Waratah Coal

China First - Geology, Soils and Landforms

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Executive Summary

E3 Consulting Pty Ltd (E3) was commissioned by Waratah Coal Pty Ltd (Waratah Coal) to undertake the assessment of land including topography, geology, soils and landform for the Galilee Coal Project – Northern Export Facility Project (China First Project). This technical report assesses the existing environment and potential impacts resulting from the China First Project for these issues.

The project includes a:

- Coal mine located near Alpha in the Galilee Basin, Central Queensland;
- Rail alignment between the mine and a coal terminal located at the Abbot Point State Development Area (APSDA); and
- Coal terminal incorporated within both the APSDA and the Port of Abbot Point.

A full description of the project is provided in the EIS.

An assessment of the terrain and a soil survey was undertaken for the mine, rail alignment and coal terminal to identify existing environmental values and potential engineering and/or environmental impacts.

Topography falls from a height of about 400m Australian Height Datum (AHD) to the coast through a number of ranges including the Leichhardt and Clarke Ranges before joining the coastal plain at about KP25. The topography rises sharply over the Clarke Range to height in excess of 1,000m although the highest the rail gets at this point is about 200m AHD.

A complex of soil units were identified across the project area, including areas of Tenosols, Chromosols, Kandosols, Vertosols and Sodosols and cracking clays. The soils present within the China First Project area are generally suitable for grazing. 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 the area, which is consistent with that of the adjoining land. Similarly, the rail alignment and coal terminal are also located on lands that have been used consistent to that of the mine (low intensity cattle grazing), while some areas have been converted to other activities.

The main potential impacts of the China First Project included 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 for portions of the rail alignment. Further, areas of geological shear zones, faulting and/or with dykes were identified that may impact upon rail construction. These potential impacts have been addressed with management strategies and commitments to further detailed investigations to mitigate the potential impacts. This will delineate areas of potential impacts and assess the appropriate scale of mitigation or management.

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1 Introduction

1.1 Project Overview

Waratah Coal Pty Ltd (Waratah Coal) proposes to establish a coal mine, railway and coal terminal to export high volatile, low sulphur, steaming coal to international markets. The Co-ordinator General declared the Galilee Coal Project – Northern Export Facility (the China First Project) to be a significant project requiring the preparation of an Environmental Impact Statement (EIS).

The project includes the following components:

- A mine located near Alpha in the Galilee Basin, Central Queensland;
- A rail network between the mine and Abbot Point State Development Area (APSDA) and Port of Abbot Point; and
- A coal terminal that is incorporated within both the APSDA and Port of Abbot Point.

The project study area is shown in Figure 1-1 and a full description of the project is provided in the Project Description section of the EIS.

1.2 Terms of Reference and Scope of Study

This technical report addresses Sections 3.2.1 (Geology), 3.2.2 (Soils) and 3.2.4 (Topography and landscape character) of the Terms of Reference (August 2009, ToR) for the Galilee Coal Project (Northern Export Facility). The report has been structured to address the three major structural components of the project separately; mine, rail corridor and the onshore coal terminal infrastructure at Abbot Point. The relevant section of this technical report is listed adjacent to the specific ToR requirements for ease of reading.

The scope of the technical work undertaken for this chapter included:

- A literature review and desktop assessment of publicly available databases/digital resources and grey literature relevant to soils, geology and landform in the study area;
- Field surveys including excavation of test pits and visual inspections of existing earthwork cuttings). A total of 58 sampling sites were selected across the project areas for analysis; and
- Providing recommendations for measures to avoid or mitigate adverse impacts associated with the project. Potential impacts and mitigation measures are discussed in terms of erosion potential which inform inputs to Erosion and Sediment Control Plans (ESCP) which will be prepared prior to the commencement of construction to address the management of earthmoving activities associated with typical construction, operation and rehabilitation activities. This includes discussion of procedures for backfilling, cover and contouring as well as topsoil management for revegetation.

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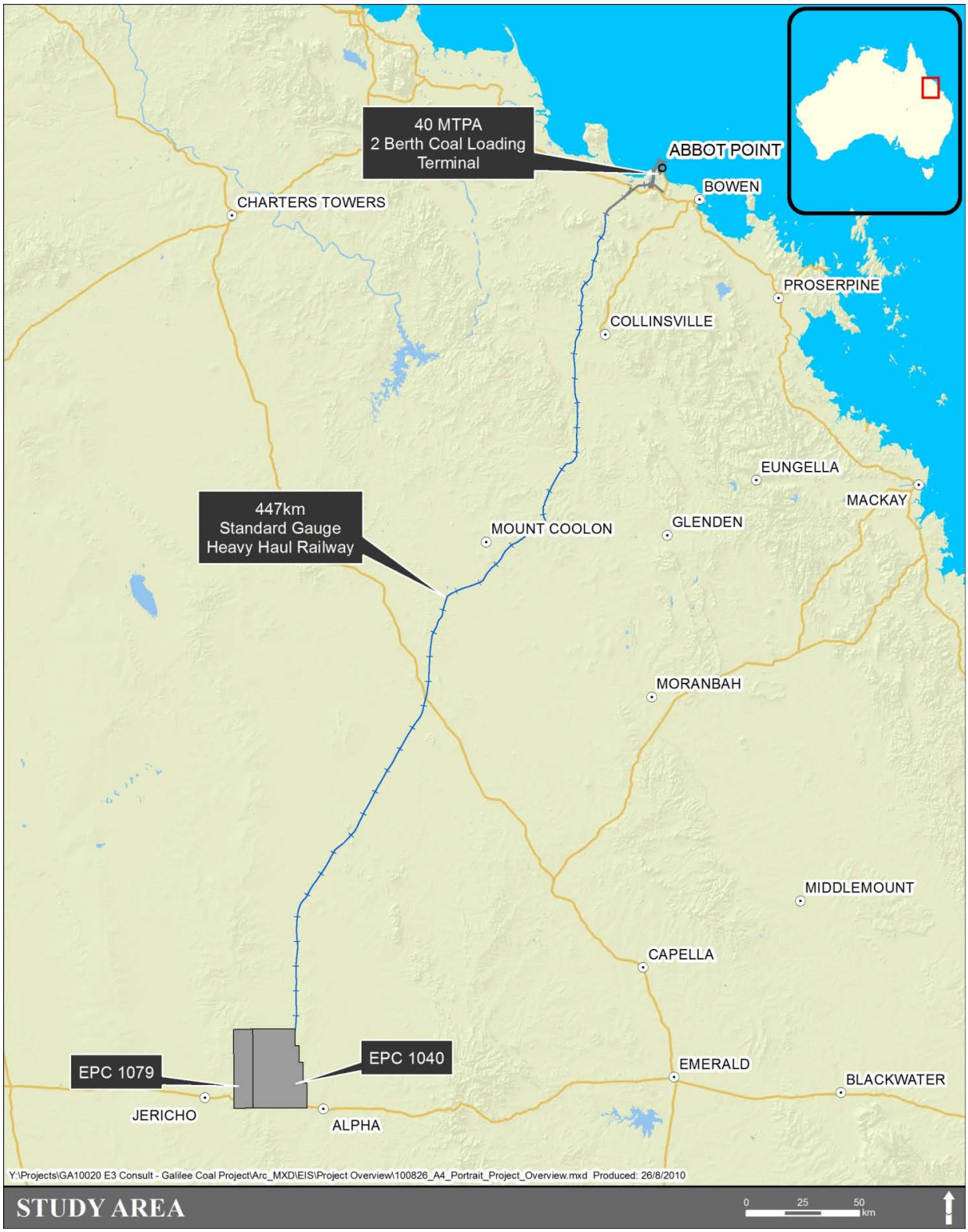

Figure 1-1: China First Project Study Area

Table 1-1: Terms of Reference - Cross Reference Table

ToR Requirements	Technical Report Section
The EIS should provide a description, map and a series of cross-sections of the geology of the project area, with particular reference to the physical and chemical properties of surface and sub-surface materials and geological structures within the proposed areas of disturbance. The general suitability of the mine site overburden material for road building (or other productive use) should be discussed briefly. Geological properties of all project sites which may influence stability, occupational health and safety, rehabilitation programs, or the quality of waste water leaving any area disturbed by the project should be described. In locations where the age and type of geology is such that significant fossil specimens (such as dinosaurs or their tracks) may be uncovered during construction/operations, the EIS should address the potential for significant finds. Investigations into the physical, geo-mechanical and chemical properties of waste rock in both fresh and weathered forms needs to be determined for slope stability, rehabilitation and possible acid generation for waste rock dump design. This section should also consider the geology underlying the proposed infrastructure corridors for coal transport, electricity easements, pipeline easements and any off-mine infrastructure. Of particular interest are any other mineral resources that may be impacted or sterilised by the infrastructure. The EIS should provide a summary of the results of studies and surveys undertaken to identify and delineate the coal resources within the project area (including any areas underlying related infrastructure). The location, tonnage and quality of the coal resources within the project area should be described in detail and include the modifying factors and assumptions made in arriving at the estimates The resources should be estimated and reported in accordance with the *Australasian Code for Reporting of Mineral Resources and Ore Reserves* (the JORC Code available at www.jorc.org/main.php) and the principles outlined in the *Australian Guidelines for the Estimating and Reporting of Inventory Coal Reserves* (available at www.jorc.org/pdf/coalguidelines.pdf), as appropriate.	Sections 4.1.2 See Geotechnical, Land Use and Planning and Waste Technical Reports for additional information
The EIS should analyse the effectiveness of the mining proposal in achieving the optimum utilisation of the coal resources within the project area and consider its impacts on other resources. It should demonstrate that the mining proposal will 'best develop' the coal resources, minimise resource wastage and avoid any unnecessary sterilisation or loss of these or any other of the state's coal, mineral, and petroleum (including gas and coal seam methane) resources that may be impacted upon or sterilised by the mining activities or related infrastructure.	Sections 4.1.2

ToR Requirements	Technical Report Section
A soil survey of the sites affected by the project should be conducted at a suitable scale, with particular reference to the physical and chemical properties of the materials that will influence erosion potential, storm water run-off quality, rehabilitation and agricultural productivity of the land. Information should also be provided on soil stability, suitability for construction of proposed facilities and any approved soil conservation plans. Soil profiles should be mapped at a suitable scale and described according to the *Australian Soil and Land Survey Field Handbook* (McDonald et al, 1990) and *Australian Soil Classification* (Isbell, 2002). An appraisal of the depth and quality of useable soil should be undertaken. Information should be presented according to the standards required in the *Planning Guidelines: The Identification of Good Quality Agricultural Land* (DPI & DHLGP, 1993), and the State Planning Policy 1/92: Development and the Conservation of Agricultural Land (DME, 1995). The requirement for soils mapping in terms of area and mapping scale should follow the Queensland Department of Mines and Energy: *Technical Guidelines for Environmental Management of Exploration and Mining in Queensland (1995)*. These guidelines recommend that disturbed areas be mapped more intensively than non-disturbed areas and provide guidance on acceptable mapping scale and site intensity.	Sections 4.1.3, 5.1.3 and 6.1.3
Acid sulphate soil (ASS) investigations are required to meet State Planning Policy 2/02, Planning and Managing Development involving ASS where the proposed development would trigger one of the criterion listed in section 2.3 of that policy. All investigations should be conducted in accordance with the SPP2/02 guideline and the guidelines for *Sampling and Analysis of Lowland Acid Sulfate Soils in Queensland 1998*. Where disturbance to ASS is unavoidable, an ASS Management Plan should be prepared in accordance with the *Queensland Acid Sulfate Soil Technical Manual – Soil Management Guidelines*.	Acid Sulphate Soils Technical Report

ToR Requirements	Technical Report Section
Possible erosion rates and management techniques should be described for all permanent and temporary landforms. The erosion potential (wind and water) and erosion management techniques should be outlined for each soil type identified. An erosion-monitoring program, including rehabilitation measures for erosion problems identified during monitoring, should also be outlined. Mitigation strategies should be developed to achieve acceptable soil loss rates, levels of sediment in rainfall runoff and wind-generated dust concentrations. The EIS should include an assessment of likely erosion effects for all disturbed areas such as: ▪ areas cleared of vegetation ▪ waste dumps ▪ stockpiles ▪ dams, banks and waterway crossings ▪ subsidence areas ▪ the port area and surrounding buildings ▪ the mine site, including buildings ▪ access roads or other transport corridors ▪ areas under rehabilitation. Methods proposed to prevent or control erosion should be specified and should be developed with regard to preventing soil loss in order to maintain land capability/suitability and preventing significant degradation of local waterways and adjacent marine and coastal habitats by suspended solids. Consideration should be given to the amendment or revocation of any approved soil conservation plans as a result of project activities.	Sections 4.1.3, 5.1.3, 6.1.3, 7, 8 and Waste Technical Report
Maps based on latitudes and longitudes using the GDA94 datum should be provided locating the project in both regional and local contexts. Topography of the project site should be detailed with contours at suitable increments at Australian Height Datum. Commentary on the maps should be provided highlighting the significant topographical features.	Sections 1.1, 4.1.1, 5.1.1, 6.1.1 and Visual Amenity Technical Report.

ToR Requirements	Technical Report Section
This section should also describe, in general terms, the existing character of the landscape that will be affected by the project. It should comment on any changes that have already been made to the natural landscape since European settlement. It should describe the general impression of the landscape that would be obtained while travelling through and around it. This section should also describe existing landscape features, panoramas and views that have, or could be expected to have, value to the community whether of local, regional, state-wide, national or international significance. Information in the form of maps, sections, elevations and photographs should be used, particularly where addressing the following issues: • identification of elements within the proposal and surrounding area that contribute to their image of the town/city as discussed in any local government strategic plan—city image and townscape objectives and associated maps • major views, existing viewing outlooks, ridgelines and other features contributing to the amenity of the area • focal points, landmarks (built form or topography), gateways associated with project site and immediate surrounding areas, waterways, and other features contributing to the visual quality of the area and the project site • character of the local and surrounding areas including character of built form (scale, form, materials and colours) and vegetation (natural and cultural vegetation) directional signage and land use • identification of the areas of the proposal that have the capacity to absorb land use changes without detriment to the existing visual quality and landscape character • the value of existing vegetation as a visual screen.	Visual Impact Technical Report

ToR Requirements	Technical Report Section
The potential impacts of the project landscape character of the site and the surrounding area should be described. Particular mention should be made of any changes to the broad-scale topography and vegetation character of the area, such as due to spoil dumps, excavated voids, stockpiles, subsidence areas and broad-scale clearing. Details should be provided of measures to be undertaken to mitigate or avoid the identified impacts. This section should analyse and discuss the visual impact of the project on particular panoramas and outlooks. It should be written in terms of the extent and significance of the changed skyline as viewed from places of residence, work, and recreation, from road, cycle and walkways and other known vantage points day and night, during all stages of the project as it relates to the surrounding landscape. The assessment is to address the visual impacts of the project structures and associated infrastructure, using appropriate simulation. Sketches, diagrams, computer imaging and photos are to be used where possible to portray the near views and far views of the completed structures and their surroundings from visually sensitive locations. Special consideration is to be given to public roads, public thoroughfares and places of residence or work, which are within the line-of-sight of the project. Details of the design and colour of any major structures, buildings or fixed plant and all proposed screenings either vegetative or material should be described and discussed where relevant to the minimisation of the visual impacts of the project. Where plantings for screening or landscaping are proposed, details should be provided of the species that will be used, and their likely provenance. Preference should be given to species native to the area. Detail should be provided of all management plans to be implemented and how these will mitigate or avoid the identified impacts. Management of the lighting of the project, during all stages, is to be provided, with particular reference to objectives to be achieved and management methods to be implemented to mitigate or avoid: ▪ the visual impact at night ▪ night operations/maintenance and effects of lighting on fauna and residents ▪ the potential impact of increased vehicular traffic ▪ changed habitat conditions for nocturnal fauna and associated impacts.	Visual Impact Technical Report

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2 Methods of Assessment

2.1 Desktop Assessment

Desktop investigations and a review were undertaken of publicly available databases, digital resources including Geosciences Australia's Mapconnect and grey literature relevant to geology, soils and landforms in the China First Project study area.

2.1.1 Topography

Topography and landscapes were reviewed with reference to CSIRO ASRIS datasets, Queensland Departments of Employment, Economic Development and Innovation (DEEDI – previously Department of Mines and Energy information) 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. Specific topographic maps used for the assessment include:

- NATMAP Map 00/050, Bowen Queensland, SE55-03 (edition 3) Topographic Map 1:250 000, Geosciences Australia, 2003;
- NATMAP Map 01/1103, Jericho Queensland, SE55-14 (edition 2) Topographic Map 1:250 000, Geosciences Australia, 2003;
- NATMAP Map 02/123, Ayr Queensland, SE55-15 (edition 3) Topographic Map 1:250 000, Geosciences Australia, 2003;
- NATMAP Map 03/091, Clermont Queensland, SE55-11(edition 3) Topographic Map 1:250 000, Geosciences Australia, 2004;
- NATMAP Map 03/092, Galilee Queensland, SE55-10 (edition 3) Topographic Map 1:250 000, Geosciences Australia, 2004;
- NATMAP Map 03/094, Mount Coolon Queensland, SE55-07 (edition 3) Topographic Map 1:250 000, Geosciences Australia, 2003; and
- Sunmap Topographic Map 8558-33, Abbot Point, Queensland, 1:25 000 Scale, (DERM, 2000).

2.1.2 Geology

The following data was used for the description and assessment of the geology and the geological structures including shear zones, faults and dykes in the project area:

- CSIRO: Australian Soil Resource Information System (ASRIS) maps;
- Geological mapping from Australia 1:250 000 Geological Series, Geosciences Australia (available at http://www.geoscience.gov.au);
- NATMAP Topographic Map Series, 1:250 000 Scale, Geosciences Australia, 2003-2004;
- Geological descriptive from Onshore Australia web pages, Geosciences Australia (available at http://www.ga.gov.au);
- Geological mapping from the Geological Survey of Queensland; and
- Sunmap Topographic Map Series, 1:25 000 Scale, (DERM, 2000).

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

2.1.3 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).

Reference was also made to the data obtained from field investigations of sections of the project area undertaken by AMEC (2009), Coffey Mining (2009) and the land resources digital atlas data sets including the CSIRO land research series.

Soils were described with reference to the following soil classification schemes:

- SPP1/92, (DEEDI, 1992);
- Planning Guidelines for The Identification of Good Quality Agricultural Land (DEEDI, 1993);
- Australian Soil Classification System (ASC) (Isbell, 2002);
- Australian Standard for Engineering Soil Classification (AS 1726-1993);
- Handbook of Australian Soils (Great Soil Groups) (Stace *et al*, 1968); and
- Principal Profile Form (PPF) (Northcote, 1974).

2.1.4 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.

2.1.5 Good Quality Agricultural Land

An assessment of Good Quality Agricultural Land (GQAL) was undertaken to assess the current and potential agricultural land use. As required in the ToR and SPP 1/92, 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), Isaac Plains Regional Council (IRC) and Whitsundays Regional Council (WRC).

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 undertaken for the China First Project to produce GQAL mapping for the entire project area. Site sampling is described in section 2.2.

2.2 Field Investigations

The dominant soil types intersected by the project were assessed, with emphasis on soils in the mine footprint, potentially dispersive soils at waterway crossings and soils along the rail alignment and at the coal terminal. 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.

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A soil survey of representative sites within the China First 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. At the time of undertaking field-based soil mapping, detailed site layout design had not been finalised. As a result, the approach adopted during field work was to focus efforts within an 800m wide buffer zone of the rail alignment.

Fieldwork undertaken was based on the following guidelines and management handbooks:

- DEEDI Technical Guidelines for Environmental Management of Exploration and Mining in Queensland (1995);
- Australian Soil Classification Guideline (Isbell, 2002) – The Guidelines recommendations that disturbed areas be mapped more intensively than non-disturbed areas; and
- Australian Soil and Land Survey Field Handbook (McDonald et al, 1990);

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 2m 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.

At the mine and coal terminal the data was interpreted to assess the extent of different soil types. However, along the rail alignment this was not done as samples were widely spaced and landforms vary along the alignment making interpolation likely to exaggerate the results.

A total of 58 sample locations were used to characterise soils within the study area with 143 sub-samples taken from these locations. Fifty eight samples were sent to the laboratory for analysis. Soil sampling was distributed amongst the three major project components as follows:

- Mine - 17 samples were collected from ten locations across the site with nine samples selected for laboratory analysis (Sites SS49-SS58);
- Rail alignment - 118 samples were collected from 43 locations along the rail alignment with 43 samples selected for laboratory analysis (Sites SS01 to SS48); and
- Coal Terminal - eight samples were collected from five locations with six samples selected for laboratory analysis (Sites SS01 to SS05).

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2.2.1 Soil Observations

Visual observations of soil type and structure were undertaken at a number of the waterway that will be disturbed by construction works. These observations were carried out in order to discuss erosion potential at waterway crossings along the rail alignment and at the mine site. Characteristics noted on site included dominant soils type, stream morphology, bank vegetation and signs of existing erosion / disturbance. A total of 52 sites were observed during the field works with an assessment of each site provided in Appendix A.

2.3 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).

Laboratory certificates are provided in Appendix B and soil data is provided in Appendix C.

Emerson Crumb Tests

Soils were assessed for stability and erosion potential by assessment of soil types from prior mapping field observations and laboratory analysis of samples by Emerson Crumb tests. The Emerson Crumb test measures the susceptibility to dispersion of the soil in water. Dispersion describes the tendency for the clay fraction of a soil to go into colloidal suspension in water. The test indicates the credibility and structural stability of the soil and its susceptibility to surface sealing under irrigation and rainfall. Soils are divided into eight classes on the basis of the coherence of soil aggregates in water (Table 2-1).

Table 2-1: Emerson Crumb Class Interpretation

Class	Expected Field Behaviour	Erodibility
Class 1	▪ Almost certainly sodic ▪ Complete dispersion of undisturbed aggregate ▪ Very fragile, difficult to manage	High
Class 2	▪ Highly likely to be sodic ▪ Some dispersion of undisturbed aggregate ▪ Fragile, difficult to manage	High

Class	Expected Field Behaviour	Erodibility
Class 3	▪ Possibly sodic ▪ Dispersion after being disturbed (for example after earthworks ▪ Fragile but stable if manage carefully	Moderate
Class4/5/6	▪ Possibly sodic ▪ Generally stable	Moderate
Class 7	▪ Unlikely to be sodic ▪ Stable	Low
Class 8	▪ Unlikely to be sodic ▪ Very stable	Low

2.3.1 Exchangeable Sodium Percentage

Exchangeable Sodium Percentage (ESP) is the proportion of sodium adsorbed onto the clay mineral of the soil as a proportion of the total cation exchange capacity (CEC). A high ESP is an indicator that the soil is prone to dispersion. Different soils will respond differently to high ESPs and Emerson Crumb tests were therefore also used to assess dispersivity and erosion potential.

Guideline values for exchangeable sodium percentage (ESP%) are provided in the Assessment and Management of Saline/Sodic Wastes (DERM, 1995)(DERM Guidelines (1995)) and the NSW Department of Environment, Climate Change and Water (2008) (DECCW, 2008) ranking for laboratory exchangeable cation test results (Table 2-2).

2.3.2 Sodium Absorption Ratio

The Sodium Absorption Ratio (SAR) is a measure of the sodicity of soil and is a ratio of the amount sodium in soil to the amount of calcium and magnesium. Where clay soils have a high SAR ratio, the soils lose their structure, become more dispersive and have lower soil permeability, rendering the soil less productive. A SAR >12 is generally considered high and indicates potential for the above sodic impacts. Sandy soils behave differently from clay soils and a high SAR ratio does not necessarily indicate a dispersive soil. Emerson Crumb tests were therefore also undertaken to assess dispersion.

Table 2-2: Guideline Values for Soil Sodicity

Test	Very Low	Low	Medium	High	Very High
Exchangeable Sodium (meq/100g)	<0.1	0.1-0.3	0.3-0.7	0.7-2.0	>2
Ca:Mg ratio	<1	1-2	2-5	>5	
ESP%	<2	2-6	6-12	12-20	>20

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2.3.3 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. Detailed information on the above is reported in the Waste Technical Chapter.

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 Coal Handling and Preparation Plant (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).

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3 Seismic Activity in Project Area

Although damaging earthquakes are relatively rare in Australia, the high impact of individual events on the community ranks makes them a costly natural hazard. The highest hazard regions in Queensland lie along the east coast and off-shore regions with most historic earthquakes having occurred within about 200km of the coast, either onshore or offshore. Six earthquakes are known to have occurred near Mackay but so far none have caused significant damage.

Middelmann and Granger (2000) investigated community risk to the Mackay area, which included an assessment of earthquake risk. Two strong earthquakes are known to have occurred in Central Queensland, one at Ravenswood (approximately 250km northwest of Mackay and 100km west of the study area) with an epicentre of the Richter magnitude 5.7 on 18 December 1913 and another offshore of Bundaberg over 600km south of the study area on 6 June 1918 with an epicentre Richter magnitude of 6.3, which was reported to have been felt in Mackay. The 1913 and 1918 earthquakes demonstrate that potentially damaging earthquakes do occur in Queensland and their occurrence near Mackay should not be discounted.

The Earthquake Hazard Map (Geosciences Australia, 1991) provides an indication of the relative expected severity of earthquake ground motion expressed as an acceleration coefficient. An excerpt from this mapping is provided as Figure 3-1.

The measure provides a 10% probability of the exceedance of this risk in a 50 year period or an annual exceedance probability of 1 in 475 years. Acceleration Coefficients of 0.24-0.4 are considered high, while coefficients of 0.08-0.09 are considered moderate and <0.05 is considered low.

The mapping indicates that the northern half of the rail alignment and the Abbot Point area have a higher acceleration coefficient of 0.05 to 0.1 which is still be considered moderate. The southern half of the rail alignment and the area of the mine have lower acceleration coefficients of 0.05 to 0.03.

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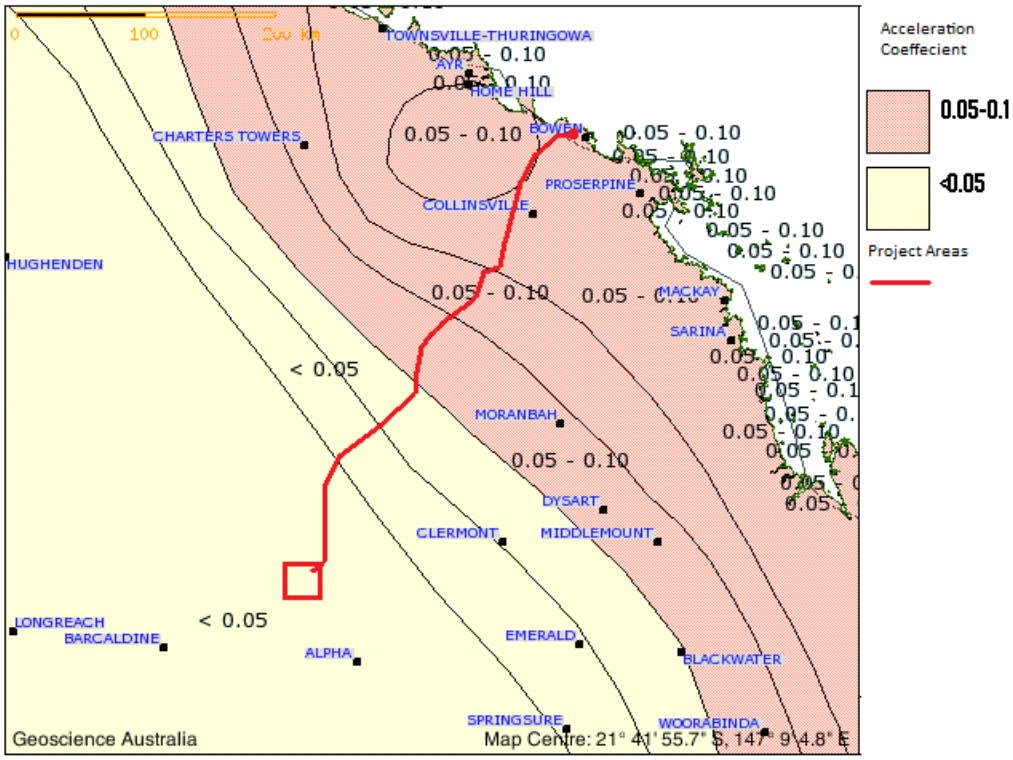

Figure 3-1: Earthquake Hazard Map of the Project Area

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4 Mine Site

The following section provides an overview of the information on topography, geology, soils and landform for the mine area.

4.1 Topography

The topography at the mine rises gently to the west up to 400m Australian Height Datum (AHD) to outcrops of the Great Artesian Basin sediments 20km to 40km west of the mine (Figure 4-1). Gently undulating plains occur throughout the majority of the mine area with strongly undulating to hilly land in the north-east corner of Exploration Permit Coal (EPC) 1040 (Plate 4-1).

Plate 4-1: Topography at the mine

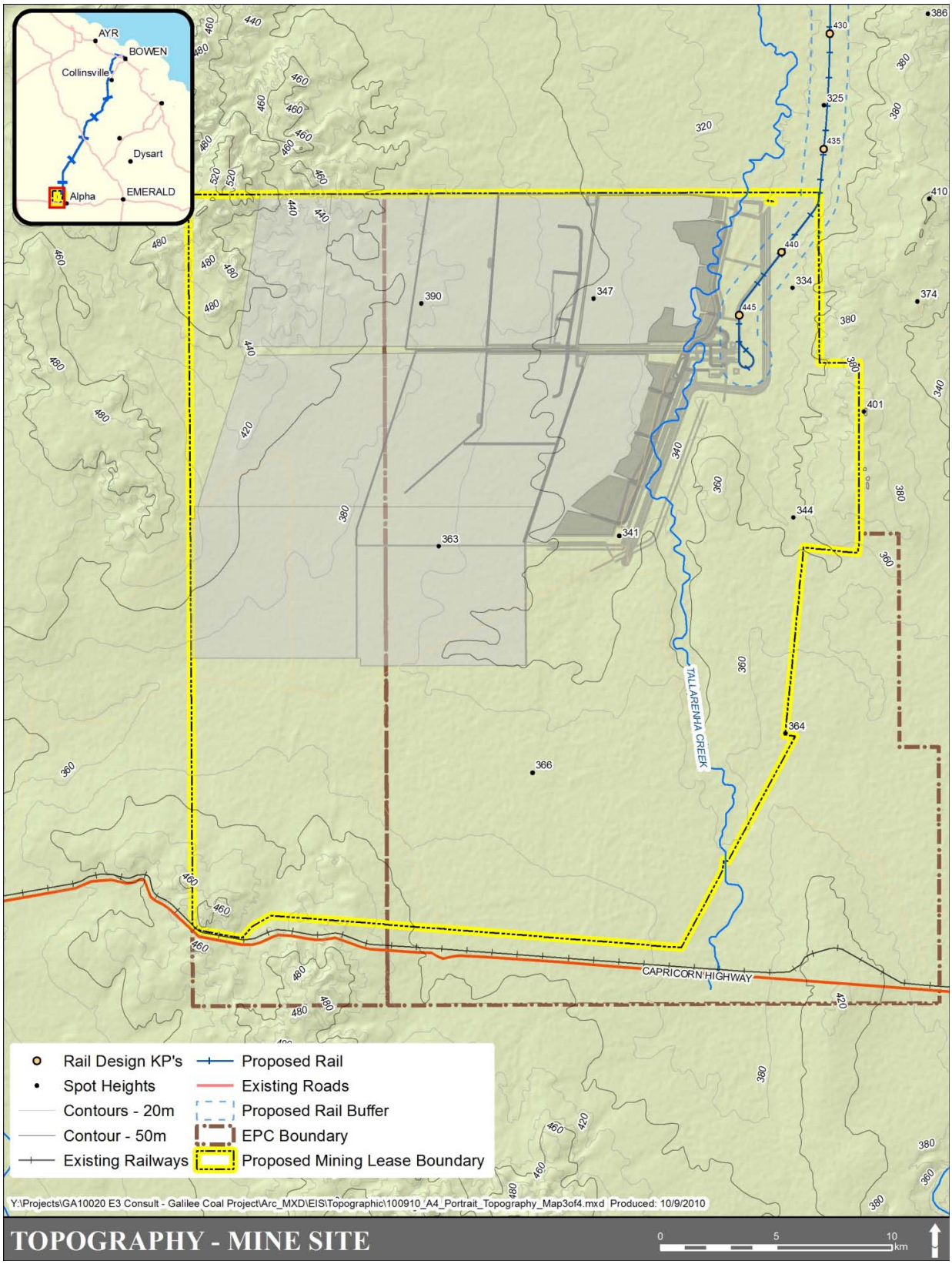

Figure 4-1: Mine Site Topography – contours in AHD

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4.2 Geology

The geology at the mine is taken from the South Alpha Project – Mine News 00201AA Resource Estimate Report (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 90m 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 Tertiary flood basalts that feature in the cover sequence in parts of the Bowen Basin are absent from South Alpha. The Cainozoic tends to be thin in the west and China First's 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. The mine's surface geology is shown on Figure 4-2. Table 4-1 provides a key to the geology figures for the mine site area.

Table 4-1: 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	-	-	Sedimentary Rocks
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
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

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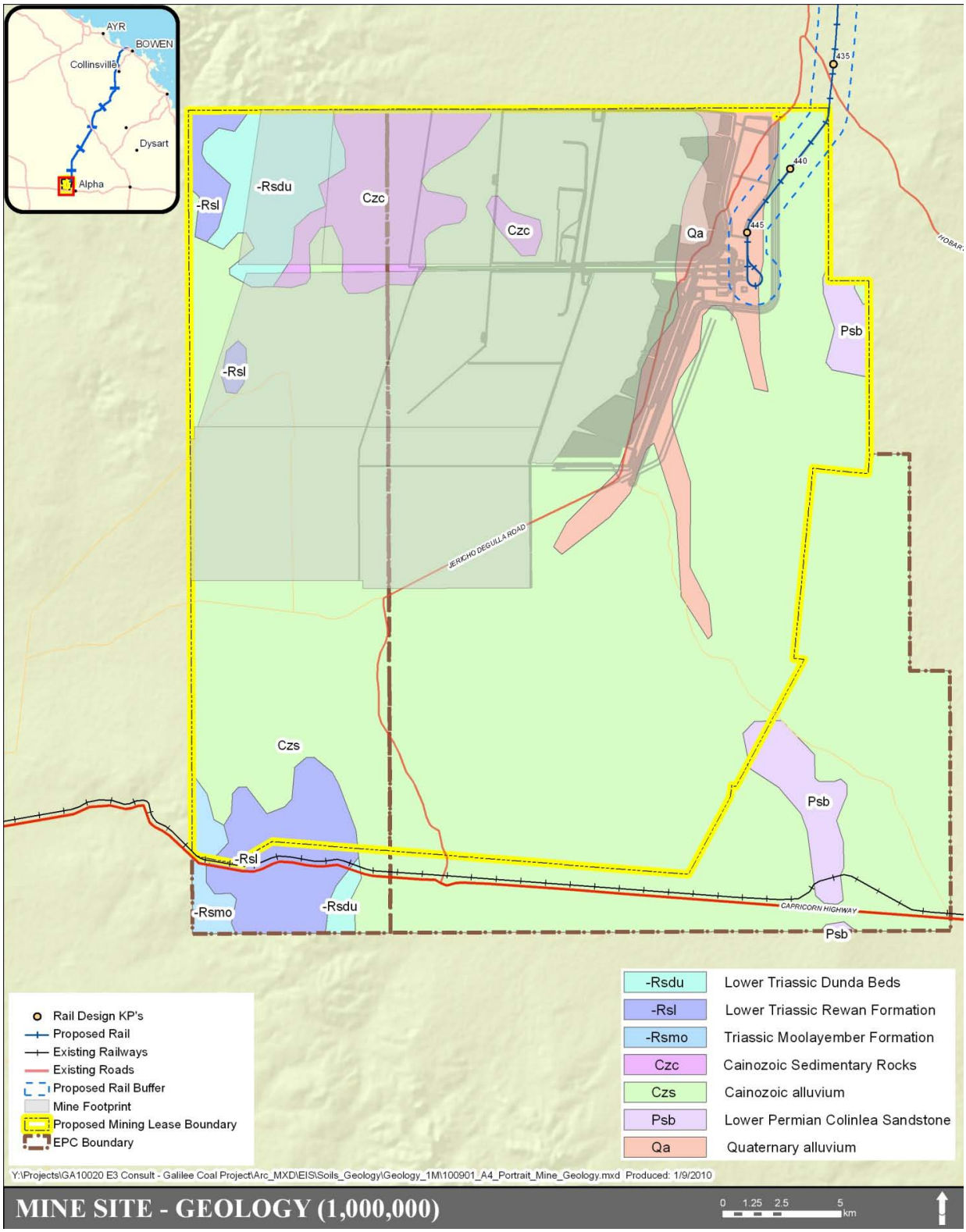

Figure 4-2: Mine Site Surface Geology

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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^{o}.

Mine Resource Geology

The China First 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 Inlier during the Upper Carboniferous, Permian and Triassic periods. The Galilee Basin is underlain by the Drummond Basin and overlain by the Eromanga Basin. The coal resource is summarised below:

- 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 in provided in Chapter 2 of the EIS. 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 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 90m 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 30km to the west and to over 1km of overlying stratigraphy (China First and SRK, 2008).

The China First deposit is estimated to contain 3.93 billion tonnes (Bt) of coal resources. Of this 1,975 million tonnes (Mt) are measured, 565Mt are indicated and 1,140Mt are inferred. Of the resource total, 830Mt would be mined as open cut mines and 3,095Mt as underground areas (Coffey, 2009). Underground

areas typically show only modest cover of 120-200m 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.

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 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.

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 China First Project area (GSQ, 1996); there is potential for similar fossils as described above in the stratigraphy in the mine area due to the similar depositional environments.

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 4-3).

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.

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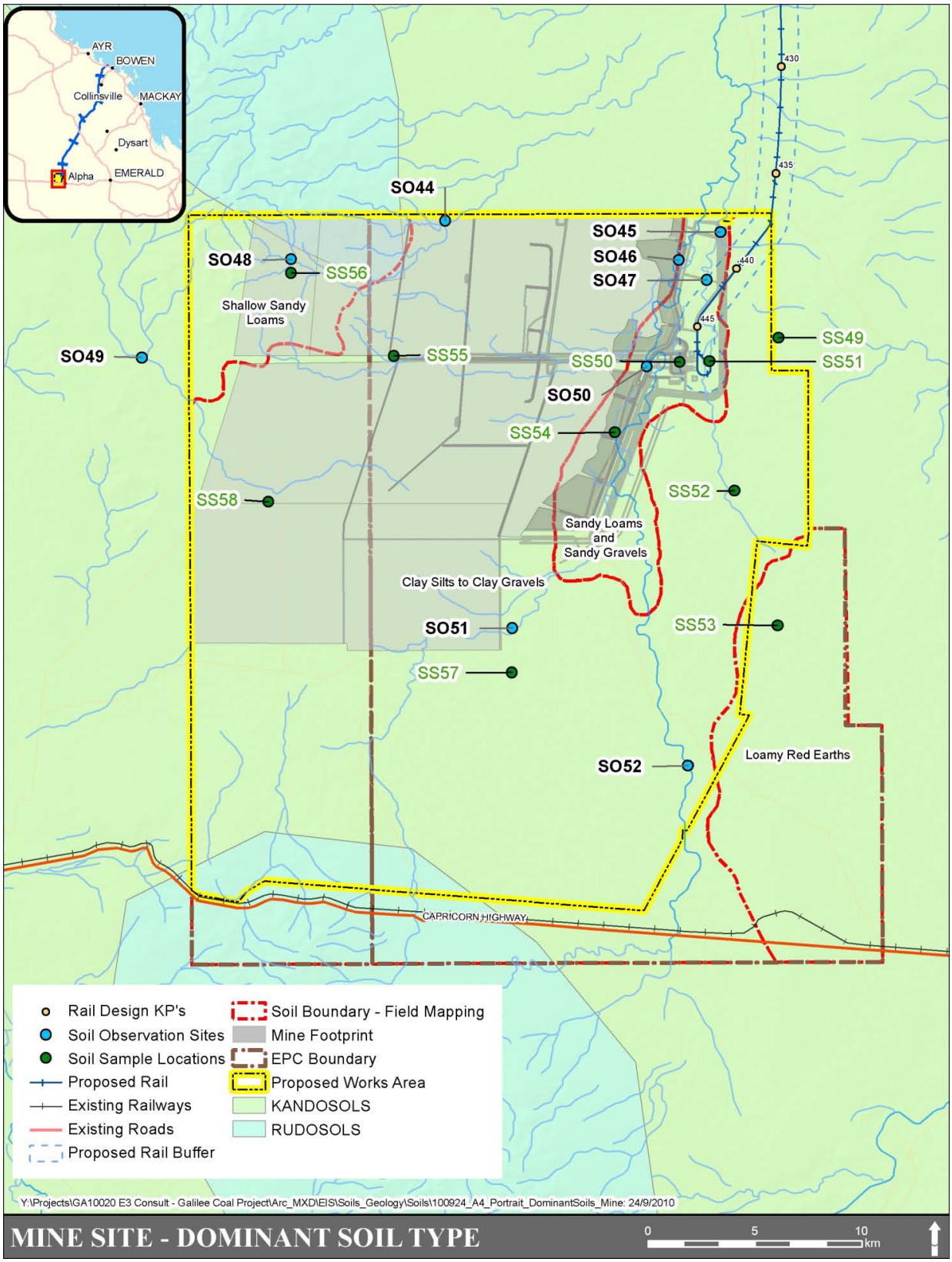

Figure 4-3: Mine Site Soil Types

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.

Table 4-2 provides approximate correlations between the Australian Soil Classification (ASC), Principal Profile Forms (PPF) and the other soil classifications for the soils within the mine area. The PPF uses a key to describe various soil parameters including (but not limited to) permeability, profile water holding capacity, soil texture profile (Plate 4-2). A full description is provided in McKenzie and Hook (1992).

Table 4-2: Description of Major Soil Classifications at the Mine

ASC	Description	PPF	Great Soil Groups
Kandosols	Structureless soils that lack texture contrast.	Gn2, Um5 soils	Red, yellow and grey earths, calcareous red earths
Rudosols	Soils with minimal soil development. Soils where soil forming factors have had little time to modify parent rocks or sediment.	Uc1, Um1 and Uf1 soils	Lithosols, alluvial soils, calcareous and silaceous sands, some solonchaks

Ten soil samples were collected in the vicinity of the mine site. A description of these samples is provided in Table 4-3.

Table 4-3: 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 (9mm), 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

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Sample	Sample Location	Soil
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

The physical results of the soil investigation indicate that Kandosols are the dominant soil type in the mine area (Plate 4-2). Laboratory analyses of the selected samples collected from the mine area are described below.

Plate 4-2: Gravelly Soils at the mine

Soil Summary

An analysis of particle size distributions for topsoil indicated that 52% to 71% of the samples passed through a 75um 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.

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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 metres below ground level (mgbl)) to 6.8 (SS53 = 0.0-0.3 mgbl) which is slightly acidic but within the range that is optimal for plant growth.

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 DECCW provides guideline values for the interpretation of laboratory cation analysis (DECCW, 2008). Soil exchangeable cation laboratory results were:

- Exchangeable Ca ranged from 0.7 meq/100g (SS50) to 4.2 meq/100g (SS53) indicating low to very exchangeable Ca;
- Exchangeable Mg ranged from 0.4 meq/100g (SS50) to 1.2 meq/100g (SS53) indicating low to moderate exchangeable Mg;
- Exchangeable K ranged from 0.1 meq/100g (SS49 and SS50) to 0.7 meq/100g (SS56) indicating very low to moderate exchangeable K; and
- CEC ranged from 1.2 meq/100g (SS50) to 5.8 meq/100g (SS53) indicating a very low CEC.

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

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 electrical conductivity (EC). These values were compared to values listed in the Guidelines for the Assessment and Management of Saline/Sodic Wastes (DERM, 1995).

The results of soil salinity laboratory analysis were:

- EC ranged from 7µS/cm (SS58) to 37µS/cm (SS53) indicating very low salinity; and
- Chloride ranged from 20mg/kg (SS50 and SS57) to 80mg/kg (SS56) indicating very low chloride.

According to the DERM Guidelines (1995), the soils are characterised as having low salinity.

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Soil Sodicity and Dispersion

ESP 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). The laboratory results of sodicity/dipersivity analysis were:

- Exchangeable sodium was below the laboratory's limit of reporting in all samples except for SS49 which measured a 0.2 meq/100g indicating very low exchangeable sodium;
- Ca:Mg ratio ranged from 0.6 (SS56) to 3.6 (SS53) indicating very low to medium Ca:Mg ratios across the area with very low to low Ca:Mg ratios detected in samples (SS49 (1.4), SS51 (1.8), SS56 (0.6) and SS58 (1);
- ESP is very low (<2%) to low (2%-6%) with the exception of sample SS49 (0.0-0.3mgbl) which reported an ESP of 11.2% and is classified as medium (6%-12%); and
- SAR ranged from 0.21 (SS53 = 0.0-0.3mgbl) to 1.51 (SS49 =0.0-0.3mgbl) indicating a very low SAR.

ESP is very low to low except at one location. Generally low ESPs indicate that clay soils are less prone to dispersion. 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 which indicates 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 will provide a further insight into these results.

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

Soil Observations

A total of 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.

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 0.3m 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.

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 4-4. Mapped Landscape units are shown on Figure 4-4.

Table 4-4: 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

Location	Landscape Unit	Landform	Soils	Remarks
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

4.5 Good Quality Agricultural Land (GQAL)

Based on the results of soil sampling the land within the mine footprint would be considered class D GQAL (Figure 4-5), which is described as being “non-agricultural land, being land not suitable for agricultural uses due to extreme limitations”. There is some Class C land in the south east of the EPC but this will not be impacted by the mine. Class C land is described as pasture “land that is suitable only for improved pastures or native pastures”.

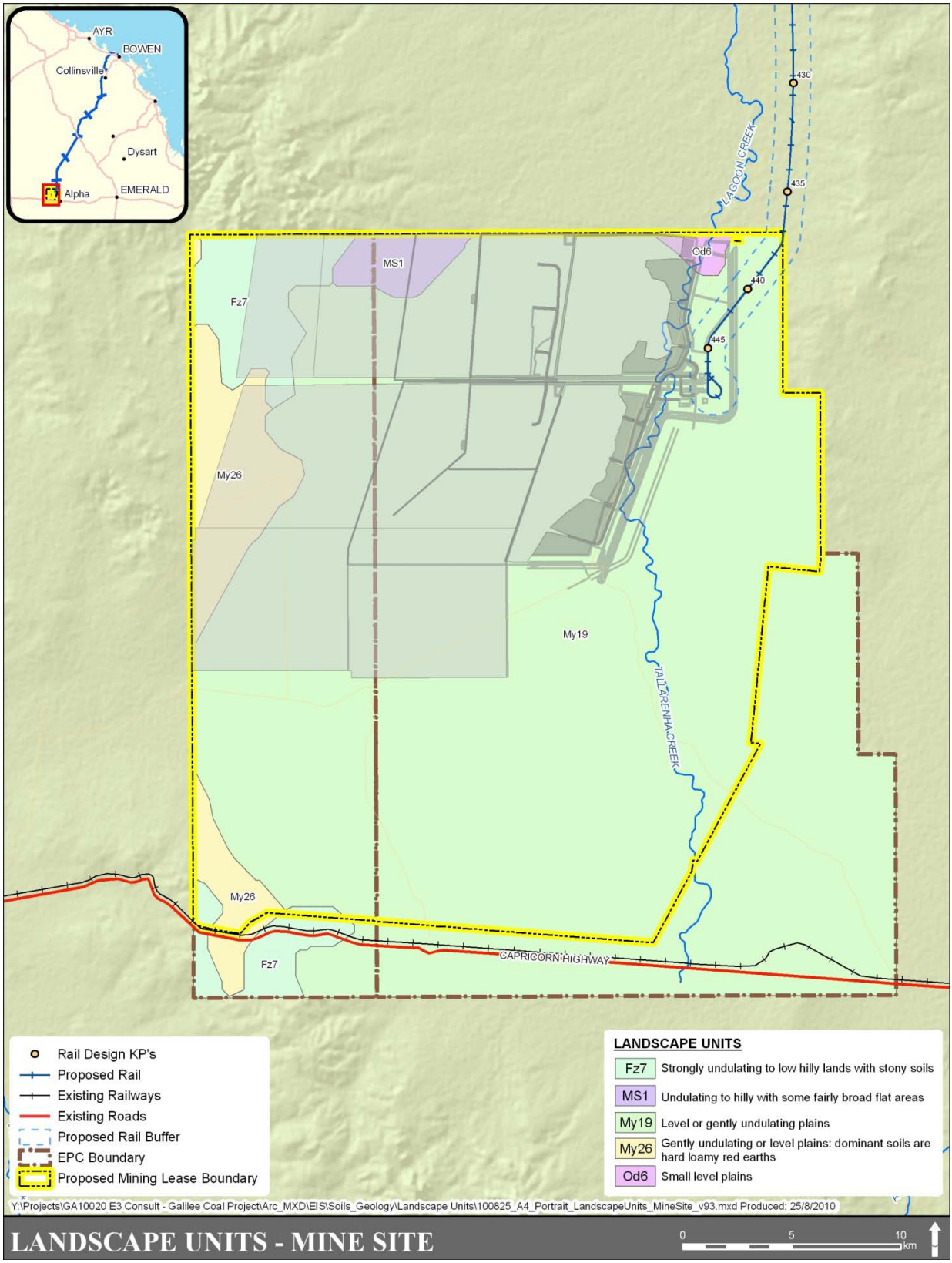

Figure 4-4: Mine Site Landscape Units

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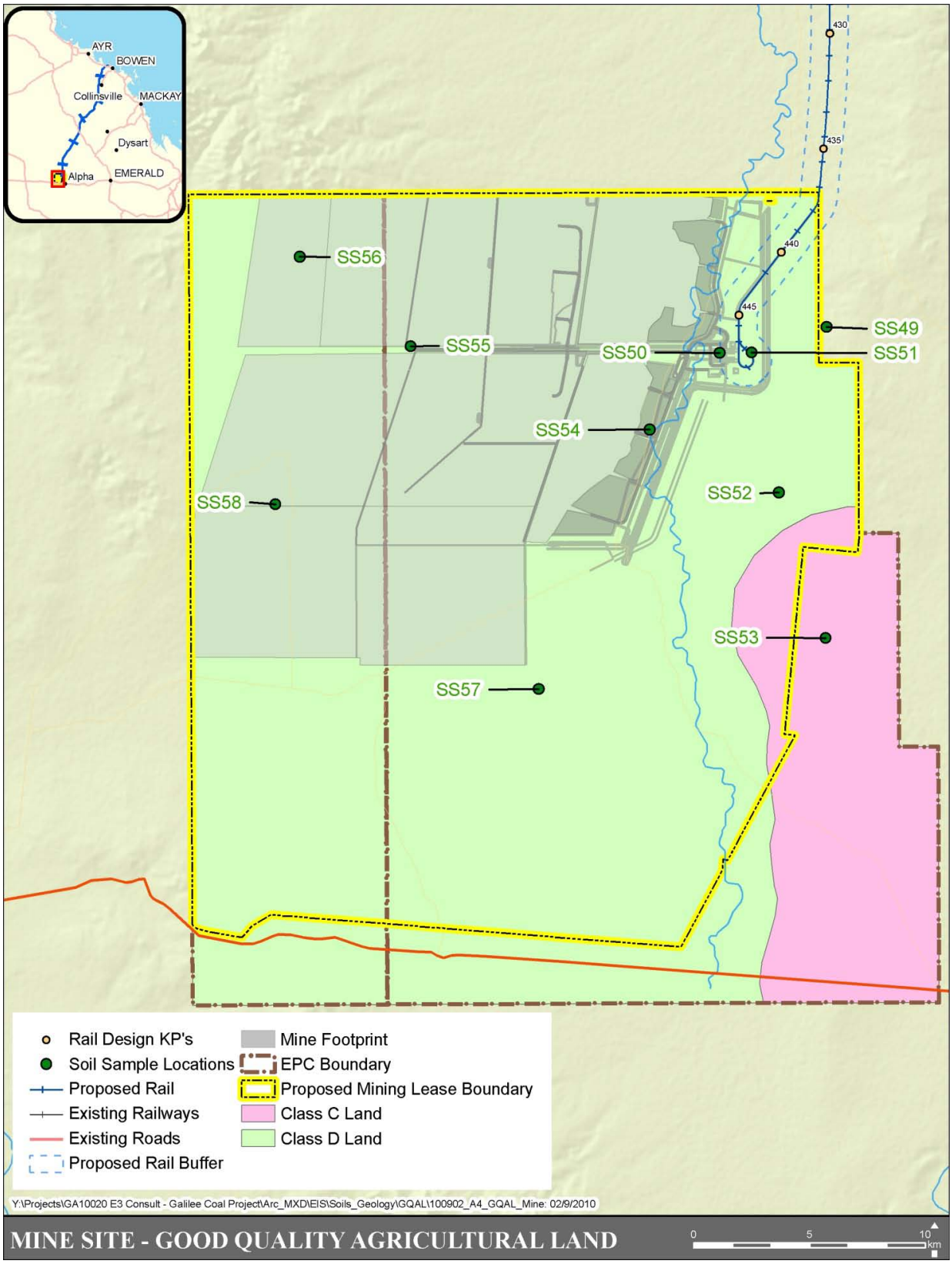

Figure 4-5: GQAL at the Mine Site

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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 4-6.

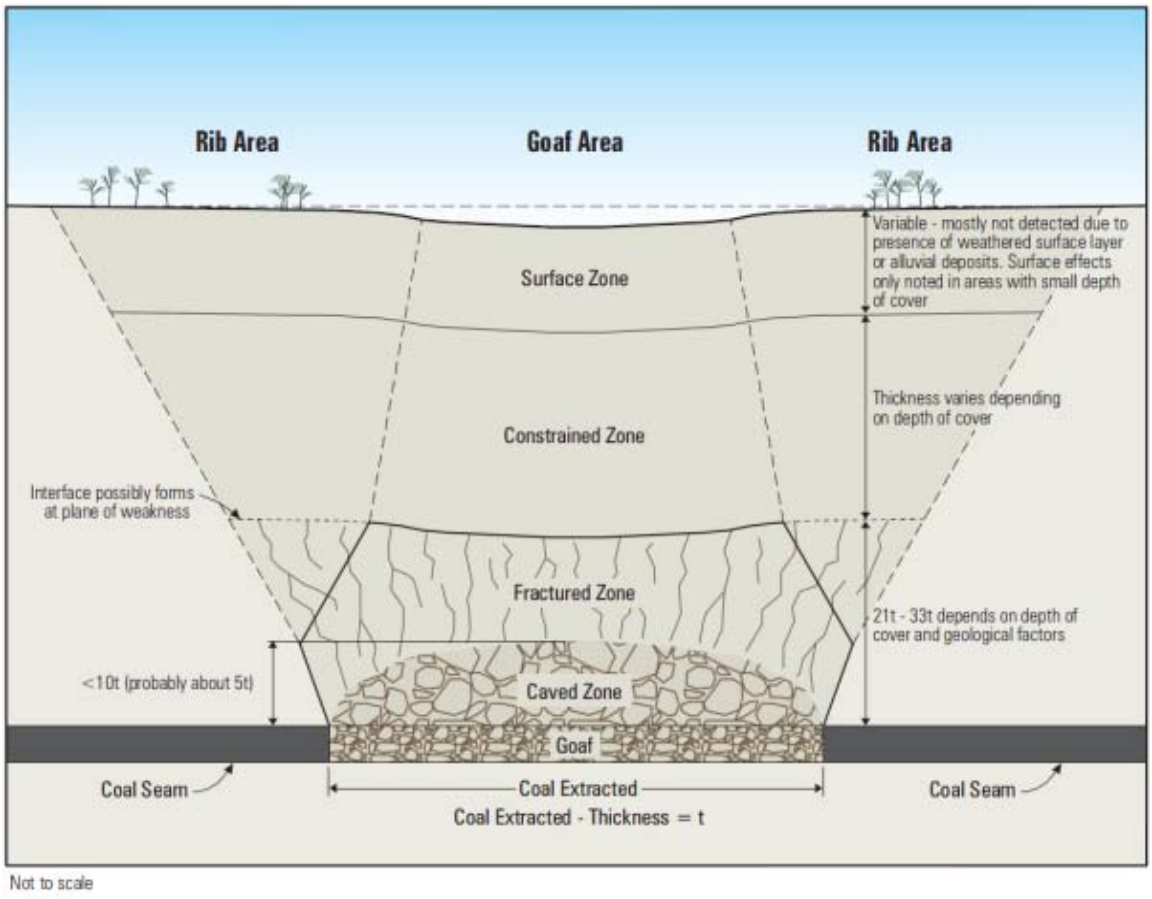

Figure 4-6: Schematic of Potential Ground Impacts Associated with Underground Mining

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 4-6) 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 moves 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.

Subsidence Estimates

Estimates of subsidence at the mine site were carried out by Coffey Mining and can be found in the detailed description of the mine construction and operations in the EIS. 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 3.27m. Average subsidence across the bulk of the mine site is expected to range between 1.3m to 1.61m.

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5 Rail Alignment

To aid in the interpretation of the key geological features intersected by the rail alignment, the alignment has been divided into five major geomorphic zones corresponding with Kilometre Points (KP) which originate at the coal terminal. These KP and geomorphic units and the soil sampling locations within each geomorphic unit are:

- KP00-KP25 – Coastal Plains (Sites SS01 to SS08);
- KP25-KP85 – Clarke Ranges (Sites SS09 to SS16);
- KP85-KP125 – Bowen River Valley (Sites SS17-SS20);
- KP125-KP190 – Leichhardt Range (Sites SS21-SS30); and
- KP190-KP447 – Inland Plains (Sites SS31-SS48).

Within each of these geomorphic units, the topography, geology, soil characteristics (i.e. soil fertility, sodicity, salinity, erosion potential, topsoil potential), landforms and GQAL are described. The locations of the relevant sections on the rail alignment are shown in Figure 5-1 and Figure 5-2.

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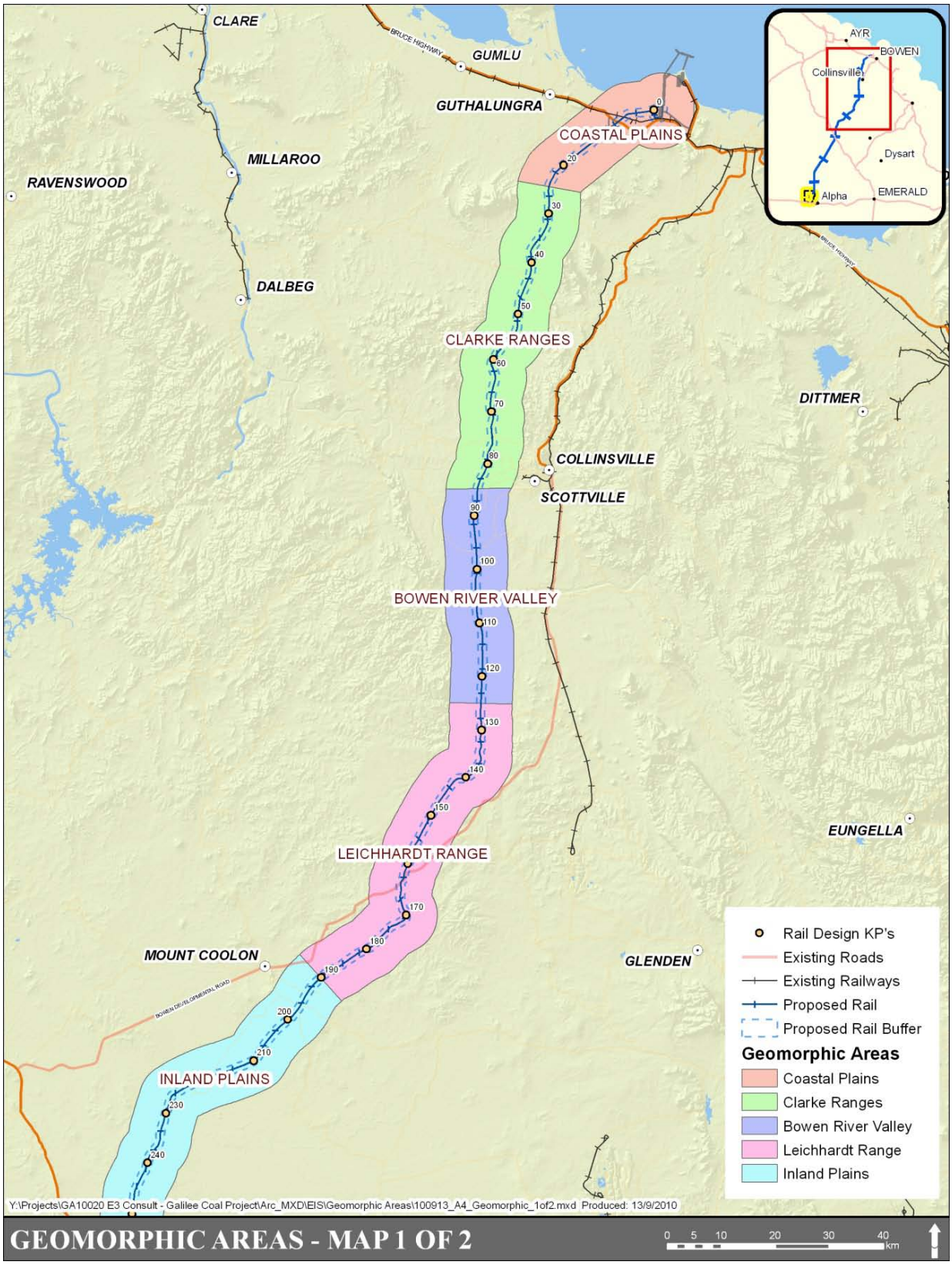

Figure 5-1: Geomorphic Units (KP00 to KP240)

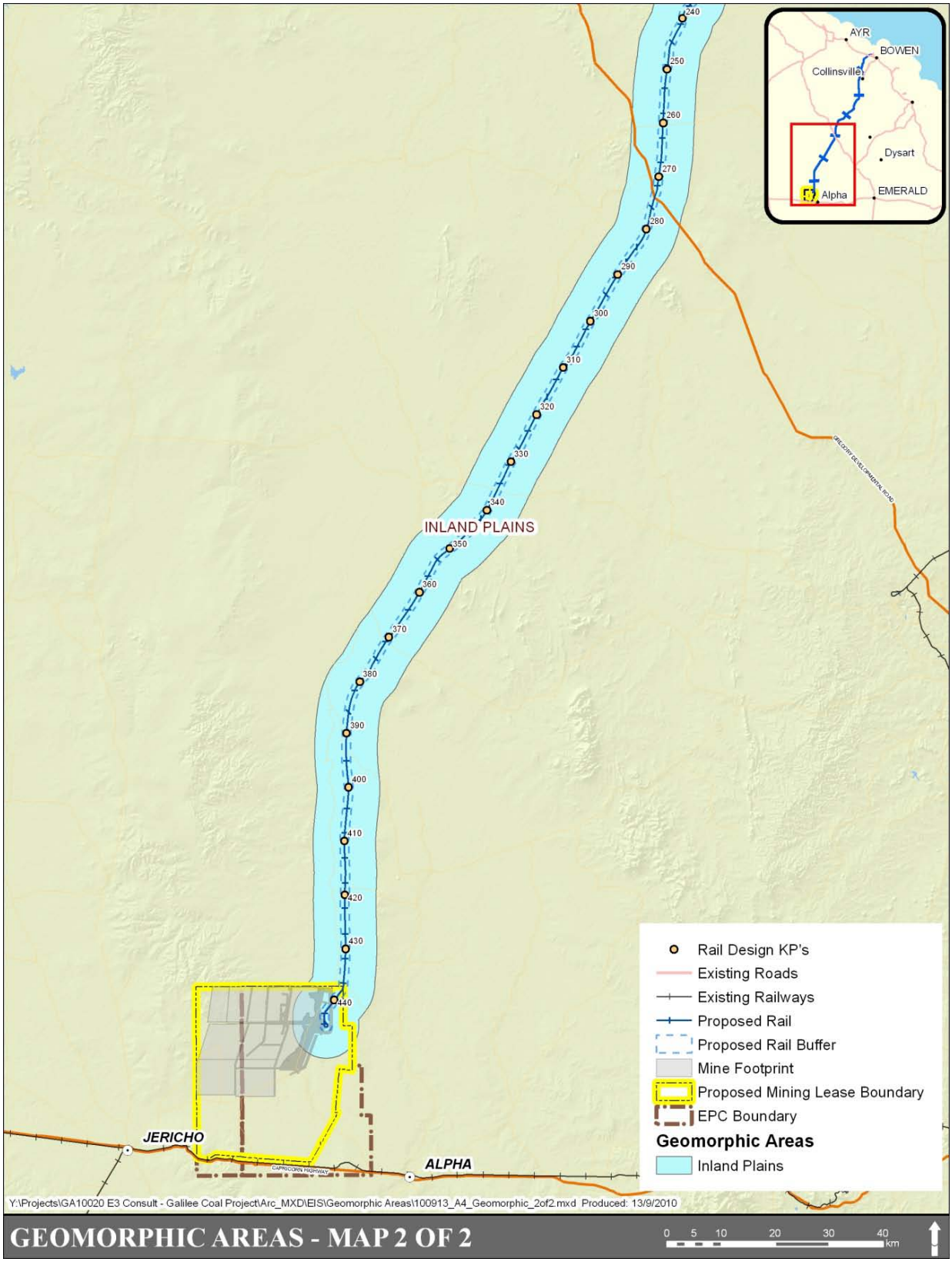

Figure 5-2: Geomorphic Units (KP240 to KP447)

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5.1 Topography

The following sections described the topography of the rail alignment in the five previously described areas of the 447km.

KP00-KP25 - Coastal Plains

The topography of the coastal plain ranges from wetlands and residual clay plains to flat, weathered granite and granitic hills. The rail alignment tracks westward for 5.6km from the coal terminal along relatively flat terrain between 5m and 15m AHD with some isolated areas below the 5m AHD contour associated with creek crossings.

KP25-KP85 - Clarke Ranges

Elevations in this area range from around 100m AHD to over 1,000m AHD; however the rail alignment reaches maximum elevations of about 200m. The topography includes the granite hills of Mt Abbot (1056m), Mt Aberdeen (910m), Mount MacKenzie (514m), Pine Hill (624m), and Highlanders Bonnet (487m).

KP85-KP125 - Bowen River Valley

The topography of this area reflects the Bowen River Valley's erosional impact upon the underlying geology with the topography falling from 233m AHD to 150m AHD in the centre of the valley before climbing up to 350m as the valley gives way to the Leichhardt Range.

KP125-KP190 - Leichhardt Range

The topography of the Leichardt Range inclines from 250m to 516m AHD and includes Bulgonunna Peak (516m). The intrusive rock types form areas of higher relief with radial drainage to the Suttor Formation which surrounds them. The area is also dissected by tributaries of the Suttor River that eventually drain to the southwest, into the Belyando and subsequently the Burdekin catchment.

KP190-KP447 - Inland Plains

The topography comprises undulating plains crossing the Suttor River Valley at 190m to 220m, rising up to 250m on areas of outcrop before dropping back to about 230m on sandy cover. The topography then steadily rises gently to the west reaching about 250m to 290m across the Belyando River valley and rising to 300m to 320m adjacent to the Permian Sandstones. It finally reaches 330m at the end of the rail alignment. The generally low undulating topography indicates a low potential for landslip in this area (Plate 5-1).

Topography along the rail alignment is shown in Figure 5-3, Figure 5-4, Figure 5-5 and Figure 5-6.

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Plate 5-1: Inland Plains with ranges in background

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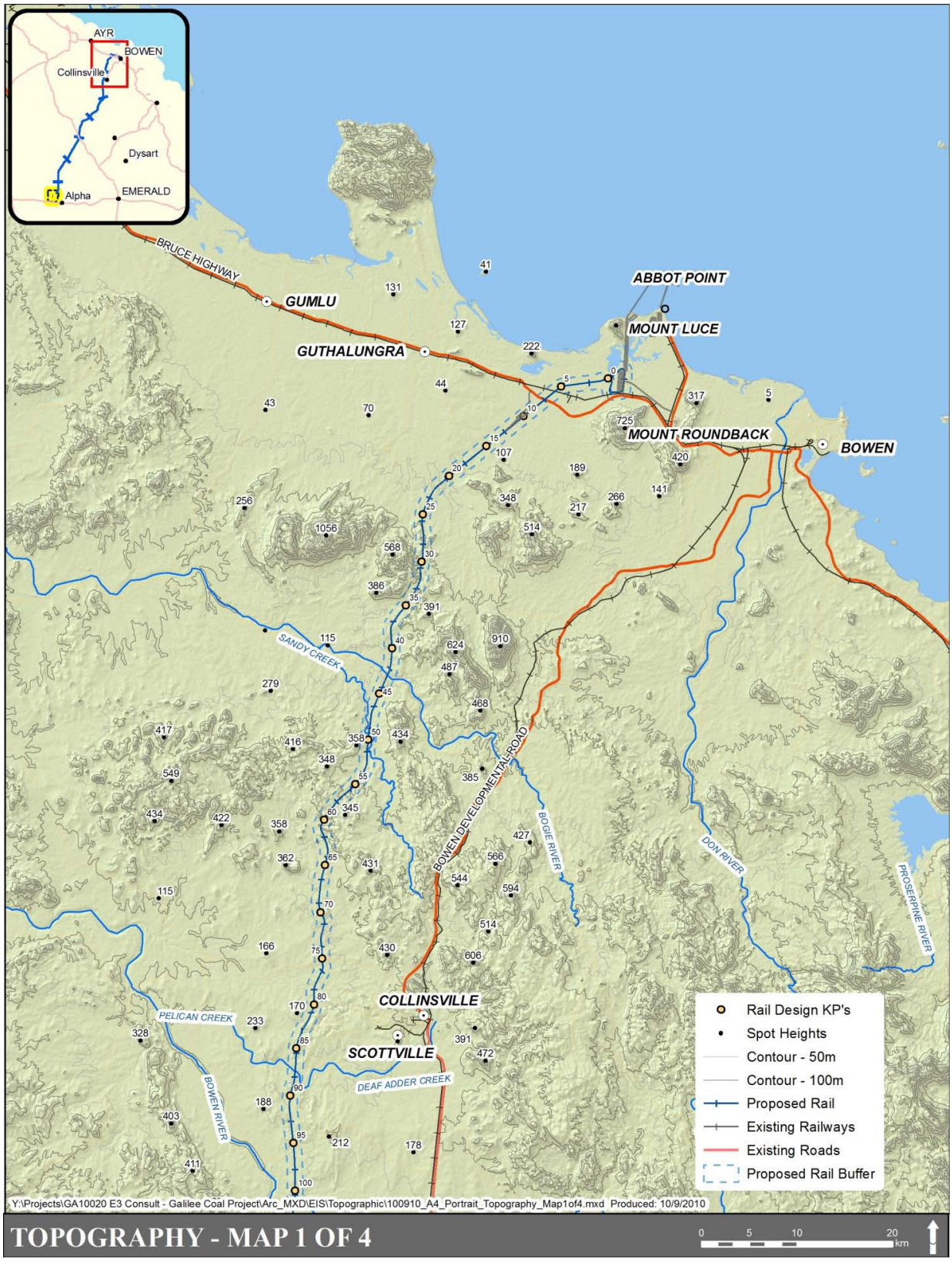

Figure 5-3: Topography (KP00 - KP85)

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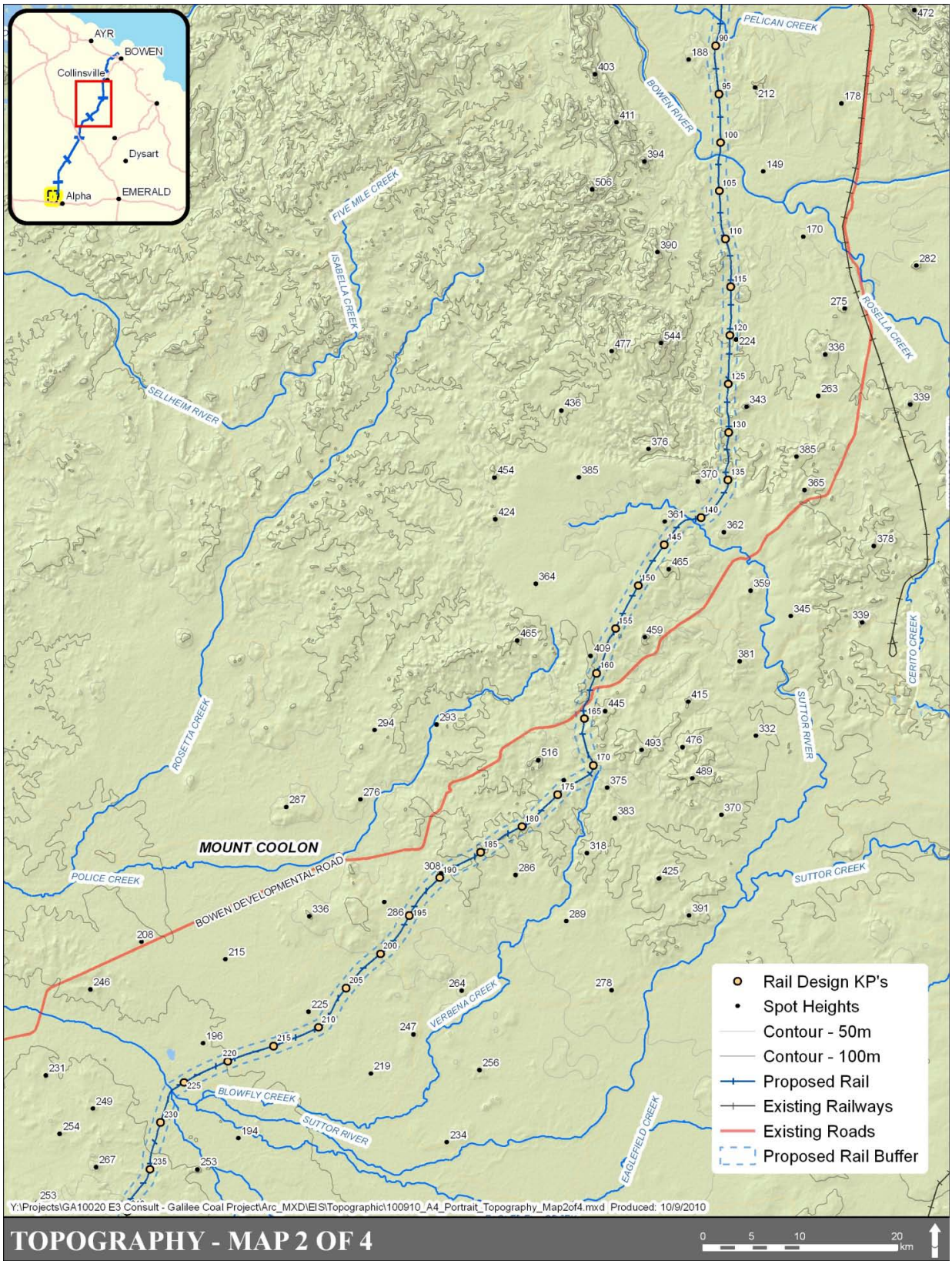

Figure 5-4: Topography (KP85 - KP235)

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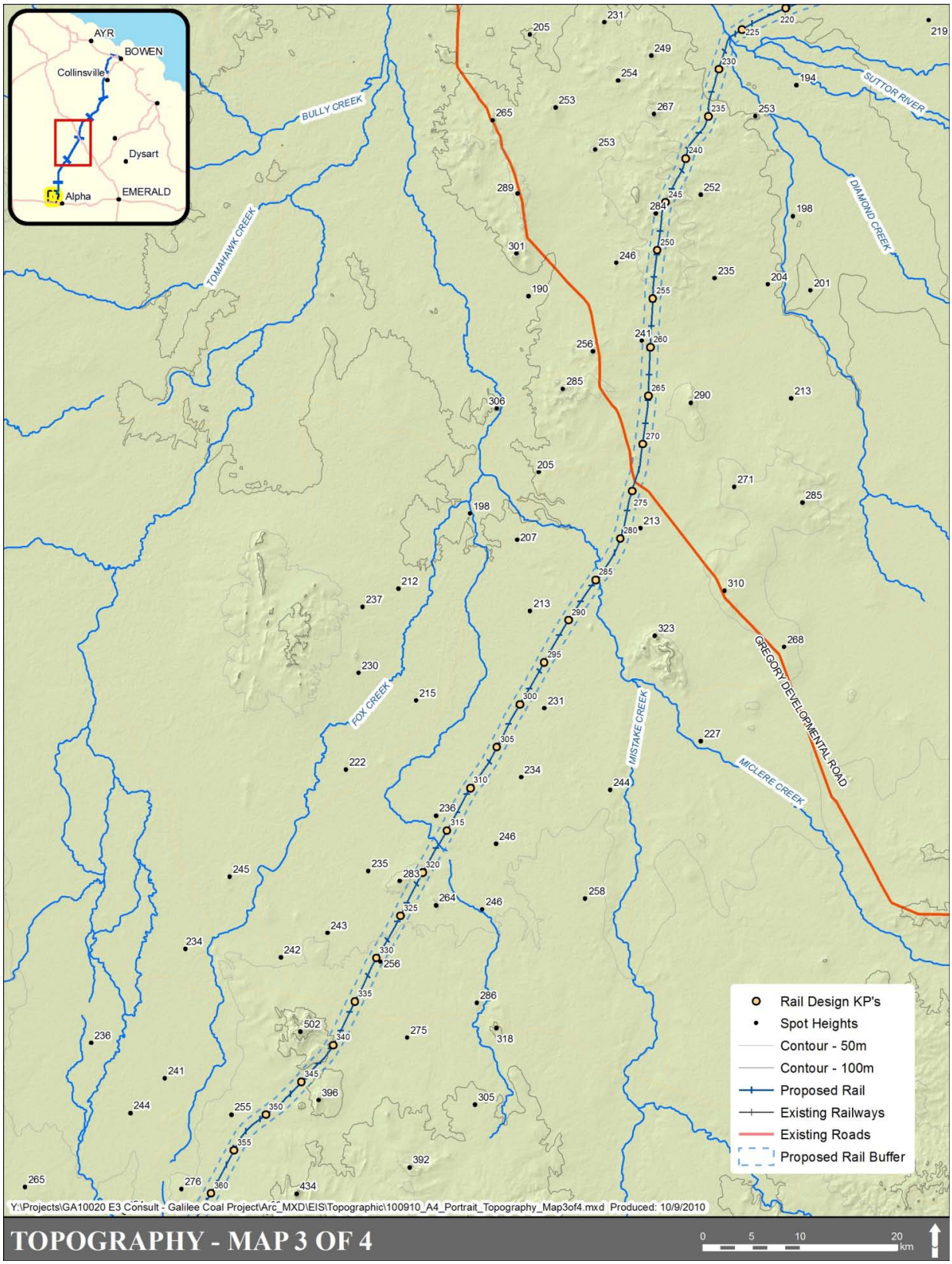

Figure 5-5: Topography (KP235 - KP360)

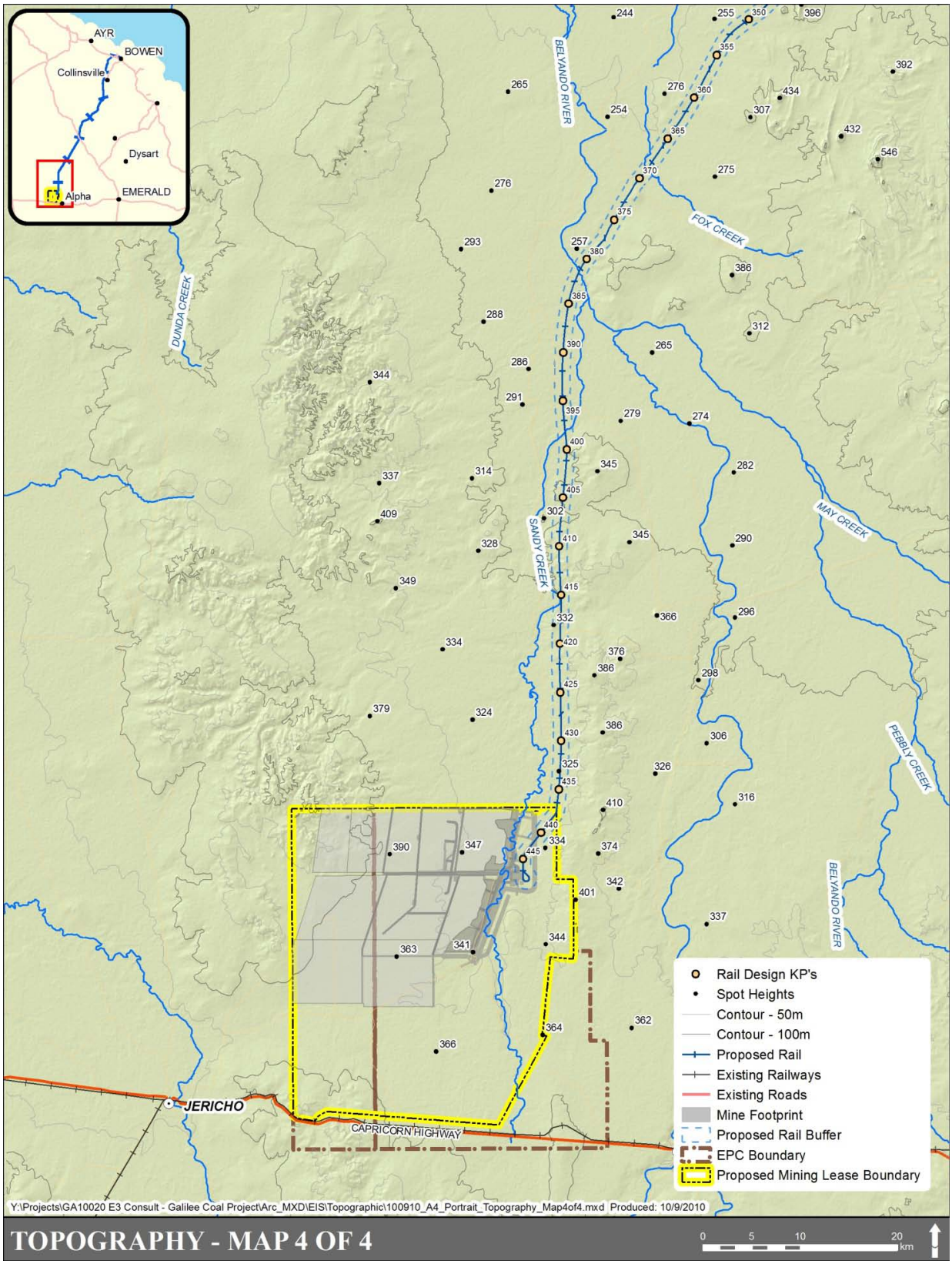

Figure 5-6: Topography (KP360 - KP447)

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5.2 Geology

This section describes the geology of the rail alignment and the main structural features that may impact upon project construction such as fault zones and dykes following structural trends within the five regional zones.

KP00-KP25 - Coastal Plains

The coastal plain is dominated by intrusive/extrusive rock types and recent alluvial and erosional geology with a low potential for fossils. This includes the predominantly Palaeozoic granitoid terrain from which the Tenosols and sandy soils are derived and the Quaternary mudflats and alluvial valley floors from which the cracking clays are derived. Quaternary coastal sand dunes and talus outwash surround the granitoid intrusives along the coast.

KP25-KP85 - Clarke Ranges

The geology of the Clarke Range is comprised of granite, rhyolite, diorite and other igneous rocks ranging in origin from Carboniferous to Early Permian age (354 to 270 million years). The foothills of the range are generally low undulations before rising to very rugged and broken country.

The major structural faults and shears that occur in close proximity to and/or intersect the rail alignment include those in the Bulgonunna Volcanics region where the north-west trending fault sets dominate including the Glenore Shear zone. Further to the south-east of the rail alignment, the Millaroo Fault Zone extends through the Lizzie Creek Volcanics. It is highly unlike that fossil will be found in this area. There are numerous other faults and structures exploited by dykes that mirror the north-west trend of these zones. The combination of localised steep topography and greater prevalence of fault and fracture systems indicates a higher potential for landslip in these areas adjacent to the rail alignment. The presence of dykes indicates the potential for bars of hard ground requiring rock breaking or explosives in areas otherwise amenable to normal excavation/construction equipment.

KP85-KP125 - Bowen River Valley

The Bowen River Valley is cut into the Lizzie Creek Volcanics including basalts, andesites, tuffs and minor acid volcanic. Further south, the Blackwater and Back Creeks Group comprising sedimentary rocks including sandstones, siltstones, shales and coal. The Hecate granite intrudes these sediments at KP95. The major structures in the area include northwest trending faults in some intrusive and the easterly dip of the Blackwater and Back Creeks Group sedimentary rocks.

The Back Creek and Blenheim groups of the Collinsville coal measures and the Blackwater Group are described as having fossiliferous content (GSQ, 1996). Recorded fossil finds in these units include marine invertebrates such as bivalves and brachiopods as well as aquatic plants (GSQ, 1996).

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KP125-KP190 - Leichhardt Range

The Leichhardt Range comprises sandstone, conglomerate and claystones of the Tertiary Suttor Formation to about KP155, after which the corridor intersects the Bulgonunna Volcanics until KP185. Here these are a group of Carboniferous intrusive volcanic including rhyolite and tuffs.

KP190 - KP447 Inland Plains

From KP190 to the mine, the alignment crosses sedimentary rocks of the Suttor Formation and alluvium of the Suttor River derived from these rock types until KP235. From KP235, the sandy alluvium derived from surrounding rock forms a sheet covering most of the landscape with outcrops of low grade metamorphic and acid igneous rocks. Tertiary sedimentary rocks and sandstones as well as siltstones of the Permian Colinlea Sandstone and sedimentary rocks of the Lower Carboniferous Drummond Group are also found in this area. The Permian and younger sedimentary rocks have fossiliferous potential; however, along the rail alignment, there is extensive Quaternary cover and therefore there is a low potential for fossiliferous geological units to occur at the surface.

The largest structure affecting the study area is the Anakie Inlier. The Post-Upper Devonian movement of the Anakie Inlier shaped the Devonian and Permian depositional basins. This controlled the major northwest trending fold axes in these basins. The adjacent basinal sediments in the southeast portion of the China First Project Area are generally much less structurally disrupted with little faulting. These areas are characterised by very gently dipping sedimentary units. Geology along the rail alignment can be seen on Figure 5-8, Figure 5-9 and Figure 5-10. A detailed description of the geological units is provided in Table 5-1.

Table 5-1: Geological Key - Rail Alignment

Geological Symbol	Era	Period/Epoch	Formation Name	Lithological Description
Qa	Cainozoic	Quaternary undifferentiated	Coastal Mudflats	Fine to medium grained unconsolidated sand
	Cainozoic	Quaternary undifferentiated	Coastal Sand Dunes	-
Qrc	Cainozoic	Quaternary undifferentiated	Outwash and talus	-
Czs/Cza	Cainozoic	Undifferentiated	Alluvial and Deltaic deposits	Sand/sand and gravel, clayey sand, silty sand, clayey silt and silty/clayey sand.
Cgcx/Cggx	Palaeozoic	Upper Carboniferous – Early Permian	Un-named Intrusives	Adamellite, granite, some granodiorite, minor fine grained variants
Cgd	Palaeozoic	Upper Carboniferous – Early Permian	Un-named Intrusives	Diorite, Quartz diorite, tonalite, gabbro, norite, minor granodiorite, adamellite and granite.
Kg	Mesozoic	Lower Permian or Cretaceous		Leucogranite, microgranite, minor adamellite, diorite
Kga	Mesozoic	Lower Cretaceous	Mount Abbot Igneous Complex	Granodiorite, and Adamellite, late stage leucocratic phases

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Geological Symbol	Era	Period/Epoch	Formation Name	Lithological Description
Pa	Palaeozoic	Lower Permian	Kurungle Volcanics	Andesite, andesite brecca, flow banded rhyolite, agglomerate, tuff
Czc	Cainozoic	Tertiary	Sedimentary Rocks	Sandstone and other sedimentary rocks
Czl	Palaeozoic	Upper Carboniferous	Bulgonunna Volcanics	Diorite, quartz diorite, tonalite, gabbro, granodiorite, rare adamelite, diorite, mononite, granite.
Pwlz	Palaeozoic	Lower Permian	Lizzie creek Volcanics	Basalt, andesite, agglomerate, lithic and tuffaceous sediments, minor acid volcanic
Pfmw	Palaeozoic	Upper Permian to Lower Triassic	Mount Wickham Rhyolite	Mainly flow banded porphyritic rhyolite, rhyolite brecca, subordinate trachyte, dacite, obsidian, agglomerate
Psb	Palaeozoic	Lower to Upper Permian	Back creek group – Collinsville coal measures	Quartzose sandstone, conglomerate, siltstone, calcareous sublabile sandstone, coal seams, carbonaceous shale, plant and marine fossils
Cglg	Mesozoic	Lower Cretaceous		Granodiorite, and Adamellite, late stage leucocratic phases
Pok	Palaeozoic	Upper Permian	Blackwater group	Cross bedded well sorted lithic sandstone, siltstone, quartose sandstone, carbonaceous shale with some coal seams, pebble and cobble conglomerate, dolomitic and calcareous sandstone, tuff plant fossils
Cgcx/Cf/Dfiv	Palaeozoic	Upper Devonian to lower Carboniferous and undifferentiated	Connors Volcanics	Andesite, rhyolite, and dacite lavas, agglomerate, volcanic brecca
Czcsu	Cainozoic	Tertiary	Suttor Formation	Coarse clayey sandstone, sandy claystone, polymictic pebble and cobble conglomerate, minor oil shale lateritised. Olivine basalt
Cfb	Palaeozoic	Devonian/ Carboniferous	Mt Rankin Beds	Sedimentary Rocks
Czl	Palaeozoic	Carboniferous	Bulgonunna Volcanics	Flow banded, porphyritic, rhyolite , quartz feldspar, porphyry, acid tuff and agglomerate, acid to intermediate stocks and bosses
Nya	Palaeozoic	Lower Palaeozoic	Anakie Metamorphic	Quartz-mica shist, mica schist, hornfels, slate, sandstone
Csry/Cwst	Palaeozoic	Devonian carboniferous	Drumond Group	Feldspathic quartz sandstone, buff siltstone and claystone, rhyolite flows and agglomerate, sublabile sandstone, siltstone fossiliferous
Czs	Cainozoic	Quaternary undifferentiated		Sand, sandy soil
Csdu/Csdl	Cainozoic	undifferentiated	Sedimentary Rocks	Sandstone / Siltstone
Psb	Palaeozoic	Lower Permian	Colinlea Sandstone	Labile and Quartz sandstone, minor siltstone and coal

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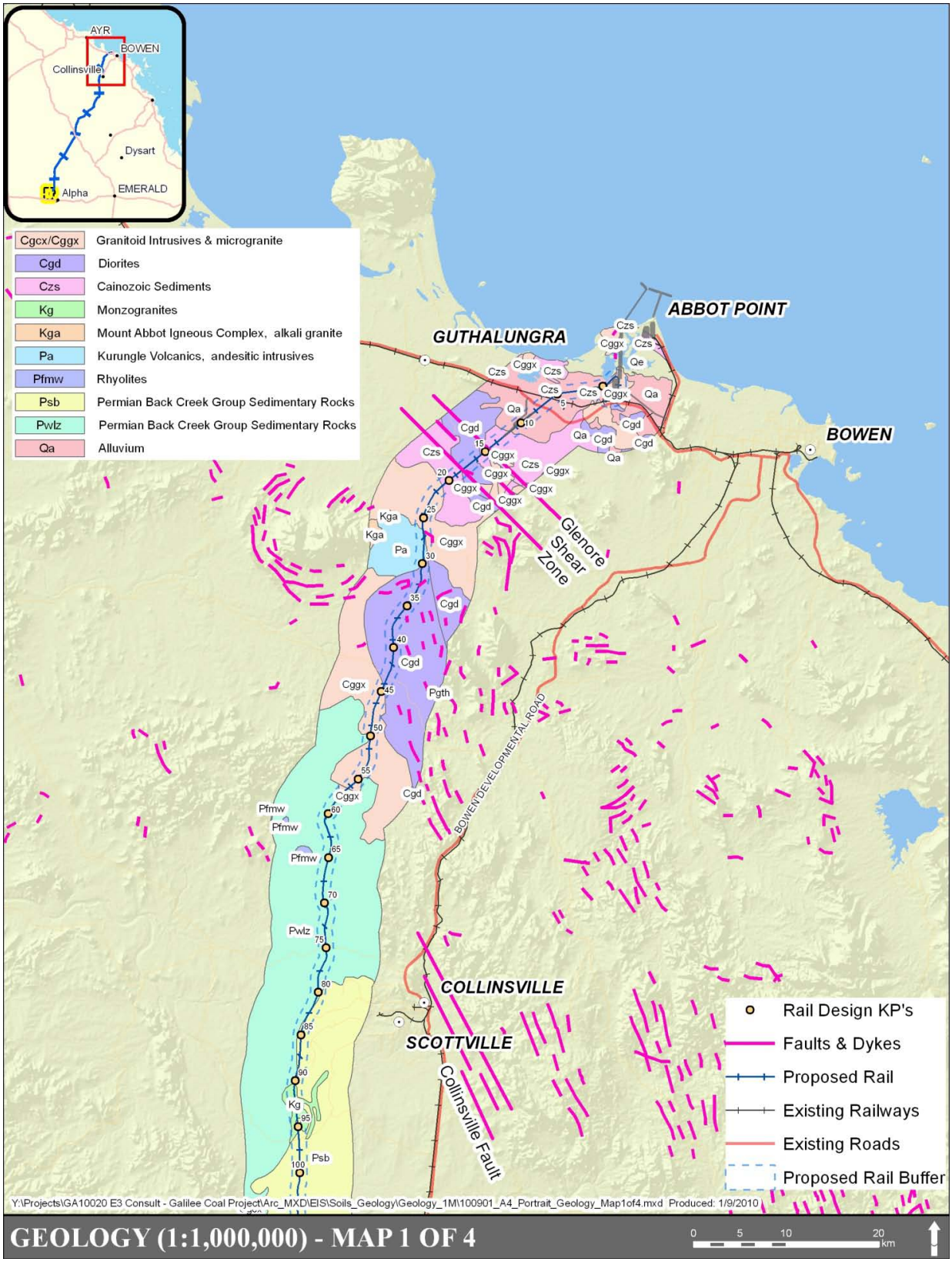

Figure 5-7: Geology (KP00 - KP85)

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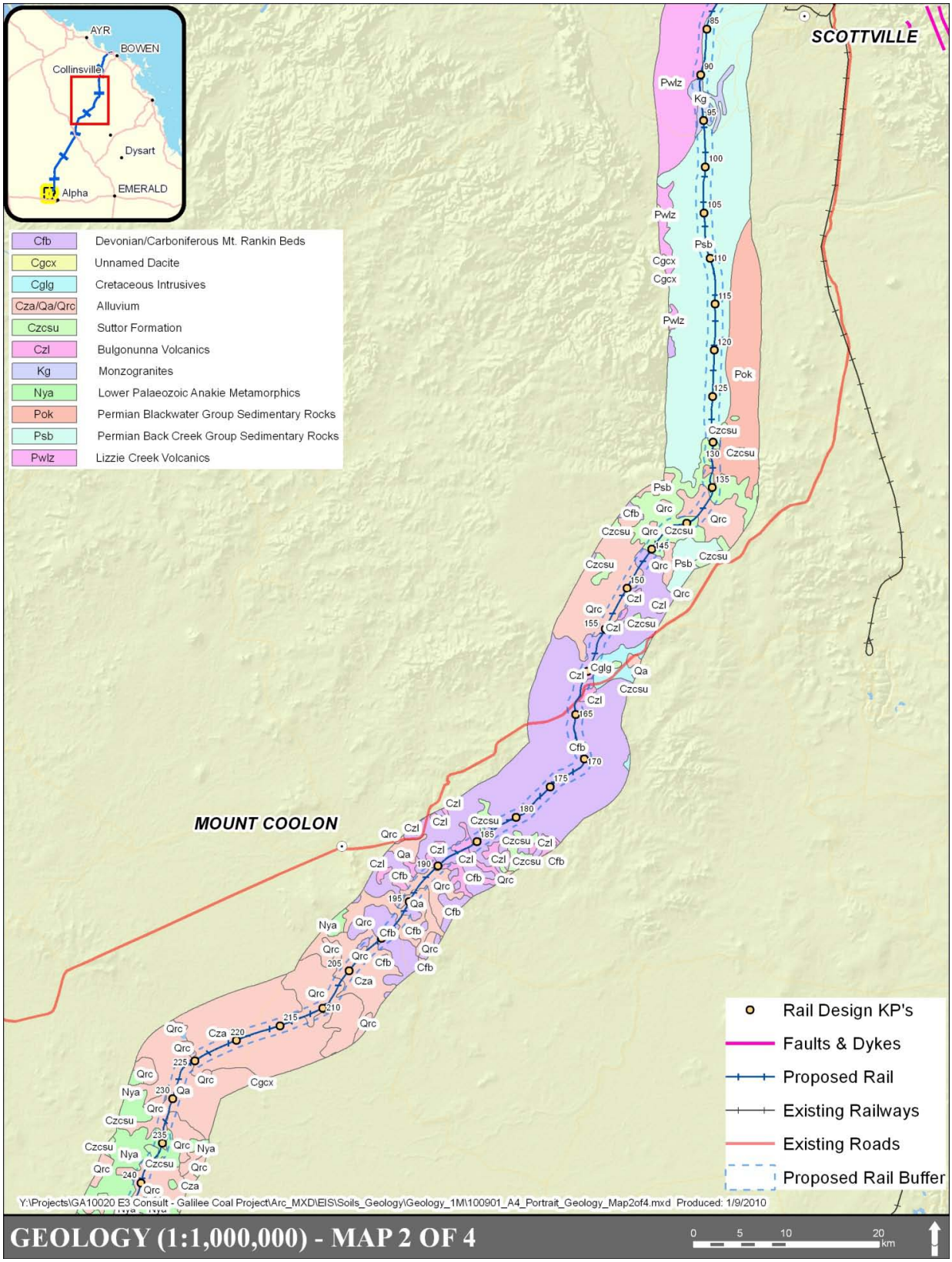

Figure 5-8: Geology (KP85 - KP235)

Waratah Coal

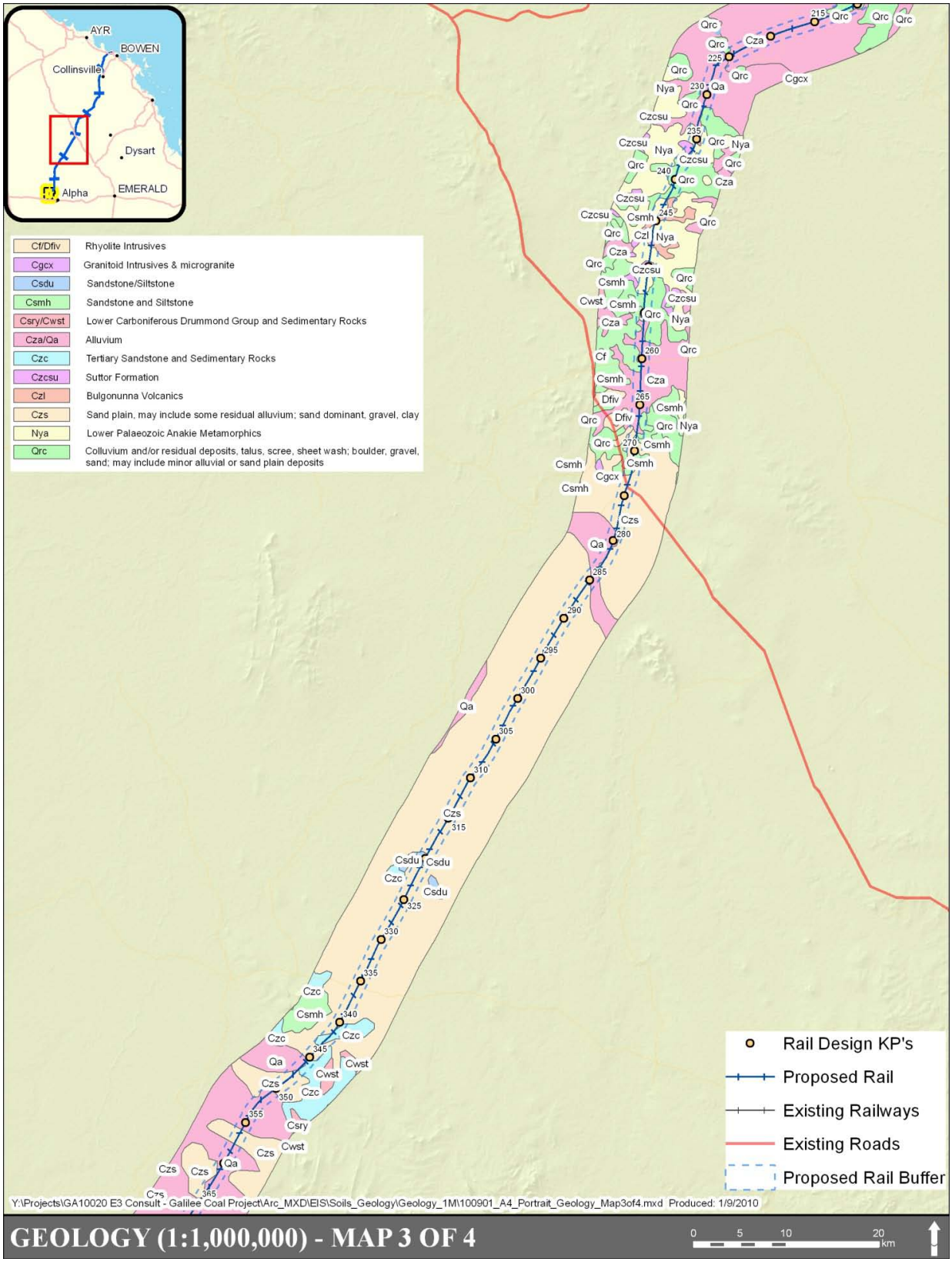

Figure 5-9: Geology (KP235 - KP360)

Waratah Coal

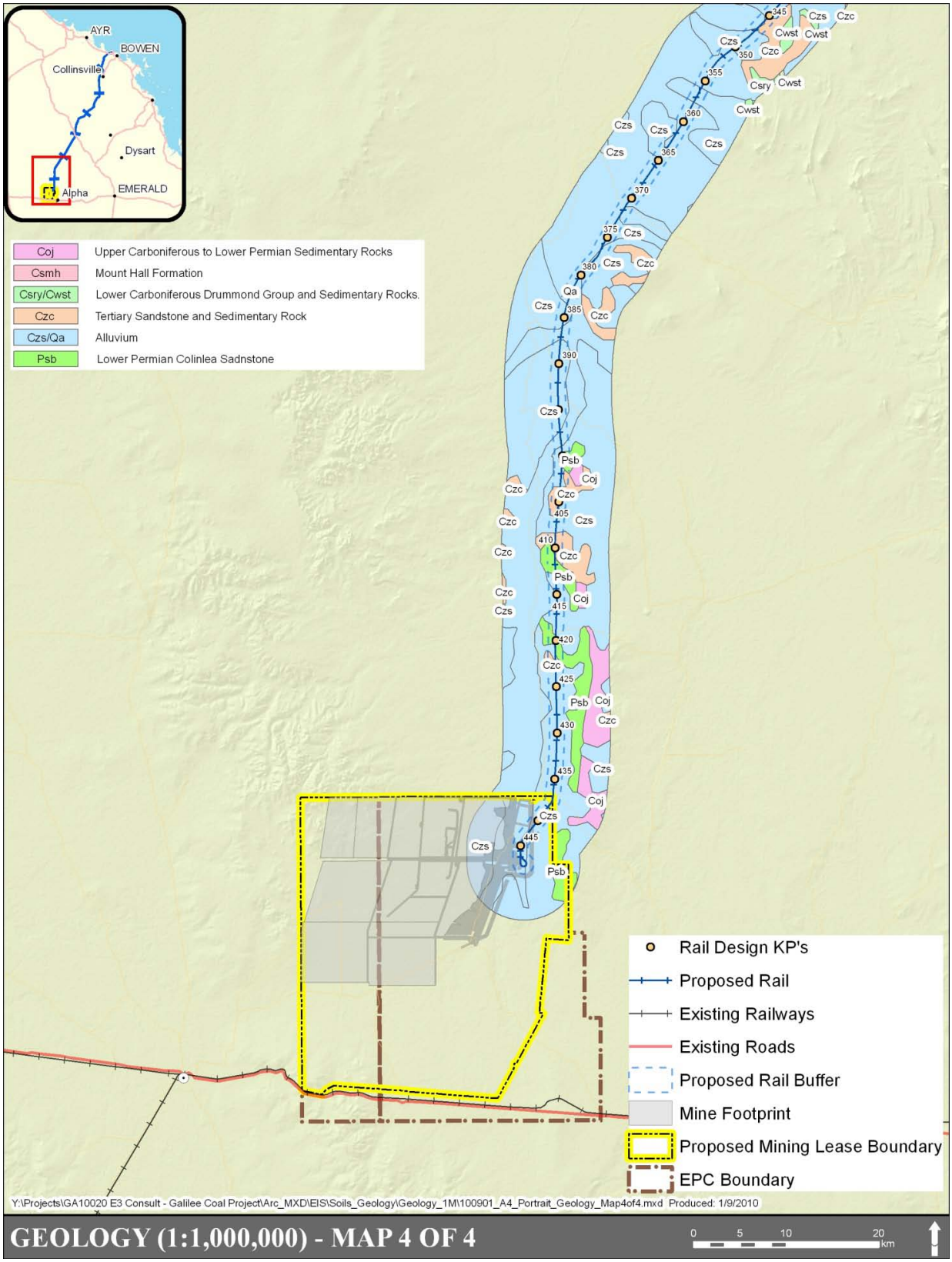

Figure 5-10: Geology (KP360 - KP447)

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5.3 Soils

The following section provides an overview of the soil types along the rail alignment split into the five specific regions.

KP00-KP25 - Coastal Plains

Soils in the coastal area are regionally mapped as Sodosols; however, site sampling in the APSDA indicates Vertosols and some Tenosols are present (see Section 6.3). Vertosols include clay soils with shrink-swell properties that exhibit strong cracking when dry and can be associated with gilgai landscape microrelief. They also form mounds and depressions in the landscape as a result of repeated shrinking and swelling of the clay blocks of subsoil. Tenosols comprise sandy to gravelly soils derived from granitoid outwash. Sodosols include sodic soils predominantly in areas subject to periodic inundation.

The descriptions of soils sampled in the coastal plains are provided in Appendix C. This includes Tenosols and Vertosols on the coastal land above the inundated saline mudflats that have a pH of 5.9 to 8.6. More alkaline soils are generally associated with Vertosols and Sodosols. The soil fertility is indicated by CEC which identifies the soil's ability to supply the plant nutrients Ca, Mg and K. The Tenosols generally have low CEC (i.e. SS01, 1.9meq/100g) while the clay soils have generally higher CEC (SS05, 52.4meq/100g). This is also reflected in the individual cation analyses. Saline soils with salt scalds are apparent on periodically inundated lands adjacent to the wetlands. Salinity as indicated by the chloride and EC suggests that Tenosols generally have low salinity while the Vertosols have moderate salinities.

The topsoil availability is likely to limited in the range of <0.1m in the area of the shallow Tenosols, while the Sodosols may produce topsoils up to 0.3m thick. Cracking clays are present at several locations (SS03, 06 and 08) throughout this area, generally in very low flat plains and/or near creeks and floodplains (Plate 5-2).

The soil sodicity and/or Emerson Crumb dispersivity analyses of samples SS02 and SS06 reported high potential for erosion and indicate that soils in these areas tend to be sodic in nature and prone to dispersion and erosion.

The variable rainfall and relatively flat topography of this area can result in localised flooding occurring over railway during rain events >200mm over a 48hr period. Flooding generally occurs during summer months as a result of heavy monsoon rainfalls caused by tropical lows and rain depressions generated from cyclones crossing the north eastern Queensland coastline. This can contribute to scour and tunnel erosion in soils in this area.

Six sites were visually assessed to determine their potential for erosion. Four of the six sites (Sites SO2, SO3, SO6 and SO8) were assessed as having a high potential for erosion. The four sites were deemed to have a high potential either due to evidence of existing erosion or were considered to be susceptible to erosion due to sandy substrates with no vegetative cover. The remaining two sites were assessed as having a low potential due to minimal erosion or comprising heavily vegetated banks.

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KP25-KP85 - Clarke Ranges

Dominant Chromosol, Sodosol and Vertosols soils within this area include loamy red duplex soils from KP25 to KP57, shallow stony, loamy red duplex soils from KP58 to KP63 and hard alkaline yellow soils from KP63 to KP74. The hilly areas have very shallow stony duplex soils, while valley floors have occasional small areas of dark clays and/or red-brown clays, hard alkaline yellow and crusty loamy soils that are generally consistent with the area being mapped as Chromosol soils with some cracking clays in valleys. However, the dominant soils are loamy red duplex soils of shallow to moderate depth (up to 0.3m). In some areas yellow loamy duplex soils are locally dominant, although these are often closely associated, particularly on lower slopes with mottled yellow duplex soils.

Plate 5-2: Cracking Clay

Between approximately KP75 and KP85, the alignment traverses an area bordering Sodosol/Vertosol soil areas. The landform in this section of the alignment includes moderate to strongly undulating lands with some hills. Dominant soils are described as grey loamy and standard loamy duplex soils associated with alluvial plains which are more consistent with Sodosol soils. From approximately KP82 to KP84, the dominant soils are shallow sands, sandy or loamy duplex soils which are more consistent with the Sodosol or Tenosol soils (weakly developed soils). Based upon the mapped soil types and observations from soil sampling, topsoil is expected to be in the range of 0.1m to 0.3m.

The area dominated by Chromosol soils are generally low salinity but often also low fertility soils as indicated by CEC results of 4.6 (SS09) to 8.6 (SS13) in most samples from this area. Though some clays around river valleys have high CEC and greater potential for agriculture (SS15), they also have low Mg content.

From approximately KP25 to KP85, the Chromosols in areas of higher relief are likely to have low to high erosion potential. While these soils generally contain high organic matter and lower proportions of sand/silts, the higher relief increases the potential for erosion in some areas. In the lowland portions of this area, the erosion potential will generally be lower, except where creeks with periodic high flows which can scour the soil profile. Where sampled, Emerson Crumb tests identified Chromosols as having moderate erodibility on the surface and at depth and are anticipated to have lower potential for erosion than other areas.

The Sodosols had near neutral pH and low salinity. Some (SS15) had low ESP and are considered to be generally less prone to erosion than the Chromosols. Topsoil depths are anticipated to be in the order of 0.1 to 0.3m in Chromosol areas and up to 0.6m deep in Sodosol areas.

Six sites were visually assessed to determine their potential for erosion. Five of the six sites (Sites SO10 to SO15) were described as having a low potential for erosion due to a combination of predominantly clayey substrates, vegetative cover and low energy stream flows. Site SO9 would likely have a high potential for erosion due to sandy banks and a rocky stream bed indicating the potential for high energy flows capable of severe scouring.

KP85-KP125 - Bowen River Valley

Sodosols mapped in the area includes loamy duplex soils with mottled yellow-brown subsoils. These were present in the undulating lands on tributaries while small alluvial areas have grey loamy duplex soils. Tenosols are present as thin soils on sandstone ridges (Figure 5-12, Plate 5-3). Dominant soils in the valley floor include dark clays of moderate depth, with older terraces and levees having deep sandy or sandy loam with 0.3m to 0.6m A horizons with a clear change to reddish brown clay or sandy clay. Gilgai microrelief is present on the deep clays. On the southern undulating slopes that rise to the south, more thin loamy duplex soils are present. This area is usually strongly dissected by many small streams and nearly all soils have a gravel-strewn surface and are often eroded.

From approximately KP85, the rail alignment traverses Sodosol mapped areas until it reaches about KP125 where the alignment traverses an area bordering Tenosol/Sodosol/Kandosol soil mapped areas.

Soils are described as sandy to loamy duplex soils and some shallow sands on the moderately undulating lands consistent with the Sodosol and Tenosol mapped areas with deep sandy or sandy loams on the alluvial flood plains more consistent with Kandosol soils (soils which lack a strong texture contrast and have a weakly structured B horizon).

Soils in these areas generally have a pH from 6.9 to 7.9, with low CEC indicating generally low fertility. The deep clays in the river valleys have higher CEC. The soils are generally low salinity soils with low EC and low

to medium ESP. However, the clay soils at SS20 (Rosella Creek a tributary of the Bowen River) were saline with a high ESP indicating some salinity is present in soils in the valley floors. These valley floor clay soils can also be sodic and therefore susceptible to dispersion, as indicated by high ESP and/or low Ca:Mg ratios.

Some clay soils (SS18) had high Emerson Crum results indicating low potential for erosion, while others (SS19) had lower results. This indicates that while clays are widespread throughout the valley floors, the erosion potential of these soils will vary over their extent in the alignment.

From a review of aerial photography and on-site observations, areas around creek lines appear to be subject to erosion. However, the erosion potential can vary along the alignment within individual soil types. The most susceptible soils for erosion are sodic or dispersive clays and loamy soils. Topsoil availability in areas is not subject to excess salinity or sodicity and is generally considered to be between 0.1m to 0.2m; however some sandy loams on alluvial terraces may have topsoils up to 0.6m deep.

Three sites (SO16, SO17 and SO18) were visually assessed for their erosion potential. One site (SO16) was assessed as having a low erosion potential due to the observed heavily vegetated clayey banks comprising a stepped formation, rather than steep incline, and moderate flow. Sites SO17 and SO18 were identified as having a high erosion potential attributable to silty /sandy banks with little vegetative cover.

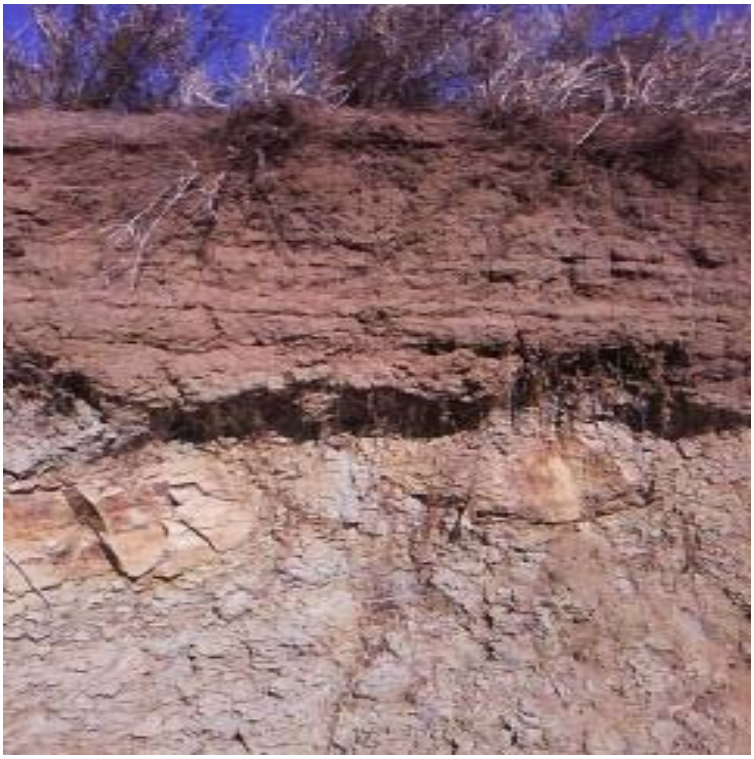

Plate 5-3: Soil Profile in Bowen River Valley

KP125-KP190 - Leichhardt Range

The rail alignment traverses mainly Tenosol with small areas of Kandosol. The landscape varies throughout this portion of the alignment from level plains to strongly undulating elevated land. Dominant soils on the level plains are loamy yellow earths with areas of loamy red earths and cracking clays. Dominant soils on the strongly undulating elevated areas may include shallow stony gritty leached sands or sandy loams more consistent with Tenosols.

Soils in this area include acidic soils with very low CEC and ESP (SS24, 25, 26, 27 and 30). Several samples (SS25, 27, 29 and 30) had very low exchangeable calcium and low Mg, indicating low fertility soils. This was further enforced by poor growth on stony soils. The soils are generally low salinity soils with Ec of <150, low chloride and low to very low ESP with the exception of Sodosols where soils (SS30) recorded a very high Ec of 2240µs/cm, chloride of 3020mg/kg and very high ESP of 54.2.

Kandosols in the generally low relief areas between KP130 and KP190 are considered to have generally low to moderate erosion potential. The higher erosion potentials are expected locally in alluvial areas with higher sand or silt contents. Emerson Crumb results indicate that some soils in the valley floors have moderate dispersion potential and will be susceptible to erosion after disturbance, while others are generally stable.

Tenosols from KP165 to KP190 are generally shallow soils in areas of moderate to high relief and are anticipated to have moderate to high erosion potential (Plate 5-4). The Tenosols were non-dispersive; however, the stoniness of these soils combined with the shallow bedrock would be unsuitable for stripping and susceptible to erosion. The Tenosols encountered in sampling had nil to minimal (0.05m) topsoil.

Five waterway sites (SO20 to SO24) were visually assessed for their erosion potential. Three of the five sites (SO20, SO21 and SO24) were assessed as likely having a high erosion potential. Evidence of erosion was observed at Sites SO20 and SO24, while Site SO21 was described as sandy banks with moderate flow. The remaining two sites (SO22 and SO23) were assessed as having a moderate to high erosion potential comprising sandy substrates with high proportions of vegetation likely to reduce the potential for erosion.

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Plate 5-4: Tenosol

KP190-KP447 - **Inland Plains**

From approximately KP190 to KP220, the alignment traverses areas mapped as Sodosols. The landscape varies from the gently undulating to low hilly lands from about KP190 to KP200 to level or gently undulating plains from approximately KP202 to KP225. Dominant soils on the hilly land are shallow stony gritty leached sands or sandy loams more consistent with Tenosol soils. The soils of the sloping plains consist of loamy duplex soils more consistent with Sodosol soils to loamy yellow, red and grey earths and cracking clays on the lower areas associated with Vertosol soils (from approximately KP215 to KP305). Landforms include level to gently undulating alluvial plains from approximately KP220 to KP230, KP257 to KP274 and KP282 to KP361 with more strongly undulating lands from KP231 to KP256.

Soils described on the more strongly undulating slopes are dominated by sand and gravelly loamy duplex soils and sandy red earths more consistent with Sodosol or Kandosol soils. Dominant soils within the more level or gently undulating land include deep grey clays and cracking clays consistent with Vertosol soils and loamy duplex soils, sandy red and yellow earths more consistent with Sodosol or Kandosol soils.

From approximately KP305 to KP420, the alignment traverses areas predominantly soils mapped as Kandosols with a section of Vertosols from KP365 to KP375. The landform in this section of the alignment varies from level plains to undulating lands with the exception of some strongly undulating land from approximately about KP410 to KP412.

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Dominant soils on the level plains to undulating lands include sandy and loamy red and yellow earths, loamy duplex soils consistent with Kandosol, Chromosol or Sodosol soils and grey deep clays consistent with Vertosol soils. The dominant soils on the strongly undulating land are shallow stony loams with small areas of stony red earths consistent more consistent with Rudosol soils.

From approximately KP420 to KP447, the soils are mapped as Kandosol soils. Land forms consist of very gently to level undulating plains. Dominant soils are sandy or loamy red and yellow earths with some areas of sandy surfaced duplex soils, associated with deep red sands that form low dunes. This is consistent with the mapped Kandosol soil description. These soils are generally neutral or near neutral pH with low salinity. The soils mostly have low CEC and ESP indicating lower fertility with the exception of some areas in the alluvial valleys. Sodicity as indicated by ESP is generally low although some clays soils have elevated sodicity.

The Emerson Crumb results (SS48) suggest that the soils have the potential for erosion through dispersion. They also generally have low Ca:Mg ratios. However, the generally lower topography results in overall lower potential erosion impact from rainfall runoff.

Topsoil depth varies along this area of the rail alignment. Deeper topsoils of 0.25-0.6m thickness were observed although, generally they are approximately 0.3m thickness which are expected in areas of heavy clay soils, while the sandy soils exhibit shallower topsoil depth of up to 0.15m.

A total of 19 sites were visually assessed for their erosion potential. Of the 19 sites:

- 12 sites (SO25 to SO30, SO32 to SO34 and Sites SO37, SO38 and SO41) were assessed as having a low erosion potential;
- Two sites (SO31 and SO40) were assessed as having moderate erosion potential;
- Four Site (SO35, SO36, SO42 and SO43) were assessed as having a moderate to high erosion potential; and
- SO39 was assessed as having a high erosion potential.

SO39 was categorised as having a high erosion potential due to loose silty soil observed on the steep and already eroded banks, compared to predominantly clayey substrates with greater proportions of vegetation at the remaining locations.

Dominant soils along the rail alignment are shown on Figure 5-11, Figure 5-12, Figure 5-13 and Figure 5-14.

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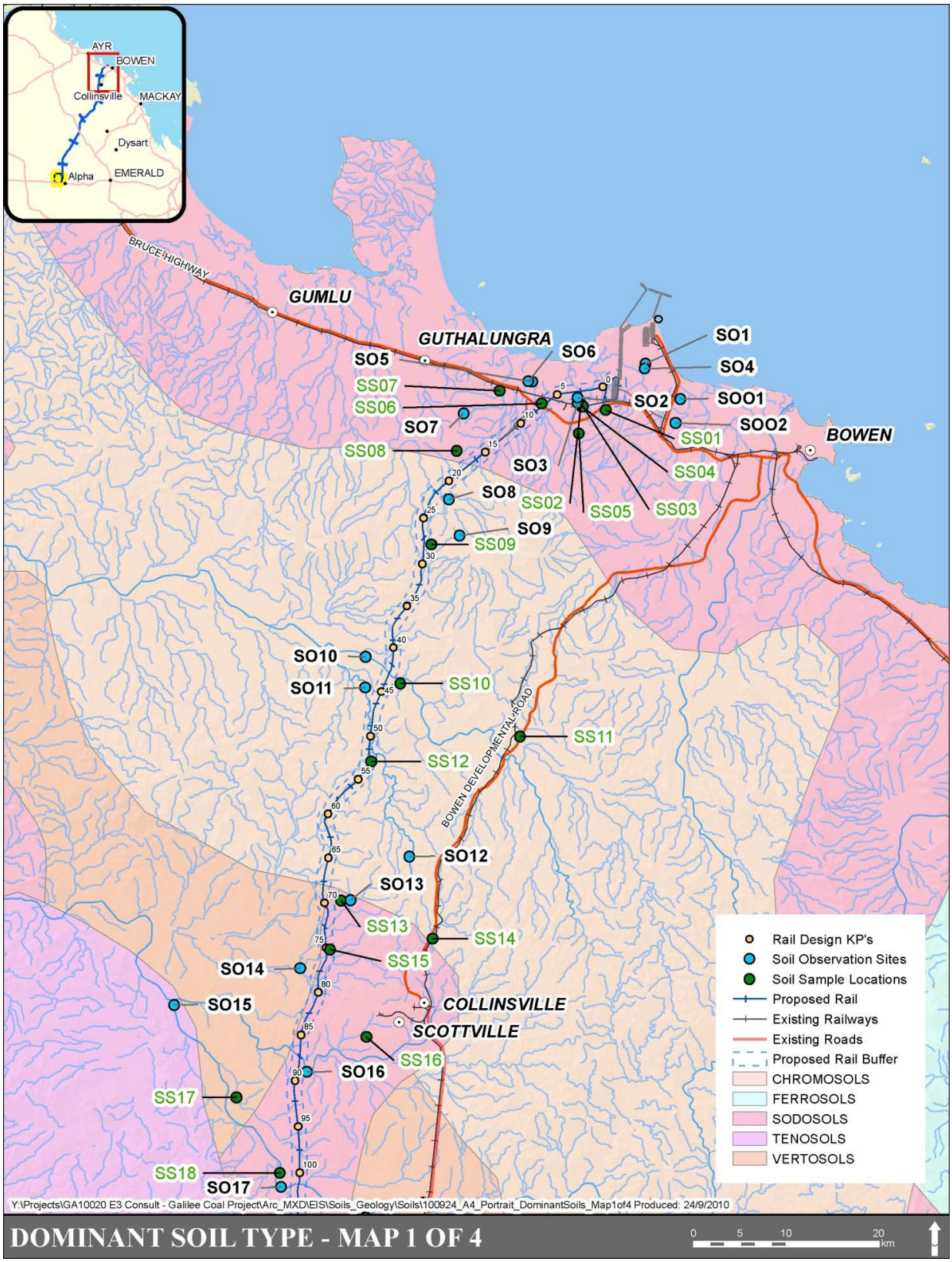

Figure 5-11: Dominant Soils (KP00 - KP85)

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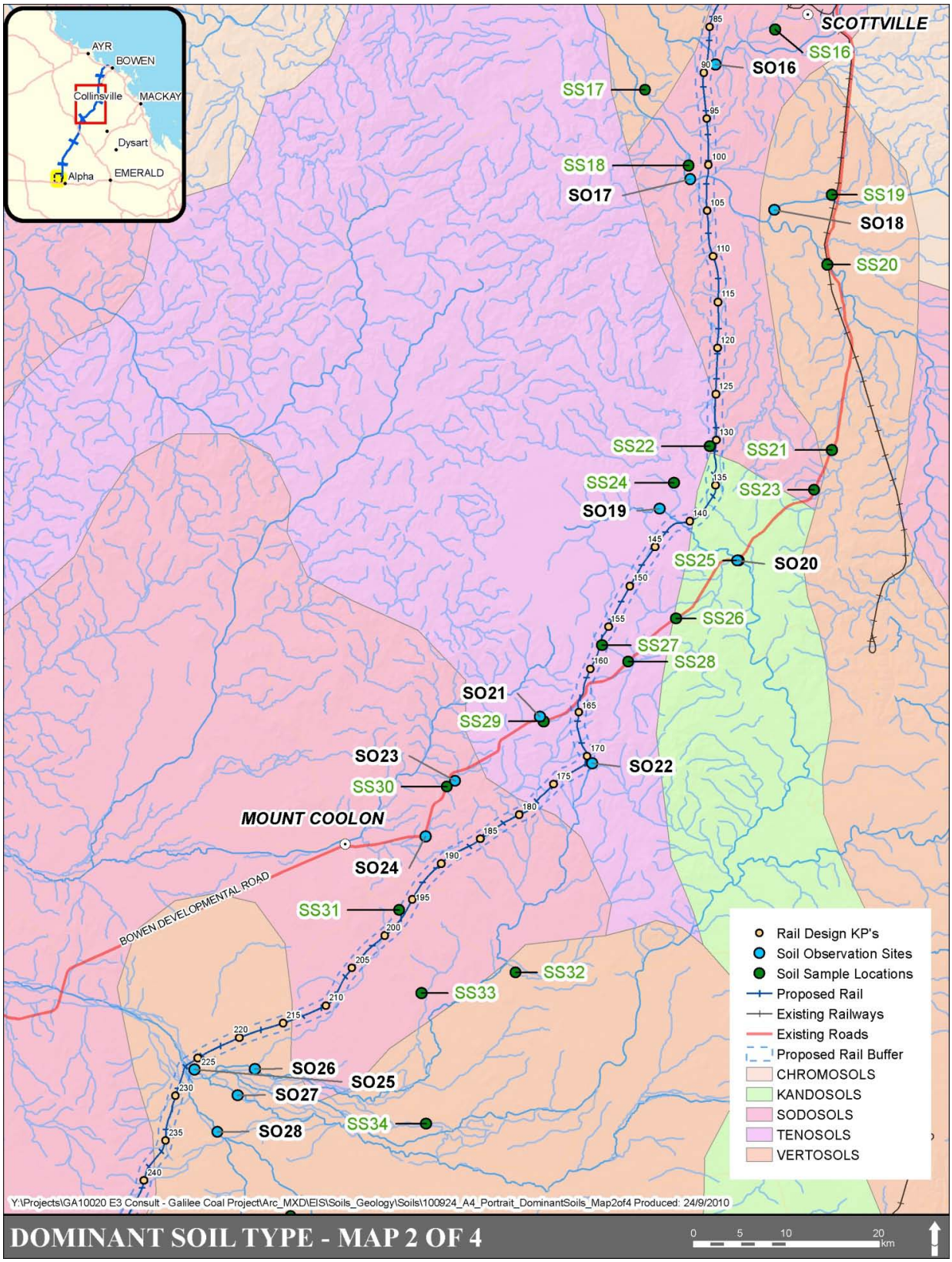

Figure 5-12: Dominant Soils (KP85 - KP235)

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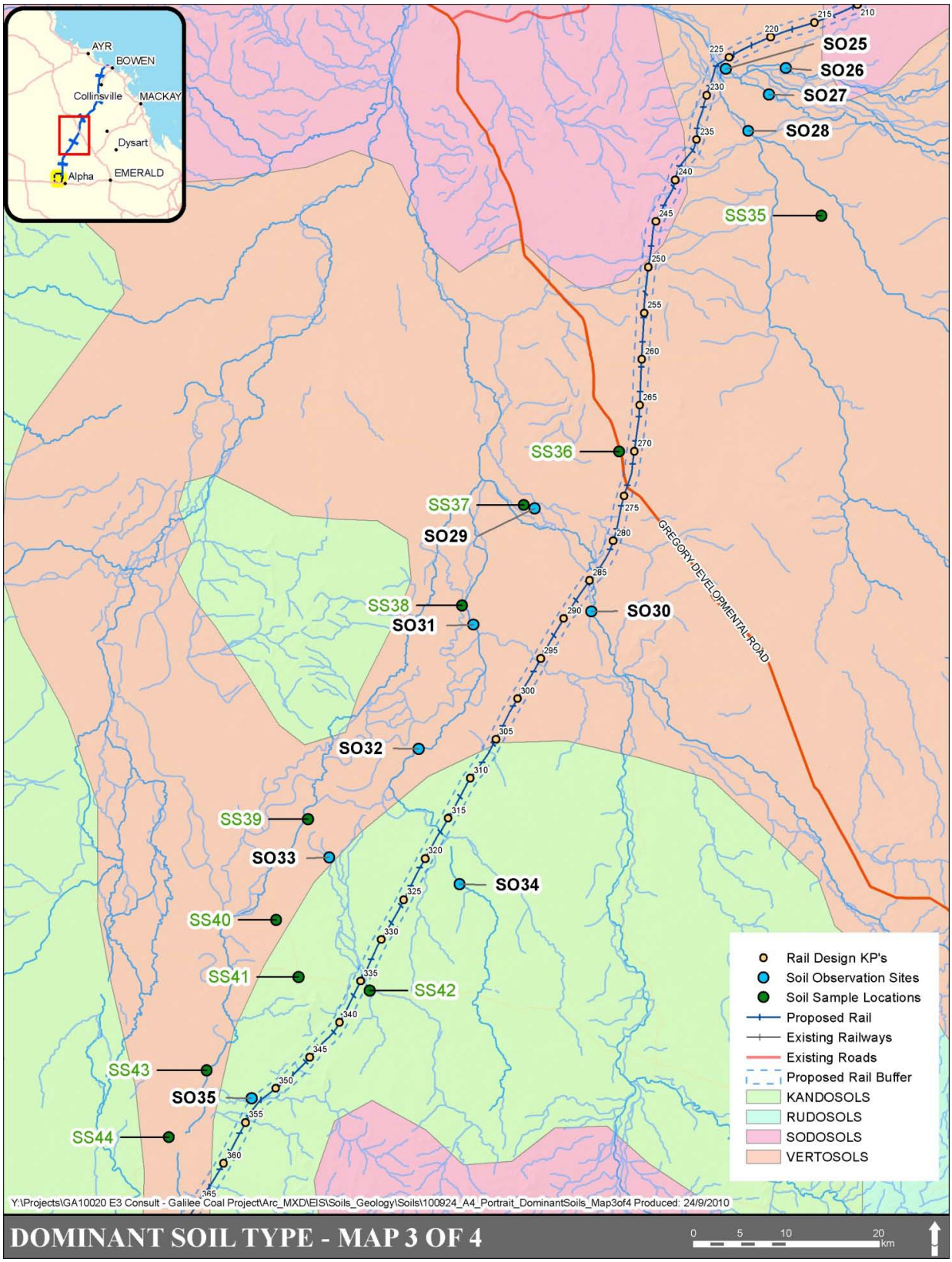

Figure 5-13: Dominant Soils (KP235 - KP360)

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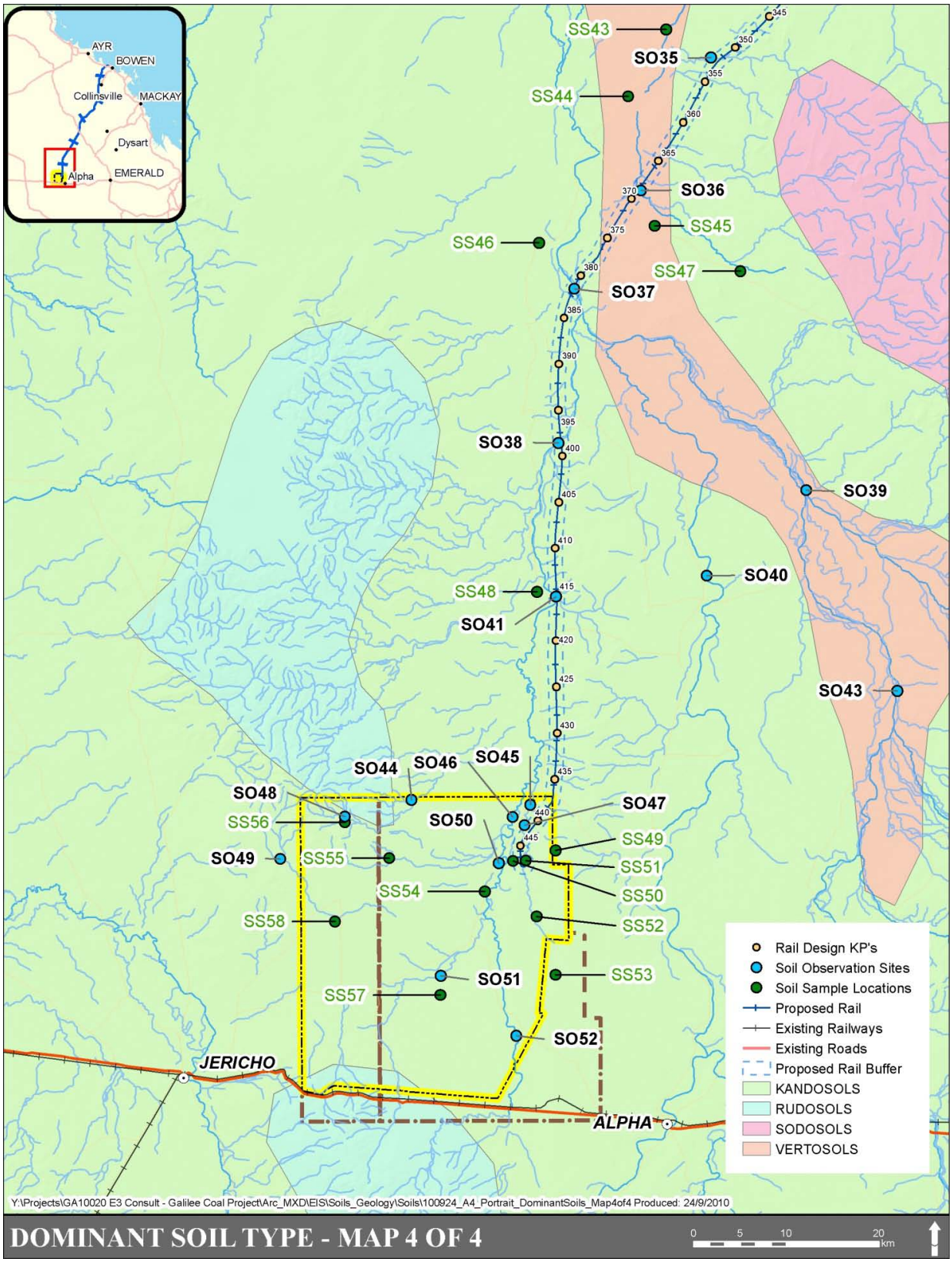

Figure 5-14: Dominant Soils (KP360 - KP447)

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5.4 Landforms

The following section provides an overview of the landforms along the rail alignment within the five identified regions.

KP00-KP25 Coastal Plains

The landform of this section of the alignment is characterised by level plains and gently undulating lands to KP18. At KP18, the slope of the land increases to moderately/strongly undulating lands in which the soils are dominated by sandy or loamy duplex soils consistent with Sodosol soils. In contrast, from KP02 to KP05, deep dark cracking clays are observed which are consistent with Vertosols with slight gilgai microrelief.

Plate 5-5: Gilgai Microrelief in the China First Project area

KP25-KP85 Clarke Ranges

The dominant landforms in the Clarke Range are moderately and/or less commonly, strongly undulating lands with occasional isolated hills surrounded by strongly dissected steep slopes with limited rock outcrop and some valley plains.

KP85-KP125 Bowen River Valley

The landforms include moderate to strongly undulating lands with occasional high strike ridges with sandstone outcrop on the south facing valleys slope, changing to undulating land with gently sloping plains,

moderate to high mostly stony ridges, and some low stony basaltic hills. Near the Bowen River the landforms comprise gently undulating alluvial flood-plains, often with marked terraces, levees, and shallow drainage depressions which rise to the south to moderate to strongly undulating lands with an occasional low hill.

KP125-KP190 Leichhardt Range

The Leichhardt Range includes strongly undulating lands with some low cuesta-like hills that frequently have massive sandstone outcrops of the Suttor Formation. This can include low sandstone mesas and lateritic scarps. There can also be level plains, with broad low lake-like depressions. The undulating lands include shallow sands with some evidence of leaching and on the lower slopes, sandy or loamy duplex soils. In the level plains and broad depressions, loamy yellow and red earths are present, with areas of cracking clays with gilgai microrelief present. In some steeply sloping areas, stony soils occur, while mesas can have kaolinised sandstone derived soils.

KP190-KP447 Inland Plains

The landforms are dominated by undulating lands, level alluvial sandy plains and clay plains. Undulating lands consist of level to sloping plains interrupted by low mesas, lateritic scarps, gravelly ridges or their dissected remnants where sedimentary rocks outcrop. These units become more strongly dissected at their margins. The intrusive rocks generally develop small steeper sided hills.

The alluvial plains are level to very gently undulating and include sandy alluvium and alluvial plains associated with major streams. In some areas, clay soils dominate the alluvial plains and these areas can have moderate to strong gilgai microrelief.

Landscape units identified along the rail alignment are shown on Figure 5-15, Figure 5-16, Figure 5-17, and Figure 5-18. A detailed description of the landscape units is provided in Table 5-2.

Table 5-2: Landscape Unit Descriptions - Rail Alignment

Landscape Units	Landform	Soils	Remarks
Va50	Undulating or gently undulating lands/small areas of granite outcrop	dominant are sandy or loamy often gritty duplex soils	The unit have shallow coarse sands
Kf13	Level plains	Dominant soils are deep dark cracking clays with lesser grey clays.	A slight gilgai microrelief is often present
Va86	Gently undulating outwash slopes and fans.	Dominant are deep loamy duplex soils with closely associated deep bleached sands.	The sands are confined to the relic stream channel infills and fans.
SI16	Gently undulating plains.	Dominant are deep loamy duplex soils. Included in the unit are areas of deep grey-brown and brown cracking clays	Data is limited.

Landscape Units	Landform	Soils	Remarks
Qa14	Moderately or, less commonly, strongly undulating lands with occasional isolated hills surrounded by strongly dissected steep slopes; limited rock outcrop may occur throughout. Very occasional small areas of dark clays or red-brown clays may also be included in the unit	Dominated by loamy red duplex soils of shallow to moderate depth. In some areas, yellow loamy duplex soils are locally dominant. Often closely associated, particularly on lower slopes with mottled yellow duplex soils	The hilly areas have very shallow stony duplex soils
Qa11	Low hilly to hilly lands with some strongly undulating marginal slopes; hill crests are often rounded and slopes are moderate	Dominated by mostly shallow and often stony loamy red duplex soils. Occasional areas of red friable earths. On some lower slopes and valley floors, yellow or brown loamy duplex soils occur	Rocky outcrop is common throughout
Qa12	High hilly lands with some mountainous areas; nearly all hills have steep slopes but crests are often rounded	Dominant are shallow stony loamy red duplex soils. Small areas of red friable earths are associated in some areas. Higher hill crests and more stony sites have shallow stony loams	Marginal to the unit, topography may be strongly undulating; rock outcrop is common throughout
SI17	Valley plains	Chief soils are probably hard alkaline yellow soils	Associated are crusty loamy soil and cracking clays
Vd5	Moderate to strongly undulating lands with occasional high strike ridges with sandstone outcrop	Dominated by loamy duplex soils with mottled yellow-brown subsoils. Associated small alluvial plains have grey loamy duplex	Occasional highly calcareous ridges have shallow loams. Where sandstone outcrop are prominent, shallow sand soil occurs
JJ13	Strongly undulating lands with some low cuesta-like hills that frequently have massive sandstone outcrops	Dominant soils are shallow sands, with some leached sands. On lower slopes, sandy or loamy duplex soils occur	In some areas, higher levels of quartz gravel may occur. Data is limited
Kb26	Undulating lands with gently sloping plains, moderate to high mostly stony ridges, and some low stony basaltic hills	Dominant soils are those of the plains and lower ridge slopes, these have dark clays of moderate depth	Often display linear gilgai. The higher ridges and low hills have rock outcrop and shallow stony soils
Qb27	Gently undulating alluvial flood-plains, often with marked terraces, levees, and shallow drainage depressions	The dominant soils are those of the older terraces and levees. They have deep sandy or sandy loam. A horizons (0.3 to 0.6m) with a clear change to reddish brown clay or sandy clay	On the most recent terraces that may be subject to flooding
SI23	Moderate to strongly undulating lands with an occasional low hill	A complex array of loamy duplex soils is present, most are shallow	The area is usually strongly dissected by many small streams and nearly all soils have a gravel-strewn surface and are often eroded and outcrops are common

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Landscape Units	Landform	Soils	Remarks
Ms5	Level plains with many broad very shallow lake-like depressions	Dominant soils are loamy yellow earths with some areas of loamy red earths. The shallow depressions have cracking clays	In many of the yellow earths nodular or massive nodular laterite occurs at relatively shallow depths with a slight sink-hole-type gilgai
Tb119	Undulating to strongly undulating lands with many low sandstone mesas, lateritic scarps, and their dissected remnants	The dominant soils are probably those on higher sloping sites where very pale grey loamy duplex soils. more extensive level plains or plateau surfaces have loamy yellow earths	On the low dissected kaolinised sandstone mesas and pallid-zone scarps shallow stony sands are common associated with very pale sandy or loamy duplex soils
Cd14	Low hilly to strongly undulating elevated lands with some steeper high hilly areas	Dominant soils are very shallow (0.15 to 0.45m) stony gritty leached sands or sandy loams. Less common are similar stony loams	Throughout this unit there may be small remnants of unit Tb119
Sl12	Level to very gently undulating alluvial plains	Dominant soils are moderately deep-surfaced loamy duplex soils. The chief associated soils in lower sites are massive mottled cracking clays	Numerous anastomosing old infilled channels
Mr1	Undulating lands consisting of some level or sloping plains interrupted by low mesas or their dissected remnants, marginally the unit may be more strongly dissected	Dominant soils of the plains and slopes are loamy yellow earth. Most soils contain much nodular ironstone at depth. Associated with areas of loamy red earths and grey earths. The low mesas consist of mottled or pallid rock or kaolinised sandstone	Included in the unit in the Mt. Coolon area are some small areas of units Cd14 and CC33
Sl12	Level to very gently undulating alluvial plains	Dominant soils are moderately deep-surfaced loamy duplex soils. The chief associated soils in lower sites are massive mottled cracking clays	Numerous anastomosing old infilled channels
Mz17	Undulating lands with occasional lateritic scarps and low mesas	Dominant soils are slightly acid loamy red earths which often contain many ironstone nodules at depth. Associated with neutral loamy red earths and lesser loamy yellow earths. The soils of the scarps and mesas are loamy red earths on the more extensive surfaces, elsewhere shallow stony loams	Has slight to moderate gilgai microrelief
CC33	Level or very gently undulating clay plains	Dominant soils are deep grey clay but areas of deep brown clays are commonly associated In some areas brown clays occur on the gilgai banks and grey clays in the depressions. Closely associated throughout the unit are areas of loamy duplex soils	Slight to moderate gilgai microrelief, occasionally stronger. Where the unit is adjacent to major streams, many small braided channels occur

Landscape Units	Landform	Soils	Remarks
CC35	-	Dominant soils are deep grey clays. Some clay soils possess a slight to moderate gilgai microrelief. Associated are lesser areas of thin-surfaced loamy duplex soil	Numerous braided channels may occur and many areas are subject to irregular flooding
Sl19	Moderate or occasionally strongly undulating lands	Dominant soils are extremely gravelly (quartz) loamy duplex soil. On some higher ridges, shallow gravelly loams occur	There may be small areas of gravel-strewn moderately gilgaied grey clays in lower sites
My35	Undulating lands, often with high gravelly ridges	Dominant soils are loamy or sandy red earths that are often gravelly. Lesser areas of yellow earths occur on lower slope sites	The high gravelly ridges have either sandy red earth extremely gravelly sandy soils
CC29	Level plains with moderate to strong gilgai microrelief	Dominant soils are grey or light grey deep clays with loamy duplex soils closely associated in non-gilgaied sites	Small flood-plains occur adjacent to associated drainage lines
Il4	Gently undulating plains	Dominant soils are very deep clays. Occasional areas of very deep brown clays may occur, and also shallow highly calcareous soils	Occasionally have linear gilgai on slopes
Sl21	Gently undulating plains	Dominant are loamy duplex soils with a slightly gravel-strewn surface. Also occurring, are smaller areas of slightly gilgaied or non-gilgaied grey clay	In some localities there may be occasional high stony ridges with shallow stony soils
Vd2	Level or very gently undulating plains	Dominant soils have deep sandy A horizons. Smaller areas of loamy-surfaced soils are associated with some drainage lines. Occasionally swampy depressions with clay soils	Broad shallow valleys associated with drainage lines
My20	Level or very gently undulating plains	Dominant soils are loamy red earths with some loamy yellow earths and limited occurrences of gilgaied clays	Small flood-plains associated with drainage lines
Ms2	Very gently undulating or level plains	Dominant soils are slightly acid sandy yellow earths. Small areas of loamy red and yellow earths also occur and broad shallow drainage depressions have sandy-surfaced duplex soils	Ironstone nodule layers often occur at moderate depths
Sl11	Small flood-plains	Chief soils are hard alkaline yellow and brown soils. Some areas may have a surface covering of stones	Largely derived from sandstones, quartzites, and limestones; occasional sandstone ridges
Ro5	Undulating lands	Dominant are brown loamy duplex soils, often with gravelly A horizons. Associated are red duplex soil and small areas of cracking clays	Other alkaline duplex soils with bleached A2 horizons also occur

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Landscape Units	Landform	Soils	Remarks
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
Qa15	Level or very gently undulating alluvial plains that are often dissected by older channels	A complex range of soils are present but mostly dominant by soft loamy red duplex soils with moderately deep A horizons. Closely associated with soft loamy or occasionally sandy red earths	Low sand dunes and slightly elevated sand-filled prior stream channels are a prominent feature of the unit
Ms1	Gently undulating or level plains	Dominant soils are sandy or, less commonly, loamy yellow earths. Throughout the unit are small areas of earthy sands	These soils are mostly underlain by nodular or concretionary laterite at shallow to moderate depths and occasionally outcropping
Fz7	Strongly undulating to low hilly lands	Dominant soils are shallow stony loams. Small areas of sandy red earths	-

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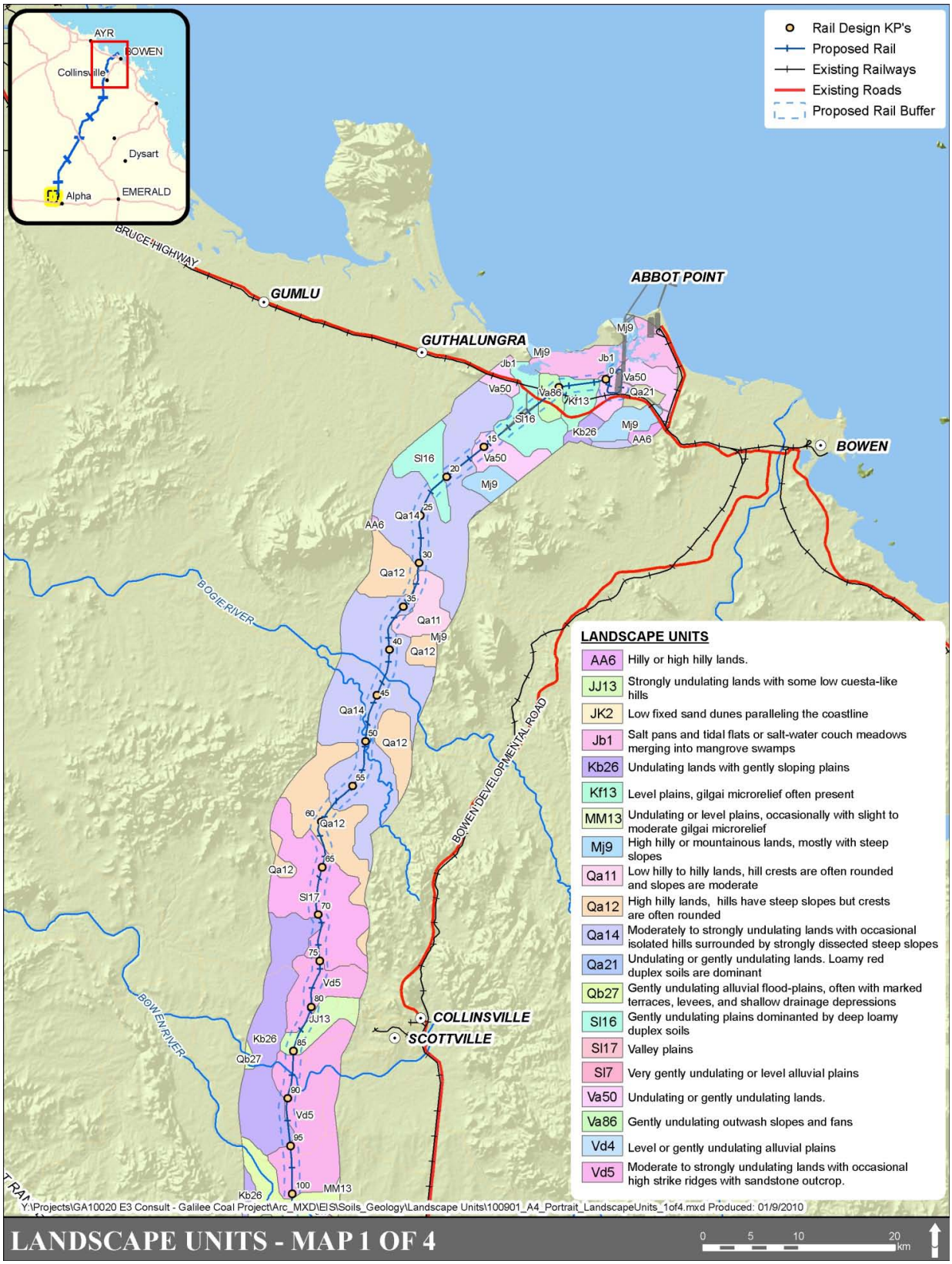

Figure 5-15: Landscape Units (KP00 - KP85)

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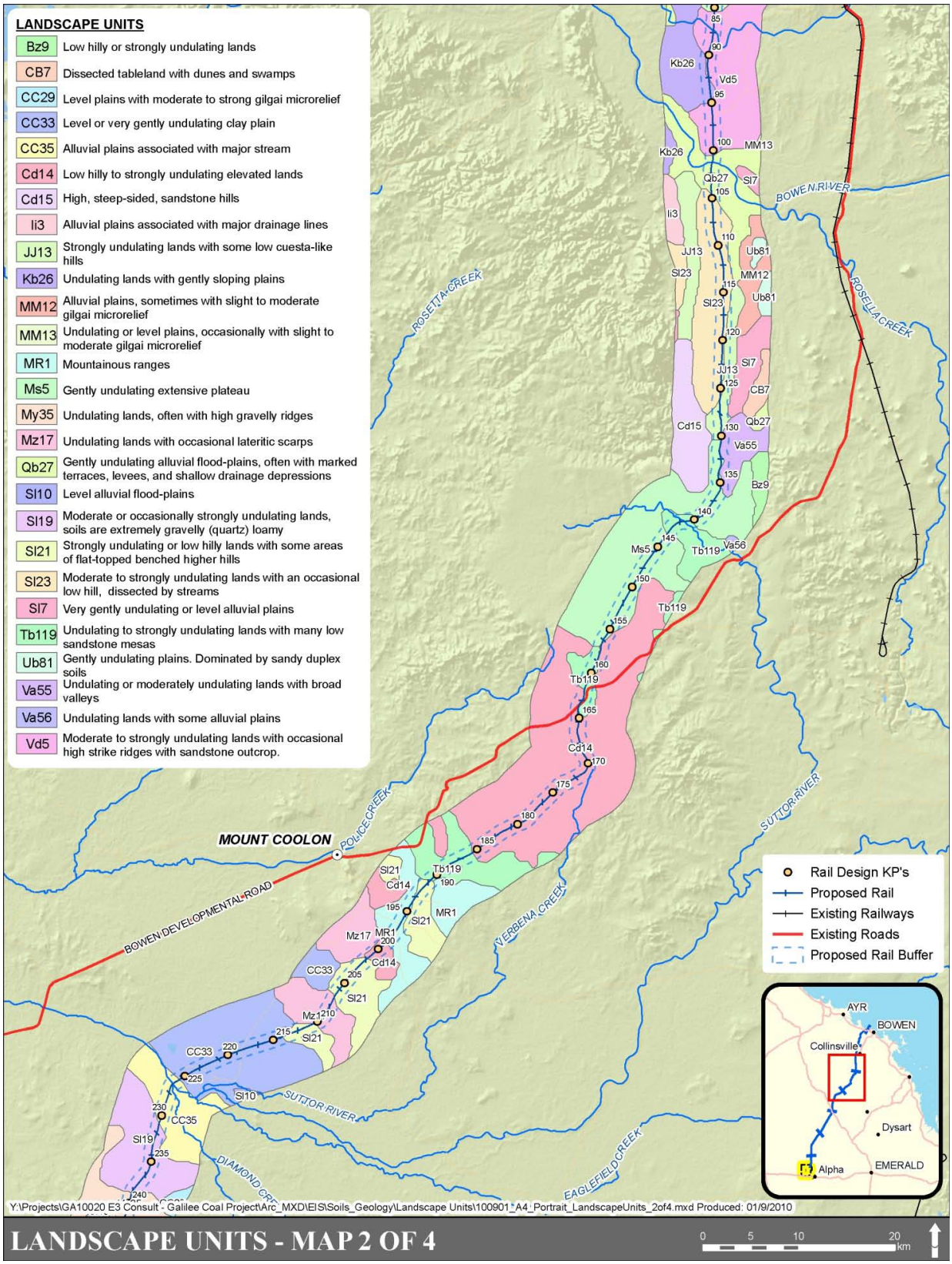

Figure 5-16: Landscape Units (KP85 - KP235)

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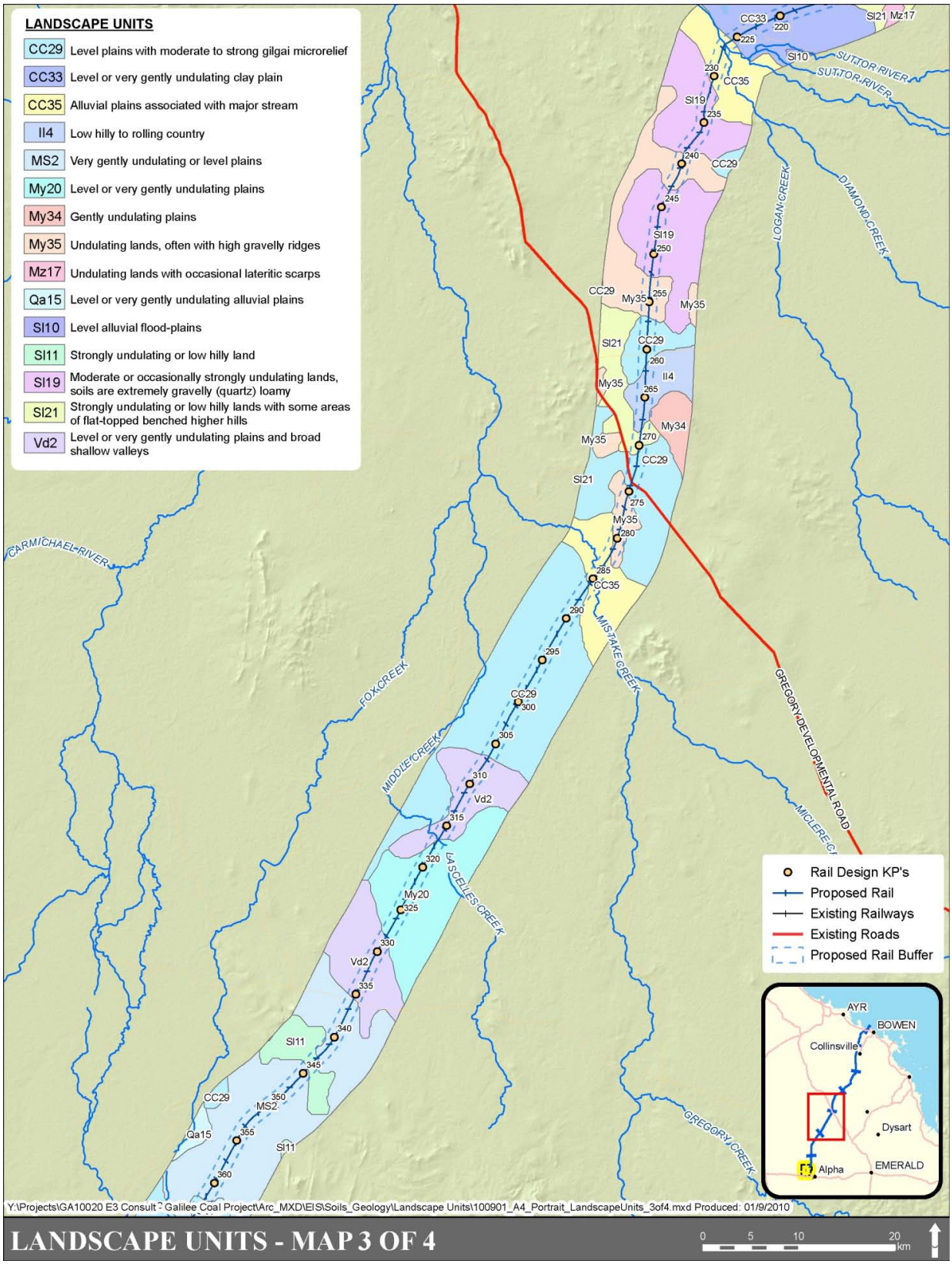

Figure 5-17: Landscape Units (KP235 - KP360)

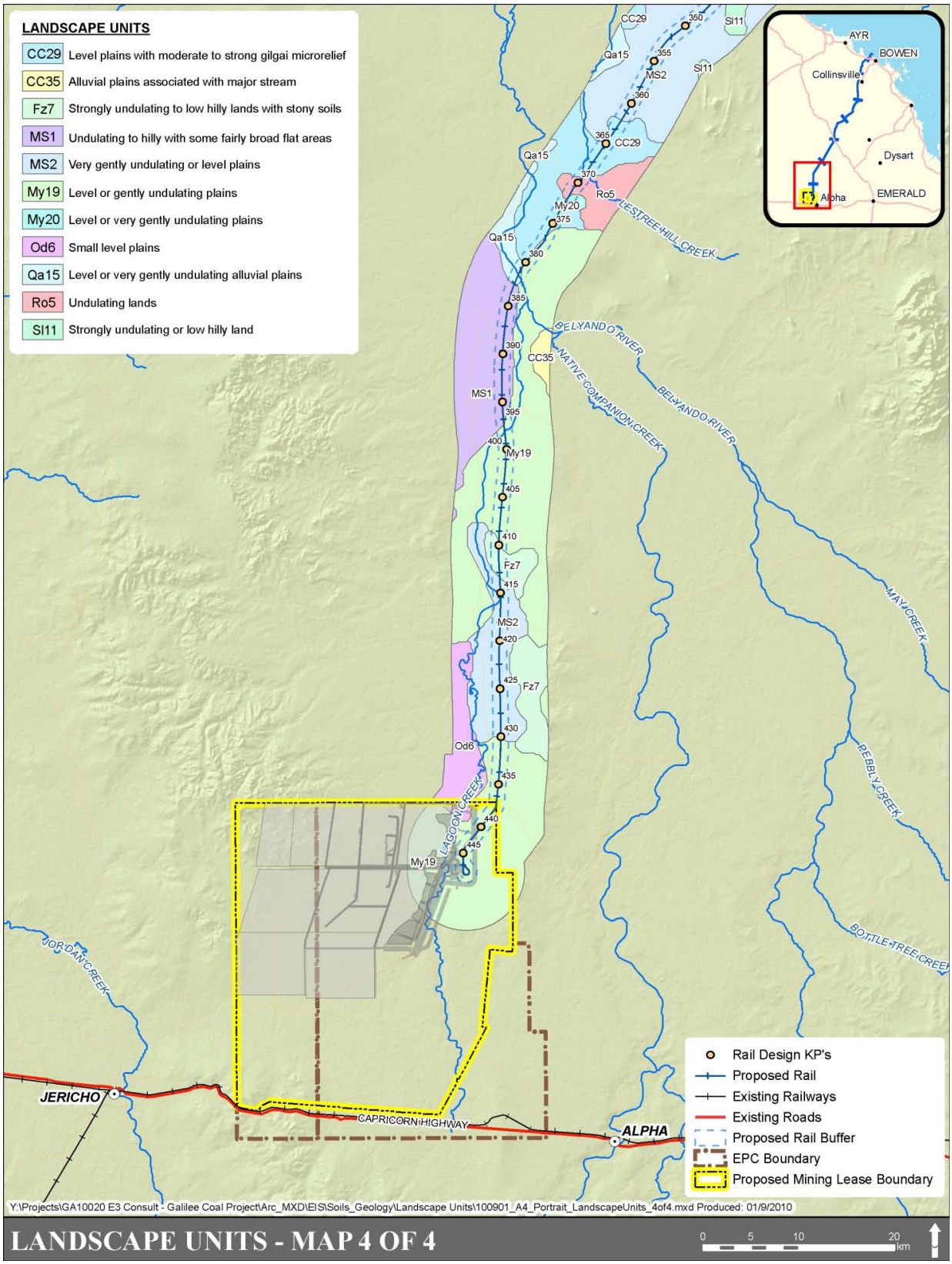

Figure 5-18: Landscape Units (KP360 - KP447)

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5.5 Good Quality Agricultural Land

The assessment of GQAL is based on the results of soil sampling, site observations and regional soil data. A summary table of GQAL assessment is provided in Appendix C.

KP00-KP25 Coastal Plains

Class C GQAL (only suitable for grazing or native pastures) extends from KP00 to KP15 except where inundated saline areas indicate land is not suitable for agricultural production. Class A GQAL (land suitable for cropping with minimal limitations) occurs in small areas between approximately KP15 and KP25.

KP25-KP85 Clarke Ranges

This section of the rail alignment includes Class C GQAL from KP25 to KP60 and Class A GQAL from KP60 to KP85.

KP85-KP125 Bowen River Valley

GQAL in this area includes class D GQAL (land not suitable for agriculture) from KP110 to KP125 with Class C (KP85-KP105) and Class A (KP105-KP110) GQAL in discrete areas.

KP125-KP190 Leichhardt Range

This section of the rail alignment has limited areas of GQAL reflecting the low fertility of the soils. Class C GQAL extends from approximately KP125 to KP155, while Class D GQAL extends from KP155 to KP190.

KP190-KP447 Inland Plains

Discrete patches of GQAL occur over the extent of this section of the rail alignment. Class A GQAL occurs between KP320 to KP355 and KP385 to KP430. Class B GQAL (marginal for current or potential crops due to severe limitations) intersects the alignment between approximately KP190 to KP225, KP255 to KP290 and KP355 to KP385. Class C GQAL extends from KP225 to KP255 and KP290 to KP320.

GQAL along the rail alignment can be seen on Figure 5-19, Figure 5-20, Figure 5-21 and Figure 5-22.

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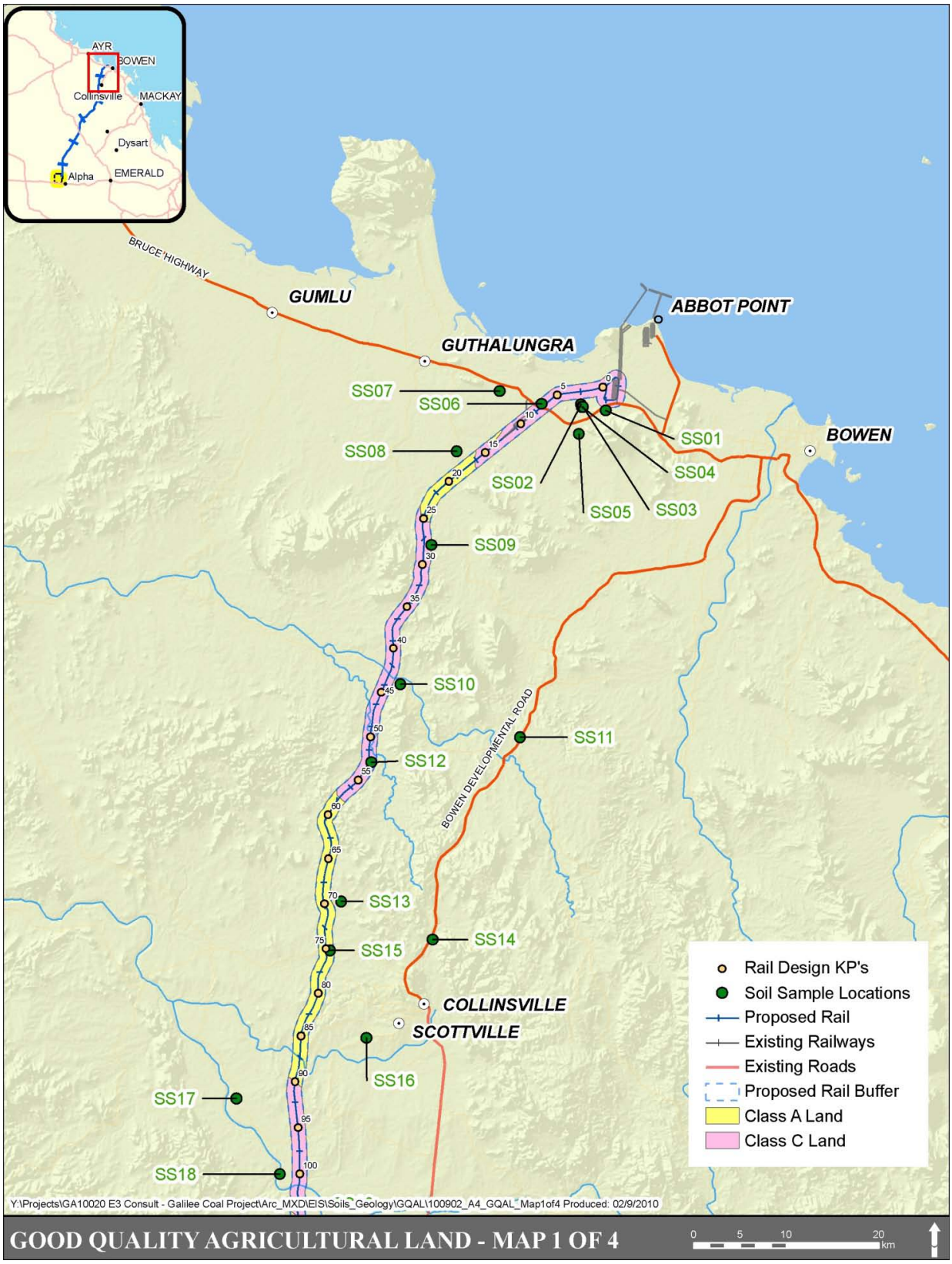

Figure 5-19: GQAL (KP00 - KP85)

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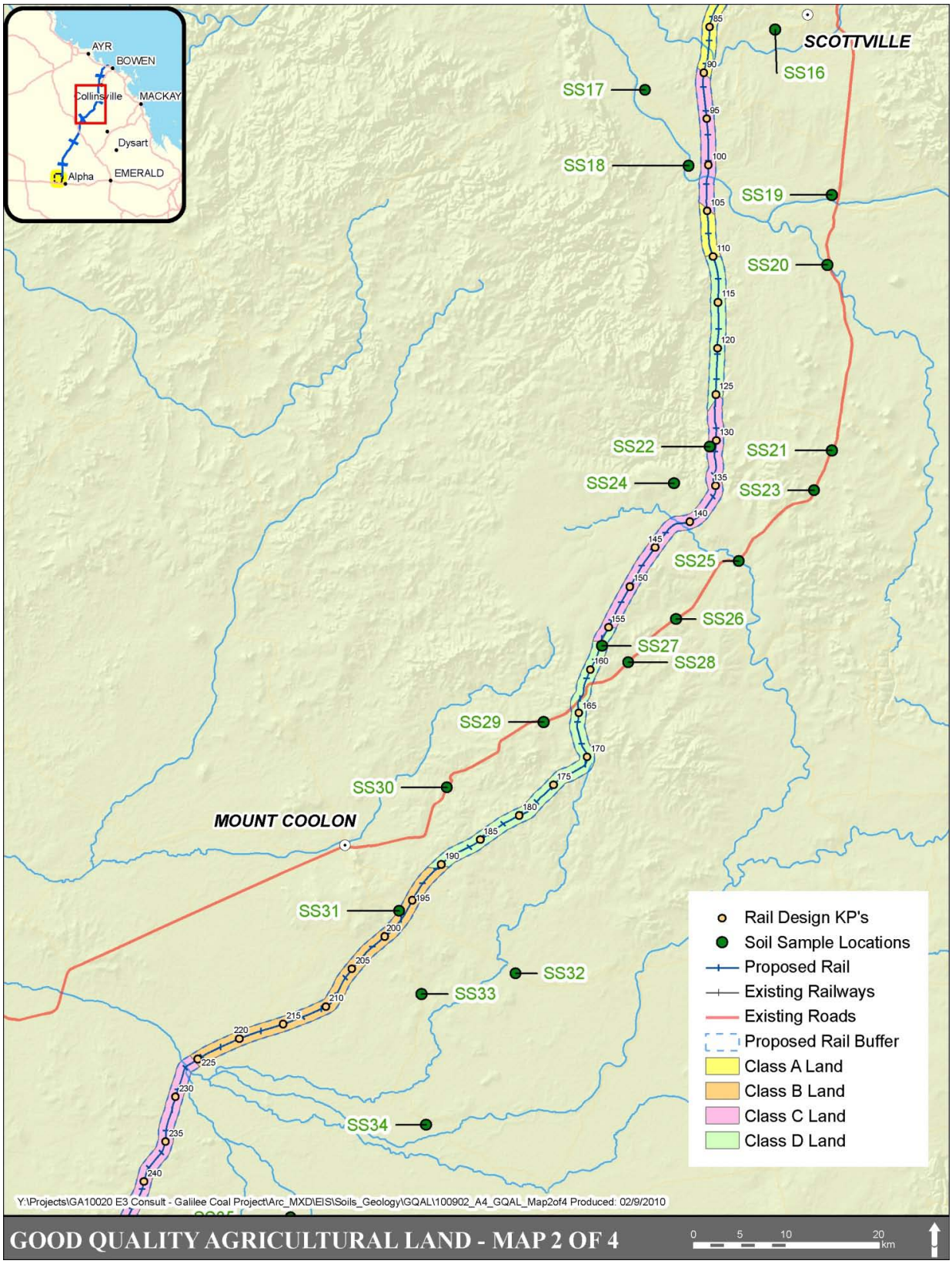

Figure 5-20: GQAL (KP85 - KP235)

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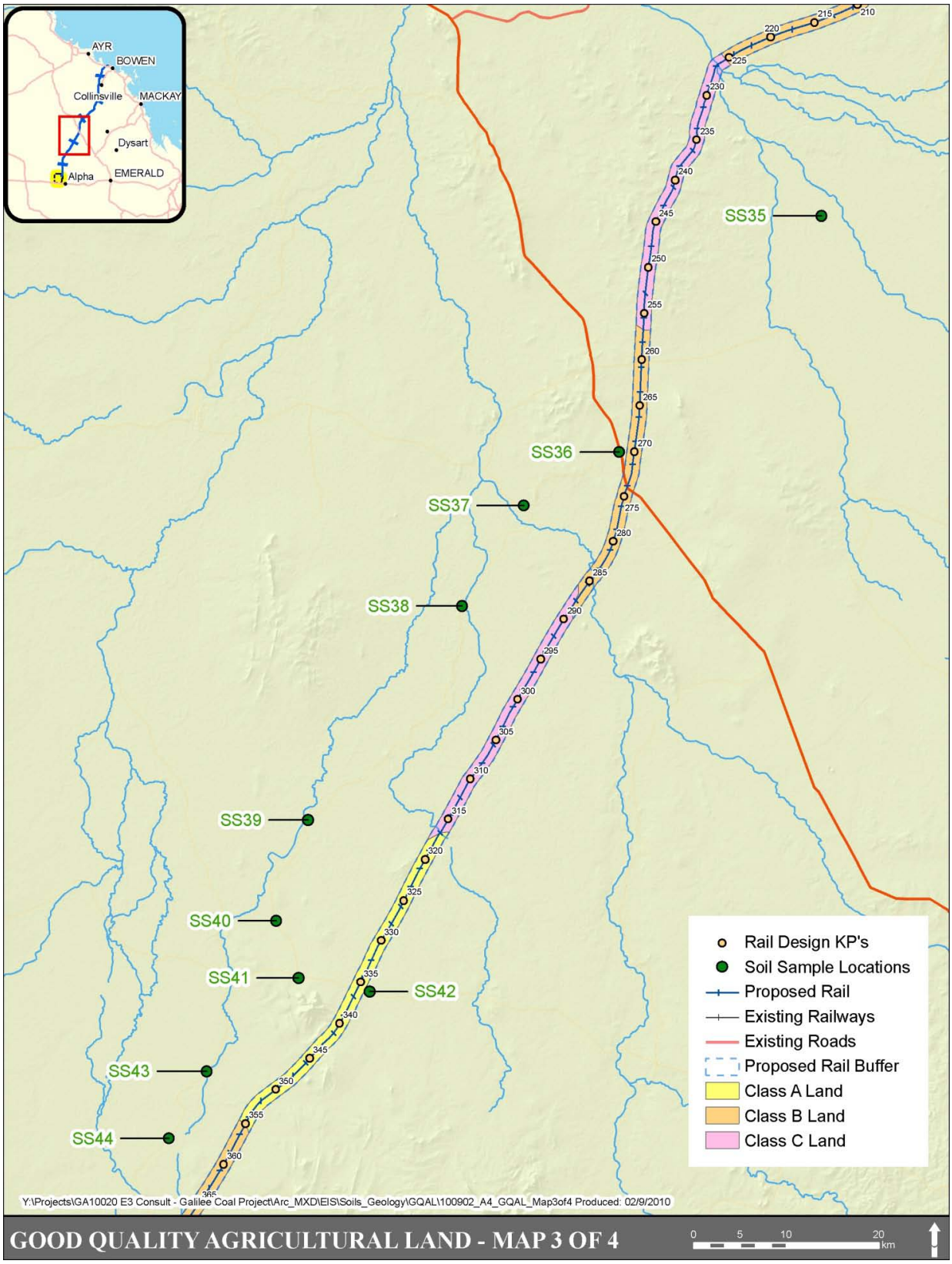

Figure 5-21: GQAL (KP235 - KP360)

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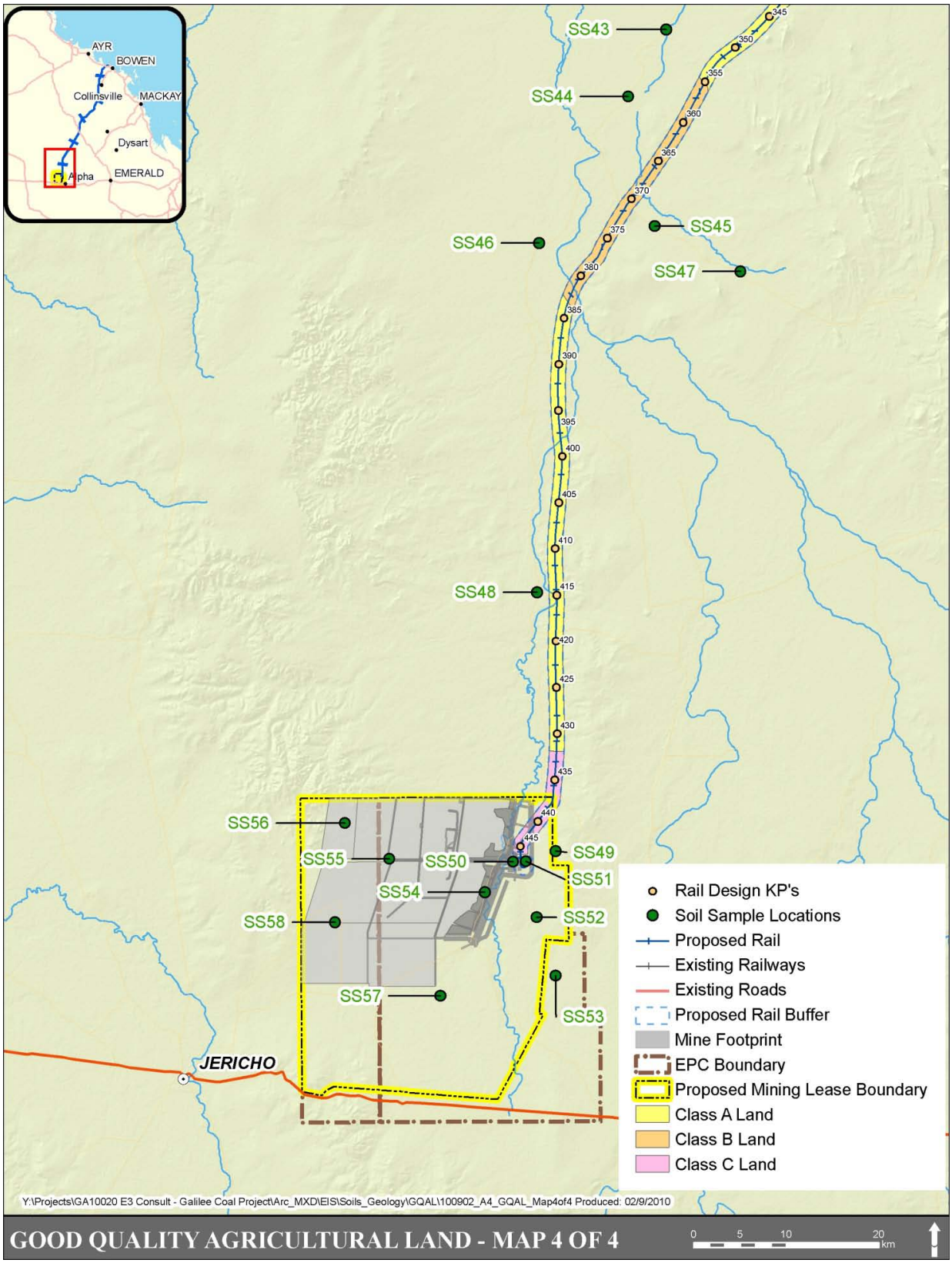

Figure 5-22: GQAL (KP360 - KP447)

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6 Coal Terminal

This section provides a description of the topography, geology, soils and landforms within the APSDA and land in proximity to the Port of Abbot Point.

6.1 Topography

The location of the coal terminal straddles the 5m AHD contour with approximately 25ha of the 38ha area located below the 5m AHD contour and 13ha above the 5m AHD contour (Figure 6-1). Approximately 2.4km of the 5.8km coal conveyor alignment crosses the coastal mudflats below 5m AHD.

The topography of Abbot Point consists of coastal mud flats lying at elevations below 5m AHD and abrupt granitic hills such as Mount Luce located to the west of the coal conveyor alignment and Mount Roundback located to the south east of the coal terminal and conveyor rising to 728m AHD.

Plate 6-1: Coastal Flats and Mt Luce

6.2 Geology

Geological mapping of the APSDA region indicates the geology in the area of the coal terminal comprises primarily Quaternary coastal dunes and sand plains comprised mainly of sands sourced from wind (Aeolian) and Cainozoic alluvial and deltaic deposits of silt, sand and clay (Figure 6-2).

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The basement underneath these more recent deposits includes significantly eroded and remnant inselbergs of granitic rock representing the basement rocks that outcrop south of the site at Bald Hill and at Mt Luce (Mt Stuart). These are granitoids of Upper Carboniferous to late Permian age into which some dolerite dykes have subsequently intruded. A summary of the geological units underlying the Abbot Point area is shown in Table 6-1.

Table 6-1: Geological Key - Abbot Point

Geological Symbol	Era	Period/Epoch	Formation Name	Lithological Description
Qa	Cainozoic	Quaternary undifferentiated	Coastal Mudflats	Fine to medium grained unconsolidated sand
Qe	Cainozoic	Quaternary undifferentiated	Coastal Sand Dunes	Fine sands
Czs	Cainozoic	Undifferentiated	Alluvial and Deltaic deposits	Sand/sand and gravel, clayey sand, silty sand, clayey silt and silty/clayey sand.
Cggx	Palaeozoic	Upper Carboniferous – Early Permian	Un-named Intrusives	Adamellite, granite, some granodiorite, minor fine grained variants
Cgd	Palaeozoic	Upper Carboniferous – Early Permian	Un-named Intrusives	Diorite, Quartz diorite, tonalite, gabbro, norite, minor granodiorite, adamellite and granite
P-Rg	Mesozoic	Lower Permian		Leucogranite, microgranite, minor adamellite, diorite
Kg	Mesozoic	Lower Cretaceous	Mount Abbot Igneous Complex	Granodiorite, and Adamellite, late stage leucocratic phases

The coal terminal lies on Quaternary and recent formations that overlie subsurface geology which would provide indications of structural geology. GSQ mapping shows the major structural faults and shears that occur in close proximity to and/or intersect the Abbot Point area. These are present predominantly along the rail alignment.

The geology of the Abbot Point area includes Carboniferous to Permian intrusive rocks and Quaternary and recent residual colluvial and alluvials. The area is very unlikely to have fossils.

Figure 6-1: Coal Terminal Topography

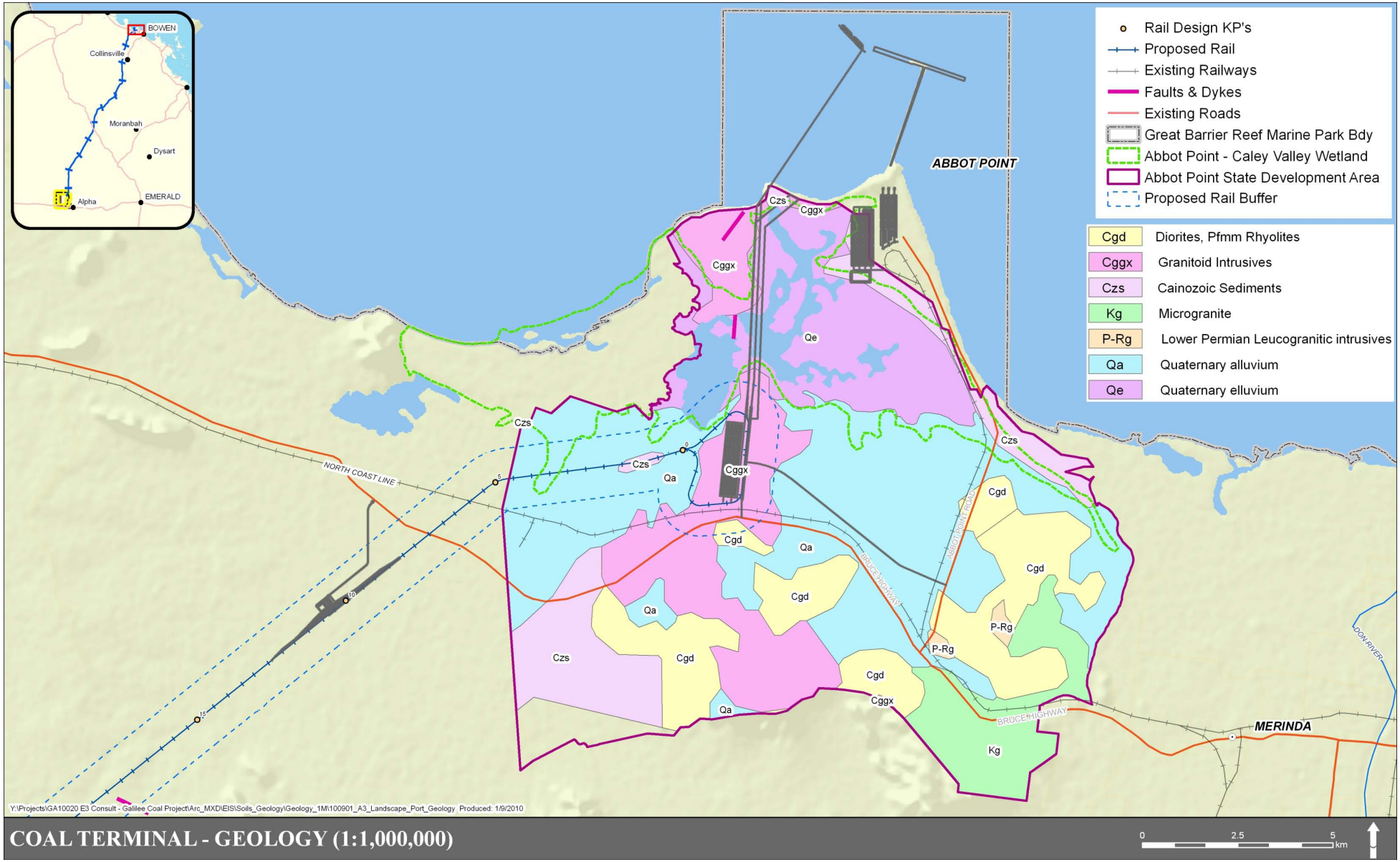

Figure 6-2: Coal Terminal Geology

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6.3 Soils

The main soil types within and adjacent to Abbot Point indicates that the area is dominated by Sodosols – soils in which a clear B horizon where the upper 0.2m or major part of the B horizon is sodic and not strongly subplastic. Sodosol soils will set hard when dry and are prone to dispersion and instability. These soils are dominantly red, brown, yellow, grey or black in the B horizon and may have hardpans or calcrete. Figure 6-3 shows the mapped soils at Abbot Point. Table 6-2 provides approximate correlations between the Australian Soil Classification and the other soil classifications for the soils encountered at Abbot Point.

The area also contains seasonally or permanently wet soils in the wetland mudflats that are regionally mapped as Sodosols but could also be termed Hydrosols and include cracking clays. In addition, there are Tenosols (weakly developed soils) derived from the granitic intrusive that are not mapped at the regional scale. The Tenosol and cracking clay extents as estimated from field observation are illustrated with regionally mapped Sodosol in Figure 6-3.

Plate 6-2: Tenosol Soils

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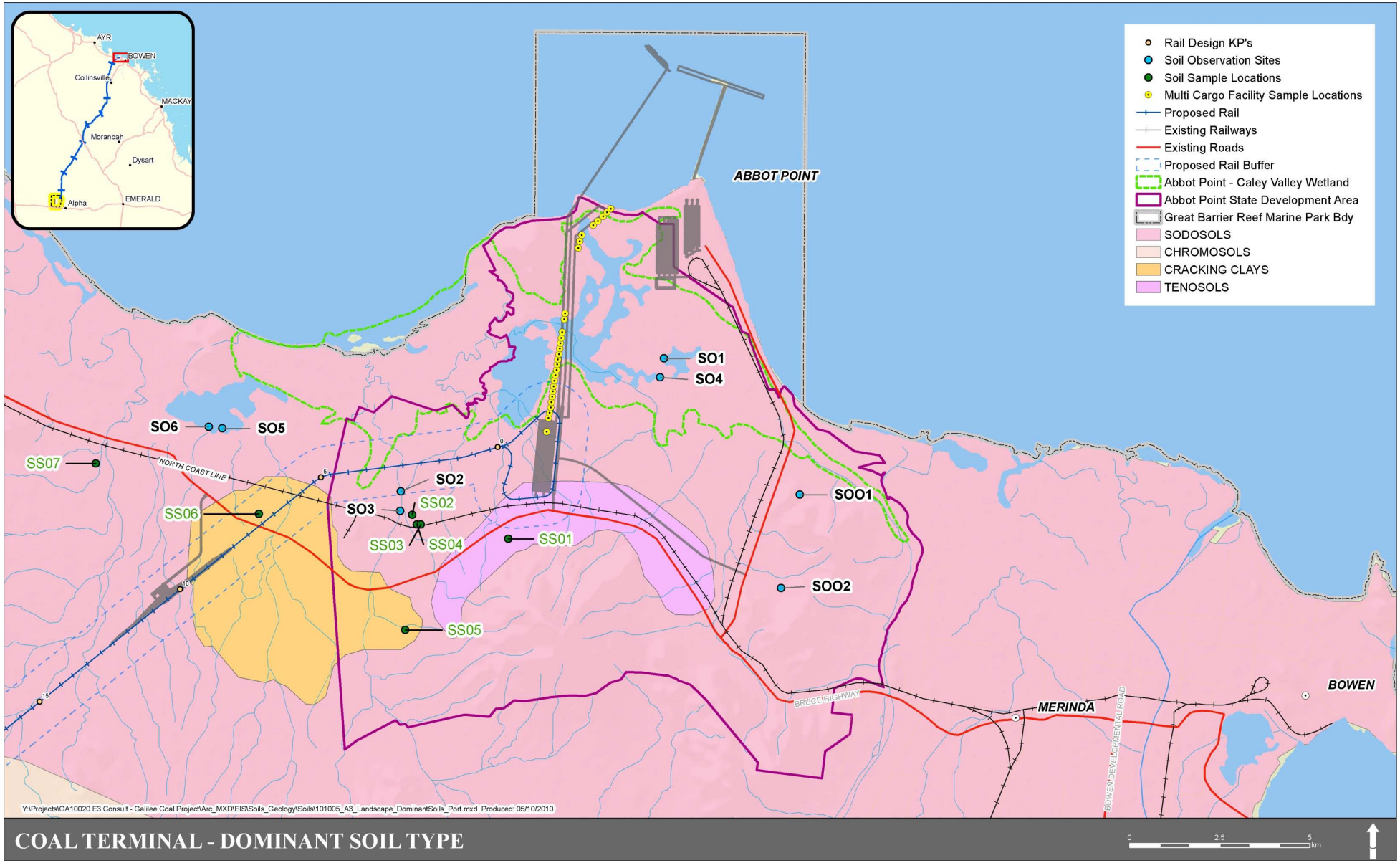

Figure 6-3: Coal Terminal Dominant Soils

Table 6-2: Description of the Major Soil Classification Schemes - Abbot Point

ASC	Description	PPF	Great Soil Groups
Sodosols	These are soils with a strong texture contrast between the A and B horizons (increase n clay) and high sodium which may lead to dispersion and instability; Hydrosols (soils seasonally or permanently wet) are excluded	Many duplex (D) soils	Solodised solonetz and solodic soils, some soloths and red brown earths, desert loams
Tenosols	Weakly developed soils apart from the A horizon	Many classes	Lithosols, silaceous and earthy sands, alpine humus soils and some alluvial soils
Hydrosols	Soils that are seasonally or permanently wet due to site topography or tidal influence	Wide range of classes, and soils	Humic Gleys, gleyed podzolic soils, solonchaks and some alluvial soils

The soil characteristics from samples collected in the Abbot Port area are described in Table 6-3.

Table 6-3: Soil Descriptions - Abbot Point

Sample	Soil
SS01	Pale Yellow/White, very loose fine sand/granitic gravel.
SS02	Clay, Dark Brown/Grey, hard friable, poorly drained.
SS03	Clay, Dark Brown, hard to friable, cracking.
SS04	Clay, Dark Brown, hard to Friable.
SS05	Clay, Dark Brown, Hard.

A review of the Geology and Soils section within the Abbott Point Multi Cargo Facility (MCF) EIS (GHD, 2010) was carried out to support the project specific investigations. MCF Investigations included 25 test pits along the length of the proposed transport corridor (refer to Figure 6-3). Results from the MCF investigations indicate that the soils can be categorised as sodosols, tenosols and hydrosols. Of the 25 test pits, the soils at 13 locations were categorised as hydrosols. As described earlier, these are seasonally or permanently wet soils in the wetland mudflats that are regionally mapped as Sodosols. The results of the MCF investigations support the findings our investigations.

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. Soil pH laboratory results were observed as follows:

- Soil pH ranged from 5.9 to 7.8;
- Two samples had a soil pH greater than 7.0. These were SS02 and SS05;
- No samples had a pH less than 4.5 or greater than 8.8; and
- Soil pH for the remaining samples was within the range that is optimal for plant growth (pH 5.5 – 7).

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Cation Exchange Capacity (CEC)

Soil exchangeable cation laboratory results indicated that:

- Exchangeable Mg ranged from 0.5mEq/100g to 18mEq/100g, indicating low to very high exchangeable Mg;
- Exchangeable Ca ranged from 0.9mEq/100g to 37mEq/100g indicating very low to very high exchangeable Ca;
- Exchangeable K ranged from 0.2mEq/100g to 0.5mEq/100g indicating very low to moderate exchangeable K; and
- CEC ranged from 1.9mEq/100g to 36.6mEq/100g indicating very low to very high CEC.

These results reflect the difference between Tenosols comprising weathered granite outwash with little structure and low CEC and low fertility to the deeper clay soils with higher CEC. However, sodic clays will have lower fertility.

Soil Salinity

EC ranged from 30µS/cm (SS01) to 166 µS/cm (SS02 and SS06) in the soils sampled at Abbot Point. This indicates very low to low salinity in the samples analysed and suggests that clay soils have the potential for low grade agricultural use when not affected by salt or tidal inundation.

Soil Sodicity

Soil is prone to dispersion, and therefore the risk of erosion, where the sodicity or proportion of sodium is high or the Ca:Mg ratio is low. The laboratory results observed:

- Exchangeable sodium concentrations ranged from 0.3meq/100g to 1.9meq/100g in soil samples collected indicate that exchangeable sodium ranges from medium to high in the samples analysed from Abbot Point; and
- The Ca:Mg ratio ranged from 0.9 (SS02 and SS06) to 2.5 (SS05), indicating very low to medium Ca:Mg ratio in the soils sampled from Abbot Point.

This indicates a potential for soil dispersion and erosion.

Exchangeable Sodium Percentage (ESP)

ESP ranged from 5.1% (SS02) to 18.3% (SS06) in the samples collected from the rail alignment indicating low to high ESP in the samples collected from the Abbot Point project area. The higher ESP coincided with clay soils and also indicates these maybe dispersive.

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Sodium Adsorption Ratio (SAR)

SAR results for the Abbot Point project area are summarised below:

- SS01: 6.8;
- SS05: 1.88;
- SS02: 3.75; and
- SS06: 20.5.

The results of the soil sodicity analysis indicate that sample SS02 has high exchangeable sodium, high ESP, high SAR and low Ca:Mg ratio indicating that these soils at this location are likely to be sodic and prone to dispersion and erosion.

Emerson Crumb tests

Three samples from the coal terminal area were analysed for Emerson Crumb dispersivity. Sample results for all three samples indicate that the soils are highly likely to be sodic, dispersive and likely to be difficult to manage. The results of the Emerson Crumb analysis were:

- One sample returned an Emerson Crumb Class of 1 (almost certainly sodic) (SS02) at the sample depth of 0.3 to 0.6mbgl; and
- Two samples returned an Emerson Crumb Class of 2 (highly likely to be sodic) (SS02 and SS06) at the sample depth of 0.0 to 0.3mbgl.

These results suggest that Tenosols with weak soil structure are susceptible to erosion and that sodic clay soils in the area are also likely to disperse and erode. Both the clays and Tenosols are very dispersible to moderately dispersible at surface and at depth. In the low lying marine and coastal areas, Sodosols with less surface cover and those with higher silt contents would be expected to have moderate erosion potential. Areas of alluvial valley floors around creek lines would have moderate to high erosion potential due to higher silt contents, the sodicity and dispersivity of the subsoils and the periodic high flood flows and scours in these areas.

The Tenosols comprising gravelly granitic outwash would be unsuitable for stripping or use as a growth medium due to excessive stoniness, poor structure and shallow depth to bedrock.

Soil Observations

Two sites (SO1 and SO4) exist within the boundaries of Coal terminal Study Area. A visual assessment was undertaken to determine the potential for erosion; both sites were deemed to have a low potential. This is largely associated with the high proportions of vegetation and inundated states characteristic of estuarine and wetland mud flats.

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Topsoil Resources

The suitability of top soil resources for rehabilitation of lands disturbed by the coal terminal requires an assessment of suitable topsoil and proposed stripping depths. The useable topsoil resources are generally limited to the surficial "A" horizon and can also occur in the upper "B" horizon which containing seed stocks, organic matter, nutrients and biota necessary for plant growth. Based on observations made on site, useable topsoil resources are likely to be restricted to the top 0.1m to 0.3m of the soil horizon. Areas of Tenosols will be too granular and will be unsuitable as topsoil.

6.4 Landforms

The landscape units at Abbot Point reflect the coastal location and topography. The Abbot Point area has relatively prominent fore-dunes up to 9m AHD adjacent to the coast with gently undulating sand plains with minor crest/swale formation and an elevation variation of generally less than 0.5m. This transitions to colluvial material (loose, heterogeneous and incoherent mass of soil material and/or rock fragments deposited by rain wash, sheet wash or slow continuous creep) occurs at approximately 5m AHD. The landscape units for the Abbot Point are shown on Figure 6-4 with the descriptions outlined in Table 6-4.

Table 6-4: Landscape Units - Abbot Point

Landscape Unit	Landform	Soils	Remarks
AA6	Hilly or high lands	Sandy duplex soils on lower slopes	Numerous large granite outcrops
Jb1	Salt pans and tidal flats or salt-water couch meadows merging into mangrove swamps	Dominant soils on the salt pans are highly saline clays. The small grassed areas in the unit have loamy duplex soils	subject to frequent inundation by tidal waters
JK2	Low fixed sand dunes paralleling the coastline	Dominant soils are those of the older (more inland) dunes, which have deep sands	The unit may include small areas of mangroves and salt pans
Kf13	Level Plains, gilgai microrelief often present	Deep dark cracking clays and grey clays can be present	Loamy grey duplex soils in low areas
Mj9	hilly or mountainous lands, mostly with steep slopes; rock outcrop is often prominent	Dominant soils are fairly shallow and nearly always stony friable earths with a dark loamy surface fading to red clay subsoils	A wide variety of other shallow stony soils occur however data is fairly limited
Qa21	Undulating or gently undulating lands. Loamy red duplex soils	Includes loamy mottled duplex soils	On higher crests soils are stony

Landscape Unit	Landform	Soils	Remarks
Sl6	Gently undulating plains, dominated by deep loamy soils	Can include deep dark cracking clays	Data is limited
Vd4	Level or gently undulating alluvial plains	Gilgai microrelief can be present.	Can include loamy duplex soils
Va50	Undulating or gently undulating lands/small areas of granite outcrop	dominant are sandy or loamy often gritty duplex soils	The unit have shallow coarse sands

6.5 Good Quality Agricultural Land

The APSDA region is not mapped in the WRC as GQAL. This corresponds with the soils mapping that indicate the land is likely to be dominated by Tenosols, Sodosols and saline mudflats. Portions of the area are Class C GQAL; however, this is of limited extent as tidal and saline land toward the oceans and Tenosols in the inland portions limit the extent of these soils (Figure 6-5).

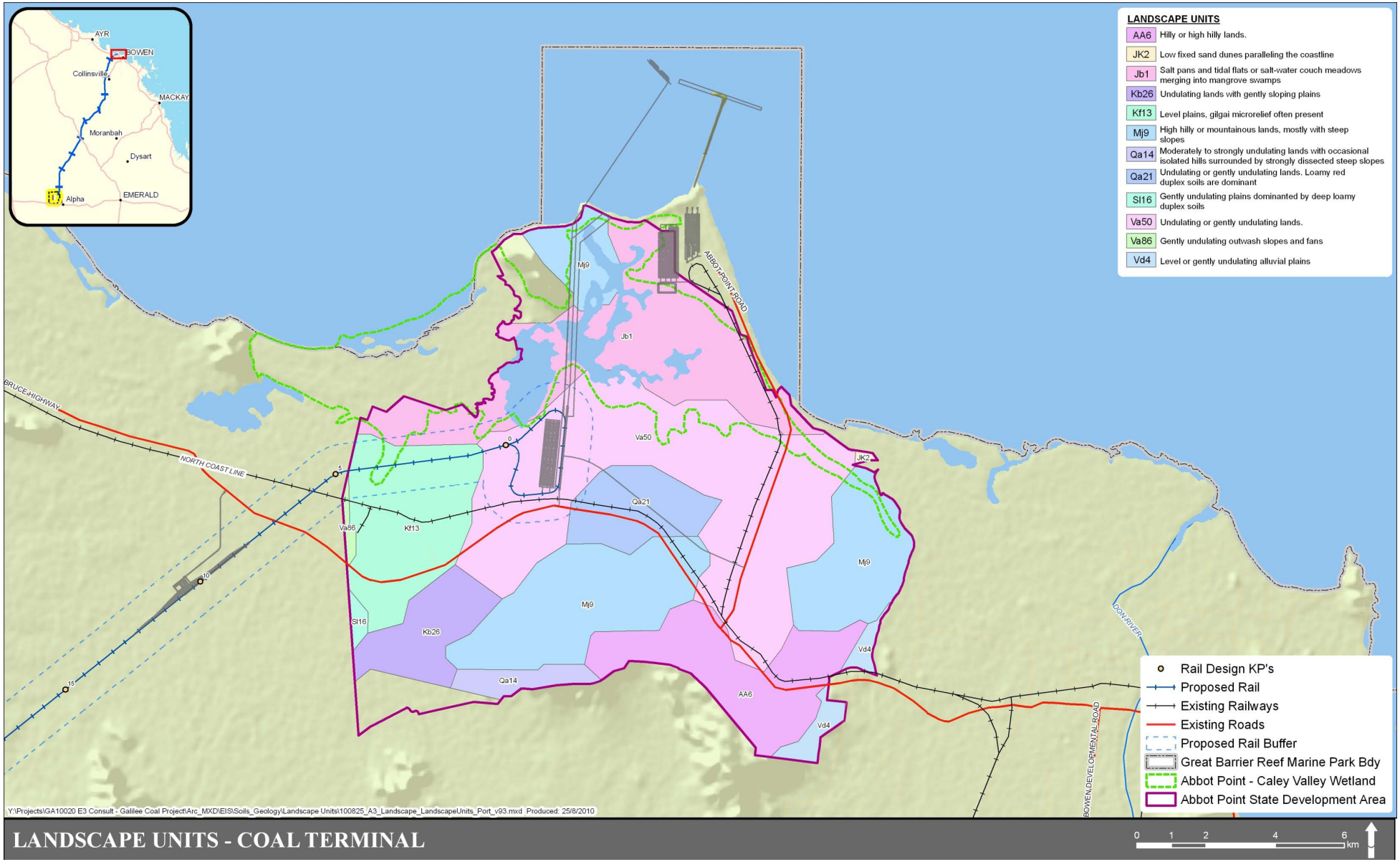

Figure 6-4: Coal Terminal Landscape Units

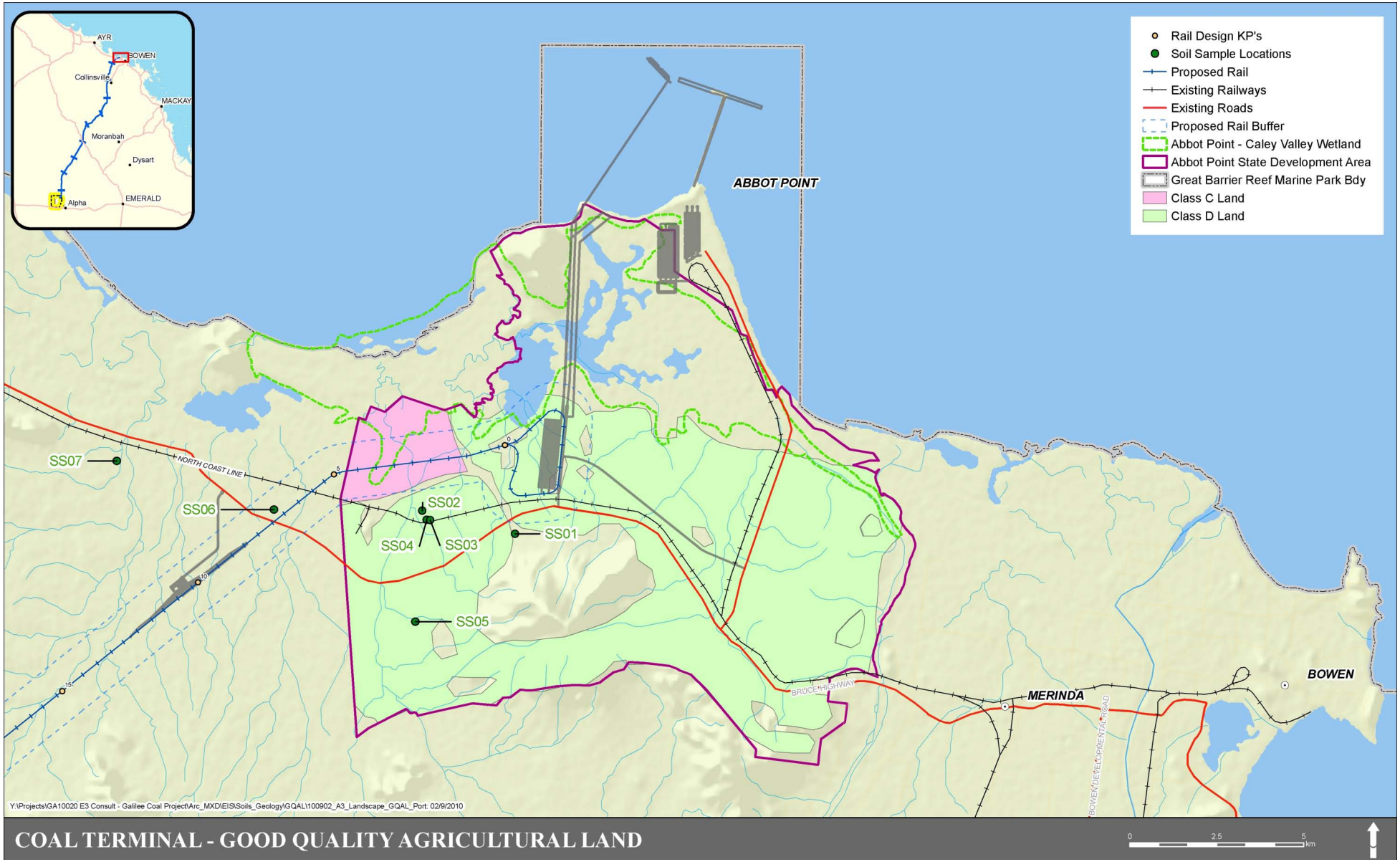

Figure 6-5: Coal Terminal GQAL

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7 Potential Impacts

The following section provides information on the likely impacts to topography, geology, soils, landform and GQAL as a result of the China First Project.

7.1 Mine

7.1.1 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.

7.1.2 Subsidence

The area where subsidence will likely occur has little topographical relief, is generally cleared (chain pulled and blade ploughed) and is currently used for cattle grazing.

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 unlikely to be significantly impacted by any minor subsidence however the maximum predicted level of 3.27m has the potential to result in some cracking.

7.1.3 Geology/Soils

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 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. Acid production potential of overburden, interburden and coal reject are discussed in the Waste Technical Report.

7.1.4 Fossils

The significance of a fossil is indicated by rarity and can be due to fossil size. 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 China First 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.

7.1.5 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 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.

7.1.6 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 1 or 2; 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 China First 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.

7.1.7 Agricultural Land Use / GQAL

During the operation of the mine, existing land uses, such as grazing may be able to continue within the MLB in 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.

7.2 Rail Alignment

7.2.1 Topography

Through the Clarke and Leichhardt Ranges, the topographical features such as rocky outcrops and steeply sloping ground can present an increased potential for landslip. Further, major rivers and tributaries may affect the extent of clearing required during construction, the type of equipment required to undertake construction and the amount of time that disturbed construction areas are in use. In these areas, there is

greater potential for landslips to occur in the areas of steeper topography between KP25-85 and KP125-190 if construction works are not managed properly.

7.2.2 Geology/Soils

Fault and slips can result in greater landslip potential or require more shallow batter angles in cuttings. The rail alignment carries the greatest potential for impacts from geological structures where it intersects the Glenore Shear Zone around KP20, extensions of the Collinsville Fault system and associated dykes between KP25-KP85, and north-west trending fault systems between KP85-KP125. These can be avoided if detailed geological/geotechnical studies are undertaken and issues are highlighted for final design. Where encountered, lower slope angles or greater setbacks for construction may be required leading to potential for erosional impacts over larger areas.

Where the alignment crosses exposed bedrock, dykes (KP25-KP85) and acidic intrusive rocks, there is potential for drilling and blasting works to be required, leading to greater potential for erosion and generation of silicic dusts from acidic intrusive rock types.

Where the alignment crosses gilgai relief, cracking clays and soils with erosive or dispersive properties, there will be potential for impacts relating to erosion to occur. Cracking clays occur in discrete areas around creeks and low lying portions of the rail alignment mainly between KP0-KP25and KP85-KP125. In addition, cracking clays with shrink/swell properties can result in damage to structures, foundations and buried services from differential ground movement. The degree of impact is dependent upon the soil profile thickness and the type of clay.

7.2.3 Soil Erosion

Thin Tenosol soils with little structure are susceptible to erosion when disturbed and occur in portions of the alignment between KP0-KP25 and KP125-KP190.

Visual observations of waterways along the alignment identified that a number of them likely have moderate to high erosion potential. Potential impacts resulting from erosion include increased sediment loads in the waterways as well as impacts to infrastructure such us undercutting of bridge buttresses.

Erosion potential at waterway crossings needs to be further assessed during detailed geotechnical investigations. The placement of infrastructure will need to be carefully considered at sites identified as having high potential with structures designed and constructed to avoid creek banks.

7.2.4 Fossils

There is limited potential for fossilised material to be discovered during the rail alignment construction as the geology with potential for fossils is limited to the Back Creek and Blenheim group of the Collinsville coal measures and the Blackwater group. Further, rail construction is anticipated to include generally shallow

earthworks with lower potential to intersect less weathered rocks with intact fossils. If fossils are encountered, all works should cease immediate and appropriate experts contacted.

7.2.5 Topsoil

Soil depth varies within dissected areas of the alignment from thin soils on slopes with Tenosols to deep soils in valleys below these areas. Areas of the rail alignment with thin topsoils include Tenosol areas with portions of the alignment around KP0-KP25, and KP125-KP190. Deeper clay soils are present in areas between KP25-KP85 and KP85-KP125. A balance of topsoil volumes can be undertaken as the final alignment of rail construction is achieved.

7.2.6 Soil Salinity

The most sodic soils were encountered around KP185, although inundated saline soils may also be encountered around creek crossings and low lying land between near KP00-KP10. Areas of saline soils in the alignment have the potential to result in increased erosion risk during construction and increased potential for corrosion of buried steel and/or concrete materials. These are generally in creek and river valleys and carry the greatest potential impact to disturbance by project construction from mobilisation of saline sediments and corrosion of infrastructure at creek crossings or where below grade cuttings are required.

7.2.7 Agricultural Land

The rail alignment will sterilise GQAL within the footprint of the alignment and fragment land parcels potentially leading to loss of access to agricultural land. The most significant agricultural land is potential Class A land between KP25-85 and KP322-355.

7.3 Coal Terminal

7.3.1 Topography/Landscape

Given the relatively flat topography of the project area near the coast, elevated topography is expected to have minor impacts to local topographical features in these areas with conveyor alignment proposed in area of flat to gently sloping land.

7.3.2 Geology/Soils

The soils in the APSDA area comprise Tenosols, Hydrosols and Sodosol clays. Where the coal terminal infrastructure crosses black cracking clays with dispersive the shrink/swell properties, the movement of these soils may result in damage to structures, foundations and buried services from differential ground movement. The degree of impact is dependent upon the soil profile thickness and the type of clays.

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7.3.3 Fossils

There is limited potential for fossilised material to be discovered during construction of the coal terminal due to the absence of sedimentary rocks from prolific fossiliferous periods and the generally shallow earthworks.

7.3.4 Topsoil

The soils in the coal stockyards area comprises Tenosols derived from granitic outwash and balc cracking clays and Sodosols merging into the inundated mudflats. The Tenosols are susceptible to erosion, while the clays will crust and set hard when dry. Both have low potential for reuse as topsoils.

During construction, soils suitable for topsoil will have to be imported to create topsoils around the infrastructure suitable for long term erosion control.

7.3.5 Soil Erosion

The reactive clays, dispersive soils and soils with high ESP in the area of the coal terminal have greater potential for erosion, while the Tenosols have thin soil profiles and little binding organic matter leading to increased potential for erosion. Construction of the coal terminal infrastructure could lead to loss of soil through increased erosion from exposed soils where the construction alignment intersects erosive or dispersive soils.

7.3.6 Soil Salinity

Some soils at the coal terminal have high salinity, due to the periodic inundation and saturated soils. This results in poor plant growth and greater potential for erosion. Potential impacts to construction include increased potential for corrosion of metal and concrete structures.

7.3.7 Agricultural Land/GQAL

The land at the APSDA is generally unsuitable for agricultural uses with most of the area either not rated as GQAL or rated as Class D, which is considered unsuitable for agricultural purposes. The APSDAs main function is to provide port services for coal and other mining industries which are incompatible with agricultural uses. The China First Project is consistent with the intent of the area.

8 Management Measures

The mitigation measures applicable to the potential impacts at the mine are also applicable to the disturbance of soils at the rail alignment and coal terminal sections of the China First Project. Where the mitigation measures are similar, reference is made to the mine mitigation measures.

Aspect	Potential Impact	Management Measure	Objective
Mine Topography/ Landscape	Excavation and spoil dumps impacting on landscape/ topography	Waratah Coal will ▪ concave slope profiles; ▪ average slope gradients at 4% (the erosion potential of longer slopes will need to be considered); ▪ irregular dump shapes (e.g. with uneven heights, ridgelines and spurs); ▪ minimise spoil dump relief (height) between the floor and the crest; ▪ minimise slopes gradients adjacent to creeks; and ▪ Follow mitigation measures in the Land Use and Planning Technical Report.	The post-mining landform should consider, and where practicable mirror, the original topographic elements of the study area. This does not require that the topography should be returned to the pre-mining profile, but where topographic highs (i.e. spoil/overburden dumps) are placed, they should be constructed to a similar outline as occur naturally in the pre-mining area if practicable.

Aspect	Potential Impact	Management Measure	Objective
Subsidence	Topographic impacts, increased, erosion, loss of land use	Mitigation measures for mine subsidence include ripping and backfilling of areas with soil cracking. Where short term elevation changes occur, earthworks are required to minimize these elevation changes	Where subsidence impacts upon slopes and/or surface waters, erosion and sediment controls should be established to minimise the potential for subsidence exacerbated erosional impacts and downstream monitoring is undertaken to assess the potential impacts. A detailed geotechnical assessment of subsidence potential should be undertaken prior to construction and will require available geotechnical data, an assessment of stratigraphy relative to the underground workings, prediction of maximum subsidence over proposed longwall blocks, goaf and pillars.
Fossils	Loss of fossil record	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 ceases 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) is maintained to allow for stoppages due to potential fossil finds.	Maintain fossil record

Aspect	Potential Impact	Management Measure	Objective
Topsoil	Loss of Topsoil	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. 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. Soils in the mine area are dominated by structureless soils (Kandosols) and soils with minimal development (Rudosols). The available topsoils should be stripped from all disturbed areas and retained for use in rehabilitation areas. Topsoil stripping may be affected by localised features such as gullies and shallow soil depth in upper slope areas. 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. Stockpiling of topsoils should be avoided where possible. Where topsoils are stockpiled, the height of stockpiles will not exceed 3m. If stockpiled for long periods, the topsoil should be cultivated to minimise the potential for weed growth and maintain the fertility of the soil. The topsoil volumes will be recorded to track if sufficient topsoil is available for rehabilitation needs. Where sampling or treatment of topsoil occurs, this will be recorded to allow optimal fertiliser amendment or weed control. Topsoils should be applied at a minimum depth of 100mm. Where poor growth mediums exist field trials should be conducted to assess the minimum topsoil cover over overburden which will provide a suitable growth medium for recommended plant types. These trials can include mixing of very sandy material with finer material, and/or sandy material maybe mixed with high clay content clay subsoil material to develop better soils for use in rehabilitation. Where soils are stripped from the adjacent rail alignment with better growth medium potential these topsoils may be retained for use at the mine site.	Retain/ Reuse Topsoil

Aspect	Potential Impact	Management Measure	Objective
Erosion	Loss of Soil	An 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. Where access is required for temporary activities the disturbed areas will be selectively cleared or lightly ripped to cause a minimum of disturbance. Areas of identified dispersive soils should be more 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 in terms of slope and length and not prone to unacceptable rates of erosion. 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 down the constructed slopes. The aim of this is to prevent runoff from achieving flow rates or depth that initiate erosion. Contour ripping or graded banks can achieve erosion control whilst also allowing for revegetation seeding. Where it is required to drain water away from a slope to a waterway or dam these may be emplaced away from the contours at gradients typically of 0.5-1%. Soil compaction due to mining traffic reduces plant growth, minimises rainfall infiltration and increases potential for rainfall runoff and erosion. When handling these soils use lighter vehicles and/or larger wheel/track size. Sediment control dams will be used to collect sediment runoff. Materials for dams should be stable and where dispersive clays are present these may require amendment with lime, gypsum or bentonite clay to achieve a suitable material that will not form tunnel erosion features.	Minimise Erosion

Aspect	Potential Impact	Management Measure	Objective
Soil Salinity	The potential for saline soils in the mine area is low	Should areas of saline soils be intersected these may be buried in spoil piles or set aside for specific rehabilitation with salt tolerant plant species.	Minimise salinity
GQAL	Loss of GQAL	The land use in the mine area is generally Class D agricultural land suitable for grazing. All impacts are to be kept within the mine footprint and at the completion of the mining operations; the site will be rehabilitated to its current state.	Minimise loss of GQAL
Rail Alignment			
Topography	Erosion and unstable slopes	The final route for the rail line can follow ridges and spur lines or traverse the less steep mid to lower parts of hill slopes. Potential areas of elevated relief, steep slope angles and creek crossings with the potential for landslip or requiring extensive excavation and/or layback of batters will be assessed through detailed geotechnical investigations to optimise the proposed excavations and minimise exposure to potential landslip areas.	Minimise erosion and slope failure
Geology	Rock breaking/blasting construction methods required	Where bedrock outcrops are encountered in construction and heavy rock breaking or blasting is required for rock removal, the noise factors and vibration effects on adjacent infrastructure will be assessed and appropriate measures taken as required to address the level of noise/vibration generated.	Minimise construction costs
Fossils	See Mine section. Mitigation measures for fossils will include measures similar to those outlined above with contingency plans prepared to allow identification and management of significant fossil finds.		
Topsoil	See Mine Section.		

Aspect	Potential Impact	Management Measure	Objective
Erosion	Erosional impacts	Erosion control measures for the rail corridor are similar to those for mine areas. Mitigation measures will include: ▪ limiting the area of disturbed land; ▪ progressive clearing immediately prior to construction to minimise the duration of exposed soils; ▪ minimise earthworks during higher rainfall months; ▪ stripping top soils prior to construction and re-using topsoils in rehabilitation; ▪ use erosion control methods such as silt fences and sediment ponds to control short term erosion potential; ▪ divert overland flow around construction areas; and ▪ ensuring all the above methods are documented, monitored and maintained. Where local geology/soils have higher dust generation risk, further mitigation measures in addition to those above should include water truck spraying of exposed soils and PVA dust suppressants to minimise dust generation from stockpiles. In areas where culverts, channel diversions or table drains are proposed to control flows or runoff, scour protection will be used including rock armouring and vegetation growth to protect soils and minimise flow rates. All temporary construction and access tracks will be ripped, seeded and fertilised upon completion of construction.	Minimise erosion
Sodic Soils	Erosion and geotechnical Impacts	Where sodic and/or dispersive soils occur, use of the above control measures will assist in mitigation of erosional impacts. Strongly sodic or dispersive materials will not be used for rehabilitation purposes, where construction exposes such soils they will be treated with gypsum/dolomite amendments to reduce sodicity/dispersion in the soils with topsoil to minimise the impact of these soils. Reactive soils will be geotechnically assessed and appropriate bridging layers, inert materials or other methods used to address these areas. Where saline soils are encountered the amount of clearing will be minimised, or where already cleared and salts are present in the root zone this may be addressed by wetting the area to leach salts out of the root zone.	Minimise erosion and geotechnical issues

Aspect	Potential Impact	Management Measure	Objective
GQAL	Loss of GQAL	Potential impacts to agricultural land use will be mitigated, by minimising the project impact. This will include removal and rehabilitation of temporary access tracks with appropriate erosion control measures as described above.	Minimise loss of GQAL
Coal Terminal			
Topography	In areas of low topography subject to periodic inundation from tides or rainfall activities and traffic in these areas will cease during heavy rainfall or inundation. Erosion control measures similar to those outlined above will be implemented		
Soils	The mitigation measures described above will be applied to the rocks and soils of the coal terminal		
Fossils	While the potential for fossils is very low, the mitigation measures described above will be adopted should fossil finds be uncovered		
Topsoil	The mitigation measures described above will be applied to the topsoil at the coal terminal. Given the lower availability of topsoil in this area, imported topsoil maybe required for mitigation measures in this area		
Erosion	The mitigation measures described above will be applied to the works at the coal terminal. Where surface waters are intersected, mitigation measures will have a greater emphasis on vegetative buffers around surface waters to minimise erosion, grading of bank materials upslope from surface waters with silt-fence and/or rock armour and riparian vegetative protection. The use of geofabric lined containment areas where flows must be diverted around construction activities with controlled release of flows		
Soil Salinity	The mitigation measures described above will be applied to the sodic/saline soils at the coal terminal		
GQAL	The mitigation measures for agricultural land use described above will be applied to the agricultural land at the coal terminal. Due to the increased risk of erosion in the flood prone areas regular monitoring and maintenance of erosion control structures will be undertaken in this area.		

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9 Conclusion

The China First Project will occur over a large area of Central and Northern Queensland. As part of the EIS, an assessment of the terrain and a soil survey was undertaken for the mine, rail alignment and coal terminal to identify existing environmental values and potential engineering and/or environmental impacts.

Topography falls from a height of about 400m AHD at the mine to the coast through a number of ranges including the Leichhardt and Clarke Ranges before joining the coastal plain at about KP25. The topography rises sharply over the Clarke Range to height in excess of 1,000m although the highest the rail gets at this point is about 200m AHD.

A complex of soil units were identified across the project area, including areas of Tenosols, Chromosols, Kandosols, Vertosols and Sodosols and cracking clays. The soils present within the China First Project area are generally suitable for grazing. 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 the area, which is consistent with that of the adjoining land. Similarly, the rail alignment and coal terminal are also located on lands that have been used consistent to that of the mine (low intensity cattle grazing), while some areas have been converted to other activities.

The main potential impacts of the China First Project included 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 for portions of the rail alignment. Further, areas of geological shear zones, faulting and/or with dykes were identified that may impact upon rail construction. 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.

10 Recommendations

Based on our investigations we recommend the following be carried out:

- 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;
- Prepare and implement erosion control measures and continue to monitor and maintain the measures implemented;
- Erosion and Sediment Control Plans will be developed and put in place prior to the commencement of construction works for all areas of the China First 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 where bridge or culvert crossing are required to better identify erosion risk and put in place appropriate management measures; and
- 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. Particular attention should be made to areas near sites SS20 and SS30 as sampling at both of these sites displayed indications of containing salinity.

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Glossary

1.1 Abbreviations

Abbreviation	Meaning
µg	microgram
µg/m^3	micrograms per cubic metre
µm	micrometre
µS/cm	microsiemens per centimetre
AASS	actual acid sulfate soil
AHD	Australian Height Datum
ANC	Acid Neutralising Capacity
APSDA	Abbot Point State Development Area
AS	Australian Standard
ASC	Australian Soil Classification
ASRIS	Australian Soil Resource Information System
ASS	acid sulfate soil
BGL	below ground level
Ca	Calcium
CEC	Cation Exchange Capacity
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DERM	Department of Environment and Resource Management (Qld)
EC	Electrical Conductivity
EIS	environmental impact statement
EPA	former Environmental Protection Agency (Qld)
EPC	Exploration permit coal (as defined in the Land use and planning chapters)
ESP	Exchangeable Sodium Percentage
g	grams
GA	Geosciences Australia
GQAL	good quality agricultural land
GSG	great soil group
K	Potassium
kg	kilograms
m	metre
Mg	Magnesium

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Abbreviation	Meaning
m/day	metres per day
m^3/s	cubic metres per second
mbgl	metres below ground level
MDL	mineral development licence
mEq	Milli equivalence
mg	milligram
MGA	Map Grid Australia
MGA94	Map Grid of Australia 1994
ML	mining lease
mm	millimetre
NAF	Non-acid forming
NAG	Net Acid Generation
NAPP	Nett Acid Production Potential
SAR	sodium adsorption ratio
SPP	State planning policy
t	tonnes
ToR	terms of reference

1.1.1 Glossary of Terms

Abbreviation	Meaning
A horizon	The original top layer of mineral soil divided into A1 (typically from 5 to 30cm thick; generally referred to as topsoil with a high content of organic matter, dark colour and maximum biological activity) and A2 horizons (usually 5 – 70 cm thick; similar texture to A1 but paler in colour, poorer in structure and less fertile).
Acid sulfate soils	Naturally occurring soils, sediments or organic substrates (e.g. peat) that are formed under waterlogged conditions. These soils contain iron sulfide minerals (predominantly as the mineral pyrite) or their oxidation products. In an undisturbed state below the water table, acid sulphate soils are benign. However if the soils are drained, excavated or exposed to air by a lowering of the water table, the sulfides will react with oxygen to form sulfuric acid.
Aggregate (soil)	A unit of soil structure consisting of primary soil particles held together by cohesive forces or by secondary soil materials such as iron oxides, silica or organic matter.
Alkaline soil, alkalinity	Alkaline soils have laboratory measured pH values >8.5. Alkalinity may inhibit the growth of plants.
Alluvial	Pertaining to, contained in, or composed of, alluvium; relating to the deposits made by flowing water; washed away from one place and deposited in another; as alluvial soil, mud, accumulations, or deposits.
Alluvial terrace	Former floodplain which either no longer floods or rarely floods due to deepening or enlargement of the stream channel.

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Abbreviation	Meaning
Alluvium	Sediment deposited from the transport by channelled stream flow or over-bank stream flow.
Analyte	Substance or chemical constituent that is determined in an analytical procedure.
Anticline	A fold in which the older rocks occupy the core.
Apedal	In the moderately moist to moist state, none of the soil material occurs in the form of peds; it is massive or single-grained and when disturbed, separates into fragments or primary particles.
Artesian	A condition which applies to aquifers which are confined by layers of low permeability, and where the hydraulic head in the aquifer is higher than the overlying ground surface. Wells penetrating such aquifers may result in groundwater flowing at the surface without pumping.
Australian Soil Classification (ASC)	A multi-category scheme with classes defined on the basis of diagnostic horizons or materials and their arrangement in vertical sequence as seen in an exposed soil profile.
Available soil water	That part of the water in the soil that can be absorbed by plant roots that can be held between field capacity and the moisture content at which plant growth ceases.
Available water holding capacity	The ability to hold that part of the water in the soil that can be absorbed by plant roots. Available water is the difference between field capacity and permanent wilting point.
B horizon	The layer of soil below the A horizon, usually of finer texture (i.e., more clayey), denser and stronger in colour. Thickness ranges from 10 cm to 2 m thick and is divided into B1 and B2 horizons.
Bedrock	The solid rock that underlies unconsolidated surficial sediments.
Boundaries (soil)	The boundary between soil horizons defines the nature of the change from one horizon to that below. It is specified by two terms—one a measure of the width of the transition zone between the two horizons, the other a description of its shape.
C horizon	Layers below the B horizon which may be weathered, consolidated or unconsolidated parent material little affected by biological soil-forming processes.
Cainozoic	The period in geologic time between 65 million years ago and the present.
Catchment	The term used to describe the area which is drained by a river. It is sometimes called the river basin or watershed. The catchment is the most significant factor determining the amount or likelihood of flooding.
Channel	An eroded depression in the soil or bedrock surface within which alluvial deposits accumulate (i.e. gravel, sands, silt, clay).
Chromosol	ASC soil order classification—soils with a clear or abrupt textural B horizon where the major half of the B2 horizon is not strongly acid (i.e. >pH5.5) and non-sodic (can be sodic at depth).
Clastic	Rocks built up from fragments of pre-existing rocks generated by weathering and erosion and transported to a point of deposition.
Coal seam	A layer, vein, or deposit of coal.
Colluvium	Unconsolidated soil and rock material transported largely by gravity (i.e., mass movement: landslide, mudflow, creep or sheetflow), deposited on a lower slope and/or at the base of a slope. Does not have bedding structure such as alluvium and is has more variable grain size.
Conductivity	A measure of waters' ability to conduct electricity.
Consolidated rock	Tightly bound geologic formation composed of sandstone, limestone, granite, or other rock.
Contaminant	A substance that is present in an environmental medium in excess of natural baseline

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Abbreviation	Meaning
	concentration.
Cuesta	A ridge with a steep face on one side and a gentle slope on the other.
Dermosol	Other soils with B2 horizons that have structure more developed than weak throughout the major part of the horizon, generally non-sodic subsoil, generally gradational textured soils (gradual boundaries).
Devonian	Geological period 395 – 345 million years ago.
Duricrust	Hardened soil crust.
Effective porosity	The percentage of the total volume of a given mass of soil or rock that consists of interconnected void spaces.
Electrical conductivity	Measure of a material to conduct electricity. Electrical conductivity of water is a measure of the impurity (dissolved ions) in water - usually measured in siemens per unit length (e.g. millisiemens per centimetre).
Environmental impact statement (EIS)	The information document prepared by the proponent when undertaking an environmental impact assessment. It is prepared in accordance with terms of reference prepared or approved by government. EIS is the term used by the Environment Protection and Biodiversity Conservation Act 1999 and the Environmental Protection Act 1994, and it is defined in Part 4 of the State Development and Public Works Organisation Act 1971.
Environmental Management Plan	A document developed by proponents during a project's planning and design. An Environmental management plan (EMP) provides life-of-project control strategies in accordance with agreed performance criteria for specified acceptable levels of environmental harm. It may continue through the whole life of a project (e.g. preconstruction, construction, operation and decommissioning).
Erosion	The process by which material, such as rock or soil, is worn away or removed by wind or water.
Fault	A crack in the earth's crust resulting from the displacement of one side with respect to the other.
Fault Line	Line determined by the intersection of a geological fault and the earth's surface.
Ferrosol	Soils with B2 horizons in which the major part has a free iron oxide content greater than 5% Fe in the fine earth fraction (<2mm). Soils with a B2horizon in which at least 0.3m has vertic properties are excluded.
Floodplain	An area of land periodically inundated by floodwater.
Fluvial	Material deposited by moving water (i.e. rivers and streams).
Fluvial deposits	Particles of minerals or rocks which are transported and deposited by moving water (i.e. a river).
Fluvial geomorphology	The study of rivers and streams and the processes that shape them, including the transport of sediment, erosion of or deposition on the river bed.
Formation	A geologic unit of distinct rock types that is large enough in scale to be mappable over a region.
Fossiliferous	Fossil containing rock formations.
Gilgai	A small, ephemeral lake formed from a depression in the soil surface.
Good quality agricultural land	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. As defined in State Planning Policy 1/92: Development and the Conservation of Agricultural Land.
Grading	The process of levelling off to a smooth horizontal or sloping surface.

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Abbreviation	Meaning
Granite	A granular igneous rock composed chiefly of felspar (orthoclase) and quartz, usually with one or more other minerals, as mica, hornblende, etc.
Granodiorite	Plutonic rock consisting of potassium felspar, quartz, plagioclase, biotite and hornblende. Granodiorite is an intermediate between quartz, monzonite and quartz diorite.
Gravel	The amount (visual abundance estimate) of gravel-sized (>2mm) materials that occur on the surface and in the A1 horizon and include hard (when moist), coarse fragments and segregations of pedogenic origin.
Gravely	Over 60% of surface cover consists of gravel (2 - 60mm).
Group	A grouping of geological or hydrogeological formations.
Holocene	Present geological epoch which commenced 10,000 years ago.
Horizon	A layer within the soil profile with morphological characteristics and properties different from layers below and/or above it.
Hydrostratigraphic unit	Geological units that are not solely based on lithologic characteristics but also include characteristics related to water movement, occurrence and storage.
Impermeable layer	A layer of material (such as clay) in an aquifer through which water does not pass.
Indicators	Anything that is used to measure the condition of something of interest. Indicators are often used as variables in the modelling of changes in complex environmental systems.
Interfluve	A ridge or area of land dividing two river valleys.
Jurassic	Geological period 295 - 135 million years ago.
Kandosol	Other soils that are lacking a strong texture contrast and (i) have well-developed B2 horizons in which the major part is massive or has only a weak grade of structure, and (ii) have a maximum clay content in some part of the B2 horizon which exceeds 15%.
Kurosol	Soils with a clear or abrupt textural B horizon and in which the major part of the upper 0.2m of the B2 horizon (or the major part of the entire B2 horizon if less than 0.2m thick) is strongly acid (i.e. pH<5.5).
Lacustrine deposits	Sedimentary material laid down in a lake environment.
Lacustrine sediment	Sediment mass deposited from transport by waves and from sediment solution and suspension in still water in a closed depression on land.
Limestone	A sedimentary rock rich in calcium carbonate.
Landform	A natural feature of a land surface such as a mountain, plain or valley.
Landscape	Natural and manmade features of the urban, rural or natural environment, such as vegetation, topography and land use elements.
Lateritic	Red, residual soil containing large amounts of aluminium and ferric hydroxides, formed by the decomposition of many kinds of rocks.
Lateritised	The process of formation of a soil by leaching of silica and residual enrichment of aluminium and iron oxides.
Lithic	Formed of rock.
Lithology	The systematic description of sediment and rocks, in terms of composition, texture and internal structure.

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Abbreviation	Meaning
Lithosol	A shallow soil showing minimal profile development and dominated by the presence of weathering rock and rock fragments. Lacking horizons other than an A1 (one layer only).
Loam	A medium, textured soil of approximate composition 10 – 25 per cent clay, 25 - 50 per cent silt and <50 per cent sand.
Melonhole	Irregularly distributed large depressions within soil surface, usually greater than 3m in diameter.
Mesa	An elevated area of land with a flat top and sides that are usually steep cliffs.
Mesozoic	The middle of the three Phanerozoic eras; it lasted from 245 to 65 million years before present.
Metamorphic rock	A rock derived from pre-existing rocks by way of mineralogical, chemical, or structural changes. These changes come in response to marked changes in temperature, pressure, shearing stress, or the chemical environment.
Mottled horizon	A horizon in which mottle abundance is greater than 10 per cent (visual abundance estimate) and contrast between colours is distinct and prominent.
Mottling	The presence of more than one soil colour in the same soil horizon, not including different nodule or cutan colours.
Mound spring	Mound springs are geomorphic formations raised above the surrounding land surface formed by a deposit of minerals and sediment brought up from artesian aquifers or confining beds by water at certain natural discharge points in the Great Artesian Basin. Other spring systems not raised above the surrounding land surface also occur throughout the Basin.
Nutrients	Any substance that promotes growth with living organisms. The term is generally applied to nitrogen and phosphorus in wastewater, but is also applied to other essential and trace elements.
Overburden	Any loose material which overlies bedrock (often used as a synonym for Quaternary sediments and/or surficial deposits) or any barren material, consolidated or loose, that overlies an ore body.
Palaeocene	Period of geological time, 65 – 54.8 million years before present.
Palaeochannel	A buried stream channel.
Peat	Unconsolidated soil material consisting largely of undecomposed, or only slightly decomposed, organic matter.
Ped	An individual, natural soil aggregate.
Pedologically	Relating to the study of soils
Permeability	A measure of the ability of a medium to transmit a fluid (any fluid). Similar to hydraulic conductivity that describes the ability of a porous medium to transmit water specifically.
Permian	Period of geological time, 290 – 248 million years before present.
pH	The logarithm of the reciprocal of hydrogen-ion concentration in gram atoms per litre; provides a measure on a scale from 0 to 14 of the acidity or alkalinity of a solution (where 7 is neutral and greater than 7 is more basic and less than 7 is more acidic).
Pleistocene	First epoch of the Quaternary period, from two million years ago to 10,000 years ago.
Porosity	The ratio of the volume of void or air spaces in a rock or sediment to the total volume of the rock or sediment. The capacity of rock or soil to hold water varies with the material. For example, saturated small grain sand contains less water than coarse gravel.
Red earths	Massive, reddish sandy profiles with a gradual increase in clay content with depth over a diffuse to gradual boundary.

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Abbreviation	Meaning
Rock pavement	Areas of shallow skeletal soils formed on Cainozoic lateritic duricrusts and sometimes lithosols derived from quartzose sandstone, forming a mosaic of exposed gravelly soils and sclerophyllous shrubs.
Rudosol	Soils with negligible pedologic organisation. They are usually young soils in the sense that the soil forming factors have had little time to pedologically modify parent rocks or sediments. The component soils can vary widely in terms of texture and depth.
Sampling sites	Specific locations within the study area where data is collected.
Sandstone	A sedimentary rock composed of individual grains of sand cemented together.
Scarp	A line of cliffs produced by faulting or erosion.
Seismic	Pertaining to shock waves, natural or artificial, within the Earth.
Shale	A sedimentary rock formed by the deposition of successive layers of clay.
Shear stress	A condition in which the material on one side of a surface pushes another material on the other side of the surface with a force that is parallel to the surface.
Sheet erosion	The removal of the upper layers of soil by raindrop splash and/or runoff.
Silt	Mud or clay or small rocks deposited by a river or lake. Fine particles in the size range 0.02 - 0.002 mm.
Siltstone	Fine-grained sandstone of consolidated silt.
Sodic	Soil containing sodium
Sodosol	Soils with strong texture contrast between A horizons and sodic B horizons which are not strongly acid.
Soil profile	A vertical section of the soil through all its horizons and extending into the parent material.
Solum	The upper part of a soil profile above the parent material in which current processes of soil formation are active. This is where the living roots and other plant and animal life characteristics are exhibited.
Stratigraphy	The study of the sequence of layered geologic deposits based on their spatial positions, depositional sequence in time, and correlations across different localities.
Subcrop	Bedrock unit occurring at the bedrock surface but covered by surficial deposits.
Subsidence	The gradual settling or sudden sinking of the land surface owing to natural or anthropogenic influences of materials in the subsurface.
Subsoil	The layer of weathered material that underlies the surface soil.
Surficial deposits	Uncompacted sediments and soil lying on bedrock or occurring on or near the earth's surface.
Surficial sediments	Gravel, sand, silt, and clay particles that form the seabed.
Terms of Reference	As defined by Part 4 of the *State Development and Public Works Organisation Act 1971*.
Tertiary	A geological time unit from about 65 to 2 million years ago.
Texture	A measure of the behaviour of a small handful of soil when moistened and kneaded into a ball (bolus) and then pressed out between the thumb and forefinger.
Texture contrast soils	Soils with a very strong contrast between layers of different soil types.
Topography	A description of the surface features of a place or region.

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Abbreviation	Meaning
Topsoil	A part of the soil profile, typically the A1 horizon, containing material which is usually darker, more fertile and better structured than the underlying layers.
Triassic	Period of geological time, approximately 180 – 250 million years before present.
Vertosol	Clay soils with shrink-swell properties that exhibit strong cracking when dry and at depth have slickensides and/or lenticular structural aggregates. Although many soils exhibit gilgai microrelief, this feature is not used in their definition.
Well	An excavation or structure created in the ground by digging, driving, boring or drilling to access water in the subsurface.
Wetland	The land area alongside fresh and salt waters, that is flooded all or part of the time.

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Appendix A – Soil Observations

Curent Site	Alignment Section	Approximate KP						Soils			Sediment	Bank	Stream	Vegetation	Disturbance	Photo	Erosion Potential
			Undistrurb	Overall Vegetation	Bank_Shape	Bank Slope	Bed stability	Mapped	soil sample	Observed	Description	Description	Description			Observations	
1	PORT	NA	No - Very limited	Extreme	Concave	Flat		Sodosols		Estuarine mud Hydrosol	Estuarine mud	no bank	not a stream	swamp grass	none	level flat wetland flooded and with grass covering, minimal flow and no banks	low
2	RAIL	KP05	Yes	Very high	Stepped	Moderate	Moderate deposition	Sodosols		Sandy creek bank. Brown clayey bank. Loose and silty/sandy where cattle have disturbed	sandy	defined step banks and secondary silted up banks	defined stream	trees and grass	grazing evident	sandy creek bank, steep clayey banks. Evidence of erosion on banks and soil loose where grazing animals have accessed water.	high
3	RAIL	KP05	No - Present		Stepped	Low	Moderate deposition	Sodosol		sandy soils on bank	sandy	modrate slope banks are grasses with soe trees	defined stream	grass and tres	there is an existing bridge with extensive erosion control	soils on banks are sandy erosion evdent around tree roots,	high
4	PORT	NA	No - Very limited	Extreme	Concave	Flat		sodosol		wetland hydrosol	can't tell	low /level bank	slow moving wetland channel	swamp grassand samphire	none evident	coastal wetland in wet season - under grass with the fresh water	low
5	RAIL	KP05	No - Very limited	Extreme	Concave	Flat	Moderate deposition	sodosol		wetland hydrsol	mud	low /level bank	slow moving wetland channel	swamp grassand some trees	not realy - looks like a pig trap is set in the stream	low fow wetland stream more fresh than salt, banks and surrounds heavily vegetated with grass. Some trees on higher areas	low
6	RAIL	KP05	No - Very limited	Extreme	Concave	Flat	Moderate deposition	sodosol		hydrosol	silty sandy mud maybe	low /level bank	defined channel	very little some trees , some grass coverage, evidence of dieback.	some clearance maybe	lots of bare soil	high
7	RAIL	KP07	No - Present	High	Stepped	Low	Moderate deposition	sodosol		Clayey on bank sandy on bottom	sandy	moderate to steep	defined channel	trees and grass	none	little erosion observed, banks under trees and grass	low
8	RAIL	KP25	No - Abundant	Low	Concave	Low		chromosol		broad channel sandy banks	sandy	low and sandy	defined channel - shallow	trees on banks	none at location observed	banks of the stream are sandy under trees	high
9	RAIL	KP30	No - Abundant	Low	Concave	Moderate	Severe deposition	chromosol		sandy banks and rocky stream bed	sandyand rocky	low slope	defined channel - fresh flowing	banks are under trees	none at location observed	broad channel, trees n banks, snady soil on banks rocky bed in stream = high energy flow, sandy sub-banks	high
10	RAIL	KP40	Yes	Very Low	Concave	Low	Severe deposition	chromosol		can only see stream bed	sandy	low poorly defined	broad shallow channel	banks are under trees	none at location observed	broad shallow channel, poorly defined bank - seems like low flow stream or section of stream where flow slows	low
11	RAIL	KP45	No - Present	Moderate	Stepped	Moderate	Severe deposition	chromosol		can only see stream bed	sandy	steep bank under grass and trees	moderate-broad shallow channel	heavily vegetated with gras shrubs and trees	none at location observed	well defined stream channel heavily sedimented with sand with pebbles	low
12	RAIL	KP65	No - Abundant	Low	Stepped	Moderate	Moderate erosion	chromosol		brown clayey/silty looking on banks. Sandy and rock in bed	sand and rock	modrate slope	small well defined channel	top of banks under grass. Trees as well - open woodland density	none at location observed	slopingbanks with clayey soil grass covered and trees and low flow conditions	low
13	RAIL	KP70						sodosol	SS13	brown/gray clayed banks pink sand banks with soe grayish silt	sandy rocky and some silty	modrate slope	small defined channel	grass and trees	none at location observed	low flow at the time of samling but rocky stream ben in sectios indicating periodic high energy conditions bu minimal bank erosion	low
14	RAIL	KP77						Vertosols		brown soil - clayey	bed rock and rock pools	modrate to high slope	full stream, well defined	grass and trees	ag land clearing in surounds	solid stream and clayey banks under grass and trees	low
15	RAIL	KP85	No - Present	Moderate				Vertosols		Steep banks brown soil	sandy	stepped - steep at top slopngi down	very broad	trees and grass	none at location observed	broad shallow channel, heavily sedinmented areas forming sandy secondary banks , primary bank well defined and clayey. Apparently low energy flow	low
16	RAIL	KP90	No - Abundant		Undercut	Vertical		sodosol		stepped clayey banks and cliffed bank	sandy and stony	steep clyey to cliffed sedimentary soil	well defined - swiftly flowing	trees and grass on banks	none at location observed	moderate size chanel, moderate energy flow heavily vegetated banks	low
17	RAIL	KP100	No - Abundant	Low	Stepped	Moderate		sodosol		sandy and stony beds and banks	stony	sandy	defined ond lowly flowing	trees on banks moderate to high density	none at location observed	broad chanel sandy banks stony sandy sediment	high
18	RAIL	KP105						sodosol		silty sandy soil on banks	-	moderat e slope sandy sity soils o slope	well defined full stream	some trees sparsley grassed	none at location observed	sany/silty soil on banks , moderate flow	high
19	RAIL	KP140	No - Abundant	Low	Stepped	Steep		tenosol	SS24	clayey banks		moderate slope	wel defined full stream	heavilty vegetated with grass and trees		turbid water evidence of high en flow over baks but no erosion	low
20	RAIL	KP145	No - Present	Moderate	Stepped	Moderate	Bed stable	kandosol	SS25	clayey banks	silty/muddy	moderate slope	wel defined full stream	grass and moderately treed		turbid water moderate flow. Evidence of erosion on banks	high
21	RAIL	KP165	No - Very limited	Very high	Concave	Flat	Moderate deposition	tenosol		sandy banks under grass	silty sand and pebbly	low and slope	defined sream3/4 full	grass and tres		sandy banks moderate flow	high
22	RAIL	KP170	No - Very limited	High	Concave	Low	Moderate deposition	tenosol		poorly defined bank - rocky sandy under grass	sandy and rocky	low sloping shallow	shallow	grass and open woodland		shallow banks sloping under grass rocky soil (rocks seen throug grass consistent with tenosol) little flow	moderate/high

23	RAIL	KP175	No - Present	High	Stepped	Moderate	Moderate deposition	tenosol		sandy silty banks and bed rock banks	silty/sandy	sloping where sandy	deep full stream strong flow	grass and trees	road present with concreted entrance to causeway	concrete for road possibly to fix previous sedimant or just to allow access without bogging - erosion not paricukary evident given that there is a road here	moderate/high
24	RAIL	KP185	No - Present	Moderate	Stepped	Low	Moderate erosion	sodosol		silty/sandy banks under grass and trees	sandy /gravelly	low banks	defined steam half full	grass and trees		sandy bank under grass some evidence f erosion	high
25	RAIL	KP225	No - Present	Moderate	Concave	Flat		vertosols		brown clay		low banks	broad stream	grass and trees		braod channel /overland flow level baks under grass, low flow	low
26	RAIL	KP225						Vertosols		under grass		flood plain	un defined	grass and open wood land		flood plain underwater - low flow	low
27	RAIL	KP230	No - Present	Low	Concave	Flat	Bed stable	Vertosols		under grass		bank full	bank full	heavily vegetaed with gras and trees		steam is bank full - banks are heavilty vegetated	low
28	RAIL	KP235	No - Very limited	High	Concave	Flat	Bed stable	Vertosols		brown clay		bank full	bank full & flowing	heavily vegetaed with gras and trees		banks heavily vegetated water turbid (reddish)	low
29	RAIL	KP275	No - Present	Moderate	Concave	Low	Bed stable	Vertosols		light brown clay silty looking surface		sloping	full stream	heavily vegetaed with gras and trees	grazing evident	low flowing stream clayey banks with trees and grassed banks	low
30	RAIL	KP290	No - Present	Low	Stepped	Moderate	Moderate erosion	Vertosols		light brown clay silty looking surface		sloping	full stream	heavily vegetaed with gras and trees		low flowing stream clayey banks with trees and grassed banks	low
31	RAIL	KP295	No - Present	Moderate	Concave	Flat	Moderate erosion	Vertosols		light brown silty clayey soil		low		heavily vegetaed with gras and trees	grazing evident	banks under grass and trees, grass and tree sparse on side where cattle access stream	moderate
32	RAIL	KP305	No - Present	Moderate	Concave	Flat	Bed stable	kandosol		under grass and or water		indistinct	bank full	grass and trees		totally under water but vegetated with grass and trees that are holding	low
33	RAIL	KP320	No - Present	Moderate	Stepped	Moderate	Moderate erosion	kandosol		ligt brown clayey soil		sloping	ful stream	trees and grass	fence and stream crossing	banks stable clay under trees and grass	low
34	RAIL	KP325			Concave	Flat	Bed stable	kandosol		under grass	under water	bank full	full stream	heavily vegetated under trees and grass	none	banks stabel under trees and grass	low
35	RAIL	KP353	No - Present	Moderate	Undercut	Moderate	Moderate erosion	kandosol		silty clayey soil on banks	slty sandy	low slope	full stream	moderately treed and grassed in riparian zone	evidence of vehicle crossing	evidence of erosion on bank where it looks like vehicles have crossed	moderate -high
36	RAIL	KP370	No - Very limited	High	Concave	Moderate	Moderate erosion	Vertosols		brown silty clay	silty	mod-steep slope	full stream	moderately treed and grassed in riparian zone		some erosion on unvegetated area	moderate -high
37	RAIL	KP382	No - Present	Low	Stepped	Low	Moderate erosion	kandosol		brown clay		mod-steep slope		moderately treed and grassed in riparian zone		banks stabl under grass and tres	low
38	RAIL	KP400	No - Present	Low	Concave	Low	Moderate deposition	kandosol		brown clay	silty sandy mud maybe	mod-steep slope		moderately treed and grassed in riparian zone		banks stabl under grass and tres	low
39	RAIL	KP402	No - Very limited	High	Concave	Moderate	Moderate erosion	kandosol		light brown sandy silty	silty	mod-steep slope	billabong	trees		loose silty sol on banks and evidence of ersion of banks through tree roots	high
40	RAIL	KP412	No - Abundant	Low	Stepped	Steep		kandosol		light brown silty sandy		steep	defined stream - full	trees and grass		steep banks apparently held firm ith tres and grass	moderate
41	RAIL	KP415	No - Present	Moderate	Concave	Low	Moderate erosion	kandosol		brown clayey	silty	low slope	defined stream - full	trees and grass		trees and grass hlding banks, low flow	low
42	RAIL	KP415	No - Abundant	Moderate	Stepped	Moderate	Severe erosion	kandosol		brown silty clay	silty	mod-steep slpe	defined stream - full	trees and grass		evidence of erosion of stream banks	mod-high
43	RAIL	KP425	No - Present	Low	Stepped	Moderate		kandosol		brown silty clay	silty	mod-steep slpe	little stream	trees and grass		evidence of erosion of stream banks	mod-high
44	MINE	NA	No - Very limited	Very high	Stepped	Moderate	Bed stable	kandosol		brown silty clay	silty	low	defined stream - shallow	trees and grass		evidence of erosion of stream banks	mod-high
45	MINE	KP440	No - Present	Low				kandosol		under grass		low	poorly defined channel	heavily vegetated		low flow through vegetated stream area	low
46	MINE	KP440	No - Very limited	High	Concave	Low	Bed stable	kandosol		light brown silty sandy						evidence of erosion of stream banks	mod-high
47	MINE	KP440	No - Very limited	Low		Flat		kandosol				low	deep bank full	trees	land aroun cleared		low
48	MINE	NA	No - Very limited	High		Flat	Severe deposition	kandosol			fine sand	no bank				shallow stream no real bank sandy bottom	high
49	MINE	NA	No - Very limited	Very high	Concave	Low	Moderate erosion	kandosol		red sandy clay	clayey	looks like an ersion channel	looks like an ersion channel	open wood land	bit of a track	looks like it is an erosion channel	high
50	MINE	NA	No - Very limited	Moderate	Concave	Low	Moderate deposition	kandosol		brown clayey	sandy	low	broad channel half sanded up	trees - oprn woodland	cattle	banks are sandy /silty where cattle have disturbed	high
51	MINE	NA	No - Present	Moderate	Concave	Low	Moderate deposition	kandosol		light brown sandy clay		low	defined channel	open wood land		small channel low flow evidence of erosion on banks	high
52	MINE	NA	No - Very limited	Moderate	Concave	Low		kandosol		sandy soils on bank	sand	low	silted up - no flow	gras and trees	live stock	no erosion evident	low

Waratah Coal

Appendix B – Laboratory Certificates

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **EB0918624**	Page	: 1 of 17
Client	: **E3 CONSULT PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR ST.JOHN HERBERT	Contact	: Tim Kilmister
Address	: 30 QUALTROUGH STREET WOOLLOONGABBA QLD, AUSTRALIA 4102	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: sherbert@e3consult.com.au	E-mail	: Services.Brisbane@alsenviro.com
Telephone	: +61 07 3129 3237	Telephone	: +61-7-3243 7222
Facsimile	: +61 07 33038776	Facsimile	: +61-7-3243 7218
Project	: B09216	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 25-NOV-2009
Sampler	: St J H, ML	Issue Date	: 08-DEC-2009
Site	: ASPDA/Waratah-Rail Alignments		
		No. of samples received	: 59
Quote number	: EN/041/09	No. of samples analysed	: 30

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
- Surrogate Control Limits

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*
Kim McCabe	Senior Inorganic Chemist	Inorganics
Matt Frost	Organic Instrument Chemist	Inorganics
Matt Frost	Organic Instrument Chemist	Organics

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 date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for processing purposes. If the sampling time is displayed as 0:00 the information was not provided by client.

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: **LIQUID**				Client sample ID	Rinse Blank 01	Trip Blank 01	----	----	----
				Client sampling date / time	20-NOV-2009 15:00	20-NOV-2009 15:00	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*		**EB0918624-017**	**EB0918624-018**	**----**	**----**	**----**
EG020T: Total Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L		<0.001	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	----	----	----	----
Chromium	7440-47-3	0.001	mg/L		<0.001	----	----	----	----
Copper	7440-50-8	0.001	mg/L		<0.001	----	----	----	----
Lead	7439-92-1	0.001	mg/L		<0.001	----	----	----	----
Nickel	7440-02-0	0.001	mg/L		<0.001	----	----	----	----
Zinc	7440-66-6	0.005	mg/L		<0.005	----	----	----	----
EG035T: Total Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	----	----	----	----
EP068A: Organochlorine Pesticides (OC)									
alpha-BHC	319-84-6	0.5	µg/L		<0.5	<0.5	----	----	----
Hexachlorobenzene (HCB)	118-74-1	0.5	µg/L		<0.5	<0.5	----	----	----
beta-BHC	319-85-7	0.5	µg/L		<0.5	<0.5	----	----	----
gamma-BHC	58-89-9	0.5	µg/L		<0.5	<0.5	----	----	----
delta-BHC	319-86-8	0.5	µg/L		<0.5	<0.5	----	----	----
Heptachlor	76-44-8	0.5	µg/L		<0.5	<0.5	----	----	----
Aldrin	309-00-2	0.5	µg/L		<0.5	<0.5	----	----	----
Heptachlor epoxide	1024-57-3	0.5	µg/L		<0.5	<0.5	----	----	----
trans-Chlordane	5103-74-2	0.5	µg/L		<0.5	<0.5	----	----	----
alpha-Endosulfan	959-98-8	0.5	µg/L		<0.5	<0.5	----	----	----
cis-Chlordane	5103-71-9	0.5	µg/L		<0.5	<0.5	----	----	----
Dieldrin	60-57-1	0.5	µg/L		<0.5	<0.5	----	----	----
4.4`-DDE	72-55-9	0.5	µg/L		<0.5	<0.5	----	----	----
Endrin	72-20-8	0.5	µg/L		<0.5	<0.5	----	----	----
beta-Endosulfan	33213-65-9	0.5	µg/L		<0.5	<0.5	----	----	----
4.4`-DDD	72-54-8	0.5	µg/L		<0.5	<0.5	----	----	----
Endrin aldehyde	7421-93-4	0.5	µg/L		<0.5	<0.5	----	----	----
Endosulfan sulfate	1031-07-8	0.5	µg/L		<0.5	<0.5	----	----	----
4.4`-DDT	50-29-3	2	µg/L		<2	<2	----	----	----
Endrin ketone	53494-70-5	0.5	µg/L		<0.5	<0.5	----	----	----
Methoxychlor	72-43-5	2	µg/L		<2	<2	----	----	----
EP068B: Organophosphorus Pesticides (OP)									
Dichlorvos	62-73-7	0.5	µg/L		<0.5	<0.5	----	----	----
Demeton-S-methyl	919-86-8	0.5	µg/L		<0.5	<0.5	----	----	----
Monocrotophos	6923-22-4	2	µg/L		<2	<2	----	----	----
Dimethoate	60-51-5	0.5	µg/L		<0.5	<0.5	----	----	----
Diazinon	333-41-5	0.5	µg/L		<0.5	<0.5	----	----	----
Chlorpyrifos-methyl	5598-13-0	0.5	µg/L		<0.5	<0.5	----	----	----

Analytical Results

Sub-Matrix: **LIQUID**			Client sample ID	**Rinse Blank 01**	**Trip Blank 01**	----	----	----
			Client sampling date / time	20-NOV-2009 15:00	20-NOV-2009 15:00	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EB0918624-017**	**EB0918624-018**	**----**	**----**	**----**
EP068B: Organophosphorus Pesticides (OP) - Continued								
Parathion-methyl	298-00-0	2	µg/L	<2	<2	----	----	----
Malathion	121-75-5	0.5	µg/L	<0.5	<0.5	----	----	----
Fenthion	55-38-9	0.5	µg/L	<0.5	<0.5	----	----	----
Chlorpyrifos	2921-88-2	0.5	µg/L	<0.5	<0.5	----	----	----
Parathion	56-38-2	2	µg/L	<2	<2	----	----	----
Pirimphos-ethyl	23505-41-1	0.5	µg/L	<0.5	<0.5	----	----	----
Chlorfenvinphos	470-90-6	0.5	µg/L	<0.5	<0.5	----	----	----
Bromophos-ethyl	4824-78-6	0.5	µg/L	<0.5	<0.5	----	----	----
Fenamiphos	22224-92-6	0.5	µg/L	<0.5	<0.5	----	----	----
Prothiofos	34643-46-4	0.5	µg/L	<0.5	<0.5	----	----	----
Ethion	563-12-2	0.5	µg/L	<0.5	<0.5	----	----	----
Carbophenothion	786-19-6	0.5	µg/L	<0.5	<0.5	----	----	----
Azinphos Methyl	----	0.5	µg/L	<0.5	<0.5	----	----	----
EP071/080: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	20	µg/L	<20	<20	----	----	----
C10 - C14 Fraction	----	50	µg/L	<50	<50	----	----	----
C15 - C28 Fraction	----	100	µg/L	<100	<100	----	----	----
C29 - C36 Fraction	----	50	µg/L	<50	<50	----	----	----
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons								
Naphthalene	91-20-3	1.0	µg/L	<1.0	<1.0	----	----	----
Acenaphthylene	208-96-8	1.0	µg/L	<1.0	<1.0	----	----	----
Acenaphthene	83-32-9	1.0	µg/L	<1.0	<1.0	----	----	----
Fluorene	86-73-7	1.0	µg/L	<1.0	<1.0	----	----	----
Phenanthrene	85-01-8	1.0	µg/L	<1.0	<1.0	----	----	----
Anthracene	120-12-7	1.0	µg/L	<1.0	<1.0	----	----	----
Fluoranthene	206-44-0	1.0	µg/L	<1.0	<1.0	----	----	----
Pyrene	129-00-0	1.0	µg/L	<1.0	<1.0	----	----	----
Benz(a)anthracene	56-55-3	1.0	µg/L	<1.0	<1.0	----	----	----
Chrysene	218-01-9	1.0	µg/L	<1.0	<1.0	----	----	----
Benzo(b)fluoranthene	205-99-2	1.0	µg/L	<1.0	<1.0	----	----	----
Benzo(k)fluoranthene	207-08-9	1.0	µg/L	<1.0	<1.0	----	----	----
Benzo(a)pyrene	50-32-8	0.5	µg/L	<0.5	<0.5	----	----	----
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L	<1.0	<1.0	----	----	----
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L	<1.0	<1.0	----	----	----
Benzo(g.h.i)perylene	191-24-2	1.0	µg/L	<1.0	<1.0	----	----	----
EP080/071: Total Petroleum Hydrocarbons								
^ C10 - C36 Fraction (sum)	----	50	µg/L	<50	<50	----	----	----
EP068S: Organochlorine Pesticide Surrogate								

Analytical Results

Sub-Matrix: **LIQUID**				Client sample ID	Rinse Blank 01	Trip Blank 01	----	----	----
				Client sampling date / time	20-NOV-2009 15:00	20-NOV-2009 15:00	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*		**EB0918624-017**	**EB0918624-018**	**----**	**----**	**----**
EP068S: Organochlorine Pesticide Surrogate - Continued									
Dibromo-DDE	21655-73-2	0.1	%		**90.8**	**89.8**	----	----	----
EP068T: Organophosphorus Pesticide Surrogate									
DEF	78-48-8	0.1	%		**93.7**	**92.1**	----	----	----
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	0.1	%		**27.9**	**26.6**	----	----	----
2-Chlorophenol-D4	93951-73-6	0.1	%		**71.4**	**71.5**	----	----	----
2.4.6-Tribromophenol	118-79-6	0.1	%		**93.8**	**88.8**	----	----	----
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	0.1	%		**85.5**	**84.8**	----	----	----
Anthracene-d10	1719-06-8	0.1	%		**89.9**	**84.4**	----	----	----
4-Terphenyl-d14	1718-51-0	0.1	%		**101**	**90.5**	----	----	----
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	0.1	%		**98.3**	**101**	----	----	----
Toluene-D8	2037-26-5	0.1	%		**94.4**	**94.8**	----	----	----
4-Bromofluorobenzene	460-00-4	0.1	%		**88.9**	**91.3**	----	----	----

Analytical Results

Sub-Matrix: SOIL			Client sample ID	KP1_1_SS01-0.0-0.3	KP5_1_SS02-0.0-0.3	KP15_1_SS03-0.0-0.3	Nui_1_0.0-0.3	Nui_2_0.0-0.3
			Client sampling date / time	16-NOV-2009 15:00	16-NOV-2009 15:00	16-NOV-2009 15:00	16-NOV-2009 15:00	16-NOV-2009 15:00
Compound	CAS Number	LOR	Unit	EB0918624-001	EB0918624-002	EB0918624-005	EB0918624-007	EB0918624-008
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	5.9	8.6	8.2	7.8	6.9
EA006: Sodium Absorption Ratio (SAR)								
^ Sodium Absorption Ratio	----	0.01	-	6.80	1.88	93.1	3.75	20.5
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	30	166	712	115	166
EA055: Moisture Content								
^ Moisture Content (dried @ 103°C)	----	1.0	%	1.8	11.4	4.2	5.6	3.9
ED007: Exchangeable Cations								
^ Exchangeable Calcium	----	0.1	meq/100g	0.9	37.0	2.6	16.2	4.0
^ Exchangeable Magnesium	----	0.1	meq/100g	0.5	14.6	3.2	18.0	4.3
^ Exchangeable Potassium	----	0.1	meq/100g	0.3	0.2	0.2	0.5	0.3
^ Exchangeable Sodium	----	0.1	meq/100g	0.3	0.6	3.5	1.9	1.9
^ Cation Exchange Capacity	----	0.1	meq/100g	1.9	52.4	9.6	36.6	10.5
^ Exchangeable Sodium Percent	----	0.1	%	14.3	1.1	37.2	5.1	18.3
^ Calcium/Magnesium Ratio	----	0.1	.	1.6	2.5	0.8	0.9	0.9
ED045: Chloride								
Chloride	16887-00-6	10	mg/kg	150	100	1050	180	400

Analytical Results

Sub-Matrix: SOIL			Client sample ID	Nui_1A_0.0-0.3	ASPDA-C1-0.3	ASPDA-C2-0.6	ASPDA-C3-0.3	ASPDA-C4-0.6
			Client sampling date / time	16-NOV-2009 15:00	16-NOV-2009 15:00	16-NOV-2009 15:00	16-NOV-2009 15:00	16-NOV-2009 15:00
Compound	CAS Number	LOR	Unit	EB0918624-010	EB0918624-011	EB0918624-012	EB0918624-013	EB0918624-014
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	6.7	----	----	----	----
EA006: Sodium Absorption Ratio (SAR)								
^ Sodium Absorption Ratio	----	0.01	-	4.46	----	----	----	----
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	113	----	----	----	----
EA055: Moisture Content								
^ Moisture Content (dried @ 103°C)	----	1.0	%	2.6	3.8	4.3	2.4	3.5
ED007: Exchangeable Cations								
^ Exchangeable Calcium	----	0.1	meq/100g	7.2	----	----	----	----
^ Exchangeable Magnesium	----	0.1	meq/100g	4.1	----	----	----	----
^ Exchangeable Potassium	----	0.1	meq/100g	0.5	----	----	----	----
^ Exchangeable Sodium	----	0.1	meq/100g	0.7	----	----	----	----
^ Cation Exchange Capacity	----	0.1	meq/100g	12.5	----	----	----	----
^ Exchangeable Sodium Percent	----	0.1	%	5.5	----	----	----	----
^ Calcium/Magnesium Ratio	----	0.1	.	1.8	----	----	----	----
ED045: Chloride								
Chloride	16887-00-6	10	mg/kg	280	----	----	----	----
EG005T: Total Metals by ICP-AES								
Arsenic	7440-38-2	5	mg/kg	----	11	6	<5	<5
Cadmium	7440-43-9	1	mg/kg	----	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg	----	61	70	32	55
Copper	7440-50-8	5	mg/kg	----	26	23	12	12
Lead	7439-92-1	5	mg/kg	----	10	7	6	<5
Nickel	7440-02-0	2	mg/kg	----	22	27	8	18
Zinc	7440-66-6	5	mg/kg	----	63	36	51	24
EG035T: Total Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	----	<0.1	<0.1	<0.1	<0.1
EP068A: Organochlorine Pesticides (OC)								
alpha-BHC	319-84-6	0.05	mg/kg	----	<0.05	<0.05	<0.05	<0.05
Hexachlorobenzene (HCB)	118-74-1	0.05	mg/kg	----	<0.05	<0.05	<0.05	<0.05
beta-BHC	319-85-7	0.05	mg/kg	----	<0.05	<0.05	<0.05	<0.05
gamma-BHC	58-89-9	0.05	mg/kg	----	<0.05	<0.05	<0.05	<0.05
delta-BHC	319-86-8	0.05	mg/kg	----	<0.05	<0.05	<0.05	<0.05
Heptachlor	76-44-8	0.05	mg/kg	----	<0.05	<0.05	<0.05	<0.05
Aldrin	309-00-2	0.05	mg/kg	----	<0.05	<0.05	<0.05	<0.05
Heptachlor epoxide	1024-57-3	0.05	mg/kg	----	<0.05	<0.05	<0.05	<0.05
trans-Chlordane	5103-74-2	0.05	mg/kg	----	<0.05	<0.05	<0.05	<0.05

Analytical Results

Sub-Matrix: SOIL				Client sample ID	Nui_1A_0.0-0.3	ASPDA-C1-0.3	ASPDA-C2-0.6	ASPDA-C3-0.3	ASPDA-C4-0.6
				Client sampling date / time	16-NOV-2009 15:00	16-NOV-2009 15:00	16-NOV-2009 15:00	16-NOV-2009 15:00	16-NOV-2009 15:00
Compound	CAS Number	LOR	Unit		EB0918624-010	EB0918624-011	EB0918624-012	EB0918624-013	EB0918624-014
EP068A: Organochlorine Pesticides (OC) - Continued									
alpha-Endosulfan	959-98-8	0.05	mg/kg		----	<0.05	<0.05	<0.05	<0.05
cis-Chlordane	5103-71-9	0.05	mg/kg		----	<0.05	<0.05	<0.05	<0.05
Dieldrin	60-57-1	0.05	mg/kg		----	<0.05	<0.05	<0.05	<0.05
4.4`-DDE	72-55-9	0.05	mg/kg		----	<0.05	<0.05	<0.05	<0.05
Endrin	72-20-8	0.05	mg/kg		----	<0.05	<0.05	<0.05	<0.05
beta-Endosulfan	33213-65-9	0.05	mg/kg		----	<0.05	<0.05	<0.05	<0.05
4.4`-DDD	72-54-8	0.05	mg/kg		----	<0.05	<0.05	<0.05	<0.05
Endrin aldehyde	7421-93-4	0.05	mg/kg		----	<0.05	<0.05	<0.05	<0.05
Endosulfan sulfate	1031-07-8	0.05	mg/kg		----	<0.05	<0.05	<0.05	<0.05
4.4`-DDT	50-29-3	0.2	mg/kg		----	<0.2	<0.2	<0.2	<0.2
Endrin ketone	53494-70-5	0.05	mg/kg		----	<0.05	<0.05	<0.05	<0.05
Methoxychlor	72-43-5	0.2	mg/kg		----	<0.2	<0.2	<0.2	<0.2
EP068B: Organophosphorus Pesticides (OP)									
Dichlorvos	62-73-7	0.05	mg/kg		----	<0.05	<0.05	<0.05	<0.05
Demeton-S-methyl	919-86-8	0.05	mg/kg		----	<0.05	<0.05	<0.05	<0.05
Monocrotophos	6923-22-4	0.2	mg/kg		----	<0.2	<0.2	<0.2	<0.2
Dimethoate	60-51-5	0.05	mg/kg		----	<0.05	<0.05	<0.05	<0.05
Diazinon	333-41-5	0.05	mg/kg		----	<0.05	<0.05	<0.05	<0.05
Chlorpyrifos-methyl	5598-13-0	0.05	mg/kg		----	<0.05	<0.05	<0.05	<0.05
Parathion-methyl	298-00-0	0.2	mg/kg		----	<0.2	<0.2	<0.2	<0.2
Malathion	121-75-5	0.05	mg/kg		----	<0.05	<0.05	<0.05	<0.05
Fenthion	55-38-9	0.05	mg/kg		----	<0.05	<0.05	<0.05	<0.05
Chlorpyrifos	2921-88-2	0.05	mg/kg		----	<0.05	<0.05	<0.05	<0.05
Parathion	56-38-2	0.2	mg/kg		----	<0.2	<0.2	<0.2	<0.2
Pirimphos-ethyl	23505-41-1	0.05	mg/kg		----	<0.05	<0.05	<0.05	<0.05
Chlorfenvinphos	470-90-6	0.05	mg/kg		----	<0.05	<0.05	<0.05	<0.05
Bromophos-ethyl	4824-78-6	0.05	mg/kg		----	<0.05	<0.05	<0.05	<0.05
Fenamiphos	22224-92-6	0.05	mg/kg		----	<0.05	<0.05	<0.05	<0.05
Prothiofos	34643-46-4	0.05	mg/kg		----	<0.05	<0.05	<0.05	<0.05
Ethion	563-12-2	0.05	mg/kg		----	<0.05	<0.05	<0.05	<0.05
Carbophenothion	786-19-6	0.05	mg/kg		----	<0.05	<0.05	<0.05	<0.05
Azinphos Methyl	----	0.05	mg/kg		----	<0.05	<0.05	<0.05	<0.05
EP071/080: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	10	mg/kg		----	<10	<10	<10	<10
C10 - C14 Fraction	----	50	mg/kg		----	<50	<50	<50	<50
C15 - C28 Fraction	----	100	mg/kg		----	<100	<100	<100	<100
C29 - C36 Fraction	----	100	mg/kg		----	<100	<100	<100	<100
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons									

Analytical Results

Sub-Matrix: SOIL				Client sample ID	Nui_1A_0.0-0.3	ASPDA-C1-0.3	ASPDA-C2-0.6	ASPDA-C3-0.3	ASPDA-C4-0.6
				Client sampling date / time	16-NOV-2009 15:00	16-NOV-2009 15:00	16-NOV-2009 15:00	16-NOV-2009 15:00	16-NOV-2009 15:00
Compound	CAS Number	LOR	Unit		EB0918624-010	EB0918624-011	EB0918624-012	EB0918624-013	EB0918624-014
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons - Continued									
Naphthalene	91-20-3	0.5	mg/kg		----	<0.5	<0.5	<0.5	<0.5
Acenaphthylene	208-96-8	0.5	mg/kg		----	<0.5	<0.5	<0.5	<0.5
Acenaphthene	83-32-9	0.5	mg/kg		----	<0.5	<0.5	<0.5	<0.5
Fluorene	86-73-7	0.5	mg/kg		----	<0.5	<0.5	<0.5	<0.5
Phenanthrene	85-01-8	0.5	mg/kg		----	<0.5	<0.5	<0.5	<0.5
Anthracene	120-12-7	0.5	mg/kg		----	<0.5	<0.5	<0.5	<0.5
Fluoranthene	206-44-0	0.5	mg/kg		----	<0.5	<0.5	<0.5	<0.5
Pyrene	129-00-0	0.5	mg/kg		----	<0.5	<0.5	<0.5	<0.5
Benz(a)anthracene	56-55-3	0.5	mg/kg		----	<0.5	<0.5	<0.5	<0.5
Chrysene	218-01-9	0.5	mg/kg		----	<0.5	<0.5	<0.5	<0.5
Benzo(b)fluoranthene	205-99-2	0.5	mg/kg		----	<0.5	<0.5	<0.5	<0.5
Benzo(k)fluoranthene	207-08-9	0.5	mg/kg		----	<0.5	<0.5	<0.5	<0.5
Benzo(a)pyrene	50-32-8	0.5	mg/kg		----	<0.5	<0.5	<0.5	<0.5
Indeno(1.2.3.cd)pyrene	193-39-5	0.5	mg/kg		----	<0.5	<0.5	<0.5	<0.5
Dibenz(a.h)anthracene	53-70-3	0.5	mg/kg		----	<0.5	<0.5	<0.5	<0.5
Benzo(g.h.i)perylene	191-24-2	0.5	mg/kg		----	<0.5	<0.5	<0.5	<0.5
EP080/071: Total Petroleum Hydrocarbons									
^ C10 - C36 Fraction (sum)	----	50	mg/kg		----	<50	<50	<50	<50
EP068S: Organochlorine Pesticide Surrogate									
Dibromo-DDE	21655-73-2	0.1	%		----	71.9	74.7	70.5	75.8
EP068T: Organophosphorus Pesticide Surrogate									
DEF	78-48-8	0.1	%		----	79.9	80.5	78.7	79.8
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	0.1	%		----	95.2	96.3	88.6	97.7
2-Chlorophenol-D4	93951-73-6	0.1	%		----	96.4	108	100	95.3
2.4.6-Tribromophenol	118-79-6	0.1	%		----	126	102	98.2	86.1
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	0.1	%		----	96.1	91.3	87.1	90.4
Anthracene-d10	1719-06-8	0.1	%		----	83.5	86.0	104	82.4
4-Terphenyl-d14	1718-51-0	0.1	%		----	102	105	87.4	107
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	0.1	%		----	102	103	103	98.7
Toluene-D8	2037-26-5	0.1	%		----	115	107	110	107
4-Bromofluorobenzene	460-00-4	0.1	%		----	117	107	110	109

Analytical Results

Sub-Matrix: SOIL			Client sample ID	QAQC-01-16/11/09	C5-0.3	Trip Spike 7	KP108_1_SS14-0.0-0.3	KP105_2b_SS13-0.0-0.3
			Client sampling date / time	16-NOV-2009 15:00	17-NOV-2009 15:00	20-NOV-2009 15:00	17-NOV-2009 15:00	17-NOV-2009 15:00
Compound	CAS Number	LOR	Unit	EB0918624-015	EB0918624-016	EB0918624-019	EB0918624-020	EB0918624-023
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	----	----	----	7.8	6.9
EA006: Sodium Absorption Ratio (SAR)								
^ Sodium Absorption Ratio	----	0.01	-	----	----	----	6.08	0.27
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	----	----	----	48	37
EA055: Moisture Content								
^ Moisture Content (dried @ 103°C)	----	1.0	%	4.3	3.5	----	5.4	6.8
ED007: Exchangeable Cations								
^ Exchangeable Calcium	----	0.1	meq/100g	----	----	----	5.6	6.8
^ Exchangeable Magnesium	----	0.1	meq/100g	----	----	----	3.7	2.9
^ Exchangeable Potassium	----	0.1	meq/100g	----	----	----	0.6	0.8
^ Exchangeable Sodium	----	0.1	meq/100g	----	----	----	0.9	0.4
^ Cation Exchange Capacity	----	0.1	meq/100g	----	----	----	10.8	10.8
^ Exchangeable Sodium Percent	----	0.1	%	----	----	----	8.1	3.2
^ Calcium/Magnesium Ratio	----	0.1	.	----	----	----	1.5	2.3
ED045: Chloride								
Chloride	16887-00-6	10	mg/kg	----	----	----	150	200
EG005T: Total Metals by ICP-AES								
Arsenic	7440-38-2	5	mg/kg	9	<5	----	----	----
Cadmium	7440-43-9	1	mg/kg	<1	<1	----	----	----
Chromium	7440-47-3	2	mg/kg	69	11	----	----	----
Copper	7440-50-8	5	mg/kg	24	<5	----	----	----
Lead	7439-92-1	5	mg/kg	9	<5	----	----	----
Nickel	7440-02-0	2	mg/kg	25	3	----	----	----
Zinc	7440-66-6	5	mg/kg	52	10	----	----	----
EG035T: Total Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	----	----	----
EP068A: Organochlorine Pesticides (OC)								
alpha-BHC	319-84-6	0.05	mg/kg	<0.05	<0.05	----	----	----
Hexachlorobenzene (HCB)	118-74-1	0.05	mg/kg	<0.05	<0.05	----	----	----
beta-BHC	319-85-7	0.05	mg/kg	<0.05	<0.05	----	----	----
gamma-BHC	58-89-9	0.05	mg/kg	<0.05	<0.05	----	----	----
delta-BHC	319-86-8	0.05	mg/kg	<0.05	<0.05	----	----	----
Heptachlor	76-44-8	0.05	mg/kg	<0.05	<0.05	----	----	----
Aldrin	309-00-2	0.05	mg/kg	<0.05	<0.05	----	----	----
Heptachlor epoxide	1024-57-3	0.05	mg/kg	<0.05	<0.05	----	----	----

Analytical Results

Sub-Matrix: SOIL				Client sample ID	QAQC-01-16/11/09	C5-0.3	Trip Spike 7	KP108_1_SS14-0.0-0.3	KP105_2b_SS13-0.0-0.3
				Client sampling date / time	16-NOV-2009 15:00	17-NOV-2009 15:00	20-NOV-2009 15:00	17-NOV-2009 15:00	17-NOV-2009 15:00
Compound	CAS Number	LOR	Unit		EB0918624-015	EB0918624-016	EB0918624-019	EB0918624-020	EB0918624-023
EP068A: Organochlorine Pesticides (OC) - Continued									
trans-Chlordane	5103-74-2	0.05	mg/kg		<0.05	<0.05	----	----	----
alpha-Endosulfan	959-98-8	0.05	mg/kg		<0.05	<0.05	----	----	----
cis-Chlordane	5103-71-9	0.05	mg/kg		<0.05	<0.05	----	----	----
Dieldrin	60-57-1	0.05	mg/kg		<0.05	<0.05	----	----	----
4.4`-DDE	72-55-9	0.05	mg/kg		<0.05	<0.05	----	----	----
Endrin	72-20-8	0.05	mg/kg		<0.05	<0.05	----	----	----
beta-Endosulfan	33213-65-9	0.05	mg/kg		<0.05	<0.05	----	----	----
4.4`-DDD	72-54-8	0.05	mg/kg		<0.05	<0.05	----	----	----
Endrin aldehyde	7421-93-4	0.05	mg/kg		<0.05	<0.05	----	----	----
Endosulfan sulfate	1031-07-8	0.05	mg/kg		<0.05	<0.05	----	----	----
4.4`-DDT	50-29-3	0.2	mg/kg		<0.2	<0.2	----	----	----
Endrin ketone	53494-70-5	0.05	mg/kg		<0.05	<0.05	----	----	----
Methoxychlor	72-43-5	0.2	mg/kg		<0.2	<0.2	----	----	----
EP068B: Organophosphorus Pesticides (OP)									
Dichlorvos	62-73-7	0.05	mg/kg		<0.05	<0.05	----	----	----
Demeton-S-methyl	919-86-8	0.05	mg/kg		<0.05	<0.05	----	----	----
Monocrotophos	6923-22-4	0.2	mg/kg		<0.2	<0.2	----	----	----
Dimethoate	60-51-5	0.05	mg/kg		<0.05	<0.05	----	----	----
Diazinon	333-41-5	0.05	mg/kg		<0.05	<0.05	----	----	----
Chlorpyrifos-methyl	5598-13-0	0.05	mg/kg		<0.05	<0.05	----	----	----
Parathion-methyl	298-00-0	0.2	mg/kg		<0.2	<0.2	----	----	----
Malathion	121-75-5	0.05	mg/kg		<0.05	<0.05	----	----	----
Fenthion	55-38-9	0.05	mg/kg		<0.05	<0.05	----	----	----
Chlorpyrifos	2921-88-2	0.05	mg/kg		<0.05	<0.05	----	----	----
Parathion	56-38-2	0.2	mg/kg		<0.2	<0.2	----	----	----
Pirimphos-ethyl	23505-41-1	0.05	mg/kg		<0.05	<0.05	----	----	----
Chlorfenvinphos	470-90-6	0.05	mg/kg		<0.05	<0.05	----	----	----
Bromophos-ethyl	4824-78-6	0.05	mg/kg		<0.05	<0.05	----	----	----
Fenamiphos	22224-92-6	0.05	mg/kg		<0.05	<0.05	----	----	----
Prothiofos	34643-46-4	0.05	mg/kg		<0.05	<0.05	----	----	----
Ethion	563-12-2	0.05	mg/kg		<0.05	<0.05	----	----	----
Carbophenothion	786-19-6	0.05	mg/kg		<0.05	<0.05	----	----	----
Azinphos Methyl	----	0.05	mg/kg		<0.05	<0.05	----	----	----
EP071/080: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	10	mg/kg		<10	<10	**26**	----	----
C10 - C14 Fraction	----	50	mg/kg		<50	<50	----	----	----
C15 - C28 Fraction	----	100	mg/kg		<100	<100	----	----	----

Analytical Results

Sub-Matrix: SOIL				Client sample ID	QAQC-01-16/11/09	C5-0.3	Trip Spike 7	KP108_1_SS14-0.0-0.3	KP105_2b_SS13-0.0-0.3
				Client sampling date / time	16-NOV-2009 15:00	17-NOV-2009 15:00	20-NOV-2009 15:00	17-NOV-2009 15:00	17-NOV-2009 15:00
Compound	CAS Number	LOR	Unit		EB0918624-015	EB0918624-016	EB0918624-019	EB0918624-020	EB0918624-023
EP071/080: Total Petroleum Hydrocarbons - Continued									
C29 - C36 Fraction	----	100	mg/kg		<100	<100	----	----	----
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	0.5	mg/kg		<0.5	<0.5	----	----	----
Acenaphthylene	208-96-8	0.5	mg/kg		<0.5	<0.5	----	----	----
Acenaphthene	83-32-9	0.5	mg/kg		<0.5	<0.5	----	----	----
Fluorene	86-73-7	0.5	mg/kg		<0.5	<0.5	----	----	----
Phenanthrene	85-01-8	0.5	mg/kg		0.5	<0.5	----	----	----
Anthracene	120-12-7	0.5	mg/kg		<0.5	<0.5	----	----	----
Fluoranthene	206-44-0	0.5	mg/kg		<0.5	<0.5	----	----	----
Pyrene	129-00-0	0.5	mg/kg		<0.5	<0.5	----	----	----
Benz(a)anthracene	56-55-3	0.5	mg/kg		<0.5	<0.5	----	----	----
Chrysene	218-01-9	0.5	mg/kg		<0.5	<0.5	----	----	----
Benzo(b)fluoranthene	205-99-2	0.5	mg/kg		<0.5	<0.5	----	----	----
Benzo(k)fluoranthene	207-08-9	0.5	mg/kg		<0.5	<0.5	----	----	----
Benzo(a)pyrene	50-32-8	0.5	mg/kg		<0.5	<0.5	----	----	----
Indeno(1.2.3.cd)pyrene	193-39-5	0.5	mg/kg		<0.5	<0.5	----	----	----
Dibenz(a.h)anthracene	53-70-3	0.5	mg/kg		<0.5	<0.5	----	----	----
Benzo(g.h.i)perylene	191-24-2	0.5	mg/kg		<0.5	<0.5	----	----	----
EP080/071: Total Petroleum Hydrocarbons									
^ C10 - C36 Fraction (sum)	----	50	mg/kg		<50	<50	----	----	----
EP080: BTEX									
Benzene	71-43-2	0.2	mg/kg		----	----	0.2	----	----
Toluene	108-88-3	0.5	mg/kg		----	----	5.3	----	----
Ethylbenzene	100-41-4	0.5	mg/kg		----	----	1.1	----	----
meta- & para-Xylene	108-38-3 106-42-3	0.5	mg/kg		----	----	5.4	----	----
ortho-Xylene	95-47-6	0.5	mg/kg		----	----	1.8	----	----
EP068S: Organochlorine Pesticide Surrogate									
Dibromo-DDE	21655-73-2	0.1	%		75.4	76.2	----	----	----
EP068T: Organophosphorus Pesticide Surrogate									
DEF	78-48-8	0.1	%		79.3	52.7	----	----	----
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	0.1	%		105	99.6	----	----	----
2-Chlorophenol-D4	93951-73-6	0.1	%		100	108	----	----	----
2.4.6-Tribromophenol	118-79-6	0.1	%		110	91.6	----	----	----
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	0.1	%		94.8	87.0	----	----	----

Analytical Results

Sub-Matrix: SOIL				Client sample ID	QAQC-01-16/11/09	C5-0.3	Trip Spike 7	KP108_1_SS14-0.0-0.3	KP105_2b_SS13-0.0-0.3
				Client sampling date / time	16-NOV-2009 15:00	17-NOV-2009 15:00	20-NOV-2009 15:00	17-NOV-2009 15:00	17-NOV-2009 15:00
Compound	CAS Number	LOR	Unit		EB0918624-015	EB0918624-016	EB0918624-019	EB0918624-020	EB0918624-023
EP075(SIM)T: PAH Surrogates - Continued									
Anthracene-d10	1719-06-8	0.1	%		**69.5**	**92.5**	----	----	----
4-Terphenyl-d14	1718-51-0	0.1	%		**103**	**108**	----	----	----
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	0.1	%		**105**	**102**	**96.7**	----	----
Toluene-D8	2037-26-5	0.1	%		**115**	**109**	**104**	----	----
4-Bromofluorobenzene	460-00-4	0.1	%		**116**	**107**	**107**	----	----

Analytical Results

Sub-Matrix: SOIL			Client sample ID	KP86_2b_SS12-0.0-0.3	KP80_2b_SS11-0.0-0.3	KP140_2b_SS17-0.0-0.3	KP155_2a_SS18-0.0-0.3	KP136_2b_SS16-0.0-0.3
			Client sampling date / time	17-NOV-2009 15:00	17-NOV-2009 15:00	17-NOV-2009 15:00	17-NOV-2009 15:00	17-NOV-2009 15:00
Compound	CAS Number	LOR	Unit	EB0918624-026	EB0918624-029	EB0918624-032	EB0918624-035	EB0918624-038
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	8.8	7.0	4.7	4.6	6.1
EA006: Sodium Absorption Ratio (SAR)								
^ Sodium Absorption Ratio	----	0.01	-	<0.10	0.42	0.44	0.32	3.21
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	84	22	52	15	12
EA055: Moisture Content								
^ Moisture Content (dried @ 103°C)	----	1.0	%	6.1	3.4	7.9	5.9	4.3
ED007: Exchangeable Cations								
^ Exchangeable Calcium	----	0.1	meq/100g	34.1	4.1	20.2	1.6	9.9
^ Exchangeable Magnesium	----	0.1	meq/100g	0.7	1.0	0.4	0.5	0.2
^ Exchangeable Potassium	----	0.1	meq/100g	0.5	0.8	0.2	0.7	0.2
^ Exchangeable Sodium	----	0.1	meq/100g	<0.1	0.1	<0.1	0.1	<0.1
^ Cation Exchange Capacity	----	0.1	meq/100g	35.4	6.0	20.8	2.9	10.3
^ Exchangeable Sodium Percent	----	0.1	%	0.3	2.2	0.3	4.0	0.6
^ Calcium/Magnesium Ratio	----	0.1	.	50.6	4.3	51.3	3.3	51.1
ED045: Chloride								
Chloride	16887-00-6	10	mg/kg	190	160	160	90	180

Analytical Results

Sub-Matrix: SOIL				Client sample ID	KP115_1_SS15-0.0-0.3	KP72_2b_SS09-0.0-0.3	KP82_1_SS10-0.0-0.3	KP30_2b_SS05-0.0-0.3	KP25_1_SS04-0.0-0.3
				Client sampling date / time	17-NOV-2009 15:00	17-NOV-2009 15:00	17-NOV-2009 15:00	17-NOV-2009 15:00	17-NOV-2009 15:00
Compound	CAS Number	LOR	Unit		EB0918624-040	EB0918624-043	EB0918624-046	EB0918624-051	EB0918624-054
EA002 : pH (Soils)									
pH Value	----	0.1	pH Unit		7.9	7.3	7.1	5.3	6.9
EA006: Sodium Absorption Ratio (SAR)									
^ Sodium Absorption Ratio	----	0.01	-		11.5	1.81	0.38	0.62	1.41
EA010: Conductivity									
Electrical Conductivity @ 25°C	----	1	µS/cm		3100	29	19	19	27
EA055: Moisture Content									
^ Moisture Content (dried @ 103°C)	----	1.0	%		8.9	9.3	1.6	2.9	8.4
ED007: Exchangeable Cations									
^ Exchangeable Calcium	----	0.1	meq/100g		37.5	15.5	6.8	2.2	11.8
^ Exchangeable Magnesium	----	0.1	meq/100g		10.9	11.1	1.0	1.6	5.0
^ Exchangeable Potassium	----	0.1	meq/100g		1.0	0.6	0.3	0.6	0.3
^ Exchangeable Sodium	----	0.1	meq/100g		8.6	0.3	0.5	0.3	0.2
^ Cation Exchange Capacity	----	0.1	meq/100g		58.0	27.5	8.6	4.6	17.3
^ Exchangeable Sodium Percent	----	0.1	%		14.8	1.1	5.5	5.9	1.1
^ Calcium/Magnesium Ratio	----	0.1	.		3.4	1.4	6.7	1.4	2.4
ED045: Chloride									
Chloride	16887-00-6	10	mg/kg		900	210	90	220	250

Analytical Results

Sub-Matrix: **SOIL**			Client sample ID	KP25_1_SS04-0.3-0.6	KP_45_2b_SS06-0.0-0.3	ALS Control Spike	----	----
			Client sampling date / time	17-NOV-2009 15:00	17-NOV-2009 15:00	17-NOV-2009 15:00	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EB0918624-055**	**EB0918624-057**	**EB0918624-059**	**----**	**----**
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	**7.1**	**7.3**	----	----	----
EA006: Sodium Absorption Ratio (SAR)								
^ Sodium Absorption Ratio	----	0.01	-	**2.12**	**7.24**	----	----	----
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	**24**	**38**	----	----	----
EA055: Moisture Content								
^ Moisture Content (dried @ 103°C)	----	1.0	%	**9.2**	**5.2**	----	----	----
ED007: Exchangeable Cations								
^ Exchangeable Calcium	----	0.1	meq/100g	**12.1**	**5.5**	----	----	----
^ Exchangeable Magnesium	----	0.1	meq/100g	**5.3**	**4.4**	----	----	----
^ Exchangeable Potassium	----	0.1	meq/100g	**0.4**	**0.6**	----	----	----
^ Exchangeable Sodium	----	0.1	meq/100g	**0.4**	**0.8**	----	----	----
^ Cation Exchange Capacity	----	0.1	meq/100g	**18.2**	**11.3**	----	----	----
^ Exchangeable Sodium Percent	----	0.1	%	**2.1**	**7.6**	----	----	----
^ Calcium/Magnesium Ratio	----	0.1	.	**2.3**	**1.2**	----	----	----
ED045: Chloride								
Chloride	16887-00-6	10	mg/kg	**200**	**280**	----	----	----
EP071/080: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	10	mg/kg	----	----	**49**	----	----
EP080: BTEX								
Benzene	71-43-2	0.2	mg/kg	----	----	**0.7**	----	----
Toluene	108-88-3	0.5	mg/kg	----	----	**9.5**	----	----
Ethylbenzene	100-41-4	0.5	mg/kg	----	----	**1.6**	----	----
meta- & para-Xylene	108-38-3 106-42-3	0.5	mg/kg	----	----	**7.7**	----	----
ortho-Xylene	95-47-6	0.5	mg/kg	----	----	**2.3**	----	----
EP080S: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	0.1	%	----	----	**98.4**	----	----
Toluene-D8	2037-26-5	0.1	%	----	----	**112**	----	----
4-Bromofluorobenzene	460-00-4	0.1	%	----	----	**114**	----	----

Surrogate Control Limits

Sub-Matrix: **LIQUID**		Recovery Limits (%)	
Compound	*CAS Number*	*Low*	*High*
EP068S: Organochlorine Pesticide Surrogate			
Dibromo-DDE	21655-73-2	10	136
EP068T: Organophosphorus Pesticide Surrogate			
DEF	78-48-8	10	110
EP075(SIM)S: Phenolic Compound Surrogates			
Phenol-d6	13127-88-3	10	94
2-Chlorophenol-D4	93951-73-6	23	134
2.4.6-Tribromophenol	118-79-6	10	123
EP075(SIM)T: PAH Surrogates			
2-Fluorobiphenyl	321-60-8	43	116
Anthracene-d10	1719-06-8	27	133
4-Terphenyl-d14	1718-51-0	33	141
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	80	120
Toluene-D8	2037-26-5	88	110
4-Bromofluorobenzene	460-00-4	86	115

Sub-Matrix: **SOIL**		Recovery Limits (%)	
Compound	*CAS Number*	*Low*	*High*
EP068S: Organochlorine Pesticide Surrogate			
Dibromo-DDE	21655-73-2	10	136
EP068T: Organophosphorus Pesticide Surrogate			
DEF	78-48-8	10	110
EP075(SIM)S: Phenolic Compound Surrogates			
Phenol-d6	13127-88-3	24	113
2-Chlorophenol-D4	93951-73-6	23	134
2.4.6-Tribromophenol	118-79-6	19	115
EP075(SIM)T: PAH Surrogates			
2-Fluorobiphenyl	321-60-8	30	115
Anthracene-d10	1719-06-8	27	133
4-Terphenyl-d14	1718-51-0	18	137
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	80	121
Toluene-D8	2037-26-5	81	117
4-Bromofluorobenzene	460-00-4	74	121

ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **EB0918649**	Page	: 1 of 8
Client	: **E3 CONSULT PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR ST.JOHN HERBERT	Contact	: Tim Kilmister
Address	: 30 QUALTROUGH STREET WOOLLOONGABBA QLD, AUSTRALIA 4102	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: sherbert@e3consult.com.au	E-mail	: Services.Brisbane@alsenviro.com
Telephone	: +61 07 3129 3237	Telephone	: +61-7-3243 7222
Facsimile	: +61 07 33038776	Facsimile	: +61-7-3243 7218
Project	: B09216	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 25-NOV-2009
Sampler	: St J H, M L	Issue Date	: 10-DEC-2009
Site	: Rail Alignment & Minesite		
		No. of samples received	: 78
Quote number	: EN/041/09	No. of samples analysed	: 30

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.

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*
Stephen Hislop	Senior Inorganic Chemist	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 date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for processing purposes. If the sampling time is displayed as 0:00 the information was not provided by client.

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	KP170_2a_SS23-0.0-0.3	KP160_2b_SS24-0.0-0.3	KP182_2a_SS25-0.0-0.3	KP195_2a_SS26-0.0-0.3	KP124_2a_SS27-0.0-0.3
				Client sampling date / time	18-NOV-2009 15:00	18-NOV-2009 15:00	18-NOV-2009 15:00	18-NOV-2009 15:00	18-NOV-2009 15:00
Compound	*CAS Number*	*LOR*	*Unit*		EB0918649-001	EB0918649-004	EB0918649-005	EB0918649-006	EB0918649-007
EA002 : pH (Soils)									
pH Value	----	0.1	pH Unit		9.2	4.9	6.2	4.5	5.2
EA006: Sodium Absorption Ratio (SAR)									
^ Sodium Absorption Ratio	----	0.01	-		5.01	1.72	2.55	28.6	1.26
EA010: Conductivity									
Electrical Conductivity @ 25°C	----	1	µS/cm		118	29	35	2240	45
EA055: Moisture Content									
^ Moisture Content (dried @ 103°C)	----	1.0	%		3.3	7.5	4.2	4.9	4.6
ED007: Exchangeable Cations									
^ Exchangeable Calcium	----	0.1	meq/100g		2.3	0.7	1.4	0.2	0.9
^ Exchangeable Magnesium	----	0.1	meq/100g		2.0	0.7	0.6	6.1	0.4
^ Exchangeable Potassium	----	0.1	meq/100g		<0.1	0.1	0.4	0.6	0.1
^ Exchangeable Sodium	----	0.1	meq/100g		0.4	<0.1	<0.1	8.2	<0.1
^ Cation Exchange Capacity	----	0.1	meq/100g		4.8	1.5	2.5	15.2	1.5
^ Exchangeable Sodium Percent	----	0.1	%		8.7	4.2	3.2	54.2	4.2
^ Calcium/Magnesium Ratio	----	0.1	.		1.1	1.0	2.3	<0.1	2.4
ED045: Chloride									
Chloride	16887-00-6	10	mg/kg		280	50	90	3020	90

Analytical Results

Sub-Matrix: **SOIL**			Client sample ID	KP235_2a_SS28-0.0-0.3	SS30a_0.0-0.3	KP338_1_SS32-0.0-0.3	SS33a-0.0-0.3	KP395_1_SS34-0.0-0.3
			Client sampling date / time	18-NOV-2009 15:00	18-NOV-2009 15:00	18-NOV-2009 15:00	18-NOV-2009 15:00	18-NOV-2009 15:00
Compound	*CAS Number*	*LOR*	*Unit*	**EB0918649-009**	**EB0918649-011**	**EB0918649-013**	**EB0918649-015**	**EB0918649-018**
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	**8.4**	**7.9**	**8.3**	**6.2**	**8.6**
EA006: Sodium Absorption Ratio (SAR)								
^ Sodium Absorption Ratio	----	0.01	-	**1.92**	**1.29**	**1.02**	**0.51**	**1.14**
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	**132**	**30**	**124**	**14**	**121**
EA055: Moisture Content								
^ Moisture Content (dried @ 103°C)	----	1.0	%	**9.4**	**6.3**	**4.6**	**4.7**	**4.2**
ED007: Exchangeable Cations								
^ Exchangeable Calcium	----	0.1	meq/100g	**23.9**	**3.5**	**16.0**	**0.6**	**5.6**
^ Exchangeable Magnesium	----	0.1	meq/100g	**5.8**	**0.9**	**0.9**	**0.3**	**0.9**
^ Exchangeable Potassium	----	0.1	meq/100g	**0.3**	**0.2**	**0.9**	**0.3**	**2.0**
^ Exchangeable Sodium	----	0.1	meq/100g	**0.4**	<0.1	<0.1	<0.1	<0.1
^ Cation Exchange Capacity	----	0.1	meq/100g	**30.4**	**4.6**	**17.9**	**1.3**	**8.6**
^ Exchangeable Sodium Percent	----	0.1	%	**1.2**	**1.7**	**0.6**	**0.9**	**0.8**
^ Calcium/Magnesium Ratio	----	0.1	.	**4.2**	**4.0**	**16.8**	**1.9**	**6.3**
ED045: Chloride								
Chloride	16887-00-6	10	mg/kg	**130**	**130**	**220**	**60**	**180**

Analytical Results

Sub-Matrix: **SOIL**				Client sample ID	SS34a-0.0-0.3	KP415_1_SS35-0.0-0.3	KP425_1_SS36-0.0-3	KP460_1_SS37-0.0-0.3	SS47-0.0-0.3
				Client sampling date / time	18-NOV-2009 15:00	18-NOV-2009 15:00	18-NOV-2009 15:00	18-NOV-2009 15:00	18-NOV-2009 15:00
Compound	*CAS Number*	*LOR*	*Unit*		**EB0918649-021**	**EB0918649-024**	**EB0918649-027**	**EB0918649-030**	**EB0918649-033**
EA002 : pH (Soils)									
pH Value	----	0.1	pH Unit		**7.4**	**7.4**	**6.8**	**5.9**	**5.7**
EA006: Sodium Absorption Ratio (SAR)									
^ Sodium Absorption Ratio	----	0.01	-		**0.48**	**2.27**	**0.77**	**6.38**	**0.51**
EA010: Conductivity									
Electrical Conductivity @ 25°C	----	1	µS/cm		**32**	**49**	**26**	**61**	**7**
EA055: Moisture Content									
^ Moisture Content (dried @ 103°C)	----	1.0	%		**3.2**	**8.3**	**3.3**	**3.8**	**7.2**
ED007: Exchangeable Cations									
^ Exchangeable Calcium	----	0.1	meq/100g		**2.6**	**3.2**	**2.1**	**1.4**	**0.9**
^ Exchangeable Magnesium	----	0.1	meq/100g		**0.8**	**1.5**	**0.3**	**1.0**	**0.9**
^ Exchangeable Potassium	----	0.1	meq/100g		**0.6**	**0.2**	**0.3**	**0.2**	**0.3**
^ Exchangeable Sodium	----	0.1	meq/100g		<0.1	**1.0**	<0.1	**0.4**	<0.1
^ Cation Exchange Capacity	----	0.1	meq/100g		**4.1**	**6.0**	**2.7**	**2.9**	**2.2**
^ Exchangeable Sodium Percent	----	0.1	%		**0.3**	**17.7**	**0.7**	**12.0**	**1.1**
^ Calcium/Magnesium Ratio	----	0.1	.		**3.3**	**2.0**	**6.3**	**1.4**	**1.0**
ED045: Chloride									
Chloride	16887-00-6	10	mg/kg		**70**	**150**	**70**	**140**	**40**

Analytical Results

Sub-Matrix: SOIL			Client sample ID	SS43-0.0-0.3	KP492_1_SS38-0.0-0.3	KP500_1_SS39-0.0-0.3	SS42-0.0-0.3	SS46-0.0-0.3
			Client sampling date / time	18-NOV-2009 15:00	18-NOV-2009 15:00	18-NOV-2009 15:00	18-NOV-2009 15:00	18-NOV-2009 15:00
Compound	CAS Number	LOR	Unit	EB0918649-037	EB0918649-039	EB0918649-041	EB0918649-043	EB0918649-045
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	6.5	6.0	6.2	6.8	6.2
EA006: Sodium Absorption Ratio (SAR)								
^ Sodium Absorption Ratio	----	0.01	-	0.34	1.51	0.75	0.21	0.31
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	15	15	9	37	17
EA055: Moisture Content								
^ Moisture Content (dried @ 103°C)	----	1.0	%	1.9	3.2	1.5	2.4	1.7
ED007: Exchangeable Cations								
^ Exchangeable Calcium	----	0.1	meq/100g	2.0	1.0	0.7	4.2	2.1
^ Exchangeable Magnesium	----	0.1	meq/100g	0.7	0.7	0.4	1.2	0.6
^ Exchangeable Potassium	----	0.1	meq/100g	0.2	0.1	0.1	0.5	0.4
^ Exchangeable Sodium	----	0.1	meq/100g	<0.1	0.2	<0.1	<0.1	<0.1
^ Cation Exchange Capacity	----	0.1	meq/100g	2.9	2.0	1.2	5.8	3.1
^ Exchangeable Sodium Percent	----	0.1	%	<0.1	11.2	2.3	<0.1	<0.1
^ Calcium/Magnesium Ratio	----	0.1	.	2.9	1.4	1.8	3.6	3.2
ED045: Chloride								
Chloride	16887-00-6	10	mg/kg	50	40	20	60	20

Analytical Results

Sub-Matrix: SOIL				Client sample ID	SS45-0.0-0.3	SS50-0.0-0.3	SS50-Burrow Pit	SS55-0.0-0.3	SS53-0.0-0.3
				Client sampling date / time	18-NOV-2009 15:00	19-NOV-2009 15:00	19-NOV-2009 15:00	19-NOV-2009 15:00	19-NOV-2009 15:00
Compound	CAS Number	LOR	Unit		EB0918649-047	EB0918649-049	EB0918649-052	EB0918649-053	EB0918649-054
EA002 : pH (Soils)									
pH Value	----	0.1	pH Unit		6.5	6.1	6.7	7.7	7.4
EA006: Sodium Absorption Ratio (SAR)									
^ Sodium Absorption Ratio	----	0.01	-		0.39	41.5	6.50	5.06	37.5
EA010: Conductivity									
Electrical Conductivity @ 25°C	----	1	µS/cm		28	368	15	59	280
EA055: Moisture Content									
^ Moisture Content (dried @ 103°C)	----	1.0	%		5.3	4.0	10.8	7.7	6.0
ED007: Exchangeable Cations									
^ Exchangeable Calcium	----	0.1	meq/100g		0.8	1.7	0.7	7.8	3.1
^ Exchangeable Magnesium	----	0.1	meq/100g		1.3	5.2	5.0	7.1	3.5
^ Exchangeable Potassium	----	0.1	meq/100g		0.7	<0.1	<0.1	0.3	0.2
^ Exchangeable Sodium	----	0.1	meq/100g		<0.1	2.6	2.2	2.3	2.4
^ Cation Exchange Capacity	----	0.1	meq/100g		2.8	9.4	7.9	17.5	9.3
^ Exchangeable Sodium Percent	----	0.1	%		0.6	27.1	28.2	12.9	26.4
^ Calcium/Magnesium Ratio	----	0.1	.		0.6	0.3	0.1	1.1	0.9
ED045: Chloride									
Chloride	16887-00-6	10	mg/kg		80	570	40	140	610

Analytical Results

Sub-Matrix: SOIL			Client sample ID	SS52-0.0-0.3	SS51-0.0-0.3	SS56-0.0-0.3	SS48-0.0-0.3	SS49-0.0-0.3
			Client sampling date / time	19-NOV-2009 15:00	19-NOV-2009 15:00	19-NOV-2009 15:00	19-NOV-2009 15:00	19-NOV-2009 15:00
Compound	CAS Number	LOR	Unit	EB0918649-057	EB0918649-058	EB0918649-060	EB0918649-063	EB0918649-065
EA002 : pH (Soils)								
pH Value	----	0.1	pH Unit	5.8	6.9	6.0	7.0	8.1
EA006: Sodium Absorption Ratio (SAR)								
^ Sodium Absorption Ratio	----	0.01	-	1.42	3.13	1.19	0.47	3.58
EA010: Conductivity								
Electrical Conductivity @ 25°C	----	1	µS/cm	9	24	98	65	170
EA055: Moisture Content								
^ Moisture Content (dried @ 103°C)	----	1.0	%	5.8	7.1	5.5	1.6	8.9
ED007: Exchangeable Cations								
^ Exchangeable Calcium	----	0.1	meq/100g	<0.1	<0.1	7.2	5.9	22.9
^ Exchangeable Magnesium	----	0.1	meq/100g	0.6	2.7	3.2	1.4	5.0
^ Exchangeable Potassium	----	0.1	meq/100g	<0.1	<0.1	0.9	0.4	0.8
^ Exchangeable Sodium	----	0.1	meq/100g	<0.1	0.4	0.1	<0.1	0.6
^ Cation Exchange Capacity	----	0.1	meq/100g	0.7	3.3	11.5	7.8	29.4
^ Exchangeable Sodium Percent	----	0.1	%	8.6	11.4	1.2	0.6	2.2
^ Calcium/Magnesium Ratio	----	0.1	.	0.2	<0.1	2.2	4.2	4.5
ED045: Chloride								
Chloride	16887-00-6	10	mg/kg	20	50	250	210	160

ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **EB1008208**	Page	: 1 of 11
Client	: **E3 CONSULT PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: RESULTS ADDRESS	Contact	: Greg Vogel
Address	: 30 QUALTROUGH STREET WOOLLOONGABBA QLD, AUSTRALIA 4102	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: vietkom@hotmail.com	E-mail	: Services.Brisbane@alsenviro.com
Telephone	: +61 07 33038775	Telephone	: +61-7-3243 7222
Facsimile	: +61 07 33038776	Facsimile	: +61-7-3243 7218
Project	: B09216 11 Kia Ora	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 10-MAY-2010
Sampler	: R.Hector	Issue Date	: 25-MAY-2010
Site	: Kia Ora		
		No. of samples received	: 20
Quote number	: EN/041/10	No. of samples analysed	: 18

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
- Surrogate Control Limits

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*
Alex Rossi	Organic Chemist	Organics
Ankit Joshi	Inorganic Chemist	Inorganics
Celine Conceicao	Spectroscopist	Inorganics
Dianne Blane	Laboratory Supervisor	Newcastle
Kim McCabe	Senior Inorganic Chemist	Inorganics
Kim McCabe	Senior Inorganic Chemist	Stafford Minerals - AY
Lana Nguyen	LCMS Chemist	Organics
Myles.Clark	Acid Sulfate Soils Supervisor	Bne Acid Sulphate Soils
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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 date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for processing purposes. If the sampling time is displayed as 0:00 the information was not provided by client.

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

- **PAHs: Sample C6 required dilution prior to analysis due to matrix interferences. Surrogates ND and LOR values have been adjusted accordingly.**

Analytical Results

Sub-Matrix: SOIL				Client sample ID	WAR44-15DL	WAR38-15B	WAR44-15DU	WAR38-15Overburden B	WAR38-15TR
				Client sampling date / time	06-MAY-2010 15:00	06-MAY-2010 15:00	06-MAY-2010 15:00	06-MAY-2010 15:00	06-MAY-2010 15:00
Compound	CAS Number	LOR	Unit		EB1008208-001	EB1008208-002	EB1008208-003	EB1008208-004	EB1008208-005
EA150: Particle Sizing									
+75µm	----	1	%		----	----	----	----	40
+150µm	----	1	%		----	----	----	----	36
+300µm	----	1	%		----	----	----	----	34
+425µm	----	1	%		----	----	----	----	34
+600µm	----	1	%		----	----	----	----	33
+1180µm	----	1	%		----	----	----	----	32
+2.36mm	----	1	%		----	----	----	----	27
+4.75mm	----	1	%		----	----	----	----	21
+9.5mm	----	1	%		----	----	----	----	12
+19.0mm	----	1	%		----	----	----	----	<1
+37.5mm	----	1	%		----	----	----	----	<1
+75.0mm	----	1	%		----	----	----	----	<1
EA009: Nett Acid Production Potential									
^ Net Acid Production Potential	----	0.5	kg H2SO4/t		2.6	-4.2	3.0	-23.6	<0.5
EA011: Net Acid Generation									
pH (OX)	----	0.1	pH Unit		5.0	7.6	3.7	8.6	5.6
NAG (pH 4.5)	----	0.1	kg H2SO4/t		<0.1	<0.1	2.3	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t		10.4	<0.1	16.4	<0.1	2.3
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		4.6	7.4	4.8	24.5	1.2
^ ANC as CaCO3	----	0.1	% CaCO3		0.5	0.8	0.5	2.5	0.1
Fizz Rating	----	0	Fizz Unit		0	0	0	2	0
EA150: Soil Classification based on Particle Size									
Clay (<2 µm)	----	1	%		----	----	----	----	18
Silt (2-60 µm)	----	1	%		----	----	----	----	40
Sand (0.06-2.00 mm)	----	1	%		----	----	----	----	14
Gravel (>2mm)	----	1	%		----	----	----	----	28
Cobbles (>6cm)	----	1	%		----	----	----	----	<1
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		0.23	0.10	0.26	0.03	0.03

Analytical Results

Sub-Matrix: SOIL			Client sample ID	DU	DL interburden	WAR 42-12Du interburden	WAR 44-15 Soil	WAR 44-15DL interburden
			Client sampling date / time	06-MAY-2010 15:00	06-MAY-2010 15:00	06-MAY-2010 15:00	06-MAY-2010 15:00	06-MAY-2010 15:00
Compound	CAS Number	LOR	Unit	EB1008208-006	EB1008208-007	EB1008208-008	EB1008208-009	EB1008208-010
EA150: Particle Sizing								
+75µm	----	1	%	----	----	----	71	----
+150µm	----	1	%	----	----	----	50	----
+300µm	----	1	%	----	----	----	26	----
+425µm	----	1	%	----	----	----	16	----
+600µm	----	1	%	----	----	----	9	----
+1180µm	----	1	%	----	----	----	2	----
+2.36mm	----	1	%	----	----	----	<1	----
+4.75mm	----	1	%	----	----	----	<1	----
+9.5mm	----	1	%	----	----	----	<1	----
+19.0mm	----	1	%	----	----	----	<1	----
+37.5mm	----	1	%	----	----	----	<1	----
+75.0mm	----	1	%	----	----	----	<1	----
EA009: Nett Acid Production Potential								
^ Net Acid Production Potential	----	0.5	kg H2SO4/t	7.4	-0.7	-3.0	----	-3.7
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	6.6	4.6	5.9	----	6.3
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	----	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	1.2	3.7	1.8	----	0.8
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	5.4	2.3	5.6	----	3.7
^ ANC as CaCO3	----	0.1	% CaCO3	0.6	0.2	0.6	----	0.4
Fizz Rating	----	0	Fizz Unit	0	0	0	----	0
EA150: Soil Classification based on Particle Size								
Clay (<2 µm)	----	1	%	----	----	----	14	----
Silt (2-60 µm)	----	1	%	----	----	----	12	----
Sand (0.06-2.00 mm)	----	1	%	----	----	----	74	----
Gravel (>2mm)	----	1	%	----	----	----	<1	----
Cobbles (>6cm)	----	1	%	----	----	----	<1	----
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.42	0.05	0.08	----	<0.01

Analytical Results

Sub-Matrix: SOIL				Client sample ID	WAR 44-15TR	WAR 38-15 Soil	WAR 48-13TR	WAR 42-13 Soil	WAR 44-15DU interburden
				Client sampling date / time	06-MAY-2010 15:00	06-MAY-2010 15:00	06-MAY-2010 15:00	06-MAY-2010 15:00	06-MAY-2010 15:00
Compound	CAS Number	LOR	Unit		EB1008208-011	EB1008208-012	EB1008208-013	EB1008208-014	EB1008208-015
EA150: Particle Sizing									
+75µm	----	1	%		56	70	64	52	----
+150µm	----	1	%		44	57	58	31	----
+300µm	----	1	%		28	47	52	13	----
+425µm	----	1	%		19	45	51	7	----
+600µm	----	1	%		13	44	50	4	----
+1180µm	----	1	%		5	42	49	<1	----
+2.36mm	----	1	%		1	36	44	<1	----
+4.75mm	----	1	%		<1	22	27	<1	----
+9.5mm	----	1	%		<1	6	4	<1	----
+19.0mm	----	1	%		<1	<1	<1	<1	----
+37.5mm	----	1	%		<1	<1	<1	<1	----
+75.0mm	----	1	%		<1	<1	<1	<1	----
EA009: Nett Acid Production Potential									
^ Net Acid Production Potential	----	0.5	kg H2SO4/t		-3.0	----	-2.8	----	-0.7
EA011: Net Acid Generation									
pH (OX)	----	0.1	pH Unit		5.1	----	6.4	----	6.2
NAG (pH 4.5)	----	0.1	kg H2SO4/t		<0.1	----	<0.1	----	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t		2.5	----	0.6	----	0.8
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		3.0	----	2.8	----	3.2
^ ANC as CaCO3	----	0.1	% CaCO3		0.3	----	0.3	----	0.3
Fizz Rating	----	0	Fizz Unit		0	----	0	----	0
EA150: Soil Classification based on Particle Size									
Clay (<2 µm)	----	1	%		33	11	11	18	----
Silt (2-60 µm)	----	1	%		8	15	23	25	----
Sand (0.06-2.00 mm)	----	1	%		58	38	22	57	----
Gravel (>2mm)	----	1	%		1	36	44	<1	----
Cobbles (>6cm)	----	1	%		<1	<1	<1	<1	----
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		<0.01	----	<0.01	----	0.08

Analytical Results

Sub-Matrix: **SOIL**			Client sample ID	C6	C7	C8	----	----
			Client sampling date / time	06-MAY-2010 15:00	06-MAY-2010 15:00	06-MAY-2010 15:00	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EB1008208-016**	**EB1008208-017**	**EB1008208-018**	**----**	**----**
EA055: Moisture Content								
^ Moisture Content (dried @ 103°C)	----	1.0	%	**7.1**	**26.6**	**3.1**	----	----
EG005T: Total Metals by ICP-AES								
Arsenic	7440-38-2	5	mg/kg	----	----	<5	----	----
EP068C: Triazines								
Atrazine	1912-24-9	0.05	mg/kg	----	----	<0.05	----	----
Simazine	122-34-9	0.05	mg/kg	----	----	<0.05	----	----
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons								
Naphthalene	91-20-3	0.5	mg/kg	<1.8	----	----	----	----
Acenaphthylene	208-96-8	0.5	mg/kg	<1.8	----	----	----	----
Acenaphthene	83-32-9	0.5	mg/kg	<1.8	----	----	----	----
Fluorene	86-73-7	0.5	mg/kg	<1.8	----	----	----	----
Phenanthrene	85-01-8	0.5	mg/kg	<3.5	----	----	----	----
Anthracene	120-12-7	0.5	mg/kg	<1.8	----	----	----	----
Fluoranthene	206-44-0	0.5	mg/kg	<1.8	----	----	----	----
Pyrene	129-00-0	0.5	mg/kg	**3.3**	----	----	----	----
Benz(a)anthracene	56-55-3	0.5	mg/kg	<1.8	----	----	----	----
Chrysene	218-01-9	0.5	mg/kg	<1.8	----	----	----	----
Benzo(b)fluoranthene	205-99-2	0.5	mg/kg	<1.8	----	----	----	----
Benzo(k)fluoranthene	207-08-9	0.5	mg/kg	<1.8	----	----	----	----
Benzo(a)pyrene	50-32-8	0.5	mg/kg	<1.8	----	----	----	----
Indeno(1.2.3.cd)pyrene	193-39-5	0.5	mg/kg	<1.8	----	----	----	----
Dibenz(a.h)anthracene	53-70-3	0.5	mg/kg	<1.8	----	----	----	----
Benzo(g.h.i)perylene	191-24-2	0.5	mg/kg	<1.8	----	----	----	----
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	10	mg/kg	<10	----	----	----	----
C10 - C14 Fraction	----	50	mg/kg	**240**	----	----	----	----
C15 - C28 Fraction	----	100	mg/kg	**31900**	----	----	----	----
C29 - C36 Fraction	----	100	mg/kg	**740**	----	----	----	----
^ C10 - C36 Fraction (sum)	----	50	mg/kg	**32900**	----	----	----	----
EP130A: Organophosphorus Pesticides (Ultra-trace)								
Bromophos-ethyl	4824-78-6	10	µg/kg	----	<10	----	----	----
Carbophenothion	786-19-6	10	µg/kg	----	<10	----	----	----
Chlorfenvinphos (E)	470-90-6	10.0	µg/kg	----	<10.0	----	----	----
Chlorfenvinphos (Z)	470-90-8	10	µg/kg	----	<10	----	----	----
Chlorpyrifos	2921-88-2	10	µg/kg	----	<10	----	----	----
Chlorpyrifos-methyl	5598-13-0	10	µg/kg	----	<10	----	----	----
Demeton-S-methyl	919-86-8	10	µg/kg	----	<10	----	----	----

Analytical Results

Sub-Matrix: SOIL				Client sample ID	C6	C7	C8	----	----
				Client sampling date / time	06-MAY-2010 15:00	06-MAY-2010 15:00	06-MAY-2010 15:00	----	----
Compound	CAS Number	LOR	Unit		EB1008208-016	EB1008208-017	EB1008208-018	----	----
EP130A: Organophosphorus Pesticides (Ultra-trace) - Continued									
Diazinon	333-41-5	10	µg/kg		----	<10	----	----	----
Dichlorvos	62-73-7	10	µg/kg		----	<10	----	----	----
Dimethoate	60-51-5	10	µg/kg		----	<10	----	----	----
Ethion	563-12-2	10	µg/kg		----	<10	----	----	----
Fenamiphos	22224-92-6	10	µg/kg		----	<10	----	----	----
Fenthion	55-38-9	10	µg/kg		----	<10	----	----	----
Malathion	121-75-5	10	µg/kg		----	<10	----	----	----
Azinphos Methyl	86-50-0	10	µg/kg		----	<10	----	----	----
Monocrotophos	6923-22-4	10	µg/kg		----	<10	----	----	----
Parathion	56-38-2	10	µg/kg		----	<10	----	----	----
Parathion-methyl	298-00-0	10	µg/kg		----	<10	----	----	----
Pirimphos-ethyl	23505-41-1	10	µg/kg		----	<10	----	----	----
Prothiofos	34643-46-4	10	µg/kg		----	<10	----	----	----
EP131A: Organochlorine Pesticides									
Aldrin	309-00-2	0.50	µg/kg		----	<0.50	----	----	----
alpha-BHC	319-84-6	0.50	µg/kg		----	<0.50	----	----	----
beta-BHC	319-85-7	0.50	µg/kg		----	<0.50	----	----	----
delta-BHC	319-86-8	0.50	µg/kg		----	<0.50	----	----	----
4.4`-DDD	72-54-8	0.50	µg/kg		----	<0.50	----	----	----
4.4`-DDE	72-55-9	0.50	µg/kg		----	<0.50	----	----	----
4.4`-DDT	50-29-3	0.50	µg/kg		----	<0.50	----	----	----
^ DDT (total)	----	0.50	µg/kg		----	<0.50	----	----	----
Dieldrin	60-57-1	0.50	µg/kg		----	<0.50	----	----	----
alpha-Endosulfan	959-98-8	0.50	µg/kg		----	<0.50	----	----	----
beta-Endosulfan	33213-65-9	0.50	µg/kg		----	<0.50	----	----	----
Endosulfan sulfate	1031-07-8	0.50	µg/kg		----	<0.50	----	----	----
^ Endosulfan (sum)	115-29-7	0.50	µg/kg		----	<0.50	----	----	----
Endrin	72-20-8	0.50	µg/kg		----	<0.50	----	----	----
Endrin aldehyde	7421-93-4	0.50	µg/kg		----	<0.50	----	----	----
Endrin ketone	53494-70-5	0.50	µg/kg		----	<0.50	----	----	----
Heptachlor	76-44-8	0.50	µg/kg		----	<0.50	----	----	----
Heptachlor epoxide	1024-57-3	0.50	µg/kg		----	<0.50	----	----	----
Hexachlorobenzene (HCB)	118-74-1	0.50	µg/kg		----	<0.50	----	----	----
gamma-BHC	58-89-9	0.25	µg/kg		----	<0.25	----	----	----
Methoxychlor	72-43-5	0.50	µg/kg		----	<0.50	----	----	----
cis-Chlordane	5103-71-9	0.25	µg/kg		----	<0.25	----	----	----
trans-Chlordane	5103-74-2	0.25	µg/kg		----	<0.25	----	----	----
^ Total Chlordane (sum)	----	0.25	µg/kg		----	<0.25	----	----	----

Analytical Results

Sub-Matrix: SOIL				Client sample ID	C6	C7	C8	----	----
				Client sampling date / time	06-MAY-2010 15:00	06-MAY-2010 15:00	06-MAY-2010 15:00	----	----
Compound	CAS Number	LOR	Unit		EB1008208-016	EB1008208-017	EB1008208-018	----	----
EP131A: Organochlorine Pesticides - Continued									
Oxychlordane	27304-13-8	0.50	µg/kg		----	<0.50	----	----	----
EP202A: Phenoxyacetic Acid Herbicides by LCMS									
4-Chlorophenoxy acetic acid	122-88-3	0.02	mg/kg		----	----	<0.02	----	----
2.4-DB	94-82-6	0.02	mg/kg		----	----	<0.02	----	----
Dicamba	1918-00-9	0.02	mg/kg		----	----	<0.02	----	----
Mecoprop	93-65-2	0.02	mg/kg		----	----	<0.02	----	----
MCPA	94-74-6	0.02	mg/kg		----	----	<0.02	----	----
2.4-DP	120-36-5	0.02	mg/kg		----	----	<0.02	----	----
2.4-D	94-75-7	0.02	mg/kg		----	----	<0.02	----	----
Triclopyr	55335-06-3	0.02	mg/kg		----	----	<0.02	----	----
2.4.5-TP (Silvex)	93-72-1	0.02	mg/kg		----	----	<0.02	----	----
2.4.5-T	93-76-5	0.02	mg/kg		----	----	<0.02	----	----
MCPB	94-81-5	0.02	mg/kg		----	----	<0.02	----	----
Picloram	1918-02-1	0.02	mg/kg		----	----	<0.02	----	----
Clopyralid	1702-17-6	0.02	mg/kg		----	----	<0.02	----	----
Fluroxypyr	69377-81-7	0.02	mg/kg		----	----	<0.02	----	----
EP068S: Organochlorine Pesticide Surrogate									
Dibromo-DDE	21655-73-2	0.1	%		----	----	93.0	----	----
EP068T: Organophosphorus Pesticide Surrogate									
DEF	78-48-8	0.1	%		----	----	62.7	----	----
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	0.1	%		Not Determined	----	----	----	----
2-Chlorophenol-D4	93951-73-6	0.1	%		Not Determined	----	----	----	----
2.4.6-Tribromophenol	118-79-6	0.1	%		Not Determined	----	----	----	----
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	0.1	%		Not Determined	----	----	----	----
Anthracene-d10	1719-06-8	0.1	%		Not Determined	----	----	----	----
4-Terphenyl-d14	1718-51-0	0.1	%		Not Determined	----	----	----	----
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	0.1	%		110	----	----	----	----
Toluene-D8	2037-26-5	0.1	%		88.4	----	----	----	----
4-Bromofluorobenzene	460-00-4	0.1	%		81.8	----	----	----	----
EP130S: Organophosphorus Pesticide Surrogate									
DEF	78-48-8	0.1	%		----	55.8	----	----	----
EP131S: OC Pesticide Surrogate									
Dibromo-DDE	21655-73-2	0.1	%		----	57.7	----	----	----
EP202S: Phenoxyacetic Acid Herbicide Surrogate									

Analytical Results

Sub-Matrix: **SOIL**			Client sample ID	C6	C7	C8	----	----
			Client sampling date / time	06-MAY-2010 15:00	06-MAY-2010 15:00	06-MAY-2010 15:00	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EB1008208-016**	**EB1008208-017**	**EB1008208-018**	**----**	**----**
EP202S: Phenoxyacetic Acid Herbicide Surrogate - Continued								
2.4-Dichlorophenyl Acetic Acid	19719-28-9	0.1	%	----	----	**83.8**	----	----

Surrogate Control Limits

Sub-Matrix: **SOIL**		Recovery Limits (%)	
Compound	*CAS Number*	*Low*	*High*
EP068S: Organochlorine Pesticide Surrogate			
Dibromo-DDE	21655-73-2	10	136
EP068T: Organophosphorus Pesticide Surrogate			
DEF	78-48-8	10	136
EP075(SIM)S: Phenolic Compound Surrogates			
Phenol-d6	13127-88-3	24	113
2-Chlorophenol-D4	93951-73-6	23	134
2.4.6-Tribromophenol	118-79-6	19	115
EP075(SIM)T: PAH Surrogates			
2-Fluorobiphenyl	321-60-8	30	115
Anthracene-d10	1719-06-8	27	133
4-Terphenyl-d14	1718-51-0	18	137
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	80	121
Toluene-D8	2037-26-5	81	117
4-Bromofluorobenzene	460-00-4	74	121
EP130S: Organophosphorus Pesticide Surrogate			
DEF	78-48-8	51.3	136.9
EP131S: OC Pesticide Surrogate			
Dibromo-DDE	21655-73-2	10	136
EP202S: Phenoxyacetic Acid Herbicide Surrogate			
2.4-Dichlorophenyl Acetic Acid	19719-28-9	70	130

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **EB1009892**	Page	: 1 of 4
Client	: **E3 CONSULT PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR ST.JOHN HERBERT	Contact	: Greg Vogel
Address	: 30 QUALTROUGH STREET WOOLLOONGABBA QLD, AUSTRALIA 4102	Address	: 32 Shand Street Stafford QLD Australia 4053
E-mail	: sherbert@e3consult.com.au	E-mail	: Services.Brisbane@alsenviro.com
Telephone	: +61 07 3129 3237	Telephone	: +61 7 3243 7222
Facsimile	: +61 07 33038776	Facsimile	: +61-7-3243 7218
Project	: b09216 11 WARATAH	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 04-JUN-2010
Sampler	: RH	Issue Date	: 11-JUN-2010
Site	: WARATAH		
		No. of samples received	: 8
Quote number	: EN/041/10	No. of samples analysed	: 8

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.

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	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 date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for processing purposes. If the sampling time is displayed as 0:00 the information was not provided by client.

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: **PULP**				Client sample ID	WAR38-15Overburden B	WAR38-15TR	DL interburden	WAR 42-12Du interburden	WAR 44-15DL interburden
				Client sampling date / time	05-JUN-2010 15:00	05-JUN-2010 15:00	05-JUN-2010 15:00	05-JUN-2010 15:00	05-JUN-2010 15:00
Compound	*CAS Number*	*LOR*	*Unit*		**EB1009892-001**	**EB1009892-002**	**EB1009892-003**	**EB1009892-004**	**EB1009892-005**
EG005T: Total Metals by ICP-AES									
Arsenic	7440-38-2	5	mg/kg		<5	**5**	<5	**10**	<5
Cadmium	7440-43-9	1	mg/kg		<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg		<2	**27**	**78**	**25**	**45**
Copper	7440-50-8	5	mg/kg		**17**	**9**	**8**	**42**	**10**
Lead	7439-92-1	5	mg/kg		**20**	**11**	**6**	**22**	**6**
Nickel	7440-02-0	2	mg/kg		**6**	**9**	**5**	**28**	**8**
Zinc	7440-66-6	5	mg/kg		**37**	**13**	**13**	**97**	**9**
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		**0.2**	**0.2**	**0.1**	**0.1**	<0.1

Analytical Results

Sub-Matrix: **PULP**				Client sample ID	**WAR 44-15TR**	**WAR 48-13TR**	**WAR 44-15DU interburden**	----	----
				Client sampling date / time	05-JUN-2010 15:00	05-JUN-2010 15:00	05-JUN-2010 15:00	----	----
Compound	*CAS Number*	*LOR*	*Unit*		**EB1009892-006**	**EB1009892-007**	**EB1009892-008**	**----**	**----**
EG005T: Total Metals by ICP-AES									
Arsenic	7440-38-2	5	mg/kg		**6**	<5	**9**	----	----
Cadmium	7440-43-9	1	mg/kg		**2**	<1	<1	----	----
Chromium	7440-47-3	2	mg/kg		**118**	**22**	**50**	----	----
Copper	7440-50-8	5	mg/kg		**12**	<5	**20**	----	----
Lead	7439-92-1	5	mg/kg		**34**	**5**	**18**	----	----
Nickel	7440-02-0	2	mg/kg		**16**	**5**	**11**	----	----
Zinc	7440-66-6	5	mg/kg		**16**	**6**	**50**	----	----
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg		<0.1	<0.1	**0.2**	----	----

A.G. LABS
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Soil & Rock Testing
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(Phone) 07 3357 5535
(Fax) 07 3357 5531
windsor@aglabs.com.au

EMERSON CLASS NUMBER TEST REPORT

Test Method: AS1289 3.8.1

Client:	E3 Consult Pty Ltd	Report No.	9120844-em
Project:	B09216.01	Test Date:	14/01/10
		Report Date:	18/01/10

Sample No.	9120844	9120845	9120846	9120847
Client ID:	EB09186247-7	EB09186247-8	EB09186247-9	EB09186247-56
Depth (m):	0.0-0.3	0.0-0.3	0.3-0.6	0.0-0.3
Description:	Sandy Clay dark grey	Sandy Silt grey	Sandy Clay brown	Sandy Clay brown
Emerson Class No.:	2	2	1	5

Sample No.	9120848	9120849	9120850	9120851
Client ID:	EB09186247-57	EB0918649-71	EB0918624-23	EB0918624-20
Depth (m):	0.3-0.6	0.3	0.0-0.3	0.0-0.3
Description:	Gravelly Sandy Clay brown	Sandy Clay brown	Silty Sand brown	Sandy Clay brown
Emerson Class No.:	3	5	5	3

Remarks: Tested with distilled water at 24^{o}C

Sample/s supplied by the client

Form Number: GT007-5

Authorised Signatory

J. Russell

Manager

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EMERSON CLASS NUMBER TEST REPORT

Test Method: AS1289 3.8.1

Client:	E3 Consult Pty Ltd	Report No.	9120852-em
Project:	B09216.01	Test Date:	14/01/10
		Report Date:	18/01/10

Sample No.	9120852	9120853	9120854	9120855
Client ID:	EB0918624-32	EB0918624-35	EB0918649-9	EB0918649-10
Depth (m):	0.0-0.3	0.0-0.3	0.0-0.3	0.0-0.3
Description:	Clay brown	Sand brown	Sandy Clay brown	Sandy Clay brown
Emerson Class No.:	5	3	4	2

Sample No.	9120856	9120857	9120858	9120859
Client ID:	EB0918649-70	EB0918649-68	EB0918649-27	EB0918649-30
Depth (m):	0.0-0.3	0.0-0.3	0.0-0.3	0.0-0.3
Description:	Sandy Clay brown	Sandy Clay brown	Sandy Silt brown	Silty Sand grey
Emerson Class No.:	2	4	3	2

Remarks: Tested with distilled water at 24ºC

Sample/s supplied by the client

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The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National standards

N ATA Accredited Laboratory Number 9926

Form Number: GT007-5

Authorised Signatory

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EMERSON CLASS NUMBER TEST REPORT

Test Method: AS1289 3.8.1

Client:	E3 Consult Pty Ltd	Report No.	9120860-em
Project:	B09216.01	Test Date:	14/01/10
		Report Date:	18/01/10

Sample No.	9120860	9120861	9120862	9120863
Client ID:	EB0918649-31	EB0918649-39	EB0918649-40	EB0918649-67
Depth (m):	0.3-0.6	0.0-0.3	0.3-0.6	0.0-0.3
Description:	Sandy Clay grey	Sandy Silt grey	Sandy Clay yellow/brown	Sandy Silty Clay brown
Emerson Class No.:	1	2	3	2

Remarks: Tested with distilled water at 24^{o}C

Sample/s supplied by the client

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The results of the tests, calibrations, and/or measurements included in this document are traceable to Australian/National standards

Authorised Signatory

J. Russell

Manager

N ATA Accredited Laboratory Number 9926

Form Number: GT007-5

Waratah Coal

Appendix C – Soil Results Summary Tables

Soil Types Tenosol
Site ID: SS01 Site Location: KP01
Regional Soil Type: Sodosol

Landform: Mj9	
High hilly or mountainous lands, mostly with steep slopes; rock outcrop is often prominent: dominantsoils are fairly shallow and nearly always stony friable earths with a dark loamy surface grading tored clay subsoils (Gn3.14). A wide variety of other shallow stony soils occur, chiefly (Um1.43), (Um4.2),(Gn3.24), (Gn3.11), (Db1.11), (Dr2.11), (Dr2.12), and (Dy2.11). Data are fairly limited	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	5.9
SAR	0.01	6.80
EC	1 µS/cm	30
Exchangeable Ca	0.1 meq/100g	0.9
Exchangeable Mg	0.1 meq/100g	0.5
Exchangeable K	0.1 meq/100g	0.3
Exchangeable Na	0.1 meq/100g	0.3
CEC	0.1 meq/100g	1.9
ESP (%)	0.001	14.3
Ca:Mg	0.1	1.6
Chloride	10 mg/kg	150
Emerson Crumb Class		na

Soil & landform Elements

Regional Soil Type	Sodosol
Map Reference	0
Permeability	Low
Drainage	Poor
Landform	Plain
Vegetation	Native Pasture
Site Disturbance	Low
Microrelief	cracking
Erosion	Moderate
PAWC	≤50mm
GQAL Class	D

Depth	**Soil Descriptions**
0 - 0.3	Sandy gravelly CLAY, Fine grain, pale, very soft, very loose, trace roots, refusal at 0.3 gravelly

Soil Types

Site ID: SS02 Site Location: KP05

Regional Soil Type: Sodosol

Landform: Kf13	
Level plains: dominant soils are deep dark cracking clays (Ug5.16), with lesser grey clays (Ug5.24, Ug5.29). A slight (6 12 in.) gilgai microrelief is often present; where it is more pronounced, the clays occur on the puffs, and in the depressions are loamy grey duplex soils (Dy3.43), (Dy2.43), (Dy3.33), and (Dy2.33), with lesser similar (Dd1) soils	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	8.6
SAR	0.01	1.88
EC	1 µS/cm	166
Exchangeable Ca	0.1 meq/100g	37.0
Exchangeable Mg	0.1 meq/100g	4.4
Exchangeable K	0.1 meq/100g	0.2
Exchangeable Na	0.1 meq/100g	0.8
CEC	0.1 meq/100g	52.4
ESP (%)	0.001	7.6
Ca:Mg	0.1	2.5
Chloride	10 mg/kg	280
Emerson Crumb Class		-

Soil & landform Elements

Regional Soil Type	Sodosol
Map Reference	
Permeability	High
Drainage	Good
Landform	Talis
Vegetation	Sparse
Site Disturbance	Low
Microrelief	Undulating
Erosion	Moderate
PAWC	100-125mm
GQAL Class	A

Depth	**Soil Descriptions**
0 - 0.3	Clay, Dark Brown/Grey, hard friable, poorly drained.

Soil Types

Site ID: SS03 Site Location: KP04

Regional Soil Type: Sodosol

Landform: Kf13	
Level plains: dominant soils are deep dark cracking clays (Ug5.16), with lesser grey clays (Ug5.24, Ug5.29). A slight (6 12 in.) gilgai microrelief is often present; where it is more pronounced, the clays occur on the puffs, and in the depressions are loamy grey duplex soils (Dy3.43), (Dy2.43), (Dy3.33), and (Dy2.33), with lesser similar (Dd1) soils	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	6.7
SAR	0.01	4.46
EC	1 µS/cm	113
Exchangeable Ca	0.1 meq/100g	7.2
Exchangeable Mg	0.1 meq/100g	4.1
Exchangeable K	0.1 meq/100g	0.5
Exchangeable Na	0.1 meq/100g	0.7
CEC	0.1 meq/100g	12.5
ESP (%)	0.001	5.5
Ca:Mg	0.1	1.8
Chloride	10 mg/kg	280
Emerson Crumb Class		na

Soil & landform Elements

Regional Soil Type	Sodosol
Map Reference	
Permeability	Low
Drainage	Poor
Landform	Plain
Vegetation	Native Pasture
Site Disturbance	Low
Microrelief	cracking
Erosion	Moderate
PAWC	100-125mm
GQAL Class	A

Depth	Soil Descriptions
0 - 0.3	Clayey SILT, dry, soft, loose, brown/orange, some roots some gravel
0.4-0.6	Gravelly Clayey SILT, dry, soft, loose, brown/orange, some roots

Soil Types

Site ID: SS04 Site Location: KP05

Regional Soil Type: Sodosol

Landform:	Kf13
Level plains: dominant soils are deep dark cracking clays (Ug5.16), with lesser grey clays (Ug5.24, Ug5.29). A slight (6 12 in.) gilgai microrelief is often present; where it is more pronounced, the clays occur on the puffs, and in the depressions are loamy grey duplex soils (Dy3.43), (Dy2.43), (Dy3.33), and (Dy2.33), with lesser similar (Dd1) soils	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	na
SAR	0.01	na
EC	1 µS/cm	na
Exchangeable Ca	0.1 meq/100g	na
Exchangeable Mg	0.1 meq/100g	na
Exchangeable K	0.1 meq/100g	na
Exchangeable Na	0.1 meq/100g	na
CEC	0.1 meq/100g	na
ESP (%)	0.001	na
Ca:Mg	0.1	na
Chloride	10 mg/kg	na
Emerson Crumb Class		na

Soil & landform Elements

Regional Soil Type	Chromosol
Map Reference	20° 3' 39.504" S 147° 53' 2.978" E
Permeability	Low
Drainage	High
Landform	Alluvial depression
Vegetation	Heavy vegetation
Site Disturbance	Nil
Microrelief	NIl
Erosion	Moderate
PAWC	<50mm
GQAL Class	D

Depth	Soil Descriptions
0 - 0.3	Clayey SILT, dry, soft, loose, brown/orange, some roots some gravel (>60mm). Profile change at 0.4m gravel (20mm)
0.4-0.6	Gravelly Clayey SILT, dry, soft, loose, brown/orange, some roots some gravel (>60mm). gravel (20mm)

Soil Types

Site ID: SS05 Site Location: KP05

Regional Soil Type: Sodosol

Landform: KB26	
Hilly or low hilly lands with some moderately undulating plateau surfaces; the unit is often boundedby steep dissected scarps; almost all soils are shallow and often stony: dominant are very dark brownclays (Ug5.12), but shallow red soils (Ug5.37) and (Gn3.12) are also common. On stronger slopesand high hills very shallow stony clays (Uf6.32 and Uf6.31) occur	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	8.6
SAR	0.01	1.88
EC	1 µS/cm	166
Exchangeable Ca	0.1 meq/100g	37.0
Exchangeable Mg	0.1 meq/100g	14.6
Exchangeable K	0.1 meq/100g	0.2
Exchangeable Na	0.1 meq/100g	0.6
CEC	0.1 meq/100g	52.4
ESP (%)	0.001	1.1
Ca:Mg	0.1	2.5
Chloride	10 mg/kg	100
Emerson Crumb Class		na

Soil & landform Elements

Regional Soil Type	Sodosol
Map Reference	-
Permeability	Moderate
Drainage	Medium
Landform	Plain
Vegetation	Sparse
Site Disturbance	Low
Microrelief	nil
Erosion	Moderate
PAWC	≥150mm
GQAL Class	C

Depth	**Soil Descriptions**
0 - 0.3	CLAY, moist, soft to hard, dark brown, very loose roots
0.3-0.6	Clay, hard to friable, very loose roots, dark brown
0.6-0.9	Clay, hard to friable, loose roots, coarse poorly sorted gravels and quartz 0.9mm, hard friable clays, dark brown.

Soil Types

Site ID: SS06 Site Location: KP10

Regional Soil Type: Sodosol

Landform:	Va86
Undulating lands with some alluvial plains: dominant are very pale grey loamy or sandy duplex soils(Dy3.43) with similar neutral and acid forms occurring on higher landscape sites. Included in theunit as mapped are small areas of loamy or sandy yellow earths (Gn2.22) and small inclusions of unitTb119. Data are limited	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	6.9
SAR	0.01	20.5
EC	1 µS/cm	166
Exchangeable Ca	0.1 meq/100g	4.0
Exchangeable Mg	0.1 meq/100g	4.3
Exchangeable K	0.1 meq/100g	0.3
Exchangeable Na	0.1 meq/100g	1.9
CEC	0.1 meq/100g	10.5
ESP (%)	0.001	18.3
Ca:Mg	0.1	0.9
Chloride	10 mg/kg	400
Emerson Crumb Class		2

Soil & landform Elements

Regional Soil Type	Sodosol
Map Reference	-
Permeability	Moderate
Drainage	Medium
Landform	Plain
Vegetation	Sparse
Site Disturbance	Nil
Microrelief	nil
Erosion	Moderate
PAWC	100-125mm
GQAL Class	A

Depth	Soil Descriptions
0 - 0.3	Silty CLAY, soft, very loose, minor roots, pale brown/grey, Poorly drained
0.3-0.6	Clay, dry, soft to hard, very loose, minor roots, dark brown.

Soil Types

Site ID: SS07 Site Location: KP10

Regional Soil Type: Sodosol

Landform:	Va50
Undulating or gently undulating lands: dominant are sandy or loamy often gritty duplex soils (Dy3.43)with lesser (Dy3.33) and (Dy3.42). Some similar (Dy2) soils also occur. Closely associated, particularlyon higher landscape sites, are loamy red duplex soils (Dr2.12), rarely (Dr2.13). Small areas of graniteoutcrop within the unit have shallow coarse sands (Uc4.2 and Uc4.1), less commonly (Uc2.12)	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	8.2
SAR	0.01	93.1
EC	1 µS/cm	712
Exchangeable Ca	0.1 meq/100g	2.6
Exchangeable Mg	0.1 meq/100g	3.2
Exchangeable K	0.1 meq/100g	0.2
Exchangeable Na	0.1 meq/100g	3.5
CEC	0.1 meq/100g	9.6
ESP (%)	0.001	37.2
Ca:Mg	0.1	0.8
Chloride	10 mg/kg	1050
Emerson Crumb Class		na

Soil & landform Elements

Regional Soil Type	Sodosol
Map Reference	-
Permeability	Moderate
Drainage	Medium
Landform	Plain
Vegetation	Sparse
Site Disturbance	Low
Microrelief	mild
Erosion	Moderate
PAWC	≤50mm
GQAL Class	C

Depth	**Soil Descriptions**
0 - 0.3	Clay, pale brown grey, very soft, very loose
0.3-0.6	sorted gravel, rounded 0.1mm, traces of clay.

Soil Types

Site ID: SS08 Site Location: KP15

Regional Soil Type: Sodosol

Landform:	Va50
Undulating or gently undulating lands: dominant are sandy or loamy often gritty duplex soils (Dy3.43)with lesser (Dy3.33) and (Dy3.42). Some similar (Dy2) soils also occur. Closely associated, particularlyon higher landscape sites, are loamy red duplex soils (Dr2.12), rarely (Dr2.13). Small areas of graniteoutcrop within the unit have shallow coarse sands (Uc4.2 and Uc4.1), less commonly (Uc2.12)	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	6.9
SAR	0.01	1.41
EC	1 µS/cm	27
Exchangeable Ca	0.1 meq/100g	11.8
Exchangeable Mg	0.1 meq/100g	5
Exchangeable K	0.1 meq/100g	0.3
Exchangeable Na	0.1 meq/100g	0.2
CEC	0.1 meq/100g	17.3
ESP (%)	0.001	1.1
Ca:Mg	0.1	2.4
Chloride	10 mg/kg	250
Emerson Crumb Class		na

Soil & landform Elements

Regional Soil Type	Sodosol
Map Reference	-
Permeability	Moderate
Drainage	Medium
Landform	Plain
Vegetation	Sparse
Site Disturbance	Low
Microrelief	mild
Erosion	Moderate
PAWC	<150mm
GQAL Class	C

Depth	**Soil Descriptions**
0 - 0.3	Sandy CLAY, fine/medium grain, soft to hard, very loose, minor roots, dark brown black, minor traces of fine sorted sands and gravel, rounded 0.1mm
0.3-0.4	Sandy CLAY, fine /medium grain Hard, very loose, minor roots, dark brown/black, traces fine sands and gravel, rounded 0.1mm.
0.4-0.6	Sandy CLAY, medium/coarse grain, hard very loose, minor roots, brown/yellow, trace fine sorted sands and gravel, rounded 0.1mm.

Soil Types

Site ID: SS09 Site Location: KP28

Regional Soil Type: Chromosol

Landform:	Qa14
Moderately or, less commonly, strongly undulating lands with occasional isolated hills surrounded by stronglydissected steep slopes; limited rock outcrop may occur throughout: dominant are loamy red duplex soils(Dr2.12) of shallow to moderate depth (18-30 in.). Commonly associated are (Dr2.11), (Dr2.21), (Dr2.22),(Gn3.12), and less often (Dr2.13). Some similar (Db1) soils occur and in some areas yellow loamy duplexsoils (Dy2.21, Dy2.22) are locally dominant. Also often closely associated, particularly on lower slopes,are mottled yellow duplex soils (Dy3.42, Dy3.43) and (Dy3.32). The hilly areas have very shallow stonyduplex soils (Dr2.12), (Dy2.12), and (Db1.12), stony loams (Um1.43) and (Um4.2), or gritty sands (Uc4.2)and (Uc2.12). Very occasional small areas of dark clays (Ug5.13) or red-brown clays (Ug5.37) may also beincluded in the unit	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	5.3
SAR	0.01	0.62
EC	1 µS/cm	19
Exchangeable Ca	0.1 meq/100g	2.2
Exchangeable Mg	0.1 meq/100g	1.6
Exchangeable K	0.1 meq/100g	0.6
Exchangeable Na	0.1 meq/100g	0.3
CEC	0.1 meq/100g	4.6
ESP (%)	0.001	5.9
Ca:Mg	0.1	1.4
Chloride	10 mg/kg	220
Emerson Crumb Class		na

Soil & landform Elements

Regional Soil Type	Chromosol
Map Reference	20° 7' 24.328" S 147° 51' 6.165" E
Permeability	Moderate
Drainage	Medium
Landform	Flat
Vegetation	Open forest
Site Disturbance	Nil
Microrelief	mild
Erosion	Moderate
PAWC	>150mm
GQAL Class	C

Depth	Soil Descriptions
0 - 0.3	Claye sandy GRAVEL, fine grain, very soft, very loose, minor roots, dark red/yellow, fine poorly sorted sands and subangular gravel 0.3mm, traces of clays.
0.3-0.6	Clayey sandy GRAVEL, fine grain, very soft , very loose, fine poorly sorted sands and subangular gravel 0.3mm, minor roots, dark red/orange, minor traces of clays
0.6-0.9	Clayey sandy GRAVEL, fine to medium grain, soft, very loose, poorly sorted sands and gravel, sun-angular gravel 0.3mm, pale orange /Yellowminor roots, minor traces of clays.

Soil Types

Site ID: SS10 Site Location: KP45

Regional Soil Type: Chromosol

Landform: Qa14	
Moderately or, less commonly, strongly undulating lands with occasional isolated hills surrounded by stronglydissected steep slopes; limited rock outcrop may occur throughout: dominant are loamy red duplex soils(Dr2.12) of shallow to moderate depth (18-30 in.). Commonly associated are (Dr2.11), (Dr2.21), (Dr2.22),(Gn3.12), and less often (Dr2.13). Some similar (Db1) soils occur and in some areas yellow loamy duplexsoils (Dy2.21, Dy2.22) are locally dominant. Also often closely associated, particularly on lower slopes,are mottled yellow duplex soils (Dy3.42, Dy3.43) and (Dy3.32). The hilly areas have very shallow stonyduplex soils (Dr2.12), (Dy2.12), and (Db1.12), stony loams (Um1.43) and (Um4.2), or gritty sands (Uc4.2)and (Uc2.12). Very occasional small areas of dark clays (Ug5.13) or red-brown clays (Ug5.37) may also beincluded in the unit	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	7.3
SAR	0.01	7.24
EC	1 µS/cm	38
Exchangeable Ca	0.1 meq/100g	5.5
Exchangeable Mg	0.1 meq/100g	4.4
Exchangeable K	0.1 meq/100g	0.6
Exchangeable Na	0.1 meq/100g	0.8
CEC	0.1 meq/100g	11.3
ESP (%)	0.001	7.6
Ca:Mg	0.1	1.2
Chloride	10 mg/kg	280
Emerson Crumb Class		5

Soil & landform Elements

Regional Soil Type	Chromosol
Map Reference	20° 14' 8.501" S 147° 48' 54.174" E
Permeability	High
Drainage	Low
Landform	Alluvial depression
Vegetation	Open forest / alluvial vegetation
Site Disturbance	Nil
Microrelief	mild
Erosion	Moderate
PAWC	125-150mm
GQAL Class	C

Depth	**Soil Descriptions**
0 - 0.3	Sand Gravel Clay, Fine grain,Pale brown Orange, Soft Minor roots, Fine poorly sorted coarse sands and subangular gravels 0.3mm
0.4-0.6	Sand Gravel Clay Fine Pale Yellow Orange Very Soft Very Loose profile change at 0.3-0.4m, poorly sorted coarse sands and subangular gravels 0.9mm

Soil Types

Site ID: SS11 Site Location: KP50

Regional Soil Type: Chromosol

Landform:	Qa14
Moderately or, less commonly, strongly undulating lands with occasional isolated hills surrounded by stronglydissected steep slopes; limited rock outcrop may occur throughout: dominant are loamy red duplex soils(Dr2.12) of shallow to moderate depth (18-30 in.). Commonly associated are (Dr2.11), (Dr2.21), (Dr2.22),(Gn3.12), and less often (Dr2.13). Some similar (Db1) soils occur and in some areas yellow loamy duplexsoils (Dy2.21, Dy2.22) are locally dominant. Also often closely associated, particularly on lower slopes,are mottled yellow duplex soils (Dy3.42, Dy3.43) and (Dy3.32). The hilly areas have very shallow stonyduplex soils (Dr2.12), (Dy2.12), and (Db1.12), stony loams (Um1.43) and (Um4.2), or gritty sands (Uc4.2)and (Uc2.12). Very occasional small areas of dark clays (Ug5.13) or red-brown clays (Ug5.37) may also beincluded in the unit	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	na
SAR	0.01	na
EC	1 µS/cm	na
Exchangeable Ca	0.1 meq/100g	na
Exchangeable Mg	0.1 meq/100g	na
Exchangeable K	0.1 meq/100g	na
Exchangeable Na	0.1 meq/100g	na
CEC	0.1 meq/100g	na
ESP (%)	0.001	na
Ca:Mg	0.1	na
Chloride	10 mg/kg	na
Emerson Crumb Class		5

Soil & landform Elements

Regional Soil Type	Chromosol
Map Reference	-
Permeability	Moderate
Drainage	Medium
Landform	Plain
Vegetation	Sparse
Site Disturbance	Nil
Microrelief	nil
Erosion	Low
PAWC	<50mm
GQAL Class	C

Depth	Soil Descriptions
0 - 0.3	Sandy Gravelly CLAY, fine to coarse grain sand, , soft to hard, loose, roots, medium poorly sorted sand and gravel, dark red/brownsubangular gravel 0.7mm
0.4-0.6	Clayey sandy GRAVEL, Fine grain sand, , soft, loose, minor roots, dark red/brown, colour gets deeper in colour (reds) with depth.

Soil Types

Site ID: SS12 Site Location: KP55

Regional Soil Type:

Landform: Qa14	
Moderately or, less commonly, strongly undulating lands with occasional isolated hills surrounded by stronglydissected steep slopes; limited rock outcrop may occur throughout: dominant are loamy red duplex soils(Dr2.12) of shallow to moderate depth (18-30 in.). Commonly associated are (Dr2.11), (Dr2.21), (Dr2.22),(Gn3.12), and less often (Dr2.13). Some similar (Db1) soils occur and in some areas yellow loamy duplexsoils (Dy2.21, Dy2.22) are locally dominant. Also often closely associated, particularly on lower slopes,are mottled yellow duplex soils (Dy3.42, Dy3.43) and (Dy3.32). The hilly areas have very shallow stonyduplex soils (Dr2.12), (Dy2.12), and (Db1.12), stony loams (Um1.43) and (Um4.2), or gritty sands (Uc4.2)and (Uc2.12). Very occasional small areas of dark clays (Ug5.13) or red-brown clays (Ug5.37) may also beincluded in the unit	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	na
SAR	0.01	na
EC	1 µS/cm	na
Exchangeable Ca	0.1 meq/100g	na
Exchangeable Mg	0.1 meq/100g	na
Exchangeable K	0.1 meq/100g	na
Exchangeable Na	0.1 meq/100g	na
CEC	0.1 meq/100g	na
ESP (%)	0.001	na
Ca:Mg	0.1	na
Chloride	10 mg/kg	na
Emerson Crumb Class		na

Soil & landform Elements

Regional Soil Type	Chromosol
Map Reference	-
Permeability	Moderate
Drainage	Medium
Landform	Plain
Vegetation	Sparse
Site Disturbance	Nil
Microrelief	mild
Erosion	Moderate
PAWC	<50mm
GQAL Class	C

Depth	Soil Descriptions
0 - 0.3	Sandy gravelly CLAY, fine grain sand, very soft very loose minor roots, pale brown orange, sparce and poorly sorted coarse sands and subangular to rounded gravel 0.9mm
0.4-0.6	Sandy gravelly CLAY, fine grain sand, Pale Brown White Very soft Very loose profile change at 0.5m, getting paler down the profile, minor roots, medium poorly sorted sand and gravel, subangular to rounded gravel 0.7mm
0.6-0.9	Sandy Gravelly CLAY, fine grain sand, Pale White Brown Very soft Very loose Minor roots,medium poorly sorted sand and gravel, sub-angular gravel 0.7mm

Soil Types

Site ID: SS13 Site Location: KP70

Regional Soil Type: Sodosol

Landform:	Sl17
Valley plains: chief soils are probably hard alkaline yellow soils (Dy2.33) but a variety of similar (Dr) and(Db) soils occur, including (Dr2.33), (Dr2.73), and (Db1.33, Db1.32). Associated are crusty loamy soils(Dy1.33) and (Dr1.33) and cracking clays (Ug5.2) and (Ug5.3)	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	7.3
SAR	0.01	1.81
EC	1 µS/cm	29
Exchangeable Ca	0.1 meq/100g	15.5
Exchangeable Mg	0.1 meq/100g	11.1
Exchangeable K	0.1 meq/100g	0.6
Exchangeable Na	0.1 meq/100g	0.3
CEC	0.1 meq/100g	27.5
ESP (%)	0.001	1.1
Ca:Mg	0.1	1.4
Chloride	10 mg/kg	210
Emerson Crumb Class		na

Soil & landform Elements

Regional Soil Type	Sodosol
Map Reference	20°27' 37.124" S 147° 46' 13.438" E
Permeability	Moderate
Drainage	High
Landform	Flat
Vegetation	Open forest
Site Disturbance	Nil
Microrelief	mild
Erosion	Moderate
PAWC	75-100mm
GQAL Class	A

Depth	**Soil Descriptions**
0 - 0.3	Clay Fine Dark Brown Black Very soft Minor roots, profile change 0.25 to 0.30m, lighter colour through profile, humid soils
0.4-0.6	Clay Gravel Fine Brown Orange Very soft Humid,poorly sorted gravels, subangular to angular gravel 0.3mm
0.6-0.9	Clay Gravel Fine Brown Orange Very soft Humid,poorly sorted gravels, subangular to angular gravel 0.3mm

Soil Types

Site ID: SS14 Site Location: KP75

Regional Soil Type: Sodosol

Landform:	Qa12
High hilly lands with some mountainous areas; nearly all hills have steep slopes but crests are oftenrounded; marginal to the unit, topography may be strongly undulating; rock outcrop is commonthroughout: dominant are shallow stony loamy red duplex soils (Dr2.12), with lesser (Dr2.22) and(Dr2.62). Other duplex soils also occur, chiefly (Db1.12), (Dy2.22), (Dy2.33), (Dy2.43), and similar(Dy3) soils. Small areas of red friable earths (Gn3.12, Gn3.14, and Gn3.15) are associated in some areas.Higher hill crests and more stony sites have shallow stony loams (Um1.43), (Um4.1), and (Um2.12)or sands (Uc2.12), (Uc4.1), and (Uc4.2)	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	7.1
SAR	0.01	0.38
EC	1 µS/cm	19
Exchangeable Ca	0.1 meq/100g	6.8
Exchangeable Mg	0.1 meq/100g	1
Exchangeable K	0.1 meq/100g	0.3
Exchangeable Na	0.1 meq/100g	0.5
CEC	0.1 meq/100g	8.6
ESP (%)	0.001	5.5
Ca:Mg	0.1	6.7
Chloride	10 mg/kg	90
Emerson Crumb Class		na

Soil & landform Elements

Regional Soil Type	Sodosol
Map Reference	20° 30' 40.564" S 147° 50' 43.632" E
Permeability	High
Drainage	Medium
Landform	Flat
Vegetation	Heavy vegetation
Site Disturbance	Roadway cleared to the east and west
Microrelief	mild
Erosion	Moderate
PAWC	>150mm
GQAL Class	A

Depth	Soil Descriptions
0 - 0.3	Clayey sandy GRAVEL, Fine grain sand, Pale Orange, Very soft, Very loose, Minor roots, Fine poorly sorted coarse sands and subangulargravels 0.3mm
0.3-0.6	Clayey sandy GRAVEL, Fine grain sand, Pale Yellow/ Orange, Very soft, Very loose, profile change at 0.3-0.4m, Poorly sorted coarse sands and subangular gravels 0.9mm

Soil Types

Site ID: SS15 Site Location: KP75

Regional Soil Type: Sodosol

Landform: MM12	
Alluvial plains, sometimes with slight to moderate (1-2 ft) gilgai microrelief: dominant soils are browndeep clays (Ug5.34) with lesser grey clays (Ug5.25 and Ug5.24). Associated are many small areaswith thin-surfaced loamy duplex soils (Db1.13 and Db1.33) and lesser similar (Dy2) soils	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	na
SAR	0.01	0.42
EC	1 µS/cm	22
Exchangeable Ca	0.1 meq/100g	4.1
Exchangeable Mg	0.1 meq/100g	1
Exchangeable K	0.1 meq/100g	0.8
Exchangeable Na	0.1 meq/100g	0.1
CEC	0.1 meq/100g	6
ESP (%)	0.001	2.2
Ca:Mg	0.1	4.3
Chloride	10 mg/kg	160
Emerson Crumb Class		na

Soil & landform Elements

Regional Soil Type	Sodosol
Map Reference	44' 45.923" E
Permeability	Low
Drainage	Medium
Landform	Flat
Vegetation	Sparse vegetation
Site Disturbance	Roadway cleared immediately north
Microrelief	nil
Erosion	Moderate
PAWC	>150mm
GQAL Class	A

Depth	**Soil Descriptions**
0 - 0.3	Clay, Pale, Brown Yellow, Very soft, Very loose, Minor roots.
0.4-0.6	Gravelly CLAY, Pale Brown/Grey, Very soft to Stiff, Very loose, Minor roots, poorly sorted gravels, subangular to angular quartz and gravel 0.3mm
0.6-0.9	CLAY, Pale Brown/Grey, Very soft to Stiff, Very loose, Hard clays, minor roots.

Soil Types

Site ID: SS16 Site Location: KP85

Regional Soil Type: Sodosol

Landform:	Vd5
Moderate to strongly undulating lands with occasional high strike ridges with sandstone outcrop:dominant are loamy duplex soils with mottled yellow-brown subsoils. The chief form is (Dy3.33) but(Dy3.23) and (Dy3.43) also occur. Important areas of red loamy duplex soils (Dr2.12), (Dr2.32),(Dr2.42), and (Dr3.33) are present in the unit. Associated small alluvial plains have grey loamy duplexsoils (Dy2.43) and occasional highly calcareous ridges have shallow loams (Um1.3). Where sandstoneoutcrop is prominent shallow sand soils of units JJ13 and Cd15 are found	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	8.8
SAR	0.01	ND
EC	1 µS/cm	84
Exchangeable Ca	0.1 meq/100g	34.1
Exchangeable Mg	0.1 meq/100g	0.7
Exchangeable K	0.1 meq/100g	0.5
Exchangeable Na	0.1 meq/100g	ND
CEC	0.1 meq/100g	35.4
ESP (%)	0.001	0.3
Ca:Mg	0.1	50.6
Chloride	10 mg/kg	190
Emerson Crumb Class		na

Soil & landform Elements

Regional Soil Type	Sodosol
Map Reference	44 17.999" E
Permeability	High
Drainage	Low
Landform	Flat
Vegetation	Sparse vegetation
Site Disturbance	Cleared for roadway, development to the north and west.
Microrelief	mild
Erosion	Moderate
PAWC	>150mm
GQAL Class	C

Depth	Soil Descriptions
0 - 0.3	Gravelly CLAY, Dark Brown/ White Very soft Very loose Minor roots, profile change at 0.2 - 0.3m, poorly sorted gravels, subangular to angular quartz and gravel 0.3mm to 0.7mm
0.3-0.6	Gravel, Pale Yellow/ Grey, Very soft, Very loose, Poorly sorted gravels, subangular to angular quartz and gravel 0.3mm
0.6-0.9	Gravel, Pale Yellow/White, Very soft, Very loose, Poorly sorted gravels, subangular to angular quartz and gravel 0.1mm

Soil Types

Site ID: SS17 Site Location: KP90

Regional Soil Type: Sodosol

Landform:	Qb27
Gently undulating alluvial flood-plains, often with marked terraces, levees, and shallow drainagedepressions: the dominant soils are those of the older terraces and levees. They have deep sandy orsandy loam A horizons (12-24 in.) with a clear change to reddish brown clay or sandy clay. The chiefform is (Dr2.22) with associated (Dr4.22), (Dy2.22), (Dy2.33), (Dy3.33), (Db1.13), and (Dr2.23). In theshallow drainage depressions loamy duplex soils (Dy2.43) and (Dy3.43) occur, with uniform loams(Um6.11) on the most recent terraces that may be subject to flooding	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	7.7
SAR	0.01	5.06
EC	1 µS/cm	59
Exchangeable Ca	0.1 meq/100g	7.8
Exchangeable Mg	0.1 meq/100g	7.1
Exchangeable K	0.1 meq/100g	0.3
Exchangeable Na	0.1 meq/100g	2.3
CEC	0.1 meq/100g	17.5
ESP (%)	0.001	12.9
Ca:Mg	0.1	1.1
Chloride	10 mg/kg	140
Emerson Crumb Class		na

Soil & landform Elements

Regional Soil Type	Sodosol
Map Reference	-
Permeability	Moderate
Drainage	Medium
Landform	Undulating
Vegetation	Sparse
Site Disturbance	Nil
Microrelief	mild
Erosion	Moderate
PAWC	<50mm
GQAL Class	C

Depth	**Soil Descriptions**
0 - 0.3	Silty gravelly SAND, Fine to Medium grain, Soft, Loose, Brown, Refusal on gravel at 0.3m

Soil Types

Site ID: SS18 Site Location: KP100

Regional Soil Type: Sodosol

Landform: MM13	
Undulating or level plains, occasionally with slight to moderate gilgai microrelief (1-2 ft): dominantsoils are brown clays of moderate depth (Ug5.33 and Ug5.32) associated with similar grey clays (Ug5.22,Ug5.23, and Ug5.24). Included in the unit, as mapped, are small areas of red-brown friable earths(Gn3.12); deeper clay soils (Ug5.25), (Ug5.15), and (Ug5.34); some small low basaltic hills with shallowstony (Um6) and (Uf6) soils; and small alluvial plains with loamy duplex soils (Db1.33), (Dd1.33),and (Dy2.33)	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	6.9
SAR	0.01	0.27
EC	1 µS/cm	37
Exchangeable Ca	0.1 meq/100g	6.8
Exchangeable Mg	0.1 meq/100g	2.9
Exchangeable K	0.1 meq/100g	0.8
Exchangeable Na	0.1 meq/100g	0.4
CEC	0.1 meq/100g	10.8
ESP (%)	0.001	3.2
Ca:Mg	0.1	2.3
Chloride	10 mg/kg	200
Emerson Crumb Class		5

Soil & landform Elements

Regional Soil Type	Sodosol
Map Reference	42' 57.686" E
Permeability	High
Drainage	Medium
Landform	Flat
Vegetation	Sparse vegetation
Site Disturbance	Some clearing evident to the west and north
Microrelief	nil
Erosion	Moderate
PAWC	≥150mm
GQAL Class	C

Depth	Soil Descriptions
0 - 0.3	CLAY, Very soft, Very loose, Minor roots,Dark Brown/Black getting lighter colour through profile.
0.4-0.6	Gravelly CLAY, Very soft, Very loose, Humid soils, Brown/ Orange, poorly sorted gravels, subangular to angular gravel 0.3mm
0.6-0.9	Gravelly CLAY Fine Nil Brown Orange Very soft Very loose Humid soils,poorly sorted gravels, subangular to angular gravel 0.3mm

Soil Types

Site ID: SS19 Site Location: KP105

Regional Soil Type: Vertosol

Landform:	Qb27
Gently undulating alluvial flood-plains, often with marked terraces, levees, and shallow drainagedepressions: the dominant soils are those of the older terraces and levees. They have deep sandy orsandy loam A horizons (12-24 in.) with a clear change to reddish brown clay or sandy clay. The chiefform is (Dr2.22) with associated (Dr4.22), (Dy2.22), (Dy2.33), (Dy3.33), (Db1.13), and (Dr2.23). In theshallow drainage depressions loamy duplex soils (Dy2.43) and (Dy3.43) occur, with uniform loams(Um6.11) on the most recent terraces that may be subject to flooding	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	7.8
SAR	0.01	6.08
EC	1 µS/cm	48
Exchangeable Ca	0.1 meq/100g	5.6
Exchangeable Mg	0.1 meq/100g	3.7
Exchangeable K	0.1 meq/100g	0.6
Exchangeable Na	0.1 meq/100g	0.9
CEC	0.1 meq/100g	10.8
ESP (%)	0.001	8.1
Ca:Mg	0.1	1.5
Chloride	10 mg/kg	150
Emerson Crumb Class		3

Soil & landform Elements

Regional Soil Type	Vertosol
Map Reference	20° 44' 57.129" S 147° 50' 56.340" E
Permeability	Low
Drainage	High
Landform	Flat
Vegetation	Sparse vegetation
Site Disturbance	Cleared for roadway
Microrelief	mild
Erosion	Low
PAWC	≥150mm
GQAL Class	C

Depth	Soil Descriptions
0 - 0.3	Clay Dark Brown minor roots, profile change at 0.3m
0.4-0.6	Clay Dark Orange Hard to Friable
0.6-0.9	Clay Dark Orange Hard to Friable

Soil Types

Site ID: SS20 Site Location: KP110

Regional Soil Type: Vertosol

Landform:	MM12
Alluvial plains, sometimes with slight to moderate (1-2 ft) gilgai microrelief: dominant soils are browndeep clays (Ug5.34) with lesser grey clays (Ug5.25 and Ug5.24). Associated are many small areaswith thin-surfaced loamy duplex soils (Db1.13 and Db1.33) and lesser similar (Dy2) soils	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	7.9
SAR	0.01	11.5
EC	1 µS/cm	3100
Exchangeable Ca	0.1 meq/100g	37.5
Exchangeable Mg	0.1 meq/100g	10.9
Exchangeable K	0.1 meq/100g	1
Exchangeable Na	0.1 meq/100g	8.6
CEC	0.1 meq/100g	58
ESP (%)	0.001	14.8
Ca:Mg	0.1	3.4
Chloride	10 mg/kg	900
Emerson Crumb Class		na

Soil & landform Elements

Regional Soil Type	Vertosol
Map Reference	50' 33.423" E
Permeability	Low
Drainage	High
Landform	Flat
Vegetation	No vegetation
Site Disturbance	Cleared for roadway
Microrelief	mild
Erosion	Low
PAWC	≤50mm
GQAL Class	D

Depth	**Soil Descriptions**
0 - 0.3	Clay Brown Orange Hard Minor roots, profile change at 0.3m
0.4-0.6	Clay Dark Brown Grey Hard to Friable
0.6-0.9	Clay Dark Brown Grey Hard to Friable

Soil Types

Site ID: SS21 Site Location: KP130

Regional Soil Type: Tenosol

Landform:	Va55
Undulating or moderately undulating lands with broad valleys: dominant are sandy to loamy mottledduplex soils of shallow to moderate depth (18-30 in.). The chief form is (Dy3.43) but a range of otherloamy duplex soils also occurs, chiefly (Dy3.33), (Dy3.32), (Dr3.21), (Dr2.12), (Dr2.42), (Dr2.31),(Dy2.43), (Db1.13), (Db1.43), and (Db1.33). In some lower sites there may be small areas of slightlygilgaied brown clays (Ug5.32 and Ug5.34). Throughout the unit there are small areas where the soilsurface is covered with a mantle of billy gravel to 4 in. diameter	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	5.8
SAR	0.01	1.42
EC	1 µS/cm	9
Exchangeable Ca	0.1 meq/100g	ND
Exchangeable Mg	0.1 meq/100g	0.6
Exchangeable K	0.1 meq/100g	ND
Exchangeable Na	0.1 meq/100g	ND
CEC	0.1 meq/100g	0.7
ESP (%)	0.001	8.6
Ca:Mg	0.1	0.2
Chloride	10 mg/kg	20
Emerson Crumb Class		na

Soil & landform Elements

Regional Soil Type	Tenosol
Map Reference	-
Permeability	Moderate
Drainage	Medium
Landform	Undulating
Vegetation	Sparse
Site Disturbance	Nil
Microrelief	mild
Erosion	Moderate
PAWC	<50mm
GQAL Class	C

Depth	Soil Descriptions
0 - 0.3	Sand Gravel Fine to Medium Dark Red Orange, pisolite to 0.2m
0.4-0.6	Clay Gravel Silt Fine to Medium Soft to Hard Roots

Soil Types

Site ID: SS22 Site Location: KP130

Regional Soil Type: Tenosol/Sodosol

Landform:	Va55
Undulating or moderately undulating lands with broad valleys: dominant are sandy to loamy mottledduplex soils of shallow to moderate depth (18-30 in.). The chief form is (Dy3.43) but a range of otherloamy duplex soils also occurs, chiefly (Dy3.33), (Dy3.32), (Dr3.21), (Dr2.12), (Dr2.42), (Dr2.31),(Dy2.43), (Db1.13), (Db1.43), and (Db1.33). In some lower sites there may be small areas of slightlygilgaied brown clays (Ug5.32 and Ug5.34). Throughout the unit there are small areas where the soilsurface is covered with a mantle of billy gravel to 4 in. diameter	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	6.1
SAR	0.01	3.21
EC	1 µS/cm	12
Exchangeable Ca	0.1 meq/100g	9.9
Exchangeable Mg	0.1 meq/100g	0.2
Exchangeable K	0.1 meq/100g	0.2
Exchangeable Na	0.1 meq/100g	ND
CEC	0.1 meq/100g	10.3
ESP (%)	0.001	0.6
Ca:Mg	0.1	51.1
Chloride	10 mg/kg	180
Emerson Crumb Class		na

Soil & landform Elements

Regional Soil Type	Tenosol/Sodosol
Map Reference	43' 15.168" E
Permeability	High
Drainage	Medium
Landform	Downslope
Vegetation	Heavy vegetation
Site Disturbance	Nil
Microrelief	nil
Erosion	Moderate
PAWC	75 - 100mm
GQAL Class	C

Depth	Soil Descriptions
0 - 0.3	Gravelly SAND Fine Brown Grey loose, profile change at 0.3m,
0.4-0.6	Gravelly SAND, Fine Pale Yellow Grey loose, poorly sorted sand and gravel, rounded, 0.1mm

Soil Types

Site ID: SS23 Site Location: KP135

Regional Soil Type: Sodosol/Kandosol

Landform:	Bz9
Low hilly or strongly undulating lands with some lateritic or sandstone mesas: dominant soils are deepsands (Uc1 .21), but on the low mesas are leached sands (Uc2. 12) and sandy red earths (Gn2. 11). On theoutwash slopes sandy duplex soils (Dy5.41 and Dy5.42) occur. Data are limited	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	7.4
SAR	0.01	37.5
EC	1 µS/cm	280
Exchangeable Ca	0.1 meq/100g	3.1
Exchangeable Mg	0.1 meq/100g	3.5
Exchangeable K	0.1 meq/100g	0.2
Exchangeable Na	0.1 meq/100g	2.4
CEC	0.1 meq/100g	9.3
ESP (%)	0.001	26.4
Ca:Mg	0.1	0.9
Chloride	10 mg/kg	610
Emerson Crumb Class		na

Soil & landform Elements

Regional Soil Type	Sodosol/Kandosol
Map Reference	-
Permeability	Moderate
Drainage	Medium
Landform	Undulating
Vegetation	Sparse
Site Disturbance	Nil
Microrelief	mild
Erosion	Low
PAWC	<50mm
GQAL Class	C

Depth	Soil Descriptions
0 - 0.3	Sandy gravelly SILT, Finegrain, Yellow/Brown, Poorly sorted, subangular gravels and sands,>0.7mm
0.4-0.6	Sandy gravelly SILT, Fine grain, Orange, poorly sorted subangular gravels and sands,>0.7mm
0.6-0.9	Gravelly SILT, Fine grain, Orange, Poorly sorted, subangular gravels >.3mm, colour change 0.7m

Soil Types

Site ID: SS24 Site Location: KP135

Regional Soil Type: Tenosol

Landform: Cd15	
Low hilly to strongly undulating elevated lands with some steeper high hilly areas; rock outcrop isvery common throughout: dominant soils are very shallow (6-18 in.) stony gritty leached sands orsandy loams (Uc2.12). Less common are similar stony loams (Um2.12) and (Um4.1). On some slopes	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	4.7
SAR	0.01	0.44
EC	1 µS/cm	52
Exchangeable Ca	0.1 meq/100g	20.2
Exchangeable Mg	0.1 meq/100g	0.4
Exchangeable K	0.1 meq/100g	0.2
Exchangeable Na	0.1 meq/100g	ND
CEC	0.1 meq/100g	20.8
ESP (%)	0.001	0.3
Ca:Mg	0.1	51.3
Chloride	10 mg/kg	160
Emerson Crumb Class		5

Soil & landform Elements

Regional Soil Type	Tenosol
Map Reference	40' 29.538" E
Permeability	Medium
Drainage	Low
Landform	Flat
Vegetation	Heavy vegetation
Site Disturbance	Cleared roadway southwest
Microrelief	mild
Erosion	Moderate
PAWC	<50mm
GQAL Class	C

Depth	Soil Descriptions
0 - 0.3	CLAY Dark Brown Red Minor roots, profile change 0.25 to 0.3m, getting lighter colour through profile,
0.4-0.6	Gravelly CLAY, Fine to Medium Orange Red Hard, poorly sorted subangular to angular gravel 0.3mm
0.6-0.9	Gravelly CLAY, Fine to Medium Orange Red poorly sorted gravels, subangular to angular gravel 0.3mm

Soil Types

Site ID: SS25 Site Location: KP145

Regional Soil Type: Kandosol

Landform:	TB119
Undulating to strongly undulating lands with many low sandstone mesas, lateritic scarps, and their dissectedremnants: the dominant soils are probably those on higher sloping sites where very pale grey loamyduplex soils (Dy3.41) occur, associated with (Dy3.42) and similar (Dy2) soils. On the low dissectedkaolinized sandstone mesas and pallid-zone scarps shallow stony sands (Uc2.12) are common associatedwith very pale sandy or loamy duplex soils (Dy3.41), (Dy2.41), (Dg4.41), and (Dg2.81). Some moreextensive level plains or plateau surfaces have loamy yellow earths (Gn2.21 and Gn2.25) with lesserareas of loamy red earths (Gn2. 11 and Gn2. 12). Throughout the unit adjacent to drainage lines are smallplains of alkaline loamy duplex soils (Dy2.43) and (Dy3.43), and included in the unit as mapped aresmall inclusions of unit Cd14	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	4.6
SAR	0.01	0.32
EC	1 µS/cm	15
Exchangeable Ca	0.1 meq/100g	1.6
Exchangeable Mg	0.1 meq/100g	0.5
Exchangeable K	0.1 meq/100g	0.7
Exchangeable Na	0.1 meq/100g	0.1
CEC	0.1 meq/100g	2.9
ESP (%)	0.001	4
Ca:Mg	0.1	3.3
Chloride	10 mg/kg	90
Emerson Crumb Class		3

Soil & landform Elements

Regional Soil Type	Kandosol
Map Reference	45' 9.029" E
Permeability	High
Drainage	Low
Landform	Flat
Vegetation	Open forest
Site Disturbance	Nil
Microrelief	mild
Erosion	Low
PAWC	100-125mm
GQAL Class	C

Depth	Soil Descriptions
0 - 0.3	Silt Clay Fine Orange Red humid soils
0.4-0.6	Silt Clay Orange Grey
0.6-0.9	Silt Clay Fine Yellow Orange profile change at 0.6m, fine well sorted humid soils, fine traces of silt

Soil Types

Site ID: SS26 Site Location: KP155

Regional Soil Type: Kandosol

Landform:	Cd14
Low hilly to strongly undulating elevated lands with some steeper high hilly areas; rock outcrop isvery common throughout: dominant soils are very shallow (6-18 in.) stony gritty leached sands orsandy loams (Uc2.12). Less common are similar stony loams (Um2.12) and (Um4.1). On some slopesshallow stony duplex soils occur, chiefly (Dy3.41), (Dy3.42), and similar (Dy2) soils. Throughoutthis unit there may be small remnants of unit Tb119	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	na
SAR	0.01	na
EC	1 µS/cm	na
Exchangeable Ca	0.1 meq/100g	na
Exchangeable Mg	0.1 meq/100g	na
Exchangeable K	0.1 meq/100g	na
Exchangeable Na	0.1 meq/100g	na
CEC	0.1 meq/100g	na
ESP (%)	0.001	na
Ca:Mg	0.1	na
Chloride	10 mg/kg	na
Emerson Crumb Class		na

Soil & landform Elements

Regional Soil Type	Kandosol
Map Reference	0
Permeability	Moderate
Drainage	Low
Landform	Undulating
Vegetation	Sparse
Site Disturbance	Nil
Microrelief	mild
Erosion	Low
PAWC	<50mm
GQAL Class	C

Depth	**Soil Descriptions**
0 - 0.3	Silty gravelly SAND, Fine Pale Orange Brown Very Soft Very Loose Minor gravel

Soil Types

Site ID: SS27 Site Location: KP158

Regional Soil Type: Tenosol

Landform:	Cd14
Low hilly to strongly undulating elevated lands with some steeper high hilly areas; rock outcrop isvery common throughout: dominant soils are very shallow (6-18 in.) stony gritty leached sands orsandy loams (Uc2.12). Less common are similar stony loams (Um2.12) and (Um4.1). On some slopesshallow stony duplex soils occur, chiefly (Dy3.41), (Dy3.42), and similar (Dy2) soils. Throughoutthis unit there may be small remnants of unit Tb119	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	4.9
SAR	0.01	1.72
EC	1 µS/cm	29
Exchangeable Ca	0.1 meq/100g	0.7
Exchangeable Mg	0.1 meq/100g	0.7
Exchangeable K	0.1 meq/100g	0.1
Exchangeable Na	0.1 meq/100g	ND
CEC	0.1 meq/100g	1.5
ESP (%)	0.001	4.2
Ca:Mg	0.1	1
Chloride	10 mg/kg	50
Emerson Crumb Class		na

Soil & landform Elements

Regional Soil Type	Tenosol
Map Reference	21° 11' 43.853" S 147° 36' 48.656" E
Permeability	High
Drainage	Low
Landform	Flat
Vegetation	Heavy vegetation
Site Disturbance	Nil
Microrelief	mild
Erosion	Moderate
PAWC	<50mm
GQAL Class	SS12-0.3-0.6

Depth	Soil Descriptions
0 - 0.3	Sand Clay Fine Pale Brown Refusal at 0.3m, rocks

Soil Types

Site ID: SS28 Site Location: KP160

Regional Soil Type: Tenosol

Landform:	Cd14
Low hilly to strongly undulating elevated lands with some steeper high hilly areas; rock outcrop isvery common throughout: dominant soils are very shallow (6-18 in.) stony gritty leached sands orsandy loams (Uc2.12). Less common are similar stony loams (Um2.12) and (Um4.1). On some slopesshallow stony duplex soils occur, chiefly (Dy3.41), (Dy3.42), and similar (Dy2) soils. Throughoutthis unit there may be small remnants of unit Tb119	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	na
SAR	0.01	na
EC	1 µS/cm	na
Exchangeable Ca	0.1 meq/100g	na
Exchangeable Mg	0.1 meq/100g	na
Exchangeable K	0.1 meq/100g	na
Exchangeable Na	0.1 meq/100g	na
CEC	0.1 meq/100g	na
ESP (%)	0.001	na
Ca:Mg	0.1	na
Chloride	10 mg/kg	na
Emerson Crumb Class		na

Soil & landform Elements

Regional Soil Type	Tenosol
Map Reference	-
Permeability	Moderate
Drainage	Low
Landform	Undulating
Vegetation	Sparse
Site Disturbance	Nil
Microrelief	nil
Erosion	Moderate
PAWC	<50mm
GQAL Class	D

Depth	Soil Descriptions
0 - 0.3	Silt Clay Fine Yellow Orange

Soil Types

Site ID: SS29 Site Location: KP165

Regional Soil Type: Tenosol

Landform:	Cd14
Low hilly to strongly undulating elevated lands with some steeper high hilly areas; rock outcrop isvery common throughout: dominant soils are very shallow (6-18 in.) stony gritty leached sands orsandy loams (Uc2.12). Less common are similar stony loams (Um2.12) and (Um4.1). On some slopesshallow stony duplex soils occur, chiefly (Dy3.41), (Dy3.42), and similar (Dy2) soils. Throughoutthis unit there may be small remnants of unit Tb119	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	6.2
SAR	0.01	2.55
EC	1 µS/cm	35
Exchangeable Ca	0.1 meq/100g	1.4
Exchangeable Mg	0.1 meq/100g	0.6
Exchangeable K	0.1 meq/100g	0.4
Exchangeable Na	0.1 meq/100g	ND
CEC	0.1 meq/100g	2.5
ESP (%)	0.001	3.2
Ca:Mg	0.1	2.3
Chloride	10 mg/kg	90
Emerson Crumb Class		na

Soil & landform Elements

Regional Soil Type	Tenosol
Map Reference	21° 16' 7.667" S 147° 32' 52.376" E
Permeability	High
Drainage	Medium
Landform	Alluvial depression
Vegetation	Heavy vegetation
Site Disturbance	Nil
Microrelief	mild
Erosion	Moderate
PAWC	<50mm
GQAL Class	D

Depth	Soil Descriptions
0 - 0.3	Gravelly SAND, Fine to Medium grain, Pale Brown/Orange, Loose, Refusal at 0.3m, rocks at surface

Soil Types

Site ID: SS30 Site Location: KP175

Regional Soil Type: Sodosol

Landform:	Cd14
Low hilly to strongly undulating elevated lands with some steeper high hilly areas; rock outcrop isvery common throughout: dominant soils are very shallow (6-18 in.) stony gritty leached sands orsandy loams (Uc2.12). Less common are similar stony loams (Um2.12) and (Um4.1). On some slopesshallow stony duplex soils occur, chiefly (Dy3.41), (Dy3.42), and similar (Dy2) soils. Throughoutthis unit there may be small remnants of unit Tb119	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	4.5
SAR	0.01	28.6
EC	1 µS/cm	2240
Exchangeable Ca	0.1 meq/100g	0.2
Exchangeable Mg	0.1 meq/100g	6.1
Exchangeable K	0.1 meq/100g	0.6
Exchangeable Na	0.1 meq/100g	8.2
CEC	0.1 meq/100g	15.2
ESP (%)	0.001	54.2
Ca:Mg	0.1	ND
Chloride	10 mg/kg	3020
Emerson Crumb Class		na

Soil & landform Elements

Regional Soil Type	Sodosol
Map Reference	21° 19' 16.264" S 147° 27' 13.439" E
Permeability	Medium
Drainage	Low
Landform	Flat
Vegetation	Heavy vegetation
Site Disturbance	Some clearing evident to the north for roadway
Microrelief	mild
Erosion	Low
PAWC	<50mm
Soil forms	0
GQAL Class	SS13-0.3-0.6

Depth	Soil Descriptions
0 - 0.3	Gravelly SAND, Fine to Medium grain, Pale to Dark Brown Orange, Loose, Refusal at 0.3m, gravel subangular 9mm.

Soil Types

Site ID: SS31 Site Location: KP196

Regional Soil Type: Sodosol

Landform:	Mr1	
Mountainous ranges with some narrow undulating ridge crests: steep, sometimes rocky, slopes ofacid leached yellow earths (Gn2.24 and Gn2.44). Associated are red earths (Gn2.14), loamy soilshaving an A2 horizon (Um4.2), and possibly undescribed soils especially on the undulating rangecrests. Data are limited		

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	6.9
SAR	0.01	3.13
EC	1 µS/cm	24
Exchangeable Ca	0.1 meq/100g	ND
Exchangeable Mg	0.1 meq/100g	2.7
Exchangeable K	0.1 meq/100g	ND
Exchangeable Na	0.1 meq/100g	0.4
CEC	0.1 meq/100g	3.3
ESP (%)	0.001	11.4
Ca:Mg	0.1	ND
Chloride	10 mg/kg	50
Emerson Crumb Class		na

Soil & landform Elements

Regional Soil Type	Sodosol
Map Reference	
Permeability	Moderate
Drainage	Low
Landform	Undulating
Vegetation	Sparse
Site Disturbance	Nil
Microrelief	mild
Erosion	Low
PAWC	75-100mm
GQAL Class	C

Depth	Soil Descriptions
0 - 0.3	Silty gravelly SAND, Fine to Medium grain, Soft to Hard, Very Loose, Orange, pisolites at surface
0.4-0.6	Silty Gravelly SAND, Fine to Medium grain, Hard. Very Loose, orange.

Soil Types

Site ID: SS32 Site Location: KP200

Regional Soil Type: Sodosol

Landform:	Mr1
Mountainous ranges with some narrow undulating ridge crests: steep, sometimes rocky, slopes ofacid leached yellow earths (Gn2.24 and Gn2.44). Associated are red earths (Gn2.14), loamy soilshaving an A2 horizon (Um4.2), and possibly undescribed soils especially on the undulating rangecrests. Data are limited	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	6.1
SAR	0.01	41.5
EC	1 µS/cm	368
Exchangeable Ca	0.1 meq/100g	1.7
Exchangeable Mg	0.1 meq/100g	5.2
Exchangeable K	0.1 meq/100g	ND
Exchangeable Na	0.1 meq/100g	2.6
CEC	0.1 meq/100g	9.4
ESP (%)	0.001	27.1
Ca:Mg	0.1	0.3
Chloride	10 mg/kg	570
Emerson Crumb Class		na

Soil & landform Elements

Regional Soil Type	Sodosol
Map Reference	0
Permeability	Moderate
Drainage	Low
Landform	Undulating
Vegetation	Sparse
Site Disturbance	Nil
Microrelief	mild
Erosion	Low
PAWC	<50mm
GQAL Class	B

Depth	**Soil Descriptions**
0 - 0.3	Silt Sand Gravel Hard Orange Brown
0.4-0.6	Clay Sand Gravel Hard Pale Orange White Hard Very Loose saprolite in
0.6-0.9	Clay Sand Gravel Hard Orange Red Hard Very Loose

Soil Types

Site ID: SS33 Site Location: KP205

Regional Soil Type: Sodosol

Landform: Mr1	
Mountainous ranges with some narrow undulating ridge crests: steep, sometimes rocky, slopes ofacid leached yellow earths (Gn2.24 and Gn2.44). Associated are red earths (Gn2.14), loamy soilshaving an A2 horizon (Um4.2), and possibly undescribed soils especially on the undulating rangecrests. Data are limited	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	5.2
SAR	0.01	1.26
EC	1 µS/cm	45
Exchangeable Ca	0.1 meq/100g	0.9
Exchangeable Mg	0.1 meq/100g	0.4
Exchangeable K	0.1 meq/100g	0.1
Exchangeable Na	0.1 meq/100g	ND
CEC	0.1 meq/100g	1.5
ESP (%)	0.001	4.2
Ca:Mg	0.1	2.4
Chloride	10 mg/kg	90
Emerson Crumb Class		na

Soil & landform Elements

Regional Soil Type	Sodosol
Map Reference	21° 32' 20.953" S 147° 25' 16.563" E
Permeability	Medium
Drainage	High
Landform	Flat
Vegetation	Sparse vegetation
Site Disturbance	Cleared to the west for roadway
Microrelief	mild
Erosion	Low
PAWC	125-150mm
GQAL Class	B

Depth	Soil Descriptions
0 - 0.3	Clay Silt Fine Pale Brown Orange Very Loose
0.4-0.6	Clay Silt Fine Pale Brown White Very Loose Profile change at 0.5m, paler down the profile

Soil Types

Site ID: SS34 Site Location: KP230

Regional Soil Type: Vertosol

Landform:	CC33
Level or very gently undulating clay plains with slight to moderate (1-2 ft) gilgai microrelief, occasionallystronger (2-4 ft). Where the unit is adjacent to major streams many small braided channels occur and Cthe area is subject to flooding. Dominant soils are deep grey clays (Ug5.24), occasionally (Ug5.28 and uUg5.29), but areas of deep brown clays are commonly associated (Ug5.34). In some areas brownclays occur on the gilgai banks and grey clays in the depressions. Closely associated throughout theunit are areas of loamy duplex soils (Dy2.33), (Dy2.43), (Db1.33), (Db1.43), and (Db1.13), particularlyadjacent to stream channels. As mapped, the unit includes small slightly higher islands of sandy orloamy red earths (Gn2.12 and Gn2.11), or less commonly yellow earths (Gn2.22). The cracking clayshave the three reaction trends listed for unit CC20	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	8.4
SAR	0.01	1.92
EC	1 µS/cm	132
Exchangeable Ca	0.1 meq/100g	23.9
Exchangeable Mg	0.1 meq/100g	5.8
Exchangeable K	0.1 meq/100g	0.3
Exchangeable Na	0.1 meq/100g	0.4
CEC	0.1 meq/100g	30.4
ESP (%)	0.001	1.2
Ca:Mg	0.1	4.2
Chloride	10 mg/kg	130
Emerson Crumb Class		4

Soil & landform Elements

Regional Soil Type	Vertosol
Map Reference	21° 39' 50.400" S 147° 21' 51.494" E
Permeability	Medium
Drainage	Low
Landform	Alluvial depression
Vegetation	Open forest
Site Disturbance	Nil
Microrelief	mild
Erosion	Low
PAWC	>150mm
GQAL Class	C

Depth	**Soil Descriptions**
0-0.3	Sandy CLAY, Fine to Medium grain,soft to hard, loose, Brown
0.3-0.6	Silty Sandy CLAY, Fine Sand, soft to hard, Dark Brown, subangular gravel 9mm
0.6-0.9	Sandy CLAY, Fine to Medium grain, soft to hard, Pale Brown, profile change at 0.7m, subangular gravel7mm

Soil Types

Site ID: SS35 Site Location: KP245

Regional Soil Type: Tenosol

Landform:	Sl19
Moderate or occasionally strongly undulating lands: dominant are extremely gravelly (quartz) loamy duplex soils (Dy2.43) and (Dy2.33) with lesser (Dr2.43), (Dr2.33), (Db1.33), (Db1.13), and (Dy3.43) soils. On some higher ridges shallow gravelly loams occur (Um1.43) and (Um4.1), less common are gravelly sands (Uc2.12). Small areas of loamy red earths (Gn2.12) occur in the unit as mapped, and there may be small areas of gravel-strewn moderately gilgaied grey clays (Ug5.24) in lower sites	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	na
SAR	0.01	na
EC	1 µS/cm	na
Exchangeable Ca	0.1 meq/100g	na
Exchangeable Mg	0.1 meq/100g	na
Exchangeable K	0.1 meq/100g	na
Exchangeable Na	0.1 meq/100g	na
CEC	0.1 meq/100g	na
ESP (%)	0.001	na
Ca:Mg	0.1	na
Chloride	10 mg/kg	na
Emerson Crumb Class		2

Soil & landform Elements

Regional Soil Type	Tenosol
Map Reference	38' 49.541" E
Permeability	Low
Drainage	Low
Landform	Flat
Vegetation	Heavy vegetation
Site Disturbance	Nil
Microrelief	mild
Erosion	Low
PAWC	<50mm
GQAL Class	C

Depth	Soil Descriptions
0 - 0.3	Silty CLAY, Dark Brown, Stiff humid soils, refusal at 0.3m.

Soil Types

Site ID: SS36 Site Location: KP270

Regional Soil Type: Vertosol

Landform:	Sl19
Moderate or occasionally strongly undulating lands: dominant are extremely gravelly (quartz) loamy duplex soils (Dy2.43) and (Dy2.33) with lesser (Dr2.43), (Dr2.33), (Db1.33), (Db1.13), and (Dy3.43) soils. On some higher ridges shallow gravelly loams occur (Um1.43) and (Um4.1), less common are gravelly sands (Uc2.12). Small areas of loamy red earths (Gn2.12) occur in the unit as mapped, and there may be small areas of gravel-strewn moderately gilgaied grey clays (Ug5.24) in lower sites	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	7.9
SAR	0.01	1.29
EC	1 µS/cm	30
Exchangeable Ca	0.1 meq/100g	3.5
Exchangeable Mg	0.1 meq/100g	0.9
Exchangeable K	0.1 meq/100g	0.2
Exchangeable Na	0.1 meq/100g	ND
CEC	0.1 meq/100g	4.6
ESP (%)	0.001	1.7
Ca:Mg	0.1	4
Chloride	10 mg/kg	130
Emerson Crumb Class		na

Soil & landform Elements

Regional Soil Type	Vertosol
Map Reference	0
Permeability	Medium
Drainage	Low
Landform	Undulating
Vegetation	Sparse
Site Disturbance	Nil
Microrelief	mild
Erosion	Low
PAWC	>150mm
GQAL Class	B

Depth	**Soil Descriptions**
0 - 0.3	Silt Clay Fine Dark Orange Soft minor roots
0.4-0.6	Silt Clay Fine Dark Red Orange Soft Minor roots, profile change at 0.5m

Soil Types

Site ID: SS37 Site Location: KP275

Regional Soil Type: Vertosol

Landform:	Sl21
Gently undulating plains: dominant are loamy duplex soils with a slightly gravel-strewn surface. The chief forms are (Dy2.43) and (Dy2.33) but (Db1.33), (Db1.13), (Db1.43), and similar (Dy3) soils are often closely associated. Also occurring are smaller areas of slightly gilgaied (1-2 ft) or non-gilgaied grey clays (Ug5.24), or less commonly brown clays (Ug5.34). In addition there are occasional low rises of loamy or sandy red earths (Gn2.12) and yellow earths (Gn2.22). In some localities there may be occasional high stony ridges with shallow stony soils (Uc1.21), (Uc2.12), (Um1.41), and (Um4.1)	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	-
SAR	0.01	-
EC	1 µS/cm	-
Exchangeable Ca	0.1 meq/100g	-
Exchangeable Mg	0.1 meq/100g	-
Exchangeable K	0.1 meq/100g	-
Exchangeable Na	0.1 meq/100g	-
CEC	0.1 meq/100g	-
ESP (%)	0.001	-
Ca:Mg	0.1	-
Chloride	10 mg/kg	-
Emerson Crumb Class		-

Soil & landform Elements

Regional Soil Type	Vertosol
Map Reference	0
Permeability	Medium
Drainage	Low
Landform	Undulating
Vegetation	Sparse
Site Disturbance	Nil
Microrelief	mild
Erosion	Low
PAWC	<50mm
GQAL Class	-

Depth	Soil Descriptions
0 - 0.3	Silty Gravelly CLAY, Fine to Medium texture, Brown, Soft to Hard, dry, Very Loose, Minor roots, aggregates >6mm.

Soil Types

Site ID: SS38 Site Location: KP290

Regional Soil Type: Vertosol

Landform:	CC29
Level plains with moderate to strong gilgai microrelief (2 4 ft): dominant soils are grey or light greydeep clays (Ug5.24) with loamy duplex soils (Dy2.33) closely associated in non-gilgaied sites. Smallflood-plains of (Dy2.43), (Dy3.43), and (Dd1.43) occur adjacent to associated drainage lines. Included inthe unit, as mapped, are small areas of loamy and sandy red earths (Gn2.12 and Gn2.13) and yellowearths (Gn2.22). The cracking clays have the three reaction trends listed for unit CC20	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	8.3
SAR	0.01	1.02
EC	1 µS/cm	124
Exchangeable Ca	0.1 meq/100g	16
Exchangeable Mg	0.1 meq/100g	0.9
Exchangeable K	0.1 meq/100g	0.9
Exchangeable Na	0.1 meq/100g	ND
CEC	0.1 meq/100g	17.9
ESP (%)	0.001	0.6
Ca:Mg	0.1	16.8
Chloride	10 mg/kg	220
Emerson Crumb Class		na

Soil & landform Elements

Regional Soil Type	Vertosol
Map Reference	55.657" E
Permeability	High
Drainage	Low
Landform	Flat
Vegetation	No vegetation
Site Disturbance	Clearing and felling of trees for agriculture to the east
Microrelief	mild
Erosion	Low
PAWC	>150mm
GQAL Class	-

Depth	Soil Descriptions
0 - 0.3	Silty CLAY, Brown, Soft, dry, Very Loose Minor roots
0.3-0.6	Silty CLAY, Pale Brown/Orange, Soft, dry, Very Loose, Minor roots, paler down the profile, profile change at 0.5m

Soil Types

Site ID: SS39 Site Location: KP320

Regional Soil Type: Vertosol

Landform: My20	
Level or very gently undulating plains: dominant soils are loamy red earths (Gn2.12) with some loamyyellow earths (Gn2.22). Lower landscape sites have a range of loamy duplex soils, chiefly (Dr2.43),(Dr2.33), (Db1.33), (Dy2.43), (Dy2.33), and (Dd1.33), and limited occurrences of gilgaied clays (Ug5.24).Small flood-plains associated with drainage lines have (Dr2.33) and (Dd1.33) soils, and occasionallysome low sand dunes (Uc1.21, Uc1.22, and Uc1.23)	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	8.1
SAR	0.01	3.58
EC	1 µS/cm	170
Exchangeable Ca	0.1 meq/100g	22.9
Exchangeable Mg	0.1 meq/100g	5
Exchangeable K	0.1 meq/100g	0.8
Exchangeable Na	0.1 meq/100g	0.6
CEC	0.1 meq/100g	29.4
ESP (%)	0.001	2.2
Ca:Mg	0.1	4.5
Chloride	10 mg/kg	160
Emerson Crumb Class		na

Soil & landform Elements

Regional Soil Type	Vertosol
Map Reference	-
Permeability	Medium
Drainage	Low
Landform	Undulating
Vegetation	Sparse
Site Disturbance	Cleared
Microrelief	mild
Erosion	Low
PAWC	>150mm
GQAL Class	A

Depth	**Soil Descriptions**
0 - 0.3	Silty CLAY, Pale Grey/Brown
0.4-0.6	Silty CLAY, Pale Grey

Soil Types

Site ID: SS40 Site Location: KP330

Regional Soil Type: Vertosol/Kandosol

Landform:	My20
Level or very gently undulating plains: dominant soils are loamy red earths (Gn2.12) with some loamyyellow earths (Gn2.22). Lower landscape sites have a range of loamy duplex soils, chiefly (Dr2.43),(Dr2.33), (Db1.33), (Dy2.43), (Dy2.33), and (Dd1.33), and limited occurrences of gilgaied clays (Ug5.24).Small flood-plains associated with drainage lines have (Dr2.33) and (Dd1.33) soils, and occasionallysome low sand dunes (Uc1.21, Uc1.22, and Uc1.23)	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	na
SAR	0.01	na
EC	1 µS/cm	na
Exchangeable Ca	0.1 meq/100g	na
Exchangeable Mg	0.1 meq/100g	na
Exchangeable K	0.1 meq/100g	na
Exchangeable Na	0.1 meq/100g	na
CEC	0.1 meq/100g	na
ESP (%)	0.001	na
Ca:Mg	0.1	na
Chloride	10 mg/kg	na
Emerson Crumb Class		4

Soil & landform Elements

Regional Soil Type	Vertosol/Kandosol
Map Reference	0
Permeability	Medium
Drainage	Low
Landform	Undulating
Vegetation	Sparse
Site Disturbance	Cleared
Microrelief	mild
Erosion	Low
PAWC	<50mm
GQAL Class	-

Depth	Soil Descriptions
0 - 0.3	Clayey SAND, Fine to Medium Grain, Brown, Soft to Stiff, dry/moist, Loose to Medium Dense, sparce quartz 9mm, roots
0.3-0.6	Clayey SAND, Fine to Medium grain, Dark Brown, Soft to Stiff, dry/moist, Loose to Medium Dense, sparce quartz 9mm, roots, refusal at 0.6m, rocks

Soil Types

Site ID: SS41 Site Location: KP335

Regional Soil Type: Vertosol/Kandosol

Landform: Vd2 Level or very gently undulating plains and broad shallow valleys associated with drainage lines: dominantsoils have deep sandy A horizons and are chiefly (Dy3.33) and (Dy3.43), but (Dy3.23), (Dy3.32), andsimilar (Dy5) soils also occur. Smaller areas of loamy-surfaced (Dy2.33) soils are associated withsome drainage lines. Included in the unit as mapped are small areas of sandy yellow earths (Gn2.22),(Gn2.62), and occasionally swampy depressions with clay soils (Ug5.24)	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	6.2
SAR	0.01	0.51
EC	1 µS/cm	14
Exchangeable Ca	0.1 meq/100g	0.6
Exchangeable Mg	0.1 meq/100g	0.3
Exchangeable K	0.1 meq/100g	0.3
Exchangeable Na	0.1 meq/100g	ND
CEC	0.1 meq/100g	1.3
ESP (%)	0.001	0.9
Ca:Mg	0.1	1.9
Chloride	10 mg/kg	60
Emerson Crumb Class		na

Soil & landform Elements

Regional Soil Type	Vertosol/Kandosol
Map Reference	0
Permeability	Medium
Drainage	Low
Landform	Undulating
Vegetation	Sparse
Site Disturbance	Cleared
Microrelief	mild
Erosion	Low
PAWC	>150mm
GQAL Class	A

Depth	Soil Descriptions
0 - 0.3	Clay Sand Fine Dark Orange Nil Soft Loose Minor roots, very sparce quartz 90mm
0.3-0.6	Clay Sand Gravel Fine to Medium Dark Orange Nil Soft Loose Minor roots, sparce quartz >7mm
0.6-0.9	Clay Sand Gravel Fine to Medium Pale Orange Nil Soft Loose Minor roots, quartz >20mm, profile change at 0.7m

Soil Types

Site ID: SS42 Site Location: KP335

Regional Soil Type: Kandosol

Landform:	Vd2
Level or very gently undulating plains and broad shallow valleys associated with drainage lines: dominantsoils have deep sandy A horizons and are chiefly (Dy3.33) and (Dy3.43), but (Dy3.23), (Dy3.32), andsimilar (Dy5) soils also occur. Smaller areas of loamy-surfaced (Dy2.33) soils are associated withsome drainage lines. Included in the unit as mapped are small areas of sandy yellow earths (Gn2.22),(Gn2.62), and occasionally swampy depressions with clay soils (Ug5.24)	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	7
SAR	0.01	0.47
EC	1 µS/cm	65
Exchangeable Ca	0.1 meq/100g	5.9
Exchangeable Mg	0.1 meq/100g	1.4
Exchangeable K	0.1 meq/100g	0.4
Exchangeable Na	0.1 meq/100g	ND
CEC	0.1 meq/100g	7.8
ESP (%)	0.001	0.6
Ca:Mg	0.1	4.2
Chloride	10 mg/kg	210
Emerson Crumb Class		na

Soil & landform Elements

Regional Soil Type	Kandosol
Map Reference	0
Permeability	Medium
Drainage	Low
Landform	Undulating
Vegetation	Sparse
Site Disturbance	Cleared
Microrelief	mild
Erosion	Low
PAWC	>150mm
GQAL Class	A

Depth	**Soil Descriptions**
0 - 0.3	Clayey SILT, Brown/Yellow, Soft to Firm, dry Loose, structureless soil
0.4-0.6	Clayey SILT, Orange/Brown, Soft to Hard, dry Loose

Soil Types

Site ID: SS43 Site Location: KP350

Regional Soil Type: Vertosol

Landform: Ms2 Very gently undulating or level plains: dominant soils are slightly acid sandy yellow earths (Gn2.21)with lesser (Gn2.22). Ironstone nodule layers often occur at moderate depths. Closely associatedare yellow earthy sands (Uc5.22) and areas of deep sandy red earths (Gn2.11 and Gn2.12). Small areasof loamy red and yellow earths also occur and broad shallow drainage depressions have sandy-surfacedduplex soils (Dy3.32, Dy3.42, and Dy3.43) or other earth soils (Gn2.95) and (Gn2.35). Small low hillyareas of unit Fz7 may be included	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	8.6
SAR	0.01	1.14
EC	1 µS/cm	121
Exchangeable Ca	0.1 meq/100g	5.6
Exchangeable Mg	0.1 meq/100g	0.9
Exchangeable K	0.1 meq/100g	2
Exchangeable Na	0.1 meq/100g	ND
CEC	0.1 meq/100g	8.6
ESP (%)	0.001	0.8
Ca:Mg	0.1	6.3
Chloride	10 mg/kg	180
Emerson Crumb Class		na

Soil & landform Elements

Regional Soil Type	Vertosol
Map Reference	28.135" E
Permeability	High
Drainage	Low
Landform	Flat
Vegetation	Sparse vegetation
Site Disturbance	Clearing for roadways east and west
Microrelief	mild
Erosion	Low
PAWC	>150mm
GQAL Class	B

Depth	**Soil Descriptions**
0 - 0.3	Clayey Gravelly SAND, Fine to Medium Grain, Pale Orange,Dry, Soft, Loose, Minor roots, sparce quartz 9mm
0.3-0.6	Clayey Gravelly SAND, Fine to Medium, Dark Orange, Soft, Dry, Loose, Minor roots, sparce quartz >20mm, profile change at 0.4m
0.6-0.9	Clayey Gravelly SAND, Fine to Medium, Dark Orange, Soft, dry, Loose, Minor roots, quartz >20mm, profile change at 0.6m

Soil Types

Site ID: SS44 Site Location: KP360

Regional Soil Type: Vertosol/Kandosol

Landform:	Ms2
Very gently undulating or level plains: dominant soils are slightly acid sandy yellow earths (Gn2.21)with lesser (Gn2.22). Ironstone nodule layers often occur at moderate depths. Closely associatedare yellow earthy sands (Uc5.22) and areas of deep sandy red earths (Gn2.11 and Gn2.12). Small areasof loamy red and yellow earths also occur and broad shallow drainage depressions have sandy-surfacedduplex soils (Dy3.32, Dy3.42, and Dy3.43) or other earth soils (Gn2.95) and (Gn2.35). Small low hillyareas of unit Fz7 may be included	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	7.4
SAR	0.01	0.48
EC	1 µS/cm	32
Exchangeable Ca	0.1 meq/100g	2.6
Exchangeable Mg	0.1 meq/100g	0.8
Exchangeable K	0.1 meq/100g	0.6
Exchangeable Na	0.1 meq/100g	ND
CEC	0.1 meq/100g	4.1
ESP (%)	0.001	0.3
Ca:Mg	0.1	3.3
Chloride	10 mg/kg	70
Emerson Crumb Class		na

Soil & landform Elements

Regional Soil Type	Vertosol/Kandosol
Map Reference	0
Permeability	High
Drainage	Low
Landform	Undulating
Vegetation	Sparse
Site Disturbance	Cleared
Microrelief	mild
Erosion	Low
PAWC	<50mm
GQAL Class	B

Depth	Soil Descriptions
0 - 0.3	Sandy CLAY, Fine grain, Pale Orange, Soft, dry, Loose, Minor roots, sparce quartz 7mm
0.3-0.6	Sandy CLAY, Fine grain, Dark Orange, Soft, Dry, Loose, Minor roots, profile change at 0.4m
0.6-0.9	Sandy CLAY, Fine grain, Dark Orange, Soft, dry, Loose, Minor roots, quartz 7mm

Soil Types

Site ID: SS45 Site Location: KP375

Regional Soil Type: Vertosol

Landform: Ro5	
Undulating lands: dominant are brown loamy duplex soils (Db1.33), (Db1.23), and (Db1.43), oftenwith gravelly A horizons. Associated are red duplex soils (Dr2.33) and (Dr2.23), and small areas ofcracking clays (Ug5.32) and (Ug5.22). Other alkaline duplex soils with bleached A2 horizons also occur,chiefly (Dy2) and (Dd1)	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	7.4
SAR	0.01	2.27
EC	1 µS/cm	49
Exchangeable Ca	0.1 meq/100g	3.2
Exchangeable Mg	0.1 meq/100g	1.5
Exchangeable K	0.1 meq/100g	0.2
Exchangeable Na	0.1 meq/100g	1
CEC	0.1 meq/100g	6
ESP (%)	0.001	17.7
Ca:Mg	0.1	2
Chloride	10 mg/kg	150
Emerson Crumb Class		na

Soil & landform Elements

Regional Soil Type	Kandosol
Map Reference	22° 47' 26.275" S 146° 30' 46.831" E
Permeability	Low
Drainage	Medium
Landform	Flat
Vegetation	Sparse vegetation
Site Disturbance	Cleared for roadways
Microrelief	mild
Erosion	Low
PAWC	>150mm
GQAL Class	A

Depth	Soil Descriptions
0 - 0.3	Sandy Silty CLAY, Finesand, Dark Brown/Orange, Soft to Stiff, Dry to moist, Loose to Medium Dense, Minor roots.
0.3-0.6	Sandy Silty CLAY, Fine sand, Dark Brown/Orange, Soft, Dry, Loose Minor roots.
0.6-0.9	Sandy Silty CLAY, Fine Sand, Pale Orange, Soft, Loose, Minor roots, dry soils, profile change at 0.8m, paler and drier down the profile

Soil Types

Site ID: SS46 Site Location: KP375

Regional Soil Type: Kandosol

Landform: Qa15 Moderately or, less commonly, strongly undulating lands with occasional isolated hills surrounded by strongly dissected steep slopes; limited rock outcrop may occur throughout: very occasional small areas of dark clays or red-brown clays may also be included in the unit. Dominant are loamy red duplex soils of shallow to moderate depth (18-30 in.).	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	6.8
SAR	0.01	0.77
EC	1 µS/cm	26
Exchangeable Ca	0.1 meq/100g	2.1
Exchangeable Mg	0.1 meq/100g	0.3
Exchangeable K	0.1 meq/100g	0.3
Exchangeable Na	0.1 meq/100g	ND
CEC	0.1 meq/100g	2.7
ESP (%)	0.001	0.7
Ca:Mg	0.1	6.3
Chloride	10 mg/kg	70
Emerson Crumb Class		3

Soil & landform Elements

Regional Soil Type	Kandosol
Map Reference	22° 47' 26.275" S 146° 30' 46.831" E
Permeability	Low
Drainage	Medium
Landform	Flat
Vegetation	Sparse vegetation
Site Disturbance	Cleared for roadways
Microrelief	mild
Erosion	Low
PAWC	>150mm
GQAL Class	A

Depth	**Soil Descriptions**
0 - 0.3	Silty CLAY, Orange/Brown, Soft, Dry, Loose, Minor roots, profile change at 0.2m,darker and richer orange/red down the profile
0.3-0.6	Silty CLAY, Dark Orange, Soft, Dry, Loose, Minor roots
0.6-0.9	Silty CLAy, Dark Orange, Soft, Dry, Loose, Minor roots.

Soil Types

Site ID: SS47 Site Location: Mine

Regional Soil Type: Kandosol

Landform:	Ro5
Undulating lands: dominant are brown loamy duplex soils (Db1.33), (Db1.23), and (Db1.43), oftenwith gravelly A horizons. Associated are red duplex soils (Dr2.33) and (Dr2.23), and small areas ofcracking clays (Ug5.32) and (Ug5.22). Other alkaline duplex soils with bleached A2 horizons also occur,chiefly (Dy2) and (Dd1)	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	6
SAR	0.01	1.19
EC	1 µS/cm	98
Exchangeable Ca	0.1 meq/100g	7.2
Exchangeable Mg	0.1 meq/100g	3.2
Exchangeable K	0.1 meq/100g	0.9
Exchangeable Na	0.1 meq/100g	0.1
CEC	0.1 meq/100g	11.5
ESP (%)	0.001	1.2
Ca:Mg	0.1	2.2
Chloride	10 mg/kg	250
Emerson Crumb Class		na

Soil & landform Elements

Regional Soil Type	Kandosol
Map Reference	-
Permeability	Medium
Drainage	Low
Landform	Undulating
Vegetation	Sparse
Site Disturbance	Cleared
Microrelief	mild
Erosion	Low
PAWC	100-125mm
GQAL Class	A

Depth	**Soil Descriptions**
0 - 0.3	Silty CLAY, Red/Brown, Soft, dry, Loose.
0.4-0.6	Silty CLAY, Red, Soft, dry, Loose.

Soil Types

Site ID: SS48 Site Location: Mine

Regional Soil Type: Kandosol

Landform:	Ms2
Very gently undulating or level plains: dominant soils are slightly acid sandy yellow earths (Gn2.21)with lesser (Gn2.22). Ironstone nodule layers often occur at moderate depths. Closely associatedare yellow earthy sands (Uc5.22) and areas of deep sandy red earths (Gn2.11 and Gn2.12). Small areasof loamy red and yellow earths also occur and broad shallow drainage depressions have sandy-surfacedduplex soils (Dy3.32, Dy3.42, and Dy3.43) or other earth soils (Gn2.95) and (Gn2.35). Small low hillyareas of unit Fz7 may be included	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	5.9
SAR	0.01	6.38
EC	1 µS/cm	61
Exchangeable Ca	0.1 meq/100g	1.4
Exchangeable Mg	0.1 meq/100g	1
Exchangeable K	0.1 meq/100g	0.2
Exchangeable Na	0.1 meq/100g	0.4
CEC	0.1 meq/100g	2.9
ESP (%)	0.001	12
Ca:Mg	0.1	1.4
Chloride	10 mg/kg	140
Emerson Crumb Class		2

Soil & landform Elements

Regional Soil Type	Kandosol
Map Reference	23° 7' 46.676" S 146° 30' 10.183" E
Permeability	Medium
Drainage	High
Landform	Flat
Vegetation	Heavy vegetation
Site Disturbance	Major clearings to the west and east
Microrelief	mild
Erosion	Low
PAWC	>150mm
GQAL Class	A

Depth	Soil Descriptions
0 - 0.3	Sandy CLAY, Fine Sand, Pale Brown, Soft to Stiff, dry, Loose,
0.4-0.6	Sandy GRAVEL, Fine sand, Dark Brown, Soft, Dry, Loose, Roots, profile change at 0.6m, aggregates> 20mm, profile

Soil Types Kandosol
Site ID: SS49 Site Location: Mine
Regional Soil Type: Kandosol

Landform:	Fz7
Strongly undulating to low hilly lands: dominant soils are shallow stony loams (Um1.43) and (Um1.41),Um4.1), and (Um5.5). Associated are shallow sandy soils (Uc2.12), (Uc3.12), and (Uc1.21). On someslopes shallow duplex soils (Dr2.33), (Dr2.32), (Dy3.43), and (Dy3.42) occur; in valley floors deepersandy soils (Uc1.21 and Uc1.23) and (Uc5.21 and Uc5.22) occur. Small areas of sandy red earths(Gn2.12 and Gn2.11) and yellow earths (Gn2.22 and Gn2.21) are also included in the unit	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	6
SAR	0.01	1.51
EC	1 µS/cm	15
Exchangeable Ca	0.1 meq/100g	1
Exchangeable Mg	0.1 meq/100g	0.7
Exchangeable K	0.1 meq/100g	0.1
Exchangeable Na	0.1 meq/100g	0.2
CEC	0.1 meq/100g	2
ESP (%)	0.001	11.2
Ca:Mg	0.1	1.4
Chloride	10 mg/kg	40
Emerson Crumb Class		2

Soil & landform Elements

Regional Soil Type	Kandosol
Map Reference	23° 23' 11.568" S 146° 31' 21.637" E
Permeability	Low
Drainage	Medium
Landform	Flat
Vegetation	Open forest
Site Disturbance	Nil
Microrelief	mild
Erosion	Low
PAWC	>150mm
GQAL Class	C

Depth	**Soil Descriptions**
0-0.3	Sandy CLAY, Fine sand, Brown Orange, Hard, Dry, Loose, roots, sparce gravel, subangular 9mm
0.3-0.6	Clayey gravelly SAND, Fine to Medium Sand, Orange/Yellow, Friable, dry, Loose, roots, profile change at 0.5m, gravels subangular 9mm

Soil Types

Site ID: SS50 Site Location: Mine

Regional Soil Type: Kandosol

Landform:	Fz7
Strongly undulating to low hilly lands: dominant soils are shallow stony loams (Um1.43) and (Um1.41),Um4.1), and (Um5.5). Associated are shallow sandy soils (Uc2.12), (Uc3.12), and (Uc1.21). On someslopes shallow duplex soils (Dr2.33), (Dr2.32), (Dy3.43), and (Dy3.42) occur; in valley floors deepersandy soils (Uc1.21 and Uc1.23) and (Uc5.21 and Uc5.22) occur. Small areas of sandy red earths(Gn2.12 and Gn2.11) and yellow earths (Gn2.22 and Gn2.21) are also included in the unit	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	6.2
SAR	0.01	0.75
EC	1 µS/cm	9
Exchangeable Ca	0.1 meq/100g	0.7
Exchangeable Mg	0.1 meq/100g	0.4
Exchangeable K	0.1 meq/100g	0.1
Exchangeable Na	0.1 meq/100g	ND
CEC	0.1 meq/100g	1.2
ESP (%)	0.001	2.3
Ca:Mg	0.1	1.8
Chloride	10 mg/kg	20
Emerson Crumb Class		na

Soil & landform Elements

Regional Soil Type	Kandosol
Map Reference	23° 23' 43.451" S 146° 28' 2.820" E
Permeability	Low
Drainage	Medium
Landform	Flat
Vegetation	Sparse vegetation
Site Disturbance	Clearing is evident
Microrelief	mild
Erosion	Low
PAWC	>150mm
GQAL Class	C

Depth	**Soil Descriptions**
0 - 0.3	Clayey Sandy GRAVELS, Friable, Pale Orange, Hard, Dry, Loose, clayey sandy gravels. roots, aggregates >60mm
0.3-0.6	Clayey Sandy GRAVELS, Fine sand, Dark Red/Orange, Soft, Dry, Loose, roots, profile change at 0.4m, aggregates> 20mm

Soil Types

Site ID: SS51 Site Location: Mine

Regional Soil Type: Kandosol

Landform:	Fz7
Strongly undulating to low hilly lands: dominant soils are shallow stony loams (Um1.43) and (Um1.41),Um4.1), and (Um5.5). Associated are shallow sandy soils (Uc2.12), (Uc3.12), and (Uc1.21). On someslopes shallow duplex soils (Dr2.33), (Dr2.32), (Dy3.43), and (Dy3.42) occur; in valley floors deepersandy soils (Uc1.21 and Uc1.23) and (Uc5.21 and Uc5.22) occur. Small areas of sandy red earths(Gn2.12 and Gn2.11) and yellow earths (Gn2.22 and Gn2.21) are also included in the unit	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	na
SAR	0.01	na
EC	1 µS/cm	na
Exchangeable Ca	0.1 meq/100g	na
Exchangeable Mg	0.1 meq/100g	na
Exchangeable K	0.1 meq/100g	na
Exchangeable Na	0.1 meq/100g	na
CEC	0.1 meq/100g	na
ESP (%)	0.001	na
Ca:Mg	0.1	na
Chloride	10 mg/kg	na
Emerson Crumb Class		2

Soil & landform Elements

Regional Soil Type	Kandosol
Map Reference	-
Permeability	Medium
Drainage	Low
Landform	Undulating
Vegetation	Sparse
Site Disturbance	Cleared
Microrelief	mild
Erosion	Low
PAWC	<50mm
GQAL Class	0

Depth	Soil Descriptions
0 - 0.3	Clayey SILT, dark brown A horizon and pale grey B horizon composite sample

Soil Types

Site ID: SS52 Site Location: Mine

Regional Soil Type: Kandosol

Landform: Fz7

Strongly undulating to low hilly lands: dominant soils are shallow stony loams (Um1.43) and (Um1.41),Um4.1), and (Um5.5). Associated are shallow sandy soils (Uc2.12), (Uc3.12), and (Uc1.21). On someslopes shallow duplex soils (Dr2.33), (Dr2.32), (Dy3.43), and (Dy3.42) occur; in valley floors deepersandy soils (Uc1.21 and Uc1.23) and (Uc5.21 and Uc5.22) occur. Small areas of sandy red earths(Gn2.12 and Gn2.11) and yellow earths (Gn2.22 and Gn2.21) are also included in the unit

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	na
SAR	0.01	na
EC	1 µS/cm	na
Exchangeable Ca	0.1 meq/100g	na
Exchangeable Mg	0.1 meq/100g	na
Exchangeable K	0.1 meq/100g	na
Exchangeable Na	0.1 meq/100g	na
CEC	0.1 meq/100g	na
ESP (%)	0.001	na
Ca:Mg	0.1	na
Chloride	10 mg/kg	na
Emerson Crumb Class		na

Soil & landform Elements

Regional Soil Type	Kandosol
Map Reference	-
Permeability	Medium
Drainage	Low
Landform	Undulating
Vegetation	Sparse
Site Disturbance	Cleared
Microrelief	mild
Erosion	Low
PAWC	<50mm
GQAL Class	na

Depth	**Soil Descriptions**
0 - 0.5	Silty Clay, Dark Red/Orange, Soft, Dry, Very Loose, Minor roots, profile change at 0.5m

Soil Types Kandosol
Site ID: SS53 Site Location: Mine
Regional Soil Type: Kandosol

Landform:	Fz7
Strongly undulating to low hilly lands: dominant soils are shallow stony loams (Um1.43) and (Um1.41),Um4.1), and (Um5.5). Associated are shallow sandy soils (Uc2.12), (Uc3.12), and (Uc1.21). On someslopes shallow duplex soils (Dr2.33), (Dr2.32), (Dy3.43), and (Dy3.42) occur; in valley floors deepersandy soils (Uc1.21 and Uc1.23) and (Uc5.21 and Uc5.22) occur. Small areas of sandy red earths(Gn2.12 and Gn2.11) and yellow earths (Gn2.22 and Gn2.21) are also included in the unit	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	6.8
SAR	0.01	0.21
EC	1 µS/cm	37
Exchangeable Ca	0.1 meq/100g	4.2
Exchangeable Mg	0.1 meq/100g	1.2
Exchangeable K	0.1 meq/100g	0.5
Exchangeable Na	0.1 meq/100g	ND
CEC	0.1 meq/100g	5.8
ESP (%)	0.001	ND
Ca:Mg	0.1	3.6
Chloride	10 mg/kg	60
Emerson Crumb Class		0

Soil & landform Elements

Regional Soil Type	Kandosol
Map Reference	23° 30' 19.324" S 146° 31' 7.758" E
Permeability	Medium
Drainage	High
Landform	Flat
Vegetation	No vegetation
Site Disturbance	Cleared
Microrelief	mild
Erosion	Low
PAWC	<50mm
GQAL Class	C

Depth	**Soil Descriptions**
0-0.3	Silty clay, hard, non plastic, dark brown underlain by soft silty clay, non plastic with orange and red colour
0.-0.6	ClaySiltFIneDarkOrangeRedSoftLooseroots, profile change at 0.4m,aggregates> 20mm

Soil Types Kandosol
Site ID: SS54 Site Location: Mine
Regional Soil Type: Kandosol

Landform:	Fz7
Strongly undulating to low hilly lands: dominant soils are shallow stony loams (Um1.43) and (Um1.41),Um4.1), and (Um5.5). Associated are shallow sandy soils (Uc2.12), (Uc3.12), and (Uc1.21). On someslopes shallow duplex soils (Dr2.33), (Dr2.32), (Dy3.43), and (Dy3.42) occur; in valley floors deepersandy soils (Uc1.21 and Uc1.23) and (Uc5.21 and Uc5.22) occur. Small areas of sandy red earths(Gn2.12 and Gn2.11) and yellow earths (Gn2.22 and Gn2.21) are also included in the unit.	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	6.5
SAR	0.01	0.34
EC	1 µS/cm	15
Exchangeable Ca	0.1 meq/100g	2
Exchangeable Mg	0.1 meq/100g	0.7
Exchangeable K	0.1 meq/100g	0.2
Exchangeable Na	0.1 meq/100g	ND
CEC	0.1 meq/100g	2.9
ESP (%)	0.001	ND
Ca:Mg	0.1	2.9
Chloride	10 mg/kg	50
Emerson Crumb Class		na

Soil & landform Elements

Regional Soil Type	Kandosol
Map Reference	23° 25' 35.585" S 146° 26' 39.533" E
Permeability	Low
Drainage	High
Landform	Flat
Vegetation	Heavy vegetation
Site Disturbance	Cleared to the east
Microrelief	mild
Erosion	Low
PAWC	>150mm
GQAL Class	C

Depth	**Soil Descriptions**
0-0.3	Sandy Clay, fine to medium grain, hard, non plastic, brown underlain by silty clay, soft, non plastic, orange.
0.3-0.6	ClaySiltFine NilOrangeSoftLooseroots, profile change at 0.4m,aggregates> 20mm

Soil Types

Site ID: SS55 Site Location: Mine

Regional Soil Type: Kandosol/Rudosol

Landform:	Fz7
Strongly undulating to low hilly lands: dominant soils are shallow stony loams (Um1.43) and (Um1.41),Um4.1), and (Um5.5). Associated are shallow sandy soils (Uc2.12), (Uc3.12), and (Uc1.21). On someslopes shallow duplex soils (Dr2.33), (Dr2.32), (Dy3.43), and (Dy3.42) occur; in valley floors deepersandy soils (Uc1.21 and Uc1.23) and (Uc5.21 and Uc5.22) occur. Small areas of sandy red earths(Gn2.12 and Gn2.11) and yellow earths (Gn2.22 and Gn2.21) are also included in the unit	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	na
SAR	0.01	na
EC	1 µS/cm	na
Exchangeable Ca	0.1 meq/100g	na
Exchangeable Mg	0.1 meq/100g	na
Exchangeable K	0.1 meq/100g	na
Exchangeable Na	0.1 meq/100g	na
CEC	0.1 meq/100g	na
ESP (%)	0.001	na
Ca:Mg	0.1	na
Chloride	10 mg/kg	na
Emerson Crumb Class		na

Soil & landform Elements

Regional Soil Type	Kandosol
Map Reference	-
Permeability	Medium
Drainage	Low
Landform	Undulating
Vegetation	Sparse
Site Disturbance	Cleared
Microrelief	mild
Erosion	Low
PAWC	>150mm
GQAL Class	-

Depth	**Soil Descriptions**
0-0.3	Clayey Gravelly SAND, Fine to Medium Sand, Orange/Yellow, Hard to Soft, Dry Loose
0.3-0.6	Silty CLAY, Dark Red, Hard to Soft, Dry, Loose, roots, profile change at 0.5m, aggregates >20mm.

Soil Types

Site ID: SS56 Site Location: Mine

Regional Soil Type: Kandosol/Rudosol

Landform: Fz7	
Strongly undulating to low hilly lands: dominant soils are shallow stony loams (Um1.43) and (Um1.41),Um4.1), and (Um5.5). Associated are shallow sandy soils (Uc2.12), (Uc3.12), and (Uc1.21). On someslopes shallow duplex soils (Dr2.33), (Dr2.32), (Dy3.43), and (Dy3.42) occur; in valley floors deepersandy soils (Uc1.21 and Uc1.23) and (Uc5.21 and Uc5.22) occur. Small areas of sandy red earths(Gn2.12 and Gn2.11) and yellow	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	6.5
SAR	0.01	0.39
EC	1 µS/cm	28
Exchangeable Ca	0.1 meq/100g	0.8
Exchangeable Mg	0.1 meq/100g	1.3
Exchangeable K	0.1 meq/100g	0.7
Exchangeable Na	0.1 meq/100g	ND
CEC	0.1 meq/100g	2.8
ESP (%)	0.001	0.6
Ca:Mg	0.1	0.6
Chloride	10 mg/kg	80
Emerson Crumb Class		na

Soil & landform Elements

Regional Soil Type	Kandosol/Rudosol
Map Reference	23° 21' 4.510" S 146° 17' 54.884" E
Permeability	Medium
Drainage	High
Landform	Flat
Vegetation	Sparse vegetation
Site Disturbance	Cleared
Microrelief	mild
Erosion	Low
PAWC	>150mm
GQAL Class	C

Depth	**Soil Descriptions**
0-0.3	Sandy CLAY, Fine to Medium Sand, Brown, Soft to Stiff, Dry/Moist, Loose to Medium Dense, sparce quartz 9mm, roots

Soil Types

Site ID: SS57 Site Location: Central mine site

Regional Soil Type: Kandosol

Landform: Fz7

Strongly undulating to low hilly lands: dominant soils are shallow stony loams (Um1.43) and (Um1.41),Um4.1), and (Um5.5). Associated are shallow sandy soils (Uc2.12), (Uc3.12), and (Uc1.21). On someslopes shallow duplex soils (Dr2.33), (Dr2.32), (Dy3.43), and (Dy3.42) occur; in valley floors deepersandy soils (Uc1.21 and Uc1.23) and (Uc5.21 and Uc5.22) occur. Small areas of sandy red earths(Gn2.12 and Gn2.11) and yellow earths (Gn2.22 and Gn2.21) are also included in the unit

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	6.2
SAR	0.01	0.31
EC	1 µS/cm	17
Exchangeable Ca	0.1 meq/100g	2.1
Exchangeable Mg	0.1 meq/100g	0.6
Exchangeable K	0.1 meq/100g	0.4
Exchangeable Na	0.1 meq/100g	ND
CEC	0.1 meq/100g	3.1
ESP (%)	0.001	ND
Ca:Mg	0.1	3.2
Chloride	10 mg/kg	20
Emerson Crumb Class		na

Soil & landform Elements

Regional Soil Type	Kandosol
Map Reference	23° 31' 40.244" S 146° 23' 33.449" E
Permeability	Medium
Drainage	Moderate
Landform	Flat
Vegetation	Sparse vegetation
Site Disturbance	Cleared
Microrelief	mild
Erosion	Low
PAWC	>150mm
GQAL Class	C

Depth	**Soil Descriptions**
0-0.3	Silty CLAY,Dark Brown/Orange, Hard, Dry, Loose, roots, profile change at 0.5m, aggregates >60mm
0.3-0.6	Silty CLAY, Dark Orange/Red, Dry, Loose, roots, aggregates> 20mm

Soil Types

Site ID: SS58 Site Location: Central west of Mine site

Regional Soil Type: Kandosol

Landform:	My26
Gently undulating lands with broad ridge crests and low rises: dominant soils are loamy or occasionallyandy red earths (Gn2.12), less often (Gn2.11). Associated are lesser loamy or sandy yellow earths	

Sample Depth		**0.0-0.3**
Analytical Data	**MDL**	**Analytical Result**
pH	0.1 pH unit	5.7
SAR	0.01	0.51
EC	1 µS/cm	7
Exchangeable Ca	0.1 meq/100g	0.9
Exchangeable Mg	0.1 meq/100g	0.9
Exchangeable K	0.1 meq/100g	0.3
Exchangeable Na	0.1 meq/100g	ND
CEC	0.1 meq/100g	2.2
ESP (%)	0.001	1.1
Ca:Mg	0.1	1
Chloride	10 mg/kg	40
Emerson Crumb Class		

Soil & landform Elements

Regional Soil Type	Kandosol
Map Reference	23° 27' 14.093" S 146° 16' 49.133" E
Permeability	Low
Drainage	High
Landform	Flat
Vegetation	Heavy vegetation
Site Disturbance	Nil
Microrelief	mild
Erosion	Low
PAWC	>150mm
GQAL Class	A

Depth	**Soil Descriptions**
0-0.3	Sandy Clay, fine to medium grain, dry hard, loose, non plastic