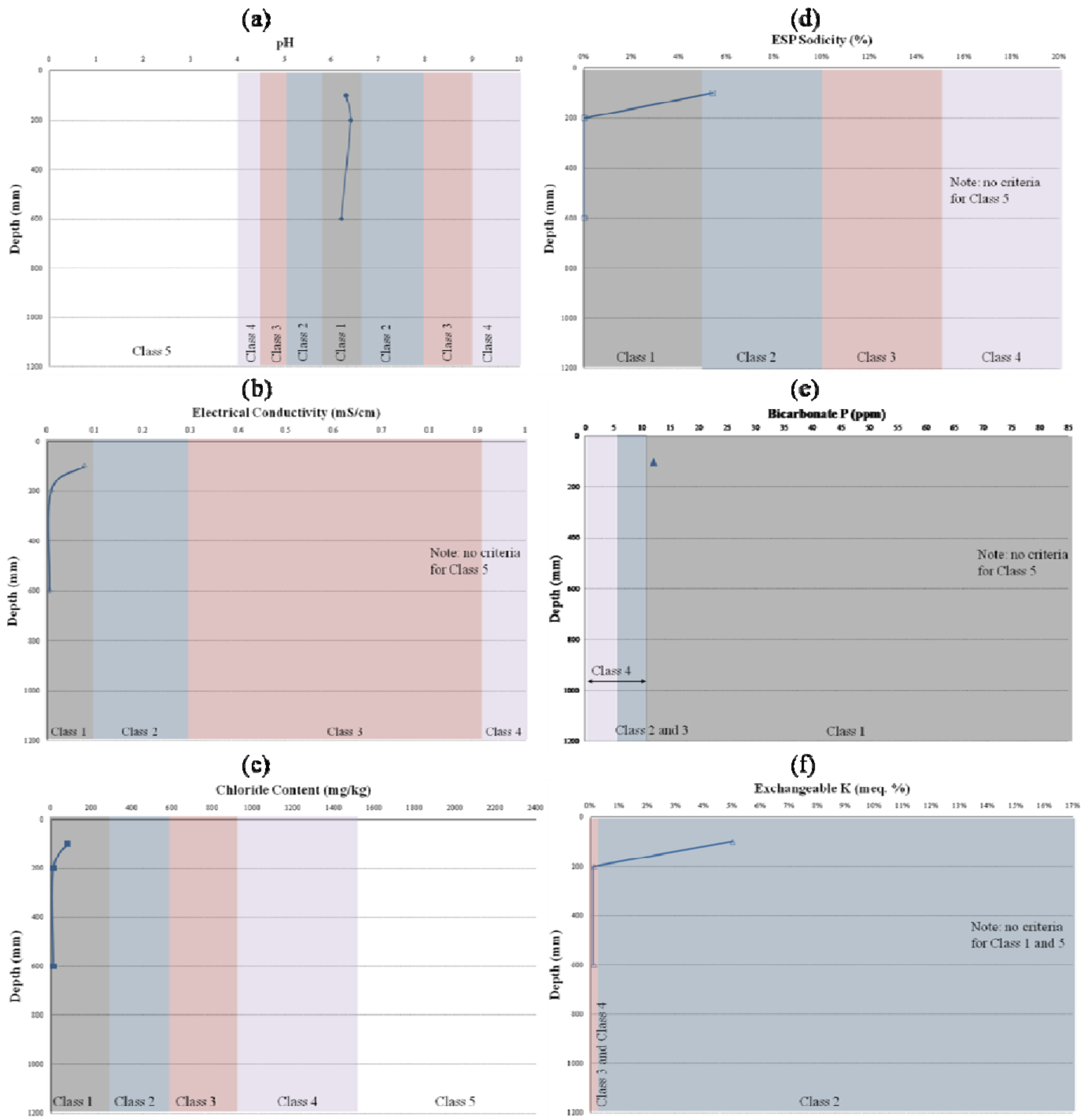
- **Figure A 13 Kandosol: Site 69 (a) pH, (b) Electrical conductivity, (c) Chloride content, (d) ESP. (e) Bicarbonate P, and (f) Exchangeable K**



- **Figure A 14 Kandosol: Site 23 (a) pH, (b) Electrical conductivity, (c) Chloride content, (d) ESP. (e) Bicarbonate P, and (f) Exchangeable K**



- **Figure A 15 Kandosol: Site 38 (a) pH, (b) Electrical conductivity, (c) Chloride content, (d) ESP. (e) Bicarbonate P, and (f) Exchangeable K**



- **Figure A 16 Kandosol: Site 44 (a) pH, (b) Electrical conductivity, (c) Chloride content, (d) ESP. (e) Bicarbonate P, and (f) Exchangeable K**

Appendix E Strategic Cropping Land Assessment

PART A - Site and Soil Data			
Site	6		
Land use / Cover	Grazing / Buffel grass, Brigalow		
Location Coordinates	0595544, 7614553		
Soil Classification	Vertosol		
Soil map unit name	Vertosol		
Soil correlation	May Downs - Dark self mulching deep clay (≥ 90 cm) and Teviot – Dark self mulching moderately deep to deep clay soils.		
Surface rock	Nil		
Gilgai microrelief	Nil		
Slope and landform	0-1% (see Figure 4-1)		
Surface condition			
Soil profile description	see Appendix A		
Part B - SCL Assessment			
SCL Zone	Western Cropping Zone		
SCL status as shown on trigger map			
SCL Criteria	Threshold Assessed	Assessment Method	Pass (P) or Fail (F)
1 - Slope	*≤ 3%*	Slope modelling from 10m DEM contour data	P
2 - Rockiness	*≤ 20% for rocks > 60 mm diameter*	Field Assessment	P
3 - Gilgai Mircrorelief	*< 50% of land surface being gilgi microrelies of > 500 mm in depth*	Field Assessment	P
4 - Soil depth	*≥ 600 mm*	Field Assessment	P
5 - Soil wetness	*Has favourable drainage*		P
6 - Soil pH	*at 300mm and 600 mm: 5 (rigid) 5.1 (non-rigid) to 5 (rigid) 8.9 (non-rigid)*	Refer to Appendix D	P (marginal)
7 - Salinity	*Chloride content <800 mg/kg within 600 mm of soil surface*	Refer to Appendix D	P
8 - Soil water storage	*≥ 100 mm to a soil depth or soil physico-chemical limitation of ≤ 1000 mm*	Refer to Section 4.2.1 and Table 4-2	F - 1000 mm based on SCL Guidelines. However surrogtae analysis from LS assessment estimated ≤ 75 mm / 10 cm with an ESP limitation

PART A - Site and Soil Data			
Site	9		
Land use / Cover	Grazing / Poplar Box, Open woodland		
Location Coordinates	598188, 7612435		
Soil Classification	Vertosol		
Soil map unit name	Kandosol		
Soil correlation	May Downs - Dark self mulching deep clay (≥ 90 cm) and Teviot – Dark self mulching moderately deep to deep clay soils.		
Surface rock	Nil		
Gilgai microrelief	Nil		
Slope and landform	0-1% (see Figure 4-1)		
Surface condition			
Soil profile description	see Appendix A		
Part B - SCL Assessment			
SCL Zone	Western Cropping Zone		
SCL status as shown on trigger map			
SCL Criteria	Threshold Assessed	Assessment Method	Pass (P) or Fail (F)
1 - Slope	*≤ 3%*	Slope modelling from 10m DEM contour data	P
2 - Rockiness	*≤ 20% for rocks > 60 mm diameter*	Field Assessment	P
3 - Gilgai Mircrorelief	*< 50% of land surface being gilgi microrelies of > 500 mm in depth*	Field Assessment	P
4 - Soil depth	*≥ 600 mm*	Field Assessment	P
5 - Soil wetness	*Has favourable drainage*		P
6 - Soil pH	*at 300mm and 600 mm: 5 (rigid) 5.1 (non-rigid) to 5 (rigid) 8.9 (non-rigid)*	Refer to Appendix D	P
7 - Salinity	*Chloride content <800 mg/kg within 600 mm of soil surface*	Refer to Appendix D	P
8 - Soil water storage	*≥ 100 mm to a soil depth or soil physico-chemical limitation of ≤ 1000 mm*	Refer to Section 4.2.1 and Table 4-2	P - 1000 mm from SCL Guidelines, 150 mm / 10 cm from LS analysis

PART A - Site and Soil Data			
Site	10		
Land use / Cover	Grazing / Grass, Acacia (various), Very few Ironbark		
Location Coordinates	0599832, 7611654		
Soil Classification	Red Dermosol		
Soil map unit name	Kandosol		
Soil correlation	Kinnoul - shallow uniform medium to fine textured soils, alkaline subsoils		
Surface rock	Nil		
Gilgai microrelief	Nil		
Slope and landform	0-1% (see Figure 4-1)		
Surface condition			
Soil profile description	see Appendix A.		
Part B - SCL Assessment			
SCL Zone	Western Cropping Zone		
SCL status as shown on trigger map			
SCL Criteria	Threshold Assessed	Assessment Method	Pass (P) or Fail (F)
1 - Slope	*≤ 3%*	Slope modelling from 10m DEM contour data	P
2 - Rockiness	*≤ 20% for rocks > 60 mm diameter*	Field Assessment	P
3 - Gilgai Mircrorelief	*< 50% of land surface being gilgi microrelies of > 500 mm in depth*	Field Assessment	P
4 - Soil depth	*≥ 600 mm*	Field Assessment	P
5 - Soil wetness	*Has favourable drainage*		P
6 - Soil pH	*at 300mm and 600 mm: 5 (rigid) 5.1 (non-rigid) to 5 (rigid) 8.9 (non-rigid)*	Refer to Appendix D	P
7 - Salinity	*Chloride content <800 mg/kg within 600 mm of soil surface*	Refer to Appendix D	P
8 - Soil water storage	*≥ 100 mm to a soil depth or soil physico-chemical limitation of ≤ 1000 mm*	Refer to Section 4.2.1 and Table 4-2	P - 1000 mm from SCL Guidelines, 150 mm / 10 cm from LS analysis

PART A - Site and Soil Data			
Site	13		
Land use / Cover	Grazing / Brigalow, Blackbutt		
Location Coordinates	601185, 7608926		
Soil Classification	Red Dermosol		
Soil map unit name	Kandosol		
Soil correlation	Kinnoul - shallow uniform medium to fine textured soils, alkaline subsoils		
Surface rock	Nil		
Gilgai microrelief	Nil		
Slope and landform	0-1% (see Figure 4-1)		
Surface condition			
Soil profile description	see Appendix A.		
Part B - SCL Assessment			
SCL Zone	Western Cropping Zone		
SCL status as shown on trigger map			
SCL Criteria	Threshold Assessed	Assessment Method	Pass (P) or Fail (F)
1 - Slope	*≤ 3%*	Slope modelling from 10m DEM contour data	P
2 - Rockiness	*≤ 20% for rocks > 60 mm diameter*	Field Assessment	P
3 - Gilgai Mircrorelief	*< 50% of land surface being gilgi microrelies of > 500 mm in depth*	Field Assessment	P
4 - Soil depth	*≥ 600 mm*	Field Assessment	P - 800 mm to chemical impedence
5 - Soil wetness	*Has favourable drainage*		P
6 - Soil pH	*at 300mm and 600 mm: 5 (rigid) 5.1 (non-rigid) to 5 (rigid) 8.9 (non-rigid)*	Refer to Appendix D	P - marginal
7 - Salinity	*Chloride content <800 mg/kg within 600 mm of soil surface*	Refer to Appendix D	P - marginal
8 - Soil water storage	*≥ 100 mm to a soil depth or soil physico-chemical limitation of ≤ 1000 mm*	Refer to Section 4.2.1 and Table 4-2	F - 1000 mm based on SCL Guidelines. However surrogtae analysis from LS assessment estimated ≤ 75 mm / 10 cm with an ESP, EC and Cl limitation

PART A - Site and Soil Data			
Site	15		
Land use / Cover	Grazing / Medium density Ironbark, Acacia, Buffel grass, Brigalow		
Location Coordinates	598820, 7617662		
Soil Classification	Vertosol		
Soil map unit name	Vertosol		
Soil correlation	May Downs - Dark self mulching deep clay (≥ 90 cm) and Teviot – Dark self mulching moderately deep to deep clay soils.		
Surface rock	Nil		
Gilgai microrelief	Nil		
Slope and landform	0-1% (see Figure 4-1)		
Surface condition			
Soil profile description	see Appendix A		
Part B - SCL Assessment			
SCL Zone	Western Cropping Zone		
SCL status as shown on trigger map			
SCL Criteria	Threshold Assessed	Assessment Method	Pass (P) or Fail (F)
1 - Slope	*≤ 3%*	Slope modelling from 10m DEM contour data	P
2 - Rockiness	*≤ 20% for rocks > 60 mm diameter*	Field Assessment	P
3 - Gilgai Mircrorelief	*< 50% of land surface being gilgi microrelies of > 500 mm in depth*	Field Assessment	P
4 - Soil depth	*≥ 600 mm*	Field Assessment	P
5 - Soil wetness	*Has favourable drainage*		P
6 - Soil pH	*at 300mm and 600 mm: 5 (rigid) 5.1 (non-rigid) to 5 (rigid) 8.9 (non-rigid)*	Refer to Appendix D	P (marginal)
7 - Salinity	*Chloride content <800 mg/kg within 600 mm of soil surface*	Refer to Appendix D	P
8 - Soil water storage	*≥ 100 mm to a soil depth or soil physico-chemical limitation of ≤ 1000 mm*	Refer to Section 4.2.1 and Table 4-2	F - 1000 mm based on SCL Guidelines. However surrogtae analysis from LS assessment estimated ≤ 75 mm / 10 cm with an ESP limitation

PART A - Site and Soil Data			
Site	22		
Land use / Cover	Grazing / Medium density Ironbark, Acacia, Buffel grass, Brigalow		
Location Coordinates	598838, 7616587		
Soil Classification	Vertosol		
Soil map unit name	Vertosol		
Soil correlation	May Downs - Dark self mulching deep clay (≥ 90 cm) and Teviot – Dark self mulching moderately deep to deep clay soils.		
Surface rock	Nil		
Gilgai microrelief	Nil		
Slope and landform	0-1% (see Figure 4-1)		
Surface condition			
Soil profile description	see Appendix A		
Part B - SCL Assessment			
SCL Zone	Western Cropping Zone		
SCL status as shown on trigger map			
SCL Criteria	Threshold Assessed	Assessment Method	Pass (P) or Fail (F)
1 - Slope	*≤ 3%*	Slope modelling from 10m DEM contour data	P
2 - Rockiness	*≤ 20% for rocks > 60 mm diameter*	Field Assessment	P
3 - Gilgai Mircrorelief	*< 50% of land surface being gilgi microrelies of > 500 mm in depth*	Field Assessment	P
4 - Soil depth	*≥ 600 mm*	Field Assessment	P
5 - Soil wetness	*Has favourable drainage*		P
6 - Soil pH	*at 300mm and 600 mm: 5 (rigid) 5.1 (non-rigid) to 5 (rigid) 8.9 (non-rigid)*	Refer to Appendix D	P
7 - Salinity	*Chloride content <800 mg/kg within 600 mm of soil surface*	Refer to Appendix D	P
8 - Soil water storage	*≥ 100 mm to a soil depth or soil physico-chemical limitation of ≤ 1000 mm*	Refer to Section 4.2.1 and Table 4-2	P - 1000 mm from SCL Guidelines, 150 mm / 10 cm from LS analysis

PART A - Site and Soil Data			
Site	23		
Land use / Cover	Grazing / Ironbark, Spear grass		
Location Coordinates	0595233, 7611393		
Soil Classification	Kandosol		
Soil map unit name	Kandosol		
Soil correlation	Dunrobin – Deep loamy red earths.		
Surface rock	Nil		
Gilgai microrelief	Nil		
Slope and landform	0-1% (see Figure 4-1)		
Surface condition			
Soil profile description	see Appendix A.		
Part B - SCL Assessment			
SCL Zone	Western Cropping Zone		
SCL status as shown on trigger map			
SCL Criteria	Threshold Assessed	Assessment Method	Pass (P) or Fail (F)
1 - Slope	*≤ 3%*	Slope modelling from 10m DEM contour data	P
2 - Rockiness	*≤ 20% for rocks > 60 mm diameter*	Field Assessment	P
3 - Gilgai Mircrorelief	*< 50% of land surface being gilgi microrelies of > 500 mm in depth*	Field Assessment	P
4 - Soil depth	*≥ 600 mm*	Field Assessment	P
5 - Soil wetness	*Has favourable drainage*		P
6 - Soil pH	*at 300mm and 600 mm: 5 (rigid) 5.1 (non-rigid) to 5 (rigid) 8.9 (non-rigid)*	Refer to Appendix D	P
7 - Salinity	*Chloride content <800 mg/kg within 600 mm of soil surface*	Refer to Appendix D	P
8 - Soil water storage	*≥ 100 mm to a soil depth or soil physico-chemical limitation of ≤ 1000 mm*	Refer to Section 4.2.1 and Table 4-2	F - 800 mm based on SCL Guidleines

PART A - Site and Soil Data			
Site	28		
Land use / Cover	Grazing / Small shrubs, Grassland, Some Ironbark		
Location Coordinates	595477, 7612063		
Soil Classification	Red Dermosol		
Soil map unit name	Kandosol		
Soil correlation	Kinnoul - shallow uniform medium to fine textured soils, alkaline subsoils		
Surface rock	Nil		
Gilgai microrelief	Nil		
Slope and landform	0-1% (see Figure 4-1)		
Surface condition			
Soil profile description	see Appendix A.		
Part B - SCL Assessment			
SCL Zone	Western Cropping Zone		
SCL status as shown on trigger map			
SCL Criteria	Threshold Assessed	Assessment Method	Pass (P) or Fail (F)
1 - Slope	*≤ 3%*	Slope modelling from 10m DEM contour data	P
2 - Rockiness	*≤ 20% for rocks > 60 mm diameter*	Field Assessment	P
3 - Gilgai Mircrorelief	*< 50% of land surface being gilgi microrelies of > 500 mm in depth*	Field Assessment	P
4 - Soil depth	*≥ 600 mm*	Field Assessment	P
5 - Soil wetness	*Has favourable drainage*		P
6 - Soil pH	*at 300mm and 600 mm: 5 (rigid) 5.1 (non-rigid) to 5 (rigid) 8.9 (non-rigid)*	Refer to Appendix D	P
7 - Salinity	*Chloride content <800 mg/kg within 600 mm of soil surface*	Refer to Appendix D	P
8 - Soil water storage	*≥ 100 mm to a soil depth or soil physico-chemical limitation of ≤ 1000 mm*	Refer to Section 4.2.1 and Table 4-2	P - 1000 mm from SCL Guidelines, 150 mm / 10 cm from LS analysis

PART A - Site and Soil Data			
Site	36		
Land use / Cover	Grazing / Small shrubs, Grassland, Some Ironbark		
Location Coordinates	0597230, 7606211		
Soil Classification	Red Dermosol		
Soil map unit name	Vertosol		
Soil correlation	Kinnoul - shallow uniform medium to fine textured soils, alkaline subsoils		
Surface rock	Nil		
Gilgai microrelief	Nil		
Slope and landform	0-1% (see Figure 4-1)		
Surface condition			
Soil profile description	see Appendix A.		
Part B - SCL Assessment			
SCL Zone	Western Cropping Zone		
SCL status as shown on trigger map			
SCL Criteria	Threshold Assessed	Assessment Method	Pass (P) or Fail (F)
1 - Slope	*≤ 3%*	Slope modelling from 10m DEM contour data	P
2 - Rockiness	*≤ 20% for rocks > 60 mm diameter*	Field Assessment	P
3 - Gilgai Mircrorelief	*< 50% of land surface being gilgi microrelies of > 500 mm in depth*	Field Assessment	P
4 - Soil depth	*≥ 600 mm*	Field Assessment	P
5 - Soil wetness	*Has favourable drainage*		P
6 - Soil pH	*at 300mm and 600 mm: 5 (rigid) 5.1 (non-rigid) to 5 (rigid) 8.9 (non-rigid)*	Refer to Appendix D	F
7 - Salinity	*Chloride content <800 mg/kg within 600 mm of soil surface*	Refer to Appendix D	P
8 - Soil water storage	*≥ 100 mm to a soil depth or soil physico-chemical limitation of ≤ 1000 mm*	Refer to Section 4.2.1 and Table 4-2	F - 1000 mm based on SCL Guidelines. However surrogtae analysis from LS assessment estimated ≤ 75 mm / 10 cm with an ESP limitation

PART A - Site and Soil Data			
Site	38		
Land use / Cover	Grazing / Poplar box, Morton Bay ash		
Location Coordinates	0396927, 7608097		
Soil Classification	Kandosol		
Soil map unit name	Kandosol		
Soil correlation	Dunrobin – Deep loamy red earths.		
Surface rock	Nil		
Gilgai microrelief	Nil		
Slope and landform	0-1% (see Figure 4-1)		
Surface condition			
Soil profile description	see Appendix A.		
Part B - SCL Assessment			
SCL Zone	Western Cropping Zone		
SCL status as shown on trigger map			
SCL Criteria	Threshold Assessed	Assessment Method	Pass (P) or Fail (F)
1 - Slope	*≤ 3%*	Slope modelling from 10m DEM contour data	P
2 - Rockiness	*≤ 20% for rocks > 60 mm diameter*	Field Assessment	P
3 - Gilgai Mircrorelief	*< 50% of land surface being gilgi microrelies of > 500 mm in depth*	Field Assessment	P
4 - Soil depth	*≥ 600 mm*	Field Assessment	P
5 - Soil wetness	*Has favourable drainage*		P
6 - Soil pH	*at 300mm and 600 mm: 5 (rigid) 5.1 (non-rigid) to 5 (rigid) 8.9 (non-rigid)*	Refer to Appendix D	P
7 - Salinity	*Chloride content <800 mg/kg within 600 mm of soil surface*	Refer to Appendix D	P
8 - Soil water storage	*≥ 100 mm to a soil depth or soil physico-chemical limitation of ≤ 1000 mm*	Refer to Section 4.2.1 and Table 4-2	F - 800 mm based on SCL Guidleines

PART A - Site and Soil Data			
Site	44		
Land use / Cover	Grazing / Ironbark, Spear Grass, Brigalow		
Location Coordinates	0602107, 7615125		
Soil Classification	Kandosol		
Soil map unit name	Kandosol		
Soil correlation	Dunrobin – Deep loamy red earths.		
Surface rock	Nil		
Gilgai microrelief	Nil		
Slope and landform	0-1% (see Figure 4-1)		
Surface condition			
Soil profile description	see Appendix A.		
Part B - SCL Assessment			
SCL Zone	Western Cropping Zone		
SCL status as shown on trigger map			
SCL Criteria	Threshold Assessed	Assessment Method	Pass (P) or Fail (F)
1 - Slope	*≤ 3%*	Slope modelling from 10m DEM contour data	P
2 - Rockiness	*≤ 20% for rocks > 60 mm diameter*	Field Assessment	P
3 - Gilgai Mircrorelief	*< 50% of land surface being gilgi microrelies of > 500 mm in depth*	Field Assessment	P
4 - Soil depth	*≥ 600 mm*	Field Assessment	P
5 - Soil wetness	*Has favourable drainage*		P
6 - Soil pH	*at 300mm and 600 mm: 5 (rigid) 5.1 (non-rigid) to 5 (rigid) 8.9 (non-rigid)*	Refer to Appendix D	P
7 - Salinity	*Chloride content <800 mg/kg within 600 mm of soil surface*	Refer to Appendix D	P
8 - Soil water storage	*≥ 100 mm to a soil depth or soil physico-chemical limitation of ≤ 1000 mm*	Refer to Section 4.2.1 and Table 4-2	F - 800 mm based on SCL Guidleines

PART A - Site and Soil Data			
Site	47		
Land use / Cover	Grazing / Small shrubs, Grassland, Some Ironbark		
Location Coordinates	603431, 7610795		
Soil Classification	Red Dermosol		
Soil map unit name	Kandosol		
Soil correlation	Kinnoul - shallow uniform medium to fine textured soils, alkaline subsoils		
Surface rock	Nil		
Gilgai microrelief	Nil		
Slope and landform	0-1% (see Figure 4-1)		
Surface condition			
Soil profile description	see Appendix A.		
Part B - SCL Assessment			
SCL Zone	Western Cropping Zone		
SCL status as shown on trigger map			
SCL Criteria	Threshold Assessed	Assessment Method	Pass (P) or Fail (F)
1 - Slope	*≤ 3%*	Slope modelling from 10m DEM contour data	P
2 - Rockiness	*≤ 20% for rocks > 60 mm diameter*	Field Assessment	P
3 - Gilgai Mircrorelief	*< 50% of land surface being gilgi microrelies of > 500 mm in depth*	Field Assessment	P
4 - Soil depth	*≥ 600 mm*	Field Assessment	P
5 - Soil wetness	*Has favourable drainage*		P
6 - Soil pH	*at 300mm and 600 mm: 5 (rigid) 5.1 (non-rigid) to 5 (rigid) 8.9 (non-rigid)*	Refer to Appendix D	P
7 - Salinity	*Chloride content <800 mg/kg within 600 mm of soil surface*	Refer to Appendix D	P
8 - Soil water storage	*≥ 100 mm to a soil depth or soil physico-chemical limitation of ≤ 1000 mm*	Refer to Section 4.2.1 and Table 4-2	P - 1000 mm from SCL Guidelines, 150 mm / 10 cm from LS analysis

PART A - Site and Soil Data			
Site	60		
Land use / Cover	Grazing / Cleared Buffel grass, Brigalow		
Location Coordinates	0596050, 7615539		
Soil Classification	Vertosol		
Soil map unit name	Vertosol		
Soil correlation	May Downs - Dark self mulching deep clay (≥ 90 cm) and Teviot – Dark self mulching moderately deep to deep clay soils.		
Surface rock	Nil		
Gilgai microrelief	Nil		
Slope and landform	0-1% (see Figure 4-1)		
Surface condition			
Soil profile description	see Appendix A.		
Part B - SCL Assessment			
SCL Zone	Western Cropping Zone		
SCL status as shown on trigger map			
SCL Criteria	Threshold Assessed	Assessment Method	Pass (P) or Fail (F)
1 - Slope	*≤ 3%*	Slope modelling from 10m DEM contour data	P
2 - Rockiness	*≤ 20% for rocks > 60 mm diameter*	Field Assessment	P
3 - Gilgai Mircrorelief	*< 50% of land surface being gilgi microrelies of > 500 mm in depth*	Field Assessment	P
4 - Soil depth	*≥ 600 mm*	Field Assessment	P
5 - Soil wetness	*Has favourable drainage*		P
6 - Soil pH	*at 300mm and 600 mm: 5 (rigid) 5.1 (non-rigid) to 5 (rigid) 8.9 (non-rigid)*	Refer to Appendix D	P
7 - Salinity	*Chloride content <800 mg/kg within 600 mm of soil surface*	Refer to Appendix D	P
8 - Soil water storage	*≥ 100 mm to a soil depth or soil physico-chemical limitation of ≤ 1000 mm*	Refer to Section 4.2.1 and Table 4-2	P- 1000 mm from SCL Guidelines, 150 mm / 10 cm from LS analysis

PART A - Site and Soil Data			
Site	69		
Land use / Cover	Grazing / Poplar box, Morton Bay ash		
Location Coordinates	0595767, 7617473		
Soil Classification	Kandosol		
Soil map unit name	Vertosol		
Soil correlation	Dunrobin – Deep loamy red earths.		
Surface rock	Nil		
Gilgai microrelief	Nil		
Slope and landform	0-1% (see Figure 4-1)		
Surface condition			
Soil profile description	see Appendix A.		
Part B - SCL Assessment			
SCL Zone	Western Cropping Zone		
SCL status as shown on trigger map			
SCL Criteria	Threshold Assessed	Assessment Method	Pass (P) or Fail (F)
1 - Slope	*≤ 3%*	Slope modelling from 10m DEM contour data	P
2 - Rockiness	*≤ 20% for rocks > 60 mm diameter*	Field Assessment	P
3 - Gilgai Mircrorelief	*< 50% of land surface being gilgi microrelies of > 500 mm in depth*	Field Assessment	P
4 - Soil depth	*≥ 600 mm*	Field Assessment	P
5 - Soil wetness	*Has favourable drainage*		P
6 - Soil pH	*at 300mm and 600 mm: 5 (rigid) 5.1 (non-rigid) to 5 (rigid) 8.9 (non-rigid)*	Refer to Appendix D	P
7 - Salinity	*Chloride content <800 mg/kg within 600 mm of soil surface*	Refer to Appendix D	P
8 - Soil water storage	*≥ 100 mm to a soil depth or soil physico-chemical limitation of ≤ 1000 mm*	Refer to Section 4.2.1 and Table 4-2	F - 800 mm based on SCL Guidleines

PART A - Site and Soil Data			
Site	75		
Land use / Cover	Grazing / Moreton Bay ash, Poplar box, Brigalow		
Location Coordinates	0599700, 7619872		
Soil Classification	Vertosol		
Soil map unit name	Vertosol		
Soil correlation	May Downs - Dark self mulching deep clay (≥ 90 cm) and Teviot – Dark self mulching moderately deep to deep clay soils.		
Surface rock	Nil		
Gilgai microrelief	Nil		
Slope and landform	0-1% (see Figure 4-1)		
Surface condition			
Soil profile description	see Appendix A		
Part B - SCL Assessment			
SCL Zone	Western Cropping Zone		
SCL status as shown on trigger map			
SCL Criteria	Threshold Assessed	Assessment Method	Pass (P) or Fail (F)
1 - Slope	*≤ 3%*	Slope modelling from 10m DEM contour data	P
2 - Rockiness	*≤ 20% for rocks > 60 mm diameter*	Field Assessment	P
3 - Gilgai Mircrorelief	*< 50% of land surface being gilgi microrelies of > 500 mm in depth*	Field Assessment	P
4 - Soil depth	*≥ 600 mm*	Field Assessment	P
5 - Soil wetness	*Has favourable drainage*		P
6 - Soil pH	*at 300mm and 600 mm: 5 (rigid) 5.1 (non-rigid) to 5 (rigid) 8.9 (non-rigid)*	Refer to Appendix D	P (marginal)
7 - Salinity	*Chloride content <800 mg/kg within 600 mm of soil surface*	Refer to Appendix D	P
8 - Soil water storage	*≥ 100 mm to a soil depth or soil physico-chemical limitation of ≤ 1000 mm*	Refer to Section 4.2.1 and Table 4-2	P - 1000 mm from SCL Guidelines, 150 mm / 10 cm from LS analysis

PART A - Site and Soil Data			
Site	94		
Land use / Cover	Grazing / Long grass up to 1.2 m		
Location Coordinates	0599580, 7622074		
Soil Classification	Shallow Vertosol		
Soil map unit name	Vertosol		
Soil correlation	Arcturus – Dark self-mulching moderately shallow clays (60-90 cm).		
Surface rock	Nil		
Gilgai microrelief	Nil		
Slope and landform	Not recorded (see Figure 4-1)		
Surface condition			
Soil profile description	see Appendix A. Soil depth - 400 mm		
Part B - SCL Assessment			
SCL Zone	Western Cropping Zone		
SCL status as shown on trigger map			
SCL Criteria	Threshold Assessed	Assessment Method	Pass (P) or Fail (F)
1 - Slope	*≤ 3%*	Slope modelling from 10m DEM contour data	P
2 - Rockiness	*≤ 20% for rocks > 60 mm diameter*	Field Assessment	P
3 - Gilgai Mircrorelief	*< 50% of land surface being gilgi microrelies of > 500 mm in depth*	Field Assessment	P
4 - Soil depth	*≥ 600 mm*	Field Assessment	F
5 - Soil wetness	*Has favourable drainage*		P
6 - Soil pH	*at 300mm and 600 mm: 5 (rigid) 5.1 (non-rigid) to 5 (rigid) 8.9 (non-rigid)*	Refer to Appendix D	P
7 - Salinity	*Chloride content <800 mg/kg within 600 mm of soil surface*	Refer to Appendix D	P
8 - Soil water storage	*≥ 100 mm to a soil depth or soil physico-chemical limitation of ≤ 1000 mm*	Refer to Section 4.2.1 and Table 4-2	P - 1000 mm from SCL Guidelines, 150 mm / 10 cm from LS analysis

Appendix F   Hillslope Erosion

The hillslope erosion map was derived using an amended version of the universal soil loss equation (USLE): Erosion = K x R x C x S x L tonnes/ha/year.

The results were truncated to values less than 100 t/ha/year to eliminate those non-realistically high erosion rates due to artefacts of 9" digital elevation model (DEM). The individual factors are described in Lu et al 2001 and are summarised as follows:

- K is soil erodibility and is derived from modelled soil data provided by ASRIS project.
- R is rainfall erosivity derived from point data supplied by DNR Queensland.
- C is the cover factor based on,
  - seasonal rainfall derived from QDNR data.
  - ABARES Landuse data at 0.01 deg cell size
  - AVHRR derived NDVI data at 0.05 deg cell size
- S is the slope factor derived by modelling high resolution 20 to 50 m cell DEM and extending this data to cover the river basins containing intensive agriculture.
- L is the slope length factor, derived by modelling high resolution 20 to 50 m cell DEM and extending this data to cover the river basins containing intensive agriculture. Outside this area the L factor was set to 1

APPENDIX 6
SMC WARDS WELL PRCP COMMUNITY CONSULTATION PLAN AND STAKEHOLDER REGISTER

Progressive Rehabilitation and Closure Plan
Wards Well

Community Consultation Plan

February 2021

Contents

Definitions

Consultation	Community consultation is a key component of the PRC plan and is intended to ensure that anyone impacted by proposed rehabilitation and closure activities at the site has an opportunity to provide input to the planning process (PRC plan Guideline, DES, 2019).
CCP	Community consultation plan, required to be submitted with the PRC plan
LoA	Life of Asset
EP Act	Environmental Protection Act 1994 (Qld)
EIS	Environmental Impact Statement – primary approval document for major projects under the State Development and Public Organisations Act 1971 and EP Act
DES	Department of Environment and Science, DES is responsible for assessing PRC plans and schedules.
DNRME	Department of Natural Resource Mining Energy
MERFP Act	Mineral and Energy Resources (Financial Provisioning) Act 2018 (Qld)
NUMA	Non-use management area - means an area of land the subject of a PRC plan that cannot be rehabilitated to a stable condition after all relevant activities for the PRC plan carried out on the land have ended. Land is in a stable condition if— (a) the land is safe and structurally stable; and (b) there is no environmental harm being caused by anything on or in the land; and (c) the land can sustain a post-mining land use
PMLU	Post-mining land use – means the purpose for which the land will be used after all relevant activities for the PRC plan carried out on the land have ended
PRC plan	Progressive rehabilitation and closure plan PRC plans must include a detailed description of how and where mining activities will be carried out, how consultation was undertaken and considered in development of a PRC plan, and any risks of not being able to rehabilitate the land to a stable condition.
PIE	Public Interest Evaluation - The MERFP Act introduces requirements for a PIE to be carried out for any EA applications that include a NUMA in a PRC plan schedule.

Wards Well	Wards Well Project

Introduction

This section describes the Community Consultation Plan (CCP) to be delivered as part of the Wards Well Project (Wards Well) Progressive Rehabilitation and Closure plan (PRC plan) to address the requirements of the *Guideline - PRC Plans* (DES, 2019). It includes:

- consultation requirements for PRC planning;
- the objectives and desired outcomes for stakeholder engagement in PRC planning for Wards Well;
- the consultation process and program including proposed frequency of consultation;
- information to be released for community consultation; and
- how community feedback will be considered in PRC plan updates.

An amendment to Wards Well's Environmental Authority (EA) will be required to enable further exploration at Wards Well as discussed in Section 1 below. The EA amendment is anticipated to be approved by the end of 2022, requiring amendments to the PRC plan and accompanying CCP. The term of this current CCP is therefore assumed as two years (2021-2022).

Figure 1 shows the location of Wards Well in regard to nearby communities and coal mines, and **Figure 2** shows the currently proposed disturbance area within the four mining leases in context with landholdings and Traditional Ownership.

Figure 1: Wards Well Location

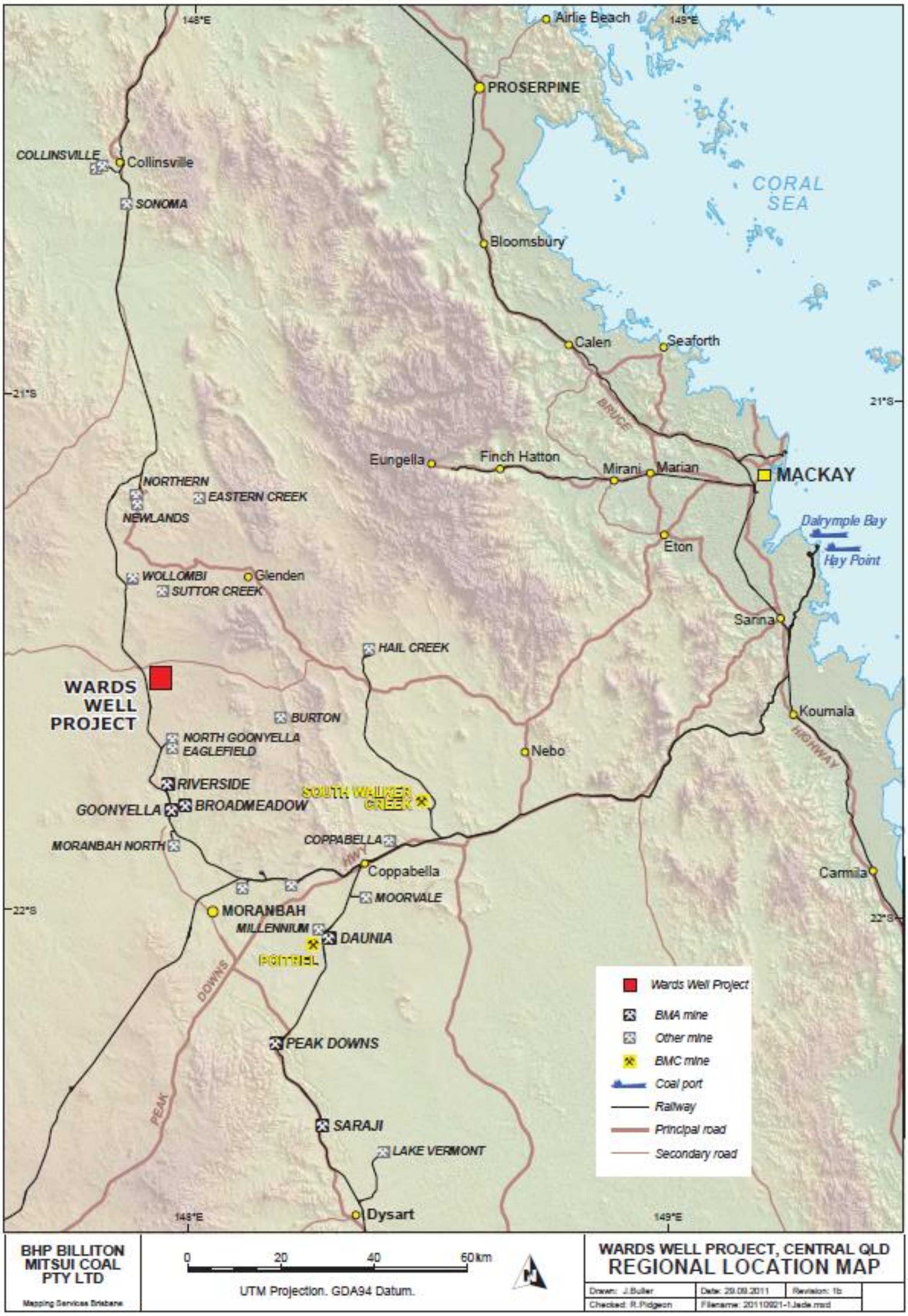
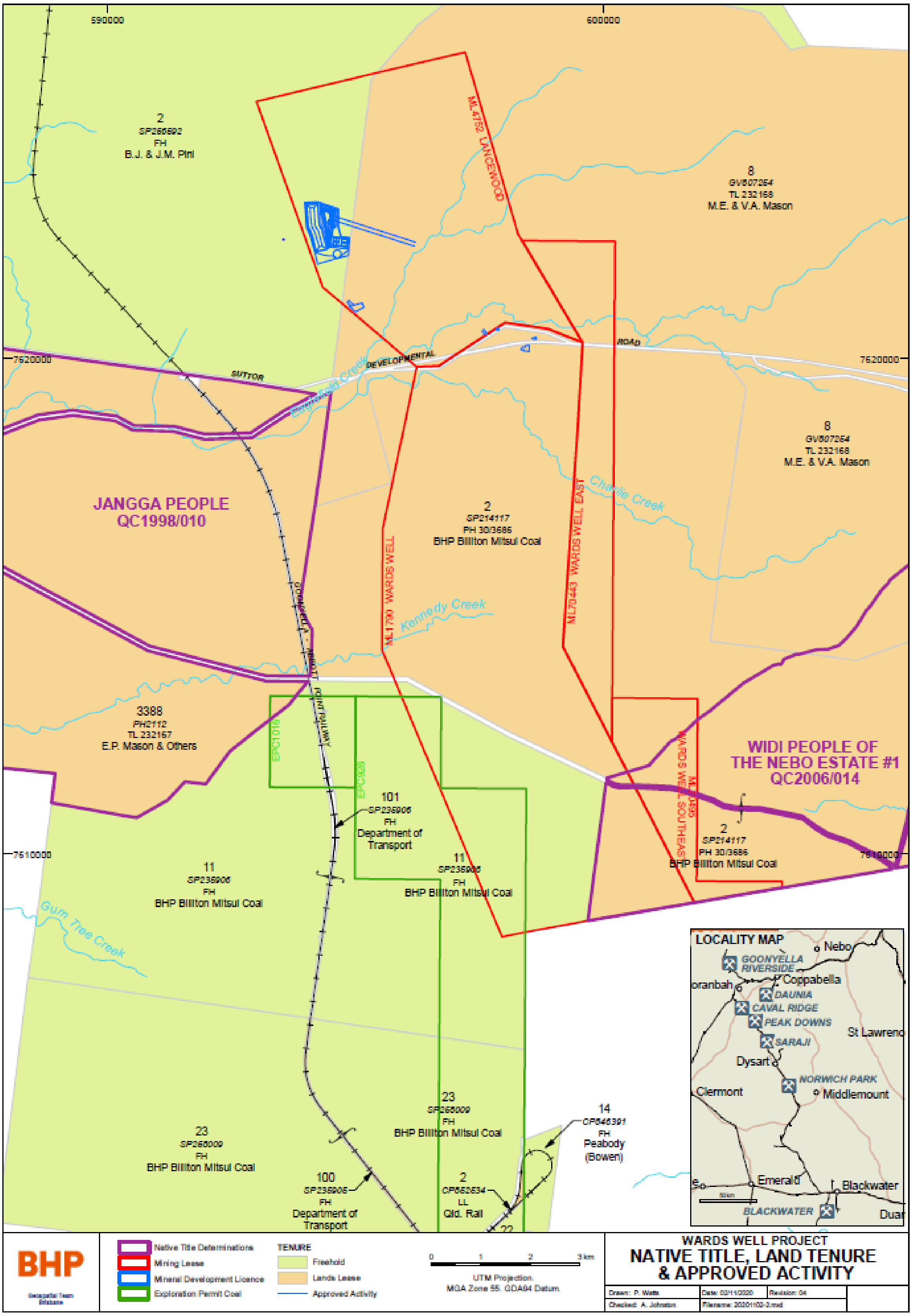


Figure 2 Wards Well Mining Leases and disturbance area



1. Consultation requirements

Consultation as part of PRC plan development

DES has produced a *Guideline - Progressive rehabilitation and closure plan*s (DES, 2019) which provides that '*community consultation is a key component of the PRC plan and is intended to ensure that anyone impacted by proposed rehabilitation and closure activities at the site has an opportunity to provide input to the planning process'*. The guideline requires that the applicant must attempt to consult all relevant members of the community, noting that 'the community may include, but are not limited to:

- affected landholders (such as underlying and adjoining land holders, and holders of land necessary for access to the land to which the proposed PRC plan relates);
- Traditional Owners;
- local government; and
- local community groups' (*Ibid*.).

The *Guideline - PRC plans* requirements are:

- consultation should occur prior to any PRCP schedule amendments that are likely to impact the community;
- the consultation register should be updated when this consultation is undertaken;
- in developing the proposed PRC plan, the community should at least be engaged on:
    - the plan for the mine;
    - Post-mining land uses (PMLUs) or non-use management areas (NUMAs);
    - areas of disturbance;
    - rehabilitation and management methods;
    - progressive rehabilitation and closure timeframes; and
- ongoing community consultation should continue throughout the stages of the mine life so that progressive rehabilitation and the socio-economic and environmental impacts related to mine closure can be discussed with the community.

The *Guideline – PRC plans* also provides that community consultation carried out through different processes (such as an EIS) may be used to address the requirements in section 126C(1)(c) of the EP Act which provides that a PRC Plan must include details of the consultation undertaken by the applicant in developing the proposed PRC plan, and details of how the applicant will undertake ongoing consultation in relation to the rehabilitation to be carried out under the plan. If there are no land outcomes identified in a land outcome document or previous consultation cannot be demonstrated, the applicant is required to comply with the requirements above as if it was a new application.

Each PRC plan is required to detail how stakeholders have been consulted in the Plan's development and the outcomes of that consultation i.e. how stakeholder inputs have informed the outcomes stated in the PRC plan.

EP Act Section 755B provides that the notification stage under chapter 5, part 4 does not apply for the assessment of the proposed PRCP schedule if either of the following matters is satisfied in relation to land the subject of a proposed PRCP schedule— (a) the outcome for land under a land outcome document is the same as, or substantially similar to, the PMLU or NUMA stated for the area under the proposed PRCP schedule; or (b) for an area of land stated in a land outcome document that could be a proposed NUMA under the PRCP schedule—the schedule proposes a PMLU for all or part of the land. As the proposed PMLU is the same as the outcome specified in the Wards Well EA, notification is not expected to be required.

Consultation on Wards Well PRC Plan

Land within the Wards Well MLs was acquired in 2007. Further acquisition of land under compensation agreements was undertaken in 2011-2012. Engagement with the affected landowners was undertaken to develop compensation, leasing and agistment agreements. This included advice that:

- in the near term, exploration activities were the only activities planned;
- an underground mine was proposed for some time in the future; and
- until land was required for exploration or mining, it would be available for grazing within the terms of the agistment agreements and leases.

In essence, the outcome of consultation during the acquisition processes was that landowners and cattle would be excluded from affected areas whilst land disturbance was occurring, and the land would then be rehabilitated and the landform returned to a state suitable for grazing. The existing use for grazing (managed under agistment agreements and leases) has been discussed with directly affected landholders as part of regular meetings between the Land Management team and these stakeholders.

An EIS has not been prepared for Wards Well, so there has been no public consultation regarding land use or land management.

Consultation undertaken as part of PRC plan preparation for Wards Well included:

- meeting with Isaac Regional Council (IRC) about Wards Well's approved activities, PRC planning process and PMLUs, provision of a presentation for Council's information, and an invitation for further discussion with Council about their involvement in future PRC plan consultations;
- writing to the three landholders that own or lease land within the MLs to provide a project update and information about the approved activities and PMLUs under Wards Well's EA, inviting feedback and discussing ongoing engagement regarding the form of IRC's involvement in future PRC planning consultations;
- writing to Widi People who are the Traditional Owners of land within ML1790 and ML70495 to provide an update on Wards Well and information on approved activities and PMLUs within the MLs, with a future meeting with Widi People planned to focus on the Wards Well PRC plan;
- writing to utility owners and the owners of overlapping tenures (mining and gas exploration) within the Wards Well MLs to advise that a PRC plan was being prepared and forecast further engagement in future stages of Wards Well's development; and
- writing to other interested stakeholders including adjacent landholders, the Jangga People (who are the Traditional Owners of land to the east of the MLs), IRC, and government representatives to advise that a PRC plan was being prepared, provide information about Wards Well, progressive rehabilitation and approved PMLUs, and invite stakeholders to contact BHP's Communities team if they would like to discuss the PRC plan or obtain more information..

Community consultation register

A community consultation register has been provided as part of the PRC plan in compliance with section 126C(1)(c)(iii) of the EP Act and includes:

- identification of each community member/stakeholder;
- previous engagements with the community;
- consultation date(s);
- description of consultation type ;

- information provided to the community;
- issues raised/discussed by the community;
- how issues have been considered;
- decisions/ outcomes of engagement; and
- commitments made by BHP.

The community consultation register will be a live instrument for recording future consultation on Wards Well's PRC plan.

PRC plan implementation community consultation plan

The *Guideline - PRC plans* notes that ongoing community consultation is expected to continue throughout the stages of the mine life so that progressive rehabilitation and the socio-economic and environmental impacts related to mine closure can be discussed with the community. Consultation is required prior to any PRC plan schedule amendments that are likely to impact the community, and the consultation register needs to be updated when this consultation is undertaken.

In order to comply with section 126C(1)(c)(iv) of the EP Act, the PRC plan must include a community consultation plan (CCP) detailing how ongoing consultation will be carried out in relation to the rehabilitation to be carried out under the PRC plan. The community consultation plan must include details of:

- the objectives for community consultation;
- how the community will be engaged;
- proposed consultation frequency;
- what information will be released for community consultation; and
- how feedback/comments will be considered.

2. Consultation approach

Stakeholder analysis

BHP is committed to consultation in PRC planning with affected and interested stakeholders, who are identified in Table 1. Affected stakeholders were determined in accordance with the International Council for Mining and Metals (ICMM) Community Development Toolkit (ICMM, 2012) guiding questions and include stakeholders who:

- reside within the project area;
- have cultural or historical ties to the area;
- may be socially or economically impacted by closure or rehabilitation;
- will benefit from closure; or
- will be responsible for implementing measures to mitigate negative impacts.

Affected stakeholders who will be consulted during the PRC plan implementation period include:

- landowners and lessees within the MLs;
- Traditional owners - Widi People and Jangga People;
- adjacent private landholders;
- Isaac Regional Council;

- utility owners – Powerlink, Aurizon, Sunwater, Department of Transport and Main Roads (DTMR); and
- owners of overlapping tenures - Arrow Energy Holdings and Anglo American plc.

Other interested stakeholders include those who will be responsible for making decisions, whose co-operation or influence would be beneficial, who might have resources to contribute, or who support or oppose the changes that PRC planning may bring (ICMM, 2012). As Wards Well's currently approved activities do not require a workforce or engagement with local suppliers, and do not result in social impacts for local communities, community members, community groups and businesses have been considered as interested stakeholders for the purpose of this PRC plan.

Table 1 identifies affected and interested stakeholders including issues which are of interest with respect to PRC planning.

Table 1: Wards Well Stakeholders

Stakeholders	Details	Issues of interest
Affected stakeholders		
Traditional owners - Widi People	The Widi People (whose claim was recognised by the NNTT in 2015) are the Traditional Owners of land to the east of Wards Well, with a small area of land within ML 1790 and ML70495 within the Widi People's claim area.	• Cultural heritage impacts • Impacts on Native Title • Potential for impacts on the cultural landscape or connections to Country • Post-mining land use and landform / land scape • Environmental management /stewardship • Employment and business opportunities in exploration, environmental management and monitoring, rehabilitation
Affected landowners and lessees	BHP-Mitsubishi Coal (BMC) has agreements with three landholders within the Wards Well MLs including two landowners and the lessees of land owned by BMC. Land within the MLs is used for grazing. Compensation Agreements are in place for properties within the MLs.	• Access to land owned by BHP whilst not required for mining purposes • Future access to and ownership of lands • Compensation for impacts on land use • Water access – water allocations, water pipelines • Environmental management /stewardship • Post-mining land use and landform/land scape • Rehabilitation
Utility owners • Powerlink • Aurizon • Sunwater • DTMR	Utility owners with assets within Wards Well MLs include Powerlink (electricity transmission), Sunwater (Burdekin water supply pipeline and Eungella water pipelines), Aurizon (rail infrastructure) and DTMR (Suttor Development Road and an unformed road). BHP engages with utility owners as required, i.e. through issue-specific or transactional engagement. Implementation of the PRC plan will require update to agreements with utility owners.	• Impact on assets/asset value • Remediation of impacts on assets • Service disruptions and mitigations • Crossing/interface agreements
Owners of overlapping tenures • Arrow Energy • Anglo American	Arrow Energy and Anglo American have overlapping tenures with the Wards Well MLs (for coal seam gas production and coal production respectively). Relationships with overlapping	• Any impacts on the use or availability of land within overlapping tenures • Water access • Access to land owned by BHP whilst not required for mining purposes • Crossing/interface agreements

Stakeholders	Details	Issues of interest
	tenures owners are managed as part of statutory and commercial processes.	
Adjacent private landholders	To the east and west of Wards Well MLs, BHP owns land which is used as a buffer to manage the potential for conflicting land uses. Peabody's North Goonyella mine adjoins the southern boundary of the mining lease. Land owned by private landholders is located to the west and east. Land uses on adjacent land holdings include grazing and mining,	• Environmental management /stewardship • Post-mining land use and landform/land scape • Access to land owned by BHP whilst not required for mining purposes • Rehabilitation schedule • Future access to and ownership of lands
Local Government • Isaac Regional Council	Isaac Regional Council is the local government and planning authority for the Isaac LGA which encompasses some 58, 000 km2 and 17 distinct and diverse communities.	• Local job opportunities • Economic and community sustainability and transformation (towards post-mining) • Environmental stewardship • Effects of on Council services and infrastructure e.g. changes to infrastructure agreements, water supply or road maintenance • Mine rehabilitation progress • Management of closure impacts on employment and businesses • Accordance of BHP rehabilitation plans with local and regional planning goals
Interested stakeholders		
Other nearby landholders	Several landholders are located within 5-6 km. BHP has established relationships with landholders to the south and east of Wards Well.	• Post-mining land use and landform/land scape • Access to land owned by BHP • Rehabilitation schedule • Future access to and ownership of lands
Jangga People	The Jangga People (whose claim was recognised in 2012) are the Traditional Owners of land to the west of Wards Well's MLs.	• Potential for impacts on the cultural landscape or connections to Country • Post-mining land use and landform / land scape • Employment and business opportunities in exploration, environmental management and monitoring, rehabilitation
BHP employees and contractors	Wards Well does not have an established on-site workforce. Exploration and land management functions are performed by contractors. Other BHP personnel will be interested in closure planning if they perceive that it may affect their employment security.	• Job opportunities • Loss of jobs with closure • Closure planning in context with other mining industry changes e.g. technology advances, autonomous haulage • Workers' conditions • Sustainability of communities that are dependent on mining
Unions	Unions with members who are employed by BHP include the Construction, Forestry, Mining and Energy Union (CFMEU), the Australian Manufacturing Workers' Union (AMWU) and the Electrical Trades Union (ETU). BHP maintains relationships with unions with respect to enterprise bargaining agreements, working conditions and workplace health and safety.	

Stakeholders	Details	Issues of interest
Businesses	BHP's Local Buying Program is delivered in a strategic partnership between BHP and C-RES, a cost neutral organisation. BHP and C-RES have an extensive network of small business suppliers, including Indigenous businesses.	• Opportunities to participate in supply chain (e.g. exploration, environmental management, rehabilitation) • Economic transformation (towards post-mining) • Economic and community sustainability • Loss of supply opportunities with closure
Community members and groups	BHP is strongly affiliated with the communities of Moranbah and Dysart (in the Isaac LGA) and Blackwater (in the Central Highlands LGA).	• Local job opportunities • Local business opportunities • Community and regional sustainability • Environmental management • Future use of mined land • With closure of an operation, loss of jobs and supply opportunities • Rehabilitation schedules
Queensland Government	State government representatives and agencies with an interest in PRC planning include: • Office of the Minister for Resources • Office of the Minister for Environment, Great Barrier Reef, Science and Youth Affairs • Member for Burdekin • Member for Gregory • Shadow Minister for Natural Resources, Mine and Energy • Department of Natural Resources, Mining and Energy (DNRME) - Deputy Director-General Georesources • DES – PRCP Team and Emerald Business Centre	• Legislative compliance • Resource development • Employment opportunities • Public interest • Environmental management • Financial assurance • Environmental risk identification and management • Future land use and landform • Company responses to stakeholder views
Federal Government	The Department of Agriculture Water and Environment (DAWE) is the lead agency for environmental protection at Commonwealth level.	

Use of existing engagement mechanisms

Communities and stakeholders within Isaac LGA will experience multiple demands for their participation in PRC planning over the next few years. To minimise additional demands on communities and stakeholders, BHP will utilise its existing stakeholder engagement mechanisms for PRC consultation wherever possible, as described in Table 2.

Table 2: Using existing BHP engagement mechanisms

Mechanism	Mechanism and frequency
Landholder meetings	BHP's Land Management team engage regularly with landholders within and near MLs. Engagement with Wards Well landholders has related to land access, agistment arrangements and leases Consultation with landowners within and adjacent to Wards Well will be conducted throughout the life of the PRC plan through regular meetings on site or in Moranbah.

Mechanism	Mechanism and frequency
IRC meetings	Twice yearly meetings are held with Isaac Regional Council, generally in March and September. The meetings have a fluid agenda which is subject to change based on key topics/issues at the time. BHP met with IRC in December 2020 to discuss Wards Well, PRC planning and Council's preferred options for engagement in PRC planning. PRC planning updates will be offered as an agenda item for bi-annual briefings. BHP will also offer site-specific and strategic engagement opportunities to IRC.
Traditional Owner meetings	Bi-monthly meetings are generally held with Barada Barna and Ghungalou People. The Indigenous Affairs and Cultural Heritage team is seeking to establish a similar routine with Widi People and Jangga People. The Indigenous Affairs and Cultural Heritage team and the Indigenous Business Specialist will be provided with information to support engagement with Traditional Owners.
Community Connect newsletter	This monthly newsletter is distributed to more than 20,000 letterboxes throughout the Bowen Basin and will include a status update on Wards Well and PRC planning, on an annual basis.
Coal Connect	This weekly electronic employee newsletter will provide a status update on Wards Well and PRC planning on an annual basis and prior to any application for EA amendments.
Moranbah Smart Transformation Advisory Committee (STAC)	The Moranbah STAC is one of two established by BHP as part of its Smart Transformations consultation (the other is the Dysart STAC.) The STACs were involved in developing the Smart Transformation Readiness Assessment and the Community Roadmap, which aim to assist Moranbah and Dysart in preparing for the Fourth Industrial Revolution. STACs generally meet monthly. There is an opportunity to seek feedback on closure planning issues from STAC members.
CSIRO Local Voices	This is a three-year engagement process which includes quarterly pulse surveys for registered participants. There is an opportunity to seek community feedback on closure planning issues through this forum.

Iterative consultation process

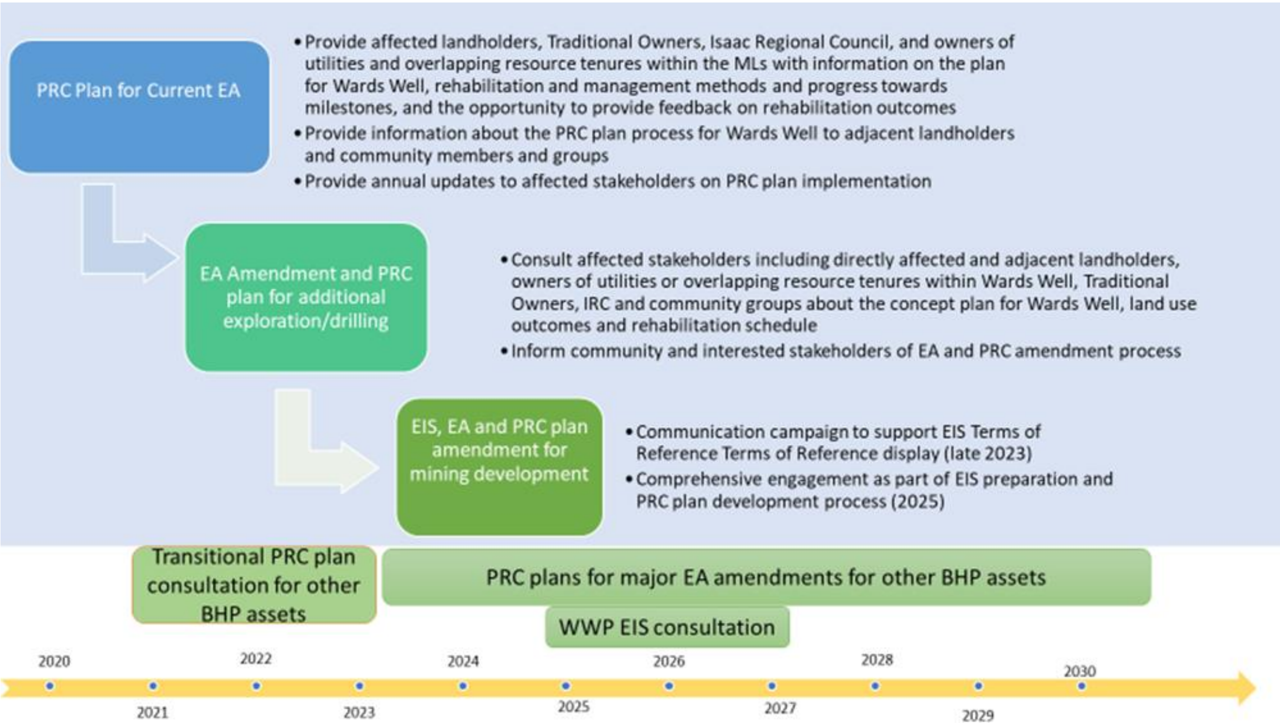
The scope of approved activities under the current Wards Well EAs is limited to exploration, and is time-limited, as the current EA requires a Major amendment in the short term to enable additional exploration and drilling at Wards Well. An application for an EA amendment to facilitate additional exploration is planned for lodgement in late 2021, and would require an accompanying consultation process, consultation register and PRC Plan.

Further EA and PRC plan amendments (expected to include an Environmental Impact Statement under the EPA Act 1994 or the SDPWO Act 1971) will be required to gain approval for mining. Development of Terms of Reference for an EIS is proposed to be finalised by 30 September 2023. This would require a communication strategy to develop community awareness of the proposed project and support stakeholders' informed involvement in the statutory consultation process. Following finalisation of the EIS Terms of Reference, BHP *may* proceed to the development of the EIS including a comprehensive engagement process.

Figure 3 shows a preliminary draft timeline for PRC plan consultation in line with the required EA amendments, forecasting consultation during the EA amendment process and a future EIS process. As consultation for other BHP assets' PRC plans will also be required during 2021 to 2023, future engagement for Wards Well PRC planning would be positioned, where possible, as part of a portfolio approach to consultation on PRC.

This CCP addresses consultation for the current EA and PRC plan implementation period, and for the commencement of the EA amendment process, anticipating that the CCP will be updated as part of updating the PRC plan for the EA amendment. Consultation as part of a PRC plan/EA amendment for mining development would be considered as part of the methodology for a future EIS.

Figure 3: Staged approach for Wards Well PRC consultation – indicative timeline



Social value

Social value is the positive contribution BHP makes to the environment and society – our workforce, partners, customers, economies and communities. Open and transparent engagement and cooperation with key stakeholders generates social value, which is a precondition to shareholder value. A social value approach goes beyond consultation and social investment, and encourages collective impact, local activation and stakeholder empowerment. The PRC planning process provides BHP with a unique opportunity to demonstrate a commitment to social value and proactively identify opportunities for genuine engagement, co-design and/or partnership with stakeholders to achieve long-term positive social, environmental and economic outcomes post-mining.

Opportunities to catalyse social value will be a focus of future consultation with stakeholders. This includes:

- the opportunity to work industry partners to develop a shared analysis and where possible alignment on PRC plans;
- the opportunity to support landholders' aspirations for future use of rehabilitated land;
- cooperation with Indigenous businesses to develop their capacity to undertake land management and rehabilitation works; and
- cooperation with Council on strategic planning outcomes and economic transformation initiatives.

3. Consultation program

Objectives and outcomes

Consultation as part of implementing the current Wards Well PRC plan will be informed by the objectives and desired outcomes shown in **Table 3**.

Table 3: PRC plan engagement objectives and outcomes

Engagement Objectives	Engagement Outcomes
Develop strong and cooperative stakeholder relationships with affected stakeholders to enable their informed consideration of PRC plans and identification of shared value and/or beneficial future land uses	Affected stakeholders have access to detailed information on plans for Wards Well and regular opportunities to provide input and feedback on Wards Well's rehabilitation methods, schedule and outcomes as they progress
Demonstrate transparency regarding BHP's PRC intentions and timeframes to local communities	A wide range of stakeholders within Isaac LGA communities have access to information about PRC planning and implementation for Wards Well and have opportunities to provide feedback on rehabilitation and closure outcomes
Incorporate community objectives and aspirations for land use and landform planning post-mining in future plans for Wards Well	BHP engagement with IRC and local communities identifies strategic objectives and opportunities for social value which are considered in Wards Well's future PRC plans

BHP will monitor progress against these objectives as part of annual PRC plan monitoring and reporting processes.

Consultation methods and frequency

Table 4 outlines the engagement program for consultation as part of Wards Well PRC plan implementation. As previously noted, an EA amendment will be required to enable further exploration at Wards Well, requiring amendments to the PRC plan and accompanying CCP, so this consultation program will be implemented as part of that process.

Table 4: Consultation program for PRC Plan implementation

Engagement objective	**Develop strong and cooperative stakeholder relationships with affected stakeholders to enable their informed consideration of PRC plans and identification of shared value and/or beneficial future land uses**	
Stakeholders	**Consultation method**	**Frequency**
• Landowners and lessees within the MLs • Traditional owners - Widi People and Jangga People • Adjacent private landholders • Isaac Regional Council • Utility owners – Powerlink, Aurizon, Sunwater, DTMR • Owners of overlapping tenures - Arrow Energy , Anglo American	Advise affected stakeholders in writing when the PRC plan is approved and provide a copy of the PRC plan for their information	One-off
	Provide information in writing to all affected stakeholders on PRC plan progress, and invite affected stakeholders' feedback on: • the approved PMLU e.g. rehabilitation methods which would optimises future grazing opportunities, or water storage • areas where land disturbance through approved exploration activities are proposed i.e. any particular values in certain areas • rehabilitation methods, schedule and progress towards milestones	Initially on commencement of rehabilitation; subsequent consultation to be defined thereafter
	Meet with directly affected and adjacent landholders, Widi People and Jangga People to provide an update on the Wards Well concept plan, communicate progress with rehabilitation against the PRC plan schedule, and discuss any other items of interest e.g. particular values pertaining to disturbed areas, or shared value initiatives	Ongoing engagement process
	As part of biannual meetings with IRC (or as determined with Council), provide an update on the status of Wards Well's EA (approved activities and PMLUs), the PRC plan and concept plan (as progressed), and progress with rehabilitation against the PRC plan schedule, and forecast upcoming PRC plan consultations for other BHP assets	Bi-annual
	Notify affected stakeholders in writing when an EA amendment application for further exploration has commenced, providing information on the scope and location of the activities for which the amendment is sought, seeking feedback on the proposed updated rehabilitation schedule, disturbance footprint and proposed PMLUs to be included in the PRC plan/amendment accompanying the EA amendment application, and advising on how to access information about the EA amendment notification process	One-off
	Meet with Widi People and Jangga People to provide an update on Wards Well and proposed disturbance areas/activities for which an EA amendment is sought. With Widi People, this will include consultation on cultural heritage management requirements, rehabilitation species, methods and timeframes. This consultation may also identify Traditional Owners' interest in and capacity for involvement in rehabilitation works.	Ongoing engagement process – meetings as agreed
	Meet with DTMR to develop an Infrastructure Plan and update/develop a crossing agreement with terms and conditions tailored to the planned exploration/ mining activity as part of a future EA amendment application process	Meetings as required
	Through correspondence and/or meetings, cooperate with Powerlink, Sunwater and Aurizon to develop interface agreements where required, with terms and conditions tailored to the planned exploration/ mining activity as part of a future EA amendment application process	One off process

Engagement objective	Demonstrate transparency regarding BHP's PRC intentions and timeframes to local communities	
Stakeholders	**Consultation method**	**Frequency**
Moranbah and Glenden community members and groups	Using Community Connect (BHP's monthly community newsletter) and community forums such as interagency meetings, partnership meetings and community and business networks, provide community updates on PRC planning (Wards Well-specific and portfolio wide) and advise community members of progress towards the Wards Well EA amendment for further exploration	Ongoing engagement process
	Via Smart Transformations Advisory Committee members, CSIRO Local Voices pulse surveys and/or PRC plan-specific workshops or focus groups, seek the involvement of community members and groups in articulating community aspirations for rehabilitation of BHP mines, PMLUs and economic transformation	One-off process
BHP employees, contractors and unions	Via Coal Connect (a weekly email newsletter to personnel), provide regular updates on PRC planning (Wards Well-specific and portfolio wide) and updates on the Wards Well concept planning process	Ongoing engagement process
Young people	Share accessible information (e.g. on-line or printed learning resources) with Moranbah and Glenden schools and community organisations (e.g. Moranbah Youth and Community Centre and Youth Advisory Committee) to enable young people to understand mine planning and rehabilitation planning and implementation	One-off
Local businesses and BHP suppliers	Via the Moranbah Traders Association and C-RES, provide updates on PRC planning (Wards Well-specific and portfolio wide), including rehabilitation plans and progress, approved PMLUs and potential future supply opportunities	One-off
Elected representatives and Government agencies	Provide updates via letter and/or meeting on PRC planning to: • Office of the Minister for Resources (Queensland) • Office of the Minister for Environment, Great Barrier Reef, Science and Youth Affairs (Queensland) • Shadow Minister for Resources • Shadow Minister for Environment, Great Barrier Reef, Science and Youth Affairs Resources • Member for Burdekin (Queensland Parliament) • Member for Gregory (Queensland Parliament) • Member for Capricornia (Australian Parliament) • DES PRCP Team and Emerald Business Centre • Director, Coal Hub, Department of Resources • Deputy Director-General Georesources, Department of Resources • Assistant Secretary Assessments and Governance Branch, DAWE	As requested, or as agreed with individual representatives /agencies

Engagement objective	Incorporate community objectives and aspirations for land use and landform planning post-mining in future plans for Wards Well	
Stakeholders	**Consultation method**	**Frequency**
Traditional Owners and Indigenous businesses, C-RES	Meet with Traditional Owners and Indigenous businesses to understand business capabilities and communicate the pipeline of opportunities relating to rehabilitation work and land management (portfolio-wide)	One-off process
	In cooperation with Traditional Owners including Widi People, Jangga People and other First Nations within Isaac LGA, plan and implement an Indigenous business capability development program to match rehabilitation opportunities, if this is required	One-off process
Isaac Regional Council	Meet with IRC to understand Council's strategic analysis and planning for Isaac LGA and the Wards Well project area as relevant, to identify objectives to be considered as part of future PRC planning for Wards Well	Annually, or as agreed with Council
	Share the results of BHP research and industry partnership projects relevant to rehabilitation with Council	One-off, or as agreed with Council
	Participate in Council-led initiatives which aim to harness social value from mine closure and rehabilitation planning, and/or work towards from economic transformation	As invited
Local businesses and BHP suppliers	Via C-RES, share information on local supply opportunities relevant to rehabilitation implementation and hold a workshop/s for interested businesses to identify and develop local capabilities for involvement in rehabilitation work	One-off process

4. Information to be released for community consultation

Whilst many stakeholders in the Isaac LGA and broader Mackay-Isaac-Whitsunday Region are well-educated about mining operations, there is less understanding of planning for Life of Mine, rehabilitation and closure planning. The CCP recognises the following social context:

- talk of closure planning will lead to community concerns, requiring careful and consistent messaging;
- Wards Well's status (in the exploration phase, with no production expected in the short to medium term) may make it difficult for stakeholders to understand impacts and opportunities relating to rehabilitation. The iterative nature of PRC plans will need to be emphasised, e.g. this PRC plan is for the currently approved activities, and EA amendment would be required to undertake further exploration, construction and operational works, which will require PRC plan amendments for these works and associated infrastructure;
- PRC plan consultations by a range of companies for a variety of assets will represent considerable cumulative demands on stakeholders, and a coordinated, strategic approach will be required to manage consultation fatigue; and
- community members are becoming increasingly aware of climate change and the impacts of resource activities and energy policies on the environment, so community and stakeholder expectations with regards to mine rehabilitation need to be understood.

Information to be released for community consultation will include:

- the rationale and scope for PRC planning;
- the approved activities and PMLUs for Wards Well;
- on-site activities to date;
- the extent of approved mining leases for Wards Well;
- the scope of the Wards Well PRC exploration plan and mining plan (when available);
- areas of disturbance e.g. indicative exploration plan and box cut location under the current ML;
- proposed rehabilitation methods, schedule and milestones;
- the proposed rehabilitation schedule and activities at Wards Well;
- requirements for EA amendments and accompanying PRC plan revision; and
- opportunities for stakeholder engagement in engagement as part of the PRC plan's implementation.

Communication tools will include:

- a holding statement for general enquiries;
- frequently asked questions and answers (FAQs) and a PRC planning fact sheet available to support engagement activities;
- face to face and virtual meetings; and
- updates and fact sheets about PRC planning for BHP assets through Community Connect, Coal Connect and C-RES.

5. How stakeholder feedback will be considered

As noted in the *Guideline – PRC plans*, in addition to the annual return requirements that relate to EAs, if a PRCP schedule applies for the activities, the annual return must also include an evaluation of the effectiveness of the PRCP schedule, including the environmental management carried out under the schedule, for the year to which the annual return relates.

BHP will monitor the progress and outcomes of progressive rehabilitation activities and report on progress against milestones to demonstrate how successful rehabilitation has been in achieving progress towards the rehabilitation milestones and approved PMLU, and to inform corrective action where required, which will be reported a part of annual returns.

Information about rehabilitation progress will be delivered as part of the consultation methods detailed in Table 4, and any feedback will be considered in PRC plan implementation and updates.

The PRC Plan Consultation Register will be updated as community consultation activities outlined in Table 4 are completed. All stakeholder feedback recorded in the Consultation Register will be considered in framing and detailing future PRC plan amendments for Wards Well. This may include feedback on e.g.:

- flora species selection;
- rehabilitation methods to protect cultural heritage and achieve optimal use for grazing;
- disturbance to areas of specific sensitivity or value;
- the rehabilitation schedule;
- water management e.g. availability for beneficial use; and/or
- development of business capacity programs to equip local and Indigenous businesses for rehabilitation works.

BHP has sought Isaac Regional Council's views on consultation options to involve Council in future PRC plan consultation for both Wards Well EA amendments and other BHP assets, and will utilise Council's preferred options to seek inputs on e.g. rehabilitation outcomes and business capability program development.

BHP will also consider any community submissions made as part of the future EA amendment process in finalising the PRC plan for further exploration.

6. PRC Plan consultation plan review

Review of the PRC plan will be undertaken as part of the annual rehabilitation auditing process and in response to community feedback. This will include monitoring progress towards the desired outcomes for consultation.

The first transitional PRC plan for Wards Well is likely to be superceded by a PRC plan amendment to support an EA amendment for further exploration and drilling. Consultation will be undertaken with affected stakeholders as outlined in Table 4, and the results of this consultation considered in revising and updating the PRC plan to accompany the EA amendment application.

Terms of reference for an EIS to enable future mining development for Wards Well are required to be developed by September 2023. The Terms of Reference will refer to the PRC plan and requirements for its development. If BHP decides to develop Wards Well as a coal mine, a comprehensive and inclusive community and stakeholder engagement process will be undertaken as part of the EIS. This will include a specific focus on progressive rehabilitation and closure planning to enable stakeholders to inform the PRC plan to be prepared for mine operations.

Wards Well PRC Plan Community Consultation Register

STAKEHOLDER DETAILS				PRC PLAN DEVELOPMENT ENGAGEMENT			ENGAGEMENT OUTCOMES			
Stakeholder Group	***Stakeholder Title***	***Property/ Organisation***	***Previous engagement***	***Consultation type***	***Consultation date***	***Information provided***	***Issues raised/discussed***	***How issues were considered***	***Decisions/outcomes of engagement***	***BHP commitments***
Affected landholders	Owner	Lenton Downs	Land within the WWP MLs was acquired in 2007. Further acquisition of land under compensation agreements was undertaken in 2011-2012. Engagement with the affected landowners was undertaken to develop compensation, leasing and agistment agreements. BHP engages with landholders regularly on lease and land use issues.	Letter, via email	19/01/21	PRC plan requirements Wards Well status Activities approved under Wards Well EA Location in relation to landholdings (map) Disturbance area (Map) Rehabilitation requirements and key steps Approved PMLUs Divestment review process for BMC assets Requirement to seek EA amendment to undertake further exploration activities and mining, involving stakeholder consultation	No feedback or enquiries were received. BHP's regular engagements with landowners indicate that their issues of interest include land access under current land access and lease agreements, the Denham Park lease, and access to BHP land for grazing use whilst is not required for mining.	Stakeholder did not raise any issues. Landowners' interest in use of the land for grazing was considered in framing PMLUs.	Land within the MLs will continue to be available for grazing under existing agreements between BHP and landholders. Landholders and cattle will be excluded from affected areas whilst land disturbance for exploration (and in the future potentially for mining) is occurring. As disturbed land becomes available, it will be rehabilitated to a state suitable for grazing.	BHP will advise affected landholders when it applies for an EA amendment for WW, provide information on the scope and location of the activities for which the amendment is sought, and seek landholders' input on the rehabilitation schedule and proposed PMLUs to be included in the PRC plan/amendment accompanying the EA amendment application.
	Owner	Lancewood Also lessee for Denham Park	As above	Letter, via email	19/01/21	As above	As above.	As above.	As above	As above
	Lessee	Dabin/Boomerang Pastoral Epsom Pastoral	As above	Letter, via email	19/01/21	As above	As above	As above.	As above	As above
Adjacent landholders	Owner	Bilyana Holding	BHP engages with adjacent landholders on an as-needed basis e.g. seeking interest in use of BHP-owned land and water issues (TBC)	Letter, via email	19/01/21	As above	As above.	As above.	As above	BHP will advise adjacent landholders when it applies for an EA amendment for WW, and provide information and consultation opportunities as for affected landholders.
	Geology & Resources Administration Support Manager	Peabody Energy Australia	Liaison regarding land access and road use BHP is involved in a partnership project between University of Queensland, International Council for Mining and Metals (ICMM), Anglo American and Peabody. The project aims to establish an understanding committed and future potential post-mining land outcomes, long-term community priorities, projects and planning constraints and opportunities surrounding the Moranbah township, and investigate collaborative opportunities for beneficial use of post-closure mine assets surrounding the Moranbah township.	Letter, via email	19/01/21	As above	No feedback or enquiries were received.	Stakeholder did not raise any issues.	The Community Consultation Plan (CCP) provided with the WW PRC plan addresses future engagement with Peabody Energy Australia.	BHP will advise Peabody Energy Australia of the schedule for preparation of further PRC plan iterations when this is known.
Tenement holders within ML	Manager Tenure	Anglo American plc	Commercial discussions regarding land tenure As above, BHP and Anglo American are working together as part of partnership to understand .committed and future potential post-mining land outcomes, community priorities, planning constraints and opportunities, and the potential for collaborative opportunities for beneficial use of post-closure mine assets surrounding the Moranbah township.	Letter, via email	19/01/21	As above	No feedback or enquiries were received.	Stakeholder did not raise any issues.	The CCP provided with the WW PRC plan addresses future engagement with Anglo American plc.	BHP will consult with Anglo American regarding their interests in land within the WW MLs as part of preparing its development plan for further exploration.
	Manager Overlapping Tenure	Arrow Energy Holdings Pty. Ltd.	Commercial discussions regarding land tenure	Letter, via email	19/01/21	As above	No feedback or enquiries were received.	Stakeholder did not raise any issues.	The CCP provided with the WW PRC plan addresses future engagement with Arrow Energy Holdings.	BHP will consult with Arrow Energy Holdings regarding their interests in land within the WW MLs as part of preparing its development plan for further exploration.
Utility owners within ML	District Director, Mackay Whitsunday District	DTMR	Correspondence regarding Infrastructure Plan required prior to any work on the ML.	Letter, via email	19/01/21	As above	No feedback or enquiries were received.	Stakeholder did not raise any issues.	DTMR require an infrastructure plan prior to any work on the ML which has been identified in the PRC Plan CCP.	BHP will work with DTMR to develop an Infrastructure Plan and update/develop a crossing agreement with terms and conditions tailored to the planned exploration/ mining activity as part of a future EA amendment application process.
	Property Projects Coordinator	Powerlink	Correspondence, issue-specific	Letter, via email	19/01/21	As above	No feedback or enquiries were received.	Stakeholder did not raise any issues.	The Community Consultation Plan provided with the WW PRC plan addresses future engagement with Powerlink.	BHP will work with Powerlink to develop/ update a crossing agreement if required, with terms and conditions tailored to the planned exploration/ mining activity as part of a future EA amendment application process.
	Commercial Advisor	Sunwater	Correspondence, issue-specific	Letter, via email	19/01/21	As above	No feedback or enquiries were received.	Stakeholder did not raise any issues.	The Community Consultation Plan provided with the WW PRC plan addresses future engagement with Sunwater.	BHP will work with Sunwater to develop/ update a crossing agreement if required, with terms and conditions tailored to the planned exploration/ mining activity as part of a future EA amendment application process.
	Senior Advisor Community Engagement	Aurizon	Correspondence, issue-specific	Letter, via email	19/01/21	As above	No feedback or enquiries were received.	Stakeholder did not raise any issues.	The CCP provided with the WW PRC plan addresses future engagement with Aurizon.	BHP will work with Aurizon to develop/ update a crossing agreement if required, with terms and conditions tailored to the planned exploration/ mining activity as part of a future EA amendment application process.
Traditional owners within ML	Legal Representative	Widi People Of The Nebo Estate #1	Consultation regarding South Walker Mine clearing and cooperation between Widi People and BHP.	Letter, via email	5-Feb-21	PRC plan requirements Wards Well MLs and proposed disturbance footprint in relation to native title areas (maps) Status of Wards Well Activities approved under Wards Well EA Rehabilitation requirements and key steps Approved PMLUs Divestment review process for BMC assets Requirement to seek EA amendment to undertake further exploration activities and mining, involving stakeholder consultation	No feedback or enquiries were received. BHP's regular engagements with Traditional Owners indicate interest in the protection of environmental values associated with land to be mined.	Stakeholder did not raise any issues. BHP is considering the potential for involvement of Indigenous businesses in future mine rehabilitation works.	Traditional owners interest in environmental management is addressed in the PRC Plan Community Consultation Plan.	BHP will notify Widi People when it is seeking an EA amendment for further exploration and meet with Widi People to provide an update on WW and proposed disturbance areas/activities for which the EA amendment is sought. This will include consultation on rehabilitation species, methods and timeframes. BHP's Indigenous business specialist will work with Traditional Owners and Indigenous businesses to understand capabilities and the pipeline of opportunities which relate to rehabilitation work and land management, and plan for capability development to match rehabilitation opportunities if this is required.
Traditional owners east of ML	Jangga Operations	Jangga People	Nil to date - no BHP assets within Jangga People's country	Letter, via email	8-Feb-21	As above	As above.	Stakeholder did not raise any issues. BHP is considering the potential for involvement of Indigenous businesses in future mine rehabilitation works.	N/A	Should BHP propose to seek an MDL / EA within EPCs that overlap or are near Jangga People's country, BHP will notify Jangga People, initiate cultural heritage management protocols, meet with Jangga People to provide an update on WW and proposed disturbance areas/activities for which the ML/EA amendment is sought, and encourage their involvement in the EA notification process. BHP's Indigenous Business Specialist will work with Jangga businesses to understand capabilities and the pipeline of opportunities which relate to rehabilitation work and land management, and plan for capability development to match rehabilitation opportunities if this is required.
Local Government	Mayor	Isaac Regional Council	Bi-annual meetings with Council	Letter, via email	Meeting - 3/12/2020 Letter - 18/12/20	BHP's approach to progressive rehabilitation and closure (PRC) planning Legislative requirements for closure planning Wards Well Project update BHP's PRC planning pipeline Council engagement in BHP's PRC planning Wards Well PRC consultation – preliminary timeframe IRC's strategic analysis and planning for Isaac LGA and Wards Well project area as relevant	Council engagement in PRC planning for BHP assets Cumulative consultation demands of PRC planning with various companies and multiple assets for some companies such as BHP Council is considering its options for engaging with companies preparing PRC plans and will take a strategic approach, with seamless consultation as the goal. Council will develop readiness of Council planning documents, with the corporate planning process re-commencing in Q1 2021. Both Isaac LGA plans and Mackay-Isaac Whitsunday regional plans may be relevant. The visions developed by the Moranbah and Dysart STACs in relation to those two towns will also be relevant. Key principal is cooperation to get the best outcome for communities, industry and Council. Interest in rehabilitation noted. No specific comments on PMLUs or rehabilitation plans. Executive Assistant to Mayor and CEO nominated as key contact for coordination of IRC-BHP engagement on PRC planning	BHP recognises the cumulative demands for Council involvement in PRC Plan engagement. Future engagement processes for BHP's PRC plans will include a strategic approach to consultation with Council, to minimise demands on Council's time and maximise the value derived from consultation with Council.	The CCP program will consider Council's preferred options for engagement as part of subsequent reviews of the CCP. Future engagement with Council will include discussion of rehabilitation methods and milestones.	BHP will engage with IRC to understand Council's strategic analysis and planning for Isaac LGA and the Wards Well project area as relevant. BHP will share the results of its research and industry partnership projects relevant to rehabilitation with Council at bi-annual meetings between Council and BHP. BHP will work with Council and other stakeholders in future PRC plan consultations to identify and implement social value opportunities.
	Division 1 Councillor	Isaac Regional Council	As above.	Meeting and provision of presentation, letter via email	Meeting - 3/12/2020 Letter - 18/12/20					
	Division 2 Councillor (Dysart)	Isaac Regional Council	As above.	Meeting and provision of presentation, letter via email	Meeting - 3/12/2020 Letter - 18/12/20					
	Division 3 Councillor (Moranbah)	Isaac Regional Council	As above.	Meeting invitation, letter via email and presentation provided	Meeting - 3/12/2020 Letter - 18/12/20					
	Division 4 Councillor (Moranbah)	Isaac Regional Council	As above.	Meeting and provision of presentation, letter via email	Meeting - 3/12/2020 Letter - 18/12/20					
	Deputy Mayor/Division 5 Councillor	Isaac Regional Council	As above.	Meeting invitation, letter via email and presentation provided	Meeting - 3/12/2020 Letter - 18/12/20					
	Division 6 Councillor		As above.	Meeting and provision of presentation, letter via email	Meeting - 3/12/2020 Letter - 18/12/20					
	Division 7 Councillor	Isaac Regional Council	As above.	Meeting and provision of presentation, letter via email	Meeting - 3/12/2020 Letter - 18/12/20					
	Division 8 Councillor	Isaac Regional Council	As above.	Meeting and provision of presentation, letter via email	Meeting - 3/12/2020 Letter - 18/12/20					
	CEO	Isaac Regional Council	As above.	Meeting and provision of presentation, letter via email	Meeting - 3/12/2020 Letter - 18/12/20					
	Galilee Basin and Bowen Basin Project Manager	Isaac Regional Council	As above.	Meeting and provision of presentation, letter via email	Meeting - 3/12/2020 Letter - 18/12/20					
	Director Engineering and Infrastructure	Isaac Regional Council	As above.	Meeting and provision of presentation, letter via email	Meeting - 3/12/2020 Letter - 18/12/20					
	Exec. Assistant to Mayor and CEO	Isaac Regional Council	As above.	Meeting and provision of presentation, letter via email	Meeting - 3/12/2020 Letter - 18/12/20					
	Director Planning, Environmental and Community Services	Isaac Regional Council	As above.	Meeting and provision of presentation, letter via email	Meeting - 3/12/2020 Letter - 18/12/20					
State Government	Manager, Environmental Services & Regulation Manager, Environmental Services Coal and Central Queensland Compliance	DES	Meetings and correspondence to identify and agree rehabilitation criteria and PMLU as part of EA application process	Pre-lodgement meeting	44218	Provision of draft PRC Plan and discussion of requirements	All issues noted and minuted.	DES feedback was considered in the development of the PRC Plan including the Community Consultation Plan	As noted and minuted.	BHP will comply with the legislative and regulatory requirements for PRC Plans.
	Director Coal Hub, Rockhampton	Department of Resources (formerly DNRME)	Meetings on an as-needed basis	Letter, via email	18/12/2020	Acknowledgement of letter, request to keep the Department informed.	No feedback or enquiries were received.	The PRC Plan's Community Consultation Plan includes provision of annual updates to Department of Resources	N/A	BHP will provide annual updates on PRC planning to the Director Coal Hub, Rockhampton.
	Deputy Director-General Georesources	Department of Resources (formerly DNRME)	Briefings on an as needed basis. Meeting and correspondence regarding resource development commitments	Letter via email	18/12/2020	As above	No feedback or enquiries were received.	The PRC Plan's Community Consultation Plan includes provision of annual updates to Department of Resources	N/A	BHP will provide annual updates on PRC planning to the Deputy Director General.
Federal Government	Assistant Secretary Assessments and Governance Branch	DAWE	Monthly meetings with Director and team, additional meetings as required	Meeting	2/02/2021	No issues raised in relation to PRC plans in regular briefings to date.	No feedback or enquiries were received. DAWE does not require regular updates on the WW PRC Plan.	Stakeholder did not raise any issues.	N/A	BHP will provide updates on PRC planning for future assets to the Secretary's office.
Community Groups	President	Moranbah Traders Association, Manager, Moranbah Community Workers Club, Member, Moranbah Smart Transformations Advisory Committee (STAC)	Moranbah STAC meetings	Letter, via email	24/12/2020	BHP's portfolio in the Bowen Basin New requirements for mine rehabilitation MERFP Act requirements Transition notice for BMC's Wards Well Project issued BHP's environmental management approach - progressive rehabilitation Wards Well overview Divestment options review Contacts for further information	No feedback or enquiries were received.	Stakeholder did not raise any issues.	N/A	BHP will provide regular community updates on PRC planning and seek the involvement of community members and groups in understanding community aspirations for rehabilitation, post mining land use and economic transformation.
	Principal	Moranbah State School, Member Moranbah STAC	Moranbah STAC meetings	Letter, via email	24/12/2020	As above	No feedback or enquiries were received.	Stakeholder did not raise any issues.	N/A	As above
	Local business owner and Board member C-Res	C-Res, Member Moranbah STAC	Moranbah STAC meetings	Letter, via email	24/12/2020	As above	No feedback or enquiries were received.	Stakeholder did not raise any issues.	N/A	BHP will involve businesses in identifying social value as part of the PRC planning process. This will include identifying local capacity for involvement in rehabilitation work. BHP will also participate in initiatives led by the business community which aim to harness social value from mine closure and rehabilitation planning, and/or work towards from economic transformation.
	C-Res Coordinator	C-Res, Member Moranbah STAC	Moranbah STAC meetings	Letter, via email	24/12/2020	As above	No feedback or enquiries were received.	Stakeholder did not raise any issues.	N/A	As above
	Local business owner	Member, Moranbah STAC	Moranbah STAC meetings	Letter, via email	24/12/2020	As above	No feedback or enquiries were received.	Stakeholder did not raise any issues.	N/A	As above
	Coordinator	4RFM Community Radio, Member Moranbah STAC	Moranbah STAC meetings	Letter, via email	24/12/2020	As above	No feedback or enquiries were received.	Stakeholder did not raise any issues.	N/A	BHP will liaise with 4RFM to provide community updates on closure planning and consultation opportunities.
	DON Moranbah Hospital	Queensland Health, Member Moranbah STAC	Moranbah STAC meetings	Letter, via email	24/12/2020	As above	No feedback or enquiries were received.	Stakeholder did not raise any issues.	N/A	BHP will provide regular community updates on PRC planning and seek the involvement of community members and groups in understanding community aspirations for rehabilitation, post mining land use and economic transformation.
	Goonyella Riverside Mine GM, Member	BHP, Member, Moranbah STAC	Moranbah STAC meetings	Letter, via email	24/12/2020	As above	No feedback or enquiries were received.	Stakeholder did not raise any issues.	N/A	BHP will involve its internal stakeholders in PRC planning processes to build capacity for community engagement on perc planning issues.

APPENDIX 7- NOT USED

APPENDIX 8
BHP (10 FEBRUARY 2021): PRELIMINARY SITE INVESTIGATION WARDS WELL MINE

BHP

Preliminary Site Investigation
Wards Well Mine

10 February 2021

Contents

Appendices

Preliminary Site Investigation – Wards Well

1 Introduction

This Preliminary Site Investigation (PSI) has been prepared to inform the development of the transitional Progressive Rehabilitation and Closure Plan (PRC Plan) for the Wards Well mine. The Wards Well mining leases at the time of this investigation were operated under the Environmental Authority (EA) number: EPPR00668513 (date effective 25 January 2018).

The mining leases, which form the boundary of this investigation, are summarised in Table 1 below.

Table 1: Wards Well Mining Leases

Mining Lease	Name
ML4752	Lancewood
ML1790	Wards Well
ML70443	Wards Well East
ML70495	Wards Well Southeast

The Wards Well mine is located within the northern region of the Bowen Basin approximately 30 kilometres (km) south of Glenden and approximately 150 km southwest of Mackay in Central Queensland. It is located immediately to the north of the existing North Goonyella Mine and approximately 45km to the north of Moranbah. The Suttor Development Road runs east-west through the Project area and is located on the northern boundary of ML1790 and southern boundary of ML4752.

Extractive mining operations had not commenced at the time of this investigation. Exploration drilling activities had occurred within the investigation area since the 1970s.

1.1 Objective

The objective of the investigation was to inform the development of the transitional PRC Plan through the identification of baseline potential contamination risks to the proposed post mining land use.

1.2 Trigger Status

This investigation has been undertaken voluntarily as part of the development of the transitional PRC Plan for the BHP mine. The investigation was not subject to an administering authority 'show cause' notice at the time of investigation.

1.3 Assessment of Site Contamination NEPM

This site investigation has been undertaken with reference to the EP Act (1994) and the National Environment Protection Measure (Assessment of Site Contamination) Measure (ASC NEPM), noting the objective of the investigation in relation to informing the PRC Plan development and that this investigation was limited to the area covered by the mining lease and not the legal property boundaries.

The relevant sections of the following schedules from the ASC NEPM were utilised and followed as part of this investigation.

- Schedule A – Recommended General Process for the Assessment of Site Contamination.
- Schedule B1 – Guideline on Investigation Levels for Soil and Groundwater.
- Schedule B2 – Guideline on Site Characterisation (applicable sections as listed below).

- 2.0 Stages of investigation
- 2.1 Preliminary site investigation
- 3.0 Preliminary investigations
- 3.1 Site identification
- 3.2 Current and proposed use
- 3.3 Site history
- 3.4 Environmental setting
- 3.5 Local geology and hydrogeology
- 3.6 Site inspection
- 4.0 Conceptual site models
- 14.0 Report presentation

2 Scope of Work

This report consists of a PSI that has been prepared with reference to the following:

- National Environment Protection Council (1999) National Environment Protection (Assessment of Site Contamination) Measure (rev: 2013) (ASC NEPM).
- Queensland Government (1994) Environmental Protection Act.
- Standards Australia (AS4482.1:2005) Guide to the Investigation and Sampling of Sites with Potentially Contaminated Soil.
- Queensland Government (2019) Queensland Auditor Handbook for Contaminated Land – Module 6: Content requirements for contaminated land investigations documents, certifications and audit reports.

In accordance with the ASC NEPM, the PSI was primarily undertaken to identify:

- Potential sources of contamination and determine potential contaminants of concern;
- Areas of potential contamination;
- Potential human and ecological receptors; and
- Potentially affected media (soil, sediment, groundwater, surface water).

To achieve the above, the following scope of work was undertaken.

- Records review including review of the following where it was publicly available or held by BHP:
  - historical aerial photographs;
  - current and historical title records;
  - site layout plans and previous investigation reports and other data;
  - licences and notices;
  - council overlay maps;
  - flood maps;
  - unexploded ordnance maps;
  - service plans (“dial before you dig” search);
  - State groundwater database;
  - Environmental Management Register (EMR) and Contaminated Land Register (CLR);

- ecological databases identifying potently sensitive receptors such as ecosystems, wetlands, vegetation types and species;
- environmental values and water quality objectives for the area in which the investigation area is located; and
- publicly available topographic, geological and hydrogeological maps.

- Inspection of the investigation area to assess for potential visible evidence of contamination, any activities or process that may result in contamination of the investigation area, surrounding land uses that have a potential for contamination of the investigation area and to validate where practical the information obtained from the records review.
- Development of a contaminated land Conceptual Site Model.

3 Site Context

3.1 Site Identification

The Wards Well mine area covered by this investigation is shown in Figure 1.

Table 2 summarises the mining leases and legal properties covered by this investigation.

Table 2: Mining Leases and Legal Properties

Mining Lease	ML4752		ML1790		ML70443		ML70495
Lease Name	Lancewood		Wards Well		Wards Well East		Wards Well Southeast
Latitude	21°29’31.74”S		21°34’16.61”S		21°32’40.38”S		21°35’49.20”S
Longitude	147°55’38.78”E		147°56’36.13”E		147°57’48.71”E		147°58’41.30”E
Permit Status	Granted		Granted		Granted		Granted
Grant Date	1978		1978		2017		2017
ML Holder	BHP Billiton Mitsui Coal Pty Ltd		BHP Billiton Mitsui Coal Pty Ltd		BHP Billiton Mitsui Coal Pty Ltd		BHP Billiton Mitsui Coal Pty Ltd
Area (ha)	2363		4392		867.6		489.6
Legal Properties	Lot 2 on SP256592	Lot 8 on GV807254	Lot 2 on SP214117	Lot 11 on SP262530	Lot 8 on GV807254	Lot 2 on SP214117	Lot 2 on SP214117
Property Ownership Type	Freehold	Land Lease	Land Lease	Freehold	Land Lease	Land Lease	Land Lease
Property Current Registered Owner	B.J. and J.M. Pini	V.A. and M.E. Mason	BHP Billiton Mitsui Coal Pty Ltd	BHP Billiton Mitsui Coal Pty Ltd	V.A. and M.E. Mason	BHP Billiton Mitsui Coal Pty Ltd	BHP Billiton Mitsui Coal Pty Ltd

Figure 1 illustrates the Wards Well Project mining leases and **Appendix A** contains survey plans for each of the legal properties intersected by the mining leases.

3.2 Local Government Authority and Zoning

The investigation area is located within the local government area of the Isaac Regional Council. The council, at the time of preparation of this report, was in the process of developing a new planning scheme for the region. Under the Draft Isaac Regional Council Planning Scheme Zoning Rural Areas, the area in which the site is located is proposed to be zoned as “Rural”. It should be noted, the Planning Act does not apply to development in mining tenements authorised under the Mineral Resources Act 1989, other than for administrating Integrated Development Assessment System (IDAS) for the Heritage Act, in relation to a Queensland heritage place.

A review of the Isaac Regional Council overlay maps covering the area of the investigation did not identify the following within the investigation area.

- Flood hazards;
- Heritage Areas;
- High ecological value waters or water resource catchments; and
- Acid sulfate soils.

Copies of the council overlays are contained in **Appendix J**.

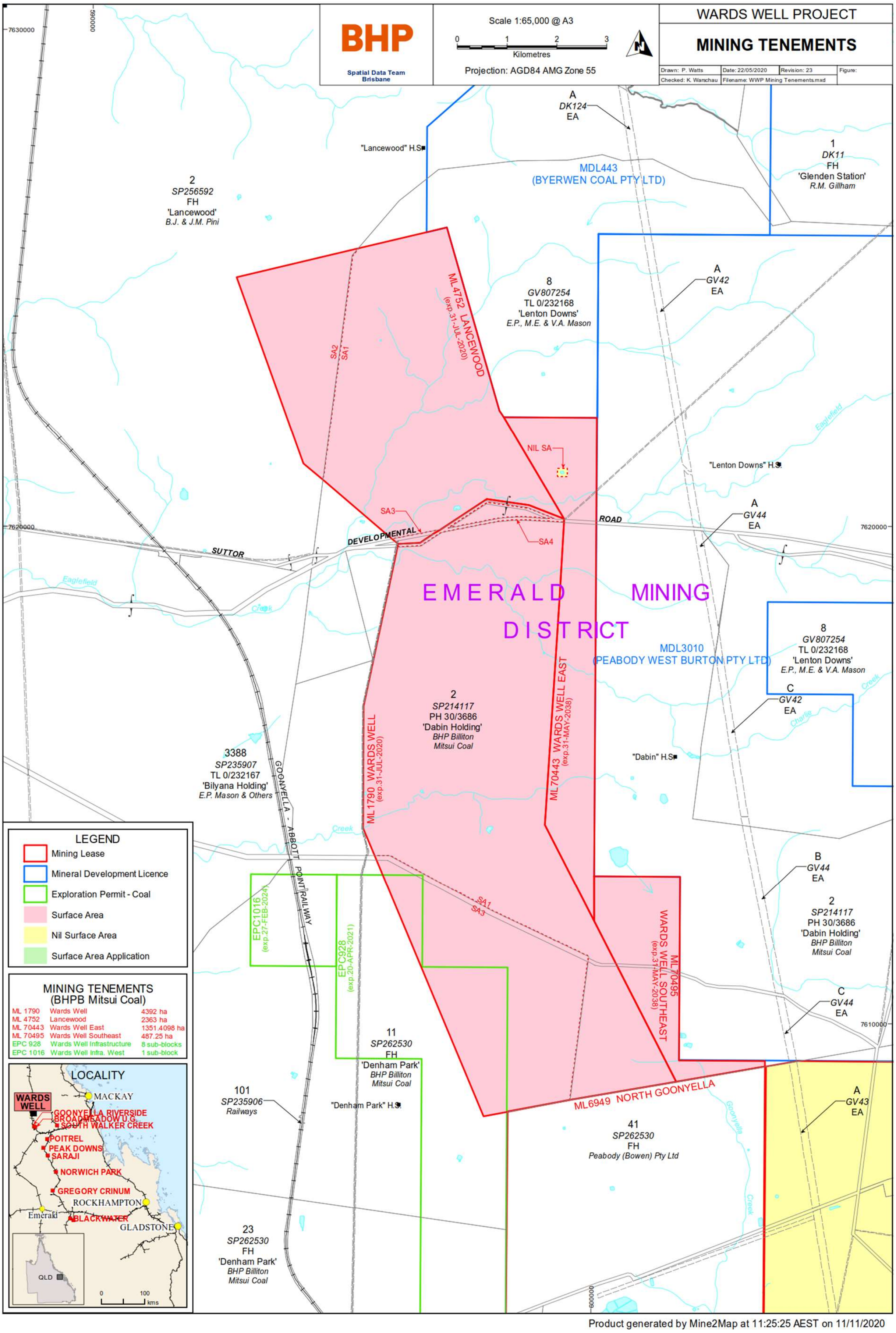


Figure 1: Wards Well Mining Tenements

3.3 Site Infrastructure

The investigation area has been subject to agricultural (grazing) and exploration activities. No commercial extraction of coal had occurred prior to this investigation. Therefore, infrastructure on site was limited to:

- Suttor Development Road (public road);
- Groundwater extraction bores for stock watering and associated water pumping infrastructure;
- Access tracks and roads;
- Fences; and
- Agricultural small water storage dams, tanks and troughs.

No homesteads, septic systems, workshops, chemical storage, cattle dips, farm dumps or other infrastructure, considered to present a significant risk of contamination, was observed within the mining leases that formed the investigation area. It should be noted that these activities were observed surrounding the investigation area generally in the proximity of the homesteads.

A dial before you dig search for the investigation area was undertaken to assess for potential services and other in-ground infrastructure that has the potential to cause contamination. The dial before you dig search results identified a Sunwater water pipeline that runs along the western boundary of ML1790 and through the investigation area along the alignment of the Suttor Development Road. The Isaac Regional Council and Ergon Energy dial before you dig searches did not identify any assets within the searched area. A copy of the dial before you dig search results are contained in **Appendix K**.

3.4 Queensland Contaminated Land Registers

A search of the Environmental Management Register (EMR) and the Contaminated Land Register (CLR) was undertaken on 6 January 2021. The search responses are contained in **Appendix B**. The results of the contaminated land searches are summarised in Table 3.

Table 3: Contaminated Land Register Search Results

Property	EMR	CLR	Comments
Lot 2 SP256592	Not Listed	Not Listed	Property includes the Lancewood Homestead site and other associated infrastructure areas to the north of the investigation area.
Lot 2 SP214117	Not Listed	Not Listed	Property includes the Dabin Homestead site to the east of the investigation area.
Lot 8 GV807254	Listed on the EMR for Livestock Dip or Spray Race.	Not Listed	Cattle dip is believed to be located within the proximity of the Lenton Downs Homestead approximately 3.6km to the east of ML70443.
Lot 11 SP262530	Not Listed	Not Listed	Property includes the Denham Park Homestead site to the west of the investigation area.

4 Site History

4.1 Summary of Previous Investigations

Preliminary Approval Studies

In 2012 studies were commenced to support future approvals for development at Wards Well, however the project was placed on hold and the studies were not completed. A summary of these preliminary assessments is provided below for background information only.

Groundwater

The findings of the preliminary hydrogeology assessment included the following:

- During 2011 the static water level on site ranged from 7.5 to 41.4m below ground level (296.6 to 314.9 mRL). The potentiometric groundwater surface is generally a subdued reflection of the surface topography and indicates a general groundwater flow direction to the west. The hydraulic gradient ranged from 1 in 250 to 1 in 400.
- An assessment of the "environmental value" of groundwater for the Project area in 2012, included:
  - Aquatic Ecosystems - There were no known permanent surface water bodies that are reliant on groundwater flows, present within the mining lease. All of the creeks that flow through the Project area were ephemeral systems that were not fed by a permanent discharge from underlying aquifers.
  - The depth to the saturated zone was between 10m and 40 m below surface and was considered unlikely that vegetation was dependent on this deep groundwater.
  - Recreational Use -This category of environmental value was not considered relevant to the groundwater regime of the area.
  - Drinking Water - The groundwater was rarely suitable for human consumption, and there was no known reliance on groundwater for drinking water in the area.
  - Agricultural Use - The groundwater was generally suitable for stock and this was the most common use of groundwater in the region surrounding the Project.
  - Industrial Use - There were no industrial users of groundwater within the Project area.
- The coal seam permeability values at Wards Well ranged from 1×10^{-3} m/day to 1×10^{-6} m/day, with values in the range of 2×10^{-5} m/day, 4×10^{-4} m/day the most common. These permeability values were considered relatively low in comparison to typical coal seam permeability values for the Bowen Basin.
- The primary environmental value of the groundwater from the aquifers within the Project area was deemed to be for agricultural use only. Available groundwater results were compared to ANZECC (2000) Guidelines for livestock watering and all the results were within the stock watering investigation levels.
- The Wards Well Project is partially located within the Isaac River sub-basin, which is contained within the Fitzroy Basin. However, due to insufficient data points close to the Project area, a specific chemistry zone has not been established for the area of interest.

Geochemical

The findings of the preliminary hydrogeology assessment included the following:

Potential coal rejects

- Potential coal rejects, whether from ROM coal from GM0 seam or from coal seam spoil/rejects encountered during construction of the access portals, were expected to generate highly alkaline, low-salinity run-off/seepage following surface exposure.
- The total sulfur concentration of all samples was generally very low (75th percentile = 0.07%; 90th percentile= 0.13%), however some samples contained low sulfide concentrations that could potentially generate weak acidity.

- Selected samples were classified as potentially acid forming (PAF), with a 'Low Capacity' to generate significant acid, however most samples, and therefore the bulk material, was expected to be non-acid forming (NAF). 'PAF' rejects are conservatively expected to comprise less than 10% of all reject material.
- Total metal and metalloid concentrations in potential coal reject samples were low – below the applied health-based investigation levels for soils. One potential coal reject sample exceeded the applied 'background' concentration for manganese.
- The multi-element results indicate that some potential coal reject materials may produce leachate containing elevated concentrations of some soluble elements (mainly molybdenum and selenium).

Access portal spoil

- Spoil from access portals was expected to generate highly alkaline, low-salinity run-off/seepage following surface exposure.
- The total sulfur and sulfide concentration of all spoil samples assessed was very low, and all samples assessed were classified as NAF.
- Total metal and metalloid concentrations in spoil samples were low – below the applied health-based investigation levels for soils. Some spoil samples had concentrations of manganese, cobalt and zinc that exceeded the applied 'background' level for these metals.
- The multi-element results indicate that some spoil materials may produce leachate containing elevated concentrations of some soluble elements (mainly molybdenum and occasionally selenium).

Coal

- Coal mined from the Project (ROM coal) is expected to generate pH-neutral to mildly alkaline, low-salinity run-off/seepage following surface exposure.
- The total sulfur concentration of the samples tested was low (less than 0.5%) and one coal sample contained low concentrations of sulfide sulfur – sufficient to classify this single sample as PAF-Low Capacity.
- All except one sample was classified as NAF, therefore the bulk coal material is expected to be NAF. The acid forming nature of the single PAF-Low Capacity sample is currently uncertain, but ROM coal would not be expected to generate significant acidity due to low sulfide concentrations.
- Total metal and metalloid concentrations in coal samples were low – below the applied health-based investigation levels for soils.
- The multi-element results indicate that coal materials, overall, are not expected to produce leachate containing soluble elements in significant concentrations.

Routine Groundwater Monitoring Results

Groundwater monitoring has been undertaken by BHP within the investigation area since 2011. A summary of the monitoring wells is contained in Table 4 and the location of the monitoring wells are shown on Figure 2.

Table 4: Summary of BHP Wards Well Monitoring Wells

Bore ID	Installation Type	Easting	Northing	Surface Elevation (m AHD)	Screen Top Elevation (m AHD)	Screen Base Elevation (m AHD)	Screened Geology
MB03	Open Standpipe	597925	7621997	317.4	267.7	255.7	Basalt
MB03A	Open Standpipe	598676	7621619	324.2	188.2	176.2	Basalt
MB04	Open Standpipe	598774	7621734	325.8	186.8	177.8	Basalt
MB05R	Open Standpipe	596747	7619460	303.3	170.3	164.3	Basalt
MB06	Open Standpipe	597605	7615403	314.6	235.1	229.1	Basalt (weathered)
MB07	Open Standpipe	596666	7613468	311.9	248.9	242.9	Basalt
MB08	Open Standpipe	599625	7611359	335.9	267.9	264.9	Basalt
MB09	Open Standpipe	597636	7609407	323.3	274.3	271.3	Basalt
MB10	Open Standpipe	600074	7620778	320.7	218.7	203.7	Basalt
MB11	Open Standpipe	599910	7620190	319.7	204.7	198.7	Basalt
MB12	Open Standpipe	599965	7616688	322.4	291.4	288.4	Basalt
MB13	Open Standpipe	598576	7621731	325.7	198.7	180.7	Basalt (weathered)
MB14	Open Standpipe	598109	7622195	317.4	247.4	235.4	Basalt
MB15	Open Standpipe	596584	7619218	303.3	173.3	164.3	Basalt
MB16	Open Standpipe	596421	7619394	303.3	185.3	173.3	Basalt
MB17R	Open Standpipe	596622	7613320	312.7	247.7	244.7	Basalt
MB18R	Open Standpipe	596791	7613519	312.7	222.7	216.7	Tertiary Sediments (Sand)
MB18R2	Open Standpipe	596807	7613530	312.7	234.7	228.7	Basalt (weathered)
PB01	Pumping Bore	598598	7621734	325.8	225.2	187.1	Basalt
PB02	Pumping Bore	596751	7619460	303	187.6	157.6	Basalt (weathered)
PB03	Pumping Bore	596679	7613457	311.9	236.7	230.7	Tertiary Sediments
VWP01_S1	Vibrating Wire Piezometer	598583	7621733	325.8	-9.2	-9.2	Overburden
VWP01_S2					-30.2	-30.2	Goonyella
P01_S3					-142.2	-142.2	Goonyella
VWP01_S4					-208.2	-208.2	Goonyella
VWP02_S1	Vibrating Wire Piezometer	596657	7619458	303	103	103	Overburden
VWP02_S2					90	90	Goonyella
VWP02_S3					73	73	Interburden
VWP02_S4					57.5	57.5	Goonyella
VWP03_S1	Vibrating Wire Piezometer	596669	7613458	311.84	146.84	146.84	Interburden
VWP03_S2					105.84	105.84	Goonyella
VWP03_S3					79.84	79.84	Goonyella
VWP03_S4					47.84	47.84	Goonyella

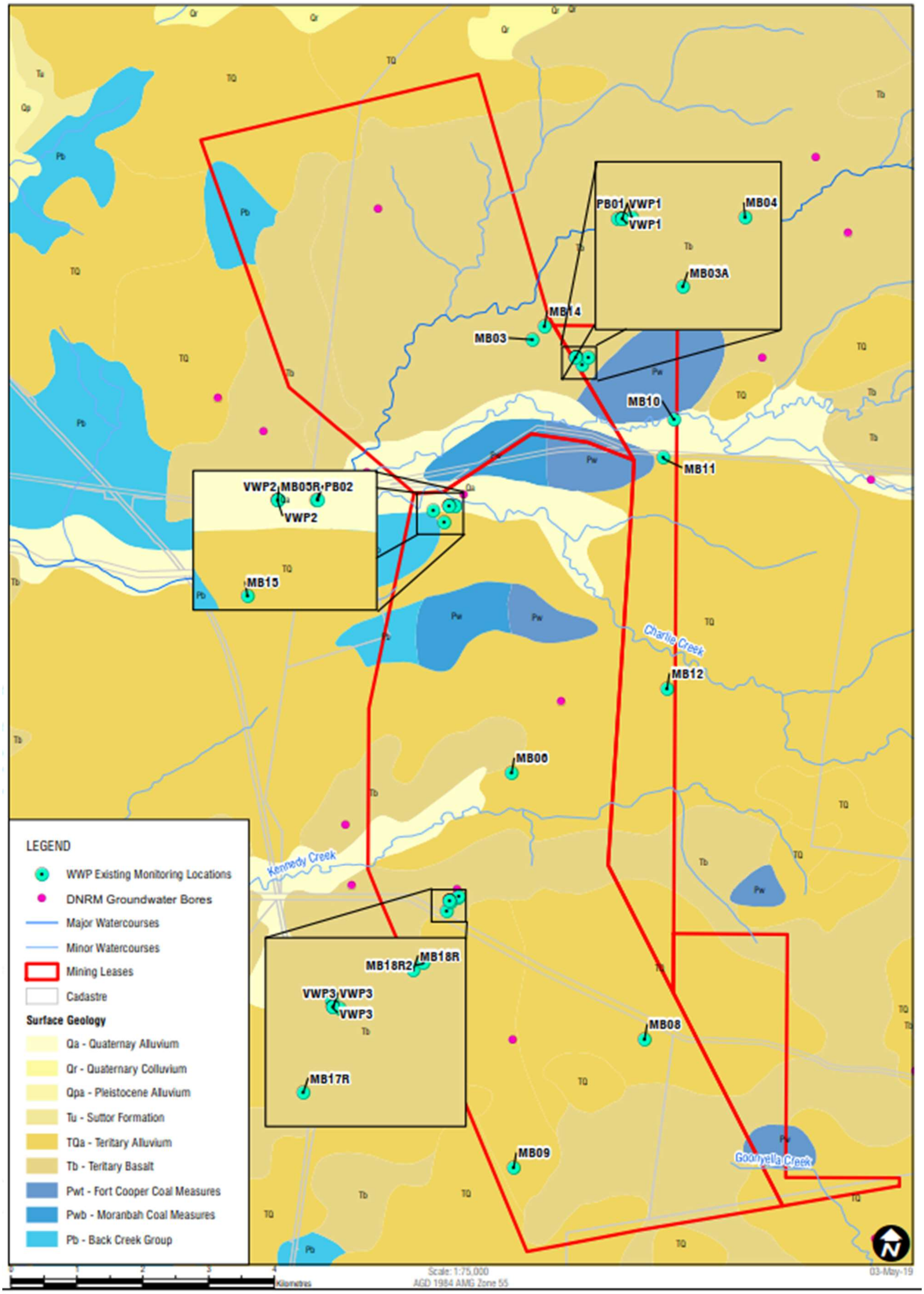


Figure 2: Wards Well Groundwater Monitoring Well Network

A summary of the water monitoring results is contained in **Appendix C.**

Samples collected from the groundwater monitoring bores (wells with the prefix MB) have been selectively analysed in accordance with the Environmental Authority conditions for the following:

- pH/electrical conductivity
- Anions/Cations
- Metals – Aluminum, Antimony, Arsenic, Barium, Beryllium, Boron, Cadmium, Calcium, Chromium (III+VI), Cobalt, Copper, Iron, Lead, Lithium, Magnesium, Manganese, Mercury, Molybdenum, Nickel, Phosphorus, Potassium, Selenium, Silver, Strontium, Titanium, Uranium, Uranium, Vanadium and Zinc.
- Total Recoverable Hydrocarbons.
- Benzene, Toluene, Ethylbenzene, Xylene and Naphthalene.
- Nutrients – Ammonia, Nitrate, Nitrite, Nitrogen (Total), Kjeldahl Nitrogen Total and Phosphorus.

All of the groundwater monitoring bores from which samples were collected and analysed, are located within Tertiary aquifers, which are utilised for stock watering within the investigation area. Vibrating Wire Piezometer (bores with the prefix VW), which were installed within the Permian aquifers were utilised for assessment of water levels and have not formed part of the groundwater sampling and analysis program.

As mining operations had not commenced, the groundwater analytical results collected from all of the monitoring bores were considered representative of pre-mining conditions. As such, the statistical assessment of the data has utilised all monitoring bores to provide an indication of overall groundwater quality and suitability within the Tertiary hosted aquifers. A summary of significant results is contained in Table 5.

Table 5: Summary of Significant Tertiary Aquifer Analytical Results

Analyte	Maximum Concentration	Mean Concentration	80^{th} Percentile	Guidelines exceeded by 80^{th} Percentile
Chloride	1,400mg/L	697mg/L	1,092mg/L	ADWG ANZECC (2000) Recreation
Sodium	1,000mg/L	411mg/L	530mg/L	ADWG ANZECC (2000) Recreation
Boron	1.1mg/L	0.259mg/L	0.45mg/L	ANZECC (2000) 95%
Selenium	0.017mg/L	0.004mg/L	0.01mg/L	ADWG ANZECC (2000) Recreation
Sulphate	174mg/L	22.826mg/L	35.6mg/L	-
Zinc	0.26mg/kg	0.017mg/L	0.026mg/L	ANZECC (2000) 95%
Total Dissolved Solids	4,310mg/L	1,584mg/L	2,470mg/L	ADWG

Notes:
Outliers removed via visual review of the results. Detection limit assumed for results below laboratory method detection limit.
ADWG = National health and Medical Research Council (2011) Australian Drinking Water Guidelines
ANZECC (2000) = Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand (2000) Australian and New Zealand guidelines for fresh and marine water quality

A preliminary review of the analytical data against the Water Quality Objectives (WQO) (see Section 5.6 for evaluation of WQOs) identified the following significant results.

- The groundwater contained within the Tertiary aquifers is sodium chloride dominated with an average and 80th Percentile concentrations exceeding the WQOs associated with the ADWG and the ANZECC (2000) Recreational guidelines. The 80th percentile concentration of selenium within the Tertiary aquifer was also found to exceed the ADWG and the ANZECC (2000) Recreational guidelines.
- The 80th Percentile concentrations of boron and zinc were above the ANZECC (2000) 95% level of species protection.
- Total Recoverable Hydrocarbons were not detected above the laboratory detection limits within the available from 2012 to 2017. The single round of monitoring for benzene, toluene, ethylbenzene, xylene, polycyclic aromatic hydrocarbons and phenols in 2012, also did not identify detectable levels within groundwater.
- With the exception of maximum result for Total Dissolved Solids, the average and 80th Percentile results were all below the established ANZECC (2000) Livestock guidelines.

Therefore, the groundwater is unlikely to be suitable for beneficial use for drinking water, other domestic purposes or recreational use without prior treatment. However, the analytical results generally indicate the tertiary aquifer was suitable for use of cattle stock watering.

It should be noted the quality of groundwater within the Permian hosted aquifers have not been assessed. However, the salinity of the Permian aquifers are expected to be higher than the overlying Tertiary aquifers.

4.2 Historical Aerial Imagery

A review of publically accessible aerial imagery available on State of Queensland, Department of Natural Resources, QImagery was undertaken for evidence of potentially contaminating activities or processes that may have occurred within the investigation area or on immediately surrounding areas. A copy of the reviewed aerial images are contained in **Appendix D** and the summary of the review is contained in the table below.

Table 6: Summary of Aerial Image Review

Queensland Globe Imagery 2016-2020
Review of the Queensland Globe satellite imagery was undertaken. Images of identified notable anthropogenic type disturbances within the investigation area are reproduced in **Appendix E** and summarised below. **ML1790** Disturbance Area 01 - Western boundary of ML1790 approx. 3.2 km south of Suttor Development Road – two areas of disturbance with material handling visible. Materials of different colours indicate potential for material from external sources stored on site. (**Appendix I**, Photograph 14) Disturbance Area 02 – Central western portion of ML1790 approximately 3.2km south of Suttor Development Road. Stock watering/mustering point. Disturbance Area 03 – Central ML1790, approx. 5km south of Suttor Creek Development Road. Stock water/mustering point. (**Appendix I**, **Photograph 15**) Disturbance Area 04 – Central eastern portion of ML1790, approximately 2.7km to the south of Suttor Development Road. Stock watering and mustering point. (**Appendix I**, **Photograph 16**) Disturbance Area 05 – Northern portion of ML1790 immediately to the south of Suttor Development Road. Cleared area with a connecting track to the road to the north. No visible use. (**Appendix I**, **Photograph 17**) Disturbance Area 06 – Central portion of ML1790, approx. 6km to the south of Suttor Development Road. Area of exposed earth, possibly natural, no apparent use. (**Appendix I**, **Photograph 18**) Disturbance Area 07 – Southern portion of ML1790. Cleared square areas and access tracks. Possible exploration drill pads. No apparent use at the time of image.

Disturbance Area 08 – Southern portion of ML1790, approx. 9.5km to the south of Suttor Development Road. Stock watering point and dams.

Disturbance Area 09 – Southern Portion of ML1790, approx. 10.5km to the south of Suttor Development Road. Possible drill pad and access track prior to drilling with mud pits excavated.

Disturbance Area 10 – Immediately to the south of Suttor development road. Area of erosion. (**Appendix I**, **Photograph 19**)

Disturbance Area 11 – Western boundary of ML1790 approx. 5.2km to the south of Suttor Development Road. The rectangular area of disturbance appears to have been subject to earthworks. (**Appendix I**, **Photograph 20**)

ML4752

Disturbance Area 01 – crosses eastern boundary with ML70443 to the north of Suttor Development Road. Possible borrow pit with visible stockpiling of earthen materials and earthworks. No visible earthmoving equipment within images. (**Appendix I**, **Photograph 11**)

Disturbance Area 02 – southern boundary of ML4752. Possible stock water dam, which contained water. (**Appendix I**, **Photograph 12**)

Disturbance Area 03 – Stock watering point with turkey nest dam. (**Appendix I**, **Photograph 13**)

ML70443

Disturbance Area 01 – crosses western boundary with ML4752 to the north of Suttor Development Road. Possible borrow pit with visible stockpiling of earthen materials and earthworks. No visible earthmoving equipment within images. (**Appendix I**, **Photograph 11**)

Disturbance Area 02 – southern portion of ML70443 on eastern boundary. Series of three small farm dams that appeared silted up.

ML70495

No areas of notable disturbance were observed on ML70495.

Surrounding Areas

To the north of ML4752 is the Lancewood Homestead and other associated agricultural infrastructure including dams, holding yards and sheds and access tracks. The observed infrastructure is between 1km and 1.5km to the north of the mining lease.

Approximately 1.5km to the east and up gradient of ML70443 is the Burton Downs Homestead and other agricultural supporting infrastructure including sheds, dams, stock holding yards, cattle dip and feed storage yards.

To the east of the southern portion of ML70443 and to the north of ML70495 on Kennedy Creek and tributaries there are three agricultural water dams.

Within 2km to the east of ML70495, five agricultural water supply dams are visible.

To the south of ML1790 and ML70495 and down gradient of investigation area are mining leases and land disturbances associated with the North Goonyella mining operations.

Approximately 1.5km to the south west of ML1790 is the Denham Park homestead and associated agricultural type infrastructure including sheds, water tanks, holding yards and cattle dip. To the south of the homestead was an unsealed airstrip.

The Newlands System rail line runs north south approximately 1.5km at its closest point to the west and down gradient of the investigation area.

Immediately to the west of ML1790 is a cleared and rehabilitated water supply infrastructure corridor with above ground infrastructure yards intermittently along the corridor.

QSat (2017) 240cm Planet 1:9,000

Both on-site and off-site land uses were consistent with those described for the Queensland Globe Imagery.

Harrybrandt (2007) 1:40,000
(note does not cover northern portion of ML4752)

The aerial images show the investigation area with increased vegetation cover and higher water levels within the dams.

ML4752 – ML70443

Disturbance Area 01 – The disturbance area associated with the possible borrow pit is smaller than observed within the 2017 images and more concentrated on ML4752.

With the exception of the above the on and off-site observations were consistent with the 2017 images.

Hillalong (2005) 1:40,000
(note does not cover areas to the south of Suttor Development Road)

Both on-site and off-site land uses were consistent with those described above for the Queensland Globe imagery and Harrybrandt (2007) images.

Harrybrandt (2000) 1:40,000
(note does not cover northern portion of ML4752)

Both on-site and off-site land uses were consistent with Harrybrandt (2007) images.

Hillalong (2000) 1:40,000
(note does not cover areas to the south of Suttor Development Road)

Both on-site and off-site land uses were consistent with the Hillalong 2005 images.

Harrybrandt (1987) 1:25,000
(note does not cover northern portion of ML4752)

ML1790 Disturbance Areas 01, 05, 07, 09, 10 and 11 and ML4752 Disturbance Area 02, mining disturbances immediately to the south, the Newlands System rail line and the water supply infrastructure corridor with above ground infrastructure yards to the west were not observed within the 1987 imagery. The site and immediately surrounding area appeared to be generally used for stock and possibly timber harvesting.

Hillalong (1985) 1:24,800
(note does not cover areas to the south of Suttor Development Road)

Both on-site and off-site land uses were consistent with the Hillalong 2000 images.

Harrybrandt (1979) 1:25,000
(note does not cover northern portion of ML4752)

ML4752 – ML70443 Disturbance Area 01, borrow pit, was not observed within the 1979 imagery. With the exception of this disturbance area Both on-site and off-site land uses were consistent with those described above.

Hillalong (1977) 1:24,900
(note does not cover areas to the south of Suttor Development Road)

Both on-site and off-site land uses were consistent with the Hillalong 1985 images. The area of the site and surrounding land uses were utilised for stock grazing.

Byerwen (1971) 1:23,900
(note does not cover areas to the south of Suttor Development Road)

Both on-site and off-site land uses were consistent with the Hillalong 1977 images. The area of the site and surrounding land uses were utilised for stock grazing.
Hillalong (1969) 1:25,900 (note does not cover areas to the south of Suttor Development Road)
Both on-site and off-site land uses were consistent with the Byerwen 1971 images. The area of the site and surrounding land uses were utilised for stock grazing.
Burton Downs (1969) 1:25,900
Both on-site and off-site land uses were consistent with the Harybrandt 1979 images with the exception of additional areas containing trees which appeared consistent with open woodlands. The predominant land use remained stock grazing.
Burton Downs (1957) 1:40,500 **(note western extent of the leases not covered by images)**
Both on-site and off-site land uses were consistent with the Burton Downs 1969 images. The predominant land use remained stock grazing.

4.3 Historical Registered Owners

A review of historical registered owners has been undertaken to identify owners/lessee that are known to undertake activities with a high potential to cause contamination. A copy of the historical title search results is contained in **Appendix F**. Table 7 below summarises the historical owners for properties, which are intersected by the Wards Well mining leases.

Table 7: Summary of Registered Owners

Year	Registered Owner	Comments
Lot 2 on SP 256592		
Pre 1981	Crown Title	
1981	Ronald Francis Camm & Tolma Rose Camm	Grazing Homestead Perpetual Lease 4106 Mackay District
2005	Benjamin Joseph Pini & Julie Maree Pini	2012 Lease to Minumbra Lancewood Pty Ltd – Lease B SP 245741, expires 01.08.2017, also 3 x 5 year options 2017 Title Granted to Benjamin Joseph Pini & Julie Maree Pini
Lot 2 on SP214117		
Pre 1961	Crown Title	
1961	George Francis Gordon	Lease of Pastoral Holding Dabin Holding Term 30 years from 30.07.1961 Now Rolling Term Lease extended to 30.06.2046

Year	Registered Owner	Comments
1969	Boomerang Holding Pty Ltd & Epson Pastoral Company Pty Ltd	
2007	BHP Mitsui Coal Pty Ltd	
Lot 11 on SP262530		
Pre 1978	Crown Title	
1978	Douglas Victor Kemp & Rhonda Ann Kemp	Grazing Homestead Freeholding Lease 30/3977 Mackay District Term of 40 years from 01.10.1978 Title grant 2007
2010	BHP Mitsui Coal Pty Ltd	
Lot 8 on GV807254		
Pre 1964	Crown Title	
1964	Richard James Fallis	Lease of Preferential Holding Term of 30 years from 01.10.1964
Date not listed	Edward Peter Mason Peter Mason Mora Ellen Mason Valda Ann Mason	
2019	Andrew David Busch Duncan Smith (Personal Representative of Mora Ellen Mason) Valda Ann Mason	
2019	Valda Ann Mason	Term expiring 11.02.2038

The review of the historical titles indicates the investigation area has been leased and utilised for grazing activities.

Historical lease conditions contained on the titles required the management of Prickly Pear and Harissa Cactus and the clearing and maintenance of cleared areas. BHP are the current owners of the lease on Lot 2 on SP214117 and registered freehold owners of Lot 11 on SP262530.

4.4 Licenses and Notices

4.4.1 Environmental Authority

Environmental Authority EPPR00668513 (EA), held by BHP Billiton Mitsui Coal Pty Ltd is held for the mining leases forming the investigation area. The EA includes the following environmentally relevant activities:

- Resource Activity, Ancillary 08 - Chemical Storage 1: Storing a total of 50t or more of chemicals of dangerous goods class 1 or class 2, division 2.3 under subsection (1)(a).
- Resource Activity, Schedule 2A, 10: Investigating the potential development of a mineral resource by large bulk sampling or constructing an exploratory shaft, adit or open pit.

- Resource Activity, Ancillary 63 - Sewage Treatment, 1: Operating sewage treatment works, other than no release works, with a total daily peak design capacity of, more than 100 but not more than 1500EP if treated effluent is discharged from the works to an infiltration trench or through an irrigation scheme.
- Resource Activity, Schedule 2A, 09: A mining activity involving drilling, costeaning, pitting or carrying out geological surveys causing significant disturbance.

Note the above environmentally relevant activities are as per the EA at the time of preparation of this investigation. Changes to the Environmental Protection Regulation have occurred since the EA was issued. Schedule 2A is now Schedule 3.

At the time of investigation the bulk sampling and exploratory shafts had not been undertaken and therefore, related environmental relevant activities of chemical storage and sewage treatment had not been undertaken. Only drilling and geotechnical surveys had been undertaken, although "*significant disturbance*" as described with the definition of Resource Activity, Schedule 2A, 09 was not identified.

In addition to the above BHP environmental authority, the following summaries all environmental authorities that are applicable to the investigation area.

Table 8: Summary of Onsite Environmental Authorities

Permit Number	Holder	Activity
EPPR00930713	QUARRICO PRODUCTS PTY LTD	ERA 16 - Extraction and Screening, 1 ERA 16 - Extraction and Screening, 2 ERA 16 - Extraction and Screening, 3
EPPG00699613	CH4 PTY LTD	Non-Scheduled, Petroleum Activity, Authority to Prospect - ATP
EPPG03219115	ARROW CSG (ATP 364) PTY LTD	Schedule 3, 08
EPPR00668513	BHP BILLITON MITSUI COAL PTY LTD	Ancillary 08 - Chemical Storage, 1 Ancillary 63 - Sewage Treatment, 1 Schedule 3, 09 Schedule 3, 10
EPVX00409013	BHP BILLITON MITSUI COAL PTY LTD	Non-Scheduled, Mining Activity, Exploration Permit Coal - EPC
EPVX00551613	Byerwen Coal Pty Ltd	Non-Scheduled, Mining Activity, Exploration Permit Coal - EPC
EPSX00377413	Byerwen Coal Pty Ltd	Non-Scheduled, Mining Activity, Exploration Permit Mineral - EPM
EPVX00409013	BHP BILLITON MITSUI COAL PTY LTD	Non-Scheduled, Mining Activity, Exploration Permit Coal - EPC
EPSX00259113	BHP BILLITON MITSUI COAL PTY LTD	Non-Scheduled, Mining Activity, Exploration Permit Coal - EPC

In addition to the onsite environmental authorities, mining related permits and authorities are present to the north and south of the investigation area and are held by Peabody Pty Ltd and Byerwen Coal Pty Ltd.

4.4.2 Transitional PRC Plan

A Progressive Rehabilitation and Closure (PRC) Plan Transitional Notice issued by the Department of Environment and Science had been provided to BHP Billiton Mitsui Coal Pty Ltd as the Environmental Authority holder for ML1790, ML70495, ML70443 and ML4752. The notice requires the holder of environmental authority EPPR00668513 to submit a proposed PRC Plan that meets the requirements of Section 126C and 126D of the Environmental Protection Act (1994) to the administering authority by 26 February 2021.

4.4.3 Enforcement Register

A review of the Queensland Government enforcement register indicated the investigation area and immediately surrounding land did not have any recorded enforcement notices.

5 Environmental Setting

5.1 Topography and Surface Water

The investigation area generally slopes gently towards the southwest and supports two shallow valleys, associated with non-perennial Eaglefield and Kennedy Creeks. On the eastern side of the lease, ground surface elevations range from RL 320 m to RL 340 m falling to the southwest to approximately RL 310 m to RL 330 m. Within the footprint of the lease, the highest ground elevations lie within the northwestern corner of ML4752 (about RL 380 m) with the lowest on the western boundary of the investigation area (about RL 310 m).

Eaglefield, Kennedy and Charlie creeks and their minor tributaries, drain the portion of the Project area located in the Burdekin Basin. The creek systems discharge the investigation area to the west flowing towards the Suttor River, which is part of the Burdekin system. In each case the water courses are non-perennial.

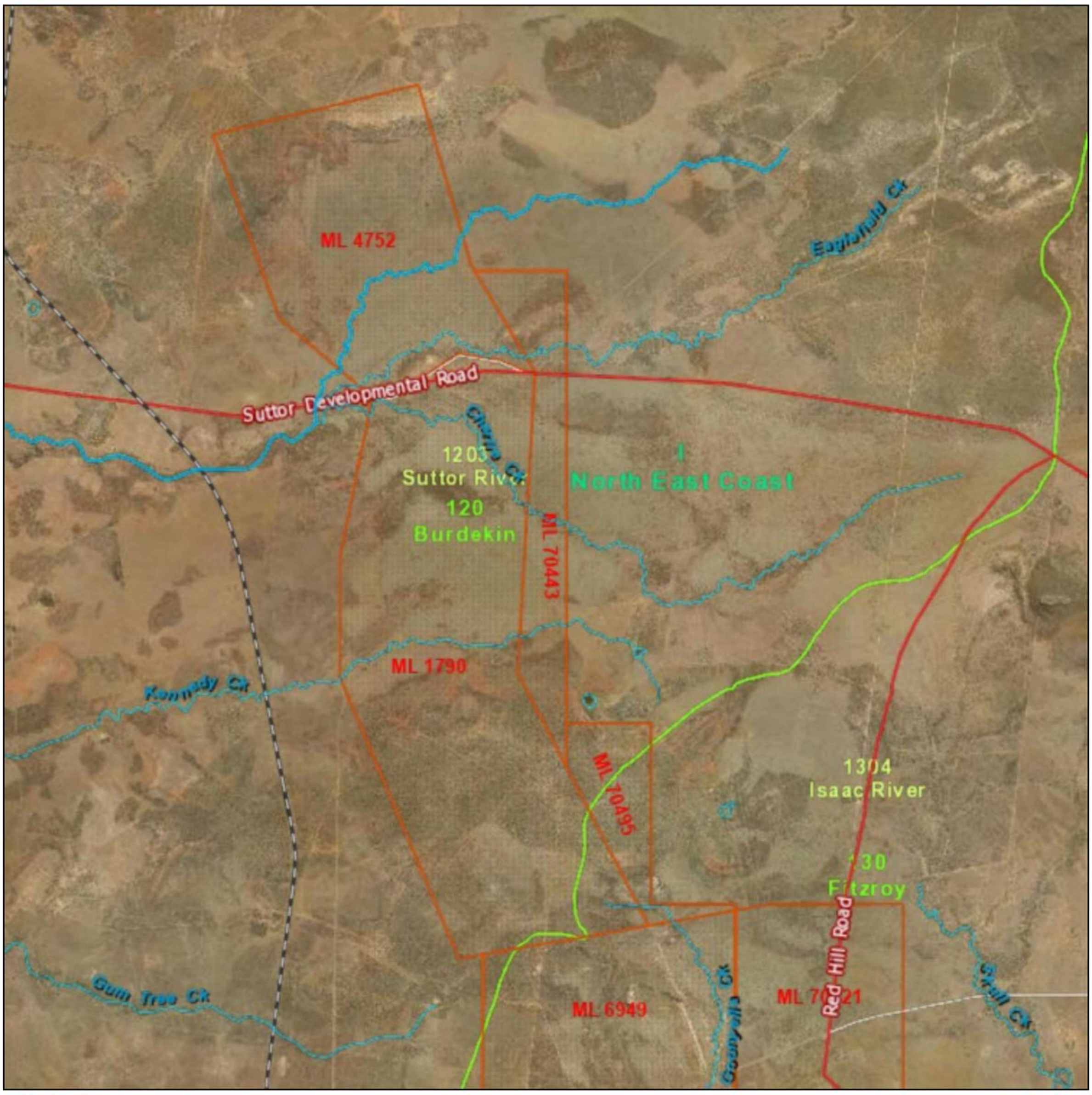
The south eastern portion of the investigation area which is located in the Fitzroy Basin forms the headwaters of Goonyella Creek, which drains the investigation area to the south east towards the Isaac River.

The location of the surface water features are shown on Figure 3 and are summarised in Table 9.

Wards Well PRCP

Local Hydrology and Fluvial Networks

21°26'59"S 147°51'23"E 21°26'59"S 148°4'14"E



21°38'56"S 147°51'23"E 21°38'56"S 148°4'14"E

A product of Queensland Globe

N

0 2.5 km

Scale: 1:120373

Printed at: A4

Print date: 12/1/2021

Datum: Geocentric Datum of Australia 1994

Projection: Web Mercator EPSG 102100

For more information, visit https://qldglobe.information.qld.gov.au/help-info/Contact-us.html

Queensland Government

Department of Natural Resources, Mines and Energy

Figure 3: Surface Water Features

Table 9: Surface Water Features

Water Course	Perenniality	Hierarchy	Stream Order	Comment
Burdekin Basin				
Eaglefield Creek	Non-perennial	Minor	3	Runs east to west across ML4752 and ML70443 to the north of Suttor Creek Development Road. Immediately to the west of the investigation area the classification changes to a hierarchy of Major and Stream order of 4. (Appendix I, Photograph 1 and Photograph 2)
Charlie Creek	Non-perennial	Minor	2	Runs south east to north west across ML70443 and ML1790 to the south of Suttor Development Road. Drains into Eaglefield Creek to the west of ML1790. (Appendix I, Photograph 4)
Kennedy Creek	Non-perennial	Minor	2	Runs east to west across ML70433 and ML1790. Two minor first order streams drain into the creek from the south. Drains into Eaglefield Creek approximately 10km to the west of the investigation area. (Appendix I, Photograph 3)
Un-named	Non-perennial	Minor	1	Runs east west across ML70443 to the south of Suttor Development Road and drains into Charlie Creek on ML1790.
Un-named	Non-perennial	Minor-Major	1-2-3	Multiple un-named drainage lines draining the norther portion of ML4752 and to the north east of the investigation area. Generally runs from north east to south west across ML4752 to the north of Suttor Development Road. Drains into Eaglefield Creek to the west of ML4752
Lake Dalrymple/Burdekin Falls Dam	-	-	-	Located approximately 130km to the north west of the site.
Man-made dams	-	-	-	Numerous small farm water supply dams are present within and immediately surrounding the investigation area.
Fitzroy Basin				
Goonyella Creek	Non-perennial	Minor	1	Source located in the south eastern corner of ML1790, running to the south east along the southern boundary of ML70495 before turning south and draining into the Isaac River.
Burton Gorge Dam	Permanent	-	-	Located on the Isaac River approximately 15km to the east of the investigation area.
Man-made dams				Numerous small farm water supply dams are present within and immediately surrounding the investigation area.

Source Department of Natural Resources (2016), Queensland Globe.

5.2 Geology

The geological setting of the site is summarised within the Golder (2020) Wards Well Mine - Progressive Rehabilitation and Closure Plan - Hydrogeological Conceptual Model report (**Appendix G**).

5.2.1 Regional setting

The Wards Well site is located on the Collinsville Shelf, near the western reaches of the Bowen Basin in Central Queensland. The Collinsville Shelf has a shallow, easterly dip between 2 to 5 degrees with localised steepening. The Bowen Basin is part of a connected group of Permian-Triassic basins spanning across eastern Australia.

5.2.2 Depositional Setting

The depositional setting of the project area comprises Quaternary alluvial and poorly consolidated sediments and basalt flows of the Tertiary Suttor Formation unconformably overlying Permian age strata.

Quaternary Sediments

The Quaternary sediments consist of sand, clay and silt of varying content associated with creeks and drainage channels. The deposits are irregular in thickness and lensoidal in nature.

Tertiary Strata

The Tertiary strata comprise four major basalt flows intercalated with pyroclastic ash flow and ash fall tuffs, volcanic breccias, clays, muds, lignites and unconsolidated fine to coarse grained sand and gravels.

Permian Strata

The underlying Permian strata comprises the Fort Cooper Coal Measures (FCCM) and Moranbah Coal Measures (MCM), which dip to the east. The FCCM unconformably underlies the Tertiary sediments and is typically massive, coarse grained sandstone, fine to medium grained sandstone, dark grey siltstone, carbonaceous shale and mudstone and coal seams with tuffaceous claystone bands. The MCM conformably underlies the FCCM and comprises low ash coal seams, laminated claystones, siltstones, interbedded siltstones/sandstones and massive sandstones.

Geological Structures

Two main fault sets have been identified at the project site during previous site investigations: normal faults striking east-west with a vertical displacement of approximately five to ten metres, and thrust faults striking north-south with approximately three metre upthrust to the east.

5.3 Acid Sulphate Soils

A review of the Atlas of Australian Acid Sulfate Soils indicates the investigation area is located in an area designated as having "*extremely low probability of occurrence*".

5.4 Hydrogeology

The hydrogeological setting for the investigation area is described in Golder Associates (2020) Wards Well Mine – Progressive Rehabilitation and Closure Plan – Hydrogeological Conceptual Model.

The area in which the Wards Well site is located is underlain by three main hydro-stratigraphic units.

Quaternary alluvium – alluvial sediments associated with river systems and sediments associated with floodplains and alluvial flats. The alluvium is classed as a porous aquifer with groundwater occurring within the pore spaces. The typical aquifer thickness is between 15m and 25m with hydraulic conductivities ranging depending on clay content between 1 x 10^{-3} and 20m/day and a general groundwater flow direction following the topographic profile.

Tertiary Strata – comprising of vesicular basalt flows which follow Tertiary palaeochannels within the Permian basement material. The aquifer is a secondary porosity aquifer with groundwater contained within fractures. Typical aquifer levels are between 6m and 60m below ground surface with variable hydraulic conductivities due to the heterogeneity of the material between 0.1 and 2.4m/day and a general groundwater flow direction from north east to south west. This is the primary aquifer utilised within the region with Total Dissolved Solids typically ranging between 480mg/L and 2900mg/L.

Permian Strata – comprising of siltstone, sandstone, calcareous and carbonaceous shale and coal. The depth of the aquifer is expected to vary between 7 and 42m below ground surface. The hydraulic conductivity of the overburden material (typically ranging from 1 x 10^{-3} m/day to 1 x 10^{-4} m/day) varies from the coal seams (typically ranging from 1 x 10^{-3} m/day to 1 x 10^{-6} m/day). Groundwater within this strata can generally be expected to have higher levels of salinity.

5.4.1 Registered Groundwater Bores

A search of the Department of Natural Resources Mines and Energy's (DNRME) groundwater bore data base was undertaken for information on hydrogeological conditions beneath the site and to provide an understanding of the groundwater use within the investigation area.

Table 10: Summary of Registered Bores

Bore ID	Installation Date	Depth (m)	Bottom Lithology	Use	Status
ML4752					
141166	2011	146	Basalt	-	Existing
85415	1990	48.7	Basalt	-	Existing
162051	2011	100	Siltstone	-	Existing
162050	2011	70	Basalt	Mine Monitoring	Existing
162064	2011	148.6	Basalt	Mine Monitoring	Existing
162054	2011	153	Basalt	Mine Monitoring	Existing
ML1790					
182311	-	117.1	-	-	Existing
162060	2011	88	Basalt/clay	Mine Monitoring	Existing
162052	2011	163	Sandstone	Mine Monitoring	Existing
162063	2011	107	Siltstone	Mine Monitoring	Existing
162065	2011	145.4	Basalt	Mine Monitoring	Existing
162053	2011	160	Basalt	Mine Monitoring	Existing

Bore ID	Installation Date	Depth (m)	Bottom Lithology	Use	Status
162059	2011	148.8	Sandstone	Mine Monitoring	Existing
162061	2011	76.7	Clay	Mine Monitoring	Existing
141160	2011	154.6	Sandstone	Sub-artesian Monitoring	Existing
141162	2011	95	Basalt/clay	Sub-artesian Monitoring	Existing
141163	2011	113	Siltstone	Sub-artesian Monitoring	Existing
162058	2011	89	Sandstone	Mine Monitoring	Existing
ML70443					
162057	2011	146	Siltstone/coal	Mine Monitoring	Existing
162062	2011	52.6	Claystone	Mine Monitoring	Existing
162056	2011	137	Clay	Mine Monitoring	Existing
162055	2011	161	Sandstone/siltstone	Mine Monitoring	Existing
ML70495 – No registered bores within lease					

The registered bores on site were predominantly listed for the purpose of groundwater monitoring. However, it should be noted that inspection of the investigation area identified five bores that appear to be unregistered and utilised for stock watering.

5.5 Ecosystems and Vegetation

5.5.1 State Environmental Reports

Searches of the Queensland Government's Environmental Reports and the Commonwealth Government's Protected Matters database were completed to identify potential ecological receptors. The search results for the Queensland Government Environmental reports are contained in **Appendix H** and summarised in

Table 11.

Table 11: Ecosystem and Vegetation Search Results

ML4752 - Lancewood

Report	Identified Aspect	Area Covered	Comments
MSES	Threatened (endangered or vulnerable) wildlife and vegetation	2060.95ha (86.9%)	Vulnerable: • Denisonia maculata - Ornamental snake. • Dichanthium queenslandicum.
	Regulated Vegetation – endangered of concern Category B remnant	1388.83ha (58.6%)	
	Regulated Vegetation – Essential habitat	1929.07ha (81.3%)	
	Regulated Vegetation – Intersecting a watercourse	16.2km	
Regional Ecosystems	Endangered	75.24 (3.17%)	Semi-evergreen vine thicket on Cainozoic sand plains and/or remnant surfaces. Semi-evergreen vine thicket and microphyll vine forest on Cainozoic igneous rocks
	Of Concern	1,273.72ha (53.71%)	Eucalyptus tereticornis or E. camaldulensis woodland fringing drainage lines. Dichanthium sericeum grassland on Cainozoic igneous rocks.
	Not of Concern at present	842.55ha (35.53%)	Eucalyptus populnea +/- E. melanophloia +/- Corymbia Eucalyptus orgadophila Eucalyptus crebra
Biodiversity and Conservation Values	Aquatic conservation significance (riverine)- Medium	2,371.68ha (100%)	
	Threatened species	-	Denisonia maculate - ornamental snake Dichanthium queenslandicum Digitaria porrecta
	Priority Species		Capparis shanesiana
Groundwater Dependent Ecosystems (GDEs)	High potential GDEs	-	Aquatic and Terrestrial GDEs Associated with drainage lines.
Inflow Dependent Ecosystems	Rankings from low to high likelihood.	-	Aquatic and Terrestrial Inflow Dependent Ecosystems
Wetlands	No Wetland Protection Areas within ML4752		

ML1790 – Wards Well

Report	Identified Aspect	Area Covered	Comments
MSES	Threatened (endangered or vulnerable) wildlife and vegetation	2992.7ha (68.3%)	Vulnerable: • Denisonia maculata - Ornamental snake. • Dichanthium queenslandicum. • Geophaps scripta scripta squatter pigeon (southern subspecies)
	Special least of concern animals	191.16ha (4.4%)	Tachyglossus aculeatus short-beaked echidna
	Regulated Vegetation – endangered of concern Category B remnant	1655.9ha (37.8%)	
	Regulated Vegetation – Endangeder/of concern Category C (regrowth)	131.36ha (3%)	
	Regulated Vegetation – Category R (GBR riverine regrowth)	1.23ha (<0.1%)	
	Regulated Vegetation – Essential habitat	3131.03 ha (81.3%)	
	Regulated Vegetation – Intersecting a watercourse	12.9km	
Regional Ecosystems	Endangered	236.64 (5.4%)	Semi-evergreen vine thicket on Cainozoic sand plains and/or remnant surfaces. Semi-evergreen vine thicket and microphyll vine forest on Cainozoic igneous rocks
	Of Concern	1,307.97ha (29.87%)	Eucalyptus tereticornis or E. camaldulensis woodland fringing drainage lines. Eucalyptus coolabah woodland on alluvial plains Dichanthium sericeum grassland on Cainozoic igneous rocks.
	Not of Concern at present	1627.48ha (37.16%)	Eucalyptus populnea +/- E. melanophloia +/- Corymbia Eucalyptus orgadophila Eucalyptus melanophloia +/- E. orgadophila Eucalyptus crebra
Biodiversity and Conservation Values	Aquatic conservation significance (riverine)- Medium	4379.28ha (100%)	
	Threatened species		Denisonia maculate - ornamental snake Dichanthium queenslandicum Digitaria porrecta Geophaps scripta scripta - squatter pigeon (southern subspecies)
	Priority Species		Capparis shanesiana Gehyra catenata Lagorchestes conspicillatus Spectacled Hare-wallaby Paradelma orientalis Brigalow Scaly-foot Pyrrholaemus sagittatus Speckled Warbler
Groundwater Dependent Ecosystems (GDEs)	High potential GDEs	-	Aquatic and Terrestrial GDEs Associated with drainage lines.
Inflow Dependent Ecosystems	Rankings from low to high likelihood.	-	Aquatic and Terrestrial Inflow Dependent Ecosystems
Wetlands	No Wetland Protection Areas within ML1790		

ML70443 – Wards Well East

Report	Identified Aspect	Area Covered	Comments
MSES	Threatened (endangered or vulnerable) wildlife and vegetation	591.04ha (68%)	Vulnerable: • Denisonia maculata - Ornamental snake. • Dichanthium queenslandicum.
	Regulated Vegetation – endangered of concern Category B remnant	535.15ha (61.6%)	
	Regulated Vegetation – Endangeder/of concern Category C (regrowth)	3.27ha (0.4%)	
	Regulated Vegetation – Category R (GBR riverine regrowth)	0.92ha (0.1%)	
	Regulated Vegetation – Essential habitat	634.18ha (73%)	
	Regulated Vegetation – Intersecting a watercourse	4.6km	
Regional Ecosystems	Endangered	57.7 (6.64%)	Semi-evergreen vine thicket on Cainozoic sand plains and/or remnant surfaces.
	Of Concern	454.44ha (52.29%)	Eucalyptus tereticornis or E. camaldulensis woodland fringing drainage lines. Dichanthium sericeum grassland on Cainozoic igneous rocks.
	Not of Concern at present	238.15ha (27.4%)	Eucalyptus populnea +/- E. melanophloia +/- Corymbia Eucalyptus orgadophila
Biodiversity and Conservation Values	Aquatic conservation significance (riverine)- Medium	969.08ha (100%)	
	Threatened species		Dichanthium queenslandicum Digitaria porrecta
	Priority Species		Gehyra catenata Lagorchestes conspicillatus Spectacled Hare-wallaby Pyrrholaemus sagittatus Speckled Warbler
Groundwater Dependent Ecosystems (GDEs)	High potential GDEs	-	Aquatic and Terrestrial GDEs Associated with drainage lines.
Inflow Dependent Ecosystems	Rankings from low to high likelihood.	-	Aquatic and Terrestrial Inflow Dependent Ecosystems
Wetlands	No Wetland Protection Areas within ML70443		

MI70495 – Wards Well South East

Report	Identified Aspect	Area Covered	Comments
MSES	Threatened (endangered or vulnerable) wildlife and vegetation	245.5ha (50.1%)	Vulnerable: • Denisonia maculata - Ornamental snake.
	Regulated Vegetation – endangered of concern Category B remnant	30.86ha (6.3%)	
	Regulated Vegetation – Endangered/of concern Category C (regrowth)	16.96ha (3.5%)	
	Regulated Vegetation – Essential habitat	247.84ha (50.6%)	
	Regulated Vegetation – Intersecting a watercourse	1.3km	
Regional Ecosystems	Endangered	61.5 (12.56%)	Semi-evergreen vine thicket on Cainozoic sand plains and/or remnant surfaces. Semi-evergreen vine thicket and microphyll vine forest on Cainozoic igneous rocks
	Of Concern	3.76ha (0.77%)	Dichanthium sericeum grassland on Cainozoic igneous rocks.
	Not of Concern at present	342.24ha (69.88%)	Eucalyptus populnea +/- E. melanophloia +/- Corymbia Eucalyptus orgadophila
Biodiversity and Conservation Values	Aquatic conservation significance (riverine)	High aquatic conservation significance – 30.05ha (6.14%) Medium aquatic conservation significance – 459.73ha (93.86%)	
	Threatened species		Dichanthium queenslandicum Geophaps scripta scripta - squatter pigeon (southern subspecies)
	Priority Species		Gehyra catenata Lagorchestes conspicillatus Spectacled Hare-wallaby Pyrrholaemus sagittatus Speckled Warbler
Groundwater Dependent Ecosystems (GDEs)	Not located within ML70495		
Inflow Dependent Ecosystems	Not located within ML70495	-	
Wetlands	No Wetland Protection Areas within ML70495		

A review of the Queensland Environmental Reports identified the presence of endangered ecosystems, of concern ecosystems, essential habitat, inflow dependent ecosystems and groundwater dependent ecosystems within the investigation area. These ecosystems were identified as supporting endangered, vulnerable and threatened species. Therefore, the investigation area supports potentially sensitive ecological receptors.

5.5.2 Protected Matters

A search of the Environment Protection and Biodiversity and Conservation Act (1999) Protected Matters database was undertaken to identify potentially sensitive receptors within proximity of the investigation area. The Protected Matters search results are contained in **Appendix H** and the results are summarised in Table 12.

Table 12: Protected Matters Search Results

Category	No	Presence	Description	Status
Threatened Ecological Communities	4	Known to Occur	Brigalow (Acacia harpophylla dominant and co-dominant)	Endangered
		Likely to occur	Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin	Endangered
			Poplar Box Grassy Woodland on Alluvial Plains	Endangered
			Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	Endangered
Threatened Species	20	Known to occur	Geophaps scripta scripta - Squatter Pigeon (southern)	Vulnerable
			Ornamental Snake - Denisonia maculata	Vulnerable
		Likely to occur	Erythrotriorchis radiatus - Red Goshawk	Vulnerable
			Neochmia ruficauda ruficauda - Star Finch (eastern), Star Finch (southern)	Endangered
			Dasyurus hallucatus - Northern Quoll	Endangered
			Macroderma gigas - Ghost Bat	Vulnerable
			Dichanthium queenslandicum - King Blue-grass	Endangered
			Dichanthium setosum - bluegrass	Vulnerable
		May occur	Calidris ferruginea - Curlew Sandpiper	Critically Endangered
			Falco hypoleucos - Grey Falcon	Vulnerable

The review of the Protected Matters database indicates that endangered ecological communities and endangered and vulnerable species are either known, likely or may occur within the investigation area. Therefore, the investigation area potential contains sensitive ecological receptors.

5.6 Water Quality Environmental Values and Objectives

The investigation area straddles the boundary between the Burdekin and Fitzroy Basins. The entirety of mining leases ML4752 and ML70443 are located in the Burdekin Basin, while the south eastern corner of ML1790 and the southern half of ML70495 are located in the Fitzroy Basin.

The declared underground water area 'Highlands Underground Water Area' protrudes into the south western portion of ML1790.

The location of the proposed box cut and associated exploration activities under the EA (number: EPPR00668513) are located on ML4752 located in the Burdekin Basin.
Figure 4, illustrates the location of the mining leases and water basins.

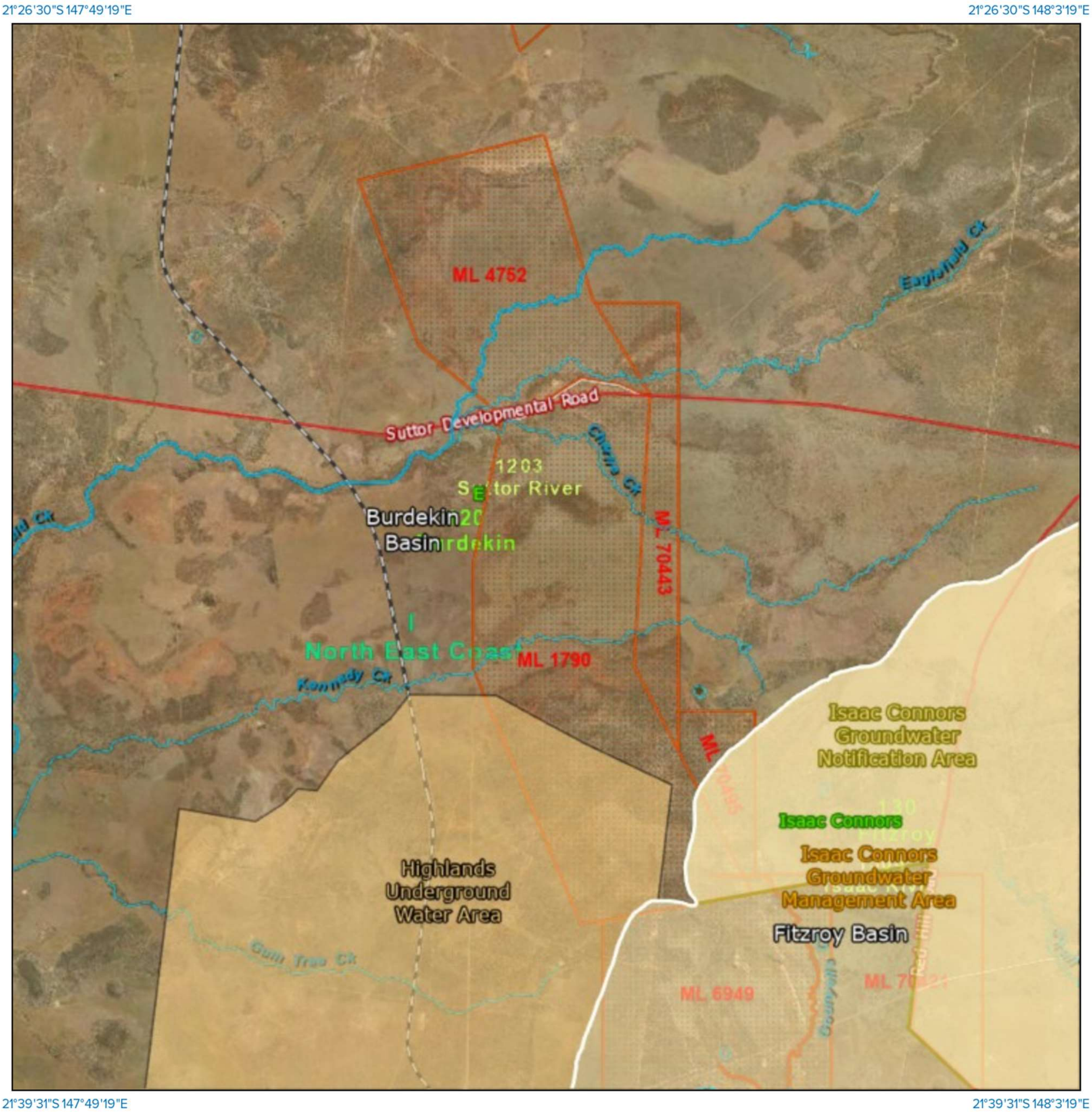
The water quality environmental values and objectives for the investigation area are documented in the following:

- NQ Dry Tropics 2016, Burdekin Region Water Quality Improvement Plan 2016, NQ Dry Tropics, Townsville.
- Queensland Government (2011) Environmental Protection (Water) Policy (2009) Isaac River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (Part).

The portion of the investigation area that is located within the Burdekin Basin is contained within the Upper Suttor River catchment. The portion of the site located in the Fitzroy Basin is located within the Isaac River Sub-basin, the Isaac Northern Rivers catchment and the Isaac Conners Water Management Area. Groundwater within this area falls within the Isaac Conners Groundwater Management Area.

5.6.1 Environmental Values

The environmental values identified under the Environmental Protection (Water and Wetland Biodiversity) Policy (2019), applicable to surface water and groundwater for the catchments in which the site is located, are summarised in the Table 13 below. An evaluation of the environmental values relevance to the site is provided in Table 14.



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Scale: 1:131240

Printed at: A4
Print date: 1/10/2020
Datum: Geocentric Datum of Australia 1994
Projection: Web Mercator EPSG 102100

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Queensland Government
Department of Natural Resources, Mines and Energy

Figure 4: Water Basins

Table 13: Environmental Values

Basin	Catchment	Aquatic Ecosystems	Irrigation	Farm Use	Stock Watering	Aquaculture	Human Consumption	Primary Recreation	Secondary Recreation	Visual Recreation	Raw Drinking Water	Industrial Use	Cultural and Spiritual
Burdekin (Draft)	Upper Suttor River – Surface Waters	✓			✓		✓	✓	✓	✓	✓	✓	✓
	Upper Suttor River - Groundwaters		✓	✓	✓						✓	✓	
Fitzroy	Isaac Northern Tributaries – Surface Waters	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
	Isaac Groundwaters	✓	✓	✓	✓			✓			✓		✓

Note the Environmental values provided within the NQ Dry Tropics 2016, Burdekin Region Water Quality Improvement Plan 2016 are draft only.

Table 14: Evaluation of Identified Environmental Values

Environmental Value	Surface Water		Groundwater	
	Evaluation	Beneficial Use	Evaluation	Beneficial Use
Aquatic Ecosystems	The drainage lines within and immediately surrounding the investigation area were Non-perennial. However, downstream of the investigation area are regionally significant waterways including the Isaac River and Suttor River.	✓	Where groundwater interacts with surface water ecosystems there is potential for groundwater to impact aquatic ecosystems. It is noted that Aquatic Ecosystems are not an identified Environmental Value for the Upper Suttor River catchment.	✓
Irrigation	The investigation area is located in a rural area predominantly utilised for grazing. However, downstream of the investigation area use of surface water for irrigation is considered likely. It is noted that irrigation is not considered an Environmental Value for the Upper Suttor River.	✓	The investigation area is located in a rural area and there are a number of water supply bores within and surrounding the investigation area.	✓
Farm Use	The investigation area is located in a rural area. It is noted that farm use is not considered an Environmental Value for the Upper Suttor River.	✓	The investigation area is located in a rural area and there are a number of water supply bores within and surrounding the investigation area. It is noted that farm use is not an identified Environmental Value for the Upper Suttor River catchment.	✓
Stock Watering	The investigation area is located in a rural area predominantly utilised for grazing.	✓	The investigation area is located in a rural area and there are a number of water supply bores within and surrounding the investigation area.	✓
Aquiculture	Not considered to be an Environmental Value for the catchments in which the investigation area is located	×	Not an identified environmental value.	×
Human Consumer	The non-perennial surface water streams within and immediately surrounding the site drain towards permanent water bodies including the Burton Gorge Dam and the Lake Dalrymple/Burdekin Falls Dam which are used for fishing and other activities.	✓	Not an identified environmental value.	×

Environmental Value	Surface Water		Groundwater	
	Evaluation	Beneficial Use	Evaluation	Beneficial Use
Primary Recreation	Surface waters downstream of the investigation area can be utilised for primary recreation.	✓	Primary recreation is identified as a potential environmental value for the Isaac Groundwater. Groundwater extraction in the area could include primary recreational use such as swimming pools.	✓
Secondary Recreation	Surface waters downstream of the investigation area can be utilised for secondary recreation.	✓	Not an identified environmental value.	×
Visual Recreation	The rivers and streams are associated with recreational areas and therefore visual recreation is applicable to the site.	✓	Not an identified environmental value.	×
Raw Drinking Water	The non-perennial surface water streams within and immediately surrounding the site drain towards Burton Gorge Dam and the Lake Dalrymple/Burdekin Falls Dam.	✓	The investigation area is located in a rural area and there are a number of water supply bores within and surrounding the investigation area. However, due to salinity of the groundwater it is likely that groundwater would require treatment prior to potable use.	✓
Industrial Use	A number of mining and industrial activates are located downstream of the site that could potentially utilise surface waters.	✓	A number of mining and rural related industrial activates within the catchments. There are also a number of groundwater supply bores within the catchments. It is noted that Industrial Use is not an identified groundwater environmental value within the Isaac catchment.	✓
Cultural and Spiritual	The waterways within the region have a demonstrated connection with indigenous Australians	✓	Groundwater has the potential to influence groundwater dependant ecosystems and cultural and spiritual values. It is noted that Cultural and Spiritual values were not identified as an Environmental Value for the Upper Suttor River groundwater.	✓

5.6.2 Water Quality Objectives

Fitzroy Basin

The portion of the investigation area that is located within the Fitzroy Basin has a management intent of ‘moderately disturbed’.

Catchment specific surface water quality objectives that have been derived for the Upper Isaac River catchment waters include the following:

- ammonia Nitrogen (N): <20 micrograms per litre (µg/L)
- oxidised N: <60 µg/L
- organic N: <420 µg/L
- total nitrogen: <500 µg/L
- filterable reactive phosphorus (FRP): <20 µg/L
- total phosphorus: <50 µg/L
- chlorophyll a: <5.0 µg/La
- dissolved oxygen: 85%–110% saturation
- turbidity: <50 NTU
- suspended solids: <55 mg/Lb
- pH: 6.5–8.5 b
- conductivity (EC) baseflow: <720 µS/cm
- conductivity (EC) high flow: <250 µS/cm
- sulfate: <25 mg/L
- Macroinvertebrates:
  - Taxa richness (composite): 12–21
  - Taxa richness (edge habitat): 23–33
  - PET taxa richness (composite): 2–5
  - PET taxa richness (edge habitat): 2–5
  - SIGNAL index (composite): 3.33–3.85
  - SIGNAL index (edge habitat): 3.31–4.20
  - % tolerant taxa (composite): 25–50%
  - % tolerant taxa (edge habitat): 44–56%

Water quality for objectives for human use environmental values applicable to the portion of the investigation area located in the Fitzroy Basin are summarised in Table 3 of the Queensland Government (2011) Isaac River Sub-basin Environmental Values and Water Quality Objectives, and were derived from the following:

- Australian Drinking Water Guidelines (NHMRC, 2011)
- Australia New Zealand Food Standards Code (Australian Government)
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC & ARMCANZ, 2000)
- Guidelines for Managing Risks in Recreational Water (NHMRC, 2008).

The portion of the investigation area located within the Fitzroy Basin is not covered by an established groundwater ‘chemistry zone’ due to insufficient data available to establish groundwater quality objectives. The objectives for groundwater include:

- Where groundwaters interact with surface waters, groundwater quality should not compromise identified EVs and WQOs for those waters.
- Where groundwaters are in good condition the intent is to maintain existing water quality (20th, 50th and 80th percentiles).

Burdekin Basin

Draft water quality objectives are provided within the, NQ Dry Tropics 2016, Burdekin Region Water Quality Improvement Plan, noting that in accordance with the national framework, the Reef Long term Sustainability Plan, and EPP Water, locally relevant water quality guidelines were under development for the Burdekin at the time of this investigation and the objectives provided were in draft only.

Draft Burdekin Basin surface water quality objectives that are provided for upland streams, include the following:

- Turbidity (NTU) 25
- Ammonia-N (µg/L) 10
- NOx-N (µg/L) 15
- Organic N (µg/L) 225
- Total N (µg/L) 250
- FRP (µg/L) 15
- Total P (µg/L) 30
- Ametryn (µg/L) Proposed 0.02
- Atrazine (µg/L) Current 0.7, Proposed 3.7
- Diuron (µg/L) 0.2
- Hexazinone (µg/L) Current 75, Proposed 0.2
- Imidacloprid (µg/L) Proposed 0.03
- Tebuthiuron (µg/L) Current 0.02 Proposed 4.3
- 2,4-D (µg/L) 140

Water quality for objectives for human use environmental values applicable to surface and groundwaters in the Burdekin Basin are summarised in Table 4.4 of the NQ Dry Tropics 2016, Burdekin Region Water Quality Improvement Plan, and include the following:

- Australian Drinking Water Guidelines (NHMRC, 2011)
- Australia New Zealand Food Standards Code (Australian Government)
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC & ARMCANZ, 2000)
- Guidelines for Managing Risks in Recreational Water (NHMRC, 2008).

5.7 Flood Risks

A review of the 1% Annual Exceedance Probability (AEP) flood map indicates that at the Wards Well mining leases flood events are predominately concentrated immediately around the creeks. As the investigation area is located towards the top of the catchment and upstream catchment areas were primarily utilised for grazing, the potential for contamination of the site from flood waters is considered low.

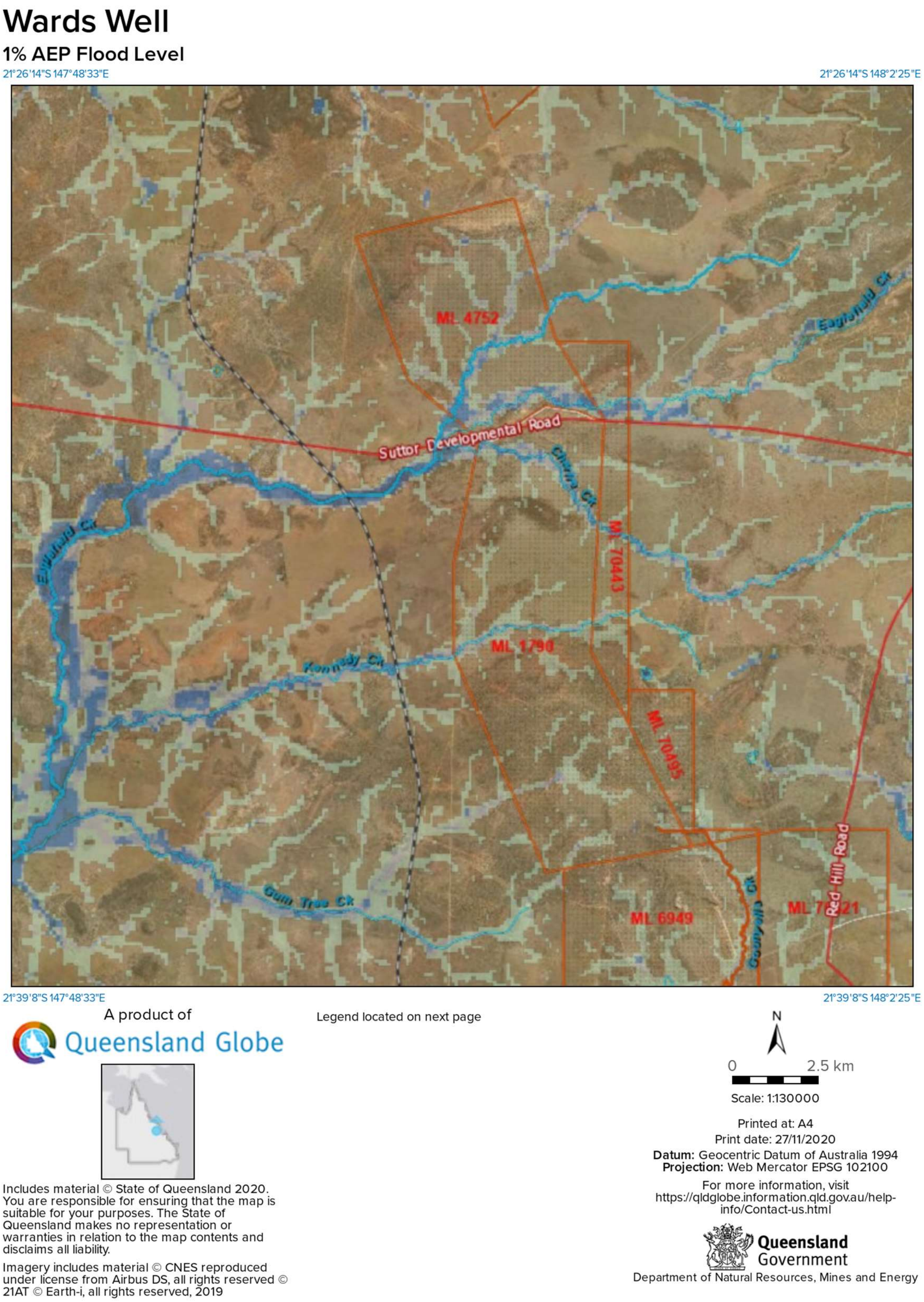

Figure 5: 1% Annual Exceedance Probability Flood Map

5.8 Surrounding Land Uses/Activities

Land uses immediately to the north east and west of the investigation area are predominantly utilised for grazing. Immediately to the south is the North Goonyella Mine (ML6949 held by Peabody Bowen Pty Ltd) and Red Hill Mine (ML70421 held by BHP). A summary of the observed land uses are summarised in Table 15.

Table 15: Summary of Surrounding Land Uses

Direction	Activity	Description
North	Homesteads	Lancewood Homestead - Approximately 1.6km to the north of ML4752. The homestead site includes a number of buildings (residential and agricultural type sheds) water tanks, stock yards, hardstand storage areas/waste disposal and water dams. Approximately 3.5 km to the south west and 1.3km to the north of ML4752 are stockyards, water dams and a possible cattle dip. The homestead and cattle yards are located on the northern side of a ridge line with surface drainage from the area draining to the north west and away from the investigation area. Talwood Homestead – Approximately 7km to the north west of ML4752. The homestead site includes two buildings (residential and small shed). The homestead is located on the northern side of a ridge line with surface drainage from the area draining to the north west and away from the investigation area.
	Grazing	Satellite images indicate the area utilised for grazing includes wooded and cleared areas with access track to homesteads and farm access.
	Mining	Suttor Creek and Wollombi mining operations are located to the north of the site with surface disturbances located approximately 6km and 10km from the northern boundary of ML4752. The southern tip of the ML4761, on which these mines are located, is approximately 2km to the north of ML4752. Surface drainage from the disturbed areas of these mining leases is to the west and away from the investigation area.
	Rail	The Newlands System rail line is located approximately 4km to the north west of the investigation area.
East	Homesteads	Lenton Downs Homestead – Approximately 3.6km to the east of ML70443 to the north of Suttor Development Road. Large homestead site with multiple residential and agricultural support type structures, dams, stockyards, cattle dip, hardstand areas solid waste disposal areas. The homestead site is located on the southern side of Eaglefield Creek, which flows approximately 4.6km to the west before entering ML70443. Dabin Homestead – Approximately 2.9km to the east of ML70443 to the south of Suttor Development Road. Multiple residential and agricultural buildings, stock yards, cattle dip, dams and solid waste disposal area. The homestead is located to the south of Charlie Creek, which flows to the north west for approximately 3.5km before entering ML70443.
	Easement	A power supply easement runs north-south approximately 1.5km to the east at its closest point of the investigation area.
	Grazing	Grazing areas to the east of the investigation area are predominantly cleared and support numerous dams and unsealed access tracks.

West	Homesteads	Denham Park Homestead – Approximately 1.4km to the west of the southern end of ML1790. The homestead site supports a residential type building, numerous agricultural buildings, stock yards, possible cattle dip, water storage, hard stand areas and an airstrip to the south.
	Easement	Sunwater Ltd and Eungella Water Pipeline Pty Ltd water supply easements run north south to the west of ML1790 (on the western boundary to the north of Kennedy Creek up to Suttor Development Road). The water supply easements also run along the northern side of Suttor Development Road through ML1790 and ML4752 before heading to the north east through ML70443.
	Rail	The Newlands System rail line runs north south past the investigation area (located approximately 1.5km to the west of the investigation area at closest point).
	Grazing	Grazing areas to the west of the investigation area are a mixture of cleared and wooded areas and support numerous dams and unsealed access tracks.
	Other	Approximately 2km to the west of ML4752 is an area (covering approximately 10.6ha) formally believed to be utilised as a Queensland Rail construction camp. Over 75 buildings were visible in the imagery taken before their removal. The site also supported what appeared to be a waste water treatment system and pond. A majority of the buildings have been removed and the area was not operational at the time of investigation. Aerial images indicates the facility was constructed post 2005 and demolished prior to 2017. The area is located down gradient of the investigation area.
South	Mining	North Goonyella underground mine - Immediately to the south of ML1790 is the Peabody operated mine on ML70495. The mining lease supports numerus disturbance areas including tailings dams waste dumps, water storage dams, coal handling areas, rail siding, industrial areas and other surface disturbance areas. This mine is located down gradient of the investigation area. Red Hill mining lease is located to the south east of the investigation area. Surface areas of the Red Hill lease adjacent to the investigation area are utilised for grazing. The Red Hill lease is down gradient of the investigation area.

Due to the topography of the area, land uses to the north, south and west are down gradient of the investigation area, and any surface contamination present within these areas is unlikely to cause contamination of the investigation area. To the east and up-gradient of investigation area are Dabin Homestead and Lenton Downs Homestead. Both of these homesteads include activities that have the potential to cause land contamination and are located adjacent to creeks (Eaglefield and Charlie creeks) that run to the west and through the investigation area). From the homesteads to the eastern boundary of the investigation area (ML70443) the creek alignments are at least 3.5km. Contamination sources from homestead sites are not expected to have migrated through the ephemeral creeks and result in contamination at concentrations that could cause environmental harm within the investigation area.

5.9 Site Waste Management

Wastes generation within the investigation area are limited to wastes resulting from the use of the land for grazing and exploration activities.

Grazing activities within the investigation area include open paddocks and watering points. Other grazing related activities, including workshops, cattle dips, homesteads and other infrastructure/activities are located outside of the investigation area, and wastes generated by these activities are also managed outside of the investigation area.

Exploration drilling activities generate liquid and solid wastes that are removed from the ground as drill cuttings and drilling fluids/groundwater. The mining leases ML1790 and ML4752 were granted in 1978 and exploration drilling is anticipated to have occurred since the early 1970's. Records of historical drilling practices and drilling fluid additives were not identified as part of this investigation. Recent exploration drilling practices include the establishment of drill pads with pits for the collection of cuttings and liquid wastes. The drill pads are rehabilitated upon completion of the exploration drilling including the covering of pits containing drilling wastes. Inspection of the investigation area did not identify any evidence of visible contamination in historical exploration drilling sites.

5.10 Earthworks

At the time of this investigation the approved box cut and underground bulk sampling program had not been undertaken. Earthworks undertaken on site included the following:

- Quarry/borrow pit located on the boundary of ML4752 and ML70443 to the north of Suttor Development Road;
- Area on western boundary of ML1790, observed in satellite image with plant and material stockpiles (area revegetated at time of site inspection);
- Construction of small farm dams;
- Drilling of groundwater extraction/monitoring wells;
- Exploration drilling including: clearing of drill pads, excavation of drilling mud pits, drilling of exploration holes, rehabilitation of drill pads; and
- Construction of access tracks and fences.

Other than minor importation of crushed rock used on selected sections of access tracks, imported earthen materials and/or landfilling was not identified within the investigation areas.

The area of the quarry/borrow pit at the time of inspection, was not operational. The area was cleared and void of vegetation and the depth of excavation appeared to be less than 2m. It is assumed the material sourced from the quarry/borrow pit was utilised for maintenance of surrounding roads.

5.11 Water Resource Use

During the site inspection the following water resource uses were observed within the investigation area:

- Earth dam located approximately 400m to the north of Suttor Development Road on ML4752 utilised for stock watering;
- Earth dam located approximately 1km to the north of Suttor Development Road on ML70443 utilised for stock watering;
- Earth dam located on the western side of ML1790 approximately 5km to the south of Suttor Development Road utilised for stock watering;
- Earth dam located in the center of ML1790 approximately 6km to the south of Suttor Development Road utilised for stock watering;
- Groundwater extraction well with small turkey nest dams, southern portion of ML1790, approximately 9.25km to the south of Suttor Development Road utilised for stock watering.
- Groundwater extraction well with small turkeys nest dams, central ML1790, approximately 5.25km to the south of Suttor Development Road, utilised for stock watering.

- Groundwater extraction well with small turkeys nest dams, western side of ML1790, approximately 3.4km to the south of Suttor Development Road, utilised for stock watering.
- Groundwater extraction well with small turkeys nest dams, tanks and solar system, eastern side of ML1790, approximately 2.6km to the south of Suttor Development Road, utilised for stock watering.
- Groundwater extraction well with small turkeys nest dam, central ML4752, approximately 4km to the north of Suttor Development Road, utilised for stock watering.

Within 5km of the investigation area there were four homestead sites, stock watering points, and numerous farm dams. Although the homestead sites were not inspected, as they were outside of the investigation area, water for use within the homesteads are anticipated to be rainwater/imported water due to the salinity of the underlying aquifers.

As identified within Section 5.5, groundwater dependent ecosystems and inflow dependent ecosystems are present within the investigation area surrounding the ephemeral creeks/drainage lines. Environmental flows of groundwater and surface water are required to maintain these ecosystems.

To the south and north of the site, water resources are managed as part of the operational mine sites. Mine affected water is collected, reused for processing and other operational uses and where required discharged under Environmental Authority conditions.

Within the portion of the investigation area located in the Burdekin Basin, surface water flows and basalt aquifer flows are in a westerly direction. Immediately downstream of the investigation area are rural grazing properties, consistent with the land uses on site. Surface water flows through the natural ephemeral drainage lines (Eaglefield, Charlie and Kennedy creeks) are directed to the west and into Eaglefield Creek, Suttor River, Lake Dalrymple water supply dam and into the Burdekin River. Environmental Values for this catchment are provided within Section 5.6.1.

The south east portion of the investigation area that forms part of the Fitzroy Basin drains in a south easterly direction through Goonyella Creek. Goonyella Creek drains into the Isaac River, which in turn drains into the Fitzroy River. Environmental Values for this catchment are provided within Section 5.6.1.

5.12 Other Databases

A search of the following databases was undertaken to identify potential contaminated land risks.

- Defence PFAS Investigation & Management Program - Investigation Sites
- Defence PFAS Investigation & Management Program - Management Sites
- Airservices Australia National PFAS Management Program
- Queensland Fire and Emergency Services PFAS Investigation Sites
- Defence 3 Year Regional Contamination Investigation Program
- National Waste Management Facilities Database
- National Liquid Fuel Facilities
- UBD Business Directories

A copy of the search results is contained within **Appendix F**.

The above searches did not identify any records within or immediately surrounding the investigation area.

6 Site Inspection

An inspection of the investigation area was undertaken 10-11 December 2020. The inspection was undertaken by vehicle and on foot targeting those areas where anthropogenic disturbances were identified within the desk top investigations. The following observations were made during the site inspection.

- The entire investigation area was utilised for grazing. No mineral exploration works were being undertaken at the time of inspection.
- The borrow pit located on the boundary of ML4752 and ML70443 (ML4752 - ML70443 Disturbance Area 01) to the north of Sutter Development Road was not operational. No plant or equipment was present and no visible signs of contamination were identified. One settled stockpile of locally won earth was present on the eastern side of the borrow pit. The borrow pit area had not been rehabilitated and no vegetation had re-established within the disturbance area.
- A disused communications pole was present within a cleared area to the south of Suttor Development Road (ML1790 Disturbance Area 05). The size of the pad indicates the area may have been used for a road works or similar support compound. No visible signs of contamination were observed and only minor residual steel, wood, pipes and tyre debris remained within the cleared area.
- The former earthworks area on the western boundary of (ML 1790 Disturbance Area 01) had been rehabilitated and was covered with grass consistent with the surrounding land. Evidence of stockpiled/imported materials or contamination was not identified.
- All former exploration drill pads viewed had been rehabilitated. No evidence of contamination or drilling wastes were observed.
- All groundwater extraction bores identified, were utilised for stock watering and powered by windmills or solar. No cattle dips, landfilling, petroleum storage, or other potentially contaminating activities associated with grazing activities were identified within the investigation area. Some maintenance work/refurbishment of stock water groundwater extraction locations was apparent with replacement of bores, windmills, tanks, troughs and pipework. Disused equipment remained in the proximity of the bore.
- All surface water dams observed were either dry or held very little water. No evidence of contamination was observed at any of the dams.
- All creek lines crossed were dry at the time of inspection and were free of rubbish and anthropogenic materials. Eaglefield and Charlie creeks, which had homestead sites up gradient were inspected at the proximity of the eastern boundary of the investigation area. No evidence of waste disposal or contamination was observed.
- An area of erosion was observed within the north western portion of ML1790 (ML1790 – disturbance Area 10) to the south of Suttor Development Road. An inspection of the area did not identify any anthropogenic disturbances other than grazing and a farm access track/Suttor Development Road up gradient. The dispersive soils had eroded up to one metre in depth within an area with a slight slope towards Charlie Creek.
- The area of reduced vegetation in the center of ML1790 (ML1790 – Disturbance Area 06) had evidence of topsoil loss and a lack of groundcover vegetation. Aside from an agricultural dam located in the center of the area, no other anthropogenic activities were noted. A tributary of Kennedy Creek ran through the area and showed evidence of accelerated erosion.

Photographs showing the investigation area at the time of field inspection are contained in **Appendix I**.

The inspection of the investigation area did not identify any evidence that would indicate a significant potential for contamination within the investigation area.

Surrounding the investigation area, homestead sites include cattle dips, workshops, landfilling and other activities that have the potential to cause contamination. Mining operations to the south and north of the investigation area also have the potential to cause contamination. Due to the distance from the investigation area and the direction of surface water flows (on the northern, southern and westerns sides) these surrounding land uses are not anticipated to have caused contamination of the investigation area.

6.1 Anecdotal Information

Due to BHP Covid-19 restrictions, access to interview land managers during the site inspection was not available. Interviews were undertaken over the phone post the site inspection. Pertinent Information from the interviews are summarised below.

Mr David Write – Land Manager for Dabin Station (Lot 2 on SP214117) including the northern portion of ML1790 and ML70495 and ML70443 south of Sutter Development Road.

- Groundwater is extracted across the Dabin properties for use as stock water. Bores were estimated to be approximately 100 to 120m deep. The quality of the water was variable with a couple of bores producing reasonable water, however others were quiet brackish.
- A cattle dip is present within the yards located at the homestead (not within the mining leases). The dip had not been operated for at least 25 years.
- Waste disposal on site was in an area between the homestead and creek (not within the mining leases). No other waste disposal locations were known.
- No known areas of contamination or spills/releases of hazardous materials within the mining lease areas, noting the “gas people” had been doing drilling but had not informed Mr Wright of any contamination/incidents.
- Approximately 20 years ago during international beef export contamination concerns, a couple of dogs brought in from Toowoomba were used to assess for potential contamination around the holding yards. The assessment identified potential low level dieldrin impacts within the cattle holding yards and a separate area was set up to hold the cattle and prevent possible contamination of the beef (not in mining lease area).

Mr Andrew Dioth, the land manager for Lenton Downs, was unable to be contacted during the course of the investigation.

7 Conceptual Site Model

The Conceptual Site Model (CSM) has been based on the guidance provided in the ASC NEPM and has been developed to determine the presence of plausible complete exposure pathways from contamination sources to receptors such as humans and/or environmental values. For an identifiable risk to exist, a complete exposure pathway must be present, which requires each of the following to be present.

- The presence of substances that have the potential to cause harm (SOURCE).
- The presence of a receptor which may be harmed at an exposure point (RECEPTOR).
- The existence of a means of exposing a receptor to the source (EXPOSURE ROUTE).

Outlined below are descriptions of the source, receptors and exposure pathways associated with the investigation area and a summary of the potentially complete exposure pathways identified.

7.1 Source

At the time of site inspection, the investigation area was predominantly utilised for grazing with historical evidence of coal exploration activities (drilling and other surveys). Mining, bulk sampling or the excavation of box cuts had not been undertaken. The investigation did not identify sources of contamination within the investigation area that had the potential to cause environmental harm. Surrounding land uses included homesteads and associated infrastructure. Two of the homesteads (Dabin and Lenton Downs) were located upstream of the investigation area and undertook activities that had the potential to cause contamination. However, the distance to the investigation areas along the ephemeral creek alignments (at least 3.5km) would prevent potential sources of contamination impacting the investigation area.

Therefore, no sources of contamination have been identified for the investigation area at the time of this investigation.

7.2 Potential Receptors

Potential receptors identified include the following:

- on-site exploration/mining personnel;
- on-site land users/managers;
- on-site stock (cattle);
- off-site maintenance workers within easements;
- off-site land users industrial land users;
- off-site residential occupants;
- public users of roads and other public areas;
- terrestrial ecological receptors within the rural and industrial environments in proximity of the investigation area; and
- ecological ecosystems of the creeks and drainage lines both on site and down gradient.

7.3 Potential Exposure Routes

The main feasible transport mechanisms that have been identified for the mobilisation of contaminants include:

- surface water flows;
- groundwater;
- airborne particulates; and
- dermal contact with contaminated soil.

7.4 Potentially Complete Exposure Pathways

As no sources of contamination have been identified within the investigation area, no complete exposure pathways have been identified.

8 Conclusions and Recommendations

8.1 Conclusions

The investigation area covered by this PSI included the mining leases held under the Environmental Authority (EA): EPPR00668513 (date effective 25 January 2018). The mining leases included: ML4752; ML1790, ML70443; and ML70495. These mining leases covered part of the following legal properties:

- Lot 2 SP256592;
- Lot 2 SP214117;
- Lot 8 GV807254; and
- Lot 11 SP262530.

Based on the results of the PSI the following conclusions are drawn.

- Lot 8 on GV807254 was listed on the Queensland Environmental Management Register (EMR) for the notifiable Activity of Livestock Dip or Spray Race. All other properties at the time of investigation were not listed on the EMR. No Notifiable Activities were identified within the investigation area (including the portion of Lot 8 on GV807254 within the investigation area). However, homestead sites located outside of the mining leases and boundaries of the investigation area, may contain 'Notifiable Activities' associated with the use of the properties for grazing. None of the properties were listed on the Queensland Contaminated Land Register.

- Groundwater monitoring within the Tertiary hosted aquifers had been undertaken by BHP since 2011. As mining operations, other than exploration drilling and seismic works, have not been undertaken prior to this investigation, the groundwater analytical results are indicative of pre-mining conditions. A preliminary assessment of the groundwater results indicated that 80th percentile concentrations of chloride, sodium, boron, selenium, zinc and total dissolved solids were above selected Water Quality Objectives for the catchments. Anthropogenic sources of these contaminants were not identified and therefore the identified concentrations are anticipated to be representative of background conditions. The Tertiary aquifer results indicate that groundwater has limited potential for potable/domestic use and for release to sensitive ecosystems without prior treatment. The analytical results indicate the Tertiary aquifer is suitable for cattle stock watering.
- Registered groundwater monitoring wells on site are predominantly utilised for monitoring purposes. However inspection of the investigation area indicates that groundwater has been and is utilised for the purpose of stock watering.
- Investigations into the quality of the Permian hosted aquifers are limited, however based on regional data, groundwater hosted within the Permian is expected to have higher levels of salinity when compared to the overlying Tertiary aquifers.
- Review of historical imagery indicates the investigation area has been utilised for grazing purposes since at least 1957 with only minor disturbance areas predominantly associated with exploration drilling, farm dams, Suttor Development Road and a quarry/borrow pit. Review of the historical titles indicates that registered owners, other than BHP for Lot 2 SP214117 and Lot 11 SP262530, have been private citizens since the deed of grant was issued.
- The majority of the investigation area is located in the Burdekin Basin, which drains the investigation area to the west and into Eaglefield Creek followed by the Suttor River and the Burdekin River. The south eastern corner of the investigation area falls within the Fitzroy Basin, with the investigation area forming the headwaters of Goonyella Creek, which flows in a south easterly direction and into the Isaac River.
- Ecosystems on site include endangered (Semi-evergreen vine thicket, Brigalow, Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin Poplar Box Grassy Woodlands) and of concern ecosystems/ecological communities and may provide habitat for a variety of the endangered and vulnerable species.
- No visible evidence of contamination was observed during the site inspection and no ‘Notifiable Activities’ or other evidence indicating the presence of ‘Prescribed Contaminated Land’ (as defined by the EP Act (1994)) was identified within the investigation area. Surrounding land uses at homestead sites (outside of the investigation area) have the potential to have undertaken ‘Notifiable Activities’. However the distance to the investigation area and in some cases the direction of overland flow would limit the potential for these activities to have impacted the investigation area.

8.2 Recommendations

Based on the results of the PSI, which did not identify a reasonable potential for the presence of ‘Prescribed Contaminated Land’ within the investigation area, no further contaminated land investigations are required to support the development of the PRC Plan.

9 References

AEG (2012) Interim Draft Report on Wards Well Environmental Impact Study Groundwater Assessment

ANZECC & ARMCANZ (2000) Australian and New Zealand Guidelines for Fresh and Marine Water Quality

Commonwealth Government (1999) *Environmental Protection and Biodiversity Conservation Act*

Commonwealth Government (2019) Australia New Zealand Food Standards Code

Ecological Australia (2017) Wards Well Coal Project Ecological Assessment Report

Golder (2021) Wards Well Progressive Rehabilitation and Closure Plan – Hydrogeological Conceptual Model

National Environment Protection Council (1999) National Environment Protection (Assessment of Site Contamination) Measure

NHMRC (2008) Guidelines for Managing Risks in Recreational Water.

NHMRC (2011) Australian Drinking Water Guidelines

NQ Dry Tropics 2016, Burdekin Region Water Quality Improvement Plan (2016), NQ Dry Tropics, Townsville.

Queensland Government (1994) Environmental Protection Act

Queensland Government (2011) Isaac River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Isaac River Sub-basin (including Connors River)

Queensland Government (2019) Environmental Protection (Water and Wetland Biodiversity) Policy

Queensland Government (2019) Queensland Auditor Handbook for Contaminated Land – Module 6: Content requirements for contaminated land investigations documents, certifications and audit reports.

RGS Environmental Pty Ltd/Terrenus Earth Sciences (2012) Draft Geochemical Assessment of Potential Coal Reject, Coal and Spoil Materials Wards Well Project

Standards Australia (AS4482.1:2005) Guide to the Investigation and Sampling of Sites with Potentially Contaminated Soil.

APPENDIX 9 – NOT USED

APPENDIX 10
WARDS WELL PRCP RISK ASSESSMENT

Wards Well Risk Assessment
Progressive Rehabiliation and Closure Plan

Risk Event* (Unplanned/unwanted event)	Scenario #	Scenario	Causes (related to risk event)	Impact Description*	MFL Basis* (Absolute worst case scenario, with no controls in place)	Highest MFL Level	Mitigating Controls	Severity Impact Description* (taking into account the effectiveness of existing mitigating controls)	Highest Severity	Preventative Controls	Likelihood Basis* (chance of the impact at the severity which is being used in the calculation of the RRR, taking into account the effectiveness of existing preventative	Likelihood	Likelihood*	RRR
Stable condition (safe, stable, non-polluting and sustainable) for land described as a post-mining land (reference PMLU table E1 - 100% cattle grazing) use is not achieved	1	Landform failure (Boxcut backfilled and 0.6m elevation on remaining dump, driven by EA conditions)	1. Erosion instability 2. Geotechnical instability 3. Differential settlement 4. Insufficent surface cover to maintain PMLU 5. Flooding and/or extreme weather events	- Erosion - Sediment transport - Topsoil loss - Failure of vegetation - Slumping and settlement - Mass movement of landform - Exposure of less desirable materials in the dump or backfill	Erosion with differential settlement	2	- Monitoring of landform stability and rehabilitation success to be undertaken post operations to confirm stability and identify requirements for rectification works. - Reshape of landform to fix differential settlement and erosion and revegetate areas.	Monitoring identifies any failure and limits the time before repairs are scheduled.	1	- Backfill box-cut in lifts to increase compaction during dumping - Prioritise placement of dispersive tertiary and weathered material in the void - Prioritise placement of less erosive Permian material on the outside of the backfill - Filling above natural surface to account for settlement and prevent possible flood impacts - Minimise height and slope gradients of landform structures - Landform structures reshaped and blended in with surrounding topography - Surface cover including vegetation to provide erosion resistance	With all controls in place including ongoing monitoring and maintenance would mean that landform failure on a large scale for this landform is unlikely	Unlikely	0.1	1
Stable condition (safe, stable, non-polluting and sustainable) for land described as a post-mining land (reference PMLU table E1 - 100% cattle grazing) use is not achieved	2	Alteration of hydrogeological conditions	1. Release of contaminants to groundwater. 2. Change in geological profiles and groundwater extraction resulting in changes to pre-mining groundwater depths. 3. Change in geological profiles and groundwater extraction resulting gin alterations of groundwater flows. 4. Interconnection of groundwater aquifers of differing characteristics. 5. Change in groundwater recharge and discharge characteristics resulting in changes to the hydrogeological system.	- Groundwater chemistry altered rendering it not suitable for extraction and use within PMLU - Grazing - Degradation of stygofauna ecosystems - Degradation of terrestrial and aquatic Groundwater dependant ecosystems - Groundwater quality not supporting the establishment/maintenance of Environmental Values and Water Quality Objectives for the basins in which the mine is located - Loss of groundwater aquifer volume and height i.e. depletion of the groundwater resource - Existing groundwater extraction bores become dry, depletion of Groundwater resource reducing availability for extraction/beneficial use - Excavation areas acting as a sink for shallower basalt/lower salinity aquifers and increasing groundwater flows into the Permian aquifers	Changes to the quality or height of groundwater aquifers that render water within the Tertiary aquifers unsuitable for stock watering and maintenance of ecosystems. If this occurred a Site Management Plan may be required to restrict groundwater extraction in the impacted area and existing groundwater bores may need to be relocated.	1	- Site operational procedures will include requirements for notification/reporting of and cleaning up of any spills. - Maintenance of all plant and equipment will be undertaken to prevent and rectify any loss of hazardous materials. - Any contamination caused by the approved activities will be investigated and remediated on-site or removed from site for disposal as appropriate. - Operational areas will be assessed at the completion of exploration activities for any releases of hazardous contaminants and any impacted areas remediated/appropriately managed. - Groundwater monitoring data collected during and post the approved exploration activities will be reviewed for evidence of groundwater impacts. If impacts to groundwater are identified, further investigations will be undertaken to determine appropriate remedial measures.	Localised degradation of groundwater quality or decrease in groundwater heights. Compartmentalised Tertiary aquifer will limit the lateral extent of the distribution. Carbon based contaminants would be expected to naturally degrade over time. No AMD risks identified. Water levels and electrical conductivity expected to reach new equilibrium relatively quickly with recharge from rainfall infiltration.	1	- All imported hazardous materials are to be stored and used in accordance with relevant standards and removed from site on completion of the exploration works. - At the completion of operations, all hazardous materials and infrastructure that have the potential to release contaminants to groundwater will be removed from site. - Box-cut void will be backfilled. - Geochemical risks associated with the material to be excavated are to be assessed prior to commencement of box cut excavation by suitably qualified persons and plans developed and implemented to manage any identified risks. - Groundwater and ecosystem monitoring to be undertaken in accordance with EA conditions. - Assessment of groundwater through development of conceptual models by suitably qualified persons to assess the potential for groundwater impacts associated with approved activities. Note that a very low risk (contamination, water level and quality change) of the proposed operations causing any long term permanent impacts has been identified (Golder 2020).	No AMD issues identified, relatively small box cut and underground bulk sampling excavation, backfill of excavation at completion and limited site operations that have the potential to cause contamination of the groundwater aquifer. Groundwater flow within backfill should be in a downward direction towards the Permian aquifer and therefore dominated by the water with similar properties to the Tertiary aquifer (see Golder 2020 Wards Well Mine - Progressive Rehabilitation and Closure Plan - Hydrogeological Conceptual Model). Therefore highly unlikely.	Unlikely	0.1	1
Stable condition (safe, stable, non-polluting and sustainable) for land described as a post-mining land (reference PMLU table E1 - 100% cattle grazing) use is not achieved	3	Alteration of surface water systems	1. Release of contaminants to surface water resources. 2. Changes to alignments and ecosystems of drainage lines and streams. 3. Changes to hydraulic flows. 4. Changes to flood patterns/distribution. 5. Alternation of surface water infiltration rates. 6. Surface water flows over unvegetated/disturbed soils.	- Surface water chemistry altered rendering it not suitable for PMLU - Grazing - Degradation of ecosystems and land uses connected to surface water flows and floodplains on and down gradient of the mine - Sedimentation of downstream surface water drainage lines resulting in changes to their hydraulic properties and impacting ecosystems - Surface water quality not supporting the establishment/maintenance of Environmental Values and Water Quality Objectives for the basins in which the mine is located - Accelerated erosion rates from surface water flows in disturbed areas and degraded ecosystems - Reduction in rehabilitation success rates due to reduced surface water quality - Alteration of soil properties associated with contaminants carried by surface waters, including erodability and geotechnical qualities	Changes to the quality and quantity of surface waters that render it not suitable for proposed final land use of grazing or results in degradation of ecosystems. If this occurred additional remediation, alteration of final landforms, or implementation of a Site Management Plan may be required.	2	- Surface water monitoring data collected during and post the approved exploration activities will be reviewed for evidence of water quality impacts. If impacts are identified, further investigations will be undertaken to determine appropriate remedial measures. - Site operational procedures will include requirements for notification/reporting of and cleaning up of any spills. - Maintenance of all plant and equipment will be undertaken to prevent and rectify any loss of hazardous materials. - Any loss of hazardous contaminants by the approved exploration activities that causes contaminated land/environmental harm will be investigated and remediated on-site or removed from site for disposal as appropriate. - Operational areas will be assessed at the completion of exploration activities for evidence of contaminated land and any impacted areas remediated/appropriately managed. - Sediment and erosion controls will be regularly inspected and maintained where required.	If surface water contamination was occurring likely to be from near surface materials which could be easily accessed and managed. Final landform only 0.6m above the pre-mining surface height. Disturbance areas not within any recognised drainage or creek lines.	1	- All imported hazardous materials and to be stored and used in accordance with relevant standards and removed from site on completion of the approved exploration works. - Box-cut void will be backfilled. - Surface water monitoring to be undertaken in accordance with EA conditions. - Separation of clean (stormwater dam) and mine-affected water (mine water dam) systems to prevent the release of contaminants/ sediments that have the potential to cause environmental harm. - Monitoring of surrounding ecosystems will be undertaken in accordance with EA conditions. - Rehabilitation of disturbed areas will be undertaken as soon as practical after the completion of operations.	No AMD issues identified, final landform only 0.6m above existing level, backfill of excavation at completion and limited site operations that have the potential to cause contamination and are to be removed at the completion of works. No alteration of surface water drainage lines or creeks required.	Unlikely	0.1	1

Risk Event* (Unplanned/unwanted event)	Scenario #	Scenario	Causes (related to risk event)	Impact Description*	MFL Basis* (Absolute worst case scenario, with no controls in place)	Highest MFL Level	Mitigating Controls	Severity Impact Description* (taking into account the effectiveness of existing mitigating controls)	Highest Severity	Preventative Controls	Likelihood Basis* (chance of the impact at the severity which is being used in the calculation of the RRR, taking into account the effectiveness of existing preventative	Likelihood	Likelihood*	RRR
Stable condition (safe, stable, non-polluting and sustainable) for land described as a post-mining land (reference PMLU table E1 - 100% cattle grazing) use is not achieved	4	Alteration of flood hydrology	1. Changes to drainage network hydraulics. 2. Artificial landforms reducing or increasing flood extent and changing velocities/flows. 3. Changes to vegetation cover and soil type which alter runoff and infiltration rates.	- Decrease in landform stability - Accelerated mobilisation of sediments and other hazardous contaminants off-site - Increasing/decreasing of flood extents, frequency and severity - Degradation of floodplain ecosystems - Degradation of ecosystems which were not previously subject to flooding due to water inundation - Infrastructure damage from increased flooding heights/velocities - Health and safety risks to on-site and off-site land users associated with increased flood heights, velocities and frequency	Alteration of flood dynamics that result in damage to the surrounding environment and infrastructure.	1	- Monitoring of landform stability and rehabilitation success to be undertaken post operations to confirm stability and identify requirements for rectification works. - Where approved activities alter floodwater characteristics that cause damage to infrastructure within the proximity of the operations, the infrastructure will be repaired and appropriate mitigation measures assessed and implemented to minimise potential future occurrence.	The area containing the box cut and associated disturbances has less than a 0.2m modelled extreme flood height (DNRME).	1	- Box-cut void will be backfilled. - Assessment of flooding risks evaluated prior to commencement of operations. Note assessment has confirmed low risk. - Final landforms are to be located, designed and constructed to minimise impact to flooding regimes and to withstand reasonably assessed flooding risks. - Monitoring of surrounding ecosystems to be undertaken in accordance with EA conditions .	Extreme flood event only has the potential to introduce <0.2m of flood waters to the box cut disturbance area.	Unlikely	0.1	1
Stable condition (safe, stable, non-polluting and sustainable) for land described as a post-mining land (reference PMLU table E1 - 100% cattle grazing) use is not achieved	5	Insufficient, inadequate or inappropriate soil and capping material required for rehabilitation activities	1. Poor soil fertility 2. Unstable material (erosive, dispersive) 3. Weed infestation 4. Disturbance by fauna (movement, burrowing, etc.) 5. Incorrect placement depth and surface treatment 6. Incorrect soil characterisation and amelioration requirements 7. Insufficent topsoil 8. Inappropriate topsoil stockpiling and management	- Erosion - Sediment transport - Topsoil loss - Failure of vegetation (poor vegetation growth or incorrect vegetation affecting PMLU)	Total failure of vegetation in rehabilitation areas.	2	- Monitoring of landform stability and rehabilitation success to be undertaken post operations to confirm stability and identify requirements for rectification works. - Repair erosion areas, retest soil and revegetate.	Monitoring identifies any failure and limits the time before repairs are scheduled.	1	- Initial topsoil survey, mapping and material balancing - Provide data into the mine plan to drive correct placement of materials - Review the topsoil material balance periodically during operations to ensure sufficient volumes for the rehabilitation needs. - Undertake rehabilitation planning and preparation in accordance with the specific requirements for soil, seed and management for a grazing PMLU - Management of topsoil stripping and application during rehabilitation. - Topsoil assessment by suitably qualified person to determine ameliorant and fertiliser requirements.	With all controls in place including ongoing monitoring and maintenance would mean that insufficient, inadequate or inappropriate soil for use on rehabilitation is unlikely	Unlikely	0.1	1
Stable condition (safe, stable, non-polluting and sustainable) for land described as a post-mining land (reference PMLU table E1 - 100% cattle grazing) use is not achieved	6	Insufficient identification and management of waste characterisation	1. Poor material characterisation 2. Geochemical not correctly defined 3. Inappropriate placement of adverse material 4. Poor landform execution 5. Inappropriate management strategy	- Release of contaminates to surface and groundwater. - Vegetation failure - Water cannot be used by end user (human and ecosystem) - Erosion	Significant quantities of carbonaceous material not identified leading to vegetation failure and impact to water.	2	- Monitoring of landform stability and rehabilitation success to be undertaken post operations to confirm stability and identify requirements for rectification works. - Cover undesirable materials and redo rehabilitation.	Monitoring identifies any failure and limits the time before repairs are scheduled.	1	- Ongoing waste characterisation during operations - Prioritise tertiary, weathered and carbonaceous material in the box-cut void.	With all controls in place including ongoing monitoring and maintenance would means that insufficient, inadequate or inappropriate soil for use on rehabilitation is unlikely	Unlikely	0.1	1
Stable condition (safe, stable, non-polluting and sustainable) for land described as a post-mining land (reference PMLU table E1 - 100% cattle grazing) use is not achieved	7	Failure of, or inadequate / inappropriate cover design	No cover design required for Wards Well as there is no environmental risk associated with any material remaining on-site.	N/A			N/A			N/A				
Stable condition (safe, stable, non-polluting and sustainable) for land described as a post-mining land (reference PMLU table E1 - 100% cattle grazing) use is not achieved	8	Inadequate and/or inappropriate revegetation	1. Unfavourable climatic conditions and/or weather events 2. Incorrect species mix 3. Poor seed quality 4. Weed contaminated seed 5. Poor quality topsoil or seed bed preparation 6. Erosion	- Exposed soils due to poor vegetation establishment and growth, resulting in enhanced erosion rates. - Increased weed establishment and growth. - Reduction in land capability of PMLU (grazing) - reduced availability of land for grazing (erosion), as well as inhibited growth of suitable fodder species - Need for ongoing corrective action - soil sampling and analysis, amelioration and re-vegetation.	Total failure of vegetation in rehabilitation areas.	2	- Monitoring of landform stability and rehabilitation success to be undertaken post operations to confirm stability and identify requirements for rectification works. - Repair erosion areas, retest soil, review seed mix and revegetate.	Monitoring identifies any failure and limits the time before repairs are scheduled.	1	- Topsoil assessment by suitably qualified person to determine ameliorant and fertiliser requirements. - Management of seed selection and quality. - Plant at optimal time of year.	With all controls in place including ongoing monitoring and maintenance would means that insufficient, inadequate or inappropriate soil for use on rehabilitation is unlikely	Unlikely	0.1	1

Risk Event* (Unplanned/unwanted event)	Scenario #	Scenario	Causes (related to risk event)	Impact Description*	MFL Basis* (Absolute worst case scenario, with no controls in place)	Highest MFL Level	Mitigating Controls	Severity Impact Description* (taking into account the effectiveness of existing mitigating controls)	Highest Severity	Preventative Controls	Likelihood Basis* (chance of the impact at the severity which is being used in the calculation of the RRR, taking into account the effectiveness of existing preventative	Likelihood	Likelihood*	RRR
Stable condition (safe, stable, non-polluting and sustainable) for land described as a post-mining land (reference PMLU table E1 - 100% cattle grazing) use is not achieved	9	Failure of TSF rehabilitation	Not applicable - no TSFs for Wards Well	N/A			N/A			N/A				
Stable condition (safe, stable, non-polluting and sustainable) for land described as a post-mining land (reference PMLU table E1 - 100% cattle grazing) use is not achieved	10	Stability failure of rehabilitated void	1. Erosion instability 2. Geotechnical instability (deterioration of geotechnical characteristics) 3. Geochemical instability (deterioration or changes) 4. Increase/decrease in predicted void water levels	- Changes to surface and groundwater flow patterns / distribution.	Erosion with differential settlement	2	- Monitoring of backfill settlement and rehabilitation success to be undertaken post operations to confirm stability and identify requirements for rectification works.	Monitoring identifies any failure and limits the time before repairs are scheduled.	1	- Box-cut void to be backfilled .	With all controls in place including ongoing monitoring and maintenance would means that insufficient, inadequate or inappropriate soil for use on rehabilitation is unlikely	Unlikely	0.1	1
Stable condition (safe, stable, non-polluting and sustainable) for land described as a post-mining land (reference PMLU table E1 - 100% cattle grazing) use is not achieved	11	Stability failure of underground mine workings'	1. Geotechnical instability of remaining pillars 2. Surface cracking and/or sinkhole formation 3. Flooding of underground workings	- Surface subsidence that may affect functionality of the PMLU (grazing) - landform changes that could hinder/change safe access to areas by livestock. - Damage to existing flora and revegetated area damage due to changing surface conditions. - Increased potential for spontaneous combustion events within underground workings. - Changes to surface water infiltration rates, flow patterns and/or flood patterns/distribution that could affect local catchment and ecosystem integrity. - Changes to groundwater flow volumes and rates that could affect local catchment integrity.	Total collapse of underground workings causing significant subsidence	2	- Monitoring of subsidence and rehabilitation success to be undertaken post operations to confirm stability and identify requirements for rectification works. - Revegetate areas of vegetation die-back. - Fill surface cracks to reduce both water and air access to underground workings (reducing water ingress and oxygen exposure for ignition of spontaneous combustion).		1	- Underground design to consider geotechnical issues and include stability analysis and subsidence modelling. - Undertake an assemment to determine the most appropriate, legislatively accepted seal requirements.	With all controls in place including ongoing monitoring and maintenance would mean that insufficient, inadequate or inappropriate soil for use on rehabilitation is unlikely	Unlikely	0.1	1
Stable condition (safe, stable, non-polluting and sustainable) for land described as a post-mining land (reference PMLU table E1 - 100% cattle grazing) use is not achieved	12	Deterioration of built infrastructure conditions	1. Potential soil contamination around mine industrial areas	- Reduced soil fertility to support PMLU land capabillity (grazing). - Potential contamination of surface water runoff affecting integrity of local catchments.		1	- Undertake a preliminary contaminated land assessment prior to the completion of the approved activities, identify if any areas require a further Detailed Site Investigation and remediation plan developed if required. - Conduct ongoing maintenance		1	- Clean up and remediate contamination during operational period. - Undertake PSI contaminated land assessment post mining to identify any areas requiring further DSI	With all controls in place including ongoing monitoring and maintenance would mean that deterioration of built infrastructure is unlikely	Unlikely	0.1	1

APPENDIX 11 - NOT USED