TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

3.1 INTRODUCTION

This chapter provides an assessment of topography, geology, soils and landform for the mine study area of the Project. This chapter describes the existing physical environment at the mine and assesses the likely changes and potential impacts to soils, geology and landforms resulting from the Project. The assessment describes the approach to be taken by Waratah Coal to minimise potential impacts.

3.2 LEGISLATIVE AND PLANNING FRAMEWORK

State Planning Policies (SPPs) are planning instruments implemented under the Sustainable Planning Act 2009 (SP Act) that the planning Minister (or any Minister in conjunction with the planning Minister) can make to protect things that are of interest to the state.

This includes:

- agricultural land;
- separating agricultural land from residential land;
- development within close proximity to airport land; and
- protecting development from adverse effects of bushfire, floods and landslides.

SPP 1/92 – Development and Conservation of Agricultural Land is relevant to the soils and geology aspects of the project.

3.3 ASSESSMENT METHODS

3.3.1 DESKTOP ASSESSMENTS

A desktop review was undertaken of publicly available databases, digital resources including Geosciences Australia's Mapconnect and grey literature relevant to geology, soils and landforms in the project study area.

3.3.1.1 Topography

Topography and landscapes were reviewed with reference to CSIRO Australian Soil Resource Information System (ASRIS) datasets, Queensland Department of Employment, Economic Development and Innovation (DEEDI) –Department of Minerals and Energy (DME) resource and tenure maps and Environment and Resource Management (DERM) records, local government mapping, cadastral data and State Planning Policies (i.e. *SP1/92 - Development and Conservation of Agricultural Lands (SPP1/92)*) mapping.

3.3.1.2 Geology

Geology and landforms were identified using mapping sourced from the ASRIS and Geological and Topographic mapping series sourced from Geosciences Australia.

The Shear zones, faults and dykes have been identified as these areas may have increased geotechnical risks.

3.3.1.3 Soils

The occurrence and distribution of the major soil groups have been mapped for the project area. The typical soil profile characteristics of the main soil groups mapped have been compiled from field observations and various sources including:

- CSIRO ASRIS Mapping (CSIRO, 2006);
- CSIRO *Regional land systems and soils mapping* (1967, 1968, and 1974);
- Geosciences Australia 1:250,000 map series (1968); and
- Atlas of Australian Soils (Isbell *et al.* 1967).

Data obtained from previous field investigations has also been reviewed including studies undertaken by AMEC (2009), Coffey Mining (2009) and the land resources digital atlas data sets including the CSIRO land research series.

3.3.1.4 Landforms

Landforms were mapped using landscape units that provided a basis for the describing of the physical environment. The information reflects the distribution of geological areas, landforms and the associated soil types. Landscape units are a combination of several map units including:

- broad landform (slope and relief), geology and lithology;
- dominant soil orders;
- local climate, drainage networks and related soil profile classes;
- regolith materials; and
- similar geomorphological systems.

3.3.1.5 Good Quality Agricultural Land

An assessment of Good Quality Agricultural Land (GQAL) was undertaken to assess the current and potential agricultural land use. The assessment was based upon a four class system that is described in the DEEDI and

Department of Housing and Local Government (DHLG) planning guidelines for the identification of GQAL. These guidelines describe land as one of the following:

- Class A: Crop land, being land suitable for current and potential crops with limitations to production which range from nil to moderate;
- Class B: Limited Crop Land, being land that is marginal for current and potential crops due to severe limitations, but is suitable for pastures. The land may require improvement before it is suitable for sustainable cropping / cultivation;
- Class C: Pasture Land, being land suitable for improved or native pastures due to limitations which preclude continuous cultivation for crop production. Some areas may tolerate short-term cultivation for improved pasture and forage crop establishment. Other areas are primarily suited to grazing of native pastures, with or without the addition of improved pasture species without ground disturbance. Elsewhere the land is suited to restricted light grazing of native pastures in accessible areas, otherwise very steep hilly lands more suited for forestry, conservation or catchment protection; or
- Class D: Non-agricultural land, being land not suitable for agricultural uses due to extreme limitations. This may comprise 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 conditions.

Data sources used in the assessment of GQAL included:

- DERM Regional Compilation of Mapping (1:250 000) Central West Region – GQAL; and
- local government planning documents including the Planning Scheme for Barcaldine Regional Council (BRC).

The local government GQAL mapping from the various planning schemes was used to undertake the desktop review of GQAL. This information was supplemented with site specific sampling.

3.3.1.6 Land Suitability

The Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland – Land Suitability Techniques (Department of Minerals and Energy, 1995) provide several criteria for the assessment of land use. These criteria are described via five Land Use Suitability class definitions and eight Land Capability Classifications. These landuse suitability classifications are assessed separately for broad acre cropping and beef cattle grazing, with the provision of criteria for the following land attributes:

- nutrient status;
- soil physical factors;
- soil workability;
- salinity;
- rockiness criteria;
- micro-relief (presence of melon holes associated with gilgai micro-relief);
- wetness criteria;
- topography;
- water erosion;
- flooding; and
- vegetation re-growth management.

A correlation exists between the guidelines for GQAL and the Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland – Land Suitability Techniques. This correlation is shown in Table 1.

Table 1. Correlation of pre-mining land capability classes with GQAL land classes

PRE-MINING LAND CAPABILITY CLASSES		GQAL LAND USES		PRE-MINING LAND SUITABILITY CLASSES	
CLASS	DESCRIPTION	CLASS	DESCRIPTION	CLASS	DESCRIPTION
1	Land suitable for all agricultural and pastoral uses.	Class A	CROP LAND: land suitable for current and potential crops. Limitations to production range from none to moderate levels. All crop land is considered good quality agricultural land.	1	Agricultural - Suitable with negligible limitations - Land which is well suited to a proposed use.
2	Land suitable for all agricultural uses with slight restrictions to cropping.			2	Suitable for agriculture with minor limitations - land which is suited to a proposed use but which may require minor changes in management to sustain use.
3	Land suitable to all agricultural uses with moderate restrictions to cropping.	Class B	LIMITED CROP LAND: land marginal for current and potential crops; and suitable for pastures. Land which is marginal or un-suitable for most current and potential crops due to severe limitations. Further engineering and/or agronomic improvements may be required before land would be considered suitable for cropping. Land marginal for particular crops of local significance is considered to be good quality agricultural land.	3	Suitable for agriculture with moderate limitations - land that is moderately suited to a proposed use but which requires significant inputs to ensure sustainable use.
4	Land primarily used for pastoral uses but can be carefully cropped occasionally.				
5	Land primarily used for pastoral uses but can be cropped if limitations are removed.	Class C	PASTURE LAND: Land suitable only for improved or native pastures. Limitations preclude continuous cultivation for crop production but some areas may tolerate a short period of ground disturbance for pasture establishment. In areas where pastoral industries are the major primary industry, land suitable for improved or high quality native pastures may be considered to be good quality agricultural land.		
6	Land is not suitable for cultivation but well suited to pastoral production.				
7	Land is not suitable for cultivation and only careful pastoral use possible.			4	Agriculturally marginally suitable land – land which is marginally suited to a proposed use and would require major inputs to ensure sustainability. These inputs may not be justified by the benefits to be obtained in using the land for the particular purpose and is hence considered presently unsuited.
8	Land not suitable for agricultural or grazing uses.	Class D	NON-AGRICULTURAL LAND: Land not suitable for agricultural uses. This may be disturbed land with significant habitat, conservation and/or catchment values. Severe limitations preclude any interference with land resources for the production of agricultural goods.	5	Agriculturally unsuitable land with extreme limitations – land which is unsuited for a proposed use.

3.3.1.7 Contaminated Land Assessment

In order to adopt an appropriate ranking system to assess the large number of properties across the study area for contaminated land risk, a tiered / ranking approach was adopted to assess lots with moderate or high potential for contamination and to select lots with potential impacts to the project area for more detailed investigation. These lots were then selected for Preliminary Site Investigations (PSIs). The ranking order of lots across the study area was classified accordingly to a system of High to Medium and Low risk.

The following summarises the approach of the of the ranking risk assessment:

- a search of DERM's Queensland Valuation and Sales System (QVSS) was conducted to establish primary landuse activities to group into high, medium or low;
- lots ranked as a high risk included industrial land use, (e.g. transport terminals, transformers, airfields, extractive industry). Lots ranked as medium risk include cattle and stock agribusinesses (potential for stock / cattle dips) and contractors / builders yards. Lots ranked as low risk include parks, gardens and residential land as it is unlikely potentially contaminating activities would have been carried out on that land;
- all sites ranked as high risk were subject to a search on the Environmental Management Register (EMR) / Contaminated Land Register (CLR). Medium risk sites were subjected to aerial imagery investigations; and
- EMR / CLR searches were not carried out on low risk sites as lots subject to residential land use were considered the most sensitive land use in terms of public use and exposure. Therefore they would have a low probability of being impacted by contamination.

Further detail on the tiered ranking risk assessment is provided in the Contaminated Land Technical report at Volume 5, Appendix 7.

3.3.2 FIELD INVESTIGATIONS

The dominant soil types intersected by the project were assessed, with emphasis on soils in the mine footprint and potentially dispersive soils at waterways. Desktop assessment of major soil types used dominant soils mapping to refine the scope of field investigations to ensure all of the major soils types within the project area were represented by the sampling. The field investigations included:

- characterisation of soil types;
- assessment of depth and quality of useable soils;
- assessment of dispersivity and erosion potential; and
- assessment for potential as a regrowth medium.

A soil survey of representative sites within the project footprint was conducted with reference to the physical soil stability and the chemical properties of the materials that influence erosion potential, storm water run-off quality, rehabilitation and agricultural productivity of the land.

Soil profiles were mapped by initially reviewing the aerial photography and regional mapping and assigning soil areas based upon common photo tones and topography. Representative samples were then collected from these areas for assessment.

An appraisal of the depth and quality of useable soil was undertaken by using a hand auger and test pitting to a maximum depth of approximately two m from the surface. Sample cores were split into two to three sub-samples depending on the number of soil horizons encountered at each site. Samples were selected for laboratory analysis in order to characterise all soil types within the study area. Data was then interpreted to assess the extent of different soil types.

Ten sample locations were used to characterise soils within or near the mine footprint with 17 sub-samples taken from these locations. Nine samples were sent to the laboratory for analysis.

3.3.2.1 Soil Observations

Visual observations of soil type and structure were undertaken at a number of the waterways that will be disturbed by construction works. These observations were carried out in order to address erosion potential at waterways within the mine site. Characteristics noted on site included dominant soils type, stream morphology, bank vegetation and signs of existing erosion / disturbance. Nine sites were observed at the mine site.

3.3.2.2 Laboratory Analysis

Samples were submitted to laboratories with National Association of Testing Authorities (NATA) accredited methods for the analyses. The laboratory analyses included:

- pH;
- Calcium (Ca) and Magnesium (Mg) Ratios;
- Chlorides (ppm);
- Electrical Conductivity (EC);
- Emerson Crumb Dispersive Analysis;
- Exchangeable Sodium Percentage (ESP); and
- Sodium Absorption Ratios (SAR).

A Detailed description of the tests carried out can be found at Volume 5, Appendix 7.

3.3.2.3 Contaminated Land

Sites with an identified potential for contaminant impacts to the project area were selected for field investigations. The field studies were conducted in November 2009 and April 2010. The following summarises the rationale and methodology for field investigations:

- selection was based upon the results of EMR searches of lots following the tiered risk assessment of land uses and the result of aerial and ground inspections;
- soil samples were collected from targeted locations based upon principals described in AS4482.1 – 2005: *Guide to sampling and investigation of potentially contaminated soil* (Part 1: Non volatile and semi volatile compounds) and AS4482.2-1999: *Guide to sampling and investigation of potentially contaminated soil* (Part 2: Volatile compounds);
- sampling was conducted with either a hand auger to a maximum depth of 0.9 metres below ground level (mgbl) into the soil profile or using a hand trowel to collect soil samples. Two types of samples were collected, either a surface sample (0.0 mgbl) or samples at depths of 0.3 mgbl, 0.6 mgbl and 0.9 mgbl, respectively; and
- the toxicant parameters analysed for both rounds of soil sampling is as follows:
  - livestock dip or spray race operation included Organochlorines (OC) and Organophosphate pesticides (OP); and
  - petroleum product or oil storage included Total Petroleum Hydrocarbons (TPH) C_6-C_9, TPH C_{10}-C_{36} and Poly Aromatic Hydrocarbons (PAH).

3.3.2.4 Overburden Testing

An assessment of topsoil, overburden, interburden and coal (as potential reject material) was undertaken to assess the potential for environmental issues arising from handling and treatment of these materials.

The geochemical testing program used samples collected from groundwater assessment boreholes emplaced in shallower overburden in the area of the mine. The presence of a uniform geology with little structural influence suggests the samples from the shallow soil, overburden, interburden and the coal layers would be representative of the whole layer.

Coal was assessed to allow for coal reject from a CHPP that may be placed in waste containment structures. There are currently no regulatory requirements in Queensland specifying the number of samples to be collected and assessed for overburden or potential reject materials at mines. The number of samples (14) is based upon availability for sampling during the groundwater investigations undertaken at the mine.

The samples were assessed for Acid Neutralising Capacity (ANC), Nett Acid Production Potential (NAPP), Net Acid Generation (NAG), total sulphur and eight priority metals (arsenic, cadmium, chromium, copper, lead, nickel, zinc and mercury).

3.4 DESCRIPTION OF EXISTING ENVIRONMENTAL VALUES

3.4.1 TOPOGRAPHY

The topography at the mine rises gently to the west up to 400 m Australian Height Datum (AHD) to outcrops of the Great Artesian Basin (GAB) sediments 20 km to 40 km west of the mine (Figure 1). Gently undulating plains occur throughout the majority of the mine area with strongly undulating to hilly land in the north-east corner of EPC 1040.

3.4.2 GEOLOGY

The geology at the mine is taken from the *South Alpha Project – Mine News 00201AA Resource Estimate Report (2009)* (Coffey Mining, 2009).

Surface geology of the mine is dominated by unconsolidated Cainozoic sediments. Unconsolidated sands, silts and clay, lateritised in part, form an extensive blanket over the mine area, with thickness of up to 90 in the eastern and central sections. There is an assortment of recent-Quaternary and Tertiary within the Cainozoic blanket but no attempt at demarcation has been made. In the east of South Alpha, the Cainozoic sits directly on the Permian. This contact is unconformable and represents an extensive time gap while the contact is erosional at least in part.

The target geology is held within the Permian interval of the Galilee Basin. The Galilee Basin is an intracratonic basin filled with dominantly fluviatile sediment. The Galilee Basin is geographically large, covering nearly 250,000 km^2 of central Queensland. The Galilee is connected to the Bowen Basin over the Springsure Shelf (south east of Alpha). In the project area, the target geology is held within the Bandanna Formation and Colinlea Sandstone, correlatives of the Bowen Basin's Group IV Permian Rangal Coal Measures.

The Tertiary flood basalts that feature in the cover sequence in parts of the Bowen Basin are absent from project area. The Cainozoic tends to be thin in the west and drilling and previous exploration show the Triassic Rewan Formation as rarely outcropping or identified in the shallow near surface in this region. The Rewan Formation is unconformable on the Permian and consists of the greenish sandstones, siltstones with some shale layers in association with the Rangal Coal Measures in the Bowen Basin to the east. Further west, outcrop of the Lower Triassic sedimentary sequences including the Dunda Beds, Rewan Formation and Moolayember Formation are present.

Much of the western and southern Galilee Basin is concealed under the Jurassic-Cretaceous Eromanga Basin. The north eastern edge of the basin (including the project area) is free of the Eromanga cover and contains some of the shallower Permian occurrences within the Galilee. The earliest Permian Aramac Coal Measures are not recognised within the South Alpha area. The mine's surface geology is shown on Figure 2. Table 2 provides a key to the geology figures for the mine site area.

Table 2. Mine site geological key

GEOLOGICAL SYMBOL	ERA	PERIOD/EPOCH	FORMATION NAME	LITHOLOGICAL DESCRIPTION
Qa	Cainozoic	Quaternary	-	Alluvium, some gravel
Czs	Cainozoic	Quaternary	-	Sand, gravel, rubble
Czc	Cainozoic	Tertiary	-	Argilaceous sandstone, sandy mud stone, lime stone: partly lateralised
Rsl	Mesozoic	Lower to middle Triassic	Clematis Sandstone	Quartz sandstone, shale layers, minor siltstone and mudstone
Rsdu	Mesozoic	Lower Triassic	Dunda Beds	Labile sandstone, siltstone, mudstone
Rsmo	Mesozoic	Lower Triassic	Moolayember	Sandstone, siltstone, shale
Psb	Paleozoic	Lower Permian	Colinea Sandstone	Labile and quartz sandstone, minor siltstone and coal
Cpj (not outcropping)	Paleozoic	Upper Carboniferous to lower permian	Joe Joe Formation	Mudstone, labile sandstone, siltstone, shale

The Permian horizons consist of liable sandstones, siltstones, mudstones and claystones with intercalated coal seams. These horizons dip gently to the west at <1° dip and appear to be free of significant structure. The seams have been allocated the alphabetical sequence used by previous explorers of the area (Figure 3).

The A and B seams are allocated membership of the Bandanna Formation and the sequence for C down the Colinlea Sandstone. It is acknowledged that the E and F seams may belong to a lower formation again. These allocations are tentative and if a definitive relationship can be proven it will be readily adopted. The provision of Formation / Group membership has no material impact on the resource geology of the deposit.

Figure 1. Mine Site Topography

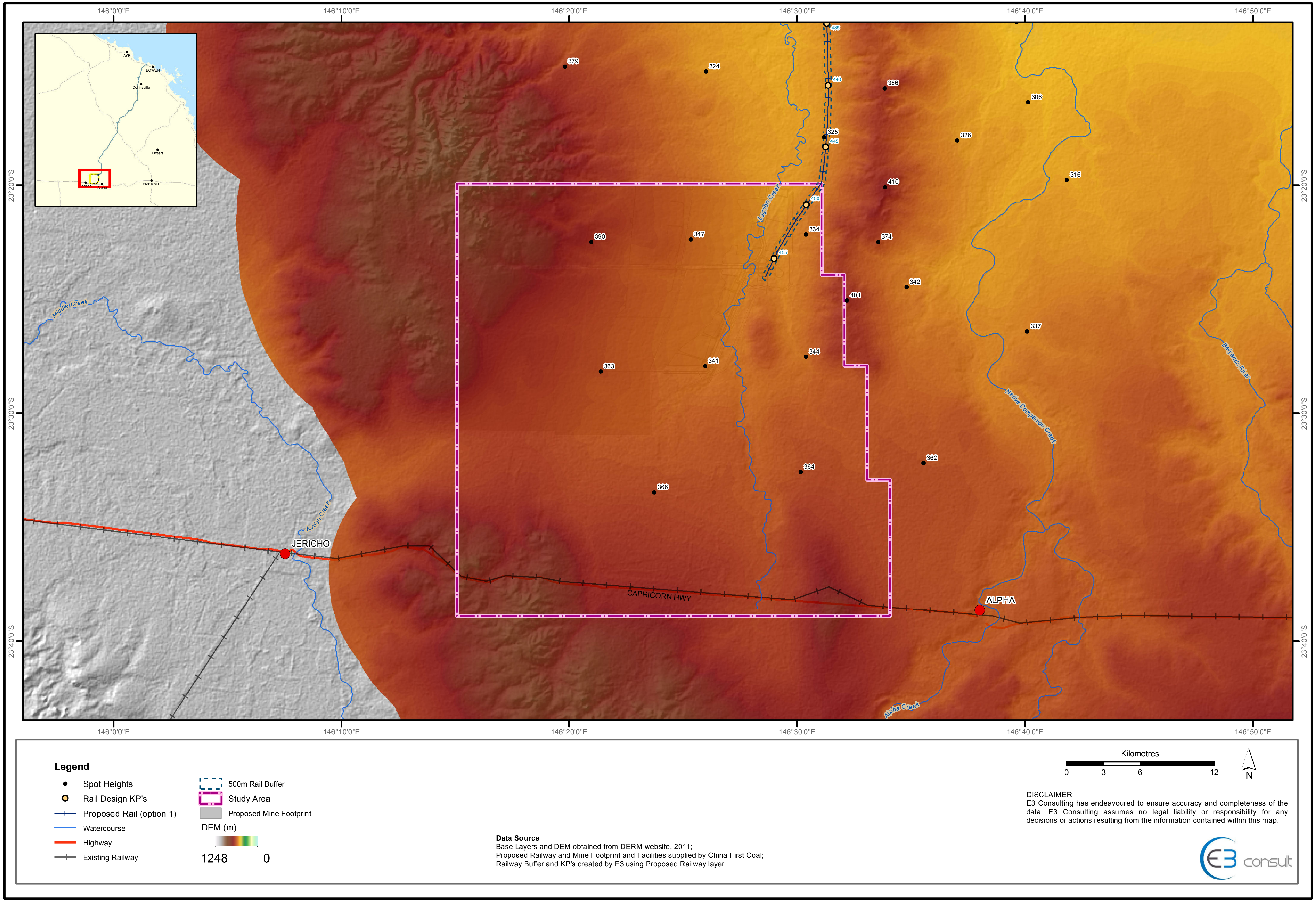


Figure 2. Mine Site Surface Geology

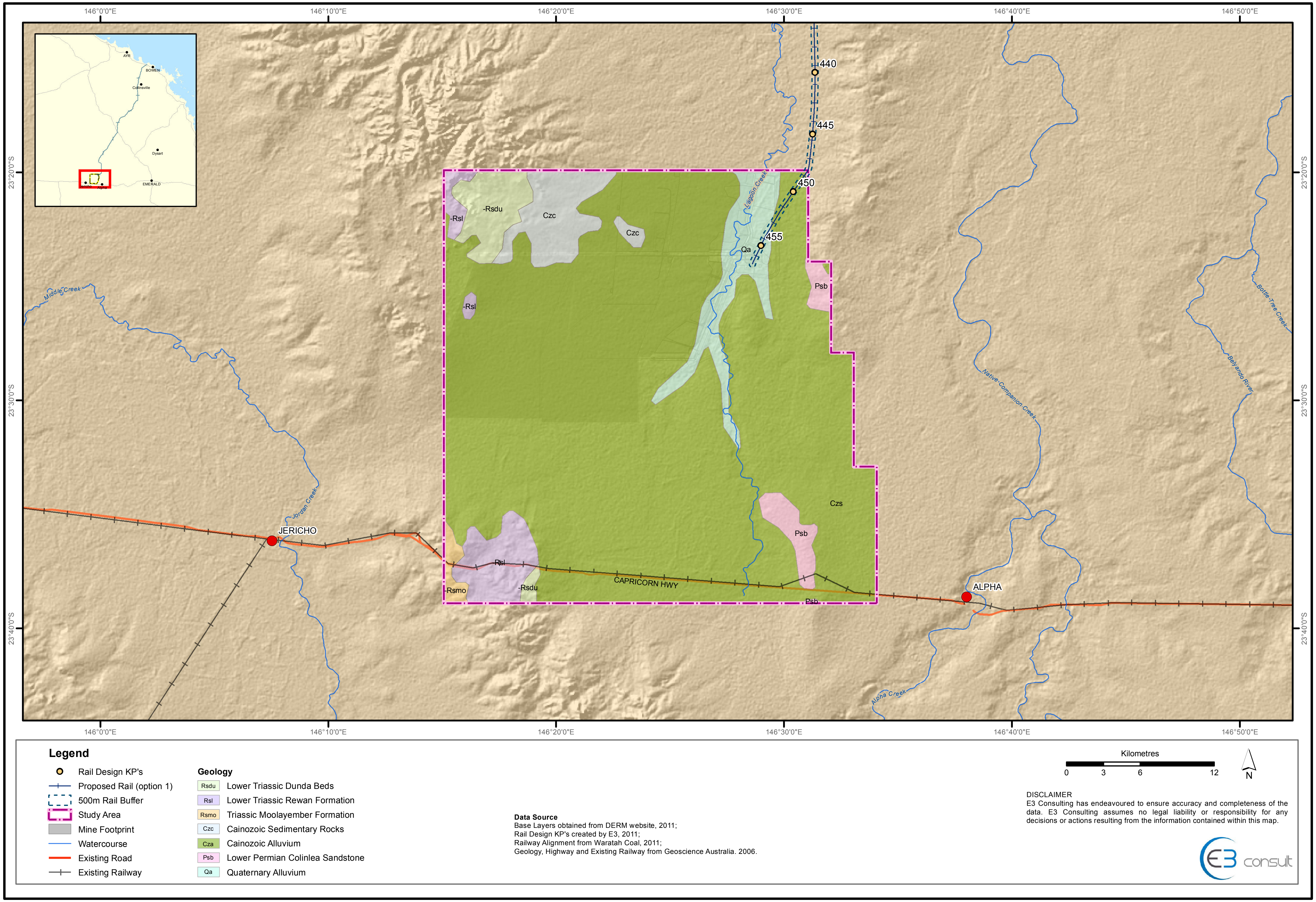
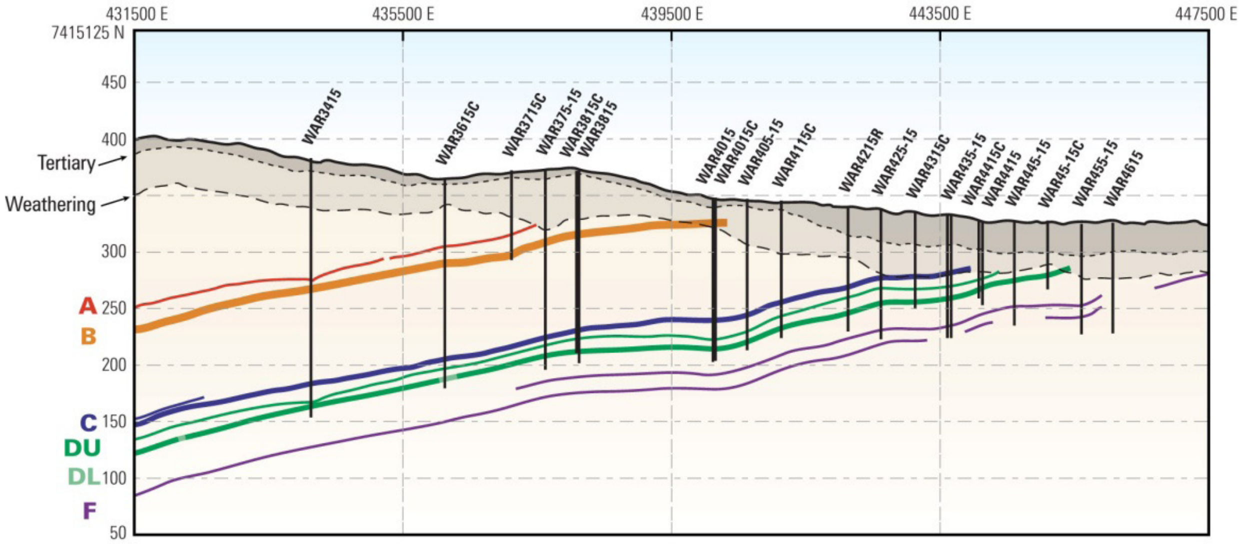


Figure 3. Diagrammatic Representation of the Geological Stratigraphy Throughout the Project Area



Source: Coffey Mining 2009. Note: Vertical Scale has been exaggerated by a factor of greater than 5:1.

The combination of a very gentle westerly dip and subdued topography creates relatively broad subcrop zones for each seam. Additionally, the B and C intervals are separated by a 90 m sandstone (vertical thickness); this separation and the dip / surface geometry causes two north-south orientated bands of seam subcrop; the A and B in the west and the C to DL in the east. The E and F Seams sit below the D splits and subcrop further east again, the seam limits often influenced by deeply incised alluvium channels associated with drainage along Sandy Creek. The full C-F sequence continues unbroken under the A and B subcrop zone and all seams continue down dip. Previous drilling has identified a recognised continuum of the seams down dip for at least 30 km to the west and to over 1,000 m cover.

3.4.2.1 Mine Resource Geology

The Project's coal deposit lies within the Galilee Basin which is a sedimentary basin formed by down-warping of a large area west of the Anakie Inliers during the Upper Carboniferous, Permian and Triassic periods. The Galilee Basin is underlain by the Drummond Basin and overlain by the Eromanga Basin.

Weathering / oxidation is variable but tends to be deep for a coal project. The weathering surface is commonly 30-50 m down into the Rewan / Permian rocks, and:

- the target geology is held within the Permian interval of the Galilee Basin;
- the target mineralisation is late Permian thermal coal; and
- in the project area, the target geology is held within the Bandanna Formation and Colinlea Sandstone that are correlatives of the Bowen Basin's Group IV Permian Rangal Coal Measures.

The coal resource is found in five principal seams from shallowest to deepest with other subordinate coal horizons present. A full description of the coal seams is provided in **Volume 2 Chapter 1**. The identified coal seams are allocated the alphabetical sequence used by previous explorers of the area. Further sub-division of the seams has occurred during Waratah's exploration including:

- a dirty top ply of the C seam is recognised but not considered economic due to high ash (C Upper 'CU');
- D seam is typically found in two splits – D Upper ('DU') and D Lower ('DL'); and
- DL is further divided into DL1 (upper split) and DL2 (lower split).

The coal resource is summarised as follows.

- **A Seam:** The A seam is typically developed to one m thick, with thickest intersection recognised so far being around 2 min the weathered zone in the southern region of the project. Because of the dip and subcrop geometry, A Seam only occurs in the far west. The A seam tends to be poorly developed and contains considerable carbonaceous shale / mudstone partings.
- **B Seam:** The B seam is the thickest in the set at South

Alpha, typically reaching six m. The B Seam is richly banded with tuffaceous carbonaceous mudstones, especially in the top three m. These banding impacts on raw ash of the overall seam and degrade its overall quality. A distinctive, clean section of 2.0 to 2.8 m dull and bright banded coal exists at the base of the seam.

- C Seam: Thickness range of one to three m is found for the C seam at the project site, typically developed at two m. A further two m of thinly banded stony coal and carbonaceous mudstone is often developed on the immediate roof of the C seam (CU Unit) but is not considered to be of resource potential. The C seam profile is generally clean of bands, with a trend of increasing frequency of pennybands at the top of the seam near the CU interface.
- DU Seam: The D Upper seam lies about 10 to 15 m below the C seam. It has fairly uniform thickness in the order of 1.8 to 2.2 m. The DU seam carries some thin stone bands in the mid-section but is generally clean. The DU seam has very sharp roof and floor definition and has a distinctive sharp, square shouldered roof and floor trace. This contrasts for example, with the C seam where increasing frequency of banding towards the roof causes an upwards, step-wise gradation in the geophysical logs at the roof. A variable parting of one to ten m splits the DU seam away from the DL seam. All of the D seamsplits are high quality and provide the lowest ash and highest energy, raw or washed, of the project area coals.
- DL Seam: The DL seam exists as the DL1 and DL2 splits, residing within 0.2 to 0.4 m of each other. The septum is occupied by a carbonaceous mudstone. The DL1 seam is around 0.7 to 0.9 m thick and the DL2 seam is 1.6 to 2.1 m thick. With the split included, the entire DL1 to DL2 interval has a cumulative consideration of around three to four m. The DL splits are also relatively clean intervals; three small pennybands persist in the DL2 dividing it into roughly equal intervals. Coal lithological types are even mixtures of bright and dull coal for the D seams.
- E and F Seams: Both E and F seams are one m thick. The E seam sits 10 to 20 m below the DL seam and the F seam a further 20 m lower again. They are slightly erratic in development and want to split and degrade. They have variable profiles reflecting differing levels of included stone bands. These seams sit outside limits for economic inclusion with any D seam operation and are too thin to support stand-alone development (they are not thick enough to support targeting mining; exist below thick Cainozoic associated with drainage) and so are without real potential.

The A and B seams are allocated membership of the Bandanna Formation and the sequence for C down the Colinlea Sandstone. The E and F seams may belong to a lower formation. These allocations are tentative. The provision of Formation / Group membership has no material impact on the resource geology of the deposit.

The combination of a very gentle westerly dip and subdued topography creates relatively broad sub-crop zones for each seam. Additionally, the B and C intervals are separated by 90 m of sandstone (vertical thickness) and this separation and the dip / surface geometry causes two north-south orientated bands of seam sub-crop; the A and B in the west and the C to DL in the east. The E and F Seams sit below the D splits and sub-crop further east, the seam limits often influenced by deeply incised alluvium channels associated with drainage along Sandy Creek. The full C-F sequence continues unbroken under the A and B sub-crop zone and all seams continue down dip. Previous studies have recognised a continuum of the seams down dip for at least 30 km to the west and to over 1 km of overlying stratigraphy.

The coal deposit is estimated to contain 3.93 billion tonnes (Bt) of coal resources. Of this 1,975 million tonnes (Mt) are measured, 565 Mt are indicated and 1,140 Mt are inferred. Of the resource total, 830 Mt would be mined as open cut mines and 3,095 Mt as underground areas (Coffey, 2009). Underground areas typically show only modest cover of 120-200 m with very gentle dips and relatively benign structural geology. The coal present is capable of producing a blended export style thermal coal with low moderate sulphur. The lower seams would make acceptable quality without blending.

3.4.2.2 Geological Structural Features and Faults

The basinal sediments in the mine area are characterised by gently dipping sedimentary units with little or no recognised faulting. The units generally dip towards the west at about 1°.

3.4.2.3 Overburden

The heavy metal concentrations of samples of overburden and interburden tested were below environmental investigation levels (EILs) for all metals with the exception of total chromium which exceeded the EIL for trivalent chromium in two samples. These results were within 10 % of the background range for total chromium.

The majority of samples have very low sulphur content (<0.1%) and therefore have a very low potential for acid generation. This is confirmed by the negative Nett Acid Production Potential NAPP results ranging from -0.7 to -23.6 which indicate the samples were non-acid forming (NAF). Geotechnical investigations also indicated that the majority of the rock material is NAF. It is anticipated that there will be minimal waste generation during construction works, as the NAF material can be used to construct mine structures including tailings storage facilities, mine levee walls and the Overburden Emplacement Facility (OEF).

Given these results, overburden and interburden material is not expected to pose a risk of causing acid rock drainage. Acid production potential of overburden, interburden and coal reject is discussed further in the Waste Technical Report Volume 5 Chapter 12.

3.4.2.4 Fossil Potential

The Permian and Tertiary periods represented by the geology in the mine area were periods when flora and fauna including amphibians (Permian) and mammals (Tertiary) were present in the general fossil record. There are records of *Glossopteris Sp*. (an extinct group of seed plants) fragments in the Joe Joe Formation, a Permian formation that underlies the projects coal measures. The Peawaddy formation, which also underlies the project coal measures, is also known to contain Permian plant fragments (DEEDI, 1973). The Peawaddy Formation was deposited in lacustrine and fluvial environments, which is similar to the terrestrial to lacustrine and fluvial environments that the project geology may have been deposited in.

While no record of fossils have been reported in the project area (Parfrey, 1996); there is potential for similar fossils as described above in the stratigraphy in the mine area due to the similar depositional environments.

3.4.3 SOILS

The mine study area is dominated by Kandosol soils with Rudosols in areas of elevated terrain in the north-western and south-eastern portions of the site (Figure 4).

Kandosols are structureless, mostly well drained permeable soils although some yellow and most grey Kandosols have impeded sub-soil drainage. Most Kandosols have low fertility and land use is limited to grazing and native pastures. Grazing lands are susceptible to surface soil degradation such as hard setting and crusting even when grazing intensity is low.

Rudosols are soils with minimal soil development. These are relatively young soils where soil forming factors have had little time to pedalogically modify parent rocks or sediment. There are a wide variety of Rudosols in terms of texture and depth with many being stratified and some hypersaline. Rudosols are apedal or only weakly structured and show no pedological colour change apart from darkening of the top horizon. Commercial land use is generally limited to grazing of native pastures due to the soil properties or occurrence in arid regions, or both.

Ten soil samples were collected to assess the mine site area. A description of these samples is provided in Table 3. The physical results of the soil investigation indicate that Kandosols are the dominant soil type in the mine area.

Table 3. Mine site description of soil samples

SAMPLE	SAMPLE LOCATION	SOIL
SS49	North east end – near rail alignment	Sandy clay, fine grain, hard, dry, non-plastic, some gravel (sub angular (9 mm), underlain by gravelly, clayey sand, fine to medium grain, dry, loose, friable, brown /orange, sodic.
SS50	North east end – Tallarenha Ck	Clayey silt, dry, firm, loose, non-plastic, dark brown A horizon, Pale gray B horizon.
SS51	North east end – near rail	Sandy gravels, dry, hard, friable, loose, orange, underlain by sandy gravelly clay, fine grain, friable, loose.
SS52	South east of mine site	Silty clay, dry, firm, pale grey / brown A horizon and pale grey B horizon.
SS53	Central east side of mine site	Silty clay, hard, non-plastic, dark brown underlain by soft silty clay, non-plastic with orange and red colour.
SS54	Central northeast mine site / Tallarenha Ck	Sandy clay, fine to medium grain, hard, non-plastic, brown underlain by silty clay, soft, non-plastic, orange.
SS55	Central north west mine site	Clayey gravelly sand, fine grain, firm, non-plastic, orange and yellow underlain by silty clay, firm, non-plastic, dark red.
SS56	North west of mine site	Silty clay, dry, hard, dark down.
SS57	Central mine site	Silty clay, dry, hard, loose, dark brown / orange underlain by silty clay, dry, firm, loose, dark orange / red colour.
SS58	Central west of site	Sandy clay, fine to medium grain, dry hard, loose, non-plastic.

3.4.3.1 Soil Summary

An analysis of particle size distributions for topsoil indicated that 52 % to 71 % of the samples passed through a 75 µm sieve size. This suggests that the soils were generally sandy to silty. These sand/silt dominated soils have low Cation Exchange Capacity (CEC) as they have lower clay content and therefore a lower surface area with less room to carry cations. This results in lower ESP and SAR and reflects lower fertility of the soils. As there is lower clay content in the soils; these results on their own cannot be used to assess dispersivity. The Emerson Crum test results provide an assessment of dispersivity and indicate some soils have the potential for dispersion.

3.4.3.2 Soil pH

Soil pH has a strong influence on the solubility and form of chemical compounds, the availability of ions in the soil solution as well as microbial activity. The optimum pH range for plant growth varies between species with a pH of 5.5 – 7.0 considered optimal for many native plants and pH 6.0 – 7.0 optimal for pasture grass. Soil pH ranged from 5.7 (SS58 = 0.0 - 0.3 mgbl) to 6.8 (SS53 = 0.0 - 0.3 mgbl) which is slightly acidic but within the range that is optimal for plant growth.

3.4.3.3 Cation Exchange Capacity (CEC)

CEC is a useful indicator of soil fertility as it demonstrates the soils ability to supply three important plant nutrients: calcium (Ca), magnesium (Mg) and potassium (K). A low CEC usually indicates low fertility. Guidelines for exchangeable cation test results specific to Queensland do not exist; however, the NSW Department of Environment Climate Change and Water (DECCW) provide guideline values for the interpretation of laboratory cation analysis (DECCW, 2008).

Comparisons of the results from the mine site to the guidelines indicate that the soils in the vicinity of the mine site are likely to have very low fertility.

3.4.3.4 Soil Salinity

Elevated levels of salt within the soil reduce the availability of water to plants which can affect germination, plant growth and the availability of essential plant nutrients. Salinity in the soils was measured by the concentrations of soil chloride and EC. These values were compared to values listed in the Guidelines for the Assessment and Management of Saline / Sodic Wastes (DERM, 1995).

Assessment against the guidelines identified the soils as having low salinity.

Figure 4. Mine Site Soil Types

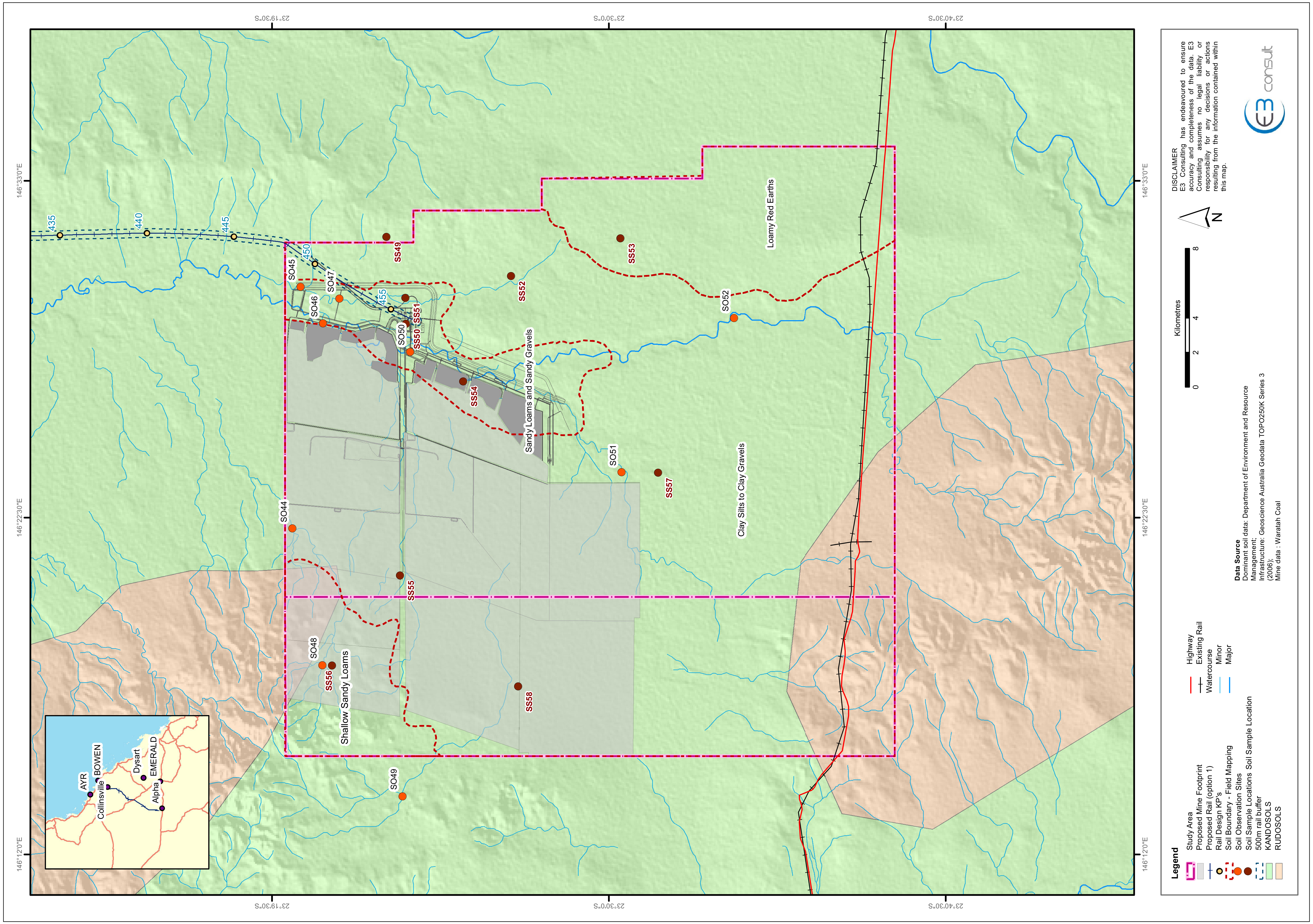
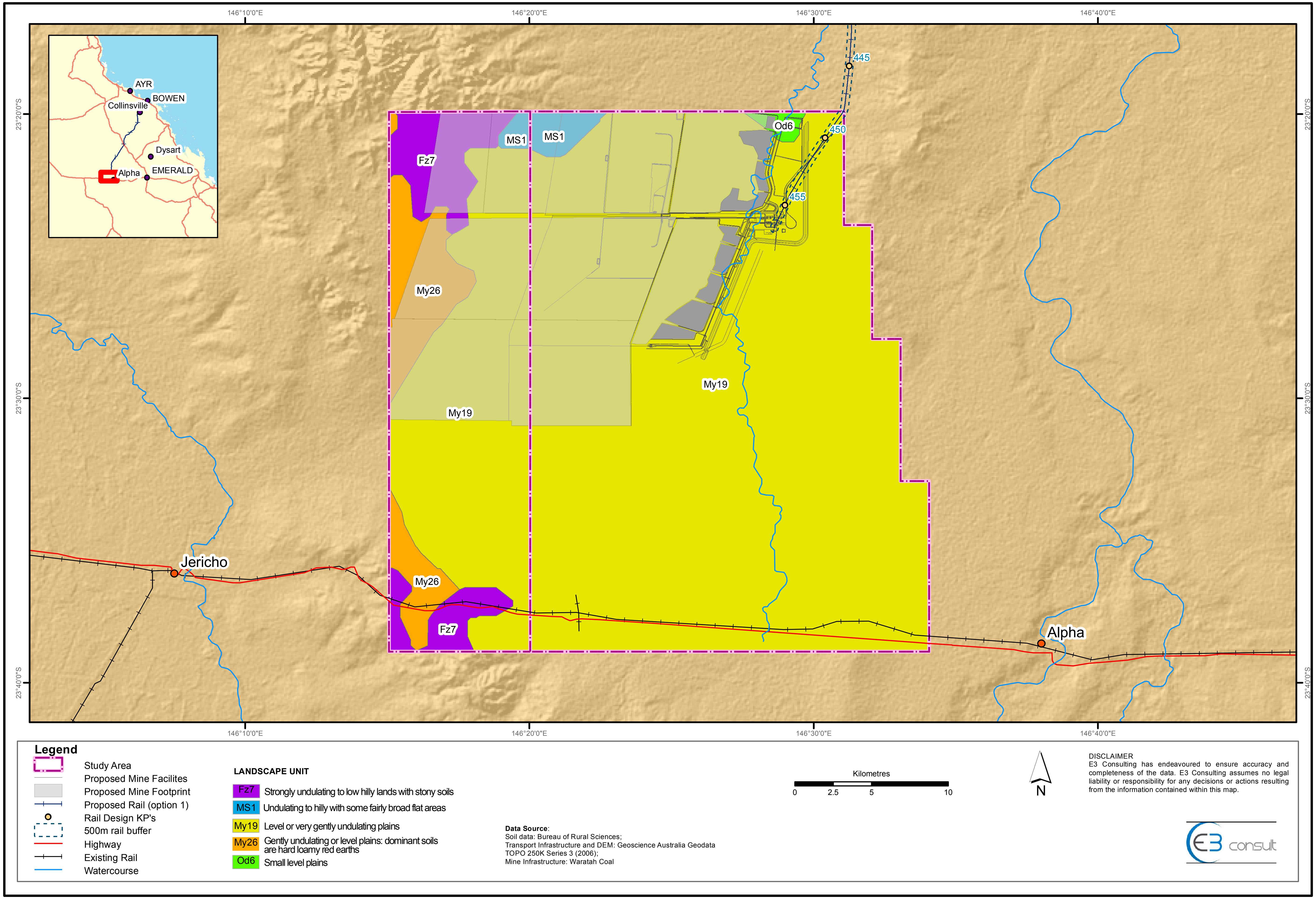


Figure 5. Mine Site Landscape Units



3.4.3.5 Soil Sodicity and Dispersion

Exchangeable Sodium Percentage and Ca: Mg ratios are provided in the DERM Guidelines (1995), the DECCW (2008) ranking for laboratory exchangeable cation test results and Northcote and Skene (1972).

Exchangeable Sodium Percentage in and around the mine site is generally very low to low except at one location. Generally low ESPs indicate that clay soils are less prone to dispersion. The SAR was low and this suggests a low risk of erosion, compaction, and / or development of hard setting crusts in the soil and subsequent effects on soil fertility in clay soils. However, sandy soils typically have lower SAR than clayey soils and the very low Ca: Mg ratios indicate that these soils may be associated with dispersive soils. The results suggest that there is the potential for dispersive soils both at samples near the mine open cuts and in higher ground west of the mine open cuts; however Emerson Crumb dispersion tests provide a further insight into these results.

3.4.3.6 Emerson Crumb Dispersive Soil Analysis

Three samples were collected from two locations within the mine site for the assessment of dispersion characteristics using the Emerson Crumb dispersion tests. The results of the Emerson Crumb indicated:

- SS49 at 0.0 – 0.3 mgbl returned an Emerson Class of 2;
- SS49 at 0.3 – 0.6 mgbl returned an Emerson Class of 3; and
- SS50 at 0.0 – 0.3 mgbl returned an Emerson Class of 2.

The Emerson Crumb results and the Ca: Mg ratios suggest that soils located at the north east part of the mine area are likely to be dispersive and will require management to avoid erosion issues. The Rudosols on the higher areas in the northwest and southeast of the mine are generally shallow and rocky and will erode on slopes or scour where present in valleys. They are therefore considered to have a moderate to high potential for erosion.

3.4.3.7 Soil Observations

Nine waterways were visually assessed within the mine area to determine their erosion potential. Two sites (SO44 and SO46) were identified as having a moderate to high potential for erosion, while four sites (SO48 to SO51) were thought to have a high potential for erosion. All six sites are dominated by either sand or silts. The sites with high potential were classified accordingly either due to their appearance as an already degraded and eroded channel. The remaining three sites were assessed as having a low potential with no evidence of erosion or significant disturbance.

3.4.3.8 Top Soil Resources

The suitability of top soil resources in the mine area for rehabilitation of lands disturbed during the development required an assessment of suitable topsoil and proposed stripping depths. The useable topsoil resources are generally limited to the surficial "A" horizon which contains seed stocks, organic matter, nutrients and biota necessary for plant growth although they can also occur in the upper "B" horizon. The mine site area soils are dominated by structureless soils (Kandosols) or soils with minimal soil development (Rudosols), generally in areas of higher relief. This soil classification is supported by both surface geology mapping and landscape unit mapping for the mine site project area. Data obtained through field investigations indicates that the soils are predominantly sandy and gravelly clays, silty clays and sandy soils of low fertility.

Useable topsoil resources are likely to be restricted to the top 0.3 m of the soils on the eastern and central portion of the mine with the lower horizons likely to be too gravelly or clay dominated with little organic matter.

3.4.4 LANDFORMS

The mine landscape units reflect the project area topography with landforms being predominantly gently undulating or level plains over most of the two EPCs rising to strongly undulating to low hilly lands in the north-west and south-west corners. A detailed description of the landscape units that are observed within the EPC are outlined in Table 4. Mapped Landscape units are shown on Figure 5.

3.4.5 GOOD QUALITY AGRICULTURAL LAND (GQAL) AND LAND SUITABILITY

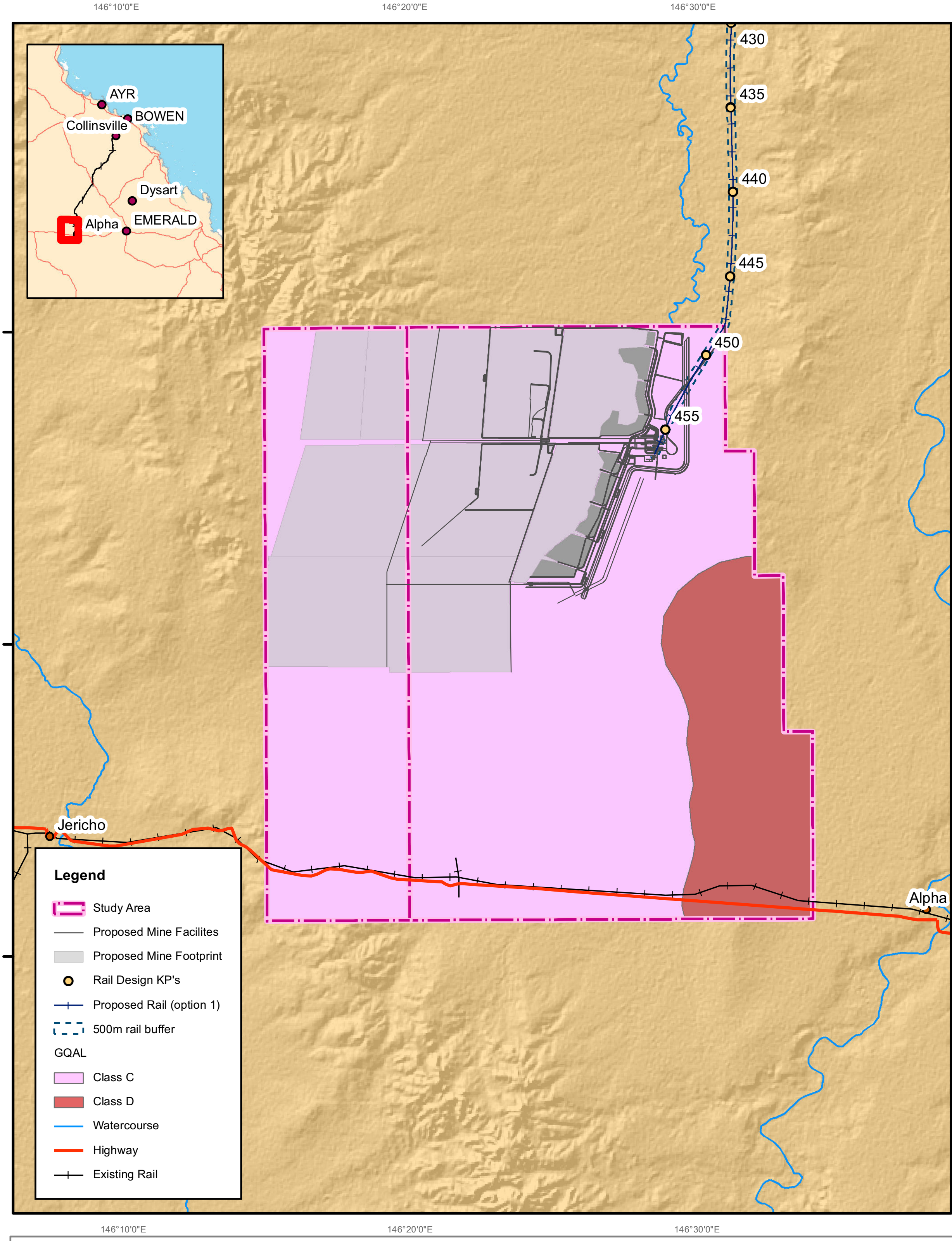
Based on the results of soil sampling the majority of the land within the mine footprint would be considered Class C GQAL (Figure 6), which is described as being "Pasture land: land suitable only for improved or native pastures". There is some land that may be considered Class D land: non Agricultural land in the east of the EPC.

The land would generally be considered Class 4 or 5 – marginally suitable or unsuitable for agriculture – under the DME (1995) land suitability guidelines.

Table 4. Mine Site Landscape Units

LOCATION	LANDSCAPE UNIT	LANDFORM	SOILS	REMARKS
North West and South West Corner of site	Fz7	Strongly undulating to low hilly lands	Dominant soils are shallow stony loams. Associated are shallow sandy soils and small areas of sandy red earths are included in the unit.	On some slopes, shallow duplex soils occur
North Central	MS1	Undulating to hilly with some fairly broad flat areas often broken by rocky knolls and ridges some of which may be steep	Dominant soils are sandy acid yellow earths sandy acid and neutral red earths and shallow sandy soils on the ridges and slopes where ferruginous rock and ironstone gravels are common. Associated are flatter and lower lying areas generally of various hard setting (D) soils. Some slopes are flatter and in some expressions of the unit there are cracking clays and small areas of soils associated with basaltic flat tops and ridges.	This is a broadly defined and complex unit
North West and Central West	My26	Gently undulating or level plains	Dominant soils are hard loamy red earths and yellow earths. The red and yellow earths may vary locally in dominance, the former occurring mainly on slightly higher sites.	Included in the unit are some low laterite or sandstone scarps with shallow stony loams, and occasional eroded mottled rock pavements
North, North East, South East and Central	My19	Level or very gently undulating plains	Dominant soils are sandy or loamy red earths with some yellow earth. In other depressed areas shallow red earths are underlain by a clay D horizon. Small areas of clay soils may be included.	Often in the form of low dunes
North East	Od6	Small level plains	Dominant are sandy or loamy-surfaced red duplex soils. Small areas of grey cracking clays. Also occurring are small areas of sandy or loamy red and yellow earths.	Occasional low sands

Figure 6. Good Quality Agricultural Land

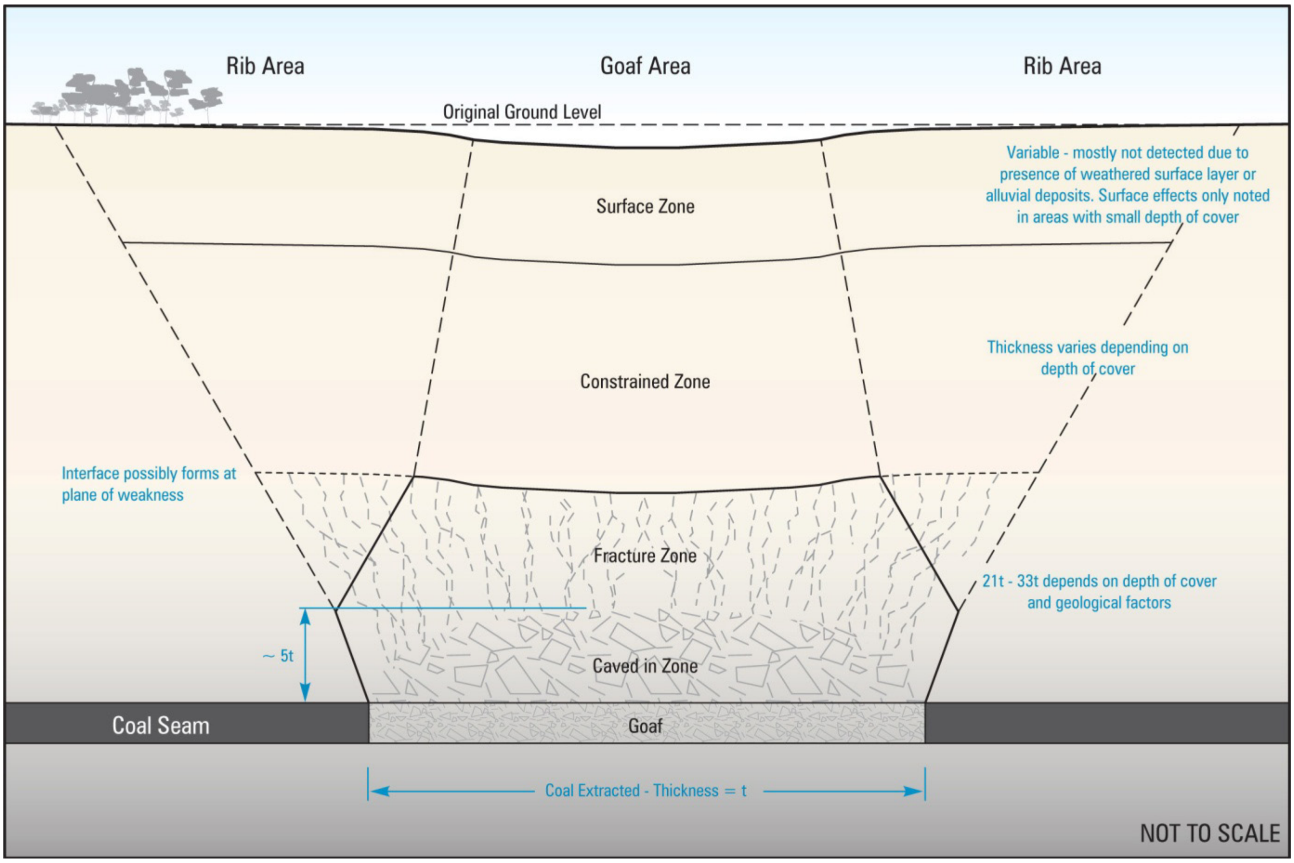


Data Source:
Transport Infrastructure and DEM: Geoscience Australia Geodata TOPO 250K Series 3 (2006);
Good Quality Agricultural Land (GQAL): based on field sampling;
Mine Infrastructure: Waratah Coal

DISCLAIMER
E3 Consulting has endeavoured to ensure accuracy and completeness of the data. E3 Consulting assumes no legal liability or responsibility for any decisions or actions resulting from the information contained within this map.

E3 consult

Figure 7. Schematic of Potential Ground Impacts Associated with Underground Mining



3.4.6 SUBSIDENCE

It is likely that underground longwall mining activities will result in surface subsidence. A schematic drawing of the ground impacts above the extracted blocks of coal in a longwall mining system is shown in Figure 7.

As the coal seam is removed by the longwall mining method a void the thickness of the longwall seam remains. The ground immediately above collapses into this void. The overlying strata (or "overburden") then sags down onto the collapsed material, resulting in an elongated subsidence "bowl" developing on the surface.

The act of this strata failure into the void is integral to the longwall mining method, as it relieves stress on the surrounding mining blocks and development roadways.

The cavity which has been left behind the retreating longwall face and is subsequently filled with the collapsed overlying strata is commonly called the "goaf" or "gob".

The extent of the overlying strata collapse and the associated shearing and cracking of the strata depends upon the strata geology, the longwall block width, the seam height extracted, and the depth of cover.

The strata immediately above the longwall goaf collapses into the open void, and hence moves down by a height equal to the thickness of the seam which was extracted. Due to the way the broken strata material "bulks" or "swells" as it breaks into the cavity, the cavity is eventually filled with broken material (shown as "caved zone" in Figure 7) and a physical cavity no longer exists. However, the vertical displacement in the strata continues to propagate upwards in the strata. Cracking and strata damage do not continue to move vertically beyond the "fractured zone", even though the ground strata all the way to the surface may be displaced vertically.

When the ground strata move downwards sufficiently that the vertical movement reaches the surface, the surface of the land may also move downwards over the extracted mining areas. This movement is called "subsidence".

The amount of subsidence witnesses at the surface is dependent on a large range of factors including:

- thickness of coal seam extracted (mining height);
- depth of cover;
- properties and rock types of ground strata (i.e. overburden strength);
- stiffness and bulking characteristics of the collapsed strata;
- width and length of longwall block;
- dimensions of the gate road coal pillars; and
- the maximum subsidence usually occurs in the middle of the extracted longwall panel.

3.4.6.1 Subsidence Estimates

Estimates of subsidence at the mine site can be found in the detailed description of the mine construction and operations in Volume 2, Chapter 1. In summary the greatest total subsidence will occur in the surface areas which are affected by the operations in both the B-seam and D-seam operations. This area will be on the surface in the north western section of the mine foot print. The total cumulative subsidence in this area is predicted to reach a maximum depth of 3.27 m. Average subsidence across the bulk of the mine site is expected to range between 1.3 m to 1.61 m.

3.4.6.2 Contaminated Land

A total of seven lots cover the EPC mine footprints. Based on the tier risk assessment:

- five were considered high risk outside the MLA boundary of the mine site and comprised of existing rail lots recorded with a land use of "Transport Terminal" and one lot adjacent to the existing rail line with a land use recorded as "Transformer";
- one of the "Transport Terminal" lots is listed on the EMR for possible high level of Arsenic; and
- one lot classed for rural land use and ranked as medium risk.

High risk rail corridor Lot 273 SP108314 was selected with targeted soil sampling. This lot was representative of other rail line lots in the area. Lot 6 on MX95 was not primarily assessed as it was not listed on the EMR and furthermore, Lot 6 is located approximately 30 km south of the mine site. Therefore, it was considered a low risk to the project.

During an inspection of the mine site Lot 1 BF72 containing an Above Ground Storage Tank (AST) and cattle stockyard was observed. This lot was selected for a PSI targeted soil sampling. Lot 1 is currently located over Waratah Coal's mine infrastructure arrangement of Underground Mine 1, Open Cut 1 and 2 North and Open Cut 1 and 2 South with reject and tailings disposal areas located north-east of Lot 1 boundary, Figure 2, Chapter 1.

The locations of the lots identified above can be seen on Figure 8.

The only site with the potential to be impacted by the mine is Lot 1 BF72 which contains an Above Ground Storage Tank (AST) and cattle stockyard.

The findings from the PSI for this lot are summarised below. A detailed account of the findings from PSIs is presented in the Contaminated Land Technical Report (Volume 5, Appendix 7).

Lot 1 BF72:

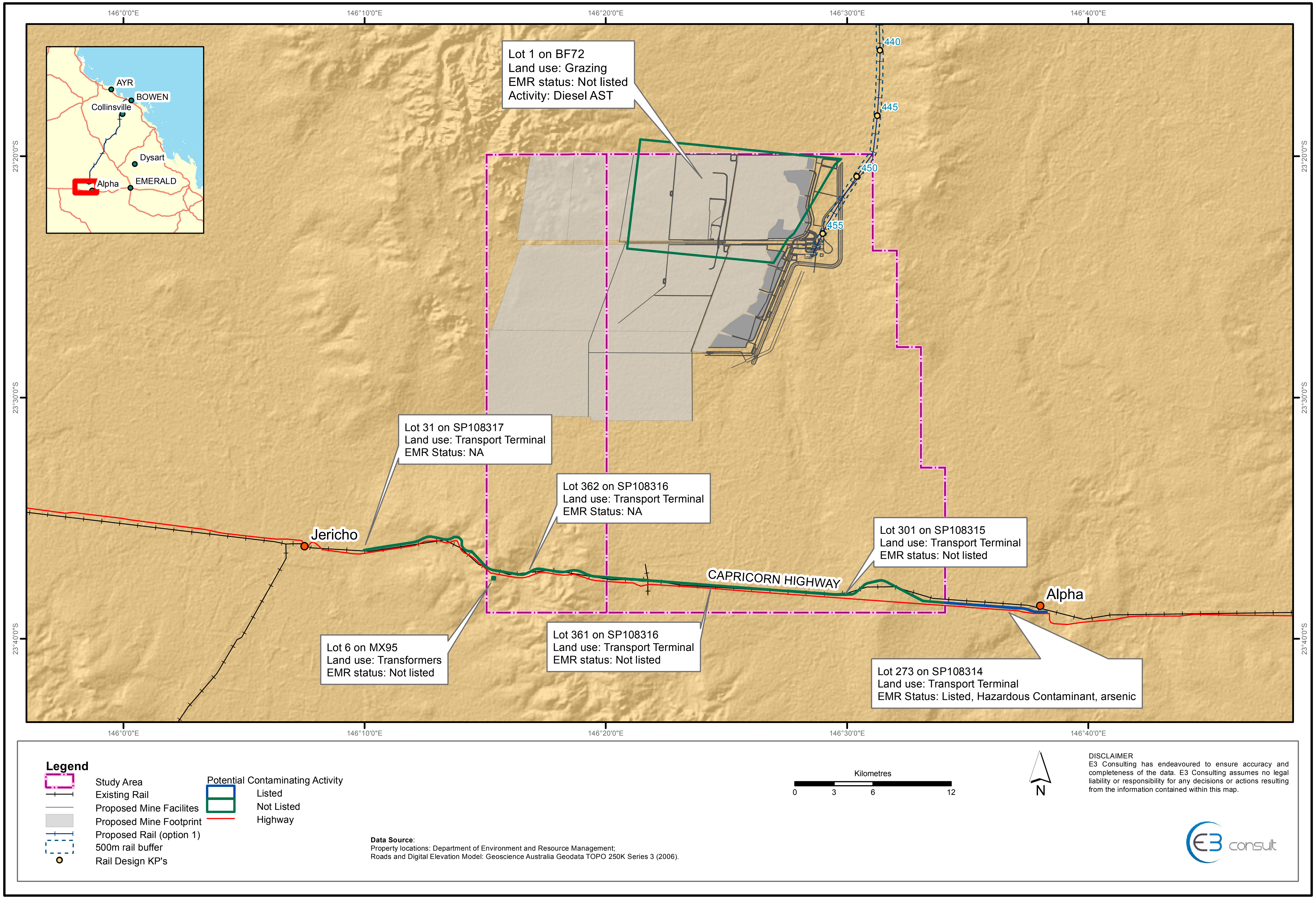
- Lot 1 BF72 is a grazing property located approximately 35 km northwest of the township of Alpha;
- the lot comprises a portion of the mine footprint and contains a residence, farm sheds, farm bores, a vehicle / equipment storage area, cattle yards and a diesel Above ground Storage Tank (AST). The site did not contain a cattle dip or spray race;
- the lot is currently under freehold title and the present activities include cattle grazing and breeding;
- a cattle stockyard and AST were present on the site;
- resource exploration on the site has resulted in an extensive drilling program. In addition to the fuels and oils used in any plant, drilling requires the use of specialised fluids designed to maintain drill hole integrity and circulation during the drilling process;
- adjacent land uses predominantly include creeks and vacant land / rural properties;
- the local geology comprises silts, shales and sandstone with coal seams held within the Triassic and Permian intervals of the Galilee Basin;
- the nearest sensitive receptor to the AST and Stockyards at the mine site is a creek >1 km east of this infrastructure. The closest residential centre is Alpha, 30 km away;
- an interview with personnel from 'Kiaora Station' indicated that mine footprint does not include a cattle dip; however, site infrastructure does include an AST and a stockyard with an associated crush;
- no information was found from local historical sources regarding potential contaminating activities at the mine site;
- flammable and combustible goods licences are not reported for Lot 1 BF72;
- historical aerial imagery for the area was available from 1951 to 2001. No significant changes for potential site contamination were present beyond those areas as identified from the site inspection;
- a review of current and historical certificates of title indicates that Colleen and Lancelot Sypher are the current registered owners. Historical certificates of title were not available;
- preliminary soil sampling was conducted in April 2010. Two primary samples were collected within Lot 1 BF72 and include:
  - Sample CL3-A (collected from stockyard); and
  - Sample CL4-A (collected from the AST).
- the sample from the AST was analysed for the major contaminants of concern for diesel, being TPH and PAH. The sample from the cattle yards were analysed for potential pesticide residues including OC / OPS;
- the laboratory results for Petroleum Hydrocarbons reported C_{10}-C_{14} chain lengths of 240 mg/kg and C_{15}-C_{28} chain lengths of 31,900 mg/kg, which exceed the Draft Guidelines of a magnitude of 100 mg/kg and 1,000 mg/kg, respectively. No detectable C_6-C_9 hydrocarbons were reported. The absence of light end hydrocarbons (C_6-C_9) reflects the typical composition of diesel fuel. The laboratory results detected pyrene; however, Total PAH and benzo(a)pyrene results were below the DERM HIL-'F' criteria; and
- the laboratory results reported below DOE's 'HIL-F' trigger values for Heptaclor of 50 mg/kg (OC's) with no exceedances for OP's. The area of observed hydrocarbon staining was of a limited area (<2 m^2). Petroleum Hydrocarbons are volatile but biodegrade naturally. Therefore, remnant impacts are often minimal where significant time has elapsed since the use of the compounds. No obvious odours were detected during sampling.

Evaluation of Risk

The laboratory results from the samples taken adjacent to the rail line and stockyards indicate no detectable concentrations of the analytes tested were present. This suggests low potential for impacts from these sources. However, the association of arsenic contamination with rail activities and the extensive rail network indicates that the presence of arsenic along other extents of the rail alignment may be likely.

The hydrocarbon impacts to soils based upon site observations of staining and the clay content of the soils present suggest a low potential for significant impacts. Based upon the extent of observed staining, distance to the nearest creeks and prior experience of spills / leakage from similar sized ASTs the potential for impacts to penetrate more than a few decimeters below ground is considered low. It is therefore considered that the impact is unlikely to comprise serious or material environmental harm and presents a low risk.

Figure 8. Contaminated Land



3.5 POTENTIAL IMPACTS

3.5.1 TOPOGRAPHY / LANDSCAPE

The mine site comprises level to gently undulating topography falling from low hills to small creeks. The mining activities will result in topographical changes to the mine area during mine operation and post-mining through the removal of existing topography during stripping of overburden and mining and the creation of new topographic highs through the placement of spoil and construction of dams. Changes to the location of Tallarenha Creek and the width of its floodplain will occur as a result of mining and creek diversions.

3.5.2 SUBSIDENCE

Surface subsidence will develop progressively within each longwall block and will present on the landform surface as a series of trough like depressions. An assumption has been made about the amount of subsidence that will occur on the land surface in comparison to the thickness of the coal seam removed underground. For the purposes of this study, this ratio has been set to 60 %. Assumed vertical movement of the surface will be 60 % thickness of the coal seam removed from underground.

The greatest (maximum) total subsidence will occur in the surface areas which are affected by the operations in both the B-seam and D-seam operations. Based on these assumptions, the maximum depth of subsidence impact from the mining operations will be in the areas where mining in the B-seam and D-seam overlap, and in the centre region of the longwall blocks in these area. This area occurs in the north western section of the mine foot print. The total cumulative subsidence in this area is predicted to reach a maximum depth of 3.27 m. Average subsidence across the bulk of the mine site is expected to range between 1.3 m to 1.61 m.

It has been assumed that the coal pillars, which remain in the development gateroad areas, will undergo significant failure once goaf has formed on both sides of the gateroads. It is assumed that these pillars will go into a yield condition and that the floor and roof strata around the pillars will fail. Due to these factors, it has been assumed that the pillars will be compressed to 30 % of their pre-mining seam height.

As discussed previously, it is usual for the surface subsidence 'bowl' to extend outside the limits of extraction by a distance equal to half the depth of cover. This assumption has been utilised in the subsidence predictions for the underground mines. This assumption equates to an angle of draw of 26.5 degrees.

The area where subsidence will likely occur has little topographical relief, and consists of both cleared (chain pulled and blade ploughed) and remnant open woodland, both of which are currently used for cattle grazing. The area where maximum subsidence will occur consists of cleared, improved pasture, to the north-west of the study area.

Potential impacts resulting from subsidence in a rural location would usually result in a change of drainage patterns due to a depression in the ground which may have an effect on the existing hydraulics of surface waters near the mine. Surface waters located above the underground mine include unnamed tributaries of Tallarenha Creek that currently drain eastwards. Subsidence can also cause increased cracking in clays. The generally sandy soils identified over the underground mining are considered unlikely to be significantly impacted by any minor subsidence however the maximum predicted level of 3.27 m has the potential to result in some cracking.

3.5.3 GEOLOGY / SOILS

The heavy metal concentrations of samples of overburden and interburden tested were below EILs for all metals with the exception of total chromium which exceeded the EIL for trivalent chromium in two samples. These results were within 10% of the background range for total chromium. The excavation and stockpiling of overburden is expected to have a low risk of producing heavy metal contamination by leachate or surface runoff based upon these results.

3.5.4 FOSSILS

Investigations suggest there is a low risk for fossilised material being discovered by works as there is no record of fossils being identified in the project area. There are records of Permian plant fragments being located in the geology underlying the project's coal measures; however, these areas will not be impacted by the excavations. While no record of fossils have been reported in the geology affected by the mine, excavation and mining activities do have the potential to uncover fossils.

3.5.5 TOPSOIL

Topsoil will be removed in the creation of the open cut mining areas as well as for some of the supporting infrastructure such as the CHPPs. Topsoils at the mine were found to have low salinity, optimal pH conditions for cultivation, low Cation Exchange Capacity CEC, and generally low ESP. The fertility of the soils is indicated to be low and the low ESP suggest that hard setting crusts could occur which would inhibit seedling growth in the area. With amendment by nutrients and use of appropriate seed stock, the soils could be made suitable as a growth medium.

3.5.6 SOIL EROSION

Some soils identified in the areas of the open cut mine area, including clays subsoils, have a high erosion potential with Emerson Crumb ratings of one or two; are sodic soils and exhibit a moderate to high potential for erosion due to dispersion. Where the topsoil of these areas is disturbed by the project's activities and where the subsoils are exposed, there is a greater potential for increased erosion. Where such disturbance occurs, at creek crossings and where sediment runoff is allowed to enter these waterways, the impact of increased sediment load could impact the health of the waterways.

3.5.7 AGRICULTURAL LAND USE / GQAL

During the operation of the mine, existing land uses, such as grazing may be able to continue within the areas not directly impacted by the open cut mines and supporting infrastructure. Areas required for the operation of the mine will be disturbed and no longer available for the existing land use. The land is not considered to have high value for agriculture and as such, the mine would not be expected to have a significant impact on agriculture in the region.

Impact to land suitability, final landforms and the appropriate mitigation measures typically include an evaluation of the future potential cropping and grazing classes of the land and limitations due to compaction of land used for roads, or use of the rehabilitated final void, stockpiles and tailings dams. Often stockpiles and tailings dam are unsuitable land for cropping or grazing until management measures have been undertaken, whereby they may become suitable for higher classes of cropping and grazing. Final voids may be suitable for wetlands or recreational land use following rehabilitation.

As discussed in Section 3.4.3.8, top soil resources and, management measures will be documented, monitored and maintained for the construction and operational phases of the mine. Reconciliation of top soil excavation and quantities used for rehabilitation will be maintained. Excess topsoil will be used in project areas with topsoil deficits. If required, Waratah coal will source further top soil from local suppliers in the project area.

3.5.8 CONTAMINATED LAND

Based upon the qualitative risk assessment, the following potential impacts are identified from identified contaminated or potentially contaminated land during the construction and operation works associated with the mine:

- there is a low potential for significant contaminated soils to be encountered during earthworks which could lead to contamination being spread across the site;
- the identified hydrocarbon impact may be delineated by completing a Stage 1 and Preliminary Stage 2 ESA;
- the anticipated extent of hydrocarbon impact is considered to be unlikely to be a significant impact under the EP Act and excavation, land farming and validation of hydrocarbon impacted soils may be undertaken on Lot 1 BF72 under a remedial plan;
- should the extent of the impact be greater than anticipated, then the site may be listed on the EMR and a site management plan (SMP) / remediation action plan (RAP) prepared to control the remediation and validation of the impact;
- demolition of site buildings has the potential to impact soils with hazardous materials if not appropriately assessed and managed; and
- spills and leaks from various contaminating sources such as petrol and other chemicals stored on site during operations should be managed properly. These sources may have the potential to leach and migrate into sensitive receptors such as waterways and permeate into the existing soil profile.

Where soil contamination may exist Waratah has committed to undertaking soil investigation in accordance with *Draft Guidelines for the Assessment and Management of Contaminated Land in Queensland (EPA, 1998)* and the *National Environment Protection (Assessment of Site Contamination) Measure 1999*. Furthermore, within the mine EMP (Volume 1, Chapter 7), Waratah Coal has committed to various management strategies to be implemented during the mine operation to limit the potential for contamination.

3.5.9 DECOMMISSIONING AND REHABILITATION PHASE

Operational decommissioning of the mine, and associated ongoing long term management and maintenance of infrastructure post-mining. will be phased accordingly to the projects sustainability indicators described in Volume 2, Chapter 1. Individual EMPs and a Mine Closure Plan will be developed to mitigate measures for decommissioning and rehabilitating phases of the project. It may be the case that the best beneficial use of some of the supporting infrastructure components (i.e. water supply infrastructure, roads, power transmission lines) is leaving the infrastructure in place to support other local needs. This will be discussed with the relevant authorities and landholders prior to formalising the decommissioning strategy. If the preferred outcome is to leave some of the infrastructure components *in-situ* as operating infrastructure, Waratah Coal that facilitates the transfer of operating licences and obligations to the relevant parties will prepare a transitional plan. Decommissioning and rehabilitation action plans, objectives and indicators are further discussed in Volume 2, Chapter 1 for the mine site and surrounds.

3.6 MANAGEMENT AND MITIGATION MEASURES

The following management measures will be put in place to mitigate potential impacts on geology, soils and landforms:

- to minimise impacts of excavation and spoil dumps on topography and surrounding landscapes, Waratah Coal will implement the following:
  - maintain concave slope profiles over the site;
  - maintain average slope gradients at 4 % or less (the erosion potential of longer slopes will need to be considered);
  - when stockpiling maintain irregular dump shapes (e.g. with uneven heights, ridgelines and spurs);
  - minimise spoil dump height; and
  - minimise slopes gradients adjacent to creeks;
- mitigation measures for mine subsidence include ripping and backfilling of areas with soil cracking. Where short term elevation changes occur, earthworks are required to minimise these elevation changes;
- geotechnical sampling results suggest that there is a low to negligible risk of acid rock drainage occurring. Despite these results, the following measures are proposed during operations (as appropriate):
  - an overburden material sampling regime will be conducted to confirm its acid generation potential prior to removal. Laboratory characterisation will be in accordance with the *Assessment and Management of Acid Drainage (Department of Primary Industries, 1995)* and/or other relevant guidelines;
  - any material that is visually assessed at the time of mining as containing pyrite, will be assessed for acid producing potential;
  - potentially acid forming material identified by visual assessment or laboratory characterisation, will not be used as capping material. Potentially acid forming material will be buried within the waste rock dump together with waste rock that has a positive acid neutralising capacity.
- where there is the potential for fossils to be uncovered during earthmoving activities, the significance of the fossils will be assessed through a contingency plan including the following measures:
  - works are to be ceased immediately;
  - consult with the Queensland Museum for identification of fossils;
  - if there are significant finds of small fossils, obtain representative samples of the media and both set aside for further analysis and contact the Queensland Museum;
  - if significant finds of large fossils are observed, contact and seek an expert's advice as to the possible extent of the fossils and stop work immediately; and
  - contingency in the Run of Mine (ROM) plan is maintained to allow for stoppages due to potential fossil finds;
- the main land disturbance areas in the mine area will be as a result of open cut excavations, construction of waste emplacement facilities, dams, mine

infrastructure and haul roads. Mitigation measures to limit the impacts of land disturbance include:

- the topsoil in these areas should be recovered and records maintained to ensure useable soils are retained and a log of soil stockpiles is kept to reconcile predicted and actual soil volumes;
- topsoil should be stripped and stored separately from subsoils and kept moist during stripping;
- stripping depths should be surveyed and marked to avoid stripping potentially dispersive subsoils;
- where the ROM plan allows, the topsoils will be stripped and placed directly onto rehabilitation areas or stored for the minimum time possible to make maximum use of seed stocks; and
- stockpiling of topsoils should be minimised or avoided where possible. Where topsoils are stockpiled, the height of stockpiles will not exceed three m;

- an Erosion and Sediment Control Plan (ESCP) will be prepared to address the potential issues arising from the field investigations. Erosion in active construction or development areas cannot be eliminated; however, impacts can be controlled and minimised through the following management actions:
  - limiting the area of disturbance and progressively clearing areas immediately before construction;
  - strip and stockpile topsoil prior to construction;
  - divert surface water runoff around construction areas;
  - minimise the period that exposed soil is left open during construction;
  - place sediment traps and silt fences to minimize off-site impacts;
  - place organic mulch and / or plant exposed soils to reduce dust generation and wind erosion; and
  - maintain a site monitoring program recorded in an EMP to assess erosion control measures;
- areas of identified dispersive soils should be closely monitored to assess the efficacy of the erosion control measures;
- where land is disturbed progressive land rehabilitation will occur as use of those areas ceases;
- post disturbance regrading should be undertaken to produce slopes that are suitable for the proposed land use;
- a drainage design that addresses runoff volumes and erosion minimisation will be put in place;
- erosion from surface water runoff can be minimised by using contour banks at intervals along the constructed slopes;
- where possible use lighter vehicles and / or larger wheel / track size to reduce compaction;
- should areas of saline soils be intersected these will be set aside for specific rehabilitation with salt tolerant plant species; and
- the land use in the mine area is generally Class C agricultural land suitable for grazing. All impacts are to be kept within the mine footprint and at the completion of the mining operation; the site will be rehabilitated to a state suitable for grazing.

Measures employed to manage land contamination issues at the mine site will include:

- where site contamination is present and remedial measures are required a SMP / RAP will be prepared in line with possible construction techniques that will minimise excavations for site preparation;
- where ROM handling and preparation plants generates contaminating materials and liquids from reject tailings and groundwater seepage, tailings/rejects will be placed in the Overburden emplacement facility (OEF);
- Potentially Acid Forming (PAF) material will be located at a level that is below the projected post-mining water table and covered with sufficient overburden;
- where contaminated tailings/rejects occur onsite it will be managed in accordance with the Reject Disposal Plan;
- where site contamination must be excavated, the work will be completed under a RAP and validated to assess the effectiveness of the remediation. A validation report will be prepared suitable for submission to DERM to assess the effectiveness of the remediation, the proposed management measures (if any), and allow a site suitability statement to be issued for the lot by DERM;
- no contaminated soils will be removed from a lot without a DERM disposal permit;
- remedial measures will include (in order of preference) risk assessment, on-site containment, on-site treatment and / or off-site treatment or disposal.

3.7 CONCLUSION

A complex of soil units were identified across the project area, including areas of Kandosols and Rudosols. Some are prone to erosion and dispersion. The majority of the soils are also unsuitable as topsoils.

The mine is currently used for low (Class C/D) intensity cattle grazing. As a result of this historical and current land use of low intensity cattle grazing, there has been extensive tree clearing throughout some of the project area.

The main potential impacts of the project in relation to land include changes to agricultural land capability, and increased risk of erosion in areas of construction and / or operation. In addition, some soils encountered will be sodic and / or dispersive and this may affect excavation conditions at the mine. Potential impacts to the topography, geology, soils and landform of the project and management strategies and commitments to mitigate these impacts have been identified. Further detailed investigations are required to fully manage some potential impacts. This will delineate areas of potential impacts and assess the appropriate scale of mitigation or management.

During an inspection of the mine site Lot 1 BF72 containing an AST and cattle stockyard was observed. This lot was selected for a PSI with targeted soil sampling.

Based upon the historical review and site inspection the potentially contaminating activities are associated with cattle grazing and breeding, and ongoing maintenance and weed management associated with the existing rail line.

Most cattle grazing or breeding properties have small fuel and farm chemical storage facilities. This may result in localised impacts around storage and handling areas. A cattle stockyard and AST were present on the site. Fuel handling has the potential for impacts from spills and leaks from petroleum hydrocarbons. Cattle stockyards are areas of potential impacts from farm chemicals such as pesticides used in treating cattle.

The contaminants of concern associated with the above activities include arsenic, OC and OP within the cattle yards, petroleum hydrocarbons from the AST, and Arsenic, herbicides and pesticides associated with the rail line.

The hydrocarbon impacts to soils based upon site observations of staining and the clay content of the soils present suggest a low potential for significant impacts. Based upon the extent of observed staining, distance to the nearest creeks and prior experience of spills / leakage from similar sized ASTs the potential for impacts to penetrate more than a few centimetres below ground is considered low. It is therefore considered that the impact is unlikely to comprise serious or material environmental harm and presents a low risk.

3.8 COMMITMENTS

Waratah Coal commit to undertaking the following actions:

- identify specific access areas and determine goals for rehabilitation of disturbed land to minimise areas that will have lower land use quality post-mining;
- manage lay down areas in a manner that will not result in a reduction in land quality;
- further characterise overburden and interburden material to assess its qualities for reuse. Opportunities for reuse may include using materials for road building, rock armour for protection and stabilisation of drainage lines and construction of rumble-pads for heavy vehicle cleaning;
- prepare and implement erosion control measures and continue to monitor and maintain the measures implemented;

ESCPs will be developed and put in place prior to the commencement of construction works for all areas of the project that may cause erosion: topsoil management measures will be documented, monitored and maintained with a reconciliation of top soil excavation and rehabilitation maintained. Excess topsoil will be used in project areas with topsoil deficits. Waratah coal will source further top soil (if required) from local suppliers in the project area;

- prior to construction carry out soil sampling at waterways to better identify erosion risk and put in place appropriate management measures;
- prior to construction undertake soil resistivity surveys of high risk areas, record the current salinity status of these areas and implement measures to ensure no further significant salinisation occurs due to the project activities;

- where contamination is present within the project footprint, Waratah Coal will enter into agreements with the owner of the contamination to assess and appropriately manage or remediate the contamination;
- any building / structures to be demolished will be assessed for hazardous material content with preparation of demolition management plans for the appropriate demolition and disposal of the hazardous materials;
- where contamination is identified it will be managed and/or remediation under the EP Act with DERM approved SMPs and / or RAPs in order to make the sites suitable for the proposed use;
- Waratah Coal will appoint a third party reviewer to assess all contaminated land assessment and remediation work;
- any Notifiable Activities that are required for the project will be implemented and managed under relevant legislation and guidelines once construction commences and also during the operational phase. The Notifiable Activities may include:
  - storing hazardous mine or exploration wastes, including, mine tailings, overburden or waste rock dumps containing hazardous contaminants;
  - coal handling and preparation plant waste characterisation of exposed contaminated materials and liquids during operational phases;
  - exploring for, or mining or processes, minerals in a way that exposes faces, or releases groundwater, containing hazardous materials;
  - petroleum product or oil storage; and
  - chemical storage;
- establish a set of environmental investigation protocols to manage gross or previously unidentified contamination encountered during project construction.