

# C | Out-of-Pit Tailings Storage Facility: Hydrogeological Assessment





# Report

## Alpha Coal Project

### Out-of-Pit Tailings Storage Facility: Hydrogeological Assessment

30 SEPTEMBER 2011

Prepared for  
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## Executive Summary

A geological and hydrogeological assessment of the proposed Alpha Coal Mine 30 year life of mine out-of-pit tailings storage facility (TSF) has been undertaken to describe the underlying geology including the nature of the boundary between the Colinlea Sandstone and the Joe Joe Group. The assessment included an evaluation of groundwater occurrence and the nature of the groundwater resources within and adjacent to the TSF footprint.

The study allowed for the construction of groundwater monitoring bores to obtain groundwater data from multiple vertical zones. These field data allowed for an evaluation of the suitability of the proposed TSF site from a groundwater perspective. The assessment also allowed for the consideration of recharge mechanisms and alteration within the proposed TSF area.

The proposed TSF is located in an area that is shown on the Jericho 1:250,000 geological map to comprise outcrop of Colinlea Sandstone and Joe Joe Group. There was relatively little data available on groundwater occurrence and recharge potential of the Colinlea Sandstone outcrop in the area of the proposed TSF. In order to address the lack of site specific data, a field investigation program was undertaken in order to obtain:

- Data relating to the stratigraphy and lithology underlying the site;
- Data relating to groundwater occurrence and aquifer types; and
- Data relating to the potential for the site to be located within a groundwater recharge area.

Drilling results were compiled into geological cross sections, which allowed for the evaluation and interpretation of drilling / groundwater data. The information indicates:

- In the proposed TSF footprint the fresh (unweathered) Joe Joe Group comprises blue-grey micaceous, chloritic, lithic sandstone and conglomerate. The sediments are well cemented and, based on low (dry) air-lift yield results, have low primary permeability. Areas of relatively high yield are therefore expected to be related to secondary permeability, such as fracturing, which may offer low sustainable yields due to low storage; and
- The weathered / lateritic Joe Joe Group sediments are difficult to distinguish from weathered / lateritic Colinlea Sandstone (Permian parent material of the Tertiary laterite is difficult to discern). However, an abundance of lithic sediments and occurrence of carbonaceous material is considered diagnostic as the Colinlea Sandstone is more quartz-rich. This distinction allowed for the delineation of the two units and determines that the Colinlea Sandstone units, including the coal seams, pinch out to the east of Lagoon Creek.

In terms of potential groundwater impacts from the proposed TSF, the stratigraphy below the proposed TSF (in terms of parent rock either Joe Joe Group or Colinlea Sandstone sediments) is considered to be less important than the lithology mapped directly below the proposed TSF footprint. This is due to the lack of rock outcrop or shallow subcrop of either unit within the TSF footprint as fresh Permian sediments are covered by clay-rich saprolite and laterite derived from weathering of the parent material.

Based on the available site specific geological and hydrogeological data an assessment of the potential impacts of the proposed TSF have been compiled. The assessment indicates:

- Limited recharge potential to the underlying Colinlea Sandstone aquifers due to the thick clay-rich Tertiary cover, thin discontinuous Colinlea Sandstone aquifers (cross-sections indicate thin sub-E

## Executive Summary

and sub-F sands), thick unsaturated zone (even though the site was subject to prolonged high rainfall events during 2010/2011), and no Colinlea Sandstone rock outcrop or shallow subcrop;

- Drilling results and blow-out yields recorded during rotary-air-percussion within the proposed TSF footprint indicate aquitards and units of limited groundwater potential;
- The majority of the shallow perched groundwater within the proposed TSF footprint comprises poor quality groundwater; and
- Discrete zones of alteration, resulting in enhanced groundwater potential, occur to the west of the northern portion of the proposed TSF footprint. These groundwater resources can be protected through the use of lining and seepage control measures down gradient of the proposed TSF.



## Introduction

Hancock Coal Pty Ltd (HCPL) is developing the Alpha Coal Project (Project), a 30 Mtpa open-pit thermal coal mine with a life-of-mine (LOM) planned for 30 years. Alpha Coal Project (Mine) waste will be generated through mining activities (overburden) and coal processing (coarse rejects and fine tailings). The annual production of tailings will be ~ 2.5 Mtpa, equating to 74 Mt over the LOM. These tailings are currently proposed to be deposited on an out-of-pit tailings disposal facility. The out-of-pit Tailings Storage Facility (TSF) is proposed to be located to the east of Lagoon Creek (Figure 1-1).

Tailings will report to the TSF in a slurry form containing approximately 30% solids and excess water will be recycled from the TSF using a decant system for reuse at the coal handling and preparation plant (CHPP). Given the arid climate of the region, the tailings surface is expected to dry out relatively quickly and form a dense compact solid material, which will facilitate a cover placement and rehabilitation at the end of mine life.

An assessment of the proposed out-of-pit TSF has been conducted from a groundwater perspective.

### 1.1 Out-of-pit tailings disposal facility site

The site proposed for the TSF covers an area of ~ 2 600 ha, spanning approximately 10.5 km (north to south) by 3.2 km (east to west) at its greatest extent. The proposed TSF is located east of Lagoon Creek, which runs parallel to and around 2 km west of the site. The TSF is bounded to the east by a northerly trending, low ridge that also runs parallel to the TSF and defines the eastern site limits. The proposed out-of-pit TSF is located immediately west of mapped (Jericho 1:250 000 scale geological map) Colinslea Sandstone outcrop (Figure 1-2).

The site generally slopes very gently (around 1°) and drains from the eastern ridge crest at approximate elevation 380 mAHD towards Lagoon Creek in the west, at approximately 310 mAHD. Representative topography at the site is depicted in Plates 1-1 and 1.2.

**Plate 1-1** Typical topographic relief across the western half of the TSF site

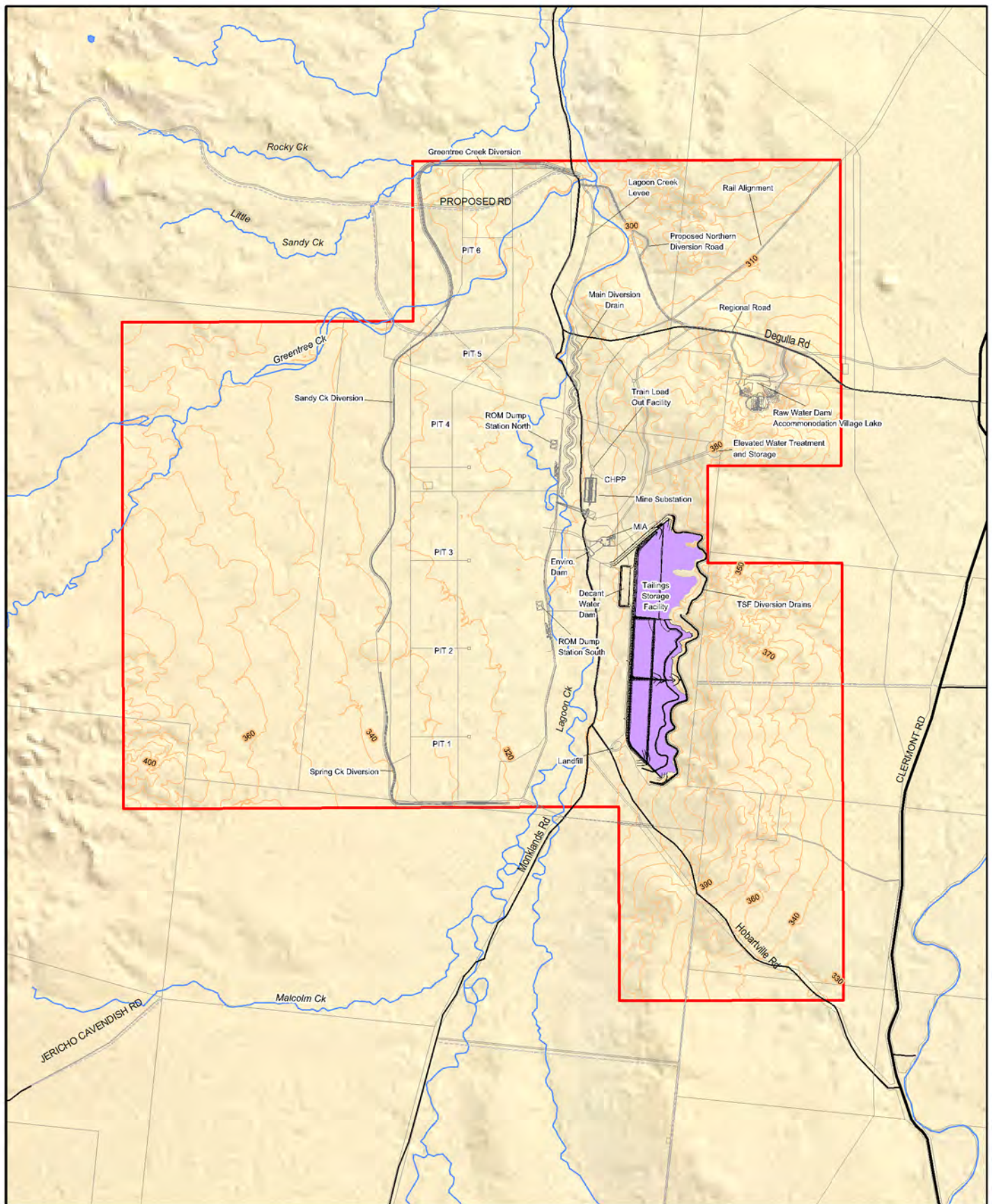


## 1 Introduction

**Plate 1-2** Greater vertical relief along the eastern TSF site boundary







0 2 4000  
Scale 1:150,000 (A4)  
Datum: GDA94, MGA Zone55

- Contours (10m)
- Tailings Storage Facility
- Mining Lease Application (MLA 70426) Boundary

Source: Client Supplied Data

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HYDROGEOLOGICAL ASSESSMENT

ALPHA TAILINGS STORAGE  
FACILITY LOCATION

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ALPHA COAL OUT-OF-PIT TAILINGS STORAGE FACILITY

Figure: 1-1

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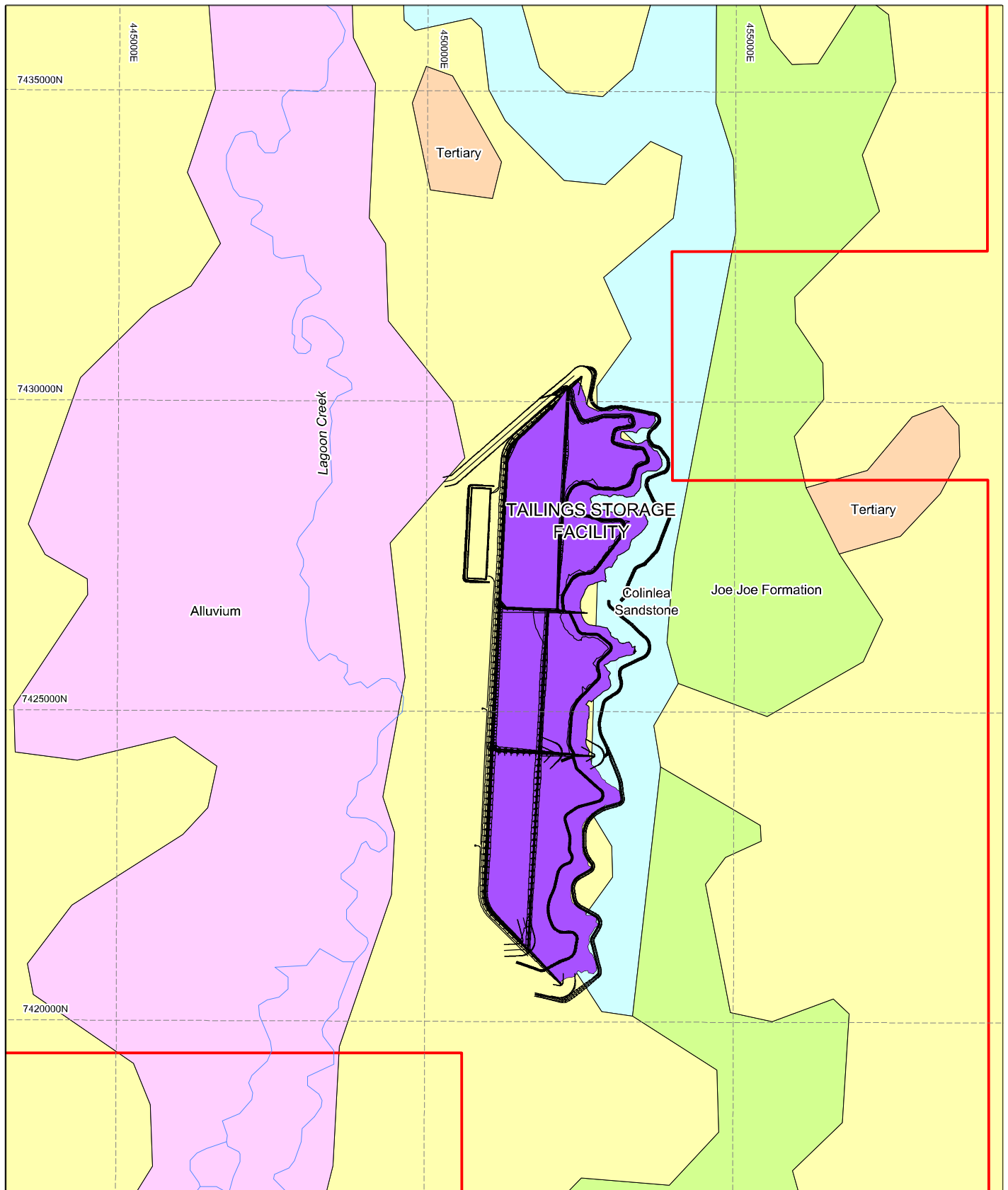
Approved: MS

Date: 27-09-2011

Rev. A

A4





0 1 2km  
Scale: 1:100 000 (A4)  
Datum: GDA94, MGA Zone 55

- Mining Lease Application (MLA70426) Boundary
- Tailings Storage Facility

Source: 1:250 000 Geological Map from Geoscience Australia

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HYDROGEOLOGICAL ASSESSMENT

**ALPHA TAILINGS STORAGE  
FACILITY ON THE 1:250 000  
GEOLOGICAL MAP**

**URS**

**ALPHA COAL OUT-OF-PIT TAILINGS STORAGE FACILITY**

Figure: **1-2**

File No: 42626680-g-527.wor

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Date: 27-09-2011

Rev. A

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## 1 Introduction

All creeks and drainage lines within the proposed TSF footprint are ephemeral and poorly defined. The creeks provide channels for westerly flowing runoff from the slightly elevated ridge to the east. Thus runoff is across grassland either as sheet flow or in ill-defined watercourses towards Lagoon Creek. Recognisable drainage lines typically peter out on encountering the more level land on the eastern flank of the existing Lagoon Creek flood plain.

### 1.2 Assessment basis

A geological and hydrogeological assessment of the proposed 30 year LOM TSF footprint has been undertaken to:

- Verify the underlying geology and investigate the nature of the boundary between the Colinslea Sandstone and the underlying Joe Joe Group;
- Identify groundwater occurrence and bore yields and determine the nature of the groundwater resources within and adjacent to the TSF footprint;
- Construct groundwater monitoring bores to obtain ambient groundwater data from multiple vertical zones;
- Assess the proposed TSF site from a groundwater perspective; and
- Assess the potential for recharge within the proposed TSF area.

The TSF assessment study included hydrogeological drilling and monitoring bore construction, which allowed for an assessment of the site geology and hydrogeology. In addition, a detailed geotechnical evaluation, which included drilling and test pit excavation, has been conducted across the entire TSF footprint.

These data were compiled and assessed in order to aid in making decisions regarding the potential impacts of the TSF on the groundwater and determining optimum mitigation and management options.

## Background

The proposed TSF is located in an area that is shown on the Jericho 1:250,000 geological map to comprise outcrop of Colinlea Sandstone and Joe Joe Group (Figure 1-2).

The geology of the Colinlea Sandstone (at least down to the D-E sandstone) and the overlying Bandanna Formation is well known within the project area based on extensive exploration drilling data. However, only a limited number of exploration holes have been drilled to specifically target the Joe Joe Group in the project area, therefore a local description of the Joe Joe Group had not been compiled.

In addition relatively little data existed on groundwater occurrence and recharge potential of the Colinlea Sandstone outcrop in the area of the proposed TSF.

In order to address the issues outlined above, a field investigation program was undertaken at the site of the proposed TSF in order to obtain:

- Data relating to the stratigraphy and lithology underlying the site, particularly the nature of the boundary between the Colinlea Sandstone and the Joe Joe Group;
- Data relating to groundwater occurrence and aquifer types; and
- Data relating to the potential for the site to be located within a groundwater recharge area.

## Geology

The Alpha Coal Project deposits occur within the Galilee Basin, a sequence of Late Permian to Early Triassic sedimentary rocks, exposed in a linear belt between the towns of Pentland in the north and Tambo in the south (Figure 3-1).

The rocks of the Galilee Basin are of similar age to those of the Bowen Basin (Late Permian), which is exposed to the east of the Drummond Basin (Figure 3-1). The Bowen and Galilee coal basins are separated by a north-trending structural ridge between Anakie and Springsure, referred to as the Springsure Shelf. Much of the western portion of the Galilee Basin is interpreted as occurring beneath Mesozoic sediments of the Eromanga Basin. The Anakie Inlier comprises older Palaeozoic rocks.

Late Permian, coal-bearing strata of the Galilee Basin sub-crop are found in a linear, north-trending Belt in the central portion of the exposed section of the basin and are essentially flat lying (dip 1 to 2° to the west). The stratigraphy of the Galilee Basin is described in Table 3-1.

**Table 3-1 Galilee Basin Stratigraphy**

<b>Era</b>	<b>Period</b>	<b>Basin</b>	<b>Unit</b>	<b>Rock types</b>
Cainozoic	Quaternary	-	-	Alluvium
	Tertiary	-	-	Argillaceous sandstone and clay
Mesozoic	Triassic		Rewan Formation	Green-grey mudstone, siltstone and labile sandstone
Paleozoic	Permian	Galilee	Bandanna Formation	Coal seams A and B, labile sandstone, siltstone, and mudstone
			Colinlea Sandstone	Coal seams C, D, E, and F, labile and quartz sandstone
	Late Carboniferous to Early Permian		Joe Joe Group	Mudstone, labile sandstone, siltstone, shale and thin carbonaceous beds
	Early Carboniferous	Drummond		

### 3.1 Project Specific Geology

Geology in the Project area is characterised by westerly dipping Permian age sediments overlain by Tertiary and Quaternary sediments. The Tertiary and Quaternary (i.e. Cainozoic era) sediments vary from 20 m to 60 m thick over the site. The site lithostratigraphy, including the target C and D coal seams, is presented in Table 3-2.

The unconsolidated Quaternary deposits comprise recent alluvial sand, silt and fine gravel. These sediments are thickest in Lagoon Creek, thinning to the east and west. The remainder of the Cainozoic stratigraphy comprises Tertiary sandy clays, laterite, saprolite, and minor ironstone lenses. This overburden is thickest in the central and eastern portions of the mining area up to 56 m with an average thickness of about 22 m. Potentially expansive and dispersive Kaolinite, montmorillonite (Al smectite) and nontronite (Fe smectite) clay minerals were identified in these deposits.

### 3 Geology

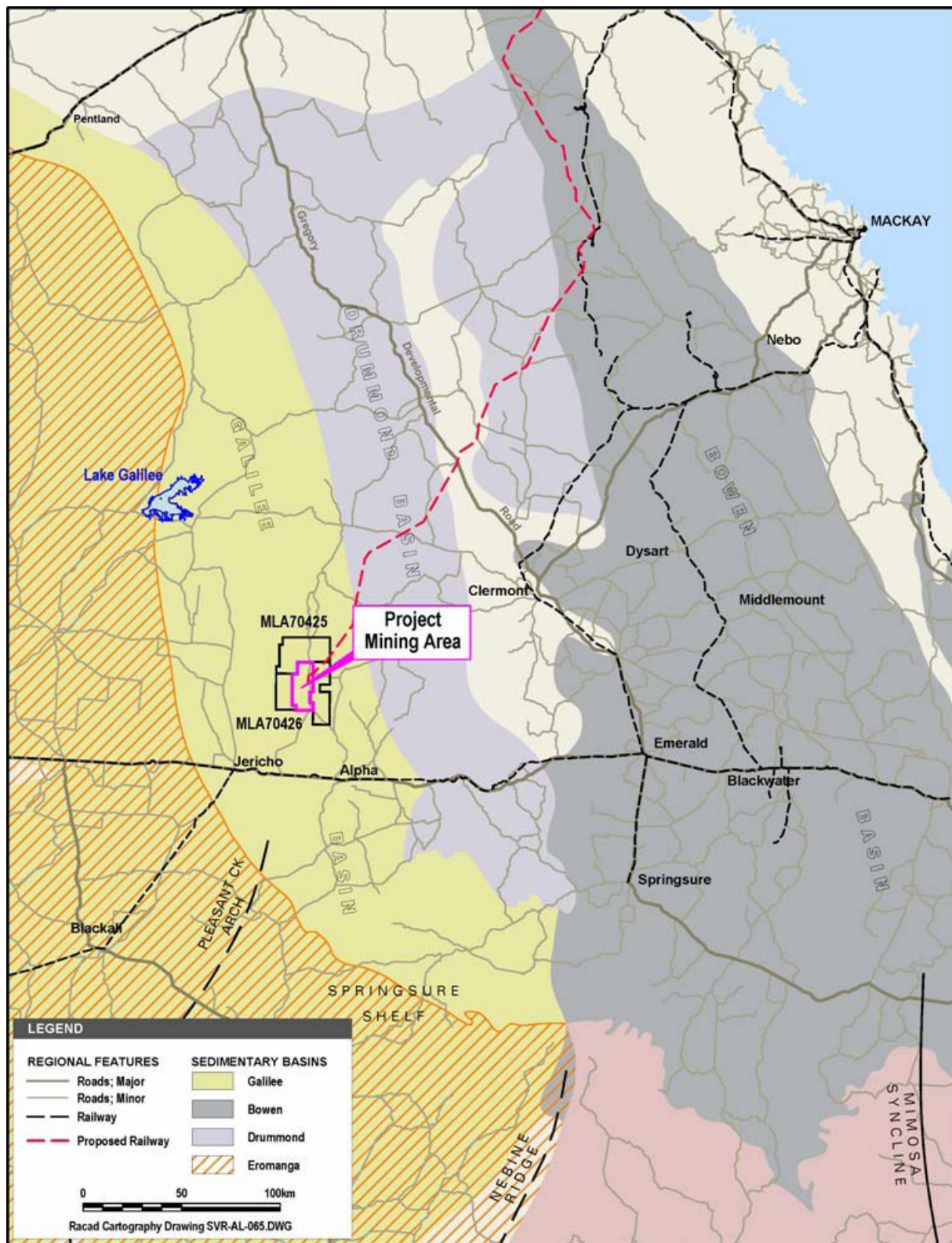


Figure 3-1 Regional Geological Map



### 3 Geology

**Table 3-2 Late Permian Coal Measure Stratigraphy**

Age	Lithology	Stratigraphic Unit	Thickness	Comments
Quaternary	Sand, fine gravel, clay		15 – 20 m	Alluvium
Tertiary	Saprolite, laterite and remanent red mudstone and white / beige sandstone		20 – 60 m	Clay-rich
Triassic	Green brown-purple mudstone, siltstone and labile sandstone	Rewan Formation	175 m	In far west
Late Permian	Sandstone	Bandanna Formation	10–30 m	Increasingly argillaceous
	Coal Seam A. Seam contains thin stone bands that thicken from south to north		1 - 2.5 m	
	Labile sandstone, siltstone and mudstone		10 m	
	Coal Seam B. Seam contains numerous dirt bands that constitute between 15 and 30% of seam. Variable in quality.		6 - 8 m	
	Siltstone and mudstone		70–90 m	
	Coal Seam C	Colinlea Sandstone	2 - 3 m	Increasingly arenaceous
	C-D sandstone		5 – 20 m	
	Coal Seam D. Stone bands present with seam thickening westward, upper section splits off main seam to north west		4.5 - 6 m	
	D-E sandstone		15 m	
	Coal Seam E		0.1 -0.4 m	
	E-F sandstone		15 – 20 m	
	Coal Seam F		0.5 - 5 m	
	Sub-F sandstone		Unknown	
Early Permian	Labile and quartz sandstone	Joe Joe Group		Early Permian

Testing indicated that the claystone, mudstone and clays are dispersive or potentially dispersive, whereas the siltstone and sandstone are only slightly dispersive.

The Cainozoic sediments unconformably overlie the Permian age Bandanna Formation. Drilling indicates that the contact undulates. This has been interpreted as Tertiary sediments filling an ancient land surface that had been eroded into the Permian coal measures of the Bandanna Formation and Colinlea Sandstone.

No faulting has been identified in the Project area, including the TSF footprint, from the various investigations.

The proposed location for the out-of-pit tailings disposal is mapped to include the Colinlea Sandstone, D coal seam and below, and the Joe Joe Group.

### 3.2 Permian Geology

Permian sedimentary deposits at site comprise the Bandanna Formation and the underlying Colinlea Sandstone, and these units contain both economic and sub-economic coal seams. There are two major coal seams that will be the target of mining within the deposit; the C seam and D seam, which vary in thickness from 3 m to 6 m in the area to be mined.

### 3 Geology

Geologically the boundary between the Bandanna Formation and the underlying Colinlea Sandstone is taken to be an interval above the C coal seam at which sedimentation style changes from increasingly argillaceous (i.e. becoming more clayey with depth) to increasingly arenaceous (i.e. becoming more sandy with depth). Therefore the Bandanna Formation hosts the A and B coal seams, while the Colinlea Sandstone hosts the target C and D coal seams.

From a groundwater perspective, major hydrostratigraphic boundaries occur within the MLA at the base of weathering, beyond which groundwater is often encountered under confined conditions in the B-C and C-D sands and B and C coal seams, and also at the base of the D coal seam. It has been observed during exploration drilling that groundwater inflows are relatively low until the D coal seam is drilled through, at which point higher rates of groundwater flow are often encountered. The sandstone unit directly below the D coal seam and above the E coal seam (D-E Sandstone) will be the major target of aquifer depressurisation, and the overlying sandstone (B-C sandstone, C-D sandstone, and C and D coal seams) will need to be locally dewatered in order for mining to occur safely.

Below the D-E sandstone the Colinlea sandstone coarsens with increasing depth. The sub-E sandstone (between the E and F coal seams) and sub-F sandstone (below the F coal seam and to the base of the Colinlea Sandstone) are regarded as containing usable groundwater resources.

The Colinlea Sandstone is in turn underlain by sediments of the Joe Joe Group. The Joe Joe Group comprises mudstone, labile sandstone, siltstone, and shale and is interpreted to be a confining unit below the Colinlea Sandstone aquifer.

#### 3.3 Geology of the Joe Joe Group

The geology of the Joe Joe Formation within the Galilee Basin has been described in detail in Gray and Swarbrick (1975). The paper notes that the strata described as the Joe Joe Formation, and shown on the Jericho 1:250,000 scale geological map, comprises (in stratigraphically ascending order) the Lake Galilee Sandstone at its base and the overlying Jericho Formation, Jochmus Formation, and Aramac Coal Measures.

On this basis the paper recommends that the Joe Joe Formation be raised to Group status (Joe Joe Group), which is the current status assigned within the Australian Stratigraphic Names Database (Geoscience Australia). The Joe Joe Formation is hereafter referred to as the Joe Joe Group.

Gray and Swarback (1975) define the Joe Joe Group as “that succession of formations which is unconformably overlain by the Colinlea Sandstone and its lateral correlative, and unconformably overlies strata of the Adavale and Drummond Basins...” The Joe Joe Group consists of entirely non-marine sediments and, based on dating of spore assemblages, is assigned a likely age of Late Carboniferous to early Permian (Gray and Swarback, 1975).

Gray and Swarback (1975) indicate that the Colinlea Sandstone is coarser and more quartz-rich than the Joe Joe Group sediments. A description of the units comprising the Joe Joe Group and overlying units is shown in Table 3-3.

### 3 Geology

**Table 3-3 Summary of Lithology of Joe Joe Group**

Age	Rock Unit		Lithology
Late Permian	Bandanna Formation		Sandstone, siltstone, mudstone, coal
	Colinlea Sandstone		Sandstone, conglomerate, coal
Late Carboniferous to early Permian	Joe Joe Group	Aramac Coal Measures	Sandstone – light grey, very fine to medium, quartzose to labile Siltstone – medium to dark grey, carbonaceous, micaceous Mudstone – grey and dark grey-brown, carbonaceous, micaceous Coal – grey to black, dull
		Jochmus Formation	Sandstone – light grey, green, fine to medium grained, labile, locally conglomeratic Siltstone – light to medium grey and grey-green, argillaceous to sandy, carbonaceous. Mudstone – grey-green, silty, micaceous, carbonaceous. Contains Edie Tuff Member (siltstone, tuff, minor sandstone. Tuff contains “Red Tuff Marker”)
		Jericho Formation	Mudstone, siltstone, sandstone. Contains Oakleigh Siltstone Member (siltstone, mudstone, shale)
		Lake Galilee Sandstone	Silicified sandstone, minor mudstone

Thus the main differences between the Colinlea Sandstone and the Joe Joe Group, when assessing bore logs and determining the contact between the two units are as follows:

- Fresh (unweathered) Joe Joe Group comprises well cemented sandstone and conglomerate, and within the project area is distinctly bluish-grey in colour;
- Abundance of lithic sediments and occurrence of carbonaceous material is considered diagnostic of Joe Joe Group units; and
- Colinlea Sandstone is more quartz-rich, and is yellowish-white to creamy white within the project area.

It is noted that the Tertiary age saprolite and laterite parent material cannot be readily identified as it can comprise either Joe Joe Group or Colinlea Sandstone sediments.

## Hydrogeology

### 4.1 Groundwater Occurrence

Based on monitoring bore drilling and construction on and adjacent to the proposed out-of-pit TSF and a review of the regional and site geology, possible aquifer systems within the proposed footprint area include:

- Shallow alluvium along creek lines;
- Tertiary aquifers;
- Permian regolith;
- Permian sandstone; and
- Permian coal seam aquifers.

Results of drilling (Section 5) indicate that limited (perched) unconfined groundwater resources occur within the alluvium and clay-rich Tertiary saprolite and laterite. The main groundwater resources are associated with the Permian sandstone and to a lesser extent the coal seams.

### 4.2 Groundwater Recharge

Groundwater recharge is a difficult area of study as recharge does not tend to occur as a uniform percentage of rainfall, and it is recognised that rainfall events of a particular intensity are often required in order for recharge to occur. One reason for this is that the hydraulic conductivity of unsaturated material is low relative to the hydraulic conductivity of the same material when saturated. During rainfall events below a particular intensity water either runs off via the surface drainage system, or is lost through evapotranspiration (resulting in no deep drainage [recharge]). The most significant recharge, therefore, tends to occur when the land surface is fully saturated, and high intensity rainfall events allow pulses of recharge to occur through a profile that has a high saturated hydraulic conductivity (relative to a lower unsaturated hydraulic conductivity).

A study of recharge rates to Great Artesian Basin (GAB) intake beds was undertaken by Kellett et al, (2003). In line with the process described above, it was concluded that rainfall in excess of 200 mm per month in the area of the intake beds is required before significant recharge events will occur, and diffuse recharge (following “average” rainfall events, occurred at a rate of up to 3 mm per year. Based on the average annual rainfall (approximately 500 mm) a volume of 3 mm of rainfall per annum would equate to a recharge rate of approximately 0.6% of mean annual precipitation (MAP).

#### 4.2.1 Recharge Mechanisms

Groundwater recharge was considered to occur in the mapped outcrop areas, similar to the mechanisms recognised in the GAB (Section 4.2). These potential intake beds, based on the Jericho 1: 250 000 Geological Map (portion indicated on Figure 1-2), include:

- The Colinlea Sandstone units mapped to outcrop to the east of Lagoon Creek; and
- The Great Dividing Range.

#### *Recharge Area 1 – Direct Recharge to Outcrop Areas*

Figure 1-2 shows the outcrop geology of the Project area. From this figure it can be seen that the Colinlea Sandstone outcrops to the east of Lagoon Creek within MLA 70426. Consideration of possible recharge via direct recharge to aquifer units in areas where they outcrop or subcrop (once sufficient rainfall has occurred to facilitate infiltration) was given. This area is proposed for the TSF,



## 4 Hydrogeology

which if constructed (covering a large area of ~ 2 600 ha) could potentially reduce recharge to the underlying Colinlea Sandstone units.

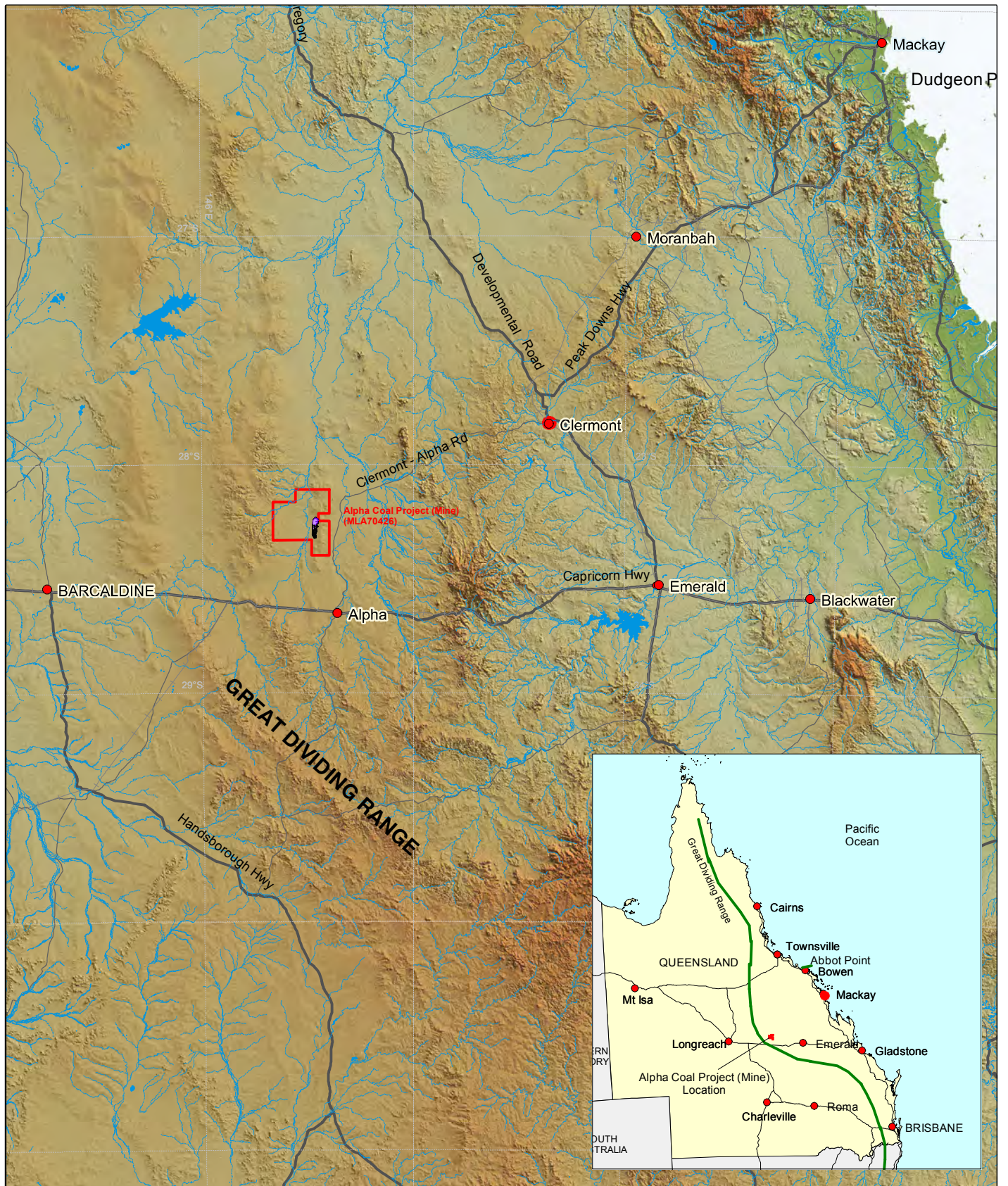
This recharge is the same mechanism assumed to occur within groundwater intake beds of the GAB. The main aquifers that underlie the project area are the sandstone units of the Colinlea Sandstone. The base of the Colinlea Sandstone is, for the purpose of this groundwater study, the eastern-most extent of Colinlea Sandstone outcrop (Figure 1-2). The top of the Colinlea Sandstone for the purpose of groundwater studies is taken to be the base of the D coal seam. Recharge may, therefore, occur in this zone from either rainfall recharge or from downward leakage from Lagoon Creek following flow events in the creek. In this recharge model, groundwater recharge enters the Colinlea Sandstone within this outcrop/subcrop area and flows down-dip (i.e. generally westward).

### *Recharge Area 2 – Diffuse recharge from the Great Dividing Range*

Figure 4-1 shows the location of the Great Dividing Range relative to the MLA 70426. The recharge mechanism conceptualised in this area is that recharge occurs in topographically elevated areas and flows down gradient (i.e. as a subdued reflection of topography) toward surface water drainage features in lower-lying areas (i.e. Lagoon Creek). Existing potentiometric surface data (Figure 4-2) indicates groundwater flow is toward Lagoon Creek, and that the depth to groundwater gets shallower to the north.

### 4.2.2 Conceptualised Recharge Mechanisms

The potentiometric surface contours presented as Figure 4-2 lend support to diffuse recharge to the west, at least for the shallow aquifer system in the vicinity of the Project site.



0 25 50km  
Scale: 1:250 000 (A4)  
Datum: GDA94, MGA Zone55

Source: TBC

- Mining Lease Allpication (MLA70426) Boundary
- Tailings Storage Facility

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GREAT DIVIDING RANGE

**URS**

ALPHA COAL OUT-OF-PIT TAILINGS STORAGE FACILITY

Figure: 4-1

File No: 42626680-g-528.wor

Drawn: XL

Approved: MS

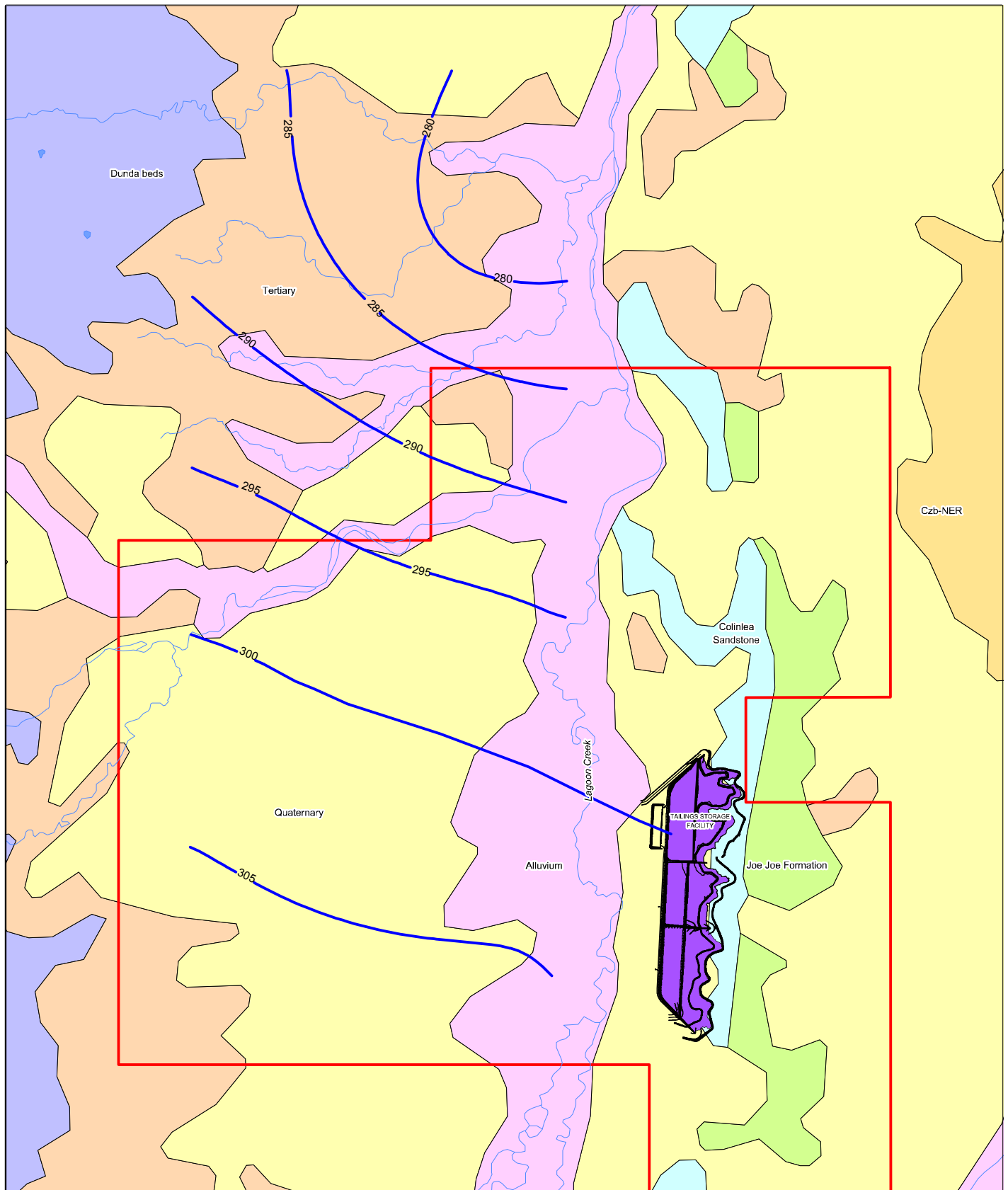
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0 2.5 5km  
Scale: 1:200 000 (A4)  
Datum: GDA94, MGA Zone 55

- Mining Lease Application (MLA70426) Boundary
- Tailings Storage Facility
- Groundwater Contour

Source: 1:250 000 Geological Map from Geoscience Australia

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**D-E SANDS POTENTIOMETRIC  
GROUNDWATER CONTOURS  
AND GROUNDWATER FLOW**

**URS**

ALPHA COAL OUT-OF-PIT TAILINGS STORAGE FACILITY

Figure: **4-2**

File No: 42626680-g-529.wor

Drawn: XL

Approved: MS

Date: 28-09-2011

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## 4 Hydrogeology

If this is the case, a groundwater divide (i.e. representing a point at which some groundwater flow is to the west, and some flow is to the east) may exist for the Colinlea Sandstone to the west of the Project site. If this recharge mechanism is dominant, recharge from the area of Colinlea Sandstone outcrop and subcrop may not be as regionally significant as recharge that occurs to the west of the site, as the area to the west of the site represents a much greater surface area in which recharge could occur.

The findings of the assessment drilling investigation (Section 5) that the TSF site is underlain by clay-rich saprolite and laterite rather than outcrop of Colinlea Sandstone or Joe Joe Group sediments supports an interpretation that the area shown on the 1:250,000 scale Jericho geology map as comprising Colinea Sandstone outcrop is not significant in terms of groundwater recharge, at least in terms of the recharge mechanisms known to occur in GAB aquifers.

The above interpretation is complicated by the fact that the coal units and interburden aquifers outcrop in the area (beneath and to east) of Lagoon Creek, and hydraulic testing data suggests that shallow units to the east are confined to semi-confined. Therefore, depending on surface water levels in Lagoon Creek, it is possible that the interburden aquifers are periodically recharged by Lagoon Creek (i.e. under flood conditions) and that the groundwater flow potential may be reversed under some conditions.

However, under “average” dry conditions, it is considered most likely that groundwater recharge occurs to the west of the site, and that groundwater flow will be from elevated topographic areas toward Lagoon Creek. The following observations support the second type of recharge mechanism:

- Groundwater flow direction in the western part of the MLA is from south-south-west to north-north-east, i.e. from a recharge area in the west to a discharge area at Lagoon Creek. This is consistent with existing data from site groundwater level monitoring; and
- Groundwater springs occur to the north of the MLA, but to the west of Lagoon Creek, indicating groundwater flow from topographically elevated areas in west toward Lagoon Creek.

### 4.3 Conceptual Hydrogeology at and Adjacent to the TSF

A review of available groundwater related data has allowed for the conceptualisation of the current (pre-mining) hydrogeology.

The conceptual hydrogeological model is summarised as:

- Groundwater resources, beneath MLA 70426, are associated with the sandstone units in between the various coal seams. The sandstone aquifers are the main aquifers (especially at depth as the sandstone is more coarse towards the base of the Colinlea Sandstone unit), however, due to low recharge these units aquifers have limited sustainable yields;
- The sandstone aquifers of the Colinlea Sandstone pinch-out and are thus limited in extent and thickness to the east of Lagoon Creek (cross-section Figure 4-3);
- The hydraulic conductivity of the aquifers, as well as groundwater occurrence, is highly variable across the site, indicating heterogeneity and anisotropy within the sandstone;
- Groundwater occurrence in the units overlying the Permian deposits (Tertiary sediments and Quaternary alluvium) occurs as sporadic unconfined perched groundwater, and the units are not regarded as significant regional aquifers. Figure 4-3 presents a conceptualisation of the pre-mining hydrogeology, indicating the potentiometric (head) surface associated with the confined D-E sands and the perched water tables (associated with Lagoon Creek alluvium and clay lenses within the Tertiary and Quaternary units);

## 4 Hydrogeology

- Recharge occurs in topographically elevated areas and flows down gradient (i.e. as a subdued reflection of topography) toward Lagoon Creek. In the area to be mined, the groundwater flow direction (on the western side of Lagoon Creek) is to the north-north-east, and the gradient is shallow; and
- Groundwater in the Permian Bandanna Formation and Colinlea Sandstone is encountered under confined conditions, even adjacent to Lagoon Creek. Differences in hydraulic heads associated with the different aquifers adjacent to Lagoon Creek (Section 5.4) indicates no hydraulic connection between units, thus groundwater (associated with the underlying confined aquifers) is not conceptualised to discharge to Lagoon Creek.

## 4 Hydrogeology

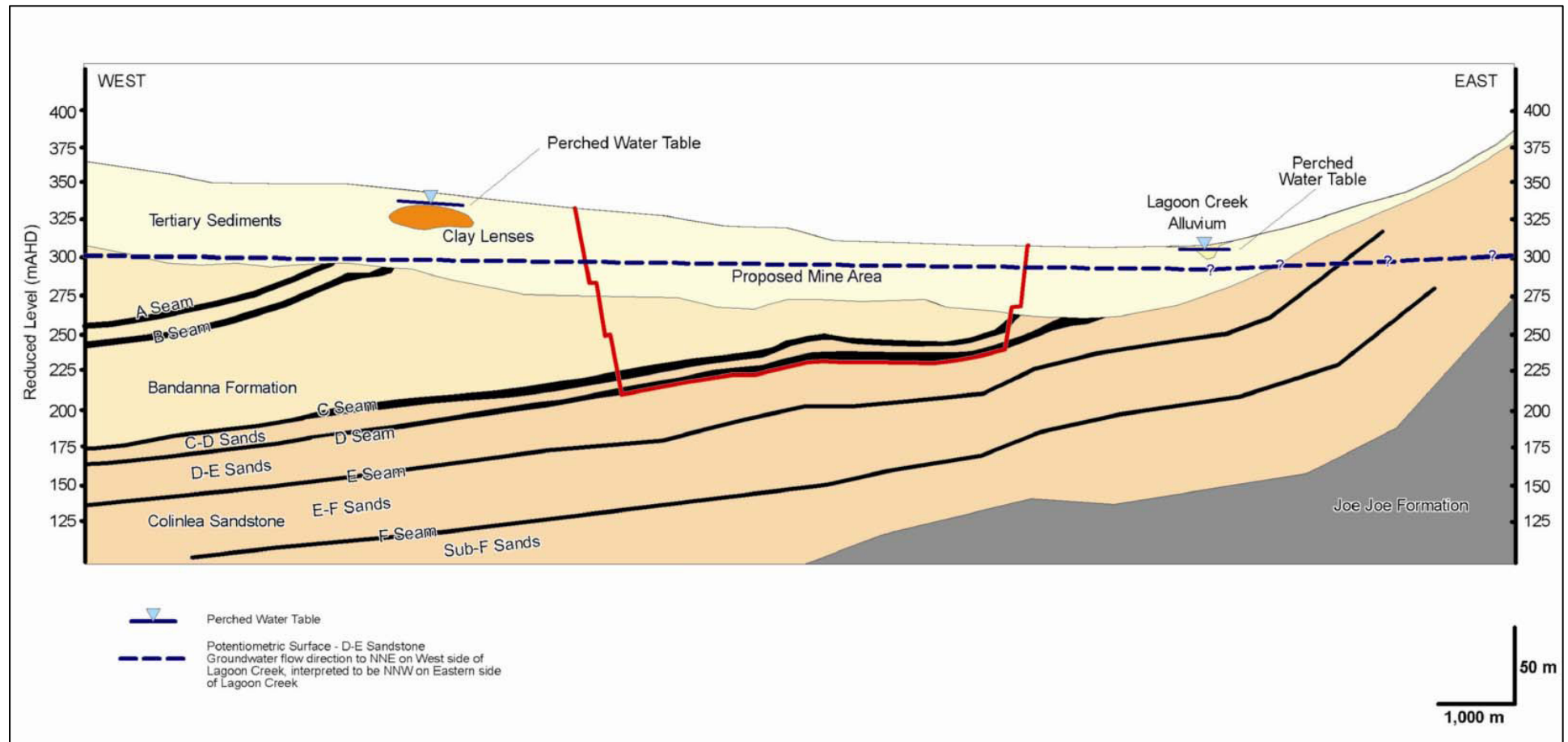


Figure 4-3 Conceptualisation of groundwater resources within Alpha Coal Project



## Site Assessment

### 5.1 Drilling

As part of the investigation program, groundwater monitoring bores were constructed at the site of a number of geological investigation bores. The intent of this phase of the program was to:

- Provide information on groundwater levels spatially and vertically, to establish groundwater flow direction and groundwater recharge potential at the site;
- Enable long-term monitoring of groundwater levels to enable study of the groundwater response to rainfall events (i.e. groundwater recharge);
- Provide a means of obtaining groundwater quality samples; and
- Nested sites were established at a number of locations as a combination of standpipe piezometers, which allow sampling for water level and water quality, and vibrating wire piezometers (VWPs), which allow measurement of groundwater level.

The field investigation program comprised drilling and logging of a number of geological / groundwater bores within the drilling targets shown on Figure 5-1. The drilling program allowed for the drilling of geological (exploration) and/or groundwater monitoring bores at 15 sites and the construction of 22 monitoring points (Table 5-1). The bore logs are included in **Appendix A**.

Two parallel lines of bores were drilled, from west to east, across the proposed TSF footprint (as indicated in Figure 5-1). These bores, drilled to intersect fresh Joe Joe Group at depth, allowed for the detailed logging of the geology across the proposed TSF site.

A summary of the bores drilled are presented in Table 5-1. **Please note** the drilling targets and bore identities are presented in Table 5-1, these different numbers refer to the nested bores located ~ 5 m from the original drilling target and contain the standpipe bores. These bores have numbers ending in R. Vibrating wire piezometers (VWP) have been installed in the drilling targets and are labelled according to the VWP number.

## 5 Site Assessment

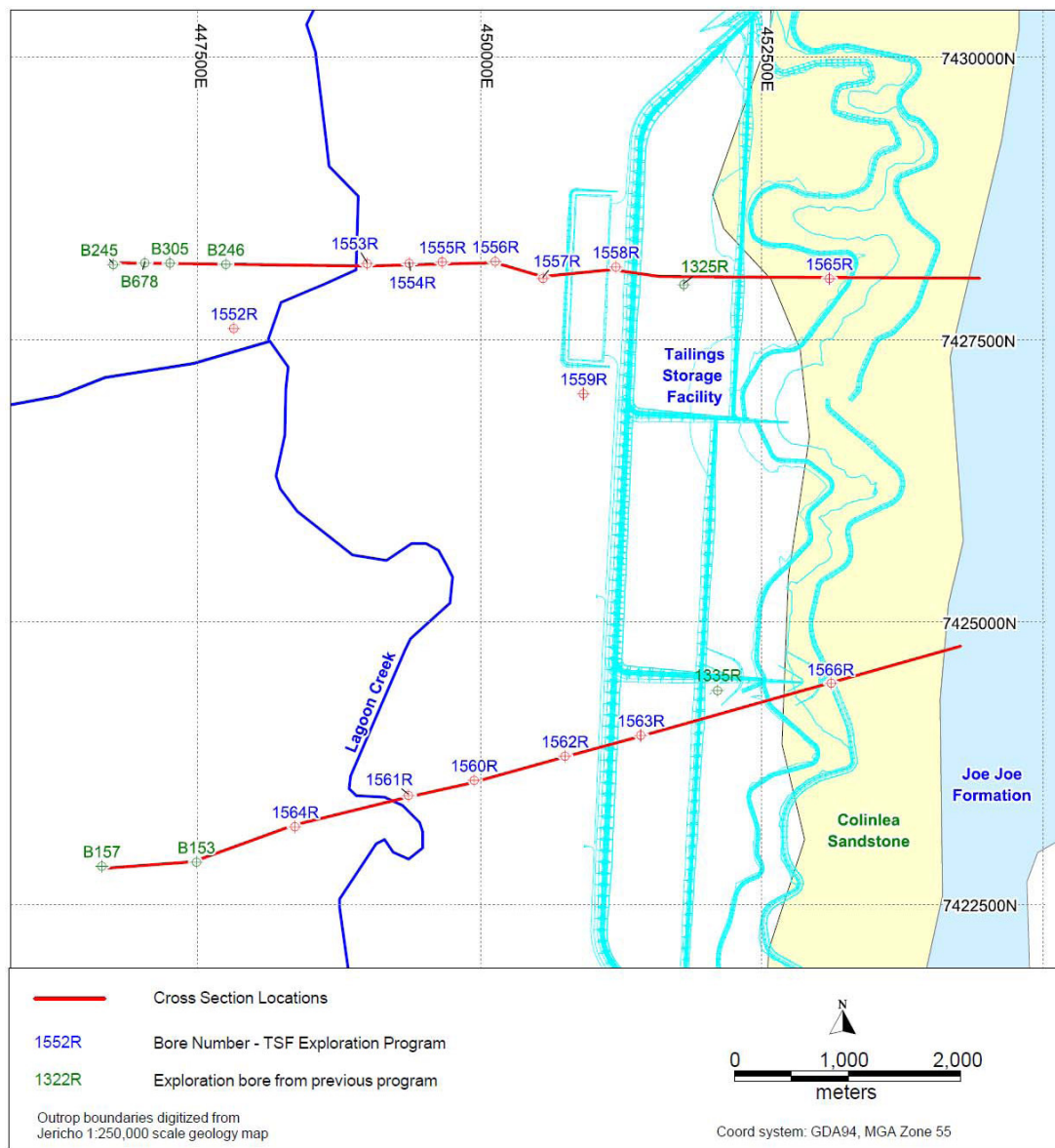
**Table 5-1 Drilling Summary (15/08/2011)**

Drill target	Bore ID	Easting (GDA94)	Northing (GDA94)	Bore depth	Bore type	Surface RL (mAHD)	SWL (mbgl)	RWL (mAHD)
1552R	-	447 816	7 427 611	132	Exploration	-	-	-
1553R	1610R	448 996	7 428 186	30	Standpipe	310	9.45	300.55
	14622			55	VWP	310	9.63	300.37
	15291			78	VWP	310	12.87	297.13
1554R	1611R	449 368	7 428 188	36	Standpipe	312	10.51	301.49
1555R	-	449 662	7 428 201	102	Exploration	-	-	-
1556R	1612R	450 132	7 428 204	36	Standpipe	317	15.76	301.24
1557R	-	450 553	7 428 055	78	Exploration	-	-	-
1558R	1613R	451 199	7 428 156	18	Standpipe	325	Dry	Dry
	14621			34	VWP	325	21.88	303.12
	15292			50	VWP	325	16.57	308.43
1559R	-	450 912	7 427 033	90	Exploration	-	-	-
1560R	-	449 944	7 423 607	102	Exploration	-	-	-
1561R	1618R	449 361	7 423 473	12	Standpipe	315	9.45	305.55
	1617R			30	Standpipe	315	12.95	302.05
	15294			57	VWP	315	13.08	301.92
1562R	-	450 748	7 423 820	90	Exploration	-	-	-
1563R	1619R	451 420	7 424 006	10	Standpipe	328	Dry	Dry
	1620R			36	Standpipe	328	24.97	303.03
	15376			70	VWP	328	26.61	301.39
1564R	1621R	448 357	7 423 195	18	Standpipe	314.5	7.37	307.13
	1622R			44	Standpipe	314.5	9.54	304.96

## 5 Site Assessment

Drill target	Bore ID	Easting (GDA94)	Northing (GDA94)	Bore depth	Bore type	Surface RL (mAHD)	SWL (mbgl)	RWL (mAHD)
	15375			68	VWP	314.5	10.23	304.27
1565R	1614R	453 090	7 428 053	18	Standpipe	340	15.52	324.48
	1615R			36	Standpipe	340	29.42	310.58
	14623			50	VWP	340	22.87	317.13
1566R	1616R	453 106	7 424 465	18	Standpipe	333	Dry	Dry
	1566R			36	Standpipe	333	25.49	307.51

## 5 Site Assessment



**Figure 5-1 Drilling Locations on and adjacent to the Alpha TSF**

### 5.2 TSF geology and groundwater

Information obtained from the field investigation program is summarised in cross sections shown as Figure 5-2 (northern line) and Figure 5-3 (southern line). The location of each cross section is shown on Figure 5-1.

The results and interpretation of drilling / groundwater data are summarised as:

- In the proposed TSF footprint the fresh (unweathered) Joe Joe Group comprises blue-grey micaceous, chloritic, lithic sandstone and well cemented conglomerate. The sediments are well cemented and, based on low (dry) air-lift yield results, have low primary permeability. Areas of relatively high yield are therefore expected to be related to secondary permeability, such as fracturing, which may offer low sustainable yields due to low storage; and

## 5 Site Assessment

- The weathered / lateritic Joe Joe Group sediments are difficult to distinguish from weathered / lateritic Colinlea Sandstone (Permian parent material of the Tertiary laterite is difficult to discern). However, an abundance of lithic sediments and occurrence of carbonaceous material is considered diagnostic as the Colinlea Sandstone is more quartz-rich.

In terms of potential groundwater impacts from the proposed TSF, the stratigraphy of the proposed TSF area (in terms of whether the TSF footprint is on outcrop of Joe Joe Group or Colinlea Sandstone sediments) is considered to be less important than the lithology underlying the proposed TSF site. This is due to the lack of rock outcrop or shallow subcrop of either unit within the TSF footprint as the fresh Permian sediments are covered by clay-rich saprolite and laterite derived from weathering of the parent material (Figures 5-2 and 5-3).

## 5 Site Assessment

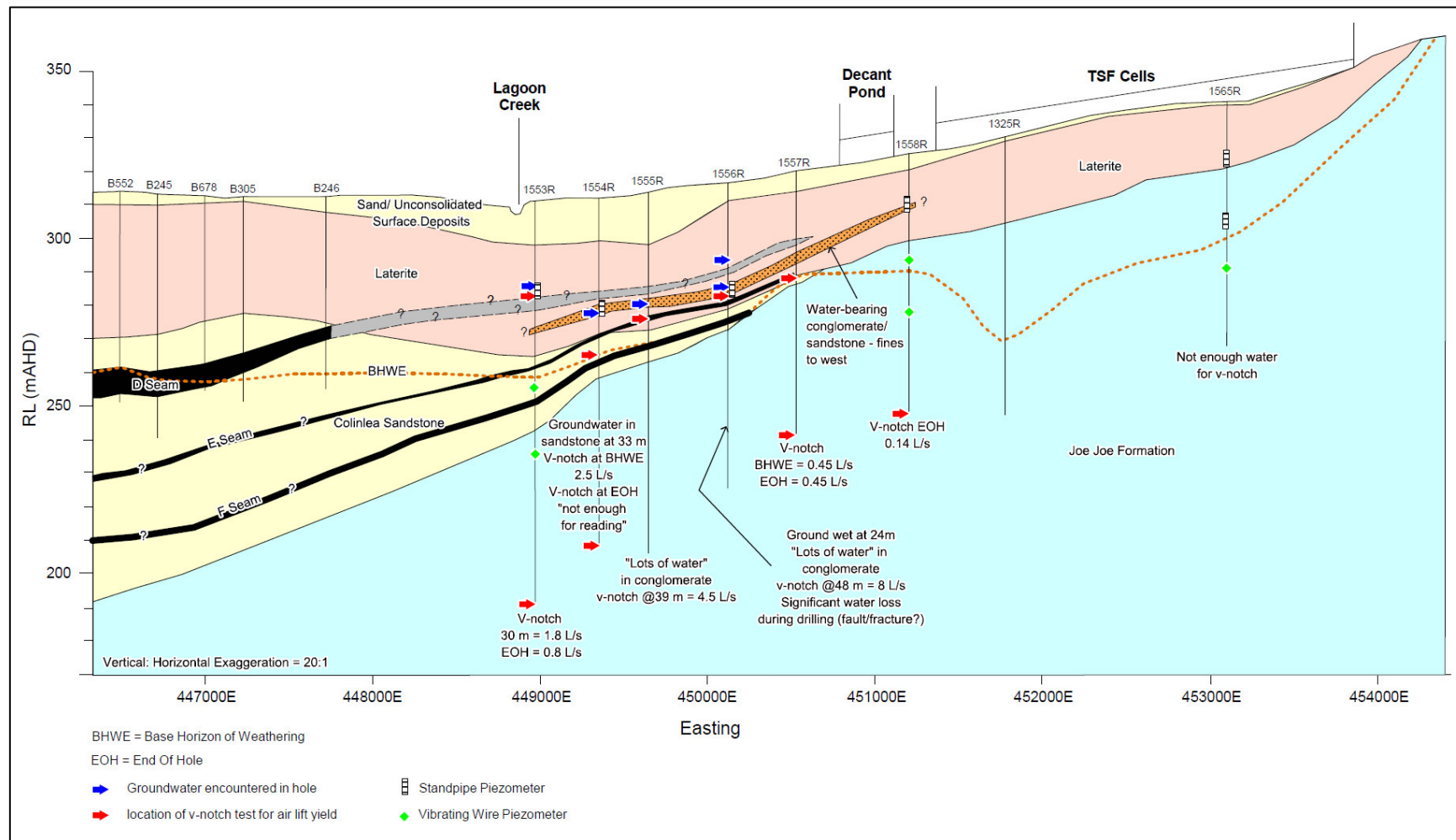


Figure 5-2 Cross-section through TSF investigation area - Northern Line

## 5 Site Assessment

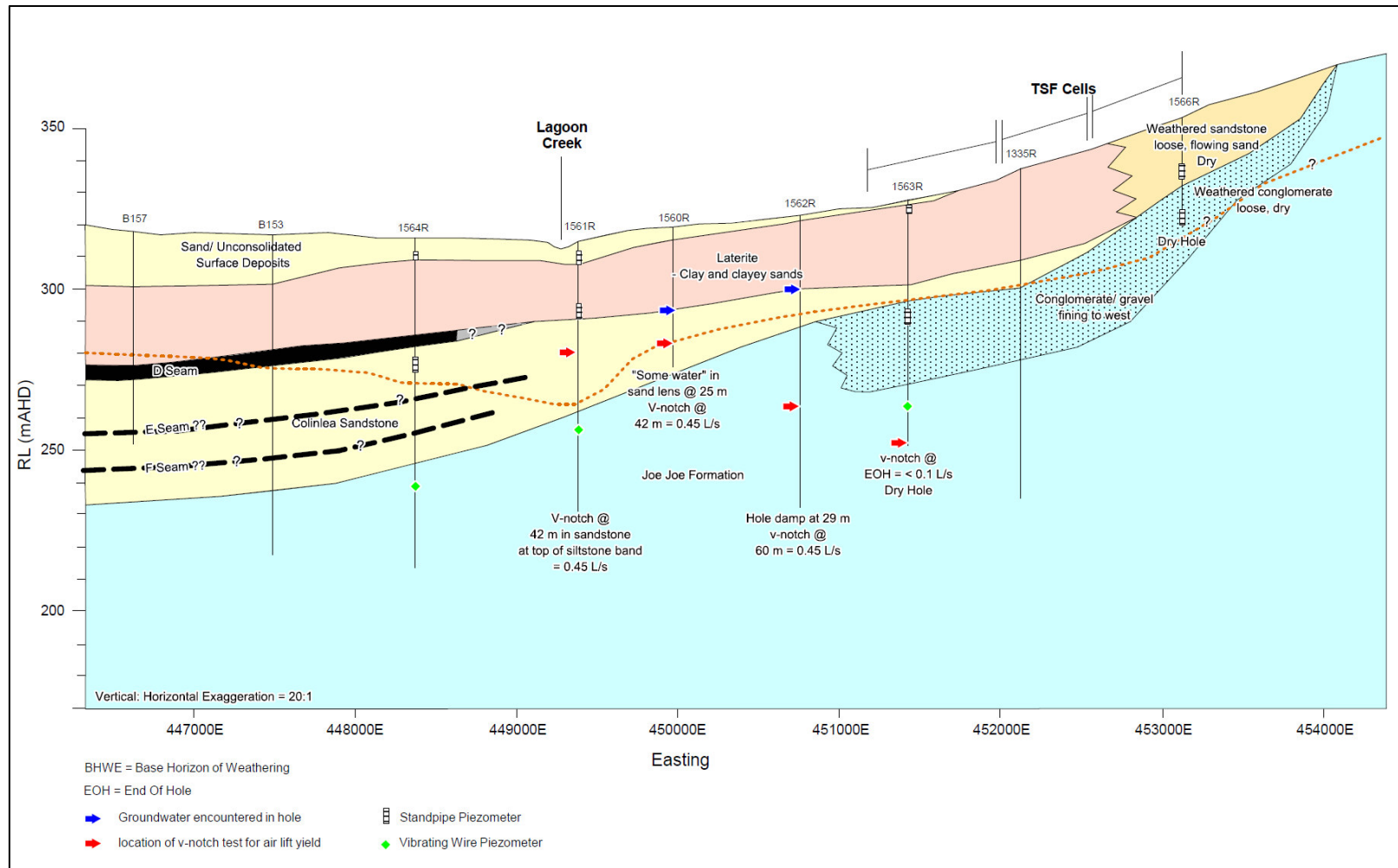


Figure 5-3 Cross-section through TSF investigation area - Southern Line



## 5 Site Assessment

### 5.3 Underlying lithology and groundwater occurrence

#### ***Northern Line (Figure 5-2)***

- The proposed TSF is underlain by laterized clays and clayey sands. The sediments drilled dry (rotary-air-percussion), and the underlying Joe Joe Group sediments contained little or no groundwater.
- Down-gradient of the proposed TSF a water-bearing conglomerate / sandstone was intersected at a depth ranging between approximately 35 and 40 mbgl<sup>1</sup> within the Tertiary laterite. Little or no groundwater was intersected within the conglomerate / sandstone unit within bores 1557R and 1558R, however, bores 1555R and 1554R intersected an area of enhanced groundwater potential within the conglomerate / sandstone down-gradient of the TSF. The volume of groundwater intersected in 1556R, and the loss of water during drilling, is suggestive of alteration (fault or fracture) at this location. The unit is less distinct in 1553R and the main occurrence of groundwater in this hole is a sandstone layer within weathered coal, between 30 and 36 mbgl.
- In bores down-gradient of the proposed TSF it was observed during drilling that the Joe Joe Group sediments made little water, even when coarse sandstone and conglomerate was encountered. This supports the observation that matrix sediments and cement have resulted in a low primary porosity for Joe Joe Group sediments.

#### ***Southern Line (Figure 5-3)***

- The area of the proposed TSF is underlain by laterized clays and sands, which drilled dry. In the eastern (high-lying) area of the proposed TSF (bore 1566R) drilling encountered highly weathered, red (iron-stained) sandstone, which occurred as flowing sand. Below this unit a highly-weathered pebble conglomerate was encountered, which also tended to fall (collapse) into the bore. Bore 1566R was drilled to a depth of 36 mbgl and was dry.
- The gravel / pebble conglomerate extends west and is encountered in bore 1563R. Further west the unit appears to fine to sand, and is generally indistinguishable from the sandstone generally encountered in the Joe Joe Group.
- In general, the bores on the southern line drilled much drier than bores on the northern line, where the main water occurrence was the contact between the laterite and the underlying sandstone.

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<sup>1</sup> mbgl – meters below ground level

## 5 Site Assessment

### 5.4 Groundwater level data

Groundwater levels within TSF monitoring bores are shown in Table 5-1. The groundwater monitoring network across and adjacent to the site allowed for the evaluation of unconfined and confined (potentiometric) groundwater levels. The different units / aquifers of interest and the relevant range in groundwater level data are presented in Table 5-2.

**Table 5-2 Groundwater level summary (15/08/2011)**

<b>Bore ID</b>	<b>Observation Depth (m)</b>	<b>Static Water Level (mbgl)</b>	<b>Static Water Level (mAHD)</b>	<b>Comment</b>
<b>Quaternary / Tertiary contact</b>				
1621R	12 - 18	7.37	307.13	West of Lagoon Creek
1618R	6 - 12	9.45	305.55	East of Lagoon Creek
1619R	6 - 10	Dry	>318	Under TSF footprint
<b>Tertiary laterite</b>				
1617R	24 - 30	12.95	302.05	East of Lagoon Creek
1616R	12 - 18	Dry	>315	Up gradient of TSF
1610R	24 - 30	9.45	300.55	East of Lagoon Creek
1614R	12 - 18	15.52	324.48	Under TSF footprint
<b>Tertiary conglomerate</b>				
1611R	30 - 36	10.51	301.49	East of Lagoon Creek
1612R	29 - 36	15.76	301.24	Down gradient of TSF
1613R	12 - 18	Dry	>325	Between TSF and decant pond
<b>Colinlea Sandstone D-E Sands</b>				
1622R	38 - 44	9.54	304.96	West of Lagoon Creek
<b>Colinlea Sandstone E-F Sands</b>				
14622	55	9.63	300.37	East of Lagoon Creek
<b>Joe Joe Group conglomerate</b>				
1620R	30 - 36	24.97	303.03	Under TSF footprint
1566R	24 - 36	25.49	307.51	Up gradient of TSF
<b>Joe Joe Group sediments</b>				
15291	78	12.87	297.13	East of Lagoon Creek
15375	68	10.23	304.27	West of Lagoon Creek
15294	57	13.08	301.92	East of Lagoon Creek
15376	70	26.61	301.39	Under TSF footprint
14621	34	21.88	303.12	Between TSF and decant pond
15292	50	16.57	308.43	Between TSF and decant pond
14623	50	22.87	317.13	Under TSF footprint
1615R	30 - 36	29.42	310.58	Under TSF footprint

## 5 Site Assessment

In general the following observations are made with respect to geology, groundwater occurrence and groundwater levels in the area of the proposed TSF:

- The depth to the perched groundwater table within the Quaternary sediments in the area of Lagoon Creek is in the order of 10 mbgl;
- Groundwater flow mimics topography and drains from south to north, adjacent to Lagoon Creek;
- Geological units of the Colinlea Sandstone are restricted east of Lagoon Creek due to Tertiary processes and more resistive (to alteration than Colinlea Sandstone units) Joe Joe Group, thus groundwater levels associated with the Colinlea Sandstone do not extend under the proposed TSF footprint;
- The multiple piezometers constructed at site 1553R indicate that there is an apparent downward potential for groundwater movement (i.e. deep drainage potential). However, vibrating wire piezometer data for bore 1558R, comprising 1613R, VWP14621, and VWP15292, (located between the toe of the proposed TSF and the decant pond, refer Figure 5-2) indicates higher potentiometric pressures with depth in the Joe Joe Formation, indicating an upward potential for groundwater flow. Bore 1565R indicates higher potentiometric pressures with depth in the Joe Joe Formation and also the potential downward migration;
- Beneath the proposed TSF footprint most bores were relatively dry during drilling, and current levels suggest groundwater levels between 25 and 30 mbgl (e.g. 1563R); and
- Hydraulic head differences (separation) between the perched groundwater table and the potentiometric levels, associated with the confined aquifers, in all the multiple piezometer bores indicate no evidence of hydraulic connection.

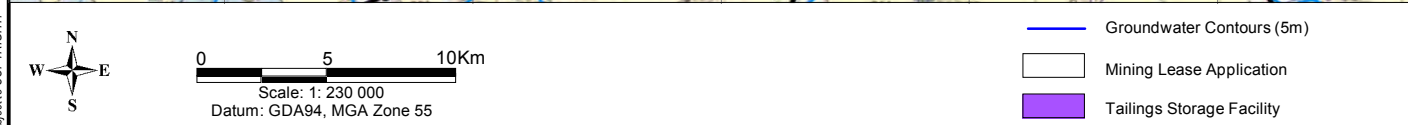
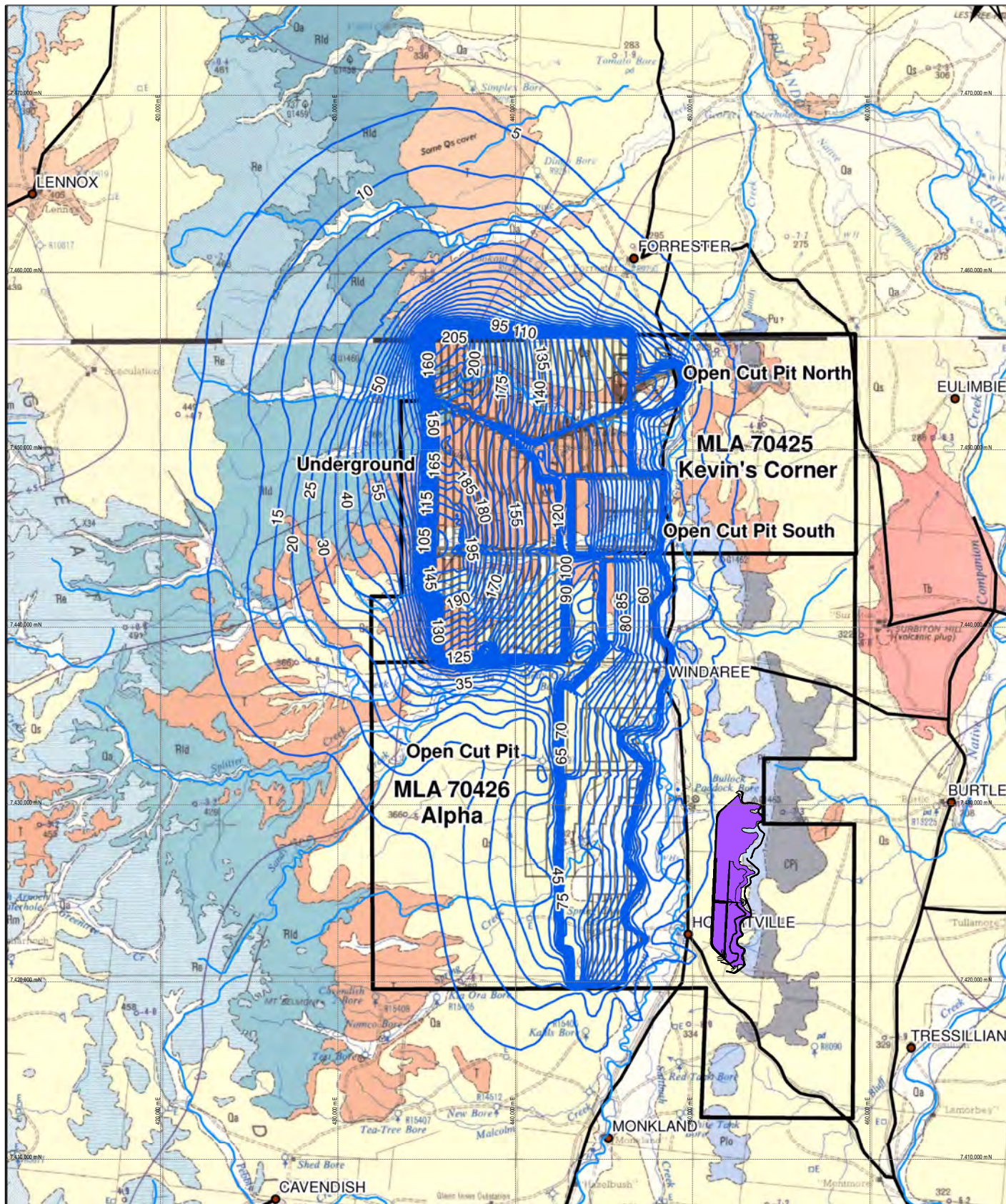
### 5.4.1 Mine dewatering impacts on groundwater

Predictive groundwater modelling has been conducted during the cumulative impacts assessment of the proposed Alpha and Kevin's Corner coal projects. Based on the envisaged mine dewatering and depressurisation of the Colinlea Sandstone units as a result of open cut and underground mining, the groundwater levels and hydraulic pressures will be altered.

Figure 5-4 indicates the predicted zone of depressurisation of the D-E sands after 31 years (Life of Mine), the units above and below the depressurised zone may be impacted due to induced flow. The depressurisation propagates down dip and along strike and indicates limited impact to the west. However, based on the predictive modelling groundwater flow patterns could be altered in the TSF area towards the mine workings.

Based on the current data not indicating any hydraulic connection between the perched groundwater and the confined aquifers, the potential for induced flow to impact on the perched groundwater table is limited.





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PREDICTIVE GROUNDWATER  
MODEL RESULTS

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ALPHA COAL OUT-OF-PIT TAILINGS STORAGE FACILITY

Figure: 5-4

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## 5 Site Assessment

Thus any potential seepage from the TSF could potentially migrate within the Quaternary and Tertiary groundwater resources, with limited potential of the seepage migrating into the confined aquifers. However, if seepage enters the confined aquifers the movement would be towards the mine and not off site.

### 5.5 Hydrochemical Data

Groundwater samples have been collected from the TSF monitoring bores in order to determine the ambient groundwater quality prior to any mining activities. Groundwater samples were collected; during the regular monthly groundwater monitoring undertaken by Hancock, from the standpipe bores (Table 5-1) where sufficient groundwater was measured. A summary of the hydrochemistry is included in Table 5-3 in accordance to the units targeted. **Appendix B** contains the full hydrochemistry results.

The electrical conductivity values for the shallow perched groundwater resources, which could potentially be impacted by TSF seepage, range as follows:

- Quaternary / Tertiary contact 17,610 to 22,200  $\mu\text{S/cm}$  (Total Dissolved Solids of  $\sim 11,450$  mg/L to 14,430 mg/L), which is saline water ( $> 5,000$  mg/L TDS);
- Tertiary laterite 921 to 32,633  $\mu\text{S/cm}$  (Total Dissolved Solids of  $\sim 600$  mg/L to 21,200 mg/L), which indicates high variability from fresh water ( $< 1,500$  mg/L TDS) to saline water;
- Tertiary conglomerate 7,056 to 7,930  $\mu\text{S/cm}$  (Total Dissolved Solids of  $\sim 5,000$  mg/L) which is brackish to saline water.

The Australian Drinking Water Guidelines (ADWG 2004) guideline for TDS is 500 mg/L and the ANZECC water quality guidelines<sup>2</sup> for stock watering is 4,000 mg/L TDS. Based on these guideline values the majority of the site is underlain by poor quality groundwater, which reduces the suitability for use with regards to local vegetation and stock watering.

The unconfined aquifers contain sodium chloride dominant groundwater with elevated sulfate concentrations and traces of dissolved metals including copper, manganese, nickel, boron, and iron.

Groundwater samples collected from bores within the deeper confined aquifers indicate that the groundwater is of better quality than the shallow unconfined groundwater. The salinity of the groundwater associated with the ranges from 566  $\mu\text{S/cm}$  to 1,957  $\mu\text{S/cm}$  (Total Dissolved Solids of  $\sim 368$  mg/L to 1,270 mg/L), which is fresh water. This groundwater has limited sustainable yield potential based on drilling results and is separated from the proposed TSF by clay-rich Quaternary and Tertiary sediments.

The single groundwater sample collected from bore 1622R, screened across the D-E sands, has an electrical conductivity value of 33,833  $\mu\text{S/cm}$  (Total Dissolved Solids of  $\sim 22,000$  mg/L), highly saline groundwater. The bore is located to the west of Lagoon Creek and will potentially be impacted by dewatering and depressurisation, as indicated in Figure 5-4.

If the area below the TSF were a groundwater recharge area, it could be expected that shallow groundwater would be less saline, especially given the significant 2010/2011 wet season rainfall.

<sup>2</sup> ANZECC water quality guidelines (Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000, National Water Quality Management Strategy. Volume 4 – Primary Industries

## 5 Site Assessment

**Table 5-3 Hydrochemistry data summary (August 2011) – Page 1**

Parameter	Units	Quaternary / Tertiary contact			Tertiary laterite			
		1621R	1618R	1619R	1617R	1616R	1610R	1614R
pH	pH units	6.9	5.87	Dry	5.29	Dry	6.17	6.87
Electrical Conductivity	µS/cm	17,610	22,200		32,633		25,633	921
Sulfate	mg/L SO <sub>4</sub>	706	1,310		2,640		768	20
Chloride	mg/L Cl	5,850	9,470		17,800		9,090	192
Calcium	mg/L Ca	124	135		266		356	20
Magnesium	mg/L Mg	172	408		898		415	9
Sodium	mg/L Na	3,570	6,490		11,800		4,740	178
Potassium	mg/L K	30	23		42		39	6
Fluoride	mg/L F	0.4	0.2		<0.1		0.4	0.5
Ammonia	mg/L N	0.07	0.06		0.22		0.02	0.03
Aluminium	mg/L Al	<0.1	<0.1		<0.1		<0.1	0.02
Arsenic	mg/L As	<0.01	<0.01		<0.01		<0.01	0.001
Cadmium	mg/L Cd	<0.001	<0.001		<0.001		<0.001	<0.0001
Copper	mg/L Cu	0.012	0.025		0.115		0.066	0.002
Lead	mg/L Pb	<0.01	<0.01		<0.01		<0.01	<0.001
Manganese	mg/L Mn	0.461	2.2		1.4		1.98	0.154
Molybdenum	mg/L Mo	<0.01	<0.01		<0.01		<0.01	0.002
Nickel	mg/L Ni	<0.01	0.028		0.038		<0.01	0.002
Boron	mg/L B	0.77	1.05		1.46		<0.5	0.1
Iron	mg/L Fe	<0.5	<0.5		3.29		<0.5	<0.05



## 5 Site Assessment

**Table 5-4 Hydrochemistry data summary (August 2011) – Page 2**

Parameter	Units	Tertiary conglomerate			Joe Joe Group	D-E Sands	Joe Joe Group conglomerate	
		1611R	1612R	1613R	1615R	1622R	1620R	1566R
pH	pH units	5.79	5.99	Dry	7.36	6.78	7.15	4.73
Electrical Conductivity	µS/cm	7,056	7,930		566	33,833	1,957	1,918
Sulfate	mg/L SO <sub>4</sub>	65	174		36	1,510	115	9
Chloride	mg/L Cl	2,400	2,630		41	12,600	484	402
Calcium	mg/L Ca	95	160		27	428	48	69
Magnesium	mg/L Mg	110	149		7	548	19	39
Sodium	mg/L Na	1,370	1,420		85	8,200	368	227
Potassium	mg/L K	15	16		7	52	10	12
Fluoride	mg/L F	<0.1	0.1		0.6	0.8	0.6	0.2
Ammonia	mg/L N	0.01	0.03		0.01	0.04	0.14	0.31
Aluminium	mg/L Al	<0.01	<0.01		<0.01	<0.1	0.01	0.24
Arsenic	mg/L As	<0.001	<0.001		0.002	<0.01	0.002	0.002
Cadmium	mg/L Cd	<0.0001	0.0002		<0.0001	<0.001	<0.0001	0.0005
Copper	mg/L Cu	0.023	0.025		0.003	0.028	0.002	0.192
Lead	mg/L Pb	<0.001	<0.001		<0.001	<0.01	<0.001	0.002
Manganese	mg/L Mn	0.643	1.03		0.063	3.28	0.513	0.303
Molybdenum	mg/L Mo	<0.001	<0.001		0.004	<0.01	0.005	<0.001
Nickel	mg/L Ni	0.005	0.016		0.001	<0.01	<0.001	0.017
Boron	mg/L B	0.15	0.15		0.11	1.1	0.14	0.18
Iron	mg/L Fe	0.05	0.07		<0.05	<0.5	0.06	7.12

## 5 Site Assessment

### 5.6 Geotechnical Studies

URS conducted a geotechnical investigation of the proposed TSF site to determine whether the site is suitable for storing tailings safely, with minimal impact to the environment for the life-of-mine. A total of 14 exploratory boreholes were drilled during the investigation. All boreholes reached their target depths, with nine drilled to approximately 10 m and five to a depth of around 20 m. Piezometers (monitoring wells) were installed in 11 of the 14 exploratory boreholes to provide both groundwater level data and samples for groundwater testing. In addition a total of 52 test pits were excavated, using a tracked Hitachi 200LC excavator. The purpose of the test pits was to observe and record the various lithologies, determine the stratigraphic profile across the footprint of the proposed TSF, and to collect bulk soil samples for laboratory testing and subsequent engineering analyses.

A detailed draft geotechnical report has been compiled by URS. A summary of the relevant data compiled and assessed has been included in order to aid in the hydrogeological assessment of the proposed site.

#### *Soil*

Higher elevations on the east–west trending “rises” (perpendicular to the ridge) are generally oxidized reddish brown (ferruginous), whereas in the relatively lower elevation parallel “swales”, the ground surface was observed to be light grey to cream in colour. Generally in the eastern half of the site (in particular the lowest points of the east–west trending drainage pathways), some locations are covered to a depth of up to 1.5 m by Quaternary alluvial deposits, comprising silty, fine to medium grained sand with occasional gravel, derived from erosion of the underlying sandstone and conglomerate bedrock. However, due to the composition of the parent rock and apparent minimal transportation of these materials, differentiation between the alluvial and residual soils was not readily apparent. Topsoil cover across the site was thin (< 500 mm), where observed in test pits.

The residual soil typically comprised dry to moist, light greyish brown to reddish brown silty/clayey sand or sandy silt/clay mixes, with varying degrees of gravel, occasionally cemented and typically dense to very dense. Residual soil was typically encountered within the upper 2 m, to a maximum depth of approximately 20 m.

#### *Residual bedrock*

The sandstone bedrock is generally light grey to reddish brown, extremely low to medium strength, fine to medium grained, and sometimes arkose, with thin inter-beds of siltstone and conglomerate. The rock mass is weathered to varying degrees, typically ranging from residual soil (over the majority of the site) to moderately weathered rock, where it is exposed as relatively resistant outcrops along the eastern ridge. Rock fabric is sometimes evident, ranging from crude, horizontal laminations to sub-horizontal (low angle), well defined thin bedding. The Colinlea Sandstone strikes approximately north-south and dips around 3° west.

#### *Soil Permeability Tests*

In-situ falling head tests conducted during the investigation indicate that the soils at the site have low permeability, ranging from  $1.1 \times 10^{-7}$  m/s to  $7.3 \times 10^{-9}$  m/s. These results are consistent with the 6 falling head permeability tests previously performed by Douglas Partners previously in the area of the TSF, which showed permeabilities in the order of  $1.5 \times 10^{-7}$  m/s to  $7.6 \times 10^{-8}$  m/s.

## 5 Site Assessment

### Water Pressure (Packer) Tests

Packer tests performed during the investigation indicate the bedrock is relatively impermeable, with no “Lugeon take” recorded during the 12 test intervals. Depths where packer tests were performed ranged from 4 m to 20.2 m. A summary of the water pressure testing is shown in Table 5-5.

**Table 5-5 Water Pressure (Packer) Test Summary**

Borehole Location	Test Interval Depth (m)	Hydraulic Conductivity (Lugeons)
BH04	13.0 – 16.0	0
BH05	7.0 – 10.0	0
BH06	9.0 – 12.0	0
BH07	9.2 – 12.2	0
	12.2 – 15.2	0
	15.2 – 18.2	0
	18.2 – 20.2	0
BH08	4.0 – 7.0	0
BH11	4.0 – 7.0	0
	7.0 – 10.0	0
BH12	4.0 – 7.0	0

### Groundwater

With the exception of BH03, BH09 and BH13 (which were exclusively augered), groundwater levels within the exploratory boreholes were unable to be accurately measured at the time of drilling, due to the methodology involved (i.e. the addition of water). However, piezometers were installed within 11 of the 14 boreholes following drilling, and subsequently monitored over the duration of the fieldwork phase to allow elevated levels to normalise and to assess the influence of heavy rainfall events on groundwater levels, if any. Groundwater was not encountered during the drilling of boreholes BH03, BH09 and BH13. Table 5-6 summarises the groundwater levels measured in the piezometers during the fieldwork (12 August 2011) and one month following.

**Table 5-6 Groundwater Summary**

Borehole Location	Date Installed	Piezometer Depth (m)	Groundwater Depth (m)	
			12/08/11	13/09/11
BH01	21/07/2011	20.0	>20.0	>20.0
BH02	22/07/2011	10.0	>10.0	>10.0
BH03	23/07/2011	10.0	>10.0	>10.0
BH05	26/07/2011	10.0	7.0	>10.0
BH07	04/08/2011	20.0	19.2	>20.0
BH09	25/07/2011	10.0	>10.0	>10.0
BH10	09/08/2011	20.0	17.1	>20.0
BH11	30/07/2011	10.0	>10.0	>10.0
BH13	02/08/2011	20.0	14.0	>20.0
BH14	31/07/2011	10.0	>10.0	>10.0

## 5 Site Assessment

The monitoring results indicate that groundwater levels across the site are at least 10 m below the existing ground surface, and likely at a depth greater than 20 m, as evidenced by the five 20 m piezometers.

Groundwater was not encountered within the excavated test pits, with the exception of TP46 (2.1 m) and TP34 (1.2 m) where perched groundwater was observed at the soil/rock interface, inferred to be a localised perched water table.

It is important to note, however, that groundwater levels and flows are transient, and are affected by such factors as soil and rock permeability, earth moving operations and preceding climatic conditions.

## Design

A conceptual design report for the proposed Alpha Coal Tailings Storage has been compiled by Parsons Brinckerhoff (Parsons Brinckerhoff 2011). This design report is currently being revisited by URS as part of the in-pit tailings disposal assessment; however for the purposes of this groundwater assessment the information available in the Parsons Brinckerhoff has been considered.

### 6.1 Storage Capacity

The Alpha TSF is proposed to receive and store ~ 74 Mt of tailings for the nominal mine life of 30 years. The tailings will be pumped to the out-of-pit TSF as slurry with a consistency of 30% solids by mass. The tailings will settle and densify with approximately 20% of the water being collected in a decant system for reuse in the CHPP. It is assumed that an additional 10% of the slurry water will be lost to evaporation.

The TSF has been designed in stages to allow for the TSF development over the LOM. The cumulative storage capacity at the end of 30 years is 155,000,000 m<sup>3</sup>.

### 6.2 Seepage Management

If the TSF is unlined then there is the potential for the migration of leachate from the facility. The mechanisms by which seepage would occur are interpreted to include:

- Downward leakage through surficial sediments;
- Lateral migration through surficial sediments, particularly through weathered conglomerates and sands/gravels;
- Movement of leachate down gradient at shallow depth towards Lagoon Creek alluvium; and
- Over time the weathered rock profile would become saturated, which would increase hydraulic conductivity by several orders of magnitude, facilitating downward leachate migration.

Thus there is the potential for movement of leachate away from an unlined TSF, both vertically along more competent (lower permeable) zones or as deep drainage into the confined aquifers.

The current proposed design of the TSF is for a fully lined impoundment to limit the potential for leakage from the facility.

#### 6.2.1 Seepage control

The TSF will be designed to minimise any adverse environmental effects arising from seepage from the impoundments. Seepage from the TSF would be minimised by implementing some, or all, of the following measures:

- Design and construction of main embankments using fill materials placed to engineering specifications;
- Providing a liner system to reduce seepage from the TSF to groundwater;
- Providing an underdrainage system to collect seepage from the TSF;
- Recovery of surface water from within the TSF using an engineered recovery system;
- Management of tailings deposition via discharge points to ensure that tailings are deposited in a controlled manner maximising evaporation and decant;



## 6 Design

- Providing appropriate embankment drainage design to manage potential seepage through the embankment; and
- Compaction of existing soils within the storage area.

### 6.2.2 Liner system

A liner system may be required in areas where sandy soils are encountered to limit seepage of tailings water into the foundation soils/rock and reduce the potential impact to groundwater and the Lagoon Creek alluvial area. It is considered that the sandy clay layer encountered in places within the TSF footprint could act as a liner system.

The liner system could be established in a number of ways, including using either the clayey soils won from site or from tailings fines. The detailed design of the liner would allow, according to accepted standards, a permeability target of  $10^{-9}$  m/s (0.00009 m/day).

### 6.2.3 Underdrainage system

Given the low density of the slurry the tailings will settle in the TSF with significant associated water content, generating a hydraulic head. Should an acceptable permeability target not be achieved, an underdrainage system will be employed. An underdrainage system or subsurface drainage would increase the rate of tailings dewatering and facilitate consolidation of placed tailings.

The underdrainage system would involve the installation above the liner system of slotted pipe and geotextile drains running across the floor of the TSF covered with granular free draining sand material. The captured seepage would discharge via a pipe into the tailings decant dam.

## Assessment Summary

Based on the available site specific geological and hydrogeological data an assessment of the potential impacts of the proposed TSF has been compiled, which can be summarised as follows: -

### 7.1 Geological Data

Drilling results across and adjacent to the proposed TSF indicate the following:

- The majority of the proposed TSF is underlain by fresh (unweathered) Joe Joe Group comprises well cemented sandstone and conglomerate.
- No Colinlea Sandstone outcrops on site and the site, except for the elevated eastern area is covered with altered (lateritic and saprolitic) parent material.
- Blow yields measured during at the end of drilling each bore indicate that the sediments have low primary permeability.
- Areas of relatively high yield occur within discrete alteration zones related to secondary permeability, such as fracturing, which may offer low sustainable yields due to low storage.
- The weathered / lateritic Joe Joe Group sediments are difficult to distinguish from weathered / lateritic Colinlea Sandstone (Permian parent material of the Tertiary laterite is difficult to discern). However, an abundance of lithic sediments and occurrence of carbonaceous material is considered diagnostic as the Colinlea Sandstone is more quartz-rich.

The drilling results indicate that there are discrete zones of alteration, which can enhance groundwater potential within the TSF study area. Cross-sections indicate that these zones are located down gradient of the proposed footprint, most markedly where conglomerate within either Colinlea Sandstone or Joe Joe Group is poorly cemented. Seepage management would be required to limit the potential for TSF seepage to enter these more permeable and transmissive zones.

### 7.2 Hydrogeology and Recharge Evaluation

#### 7.2.1 Direct Recharge to Outcrop Areas

Drilling to the east of Lagoon Creek (Section 5) indicates that the Colinlea Sandstone units do not outcrop but are covered by unconsolidated Quaternary sands (alluvium, colluvium, and aeolian deposits) and Tertiary age laterite and saprolite. This cover material, which is clay-rich, results in areas of perched water separated from the underlying potentiometric groundwater levels associated with the confined Colinlea Sandstone aquifers (Section 5). This lack of hydraulic linkage, between the perched water table and the confined aquifers, limits recharge. Figures 5-2 and 5-3 are cross-sections based on bores drilled across the proposed TSF. The bores are drilled to the east of Lagoon Creek within the Colinlea Sandstone and Joe Joe Group sediments. The drilling results indicate the lack of Colinlea Sandstone outcrop, cover material, and dry sediments (even after high 2010/2011 rains) indicating limited recharge.

Groundwater flow patterns (Figure 4-2) from south west to north east across the site indicate recharge away from the units to the east of Lagoon Creek.

Geotechnical drilling undertaken in the TSF footprint included hydraulic conductivity testing of the unsaturated weathered Colinlea Sandstone sediments. These tests indicated very low hydraulic conductivity values (in the range of  $10^{-7}$  to  $10^{-8}$  m/s), and also found a single occurrence of (perched) groundwater in shallow unconsolidated sands lenses above weathered rock (Section 5.5). These

## 7 Assessment Summary

results support the conclusion that even under above average rainfall conditions (2010/2011 rains) infiltration is limited in this area of Colinlea Sandstone subcrop.

### 7.2.2 Diffuse Recharge along the Great Dividing Range

The potentiometric surface contours presented in Figure 4-2 and the VWP data (indicating pressure difference that promotes downward migration) lend support to the majority of recharge within the study area being derived as diffuse recharge from the Great Dividing Range.

Thus recharge from the area of Colinlea Sandstone subcrop is not regionally significant compared to recharge that occurs to the west of the site, as the area to the west of the site represents a much greater surface area in which recharge could occur.

## 7.3 Hydrochemistry

Ambient groundwater quality within the TSF study area indicates that the shallow groundwater resources associated with the unconfined Quaternary and Tertiary units has variable groundwater quality, the majority of which is saline. Based on a comparison to domestic and stock watering guidelines the majority of the site is underlain by poor quality groundwater, which reduces the suitability for use with regards to local vegetation and stock watering.

In addition, if the area below the TSF were a groundwater recharge area, it could be expected that shallow groundwater would be less saline, especially given the significant 2010/2011 wet season rainfall. This supports an interpretation that the area underlying the TSF is not a significant groundwater recharge area.

A single groundwater sample from bore 1614R, however, had low TDS groundwater. As this groundwater can potentially be impacted by seepage from the TSF it is considered that the proposed design components, discussed in Section 6, need to be in place to minimise potential impacts.

Groundwater samples collected from bores within the deeper confined aquifers indicate that the groundwater is of better quality than the shallow unconfined groundwater. This groundwater has limited sustainable yield potential based on drilling results and is separated from the proposed TSF by clay-rich Quaternary and Tertiary sediments. The inclusion of design components (Section 6) will further protect these groundwater resources.

## 7.4 Geotechnical Evaluation

Based on the results of this investigation and a review of data previously collected, the TSF site is considered suitable for storing tailings from a geotechnical perspective. This conclusion assumes that the TSF will be designed based on good engineering practice and constructed accordingly.

It is considered highly unlikely that well-developed Lagoon Creek palaeochannels or extensive former drainage pathways are present beneath the proposed TSF footprint. Slight horizontal migration of tailings liquor through surficial alluvial or low density residual soils (if any) can be expected during the life-of-mine, however, the construction of an engineered cut-off trench that intercepts the soil/weathered rock interface (where liquor may accumulate over time) would mitigate the risk of contamination into Lagoon Creek to acceptable levels.

Due to the low groundwater level and low hydraulic conductivity measured during in situ falling head and packer testing, the residual soil and weathered sandstone in the floor of the TSF footprint appears

## 7 Assessment Summary

to be sufficiently impermeable to limit significant vertical migration of tailings liquor into the groundwater table. Given the relatively low permeability of these materials, it is expected that the TSF can be designed to mitigate adverse impacts to the regional groundwater system. To the extent prudent engineering and best practice are adopted during design and construction, no adverse effect to groundwater quality is expected.

### 7.5 Summary

The hydrogeological assessment indicates:

- Limited recharge potential to the underlying Colinlea Sandstone aquifers due to the thick clay-rich Tertiary cover, thin discontinuous Colinlea Sandstone aquifers (cross-sections indicate thin sub-E and sub-F sands), thick unsaturated zone (even though the site was subject to prolonged high rainfall events during 2010/2011), and no Colinlea Sandstone rock outcrop or shallow subcrop. This coincides with the conceptualisation, borne from the groundwater flow patterns recorded on site, from south west to north east, that groundwater recharge predominantly occurs to south west along the Great Dividing Range.
- Drilling results and blow-out yields recorded during rotary-air-percussion within the proposed TSF footprint indicate aquitards and units of limited groundwater potential. The shallow groundwater resources (perched water tables) that could potentially be impacted by the proposed TSF have limited sustainable yields, limited effective storage, and contain poor quality groundwater (Table 5-3).
- Discrete zones of alteration, resulting in enhanced groundwater potential, occur to the west of the northern portion of the proposed TSF footprint. These groundwater resources can be protected through the use of lining and seepage control measures down gradient of the proposed TSF.
- The footprint is underlain by Tertiary age saprolite and laterite (Tertiary weathering of Colinlea Sandstone sediments) and Joe Joe Group sediments that are shown from drilling to be hydraulically tight and to have very low groundwater potential.

The TSF will be designed based on good engineering practice and constructed accordingly, thus the potential impacts of artificial recharge with poor quality TSF seepage will be minimised. The reduction in recharge will only affect the shallow perched groundwater resources located within the Quaternary and Tertiary sediments directly within the footprints. These groundwater resources are considered to have limited environmental values, except for possible vegetation communities, due to groundwater quality and limited abstraction potential.

## References

Gray and Swarbrick, 1975. Nomenclature of Late Palaeozoic Strata in the Northeastern Galilee Basin. Queensland Government Mining Journal Vol. LXXVI No.888

Parsons Brinkerhoff, 2011. Alpha Coal Tailings Storage Facility – Conceptual Design Report for Hancock Coal Pty Ltd. Report reference HC-PBA-67510-RPT-0014-E

URS, 2011. Preliminary Report Alpha Coal Project Out-of-Pit Tailings Storage Facility (TSF): Geotechnical Investigation. Prepared for Hancock Coal Pty Ltd. Report reference 42626683

## Limitations

### 9.1 Geotechnical & Hydro Geological Report

URS Australia Pty Ltd (URS) has prepared this report in accordance with the usual care and thoroughness of the consulting profession for the use of Hancock Coal Pty Ltd and only those third parties who have been authorised in writing by URS to rely on the report. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report. It is prepared in accordance with the scope of work and for the purpose outlined in the Proposal dated 19 May 2011.

The methodology adopted and sources of information used by URS are outlined in this report. URS has made no independent verification of this information beyond the agreed scope of works and URS assumes no responsibility for any inaccuracies or omissions. No indications were found during our investigations that information contained in this report as provided to URS was false.

This report was prepared between 01 and 26 September 2011 and is based on the conditions encountered and information reviewed at the time of preparation. URS disclaims responsibility for any changes that may have occurred after this time.

This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

This report contains information obtained by inspection, sampling, testing or other means of investigation. This information is directly relevant only to the points in the ground where they were obtained at the time of the assessment. The borehole logs indicate the inferred ground conditions only at the specific locations tested. The precision with which conditions are indicated depends largely on the frequency and method of sampling, and the uniformity of conditions as constrained by the project budget limitations. The behaviour of groundwater and some aspects of contaminants in soil and groundwater are complex. Our conclusions are based upon the analytical data presented in this report and our experience. Future advances in regard to the understanding of chemicals and their behaviour, and changes in regulations affecting their management, could impact on our conclusions and recommendations regarding their potential presence on this site.

Where conditions encountered at the site are subsequently found to differ significantly from those anticipated in this report, URS must be notified of any such findings and be provided with an opportunity to review the recommendations of this report.

Whilst to the best of our knowledge information contained in this report is accurate at the date of issue, subsurface conditions, including groundwater levels can change in a limited time. Therefore this document and the information contained herein should only be regarded as valid at the time of the investigation unless otherwise explicitly stated in this report.



## Appendix A Bore Logs

URS Australia Pty. Ltd.  
Lvl 17, 240 Queen St., Brisbane QLD 4000

Phone (07) 3243 2111  
Fax: (07) 3243 2199

Project No.:

Project Reference:

## Hancock Alpha SEIS

**42626680**

Drilling Contractor:

**Drilling Method:**

**RC**  
Drill Model:

Logged By:

Checked By:

Date Started:

Date Finished:

Elevation: 314.5 mAHD

Coordinates: 448357 mE

7423195 mN

Permit No: -

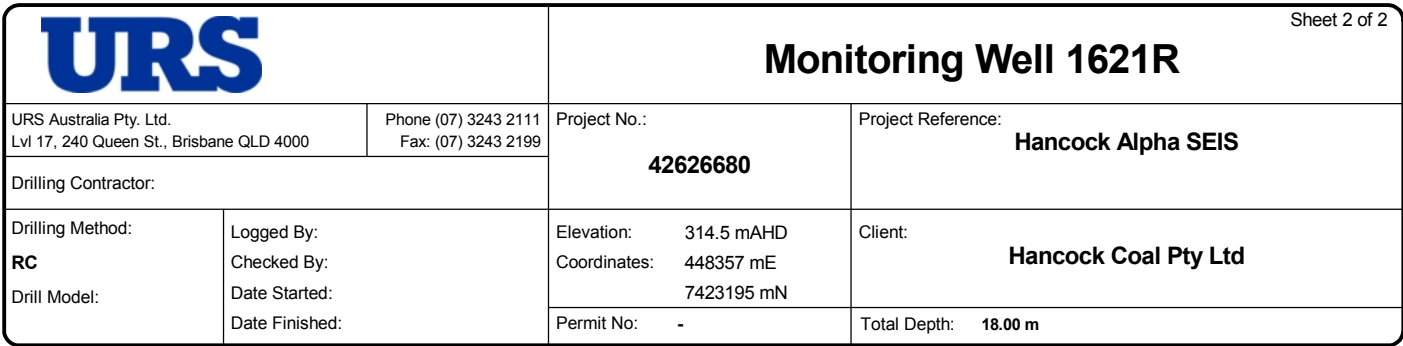
Client:

**Hancock Coal Pty Ltd**

Total Depth: 18.00 m

MONITORING WELL - ELEVATION (MAHD) JULY 2011.GPJ BRISBANE\_JOB\_TEMPLATE.GDT 20/9/11 This drawing is subject to COPYRIGHT. It remains the property of URS Australia Pty Ltd.

## REMARKS:

[illegible]



# Monitoring Well 1620R

URS Australia Pty. Ltd.  
Lvl 17, 240 Queen St., Brisbane QLD 4000Phone (07) 3243 2111  
Fax: (07) 3243 2199

Project No.:

**42626680**

Project Reference:

**Hancock Alpha SEIS**

Drilling Contractor:

Drilling Method:

**RC**

Drill Model:

Logged By:

Checked By:

Date Started:

Date Finished:

Elevation:

328 mAHD

Coordinates:

451420 mE

7424006 mN

Client:

**Hancock Coal Pty Ltd**

Permit No:

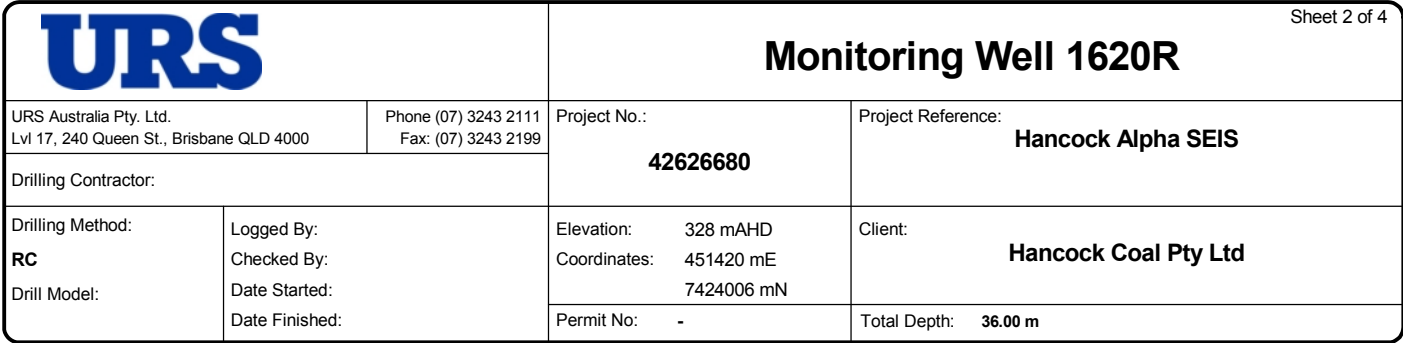
-

Total Depth:

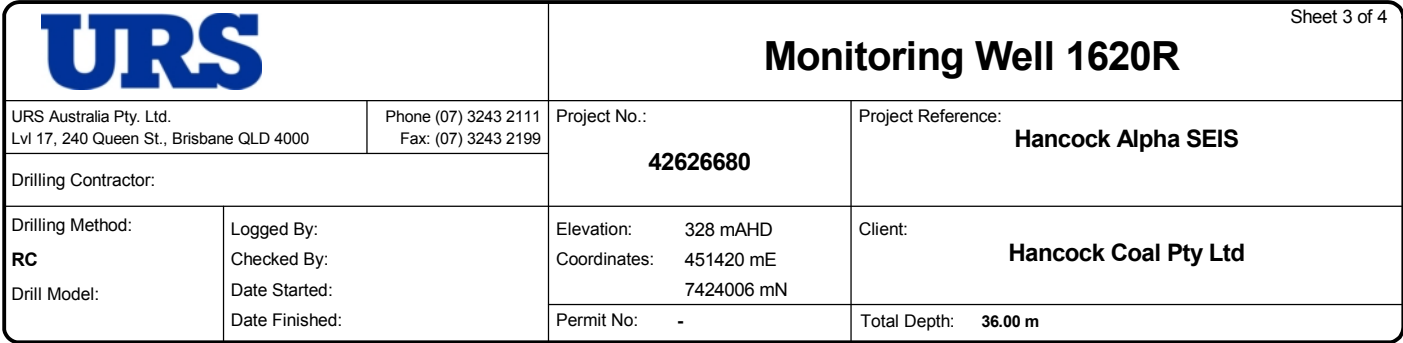
**36.00 m****SAMPLING DETAILS****WELL CONSTRUCTION DETAILS****DESCRIPTION OF STRATA**

Sample Type	Sampling and Observations	PID (ppm)	Lockable Stand Pipe	Lockable Envirocap Stick-up 0.84m	Elevation (mAHD)	Legend	Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Plasticity	Moisture	Classification
					328		SOIL - dark, brown, clayey in part, friable, very loose, completely weathered.	Fr - VL							
					327		SOIL - light, yellowish, brown, clayey in part, friable, very loose, completely weathered.	Fr - VL							
					326		CLAY - light, creamy, brown, minor sandy in part, loose mechanical state, very soft, completely weathered.	VSo							
					325		LATERITE - light, pinkish, brown, clayey throughout, waxy, very soft, completely weathered.	VSo							
					324										
					323		LATERITE - light, creamy, white, clayey throughout, waxy, soft, completely weathered.	So							
					322										
					321										
					320										
					319										

**REMARKS:**

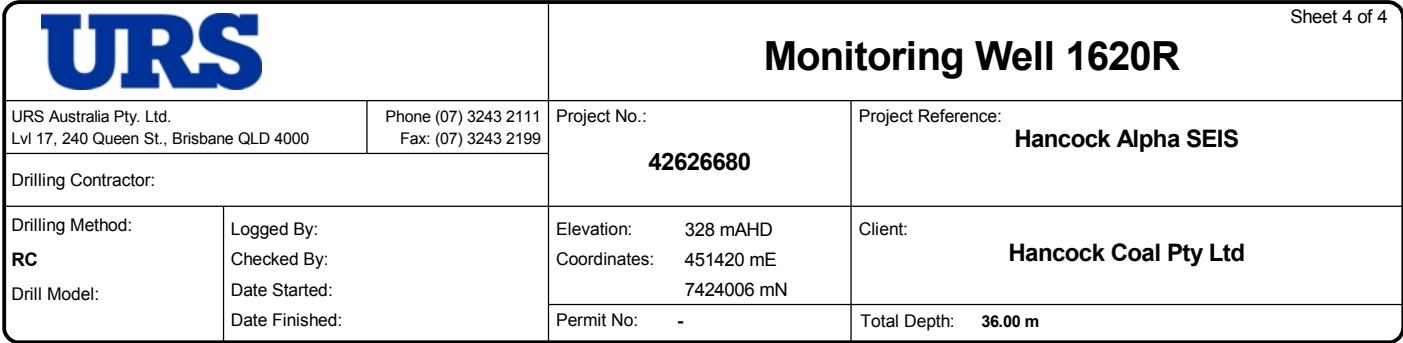
[illegible]

REMARKS:



SAMPLING DETAILS			WELL CONSTRUCTION DETAILS		Elevation (mAHD)	DESCRIPTION OF STRATA									
Sample Type	Sampling and Observations	PID (ppm)				Legend	Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Plasticity	Moisture	Classification



[illegible]

REMARKS:

## Monitoring Well 1619R

URS Australia Pty. Ltd.  
Lvl 17, 240 Queen St., Brisbane QLD 4000

Phone (07) 3243 2111  
Fax: (07) 3243 2199

Project No.:

**42626680**

Project Reference:

**Hancock Alpha SEIS**

Drilling Contractor:

Drilling Method:

**RC**

Drill Model:

Logged By:

Checked By:

Date Started:

Date Finished:

Elevation:

328 mAHD

Coordinates:

451420 mE

7424006 mN

Client:

**Hancock Coal Pty Ltd**

Permit No:

-

Total Depth:

**10.00 m**

MONITORING WELL - ELEVATION (MAHD) JULY 2011.GPJ BRISBANE\_JOB\_TEMPLATE.GDT 20/9/11 This drawing is subject to COPYRIGHT. It remains the property of URS Australia Pty Ltd.

SAMPLING DETAILS				WELL CONSTRUCTION DETAILS		DESCRIPTION OF STRATA										
Sample Type	Sampling and Observations	PID (ppm)		Lockable Stand Pipe	Lockable Envirocap Stick-up 0.82m	Elevation (mAHD)	Legend	Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Plasticity	Moisture	Classification
						328		SOIL - dark, brown, clayey in part, friable, very loose, completely weathered.	Fr - VL							
						327		SOIL - light, yellowish, brown, clayey in part, friable, very loose, completely weathered.	Fr - VL							
						326		CLAY - light, creamy, brown, minor sandy in part, loose mechanical state, very soft, completely weathered.	VSo							
						325		LATERITE - light, pinkish, brown, clayey throughout, waxy, very soft, completely weathered.	VSo							
						324										
						323		LATERITE - light, creamy, white, clayey throughout, waxy, soft, completely weathered.	So							
						322										
						321										
						320										
						319										

50 mm UPVC Class 18 Standpipe in Cement Grout

50 mm UPVC Class 18 Standpipe in Bentonite Seal

50 mm UPVC Class 18 Standpipe in Sand/Gravel Pack

50 mm UPVC Class 18 Screen in Sand/Gravel Pack

REMARKS:

REMARKS:



# Monitoring Well 1619R

URS Australia Pty. Ltd.  
Lvl 17, 240 Queen St., Brisbane QLD 4000Phone (07) 3243 2111  
Fax: (07) 3243 2199

Project No.:

**42626680**

Project Reference:

**Hancock Alpha SEIS**

Drilling Contractor:

Drilling Method:

**RC**

Drill Model:

Logged By:

Checked By:

Date Started:

Date Finished:

Elevation:

328 mAHD

Coordinates:

451420 mE

7424006 mN

Client:

**Hancock Coal Pty Ltd**

Permit No:

-

Total Depth:

**10.00 m****SAMPLING DETAILS****WELL CONSTRUCTION DETAILS****DESCRIPTION OF STRATA**

Sample Type

Sampling  
and  
Observations

PID (ppm)

End cap

Elevation (mAHD)

Legend

Lithology

Consistency

Structure

Grain Size

Shape

Sorting

Plasticity

Moisture

Classification

318

317

316

315

314

313

312

311

310

309

Base of Well

**REMARKS:**

## Monitoring Well 1618R

URS Australia Pty. Ltd.  
Lvl 17, 240 Queen St., Brisbane QLD 4000

Phone (07) 3243 2111  
Fax: (07) 3243 2199

Project No.:

**42626680**

Project Reference:

**Hancock Alpha SEIS**

Drilling Contractor:

Drilling Method:

**RC**

Drill Model:

Logged By:

Checked By:

Date Started:

Date Finished:

Elevation:

315 mAHD

Coordinates:

449361 mE

7423473 mN

Client:

**Hancock Coal Pty Ltd**

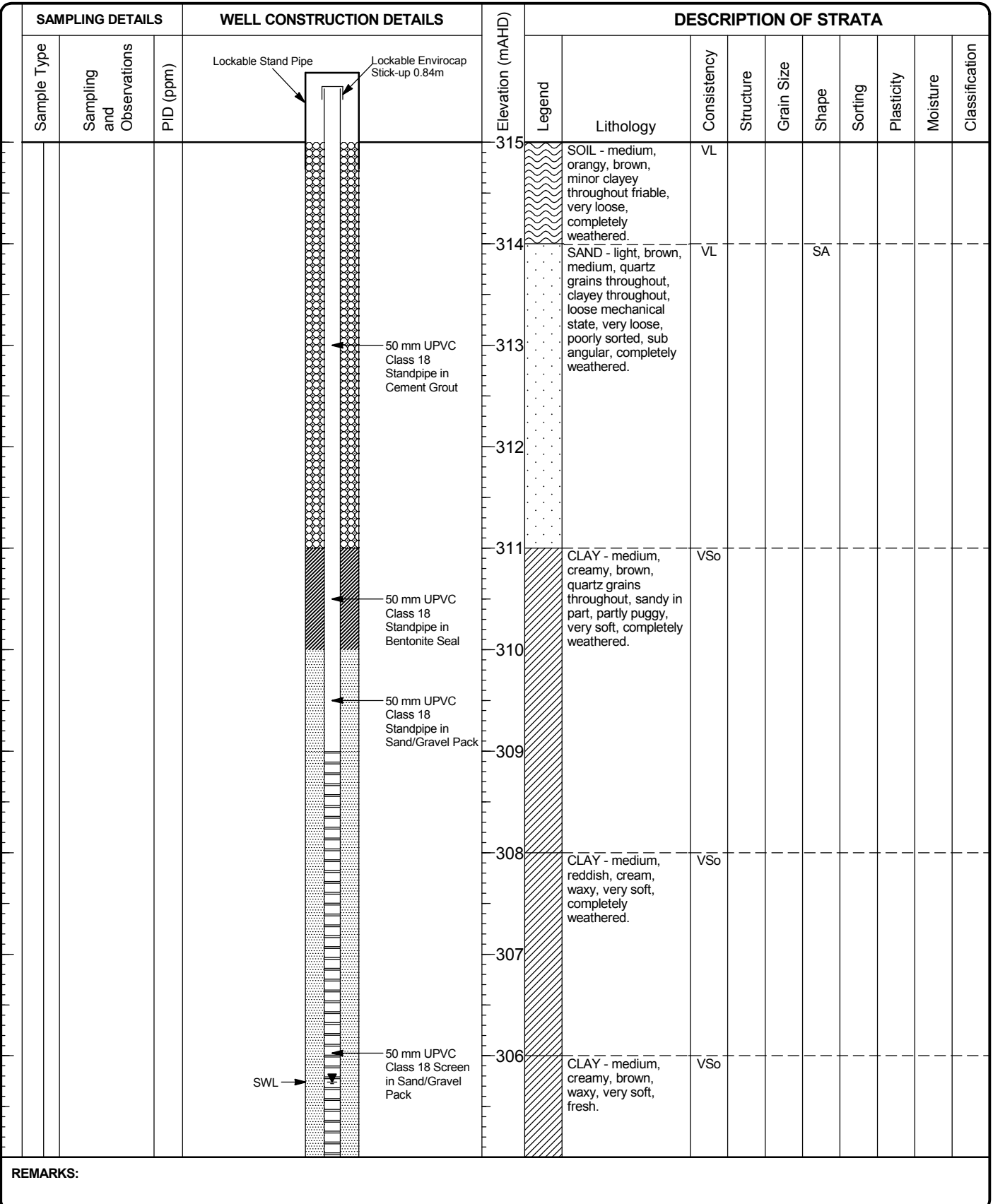
Permit No:

-

Total Depth:

**12.00 m**

MONITORING WELL - ELEVATION (MAHD) JULY 2011.GPJ BRISBANE\_JOB\_TEMPLATE.GDT 20/9/11 This drawing is subject to COPYRIGHT. It remains the property of URS Australia Pty Ltd.



**Monitoring Well 1618R**URS Australia Pty. Ltd.  
Lvl 17, 240 Queen St., Brisbane QLD 4000Phone (07) 3243 2111  
Fax: (07) 3243 2199

Project No.:

**42626680**

Project Reference:

**Hancock Alpha SEIS**

Drilling Contractor:

Drilling Method:

**RC**

Drill Model:

Logged By:

Checked By:

Date Started:

Date Finished:

Elevation:

315 mAHD

Coordinates:

449361 mE

7423473 mN

Client:

**Hancock Coal Pty Ltd**

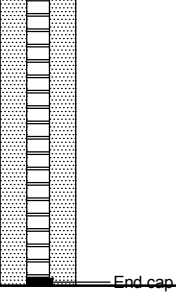

Permit No:

-

Total Depth:

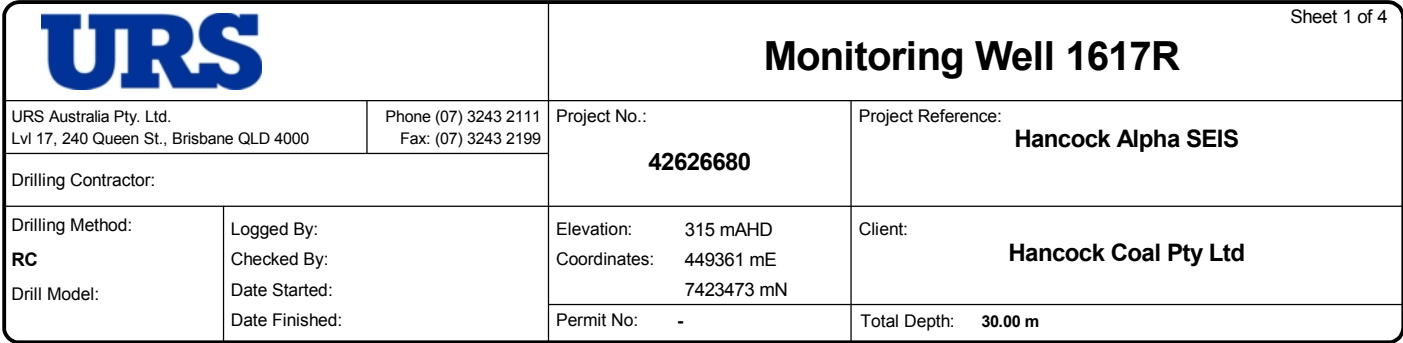
**12.00 m**






MONITORING WELL - ELEVATION (MAHD) JULY 2011.GPJ BRISBANE\_JOB\_TEMPLATE.GDT 20/9/11 This drawing is subject to COPYRIGHT. It remains the property of URS Australia Pty Ltd.

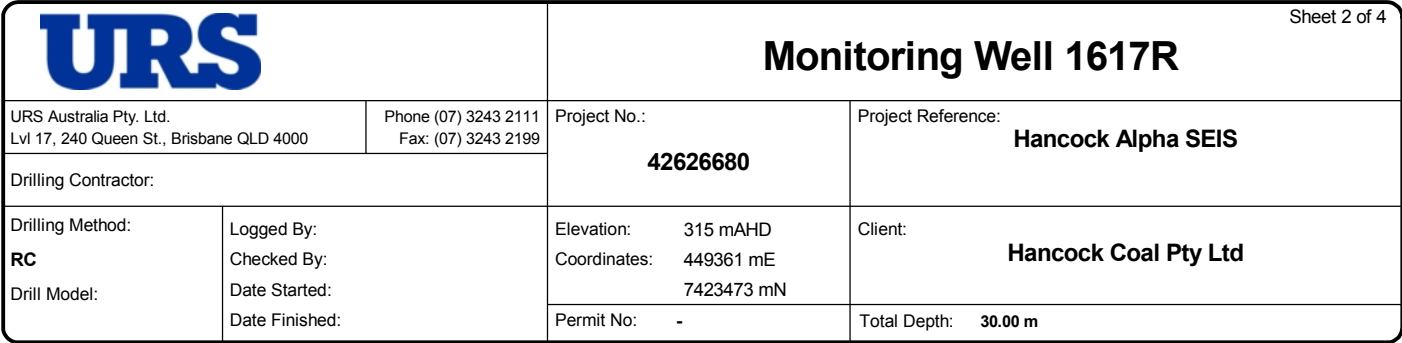
SAMPLING DETAILS			WELL CONSTRUCTION DETAILS		DESCRIPTION OF STRATA										
Sample Type	Sampling and Observations	PID (ppm)			Elevation (mAHD)	Legend	Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Plasticity	Moisture	Classification
					305										
					304										
					303		Base of Well								
					302										
					301										
					300										
					299										
					298										
					297										
					296										

**REMARKS:**





SAMPLING DETAILS				WELL CONSTRUCTION DETAILS		DESCRIPTION OF STRATA										
Sample Type	Sampling and Observations	PID (ppm)		Lockable Stand Pipe	Lockable Envirocap Stick-up 0.82m	Elevation (mAHD)	Legend	Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Plasticity	Moisture	Classification
						315		SOIL - medium, orangey, brown, minor clayey throughout friable, very loose, completely weathered.	Fr - VL							
						314		SAND - light, brown, medium, quartz grains throughout, clayey throughout, loose mechanical state, very loose, poorly sorted, sub angular, completely weathered.	VL							
						313										
						312										
						311		CLAY - medium, creamy, brown, quartz grains throughout, sandy in part, partly puggy, very soft, completely weathered.	VSo							
						310										
						309										
						308		CLAY - medium, reddish, cream, waxy, very soft, completely weathered.	VSo							
						307										
						306		CLAY - medium, creamy, brown, waxy, very soft, fresh.	VSo							
REMARKS:																



# Monitoring Well 1617R

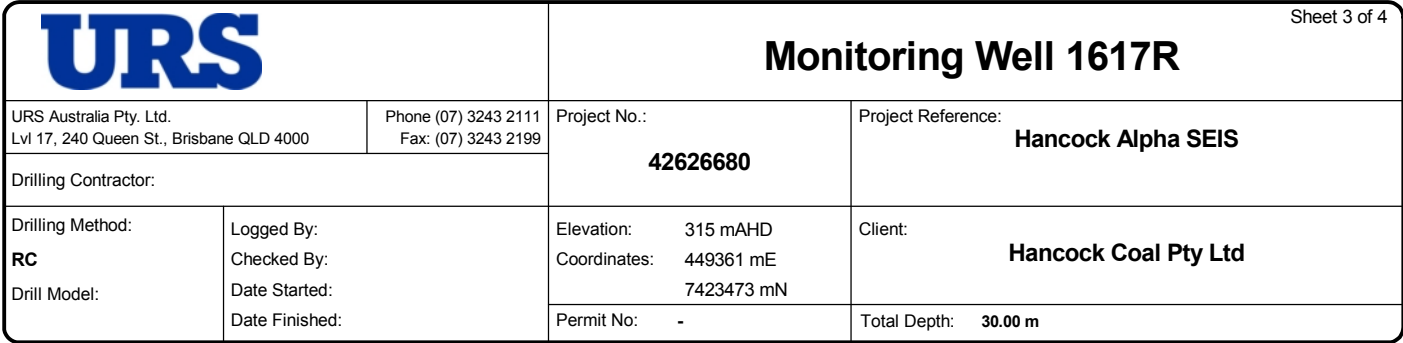
Project Reference: **Hancock Alpha SEIS**

Total Depth:	30.00 m
--------------	---------

SAMPLING DETAILS				WELL CONSTRUCTION DETAILS		Elevation (mAHD)	DESCRIPTION OF STRATA									
Sample Type	Sampling and Observations	PID (ppm)					Legend	Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Plasticity	Moisture	Classification
						305										
						304										
						303										
						302										
						301										
						300										
						299										
						298										
						297										
						296										

REMARKS:

MONITORING WELL - ELEVATION (MAHD) JULY 2011.GPJ BRISBANE JOB TEMPLATE.GDT 20/9/11 This drawing is subject to COPYRIGHT. It remains the property of URS Australia Pty Ltd.



SAMPLING DETAILS				WELL CONSTRUCTION DETAILS		DESCRIPTION OF STRATA										
Sample Type	Sampling and Observations	PID (ppm)			Elevation (mAHD)	Legend	Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Plasticity	Moisture	Classification	
					295											
					294											
					293											
					292		CLAY - light, creamy, brown, partly puggy, soft, completely weathered.	So								
					291		SANDSTONE - light, creamy, grey, medium to coarse, quartz grains throughout, clayey matrix, low to poorly sorted, sub angular, completely weathered.			M-C	SA	P				
					290											
					289											
					288											
					287											
					286		SANDSTONE - dark, reddish, brown, fine to coarse, iron oxide stains throughout, medium, moderately sorted, sub angular,			F-C	SA	M				
REMARKS:																



# Monitoring Well 1617R

URS Australia Pty. Ltd.  
Lvl 17, 240 Queen St., Brisbane QLD 4000Phone (07) 3243 2111  
Fax: (07) 3243 2199

Project No.:

**42626680**

Project Reference:

**Hancock Alpha SEIS**

Drilling Contractor:

Drilling Method:

**RC**

Drill Model:

Logged By:

Checked By:

Date Started:

Date Finished:

Elevation:

315 mAHD

Coordinates:

449361 mE

7423473 mN

Client:

**Hancock Coal Pty Ltd**

Permit No:

-

Total Depth:

**30.00 m****SAMPLING DETAILS****WELL CONSTRUCTION DETAILS****DESCRIPTION OF STRATA**

Sample Type	Sampling and Observations	PID (ppm)	Elevation (mAHD)	Legend	Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Plasticity	Moisture	Classification
			End cap	285	slightly weathered. Base of Well								
				284									
				283									
				282									
				281									
				280									
				279									
				278									
				277									
				276									

**REMARKS:**

## Monitoring Well 1616R

URS Australia Pty. Ltd.  
Lvl 17, 240 Queen St., Brisbane QLD 4000

Phone (07) 3243 2111  
Fax: (07) 3243 2199

Project No.:

**42626680**

Project Reference:

**Hancock Alpha SEIS**

Drilling Contractor:

Drilling Method:

**RC**

Drill Model:

Logged By:

Checked By:

Date Started:

Date Finished:

Elevation:

333 mAHD

Coordinates:

453106 mE

7424465 mN

Client:

**Hancock Coal Pty Ltd**

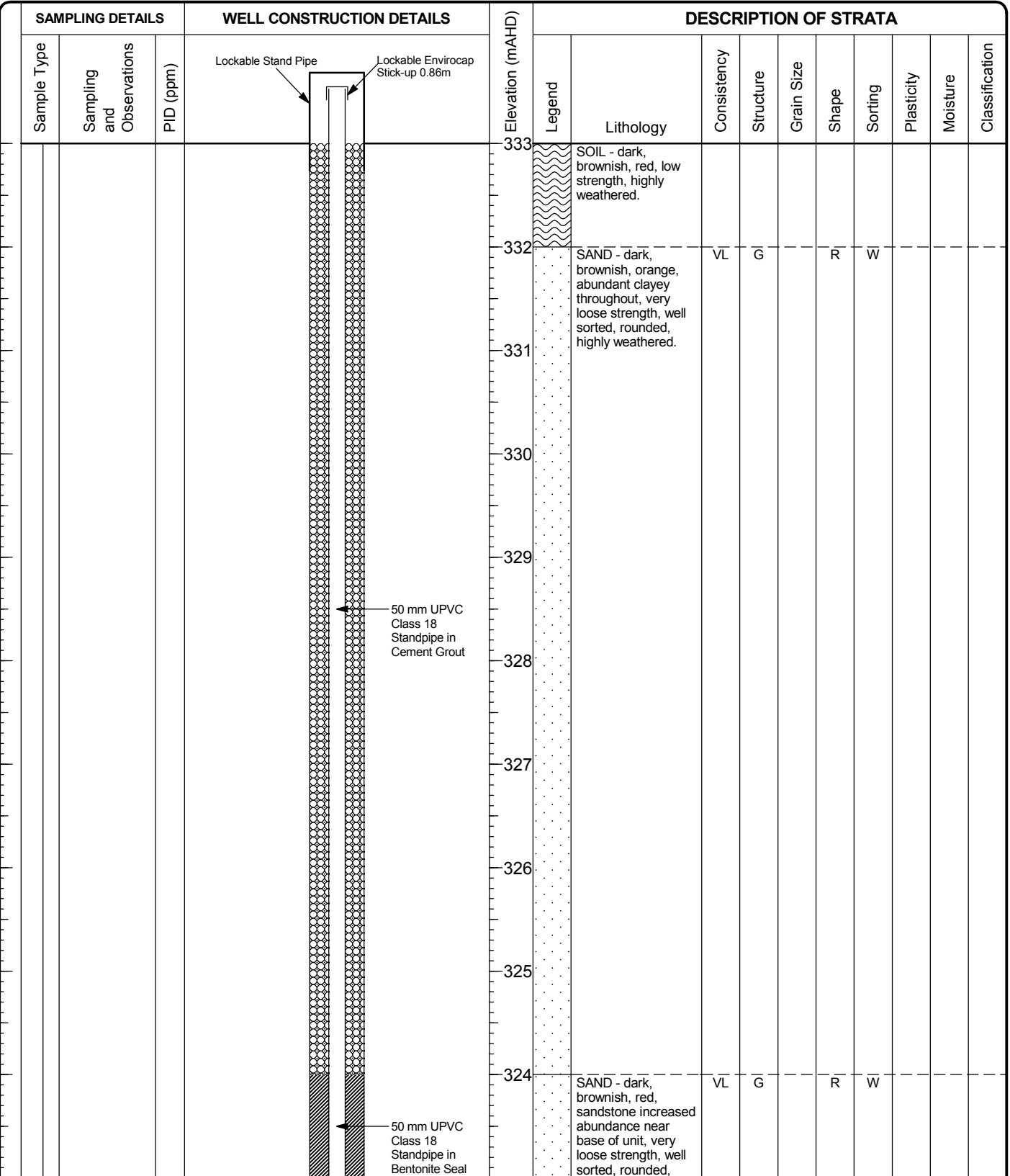
Permit No:

-

Total Depth:

**18.00 m**

MONITORING WELL - ELEVATION (MAHD) JULY 2011.GPJ BRISBANE\_JOB\_TEMPLATE.GDT 20/9/11 This drawing is subject to COPYRIGHT. It remains the property of URS Australia Pty Ltd.



**REMARKS:** IWL: Initial Water Level SWL: Standing Water Level





# Monitoring Well 1616R

URS Australia Pty. Ltd.  
Lvl 17, 240 Queen St., Brisbane QLD 4000Phone (07) 3243 2111  
Fax: (07) 3243 2199

Project No.:

**42626680**

Project Reference:

**Hancock Alpha SEIS**

Drilling Contractor:

Drilling Method:

**RC**

Drill Model:

Logged By:

Checked By:

Date Started:

Date Finished:

Elevation:

333 mAHD

Coordinates:

453106 mE

7424465 mN

Client:

**Hancock Coal Pty Ltd**

Permit No.:

-

Total Depth:

**18.00 m****SAMPLING DETAILS****WELL CONSTRUCTION DETAILS****DESCRIPTION OF STRATA**

Sample Type	Sampling and Observations	PID (ppm)			Elevation (mAHD)	Legend	Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Plasticity	Moisture	Classification
					323		highly weathered, common Qtz fragments.								
					322										
					321										
					320										
					319										
					318										
					317										
					316										
					315										
					314										

50 mm UPVC  
Class 18  
Standpipe in  
Sand/Gravel Pack50 mm UPVC  
Class 18 Screen  
in Sand/Gravel  
Pack

End cap

Base of Well

**REMARKS:**

URS Australia Pty. Ltd.  
Lvl 17, 240 Queen St., Brisbane QLD 4000

Phone (07) 3243 2111  
Fax: (07) 3243 2199

Project No.:

Project Reference:

## Hancock Alpha SEIS

**42626680**

Drilling Contractor:

**Drilling Method:**

Logged By:

Checked By:

Date Started:

Date Finished:

Elevation:

340 mAHD

Coordinates:

453090 mE

7428053 mN

Permit No:

—

Client:

**Hancock Coal Pty Ltd**

Total Depth:

36.00 m

MONITORING WELL - ELEVATION (MAHD) JULY 2011.GPJ BRISBANE\_JOB\_TEMPLATE.GDT 20/9/11 This drawing is subject to COPYRIGHT. It remains the property of URS Australia Pty Ltd.

REMARKS:

**Monitoring Well 1615R**URS Australia Pty. Ltd.  
Lvl 17, 240 Queen St., Brisbane QLD 4000Phone (07) 3243 2111  
Fax: (07) 3243 2199

Project No.:

**42626680**

Project Reference:

**Hancock Alpha SEIS**

Drilling Contractor:

Drilling Method:

**RC**

Drill Model:

Logged By:

Checked By:

Date Started:

Date Finished:

Elevation:

340 mAHD

Coordinates:

453090 mE

7428053 mN

Client:

**Hancock Coal Pty Ltd**

Permit No:

-

Total Depth:

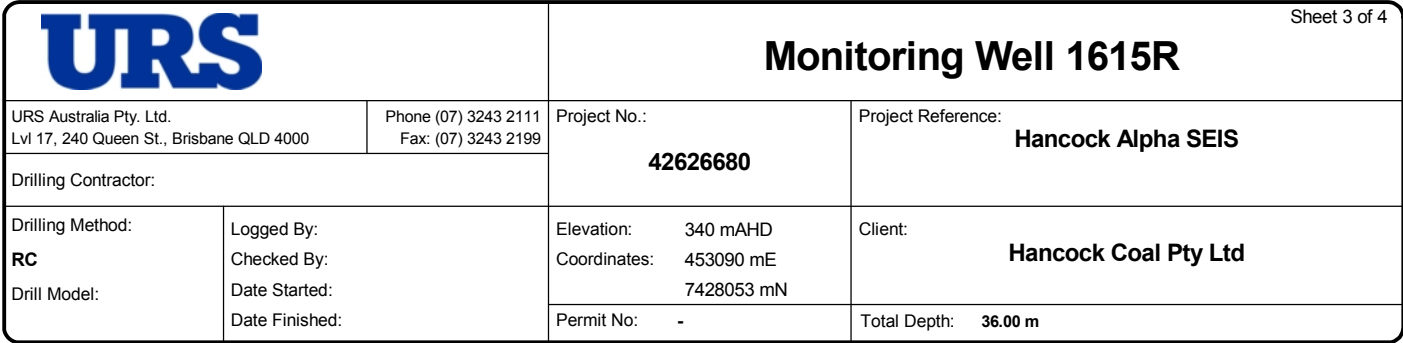
**36.00 m**

MONITORING WELL - ELEVATION (MAHD) JULY 2011.GPJ BRISBANE\_JOB\_TEMPLATE.GDT 20/9/11 This drawing is subject to COPYRIGHT. It remains the property of URS Australia Pty Ltd.

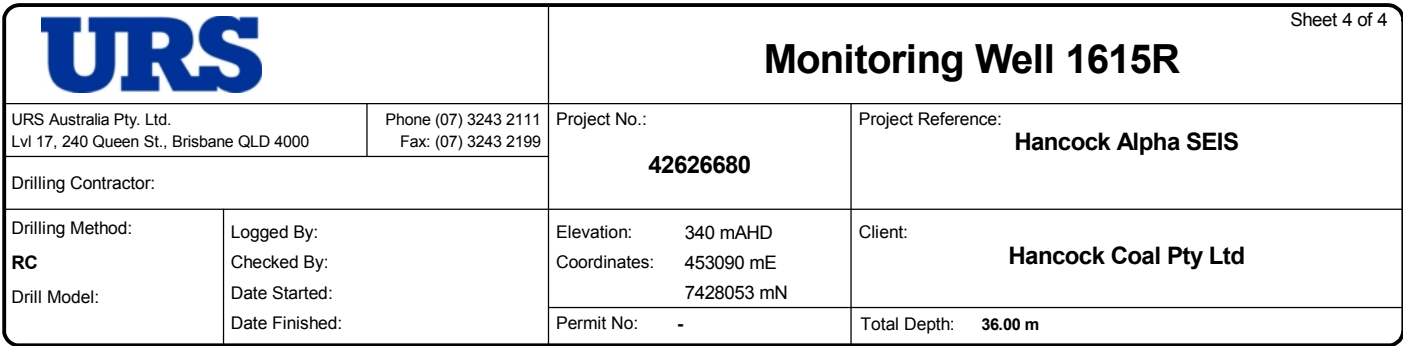
SAMPLING DETAILS				WELL CONSTRUCTION DETAILS		DESCRIPTION OF STRATA									
Sample Type	Sampling and Observations	PID (ppm)			Elevation (mAHD)	Legend	Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Plasticity	Moisture	Classification
					330		sorted, rounded, highly weathered.	VSo							
					329		SAND - light, yellow, sparse clayey throughout, very soft strength, highly weathered.	VL			R	W			
					328		SAND - light, orangey, yellow, sparse clayey throughout, very loose strength, well sorted, rounded, highly weathered.								
					327		SAND - dark, orange, sparse clayey throughout, very loose strength, well sorted, rounded, highly weathered.	VL			R	W			
					326										
					325										
					324										
					323										
					322		SAND - dark, yellow, sparse clayey throughout, very loose strength, well sorted, rounded, highly weathered.	VL			R	W			
					321										

50 mm UPVC  
Class 18  
Standpipe in  
Cement Grout

REMARKS:

[illegible]

REMARKS:



SAMPLING DETAILS				WELL CONSTRUCTION DETAILS		DESCRIPTION OF STRATA									
Sample Type	Sampling and Observations	PID (ppm)			Elevation (mAHD)	Legend	Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Plasticity	Moisture	Classification
					310		CLAYSTONE - dark, orangey, yellow, abundant sandy throughout, very soft strength, highly weathered.	VSo							
					309										
					308										
					307		SANDSTONE - dark, yellow, fine to medium, abundant sandy throughout, low strength, moderately sorted, rounded, moderately weathered, sporadic Qtz fragments.			F-M	R	M			
					306										
					305										
					304		Base of Well								
					303										
					302										
					301										

REMARKS:



**Monitoring Well 1614R**URS Australia Pty. Ltd.  
Lvl 17, 240 Queen St., Brisbane QLD 4000Phone (07) 3243 2111  
Fax: (07) 3243 2199

Project No.:

**42626680**

Project Reference:

**Hancock Alpha SEIS**

Drilling Contractor:

Drilling Method:

**RC**

Drill Model:

Logged By:

Checked By:

Date Started:

Date Finished:

Elevation:

340 mAHD

Coordinates:

453090 mE

7428053 mN

Permit No:

-

Client:

**Hancock Coal Pty Ltd**

Total Depth:

**18.00 m**

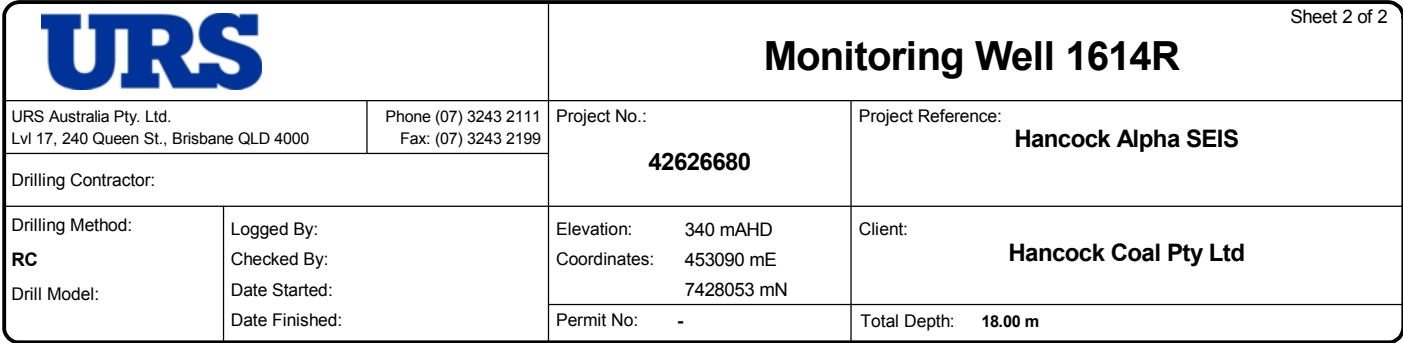
MONITORING WELL - ELEVATION (MAHD) JULY 2011.GPJ BRISBANE\_JOB\_TEMPLATE.GDT 20/9/11 This drawing is subject to COPYRIGHT. It remains the property of URS Australia Pty Ltd.

SAMPLING DETAILS				WELL CONSTRUCTION DETAILS		DESCRIPTION OF STRATA										
Sample Type	Sampling and Observations	PID (ppm)		Lockable Stand Pipe	Lockable Envirocap Stick-up 0.84m	Elevation (mAHD)	Legend	Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Plasticity	Moisture	Classification
						340		SOIL - dark, brown, low strength, highly weathered.								
						339		LATERITE - light, brownish, orange, clayey in part, low strength, well sorted, rounded, highly weathered.				R	W			
						338		LATERITE - light, whitish, pink, quartzose grains throughout, low strength, well sorted, rounded, highly weathered.				R	W			
						337		LATERITE - light, whitish, yellow, abundant clayey throughout, low strength, well sorted, rounded, highly weathered.				R	W			
						336		SAND - light, orange, abundant clayey throughout, low strength, well sorted, rounded, highly weathered.				R	W			
						335		CLAYSTONE - white, sparse sandy grains, very soft strength, highly weathered.	VSo							
						334										
						333										
						332		SAND - light, whitish, grey, very loose strength, well sorted, rounded, highly weathered.				R	W			
						331		SAND - medium, pinkish, orange, very loose strength, well				R	W			

50 mm UPVC Class 18 Standpipe in Cement Grout

50 mm UPVC Class 18 Standpipe in Bentonite Seal

REMARKS:



SAMPLING DETAILS				WELL CONSTRUCTION DETAILS		DESCRIPTION OF STRATA								
Sample Type	Sampling and Observations	PID (ppm)		Elevation (mAHD)	Legend	Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Plasticity	Moisture	Classification
				330		sorted, rounded, highly weathered.	VSo							
				329		SAND - light, yellow, sparse clayey throughout, very soft strength, highly weathered.	VL			R	W			
				328		SAND - light, orangey, yellow, sparse clayey throughout, very loose strength, well sorted, rounded, highly weathered.								
				327		SAND - dark, orange, sparse clayey throughout, very loose strength, well sorted, rounded, highly weathered.	VL			R	W			
				326										
				325										
				324										
				323										
				322		Base of Well								
				321										

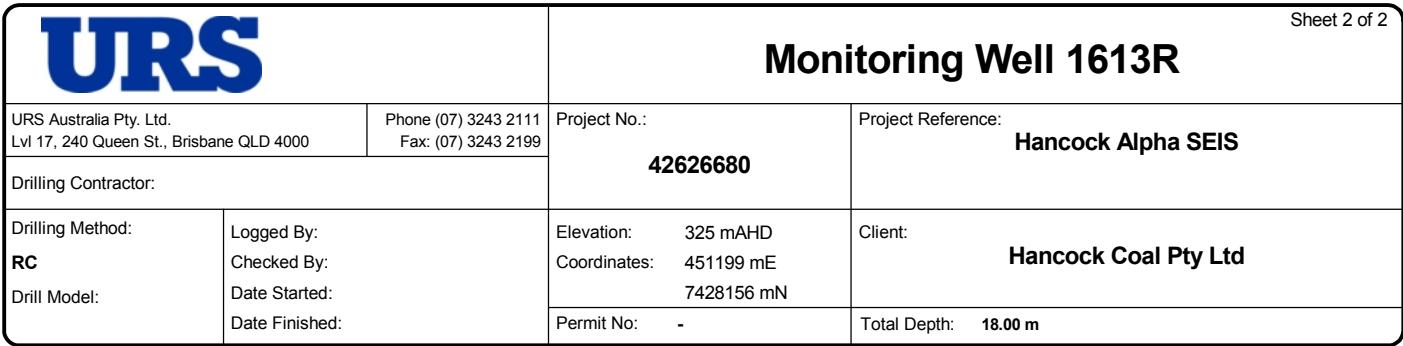
REMARKS:

## Monitoring Well 1613R

URS Australia Pty. Ltd. Lvl 17, 240 Queen St., Brisbane QLD 4000		Phone (07) 3243 2111 Fax: (07) 3243 2199	Project No.: <b>42626680</b>	Project Reference: <b>Hancock Alpha SEIS</b>
Drilling Contractor:				
Drilling Method: <b>RC</b>	Logged By:	Checked By:	Elevation: 325 mAHD Coordinates: 451199 mE 7428156 mN	Client: <b>Hancock Coal Pty Ltd</b>
Drill Model:	Date Started:	Date Finished:	Permit No: -	Total Depth: <b>18.00 m</b>

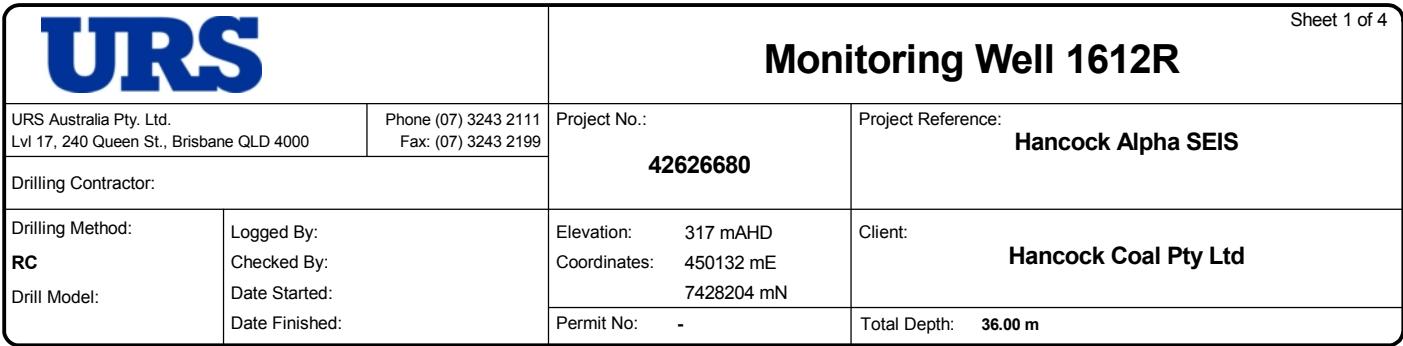
SAMPLING DETAILS			WELL CONSTRUCTION DETAILS		DESCRIPTION OF STRATA										
Sample Type	Sampling and Observations	PID (ppm)	Lockable Stand Pipe	Lockable Envirocap Stick-up 0.86m	Elevation (mAHD)	Legend	Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Plasticity	Moisture	Classification
					325		SOIL - medium, brown, clayey, friable, soft, completely weathered.	Fr, So							
					324										
					323		SAND - medium, creamy, brown, clayey in part, loose mechanical state, dense, completely weathered.	De							
					322										
					321		LATERITE - variegated, creamy, white, iron oxide stains in part, brittle, medium, completely weathered.	Br							
					320										
					319										
					318		LATERITE - variegated, whitish, red, iron oxide stains throughout, brittle, medium, completely weathered.	Br							
					317		LATERITE - variegated, reddish, white, iron oxide stains throughout, brittle, medium, completely weathered.	Br							
					316										

REMARKS:

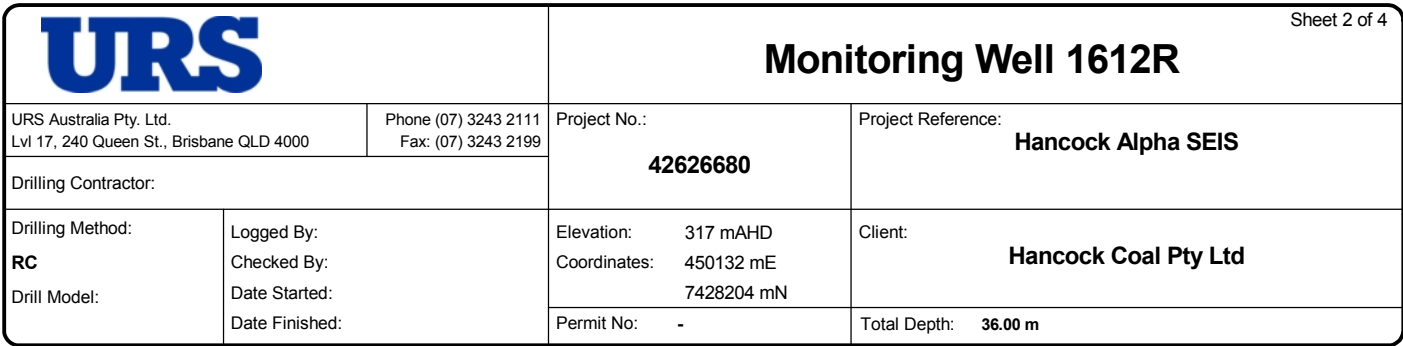
[illegible]

MONITORING WELL - ELEVATION (MAHD) JULY 2011.GPJ BRISBANE\_JOB\_TEMPLATE.GDT 20/9/11 This drawing is subject to COPYRIGHT. It remains the property of URS Australia Pty Ltd.

REMARKS:



SAMPLING DETAILS			WELL CONSTRUCTION DETAILS		DESCRIPTION OF STRATA										
Sample Type	Sampling and Observations	PID (ppm)	<div><div>Lockable Stand Pipe</div><div>Lockable Envirocap Stick-up 0.80m</div></div>		Elevation (mAHD)	Legend	Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Plasticity	Moisture	Classification
					317		SOIL - medium, creamy, brown, sandy, loose mechanical state, dense, completely weathered.	De							
					316		SAND - medium, creamy, brown, loose mechanical state, loose, completely weathered.	Lo							
					315										
					314										
					313										
					312										
					311		LATERITE - variegated, reddish, white, sandy throughout, loose mechanical state, very dense, completely weathered.	VD							
					310										
					309										
					308										
REMARKS:															



REMARKS:

MONITORING WELL - ELEVATION (MAHD) JULY 2011.GPJ BRISBANE\_JOB\_TEMPLATE.GDT 20/9/11 This drawing is subject to COPYRIGHT. It remains the property of URS Australia Pty Ltd.



**Monitoring Well 1612R**URS Australia Pty. Ltd.  
Lvl 17, 240 Queen St., Brisbane QLD 4000Phone (07) 3243 2111  
Fax: (07) 3243 2199

Project No.:

**42626680**

Project Reference:

**Hancock Alpha SEIS**

Drilling Contractor:

Drilling Method:

**RC**

Drill Model:

Logged By:

Checked By:

Date Started:

Date Finished:

Elevation:

317 mAHD

Coordinates:

450132 mE

7428204 mN

Permit No.:

-

Client:

**Hancock Coal Pty Ltd**

Total Depth:

**36.00 m**

MONITORING WELL - ELEVATION (MAHD) JULY 2011.GPJ BRISBANE\_JOB\_TEMPLATE.GDT 20/9/11 This drawing is subject to COPYRIGHT. It remains the property of URS Australia Pty Ltd.

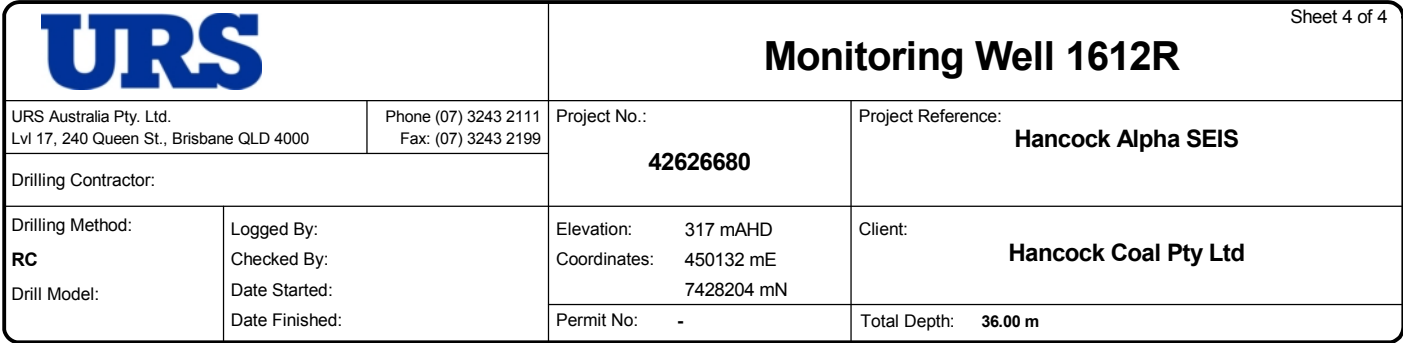
SAMPLING DETAILS			WELL CONSTRUCTION DETAILS		DESCRIPTION OF STRATA										
Sample Type	Sampling and Observations	PID (ppm)			Elevation (mAHD)	Legend	Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Plasticity	Moisture	Classification
					297		LATERITE - pale, creamy, white, iron oxide stains in part, brittle, low to completely weathered.	Br							
					296										
					295										
					294		LATERITE - variegated, yellowish, white, limonitic and iron oxide stains in part, uniform, medium, completely weathered.								
					293		LATERITE - variegated, reddish, white, iron oxide stains in part, uniform, medium, completely weathered.								
					292		SANDSTONE - variegated, reddish, grey, granular, lateritic in part, loose mechanical state, low to moderately sorted, well rounded, completely weathered.	Fr			WR	P-M			
					291		SANDSTONE - variegated, reddish, grey, granular, lateritic throughout, friable, low to completely weathered.	Br							
					290		LATERITE - variegated, reddish, grey, quartz grains throughout, brittle, low to completely weathered.	Br			WR	P-M			
					289		SANDSTONE - variegated, reddish, grey, granular, brittle, low to moderately sorted, well rounded, completely weathered.								
					288										

IWL

50 mm UPVC Class 18 Standpipe in Bentonite Seal

50 mm UPVC Class 18 Standpipe in Sand/Gravel Pack

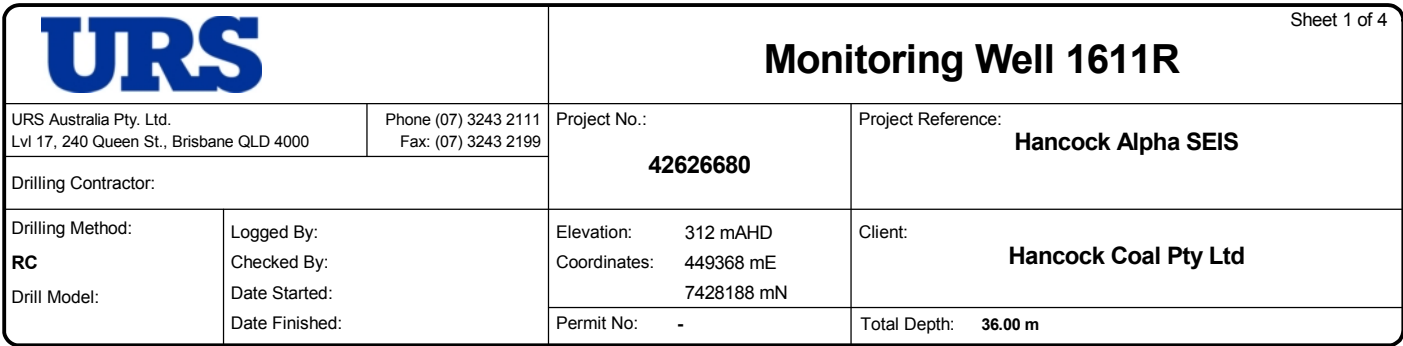
REMARKS:



SAMPLING DETAILS				WELL CONSTRUCTION DETAILS		DESCRIPTION OF STRATA									
Sample Type	Sampling and Observations	PID (ppm)			Elevation (mAHD)	Legend	Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Plasticity	Moisture	Classification
					287		SANDSTONE - variegated, reddish, grey, granular, conglomeratic, friable, low to moderately sorted, well rounded, completely weathered.	Fr			WR	P-M			
					286										
					285		CONGLOMERATE - variegated, reddish, brown, granular, iron oxide stains throughout, brittle, low to poorly sorted, angular, completely weathered.	Br			A	P			
					284		CLAYSTONE - pale, creamy, grey, waxy, low to completely weathered.								
					283										
					282		Weathered COAL - pale, creamy, black, waxy, low to completely weathered.								
					281		Base of Hole								
					280										
					279										
					278										

50 mm UPVC Class 18 Screen in Sand/Gravel Pack

End cap



REMARKS:

MONITORING WELL - ELEVATION (MAHD) JULY 2011.GPJ BRISBANE\_JOB\_TEMPLATE.GDT 20/9/11 This drawing is subject to COPYRIGHT. It remains the property of URS Australia Pty Ltd.

URS Australia Pty. Ltd.  
Lvl 17, 240 Queen St., Brisbane QLD 4000

Phone (07) 3243 2111  
Fax: (07) 3243 2199

Project No.:

Project Reference:

## Hancock Alpha SEIS

**42626680**

Drilling Contractor:

**Drilling Method:**

Logged By:

Checked By:

Date Started:

Date Finished:

Elevation:

312 mAHD

Coordinates:

449368 mE

7428188 mN

Permit No:

—

Client:

**Hancock Coal Pty Ltd**

Total Depth:

36.00 m

MONITORING WELL - ELEVATION (MAHD) JULY 2011.GPJ BRISBANE\_JOB\_TEMPLATE.GDT 20/9/11 This drawing is subject to COPYRIGHT. It remains the property of URS Australia Pty Ltd.

REMARKS:



# Monitoring Well 1611R

URS Australia Pty. Ltd.  
Lvl 17, 240 Queen St., Brisbane QLD 4000Phone (07) 3243 2111  
Fax: (07) 3243 2199

Project No.:

**42626680**

Project Reference:

**Hancock Alpha SEIS**

Drilling Contractor:

Drilling Method:

**RC**

Drill Model:

Logged By:

Checked By:

Date Started:

Date Finished:

Elevation:

312 mAHD

Coordinates:

449368 mE

7428188 mN

Client:

**Hancock Coal Pty Ltd**

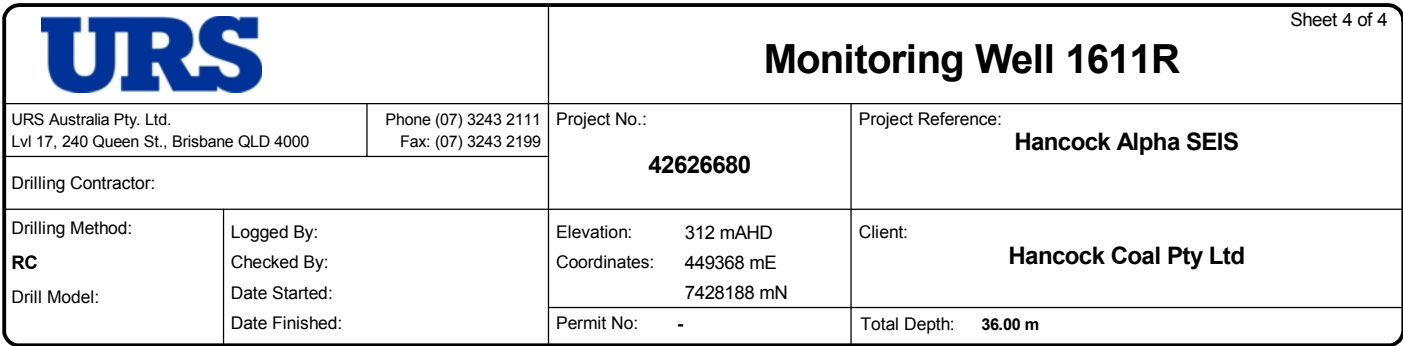
Permit No:

-

Total Depth:

**36.00 m****SAMPLING DETAILS****WELL CONSTRUCTION DETAILS****DESCRIPTION OF STRATA**

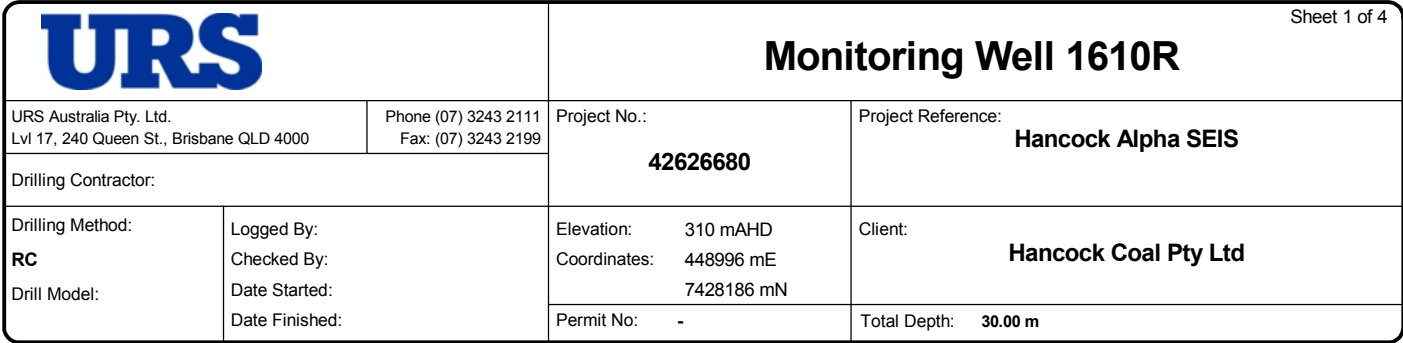
Sample Type	Sampling and Observations	PID (ppm)		Elevation (mA)	Legend	Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Plasticity	Moisture	Classification
				292										
				291										
				290										
				289										
				288		LATERITE - variegated, reddish, white, iron oxide stains throughout, limonitic throughout, clayey throughout, partly puggy, low to completely weathered.								
				287										
				286										
				285										
				284		LATERITE - variegated, reddish, white, limonitic in part, iron oxide stains in part, brittle, low to completely weathered.	Br							
				283										



SAMPLING DETAILS			WELL CONSTRUCTION DETAILS		DESCRIPTION OF STRATA									
Sample Type	Sampling and Observations	PID (ppm)		Elevation (mAHD)	Legend	Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Plasticity	Moisture	Classification
				282										
				281										
				280		SANDSTONE - variegated, yellowish, grey, granular, limonitic near top of unit, iron oxide stains throughout, loose mechanical state,				R	P-W			
			IWL →	279		low to well sorted, rounded, completely weathered.				R	P-W			
			→ 50 mm UPVC Class 18 Screen in Sand/Gravel Pack	278		SANDSTONE - variegated, reddish, white, granular, iron oxide stains throughout, loose mechanical state, low to well sorted, rounded, completely weathered.								
				277		LATERITE - variegated, reddish, white, clayey throughout, partly puggy, low to completely weathered.								
			End cap	276		Base of Hole								
				275										
				274										
				273										

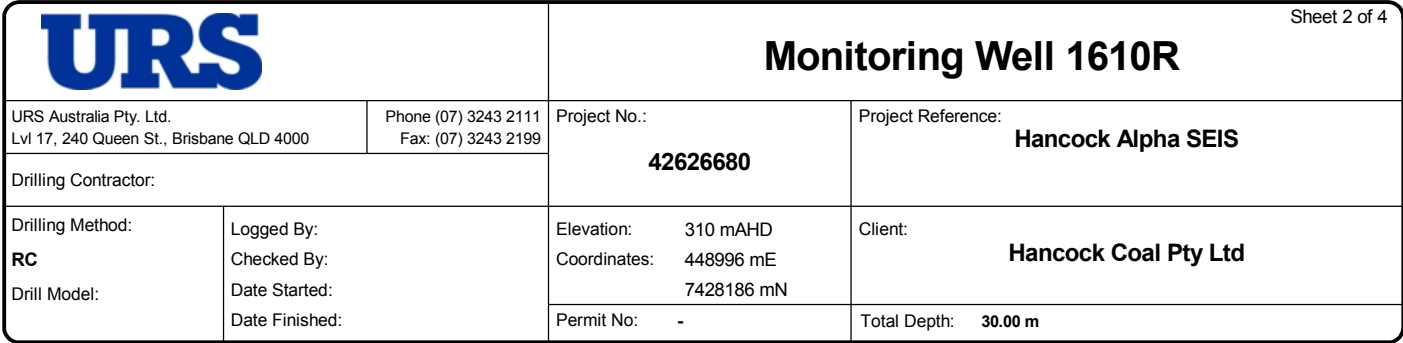
REMARKS:



[illegible]

MONITORING WELL - ELEVATION (MAHD) JULY 2011.GPJ BRISBANE\_JOB\_TEMPLATE.GDT 20/9/11 This drawing is subject to COPYRIGHT. It remains the property of URS Australia Pty Ltd.

REMARKS:



SAMPLING DETAILS				WELL CONSTRUCTION DETAILS		DESCRIPTION OF STRATA									
Sample Type	Sampling and Observations	PID (ppm)			Elevation (mAHD)	Legend	Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Plasticity	Moisture	Classification
					300		SAND - pale, creamy, brown, clayey in part, loose mechanical state, medium dense, completely weathered.	MD							
					299										
					298		SAND - medium, creamy, brown, clayey throughout, loose mechanical state, dense, completely weathered.	De							
					297		CLAY - pale, creamy, white, lithic labile throughout, puggy, soft, completely weathered.	So							
					296										
					295										
					294										
					293										
					292										
					291										

REMARKS:

URS Australia Pty. Ltd.  
Lvl 17, 240 Queen St., Brisbane QLD 4000

Project No.: **42626680**

Project Reference: **Hancock Alpha SEIS**

**Drilling Method:**

Logged By:

RC

Checked By:

**Drill Model:**

Date Started:

Date Finished:

Elevation: 310 mAHD  
Coordinates: 448996 mE  
7428186 mN

Client: **Hancock Coal Pty Ltd**

Permit No: -	Total Depth: 30.00 m
--------------	----------------------

SAMPLING DETAILS				WELL CONSTRUCTION DETAILS		DESCRIPTION OF STRATA									
Sample Type	Sampling and Observations	PID (ppm)			Elevation (mAHD)	Legend	Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Plasticity	Moisture	Classification
					290		LATERITE - variegated, reddish, white, rare clayey iron oxide stains, brittle, low to completely weathered.	Br							
					289										
					288										
					287										
					286										
					285										
					284		CLAY - variegated, yellowish, white, limonitic throughout clayey in part, brittle, low to completely weathered.	Br							
					283										
					282										
					281										

REMARKS:



# Monitoring Well 1610R

URS Australia Pty. Ltd.  
Lvl 17, 240 Queen St., Brisbane QLD 4000Phone (07) 3243 2111  
Fax: (07) 3243 2199

Project No.:

**42626680**

Project Reference:

**Hancock Alpha SEIS**

Drilling Contractor:

Drilling Method:

**RC**

Drill Model:

Logged By:

Checked By:

Date Started:

Date Finished:

Elevation:

310 mAHD

Coordinates:

448996 mE

7428186 mN

Client:

**Hancock Coal Pty Ltd**

Permit No:

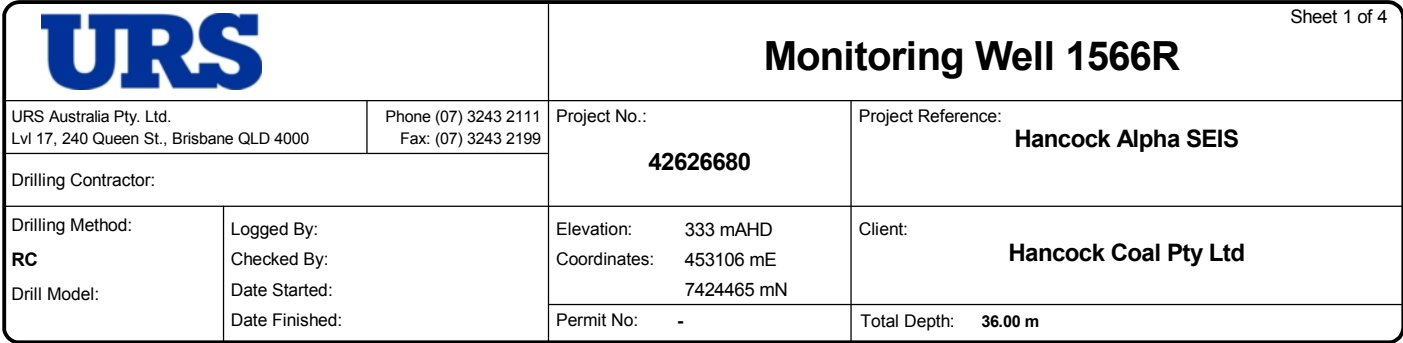
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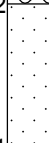
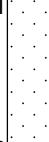
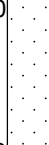
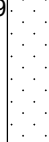
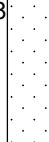
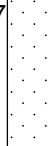
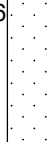
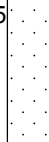
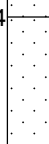
Total Depth:

**30.00 m****SAMPLING DETAILS****WELL CONSTRUCTION DETAILS****DESCRIPTION OF STRATA**

Sample Type	Sampling and Observations	PID (ppm)	Elevation (mAHD)	Legend	Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Plasticity	Moisture	Classification
			280		Base of Well								
			279										
			278										
			277										
			276										
			275										
			274										
			273										
			272										
			271										

**REMARKS:**



SAMPLING DETAILS				WELL CONSTRUCTION DETAILS		Elevation (mAHD)	DESCRIPTION OF STRATA									
Sample Type	Sampling and Observations	PID (ppm)		Lockable Stand Pipe	Lockable Envirocap Stick-up 0.82m		Legend	Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Plasticity	Moisture	Classification
						333		SOIL - dark, brownish, red, low strength, highly weathered.								
						332		SAND - dark, brownish, orange, abundant clayey throughout, very loose strength, well sorted, rounded, highly weathered.	VL	G		R	W			
						331										
						330										
						329										
						328										
						327										
						326										
						325										
						324		SAND - dark, brownish, red, sandstone increased abundance near base of unit, very loose strength, well sorted, rounded,	VL	G		R	W			

**REMARKS:** IWL: Initial Water Level    SWL: Standing Water Level



# Monitoring Well 1566R

URS Australia Pty. Ltd.  
Lvl 17, 240 Queen St., Brisbane QLD 4000Phone (07) 3243 2111  
Fax: (07) 3243 2199

Project No.:

**42626680**

Project Reference:

**Hancock Alpha SEIS**

Drilling Contractor:

Drilling Method:

**RC**

Drill Model:

Logged By:

Checked By:

Date Started:

Date Finished:

Elevation:

333 mAHD

Coordinates:

453106 mE

7424465 mN

Client:

**Hancock Coal Pty Ltd**

Permit No:

-

Total Depth:

**36.00 m****SAMPLING DETAILS****WELL CONSTRUCTION DETAILS****DESCRIPTION OF STRATA**

Sample Type	Sampling and Observations	PID (ppm)			Elevation (mAHD)	Legend	Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Plasticity	Moisture	Classification
					323		highly weathered, common Qtz fragments.								
					322										
					321										
					320										
					319										
					318										
					317										
					316										
					315		SAND - dark, brownish, red, sparse sandstone fragments, very loose strength, moderately sorted, sub angular, highly weathered, common Qtz fragments.	VL	G		SA	M			
					314		SAND - medium, brownish, red, abundant quartz fragments, very loose strength.	VL	G		SA	M			

**REMARKS:**



**Monitoring Well 1566R**URS Australia Pty. Ltd.  
Lvl 17, 240 Queen St., Brisbane QLD 4000Phone (07) 3243 2111  
Fax: (07) 3243 2199

Project No.:

**42626680**

Project Reference:

**Hancock Alpha SEIS**

Drilling Contractor:

Drilling Method:

**RC**

Drill Model:

Logged By:

Checked By:

Date Started:

Date Finished:

Elevation:

333 mAHD

Coordinates:

453106 mE

7424465 mN

Permit No.:

-

Client:

**Hancock Coal Pty Ltd**

Total Depth:

**36.00 m**

MONITORING WELL - ELEVATION (MAHD) JULY 2011.GPJ BRISBANE\_JOB\_TEMPLATE.GDT 20/9/11 This drawing is subject to COPYRIGHT. It remains the property of URS Australia Pty Ltd.

SAMPLING DETAILS				WELL CONSTRUCTION DETAILS		DESCRIPTION OF STRATA									
Sample Type	Sampling and Observations	PID (ppm)			Elevation (mAHD)	Legend	Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Plasticity	Moisture	Classification
					313		moderately sorted, sub angular, highly weathered.								
					312		PEBBLE CONGLOMERATE - medium, reddish, brown, bimodal sorting, highly weathered, abundant Qtz fragments.					B			
					311										
					310										
					309										
					308										
					307										
					306		CONGLOMERATE - medium, reddish, brown, bimodal sorting, rounded, highly weathered.				R	B			
					305		PEBBLE CONGLOMERATE medium, reddish, brown, bimodal sorting, highly weathered, abundant Qtz fragments.					B			
					304										

50 mm UPVC Class 18 Standpipe in Bentonite Seal

50 mm UPVC Class 18 Standpipe in Sand/Gravel Pack

REMARKS:



# Monitoring Well 1566R

URS Australia Pty. Ltd.  
Lvl 17, 240 Queen St., Brisbane QLD 4000Phone (07) 3243 2111  
Fax: (07) 3243 2199

Project No.:

**42626680**

Project Reference:

**Hancock Alpha SEIS**

Drilling Contractor:

Drilling Method:

**RC**

Drill Model:

Logged By:

Checked By:

Date Started:

Date Finished:

Elevation:

333 mAHD

Coordinates:

453106 mE

7424465 mN

Client:

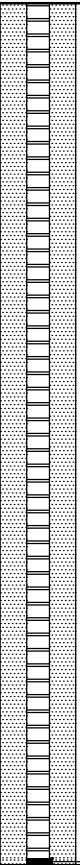
**Hancock Coal Pty Ltd**

Permit No:

-

Total Depth:

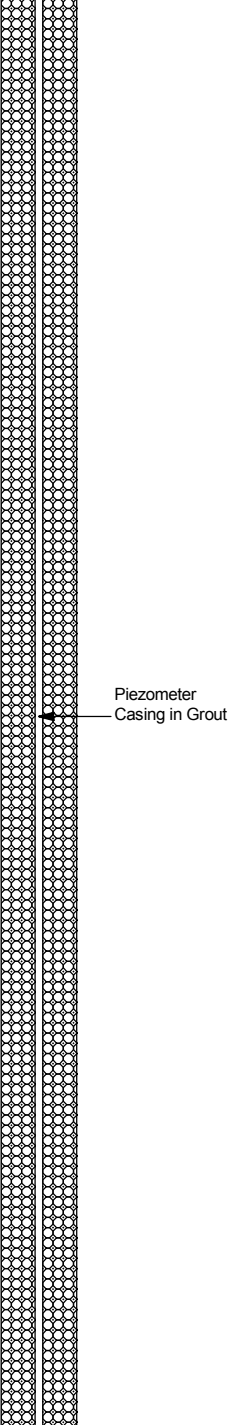















**36.00 m****SAMPLING DETAILS****WELL CONSTRUCTION DETAILS****DESCRIPTION OF STRATA**

Sample Type	Sampling and Observations	PID (ppm)			Elevation (mAHD)	Legend	Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Plasticity	Moisture	Classification
					303		CONGLOMERATE - medium, reddish, brown, abundant tuffaceous throughout, bimodal sorting, highly weathered.					B			
					302										
					301										
					300										
					299										
					298										
					297										
					297		Base of Hole								
					296										
					295										
					294										

**REMARKS:**

## VWP Piezometer 1565R

URS Australia Pty. Ltd. Lvl 17, 240 Queen St., Brisbane QLD 4000		Phone (07) 3243 2111 Fax: (07) 3243 2199	Project No.: <b>42626680</b>	Project Reference: <b>Hancock Alpha SEIS</b>
Drilling Contractor: <b>Salva Resources</b>				
Drilling Method: <b>RC</b>	Logged By:	Checked By:	Elevation: 340 mAHD Coordinates: 453090 mE 7428053 mN	Client: <b>Hancock Coal Pty Ltd</b>
Drill Model:	Date Started:	Date Finished:	Permit No: -	Total Depth: <b>72.00 m</b>

OBSERVATIONS / DETAILS		WELL CONSTRUCTION DETAILS		DESCRIPTION OF STRATA										
Sample Type	Comments			Depth (mbgl)	Legend	Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Weathering	Moisture	Classification
				0		SOIL - dark, brown, low strength, highly weathered.						HW		
				1		LATERITE - light, brownish, orange, clayey in part, low strength, well sorted, rounded, highly weathered.				R	W	HW		
				2		LATERITE - light, whitish, pink, quartzose grains throughout, low strength, well sorted, rounded, highly weathered.				R	W	HW		
				3		LATERITE - light, whitish, yellow, abundant clayey throughout, low strength, well sorted, rounded, highly weathered.				R	W	HW		
				4		LATERITE - light, whitish, yellow, abundant clayey throughout, low strength, well sorted, rounded, highly weathered.	Low			R	W	HW		
				5		SAND - light, orange, abundant clayey throughout, low strength, well sorted, rounded, highly weathered.	VSo					HW		
				6		SAND - light, orange, abundant clayey throughout, low strength, well sorted, rounded, highly weathered.								
				7		CLAYSTONE - white, sparse sandy grains, very soft strength, highly weathered.								
				8		SAND - light, whitish, grey, very loose strength, well sorted, rounded, highly weathered.	VL			R	W	HW		
				9										
				10		SAND - medium, pinkish, orange, very loose strength, well sorted, rounded, highly weathered.	VL			R	W	HW		
				11		SAND - light, yellow, sparse clayey throughout, very soft strength, highly weathered.	VSo					HW		
				12		SAND - light, orangey, yellow, sparse clayey throughout, very loose strength, well sorted, rounded, highly weathered.	VL			R	W	HW		
				13		SAND - light, orangey, yellow, sparse clayey throughout, very loose strength, well sorted, rounded, highly weathered.	VL			R	W	HW		
				14		SAND - dark, orange, sparse clayey throughout, very loose strength, well sorted, rounded, highly weathered.								

REMARKS:

**VWP Piezometer 1565R**URS Australia Pty. Ltd.  
Lvl 17, 240 Queen St., Brisbane QLD 4000Phone (07) 3243 2111  
Fax: (07) 3243 2199

Project No.:

**42626680**

Project Reference:

**Hancock Alpha SEIS**Drilling Contractor: **Salva Resources**Drilling Method:  
**RC**

Logged By:

Checked By:

Drill Model:

Date Started:

Date Finished:

Elevation:

340 mAHD

Coordinates:

453090 mE

7428053 mN

Client:

**Hancock Coal Pty Ltd**

Permit No:

-

Total Depth:

**72.00 m****OBSERVATIONS /  
DETAILS****WELL CONSTRUCTION DETAILS****DESCRIPTION OF STRATA**

Sample Type

Comments

Depth (mbgl)

Legend

Lithology

Consistency

Structure

Grain Size

Shape

Sorting

Weathering

Moisture

Classification

15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29SAND - dark, yellow,  
sparse clayey  
throughout, very  
loose strength, well  
sorted, rounded,  
highly weathered.

VL

R

W

HW

CLAYSTONE - pale,  
whitish, yellow,  
abundant sandy  
throughout, very soft  
strength, highly  
weathered.

VSo

HW

SAND - dark,  
orangey, yellow,  
sparse clayey  
throughout, very  
loose strength, well  
sorted, rounded,  
highly weathered.

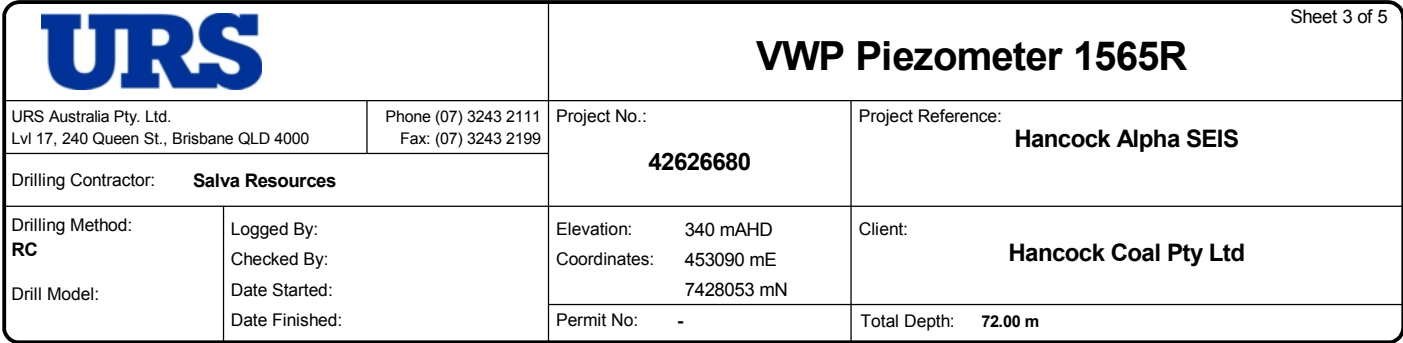
VL

R

W

HW

Piezometer  
Casing in Grout**REMARKS:**



# VWP Piezometer 1565R

Project No.: **42626680**

Drilling Contractor: **Salva Resources**

Drilling Method: <b>RC</b>	Logged By:
	Checked By:
Drill Model:	Date Started:
	Date Finished:

Elevation: 340 mAHD  
Coordinates: 453090 mE  
7428053 mN

Client: **Hancock Coal Pty Ltd**

Permit No: -	Total Depth: 72.00 m
--------------	----------------------

OBSERVATIONS / DETAILS		WELL CONSTRUCTION DETAILS		DESCRIPTION OF STRATA										
Sample Type	Comments			Depth (mbgl)	Legend	Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Weathering	Moisture	Classification
				30		CLAYSTONE - dark, orangey, yellow, abundant sandy throughout, very soft strength, highly weathered.	VSo					HW		
				31										
				32										
				33		SANDSTONE - dark, yellow, fine to medium, abundant sandy throughout, low strength, moderately sorted, rounded, moderately weathered, sporadic Qtz fragments.	Low		F-M	R	M	MW		
				34										
				35										
				36		SANDSTONE - dark, yellow, fine to medium, abundant sandy throughout, low strength, moderately sorted, sub rounded, moderately weathered, abundant Quartz fragments.	Low		F-M	SR	M	MW		
				37										
				38										
				39		CLAYSTONE - dark, yellow, friable, slightly weathered.	Fr					SW		
				40		SANDSTONE - dark, brownish, red, medium, poorly sorted, sub angular, slightly weathered, abundant Quartz fragments.			M	SA	P	SW		
				41			Med		F-M	SR	M	FR		
				42		SANDSTONE - dark, greenish, grey, fine to medium, medium strength, moderately sorted, sub rounded, fresh, mica, granules.	High		F-M	R	W	FR		
				43						SR	P	FR		
				44		SANDSTONE - dark, greenish, grey, fine to medium, abundant micaceous throughout, high strength, well sorted, rounded, fresh.	High							
						CONGLOMERATE - dark, greenish, grey,								

REMARKS:

WVP PIEZOMETER JULY 2011.GPJ BRISBANE JOB TEMPLATE.GDT 27/9/11 This drawing is subject to COPYRIGHT. It remains the property of URS Australia Pty Ltd.

URS Australia Pty. Ltd. Lvl 17, 240 Queen St., Brisbane QLD 4000	Phone (07) 3243 2111 Fax: (07) 3243 2199
---	---

Project Reference: **Hancock Alpha SEIS**

Permit No: -	Total Depth: 72.00 m
--------------	----------------------

REMARKS:



**VWP Piezometer 1565R**URS Australia Pty. Ltd.  
Lvl 17, 240 Queen St., Brisbane QLD 4000Phone (07) 3243 2111  
Fax: (07) 3243 2199

Project No.:

**42626680**

Project Reference:

**Hancock Alpha SEIS**Drilling Contractor: **Salva Resources**Drilling Method:  
**RC**

Logged By:

Checked By:

Drill Model:

Date Started:

Date Finished:

Elevation:

340 mAHD

Coordinates:

453090 mE

7428053 mN

Client:

**Hancock Coal Pty Ltd**

Permit No:

-

Total Depth:

**72.00 m****OBSERVATIONS /  
DETAILS****WELL CONSTRUCTION DETAILS****DESCRIPTION OF STRATA**

Sample Type

Comments

Depth (mbgl)

Legend

Lithology

Consistency

Structure

Grain Size

Shape

Sorting

Weathering

Moisture

Classification

60

61

62

63

64

65

66

67

68

69

70

71

72

73

74

SANDSTONE - light,  
grey, fine to  
medium, abundant  
micaceous  
throughout, medium  
strength, well sorted,  
well rounded, fresh.

Med

F-M

WR

W

FR

SANDSTONE - light,  
grey, fine, abundant  
micaceous  
throughout, medium  
strength, well sorted,  
well rounded, fresh.

Med

F

WR

W

FR

CONGLOMERATE -  
poorly sorted,  
angular, abundant  
chlorite fragments.

A

P

End of Hole

Grout fill

**REMARKS:**

## VWP Piezometer 1564R

URS Australia Pty. Ltd. Lvl 17, 240 Queen St., Brisbane QLD 4000		Phone (07) 3243 2111 Fax: (07) 3243 2199	Project No.: <b>42626680</b>	Project Reference: <b>Hancock Alpha SEIS</b>
Drilling Contractor: <b>Salva Resources</b>				
Drilling Method: <b>RC</b>	Logged By:	Checked By:	Elevation: 314.5 mAH Coordinates: 448357 mE 7423195 mN	Client: <b>Hancock Coal Pty Ltd</b>
Drill Model:	Date Started:	Date Finished:	Permit No: -	Total Depth: <b>102.00 m</b>

OBSERVATIONS / DETAILS		WELL CONSTRUCTION DETAILS		DESCRIPTION OF STRATA											
Sample Type	Comments	<div><div></div><div>Envirocap</div></div>		Depth (mbgl)	Legend	Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Weathering	Moisture	Classification	
	Base of Tertiary	<div><div></div><div>Piezometer Casing in Grout</div></div>		0	<div></div>	SOIL - dark, brown, clayey in part, friable, very loose, completely weathered.	Fr - VL						CW		
				1											
				2	<div></div>	CLAY - light, brown, sandy in part, waxy, very soft, completely weathered.	VSo						CW		
				3											
				4		SAND - light, orangy, brown, medium, clayey throughout, loose mechanical state, very loose, moderately sorted, sub angular, completely weathered.	VL			SA	M	CW			
				5											
				6											
				7	<div></div>	CLAY - light, creamy, brown, sandy throughout quartz grains throughout, waxy, very soft, completely weathered.	VSo						CW		
				8											
				9											
				10											
				11	<div></div>	CLAY - light, creamy, brown, lateritic occasional quartz grains throughout, waxy, very soft, completely weathered.	VSo						CW		
				12											
				13											
	14														
REMARKS:															

REMARKS:

**VWP Piezometer 1564R**URS Australia Pty. Ltd.  
Lvl 17, 240 Queen St., Brisbane QLD 4000Phone (07) 3243 2111  
Fax: (07) 3243 2199

Project No.:

**42626680**

Project Reference:

**Hancock Alpha SEIS**Drilling Contractor: **Salva Resources**Drilling Method:  
**RC**

Logged By:

Checked By:

Drill Model:

Date Started:

Date Finished:

Elevation:

314.5 mAHd

Coordinates:

448357 mE

7423195 mN

Client:

**Hancock Coal Pty Ltd**

Permit No:

-

Total Depth:

**102.00 m****OBSERVATIONS /  
DETAILS****WELL CONSTRUCTION DETAILS****DESCRIPTION OF STRATA**

Sample Type

Comments

Depth (mbgl)

Legend

Lithology

Consistency

Structure

Grain Size

Shape

Sorting

Weathering

Moisture

Classification

Likely D seam

Piezometer  
Casing in GroutWeathered COAL -  
light, reddish, brown,  
clayey throughout,  
waxy, very soft,  
completely  
weathered.

VSo

CW

**REMARKS:**

URS Australia Pty. Ltd.  
Lvl 17, 240 Queen St., Brisbane QLD 4000

Project No.: **42626680**







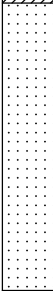











Project Reference: **Hancock Alpha SEIS**

Drilling Method:  
**RC**

Elevation: 314.5 mAHd  
Coordinates: 448357 mE  
7423195 mN






Client: **Hancock Coal Pty Ltd**

Permit No: -	Total Depth: 102.00 m
--------------	-----------------------

OBSERVATIONS / DETAILS		WELL CONSTRUCTION DETAILS		DESCRIPTION OF STRATA										
Sample Type	Comments			Depth (mbgl)	Legend	Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Weathering	Moisture	Classification
				30										
				31										
				32										
				33										
				34										
				34		CLAY - light, pinkish, brown, quartz throughout, waxy, very soft, completely weathered.	VSo					CW		
	E sands			35		SANDSTONE - light, creamy, brown, coarse, clayey matrix, medium, moderately sorted, sub angular, slightly weathered.	Med		C	SA	M	SW		
				36										
				37										
			Piezometer Casing in Grout	37										
	Base of Weathering			38										
				38		GRAVEL - light, creamy, white, pebbly, quartz grains throughout, loose mechanical state, low to moderately sorted, sub angular, slightly weathered.	Lo			SA	P-M	SW		
				39										
				40										
				41										
				42										
				43										
				44										
REMARKS:														

# VWP Piezometer 1564R

URS Australia Pty. Ltd. Lvl 17, 240 Queen St., Brisbane QLD 4000		Phone (07) 3243 2111 Fax: (07) 3243 2199	Project No.: <b>42626680</b>	Project Reference: <b>Hancock Alpha SEIS</b>
Drilling Contractor: <b>Salva Resources</b>				
Drilling Method: <b>RC</b>	Logged By:	Checked By:	Elevation: 314.5 mAH Coordinates: 448357 mE 7423195 mN	Client: <b>Hancock Coal Pty Ltd</b>
Drill Model:	Date Started:	Date Finished:	Permit No: -	Total Depth: <b>102.00 m</b>

OBSERVATIONS / DETAILS		WELL CONSTRUCTION DETAILS		DESCRIPTION OF STRATA										
Sample Type	Comments			Depth (mbgl)	Legend	Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Weathering	Moisture	Classification
				45		SANDSTONE - light, creamy, white, fine, minor clayey throughout, medium, moderately sorted, angular, fresh.	Med		F	A	M	FR		
				46										
				47										
				48		CONGLOMERATE - light, whitish, cream, granular, clayey in part, loose mechanical state, low, poorly sorted, sub angular, fresh.	Lo			SA	P	FR		
				49										
				50		SANDSTONE - light, orangy, brown, fine to medium, quartz grains throughout, medium, moderately sorted, angular, fresh.	Med		F-M	A	M	FR		
				51		CLAYSTONE - white, occasional quartz grains throughout, waxy, low, fresh.						FR		
				52		SANDSTONE - light, orangy, brown, fine to medium, quartz grains throughout, medium, well sorted, sub angular, fresh.	Med		F-M	SA	W	FR		
				53		CLAYSTONE - white, occasional quartz grains throughout, waxy, low, fresh.						FR		
				54		CLAYSTONE - medium, orangy, brown, sandy in part, Ferruginous throughout, waxy, low, fresh.	Med					FR		
				55										
				56										
	Casing set here due to loose fresh rock above			57		SANDSTONE - light, orangy, brown, fine to medium, silty clasts throughout clayey in part, uniform, medium, well sorted, sub rounded, fresh.	Med		F-M	SR	W	FR		
				58										
				59										

Piezometer Casing in Grout

Casing set here due to loose fresh rock above

REMARKS:

URS Australia Pty. Ltd.  
Lvl 17, 240 Queen St., Brisbane QLD 4000

Phone (07) 3243 2111  
Fax: (07) 3243 2199

Project No.:

Project Reference:

## Hancock Alpha SEIS

Drilling Contractor: **Salva Resources**

**42626680**

Drilling Method:  
**RC**

Logged By:

Checked By:

Elevation: 314.5 mAHD

Client:

**Hancock Coal Pty Ltd**

### Drill Model:

Date Started:

7423195 mN

Permit No: -

Total Depth: 102.00 m

OBSERVATIONS / DETAILS		WELL CONSTRUCTION DETAILS		DESCRIPTION OF STRATA										
Sample Type	Comments			Depth (mbgl)	Legend	Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Weathering	Moisture	Classification
				60										
				61										
				62										
				63										
				64										
				65										
				66										
				67		CLAYSTONE - light, yellowish, brown, sandy throughout, partly puggy, soft, fresh.	So					FR		
				68		CLAY - yellowish, brown, minor sandy throughout, partly puggy, very soft, fresh.	VSo					FR		
				69										
				70		SANDSTONE - medium, brownish, grey, fine to medium, clayey throughout, uniform, low, well sorted, sub rounded, fresh.	Lo		F-M	SR	W	FR		
				71										
				72		SANDSTONE- medium, grey, medium, carbonaceous occasional throughout, uniform, low, well sorted, sub rounded, fresh.	Lo		M	SR	W	FR		
				73										
				74										

REMARKS:



**VWP Piezometer 1564R**URS Australia Pty. Ltd.  
Lvl 17, 240 Queen St., Brisbane QLD 4000Phone (07) 3243 2111  
Fax: (07) 3243 2199

Project No.:

**42626680**

Project Reference:

**Hancock Alpha SEIS**Drilling Contractor: **Salva Resources**Drilling Method:  
**RC**

Logged By:

Checked By:

Drill Model:

Date Started:

Date Finished:

Elevation: 314.5 mAHD

Coordinates: 448357 mE

7423195 mN

Client:

**Hancock Coal Pty Ltd**

Permit No: -

Total Depth: **102.00 m****OBSERVATIONS /  
DETAILS****WELL CONSTRUCTION DETAILS****DESCRIPTION OF STRATA**

Sample Type

Comments

Depth (mbgl)

Legend

Lithology

Consistency

Structure

Grain Size

Shape

Sorting

Weathering

Moisture

Classification

75

76

77

78

79

80

81

82

83

84

85

86

87

88

89

Grout fill

SANDSTONE -  
medium, bluish,  
grey, medium,  
chloritic clayey in  
part. MD,  
moderately sorted,  
sub angular, fresh.

MD

M

SA

M

FR

SANDSTONE -  
medium, bluish,  
grey, medium,  
chloritic, medium,  
moderately sorted,  
sub angular, fresh.

Med

M

SA

M

FR

**REMARKS:**

**VWP Piezometer 1564R**URS Australia Pty. Ltd.  
Lvl 17, 240 Queen St., Brisbane QLD 4000Phone (07) 3243 2111  
Fax: (07) 3243 2199

Project No.:

**42626680**

Project Reference:

**Hancock Alpha SEIS**Drilling Contractor: **Salva Resources**Drilling Method:  
**RC**

Logged By:

Checked By:

Drill Model:

Date Started:

Date Finished:

Elevation:

314.5 mAHD

Coordinates:

448357 mE

7423195 mN

Client:

**Hancock Coal Pty Ltd**

Permit No:

-

Total Depth:

**102.00 m****OBSERVATIONS /  
DETAILS****WELL CONSTRUCTION DETAILS****DESCRIPTION OF STRATA**

Sample Type

Comments

Depth (mbgl)

Legend

Lithology

Consistency

Structure

Grain Size

Shape

Sorting

Weathering

Moisture

Classification

Grout fill

SANDSTONE -  
medium, bluish,  
grey, fine to coarse,  
medium, moderately  
sorted, sub angular,  
fresh.

Med

F-C

SA

M

FR

End of Hole

**REMARKS:**

# VWP Piezometer 1563R

URS Australia Pty. Ltd. Lvl 17, 240 Queen St., Brisbane QLD 4000		Phone (07) 3243 2111 Fax: (07) 3243 2199	Project No.: <b>42626680</b>	Project Reference: <b>Hancock Alpha SEIS</b>
Drilling Contractor: <b>Salva Resources</b>				
Drilling Method: <b>RC</b>	Logged By:	Checked By:	Elevation: 328 mAHD Coordinates: 451420 mE 7424006 mN	Client: <b>Hancock Coal Pty Ltd</b>
Drill Model:	Date Started:	Date Finished:	Permit No: -	Total Depth: <b>76.00 m</b>

OBSERVATIONS / DETAILS		WELL CONSTRUCTION DETAILS		DESCRIPTION OF STRATA										
Sample Type	Comments	<div><div></div><div>Envirocap</div></div>		Depth (mbgl)	Legend	Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Weathering	Moisture	Classification
	Top of laterite	<div><div></div><div>Piezometer Casing in Grout</div></div>		0		SOIL - dark, brown, clayey in part, friable, very loose, completely weathered.	Fr - VL					CW		
1					SOIL - light, yellowish, brown, clayey in part, friable, very loose, completely weathered.	Fr - VL					CW			
2					CLAY - light, creamy, brown, minor sandy in part, loose mechanical state, very soft, completely weathered.	VSo					CW			
3					LATERITE - light, pinkish, brown, clayey throughout, waxy, very soft, completely weathered.	VSo					CW			
4					LATERITE - light, pinkish, brown, clayey throughout, waxy, very soft, completely weathered.	So					CW			
5					LATERITE - light, creamy, white, clayey throughout, waxy, soft, completely weathered.									
6					LATERITE - light, brownish, cream, Ferruginous throughout, waxy, very soft, completely weathered.	VSo					CW			
7					LATERITE - light, pinkish, cream, Ferruginous throughout, waxy, very soft, completely weathered.	VSo					CW			
8					LATERITE - light, pinkish, cream, Ferruginous throughout, waxy, very soft, completely weathered.	VSo					CW			
9					LATERITE - light, pinkish, cream, Ferruginous throughout, waxy, very soft, completely weathered.									
10					LATERITE - light, pinkish, cream, Ferruginous throughout, waxy, very soft, completely weathered.	VSo					CW			
11					LATERITE - light, pinkish, cream, Ferruginous throughout, waxy, very soft, completely weathered.	VSo					CW			
12					LATERITE - light, pinkish, cream, Ferruginous throughout, waxy, very soft, completely weathered.									
13					LATERITE - light, pinkish, cream, Ferruginous throughout, waxy, very soft, completely weathered.									
14		LATERITE - light, pinkish, cream, Ferruginous throughout, waxy, very soft, completely weathered.												

REMARKS:

**VWP Piezometer 1563R**URS Australia Pty. Ltd.  
Lvl 17, 240 Queen St., Brisbane QLD 4000Phone (07) 3243 2111  
Fax: (07) 3243 2199

Project No.:

**42626680**

Project Reference:

**Hancock Alpha SEIS**Drilling Contractor: **Salva Resources**Drilling Method:  
**RC**

Logged By:

Checked By:

Drill Model:

Date Started:

Date Finished:

Elevation:

328 mAHD

Coordinates:

451420 mE

7424006 mN

Client:

**Hancock Coal Pty Ltd**

Permit No:

-

Total Depth:

**76.00 m****OBSERVATIONS /  
DETAILS****WELL CONSTRUCTION DETAILS****DESCRIPTION OF STRATA**

Sample Type

Comments

Depth (mbgl)

Legend

Lithology

Consistency

Structure

Grain Size

Shape

Sorting

Weathering

Moisture

Classification

Base of laterite

F seam

Piezometer  
Casing in Grout15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29

LATERITE - light, brownish, cream, Ferruginous throughout, clayey throughout, waxy, very soft, completely weathered.

LATERITE - light, pinkish, cream, Ferruginous and clayey throughout, waxy, very soft, completely weathered.

LATERITE - light, creamy, pink, Ferruginous throughout, clayey, waxy, very soft, completely weathered.

SAND - light, orangy, brown, fine to medium, clayey throughout, loose mechanical state, very loose, poorly sorted, angular, moderately weathered.

Weathered COAL - dark, reddish, brown, clayey throughout, waxy, very soft, moderately weathered.

CLAY - light,

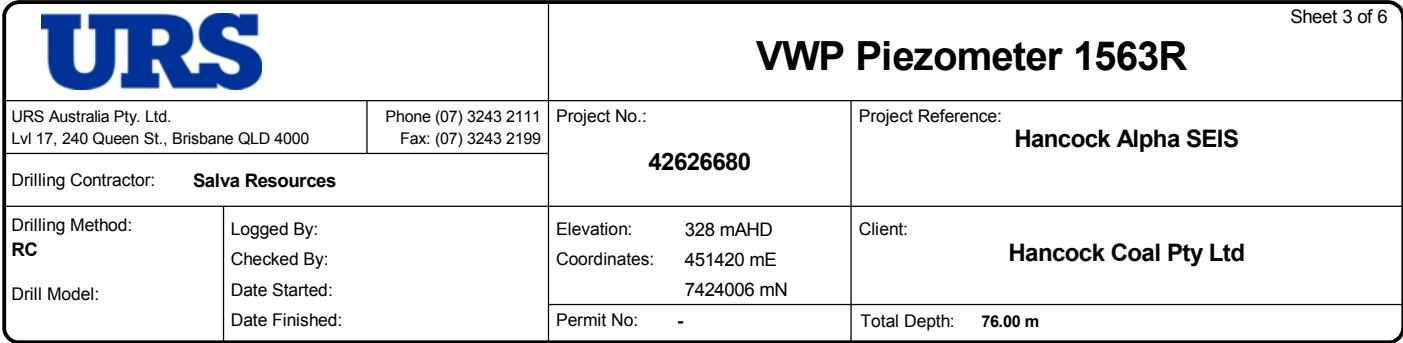
VSo  
VSo  
VSo  
VL  
VSo

F-M

A

P

CW  
CW  
CW  
MW  
MW  
MW**REMARKS:**



OBSERVATIONS / DETAILS		WELL CONSTRUCTION DETAILS		DESCRIPTION OF STRATA										
Sample Type	Comments			Depth (mbgl)	Legend	Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Weathering	Moisture	Classification
				30		creamy, grey, minor sandy throughout, waxy, low to moderately weathered.	Lo		C	SA	P-M	MW		
				31		GRAVEL - light, greyish, brown, pebbly, clayey throughout, loose mechanical state, low to moderately sorted, sub angular, moderately weathered.								
				32		GRAVEL - light, creamy, brown, clayey throughout, loose mechanical state, low, poorly sorted, sub angular, moderately weathered.	Lo			SA	P	MW		
				33		GRAVEL - light, creamy, brown, clayey throughout, loose mechanical state, low, poorly sorted, sub angular, moderately weathered.								
				34		GRAVEL - light, greyish, brown, pebbly, silty clasts quartz clasts throughout, loose mechanical state, low, moderately sorted, sub angular, moderately weathered.	Lo		C	SA	M	MW		
				35										
				36										
				37										
				38										
				39										
				40										
				41										
				42		GRAVEL - light, greyish, brown, pebbly, clayey in part, quartz granular throughout, loose mechanical state, low, moderately sorted, sub angular, moderately weathered.	Lo			SA	M	MW		
				43										
				44										

REMARKS:

**VWP Piezometer 1563R**URS Australia Pty. Ltd.  
Lvl 17, 240 Queen St., Brisbane QLD 4000Phone (07) 3243 2111  
Fax: (07) 3243 2199

Project No.:

**42626680**

Project Reference:

**Hancock Alpha SEIS**Drilling Contractor: **Salva Resources**Drilling Method:  
**RC**

Logged By:

Checked By:

Drill Model:

Date Started:

Date Finished:

Elevation:

328 mAHD

Coordinates:

451420 mE

7424006 mN

Client:

**Hancock Coal Pty Ltd**

Permit No:

-

Total Depth:

**76.00 m****OBSERVATIONS /  
DETAILS****WELL CONSTRUCTION DETAILS****DESCRIPTION OF STRATA**

Sample Type

Comments

Depth (mbgl)

Legend

Lithology

Consistency

Structure

Grain Size

Shape

Sorting

Weathering

Moisture

Classification

Set casing at 60m

Piezometer  
Casing in GroutSANDSTONE - light,  
bluish, grey, fine to  
medium, clayey in  
part, chloritic  
throughout, low,  
moderately sorted,  
sub rounded, fresh.

F-M

SR

M

FR

**REMARKS:**



**VWP Piezometer 1563R**URS Australia Pty. Ltd.  
Lvl 17, 240 Queen St., Brisbane QLD 4000Phone (07) 3243 2111  
Fax: (07) 3243 2199

Project No.:

**42626680**

Project Reference:

**Hancock Alpha SEIS**Drilling Contractor: **Salva Resources**Drilling Method:  
**RC**

Logged By:

Checked By:

Drill Model:

Date Started:

Date Finished:

Elevation: 328 mAHD  
Coordinates: 451420 mE  
7424006 mN

Client:

**Hancock Coal Pty Ltd**

Permit No: -

Total Depth: **76.00 m**

VWP PIEZOMETER JULY 2011.GPJ BRISBANE\_JOB\_TEMPLATE.GDT 27/9/11 This drawing is subject to COPYRIGHT. It remains the property of URS Australia Pty Ltd.

OBSERVATIONS / DETAILS		WELL CONSTRUCTION DETAILS		Depth (mbgl)	DESCRIPTION OF STRATA									
Sample Type	Comments				Legend	Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Weathering	Moisture	Classification
				60		SANDSTONE - light, bluish, grey, fine to medium, clayey in part chloritic, low, moderately sorted, sub angular, fresh.			F-M	SA	M	FR		
				61										
				62		CONGLOMERATE - light, bluish, grey, granular, chloritic, medium, moderately sorted, sub angular, fresh.	Med	G		SA	M	FR		
				63		CONGLOMERATE - light, brownish, grey, granular, clayey in part, chloritic, medium, moderately sorted, sub angular, fresh.	Med	G		SA	M	FR		
				64		SANDSTONE - light, reddish, brown, fine to medium, clayey in part, medium, moderately sorted, sub angular, fresh.	Med		F-M	SA	M	FR		
				65										
				66										
				67										
				68		SANDSTONE - medium, grey, fine, silty and quartz clasts throughout, loose mechanical state, low, moderately sorted, sub angular, fresh.	Lo		M	SA	M	FR		
				69										
				70										
				71										
				72										
				73										
				74										

End Of Hole. Sediments lost through the sieve as they are too fine.

Piezometer Casing in Grout

Wireline Piezometer in Grout

Grout fill

VWP-15376 @ 70m

REMARKS:

**VWP Piezometer 1563R**URS Australia Pty. Ltd.  
Lvl 17, 240 Queen St., Brisbane QLD 4000Phone (07) 3243 2111  
Fax: (07) 3243 2199

Project No.:

**42626680**

Project Reference:

**Hancock Alpha SEIS**Drilling Contractor: **Salva Resources**Drilling Method:  
**RC**

Logged By:

Checked By:

Drill Model:

Date Started:

Date Finished:

Elevation:

328 mAHD

Coordinates:

451420 mE

7424006 mN

Client:

**Hancock Coal Pty Ltd**

Permit No:

-

Total Depth:

**76.00 m****OBSERVATIONS /  
DETAILS****WELL CONSTRUCTION DETAILS****DESCRIPTION OF STRATA**

Sample Type

Comments

Depth (mbgl)

Legend

Lithology

Consistency

Structure

Grain Size

Shape

Sorting

Weathering

Moisture

Classification

75

76

77

78

79

80

81

82

83

84

85

86

87

88

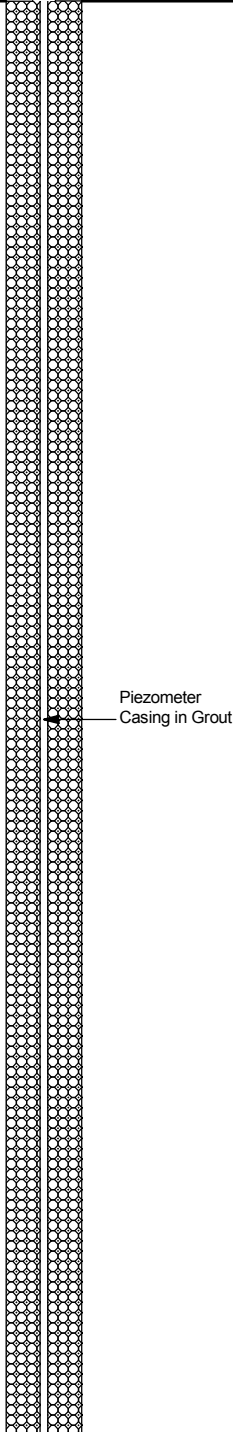
89

End of Hole

**REMARKS:**

# VWP Piezometer 1561R

URS Australia Pty. Ltd. Lvl 17, 240 Queen St., Brisbane QLD 4000		Phone (07) 3243 2111 Fax: (07) 3243 2199	Project No.: <b>42626680</b>	Project Reference: <b>Hancock Alpha SEIS</b>
Drilling Contractor: <b>Salva Resources</b>				
Drilling Method: <b>RC</b>	Logged By:	Checked By:	Elevation: 315 mAHD Coordinates: 449361 mE 7423473 mN	Client: <b>Hancock Coal Pty Ltd</b>
Drill Model:	Date Started:	Date Finished:	Permit No: -	Total Depth: <b>84.00 m</b>

OBSERVATIONS / DETAILS		WELL CONSTRUCTION DETAILS		DESCRIPTION OF STRATA											
Sample Type	Comments			Depth (mbgl)	Legend	Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Weathering	Moisture	Classification	
	Base of Tertiary			0		SOIL - medium, orangy, brown, minor clayey throughout friable, very loose, completely weathered.	Fr - VL						CW		
				1		SAND - light, brown, medium, quartz grains throughout, clayey throughout, loose mechanical state, very loose, poorly sorted, sub angular, completely weathered.	VL		M	SA	P	CW			
				2											
				3											
				4		CLAY - medium, creamy, brown, quartz grains throughout, sandy in part, partly puggy, very soft, completely weathered.	VSo						CW		
				5											
				6											
				7		CLAY - medium, reddish, cream, waxy, very soft, completely weathered.	VSo							CW	
				8											
				9		CLAY - medium, creamy, brown, waxy, very soft, fresh.	VSo							FR	
				10											
				11											
				12											
				13		CLAY - light, brownish, cream, partly puggy, soft.	So								
				14											
REMARKS:															

**VWP Piezometer 1561R**URS Australia Pty. Ltd.  
Lvl 17, 240 Queen St., Brisbane QLD 4000Phone (07) 3243 2111  
Fax: (07) 3243 2199

Project No.:

**42626680**

Project Reference:

**Hancock Alpha SEIS**Drilling Contractor: **Salva Resources**Drilling Method:  
**RC**

Logged By:

Checked By:

Drill Model:

Date Started:

Date Finished:

Elevation:

315 mAHD

Coordinates:

449361 mE

7423473 mN

Client:

**Hancock Coal Pty Ltd**

Permit No:

-

Total Depth:

**84.00 m****OBSERVATIONS /  
DETAILS****WELL CONSTRUCTION DETAILS****DESCRIPTION OF STRATA**

Sample Type

Comments

Depth (mbgl)

Legend

Lithology

Consistency

Structure

Grain Size

Shape

Sorting

Weathering

Moisture

Classification

Piezometer  
Casing in GroutCLAY - light,  
creamy, brown,  
partly puggy, soft,  
completely  
weathered.

So

CW

SANDSTONE - light,  
creamy, grey,  
medium to coarse,  
quartz grains  
throughout, clayey  
matrix, low to poorly  
sorted, sub angular,  
completely  
weathered.

M-C

SA

P

CW

SANDSTONE -  
dark, reddish,  
brown, fine to  
coarse, iron oxide

Med

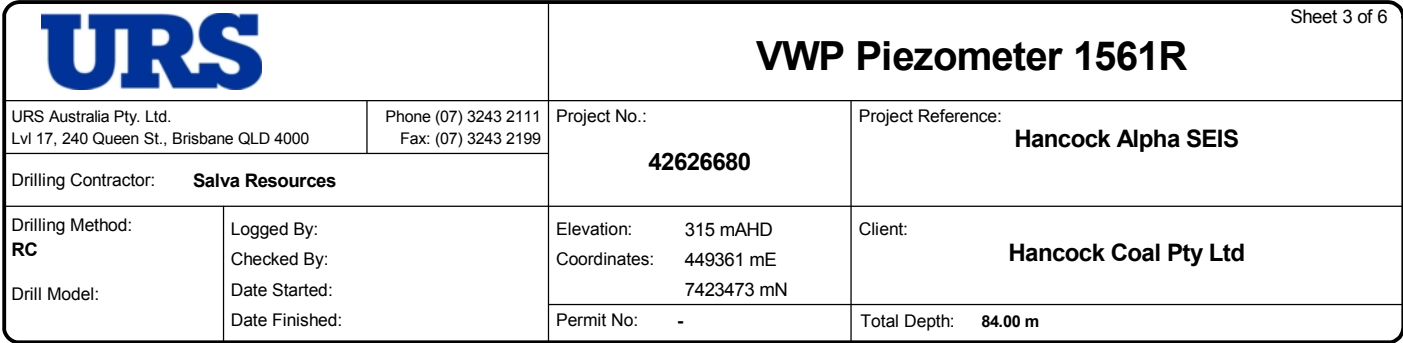
F-C





SA

M

SW

**REMARKS:**



OBSERVATIONS / DETAILS		WELL CONSTRUCTION DETAILS		DESCRIPTION OF STRATA										
Sample Type	Comments			Depth (mbgl)	Legend	Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Weathering	Moisture	Classification
				30		stains throughout, medium, moderately sorted, sub angular, slightly weathered.								
				31		SANDSTONE - light, cream, fine, clayey in part, occasional iron oxide stains throughout, medium, well sorted, angular, slightly weathered.	Med		F	A	W	SW		
				32										
				33										
				34										
				35		SANDSTONE - light, cream, fine, granular quartz throughout, medium, poorly sorted, angular, slightly weathered.	Med		F	A	P	SW		
				36										
				37										
				38										
				39										
				40										
				41		SANDSTONE - light, pinkish, cream, fine, silty throughout, medium, poorly sorted, angular, slightly weathered.	Med		F	A	P	SW		
				42		SANDSTONE - light, brownish, cream, fine, medium, moderately sorted, angular, slightly weathered.	Med		F	A	P	SW		
				43										
				44		SILTSTONE - 60% medium, brown, medium, slightly weathered,	Med		F	A	M	SW		

REMARKS:

**VWP Piezometer 1561R**URS Australia Pty. Ltd.  
Lvl 17, 240 Queen St., Brisbane QLD 4000Phone (07) 3243 2111  
Fax: (07) 3243 2199

Project No.:

**42626680**

Project Reference:

**Hancock Alpha SEIS**Drilling Contractor: **Salva Resources**Drilling Method:  
**RC**

Logged By:

Checked By:

Drill Model:

Date Started:

Date Finished:

Elevation:

315 mAHD

Coordinates:

449361 mE

7423473 mN

Client:

**Hancock Coal Pty Ltd**

Permit No: -

Total Depth:

**84.00 m****OBSERVATIONS /  
DETAILS****WELL CONSTRUCTION DETAILS****DESCRIPTION OF STRATA**

Sample Type	Comments	Depth (mbgl)	Legend	Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Weathering	Moisture	Classification
		45		intermixed with SANDSTONE - 40% light, cream, fine, medium, moderately sorted, angular, slightly weathered. Minor clayey throughout	Lo		C	SA	P	SW		
		46		GRAVEL - variegated, orangy, brown, pebbly, sandy and silty throughout, loose mechanical state, low, poorly sorted, sub angular, slightly weathered.								
		47										
		48										
		49										
		50										
		51										
		52										
		53		SANDSTONE - light, creamy, brown, fine, quartz grains throughout, low, moderately sorted, angular, slightly weathered.	Low		F	A	M	FR		
		54		SANDSTONE - dark, creamy, brown, fine, silty clasts throughout, low, moderately sorted, angular, fresh.								
		55		SANDSTONE - dark, bluish, grey, fine, occasional silty clasts, minor chloritic, low, moderately sorted, angular, fresh.	Low		F	A	M	FR		
		56										
		57										
		58										
		59										

Piezometer  
Casing in GroutVWP-15294 @  
57mWireline  
Piezometer in  
Grout

Base of Weathering

**REMARKS:**



**VWP Piezometer 1561R**URS Australia Pty. Ltd.  
Lvl 17, 240 Queen St., Brisbane QLD 4000Phone (07) 3243 2111  
Fax: (07) 3243 2199

Project No.:

**42626680**

Project Reference:

**Hancock Alpha SEIS**Drilling Contractor: **Salva Resources**Drilling Method:  
**RC**

Logged By:

Checked By:

Drill Model:

Date Started:

Date Finished:

Elevation:

315 mAHD

Coordinates:

449361 mE

7423473 mN

Client:

**Hancock Coal Pty Ltd**

Permit No:

-

Total Depth:

**84.00 m****OBSERVATIONS /  
DETAILS****WELL CONSTRUCTION DETAILS****DESCRIPTION OF STRATA**

Sample Type

Comments

Depth (mbgl)

Legend

Lithology

Consistency

Structure

Grain Size

Shape

Sorting

Weathering

Moisture

Classification

60

61

62

63

64

65

66

67

68

69

70

71

72

73

74

SANDSTONE - 50% medium, bluish, grey, fine, low, moderately sorted, sub angular, fresh, intermixed with SILTSTONE - 50% dark, grey, low, fresh. Occasional quartz grains throughout minor chloritic clayey in part.

Low

F

SA

M

FR

Grout fill

**REMARKS:**

**VWP Piezometer 1561R**URS Australia Pty. Ltd.  
Lvl 17, 240 Queen St., Brisbane QLD 4000Phone (07) 3243 2111  
Fax: (07) 3243 2199

Project No.:

**42626680**

Project Reference:

**Hancock Alpha SEIS**Drilling Contractor: **Salva Resources**Drilling Method:  
**RC**

Logged By:

Checked By:

Drill Model:

Date Started:

Date Finished:

Elevation:

315 mAHD

Coordinates:

449361 mE

7423473 mN

Client:

**Hancock Coal Pty Ltd**

Permit No:

-

Total Depth:

**84.00 m****OBSERVATIONS /  
DETAILS****WELL CONSTRUCTION DETAILS****DESCRIPTION OF STRATA**

Sample Type

Comments

Depth (mbgl)

Legend

Lithology

Consistency

Structure

Grain Size

Shape

Sorting

Weathering

Moisture

Classification

Grout fill

End Of Hole

**REMARKS:**

## VWP Piezometer 1558R

URS Australia Pty. Ltd. Lvl 17, 240 Queen St., Brisbane QLD 4000		Phone (07) 3243 2111 Fax: (07) 3243 2199	Project No.: <b>42626680</b>	Project Reference: <b>Hancock Alpha SEIS</b>
Drilling Contractor: <b>Salva Resources</b>				
Drilling Method: <b>RC</b>	Logged By:	Checked By:	Elevation: 325 mAHD Coordinates: 451199 mE 7428156 mN	Client: <b>Hancock Coal Pty Ltd</b>
Drill Model:	Date Started:	Date Finished:	Permit No: -	Total Depth: <b>78.00 m</b>

OBSERVATIONS / DETAILS		WELL CONSTRUCTION DETAILS		DESCRIPTION OF STRATA											
Sample Type	Comments	<div><div></div><div>Envirocap</div></div>		Depth (mbgl)	Legend	Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Weathering	Moisture	Classification	
	Base of Tertiary	<div><div></div><div>Piezometer Casing in Grout</div></div>		0	<div></div>	SOIL - medium, brown, clayey, friable, soft, completely weathered.	Fr, So						CW		
				1											
				2	<div></div>	SAND - medium, creamy, brown, clayey in part, loose mechanical state, dense, completely weathered.	De							CW	
				3											
				4	<div></div>	LATERITE - variegated, creamy, white, iron oxide stains in part, brittle, medium, completely weathered.	Br		M					CW	
				5											
				6											
				7	<div></div>	LATERITE - variegated, whitish, red, iron oxide stains throughout, brittle, medium, completely weathered.	Br		M					CW	
				8	<div></div>	LATERITE - variegated, reddish, white, iron oxide stains throughout, brittle, medium, completely weathered.	Br		M					CW	
				9											
				10											
				11											
				12	<div></div>	LATERITE - variegated, reddish, white, conglomeratic in part, waxy, low to completely weathered.							CW		
				13	<div></div>	CONGLOMERATE - variegated, reddish, grey, lateritic near base of unit, friable, low to completely weathered.	Fr						CW		
				14	<div></div>										
REMARKS:															

REMARKS:

# VWP Piezometer 1558R

URS Australia Pty. Ltd. Lvl 17, 240 Queen St., Brisbane QLD 4000		Phone (07) 3243 2111 Fax: (07) 3243 2199	Project No.:  <b>42626680</b>	Project Reference:  <b>Hancock Alpha SEIS</b>
Drilling Contractor: <b>Salva Resources</b>				
Drilling Method: <b>RC</b>	Logged By:	Elevation: 325 mAHD	Client:  <b>Hancock Coal Pty Ltd</b>	
	Checked By:	Coordinates: 451199 mE 7428156 mN		
Drill Model:	Date Started:	Permit No: -	Total Depth: <b>78.00 m</b>	
	Date Finished:			

OBSERVATIONS / DETAILS		WELL CONSTRUCTION DETAILS		DESCRIPTION OF STRATA										
Sample Type	Comments			Depth (mbgl)	Legend	Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Weathering	Moisture	Classification
	Looks like it may be weathered COAL			15		CLAY - medium, creamy, brown, puggy, low to completely weathered.						CW		
				16		CLAY - variegated, purplish, grey, lateritic near base of unit, partly puggy, low to completely weathered.						CW		
				17		LATERITE - variegated, reddish, white, iron oxide stains in part, brittle, medium, completely weathered.	Br		M			CW		
				18		LATERITE - pale, pinkish, white, iron oxide stains throughout, brittle, medium, completely weathered.	Br		M			CW		
				19		LATERITE - variegated, reddish, white, iron oxide stains and limonitic in part clayey, brittle, medium, completely weathered.	Br		M			CW		
				20		LATERITE - variegated, yellowish, white, iron oxide stains and limonitic in part clayey, brittle, medium, completely weathered.	Br		M			CW		
				21		LATERITE - variegated, yellowish, white, iron oxide stains and limonitic in part clayey, brittle, medium, completely weathered.	Br		M			CW		
				22		LATERITE - variegated, yellowish, white, iron oxide stains and limonitic in part clayey, brittle, medium, completely weathered.	Br		M			CW		
				23		LATERITE - variegated, yellowish, white, iron oxide stains and limonitic in part clayey, brittle, medium, completely weathered.	Br		M			CW		
				24		SANDSTONE - pale, creamy, yellow, fine, clayey throughout, brittle, medium, moderately sorted, sub rounded, completely weathered.	Br		M	SR	M	CW		
				25		SANDSTONE - medium, creamy, yellow, fine, clayey throughout, brittle, medium, moderately sorted, sub rounded, completely weathered.	Br		M	SR	M	CW		
				26		SANDSTONE - medium, creamy, yellow, fine, clayey throughout, brittle, medium, moderately sorted, sub rounded, completely weathered.	Br		M	SR	M	CW		
				27		SANDSTONE - medium, creamy, yellow, fine, clayey throughout, brittle, medium, moderately sorted, sub rounded, completely weathered.	Br		M	SR	M	CW		
				28		SANDSTONE - medium, creamy, yellow, fine, clayey throughout, brittle, medium, moderately sorted, sub rounded, completely weathered.	Br		M	SR	M	CW		
				29		SANDSTONE - medium, yellowish, brown, fine, clayey throughout, friable,	Fr			SR	P-M	CW		

REMARKS:

REMARKS:

## VWP Piezometer 1558R


URS Australia Pty. Ltd. Lvl 17, 240 Queen St., Brisbane QLD 4000		Phone (07) 3243 2111 Fax: (07) 3243 2199	Project No.: <b>42626680</b>	Project Reference: <b>Hancock Alpha SEIS</b>
Drilling Contractor: <b>Salva Resources</b>				
Drilling Method: <b>RC</b>	Logged By:	Checked By:	Elevation: 325 mAHD Coordinates: 451199 mE 7428156 mN	Client: <b>Hancock Coal Pty Ltd</b>
Drill Model:	Date Started:	Date Finished:	Permit No: -	Total Depth: <b>78.00 m</b>

OBSERVATIONS / DETAILS		WELL CONSTRUCTION DETAILS		DESCRIPTION OF STRATA										
Sample Type	Comments			Depth (mbgl)	Legend	Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Weathering	Moisture	Classification
				30		low to moderately sorted, sub rounded, completely weathered.								
				31										
	Base of Weathering			32		SANDSTONE - dark, brown, fine, brittle, medium, moderately sorted, sub rounded, highly weathered.	Br		M	SR	M	HW		
				33										
				34										
				35										
				36		SANDSTONE - dark, bluish, grey, medium to fine, feldspathic chloritic, uniform, high, moderately sorted, sub rounded, fresh.	High		F-M	SR	M	FR		
				37										
				38										
				39										
				40										
				41										
				42		SANDSTONE - dark, grey, medium to fine, feldspathic, uniform, high, moderately sorted, sub rounded, fresh.	High		F-M	SR	M	FR		
				43		SANDSTONE - pale, bluish, grey, medium to fine, chloritic clayey in part, uniform, medium, moderately sorted, sub rounded, fresh.	Med		F-M	SR	M	FR		
				44		CLAY - medium.	Med					SW		

REMARKS:

## VWP Piezometer 1558R

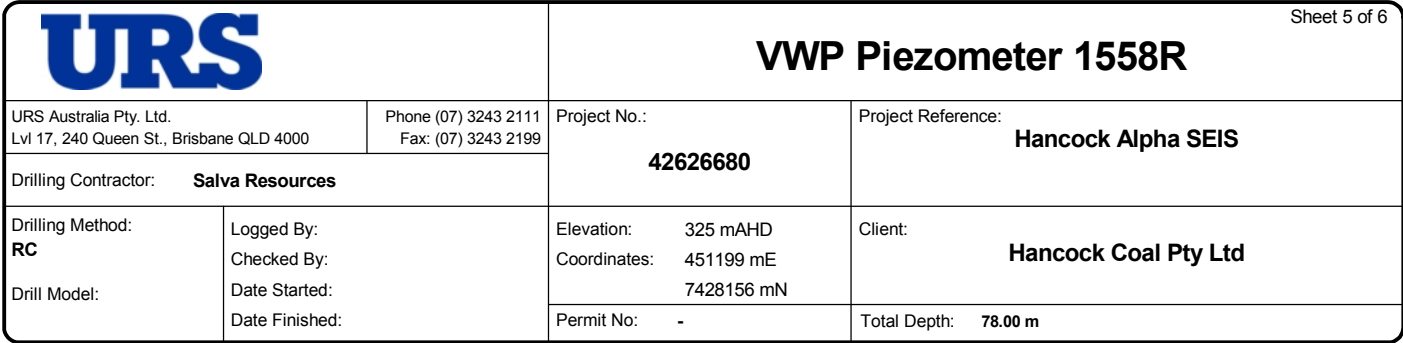
URS Australia Pty. Ltd. Lvl 17, 240 Queen St., Brisbane QLD 4000		Phone (07) 3243 2111 Fax: (07) 3243 2199	Project No.: <b>42626680</b>	Project Reference: <b>Hancock Alpha SEIS</b>
Drilling Contractor: <b>Salva Resources</b>				
Drilling Method: <b>RC</b>	Logged By:	Checked By:	Elevation: 325 mAHD Coordinates: 451199 mE 7428156 mN	Client: <b>Hancock Coal Pty Ltd</b>
Drill Model:	Date Started:	Date Finished:	Permit No: -	Total Depth: <b>78.00 m</b>

OBSERVATIONS / DETAILS		WELL CONSTRUCTION DETAILS		DESCRIPTION OF STRATA											
Sample Type	Comments			Depth (mbgl)	Legend	Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Weathering	Moisture	Classification	
				45		yellowish, brown, sandy throughout siltstone pebbles in part, puggy, low, slightly weathered.									
				46											
				47											
				48		SANDSTONE - pale, creamy, yellow, medium to fine, siltstone pebbles in part feldspathic, uniform, medium, poorly sorted, sub rounded, slightly weathered.	Med		F-M	SR	P	SW			
				49											
				50											
				51											
				52											
				53											
				54		SANDSTONE - pale, creamy, yellow, medium to fine, siltstone pebbles rare feldspathic, uniform, medium, moderately sorted, sub rounded, slightly weathered.	Med		F-M	SR	M	SW			
				55											
				56											
				57		SANDSTONE - dark, bluish, grey, fine, feldspathic chloritic, brittle, high, well sorted, sub rounded, fresh.	Br		F	SR	W	FR			
				58											
				59											
REMARKS:															

VWP PIEZOMETER JULY 2011.GPJ BRISBANE\_JOB\_TEMPLATE.GDT 27/9/11 This drawing is subject to COPYRIGHT. It remains the property of URS Australia Pty Ltd.

REMARKS:





OBSERVATIONS / DETAILS		WELL CONSTRUCTION DETAILS		DESCRIPTION OF STRATA										
Sample Type	Comments			Depth (mbgl)	Legend	Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Weathering	Moisture	Classification
				60		SANDSTONE - pale, bluish, grey, medium to fine, siltstone fragments throughout feldspathic chloritic, uniform, high, moderately sorted, sub rounded, fresh.	High		F-M	SR	M	FR		
				61										
				62										
				63										
				64										
	Sandstone as before but more Siltstone, green lithic and Quartz fragments			65		CONGLOMERATE - variegated, bluish, grey, siltstone fragments quartz fragments	Fr		M	SA	P	FR		
	As above but with green and red lithic frags and carbonaceous siltstone in part			66		feldspathic clayey, friable, medium, poorly sorted, sub angular, fresh.	Fr		M	SA	P	FR		
				67		CONGLOMERATE - variegated, bluish, grey, siltstone fragments quartz fragments								
				68		feldspathic clayey, friable, medium, poorly sorted, sub angular, fresh.								
				69										
				70										
				71		SANDSTONE - pale, bluish, grey, lithic fragments in part conglomeratic clayey			M	SA	M	FR		
			Grout fill	72		feldspathic, uniform, medium, moderately sorted, sub angular, fresh.	High		M	SR	M	FR		
	Occasional red and green lithic fragments. V-Notch at E.O.H.@ 78.00m - 25mm over weir -1558R_WSS_001			73		SANDSTONE - medium, bluish, grey, fining downwards, uniform, high, moderately sorted, sub rounded, fresh.								
				74										

REMARKS:

**VWP Piezometer 1558R**URS Australia Pty. Ltd.  
Lvl 17, 240 Queen St., Brisbane QLD 4000Phone (07) 3243 2111  
Fax: (07) 3243 2199

Project No.:

**42626680**

Project Reference:

**Hancock Alpha SEIS**Drilling Contractor: **Salva Resources**Drilling Method:  
**RC**

Logged By:

Checked By:

Drill Model:

Date Started:

Date Finished:

Elevation:

325 mAHD

Coordinates:

451199 mE

7428156 mN

Client:

**Hancock Coal Pty Ltd**

Permit No:

-

Total Depth:

**78.00 m****OBSERVATIONS /  
DETAILS****WELL CONSTRUCTION DETAILS****DESCRIPTION OF STRATA**

Sample Type

Comments

Depth (mbgl)

Legend

Lithology

Consistency

Structure

Grain Size

Shape

Sorting

Weathering

Moisture

Classification

75

76

77

78

79

80

81

82

83

84

85

86

87

88

89

End of Hole

**REMARKS:**

# VWP Piezometer 1553R

URS Australia Pty. Ltd. Lvl 17, 240 Queen St., Brisbane QLD 4000		Phone (07) 3243 2111 Fax: (07) 3243 2199	Project No.: <b>42626680</b>	Project Reference: <b>Hancock Alpha SEIS</b>
Drilling Contractor: <b>Salva Resources</b>			Elevation: 310 mAHD Coordinates: 448996 mE 7428186 mN	Client: <b>Hancock Coal Pty Ltd</b>
Drilling Method: <b>RC</b>	Logged By:	Checked By:	Permit No: -	Total Depth: <b>120.00 m</b>
Drill Model:	Date Started:	Date Finished:		

OBSERVATIONS / DETAILS		WELL CONSTRUCTION DETAILS		DESCRIPTION OF STRATA										
Sample Type	Comments	<div><div></div><div>Envirocap</div></div>		Depth (mbgl)	Legend	Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Weathering	Moisture	Classification
				0		SOIL - medium, brown, loose mechanical state, very soft, completely weathered.	VSo					CW		
				1		SAND - medium, creamy, brown, loose mechanical state, very loose, completely weathered.	VL					CW		
				2		SAND - pale, creamy, brown, loose mechanical state, very loose, completely weathered.	VL					CW		
				3										
				4										
				5										
				6										
		<div><div></div><div>Piezometer Casing in Grout</div></div>		7		SAND - pale, creamy, brown, loose mechanical state, loose, completely weathered.	Lo					CW		
				8										
				9										
				10		SAND - pale, creamy, brown, clayey in part, loose mechanical state, medium dense, completely weathered.	MD					CW		
				11										
	Base Of Tertiary TULA			12		SAND - medium, creamy, brown,	De					CW		
REMARKS:														

**VWP Piezometer 1553R**URS Australia Pty. Ltd.  
Lvl 17, 240 Queen St., Brisbane QLD 4000Phone (07) 3243 2111  
Fax: (07) 3243 2199

Project No.:

**42626680**

Project Reference:

**Hancock Alpha SEIS**Drilling Contractor: **Salva Resources**Drilling Method:  
**RC**

Logged By:

Checked By:

Drill Model:

Date Started:

Date Finished:

Elevation:

310 mAHD

Coordinates:

448996 mE

7428186 mN

Client:

**Hancock Coal Pty Ltd**

Permit No: -

Total Depth:

**120.00 m****OBSERVATIONS /  
DETAILS****WELL CONSTRUCTION DETAILS****DESCRIPTION OF STRATA**

Sample Type	Comments	Depth (mbgl)	Legend	Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Weathering	Moisture	Classification
		13		clayey throughout, loose mechanical state, dense, completely weathered.	So					CW		
		14		CLAY - pale, creamy, white, lithic labile throughout, puggy, soft, completely weathered.								
		15										
		16										
		17										
		18										
		19										
		20										
		21										
		22		LATERITE - variegated, reddish, white, rare clayey iron oxide stains, brittle, low to completely weathered.	Br					CW		
		23										
		24		CLAY - variegated, yellowish, white, limonitic throughout clayey in part, brittle, low to completely	Br					CW		

Piezometer  
Casing in GroutSignificant amounts  
of Groundwater**REMARKS:**

**VWP Piezometer 1553R**URS Australia Pty. Ltd.  
Lvl 17, 240 Queen St., Brisbane QLD 4000Phone (07) 3243 2111  
Fax: (07) 3243 2199

Project No.:

**42626680**

Project Reference:

**Hancock Alpha SEIS**Drilling Contractor: **Salva Resources**Drilling Method:  
**RC**

Logged By:

Checked By:

Drill Model:

Date Started:

Date Finished:

Elevation:

310 mAHD

Coordinates:

448996 mE

7428186 mN

Client:

**Hancock Coal Pty Ltd**

Permit No:

-

Total Depth:

**120.00 m****OBSERVATIONS /  
DETAILS****WELL CONSTRUCTION DETAILS****DESCRIPTION OF STRATA**

Sample Type

Comments

Depth (mbgl)

Legend

Lithology

Consistency

Structure

Grain Size

Shape

Sorting

Weathering

Moisture

Classification

1553\_WSS\_001 and  
V-Notch @ 70mm  
over from 24-30m runPiezometer  
Casing in Grout25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37weathered.  
LATERITE -  
variegated,  
yellowish, white,  
limonitic throughout  
clayey in part, brittle,  
low to completely  
weathered.  
LATERITE -  
variegated,  
yellowish, white,  
lateritic throughout  
and iron oxide stains  
in part, brittle, low to  
completely  
weathered.  
LATERITE -  
variegated, reddish,  
white, limonitic in  
part quartz grains  
common, brittle, low  
to completely  
weathered.

Br

Br

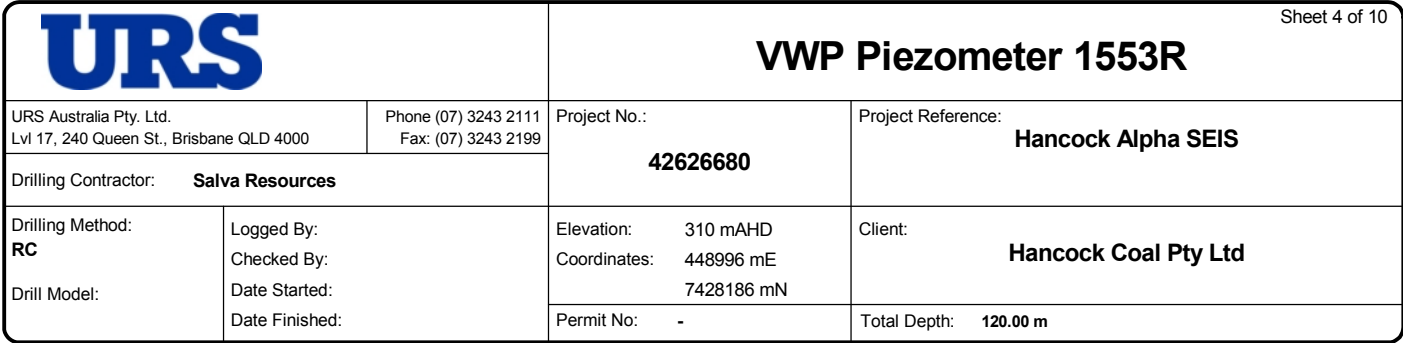
Br

CW

CW

CW

**REMARKS:**



# VWP Piezometer 1553R

Project No.: **42626680**

Project Reference: **Hancock Alpha SEIS**













Drilling Contractor: **Salva Resources**

Drilling Method:	Logged By:
<b>RC</b>	Checked By:
Drill Model:	Date Started:
	Date Finished:

Elevation: 310 mAHD  
Coordinates: 448996 mE  
7428186 mN

Client: **Hancock Coal Pty Ltd**





Permit No: -	Total Depth: 120.00 m
--------------	-----------------------

OBSERVATIONS / DETAILS		WELL CONSTRUCTION DETAILS		DESCRIPTION OF STRATA										
Sample Type	Comments			Depth (mbgl)	Legend	Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Weathering	Moisture	Classification
				38		LATERITE - variegated, yellowish, white, limonitic common quartz grains throughout, friable, low to completely weathered.	Fr					CW		
				39		SANDSTONE - variegated, whitish, grey, granular, quartz grains near top of unit, friable, low to moderately sorted, sub angular, completely weathered.	Fr			SA	P-M	CW		
				40		LATERITE - pale, creamy, white, common quartz grains, brittle, low to completely weathered.	Br					CW		
				41		LATERITE - variegated, yellowish, white, limonitic common quartz grains in part, brittle, low to completely weathered.								
				42		LATERITE - variegated, yellowish, white, limonitic common quartz grains in part, brittle, low to completely weathered.	Br					CW		
				43		LATERITE - pale, creamy, white, common quartz grains, brittle, low to completely weathered.								
				44		LATERITE - variegated, yellowish, white, limonitic common quartz grains in part, brittle, low to completely weathered.								
	Hole cased off at 48m with PVC - BULA			45		LATERITE - variegated, yellowish, white, limonitic common quartz common, brittle, low to completely weathered.	Br					CW		
				46		LATERITE - variegated, yellowish, white, limonitic common quartz common, brittle, low to completely weathered.								
				47		LATERITE - variegated, yellowish, white, limonitic common quartz common, brittle, low to completely weathered.								
	Quartz grains DMAX 2mm, looks similar to C/D SANDSTONE, contains groundwater			48		SANDSTONE - variegated, creamy, grey, granular, limonitic fragments in part, loose mechanical state, low to moderately sorted, sub angular, completely weathered.	Lo			SA	P-M	CW		
				49		SANDSTONE - variegated, creamy, grey, granular, limonitic fragments in part, loose mechanical state, low to moderately sorted, sub angular, completely weathered.								
REMARKS:														



## VWP Piezometer 1553R

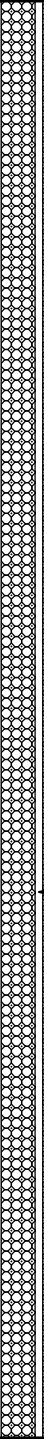


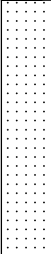
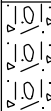
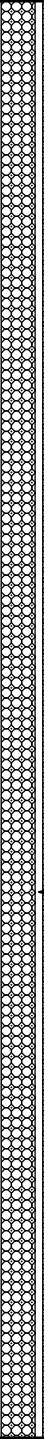

URS Australia Pty. Ltd. Lvl 17, 240 Queen St., Brisbane QLD 4000		Phone (07) 3243 2111 Fax: (07) 3243 2199	Project No.:  <b>42626680</b>	Project Reference:  <b>Hancock Alpha SEIS</b>
Drilling Contractor: <b>Salva Resources</b>				
Drilling Method: <b>RC</b>	Logged By:	Checked By:	Elevation: 310 mAHD Coordinates: 448996 mE 7428186 mN	Client:  <b>Hancock Coal Pty Ltd</b>
Drill Model:	Date Started:	Date Finished:	Permit No: -	Total Depth: <b>120.00 m</b>

OBSERVATIONS / DETAILS		WELL CONSTRUCTION DETAILS		Depth (mbgl)	DESCRIPTION OF STRATA									
Sample Type	Comments				Legend	Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Weathering	Moisture	Classification
	Possibly F SEAM, very highly weathered. Around 0.5m thick with yellow SANSTONE in part  Base of Weathering			50		Weathered COAL - medium, orangy, brown, waxy, low to completely weathered.	Med					CW		
				51		SANDSTONE - light, creamy, grey, medium, uniform, medium, poorly sorted, sub rounded, moderately weathered.	Med		M	SR	P	MW		
				52										
				53		SANDSTONE - medium, orangy, brown, medium, uniform, high, poorly sorted, sub angular, fresh.	Med		M	SA	P	FR		
				54										
		VWP-14622 @ 55m	Wireline Piezometer in Grout	55										
	Iron-rich SANDSTONE, mineralogically diverse, grainsize decreasing slightly with depth		Piezometer Casing in Grout	56		SANDSTONE - medium, orangy, brown, coarse, iron oxide stains throughout fining downwards, uniform, medium, moderately sorted, sub angular, fresh.	Med		C	SA	M	FR		
				57										
				58										
				59										
				60										
				61										
				62										

REMARKS:

## VWP Piezometer 1553R

URS Australia Pty. Ltd. Lvl 17, 240 Queen St., Brisbane QLD 4000		Phone (07) 3243 2111 Fax: (07) 3243 2199	Project No.: <b>42626680</b>	Project Reference: <b>Hancock Alpha SEIS</b>
Drilling Contractor: <b>Salva Resources</b>				
Drilling Method: <b>RC</b>	Logged By:	Checked By:	Elevation: 310 mAHD Coordinates: 448996 mE 7428186 mN	Client: <b>Hancock Coal Pty Ltd</b>
Drill Model:	Date Started:	Date Finished:	Permit No: -	Total Depth: <b>120.00 m</b>

OBSERVATIONS / DETAILS		WELL CONSTRUCTION DETAILS		DESCRIPTION OF STRATA													
Sample Type	Comments			Depth (mbgl)	Legend	Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Weathering	Moisture	Classification			
	Well cemented SANDSTONE			63		Weathered COAL - medium, creamy, brown, waxy, low to completely weathered.	Med					CW					
				64		SANDSTONE - medium, creamy, yellow, medium to coarse, quartz grains in part, uniform, medium, moderately sorted, sub rounded, slightly weathered.	Med		M	SR	M	SW					
				65													
				66				SANDSTONE - medium, creamy, brown, medium to coarse, uniform, medium, poorly sorted, sub rounded, slightly weathered.	Med		M	SR	P	SW			
				67													
				68				SANDSTONE - medium, bluish, grey, medium, conglomeratic, uniform, medium, moderately sorted, sub rounded, fresh.	Med		M	SR	M	FR			
				69													
				70													
				71					SANDSTONE - brownish, blue, quartz grains throughout, uniform, medium, moderately sorted, sub rounded, fresh.			M	SR	M	FR		
				72					CONGLOMERATE - medium, bluish, grey, quartz pebbles and sandstone pebbles, brittle, low to poorly sorted, rounded, fresh.	Br			R	P	FR		
	Quartz grains DMAX 2mm, red SANDSTONE fragments also present			73		SANDSTONE - medium, bluish, grey, medium, uniform, medium, moderately sorted, sub rounded, fresh.	Med		M	SR	M	FR					
				74													
REMARKS:																	

REMARKS:

# VWP Piezometer 1553R

URS Australia Pty. Ltd. Lvl 17, 240 Queen St., Brisbane QLD 4000		Phone (07) 3243 2111 Fax: (07) 3243 2199	Project No.:  <b>42626680</b>	Project Reference:  <b>Hancock Alpha SEIS</b>
Drilling Contractor: <b>Salva Resources</b>				
Drilling Method: <b>RC</b>	Logged By:	Checked By:	Elevation: 310 mAHD Coordinates: 448996 mE 7428186 mN	Client:  <b>Hancock Coal Pty Ltd</b>
Drill Model:	Date Started:	Date Finished:	Permit No: -	Total Depth: <b>120.00 m</b>

OBSERVATIONS / DETAILS		WELL CONSTRUCTION DETAILS		DESCRIPTION OF STRATA										
Sample Type	Comments			Depth (mbgl)	Legend	Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Weathering	Moisture	Classification
				75										
				76										
				77										
				78		SANDSTONE - medium, bluish, grey, medium, quartz grains in part, uniform, medium, poorly sorted, sub rounded, fresh. SANDSTONE - variegated, bluish, grey, medium, quartz grains in part lithic fragments in part, friable, medium, poorly sorted, sub angular, fresh.	Med		M	SR	P	FR		
	Conglomeratic throughout			78			Fr		M	SA	P	FR		
				79			Med		M-C	SR	M	FR		
				80										
				81			Med		M-C	SR	M	FR		
	Weathered COAL material makes up 20% of meter but may have fallen in			82			Med		M-C	SR	M	FR		
				83										
				84			Fr		M-C	SA	P	FR		
	Lithic frags of Dark Siltstone, red/orange Sandstone, QTZ pebbles and green rock			85										
				86										
				87										

REMARKS:

VWP PIEZOMETER JULY 2011.GPJ BRISBANE\_JOB\_TEMPLATE.GDT 27/9/11 This drawing is subject to COPYRIGHT. It remains the property of URS Australia Pty Ltd.

REMARKS:

## VWP Piezometer 1553R

URS Australia Pty. Ltd.  
Lvl 17, 240 Queen St., Brisbane QLD 4000

Phone (07) 3243 2111  
Fax: (07) 3243 2199

Project No.:

Project Reference:

**42626680**

## Hancock Alpha SEIS

Drilling Contractor: **Salva Resources**

Drilling Method:  
**RC**

Logged By:

Checked By:

Date Started:

Date Finished:

Elevation: 310 mAHD

Coordinates: 448996 mE

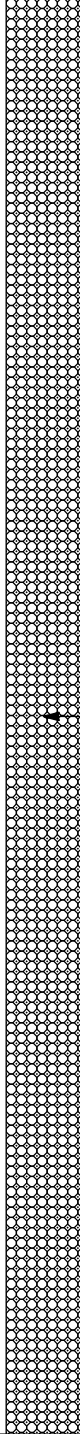
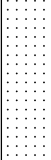
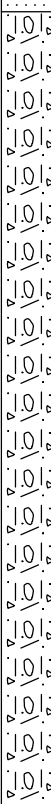
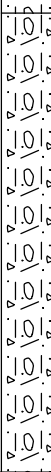
7428186 mN

Client:

**Hancock Coal Pty Ltd**

Permit No: -

Total Depth:	120.00 m
--------------	----------

OBSERVATIONS / DETAILS		WELL CONSTRUCTION DETAILS		DESCRIPTION OF STRATA									
Sample Type	Comments		Depth (mbgl)	Legend	Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Weathering	Moisture	Classification
	QTZ grains DMAX 4MM, lithic frags of Dark Silt, green rock and red Sandstone in med/coarse SST matrix. Decreasing amount of SST matrix with depth		88 89 90 91 92 93 94 95 96 97 98 99	  		Fr	-	M	SR	P	FR	-	-
	Dark SILTSTONE clasts, increasing amount of green lithic frags of SST					Fr	-	M	A	P	FR	-	-

REMARKS:

**VWP Piezometer 1553R**URS Australia Pty. Ltd.  
Lvl 17, 240 Queen St., Brisbane QLD 4000Phone (07) 3243 2111  
Fax: (07) 3243 2199

Project No.:

**42626680**

Project Reference:

**Hancock Alpha SEIS**Drilling Contractor: **Salva Resources**Drilling Method:  
**RC**

Logged By:

Checked By:

Drill Model:

Date Started:

Date Finished:

Elevation:

310 mAHD

Coordinates:

448996 mE

7428186 mN

Client:

**Hancock Coal Pty Ltd**

Permit No:

-

Total Depth:

**120.00 m****OBSERVATIONS /  
DETAILS****WELL CONSTRUCTION DETAILS****DESCRIPTION OF STRATA**

Sample Type

Comments

Depth (mbgl)

Legend

Lithology

Consistency

Structure

Grain Size

Shape

Sorting

Weathering

Moisture

Classification

Much smaller clasts,  
dominated by green  
lithic material, rich in  
biotite, feldspar and  
chlorite  
Bluish version of hard  
SANDSTONE from  
previous hole. Gets  
greyer towards the  
bottom

100

101

102

103

104

105

106

107

108

109

110

111

112

CONGLOMERATE -  
variegated,  
greenish, grey,  
fining downwards,  
friable, medium,  
poorly sorted,  
angular, fresh.  
SANDSTONE - pale,  
bluish, grey, very  
fine, uniform, high to  
well sorted, sub  
rounded, fresh.

Fr

M

A

P

FR

VF

SR

W

FR

Grout fill

Water sample taken;  
1553R\_WSS\_002  
V-Notchtaken; 50mm

SANDSTONE -  
medium, greyish,

Med

F

SR

W

FR

**REMARKS:**

**VWP Piezometer 1553R**URS Australia Pty. Ltd.  
Lvl 17, 240 Queen St., Brisbane QLD 4000Phone (07) 3243 2111  
Fax: (07) 3243 2199

Project No.:

**42626680**

Project Reference:

**Hancock Alpha SEIS**Drilling Contractor: **Salva Resources**Drilling Method:  
**RC**

Logged By:

Checked By:

Drill Model:

Date Started:

Date Finished:

Elevation:

310 mAHD

Coordinates:

448996 mE

7428186 mN

Client:

**Hancock Coal Pty Ltd**

Permit No:

-

Total Depth:

**120.00 m****OBSERVATIONS /  
DETAILS****WELL CONSTRUCTION DETAILS****DESCRIPTION OF STRATA**

Sample Type

Comments

Depth (mbgl)

Legend

Lithology

Consistency

Structure

Grain Size

Shape

Sorting

Weathering

Moisture

Classification

over the weir

113

114

115

116

117

118

119

120

121

122

123

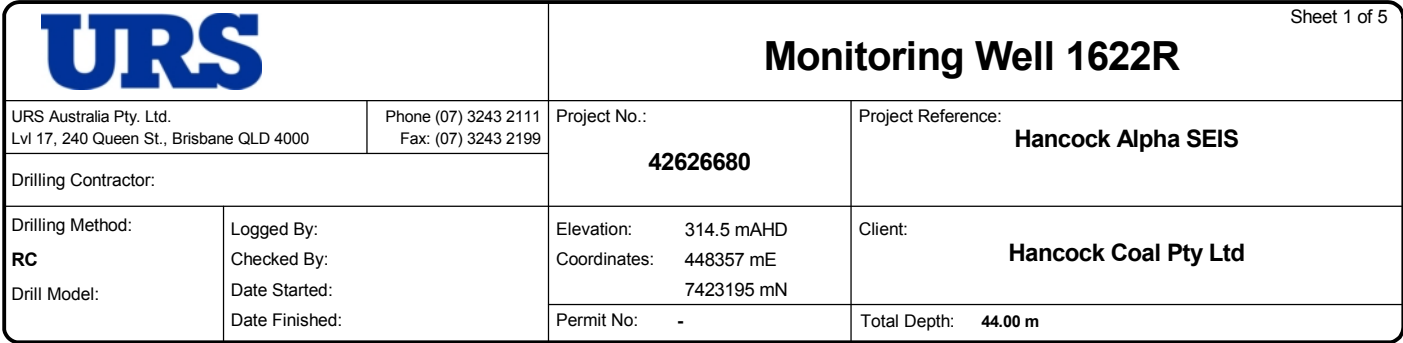
124

white, fine to very  
fine, uniform, high,  
well sorted, sub  
rounded, fresh.

End of Hole

**REMARKS:**



[illegible]

MONITORING WELL - ELEVATION (MAHD) JULY 2011.GPJ BRISBANE\_JOB\_TEMPLATE.GDT 20/9/11 This drawing is subject to COPYRIGHT. It remains the property of URS Australia Pty Ltd.

REMARKS:

**Monitoring Well 1622R**URS Australia Pty. Ltd.  
Lvl 17, 240 Queen St., Brisbane QLD 4000Phone (07) 3243 2111  
Fax: (07) 3243 2199

Project No.:

**42626680**

Project Reference:

**Hancock Alpha SEIS**

Drilling Contractor:

Drilling Method:

**RC**

Drill Model:

Logged By:

Checked By:

Date Started:

Date Finished:

Elevation:

314.5 mAHd

Coordinates:

448357 mE

7423195 mN

Client:

**Hancock Coal Pty Ltd**

Permit No:

-

Total Depth:

**44.00 m**

MONITORING WELL - ELEVATION (MAHD) JULY 2011.GPJ BRISBANE\_JOB\_TEMPLATE.GDT 20/9/11 This drawing is subject to COPYRIGHT. It remains the property of URS Australia Pty Ltd.

SAMPLING DETAILS				WELL CONSTRUCTION DETAILS		Elevation (mAHD)	DESCRIPTION OF STRATA									
Sample Type	Sampling and Observations	PID (ppm)			Legend		Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Plasticity	Moisture	Classification	

50 mm UPVC  
Class 18  
Standpipe in  
Cement Grout



# Monitoring Well 1622R

URS Australia Pty. Ltd.  
Lvl 17, 240 Queen St., Brisbane QLD 4000Phone (07) 3243 2111  
Fax: (07) 3243 2199

Project No.:

**42626680**

Project Reference:

**Hancock Alpha SEIS**

Drilling Contractor:

Drilling Method:

**RC**

Drill Model:

Logged By:

Checked By:

Date Started:

Date Finished:

Elevation:

314.5 mAHd

Coordinates:

448357 mE

7423195 mN

Client:

**Hancock Coal Pty Ltd**

Permit No:

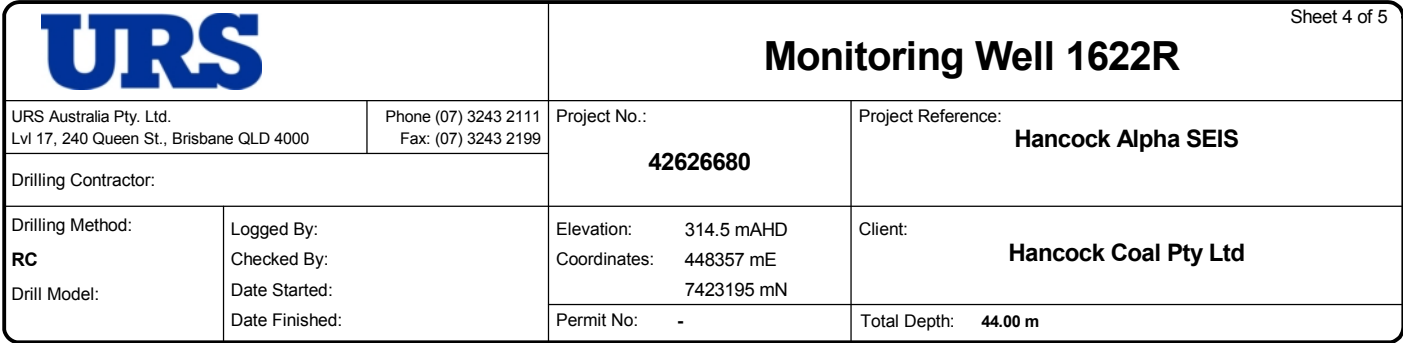
-

Total Depth:

**44.00 m****SAMPLING DETAILS****WELL CONSTRUCTION DETAILS****DESCRIPTION OF STRATA**

Sample Type	Sampling and Observations	PID (ppm)	Elevation (mAHd)	Legend	Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Plasticity	Moisture	Classification
			294										
			293										
			292										
			291										
			290										
			289										
			288										
			287		Weathered COAL - light, reddish, brown, clayey throughout, waxy, very soft, completely weathered.	VSo							
			286										
			285										

**REMARKS:**

[illegible]

REMARKS:



# Monitoring Well 1622R

URS Australia Pty. Ltd.  
Lvl 17, 240 Queen St., Brisbane QLD 4000Phone (07) 3243 2111  
Fax: (07) 3243 2199

Project No.:

**42626680**

Project Reference:

**Hancock Alpha SEIS**

Drilling Contractor:

Drilling Method:

**RC**

Drill Model:

Logged By:

Checked By:

Date Started:

Date Finished:

Elevation:

314.5 mAHd

Coordinates:

448357 mE

7423195 mN

Client:

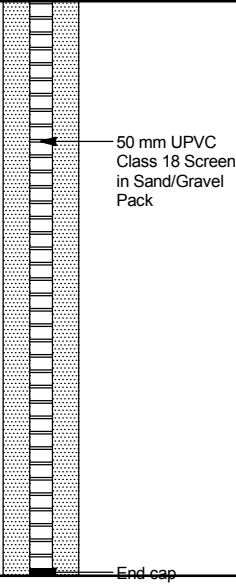
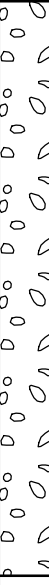

**Hancock Coal Pty Ltd**

Permit No.:

-

Total Depth:

**44.00 m****SAMPLING DETAILS****WELL CONSTRUCTION DETAILS****DESCRIPTION OF STRATA**

Sample Type	Sampling and Observations	PID (ppm)			Elevation (mAHd)	Legend	Lithology	Consistency	Structure	Grain Size	Shape	Sorting	Plasticity	Moisture	Classification
					274										
					273										
					272										
					271										
					270										
					269		Base of Well								
					268										
					267										
					266										
					265										

**REMARKS:**

## Appendix B Hydrochemistry





## Environmental Division

### CERTIFICATE OF ANALYSIS

<b>Work Order</b>	<b>: EB1116777</b>	<b>Page</b>	<b>: 1 of 12</b>
<b>Client</b>	<b>: 4T CONSULTANTS PTY LTD</b>	<b>Laboratory</b>	<b>: Environmental Division Brisbane</b>
<b>Contact</b>	<b>: RESULTS ADDRESS</b>	<b>Contact</b>	<b>: Customer Services</b>
<b>Address</b>	<b>: PO BOX 1946 EMERALD QLD, AUSTRALIA 4720</b>	<b>Address</b>	<b>: 32 Shand Street Stafford QLD Australia 4053</b>
<b>E-mail</b>	<b>: data@4t.com.au</b>	<b>E-mail</b>	<b>: Brisbane.Enviro.Services@alsglobal.com</b>
<b>Telephone</b>	<b>: +61 7 49824100</b>	<b>Telephone</b>	<b>: +61 7 3243 7222</b>
<b>Facsimile</b>	<b>: ----</b>	<b>Facsimile</b>	<b>: +61 7 3243 7218</b>
<b>Project</b>	<b>: GWQ 106</b>	<b>QC Level</b>	<b>: NEPM 1999 Schedule B(3) and ALS QCS3 requirement</b>
<b>Order number</b>	<b>: ----</b>		
<b>C-O-C number</b>	<b>: ----</b>	<b>Date Samples Received</b>	<b>: 19-AUG-2011</b>
<b>Sampler</b>	<b>: ----</b>	<b>Issue Date</b>	<b>: 02-SEP-2011</b>
<b>Site</b>	<b>: ----</b>		
<b>Quote number</b>	<b>: BN/290/10</b>	<b>No. of samples received</b>	<b>: 15</b>
		<b>No. of samples analysed</b>	<b>: 15</b>

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.

<i>Signatories</i>	<i>Position</i>	<i>Accreditation Category</i>
Andrew Matheson	Senior Organic Instrument Chemist	Brisbane Organics
Greg Vogel	Laboratory Manager	Brisbane Inorganics
Jonathon Angell	Inorganic Coordinator	Brisbane Inorganics
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics
Scott Beddoes		Brisbane Inorganics

**Environmental Division Brisbane**  
Part of the **ALS Laboratory Group**

32 Shand Street Stafford QLD Australia 4053  
Tel. +61-7-3243 7222 Fax. +61-7-3243 7218 [www.alsglobal.com](http://www.alsglobal.com)  
A Campbell Brothers Limited Company



## 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 insufficient sample for analysis.

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

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

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

- **EG020A-F (Dissolved Metals): LORs for EB1116777-008 (1610R), 009 (1618R), 010 (1617R), 014 (1622R), 015 (1621R) have been raised due to matrix interference.**
- **TDS by method EA-015 may bias high due to the presence of fine particulate matter, which may pass through the prescribed GF/C paper.**



## Analytical Results

Sub-Matrix: WATER

Client sample ID

Client sampling date / time

				AMB01	AMB02	AMB03	AMB04	1566R
				16-AUG-2011 14:34	16-AUG-2011 12:49	16-AUG-2011 16:08	16-AUG-2011 11:31	15-AUG-2011 11:15
Compound	CAS Number	LOR	Unit	EB1116777-001	EB1116777-002	EB1116777-003	EB1116777-004	EB1116777-005
<b>EA005P: pH by PC Titrator</b>								
pH Value	----	0.01	pH Unit	8.00	7.89	8.00	7.26	4.85
<b>EA010P: Conductivity by PC Titrator</b>								
Electrical Conductivity @ 25°C	----	1	µS/cm	1480	1580	1380	4760	1800
<b>EA015: Total Dissolved Solids</b>								
^ Total Dissolved Solids @180°C	GIS-210-010	5	mg/L	775	842	729	2550	1730
<b>ED037P: Alkalinity by PC Titrator</b>								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	96	89	86	139	113
Total Alkalinity as CaCO3	----	1	mg/L	96	89	86	139	113
<b>ED040F: Dissolved Major Anions</b>								
Sulfate as SO4 2-	14808-79-8	1	mg/L	<1	<1	<1	61	9
<b>ED045G: Chloride Discrete analyser</b>								
Chloride	16887-00-6	1	mg/L	434	487	404	1450	402
<b>ED093F: Dissolved Major Cations</b>								
Calcium	7440-70-2	1	mg/L	10	13	7	47	69
Magnesium	7439-95-4	1	mg/L	2	3	<1	38	39
Sodium	7440-23-5	1	mg/L	328	360	313	965	227
Potassium	7440-09-7	1	mg/L	3	2	2	13	12
<b>EG020F: Dissolved Metals by ICP-MS</b>								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	0.24
Arsenic	7440-38-2	0.001	mg/L	<0.001	0.005	<0.001	<0.001	----
Arsenic	7440-38-2	0.001	mg/L	----	----	----	----	0.002
Boron	7440-42-8	0.05	mg/L	0.19	0.18	0.15	0.51	----
Barium	7440-39-3	0.001	mg/L	0.061	0.060	0.035	0.158	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Bismuth	7440-69-9	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	0.001	----
Cadmium	7440-43-9	0.0001	mg/L	----	----	----	----	0.0005
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Cerium	7440-45-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Caesium	7440-46-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Lithium	7439-93-2	0.001	mg/L	0.032	0.036	0.031	<0.001	----
Manganese	7439-96-5	0.001	mg/L	0.060	0.017	0.022	0.061	----
Molybdenum	7439-98-7	0.001	mg/L	0.001	0.001	<0.001	0.001	----



## Analytical Results

Sub-Matrix: WATER

Client sample ID

Client sampling date / time

Compound	CAS Number	LOR	Unit	AMB01	AMB02	AMB03	AMB04	1566R
				16-AUG-2011 14:34	16-AUG-2011 12:49	16-AUG-2011 16:08	16-AUG-2011 11:31	15-AUG-2011 11:15
				EB1116777-001	EB1116777-002	EB1116777-003	EB1116777-004	EB1116777-005
<b>EG020F: Dissolved Metals by ICP-MS - Continued</b>								
Copper	7440-50-8	0.001	mg/L	----	----	----	----	<b>0.192</b>
Nickel	7440-02-0	0.001	mg/L	<0.001	<b>0.002</b>	<0.001	<0.001	----
Dysprosium	7429-91-6	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Erbium	7440-52-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Europium	7440-53-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----
Gadolinium	7440-54-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Gallium	7440-55-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Thallium	7440-28-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Hafnium	7440-58-6	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----
Holmium	7440-60-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Zinc	7440-66-6	0.005	mg/L	<b>0.008</b>	<b>0.005</b>	<b>0.008</b>	<b>0.016</b>	----
Indium	7440-74-6	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Lanthanum	7439-91-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Lead	7439-92-1	0.001	mg/L	----	----	----	----	<b>0.002</b>
Lutetium	7439-94-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Manganese	7439-96-5	0.001	mg/L	----	----	----	----	<b>0.303</b>
Molybdenum	7439-98-7	0.001	mg/L	----	----	----	----	<0.001
Neodymium	7440-00-8	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Nickel	7440-02-0	0.001	mg/L	----	----	----	----	<b>0.017</b>
Praseodymium	7440-10-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Rubidium	7440-17-7	0.001	mg/L	<b>0.015</b>	<b>0.008</b>	<b>0.005</b>	<b>0.008</b>	----
Samarium	7440-19-9	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Strontium	7440-24-6	0.001	mg/L	<b>0.174</b>	<b>0.267</b>	<b>0.178</b>	<b>1.21</b>	----
Tellurium	22541-49-7	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	----
Terbium	7440-27-9	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Thorium	7440-29-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Thulium	7440-30-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Titanium	7440-32-6	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Ytterbium	7440-64-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Yttrium	7440-65-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Zirconium	7440-67-7	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	----



## Analytical Results

Sub-Matrix: **WATER**

Client sample ID

Client sampling date / time

				AMB01	AMB02	AMB03	AMB04	1566R
				16-AUG-2011 14:34	16-AUG-2011 12:49	16-AUG-2011 16:08	16-AUG-2011 11:31	15-AUG-2011 11:15
Compound	CAS Number	LOR	Unit	EB1116777-001	EB1116777-002	EB1116777-003	EB1116777-004	EB1116777-005
<b>EG020F: Dissolved Metals by ICP-MS - Continued</b>								
Boron	7440-42-8	0.05	mg/L	----	----	----	----	<b>0.18</b>
Iron	7439-89-6	0.05	mg/L	<b>0.07</b>	<0.05	<0.05	<b>0.54</b>	<b>7.12</b>
<b>EG020T: Total Metals by ICP-MS</b>								
Aluminium	7429-90-5	0.01	mg/L	<b>0.06</b>	<b>0.59</b>	<b>0.20</b>	<b>0.48</b>	----
Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Arsenic	7440-38-2	0.001	mg/L	<0.001	<b>0.006</b>	<0.001	<0.001	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Barium	7440-39-3	0.001	mg/L	<b>0.066</b>	<b>0.077</b>	<b>0.052</b>	<b>0.174</b>	----
Bismuth	7440-69-9	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	----
Cerium	7440-45-1	0.001	mg/L	<0.001	<b>0.003</b>	<0.001	<b>0.002</b>	----
Caesium	7440-46-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<b>0.001</b>	----
Copper	7440-50-8	0.001	mg/L	<b>0.001</b>	<b>0.006</b>	<b>0.003</b>	<b>0.002</b>	----
Dysprosium	7429-91-6	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Erbium	7440-52-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Europium	7440-53-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Gadolinium	7440-54-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Gallium	7440-55-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Hafnium	7440-58-6	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----
Holmium	7440-60-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Indium	7440-74-6	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Lanthanum	7439-91-0	0.001	mg/L	<0.001	<b>0.001</b>	<0.001	<0.001	----
Lead	7439-92-1	0.001	mg/L	<0.001	<b>0.002</b>	<0.001	<0.001	----
Lithium	7439-93-2	0.001	mg/L	<b>0.034</b>	<b>0.038</b>	<b>0.033</b>	<b>0.001</b>	----
Lutetium	7439-94-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Manganese	7439-96-5	0.001	mg/L	<b>0.068</b>	<b>0.022</b>	<b>0.030</b>	<b>0.057</b>	----
Molybdenum	7439-98-7	0.001	mg/L	<0.001	<b>0.001</b>	<0.001	<b>0.001</b>	----
Neodymium	7440-00-8	0.001	mg/L	<0.001	<b>0.001</b>	<0.001	<0.001	----
Nickel	7440-02-0	0.001	mg/L	<0.001	<b>0.002</b>	<0.001	<b>0.001</b>	----
Praseodymium	7440-10-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Rubidium	7440-17-7	0.001	mg/L	<b>0.016</b>	<b>0.010</b>	<b>0.006</b>	<b>0.008</b>	----
Samarium	7440-19-9	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----
Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Strontium	7440-24-6	0.001	mg/L	<b>0.191</b>	<b>0.292</b>	<b>0.187</b>	<b>1.29</b>	----
Tellurium	22541-49-7	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	----



## Analytical Results

Sub-Matrix: WATER

Client sample ID

Client sampling date / time

				AMB01	AMB02	AMB03	AMB04	1566R
				16-AUG-2011 14:34	16-AUG-2011 12:49	16-AUG-2011 16:08	16-AUG-2011 11:31	15-AUG-2011 11:15
Compound	CAS Number	LOR	Unit	EB1116777-001	EB1116777-002	EB1116777-003	EB1116777-004	EB1116777-005
<b>EG020T: Total Metals by ICP-MS - Continued</b>								
Terbium	7440-27-9	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Thallium	7440-28-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Thorium	7440-29-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Thulium	7440-30-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Titanium	7440-32-6	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----
Ytterbium	7440-64-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Yttrium	7440-65-5	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Zinc	7440-66-6	0.005	mg/L	0.014	0.056	0.023	0.013	----
Zirconium	7440-67-7	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	----
Boron	7440-42-8	0.05	mg/L	0.19	0.18	0.15	0.50	----
Iron	7439-89-6	0.05	mg/L	0.21	0.51	0.19	1.08	----
<b>EG035F: Dissolved Mercury by FIMS</b>								
Mercury	7439-97-6	0.0001	mg/L	----	----	----	----	<0.0001
<b>EK040P: Fluoride by PC Titrator</b>								
Fluoride	16984-48-8	0.1	mg/L	----	----	----	----	0.2
<b>EK055G: Ammonia as N by Discrete Analyser</b>								
Ammonia as N	7664-41-7	0.01	mg/L	----	----	----	----	0.31
<b>EK057G: Nitrite as N by Discrete Analyser</b>								
Nitrite as N	----	0.01	mg/L	----	----	----	----	0.01
<b>EK058G: Nitrate as N by Discrete Analyser</b>								
^ Nitrate as N	14797-55-8	0.01	mg/L	----	----	----	----	0.03
<b>EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser</b>								
Nitrite + Nitrate as N	----	0.01	mg/L	----	----	----	----	0.04
<b>EK061G: Total Kjeldahl Nitrogen By Discrete Analyser</b>								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	----	----	----	----	6.4
<b>EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser</b>								
^ Total Nitrogen as N	----	0.1	mg/L	----	----	----	----	6.4
<b>EN055: Ionic Balance</b>								
^ Total Anions	----	0.01	meq/L	14.2	15.5	13.1	45.0	----
Total Anions	----	0.01	meq/L	----	----	----	----	16.4
^ Total Cations	----	0.01	meq/L	15.0	16.6	14.0	47.8	16.8
^ Ionic Balance	----	0.01	%	2.88	3.37	3.29	3.03	----
Ionic Balance	----	0.01	%	----	----	----	----	1.18
<b>EP080/071: Total Petroleum Hydrocarbons</b>								



## Analytical Results

Sub-Matrix: **WATER**

Client sample ID

Client sampling date / time

				AMB01	AMB02	AMB03	AMB04	1566R
				16-AUG-2011 14:34	16-AUG-2011 12:49	16-AUG-2011 16:08	16-AUG-2011 11:31	15-AUG-2011 11:15
Compound	CAS Number	LOR	Unit	EB1116777-001	EB1116777-002	EB1116777-003	EB1116777-004	EB1116777-005
<b>EP080/071: Total Petroleum Hydrocarbons - Continued</b>								
C6 - C9 Fraction	----	20	µg/L	20	20	<20	20	----
C10 - C14 Fraction	----	50	µg/L	<50	<50	<50	<50	----
C15 - C28 Fraction	----	100	µg/L	<100	<100	<100	<100	----
C29 - C36 Fraction	----	50	µg/L	<50	<50	<50	<50	----
^ C10 - C36 Fraction (sum)	----	50	µg/L	<50	<50	<50	<50	----
<b>EP080/071: Total Recoverable Hydrocarbons - NEPM 2010 Draft</b>								
C6 - C10 Fraction	----	20	µg/L	30	20	20	20	----
>C10 - C16 Fraction	----	100	µg/L	<100	<100	<100	<100	----
>C16 - C34 Fraction	----	100	µg/L	<100	<100	<100	<100	----
>C34 - C40 Fraction	----	100	µg/L	<100	<100	<100	<100	----
^ >C10 - C40 Fraction (sum)	----	100	µg/L	<100	<100	<100	<100	----
<b>EP080S: TPH(V)/BTEX Surrogates</b>								
1,2-Dichloroethane-D4	17060-07-0	0.1	%	106	104	101	105	----
Toluene-D8	2037-26-5	0.1	%	98.9	95.1	96.1	97.3	----
4-Bromofluorobenzene	460-00-4	0.1	%	99.9	95.9	95.9	97.3	----





## Analytical Results

Sub-Matrix: WATER

Client sample ID

Client sampling date / time

				1612R	1611R	1610R	1618R	1617R
				15-AUG-2011 13:30	15-AUG-2011 14:36	15-AUG-2011 15:18	15-AUG-2011 16:12	15-AUG-2011 16:27
Compound	CAS Number	LOR	Unit	EB1116777-006	EB1116777-007	EB1116777-008	EB1116777-009	EB1116777-010
<b>EA005P: pH by PC Titrator</b>								
pH Value	----	0.01	pH Unit	6.54	6.32	6.73	6.69	5.94
<b>EA010P: Conductivity by PC Titrator</b>								
Electrical Conductivity @ 25°C	----	1	µS/cm	8280	7440	27700	29000	52300
<b>EA015: Total Dissolved Solids</b>								
^ Total Dissolved Solids @180°C	GIS-210-010	5	mg/L	5520	4740	18900	18700	37300
<b>ED037P: Alkalinity by PC Titrator</b>								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	68	42	126	71	42
Total Alkalinity as CaCO3	----	1	mg/L	68	42	126	71	42
<b>ED040F: Dissolved Major Anions</b>								
Sulfate as SO4 2-	14808-79-8	1	mg/L	174	65	768	1310	2640
<b>ED045G: Chloride Discrete analyser</b>								
Chloride	16887-00-6	1	mg/L	2630	2400	9090	9470	17800
<b>ED093F: Dissolved Major Cations</b>								
Calcium	7440-70-2	1	mg/L	160	95	356	135	266
Magnesium	7439-95-4	1	mg/L	149	110	415	408	898
Sodium	7440-23-5	1	mg/L	1420	1370	4740	6490	11800
Potassium	7440-09-7	1	mg/L	16	15	39	23	42
<b>EG020F: Dissolved Metals by ICP-MS</b>								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	<0.10	<0.10	<0.10
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.010	<0.010	<0.010
Cadmium	7440-43-9	0.0001	mg/L	0.0002	<0.0001	<0.0010	<0.0010	<0.0010
Copper	7440-50-8	0.001	mg/L	0.025	0.023	0.066	0.025	0.115
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.010	<0.010	<0.010
Manganese	7439-96-5	0.001	mg/L	1.03	0.643	1.98	2.20	1.40
Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	<0.010	<0.010	<0.010
Nickel	7440-02-0	0.001	mg/L	0.016	0.005	<0.010	0.028	0.038
Boron	7440-42-8	0.05	mg/L	0.15	0.15	<0.50	1.05	1.46
Iron	7439-89-6	0.05	mg/L	0.07	0.05	<0.50	<0.50	3.29
<b>EG035F: Dissolved Mercury by FIMS</b>								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
<b>EK040P: Fluoride by PC Titrator</b>								
Fluoride	16984-48-8	0.1	mg/L	0.1	<0.1	0.4	0.2	<0.1
<b>EK055G: Ammonia as N by Discrete Analyser</b>								
Ammonia as N	7664-41-7	0.01	mg/L	0.03	0.01	0.02	0.06	0.22



## Analytical Results

Sub-Matrix: **WATER**

Client sample ID

Client sampling date / time

				1612R	1611R	1610R	1618R	1617R
				15-AUG-2011 13:30	15-AUG-2011 14:36	15-AUG-2011 15:18	15-AUG-2011 16:12	15-AUG-2011 16:27
Compound	CAS Number	LOR	Unit	EB1116777-006	EB1116777-007	EB1116777-008	EB1116777-009	EB1116777-010
<b>EK057G: Nitrite as N by Discrete Analyser</b>								
Nitrite as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
<b>EK058G: Nitrate as N by Discrete Analyser</b>								
^ Nitrate as N	14797-55-8	0.01	mg/L	0.05	0.02	0.02	0.02	0.02
<b>EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser</b>								
Nitrite + Nitrate as N	----	0.01	mg/L	0.05	0.02	0.02	0.02	0.02
<b>EK061G: Total Kjeldahl Nitrogen By Discrete Analyser</b>								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	0.5
<b>EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser</b>								
^ Total Nitrogen as N	----	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	0.5
<b>EN055: Ionic Balance</b>								
^ Total Anions	----	0.01	meq/L	79.2	69.9	275	296	558
^ Total Cations	----	0.01	meq/L	82.4	73.8	259	323	602
^ Ionic Balance	----	0.01	%	2.00	2.68	2.98	4.40	3.74



## Analytical Results

Sub-Matrix: WATER

Client sample ID

Client sampling date / time

				1620R	1614R	1615R	1622R	1621R
				15-AUG-2011 17:18	16-AUG-2011 07:00	16-AUG-2011 07:05	16-AUG-2011 09:18	16-AUG-2011 09:21
Compound	CAS Number	LOR	Unit	EB1116777-011	EB1116777-012	EB1116777-013	EB1116777-014	EB1116777-015
<b>EA005P: pH by PC Titrator</b>								
pH Value	----	0.01	pH Unit	7.76	7.16	7.75	7.31	7.41
<b>EA010P: Conductivity by PC Titrator</b>								
Electrical Conductivity @ 25°C	----	1	µS/cm	1940	900	560	36000	18500
<b>EA015: Total Dissolved Solids</b>								
^ Total Dissolved Solids @180°C	GIS-210-010	5	mg/L	1140	520	377	25000	11000
<b>ED037P: Alkalinity by PC Titrator</b>								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	150	187	184	270	184
Total Alkalinity as CaCO3	----	1	mg/L	150	187	184	270	184
<b>ED040F: Dissolved Major Anions</b>								
Sulfate as SO4 2-	14808-79-8	1	mg/L	115	20	36	1510	706
<b>ED045G: Chloride Discrete analyser</b>								
Chloride	16887-00-6	1	mg/L	484	192	41	12600	5850
<b>ED093F: Dissolved Major Cations</b>								
Calcium	7440-70-2	1	mg/L	48	20	27	428	124
Magnesium	7439-95-4	1	mg/L	19	9	7	548	172
Sodium	7440-23-5	1	mg/L	368	178	85	8200	3570
Potassium	7440-09-7	1	mg/L	10	6	7	52	30
<b>EG020F: Dissolved Metals by ICP-MS</b>								
Aluminium	7429-90-5	0.01	mg/L	0.01	0.02	<0.01	<0.10	<0.10
Arsenic	7440-38-2	0.001	mg/L	0.002	0.001	0.002	<0.010	<0.010
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0010	<0.0010
Copper	7440-50-8	0.001	mg/L	0.002	0.002	0.003	0.028	0.012
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.010	<0.010
Manganese	7439-96-5	0.001	mg/L	0.513	0.154	0.063	3.28	0.461
Molybdenum	7439-98-7	0.001	mg/L	0.005	0.002	0.004	<0.010	<0.010
Nickel	7440-02-0	0.001	mg/L	<0.001	0.002	0.001	<0.010	<0.010
Boron	7440-42-8	0.05	mg/L	0.14	0.10	0.11	1.10	0.77
Iron	7439-89-6	0.05	mg/L	0.06	<0.05	<0.05	<0.50	<0.50
<b>EG035F: Dissolved Mercury by FIMS</b>								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
<b>EK040P: Fluoride by PC Titrator</b>								
Fluoride	16984-48-8	0.1	mg/L	0.6	0.5	0.6	0.8	0.4
<b>EK055G: Ammonia as N by Discrete Analyser</b>								
Ammonia as N	7664-41-7	0.01	mg/L	0.14	0.03	0.01	0.04	0.07



## Analytical Results

Sub-Matrix: **WATER**

Client sample ID

Client sampling date / time

				1620R	1614R	1615R	1622R	1621R
				15-AUG-2011 17:18	16-AUG-2011 07:00	16-AUG-2011 07:05	16-AUG-2011 09:18	16-AUG-2011 09:21
Compound	CAS Number	LOR	Unit	EB1116777-011	EB1116777-012	EB1116777-013	EB1116777-014	EB1116777-015
<b>EK057G: Nitrite as N by Discrete Analyser</b>								
Nitrite as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
<b>EK058G: Nitrate as N by Discrete Analyser</b>								
^ Nitrate as N	14797-55-8	0.01	mg/L	0.05	0.04	0.04	0.02	0.03
<b>EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser</b>								
Nitrite + Nitrate as N	----	0.01	mg/L	0.05	0.04	0.04	0.02	0.03
<b>EK061G: Total Kjeldahl Nitrogen By Discrete Analyser</b>								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.2	1.5	0.4	<0.1	0.5
<b>EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser</b>								
^ Total Nitrogen as N	----	0.1	mg/L	0.2	1.5	0.4	<0.1	0.5
<b>EN055: Ionic Balance</b>								
^ Total Anions	----	0.01	meq/L	19.0	9.57	5.58	392	183
^ Total Cations	----	0.01	meq/L	20.2	9.63	5.80	424	176
^ Ionic Balance	----	0.01	%	2.98	0.32	1.88	3.93	1.96



Surrogate Control Limits

Sub-Matrix: WATER		Recovery Limits (%)	
Compound	CAS Number	Low	High
EP080S: TPH(V)/BTEX Surrogates			
1,2-Dichloroethane-D4	17060-07-0	66.1	137.9
Toluene-D8	2037-26-5	79.2	119.6
4-Bromofluorobenzene	460-00-4	74.2	118.0



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