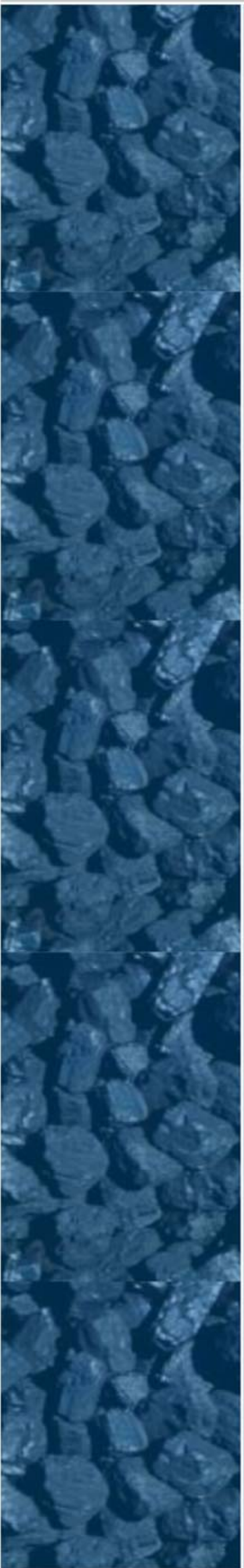
Adani Mining Pty Ltd



Adani Mining Pty Ltd

Carmichael Coal Mine and Rail Project: Mine Technical Report

Mine Water Quality 25215-D-RP-0005

15 November 2012

Revision 2

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Abbreviations and Glossary

Project Specific Terminology	
Abbreviation	**Term**
the EIS	Carmichael Coal Mine and Rail Project Environmental Impact Statement
the Proponent	Adani Mining Pty Ltd
the Project	Carmichael Coal Mine and Rail Project
Generic Terminology	
Abbreviation	**Term**
ANZECC	Australian and New Zealand Environment and Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
BOM	Bureau of Meteorology
cfu	Colony Forming Units
DAFF	Department of Agriculture, Forestry and Fisheries (Qld)
DEHP	Departmen of Environment and Heritage Protection
DERM	Former Department of Environment and Resource Management (Qld)
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities (former DEWHA, Department of Environment, Water, Heritage and the Arts)
DI	deionised
DO	Dissolved Oxygen
EC	Electrical Conductivity
EIS	Environmental Impact Statement
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EPC	Exploration Permit for Coal
EPP (Water)	Queensland Environmental Protection (Water) Policy 2009
EVs	Environmental Values
Ha	Hectares
HD	Highly disturbed
HEV	High ecological / conservation value
HMTV	Hardness-modified trigger value
ISQG	Interim Sediment Quality Guideline

LTV	Long-term trigger value
MAW	Mine affected water
MIA	Mine Infrastructure Area
matters of NES	Matters of National Environmental Significance
Generic Terminology	
Abbreviation	**Term**
NWQMS	National Water Quality Management Strategy
NWQMS	National Water Quality Management Strategy
PAHs	Polycyclic Aromatic Hydrocarbons
PMEWQCQ	Policy for the Maintenance and Enhancement of Water Quality in Central Queensland
QWQG	Queensland Water Quality Guidelines
SMD	Slightly-moderately disturbed
SQOs	Sediment Quality Objectives
STV	Short-term trigger value
TDS	Total dissolved solids
ToR	terms of reference
TPHs	Total Petroleum Hydrocarbons
TSS	Total suspended solids
WQOs	Water Quality Objectives

Executive Summary

This assessment addresses the surface water quality aspects of final terms of reference (ToR) for the mine component of the Carmichael Coal Mine and Rail Project Environmental Impact Statement (May, 2011). A combination of desktop and field assessments were undertaken to describe the existing surface water resources that may be affected by the Project in the context of environmental values as defined by:

- *Queensland Environmental Protection Act 1994* (EP Act)
- Queensland Environmental Protection (Water) Policy 2009 (EPP (Water))
- Australia and New Zealand Guidelines for Fresh and Marine Water Quality 2000 (the ANZECC guidelines) (ANZECC and ARMCANZ, 2000)
- Queensland Water Quality Guidelines 2009 (QWQG) (DERM, 2009a)

In order to characterise the quality of the surface water resources within the Study Area a field-based water and in-stream sediment quality assessment was undertaken from April to September 2011. Twelve sites representative of the resources within the Study Area were assessed. Of these, four were located on the Carmichael River, one on Cabbage Tree Creek, three on Eight Mile Creek (dry throughout the sampling program) and four at farm dams. Sampling of the Carmichael River and Dam sites was achieved during all six sampling events. Site access limited the sampling of Cabbage Tree Creek to four sampling events. Sampling of the dry sites, located on Eight Mile Creek, was achieved once during the monitoring program. Following completion of the monitoring program, EPC1080 was achieved, which includes a number of surface water resources that have not been investigated during this program. Additional downstream monitoring sites will be chosen following the inclusion of EPC1080. Further background monitoring will be undertaken by Adani prior to commencement of construction.

The sampling program was comprised of a combination of *in-situ* sampling of physical water quality parameters, collection of water samples for laboratory analysis of basic and broad suites, and collection of sediment samples for laboratory analysis. All sampling was undertaken in accordance with the requirements of the QWQG (DERM, 2009a), the Monitoring and Sampling Manual 2009 (DERM, 2009b), and the ANZECC guidelines (ANZECC and ARMCANZ, 2000).

Physical water quality parameters measured include temperature, turbidity, dissolved oxygen, electrical conductivity and pH. The basic analytical suite was comprised of nutrients, chlorophyll a, faecal coliforms, total dissolved solids and total suspended solids. The broad analytical suite was comprised of total and dissolved metals, hydrocarbons (total and PAHs), major anions and cations, fluoride, silicon, and hardness.

In-stream sediment samples were analysed once during the monitoring program for physical parameters including grain size, total organic carbon and moisture content, total metals, nutrients, hydrocarbons (total and PAHs) and faecal coliforms. Additional sediment samples were collected from the monitoring sites that did not contain any water during the monitoring program. These samples were subject to a deionised water leach preparation. The resulting supernatant was analysed in order to gain an understanding of the potential for release of contaminants during flow events.

Quality Assurance/Quality Control procedures were undertaken in accordance with the requirements of the Monitoring and Sampling Manual (DERM, 2009b). Similarly, analysis of the data was undertaken in accordance with the various guidelines. Interpretation of results to the nominated WQOs was undertaken by comparing:

- Median values for physical parameters and nutrient data (refer to QWQG; DERM 2009a)
- 95th percentile values for toxicant data (refer to the ANZECC guidelines; ANZECC and ARMCANZ, 2000)

Where appropriate, hardness-modified trigger values were calculated for the comparison of metal data, as required by the ANZECC guidelines (ANZECC and ARMCANZ, 2000).

The existing surface water resources within the Study Area include the Carmichael River, two ephemeral creek drainage lines (Cabbage Tree Creek and Eight Mile Creek, dry during the monitoring period) and thirteen farm dams. The Carmichael River, designated as a fifth order stream (DERM, 2009c), is the major surface water resource within the Study Area. The flow regime of the Carmichael River (further described in Volume 4 Appendix P) is subject to seasonal variability as wet season overland flow drains from the catchment. Late in the dry season the Carmichael River is reduced to a low flow environment, interspersed with deeper pools. The Carmichael River was characterised by a well-established riparian zone that provided extensive shading of the water. Conversely, the farm dam sites and Cabbage Tree Creek all had limited riparian zones, resulting in increased exposure to direct radiance from the sun.

An assessment of the water chemistry of the Carmichael River and nearby groundwater resources identified that it is likely that the surface water quality of the Carmichael River is influenced by the nearby groundwater aquifers. Temporal changes in the surface water chemistry also indicate that the influence of groundwater on the Carmichael River is greater in the dry season than in the wet season when rain water is entering the system.

Parameters analysed as part of the monitoring program displayed both spatial and temporal variations. Spatial patterns were consistently related to the differences between the types of water resources (Carmichael River versus non-flowing environments). Sites sampled along the Carmichael River displayed little spatial variation, indicating that the results obtained from the monitoring program are fairly typical of that stretch of the river. Temporal patterns at the Carmichael River sites were related to seasonal variability associated with the influx of overland flows prior to the start of the monitoring program, and subsequent drying of the water resources as the dry season progressed. All monitoring was undertaken in low-flow conditions, and flow progressively decreased as monitoring progressed.

The Carmichael River displayed high turbidity at the start and end of the monitoring program. This has been attributed to the increase of overland flow input of fine sediments (associated with preceding rainfall events) at the start of the monitoring program, and re-suspension of sediments in shallower waters at the end of the monitoring program. Dissolved oxygen concentrations in the Carmichael River were relatively low throughout the monitoring program. These low values are likely associated with the low flow conditions experienced for the majority of the program. The waters of the Carmichael River displayed an alkaline pH throughout the monitoring program. The soils investigation report associated with this Project (Mine) indicates this is likely linked to the alkalinity of the adjacent soils (refer Volume 4 Appendix L Soils Report). Temperature characteristics of the Carmichael River were closely linked to seasonality, whereby higher temperatures were recorded in the warmer months. Effects of shading were also evident; the Carmichael River sites which were shaded had greater buffering capacity against changes in temperature than the exposed sites at the farm dams and Cabbage Tree Creek.

Concentrations of total nitrogen in the Carmichael River were consistently greater than expected ranges, and were primarily derived from concentrations of organic nitrogen. Other nutrients, including total and reactive phosphorus were within expected ranges. Despite the high concentrations of nitrogen, no algal blooms were observed onsite, or from chlorophyll a testing. Faecal coliform testing identified faecal coliforms to be present at all the Carmichael River sites. This has been linked to the ongoing cattle grazing of the Study Area. Hydrocarbons were not present in the waters of the Carmichael River.

The in-stream sediments of the Carmichael River were characterised by sands. Nutrients were present in low concentrations and faecal coliforms were only present in the sediments at only one site. As with the findings from the water quality assessment, hydrocarbons were not present in the in-stream sediments of the Carmichael River.

Metals detected in the waters of the Carmichael River include aluminium, antimony, arsenic, barium, boron, chromium, cobalt, copper, iron, lead, manganese, nickel, tin, vanadium and zinc. The majority of these metals were also present in the in-stream sediments of the river. Total copper and dissolved zinc 95^{th} percentile concentrations were above the HMTV for protection of aquatic ecosystems. Total and dissolved iron and manganese 95^{th} percentile concentrations exceeded the long-term trigger values (LTV) for metals in irrigation water.

The quality of the water in the still water bodies was different to the Carmichael River, which is primarily due to the non-flow conditions of those bodies, lack of riparian cover and use of the dam water resources by cattle. The electrical conductivity of the still water bodies was substantially lower than the Carmichael River, indicating that input from the alluvial groundwater aquifer that interacts with the river is unlikely. Given that dams are designed to limit the potential for leaching of waters, the disconnect between these resources and groundwater aquifers is not unexpected.

Turbidity values in the still water bodies were elevated, but still lower than those recorded in the Carmichael River. This has been associated with the non-flow conditions which allow for sediments to settle out of suspension. Dissolved oxygen concentrations were also low, one of the few parameters which was comparable to river concentrations. This is not unexpected given that the low DO concentrations in the river are likely associated with low-flow conditions. The pH values in the still water bodies were slightly elevated, although less alkaline than the waters of the Carmichael River. Temperature trends observed in the still water bodies were similar to the Carmichael River trends, although still water bodies experienced a greater range in temperature. This is associated with the lack of shading, and thus reduced temperature buffering capacity of the still water bodies.

The concentrations of nutrients were generally higher in the still water bodies than in the Carmichael River. As with the Carmichael River results, concentrations of total nitrogen were attributable to concentrations of organic nitrogen. Some still water bodies also contained moderate concentrations of ammonia. Reactive phosphorus concentrations in the still water bodies were consistently higher than the concentrations found in the Carmichael River.

Chlorophyll a concentrations were also higher in the still water bodies than in the Carmichael River sites, however, no blooms were observed during monitoring. Faecal coliform testing identified that faecal coliforms were present at all the still water body sites. No distinct spatial patterns between the Carmichael River sites and the still water bodies were observed.

As with the Carmichael River sites, hydrocarbons were not present at the still water bodies. Similarly, a number of metals were present in the waters and sediments of the still water bodies. These include aluminium, arsenic, barium, boron, chromium, cobalt, copper, iron, lead, manganese, nickel, strontium,

vanadium and zinc. The differences in metal concentrations between the Carmichael River and the still water bodies are likely attributable to local soil characteristics and previous farming activities. Total and dissolved aluminium, chromium, copper, lead and zinc 95th percentile concentrations exceeded the WQOs for protection of aquatic ecosystems. Total aluminium 95th percentile concentrations also exceeded the LTV for metals in irrigation water and the WQOs nominated for stock watering. The 95th percentile concentrations of total and dissolved manganese exceeded the LTV for metals in irrigation water.

The sediments of the still water bodies were comprised of sands, silts and clays. Concentrations of nutrients in the sediments were generally much higher in the still water bodies than in the Carmichael River. These results are consistent with the findings of the water quality assessment, and have been attributed to the lack of flushing of the still water bodies. Faecal coliforms were detected in the sediments of all of the still water bodies, reflecting the findings of the water quality assessment. Hydrocarbons were not present in the sediments of the still water bodies.

Some of the nominated sampling sites located in the north of the Study Area were dry throughout the monitoring program. In order to gain an understanding of the potential contaminants that may be released during flow events, DI leach testing was undertaken. Results were generally consistent with the findings of the broader monitoring program, indicating that the sampling sites can be considered to be representative of the water resources present within the Study Area.

Collated information relating to the water resources of the Study Area identified the following EVs of relevance:

- Aquatic ecosystems – slightly to moderately disturbed
- Primary industries – irrigation
- Primary industries – stock watering
- Cultural and spiritual values

As required by the QWQG (DERM, 2009a), WQOs for the protection of the EVs were identified. Data obtained during the assessment has been compared to the nominated WQOs.

Data collected did not consistently align with the WQOs. This was particularly evident at the end of the wet season (April), and at the end of the dry season (September). As such, the nominated WQOs are not considered to be appropriate for the management of surface water quality during construction and operation of the Project (Mine). The development of site specific WQOs will need to take the large observed temporal variation into consideration.

Assessment of the potential impacts associated with the construction and operation phases of the Project (Mine) identified that activities have the potential to negatively affect the quality of the water in the region. Measures to mitigate and/or manage potential impacts have been identified, including those that will be implemented through engineering design, management plans and monitoring programs. Implementation of identified measures is considered to substantially reduce the risk of impact to water quality, such that the majority of actions are considered to have no residual risk. Those actions with residual risk to water quality include:

- The mobilisation of pollutants to water resources as a result of a spill outside bunded areas.
- The loss of catchment and alteration of flows associated with a development footprint of approximately 41,245 ha.

- Potential flow on effects to water quality as a result of changes to the interaction between groundwater and surface water.

1. Introduction

1.1 Project Overview

Adani Mining Pty Ltd (Adani) is proposing to develop a 60 million tonne (product) per annum (Mtpa) thermal coal mine in the north Galilee Basin approximately 160 kilometres (km) north-west of the town of Clermont, Central Queensland. All coal will be railed via a privately owned rail line connecting to the existing QR National rail infrastructure, and shipped through coal terminal facilities at the Port of Abbot Point and the Port of Hay Point (Dudgeon Point expansion). The Carmichael Coal Mine and Rail Project (the Project) will have an operating life of approximately 90 years.

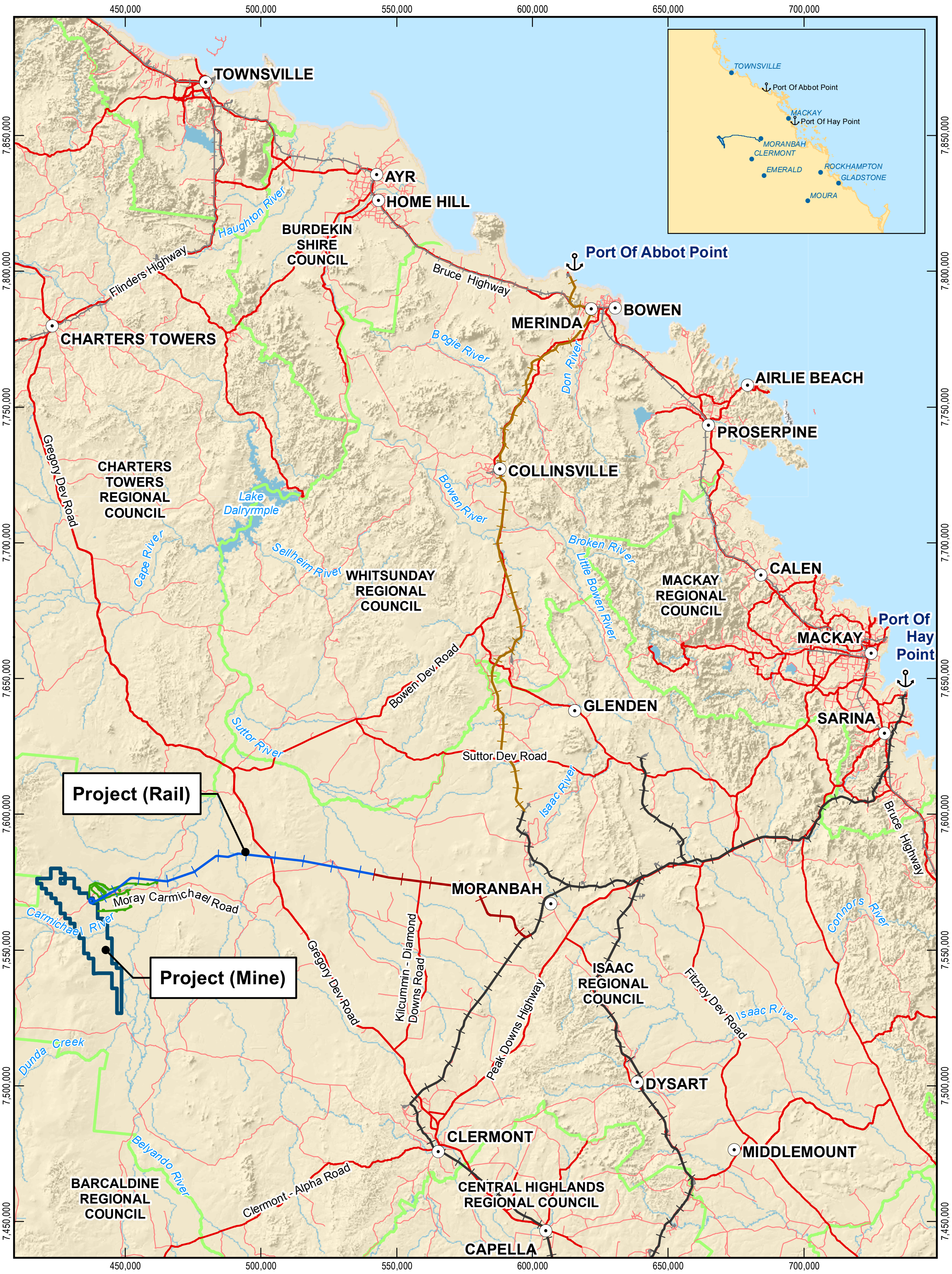
The Project comprises of two major components:

- The Project (Mine): a greenfield coal mine over EPC1690 and the eastern portion of EPC1080, which includes both open cut and underground mining, on mine infrastructure and associated mine processing facilities (the Mine) and the Mine (offsite) infrastructure including:
  - A workers accommodation village
  - An industrial development area and airport site
  - Water supply infrastructure
- The Project (Rail): a greenfield rail line connecting the Mine to the existing Goonyella and Newlands rail systems to provide for the export of coal via the Port of Hay Point (Dudgeon Point expansion) and the Port of Abbot Point, respectively; including:
  - Rail (west): a 120 km dual gauge portion from the Mine site running west to east to Diamond Creek
  - Rail (east): a 69 km narrow gauge portion running east from Diamond Creek connecting to the Goonyella rail system south of Moranbah

The Project has been declared a 'significant project' under the *State Development and Public Works Organisation Act 1971* (SDPWO Act) and as such, an Environmental Impact Statement (EIS) is required for the Project. The Project is also a 'controlled action' and requires assessment and approval under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The Project EIS has been developed with the objective of avoiding or mitigating all potential adverse impacts to environmental, social and economic values and enhancing positive impacts. Detailed descriptions of the Project are provided in Volume 2 Section 2 Project Description (Mine) and Volume 3 Section 2 Project Description (Rail).

Figure 1-1 shows the Project location.



LEGEND

Town	State Road	Project (Rail)	Project (Mine)
Major Port	Local Road	Rail (West)	Mine (Offsite)
Other Rail Network	Watercourse	Rail (East)	
Goonyella System	Local Government Area		
Newlands System			

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Horizontal Datum: Geocentric Datum of Australia (GDA)
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Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project

Job Number 41-25215
Revision L
Date 28-08-2012

Project Location

Figure: 1-1

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Level 4, 201 Charlotte St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data Source: © Commonwealth of Australia (Geoscience Australia): Town, Railways, Watercourses (2007); DERM: LGA, (2011), Hillshade (2009); DMR: State Roads (2008); Gassman/Hyder: Mine (Offsite) (2012); DME: EPC1690 (2010), EPC1080 (2011); Adani: Alignment Opt9 Rev3 (2012). Created by: BW, JVC

1.2 Assessment and Reporting Scope

This assessment addresses the surface water quality aspects of final terms of reference (ToR) for the mine component of the Carmichael Coal Mine and Rail Project Environmental Impact Statement (the EIS; May, 2011). A combination of desktop and field assessments were undertaken to describe the existing surface water resources that may be affected by the Project in the context of environmental values as defined by:

- *Queensland Environmental Protection Act 1994* (EP Act)
- Queensland Environmental Protection (Water) Policy 2009 (EPP (Water))
- Australia and New Zealand Guidelines for Fresh and Marine Water Quality 2000 (the ANZECC guidelines) (ANZECC and ARMCANZ, 2000)
- Queensland Water Quality Guidelines 2009 (QWQG) (DERM, 2009a)

Field assessments were undertaken in accordance with the former Queensland Department of Environment and Resource Management (DERM) *Monitoring and Sampling Manual 2009* (DERM, 2009b). Where appropriate, results have been compared to guidelines and trigger levels.

The EIS comprises multiple elements, including sections on the description and assessment of potential impacts on the surface water resources of the Study Area. This document provides a summary of the surface water quality assessments undertaken to date, and recommendations for incorporation into the EIS. Additional assessments that complement this report are the surface hydrology assessment and the flood assessment (Volume 4 Appendix P Mine Hydrology Report), the groundwater report (Volume 4 Appendix R Mine Hydrogeology Report), the aquatic ecology report (Volume 4 Appendix O Mine Aquatic Ecology Report) and the terrestrial flora and fauna report (Volume 4 Appendix N Mine Terrestrial Ecology Report). Readers should be familiar with all relevant documents to assist in providing context to the findings reported here.

Table 1-1 provides a cross-reference with the section of this report and the Project terms of reference (ToR). The complete Project ToR is provided in Appendix A.

Table 1-1 Terms of Reference Cross Reference

Terms of Reference Requirement/Section Number	Section of this report
Section 3.4 Water Resources	
Section 3.4.1 Description of environmental values	
Describe the surface water and ground water quality considering seasonal variations in depth and flow.	Section 4.3
Investigate the relationship between groundwater and surface water to assess the nature of any interaction between the two, and any implications of the proposed mine that would affect the interaction	Section 4.3
Describe the environmental values of the surface waterways and groundwater of the affected area	Sections 4
Potential for contamination to surface water	Section 5.2

1.3 Surface Water Features in the Study Area

The Study Area for the water quality assessment is defined by the boundaries of EPC 1690, and the area immediately upstream and downstream of the boundary where the Carmichael River crosses EPC 1690 (Figure 1-2). This encompasses approximately 26,000 hectares (ha) of predominantly grazing land.

The Study Area was determined based on early design of the proposed Carmichael Coal Mine, and incorporated sites located upstream and downstream the mine footprint. Post completion of the field assessment the footprint of the proposed Carmichael Coal Mine Site was expanded to include additional areas to the east and north of the Study Area (Figure 1-2). Field investigations completed to date address this additional footprint but don't provide downstream information. However, impact assessment has taken into consideration the similarity of the surrounding water bodies based on data collected within this study to understand potential for downstream affects from the Project (Mine).

The water quality assessment was undertaken prior to the inclusion of part of EPC1080 into the Project (Mine). The assessment herein describes impacts to water resources within EPC1080 based on data collected from similar water bodies within EPC1690. To assist the development of baseline water quality information and threshold values, additional surveys to monitoring water quality conditions within EPC1080 will occur. Additional survey sites will be representatively of the water resources within EPC1080 with sufficient replication to enable the development of threshold values (i.e. at least 12 samples). Further water quality baseline monitoring has been commissioned by Adani and will occur through 2012 and 2013 at the same sites sampled in 2011, in order to further understand receiving water quality characteristics and inform decision making and conditioning in regards to construction and operational water discharges to waterways adjacent to the Project (Mine).

The Study Area contains one major waterway, the Carmichael River, which is designated as a fifth order stream (DERM, 2010). The Carmichael River flows through the southern section of Study Area (Figure 1-2) joining the Belyando River approximately 20 km to the east. The Belyando Catchment is approximately 35,411 km^2 and is one of the main sub-catchments in the Burdekin Basin (Figure 1-1).

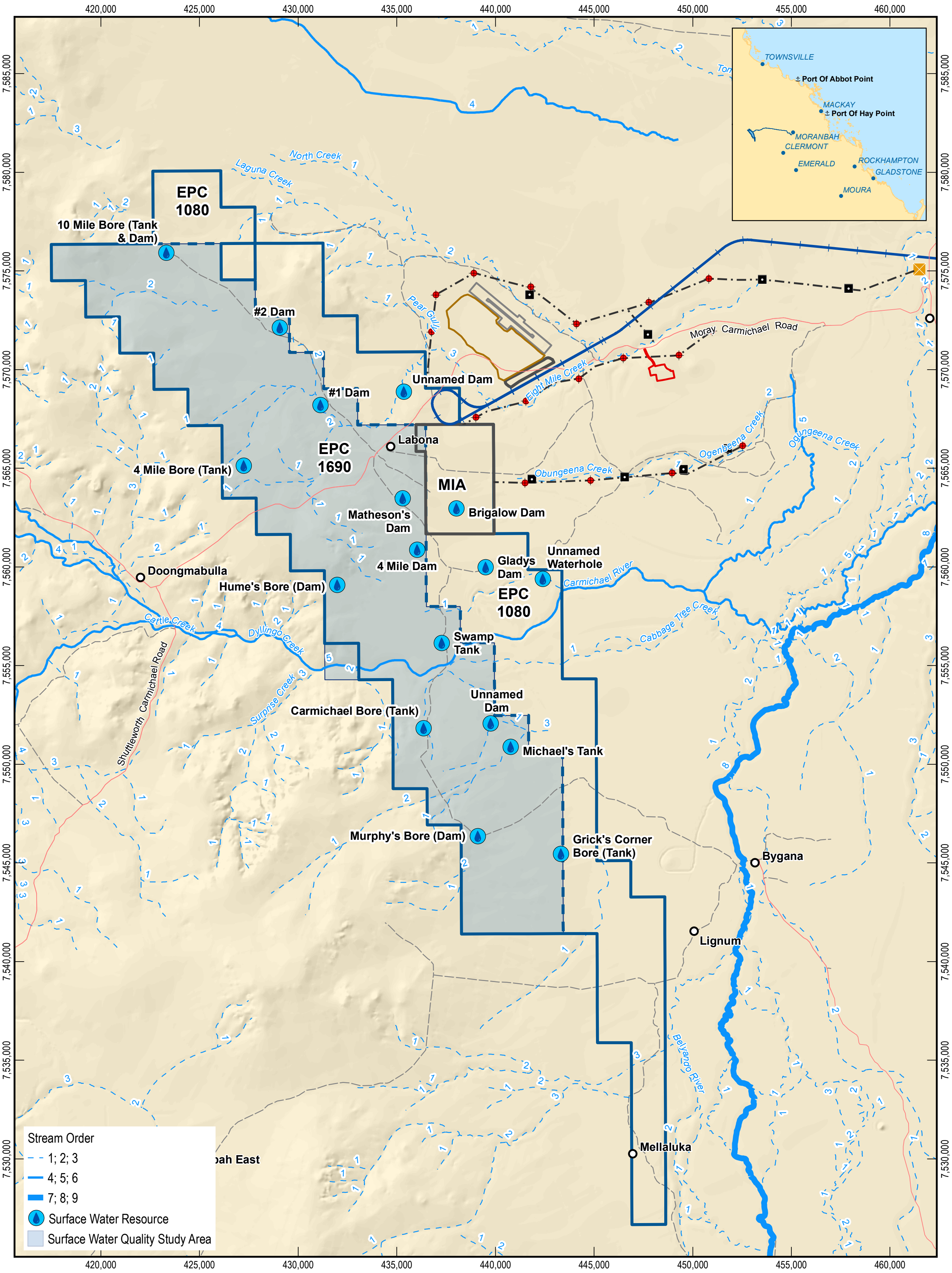
Other water resources within the Study Area include a number of ephemeral creeks, drainage lines and farm dams. These resources, shown on Figure 1-2, include:

- Eight Mile Creek, located at the north of the Study Area. Within the Study Area this ephemeral creek is designated as a first and second order stream (DERM, 2010).
- Cabbage Tree Creek, located to the south of the Carmichael River. Within the Study Area this ephemeral creek is designated as a first order stream (DERM, 2010).
- Thirteen farm dams on EPC 1690, often associated with tanks or bores:
  - Ten Mile Bore (Tank and Dam)
  - Number Two Dam located along a drainage line associated with Eight Mile Creek
  - Number One Dam located along a drainage line associated with Eight Mile Creek
  - Four Mile Bore (Tank)
  - Matheson's Dam located to the north of the Carmichael River
  - Four Mile Dam located to the north of the Carmichael River
  - Humes Bore (Dam) located to the north of the Carmichael River
  - Swamp Tank located to the north of the Carmichael River
  - Carmichael Bore (Tank) located to the south of the Carmichael River

– Unnamed Dam located to the south of the Carmichael River
– Michael's Tank located to the south of the Carmichael River
– Murphy's Bore (Dam) located to the south of the Carmichael River
– Grick's Corner Bore (Tank), located to the south of the Carmichael River

The Mine (offsite) infrastructure is located to the north east of EPC 1690 and 1080 between Eight Mile Creek and North Creek.

Outside of the main Study Area, Doongmabulla Springs has been sampled to provide a baseline for ongoing analysis and management of this area. The sampling locations for this area are provided in Figure 2-2 and are reported separately in Section 4.6.



LEGEND

- Homestead
- Local Road
- Track
- Rail (West)
- Mine (Onsite)
- Mine Infrastructure Area
- Mine (Offsite)
- Borehole
- Storage Site (Instream)
- Storage Facility (Offstream)
- Pipeline Network
- Airport Location
- Rail Siding
- Industrial Area
- Workers Accommodation Village

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Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

Adani Mining Pty Ltd

Carmichael Coal Mine and Rail Project

Surface Water Quality Study Area

Job Number	41-25215
Revision	A
Date	29-08-2012

Figure: 1-2

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Level 4, 201 Charlotte St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data Source: DERM: DCDB, Stream Network (2010); DME: EPC 1690 (2010)/EPC 1080 (2011); © Copyright Commonwealth of Australia - Geoscience Australia: Mainland, Homestead, Locality, Road (2007); GHD: Surface Water Resources, Study Area(2011); Adani: Alignment Opt9 Rev3 (2012); Gassman/Hyder: Mine (Offsite) (2012); Created by: BW.

2. Methods

2.1 EPC 1690 Field Assessment

2.1.1 Overview

A field-based water and in-stream sediment quality assessment of the Study Area was undertaken from April to September 2011. The objective of this assessment was to characterise the quality of the existing surface water resources. Survey design was undertaken having regard to the following factors:

- Seasonal constraints regarding sampling and site access, i.e. access to the Study Area is limited during the wet season when the Moray Carmichael Road becomes impassable.
- Accessibility to the southern portion of the Study Area was restricted during periods of flood such that not all water bodies, particularly to the south of the Carmichael River have been sampled.

Areas sampled are, however, considered to be representative based on knowledge of land use and catchment inputs that would influence those water bodies.

Note that specific field assessment was not undertaken on EPC 1080.

2.1.2 Surface Water Resource Descriptions

As described in Section 1.3, the Study Area is comprised of a number of different surface water resources. A desktop based assessment of these resources was undertaken to identify defining characteristics. This information was used to supplement observations made by teams that had already visited the site. As such, four types of water resources were identified:

- A major waterway with established riparian zone (the Carmichael River)
- A minor waterway with a standing pool (Cabbage Tree Creek)
- A minor waterway that contained water only during flash flow events (Eight Mile Creek)
- Farm dams

Sites representative of the characteristics of the four water resource types were identified for this assessment. With the exception of Cabbage Tree Creek these sites were constrained to the north of the Carmichael River in order to avoid discontinuity in the data sets associated with lack of site access across the river. Sites that were sampled during the field assessment (Figure 2-1).

- Four sites at the Carmichael River:
  - Site 1 located immediately upstream of EPC 1690
  - Site 2 and Site 3 located within EPC 1690
  - Site 4 located immediately downstream of EPC 1690
- One site at Cabbage Tree Creek (Site 5)
- Four sites at farm dams:
  - Site 6 located at Four Mile Dam
  - Site 7 located at Swamp Tank
  - Site 8 located at Number One Dam

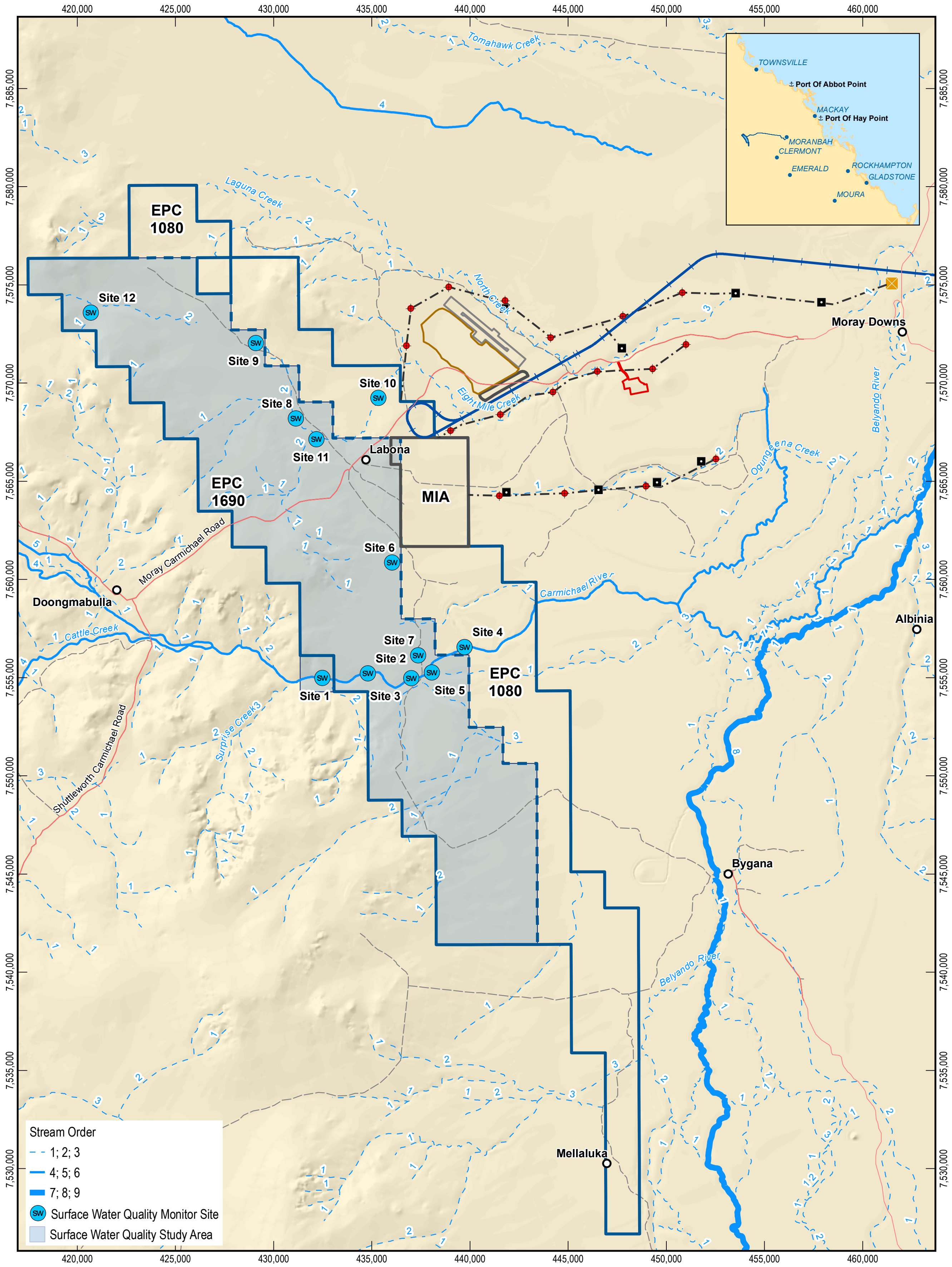
- Site 9 located at Number Two Dam
- Three sites at Eight Mile Creek:
  - Site 10 located downstream of EPC 1690
  - Site 11 located within EPC 1690
  - Site 12 located in the upstream portion of EPC 1690

Detailed information regarding each sampling site is provided in Figure 2-1, including a description of the physical environment at the site, existing pressures and representative photographs taken with a 100 m radius of the sampling location (as indicated by GPS).

The sampling program was comprised of a combination of *in-situ* sampling of physical water quality parameters, collection of water samples for laboratory analysis of basic and broad suites, and collection of sediment samples (from the aforementioned sites) for laboratory analysis. Section 1.1.1 and Section 2.1.4 provide information on the methods used to achieve the water and in-stream sediment sampling, respectively. All sampling was conducted in accordance with the following guidelines and standards:

- Monitoring and Sampling Manual 2009 (DERM, 2009b)
- The ANZECC guidelines (ANZECC and ARMCANZ, 2000)
- Australian Standard Number 5667.1.1998 – Water Quality – Sampling – Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples
- Australian Standard Number 5667.6.1998 – Water Quality – Sampling – Guidance on sampling rivers and streams
- Australian Standard Number 5667.12.1999 – Water Quality – Sampling – Guidance on sampling of bottom sediments

Quality assurance and quality control measures implemented throughout the field assessment are detailed in Section 2.1.5.



LEGEND

Homestead	Rail (West)	Mine (Offsite)	Airport Location
Local Road	Mine (Onsite)	Borehole	Rail Siding
Track	Mine Infrastructure Area	Storage Site (Instream)	Industrial Area
		Storage Facility (Offstream)	Workers Accommodation Village
		Pipeline Network	

Based on or contains data provided by the State of QLD (DERM) [2010]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:275,000 (at A4)
0 1 2 3 4 5
Kilometres
Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

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Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project

Field Assessment
Sampling Sites

Job Number 41-25215
Revision C
Date 29-08-2012

Figure: 2-1

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Data Source: DERM: DCDB, Stream Network (2010); DME: EPC1690 (2010)/EPC1080 (2011); © Copyright Commonwealth of Australia - Geoscience Australia: Mainland, Homestead, Locality, Road (2007); GHD: Surface Water Resources, Study Area (2011); Adani: Alignment Opt9 Rev3 (2012); Gassman/Hyder: Mine (Offsite) (2012). Created by: BW.

Table 2-1 Site Descriptions

Site	Description	Indicative Photographs	
Site 1	**Location:** Carmichael River – upstream of EPC 1690 **Waterway type:** River **Stream type:** Run (autumn) / sandy pool (spring) **Physical environment:** ◗ 5th order stream ◗ High degree of shading by overhanging paperbark trees (10 m) in the riparian zone ◗ Established riparian zone > 20 m wide ◗ No algae or macrophytes were visually detected on the substrate or in the water column ◗ Sandy substrate ◗ Low flow; flow decreased as monitoring progressed from April to September ◗ Turbid conditions noted at the start (April) and end (September) of the monitoring program **Disturbance:** ◗ Evidence of cattle presence (tracks and manure)	 Autumn 2011	 Spring 2011

Site	Description	Indicative Photographs	
Site 2	**Location:** Carmichael River – within EPC 1690 **Waterway type:** River **Stream type:** Run (autumn) / combination of run and sandy pool (spring) **Physical environment:** ◗ 5th order stream ◗ High degree of shading by overhanging paperbark trees (10 m) in the riparian zone ◗ Established riparian zone > 20 m wide ◗ No algae or macrophytes were observed on the substrate or in the water column during autumn or spring sampling. A small amount of algae was observed on the substrate during spring sampling. ◗ Mainly sandy substrate ◗ Low flow; flow decreased as monitoring progressed from April to September ◗ Turbid conditions noted at the start (April) and end (September) of the monitoring program **Disturbance:** ◗ Evidence of cattle presence (tracks and manure)	 Autumn 2011	 Spring 2011

Site	Description	Indicative Photographs	
Site 3	**Location:** Carmichael River – within EPC 1690 **Waterway type:** River **Stream type:** Run (autumn) / combination of run and sandy pool (spring) **Physical environment:** ◗ 5th order stream ◗ High degree of shading by overhanging paperbark trees (10 m) in the riparian zone. ◗ Established riparian zone at least 10 m wide ◗ No algae or macrophytes were observed on the substrate or in the water column during autumn or spring sampling. A small amount of algae was observed on the substrate during spring sampling. ◗ Sandy substrate ◗ Low flow; flow decreased as monitoring progressed from April to September ◗ Turbid conditions noted at the start (April) and end (September) of the monitoring program **Disturbance:** ◗ Evidence of cattle grazing (tracks and manure)	 Autumn 2011	 Spring 2011

Site	Description	Indicative Photographs	
Site 4	**Location:** Carmichael River – downstream of EPC 1690 **Waterway type:** River **Stream type:** Combination of run and riffle (autumn) / sandy pool (spring). **Physical environment:** ◗ 5th order stream ◗ High degree of shading by overhanging paperbark trees (10 m) in the riparian zone ◗ Established riparian zone at least 10 m wide ◗ No algae or macrophytes were observed on the substrate or in the water column during autumn or spring sampling. A small amount of algae was observed on the substrate during spring sampling. ◗ Sandy substrate ◗ Moderate flow in autumn and no flow in spring ◗ Turbid conditions noted at the start (April) and end (September) of the monitoring program **Disturbance:** ◗ Evidence of cattle presence (tracks and manure)	 Autumn 2011	 Spring 2011

Site	Description	Indicative Photographs	
Site 5	**Location:** Cabbage Tree Creek **Waterway type:** Creek **Stream type:** silt/clay pool **Physical environment:** ◗ Mapped as a 1st order stream ◗ Low/moderate degree of shading by overhanging trees ◗ Limited riparian zone (2 m width) ◗ Submerged, emergent and floating macrophytes ◗ Algae on the substrate ◗ Silt/clay substrate ◗ Isolated pool with no flow **Disturbance:** ◗ Evidence of cattle presence (tracks and manure) and pig disturbance (tracks)	 Autumn 2011	 Spring 2011

Site	Description	Indicative Photographs	
Site 6	**Location:** Four Mile Dam **Waterway type:** Artificial Farm Dam **Stream type:** silt/clay pool **Physical environment:** ◗ Approximately 40 m in diameter, drop off from vegetated edge ◗ No shading ◗ Limited riparian zone consisting of sedges (less than 2 m) ◗ Small amounts of macrophytes observed ◗ Silt/clay substrate ◗ Isolated dam with no flow ◗ Turbid conditions across sampling period **Disturbance:** ◗ Cattle disturbance (tracks and manure) along some of the perimeter	 Autumn 2011	 Spring 2011

Site	Description	Indicative Photographs	
Site 7	**Location:** Swamp Tank **Waterway type:** Artificial Farm Dam **Stream type:** silt/clay pool **Physical environment:** ◗ Approximately 50 m across, gently sloping bed ◗ No shading ◗ Limited riparian zone consisting of grasses (less than 2 m) ◗ Some floating and emergent macrophytes and algae (on substrate) observed during autumn sampling ◗ No macrophytes observed during spring sampling ◗ Silt/clay substrate ◗ Isolated dam with no flow **Disturbance:** ◗ Cattle (tracks and manure) disturbance along the perimeter	 Autumn 2011	 Spring 2011

Site	Description	Indicative Photographs
Site 8	**Location:** Number One Dam **Waterway type:** Artificial Farm Dam **Stream type:** silt/clay pool **Physical environment:** ◗ Dam is approximately 20 m across with a gently sloping bed ◗ No shading ◗ Limited riparian zone consisting of grasses (less than 2 m) ◗ Some macrophytes and algae (in water column) observed during sampling ◗ Silt/clay substrate ◗ Isolated dam with no flow **Disturbance:** ◗ Cattle disturbance (tracks and manure) along the perimeter	 Autumn 2011  Spring 2011

Site	Description	Indicative Photographs	
Site 9	**Location:** Number Two Dam **Waterway type:** Artificial Farm Dam **Stream type:** silt/clay pool **Physical environment:** ◗ Dam is approximately 30 m across with a gently sloping bed ◗ No shading ◗ Limited riparian zone consisting of grasses (less than 2 m) ◗ Some macrophytes (emergent) and algae (on substrate) observed during sampling ◗ Silt/clay substrate ◗ Isolated dam with no flow **Disturbance:** ◗ Cattle and pig disturbance (tracks and manure) around the perimeter	 Autumn 2011	 Spring 2011

Site	Description	Indicative Photographs	
Site 10	**Location:** Eight Mile Creek – downstream of EPC 1690 **Waterway type:** Drainage line **Stream type:** Dry stream bed **Physical environment:** ◗ Mapped as a 3rd order stream ◗ Moderate degree of shading by overhanging trees ◗ No aquatic vegetation within the stream bed ◗ Minimal terrestrial vegetation within the streambed Sandy/silty substrate ◗ No permanent water, facilitates flash flows only **Disturbance:** ◗ Evidence of cattle grazing disturbance (tracks and manure)	 Photograph taken in July 2011	This site was only sampled once, therefore no Spring photograph available.

Site	Description	Indicative Photographs	
Site 11	**Location:** Eight Mile Creek – within EPC 1690 **Waterway type:** Drainage line **Stream type:** dry stream bed **Physical environment:** ◗ 2nd order stream ◗ Limited shading ◗ No aquatic vegetation within the stream bed ◗ Minimal terrestrial vegetation within the streambed ◗ Sandy substrate ◗ No permanent water, facilitates flash flows only **Disturbance:** ◗ Evidence of cattle grazing and pig disturbance (tracks and manure)	 Photograph taken in July 2011	This site was only sampled once, therefore no Spring photograph available.

Site	Description	Indicative Photographs	
Site 12	**Location:** Eight Mile Creek – upstream of EPC 1690 **Waterway type:** Drainage line **Stream type:** dry stream bed **Physical environment:** ◗ 1st order stream ◗ Limited shading ◗ No aquatic vegetation within the stream bed ◗ Minimal terrestrial vegetation within the streambed ◗ Sandy/silty substrate ◗ No permanent water, facilitates flash flows only **Disturbance:** ◗ Evidence of pig disturbance (tracks and manure)	 Photograph taken in July 2011	This site was only sampled once, therefore no Spring photograph available.

2.1.3 Water Quality Sampling

All water quality sampling was undertaken in accordance with the requirements of the Monitoring and Sampling Manual 2009 (DERM, 2009b), ANZECC Guidelines (ANZECC and ARMCANZ 2000) and the Australian Standards mentioned above. Quality assurance and quality control measures implemented throughout the field assessment are detailed in Section 2.1.5.

Physio-chemical water quality parameters (as indicated by in Table 2-3) were sampled *in-situ* using a hand held multi-parameter water quality meter with logging capacity for:

- Turbidity (NTU)
- Dissolved oxygen (per cent saturation)
- pH
- Temperature (°C)
- Electrical conductivity (µS/cm)

Ten replicate samples from each site were stored on the logger and downloaded at the end of each sampling event.

Water samples were collected for laboratory analysis of the basic (as indicated by) and / or broad (as indicated by) analytical suites (refer to Table 2-2). In conjunction with sampling, observational data was collected during each event using a standard pro-forma data sheet adapted from those provided in the Monitoring and Sampling Manual 2009 (DERM, 2009b). Information including weather conditions, localised disturbances, surface oils, foaming, colour and aquatic vegetation were noted to assist in interpretation of data.

Table 2-2 Basic and Broad Analytical Suites

Basic Analytical Suite	Broad Analytical Suite
◗ Nutrients ◗ Chlorophyll a ◗ Faecal (thermotolerant) coliforms ◗ Total dissolved solids (TDS) ◗ Total suspended solids (TSS)	◗ Major cations and anions ◗ Total hardness as $CaCO_3$ ◗ Total petroleum hydrocarbons (TPH): C6-C9 fraction, C10-C14 fraction, C15-C28 fraction and C29-C36 fraction ◗ Polycyclic aromatic hydrocarbons (PAH) ◗ Total and dissolved metals (aluminium, antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, silver, tin, uranium, vanadium and zinc) ◗ Dissolved silicon ◗ Flouride

2.1.4 In-stream Sediment Quality Sampling

In-stream sediments (represented by in Table 2-3) were collected for laboratory analysis of:

- Grain size
- Total organic carbon and moisture content
- Nutrients
- Faecal (thermotolerant) coliforms
- PAHs
- TPHs (C6-C9, C10-C14, C15-C28 and C29-C36 fractions)
- Total metals (aluminium, arsenic, barium, beryllium, boron, cadmium, chromium, copper, iron, lead, manganese, molybdenum, nickel, selenium, silver, strontium, uranium, vanadium, mercury and zinc)

Sediment samples were also collected at sites where water was not present (represented by in Table 2-3). Site 10, Site 11 and Site 12 are sites that support flash flows only. These sites did not contain any water during the monitoring program and were analysed differently to sediment samples collected at sites with water. Additional sediment samples were collected from the stream bed at these sites during the July sampling event. These samples were subject to a deionised (DI) water leach preparation. Testing of the DI leachate was undertaken in order to gain an understanding of the potential for the release of contaminants into surface waters during flow events. DI leachate testing was only undertaken once during the monitoring program as sampled parameters were not expected to display large temporal variability. The DI water leachate was analysed for:

- Ultra-trace nutrients
- PAHs
- TPHs (C6-C9, C10-C14, C15-C28 and C29-C36 fractions)
- Metals (aluminium, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, iron, lead, manganese, molybdenum, nickel, selenium, silver, strontium, uranium, vanadium and zinc)

A summary of the field assessment effort for each sampling location per event is provided in Table 2-3 and reflects the colour coding symbols used above to identify each of the sampling types completed per event.

Table 2-3 Summary of Field Assessment Effort

	Event 1 13-14 April 2011	Event 2 4-5 May 2011	Event 3 21-22 June 2011	Event 4 26-27 July 2011	Event 5 23-24 Aug 2011	Event 6 20-21 Sept 2011
Site 1	🔵 🟢	🔵 🟢 🔴	🔵 🟢	🔵 🟢 🔴 🟡	🔵 🟢	🔵 🟢 🔴
Site 2	🔵 🟢	🔵 🟢 🔴	🔵 🟢	🔵 🟢 🔴 🟡	🔵 🟢	🔵 🟢 🔴
Site 3	🔵 🟢	🔵 🟢 🔴	🔵 🟢	🔵 🟢 🔴 🟡	🔵 🟢	🔵 🟢 🔴
Site 4	🔵 🟢	🔵 🟢 🔴	🔵 🟢	🔵 🟢 🔴 🟡	🔵 🟢	🔵 🟢 🔴
Site 5	🔵 🟢	Site not accessible	🔵 🟢	Site not accessible	🔵 🟢	🔵 🟢 🔴
Site 6	🔵 🟢	🔵 🟢 🔴	🔵 🟢	🔵 🟢 🔴 🟡	🔵 🟢	🔵 🟢 🔴
Site 7	🔵 🟢	🔵 🟢 🔴	🔵 🟢	🔵 🟢 🔴 🟡	🔵 🟢	🔵 🟢 🔴
Site 8	🔵 🟢	🔵 🟢 🔴	🔵 🟢	🔵 🟢 🔴 🟡	🔵 🟢	🔵 🟢 🔴
Site 9	🔵 🟢	🔵 🟢 🔴	🔵 🟢	🔵 🟢 🔴 🟡	🔵 🟢	🔵 🟢 🔴
Site 10	No water	No water	No water	🟡 🟣	No water	No water
Site 11	No water	No water	No water	🟡 🟣	No water	No water

	Event 1 13-14 April 2011	Event 2 4-5 May 2011	Event 3 21-22 June 2011	Event 4 26-27 July 2011	Event 5 23-24 Aug 2011	Event 6 20-21 Sept 2011
Site 12	No water	No water	No water	[yellow] [purple]	No water	No water

KEY: [blue] *In-situ* water suite [green] Basic analytical suite (water) [red] Broad analytical suite (water) [yellow] Sediment sampling suite [purple] DI leach suite

2.1.5 Quality Assurance and Quality Control

All samples were collected, preserved and transported in accordance with the requirements of the *Monitoring and Sampling Manual 2009* (DERM, 2009b) and the analytical laboratory, under chain of custody documentation (Appendix B). In addition to the internal laboratory quality assurance procedures, quality assurance replicates were collected at two separate sampling locations per event and tested as per the primary samples. Replicates were marked as QA01 or QA02 and noted on the corresponding field sheet. Upon receipt of laboratory results, Quality Assurance/Quality Control (QA/QC) results were checked and the results reviewed for anomalies. Validation of the laboratory data and quality assurance samples was undertaken according to the requirements of the *Monitoring and Sampling Manual 2009* (DERM, 2009). A summary of the QA/QC results are provided in Appendix C.

2.2 Data Analysis

Analysis of the water and sediment quality data was undertaken in accordance with the requirements of the QWQG (DERM, 2009a), the *Monitoring and Sampling Manual 2009* (DERM, 2009b), and the ANZECC guidelines (ANZECC and ARMCANZ, 2000). Summary statistics, including minima, 20^{th} percentiles, medians, averages, 80^{th} percentiles, 95^{th} percentiles and maxima have been presented where appropriate. Spatial and temporal presentation of the data has also been included in the assessment in order to gain an understanding of any trends in the data.

Comparisons against nominated water quality objectives (WQOs) have been undertaken. As defined by the QWQG (DERM, 2009a), median values have been used for comparison of physical parameters and nutrients against nominated WQOs. The ANZECC guidelines (ANZECC and ARMCANZ, 2000) require comparison of toxicant data to WQOs be undertaken using 95^{th} percentile values. This procedure has been followed for the assessment. Algorithms for the calculation of a hardness-modified trigger value (HMTV) for metals and metalloids have been utilised where appropriate, as described by the ANZECC guidelines (ANZECC and ARMCANZ, 2000).

Interpretation of results to the nominated WQOs was undertaken by comparing:

- Median values for physical parameters and nutrient data (refer to QWQG; DERM 2009a)
- 95^{th} percentile values for toxicant data (refer to the ANZECC guidelines; ANZECC and ARMCANZ, 2000)

Where appropriate hardness-modified trigger values were calculated for the comparison of metal data, as required by the ANZECC guidelines (ANZECC and ARMCANZ, 2000).

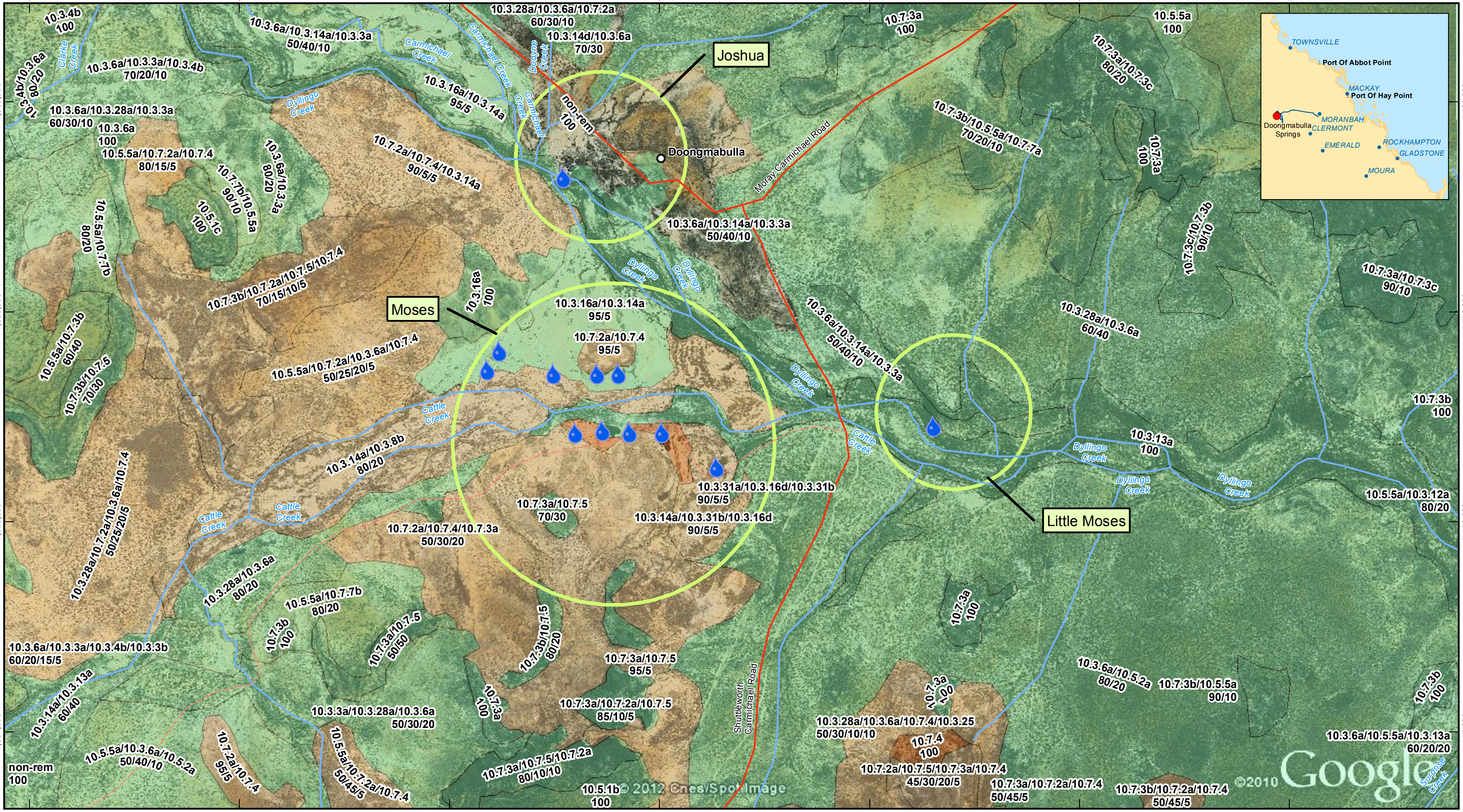
2.3 Doongmabulla Springs Field Survey

2.3.1 Sample Collection

In order to characterise the quality of the surface water resources within the Doongmabulla Springs area water samples were collected from four springs during a three day ecology field inspection of the complex between 22 and 24 May 2012. Following on from this initial sampling, water samples were collected on 22 and 24 June 2012 from 14 of the springs that were located during the field inspection and two creeks. The sampled locations are summarised in Table 2-4 and their locations are shown in Figure 2-2. Where there was insufficient standing or flowing water for collection directly into a laboratory sample bottle, it was collected using a single use sterile plastic syringe (dedicated to each spring) and then decanted into the laboratory sample bottle. All water samples were stored on ice in an insulated container immediately after collection and sent under chain of custody to a NATA accredited laboratory, Australian Laboratory Services (ALS) in Sydney and Brisbane, for analysis.

Table 2-4 Summary of Sampled Locations

GHD Location ID	Sampled	Sample Collection Point
Doon Spring 1	May and June 2012	Directly from the spring
Doon Spring 2A	June 2012	Water collected into shallow hole dug adjacent to the vegetation
Location 3A	June 2012	Water draining from grassed wetland area, approximately 40 m west of Doon Spring 3. No water to collect at Doon Spring 3.
Doon Spring 4	June 2012	Water ponded adjacent to the mound spring vegetation
Doon Spring 5	June 2012	Water ponded amongst the mound spring vegetation
Doon Spring 5A	June 2012	Water ponded adjacent to the mound spring vegetation
Doon Spring 5B	May and June 2012	Water ponded amongst the mound spring vegetation
Doon Spring 6	June 2012	Water ponded amongst the mound spring vegetation
Doon Spring 7	June 2012	Water ponded amongst the mound spring vegetation
Doon Spring 8	June 2012	Water ponded adjacent to the mound spring vegetation
Doon Spring 8A	June 2012	Water ponded adjacent to the mound spring vegetation
Doon Spring 9A	June 2012	Water ponded adjacent to the mound spring vegetation
Doon Spring 10	May and June 2012	Directly from the spring
Doon Spring 11C	May 2012	Water ponded amongst the mound spring vegetation
Dyllingo Creek crossing (Shuttleworth Carmichael Road)	June 2012	Directly from the creek
Cattle Creek crossing (Shuttleworth Carmichael Road)	June 2012	Directly from the creek



1:50,000 (at A4)

0 500 1,000 1,500 2,000

Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

N

LEGEND

- Homestead
- Minor Road
- Track
- Springs
- Watercourse
- Spring Groups

Regional Ecosystems v6.1

- Endangered - Dominant
- Endangered - Sub-dominant
- Of Concern - Dominant
- Of Concern - Sub-dominant
- Not of Concern
- Clear

GHD adani

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project

Doongmabulla Wetland
Visited Spring Locations

Job Number	41-25215
Revision	1
Date	29-08-2012

Figure 2-2

G:\41\25215\GIS\Maps\MXD\500_SurfaceWater\41-25215_955_DoongmabullaWetland_Rev_1.mxd Level 4, 201 Charlotte St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data Source: GHD: Spring Complex/2012, Springs/2012; GA: Watercourses, Roads, Homesteads (2007); DERM: Regional Ecosystem v6.1 (2011); Adani: Alignment Opt9 Rev3 (2012); DME: EPC 1690 (2010)/EPC 1080 (2011); Google: Imagery (2012). Created by: SB,MS

2.3.2 Sample Analysis

The Doongmabulla Springs samples were tested for the parameters summarised in Table 2-5.

Table 2-5 Summary of Sample Analysis – Doongmabulla Springs

	Parameters
Field Measurements	
measured at the sample location, prior to collection of sample for laboratory testing	pH, temperature, electrical conductivity (EC), dissolved oxygen, total dissolved solids (TDS)
Laboratory Analysis	
Major ions and alkalinity	Calcium, magnesium, potassium, sodium, chloride, sulphate, alkalinity (carbonate, bicarbonate and hydroxide as $CaCO_3$), total alkalinity as $CaCO_3$ and hardness as $CaCO_3$
Inorganics	Silica, fluoride, EC, pH
Selected dissolved metals	Arsenic, barium, beryllium, cadmium, cobalt, chromium, copper, nickel, lead, vanadium, zinc and iron

3. Relevant Legislation

3.1 Overview

A detailed description of legislation, policies and regulations applicable to the Project is provided in Volume 4 Appendix D Project Approvals and Planning Assessment. Outlined below is an overview of the key regulatory instruments of relevance to the surface water quality assessment.

3.2 Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is the Commonwealth's principal piece of environmental protection legislation. It provides a national framework for the protection of the Australian environment and its unique biodiversity. Specifically, the EPBC Act aims to protect the environment by reducing significant impacts to matters of national environmental significance (NES), these being:

- World heritage properties
- National heritage places
- Wetlands of international importance (listed under the Ramsar Convention)
- Listed threatened species and ecological communities
- Migratory species (protected under international agreements)
- Commonwealth marine areas
- Great Barrier Reef Marine Park
- Nuclear actions

In addition to endowing protection on Australia's environment, the EPBC Act provides a systematic framework for assessment and approval of actions potentially affecting matters of NES. The Project was referred to the Commonwealth Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) on 18 November 2010 (EPBC 2010/5736). It was declared a 'controlled action' requiring assessment and approval under the EPBC Act on 6 January 2011. The controlling provisions for the Project (i.e. those matters of NES which the Project may potentially have a significant impact on) include:

- World Heritage properties (section 12 & 15A)
- National Heritage places (section 15B & 15C)
- Wetlands (Ramsar) (section 16 & 17B)
- Listed threatened species and communities (sections 18 & 18a)
- Listed migratory species (section 20 & 20A)
- Great Barrier Reef Marine Park (section 24B & 24C)

Relevance to the Project

The Project has been declared a 'controlled action' requiring assessment and approval under the EPBC Act. Changes to water quality have the potential to affect the matters of NES listed as controlling provisions for the Project.

In relation to surface water quality, degradation of surface water quality could affect habitat for listed threatened species and habitat communities.

3.3 Queensland Legislation

3.3.1 Queensland Environmental Protection Act 1994

The *Environment Protection Act 1994* (EP Act) provides a regulatory framework for the protection and management of the Queensland environment. The objective of the EP Act is to protect Queensland's environment while allowing for development that is ecologically sustainable.

Relevance to the Project

The environmental values of Queensland's waterways, including those located within the Study Area, are protected under the EP Act and the subordinate *Environmental Protection (Water) Policy 2009*.

The Project will require an environmental authority (mining lease) issued under the EP Act and this will include conditions in relation to protecting water quality. Approval will also be required for any development impacting waterways offsite.

3.3.2 Queensland *Environmental Protection (Water) Policy 2009*

The *Environmental Protection (Water) Policy 2009* (EPP (Water)) is subordinate legislation that supports the EP Act. The EPP (Water) provides environmental values (EVs) and water quality objectives (WQOs) for all Queensland waters. Environmental values are defined by the EPP (Water) as the qualities of waterways that need to be protected to ensure that the ecological, social and economic values and uses of the waterway are maintained. The EVs represented at the Project site that are to be enhanced or protected under the EPP (Water) are:

- Biological integrity of an aquatic ecosystem
- Suitability for recreational use
- Suitability for minimal treatment before supply as drinking water
- Suitability for agricultural use
- Suitability for industrial use
- Cultural and spiritual values

Water quality objectives are defined by the EPP (Water) as measurable indicators of the characteristics needed to protect the EVs of a waterway.

Schedule 1 of the EPP (Water) provides EVs and WQOs adopted by the Government for particular waters. Specific EVs and WQOs for the Burdekin Basin are yet to be scheduled in the EPP (Water). The development of Burdekin Basin specific EVs and WQOs is underway, with scheduling expected to be achieved by December 2013. The following documents have been referenced for the development of EVs and WQOs for the Study Area:

- Social, Economic, Cultural and Environmental Values of Streams and Wetlands in the Burdekin Dry Tropics Region (Greiner and Hall, 2006)
- Burdekin Water Quality Improvement Plan (Dight, 2009)
- Australia and New Zealand Guidelines for Fresh and Marine Water Quality 2000 (the ANZECC guidelines) (ANZECC and ARMCANZ, 2000)
- Queensland Water Quality Guidelines 2009 (QWQG) (DERM, 2009a)

Relevance to the Project

The EPP (Water) provides a framework for the development of environmental values (EVs) and water quality objectives (WQOs) for all Queensland waters. This framework has been applied for the current assessment. Section 4 provides details regarding the EVs and WQOs relevant to the Study Area.

3.3.3 Queensland Water Act 2000

The *Water Act 2000* (Water Act) is jointly administered by the Department of Environment and Heritage Protection, the Department of Natural Resources and Mines and the Department of Energy and Water Supply. It is the primary statutory document that establishes a system for water planning, allocation and use, and includes allocation of water resources for environmental purposes. The purpose of the Water Act is to advance sustainable management and efficient use of water and other resources. The Water Act provides for a number of activities including the measurement and management of water, construction, control and management of works for conservation and protection, irrigation and water supply, drainage, flood control and prevention, improvement of the flow in, or changes to watercourses, protection and improvement of the physical integrity of watercourses, lakes and springs.

Relevance to the Project

Management of the water resources within the Project footprint during construction and operation will need to be undertaken in accordance with the requirements of the Water Act.

3.3.4 Queensland *Fisheries Act 1994*

The *Fisheries Act 1994* (Fisheries Act) is implemented by the state government, and provides for the management, use, development and protection of fisheries resources and fish habitats and the management of aquaculture activities. The Act's objective is to provide for the use, conservation and enhancement of the community's fisheries resources and fish habitats through the application of the principles of ecologically sustainable development. If a polluting matter is likely to affect fisheries resources or a fish habitat, the Chief Executive of the Department of Agriculture, Fisheries and Forestry may issue a notice to restore fish habitat requiring the responsible person to take action to redress the situation.

Relevance to the Project

Significant changes to water quality as a result of the Project have the potential to affect fisheries resources and fish habitats protected by the Fisheries Act. Approvals requirements under the Fisheries Act are given effect through the *Sustainable Planning Act 2009* and hence do not apply to activities on a mining lease.

3.3.5 Policy for the Maintenance and Enhancement of Water Quality in Central Queensland 2003

This policy was created by the former Queensland Department of Local Government and Planning (2003). The *Policy for the Maintenance and Enhancement of Water Quality in Central Queensland 2003* (PMEWQCQ) provides a non-regulatory Head of Agreement for collaborative planning and management of water quality by local government, industry and landholders. It provides guidance for implementing strategies for river health and water quality. The policy also recognises the importance of accurately assessing, valuing, monitoring and reporting on the condition of the region's water resources for planning and management.

Relevance to the Project

The guiding principles of the PMEWQCQ should be taken into consideration during the development of water management plans for the Project (Mine).

4. Existing Environment

4.1 Environmental Values and Water Quality Objectives

4.1.1 Environmental Values

The QWQG (DERM, 2009a) provide a suite of EVs that may be applicable to an area of interest. These EVs capture both aquatic ecosystem values and human use values. An assessment of information available relating to the Study Area, including information collated during the field assessment, has been used to determine which EVs are applicable to the Study Area (Table 4-1).

Table 4-1 Environmental Values Applicable to the Study Area

Environmental Value	QWQG Definition (DERM, 2009a)	Relevant to the Study Area
Aquatic Ecosystems Level 1: High ecological / conservation value (HEV) ecosystem	Effectively unmodified or other highly valued systems, typically occurring in national parks, conservations reserves or in remote and/inaccessible locations. The ecological integrity of HEV systems is regarded as intact.	× The catchment of the Study Area is considered to be SMD (see below)
Aquatic Ecosystems Level 2: Slightly-moderately disturbed (SMD) ecosystem	Ecosystems in which aquatic biological diversity may have been adversely affected to a relatively small but measurable degree by human activity. The biological communities remain in a healthy condition and ecosystem integrity is largely retained. Typically, freshwater systems would have slightly to moderately cleared catchments and/or reasonably intact riparian vegetation. SMD systems could include rural streams receiving runoff from land disturbed to varying degrees by grazing or pastoralism.	✓ The catchment of the Study Area is considered to be SMD as the water resources receive runoff from land disturbed by grazing, watercourses are accessed by stock for watering and dams are artificial habitat
Aquatic Ecosystems Level 3: Highly disturbed (HD) ecosystem	These are measurably degraded ecosystems of lower ecological value. Examples of HD systems include rural streams receiving runoff from intensive horticulture.	× The catchment of the Study Area is considered to be SMD (see above)

Environmental Value	QWQG Definition (DERM, 2009a)	Relevant to the Study Area
Primary Industries Irrigation	Suitability of water supply for irrigation	✓ Some downstream crop irrigation occurs The site drains to the Burdekin Falls dam which supplies a number of irrigation areas
Primary Industries Farm Water Supply	Suitability of domestic farm water supply, other than drinking water.	× Farm dams used for stock watering only. This is captured under Stock Watering below
Primary Industries Stock Watering	Suitability of water supply for production of healthy livestock.	✓ Water resources within and downstream of Study Area used for stock watering
Primary Industries Aquaculture	Health of aquaculture species and humans consuming aquatic foods from commercial ventures.	× No aquaculture occurs within or immediately downstream of the Study Area. The ephemeral nature of the streams makes it unlikely that aquaculture would be introduced to the area
Primary Industries Human Consumers of Aquatic Foods	Health of humans consuming aquatic foods from natural waterways.	× No aquaculture or recreational fisheries within or immediately downstream of the Study Area.

Environmental Value	QWQG Definition (DERM, 2009a)	Relevant to the Study Area
Recreation and Aesthetics Primary Recreation 	Health of humans during recreation which involves direct contact and a high probability of water being swallowed.	× No water-based recreation activities occur within or immediately downstream of the Study Area. The ephemeral nature of watercourses would generally preclude primary recreation.
Recreation and Aesthetics Secondary Recreation 	Health of humans during recreation which involves indirect contact and a low probability of water being swallowed.	× No water-based recreation activities occur within or immediately downstream of the Study Area. The ephemeral nature of watercourses would generally preclude secondary recreation.
Recreation and Aesthetics Visual Recreation 	Amenity of waterways for recreation which does not involve any contact with water.	× No water-based recreation activities occur within or immediately downstream of the Study Area due to lack of public access and distance from settlements
Drinking Water 	Suitability of raw drinking water supply. This assumes minimal treatment of water is required.	× Farm dams used for stock watering only
Industrial Uses 	Suitability of water supply for industrial use.	× Farm dams used for stock watering only

Environmental Value	QWQG Definition (DERM, 2009a)	Relevant to the Study Area
Cultural and Spiritual Values	Indigenous and non-indigenous cultural heritage.	✓ Traditional owners of the Study Area are the Wangan and Jagalingou people. The EIS are of relevance to these groups

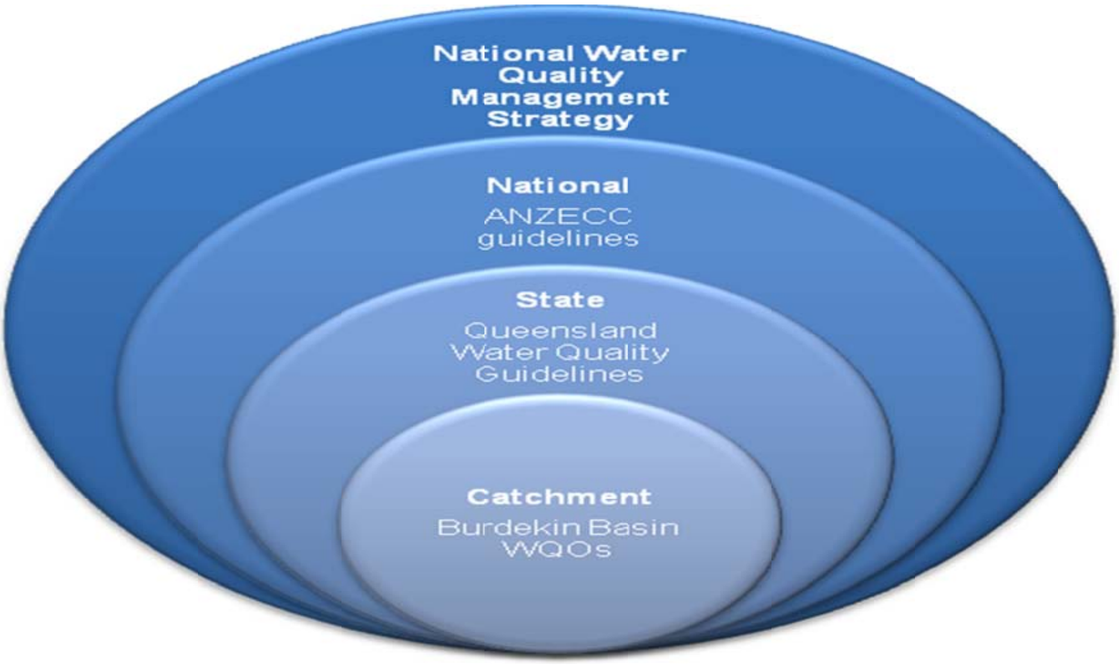
In summary, the following EVs are considered to be relevant to the Study Area:

- Aquatic ecosystems – slightly to moderately disturbed
- Primary industries – irrigation
- Primary industries – stock watering
- Cultural and spiritual values

4.1.2 Water Quality Objectives

The National Water Quality Management Strategy (NWQMS) provides a framework for water quality management that is based on the principle of ecologically sustainable development. The ANZECC guidelines (ANZECC and ARMCANZ, 2000) are national guidelines that were developed as part of the NWQMS. These guidelines suggest that in order to protect and improve water resources a three tiered approach, comprising national, state (or territory) and regional or catchment, is required. Figure 4-1 provides an overview of this approach, including those guidelines and objectives that are relevant to the Study Area.

Figure 4-1 Tiered Approach to Water Quality Management Relevant to the Study Area



When determining water quality objectives, locally derived objectives can be determined using processes set out in the Queensland Water Quality Guidelines (QWQG) 2009 (DERM 2009) if sufficient data is available. If local data is not available, regional or catchment based water quality objectives are then relied on and if no such objectives exist, or objectives are not set for a certain variable, then reference is made to the Queensland and then national water quality guidelines. Thus, locally derived water quality objectives take precedence over regional or catchment objectives which in turn take precedence over state and national water quality objectives.

The Study Area is located in the Burdekin Basin, defined as part of the central coast region in the QWQG (DERM, 2009a). The water types within the Study Area, as defined by the QWQG (DERM, 2009a), include upland streams (greater than 150 m elevation above sea level), and freshwater lakes/reservoirs.

As outlined in Section 3.3.2, WQOs for the Burdekin Basin are yet to be scheduled in the EPP (Water). Draft WQOs are proposed in the Burdekin Water Quality Improvement Plan (Dight, 2009) for four water types; upland streams, lowland streams, lakes, and wetlands. An assessment of the draft WQOs has identified that they are consistent with the WQOs contained in the QWQG (DERM, 2009a) and the ANZECC guidelines (ANZECC and ARMCANZ, 2000). The water and sediment quality objectives adopted for this assessment to protect the EVs identified in Section 4.1.1 are provided in, Table 4-2 and Table 4-3, respectively. The nominated objectives are based upon the QWQG (DERM, 2009a) and the ANZECC guidelines (ANZECC and ARMCANZ, 2000), and are thus also consistent with the draft WQOs for the Burdekin Basin (Dight, 2009). There are currently no guidelines for TPH.

Table 4-2 Water Quality Objectives Adopted for the Assessment

Parameter	Units	Aquatic Ecosystems#		Primary Industries*	
		Upland streams	Lakes and reservoirs	Irrigation	Stock Watering
Physical Parameters					
Dissolved oxygen	% saturation	90 - 110	90 - 110	-	-
pH		6.5 - 7.5	6.5 - 8.0	-	6.0 – 8.5
Electrical Conductivity	µS/cm	168^	168^	-	16,700
Turbidity	NTU	25	1 - 20	2 - 15	-
Biological					
Chlorophyll a	µg/L	-	5	-	-
Faecal coliforms	cfu/100 mL			10 (direct contact) 1000 (indirect contact)	1000
Nutrients					
Ammonia as N	µg/L	10	10	-	-
Nitrate (as N)	mg/L	0.158	0.158	-	400
Nitrite (as N)	mg/L	-	-	-	30
Nitrogen (Total)	µg/L	250	350	5000 - 125000	-
Organic Nitrogen	µg/L	225	330		
Phosphorus	mg/L	0.03	0.01	0.05 - 12	-
Reactive Phosphorus as P	mg/L	0.015	0.005	-	-

Parameter	Units	Aquatic Ecosystems#		Primary Industries*	
		Upland streams	Lakes and reservoirs	Irrigation	Stock Watering
Major Ions					
Calcium	mg/L	-	-	-	1,000
Magnesium	mg/L	-	-	-	2,000
Fluoride	mg/L	-	-	1 - 2	2
Sulphate	mg/L	-	-	-	1,000
TDS	mg/L	-	-	-	2,500
Metals and Metalloids*					
Aluminium	mg/L	0.055	0.055	5 - 20	5
Arsenic	mg/L	0.013	0.013	0.1 - 2	0.5
Beryllium	mg/L	-	-	0.1 - 0.5	-
Boron	mg/L	0.37	0.37	0.5	5
Cadmium	mg/L	0.0002	0.0002	0.01 - 0.05	0.01
Chromium (III+VI)	mg/L	0.001	0.001	0.1 - 1	1
Cobalt	mg/L			0.05 - 0.1	1
Copper	mg/L	0.0014	0.0014	0.2 - 5	1
Iron	mg/L			0.2 - 10	-
Lead	mg/L	0.0034	0.0034	2 - 5	0.1
Manganese	mg/L	1.9	1.9	0.2 - 10	-

Parameter	Units	Aquatic Ecosystems#		Primary Industries*	
		Upland streams	Lakes and reservoirs	Irrigation	Stock Watering
Mercury	mg/L	0.00006	0.00006	0.002	0.002
Molybdenum	mg/L			0.01 - 0.05	0.15
Nickel	mg/L	0.011	0.011	0.2 - 2	1
Selenium	mg/L	0.005	0.005	0.02 - 0.05	0.02
Silver	mg/L	0.00005	0.00005	-	-
Uranium	µg/L	-	-	10 - 100	200
Vanadium	mg/L	-	-	0.1 - 0.5	-
Zinc	mg/L	0.008	0.008	2 - 5	20
Polycyclic Aromatic Hydrocarbons					
Naphthalene	µg/L	16	16	-	-

from the QWQG (DERM, 2009a); * from the ANZECC guidelines (ANZECC and ARMCANZ, 2000), range values for irrigation WQOs represent long-term trigger values (LTV) and short term trigger values (STV); ^ 75th percentile for Belyando-Suttor salinity zone (DERM 2009a).

Table 4-3 Sediment Quality Objectives Adopted for the Assessment

Parameter	ISQG Low* (mg/kg)	ISQG High* (mg/kg)
Arsenic	20	70
Cadmium	1.5	10
Chromium (III+VI)	80	370
Copper	65	270
Lead	50	220
Mercury	0.15	1
Nickel	21	52
Silver	1	3.7
Zinc	200	410
Acenaphthene	0.016	0.5
Anthracene	0.085	1.1
Benz(a)anthracene	0.261	1.6
Benzo(a) pyrene	0.43	1.6
Chrysene	0.384	2.8
Dibenz(a,h)anthracene	0.063	0.26
Fluoranthene	0.6	5.1
Fluorene	0.019	0.54
Naphthalene	0.16	2.1
Phenanthrene	0.24	1.5
Pyrene	0.665	2.6

*ISQG (Interim Sediment Quality Guidelines); from the ANZECC guidelines (ANZECC and ARMCANZ, 2000)

4.2 Weather Observations

Rainfall inputs to waterways and associated overland flows have the potential to substantially influence the water quality observations. Accordingly, in order to assist in interpretation of the monitoring program results (presented following), a summary of the climatic conditions experienced prior to and during monitoring is provided. Data sourced from the Bureau of Meteorology (BOM) weather station closest to the Study Area, located at Clermont, has been assessed. The Clermont BOM station (ID 035019) is located approximately 150 km south east of the Study Area (refer Figure 1-1) and gives the most geographically relevant data available.

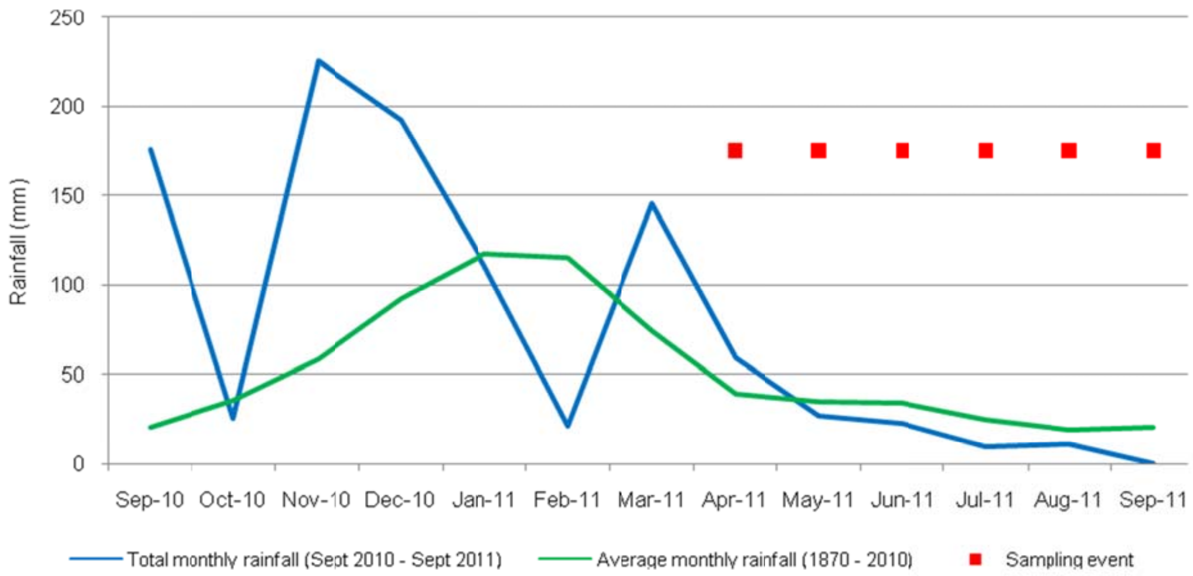
Above average rainfall was experienced in the region prior to the commencement of sampling in April 2011 (This data will be utilised for future comparison.

Figure 4-2). In the period leading up to water quality sampling, between September 2010 and March 2011, a total of 896 mm of rain was recorded in Clermont. This is well above the long-term (1870-2010) average of 513 mm for the same period (BOM, 2011). A significant amount of this rainfall (418 mm) fell during November and December 2010 (This data will be utilised for future comparison.

Figure 4-2). During that period dry watercourses and drainage lines at the north of the Study Area exhibited flash flows (refer Volume 4 Appendix O – Mine Aquatic Ecology Report). The riparian zone of the Carmichael River showed signs of recent flooding including scattered debris at the commencement of the sampling program (refer Plate 4-1).

During the sampling program, between April 2011 and September 2011, a total rainfall of 129 mm was recorded in Clermont. This is below the long-term (1870-2010) average of 172 mm for the same period (BOM, 2011). Adani installed an automated weather station at the Mine site in October 2012. This data will be utilised for future comparison.

Figure 4-2 Rainfall Recorded Prior to and During Monitoring



Source: BOM, 2011

Plate 4-1 Evidence of Recent Flooding at the Carmichael River (July 2011)

4.3 EPC 1690 Water Quality

4.4 Physical Parameters

Physical parameters tested as part of the monthly *in-situ* sampling program (from April to September 2011) included turbidity, dissolved oxygen, pH, temperature and electrical conductivity. The following section provides a discussion of the existing surface water quality environment in relation to these physical parameters, including comparison to WQOs where applicable. Further data, currently being collected is required to determine temporal variability in water quality.

4.4.1.1 Turbidity

Turbidity is a measure of suspended particulate matter in water. Turbidity is known to fluctuate naturally with changes in flow regimes and rates of particle re-suspension, with high turbidity often corresponding to catchment runoff events. The bulk movement of suspended solids is often associated with high flow events (Dunlop *et al*., 2005). Levels of turbidity within a system are closely linked to environmental characteristics of the system including sediment grain size and the presence and prevalence of phytoplankton and organic matter. High levels of suspended sediment are noted by Dunlop *et al*. (2005) to be a major contributor to the turbidity of Queensland streams. Other contributors to turbidity measures include organic matter, biological matter and water colour (Dunlop *et al*., 2005). Sources of suspended sediment can include point sources (such as stormwater drains), diffuse land run off due to erosion of terrestrial soils (ANZECC and ARMCANZ, 2000) and alluvial processes within river channels (Dunlop *et al*., 2005) that result in sediment re-suspension. There do not appear to be any point sources in the study area, and hence land runoff and alluvial sources are the contributors to suspended solids levels and turbidity.

Spatial and temporal variations in turbidity were observed throughout the program (Figure 4-3 and Figure 4-4). Missing values at Site 4, Site 5 and Site (Figure 4-3) are related to probe malfunction and site access issues. Sites 10 – 12 were dry throughout the assessment, and therefore do not have associated turbidity data. The highest turbidity values were recorded in April at the start of the monitoring program, which coincided with the end of the wet season. As monitoring progressed into the dry season and water flow decreased, the turbidity values decreased such that some sites were consistent with guideline values. In September, towards the end of the dry season, turbidity generally increased to values substantially greater than the WQOs (Figure 4-3).

The sites located on the Carmichael River (Sites 1 – 4) were fairly comparable to each other; turbidity at these sites ranged from less than 5 NTU to greater than 220 NTU.   The median turbidity (Figure 4-3) of the Carmichael River sites was typically greater than the sites located in the farm dams (Sites 6 – 9) and on Cabbage Tree Creek (Site 5), which was not flowing during sampling. The range of turbidity experienced at the farm dam sites was less than the Carmichael River sites, with Site 7, located at Swamp Tank dam, displaying the smallest range of the program (56 NTU; Table 4-4). The minimum turbidity value at Site 6 (Four Mile Dam) was higher than all other sites. Similarly, Site 6 displayed the highest median and average turbidity values, indicating that occurrences of lower turbidity were not as common at this site compared to the other still water bodies.

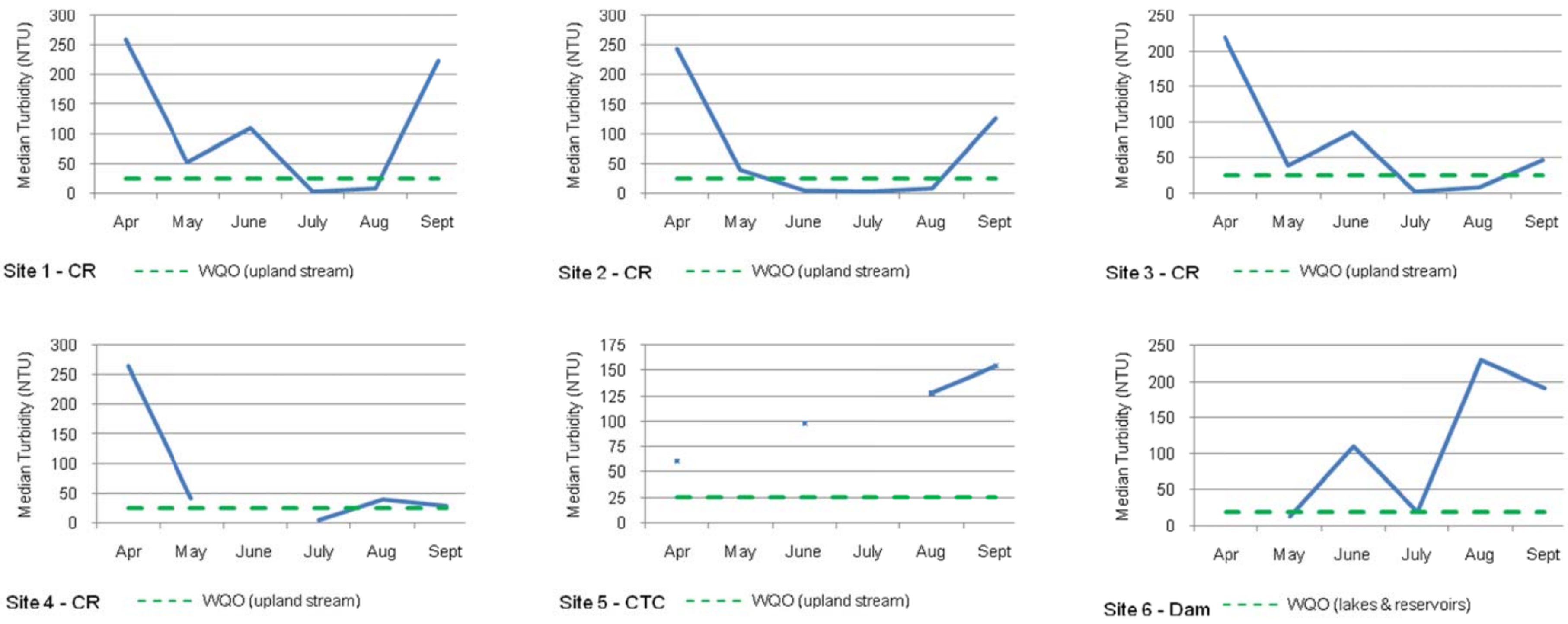
It is expected that sediment re-suspension in the flowing river is the cause of the spatial variation between the river and still water bodies. It is likely that the observed temporal variations in turbidity are linked to the changes in the onsite flow regime and associated process of evapo-concentration. All of the sites experienced a decrease in depth through time. The change in depth at the Carmichael River sites is likely to have increased the potential for alluvial sediment re-suspension.

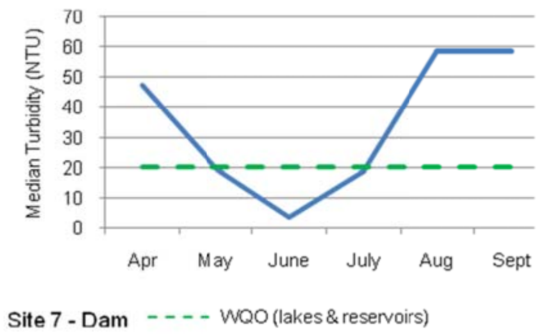
None of the sites displayed turbidity values consistent with the nominated WQOs. As such, the nominated WQOs are not considered to be appropriate for the management of surface water quality during construction and operation of the Project (Mine). The development of site specific WQOs will need to take the large observed temporal variation into consideration.

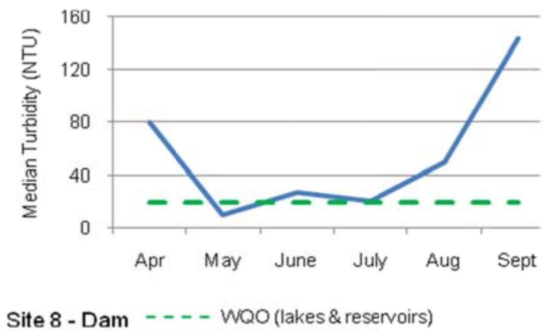
Table 4-4 Turbidity (NTU) Summary Statistics

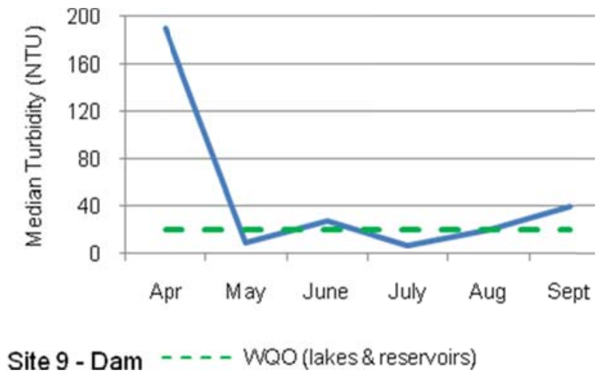
	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9
Number of samples (n)	60	60	60	50	40	50	60	60	60
Minimum	3.00	2.30	2.00	4.70	4.70	12.70	3.60	9.80	6.60
20th percentile	8.38	3.98	7.70	23.54	59.30	17.10	18.34	18.76	10.20
Median	81.35	23.20	39.30	40.05	98.50	110.20	33.55	35.30	27.00
Average	110.02	70.00	64.20	76.18	107.28	113.01	34.56	56.20	49.60
80th percentile	224.52	125.42	85.30	86.80	154.52	201.80	58.38	83.02	40.68
95th percentile	264.15	247.05	219.10	266.00	264.74	232.00	59.51	159.16	190.11
Maximum	267.00	257.00	223.00	267.00	267.00	232.00	59.60	195.60	192.80
WQOs	25.00 upland streams	25.00 upland streams	25.00 upland streams	25.00 upland streams	20.00 lakes & reservoirs	20.00 lakes & reservoirs	20.00 lakes & reservoirs	20.00 lakes & reservoirs	20.00 lakes & reservoirs

Figure 4-3 Median Turbidity (NTU) Values for each Site through Time









Note: Sites 10 – 12 were dry during sampling

4.4.1.2 Dissolved Oxygen

Dissolved oxygen (DO) is influenced by the balance between oxygen consuming processes, such as respiration, and oxygen releasing processes, such as photosynthesis and atmospheric input (ANZECC and ARMCANZ, 2000). The amount of DO within a water body can be affected by a number of environmental and biological factors including, but not limited to temperature, salinity, atmospheric and hydrostatic pressure, rates of photosynthesis (which displays strong diurnal pattern), rates of atmospheric input, and turbulence of the water body.

Values of DO displayed both temporal and spatial changes (Figure 4-4 and Table 4-5) which is not unexpected given the number of different factors that influence DO concentrations. Missing values at Site 5 are related to the inaccessibility of the site during some sampling events.

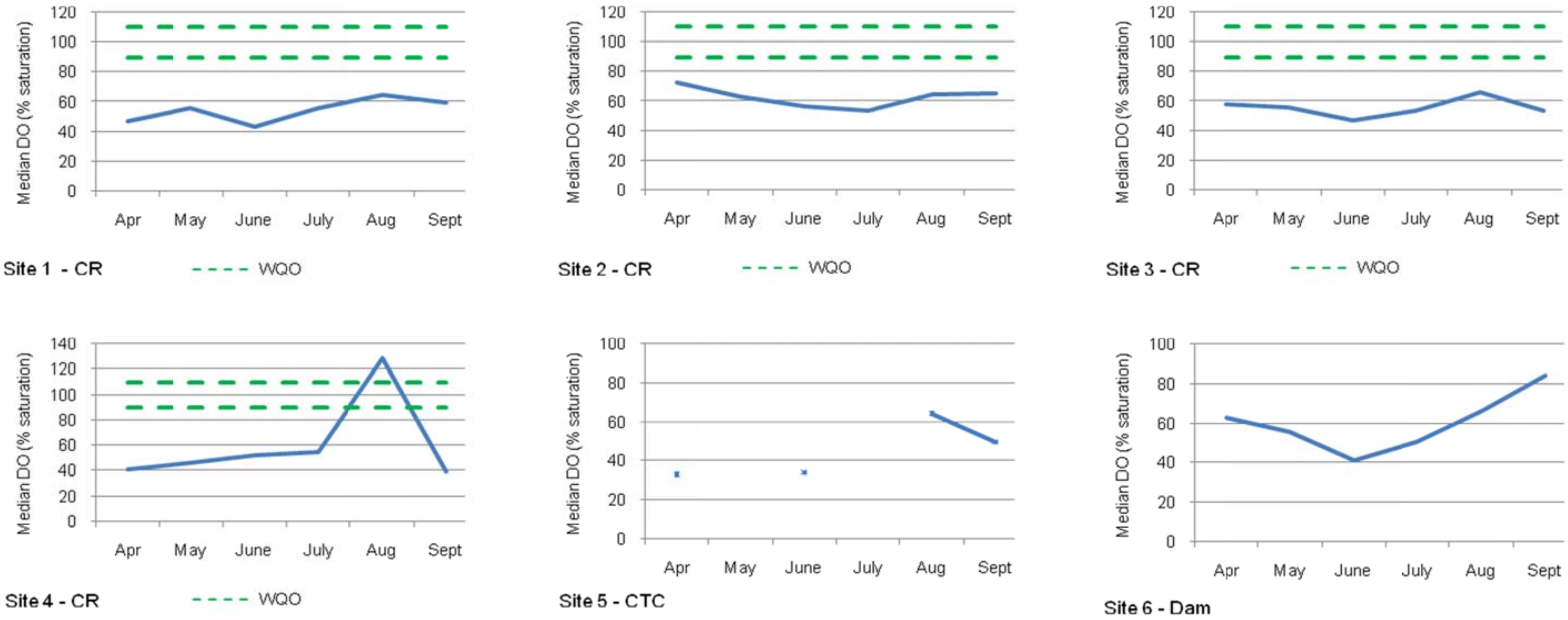
All DO concentrations recorded at all sites throughout the monitoring program were below the lower bound of the WQO range (Figure 4-4). The QWQG (DERM, 2009a) states that the DO guidelines for freshwater should only be applied to flowing waters. Stagnant pools in ephemeral waters can naturally experience DO levels below 50 per cent saturation (DERM, 2009a), which is consistent with the findings of the monitoring program.

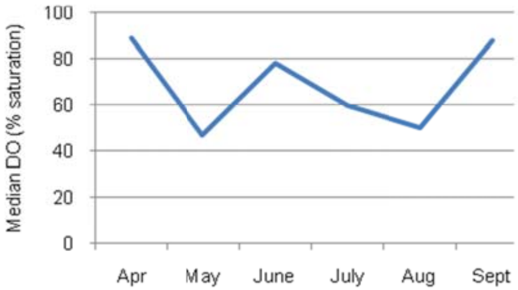
The distinct spatial patterns observed in the turbidity results were not present in the DO results. DO results at Sites 1 – 3 on the Carmichael River followed a similar temporal pattern (Figure 4-4), and displayed a range of less than 25 per cent saturation (Table 4-5). DO concentrations at Site 4, also located on the Carmichael River, were more comparable to those recorded at Site 5 (Cabbage Tree Creek) than the other Carmichael River sites. These two sites displayed a DO concentration range of greater than 90 per cent saturation (Table 4-5). The dam sites (Sites 6 – 9) generally followed a similar temporal pattern (Figure 4-4). These sites also displayed comparable ranges in DO concentration; approximately 45 per cent saturation (Table 4-5).

Table 4-5 Dissolved Oxygen (per cent saturation) Summary Statistics

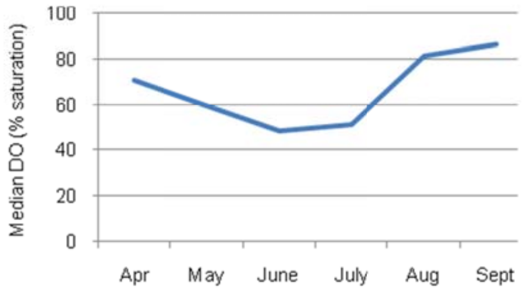
	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9
Number of samples (n)	60	60	60	60	40	60	60	60	60
Minimum	42.40	53.00	47.20	37.90	31.03	40.40	46.28	46.40	35.80
20th percentile	45.61	56.28	53.14	40.33	34.20	50.40	48.56	50.80	49.48
Median	55.84	64.18	55.03	49.11	40.40	59.47	69.40	64.74	58.35
Average	54.16	62.97	55.95	60.11	51.11	60.40	68.79	66.48	59.77
80th percentile	59.60	67.24	59.17	55.86	63.76	67.58	88.12	83.14	75.90
95th percentile	64.82	73.48	66.41	129.72	127.71	84.88	90.31	87.91	81.61
Maximum	65.20	76.46	67.90	130.50	130.50	86.60	91.76	89.90	82.27
WQOs	90-110 upland streams	90-110 upland streams	90-110 upland streams	90-110 upland streams	n/a	n/a	n/a	n/a	n/a

Figure 4-4 Median Dissolved Oxygen (per cent saturation) Values for each Site through Time

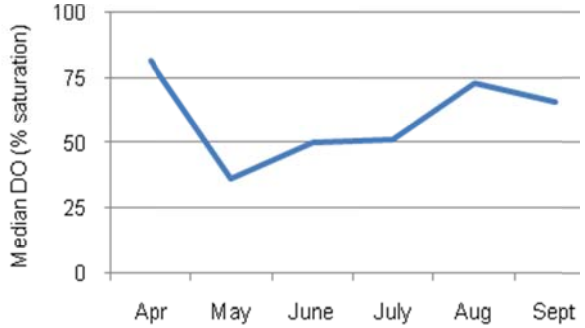




Site 7 - Dam



Site 8 - Dam



Site 9 - Dam

Note: Sites 10 – 12 were dry during sampling

4.4.1.3 pH

pH is a measure of the acidity or alkalinity of water. The pH of surface waters can be highly variable, being driven by local and regional factors such as underlying geology, climate, land use, organic loading and flow regime. Most natural freshwaters range in pH from 6.5 (slightly acidic) to 8.0 (slightly alkaline; ANZECC and ARMCANZ, 2000). The QWQG (DERM, 2009a) considers extremes of pH to be less than 5 and greater than 9.

All sites located on the Carmichael River (Sites 1 – 4) were consistently outside the identified WQO range (6.5 – 7.5; Figure 4-5 and Table 4-6). pH at these sites ranged from 7.7 – 8.48, which, whilst above the upper WQO, is not considered to be extreme. The Carmichael River sites all displayed a similar temporal pattern in pH, with little spatial variation between sites during each of the events. An investigation of the soil properties of the immediate surrounds identified that the soil types are alkaline (refer Volume 4 Appendix L Soils Report). It is expected that the soil alkalinity strongly influenced the alkaline pH levels of water quality of the Carmichael River.

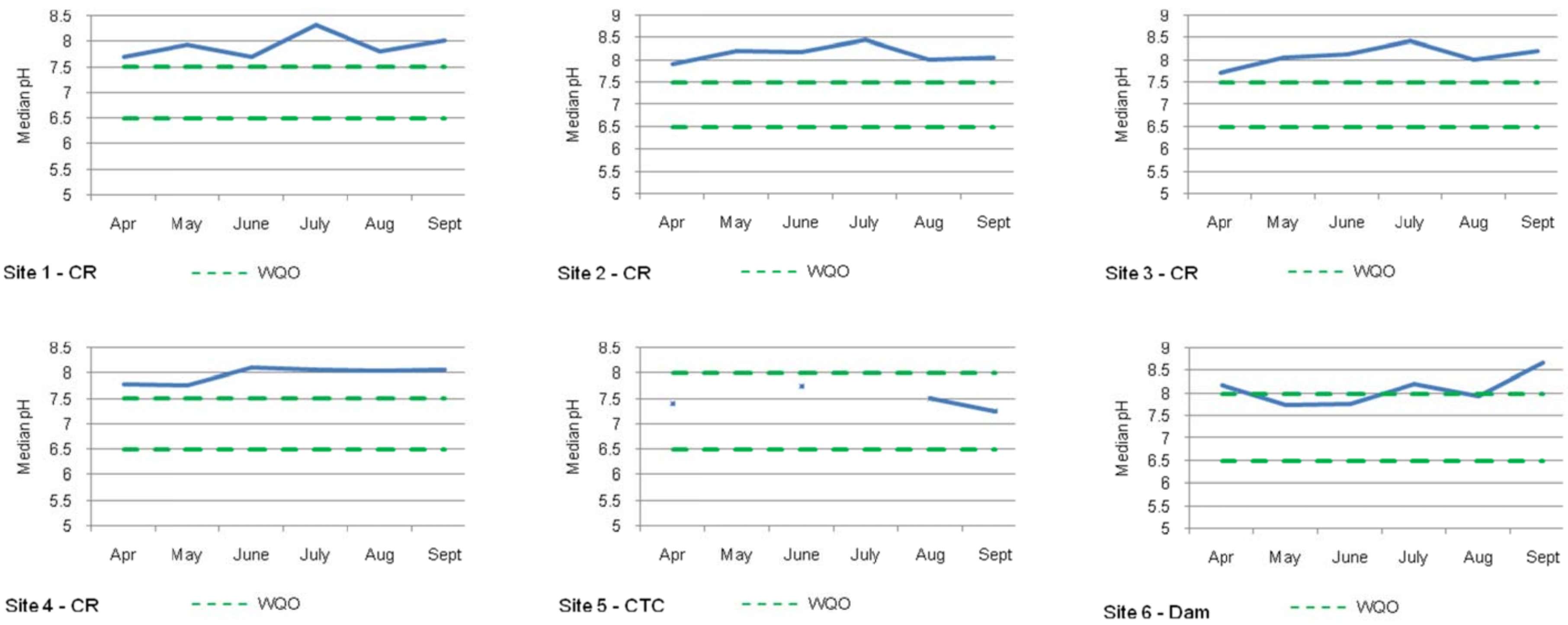
The pH of the still water bodies (Site 5, Cabbage Tree Creek and Sites 6 – 9, farm dams) were also regularly above identified WQOs (6.5 – 8.0. Figure 4-5). Missing data points at Site 5 are related to site access issues encountered during monitoring. pH at the still water sites showed a greater variation within each site, with ranges varying from 0.89 pH units at Site 5 to 2.64 pH units at Site 9 (Table 4-6). Extreme values of pH (> 9) were recorded at Site 7, Site 8 and Site 9. These values were recorded at the end of the monitoring program (September) at Site 7 and Site 8, and at the start of the monitoring program (April) at Site 9. Temporal patterns at the still water sites were not as distinct as those observed at the Carmichael River sites. Similarly, spatial variability between the still water sites was more pronounced during each monitoring event.

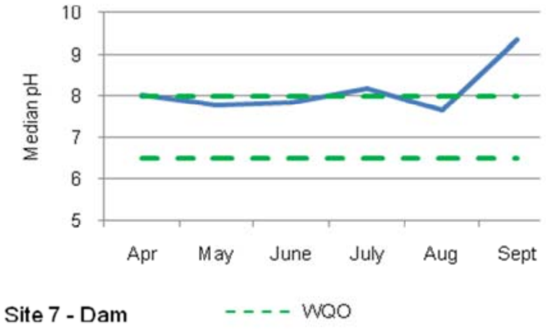
A number of sites were greater than the WQOs pH range. As such, the nominated WQOs are not considered to be appropriate for the management of surface water quality during construction and operation of the Project (Mine). The development of site specific WQOs will need to take the large observed temporal variation into consideration.

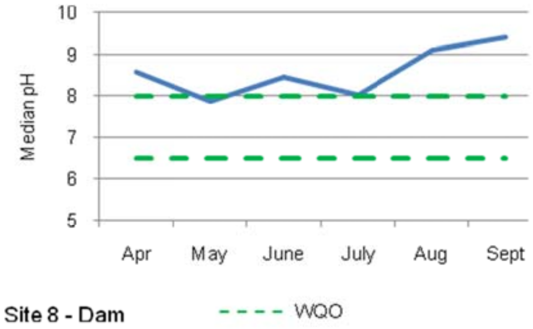
Table 4-6 pH Summary Statistics

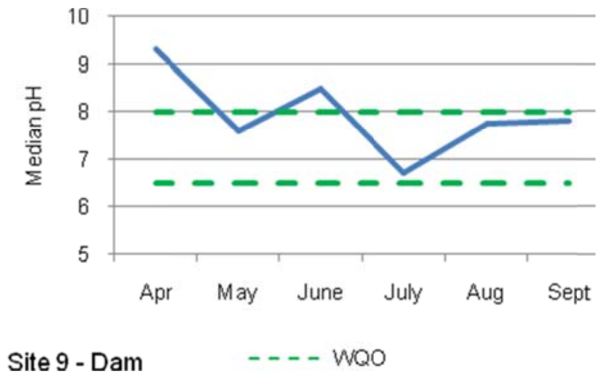
	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9
Number of samples (n)	60	60	60	60	40	60	60	60	60
Minimum	7.70	7.90	7.71	7.70	7.23	7.75	7.65	7.88	6.68
20th percentile	7.71	7.95	8.01	7.78	7.40	7.77	7.77	7.99	7.59
Median	7.89	8.13	8.10	8.06	7.52	8.01	7.94	8.53	7.80
Average	7.92	8.14	8.09	7.97	7.64	8.08	8.14	8.58	7.95
80th percentile	8.03	8.24	8.21	8.07	8.07	8.25	8.21	9.10	8.49
95th percentile	8.34	8.47	8.43	8.12	8.11	8.69	9.35	9.41	9.32
Maximum	8.34	8.48	8.43	8.12	8.12	8.69	9.36	9.41	9.32
WQOs	6.5-7.5 upland streams	6.5-7.5 upland streams	6.5-7.5 upland streams	6.5-7.5 upland streams	6.5-8.0 lakes & reservoirs	6.5-8.0 lakes & reservoirs	6.5-8.0 lakes & reservoirs	6.5-8.0 lakes & reservoirs	6.5-8.0 lakes & reservoirs

Figure 4-5 Median pH Values for each Site through Time









Note: Sites 10 – 12 were dry during sampling

4.4.1.4 Temperature

Variations in surface water temperature can occur naturally as part of diurnal and seasonal cycles, as changes in depth occur, or as a result of anthropogenic activities (ANZECC and ARMCANZ, 2000). Site specific influences, such as shading, wind and rainfall regime can also affect water temperature. WQOs for temperature have not been developed due to the very wide range of temperatures that may occur in fresh waters.

Recorded water temperature varied in accordance with seasonality (and air temperatures) throughout the monitoring period, with minimum temperatures recorded in June at all sites (Table 4-7 and Figure 4-6; missing data at Site 5 due to site access issues). Spatial variation in temperature was also observed (Figure 4-6) with the sites on the Carmichael River (Sites 1 – 4) generally recording lower temperatures to those in the still water bodies (Cabbage Tree Creek and dam sites).

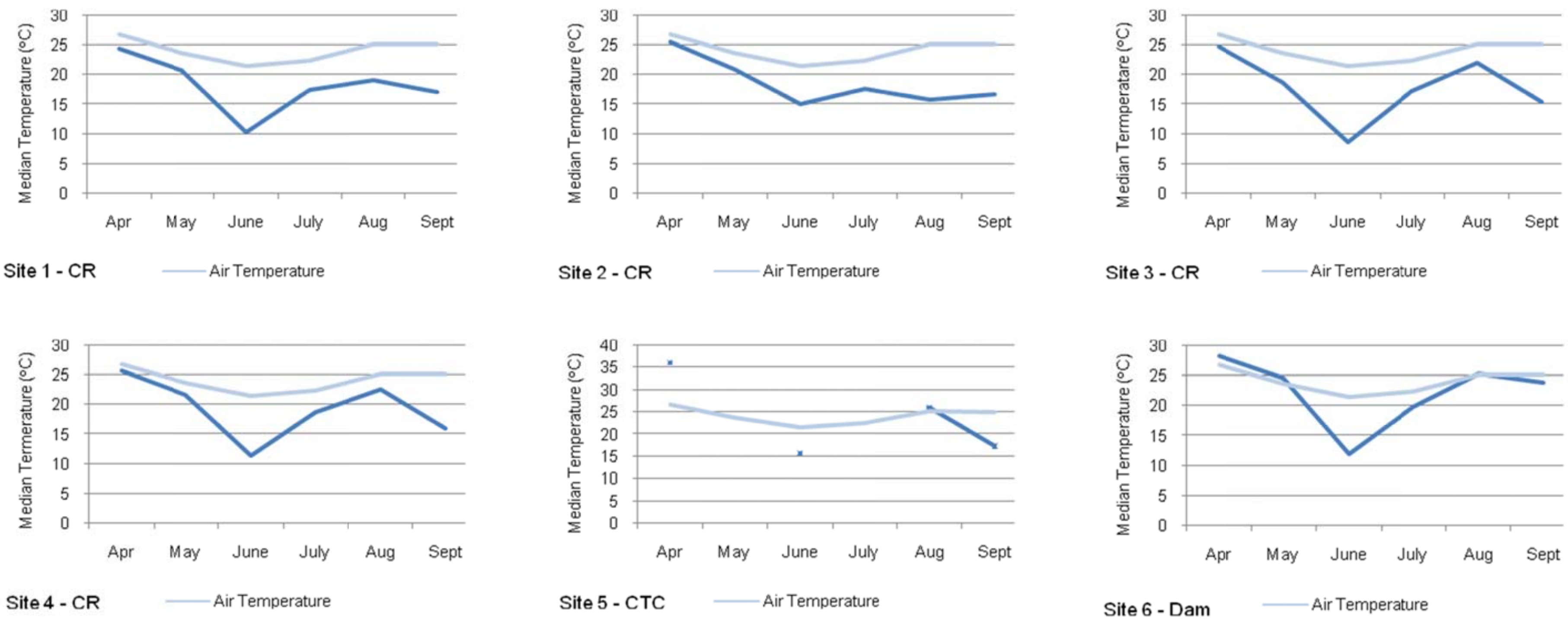
Temporal variation in temperature at the Carmichael River sites ranged from 10 °C at Site 2 to 16 °C at Site 3 (Table 4-7). In contrast, sites located in the still water bodies displayed a higher temporal variation with ranges from 16 °C at Site 6 to 25 °C at Site 5 (Table 4-7). The contrast in temporal variation trends is associated with the temperature maxima; there was less variation between river and still water body sites at the lower temperatures than at the higher temperatures.

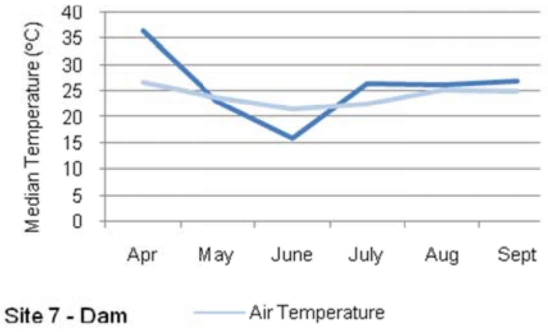
The differences in temperature between the Carmichael River sites and the still water bodies is likely associated with the high degree of shading by riparian vegetation at the river sites. The still water bodies had limited to no shading and would thus be more influenced by direct radiance from the sun, leading to heating of the water body (refer Section 2.1 for site descriptions). This indicates that shading of water bodies provides a buffering capacity against variations in temperature.

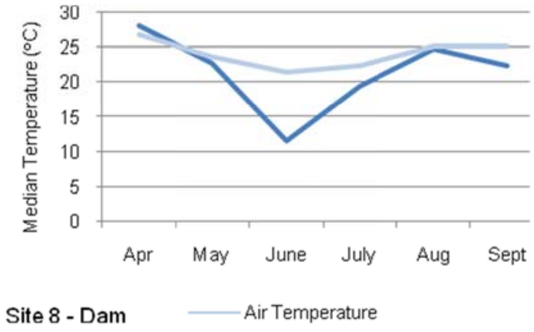
Table 4-7 Temperature (°C) Summary Statistics

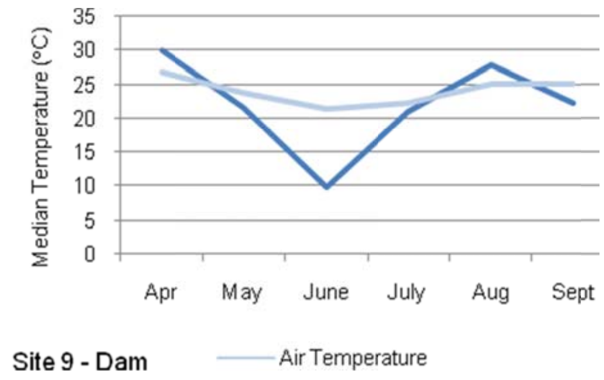
	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9
Number of samples (n)	60	60	60	60	40	60	60	60	60
Minimum	10.30	15.00	8.60	11.30	11.30	12.00	15.80	11.50	9.90
20th percentile	17.00	15.68	15.40	15.90	15.90	19.90	23.20	19.40	21.10
Median	18.30	17.15	18.00	20.15	17.30	24.50	26.45	22.65	22.00
Average	18.19	18.55	17.79	19.30	22.54	22.35	25.96	21.54	22.17
80th percentile	20.90	20.92	22.00	22.60	26.20	25.50	27.10	24.82	27.90
95th percentile	24.40	25.50	24.80	25.70	36.10	28.30	36.60	28.20	30.11
Maximum	24.40	25.50	24.80	25.70	36.20	28.30	36.60	28.20	30.20
WQOs	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Figure 4-6 Median Temperature (°C) Values for each Site through Time









Note: Sites 10 – 12 were dry during sampling; air temperature data sourced from BoM, 2011

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4.4.1.5 Electrical Conductivity

Electrical conductivity (EC) is an indicator used to measure the total concentration of inorganic ions (salts) in water. Freshwaters are generally defined by having an EC of less than 1,000 μS/cm (ANZECC and ARMCANZ, 2000). The EC of a water body can be affected by a number of factors including concentrations of salts in catchment soils and groundwater, land use, climate and flow regime.

Average EC values across the sites were close to or less than 1,000 μS/cm (Table 4-8). As such, the waters of the Study Area can be considered to be freshwater. EC levels at the Carmichael River sites (Sites 1 – 4) were substantially higher than the still water bodies (Cabbage Tree Creek and dam sites, Sites 5 – 9), and the nominated WQOs. EC levels at the still water bodies were generally below the nominated WQOs (Sites 5 – 9; Figure 4-7; missing data at Site 5 related to site access issues). The Carmichael River sites all displayed a similar temporal pattern, with EC generally increasing through the dry season (Figure 4-7). By June the EC levels at the river sites had increased above 1,000 μS/cm, indicating an increased concentration of major ions present in the water. This water is still considered to be freshwater due to its location and lack of tidal influence, but higher EC values mean that the ability of the water to provide aquatic habitat is compromised.

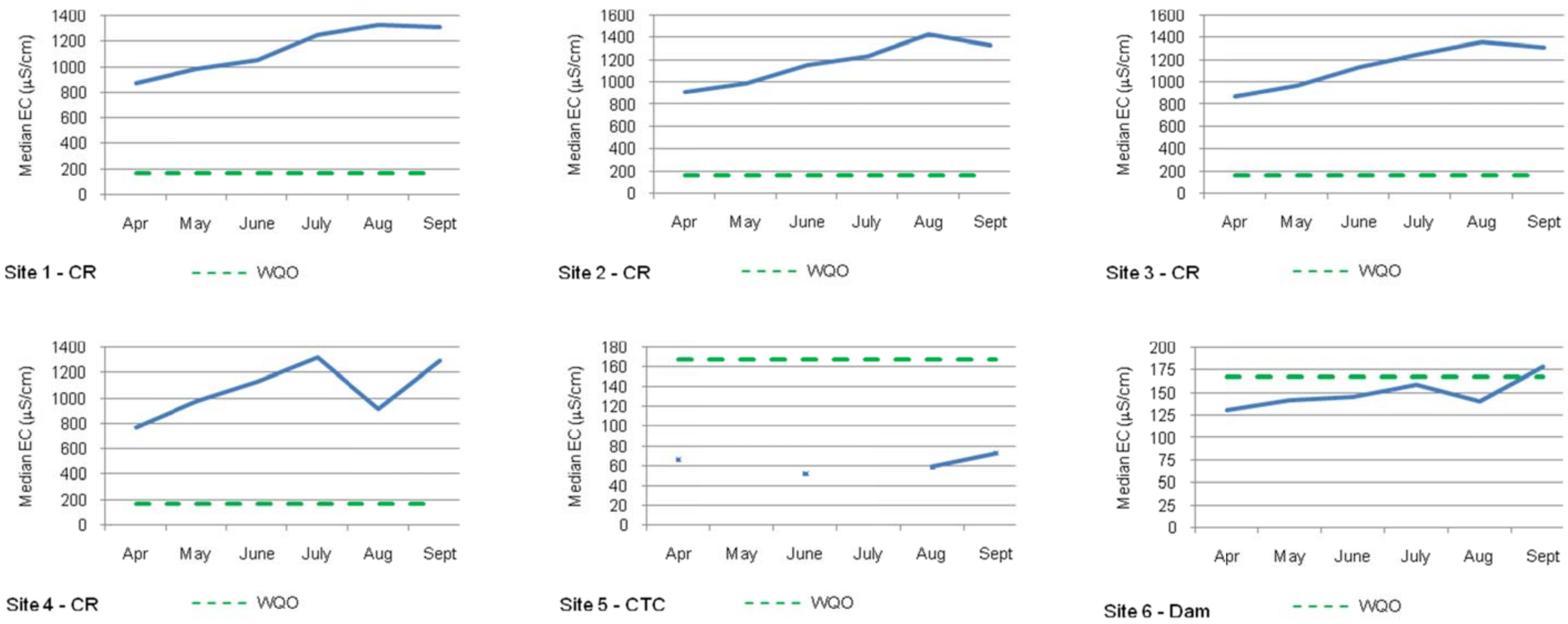
The temporal trends observed in the EC of river sites are likely linked to the local climate and flow regime. The lower EC levels were present at the end of the wet season during which time the heavy rainfall would have caused dilution of the salts present in the river. The observed increase in EC is as the dry season progressed is likely related to the cumulative effects of the evapo-concentration of the salts, and groundwater inputs. Potential inputs of saline groundwater are further explored in Volume 4 Appendix R Mine Hydrogeology Report.

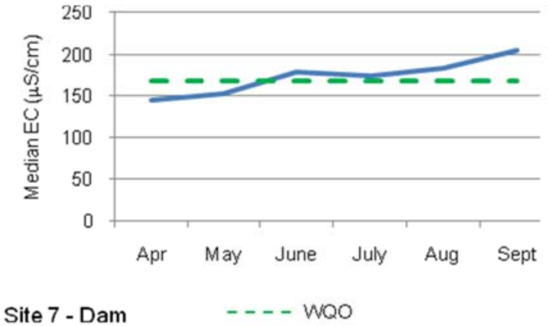
None of the sites displayed EC levels consistent with the nominated WQOs. As such, the nominated WQOs are not considered to be appropriate for the management of surface water quality during construction and operation of the Project (Mine). The development of site specific WQOs will need to take the large observed temporal variation into consideration.

Table 4-8 Electrical Conductivity (μS/cm) Summary Statistics

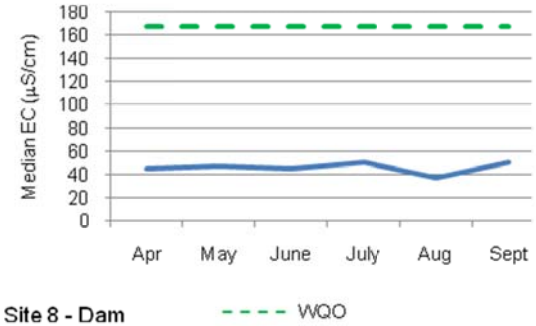
	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9
Number of samples (n)	60	60	60	60	40	60	60	60	60
Minimum	877	911	875	773	52	131	145	37	62
20^{th} percentile	988	988	972	919	59	141	153	45	66
Median	1153	1193	1199	1054	67	144	177	47	74
Average	1135	1175	1154	1069	383	150	174	46	75
80^{th} percentile	1309	1336	1315	1293	1292	159	184	51	84
95^{th} percentile	1328	1429	1360	1323	1320	179	206	51	93
Maximum	1328	1430	1360	1327	1327	180	206	51	93
WQOs	168	168	168	168	168	168	168	168	168

Figure 4-7 Median Electrical Conductivity (μS/cm) Values for each Site through Time

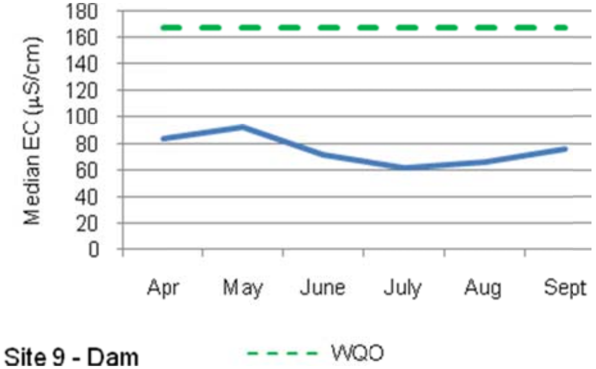




Site 7 - Dam



Site 8 - Dam



Site 9 - Dam

4.4.2 Major Ions

An assessment of the major ion concentrations (sodium (Na^+), potassium (K^+), magnesium (Mg^{2+}), calcium (Ca^{2+}), chloride (Cl^-), sulphate (SO_4^{2-}), bicarbonate (HCO_3^-) and carbonate (CO_3^{2-}) of the surface water resources of the Study Area has been undertaken. Figure 4-8 presents a piper diagram categorising the water types based on major ion chemistry. This indicates that the water present in the still water bodies has a different major ion 'finger print' than the water present in the Carmichael River.

The still water bodies were characterised by a major ion water type comprising sodium/potassium bicarbonate. This characterisation was consistent throughout the monitoring program. By contrast, there was variation in the major ion characteristics in the Carmichael River over the sampling period. At the end of the wet season (May) the Carmichael River was characterised by a major ion water type comprising sodium chloride bicarbonate. As the influence of the wet season decreased, the water type of the Carmichael River changed; concentrations of bicarbonate decreased and concentrations of sodium and chloride increased, resulting in a water type classified as sodium chloride. Towards the end of the dry season (September, October and November) the concentrations of magnesium in the Carmichael River substantially increased, as reflected by the changes in EC (refer results presented above).

Groundwater sampling bores in proximity to the Carmichael River were established towards the end of the surface water quality monitoring program (refer Volume 4 Appendix R Hydrogeology Report for details of the groundwater program). Sampling of the major ion chemistry of the groundwater in proximity to the Carmichael River was undertaken in October and November 2011 (Figure 4-8). The major ion chemistry of the groundwater at this time was characterised by a water type of sodium chloride. Magnesium was also present in the groundwater samples.

Additional surface water samples were obtained from Carmichael River sites during the groundwater sampling events in October and November. These samples were tested for major ion concentrations. The additional samples provide temporal continuity between the surface water and groundwater major ion data sets, thus allowing for a comparison between these water resources to be undertaken.

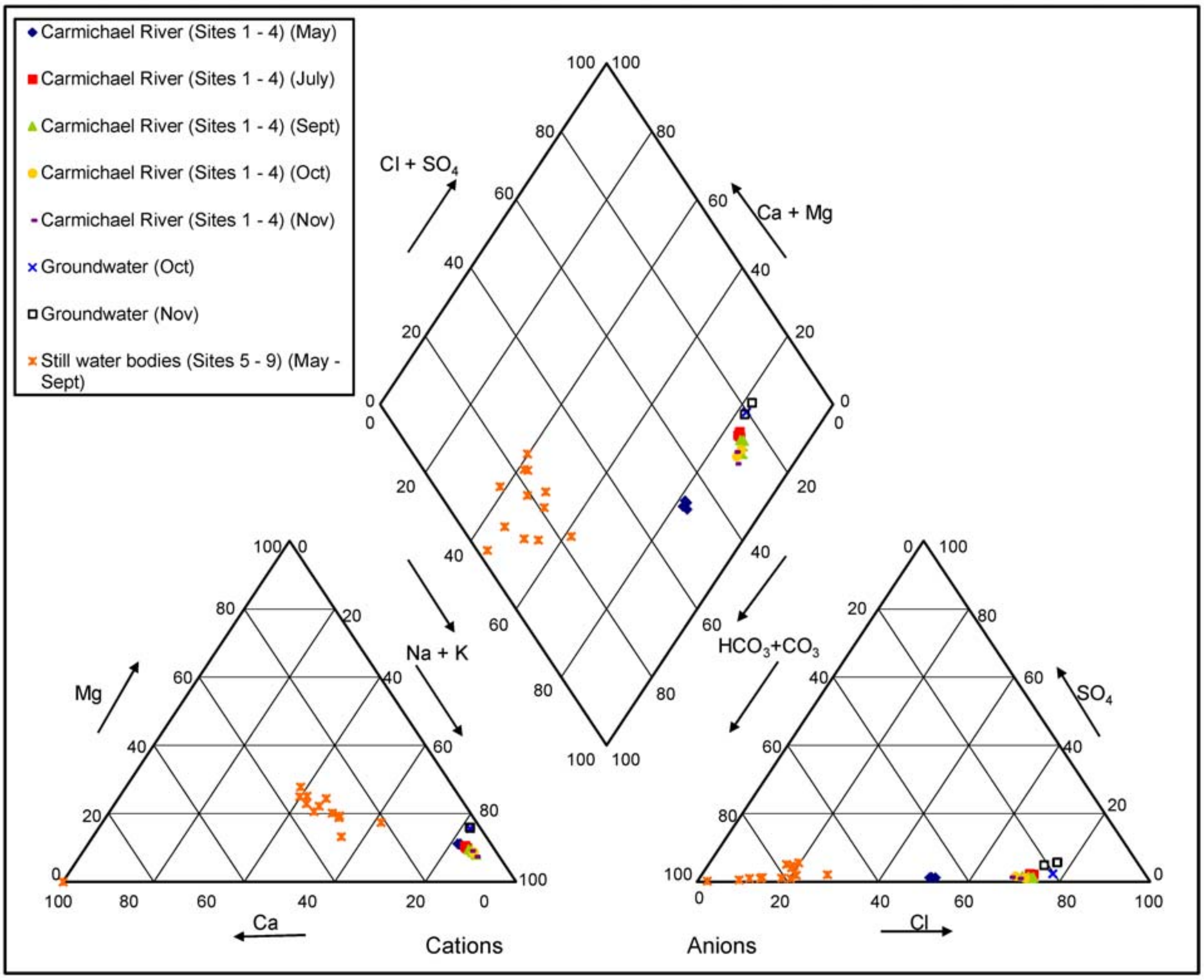
A comparison of the major ion chemistry of the groundwater and surface water (Figure 4-8) indicates that it is likely that the surface water of the Carmichael River is influenced by the nearby groundwater aquifers. From the temporal change observed in the surface water major ion chemistry it can also be surmised that the influence of groundwater on the Carmichael River is greater in the dry season than in the wet season when rain water is entering the system. Further sampling of the major ion chemistry of the groundwater and surface waters of the Carmichael River is planned so as to confirm this surface water / groundwater interaction.

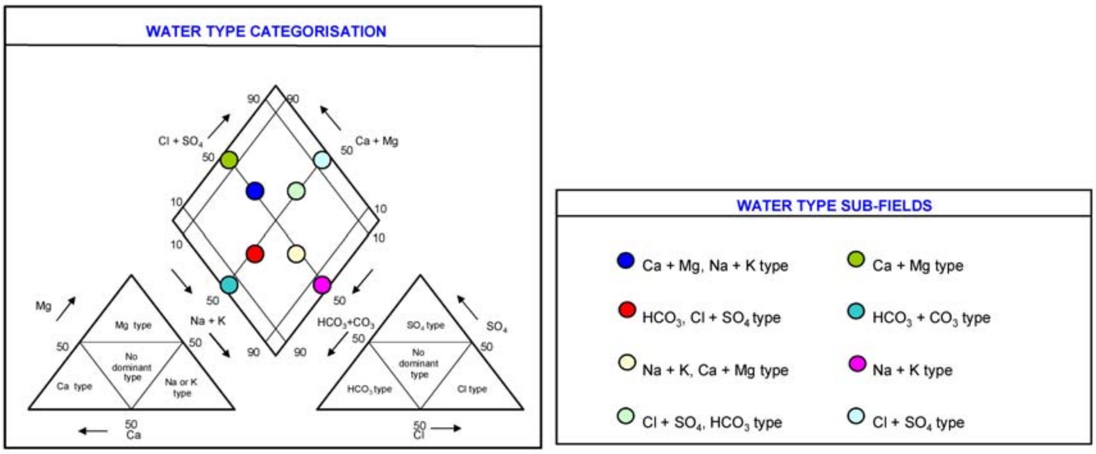
All surface water major ion concentrations were consistent with the nominated WQOs (Table 4-9). As a result, the nominated WQOs may be appropriate for the management of major ions during construction and operation of the Project (Mine). The applicability of the WQOs will be confirmed following the investigation into the surface water / groundwater interaction.

Table 4-9 Maximum Values of Major Ion Concentrations (mg/L)

	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9
Calcium	14	14	14	15	5	14	13	4	6
Calcium WQO	1000	1000	1000	1000	1000	1000	1000	1000	1000
Magnesium	14	14	15	16	2	6	5	1	3
Magnesium WQO	2000	2000	2000	2000	2000	2000	2000	2000	2000
Fluoride	0.4	0.4	0.4	0.4	0	0.2	0	0	0
Fluoride WQO	2	2	2	2	2	2	2	2	2
Sulphate	14	13	14	14	2	5	1	0.5	0.5
Sulphate WQO	1000	1000	1000	1000	1000	1000	1000	1000	1000
TDS	932	960	894	954	234	378	240	129	136
TDS WQO	2500	2500	2500	2500	2500	2500	2500	2500	2500

Figure 4-8 Piper Diagram of Major Ion Chemistry





4.4.3 Nutrients

Nutrients that were assessed as part of the monitoring program were total nitrogen, ammonia, oxides of nitrogen, total phosphorus and reactive phosphorus. A table of all the nutrient analytical results is provided in Appendix D; summary statistics are provided below to assist in data interpretation. Nutrient pollution has the potential to impact upon a system via the stimulation of growth of nuisance plants and cyanobacteria (ANZECC and ARMCANZ, 2000). Growth of these plants can lead to changes in the biological community composition as well as flow on affects to aspects of water quality such as depletion of dissolved oxygen concentration. Observations of macrophyte presence and prevalence were undertaken during each monitoring event. No macrophytes of high prevalence (blooms) were noted during monitoring.

Nitrogen concentrations displayed distinct spatial patterns whereby the concentrations found in the still water bodies were consistently higher than those found in the Carmichael River. The total nitrogen concentrations of the still water bodies were also consistently much higher than the nominated WQOs. Summary statistics of the total nitrogen values recorded throughout the monitoring program are provided in Table 4-10.

Table 4-10 Total Nitrogen (µg/L) Summary Statistics

	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9
Minimum	250	140	120	150	830	590	1530	1360	1140
20^{th} percentile	250	230	220	240	866	640	1530	1930	2150
Median	310	300	235	280	995	670	1925	2030	2175
Average	362	325	297	328	1063	697	2068	2028	2070
80^{th} percentile	350	350	370	320	1232	780	2700	2210	2270
95^{th} percentile	613	560	543	605	1381	818	2775	2510	2450
Maximum	700	630	600	700	1430	830	2800	2610	2510
WQOs	250 upland streams	250 upland streams	250 upland streams	250 upland streams	350 lakes & reservoirs	350 lakes & reservoirs	350 lakes & reservoirs	350 lakes & reservoirs	350 lakes & reservoirs

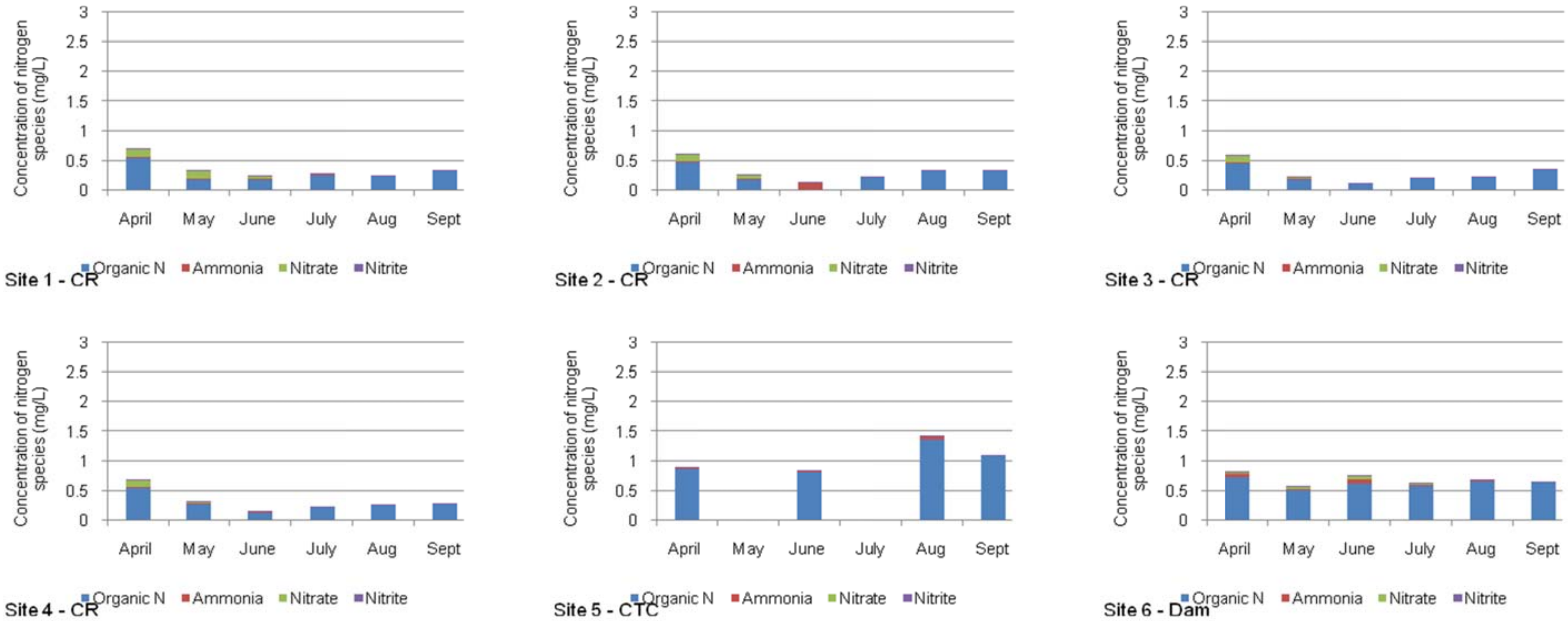
There was little spatial separation of the total nitrogen concentrations at the Carmichael River sites. These sites all followed a similar pattern of high concentrations (above WQOs) at the end of the wet season (April), followed by a decrease to below WQOs in June and then a gradual increase back to values above WQOs in September.

Total nitrogen is comprised of organic nitrogen, and inorganic nitrogen, including ammonia (NH_3 or NH_4^+), nitrate (NO_3^-) and nitrite (NO_2^-). The composition of the total nitrogen samples collected throughout the monitoring program is presented in Figure 4-9. This shows that the total nitrogen concentration was mainly comprised of organic nitrogen. Levels of organic nitrogen were generally above the nominated WQOs (225 µg/L and 330 µg/L for Carmichael River and the still water bodies (including Cabbage Tree Creek), respectively). The QWQG (DERM, 2009a) state that during periods of low flow increased organic nitrogen levels can result from a build-up of organic matter derived from natural sources. These higher organic nitrogen levels should not be considered to be exceedences of the guidelines if levels of inorganic nitrogen remain low (DERM, 2009). The Study Area was subject to low (Carmichael River sites) or no flow (Cabbage Tree Creek and dam sites) throughout the monitoring program (April – September). A build-up of organic matter, such as plant detritus and cow manure, was observed at all sites during the monitoring program. As such, higher organic nitrogen levels, including those above the nominated WQOs, are not unexpected.

As seen in Figure 4-9, some nitrate, ammonia and nitrite was present at the Carmichael River sites early in the monitoring program. With the exception of one sample (Site 2, June); concentrations of these inorganic nitrogen species at the Carmichael River sites were below the nominated WQOs. As such, the organic nitrogen levels above the WQOs are not considered to represent significant exceedences of the QWQG.

Concentrations of organic nitrogen in the still water bodies were consistently greater than the nominated WQOs, this may be due runoff from the surrounding grazing land. Similarly, when present, the concentrations of ammonia were above the nominated WQOs.

Figure 4-9 Composition of Nitrogen Species (mg/L) for each Site through Time



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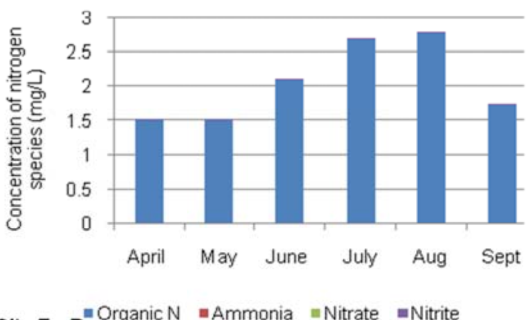
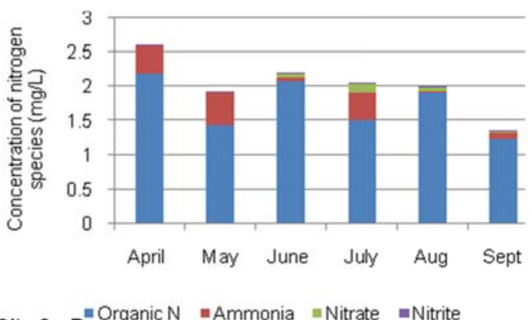
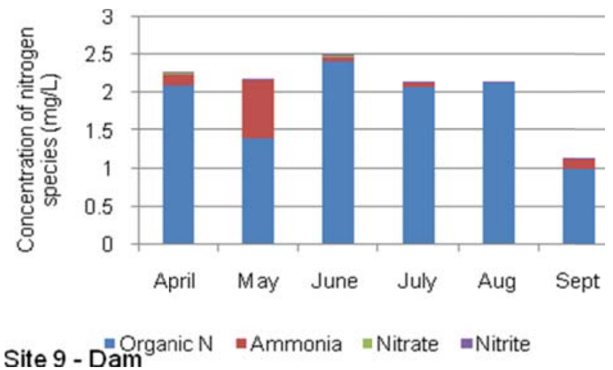


Site 7 - Dam



Site 8 - Dam



Site 9 - Dam

Note: Sites 10 – 12 were dry during sampling

Total phosphorus concentrations exhibited similar spatial and temporal patterns to total nitrogen concentrations. The still water bodies displayed substantially higher total phosphorus concentrations than the sites located in the Carmichael River. The Carmichael River sites displayed a small temporal variation (maximum variation of 0.029 mg/L at Site 4) when compared to the Cabbage Tree Creek and dam sites (maximum variation of 0.257 mg/L at Site 7; Table 4-11). The Carmichael River sites also displayed little spatial variation. With the exception of Site 1 and Site 2 in April, and Site 4 in May and August, all total phosphorus values recorded from the Carmichael River were below the nominated WQOs of 0.03 mg/L. All concentrations of total phosphorus in the still water bodies were above the nominated WQOs of 0.01 mg/L (Table 4-11).

Table 4-11 Total Phosphorus (mg/L) Summary Statistics

	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9
Minimum	0.011	0.009	0.007	0.009	0.077	0.064	0.091	0.087	0.068
20th percentile	0.018	0.014	0.013	0.013	0.132	0.070	0.159	0.096	0.087
Median	0.021	0.019	0.019	0.025	0.170	0.076	0.202	0.101	0.113
Average	0.021	0.020	0.016	0.024	0.172	0.079	0.219	0.108	0.115
80th percentile	0.025	0.024	0.019	0.033	0.212	0.088	0.310	0.120	0.140
95th percentile	0.029	0.032	0.021	0.037	0.257	0.098	0.339	0.137	0.160
Maximum	0.030	0.034	0.021	0.038	0.272	0.101	0.348	0.142	0.167
WQOs	0.030 upland streams	0.030 upland streams	0.030 upland streams	0.030 upland streams	0.010 lakes & reservoirs	0.010 lakes & reservoirs	0.010 lakes & reservoirs	0.010 lakes & reservoirs	0.010 lakes & reservoirs

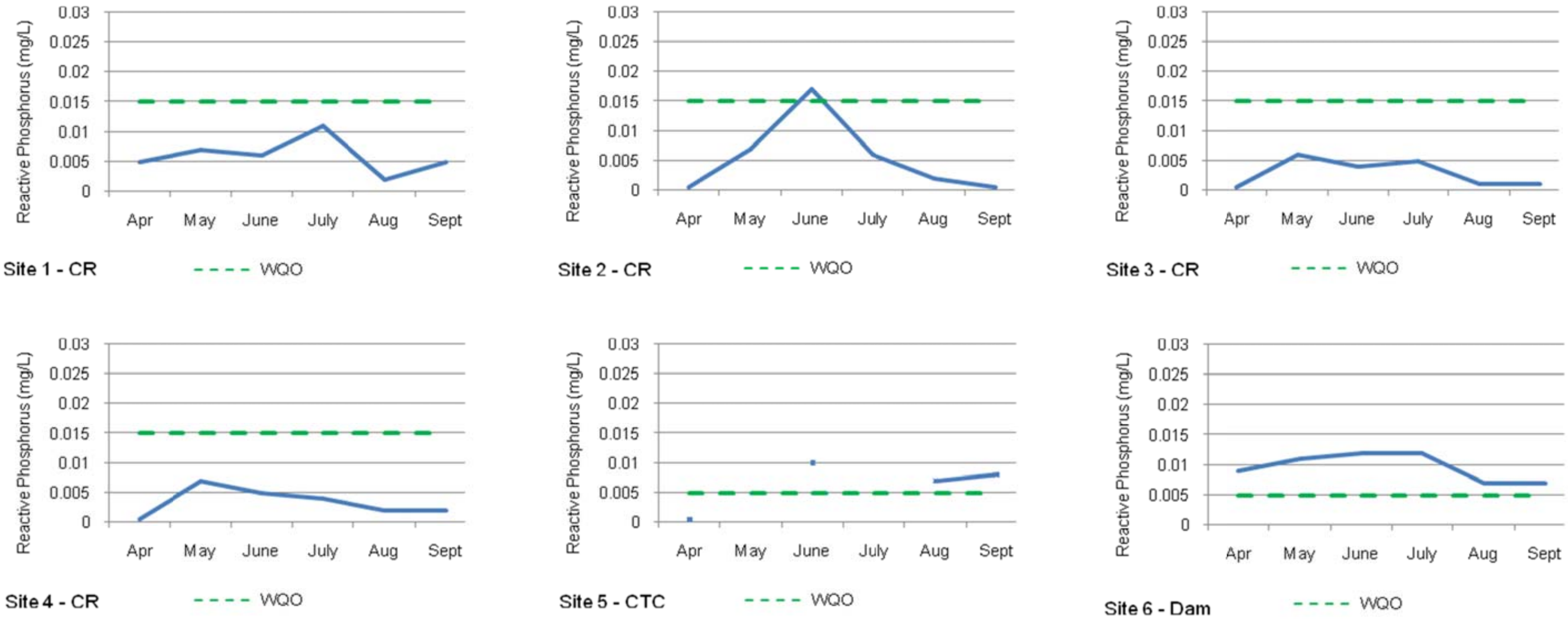
Measures of reactive phosphorus provide an indication of the potentially bioavailable forms of phosphorus in the system. The majority of reactive phosphorus samples from the Carmichael River were below the nominated WQOs (Figure 4-10). Conversely, the majority of the reactive phosphorus samples from the still water bodies were above the nominated WQOs (Figure 4-10).

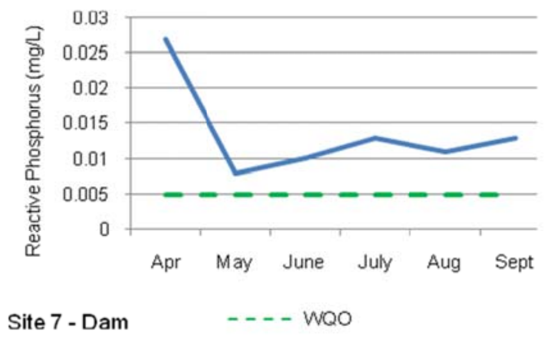
Reactive phosphorus concentrations ranged from 0.001 mg/L (Site 3) to 0.017 mg/L (Site 2) at the Carmichael River sites (Sites 1 – 4; Table 4-12). The still water body site (Sites 5 – 9), which generally contained higher levels of reactive phosphorus, ranged from 0.004 mg/L (Site 9) to 0.027 mg/L (Site 7). Overall nutrient levels were not consistent with the nominated WQOs. As such, the nominated WQOs are not considered to be appropriate for the management of surface water quality during construction and operation of the Project (Mine). The development of site specific WQOs will need to take the large observed temporal variation into consideration.

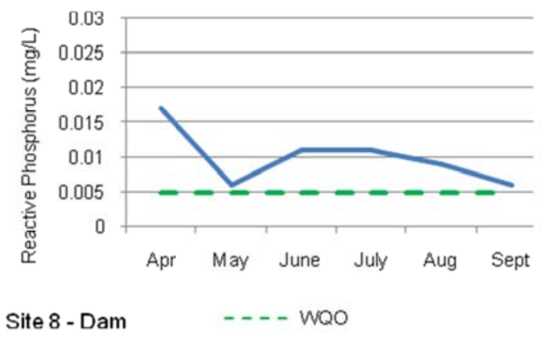
Table 4-12 Reactive Phosphorus (mg/L) Summary Statistics

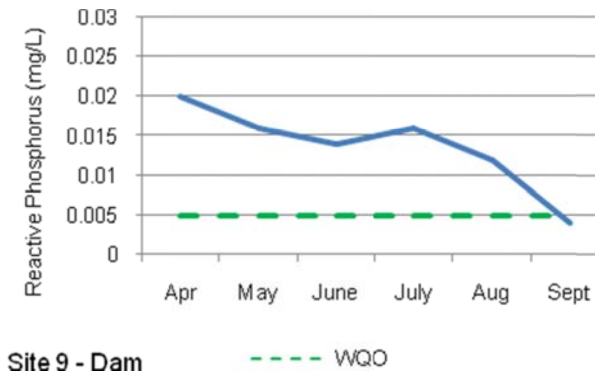
	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9
Minimum	0.002	0.002	0.001	0.002	0.007	0.007	0.008	0.006	0.004
20th percentile	0.005	0.004	0.001	0.002	0.007	0.007	0.010	0.006	0.012
Median	0.006	0.007	0.004	0.004	0.008	0.010	0.012	0.010	0.015
Average	0.006	0.008	0.003	0.004	0.008	0.010	0.014	0.010	0.014
80th percentile	0.007	0.011	0.005	0.005	0.009	0.012	0.013	0.011	0.016
95th percentile	0.010	0.016	0.006	0.007	0.010	0.012	0.024	0.016	0.019
Maximum	0.011	0.017	0.006	0.007	0.010	0.012	0.027	0.017	0.020
WQOs	0.015 upland streams	0.015 upland streams	0.015 upland streams	0.015 upland streams	0.005 lakes & reservoirs	0.005 lakes & reservoirs	0.005 lakes & reservoirs	0.005 lakes & reservoirs	0.005 lakes & reservoirs

Figure 4-10 Reactive Phosphorus (mg/L) Values for each Site through Time









Note: Sites 10 – 12 were dry during sampling

4.4.4 Biological Parameters

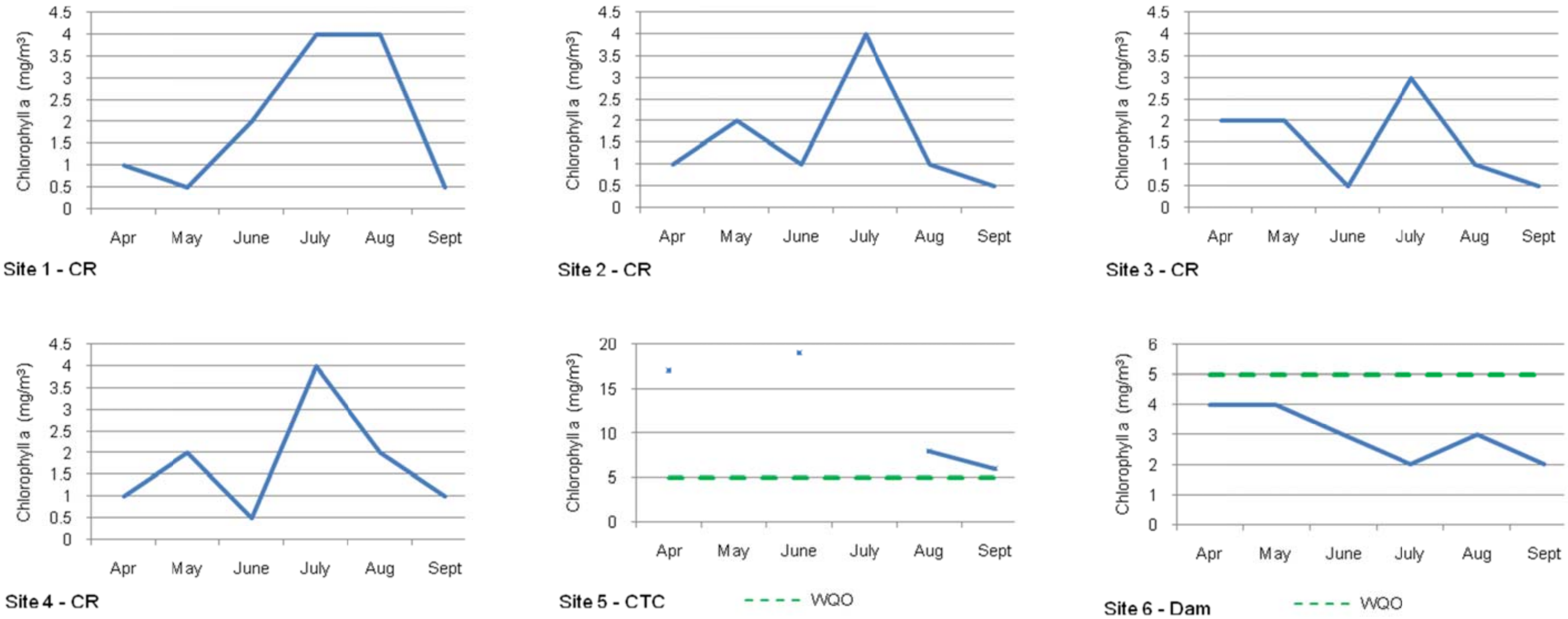
Biological parameters tested as part of the monitoring program were chlorophyll a and faecal coliforms. As noted in the QWQG (DERM, 2009a) measures of chlorophyll a provide an indication of the algal biomass in a water sample. Temporal trends in chlorophyll a at the Carmichael River sites (Sites 1 – 4) were consistent, with the majority of sites comparable during each sampling event (Table 4-13 and Figure 4-11). Temporal variation at these sites was between 2 mg/m^3 and 3 mg/m^3. Maximum concentrations at the Carmichael River sites of 4 mg/m^3 were recorded in July (Table 4-13 and Figure 4-11). There are currently no nominated WQOs for chlorophyll a for upland streams for comparison of the results from the Carmichael River sites.

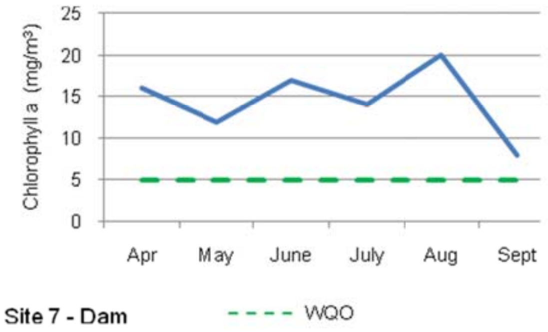
With the exception of Site 6, all still water bodies (Sites 5 – 9) contained much greater concentrations of chlorophyll a, and thus higher algal biomass, than the Carmichael River sites (Table 4-13 and Figure 4-11; missing data from Site 5 due to site access issues). Temporal variation at these sites was between 2 mg/m^3 and 52 mg/m^3 (Table 4-13). With the exceptions of Site 6, the chlorophyll a concentrations at all the still water bodies were consistently greater than the nominated WQOs (5 mg/m^3). There was a similar trend in the concentration of nitrogen in the still water bodies (Section 4.4.3). As described in Section 4.3, Site 6 displayed higher minimum turbidity values than the other still water bodies. It is likely that the turbidity values at this site limited the growth of algae in this water body.

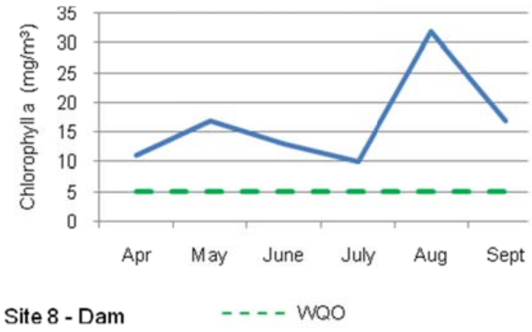
Table 4-13 Chlorophyll a (mg/m^3) Summary Statistics

	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9
Minimum	1.0	1.0	1.0	1.0	6.0	2.0	8.0	10.0	12.0
20th percentile	1.6	1.0	1.6	1.0	7.2	2.0	12.0	11.0	18.0
Median	3.0	1.0	2.0	2.0	12.5	3.0	15.0	15.0	23.5
Average	2.8	1.8	2.0	2.0	12.5	3.0	14.5	16.7	30.3
80th percentile	4.0	2.4	2.4	2.4	17.8	4.0	17.0	17.0	41.0
95th percentile	4.0	3.6	2.9	3.6	18.7	4.0	19.3	28.3	58.3
Maximum	4.0	4.0	3.0	4.0	19.0	4.0	20.0	32.0	64.0
WQOs	n/a	n/a	n/a	n/a	5.0 lakes & reservoirs	5.0 lakes & reservoirs	5.0 lakes & reservoirs	5.0 lakes & reservoirs	5.0 lakes & reservoirs

Figure 4-11 Chlorophyll a (mg/m^3) Values for each Site through Time







Note: Sites 10 – 12 were dry during sampling

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Testing for the presence and prevalence of faecal coliforms provides an indication of faecal contamination, and thus the potential presence of microbial pathogens, in a water sample. Faecal coliform concentrations at all sites were consistently above the WQOs for irrigation (direct contact; 10 cfu/100 ml; Table 4-14). Site 2, Site 4, Site 6 and Site 8 all exceeded the WQOs for stock watering and irrigation (indirect contact; 1000 cfu/100 ml) for at least one monitoring event (Table 4-14).

Faecal contamination of a water body can be caused by a number of human and animal vectors. As cattle grazing is the current land use of the Study Area and adjacent surrounds, it is likely that the faecal coliform concentrations identified during monitoring are associated with the presence of cattle onsite (Table 4-14).

Table 4-14 Faecal Coliform (cfu/100 ml) Summary Statistics

	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9
Minimum	10	40	60	20	30	20	20	24	64
20^{th} percentile	50	140	74	30	42	36	26	30	69
Median	82	245	160	73	56	79	90	89	90
Average	71	2028	142	399	161	602	238	522	97
80^{th} percentile	100	500	200	200	237	1400	370	1100	124
95^{th} percentile	100	8375	200	1550	434	1850	715	1625	136
Maximum	100	11000	200	2000	500	2000	830	1800	140
WQOs	10 direct contact 1000 indirect contact	10 direct contact 1000 indirect contact	10 direct contact 1000 indirect contact	10 direct contact 1000 indirect contact	10 direct contact 1000 indirect contact	10 direct contact 1000 indirect contact	10 direct contact 1000 indirect contact	10 direct contact 1000 indirect contact	10 direct contact 1000 indirect contact

4.4.5 Hydrocarbons

All PAHs and TPHs tested were below the laboratory limit of reporting across all sites and all sampling events. Hence hydrocarbons are not considered to exceed any guidelines.

4.4.6 Metals and Metalloids

Total and dissolved metals measured as part of the monitoring program were aluminium, antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, iron, lead, manganese, molybdenum, mercury, nickel, selenium, silver, tin, uranium, vanadium and zinc. A table of all the metal and metalloid analytical results is provided in Appendix D. A number of the tested metals were not detected above laboratory limits of reporting throughout the monitoring program at any sites or times, these were:

- Beryllium (total and dissolved)
- Cadmium (total and dissolved)
- Mercury (total and dissolved)
- Molybdenum (total and dissolved)
- Selenium (total and dissolved)
- Silver (total and dissolved)
- Uranium (total and dissolved)
- Vanadium (dissolved)

Summary statistics of the dissolved metals that returned results for the Carmichael River sites (Sites 1 – 4) and the still water bodies (Cabbage Tree Creek and farm dams; Sites 5 – 9) are provided in Table 4-15 and Table 4-16, respectively. Sites 10 – 12 were dry throughout the monitoring program; as such no data for these sites is presented in this section. Where applicable, the 95th percentile value for each metal has been compared to the nominated WQOs. Shaded values denote those concentrations that exceeded the nominated WQOs.

The hardness of a water sample has the potential to affect the toxicity of metals and metalloids at particular concentrations (ANZECC and ARMCANZ, 2000). An assessment of water hardness across the Study Area has identified that the use of a hardness-modified trigger value (HMTV) is appropriate for the Carmichael River samples (moderate hardness; 60 – 119 mg/L).

Total copper and dissolved zinc 95th percentile concentrations were the only analytes that were above the HMTV for protection of aquatic ecosystems at the Carmichael River sites (Sites 1 – 4). Total and dissolved iron and manganese 95th percentile concentrations exceeded the long-term trigger values (LTV) for metals in irrigation water at the Carmichael River sites. All other 95th percentile metal concentrations recorded from the Carmichael River were below the nominated WQOs (Figure 4-15).

A number of exceedances of the nominated WQOs were recorded at the still water bodies (Sites 5 – 9). Total and dissolved aluminium, chromium, copper, lead and zinc 95th percentile concentrations exceeded the WQOs for protection of aquatic ecosystems. Total aluminium 95th percentile concentrations also exceeded the LTV for metals in irrigation water and the WQOs nominated for stock watering (Table 4-16). The 95th percentile concentrations of total and dissolved manganese in the still water bodies also exceeded the LTV for metals in irrigation water. All other 95th percentile metal concentrations recorded from the still water bodies were below the nominated WQOs (Table 4-16).

Table 4-15 Metal Summary Statistics (mg/L) for Carmichael River Sites (Sites 1 – 4)

Metal		Number of Detects (n = 12)	Minimum	20th percentile	Median	Average	80th percentile	95th percentile	Maximum
Aluminium	Total	12	0.080	0.118	0.180	0.416	0.298	1.444	2.200
	Dissolved	12	0.010	0.020	0.050	0.040	0.054	0.060	0.060
Arsenic	Total	1	0.002	0.002	0.002	0.002	0.002	0.002	0.002
	Dissolved	0	-	-	-	-	-	-	-
Barium	Total	8	0.285	0.287	0.295	0.305	0.330	0.337	0.339
	Dissolved	12	0.241	0.251	0.263	0.269	0.266	0.322	0.358
Boron	Total	12	0.120	0.126	0.150	0.143	0.160	0.160	0.160
	Dissolved	12	0.110	0.130	0.160	0.148	0.160	0.166	0.170
Chromium (III+VI)	Total	1	0.004	0.004	0.004	0.004	0.004	0.004	0.004
	Dissolved	4	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Cobalt	Total	4	0.002	0.002	0.002	0.003	0.003	0.004	0.004
	Dissolved	1	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Copper	Total	7	0.0010	0.0010	0.0050	0.0098	0.0144	0.0276	0.0320
	Dissolved	7	0.0010	0.0010	0.0050	0.0044	0.0066	0.0084	0.0090
Iron	Total	12	0.630	0.680	1.590	2.212	2.664	5.946	7.950
	Dissolved	12	0.140	0.156	0.230	0.267	0.392	0.440	0.440
Lead	Total	2	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020

Metal		Number of Detects (n = 12)	Minimum	20th percentile	Median	Average	80th percentile	95th percentile	Maximum
	Dissolved	0	-	-	-	-	-	-	-
Manganese	Total	8	0.136	0.158	0.167	0.173	0.186	0.216	0.226
	Dissolved	12	0.034	0.048	0.078	0.082	0.103	0.138	0.161
Nickel	Total	8	0.001	0.001	0.002	0.002	0.003	0.004	0.004
	Dissolved	4	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Strontium	Total	12	0.205	0.206	0.210	0.213	0.218	0.226	0.231
	Dissolved	12	0.181	0.190	0.197	0.195	0.199	0.203	0.203
Zinc	Total	5	0.005	0.005	0.007	0.007	0.008	0.008	0.008
	Dissolved	2	0.043	0.043	0.043	0.043	0.043	0.043	0.043

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Table 4-16 Metal Summary Statistics (mg/L) for Still Water Body Sites (Cabbage Tree Creek (Sites 5) and Farm Dams (Sites 6 – 9))

Metal		Number of Detects	Minimum	20th per centile	Median	Average	80th per centile	95th per centile	Maximum
Aluminium	Total	11 (n=11)	0.050	0.134	0.425	1.594	3.578	5.705	6.160
	Dissolved	11 (n=11)	0.020	0.030	0.050	0.274	0.180	1.322	2.030
Arsenic	Total	11 (n=13)	0.001	0.002	0.002	0.002	0.002	0.003	0.003
	Dissolved	4 (n=13)	0.001	0.001	0.002	0.002	0.002	0.002	0.002
Barium	Total	11 (n=11)	0.034	0.057	0.107	0.146	0.247	0.279	0.286
	Dissolved	13 (n=13)	0.023	0.039	0.176	0.165	0.242	0.317	0.354
Boron	Total	7 (n=11)	0.050	0.050	0.055	0.079	0.114	0.147	0.160
	Dissolved	11 (n=11)	0.050	0.060	0.080	0.091	0.104	0.174	0.180
Chromium (III+VI)	Total	5 (n=13)	0.002	0.004	0.006	0.005	0.007	0.008	0.008
	Dissolved	2 (n=13)	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Cobalt	Total	9 (n=11)	0.001	0.002	0.002	0.002	0.002	0.003	0.004
	Dissolved	1 (n=13)	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Copper	Total	11 (n=13)	0.0010	0.0020	0.0030	0.0041	0.0060	0.0082	0.0100
	Dissolved	9 (n=13)	0.0010	0.0020	0.0020	0.0026	0.0030	0.0045	0.0050
Iron	Total	11 (n=11)	0.730	0.894	1.545	3.246	6.590	8.383	8.760
	Dissolved	10 (n=11)	0.060	0.074	0.160	0.353	0.470	1.218	1.680
Lead	Total	8 (n=13)	0.0010	0.0010	0.0010	0.0019	0.0030	0.0036	0.0040
	Dissolved	1 (n=13)	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010

Metal		Number of Detects	Minimum	20th per centile	Median	Average	80th per centile	95th per centile	Maximum
Manganese	Total	11 (n=11)	0.048	0.124	0.228	0.250	0.356	0.508	0.528
	Dissolved	10 (n=13)	0.002	0.003	0.007	0.034	0.038	0.155	0.182
Nickel	Total	10 (n=13)	0.001	0.002	0.002	0.003	0.006	0.006	0.007
	Dissolved	9 (n=13)	0.001	0.001	0.002	0.002	0.002	0.002	0.002
Strontium	Total	11 (n=11)	0.021	0.070	0.161	0.139	0.203	0.220	0.224
	Dissolved	11 (n=11)	0.017	0.065	0.142	0.124	0.181	0.202	0.207
Vanadium	Total	4 (n=11)	0.010	0.010	0.015	0.015	0.020	0.020	0.020
	Dissolved	0 (n=13)	-	-	-	-	-	-	-
Zinc	Total	6 (n=13)	0.008	0.009	0.011	0.012	0.012	0.019	0.022
	Dissolved	5 (n=13)	0.012	0.015	0.020	0.023	0.031	0.038	0.040

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4.5 EPC 1690 In-stream Sediment Quality

In-stream sediment quality testing undertaken as part of the monitoring program comprised testing for physical parameters, total metals, nutrients, biological parameters and hydrocarbons. A table of all in-stream sediment quality analytical results is provided in Appendix D. Sampling of in-stream sediments at Cabbage Tree Creek was not achieved due to site access restrictions. References to still water body sites in relation to in-stream sediment quality therefore relate only to the farm dam sites (Sites 6 – 9).

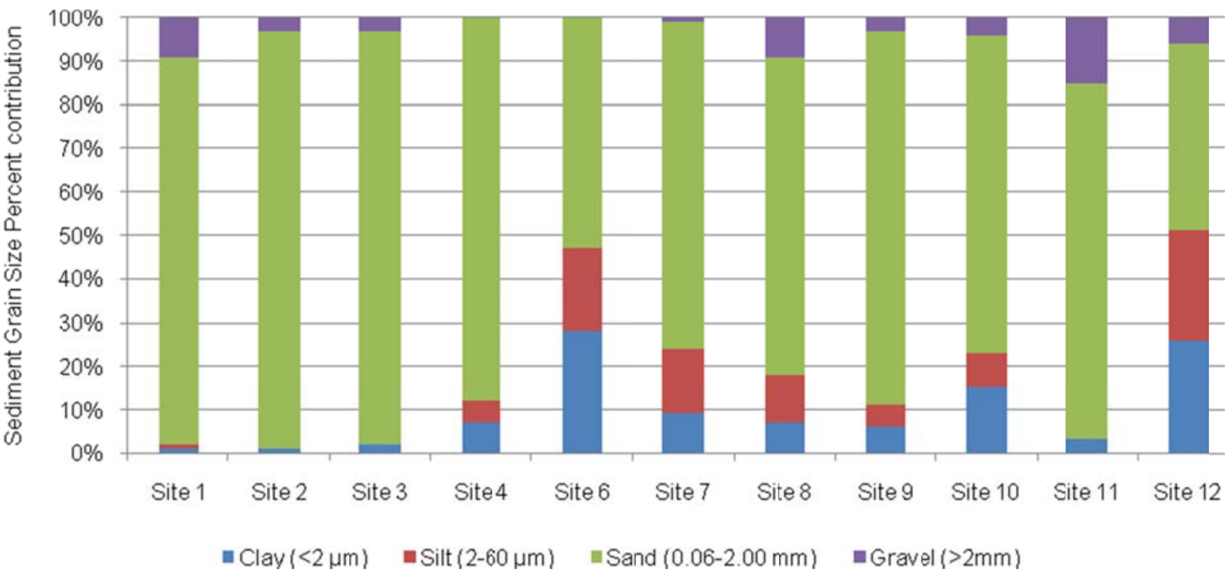
4.5.1 Physical Parameters

Physical parameters assessed as part of the monitoring program were sediment grain size, total organic carbon and moisture content. The latter two parameters were tested to assist in interpretation of analytical results; results are provided in Appendix D. Sediment grain size results are presented below.

The sediment composition across the Study Area was dominated by sands (0.06 – 2 mm; Figure 4-12). The Carmichael River sites (Sites 1 – 4) were comprised of sand, gravel, clay and silt, at an average ratio of 92:4:3:1. Sampling of in-stream sediments at Cabbage Tree Creek was not achieved due to site access restrictions. The still water body sites (Sites 6 – 9) contained less sand than the Carmichael River sites, comprising sand, clay, silt and gravel (average ratio of 72:12.5:12.5:3). The sites with no water contained an average ratio of 66:15:11:8 of sand, clay, silt and gravel.

As outlined above, and shown in Figure 4-12, the Carmichael River sediments contained a greater proportion of coarse material, and conversely a smaller proportion of fine material on the river beds compared to the sites with no flow, or no water. This is likely associated with the flow characteristics of the Carmichael River, whereby fine materials are more easily mobilised and transported from the bed than coarser materials. This is supported by the turbidity findings presented in Section 4.3, which identified high loads of fine sediments suspended in the water column.

Figure 4-12 Sediment Grain Size Results for each Site



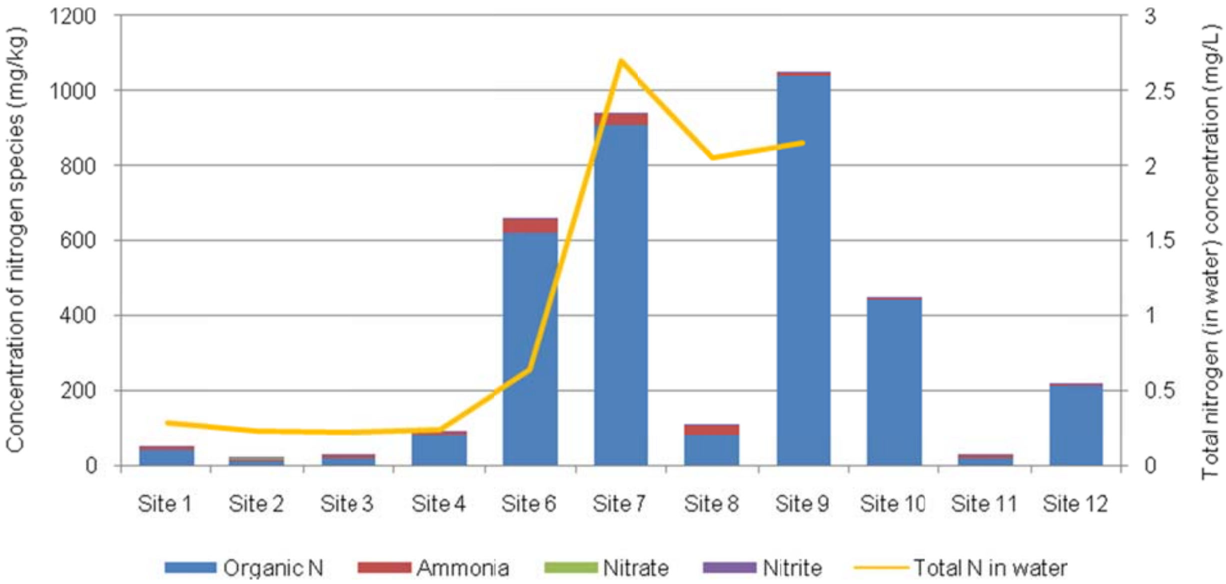
Note: Cabbage Tree Creek (Site 5) not sampled

4.5.2 Nutrients

The concentration of total nitrogen in the sediment samples displayed a similar spatial pattern to that observed in the water quality analysis when compared to water quality samples taken at the same time (July; Figure 4-13). The Carmichael River sites (Sites 1 – 4) contained substantially less total nitrogen than the majority of the still water bodies (Sites 6 – 9), and three of the sites with no water (Site 10 - 12; Figure 4-13).

The composition of nitrogen species within the sediment was dominated by organic nitrogen (Figure 4-13), which is consistent with the findings of the water quality assessment (refer Section 4.4.3).

Figure 4-13 Composition of Nitrogen Species (mg/L) for each Site

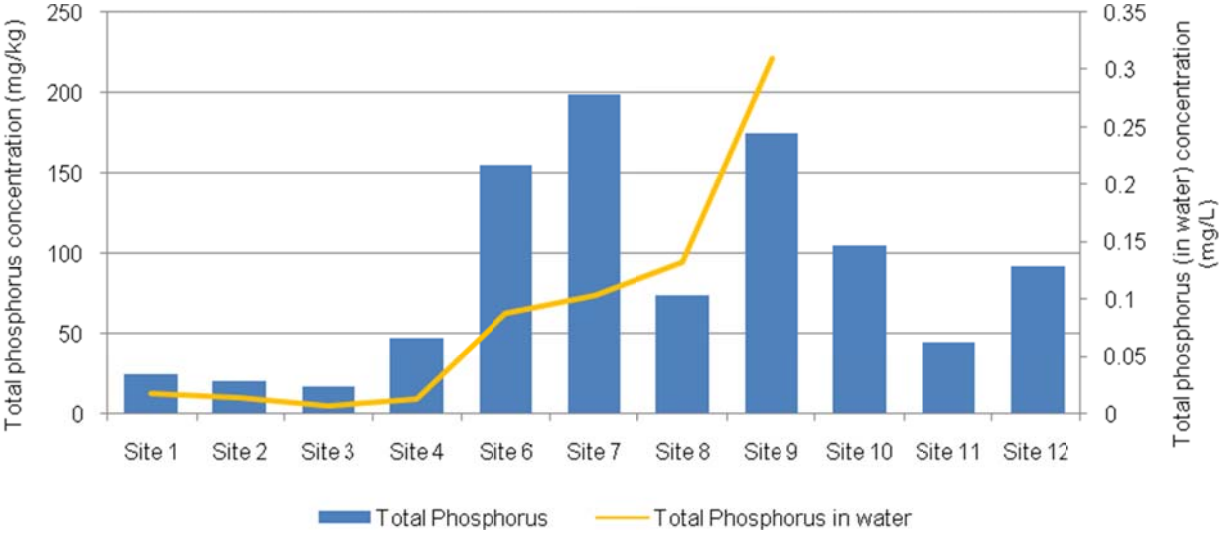


Note: Sites 10, 11 and 12 did not have water at the time of sampling therefore no dissolved Nitrogen results are available.

Concentrations of total phosphorus in the sediment samples displayed a similar pattern to total nitrogen (Figure 4-14). The Carmichael River sites (Sites 1 – 4) contained substantially lower total phosphorus concentrations than the still water bodies and dry creek beds (Figure 4-14). This observed spatial pattern is consistent with the results of the water quality assessment (refer Section 4.4.3), however trends in sediment and water concentrations are not as closely aligned as those observed for total nitrogen (Figure 4-14). Reactive phosphorus was not found above laboratory limits of detection at the Carmichael River sites. Where detected at the still water bodies and dry creek beds, concentrations were low (maximum of 0.2 mg/kg).

There are no available sediment quality objectives (SQOs) for nutrients. As such, no comparison of data to SQOs has been undertaken.

Figure 4-14 Total Phosphorus Concentrations for each Site



Note: Sites 10, 11 and 12 did not have water at the time of sampling therefore no dissolved Phosphorus results are available.

4.5.3 Biological Parameters

Testing for the presence and prevalence of faecal coliforms in the sediment was undertaken as part of the monitoring program. Faecal coliforms were only detected above laboratory limits of reporting at one of the Carmichael River sites (Site 4). Faecal coliforms were detected at all of the still water bodies and one of the dry creek bed sites. The highest concentrations of faecal coliforms were associated with the farm dams (still water bodies). These results are not unexpected given the presence of cattle in these areas, and the infrequent flushing of the farm dams.

The spatial patterns of faecal coliforms observed in the sediments is different to that identified in the water samples. It is likely that the results obtained from the water samples provide an indication of recent faecal coliform additions to the resources, whereas concentrations in the sediment are indicative of long term accumulation. There are no SQOs for faecal coliforms; as such no comparison of the data to SQOs has been undertaken.

4.5.4 Hydrocarbons

All PAHs and TPHs tested were below the laboratory limit of reporting; data is provided in Appendix D. For some PAHs (acenaphthene, anthracene, benz(a)anthracene, benzo(a)pyrene, chrysene, dibenz(a,h)anthracene, fluoranthene, fluorene, naphthalene, phenanthrene, pyrene), the laboratory limit of reporting was not able to achieve the required level of detection for comparison against the nominated ISQG Low SQOs. All PAHs were below the nominated ISQG High SQOs.

4.5.5 Metals and Metalloids

A number of metals were not detected above the laboratory limits of reporting, including boron, cadmium, mercury, selenium and silver and these are not reported further. Where metals were detected, concentrations were generally lower in the Carmichael River sediments than at the other sites Table 4-17). Where applicable, the concentrations of metals and metalloids in the sediment samples have

been compared to the nominated SQOs. No exceedances of the lower interim sediment quality guidelines (ISQG Low) were recorded (Table 4-17).

Table 4-17 Metal and Metalloid Concentrations (mg/kg) in Sediment during July Sampling

	SQO ISQG Low	SQO ISQG High	Site 1	Site 2	Site 3	Site 4	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11	Site 12
Aluminium	n/a	n/a	600	380	320	1200	7950	2100	2860	2100	3280	2020	6090
Arsenic	20	70	0.3	0.5	0.3	0.5	1.2	1.9	0.9	1.1	4	3.1	1.5
Barium	n/a	n/a	12.6	6.8	9.8	24.1	188	89.7	20.7	33.8	31.5	665	17.4
Beryllium	n/a	n/a	<0.1	<0.1	<0.1	0.2	0.5	0.5	0.2	0.2	0.4	0.5	0.7
Chromium (III+VI)	80	370	2.2	1.5	1.6	4.5	17.4	9.9	24	20.3	36.6	47.1	21.1
Cobalt	n/a	n/a	0.5	0.5	0.6	1.5	5	5.4	2.3	4.4	4.8	28	4.6
Copper	65	270	0.6	0.3	0.4	1.7	8.1	6.3	3.6	3.2	5	6.2	12.1
Iron	n/a	n/a	1360	1090	1100	2220	9410	6720	4880	6280	10,200	12,100	10,900
Manganese	n/a	n/a	13.3	11.4	59.1	27.3	225	232	58.6	181	136	3450	87.4
Molybdenum	n/a	n/a	<0.1	<0.1	<0.1	<0.1	0.1	0.1	0.2	0.2	0.3	0.4	0.3
Nickel	21	52	0.6	0.4	0.5	1.4	6.6	3.9	3.3	2.1	5.3	13.1	6.2
Phosphorus	n/a	n/a	25	21	17	47	155	199	74	175	105	45	92
Strontium	n/a	n/a	1.4	0.6	0.9	2.8	21.9	10.5	2.1	4.5	5.8	12.1	7.1
Uranium	n/a	n/a	<0.1	<0.1	<0.1	0.1	0.7	0.2	0.1	0.2	0.4	0.2	1.6
Vanadium	n/a	n/a	4	2	3	8	34	24	20	22	46	51	32
Zinc	200	410	1.5	0.8	1.1	3.5	12.5	9.7	2.6	4.7	4.4	2.7	10

4.5.6 Deionised Water Leach

As outlined in Section 2.1.4, stream bed sediment samples collected at the sites that did not contain any water throughout the monitoring program were subject to a DI water leach preparation. This was undertaken in order to gain an understanding of the potential for the release of contaminants into surface waters during flow events. As outlined in the QWQG (DERM, 2009a), short-term spikes in pollutants during flood events in ephemeral streams can be expected as surface runoff mobilises pollutants within the stream bed and from the surrounding catchment. The values above the nominated guidelines (described following) are considered to be reflective of this process.

A table of all DI leach supernatant analytical results is provided in Appendix D.

4.5.6.1 Nutrients

Nutrients measured from the DI water leach supernatant were total nitrogen, ammonia, oxides of nitrogen, total phosphorus and reactive phosphorus. Total nitrogen concentrations, which ranged from 20 to 80 µg/L, were below the nominated WQOs at all sites, as were nitrate concentrations. In contrast to the sites that contained water during the monitoring program, ammonia was present in higher concentrations than organic nitrogen. The concentrations of ammonia exceeded the nominated WQOs at all sites.

Total phosphorus concentrations ranged from 0.021 and 0.128 mg/L, with two of three sites exceeding the nominated WQOs for upland streams. Reactive phosphorus exceeded the nominated WQOs for upland streams at all three DI leach testing sites.

4.5.6.2 Metals and Metalloids

Concentrations of total and dissolved aluminium and chromium were above the nominated WQOs for upland streams at all three locations. Concentrations of total and dissolved zinc at Site 10 and Site 12 were above the nominated WQOs for upland streams. Concentrations of total copper were also above the nominated WQOs, however dissolved copper concentrations remained below nominated WQOs. All other metals were below nominated WQOs, or were not detected above the laboratory limits of reporting.

4.5.6.3 Hydrocarbons

All PAHs and TPHs tested from the DI water leach supernatant were below the laboratory limit of reporting at all three sites and did not exceed any guidelines.

4.6 Doongmabulla Springs Water Quality

4.6.1 Overview

The Doongmabulla Springs complex is located approximately 8 km west of the proposed Carmichael Coal Project area. These springs are a Great Artesian Basin (GAB) spring complex and comprises of two spring groups, Moses and Joshua, located on Doongmabulla Station near the confluence of three creek systems; Cattle Creek, Dyllingo Creek and Carmichael Creek. Carmichael Creek joins Dyllingo Creek just upstream of Doongmabulla Station, the Dyllingo Creek and Cattle Creek converge east of the Doongmabulla Springs complex to form the Carmichael River. A description of the ecology of the Doongmabulla Springs complex, based on a desktop review of existing information and on a field inspection (between 22 and 24 May 2012), can be found in Volume 4 Appendix N2 Doongmabulla Springs Report.

Water quality sampling and analysis from the Doongmabulla Springs complex and nearby creeks has therefore been undertaken to provide further information on potential water sources to the springs and to identify any similarities and/or variations in the water quality between:

- Individual springs of the springs complex
- The spring complex and nearby creeks

4.6.2 Sampling Observations

Observations made at each sampled location on 22 and 24 June 2012, along with the name of the spring or group of springs and assigned spring 'morphology' are summarised in Table 4-18.

Table 4-18 Sampling Observations, June 2012

Location ID (and Sample ID)	Spring / group of springs	Assigned spring ‘morphology’	Observations at sample collection
Doon Spring (DS1)	Believed to be Little Moses Spring	Non mounding artesian spring	On east side of small rise. Flowing water (clear, colourless) from beneath possible sandstone outcrop on rise. Algal growth along edges of flow channel. Flow rate estimated <0.5 L/s.
Doon Spring 2a (DS2A)	Un-named	Non artesian (recharge) spring	Standing stagnant looking water in pools within shallow sloping, shallow gully - no vegetation. Tall grasses down-slope, boggy ground. Sample collected from hand dug hole (brown muddy water).
Doon Spring 3	Moses Spring group	Mound spring	No flow observed from mound. Mound squelchy under foot but no standing water. Two wet areas (seeps, approximately 30 cm x 30 cm) on perimeter of mound but no flow, just glistening with water. No sample collected.
Doon Spring 4 (DS4)	Moses Spring group	Mound spring	Mound within extensive wetland (boggy) grassed area. Shallow ponding of standing water adjacent to spring mound, water slightly cloudy, brown colour. No flow observed.
Doon Spring 5 (DS5)	Moses Spring group	Mound spring	Located around 10 m south of sandstone bluff on flat plain. Standing water within grasses of mound spring, with some dampness of the surrounding ground. Water clear and colourless. No flow observed.
Doon Spring 5A	Moses Spring group	Mound spring	Minor seepage from mound, but not enough to sample.
Doon Spring 5B (DS5B)	Moses Spring group	Mound spring	Located around 30 m south of sandstone bluff (around 10 m high) on flat plain. Pool of water in centre of mound spring (no movement or bubbling of this water observed). Water also ponded within grasses of mound spring (sampled). Ground boggy around vicinity of mound. Minor flow observed (<0.1 L/s) from mound area towards ponded water adjacent to mound (slightly cloudy, colourless).

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Location ID (and Sample ID)	Spring / group of springs	Assigned spring 'morphology'	Observations at sample collection
Doon Spring 6 (DS6)	Moses Spring group	Mound spring	Water ponded within grasses on mound. Mound is wobbly like a water bed. Seepage evident from perimeter of mound to immediate area surrounding spring, but dry beyond this.
Doon Spring 7 (DS7)	Moses Spring group	Mound spring	Water ponded within grasses on mound, slightly cloudy. Area surrounding mound spring is dry but with some seepage evident from perimeter of mound.
Doon Spring 8 (DS8)	Moses Spring group	Mound spring	Standing water ponded adjacent to outer edge of spring, slightly cloudy and brown. No flow observed.
Doon Spring 8A (DS8A)	Moses Spring group	Mound spring	Some ponding of water in places adjacent to edge of mound spring. Water very muddy. No sample collected.
Doon Spring 9A (DS9A)	Moses Spring group	Mound spring	Mound within the same extensive wetland (boggy) grassed area as Doon Spring 4. Shallow standing water adjacent to spring mound. Water slightly cloudy. No flow observed.
Doon Spring 10 (DS10)	Joshua Spring (modified to turkeys nest to store water)	Modified high flow spring (artesian?)	Clear water flowing from overflow pipe of turkeys nest (at rate of approximately 5 L/s). Surface of the ponded water within turkeys nest moving as if water is being pushed up from below in one small area towards western side of turkeys nest.
Close vicinity to Doon Spring 3 (DS3A)	Drainage from wetland area to lake	Not applicable	Located around 40 m west of Spring 3. Clear, colourless water, flowing from nearby grassed wetland area towards lake adjacent to nearby group of Melaleuca trees. Flow rate approximately <0.1 L/s.
Dyllingo Creek	Downstream of springs complex, upstream of Doon Spring 2A	Not applicable	Creek flowing. Water cloudy, pale orange-brown colour. Sandy creek bed with sandstone gravels and cobbles. Creek banks sandy, incised by around 3 m. Melaleuca trees present.
Cattle Creek	Downstream of springs complex, upstream of Doon Spring 2A	Not applicable	No flow in creek, large pools of standing water. Water cloudy and pale brown with purple film on surface, containing particulates. Creek bed sandy, Melaleuca trees present.

4.6.3 Data Analysis

4.6.3.1 Major Ion Chemistry

A piper plot of the major ion chemistry for all of the sampled springs and creeks is shown in Figure 4-15 and for the springs sampled within the Moses Spring group in Figure 4-16. Summary tables of the water quality sampling analysis results are included in Appendix E.

The piper plots indicate the following:

- All of the samples collected from the Little Moses (DS1) and the Moses Spring group (DS4, DS5, DS5B, DS6, DS7, DS8 and DS9) mound springs, with the exception of DS11, have a similar major ion chemistry but with variable proportions of chloride (Figure 4-15). The sample collected from DS3A (of water draining from a wetland area around 40 m from mound spring Doon Spring 3) was also similar in its major ion chemistry. The concentrations of calcium and magnesium in all of these samples (except for Little Moses) are less than 1 mg/L (refer to Appendix E). This suggests that the groundwater feeding these springs is likely to be from the same source and has been subject to similar conditions below the surface. The higher proportions of bicarbonate, coupled with the very low proportions of calcium, magnesium and potassium suggests that ion exchange may have occurred. This typically occurs when water passes through clays, whereby the positive ions (i.e. calcium, magnesium, potassium and sodium) are preferentially removed from solution by adsorbing onto clay particles if conditions (such as pH) are favourable.
- The samples from Joshua Spring (DS10) have proportionally more calcium and magnesium than the samples collected from Little Moses and the Moses Spring group. This spring is physically very different to the Moses Spring group (mound springs) with the highest discharge flow rate of all the springs sampled (estimated at approximately 5 L/s) and, if it had not been modified to store water for supply use, may have looked similar to Little Moses spring. The differences in major ion chemistry of Joshua Spring to the Moses Spring group suggests either a different source of water (which given the geological setting is considered unlikely), different pathway and hence contact with different lithological units before discharging to surface. However, the modification to the spring could also play a part in the different chemistry.
- The major ion chemistry for the Cattle Creek and Dyllingo Creek samples is very similar to each other and, of the spring samples, is most similar to Joshua Spring with similar proportions of calcium and sodium although with a higher proportion of chloride than Joshua Spring.
- The sample collected from DS2A (non-artesian (recharge) spring) has a different major ion chemistry to the other spring samples, containing both calcium and magnesium and with the highest proportion of chloride of all of samples. The sampled location is almost 2 km east of Little Moses spring and is in the near vicinity of the stratigraphic boundary of the Moolayember Formation, Clematis Sandstone and Tertiary-age strata at a very slight break in slope. This suggests that the source of the spring water is likely to be the Clematis Sandstone (as for the other springs) but that the spring mechanism for discharge may be different (i.e. groundwater is forced out of the aquifer at a sudden change to a low permeability lithology along the groundwater flow path). The likely different mechanism for discharge at this spring and the different major ion chemistry is consistent with the findings of the ecology inspection which found different species at this spring in comparison to the other springs inspected.

- The major ion chemistry of sample DS11C is significantly different to the other samples collected from the Moses Spring group, with almost 100 per cent bicarbonate. However, this result may not be representative of the water at this location given that the cation-anion balance for this sample is unusually high (+10 per cent).
- The Moses Spring group are considered to be discharge springs, i.e. the water source of the springs passes through a low permeability confining layer before discharging to surface (Fensham pers. Comm.). In this case the low permeability confining layer is likely to be the Quaternary alluvium and/or underlying (mapped) Moolayember Formation.
- Samples from DS10 (Joshua Spring), DS2A (non-artesian (recharge) spring), Cattle Creek and Dyllingo Creek have higher proportions of calcium, magnesium and potassium in comparison to the Moses Spring group samples coupled with lower proportions of bicarbonate. The same applies to DS1 (Little Moses spring), although to a lesser extent. This suggests that whilst ion exchange may still be occurring, it is not as pronounced. This in turn suggests the groundwater is taking a more rapid pathway such as through a better connected fracture system and/or a shorter pathway to the ground surface at these locations. In the case of DS2A, groundwater is forced out of the aquifer at a low permeability lithology along the groundwater flow path and therefore a shorter pathway existing to recharge the spring.

With reference to Figure 4-17, comparison between the major ion chemistry of the springs complex (and creeks) and that of samples from the Carmichael River (see Section 0) suggests that with the exception of the May 2011 sample round (collected following the wet season), the samples collected from the Carmichael River within the Mine lease area (July, September, October and November 2011), plot in a similar location on the piper plot to the samples collected from Cattle Creek and Dyllingo Creek. This suggests that all of these samples have similar major ion chemistry characteristics, which is not surprising given that Cattle Creek and Dyllingo Creek feed into the Carmichael River upstream of the Mine lease area. It is likely that the Doongmabulla springs provide base flow to the adjacent Carmichael River.

Figure 4-15 Piper Plot, All Sampled Springs and Creeks (May and June 2012)

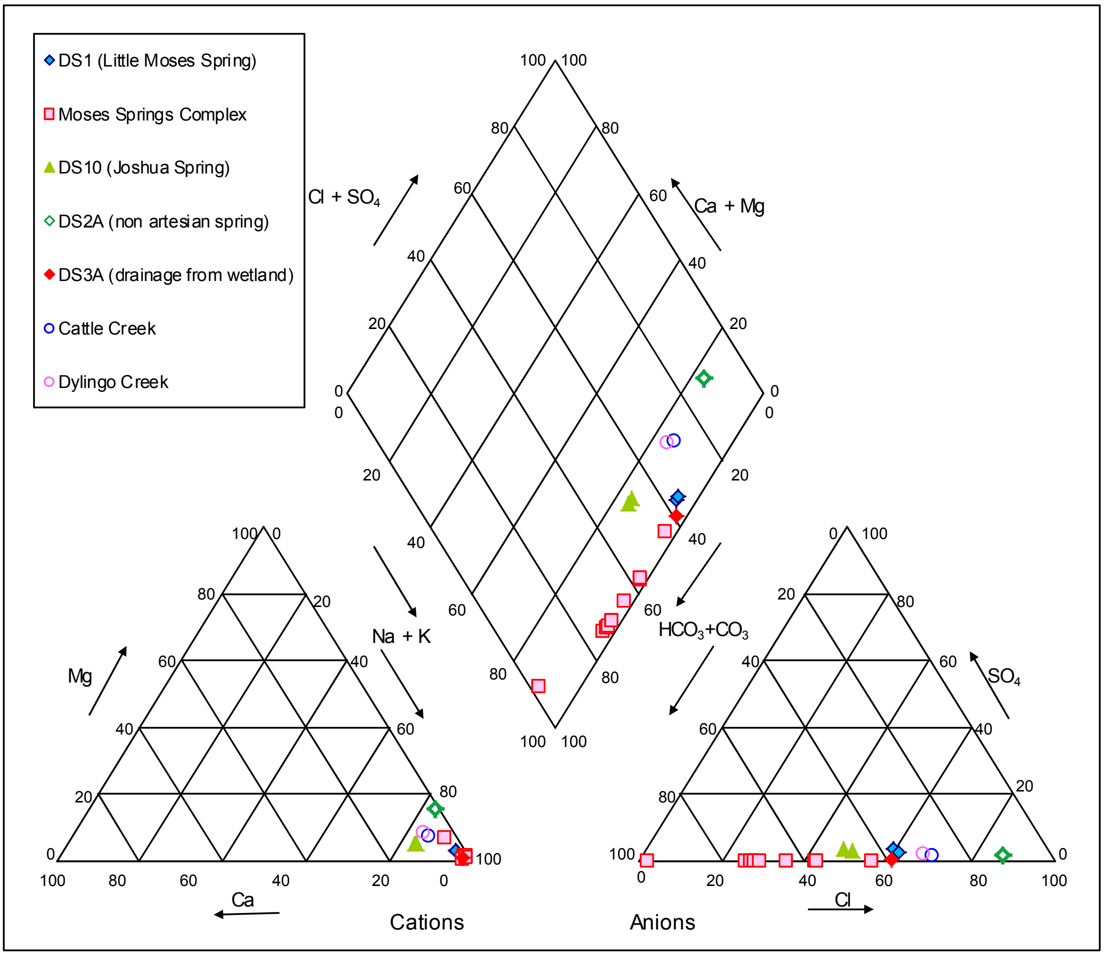


Figure 4-16 Piper Plot, Moses Spring Group

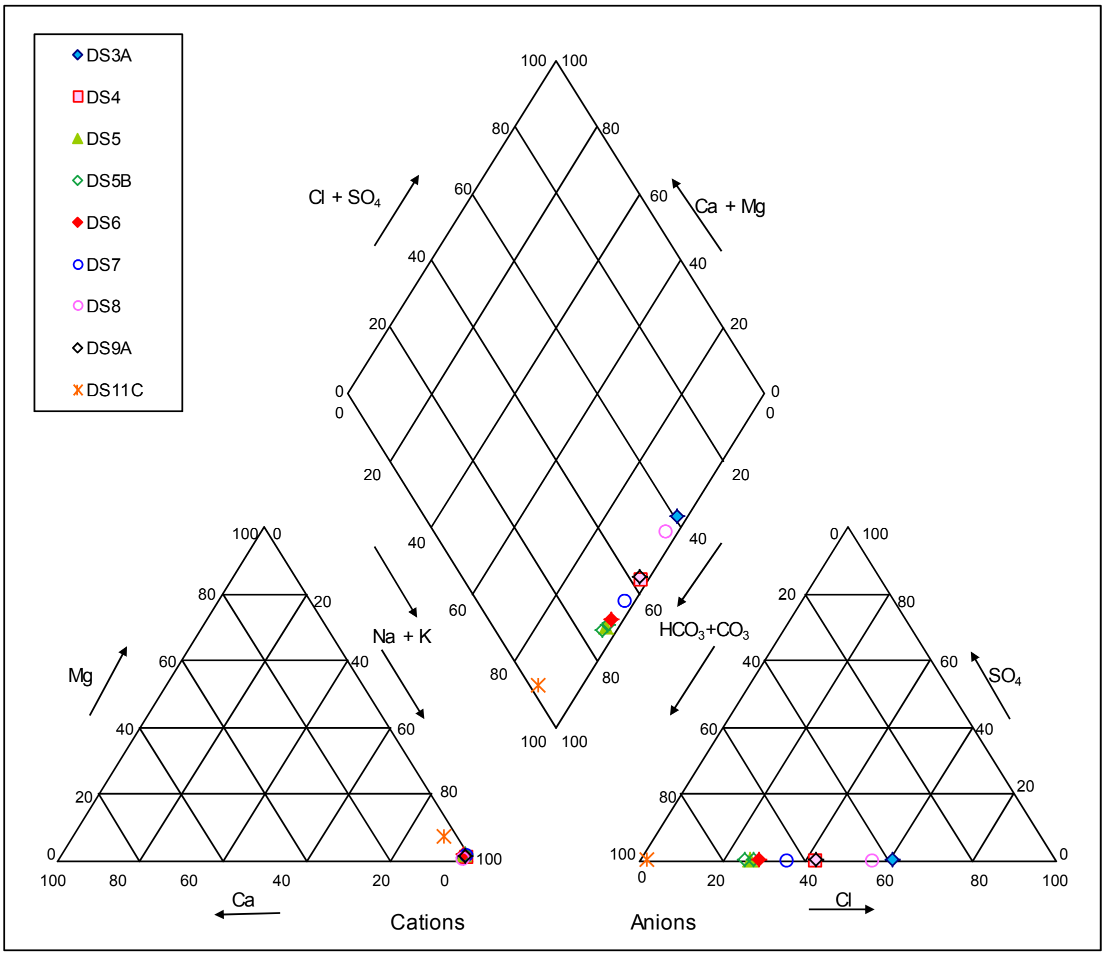
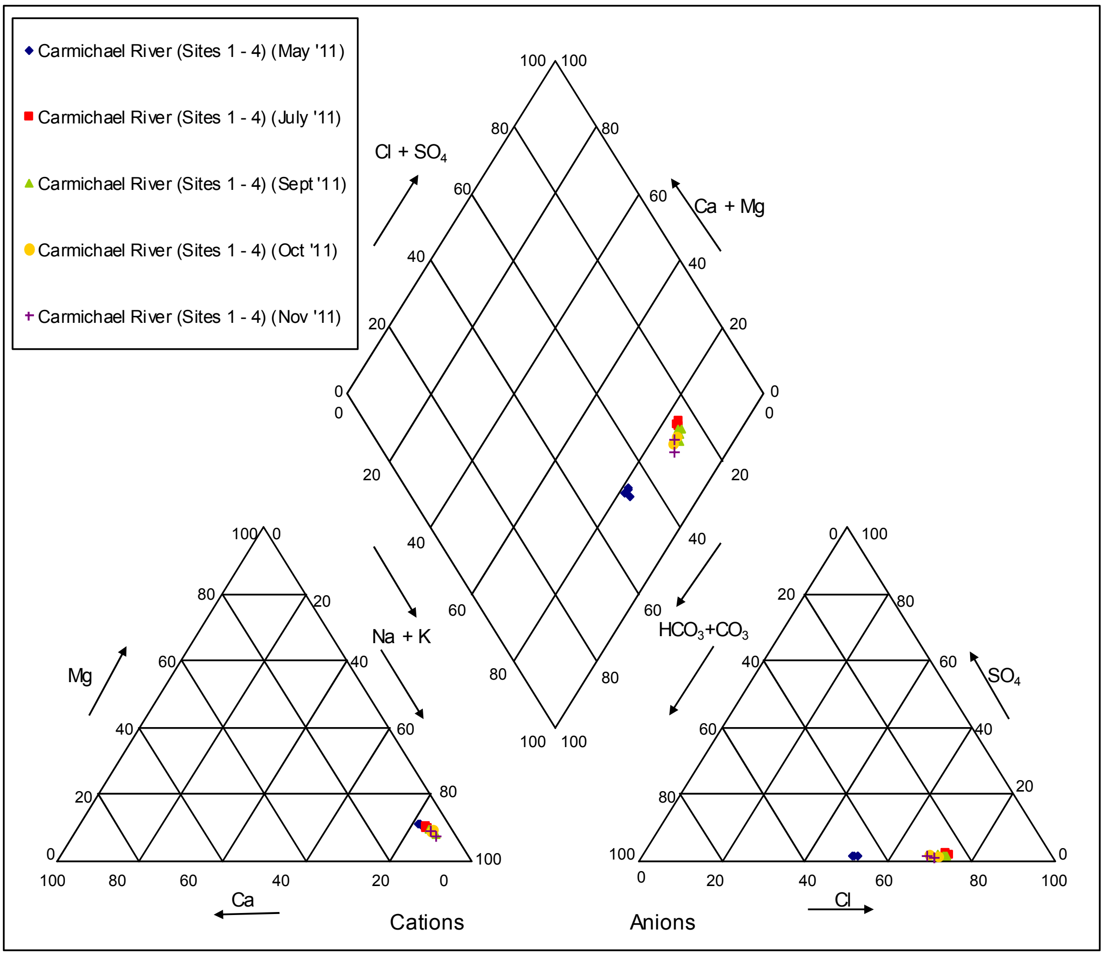


Figure 4-17 Piper Plot, Carmichael River



4.6.3.2 Inorganics

The samples from the springs and creeks can be described as relatively fresh, with electrical conductivity (EC) for the spring samples ranging from 376 to 889 µS/cm and EC values of 742 µS/cm in Dyllingo Creek and 1,370 µS/cm in Cattle Creek (refer to Appendix E). The concentrations of the inorganic parameters analysed (fluoride, silica, electrical conductivity, total dissolved solids and pH) show no significant variation between Little Moses spring, the Moses Springs group or Joshua spring.

The one exception is the sample from DS2A with significantly higher concentrations of silica and fluoride and a slightly more acidic (pH 5.4) than the other springs. This is consistent with the location of this spring, which is geographically set apart from the other springs to the west and within a different geological setting.

4.6.3.3 Dissolved Metals

Of the dissolved metals, low concentrations of dissolved iron (0.06 to 0.79 mg/L), manganese (0.002 to 0.29 mg/L) and zinc (0.005 to 0.014 mg/L) were identified in the spring and creek samples (refer to Appendix E). The concentrations of these metals are relatively consistent between the various springs sampled within the Little Mosses group (i.e. mound springs, samples DS4, DS5, DS5B, DS6, DS7, DS8 and DS9A). However, are somewhat different to the concentrations of dissolved iron and manganese found in the samples from Joshua spring (DS10) and Little Moses spring (DS1).

4.6.4 Summary

The mapped geology in the vicinity of the Doongmabulla Springs complex suggests that all of the springs are likely fed by groundwater from the Clematis Sandstone aquifer, with most springs discharging through the overlying Moolayember Formation and/or Quaternary alluvium. This is consistent with available information on the physical features of Doongmabulla Springs (reference QLD081) which are described as ‘derived from faults allowing water to flow from thin confining beds of the Great Artesian Basin aquifer’ (in the *Australian Wetlands Database – Directory Wetland Information* (http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW&doiw_refcodelist=QLD081)).

Despite the apparent single aquifer source some potentially significant differences can be observed in the hydrochemistry of samples taken from the springs. Potential causes of the observed differences in major ion chemistry include:

- The characteristics of the material overlying the source aquifer through which the water passes (i.e. the material overlying the Clematis Formation in the area which includes the Moolayember Formation and Quaternary alluvium).
- Post discharge processes including dissolution and evaporation which are in turn likely to be related a range of additional factors including discharge rate and, the degree of ponding at the discharge location.

Based on the limited geological and major ion data currently available, and bearing in mind the potential causes of chemical differences identified above, the main conclusions from the sampling work can be summarised as follows:

- The major ion chemistry of the sample taken from spring DS2A is distinctly different from the other samples in that it shows elevated proportions of calcium and magnesium and the highest proportion of chloride of all of samples. Given the location of this spring close to the mapped boundary of the Moolayember Formation and the underlying Clematis Sandstone it is considered most likely that the observed chemistry differences are due to the source aquifer being relatively close to the surface at this location. It may be that the Moolayember Formation is absent and that water is being discharged directly from the Clematis Sandstone. The different major ion chemistry observed at Spring DS2a is consistent with the findings of the ecological site visit which found different species at this spring in comparison to the other springs visited.

- The sample taken from the Joshua Spring (DS10) is also characterised by proportionally more calcium and magnesium than the samples collected from Moses and Little Moses mound springs. Unlike Spring DS2a this site is located in an area where the Moolayember Formation is likely to be relatively thick and hence the chemical similarities between the two samples are surprising. However, the Joshua Spring (DS10) is also characterised by the highest discharge rate of all the springs in the complex. It may be that a fault or similar feature is present at this location forming a relatively rapid pathway for flow through the Moolayember Formation despite its thickness.
- The majority of the remaining spring samples which were taken from the Moses and Little Moses mound springs (i.e. samples. DS1, DS4, DS5, DS5B, DS6, DS7, DS8 and DS9) are all characterised by very low proportions of calcium and magnesium but variable proportions of chloride. Given the similar morphology and ecology observed at these springs and their close proximity it is considered likely that the discharge pathway at each of the springs is similar. The observed differences in the proportion of chloride are therefore thought most likely to be related the degree of post discharge evaporation occurring at each spring head.

4.7 Existing Environment Summary

The existing surface water resources within the Study Area include the Carmichael River, ephemeral creek drainage lines (dry during the monitoring period) and numerous farm dams. The Carmichael River, designated as a fifth order stream (DERM, 2009c), is the major surface water resource within the Study Area. The flow regime of the Carmichael River (further described in Volume 4 Appendix R Hydrogeology Report) is subject to seasonal variability as wet season overland flow drains from the catchment. Late in the dry season the Carmichael River is reduced to a low flow environment, interspersed with deeper pools. The Carmichael River was characterised by a well-established riparian zone that provided extensive shading of the water. Conversely, the farm dam sites and Cabbage Tree Creek all had limited or absent riparian zones, resulting in increased exposure to direct radiance from the sun.

An assessment of the water chemistry of the Carmichael River and nearby groundwater resources identified that it is likely that the surface water of the Carmichael River is influenced by the nearby groundwater aquifers. Temporal changes in the surface water chemistry also indicate that the influence of groundwater on the Carmichael River is greater in the dry season than in the wet season when rain water is entering the system.

Parameters analysed as part of the monitoring program displayed both spatial and temporal variations. Spatial patterns were consistently related to the differences between the types of water resources (Carmichael River versus non-flowing environments). Sites sampled along the Carmichael River displayed little spatial variation, indicating that the results obtained from the monitoring program are fairly typical of that stretch of the river. Temporal patterns at the Carmichael River sites were related to seasonal variability associated with the influx of overland flows prior to the start of the monitoring program, and subsequent drying of the water resources as the dry season progressed. All monitoring was undertaken in low-flow conditions, and flow progressively decreased as monitoring progressed through the dry season.

The Carmichael River displayed high turbidity at the start and end of the monitoring program. This has been attributed to the increase of overland flow input of fine sediments (associated with preceding rainfall events) at the start of the monitoring program, and re-suspension of sediments in shallower waters at the end of the monitoring program. Dissolved oxygen concentrations in the Carmichael River were relatively low throughout the monitoring program. These low values are likely associated with the low flow conditions experienced for the majority of the program. The waters of the Carmichael River displayed an alkaline pH throughout the monitoring program with values generally above the upper limit of the water quality objectives. The soils investigation report associated with this Project (Mine) indicates this is likely linked to the alkalinity of the adjacent soils (refer Volume 4 Appendix L Soils Report). Temperature characteristics of the Carmichael River were closely linked to seasonality, whereby higher temperatures were recorded in the warmer months. Effects of shading were also evident; the Carmichael River sites which were shaded had greater buffering capacity against changes in temperature than the exposed sites at the farm dams and Cabbage Tree Creek.

Concentrations of total nitrogen in the Carmichael River were consistently greater than expected ranges, and were primarily derived from concentrations of organic nitrogen. Other nutrients, including total and reactive phosphorus were within expected ranges. Despite the high concentrations of nitrogen, no algal blooms were observed onsite, or from chlorophyll a testing. Faecal coliform testing identified faecal coliforms to be present at all the Carmichael River sites. This has been linked to the ongoing cattle grazing of the Study Area. Hydrocarbons were not present in the waters of the Carmichael River.

The in-stream sediments of the Carmichael River were characterised by sands. Nutrients were present in low concentrations and faecal coliforms were present in the sediments at only one site. As with the findings from the water quality assessment, hydrocarbons were not present in the in-stream sediments of the Carmichael River.

Metals detected in the waters of the Carmichael River include aluminium, antimony, arsenic, barium, boron, chromium, cobalt, copper, iron, lead, manganese, nickel, tin, vanadium and zinc. The majority of these metals were also present in the in-stream sediments of the river. Total copper and dissolved zinc 95th percentile concentrations were above the HMTV for protection of aquatic ecosystems. Total and dissolved iron and manganese 95th percentile concentrations exceeded the long-term trigger values (LTV) for metals in irrigation water.

The quality of the water in the still water bodies was different to the Carmichael River, which is primarily due to the non-flow conditions of those bodies, lack of riparian cover and use of the dam water resources by cattle. The electrical conductivity of the still water bodies was substantially lower than the Carmichael River, indicating that input from the alluvial groundwater aquifer that interacts with the river is unlikely. Given that dams are designed to limit the potential for leaching of waters, the disconnect between these resources and groundwater aquifers is not unexpected.

Turbidity values in the still water bodies were elevated, but still lower than those recorded in the Carmichael River. This has been associated with the non-flow conditions which allow for sediments to settle out of suspension. Dissolved oxygen concentrations were also low, one of the few parameters which was comparable to river concentrations. This is not unexpected given that the low DO concentrations in the river are likely associated with low-flow conditions. The pH values in the still water bodies were slightly elevated, although less alkaline than the waters of the Carmichael River. Temperature trends observed in the still water bodies were similar to the Carmichael River trends, although still water bodies experienced a greater range in temperature. This is associated with the lack of shading, and thus reduced temperature buffering capacity of the still water bodies.

The concentrations of nutrients were generally higher in the still water bodies than in the Carmichael River. As with the Carmichael River results, concentrations of total nitrogen were attributable to concentrations of organic nitrogen. Some still water bodies also contained moderate concentrations of ammonia. Reactive phosphorus concentrations in the still water bodies were consistently higher than the concentrations found in the Carmichael River.

Chlorophyll a concentrations were also higher in the still water bodies than in the Carmichael River sites, however, no blooms were observed during monitoring. Faecal coliform testing identified that faecal coliforms were present at all the still water body sites. No distinct spatial patterns between the Carmichael River sites and the still water bodies were observed.

As with the Carmichael River sites, hydrocarbons were not present at the still water bodies. A number of metals were present in the waters and sediments of the still water bodies. These include aluminium, arsenic, barium, boron, chromium, cobalt, copper, iron, lead, manganese, nickel, strontium, vanadium and zinc. The differences in metal concentrations between the Carmichael River and the still water bodies are likely attributable to local soil characteristics and previous farming activities. Total and dissolved aluminium, chromium, copper, lead and zinc 95^{th} percentile concentrations exceeded the WQOs for protection of aquatic ecosystems. Total aluminium 95^{th} percentile concentrations also exceeded the LTV for metals in irrigation water and the WQOs nominated for stock watering. The 95^{th} percentile concentrations of total and dissolved manganese exceeded the LTV for metals in irrigation water.

The sediments of the still water bodies were comprised of sands, silts and clays. Concentrations of nutrients in the sediments were generally much higher in the still water bodies than in the Carmichael River. These results are consistent with the findings of the water quality assessment, and have been attributed to the lack of flushing of the still water bodies. Faecal coliforms were detected in the sediments of all of the still water bodies, reflecting the findings of the water quality assessment. Hydrocarbons were not present in the sediments of the still water bodies.

Some of the nominated sampling sites located in the north of the Study Area were dry throughout the monitoring program. In order to gain an understanding of the potential contaminants that may be released during flow events DI leach testing was undertaken. Results were generally consistent with the findings of the broader monitoring program, indicating that the sampling sites can be considered to be representative of the water resources present within the Study Area.

Limited site access during October to March prevented monitoring during the wet season when high flow conditions are expected to occur. The increase in flow and water depth that occurs during this period is expected to directly impact water quality within the Study Area. During the first flushing flows, water quality variance within the Carmichael River is expected to be high as mobilisation of nutrients, sediments and other parameters occurs. As flow and water depth increase with rainfall during the summer period, water quality within the Carmichael River is expected to become less influenced by groundwater conditions. Overland flow input of fine sediments is expected to result in an increase in turbidity and nutrients.

Collated information relating to the water resources of the Study Area identified the following EVs of relevance:

- Aquatic ecosystems – slightly to moderately disturbed
- Primary industries – irrigation

- Primary industries – stock watering
- Cultural and spiritual values.

As required by the QWQG (DERM, 2009a), WQOs for the protection of the EVs were identified. Data obtained during the assessment has been compared to the nominated WQOs.

As outlined in Table 4-19, data collected did not consistently align with the WQOs. This was particularly evident at the end of the wet season (April) and at the end of the dry season (September). Further monitoring is required to determine the spatial and temporal variability in water quality for the Study Area. The development of site specific WQOs will need to take the large observed temporal variation into consideration.

Table 4-19 Assessment of Data Exceedances of Nominated Water Quality Objectives

Parameter	Aquatic Ecosystems		Primary Industries	
	Upland streams	Lakes and reservoirs	Irrigation	Stock Watering
Physical parameters				
Dissolved oxygen	✓	✓	-	-
pH	✓	✓	-	-
Electrical Conductivity	✓	✓	-	-
Turbidity	✓	✓	✓	-
Biological				
Chlorophyll a	-	✓	-	-
Faecal coliforms			✓	✓
Nutrients				
Ammonia as N	✓	✓	-	-
Nitrate (as N)	×	×	-	×
Nitrite (as N)	-	-	-	×
Nitrogen (Total)	✓	✓	×	-
Organic Nitrogen	✓	✓		
Phosphorus	✓	✓	✓	-
Reactive Phosphorus as P	✓	✓	-	-
Major ions				
Calcium	-	-	-	×

Parameter	Aquatic Ecosystems		Primary Industries	
Magnesium	-	-	-	×
Fluoride	-	-	×	×
Sulphate	-	-	-	×
TDS	-	-	-	×
Metals and Metalloids				
Aluminium	×	✓	✓	✓
Arsenic	-	-	×	×
Beryllium	-	-	×	-
Boron	×	×	×	×
Cadmium	×	×	×	×
Chromium (III+VI)	×	✓	×	×
Cobalt			×	×
Copper	✓	✓	×	×
Iron			✓	-
Lead	×	✓	×	×
Manganese	×	×	✓	-
Mercury	×	×	×	×
Molybdenum			×	×
Nickel	×	×	×	×
Selenium	×	×	×	×
Silver	×	×	-	-
Uranium	-	-	×	×
Vanadium	-	-	×	-
Zinc	✓	✓	×	×
Polycyclic Aromatic Hydrocarbons				
Naphthalene	×	×	-	-

✓ indicates as least one exceedance of the nominated WQO; × indicates no exceedances; - no available WQOs.

5. Potential Impacts and Mitigation Measures – Construction Phase

5.1 Introduction

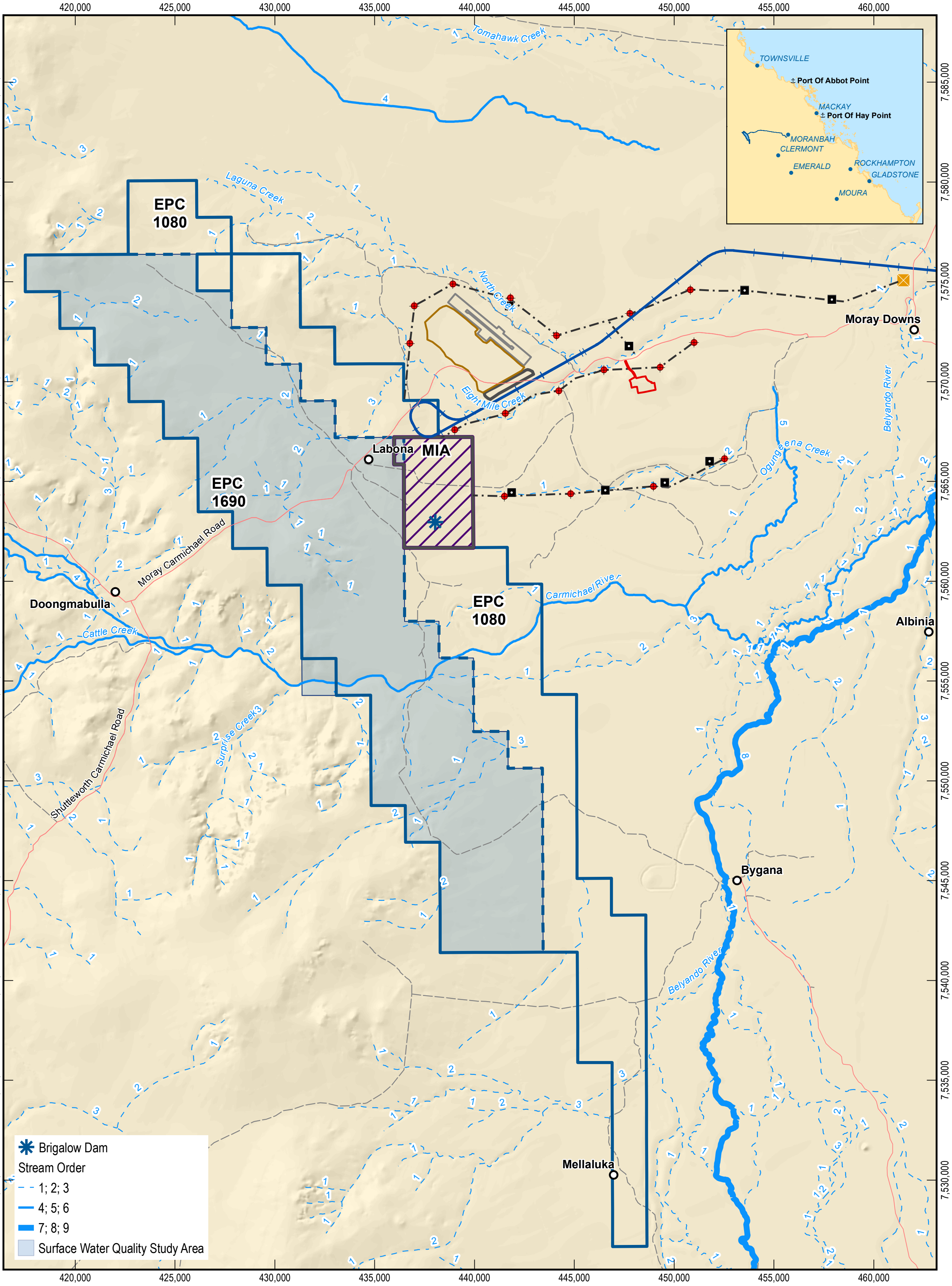
The construction phase of the Project (Mine) will involve the following principal activities:

- Development of Mine Infrastructure Area (MIA)
- Construction of Mine access roads
- Construction of water management structures including levees, bunds and water storages
- Installation of erosion and sediment control structures such as diversion drains and sediment controls
- Initial diversion of minor drainage lines
- Development of airport (off site)
- Development of workers accommodation village (off site)
- Development of Offsite Water infrastructure (off site), including:
  - Enlargement of four existing in-stream storages on North Creek and four existing in-stream storages on Obungeena Creek
  - Placement of a pump inlet into the Belyando River
  - Installation of groundwater bores
  - construction of pipelines
- Infrastructure crossings of watercourses including:
  - Pipeline crossings, which will be buried
  - Access roads and haul roads. These will involve culvert crossings or, for minor access roads, crossings with low flow pipes
  - Conveyor crossings which will span watercourses

Figure 5-1 provides details of the expected disturbance area during the construction phase of the Project (Mine).

Initial water management activities and protocols would include:

- Reuse of water captured in sediment dams
- Utilising existing dams for water supply wherever possible
- Use of treated wastewater for dust suppression or irrigation



LEGEND

Homestead | Local Road | Track | Construction Phase Footprint | Rail (West) | Mine (Onsite) | Mine Infrastructure Area | Mine (Offsite) | Borehole | Storage Site (Instream) | Storage Facility (Offstream) | Pipeline Network | Airport Location | Rail Siding | Industrial Area | Workers Accommodation Village

Based on or contains data provided by the State of QLD (DERM) [2010]. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

1:275,000 (at A4)
0 1 2 3 4 5
Kilometres
Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

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GHD adani

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project

Job Number 41-25215
Revision C
Date 29-08-2012

Construction Phase Footprint

Figure: 5-1

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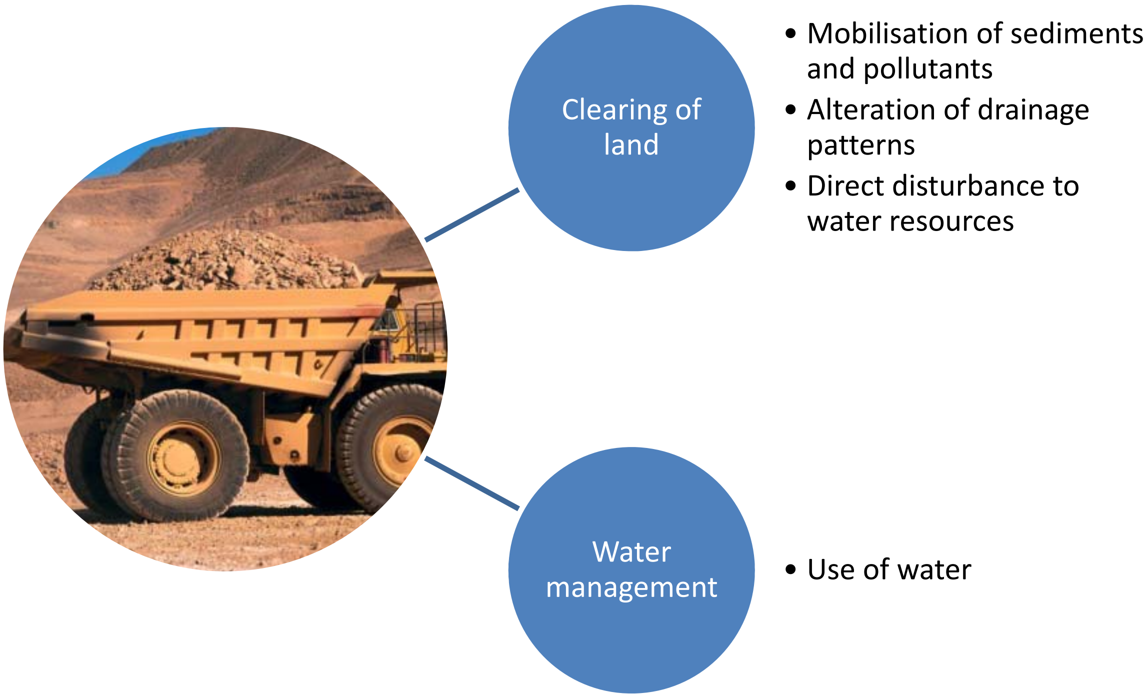
Data Source: DERM: DCDB, Stream Network (2010); DME: EPC 1690 (2010)/EPC 1080 (2011); © Copyright Commonwealth of Australia - Geoscience Australia: Mainland, Homestead, Locality, Road (2007); GHD: Construction Phase Footprint, Study Area (2011); Adani: Alignment Opt9 Rev3 (2012); Gassman/Hyder: Mine (Offsite) (2012). Created by: AJ, MS

This impact assessment has been structured to address impacts associated with primary construction activities (refer Figure 5-2). The potential impacts to surface water quality have been considered and appropriate management and mitigation measures proposed to ameliorate identified impacts.

Figure 5-2 Conceptual Diagram of Potential Construction Phase Impacts



5.2 Clearing of Land

5.2.1 Overview

Land that will be cleared as part of the construction phase of the Project (Mine) includes the footprint of the Mine Infrastructure Area (MIA), mine village, airport and access corridors (Figure 5-1). Water resources within the footprint include Brigalow Dam and a section of Obungeena Creek (Figure 5-1).

Brigalow Dam is a small farm dam approximately 50 m in diameter, with a moderately sloping bank. During the dry season the water storage of this dam is substantially reduced, such that only a small, shallow pool of water remains (Plate 5-1). Evidence of cattle and pig disturbance was observed during aquatic ecology site assessments (refer to Volume 4 Appendix O - Mine Aquatic Ecology Report for further details). Brigalow Dam is located within the EPC1080 and was therefore not included in the water quality monitoring program. However, as Brigalow Dam has a similar structure and surrounding land use as dams within the EPC1690 that were monitored during baseline studies, water quality of this dam when full is likely to be comparable to the dams that were assessed as part of the water quality monitoring program (Sites 6 – 9); characterised by high turbidity, low dissolved oxygen concentrations and elevated nutrient and faecal coliform levels. Additional survey work will be undertaken within EPC1080 to supplement the conclusions provided herein.

Obungeena Creek is an ephemeral drainage line that is likely to only contain water immediately after heavy rainfall (Plate 5-2). This creek has a width of 2 m to 4 m and has a limited riparian zone. Evidence of cattle disturbance was observed during aquatic ecology site assessments (refer to Volume 4 Appendix O - Mine Aquatic Ecology Report for further details). The environmental values of Obungeena Creek are considered comparable to the other dry creek beds assessed as part of the water quality monitoring program (Sites 10 – 12). It is therefore expected that potential pollutants identified at Sites 10 – 12 may be mobilised during flow events. Potential pollutants include fine sediments, elevated nutrients and some metals.

Clearing of land within the construction phase footprint (Figure 5-1) is a direct disturbance that has the potential to impact upon the water resources within and in proximity to the footprint. Potential impacts that may be realised as a result of land clearing include:

- Mobilisation of sediments and pollutants via the removal of vegetation which provides natural erosion control features, exposure of and disturbance to soils, and introduction of potential pollutants to watercourses
- Direct disturbances to water resources, relating to construction activities undertaken within water resources and riparian zones
- Loss of catchment area and alteration of flows associated with the changes in existing overland flow paths during construction activities

These impacts and potential management and mitigation measures are individually addressed below. Where interactions between impacts are likely this has been noted.

Plate 5-1 Brigalow Dam (Sept 2011)

Plate 5-2 North Creek (downstream of proposed construction footprint) (Sept 2011)

5.2.2 Mobilisation of Sediments and Pollutants

5.2.2.1 Potential Impact

The construction phase of the Project (Mine) will require clearing of vegetation and cut, fill and compaction earthworks. These activities will take place across the entire construction phase footprint (Figure 5-1).

The vegetation clearing and earthworks will expose soils to erosive forces. Rainfall and surface runoff may then convey soils to watercourses, resulting in degradation of water quality. An investigation of the soils of the region identified that the soil has a high proportion of fine sands and poor structural properties, making it susceptible to rain-related erosion on all but the flattest slopes. (refer to Volume 4 Appendix L Soils Report for further information). Wind erosion may also convey fine soils to water bodies. Once disturbed these soils are readily mobilised, and once in suspension within a water resource, may take a long time to settle out of suspension. Soils and subsoils from the exposed areas, will be readily mobilised into local drainage lines and water bodies via erosion processes.

Works directly in watercourses will also destabilise bed and banks of watercourses and, if these are not managed during construction and stabilised after construction, this can result in long term sediment releases. Geomorphic effects are discussed in Section 0.

Surface water resources in the area are expected to be subject to spikes in suspended solids loads during flow events, particularly early in the flow event, due to catchment characteristics. However, runoff from areas disturbed by construction is likely to carry higher than usual suspended solids loads and hence, further degrade water quality in streams downstream of the construction activities.

Areas to be disturbed during construction drain to Eight Mile Creek/North Creek and Obungeena Creek. Downstream, of EPC1080, these two creeks traverse a very flat area and become un-channelised in some sections, meaning that flows then spread across a wider shallow floodplain. Ultimately, water from this area will drain to the Belyando River, 20 km east of the proposed construction activities.

The most significant impacts associated with increased sediment levels in the Belyando River would be in relation to aquatic ecosystem health, which is discussed in more detail in the Mine Aquatic Ecology Report (Volume 4, Appendix O). There are limited downstream water users taking water for stock and domestic use. Assuming that any water taken for potable uses would be filtered or otherwise treated, this use is not particularly affected except that, in the short term, potable water treatment costs may increase due to the need to remove higher levels of suspended solids.

Both North and Obungeena Creeks have existing in-stream storages which would assist in capturing flows from the construction area, and provide for some settlement of sediment. Nevertheless, in larger flow events there is potential for sediment to be conveyed to the Belyando River and erosion and sediment controls should be applied to construction activities undertaken during the wet season to minimise mobilisation of soils from the site.

Diesel and oils will be utilised in construction vehicles and equipment and there will be a need to store diesel and oils in construction laydown areas. Spills of diesel and oils within watercourses, whether wet or dry, could result in mobilisation of contaminants to downstream environments. Spills to soils could also result in contaminants being mobilised by overland flow during a rain event. Impacts of these pollutants on aquatic ecosystems is discussed in Mine Aquatic Ecology Report (Volume 4, Appendix O).

Downstream water users could be affected if hydrocarbons were mobilised into the Belyando River. Australian drinking water guidelines do not include guidelines for diesel or oils. Diesel fuel has a taste and odour threshold of 0.0005 mg/L and hence, waters taken for domestic use that are tainted with diesel are unlikely to be ingested (NHMRC 2011).

Minor spills of diesel and oil would be expected to break down naturally, however a larger spill or ongoing minor releases could render water in the Belyando River unusable for stock and domestic water supply with significant consequences.

Wash down facilities will be required for vehicle washing and water used for wash down will become contaminated with sediment and hydrocarbons and will therefore be unsuitable for release to the environment without treatment.

Sewage will be generated at the workers accommodation village and, a smaller package treatment plant will also be required to manage sewage from toilet facilities at the MIA area. Release of untreated or partially treated sewage may have a range of impacts:

- Nutrient levels may cause eutrophication of downstream aquatic ecosystems. This is discussed further in the Mine Aquatic Ecology Report (Volume 4, Appendix O).
- Bacteria and other pathogens may cause illness in humans using water for domestic supply or primary contact recreation.
- Odour may affect aesthetic enjoyment of affected watercourses.

As these impacts are likely to be significant if not managed, sewage must be treated and managed such that exposure to harmful pollutants does not occur. The approach to sewage treatment and management is provided in Section 5.2.2.2.

Litter and other gross pollutants may also be conveyed into watercourses during construction. The main impacts of this is on aesthetic enjoyment of watercourses, and direct impacts on larger aquatic animals that may become entangled in plastics and other litter.

Cement will also be utilised in construction and concrete batching carried out. These materials are generally low hazard however if a significant quantity of cement was spilled into a confined watercourse, it could cause an increase in pH with localised impacts on aquatic ecosystems from this change in water quality, and from direct smothering. Downstream water users would not be affected as any changes in pH would quickly be buffered in the aquatic environment.

5.2.2.2 Management and Mitigation

The impacts associated with mobilisation of sediments and pollutants to water resources will be managed/mitigated via engineering and construction management solutions. Construction management solutions will be embedded in an Environmental Management Plan (EMP) to be implemented throughout the construction phase of the Project (Mine).

Mobilisation of Sediments

Management and mitigation measures to be implemented to minimise the impact associated with mobilisation of sediments include:

- Scheduling construction activities such that, during the wet season, erosion and sediment control devices are installed before any significant exposure of soils occurs
- Scheduling construction works such that permanent stormwater management systems are installed as early as possible in the construction process

- Scheduling construction works to minimise the period of time that soils are exposed between vegetation clearing and placement of final ground cover or reinstatement of disturbed surfaces
- Developing an erosion and sediment control plan that complies with International Erosion Control Association of Australasia Best Practice Erosion and Sediment Control Guidelines (IECA 2007)
- Installing diversion drains around areas to be cleared or otherwise disturbed. Diversion drains will connect to existing flow paths or drainage lines and scour protection will be provided at outlets.
- Use of erosion control measures to minimise mobilisation of soils due to wind or water erosion. This may include temporary placement of mulch, matting or gravel.
- Use of sediment control devices to capture and retain flow from disturbed areas. Sediment control devices may include sediment fences, sediment ponds or sediment weirs in drainage lines.
- Avoiding works in watercourses during flow events, and stabilising any open works in anticipation of major flow events.
- Placing topsoil and mulch stockpiles at least 100 m from any watercourse or drainage line, and in such a way that the material cannot enter the watercourse.
- Stabilise disturbed areas as soon as practicable after disturbance in accordance with the relevant operational requirements of these areas.
- Using dust suppression to prevent significant windblown erosion from depositing in watercourses.

Mobilisation of Pollutants, Construction Waste and Litter

In relation to potential impacts of releases of hydrocarbons and other environmentally hazardous materials, mitigation measures rely on:

- Preventative measures, including:
  - Storing all materials, including environmentally hazardous materials and equipment at least 100 m from any watercourse or drainage line, and in such a way that the material cannot enter the watercourse.
  - Provision of diesel storages compliant with AS 1940-2004 - the storage and handling of flammable and combustible liquids
  - Storage and handling procedures for diesel in accordance with AS 1940-2004 - the storage and handling of flammable and combustible liquids
  - Transport of diesel and oils in accordance with the Australian Code for the Transport of Dangerous Goods by Road and Rail (ADG Code)
  - Handling of diesel
  - Storage of oils and oily wastes in enclosed and contained areas such that the volume of the largest container can be easily contained by secondary containment
  - Procedures in relation to handling of diesel and oils, including refuelling procedures
  - Training of staff in correct handling and storage procedures
- Responsive measures, including:
  - Provision of spill containment and clean up kits at all locations where a risk of spills greater than 20 L is identified. This will include spill kits in vehicles involved in mobile refuelling.

- Spill response procedures
- Training of staff in containing and cleaning up spills
- Incident investigations and identification of corrective actions.

The hazard and risk assessment (detailed in Volume 2 Section 12 - Hazard and Risk Assessment) provides more information on prevention and management of spills. Other mitigation measures to be implemented to minimise the potential for impacts associated with mobilisation of pollutants include:

- Location of concrete and asphalt batch plants at least 100 m from any watercourse or drainage line
- Dedicated waste storage facilities and prompt removal of wastes
- Dedicated vehicle washdown areas that drain to a collection sump and treatment facility to remove hydrocarbons and sediment. Treated water is either to be recirculated for vehicle washing or used for dust suppression.
- All wash down of equipment to be undertaken within bunded areas to reduce the risk of uncontrolled releases to the environment

Domestic Waste Water

All domestic waste water, including sewage, will be treated via package treatment plants located at the workers accommodation village and MIA.

Wastewater generated at the workers accommodation village will be used in irrigation of landscaped areas, rehabilitation trials and pasture areas and for dust suppression of construction activities at the off-site infrastructure area. Depending on the potential for human exposure during reuse, it will be treated to at least class B in relation to pathogens. Nitrogen and phosphorus levels will be determined following modelling of irrigation requirement using the Model for Effluent Disposal by Land Irrigation (MEDLI). This model will also determine the optimal area required for irrigation to avoid impacts on soils, surface waters and groundwater and support development of an irrigation management plan.

For wastewater generated within the mining lease, this will be reused in dust suppression during construction. Treatment will be to Class A+ in relation to pathogens and indicative nitrogen and phosphorus concentrations will be 30 mg/L and 5 mg/L respectively.

5.2.2.3 Monitoring, Inspections and Corrective Actions

Treated effluent quality will be monitored on a weekly basis. Monitoring of irrigation areas will also be carried out as identified in the land irrigation management plan.

Monitoring will also involve regular inspections of:

- Erosion and sediment control devices, including inspections before and after rainfall events resulting in any overland flow
- Fuel, oil and waste disposal areas to check for proper storage and signs of spills
- Watercourses and drainage lines to check that materials have not been placed in such a way that the material might be conveyed to the watercourse.
- General work areas for litter or signs of potential contamination.

Corrective actions will be implemented as required where inspection indicates that there is a risk to surface water quality.

While a general program of surface water quality monitoring is proposed (See Section 6.2.2.2), specific monitoring in relation to construction water quality will only be undertaken in the event of an incident involving actual or potential contamination of a watercourse.

5.2.2.4 Summary

Construction activities have the potential to impact on water quality via mobilisation of sediments and pollutants. Without controls, significant impacts on downstream water users may arise from major diesel spills, prolonged release of smaller quantities of hydrocarbons and release of untreated sewage. Significant aquatic ecosystem impacts may also occur, particularly in relation to sediment releases and this is discussed further in Mine Aquatic Ecology Report (Volume 4, Appendix O).

Suitable mitigation measures are available to avoid or mitigate potential impacts and risks to surface water quality and with these measures in place, significant impact or risk is not expected.

5.2.3 Alteration of Drainage Patterns and Flooding

5.2.3.1 Potential Impact

Development works can alter drainage patterns in several ways:

- By changing the rainfall runoff characteristics of land. Typically, runoff becomes more intense as lower permeability, rougher surfaces are replaced with higher permeability, smoother surfaces
- By changing the directions of flows when areas are levelled for placement of infrastructure or facilities

To develop the MIA, workers accommodation village, airport and infrastructure corridors clearing of land needs to occur. These construction activities will remove approximately 1,830 ha from the Obungeena Creek catchment (Figure 5-1). These will be changed from open permeable grazing land to developed areas, with compacted or sealed surfaces. Rainfall runoff will therefore occur more quickly with less infiltration, potentially leading to increased concentration of flow around minor drainage lines and higher intensity of flow in downstream watercourses. This concentration of flow can cause degradation of water quality due to erosion and scouring and destabilisation of bed and banks at and downstream of the affected area.

Given that the areas of each catchment to be disturbed are relatively small, adverse effects are expected to be localised only and substantial changes in flow volumes and rates downstream of construction areas are not expected. In any case, the water supply strategy involves increasing the storage capacity of eight in-stream storages in North Creek and Obungeena Creek and this will offset any increase in flow.

Erosion and sediment control measures during construction will minimise water quality degradation and in the longer term, stormwater management measures will also minimise water quality degradation. Mitigation measures in this regard are presented in Section 5.2.2.2

Only minor changes in topography are required in the vicinity of the off-site infrastructure as this area is relatively flat. The MIA will require more earthworks to prepare a flat surface for the various infrastructure and plant required at the MIA, however, runoff will still flow towards Obungeena Creek. Again, any increases in flow will be negated by the expanded in-stream storages on Obungeena Creek.

An assessment of the surface hydrology and water balance has been undertaken as part of the EIS (refer Volume 4 Appendix P Hydrology Report). Mapping of the existing flood conditions for various average recurrence intervals up to 1000 years shows that, within the MLA, the flooding of the Carmichael River is largely contained within a 1.5 km corridor. For this reason, flooding from the Carmichael is unlikely to affect the construction footprint. However large rainfall events could cause surface runoff to flood the construction footprint with the potential for sediments and contaminants to mobilise to nearby water resources such as Obungeena Creek and Eight Mile Creek. Flooding may also impact upon the integrity of impact management infrastructure, such as sediment control devices, already established on site.

Construction of crossings of creeks for road access or pipeline construction may also cause short or long term disruption to flows and exacerbation of flooding upstream due to afflux. This can be addressed through design and construction measures. In any case, there are no flood sensitive receptors upstream of proposed crossings.

5.2.3.2 Management and Mitigation

In relation to impacts of structures in streams, all crossings will be designed to:

- Maintain the bed level of streams
- Minimise disturbance within the bed and banks of streams
- Minimise afflux

Relevant guidelines include:

- Fish Habitat Management Operational Policy FHMOP 008
- Best practice principles for riverine management (DNRM, September 2012).

The following additional management and mitigation measures should be considered to manage the risk associated with flooding during construction:

- Construction of bunded areas for chemical storage will be completed prior to any chemicals being delivered to site
- Identification of threshold rainfall intensity or level in Eight Mile Creek at which construction activities will be ceased and personnel evacuated due to flood risk. Emergency response procedures, including flood forecasting and warning systems will be detailed in the construction EMP

5.2.3.3 Summary

Given the relatively small proportion of the catchments to be disturbed and minimal changes to topography, it is unlikely that changes in flow will lead to adverse impacts on watercourses and drainage lines. No residual impacts to surface water quality are expected as a result of alteration of drainage patterns.

5.2.4 Direct Disturbance to Water Resources

5.2.4.1 Potential Impact

Direct disturbance to watercourses and dams will occur as follows:

- Brigalow Dam will be removed
- The existing dams on North Creek and Obungeena Creek will be emptied and storage capacity increased by a combination of excavation and raising of walls

- Crossings will be installed in watercourses for access roads, these will be culvert style crossings
- Pipeline crossings will be installed, with all pipeline crossings buried beneath watercourses
- A pump inlet will be installed in the Belyando River.

Each of these will result in direct disturbance to the bed and banks of watercourses. Water quality may be degraded if flows mobilise exposed soils and sediments downstream. Impacts associated with this are discussed further in Section 5.2.2and mitigation measures proposed in Section 5.2.2.2.

In the longer term, if disturbance to the bed and banks of watercourses is not stabilised, flows within the watercourses will continue to erode the bed and bank material and lead to instability in the watercourse, as well as ongoing sediment inputs to downstream waters.

In addition any water that may be present in Brigalow Dam and in the existing storages on North Creek and Obungeena Creek will need to be removed. Depending on recent rainfall, water quality may be poor, particularly in relation to elevated nutrients, low dissolved oxygen and high sediment levels (see also Section 4.3). This water may therefore not be suitable for release to surface waters.

5.2.4.2 Management and Mitigation

In relation to works within the bed and banks of watercourses, the following mitigation measures are required in addition to those set out in Section 5.2.2.2:

- Works in watercourses should be planned ahead, so that the actual works can be completed as quickly as possible
- Works should preferably be carried out in periods of no flow, or in the case of the Belyando River, low flow
- Design should take into account the need to stabilise the bed and banks and avoid scouring. Soft structures should be used rather than concrete

Where water from existing storages needs to be removed, this water should be preferentially used for dust suppression or, if not required for dust suppression, transferred to another storage or used to irrigate pasture areas. The water should only be released to watercourses if the release will not result in the receiving waters exceeding the water quality objectives in Section 4.1. Forward planning will be required to ensure that water in the existing storages can be managed appropriately.

5.2.4.3 Summary

The removal of the Brigalow Dam water resource is unavoidable. Potential to impact upon the quality of surrounding water bodies will be managed through appropriate treatment of any waters to be decanted and/or reused onsite such that no flow on degradation to adjacent water bodies will be realised. Lost habitats and the value of these environments to flora and fauna are addressed under the Aquatic Ecology Report (refer Volume 4 Appendix O). No residual impacts to water quality of the site are expected from removal of this dam resource.

5.3 Use of Water during Construction Activities

5.3.1.1 Potential Impact

Development of the MIA, airport, access corridor and workers accommodation village will require water. Uses include domestic use in support of up to 3,000 person construction workforce, and use during construction for activities such as dust suppression and material handling.

Construction water supply will initially come from:

- Existing farm dams
- A bore field that is being installed at the off-site infrastructure area
- Any water captured in sediment basins.

As construction proceeds, the operational water supply strategy will be developed and water for construction will be available from these sources. Impacts associated with flow reductions from the water supply strategy are discussed in Section 6.3.

No water will be taken from the Carmichael River for use in the construction phase of the Project (Mine). Given no water extraction is intended no impacts relating to such are required to be considered here.

5.3.1.2 Management and Mitigation

Release quality characteristics for reuse of treated waste water have been outlined in Table 6-1. If treated waste water is to be used for dust suppression or irrigation activities these release quality characteristics must be achieved.

If treated waste water is not reused onsite the water must be managed appropriately such as disposal via an irrigation system downwind of the mine site.

5.3.1.3 Summary

No impact to the water quality of surface water resources onsite will be realised from this activity if the release quality characteristics outlined in Table 6-1 are achieved.

6. Potential Impacts and Mitigation Measures – Operation Phase

6.1 Introduction

The operation phase of the Project (Mine) will involve the following principal activities, relevant to this assessment of water quality impacts:

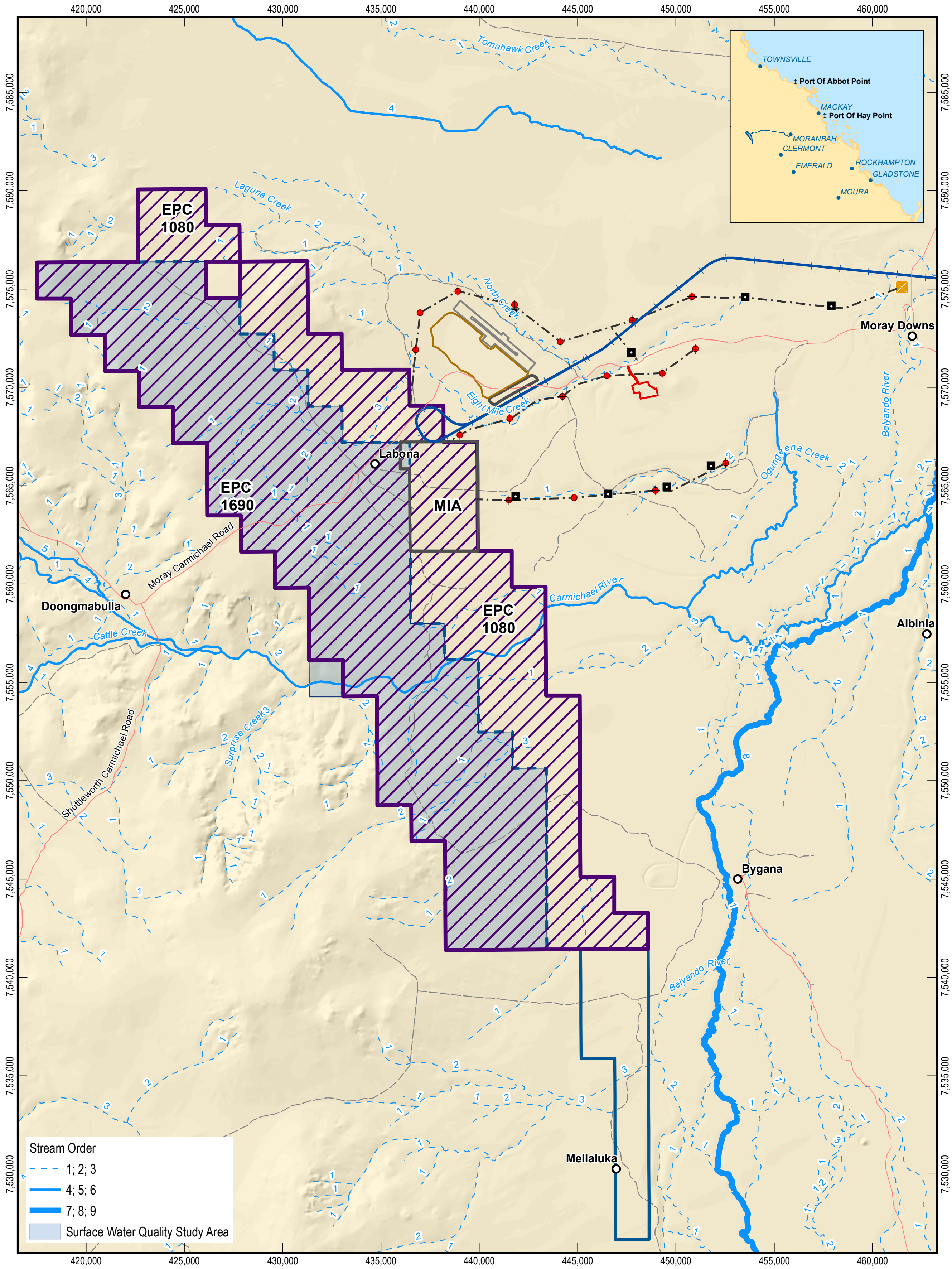
- Underground mining staged through development with subsidence of mined areas expected to occur
- Open cut mining staged through development and rehabilitation of pits over a 90 year mine life
- Management of overburden through development and rehabilitation of waste areas over a 90 year mine life
- Development and maintenance of clean water diversion drains to be established through the open cut pit areas linking the existing natural waterways and separating clean inflows from dirty water areas
- Development and maintenance of an approximately 500 m flood buffer from each bank of the Carmichael River (see Volume 2 Section 2 for further details). This will become the levee corridor once its construction occurs circa Year 2047.
- Management of MAW water from operations through capture in dams for treatment and reuse
- Management of spoil runoff through capture in sediment ponds
- Discharge of water from sediment ponds to designated licenced discharge points if and when required
- Sanitation wastewater for the operation will be treated in a packaged plant to a Class A+ standard. All effluent will be recycled on site, or removed from site and managed appropriately
- Access to the southern portion of the lease will be achieved via one access point, a spanned bridge across the Carmichael River

Figure 6-1 shows the expected disturbance area during the operational phase of the Project (Mine).

This impact assessment has been structured to address impacts associated with the following primary operational activities (refer Figure 6-2):

- Clearing of land
- Operational water management
- Alteration to groundwater regime

The identified potential impacts associated with these activities are described following, with appropriate management and mitigation measures proposed.



LEGEND

Homestead	Operational Phase Footprint	Mine (Offsite)	Airport Location
Local Road	Rail (West)	Borehole	Rail Siding
Track	Mine (Offsite)	Storage Site (Instream)	Industrial Area
	Mine Infrastructure Area	Storage Facility (Offstream)	Workers Accommodation Village
		Pipeline Network	

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Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

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Adani Mining Pty Ltd

Carmichael Coal Mine and Rail Project

Job Number 41-25215
Revision A
Date 29-08-2012

Operational Phase Footprint

Figure: 6-1

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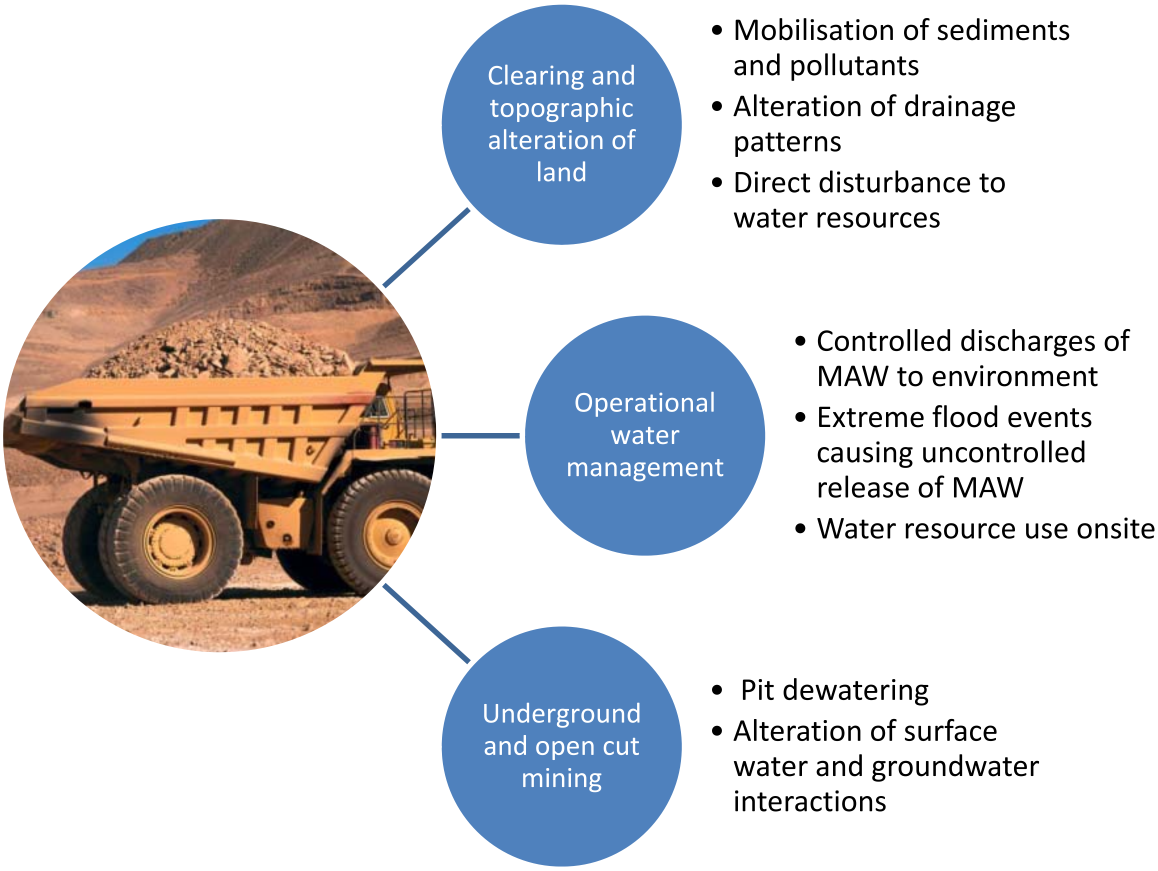
Level 4, 201 Charlotte St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data Source: DERM: DCDB, Stream Network (2010); DME: EPC 1690 (2010)/EPC 1080 (2011); © Copyright Commonwealth of Australia - Geoscience Australia: Mainland, Homestead, Locality, Road (2007); GHD: Operational Phase Footprint, Study Area(2011); Adani: Alignment Opt9 Rev3 (2012); Gassman/Hyder: Mine (Offsite) (2012). Created by: AJ,MS

Figure 6-2 Conceptual Diagram of Potential Operation Phase Activities and Associated Impacts



6.2 Clearing and Topographical Alteration of Land

6.2.1 Overview

In order to operate the Carmichael Coal Mine, land across the site will be cleared or directly disturbed (Figure 6-1) comprising the following footprints:

- Open cut pits
- Out of pit waste dumps
- Water management dams
- Access corridors, including Carmichael River crossing
- Flood protection levees
- Mine Infrastructure such as overland conveying systems
- Explosives storage area

- Topside mine support facilities

Water resources within the operation phase footprint include numerous farm dams, the Carmichael River (access corridor crossing), Eight Mile Creek, Cabbage Tree Creek and numerous drainage lines (Figure 6-1). Detailed descriptions of these resources are provided in earlier sections of this report, and in the Aquatic Ecology Report (refer Volume 4 Appendix O).

All of these resources will be subject to varying levels of disturbance during the operational phase of the Project (Mine). The disturbance will also occur in stages as the development and operation of the mine progresses. In summary, the following levels of disturbance are expected:

- Farm dams, excluding those overlying the underground mine footprint, will be drained and removed or in-filled
- Farm dams overlying the underground mine footprint will be subject to subsidence and will possibly be drained subject to risk assessment review
- The Carmichael River will be crossed by an access corridor and bridge
- Operational activities over sections of existing waterway

Clearing of land within the operation phase footprint (Figure 6-1) is a direct disturbance that has the potential to impact upon the water resources within and in proximity to the footprint. Potential impacts that may be realised as a result of land clearing include:

- Mobilisation of sediments and pollutants via the removal of vegetation which provides natural erosion control features, exposure of and disturbance to soils, and introduction of potential pollutants to watercourses
- Loss of catchment area and alteration of flows associated with the changes in existing overland flow paths during operation activities
- Direct disturbances to water resources, relating to operation activities undertaken within water resources and riparian zones

These impacts and potential management and mitigation measures are individually addressed following. Where interactions between impacts are likely this has been noted.

6.2.2 Mobilisation of Sediments and Pollutants

6.2.2.1 Potential Impact

Operation of the mine will require a variety of activities that have the potential to mobilise sediments and pollutants, including:

- Removal of vegetation
- Removal and stockpiling of topsoil
- Cut, fill and compaction earthworks
- Mining activities

The potential impacts outlined in the construction phase (Section 5.2.2) all have the potential to be realised in this phase of the Project (Mine), albeit at a larger scale, including:

- Contaminated runoff from chemical and fuel storage areas

- Contaminated runoff equipment wash down facilities
- General construction waste and litter
- Domestic waste water, including sewage

The management and mitigation measures identified in the construction phase under Section 5.2.2.2 are applicable to the operation phase and will be applied here. Other potential impacts to water quality are associated with the unlikely occurrence of uncontrolled releases of MAW to the environment in the event of a flood event exceeding 1,000 year ARI and the provided freeboard. Management and mitigation measures for these additional potential impacts are identified below.

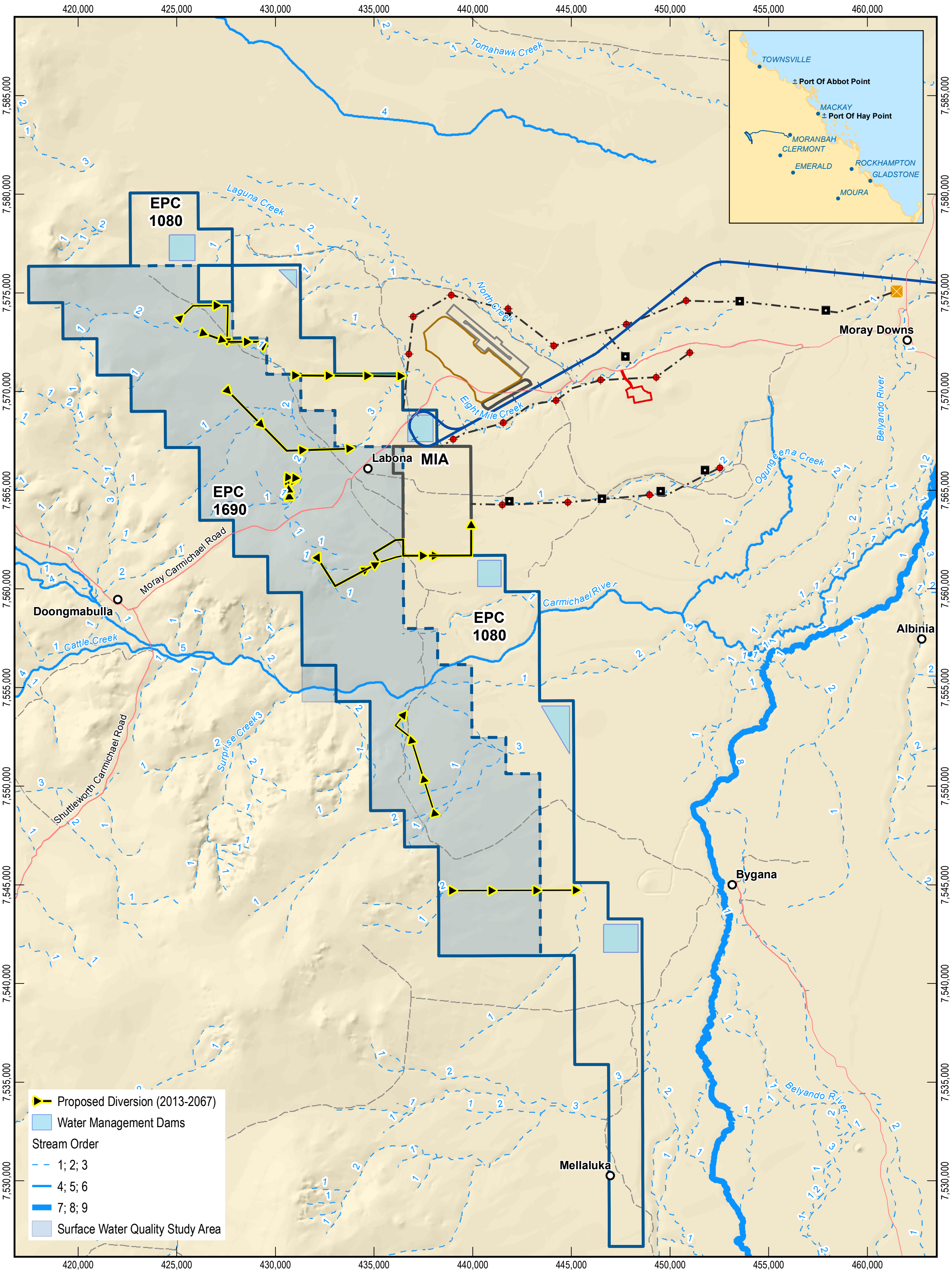
6.2.2.2 Management and Mitigation

The impacts associated with the potential mobilisation of sediments and will be managed/mitigated via engineering and operational management solutions. Operational management solutions will be embedded in an Environmental Management Plan (EMP) to be implemented throughout the operation phase of the Project (Mine) to avoid interactions between 'clean' water and MAW.

Engineering solutions include the establishment of creek diversions, flood levees and water management dams to manage and maintain, as much as possible, the surface hydrology of the site. Details of these solutions are provided in Volume 4 Appendix P1 Hydrology Report and P2 Preliminary Water Balance. A summary of the solutions include the following:

- Staged construction of watercourse diversions through open cut pits to divert clean water from entering the site, maintain existing flows in waterways as practicable, and minimise disturbance to existing waterways. These diversions link existing sections of waterway to minimise changes to existing hydrology downstream of the mine site. Diversions are mapped in Figure 6-3.
- Construction of sediment basins to collect runoff from waste rock heaps for treatment of suspended sediments in water. This water is not likely to be reused but will likely be evaporated or discharged to the nearest existing waterway once sedimentation has occurred. Sizing of these dams to meet WQOs is described in Volume 4 Appendix P1 Hydrology Report.
- Staged construction of local surface water management drains from the subsidence areas overlying the underground mining areas. These will divert localised clean runoff into the waterway diversions to maintain existing catchment areas and avoid pooling in subsidence areas.
- Construction of MAW storage dams to receive dewatering product from the mine areas and other MAW. The site water management strategy aims to reuse MAW as much as possible to limit water supply requirements and discharges to the environment. This leads to only excess water requiring temporary storage in the MAW storages and allows optimisation of the storage size according to the results of the mine water balance. Potential sizing of these storages, based on currently available information, is described in Volume 4 Appendix P1 Hydrology Report.
- Flood levees, designed for protection against 1,000 year ARI flood events, will be established along each bank of the Carmichael River. Construction of these levees will occur as required by the staged mining activities as the pits become operational adjacent to the Carmichael River. At no time will mining activity occur within the existing 1,000 year ARI flood extents prior to the construction of the levees. These levees must be in place prior to the commencement of mining activities that would be affected by such a flood event.

- Construction of levees to protect waterway diversion through waste rock dumps just north-west of the infrastructure area. This is to allow the existing waterway to maintain connection through the mine site without contamination from the waste rock heap runoff.



LEGEND

- Homestead
- Local Road
- Track
- Rail (West)
- Mine (Offsite)
- Mine Infrastructure Area

Mine (Offsite)

- Borehole
- Storage Site (Instream)
- Storage Facility (Offstream)
- Pipeline Network
- Airport Location
- Rail Siding
- Industrial Area
- Workers Accommodation Village

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Kilometres
Map Projection: Universal Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 55

Adani Mining Pty Ltd
Carmichael Coal Mine and Rail Project

Job Number 41-25215
Revision A
Date 29-08-2012

Diversion of Watercourses

Figure: 6-3

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Level 4, 201 Charlotte St Brisbane QLD 4000 T +61 7 3316 3000 F +61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

Data Source: DERM: DCDB, Stream Network (2010); DME: EPC 1690 (2010)/EPC 1080 (2011); © Copyright Commonwealth of Australia - Geoscience Australia: Mainland, Homestead, Locality, Road (2007);
GHD: Study Area, Water Management Areas, Proposed Diversion (2012); Adani: Alignment Opt9 Rev3 (2012); Gassman/Hyder: Mine (Offsite) (2012) Created by: AJ, MS

The preliminary Water Balance Model found that despite the large reuse component there is a potential for large volumes of MAW to build-up in the mine water management dams, particularly if a series of wet years occurred. On an annual basis the average build-up of MAW is well within what might be able to be stored on the mine site, over the long operational life of the mine MAW volumes could build-up significantly without the ability to make controlled discharges to the environment. The estimated average annually required discharges show that controlled discharges are expected to be well within discharge limitations (based on flow volumes of the receiving environment) (Refer to Volume 4, Appendix P – Mine Hydrology Report for further details).

MAW that has the potential to cause environmental harm will not be released to the environment except under environmental authority permit conditions. Waters to be released to the environment must comply with the contaminant release limits which will be identified in a Receiving Environment Monitoring Program.

An assessment of the existing water quality of the Study Area identified that the naturally variable conditions onsite are not consistent with the water quality objectives contained in the QWQG (DERM, 2009a) and the ANZECC Guidelines (ANZECC and ARMCANZ, 2000). It is therefore recommended that site specific contaminant release limits be identified to protect the environmental values of the region. This should be done following the survey design protocols contained in the QWQG (DERM, 2009a) to ensure that data is scientifically robust to effectively describe seasonal variation of the system.

Where appropriate, site specific contaminant release limits will be identified for the parameters identified in Table 6-1. The data collected as part of this monitoring program can be used to facilitate this process however, additional temporal information will need to be collected to achieve QWQG (DERM, 2009a) survey design protocols.

Table 6-1 Potential Contaminants for Which Site Specific Release Limits Should be Established

Electrical conductivity	Copper	Selenium
pH	Iron	Silver
Turbidity	Lead	Uranium
Suspended Solids	Mercury	Vanadium
Sulphate	Nickel	Ammonia
Aluminium	Boron	Nitrate
Arsenic	Cobalt	Hydrocarbons (C6 – C9 and C10 – C36)
Cadmium	Manganese	Fluoride (total)
Chromium	Molybdenum	

* Contaminants proposed are to be reconsidered following determination of site specific WQOs. All metals and metalloids must be measured as total (unfiltered) and dissolved (filtered).

At a minimum water quality will be monitored at the contaminant release points, sources (MAW dams, sediment ponds), receiving water (upstream and downstream of the discharge points) and subsidence areas.

It is proposed that electrical conductivity and pH will be monitored continuously and for all other parameters monitoring is to commence within 2 hrs of commencement of release and then at 24 hours thereafter.

The release of MAW to waters will take place during periods of natural flow events and must not exceed the electrical conductivity limits or the maximum release rate for each receiving water flow criteria for discharge as determined through additional monitoring prior to construction. The release of MAW will be undertaken so as to not cause erosion of the bed or banks of the receiving waters and cease if the water quality within the receiving waters (upstream or downstream) do not met the receiving water release limits.

6.2.2.3 Summary

Operational activities have the potential to impact on water quality via discharge of contaminants to the environment. The potential for this to occur will be managed by a range of site water management strategies and environmental authority permit conditions. This is expected to negate any impacts to water quality of the site. There is however residual risk in the potential for events larger than design capacity to occur in extreme circumstances and cause uncontrolled releases of MAW into the environment.

6.2.3 Alteration of drainage patterns

6.2.3.1 Potential Impact

Similarly, to the construction phase, operational works can alter drainage patterns in several ways:

- By changing the rainfall runoff characteristics of land. Typically, runoff becomes more intense as lower permeability, rougher surfaces are replaced with higher permeability, smoother surfaces
- By changing the directions of flows when areas are levelled for placement of infrastructure or facilities.
- By establishing creek diversions, flood levees and water management dams to manage and maintain, as much as possible, the surface hydrology of the site.

The operation of the Project (Mine), which includes construction of the mine, as a worst case, has the potential to remove 38,380 ha from the local river catchments, comprising 16,480 ha within the Carmichael River Catchment and 21,900 ha from the Eight Mile Creek catchment. Development of the onsite water management and waterway diversions will occur over 10 differing stages over the 90 year mine life, staged according to the mining operations are described in Volume 4 Appendix P Hydrology. The system is designed to maintain environmental flows as far as practicable by connecting waterways across the mine site and maintaining flows close to existing. Further details regarding the design of diversion drains are provided in Volume 2 Section 2 Mine Project Description and Volume 4 Appendix P Hydrology as mentioned in Section 6.2.2.

Most diversions connect existing waterways upstream and downstream however an unnamed waterway traversing the mine site just to the south of the flood protection levee corridor is diverted to discharge to the Carmichael River.

The area overlying the underground mining area will be subject to subsidence. Whilst flow from higher in the catchment will be diverted through this area by the waterway diversions, it is expected that some flow will occur in this footprint as a result of localised rainfall. There is potential for this water to accumulate in subsidence depressions, creating new water resources. Localised subsidence drains will be constructed as required to drain these areas to the waterway diversions. Impacts associated with changes to surface hydrology are discussed in Volume 4 Appendix P1 Hydrology Report.

Construction of an access corridor across the Carmichael River has the potential to alter the flow regime of the river. This may include impeding flows by narrow river crossing openings and changes to downstream geomorphology via deposition and scouring of sediment. Changes to water quality as a result of alteration of flow regime may be realised via increased input of sediment and pollutants.

6.2.3.2 Management and Mitigation

Loss of catchment area and some diversion of waterways is unavoidable; offset of the ecological loss associated with this impact should be considered as further discussed in the Aquatic Ecology Report (Volume 4 Appendix O) and the Terrestrial Ecology Report (Volume 4 Appendix N1).

The potential alteration of flow regime associated with a crossing at the Carmichael River will be managed/mitigated via engineering and construction management solutions including:

- Development of a crossing corridor across Carmichael River, with construction within the bed and banks restricted to the minimum amount necessary.
- Crossing infrastructure will comply with the Fish Habitat Management Operational Policy FHMOP 008.

Measures addressing impacts associated with mobilisation of sediments and pollutants, identified in Section 6.2.2, will be applied to manage/mitigate impacts associated with the alteration of flows.

6.2.3.3 Summary

Loss of catchment area is unavoidable and diversion of waterways is essential to protect clean water. Offset of the ecological loss associated with this impact should be considered. Waterway diversion design has maintained flows across the site as much as practicable to minimise this impact. Implementation of the identified management and mitigation measures during construction of the access corridor will maintain the flow regime of the Carmichael River such that flow-on effects to water quality are unlikely to occur.

6.2.4 Direct Disturbance to Water Resources

6.2.4.1 Potential Impact

Direct disturbances to water resources will include draining and removal/infilling of farm dams, diverting creeks and drainage lines and operation of an access corridor across the Carmichael River as discussed in the construction phase (Section 5.2.4). Potential impacts associated with these activities include relocating potentially lower quality water from the farm dams to other existing water resources, mobilisation of sediment, and impediments to water flow. The latter two potential impacts and associated management and mitigation measures are addressed individually under Section 6.2.2 and Section 0, respectively.

6.2.4.2 Management and Mitigation

Removal of the farm dams is unavoidable and will be undertaken in a staged manner over the life of the mine. Care will be taken to maintain the quality of the water resources until removal of the resources is required. This will assist in minimising localised impacts to ecological values (refer to Volume 4

Appendix O). As such, management of the dam water removal will be undertaken to minimise impacts to the remaining water resources. Management measures identified for the management of dam water removal in the construction phase of the Project (Mine) (refer Section 0) are relevant to the operation phase of the Project (Mine), and will be applied.

6.2.4.3 Summary

Implementation of the identified management and mitigation measures will maintain the water quality of the resources until they are scheduled for drainage and removal/infilling. Construction of alternative water resources on or in proximity to site should be considered to offset the ecological loss that will be caused by this unavoidable impact.

6.3 Operational Water Management

6.3.1 Overview

Operation of the Carmichael Coal Mine will require the construction and operation of water management infrastructure, including water management dams, creek diversions and flood levees. Water will also be required to support the operation of the mine, utilised for activities such as coal processing and dust suppression. These water use activities have the potential to impact on the water quality of the site via the release of polluted water to the environment. Water usage and management during operation will be managed via a Mine Water Management Plan which will be implemented throughout the operation phase of the Project (Mine).

There is the potential for flood events greater than the design immunity events to occur. Overtopping or failure of the water management infrastructure could lead to uncontrolled releases of polluted water to the environment. This is unlikely to occur for infrastructure sized to the 1000 year ARI event, such as the flood protection levees, but more likely to occur for optimised infrastructure such as the sediment dams.

Water usage and management during operation will be managed via a Water Management Plan which will be embedded within the EMP.

6.3.2 Uncontrolled Release of Mine Affected Water

6.3.2.1 Potential Impact

An uncontrolled release of MAW has the potential to impact water quality in the surrounding environment. Uncontrolled releases could occur where there is overtopping or failure of the water management infrastructure during flood events above the design immunity. While unlikely to occur, examples of potential infrastructure failure include:

- Potential overtopping or failure of the MAW storages during flood events greater than the design storage capacity.
- Diverted waterways spilling into surrounding mine, creating additional MAW that must be stored and treated.
- Potential overtopping or failure of the sediment dams during flood events greater than the design storage capacity.

- Failure or overtopping of the flood levee in events greater than 1000 year ARI plus freeboard, allowing the uncontrolled transfer of water between the Carmichael River into the mine with potential impacts to water quality.

6.3.2.2 Management and Mitigation

Management and mitigation of potential impacts associated with the failure of water infrastructure will primarily be implemented through appropriate design immunity choices and engineering design solutions. Hydrologic modelling and the Preliminary Water Balance assessment have identified appropriate infrastructure designs based on modelling of extreme weather events (refer Volume 4 Appendix P Hydrology Report for infrastructure design requirements).

Operational dam management solutions will be embedded as part of the Mine Water Management Plan and releases will be made when required to avoid uncontrolled overtopping during larger events. Regular inspection and servicing of all water management infrastructure will be part of the management strategy. Ongoing monitoring of the discharge water quality will be required to confirm the efficacy of the water management infrastructure. Monitoring requirements will form part of the Receiving Environment Monitoring Program and include sites upstream and downstream of the discharge point.

A warning threshold indicator will be established for flooding of operational areas. This threshold could be an agreed flow or water level in the Carmichael River or rainfall intensity at the nearest gauge. Should this threshold be reached, works onsite will cease and workers will be evacuated prior to flooding occurring. Works will not recommence until all relevant impact management infrastructure has been inspected and re-established to good working order.

6.3.2.3 Summary

Appropriate design of the water management infrastructure, in conjunction with regular inspection, servicing and monitoring of the receiving environment will mitigate the potential for impacts associated with uncontrolled MAW releases due to infrastructure overtopping or failure. The dams on site will have the capacity to hold water until conditions are suitable for release or indefinitely if necessary.

The mitigation options are expected to leave minimal residual probability of uncontrolled releases.

6.3.3 Use of Water During Operation

6.3.3.1 Potential Impact

Potential impacts associated with the use of water during operational are associated with the quality of water that may be released to the environment. This release may occur as part of the water usage (e.g. during dust suppression activities), or during disposal after usage (e.g. sewage disposal). As outlined in Section 6.1, all treated waste water will be managed appropriately and disposed of via irrigation.

Reuse of MAW during operation may be undertaken for dust suppression activities, irrigation of revegetated areas or coal processing. Dust suppression during operational activities is an essential management measure to minimise the potential for sediment/coal dust mobilisation into the downstream environment with impacts to water quality. Using MAW for this purpose has the dual benefit of reducing the need for an external source of water and allowing minimisation of the size of the MAW storages. The quality of the water used for operational activities must be managed in order to avoid potential contamination of water resources. Much of the MAW is likely to come from pit dewatering. As the groundwater is somewhat saline (above the ANZECC 2000 long-term irrigation guidelines for sodium and chloride, as described in Volume 4 Appendix R Hydrogeology Report), its usage for operational activities is likely to slightly increase the salinity of the surrounding environment.

6.3.3.2 Management and Mitigation

Release quality characteristics for reuse of treated contaminated water have been outlined in Table 6-1. If treated water such as MAW is to be used for dust suppression or irrigation activities these release quality characteristics must be achieved.

MAW and treated wastewater from the site must be managed appropriately to avoid a build-up in storages. Management tactics include the following, as also listed in Volume 4 Appendix P Hydrology Report:

- Maximise evaporation by either extending the storage areas, or spread water over as many storages as possible
- Increasing volumes used for dust suppression either by increasing the area or by increasing the volume used per ha.
- Discharge into the Carmichael River or local waterways whenever MAW water quality and volumes in the receiving waterways allow for discharges
- An expensive solution may be to build a pipeline to the Belyando River for discharge purposes as the Belyando is expected to allow for larger discharge volumes. This type of excess MAW management is being considered by other miners, however the acceptability

6.3.3.3 Summary

Minimal impacts to the water quality of surface water resources onsite are expected to be realised from operational water usage if the reuse quality characteristics outlined in Table 6-1 are achieved. The most likely parameter to be impacted is salinity, should MAW be used for operational water requirements.

6.4 Underground and Open Cut Mining

6.4.1 Overview

Mining operations will require dewatering of open cut and underground mining areas. This activity will have the potential to impact upon surface water quality via changes to the interactions between surface water and groundwater. An assessment of the water chemistry of the Carmichael River and nearby groundwater resources identified that it is likely that the surface water of the Carmichael River is influenced by the nearby groundwater aquifers. Temporal changes in the surface water chemistry also indicate that the influence of groundwater on the Carmichael River is greater in the dry season than in the wet season when rain water is entering the system. Impacts to surface water may also be realised if dewatered material is released untreated to the environment.

6.4.2 Changes to Surface Water – Groundwater Interactions

6.4.2.1 Potential Impact

Mining operations will require dewatering of open cut and underground mining areas. This will lower the water table in the mining areas, which may lead to a decrease in the proportion of water that discharges into the Carmichael River. Preliminary groundwater modelling results show a potential for groundwater discharges to the Carmichael River to be reduced by up to 7 per cent of pre-development discharge during the operational phase. This decrease in discharge will tend to increase the duration of zero flow and / or low flow periods in the Carmichael River. The reduction in flow of the Carmichael has the potential to have flow on effects to the water quality and EV's including downstream water users. Further information regarding the impacts to groundwater resources is provided in Volume 4 Appendix R Hydrogeology Report.

6.4.2.2 Management and Mitigation

Management of indirect impacts to surface water quality will be achieved via management of the groundwater resources. Details regarding the proposed management and mitigation measures for groundwater resources are provided in Volume 4 Appendix R Hydrogeology Report.

6.4.2.3 Summary

Groundwater discharges to the Carmichael River may potentially be reduced by up to 7 per cent resulting in a decrease in discharges to surface water and an increase in the duration of zero flow and / or low flow periods in the Carmichael River.

6.4.3 Disposal of Pit Dewatering Product

6.4.3.1 Potential Impact

Mining operations will require dewatering of open cut and underground mining areas. Dewatering has the potential to impact surface water quality if the dewatered material is released to the environment.

6.4.3.2 Management and Mitigation

All water from pit dewatering will be managed under the Mine Water Management Plan. This plan will include the requirement for the pit dewatering to be contained within the MAW storage dams. All discharges from the MAW dams will be subject to appropriate levels of control and monitoring such that it can be reused or discharged to the receiving water courses without significant detrimental impacts on water quality and flow. Strategies to manage the potential for impact associated with release of water from the MAW dams are identified in Section 6.2.2 and Section 6.3.2. These strategies include:

- The design of the MAW dams will be based on the water balance assessment with sufficient capacity to manage MAW not reused in operational processes such as dust suppression (refer to Volume 4 Appendix P Hydrology Report for details on preliminary dam sizing requirements). This will manage the potential for overtopping and uncontrolled releases from the MAW dams.
- Contaminants that have the potential to cause environmental harm will not be released to the environment except under environmental authority permit conditions. Waters to be released to the environment must comply with the contaminant release limits which will be identified in a Receiving Environment Monitoring Program. An assessment of the existing water quality of the Study Area identified that the naturally variable conditions onsite are not consistent with the water quality objectives contained in the QWQG (DERM, 2009a) and the ANZECC Guidelines (ANZECC and ARMCANZ, 2000). It is therefore recommended that site specific contaminant release limits be identified to protect the environmental values of the region. This should be done following the survey design protocols contained in the QWQG (DERM, 2009a) to ensure that data is scientifically robust to effectively describe seasonal variation of the system. Where appropriate, site specific contaminant release limits will be identified for the parameters identified in Table 6-1. The data collected as part

of this monitoring program can be used to facilitate this process however, additional temporal information will need to be collected to achieve QWQG (DERM, 2009a) survey design protocols.

- Regular inspection and servicing of all water management infrastructure. Ongoing monitoring of the receiving environment will be required to confirm the efficacy of the water management infrastructure. Monitoring requirements will form part of the Receiving Environment Monitoring Program.

6.4.3.3 Summary

Implementation of the management and mitigation measures will manage the potential for impact to water quality as a result of release of dewatered material. No residual impacts to surface water quality are expected as a result of dewatering activities.

7. Potential Impacts and Mitigation Measures – Decommissioning Phase

The operational lifespan of the mine is approximately 90 years. There are a number of aspects of relevance to environmental management when decommissioning the mining operation, including:

- Rehabilitation and remediation of open cut pits and voids, and out of pit dumps
- Removal of industrial infrastructure, camp and airstrip

Details on the approach to decommissioning the mining operation are provided in Volume 1 of the Project EIS, Project Description. With respect to the potential impacts to the environment and associated mitigation for this phase, the decommissioning of the mine will require detailed planning. Planning and subsequent development of a Decommissioning Environmental Management Plan should incorporate a phase of impact assessment that includes consideration of the potential impacts to the aquatic ecosystems within and downstream of the site as they occur at the time of decommissioning with reference to pre-mining state, as described herein.

The resultant plan should consider (but not be limited to) incorporation of the following with respect to the management of water resources:

- Remediation and development of the final landform to consider drainage, erosion resistance and potential resultant change to surface water flows (direct and volume) in order to minimise changes to the water quality of the Carmichael River and downstream
- Rehabilitation requirements for any watercourse crossings
- Rehabilitation or re-establishment of riparian zones for watercourses
- Monitoring requirements for water quality and aquatic communities
- Decommissioning and rehabilitation of MAW dams and the potential need to remove residual sediment

It is recommended that at the time of decommissioning, suitably qualified water scientists and ecologists are consulted during planning and implementation to provide appropriate direction on management of the water resources and aquatic ecosystems and to incorporate the relevant policy, legislation and standards of the time.

8. Conclusion

The assessment of the existing surface water quality environment identified that the surface water resources onsite display both spatial and temporal variability. This variability is such that the collected data did not consistently align with established WQOs. Deviations from WQOs were particularly evident at the end of the wet season (April), at the end of the dry season (September) and at sites exposed to cattle disturbance. As such, the nominated WQOs are not considered to be appropriate for the management of surface water quality during construction and operation of the Project (Mine). The development of site specific WQOs will need to take the large observed temporal variation into consideration. Ongoing water quality monitoring is currently being undertaken to assist in the determination of site specific WQOs and the intention is to finalise these during the development of the Environmental Management Plan.

Assessment of the potential impacts associated with the construction and operation phases of the Project (Mine) identified that activities have the potential to negatively affect the quality of the water in the Carmichael River Catchment. Measures to mitigate and/or manage potential impacts have been identified, including those that will be implemented through engineering design, management plans and monitoring programs. Implementation of identified measures is considered to substantially reduce the risk of impact to water quality, such that the majority of actions are considered to have no residual risk. Those actions with residual risk to water quality include:

- The mobilisation of pollutants to water resources as a result of a spill outside bunded areas
- The loss of catchment and alteration of flows associated with the total impact footprint of approximately 38,380 ha (albeit over a long and stage operational mine life)
- Potential flow on effects to water quality as a result of changes to the interaction between groundwater and surface water

9. References

ANZECC and ARMCANZ, 2000, The Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand.

Australian Code for the Transport of Dangerous Goods by Road and Rail (ADG Code)

Bureau of Meteorology (BoM), 2011, Climate Data Online. Available from: http://www.bom.gov.au/climate/data/index.shtml?bookmark=200 (Accessed: 14.12.11).

Dight, I, 2009, Burdekin Water Quality Improvement Plan. NQ Dry Tropics, Townsville.

DERM, 2009a, Queensland Water Quality Guidelines Version 3, September 2009. Department of Environment and Resource Management, Brisbane.

DERM, 2009b, Monitoring and Sampling Manual Environment Protection (Water) Policy 2009 Version 2 September 2010. Department of Environment and Resource Management, Brisbane.

DERM, 2010, Stream Network GIS Resource.

Dunlop, J., McGergor, G. and Horrigan, N., 2005, Potential impacts of salinity and turbidity in riverine ecosystems: Characterisation of impacts and discussion of regional targe setting for riverine ecosystems in Queensland. Aquatic Ecosystem Health Unit, Water Quality and Monitoring, Natural Resource Sciences, Queensland Department of Natural Resources and Mines.

Fensham, R. 2012. Queensland Herbarium. Personal communication. July 24 2012.

Greiner, R. and Hall, N, 2006, Social, Economic, Cultural and Environmental Values of Streams and Wetlands in the Burdekin Dry Tropics Region. Inventory based on published data and information. Prepared for the Burdekin Dry Tropics NRM and the Coastal Catchments Initiative.

International Erosion Control Association of Australasia, 2007, *Best Practice Erosion and Sediment Control Guidelines*, IECA http://www.austieca.com.au/BestPracticeESCDocumentInfo.aspx

National Health and Medical Research Council, 2011, *Australian Drinking Water Guidelines 6*, Australian Government, Canberra.

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Appendix A

Project Terms of Reference

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Terms of reference cross-reference

Terms of Reference Requirement/Section Number	Section of this report
Section 3.4 Water Resources	
Section 3.4.1 Description of Environmental Values	
Describe the existing water resources that may be affected by the project in the context of environmental values as defined in such documents as the EP Act, Environmental Protection (Water) Policy 2009 (EPP (Water)), Australia and New Zealand Guidelines for Fresh and Marine Water Quality and the Queensland Water Quality Guidelines.	Section 4 of this report and Volume 4 Appendix P and Appendix R
Describe present and potential users and uses of water in areas potentially affected by the project, including municipal, agricultural, industrial and recreational uses of water, and reference to any licences held by users.	Volume 4 Appendix P and Appendix R
Describe the environmental values of the surface waterways of the affected area in terms of existing and other potential surface and groundwater users	Section 4 of this report and Volume 4 Appendix R
Provide a detailed description of the quality and quantity of surface and groundwater resources in the area potentially affected by the project.	Section 4 of this report and Volume 4 Appendix R
Describe the groundwater quality considering seasonal variations in depth and flow and all times of natural flow in ephemeral streams. Parameters should include a broad range of water quality indicators including, but not necessarily limited to: ◗ Electrical conductivity ◗ Major cations and anions ◗ Dissolved metals (including Al, Ag, As, B, Br, Ca, Co, Cr, Cu, Fe, Hg, Mo, Mn, Ni, Pb, Se, U, V, Zn) ◗ Minor ions (such as ammonia, nitrite, nitrate, fluoride) ◗ Hydrocarbons ◗ Any other potential toxic or harmful substances ◗ Turbidity ◗ Suspended sediments ◗ pH.	Volume 4 Appendix R Groundwater Report
All sampling should be performed in accordance with the Monitoring and Sampling Manual 2009 or the most current edition. The description of water quality should include medians, ranges and percentiles appropriate for comparison with appropriate trigger levels and guidelines for the protection of aquatic ecosystems and downstream users.	Volume 4 Appendix R Groundwater Report
Investigate the relationship between groundwater and surface water to assess the nature of any interaction between the two resources and any implications of the proposed mine that would affect the interaction. If the project is likely to use or affect local sources of groundwater,	Section 4.3 of this report and Volume 4 Appendix R Groundwater Report

Terms of Reference Requirement/Section Number	Section of this report
describe the groundwater resources in the area in terms of: ◗ Interaction with surface water	
Describe the environmental values of the surface waterways and groundwater of the affected area in terms of: ◗ Values identified in the EPP ◗ Physical integrity, fluvial processes and morphology ◗ Any impoundments ◗ Hydrology of waterways and groundwater ◗ Sustainability (quality and quantity) ◗ Dependent ecosystems ◗ Existing and other potential surface and groundwater users ◗ Details of any proposed buffer widths between project activities and waterways ◗ Any water resource plans relevant to the affected catchments	Section 4 of this report and Volume 4 Appendix R Groundwater Report
The groundwater assessment should also be consistent with relevant guidelines for the assessment of acid sulfate soils, including spatial and temporal monitoring, to accurately characterise baseline groundwater characteristics.	Volume 4 Appendix R Groundwater Report
For the taking of groundwater, the EIS should review the significance of groundwater in the project area, together with groundwater use in neighbouring areas. Specific reference should be made to relevant legislation or water resource plans for the region. The review should also assess the potential take of water from the aquifer and how current users and the aquifer itself and any connected aquifers will be affected.	Volume 4 Appendix R Groundwater Report

Terms of Reference Requirement/Section Number	Section of this report
If the project is likely to use or affect local sources of groundwater, describe the groundwater resources in the area in terms of: ◗ A comprehensive hydrogeological description covering: the coal seams and surrounding aquifers, both artesian and sub-artesian; inter-aquifer connectivity; flow of water; recharge and discharge mechanisms; and hydrogeological processes at work ◗ Current extraction regime ◗ Geology/stratigraphy ◗ Aquifer type ◗ Depth to and thickness of aquifers ◗ Depth to water level and seasonal changes in levels ◗ Groundwater flow directions ◗ Interaction with surface water ◗ Possible sources of recharge ◗ Potential exposure to pollution ◗ Current access to groundwater resources (bores, springs, ponds, etc.)	Volume 4 Appendix R Groundwater Report
The review should include a survey of existing groundwater supply facilities (bores, wells, or excavations) to the extent of any environmental harm. Information gathered for analysis should include: ◗ location, type and status of existing water entitlements and associated infrastructure (bores, wells or excavations) ◗ pumping parameters ◗ draw down and recharge at normal pumping rates ◗ seasonal variations (if records exist) of groundwater levels	Volume 4 Appendix R Groundwater Report
Develop a network of observation points that would satisfactorily monitor groundwater resources both before and after commencement of operations.	Volume 4 Appendix R Groundwater Report
The data obtained from the groundwater survey should be sufficient to enable specification of the major ionic species present in the groundwater, pH, electrical conductivity and total dissolved solids.	Volume 4 Appendix R Groundwater Report

Terms of Reference Requirement/Section Number	Section of this report
3.4.2 Potential Impacts and Mitigation Measures	
Assess potential impacts, including long-term indirect impacts of the project on water resource environmental values identified in the previous section. Define and describe the objectives and practical measures for protecting or enhancing water resource environmental values, to describe how nominated quantitative standards and indicators may be achieved, and how the achievement of the objectives will be monitored, audited and managed. Address and describe the following matters, including provision of maps: ◗ Potential impacts on the flow and the quality of surface and groundwater from all phases of the project, with reference to their suitability for the current and potential downstream uses and discharge licences ◗ All likely impacts on groundwater depletion or recharge regimes ◗ The likely volume of groundwater to be dewatered during the operations, and its likely quality characteristics, including salinity ◗ The impacts on groundwater resources in each aquifer of any take of groundwater or dewatering as a result of the mine's operation, including any potential migration and risks associated with the inter-basin transfer of water ◗ How extracted groundwater will be managed in the surface water management system to minimise the likelihood of discharging highly saline water ◗ Measures to prevent, mitigate and remediate any impacts on existing users or groundwater-dependent ecosystems ◗ The potential environmental impact caused by the project (and its associated project components) to local groundwater resources, including the potential for groundwater-induced salinity ◗ Response of the groundwater resource to the progression and cessation of the proposal ◗ Impact on the local groundwater regime caused by the altered porosity and permeability of any land disturbance ◗ The project's impact on the local groundwater regime caused by the altered porosity and permeability of any land disturbance ◗ Any potential for the project to impact on groundwater-dependent vegetation, including avoidance and mitigation measures ◗ Potential impacts of surface water flow on existing infrastructure, with	Sections 5 and 6 of this report relate to impacts upon water quality. Refer to Volume 4 Appendix P for hydrology and Volume 4 Appendix R for groundwater related impacts.

Terms of Reference Requirement/Section Number	Section of this report
reference to the EPP (Water) and the Water Act 2000 ◗ Chemical and physical properties of any wastewater including stormwater at the point of discharge into natural surface waters, including the toxicity of effluent to flora and fauna ◗ How contaminants and wastes are avoided, minimised, treated and managed in accordance with section 13 of EPP (Water) ◗ Environmental monitoring to check the effectiveness of mitigation measures ◗ Potential impacts on other downstream receiving environments, considering the available assimilative capacity of the receiving waters, if it is proposed to discharge water to a riverine system ◗ If it is proposed to discharge water to a riverine system, mitigation measures for water treatment ◗ The results of a risk assessment for uncontrolled releases to water due to system or catastrophic failure, implications of such emissions for human health and natural ecosystems, and strategies to prevent, minimise and contain impacts ◗ The potential to contaminate surface and groundwater resources and measures to prevent, mitigate and remediate such contamination.	
Describe and address the impacts of subsidence, including but not limited to: ◗ Surface water resources ◗ Local drainage patterns ◗ Floodplains and overland flows ◗ Areas susceptible to higher levels of erosion, such as water course confluences ◗ Ponding areas within the floodplain ◗ Volumes of local and large-scale catchment runoff, including the interception of low flow events ◗ Downstream users ◗ Infrastructure within and above the watercourse	Volume 4 Appendix P and Volume 4 Appendix R
Assess any potential surface water and groundwater interaction as a result of subsidence of a watercourse. Also assess the potential impacts on the groundwater regime in alluvial and deeper aquifers due to altered porosity, permeability and interconnectivity from any land disturbance, including subsidence.	Volume 4 Appendix P and Volume 4 Appendix R
Assess the potential impacts of subsidence on the sediment load within watercourses. Identify any existing Quarry Material Allocation Notice (QMAN) holders in, or downstream of, subsidence areas; and if there are any QMAN holders, assess whether there would be potential impacts on their resource or entitlement. Provide mitigation measures for any impacts on any QMAN holders.	Volume 4 Appendix P and Volume 4 Appendix R

Terms of Reference Requirement/Section Number	Section of this report
Assess the impacts of subsidence on the ecological condition of the bed and banks, including fish passage	Volume 4 Appendix N Mine Terrestrial Ecology Report and Volume 4 Appendix P Mine Hydrology Report
Assess the impacts of subsidence effects on terrestrial ecosystems	Volume 4 Appendix N Mine Terrestrial Ecology
Detail measures that would mitigate the impacts of subsidence	Volume 2 Section 4
Outline impacts on all surface water resources by describing: ◗ Local overland flow catchment characteristics and estimated change to mean and median (50th percentile) annual run off from local overland flow catchments ◗ Change to flows including mean and median (50th percentile) annual flow, in watercourses immediately downstream of the site	Volume 4 Appendix P Mine Hydrology Report
Describe the option for supplying water to the project, and assess the consequential impacts.	Volume 2 Section 2 and Volume 4 Appendix P Mine Hydrology Report
Reference the properties of the land disturbed and processing liquid wastes, the technology for settling suspended clays from contaminated water and the techniques to be employed to ensure contaminated water is contained and successfully treated on site.	Volume 4 Appendix R Mine Hydrogeology Report
Describe the proposed stormwater drainage system and proposed disposal arrangements. (Illustrate with figures and contours).	Volume 4 Appendix P Mine Hydrology Report and Volume 2 Section 2
The EIS should outline all of the approvals required under the Water Act 2000, Water Regulation 2002 and subordinate legislation to complete the project, including construction and operational stages	Volume 4 Appendix D Project Approvals and Planning Assessment
Describe management strategies in adequate detail to demonstrate best practice management and environmental values of receiving waters will be maintained to nominated water quality objectives.	Sections 4, 5, 6 and 7 and of this report.
Address where there will be a requirement for a Quarry Material Allocation and an associated Development Approval under the Sustainable Planning Act.	Volume 4 Appendix D Project Approvals and Planning Assessment

Appendix B

Laboratory Documentation

Chain of custody documentation

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Chain of Custody & Analysis Request

Chain of Custody Number:

GHD Brisbane - 201 Charlotte Street, Brisbane 4000

PROJECT ID:	41/23244/14	QUOTE:	BN/505/10 V5
PROJECT:	Carmichael Coal Mine and Rail Project - Surface Water Quality Monitoring		
CLIENT:	GHD		
POSTAL ADDRESS:	GPO Box 668 Brisbane QLD 4000		
CONTACT:	Anna Boden		
PHONE:	07 3316 3525	FAX:	07 3316 3333
EMAIL:	Anna.Boden@ghd.com		
INVOICE:	Anna.Boden@ghd.com Sarah.Watkin@ghd.com		
DATA NEEDED BY:	ASAP		
REPORT FORMAT:			
EMAIL FORMAT:	ESDAT, EXCEL & PDF		

LABORATORY BATCH NO.:

FOR LAB USE ONLY

COOLER SEAL: Yes ... No ...... Broken ... Intact ......

COOLER TEMP: ..... deg.C

SENT TO: ALS Laboratory Group
26 Shand Street
Stafford, QLD 4053
07 3243 7222

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

Water samples and sediment samples (Background sampling)

(EMAIL ADDRESSES PROVIDED ABOVE)

ANALYSIS REQUIRED

	SAMPLE ID	MATRIX	DATE	DETECTION LIMIT	PRESERVATION	Ultra trace nutrients (UTN - 04) (TP, RP, NH3, NO2, NO3, TKN, TN)	Chlorophyll-a (EP008)	Faecal (Thermotolerant) Coliforms (MF) (MW006)	TDS (EA015H)	TSS (EA025)
1	WQST-130411	W	13/4/11	LOR	As Required	X	X	X	X	X
2	WQ02-130411	W	13/4/11	LOR	As Required	X	X	X	X	X
3	WQ03-130411	W	13/4/11	LOR	As Required	X	X	X	X	X
4	WQ05-130411	W	13/4/11	LOR	As Required	X	X	X	X	X
5	WQ04-130411	W	13/4/11	LOR	As Required	X	X	X	X	X
6	QA01	W	13/4/11	LOR	As Required	X	X	X	X	X
				LOR	As Required					
				LOR	As Required					
				LOR	As Required					
				LOR	As Required					
				LOR	As Required					
				LOR	As Required					
				LOR	As Required					
				LOR	As Required					
				LOR	As Required					

NOTES:

CONTAINED WITHIN 2 ESKIES

URGENT

Environmental Division Brisbane
Work Order
EB1107318

Telephone : +61-7-3243 7222

RELINQUISHED BY:		RECEIVED BY:	
NAME: J KREUGER	DATE: 13/4/11	NAME :	DATE:
OF: GHD Brisbane	TIME: 12:30	OF:	TIME:

PLEASE EMAIL COMPLETED ANALYSIS REQUEST TO: Anna.Boden@ghd.com

*Container Type and Preservative Codes: P = Neutral Plastic; N = Nitric Acid Preserved; C = Sodium Hydroxide Preserved; J = Solvent Washed Acid Rinced Jar; S = Solvent Washed Acid Rinced Glass Bottle; VC = Hydrochloric Acid Preserved Vial; VS = Sulfuric Acid Preserved Vial; BS = Sulfuric Acid Preserved Glass Bottle; Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; O = Other.

Chain of Custody & Analysis Request

Chain of Custody Number:

GHD Brisbane - 201 Charlotte Street, Brisbane 4000

PROJECT ID:	41/23244/14	QUOTE:	BN/505/10 V5
PROJECT:	Carmichael Coal Mine and Rail Project - Surface Water Quality Monitoring		
CLIENT:	GHD		
POSTAL ADDRESS:	GPO Box 668 Brisbane QLD 4000		
CONTACT:	Anna Boden		
PHONE:	07 3316 3525	FAX:	07 3316 3333
EMAIL:	Anna.Boden@ghd.com		
INVOICE:	Anna.Boden@ghd.com Sarah.Watkin@ghd.com		
DATA NEEDED BY:	ASAP		
REPORT FORMAT:			
EMAIL FORMAT:	ESDAT, EXCEL & PDF		

LABORATORY BATCH NO.:

FOR LAB USE ONLY

COOLER SEAL: Yes ... No ...... Broken ... Intact ......

COOLER TEMP: .....deg.C

SENT TO: ALS Laboratory Group
26 Shand Street
Stafford, QLD 4053
07 3243 7222

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

Water samples and sediment samples (Background sampling)

(EMAIL ADDRESSES PROVIDED ABOVE)

ANALYSIS REQUIRED

	SAMPLE ID	MATRIX	DATE	DETECTION LIMIT	PRESERVATION	Ultra trace nutrients (UTN - 04) (TP, RP, NH3, NO2, NO3, TKN, TN)	Chlorophyll-a (EP008)	Faecal (Thermotolerant) Coliforms (MF) (MW006)	TDS (EA015H)	TSS (EA025)
1	WQ06-140411	W	14/4/11	LOR	As Required	X	X	X	X	X
2	WQ01-140411	W	14/4/11	LOR	As Required	X	X	X	X	X
3	WQ08-140411	W	14/4/11	LOR	As Required	X	X	X	X	X
4	WQ09-140411	W	14/4/11	LOR	As Required	X	X	X	X	X
5	QA02	W	14/4/11	LOR	As Required	X	X	X	X	X
				LOR	As Required					
				LOR	As Required					
				LOR	As Required					
				LOR	As Required					
				LOR	As Required					
				LOR	As Required					
				LOR	As Required					
				LOR	As Required					
				LOR	As Required					
				LOR	As Required					

NOTES:

URGENT

Environmental Division
Brisbane
Work Order
EB1107452
Telephone : +61-7-3243 7222

RELINQUISHED BY:
NAME: K. TASKE
OF: GHD Brisbane
DATE: 14/4/11
TIME: 11:45am

RECEIVED BY:
NAME: TEHY
OF: ALS
DATE: 15/4
TIME: 7:50

PLEASE EMAIL COMPLETED ANALYSIS REQUEST TO: Anna.Boden@ghd.com

*Container Type and Preservative Codes: P = Neutral Plastic; N = Nitric Acid Preserved; C = Sodium Hydroxide Preserved; J = Solvent Washed Acid Rinced Jar; S = Solvent Washed Acid Rinced Glass Bottle; VC = Hydrochloric Acid Preserved Vial; VS = Sulfuric Acid Preserved Vial; BS = Sulfuric Acid Preserved Glass Bottle; Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; O = Other.

Chain of Custody & Analysis Request

Chain of Custody Number:

GHD Brisbane - 201 Charlotte Street, Brisbane 4000

PROJECT ID:	41/23244/14	QUOTE:	BN/505/10 V5
PROJECT:	Carmichael Coal Mine and Rail Project - Surface Water Quality Monitoring		
CLIENT:	GHD		
POSTAL ADDRESS:	GPO Box 668 Brisbane QLD 4000		
CONTACT:	Anna Boden		
PHONE:	07 3316 3525	FAX:	07 3316 3333
EMAIL:	Anna.Boden@ghd.com		
INVOICE:	Anna.Boden@ghd.com Sarah.Watkin@ghd.com		
DATA NEEDED BY:	ASAP		
REPORT FORMAT:			
EMAIL FORMAT:	ESDAT, EXCEL & PDF		

LABORATORY BATCH NO.:

FOR LAB USE ONLY

COOLER SEAL: Yes / No; Broken / Intact

COOLER TEMP: deg C

SENT TO: ALS Laboratory Group
26 Shand Street
Stafford, QLD 4053
07 3243 7222

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

Water samples and sediment samples (Background sampling)

(EMAIL ADDRESSES PROVIDED ABOVE)

NOTES: All samples freshwater

ANALYSIS REQUIRED

	SAMPLE ID	MATRIX	DATE	DETECTION LIMIT	PRESERVATION	Ultra trace nutrients (UTN - 04) (TP, RP, NH3, NO2, NO3, TKN, TN)	Chlorophyll-a (EP008)	Faecal (Thermotolerant) Coliforms (MF) (MW006)	TDS (EA015H)	TSS (EA025)	Dissolved Metals (W-3 and EG020F)	Total Metals (W-2T and EG020T)	TPH C6-C36 (EP071/080)	PAH (EP075B)	Fluoride - Soluble (EK040)	Major Cations (NT-1)	Major Anions (NT-2)	Dissolved Silicon (ED040F)	Hardness - Total (EA065)	
1	WQ08	W	4/5/11	LOR	As Required	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
2	WQ09	W	4/5/11	LOR	As Required	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
3	WQ06	W	4/5/11	LOR	As Required	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
4	QA01	W	4/5/11	LOR	As Required	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
				LOR	As Required															
				LOR	As Required															
				LOR	As Required															
				LOR	As Required															
				LOR	As Required															
				LOR	As Required															
				LOR	As Required															
				LOR	As Required															
				LOR	As Required															
				LOR	As Required															
				LOR	As Required															

Environmental Division
Brisbane
Work Order
EB1108606

Telephone : + 61-7-3243 7222

RELINQUISHED BY:		RECEIVED BY:	
NAME: Anna Boden	DATE: 4/5/11	NAME:	DATE:
OF: GHD Brisbane	TIME: 1200	OF:	TIME:

PLEASE EMAIL COMPLETED ANALYSIS REQUEST TO: Anna.Boden@ghd.com

*Container Type and Preservative Codes: P = Neutral Plastic; N = Nitric Acid Preserved; C = Sodium Hydroxide Preserved; J = Solvent Washed Acid Rinced Jar; S = Solvent Washed Acid Rinced Glass Bottle; VC = Hydrochloric Acid Preserved Vial; VS = Sulfuric Acid Preserved Vial; BS = Sulfuric Acid Preserved Glass Bottle; Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; O = Other.

Chain of Custody & Analysis Request

Chain of Custody Number:

GHD Brisbane - 201 Charlotte Street, Brisbane 4000

PROJECT ID:	41/23244/14	QUOTE:	BN/505/10 V5
PROJECT:	Carmichael Coal Mine and Rail Project - Surface Water Quality Monitoring		
CLIENT:	GHD		
POSTAL ADDRESS:	GPO Box 668 Brisbane QLD 4000		
CONTACT:	Anna Boden		
PHONE:	07 3316 3525	FAX:	07 3316 3333
EMAIL:	Anna.Boden@ghd.com		
INVOICE:	Anna.Boden@ghd.com Sarah.Watkin@ghd.com		
DATA NEEDED BY:	ASAP		
REPORT FORMAT:			
EMAIL FORMAT:	ESDAT, EXCEL & PDF		

LABORATORY BATCH NO.:

FOR LAB USE ONLY

COOLER SEAL: Yes No Broken Intact

COOLER TEMP: deg C

SENT TO: ALS Laboratory Group
26 Shand Street
Stafford, QLD 4053
07 3243 7222

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

Water samples and sediment samples (Background sampling)

(EMAIL ADDRESSES PROVIDED ABOVE)

NOTES: All samples freshwater.

ANALYSIS REQUIRED

	SAMPLE ID	MATRIX	DATE	DETECTION LIMIT	PRESERVATION	Ultra trace nutrients (UTN - 04) (TP, RP, NH3, NO2, NO3, TKN, TN)	Chlorophyll-a (EP008)	Faecal (Thermotolerant) Coliforms (MF) (MW006)	TDS (EA015H)	TSS (EA025)	Dissolved Metals (W-3 and EG020F)	Total Metals (W-2T and EG020T)	TPH C6-C36 (EP071/080)	PAH (EP075B)	Fluoride - Soluble (EK040)	Major Cations (NT-1)	Major Anions (NT-2)	Dissolved Silicon (ED040F)	Hardness - Total (EA065)	
1	WQ01	W	5/5/11	LOR	As Required	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
2	WQ02	↓	↓	LOR	As Required	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
3	WQ03			LOR	As Required	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
4	WQ04			LOR	As Required	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
5	WQST			LOR	As Required	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
6	QA02			LOR	As Required	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
				LOR	As Required															
				LOR	As Required															
				LOR	As Required															
				LOR	As Required															
				LOR	As Required															
				LOR	As Required															
				LOR	As Required															
				LOR	As Required															
				LOR	As Required															

Environmental Division
Brisbane
Work Order
EB1108729
Telephone : +61-7-3243 7222

URGENT

RELINQUISHED BY:
NAME: Anna Boden
OF: GHD Brisbane
DATE: 5/5/11
TIME: 1200

RECEIVED BY:
NAME: [illegible]
OF: ALS
DATE: 06/05/11
TIME: 09:30

PLEASE EMAIL COMPLETED ANALYSIS REQUEST TO: Anna.Boden@ghd.com

*Container Type and Preservative Codes: P = Neutral Plastic; N = Nitric Acid Preserved; C = Sodium Hydroxide Preserved; J = Solvent Washed Acid Rinced Jar; S = Solvent Washed Acid Rinced Glass Bottle; VC = Hydrochloric Acid Preserved Vial; VS = Sulfuric Acid Preserved Vial; BS = Sulfuric Acid Preserved Glass Bottle; Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; O = Other.

GHD

Chain of Custody & Analysis Request

Chain of Custody Number:

GHD Brisbane - 201 Charlotte Street, Brisbane 4000

PROJECT ID:	41/23244/14	QUOTE:	BN/505/10 V5
PROJECT:	Carmichael Coal Mine and Rail Project - Surface Water Quality Monitoring		
CLIENT:	GHD		
POSTAL ADDRESS:	GPO Box 668 Brisbane QLD 4000		
CONTACT:	Anna Boden		
PHONE:	07 3316 3525	FAX:	07 3316 3333
EMAIL:	Anna.Boden@ghd.com		
INVOICE:	Anna.Boden@ghd.com Sarah.Watkin@ghd.com		

LABORATORY BATCH NO.: FOR LAB USE ONLY

COOLER SEAL: Yes / No / Broken / Intact — COOLER TEMP: deg C

SENT TO: ALS Laboratory Group, 26 Shand Street, Stafford, QLD 4053, 07 3243 7222

DATA NEEDED BY:	ASAP
REPORT FORMAT:	
EMAIL FORMAT:	ESDAT, EXCEL & PDF

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

Water samples and sediment samples (Background sampling)

(EMAIL ADDRESSES PROVIDED ABOVE)

ANALYSIS REQUIRED

SAMPLE ID	MATRIX	DATE	DETECTION LIMIT	PRESERVATION	Ultra trace nutrients (UTN - 04) (TP, RP, NH3, NO2, NO3, TKN, TN)	Chlorophyll-a (EP008)	Faecal (Thermotolerant) Coliforms (MF) (MW006)	TDS (EA015H)	TSS (EA025)
WQ01	Water	21/6/11	LOR	As Required	X	X	X	X	X
WQ02	↓	↓	LOR	As Required	X	X	X	X	X
WQ03	↓	↓	LOR	As Required	X	X	X	X	X
WQ04	↓	↓	LOR	As Required	X	X	X	X	X
WQ05	↓	↓	LOR	As Required	X	X	X	X	X
QA1	↓	↓	LOR	As Required	X	X	X	X	X
			LOR	As Required					
			LOR	As Required					
			LOR	As Required					
			LOR	As Required					
			LOR	As Required					
			LOR	As Required					
			LOR	As Required					
			LOR	As Required					
			LOR	As Required					

NOTES: Please freeze ultratrace nutrient samples immediately upon receipt.

URGENT

Environmental Division Brisbane
Work Order
EB1111938
Telephone : +61-7-3243 7222

RELINQUISHED BY:		RECEIVED BY:	
NAME: Jody Kreuger	DATE: 21/6/11	NAME: [illegible]	DATE: 22/06/11
OF: GHD Brisbane	TIME: 1200	OF: ALS	TIME: 08:35

PLEASE EMAIL COMPLETED ANALYSIS REQUEST TO: Anna.Boden@ghd.com

*Container Type and Preservative Codes: P = Neutral Plastic; N = Nitric Acid Preserved; C = Sodium Hydroxide Preserved; J = Solvent Washed Acid Rinced Jar; S = Solvent Washed Acid Rinced Glass Bottle; VC = Hydrochloric Acid Preserved Vial; VS = Sulfuric Acid Preserved Vial; BS = Sulfuric Acid Preserved Glass Bottle; Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; O = Other.

GHD

Chain of Custody & Analysis Request

Page _1_ of _1_

Chain of Custody Number:

GHD Brisbane - 201 Charlotte Street, Brisbane 4000

PROJECT ID:	41/23244/14	QUOTE:	BN/505/10 V5
PROJECT:	Carmichael Coal Mine and Rail Project - Surface Water Quality Monitoring		
CLIENT:	GHD		
POSTAL ADDRESS:	GPO Box 668 Brisbane QLD 4000		
CONTACT:	Anna Boden		
PHONE:	07 3316 3525	FAX:	07 3316 3333
EMAIL:	Anna.Boden@ghd.com		
INVOICE:	Anna.Boden@ghd.com Sarah.Watkin@ghd.com		
DATA NEEDED BY:	ASAP		
REPORT FORMAT:			
EMAIL FORMAT:	ESDAT, EXCEL & PDF		

LABORATORY BATCH NO.:

FOR LAB USE ONLY

COOLER SEAL: Yes No ..... Broken Intact .....

COOLER TEMP: ..... deg.C

SENT TO: ALS Laboratory Group
26 Shand Street
Stafford, QLD 4053
07 3243 7222

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

Water samples and sediment samples (Background sampling)

(EMAIL ADDRESSES PROVIDED ABOVE)

ANALYSIS REQUIRED

SAMPLE ID	MATRIX	DATE	DETECTION LIMIT	PRESERVATION	Ultra trace nutrients (UTN - 04) (TP, RP, NH3, NO2, NO3, TKN, TN)	Chlorophyll-a (EP008)	Faecal (Thermotolerant) Coliforms (MF) (MW006)	TDS (EA015H)	TSS (EA025)										
WQ01	W	21-6-11	LOR	As Required															
WQ02	W	↓	LOR	As Required															
WQ03	W	↓	LOR	As Required															
WQ04	W	↓	LOR	As Required															
WQ05	W	↓	LOR	As Required															
QA1	W	↓	LOR	As Required															
			LOR	As Required															
			LOR	As Required															
			LOR	As Required															
			LOR	As Required															
			LOR	As Required															
			LOR	As Required															
			LOR	As Required															
			LOR	As Required															
			LOR	As Required															

URGENT

NOTES:

Freeze ultra trace nutrient samples upon receipt

Freeze water samples

RELINQUISHED BY:

NAME: Jody Kreuger DATE: 21-6-11

OF: GHD Brisbane TIME: 1215

RECEIVED BY:

NAME: [illegible] DATE: 22/06/11

OF: ALS TIME: [illegible]

PLEASE EMAIL COMPLETED ANALYSIS REQUEST TO: Anna.Boden@ghd.com

*Container Type and Preservative Codes: P = Neutral Plastic; N = Nitric Acid Preserved; C = Sodium Hydroxide Preserved; J = Solvent Washed Acid Rinced Jar; S = Solvent Washed Acid Rinced Glass Bottle; VC = Hydrochloric Acid Preserved Vial; VS = Sulfuric Acid Preserved Vial; BS = Sulfuric Acid Preserved Glass Bottle; Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; O = Other.

Chain of Custody & Analysis Request

Chain of Custody Number:

GHD Brisbane - 201 Charlotte Street, Brisbane 4000

PROJECT ID:	41/23244/14	QUOTE:	BN/505/10 V5
PROJECT:	Carmichael Coal Mine and Rail Project - Surface Water Quality Monitoring		
CLIENT:	GHD		
POSTAL ADDRESS:	GPO Box 668 Brisbane QLD 4000		
CONTACT:	Anna Boden		
PHONE:	07 3316 3525	FAX:	07 3316 3333
EMAIL:	Anna.Boden@ghd.com		
INVOICE:	Anna.Boden@ghd.com Sarah.Watkin@ghd.com		
DATA NEEDED BY:	ASAP		
REPORT FORMAT:			
EMAIL FORMAT:	ESDAT, EXCEL & PDF		

LABORATORY BATCH NO.:

FOR LAB USE ONLY

COOLER SEAL: Yes ...... No ...... Broken ...... Intact ......

COOLER TEMP: ...... deg.C

SENT TO: ALS Laboratory Group, 26 Shand Street, Stafford, QLD 4053, 07 3243 7222

Environmental Division Brisbane
Work Order
EB1112105
Telephone : +61-7-3243 7222

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

Water samples and sediment samples (Background sampling)

(EMAIL ADDRESSES PROVIDED ABOVE)

	SAMPLE ID	MATRIX	DATE	DETECTION LIMIT	PRESERVATION	Ultra trace nutrients (UTN - 04) (TP, RP, NH3, NO2, NO3, TKN, TN)	Chlorophyll-a (EP008)	Faecal (Thermotolerant) Coliforms (MF) (MW006)	TDS (EA015H)	TSS (EA025)
1	WQ09	Water	22/6/11	LOR	As Required	X	X	X	X	X
2	WQ08	↓	↓	LOR	As Required	X	X	X	X	X
3	WQ06	↓	↓	LOR	As Required	X	X	X	X	X
4	WQST	↓	↓	LOR	As Required	X	X	X	X	X
5	QA[illegible]2	↓	↓	LOR	As Required	X	X	X	X	X
	EXTRA SAMPLE			LOR	As Required					
6	DOONGABOOLA SPRING	W	22/6/11	LOR	As Required					
				LOR	As Required					
				LOR	As Required					
				LOR	As Required					
				LOR	As Required					
				LOR	As Required					
				LOR	As Required					
				LOR	As Required					
				LOR	As Required					

NOTES: FREEZE ULTRATRACE NUTRIENT SAMPLES UPON RECEIPT

SAMPLES ARE FRESHWATER.

URGENT

RELINQUISHED BY:		RECEIVED BY:	
NAME: Robert Coulson	DATE: 22/6/11	NAME:	DATE:
OF: GHD Brisbane	TIME: 1115	OF:	TIME:

PLEASE EMAIL COMPLETED ANALYSIS REQUEST TO: Anna.Boden@ghd.com

*Container Type and Preservative Codes: P = Neutral Plastic; N = Nitric Acid Preserved; C = Sodium Hydroxide Preserved; J = Solvent Washed Acid Rinced Jar; S = Solvent Washed Acid Rinced Glass Bottle; VC = Hydrochloric Acid Preserved Vial; VS = Sulfuric Acid Preserved Vial; BS = Sulfuric Acid Preserved Glass Bottle; Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; O = Other.

Chain of Custody & Analysis Request

Chain of Custody Number:

GHD Brisbane - 201 Charlotte Street, Brisbane 4000

PROJECT ID:	41/23244/14	QUOTE:	BN/505/10 V5
PROJECT:	Carmichael Coal Mine and Rail Project - Surface Water Quality Monitoring		
CLIENT:	GHD		
POSTAL ADDRESS:	GPO Box 668 Brisbane QLD 4000		
CONTACT:	Anna Boden		
PHONE:	07 3316 3525	FAX:	07 3316 3333
EMAIL:	Anna.Boden@ghd.com		
INVOICE:	Anna.Boden@ghd.com Juiie.Keane@ghd.com		
DATA NEEDED BY:	ASAP		
REPORT FORMAT:			
EMAIL FORMAT:	ESDAT, EXCEL & PDF		

LABORATORY BATCH NO.:

FOR LAB USE ONLY

COOLER SEAL: Yes / No ..... Broken / Intact .....

COOLER TEMP: ..... deg.C

SENT TO: ALS Laboratory Group, 26 Shand Street, Stafford, QLD 4053, 07 3243 7222

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

Water samples and sediment samples (Background sampling)

(EMAIL ADDRESSES PROVIDED ABOVE)

ANALYSIS REQUIRED

	SAMPLE ID	MATRIX	DATE	DETECTION LIMIT	PRESERVATION	Ultra trace nutrients (UTN - 04) (TP, RP, NH3, NO2, NO3, TKN, TN)	Chlorophyll-a (EP008)	Faecal (Thermotolerant) Coliforms (MF) (MW006)	TDS (EA015H)	TSS (EA025)	Dissolved Metals (W-3 and EG020F)	Total Metals (W-2T and EG020T)	TPH C6-C36 (EP071/080)	PAH (EP075B)	Fluoride - Soluble (EK040)	Major Cations (NT-1)	Major Anions (NT-2)	Dissolved Silicon (ED040F)	Hardness - Total (EA065)	
1	WQ01	W	26/7	LOR	As Required	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
2	WQ02	↓	↓	LOR	As Required	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
3	WQ03	↓	↓	LOR	As Required	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
4	WQ04	↓	↓	LOR	As Required	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
5	QA01	↓	↓	LOR	As Required	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
				LOR	As Required															
				LOR	As Required															
				LOR	As Required															
				LOR	As Required															
				LOR	As Required															
				LOR	As Required															
				LOR	As Required															
				LOR	As Required															
				LOR	As Required															
				LOR	As Required															

NOTES:

PLEASE FREEZE ULTRATRACE NUTRIENT SAMPLES IMMEDIATELY UPON RECIEPT

All samples freshwater

URGENT

Environmental Division Brisbane
Work Order
EB1114640
Telephone : +61-7-3243 7222

RELINQUISHED BY:
NAME: Robert Coulson DATE: 26/7/11
OF: GHD Brisbane TIME: 1230

RECEIVED BY:
NAME: OTO DATE: 27/07/11
OF: ALS TIME: 08:35

PLEASE EMAIL COMPLETED ANALYSIS REQUEST TO: Anna.Boden@ghd.com

*Container Type and Preservative Codes: P = Neutral Plastic; N = Nitric Acid Preserved; C = Sodium Hydroxide Preserved; J = Solvent Washed Acid Rinced Jar; S = Solvent Washed Acid Rinced Glass Bottle; VC = Hydrochloric Acid Preserved Vial; VS = Sulfuric Acid Preserved Vial; BS = Sulfuric Acid Preserved Glass Bottle; Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; O = Other.

Chain of Custody & Analysis Request

Chain of Custody Number:

GHD Brisbane - 201 Charlotte Street, Brisbane 4000

PROJECT ID:	41/23244/14	QUOTE:	BN/505/10 V5
PROJECT:	Carmichael Coal Mine and Rail Project - Surface Water Quality Monitoring		
CLIENT:	GHD		
POSTAL ADDRESS:	GPO Box 668 Brisbane QLD 4000		
CONTACT:	Anna Boden		
PHONE:	07 3316 3525	FAX:	07 3316 3333
EMAIL:	Anna.Boden@ghd.com		
INVOICE:	Anna.Boden@ghd.com Julie.Keane@ghd.com		
DATA NEEDED BY:	ASAP		
REPORT FORMAT:			
EMAIL FORMAT:	ESDAT, EXCEL & PDF		

LABORATORY BATCH NO.:

FOR LAB USE ONLY

COOLER SEAL: Yes ...... No ...... Broken ...... Intact ......

COOLER TEMP: ...... deg.C

SENT TO: ALS Laboratory Group
26 Shand Street
Stafford, QLD 4053
07 3243 7222

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

Water samples and sediment samples (Background sampling)

(EMAIL ADDRESSES PROVIDED ABOVE)

ANALYSIS REQUIRED

	SAMPLE ID	MATRIX	DATE	DETECTION LIMIT	PRESERVATION	Ultra trace nutrients (UTN - 04) (TP, RP, NH3, NO2, NO3, TKN, TN)	Chlorophyll-a (EP008)	Faecal (Thermotolerant) Coliforms (MF) (MW006)	TDS (EA015H)	TSS (EA025)	Dissolved Metals (W-3 and EG020F)	Total Metals (W-2T and EG020T)	TPH C6-C36 (EP071/080)	PAH (EP075B)	Fluoride - Soluble (EK040)	Major Cations (NT-1)	Major Anions (NT-2)	Dissolved Silicon (ED040F)	Hardness - Total (EA065)	
1	WQ09	W	27/7/11	LOR	As Required															
2	WQ08	↓	↓	LOR	As Required															
3	WQ06	↓	↓	LOR	As Required															
4	WQST	↓	↓	LOR	As Required															
5	QA02	↓	↓	LOR	As Required															
				LOR	As Required															
				LOR	As Required															
				LOR	As Required															
				LOR	As Required															
				LOR	As Required															
				LOR	As Required															
				LOR	As Required															
				LOR	As Required															
				LOR	As Required															
				LOR	As Required															

NOTES:
PLEASE FREEZE ULTRATRACE NUTRIENT SAMPLES IMMEDIATELY UPON RECEIPT

ALL SAMPLES FRESHWATER

URGENT

Environmental Division
Brisbane
Work Order
EB1114769

Telephone : +61-7-3243 7222

RELINQUISHED BY:
NAME: Robert Coulson DATE: 27/7/11
OF: GHD Brisbane TIME: 1230

RECEIVED BY:
NAME: [signature] DATE: 28/7
OF: ALS TIME: 8:35

PLEASE EMAIL COMPLETED ANALYSIS REQUEST TO: Anna.Boden@ghd.com

*Container Type and Preservative Codes: P = Neutral Plastic; N = Nitric Acid Preserved; C = Sodium Hydroxide Preserved; J = Solvent Washed Acid Rinced Jar; S = Solvent Washed Acid Rinced Glass Bottle; VC = Hydrochloric Acid Preserved Vial; VS = Sulfuric Acid Preserved Vial; BS = Sulfuric Acid Preserved Glass Bottle; Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; O = Other.

Chain of Custody & Analysis Request

Chain of Custody Number:

GHD Brisbane - 201 Charlotte Street, Brisbane 4000

PROJECT ID:	41/23244/14	QUOTE:	BN/505/10 V5
PROJECT:	Carmichael Coal Mine and Rail Project - Sediment		
CLIENT:	GHD		
POSTAL ADDRESS:	GPO Box 668 Brisbane QLD 4000		
CONTACT:	Anna Boden		
PHONE:	07 3316 3525	FAX:	07 3316 3333
EMAIL:	Anna.Boden@ghd.com		
INVOICE:	Anna.Boden@ghd.com Julie.Keane@ghd.com		
DATA NEEDED BY:	ASAP		
REPORT FORMAT:			
EMAIL FORMAT:	ESDAT, EXCEL & PDF		

LABORATORY BATCH NO.:

FOR LAB USE ONLY

COOLER SEAL: Yes ... No ...... Broken ... Intact ......

COOLER TEMP: ......deg.C

SENT TO: ALS Laboratory Group
26 Shand Street
Stafford, QLD 4053
07 3243 7222

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL: ATTN: Bryn Stephens / Dean Sullivan

Water samples and sediment samples (Background sampling)

(EMAIL ADDRESSES PROVIDED ABOVE)

ANALYSIS REQUIRED

	SAMPLE ID	MATRIX	DATE	DETECTION LIMIT	PRESERVATION	TOC (EP005)	PSD (EA150)	TPH (EP071/080)	PAH (EP075B)	Metals (S-2T) (EG020T) Al , As , Ba , Be , Cd , Co , Cr , Cu , Mn , Ni , Pb , V , Zn , Mo , Se , Ag , Sr , U , B , Fe	Total Faecal (MW008-S)	Nutrients (NT-8S) (EK071)								NOTES:
1	WQ01	Sed	26/7/11	LOR	As Required	X	X	X	X	X	X	X								
2	WQ02	Sed	↓	LOR	As Required	X	X	X	X	X	X	X								
3	WQ03	Sed	↓	LOR	As Required	X	X	X	X	X	X	X								
4	WQ04	Sed	↓	LOR	As Required	X	X	X	X	X	X	X								
5	WQ06	Sed	27/7/11	LOR	As Required	X	X	X	X	X	X	X								
6	WQ08	Sed	↓	LOR	As Required	X	X	X	X	X	X	X								
7	WQ09	Sed	↓	LOR	As Required	X	X	X	X	X	X	X								
8	WQ10	Sed	↓	LOR	As Required	X	X	X	X	X	X	X								
9	WQ11	Sed	↓	LOR	As Required	X	X	X	X	X	X	X								
10	WQ12	Sed	↓	LOR	As Required	X	X	X	X	X	X	X								
11	QA01	Sed	26/7/11	LOR	As Required	X		X	X	X	X	X								
12	QA02	Sed	27/7/11	LOR	As Required	X		X	X	X	X	X								
13	WQ5T	Sed	27/7/11	LOR	As Required	X	X	X	X	X	X	X								
		Sed		LOR	As Required															
		Sed		LOR	As Required															

Environmental Division
Brisbane
Work Order
EB1114957
Telephone : +61-7-3243 7222

RELINQUISHED BY:				RECEIVED BY:			
NAME:	R. Coulson	DATE:	28/7/11	NAME:	ROWAN MORRISON	DATE:	28/7/11
OF:	GHD Brisbane	TIME:	1400	OF:	ACIRL	TIME:	1400

PLEASE EMAIL COMPLETED ANALYSIS REQUEST TO: Anna.Boden@ghd.com

*Container Type and Preservative Codes: P = Neutral Plastic; N = Nitric Acid Preserved; C = Sodium Hydroxide Preserved; J = Solvent Washed Acid Rinced Jar; S = Solvent Washed Acid Rinced Glass Bottle; VC = Hydrochloric Acid Preserved Vial; VS = Sulfuric Acid Preserved Vial; BS = Sulfuric Acid Preserved Glass Bottle; Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; O = Other.

REC: ALS 29/07/11 10:25

Chain of Custody & Analysis Request

Chain of Custody Number:

GHD Brisbane - 201 Charlotte Street, Brisbane 4000

PROJECT ID:	41/23244/14	QUOTE:	BN/505/10 V5
PROJECT:	Carmichael Coal Mine and Rail Project - Surface Water Quality Monitoring		
CLIENT:	GHD		
POSTAL ADDRESS:	GPO Box 668 Brisbane QLD 4000		
CONTACT:	Anna Boden		
PHONE:	07 3316 3525	FAX:	07 3316 3333
EMAIL:	Anna.Boden@ghd.com		
INVOICE:	Anna.Boden@ghd.com Julie.Keane@ghd.com		
DATA NEEDED BY:	ASAP		
REPORT FORMAT:			
EMAIL FORMAT:	ESDAT, EXCEL & PDF		

LABORATORY BATCH NO.:

FOR LAB USE ONLY

COOLER SEAL: Yes ...... No ...... Broken ...... Intact ......

COOLER TEMP: ...... deg.C

SENT TO: ALS Laboratory Group
26 Shand Street
Stafford, QLD 4053
07 3243 7222

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL: ATTN Bryn Stephens / Dean Sullivan

Water samples and sediment samples (Background sampling)

(EMAIL ADDRESSES PROVIDED ABOVE)

NOTES:

DI Leach all samples

ANALYSIS REQUIRED

	SAMPLE ID	MATRIX	DATE	DETECTION LIMIT	PRESERVATION	Total Metals (EG020C-T) Al, As, Ba, Be, Cd, Co, Cr, Cu, Mn, Ni, Pb, V, Zn, Mo, Se, Ag, Sr, U, B, Fe	Dissolved Metals (EG020C-F) Al, As, Ba, Be, Cd, Co, Cr, Cu, Mn, Ni, Pb, V, Zn, Mo, Se, Ag, Sr, U, B, Fe	Fluoride- soluble (EK040)	Major Cations (NT-1)	Major Anions (NT-2)	Ultratrace nutrients (UTN-04)	TPH (C10-36) (EP071/080)	PAH (EP075B)
14	QA03	Sed	27/7/11	LOR	As Required	X	X	X	X	X	X	X	X
15	WQ10	Sed	↓	LOR	As Required	X	X	X	X	X	X	X	X
16	WQ11	Sed	↓	LOR	As Required	X	X	X	X	X	X	X	X
17	WQ12	Sed	↓	LOR	As Required	X	X	X	X	X	X	X	X
		Sed		LOR	As Required								
		Sed		LOR	As Required								
		Sed		LOR	As Required								
		Sed		LOR	As Required								
		Sed		LOR	As Required								
		Sed		LOR	As Required								
		Sed		LOR	As Required								
		Sed		LOR	As Required								
		Sed		LOR	As Required								
		Sed		LOR	As Required								
		Sed		LOR	As Required								

RELINQUISHED BY:		RECEIVED BY:	
NAME: Robert Coulson	DATE: 28/7/11	NAME: ROWAN MORRISON	DATE: 28/7/11
OF: GHD Brisbane	TIME: 1400	OF: ACIRL	TIME: 1400

PLEASE EMAIL COMPLETED ANALYSIS REQUEST TO: Anna.Boden@ghd.com

*Container Type and Preservative Codes: P = Neutral Plastic; N = Nitric Acid Preserved; C = Sodium Hydroxide Preserved; J = Solvent Washed Acid Rinced Jar; S = Solvent Washed Acid Rinced Glass Bottle; VC = Hydrochloric Acid Preserved Vial; VS = Sulfuric Acid Preserved Vial; BS = Sulfuric Acid Preserved Glass Bottle; Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; O = Other.

REC: ALS 29/07/11 10:25

Chain of Custody & Analysis Request

Chain of Custody Number:

GHD Brisbane - 201 Charlotte Street, Brisbane 4000

PROJECT ID:	41/23244/14	QUOTE:	BN/505/10 V5	LABORATORY BATCH NO.:	
PROJECT:	Carmichael Coal Mine and Rail Project - Surface Water Quality Monitoring			FOR LAB USE ONLY	
CLIENT:	GHD			COOLER SEAL	COOLER TEMP
POSTAL ADDRESS:	GPO Box 668 Brisbane QLD 4000			Yes / No	deg C
CONTACT:	Anna Boden			Broken / Intact	
PHONE:	07 3316 3525	FAX:	07 3316 3333	SENT TO:	ALS Laboratory Group
EMAIL:	Anna.Boden@ghd.com				26 Shand Street
INVOICE:	Anna.Boden@ghd.com Julie.Keane@ghd.com				Stafford, QLD 4053
					07 3243 7222
DATA NEEDED BY:	ASAP				
REPORT FORMAT:					
EMAIL FORMAT:	ESDAT, EXCEL & PDF				

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

Water samples and sediment samples (Background sampling)

(EMAIL ADDRESSES PROVIDED ABOVE)

ANALYSIS REQUIRED

	SAMPLE ID	MATRIX	DATE	DETECTION LIMIT	PRESERVATION	Ultra trace nutrients (UTN - 04) (TP, RP, NH3, NO2, NO3, TKN, TN)	Chlorophyll-a (EP008)	Faecal (Thermotolerant) Coliforms (MF) (MW006)	TDS (EA015H)	TSS (EA025)
1	WQ01	Water	23/08/2011	LOR	As Required	x	x	x	x	x
2	WQ02	Water	23/08/2011	LOR	As Required	x	x	x	x	x
3	WQ03	Water	23/08/2011	LOR	As Required	x	x	x	x	x
4	WQ04	Water	23/08/2011	LOR	As Required	x	x	x	x	x
5	QA01	Water	23/08/2011	LOR	As Required	x	x	x	x	x
				LOR	As Required					
				LOR	As Required					
				LOR	As Required					
				LOR	As Required					
				LOR	As Required					
				LOR	As Required					
				LOR	As Required					
				LOR	As Required					
				LOR	As Required					
				LOR	As Required					

NOTES:

PLEASE FREEZE ULTRA TRACE NUTRIENT SAMPLES IMMEDIATELY UPON RECEIPT

All samples freshwater

Environmental Division
Brisbane
Work Order
EB1117117
Telephone : +61-7-3243 7222

RELINQUISHED BY:		RECEIVED BY:	
NAME: Robert Coulson	DATE: 23/8/11	NAME: C. Bryant	DATE: 24-8-11.
OF: GHD Brisbane	TIME: 1200	OF: ALS	TIME: 1700

PLEASE EMAIL COMPLETED ANALYSIS REQUEST TO: Anna.Boden@ghd.com

*Container Type and Preservative Codes: P = Neutral Plastic; N = Nitric Acid Preserved; C = Sodium Hydroxide Preserved; J = Solvent Washed Acid Rinced Jar; S = Solvent Washed Acid Rinced Glass Bottle; VC = Hydrochloric Acid Preserved Vial; VS = Sulfuric Acid Preserved Vial; BS = Sulfuric Acid Preserved Glass Bottle; Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; O = Other.

GHD

Chain of Custody & Analysis Request

Chain of Custody Number:

Environmental Division
Brisbane
Work Order
EB1117183

Telephone : + 61-7-3243 7222

GHD Brisbane - 201 Charlotte Street, Brisbane 4000

PROJECT ID:	41/23244/14	QUOTE:	BN/505/10 V5
PROJECT:	Carmichael Coal Mine and Rail Project - Surface Water Quality Monitoring		
CLIENT:	GHD		
POSTAL ADDRESS:	GPO Box 668 Brisbane QLD 4000		
CONTACT:	Anna Boden		
PHONE:	07 3316 3525	FAX:	07 3316 3333
EMAIL:	Anna.Boden@ghd.com		
INVOICE:	Anna.Boden@ghd.com Sarah.Watkin@ghd.com		
DATA NEEDED BY:	ASAP		
REPORT FORMAT:			
EMAIL FORMAT:	ESDAT, EXCEL & PDF		

LABORATORY BATCH NO.:

FOR LAB USE ONLY

COOLER SEAL: Yes No Broken Intact

SENT TO: ALS Laboratory Group, 26 Shand Street, Stafford, QLD 4053, 07 3243 7222

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

Water samples and sediment samples (Background sampling)

(EMAIL ADDRESSES PROVIDED ABOVE)

ANALYSIS REQUIRED

	SAMPLE ID	MATRIX	DATE	DETECTION LIMIT	PRESERVATION	Ultra trace nutrients (UTN - 04) (TP, RP, NH3, NO2, NO3, TKN, TN)	Chlorophyll-a (EP008)	Faecal (Thermotolerant) Coliforms (MF) (MW006)	TDS (EA015H)	TSS (EA025)
1	QA02	W	24/8/11	LOR	As Required	X	X	X	X	X
2	WQ09	↓	↓	LOR	As Required	X	X	X	X	X
3	WQ08	↓	↓	LOR	As Required	X	X	X	X	X
4	WQ06	↓	↓	LOR	As Required	X	X	X	X	X
5	WQ05	↓	↓	LOR	As Required	X	X	X	X	X
6	WQST	↓	↓	LOR	As Required	X	X	X	X	X
				LOR	As Required					
				LOR	As Required					
				LOR	As Required					
				LOR	As Required					
				LOR	As Required					
				LOR	As Required					
				LOR	As Required					
				LOR	As Required					
				LOR	As Required					

NOTES:

Please FREEZE ultratrace nutrients upon reciept

All samples are freshwater

URGENT HT

RELINQUISHED BY:		RECEIVED BY:	
NAME: Robert Coulson	DATE: 24/8/11	NAME: [illegible]	DATE: 25/08/11
OF: GHD Brisbane	TIME: 12:30pm	OF: ALS	TIME: 08:00

PLEASE EMAIL COMPLETED ANALYSIS REQUEST TO: Anna.Boden@ghd.com

*Container Type and Preservative Codes: P = Neutral Plastic; N = Nitric Acid Preserved; C = Sodium Hydroxide Preserved; J = Solvent Washed Acid Rinced Jar; S = Solvent Washed Acid Rinced Glass Bottle; VC = Hydrochloric Acid Preserved Vial; VS = Sulfuric Acid Preserved Vial; BS = Sulfuric Acid Preserved Glass Bottle; Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; O = Other.

Chain of Custody & Analysis Request

Chain of Custody Number:

Environmental Division Brisbane
Work Order
EB1119345

_ of _1_

Telephone : +61-7-3243 7222

GHD Brisbane - 201 Charlotte Street, Brisbane 4000

PROJECT ID:	41/23244/14	QUOTE:	BN/505/10 V5
PROJECT:	Carmichael Coal Mine and Rail Project - Surface Water Quality Monitoring		
CLIENT:	GHD		
POSTAL ADDRESS:	GPO Box 668 Brisbane QLD 4000		
CONTACT:	Anna Boden		
PHONE:	07 3316 3525	FAX:	07 3316 3333
EMAIL:	Anna.Boden@ghd.com		
INVOICE:	Anna.Boden@ghd.com Julie.Keane@ghd.com		
DATA NEEDED BY:	ASAP		
REPORT FORMAT:			
EMAIL FORMAT:	ESDAT, EXCEL & PDF		

LABORATORY BATCH NO.: FOR LAB USE ONLY
COOLER SEAL: Yes No Broken Intact

SENT TO: ALS Laboratory Group
26 Shand Street
Stafford, QLD 4053
07 3243 7222

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

Water samples and sediment samples (Background sampling)

(EMAIL ADDRESSES PROVIDED ABOVE)

ANALYSIS REQUIRED

	SAMPLE ID	MATRIX	DATE	DETECTION LIMIT	PRESERVATION	Ultra trace nutrients (UTN - 04) (TP, RP, NH3, NO2, NO3, TKN, TN)	Chlorophyll-a (EP008)	Faecal (Thermotolerant) Coliforms (MF) (MW006)	TDS (EA015H)	TSS (EA025)	Dissolved Metals (W-3 and EG020F)	Total Metals (W-3T and EG020T)	TPH C6-C36 (EP071/080)	PAH (EP075B)	Fluoride - Soluble (EK040)	Major Cations (NT-1)	Major Anions (NT-2)	Dissolved Silicon (ED040F)	Hardness - Total (EA065)
1	WQ01	w	20/09/2011	LOR	As Required	x	x	x	x	x	x	x	x	x	x	x	x	x	x
2	WQ02	w	20/09/2011	LOR	As Required	x	x	x	x	x	x	x	x	x	x	x	x	x	x
3	WQ03	w	20/09/2011	LOR	As Required	x	x	x	x	x	x	x	x	x	x	x	x	x	x
4	WQ04	w	20/09/2011	LOR	As Required	x	x	x	x	x	x	x	x	x	x	x	x	x	x
5	WQ05	w	20/09/2011	LOR	As Required	x	x	x	x	x	x	x	x	x	x	x	x	x	x
6	WQ06	w	20/09/2011	LOR	As Required	x	x	x	x	x	x	x	x	x	x	x	x	x	x
7	WQST	w	20/09/2011	LOR	As Required	x	x	x	x	x	x	x	x	x	x	x	x	x	x
8	QA01	w	20/09/2011	LOR	As Required	x	x	x	x	x	x	x	x	x	x	x	x	x	x
				LOR	As Required														
				LOR	As Required														
				LOR	As Required														
				LOR	As Required														
				LOR	As Required														
				LOR	As Required														
				LOR	As Required														

NOTES:

PLEASE FREEZE ULTRA TRACE NUTRIENT SAMPLES IMMEDIATELY UPON RECEIPT

All samples freshwater

HT

URGENT

RELINQUISHED BY:		RECEIVED BY:	
NAME : Robert Coulson	DATE: 20/9/11	NAME : OTO [illegible]	DATE: 21/09/11
OF: GHD Brisbane	TIME: 1200	OF: AJ	TIME: 08:15

PLEASE EMAIL COMPLETED ANALYSIS REQUEST TO: Anna.Boden@ghd.com

*Container Type and Preservative Codes: P = Neutral Plastic; N = Nitric Acid Preserved; C = Sodium Hydroxide Preserved; J = Solvent Washed Acid Rinced Jar; S = Solvent Washed Acid Rinced Glass Bottle; VC = Hydrochloric Acid Preserved Vial; VS = Sulfuric Acid Preserved Vial; BS = Sulfuric Acid Preserved Glass Bottle; Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; O = Other.

Chain of Custody & Analysis Request

Chain of Custody Number:

GHD Brisbane - 201 Charlotte Street, Brisbane 4000

PROJECT ID:	41/23244/14	QUOTE:	BN/505/10 V5	LABORATORY BATCH NO.:
PROJECT:	Carmichael Coal Mine and Rail Project - Surface Water Quality Monitoring			FOR LAB USE ONLY
CLIENT:	GHD			COOLER SEAL: Yes / No ...... Broken / Intact ...... — COOLER TEMP: ..... deg.C
POSTAL ADDRESS:	GPO Box 668 Brisbane QLD 4000			
CONTACT:	Anna Boden			
PHONE:	07 3316 3525	FAX:	07 3316 3333	SENT TO: ALS Laboratory Group, 26 Shand Street, Stafford, QLD 4053, 07 3243 7222
EMAIL:	Anna.Boden@ghd.com			
INVOICE:	Anna.Boden@ghd.com Julie.Keane@ghd.com			
DATA NEEDED BY:	ASAP			
REPORT FORMAT:				
EMAIL FORMAT:	ESDAT, EXCEL & PDF			

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

Water samples and sediment samples (Background sampling)

(EMAIL ADDRESSES PROVIDED ABOVE)

ANALYSIS REQUIRED

SAMPLE ID	MATRIX	DATE	DETECTION LIMIT	PRESERVATION	Ultra trace nutrients (UTN - 04) (TP, RP, NH3, NO2, NO3, TKN, TN)	Chlorophyll-a (EP008)	Faecal (Thermotolerant) Coliforms (MF) (MW006)	TDS (EA015H)	TSS (EA025)	Dissolved Metals (W-3 and EG020F)	Total Metals (W-2T and EG020T)	TPH C6-C36 (EP071/080)	PAH (EP075B)	Fluoride - Soluble (EK040)	Major Cations (NT-1)	Major Anions (NT-2)	Dissolved Silicon (ED040F)	Hardness - Total (EA065)	
QA01	W	20/9/11	LOR	As Required	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
WQ01	↓	↓	LOR	As Required	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
WQ02	↓	↓	LOR	As Required	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
WQ03	↓	↓	LOR	As Required	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
WQ04	↓	↓	LOR	As Required	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
WQ05	↓	↓	LOR	As Required	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
WQ06	↓	↓	LOR	As Required	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
WQST	↓	↓	LOR	As Required	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
			LOR	As Required															
			LOR	As Required															
			LOR	As Required															
			LOR	As Required															
			LOR	As Required															
			LOR	As Required															
			LOR	As Required															

NOTES:

PLEASE FREEZE ULTRATRACE NUTRIENT SAMPLES IMMEDIATELY UPON RECEIPT

ALL SAMPLES FRESHWATER

SUPERCEDED

RELINQUISHED BY:		RECEIVED BY:	
NAME: Robert Coulson	DATE: 20-9-11	NAME:	DATE:
OF: GHD Brisbane	TIME: 1230	OF:	TIME:

PLEASE EMAIL COMPLETED ANALYSIS REQUEST TO: Anna.Boden@ghd.com

*Container Type and Preservative Codes: P = Neutral Plastic; N = Nitric Acid Preserved; C = Sodium Hydroxide Preserved; J = Solvent Washed Acid Rinced Jar; S = Solvent Washed Acid Rinced Glass Bottle; VC = Hydrochloric Acid Preserved Vial; VS = Sulfuric Acid Preserved Vial; BS = Sulfuric Acid Preserved Glass Bottle; Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; O = Other.

GHD

Chain of Custody & Analysis Request

Chain of Custody Number:

Environmental Division
Brisbane
Work Order
EB1119508

Telephone : + 61-7-3243 7222

GHD Brisbane - 201 Charlotte Street, Brisbane 4000

PROJECT ID:	41/23244/14	QUOTE:	BN/505/10 V5	LABORATORY BATCH NO.:	
PROJECT:	Carmichael Coal Mine and Rail Project - Surface Water Quality Monitoring			FOR LAB USE ONLY	
CLIENT:	GHD			COOLER SEAL:	
POSTAL ADDRESS:	GPO Box 668 Brisbane QLD 4000			Yes	No ......
CONTACT:	Anna Boden			Broken	Intact ......
PHONE:	07 3316 3525	FAX:	07 3316 3333	SENT TO:	ALS Laboratory Group
EMAIL:	Anna.Boden@ghd.com				26 Shand Street
INVOICE:	Anna.Boden@ghd.com Julie.Keane@ghd.com				Stafford, QLD 4053
					07 3243 7222

DATA NEEDED BY: ASAP

REPORT FORMAT:

EMAIL FORMAT: ESDAT, EXCEL & PDF

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

Water samples and sediment samples (Background sampling)

(EMAIL ADDRESSES PROVIDED ABOVE)

ANALYSIS REQUIRED

	SAMPLE ID	MATRIX	DATE	DETECTION LIMIT	PRESERVATION	Ultra trace nutrients (UTN - 04) (TP, RP, NH3, NO2, NO3, TKN, TN)	Chlorophyll-a (EP008)	Faecal (Thermotolerant) Coliforms (MF) (MW006)	TDS (EA015H)	TSS (EA025)	Dissolved Metals (W-3 and EG020F)	Total Metals (W-2T and EG020T)	TPH C6-C36 (EP071/080)	PAH (EP075B)	Fluoride - Soluble (EK040)	Major Cations (NT-1)	Major Anions (NT-2)	Dissolved Silicon (ED040F)	Hardness - Total (EA065)	
1	QA02	W	21-9-11	LOR	As Required	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
2	WQ08	↓	↓	LOR	As Required	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
3	WQ09	↓	↓	LOR	As Required	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
				LOR	As Required															
				LOR	As Required															
				LOR	As Required															
				LOR	As Required															
				LOR	As Required															
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				LOR	As Required															
				LOR	As Required															
				LOR	As Required															

NOTES:

PLEASE FREEZE ULTRATRACE NUTRIENTS IMMEDIATELY UPON RECEIPT

ALL SAMPLES FRESHWATER

RELINQUISHED BY:				RECEIVED BY:			
NAME:	Robert Coulson	DATE:	21-9-11	NAME:	OTO	DATE:	22/09/11
OF:	GHD Brisbane	TIME:	12:1 pm	OF:	ALS	TIME:	08:40

PLEASE EMAIL COMPLETED ANALYSIS REQUEST TO: Anna.Boden@ghd.com

URGENT

*Container Type and Preservative Codes: P = Neutral Plastic; N = Nitric Acid Preserved; C = Sodium Hydroxide Preserved; J = Solvent Washed Acid Rinced Jar; S = Solvent Washed Acid Rinced Glass Bottle; VC = Hydrochloric Acid Preserved Vial; VS = Sulfuric Acid Preserved Vial; BS = Sulfuric Acid Preserved Glass Bottle; Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; O = Other.

Appendix C

Quality Assurance/Quality Control Results

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1. Quality Assurance/Quality Control Results

Australian Laboratory Services (ALS) was engaged to carry out chemical analysis of water and sediment samples. ALS is a NATA accredited laboratory, and perform Quality Assurance (QA) and Quality Control (QC) procedures to support this certification.

Field duplicate samples were collected (QA01, QA02, QA03) in order to audit laboratory QA/QC procedures. The identity of the parent sample remained anonymous to the laboratory.

Field Duplicates

Results from the primary sample and the corresponding anonymous field duplicate generally exhibited a relatively good correlation across analytes. This indicates a high degree of precision and reliability from the laboratory. Correlation was measured by the Relative Percent Difference (RPD) between the primary sample result and the field duplicate result. A RPD between 0 – 50 % was considered a reliable indication of laboratory accuracy. Samples with a RPD greater than 50 % are identified in Table 1. Some of the large RPDs occurred due to the sample result being below the LOR.

Table 1 Field Duplicate samples with RPD > 50 %

Work Order	Sample Date	Analyte	EQL / LOR	Sample ID	Field Duplicate	RPD
EB1108606	4/05/2011			WQ09	QA01	
		Nitrate (as N) (mg/L)	0.002	0.002	0.004	67
		Aluminium (mg/L)	0.01	0.09	0.04	77
		Copper (mg/L)	0.001	<0.001	0.004	120
		Managanese (filtered) (mg/L)	0.001	0.002	0.001	67
		Zinc (mg/L)	0.005	0.012	<0.005	82
EB1114769	27/07/2011			WQ09	QA02	
		Nitrate (as N) (mg/L)	0.002	0.008	0.003	91
		Arsenic (mg/L)	0.001	0.002	0.001	67
EB1114640	26/07/2011			WQ04	QA01	
		Reactive Phosphorus as P (mg/L)	0.001	0.004	0.002	67
EB1114957 (soil)	26/07/2011			WQ04	QA01	
		Kjeldahl Nitrogen Total (mg/kg)	20	90	150	50
		Nitrogen Total (mg/kg)	20	90	150	50
		Aluminium (mg/kg)	50	1200	2010	50

Work Order	Sample Date	Analyte	EQL / LOR	Sample ID	Field Duplicate	RPD
		Uranium (mg/kg)	0.1	0.1	0.2	67
EB1114957 (soil)	27/07/2011 1			WQ09	QA02	
		TOC (%)	0.02	0.47	1.07	78
		lead (mg/kg)	0.1	6.2	2.8	76
		Arsenic (mg/kg)	0.1	1.1	0.6	59
		Vanadium (mg/kg)	1	22	13	51
EB1114957 (elutriate)	27/07/2011			WQ12	QA03	
		Kjeldahl Nitrogren Total (mg/L)	0.01	0.03	0.05	50
		Lead (mg/L)	0.001	0.002	0.001	67
		Lead (leached) (mg/L)	0.001	0.002	0.001	67
		Iron (mg/L)	0.05	2.43	1.33	59
		Nickel (mg/L)	0.001	0.002	0.001	67
EB1117117	23/08/2011			WQ04	QA01	
		Chlorophyll a (mg/m3)	1	2	1	67
EB1119345	20/09/2011			WQ04	QA01	
		Chlorophyll a (mg/m3)	1	1	2	67
		Chromium (III+VI) (Filtered) (mg/L)	0.001	0.002	0.001	67
		Copper (mg/L)	0.001	0.001	0.002	67
		Nickel (mg/L)	0.001	0.002	0.001	67
		Zinc (Filtered) (mg/L)	0.005	0.04	0.012	108

Holding Time Compliance for Analysis

Some samples from Event 1 (April) and Event 4 (July) were extracted and/or analysed between one and five days past analysis holding times (Table 2).

Table 2 Laboratory Analysis Holding Time Breaches

				Extraction/Preparation			Analysis		
Work Order	Date Sampled	Sample ID	Analysis	Due for extraction	Date extracted	Days overdue	Due for analysis	Date analysed	Days overdue
EB1107452	14/04/2011	WQ01 WQ06 WQ08 WQ09 QA02	Chlorophyll a & Pheophytin a	-	-	-	18/04/2011	15/04/2011	3
EB1107452	14/04/2011	WQ01 WQ06 WQ08 WQ09 QA02	Ultra-trace Nutrients	18/04/2011	15/04/2011	3	18/04/2011	15/04/2011	3
EB1114769	27/07/2011	WQ06 WQ08 WQ09 WQST QA02	Chlorophyll a & Pheophytin a	-	-	-	29/07/2011	1/08/2011	3
EB1114957 (soil)	26/07/2011	WQ01 WQ02 WQ03 WQ04 QA01	Faecal coliforms & E.coli by MPN	-	-	-	28/07/2011	2/08/2011	5

				Extraction/Preparation			Analysis		
Work Order	**Date Sampled**	**Sample ID**	**Analysis**	**Due for extraction**	**Date extracted**	**Days overdue**	**Due for analysis**	**Date analysed**	**Days overdue**
EB1114957 (soil)	27/07/2011	WQ06 WQ08 WQ09 WQ10 WQ11 WQ12 WQST QA02	Faecal coliforms & E.coli by MPN	-	-	-	29/07/2011	2/08/2011	4
EB1114957 (soil)	27/07/2011	WQ10 WQ11 WQ12 QA03	Ultra-trace nutrients	4/08/2011	5/08/2011	1	4/08/2011	5/08/2011	1

Quality Control Samples

Quality control samples included laboratory duplicates, method blanks, laboratory control samples, matrix spikes, and regular sample surrogates. The majority of control sample matrix spikes were able to be determined, and almost all remained within the spike recovery limits. Quality control sample outliers are shown below (Table 3).

Table 3 Laboratory Quality Control Samples with Outliers

Laboratory Quality Control Samples	Work Order	Matrix	Sample ID	Analyte	Data	Limits	Comment
Duplicate RPDs	EB1114957	Soil	QA01	Total Phosphorus as P	40.40%	0 - 20 %	RPD exceed LOR based limits
Duplicate RPDs	EB1114957	Soil	WQ02	Total Phosphorus as P	59%	0 - 20 %	RPD exceed LOR based limits
Laboratory Control Spike (LCS) recoveries	EB1114957	Soil	-	Fluoranthene	119%	64 - 111%	Recovery greater than upper control limit
Regular Sample Surrogates	EB1114957	Soil	WQ12	PAH surrogate 4-Terphenyl-d14	190%	41.8 - 172.2%	Recovery greater than upper data quality objective

Appendix D

Laboratory results

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Table C1 Water Results – Biological Analyses, Major Ions and Physical Parameters and Nutrients

Sampling Event	Field ID	Location Code	Sampling Date	Work Order	Chlorophyll a	Faecal Coliforms	Alkalinity (Hydroxide) as CaCO3	Alkalinity (total) as CaCO3	Anions Total	Bicarbonate as CaCO3	Cations Total	Chloride	Fluoride	Ionic Balance	Silica	TDS	Hardness as CaCO3	TSS	Ammonia as N	Kjeldahl Nitrogen Total	Nitrate (as N)	Nitrite (as N)	Nitrogen (Total)	Reactive Phosphorus as P	Sulphate (Filtered)
					Biological		Major Ions and Physcial Parameters												Nutrients						
					mg/m³	CFU/100mL	µg/L	mg/L	meq/L	mg/L	meq/L	mg/L	mg/L	%	µg/L	mg/L	mg/L	mg/L	µg/L	mg/L	mg/L	mg/L	µg/L	mg/L	mg/L
Laboratory Limit of Reporting					1	1	1000	1	0.01	1	0.01	1	0.1	0.01	100	5	1	5	5	0.01	0.002	0.002	10	0.001	1
Event 1	QA01	WQ04	13/04/2011	EB1107318	<1	80	-	-	-	-	-	-	-	-	-	505	-	104	8	0.48	0.129	0.002	610	<0.001	-
	WQ02	WQ02	13/04/2011	EB1107318	1	500	-	-	-	-	-	-	-	-	-	604	-	86	<5	0.49	0.133	<0.002	630	<0.001	-
	WQ03	WQ03	13/04/2011	EB1107318	2	170	-	-	-	-	-	-	-	-	-	597	-	73	<5	0.47	0.129	<0.002	600	<0.001	-
	WQ04	WQ04	13/04/2011	EB1107318	1	200	-	-	-	-	-	-	-	-	-	508	-	112	7	0.57	0.128	0.003	700	<0.001	-
	WQ05	WQ05	13/04/2011	EB1107318	17	500	-	-	-	-	-	-	-	-	-	103	-	38	<5	0.88	0.01	<0.002	890	<0.001	-
	WQST	WQST	13/04/2011	EB1107318	16	830	-	-	-	-	-	-	-	-	-	136	-	82	<5	1.53	<0.002	<0.002	1530	0.027	-
	QA02	QA02	14/04/2011	EB1107452	10	1400	-	-	-	-	-	-	-	-	-	58	-	66	388	2.52	0.004	<0.002	2530	0.018	-
	WQ01	WQ01	14/04/2011	EB1107452	1	100	-	-	-	-	-	-	-	-	-	536	-	121	9	0.56	0.145	<0.002	700	0.005	-
	WQ06	WQ06	14/04/2011	EB1107452	4	2000	-	-	-	-	-	-	-	-	-	291	-	176	56	0.79	0.035	<0.002	830	0.009	-
	WQ08	WQ08	14/04/2011	EB1107452	11	1100	-	-	-	-	-	-	-	-	-	76	-	72	419	2.6	0.005	<0.002	2610	0.017	-
	WQ09	WQ09	14/04/2011	EB1107452	18	<2	-	-	-	-	-	-	-	-	-	88	-	15	157	2.26	0.011	0.004	2270	0.02	-
Event 2	QA01	QA01	4/05/2011	EB1108606	52	-	<1000	44	1.02	44	0.93	5	<0.1	-	26,600	99	27	20	774	2.33	0.004	0.005	2340	0.015	<1
	WQ06	WQ06	4/05/2011	EB1108606	4	-	<1000	57	1.48	57	1.45	10	0.2	-	23,100	285	41	68	<5	0.53	0.06	0.003	590	0.011	3
	WQ08	WQ08	4/05/2011	EB1108606	17	1800	<1000	20	0.51	20	0.47	4	<0.1	-	11,700	64	9	33	482	1.92	0.008	0.005	1930	0.006	<1
	WQ09	WQ09	4/05/2011	EB1108606	41	-	<1000	44	1	44	0.9	5	<0.1	-	25,700	88	27	31	774	2.18	0.002	0.005	2190	0.016	<1
	QA02	QA02	5/05/2011	EB1108729	<1	150	<1000	97	-	-	-	252	0.3	-	-	624	82	17	<5	0.18	0.065	0.002	250	0.008	8
	WQ01	WQ01	5/05/2011	EB1108729	<1	10	<1000	324	-	-	-	247	0.4	-	-	630	82	28	<5	0.2	0.147	0.003	350	0.007	9
	WQ02	WQ02	5/05/2011	EB1108729	2	290	<1000	318	-	-	-	252	0.3	-	-	601	79	17	<5	0.19	0.077	0.002	260	0.007	8
	WQ03	WQ03	5/05/2011	EB1108729	2	150	<1000	314	-	-	-	248	0.3	-	-	603	82	19	<5	0.2	0.034	0.002	230	0.006	8
	WQ04	WQ04	5/05/2011	EB1108729	2	2000	<1000	331	-	-	-	248	0.3	-	-	611	82	42	<5	0.29	0.034	<0.002	320	0.007	8
	WQST	WQST	5/05/2011	EB1108729	12	-	<1000	261	-	-	-	4	<0.1	-	-	181	44	267	<5	1.53	<0.002	<0.002	1530	0.008	<1
Event 3	QA01	WQ01	21/06/2011	EB1111938	4	60	-	-	-	-	-	-	-	-	-	557	-	<5	6	0.16	0.043	<0.002	200	0.006	-
	WQ01	WQ01	21/06/2011	EB1111938	2	50	-	-	-	-	-	-	-	-	-	557	-	22	6	0.2	0.054	<0.002	250	0.006	-
	WQ02	WQ02	21/06/2011	EB1111938	1	40	-	-	-	-	-	-	-	-	-	590	-	<5	132	0.12	0.016	<0.002	140	0.017	-
	WQ03	WQ03	21/06/2011	EB1111938	<1	60	-	-	-	-	-	-	-	-	-	583	-	<5	<5	0.12	0.005	<0.002	120	0.004	-
	WQ04	WQ04	21/06/2011	EB1111938	<1	30	-	-	-	-	-	-	-	-	-	590	-	14	<5	0.15	0.002	<0.002	150	0.005	-
	WQ05	WQ05	21/06/2011	EB1111938	19	50	-	-	-	-	-	-	-	-	-	92	-	111	14	0.83	0.004	<0.002	830	0.01	-
	QA02	WQ09	22/06/2011	EB1112105	55	110	-	-	-	-	-	-	-	-	-	92	-	22	46	2.47	0.04	0.006	2520	0.009	-

Sampling Event	Field ID	Location Code	Sampling Date	Work Order	Chlorophyll a	Faecal Coliforms	Alkalinity (Hydroxide) as CaCO3	Alkalinity (total) as CaCO3	Anions Total	Bicarbonate as CaCO3	Cations Total	Chloride	Fluoride	Ionic Balance	Silica	TDS	Hardness as CaCO3	TSS	Ammonia as N	Kjeldahl Nitrogen Total	Nitrate (as N)	Nitrite (as N)	Nitrogen (Total)	Reactive Phosphorus as P	Sulphate (Filtered)
					Biological		**Major Ions and Physcial Parameters**												**Nutrients**						
					mg/m³	CFU/100mL	µg/L	mg/L	meq/L	mg/L	meq/L	mg/L	mg/L	%	µg/L	mg/L	mg/L	mg/L	µg/L	mg/L	mg/L	mg/L	µg/L	mg/L	mg/L
				Laboratory Limit of Reporting	1	1	1000	1	0.01	1	0.01	1	0.1	0.01	100	5	1	5	5	0.01	0.002	0.002	10	0.001	1
	WQ06	WQ06	22/06/2011	EB1112105	3	68	-	-	-	-	-	-	-	-	-	228	-	196	76	0.7	0.076	<0.002	780	0.012	-
	WQ08	WQ08	22/06/2011	EB1112105	13	48	-	-	-	-	-	-	-	-	-	90	-	46	69	2.14	0.061	0.008	2210	0.011	-
	WQ09	WQ09	22/06/2011	EB1112105	64	140	-	-	-	-	-	-	-	-	-	100	-	29	48	2.46	0.042	0.006	2510	0.014	-
	WQST	WQST	22/06/2011	EB1112105	17	370	-	-	-	-	-	-	-	-	-	163	-	38	<5	2.11	0.004	<0.002	2110	0.01	-
Event 4	QA01	WQ04	26/07/2011	EB1114640	3	200	<1000	168	13.9	-	12.6	364	0.4	4.96	-	715	103	9	<5	0.23	<0.002	<0.002	230	0.002	14
	WQ01	WQ01	26/07/2011	EB1114640	4	100	<1000	160	12.7	-	11.6	326	0.4	4.67	-	711	93	9	<5	0.28	<0.002	<0.002	280	0.011	14
	WQ02	WQ02	26/07/2011	EB1114640	4	200	<1000	160	12.7	-	11.9	328	0.4	3.52	-	658	93	7	<5	0.23	0.004	<0.002	230	0.006	13
	WQ03	WQ03	26/07/2011	EB1114640	3	200	<1000	166	13.1	-	11.9	337	0.4	4.95	-	593	97	8	<5	0.22	<0.002	<0.002	220	0.005	14
	WQ04	WQ04	26/07/2011	EB1114640	4	20	<1000	170	13.9	-	12.6	361	0.4	4.98	-	703	103	9	<5	0.24	<0.002	<0.002	240	0.004	14
	QA02	WQ09	27/07/2011	EB1114769	26	28	<1000	36	0.89	-	1.01	6	<0.1	-	-	85	27	18	65	2.16	0.003	0.002	2170	0.015	<1
	WQ06	WQ06	27/07/2011	EB1114769	2	36	<1000	63	1.62	-	1.64	10	0.2	-	-	268	48	59	13	0.61	0.022	0.005	640	0.012	4
	WQ08	WQ08	27/07/2011	EB1114769	10	24	<1000	17	0.48	-	0.39	5	<0.1	-	-	31	5	29	411	1.92	0.118	0.016	2050	0.011	<1
	WQ09	WQ09	27/07/2011	EB1114769	19	64	<1000	37	0.91	-	1.01	6	<0.1	-	-	104	27	17	62	2.14	0.008	0.002	2150	0.016	<1
	WQST	WQST	27/07/2011	EB1114769	14	110	<1000	84	1.85	-	1.85	6	<0.1	-	-	149	50	45	<5	2.7	<0.002	<0.002	2700	0.013	<1
Event 5	QA01	WQ04	23/08/2011	EB1117117	1	100	-	-	-	-	-	-	-	-	-	950	-	18	<5	0.33	<0.002	<0.002	330	0.002	-
	WQ01	WQ01	23/08/2011	EB1117117	4	90	-	-	-	-	-	-	-	-	-	932	-	<5	<5	0.25	<0.002	<0.002	250	0.002	-
	WQ02	WQ02	23/08/2011	EB1117117	1	140	-	-	-	-	-	-	-	-	-	960	-	<5	<5	0.35	0.002	<0.002	350	0.002	-
	WQ03	WQ03	23/08/2011	EB1117117	1	74	-	-	-	-	-	-	-	-	-	894	-	<5	<5	0.24	<0.002	<0.002	240	0.001	-
	WQ04	WQ04	23/08/2011	EB1117117	2	60	-	-	-	-	-	-	-	-	-	954	-	25	<5	0.27	<0.002	<0.002	270	0.002	-
	QA02	WQ09	24/08/2011	EB1117183	24	40	-	-	-	-	-	-	-	-	-	117	-	17	<5	2.15	<0.002	<0.002	2150	0.012	-
	WQ05	WQ05	24/08/2011	EB1117183	8	30	-	-	-	-	-	-	-	-	-	234	-	14	56	1.42	0.004	0.003	1430	0.007	-
	WQ06	WQ06	24/08/2011	EB1117183	3	20	-	-	-	-	-	-	-	-	-	378	-	32	12	0.67	0.018	<0.002	690	0.007	-
	WQ08	WQ08	24/08/2011	EB1117183	32	30	-	-	-	-	-	-	-	-	-	129	-	32	20	1.94	0.054	0.014	2010	0.009	-
	WQ09	WQ09	24/08/2011	EB1117183	28	90	-	-	-	-	-	-	-	-	-	136	-	18	<5	2.16	<0.002	<0.002	2160	0.012	-
	WQST	WQST	24/08/2011	EB1117183	20	20	-	-	-	-	-	-	-	-	-	240	-	47	<5	2.8	<0.002	0.002	2800	0.011	-
Event 6	QA01	WQ04	20/09/2011	EB1119345	2	46	<1000	162	12.5	-	12	323	0.4	1.92	-	678	93	25	<5	0.28	<0.002	<0.002	280	0.003	7
	WQ01	WQ01	20/09/2011	EB1119345	<1	74	<1000	172	12.6	-	12.4	318	0.4	1.07	-	697	79	9	<5	0.34	0.003	<0.002	340	0.005	10
	WQ02	WQ02	20/09/2011	EB1119345	<1	11,000	<1000	168	12.9	-	12.4	331	0.4	2.03	-	697	86	6	<5	0.34	<0.002	0.002	340	<0.001	9
	WQ03	WQ03	20/09/2011	EB1119345	<1	200	<1000	164	13.1	-	12.4	343	0.4	2.62	-	689	90	37	<5	0.37	<0.002	0.002	370	0.001	8
	WQ04	WQ04	20/09/2011	EB1119345	1	86	<1000	162	12.6	-	12.2	328	0.4	1.95	-	683	93	16	<5	0.29	<0.002	<0.002	290	0.002	7

					Biological		Major Ions and Physcial Parameters												Nutrients						
					Chlorophyll a	Faecal Coliforms	Alkalinity (Hydroxide) as CaCO3	Alkalinity (total) as CaCO3	Anions Total	Bicarbonate as CaCO3	Cations Total	Chloride	Fluoride	Ionic Balance	Silica	TDS	Hardness as CaCO3	TSS	Ammonia as N	Kjeldahl Nitrogen Total	Nitrate (as N)	Nitrite (as N)	Nitrogen (Total)	Reactive Phosphorus as P	Sulphate (Filtered)
					mg/m³	CFU/100mL	µg/L	mg/L	meq/L	mg/L	meq/L	mg/L	mg/L	%	µg/L	mg/L	mg/L	mg/L	µg/L	mg/L	mg/L	mg/L	µg/L	mg/L	mg/L
Laboratory Limit of Reporting					1	1	1000	1	0.01	1	0.01	1	0.1	0.01	100	5	1	5	5	0.01	0.002	0.002	10	0.001	1
Sampling Event	**Field ID**	**Location Code**	**Sampling Date**	**Work Order**																					
	WQ05	WQ05	20/09/2011	EB1119345	6	62	<1000	33	0.69	-	0.82	6	<0.1	-	-	211	21	31	10	1.1	<0.002	0.005	1100	0.008	2
	WQ06	WQ06	20/09/2011	EB1119345	2	1400	<1000	69	1.85	-	1.98	13	0.2	-	-	240	60	53	<5	0.65	0.004	<0.002	650	0.007	5
	WQST	WQST	20/09/2011	EB1119345	8	26	<1000	89	2.02	-	2.19	8	<0.1	-	-	168	53	37	<5	1.74	<0.002	<0.002	1740	0.013	1
	QA02	WQ09	21/09/2011	EB1119508	14	<2	<1000	38	0.96	-	0.85	7	<0.1	-	-	93	21	12	104	1.42	0.021	<0.002	1440	0.004	<1
	WQ08	WQ08	21/09/2011	EB1119508	17	130	<1000	34	0.79	-	0.62	4	<0.1	-	-	60	14	34	82	1.32	0.038	<0.002	1360	0.006	<1
	WQ09	WQ09	21/09/2011	EB1119508	12	120	<1000	38	0.96	-	0.85	7	<0.1	-	-	68	21	13	121	1.12	0.021	<0.002	1140	0.004	<1

Table C2 Water Results – Metals (Aluminium to Cobalt)

Sampling Event	Field ID	Location Code	Sampling Date	Work Order	Aluminium	Aluminium (Filtered)	Arsenic	Arsenic (Filtered)	Barium	Barium (Filtered)	Beryllium	Beryllium (Filtered)	Boron	Boron (Filtered)	Cadmium	Cadmium (Filtered)	Calcium (Filtered)	Chromium (III+VI)	Chromium (III+VI) (Filtered)	Cobalt
					mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Laboratory Limit of Reporting					0.01	0.01	0.001	0.001	0.001	0.001	0.001	0.001	0.05	0.05	0.0001	0.0001	1	0.001	0.001	0.001
Event 1	QA01	WQ04	13/04/2011	EB1107318	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ02	WQ02	13/04/2011	EB1107318	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ03	WQ03	13/04/2011	EB1107318	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ04	WQ04	13/04/2011	EB1107318	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ05	WQ05	13/04/2011	EB1107318	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQST	WQST	13/04/2011	EB1107318	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	QA02	QA02	14/04/2011	EB1107452	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ01	WQ01	14/04/2011	EB1107452	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ06	WQ06	14/04/2011	EB1107452	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ08	WQ08	14/04/2011	EB1107452	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ09	WQ09	14/04/2011	EB1107452	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Event 2	QA01	QA01	4/05/2011	EB1108606	0.04	0.02	0.002	0.001	0.062	0.038	<0.001	<0.001	0.05	0.07	<0.0001	<0.0001	6	<0.001	<0.001	0.001
	WQ06	WQ06	4/05/2011	EB1108606	5.46	0.24	0.002	<0.001	0.218	0.128	<0.001	<0.001	<0.05	0.06	<0.0001	<0.0001	10	0.007	<0.001	0.002
	WQ08	WQ08	4/05/2011	EB1108606	0.5	0.04	0.001	<0.001	0.039	0.023	<0.001	<0.001	0.05	0.06	<0.0001	<0.0001	2	<0.001	<0.001	<0.001
	WQ09	WQ09	4/05/2011	EB1108606	0.09	0.02	0.002	0.001	0.062	0.037	<0.001	<0.001	0.05	0.05	<0.0001	<0.0001	6	<0.001	<0.001	0.001
	QA02	QA02	5/05/2011	EB1108729	0.16	0.05	<0.001	<0.001	0.303	0.262	<0.001	<0.001	0.11	0.12	<0.0001	<0.0001	13	<0.001	<0.001	0.001
	WQ01	WQ01	5/05/2011	EB1108729	2.2	0.04	0.002	<0.001	0.339	0.263	<0.001	<0.001	0.12	0.13	<0.0001	<0.0001	13	0.004	<0.001	0.002
	WQ02	WQ02	5/05/2011	EB1108729	0.18	0.05	<0.001	<0.001	0.33	0.26	<0.001	<0.001	0.13	0.13	<0.0001	<0.0001	12	<0.001	<0.001	0.004
	WQ03	WQ03	5/05/2011	EB1108729	0.13	0.05	<0.001	<0.001	0.285	0.241	<0.001	<0.001	0.12	0.11	<0.0001	<0.0001	13	<0.001	<0.001	0.002
	WQ04	WQ04	5/05/2011	EB1108729	0.15	0.05	<0.001	<0.001	0.286	0.242	<0.001	<0.001	0.11	0.11	<0.0001	<0.0001	13	<0.001	<0.001	0.002
	WQST	WQST	5/05/2011	EB1108729	0.11	0.03	0.002	0.001	0.107	0.08	<0.001	<0.001	0.06	0.06	<0.0001	<0.0001	11	<0.001	<0.001	0.002
Event 3	QA01	WQ01	21/06/2011	EB1111938	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ01	WQ01	21/06/2011	EB1111938	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ02	WQ02	21/06/2011	EB1111938	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ03	WQ03	21/06/2011	EB1111938	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ04	WQ04	21/06/2011	EB1111938	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ05	WQ05	21/06/2011	EB1111938	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	QA02	WQ09	22/06/2011	EB1112105	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ06	WQ06	22/06/2011	EB1112105	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ08	WQ08	22/06/2011	EB1112105	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ09	WQ09	22/06/2011	EB1112105	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQST	WQST	22/06/2011	EB1112105	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Event 4	QA01	WQ04	26/07/2011	EB1114640	0.22	0.02	<0.001	<0.001	-	0.246	-	<0.001	0.17	0.17	0.0001	<0.0001	15	<0.001	<0.001	-
	WQ01	WQ01	26/07/2011	EB1114640	0.08	0.01	<0.001	<0.001	-	0.267	-	<0.001	0.15	0.16	<0.0001	<0.0001	14	<0.001	<0.001	-
	WQ02	WQ02	26/07/2011	EB1114640	0.1	0.02	<0.001	<0.001	-	0.266	-	<0.001	0.15	0.16	<0.0001	<0.0001	14	<0.001	<0.001	-
	WQ03	WQ03	26/07/2011	EB1114640	0.16	0.02	<0.001	<0.001	-	0.247	-	<0.001	0.16	0.16	<0.0001	<0.0001	14	<0.001	<0.001	-
	WQ04	WQ04	26/07/2011	EB1114640	0.2	0.03	<0.001	<0.001	-	0.242	-	<0.001	0.16	0.18	<0.0001	<0.0001	15	<0.001	<0.001	-
	QA02	WQ09	27/07/2011	EB1114769	0.05	0.03	0.001	<0.001	0.056	0.041	<0.001	<0.001	0.05	0.07	<0.0001	<0.0001	6	<0.001	<0.001	0.001
	WQ06	WQ06	27/07/2011	EB1114769	6.16	0.13	0.002	<0.001	0.234	0.161	<0.001	<0.001	<0.05	0.06	<0.0001	<0.0001	11	0.008	<0.001	0.002
	WQ08	WQ08	27/07/2011	EB1114769	0.99	0.94	0.002	<0.001	0.034	0.026	<0.001	<0.001	<0.05	0.06	<0.0001	<0.0001	2	<0.001	<0.001	<0.001
	WQ09	WQ09	27/07/2011	EB1114769	0.05	0.03	0.002	<0.001	0.054	0.039	<0.001	<0.001	0.05	0.07	<0.0001	<0.0001	6	<0.001	<0.001	0.001
	WQST	WQST	27/07/2011	EB1114769	0.35	0.07	0.003	0.002	0.096	0.211	<0.001	<0.001	0.05	0.09	<0.0001	<0.0001	12	<0.001	<0.001	0.002
Event 5	QA01	WQ04	23/08/2011	EB1117117	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ01	WQ01	23/08/2011	EB1117117	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ02	WQ02	23/08/2011	EB1117117	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ03	WQ03	23/08/2011	EB1117117	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ04	WQ04	23/08/2011	EB1117117	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	QA02	WQ09	24/08/2011	EB1117183	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ05	WQ05	24/08/2011	EB1117183	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ06	WQ06	24/08/2011	EB1117183	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ08	WQ08	24/08/2011	EB1117183	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ09	WQ09	24/08/2011	EB1117183	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQST	WQST	24/08/2011	EB1117183	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Event 6	QA01	WQ04	20/09/2011	EB1119345	0.54	0.03	<0.001	<0.001	0.29	0.322	<0.001	<0.001	0.14	0.16	<0.0001	<0.0001	14	<0.001	0.001	<0.001
	WQ01	WQ01	20/09/2011	EB1119345	0.29	0.06	<0.001	<0.001	0.287	0.254	<0.001	<0.001	0.16	0.16	<0.0001	<0.0001	12	<0.001	0.002	<0.001
	WQ02	WQ02	20/09/2011	EB1119345	0.31	0.06	<0.001	<0.001	0.296	0.264	<0.001	<0.001	0.16	0.15	<0.0001	<0.0001	13	<0.001	0.002	<0.001
	WQ03	WQ03	20/09/2011	EB1119345	0.29	0.05	<0.001	<0.001	0.293	0.358	<0.001	<0.001	0.14	0.17	<0.0001	<0.0001	13	<0.001	0.002	<0.001
	WQ04	WQ04	20/09/2011	EB1119345	0.52	0.03	<0.001	<0.001	0.274	0.305	<0.001	<0.001	0.13	0.17	<0.0001	<0.0001	14	<0.001	0.002	<0.001
	WQ05	WQ05	20/09/2011	EB1119345	3.07	2.03	0.003	<0.001	0.106	0.301	<0.001	<0.001	<0.05	0.1	<0.0001	<0.0001	5	0.004	0.002	0.004
	WQ06	WQ06	20/09/2011	EB1119345	4.34	0.14	0.001	<0.001	0.256	0.354	<0.001	<0.001	0.05	0.1	<0.0001	<0.0001	14	0.006	<0.001	0.002
	WQST	WQST	20/09/2011	EB1119345	0.33	0.05	0.002	0.002	0.126	0.222	<0.001	<0.001	0.08	0.1	<0.0001	<0.0001	13	<0.001	<0.001	0.002
	QA02	WQ09	21/09/2011	EB1119508	-	-	0.001	<0.001	-	0.111	-	<0.001	-	-	<0.0001	<0.0001	5	<0.001	<0.001	-
	WQ08	WQ08	21/09/2011	EB1119508	-	-	<0.001	<0.001	-	0.191	-	<0.001	-	-	<0.0001	<0.0001	4	0.002	0.002	-
	WQ09	WQ09	21/09/2011	EB1119508	-	-	<0.001	<0.001	-	0.082	-	<0.001	-	-	<0.0001	<0.0001	5	<0.001	<0.001	-

Table C3 Water Results - Metals (Cobalt to Phosphorus)

Sampling Event	Field ID	Location Code	Sampling Date	Work Order	Cobalt (Filtered)	Copper	Copper (Filtered)	Iron	Iron (Filtered)	Lead	Magnesium (Filtered)	Manganese	Manganese (Filtered)	Mercury	Mercury (Filtered)	Molybdenum	Molybdenum (Filtered)	Nickel	Nickel (Filtered)	Phosphorus
					mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
				Laboratory Limit of Reporting	0.001	0.001	0.001	0.05	0.05	0.001	1	0.001	0.001	0.0001	0.0001	0.001	0.001	0.001	0.001	0.005
Event 1	QA01	WQ04	13/04/2011	EB1107318	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.027
	WQ02	WQ02	13/04/2011	EB1107318	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.034
	WQ03	WQ03	13/04/2011	EB1107318	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.019
	WQ04	WQ04	13/04/2011	EB1107318	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.024
	WQ05	WQ05	13/04/2011	EB1107318	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.077
	WQST	WQST	13/04/2011	EB1107318	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.091
	QA02	QA02	14/04/2011	EB1107452	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.09
	WQ01	WQ01	14/04/2011	EB1107452	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.03
	WQ06	WQ06	14/04/2011	EB1107452	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.064
	WQ08	WQ08	14/04/2011	EB1107452	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.087
	WQ09	WQ09	14/04/2011	EB1107452	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.068
Event 2	QA01	QA01	4/05/2011	EB1108606	<0.001	<0.001	0.004	3.25	0.95	<0.001	3	0.287	0.001	<0.0001	<0.0001	<0.001	<0.001	<0.001	<0.001	0.116
	WQ06	WQ06	4/05/2011	EB1108606	<0.001	0.006	0.005	7.67	0.18	0.003	4	0.212	0.002	<0.0001	<0.0001	<0.001	<0.001	0.006	0.002	0.078
	WQ08	WQ08	4/05/2011	EB1108606	<0.001	0.002	<0.001	0.87	0.06	<0.001	1	0.061	0.002	<0.0001	<0.0001	<0.001	<0.001	0.001	<0.001	0.096
	WQ09	WQ09	4/05/2011	EB1108606	<0.001	<0.001	<0.001	3.05	0.84	<0.001	3	0.274	0.002	<0.0001	<0.0001	<0.001	<0.001	<0.001	<0.001	0.093
	QA02	QA02	5/05/2011	EB1108729	<0.001	0.006	0.003	3.28	0.15	<0.001	12	0.143	0.096	<0.0001	<0.0001	<0.001	<0.001	0.002	0.001	0.017
	WQ01	WQ01	5/05/2011	EB1108729	0.001	0.005	0.009	7.95	0.16	0.002	12	0.226	0.161	<0.0001	<0.0001	<0.001	<0.001	0.004	0.001	0.025
	WQ02	WQ02	5/05/2011	EB1108729	<0.001	0.032	0.006	2.94	0.14	<0.001	12	0.186	0.103	<0.0001	<0.0001	<0.001	<0.001	0.003	0.001	0.024
	WQ03	WQ03	5/05/2011	EB1108729	<0.001	0.01	0.005	2.48	0.15	<0.001	12	0.136	0.088	<0.0001	<0.0001	<0.001	<0.001	0.002	0.001	0.021
	WQ04	WQ04	5/05/2011	EB1108729	<0.001	0.01	0.004	2.5	0.14	0.001	12	0.228	0.182	<0.0001	<0.0001	<0.001	<0.001	0.002	0.001	0.038
	WQST	WQST	5/05/2011	EB1108729	<0.001	0.007	0.003	0.91	0.14	0.001	4	0.375	0.144	<0.0001	<0.0001	<0.001	<0.001	0.002	0.002	0.159
Event 3	QA01	WQ01	21/06/2011	EB1111938	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.013
	WQ01	WQ01	21/06/2011	EB1111938	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.011
	WQ02	WQ02	21/06/2011	EB1111938	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.009
	WQ03	WQ03	21/06/2011	EB1111938	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.005
	WQ04	WQ04	21/06/2011	EB1111938	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.009
	WQ05	WQ05	21/06/2011	EB1111938	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.168
	QA02	WQ09	22/06/2011	EB1112105	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.142
	WQ06	WQ06	22/06/2011	EB1112105	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.07
	WQ08	WQ08	22/06/2011	EB1112105	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.099
	WQ09	WQ09	22/06/2011	EB1112105	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.14
	WQST	WQST	22/06/2011	EB1112105	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.202
Event 4	QA01	WQ04	26/07/2011	EB1114640	<0.001	<0.001	<0.001	0.76	0.24	<0.001	16	-	0.021	<0.0001	<0.0001	<0.001	<0.001	<0.001	<0.001	0.011
	WQ01	WQ01	26/07/2011	EB1114640	<0.001	<0.001	<0.001	0.7	0.21	<0.001	14	-	0.049	<0.0001	<0.0001	<0.001	<0.001	<0.001	<0.001	0.018

Sampling Event	Field ID	Location Code	Sampling Date	Work Order	Cobalt (Filtered)	Copper	Copper (Filtered)	Iron	Iron (Filtered)	Lead	Magnesium (Filtered)	Manganese	Manganese (Filtered)	Mercury	Mercury (Filtered)	Molybdenum	Molybdenum (Filtered)	Nickel	Nickel (Filtered)	Phosphorus
					mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Laboratory Limit of Reporting					0.001	0.001	0.001	0.05	0.05	0.001	1	0.001	0.001	0.0001	0.0001	0.001	0.001	0.001	0.001	0.005
	WQ02	WQ02	26/07/2011	EB1114640	<0.001	<0.001	<0.001	0.63	0.27	<0.001	14	-	0.034	<0.0001	<0.0001	<0.001	<0.001	<0.001	<0.001	0.014
	WQ03	WQ03	26/07/2011	EB1114640	<0.001	<0.001	<0.001	0.65	0.23	<0.001	15	-	0.047	<0.0001	<0.0001	<0.001	<0.001	<0.001	<0.001	0.007
	WQ04	WQ04	26/07/2011	EB1114640	<0.001	<0.001	<0.001	0.73	0.23	<0.001	16	-	0.022	<0.0001	<0.0001	<0.001	<0.001	<0.001	<0.001	0.013
	QA02	WQ09	27/07/2011	EB1114769	<0.001	<0.001	<0.001	0.96	0.09	<0.001	3	0.255	0.009	<0.0001	<0.0001	<0.001	<0.001	<0.001	<0.001	0.135
	WQ06	WQ06	27/07/2011	EB1114769	<0.001	0.006	0.002	8.18	0.06	0.003	5	0.13	0.012	<0.0001	<0.0001	<0.001	<0.001	0.007	0.001	0.088
	WQ08	WQ08	27/07/2011	EB1114769	<0.001	0.002	0.002	1.51	0.53	<0.001	<1	0.048	0.003	<0.0001	<0.0001	<0.001	<0.001	0.002	0.001	0.103
	WQ09	WQ09	27/07/2011	EB1114769	<0.001	<0.001	<0.001	0.87	0.09	<0.001	3	0.246	0.01	<0.0001	<0.0001	<0.001	<0.001	<0.001	<0.001	0.132
	WQST	WQST	27/07/2011	EB1114769	<0.001	0.003	0.002	1.58	<0.05	0.001	5	0.495	0.007	<0.0001	<0.0001	<0.001	<0.001	0.002	0.002	0.31
Event 5	QA01	WQ04	23/08/2011	EB1117117	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.034
Event 5	WQ01	WQ01	23/08/2011	EB1117117	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.018
Event 5	WQ02	WQ02	23/08/2011	EB1117117	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.014
Event 5	WQ03	WQ03	23/08/2011	EB1117117	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.015
Event 5	WQ04	WQ04	23/08/2011	EB1117117	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.033
Event 5	QA02	WQ09	24/08/2011	EB1117183	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.167
Event 5	WQ05	WQ05	24/08/2011	EB1117183	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.272
Event 5	WQ06	WQ06	24/08/2011	EB1117183	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.101
Event 5	WQ08	WQ08	24/08/2011	EB1117183	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.142
Event 5	WQ09	WQ09	24/08/2011	EB1117183	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.167
Event 5	WQST	WQST	24/08/2011	EB1117183	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.348
Event 6	QA01	WQ04	20/09/2011	EB1119345	<0.001	0.002	<0.001	1.61	0.21	<0.001	14	0.131	0.006	<0.0001	<0.0001	<0.001	<0.001	0.001	<0.001	0.025
Event 6	WQ01	WQ01	20/09/2011	EB1119345	<0.001	<0.001	0.001	1.8	0.44	<0.001	12	0.169	0.103	<0.0001	<0.0001	<0.001	<0.001	0.001	<0.001	0.023
Event 6	WQ02	WQ02	20/09/2011	EB1119345	<0.001	0.001	<0.001	1.59	0.44	<0.001	13	0.165	0.076	<0.0001	<0.0001	<0.001	<0.001	0.001	<0.001	0.024
Event 6	WQ03	WQ03	20/09/2011	EB1119345	<0.001	0.001	0.001	1.17	0.36	<0.001	14	0.158	0.078	<0.0001	<0.0001	<0.001	<0.001	0.001	<0.001	0.019
Event 6	WQ04	WQ04	20/09/2011	EB1119345	<0.001	0.001	0.001	1.48	0.21	<0.001	14	0.12	0.007	<0.0001	<0.0001	<0.001	<0.001	0.002	<0.001	0.026
Event 6	WQ05	WQ05	20/09/2011	EB1119345	0.001	0.005	0.003	8.76	1.68	0.004	2	0.327	0.101	<0.0001	<0.0001	<0.001	<0.001	0.004	0.002	0.172
Event 6	WQ06	WQ06	20/09/2011	EB1119345	<0.001	0.006	0.003	5.87	0.07	0.002	6	0.205	<0.001	<0.0001	<0.0001	<0.001	<0.001	0.006	0.002	0.074
Event 6	WQST	WQST	20/09/2011	EB1119345	<0.001	0.002	0.002	1.47	<0.05	0.001	5	0.528	0.006	<0.0001	<0.0001	<0.001	<0.001	0.003	0.002	0.201
Event 6	QA02	WQ09	21/09/2011	EB1119508	<0.001	<0.001	<0.001	-	-	<0.001	2	-	0.002	<0.0001	<0.0001	-	-	<0.001	<0.001	0.119
Event 6	WQ08	WQ08	21/09/2011	EB1119508	<0.001	0.002	0.002	-	-	0.001	1	-	0.006	<0.0001	<0.0001	-	-	0.002	0.002	0.12
Event 6	WQ09	WQ09	21/09/2011	EB1119508	<0.001	0.001	<0.001	-	-	<0.001	2	-	0.003	<0.0001	<0.0001	-	-	<0.001	<0.001	0.087

Table C4 Water Results – Metals (Potassium to Zinc)

Sampling Event	Field ID	Location Code	Sampling Date	Work Order	Potassium (Filtered)	Selenium	Selenium (Filtered)	Silicon (Filtered)	Silver	Silver (Filtered)	Sodium (Filtered)	Strontium	Strontium (Filtered)	Uranium	Uranium (Filtered)	Vanadium	Vanadium (Filtered)	Zinc	Zinc (Filtered)
					mg/L	mg/L	mg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L	mg/L	mg/L	mg/L	mg/L
Laboratory Limit of Reporting					1	0.01	0.01	50	0.001	0.001	1	0.001	0.001	1	1	0.01	0.01	0.005	0.005
Event 1	QA01	WQ04	13/04/2011	EB1107318	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ02	WQ02	13/04/2011	EB1107318	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ03	WQ03	13/04/2011	EB1107318	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ04	WQ04	13/04/2011	EB1107318	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ05	WQ05	13/04/2011	EB1107318	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQST	WQST	13/04/2011	EB1107318	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	QA02	QA02	14/04/2011	EB1107452	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ01	WQ01	14/04/2011	EB1107452	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ06	WQ06	14/04/2011	EB1107452	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ08	WQ08	14/04/2011	EB1107452	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ09	WQ09	14/04/2011	EB1107452	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Event 2	QA01	QA01	4/05/2011	EB1108606	10	<0.01	<0.01	12,400	<0.001	<0.001	2	0.077	0.071	<1	<1	<0.01	<0.01	<0.005	<0.005
	WQ06	WQ06	4/05/2011	EB1108606	5	<0.01	<0.01	10,800	<0.001	<0.001	11	0.137	0.113	<1	<1	0.02	<0.01	0.011	<0.005
	WQ08	WQ08	4/05/2011	EB1108606	8	<0.01	<0.01	5470	<0.001	<0.001	2	0.021	0.017	<1	<1	<0.01	<0.01	<0.005	<0.005
	WQ09	WQ09	4/05/2011	EB1108606	10	<0.01	<0.01	12,000	<0.001	<0.001	2	0.074	0.069	<1	<1	<0.01	<0.01	0.012	<0.005
	QA02	QA02	5/05/2011	EB1108729	14	<0.01	<0.01	6880	<0.001	<0.001	164	0.219	0.198	<1	<1	<0.01	<0.01	0.01	0.006
	WQ01	WQ01	5/05/2011	EB1108729	16	<0.01	<0.01	7920	<0.001	<0.001	177	0.205	0.194	<1	<1	<0.01	<0.01	0.008	<0.005
	WQ02	WQ02	5/05/2011	EB1108729	13	<0.01	<0.01	6840	<0.001	<0.001	160	0.231	0.197	<1	<1	<0.01	<0.01	0.008	<0.005
	WQ03	WQ03	5/05/2011	EB1108729	13	<0.01	<0.01	6150	<0.001	<0.001	158	0.218	0.197	<1	<1	<0.01	<0.01	<0.005	<0.005
	WQ04	WQ04	5/05/2011	EB1108729	13	<0.01	<0.01	6090	<0.001	<0.001	162	0.216	0.2	<1	<1	<0.01	<0.01	0.008	<0.005
	WQST	WQST	5/05/2011	EB1108729	18	<0.01	<0.01	9660	<0.001	<0.001	6	0.163	0.148	<1	<1	<0.01	<0.01	0.022	<0.005
Event 3	QA01	WQ01	21/06/2011	EB1111938	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ01	WQ01	21/06/2011	EB1111938	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ02	WQ02	21/06/2011	EB1111938	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ03	WQ03	21/06/2011	EB1111938	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ04	WQ04	21/06/2011	EB1111938	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ05	WQ05	21/06/2011	EB1111938	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	QA02	WQ09	22/06/2011	EB1112105	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ06	WQ06	22/06/2011	EB1112105	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ08	WQ08	22/06/2011	EB1112105	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ09	WQ09	22/06/2011	EB1112105	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQST	WQST	22/06/2011	EB1112105	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Event 4	QA01	WQ04	26/07/2011	EB1114640	26	<0.01	<0.01	930	<0.001	<0.001	227	0.22	0.21	<1	<1	-	<0.01	<0.005	<0.005
	WQ01	WQ01	26/07/2011	EB1114640	24	<0.01	<0.01	1880	<0.001	<0.001	209	0.213	0.202	<1	<1	-	<0.01	<0.005	<0.005
	WQ02	WQ02	26/07/2011	EB1114640	24	<0.01	<0.01	1540	<0.001	<0.001	216	0.21	0.203	<1	<1	-	<0.01	<0.005	<0.005

Sampling Event	Field ID	Location Code	Sampling Date	Work Order	Potassium (Filtered)	Selenium	Selenium (Filtered)	Silicon (Filtered)	Silver	Silver (Filtered)	Sodium (Filtered)	Strontium	Strontium (Filtered)	Uranium	Uranium (Filtered)	Vanadium	Vanadium (Filtered)	Zinc	Zinc (Filtered)
					mg/L	mg/L	mg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L	mg/L	mg/L	mg/L	mg/L
Laboratory Limit of Reporting					1	0.01	0.01	50	0.001	0.001	1	0.001	0.001	1	1	0.01	0.01	0.005	0.005
	WQ03	WQ03	26/07/2011	EB1114640	25	<0.01	<0.01	1240	<0.001	<0.001	214	0.206	0.197	<1	<1	-	<0.01	<0.005	<0.005
	WQ04	WQ04	26/07/2011	EB1114640	26	<0.01	<0.01	940	<0.001	<0.001	226	0.224	0.207	<1	<1	-	<0.01	<0.005	<0.005
	QA02	WQ09	27/07/2011	EB1114769	13	<0.01	<0.01	11,800	<0.001	<0.001	3	0.062	0.059	<1	<1	<0.01	<0.01	<0.005	<0.005
	WQ06	WQ06	27/07/2011	EB1114769	6	<0.01	<0.01	6350	<0.001	<0.001	12	0.159	0.135	<1	<1	0.02	<0.01	0.012	<0.005
	WQ08	WQ08	27/07/2011	EB1114769	8	<0.01	<0.01	5150	<0.001	<0.001	2	0.022	0.02	<1	<1	<0.01	<0.01	<0.005	<0.005
	WQ09	WQ09	27/07/2011	EB1114769	13	<0.01	<0.01	11,700	<0.001	<0.001	3	0.063	0.058	<1	<1	<0.01	<0.01	<0.005	<0.005
	WQST	WQST	27/07/2011	EB1114769	21	<0.01	<0.01	6430	<0.001	<0.001	7	0.172	0.162	<1	<1	<0.01	<0.01	<0.005	0.021
Event 5	QA01	WQ04	23/08/2011	EB1117117	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ01	WQ01	23/08/2011	EB1117117	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ02	WQ02	23/08/2011	EB1117117	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ03	WQ03	23/08/2011	EB1117117	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ04	WQ04	23/08/2011	EB1117117	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	QA02	WQ09	24/08/2011	EB1117183	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ05	WQ05	24/08/2011	EB1117183	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ06	WQ06	24/08/2011	EB1117183	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ08	WQ08	24/08/2011	EB1117183	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ09	WQ09	24/08/2011	EB1117183	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQST	WQST	24/08/2011	EB1117183	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Event 6	QA01	WQ04	20/09/2011	EB1119345	22	<0.01	<0.01	1590	<0.001	<0.001	221	0.227	0.198	<1	<1	<0.01	<0.01	<0.005	0.012
	WQ01	WQ01	20/09/2011	EB1119345	23	<0.01	<0.01	3510	<0.001	<0.001	234	0.205	0.181	<1	<1	<0.01	<0.01	0.005	<0.005
	WQ02	WQ02	20/09/2011	EB1119345	22	<0.01	<0.01	3110	<0.001	<0.001	232	0.208	0.184	<1	<1	<0.01	<0.01	0.005	<0.005
	WQ03	WQ03	20/09/2011	EB1119345	22	<0.01	<0.01	2330	<0.001	<0.001	232	0.218	0.196	<1	<1	<0.01	<0.01	<0.005	0.043
	WQ04	WQ04	20/09/2011	EB1119345	22	<0.01	<0.01	1580	<0.001	<0.001	224	0.218	0.197	<1	<1	<0.01	<0.01	<0.005	0.04
	WQ05	WQ05	20/09/2011	EB1119345	9	<0.01	<0.01	8470	<0.001	<0.001	4	0.104	0.083	<1	<1	0.01	<0.01	0.009	0.031
	WQ06	WQ06	20/09/2011	EB1119345	7	<0.01	<0.01	7320	<0.001	<0.001	14	0.179	0.153	<1	<1	0.01	<0.01	0.01	0.018
	WQST	WQST	20/09/2011	EB1119345	27	<0.01	<0.01	6260	<0.001	<0.001	10	0.194	0.171	<1	<1	<0.01	<0.01	<0.005	0.015
	QA02	WQ09	21/09/2011	EB1119508	12	-	-	12,400	-	-	3	-	-	-	-	-	<0.01	<0.005	0.018
	WQ08	WQ08	21/09/2011	EB1119508	10	-	-	9680	-	-	2	-	-	-	-	-	<0.01	<0.005	<0.005
	WQ09	WQ09	21/09/2011	EB1119508	12	-	-	12,300	-	-	3	-	-	-	-	-	<0.01	<0.005	0.012

Table C5 Water Results – Hydrocarbon analyses

Sampling Event	Field ID	Location Code	Sampling Date	Work Order	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a) pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Naphthalene	Phenanthrene	Pyrene	>C10 - C16 Fraction	>C16 - C34 Fraction	>C34 - C40 Fraction	TPH C6 - C9	TPH C10 - C14	TPH C15 - C28	TPH C29-C36	TPH C10 - C40 (Sum of total)	TPH+C10 - C36 (Sum of total)	TPH C6-C10
					Hydrocarbons																									
					PAH/Phenols																TPH									
					µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L
Laboratory Limit of Reporting					1	1	1	1	0.5	1	1	1	1	1	1	1	1	1	1	1	100	100	100	20	50	100	50	100	50	0.02
Event 1	QA01	WQ04	13/04/2011	EB1107318	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ02	WQ02	13/04/2011	EB1107318	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ03	WQ03	13/04/2011	EB1107318	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ04	WQ04	13/04/2011	EB1107318	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ05	WQ05	13/04/2011	EB1107318	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQST	WQST	13/04/2011	EB1107318	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	QA02	QA02	14/04/2011	EB1107452	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ01	WQ01	14/04/2011	EB1107452	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ06	WQ06	14/04/2011	EB1107452	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ08	WQ08	14/04/2011	EB1107452	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ09	WQ09	14/04/2011	EB1107452	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Event 2	QA01	QA01	4/05/2011	EB1108606	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<100	<100	<100	<20	<50	<100	<50	<100	<50	<0.02
	WQ06	WQ06	4/05/2011	EB1108606	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<100	<100	<100	<20	<50	<100	<50	<100	<50	<0.02
	WQ08	WQ08	4/05/2011	EB1108606	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<100	<100	<100	<20	<50	<100	<50	<100	<50	<0.02
	WQ09	WQ09	4/05/2011	EB1108606	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<100	<100	<100	<20	<50	<100	<50	<100	<50	<0.02
	QA02	QA02	5/05/2011	EB1108729	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<100	<100	<100	<20	<50	<100	<50	<100	<50	<0.02
	WQ01	WQ01	5/05/2011	EB1108729	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<100	<100	<100	<20	<50	<100	<50	<100	<50	<0.02
	WQ02	WQ02	5/05/2011	EB1108729	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<100	<100	<100	<20	<50	<100	<50	<100	<50	<0.02
	WQ03	WQ03	5/05/2011	EB1108729	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<100	<100	<100	<20	<50	<100	<50	<100	<50	<0.02
	WQ04	WQ04	5/05/2011	EB1108729	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<100	<100	<100	<20	<50	<100	<50	<100	<50	<0.02
	WQST	WQST	5/05/2011	EB1108729	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<100	<100	<100	<20	<50	<100	<50	<100	<50	<0.02
Event 3	QA01	WQ01	21/06/2011	EB1111938	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ01	WQ01	21/06/2011	EB1111938	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ02	WQ02	21/06/2011	EB1111938	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ03	WQ03	21/06/2011	EB1111938	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ04	WQ04	21/06/2011	EB1111938	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ05	WQ05	21/06/2011	EB1111938	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	QA02	WQ09	22/06/2011	EB1112105	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

					Hydrocarbons																									
					PAH/Phenols																TPH									
					Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a) pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Naphthalene	Phenanthrene	Pyrene	>C10 - C16 Fraction	>C16 - C34 Fraction	>C34 - C40 Fraction	TPH C6 - C9	TPH C10 - C14	TPH C15 - C28	TPH C29-C36	TPH C10 - C40 (Sum of total)	TPH+C10 - C36 (Sum of total)	TPH C6-C10
					µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L
Laboratory Limit of Reporting					1	1	1	1	0.5	1	1	1	1	1	1	1	1	1	1	1	100	100	100	20	50	100	50	100	50	0.02
Sampling Event	Field ID	Location Code	Sampling Date	Work Order																										
	WQ06	WQ06	22/06/2011	EB1112105	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ08	WQ08	22/06/2011	EB1112105	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ09	WQ09	22/06/2011	EB1112105	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQST	WQST	22/06/2011	EB1112105	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Event 4	QA01	WQ04	26/07/2011	EB1114640	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<100	<100	<100	<20	<50	<100	<50	<100	<50	<0.02
	WQ01	WQ01	26/07/2011	EB1114640	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<100	<100	<100	<20	<50	<100	<50	<100	<50	<0.02
	WQ02	WQ02	26/07/2011	EB1114640	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<100	<100	<100	<20	<50	<100	<50	<100	<50	<0.02
	WQ03	WQ03	26/07/2011	EB1114640	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<100	<100	<100	<20	<50	<100	<50	<100	<50	<0.02
	WQ04	WQ04	26/07/2011	EB1114640	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<100	<100	<100	<20	<50	<100	<50	<100	<50	<0.02
	QA02	WQ09	27/07/2011	EB1114769	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<100	<100	<100	<20	<50	<100	60	<100	60	<0.02
	WQ06	WQ06	27/07/2011	EB1114769	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<100	<100	<100	<20	<50	<100	<50	<100	<50	<0.02
	WQ08	WQ08	27/07/2011	EB1114769	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<100	<100	<100	<20	<50	<100	<50	<100	<50	<0.02
	WQ09	WQ09	27/07/2011	EB1114769	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<100	<100	<100	<20	<50	<100	<50	<100	<50	<0.02
	WQST	WQST	27/07/2011	EB1114769	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<100	<100	<100	<20	<50	<100	<50	<100	<50	<0.02
Event 5	QA01	WQ04	23/08/2011	EB1117117	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ01	WQ01	23/08/2011	EB1117117	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ02	WQ02	23/08/2011	EB1117117	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ03	WQ03	23/08/2011	EB1117117	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ04	WQ04	23/08/2011	EB1117117	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	QA02	WQ09	24/08/2011	EB1117183	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ05	WQ05	24/08/2011	EB1117183	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ06	WQ06	24/08/2011	EB1117183	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ08	WQ08	24/08/2011	EB1117183	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ09	WQ09	24/08/2011	EB1117183	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQST	WQST	24/08/2011	EB1117183	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Event 6	QA01	WQ04	20/09/2011	EB1119345	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<100	<100	<100	<20	<50	<100	<50	<100	<50	<0.02
	WQ01	WQ01	20/09/2011	EB1119345	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<100	<100	<100	<20	<50	<100	<50	<100	<50	<0.02
	WQ02	WQ02	20/09/2011	EB1119345	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<100	<100	<100	<20	<50	<100	<50	<100	<50	<0.02
	WQ03	WQ03	20/09/2011	EB1119345	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<100	<100	<100	<20	<50	<100	<50	<100	<50	<0.02

					Hydrocarbons																										
					PAH/Phenols																TPH									
					Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a) pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Naphthalene	Phenanthrene	Pyrene	>C10 - C16 Fraction	>C16 - C34 Fraction	>C34 - C40 Fraction	TPH C6 - C9	TPH C10 - C14	TPH C15 - C28	TPH C29-C36	TPH C10 - C40 (Sum of total)	TPH+C10 - C36 (Sum of total)	TPH C6-C10
					µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L
Laboratory Limit of Reporting					1	1	1	1	0.5	1	1	1	1	1	1	1	1	1	1	1	100	100	100	20	50	100	50	100	50	0.02
Sampling Event	**Field ID**	**Location Code**	**Sampling Date**	**Work Order**																										
	WQ04	WQ04	20/09/2011	EB1119345	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<100	<100	<100	<20	<50	<100	<50	<100	<50	<0.02
	WQ05	WQ05	20/09/2011	EB1119345	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<100	<100	<100	<20	<50	<100	<50	<100	<50	<0.02
	WQ06	WQ06	20/09/2011	EB1119345	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<100	<100	<100	<20	<50	<100	<50	<100	<50	<0.02
	WQST	WQST	20/09/2011	EB1119345	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<100	<100	<100	<20	<50	<100	<50	<100	<50	<0.02
	QA02	WQ09	21/09/2011	EB1119508	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<100	<100	<100	<20	<50	<100	<50	<100	<50	<0.02
	WQ08	WQ08	21/09/2011	EB1119508	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<100	<100	<100	<20	<50	<100	<50	<100	<50	<0.02
	WQ09	WQ09	21/09/2011	EB1119508	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<100	<100	<100	<20	<50	<100	<50	<100	<50	<0.02

Table C6 Elutriate Results – Major Ions, Physical Parameters and Nutrients

						Major Ions and Physical Parameters					Nutrients						
						Alkalinity (Hydroxide) as CaCO3	Alkalinity (total) as CaCO3	Chloride	pH (Final)	Fluoride	Ammonia as N	Kjeldahl Nitrogen Total	Nitrate (as N)	Nitrite (as N)	Nitrogen (Total)	Reactive Phosphorus as P	Sulphate
						µg/L	mg/L	mg/L	pH unit	mg/L	µg/L	mg/L	mg/L	mg/L	µg/L	mg/L	mg/L
					Laboratory Limit of Reporting	1000	1	1	0.1	0.1	5	0.01	0.002	0.002	10	0.001	1
Sampling Event	**Field ID**	**Location Code**	**Sampling Date**	**Work Order**	**Filter**												
Event 4	QA03	WQ12	27/07/2011	EB1114957		<1000	4	<1	6.4	0.1	86	0.05	<0.002	0.08	70	0.092	2
	QA03	WQ12	27/07/2011	EB1114957	.45µm filter	-	-	-	6.4	-	-	-	-	-	-	-	-
	WQ10	WQ10	27/07/2011	EB1114957		<1000	2	<1	7.5	<0.1	24	0.02	<0.002	0.023	30	0.052	2
	WQ10	WQ10	27/07/2011	EB1114957	.45µm filter	-	-	-	7.5	-	-	-	-	-	-	-	-
	WQ11	WQ11	27/07/2011	EB1114957		<1000	22	<1	9.1	0.1	10	<0.01	0.002	0.016	20	0.105	<1
	WQ11	WQ11	27/07/2011	EB1114957	.45µm filter	-	-	-	9.1	-	-	-	-	-	-	-	-
	WQ12	WQ12	27/07/2011	EB1114957		<1000	3	<1	7.7	<0.1	122	0.03	<0.002	0.11	80	0.077	2
	WQ12	WQ12	27/07/2011	EB1114957	.45µm filter	-	-	-	7.7	-	-	-	-	-	-	-	-

Table C7 Elutriate Results - Metals

						Metals																									
						Aluminium	Arsenic	Barium	Beryllium	Boron	Cadmium	Calcium	Chromium (III+VI)	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Molybdenum	Nickel	Phosphorus	Potassium	Selenium	Silver	Sodium	Strontium	Uranium	Vanadium	Zinc
						mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	mg/L	mg/L
Laboratory Limit of Reporting						0.01	0.001	0.001	0.001	0.05	0.0001	1	0.001	0.001	0.001	0.05	0.001	1	0.001	0.001	0.001	0.005	1	0.01	0.001	1	0.001	1	0.01	0.005
Sampling Event	**Field ID**	**Location Code**	**Sampling Date**	**Work Order**	**Filter**																									
Event 4	QA03	WQ12	27/07/2011	EB1114957		2.76	<0.001	0.309	<0.001	0.14	<0.0001	<1	0.002	<0.001	0.002	1.33	0.001	<1	0.009	<0.001	0.001	0.102	<1	<0.01	<0.001	4	0.009	<1	<0.01	0.034
	QA03	WQ12	27/07/2011	EB1114957	.45µm filter	1.14	0.001	0.108	<0.001	0.13	<0.0001	-	<0.001	<0.001	<0.001	0.5	<0.001	-	0.002	<0.001	<0.001	-	-	<0.01	<0.001	-	0.004	<1	<0.01	0.012
	WQ10	WQ10	27/07/2011	EB1114957		1.73	<0.001	0.279	<0.001	0.11	<0.0001	<1	0.003	<0.001	0.002	1.8	0.001	<1	0.023	<0.001	0.002	0.039	<1	<0.01	<0.001	3	0.008	<1	<0.01	0.025
	WQ10	WQ10	27/07/2011	EB1114957	.45µm filter	1.13	<0.001	0.148	<0.001	0.14	<0.0001	-	0.002	<0.001	<0.001	0.9	<0.001	-	0.007	<0.001	<0.001	-	-	<0.01	<0.001	-	0.006	<1	<0.01	0.009
	WQ11	WQ11	27/07/2011	EB1114957		1.04	0.001	0.47	<0.001	0.06	<0.0001	6	0.005	0.002	0.002	1.27	0.002	<1	0.155	<0.001	0.001	0.021	<1	<0.01	<0.001	3	0.047	<1	0.01	0.007
	WQ11	WQ11	27/07/2011	EB1114957	.45µm filter	0.25	0.001	0.397	<0.001	0.05	<0.0001	-	0.003	<0.001	<0.001	0.18	<0.001	-	0.009	<0.001	<0.001	-	-	<0.01	<0.001	-	0.045	<1	<0.01	<0.005
	WQ12	WQ12	27/07/2011	EB1114957		4.24	0.001	0.372	<0.001	0.12	<0.0001	<1	0.003	<0.001	0.003	2.43	0.002	<1	0.014	<0.001	0.002	0.128	<1	<0.01	<0.001	3	0.011	<1	<0.01	0.039
	WQ12	WQ12	27/07/2011	EB1114957	.45µm filter	1.33	<0.001	0.122	<0.001	0.12	<0.0001	-	0.001	<0.001	<0.001	0.62	<0.001	-	0.002	<0.001	<0.001	-	-	<0.01	<0.001	-	0.005	<1	<0.01	0.01

Table C8 Elutriate Results - Hydrocarbons

						Hydrocarbons																							
						PAH/Phenols																TPH							
						Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a) pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Naphthalene	Phenanthrene	Pyrene	>C10 - C16 Fraction	>C16 - C34 Fraction	>C34 - C40 Fraction	TPH C10 - C14	TPH C15 - C28	TPH C29-C36	TPH C10 - C40 (Sum of total)	TPH+C10 - C36 (Sum of total)
						µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Laboratory Limit of Reporting						1	1	1	1	0.5	1	1	1	1	1	1	1	1	1	1	1	100	100	100	50	100	50	100	50
Sampling Event	Field ID	Location Code	Sampling Date	Work Order	Filter																								
Event 4	QA03	WQ12	27/07/2011	EB1114957		<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<100	120	<100	<50	<100	80	120	80
	QA03	WQ12	27/07/2011	EB1114957	.45µm filter	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ10	WQ10	27/07/2011	EB1114957		<1	<1	<1	<1	<0.6	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<100	<100	<100	<50	<100	<50	<100	<50
	WQ10	WQ10	27/07/2011	EB1114957	.45µm filter	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ11	WQ11	27/07/2011	EB1114957		<1	<1	<1	<1	<0.6	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<100	<100	<100	<50	<100	<50	<100	<50
	WQ11	WQ11	27/07/2011	EB1114957	.45µm filter	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ12	WQ12	27/07/2011	EB1114957		<1	<1	<1	<1	<0.6	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<100	<100	<100	<50	<100	<50	<100	<50
	WQ12	WQ12	27/07/2011	EB1114957	.45µm filter	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table C9 Sediment Results – Biological Analyses, Nutrients and PSD

					Biological	Nutrients									PSD															
					Faecal Coliforms	Ammonia as N	Kjeldahl Nitrogen Total	Moisture	Nitrate (as N)	Nitrite (as N)	Nitrogen (Total Oxidised)	Nitrogen (Total)	Reactive Phosphorus as P	TOC	+1180µm	+150µm	+19.0mm	+2.36mm	+300µm	+37.5mm	+4.75mm	+425µm	+600µm	+75.0mm	+75µm	+9.5mm	Clay (<2 µm)	Gravel (>2mm)	Silt (2-60 µm)	Sand (0.06-2.00 mm)
					MPN/g	mg/kg	mg/kg	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
Laboratory Limit of Reporting						20	20	1	0.1	0.1	0.1	20	0.1	0.02	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Sampling Event	Field ID	Location Code	Sampling Date	Work Order																										
Event 4	QA01	WQ04	26/07/2011	EB1114957	4	<20	150	24.3	<0.1	<0.1	<0.1	150	<0.1	0.41	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	QA02	WQ09	27/07/2011	EB1114957	>1100	<20	870	38.2	<0.1	<0.1	<0.1	870	<0.1	1.07	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	WQ01	WQ01	26/07/2011	EB1114957	<3	<20	50	18.7	<0.1	<0.1	<0.1	50	<0.1	0.09	40	97	<1	9	90	<1	<1	81	69	<1	98	<1	1	9	1	89
	WQ02	WQ02	26/07/2011	EB1114957	<3	<20	20	22.8	<0.1	<0.1	<0.1	20	<0.1	0.02	20	98	<1	3	96	<1	<1	85	58	<1	98	<1	1	3	<1	96
	WQ03	WQ03	26/07/2011	EB1114957	<3	<20	30	23	<0.1	<0.1	<0.1	30	<0.1	0.06	24	98	<1	3	97	<1	<1	86	63	<1	98	<1	2	3	<1	95
	WQ04	WQ04	26/07/2011	EB1114957	9	<20	90	25.1	<0.1	<0.1	<0.1	90	<0.1	0.32	<1	78	<1	<1	40	<1	<1	9	1	<1	87	<1	7	<1	5	88
	WQ06	WQ06	27/07/2011	EB1114957	9	40	660	28.1	<0.1	<0.1	<0.1	660	<0.1	0.65	<1	23	<1	<1	8	<1	<1	4	2	<1	47	<1	28	<1	19	53
	WQ08	WQ08	27/07/2011	EB1114957	4	30	110	19.4	<0.1	<0.1	<0.1	110	0.1	0.86	12	62	<1	9	36	<1	4	24	17	<1	80	<1	7	9	11	73
	WQ09	WQ09	27/07/2011	EB1114957	240	<20	1050	39.3	<0.1	<0.1	<0.1	1050	<0.1	0.47	5	62	<1	3	28	<1	<1	15	9	<1	86	<1	6	3	5	86
	WQ10	WQ10	27/07/2011	EB1114957	<3	<20	450	14.3	0.2	<0.1	0.2	450	0.1	0.59	8	73	<1	4	64	<1	2	49	28	<1	76	<1	15	4	8	73
	WQ11	WQ11	27/07/2011	EB1114957	<3	<20	30	17	0.3	<0.1	0.3	30	0.1	0.07	28	94	<1	15	79	<1	6	63	47	<1	96	<1	3	15	<1	82
	WQ12	WQ12	27/07/2011	EB1114957	15	<20	220	18.9	0.1	<0.1	0.1	220	0.2	0.25	7	30	<1	6	17	<1	4	12	9	<1	44	<1	26	6	25	43
	WQ5T	WQ5T	27/07/2011	EB1114957	9	30	940	26.5	<0.1	0.1	0.1	940	0.2	1.12	3	47	<1	1	18	<1	<1	10	6	<1	70	<1	9	1	15	75

Table C10 Sediment Results - Metals

					Metals																						
					Aluminium	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium (III+VI)	Cobalt	Copper	Iron	Lead	Manganese	Mercury	Molybdenum	Nickel	Phosphorus	Selenium	Silver	Strontium	Uranium	Vanadium	Zinc
					mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Laboratory Limit of Reporting					50	0.1	0.1	0.1	50	0.1	0.1	0.1	0.1	50	0.1	0.1	0.1	0.1	0.1	2	1	0.1	0.1	0.1	1	0.1
Sampling Event	Field ID	Location Code	Sampling Date	Work Order																						
Event 4	QA01	WQ04	26/07/2011	EB1114957	2010	0.8	36.5	0.2	<50	<0.1	6	2.4	2.8	3680	2.5	63.2	<0.1	<0.1	2.2	64	<1	<0.1	3.6	0.2	12	4.9
	QA02	WQ09	27/07/2011	EB1114957	1900	0.6	27.6	0.2	<50	<0.1	16.6	3.6	2.6	4280	2.8	127	<0.1	0.1	1.8	136	<1	<0.1	3.9	0.2	13	4.4
	WQ01	WQ01	26/07/2011	EB1114957	600	0.3	12.6	<0.1	<50	<0.1	2.2	0.5	0.6	1360	0.9	13.3	<0.1	<0.1	0.6	25	<1	<0.1	1.4	<0.1	4	1.5
	WQ02	WQ02	26/07/2011	EB1114957	380	0.5	6.8	<0.1	<50	<0.1	1.5	0.5	0.3	1090	0.5	11.4	<0.1	<0.1	0.4	21	<1	<0.1	0.6	<0.1	2	0.8
	WQ03	WQ03	26/07/2011	EB1114957	320	0.3	9.8	<0.1	<50	<0.1	1.6	0.6	0.4	1100	0.4	59.1	<0.1	<0.1	0.5	17	<1	<0.1	0.9	<0.1	3	1.1
	WQ04	WQ04	26/07/2011	EB1114957	1200	0.5	24.1	0.2	<50	<0.1	4.5	1.5	1.7	2220	1.8	27.3	<0.1	<0.1	1.4	47	<1	<0.1	2.8	0.1	8	3.5
	WQ06	WQ06	27/07/2011	EB1114957	7950	1.2	188	0.5	<50	<0.1	17.4	5	8.1	9410	8.4	225	<0.1	0.1	6.6	155	<1	<0.1	21.9	0.7	34	12.5
	WQ08	WQ08	27/07/2011	EB1114957	2860	0.9	20.7	0.2	<50	<0.1	24	2.3	3.6	4880	3.3	58.6	<0.1	0.2	3.3	74	<1	<0.1	2.1	0.1	20	2.6
	WQ09	WQ09	27/07/2011	EB1114957	2100	1.1	33.8	0.2	<50	<0.1	20.3	4.4	3.2	6280	6.2	181	<0.1	0.2	2.1	175	<1	<0.1	4.5	0.2	22	4.7
	WQ10	WQ10	27/07/2011	EB1114957	3280	4	31.5	0.4	<50	<0.1	36.6	4.8	5	10,200	5.2	136	<0.1	0.3	5.3	105	<1	<0.1	5.8	0.4	46	4.4
	WQ11	WQ11	27/07/2011	EB1114957	2020	3.1	665	0.5	<50	<0.1	47.1	28	6.2	12,100	22.4	3450	<0.1	0.4	13.1	45	<1	<0.1	12.1	0.2	51	2.7
	WQ12	WQ12	27/07/2011	EB1114957	6090	1.5	17.4	0.7	<50	<0.1	21.1	4.6	12.1	10,900	6.7	87.4	<0.1	0.3	6.2	92	<1	<0.1	7.1	1.6	32	10
	WQ5T	WQ5T	27/07/2011	EB1114957	2100	1.9	89.7	0.5	<50	<0.1	9.9	5.4	6.3	6720	30.2	232	<0.1	0.1	3.9	199	<1	<0.1	10.5	0.2	24	9.7

Table C11 Sediment Results - Hydrocarbons

Sampling Event	Field ID	Location Code	Sampling Date	Work Order	Hydrocarbons																									
					PAH/Phenols																TPH									
					Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a) pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Naphthalene	Phenanthrene	Pyrene	>C10 - C16 Fraction	>C16 - C34 Fraction	>C34 - C40 Fraction	TPH C6 - C9	TPH C10 - C14	TPH C15 - C28	TPH C29-C36	TPH C10 - C40 (Sum of total)	TPH+C10 - C36 (Sum of total)	TPH C6-C10
					mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	-	-	-	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Laboratory Limit of Reporting					0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	50	100	100	10	50	100	100	50	50	10
Event 4	QA01	WQ04	26/07/2011	EB1114957	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<50	<100	<100	<10	<50	<100	<100	<50	<50	<10
	QA02	WQ09	27/07/2011	EB1114957	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<50	<100	<100	<10	<50	<100	<100	<50	<50	<10
	WQ01	WQ01	26/07/2011	EB1114957	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<50	<100	<100	<10	<50	<100	<100	<50	<50	<10
	WQ02	WQ02	26/07/2011	EB1114957	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<50	<100	<100	<10	<50	<100	<100	<50	<50	<10
	WQ03	WQ03	26/07/2011	EB1114957	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<50	<100	<100	<10	<50	<100	<100	<50	<50	<10
	WQ04	WQ04	26/07/2011	EB1114957	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<50	<100	<100	<10	<50	<100	<100	<50	<50	<10
	WQ06	WQ06	27/07/2011	EB1114957	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<50	<100	<100	<10	<50	<100	<100	<50	<50	<10
	WQ08	WQ08	27/07/2011	EB1114957	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<50	<100	<100	<10	<50	<100	<100	<50	<50	<10
	WQ09	WQ09	27/07/2011	EB1114957	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<50	<100	<100	<10	<50	<100	<100	<50	<50	<10
	WQ10	WQ10	27/07/2011	EB1114957	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<50	<100	<100	<10	<50	<100	<100	<50	<50	<10
	WQ11	WQ11	27/07/2011	EB1114957	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<50	<100	<100	<10	<50	<100	<100	<50	<50	<10
	WQ12	WQ12	27/07/2011	EB1114957	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<50	<100	<100	<10	<50	<100	<100	<50	<50	<10
	WQ5T	WQ5T	27/07/2011	EB1114957	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<50	<100	<100	<10	<50	<100	<100	<50	<50	<10

Appendix E

Doongmabulla Springs

Sampling Analysis Results Summary Tables

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Summary Table - Doongmabulla Springs: Water Quality Analysis Results, Field Measurements

			Field						
			Dissolved Oxygen (% saturated) (Field)	Dissolved Oxygen (Field)	Electrical Conductivity (Field)	pH (Field)	TDS (Field)	Temp (Field)	Turbidity (Field)
			%S	mg/L	uS/cm	pH Units	PPM	oC	NTU
Field_ID	**LocCode**	**Sampled_Date-Time**							
Cattle Creek	Cattle Creek	24/06/2012	-	3.95	935	7.25	-	16.7	-
DS1	DS1	22/05/2012	0.1	-	497	7.98	333	35.5	-1.7
DS1	DS1	24/06/2012	-	0.46	409	6.36	-	26.4	-
DS10	DS10	24/05/2012	0	-	301.5	6.87	202	28.3	3.1
DS10	DS10	22/06/2012	-	0.43	70	6.2	-	25.6	-
DS2A	DS2A	22/06/2012	-	0.22	4.9	5.42	-	-	-
DS3A	DS3A	24/06/2012	-	10.4	604	7.64	-	17.6	-
DS4	DS4	24/06/2012	-	5.41	368	6.34	-	18.5	-
DS5	DS5	24/06/2012	-	3.35	286	7.15	-	25.6	-
DS5B	DS5B	23/05/2012	1	-	204.5	7.6	137	27.2	7.5
DS5B	DS5B	24/06/2012	-	8.55	284	7.27	-	23.2	-
DS6	DS6	24/06/2012	-	4.03	289	6.45	-	23.9	-
DS7	DS7	24/06/2012	-	4.9	330	6.34	-	21.6	-
DS8	DS8	24/06/2012	-	11.29	639	7.73	-	21.3	-
DS9A	DS9A	24/06/2012	-	4.5	353	6.38	-	21.8	-
Dylingo Creek	Dylingo Creek	24/06/2012	-	6.16	510	6.84	-	19	-

Statistical Summary

Number of Results	3	13	16	16	3	15	3
Number of Detects	3	13	16	16	3	15	3
Minimum Concentration	1	0.22	4.9	5.42	137	16.7	-1.7
Minimum Detect	0.1	0.22	4.9	5.42	137	16.7	ND
Maximum Concentration	1	11.29	935	7.98	333	35.5	7.5
Maximum Detect	1	11.29	935	7.98	333	35.5	7.5
Average Concentration	0.37	4.9	380	6.9	224	23	3
Median Concentration	0.1	4.5	341.5	6.855	202	23.2	3.1
Standard Deviation	0.55	3.6	225	0.7	100	4.9	4.6
Number of Guideline Exceedances	0	0	0	0	0	0	0
Number of Guideline Exceedances(Detects Only)	0	0	0	0	0	0	0

Summary Table - Doongmabulla Springs: Water Quality Analysis Results, Major Ions and Alkalinity

Field_ID	LocCode	Sampled_Date-Time	Alkalinity							Major Ions										
			Alkalinity (total) as CaCO3	Alkalinity (Bicarbonate as CaCO3)	Alkalinity (Carbonate as CaCO3)	Alkalinity (Hydroxide) as CaCO3	Bicarbonate	Carbonate	Hardness as CaCO3 (Filtered)	Calcium (Filtered)	Chloride	Magnesium (Filtered)	Potassium (Filtered)	Sodium (Filtered)	Sulphate	Sulphate (Filtered)	Anions Total	Cations Total	Ionic Balance
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	meq/L	meq/L	%
EQL			1	1	1	1			1	1	1	1	1	1	1	1	0.01	0.01	0.01
DS1	DS1	24/05/2012	118	118	<1	<1	144	<1.2	16	3	137	2	16	128	10	-	6.43	6.29	1.12
DS1	DS1	24/06/2012	113	113	<1	<1	-	-	16	3	137	2	14	124	-	8	6.29	6.07	1.83
DS10	DS10	24/05/2012	123	123	<1	<1	150.1	<1.2	40	11	86	3	20	83	8	-	5.05	4.92	1.34
DS10	DS10	22/06/2012	123	123	<1	<1	-	-	40	11	93	3	22	85	-	7	5.23	5.06	1.68
DS11C	DS11C	24/05/2012	230	230	<1	<1	280.6	<1.2	30	4	3	5	55	87	<1	-	4.68	5.8	10.7
DS2A	DS2A	22/06/2012	48	48	<1	<1	-	-	67	2	259	15	20	146	-	6	8.39	8.2	1.18
DS3A	DS3A	24/06/2012	173	173	<1	<1	-	-	7	3	191	<1	6	198	-	<1	8.84	8.92	0.36
DS4	DS4	24/06/2012	152	152	<1	<1	-	-	<1	<1	79	<1	9	119	-	<1	5.27	5.41	1.28
DS5	DS5	24/06/2012	155	155	<1	<1	-	-	<1	<1	40	<1	9	89	-	<1	4.23	4.1	1.54
DS5B	DS5B	23/05/2012	147	147	<1	<1	179.3	<1.2	<1	<1	36	<1	11	86	<1	-	3.95	4.02	0.82
DS5B	DS5B	24/06/2012	157	157	<1	<1	-	-	<1	<1	42	<1	9	95	-	<1	4.32	4.36	0.42
DS6	DS6	24/06/2012	156	156	<1	<1	-	-	<1	<1	45	<1	9	92	-	<1	4.39	4.23	1.84
DS7	DS7	24/06/2012	154	154	<1	<1	-	-	<1	<1	60	<1	8	102	-	<1	4.77	4.64	1.41
DS8	DS8	24/06/2012	182	182	<1	<1	-	-	14	4	162	1	5	184	-	<1	8.21	8.41	1.21
DS9A	DS9A	24/06/2012	151	151	<1	<1	-	-	<1	<1	80	<1	8	113	-	<1	5.27	5.12	1.52
CATTLE CREEK	CATTLE CREEK	24/06/2012	196	196	<1	<1	-	-	94	18	339	12	28	234	-	11	13.7	12.8	3.52
DUP1	DYLINGO CREEK	24/06/2012	111	111	<1	<1	-	-	60	11	173	8	12	132	-	7	7.24	7.26	0.06
DYLINGO CREEK	DYLINGO CREEK	24/06/2012	110	110	<1	<1	-	-	60	11	172	8	14	133	-	8	7.22	7.35	0.9

Statistical Summary

Statistical Summary	Alkalinity (total) as CaCO3	Alkalinity (Bicarbonate as CaCO3)	Alkalinity (Carbonate as CaCO3)	Alkalinity (Hydroxide) as CaCO3	Bicarbonate	Carbonate	Hardness as CaCO3 (Filtered)	Calcium (Filtered)	Chloride	Magnesium (Filtered)	Potassium (Filtered)	Sodium (Filtered)	Sulphate	Sulphate (Filtered)	Anions Total	Cations Total	Ionic Balance
Number of Results	18	18	18	18	4	4	18	18	18	18	18	18	4	14	18	18	18
Number of Detects	18	18	0	0	4	0	11	11	18	10	18	18	2	6	18	18	18
Minimum Concentration	48	48	<1	<1	144	<1.2	<1	<1	3	<1	5	83	<1	<1	3.95	4.02	0.06
Minimum Detect	48	48	ND	ND	144	ND	7	2	3	1	5	83	8	6	3.95	4.02	0.06
Maximum Concentration	230	230	<1	<1	280.6	<1.2	94	18	339	15	55	234	10	11	13.7	12.8	10.7
Maximum Detect	230	230	ND	ND	280.6	ND	94	18	339	15	55	234	10	11	13.7	12.8	10.7
Average Concentration	144	144	0.5	0.5	189	0.6	25	4.7	119	3.5	15	124	4.8	3.6	6.3	6.3	1.8
Median Concentration	151.5	151.5	0.5	0.5	164.7	0.6	15	3	89.5	1.5	11.5	116	4.25	0.5	5.27	5.605	1.31
Standard Deviation	40	40	0	0	63	0	29	5.3	87	4.4	12	43	5	3.9	2.4	2.2	2.3
Number of Guideline Exceedances	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of Guideline Exceedances(Detects Only)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary Table - Doongmabulla Springs: Water Quality Analysis Results, Inorganics

			Inorganics				
			Electrical conductivity *(lab)	Fluoride	pH (Lab)	Silica	Total Dissolved Solids (est.)
			uS/cm	mg/L	pH_Units	mg/L	mg/L
EQL			1	0.1	0.01	0.1	1
Field_ID	**LocCode**	**Sampled_Date-Time**					
DS1	DS1	24/05/2012	635	0.2	7.48	-	413
DS1	DS1	24/06/2012	647	0.2	7.32	15.6	420
DS10	DS10	24/05/2012	502	0.5	7.5	-	326
DS10	DS10	22/06/2012	538	0.6	7.34	14.7	350
DS11C	DS11C	24/05/2012	612	0.5	7.61	-	398
DS2A	DS2A	22/06/2012	886	1	6.29	51.2	576
DS3A	DS3A	24/06/2012	889	0.3	7.99	4.4	578
DS4	DS4	24/06/2012	526	0.3	7.54	15.3	342
DS5	DS5	24/06/2012	419	0.5	7.69	15	272
DS5B	DS5B	23/05/2012	376	0.4	8.01	-	244
DS5B	DS5B	24/06/2012	416	0.5	7.86	14.2	270
DS6	DS6	24/06/2012	426	0.4	7.31	15.2	277
DS7	DS7	24/06/2012	472	0.3	7.5	15.1	307
DS8	DS8	24/06/2012	807	0.3	7.69	12.8	524
DS9A	DS9A	24/06/2012	534	0.4	7.99	16.4	347
CATTLE CREEK	CATTLE CREEK	24/06/2012	1370	0.4	7.59	16	890
DUP1	DYLINGO CREEK	24/06/2012	745	0.3	7.51	14.6	484
DYLINGO CREEK	DYLINGO CREEK	24/06/2012	742	0.2	7.39	15.2	482

Statistical Summary

Number of Results	18	18	18	14	18
Number of Detects	18	18	18	14	18
Minimum Concentration	376	0.2	6.29	4.4	244
Minimum Detect	376	0.2	6.29	4.4	244
Maximum Concentration	1370	1	8.01	51.2	890
Maximum Detect	1370	1	8.01	51.2	890
Average Concentration	641	0.41	7.5	17	417
Median Concentration	575	0.4	7.525	15.15	374
Standard Deviation	243	0.19	0.38	10	158
Number of Guideline Exceedances	0	0	0	0	0
Number of Guideline Exceedances(Detects Only)	0	0	0	0	0

Summary Table - Doongmabulla Springs: Water Quality Analysis Results, Dissolved Metals

			Metals											
			Arsenic (Filtered)	Cadmium (Filtered)	Chromium (III+VI) (Filtered)	Cobalt (Filtered)	Copper (Filtered)	Iron (Filtered)	Lead (Filtered)	Manganese (Filtered)	Mercury (Filtered)	Nickel (Filtered)	Vanadium (Filtered)	Zinc (Filtered)
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
EQL			0.001	0.0001	0.001	0.001	0.001	0.05	0.001	0.001	0.0001	0.001	0.01	0.005
Field_ID	**LocCode**	**Sampled_Date-Time**												
DS1	DS1	24/06/2012	0.002	<0.0001	<0.001	0.002	<0.001	0.79	<0.001	0.055	<0.0001	<0.001	<0.01	0.007
DS10	DS10	22/06/2012	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.05	<0.001	0.136	<0.0001	<0.001	<0.01	0.005
DS3A	DS3A	24/06/2012	<0.001	<0.0001	<0.001	<0.001	0.001	0.58	<0.001	0.028	<0.0001	0.001	<0.01	0.014
DS4	DS4	24/06/2012	<0.001	<0.0001	<0.001	<0.001	<0.001	0.16	<0.001	0.004	<0.0001	<0.001	<0.01	0.007
DS5	DS5	24/06/2012	0.002	<0.0001	<0.001	<0.001	<0.001	0.23	<0.001	0.008	<0.0001	<0.001	<0.01	0.008
DS5B	DS5B	24/06/2012	0.002	<0.0001	<0.001	<0.001	<0.001	0.21	<0.001	0.005	<0.0001	<0.001	<0.01	0.006
DS6	DS6	24/06/2012	<0.001	<0.0001	<0.001	<0.001	<0.001	0.27	<0.001	0.019	<0.0001	<0.001	<0.01	0.007
DS7	DS7	24/06/2012	0.002	<0.0001	<0.001	<0.001	<0.001	0.14	<0.001	0.005	<0.0001	<0.001	<0.01	0.006
DS8	DS8	24/06/2012	<0.001	<0.0001	0.001	<0.001	0.003	0.6	<0.001	0.02	<0.0001	0.001	<0.01	0.009
DS9A	DS9A	24/06/2012	0.001	<0.0001	<0.001	<0.001	<0.001	0.06	<0.001	0.002	<0.0001	<0.001	<0.01	0.013
CATTLE CREEK	CATTLE CREEK	24/06/2012	<0.001	<0.0001	<0.001	0.001	<0.001	0.33	<0.001	0.255	<0.0001	0.001	<0.01	0.007
DUP1	DYLINGO CREEK	24/06/2012	<0.001	<0.0001	<0.001	0.001	0.001	0.25	<0.001	0.284	<0.0001	0.001	<0.01	0.012
DYLINGO CREEK	DYLINGO CREEK	24/06/2012	<0.001	<0.0001	<0.001	0.001	0.001	0.26	<0.001	0.29	<0.0001	0.001	<0.01	0.008
Statistical Summary														
Number of Results			13	13	13	13	13	13	13	13	13	13	13	13
Number of Detects			5	0	1	4	4	12	0	13	0	5	0	13
Minimum Concentration			<0.001	<0.0001	<0.001	<0.001	<0.001	<0.05	<0.001	0.002	<0.0001	<0.001	<0.01	0.005
Minimum Detect			0.001	ND	0.001	0.001	0.001	0.06	ND	0.002	ND	0.001	ND	0.005
Maximum Concentration			0.002	<0.0001	0.001	0.002	0.003	0.79	<0.001	0.29	<0.0001	0.001	<0.01	0.014
Maximum Detect			0.002	ND	0.001	0.002	0.003	0.79	ND	0.29	ND	0.001	ND	0.014
Average Concentration			0.001	0.00005	0.00054	0.00073	0.00081	0.3	0.0005	0.085	0.00005	0.00069	0.005	0.0084
Median Concentration			0.0005	0.00005	0.0005	0.0005	0.0005	0.25	0.0005	0.02	0.00005	0.0005	0.005	0.007
Standard Deviation			0.00071	0	0.00014	0.00044	0.00069	0.22	0	0.11	0	0.00025	0	0.0028
Number of Guideline Exceedances			0	0	0	0	0	0	0	0	0	0	0	0
Number of Guideline Exceedances(Detects Only)			0	0	0	0	0	0	0	0	0	0	0	0

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