Waratah Coal

China First - Acid Sulfate Soils Assessment

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Waratah Coal

EXECUTIVE SUMMARY

E3 Consult were engaged by Waratah Coal Pty Ltd (Waratah Coal) to undertake a desktop assessment only of the acid sulfate soil (ASS) risks associated with the China First coal terminal development. Waratah Coal proposes to establish a new coal mine, railway and coal terminal to export high volatile, low sulphur, steaming coal to international markets.

This technical report assesses the ASS risk to the development of infrastructure related to the onshore coal terminal that is incorporated within the Abbot Point State Development Area (APSDA) area and portions of the rail network that cross ASS risk areas.

The results of the ASS assessment are:

- ASS has been identified in the surface layers of soils along the alignment of the coal conveyor at the APSDA. There is a high probability of disturbing ASS during construction;
- Investigations have been carried out to a maximum depth of 2m below ground level (bgl). Further investigations are required prior to construction activities involving excavation or piling deeper than 2m bgl;
- Existing information indicates that ASS is unlikely to extend to the proposed coal stockyards; however boreholes from previous studies were only completed to 2m bgl;
- There is a potential for ASS to be present in close proximity to past and present waterways at and above the 5m Australian Height Datum (AHD) contour;
- Potential ASS (PASS) impacts associated with the coal conveyor consist of the possible exposure of PASS to oxidation and acidification during construction works impacting on the water quality and biota of receiving waters and potentially shortening the lifespan of the coal conveyor structure;
- PASS impacts associated with the coal stockyards include the possible displacement and/or extrusion of PASS from below the stockyards exposing PASS previously below the groundwater table to oxidizing conditions causing potential acidification and / or the displacement of groundwater potentially mobilising acidic groundwater and metals to receiving waters; and
- PASS impacts associated with the rail corridor include the possible acidification of ASS excavated or removed during the construction of creek crossings and culverts where ASS is present above the 5m AHD contour with the potential to impact the water quality of receiving waters, biota and potentially shortening the lifespan of the constructed structures.

Based on the results of the ASS desktop assessment, the following commitments will be implemented prior to construction:

- Investigations to assess the presence of ASS within the footprint of the coal terminal infrastructure will be carried out prior to finalising the design;
- An ASS Management Plan (ASSMP) will be developed prior the construction of the coal conveyor system detailing the management requirements for ASS during construction including monitoring, treatment, verification testing and reporting;
- ASS and hydrogeological investigations will be conducted at the location of the coal stockyards to assess the potential for filling activities to impact on ASS below the stockyards causing the extrusion of PASS, acidification of groundwater and or the mobilisation of acidified groundwater to receiving waters;
- ASS investigations will be conducted on waterway crossings below 20m AHD where ASS may be present at or above the 5m AHD contour; and
- Where ASS are identified within the rail corridor, a detailed ASSMP will be developed including monitoring, treatment, verification testing and reporting for the individual construction works.

1 Introduction

1.1 Project Overview

Waratah Coal Pty Ltd (Waratah Coal) proposes to establish a new 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 new coal mine located near Alpha in the Galilee Basin, Central Queensland;
- A rail network between the mine and Abbot Point State Development Area (APSDA); and
- A new coal terminal that is incorporated within the APSDA and existing infrastructure at the Port of Abbot Point.

A full description of the project is provided in the Project Description section of the EIS.

This technical report documents the Acid Sulfate Soils (ASS) risk to the development of the onshore coal infrastructure at the APSDA area and the portions of the rail network that may cross ASS risk areas. These are the only locations within the China First project area where ASS are likely to occur.

1.1.1 New Coal Terminal

The onshore infrastructure for the China First project includes coal stockyards, an overland coal conveyor, an access road running parallel to the conveyor and a haul road connecting the stockyards to the existing Port access road. The Port of Abbot Point is an existing port with coal stockyards and offshore infrastructure including a rail in-loading facility, coal handling and stockpile areas, and a single trestle jetty and conveyor connected to a berth and ship loader, located 2.75km off-shore.

Figure 1.1 depicts the location of the China First port infrastructure as well as existing infrastructure at Abbot Point.

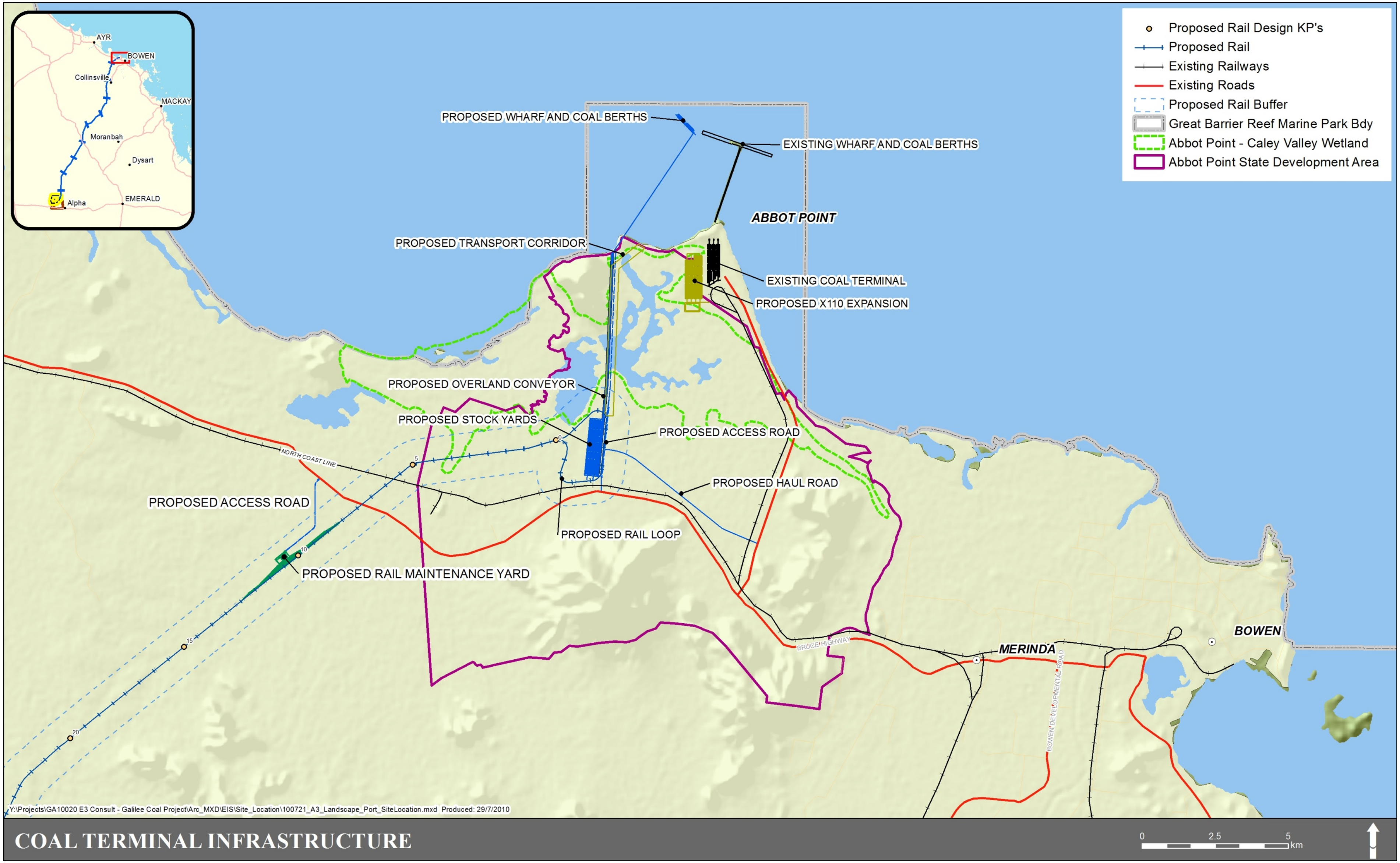

Figure 1-1: Proposed Layout of China First Infrastructure at Abbot Point

1.2 Acid Sulfate Soils

ASS are soils that contain iron pyrites formed under specific conditions. These conditions require the presence of iron, sulphur and organic matter and generally occur only in alluvial coastal soils. The pyrites oxidise when exposed to air, and when combined with water, forms sulphuric acid. This normally occurs when soils are changed from anaerobic to aerobic conditions when they are removed from below the groundwater table or when the groundwater table is lowered. The sulphuric acid will leach out of the soil and may lower the pH of receiving waters, increase the levels of metals in the receiving waters (particularly iron and aluminium), strip the natural neutralising capacity of receiving waters, deplete the dissolved oxygen from the receiving waters and produce unsightly discolouration of surface waters and associated substrates. These consequences can have a serious impact on the receiving waters and its ecosystem.

Sulfuric acid produced from the oxidation of ASS can affect concrete structures such as pipes, foundations and piles by reacting with the lime in the concrete exposing the aggregate and eroding the structure. Steel structures can also be corroded by the sulfuric acid. These consequences can seriously impact the integrity and lifespan of such structures.

There are two types of ASS. These are Actual ASS (AASS) which are soils in which the pyrite has already been oxidised and sulphuric acid is present in the soil and Potential ASS (PASS) where the pyrite is present but has not been oxidised. Both AASS and PASS have the potential to do environmental harm.

1.3 Scope of Report

This report addresses Section 3.2.2 (Soils) of the Terms of Reference (ToR) relating to ASS for the Galilee Coal Project. The ToR (August 2009) pertaining to these requirements are listed in Table 1.1. The report describes the ASS risks within the study area, identifies potential impacts resulting from the proposed works and develops management measures to minimise the risk of impact. The scope of the ASS assessment includes:

- Literature review and desktop assessment of publicly available databases in the study area and region; and
- Recommendations for measures to avoid or mitigate adverse impacts or significant disturbance of ASS during the construction phase of the project construction.

The report does not include marine areas associated with proposed upgrades to the Port of Abbot Point. The potential for ASS to occur in marine sediments is addressed in the coastal environmental technical assessment.

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

ToR Requirement	Technical report section
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*.	All sections of report

2 Methods of Assessment

Methods of assessment employed to assess ASS within the project area consisted of the following studies:

- A review of the relevant legislation and guidelines applicable to ASS within the project area;
- A review of topography, geology and soils mapping and aerial photography available for the project area;
- A review of previous ASS investigations relevant to the project area; and
- Recommendation of further ASS investigations required prior to commencing construction of the coal terminal. These investigations would be required to develop site specific management plans for use during construction and operational activities.

No field work was undertaken in the preparation of this report.

2.1 Desktop Review

2.1.1 ASS Legislation and Assessment Criteria

ASS in Queensland are assessed in accordance with the following applicable regulations:

- *State Planning Policy 2/02 (SPP2/02) – Planning and Managing Development Involving Acid Sulfate Soils* and the *SPP2/02 Guidelines: Acid Sulfate Soil*;
- *Acid Sulfate Soil Technical Manual* - Queensland Acid Sulfate Soils Investigation Team (QASSIT) Guidelines;
- *Guidelines for the Sampling and Analysis of Lowland Acid Sulfate Soils (ASS) in Queensland* (QASSIT Guidelines), 1998;
- *Queensland Acid Sulfate Soil Technical Manual, Soil Management Guidelines*, Version 3.8;
- *ASS, Laboratory Methods and Guidelines*, Version 2.1 – June 2000;
- *Draft Identification and Investigation of ASS, Acid Sulfate Soils Guideline Series*, Department of Environment; and
- *Instructions for the Treatment and Management of ASS*, 2001, EPA.

2.1.2 The State Planning Policy 2 / 02

The principal policy framework for the management of ASS in Queensland is the *State Planning Policy 2/02* which took effect on the 18 November 2002. The SPP2/02 made under Schedule 4 of the *Integrated Planning Act 1997* remains current under Chapter 2 of the *Sustainable Planning Act 2009* (SP Act). The stated outcome of SPP2/02 is the avoidance of the release of acid and associated metals contamination into the environment by either not disturbing ASS when excavating or otherwise removing soil, sediment, extracting groundwater or filling land or treating, and if required, undertaking ongoing management of any disturbed ASS and drainage waters.

Under the SP Act, the SPP2/02 has effect when certain development applications are assessed, when planning schemes are made or amended, and when land is designated for community infrastructure. SPP2/02 applies to all land, soil and sediment at or below 5m AHD where the natural ground level is less than 20m AHD. Within the area described above, the SPP2/02 applies to development involving any of the following activities:

- Excavating or otherwise removing 100m^3 or more of soil or sediment; or
- Filling of land involving 500m^3 or more of material with an average depth of 0.5m or greater.

2.1.3 QASSIT Guidelines

The *Acid Sulfate Soil Technical Manual* (QASSIT 2002 and 2004) provides a series of guidelines including the soil management guidelines, water treatment and management guidelines, sampling guidelines, laboratory method guidelines, environmental management plan guidelines and remediation guidelines. These guidelines were produced by the Department of Environment and Resource Management (DERM) and provide detailed guidelines for the investigation and management of ASS in Queensland. The Manual outlines the key responsibilities and methodologies that proponents should follow in the interests of avoiding environmental harm. DERM produced instructions for the Treatment and Management of ASS as conditions for the compliance of statutory approvals. The DERM Instructions reference the QASSIT Guidelines in most aspects, but also provide additional instruction on sampling density for verification testing of treated ASS.

2.2 Data Sources

The following data was used and /or referred to in this report:

- CSIRO: Australian Soil Resource Information System (ASRIS) ASS maps;
- DERM ASS hazard maps;
- NATMAP Topographic Map Series, 1:250,000 Scale, Geoscience Australia, Commonwealth of Australia, 2003-2004;
- Geological mapping from Australia 1:250,000 Geological Series, Bureau of Mineral Resources, Geology and Geophysics (1968), Geosciences Australia;
- Geological descriptive from Onshore Australia web pages, Geosciences Australia;
- Sunmap Topographic Map Series, 1:25,000 Scale, The State of Queensland Department of Natural Resources 2000; and
- Previous ASS investigations including:
    - *Abbot Point Coal Terminal Stage 3 Expansion Environmental Impact Statement* (February 2006);
    - *Abbot Point Coal Terminal X110 Expansion, Infrastructure Development Project, Draft Voluntary Environmental Assessment* (October 2009); and
    - *Proposed Abbot Point Multi Cargo Facility Draft Environmental Impact Statement* (May 2010)

3 Results

The areas of the development anticipated to encounter ASS include:

- The coal stockyards;
- The haul road connecting the existing port access road and the proposed coal stockyards;
- The coal conveyer and access road alignment; and
- The rail alignment below 20m AHD where ASS may be buried below alluvium of past and present stream channels or associated with Stream channel crossings some distance up stream of the 5m AHD contour level.

As a portion of the land proposed for the development is below 5m AHD, investigations are required to be undertaken prior to the finalisation of the coal terminal design to assess the possible presence of ASS in accordance with SPP2/02.

3.1 Map Information Review

3.1.1 Topography

A review of topographical maps encompassing the Abbot Point region indicates relatively prominent fore-dunes up to 9m AHD are located adjacent to the coast with gently undulating sand plains with minor crest/swale formation and an elevation variation of generally less than 0.5m. There is a transition to colluvial material (loose, heterogenous and incoherent mass of soil material and/or rock fragments deposited by rain wash, sheet wash or slow continuous creep) at approximately 5m AHD. The sand plains have potential for ASS to occur while the colluvium is derived from the granitoid outcrops and accordingly would have no ASS.

Approximately 2.4km of the 5.8km coal conveyor alignment crosses the coastal mudflats below 5m AHD. The proposed coal stock yards straddle the 5m AHD contour with approximately two thirds of the 38ha (approximately 25ha) area located below the 5m AHD contour and the remainder (approximately 13ha) above the 5m AHD contour. The rail alignment continues westward for 5.6km from the coal stock yards along relatively flat terrain between 5m and 15m AHD with some isolated areas below the 5m AHD contour associated with waterway crossings.

Where the rail alignment turns to the south at KP5.6, the topography gradually rises from 5m AHD to 20m AHD. Figure 3.1 shows the location of the 5m and 20m AHD contours in relation to the project.

The haul road which extends from the proposed stockyards to the existing access road connecting the Bruce Highway to the existing Abbot Point Coal Terminal (APCT) traverses gently undulating land above 5m AHD.

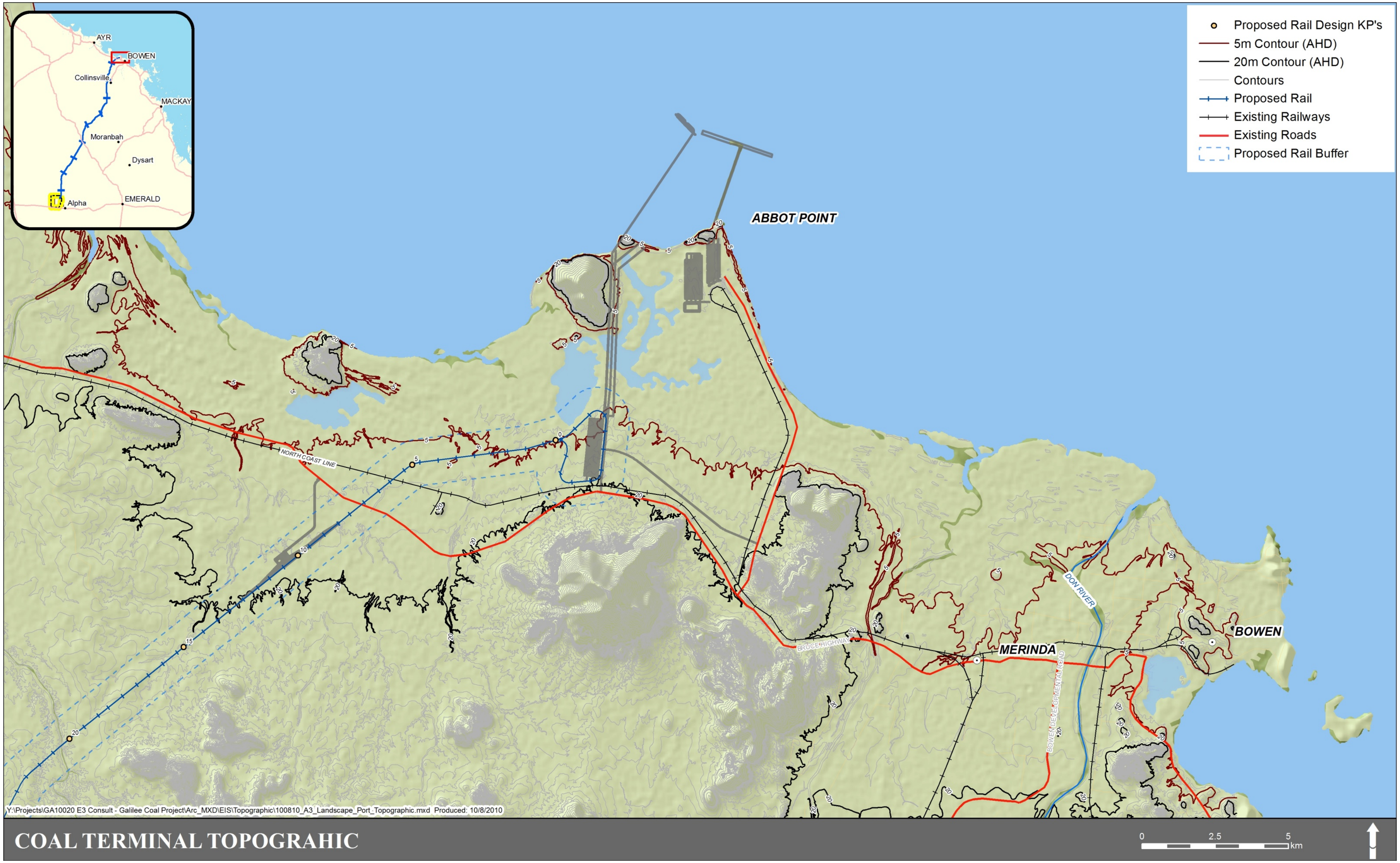

Figure 3-1: Abbot Point Topography

Waratah Coal

3.1.2 Soils and Geology

The regional geological mapping indicates that the geology in the area of Abbot Point comprises primarily of Quaternary coastal dunes and Coastal mudflats (Czs, Qe) that are mainly sands sourced from wind (Aeolian) and Cainnozoic alluvial and deltaic deposits of silt, sand and clay.

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 Mt Luce. These granitoids are of Upper Carboniferous to late Permian age into which some dolerite dykes have subsequently intruded. Figure 3.2 displays geology of the region surrounding Abbot Point. Descriptions of the geological units present within the APSDA are listed in Table 3.1**.**

Table 3-1: Geological Key - Abbot Point and Associated Rail Alignment

Era	Period / Epoch	Geological Symbol	Formation Name	Lithological Description
Cenozoic	Quaternary undifferentiated	Qe	Coastal Mudflats – Estuarine, Tidal Delta Deposits	Estuarine tidal delta deposits
Cenozoic	Quaternary undifferentiated	Czs	Coastal Sand Dunes and Sand Plain	Fine to medium grained unconsolidated sand
Cenozoic	Quaternary undifferentiated	Qa	Channel and Flood Plain Alluvial and Deltaic deposits	Residual soil, sand and gravel, clayey sand, silty sand, clayey silt and silty / clayey sand , colluviums, sand, soil, clay and rock debris
Palaeozoic	Upper Carboniferous – Early Permian	Cggx	Un-named Intrusives	Monzogranite, adamellite, granite, some granodiorite, porphyry, quartz diorite, microtrondhjemite, minor fine grained variants
Palaeozoic	Upper Carboniferous – Early Permian	Cgd	Un-named Intrusives	Diorite, Quartz diorite, hornblend-augite diorite, tonalite, gabbro, norite, minor granodiorite, adamellite and granite.

The soil types within and adjacent to the proposed coal terminal are dominated by Sodosols. These soils have a clear B horizon where the upper 0.2m or major part of the B horizon is sodic and not strongly subplastic. The B horizon is the layer of soil within a soil profile with different characteristics to the surface layer (A Horizon) and any layers of soil immediately below. Soils are predominantly red, brown, yellow, grey or black in the B horizon and may have hardpans or calcrete. Since the coal terminal footprint includes sections of the Caley Valley Wetlands and the geological mapping identifies coastal mudflats, coastal sand dunes, residual soil, sand and gravel, colluviums, clay and rock debris (Qe, Czs and Qa), it is expected that the soils will also contain Hydrosol soils (seasonally or permanently wet soils) and possibly Tenosol (weakly developed soils) and Rudosol (minimal soil development) soil types.

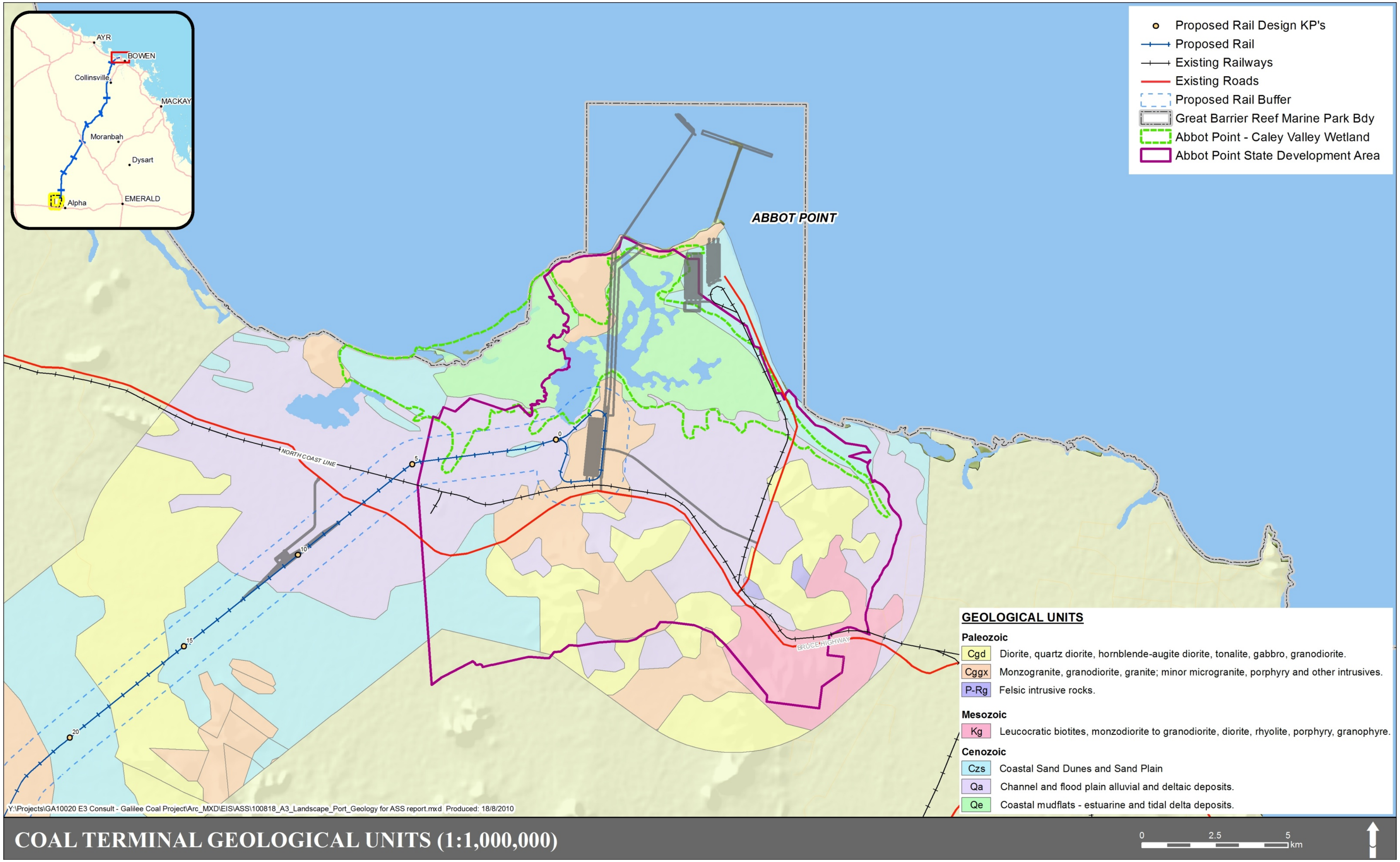

Figure 3-2: Abbot Point Regional Geology

Further investigations proposed for the new coal terminal have been developed with a focus on assessment of the subdivision of the sodosols and the possible presence of ASS due to part of the proposed stockyard and coal conveyor areas being below 5m AHD. The mapped landscape units that are observed in the project area are listed in Table 3.2 and displayed on Figure 3.3.

Table 3-2: Landscape Units - Abbot Point and Associated Rail Alignment

Landscape Unit	Landform	Soils	Remarks
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. Small grassed areas have loamy duplex soils	Subject to frequent inundation by tidal waters
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
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
Va50	Undulating or gently undulating lands / Small areas of granite outcrop within	Dominant soils 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 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

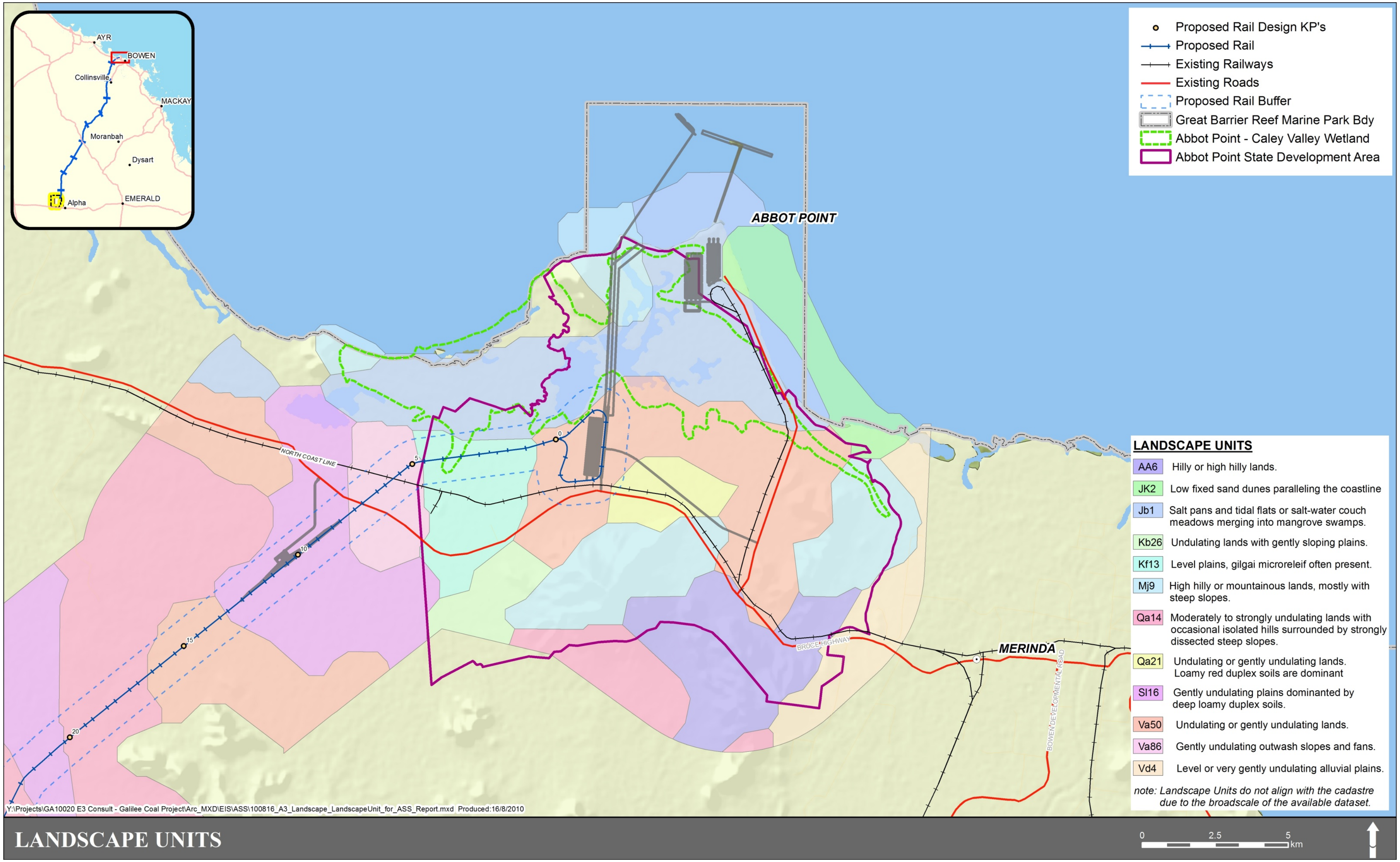

Figure 3-3: Abbot Point Landscape Units

3.1.3 Review of ASS Hazard Maps

DERM have produced ASS risk maps for various regions across Queensland that provides risk mapping based on field investigations carried out by QASSIT. Current DERM ASS mapping does not include the project site. The closest ASS Hazard map is the Bowen ASS Area Map. ASS investigations terminated on the south east bank of the Don River approximately 15km south east of Abbot Point.

A review of the CSIRO's ASRIS broad scale soils mapping (mapped at a scale of 1:2,000,000) indicates that the project area contains a high probability of containing ASS. The CSIRO's ASRIS broad scale mapping also indicates that the 5.6km of rail alignment from the coal stock yards to the point at which the alignment turns south includes areas with low probability of containing ASS and areas with a high probability of containing ASS. The CSIRO mapping generally reflects the topography of Abbot Point with most areas under 5m AHD considered to have a high probability of containing ASS (refer to Figure 3.4).

3.1.4 Discussion

The geological sequence of relevance to ASS are those that have formed during the Holocene epoch of the Quaternary Period. The Quaternary period consists of the Holocene epoch (10,000 years before present (BP) to present day) and the Pleistocene epoch (2-3 million years BP to 10,000 years BP). During the Holocene epoch, sea levels rose following the end of the last ice age. Mean sea level 10,000 years BP was 25m lower than present and this rose to over 1m above current mean sea level approximately 6,000 years BP at which point there was a climatic optimum. There has been a gradual deterioration in climate to present sea levels. New coastal landscapes formed through rapid sedimentation. Bacteria in these organically rich, water logged sediments converted sulphate from tidal waters and iron from the sediments to iron disulfide (iron pyrite) (Sammut J. Lines-Kelly R., 2000).

The formation of ASS at Abbot Point appears to be consistent with how ASS usually formed with risk areas identified on coastal mudflats described (Qe) as estuarine tidal delta deposits (landscape unit Jb1).

3.2 Previous Investigations at Abbot Point

A number of ASS investigations have been carried out at Abbot Point for existing and other proposed infrastructure projects. These investigations include:

- *Abbot Point Coal Terminal Stage 3 Expansion Environmental Impact Statement* (2006);
- *Abbot Point Coal Terminal X110 Expansion Infrastructure Development Project Draft Voluntary Environmental Assessment* (2009); and
- *Proposed Abbot Point Multi Cargo Facility Draft Environmental Impact Statement* (2010).

The previous investigations include the APCT and the proposed x80/x110 expansion area, both of which are more than 2km east of the proposed China First infrastructure and the proposed transport corridor. These investigations do not cover the haul road which extends from the access road alignment to the existing access road connecting the Bruce Highway to the APCT (Figure 1.1).

In view of the relatively contiguous nature of ASS, these investigations provide an indication of the potential conditions that may be found within the project area.

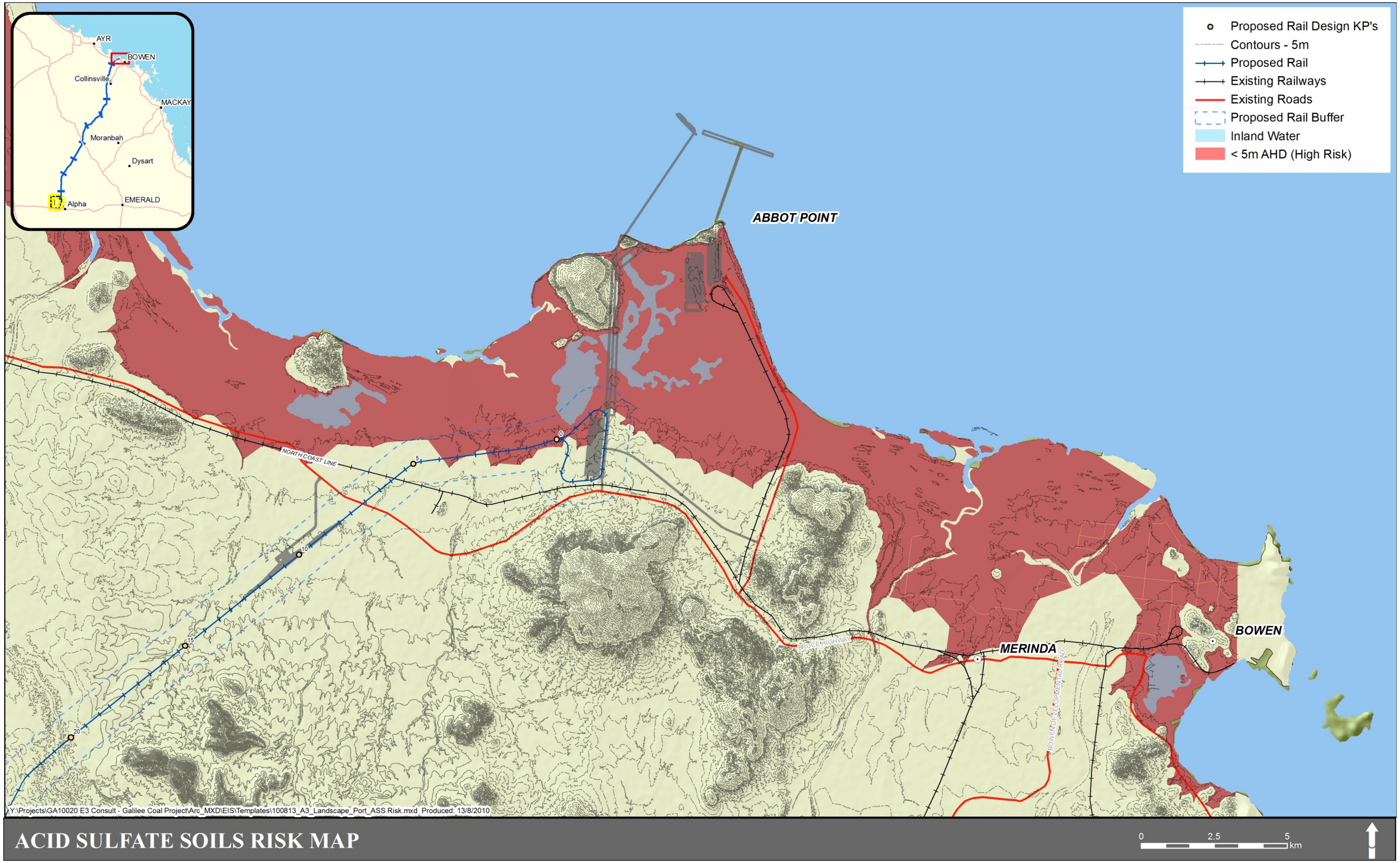

Figure 3-4: Abbot Point ASS Risk Areas

Abbot Point Coal Terminal Stage 3 Expansion Environmental Impact Statement **(2006)**

The report indicates that the surface soils in and around the APCT may extend to more than 1m from the surface and comprise homogenous fine to medium grained sands. The prevailing groundwater level is likely to be at approximately at 0.0AHD or close to sea level. There was no evidence of conditions that may have caused the formation of pyritic material in these soils and field screening and suspension peroxide oxidation combined acidity and sulfur method (SPOCAS) analyses indicated an absence of ASS material within this area.

The laboratory data found that field screening test results indicated all samples had a pH > 4 (non ASS) and there was low Titratable Actual Acidity (TAA) in all samples. The laboratory interpretation also reported low Titratable Peroxide Acidity (TPA) indicating sulphides, and therefore the potential to produce acids were present in the samples tested. ASS analysis using the SPOCAS method for the initial five sites sampled and the Chromium reducible sulfur suite of tests for the subsequent 19 sites sampled indicated that there was no significant PASS in the samples analysed. Three samples recorded results for TAA marginally above the action criteria of 18 mol/tonne H^+ (B5/5, B6/5 and B13/2).

The maximum depth of sampling was 1.3m bgl. The depth of sampling was impacted by rainfall and the site was saturated at the time of sampling limiting sampling to depths of less than 1.3m bgl. Therefore ASS conditions below this depth are unknown.

Sample sites from this investigation are shown on Figure 3.5.

Abbot Point Coal Terminal X110 Expansion Infrastructure Development Project Draft Voluntary Environmental Assessment **(2009)**

The APCT X110 Expansion Infrastructure Development Project Draft Voluntary Environmental Assessment (VEA) included a brief section addressing ASS consisting of the following:

- A desktop review of mapped geology;
- A desktop review of previous ASS investigation reports; and
- Limited field investigations.

The results of this assessment determined:

- The X110 area is characterised by Quaternary aged coastal deposits Czs (coastal sand dunes) and Qe (coastal mudflats);
- CSIRO ASRIS map information identifies the X110 area as containing a high probability for occurrence of ASS;
- The primary areas where ASS were identified generally correspond to the Quaternary coastal mudflats and hydrosol soils; and
- ASS are present within the rail loop of the existing infrastructure. The report refers to 33 test locations being carried out on site out of which four test locations indicated the occurrence of ASS, however the assessment does not provide test locations or sampling data for these field works.

The VEA study area is located approximately 2 – 3 km from the Waratah coal stockyards and coal conveyor system therefore can only be used as an indication of the potential for ASS to exist in the Abbot Point area.

Abbot Point Multi Cargo Facility Draft Environmental Impact Statement **(2010)**

The Preliminary ASS Investigations for the Multi Cargo Facility (MCF) consisted of the following works:

- A desktop review of topography, geology, soils and aerial photography of the region;
- Ground observations at 28 locations and the collection of samples at 25 locations to a depth of 2m bgl;
- Collection of 149 samples all of which underwent ASS field screening analysis (field and field oxidised pH tests); and
- The laboratory analysis of 88 samples (selected on the basis of ASS screening test results) using the SPOCAS method.

The sample locations were all within or near the China First transport corridor and coal conveyor (Figure 3.5).

A summary of the Abbot Point Access Road ASS Investigation results were:

- A total of 149 samples were collected from 28 sample locations and submitted to a NATA accredited laboratory for analysis including the field screening testing;
- The ASS screening tests indicated that the field ph (pH_f) of all samples were >4 and therefore no samples would be considered AASS;
- Field oxidized pH (pH_{fox}), which is the pH of the soil after oxidation with hydrogen peroxide, identified 88 samples from 16 sample locations as containing PASS requiring further analysis;
- The 88 samples were analysed using the SPOCAS method;
- The results of laboratory analysis indicated that TAA results exceeded the ASS action criteria of 0.03%S in 10 of the samples analysed with a maximum TAA of 0.08%S;
- Potential acidity (measured as Peroxide Oxidisable Sulfur (Spos)) exceeded the ASS action criteria of 0.03%S in 13 of the samples analysed with a maximum of 0.46%S;
- The ASS exceedances were generally identified between 0.75m and 2.0m bgl in saturated silty and sandy clay loam soils in boreholes located below the 5m AHD contour;
- Net acidity (the result of summing all measured acidity and subtracting any neutralising capacity) exceeded the ASS action criteria of 0.03%S in 14 of the samples analysed with a maximum of 0.45%S or 262 mol H^+ / ton; and
- Liming rates were calculated based on the net acidity results with the highest liming rate being calculated as 170kg CaCO3 / tone of soil and an average liming rate of 27kg CaCO3/tonne of soil.

The report concluded that:

- ASS was present in the vicinity of the proposed transport corridor in the form of PASS;
- AASS was not identified in any of the test locations;
- A detailed ASSMP was recommended for works within the study area; and
- A detailed geotechnical assessment was recommended to assess the ASS risks involved with filling works within the study area.

Importantly, although the soil pH in all samples was > pH 4.0, the TAA exceeded the ASS action criteria of 0.3%S (or 18 mol H^+/tonne) in 10 of the samples analysed (AR-TP06 (1.0-1.25), ARSB11(1.0-1.5), ARSB11(1.5-2.0), ARSB12(0.25-0.5), ARSB12(0.75-1.0), ARSB12(1.25-1.5), ARSB12(1.75-2.0), ARTP13(1.0-1.25), AR-TP15(0.75-1.0), and AR-TP17(0.25-0.55)). This suggests AASS were present in these samples and that the results of the screening tests may have been biased by an external factor. Further, all samples in which ASS were identified were collected from locations below the 5m AHD contour south of Mount Luce and in a section of the access road alignment (below 5m AHD) that turns east between Mount Luce and Dingo Beach.

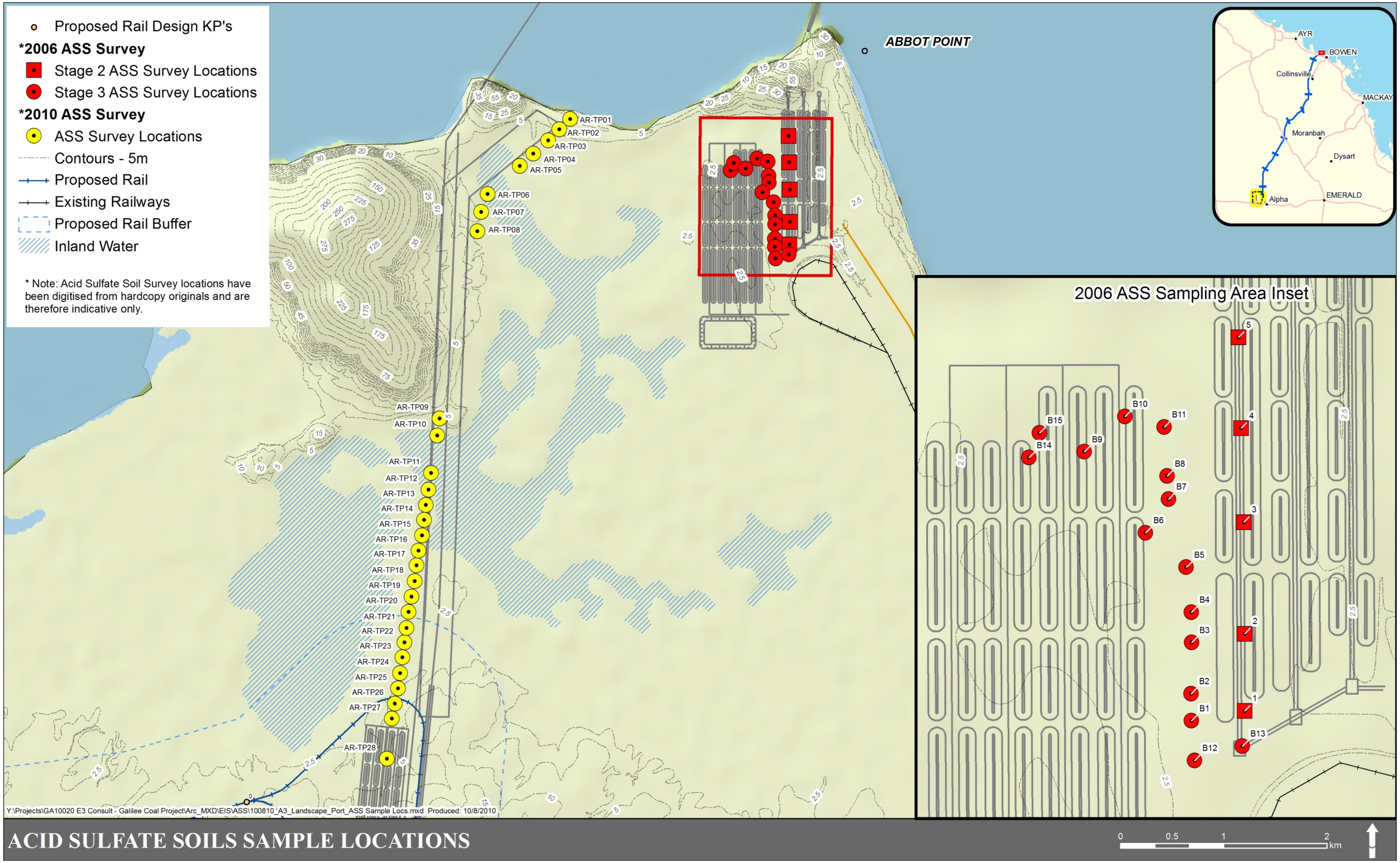

Figure 3-5: ASS Sample Locations (Previous Studies)

3.2.1 Discussion

The 2006 EIS reported no evidence of significant ASS material in the vicinity of the APCT. However, a review of the laboratory data indicated that there were three samples that recorded results for TAA marginally above the action criteria of 18 mol/tonne H+ (B5/5, B6/5 and B13/2). Importantly, the maximum depth of investigation stated in the report was 1.3m blg. The area of investigation for this study is approximately 2km to the east from the China First conveyor alignment. Therefore, the results should only be used as a guide to the level and extent of ASS in the region.

The APCT VEA (2009) identified the primary areas where ASS occurred as generally corresponding to the Quaternary coastal mudflats and hydrosol soils at Abbot Point. The report also identify a secondary area of ASS within the rail loop of the existing infrastructure, referring to 33 test locations out of which four test locations indicated the occurrence of ASS. However, the assessment does not provide test locations or sampling data for these investigations. The APCT X110 Expansion Infrastructure Development Project Area is located 2-3km from the China First stockyards and coal conveyor alignment. Therefore, these results should again only be used as a guide to the extent of ASS in the region.

Field investigations carried out for the MCF also identified AASS in the coastal mud flats in the vicinity of the access road alignment with maximum liming rates calculated as 170kg CaCO3/tonne of soil at borehole location AR-TP13 (1.75m – 2.0m). The average liming rate was 27kg CaCO3/tonne of soil. The primary areas containing ASS identified in by the study corresponded to the Quaternary Coastal mudflats and the hydrosol soils.

Evidence from these previous investigations indicates the likely presence of ASS within the China First conveyor alignment, which if disturbed, would require treatment to minimise the potential for adverse impacts.

The previous investigations do not cover the areas in which the China First coal stockyards are located. The coal stockyards would be located south of the MCF study and the results of samples taken at the southern end of that study area indicated that ASS were not present beyond this point. However, the depths of the boreholes in that study terminated at 2m bgl so the presence of ASS below this depth are unknown.

The previous investigations do not cover the haul road which connects to the southern end of the access road and extends to the existing access road to the APCT and Bruce Highway. The rational for not sampling this area could be that the location of the haul road is above 5m AHD elevation and not within geological or landscape mapped areas associated with ASS.

It is not envisaged that road works associated with the construction of the proposed haul road will trigger the SPP2/02; however, if road construction design plans indicate that excavations involved with the road construction will penetrate 5m AHD, the SPP2/02 will come into effect and ASS investigations would be necessary to mitigate ASS risks associated with the proposed haul road construction.

4 Potential ASS Impacts

4.1 Introduction

Inappropriately managed ASS can have a substantial impact both environmentally and on the life span of infrastructure built within areas containing ASS. Potential impacts involved with the disturbance of ASS will depend upon the nature of the disturbance (i.e. excavating or removing ASS or placing fill upon the soil) and location relative to environmentally sensitive receptors such as waterways. These can range from direct impacts such as mass mortality of marine flora and fauna and the corrosion of concrete and steel structures, to the more indirect impact on organisms requiring carbonate for shell development and the removal of the mucus layer that protects fish from viruses leading to diseases in fish populations such as Red Spot disease.

4.1.1 Excavation/Removal of ASS

The potential impacts of excavating or removing ASS include:

- The oxidation of PASS producing sulfuric acid and leaching out of metals (principally iron and aluminium) from the soil matrix and the resulting surface water impacts of lowered pH, metals contamination, dissolved oxygen depletion, iron staining of water ways and effects on marine biota such as mass mortalities and chronic disease; and
- The shortening of the lifespan of built infrastructure due to corrosion of metal and calcium substitution in concrete.

4.1.2 Potential Impacts of Placing Fill On ASS

The potential impacts of filling on ASS include:

- Bringing actual ASS into contact with groundwater (thus potentially mobilising and transporting existing acidity out of ASS into the groundwater) and the resulting discharge/recharge of acidic groundwater water with elevated metals concentrations;
- Raising acidic groundwater tables with the short term release of acid into water ways; and
- Displacing or extruding previously saturated PASS above the water table and aerating these soils or sediments and the resulting discharge/recharge of acidic groundwater and surface water with elevated metals concentrations.

The displacement or extrusion of clayey ASS is due to some clayey ASS having a high water content (up to 70 to 80% by volume), and low hydraulic conductivities. Under load such soils may flow like gels resulting in subsidence at the load point and the raising of the displaced soil (below the water table) into oxidizing conditions above the water table (ASS Technical Manual, DERM, 2002).

4.1.3 Potential Dewatering Impacts

Additional impacts may exist if there is a requirement during construction for the dewatering of excavations. The potential impacts associated with dewatering with ASS areas include:

- Water table drawdown resulting in oxidation of PASS in areas surrounding excavations and resultant leaching of acidic groundwater with elevated metals concentrations;
- Discharge/recharge of acidic water; and
- Discharge/recharge of groundwater with elevated metals concentrations.

4.2 New Coal Terminal

4.2.1 Mechanisms of Impact

The mechanisms for impact for the project will depend on the construction methods employed for the construction of the coal conveyor system and the coal stockyards facility. Excavation in areas where ASS has been identified for the support of the coal conveyor system such as piling may require the excavation of significant quantities of ASS requiring treatment. Additionally, since sections of the coal conveyor alignment are to be constructed through the tidal mud flats, there may be the requirement to dewater excavations for the support of the conveyor structure. Hence the construction impacts may also include the groundwater dewatering impacts discussed in Section 4.1.

The coal stockyards may require significant filling to take place for equipment lay down areas and to provide a stable platform for the storage of bulk coal. The potential impacts of filling on ASS within the coal stockyards area are as those detailed in Section 4.1.

4.2.2 Construction Impacts

The principal ASS impacts during the construction phase are the PASS excavation and dewatering impacts associated with the construction of the coal conveyor system and the potential impacts of the displacement and extrusion of PASS associated with the filling on ASS associated with the construction of the coal stockyards. These are principally environmental impacts associated with the release of acid into receiving water with the potential for impacts such as lowering the pH of receiving waters, lowering the dissolved oxygen levels, metals contamination, discolouration of water and impacts on marine flora and fauna such as mass mortality and Red Spot disease.

4.2.3 Operational Impacts

Potential operational impacts of ASS if not managed correctly include the ongoing environmental impacts and the impacts on the coal conveyor system itself. Potential operational impacts also include those impacts associated with the filling activities on PASS for the coal stockyards.

Mismanaged ASS that are disturbed and not treated, have the potential to result in the corrosion of concrete footings/piles and steel structures weakening the coal conveyor support structures with the potential to cause catastrophic failure of the structure (worst case scenario) or increased maintenance and repair costs involved with dealing with the accelerated corrosion due to sulphuric acid attack on the coal conveyor structure.

4.3 Rail Corridor

Potential impacts associated with the rail corridor consist of the impacts associated with the excavation of ASS during construction works. There has been no ASS investigations available for review for the rail corridor and ASS mapping is limited to the broad scale (1:2,000,000) which show low probability of ASS in the areas where the rail corridor crosses. However, at this mapping scale, ASS risks associated with past and present stream channels are not addressed. There is therefore a risk that ASS may be encountered within the rail corridor alignment at or below 5m AHD where the rail corridor crosses creeks and streams.

There is therefore a requirement for ASS investigations to be undertaken along the rail corridor at locations below 20m AHD where the rail corridor crosses creeks and stream channels and where the alignment is identified as being in areas below 5m AHD.

4.3.1 Mechanisms for Impact

The mechanisms for impact for ASS associated with the rail corridor consist of the excavation and removal of ASS oxidising PASS currently below the groundwater table and or the displacement of ASS such that it may leach acid and metals into receiving waters. These impacts would likely occur during construction works associated with bridges or culverts where the rail alignment crosses water ways.

4.3.2 Construction Impacts

The principal potential impacts are expected to consist of the excavation or removal of ASS involved with the construction of bridges and culverts for creek and stream crossings leading to the oxidation of ASS. These are principally environmental impacts associated with the release of acid and metals into receiving waters.

4.3.3 Operational Impacts

Operational impacts associated with the ASS within the rail corridor if not managed correctly, are the ongoing environmental impacts associated with the release of acid and metals into receiving waters and the impacts on the rail infrastructure such as the corrosion of concrete and steel on culverts and bridge footings requiring increased maintenance and repair costs to avoid the failure of the structures. If the results of ASS investigations indicate significant PASS on the approaches to creek and steam crossings then the potential impacts of filling on ASS will be an ongoing operational impact.

4.4 Potential Impacts in Remaining Project Areas

The conditions necessary for the formation of ASS occurring are predominantly in coastal areas below 5m AHD elevation. It is therefore not anticipated to be any ASS risks associated with the rail alignment above 20m AHD and from the 5.6km point onward.

5 Management Measures

Management considerations would depend on site-specific factors and would be dependent on the results of ASS investigations on the specific areas. For the infrastructure proposed, previous investigations have identified ASS that would require management if disturbed. Therefore the development of an ASSMP for works within this area would be required. Additional investigations would be required for construction works involving excavations or piling works below 2m bgl (the limit of current ASS investigations in the project area).

ASS investigations have not been undertaken in the area where the coal stockyards are proposed. The results of previous investigations indicates that ASS is not present in this area to 2m bgl but it is not known if ASS is present below this depth. Accordingly there could be the potential for filling activities associated with the coal stockyards to impact on ASS. SPP2/02 states that for filling activities involving 500m^3 or more of material with an average depth of 0.5m or greater triggers the SPP2/02. Therefore further investigations will be required in this area with possible management strategies put in place to manage the risks of filling on ASS.

For the areas where the rail corridor crosses creek and stream channels and / or where the elevation is at or below 5m AHD, ASS investigations will need to undertaken to assess the potential ASS risks. It is likely that there will be a need for the management of ASS for the construction of the rail corridor from the coal stockyards to where the rail corridor turns south or rises above 20m AHD.

5.1 New Coal Terminal – Coal Conveyor and Access Road Alignment

The new coal terminal ASS issues include:

- Excavation/removal of ASS during construction; and
- Potential dewatering activities during construction.

Management requirement	Management measure	Timing	Responsibility
Comply with the requirements of the SPP2/02, QASSIT and DERM *Guidelines for the Management of Acid Sulfate Soils*	Development of an ASSMP for Specific Construction Works involved with the construction of the coal conveyor system.	Pre construction	Environmental Manager
	Implement an ASSMP	During Construction	Environmental Manager and Construction Contractor

5.2 Coal Stockyards

The coal stockyards ASS issues include:

- There has been no intrusive ASS investigation specific to the coal stockyards; and
- There are potential impacts associated with the filling on ASS with respect to PASS displacement and acidification and groundwater acidification and/or displacement.

Management requirement	Management measure	Timing	Responsibility
Comply with the requirements of the SPP2/02, QASSIT and DERM *Guidelines for the Management of Acid Sulfate Soils*	Conduct ASS Investigations to determine the specific ASS conditions for the coal stockyard area	Pre construction	Environmental Manager
	Conduct hydrogeological investigations for the coal stockyards including the installation of groundwater monitoring wells.	Pre construction	Environmental Manager
	Implementation of an ASSMP if required	During Construction	Environmental Manager and Construction Contractor
Management requirements contingent upon the outcome of ASS and geotechnical investigations	Management requirements are contingent upon the outcome of ASS and geotechnical investigations but may require the development of an ASSMP for the coal stockyards	Pre construction	Environmental Manager

5.3 Rail Corridor

The issues with respect to ASS for the rail corridor include:

- PASS occurrence along the rail corridor between the coal stockyards and the 20m AHD elevation contour particularly where the rail alignment crosses creeks and streams channels where ASS may be present at or above 5m AHD; and
- There has been no intrusive ASS investigation undertaken for the creek and stream channels below 20m AHD along the rail corridor alignment.

Management requirement	Management measure	Timing	Responsibility
Comply with the requirements of the SPP2/02, QASSIT and DERM *Guidelines for the Management of Acid Sulfate Soils*	Identify creek and stream channel crossings below 20m AHD requiring bulk excavation and target for ASS investigation	Pre construction	Environmental Manager
	Implementation of the requirements of the ASSMP if required	During construction	Environmental Manager and Construction Contractor
Management requirements contingent upon the outcome of ASS investigations	Management requirements contingent upon the outcome of ASS investigations but may require the development of an ASSMP for the construction works	Pre construction	Environmental Manager

6 Conclusions

The results of inappropriately managed ASS can have significant impacts on both the natural environment and built structures. These impacts are well documented and range from the effects on receiving waters such as acidification, de-oxygenation, discolouration of water ways and the mass mortality of marine biota to the effects on built structures such as accelerated corrosion of steel structures and concrete.

Based on the results of this ASS desktop assessment for the China First project area the following conclusions are made:

- ASS have been identified along the proposed China First conveyor alignment. There is a high probability of disturbing ASS during the construction of the coal conveyor system and access road and the required treatment for the ASS is estimated to be on average 27kg $CaCO_3$/tonne with a maximum of 170kg $CaCO_3$/tonne;
- Investigations have been carried out to a maximum depth of 2m bgl. Further investigation would be required for construction works involving excavation or piling deeper than 2m bgl;
- The MCF EIS indicated that ASS is unlikely to extend to the proposed coal stockyards; however boreholes were only completed to 2m bgl;
- Since the coal stockyards are to be designed to hold 5% of the 40 Mtpa of coal during its operation, the risks associated with filling on top of ASS are considered to be high requiring additional ASS investigations including hydrogeological assessment;
- There is a potential for ASS to be present in close proximity to past and present creeks and stream channels at and above the 5m AHD contour along the rail alignment from the proposed coal stockyards to approximately 6km along the rail alignment;
- PASS impacts associated with the coal conveyor consist of the possible exposure of PASS to oxidation and acidification during construction works impacting on the water quality and biota of receiving waters and potentially shortening the lifespan of the coal conveyor structure;
- PASS impacts associated with the coal stockyards include the possible displacement and / or extrusion of PASS from below the stockyards placing PASS previously below the groundwater table to oxidizing conditions potentially causing acidification and/or the displacement of groundwater potentially mobilising acidic groundwater and metals to receiving waters; and
- PASS impacts associated with the rail corridor include the possible acidification of ASS excavated or removed during the construction of creek crossings and culverts where ASS is present above the 5m AHD contour with the potential to impact the water quality of receiving waters, biota and potentially shortening the lifespan of the constructed structures.

7 Commitments

Based on the results of this desktop review, Waratah Coal commits to the following:

- Full investigations will be carried out to assess the presence of ASS within the footprint of the coal terminal prior to finalising the design;
- An ASSMP will be developed for the construction of the coal conveyor system detailing the management requirements for ASS during construction of the coal conveyor including monitoring, treatment, verification testing and reporting;
- ASS investigations and hydrogeological investigations will be conducted for the coal stockyards areas to assess the potential for the filling activities to be conducted on site to impact on ASS below the stockyards causing the extrusion of PASS, acidification of groundwater and or the mobilisation of acidified groundwater to receiving waters;
- ASS investigations will be conducted on creek and steam channel crossings below 20m AHD where acid sulfate soils may be present at or above the 5m AHD contour; and
- Where ASS are identified within the rail corridor, a detailed ASSMP will be developed including monitoring, treatment, verification testing and reporting for the individual construction works.

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Waratah Coal

9 Glossary

Abbreviations

Abbreviation	Meaning
AASS	actual acid sulfate soil
AHD	Australian Height Datum
ASS	acid sulfate soil
ASSMP	acid sulfate soil management plan
DERM	Department of Environment and Resource Management (Qld)
EIS	environmental impact statement
Mbgl	metres below ground level
PASS	potential acid sulfate soils
QASSIT	Queensland Acid Sulfate Soil Investigation Team.
SPOCAS	Suspension peroxide oxidation combined acidity and sulphur analysis for acid sulfate soils using peroxide oxidisable sulphur (Spos) to determine sulphur percent
SPP2/02	*State Planning Policy 2/02, Guideline for the Planning and Management of Acid Sulfate Soils*
TAA	Titratable Actual Acidity
TPA	Titratable Peroxide Acidity

Glossary of Terms

Abbreviation	Meaning
Cenozoic	Geological Era dating from 65 million years before present to present
Chromium Reducible Sulfur Suite	suite of analysis for acid sulfate soils using chromium reducible sulfur (Scr) to determine sulfur percent
Holocene	Present geological epoch which commenced 10,000 years ago.
Hydrosols	Seasonally or permanently wet soils
kg $CaCO_3$ / tonne	Acid neutralisation liming rate unit expressed as kilograms of calcium carbonate per metric tonne
Palaeozoic	Geological Era dating from 570 million years before present to 225 million years before present
Pleistocene Epoch	Geological time epoch dating from 2-3 million years before present to 10 000 years before present. The Pleistocene epoch and the Holocene epoch make up the quaternary period

Abbreviation	Meaning
Mol H+ / tonne	Acid quantity expressed as molar concentration of hydrogen ions per metric tonne
pH_f	Soil pH measured in the field on saturated soil paste sub sample
pH_{fox}	Soil pH measured in the field on a sub sample of soil after oxidation with 30% hydrogen peroxide
Quaternary Period	A time period dating from approximately 2-3 million years before present to present time
Rudosols	Soils with minimal soil development
%S	Acid quantity expressed as the percentage of sulfur determined By laboratory for the dry mass of soil
Sodosols	Soils high in sodium with an abrupt increase in clay in the B horizon
Tenosols	Weakly developed soils