NEW HOPE
GROUP

H.2 IESC Submission

Contents

Executive Summary

New Acland Coal Pty Ltd (NAC) currently operates the existing New Acland Coal Mine (the Mine) in southeast Queensland's Clarence-Moreton Basin. NAC is proposing to develop the New Acland Coal Mine Stage 3 Project (the revised Project), which involves the extension of the Mine's operating life to approximately 2029. An Environmental Impact Statement (EIS) has been prepared for the revised Project that addresses the Terms of Reference (ToR) issued by the Queensland Coordinator-General. The ToR includes the requirement to provide a stand-alone document on the revised Project's potential impacts on water resources. This stand-alone document has been prepared having regard to the *Independent Expert Scientific Committee Information Guidelines for Proposals Relating to the Development of Coal Seal Gas and Large Coal Mines where there is a Significant Impact on Water Resources*.

The revised Project site is wholly located in the Lagoon Creek catchment. Lagoon Creek is an ephemeral creek with a shallow narrow poorly defined channel and wide floodplains, flowing only following periods of significant rainfall into Oakey Creek which is part of the larger Condamine River Catchment. Lagoon Creek has been moderately disturbed through past agricultural practices including a number of in-stream dams. The revised Project lies immediately south of the Myall Creek catchment; no part of the revised Project site is within the Myall Creek catchment. Spring Creek is the closest tributary of Myall Creek to the revised Project site, and is located 2.5 km north of the revised Project site. Myall Creek joins the Condamine River 48 km west of the revised Project site.

Five aquifers exist within the revised Project site; the Quaternary alluvial aquifer, the Tertiary basalt aquifer, the Walloon Coal Measures aquifer, and the deeper Marburg Sandstone and Helidon Sandstone aquifers. The Quaternary Alluvial aquifer is limited in spatial extent and within the revised Project site may only exist within the westernmost part in association with Lagoon Creek, although investigations have shown that Lagoon Creek is very likely disconnected from the regional groundwater system. The alluvial aquifer is known to form a significant groundwater resource outside of the revised Project site, especially in association with Oakey Creek south of the revised Project site and Myall Creek northwest of the revised Project site.

There is only minor outcrop of the Tertiary Basalt aquifer in the northwestern and extreme southwestern sections of the revised Project site and therefore it is unlikely that mining activities will have a direct regional impact on the basalt aquifer; however, the depositional environment means that mining undertaken as part of the revised Project has the potential to cause groundwater drawdown in the basalt aquifer as mining occurs. The Walloon Coal Measures aquifer forms the main groundwater aquifer intersected by the revised Project and on a local scale it is known to support significant groundwater extraction for stock and domestic use. The Marburg Sandstone and Helidon Sandstone aquifers lie at significant depth below the revised Project's mine pits and are separated from them by significant thicknesses of low-permeability strata. As such only very small impacts from the revised Project are expected on the Marburg Sandstone aquifer and no impacts will occur to the Helidon Sandstone aquifer.

No environmental users of groundwater have been identified within or adjacent to the revised Project site (i.e. Groundwater Dependent Ecosystems (GDEs)). A search of existing GDE mapping identified a low to moderate potential for the presence of terrestrial vegetation that is reliant on the occurrence of subsurface groundwater within the Study area. On ground work has shown that terrestrial ecosystems within and adjacent the revised Project site rely on rainfall and residual soil moisture, and those located adjacent Lagoon Creek are also reliant on surface water flows and flooding in the creek. Aquatic ecosystems in the revised Project site are only found along Lagoon Creek, associated with a series of temporal pools and farm dams during the dry season. The short-lived periods of flow throughout the wet season during or immediately following rainfall temporarily increase the diversity of aquatic habitats within Lagoon Creek. Water quality values frequently exceed the guidelines for the protection of moderately disturbed aquatic ecosystems. Macrophyte diversity within Lagoon Creek is low generally restricted to permanent waterbodies. Only a small number of fish species, which are highly tolerant of degraded habitat and poor water quality, are likely to persist in the revised Project site.

Mine pit inflows are predicted to range from 0.8 to 4.0 ML/day during mining, with drawdown of 1 to 5 m in the Walloon Coal Measures and Tertiary Basalt aquifers extending approximately 7 km west from the revised Project's boundary. Groundwater extraction (mine pit inflows) from the Walloon Coal Measures associated with the revised Project are about 1% of the basin-scale CSG extraction volumes and impacts on the regional water balance from groundwater extraction associated with mining are considered negligible in comparison to CSG. Drawdown in the Walloon Coal Measures aquifer to the south and east of the revised Project site is not predicted to exceed much more than 5 m outside the Project's boundaries. Drawdown within the Marburg Sandstone aquifer is predicted to be less than 3 m throughout the revised Project's duration.

After cessation of mining in 2030, groundwater levels are predicted to gradually recover so that for the most part there is less than 5 m residual drawdown outside the revised Project's boundaries. Recovery to pre-mining conditions throughout the revised Project site is limited by evapotranspirative losses from the depressed landforms (rehabilitated final voids). Due to the high regional potential evapotranspiration rate, groundwater discharge to the depressed landforms is predicted continue at a rate only slightly less (3.5 ML/day) to that in the last year of mine operation. Drawdown adjacent the last areas to be mined is predicted to remain relatively high (approximately 20 to 30 m) due to the ongoing evaporation-driven groundwater discharge into the depressed landforms. Residual drawdowns outside the Study area are for the most part not expected to cause long term negative effect on groundwater users outside the revised Project site. A pit lake is expected to form within the Manning Vale West depressed landform, but a lake may not form to any significant degree in the Willeroo depressed landform and is not expected to form at all in the Manning Vale East depressed landform. The depressed landforms form a depression of the potentiometric surface and act as a groundwater sink that will not permit any pooled water within or adjacent to the depressed landforms (rehabilitated final voids) to flow outwards into the regional groundwater system. The revised Project is not expected to cause in impact to groundwater quality either during or post-mining.

Diversion or alteration of the Lagoon Creek channel is not proposed to occur as part of the revised Project and the revised Project's resource areas are offset from the creek bank by approximately 150 m. The 150 m operational offset includes a commitment by NAC to a 50 m 'no mining' buffer to promote the re-establishment of the creek's riparian zone. The revised Project is not expected to have a significant impact on the existing flood regime of Lagoon Creek, and impacts to flooding as a result of the proposed flood protection levee and railway crossing are largely located on land owned by the Acland Pastoral Company (APC), owned by the New Hope Group). There is no increase in the extent of inundation or water surface levels on any properties not owned by NAC. Furthermore, analysis indicates there will be negligible impacts to water users downstream of the revised Project site including no significant impacts on the flood warning in Jondaryan.

The revised Project will have a negligible impact on the existing flow regime. No licenced surface water users were identified on Lagoon Creek with the closet downstream user located after the Oakey Creek confluence 19 km downstream of the revised Project site. Therefore, the impacts of the revised Project to downstream users and the environment are expected to be negligible.

Flood protection for the revised Project's resource areas will be provided through two flood levees designed to provide protection from a PMF flood event, which is well in excess of the current legislative requirements. In addition, NAC has committed to ensuring the revised Project's final landform is outside the existing PMF flood extent, and as a result, there are no flooding impacts on the key aspects of the proposed final landform. Water in the final landform will be located over 50 m below natural surface level and as a result there is no risk of contamination of other surface waters from groundwater inflows to the final landform.

As part of NAC's water management system, runoff from disturbed areas will be captured and treated with an amount available for reuse by the revised Project's mining activities. NAC's water management system will include a controlled release system to manage rainfall events and minimise adverse impacts to the downstream receiving environment. The ephemeral nature of Lagoon Creek means that controlled releases will occur on a minimal basis over the life of the revised Project, and are not expected to have a significant impact on water quality, aquatic ecology and downstream water users.

NAC is not seeking any new water allocations for the revised Project other than those already held by the Mine. The majority of the revised Project water demands are provided from the Toowoomba Wastewater Reclamation Facility (WWRF) through a pipeline constructed in 2009, supplemented by less than 50ML per year from the Tertiary basalt and Marburg Sandstone aquifers. The beneficial use of a waste water product through the WWRF ensures the revised Project possesses a sufficient and reliable water supply.

1 Introduction

1.1 Background

New Acland Coal Pty Ltd (NAC) currently operates the existing New Acland Coal Mine (the Mine) in southeast Queensland's Clarence-Moreton Basin, as a 4.8 million tonne (product coal) per annum (Mtpa) open cut coal mine on mining lease (ML) 50170 and ML 50216, within the original boundary of Mineral Development Licence (MDL) 244, and under the approval of Environmental Authority (EA) EPML00335713.

NAC is proposing to develop the New Acland Coal Mine Stage 3 Project (the revised Project), which involves the extension of the Mine's operating life to approximately 2029 with the inclusion and progressive development of two new resource areas within MLA 50232. These resource areas are identified as the Manning Vale and Willeroo resource areas. The revised Project is expected to extend the Mine's operating life until approximately 2029.

NAC submitted an Environmental Impact Statement (EIS) in November 2009 for the New Acland Stage 3 Coal Mine Expansion Project (the original proposal), which involved the staged expansion of the Mine up to a capacity of 10 Mtpa. The original proposal was expected to extend coal production at the Mine until approximately 2042.

Since that time, the New Hope Group (NHG) liaised with the State and Commonwealth governments in the preparation of a Supplementary Report. Prior to the finalisation of the Supplementary Report, the NHG revised the Project's scope, in response to comments and concerns raised by Government and other stakeholders during the EIS process. The NHG understands the importance of properly securing its social licence to operate, and as a consequence, has made significant changes to the original proposal.

On 9 November 2012, the Commonwealth Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) made a decision to accept a 'project variation' under Section 156B of the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). The revised Project will be assessed under the Bilateral Agreement between the Queensland and Australian governments.

An EIS has been prepared for the revised Project. This EIS has been prepared to inform decision makers, affected parties, interest groups and the public about potential environmental issues relating to the development and operation of the revised Project and how these issues will be managed. This EIS supersedes the EIS (November 2009) for the original proposal, and therefore the content of the original EIS will not be evaluated in the future assessment of the revised Project.

The final Terms of Reference (ToR) for the revised Project were issued March 2013. The proponent was requested to provide a stand-alone document to the Coordinator-General that includes details of the revised Project's potential impact on water resources. The document must be provided when the EIS is lodged. On 13 March 2013, an amendment to the EPBC Act was introduced into Federal Parliament to enable water resources to become a matter of national environmental significance in relation to coal seam gas and large coal mining development. The amendment was passed in June 2013 and is now in force, providing the Minister with the power to consider and impose conditions directly relating to impacts on a water resource itself.

This stand-alone document, as required by the ToR, has been prepared in accordance with the *Independent Expert Scientific Committee Information Guidelines for Proposals Relating to the Development of Coal Seal Gas and Large Coal Mines where there is a Significant Impact on Water Resources*.

Section 1 provides more detail of the revised Project.

1.2 Methodology

The methodology undertaken to prepare this document draws on the methodology set out in the *Information Guidelines for Proposals Relating to the Development of Coal Seam Gas and Large Coal Mines where there is a Significant Impact on Water Resources* (IESC, 2013) and includes:

- A description of the proposal.
- An assessment of likely significant impacts on water resources and water related assets.
- A site and regional water balance.
- An assessment of risk.
- An assessment of cumulative impacts.
- A plan for ongoing management and monitoring.

The information contained within this document is largely drawn from the revised Project's EIS, with additional information to meet the IESC's Information Guidelines as required.

2 Project Description

2.1 Introduction

The Project Proponent is NAC, which is a fully owned subsidiary of New Hope Corporation Limited. New Hope Corporation Limited is an independent Australian company, publicly listed on the Australian Stock Exchange. Both NAC and New Hope Corporation Limited are part of the New Hope Group (NHG). Further information on the NHG can be found on their website: http://www.newhopegroup.com.au/

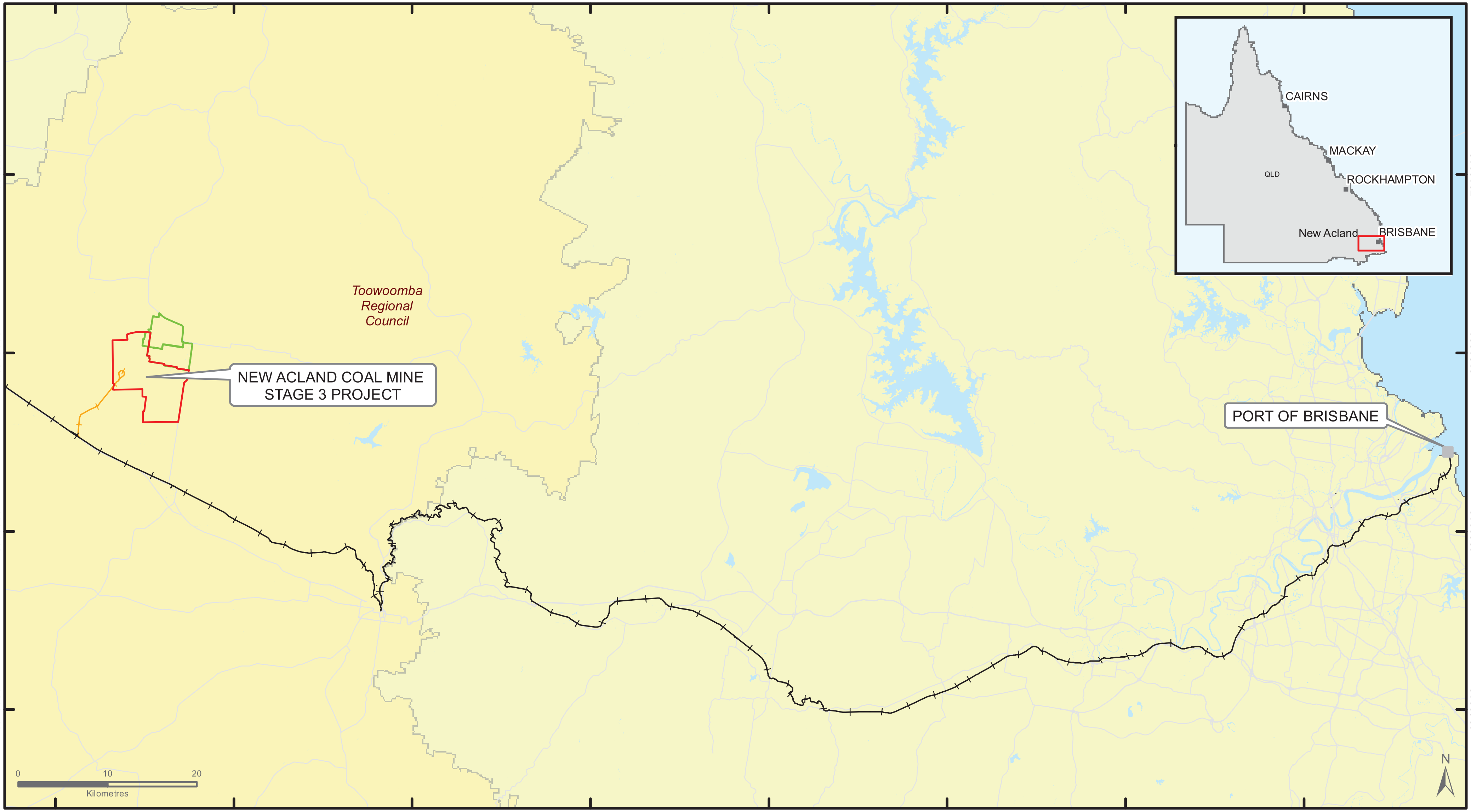
NAC currently operates the Mine as a 4.8 million tonne (product coal) per annum (Mtpa) open cut coal mine on Mining Lease (ML) 50170 and ML 50216 within Mineral Development Licence (MDL) 244, under the approval of Environmental Authority EPML00335713. The Mine extracts coal reserves from the Walloon Coal Measures of the Clarence-Moreton Basin. The Mine reserve is forecast to be depleted by 2018. The revised Project involves the extension and operation of the Mine, while increasing production from 4.8 Mtpa up to 7.5 Mtpa of thermal product coal. **Figure 2-1** presents the location of the Mine and the revised Project.

The revised Project involves the extension of the Mine's operating life to approximately 2029 with the inclusion and progressive development of two new resource areas within MLA 50232. These resource areas are identified as the Manning Vale and Willeroo resource areas. The revised Project will include mining in three new mine pits, namely Manning Vale West, Manning Vale East and Willeroo mine pits.

The NHG has invested significantly to secure surface rights over future development areas within MDL 244, to establish buffer zones between operations and surrounding landowners, and to secure transport corridors. Negotiations with landowners have involved several strategies including outright purchase, option to purchase and compensation agreements. The majority of landowners have opted to sell their properties outright. Since the development of the Mine, the NHG has acquired 160 lots totalling 10,151 ha from 157 owners. The NHG owns the majority of the land within MLA 50232. The APC is responsible for the sustainable management of the NHG's Acland district landholdings, which generally involves the application of recognised agricultural practices outside the active mine areas.

2.2 Revised Project Overview

The revised Project overview is shown in **Figure 2-2**. The key elements of the revised Project are outlined below.



LEGEND

- Towns and Localities
- Major Road
- Western Rail Line
- Revised Project Rail Spur
- New Aland Coal Mine Stage 3 Project MLA Boundary
- New Acland Coal Mine
- Local Government Area
- Water Resource

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NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 2-1
Revised Project Location

Scale 1:600,000 on A4
Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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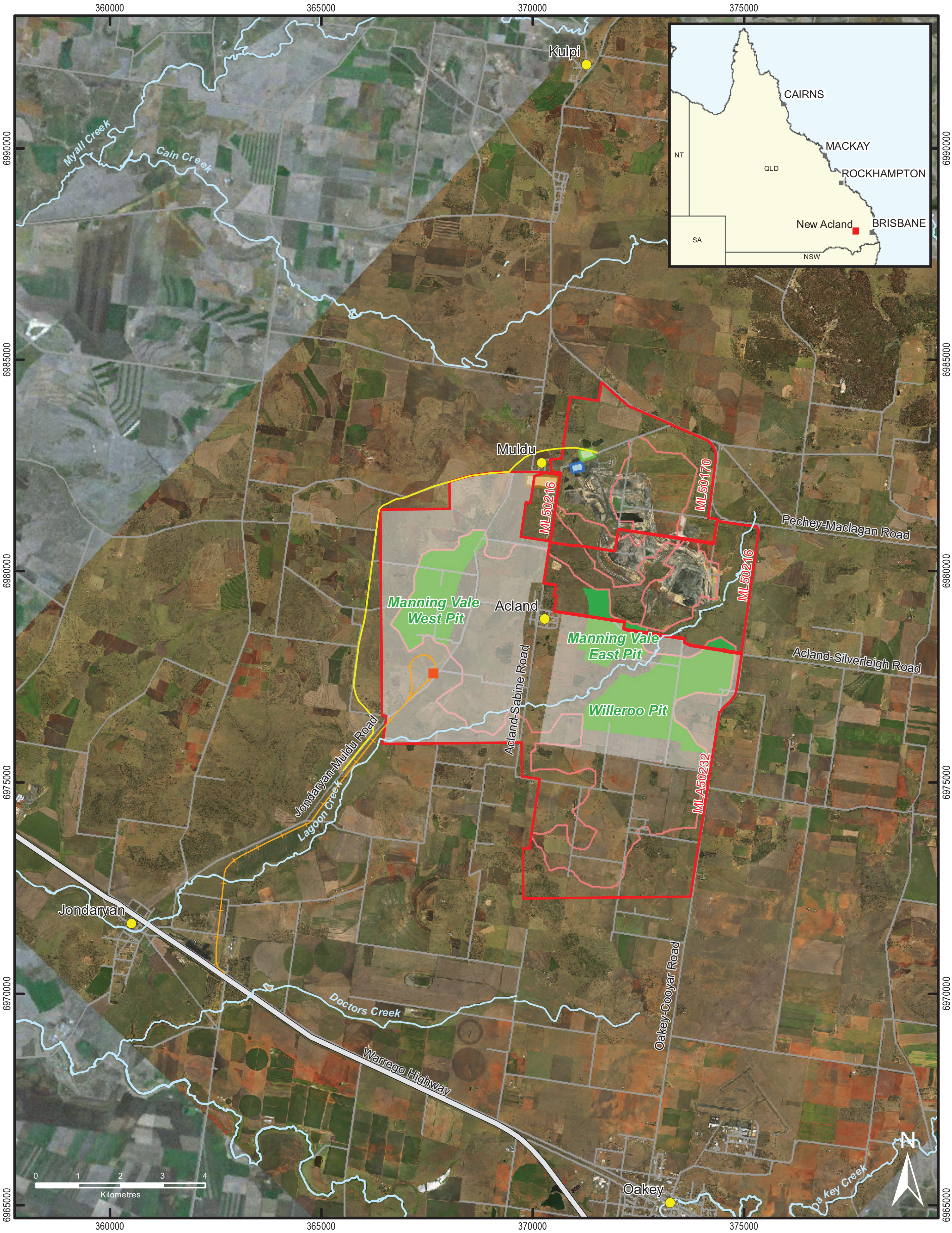

LEGEND

- Towns and Localities
- Train Loadout Facility
- Rail Spur
- Roads
- Creeks
- Jondaryan-Muldu Road Diversion
- Proposed Extent of Surface Rights Area
- Coal Resource Area
- Mining Tenements
- Stage 3 Pit Areas
- CHPP Precinct
- Material Handling Facility
- Mine Industrial Area

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NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 2-2 - Revised Project Overview

Scale 1:120,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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2.2.1 Mine Development

The mine will consist of the following key components:

- continuation of existing mining activities to progressively extend to parts of the Manning Vale and Willeroo resource areas within MLA 50232, located to the south and west of current MLs 50170 and 50216;
- production of up to 7.5 Mtpa of product coal equating to approximately 14 Mtpa Run-of-Mine (RoM) coal;
- production of up to 80.4 Mt of product coal over the life of the revised Project;
- maintenance of the existing thin seam coal mining equipment, continuation of the current open cut mining techniques and expansion of the truck and loader mining fleet;
- progressive disposal of coarse rejects to cells within the overburden dumps, along with fine tailings being disposed of in In-Pit Tailings Storage Facilities (ITSFs);
- emplacement of two out-of-pit spoil dumps associated with the Manning Vale and Willeroo mine pits; and
- generation of three depressed landforms at the end of mining by backfilling and re-profiling final mine pits.

In determining the viability of the mine's development, the revised Project reserves have been extensively tested by drilling, geophysical logging, ground geophysics, geotechnical, hydrogeological and geochemical investigations by New Hope Exploration Pty Ltd (NHEPL), a subsidiary of NHCL and sister company to NAC.

2.2.2 Mine Plan Schedule

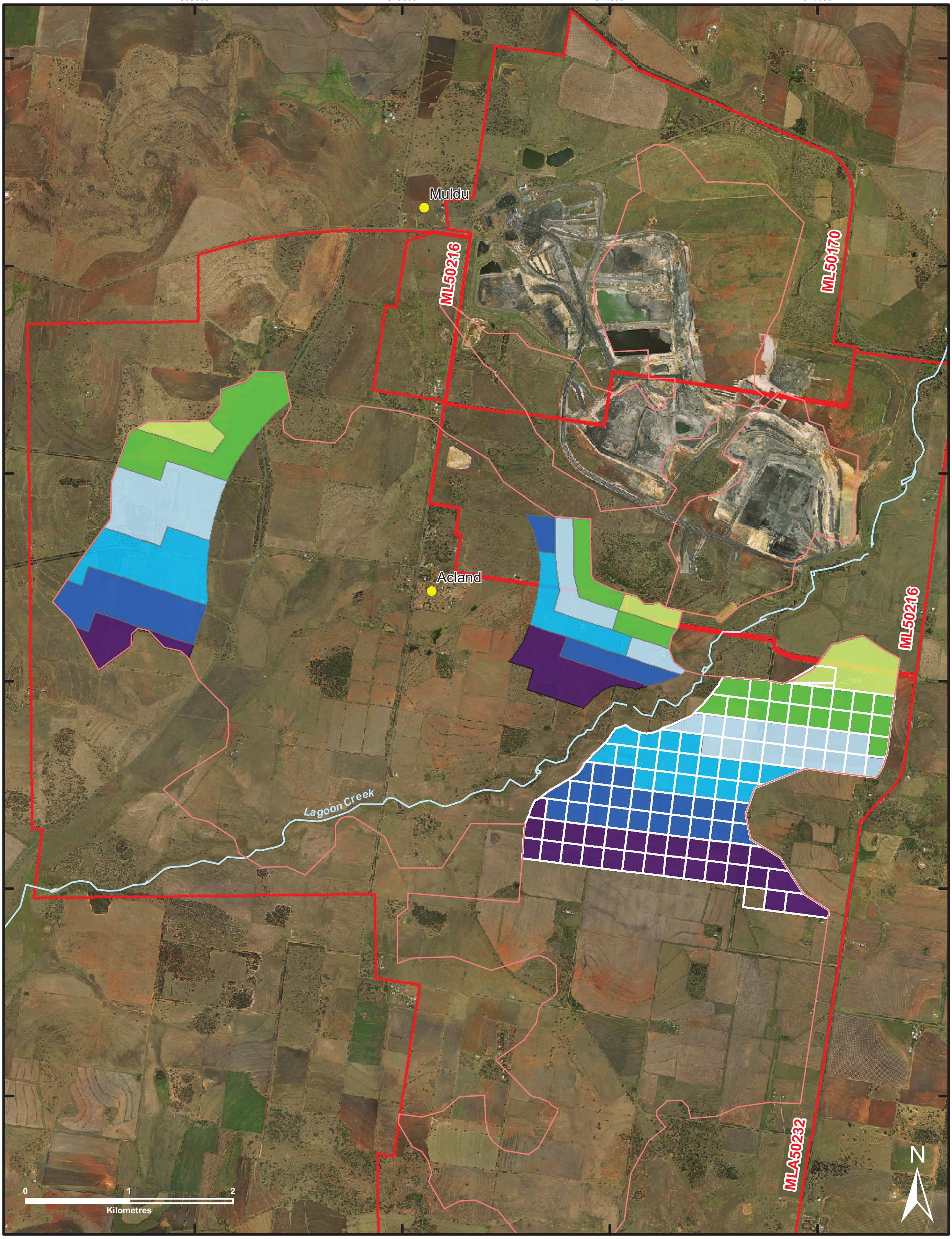
The revised Project involves the continued development of the Mine by the progressive commissioning of two additional resource areas within MLA 50232. The two resource areas will be developed sequentially and combined with the current operations to supply up to 7.5 Mtpa of saleable product coal for export and domestic markets until approximately 2029.

Life of Mine Schedule

The life of mine schedule is outlined in **Figure 2-3**. The life of mine schedule has been developed to allow an exclusion zone around Acland, increase the buffer distance from Oakey and to avoid disturbance of Lagoon Creek.

Final Landform Design

The revised Project's final landform design comprises a two staged approach initially involving the completion of mining activities which will result in a void being created in each of the three mine pits. The second stage involves the backfilling and re-shaping of the voids to create depressed landforms. **Figure 2-4** provides the proposed conceptual final landform including the locations of



LEGEND

- Towns and Localities
- Mining Tenements
- Coal Resource Area
- Creeks

Year

- FY2017-18
- FY2019-20
- FY2021-22
- FY2023-24
- FY2025-26
- FY2027-29

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NEW ACLAND COAL MINE
STAGE 3 PROJECT

Figure 2-3 - Life of Mine Schedule

Scale 1:50,000 on A4

Projection: Australian Geodetic Datum - Zone 56 (AGD84)

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LEGEND

- Towns and Localities
- Rail Spur
- Roads
- Creeks
- Mining Tenements

Elevation	
604 - 636	480 - 511
573 - 604	449 - 480
542 - 573	417 - 449
511 - 542	386 - 417
	355

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NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 2-4 - Conceptual Final Landform

Scale 1:54,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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Produced: 29/08/2013

the elevated landforms (former out-of-pit spoil dumps) and the depressed landforms (former residual voids).

2.2.3 Associated Infrastructure

The key infrastructure requirements for the revised Project are outlined below:

- upgrade of the existing CHPP complex, RoM and product coal stockpile areas and supporting infrastructure on ML 50170;
- continued use of tailings disposal within ITSFs located in-pit on ML areas;
- continued use of recycled water from the Wetalla Wastewater Reclamation Facility (WWRF) within current allocations supplied from Toowoomba via an approved 45 km pipeline that is currently fully operational;
- continued use of a mine surface water management system involving various water management structures staged to accommodate the progressive development of the Mine and based on the principles of diverting clean water and capturing and reusing water from disturbed areas;
- upgrades to the existing administration and heavy vehicle maintenance area on ML 50170;
- relocation and potential upgrade of the current power supply for the mine operation and the local 11kV distribution system;
- diversion of the Jondaryan-Muldu Road around the Manning Vale resource area;
- decommissiong of the Jondaryan Rail Loadout Facility (JRLF);
- construction of a new 8 km rail spur line and balloon loop from Jondaryan onto MLA 50232;
- construction of the Train Loadout Facility (TLF) within MLA 50232; and
- relocation and potential upgrade of the existing local telecommunication network.

It is anticipated the construction period for associated infrastructure will occur from 2015 to 2017.

2.2.4 Accommodation and Workforce

No construction or operational camps will be located on-site during the construction and operational phases of the revised Project. Construction and operational workforces will reside in regional towns and cities. Arrival and departure times for workers will be staggered by at least half-an-hour to minimise traffic and other interactions.

2.2.5 Environmental Management

An EM Plan will be developed for the revised Project and consist of the following key components:

- environmental values likely to be affected;
- potential adverse and beneficial impacts;
- environmental protection objectives; and
- control strategies adopted to achieve these environmental protection objectives.

  In particular, the EM Plan will facilitate the:

- development of a suitable ‘offset’ strategy to satisfy State and Federal requirements for clearance of significant vegetation communities within new operational areas (i.e. extent of surface rights areas); and
- development of a comprehensive progressive rehabilitation program involving continuous monitoring and reporting in line with the agreed post mining land use.

3 Existing Environment – Groundwater

3.1 Project Location

The revised Project site is situated in the western portion of the Clarence-Moreton Basin. The Walloon Coal Measures within the Clarence-Moreton Basin underlie the revised Project site and regionally contain an estimated coal resource of over 800 million tonnes.

3.2 Regulatory Framework

3.2.1 Queensland Legislation

Groundwater use and management in Queensland is regulated under the:

- Water Act 2000
- Water Regulation 2002 (Water Regulation)
- Environmental Protection Act 1994 (EP Act)
- Environmental Protection (Water) Policy 2009 (EPP (Water)).

In Queensland, a number of groundwater areas have been established to project underground water resources. A groundwater area is an area identified in the Water Regulation 2002 (Water Regulation), a water resource plan or a wild river declaration within which management requirements for groundwater exist.

The revised Project sits within the Eastern Downs Groundwater Management Unit (GMU), and to a very minor extent the Oakey Creek Groundwater Management Area where alluvial sediments exist in the southeastern most portion of the revised Project site. **Section 3.3** describes the occurrence of alluvial sediments across the revised Project site.

Authorisation is required to take subartesian water where the water is taken from:

(a) a sub-artesian area declared under Schedule 11 of the Water Regulation;

(b) a groundwater management area established under the Water Regulation;

(c) a groundwater management area or sub-artesian management area established under a water resource plan.

The EP Act provides the framework for the management of natural resources in Queensland. The objective of the EP Act is to achieve ecological sustainable development. The EPP (Water) is made under the EP Act. The purpose of the EPP (Water) is to achieve the object of the EP Act in relation to Queensland Waters. Queensland Waters include water in aquifers. The purpose of the EPP (Water) is stated to be achieved by:

(a) identifying environmental values and management goals for Queensland waters; and

(b) stating water quality guidelines and water quality objectives to enhance or protect the environmental values; and

(c) providing a framework for making consistent, equitable and informed decisions about Queensland waters; and

(d) monitoring and reporting on the condition of Queensland waters.

For particular water resources, Schedule 1 to the EPP (Water) sets out environmental values to be enhanced to protected. Otherwise, the environmental values to be enhanced or protected are those set out in 6(2) of the EPP (Water).

Water resources relevant to the revised Project are not listed in schedule 1 of the EPP (Water)Therefore, for the revised Project, the environmental values (EVs) for groundwater are identified in section 6(2) of the EPP (Water) which are described as:

- Aquatic Ecosystems
  a) for high ecological value waters—the biological integrity of an aquatic ecosystem that is effectively unmodified or highly valued;
  b) for slightly disturbed waters—the biological integrity of an aquatic ecosystem that has effectively unmodified biological indicators, but slightly modified physical, chemical or other indicators;
  c) for moderately disturbed waters—the biological integrity of an aquatic ecosystem that is adversely affected by human activity to a relatively small but measurable degree;
  d) for highly disturbed waters—the biological integrity of an aquatic ecosystem that is measurably degraded and of lower ecological value than waters mentioned in paragraphs (a) to (c).

  Regional, Agricultural and industrial Use
  a) for waters that may be used for producing aquatic foods for human consumption—the suitability of the water for waters that may be used for aquaculture—the suitability of the water for aquacultural use;
  b) for waters that may be used for agricultural purposes—the suitability of the water for agricultural purposes;
  c) for waters that may be used for recreation or aesthetic purposes, the suitability of the water for—
     1. primary recreational use; or
     2. secondary recreational use; or
     3. visual recreational use;
  d) for waters that may be used for industrial purposes—the suitability of the water for industrial use;
  e) the cultural and spiritual values of the water.

  Drinking water (Potable)
  a) for waters that may be used for drinking water—the suitability of the water for supply as drinking water as defined by the Australian Drinking Water Guidelines (ADWG).

3.2.2 Groundwater Management Units

The revised Project site is located within both the Eastern Downs GMU, and a small portion of the Oakey Creek Groundwater Management Area GMU where alluvial sediments associated with Oakey Creek and its tributaries lie within the southeastern most extent of the revised Project site (**Section 3.3** describes occurrence of this alluvium in relation to the revised Project site). The size of the Eastern Downs GMU in Queensland is 22,635 km^2 whilst the size of the Oakey Creek GMU is 213 km^2.

Capping of resource extraction volumes is an accepted way to manage overexploitation of groundwater. In both the Eastern Downs and Oakey Creek GMUs, a water resource cap has been placed on groundwater usage which applies to irrigation, urban supply, commercial / industrial, forestry, drought supply and mining / oil and gas. Groundwater users are required to hold entitlements to extract groundwater from the GMUs for these purposes. The water resource cap does not include stock and domestic supplies.

3.2.3 Water Resource (Great Artesian Basin) Plan 2006

The *Water Resource (Great Artesian Basin) Plan 2006*, which is a subordinate regulation to the Water Act (2000), covers the management of all artesian and subartesian water in the Eastern Downs GMU. This coverage includes management of the Walloon Coal Measures aquifer, Marburg Sandstone aquifer and Helidon Sandstone aquifer.

3.2.4 Water Resource (Condamine and Balonne) Plan 2004

The Water Resource (Condamine and Balonne) Plan 2004, which is a subordinate regulation to the Water Act, provides a framework for advancing sustainable management and efficient use of water by creating an effective cap on diversions from watercourses, lakes, springs and overland flows in the Condamine and Balonne Water Resource Plan (WRP) Area. The *Condamine and Balonne draft resource operations plan amendment proposes amendments* for the *draft Condamine and Balonne resource operations plan* and was released on 28 October 2013 for public comment. A moratorium is currently in place for Condamine and Balonne WRP Area that limits new development related to water in a watercourse or lake, water in springs not connected to artesian groundwater, and overland flow water.

3.2.5 Environmental Authority

The Mine operates under EA EPML00335713 in accordance with the EP Act. The EA includes conditions for the monitoring of groundwater levels and quality (Conditions C21 to C33).

For compliance purposes, groundwater level fluctuations are compared with groundwater levels observed in the reference bores. If the cause of observed fluctuations is not related to the licensed extraction from the aquifer, this change in level is required to be reported to the DNRM.

Under the current EA, NAC has recently received approval from EHP to allow the use of site specific groundwater quality guidelines for the Mine. These site specific guidelines were developed from a study conducted over a number of years.

3.3 Geology

This Section outlines the geology of the revised Project site and Study area.

3.3.1 Regional Geology

The revised Project site lies within the Cecil Plains Sub-Basin which is located within the western portion of the Clarence-Moreton Basin. In Queensland, the Clarence-Moreton Basin merges with the Surat Basin. The Kumbarilla Ridge is a basement high consisting of the Upper Devonian to Upper Carboniferous Texas beds and separates the Cecil Plains Sub-Basin of the Clarence Moreton Basin, from the Surat Basin. The Clarence-Moreton Basin represents an eastern portion of the Mesozoic GAB. In this portion, major aquifers of the GAB comprise the Marburg Sandstone and Helidon Sandstone. The Walloon Coal Measures is also considered to form a GAB aquifer.

The economic coal-bearing sediments of the Surat and Clarence-Moreton basins occur in the Walloon Coal Measures. The Walloon Coal Measures are Middle to Upper Jurassic in age and are a part of the Injune Creek Group. Although the Kumbarilla Ridge is considered to structurally separate the Clarence-Moreton Basin from the Surat Basin, the Walloon Coal Measures occur on both sides of the Kumbarilla Ridge and are laterally continuous between the Clarence-Moreton Basin and the Surat Basin.

The Injune Creek Group cannot be identified as a distinct unit in the western Clarence-Moreton Basin. However it is broken up into a productive coal bearing lower unit, the Walloon Coal Measures, and a coal resource barren upper unit, the Kumbarilla Beds. The upper unit is absent in the revised Project site.

Within the revised Project site, the major coal bearing unit within the Walloon Coal Measures is referred to as the Acland-Sabine Sequence. The Acland-Sabine Sequence occurs in the lower coal bearing unit (Taroom Coal Measures equivalent) of the Walloon Coal Measures.

Tertiary Basalts unconformably overlie the Walloon Coal Measures in some areas of the revised Project site. The Tertiary age was a period of intense volcanic activity during which the eroded palaeosurface of the Walloon Coal Measures at the revised Project site was covered with basalt flows. Basalt filled palaeo-channels occur within the north western and southern margins of the current Mine's Central and Southern Pits.

Quaternary age alluvium is associated with present day natural drainage channels within the region.

The geology of the region is summarised in **Table 3-1**

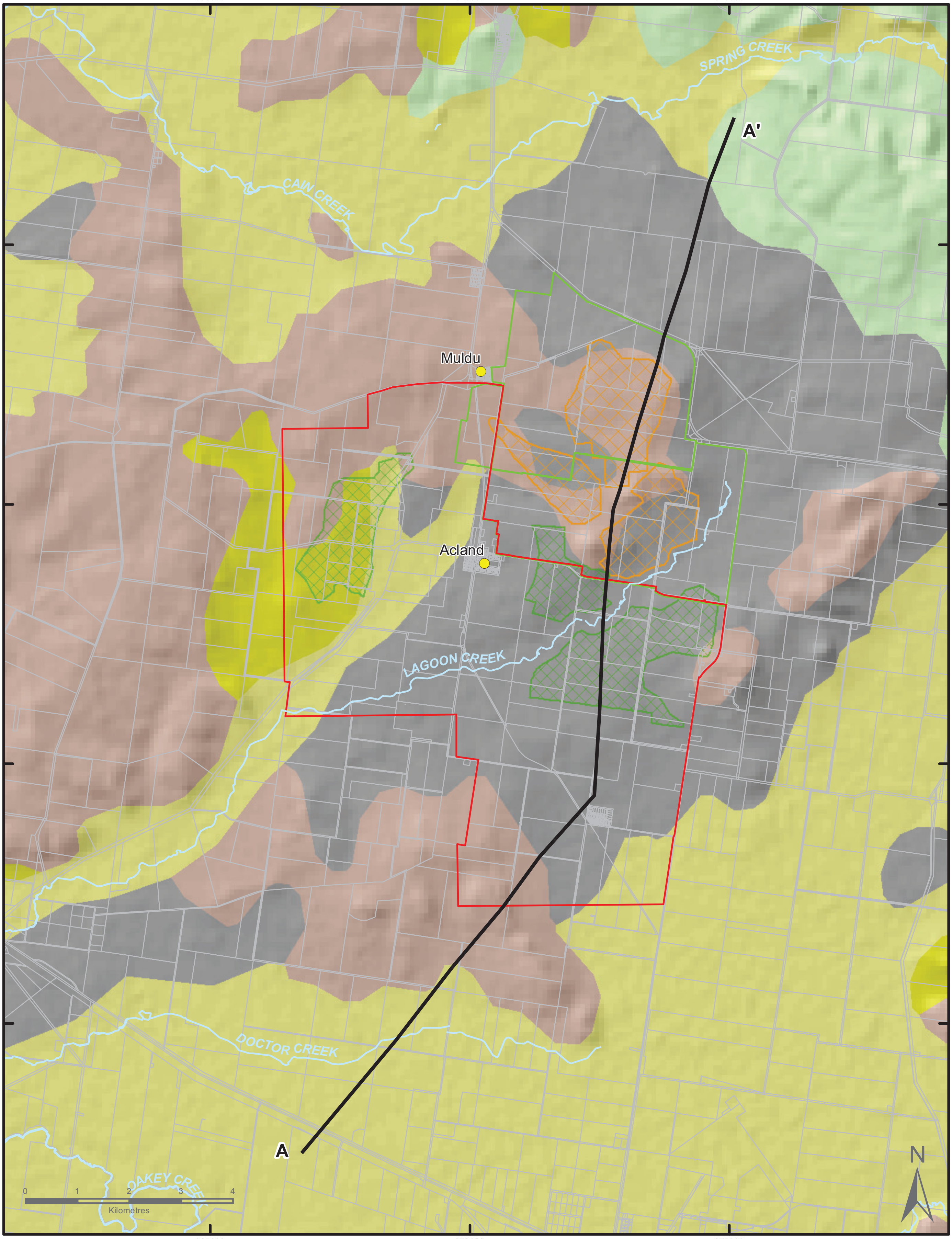
3.3.2 Local Geology

The local geology of the revised Project site is described below. **Figure 3-1** presents the local surface geology of the revised Project site and **Figure 3-2** displays an indicative geological cross section through the revised Project site. The location of the cross section is shown on **Figure 3-1**.

Table 3-1 Geology of the Region

Age	Geological Unit		Clarence-Moreton Basin Acland Area		Surat Basin	Lithology
Quaternary	-		-		-	Alluvium: sand, clay, gravel
Tertiary	Main Range Volcanics		Tertiary Basalts		-	Olivine basalt, tuff, agglomerate
Upper Jurassic	Injune Creek Group	Kumbarilla Beds	-		Springbok Sandstone	Claystone, siltstone, sandstone, minor coal
Middle Jurassic		Walloon Coal Measures	Kogan		Juandah Coal Measures	Claystone, siltstone, sandstone, coal
			Macallister			
			Wonkers			
			Waipanna		Tangalooma Sandstone	
			Acland/Sabine		Taroom Coal Measures	
			Balgowan			
		-	-		Eurombah Formation	Claystone, siltstone, sandstone, minor coal
Lower Jurassic	Bundamba Group		Marburg Subgroup	Marburg Sandstone	Hutton Sandstone	Sandstone, minor siltstone claystone and coal
				Evergreen Formation	Evergreen Formation	Interbedded shale and sandstone
			Helidon Sandstone		Precipice Sandstone	Interbedded shale and sandstone, quartz sandstone
Carboniferous to Devonian	Texas Beds		-		-	Greywacke, conglomerate, siltstone, mudstone, slate, local phyllite, chert, basalt, limestone and rare tuff

Notes: 1. The age of geological units shown is from most recent (Quaternary) to oldest (Carboniferous to Devonian) in formation.



LEGEND

- Towns and Localities
- Watercourse
- Alignment of Geological Cross-section
- New Acland Coal Mine
- New Aland Coal Mine-Stage 3
- Existing Permission
- Stage 3 Pit Areas
- Cadastre

Dominant Geology

- Basalt (Tm)
- Alluvium (Qa)
- Colluvium (TQs)
- Walloon Subgroup (Jw)
- Marburg Sandstone (Jbm)

NEW HOPE GROUP

SINCLAIR KNIGHT MERZ SKM

NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 3-1 - Surface Geology

Scale 1:100,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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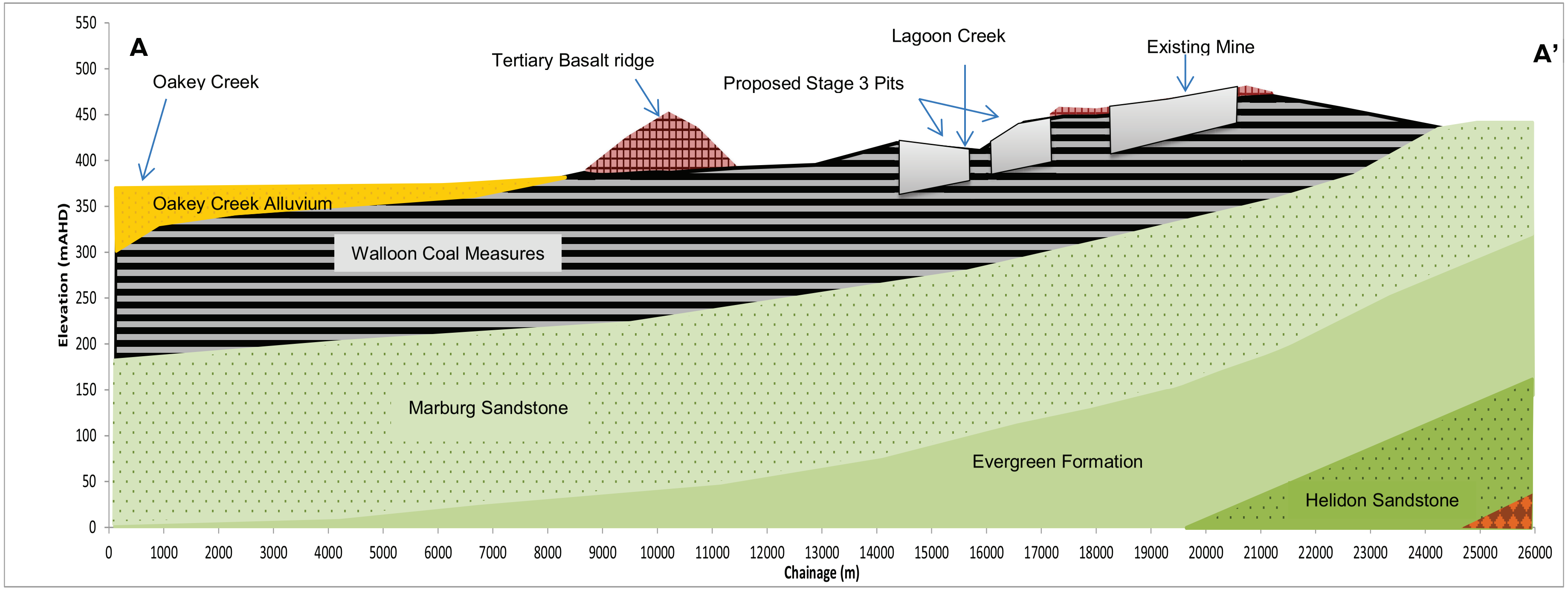


Note: Faulting not represented in conceptualised cross-section. Geologic information based on bore logs along cross-section, known ground elevations, surface geological mapping, and inferred depths for deeper formations due to lack of deep drilling information along section.

Figure 3-2 Conceptualised Geological Cross Section

Quaternary Deposits

Quaternary deposits consist of recent alluvium deposited by creeks and rivers. Within the revised Project site, these deposits are only likely to occur in association with the Lagoon Creek catchment in the west of the revised Project site. South and east of the revised Project site, major and widespread alluvium deposits are associated with Oakey Creek and its tributary Doctor Creek, and to the north of the existing Mine major and widespread alluvium deposits are associated with Myall Creek and its tributary Cain/Spring Creek.

Tertiary Basalt

The Tertiary Basalt unconformably overlies the Walloon Coal Measures in several localities within the revised Project site. Remnants of Tertiary age basalt flows occur on hill tops, and show that the basalt formed as low lying horizontal continuous flows within palaeochannels eroded into the Walloon Coal Measures palaeosurface. Given the depositional environment, it is likely that in some locations the elevation of the base of the basalt flows lies below the elevation of the top of the older Walloon Coal Measures formation lying adjacent to the basalt flow, such that the basalt and coal measures in part lie at similar depths. Following basalt deposition, preferential erosion of the softer Walloon Coal Measures around the channelled basalt flows has resulted in the elevated basalt remnants currently seen at the revised Project site.

The presence of weathered basalt below fresh basalt, in combination with relict soil profiles and sedimentary layers interbedded with the flows, indicates that there has been a succession of basalt flows within the revised Project site. Evidence of two to three distinct flows have been observed during drilling investigations. There is some outcrop of the Tertiary Basalt in the northern section of the revised Project site, but only very minor outcrop within the proposed western pit (Manning Vale West pit) area of the revised Project.

Borehole logs show that the basalt thickness is highly variable within the revised Project site. In general, whilst basalt extent and thickness is shown to be highly variable, it is known to become more prolific and widespread immediately west of the revised Project site.

In the revised Project site, the basalt thickness ranges from absent to 25 m as recorded in NAC exploration borehole AC2. In excess of 30 m of basalt was logged in the then DNRW boreholes (NS 26, 27, 28, 33, 42 and 44) located on or near the basalt ridge adjacent the current Mine’s Centre Pit. Some 33 m of basalt was intersected in the NHG borehole AC515 located between the current Mine’s Centre and South Pits. Around 90 m of basalt was recorded in AC480 located west of the current Mine’s North Pit.

The unaltered basalts are black in colour and microcrystalline, whilst some basalt is porphyritic containing olivine phenocrysts. Vesicular and amygdaloidal basalts are common, and the base of the basalt flows is typically vesicular. Vesicles are often partially or completely infilled with zeolites, calcite and clay minerals. Products of the basalts decomposition include red clay in which magnesite is common.

Walloon Coal Measures

The Walloon Coal Measures are around 120 to 130 m thick across most of the revised Project site, although planned mining activities are limited to the base of the economically recoverable coal reserves lying less than 75 m below ground level at their deepest point.

The three major coal intervals identified within the lower Walloon Coal Measures (Taroom Coal Measures equivalent) are the Waipanna, Acland-Sabine, and Balgowan (as shown in **Table 3-1**). NAC mines the Acland-Sabine sequence within the lower Walloon Coal Measures. **Chapter 3** of the revised Project's EIS outlines the mine plan for the revised Project.

The Mine currently extracts coal from the Acland-Sabine interval. The Acland-Sabine interval contains six seam groups. From the top to bottom these are nominated as A to F. Each seam group contains up to 10 seam plies. Seam plies are discrete layers of coal within a seam group. In total, the Acland-Sabine interval has 47 seam plies. The average thickness of an individual seam ply is 0.23 m. Individual seam plies are unlikely to extend great lateral distances, but rather form isolated pods of coal.

The Waipanna interval contains six seam groups which contain 53 seam plies. The Balgowan interval contains seven seam groups which contain 21 seam plies.

The regional dip of the Walloon Coal Measures is one to three degrees south-southwest. Local variations of both dip and strike occur due to both folding and faulting. The general geological structure of the revised Project site can best be described as a fault modified southwesterly plunging syncline, with the fold axis centred on the Lagoon Creek drainage channel. Folding has been interpreted from photogeological interpretation, regional drilling and geological interpretation of the drilling results elsewhere in the Clarence-Moreton Basin.

Faulting is known to have occurred from observations made from underground mines in the Acland area and has also been interpreted from drilling results and from the existing open cut. Faulting is developed along two main trends, northeast-southwest and northwest-southeast, however, east-west faults with significant throws have also been observed in the Mine pits. The age of faulting is not known, however NAC's geologists have identified that basement faulting could have been re-activated during the Tertiary period synchronous with basalt deposition, i.e. the basalt overlying the Walloon Coal Measures may also have been faulted. Typically, the downthrown strata are on the downdip side of the fault.

Eurombah Formation

The Eurombah Formation underlies the Walloon Coal Measures and consists dominantly of fine grained sediments including siltstones, mudstones, fine sandstones and rare coals. The unit is difficult to distinguish between the overlying Walloon Coal Measures and often in literature the Eurombah Formation unit is not distinguished from the overlying Walloon unit. The main difference between the Eurombah Formation and the overlying Walloon Coal Measures is that the Eurombah Formation is comparatively coal barren.

Marburg Sandstone

The Marburg Sandstone is typically around 200 to 300 m thick at the revised Project site and regionally dips to the southwest. The unit outcrops 3 km northeast of the current New Acland Mine, however at the revised Project site the unit lies at a depth of approximately 150 m below ground surface and 75 m below the base of the current and proposed mine workings. The Marburg Sandstone is made up of poorly sorted, coarse to medium-grained, feldspathic sublabile sandstone and fine-grained, well sorted quartzose sandstone. Minor carbonaceous siltstone, mudstone, coal and rare pebble conglomerate also occur within the Marburg Sandstone. The unit grades into the underlying Evergreen Formation which can therefore be difficult to distinguish from the base of the Marburg Sandstone. The literature does not always separate these two units within the Clarence-Moreton Basin, possibly due to the gradational nature of the contact, with the entire sequence collectively termed the Marburg Subgroup.

Available bore log data for the Marburg Sandstone from deep production bores at the Mine site describe the unit as variably sandstone, siltstone and mudstone, with some clean quartzose sandstone intervals.

Evergreen Formation

The Evergreen Formation is a dominantly finer grained unit than the overlying and underlying Marburg and Helidon sandstones, and is generally up to 200 m thick in the revised Project site. As described above, the boundary is transitional with the overlying Marburg Sandstone which may be responsible for the Evergreen Formation not being described separately in some parts of the Clarence Moreton Basin. The Evergreen Formation has been described on the 1:250 000 Geology Map of Ipswich (Geological Survey of Queensland, 1980) as consisting of sandstone, siltstone, shale, mudstone and oolitic ironstone.

Available bore log data for the deep production bores at the Mine site describe the Evergreen Formation unit as variably siltstone and mudstone with some sandstone.

Helidon Sandstone

The Helidon Sandstone is up to 170 m thick and is extensive within the Cecil Plains Sub-Basin of the Clarence-Moreton Basin. The unit is generally found at depths of between 500 and 600 m below ground level at the revised Project site, however the sandstone is known to outcrop near the township of Helidon located approximately 50 km southeast of the revised Project site. The Helidon Sandstone can be divided into two sections, an upper section of interbedded shale and sandstone with kaolinitic clays that is difficult to distinguish from the Evergreen Formation, and a lower section of fine to very coarse quartz sandstone.

Available bore log data for the Helidon Sandstone production bores at the Mine site describe the unit as variably sandstone, siltstone and mudstone.

Texas Beds

The Upper Carboniferous Texas Beds consist of greywacke, conglomerate, siltstone, mudstone, slate, local phyllite, chert, basalt, limestone and rare tuff. Generally, the Texas Beds are rich in felsic volcanic detritus which were derived from an active magmatic arc to the west. The Texas Beds are low grade regionally metamorphosed and variably deformed.

3.4 Hydrogeology

This Section provides a summary of the five aquifers which occur within the revised Project site. **Section 3.14** provides further information on these aquifers and discusses aquifer parameters including depth to groundwater, aquifer thickness, transmissivity/ hydraulic conductivity, and storativity.

3.4.1 Quaternary Alluvial Aquifer

The Quaternary alluvial aquifer is located within the Quaternary alluvium which consists of clay, silt, sand and gravel deposited by creeks and rivers. The Quaternary alluvium is limited in extent, being restricted to the lower lying areas associated with modern drainage lines. The nearest alluvium with significant groundwater supplies is associated with Oakey Creek (and its tributary Doctors Creek) approximately 15 km southeast of Acland Township. This aquifer may also exist in association with Lagoon Creek (another tributary of Oakey Creek); surface geological mapping as shown in **Figure 3-1** indicates some alluvium in the western part of the revised Project site, extending to the southwest of MLA 50232. No groundwater bores are present in this area however, suggesting the aquifer is either not well developed or is not present.

3.4.2 Tertiary Basalt Aquifer

The Tertiary Basalt aquifer consists of olivine basalts and where present, varies in thickness from 1 m to 90 m. The Tertiary Basalt aquifer is interbedded with low permeability sediments including clay which have the potential to act as a local aquitard within the Tertiary Basalt.

The Mine is currently permitted to draw groundwater from the Tertiary Basalt aquifer which is treated for potable use. This potable water supply is currently covered under a license for 160 ML/year, although actual use is much less than the allocation. **Section 3.5** describes Mine groundwater use in more detail. Groundwater extraction from the Tertiary Basalt aquifer is also undertaken by nearby private users.

3.4.3 Walloon Coal Measures Aquifer

The Walloon Coal Measures on a regional scale is not considered a major aquifer, consisting of low permeability shale, siltstone, carbonaceous mudstone, minor sandstone and coal layers. However, on a local scale, coal seams within the unit may have permeability suitably high to store and transmit useful quantities of water. This geological unit outcrops over much of the revised Project site with the coal seams being the principal conduit for groundwater. Despite comprising dominantly low permeability sediments, the unit is still considered a GAB aquifer in the Water Resource (Great Artesian Basin) Plan (2006) as some useful water supplies can be drawn from coal seams regionally.

Faulting within the Walloon Coal Measures unit has possible significance for the horizontal movement of groundwater. Pumping tests, groundwater levels and groundwater chemistry data (discussed later in this Chapter) indicate that the throw of some faults within the Walloon unit is sufficient to cause compartmentalisation of water bodies within the coal seams and also the overlying basalt. Observations of Mine pit inflows and also from nearby observation bores (discussed later in this Chapter) show that faults can also act as significant conduits for lateral groundwater flow within the Walloon Coal Measures aquifer.

The Mine uses groundwater which flows into the mine pit from the Walloon Coal Measures aquifer. The inflow is mainly used for dust suppression purposes. Neighbouring farm properties also use groundwater from the Walloon Coal Measures.

Within the Walloon Coal Measures, the Acland-Sabine interval which is mined by NAC is hydraulically separated from the underlying Balgowan interval by low permeability interburden sediments. In the vicinity of the revised Project site, the top of the Balgowan interval is approximately 30 m deeper than the lowest Acland-Sabine seam and is separated by clay-matrix sandstones which lack primary porosity and act as an aquitard between the two coal sequences.

Aquifer testing was conducted at two locations within the revised Project site as part of investigations for the revised Stage 3 Project. The locations of these bores are shown in **Figure 3-3**. Each location consisted of a production bore and two nearby observation bores, namely:

- Location 1: 120WB (Production bore) and 118P and 117PGC (Observation bores); and
- Location 2: 121WB (Production bore) and 113PGCA and 113PGCB (Observation bores).

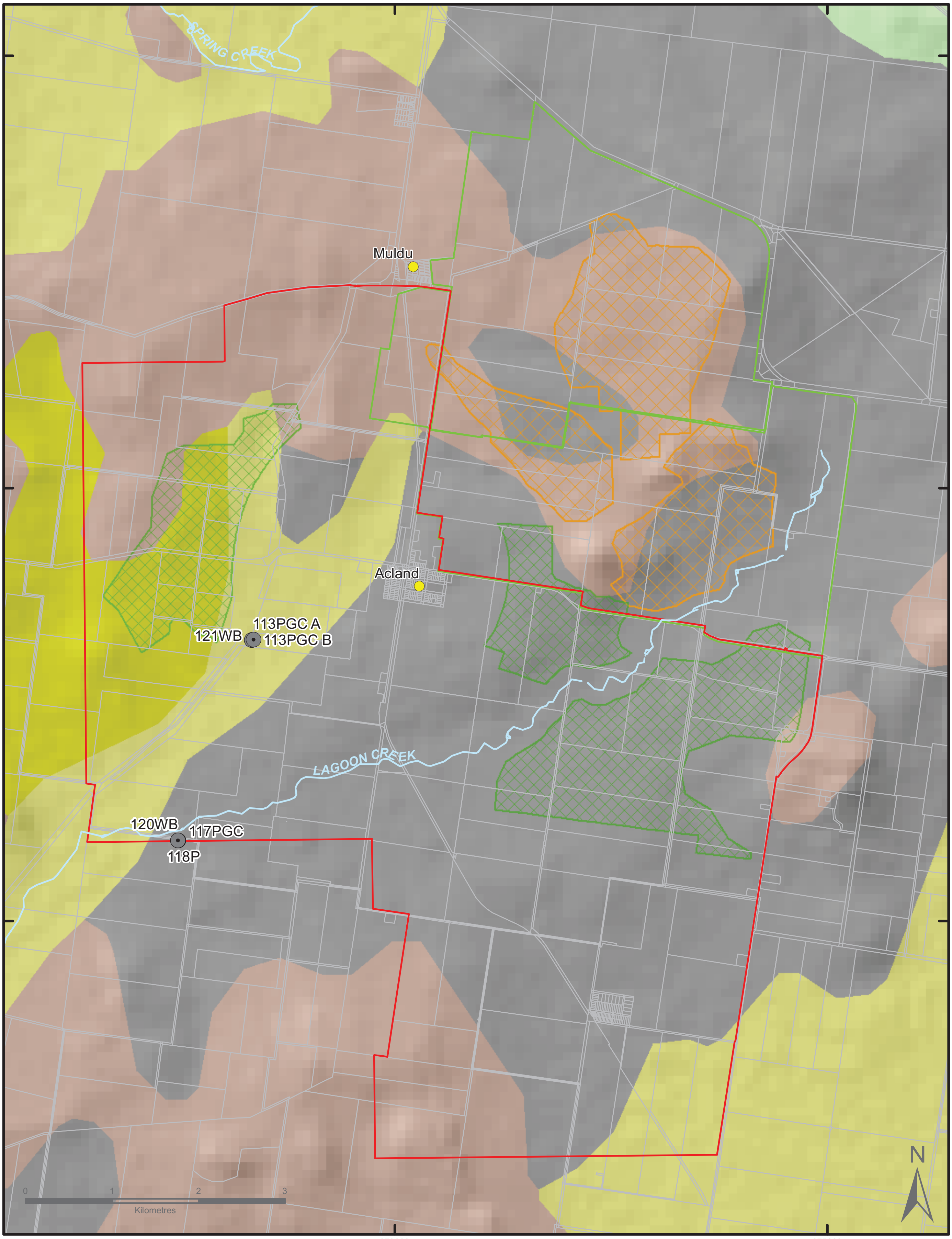
The aquifer tests targeted the Walloon Coal Measures as the primary aquifer that will be affected by the revised Project. The two aquifer testing locations are approximately 2.5 km apart, and given the discontinuous nature of the coal seams within the Walloon Coal Measures as well as the different depths of testing at the two locations, it is considered unlikely that the two test locations tested the same laterally extensive coal seam.

Hydraulic properties of the Walloon Coal Measures aquifer were obtained by conducting a step test and a constant rate test at each pumping test site. Aquifer pumping test results were analysed to derive the hydraulic properties (transmissivity and storativity) for the Walloon Coal Measures aquifer within the revised Project site. Transmissivity values derived for the Walloon Coal Measures aquifer are summarised in **Table 3-2**. Storativity values are summarised in **Table 3-3**.

Table 3-2 Transmissivity Values for the Walloon Coal Measures

Location	Bore ID	Transmissivity (m^2/day)	Screen depth of bore (mBGL)	Unit
Location 1	120WB (pumped)	6	74 – 83.5	Acland/Sabine
	117P (obs)	8	74 – 83.5	Acland/Sabine
Location 2	121WB (pumped)	47	27 – 34	Acland/Sabine
	113PGCA (obs)	31*	27 – 34	Acland/Sabine

*Note: Value was derived using the Hantush-Jacob (1955) leaky aquifer solution. All other values derived using the Theis (1935) confined aquifer solution.



LEGEND

- Towns and Localities

Aquifer

- Alluvium
- Basalt
- Coal Measures

- Watercourse
- New Acland Coal Mine
- New Aland Coal Mine-Stage 3
- Cadastre
- Existing Permission
- Stage 3 Pit Areas

Dominant Geology

- Basalt (Tm)
- Alluvium (Qa)
- Colluvium (TQs)
- Walloon Subgroup (Jw)
- Marburg Sandstone (Jbm)

NEW HOPE GROUP

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NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 3-3 - Location of Aquifer Testing Sites

Scale 1:60,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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Table 3-3 Storativity Values

Location	Bore ID	Storage Coefficient (dimensionless)	Screen depth of bore (mBGL)	Unit
Location 1	120WB	-	74 – 83.5	Acland-Sabine
	117P	0.00006	74 – 83.5	Acland-Sabine
Location 2	121WB	-	27 – 34	Acland-Sabine
	113PGCA	0.006*	27 – 34	Acland-Sabine

*Note: Value was derived using the Hantush-Jacob (1955) leaky aquifer solution. All other values derived using the Theis (1935) confined aquifer solution.

An assessment of the results suggests that transmissivity of the shallower coal seams is generally greater than the transmissivity of the deeper coal seams, although this conclusion is limited to data from the two tests sites only. However, this conclusion supports the widely accepted hydrogeologic concept that the hydraulic conductivity of coal seams decreases with depth of burial, due to the weight/pressure effects of burial closing cleats and joints within the seams.

Pumping tests conducted during the Stage 2 EIS in 2005 indicated that transmissivity values of 30 m^2/day were observed within the Walloon Coal Measures aquifer. This result is consistent with transmissivity values observed for the shallower seams during the revised Project investigations.

The best fit solutions for calculating aquifer parameters from testing were mostly obtained with non-leaky solutions, suggesting that the interseam sediments are very ‘tight’ and did not contribute meaningful volumes of water to the pumped bores over the duration of testing.

3.4.4 Marburg Sandstone Aquifer

The Marburg Sandstone aquifer consists of sandstone, minor coal and conglomerate rock types. These water bearing units are interbedded with less permeable rock units such as mudstone, siltstone and shale.

The Marburg Sandstone aquifer is a confined aquifer which occurs at a depth of approximately 150 mBGL beneath the revised Project site. Non-coal aquitards within the Walloon Coal Measures act as effective confining layers for the Marburg Sandstone aquifer.

Aquifer parameters based on pumping tests conducted for the Stage 2 EIS for a single water bearing unit within the Marburg Sandstone indicate a transmissivity of 14 m^2/day and a storativity of 0.003.

The Mine previously extracted groundwater for industrial use from the Marburg Sandstone aquifer and still possesses an allocation of 271 ML/year. **Section 3.5** describes Mine groundwater use in more detail. Nearby private groundwater users are the main known sources of groundwater extraction from the Marburg Sandstone aquifer.

3.4.5 Helidon Sandstone Aquifer

The Helidon Sandstone aquifer is the deepest aquifer underlying the revised Project site and is separated from the shallower Marburg Sandstone aquifer by the intervening Evergreen Formation aquitard. The Helidon Sandstone aquifer is extensive within the Cecil Plains Sub-Basin of the Clarence-Moreton Basin and has been divided into two sub-aquifers. The upper aquifer consists of interbedded shale and sandstone. The lower section is made up of fine to very coarse quartz sandstone. The Helidon Sandstone is a confined, primary porosity aquifer and is isolated from the overlying aquifers by the relatively impermeable Evergreen Formation.

Pumping test data in previous investigations in the Mine area indicates the transmissivity of this aquifer varies between 45 and 200 m^2/day.

The Mine previously extracted groundwater from the Helidon Sandstone aquifer for industrial use and still possesses an allocation of 710 ML/year. **Section 3.5** describes Mine groundwater use in more detail. The Oakey Abattoir is the main local source of groundwater extraction from the Helidon Sandstone aquifer.

3.5 Groundwater Use

3.5.1 Groundwater Use adjacent to the Mine

DNRM database search

A search of the DNRM registered bore database was conducted in relation to the revised Project site. This survey identified a total of 939 registered groundwater bores within an 8 km radius of the revised Project site. The location of these bores is shown in **Figure 3-4**. The status of these groundwater bores is shown in **Table 3-4** (note that bores listed as "Abandoned and Destroyed" in the database are not shown in **Figure 3-4**).

Table 3-4 Status of DNRM groundwater bores

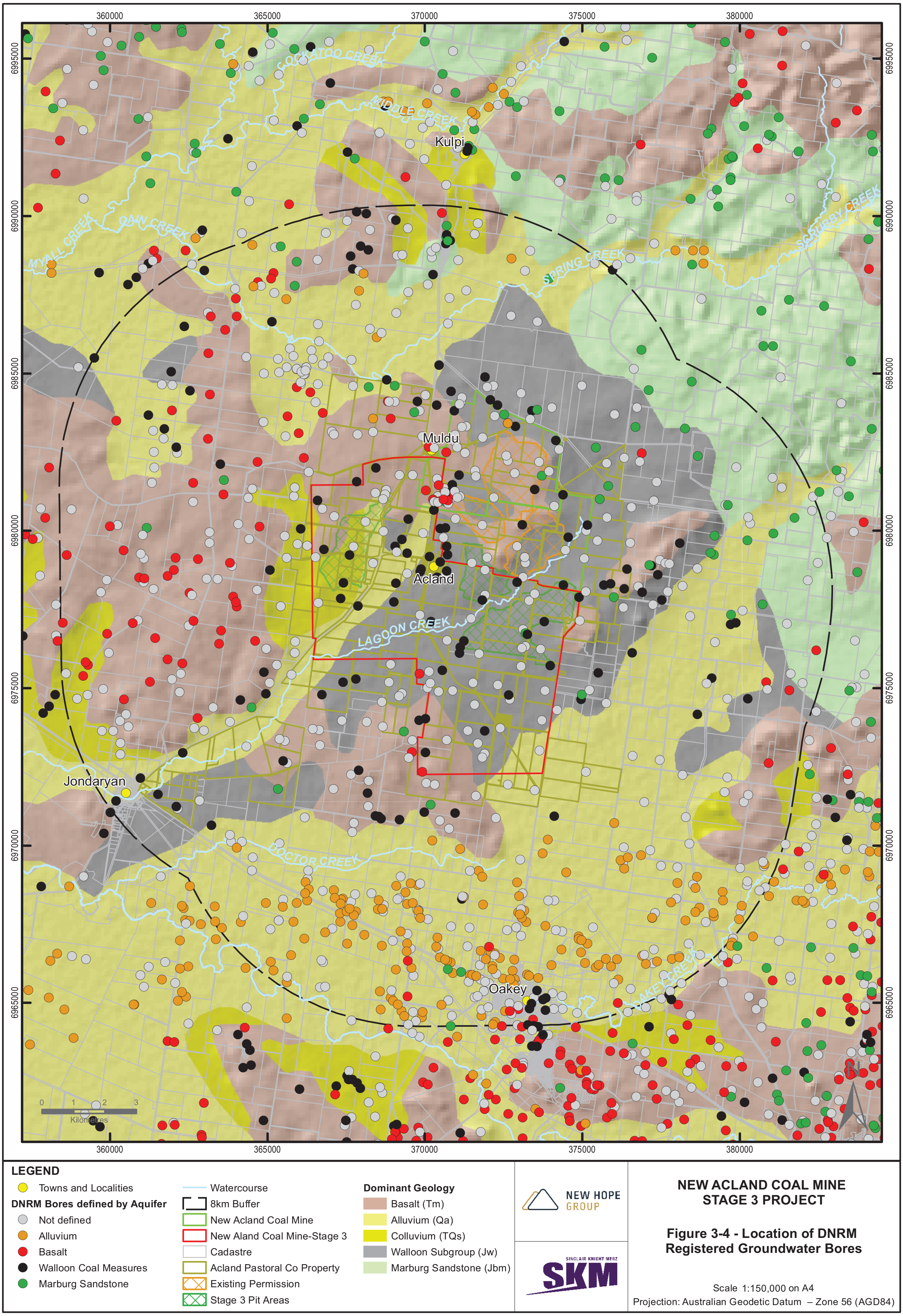
	Existing	Abandoned or Destroyed	Abandoned but still Useable	Proposed
Number of Bores	827	81	4	27

A review was undertaken of the available aquifer details for the identified bores. Only 447 (47%) of the 939 registered bores within 8 km of the revised Project site have information regarding the aquifer from which its groundwater is extracted. **Table 3-5** provides a summary of the bores that have been installed in each aquifer.

Table 3-5 Number of Bores with Known Aquifer

	Quaternary Alluvium	Tertiary Basalt	Walloon Coal Measures	Marburg Sandstone	Helidon Sandstone
Number of Bores	117	83	139	47	1

The available bore data were further reviewed to identify groundwater quality, yield and standing water levels (SWL) in each aquifer for these groundwater users. Available information is summarised in **Table 3-6**.



NEW ACLAND COAL MINE
STAGE 3 PROJECT

Figure 3-4 - Location of DNRM Registered Groundwater Bores

Scale 1:150,000 on A4
Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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Table 3-6 Groundwater Quality, Yield and SWL in Each Aquifer for Registered Bores within 8 km of the revised Project

Registration Number (RN)	Aquifer[1]	Quality[2]	Yield (L/sec)	SWL (mBGL)
86723	Alluvium	Potable	6.1	13
94974	Alluvium	Not available	3.8	Not available
94995	Alluvium	Not available	Not available	16.46
107119	Alluvium	Potable	4.7	13
107120	Alluvium	Potable	0.4	12.5
107538	Alluvium	Potable	4.1	13.4
107548	Alluvium	Not available	20	10.4
107225	Alluvium	Not available	Not available	12.6
119133	Alluvium	Salty	Not available	Not available
119297	Alluvium	Not available	3.8	25
119565	Alluvium	Not available	Not available	11.3
119566	Alluvium	Not available	Not available	15.2
137743	Alluvium	Potable	0.1	Not available
137888	Alluvium	Not available	Not available	8.53
137030	Alluvium	Brackish	0.6	13.8
147098	Alluvium	Not available	2	33
147099	Alluvium	Salty	Not available	Not available
147211	Alluvium	Potable	Not available	Not available
147317	Alluvium	Brackish	.7	13.2
147498	Alluvium	Salty	1.3	Not available
107838	Alluvium	Not available	Not available	18.9
147465	Alluvium	Potable	1.4	15.24
147352	Alluvium	Potable	0.7	17
147269	Alluvium	Not available	Not available	8.8
87330	Tertiary Basalt	Potable	9.6	Not available
87331	Tertiary Basalt	Potable	12.6	2.4
87365	Tertiary Basalt	Potable	7.0	4.9
94190	Tertiary Basalt	Potable to Brackish	4.5	6.8
94343	Tertiary Basalt	Potable	Not available	34.5
94423	Tertiary Basalt	Potable	2.8	21.9
94846	Tertiary Basalt	Potable	0.6	22
94919	Tertiary Basalt	Potable	Not available	Not available
94996	Tertiary Basalt	Brackish	1.9	45
107547	Tertiary Basalt	Not available	15.6	10.4
107145	Tertiary Basalt	Potable	1.9	3.96
107255	Tertiary Basalt	Potable	0.5	11
107357	Tertiary Basalt	Potable	2.1	Not available
107358	Tertiary Basalt	Potable	Not available	Not available
119008	Tertiary Basalt	Not available	6.3	Not available

Registration Number (RN)	Aquifer[1]	Quality[2]	Yield (L/sec)	SWL (mBGL)
119387	Tertiary Basalt	Brackish	0.1	8.3
119386	Tertiary Basalt	Brackish	0.6	8
119572	Tertiary Basalt	Potable	Not available	Not available
42231617	Tertiary Basalt	Not available	Not available	2.7
42231618	Tertiary Basalt	Not available	Not available	1.7
42231620	Tertiary Basalt	Not available	Not available	1.15
42231619	Tertiary Basalt	Not available	Not available	0.3
119944	Tertiary Basalt	Brackish	1.9	9.1
119951	Tertiary Basalt	Potable	Not available	Not available
137974	Tertiary Basalt	Brackish	0.5	16.8
147100	Tertiary Basalt	Potable	1.2	6.5
147104	Tertiary Basalt	Potable	3.0	25
147487	Tertiary Basalt	Not available	1.33	18.5
147489	Tertiary Basalt	Not available	0.5	18.5
147464	Tertiary Basalt	Potable	0.1	18.29
147526	Tertiary Basalt	Potable	0.8	41
83742	Walloon Coal Measures	Potable	Not available	Not available
87379	Walloon Coal Measures	Potable	Not available	Not available
94298	Walloon Coal Measures	Not available	0.4	Not available
94710	Walloon Coal Measures	Potable	3.3	13.1
94873	Walloon Coal Measures	Potable	Not available	Not available
94887	Walloon Coal Measures	Not available	0.8	30
107069	Walloon Coal Measures	Potable	Not available	Not available
107083	Walloon Coal Measures	Potable	3.3	103
107132	Walloon Coal Measures	Potable	0.2	24.4
107236	Walloon Coal Measures	Potable	Not available	Not available
107349	Walloon Coal Measures	Not available	0.5	Not available
107364	Walloon Coal Measures	Potable	0.4	Not available
107795	Walloon Coal Measures	Potable	1.2	17
107882	Walloon Coal Measures	Not available	Not available	22.2
107883	Walloon Coal Measures	Salty	Not available	21.5
107884	Walloon Coal Measures	Salty	Not available	23
119581	Walloon Coal Measures	Potable	Not available	Not available
42231622	Walloon Coal Measures	Not available	Not available	2.7
137284	Walloon Coal Measures	Not available	0.1	38.1
137270	Walloon Coal Measures	Brackish	0.2	47.85
137443	Walloon Coal Measures	Not available	12	53
137463	Walloon Coal Measures	Not available	5.4	60
107812	Walloon Coal Measures	Potable	0.8	36
147259	Walloon Coal Measures	Not available	2.1	13.4
147260	Walloon Coal Measures	Brackish	4.4	13.8

Registration Number (RN)	Aquifer[1]	Quality[2]	Yield (L/sec)	SWL (mBGL)
147262	Walloon Coal Measures	Not available	1.7	17
147497	Walloon Coal Measures	Salty	0.3	Not available
147480	Walloon Coal Measures	Not available	1.0	30
87941	Marburg Sandstone	Potable	Not available	Not available
94997	Marburg Sandstone	Potable	Not available	Not available
107121	Marburg Sandstone	Potable	5.4	Not available
107333	Marburg Sandstone	Potable	Not available	Not available
107371	Marburg Sandstone	Potable	Not available	Not available
107386	Marburg Sandstone	Potable	2.5	61
119007	Marburg Sandstone	Not available	1	21.84
119138	Marburg Sandstone	Potable	2.6	27.7
119328	Marburg Sandstone	Not available	10.7	20.8
119570	Marburg Sandstone	Potable	0.4	Not available
137228	Marburg Sandstone	Potable	5.6	Not available
137244	Marburg Sandstone	Brackish	Not available	73.76
137763	Marburg Sandstone	Not available	8.3	115
137768	Marburg Sandstone	Not available	0.4	120
147604	Marburg Sandstone	Potable	0.4	58.83
147605	Marburg Sandstone	Potable	1.5	21.95

Notes: 1. Helidon Sandstone bores not listed as Quality, Yield and SWL information not available within the search radius
2. Qualitative description as provided in the DNRM database

Registered groundwater bores accessing the alluvial aquifers report standing water levels which range from 8.5 to 33 mBGL. Groundwater quality ranges from “potable” to “salty” as described in the database, with bore yields ranging from 0.4 to 20 L/sec. The majority of bores are located to the south of the revised Project site within the Oakey Creek Alluvium, with several bores also located to the northwest of the revised Project site in association with the Myall Creek (including its tributaries Cain Creek and Spring Creek) Alluvium.

Investigations undertaken during the Stage 2 EIS in 2005 show that groundwater use for stock and domestic purposes occurs locally in the Tertiary Basalt aquifer. There is a concentration of bores in the Tertiary Basalt aquifer to the west of the revised Project site where the basalt unit is known to increase in thickness. Information from the DNRM database shows that groundwater in the Tertiary Basalt aquifer has standing water levels which range from 0.3 to 45 mBGL and water quality is generally listed in the DNRM database as “potable” with some occurrences of “brackish” water. The groundwater yield from these bores is relatively low, ranging from 0.1 to 15.6 L/sec.

The Walloon Coal Measures aquifer supplies “potable”, “brackish” and “salty” (as listed in the DNRM database) water mainly for livestock use. Standing water levels in this aquifer range from 2.7 to 103 mBGL. Information from the DNRM database suggests that this aquifer generally produces yields which range from 0.1 to 5.4 L/sec, on average lower than those in the other aquifers.

Stock watering and municipal supplies are extracted from the Marburg Sandstone aquifer. The majority of the Marburg Sandstone bores are located to the northeast of the revised Project site where the aquifer is relatively shallow. Standing water levels in this aquifer are reported to range from around 21 to 120 mBGL. The DNRM survey data show that this aquifer is generally of "potable" quality (as listed in the database) and produces yields listed as ranging from 0.4 to 10.7 L/sec.

The single DNRM registered groundwater bore listed in the database as accessing the Helidon Sandstone aquifer within 8 km of the revised Project site is located adjacent the township of Oakey, 6.6 km south of the revised Project site. Neither quality, yield nor standing water level information is available in the database for this bore.

The DNRM also holds records of Water Entitlements (maximum licensed extraction volumes) for bores within 8 km of the revised Project site. This information is presented in **Table 3-7**. As shown, the Quaternary Alluvial aquifer is the most utilised by licensed volume, at an order of magnitude greater than the next most utilised aquifer, the Tertiary Basalt. Licensed usage from the Walloon Coal Measures and Marburg Sandstone is approximately half that of the Tertiary Basalt.

Table 3-7 Maximum Entitlement Volumes for Bores within 8km of the revised Project

	Quaternary Alluvium	Tertiary Basalt[1]	Walloon Coal Measures[1]	Marburg Sandstone[1]	Helidon Sandstone[1]
Volume (ML/year)	6,663	2,313	781	868	710

Notes: 1. Including licensed volumes at the Mine, see **Table 3-9**.

Landholder Bore Survey

A landholder bore field survey was undertaken as part of the revised Project's groundwater investigations. The survey was conducted in order to confirm and build on the information gathered from the DNRM database on groundwater occurrence and use in the vicinity of the revised Project.

Due to the large number of properties and groundwater bores adjacent the revised Project, only a selection of suitable, representative bores were targeted in the survey. The selection process was based on identifying properties within 3 km of the revised Project's boundaries, and then selecting a representative distribution of properties surrounding the revised Project site that contain bores for which the source aquifer is known in the DNRM database. The bores/properties selected comprise a mixture of both private and APC land.

Following selection of sites, landholders were contacted to request participation in the survey. Where landholders were willing to participate, they were also asked to be present during the survey to provide additional anecdotal and historical bore information. Of the 19 originally selected private landholders/properties, 12 chose to participate in the program.

Information collected for each bore included (where available/possible):

- location GPS co-ordinates;
- current physical bore depth;

- construction details;
- source aquifer;
- current condition and status;
- details of pumping infrastructure;
- drilling & construction logs;
- licence details;
- current and historical usage;
- historical water quality information;
- field groundwater parameters (SWL, EC/TDS, pH, temperature, DO and Redox); and
- water samples for laboratory analysis.

Table 3-8 presents a summary of the landholder bore survey and **Figure 3-5** displays the location of bores assessed. As shown, a total of 50 bores were visited on 32 properties. Full details of the survey results are available in **Appendix B**.

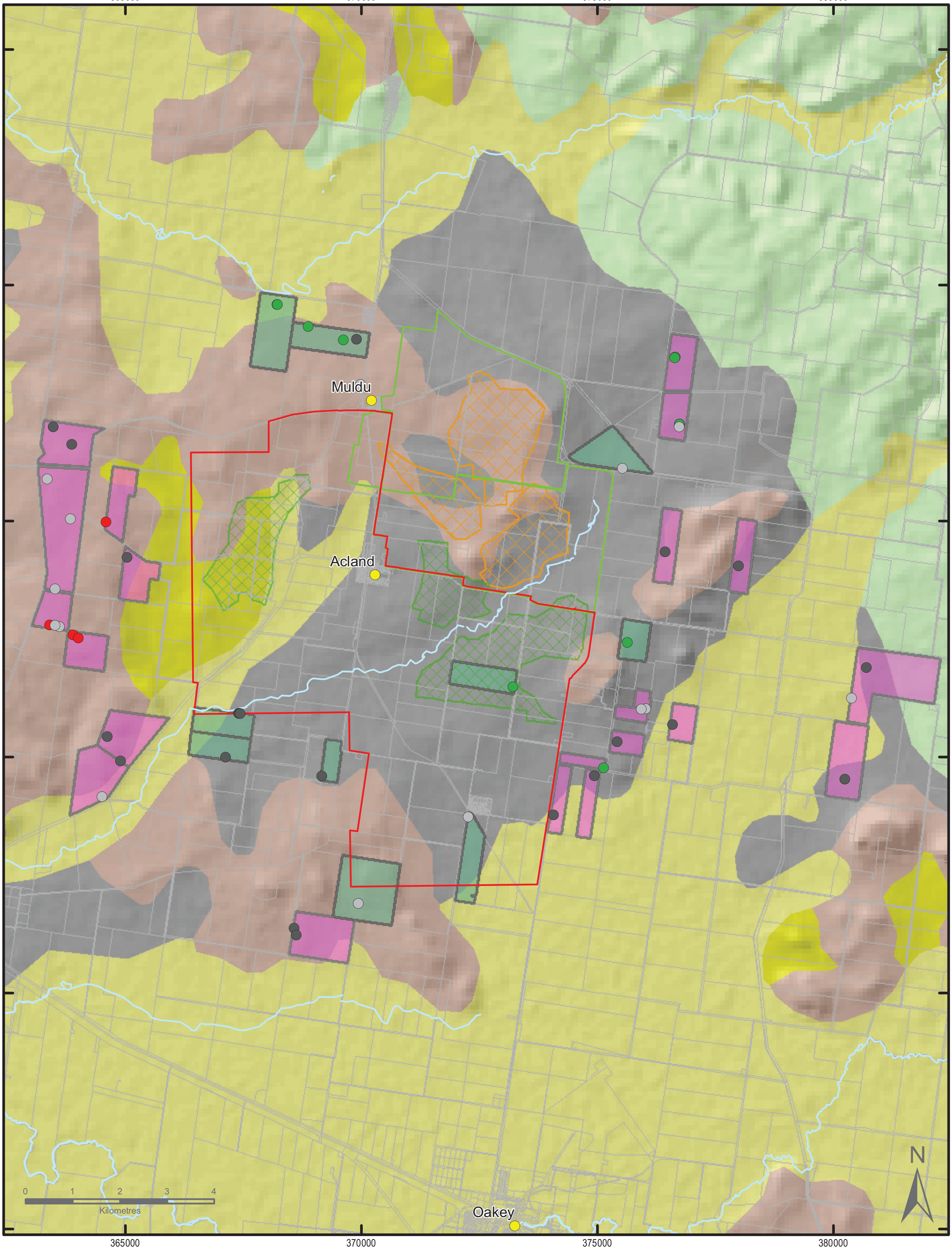
Table 3-8 Summary of Landholder Bore Survey

Aquifer[1]	Number of Bores Visited	Number of Bores with Water Level Information	Number of Bores with Water Quality Samples
Basalt	4	2	3
Walloon Coal Measures	21	9	8
Marburg Sandstone	11	4	6
Unknown	14	2	5
Total	**50**	**17**	**22**

Notes: 1. Based on information recorded in DNRM database, drillings logs, bore depth or landholder communication

The results of the landholder bore survey show that most bores surveyed access the Walloon Coal Measures aquifer (42%), followed by the Marburg Sandstone aquifer (22%) and finally the Tertiary Basalt aquifer (8%). It should be noted that 14 of the 50 surveyed bores (28%) were not able to be assigned to a specific aquifer, due to a lack of information contained within the DNRM bore database or able to be provided by the bore owners.

Water level information was able to be collected from a total of 17 bores (34%) during the survey. Where water levels were unable to be collected, this was primarily as a result of installed pumping infrastructure limiting access, or abandonment of bores. Historical anecdotal water level information was also collected during the assessment; however this information has not been included in the count for the number of bores with water level information, as it was deemed unverifiable and possibly not representative of current conditions.



LEGEND

- Towns and Localities

Landholder Survey Bores defined by Aquifer

- Not Defined
- Basalt
- Walloon Coal Measures
- Marburg Sandstone
- Watercourse

- New Acland Coal Mine
- New Aland Coal Mine-Stage 3
- Cadastre
- Existing Permission
- Stage 3 Pit Areas

Cadastre- Survey Undertaken

- APC
- Public

Dominant Geology

- Basalt (Tm)
- Alluvium (Qa)
- Colluvium (TQs)
- Walloon Subgroup (Jw)
- Marburg Sandstone (Jbm)

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Figure 3-5 - Location of Surveyed Landholder Bores

Scale 1:110,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

Produced: 29/08/2013 Path: I:\QENV2\Projects\QE06644\Spatial\ArcGIS\01_Figures\01_SEIS\IESC_Submission\130828_NewHope_IESC_Figure3-5_LocationOfSurveyedLandholderBores.mxd

Water quality information was able to be collected from a total of 22 bores (44%) during the survey. Where water samples were unable to be collected, this was primarily as a result of a lack of installed and active pumping infrastructure.

3.5.2 Groundwater Use at the Mine

The Mine's main operational water supply is from fine tailings decant, supplemented by the WWRF Pipeline, groundwater sources and surface water captured in environmental dams and mine pit inflows. NAC currently holds water licenses to extract groundwater from the Cecil Plains Sub-Basin of the western section of the Clarence-Moreton Basin, but water use has been reduced significantly for Mine purposes since 2010 with the WWRF Pipeline constructed and fully operational.

Table 3-9 summarises the licenced groundwater allocations for the Mine water supply bores as well as the current usage rates. The locations of the Mine's extraction bores are shown in **Figure 3-6**.

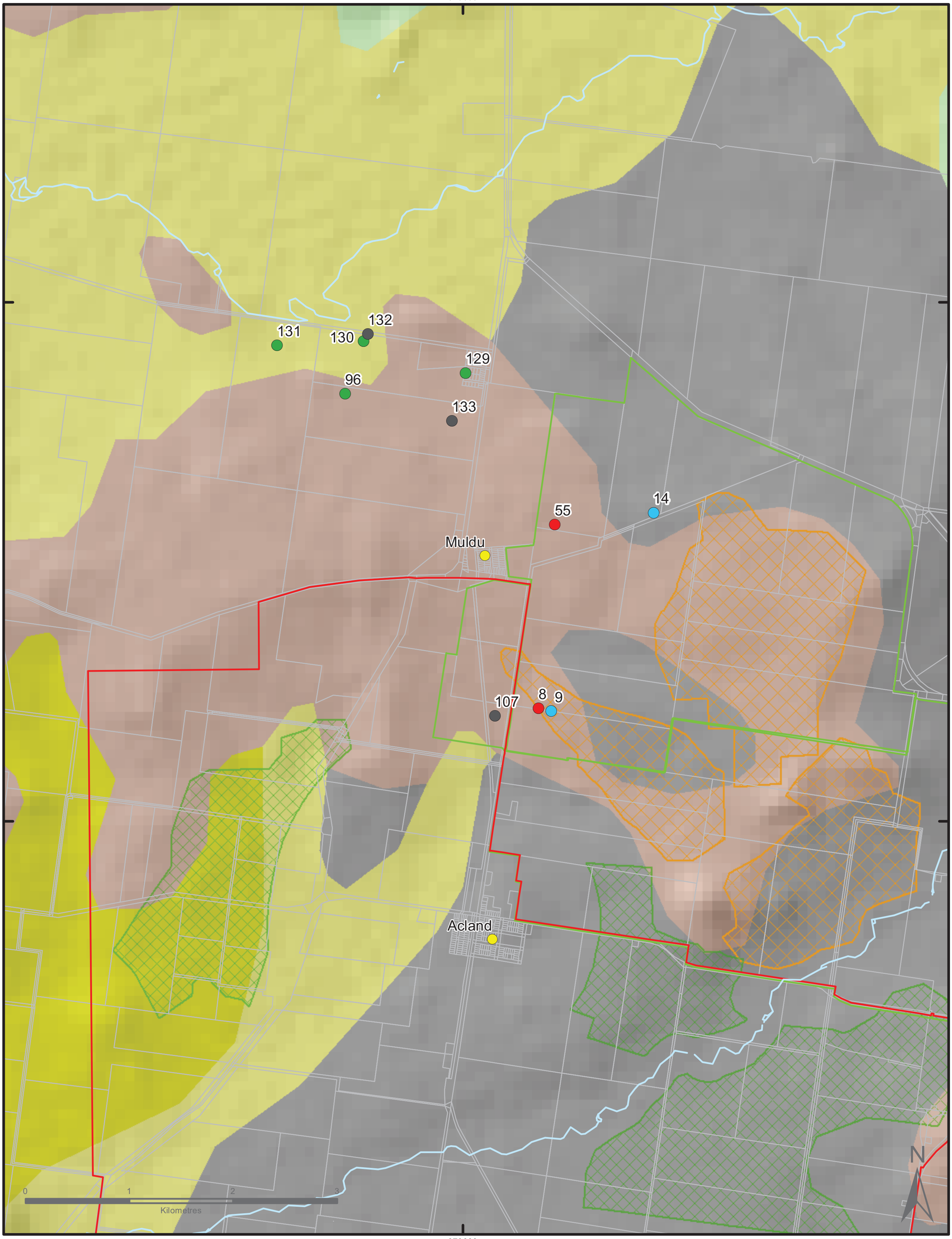
Table 3-9 Groundwater Use at the Mine

Aquifer	Licence No.	Current Allocation (ML/year)	Current Usage (ML/year)[1]	Use
Helidon Sandstone	406524	710	17.1	Industrial
Marburg Sandstone	174733 and 403871	271	10.5	Industrial
Walloon Coal Measures	189552	271	2.6	Industrial
Tertiary Basalt	189547	160	11.0	Potable (after treatment)

Notes: 1. Based on 2012 data

The WWRF Pipeline, established in 2010, has reduced the Mine's reliance on the Helidon Sandstone and Marburg Sandstone aquifers for industrial use. The Mine's recorded groundwater usage in 2012 (shown as "Current Usage" **Table 3-9** above) is significantly less than the licenced allocation before the WWRF Pipeline's commissioning.

For the revised Project, the Tertiary Basalt allocation will continue to be partially used as the main water source to be treated for potable water. The Helidon Sandstone and Marburg Sandstone allocations will be maintained for emergency water supply purposes, which will involve periodic pumping of the associated bores to ensure groundwater extraction infrastructure is functioning efficiently. The extraction from the Walloon Coal Measures will be as a result of incidental groundwater inflows to the mine pit and will continue to be used for dust suppression.



LEGEND

Towns and Localities

APC Extraction Bores defined by Aquifer
- Basalt
- Walloon Coal Measures
- Marburg Sandstone
- Helidon Sandstone

Watercourse
New Acland Coal Mine
New Aland Coal Mine-Stage 3
Cadastre
Existing Permission
Stage 3 Pit Areas

Dominant Geology
- Basalt (Tm)
- Alluvium (Qa)
- Colluvium (TQs)
- Walloon Subgroup (Jw)
- Marburg Sandstone (Jbm)

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Figure 3-6 - Location of NAC Extraction Bores

Scale 1:50,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

3.6 Existing Mine Groundwater Monitoring

A groundwater monitoring program is currently in place for the Mine in accordance with the conditions outlined in the Environmental Authority held by NAC. The groundwater monitoring program is summarised in **Table 3-10**. The locations of the groundwater monitoring bores for the Mine are shown in **Figure 3-7**.

Groundwater quality monitoring from compliance bores is conducted on a half yearly basis. The parameters monitored are shown in the notes at the end of **Table 3-10**. **Section 3.12** provides a summary of the groundwater quality monitoring results for the Mine.

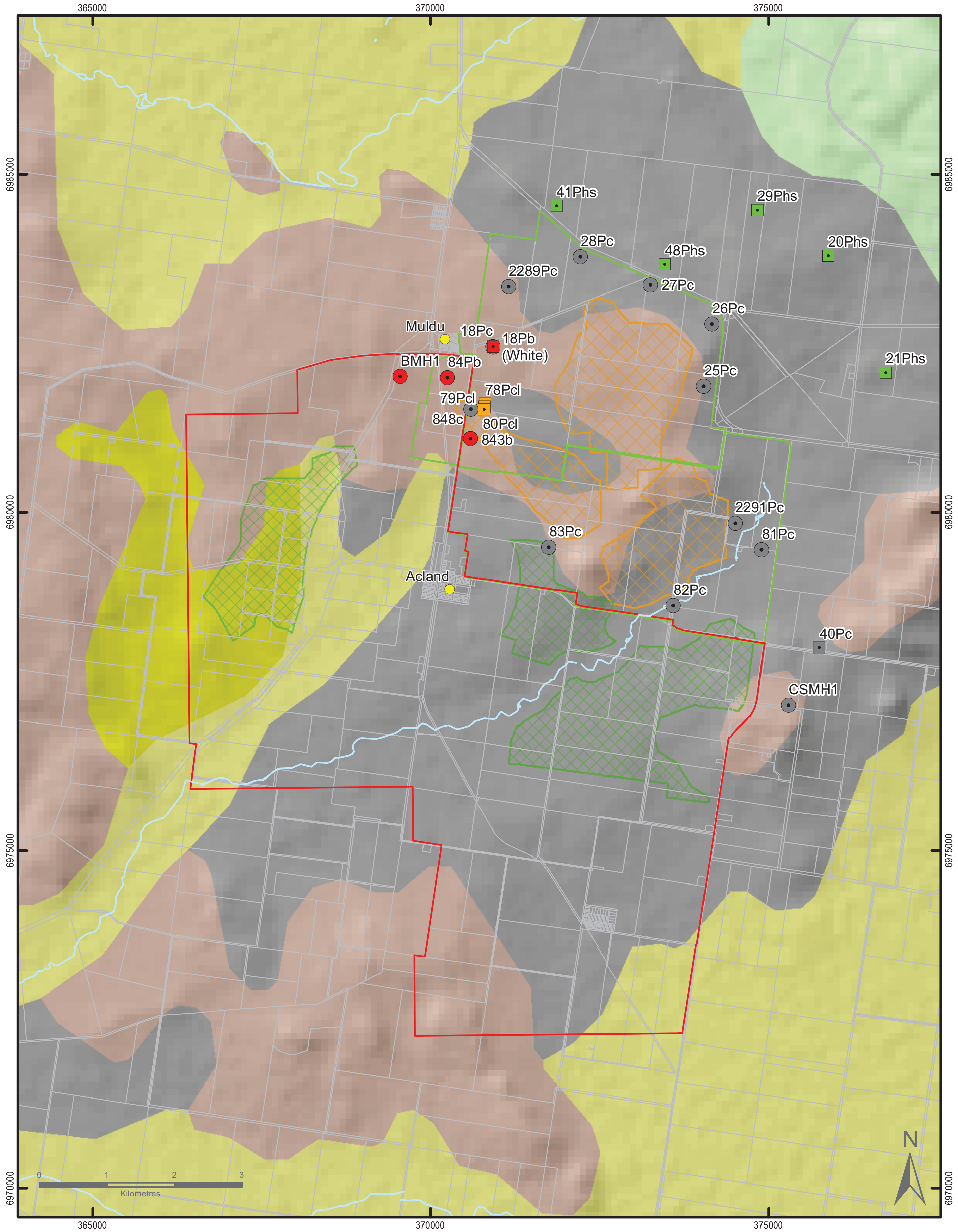
Groundwater level monitoring from compliance bores is conducted on a monthly basis. Groundwater levels which have been recorded at the Mine are summarised in **Section 3.8**.

In addition to the EA compliance monitoring sites, NAC undertakes groundwater level monitoring from additional groundwater monitoring bores. These are summarised in **Table 3-11** and locations are shown in **Figure 3-7**.

Table 3-10 Groundwater Monitoring Program defined by NAC's Mine EA

Site ID	Type	Aquifer	Groundwater Level Monitoring Frequency	WQ1[1] Monitoring Frequency
BMH1	Reference	Tertiary Basalt	Monthly	Half Yearly
CSMH1	Reference	Walloon Coal Measures		
2289Pc	Compliance	Walloon Coal Measures		
2291Pc	Compliance	Walloon Coal Measures		
18Pc	Compliance	Walloon Coal Measures		
25Pc	Compliance	Walloon Coal Measures		
26Pc	Compliance	Walloon Coal Measures		
27Pc	Compliance	Walloon Coal Measures		
28Pc	Compliance	Walloon Coal Measures		
81Pc	Compliance	Walloon Coal Measures		
82Pc	Compliance	Walloon Coal Measures		
83Pc	Compliance	Walloon Coal Measures		
84Pb	Compliance	Tertiary Basalt		
843b	Compliance	Tertiary Basalt		
848c	Compliance	Walloon Coal Measures		

Notes: 1. Aluminium (Al), Arsenic (As), Selenium (Se), Copper (Cu), Fluorine (F), Iron (F), Total Nitrogen (Total N), Manganese (Mn); Calcium (Ca), Chloride (Cl), Potassium (K), Magnesium (Mg), Sodium (Na), Sulphate (SO_4), Bicarbonate (HCO_3), Carbonate (CO_3), Total Dissolved Solids (TDS), Electrical Conductivity (EC); Acidity/Alkalinity (pH).



LEGEND

EA Compliance\Reference Bores
- Tertiary Basalt
- Walloon Coal Measures

Non-EA Additional Bores
- Clays (Alluvium)
- Tertiary Basalt
- Walloon Coal Measures
- Marburg Sandstone

- Towns and Localities
- Watercourse
- New Acland Coal Mine
- New Aland Coal Mine-Stage 3
- Cadastre
- Existing Permission
- Stage 3 Pit Areas

Dominant Geology
- Basalt (Tm)
- Alluvium (Qa)
- Colluvium (TQs)
- Walloon Subgroup (Jw)
- Marburg Sandstone (Jbm)

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Figure 3-7 - Location of Mine Groundwater Monitoring Bores

Scale 1:75,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

Produced: 13/09/2013 Path: I:\QENV2\Projects\QE06644\Spatial\ArcGIS\01_Figures\01_SEIS\ESC_Submission\130828_NewHope_IESC_Figure3-7_LocationOfMineGroundwaterMonitoringBores.mxd

Table 3-11 Additional Mine Groundwater Monitoring Sites

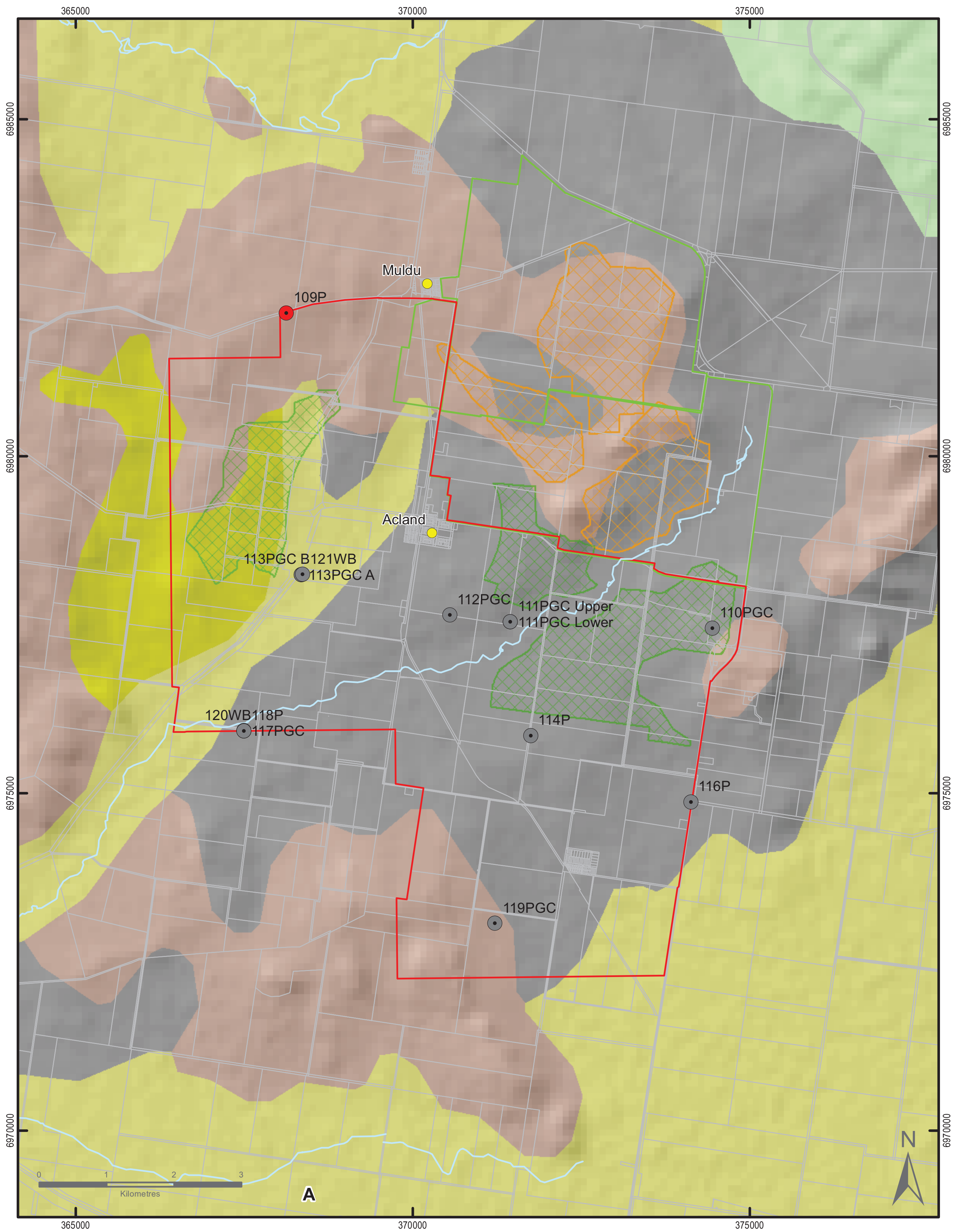
Site ID	Type	Aquifer	Groundwater Level Monitoring Frequency
18Pb (White)	Additional	Tertiary Basalt	Two-Monthly
20Phs	Additional	Marburg Sandstone	
21Phs	Additional	Marburg Sandstone	
29Phs	Additional	Marburg Sandstone	
40Pc	Additional	Walloon Coal Measures	
41Phs	Additional	Marburg Sandstone	
48Phs	Additional	Marburg Sandstone	
78Pcl	Additional	Clays (Alluvium)	
79Pcl	Additional	Clays (Alluvium)	
80Pcl	Additional	Clays (Alluvium)	

3.7 Revised Project Baseline Groundwater Monitoring

The purpose of the revised Project baseline groundwater monitoring is to expand the monitoring undertaken for the Mine to include the revised Project site. This expansion involved the installation of 14 groundwater monitoring bores at the revised Project site, which comprised 13 bores in the Walloon Coal Measures and one bore in the Tertiary Basalt. The locations of the additional Stage 3 groundwater monitoring bores are shown in **Figure 3-8**. A summary of the bore details is provided in **Table 3-12**.

Table 3-12 Summary of Stage 3 Monitoring Bore Details

Bore ID	Screen From (m)	Screen To (m)	Screened Aquifer
112PGC	35.5	41.25	Walloon Coal Measures
113PGCA	27	34	Walloon Coal Measures
113PGCB	43	50	Walloon Coal Measures
121WB	27	34	Walloon Coal Measures
117PGC	73.5	83.5	Walloon Coal Measures
118P	49	56	Walloon Coal Measures
120WB	73.5	83.5	Walloon Coal Measures
111PGC upper	28.5	33.5	Walloon Coal Measures
111PGC lower	39.5	45.5	Walloon Coal Measures
110PGC	39.5	54.5	Walloon Coal Measures
109P	98	102	Tertiary Basalt
116P	42	58	Walloon Coal Measures
119PGC	28.3	45.3	Walloon Coal Measures
114P	71	80	Walloon Coal Measures



LEGEND

- Towns and Localities

Aquifer

- Basalt
- Coal Measures

- Watercourse
- New Acland Coal Mine
- New Aland Coal Mine-Stage 3
- Existing Permission
- Stage 3 Pit Areas
- Cadastre

Dominant Geology

- Basalt (Tm)
- Alluvium (Qa)
- Colluvium (TQs)
- Walloon Subgroup (Jw)
- Marburg Sandstone (Jbm)

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Figure 3-8 - Location of Stage 3 Groundwater Monitoring Bores

Scale 1:75,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

Produced: 29/08/2013 Path: I:\QENV2\Projects\QE06644\Spatial\ArcGIS\01_Figures\01_SEIS\IESC_Submission\130828_NewHope_IESC_Figure3-8_LocationOfStage3GroundwaterMonitoringBores.mxd

Baseline groundwater monitoring is currently undertaken to assess the following attributes within the Walloon Coal Measures and Tertiary Basalt aquifers at the revised Project site:

- groundwater levels; and
- groundwater quality.

Groundwater monitoring at these bores continues on a monthly basis as part of the revised Project.

3.8 Groundwater Levels

3.8.1 Groundwater Levels at the Mine

Groundwater level monitoring has been undertaken in accordance with the Mine's EA on a monthly basis since 2003. From 2001 to 2003, groundwater level monitoring was undertaken in accordance with the Mine's pre-EA approval, which was the accepted Environmental Management Overview Strategy (NAC, 2001). These bores provide groundwater levels in various aquifers, including the Tertiary Basalt and Walloon Coal Measures aquifers. Voluntary groundwater monitoring is also undertaken for the Marburg Sandstone aquifer.

Reduced water levels (mAHD) for the groundwater monitoring sites within the Walloon Coal Measures are shown in **Figure 3-9**. Bore locations for currently active monitoring bores are shown on **Figure 3-7**. There are 13 monitoring bores currently in place to monitor groundwater level changes in the Walloon Coal Measures aquifer adjacent the Mine. Monitoring within the Walloon Coal Measures commenced in early 2002 and is ongoing. Monitoring has been undertaken in a staged fashion, with more bores coming online as mining has progressed, consistent Mine expansions.

Monitoring in bores 18P, 27P and 28P show little influence from mining from 2002 through to 2010, with varying degrees of response to recharge events. The influence of a large rainfall event at the end of 2010 (and generally above average rainfall throughout 2010) is clearly evident in these bores, as well as most other Walloon monitoring bores, suggesting significant groundwater recharge from this period. Monitoring bore 848c shows a very clear influence from mining activities, with drawdown in 2006 reaching a peak of around 20 m, before recovering back to pre-2006 levels by the start of 2011. Bores 81P and 82P show drawdown influence of up to around 12 m attributed to mining from around 2011, and recent investigations by NHG have shown this may be a result of faulting-related preferential groundwater flow within the Walloon Coal Measures aquifer. Bores CSMH1, 42P, 40P are relatively stable over the period of monitoring, with water level fluctuations limited to less than 5 m. Bore 2289 shows recovery of around 6 m over the period of monitoring.

No monitoring bore shows drawdown impacts of more than around 20 m over the duration of monitoring, and all drawdowns appear to stabilise over a period of around two years (i.e. continuing drawdown at a rapid rate does not occur in any bore).

Figure 3-10 shows the groundwater levels (mAHD) for the groundwater monitoring sites within the Tertiary Basalts.

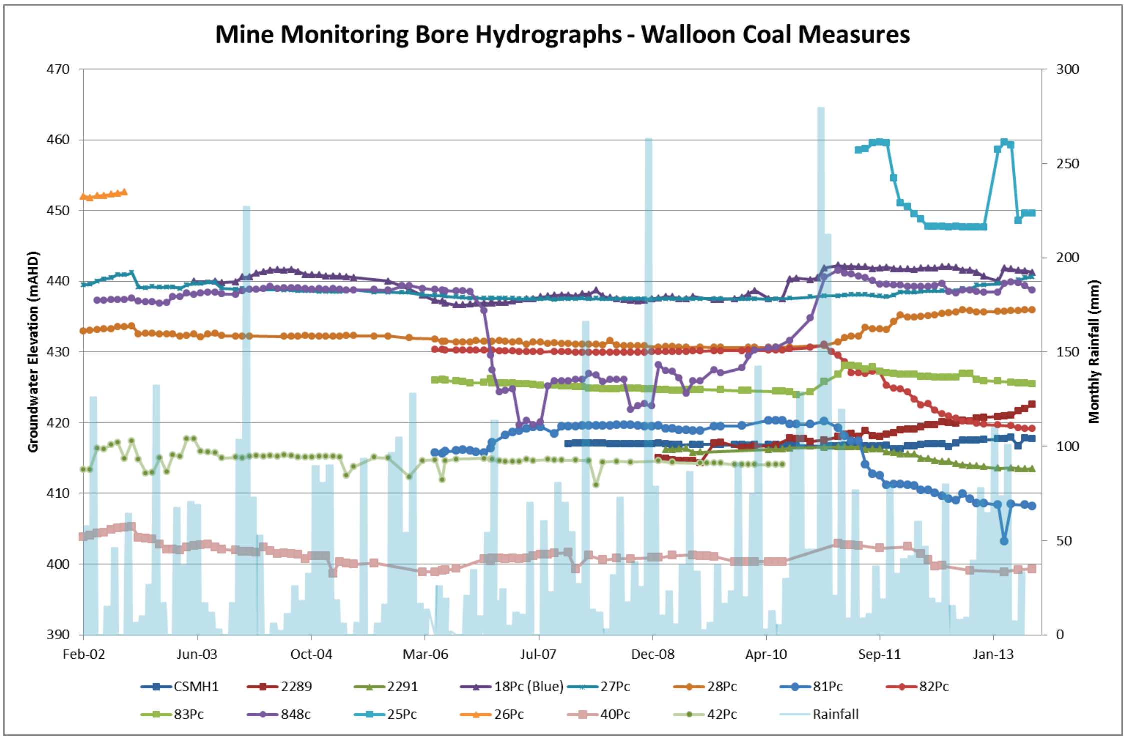


Figure 3-9 Walloon Coal Measures Compliance Monitoring Bore Hydrographs

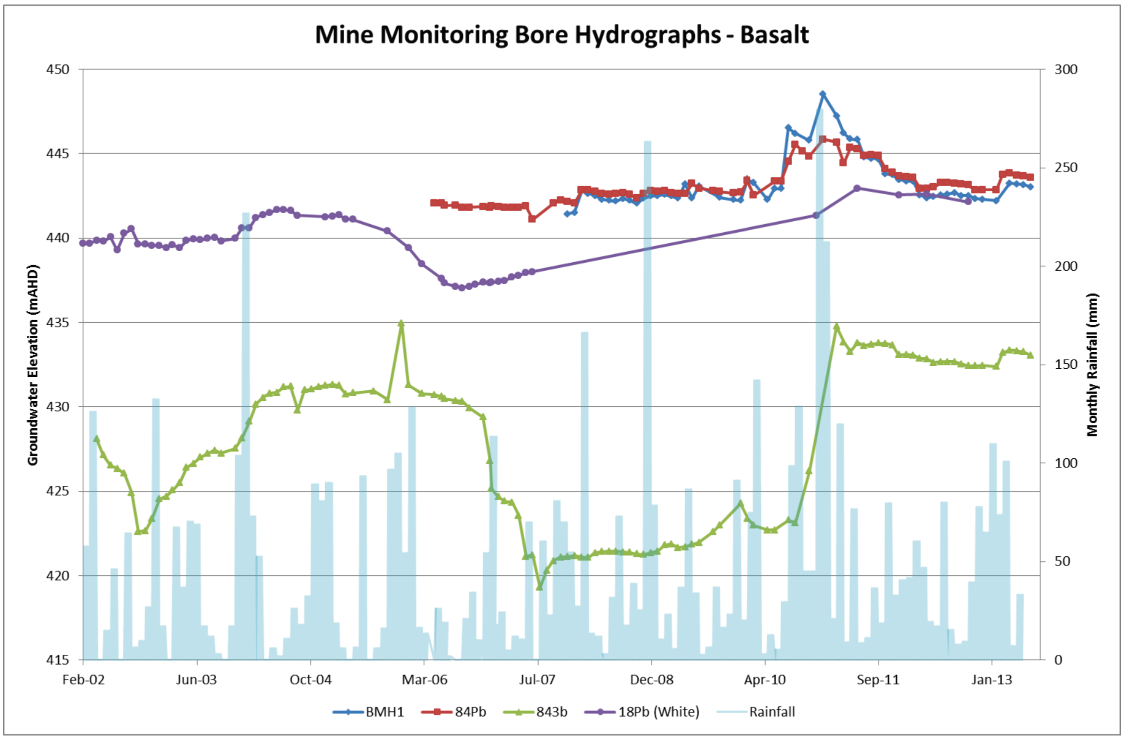


Figure 3-10 Tertiary Basalt Monitoring Bore Hydrographs

Tertiary Basalt monitoring bores display groundwater elevations ranging from 420 to 445 mAHD, with three of the monitoring bores displaying groundwater elevations that are consistently between 430 and 445 mAHD over the latter part of the monitoring period. The monitoring bore hydrographs show varying responses over the period of monitoring, with bores 18P and 843b show fluctuations of up to 15 m, and this may be related to their proximity to water supply bores sourcing water from the same aquifer. There is clear evidence of a recharge event in the Tertiary Basalt aquifer associated with significant rainfall during 2010 and start of 2011. Bore 843b displays both lower and more variable groundwater levels, and is located closest to Mine water supply bores (as shown in **Figure 3-6**), suggesting this bore is displaying groundwater level fluctuations associated with Mine water supply extraction.

There are five bores currently used for monitoring the Marburg Sandstone as shown in **Figure 3-11**, located to the north and northeast of the current Mine. Marburg Sandstone monitoring bores show groundwater elevations ranging from 395 to 444 mAHD, with four of the five bores in the range 395 to 420 mAHD. Bore 29P consistently reports water levels 20 to 25 m above the other four bores, despite being located relatively closely to the other bores as shown on **Figure 3-7**. Two of the bores (41P and 48P) show a distinct drawdown trend through to the end of 2008, likely associated with extraction for Mine water supply purposes. Groundwater elevations in these two monitoring bores range from 416 to 419 mAHD at the start of the monitoring record in 2002 before showing rapid drawdown from mid-2006. However, water levels in these bores show an increasing (recovering) trend from the start of 2009, and continue to recover through to present day. Recovery is associated with a reduction in Mine groundwater use due to the WWRF Pipeline coming online, and further recovery is expected to continue into the future. By comparison, bores 29P, 21P and 20P show relatively stable water levels over the period of monitoring, with fluctuations generally in the range of less than 5 m over the monitoring period.

3.8.2 Groundwater Levels for the revised Project Site

Groundwater level monitoring results for the revised Project site are shown in **Figure 3-12**. Bore locations are shown in Figure 9-1. The majority of bores are screened in the Walloon Coal Measures except bore 109P which is screened in the Tertiary Basalt.

Monitoring data prior to 2013 is available for a single monitoring event in 2007 for the Walloon Coal Measures and in 2008 for the Tertiary Basalt aquifer. Regular (monthly) monitoring was instigated in April 2013 and continues currently, with all bores added to the routine Mine groundwater monitoring schedule. The monitoring bores within the revised Project site show groundwater elevations ranging from 380 to 410 mAHD in the Walloon Coal Measures aquifer (appearing to be in quasi-steady state for individual bores), and 450 to 460 mAHD in the Tertiary Basalt aquifer. Although the data is limited from which to draw meaningful conclusions on long term trends, it is evident that groundwater levels have fluctuated over a range of up to 5 m in the Walloon Coal measures aquifer and 10 m (increase) in the Tertiary Basalt aquifer over the duration of monitoring (around 5 years), which possibly suggests some sensitivity to recharge events.

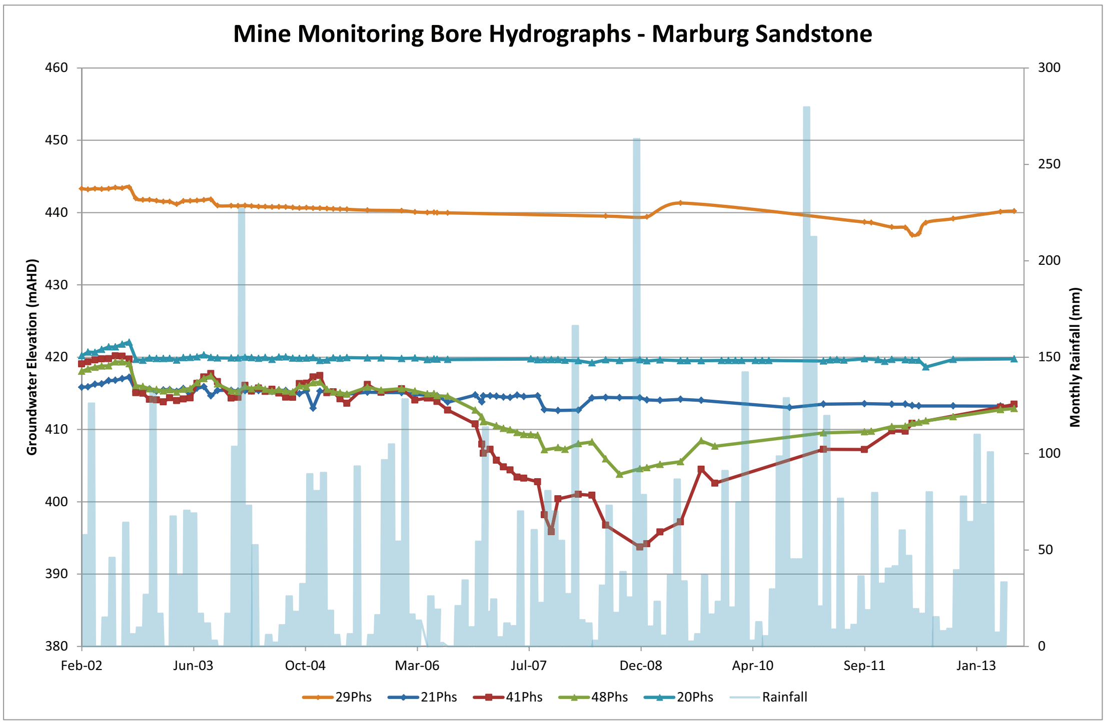


Figure 3-11 Marburg Sandstone Monitoring Bore Hydrographs

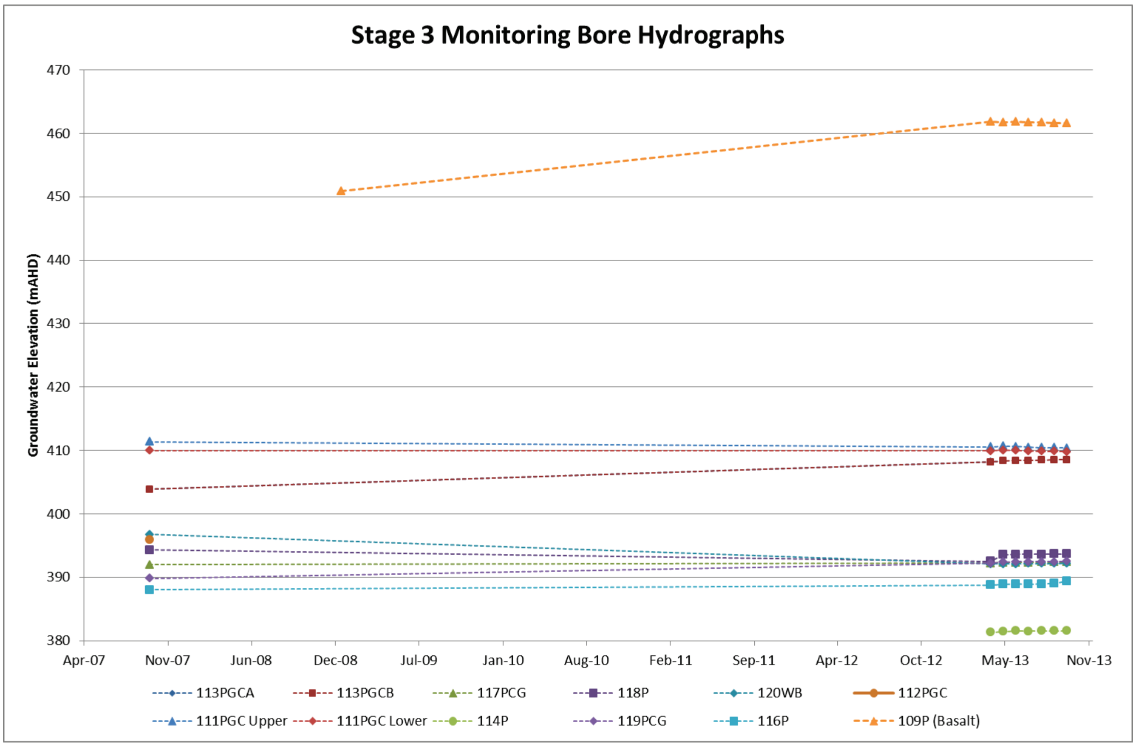


Figure 3-12 Stage 3 Monitoring Bore Hydrographs

3.9 Groundwater Movement

The movement of groundwater within an aquifer is driven by the elevation of the groundwater potentiometric surface, which often mirrors topographic surface terrain in a more subdued manner, but is also influenced by various natural and anthropogenic factors including geological structure, enhanced or decreased recharge, and groundwater extraction.

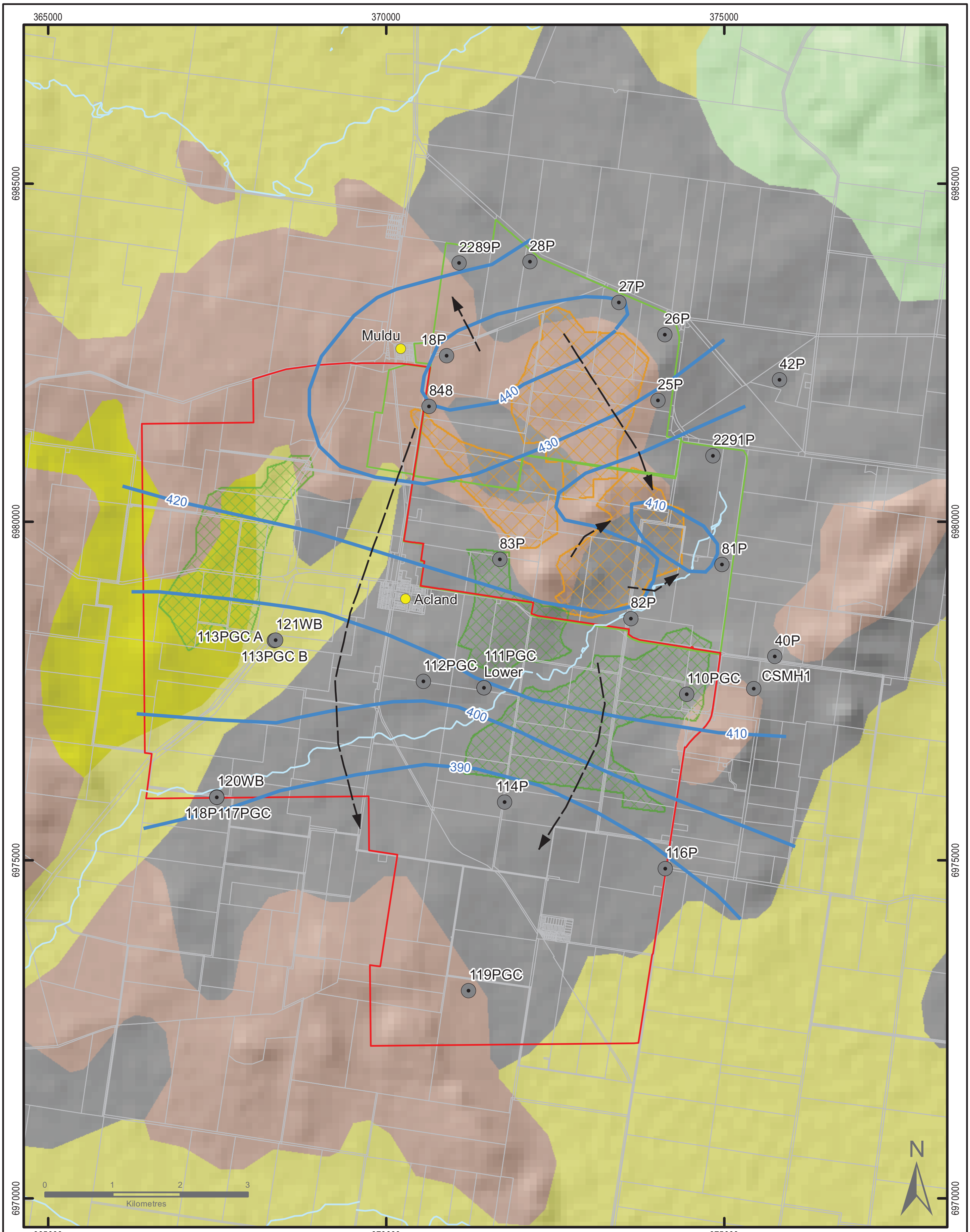
Groundwater elevation contours (potentiometric surface) for the Walloon Coal Measures aquifer were constructed for the current Mine and the revised Project site for May 2013, based on data collected from Mine and Stage 3 monitoring bores and the known Mine pit extents and working depths at the time, and are shown on **Figure 3-13**.

The groundwater level data indicate that the overall direction of groundwater flow in the Walloon Coal Measures aquifer beneath the revised Project site is to the south, from elevations of around 430 mAHD in the north to 390 mAHD in the south. This direction of flow is consistent with the regional topographic surface and the geological dip of the Walloon Coal Measures to the south-southwest.

The data show that there is an area of elevated groundwater levels (approximately 440 mAHD) within the Walloon Coal Measures in the north of the current Mining area, consistent with the location of the previously worked and backfilled mining areas and the location of in-pit tailings dams. The extent of this groundwater mounding is limited to 1 to 2 km from the mined and backfilled area, and inferred groundwater flow contours show that much of the mounded groundwater flows to the active mine pits which act as a groundwater sink.

The contours also show the extent of potentiometric surface disruption related to current mining, which appears to be limited to within 1 km of the currently active pit and currently show groundwater elevations of 410 mAHD.

The distribution of the Tertiary Basalt aquifer within the current mining area and revised Project site, and therefore the distribution of monitoring bores within the Mine and revised Project leases accessing that aquifer, is insufficient to draw meaningful conclusions of regional groundwater movement within the basalt aquifer. Further monitoring as proposed in **Section 9.1** is aimed at addressing these data gaps. However, for the purpose of the groundwater impact assessment this data gap is not considered significant, and the data currently available for the area to the northwest of the current Mine area show a general increase in groundwater elevation in the westerly direction, from around 433 mAHD to 460 mAHD in May 2013. These groundwater elevations in the Tertiary Basalt aquifer are generally slightly higher than groundwater elevations for the Walloon Coal Measures in the same area, especially to the west away from the Mine area, suggesting some degree of hydraulic disconnection between the two aquifers, and a downwards hydraulic gradient between them. However, the lower groundwater elevation at the closest basalt monitoring bore (853b, ~ 433 mAHD) may indicate some drawdown influence from historical mining activities.



LEGEND

- Towns and Localities
- Mine Monitoring Bores - Coal Measures
- Walloon Coal Measures Groundwater Elevation Contours (May 2013)(mAHD)
- Inferred Groundwater Flow Direction
- Watercourse
- Cadastre
- New Acland Coal Mine
- New Aland Coal Mine-Stage 3
- Existing Permission
- Stage 3 Pit Areas

Dominant Geology

- Basalt (Tm)
- Alluvium (Qa)
- Colluvium (TQs)
- Walloon Subgroup (Jw)
- Marburg Sandstone (Jbm)

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Figure 3-13 - Potentiometric Surface - Walloon Coal Measures (May 2013)

Scale 1:75,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

Path: I:\QENV2\Projects\QE06644\Spatial\ArcGIS\01_Figures\01_SEIS\IESC_Submission\130828_NewHope_IESC_Figure3-13_PotentiometricSurface_WalloonCoalMeasures.mxd

Produced: 29/08/2013

The distribution of current Mine and revised Project monitoring bores within the Marburg Sandstone aquifer is insufficient to draw meaningful conclusions of the direction of groundwater movement within that aquifer; given the significant depth of this aquifer below the Mine workings the only requirement for monitoring in this aquifer to date has been in the area of the Mine's Marburg Sandstone water supply bores to the north of the current mining area. However, on a regional scale groundwater flow within the Marburg Sandstone is expected to be from the recharge areas northeast of the revised Project site where the formation outcrops, in a southwesterly direction consistent with the general structural dip of the formation.

3.10 Inter-aquifer Connectivity

The Quaternary Alluvial aquifer is shown to be unlikely to be present within the revised Project site. However, the aquifer is known to occur in association with Oakey Creek and its tributaries south of the revised Project site, and Myall Creek and its tributaries north of the revised Project site, where it directly overlies the Walloon Coal Measures. As such, the potential exists for hydraulic connection between the two units south of the revised Project site, especially if coal seams (the main water bearing units of the Walloon Coal Measures) subcrop in direct connection with the overlying alluvium. However, drawdown impact on the alluvial aquifer from mining activities associated with the revised Project would require significant expansion of drawdown within the Walloon Coal Measures outside of the revised Project site which is considered unlikely.

Given that there is little occurrence of the basalt aquifer within the revised Project site, it is unlikely that mining activities will have a direct regional impact on the basalt aquifer. However, it is known that the Tertiary basalt aquifer was deposited in palaeochannels incised into the Walloon Coal Measures palaeosurface and so the potential exists for direct hydraulic connection between the basalt aquifer and the Walloon Coal Measures, especially if a coal seam (the main water bearing units of the Walloon aquifer) were exposed to the basalt-filled palaeochannels. This depositional environment means that mining undertaken as part of the revised Project has the potential to cause groundwater drawdown in the basalt aquifer as mining occurs below the water table in the Walloon Coal Measures. Similarly to the Quaternary Alluvial aquifer, the degree of drawdown in the basalt aquifer will depend on the extent to which drawdown in the Walloon Coal Measures expands outside of the revised Project site to where the basalt aquifer occurs (mainly to the south and west outside of the revised Project site).

The Marburg Sandstone aquifer lies at significant depth (>75 m) below the deepest proposed mining depths in the revised Project site, and is separated from the mined coal seams by dominantly low permeability sediments (mudstones and siltstones) of the Walloon Coal Measures and Eurombah Formation. These low permeability strata act as a confining aquitard to limit the hydraulic connection between the two units; as a result, little impact on the Marburg Sandstone aquifer is expected from mining activities. Hydraulic separation is supported by monitoring bore data from the current Mine monitoring network showing water levels in the Marburg Sandstone to be significant below those of the Walloon Coal Measures aquifer; this is highlighted in **Figure 3.9** and **Figure 3.11** showing bore 27P (Walloon Coal Measures) currently displaying a potentiometric head around 25 m above that of bore 48P (Marburg Sandstone) at a similar location (**Figure 3.7** shows bore locations). However, the occurrence of faults extending from the Marburg Sandstone to the coal seams of the Walloon Coal

Measures cannot be discounted, and it is possible that some of these faults may act as conduits for groundwater flow.

The Helidon Sandstone aquifer is separated from the Marburg Sandstone aquifer by the dominantly low permeability Evergreen Formation which acts as a confining aquitard to limit the hydraulic connection between the two units. Again, the occurrence of faults extending from the Helidon Sandstone to the Marburg Sandstone or coal seams of the Walloon Coal Measures cannot be discounted, and it is possible that some of these faults may act as conduits for groundwater flow. However, it is generally considered that the Helidon Sandstone aquifer is almost completely hydraulically isolated from the overlying units due to the presence of the Evergreen Formation.

3.11 Surface Water and Groundwater Interaction

Based on the studies undertaken as part of the revised Project's EIS and described in **Section 4**, Lagoon Creek is assessed as being ephemeral and there are no perennial water courses or water holes present within the revised Project site. A comparison of groundwater levels and stream bed levels indicates that groundwater elevations lie below those of stream beds in the revised Project site, indicating groundwater does not contribute to surface water flow within Lagoon Creek and that groundwater drawdown is unlikely to cause stream flow losses during flow events.

Oakey and Myall Creeks are also ephemeral where they are closest to the revised Project site, suggesting that surface flows are not supported by groundwater discharge. Previous studies and reports on the nature of groundwater related to Oakey and Myall Creeks suggest that the creeks are disconnected from the underlying alluvial groundwater in their upper reaches (DNR 2000; MDBA 2004) and therefore any impacts to groundwater in the vicinity of the revised Project site are unlikely to impact on surface water flows.

After significant rainfall events which result in runoff to surface water drainage lines, it is anticipated that a component of surface flow will infiltrate and a small amount will reach the Quaternary Alluvial aquifer water table, which is generally several tens of metres below the stream beds. The majority of the infiltrated water is likely to be lost by direct evapotranspiration along the stream riparian zone.

3.12 Groundwater Quality

The following sub-sections provide a summary of the water quality data collected for the Mine and the revised Project site. As well as in consideration of the EPP Water as described in **Section 3.13**, groundwater quality data has been compared to the following guidelines based on the EVs of the revised Project site:

- ANZECC 2000 Guidelines;
- Queensland Water Quality Guidelines 2009 (QWQG); and
- Australian Drinking Water Guidelines 2011 (ADWG).

The revised Project site lies within the Murray-Darling Region of the QWQG. For this Region, the QWQG states that background water quality information is insufficient to set reliable guidelines and so water users may default to the ANZECC 2000 Guidelines. This suggestion has been followed in the following groundwater quality assessment.

Groundwater results were not compared to ANZECC Guidelines for the protection of aquatic ecosystems for reasons outlined in **Section 3.13**.

3.12.1 Groundwater Quality for the Mine

A groundwater quality monitoring program is undertaken at the Mine in accordance with the conditions of the EA. This monitoring is performed in accordance with EHP's Monitoring and Sampling Manual (2009). The monitoring program targets the Walloon Coal Measures aquifer and the Tertiary Basalt aquifer. **Appendix C** presents the results of all groundwater quality monitoring undertaken at the Mine from 2003 to 2012, including the results of monitoring for major ions and hydrocarbons. The following provides a summary of the groundwater monitoring results for the main groundwater quality indicators (pH, EC and TDS) that have been collected since the commencement of the program.

Walloon Coal Measures Aquifer

The results for pH from groundwater bores in the Walloon Coal Measures are shown in **Figure 3-14**. Based on the results obtained from groundwater monitoring bores installed in the Walloon Coal Measures, pH is generally neutral to slightly alkaline and ranges from 6.8 to 8.5 for most bores. Exceptions are an isolated anomalous measurement of pH > 9 for bore 18P and bore 2289 which reports highly variable pH readings of generally at or less than 7. No trends are evident in the data that can be directly attributed to mining. The ADWG suggest that the pH of drinking water should be between 6.5 and 8.5. The majority of the results are within this guideline limit.

The results for Electrical Conductivity (EC) from groundwater bores in the Walloon Coal Measures are shown in **Figure 3-15**. EC within the Walloon Coal Measures ranges from around 500 µS/cm to 11,000 µS/cm and is generally fairly stable, with a slightly declining trend possibly evident in some bores. Bore 2289 shows highly variable EC measurements, consistent with the highly variable pH readings.

Figure 3-16 shows the results for Total Dissolved Solids (TDS) for groundwater bores in the Walloon Coal Measures. TDS results range from around 300 mg/L to 7,000 mg/L, with fairly stable readings from individual bores with the exception of bore 2289. A slight decreasing trend may be evident in some bores. Again, bore 2289 shows significant variation in readings. The ADWG suggest that the TDS of drinking water should not exceed 600 mg/L. The majority of the results are well in excess of this guideline limit.

The tolerance of livestock to TDS in drinking water has been identified in the ANZECC Guidelines. In general terms, for no adverse effects to occur to animals the upper limit for TDS is 4,000 mg/L. The majority of results from the groundwater monitoring in the Walloon Coal Measures are within these guideline limits and therefore suggest that the quality of water in the bores monitored remains acceptable for livestock use. However bores, 27P, 28P and 2289 had results consistently above 4,000 mg/L which exceed the upper limit of the ANZECC Guidelines. The ANZECC Guidelines also state that when TDS ranges from 4,000 mg/L to 10,000 mg/L, animals may have an initial reluctance to drink, however, they should eventually adapt to these conditions without a measurable loss of production. EC values are generally in the range suitable only for irrigation where the crops are tolerant or very tolerant to salinity as described in the ANZECC Guidelines.

On the basis that results from bore 2289 were not found in any other bores, the results for bore 2289 have been considered to be anomalous and are possibly due to poor bore construction, minimal aquifer intersection, or erroneous sampling procedures in the field, all which can lead to sample contamination or false measurements.

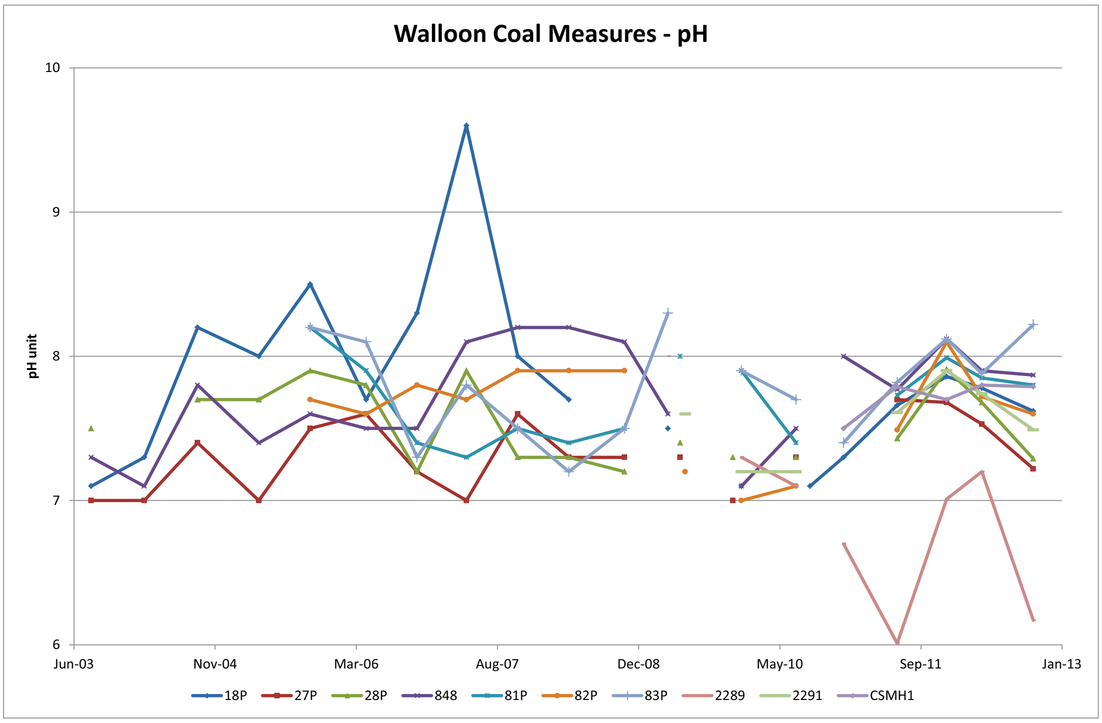


Figure 3-14 pH results for the Walloon Coal Measures

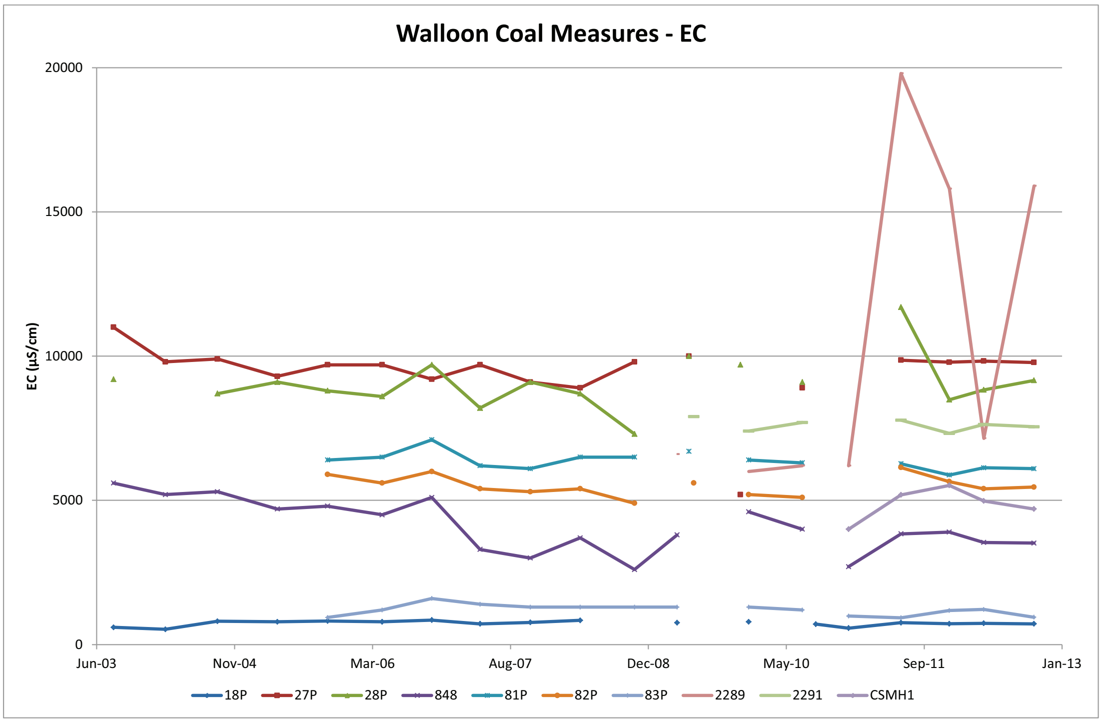


Figure 3-15 Electrical Conductivity results for the Walloon Coal Measures

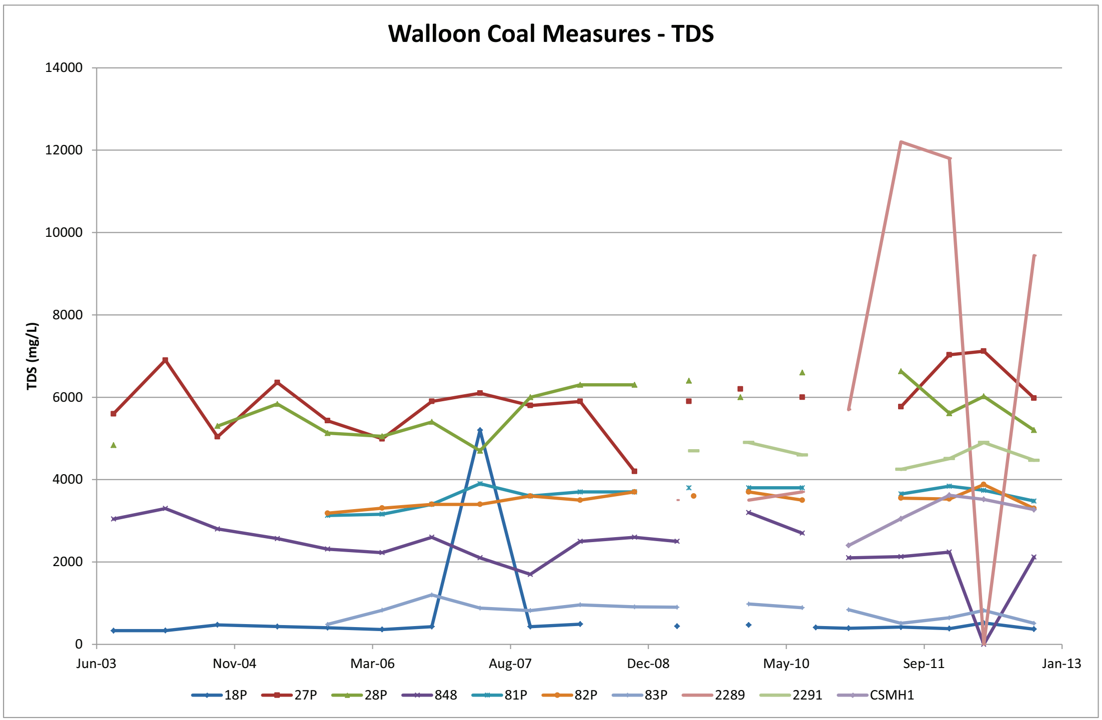


Figure 3-16 Total Dissolved Solids for the Walloon Coal Measures

Tertiary Basalt Aquifer

The results for pH in the Tertiary Basalts are shown in **Figure 3-17**. The results for pH within the Tertiary Basalts range from 7.2 to 8.2, which indicates that groundwater quality within the basalts is neutral to slightly alkaline. pH values are relatively stable over the period of monitoring with no trends discernible. Results fall within the ADWG pH limit of 6.5 to 8.5.

The results for EC from groundwater bores in the Tertiary Basalt are shown in **Figure 3-18** and **Figure 3-19** shows the results for TDS for groundwater bores in the Tertiary Basalt. No discernible trends that can be attributed to mining are evident in the data. However, there may be a rainfall (recharge) related trend as shown by increasing pH following 2010.

The groundwater salinity in the Tertiary Basalts is generally lower than the Walloon Coal Measures, with TDS ranging from 800 to 3,000 mg/L (i.e. 1,300 to 4,500 µS/cm EC), further suggesting a recharge related phenomena. Accordingly, a greater number of users extract groundwater from this aquifer for livestock and domestic purposes.

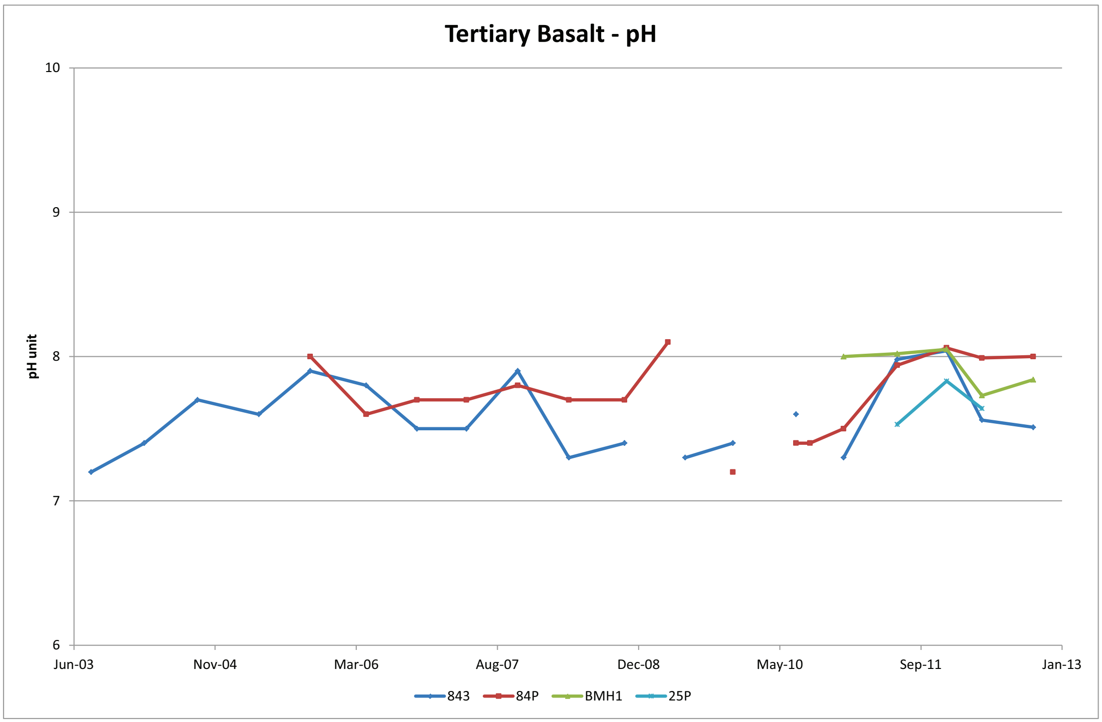


Figure 3-17 pH results for the Tertiary Basalts

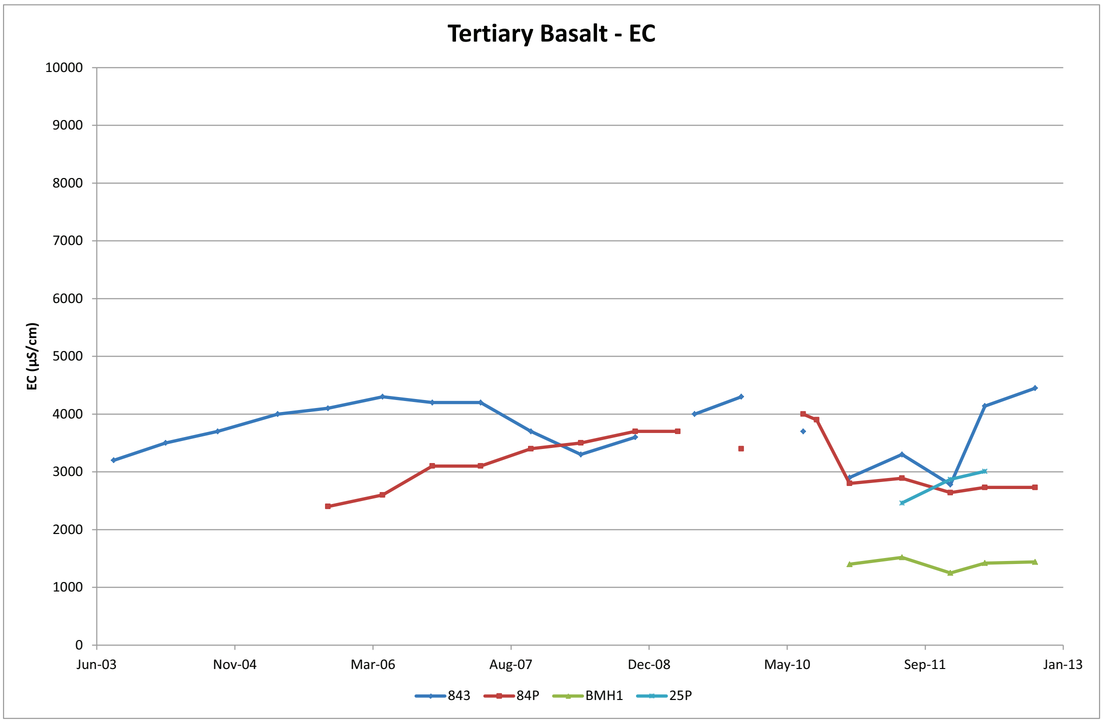


Figure 3-18 Electrical Conductivity results for the Tertiary Basalts

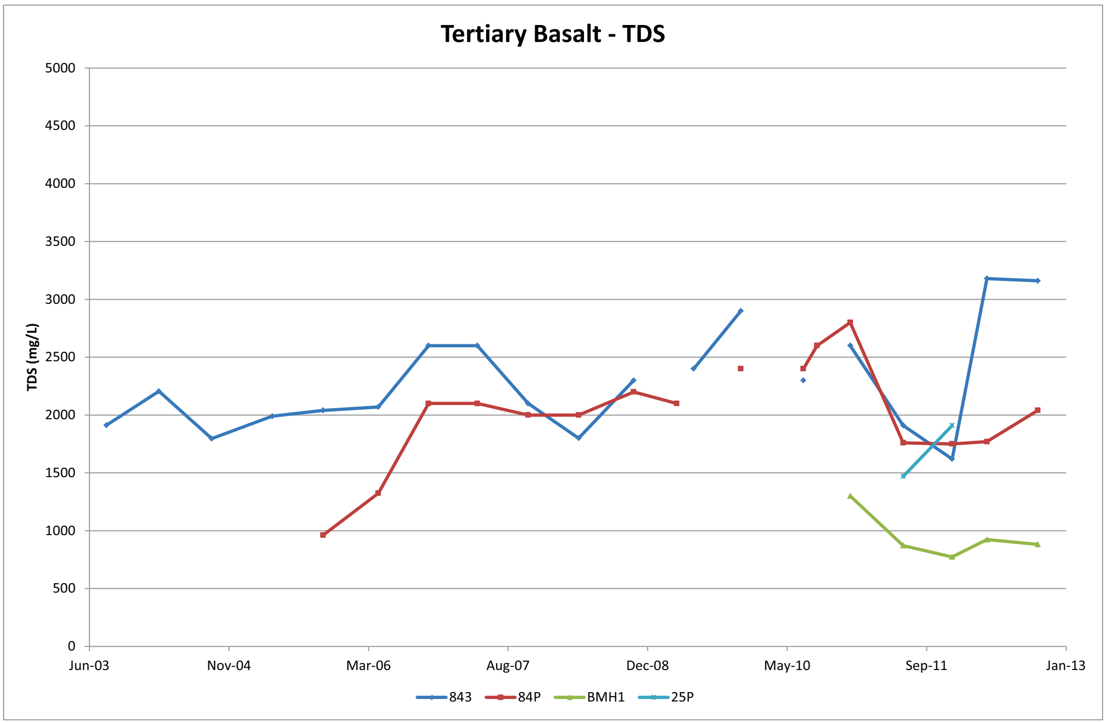


Figure 3-19 Total Dissolved Solids results for the Tertiary Basalts

All of the groundwater monitoring results from the Tertiary Basalts were within the ANZECC Guidelines for livestock use of 4,000 mg/L. EC values are generally in the range suitable only for irrigation where the crops are moderately tolerant to salinity as described in the ANZECC Guidelines. The ADWG suggest that the TDS of drinking water should not exceed 600 mg/L. All results from the Tertiary Basalt are well in excess of this guideline limit.

3.12.2 Groundwater Quality for the revised Project site

Groundwater quality monitoring was undertaken from monitoring wells installed within the Walloon Coal Measures and Tertiary Basalt within the revised Project site. Physico-chemical results from the revised Project baseline groundwater monitoring program are summarised in **Table 3-13**.

As shown in **Table 3-13**, pH in groundwater ranged around neutral in the Walloon Coal Measures (6.8 to 7.4) and is slightly alkaline in the Tertiary Basalt (8.2). All of the results are within the ADWG limit for pH.

The EC and TDS results indicate that the groundwater within the Walloon Coal Measures is generally brackish beneath the revised Project site, with TDS results ranging from 1,240 to 6,610 mg/L. The majority of results from the groundwater monitoring in the Walloon Coal Measures are within the ANZECC Guidelines of 4,000 mg/L for TDS and therefore suggest that the quality of groundwater is acceptable for livestock use. Bores 118P and 111PGC had results above 4,000 mg/L which exceed the upper ANZECC Guideline limit for salinity. All results for the Walloon Coal Measures in the revised Project site are well in excess of the ADWG limit of 600 mg/L TDS.

Table 3-13 Physico-chemical Results from revised Project Groundwater Monitoring (October 2007)

Site Number	Dissolved Oxygen % Saturated	TDS (mg/L)	Electrical Conductivity (µS/cm)	pH	Redox (mV)	Temperature (ºC)
Walloon Coal Measures						
121WB	25.9	3,140	-	7.05	275	28.9
113PGC A	34.0	3,770	6,020	6.81	-178	30.1
113PGC B	18.4	2,930	4,770	6.95	-280	25.9
118P	33.7	6,610	10,340	7.06	-216	24.6
117PGC	43.4	2,740	4,530	7.43	-250	26.7
116P	47.9	1,240	2,260	7.38	85	31.3
111PGC lower	27.8	2,940	-	7.11	-2	24.2
111PGC upper	23.4	4,220	6,740	7.04	-299	23.4
119PGC	30.5	1,280	2,130	7.37	-32	24.5
Tertiary Basalt						
109P	15.2	330	-	8.17	-270	26.4

Groundwater within the Tertiary Basalt aquifer is significantly fresher than the Walloon Coal Measures, with a TDS of 330 mg/L. This single recorded value for Tertiary Basalt salinity is at the lower end of measured salinities from basalt monitoring bores associated with the current Mine (and discussed in **Section 3.12**). The single TDS measurement from the Tertiary Basalt in the revised Project site is within the ADWG limit of 600 mg/L TDS.

A single round of major ion and dissolved metals chemical analysis was undertaken for bores installed the revised Project site in October 2007. The laboratory results for the analysis are included in **Appendix D**. **Table 3-14** provides a summary of the results.

Based on the comparison of physico-chemical and groundwater quality results to the ANZECC Guidelines and ADWG, groundwater from the Walloon Coal Measures within the revised Project site is considered suitable for livestock watering but only suitable for cropping for salt tolerant crops.

The normalised results from major ion chemistry analysis are presented as a Piper tri-linear diagram in **Figure 3-20**. Based on this plot, groundwater quality in the Walloon Coal Measures is generally brackish (saline) with sodium and chloride ions dominating. However, slight variations in water chemistry within the Walloon Coal Measures were present which may indicate the occurrence of different levels of water-rock interaction and natural heterogeneity within the aquifer. This characteristic is due to the residence time of the groundwater, weathering processes and recharge inputs.

Groundwater from the Tertiary Basalt is shown to be a different water type than the Walloon Coal Measures, having a comparatively greater proportion of bicarbonate and less chloride than the Walloon Coal Measures. This may indicate some degree of hydraulic disconnection between the two aquifers.

Table 3-14 Groundwater Quality Results from bores in the revised Project Site (Walloon Coal Measures)

Analyte	ADWG Drinking Water	ANZECC Irrigation	ANZECC Livestock	No. of Samples	Minimum	Median	Maximum
Hydroxide Alkalinity as CaCO3	-	-	-	9	<1	<1	<1
Carbonate Alkalinity as CaCO3	-	-	-	9	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	-	-	-	9	195	413	527
Arsenic	0.007	0.1	0.5	9	<0.001	0.0025	0.003
Cadmium	0.002	0.01	0.01	9	<0.0001	0.001	0.001
Chromium	0.05	0.1	1	9	<0.001	0.008	0.008
Copper	2	0.2	0.5	9	<0.001	0.002	0.004
Lead	0.01	2.0	0.1	9	<0.001	0.005	0.009
Nickel	0.02	0.2	1	9	<0.001	0.002	0.002
Zinc	3	2.0	20	9	0.005	0.011	0.046
Mercury	0.001	0.002	0.002	9	<0.0001	<0.0001	<0.0001

Note: All results and guideline values are reported in mg/L. '<' signifies that laboratory reports concentrations below the level of reporting.

3.13 Environmental Values in the EPP Water

The following provides a comparison of the groundwater quality data with respect to the EVs for the revised Project site as listed in the EPP (Water).

3.13.1 Aquatic Ecosystems and GDEs

The EPP (Water) identifies that EV's for groundwater in the revised Project site may include aquatic ecosystems. Aquatic ecosystems reliant in some way on groundwater are a form of Groundwater Dependent Ecosystem (GDE). GDEs are ecosystems which have their species composition and natural ecological processes determined to at least some extent by groundwater (ARMCANZ & ANZECC, 1996). Hatton and Evans (1998) defined four functional groups of GDEs including terrestrial vegetation, river baseflow systems, aquifer and cave systems and wetlands. Clifton and Evans (2001) expanded this list to include fauna and estuarine systems dependent upon groundwater discharge. The health of a GDE is generally defined by four parameters: flux, level, pressure and quality (Clifton and Evans, 2001), with dependence potentially being a function of one or all of the above factors. Groundwater dependency can also vary spatially and temporally and is dependent upon whether the system represents a local or regional GDE.

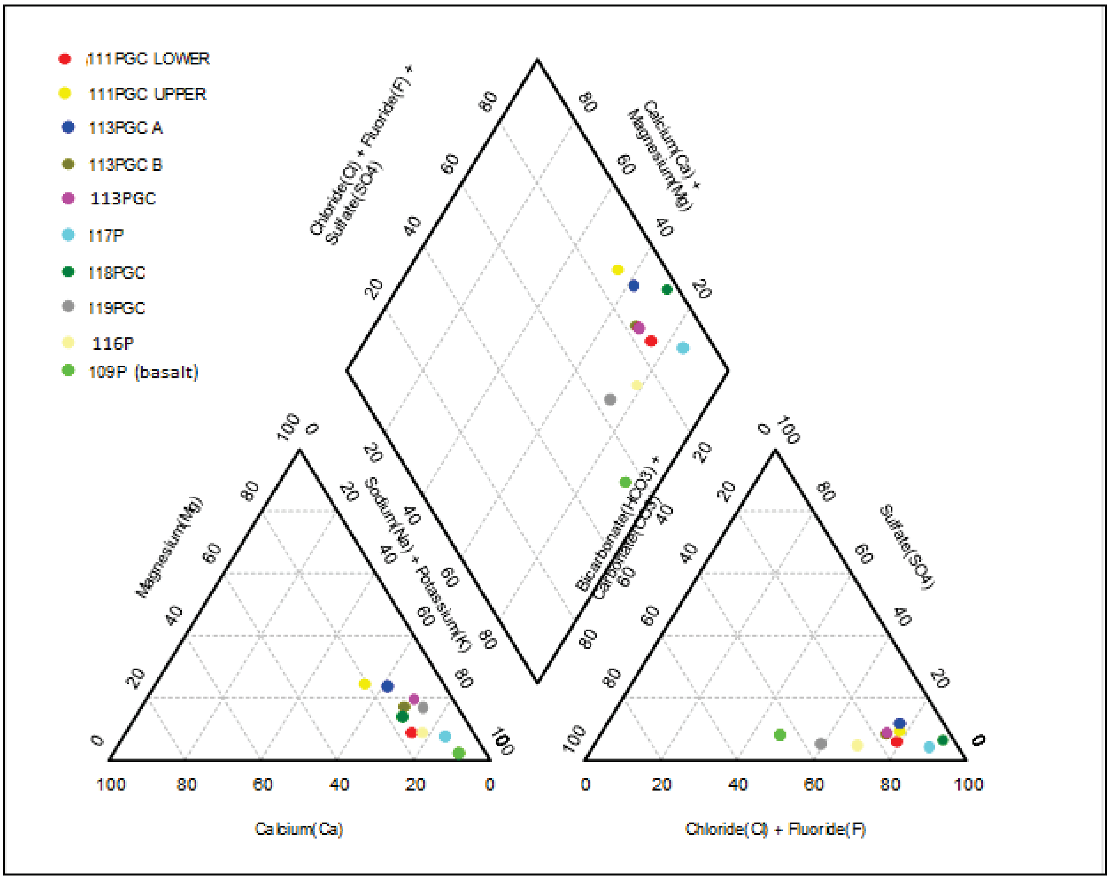


Figure 3-20 Piper tri-linear diagram showing groundwater composition type in the revised Project site (note all bores are Walloon Coal Measures except 109P which is Tertiary Basalt)

A search of the BoM's GDE Atlas and also published DERM and Regional Ecosystem (2005) mapping data has identified no GDEs reliant on the surface expression of groundwater (such as rivers, springs or wetlands) within 10 km of the revised Project site. The same search has however identified a low to moderate potential for the presence of terrestrial vegetation that is reliant on the occurrence of subsurface groundwater within the revised Project site. **Chapter 7** of the revised Project's EIS describes the revised Project related terrestrial ecosystems in detail and a summary is provided in **Section 5** of this document. A review of the terrestrial ecosystems existing within the vicinity of the revised Project site indicates that the water requirements for these species are likely to be derived from depths significantly shallower than 10 m below ground level. Given that the depth to the water table in the Walloon Coal Measures aquifer is between approximately 10 m to 50 m below ground level across the revised Project site, there are unlikely to be GDEs (including terrestrial vegetation reliant to some degree on groundwater) present within the revised Project site.

Groundwater elevations of all aquifers lie significantly below stream bed elevations in the revised Project site; studies undertaken as part of Stage 2 EIS in 2005 compared groundwater levels to stream bed levels for Lagoon Creek under average conditions and found that there was significant separation such that groundwater does not contribute to surface water flows. Accordingly it is considered unlikely that baseflow systems exist within the revised Project site and therefore unlikely that groundwater supports aquatic ecosystems within the revised Project site. Groundwater levels within the Oakey Creek alluvium to the south of the revised Project site are also known to be below the base of the stream channel. As a result, the potential for mining effects on groundwater to impact ecosystems is considered low.

3.13.2 Recreational, Agricultural and Industrial Use

Recreational uses for groundwater encompass primary and secondary contact such as swimming and boating respectively. Given that the depth to groundwater is generally greater than 10 mBGL, it is unlikely that there is input from the groundwater to water bodies which may be used for recreational purposes. Therefore, recreational use of groundwater within the revised Project site is considered negligible.

Agricultural uses of groundwater in the revised Project site are dominated by livestock watering and to a lesser extent irrigation. Groundwater use for livestock purposes has been identified to occur locally from the Tertiary Basalt aquifer. The Walloon Coal Measures aquifer supplies brackish livestock water and is generally low yielding (up to 1 L/sec). Livestock watering and municipal supplies have also been identified to be extracted from the Marburg Sandstone aquifer.

The Mine currently extracts groundwater for use at the Mine from the Tertiary Basalt aquifer. Groundwater flowing into the existing mine pits from the Walloon Coal Measures aquifer is also used by the Mine. Groundwater extraction by the Mine from the Helidon Sandstone and Marburg Sandstone aquifers is minimal and irregular by comparison.

3.13.3 Drinking Water

A comparison of the groundwater quality data to the ADW Guidelines indicates that groundwater within the Tertiary Basalt, Marburg Sandstone and Helidon Sandstone aquifers is generally suitable for potable use (based on TDS). Groundwater quality data demonstrates variability between and within aquifers. Groundwater use for domestic purposes has been identified to occur locally from the Tertiary Basalt aquifer.

Groundwater within the Walloon Coal Measures is generally unsuitable for potable use without treatment, primarily due to elevated salinity levels.

3.14 Conceptual Hydrogeological Model

A conceptual hydrogeological model has been formulated for the revised Project site based on the geological and hydrogeological data for the Mine and the revised Project. The data indicate that the geology and hydrogeology of the Mine is similar to that found within the revised Project site.

The conceptual hydrogeological model describes the aquifers present within the revised Project site, how they interact with each other and surface waters, and their attributes such as groundwater depth, thickness, transmissivity, storativity and hydraulic conductivity.

The aquifers present within the revised Project site include the following:

- Quaternary Alluvial aquifer;
- Tertiary Basalt aquifer;
- Walloon Coal Measures aquifer;
- Marburg Sandstone aquifer; and
- Helidon Sandstone aquifer.

These aquifers are described further in the following Sections.

Figure 3-21 presents a schematic of the conceptual hydrogeological model for the revised Project.

The conceptual hydrogeological model has been developed using the best available data and assumptions. The conceptual hydrogeological model will continue to be updated and refined based on the results of a targeted groundwater monitoring program and further investigations into local bore information (e.g. landholder bore surveys).

3.14.1 Quaternary Alluvial Aquifer

The shallow Quaternary Alluvial aquifer is limited in aerial extent and unlikely to form a major aquifer at the revised Project site. The alluvial aquifer is known to occur south of the revised Project site in association with Oakey Creek, and its tributaries, where it reaches a thickness of up to 60 m and contains significant groundwater supplies. Similarly, groundwater supplies may also be developed in association with this aquifer to the northwest of the current Mine site in association with Myall creek and its tributaries.

The predominant mechanism for recharge of the alluvial aquifer is direct infiltration. Discharge is likely to occur via evapotranspiration and infiltration to underlying aquifers.

Due to the minor nature of this aquifer within the revised Project site, data on groundwater yield and quality within the revised Project site was not obtained. Due to the lack of alluvial aquifer presence close to current mining activities, the current Mine is not expected to be causing an impact to this aquifer.

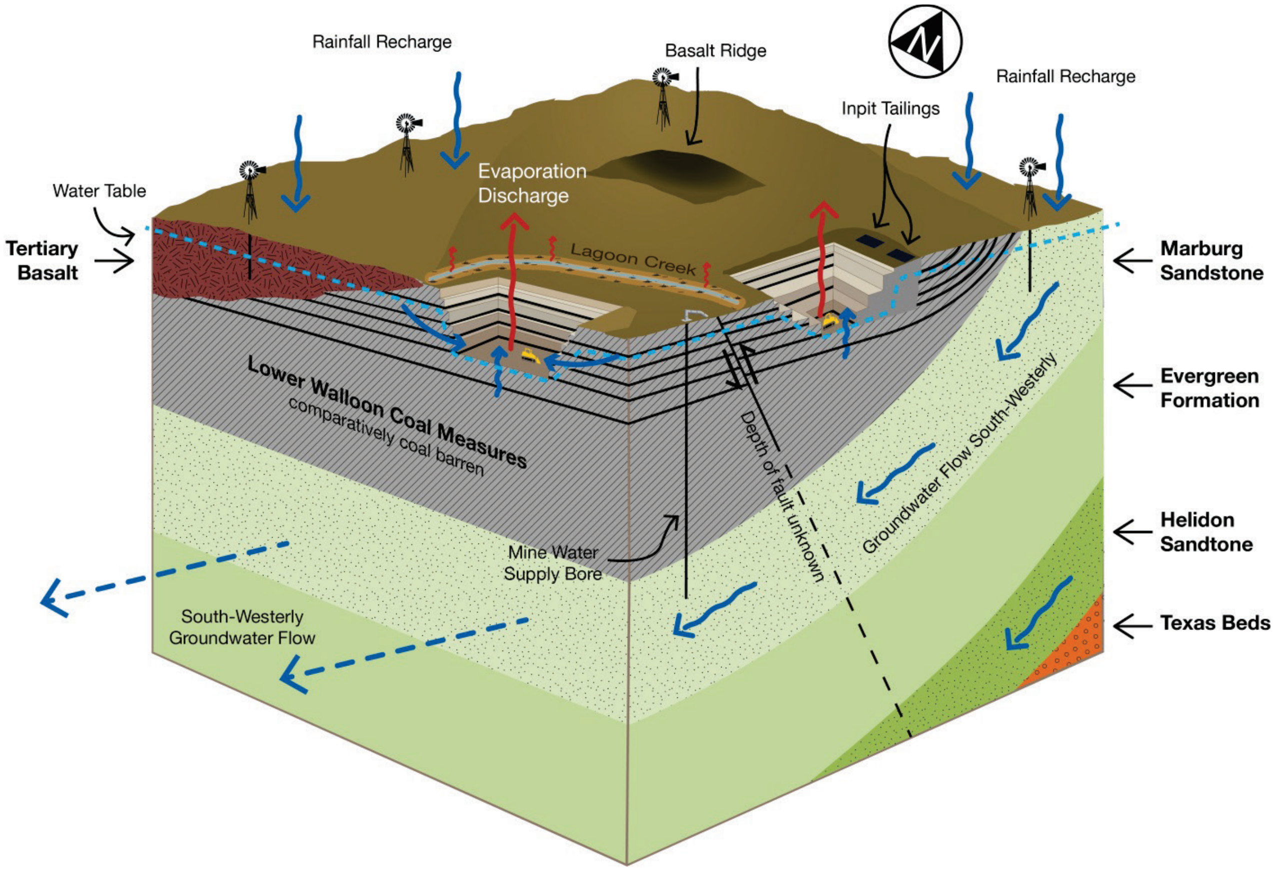


Figure 3-21 Conceptual Hydrogeological Model

3.14.2 Tertiary Basalt Aquifer

There is a minor occurrence of the Tertiary Basalt aquifer in the northwestern section of the revised Project site. The location of this aquifer in relation to the revised Project's mine pits means that this aquifer is unlikely to be affected by the revised Project, except where the western Manning Vale West Pit may intersect basalt to only a very minor degree. Where present in the revised Project site, the Tertiary Basalt aquifer varies in thickness from 1 m to 90 m.

Permeability within this aquifer is considered to consist of both primary and secondary porosity; however the latter is expected to dominate. The Tertiary Basalt aquifer has relatively shallow depth to groundwater at the revised Project site. Groundwater yield in the Tertiary Basalt aquifer can be up to 10 L/sec. An average bore yield of approximately 3 to 5 L/sec was reported in the Stage 2 EIS.

Pumping test data obtained from the Stage 2 EIS indicate a relatively high transmissivity of 150 m²/day and storativity ranging from 0.001 to 0.05. The storativity values suggest that the aquifer is unconfined to semi-confined in the test locations.

The DNRM uses a uniform value of 80 mm of groundwater recharge per annum for basalt aquifers in the local area as part of water allocation assessments. This factor has been calculated to be approximately 12.7% of annual mean rainfall based on 635 mm mean annual rainfall observed at the Oakey Aero station. This suggests that recharge rates are relatively high for this aquifer.

The Mine currently draws groundwater from the Tertiary Basalt aquifer, covered under a license for 160 ML/year. However, the Mine uses only approximately 11 ML/year of this allocation. Groundwater extraction from the Tertiary Basalt aquifer is also undertaken by nearby private groundwater users, mainly to the west and northwest of the revised Project site. Groundwater salinity in the Tertiary Basalt aquifer is generally lower than in the Walloon Coal Measures aquifer. This fact is reflected by a greater number of livestock and domestic users in the Tertiary Basalt aquifer.

Given that there is little occurrence of the basalt aquifer within the revised Project site, it is unlikely that mining activities will have a direct impact on the basalt aquifer. However, it is known that the basalt aquifer was deposited in palaeochannels incised into the Walloon Coal Measures palaeosurface and so the potential exists for direct hydraulic connection between the basalt aquifer and the Walloon Coal Measures, especially if a coal seam (the main water bearing units of the Walloon aquifer) were exposed in the palaeochannels.

3.14.3 Walloon Coal Measures Aquifer

The Walloon Coal Measures will be the main aquifer which will be affected by the revised Project. The Walloon Coal Measures outcrop across much of the revised Project site with coal seams being the principal conduit for groundwater. Pumping tests undertaken in this aquifer, suggest that it is semi-confined, and of low to moderate transmissivity. Groundwater within the Walloon Coal Measures regionally flows from the north-east to south-west in accordance with the regional dip of the coal seams. Groundwater flow within this aquifer at the revised Project site is to the south, from potentiometric elevations of around 420 mAHD to potentiometric elevations of around 380 mAHD. A groundwater depression reaching around 410 mAHD exists in the vicinity of the current Mine workings, whilst a groundwater mound of around 440 mAHD exists in the vicinity of previously mined and backfilled northern Mine areas, where in-pit tailing dams now exist. The current Mine workings are likely to intercept much of this groundwater mounding given the close proximity and hydraulic gradient between the two features.

Recharge into the upper portions of the Acland-Sabine Sequence, is likely to be predominantly via coal subcrop areas on the upthrown side of faults and through deep drainage from the overlying basalt and alluvium where they occur. The comparatively higher salinity of groundwater in the lower seams of the Acland-Sabine interval and underlying Balgowan interval suggests that recharge zones for these measures are progressively more remote with depth and groundwater has longer residence times and longer migration paths. Leakage from underlying and overlying seams within the Walloon Coal Measures to these lower-lying coal seams is likely to be insignificant. Discharge from the Walloon Coal Measures aquifer occurs via mine pit dewatering and private bore extraction within the Clarence-Moreton Basin.

Significant surface water and groundwater interaction is unlikely for the Walloon Coal Measures aquifer. Groundwater has not been identified as contributing to surface water flows within nearby creeks and streams. Groundwater levels within the Walloon Coal Measures underlying the revised Project site range from around 6 to 55 mBGL.

The Walloon Coal Measures aquifer varies from being confined to semi-confined by low permeability mudstones and siltstones which occur in between the coal seams. Short term pumping tests indicate that the coal seams behave as separate aquifers. However, it is considered likely that over the long term the seams would behave as one aquifer system when stressed by dewatering in association with mining operations. Results from these tests suggest that a leaky aquifer system is likely to exist with vertical movement of groundwater occurring between seams, especially where the confining layer is thin, and via fractures within the coal measures aquifer system.

Transmissivity values within the Walloon Coal Measures were estimated to range between 7 and 47 m^2/day. Transmissivity values obtained from pumping tests undertaken for the Stage 2 EIS are consistent with those estimated from field tests undertaken for the revised Project. This result demonstrates that the transmissivity of the Walloon Coal Measures aquifer is similar from the Mine to the revised Project site.

Storage coefficients were estimated to range between 0.006 and 0.00006 for the shallow and deep coal seam aquifers respectively, suggesting the deeper seams act as confined aquifers whereas the shallow seams act as semi-confined aquifers. Bore yields for this aquifer are around 1 L/sec or less. Groundwater quality in the Walloon Coal Measures at the revised Project site is slightly acidic to slightly alkaline and is generally brackish with sodium chloride ions dominating.

3.14.4 Marburg Sandstone Aquifer

The Marburg Sandstone aquifer underlies the Walloon Coal Measures and is up to 500 m thick. This aquifer exists as a confined aquifer at a depth of about 150 m within the revised Project site and is a major aquifer of the GAB.

Aquifer parameters based on pumping tests conducted for the Stage 2 EIS indicate a transmissivity of 14 m^2/day and a storativity of 0.003.

Aquitards within the Walloon Coal Measures and the intervening lower permeability sediments of the Eurombah Formation act as effective confining layers for the Marburg Sandstone aquifer, hydraulically isolating it from the coal seams of the Walloon Coal Measures. Groundwater levels obtained from on and off site bores ranged from 410 m AHD to 425 m AHD. Typical production rates range from 5 L/sec to 25 L/sec within this aquifer. The higher yields indicate that the transmissivity of the aquifer may be larger than 14 m^2/day as indicated in the Stage 2 EIS pumping tests.

Recharge within this aquifer is likely to occur from surface water infiltration where the geological formation outcrops to the northeast of the revised Project site, with discharge via groundwater bores and throughflow to the southwest.

The Mine periodically extracts groundwater from the Marburg Sandstone aquifer at a rate of approximately 10 ML/year for industrial use and bore maintenance purposes.

The Marburg Sandstone aquifer is a confined aquifer located more than 75m below the base of the revised Project mine pits. Therefore, the revised Project's mine pits and depressed landforms (rehabilitated final voids) are unlikely to have an effect on this aquifer.

3.14.5 Helidon Sandstone Aquifer

The Helidon Sandstone is the deepest aquifer at the revised Project site and is a major aquifer of the GAB. This aquifer is separated from overlying aquifers by the relatively impermeable Evergreen Formation and is up to 170 m thick.

Pumping test data indicates the transmissivity of this formation is likely to vary between 45 m²/day to 200 m²/day. Recharge to the Helidon Sandstone aquifer occurs where the aquifer outcrops in the northeast. This area represents the primary source of recharge to the aquifer via infiltration of rainfall and overland surface water flow, with discharge occurring mainly via groundwater bores and throughflow to the southwest.

The Mine periodically extracts groundwater from the Helidon Sandstone aquifer at a rate of 17 ML/year for industrial use and has an allocation of 710 ML/year from this aquifer. Groundwater extraction from the Helidon Sandstone aquifer for industrial use reduced greatly once the WWRF Pipeline came into operation in 2010. The Mine and other nearby private groundwater users are the main sources of groundwater extraction from the Helidon Sandstone aquifer.

The Helidon Sandstone aquifer is a confined aquifer and is located below the relatively impermeable Evergreen Formation, which in turn is located below the Marburg Sandstone aquifer. Accordingly, it is unlikely the revised Project's mine pits and depressed landforms (rehabilitated final voids) will effect on this aquifer.

3.14.6 Groundwater Receptors

Table 3-15 presents a summary of the groundwater receptors that may be impacted by the revised Project, for each of the aquifers associated with the revised Project site. As shown, the primary groundwater receptors have been identified as anthropogenic groundwater users who extract groundwater via bores. Environmental users such as GDEs are not identified as groundwater receptors within and adjacent the revised Project site.

Table 3-15 Groundwater Receptor Identification for the revised Project site and Surrounds

Aquifer	Receptor Type		
	Environmental Use (GDEs, river baseflow, etc.)	**Extractive Use – Private/Agricultural**	**Extractive Use - Industrial**
Quaternary Alluvium	No GDE's identified within or surrounding the revised Project site. Terrestrial vegetation present likely supported by direct rainfall and surface flows as groundwater levels are typically deeper than vegetation rooting depths.	No use within the revised Project site. Minor use around 3 km north/northwest of the current Mine and major use 3 km south of the revised Project site as shown in Figure 3-4.	None identified.
Tertiary	No GDE's identified within or surrounding the revised	Very minor use within the revised Project site, and	NAC currently extracts water that is treated for

Aquifer	Receptor Type		
	Environmental Use (GDEs, river baseflow, etc.)	**Extractive Use – Private/Agricultural**	**Extractive Use - Industrial**
Basalt	Project site. Terrestrial vegetation likely supported by direct rainfall and surface flows as groundwater levels are typically deeper than vegetation rooting depths.	extensive use west and northwest of the revised Project site as shown in Figure 3-4.	potable supply at the Mine. No other users are identified.
Walloon Coal Measures	No GDE's identified within or surrounding the revised Project site. Terrestrial vegetation likely supported by direct rainfall and surface flows as groundwater levels are typically deeper than vegetation rooting depths.	Commonly utilised within and for 3 km surrounding the revised Project site, and minor use greater than 3 km outside the revised Project site as shown in Figure 3-4.	NAC currently takes water as a result of incidental water make in open cut Mine pits. No other users are identified.
Marburg Sandstone	No GDE's identified within or surrounding the revised Project site. Aquifer lies at significant depth. Where the aquifer outcrops in the northeast, terrestrial vegetation likely supported by direct rainfall and surface flows as groundwater levels are typically deeper than vegetation rooting depths.	Minor use within 3 km the revised Project site, especially to the northeast as shown in Figure 3-4.	NAC periodically extracts water for industrial supply at the Mine. No other users are identified.
Helidon Sandstone	No GDE's identified within or surrounding the revised Project site. Aquifer lies at significant depth.	None identified as shown in Figure 3-4.	Oakey abattoir extracts water at approximately 1200 ML/year. No other users identified within 8km of the revised Project.

4 Existing Environment – Surface Water

The revised Project site is wholly located in the Lagoon Creek catchment. Lagoon Creek is an ephemeral creek flowing only following periods of significant rainfall. Lagoon Creek has a total catchment area of 200 km^2 with 146 km^2 of the catchment area located upstream of the Jondaryan Township. The creek headwaters are located 6 km north east of the revised Project site. This upper catchment, outside the revised Project site, has an area of approximately 16.3 km^2. The catchment area upstream of and including the revised Project site is 85 km^2, approximately 42 % of the total Lagoon Creek catchment. Lagoon Creek flows into Oakey Creek which is part of the larger Condamine River Catchment.

The revised Project lies immediately south of the Myall Creek catchment; no part of the revised Project site is within the Myall Creek catchment. Spring Creek is the closest tributary of Myall Creek to the revised Project site, and is located 2.5 km north of the revised Project site. Myall Creek joins the Condamine River 48 km west of the revised Project site.

The Upper Condamine River catchment has an area of approximately 13,000 km^2. The Upper Condamine is part of the Condamine-Balonne Basin which includes most of the Darling Downs and forms part of the Murray Darling Basin Catchment.

4.1 Regulatory Framework

4.1.1 Queensland Legislation

Lagoon, Doctors and Oakey Creeks are declared water courses under the Water Act 2000. Resources within a declared water course are managed by the State and may be subject to licensing provisions (DNRM, 2013a). The DNRM defines the upstream limit of a watercourse as being the point where the stream becomes so small that it does not have sustained base flows after rainfall events – usually evident by the lack of riverine vegetation species or aquatic-dependant habitat such as pools and riffles (the natural limit) unless otherwise declared by the Water Regulation. Lagoon Creek has no declared upstream or downstream limit (DNRW, 2013).

Lagoon Creek is part of the greater Condamine and Balonne Catchment which is subject to the requirements of the *Water Resource (Condamine and Balonne) Plan 2004*, (the WRP) under the Water Act 2000. The WRP outlines the availability of water in the catchment and defines the framework for managing the allocations and use of water resources. Generally riverine protection permits are not required for works on a mining lease where consistent with the guidelines - "Activities in a watercourse lake or spring associated with a resource activity or mining operations".

In addition, the WRP manages the taking or interfering of water in a watercourse. The WRP also includes provisions for holders of a mining lease to take and store water from overland flow. The intent of this provision is to allow water that flows through disturbed areas, referred to as “mine-affected water”, to be managed to minimise water quality impacts on downstream users and the environment. The taking and storing of overland flow water is only permitted in accordance with the environmental authority for the mining lease.

The details and guidelines for the implementation of the WRP are outlined in the *Condamine and Balonne Resource Operations Plan 2008 Amended December 2011 (Revision 3)* (the ROP). It is noted that the ROP, in its current format, does not include the Oakey Creek catchment. A draft amendment to the ROP was released on the 28th of October for public comment. The draft amendment establishes the Gowrie and Oakey Creek Water Management Area to manage unsupplemented water and converts existing water harvesting licences to tradable water allocations. Lagoon Creek forms Zone GOU-09 of the water management area, within which there is currently only one water user. This user is described further in **Section 4.4**. While the ROP amendment is in draft form, the 2008 Moratorium on the Condamine and Balonne water resource plan area (which includes the Oakey Creek Catchment) remains in place.

The Condamine and Balonne Catchment forms one of the upper catchments of the Murray Darling Basin. As such the catchment is also subject to the provisions of the Federal *Water Act 2007*. The Federal *Water Act 2007*, establishes the Murray-Darling Basin Authority (MDBA) with the functions and powers, including enforcement powers, needed to ensure that Basin water resources are managed in an integrated and sustainable way. The *Federal Water Act 2007* also requires the MDBA to prepare the Basin Plan – a strategic plan for the management of water resources in the Murray-Darling Basin. The Act provides the Australian Competition and Consumer Commission (ACCC) with a key role in developing and enforcing water charge and water market rules along the lines agreed in the National Water Initiative.

The ROP identifies four Water Supply Schemes for supplemented water. Supplemented water users have an authority to operate water infrastructure and have a high priority for water allocations compared to unsupplemented users. The supplemented water supply schemes include, the Upper Condamine, Chinchilla Weir, Maranoa River and St George. Lagoon Creek has no influence on the Upper Condamine or Maranoa River Supply Scheme which are upstream of the Oakey Creek Confluence.

The Chinchilla Weir and St George water supply schemes are located downstream of the revised Project Site. This water is supplied to high and medium priority water users through a number of dams and weirs. The Chinchilla Weir Water Supply Scheme is the smaller of the downstream water supply schemes with a maximum permitted distribution of 5, 637 ML. The largest highest priority user of the Scheme at 1160 ML per annum is the Chinchilla region of the Western Downs Regional Council. The St George Water Supply Scheme is significantly larger with maximum permitted distribution of 84,575 ML (medium and high priority). This includes 3,000 ML per annum allocated at high priority to Sunwater.

At the peak of mining operations the mine water management system will capture rainfall runoff from up to 10 km^2 of the Lagoon Creek catchment. This constitutes less than 0.1 % of the catchment to the Chinchilla Weir Water Supply Scheme and less than 0.001 % of the catchment to the St George Water Supply Scheme.

The WRP also specifies Environmental Flow Objectives (EFO's) and Water Allocation Security Objectives (WASO) for the region. The EFO's for the WRP are that the "*extent to which a performance indicators, at each node described in Schedule 2, expressed as a percentage of the pre-development flow pattern is less than 66% or more than 133% of the same indicator is to be* *minimised*". The closest node to the revised Project (Schedule 2) is located at Chinchilla Weir. As the revised Project constitutes less than 0.1% of the catchment to this node the percentage change to the pre-development flow pattern is expected to be less than 0.1% and well within the EFO's indicators. Similarly the impacts to water volume under the WASO's are expected to be well within the annual volume probability and 45% annual volume probability objectives. **Section 5.4** provides a comparison of the flow exceedance probability under existing conditions and with the revised Project.

The revised Project is not seeking a new water supply allocation. A maximum water supply allocation to the Mine of 5,650 ML/year is already available from two sources. The smaller of the two sources is brine water from the Oakey Reverse Osmosis Water Treatment Plant. The major source is via a long term contract to the year 2055 with the TRC to purchase up to 5,500 ML per annum of Class A+ recycled water from the WWRF. Class A+ is the highest class of recycled water for non- drinking purposes in Queensland. This supply contract is in place for the projected duration of the revised Project. The 45 km pipeline and infrastructure was constructed in 2009 and is fully operational. This water supply contract is a beneficial use of a wastewater and therefore does not introduce new impacts on water resource availability within the Chinchilla Weir or St George Water Supply Schemes.

NAC commissioned a new water pipeline from the TRC WWRF to the Mine in 2009. This project was subject to a separate approvals process under the SDPWO Act for which an EIS was approved by the Queensland CoG during late 2008. A 43 year Agreement has been established between the TRC and NAC to supply the Project with Class A^+ recycled water up to a maximum of 5,500 ML per annum. The impacts of the pipeline are therefore excluded from this assessment.

4.2 Regional Climate and Streamflow Records

The Bureau of Meteorology (BoM) operates rainfall and evaporation gauges for several locations in the vicinity of the revised Project site. The historical rainfall and evaporation records were analysed to determine the climate at the revised Project site. The rainfall and evaporation gauge data are summarised in **Table 4-1**. The locations of the gauges are illustrated in **Figure 4-2**.

Table 4-1 Rainfall and Evaporation Gauge Data

Gauge Number	Catchment	Name	Open - Closed	Number of Years of data	Location (degrees south)	Location (degrees west)
040431	Oakey	Geham State School	1912 - 1974	63 (23% missing)	27.4	152.02
041074	Doctors	Netherby	1929 -1981	52 (3% missing)	27.35	151.8
041053	Lagoon	Jondaryan Post Office	1899 – 2012	>110 (10% missing)	27.36	151.59
041024	Doctors	Doctors Creek	1906 - 2005	99 (10% missing)	27.21	181.85
041000	Lagoon	Acland Post Office	1912 -1992	81 (5% missing)	27.3	151.69
041039	Gowrie	Gowrie Junction	1899 -1972	73 (5% missing)	27.5	151.9
041359*	Oakey	Oakey Aero	1973 -2012	34 (8% missing)	27.4	151.74
NAC^	Lagoon	New Acland Mine	2008-2013	5 (not recorded)	27.27	151.69

Note: * Evaporation Gauge, ^New Acland mine site gauge – tipping bucket gauge therefore missing days not recorded

Monthly Rainfall and Evaporation averages are presented in **Figure 4-1**. The results are indicative of a dry climate showing evaporation exceeding average rainfall for every month of the year. These results also illustrate the seasonal variation of rainfall in the area.

The DEHP does not operate stream gauges within close proximity to the revised Project site. There are several gauges in the vicinity of the catchment on Oakey and Gowrie Creek. **Table 4-2** outlines the stream flow gauge details. The location of the gauges is shown in **Figure 4-2.**
The nearest stream flow gauge downstream of the revised Project site is the Oakey Creek gauge at Fairview. The Fairview gauge has 33 years of data but receives flow from a number of other catchments resulting in a catchment area approximately 10 times the Lagoon Creek catchment area. The Gowrie Creek gauges are considered to have upstream catchments materially different to that of Lagoon Creek with significant urban areas and historical flows, prior to 2009, influenced by releases from the TRC WWRF. Therefore stream flow gauge no. 422330, Oakey Creek at Oakey, was used to provide an overview of typical stream flows in the Study area.

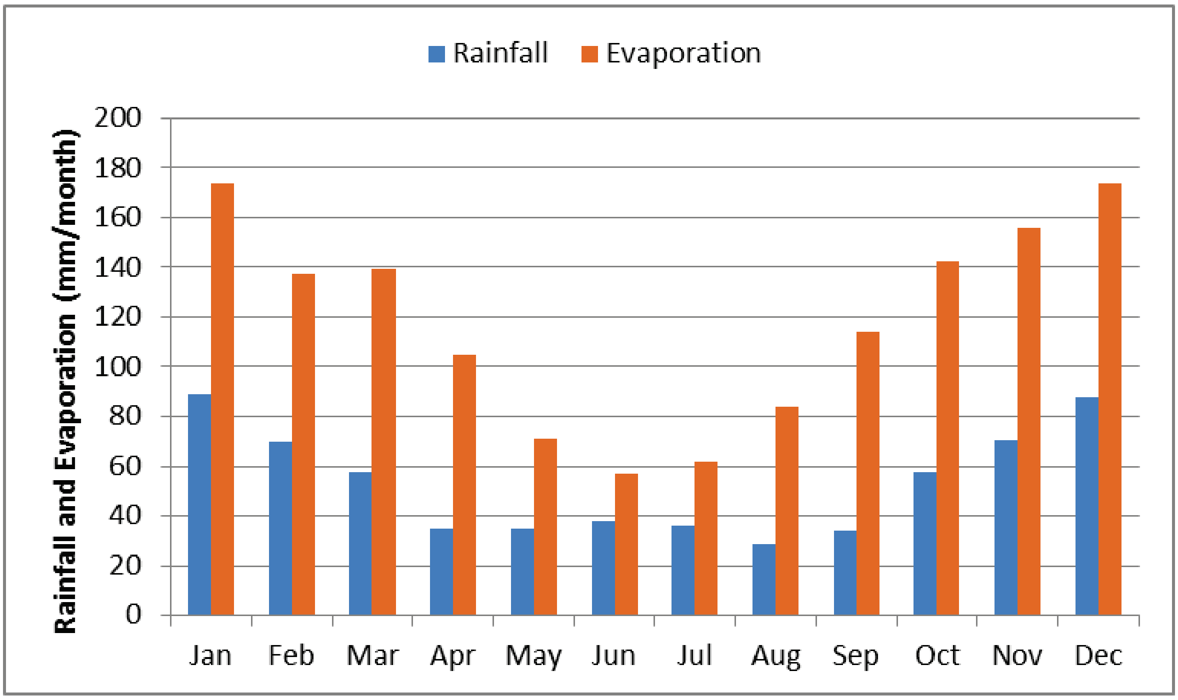
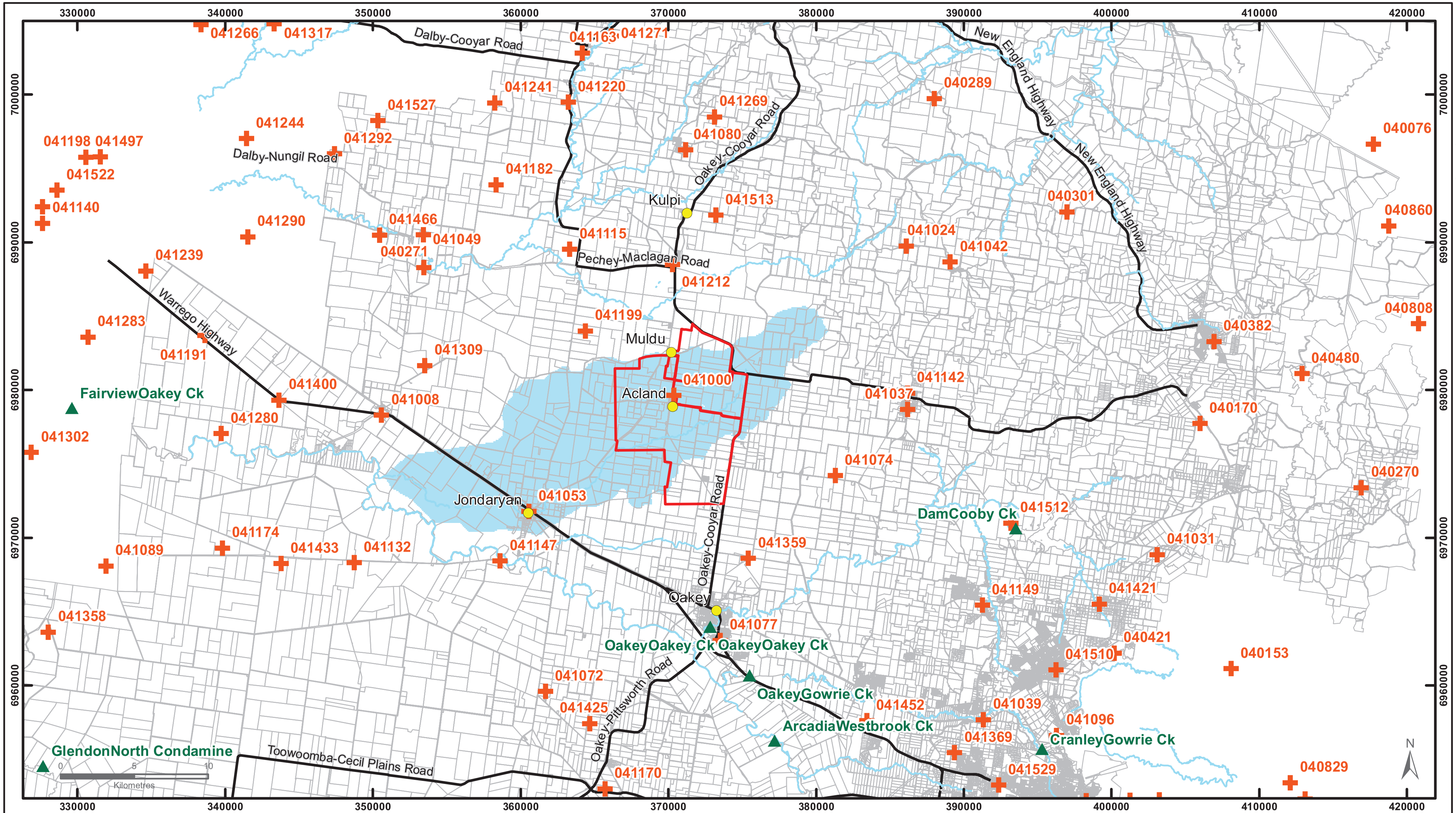


Figure 4-1 Average Monthly Rainfall Data (041053) and Evaporation Data (041359)

Table 4-2 Stream flow gauge details

Gauge Number	River Name	Catchment Area (km^2)	Open - Closed	Missing Data	Location (degrees south)	Location (degrees west)
422312A	Cooby Ck Dam	184	1935 -1940	20%	27.38	151.92
422326A	Gowrie Ck at Cranley	47	1969 -present	4%	27.52	151.94
422332A	Gowrie Ck at Oakey	142	1967 -1981	4%	27.47	151.74
422332B	Gowrie Ck at Oakey	142	1992 - present	4%	27.47	151.74
422330A	Oakey Ck at Oakey	540	1967 -1976	7%	27.44	151.71
422330B	Oakey Ck at Oakey	545	1976 -1981	12%	27.44	151.71
422350A	Oakey Ck at Fairview	1970	1980 - present	2%	27.30	151.28
422331A	Westbrook Ck at Arcadia	256	1967 -1981	17%	27.51	151.76
422333A	Condamine at Loudoun Bridge	12380	1969- present	6%	27.22	151.18



LEGEND

- Towns and Localities
- Streamflow Gauges
- Daily Rainfall Gauge
- Road
- Creeks
- Cadastre
- Mining Tenements

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SINCLAIR KNIGHT MERZ SKM

NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 4-2
Location of Gauged Rainfall and Streamflow Data

Scale 1:350,000 on A4
Projection: Australian Geodetic Datum – Zone 56 (AGD84)

Produced: 29/08/2013 Path: I:\QENV2\Projects\QE06644\Spatial\ArcGIS\01_Figures\01_SEIS\IESC_Submission\130828_NewHope_IESC_Figure4-2_GaugedRainfallStreamflow.mxd

It is noted that since 2007, NAC has operated two water level loggers on Lagoon Creek. These loggers record water surface level and indicate the ephemeral nature of the creek with long periods of zero depth records. A rating curve was developed for these gauges based on the LiDAR data collected for the revised Project. This has enabled flows to be estimated for the recorded water surface levels. However, Lagoon Creek is a relatively small channel with poorly defined bed and banks and a large floodplain which conveys a significant volume of water during a flow event. As such the error range on the rating curve developed for the gauges is significant and the resulting accuracy of the flow data was not sufficient to support development of a daily rainfall runoff model for the Lagoon Creek catchment.

The daily discharge exceedance curve for Oakey Creek at Oakey is provided in **Figure 4-3**. **Figure 4-3** indicates that Oakey Creek at Oakey is dry 50 % of days, a result typical of an ephemeral creek. **Figure 4-3** also illustrates the exceedance curve for the simulated flows in Lagoon Creek, provided by DISITA, which indicates Lagoon Creek is dry 20 % of days, while this flow is simulated based on a calibration point significantly further downstream the results indicate the ephemeral nature of the creek and the significant proportion of zero and low flow days.

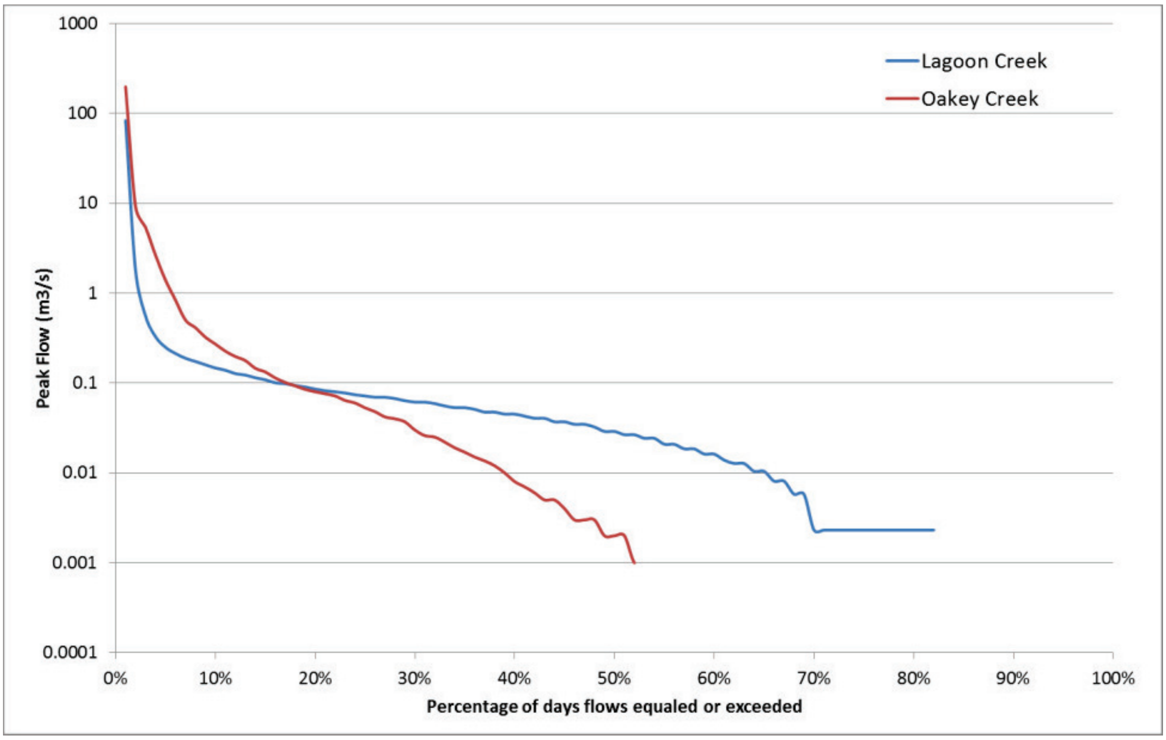


Figure 4-3 Daily Discharge Exceedance Curve Oakey Creek at Oakey & Simulated Lagoon Creek

The period of record for the Oakey Creek gauge at Oakey has a short and broken record with a significant proportion of missing data. The stream flow records, listed in **Table 4-2**, were therefore assumed insufficient to support a flood frequency assessment.

4.3 Existing Flooding Characteristics

Hydrologic analysis was performed for flows in Lagoon Creek using the *XP-RAFTS* software package. *XP-RAFTS* is a run-off routing model that has been applied to watersheds ranging from rural to fully urban environments with catchments varying from less than 1 ha to several thousand square kilometres. The *XP-RAFTS* model uses rainfall patterns and depths as well as physical catchment characteristics to estimate catchment flow. The catchment characteristics are described by parameters such as catchment area, average slope and resistance. Catchment response to rainfall was described in the form of a loss model with initial and continuing rainfall losses.

Catchment delineation, slope and roughness parameters were developed based on LIDAR terrain data with a +/-0.12m vertical accuracy and aerial photography. A Manning's 'n' roughness of 0.06 was adopted for cleared agricultural land, consistent with the RAFTS Manual (WP-Software, 1994). All catchment areas were assumed to be 100 % pervious.

The main stream channel routing between each RAFTS sub-catchments is modelled though link-lags. The link-lag routing has been modelled as fixed time link-lags based on the average stream velocity of 1.5 m/s determined from Manning's equation assuming a hydraulic radius of 1 based on the assumption of wide floodplain flows. However, as illustrated in **Figure 4-4**, the hydraulic model extent included the entire Lagoon Creek catchment with only one total hydrograph introduced into the hydraulic model. Therefore the majority of the routing between sub-catchments occurs within the hydraulic model as such the link lag assumption is not material to the resulting flood model results.

As there was no historical gauging for this catchment, loss parameters used in the model were adopted from regional averages (Ilahee, 2005) and adjusted, along with the storage routing parameter to provide peak flows that were consistent with those observed in the regional flood frequency analysis. The final adopted values are presented in **Table 4-3**. It is noted that due to the inter-catchment routing occurring through the hydraulic model domain, this process involved both hydrologic and hydraulic modelling.

Table 4-3 Loss and Routing Parameters

Parameter	Annual Exccedance Probability (AEP)		
	1 in 10	1 in 100	1 in 1000
Initial Loss (mm)	25	5	0
Continuing Loss (mm/hr)	4	2	0
B – Storage Multiplier	0.6	0.6	0.6

It is noted that the B multiplier factor of 0.6 is considered low for a catchment such as Lagoon Creek which is dominated by floodplain flows. Lower B multiplier values result in higher peaked flood events and this value was required to achieve flood peaks for the rare flood events (1 in 1000 AEP) that are consistent with the range expected through the regional flood frequency analysis. It is therefore considered that the adopted B multiplier value is appropriate for the purposes of the assessment.

The Lagoon Creek catchment was modelled as 17 sub-catchments, presented in **Figure 4-4**. **Table 4-4** presents shows the adopted catchment parameters.

Table 4-4 Adopted Hydrologic Model Parameters

Catchment	Area (ha)	Slope (%)
A	1123	1.52
B	1276	0.98
C	1268	0.89
D	1656	0.80
E	1606	0.57
F	1397	0.54
G	1445	0.56
H	688	0.65
I	388	0.73
J	455	0.78
K	917	1.17
L	126	0.53
M	370	1.22
N	528	1.09
O	370	0.13

Design rainfall depths were determined using the CRC-Forge method for Queensland (DNRW, 2005) for AEPs up to and including the 1 in 2,000 AEP. The CRC-Forge point based rainfall depths for the 1 in 100 AEP design storm were compared to those of Australian Rainfall & Runoff (AR&R). Comparison of the results found very small differences in the two methods. Limited spatial variation in rainfall was observed across the catchment; therefore a uniform rainfall depth was adopted.

An Areal Reduction Factor (ARF) is used in the modelling process to represent the likelihood that rainfall does not fall uniformly across a large catchment. The catchment area for Lagoon Creek dictated that an ARF be applied to the point rainfall to develop catchment based rainfall. The ARF is based on the storm duration and catchment area. The adopted method for estimation of an ARF is from the Extreme Rainfall Estimation Project (DNRM, 2005), which produced a set of ARF's for Queensland. The analysis used a modified Bell's Method (i.e. nominal circular 'catchments' for sampling over areas 125 km^2 to 8,000 km^2). The adopted formula for the derivation of an ARF was:

$$ARF = 1 - 0.2257\,(Area^{0.1685} - 0.8306 \log(Duration))\,Duration^{-0.3994}$$

A conservative assumption was made to determine the ARF for the catchment to the downstream extent of the Study area, rather than the entire Lagoon Creek catchment area. This methodology provided higher rainfall depths and is considered an appropriately conservative assumption for the design for the Lagoon Creek levee. The developed ARF for Lagoon Creek to the downstream extent of the revised Project site was 0.95 for the critical storm duration of 6 hours.

Probable Maximum Precipitation (PMP) depths were estimated using the Generalised Tropical Storm Method (BoM, 2003a; 2003b) and Generalised Short Duration Method (BoM, 2003c). Rainfall depths for intermediate AEPs were determined using log-linear interpolation according to methods in Book VI of Australian Rainfall and Runoff (Nathan and Weinmann, 1999).

4.3.1 Verification of Results

The results of the hydrologic modelling are verified through the hydraulic modelling, as routing between sub-catchments is modelled in the hydraulic model domain.

The results of the hydrologic modelling in the upper section of the catchment were also compared to the results of a rational method calculation. This check was only performed for the total flow to catchment B as the rational method is only applicable for small catchments of less than 25 km^2. The results indicated that the rational method and RAFTS modelling are comparable with a value of 134 m^3/s and 112 m^3/s for the 1 in 100 AEP respectively.

4.3.2 Existing Flooding Characteristics

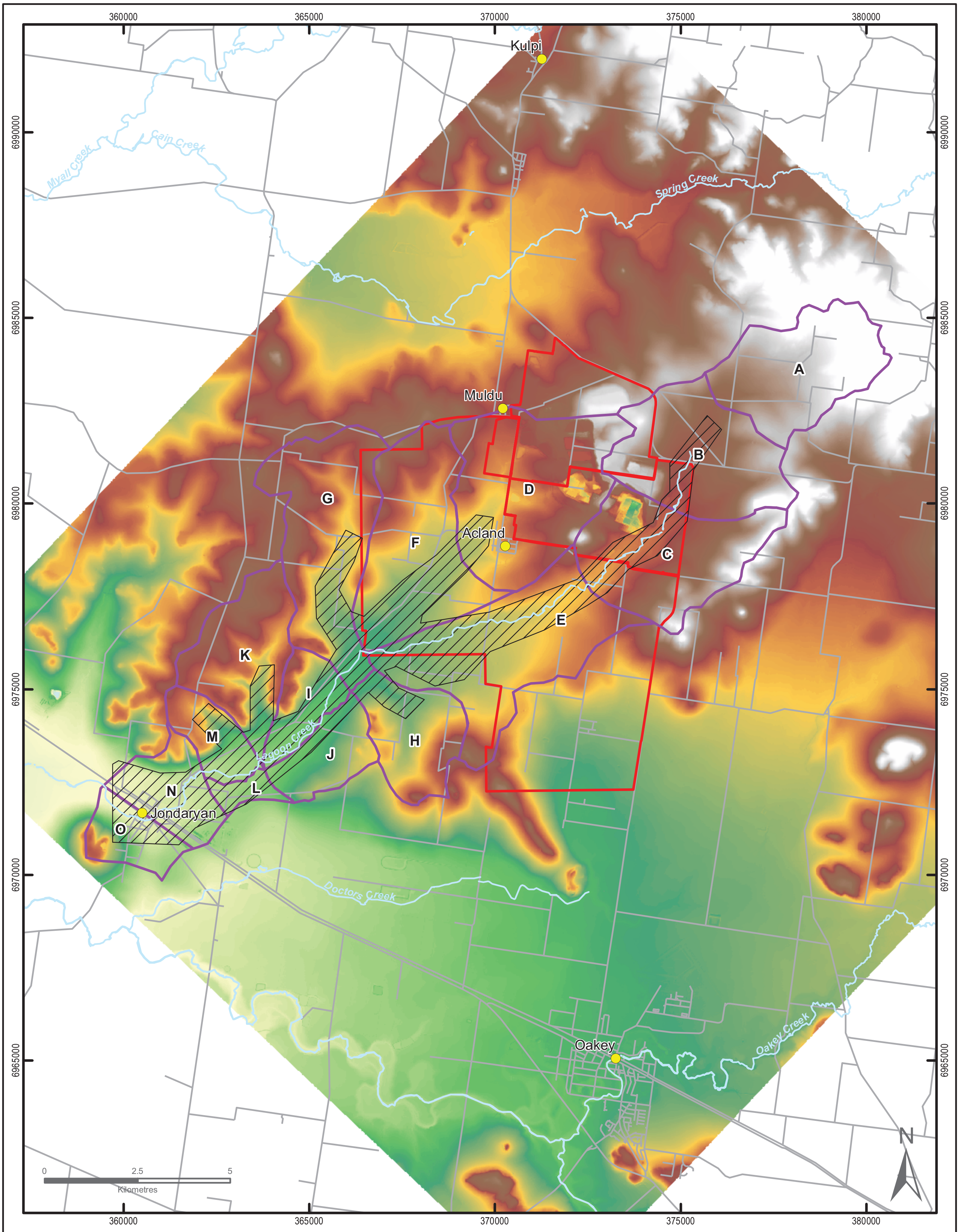
The existing flood characteristics of Lagoon Creek were assessed using the TUFLOW hydraulic modelling package. The two dimensional nature of the TUFLOW model is particularly appropriate for catchments with poorly defined channels and extensive floodplain flow such as Lagoon Creek.

4.3.3 Model Area and Terrain Development

The hydraulic model coverage adopted for this investigation extended from north of the Mine downstream to the Warrego Highway and Jondaryan and included a tributary of Lagoon Creek which crosses the proposed rail spur and balloon loop. The model area is illustrated in **Figure 4-4**.

The formulation of a hydraulic model grid was achieved by the development of a Triangular Irregular Model (TIN) of the ALS survey points, with a terrain grid developed from the TIN. The data source for the TIN was the LIDAR data with a +/-0.12 m vertical accuracy and a +/-0.26 m horizontal accuracy.

The hydraulic modelling adopted a 10 m grid resolution for the representation of the terrain. The grid resolution was selected given the size of the model, lack of channel definition and predominately floodplain based flows. This grid resolution was considered appropriate with the width of Lagoon Creek in the downstream reach near Jondaryan and the proposed rail crossing in the order of 50 m. While the creek width in the upper reaches is in the order of 5 m the 10 m grid resolution is considered to provide conservative results for the Lagoon creek flood levees, with the majority of the creek conveyance provided within the floodplain.



LEGEND

- Towns and Localities
- Roads
- Creeks
- Mining Tenements
- Hydraulic Model Extent
- Lagoon Creek Sub Catchments

Terrain Elevation

High : 604

Low : 335

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NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 4-4 -Extent of Hydrologic and Hydraulic Model

Scale 1:135,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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Produced: 29/08/2013

To enhance the reliability of this data, key features including the stream centreline, existing Lagoon Creek Levee and the Warrego Highway were sampled from the 1m LIDAR grid and stamped onto the TUFLOW model as ridge or gully lines.

4.3.4 Adopted Design Parameters

The hydraulic modelling adopted a uniform Manning's n roughness value of 0.04 for the floodplain. This value is consistent with those recommended by Chow (Open Channel Hydraulics, 1959) for field crops and scattered brush areas. A Manning's n value of 0.08 was adopted for the main channel of Lagoon Creek. This decision was based on aerial photography and field inspections which indicated reeds, long grass and scattered trees within the main channel of Lagoon Creek. A sensitivity analysis of the effect of the Manning's n value on water surface levels was performed and the results found that the model was not sensitive to Manning's with an overbank value of 0.03 and creek of 0.045 resulting in a water surface level difference of less than 4 mm.

Crossings of major existing infrastructure including the Warrego Highway and railway line were modelled in one dimension using TUFLOW esry code with standard entrance and exit losses.

4.3.5 Boundary Conditions

The hydrology developed in **Section 4.3.1** was input to the hydraulic modelling through a number of source areas within the model area. Catchments outside of the model area were incorporated through the introduction of RAFTS total flow hydrographs. Total flow hydrographs incorporated routed sub-catchments from all linked catchments upstream of the revised Project site. The hydraulic model accounts for sub-catchment routing for catchments within the model.

The downstream boundary condition for Lagoon Creek utilised a water level discharge relationship (Q-H relationship) based on the terrain at the location of the boundary.

4.3.6 Model Verification

The peak flows were compared to the results of a regional flood frequency analysis undertaken for several gauges of similar magnitude within the Study area. The results of the regional flood frequency analysis are plotted based on catchment area in **Figure 4-5**. **Figure 4-5** illustrates that the 1 in 10 and 1 in 100 AEP peak flows are generally within the range expected for a catchment of similar size within the vicinity of the Project site.

It is noted that **Figure 4-5** illustrates the 1 in 1,000 AEP is at the lower end of the expected range. However, it is noted that there is significant uncertainty associated with this regional flood frequency estimates for rare events such as the 1 in 1,000 AEP, due to the relative short length of flow records from the surrounding gauges. A sensitivity analysis was undertaken whereby the peak flows from the 1 in 1,000 AEP flow hydrograph were increased by 20% to examine the implications of a higher 1 in 1,000 AEP flood peak. The sensitivity assessment indicated that the relative levels of impacts associated with the revised Project were not changed as a result of the increased peak flows. Furthermore, NAC have opted to adopt a higher flood immunity for their flood levees of the PMF and as such the risk associated with the uncertainty for the 1 in 1,000 AEP is not considered to alter the findings of this impact assessment.

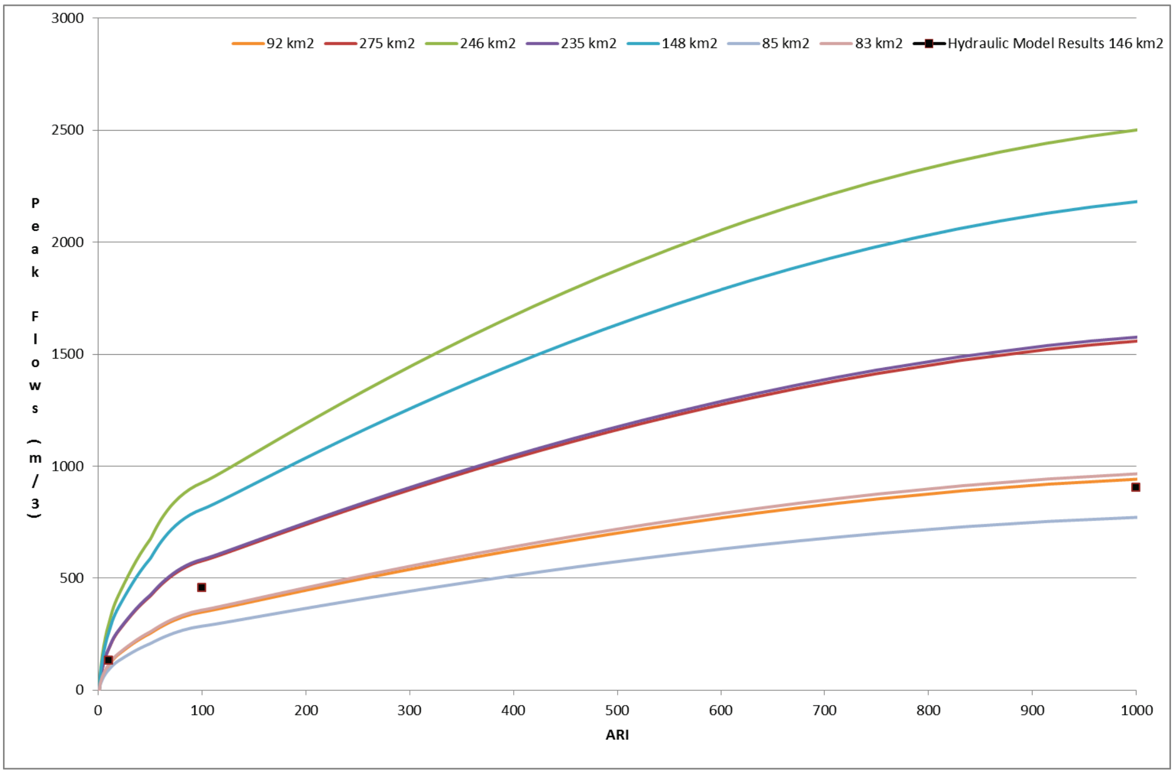


Figure 4-5 Regional Flood Frequency Verification of Results

At the time of writing the Queensland Reconstruction Authority (QldRA) had just released the results of their level 2 flood assessment at Jondaryan. The level 2 assessment included a flood analysis for Lagoon Creek at Jondaryan based on a flood frequency analysis for the Oakey Creek gauge at Fairview. **Table 4-5** provides a comparison of the peak flows within the TUFLOW model and the results of the Flood Frequency Analysis completed by the QldRA. The comparison indicates that the TUFLOW hydraulic model peak flows are not inconsistent with those of the QRA flood analysis.

Table 4-5 Estimation of Design Peak Flows for Lagoon Creek

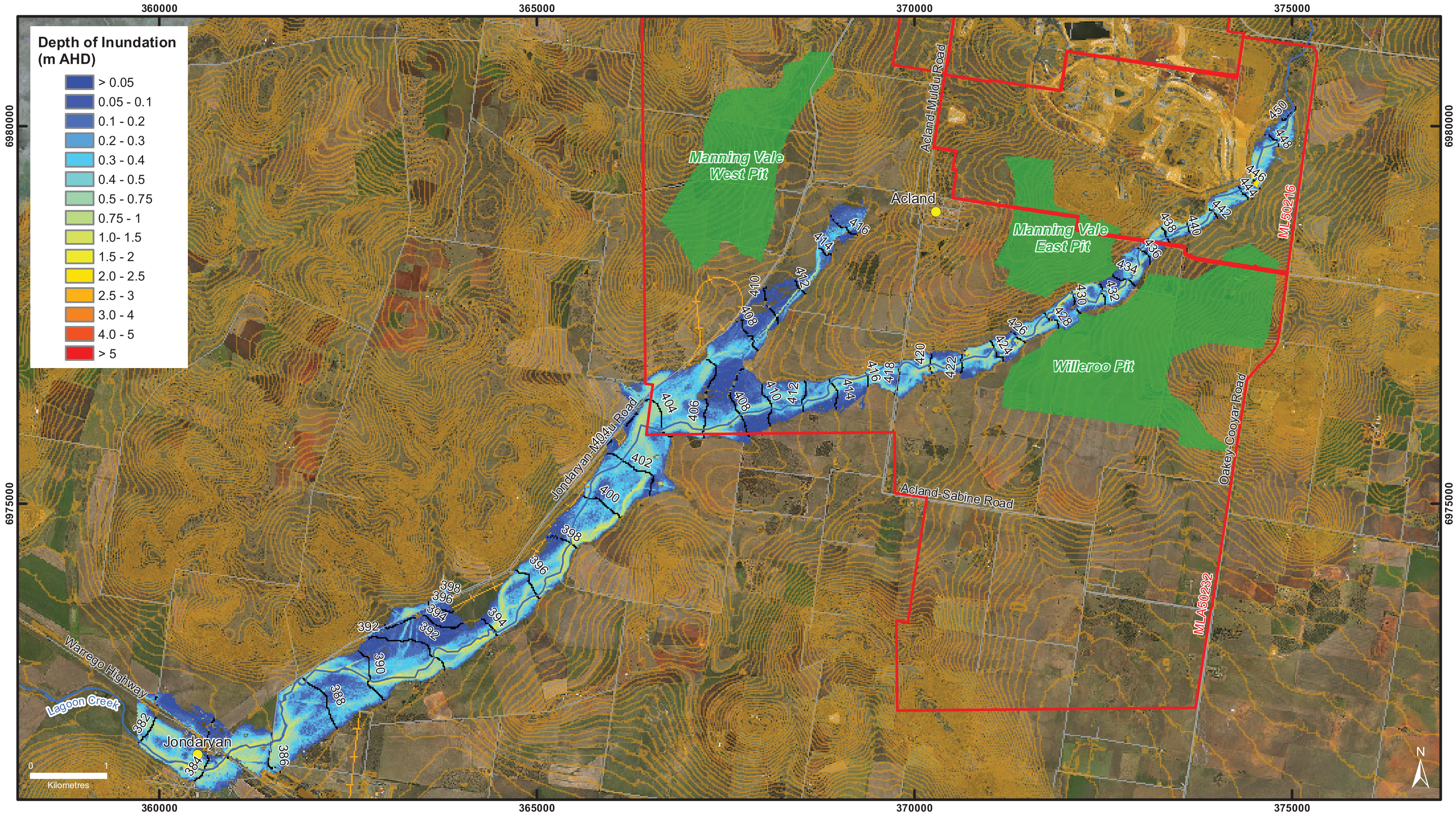
AEP (1 in Y)	Lagoon Creek Peak Flow (m³/s) at Jondaryan	
	New Acland TUFLOW model	QldRA FFA
1 in 10	130	N/A
1 in 20	Not modelled	240
1 in 50	Not modelled	360
1 in 100	455	470
1 in 200	Not modelled	610
1 in 500	Not modelled	800
1 in 1,000	905	N/A
PMF	4,131	N/A

4.3.7 Results

Figure 4-6 to **Figure 4-9** present the existing model results for flood depth and flow velocity for the 1 in 10 and 1 in 100 AEP flood events. The results indicate the shallow and wide nature of flood flows within the catchment. Flow depths within the creek channel are typically in the order of 1 m to 1.5 m for the 1 in 10 AEP and 1.5 m to 2 m for the 1 in 100 AEP flood event. Flow depths on the floodplain are typically less than 1 m for the 1 in 100 AEP and less than 300 mm for the 1 in 10 AEP. Flow velocities vary with flows of up to 1 m/s and 1.5 m/s within the creek channel in the upper reaches surrounding the revised Project's mining area and 1.4 m/s and 1.8 m/s downstream near Jondaryan for the 1 in 10 AEP and 1 in 100 AEP respectively. Flow velocities on the floodplain are typically less than 1 m/s for the 1 in 100 AEP.

Figure 4-10 and **Figure 4-11** present the existing flood depth and water surface level contours for the 1 in 1,000 and PMF flood extent. The results indicate that the proposed flood levees protect the revised Project's mine pit areas for events up to and including the PMF.

Hydrologic and hydraulic modelling contains a number of sources of uncertainty. Uncertainty is associated with the model input data such as the terrain vertical accuracy, design rainfalls and assumptions of catchment characteristics. Uncertainty associated with these parameters and/or the sensitivity of the results to these assumptions is discussed in the model parametisation, in general conservative assumptions have been adopted. This report and the associated modelling has been prepared in accordance with the usual care and thoroughness of the profession, and by reference to applicable standards, procedures and practices at the date of issue of this report.



LEGEND

- Towns and Localities
- Proposed Rail Spur
- Creeks
- Roads
- Water Surface Level (m AHD)
- Topographical Contours (2m interval)
- Mining Tenements
- Stage 3 Pit Areas

NEW HOPE GROUP

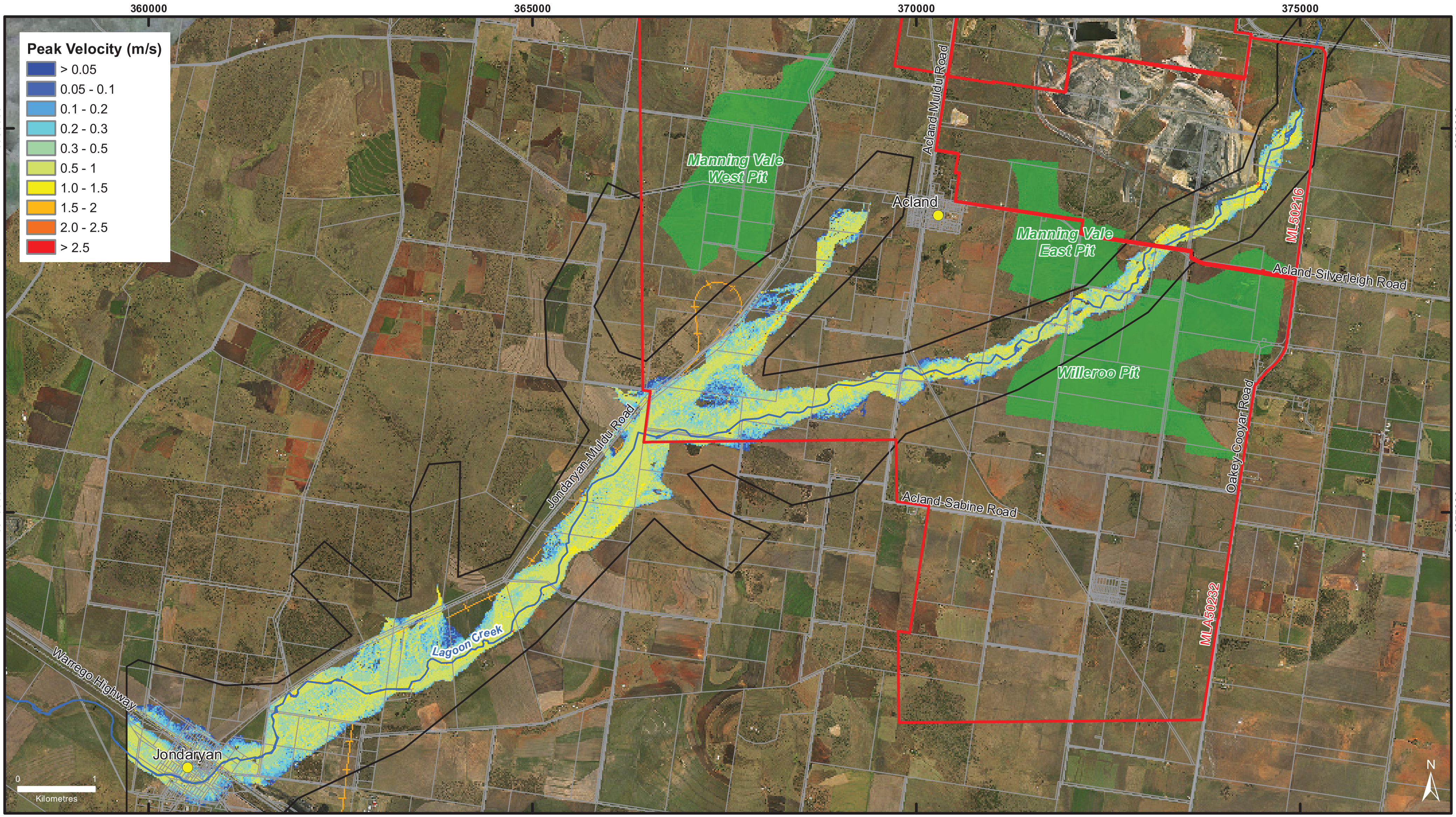
SINCLAIR KNIGHT MERZ SKM

NEW ACLAND COAL MINE
STAGE 3 PROJECT

Figure 4-6 - Existing Peak Flood Depth 1 in 10 AEP

Scale 1:69,000 on A4
Projection: Australian Geodetic Datum – Zone 56 (AGD84)

Produced: 29/08/2013 Path: I:\QENV2\Projects\QE06644\Spatial\ArcGIS\01_Figures\01_SEIS\IESC_Submission\130828_NewHope_IESC_Figure4-6_ExistingPeakFloodDepth_1in10AEP.mxd



LEGEND

- Towns and Localities
- Proposed Rail Spur
- Creeks
- Roads
- Cadastre
- Mining Tenements
- Stage 3 Pit Areas
- Hydraulic Model Extent

NEW HOPE GROUP

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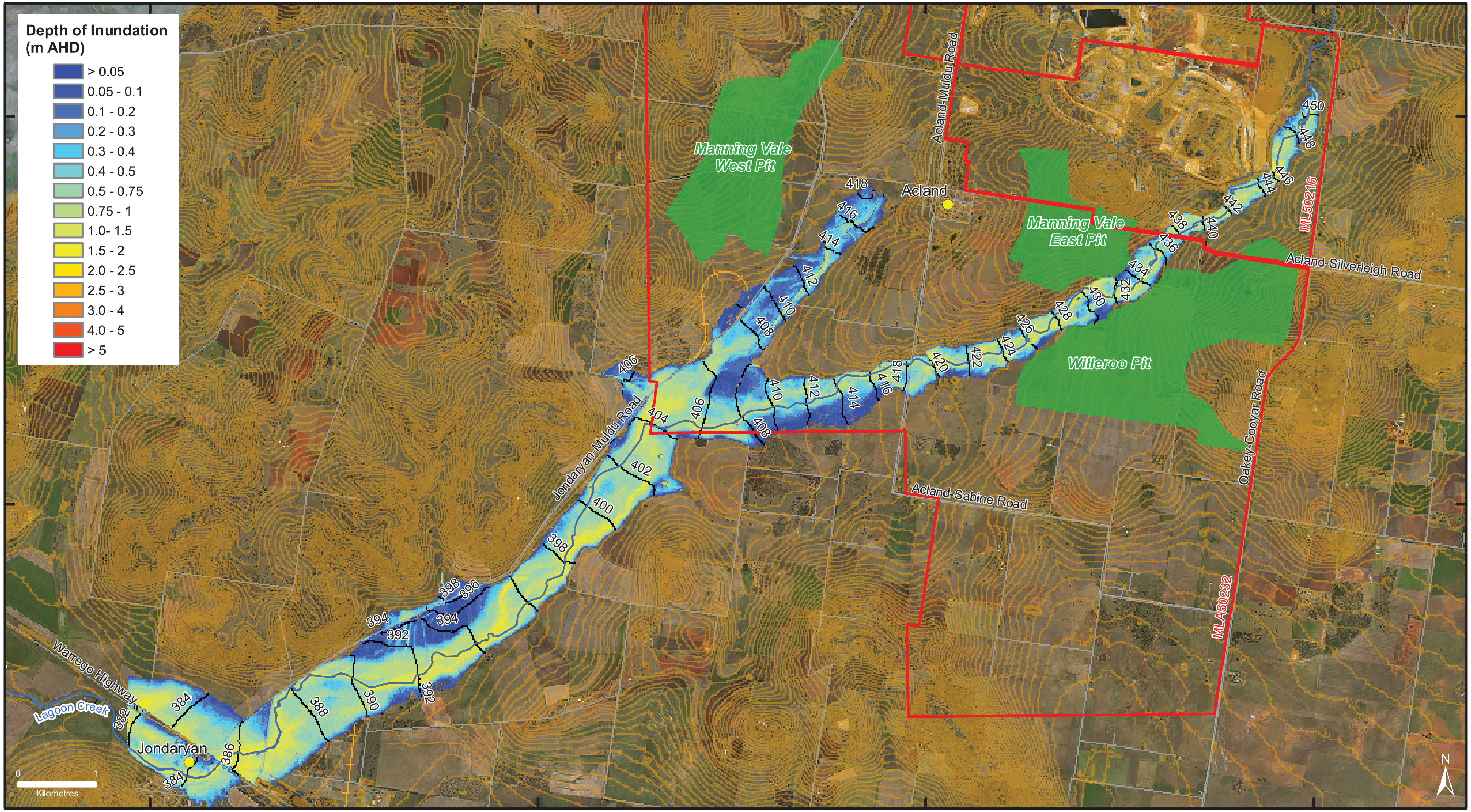
Figure 4-7 - Existing Peak Flood Velocity 1 in 10 AEP

Scale 1:69,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

Produced: 29/08/2013 Path: I:\QENV2\Projects\QE06644\Spatial\ArcGIS\01_Figures\01_SEIS\IESC_Submission\130828_NewHope_IESC_Figure4-7_ExistingPeakFloodVelocity_1in10AEP.mxd



LEGEND

- Towns and Localities
- Proposed Rail Spur
- Creeks
- Roads
- Water Surface Level (m AHD)
- Topographical Contours (2m interval)
- Mining Tenements
- Stage 3 Pit Areas

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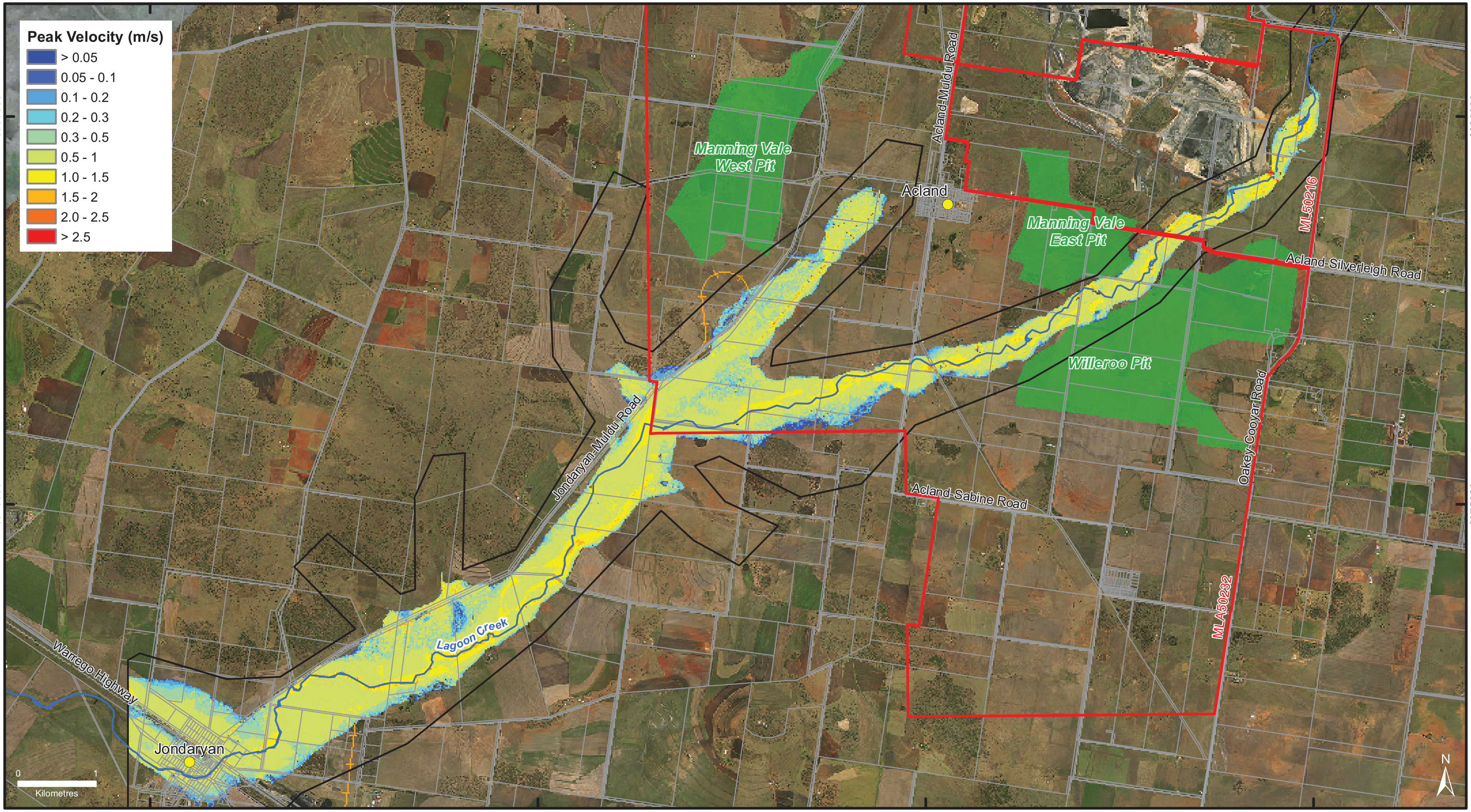
Figure 4-8 - Existing Peak Flood Depth 1 in 100 AEP

Scale 1:69,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

Produced: 29/08/2013 Path: I:\QENV2\Projects\QE06644\Spatial\ArcGIS\01_Figures\01_SEIS\IESC_Submission\130828_NewHope_IESC_Figure4-8_ExistingPeakFloodDepth_1in100AEP.mxd



LEGEND

- Towns and Localities
- Proposed Rail Spur
- Creeks
- Roads
- Cadastre
- Mining Tenements
- Stage 3 Pit Areas
- Hydraulic Model Extent

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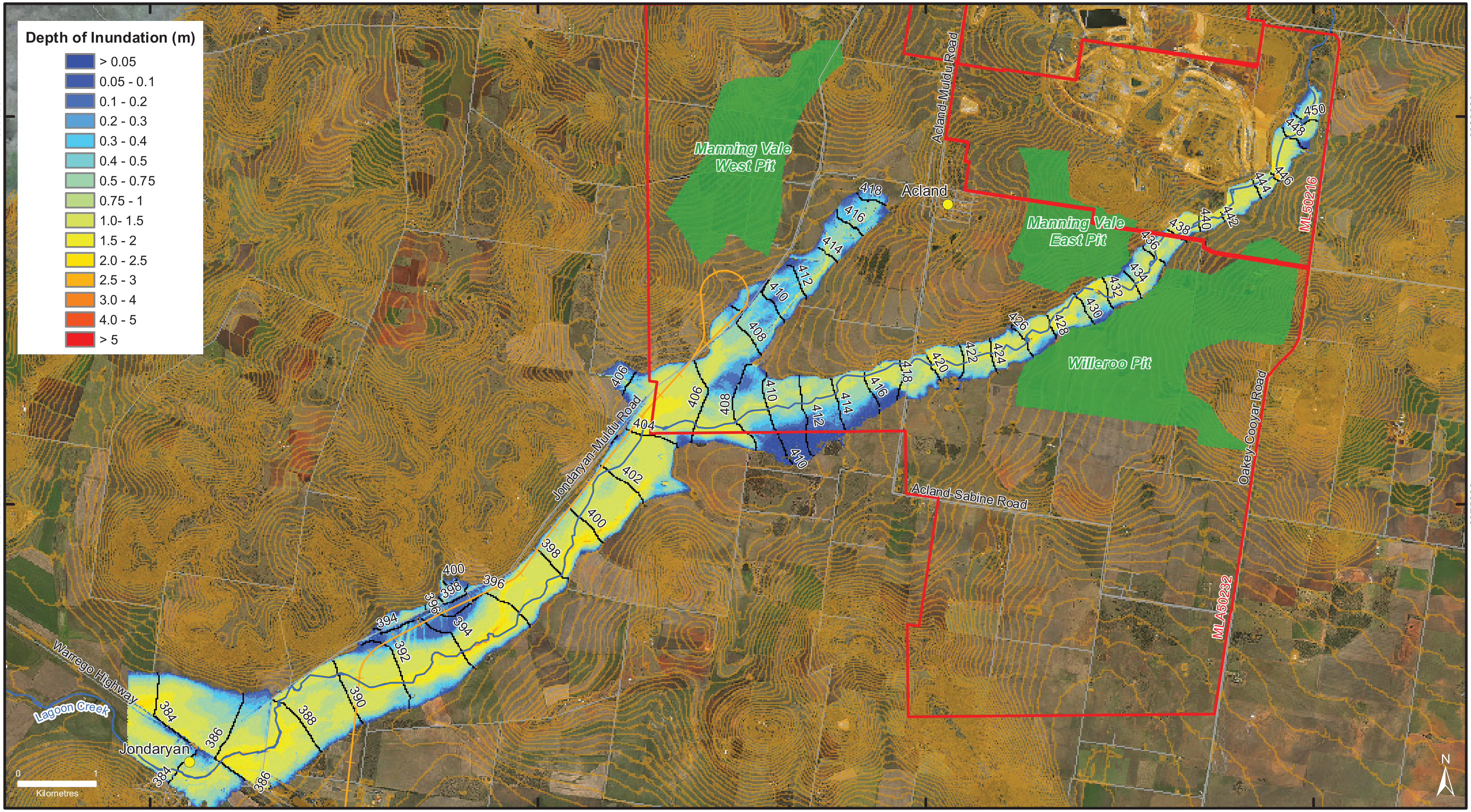
NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 4-9 - Existing Peak Flood Velocity 1 in 100 AEP

Scale 1:69,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

Produced: 29/08/2013 Path: I:\QENV2\Projects\QE06644\Spatial\ArcGIS\01_Figures\01_SEIS\IESC_Submission\130828_NewHope_IESC_Figure4-9_ExistingPeakFloodVelocity_1in100AEP.mxd



LEGEND

- Towns and Localities
- Proposed Rail Spur
- Creeks
- Roads
- Water Surface Level (m AHD)
- Topographical Contours (2m interval)
- Mining Tenements
- Stage 3 Pit Areas

NEW HOPE GROUP

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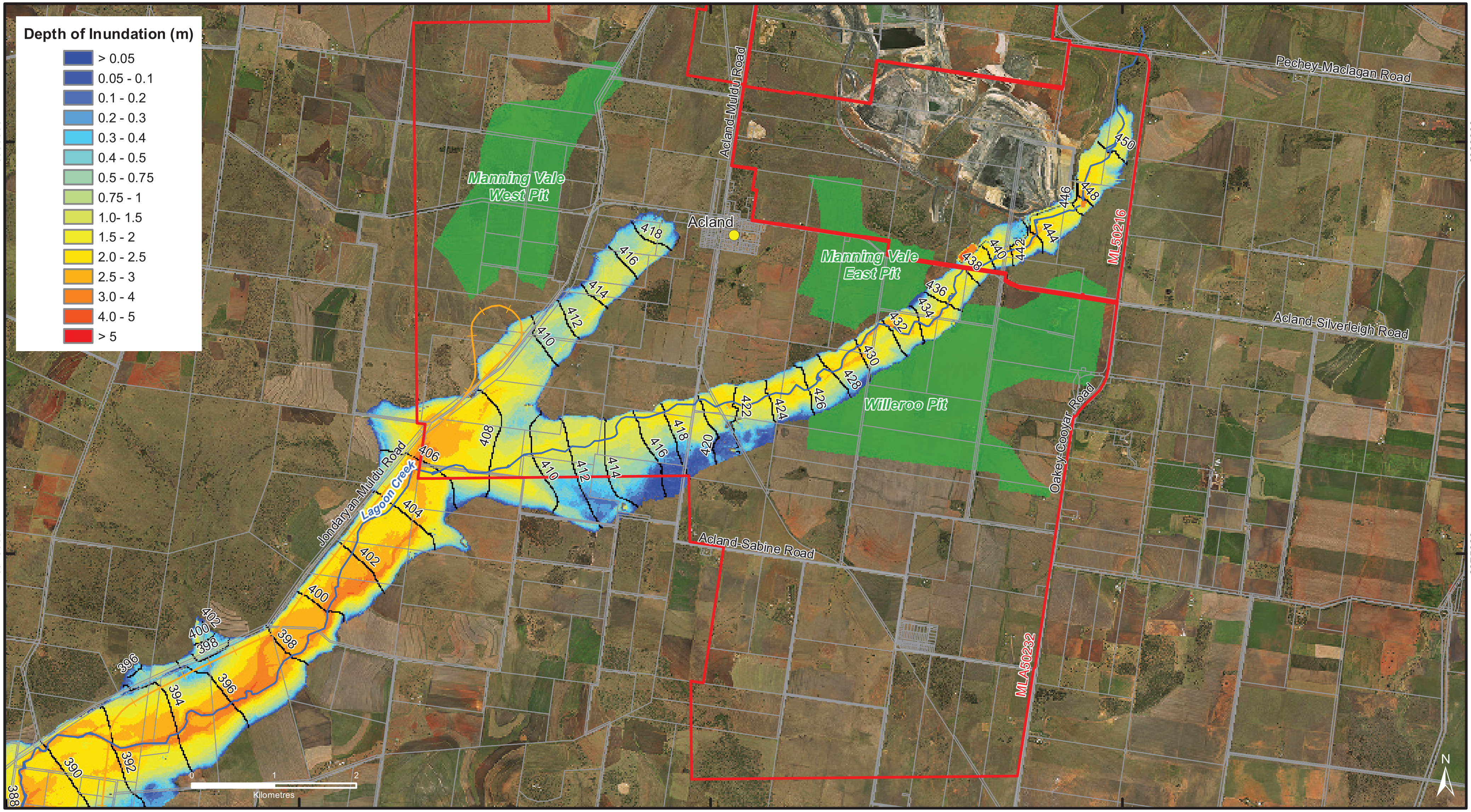
NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 4-10 - Existing Peak Flood Depth 1 in 1000 AEP

Scale 1:69,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

Produced: 29/08/2013 Path: I:\QENV2\Projects\QE06644\Spatial\ArcGIS\01_Figures\01_SEIS\IESC_Submission\130828_NewHope_IESC_Figure4-10_ExistingPeakFloodDepth_1in1000AEP.mxd



LEGEND

- Towns and Localities
- Proposed Rail Spur
- Creeks
- Roads
- Cadastre
- Mining Tenements
- Stage 3 Pit Areas

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NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 4-11 - Existing Peak Depth PMF

Scale 1:65,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

Path: I:\QENV2\Projects\QE06644\Spatial\ArcGIS\01_Figures\01_SEIS\IESC_Submission\130828_NewHope_IESC_Figure4-11_ExistingPeakFloodDepth_PMF.mxd

Produced: 29/08/2013

4.4 Existing Water Users

A list of existing surface water users was compiled through a search of the DNRM database on surface water extraction licences within Lagoon, Oakey and Doctors Creeks downstream of the revised Project site. The search revealed 15 surface water licences, consisting of 11 licences for water harvesting purposes and three licences for irrigation purposes and one for both irrigation and water harvesting. These surface water licences are all located a significant distance downstream with the closest located 19 km downstream of the revised Project site. All but one of the licences are located downstream of the confluence with Oakey Creek and Lagoon Creek. A summary of these licences is provided in **Table 4-6**.

It is also noted that Lagoon Creek includes a number of small on-stream rural dams. These existing stream dams attenuate flows in the creek, particularly for smaller events. However, all of the land on which these dams are located is owned by the APC.

The Department of Science, Information Technology, Innovation and the Arts (DISITA) are currently developing a daily rainfall runoff model for the upper Condamine catchment using the Sacremento model. The model has been developed to provide a long term historical flow series for the Gowrie Oakey Creek catchment to support the ROP amendment.

4.5 Environmental Values and Water Quality Objectives

Environmental Protection Policies (EPPs) are developed under the EP Act to provide frameworks and guidelines in conjunction with *Environmental Protection Regulation 2008*, to identify environmental values to be protected, and to manage specific aspects of Queensland's environment. A key objective of the EPPs is to protect Queensland's environment while allowing for development that improves the total quality of life, both now and in the future, and maintains the ecological process on which life depends.

The *Environmental Protection (Water) Policy 2009* (EPP Water), provides the framework for decision making about Queensland waters particularly, the EPP Water provides a framework for identifying environmental values to be protected for Queensland waters and deciding the water quality objectives to protect or enhance those environmental values, including their biological integrity and suitability for drinking, recreational, agricultural and industrial uses. One or all of the environmental values in the EPP Water can be chosen for a particular water body.

Draft environmental values for surface waters in the Condamine catchment have been released by the Condamine Alliance (2012) and were used to determine the environmental values for Lagoon Creek. The draft environmental values that apply to Lagoon Creek were those identified for the upper Oakey Creek sub-catchment (Condamine Alliance 2012) and are listed in **Table 4-7**.

Table 4-6 Surface Water Extraction Licences

Authorisation No	Lot / Plan	Creek	Purpose
18143R	110 / AG1841	Oakey Creek	Irrigation
182982	86 / AG1796	Oakey Creek	Water harvesting
35478R	1 / RP122994	Oakey Creek	Water harvesting
35480WR	3 / RP122994	Oakey Creek	Irrigation; Water harvesting
35525WR	297 / A34722	Oakey Creek	Water harvesting
35679R	1 / RP64853	Oakey Creek	Water harvesting
42816R	1 / RP81265	Oakey Creek	Water harvesting
46029R	81 / AG1794	Oakey Creek	Water harvesting
56010R	2 / RP188947	Lagoon Creek	Water harvesting
51871R	2 / RP188947	Oakey Creek	Irrigation
55909R	83 / AG1794	Oakey Creek	Irrigation
55935R	9 / RP7980	Oakey Creek	Irrigation
56090WR	5 / RP124540	Oakey Creek	Water harvesting
58572R	3 / RP57668	Oakey Creek	Water harvesting
58674R	8 / RP7980	Oakey Creek	Water harvesting

Table 4-7 Draft environmental values and description identified for Lagoon Creek (Condamine Alliance 2012)

Environmental Value		Description
	**Aquatic Ecosystems**	A community of organisms living within or adjacent to water, including riparian or foreshore area. Levels of protection for aquatic ecosystems: ▪ High ecological/conservation value waters (HEV): waters in which the biological integrity is unmodified or highly valued ▪ Slightly to moderately disturbed (SMD): waters that retain biological integrity but are affected by human activity. ▪ Highly disturbed (HD): waters that are significantly degraded by human activity and have lower ecological value
	**Irrigation**	Suitability of water supply for irrigation-for example, irrigation of crops, pastures, parks, gardens and recreational areas.
	**Farm Water Supply**	Suitability of domestic farm water supply, other than drinking water. For example, water used for laundry and produce preparation.
	**Stock Watering**	Suitability of water supply for production of healthy livestock.
	**Human Consumers of Aquatic Foods**	Health of humans consuming aquatic foods-such as fish, crustaceans and shellfish (other than oysters) from natural waterways.
	**Visual Recreation**	Amenity of waterways for recreation which does not involve any contact with water-for example, walking and picnicking adjacent to a waterway.
	**Drinking Water**	Suitability of raw drinking water supply. This assumes minimal treatment of water is required-for example, coarse screening and/or disinfection.

All relevant environmental values need to be considered when evaluating a water body. The level of environmental and water quality protection must be determined to maintain each of the environmental values. Management goals that are established to protect the environmental values should reflect the specific problems and/or threats to the values, desired levels of protection and key attributes that must be protected (ANZECC & ARMCANZ, 2000).

There are four levels of aquatic ecosystem condition and protection under EPP Water (Section 6), which are:

- **high conservation / ecological value systems:** the biological integrity of an aquatic ecosystem that is effectively unmodified or highly valued;
- **slightly disturbed systems**: the biological integrity of an aquatic ecosystem that has effectively unmodified biological indicators, but slightly modified physical, chemical or other indicators;
- **moderately disturbed systems**: the biological integrity of an aquatic ecosystem that is adversely affected by human activity to a relatively small but measurable degree; and
- **highly disturbed systems**: the biological integrity of an aquatic ecosystem that is measurably degraded and of lower ecological value than waters mentioned in the above three descriptions.

The values of Lagoon Creek have been heavily impact on by current land use practices, specifically the area used for stock access. Much of the riparian zone and creek banks have been damaged with obvious signs of scour and erosion. Lagoon Creek was defined as slightly to moderately disturbed aquatic ecosystem for the purposes of applying water quality guidelines and trigger values and this intends to produce a level of 95 % protection of species.

At present, local water quality objectives to protect the Lagoon Creek EV's have not been published, and are currently in development by EHP (EHP, 2012) in conjunction with the Condamine Alliance under the EPP Water. It is noted that in 2008, prior to the EPP Water, Natural Solutions on behalf of the Condamine Alliance developed local water quality guidelines for the Condamine catchment. These now superseded, local water quality guidelines are generally consistent with Australian Water Quality Guidelines (AWQG)'s (Natural Solutions, 2008). Therefore, in lieu of any local water quality guidelines under the EPP Water, the AWQG's have been adopted.

The water quality guidelines adopted for the relevant water quality parameters within Lagoon Creek are presented in **Table 4-8**. The parameters are based on the AWQG's guideline values for the protection of aquatic ecosystems. This decision is based on recently released local water quality objectives for adjacent catchments such as the Fitzroy River Basin, for which the objectives that apply to the protection of aquatic ecosystems and for drinking water supply are the most stringent.

Table 4-8 Lagoon Creek Water quality guidelines for the protection of aquatic ecosystems

Water quality variable	Guideline Value	Water quality variable	Guideline Value
pH	6.5-7.5	Metals (Dissolved)	
EC (µS cm^{-1})$^{\$}$	<500	Arsenic (As) (mg L-1)	<0.013
Turbidity (NTU)	<25	Cadmium (mg L-1)	<0.0002
Dissolved oxygen (DO) (% saturation (mg L^{-1})	90-110%	Chromium III (Cr) (mg L-1)	<0.0027
Total suspended solids (TSS) (mg L^{-1})	-	Copper (Cu) (mg L-1)*	<0.0014
Hardness ($CaCO_3$) (mg L^{-1})	-	Lead (mg L-1)*	<0.0034
Sulfate (SO_4)* (mg L^{-1})	-	Nickel (Ni) (mg L-1)*	<0.011
Ammonia (NH_3) (mg L^{-1})	<0.010	Zinc (Zn) (mg L-1)*	<0.008
Dissolved inorganic nitrogen (DIN) (mg L^{-1})	<0.015	Manganese (Mn) (mg L-1)	1.9
Total nitrogen (TN) (mg L^{-1})	<0.25	Mercury (Hg) (mg L-1)	<0.00006
Total phosphorus (TP) (mg L^{-1})	<0.030	Beryllium (Be) (mg L-1)**	*
Filterable reactive phosphorus (FRP) (mg L^{-1})	<0.015	Vanadium* (V) (mg L-1)**	*
TPH C6 - C9 Fraction* (mg L^{-1})	-	Cobalt* (Co) (mg L-1)**	*
TPH C10 - C36 Fraction* (mg L^{-1})	-	Barium* (Ba) (mg L-1)**	*

Notes: * indicates requirement for hardness correction of trigger values (TVs). (**) Indicates trigger values are not specified in AWQG. All trigger values derived from AWQG except for $ which is derived from the QWQG

Table 4-8 provides the pH, dissolved oxygen, turbidity and nutrient concentrations assessed against the AWQG's for freshwaters of south east Australia. Metals are assessed against the trigger values for freshwaters in the AWQG and trigger values were corrected for hardness according to the methodology in the guidelines (ANZECC, 2000). Electrical conductivity was assessed against the regional salinity guidelines of the Queensland Water Quality Guidelines (QWQG) using the 75th percentile for the Condamine-Macintyre zone.

In addition to the water quality objectives outlined in **Table 4-8**, water quality guidelines for the protection of drinking water supply (raw water) have additional water quality indicators. These parameters include concentrations of toxins, sulphate and hardness. While no water quality objectives for the protection of drinking water have been set for the Condamine catchment the objectives fr om the adjacent Dawson River sub catchment have been reviewed. These values are presented in **Table 4-9**; several of these parameters, such as turbidity, will be derived from regionally sourced water quality data and therefore do not represent valid guidelines for waters of the Condamine. However, parameters such as sodium concentration are likely to be standard values for all sub-basins.

4.6 Water Quality

4.6.1 Water Quality Sampling Methods

Historical water quality data for Lagoon Creek is limited. DNRM operate one regional water quality gauge on Oakey Creek at Fairview downstream of the confluence with Lagoon Creek. This gauge is located downstream of the Lagoon and Oakey Creek confluence and downstream of several towns, and agricultural areas. Water quality at this site is unlikely to be representative of that in Lagoon Creek as it is influenced by the water quality in Oakey Creek, which up until 2009 included the releases from the upstream Toowoomba Water Treatment Facility. Currently, releases from the Toowoomba Water Treatment Facility occur on occasion dependant on the volume of water pumped through the Wetalla pipeline.

Table 4-9 Water Quality Objectives for the protection of drinking water supply

Indicator	**Water Quality Objective** EPP (Water) for the Dawson River sub-basin
Blue-green algae (cyanobacteria) *	< 5,000 cells/mL
Algal toxin	Level 1: 0.1 µg/L *Microcystin* * Level 2: 4 µg/L *Microcystin**
Cryptosporidium *	0 cysts
*Giardia**	0 cysts
Sodium*	30 mg L^{-1}
Sulfate*	200 mg L^{-1}
Colour*	Level 1: 50 Hazen Units No Level 2
Hardness*	Level 1 > 150 mg L^{-1} Level2 > 200 mg L^{-1}
E. coli	None specified for raw water (<10 cfu's for irrigation supply of raw human food crops)
pH	6.5-8.5
Turbidity	Level 1: 500 NTU Level 2: 1000 NTU
Conductivity	Level 1: > 400 µS cm^{-1} Level 2 same as Level 1 (no treatment options to remove salt)
Dissolved oxygen	Level 1: < 4 mg L^{-1} at surface No Level 2

Source: EPP (Water) Dawson River Sub-basin.
*indicates a WQO more stringent than for protection of aquatic ecosystem or one not covered by the aquatic ecosystem environmental value.
*Level 1 denotes Level 1 Hazard and Critical Control Point (HACCP) response rating, namely: treatment-plant-process-change required to ensure water quality and quantity to customers is not compromised.
*Level 2 denotes Level 2 Hazard and Critical Control Point (HACCP) response rating, namely: treatment-plant-process-change required but water quality and quantity to customers may still be compromised.

Water quality data was available from routine water monitoring conducted by NAC under its current environmental monitoring plan for the Mine and from two targeted monitoring events. The monitoring program assesses water quality at the locations outlined in **Table 4-10** and illustrated in **Figure 4-12**.

Table 4-10 Water Quality Sampling Sites

Site Code	Description
LCU1	Monitoring site located on Lagoon Creek upstream of the existing mining operation. This site is monitored under the Mine's EA.
LCD1	Monitoring site located on Lagoon Creek downstream of the existing mining operation. This site is in the approximate location of the proposed Manning Vale East pit. This site is monitored under the Mine's EA.
LCD2	Monitoring site located on Lagoon Creek downstream of the existing mining operation. This site is downstream of the proposed Manning Vale East pit. This site is monitored under the Mine's EA.
Site 1, 3, 4 and 5	These 4 sites are located within 200 m of each other and are at the upstream boundary of the revised Project pit areas, insitu sampling was undertaken at this site in 2009 to support the revised Projects baseline activities.
Site 2	Located downstream approximately 5 kms downstream of the downstream boundary of the revised Project mining area (DS1), insitu sampling was undertaken at this site in 2009 to support the revised Projects baseline activities.
AH4	Aquatic ecology monitoring site 4, downstream of the existing mining operations and immediately adjacent to the northern extent of the Manning Vale East and Wileroo pits.
DS1	New water quality monitoring site located at the downstream boundary of the revised Project mining area.

Water quality monitoring was conducted at established monitoring sites on Lagoon Creek upstream (LCU1) and downstream (LCD1 and LCD2) of the existing mining operation in accordance with the Mine's EA between 2009 and 2011. Sampling of surface waters was undertaken by NAC's environmental officers using on-site field equipment. Water samples were collected for measurements of temperature, dissolved oxygen, electrical conductivity, pH, and analysis of sulphate and suspended sediments.

A single monitoring event was conducted between 23rd January 2008 and 24th January 2008 at four sites upstream (Site 1, Site 3, Site 4, Site 5) and one site downstream (Site 2) of the Project. In-situ measurements of temperature, dissolved oxygen, electrical conductivity, and pH, were taken with a TROLL 9500 Professional XP multi-parameter water quality probe and logger. Measurements were taken near the middle of the watercourse at each location, at a depth of approximately 15 cm. All water quality equipment was calibrated prior to undertaking the field based assessments.

LEGEND

- Towns and Localities
- Sample Site
- Rail Spur
- Roads
- Creeks
- Mining Tenements
- Stage 3 Pit Areas

NEW HOPE GROUP

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NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 4-12
Water Quality Sample Sites

Scale 1:60,000 on A4
Projection: Australian Geodetic Datum – Zone 56 (AGD84)

Path: I:\QENV2\Projects\QE06644\Spatial\ArcGIS\01_Figures\01_SEIS\IESC_Submission\130828_NewHope_IESC_Figure4-12_WQSamplingSites.mxd

Produced: 29/08/2013

An additional monitoring event was conducted on 8th March 2013 during a period of flow at two established monitoring sites upstream (LCU1) and downstream of the Mine and at an additional two downstream sites, with one site being downstream of the revised Project. In-situ measurements of temperature, dissolved oxygen, electrical conductivity, pH, and sampling of surface waters were undertaken by NAC's environmental officers using on-site field equipment. Water samples were collected for chemical analysis of the following parameters:

- Metals - total and dissolved (As, Be, Co, Cr, Cu, Hg, Ni, Mg, Ba, V, Zn);
- Nutrients (TP, TN, FRP, DIN, NH3);
- Major cations and anions;
- Total petroleum hydrocarbons (TPH C6-C36);
- Total Suspended Solids (TSS); and
- Pesticides.

Water samples were preserved and transported to SGS, a NATA accredited laboratory within the specific holding times for analysis. The water quality sampling was conducted in accordance with AS/NZ 5667.11:1998 Water Quality – Sampling Part 1, Part 6 and Part 11, (Standards Australia 1998) and with the Queensland Monitoring and Sampling Manual (DERM 2009).

4.6.2 Lagoon Creek Water Quality

Table 4-11 provides the median and ranges of water quality variables from the long term monitoring at the DNRM Oakey Creek at Fairview gauging station and NAC's existing EA monitoring. **Table 4-11** also provides the physicochemistry values recorded during a period of no flow during the 2008 monitoring event.

Table 4-12 provides a summary of results for water quality monitoring during a flow event (2013), including physicochemical properties, concentrations of nutrients, major ions and dissolved metals. Full sets of water quality results are provided in **Appendix E**.

Physicochemistry

The water temperatures varied between sites depending on location, time and volume of water at the sample location. Guidelines are not set for temperature but long-term monitoring from Lagoon Creek and Oakey Creek provides expected ranges for waters in the subcatchments. Water temperatures during January were at the upper range temperature range, whilst water temperatures in March were closer to the mid-range. However the results were within the expected range for these seasons.

Table 4-11 Water Quality Data

Guideline		**Temp (ºC)**	**Suspended Solids (mg/L)**	**Turbidity (NTU)**	**pH**	**DO (ppm)**	**Sulphate (mg/L)**	**EC (µS/cm)**
		N/A	**N/A**	**<25**	**6.5-7.5**	**90-110%**	**<200**	**<500**
Site	**Time/ Date**	**Temp (ºC)**	**Suspended Solids (mg/L)**	**Turbidity (NTU)**	**pH**	**DO (ppm)**	**Sulphate (mg/L)**	**EC (µS/cm)**
Regional Water Quality Sampling								
Oakey Creek at Fairview (DNRM)	1995 - 2012	20.50 5.9-34.8	N/A	**84 (10 – 999)**	**8.10 (5.4-10.4)**	1.2 to 17.8 (mg/L)^	43 (3 **- 269**)	**1018** (159 – **3204)**
Environmental Authority Monitoring								
LCU1	2008-2013	22.40 (15.5-30.5)	18 (2-179)	N/A	7.46 (6.6-**8.4**)	N/A	2 (1-190)	210.0 (97-**590**)
LCD1	2008-2013	23.85 (17.9-29.6)	11 (1-335)	N/A	**7.80** (7.3-**8.9**)	N/A	25 (3-220)	418.5 (176-**3900**)
LCD2	2008-2013	23.40 (19.3-29.6)	10 (2-353)	N/A	**7.80** (7.4-**8.9**)	N/A	30 (1-200)	**596.0** (136-**1700**)
Insitu Sampling No Flow Event (January 2008)								
Lagoon Creek (Site 1)	23rd Jan 1325	31.42	N/A	**94.89**	**8.90**	**111.67**	N/A	**596.4**
Lagoon Creek (Site 2)	23rd Jan 1540	26.34	N/A	**33.35**	**8.91**	95.23	N/A	463.1
Lagoon Creek (Site 3)	23rd Jan 1730	25.99	N/A	3.15	**8.03**	94.73	N/A	**8 089.6**
Lagoon Creek (Site 4)	24th Jan 1430	26.89	N/A	20.45	**8.52**	**65.61**	N/A	**642.1**
Lagoon Creek (Site 5)	24th Jan 1520	30.93	N/A	16.95	**8.69**	92.10	N/a	**636.9**

*Note: Bold indicates exceedance of relevant guidelines; shaded cells indicate median exceeds relevant guidelines. ^ gauge only reports in mg/L

The long term monitoring undertaken under the Mine's EA illustrates a spatial trend in the pH and EC values. Median pH and EC values were higher at sites downstream of the Mine with pH exceeding guidelines at the both downstream sites and EC exceeding guidelines at LCD2. EC was below guidelines during the flow event and contrasted with the high EC values recorded in the no-flow period. pH values were higher during the no-flow monitoring event although pH varies diurnally and seasonally and single measurement were within the ranges recorded from the long term monitoring. pH measurement during the flow event were slightly lower than the long term medians.

Table 4-12 Water quality monitoring during a period of flow (March 2013)

Water quality variable	Unit	Guideline	LCU1	LCD1	AE4	DS1
Flow		N/A	Yes	Yes	Yes	Yes
Temperature*	°C	N/A	23.9	25.9	21.9	21.6
Dissolved oxygen	%	90-110%	**15.0**	**51.8**	**44.3**	**46.0**
pH	pH Units	6.5-7.5	7.0	7.5	**7.6**	7.4
Electrical conductivity	µS/cm	<500	240	310	240	280
Turbidity	NTU	<25	8.6	**55**	19	10
Total nitrogen	mg/L	<0.25	**1.4**	**0.84**	**1.2**	**0.97**
Ammonia	mg/L	<0.010	**0.35**	**0.037**	**0.061**	**0.040**
Total phosphorus	mg/L	<0.030	**0.15**	**0.12**	**0.31**	**0.26**
Filterable reactive phosphorus	mg/L	<0.015	**0.052**	**0.059**	**0.18**	**0.17**
DIN	mg/L		**0.02**	**0.29**	**0.02**	<0.02
Sodium#	mg/L		12	32	15	15
Sulphate#	mg/L		1	20	4	5
Total hardness#	mg/L	Level 1 >150 Level2 > 200	95	84	98	110
Calcium*	mg/L		20	15	23	22
Magnesium*	mg/L		5.9	8.4	7.7	8.0
Potassium*	mg/L		10	6.0	12	11
Fluoride*	mg/L		<0.1	0.6	0.2	0.1
Chloride*	mg/L		9	26	10	13
Dissolved metals						
Arsenic (As)	µg/L	<0.013	2	1	2	2
Chromium, (Cr)	µg/L	<0.0027	btl (8.5)	btl (7.7)	btl (8.7)	btl (9.6)
Copper, (Cu)	µg/L	<0.0014	2 (3.7)	3 (3.4)	**4 (3.8)**	3 (4.2)
Manganese, (Mn)	µg/L	1.9	1	btl	22	1
Mercury (Hg)	mg/L	<0.00006	btl	btl	btl	btl
Nickel, (Ni)	µg/L	<0.011	5 (29)	2 (26)	4 (30)	4 (24)
Zinc (Zn)	µg/L	<0.008	btl (21.3)	btl 19.2)	6 (21.9)	btl (24.1)
Barium, (Ba)*	µg/L		39	28	69	61
Beryllium, (Be)*	µg/L		<1	<1	<1	<1
Cobalt, (Co)*	µg/L		<1	<1	<1	<1
Vanadium, (V)*	µg/L		2	4	8	5

Note - * indicates no guidelines currently available. # shows water quality indicator values used for protection of drinking water supply (for example the see the EPP (Water) Dawson River Sub-basin), all other indicator values apply to the protection of aquatic ecosystem. Values in brackets are the trigger values for dissolved metals that require a hardness correction (AWQG). Below detection limits (btl) indicates the variable was below detection limits of the laboratory analysis. Shaded and bold values indicate exceedance of the relevant guideline.

Median pH and EC values from the Fairview gauging station exceeded the guidelines and indicate that this may be a feature of the Oakey Creek subcatchment, possibly due to the higher alkalinity and salinity of the local soils.

Dissolved oxygen was below guidelines at all sites during the flow period with very low concentrations at the site upstream of the Mine and concentrations similar at the three downstream sites. Turbidity was variable between sites during periods of both flow and no-flow and exceeded guidelines at three sites but values were not as high as commonly occur in some waterways of the Condamine catchment (CBWC, 1999) and a spatial trend was not evident.

Dissolved metals and Toxicants

Dissolved concentrations of metals were below guidelines with the exception of copper, which was detected at all sites and exceeded the guidelines at AE4; this site also had a notably higher concentration of manganese. Concentrations of pesticides and hydrocarbons were below detection limits at all sites.

Environmental considerations

Water in the Condamine catchment is generally high in concentrations of total phosphorus and in turbidity (CBWC, 1999) and is indicative of catchments that are affected by agriculture. The revised Project site and its immediate surrounds have been impacted by land uses including grazing and dryland cropping. These land-use practices have affected the surrounding waterways including Lagoon Creek. The very high concentrations of nutrients in Lagoon Creek during the flow period indicate mobilisation of inorganic and organic forms of nitrogen and phosphorus from catchment run-off possibly related to agricultural activities. The concentrations of dissolved oxygen during the period of flow were low and were possibly due to the decomposition of suspended and dissolved organic matter in the rainfall run-off. The turbidity in Lagoon Creek and Oakey Creek was low in comparison to other subcatchments of the Condamine River basin, where high turbidity has been identified as a major influencing and limiting factor for the EV's. The long term monitoring results of EC in Lagoon Creek indicate increased EC levels downstream of the Mine. While it is expected that the EC of Lagoon Creek may increase following controlled releases from the Mine, all releases are undertaken based on strict water quality targets and therefore any changes in EC that may cause environmental impacts are mitigated. It is noted that EC values are generally below guideline values at all sites. Furthermore, EC values immediately downstream of the Mine are significantly lower than the EC values at the DNRM monitoring site on Oakey Creek. This observation suggests that the EC values of the Lagoon Creek catchment are generally lower than the Oakey Creek catchment.

The water quality of the Lagoon Creek catchment is also impacted by the ephemeral nature of Lagoon Creek. Ephemeral waters are variable in their water quality primarily due to the irregularity and intensity of flow/rainfall events. The Study area experiences seasonal and highly variable rainfall. Large flow events will generally carry a large sediment load, which can be intensified by a long dry period. Flows and connectivity are also impacted by the numerous waterway barriers as a result of the construction of in-stream farm dams.

The variability in the rainfall/flow/drought cycle of ephemeral streams can lead to similar variation in the physical and chemical properties of the water compared with more permanent water bodies. In view of this variability, the current Australian and New Zealand Guidelines for Fresh and Marine Water Quality, ANZEC Guidelines (the ANZECC Guidelines) are often not suitable for such ephemeral environments. Two characteristics that often typify ephemeral streams are high turbidity and high sediment loads. However, other physicochemical properties can vary greatly in these systems. Variations in water quality may also exist over small spatial scales resulting from differing land management practices and local industry discharging or releasing waters into ephemeral streams.

From an ecological perspective, in addition to variable water quality over varying temporal and spatial scales, it is the period for which waters within ephemeral streams are connected, the frequency of connectivity and detachment, and the physical/chemical properties of these waters that are also critical factors in the survival of aquatic communities. The aquatic ecosystem values of the revised Project site are discussed in **Section 5** of this document.

The general water guidelines that have been applied need to be considered with reference to local water quality conditions. The long term monitoring at Oaky Creek and Lagoon Creek provide a local context for water quality and are useful for interpreting water quality data, particularly prior to the release of WQO's for the Condamine catchment.

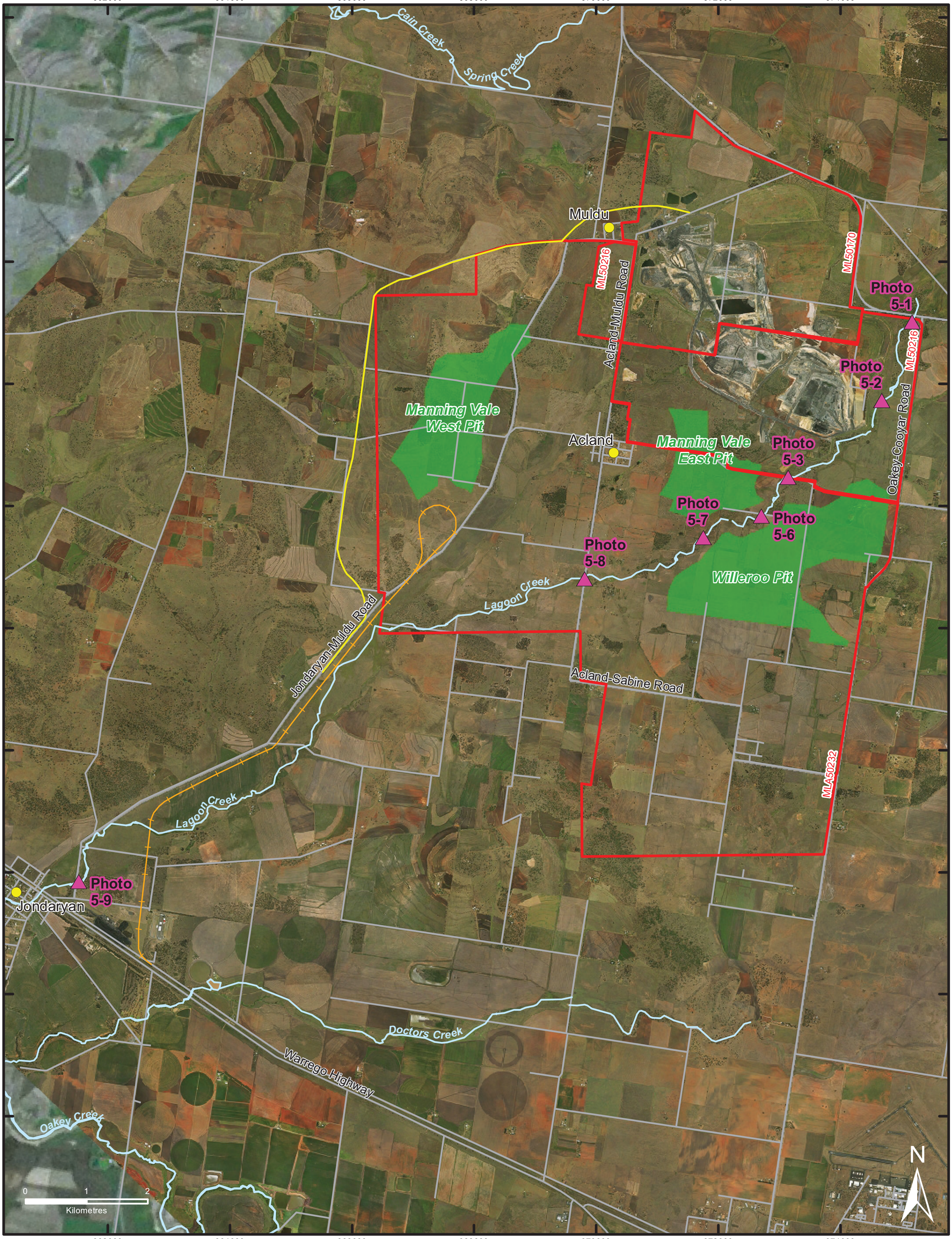
4.7 Geomorphology

The revised Project site is located within the Lagoon Creek catchment. The majority of the terrain within these catchments is undulating and land use is predominantly grazing. Historically, Lagoon Creek is grazed and cultivated up to and within the creek channel. In the upper reaches of the catchment, the terrain becomes steeper and possesses tracts of remnant vegetation. Higher, localised peaks in the Lagoon Creek catchment are also vegetated with trees.

Lagoon Creek is an ephemeral waterway that has historically been used for agricultural purposes, and as a result, is a disturbed creek system. The Lagoon Creek channel includes a number of in-stream farm dams which disrupt the natural flow regime. The main channel of Lagoon creek is poorly defined with significant erosion along the creek banks. The Upper Condamine catchment was assessed as part of the State of the Rivers report, completed in 1994. The report notes existing issues of erosion and a lack of riparian vegetation, but that the majority of the existing banks were stable despite signs of erosion.

A site visit was undertaken on 29th October 2008 following a period of prolonged drought and again on 31st January 2013, six days after the Australia Day flood event to assess the existing condition of the Lagoon Creek within the Study area.

Photo 4-1 through to **Photo 4-10** illustrate the existing geomorphic condition of Lagoon Creek, upstream and downstream of the mine location. **Figure 4-** illustrates the approximate location of these photos.



LEGEND

- Towns and Localities
- Geomorph Approximate Photo Locations
- Rail Spur
- Roads
- Creeks
- Mining Tenements
- Stage 3 Pit Areas

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Figure 4-13
Geomorphic Photo Locations

Scale 1:85,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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Produced: 28/11/2013

Photo 4-1 Lagoon Creek's upstream crossing of the Mine Lease Boundary (2008)

Photo 4-1 illustrates the existing conditions of Lagoon Creek as it crosses into the Mine. The figure is representative of the Lagoon catchment with a poorly defined creek channel. **Photo 4-2** indicates the channel definition further south adjacent to the existing South Pit and upstream of the Study area. **Photo 4-2** also illustrates significant erosion and degradation of the existing creek channel. Wet weather prevented access to these locations in 2013.

Photo 4-3 illustrates the existing conditions of Lagoon Creek following drought in 2008 looking into the revised Project site just downstream of Acland Road. The photo illustrates the relatively narrow and shallow nature of the creek channel. **Photo 4-4** was taken in approximately the same location following the Australia Day rainfall event in January 2013 and illustrates a flow event in Lagoon Creek. **Photo 4-5** was taken at approximately the same location several days later with shallow standing water observed in the Study area immediately downstream of the road crossing. No obvious signs of erosion were observed.

Photo 4-6 and **Photo 4-7** illustrate the Lagoon Creek channel adjacent to the Study area. The photos illustrate the discontinuity of the channel with sections of relatively defined channel and large sections of floodplain. This is also illustrated in **Photo 4-8** which illustrates the Lagoon creek channel looking upstream into the Study area from the approximately location of downstream boundary of the MLA.

Photo 4-2 Lagoon Creek's channel adjacent to the South Pit (2008)

Photo 4-3 Lagoon Creek's channel looking downstream of Acland Road to Study area (2008)

Photo 4-4 Lagoon Creek's channel looking downstream of Acland Road (Flow Event 27th January 2013)

Photo 4-5 Lagoon Creek's channel looking downstream of Acland Road to the Study area (2013)

Photo 4-6 Lagoon Creek's adjacent to the Study Area (2008)

Photo 4-7 Lagoon Creek's adjacent to the Study area (2008)

Photo 4-8 Lagoon Creek's looking upstream of Acland-Sabine Road to the Study area (2013)

Photo 4-9 and **Photo 4-10** characterise the Lagoon Creek downstream of the proposed railway line looking towards Jondaryan. The photos illustrate the expansive floodplain and limited channel definition.

Photo 4-9 Lagoon Creek looking Downstream to Jondaryan at Approx Railway Location (2008)

Photo 4-10 Lagoon Creek looking Downstream to Jondaryan at Approx Railway Location (2013)

5 Ecological Environment

5.1 Terrestrial Ecosystems

Terrestrial ecosystems of the revised Project site are a combination of native vegetation and agricultural areas (pasture and cropping). The native vegetation is remnant vegetation comprising brigalow, poplar box, mountain coolibah, belah and grassland communities. The brigalow, poplar box, mountain coolabah and belah communities are dominated by species of Acacia and Eucalyptus. The grassland communities feature grasses and a range of herb species. There are no terrestrial ecosystem communities associated with groundwater springs, seeps or other similar areas within the Project site and its surrounds.

The brigalow, poplar box, mountain coolibah and belah communities are dry woodland/open forest communities that have a typical structure of a canopy layer of the dominate overstorey species, a mid layer of shrubs and immature overstorey species, and a ground layer of grasses, herbs and forbs. The canopy height of the brigalow, poplar box, mountain coolabah and belah ranges between eight metres and 20 metres. These communities are located in the northwestern area of the revised Project site on a ridge of sedimentary rock and basalt, high in the local landscape. Groundwater monitoring bore 109P is located in this area and suggests depth to groundwater in the basalt aquifer is around 17 m below ground level as described in **Section 3.8.2**; as such, there is only very limited possibility that these remnant communities receive benefit from groundwater, and are much more likely to be reliant on residual rainfall-derived soil moisture. Much of these remnant vegetation communities will be cleared as part of the revised Project.

Alluvial areas (mainly along and adjacent to Lagoon Creek) are dominated by poplar box and brigalow woodlands, interspersed with areas of native grassland dominated by Queensland blue grass. The grassland community and the associated species are likely to have root depths of around two to three metres, significantly shallower than groundwater across the revised Project site as described in **Section 3.8**. The grassland community relies on rainfall and surface water to sustain the community. Surface water will be in form of overland flows and occasional floods from Lagoon Creek. The woodland/open forest communities will also make use of water from overland flows and floods, as surface water will be available following rain. Vegetation on the alluvial areas of the revised Project site will also access soil moisture derived from residual rainfall that is held in the soil profile.

Chapter 7 of the revised Project's EIS presents the complete discussion of Terrestrial Ecosystems at the revised Project site.

5.2 Aquatic Ecosystems

Aquatic ecosystems in the revised Project site are only found along Lagoon Creek. During the dry season aquatic ecosystems are associated with a series of temporal pools and farm dams. The short-lived periods of flow throughout the wet season during or immediately following rainfall temporarily increase the diversity of aquatic habitats within Lagoon Creek and provide opportunities for fish migration. Water quality within Lagoon Creek is generally poor, with low dissolved oxygen levels and high pH, electrical conductivity and nutrient concentrations. Water quality values frequently exceed the guidelines for the protection of moderately disturbed aquatic ecosystems. There are no aquatic ecology values associated with groundwater sources at the revised Project site, and flows within Lagoon Creek are strongly associated with surface water runoff.

Macrophyte diversity within Lagoon Creek is low, with fringing rushes and sedges the dominant forms, and are generally restricted to permanent waterbodies. A low diversity of macroinvertebrates is supported by Lagoon Creek, which is similar to other systems impacted by high levels of disturbance from clearing and agricultural land use. The degraded aquatic habitat and lack of connectivity between isolated pools means that only a small number of fish species, which are highly tolerant of degraded habitat and poor water quality, are likely to persist in the revised Project site. These species include the spangled perch (*Leiopotherapon unicolor*), gudgeon (*Hypseleotris* spp.) and the introduced mosquito fish (*Gambusia holbrooki*). The vulnerable murray cod (*Maccullochella peelii*) is highly unlikely to be present in the revised Project site. The eastern snake-necked turtle (*Chelodina longicollis*) has been observed within Lagoon Creek and is the only turtle species likely to be present at the revised Project site.

Chapter 8 of the revised Project's EIS presents the complete discussion of Aquatic Ecosystems at the revised Project site.

6 Impact Assessment - Groundwater

The revised Project will include a series of mine pits and depressed landforms (rehabilitated final voids) which will intersect the Quaternary Alluvial aquifer, the Tertiary Basalt aquifer and the Walloon Coal Measures aquifer.

The Quaternary Alluvial aquifer is considered to be a minor aquifer within the revised Project site itself and does not form a significant groundwater resource in the proposed mining area. The Tertiary Basalt aquifer will be intersected by mining to only a small degree on the northern and northwestern edges of the revised Project's western pit (i.e. the Manning Vale West Pit).

The Walloon Coal Measures is the main groundwater aquifer affected by the revised Project, and will be intersected by all proposed mine pits. As a result, potential effects to receptors from the revised Project are predominantly associated with the Walloon Coal Measures aquifer.

The following discussion provides an assessment of the potential effects from the revised Project on the Walloon Coal Measures aquifer and to a lesser extent the Tertiary Basalt and Quaternary Alluvial aquifers. The assessment includes:

- direct effects of mining on groundwater quality and quantity, aquifer integrity and groundwater-surface water interaction; and
- effects on potential receptors.

This Section does not include a specific assessment of potential effects from the Mine's current groundwater extraction from the Tertiary Basalt, Marburg Sandstone and Helidon Sandstone aquifers. Approval for the extraction of groundwater from these aquifers has already been obtained. Groundwater extraction from the Marburg Sandstone and Helidon Sandstone aquifers for industrial has reduced significantly since 2010 once the WWRF Pipeline was brought into operation as described in **Section 3.5**.

6.1 Effects on Groundwater Levels

Throughout the operational phase of the revised Project, the mine pits will intersect the water table within the Walloon Coal Measures and some groundwater will discharge to the pits. Groundwater discharge into the mine pits will cause drawdown in groundwater levels in the Walloon Coal Measures aquifer. The mine pits will be excavated as a series of strips which will be backfilled and rehabilitated after each strip has been mined. Following cessation of mining, groundwater may continue to discharge to the depressed landforms (rehabilitated final voids) as a result of evaporative losses from the depressed landforms.

Numerical groundwater modelling has been conducted to determine the potential magnitude and extent of effect of mining on groundwater levels within aquifers located at and surrounding the revised Project site, including the potential effect on neighbouring groundwater users. The following Sections summarise the numerical modelling undertaken and the predicted effect on groundwater levels in aquifers located at and surrounding the revised Project site.

6.1.1 Numerical Groundwater Modelling

Model Description

A fully transient three dimensional finite difference groundwater flow model of the Mine, the revised Project site and its surroundings has been developed in the MODFLOW-2000 code using the Groundwater Vistas Version 6 Graphical User Interface. The model has been developed using the best available data, and where data was unavailable the most conservative assumptions have been made (e.g. the nature of the hydraulic connection (or lack thereof) between the Walloon Coal Measures and Tertiary Basalt aquifers is unquantified to date however the two units have been modelled as completely hydraulically connected). As a result, all hydrogeological model outputs represent a 'worst case' scenario to ensure the maximum potential groundwater impacts for the revised Project are identified for assessment and mitigation purposes. The model will continue to be updated and refined based on the results of a targeted groundwater monitoring program and further investigations into local bore information (e.g. landholder bore surveys) as described in **Section 9.4**.

The model covers an area of 1,908 km^2 extending 36 km in the east-west direction and 53 km in the north-south direction. It is centred on the Mine and revised Project site and has grid cells of 200 m by 200 m near the Mine and Project area and 400 m by 400 m in outer areas. The model domain and boundary conditions are shown in **Figure 6-1**.

The model consist of four layers with depth intervals that correspond to mapped or interpreted contacts between geological units and to the geometry of the historical, current and proposed mining pits. The layering structure is defined in **Table 6-1** and is based on the hydrogeological conceptualisation defined in **Section 3.14**. Given the presence of the Evergreen Formation aquitard beneath the Marburg Sandstone, the thickness of the low permeability strata beneath the proposed mine pits, and the depth of the Helidon Sandstone below the proposed mine pits, it was decided that modelling of the Evergreen Formation and Helidon Sandstone was not warranted as measurable impacts from mining are not expected to occur in relation to these formations. Note that individual layers in the model include a number of different hydrogeological units based on mapped distribution of the various geologic units in the model domain.

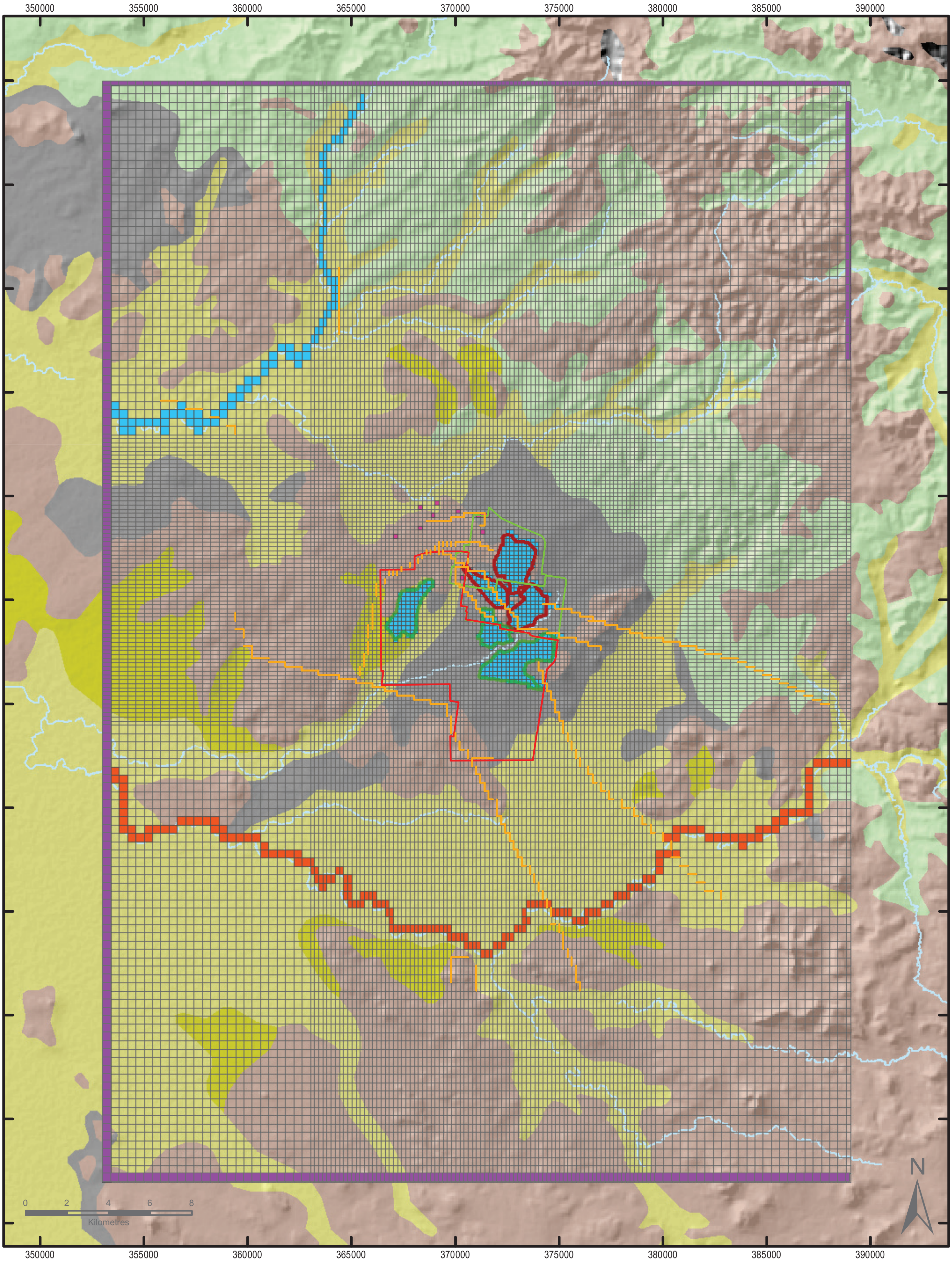

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Figure 6-1 - Model Domain and Boundary Conditions

Scale 1:250,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

Path: I:\QENV2\Projects\QE06644\Spatial\ArcGIS\01_Figures\01_SEIS\IESC_Submission\130828_NewHope_IESC_Figure6-1_ModelDomainAndBoundaryConditions.mxd

Produced: 29/08/2013

Table 6-1 Definition of model layers

Model Layer	Elevation Range	Hydrogeological Units Present
1	Ground surface to base of Mine pits	Walloon Coal Measures, Tertiary Basalts, Quaternary Alluvium, Marburg Sandstone
2	Base of Mine pits to base of the Basalts	Walloon Coal Measures, Tertiary Basalts, Quaternary Alluvium, Marburg Sandstone
3	45 m thickness	Lower Walloon Coal Measures, Quaternary Alluvium, Marburg Sandstone
4	250 m thickness	Marburg Sandstone

The model provides for exchange of water with surrounding aquifers outside the model domain through the inclusion of Constant Head Boundary Conditions assigned to its northern, western, southern and eastern (in part) boundaries as depicted in **Figure 6-1**.

The southern part of the eastern lateral model boundary is defined as a no-flow boundary through which water cannot enter or leave the groundwater model domain.

A nominal level of rainfall recharge has been applied across the top surface of the model. Recharge values were set at a fixed percentage of rainfall measured at BOM rainfall gauging stations located within and near the model domain. The model is subdivided into four recharge zones according to the permeability of the outcropping hydrogeological units.

Myall Creek is modelled as a gaining stream using the Modflow Drain Boundary Condition and groundwater recharge through the creek bed is not allowed for in the model. This representation is consistent with the fact that it is an ephemeral water course that is not a consistent source of groundwater recharge throughout the year. Oakey Creek has been included in the model using the Modflow River Boundary Condition that allows groundwater to enter or exit the model depending on the predicted groundwater heads and those specified as the river stage, i.e. the creek is modelled as both a losing and a gaining stream depending on the groundwater heads adjacent the creek. Lagoon Creek is not included in the model as investigations have shown the ephemeral creek to be disconnected from the regional groundwater system as described in **Section 3.13**.

Inflows to the mining pit are modelled as time varying Drain Boundary Conditions that drain the pit to the elevation of the pit floor. The locations of Drain Boundary Conditions are also shown in **Figure 6-1**. Historical Mine water supply extraction from water supply bores was included in the model calibration, using historical usage data as supplied by NHG.

Model calibration (discussed below) highlighted the fact head differences measured in neighbouring groundwater monitoring bores suggest localised areas of low permeability and associated compartmental nature of the aquifers in the region of the Mine and revised Project site, derived from faulting. In the model the Modflow Horizontal Flow Barrier Package was implemented in order to represent faulting and the compartmental nature of the groundwater system. This package simulates thin, vertical low-permeability geologic features that impede the horizontal flow of ground water. Faults are approximated as a series of horizontal-flow barriers (or “walls”) conceptually situated on the boundaries between pairs of adjacent cells in the finite-difference grid. Wall settings were adopted to represent the faulting present at the Mine and revised Project site. The locations, alignment and permeability of the flow "walls" were derived from faults mapped by NHG at the site and during model calibration process. The "walls" were defined through Layer 1 to Layer 4 and the locations of the walls are shown in **Figure 6-1**.

Model Calibration

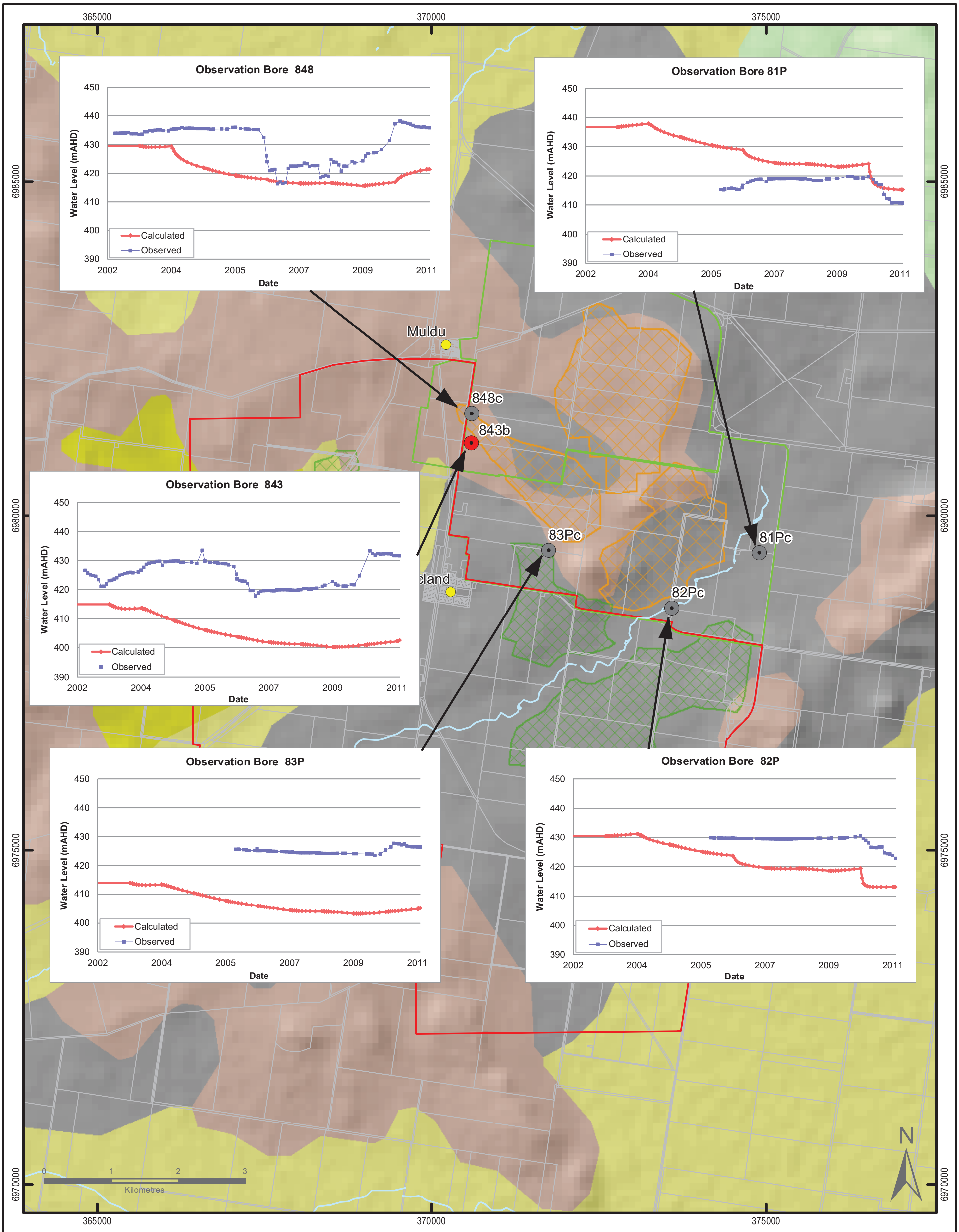
Due to the history of mining development in the modelled region and lack of detailed site-specific pre-mining groundwater level information, steady-state (i.e. pre-mining) calibration was deemed unsuitable and not as reliable as a fully transient model calibration. Fully transient model calibration was therefore undertaken using historical Mine development information and groundwater level monitoring data for the period 2002 through to 2012.

During the model calibration process, modifications to the model parameters were made in an effort to improve the model's ability to replicate the observed responses. Manual trial and error calibration runs were followed by PEST automated calibration. The following constraints were placed on the calibration procedure:

1) Calibration was attempted without changing the hydrogeological zonation as defined by the interpreted distribution of the principal hydrogeological units present at the site.
2) Calibration was attained through refinement of the following model parameters and features:
    a) Hydraulic conductivity in the horizontal and vertical dimensions.
    b) Anisotropy between the principal components of horizontal hydraulic conductivity (i.e. the kx/ky ratio).
    c) Specific yield.
    d) Recharge.
    e) Hydraulic conductivity assigned to the "walls" used to replicate the influence of faults.
    f) Conductance assigned to the Drain cells that define the flux of water into the historical mining pits.

The only formation property not varied during calibration was specific storage. It was assumed that, due to the consolidated nature of the confined aquifers in the model domain, specific storage for these aquifers is equivalent to the compressibility of water (i.e. $5x10^{-6}$ /m).

The results of the model calibration are illustrated by hydrographs showing the model match to observed groundwater responses in the region of the historical Mine pits, and are presented in **Figure 6-2**. The calibration to observed heads can be quantified through estimation of the scaled RMS error for the goodness of fit (in this case 8%). The scatter plot and estimates of goodness of fit are shown in **Figure 6-3**.



LEGEND

Compliance\Reference Bores
- Tertiary Basalt
- Walloon Coal Measures

- Towns and Localities
- Watercourse
- New Acland Coal Mine
- New Aland Coal Mine-Stage 3
- Cadastre
- Existing Permission
- Stage 3 Pit Areas

Dominant Geology
- Basalt (Tm)
- Alluvium (Qa)
- Colluvium (TQs)
- Walloon Subgroup (Jw)
- Marburg Sandstone (Jbm)

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Figure 6-2
Model Calibration Hydrographs

Scale 1:75,000 on A4
Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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Produced: 7/01/2014

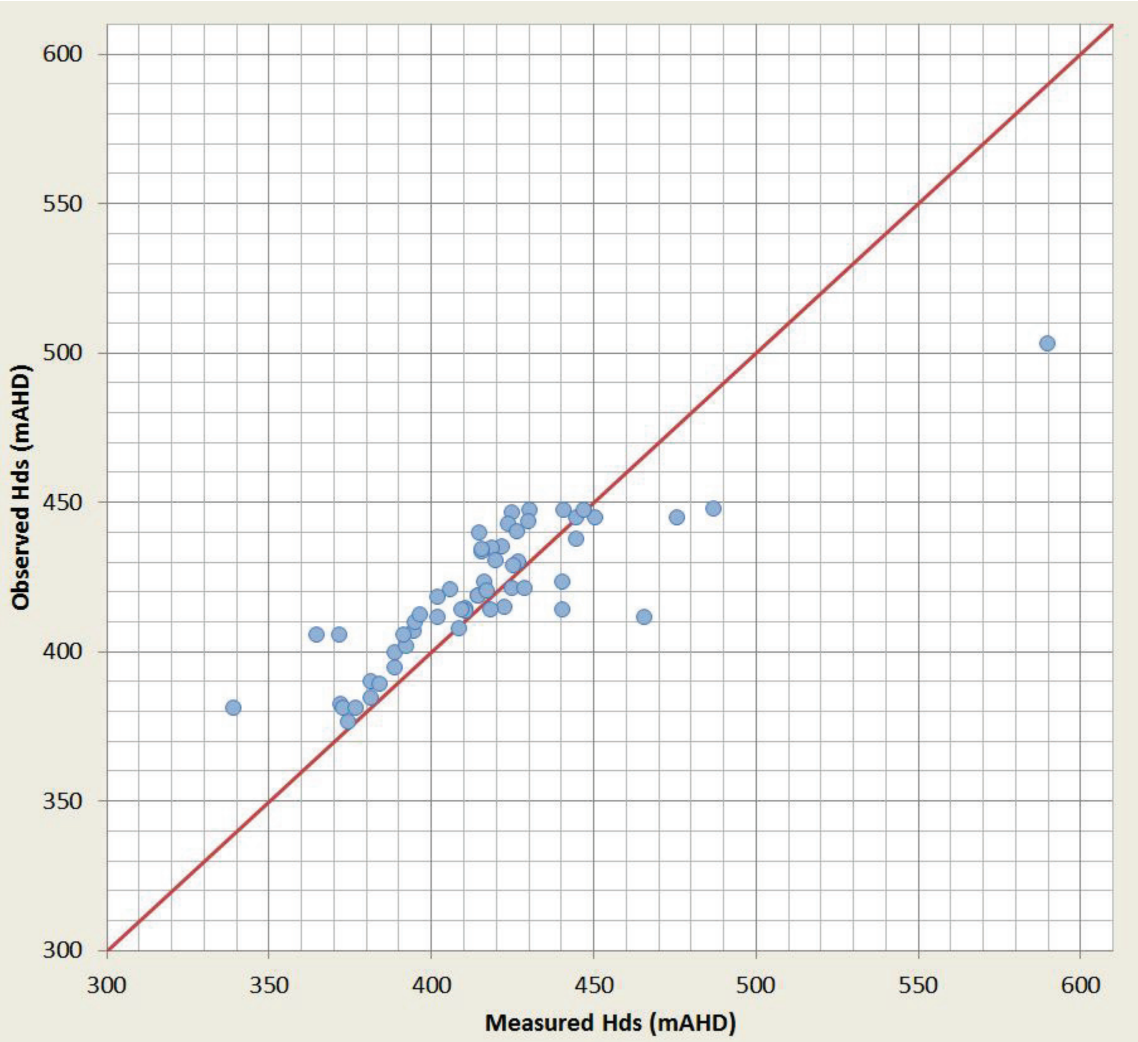


Figure 6-3 Calibration Results

Hydraulic conductivity, storage and recharge parameters included in the model as refined during the calibration procedure are presented in **Table 6-2**. Values of hydraulic conductivity are slightly lower than those indicated by pumping tests carried out in the Walloon Coal Measures as part of the revised Project EIS suggesting that on a regional scale the Walloon Coal Measures form a less significant aquifer than available individual bore tests might suggest. Similarly, the Marburg Sandstone hydraulic conductivity included in the model is higher than indicated by pumping tests associated with the Stage 2 Project EIS, suggesting the Marburg Sandstone forms a more prolific regional aquifer than available individual bore tests suggest. Parameter values included in the model provide a reasonable level of calibration and are consistent with observations from the mine and from the general recognition that the Marburg Sandstone is an important regional aquifer while the Walloon Coal Measures does not yield substantial quantities of water.

Table 6-2 Calibrated Model Parameters

Unit	Kx (m/d)	Kz (m/d)	Sy	Ss (/m)	Recharge (% of rainfall)
Myall Creek Alluvials	10	0.1	0.01	n/a	7.0
Oakey Creek Alluvials	10	0.1	0.01	n/a	7.0
Tertiary Basalt	3.0	0.004	0.007	5.0e-6	7.0
Walloon Coal Measures	0.5	0.0003	0.002	5.0e-6	0.1
Lower Walloon Coal Measures	0.2	0.0001	0.0004	5.0e-6	NA
Marburg Sandstone	1.0	0.0003	0.0004	5.0e-6	1.6

6.1.2 Effects on Groundwater Levels During Mining

Groundwater discharge into the revised Project mine pits will lead to a localised depression or drawdown of the groundwater levels in the Walloon Coal Measures aquifer within the vicinity of the revised Project site. This drawdown in the Walloon Coal Measures may in turn cause drawdown in adjacent aquifers. The calibrated numerical model was used to estimate groundwater level drawdown in aquifers that might be affected by the revised Project.

The groundwater predictive modelling assumes a mine progression according to the revised Project's mining schedule. Mining generally progresses in a southerly direction away from the current Mine area and ceases at the end of 2029. A series of Modflow Drain cells were assigned to the model to simulate the removal of water flowing into the mining pit throughout the life of the revised Project. These cells are activated and de-activated in a manner that replicates the mining schedule, where activation represents pit dewatering and deactivation represents backfilling of pits. The drain elevations have been set to the base of the planned mining pits as determined from revised Project mine planning information.

For the predictive modelling, rainfall and evapotranspiration parameters were assigned the long term average rates from available climate stations within the model domain. Extraction rates from Mine water supply bores were set equivalent to those rates recorded during 2012.

The predicted groundwater inflows to the revised Project's mining pits are shown in **Figure 6-4**. Inflows are expected to peak immediately prior to the completion of the mining phase (2030) at approximately 1,480 ML/year (4 ML/day), which will be spread variably across the three operational pits. The general increase in groundwater inflows to the revised Project's mining pits over the duration of the revised Project is a result of mining depths generally becoming greater as the revised Project progresses, especially in the Willaroo Pit.

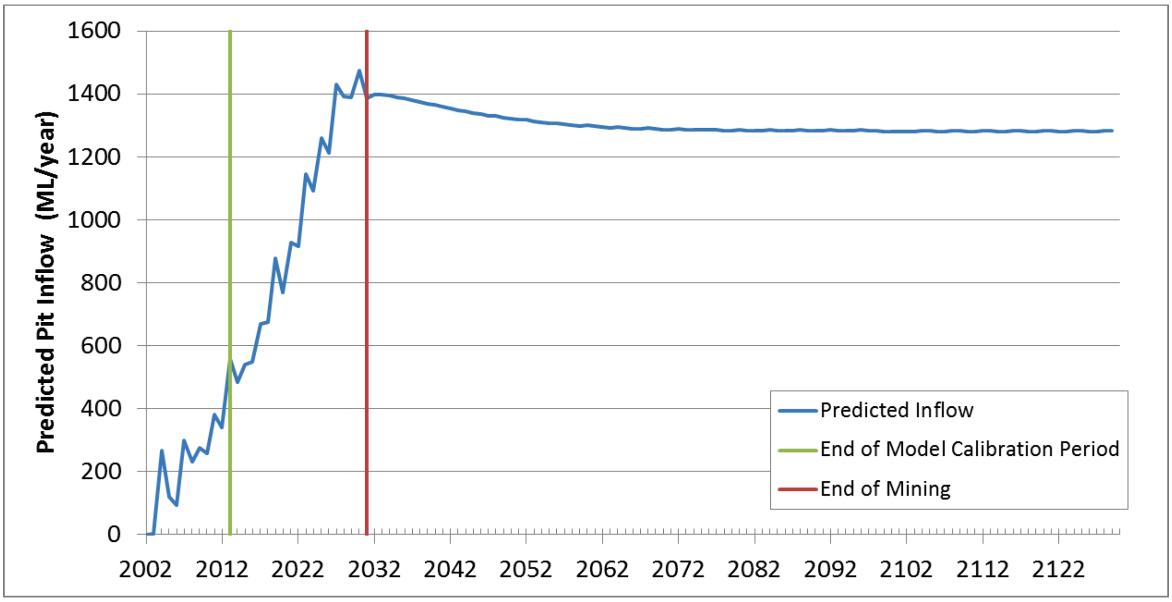
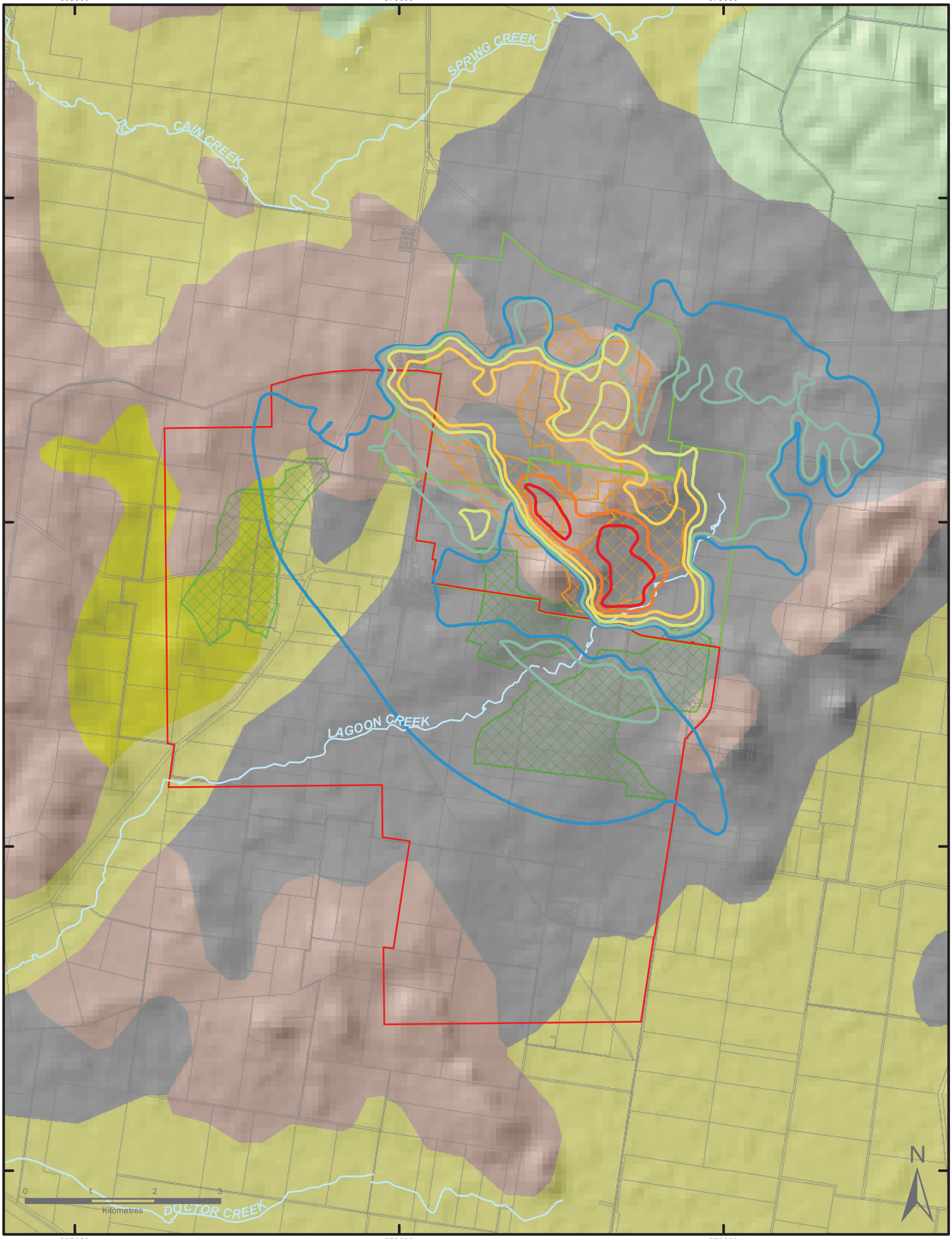


Figure 6-4 Predicted Inflow to revised Project Pits

Predicted groundwater level drawdown in the Tertiary Basalt and Walloon Coal Measures aquifers, arising from predicted revised Project pit inflows, are presented for selected years in **Figure 6-5** through **Figure 6-8**. The results indicate that groundwater drawdowns of greater than 5 m only extend more than around 3 km from the boundary of the revised Project site. The greatest drawdown is expected to occur at the end of mining (2030) in association with the Manning Vale West Pit reaching its greatest depth. Groundwater drawdown expansion away from the revised Project site occurs to a limited degree to the west and southwest, consistent with a thickening of the higher permeability Tertiary Basalt in this area.

At all times the drawdown in the Marburg Sandstone is predicted as being less than 3 m. **Figure 6-9** illustrates the predicted drawdown in the Marburg Sandstone at 2030, and shows that drawdown greater than 2 m is largely restricted to the revised Project lease area, with the 1 m predicted drawdown contour extending up to around 5 km from the site boundary to the west.

The impact of predicted groundwater drawdown associated with the revised Project mining activities on the alluvium of Oakey and Myall Creeks (including their tributaries of Doctors, Lagoon and Spring Creeks) is best represented by the predicted change in flows in the Oakey and Myall Creeks as shown in **Figure 6-10**. These indicate a maximum predicted loss of flow of around 0.35 and 0.2 ML/d for Oakey and Myall Creeks, respectively. Stream flow gauging data is not available for Myall Creek. However, DNRM data for Oakey Creek at Fairview (~37 km west of the revised Project site and the nearest downstream station from the revised Project site and confluence of Lagoon and Oakey creeks) indicate that the 10, 50 and 90th percentile stream flow values are approximately 82, 10.5 and 0 ML/day respectively, with cease to flow occurrences of approximately 19% of the time.



LEGEND

Predicted Drawdown Contour (m)

- 1
- 2
- 5
- 10
- 20
- 30

- Watercourse
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Cadastre
- Stage 3 Pit Areas
- Existing Permission

Dominant Geology

- Basalt (Tm)
- Alluvium (Qa)
- Colluvium (TQs)
- Walloon Subgroup (Jw)
- Marburg Sandstone (Jbm)

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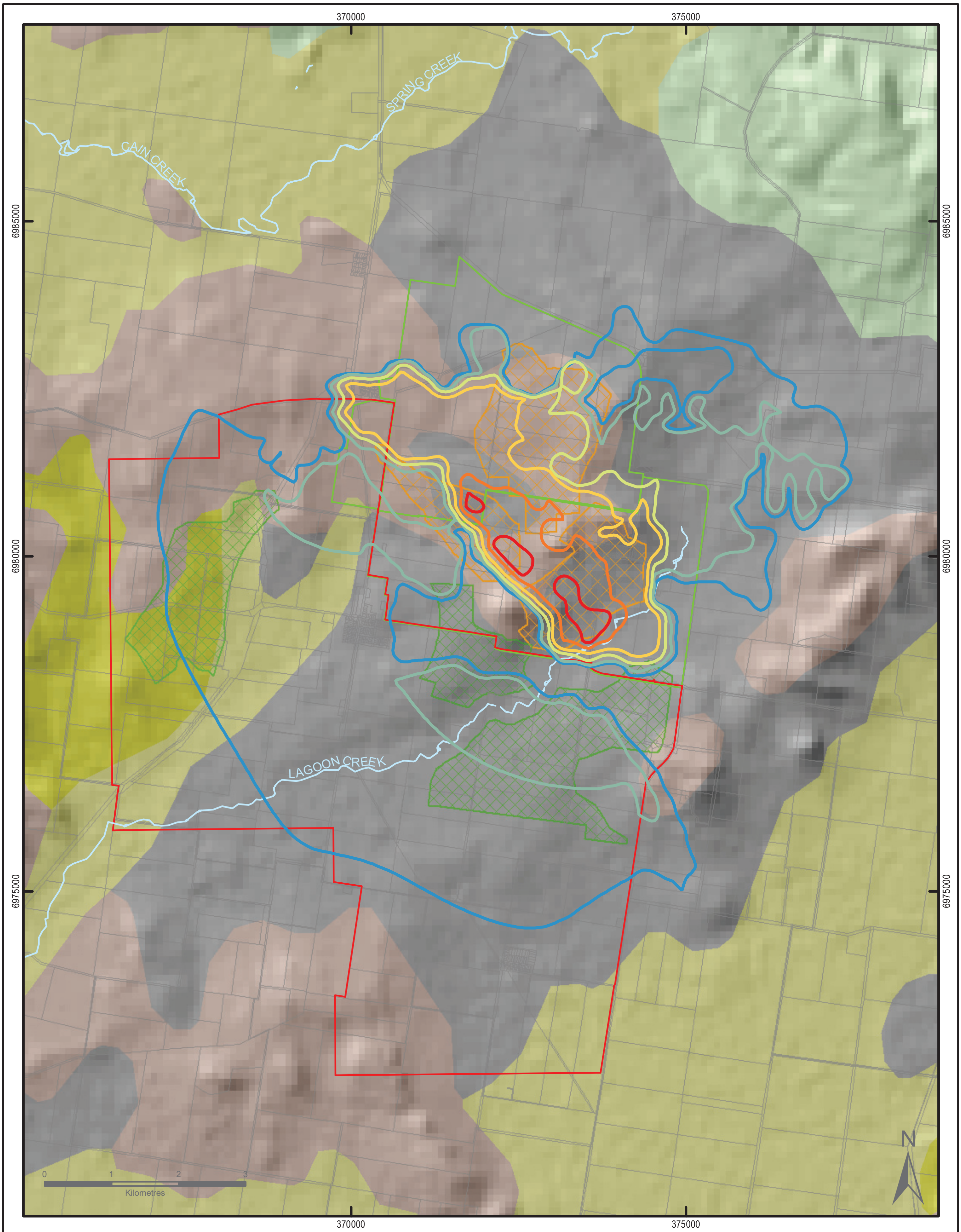
Figure 6-5 - Predicted Drawdown in the Walloon Coal Measures & Tertiary Basalt 2015

Scale 1:80,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

Produced: 29/08/2013 Path: I:\QENV2\Projects\QE06644\Spatial\ArcGIS\01_Figures\01_SEIS\IESC_Submission\130828_NewHope_IESC_Figure6-5_PredictedDrawdownInTheWalloonCoalMeasures_2015.mxd



LEGEND

Predicted Drawdown Contour (m)

- 1
- 2
- 5
- 10
- 20
- 30

- Watercourse
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Cadastre
- Stage 3 Pit Areas
- Existing Permission

Dominant Geology

- Basalt (Tm)
- Alluvium (Qa)
- Colluvium (TQs)
- Walloon Subgroup (Jw)
- Marburg Sandstone (Jbm)

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Figure 6-6 - Predicted Drawdown in the Walloon Coal Measures & Tertiary Basalt 2017

Scale 1:75,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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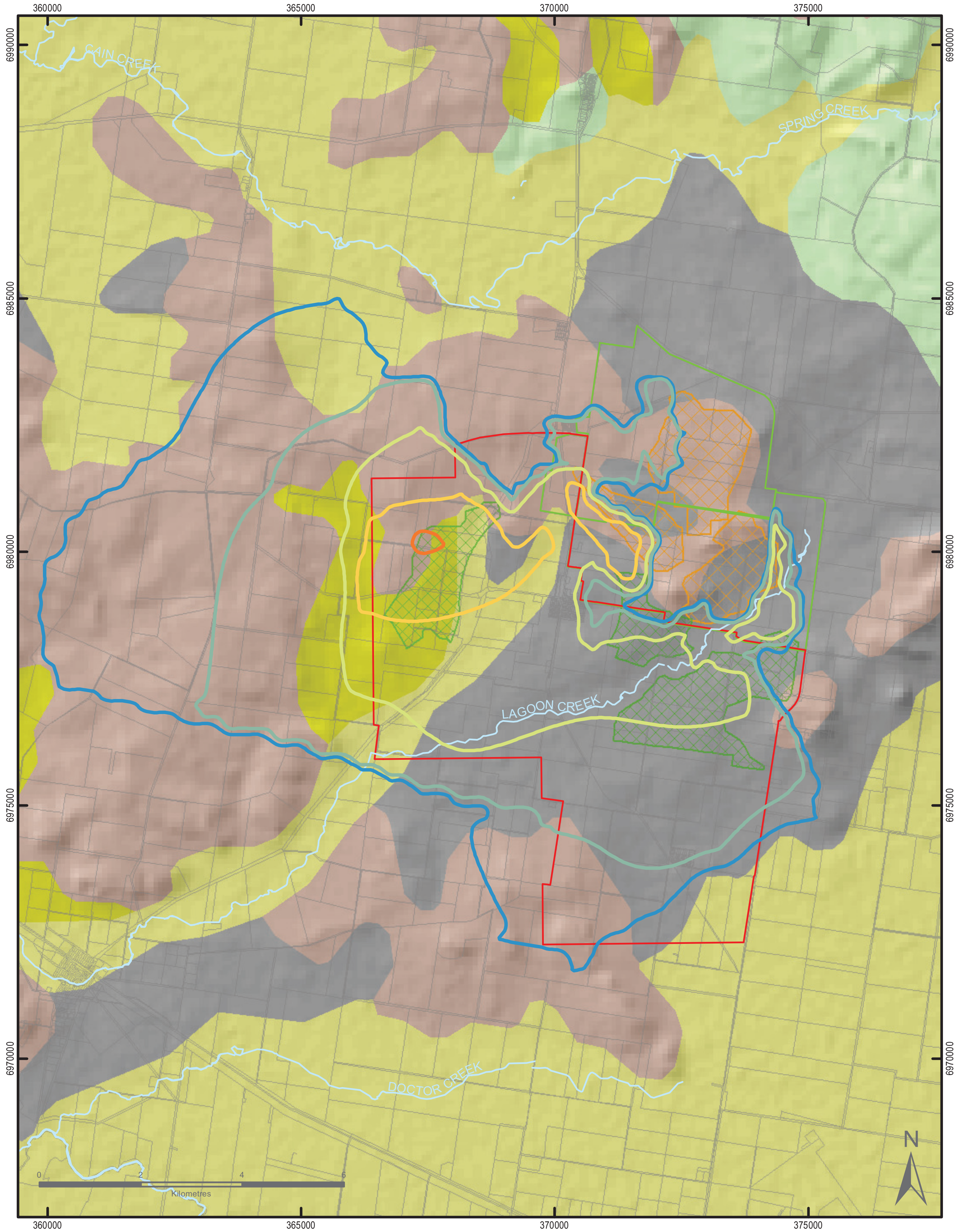

LEGEND

Predicted Drawdown Contour (m)

- 1
- 2
- 5
- 10
- 20
- 30

- Watercourse
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Cadastre
- Stage 3 Pit Areas
- Existing Permission

Dominant Geology

- Basalt (Tm)
- Alluvium (Qa)
- Colluvium (TQs)
- Walloon Subgroup (Jw)
- Marburg Sandstone (Jbm)

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Figure 6-7 - Predicted Drawdown in the Walloon Coal Measures & Tertiary Basalt 2021

Scale 1:100,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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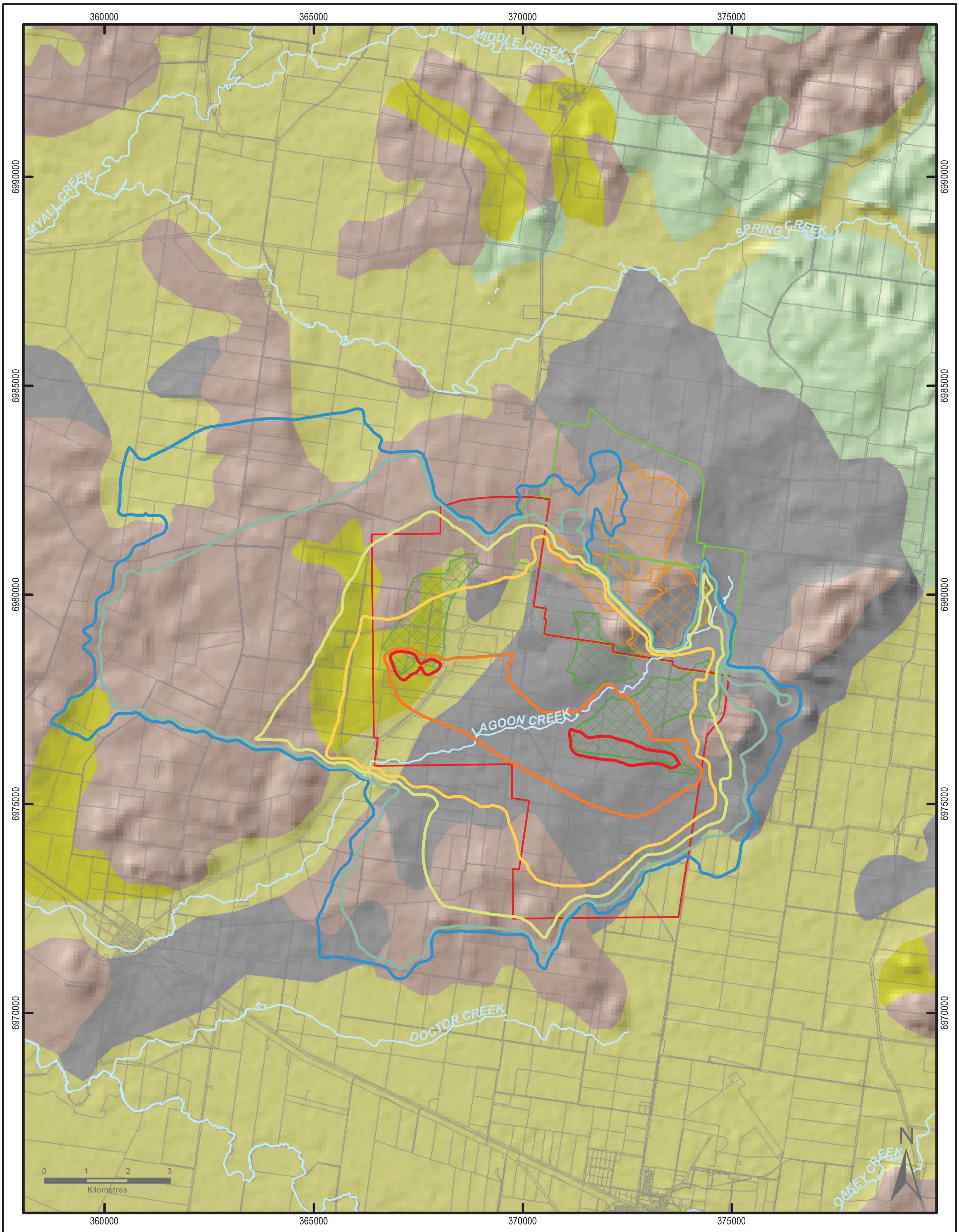
Produced: 29/08/2013



LEGEND

Predicted Drawdown Contour (m)
- 1
- 2
- 5
- 10
- 20
- 30

- Watercourse
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Cadastre
- Stage 3 Pit Areas
- Existing Permission

Dominant Geology
- Basalt (Tm)
- Alluvium (Qa)
- Colluvium (TQs)
- Walloon Subgroup (Jw)
- Marburg Sandstone (Jbm)

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Figure 6-8 - Predicted Drawdown in the Walloon Coal Measures & Tertiary Basalt 2030 (End of Mining)

Scale 1:120,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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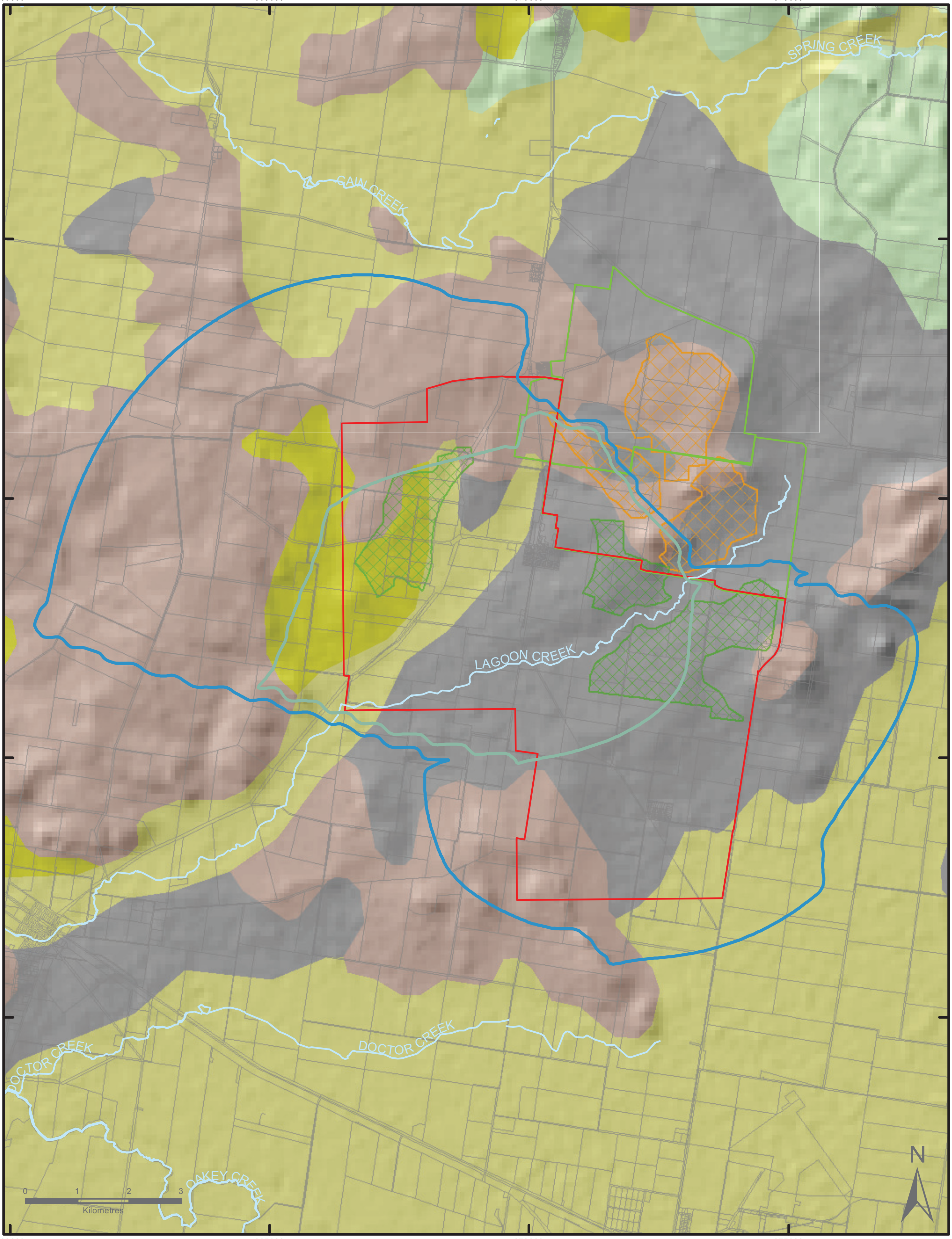
Produced: 29/08/2013



LEGEND

Predicted Drawdown Contour (m)
- 1
- 2
- 5
- 10
- 20
- 30

- Watercourse
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Cadastre
- Stage 3 Pit Areas
- Existing Permission

Dominant Geology
- Basalt (Tm)
- Alluvium (Qa)
- Colluvium (TQs)
- Walloon Subgroup (Jw)
- Marburg Sandstone (Jbm)

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Figure 6-9 - Predicted Drawdown in the Marburg Sandstone - 2030 (End of Mining)

Scale 1:100,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

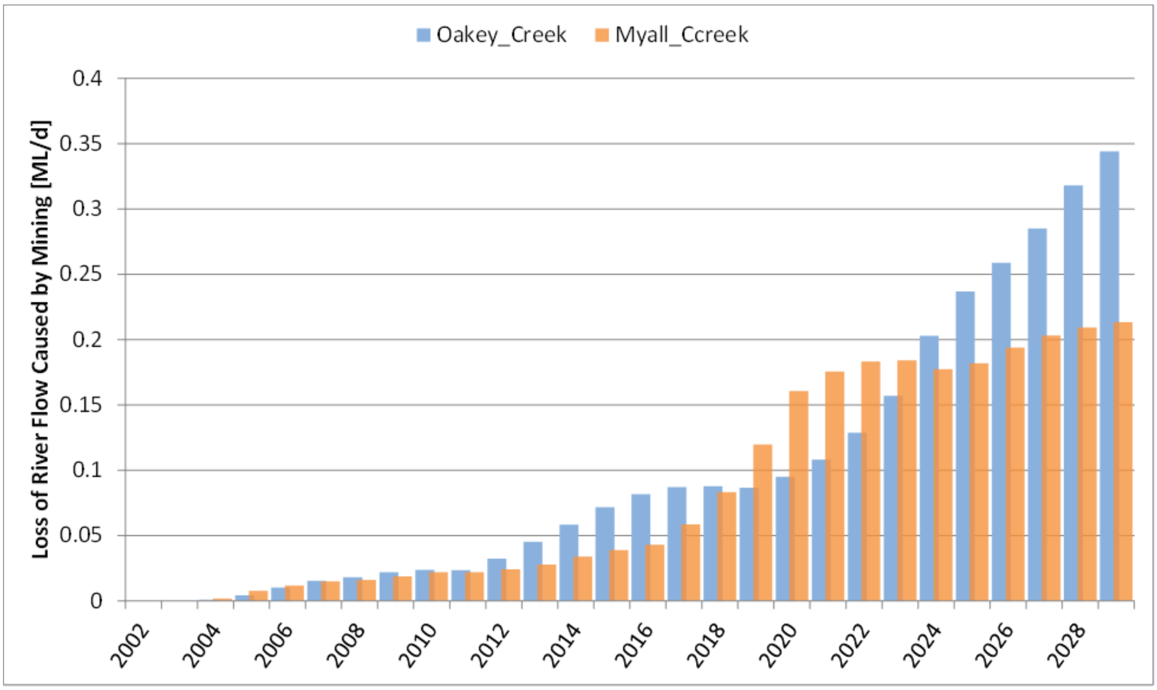


Figure 6-10 Predicted loss of stream flow in Myall and Oakey Creeks

Figure 6-11 presents flow duration curves for Oakey Creek at Fairview at various stages of mining, incorporating surface water releases from the revised Project to Lagoon Creek from 2020 onwards as described in **Section 7.5**. As shown, the predicted reduction in stream flow is in the order of 0.1 ML/day, corresponding to a 2% increase in the number of cease to flow occurrences and a 2% reduction in the 50% percentile flow volume at the end of mining. These small reductions in stream flow are considered to be within the groundwater model's range of error.

Lagoon Creek is not included in the groundwater model as investigations have shown the ephemeral creek to be disconnected from the regional groundwater system with only very minor occurrence of alluvium as described in **Section 3.13**.

6.1.3 Effects on Groundwater Levels Post Mining

The numerical model was used to predict groundwater level recovery post-closure. This component of the modelling requires representation of the final long-term depressed landforms (rehabilitated final voids) that will exist post-closure and will form long-term evaporative groundwater sinks.

In the model, the depressed landforms (rehabilitated final voids) were represented as regions of high hydraulic conductivity and storage for the simulation of a depressed landform in which water can accumulate. Rainfall and evaporation were assumed to be active on the depressed landforms (rehabilitated final voids) and these climatic stresses determine where the final water level will recover to in each of the three depressed landforms (rehabilitated final voids).

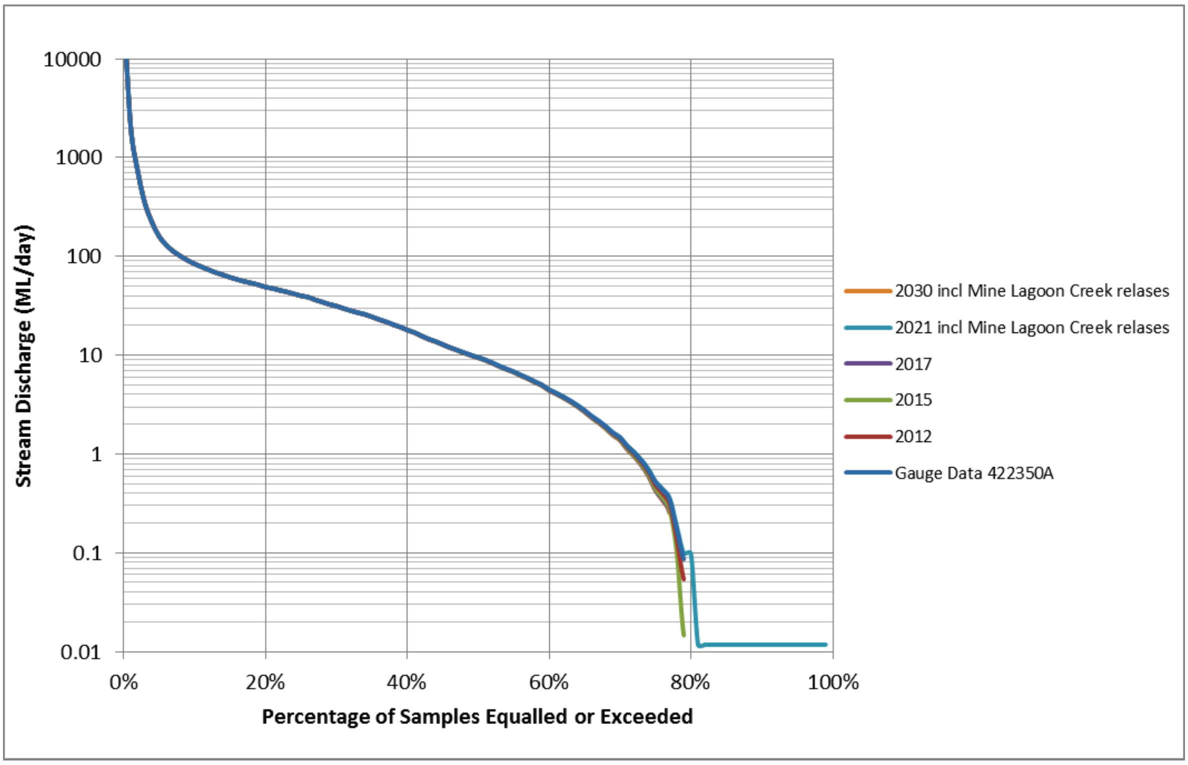
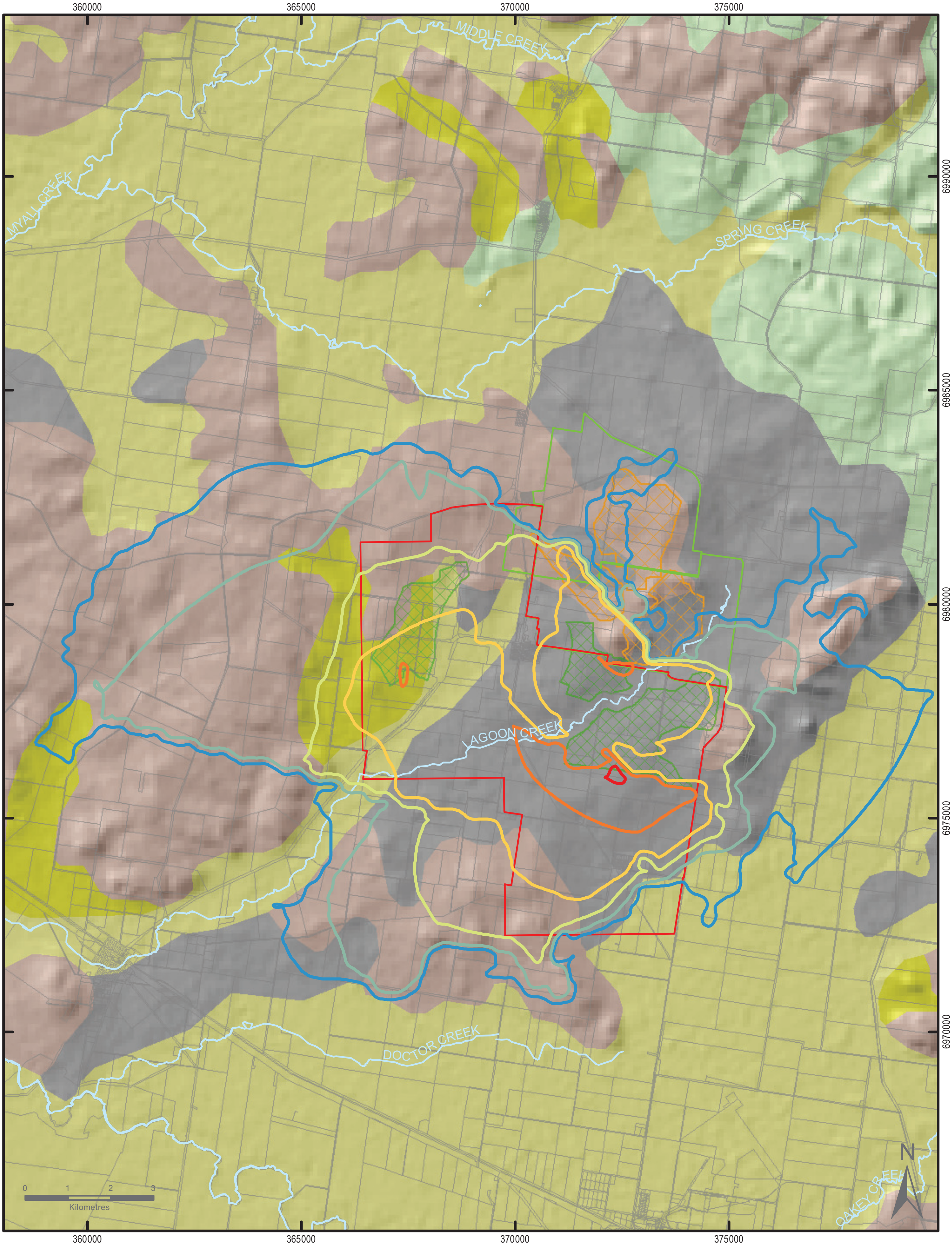


Figure 6-11 Stream flow duration curve - Oakey Creek at Fairview

After cessation of mining in 2030, groundwater levels are predicted to gradually recover so that for the most part there is less than 5 m residual drawdown outside the revised Project's boundary as depicted in **Figure 6-12** and **Figure 6-13**. Recovery to pre-mining conditions throughout the revised Project site is limited by evapotranspirative losses from the depressed landforms (rehabilitated final voids). Drawdown adjacent the last areas to be mined is predicted to remain relatively high (approximately 20 to 30 m) due to the ongoing evapotranspiration-driven groundwater discharge into the depressed landforms (rehabilitated final voids). The 1 m drawdown extent is predicted to remain at approximately 7 km from the revised Project boundary at its greatest (western) extent. Although recovery to pre-mining groundwater levels does not occur post-mining, the groundwater system recovers to a new steady-state equilibrium such that there are no additional groundwater impacts other than those that have already occurred during operation of the revised Project.

The amount of groundwater discharge into the depressed landforms (rehabilitated final voids) after mining was completed would normally be expected to decline as groundwater gradually fills the depressed landforms (rehabilitated final voids) to form permanent pit lakes. However, with a potential annual evapotranspiration rate listed by the BOM of around 1,500 mm in the revised Project site and a total depressed landform area below the pre-mining water table of 1.6 km^2, the volume of water lost from these landforms due to evaporation is potentially as high as 2,400 ML/yr.



LEGEND

Contours - 50years Post Closure

- 1
- 2
- 5
- 10
- 20
- 30

- Watercourse
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Cadastre
- Stage 3 Pit Areas
- Existing Permission

Dominant Geology

- Basalt (Tm)
- Alluvium (Qa)
- Colluvium (TQs)
- Walloon Subgroup (Jw)
- Marburg Sandstone (Jbm)

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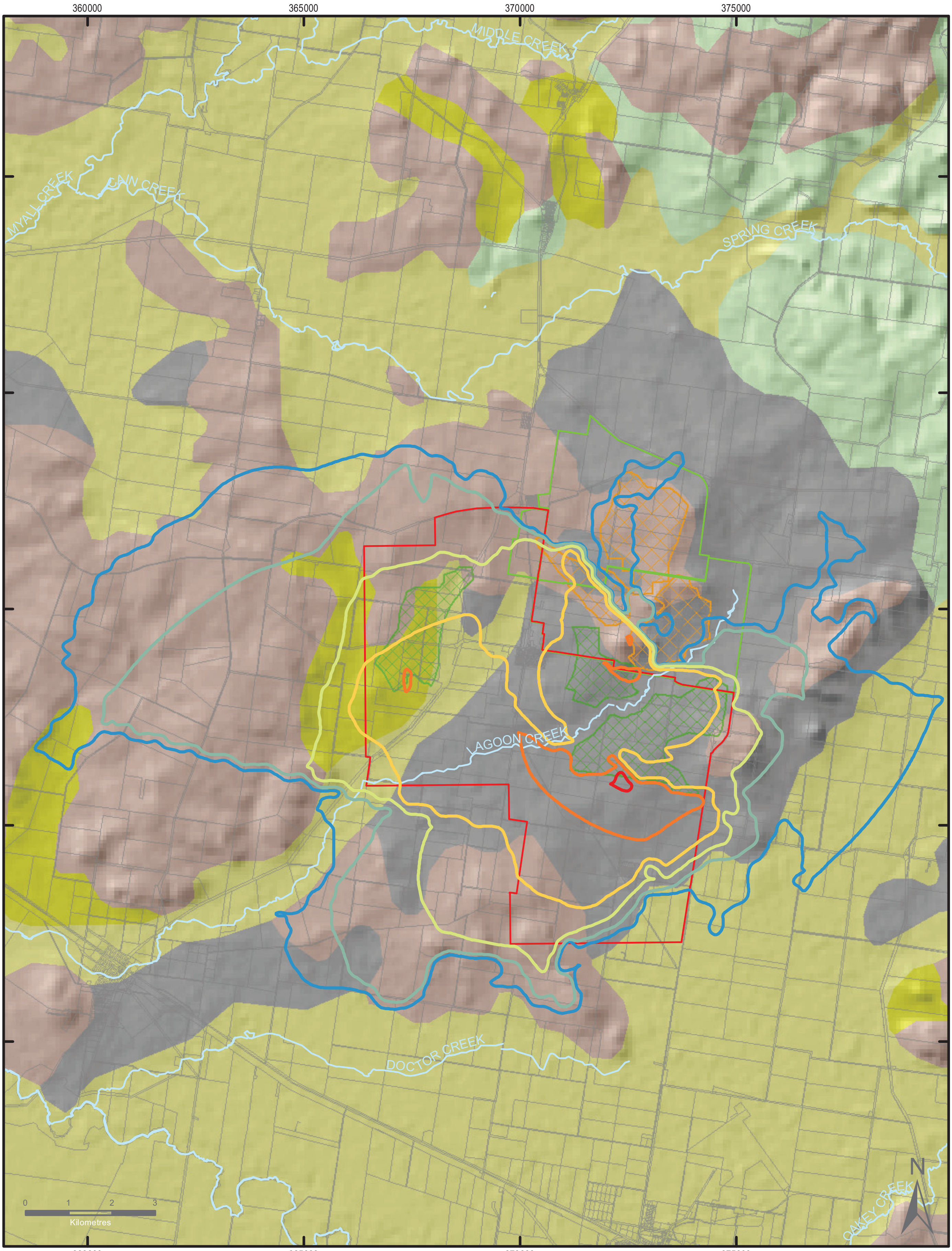
Figure 6-12 - Predicted Drawdown in the Walloon Coal Measures & Tertiary Basalt 50 years after Cessation of Mining

Scale 1:120,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

Produced: 29/08/2013 Path: I:\QENV2\Projects\QE06644\Spatial\ArcGIS\01_Figures\01_SEIS\IESC_Submission\130828_NewHope_IESC_Figure6-12_PredictedDrawdownInTheWalloonCoalMeasures_50years.mxd



LEGEND

Contours - 100years Post Closure

- 1
- 2
- 5
- 10
- 20
- 30

- Watercourse
- New Aland Coal Mine-Stage 3
- New Acland Coal Mine
- Cadastre
- Stage 3 Pit Areas
- Existing Permission

Dominant Geology

- Basalt (Tm)
- Alluvium (Qa)
- Colluvium (TQs)
- Walloon Subgroup (Jw)
- Marburg Sandstone (Jbm)

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NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 6-13 - Predicted Drawdown in the Walloon Coal Measures & Tertiary Basalt 100 years after the Cessation of Mining

Scale 1:120,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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Produced: 29/08/2013

This potential evapotranspiration rate is well in excess of the predicted inflows to the voids post-mining of approximately 1,300 ML/year as shown in **Figure 6-4**. Due to the high evapotranspiration rate, groundwater discharge to the depressed landforms (rehabilitated final voids) is predicted continue at a rate only slightly less (3.5 ML/day) to that in the last year of mine operation, and the water levels within the depressed landforms (rehabilitated final voids) only partially recover towards pre-mining groundwater levels, with around 30 to 40 m long term residual drawdown within the depressed landforms (rehabilitated final voids) as shown in **Figure 6-14**.

A permanent lake is only predicted to form in the Manning Vale West depressed landform (rehabilitated final void) (**Figure 6-14)**. Recovery of groundwater levels in this area is relatively rapid for the first few years post-mining. Formation of a lake within the Manning Vale East depressed landform (rehabilitated final void) is not predicted to occur, and formation of a lake within the Willeroo depressed landform (rehabilitated final void) is only predicted to occur to a minor extent (<4 m depth) for the deepest part of the landform. As such, formation of a lake in the southern depressed landform may be intermittent, driven by climatic water fluxes.

As a dynamic system, the quantity of water remaining in the depressed landforms (rehabilitated final voids) will be influenced over time by factors such as climate (e.g. ambient temperature and humidity profiles, rainfall patterns, and wind conditions), the type of vegetation present and the amount of overland flow directed to the depressed landforms (rehabilitated final voids). Nevertheless, evaporative loss from the depressed landforms (rehabilitated final voids) will remain high in comparison to the sum of the water inputs, especially as overland flow is planned to be diverted away from the depressed landforms (rehabilitated final voids). In addition, the vegetated rehabilitated slopes of the depressed landforms, which will include pasture grass species and possibly selected tree species, will further increase the water loss from the system through evapotranspiration.

6.2 Effects on Groundwater Quality

6.2.1 Effects on Groundwater Quality During Mining

The existing Mine operation has not had a detrimental effect on groundwater quality and therefore, the revised Project is not expected to have a detrimental effect on groundwater quality during mining.

Potential sources of contamination to groundwater may include incidents involving significant fuel or oil spills. In the event of this type of incident occurring, potential effects would be contained on the surface and unlikely to effect on groundwater resources. Depending on their size and volume, smaller oil spills will be treated in-situ and larger spills will be excavated and treated under a temporary land farm arrangement, which will include an impermeable base.

To date, net acid generation resulting in the lowering of pH in water in the Mine pits has not occurred at the Mine and is not expected to occur within the revised Project's new mining areas due to the similar geological nature of the current and new resource areas.

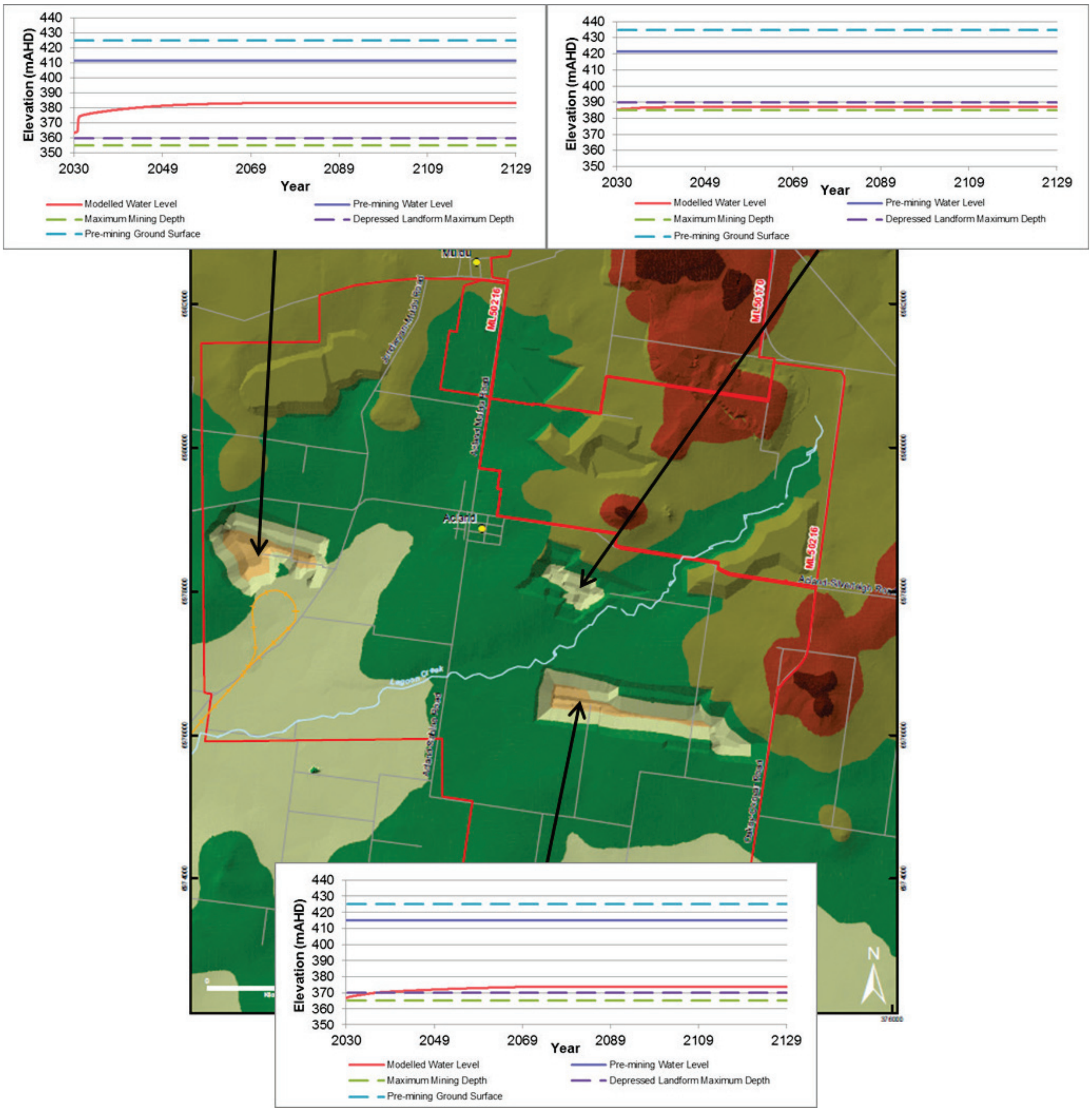

Figure 6-14 Predicted final depressed landform groundwater recovery

The extraction of groundwater within the revised Project site will create a depression in groundwater levels. As a result, groundwater in the Walloon Coal Measures aquifer surrounding the revised Project site will move towards this depression. The surrounding underlying aquifers in the revised projects vicinity will continue to receive recharge via the same processes that occurred prior to the operational phase of the revised Project. Therefore, the groundwater in the vicinity of the revised Project should be of similar quality to its current physico-chemical state.

Due to the confined state of the underlying Marburg Sandstone and Helidon Sandstone aquifers, potential effect to these aquifers is considered negligible. The Tertiary Basalt aquifer is not expected to be affected by the revised Project in terms of groundwater quality.

In summary, the operational phase of the revised Project is not expected to effect on groundwater quality. Groundwater quality will continue to be monitored throughout the life of the revised Project to confirm that potential effects are not occurring.

6.2.2 Effects on Groundwater Quality Post Mining

The depressed landforms (rehabilitated final voids) will potentially collect and accumulate water from:

- groundwater ingress from the Walloon Coal Measures aquifers; and
- incident direct rainfall.

Water quality in the Manning Vale West and potentially the Willeroo depressed landforms (rehabilitated final voids) where pit lakes form will be moderately saline due to inflows of moderately saline groundwater from the Walloon Coal Measures, and any groundwater collected in the depressed landforms (rehabilitated final voids) will be further concentrated by evaporation, but offset by overland runoff into, and direct rainfall on, the pit lakes. Analytical calculations, based on the groundwater and surface water model results for the revised Project, suggest that the increase in salinity of the groundwater collected in the depressed landforms (rehabilitated final voids) resulting from evaporation is limited to a maximum of 25 to 30% of background groundwater salinity (i.e. limited to around 5,000 mg/L compared to background groundwater salinity of approximately 4,000 mg/L) in the long term. Any increase in salinity beyond this is shown to be limited by overland runoff into, and direct rainfall on, the pit lakes.

The depressed landforms (rehabilitated final voids) will act as groundwater sinks and as a result, will not permit pooled water to flow outwards into the regional system. Therefore, any pooled saline water should remain confined within the depressed landforms (rehabilitated final voids) and not have an impact on the water quality of the surrounding aquifers.

There is potential for density driven flow to groundwater in the Walloon Coal Measures aquifer immediately adjacent to the depressed landforms (rehabilitated final voids) due to evaporative concentration of pooled water within the Manning Vale West (and potentially Willeroo) void lake and in the aquifer adjacent the depressed landform (rehabilitated final void). Should this occur, it is likely to be a localised effect immediately around the depressed landform (rehabilitated final void) areas. Although this has the potential to create a density contrast between the groundwater adjacent the depressed landform (rehabilitated final void) and the less saline native groundwater further from the depressed landform (rehabilitated final void), the resulting density difference calculated is not expected to be great enough to overcome the head gradient between the aquifer and the depressed landform (rehabilitated final void), and therefore density driven flow away from the depressed landform (rehabilitated final void) is not expected to occur.

It is unlikely that water captured in the depressed landforms (rehabilitated final voids) will become acidic from oxidation of pyrites in the Walloon Coal Measures because of the neutralising effect of the surrounding sediments which are alkaline by nature.

In summary, the revised Project is not expected to effect on groundwater quality post mining.

6.3 Effects on Groundwater Users

6.3.1 Effects to Groundwater Users During Mining

Based on the predicted groundwater level drawdown in **Section 6.1**, the influence of dewatering on adjacent groundwater users can be estimated. The numerical model predicts that the effect of groundwater drawdown in the Walloon Coal Measures and Tertiary Basalt at the end of the mine life extends to approximately 7 km west and northwest from the Project's boundary, but less than 2 km to the east and south. Properties within 3 km of the western boundary of the revised Project site are predicted to have the greatest effects, with drawdown in the Walloon Coal Measures of between 5 m and 20 m. **Section 9.4** describes proposed mitigation measures associated with affected groundwater users.

Drawdown in the Marburg Sandstone is predicted to be less than 3 m at all times during mining and less than 2 m for most areas outside the revised Project site, and so no effects to groundwater users from this aquifer are expected.

6.3.2 Effects to Groundwater Users Post Mining

After cessation of mining in 2030, groundwater levels are predicted to gradually recover in the first 30 years post-mining so that for the most part there is less than 5 m residual drawdown outside the revised Project's boundary in the long term for both the Walloon Coal Measures and the Tertiary Basalt aquifer. The 1 m drawdown extent is predicted to remain at approximately 7 km from the revised Project boundary at its greatest (western) extent. These small residual drawdowns outside the revised Project site are for the most part not expected to cause long term negative effect on groundwater users outside the revised Project site. **Section 9.4** describes proposed mitigation measures associated with affected groundwater users.

The groundwater quality within bores is not expected to change following the cessation of mining as described in **Section 6.2**.

6.4 Effects on Groundwater Dependent Ecosystems

As previously described, a search of the BoM's GDE Atlas and also published DERM and Regional Ecosystem (2005) mapping data has identified no GDEs reliant on the surface expression of groundwater (such as rivers, springs or wetlands) within 10 km of the revised Project site. The same search has however identified a low to moderate potential for the presence of terrestrial vegetation that is reliant on the occurrence of subsurface groundwater within the revised Project site.

Chapter 7 of the revised Project's EIS describes the revised Project related terrestrial ecosystems in detail and a summary is presented in **Section 5** of this document. A review of the terrestrial ecosystems existing within the vicinity of the revised Project site indicates that the water requirements for these species are likely to be derived from depths less than 10 m below ground level. Given that the depth to the water table in the Walloon Coal Measures aquifer is between approximately 10 m to 50 m below ground level across the revised project site, there are likely to be no GDEs present within the revised Project site.

7 Impact Assessment – Surface Water

7.1 Flow Duration

7.1.1 Lagoon Creek

The Department of Science, Information Technology, Innovation and the Arts (DISITA) are currently developing a daily rainfall runoff model for the upper Condamine catchment using the Sacremento model. The model has been developed to provide a long term historical flow series for the Gowrie Oakey Creek catchment to support the ROP amendment. The model was developed using upstream and downstream gauges and calibrated back to 1922. While this project was not finalised at the time of writing, DISITA have provided the output for the flow apportioned to the Lagoon Creek catchment for use by the revised Project. This flow was apportioned based on the creek catchment area.

The Lagoon Creek flow series provided by the DISITA was used to determine the potential change on the flow regime in Lagoon Creek as a result of the revised Project.

Figure 7-1 illustrates minimal change in the flow exceedance curve for Lagoon Creek as a result of the revised Project. This is not unexpected with the revised Project capturing less than 5 % of the total Lagoon Creek catchment flows at the peak of the mining activities. Furthermore, it is noted that the mine water management system will include a controlled release which will further minimise the impacts of the revised Project on water users in Lagoon Creek.

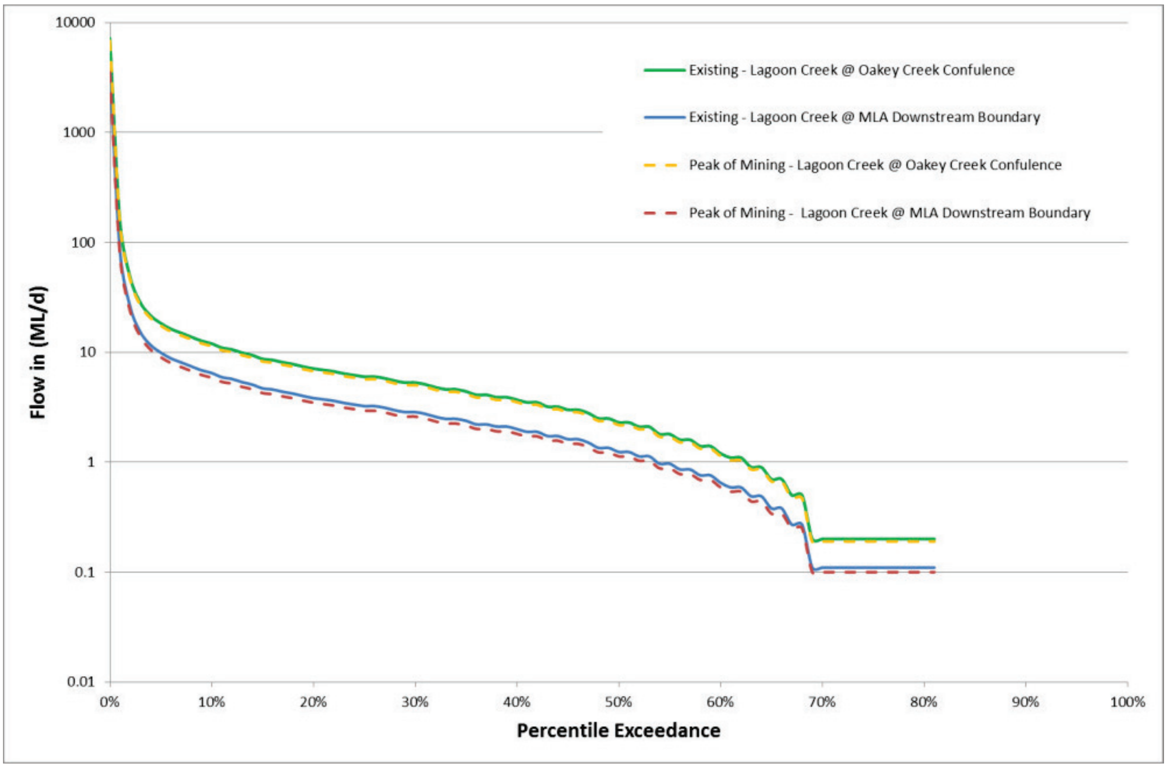

Figure 7-1 Predicted Changes to Lagoon Creek Flow Exceedance

The flow series provided by DISITA was used to assess the potential for impacts to the Lagoon Creek water licence holder. A spells analysis was undertaken over the flow series under the existing conditions and with the revised Project. A spells analysis identifies the number of flow events over a specified threshold, the duration of the event over this threshold and the number of days between events (spells). The spells analysis assists in identifying how access to water under a water harvesting licence may change as a result of a change in the catchment, such as the revised Project.

The Lagoon Creek water harvesting licence conditions permit water harvesting when the passing flow is in excess of 0.1 m^3/s or 8.64 ML/d. Therefore, the spells analysis was undertaken for flows in excess of 8.64 ML/d. Spells were considered independent if the interval between flows was more than 7 days apart. The spells analysis predicted that over the 116 year flow series there were 1103 spells where flow was above the 8.64 ML/d threshold. This is equivalent to 2.60% of the total number of days in the flow series. With the revised Project this reduced to 1073 spells this equates to a 2.53% of the total flow series. This change of 0.07% is considered very small. **Figure 7-2** presents the change in the number of days where flow is above the threshold and the time interval between spells for the 10^{th}, 50^{th} and 90^{th} percentile. **Figure 7-2** illustrates that there is no change to the duration of flow at the 50^{th} percentile and with the duration of flow reduced by only 1 day at the 90^{th} percentile. **Figure 7-2** also illustrates that on average the number of days between flows events will be very similar at 19 days compared to 20 days with less than 5 days difference at the 90^{th} percentile. This change is considered minor and is not considered to materially change the licence holder's access to water.

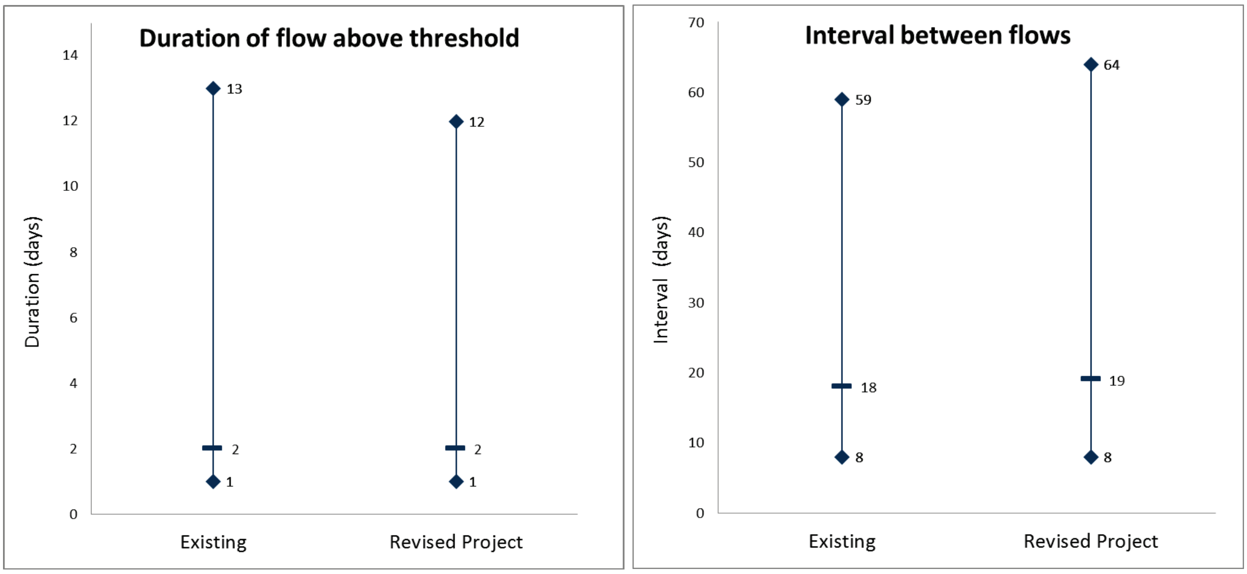

Figure 7-2 Spells analysis for flows above 8.64 ML/d for the $10^{th,}$ 50^{th} and 90^{th} percentile

A spells analysis was also undertaken for flows downstream of the Lagoon and Oakey Creek confluence. The analysis found that there was no change to the average number of flow days a year where flow is in excess of 0.01 m^3/s. It is therefore considered that there will be negligible impacts to water licence holders and stock and domestic users downstream of the revised Project site.

7.1.2 Oakey Creek

Figure 7-2 also illustrates the flow exceedance curve for Lagoon Creek at the confluence with Oakey Creek a result of the revised Project. This again shows minimal change in the flow exceedance as a result of the revised Project. The potential change on the flow regime in Lagoon Creek as a result of the revised Project translates to less than 0.5 % of the total Oakey Creek catchment to Fairview.

7.1.3 Myall Creek

The revised Project site does not lie within the catchment for Myall Creek. As such, no impacts to flow duration in Myall Creek are expected from revised Project activities that might affect surface water drainage. There are no GDEs (including terrestrial vegetation reliant on groundwater to some degree) present within the revised Project site.

7.2 Developed Flooding Characteristics

Flood modelling of the developed conditions for the proposed mining activities was undertaken to determine the flood protection strategy for the revised Project and to assess potential impacts on flooding caused by the revised Project.

7.2.1 Model Area and Terrain Development

Terrain for the developed condition was created from the existing bathymetry, discussed in **Section 4.3.3** Modifications were made to the existing terrain to add the:

- flood levees along the Manningvale East and Willeroo pits; and
- rail spur and balloon loop.

The flood levees were modelled as an infinitely high wall to ensure it provided flood immunity for all modelled cases. No functional elements of the revised Project are proposed to be located between the levee and Lagoon Creek, except for one dedicated creek crossing for coal haulage to the CHPP from the Willeroo resource area.

Maximum flood heights along this wall were extracted to obtain the level of the levee banks. The levee banks will be designed to provide a PMF flood immunity with a 0.5 m freeboard in accordance with NHG's design standards for the existing Stage 2 levee. It is noted that this level of protection is higher than the a 1 in 1,000 AEP flood immunity required by the Manual for *Assessing Hazard Categories and Hydraulic Performance of Dams*, DNRM, February 2012.

The rail spur and balloon loop alignments and track levels were imported into the model bathymetry to replace existing terrain. Where the rail corridor passed through areas of high flow as identified in the existing case model, a 10 m grid cell was left open to simulate flow through a culvert. A table drain will also be constructed on the northern side of the railway corridor within the rail easement between Jondaryan-Muldu Road. This table drain will convey flows from minor drainage paths north of Jondaryan-Muldu Road south to designated crossings under the railway line. These table drains will be designed so that there is no increase to flood levels on the Jondaryan-Muldu Road as a result of the rail corridor.

The flow through the major crossing of Lagoon Creek adjacent to the existing Jondaryan-Muldu Road was simulated through a 60 m wide grid cell opening. This design is relatively consistent with the existing QR railway crossing at Jondaryan which is approximately 58 m wide.

Two additional flow openings of 60 m each were modelled on the floodplain either side of the main railway crossing to provide additional conveyance of floodplain flows. The maximum flood heights along the railway were extracted to obtain the level of the railway. The railway was designed to provide 1 in 100 AEP flood immunity with a 300 mm freeboard. This approach is consistent with Queensland Rail Design Guidelines.

It is noted that the vertical accuracy of the LIDAR is well within the adopted freeboard of both the levee and railway. However detailed ground survey will be undertaken to support the final design of the railway and levee.

The location of these model features incorporated into the hydraulic model are presented in **Figure 7-3**.

7.2.2 Model Parameters

Model parameters including Manning's Roughness, boundary conditions and initial conditions remained consistent with those used in the existing conditions model described in **Section 4.3**.

Flow constriction cells were modelled at each of the openings along the railway corridor. These flow constriction cells simulate the entrance and exit losses associated with cross drainage structures such as culverts and bridge piers.

7.2.3 Flood Impacts

The results of the developed case flood modelling are presented in **Figure 7-5** to **Figure 7-15**. **Figure 7-10** and **Figure 7-11** present the flood depth and velocity afflux for the 1 in 100 AEP flood event.

LEGEND

- Towns and Localities
- Proposed Rail Spur
- Proposed Flood Levee
- Creeks
- Roads
- Cadastre
- Mining Tenements
- Stage 3 Pit Areas
- Hydraulic Model Extent

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Figure 7-3 - Developed Flood Conditions Modelled Infrastructure

Scale 1:69,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

Produced: 29/11/2013 Path: I:\QENV2\Projects\QE06644\Spatial\ArcGIS\01_Figures\01_SEIS\IESC_Submission\131129_NewHope_IESC_Figure7-3_DevelopedFloodCondModelInfrastructure.mxd

Minor increases in flood levels at the location of the flood levee were observed in the order of 0.5 m for the 1 in 1,000 AEP. However, all of these increases are contained within the revised Projects mining lease area. The results indicate only minor changes to flow velocity in the mine area as a result of the flood levees encroaching on the floodplain.

No change in the flood velocity or levels was observed for the 1 in 10 AEP within the revised Project site. This result is because the flood levees are located outside of the 1 in 10 AEP flood extent.

The revised Project's railway crossing of Lagoon Creek results in an increase in flood levels immediately upstream of the railway crossing of up to 1.2 m. However these impacts reduce to zero within 500 m of the railway crossing. The majority of the land impacted by the increased water surface levels is owned by the APC. There is a small parcel of land of approximately 0.5 ha which is likely to be impacted by the revised Project railway crossing, through an increase in water levels of approximately 150 mm over land not previously inundated. This small increase in flooding levels is not expected to affect any existing infrastructure on the affected property. NAC are currently in discussions with this land owner regarding this impact and will seek to reduce this impact to zero through detailed design or through a compensation agreement with the land owner.

There is no increase in the extent of inundation or water surface levels on any properties not owned by NAC. Downstream of the new railway crossing there is a minor decrease in flood levels of approximately 0.2 m, a result of the railway embankment which attenuates the flood peak. This decrease in flood level is accompanied by an increase in peak flow velocity immediately downstream of the railway drainage crossings in the order of 0.5 m/s. This velocity increase increases the peak velocities in this area to 1.5 m/s. However, this increase is completely contained within land owned by the APC. The need for scour protection at the outlet of the culvert crossing will be assessed and incorporated in the revised Projects detailed design.

Minor increases in flood levels for the 1 in 10 AEP flood event were observed upstream of the railway line in the order of 0.3 m. These impacts are completely contained within land owned by APC.

In events greater than a 1 in 100 AEP flood event the railway line will be overtopped by flood waters. This outcome is also demonstrated in the 1 in 1,000 AEP flood event. However, the railway line attenuates the flood peak such that when the railway overtops the increase in flood levels downstream of the railway line is less than the existing 1 in 1,000 AEP flood depths and extent of inundation. It is noted that in a 1 in 1,000 AEP, there is a minor increase in flood levels on an adjacent property upstream of the proposed railway line. This increase is less than 300 mm and is contained to a small area of agricultural land in the order of 0.5 ha. This increase is not considered to increase the flood hazard or development potential for this property. As previously discussed, NAC is currently in discussions with this land owner regarding this impact and will seek to reduce this impact to zero through detailed design or through a compensation agreement with the land owner.

As part of the impact assessment changes to the duration of flooding and flood warning were examined for Jondaryan. **Figure 7-4** illustrates the design flood hydrograph exported from the TUFLOW flood model under existing and developed conditions. **Figure 7-4** illustrates that there is actually a very minor increase in the time prior to the flood peak as a result of the revised Project. This result is due to the attenuation of the flood peak through the railway crossings. It is therefore considered that the revised Project will not have significant impacts on the flood warning in Jondaryan.

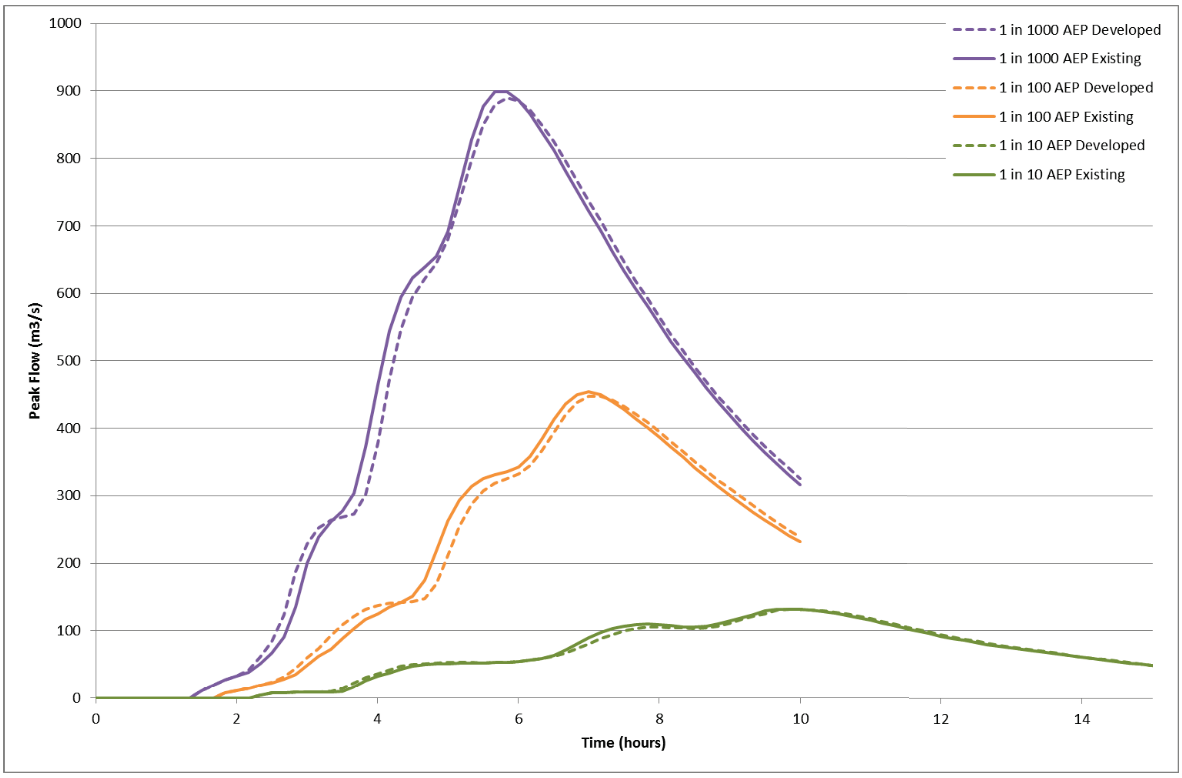
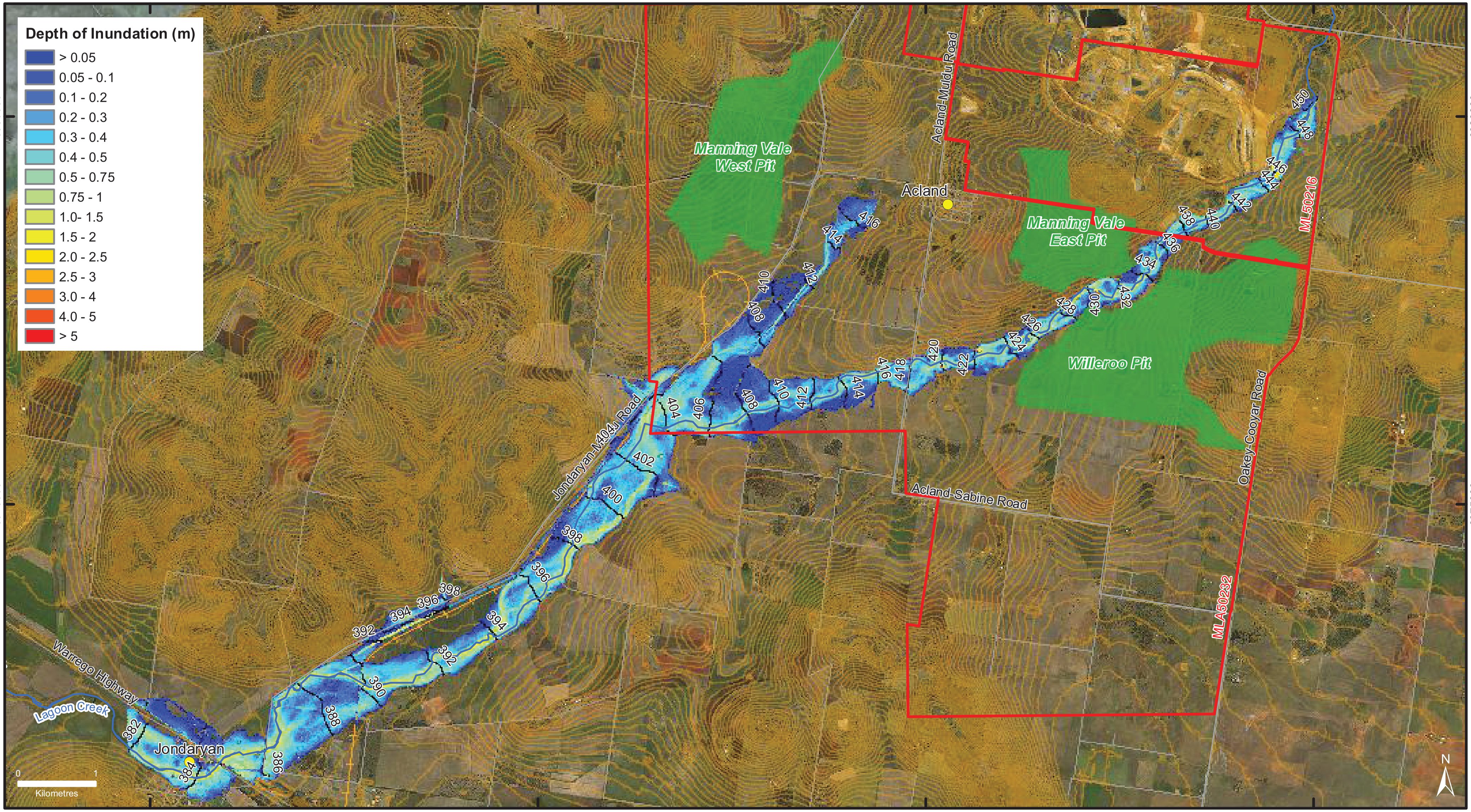


Figure 7-4 Peak Flood Warning Jondaryan

The flood modelling evaluation discussed above is based only on conceptual design parameters. The levee alignment, freeboard, civil and geotechnical design will be revised through the detailed design phase of the revised Project. However, any refinements made during detailed design will not exceed the level of impact detailed in this report.



LEGEND

- Towns and Localities
- Proposed Rail Spur
- Creeks
- Roads
- Water Surface Level (m AHD)
- Topographical Contours (2m interval)
- Mining Tenements
- Stage 3 Pit Areas

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Figure 7-5 - Developed Peak Flood Depth 1 in 10 AEP

Scale 1:69,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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LEGEND
- Towns and Localities
- Proposed Rail Spur
- Creeks
- Roads
- Cadastre
- Hydraulic Model Extent
- Mining Tenements
- Stage 3 Pit Areas

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Figure 7-6 - Afflux 1 in 10 AEP

Scale 1:69,000 on A4
Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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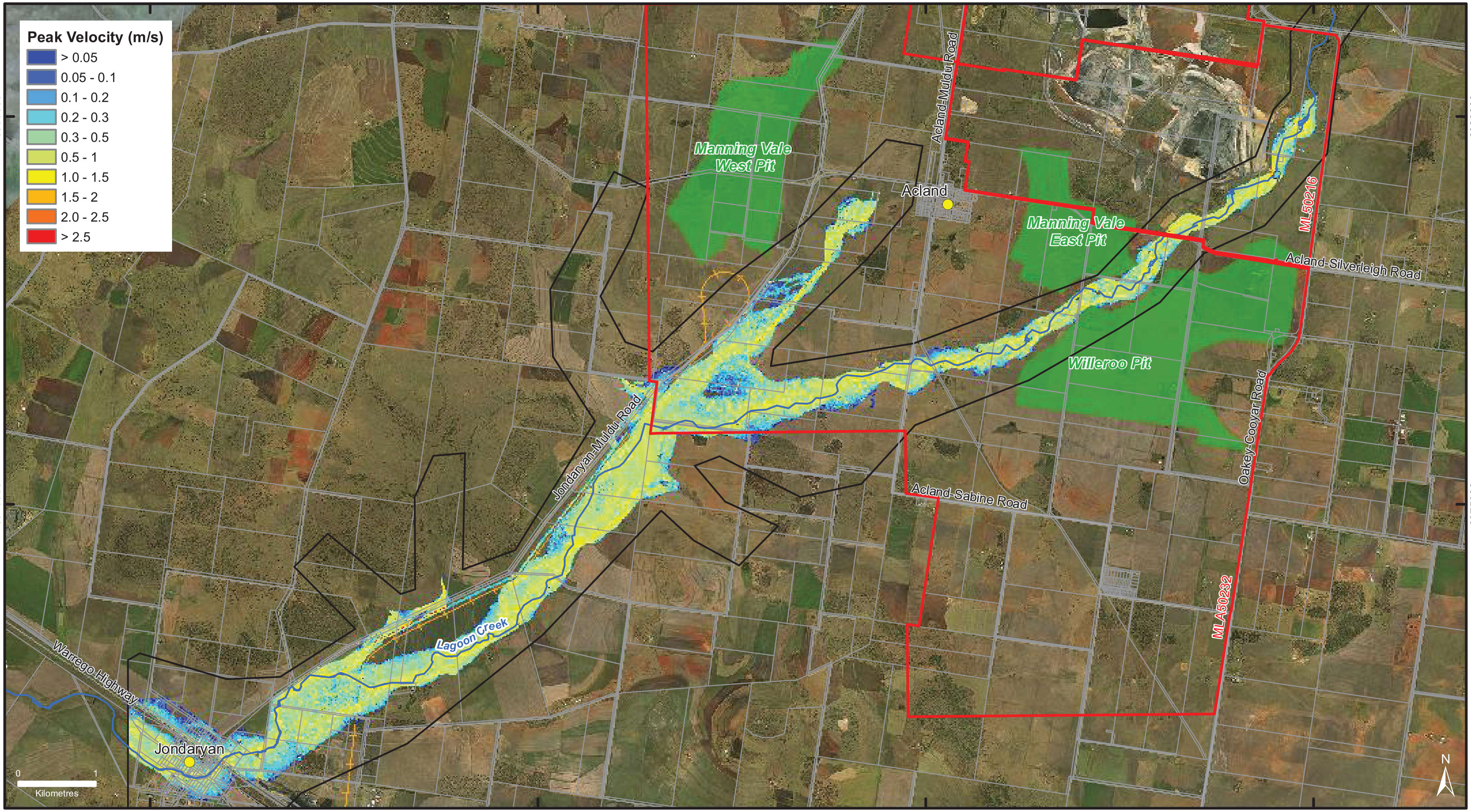

LEGEND

- Towns and Localities
- Proposed Rail Spur
- Creeks
- Roads
- Cadastre
- Mining Tenements
- Stage 3 Pit Areas
- Hydraulic Model Extent

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Figure 7-7 - Developed Peak Flood Velocity 1 in 10 AEP

Scale 1:69,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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Produced: 29/11/2013

LEGEND

- Towns and Localities
- Proposed Rail Spur
- Creeks
- Roads
- Cadastre
- Hydraulic Model Extent
- Mining Tenements
- Stage 3 Pit Areas

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Figure 7-8 - Velocity Afflux 1 in 10 AEP

Scale 1:69,000 on A4
Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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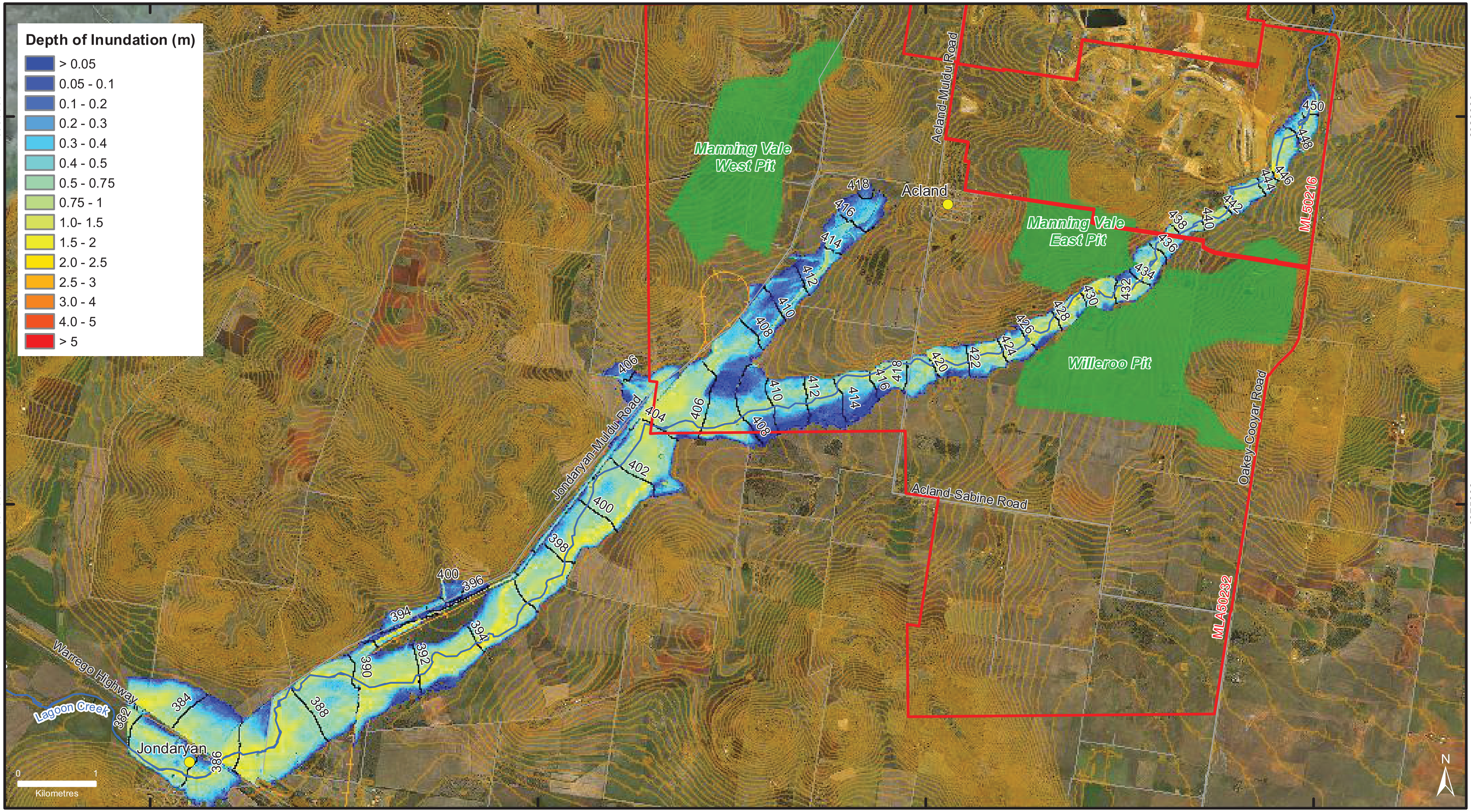

LEGEND

- Towns and Localities
- Proposed Rail Spur
- Creeks
- Roads
- Water Surface Level (m AHD)
- Topographical Contours (2m interval)
- Mining Tenements
- Stage 3 Pit Areas

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NEW ACLAND COAL MINE
STAGE 3 PROJECT

Figure 7-9 - Developed Peak Flood Depth 1 in 100 AEP

Scale 1:69,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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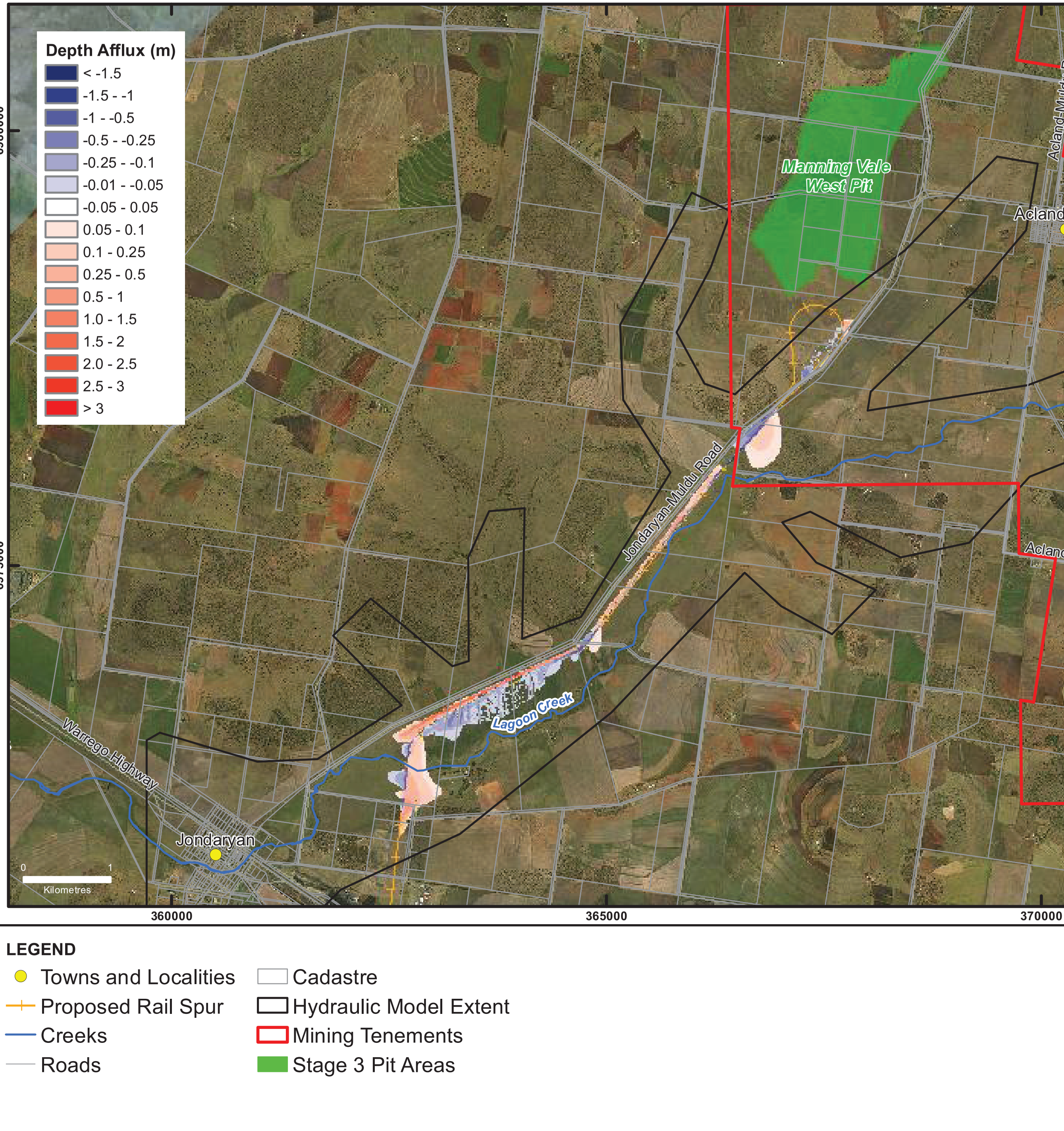

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Figure 7-10 - Afflux 1 in 100 AEP

Scale 1:69,000 on A4
Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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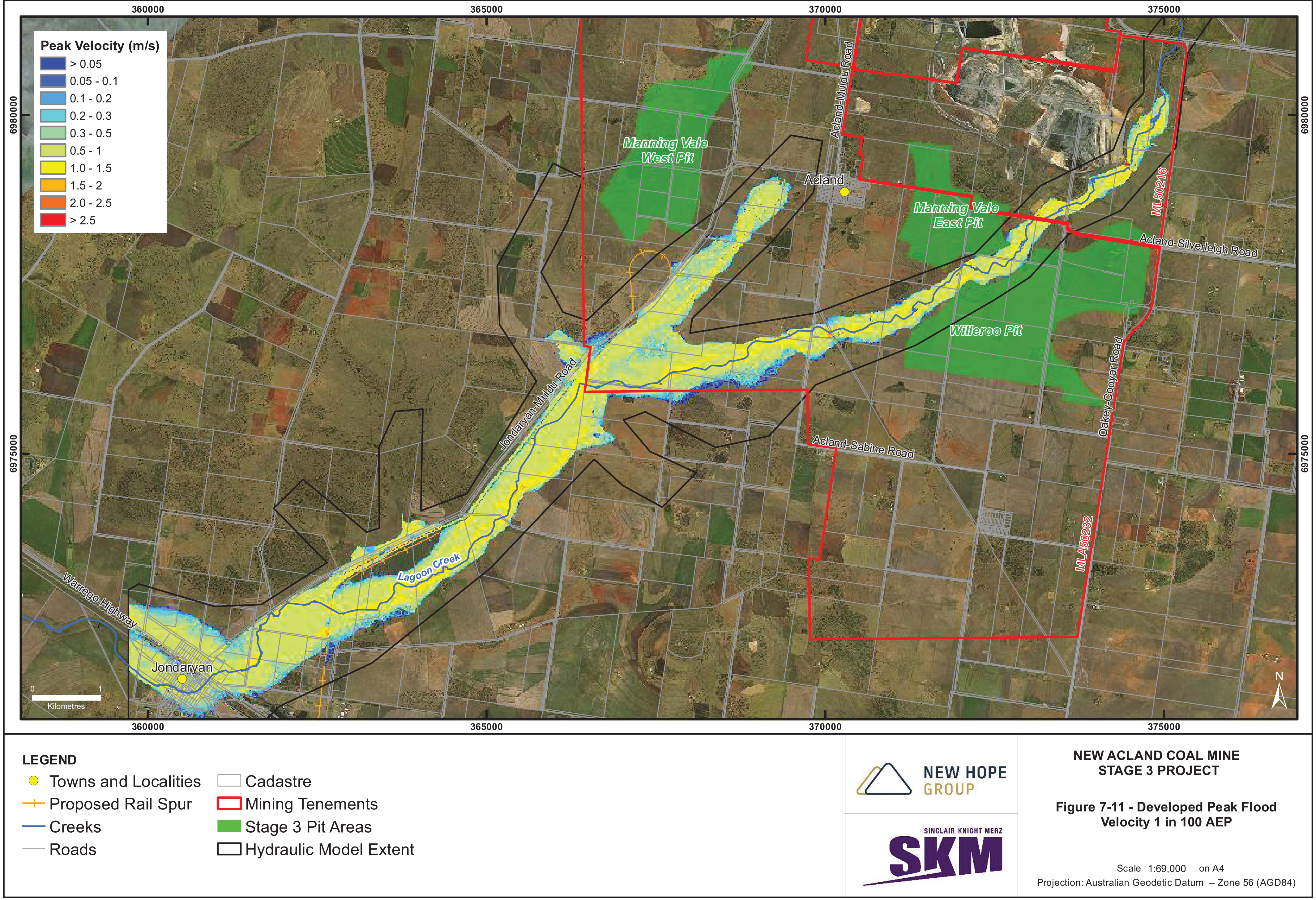

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Figure 7-11 - Developed Peak Flood Velocity 1 in 100 AEP

Scale 1:69,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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LEGEND

Towns and Localities
Proposed Rail Spur
Creeks
Roads
Cadastre
Hydraulic Model Extent
Mining Tenements
Stage 3 Pit Areas

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STAGE 3 PROJECT

Figure 7-12 - Velocity Afflux 1 in 100 AEP

Scale 1:69,000 on A4
Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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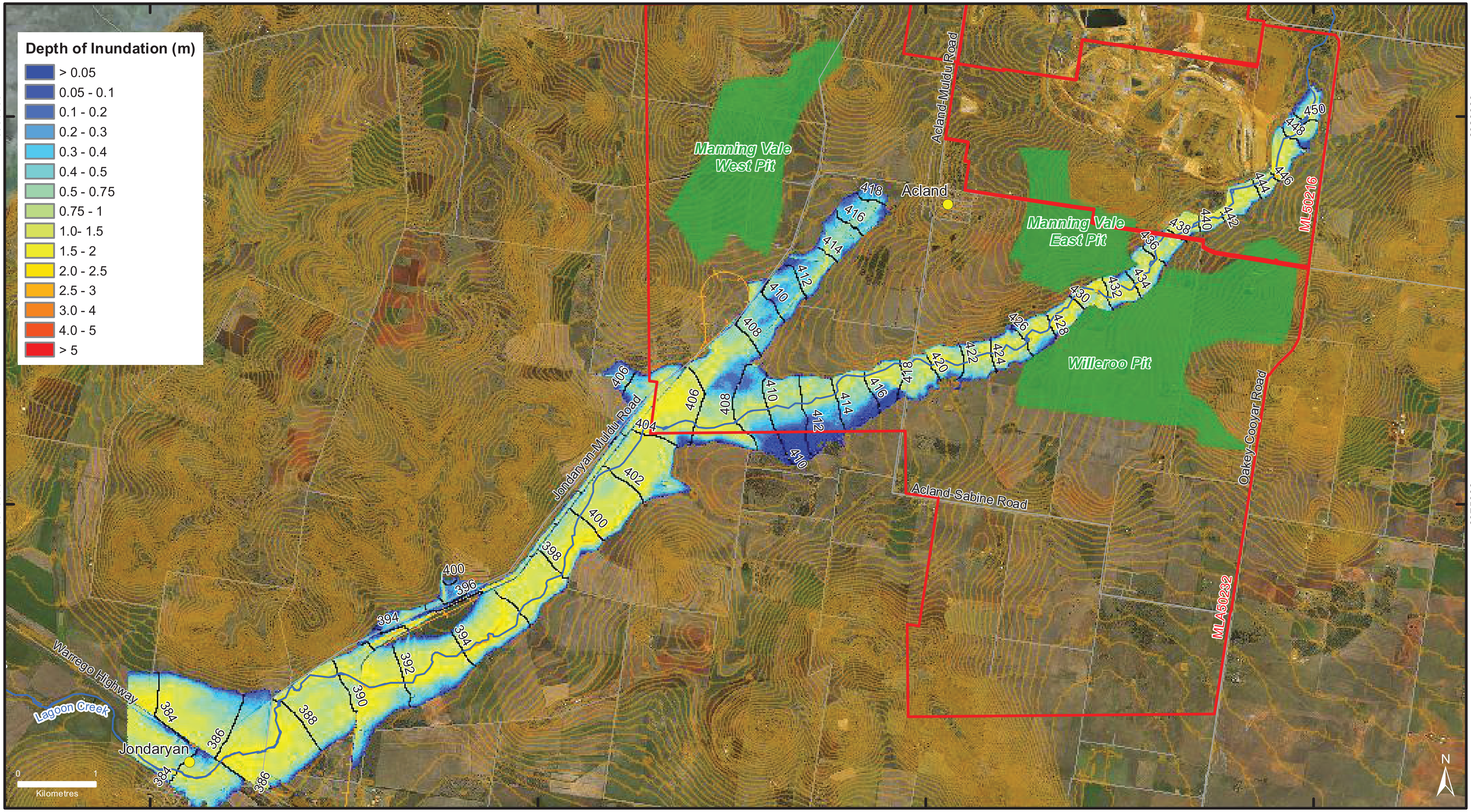

LEGEND

- Towns and Localities
- Proposed Rail Spur
- Creeks
- Roads
- Water Surface Level (m AHD)
- Topographical Contours (2m interval)
- Mining Tenements
- Stage 3 Pit Areas

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Figure 7-13 - Developed Peak Flood Depth 1 in 1000 AEP

Scale 1:69,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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LEGEND

- Towns and Localities
- Proposed Rail Spur
- Creeks
- Roads
- Cadastre
- Hydraulic Model Extent
- Mining Tenements
- Stage 3 Pit Areas

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Figure 7-14 - Afflux 1 in 1000 AEP

Scale 1:69,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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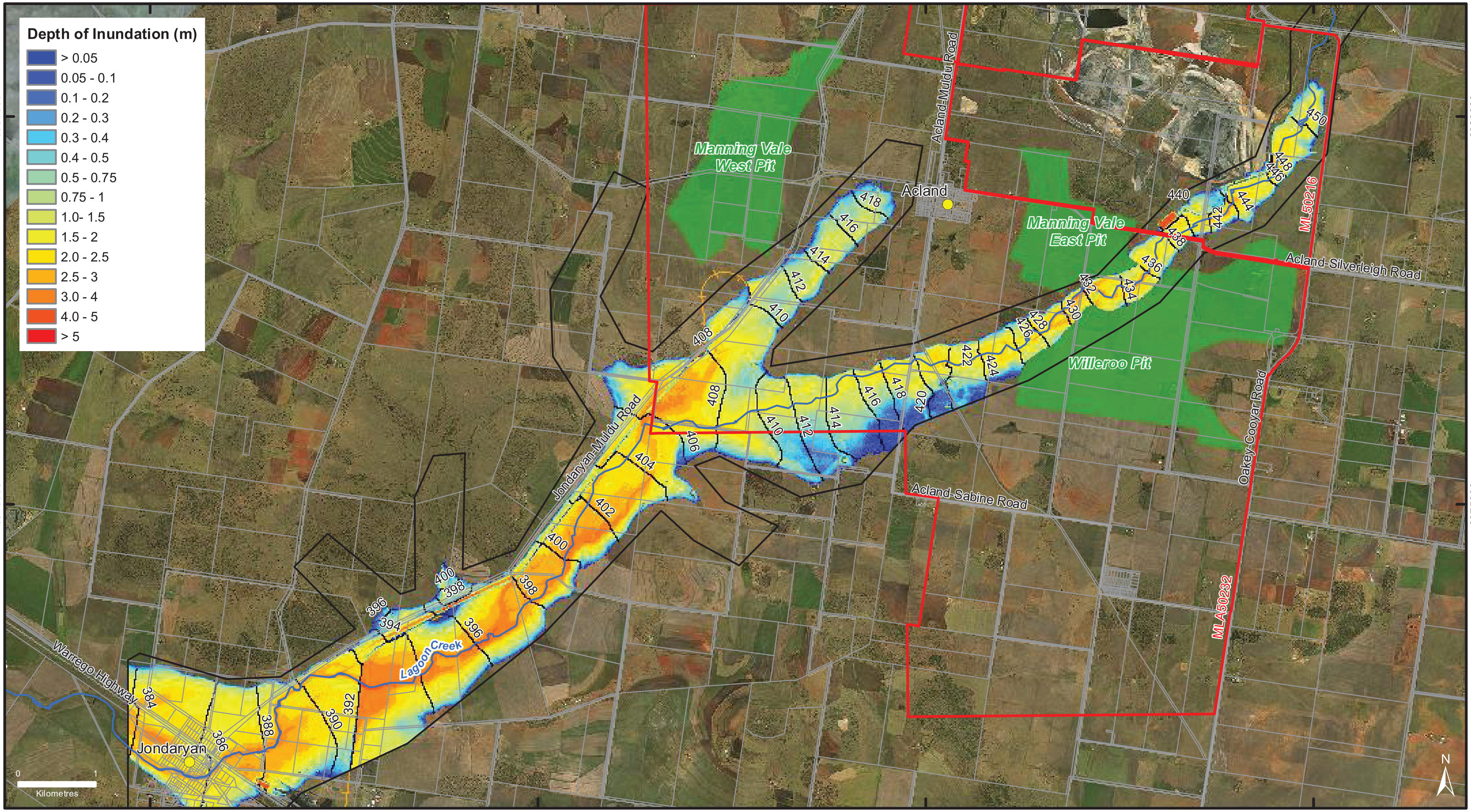

LEGEND

- Towns and Localities
- Proposed Rail Spur
- Creeks
- Roads
- Cadastre
- Mining Tenements
- Stage 3 Pit Areas
- Hydraulic Model Extent

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Figure 7-15 - Developed Peak Depth PMF

Scale 1:69,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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Produced: 29/11/2013

7.3 Water Quality and Geomorphology

The revised Project includes an operational separation distance of approximately 150 m from the banks of Lagoon Creek to the edge of the mining pits, which includes a 50 m buffer adjacent the creek for conservation purposes. This buffer distance is consistent with the requirements of the *Vegetation Management Act 1999*, which protects remnant vegetation growing within 50m of a watercourse. In addition to this (Rutherfurd et. al, 2001) recommends that offsets determined based on:

- a starting width of 5 m; plus
- a width not less than the height of the bank from bank toe to bank crest; plus
- a width equal to amount of bank migration expected to occur in the time it takes for vegetation to establish.

Rutherfurd et. al recommends widths of riparian vegetation are derived based on the 1993 study of contemporary rates of both channel widening and outside bend migration undertaken by Ian Drummond and Associated. This study identifies a maximum vegetation establishment time of 25 years and a bank erosion rate of 1 m/year. Therefore the recommended offset for Lagoon Creek would be in the order of 35 m. This indicates that the 50 m buffer and 150 m offset for Lagoon Creek is well in excess of the current industry standards.

As a result of this offset, there is not expected to be any significant disturbance to Lagoon Creek and subsequent impacts on water quality. The offset has the potential to improve water quality within Lagoon Creek by preserving the creek and its riparian zone from agricultural activities. A proposed extension of the conservation zone along Lagoon Creek from the Mine area to the revised Project site will allow riparian vegetation to re-establish, improving the channel stability and subsequently the water quality and associated environmental values.

The potential impacts of the revised Project on water quality may result from:

- increased sediment load or chemical spillage during construction; and
- a reduction in water quality through controlled or uncontrolled releases from the mine water management system.

The risks associated with releases from the mine water management system are discussed in further detail in **Section 7.5.2** and mitigation measures including soil and erosion control are presented in **Section 9.6**.

7.4 Final Landform Flood Protection

NAC have committed to design the revised Project's final landform so that any depressions and or hills are located outside the PMF flood extent. **Figure 7-15** illustrates the PMF flood extent in the vicinity of the revised Project. **Figure 7-15** shows that the existing site is predominantly not affected by flooding in the PMF event. Similarly, the currently proposed depressed landform locations are generally not affected by the PMF. Further refinement of the depressed landform locations through detailed design and mine planning will ensure that the depressed landform locations are not affected by the predicted PMF. As a result, there are no flood impacts predicted for the revised Project's final landform.

The final landform will contain water at its lowest point due to inflows from groundwater inflows. Modelling of the groundwater inflows including consideration for rainfall and evaporation is presented in Chapter 6 Groundwater. Chapter 6 also includes a discussion on water quality within the final landform. Water in the final landform will be located over 50 m below natural surface level and as a result there is no risk of contamination of other surface waters from groundwater inflows to the final landform.

7.5 Site Water Management

The philosophy of the water management strategy is to provide adequate water to the revised Project site to operate successfully while minimising environmental impacts by collecting and managing dirty runoff water. The Mine's water management system is based on the following key principles.

- Where possible, stormwater runoff from undisturbed areas both on and surrounding the revised Project site will be diverted away from disturbed areas and released directly into adjacent waterways.
- Disturbed area runoff will be captured in sediment dams and used preferentially for dust suppression or as process water in the CHPP.
- Water will be recycled from the IPTSFs to supplement the water supply for coal washing.
- Mine-affected water will be treated through settling in sedimentation basins and/or oil-water separators to allow as required discharges off-site that comply with the revised Project's EA.
- Recycled water from the TRC's WWRF is pumped to the site as the main operational water supply.
- Shallow groundwater bores will be treated to supply potable water for human use.
- Infrastructure and mining areas will be protected from flooding using flood levees.
- All significant quantities of hydrocarbon and chemical products stored on site will be stored in temporary or permanent bunding.
- Spill capture and retention devices will be used for refuelling and similar areas.
- Oily water areas will be captured and treated using an oil-water separator.
- Progressive rehabilitation will be employed to revegetate disturbed areas no longer required for operational use. .

7.5.1 Components of the Water Management System

The revised Project's water management system will, in its initial stages, operate in conjunction with the Mine water management system. As a result, the water management strategy for the revised Project will utilise existing water management infrastructure designed and constructed as part of the Mine. The key components of the mine water management system are the:

- WWRF pipeline;
- process water dams;
- environmental dams;
- sedimentation dams; and

- tailings dams.

Where practical, the stormwater runoff from clean, undisturbed catchments will be diverted around disturbed areas using bunds and channels and released directly into adjacent gullies and waterways. Rainfall runoff from disturbed areas including un-rehabilitated spoil areas will be collected. Spoil area runoff will report to sediment and environmental water dams for treatment before potential release off site. Water that reports to a mine pit floor will be pumped to environment dams and stored for use to supplement the revised Project's water demands for activities, such as dust suppression.

The sections below outline the purpose of each component of the water management system. The operation of the existing water management system is described in detail in **Chapter 3**. The operation of the revised Project water management system is discussed in **Section 7.5.2**.

Water Supply

The Mine has secured a water supply allocation of up to 5,650 ML/year. The major source of this allocation is via a long term contract to the year 2055 with the TRC that allows the purchase of up to 5,500 ML per annum of Class A+ recycled water from the WWRF. The duration of this supply contract is well beyond the projected life of mine. This water supply option represents a beneficial use of a wastewater product and has eliminated the Project's reliance on deep sourced groundwater from the Great Artesian Basin. **Chapter 3** outlines the details with regard to the TRC's WWRF agreement with the NHG.

Process Water Dams

Water from the WWRF is supplied to the revised Project site via a pipeline and delivered to the Process Water Dam (PWD) 1 within the Mine site. Water from PWD 1 will be balanced with PWD 2 and will supply the revised Project's new CHPP 3.

The process water dams are used to supply process water to the CHPPs. The process water dams also aid in the management and segregation of clean and dirty water at the revised Project site. The process water dams generally do not have a local catchment and will only receive clean water inflows from the WWRF pipeline, recycled water from the mine water management system, direct rainfall and recycled brine water in small periodic quantities from the Oakey Reverse Osmosis Water Treatment Plant. Water that has been settled in the sediment dams and tailings storage facilities can be transferred to the process water dams to maximise sediment dam capacity providing optimal storage volume for flood events.

Environment Dams for Pit Water Storage

The new mining areas of Manning Vale East and Manning Vale West and Willeroo are located within the upper sections of the Lagoon Creek catchment. As a result, the area of undisturbed or disturbed catchment upstream of the pits is minimal. The majority of water that collects on the site accumulates in the pits as a result of direct rainfall runoff and groundwater infiltration from in situ strata (high wall) and backfilled areas (low wall). Water that collects in the mine pits will be captured in small temporary sumps where it is used for dust suppression activities. During high rainfall periods, excess pit water will be pumped to sedimentation dams for eventual use by the CHPP Precinct. Three additional environment dams will be constructed for the revised Project's Manning Vale East, Manning Vale West and Willeroo resource areas. These dams will be constructed in close proximity and on the downstream edge of the pit to minimise pumping costs.

Rainfall runoff from the two out of pit spoil dumps at the Manning Vale West and Willeroo mine pits will be captured in sediment dams with any overflows diverted to the environment dams via diversion bunds. The placement of these bunds will be determined through the detailed mine planning and will change as the mine pit progresses. As the disturbed area is in the upper parts of the catchment and the out of pit dump areas are relatively small, the environment dams will manage a relatively small catchment area. As a result inflows to the environment dams can be largely controlled through the pump rates from the adjacent pit.

A controlled release system is proposed from the new Environment Dams. The purpose of the controlled releases is to allow relatively clean water from a significant rainfall event to be removed from the site, rather than collected in the pits and increase in salinity through evaporation. This controlled release system will also assist in minimising the revised Project's impacts to flows in Lagoon Creek. The controlled release system will be based on specific water quality targets. The NHG's plans regarding how it will carefully manage pit water to ensure controlled discharges of treated water off site is further discussed in **Section 7.5.2**.

The environmental dams are normally located downstream of existing sedimentation and raw water dams. The environmental dams provide additional storage and treatment for water in significant rainfall events and mitigate against uncontrolled releases to the downstream environment. As is currently practised, water captured by the environmental dams will be used to supplement the revised Project's water requirements. This practice is employed to maximise the EDs storage capacity and reduce the risk of off-site discharges. Water may also be transferred from the sediment dams to the environmental dams to maintain the optimum operating level for the sediment dams. The placement of the environmental dams will require consideration of the mine pit progression and will be finalised through the detailed mine planning.

Sediment Dams

Sediment Dams will be required to entrap soil and other particles eroded from moderately disturbed areas due to rainfall runoff within the revised Project's site. The Mine area currently employs Sediment Dams 1 and 2. As required, new Sediment Dams will be constructed for the revised Project's Manning Vale West, Manning Vale East and Willeroo resource areas.

Typically, the Sediment Dams will receive rainfall runoff from out-of-pit dumps that are being progressively rehabilitated or areas disturbed by clearing and access tracks. These dams will also provide additional emergency storage for water captured in the revised Project's operational mining pits by direct rainfall or groundwater infiltration. Water from the Sediment dams will also be used preferentially for dust suppression and as appropriate to supplement the CHPP Precinct's process water demands.

Sediment Dams will be designed to provide enough storage volume to capture a 24 hr 10 yr ARI storm event for sufficient time to settle 0.05 mm diameter (course silt) particles; and maximise the length of the dam relative to the width of the dam to maximise hydraulic retention time and deposition. The placement of the Sediment Dams will require consideration of the mine pit progression and will be finalised through the detailed mine planning. Bunding and or catch drains will be used to direct runoff into sediment dams and or overflows from the sediment dams. These bunds and / or catch drains will be incorporated into the mine pit progression, this will minimise the sites reliance on pumping infrastructure.

Tailings Dams

The current tailings strategy that is being utilised on-site involves progressive construction of in-pit tailings cells as part of the dump design. This approach will continue to be practised as the preferred option for the revised Project. The tailings storage facilities currently on site or proposed for development will possess sufficient capacity to hold the tailings produced by the revised Project. This tailings management scenario is discussed further in **Chapter 3** of the revised Project's EIS.

Summary of Mine Water Management Infrastructure

Table 7-1 and **Figure 7-16** provide a summary of the current and proposed mine water management infrastructure for the revised Project.

Table 7-1 Summary of Mine Water Management System Storages

Structure	Size	Location
Existing Water Management Infrastructure		
Environmental Dam 1	126 ML	Northwest mining lease boundary area (ML50170).
Environmental Dam 2	232 ML	Downstream of the tailings dam, southwest mining lease boundary area (ML50170).
Environmental Dam 3	45 ML	Southern mining lease boundary (ML50216)
Environmental Dam 4*	110 ML	Southwest mining lease boundary area (ML50216), captures surface water runoff from the centre pit's disturbance area.
Sediment Dam 1	97 ML (including 16 ML of sediment)	Near the product coal haul road exit, western mining lease boundary area (ML50170).
Sediment Dam 2	62 ML	Near the South Pit's out-of-pit dump (ML50216)
Process Water Dam 1	136 ML	North of the main administration area, adjacent the main access to the Mine (ML50170).
Process Water Dam 2	175 ML	Immediately east of Process Water Dam 1 (ML50170)
Tailings Dam (Out-of-pit) TSF 1 – Stage 1 & 2	2,550 ML (of tailings)	Western mining lease boundary area (south of the RoM stockpile area) (ML 50170). – Stage 1 is under rehabilitation.
Tailings Dam (In-pit) IPTSF 1	2,800 ML (of tailings)	Within the North Pit (ML 50170)
Tailings Dam (In-pit) IPTSF 2-1	3,320 ML (of tailings)	Within the North Pit (ML 50170)
Tailings Dam (In-pit) IPTSF 2-2	3,400 ML (of tailings)	Within the North Pit (ML 50170)
Tailings Dam (In-Pit) TSF 3	TBA (under construction)	Within the Centre Pit (ML50216)

Structure	Size	Location
Existing Water Management Infrastructure		
Return Water Dam	300 ML	Upstream of Environmental Dam 2, western mining lease boundary area (ML50170).
Lagoon Creek Flood Bund	Approx. 3 m high and 3 km in length	Between Lagoon Creek and the South Pit area (ML50216).
New Acland Continuation Project Water Management Infrastructure		
Environment Dam 5 Manning Vale West	250 ML	Southwest of Manning Vale West final pit extent
Environment Dam 6 Manning Vale East	250 ML	South of Manning Vale East final pit extent
Environment Dam 7 Willaroo	350 ML	Southeast of Willaroo final pit extent
Sediment Dam 3 Manning Vale East Pit	160 ML	North of Manning Vale East Pit
Sediment Dam 4 Willaroo Pit	130 ML	North of Willaroo Pit
Lagoon Creek Flood Levee 2	Approximately 3.5 m high and 1.5 km in length	Between Lagoon Creek and the Manning Vale East Pit area
Lagoon Creek Flood Levee 3	Approximately 3.5 m high and 2 km in length	Between Lagoon Creek and the Willeroo Pit area

*will become Sediment Dam 5 in the revised project.

7.5.2 Water Balance Modelling

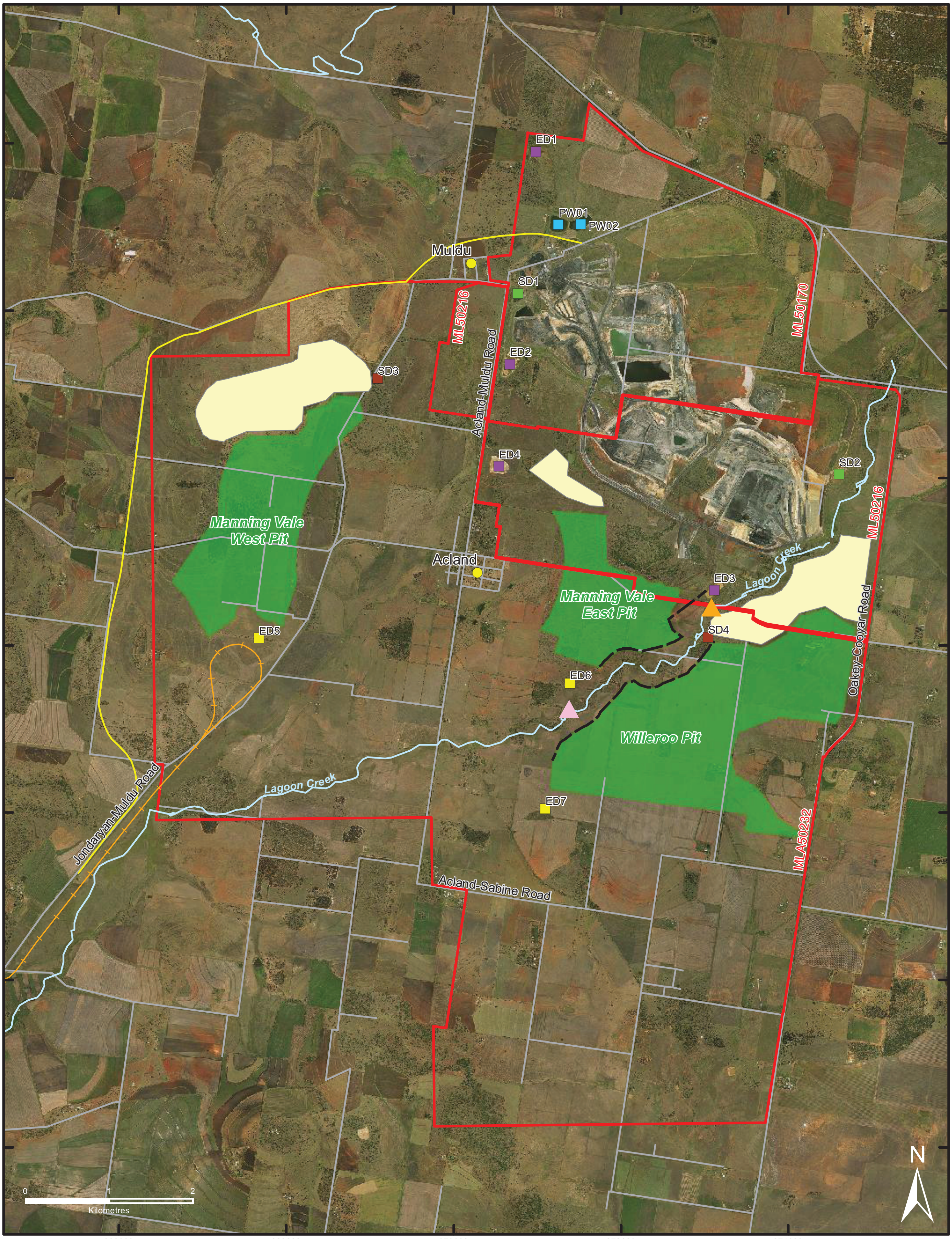
Methodology

The performance of the revised Project's water management system was assessed using the modelling software program GoldSim. GoldSim is a software package developed by the GoldSim Technology Group to model continuous systems and has the ability to track the movement of water with time based inputs and operating rules.

The water balance model was established at a daily resolution and developed to predict the operation of the Mine's current and proposed water management system. The results of the water balance illustrate the revised Project's capacity to manage weather extremes over the mine's life. The objectives of the mine water balance are to:

- control the release of water from the storages so that that releases occur in a manner that minimises impacts upon downstream users and the environment;
- manage dam storages so that they maintain water to the operation of the revised Project;
- maximise pit operability through bunding and transferring water to sedimentation dams; and
- control and manage the separation and use of clean and dirty water.

The water balance model was developed from a schematisation of the water management system, based on the component descriptions outlined in **Section 7.5.1** and based on the mine sequence plans illustrated in **Chapter 3** of the revised Project's EIS. The water balance model schematisation is illustrated in **Figure 7-17**.



LEGEND

- Towns and Localities
- Existing Release Point
- Proposed Release Point

Proposed Dam
- Environment Dam
- Sediment Dam

Existing Dam
- Environment Dam
- Process Water
- Sediment Dam
- Rail Spur
- Roads
- Creeks

- Jondaryan-Muldu Road Diversion
- Dumping Area
- Mining Tenements
- Stage 3 Pit Areas

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Figure 7-16 - Existing& Proposed Release Points & Proposed Flood Levee

Scale 1:62,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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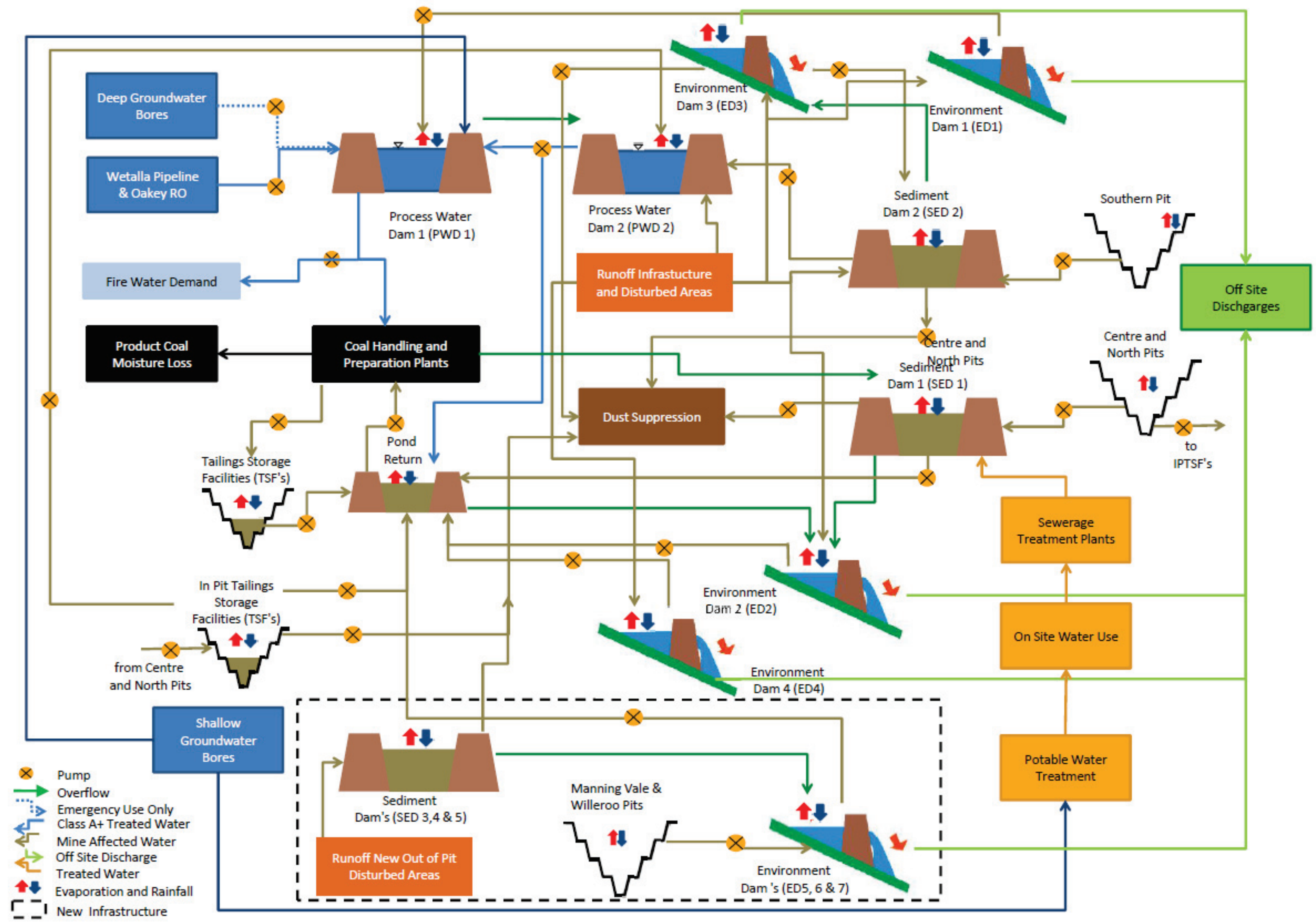


Figure 7-17 Water Balance Model Schematisation

Climate Inputs

The water balance model was based on a probabilistic rainfall generation. The purpose of the probabilistic rainfall generation is to develop a range of climate sequences for the life of the revised Project based on the recorded historical rainfall data of the Study area. The probabilistic rainfall data was generated from recorded historical data using the Stochastic Climate Library for 500 replicates over 15 year sequences of daily rainfall data. This method allows assessment of a wide range of rainfall sequences which may be experienced over the life of the revised Project and the calculation of a range of exceedance probabilities. This methodology aims to provide an indication of the potential for future climate variability and the uncertainty associated with future climate as it influences rainfall and runoff. This approach allows both climate extremes of drought and wet to be considered in balance with the historical series forming the 50^{th} percentile of the scenarios modelled.

Evaporation from the site was determined based on monthly averages as recorded at gauge 041359 Oakey Aero.

Mine Water Sources and Demands

The revised Project's water sources and demands vary over its life. A summary of the annual average volumes is shown below in **Table 7-2** and **Table 7-2**. The catchments that contribute to the water balance are discussed in further detail in the following Section.

Table 7-2 Mine Water Inflows

Description	Value
Rainfall	500 Stochastic Replicates based on data generated from gauge 041053 at Jondaryan Post Office.
Wetalla Pipeline	5 500 ML per annum from the WWRF at a rate of 340 cum /hr
Oakey Reverse Osmosis Plant	150 ML per annum
Ground and surface water capture	Varying with mine life climate, refer to contributing catchments
Deep and Shallow Groundwater Bores	Not considered in the Water Balance. Water Balance developed assuming zero inputs from groundwater bores. Shallow Groundwater bores will be used to supply potable water to the site and it is assumed that this supply will be sufficient to meet potable water demands.
Groundwater Inflow to the Pits	Output of groundwater modelling, varies over the life of mine (typically between 2.5 to 0.5 ML/d)

Contributing Catchments

The revised Project's water demands and catchments change over its operation. To assess this, several mine stages were examined. Catchment areas were determined from the mine plans and GIS analysis and are presented below in **Table 7-4**. A description of each catchment type is provided below.

Table 7-24 Mine and Future Project Raw Water Demands

Water Supply Activity		Current Usage (approx) (ML/ year)	Future Usage (2021) (approx) (ML/ year)
Operation of the CHPPs	(~550 L/RoM tonne)	5,280	8,250
Wash down of machinery			
Fire suppression			
Shower and ablution use			
Dust suppression (~ 45 L/RoM tonne)		432	675
TOTAL USAGE		**5,712**	**8,925**
Estimated recovery Tailings Storage Facilities (50%)		2,860	4,460
Estimated water collected at site (rainfall runoff & groundwater inflows)		740	1,170
TOTAL NET WATER USAGE (~265 L/RoM tonne)		**2,112**	**3,295**

- **Ex Pit Dump** – Surface runoff reports to sedimentation basins and seepage through the dump flows to the dump toe and into sedimentation basins;
- **In Pit Dump** – Surface runoff reports to sedimentation basins or the pit floor dependant on the topography of the mine pit. The majority of water from the in pit dumps reports to the pit floor. Seepage from spoil will report to the mine pit floor and be considered by the water balance;
- **Ex Pit Rehabilitated** – The direction of runoff is consistent of that with the ex-pit dump until the area becomes fully rehabilitated and is diverted clear of the system to the natural waterway. Until this time, the rehabilitated area differs only from the dump area by the assumed soil storage characteristics outlined in **Table 7-3**;
- **In Pit Rehabilitated** – Differing from the in pit dump, rehabilitated areas have been backfilled to natural surface levels and may be bunded to report directly to the sedimentation dams, thereby maximising pit operability. Seepage from these areas will report to the mine pit. Once the area is fully rehabilitated it will be diverted clear of the system to the natural waterway;
- **Mining Area/Pit Floor** – This area represents the active mining area and mine pit floor. All runoff reports to the mine pit floor; and
- **Disturbed and Pre-Strip Area** – This represents areas that have already been stripped of top soil in preparation for mining or have been disturbed from their natural state in some way. Runoff from these areas typically flows into the pit or a sedimentation dam based on the slope and orientation of the area.
- **Undisturbed Area** – Where possible, areas that have not been disturbed will be diverted around water storages and discharged to local streams. Where this is not practical, runoff will be collected and used to meet site demands.

A key difference between each of these areas is the assumed soil storage characteristics. Surface water runoff in the model is generated based on a conceptual soil storage capacity and base flow index. The soil storage capacity represents the depth of soil storage which must be filled before runoff occurs. This soil storage capacity is based on the stage of mining or rehabilitation. The base flow index designates the rainfall that becomes surface runoff and a proportion that goes to groundwater.

Table 7-3 outlines the conceptual soil storage capacities and base flow index for the revised Project site. The values adopted in **Table 7-3** are consistent with those adopted from similar open cut mining operations in Queensland.

Table 7-3 Conceptual Soil Storage Characteristics

Land Use	Mining Pits	Spoil Dump	Undisturbed Area	Pre Strip Area	Rehabilitated Spoil Dump
Small Storage Capacity (mm)	5	40	7	20	7
Medium Storage Capacity (mm)	10	220	120	150	120
Large Storage Capacity	25	300	150	220	150
Small Area Proportion	0.134	0.134	0.134	0.134	0.134
Medium Area Proportion	0.134	0.134	0.134	0.134	0.134
Baseflow Index	0.1	0.1	0.1	0.1	0.1
Baseflow Coefficient	0.8	0.5	0.5	0.5	0.5

Table 7-4 Mine Water Balance Catchment Areas

Catchment		AREA (ha)					
		2013	2019	2021	2023	2025	2029
MANNING VALE EAST PIT	Mining Area	-	28	36	46	23	16
	Disturbed Area	-	44	48	43	37	28
	Undisturbed Area	-	168	168	-	33	44
	In Pit Dump	-	29	45	53	58	40
	In Pit Rehabilitated	-	-	15	48	-	-
MANNING VALE WEST PIT	Mining Area	-	29	25	35	26	31
	Disturbed Area	-	46	32	33	32	32
	Undisturbed Area	-	135	15	-	-	14
	In Pit Dump	-	163	33	41	37	42
	In Pit Rehabilitated	-	-	118	-	-	55
WILLEROO PIT	Mining Area	-	33	41	37	25	14
	Disturbed Area	-	39	44	45	39	63
	Undisturbed Area	-	72	45	-	-	71
	In Pit Dump	-	81	53	72	53	76
	In Pit Rehabilitated	-	-	90	-	-	-

Water Balance Operating Rules and Assumptions

The water balance is based on several operating rules and assumptions as outlined below.

- The water balance starts at a volume of zero.
- Process water demands have priority. These demands can only be withdrawn from water in the raw water dams.
- A minimum WWRF pipeline inflow of 3,000 ML per annum must be used or stored on-site.
- If the Mine has less than two days CHPP process water supply in storage, WWRF pipeline pumping hours may be increased up to 4,800 ML per annum to ensure the Mine does not dry out.
- The WWRF pipeline inflows are delivered to RWD 1. Water is supplied to the Project's CHPP precinct via a gravity fed pipeline.
- Water collected from rainfall runoff within the revised Project mining areas can be transferred back to the Mine's water management system, via the Pond Return dam to be used to supplement process water requirements.
- With the exception of the central connection to the Pond Return dam, water cannot be pumped between storages more than 1 km apart. That is, water from storages to the south of the South Pit could not be pumped up to the existing storages in the north east section of the Mine. However, water may be gravity fed between the revised Project storages, through pipelines or channels and bunding.
- Pumping rates for transfers between eligible storages are up to 4 ML/d.
- Pit dewatering rates are typically 40 l/s increasing up to 200 l/s following periods of extended significant rainfall.
- Dust suppression demands can be withdrawn from sediment dams, environmental dams, pit sumps or mine voids. Dust suppression demands are preferentially withdrawn from sediment dams to maximise available storage.
- Dust suppression demands are reduced on days when the daily rainfall total is in excess of 5 mm.
- Dust suppression is not required on days when rainfall is exceeds 10 mm.

The revised Project operating rules and assumptions will be confirmed through detailed design in accordance with the mine plan.

Site Surface Water Quality

The water balance model was developed to include a high level salt balance to track both the quantity and quality of water on-site. The salt balance tracks the water quality in all of the inflows to the revised Project's Sediment Dams and Environment Dams and subsequent affects from evaporation and releases on the storage water quality. The water quality values are presented in **Table 7-5**. These adopted values are consistent with other water balance models developed from Mine site records. In particular, the assumed salinity for undisturbed catchments is consistent with the median values from the existing EA water quality monitoring along Lagoon Creek (refer to **Section 4.6.2**).

Table 7-5 Assumed Salinity

Source	Assumed Salinity (µs/cm)
Undisturbed Catchments	400
Spoil Dumps and Industrial Areas	500
Raw water pipeline	250
Receiving Waters	400
Pit Water	4,000

The above salinity values are converted to a concentration in milligrams per litre using a multiplication factor of 0.67 (Measuring Salinity DERM, June 2007) to quantify the mass of salt transferred in the model. The salt balance is used as an indicator of water quality. Actual releases will be made based on sampling and monitoring of a number of water quality parameters.

Salinity values for undisturbed catchments and receiving waters are based on water quality records from other Project sites. For modelling purposes, a conservative assumption was made to assume a salinity level of 4,000 µs/cm for all water pumped from the in-pit sumps.

Controlled Release Conditions

A controlled release strategy is proposed as part of the revised Project's site water management to support proactive management of water during periods of extended rainfall. The controlled release strategy has been developed to minimise the potential for impacts on water quality, aquatic ecology and existing users downstream. The strategy seeks to optimise the potential for the controlled release of good quality water, so that it does not become saline as a result of prolonged storage. The strategy has benefits for downstream users and the environment by releasing good quality water from large rainfall events. As a result, the impacts of the mine on the overland flow regime are further minimised.

Following the 2008 flooding in the Fitzroy Basin, the then DERM published several documents to provide guidelines on the discharge licensing for coal mines in the Fitzroy Basin. These documents include:

- *A Study of the Cumulative Impacts on Water Quality of Mining Activities in the Fitzroy River Basin* (Qld Environmental Protection Agency (now DERM), April 2009). This study recommended approaches to standardise the licensing and discharges from mines to the Fitzroy River basin. The study also provides a cumulative risk assessment matrix to assess the mine discharges, and is discussed further below.
- *Conditions for Coal Mines in the Fitzroy Basin – Approach to Discharge Licensing Version 10*, (DERM, June 2009). This document includes references to studies by Hart (2008) and states that salinity effects on macroinvertebrates are unlikely at or below 1,000 µs/cm.
- *Final Model Water Conditions for Coal Mines in the Fitzroy Basin* (DEHP, 2013). This document outlines how discharge conditions should be determined and managed under the Environmental Authority.

The above guidelines are considered to form the latest industry standards for mine water releases and in lieu of catchment specific guidelines, have been adopted for the revised Project. The revised Project proposes that controlled releases be made to Lagoon Creek on the Mine. Releases will be made in accordance with the principles outlined in the *Final Model Water Conditions for Coal Mines in the Fitzroy Basin* (DEHP, 2013). The release conditions were developed to only allow discharges that are less than 1,000 µs/cm downstream of the point of discharge.

The Lagoon Creek historical flow series which was provided by DSITIA, and discussed in **Section 7.1.1**, was used to derive flow statistics to inform the Lagoon Creek release conditions as an output of the calibrated Sacremento Model for the Oakey Creek catchment Missing days and dry days within the streamflow series were excluded from the analysis. As a conservative measure, flows which recorded less than 1 ML/d were considered to be dry and also excluded from the analysis. Percentage exceedence values were then calculated on the remaining data set and are presented in **Table 7-6**.

Table 7-6 Release Conditions

Receiving Water Flow Criteria for Discharge (ML/d)	Approximate % of Lagoon Creek Streamflow	Maximum release rate*	Electrical Conductivity Release Limits (µs/cm)
Low Flow < 4 ML/d for a period of 28 days after natural flow events that exceed 1.24 ML/d	< 20%	<1.5 ML/d	700
Medium Flow (low) > 4 ML/d	> 20%	<1.5 ML/d	1,500
		<0.7 ML/d	2,500
		<0.5 ML/d	3,500
Medium Flow (high) > 11.55 ML/d	> 40%	<3 ML/d	1,500
		<2 ML/d	2,500
		<1.3 ML/d	3,500
High Flow > 34 ML/d	> 60%	<8 ML/d	1,500
		<6 ML/d	2,500
		<6 ML/d	3,500
		<2.8 ML/d	4,500
		<1.7 ML/d	7,500
Very High Flow > 66 ML/d	> 80%	<4.5 ML/d	4,500

In order to simulate flow conditions in Lagoon Creek for the 500 replicates of probabilistic rainfall data, a Sacramento rainfall runoff model was developed within the GOLDSIM model. Parameters for the Calibrated Oakey Creek Sacramento model were provided by DSITIA and are shown in **Table 7-7**.

The controlled release strategy proposes one release point to Lagoon Creek. No release points are proposed on any adjacent gullies including Spring and Myall Creek as these gullies are considered to have insufficient annual flows to support a the revised Project's controlled release strategy. The connection of the three environmental dams to this release point will be established through detailed design of the water management system and take into account infrastructure and site constraints, this may include gravity fed pipelines and or the placement of smaller intermediate storages to support a pumping regime.

Table 7-7 Sacramento Model parameters for Lagoon Creek

Parameter	Value
Lztwm	100
Uzfwm	90
Uzk	0.18
Rexp	1
Uztwm	72
Pfree	0.1475
Zperc	200
Lzfpm	30
Side	0.001
Lzsk	0.8
Pctim	0.0028
Lzfsm	40
Sarva	0.0029
Lzpk	0.005
Adimp	0.0001
Ssout	0.001

Mine Water Balance Results

Demand Reliability

The water balance model was used to predict the reliability of the demands for the operations including the clean water, process water and dust suppression demands from varying water sources. The model was also used to predict the adequacy of the site storage to manage extreme rainfall events. The model was run for 500 climates replicates over the 12 year mine sequence. **Similarly,** the dust suppression demands are met on 99.9% of days with only a minor volumetric deficit predicted for the 1% exceedance over the total life of mine.

Table 7-8 below presents the reliability of the major site water demands. The water balance predicted zero days of deficit for the CHPP plants supply with demands supplied on 100 % of days for all scenarios modelled. Similarly, the dust suppression demands are met on 99.9% of days with only a minor volumetric deficit predicted for the 1% exceedance over the total life of mine.

Table 7-8 Reliability Demand for Site

Demands	Number of Days Demand Supplied (%)		Total Mine Life Volume Deficit (ML)	
	50% Exceedance	1% Exceedance	50% Exceedance	1% Exceedance
Potable Water/Fire Fighting	100	100	0	0
CHPP Demands	100	100	0	0
Dust Suppression	100	99.9	0	200

Mine Water Management

Three additional environment dams are proposed to manage rainfall runoff from mine affected areas. These dams are located adjacent to the Manning Vale East, Manning Vale West and Willaroo Pits. **Figure 7-18** illustrates the combined volume contained within these storages over the life of mine. The results indicate that the proposed water management system, and combined storage of 800 ML will be more than sufficient to manage the revised Project's climatic extremes.

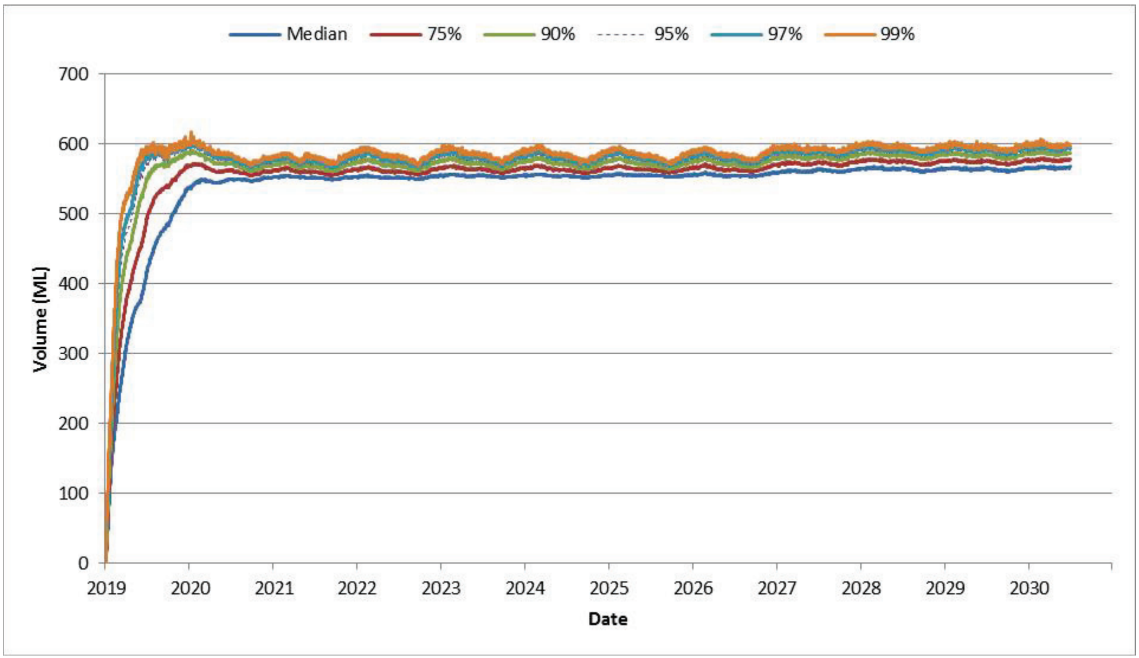


Figure 7-18 Combined volume in additional on-site storages

The potential for in-pit flooding due to an extreme rainfall event or period of continuous heavy rainfall was also examined. **Figure 7-19** illustrates the number of days over the life of mine where in pit flooding would exceed 100 ML, resulting in disruptions to the mining operations. The results indicate that for the 3 % exceedance probability there would be a risk of up to 30 days of mining interruptions and a risk of up to 4 months of delays at the 1 % exceedance probability through the first 10 years of mining operations. Additional water accumulation is expected in later mine life to an increase in predicted groundwater inflows. This risk is considered to be a low likelihood, and in the event that this occurs the NHG will manage the impacts through additional pump infrastructure.

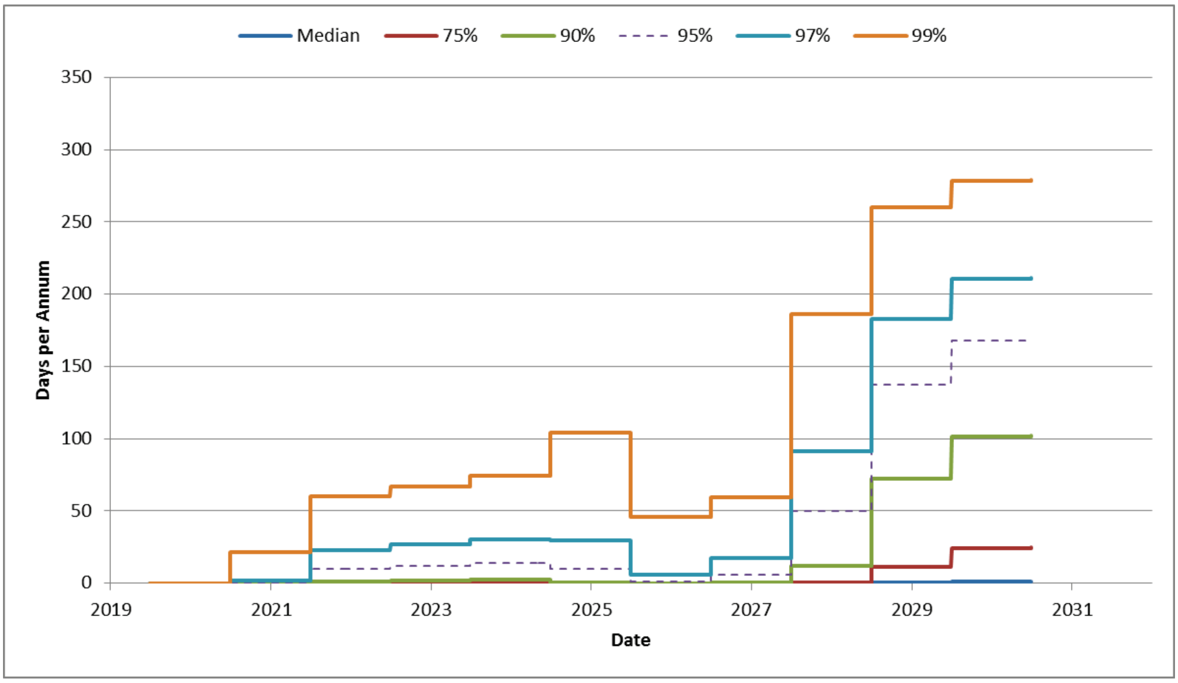


Figure 7-19 Days of pit flooding greater than 100 ML per annum

Controlled Release

The average annual volume released to Lagoon Creek over the revised Project life of mine is illustrated in **Figure 7-20**. The results indicate that in an average year only minor releases in the order of 20 ML/year will be made to Lagoon Creek with releases increasing to a maximum of 170 ML/year in the 1 % exceedance probability (very wet year). This volume of water is minimal, with the ephemeral nature of Lagoon Creek restricting the opportunity for release of large volumes of mine-affected water. However, the release condition is still considered important for the revised Project and in keeping with current industry guidelines. The release condition allows for good quality water to be released off site following periods of significant rainfall. This approach prevents good quality water increasing in salinity through evaporation and maximises the available storage within the mine site to manage climatic extremes.

Figure 7-21 illustrates the predicted salinity within Lagoon Creek at the point immediately downstream of the mine water releases. The results illustrate the adopted baseline salinity of approximately 400 µS/cm (As discussed in **Table 7-8** and **Section 4.6.2**), with salinity values increasing to up to 700 µS/cm during the 1 % exceedance probability release conditions. These results indicate the proposed controlled release system is unlikely to result in significant changes to the salinity in Lagoon

Creek, with this value below the median values recorded at the downstream Oakey Gauge and consistent with recorded values during the Lagoon Creek flow events (1,000 µS/cm).

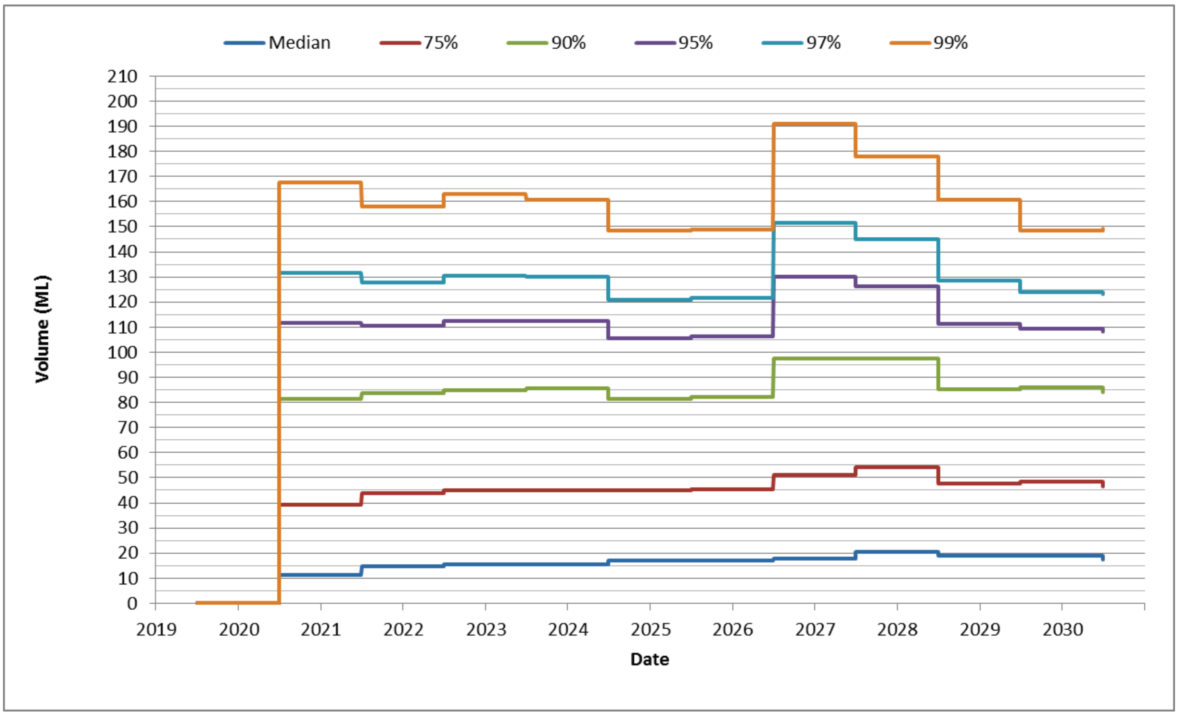


Figure 7-20 Annual Controlled Release Volume

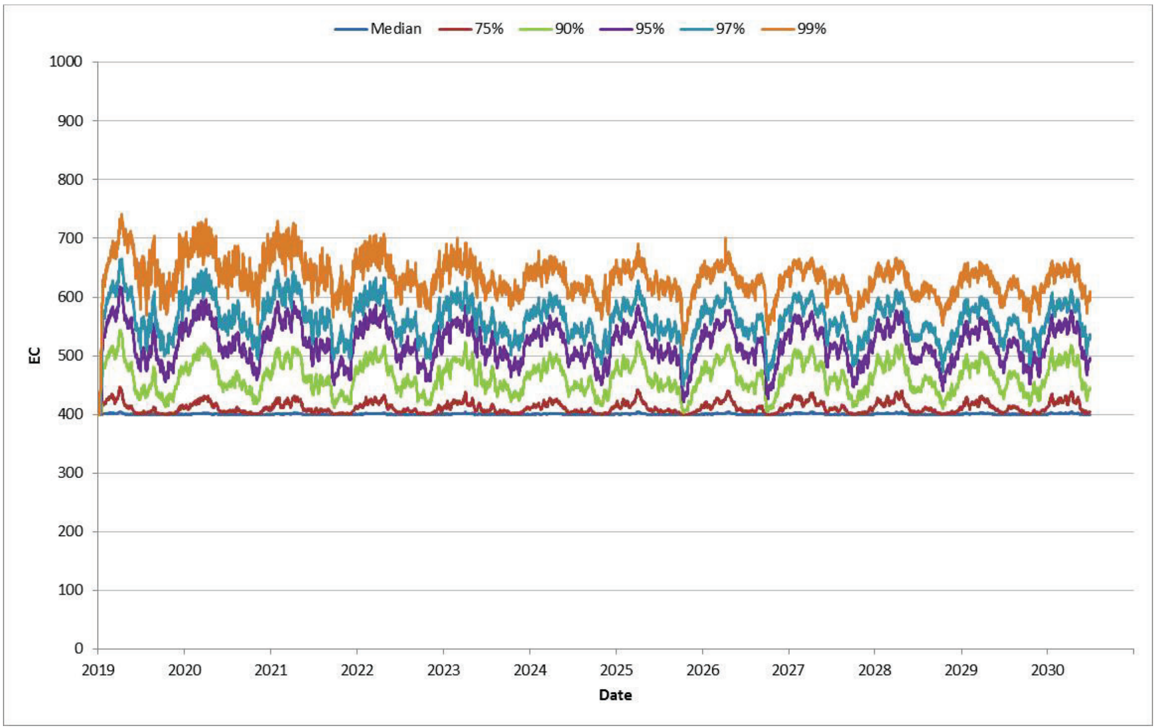


Figure 7-21 Salinity of Lagoon Creek downstream of mixing point

A study by the then DERM in 2009 developed a risk assessment framework based on the ambient EC levels and the frequency and volume of mine discharges in the Fitzroy River catchment. The study was aimed at identifying the risks of cumulative mine releases within a catchment. While there is limited mining activity in the Condamine River catchment the process of the development of the framework is relevant. The results of the water balance modelling indicate median discharges of less than 20 ML/ year with a high probability (1 % exceedance) of an annual discharge volume of less than 170 ML/year and water quality of the receiving environment being less than 700 µS/cm. This is considered to be a “Low” water quality risk to receiving waters being less than the 90th percentile EC value at the downstream Fairview gauging station. The flow frequency and volume is also considered to be a “Very Low” risk with release on only a few days and average volumes well below 100 ML per year. The revised Project’s controlled release system is therefore predicted to be a ‘Low’ risk. As such the impacts of the proposed controlled release system on water quality and the downstream environment is predicted to be minimal. Furthermore a controlled release system of good quality water minimises the impact of the revised Project on overland flow paths and hence the volume of water available to downstream users.

8 Water Balance

One of the requirements under the IESC Information Guidelines is to develop a site specific water balance, complemented by a regional water balance, covering the larger area of potential impact. Given the duration of the revised Project, site specific water balances for different periods of the revised Project life are provided, with a discussion of the regional water resources (with estimates of volumes where available) for context.

8.1 Regional Water Balance

It is generally acknowledged that it is unrealistic for project proponents to undertake cumulative (regional) water resource impact modelling where data for water use by other users and resource projects is only partially available or unavailable; regional water balance modelling in this case would result in considerable uncertainties such that any quantitative outputs would be highly questionable. As such, the approach taken in this report is to present information on regional water flows and usage as derived from various publically available data sources rather than attempt a quantitative water balance.

For the purposes of the regional water balance, the study area has been defined as the Central-Northern Downs Subregion (part of the Condamine-Balonne Catchment) presented in the South West Queensland Water Demand Analysis (Non-Urban Demand) report of the DERM Healthy Headwaters Coal Seam Gas Feasibility Study (DERM, 2010) as shown in **Figure 8-1** and **Figure 8-2**. It is considered that this represents the water resource area relevant to the revised Project and within which all water impacts related to the revised Project will be contained. Importantly, information on the status and use of all water resources in the Central-Northern Downs Subregion is available in the Healthy Headwaters study.

The Central - Northern Downs Subregion is a major agricultural region, with large areas of cotton, grains and fodder crops grown both under irrigation and dryland. Some horticulture and a large intensive livestock industry are also present. A significant energy industry is present in the subregion, including coal mining, power generation and an emerging CSG industry (DERM, 2010).

8.1.1 Groundwater

There are three principal types of consumptive groundwater use with the potential to influence the regional water balance: groundwater extraction associated with CSG production, groundwater extraction associated with mining activities, and groundwater extraction from bores associated with non CSG/mining activities. Approved CSG and mining operations in the regional water balance area are shown in **Figure 8-2**.

Coal Seam Gas

The closest CSG developments to the revised Project are Arrow Energy's Tipton developments, located 32 km west of the revised Project shown in **Figure 8-2**.

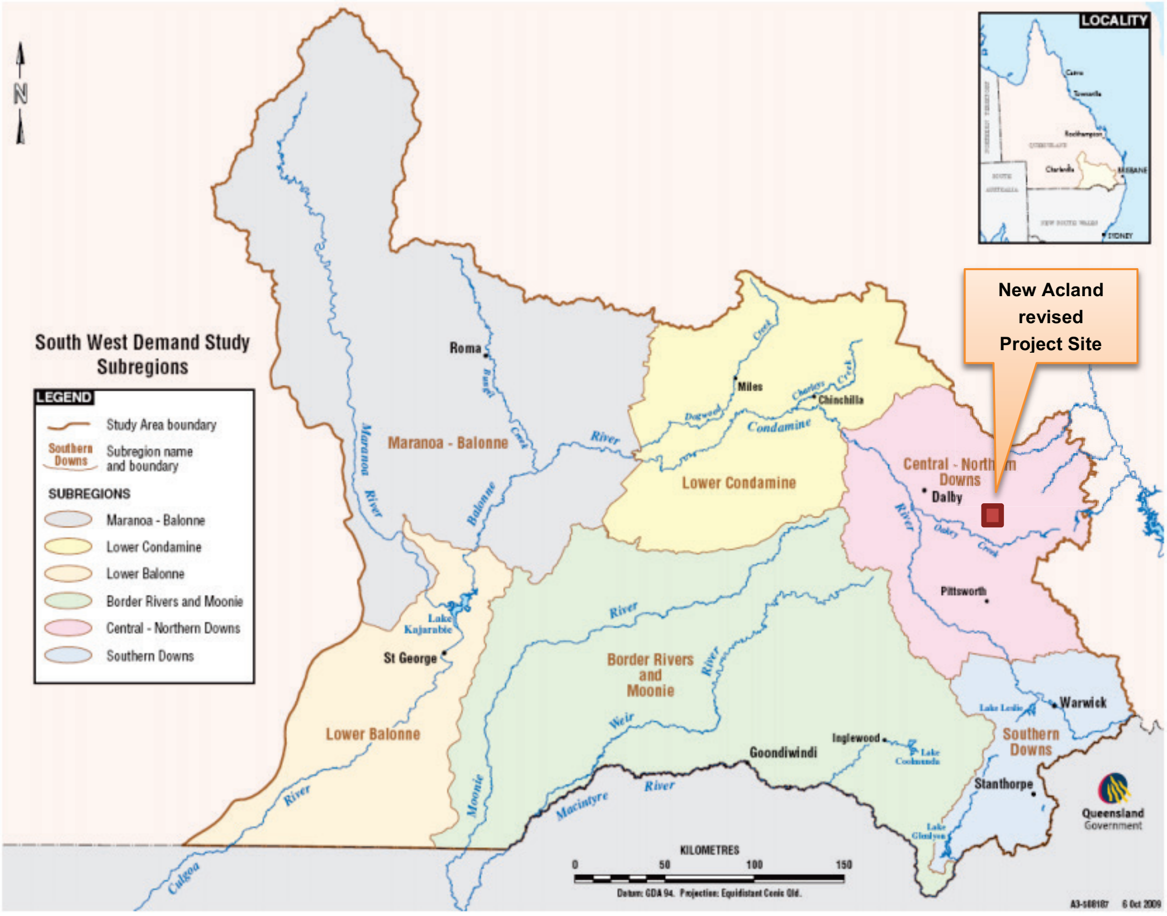
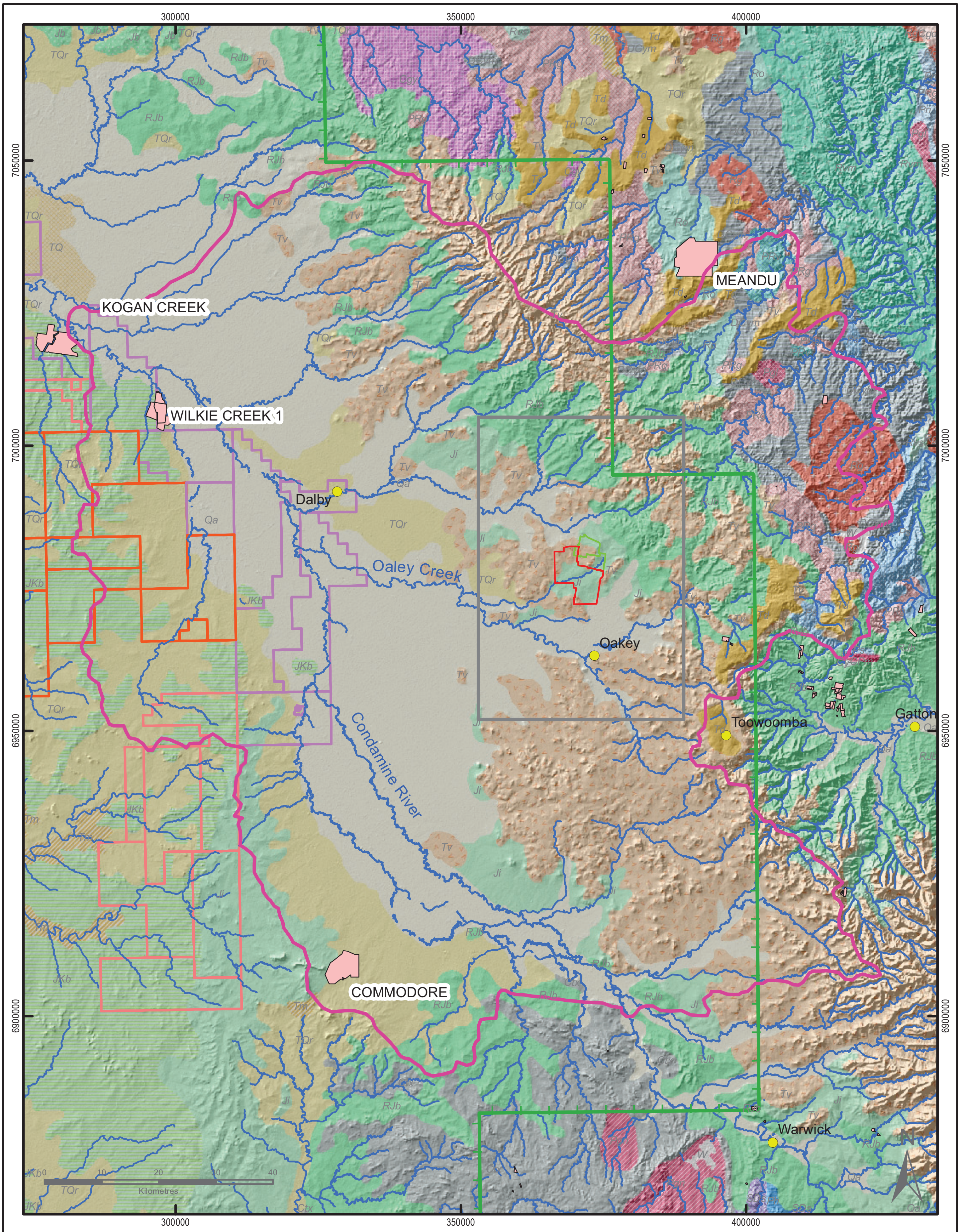


Figure 8-1 Regional Water Balance Area (after DERM, 2010)

Groundwater production information associated with CSG projects is considered commercially sensitive and generally not released publically. The revised Project lies within the eastern most part of the Surat Cumulative Management Area (CMA); the Queensland Government's Office of Groundwater Impact Assessment (OGIA) (formerly the Queensland Water Commission, QWC) assessed the cumulative impacts of CSG groundwater extraction from the Surat CMA in their Surat CMA Underground Water Impact Report (UWIR) dated May 2012, undertaken pursuant to the Water Act 2000 (Qld) and also pursuant to historical EPBC approvals for previous projects in the Surat CMA. The findings of the UWIR are based on the outputs of a regional groundwater model developed for the UWIR, which is aimed at predicting cumulative impacts from CSG and conventional petroleum / gas extraction. The UWIR model simulates groundwater extraction associated with all current and proposed CSG projects within the Surat CMA. As such, it is considered for the purposes of the revised Project that cumulative impact modelling as it pertains to CSG impacts on the revised Project site and its surrounds has already been undertaken.



LEGEND

- Major Towns
- Groundwater Model Domain
- Watercourse
- Regional Water Balance Area
- Surat CMA
- New Acland Coal Mine
- New Aland Coal Mine-Stage 3
- Active Mining Leases

Petroleum Leases (CSG)

- Arrow
- APLNG (Origin)
- QCLNG (QGC)
- GLNG (Santos)

Map Background:
Qld Structural Geology
DNRM, 2012

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NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 8-2 - Regional Water Balance Area

Scale 1:880,000 on A4
Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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On a basin scale, the water production volumes related to CSG are currently in the order of 18,000 ML/year based on 2011 data (QWC, 2012), predominantly from the Walloon Coal Measures. This is expected to increase significantly to around 120,000 ML/yr by 2020, based on public EIS data for each CSG project (KCB, 2012). It is conservatively considered for the purpose of this report that perhaps 10 to 20% of these water extraction volumes (i.e. 5 to 10 ML/day currently; 33 to 66 ML/day by 2020) come directly from within the regional water balance area.

In comparison, groundwater extraction (mine pit inflows) from the Walloon Coal Measures associated with the revised Project are small, with maximum predicted inflows being somewhere between 5 and 10% of the future CSG extraction volumes in the regional water balance area, and about 1% of the basin-scale CSG extraction volumes.

Mining

Approved mine leases within the regional water balance area are shown in **Figure 8-2**. Approved or operational mining leases include:

- Wilkie Creek Mine, Peabody Energy Corp. Located 70km northwest of revised Project and mining coal resources from the Walloon Coal Measures.
- Commodore Mine, InterGen Australia. Located 72km southwest of revised Project and mining coal resources from the Walloon Coal Measures.
- Kogan Creek Mine, CS Energy. Located 91km northwest of revised Project and mining coal resources from the Walloon Coal Measures. This mine is located just outside the regional water balance area.
- Meandu Mine, Stanwell Corporation. Located 50km north northeast of the revised Project site and mining coal resources from the Triassic-aged Tarong Basin (structurally separate from the Clarence-Moreton and Surat Basins). This mine is located just outside the regional water balance area.

Other small mining leases within the regional water balance area are small scale shallow quarries extracting resources such as sandstone. These operations extract resources from above the water table and therefore do not intersect groundwater.

In general, groundwater extraction volumes associated with mining projects in the regional water balance area similar in magnitude to those predicted for the revised Project (< 4 ML/day each) are many orders of magnitude smaller than the current volumes of extraction associated with CSG projects in the Surat Basin (>18,000 ML/yr). As such, impacts to the regional groundwater system from these mining operations are likely to be constrained within several km from the mines, and impacts on the regional water balance from groundwater extraction associated with mining are considered negligible in comparison to CSG.

Bore Allocations

Groundwater usage from bores within the regional water balance area is associated with the aquifers of the Clarence-Moreton Basin as well as those within the adjoining Surat Basin to the west. All aquifers listed in **Section 3.4** of this report, as well as those aquifers located in the Surat Basin within the regional water balance area, contain bores that extract groundwater for anthropogenic purposes including stock, domestic, irrigation and industrial use.

The Healthy Headwaters Coal Seam Gas Feasibility Study (DERM, 2010) defines indicative groundwater extraction volumes in the regional water balance area of 80,000 ML/year, based on historical allowed allocations of 60% of the total volume of bore entitlements.

8.1.2 Surface Water Use

The following discussion of surface water use in the regional water balance area is drawn largely from the Healthy Headwaters Coal Seam Gas Feasibility Study (DERM, 2010).

The Condamine River, and its main tributary Oakey Creek, form the main surface water features within the regional water balance area as shown in **Figure 8-2**. There are two major surface water storages in the regional water balance area; the Cecil Plains Weir on the Condamine River (700 ML storage volume), and the Cooby Creek Dam on Cooby Creek (Oakey Creek) (23,092 ML storage volume).

Within the regional water balance area, surface water flows in the Condamine River increase from an average of around 95 ML/day in the south (DNRM Gauging Station 422340A at Talgai Weir) to 1,901 ML/day in the northwest (DNRM Gauging Station 422336A at Brigalow).

Unsupplemented water resources are the primary surface water resources in the regional water balance area, and amount to approximately 80,000 ML/yr. Water harvesting provides a significant volume of water to agriculture in the study region. Irrigators divert from both major streams and tributaries, typically using large diversion pumps and private ring tank storages. Water harvesting reliabilities are not generally defined as they are dependent on rainfall events.

Capture of overland flows is a very common source of water in the study region, due to the low gradient of much of the arable land in the area. Overland flow licenses do not have a defined reliability as water availability is entirely dependent on rainfall. Estimates of overland flow capture in the study region place the nominal volume at around 140 GL/year. Anecdotal information from farmers indicates that "good" overland flows now occur only once in five years rather than once in three as occurred previously. There is no information available regarding how these systems will behave in the longer term future (DERM, 2010). Current estimated usage of captured overland flow in the regional water balance area amounts to 50,100 ML/yr (DERM, 2010).

8.2 Site Water Balance

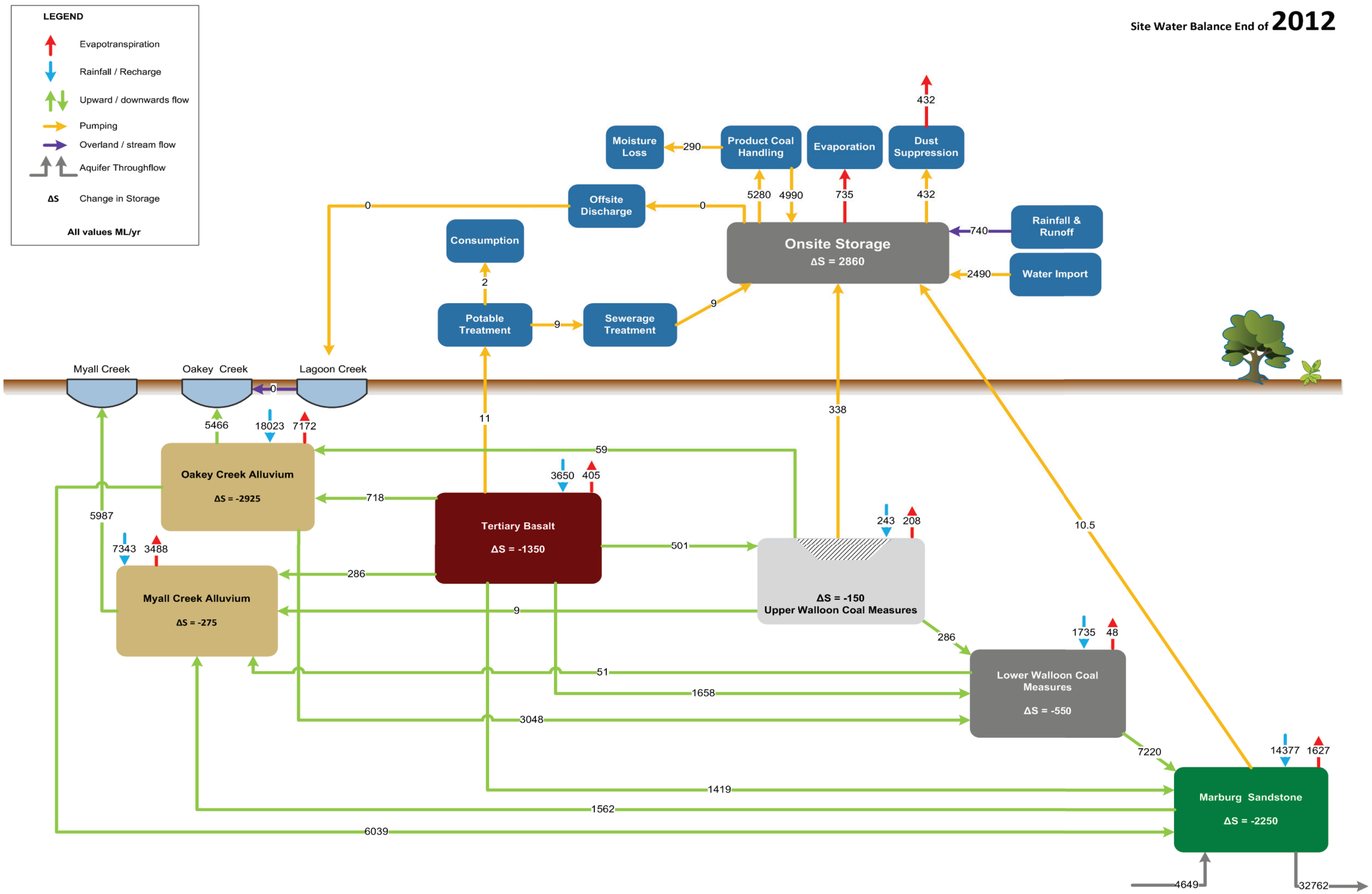
Water balances for the revised Project were compiled based on site-specific surface and groundwater modelling undertaken as part of the revised Project's EIS and as described in **Section 7.2 and Section 6.1.1** of this report.

Given the duration of the revised Project, site specific water balances for different periods of the revised Project life are provided for the following times:

- End of 2012 (i.e. in consideration of the existing Mine and prior to implementation of the revised Project);

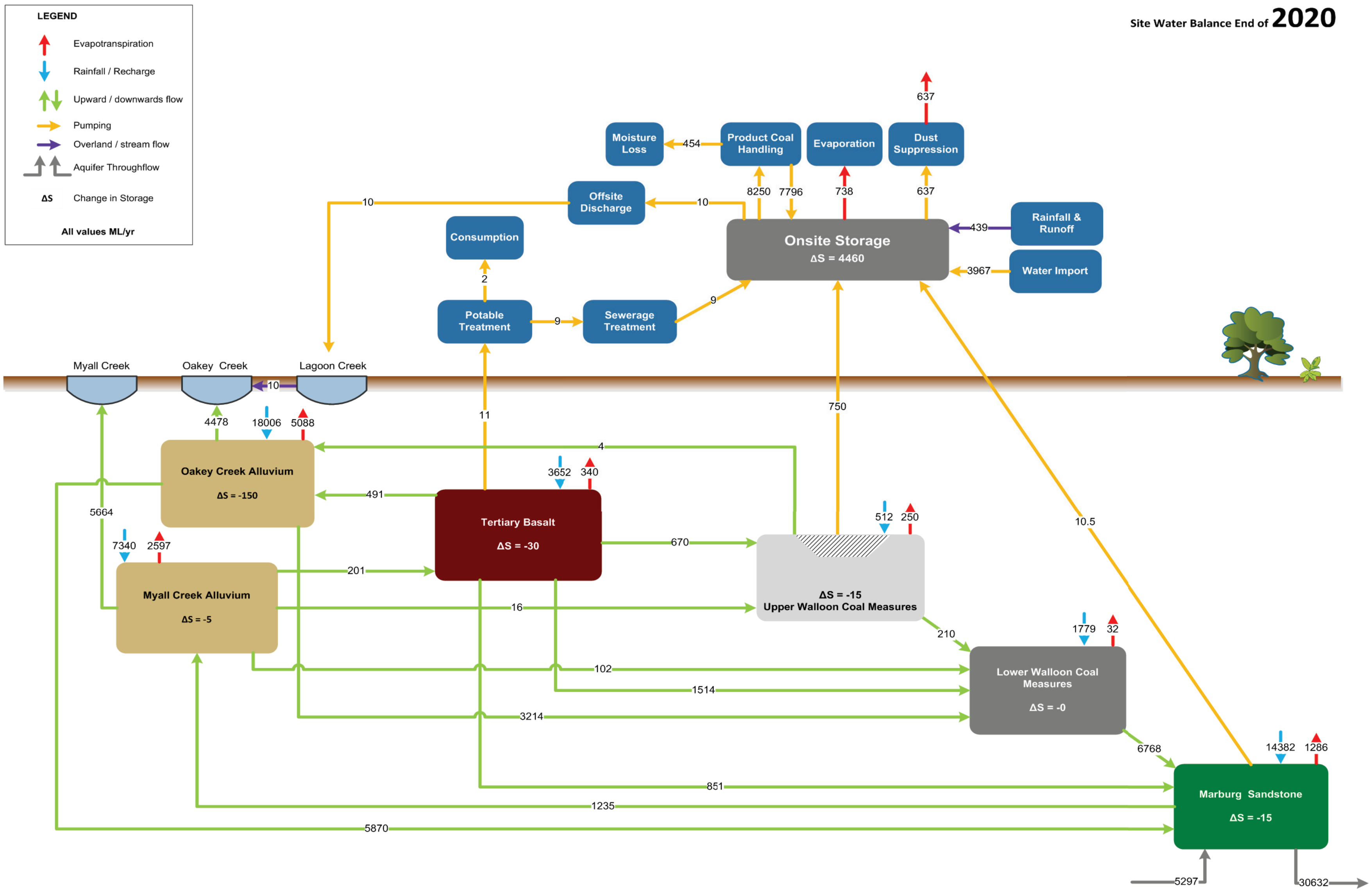
- End of 2020 (approximately half way through the revised Project's operation);
- End of 2029 (at the end of operation of the revised Project); and
- End of 2129 (100 years post-mining).

The results of the site water balances are presented in **Figure 8-3** through **Figure 8-6**.



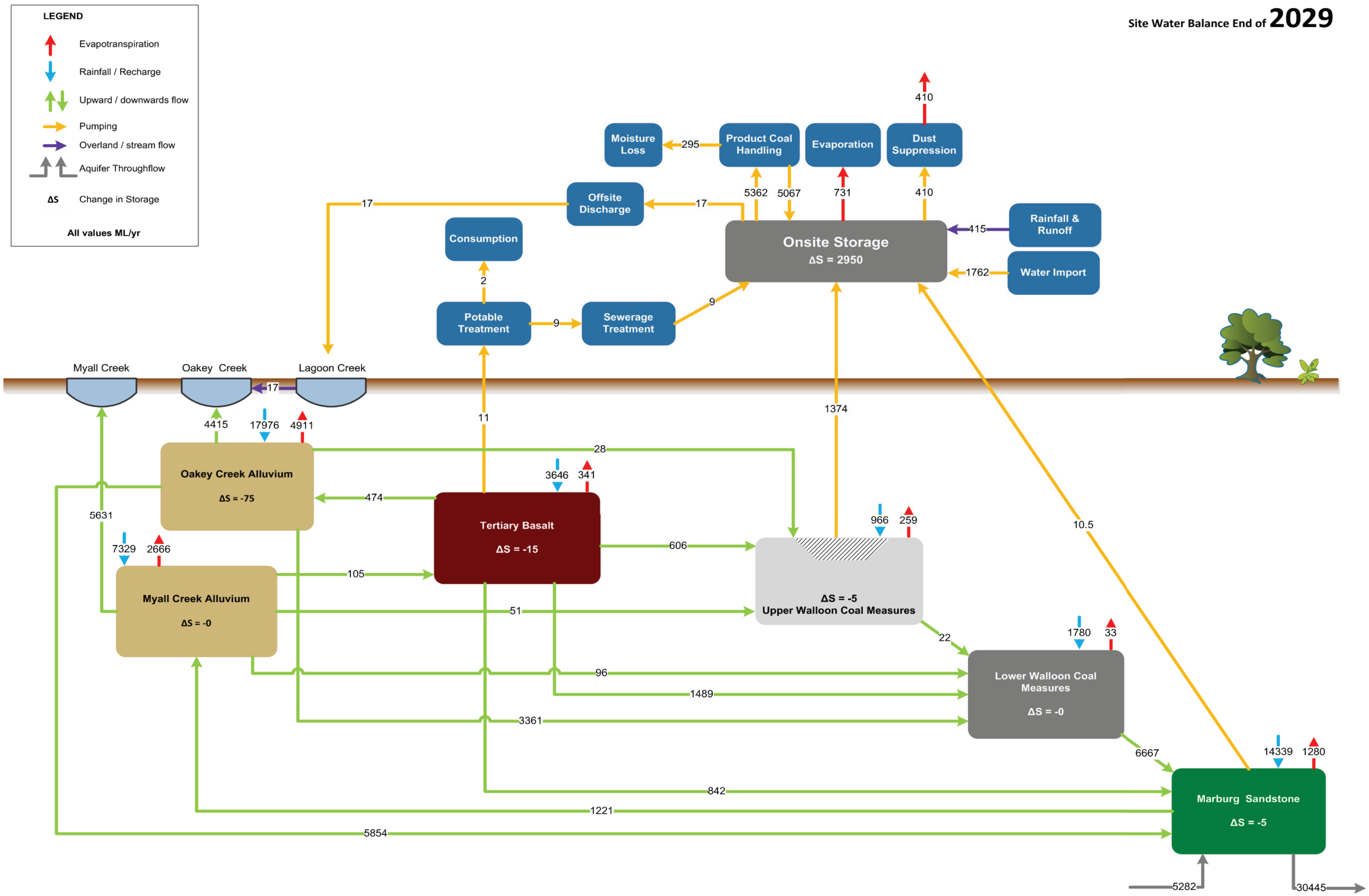
Note: Surface water balance derived from site water balance modelling; see Section 7.5
Groundwater balance derived from (and representative of) sub-regional groundwater modelling; see Section 6.1

Figure 8-3 Site Water Balance for the end of 2012



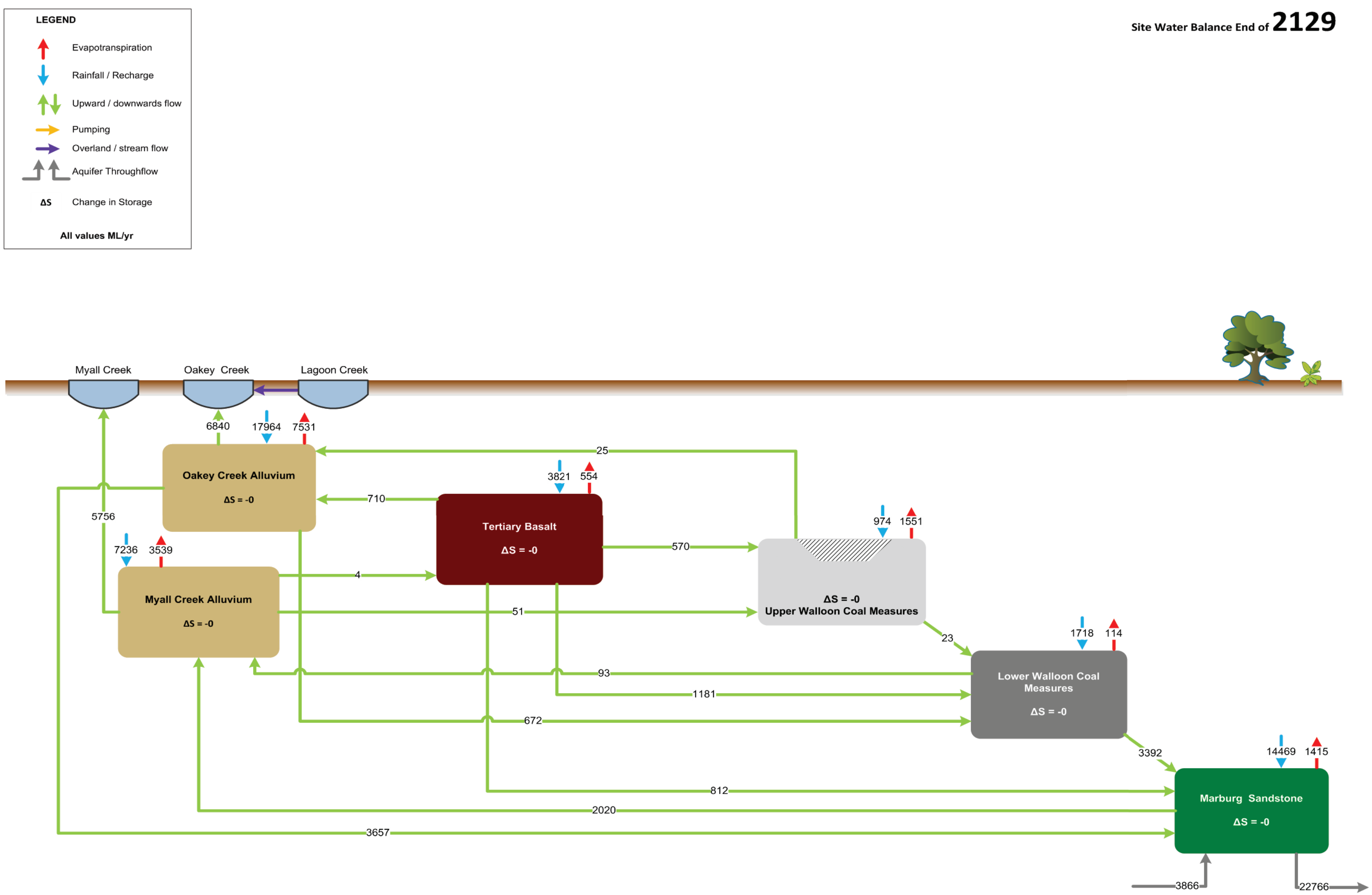
Note: Surface water balance derived from site water balance modelling; see Section 7.5
Groundwater balance derived from (and representative of) sub-regional groundwater modelling; see Section 6.1

Figure 8-4 Site Water Balance for the end of 2020



Note: Surface water balance derived from site water balance modelling; see Section 7.5
Groundwater balance derived from (and representative of) sub-regional groundwater modelling; see Section 6.1

Figure 8-5 Site Water Balance for the end of 2029



Note: Surface water balance derived from site water balance modelling; see Section 7.5
Groundwater balance derived from (and representative of) sub-regional groundwater modelling; see Section 6.1

Figure 8-6 Site Water Balance for the end of 2129

9 Mitigation Measures

This Section describes the measures proposed to mitigate the potential effects assessed in **Section 6** and **Section 7**.

9.1 Groundwater Monitoring Program

The groundwater monitoring program for the revised Project combines the current monitoring program for the existing Mine with an extended network of monitoring bores enclosing the revised Project site. Data collected from the groundwater monitoring program will:

- be operated in accordance with the revised Project's approved EA, including adoption of suitable guideline criteria and temporal investigation;
- be used in the continued development and refinement of groundwater impact assessment criteria and investigation triggers;
- enable verification and refinement (where necessary) of the groundwater modelling predictions presented in this EIS; and
- be collated into a database that will be made available to the administering authority on request.

The current groundwater monitoring program conforms to Conditions C21 to C33 of the current EA EPML00335713 for New Acland Coal Mine. **Table 9-1** summarises the bores that will be monitored, monitoring parameters, and frequency. The groundwater monitoring program combines the existing Mine monitoring bores together with the seven additional bores already installed around the revised Project site.

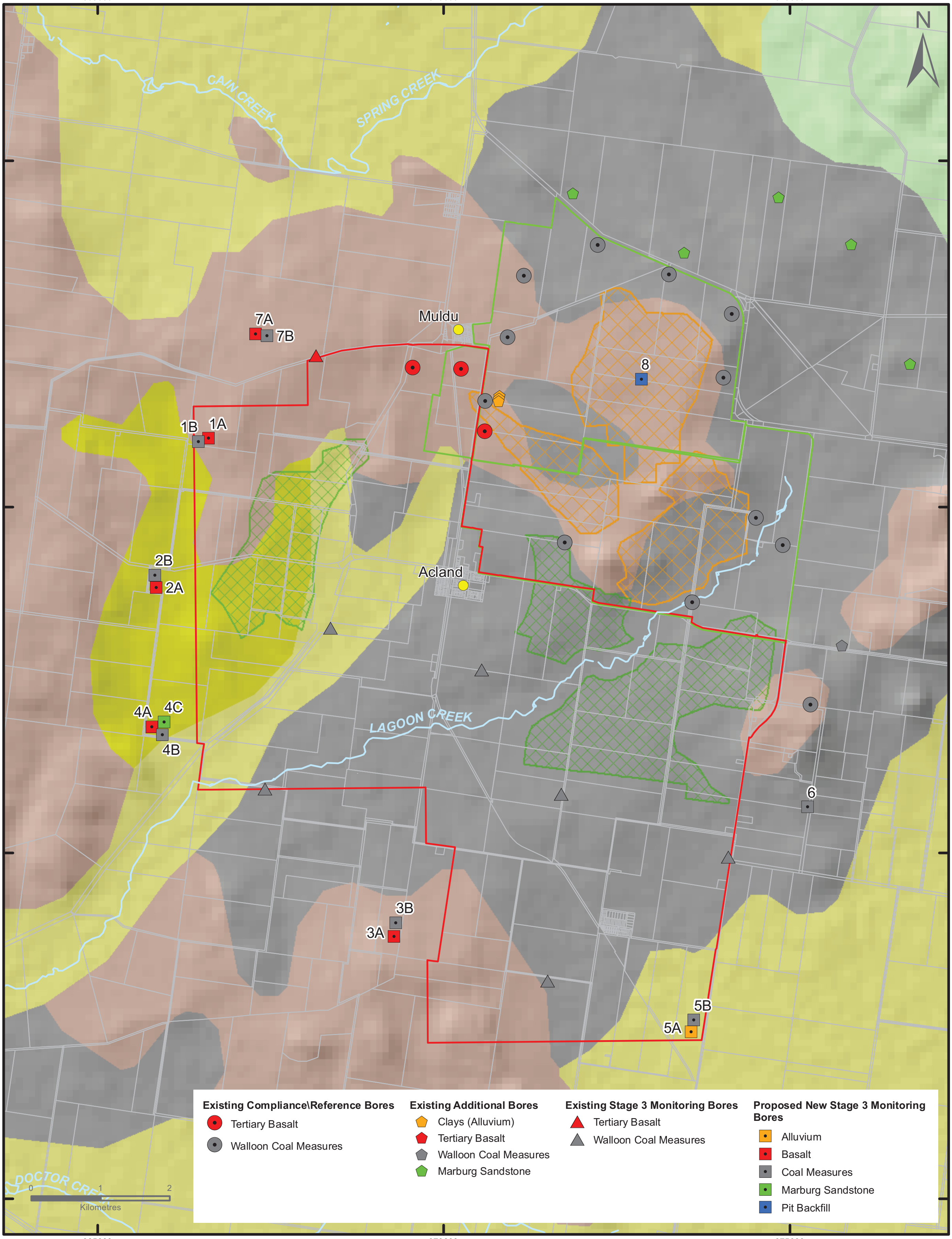
In addition, a further 15 bores will be added to the monitoring network, which brings the total number of bores included in the groundwater monitoring program to 37. The monitoring program for new bores will be established prior to the commencement of mining to ensure there is sufficient baseline information on groundwater levels and quality for those bores.

The locations of the monitoring bores in **Table 9-1** are presented in **Figure 9-1**. Proposed additional monitoring bore locations have been chosen based on model drawdown predictions and presence of aquifers and receptors of interest. For example, new nested monitoring bores are proposed to be installed immediately west of the Manning Vale West pit area where model results indicate significant drawdown in the Walloon Coal Measures, Tertiary Basalt and some drawdown in the Marburg Sandstone. Installation of nested monitoring bores in these locations will allow early detection of impacts from mining in both the Tertiary Basalt and Walloon Coal Measures aquifers, and also provide information on the degree of interconnectivity of these two aquifers as mining progresses. In the southeast of the revised Project site, nested monitoring bores will be installed into the Oakey Creek Alluvium and the Walloon Coal Measures aquifer, to confirm model predictions of limited groundwater impact in those areas.

Table 9-1 Groundwater Monitoring Schedule

Monitoring Point	Aquifer	Parameter and Monitoring Frequency
Bores monitored under current monitoring program (Compliance bores)		
2289P	Coal Measures	Groundwater levels: **monthly**. Groundwater quality: **six monthly** to include: Al, As, Ca, Se, Cl, Cu, F, Fe, Total N, K, Mg, Mn, Na, SO_4, HCO_3, TDS, EC, pH
2291P	Coal Measures	
18P	Coal Measures	
25P	Basalt	
26P	Coal Measures	
27P	Coal Measures	
28P	Coal Measures	
843	Basalt	
848	Coal Measures	
81P	Coal Measures	
82P	Coal Measures	
83P	Coal Measures	
84P	Basalt	
BMH1	Basalt	
CSMH1	Coal Measures	
Existing monitoring bores to be incorporated into the revised Project's monitoring program		
109P	Basalt	Groundwater levels: **monthly**. Groundwater quality: **six monthly** to include: Al, As, Ca, Se, Cl, Cu, F, Fe, Total N, K, Mg, Mn, Na, SO_4, HCO_3, TDS, EC, pH
114P	Coal Measures	
116P	Coal Measures	
117PGC	Coal Measures	
118P	Coal Measures	
119PGC	Coal Measures	
120WB	Coal Measures	
Proposed additional monitoring points which will be monitored as part of the revised Project's monitoring program		
1A	Basalt	Groundwater levels: **monthly**. Groundwater quality: **six monthly** to include: Al, As, Ca, Se, Cl, Cu, F, Fe, Total N, K, Mg, Mn, Na, SO_4, HCO_3, TDS, EC, pH
1B	Coal Measures	
2A	Basalt	
2B	Coal Measures	
3A	Coal Measures	
3B	Coal Measures	
4A	Oakey Creek Alluvium	
4B	Coal Measures	
5A	Oakey Creek Alluvium	
5B	Coal Measures	
6	Coal Measures	
7A	Basalt	
7B	Coal Measures	
8	Mine Pit Backfill	

Aluminium (Al), Arsenic (As), Selenium (Se), Copper (Cu), Fluorine (F), Iron (F), Total Nitrogen (Total N), Manganese (Mn); Calcium (Ca), Chloride (Cl), Potassium (K), Magnesium (Mg), Sodium (Na), Sulfate (SO4), Bicarbonate (HCO3), Carbonate (CO3), Total Dissolved Solids (TDS), Electrical Conductivity (EC); Acidity/Alkalinity (pH).



LEGEND

- Towns and Localities
- Watercourse
- New Acland Coal Mine
- New Aland Coal Mine-Stage 3
- Existing Permission
- Stage 3 Pit Areas
- Cadastre

Dominant Geology

- Basalt (Tm)
- Alluvium (Qa)
- Colluvium (TQs)
- Walloon Subgroup (Jw)
- Marburg Sandstone (Jbm)

NEW HOPE GROUP

SINCLAIR KNIGHT MERZ SKM

NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 9-1 - Proposed Groundwater Monitoring Locations

Scale 1:75,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

Path: I:\QENV2\Projects\QE06644\Spatial\ArcGIS\01_Figures\01_SEIS\ESC_Submission\131126_NewHope_IESC_Figure9-1_ProposedMonitoringLocations.mxd

Produced: 26/11/2013

In addition, a single monitoring bore is proposed to be installed within the Mine's existing worked pit backfill area, given the apparent presence of a developing groundwater mound in this area. The final location of the proposed additional bores may vary slightly depending on land access and proximity to local groundwater users. These bores will be individually identified in accordance with the bore naming convention at the revised Project site.

The groundwater monitoring network will:

- be installed and maintained by a person possessing appropriate qualifications and experience in the fields of hydrogeology and groundwater monitoring program design to be able to competently make recommendations about these matters;
- be constructed in accordance with methods prescribed in the *"Minimum Construction Requirements for Water Bores in Australia"* (National Uniform Drillers Licensing Committee, 2012) by an appropriately qualified driller; and
- include a sufficient number of 'bores of compliance' that are located at an appropriate distance from potential sources of impact from mining activities and provide the following:
- representative groundwater samples from the uppermost aquifer;
- background water quality in hydraulically up-gradient or background bore(s) that have not been affected by any mining activities conducted by NAC; and
- the quality of groundwater down gradient of potential sources of contamination.

Groundwater monitoring will be undertaken by appropriately qualified personnel. Groundwater level measurements, sample collection, storage and transportation will be undertaken in accordance with procedures conforming to the current industry standard: AS/NZS 5667.1, .11 1998.

The data gathered from the groundwater monitoring program will be collated into a database which will include:

- a site plan showing sample locations;
- tabulated results of the monitoring compared with applicable background/trigger levels;
- all data collected during each monitoring round;
- a record of chain of custody of the samples from sampling through to analysis;
- laboratory analysis certificates;
- groundwater monitoring program reports, and
- a description of the procedures, methods and calculations used.

Groundwater sample analysis will continue to be undertaken by a laboratory accredited by the National Association of Testing Authorities (NATA). Field measurement of water quality parameters will continue to be undertaken using appropriate field equipment that is maintained and calibrated in accordance with the manufacturer's recommendations.

Data collected from landholder bores, wells, and waterholes will be used in conjunction with the groundwater impact investigation procedure to determine if contingency measures are required.

9.1.1 Alluvium

The nearest alluvium with significant groundwater supplies is associated with Oakey Creek south of the revised Project site. A new monitoring bore installed at location 5A (**Table 9-1** and shown on **Figure 9-1**) will monitor groundwater levels and quality in the Oakey Creek Alluvium within the Project's southern boundary.

9.1.2 Basalt

Eight basalt bores will be monitored, including five new bores (**Table 9-1** and shown on **Figure 9-1**).

9.1.3 Walloon Coal Measures

The groundwater monitoring program includes 25 bores in the Walloon Coal Measures (**Table 9-1** and shown on **Figure 9-1**), including seven new bores.

9.1.4 Marburg Sandstone

Due to the lack of predicted impacts on the Marburg Sandstone aquifer arising from the revised Project, only one additional monitoring bore is proposed for this aquifer to confirm those predictions. This bore is located west of the revised Project site and is located in a nested configuration adjacent proposed monitoring bores in the Tertiary Basalt and Walloon Coal Measures aquifers (**Table 9-1** and shown on **Figure 9-1**).

9.1.5 Pit Backfill

Due to the apparent presence of a developing groundwater mound in the existing Mine's backfilled pit area, a groundwater monitoring bore (**Table 9-1** and shown on **Figure 9-1)** will be installed in the mound area to directly test for its presence and monitor its development over time. Groundwater levels will be monitored on a monthly basis and samples will be collected and submitted for the analytical suite set out in **Table 9-1** every six months.

9.2 Landholder Bores

Groundwater monitoring will be undertaken at selected landholder bores surrounding the revised Project site, following consultation with relevant landholders. Primarily this will include monitoring of groundwater levels and groundwater quality in conjunction with metering groundwater abstraction rates at suitable bores in order to assess potential groundwater level impacts from mine dewatering in the context of any variations to bore pumping rates. Landholder bores targeted for monitoring will be selected based on a thorough review of bores within the predicted drawdown impact zone. **Section 9.4** details the approach for managing impacts on landholder bores in further detail.

9.3 Groundwater Impact Prediction, Validation and Review

During the life of the revised Project, data collected through the groundwater monitoring program, will be used to update and refine the revised Project's groundwater model and it's predictions to reflect the actual activities undertaken on site (e.g. mine development and sump locations).

The need to review and update the revised Project's model will depend on the stage of the revised Project's mine development, changes in the depth of working, and availability and results of new monitoring data. For example, at the conclusion of the installation program for new monitoring bores as detailed in **Section 9.1**, the data collected from the monitoring program will be used to immediately refine the model and produce a revised impact assessment. **Table 9-2** presents the proposed schedule for groundwater impact prediction, validation and review.

The results of the groundwater model verification and refinement, or the justification that this action is not necessary, will be documented, and as required, presented to the DNRM (regulatory authority).

Table 9-2 Schedule for Groundwater Impact Prediction, Validation and Review

Model Revision	Timing
Initial Review	At the conclusion of the revised monitoring network installation program
2nd Review	After one (1) year of operation of the revised Project
3rd and subsequent Reviews	Every three (3) years or if water level drawdown monitoring results exceed model predictions at any time of the revised Project operation

9.4 Mitigation Measures for affected Groundwater Users

NAC will undertake a program of works to characterise and assess predicted impacts on individual groundwater users within the predicted drawdown area. The work program will have the primary outcome of determining the most appropriate means of 'Make Good' for individual users should groundwater monitoring validate model predictions of groundwater effects on those users. Results of this characterisation work will also feed into the first revision of the groundwater model where possible.

If required in these circumstances, NAC will provide an alternative water supply arrangement to affected third parties. Due to the progressive nature of drawdown within aquifers, the provision of alternative supplies may be staged. Options for possible alternative supplies include:

- the deepening and / or refurbishment of existing bores;
- the installation of new pumps capable of extracting groundwater from greater depths within existing bores;
- the installation of a new bores at other locations on the affected landholder's property; and
- the installation of a new high yielding 'community bore' and subsequent pipeline to multiple affected landholders.

NAC will implement a groundwater monitoring regime aimed at identifying possible effects to neighbouring groundwater users from the revised Project's operations (i.e., in relation to drawdown levels and water quality). NAC will review and update its groundwater monitoring regime on a regular basis in line with the progression of mining over the life of the revised Project. The revised Project's groundwater monitoring regime will be periodically updated in NAC's current Environmental Monitoring Plan, which forms a supporting document to the NAC Plan of Operations.

NAC will investigate all groundwater complaints related to the revised Project both during the operational phase and following mine closure. NAC will ensure all legitimate groundwater complaints are addressed in an expedient manner.

NAC has developed a Groundwater Monitoring and Impact Management Plan (GMIMP) to formalise the management of the revised Project's potential impacts on the surrounding groundwater environment. The GMIMP is based on the groundwater impact assessment work completed for the revised Project's EIS. The GMIMP will be regularly reviewed over the life of the revised Project, and as required, will be updated based on monitoring results, new outputs from revisions to the groundwater modelling and any other applicable groundwater management matters that relate to operation of the revised Project. The GMIMP will form a supporting document to NAC's Plan of Operations for the revised Project and is provided in **Appendix F**.

9.5 Surface Water Management Intent

The 'management intent for waters' is set out in Section 14 of the *Environmental Protection (Water) Policy 2009* (EPP Water). This section of the EPP Water sets out what NAC is required to take into consideration when proposing to release waste water, in this case water from the Environmental Dams, to a watercourse.

The EPP Water states the following.

High Ecological Value Waters – the measures for the indicators for all environmental values are maintained.

Slightly Disturbed Waters – the measures for the slightly modified physical or chemical indicators are progressively improved to achieve the water quality objectives for high ecological value water.

Moderately Disturbed Waters – if the measures for indicators of the environmental values achieve the water quality objectives for the water—the measures for the indicators are maintained at levels that achieve the water quality objectives for the water.

If the measures for indicators of the environmental values do not achieve the water quality objectives for the water—the measures for indicators of the environmental values are improved to achieve the water quality objectives for the water.

Highly Disturbed Waters – the measures for the indicators of all environmental values are progressively improved to achieve the water quality objectives for water.

Based on the above parameters and those EVs outlined for Lagoon Creek in **Section 4.6.2**, all values were either slight to moderately disturbed due to historical land use practices, such as stock access, land clearing and agriculture. This assessment is supported with the water quality data collected in **Section 4.6** also indicating that the majority of samples, including those taken upstream of the Mine exceeded ANZECC and QWQG criteria.

It is the intention of the NAC to minimise the impact on Lagoon Creek where the mining operation has an influence, and to ensure that practices do not further degrade the environs. The measures undertaken to ensure these outcomes are achieved are discussed in **Section 9.6** below.

9.6 Surface Water Mitigation Measures

The key activities that will require mitigation measures to prevent or minimise adverse water quality impacts during construction are:

- hydrocarbon spills from the CHPP area, vehicles and other plant and equipment contaminating surrounding water with chemicals, hydrocarbons, oil and grease;
- clearing of vegetation and stripping of top soils;
- handling and storage of fuels during construction and operation and;
- any releases of water from the site and site sedimentation dams.

Work methods will be developed and included in the Contractor Environmental Management Plans. These methods will detail appropriate control and mitigation measures for the revised Project. In addition to these measures, the specific environmental management conditions will be implemented to mitigate the impacts of the construction of the railway line crossing of Lagoon Creek. The following outlines the major mitigation measures that will be implemented where practicable during the construction phase. Importantly, current good practice erosion and sediment control measures will be provided as outlined in the Institution of Engineers publication *IECA Best Practice Erosion and Sediment Control Guidelines* (2008) to comply with the EPP (Water). These measures include:

- construction work in creeks will be undertaken in dry weather and conditions of minimal or no flow;
- weather conditions will be monitored so that work in creek crossings and erosion prone areas will not take place if rain and/or extreme weather (e.g. storms) are forecast;
- sedimentation fences and bunds will be used to contain fill or excavated material during construction;
- fill and excavated material will be stockpiled away from gully heads, active creek banks, bank erosion or other unstable areas;
- local runoff from disturbed areas will be routed clear of disturbed areas;
- assessment of the integrity and effectiveness of erosion control measures will be undertaken at regular periods and following significant rainfall events; and
- if required the erection of temporary waterway barriers during construction will include the provision to transfer flows from upstream of the works to the downstream channel without passing though the disturbed construction site.

Operational activities that have the potential to compromise water quality conditions at and downstream of the revised Project site, including the following:

- runoff from disturbed areas conveying increased sediment load and pollutant load to the site's sediment dams;
- operation and management of bunded fuel tanks, dangerous goods containers, hazardous chemicals and workshop wastes (batteries, oil filters), and handling and storage of fuels on site; and
- controlled releases from the revised Project's Sediment and/or Environmental Dam(s).

The controls to mitigate potential environmental impacts from operational activities are detailed in the revised Project's EM Plan (**Chapter 21** of the revised Project's EIS). The following management strategies will be implemented by the revised Project to protect surface water quality and the downstream receiving environment

- An operational separation distance of approximately 150 m will be maintained from the edge of the mining pits to Lagoon Creek, which will include a 50 m conservation buffer where no mining activities will be undertaken.
- The current conservation zone, 50 m either side of Lagoon Creek, from the Mine will be extended into the revised Project site to promote the re-establishment of the riparian zone. No mining activities will occur within the proposed conservation zone.
- Sediment dams, environmental dams, pit water storage and other water management structures (e.g. bunds and drains) will be used appropriately by the revised Project as per the water management plan (WMP).
- The revised Project's water management will be based on the separation and management of clean and dirty water catchments where practicable.
- Water capture within the revised Project's clean areas will be diverted around operational areas and where practical, allowed to discharge off site as part of normal overland flow.
- Water from disturbed areas within the revised Project site will be diverted to sediment dams for treatment and possible reuse as a supplementary supply for the revised Project's water requirement.
- Surface runoff from the revised Project's potentially contaminated areas, such as infrastructure areas, will receive additional levels of treatment (e.g. oil-water separators and bunding). Water captured by these devices will be preferentially reused on site, while captured oil will collected for recycling by a licensed contractor.
- Progressive rehabilitation will be undertaken as the revised Project's operational areas become available to reduce the amount of disturbed areas.
- Fuel, dangerous goods and hazardous chemicals will be managed as outlined by current standards, guidelines and in compliance with statutory requirements.
- Refuelling locations and handling of fuels will be undertaken away from all waterways including creeks and drainage paths.
- NAC's existing SOP for spills and emergency response procedures will be expanded to incorporate the revised Project. Spill recovery and containment equipment will be available when working adjacent to sensitive drainage paths and within other areas, such as workshops.
- NAC will continue to commit to investigating all legitimate surface water complaints, and if a genuine problem is identified, conduct immediate remediation measures and establish standard operating procedures to minimise the possibility of a reoccurrence of the original issue.
- NAC's current water quality monitoring program will be expanded to incorporate the operational and decommissioning phases of the revised Project. The program is designed to ensure the WMP is effective, to demonstrate compliance with the Mine's strict discharge limits, and to ensure the downstream water quality (physico-chemical parameters, at a minimum) is not being adversely impacted. In general, the monitoring program will include the following actions.

- Water quality will be measured upstream and downstream of the revised Project site. Basic water quality indicators (i.e. Salinity, pH, DO, EC, temperature) will continue to be monitored on a monthly basis, or when water is present, and heavy metals, nutrients, anions and cations monitored twice annually.
- During any release event, the receiving water will be monitored upstream (50 m to 100 m upstream of the release point) and downstream (200 m downstream of the release point) locations. Water quality variables will include basic water quality indicators, suspended solids, heavy metals, nutrients, anions and cations.
- Progressive rehabilitation of areas impacted by operational activities will be undertaken as soon as practical in order to reduce the amount of exposed soil.
- Fuel, dangerous goods, hazardous chemicals and work shop wastes will be managed to ensure compliance with current industry standards and guidelines for safety and environmental protection. These management actions will focus on handling, storage, spill containment, emergency response, establishment of 'standard operating procedures' for key operational aspects, and development of a responsibility matrix for operational and reporting matters.

As per the management intent under the EPP Water, where possible NHG will seek to improve the environmental values of the Lagoon Creek catchment through the preservation of the main channel and the riparian zone 50 m either side of the creek. The NHG's implementation of the above management strategies for surface water management under normal circumstances will minimise the risk of adverse impacts to the water quality of Lagoon Creek, Oakey Creek and the Condamine River downstream of the revised Project.

A WMP will be developed for the revised Project to ensure the protection of surrounding waterways (downstream receiving environment).

10 Summary of Impacts to Water Resources and Risk Assessment

10.1 Summary of Potential Impacts

The outcomes of the surface and groundwater impact assessments as presented in **Section 7** and **Section 6** of this report and are summarised below. Potential impacts on water resources include:

- Groundwater drawdown leading to a reduction of groundwater levels and in turn bore yields for anthropogenic users within 8 km of the revised Project site.
- Groundwater drawdown leading to a reduction of groundwater levels and in turn baseflow to surface water features outside the revised Project site.
- Alteration of the natural overland and stream flow patterns within the revised Project site.
- Persistent organic chemicals, heavy metals or other potentially harmful chemicals accumulating in the surface water aquatic environments within and downstream of the revised Project site.
- A reduction in water quality within and downstream of the revised Project site through controlled or uncontrolled releases from the mine water management system.
- Increased sediment load in surface water features during mine construction.

The following presents a risk assessment for each one of the identified potential impacts to water resources arising from the revised Project.

As outlined in **Section 8**, prediction of regional cumulative impacts to water resources from other resource projects has been undertaken by the OGIA as part of the Surat CMA UWIR. Those impacts relate to projects located at least 32 km west of the revised Project and do not extend to the revised Project site or overlap with impacts presented in **Section 6**. Impacts arising from the revised Project are considered minor and localised in comparison to those predicted in the UWIR. As such, for the purpose of the risk assessment, water resource impacts related revised Project are considered isolated from those predicted in the UWIR.

10.2 Risk Assessment

A qualitative risk assessment has been undertaken on the potential for water resource values to be impacted by the revised Project. The potential risk to the water resources values is based on a consideration of both the:

- severity of the potential impact – this takes into account both the potential nature of the impact and the sensitivity of the water value.
- likelihood of an impact (probability) – takes into account both the potential for the impact to occur to the receptor or water value and presence of the receptor or value.

The resulting risk classification is the designation of risk is based upon the combination of both:

a) the magnitude of the potential consequence (i.e. severity), and

b) the magnitude of probability (i.e. likelihood of the impact) [takes into account both the presence of the impact and receptor and the integrity of the connection or pathway]

Once having defined the consequence and probability of an impact to a water value, the matrix shown in the **Table 10-1** below is used to provide a classification of the risk.

Table 10-2 provides a qualitative assessment and summary of risks to water resource environmental values identified in relation to the revised Project. The assessment is based on the information presented in the preceding sections of this report.

Table 10-1 Risk Assessment Matrix

		Consequence \ Severity			
		Severe	**Medium**	**Mild**	**Minor**
Probability (Likelihood)	**High likelihood**	Very high risk	High risk	Moderate risk	Low risk
	Likely	High risk	Moderate risk	Moderate / Low risk	Low risk
	Low likelihood	Moderate risk	Moderate / low risk	Low risk	Very low risk
	Unlikely	Moderate / low risk	Low risk	Very low risk	Very low risk

Very high risk
There is a high probability that severe impact could arise without remedial action,

High risk
Harm or impact to a receptor or water value is likely to arise from an identified effect from the site without remedial action.

Moderate risk
It is possible that harm or impact to a receptor or a water value could arise from an identified effect from the site. However, it is either relatively unlikely that any such harm would be severe, and if any harm were to occur it is more likely, that the harm would be relatively mild.

Low risk
It is possible that harm or impact to a receptor or a water value could arise from an identified effect, but it is likely that at worst, that this harm if realised would normally be mild.

Very low risk
There is a low possibility that harm or impact to a receptor or a water value could arise, but it is likely that at worst, that this harm if realised would normally be mild or minor.

No potential risk
There is no potential risk if no link can be established between a receptor or a water value and an effect from the site.

Table 10-2 Qualitative Risk Assessment

Potential effect from revised Project	Potential Environmental Value of Water	Associated Impact [Consequence\Severity]	Likelihood of Occurrence	Risk to Water Value
Reduction in water availability as a result of lowering groundwater potentiometric surfaces (i.e. drawdown) as a result of pit inflows, pumping activities, and ongoing long term discharges to rehabilitated depressed landforms (final voids).	**Water supply - Alluvium:** groundwater use for agricultural and domestic purposes	A reduction of groundwater level at supply bores and in turn reduction in yield. The vast majority of groundwater allocations within 8 km of the revised Project are within the alluvium [**Severe**]	**Unlikely**: No alluvial bores are located within the simulated impact zone.	**Moderate / Low Risk**
	Water supply - Basalt: groundwater use for stock and domestic purposes	Reduction of groundwater level at supply bore and in turn reduction in yield. Predicted drawdowns range from minor to large dependent upon location. However total water allocation\use is relatively small and can be mitigated [**Minor\Medium**]	**Likely**: Some bores within the Basalt are located within the simulated impact zone. Some of these bores are owned by NHG.	**Moderate / Low Risk** (bores between 3 and 7 km of the revised Project's western boundary) **Moderate Risk** (bores within 3 km of the revised Project's western boundary)
	Water supply - Walloon Coal Measures: groundwater mainly for livestock use	Reduction of groundwater level at supply bore and in turn reduction in yield. Predicted drawdowns range from minor to large dependent upon location. However total water allocation\use is relatively small and can be mitigated [**Minor\Medium**]	**Likely**: Some bores within the Walloon Coal Measures are located within the simulated impact zone. Many of these bores are owned by NHG.	**Moderate / Low Risk** (bores between 3 and 7 km of the revised Project's western boundary) **Moderate Risk** (bores within 3 km of the revised Project's western boundary)
	Water supply - Marburg Sandstone: groundwater use for stock and municipal supplies	Reduction of groundwater level at supply bore and in turn reduction in yield. Predicted drawdowns are relatively small [**Medium**]	**Unlikely**: Some bores within the Marburg Sandstone are located within the simulated impact zone however the range of drawdown is so small (< 3m) that there will likely not be any net negative affect on bore yields.	**Moderate / Low Risk**
	Water supply - Helidon Sandstone: groundwater use for industrial supplies (1 user within 8	Reduction of groundwater level at supply bore and in turn reduction in yield. Minimal use of the aquifer for	**Unlikely**: the Helidon Sandstone is separated from the above aquifers by the thick Evergreen Formation	**Very Low Risk**

Potential effect from revised Project	Potential Environmental Value of Water	Associated Impact [Consequence\Severity]	Likelihood of Occurrence	Risk to Water Value
	km)	water supply within the study area. [**Minor**]	which acts as an aquitard.	
	Groundwater dependant ecosystems: springs, and wetlands supported to some degree by groundwater discharge.	Reduction in groundwater level resulting in loss of baseflow to ecologically sensitive wetlands and springs [**Severe**]	**Unlikely**: The adjacent creeks are ephemeral and when flowing considered most likely to lose flow to ground rather than be supported by groundwater discharge. No springs identified within area of impact. No local GDEs identified on the GDE Atlas.	**Moderate / Low Risk**
	Watercourses: watercourses supported to some degree by groundwater discharge	Reduction in groundwater level resulting in loss of baseflow to water courses reducing water supply availability. Minor increases in leakage are predicted. [**Minor**]	**Likely**: The adjacent creeks are ephemeral and when flowing considered most likely to lose flow to groundwater rather than be supported by groundwater discharge.	**Moderate / Low Risk**
		Reduction in biological diversity or change species composition as a result of impacts on water resources [**Severe**]	**Unlikely**: Only minor increases in leakage from surface water features are predicted.	**Moderate / Low Risk**
	Cultural and spiritual values: All wetland complexes are of material and cultural importance to indigenous people and many will have profound cultural significance and values.	Reduction in groundwater level resulting in loss of / changes to culturally significant wetlands, watercourses and springs [**Severe**]	**Unlikely**: No groundwater dependant ecosystems are present in the predicted zone of impact	**Moderate / Low Risk**

Potential effect from revised Project	Potential Environmental Value of Water	Associated Impact [Consequence\Severity]	Likelihood of Occurrence	Risk to Water Value
Persistent organic chemicals, heavy metals or other potentially harmful chemicals accumulating in the aquatic environments	**Aquatic environments:** biodiversity, ecological integrity, human health or other community and economic use	A reduction of biodiversity, ecological integrity, human health or other community and economic use as a result of reduced water quality. [**Medium**]	**Unlikely**: Both due to the revised Project's offset from Lagoon Creek, and the fact that releases from the mine water management system will be based on water quality targets as defined in the EMP.	**Low Risk**
Divert or impound rivers or creeks and\or alter catchment runoff	**Water supply:** watercourses downstream of the revised Project are used for water supply purposes.	A reduction in water availability due to changes in landform and runoff properties [**Minor**]	**Likely**: Onsite activities could have minor changes to base flow conditions within Myall and Oakey Creeks and their tributaries.	**Low Risk**
	Final Landform Flood Protection: the revised Project should not alter the downstream flooding characteristics (i.e. stage, frequency and\or duration).	A reduction in flood protection due to changes in final landform and runoff properties [**Minor**]	**Unlikely**: Modelling of Lagoon Creek indicates there are no flood impacts predicted for the revised Project's final landforms.	**Very Low Risk**
	Aquatic environments: biodiversity, ecological integrity, human health or other community and economic use	A reduction of biodiversity, ecological integrity, human health or other community and economic use as a result of reduced water quality. [**Medium**]	**Unlikely**: Both due to the revised Project's offset from Lagoon Creek, and the fact that releases from the mine water management system will be based on water quality targets as defined in the EMP.	**Low Risk**
	**Coastal and marine environments : ** coastal processes, including sediment movement or accretion, or water circulation patterns	Alter coastal processes, including sediment movement or accretion, or water circulation patterns. [**Minor**]	**Unlikely**: The revised Project is located far from the coast.	**Very Low Risk**

Potential effect from revised Project	Potential Environmental Value of Water	Associated Impact [Consequence\Severity]	Likelihood of Occurrence	Risk to Water Value
Increased sediment load or chemical spillage during construction	**Aquatic environments:** biodiversity, ecological integrity, human health or other community and economic use	A reduction of biodiversity, ecological integrity, human health or other community and economic use as a result of reduced water quality. [**Medium**]	**Unlikely**: Due to the revised Project's offset from Lagoon Creek	**Low Risk**
A reduction in water quality through controlled or uncontrolled releases from the mine water management system	**Aquatic environments:** biodiversity, ecological integrity, human health or other community and economic use	A reduction of biodiversity, ecological integrity, human health or other community and economic use as a result of reduced water quality. [**Medium**]	**Unlikely**: Both due to the revised Project's offset from Lagoon Creek, and the fact that releases from the mine water management system will be based on water quality targets as defined in the EMP.	**Low Risk**

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Appendix A. IESC Request for Advice Checklist - Cross Reference Tables

Table A1 Summary Details

Project Information	Description	Where discussed in this Document
Project Title	Project Name	Section 2.1
Date of Request	Date	Cover page
Requesting Organisation	Name of the requesting organisation (the Regulator)	Section 1.1
EPBC Act Referral	Reference (referral number, type – if EPBC referral)	n/a
Advice Stage	Stage of EIS process at which request has been made	Section 1.1
Request Details	Background to the referral and advice that is sought from the Committee	Section 1.1
Proponent Details	Proponent name	Section 2.1
Website Links	Links to web sites, including proponent website and documents	Section 2.1
Public Submission	Summary of public submissions	n/a

Table A2 Project Description

Project Information	Description	Where discussed in this Document
Project Location	Overview of project location, including geographical, geologic, river basin/catchment, hydro-geological basin	Section 2.2 Section 3.1
Project Description	Brief project description	Section 1
Project Type	Type of project that is being proposed (e.g. new project or extension) and type of operation (CSG, large coal mine)	Section 1
Resource	Geologic/ hydro-carbon resource that will be targeted	Section 1
Operation Area	Information to define the extent of the operation	Section 1
Establishment Activities	Relevant activities required to establish the proposed project	Section 1
Operation Details	How the project operations will be undertaken operationally	Section 1
Lifetime	Lifetime of the project	Section 1
Residual Site Condition	Expected site condition after decommissioning and proposed monitoring regime	Section 7
Site Rehabilitation	Outline of planned site rehabilitation works	Section 2.2.2

Table A3 Regional Water Balance Model

Project Information	Description	Where discussed in this Document
Regional Overview	Proponent's regional and site water balance model	Section 8
Regional Groundwater	Regional groundwater description	Section 1
Regional Surface Water	Regional surface water description	Section 4
Data Uncertainties / Data Integrity Issues	Level of certainty/uncertainty with respects to the information provided	Section 8.1

Table A4 Local Water Balance Model incorporating the Site

Project Information	Description	Where discussed in this Document
Site Overview	Pre-development baseline water resources	Section 8
Local and Site Groundwater Overview	Local groundwater description	Section 1
Local and Site Surface Water Overview	Local surface water description	Section 4
Data Uncertainties / Data Integrity Issues	Level of certainty/uncertainty with respects to the information provided	Section 3.14 Section 4.3.7 Section 6.1.1 Section 7.5.2

Table A5 Impacts of Development

Project Information	Description	Where discussed in this Document
Groundwater Impacts from Project Activities	Impacts to regional, local and site groundwater	Section 6
Surface Water Impacts from Project Activities	Impacts to surface water	Section 7
Landform and Land-use Change Impacts from Project Activities	Changes and impacts to landform, geomorphology and land-use	Section 7.2.3 Section 7.3 Section 7.4 Section 6.3.2
Water Related Assets of National Environmental Significance	Relevant impacts to water related Matters of National Environmental Significance for surface and groundwater	Section 6 Section 7
Impacts on Other Water Related Assets	Assessment of direct and indirect impacts on other water related assets	Section 6 Section 7 Section 10

Project Information	Description	Where discussed in this Document
Data Uncertainties / Data Integrity Issues	Level of certainty/uncertainty with respects to the information provided	Section 4.3.6 Section 3.8.1

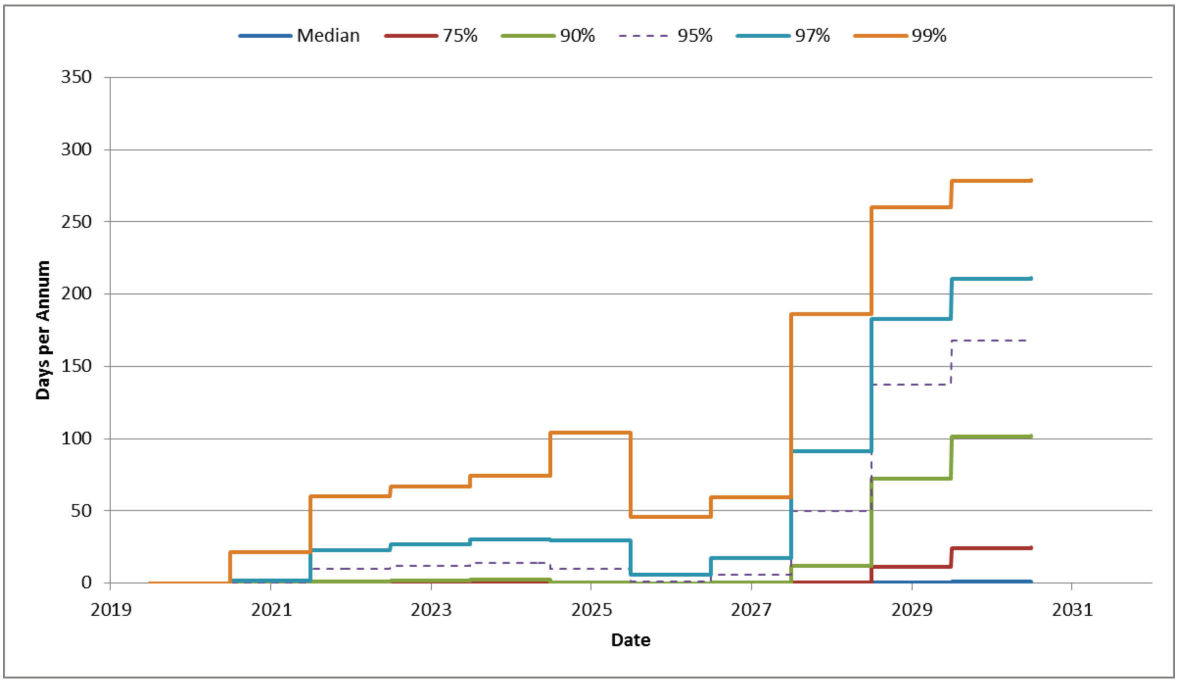
Table A6 Water Related Risk Assessment

Project Information	Description	Where discussed in this Document
Risk Assessment Overview	Overview of Risk Assessment method that has been used	Section 10
Risk Assessment	Assessment of the overall level of risk to water balance and water related assets	Section 10
Mitigation Measures	Proposed mitigation measures to address potential risks and/or impacts	Section 9
Residual Risks	Mitigation measures that have been provided for residual risk (including monitoring and reporting)	Section 10

Table A7 Cumulative Impacts

Project Information	Description	Where discussed in this Document
Regional Overview	Summary of CSG and large coal mine developments within the region. Catchment and regional scale information provided through the bioregional assessments or other relevant assessments	Section 8.1
Cumulative Risk Assessment	Cumulative risk assessment of the proposal, considering all relevant developments. Assessment of the overall cumulative level of risk to water related assets	Section 8 Section 10

Appendix B. Landholder Bore Survey Results



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Appendix C. Groundwater Quality Results (WSA, 2012)

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ESTABLISHMENT OF GROUNDWATER QUALITY BACKGROUND LIMITS (2012)

waste solutions
AUSTRALIA PTY LTD

NEW ACLAND COAL PTY LTD
RN12 / W316-14 / 01
December 2012

Document Control Summary Sheet

Title	Establishment of Groundwater Quality Background Limits (2012)
Document Type	Groundwater Report
Issued By	Waste Solutions Australia Pty Ltd (ABN 64 010 824 487)
Author/s	Patrick Mason Paul Smith
Client	New Acland Coal Pty Ltd (NAC)
Document ID	(RN12-W316-14/1-01)
Recipient	Thomas Sheppard

Revision Status				
Status	**Revision**	**Date**	**Author**	**Verified**
Final	0	19 December 2012	Patrick Mason	Paul Smith

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List of Acronyms/Abbreviations

NAC	New Acland Coal Pty Ltd
BOM	Bureau of Meteorology
DERM	Department of Environment and Resource Management (formerly EPA)
DEHP	Department of Environment and Heritage Protection (formerly DERM)
EA	Environmental Authority
EC	Electrical Conductivity
LOR	Limit of Reporting
mBTOC	meters Below Top Of Casing
NATA	National Association of Testing Authorities
QA	Quality Assurance
QC	Quality Control
RPD	Relative Percent Difference
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
WSA	Waste Solutions Australia Pty Ltd

1 INTRODUCTION

Waste Solutions Australia Pty Ltd (WSA) was commissioned by New Acland Coal Pty Ltd (NAC) to set background limits for monitoring bores within their compliance borefield network. This report includes background limits for monitoring bore CSMH1, with background limits for monitoring bores 2289, 2291, and BMH1 determined in the July 2012 revision of this report. It was determined following field investigations in the October 2012 routine monitoring round that bailing is the only suitable method to purge and sample CSMH1. Therefore data collected up to date from this bore can be considered acceptable and background values can be established for this bore as three years of data has been obtained (as stipulated in condition C31 in the site EA).

Setting of these background limits was conducted in accordance with sections C21 to C33 (specifically C31) of the Department of Environment and Heritage Protection (DEHP, formally DERM) Environmental Authority (EA #MIN100550507) effective 22 July 2011. It should be noted that the off-lease groundwater monitoring bores (BMH1 and CSMH1) are not required to have background limits set as stipulated in the NAC's EA (refer to C31), NAC are setting values for these bores at their own initiative.

Background limits have been set for all monitoring bores within the compliance network, with the exception of 25P (limited field data available as this bore regularly goes dry) and 26P (this bore has been historically dry during each monitoring round). Setting of these background limits was reported in *Establishment of Groundwater Quality Background Limits (WSA September 2008 and July 2012)*.This report will include the analysis and results outlined in these reports and will be a compendium of all results. The results from the WSA 2008 report were rechecked for the July 2012 revision and six errors were detected, these have now been corrected. Modification of these values has not resulted in any additional exceedances of routine monitoring results prior to and including the April 2012 monitoring round.

The location of the bores on-site is shown in Figure 1 Compliance Borefield Plan.

2 SCOPE OF WORK

The scope of works comprised of the following:

- Document the previous background limit determinations and historical correspondence with Department of Environment and Heritage Protection (DEHP) pertaining to these values.
- Compilation of analytical results and tabulation of new background limits for monitoring bore CSMH1. The background limits determined in WSA 2008 and those for 2289, 2291, and BMH1, determined in the July 2012 revision of this report, will remain unchanged.
- An encompassing report will be produced incorporating the data from WSA 2008 and 2012 and will include tabulation of new background limits results for monitoring bore CSMH1. This report will also be suitable for submission to DEHP. This data will be incorporated into the next round of routine groundwater monitoring at the NAC site (October 2012) for comparison with the new sampling data.

3 DEVELOPMENT OF BACKGROUND LIMITS

Background limits were developed for the following monitoring bores in WSA 2008: 16P (now decommissioned and replaced by 2291, with the first sampling in June 2009), 18P Coal, 27P, 28P, 81P, 82P, 83P, 84P, 843, and 848. 15P was decommissioned (due to inundation with water from the nearby environmental dam) and replaced by 2289 (with the first sampling in April 2009). The WSA 2008 derived background limits statistically analysed five years of data obtained from the compliance bores across the site. Background limits were developed for 2289, 2291, and BMH1 determined in the July 2012 revision of this report using data collected from 2008/2009 to April 2012.

This review has included the statistical assessment of information to identify trends and establish background limits for water quality parameters. The following sections describe the data used and the methodology chosen for derivation of the background limits.

3.1 Data Collection and Analysis

Data for the 2008 derived background limits was obtained principally from routine (6 monthly) groundwater sampling performed by WSA. Simmonds & Bristow Pty Ltd conducted laboratory analyses over this period. Data for the 2012 derived background limits was obtained from in-house sampling by NAC up to December 2010 when WSA undertook groundwater sampling; the only exception was the April 2008 sampling of BMH1 and CSMH1, which was undertaken by WSA. BMH1 and CSMH1 were not sampled over the period sampling was undertaken by NAC. As this bore is not required to have background limits determined, the smaller sample set for statistical analysis is not considered significant. Simmonds & Bristow Pty Ltd was used for sample analysis up to December 2010, and then from June 2011, Australian Laboratory Services (ALS) was used for sample analysis. Background limit values for 2289, 2291, and BMH1 were determined following the April 2012 routine groundwater monitoring round and values for CSMH1 were determined following the October 2012 routine groundwater monitoring round.

3.2 Statistical Analysis Methodology

A statistical analysis was performed using boxplots to analyse the variance of the data. Boxplots are used to highlight the centre and the symmetry of data sets as well as any outliers. Boxplots were generated from data collected at each compliance bore. The boxes shown on the plots for individual boreholes surround the area on the graph occupied by 80% of the sample results for each ion. This was done to help highlight any data points that are anomalously large or small, as they lie outside the box range. The generic boxplot is broken up into quartiles, with 50% of the data outlying the box area. With some of the sample ranges in these data sets only consisting of a small number of points then only three points would be left in the box. This small amount of data is not enough to establish a trend in the results. It was decided to select 80% as the cut-off value for the plotting of the data due to the limited size of the smaller data sets. However, the cut-off value is still high enough to highlight the extreme outliers on the graphs and remove them from the box without excluding relevant results. If values for all the data sets over time were below the laboratory limit of reporting (LOR), the LOR value has been adopted for the analyte value in absence of data.

Each background upper and lower limit nominated (refer to ***Appendix A***) was determined by selecting the maximum (90^{th} percentile) and minimum (10^{th} percentile) values in the box from each boxplot. These values, based on the statistical analysis, were selected as they provided the most conservative estimate of a value that is representative of the borehole location whilst not being an outlier. These are more realistic values than the mean or median value for the site. If the mean or median value had been taken as the baseline amount then there would be regular exceedances because half of the data that has been obtained at each bore location is over that value. This method discounts extreme outliers that are anomalous and are far too high to be used in generating a realistic background limit.

To produce these boxplots the median and lower and upper percentile cut-off values had to be calculated for each test parameter. As mentioned above, the majority of the lower and upper 10 percent of the data lie outside of the boxes. When the variation in data sets is very low, it is possible that the minimum and the bottom 10th percentile value are the same. The minimum and maximum 10th percentile values are used to determine the boundaries of the boxplots. The boxplots for all of the compliance bores can be seen in ***Appendix B***. Individual box plots were generated for each borehole for the following parameters:

- pH[1];
- Electrical conductivity (EC);
- Total Dissolved Solids (TDS);
- Major ions: calcium (Ca), , sodium (Na), potassium (K), chlorine (Cl), sulphate (SO4), bicarbonate (HCO3),
- Minor ions: Total Nitrogen (Total N), fluorine (F);
- Dissolved metals: aluminium (Al), arsenic (As), copper (Cu), iron (Fe), magnesium (Mg), manganese (Mn) and selenium (Se).

All of the data contained within the boxes is considered to be representative for that analyte for that compliance bore. It can be seen in the boxplots that these values vary from bore to bore for the same analyte. Variability in each parameter was considered too high when comparing multiple bore locations and was deemed to be unusable in establishing aquifer specific values. For this reason it was decided that the establishment of borehole specific data sets would be more appropriate. The historical data tables used to generate these statistics and the boxplots data are shown in ***Appendix C***.

The size of the boxes are indicative of the amount of variation in the data set, the larger the size of the box on the graph, the greater the variation in the values. The background limit ranges for each analyte in the compliance bores is determined to be between 10% less than to 10% greater than the box boundary values for the major ions. For the minor ions and metals the background limit ranges extends to 20% less than to 20% greater than the box boundary values for each analyte. These values were considered to reflect the individual hydrochemistry at each bore and provide an indicator if there is change in groundwater chemistry.

3.3 Correspondence with DEHP

After submission of Establishment of Groundwater Quality Background Limits (WSA

[1] Note that pH, as well as standing water level, do not require baseline limit determinations as stipulated in Schedule C – Table 7 in the EA. However, for completeness baseline limits have been determined for the analytical parameter pH.

September 2008), DEHP (then the Environmental Protection Agency) responded to NAC with comments on the derivation of the background limits as stated in the WSA 2008 report. This correspondence is provided in ***Appendix D***. WSA responded to these comments in two letters, dated 26th November 2008 and 8th January 2009 to NAC as provided in ***Appendix E***. These letters aimed to justify the statistical methodology used and no further correspondence was received from DEHP and has therefore been considered to have provided resolution to comments offered by the DEHP (former Environmental Protection Agency).

4 DISCUSSION

Most of the bores show elevated levels of aluminium and iron, as compared to other dissolved metal concentrations such as arsenic, copper and selenium. Levels of these parameters can become elevated following the field filtration process as very fine clay particles carrying metal ions pass through the standard 0.45-micron filter into the sample, skewing the concentration observed. Therefore, the concentration of these two parameters is likely controlled by physical processes (i.e. the level of sediment in the sample resulting from borehole purging), it was recommended in WSA 2008 that no background limits be placed on these two parameters, however for report completeness values, they have been derived.

At the time of compiling this report, two compliance bores (25P and 26P) listed in Schedule C Table 5: On-Lease Groundwater Monitoring Locations and Frequency within Environmental Authority # MIM800317705, have not yielded sufficient data to successfully generate background limits. This was due to the limited amount of samples collected from compliance bores 25P and 26P.

5 CONCLUSION & RECOMMENDATIONS

WSA has reviewed the appropriate sampling data for the compliance bores at the site and implemented a statistical assessment to produce background limits for each compliance bore. The compendium of the baseline limits, including the newly derived limits for monitoring bore CSMH1, are shown in ***Appendix A***. The technique of using boxplots to highlight the spread and symmetry of data sets is recognised and accepted. It is a commonly used method for statistical analysis.

The method of chemical data analysis yields both a ‘lower’ and ‘higher’ background value. With the exception of pH (which does not require determination of a background limit, however has been included for data completeness), any increase in concentration above the ‘higher’ value should be investigated. If concentrations decrease below the ‘lower’ background value, quality of water will be improving and hence should not be of concern.

After assessing the variation in the data from bore to bore, it was concluded that there was no possibility of having only one baseline limit per analyte for each aquifer across the whole site. It was decided that limits would be set for each individual bore.

6 LIMITATIONS

Waste Solutions Australia Pty Ltd has prepared this report for the use of New Acland Coal Pty Ltd and the Department of Environment and Heritage Protection in accordance with generally accepted consulting practice. No other warranty, expressed or implied, is made as to the professional advice included in this report. This report may not contain sufficient information for purposes other than for the client and its respective consulting advisers.

The accuracy of the assessment made in this report is dependent upon the accuracy and reliability of evidence drawn together from a number of sources. The field investigations on which this report is based were restricted to a level of detail appropriate for the project.

Waste Solutions Australia Pty Ltd has taken steps to ensure the accuracy and reliability of field observations and investigations. It is important, however, that the limitations of the assessment be clearly recognised when the findings of this study are being interpreted. This report is based on information derived partly from others over which Waste Solutions Australia Pty Ltd had no control.

Prepared by:

Patrick Mason
B Env Science
Environmental Scientist

Reviewed by:

Paul Smith
M Sc (Hydrogeo) M Sc (Envir Sc)
Director & Principal Consultant

Legend:

18c Bore Location and name, "c" refer to coal aquifer monitoring bore

Map courtesy of New Acland Coal

waste solutions AUSTRALIA PTY LTD			New Acland Coal Pty Ltd		
			Compliance Borefield Map		
			Establishment of Groundwater Quality Background Limits (2012)		
	Drawn by: PM	Approved: PS	Date: December 2012	Job: W 316-14	Figure 1

APPENDIX A

GROUNDWATER QUALITY BACKGROUND LIMITS

Borehole 18P (Coal)				
Analyte	**Units**	**Statistically Derived Background Limits**	**Actual Background Limits***	**Monitoring Frequency**
pH		7.28 - 10% to 8.61 + 10%	6.6 – 9.5	Half Yearly
EC	µS/cm	593 - 10% to 841 + 10%	534 – 925	Half Yearly
TDS	mg/L	333.8 - 10% to 961 + 10%	300 – 1057	Half Yearly
Ca	mg/L	6.7 - 10% to 18.1 + 10%	6 – 20	Half Yearly
Mg	mg/L	1.86 - 10% to 3.22 + 10%	1.7 – 3.5	Half Yearly
Na	mg/L	90.7 - 10% to 151 + 10%	82 – 166	Half Yearly
K	mg/L	2.64 - 10% to 5.24 + 10%	2.4 – 5.8	Half Yearly
Cl	mg/L	92 - 10% to 385 + 10%	83 – 424	Half Yearly
HCO3	mg/L	64 - 10% to 152.9 + 10%	58 – 168	Half Yearly
SO4	mg/L	5.45 - 10% to 18.4 + 10%	4.9 – 20	Half Yearly
F	mg/L	0.1 - 20% to 0.42 + 20%	0.08 – 0.51	Half Yearly
Al	µg/L	18.7 - 20% to 1350 + 20%	15 – 1620	Half Yearly
As	µg/L	2.59 - 20% to 9 + 20%	2.1 – 11	Half Yearly
Cu	µg/L	1.68 - 20% to 35.2 + 20%	1.3 – 42	Half Yearly
Fe	µg/L	108.9 - 20% to 1620 + 20%	87 – 1944	Half Yearly
Mn	µg/L	4.76 - 20% to 68.6 + 20%	3.8 – 82	Half Yearly
Se	µg/L	2 - 20% to 5.9 + 20%	1.6 – 7.1	Half Yearly
Total N	mg/L	0.434 - 20% to 3.26 + 20%	0.35 – 3.9	Half Yearly

* Please note that the Actual Background Limit values have been rounded. For values below 1 they are rounded to 2 decimal places, for values below 10 they are rounded to 1 decimal place and for values above 10 they are rounded to the nearest integer.

Borehole 27P (Coal)				
Analyte	**Units**	**Statistically Derived Background Limits**	**Actual Background Limits***	**Monitoring Frequency**
pH		7 - 10% to 7.6 + 10%	6.3 – 8.4	Half Yearly
EC	µS/cm	9080 - 10% to 10010 + 10%	8172 – 10110	Half Yearly
TDS	mg/L	5035 - 10% to 6412.2 + 10%	4532 – 7053	Half Yearly
Ca	mg/L	388 - 10% to 507 + 10%	349 – 558	Half Yearly
Mg	mg/L	190 - 10% to 230 + 10%	171 – 257	Half Yearly
Na	mg/L	1390 - 10% to 1600 + 10%	1251 – 1760	Half Yearly
K	mg/L	19.9 - 10% to 36.8 + 10%	18 – 41	Half Yearly
Cl	mg/L	2480 - 10% to 2880 + 10%	2232 – 3168	Half Yearly
HCO3	mg/L	289 - 10% to 461 + 10%	260 – 507	Half Yearly
SO4	mg/L	578 - 10% to 713 + 10%	520 – 784	Half Yearly
F	mg/L	0.1 - 20% to 0.203 + 20%	0.08 – 0.24	Half Yearly
Al	µg/L	14.2 - 20% to 151600 + 20%	11 – 181920	Half Yearly
As	µg/L	18.2 - 20% to 129.2 + 20%	15 – 155	Half Yearly
Cu	µg/L	3.98 - 20% to 335 + 20%	3.2 – 402	Half Yearly
Fe	µg/L	1400 - 20% to 163920 + 20%	1120 – 196704	Half Yearly
Mn	µg/L	88.9 - 20% to 956 + 20%	71 – 1147	Half Yearly
Se	µg/L	7.95 - 20% to 157.7 + 20%	6.4 – 189	Half Yearly
Total N	mg/L	1.38 - 20% to 4.18 + 20%	1.1 – 5	Half Yearly

* Please note that the Actual Background Limit values have been rounded. For values below 1 they are rounded to 2 decimal places, for values below 10 they are rounded to 1 decimal place and for values above 10 they are rounded to the nearest integer.

Borehole 28P (Coal)				
Analyte	**Units**	**Statistically Derived Background Limits**	**Actual Background Limits***	**Monitoring Frequency**
pH		7.28 - 10% to 7.9 +10%	6.6 – 8.7	Half Yearly
EC	µS/cm	8520 - 10% to 9300 + 10%	7668 – 10230	Half Yearly
TDS	mg/L	4808.8 - 10% to 6060 +10%	4327 – 6666	Half Yearly
Ca	mg/L	210 - 10% to 312 + 10%	189 – 343	Half Yearly
Mg	mg/L	204 - 10% to 278 + 10%	184 – 306	Half Yearly
Na	mg/L	1280 - 10% to 1720 + 10%	1152 – 1892	Half Yearly
K	mg/L	17.4 - 10% to 46.8 + 10%	16 – 52	Half Yearly
Cl	mg/L	2080 - 10% to 2720 + 10%	1872 – 2992	Half Yearly
HCO3	mg/L	689.6 - 10% to 992 + 10%	621 – 1091	Half Yearly
SO4	mg/L	366 - 10% to 630 + 10%	329 – 693	Half Yearly
F	mg/L	0.1 - 20% to 0.1 + 20%	0.08 – 0.12	Half Yearly
Al	µg/L	18.4 - 20% to 360576 + 20%	15 – 432691	Half Yearly
As	µg/L	16.1 - 20% to 179.7 + 20%	13 – 216	Half Yearly
Cu	µg/L	3.18 - 20% to 484.2 + 20%	2.5 – 581	Half Yearly
Fe	µg/L	952 - 20% to 306240 +20%	762 – 367488	Half Yearly
Mn	µg/L	6 - 20% to 1616 +20%	4.8 – 1939	Half Yearly
Se	µg/L	11.6 - 20% to 235 + 20%	9.3 – 282	Half Yearly
Total N	mg/L	0.93 - 20% to 2.76 + 20%	0.74 – 3.3	Half Yearly

* Please note that the Actual Background Limit values have been rounded. For values below 1 they are rounded to 2 decimal places, for values below 10 they are rounded to 1 decimal place and for values above 10 they are rounded to the nearest integer.

Borehole 843 (Basalt)				
Analyte	**Units**	**Statistically Derived Background Limits**	**Actual Background Limits***	**Monitoring Frequency**
pH		7.29 -10% to 7.9 + 10%	6.6 – 8.6	Half Yearly
EC	µS/cm	3290 - 10% to 4210 + 10%	2961 – 4631	Half Yearly
TDS	mg/L	1799.6 - 10% to 2600 + 10%	1620 – 2860	Half Yearly
Ca	mg/L	129 - 10% to 290 +10%	116 – 319	Half Yearly
Mg	mg/L	167 - 10% to 203 + 10%	150 – 223	Half Yearly
Na	mg/L	239 - 10% to 332 + 10%	215 – 365	Half Yearly
K	mg/L	1.1 - 10% to 4.93 + 10%	0.99 – 5.4	Half Yearly
Cl	mg/L	642 - 10% to 943 + 10%	578 – 1037	Half Yearly
HCO3	mg/L	544 - 10% to 828.9 + 10%	490 – 912	Half Yearly
SO4	mg/L	100 - 10% to 151 + 10%	90 – 166	Half Yearly
F	mg/L	0.39 - 20% to 0.9 + 20%	0.31 – 1.1	Half Yearly
Al	µg/L	13.5 - 20% to 36162 + 20%	11 – 79556	Half Yearly
As	µg/L	4.96 - 20% to 46 + 20%	3.9 – 55	Half Yearly
Cu	µg/L	2.32 - 20% to 136.8 + 20%	1.9 – 164	Half Yearly
Fe	µg/L	400 - 20% to 40020 + 20%	320 – 48024	Half Yearly
Mn	µg/L	8.8 - 20% to 1772 + 20%	7 – 2126	Half Yearly
Se	µg/L	5.6 - 20% to 162.8 + 20%	4.5 – 195	Half Yearly
Total N	mg/L	4.5 - 20% to 14.1 + 20%	3.6 – 17	Half Yearly

* Please note that the Actual Background Limit values have been rounded. For values below 1 they are rounded to 2 decimal places, for values below 10 they are rounded to 1 decimal place and for values above 10 they are rounded to the nearest integer.

Borehole 848 (Coal)				
Analyte	**Units**	**Statistically Derived Background Limits**	**Actual Background Limits***	**Monitoring Frequency**
pH		7.28 - 10% to 8.2 + 10%	6.6 – 9.1	Half Yearly
EC	µS/cm	3270 - 10% to 5330 + 10%	2943 – 5863	Half Yearly
TDS	mg/L	2060 - 10% to 3069.6 + 10%	1854 – 3377	Half Yearly
Ca	mg/L	77.4 - 10% to 173 + 10%	70 – 190	Half Yearly
Mg	mg/L	77.9 - 10% to 181 + 10%	70 – 199	Half Yearly
Na	mg/L	427 - 10% to 694 + 10%	384 – 763	Half Yearly
K	mg/L	2.18 - 10% to 7.03 + 10%	1.9 – 7.7	Half Yearly
Cl	mg/L	644 - 10% to 1210 + 10%	580 – 1331	Half Yearly
HCO3	mg/L	582.6 - 10% to 850.7 + 10%	524 – 936	Half Yearly
SO4	mg/L	69 – 10% to 148 + 10%	62 – 163	Half Yearly
F	mg/L	0.2 - 20% to 1.01 + 20%	0.16 – 1.2	Half Yearly
Al	µg/L	8.6 - 20% to 374 + 20%	6.9 – 449	Half Yearly
As	µg/L	7.02 - 20% to 29 + 20%	5.6 – 35	Half Yearly
Cu	µg/L	1.88 - 20% to 16.2 + 20%	1.5 – 19	Half Yearly
Fe	µg/L	278 - 20% to 5460 + 20%	222 – 6552	Half Yearly
Mn	µg/L	7.28 - 20% to 120 + 20%	5.8 – 144	Half Yearly
Se	µg/L	5 - 20% to 21 + 20%	4 – 25	Half Yearly
Total N	mg/L	0.99 - 20% to 8.22 + 20%	0.8 – 9.9	Half Yearly

* Please note that the Actual Background Limit values have been rounded. For values below 1 they are rounded to 2 decimal places, for values below 10 they are rounded to 1 decimal place and for values above 10 they are rounded to the nearest integer.

Borehole 81P (Coal)				
Analyte	**Units**	**Statistically Derived Background Limits**	**Actual Background Limits***	**Monitoring Frequency**
pH		7.35 - 10% to 8.05 + 10%	6.6 – 8.9	Half Yearly
EC	µS/cm	6150 - 10% to 6800 + 10%	5535 – 7480	Half Yearly
TDS	mg/L	3145 - 10% to 3800 + 10%	2831 – 4180	Half Yearly
Ca	mg/L	200 - 10% to 235 + 10%	180 – 259	Half Yearly
Mg	mg/L	92 - 10% to 100 + 10%	83 – 110	Half Yearly
Na	mg/L	810 - 10% to 980 + 10%	729 – 1078	Half Yearly
K	mg/L	12 - 10% to 16 + 10%	11 – 18	Half Yearly
Cl	mg/L	1600 - 10% to 1800 + 10%	1440 – 1980	Half Yearly
HCO3	mg/L	312.5 - 10% to 400 + 10%	281 – 440	Half Yearly
SO4	mg/L	230 - 10% to 265 + 10%	207 – 292	Half Yearly
F	mg/L	0.11 - 20% to 0.19 + 20%	0.09 – 0.23	Half Yearly
Al	µg/L	20.4 - 20% to 58.2 + 20%	16 – 70	Half Yearly
As	µg/L	10.08 - 20% to 17.1 + 20%	8.1 – 21	Half Yearly
Cu	µg/L	2.12 - 20% to 3.8 + 20%	1.7 – 4.6	Half Yearly
Fe	µg/L	676 - 20% to 1460 + 20%	541 – 1752	Half Yearly
Mn	µg/L	142 - 20% to 442 + 20%	114 – 530	Half Yearly
Se	µg/L	6.9 - 20% to 38.4 + 20%	5.5 – 46	Half Yearly
Total N	mg/L	1.17 - 20% to 1.95 + 20%	0.94 – 2.5	Half Yearly

* Please note that the Actual Background Limit values have been rounded. For values below 1 they are rounded to 2 decimal places, for values below 10 they are rounded to 1 decimal place and for values above 10 they are rounded to the nearest integer.

Borehole 82P (Coal)				
Analyte	**Units**	**Statistically Derived Background Limits**	**Actual Background Limits***	**Monitoring Frequency**
pH		7.65 - 10% to 7.9 + 10%	6.9 – 8.7	Half Yearly
EC	µS/cm	5350 - 10% to 5950 + 10%	4815 – 6545	Half Yearly
TDS	mg/L	3246.5 - 10% to 3550 + 10%	2921 – 3905	Half Yearly
Ca	mg/L	125 - 10% to 145 + 10%	113 – 160	Half Yearly
Mg	mg/L	130 - 10% to 140 + 10%	117 – 154	Half Yearly
Na	mg/L	755 - 10% to 880 + 10%	680 – 968	Half Yearly
K	mg/L	5.55 - 10% to 6.9 + 10%	4.9 – 7.6	Half Yearly
Cl	mg/L	1100 - 10% to 1200 + 10%	990 – 1320	Half Yearly
HCO3	mg/L	764.5 - 10% to 916.5 + 10%	688 – 1008	Half Yearly
SO4	mg/L	430 - 10% to 505 + 10%	387 – 556	Half Yearly
F	mg/L	0.22 - 20% to 0.525 + 20%	0.17 – 0.6	Half Yearly
Al	µg/L	10 - 20% to 78 +20%	8 – 94	Half Yearly
As	µg/L	6.66 - 20% to 11.6 + 20%	5.3 – 14	Half Yearly
Cu	µg/L	2.38 - 20% to 4.4 + 20%	1.9 – 5.3	Half Yearly
Fe	µg/L	740 - 20% to 2400 + 20%	592 – 2880	Half Yearly
Mn	µg/L	56.5 - 20% to 145 + 20%	45 – 174	Half Yearly
Se	µg/L	6.3 - 20% to 25.5 + 20%	5 – 31	Half Yearly
Total N	mg/L	0.74 - 20% to 1.55 + 20%	0.6 – 1.9	Half Yearly

* Please note that the Actual Background Limit values have been rounded. For values below 1 they are rounded to 2 decimal places, for values below 10 they are rounded to 1 decimal place and for values above 10 they are rounded to the nearest integer.

Borehole 83P (Coal)				
Analyte	**Units**	**Statistically Derived Background Limits**	**Actual Background Limits***	**Monitoring Frequency**
pH		7.25 - 10% to 8.15 + 10%	6.6 – 9	Half Yearly
EC	µS/cm	1070 - 10% to 1500 + 10%	963 – 1650	Half Yearly
TDS	mg/L	652.5 - 10% to 1080 + 10%	587 – 1188	Half Yearly
Ca	mg/L	50 - 10% to 113 +10%	45 – 124	Half Yearly
Mg	mg/L	28.5 - 10% to 58.5 + 10%	26 – 64	Half Yearly
Na	mg/L	99.5 - 10% to 130 +10%	90 – 143	Half Yearly
K	mg/L	2.85 - 10% to 6 + 10%	2.6 – 6.6	Half Yearly
Cl	mg/L	115 - 10% to 160 + 10%	104 – 176	Half Yearly
HCO3	mg/L	356.5 - 10% to 644.5 + 10%	321 – 709	Half Yearly
SO4	mg/L	15.6 - 10% to 26.8 + 10%	14 – 30	Half Yearly
F	mg/L	0.15 - 20% to 0.305 + 20%	0.12 – 0.36	Half Yearly
Al	µg/L	23.5 - 20% to 308 + 20%	19 – 370	Half Yearly
As	µg/L	1.42 - 20% to 1.9 + 20%	1.1 – 2.3	Half Yearly
Cu	µg/L	1.04 - 20% to 2.64 + 20%	0.83 – 3.2	Half Yearly
Fe	µg/L	410 - 20% to 935 + 20%	328 – 1122	Half Yearly
Mn	µg/L	32 - 20% to 84.5 + 20%	26 – 101	Half Yearly
Se	µg/L	3 - 20% to 3 + 20%	2.4 – 3.6	Half Yearly
Total N	mg/L	0.405 - 20% to 11.6 + 20%	0.32 – 14	Half Yearly

* Please note that the Actual Background Limit values have been rounded. For values below 1 they are rounded to 2 decimal places, for values below 10 they are rounded to 1 decimal place and for values above 10 they are rounded to the nearest integer.

Borehole 84P (Basalt)				
Analyte	**Units**	**Statistically Derived Background Limits**	**Actual Background Limits***	**Monitoring Frequency**
pH		7.65 - 10% to 7.9 + 10%	6.9 – 8.7	Half Yearly
EC	µS/cm	2500 - 10% to 3450 +10%	2250 – 3795	Half Yearly
TDS	mg/L	1142.5 -10% to 2100 +10%	1028 – 2310	Half Yearly
Ca	mg/L	130 -10% to 225 +10%	117 – 248	Half Yearly
Mg	mg/L	125 -10% to 195 +10%	113 – 215	Half Yearly
Na	mg/L	150 -10% to 210 +10%	135 – 231	Half Yearly
K	mg/L	2.65 - 10% to 3.6 +10%	3.2 – 3.9	Half Yearly
Cl	mg/L	420 - 10% to 765 +10%	378 – 842	Half Yearly
HCO3	mg/L	387.5 - 10% to 599 + 10%	349 – 659	Half Yearly
SO4	mg/L	88 - 10% to 220 +10%	79 – 242	Half Yearly
F	mg/L	0.16 - 20% to 0.25 + 20%	0.13 – 0.3	Half Yearly
Al	µg/L	10.85 -20% to 18.5 + 20%	8.7 – 22	Half Yearly
As	µg/L	5 - 20% to 7.9 +20%	4 – 9.5	Half Yearly
Cu	µg/L	2.08 - 20% to 3.68 + 20%	1.7 – 4.5	Half Yearly
Fe	µg/L	630 - 20% to 12000 +20%	504 – 1440	Half Yearly
Mn	µg/L	12 - 20% to 37 + 20%	9.6 – 44	Half Yearly
Se	µg/L	5.5 - 20% to 20 + 20%	4.4 – 24	Half Yearly
Total N	mg/L	2.4 - 20% to 3.25 + 20%	1.9 – 3.9	Half Yearly

* Please note that the Actual Background Limit values have been rounded. For values below 1 they are rounded to 2 decimal places, for values below 10 they are rounded to 1 decimal place and for values above 10 they are rounded to the nearest integer.

Borehole 2289 (Coal)				
Analyte	**Units**	**Statistically Derived Background Limits**	**Actual Background Limits***	**Monitoring Frequency**
pH		6.424 - 10% to 7.58 + 10%	5.8 – 8.3	Half Yearly
EC	µS/cm	6120 - 10% to 17400 +10%	5508 – 19140	Half Yearly
TDS	mg/L	3500 -10% to 11960 +10%	3150 – 13156	Half Yearly
Ca	mg/L	185.6 -10% to 779.2 +10%	167 – 857	Half Yearly
Mg	mg/L	6.4 -10% to 742.6 +10%	5.8 – 817	Half Yearly
Na	mg/L	706 -10% to 2578 +10%	635 – 2836	Half Yearly
K	mg/L	11.8 - 10% to 17.4 +10%	11 – 19	Half Yearly
Cl	mg/L	1700 - 10% to 5834 +10%	1530 – 6417	Half Yearly
HCO3	mg/L	159.097 - 10% to 324 + 10%	143 – 356	Half Yearly
SO4	mg/L	350 - 10% to 2358 +10%	315 – 2594	Half Yearly
F	mg/L	0.14 - 20% to 0.42 + 20%	0.11 – 0.5	Half Yearly
Al	µg/L	10.32 -20% to 236 + 20%	8.3 – 283	Half Yearly
As	µg/L	1 - 20% to 1 +20%	0.8 – 1.2	Half Yearly
Cu	µg/L	3.5 - 20% to 13.5 + 20%	2.8 – 16.2	Half Yearly
Fe	µg/L	1182 - 20% to 3540 +20%	946 – 4248	Half Yearly
Mn	µg/L	233.2 - 20% to 1012.4 + 20%	187 – 1215	Half Yearly
Se	µg/L	22.4 - 20% to 36.4 + 20%	18 – 44	Half Yearly
Total N	mg/L	1 - 20% to 4.8 + 20%	0.8 – 5.8	Half Yearly

* Please note that the Actual Background Limit values have been rounded. For values below 1 they are rounded to 2 decimal places, for values below 10 they are rounded to 1 decimal place and for values above 10 they are rounded to the nearest integer.

Borehole 2291 (Coal)				
Analyte	**Units**	**Statistically Derived Background Limits**	**Actual Background Limits***	**Monitoring Frequency**
pH		7.2 - 10% to 7.82 + 10%	6.5 – 8.6	Half Yearly
EC	µS/cm	7360 - 10% to 7840 +10%	6624 – 8624	Half Yearly
TDS	mg/L	4380 -10% to 4900 +10%	3942 – 5390	Half Yearly
Ca	mg/L	230 -10% to 253 +10%	207 – 278	Half Yearly
Mg	mg/L	133 -10% to 145 +10%	120 – 160	Half Yearly
Na	mg/L	1130 -10% to 1400 +10%	1017 – 1540	Half Yearly
K	mg/L	13 - 10% to 17 +10%	12 – 19	Half Yearly
Cl	mg/L	2040 - 10% to 2200 +10%	1836 – 2420	Half Yearly
HCO3	mg/L	509 - 10% to 549.323 + 10%	458 – 604	Half Yearly
SO4	mg/L	290.5 - 10% to 379 +10%	261 – 417	Half Yearly
F	mg/L	0.248 - 20% to 0.472 + 20%	0.20 – 0.57	Half Yearly
Al	µg/L	9.4 -20% to 734 + 20%	7.5 – 881	Half Yearly
As	µg/L	1 - 20% to 1 +20%	0.8 – 1.2	Half Yearly
Cu	µg/L	4.23 - 20% to 5 + 20%	3.4 – 6	Half Yearly
Fe	µg/L	2435 - 20% to 5125 +20%	1948 – 6150	Half Yearly
Mn	µg/L	48.5 - 20% to 100 + 20%	39 – 120	Half Yearly
Se	µg/L	45.2 - 20% to 62.8 + 20%	36 – 75	Half Yearly
Total N	mg/L	1.05 - 20% to 6.25 + 20%	0.84 – 7.5	Half Yearly

Arsenic results were all below the LOR, therefore the LOR value has been adopted for the analyte value in absence of data.

* Please note that the Actual Background Limit values have been rounded. For values below 1 they are rounded to 2 decimal places, for values below 10 they are rounded to 1 decimal place and for values above 10 they are rounded to the nearest integer.

Borehole BMH1 (Basalt)				
Analyte	**Units**	**Statistically Derived Background Limits**	**Actual Background Limits***	**Monitoring Frequency**
pH		7.811 - 10% to 8.041 + 10%	7.0 – 8.8	Half Yearly
EC	µS/cm	1295 - 10% to 1490 +10%	1166 – 1639	Half Yearly
TDS	mg/L	803.1 -10% to 1186.9 +10%	723 – 1306	Half Yearly
Ca	mg/L	88.6 -10% to 101.4 +10%	80 – 112	Half Yearly
Mg	mg/L	64 -10% to 90.2 +10%	58 – 99	Half Yearly
Na	mg/L	86.4 -10% to 181.9 +10%	78 – 200	Half Yearly
K	mg/L	1 - 10% to 1.98 +10%	0.9 – 2.2	Half Yearly
Cl	mg/L	85.6 - 10% to 95.2 +10%	77 – 105	Half Yearly
HCO3	mg/L	698.1224 - 10% to 825.3 + 10%	628 – 908	Half Yearly
SO4	mg/L	11 - 10% to 20.7 +10%	9.9 – 23	Half Yearly
F	mg/L	0.13 - 20% to 0.27 + 20%	0.1 – 0.32	Half Yearly
Al	µg/L	13 -20% to 37 + 20%	10 – 44	Half Yearly
As	µg/L	1 - 20% to 1 +20%	0.8 – 1.2	Half Yearly
Cu	µg/L	1.1 - 20% to 1.9 + 20%	0.88 – 2.3	Half Yearly
Fe	µg/L	340 - 20% to 340 +20%	272 – 408	Half Yearly
Mn	µg/L	4.2 - 20% to 71.6 + 20%	3.4 – 86	Half Yearly
Se	µg/L	10 - 20% to 10 + 20%	8 – 12	Half Yearly
Total N	mg/L	9.75 - 20% to 17.01 + 20%	7.8 – 20	Half Yearly

Arsenic results were all below the LOR, therefore the LOR value has been adopted for the analyte value in absence of data.

* Please note that the Actual Background Limit values have been rounded. For values below 1 they are rounded to 2 decimal places, for values below 10 they are rounded to 1 decimal place and for values above 10 they are rounded to the nearest integer.

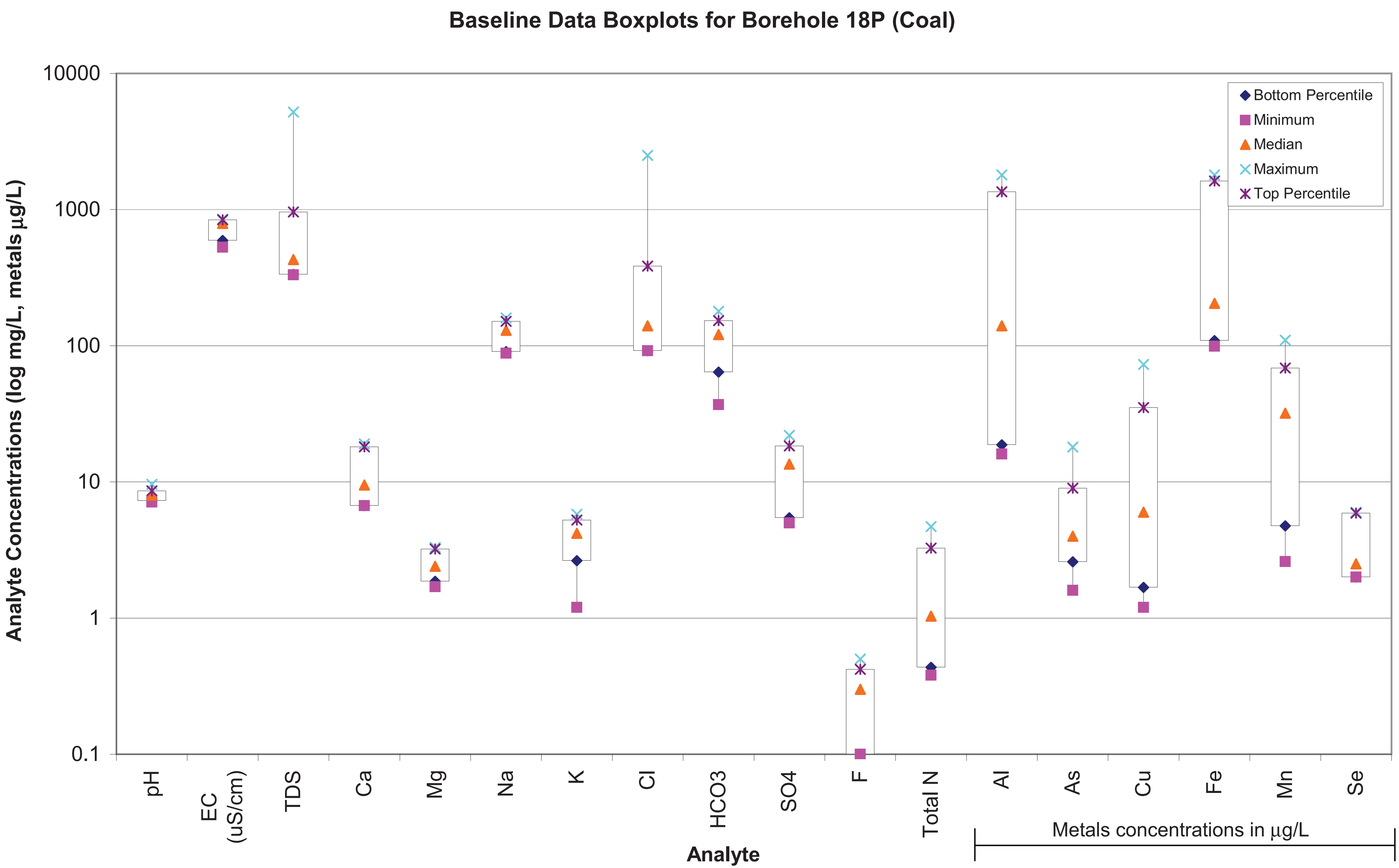
Borehole CSMH1 (Coal)				
Analyte	**Units**	**Statistically Derived Background Limits**	**Actual Background Limits***	**Monitoring Frequency**
pH		7.58 - 10% to 7.80 + 10%	6.8 – 8.6	Half Yearly
EC	µS/cm	4280 - 10% to 5388 +10%	3852 – 5927	Half Yearly
TDS	mg/L	2660 -10% to 3580 +10%	2394 – 3938	Half Yearly
Ca	mg/L	176.4 -10% to 282.6 +10%	159 – 311	Half Yearly
Mg	mg/L	126.4 -10% to 223.2 +10%	114 – 246	Half Yearly
Na	mg/L	542.4 -10% to 631.8 +10%	488 – 695	Half Yearly
K	mg/L	9.1 - 10% to 11.2 +10%	8.2 – 12	Half Yearly
Cl	mg/L	916 - 10% to 1374 + 10%	824 – 1511	Half Yearly
HCO3	mg/L	467 - 10% to 658 + 10%	420 – 724	Half Yearly
SO4	mg/L	290.4 - 10% to 501.4 +10%	261 – 552	Half Yearly
F	mg/L	0.1 - 20% to 0.16 + 20%	0.08 – 0.19	Half Yearly
Al	µg/L	10 - 20% to 106 + 20%	8 – 127	Half Yearly
As	µg/L	1 - 20% to 1 + 20%	0.8 – 1.2	Half Yearly
Cu	µg/L	1 - 20% to 2.6 + 20%	0.8 – 3.1	Half Yearly
Fe	µg/L	54 - 20% to 438 + 20%	43 – 526	Half Yearly
Mn	µg/L	133 - 20% to 506.8 + 20%	106 – 608	Half Yearly
Se	µg/L	10 - 20% to 12.4 + 20%	8 – 15	Half Yearly
Total N	mg/L	3.62 - 20% to 11.18 + 20%	2.9 – 13	Half Yearly

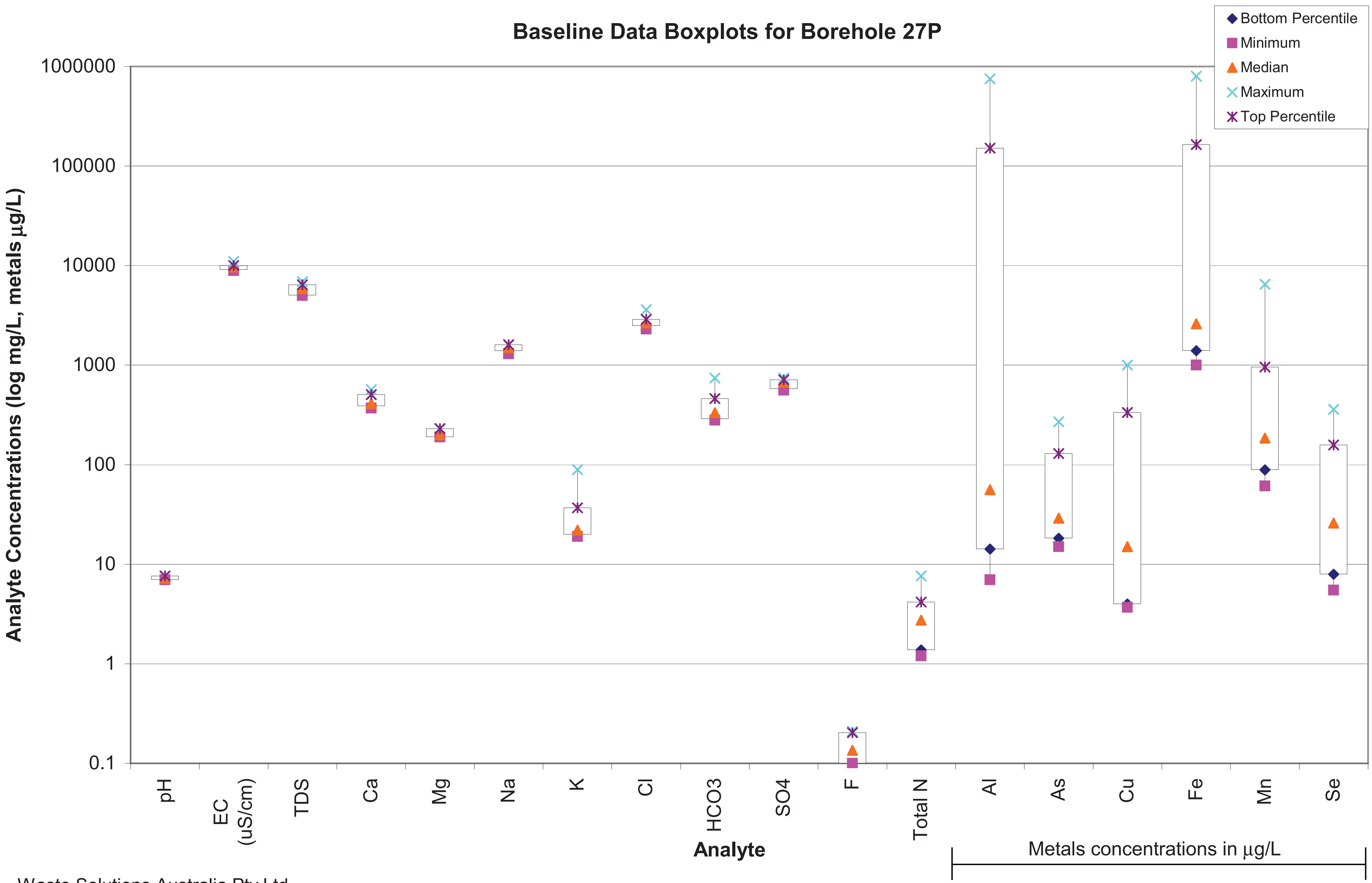
Arsenic results were all below the LOR, therefore the LOR value has been adopted for the analyte value in absence of data.

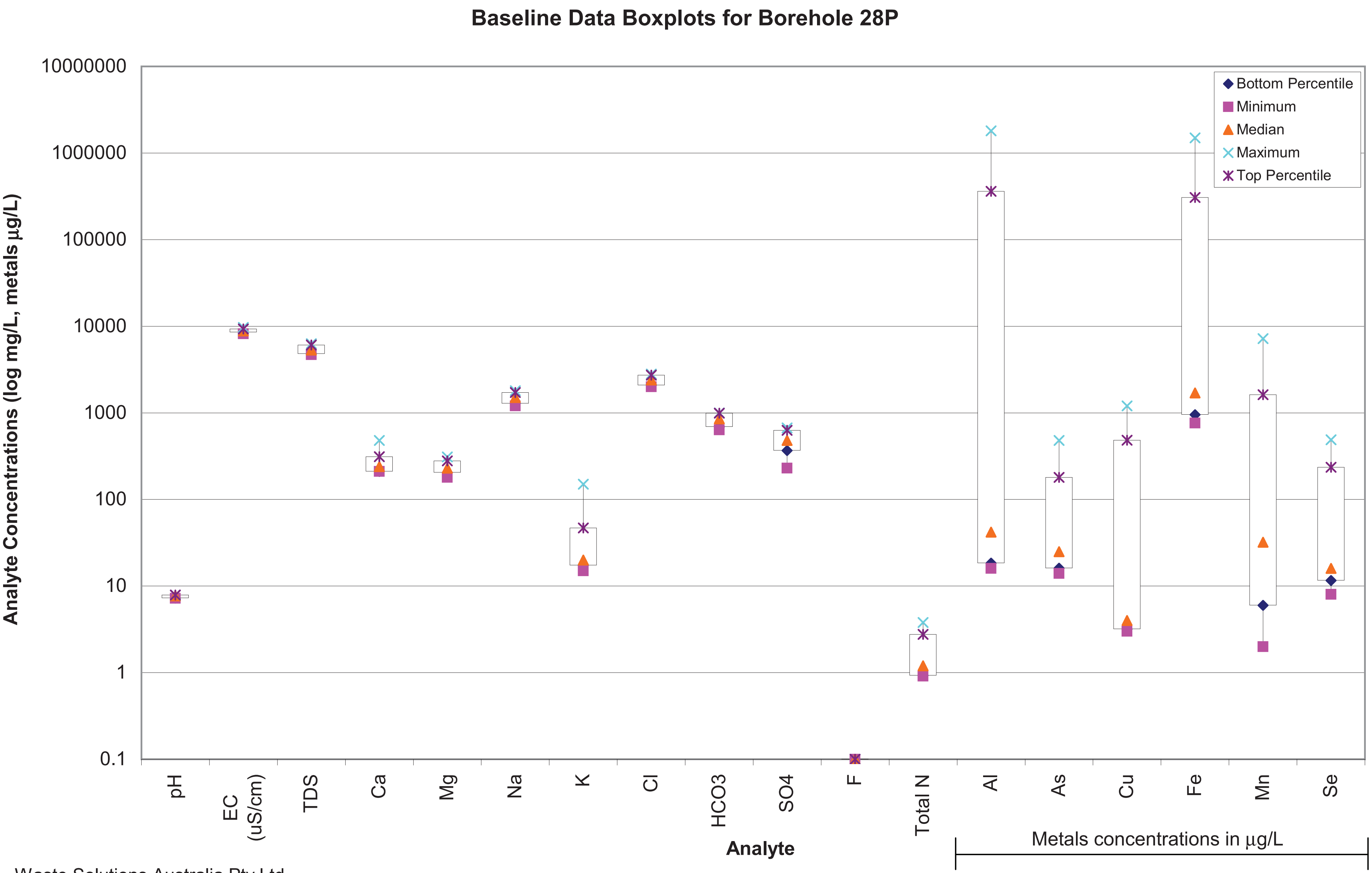
* Please note that the Actual Background Limit values have been rounded. For values below 1 they are rounded to 2 decimal places, for values below 10 they are rounded to 1 decimal place and for values above 10 they are rounded to the nearest integer.

APPENDIX B

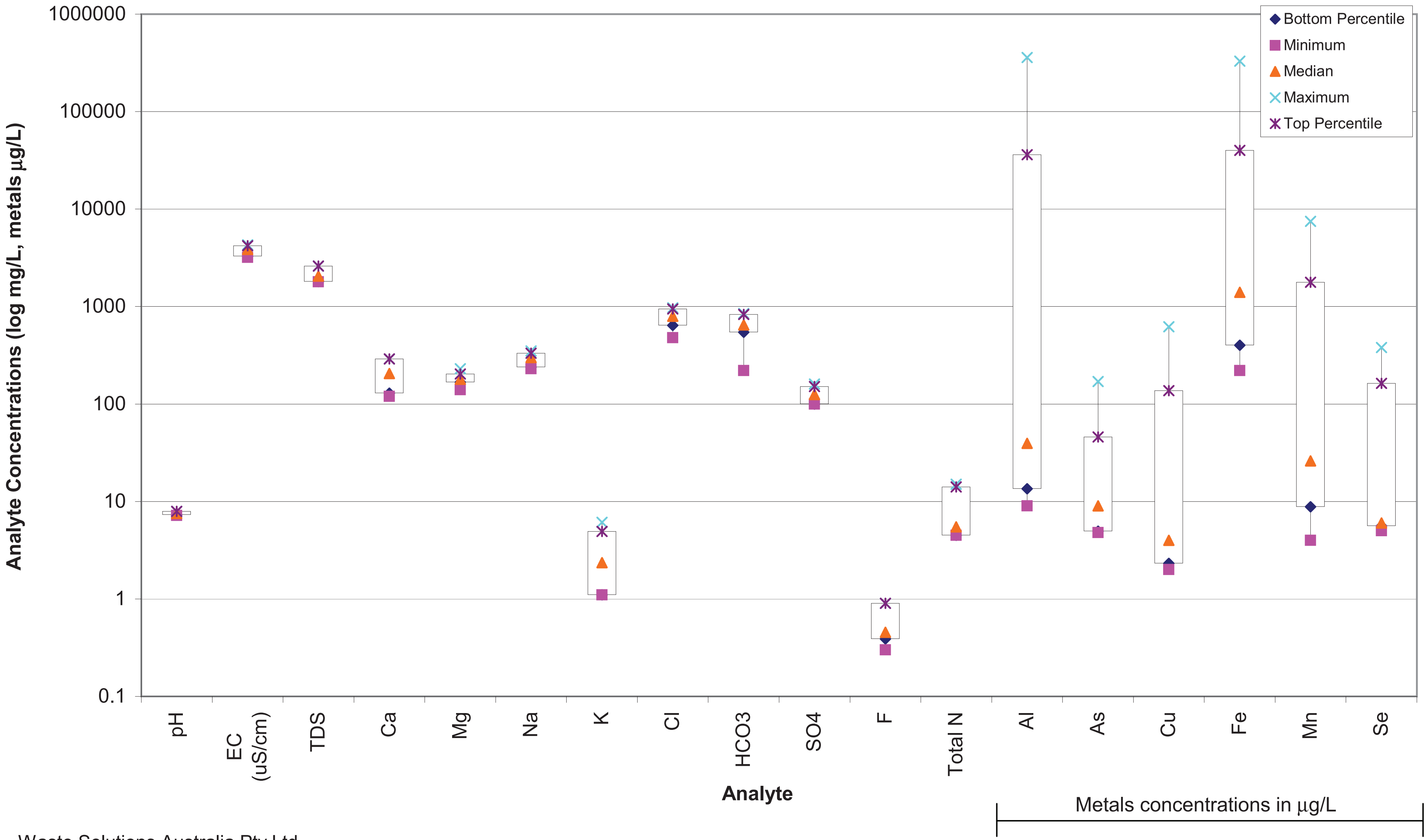
MONITORING BORE BOXPLOTS FOR EACH ANALYTE


Baseline Data Boxplots for Borehole 18P (Coal)
Analyte Concentrations (log mg/L, metals µg/L)
10000
1000
100
10
1
0.1
Bottom Percentile
Minimum
Median
Maximum
Top Percentile
pH
EC (uS/cm)
TDS
Ca
Mg
Na
K
Cl
HCO3
SO4
F
Total N
Al
As
Cu
Fe
Mn
Se
Metals concentrations in µg/L
Analyte

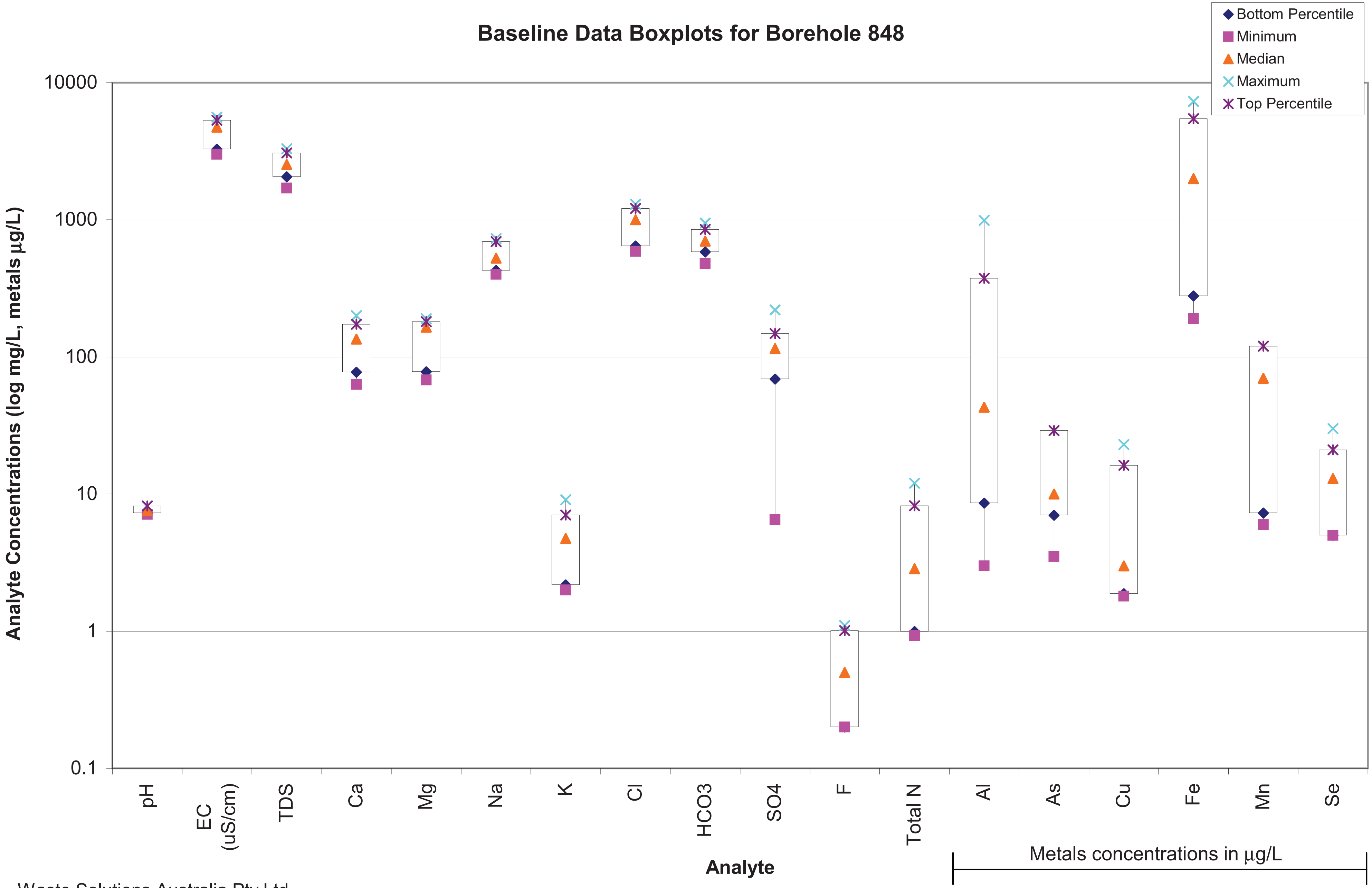

Baseline Data Boxplots for Borehole 27P
Bottom Percentile
Minimum
Median
Maximum
Top Percentile
Analyte Concentrations (log mg/L, metals µg/L)
1000000
100000
10000
1000
100
10
1
0.1
pH
EC (uS/cm)
TDS
Ca
Mg
Na
K
Cl
HCO3
SO4
F
Total N
Al
As
Cu
Fe
Mn
Se
Analyte
Metals concentrations in µg/L

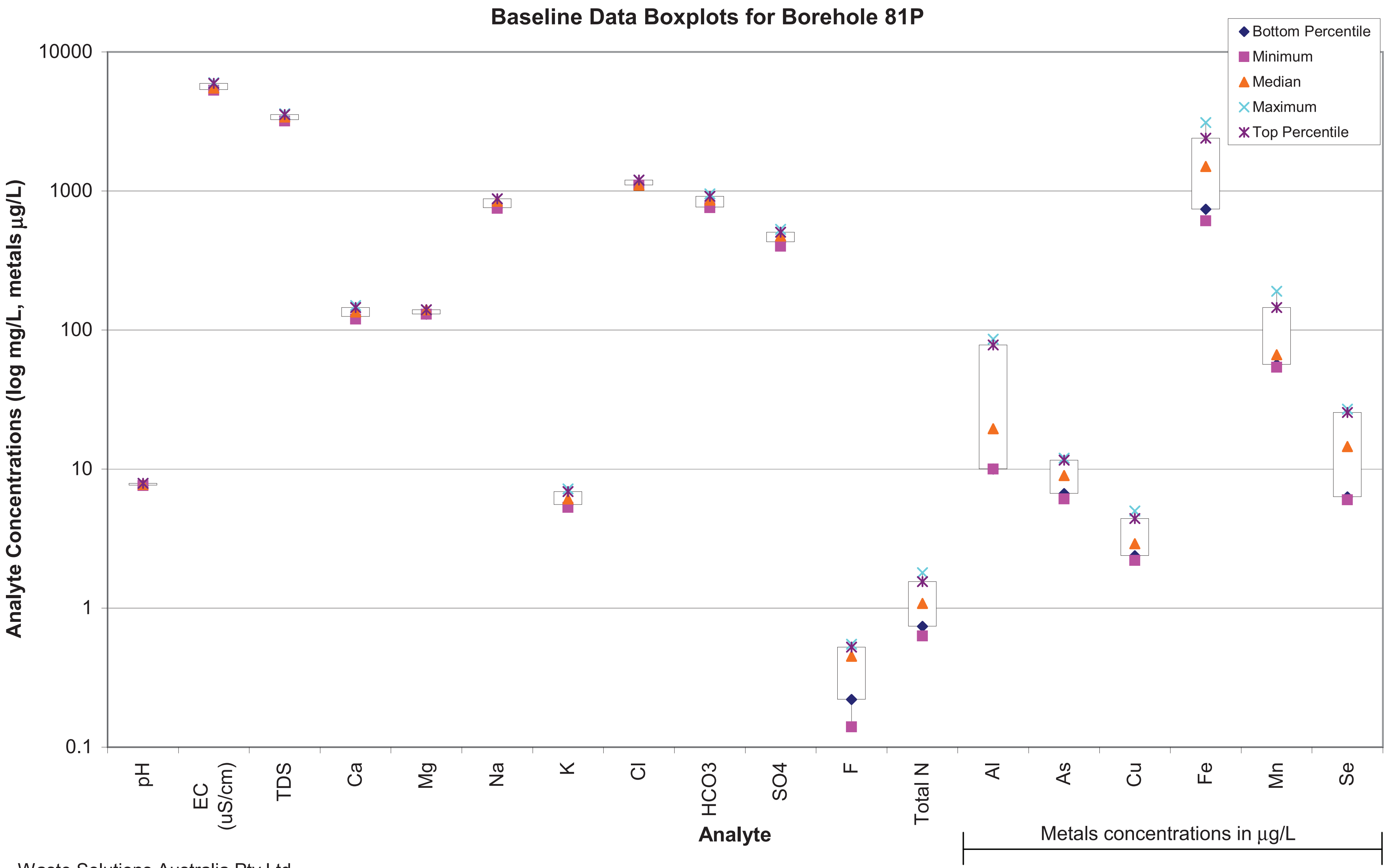

Baseline Data Boxplots for Borehole 28P
Analyte Concentrations (log mg/L, metals µg/L)
10000000
1000000
100000
10000
1000
100
10
1
0.1
Bottom Percentile
Minimum
Median
Maximum
Top Percentile
pH
EC (uS/cm)
TDS
Ca
Mg
Na
K
Cl
HCO3
SO4
F
Total N
Al
As
Cu
Fe
Mn
Se
Analyte
Metals concentrations in µg/L

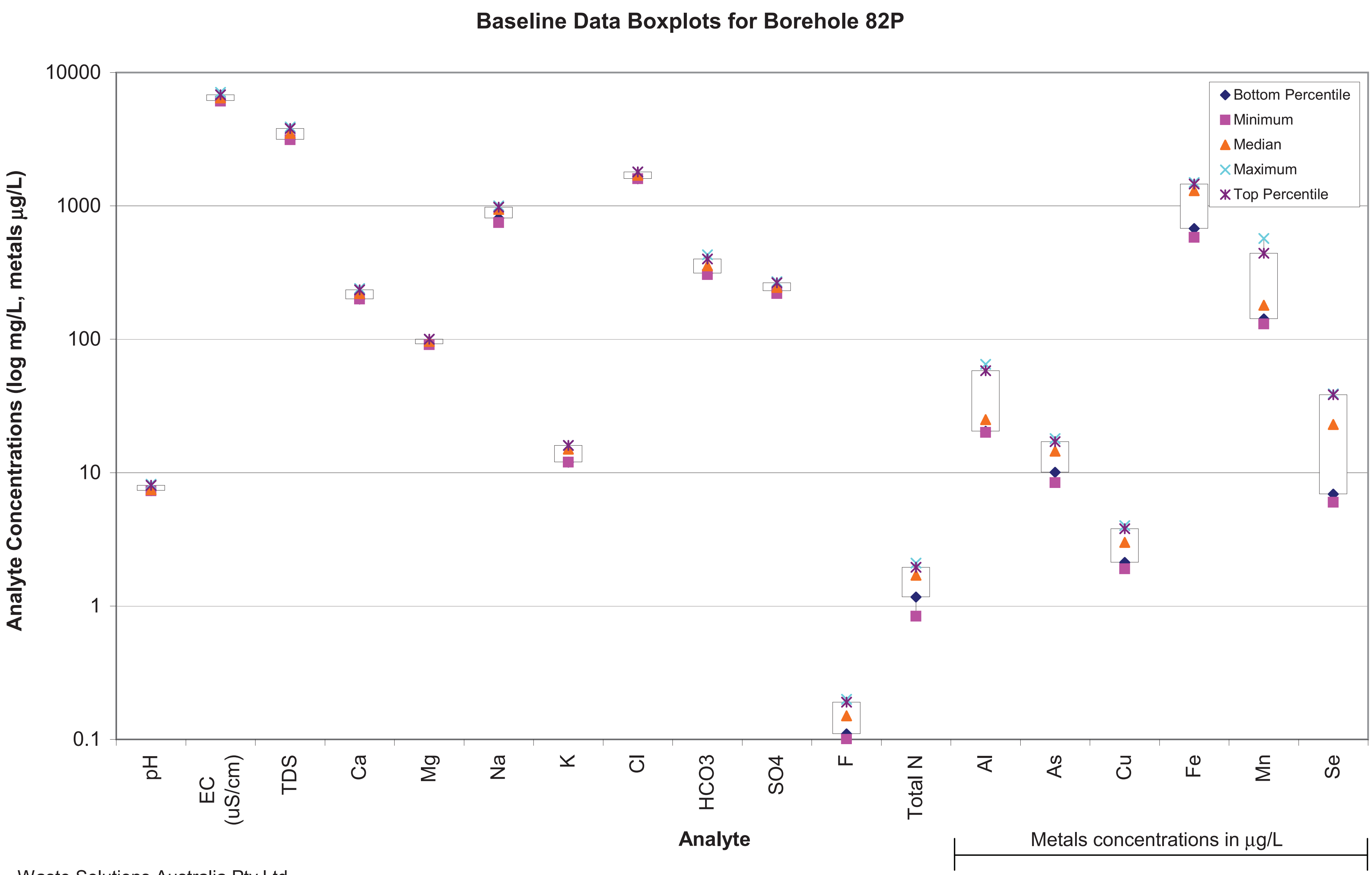
Baseline Data Boxplots for Borehole 843



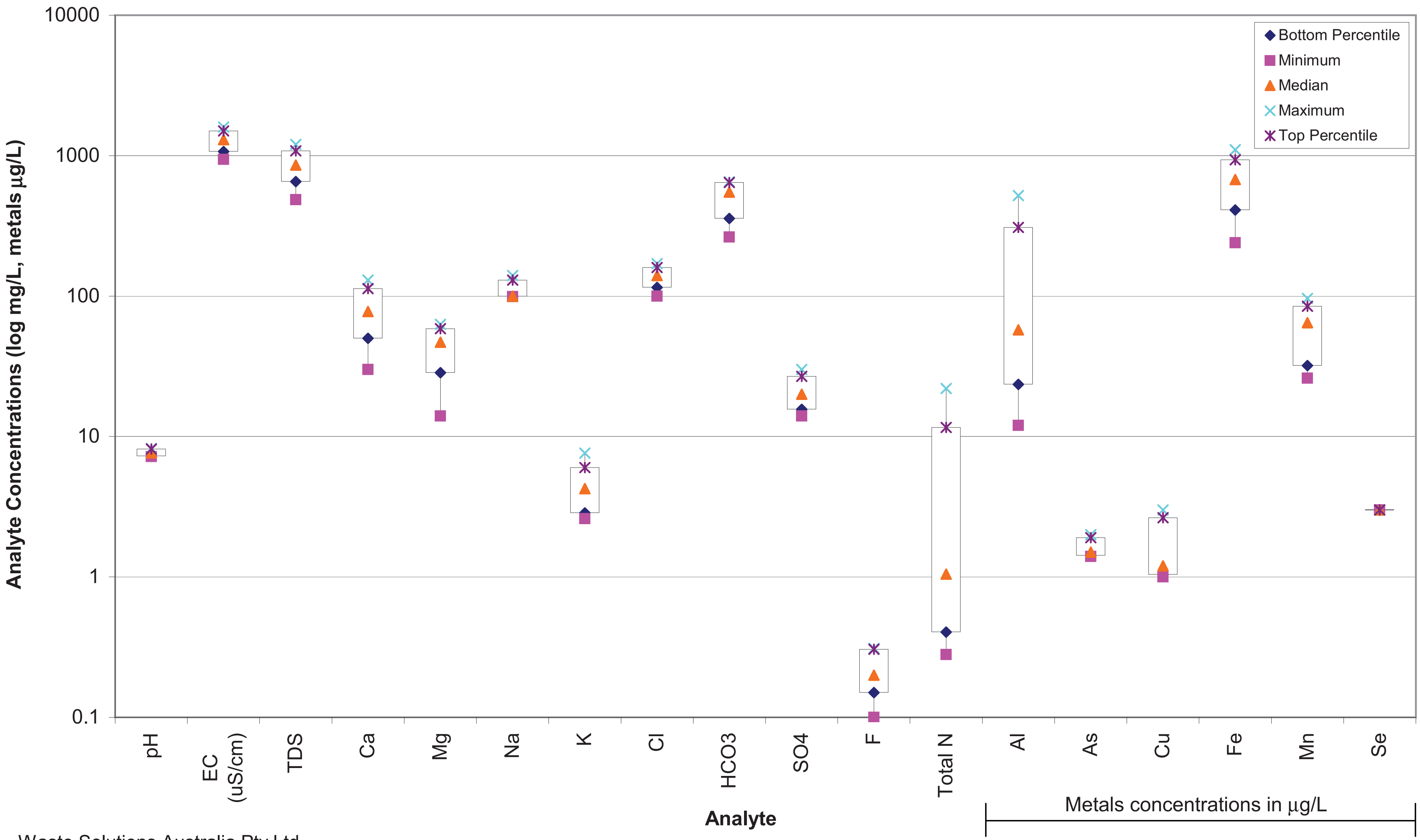
Baseline Data Boxplots for Borehole 848



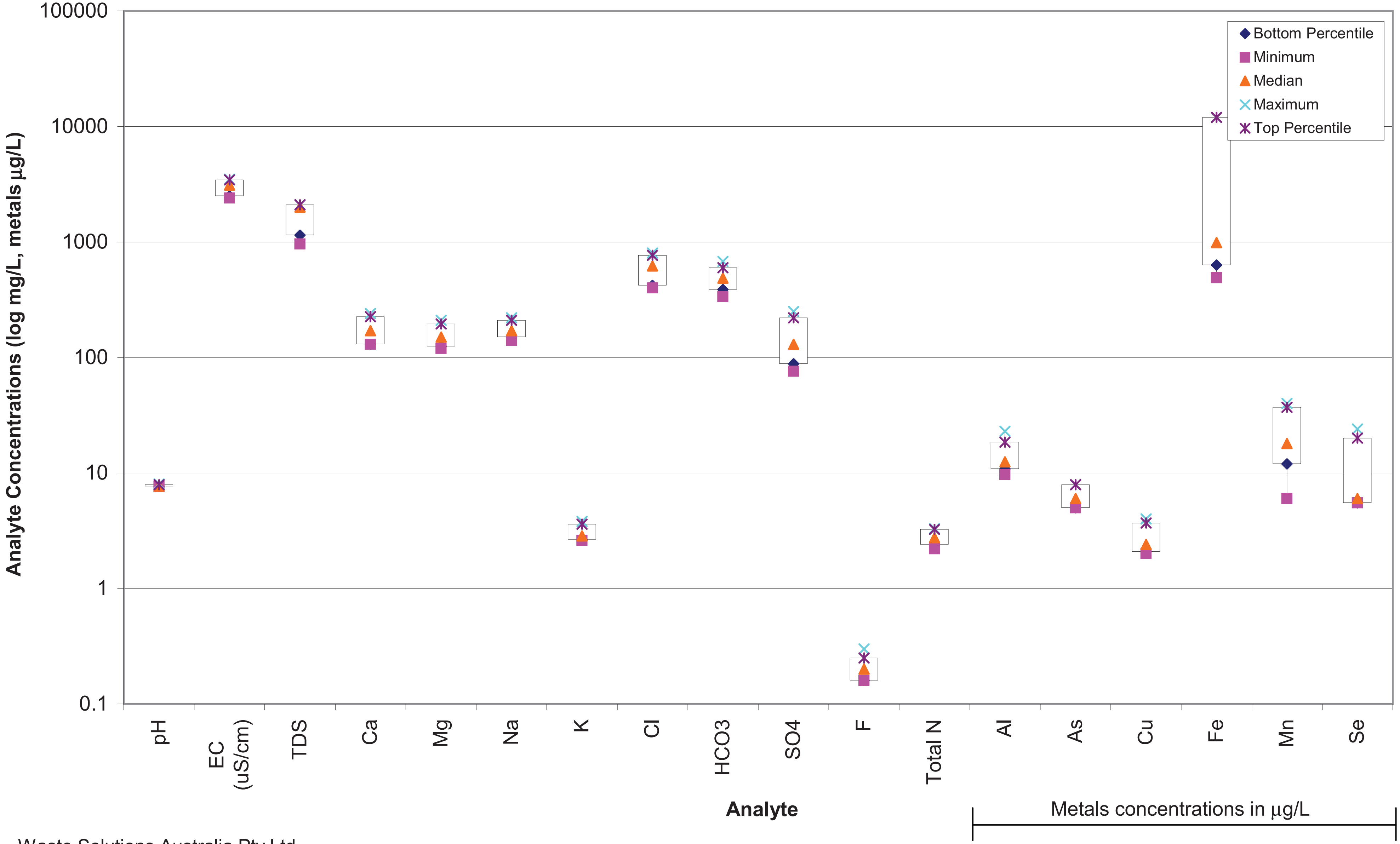

Baseline Data Boxplots for Borehole 81P
Bottom Percentile
Minimum
Median
Maximum
Top Percentile
Analyte Concentrations (log mg/L, metals µg/L)
10000
1000
100
10
1
0.1
pH
EC (uS/cm)
TDS
Ca
Mg
Na
K
Cl
HCO3
SO4
F
Total N
Al
As
Cu
Fe
Mn
Se
Analyte
Metals concentrations in µg/L

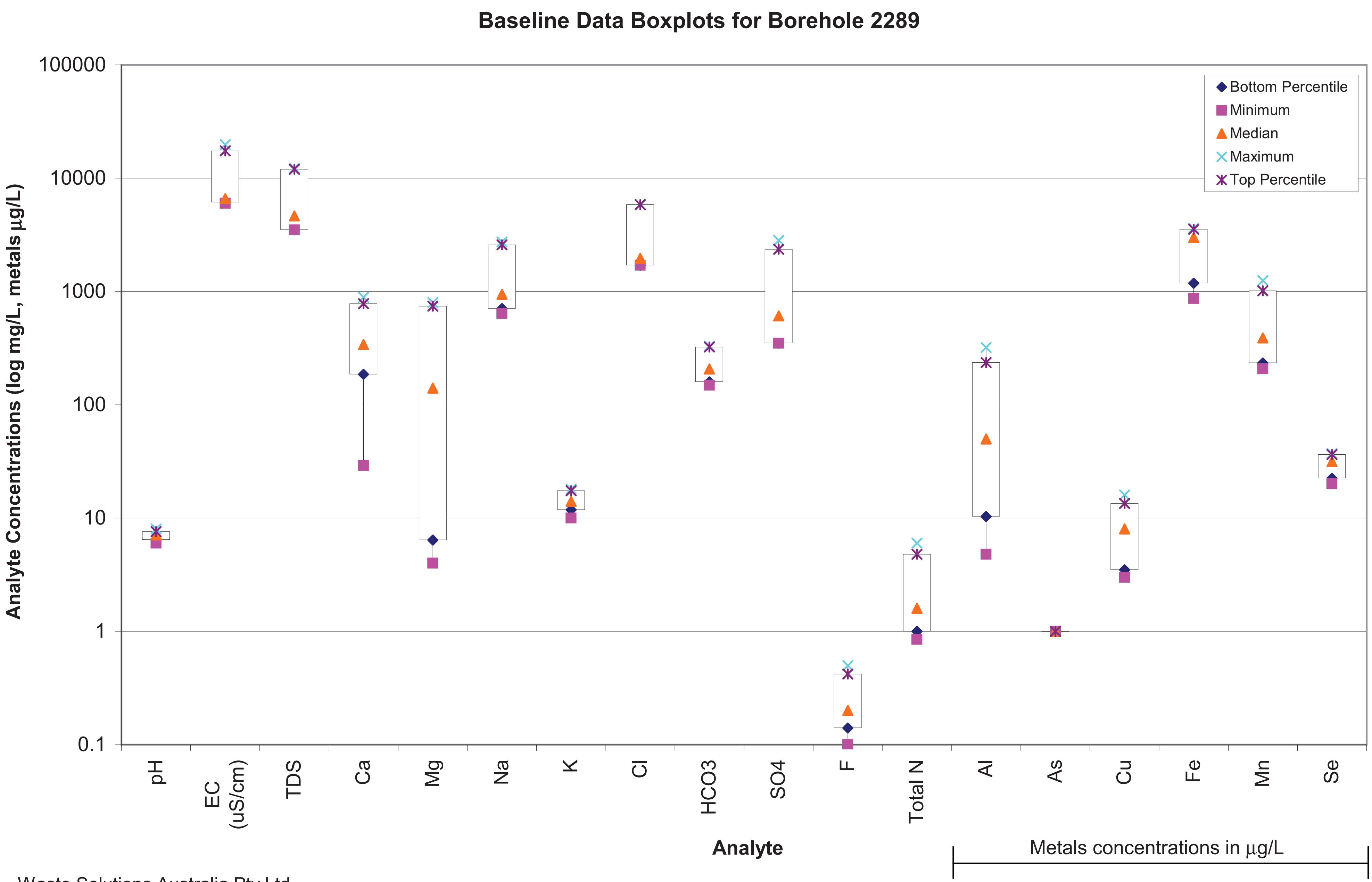

Baseline Data Boxplots for Borehole 82P
Analyte Concentrations (log mg/L, metals µg/L)
10000
1000
100
10
1
0.1
pH
EC (uS/cm)
TDS
Ca
Mg
Na
K
Cl
HCO3
SO4
F
Total N
Al
As
Cu
Fe
Mn
Se
Analyte
Metals concentrations in µg/L
Bottom Percentile
Minimum
Median
Maximum
Top Percentile

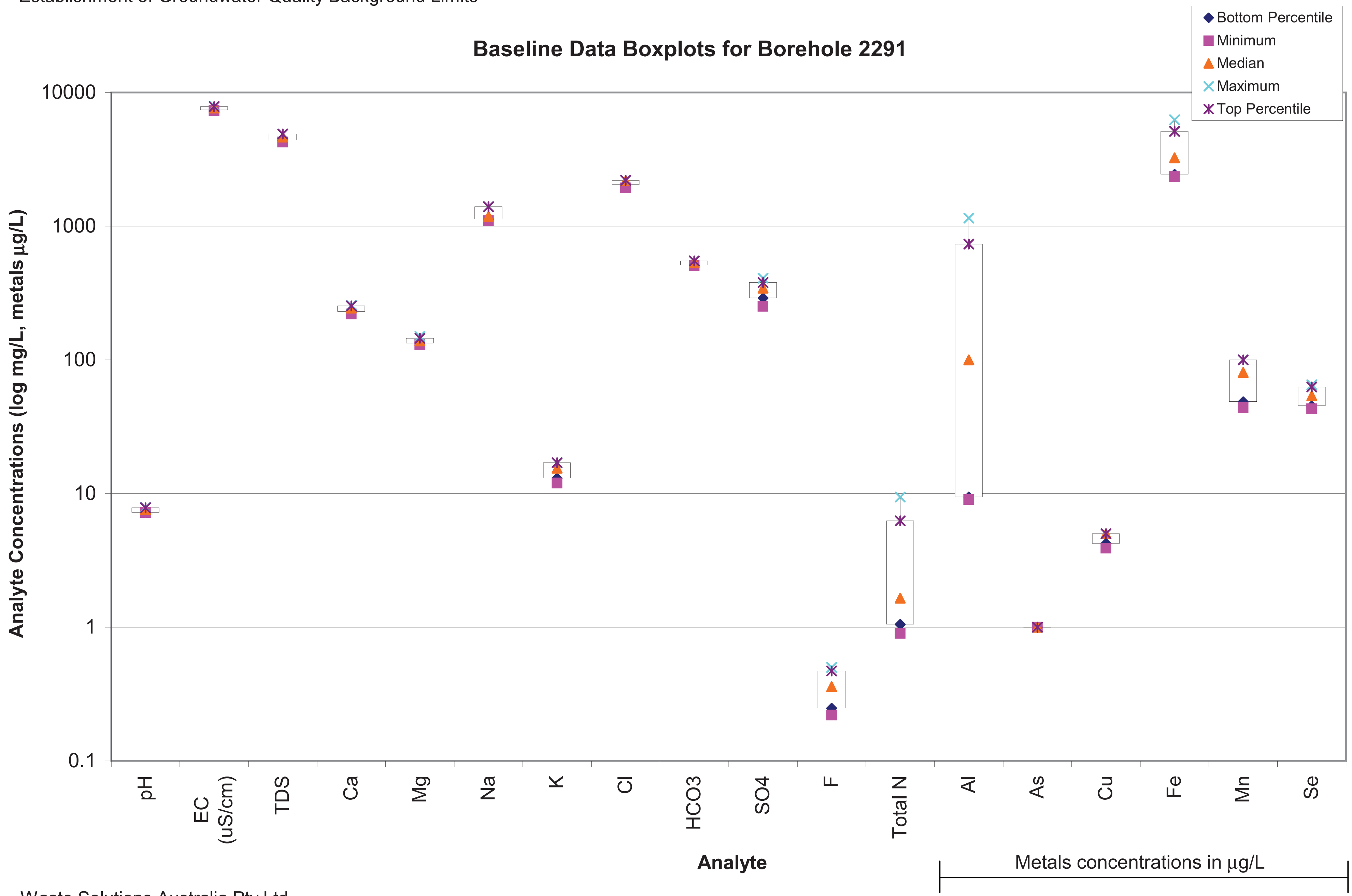
Baseline Data Boxplots for Borehole 83P



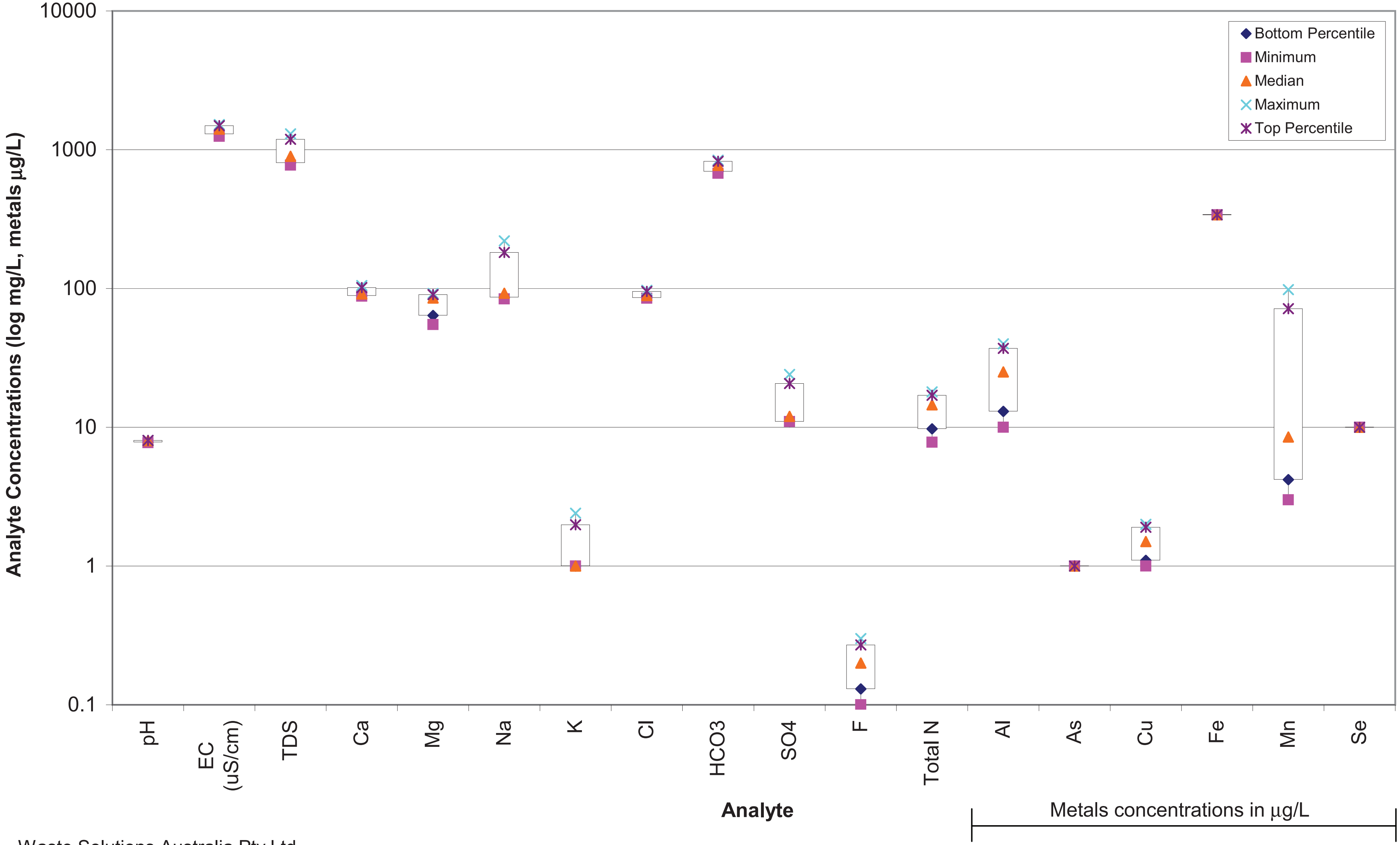
Baseline Data Boxplots for Borehole 84P



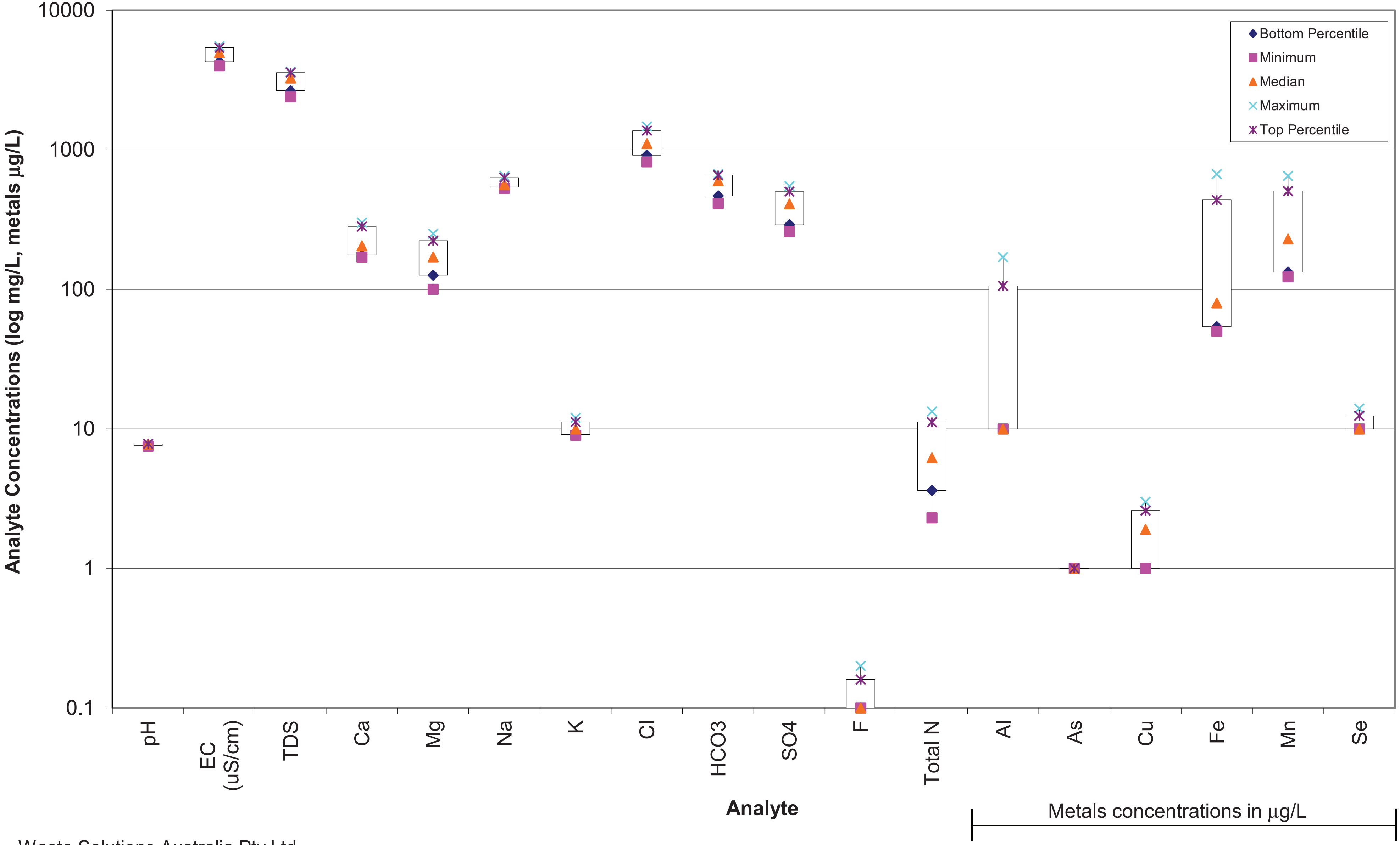

Baseline Data Boxplots for Borehole 2289
Analyte Concentrations (log mg/L, metals µg/L)
100000
10000
1000
100
10
1
0.1
Bottom Percentile
Minimum
Median
Maximum
Top Percentile
pH
EC (uS/cm)
TDS
Ca
Mg
Na
K
Cl
HCO3
SO4
F
Total N
Al
As
Cu
Fe
Mn
Se
Analyte
Metals concentrations in µg/L


Baseline Data Boxplots for Borehole 2291
Bottom Percentile
Minimum
Median
Maximum
Top Percentile
Analyte Concentrations (log mg/L, metals µg/L)
10000
1000
100
10
1
0.1
pH
EC (uS/cm)
TDS
Ca
Mg
Na
K
Cl
HCO3
SO4
F
Total N
Al
As
Cu
Fe
Mn
Se
Analyte
Metals concentrations in µg/L

Baseline Data Boxplots for Borehole BMH1



Baseline Data Boxplots for Borehole CSMH1



APPENDIX C

DATA TABLES

Groundwater Bore No. 18P (Coal)

		28/08/2003	3/03/2004	8/09/2004	13/04/2005	12/10/2005	28/04/2006	25/10/2006	18/04/2007	17/10/2007	15/04/2008	Calculated Statistical Values				
Parameter	**Units**											Bottom Percentile	Minimum	Median	Maximum	Top Percentile
pH	pH units	7.1	7.3	8.2	8	8.5	7.7	8.3	9.6	8	7.7	7.28	7.1	8	9.6	8.61
EC	mS/cm	600	530	810	790	820	790	850	720	770	840	593	530	790	850	841
TDS	mg/L	332	334	474	431	403	360	430	5200	430	490	333.8	332	430	5200	961
Major Ions																
Ca	mg/L	19	9.2	18	9.6	6.7	6.7	11	7.4	9.4	11	6.7	6.7	9.5	19	18.1
Mg	mg/L	3	1.9	3.2	2	2	1.7	3.3	<1	2.5	2.4	1.86	1.7	2.4	3.3	3.22
Na	mg/L	88	91	130	130	130	110	130	150	150	160	90.7	88	130	160	151
K	mg/L	3	1.2	5.8	5.1	4.7	3	4.1	<1	4.3	4.2	2.64	1.2	4.2	5.8	5.24
Cl	mg/L	92	92	150	140	130	120	150	2500	140	150	92	92	140	2500	385
HCO_3	mg/L	122	67	179	132	117	134	120	37	120	150	64	37	121	179	152.9
SO_4	mg/L	5	11	5.5	22	16	16	17	18	5.9	6	5.45	5	13.5	22	18.4
Minor Ions																
F	mg/L	0.3	0.3	0.4	0.1	0.5	0.4	<0.1	0.17	0.1	0.2	0.1	0.1	0.3	0.5	0.42
Total N	mg/L	3.1	0.38	0.87	1.2	1.7	0.53	0.83	0.44	1.3	4.7	0.434	0.38	1.035	4.7	3.26
Dissolved Metals																
Al	mg/L	1300	19	16	1800	150	750	130	77	590	24	18.7	16	140	1800	1350
As	mg/L	5	4	18	8	3	4	3.6	4.4	2.7	1.6	2.59	1.6	4	18	9
Cu	mg/L	73	5	8	10	2	6	<2	<2	<2	1.2	1.68	1.2	6	73	35.2
Fe	mg/L	110	180	1800	1600	160	800	180	99	490	230	108.9	99	205	1800	1620
Mn	mg/L	5	110	39	37	14	27	14	2.6	56	64	4.76	2.6	32	110	68.6
Se	mg/L	2	2	<1	6	3	2	<5	<5	<5	5.8	2	2	2.5	6	5.9

N.B. Values highlighted in red indicate potentially erroneous analysis readings.

Groundwater Bore No. 27P (Coal)

		28/08/2003	3/03/2004	8/09/2004	13/04/2005	12/10/2005	28/04/2006	25/10/2006	18/04/2007	17/10/2007	15/04/2008	Calculated Statistical Values				
Parameter	**Units**											Bottom Percentile	Minimum	Median	Maximum	Top Percentile
pH	pH units	7	7	7.4	7	7.5	7.6	7.2	7	7.6	7.3	7	7	7.25	7.6	7.6
EC	mS/cm	11000	9800	9900	9300	9700	9700	9200	9700	9100	8900	9080	8900	9700	11000	10010
TDS	mg/L	5597	6900	5040	6358	5430	4990	5900	6100	5800	5900	5035	4990	5850	6900	6412.2
Major Ions																
Ca	mg/L	390	400	370	500	390	420	570	430	410	410	388	370	410	570	507
Mg	mg/L	190	210	200	230	200	200	230	190	190	200	190	190	200	230	230
Na	mg/L	1400	1500	1500	1600	1600	1500	1300	1600	1500	1600	1390	1300	1500	1600	1600
K	mg/L	22	20	21	89	23	19	31	21	22	24	19.9	19	22	89	36.8
Cl	mg/L	2600	2300	2600	3600	2800	2500	2500	2700	2700	2700	2480	2300	2650	3600	2880
HCO_3	mg/L	414	390	327	328	314	337	740	430	290	280	289	280	332.5	740	461
SO_4	mg/L	580	580	590	740	690	690	560	670	710	680	578	560	675	740	713
Minor Ions																
F	mg/L	<0.1	0.1	0.2	<0.1	0.1	0.1	0.21	0.17	0.2	0.1	0.1	0.1	0.135	0.21	0.203
Total N	mg/L	1.2	1.8	2.5	7.6	3.7	3.8	3	3	1.4	2.4	1.38	1.2	2.75	7.6	4.18
Dissolved Metals																
Al	mg/L	640		7	750000	46	56	2000	140	16	25	14.2	7	56	750000	151600
As	mg/L	29	94	54	270	33	21	19	25	15	<1	18.2	15	29	270	129.2
Cu	mg/L	35	20	50	1000	10	8	<2	4.1	<2	3.7	3.98	3.7	15	1000	335
Fe	mg/L	2600		4200	800000	2100	2600	2700	4900	1000	1500	1400	1000	2600	800000	163920
Mn	mg/L	160	330	200	6500	170	98	340	300	92	61	88.9	61	185	6500	956
Se	mg/L	16	36	<10	360	15	9	5.5	<5	71	58	7.95	5.5	26	360	157.7

Groundwater Bore No. 28P (Coal)

		28/08/2003	3/03/2004	8/09/2004	13/04/2005	12/10/2005	28/04/2006	25/10/2006	18/04/2007	17/10/2007	15/04/2008	Calculated Statistical Values				
Parameter	**Units**											Bottom Percentile	Minimum	Median	Maximum	Top Percentile
pH	pH units	7.5	N/S	7.7	7.7	7.9	7.8	7.2	7.9	7.3	7.3	7.28	7.2	7.7	7.9	7.9
EC	mS/cm	9200	N/S	8700	9100	8800	8600	9700	8200	9100	8700	8520	8200	8800	9700	9300
TDS	mg/L	4836	N/S	5301	5836	5129	5051	5400	4700	6000	6300	4808.8	4700	5301	6300	6060
Major Ions																
Ca	mg/L	230	N/S	240	480	210	210	260	230	260	270	210	210	240	480	312
Mg	mg/L	180	N/S	210	310	220	230	220	230	230	270	204	180	230	310	278
Na	mg/L	1200	N/S	1400	1800	1500	1700	1300	1500	1500	1500	1280	1200	1500	1800	1720
K	mg/L	20	N/S	20	150	19	15	19	21	18	20	17.4	15	20	150	46.8
Cl	mg/L	2000	N/S	2700	2800	2400	2100	2300	2500	2400	2500	2080	2000	2400	2800	2720
HCO_3	mg/L	968	N/S	769	636	703	897	850	770	990	1000	689.6	636	850	1000	992
SO_4	mg/L	230	N/S	400	440	490	480	430	610	620	670	366	230	480	670	630
Minor Ions																
F	mg/L	0.1	N/S	0.1	<0.1	0.1	0.1	<0.1	<0.1	<0.1	<0.1	0.1	0.1	0.1	0.1	0.1
Total N	mg/L	2.5	N/S	1.2	3.8	1.9	1.2	1.1	0.93	0.91	1.7	0.926	0.91	1.2	3.8	2.76
Dissolved Metals																
Al	mg/L	400	N/S	16	1800000	23	71	720	42	19	42	18.4	16	42	1800000	360576
As	mg/L	19	N/S	51	480	27	17	26	24	14	<1	16.1	14	25	480	179.7
Cu	mg/L	<1	N/S	6	1200	4	7	<2	3.8	3.3	3	3.18	3	4	1200	484.2
Fe	mg/L	1500	N/S	7800	1500000	1700	1500	1000	760	4300	5800	952	760	1700	1500000	306240
Mn	mg/L	140	N/S	2	7200	8	7	220	19	32	33	6	2	32	7200	1616
Se	mg/L	16	N/S	<5	490	14	8	14	<5	65	45	11.6	8	16	490	235

Groundwater Bore No. 843 (Basalt)

		28/08/2003	3/03/2004	8/09/2004	13/04/2005	12/10/2005	28/04/2006	25/10/2006	18/04/2007	17/10/2007	15/04/2008	Calculated Statistical Values				
Parameter	**Units**											Bottom Percentile	Minimum	Median	Maximum	Top Percentile
pH	pH units	7.2	7.4	7.7	7.6	7.9	7.8	7.5	7.5	7.9	7.3	7.29	7.2	7.55	7.9	7.9
EC	mS/cm	3200	3500	3700	4000	4100	4300	4200	4200	3700	3300	3290	3200	3850	4300	4210
TDS	mg/L	1912	2205	1796	1990	2040	2070	2600	2600	2100	1800	1799.6	1796	2055	2600	2600
Major Ions																
Ca	mg/L	130	290	270	290	240	290	170	170	160	120	129	120	205	290	290
Mg	mg/L	140	230	180	190	180	200	170	170	170	180	167	140	180	230	203
Na	mg/L	230	270	240	300	330	300	310	310	300	350	239	230	300	350	332
K	mg/L	2	3.4	6.1	4.8	2.7	2.6	1.1	1.1	2.1	1.9	1.1	1.1	2.35	6.1	4.93
Cl	mg/L	480	660	810	940	970	910	780	780	740	870	642	480	795	970	943
HCO_3	mg/L	827	691	603	580	587	846	700	700	600	220	544	220	647	846	828.9
SO_4	mg/L	100	100	130	160	140	150	120	120	130	120	100	100	125	160	151
Minor Ions																
F	mg/L	0.6	0.9	0.8	0.3	0.4	0.9	0.41	0.41	0.5	0.4	0.39	0.3	0.455	0.9	0.9
Total N	mg/L	5.2	4.5	5.8	14	10	15	5.2	5.2	4.5	7.1	4.5	4.5	5.5	15	14.1
Dissolved Metals																
Al	mg/L	180	9	23	360000	20	14	56	56	70	18	13.5	9	39.5	360000	36162
As	mg/L	5	9	15	170	13	11	6.4	6.4	4.8	<1	4.96	4.8	9	170	46
Cu	mg/L	2	16	7	620	4	4	2.4	2.4	<2	3.3	2.32	2	4	620	136.8
Fe	mg/L	790	220	7800	330000	1900	1600	1400	1400	420	510	400	220	1400	330000	40020
Mn	mg/L	120	340	<1	7500	4	10	26	26	27	17	8.8	4	26	7500	1772
Se	mg/L	6	5	<50	380	6	6	<5	<5	18	14	5.6	5	6	380	162.8

Groundwater Bore No. 848 (Coal)

Parameter	Units	28/08/2003	3/03/2004	8/09/2004	13/04/2005	12/10/2005	28/04/2006	25/10/2006	18/04/2007	17/10/2007	15/04/2008	Calculated Statistical Values: Bottom Percentile	Minimum	Median	Maximum	Top Percentile
pH	pH units	7.3	7.1	7.8	7.4	7.6	7.5	7.5	8.1	8.2	8.2	7.28	7.1	7.55	8.2	8.2
EC	mS/cm	5600	5200	5300	4700	4800	4500	5100	3300	3000	3700	3270	3000	4750	5600	5330
TDS	mg/L	3044	3300	2802	2567	2313	2228	2600	2100	1700	2500	2060	1700	2533.5	3300	3069.6
Major Ions																
Ca	mg/L	90	140	130	200	170	160	160	79	63	87	77.4	63	135	200	173
Mg	mg/L	160	170	170	190	180	170	160	79	68	120	77.9	68	165	190	181
Na	mg/L	730	670	690	540	430	510	440	450	400	600	427	400	525	730	694
K	mg/L	2	4.5	5	9.1	6.8	6.6	6.4	3.9	4.1	2.2	2.18	2	4.75	9.1	7.03
Cl	mg/L	1000	1100	1300	1200	1100	910	1000	650	590	790	644	590	1000	1300	1210
HCO_3	mg/L	947	732	697	594	641	810	700	660	480	840	582.6	480	698.5	947	850.7
SO_4	mg/L	110	140	6.5	220	130	130	120	77	76	84	69.05	6.5	115	220	148
Minor Ions																
F	mg/L	1.1	0.6	1	0.2	0.2	0.2	0.23	0.74	0.4	1	0.2	0.2	0.5	1.1	1.01
Total N	mg/L	7.8	1	3.7	2.1	1.8	0.93	1	5.6	3.6	12	0.993	0.93	2.85	12	8.22
Dissolved Metals																
Al	mg/L	190		3	990	220	54	18	43	42	10	8.6	3	43	990	374
As	mg/L	11	29	29	18	10	9	8.3	7.9	3.5	<1	7.02	3.5	10	29	29
Cu	mg/L	<1	<1	6	23	2	3	<2	<2	<2	1.8	1.88	1.8	3	23	16.2
Fe	mg/L	460		5000	7300	3900	4100	1300	2000	190	300	278	190	2000	7300	5460
Mn	mg/L	6	70	<1	120	110	120	99	39	27	7.6	7.28	6	70	120	120
Se	mg/L	13	7	<5	30	5	5	<5	<5	15	15	5	5	13	30	21

Groundwater Bore No. 81P (Coal)

Parameter	Units	28/08/2003	3/03/2004	8/09/2004	13/04/2005	12/10/2005	28/04/2006	25/10/2006	18/04/2007	17/10/2007	15/04/2008	Calculated Statistical Values: Bottom Percentile	Minimum	Median	Maximum	Top Percentile
pH	pH units	N/S	N/S	N/S	N/S	8.2	7.9	7.4	7.3	7.5	7.4	7.35	7.3	7.45	8.2	8.05
EC	mS/cm	N/S	N/S	N/S	N/S	6400	6500	7100	6200	6100	6500	6150	6100	6450	7100	6800
TDS	mg/L	N/S	N/S	N/S	N/S	3129	3161	3400	3900	3600	3700	3145	3129	3500	3900	3800
Major Ions																
Ca	mg/L	N/S	N/S	N/S	N/S	230	230	240	200	200	210	200	200	220	240	235
Mg	mg/L	N/S	N/S	N/S	N/S	97	91	100	93	96	100	92	91	96.5	100	100
Na	mg/L	N/S	N/S	N/S	N/S	750	1000	870	960	940	940	810	750	940	1000	980
K	mg/L	N/S	N/S	N/S	N/S	12	16	16	14	12	16	12	12	15	16	16
Cl	mg/L	N/S	N/S	N/S	N/S	1800	1600	1600	1800	1700	1700	1600	1600	1700	1800	1800
HCO_3	mg/L	N/S	N/S	N/S	N/S	305	361	430	320	350	370	312.5	305	355.5	430	400
SO_4	mg/L	N/S	N/S	N/S	N/S	250	240	220	240	270	260	230	220	245	270	265
Minor Ions																
F	mg/L	N/S	N/S	N/S	N/S	0.1	0.2	<0.1	<0.1	<0.1	<0.1	0.11	0.1	0.15	0.2	0.19
Total N	mg/L	N/S	N/S	N/S	N/S	1.5	1.7	1.7	2.1	0.84	1.8	1.17	0.84	1.7	2.1	1.95
Dissolved Metals																
Al	mg/L	N/S	N/S	N/S	N/S	20	21	<1	48	65	25	20.4	20	25	65	58.2
As	mg/L	N/S	N/S	N/S	N/S	18	14	<1	15	8.4	<1	10.08	8.4	14.5	18	17.1
Cu	mg/L	N/S	N/S	N/S	N/S	3	4	<2	<2	<2	1.9	2.12	1.9	3	4	3.8
Fe	mg/L	N/S	N/S	N/S	N/S	1500	1400	<5	580	820	1300	676	580	1300	1500	1460
Mn	mg/L	N/S	N/S	N/S	N/S	570	130	<1	250	180	160	142	130	180	570	442
Se	mg/L	N/S	N/S	N/S	N/S	9	6	<5	<5	37	39	6.9	6	23	39	38.4

Groundwater Bore No. 82P (Coal)

		28/08/2003	3/03/2004	8/09/2004	13/04/2005	12/10/2005	28/04/2006	25/10/2006	18/04/2007	17/10/2007	15/04/2008	Calculated Statistical Values				
Parameter	**Units**											Bottom Percentile	Minimum	Median	Maximum	Top Percentile
pH	pH units	N/S	N/S	N/S	N/S	7.7	7.6	7.8	7.7	7.9	7.9	7.65	7.6	7.75	7.9	7.9
EC	mS/cm	N/S	N/S	N/S	N/S	5900	5600	6000	5400	5300	5400	5350	5300	5500	6000	5950
TDS	mg/L	N/S	N/S	N/S	N/S	3185	3308	3400	3400	3600	3500	3246.5	3185	3400	3600	3550
Major Ions																
Ca	mg/L	N/S	N/S	N/S	N/S	140	130	130	120	150	140	125	120	135	150	145
Mg	mg/L	N/S	N/S	N/S	N/S	140	140	140	130	130	140	130	130	140	140	140
Na	mg/L	N/S	N/S	N/S	N/S	750	880	760	850	840	880	755	750	845	880	880
K	mg/L	N/S	N/S	N/S	N/S	6.4	5.3	5.8	5.8	7.2	6.6	5.55	5.3	6.1	7.2	6.9
Cl	mg/L	N/S	N/S	N/S	N/S	1200	1100	1100	1200	1100	1100	1100	1100	1100	1200	1200
HCO_3	mg/L	N/S	N/S	N/S	N/S	759	953	880	770	880	840	764.5	759	860	953	916.5
SO_4	mg/L	N/S	N/S	N/S	N/S	460	530	400	480	470	480	430	400	475	530	505
Minor Ions																
F	mg/L	N/S	N/S	N/S	N/S	0.5	0.4	0.14	0.55	0.3	0.5	0.22	0.14	0.45	0.55	0.525
Total N	mg/L	N/S	N/S	N/S	N/S	1.3	1.8	0.63	0.85	0.86	1.3	0.74	0.63	1.08	1.8	1.55
Dissolved Metals																
Al	mg/L	N/S	N/S	N/S	N/S	10	86	70	15	10	24	10	10	19.5	86	78
As	mg/L	N/S	N/S	N/S	N/S	11	9	7.5	12	6.1	<1	6.66	6.1	9	12	11.6
Cu	mg/L	N/S	N/S	N/S	N/S	3	5	<2	2.2	<2	2.8	2.38	2.2	2.9	5	4.4
Fe	mg/L	N/S	N/S	N/S	N/S	870	3100	1600	1700	610	1400	740	610	1500	3100	2400
Mn	mg/L	N/S	N/S	N/S	N/S	54	60	59	73	190	100	56.5	54	66.5	190	145
Se	mg/L	N/S	N/S	N/S	N/S	7	6	<5	<5	27	22	6.3	6	14.5	27	25.5

Groundwater Bore No. 83P (Coal)

		28/08/2003	3/03/2004	8/09/2004	13/04/2005	12/10/2005	28/04/2006	25/10/2006	18/04/2007	17/10/2007	15/04/2008	Calculated Statistical Values				
Parameter	**Units**											Bottom Percentile	Minimum	Median	Maximum	Top Percentile
pH	pH units	N/S	N/S	N/S	N/S	8.2	8.1	7.3	7.8	7.5	7.2	7.25	7.2	7.65	8.2	8.15
EC	mS/cm	N/S	N/S	N/S	N/S	940	1200	1600	1400	1300	1300	1070	940	1300	1600	1500
TDS	mg/L	N/S	N/S	N/S	N/S	485	830	1200	880	820	960	652.5	485	855	1200	1080
Major Ions																
Ca	mg/L	N/S	N/S	N/S	N/S	30	70	130	82	73	96	50	30	77.5	130	113
Mg	mg/L	N/S	N/S	N/S	N/S	14	44	63	54	43	50	28.5	14	47	63	58.5
Na	mg/L	N/S	N/S	N/S	N/S	100	100	120	140	99	100	99.5	99	100	140	130
K	mg/L	N/S	N/S	N/S	N/S	2.6	3.1	7.6	4.4	4.2	4.3	2.85	2.6	4.25	7.6	6
Cl	mg/L	N/S	N/S	N/S	N/S	100	140	170	150	130	140	115	100	140	170	160
HCO_3	mg/L	N/S	N/S	N/S	N/S	263	639	650	550	450	550	356.5	263	550	650	644.5
SO_4	mg/L	N/S	N/S	N/S	N/S	14	<50	30	22	20	18	15.6	14	20	30	26.8
Minor Ions																
F	mg/L	N/S	N/S	N/S	N/S	0.2	0.1	0.2	0.31	0.2	0.3	0.15	0.1	0.2	0.31	0.305
Total N	mg/L	N/S	N/S	N/S	N/S	1.2	1.1	0.53	22	0.28	0.99	0.405	0.28	1.045	22	11.6
Dissolved Metals																
Al	mg/L	N/S	N/S	N/S	N/S	35	74	520	96	12	41	23.5	12	57.5	520	308
As	mg/L	N/S	N/S	N/S	N/S	<1	2	1.4	1.5	<1	<1	1.42	1.4	1.5	2	1.9
Cu	mg/L	N/S	N/S	N/S	N/S	1	3	<2	<2	<2	1.2	1.04	1	1.2	3	2.64
Fe	mg/L	N/S	N/S	N/S	N/S	240	580	1100	770	690	660	410	240	675	1100	935
Mn	mg/L	N/S	N/S	N/S	N/S	26	38	96	59	70	73	32	26	64.5	96	84.5
Se	mg/L	N/S	N/S	N/S	N/S	3	3	<5	<5	<5	<5	3	3	3	3	3

Groundwater Bore No. 84P (Basalt)

Parameter	Units	28/08/2003	3/03/2004	8/09/2004	13/04/2005	12/10/2005	28/04/2006	25/10/2006	18/04/2007	17/10/2007	15/04/2008	Calculated Statistical Values: Bottom Percentile	Minimum	Median	Maximum	Top Percentile
pH	pH units	N/S	N/S	N/S	N/S	8	7.6	7.7	7.7	7.8	7.7	7.65	7.6	7.7	8	7.9
EC	mS/cm	N/S	N/S	N/S	N/S	2400	2600	3100	3100	3400	3500	2500	2400	3100	3500	3450
TDS	mg/L	N/S	N/S	N/S	N/S	961	1324	2100	2100	2000	2000	1142.5	961	2000	2100	2100
Major Ions																
Ca	mg/L	N/S	N/S	N/S	N/S	130	130	170	170	210	240	130	130	170	240	225
Mg	mg/L	N/S	N/S	N/S	N/S	120	130	150	150	180	210	125	120	150	210	195
Na	mg/L	N/S	N/S	N/S	N/S	140	220	170	170	160	200	150	140	170	220	210
K	mg/L	N/S	N/S	N/S	N/S	3	2.6	2.7	2.7	3.4	3.8	2.65	2.6	2.85	3.8	3.6
Cl	mg/L	N/S	N/S	N/S	N/S	400	440	620	620	730	800	420	400	620	800	765
HCO_3	mg/L	N/S	N/S	N/S	N/S	335	678	520	520	450	440	387.5	335	485	678	599
SO_4	mg/L	N/S	N/S	N/S	N/S	76	100	130	130	190	250	88	76	130	250	220
Minor Ions																
F	mg/L	N/S	N/S	N/S	N/S	0.3	0.2	0.16	0.16	0.2	0.2	0.16	0.16	0.2	0.3	0.25
Total N	mg/L	N/S	N/S	N/S	N/S	3.2	2.9	2.6	2.6	2.2	3.3	2.4	2.2	2.75	3.3	3.25
Dissolved Metals																
Al	mg/L	N/S	N/S	N/S	N/S	23	13	12	12	14	9.7	10.85	9.7	12.5	23	18.5
As	mg/L	N/S	N/S	N/S	N/S	5	6	7.9	7.9	5	<1	5	5	6	7.9	7.9
Cu	mg/L	N/S	N/S	N/S	N/S	2	4	<2	<2	<2	2.4	2.08	2	2.4	4	3.68
Fe	mg/L	N/S	N/S	N/S	N/S	970	1000	12000	12000	490	770	630	490	985	12000	12000
Mn	mg/L	N/S	N/S	N/S	N/S	6	34	18	18	18	40	12	6	18	40	37
Se	mg/L	N/S	N/S	N/S	N/S	6	6	5.5	5.5	24	16	5.5	5.5	6	24	20

Groundwater Bore No. 2289 (Coal)

Parameter	Units	1/04/2009	1/12/2009	1/06/2010	13/12/2010	22/06/2011	14/12/2011	16/04/2012				Calculated Statistical Values: Bottom Percentile	Minimum	Median	Maximum	Top Percentile
pH	pH units	8	7.3	7.1	6.7	6.01	7.01	7.2				6.424	6.01	7.1	8	7.58
EC	mS/cm	6600	6000	6200	6200	19800	15800	7150				6120	6000	6600	19800	17400
TDS	mg/L	3500	3500	3700	5700	12200	11800	4650				3500	3500	4650	12200	11960
Major Ions																
Ca	mg/L	340	290	400	29	889	706	309				185.6	29	340	889	779.2
Mg	mg/L	140	130	8	4	799	705	182				6.4	4	140	799	742.6
Na	mg/L	640	780	750	1100	2740	2470	944				706	640	944	2740	2578
K	mg/L	14	17	13	18	17	10	14				11.8	10	14	18	17.4
Cl	mg/L	1700	1700	1700	2100	5830	5840	1960				1700	1700	1960	5840	5834
HCO_3	mg/L	290	330	320	207.3	166	172	149				159	149	207.3	330	324
SO_4	mg/L	350	350	370	660	2820	2050	609				350	350	609	2820	2358
Minor Ions																
F	mg/L	<0.1	<0.1	0.5	0.1	0.2	0.3	0.2				0.14	0.1	0.2	0.5	0.42
Total N	mg/L	1.6	1.1	0.85	2.2	6	4	1.2				1	0.85	1.6	6	4.8
Dissolved Metals																
Al	mg/L	4.8	180	14	320	50	30	80				10.32	4.8	50	320	236
As	mg/L	<1	<1	<1	<1	1	1	<1				1	1	1	1	1
Cu	mg/L	<1	7	3	11	16	9	4				3.5	3	8	16	13.5
Fe	mg/L	3000	3500	3600	3000	2250	870	1390				1182	870	3000	3600	3540
Mn	mg/L	390	270	390	250	1250	854	208				233.2	208	390	1250	1012.4
Se	mg/L	28	35	37	20	<10	<10	<10				22.4	20	31.5	37	36.4

N.B. Values highlighted in red indicate potentially erroneous analysis readings. Values in blue indicate calculated TDS.

Groundwater Bore No. 2291 (Coal)

		9/06/2009	17/12/2009	1/07/2010	23/06/2011	13/12/2011	17/04/2012	Calculated Statistical Values				
Parameter	**Units**							Bottom Percentile	Minimum	Median	Maximum	Top Percentile
pH	pH units	7.6	7.2	7.2	7.61	7.9	7.74	7.2	7.2	7.605	7.9	7.82
EC	mS/cm	7900	7400	7700	7780	7320	7630	7360	7320	7665	7900	7840
TDS	mg/L	4700	4900	4600	4250	4510	4900	4380	4250	4650	4900	4900
Major Ions												
Ca	mg/L	220	240	250	256	247	240	230	220	243.5	256	253
Mg	mg/L	140	150	130	136	137	140	133	130	138.5	150	145
Na	mg/L	1400	1400	1100	1200	1160	1170	1130	1100	1185	1400	1400
K	mg/L	15	14	12	17	16	17	13	12	15.5	17	17
Cl	mg/L	2200	2200	2200	1930	2150	2180	2040	1930	2190	2200	2200
HCO_3	mg/L	510	540	550	508	530	549	509	508	535	550	549
SO_4	mg/L	330	350	340	346	251	408	290.5	251	343	408	379
Minor Ions												
F	mg/L	<0.1	0.5	0.22	<0.1	<0.1	<0.1	0.248	0.22	0.36	0.5	0.472
Total N	mg/L	9.4	0.9	1.2	1.5	1.8	3.1	1.05	0.9	1.65	9.4	6.25
Dissolved Metals												
Al	mg/L	100	110	9	<10	1150	10	9.4	9	100	1150	734
As	mg/L	<1	<1	1	<1	<1	<1	1	1	1	1	1
Cu	mg/L	3.9	5	5	<1	5	<1	4.23	3.9	5	5	5
Fe	mg/L	3200	3300	4000	2340	6250	2530	2435	2340	3250	6250	5125
Mn	mg/L	100	76	85	44	100	53	48.5	44	80.5	100	100
Se	mg/L	43	65	54	<10	<10	<10	45.2	43	54	65	62.8

Groundwater Bore No. BMH1 (Basalt)

		16/04/2008	22/06/2011	14/12/2011	17/04/2012	Calculated Statistical Values				
Parameter	**Units**					Bottom Percentile	Minimum	Median	Maximum	Top Percentile
pH	pH units	8	8.02	8.05	7.73	7.811	7.73	8.01	8.05	8.041
EC	mS/cm	1400	1520	1250	1420	1295	1250	1410	1520	1490
TDS	mg/L	1300	871	774	923	803.1	774	897	1300	1186.9
Major Ions										
Ca	mg/L	88	105	93	90	88.6	88	91.5	105	101.4
Mg	mg/L	55	92	85	86	64	55	85.5	92	90.2
Na	mg/L	220	92	84	93	86.4	84	92.5	220	181.9
K	mg/L	2.4	1	1	1	1	1	1	2.4	1.98
Cl	mg/L	85	91	97	87	85.6	85	89	97	95.2
HCO_3	mg/L	840	791	675	751	698	675	771	840	825
SO_4	mg/L	11	13	11	24	11	11	12	24	20.7
Minor Ions										
F	mg/L	0.1	0.3	0.2	0.2	0.13	0.1	0.2	0.3	0.27
Total N	mg/L	18	14.7	7.8	14.3	9.75	7.8	14.5	18	17.01
Dissolved Metals										
Al	mg/L	40	<10	10	<10	13	10	25	40	37
As	mg/L	<1	<1	<1	<1	1	1	1	1	1
Cu	mg/L	1	2	<1	<1	1.1	1	1.5	2	1.9
Fe	mg/L	340	<50	<50	<50	340	340	340	340	340
Mn	mg/L	98	7	10	3	4.2	3	8.5	98	71.6
Se	mg/L	<5	<10	<10	<10	10	10	10	10	10

N.B. Values in blue indicate calculated TDS.

Groundwater Bore No. CSMH1 (Coal)

		16/04/2008	23/06/2011	12/12/2011	18/04/2012	16/10/2012						Calculated Statistical Values				
Parameter	**Units**											Bottom Percentile	Minimum	Median	Maximum	Top Percentile
pH	pH units	7.5	7.79	7.7	7.8	7.79						7.58	7.50	7.79	7.80	7.80
EC	mS/cm	4000	5190	5520	4980	4700						4280	4000	4980	5520	5388
TDS	mg/L	2400	3050	3620	3520	3270						2660	2400	3270	3620	3580
Major Ions																
Ca	mg/L	170	255	301	205	186						176.4	170	205	301	282.6
Mg	mg/L	100	171	250	183	166						126.4	100	171	250	223.2
Na	mg/L	530	609	647	565	561						542.4	530	565	647	631.8
K	mg/L	9.3	10	12	10	9						9.1	9.0	10.0	12.0	11.2
Cl	mg/L	820	1110	1470	1230	1060						916	820	1110	1470	1374
HCO_3	mg/L	550	670	640	601	412						467	412	601	670	658
SO_4	mg/L	260	410	336	430	549						290.4	260	410	549	501.4
Minor Ions																
F	mg/L	0.1	0.2	0.1	<0.1	<0.1						0.1	0.1	0.1	0.2	0.16
Total N	mg/L	2.3	13.3	6.2	5.6	8						3.62	2.3	6.2	13.3	11.18
Dissolved Metals																
Al	mg/L	170	<10	<10	<10	<10						10	10	10	170	106
As	mg/L	<1	<1	<1	<1	<1						1	1	1	1	1
Cu	mg/L	1.9	<1	<1	2	3						1	1	1.9	3	2.6
Fe	mg/L	670	<50	60	80	90						54	50	80	670	438
Mn	mg/L	650	292	230	148	123						133	123	230	650	506.8
Se	mg/L	14	<10	<10	<10	<10						10	10	10	14	12.4

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Appendix D. Stage 3 Groundwater Bore Water Quality Laboratory Results

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ALS Environmental

CERTIFICATE OF ANALYSIS

Client	: SINCLAIR KNIGHT MERZ	*Laboratory*	: Environmental Division Brisbane	*Page*	: 1 of 5
Contact	: KAVITA PRASAD	*Contact*	: Tim Kilmister	*Work Order*	: **EB0711541**
Address	: LEVEL 1 369 ANN STREET BRISBANE QLD AUSTRALIA 4000	*Address*	: 32 Shand Street Stafford QLD Australia 4053		
E-mail	: kprasad@skm.com.au	*E-mail*	: Services.Brisbane@alsenviro.com		
Telephone	: 32447381	*Telephone*	: +61-7-3243 7222		
Facsimile	: 0732447306	*Facsimile*	: +61-7-3243 7218		
Project	: QE06455.004	*Quote number*	: EN/003/05	*Date received*	: 8 Oct 2007
Order number	: SKM SQ			*Date issued*	: 16 Oct 2007
C-O-C number	: - Not provided -			*No. of samples*	- *Received* : 10
Site	: New Aclands EIS				*Analysed* : 10

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WORLD RECOGNISED ACCREDITATION

This document has been electronically signed by those names that appear on this report and are the authorised signatories. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatory	*Position*	*Department*
Kim McCabe	Senior Inorganic Chemist	Inorganics - NATA 825 (818 - Brisbane)

Comments

This report for the ALSE reference EB0711541 supersedes any previous reports with this reference. Results apply to the samples as submitted. All pages of this report have been checked and approved for release.

This report contains the following information:

- **Analytical Results for Samples Submitted**
- **Surrogate Recovery Data**

The analytical procedures used by ALS Environmental have been developed from established internationally-recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported herein. Reference methods from which ALSE methods are based are provided in parenthesis.

When moisture determination has been performed, results are reported on a dry weight basis. When a reported 'less than' result is higher than the LOR, this may be due to primary sample extracts/digestion dilution and/or insuffient sample amount for analysis. Surrogate Recovery Limits are static and based on USEPA SW846 or ALS-QWI/EN38 (in the absence of specified USEPA limits). Where LOR of reported result differ from standard LOR, this may be due to high moisture, reduced sample amount or matrix interference. When date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for process purposes. Abbreviations: CAS number = Chemical Abstract Services number, LOR = Limit of Reporting. * Indicates failed Surrogate Recoveries.

Analytical Results

Analyte	CAS number	LOR	Units	E012	E016 (117P)	E016 (118PGC)	E019 (119PGC)	E021
Sample Matrix Type / Description :				WATER	WATER	WATER	WATER	WATER
Sample Date / Time :				4 Oct 2007 15:00	4 Oct 2007 15:00	4 Oct 2007 15:00	5 Oct 2007 15:00	5 Oct 2007 15:00
Laboratory Sample ID :				EB0711541-001	EB0711541-002	EB0711541-003	EB0711541-004	EB0711541-005
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	482	206	195	409	430
Total Alkalinity as CaCO3		1	mg/L	482	206	195	409	430
ED040F: Dissolved Major Anions								
Sulphate as SO4 2-	14808-79-8	1	mg/L	209	78	317	43	54
ED045P: Chloride by PC Titrator								
Chloride	16887-00-6	1	mg/L	1270	1330	3270	402	659
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	103	65	319	38	74
Magnesium	7439-95-4	1	mg/L	117	36	164	40	31
Sodium	7440-23-5	1	mg/L	795	802	1620	338	507
Potassium	7440-09-7	1	mg/L	6	6	14	4	6
EG020F: Dissolved Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	0.002	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	0.0010	<0.0001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	0.004	0.002	0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L	0.009	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	0.002	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L	0.014	0.008	0.009	0.011	0.046
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EN055: Ionic Balance								
Total Anions		0.01	meq/L	49.8	43.2	103	20.4	28.3
Total Cations		0.01	meq/L	49.5	41.2	100	19.9	28.5
Ionic Balance		0.01	%	0.24	2.26	1.33	1.22	0.28

ALS Environmental

Analytical Results

Client Sample ID :				109P (E003)	(E014) 111PGC UPPER	(E014) 111PGC LOWER	113PGC A	113PGC B
Sample Matrix Type / Description :				WATER	WATER	WATER	WATER	WATER
Sample Date / Time :				4 Oct 2007 15:00	4 Oct 2007 15:00	4 Oct 2007 15:00	5 Oct 2007 15:00	5 Oct 2007 15:00
Laboratory Sample ID :				EB0711541-006	EB0711541-007	EB0711541-008	EB0711541-009	EB0711541-010
Analyte	*CAS number*	*LOR*	*Units*					
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	108	527	411	413	453
Total Alkalinity as CaCO3		1	mg/L	108	527	411	413	453
ED040F: Dissolved Major Anions								
Sulphate as SO4 2-	14808-79-8	1	mg/L	15	318	129	342	184
ED045P: Chloride by PC Titrator								
Chloride	16887-00-6	1	mg/L	68	1920	1250	1620	1190
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	6	289	147	190	131
Magnesium	7439-95-4	1	mg/L	1	211	50	180	100
Sodium	7440-23-5	1	mg/L	88	886	791	889	748
Potassium	7440-09-7	1	mg/L	2	12	10	9	8
EG020F: Dissolved Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	0.003	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	0.008
Copper	7440-50-8	0.001	mg/L	0.002	<0.001	<0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L	0.002	<0.001	0.002	0.001	<0.001
Zinc	7440-66-6	0.005	mg/L	0.011	0.005	0.021	0.008	0.022
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EN055: Ionic Balance								
Total Anions		0.01	meq/L	4.39	71.3	46.0	61.1	46.5
Total Cations		0.01	meq/L	4.28	70.6	46.1	63.2	47.5
Ionic Balance		0.01	%	1.36	0.46	0.03	1.68	1.10

Surrogate Control Limits

- **No surrogates present on this report.**

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Appendix E. Lagoon Creek Surface Water Quality Results

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Lagoon Creek Sampling			Description	LCU1-SKM	LCD1-SKM	NACP-AE4-SKM	NACP-DS1-SKM
			Sample Date	8/3/2013 8:00	8/3/2013 8:10	8/3/2013 10:00	8/3/2013 10:15
Method Name	Analyte Name	Units	Reporting Limit	Result	Result	Result	Result
Turbidity	Turbidity	NTU	0.5	8.6	55	19	10
pH in water	pH**	pH Units	0.1	7.0	7.5	7.6	7.4
Conductivity and TDS by Calculation - Water	Conductivity @ 25 C	µS/cm	5	240	310	240	280
Trace Metals (Dissolved) in Water by ICPMS	Arsenic, As	µg/L	1	2	1	2	2
Trace Metals (Dissolved) in Water by ICPMS	Barium, Ba	µg/L	1	39	28	69	61
Trace Metals (Dissolved) in Water by ICPMS	Beryllium, Be	µg/L	1	<1	<1	<1	<1
Trace Metals (Dissolved) in Water by ICPMS	Chromium, Cr	µg/L	2	<2	<2	<2	<2
Trace Metals (Dissolved) in Water by ICPMS	Cobalt, Co	µg/L	1	<1	<1	<1	<1
Trace Metals (Dissolved) in Water by ICPMS	Copper, Cu	µg/L	1	2	3	4	3
Trace Metals (Dissolved) in Water by ICPMS	Manganese, Mn	µg/L	1	1	<1	22	1
Trace Metals (Dissolved) in Water by ICPMS	Nickel, Ni	µg/L	1	5	2	4	4
Trace Metals (Dissolved) in Water by ICPMS	Vanadium, V	µg/L	1	2	4	8	5
Trace Metals (Dissolved) in Water by ICPMS	Zinc, Zn	µg/L	2	<2	<2	6	<2
Trace Metals (Total) in Water by ICPMS	Total Arsenic	µg/L	1	2	2	2	3
Trace Metals (Total) in Water by ICPMS	Total Barium	µg/L	1	88	54	90	110
Trace Metals (Total) in Water by ICPMS	Total Beryllium	µg/L	1	<1	<1	<1	<1
Trace Metals (Total) in Water by ICPMS	Total Cobalt	µg/L	1	4	<1	<1	<1
Trace Metals (Total) in Water by ICPMS	Total Chromium	µg/L	1	<1	1	<1	<1
Trace Metals (Total) in Water by ICPMS	Total Copper	µg/L	1	3	4	4	4
Trace Metals (Total) in Water by ICPMS	Total Nickel	µg/L	1	7	3	5	4
Trace Metals (Total) in Water by ICPMS	Total Manganese	µg/L	1	490	9	31	10
Trace Metals (Total) in Water by ICPMS	Total Vanadium	µg/L	1	4	7	11	8
Trace Metals (Total) in Water by ICPMS	Total Zinc	µg/L	1	<1	<1	8	<1
Mercury (dissolved) in Water	Mercury	mg/L	0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Mercury (total) in Water	Total Mercury	mg/L	0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Total Nitrogen by Persulphate Digestion DA	Total Nitrogen (Persulphate Digestion)	mg/L	0.02	1.4	0.84	1.2	0.97
Ammonia Nitrogen by Discrete Analyser	Ammonia Nitrogen, NH_3 as N	mg/L	0.006	0.29	0.031	0.051	0.033
Ammonia Nitrogen by Discrete Analyser	Ammonia, NH3	mg/L	0.005	0.35	0.037	0.061	0.040
Total Phosphorus by Persulphate Digestion DA i	Total Phosphorus (Persulphate Digestion)	mg/L	0.02	0.15	0.12	0.31	0.26
Filterable Reactive Phosphorus (FRP)	Filterable Reactive Phosphorus	mg/L	0.006	0.052	0.059	0.18	0.17
Nitrate/Nitrite Nitrogen (NOx) by Discrete Analyse	Nitrate/Nitrite Nitrogen, NOx as N	mg/L	0.02	0.02	0.29	0.02	<0.02
Anions by Ion Chromatography in Water	Fluoride	mg/L	0.1	<0.1	0.6	0.2	0.1
Anions by Ion Chromatography in Water	Chloride	mg/L	1	9	26	10	13
Anions by Ion Chromatography in Water	Sulphate, SO4	mg/L	1	1	20	4	5
Alkalinity	Bicarbonate Alkalinity as CaCO3	mg/L	5	95	84	98	110
Alkalinity	Bicarbonate Alkalinity as HCO3	mg/L	5	120	100	120	140
Alkalinity	Bicarbonate Alkalinity as HCO3 (meq/L)	meq/L	0.06	1.9	1.7	2.0	2.3
Alkalinity	Carbonate Alkalinity as CaCO3	mg/L	5	<5	<5	<5	<5
Alkalinity	Carbonate Alkalinity as CO3	mg/L	5	<5	<5	<5	<5
Alkalinity	Carbonate Alkalinity as CO3 (meq/L)	meq/L	0.03	<0.03	<0.03	<0.03	<0.03
Alkalinity	Hydroxide Alkalinity as CaCO3	mg/L	5	<5	<5	<5	<5
Alkalinity	Hydroxide Alkalinity as OH	mg/L	5	<5	<5	<5	<5
Alkalinity	Hydroxide Alkalinity as OH (meq/L)	meq/L	0.06	<0.06	<0.06	<0.06	<0.06

Alkalinity	Phenolphthalein Alkalinity as CaCO3	mg/L	5	<5	<5	<5	<5
Alkalinity	Total Alkalinity as CaCO3	mg/L	5	95	84	98	110
Total and Volatile Suspended Solids (TSS / VSS	Total Suspended Solids Dried at 105°C	mg/L	5	19	28	21	7
TRH (Total Recoverable Hydrocarbons) in Water	TRH C10-C14	µg/L	50	<50	<50	<50	<50
TRH (Total Recoverable Hydrocarbons) in Water	TRH C15-C28	µg/L	200	<200	<200	<200	<200
TRH (Total Recoverable Hydrocarbons) in Water	TRH C29-C36	µg/L	200	<200	<200	<200	<200
Volatile Petroleum Hydrocarbons in Water	TRH C6-C9	µg/L	40	<40	<40	<40	<40
Volatile Petroleum Hydrocarbons in Water	d4-1,2-dichloroethane (Surrogate)	%	0	112	87	90	101
Volatile Petroleum Hydrocarbons in Water	d8-toluene (Surrogate)	%	0	153	109	110	118
Volatile Petroleum Hydrocarbons in Water	Dibromofluoromethane (Surrogate)	%	0	123	103	105	118
Volatile Petroleum Hydrocarbons in Water	Bromofluorobenzene (Surrogate)	%	0	128	90	89	92
OC Pesticides in Water	Alpha BHC	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
OC Pesticides in Water	Hexachlorobenzene (HCB)	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
OC Pesticides in Water	Beta BHC	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
OC Pesticides in Water	Lindane (gamma BHC)	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
OC Pesticides in Water	Delta BHC	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
OC Pesticides in Water	Heptachlor	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
OC Pesticides in Water	Aldrin	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
OC Pesticides in Water	Heptachlor epoxide	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
OC Pesticides in Water	Isodrin	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
OC Pesticides in Water	Gamma Chlordane	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
OC Pesticides in Water	Alpha Chlordane	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
OC Pesticides in Water	Alpha Endosulfan	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
OC Pesticides in Water	p,p'-DDE	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
OC Pesticides in Water	Dieldrin	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
OC Pesticides in Water	Endrin	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
OC Pesticides in Water	Beta Endosulfan	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
OC Pesticides in Water	p,p'-DDD	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
OC Pesticides in Water	Endosulfan sulphate	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
OC Pesticides in Water	p,p'-DDT	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
OC Pesticides in Water	Endrin ketone	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
OC Pesticides in Water	Methoxychlor	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
OC Pesticides in Water	Mirex	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
OC Pesticides in Water	d14-p-terphenyl (Surrogate)	%	0	50	90	80	70
OC Pesticides in Water	2-fluorobiphenyl (Surrogate)	%	0	50	80	70	70
OC Pesticides in Water	d5-nitrobenzene (Surrogate)	%	0	60	100	80	70
OP Pesticides in Water	Dichlorvos	µg/L	1	<1	<1	<1	<1
OP Pesticides in Water	Dimethoate	µg/L	1	<1	<1	<1	<1
OP Pesticides in Water	Diazinon (Dimpylate)	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
OP Pesticides in Water	Fenitrothion	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
OP Pesticides in Water	Malathion	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
OP Pesticides in Water	Chlorpyrifos (Chlorpyrifos Ethyl)	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
OP Pesticides in Water	Parathion-ethyl (Parathion)	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
OP Pesticides in Water	Bromophos Ethyl	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
OP Pesticides in Water	Methidathion	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
OP Pesticides in Water	Ethion	µg/L	0.2	<0.2	<0.2	<0.2	<0.2

OP Pesticides in Water	Azinphos-methyl	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
OP Pesticides in Water	d14-p-terphenyl (Surrogate)	%	0	50	90	80	70
OP Pesticides in Water	d5-nitrobenzene (Surrogate)	%	0	50	80	70	70
OP Pesticides in Water	2-fluorobiphenyl (Surrogate)	%	0	60	100	80	70
Dissolved Oxygen by Membrane Electrode	Dissolved Oxygen**	mg/L	1	3.0	6.5	6.0	6.2
Metals in Water (Dissolved) by ICPOES	Calcium, Ca	mg/L	0.05	20	15	23	22
Metals in Water (Dissolved) by ICPOES	Magnesium, Mg	mg/L	0.05	5.9	8.4	7.7	8.0
Metals in Water (Dissolved) by ICPOES	Potassium, K	mg/L	0.05	10	6.0	12	11
Metals in Water (Dissolved) by ICPOES	Sodium, Na	mg/L	0.5	12	32	15	15

Environmental Authority - Field Monitoring Data

Monitoring Point	DATE (dd/mm/yyyy)	Electrical Conductivity (µS/cm)	pH (Unit)	Temperature (^oC)	Turbidity (NTU)	Suspended Solids (mg/L)	Sulphate (mg/L)	Analysed in Lab (L) or Field (F)
LCU1	21/12/2009	160	7.2	20.7		130	160	L
LCU1	22/12/2009	210	7.4	22.5		21	3	L
LCU1	23/12/2009	290	7.6	23.1		30	ND	F
LCU1	3/03/2010	210	7.2	25.3		9	3	L
LCU1	9/03/2010	183	7.7	25.2		32	2	L
LCU1	24/08/2010	150	7.7	16.2		4	4	L
LCU1	6/09/2010	190	7.7	22.1		3	4	L
LCU1	24/09/2010	164	7.6	ND		63	2	L
LCU1	29/09/2010	187	7.8	ND		48	2	L
LCU1	18/10/2010	180	7.6	ND		<1	ND	L
LCU1	6/12/2010	198	7.4	21.2		14	4	L
LCU1	6/12/2010	200	7.3	24.9		11	2	L
LCU1	7/12/2010	220	7.2	22		10	1	L
LCU1	8/12/2010	590	7.9	27.7		3	<1	L
LCU1	9/12/2010	590	7.6	28.6		6	<1	L
LCU1	10/12/2010	230	8.4	30.5		2	<1	L
LCU1	13/12/2010	150	7.4	21.6		49	<1	L
LCU1	14/12/2010	200	7.7	24		7	<1	L
LCU1	15/12/2010	230	7.9	30		<1	<1	L
LCU1	16/12/2010	260	7.6	24.9		<1	<1	L
LCU1	17/12/2010	260	7.5	22.6		<1	<1	L
LCU1	19/12/2010	100	6.8	ND		59	<1	L
LCU1	20/12/2010	200	7.5	19.5		28	<1	L
LCU1	22/12/2010	210	7.3	21		<1	<1	L
LCU1	23/12/2010	280	7.2	19.8		11	<1	L
LCU1	24/12/2010	270	7.3	20.4		30	<1	L
LCU1	25/12/2010	210	7.5	ND		24	<1	L
LCU1	26/12/2010	270	7.4	ND		21	<1	L
LCU1	29/12/2010	180	7.5	21.7		<1	2	L
LCU1	30/12/2010	220	7	21.1		9	<1	L
LCU1	31/12/2010	320	7.2	22.4		3	32	L
LCU1	5/01/2011	290	7.3	ND		<1	<1	L
LCU1	6/01/2011	125	7.1	21.4		179	2	L
LCU1	8/01/2011	184	7.6	ND		17	2	L
LCU1	9/01/2011	191	7.5	ND		29	1	L
LCU1	10/01/2011	124	7.4	ND		19	1	L
LCU1	12/01/2011	184	7.4	24.3		7	2	L
LCU1	13/01/2011	222	7.3	27.4		4	15	L
LCU1	17/01/2011	300	7.5	26.9		5	<1	L
LCU1	18/01/2011	337	7.5	24.8		19	<1	L
LCU1	19/01/2011	368	7.4	23.8		13	<1	L
LCU1	20/01/2011	387	7.5	23.5		11	<1	L
LCU1	21/01/2011	402	7.7	23.3		11	<1	L
LCU1	22/01/2011	400	7.4	ND		<1	<1	L
LCU1	23/01/2011	400	7.1	ND		95	<1	L
LCU1	24/01/2011	410	7.8	21.6		<1	<1	L
LCU1	25/01/2011	ND	7.2	22.2		ND	ND	F
LCU1	27/01/2011	ND	7.2	23.2		ND	ND	F

LCU1	8/02/2011	ND	6.8	22.9		ND	ND	F
LCU1	9/02/2011	ND	7.57	22.1		ND	ND	F
LCU1	10/02/2011	ND	7.46	22.3		ND	ND	F
LCU1	11/02/2011	ND	6.57	21.7		ND	ND	F
LCU1	14/03/2011	420	8.2	ND		53	ND	L
LCU1	20/03/2011	190	7.3	ND		<1	3	L
LCU1	21/03/2011	190	7.3	ND		<1	190	L
LCU1	22/03/2011	190	7.3	ND		<1	2	L
LCU1	23/03/2011	220	7.6	ND		<1	2	L
LCU1	24/03/2011	240	7.5	ND		<1	2	L
LCU1	30/08/2011	110	7.2	15.5		22	6	L
LCU1	1/11/2011	170	7.6	21		18	4	L
LCU1	2/05/2012	97	7.6	20.6		21	<1	L
SCU1	21/12/2009	310	7.3	20.6		4	7	L
SCU1	3/03/2010	85	7.9	24.3		44	2	L
SCU1	7/06/2010	490	8.5	15.6		9	3	L
SCU1	24/08/2010	100	7.4	17.7		31	2	L
SCU1	27/10/2010	320	7.9	ND		12	<1	L
SCU1	2/12/2010	340	7.8	22.7		7	ND	L
SCU1	12/01/2011	225	7.5	26.5		33	3	L
SCU1	13/01/2011	361	7.9	29.8		6	35	L
SCU1	17/01/2011	648	7.9	30.8		6	2	L
SCU1	19/01/2011	711	7.6	31.8		116	ND	L
SCU1	20/01/2011	694	7.6	24		25	<1	L
SCU1	21/01/2011	776	7.8	24.9		19	<1	L
SCU1	24/01/2011	900	7.9	23.4		<1	<1	L
SCU1	30/05/2011	460	8.2	18.1		<1	3.7	L
SCU1	4/07/2011	470	8.1	17.6		46	4	L
SCU1	1/08/2011	480	8.2	11.5		47	4.2	L
SCU1	29/08/2011	520	8.7	17.4		46	4	L
SCU1	4/10/2011	490	8.4	14.9		69	10	L
SCU1	31/10/2011	180	7.6	20.9		62	4	L
SCU1	29/11/2011	410	8.6	28.6		110	5.3	L
SCU1	30/01/2012	420	8.1	25.7		51	5	L
SCU1	28/02/2012	350	8.2	22.1		120	5	L
SCU1	11/04/2012	460	8.4	16		140	3	L
SCU1	1/05/2012	410	9.2	17.5		140	3	L
SCU1	31/07/2012	270	7.5	17.7		49	9	L
SCU1	29/08/2012	300	7.8	15.7		23	10	L
LCD1	21/12/2009	220	7.5	21.2		39	220	L
LCD1	23/12/2009	360	7.6	24.1		7	ND	L
LCD1	13/03/2010	361	7.5	24.5		11	10	L
LCD1	14/03/2010	350	7.7	24.8		8	9	L
LCD1	16/03/2010	372	8.3	25.1		12	16	L
LCD1	17/03/2010	379	8.1	24.3		12	18	L
LCD1	19/03/2010	403	8.2	23.3		13	21	L
LCD1	22/03/2010	417	7.8	23.1		14	17	L
LCD1	24/03/2010	439	7.8	22.7		9	18	L
LCD1	12/10/2010	342	7.9	20.4		26	ND	L
LCD1	16/10/2010	320	7.8	ND		7	4	L
LCD1	16/10/2010	390	7.8	ND		60	21	L
LCD1	17/10/2010	300	7.7	ND		14	9	L

LCD1	18/10/2010	370	7.9	ND		<1	19	L
LCD1	18/10/2010	390	8.2	ND		3	22	L
LCD1	26/10/2010	3900	8.1	ND		<1	160	L
LCD1	6/12/2010	600	7.5	24.3		20	25	L
LCD1	7/12/2010	600	7.3	21.3		21	34	L
LCD1	8/12/2010	460	7.6	25.9		<1	29	L
LCD1	9/12/2010	490	8.2	27.4		1	33	L
LCD1	10/12/2010	470	7.9	28.9		29	34	L
LCD1	13/12/2010	520	8.3	23.7		2	48	L
LCD1	14/12/2010	340	7.7	23.7		5	21	L
LCD1	16/12/2010	550	7.8	23.9		<1	36	L
LCD1	17/12/2010	420	7.7	22.8		<1	16	L
LCD1	19/12/2010	540	7.6	ND		56	25	L
LCD1	20/12/2010	250	8.1	19.4		23	5	L
LCD1	21/12/2010	300	7.5	17.9		9	7	L
LCD1	22/12/2010	340	7.5	20.5		<1	12	L
LCD1	23/12/2010	380	7.5	20.4		<1	16	L
LCD1	24/12/2010	340	7.6	21.4		14	10	L
LCD1	25/12/2010	380	7.6	ND		25	14	L
LCD1	26/12/2010	390	7.6	ND		32	15	L
LCD1	29/12/2010	220	7.6	20.6		<1	3	L
LCD1	30/12/2010	250	7.6	21.1		2	31	L
LCD1	31/12/2010	290	7.7	22.7		8	54	L
LCD1	5/01/2011	360	7.5	ND		<1	13	L
LCD1	6/01/2011	272	7.8	21.5		335	19	L
LCD1	7/01/2011	228	7.4	21.7		40	8	L
LCD1	8/01/2011	260	7.5	ND		10	9	L
LCD1	9/01/2011	284	7.5	ND		12	14	L
LCD1	10/01/2011	176	7.4	ND		30	7	L
LCD1	12/01/2011	197	7.5	24.2		15	4	L
LCD1	13/01/2011	263	7.5	26.9		9	12	L
LCD1	17/01/2011	657	8.9	28.6		5	80	L
LCD1	18/01/2011	820	8.7	29.6		11	97	L
LCD1	19/01/2011	778	7.9	25.1		7	90	L
LCD1	20/01/2011	793	7.8	24.3		10	91	L
LCD1	21/01/2011	864	8.6	24.5		10	106	L
LCD1	22/01/2011	960	8.7	ND		<1	110	L
LCD1	23/01/2011	1000	8.6	ND		<1	120	L
LCD1	24/01/2011	1100	8.4	24.2		<1	140	L
LCD1	25/01/2011	ND	7.7	24.8		ND	ND	F
LCD1	27/01/2011	ND	7.8	25.3		ND	ND	F
LCD1	28/01/2011	1300	8	25.5		<1	160	L
LCD1	30/01/2011	1300	8.5	ND		<1	160	L
LCD1	31/01/2011	1300	8.2	23.3		<1	160	L
LCD1	1/02/2011	ND	7.7	23.8		ND	ND	F
LCD1	2/02/2011	ND	7.8	25.2		ND	ND	F
LCD1	8/02/2011	ND	8.5	25.5		ND	ND	F
LCD1	9/02/2011	1610	8.1	23.1		9	198	L
LCD1	10/02/2011	1640	8	22.8		31	ND	L
LCD1	11/02/2011	ND	7.93	22.9		ND	ND	F
LCD1	15/02/2011	ND	8.24	24.3		ND	ND	F
LCD1	16/02/2011	ND	8.64	25.2		ND	ND	F
LCD1	17/02/2011	ND	8.9	23.5		ND	ND	F
LCD1	24/02/2011	1600	8.1	ND		10	210	L

LCD1	1/03/2011	1600	8.1	ND		26	210	L
LCD1	5/03/2011	1600	8.2	ND		<1	170	L
LCD1	6/03/2011	1600	8.1	ND		8	180	L
LCD1	7/03/2011	1700	8	ND		10	180	L
LCD1	8/03/2011	1600	8.2	ND		<1	160	L
LCD1	9/03/2011	1600	8.1	ND		3	170	L
LCD1	10/03/2011	1600	8.2	ND		8	180	L
LCD1	11/03/2011	1600	8	ND		13	180	L
LCD1	12/03/2011	1700	8.4	ND		16	180	L
LCD1	13/03/2011	1700	8.3	ND		9	180	L
LCD1	20/03/2011	300	7.4	ND		11	17	L
LCD1	21/03/2011	340	7.4	ND		2	18	L
LCD1	22/03/2011	440	7.5	ND		7	29	L
LCD1	23/03/2011	400	7.9	ND		3	22	L
LCD1	24/03/2011	450	7.8	ND		11	26	L
LCD1	25/03/2011	390	7.7	ND		29	16	L
LCD2	6/12/2010	612	7.4	21.1		10	7	L
LCD2	6/12/2010	660	7.6	24.6		16	7	L
LCD2	7/12/2010	660	7.5	21.8		21	13	L
LCD2	9/12/2010	480	7.8	26.7		<1	28	L
LCD2	10/12/2010	480	8	29		<1	30	L
LCD2	13/12/2010	510	8.1	23.5		5	48	L
LCD2	14/12/2010	330	7.8	23.3		8	17	L
LCD2	16/12/2010	540	7.7	24.5		<1	33	L
LCD2	19/12/2010	580	7.4	ND		32	30	L
LCD2	20/12/2010	240	7.4	19.3		25	4	L
LCD2	22/12/2010	320	7.5	20.5		<1	10	L
LCD2	23/12/2010	380	7.5	20.3		<1	15	L
LCD2	24/12/2010	340	7.6	21.1		13	9	L
LCD2	25/12/2010	380	7.5	ND		12	13	L
LCD2	29/12/2010	220	7.5	20.6		<1	2	L
LCD2	30/12/2010	250	7.6	20.7		<1	7	L
LCD2	31/12/2010	290	7.7	22.8		4	4	L
LCD2	5/01/2011	350	7.5	23.7		<1	12	L
LCD2	6/01/2011	275	7.7	21.4		353	20	L
LCD2	7/01/2011	228	7.5	21.9		12	8	L
LCD2	8/01/2011	228	7.5	ND		17	7	L
LCD2	9/01/2011	304	7.5	ND		20	19	L
LCD2	10/01/2011	136	7.4	ND		30	1	L
LCD2	17/01/2011	664	8.9	28.4		10	80	L
LCD2	18/01/2011	805	8.7	29.6		7	96	L
LCD2	19/01/2011	786	7.8	25.1		13	90	L
LCD2	20/01/2011	805	7.7	23.9		6	91	L
LCD2	21/01/2011	867	8.4	24		5	105	L
LCD2	22/01/2011	950	8.5	ND		<1	110	L
LCD2	23/01/2011	1000	8.6	ND		<1	120	L
LCD2	24/01/2011	1100	8.3	24		<1	130	L
LCD2	27/01/2011	ND	7.8	25.4		ND	ND	F
LCD2	28/01/2011	1300	7.9	25.3		<1	160	L
LCD2	30/01/2011	1300	8.3	ND		<1	160	L
LCD2	31/01/2011	1300	7.9	22.9		<1	160	L
LCD2	1/02/2011	ND	7.6	23.7		ND	ND	F
LCD2	2/02/2011	ND	7.6	25.1		ND	ND	F

LCD2	8/02/2011	ND	8.44	25.4		ND	ND	F
LCD2	9/02/2011	ND	8.34	23.2		ND	ND	F
LCD2	10/02/2011	ND	7.64	22.7		ND	ND	F
LCD2	11/02/2011	ND	7.5	22.4		ND	ND	F
LCD2	15/02/2011	ND	7.53	23		ND	ND	F
LCD2	16/02/2011	ND	7.97	25		ND	ND	F
LCD2	17/02/2011	ND	7.65	22.3		ND	ND	F
LCD2	24/02/2011	1600	8.3	ND		3	200	L
LCD2	1/03/2011	1700	7.8	ND		<1	200	L
LCD2	5/03/2011	1500	8.1	ND		<1	160	L
LCD2	6/03/2011	1600	7.9	ND		<1	180	L
LCD2	7/03/2011	1700	7.8	ND		<1	180	L
LCD2	8/03/2011	1500	8	ND		<1	180	L
LCD2	9/03/2011	1600	7.8	ND		<1	180	L
LCD2	10/03/2011	1600	8	ND		<1	190	L
LCD2	11/03/2011	1700	7.6	ND		<1	170	L
LCD2	12/03/2011	1700	8.2	ND		<1	170	L
LCD2	13/03/2011	1700	8.3	ND		7	180	L
LCD2	21/03/2011	330	7.4	ND		2	16	L
LCD2	22/03/2011	440	7.4	ND		4	29	L
LCD2	23/03/2011	410	7.8	ND		7	23	L
LCD2	24/03/2011	450	7.7	ND		4	26	L
LCD2	25/03/2011	410	7.8	ND		12	19	L

In-Situ Inc.	Troll 9000 Pro XP
Win-Situ® Version	4.57.5.0
Serial number:	45725
Firmware Version	2
Unit	Troll 9000

Site	Date	Time	ET (sec)	Temperature Celsius	Pressure Meters H2O	Barometric Bars	Turbidity NTU	Battery Volts	ORP millivolts	pH pH	Clark DO milligrams	Clark DO S %Saturati	Conductivity microSiemens/cm
	--------	--------	------------	---------------	---------------	---------------	--------------	--------------	--------------	---------	--------------	--------------	---------------
AE1	01/23/08	13:24:55	641	31.42	0	0.964	94.6	3.02	188	8.9	7.87	112.5837	596.71
	01/23/08	13:25:00	646	31.46	0.003	0.964	93.4	3.072	188	8.9	7.83	112.0424	597.39
	01/23/08	13:25:05	651	31.44	0.002	0.964	93.1	3.046	187	8.9	7.81	111.8204	597.39
	01/23/08	13:25:10	656	31.41	0.002	0.964	94.8	3.02	186	8.9	7.83	112.0272	596.49
	01/23/08	13:25:15	661	31.42	0.001	0.964	95.9	3.02	185	8.91	7.83	111.9582	595.58
	01/23/08	13:25:20	666	31.46	0.002	0.964	96.1	3.072	185	8.9	7.78	111.4461	596.49
	01/23/08	13:25:25	671	31.41	0	0.964	99.1	3.046	184	8.9	7.78	111.2465	595.81
	01/23/08	13:25:30	676	31.42	0.002	0.964	96.7	3.046	183	8.9	7.77	111.1524	596.27
	01/23/08	13:25:35	681	31.39	0.003	0.964	93.7	3.072	183	8.9	7.78	111.3098	595.14
	01/23/08	13:25:40	686	31.41	0	0.964	91.5	3.072	182	8.9	7.77	111.1104	596.27
AE2	01/23/08	15:38:59	66	26.35	0	0.968	33.3	3.072	172	8.92	7.31	95.1543	463.49
	01/23/08	15:39:04	71	26.37	0	0.968	35.7	3.072	172	8.91	7.29	94.9709	463.07
	01/23/08	15:39:09	76	26.35	-0.002	0.968	36.5	3.046	171	8.92	7.3	95.0081	463.07
	01/23/08	15:39:14	81	26.34	-0.002	0.968	33.9	3.046	171	8.92	7.31	95.1171	462.93
	01/23/08	15:39:19	86	26.33	-0.002	0.968	33.2	3.02	171	8.91	7.31	95.1931	462.65
	01/23/08	15:39:24	91	26.33	-0.002	0.968	34.9	3.072	171	8.92	7.33	95.3385	463.33
	01/23/08	15:39:29	96	26.33	0.001	0.968	30.3	3.072	171	8.91	7.34	95.4929	463.06
	01/23/08	15:39:34	101	26.36	0	0.968	29	3.046	171	8.92	7.34	95.5789	463.05
AE3	01/23/08	17:28:57	212	25.99	0	0.964	3.1	3.072	244	8.03	7.09	94.3422	8089.83
	01/23/08	17:29:02	217	26.01	0.002	0.964	3.1	3.072	244	8.02	7.08	94.2649	8089.82
	01/23/08	17:29:07	222	25.99	0	0.964	3.1	3.072	244	8.03	7.09	94.3538	8090.8
	01/23/08	17:29:12	227	26.02	0.002	0.964	3.1	3.072	244	8.02	7.08	94.2781	8088.82

	01/23/08	17:29:17	232	25.99	0	0.964	3.1	3.02	244	8.02	7.09	94.4383	8087.82
	01/23/08	17:29:22	237	25.98	0	0.964	3.2	3.072	244	8.02	7.11	94.6575	8089.79
	01/23/08	17:29:27	242	26.01	0.002	0.964	3.2	3.02	244	8.03	7.11	94.7447	8086.82
	01/23/08	17:29:32	247	25.98	0	0.964	3.3	3.046	244	8.03	7.15	95.1262	8090.77
	01/23/08	17:29:37	252	25.97	0	0.964	3.2	2.994	243	8.03	7.17	95.4445	8090.76
	01/23/08	17:29:42	257	25.97	0	0.964	3.1	3.072	243	8.03	7.19	95.6988	8090.76
AE4	01/24/08	14:26:37	96	26.83	0	0.963	19.5	3.02	334	8.52	5.08	67.0516	641.66
	01/24/08	14:26:42	101	26.84	0	0.963	19.3	3.02	333	8.52	5.06	66.7864	641.92
	01/24/08	14:26:47	106	26.87	0.002	0.963	19.6	2.941	333	8.51	5.03	66.454	642.17
	01/24/08	14:26:52	111	26.88	0.003	0.963	20.4	3.02	332	8.52	5.01	66.1947	642.69
	01/24/08	14:26:57	116	26.87	0	0.963	20.2	3.02	331	8.52	4.99	65.9794	641.63
	01/24/08	14:27:02	121	26.91	0.003	0.963	19.8	3.02	331	8.52	4.96	65.6064	641.88
	01/24/08	14:27:07	126	26.9	0.001	0.963	20	3.046	330	8.52	4.95	65.426	642.66
	01/24/08	14:27:12	131	26.93	0.005	0.963	20.4	3.02	330	8.52	4.92	65.123	642.39
	01/24/08	14:27:17	136	26.93	0.006	0.963	20.8	3.02	329	8.52	4.91	64.9163	642.64
	01/24/08	14:27:22	141	26.91	0.005	0.963	21.3	2.968	328	8.53	4.9	64.7385	642.37
	01/24/08	14:27:27	146	26.9	0.01	0.963	21.6	2.994	328	8.53	4.88	64.5629	641.84
	01/24/08	14:27:32	151	26.92	0.011	0.963	22.5	3.046	327	8.54	4.87	64.45	642.09
AE5	01/24/08	15:20:51	61	30.94	0	0.964	17.3	3.02	155	8.69	6.59	93.4737	637.32
	01/24/08	15:20:56	66	30.97	-0.002	0.964	17.3	2.994	154	8.69	6.56	93.181	637.06
	01/24/08	15:21:01	71	30.96	0.001	0.964	17.4	2.994	154	8.69	6.55	93.0058	637.05
	01/24/08	15:21:06	76	30.95	0	0.964	17.5	2.941	155	8.68	6.53	92.7626	636.79
	01/24/08	15:21:11	81	30.94	0	0.964	17.5	3.02	154	8.69	6.52	92.5693	636.78
	01/24/08	15:21:16	86	30.91	0	0.964	17	3.02	155	8.68	6.52	92.4531	637.04
	01/24/08	15:21:21	91	30.93	-0.001	0.963	16.8	3.02	155	8.68	6.5	92.2236	636.77
	01/24/08	15:21:26	96	30.94	0	0.963	16.5	2.994	154	8.69	6.48	91.9878	637.03
	01/24/08	15:21:31	101	30.93	0.001	0.963	16.5	3.02	154	8.68	6.46	91.7276	637.02
	01/24/08	15:21:36	106	30.94	0.001	0.963	17	3.02	154	8.69	6.43	91.3226	637.79
	01/24/08	15:21:41	111	30.94	0.001	0.963	16.4	3.046	154	8.69	6.41	91.0107	637.01
	01/24/08	15:21:46	116	30.91	0.001	0.963	16.6	3.02	154	8.69	6.41	90.8902	635.98
	01/24/08	15:21:51	121	30.91	-0.001	0.963	16.6	3.046	154	8.69	6.4	90.7375	636.23

Appendix F. Groundwater Monitoring and Impact Management Plan (GMIMP)

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NEW HOPE GROUP

GROUNDWATER MONITORING AND IMPACT MANAGEMENT PLAN

New Acland Coal Mine Stage 3 Project

JANUARY 2014

Contents

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1. Introduction

This Groundwater Monitoring and Impact Management Plan (GMIMP) has been prepared to address the issues associated with the predicted impacts on groundwater at and surrounding the revised Project site from the proposed Stage 3 Expansion, south and west of New Acland Coal Pty Ltd's (NAC) current mining operation. It sets out the groundwater monitoring program for the revised Project site and the associated groundwater impact triggers that will invoke further assessment and groundwater impact management. The GMIMP is designed to provide consistency with the revised Project's Environmental Management Plan (EMP) and regulatory requirements.

Groundwater management plans are typically prepared following the issue of an Environmental Authority (EA) and address the relevant conditions stipulated therein. This plan has been developed as part of the Environmental Impact Statement (EIS) process and will be amended and finalised as necessary following the issue of a new draft Environmental Authority (EA) for the revised Project site.

The GMIMP will be administered as a supporting document to the revised Project's Plan of Operations.

The existing Mine currently operates under EA EMPL00335713 which covers Mining Leases (MLs) 50170 and 50216 immediately to the north of the revised Project area. The existing EA includes a number of conditions relating to groundwater monitoring and groundwater impact triggers. These conditions have been incorporated into the GMIMP for the revised Project site.

The GMIMP is structured as follows.

- Section 2: describes the principal aquifers of interest around the revised Project site, local use of groundwater, and the predicted impacts on groundwater from the revised Project's operations.
- Section 3: describes the groundwater monitoring program for the revised Project site including monitoring locations, monitoring frequency, and the parameters to be recorded/analysed.
- Section 4: sets out the groundwater impact triggers and protocols for investigating, and if required, mitigating the impacts on groundwater from the revised Project's operations.
- Section 5: describes the process of continual review and improvement of the GMIMP to ensure it continues to meet its objectives.

2. Predicted Impacts on Groundwater Levels

This section provides a summary of the five aquifers of interest in the vicinity of the revised Project site, the local use of groundwater and the predicted impacts from the revised Project's operations on these aquifers.

2.1. Principal Aquifers of Interest at the revised Project site

In the vicinity of the revised Project site, three of the principal aquifers of interest – the Walloon Coal Measures, the Marburg Sandstone, and the Helidon Sandstone – are subartesian aquifers within the Great Artesian Basin Groundwater Management Unit (GAB GMU). The *Water Resource (Great Artesian Basin) Plan 2006*, a subordinate regulation to the Water Act (2000), covers the management of all artesian and subartesian water in the vicinity of the revised Project site.

To implement the *Water Resource (Great Artesian Basin) Plan 2006*, the Queensland Government has produced the Great Artesian Basin Resource Operations Plan (GABROP). This plan came into force during early 2007 and was amended during late 2012. The GABROP applies to artesian, subartesian and spring connected water, and provides processes for dealing with unallocated water reserves (general and State). The GABROP subdivides the GAB GMU into 25 management areas. The revised Project is located within the Eastern Downs groundwater management area (Eastern Downs GMA) of the GAB GMU.

The revised Project access to unallocated general and State water reserves is very limited as a consequence of the status of the Eastern Downs GMA. Capping of abstraction volumes is employed to prevent overexploitation of groundwater and is essential for the Eastern Downs GMA, which is currently over allocated.

In addition to the three subartesian GAB aquifers at the revised Project site, the Tertiary Basalt and Quaternary Alluvium aquifers in the vicinity of the revised Project site contribute to the local hydrological environment.

The Quaternary Alluvial aquifer is not present within the revised Project site, except potentially for a very small portion of the far southeastern corner. However, to the south and north of the revised Project site, the Alluvial aquifer is associated with the Oakey and Myall Creeks and is known to support significant groundwater abstraction. Groundwater contained within the Quaternary Alluvium associated with Oakey Creek is managed under the Oakey Creek groundwater management area (Oakey Creek GMA). The water resource cap of the Oakey Creek GMA applies to abstraction for the mining, oil and gas industries.

The Tertiary Basalt aquifer is only present to a minor extent within the northwest of the revised Project site, however the aquifer becomes prolific immediately west of the revised Project site. Groundwater contained within the Tertiary Basalt aquifer is managed under the Eastern Downs GMA. As previously explained, the water resource cap of the Eastern Downs GMA applies to abstraction for the mining, oil and gas industries.

Quaternary Alluvial Aquifers

Quaternary alluvium across the revised Project site is limited in extent and thickness and is not considered to possess significant potential to supply water. The nearest alluvium supporting groundwater supplies is the Oakey Creek Alluvium to the south-east of the revised Project site where the alluvium reaches a maximum thickness of 60 m. The proposed mine pits will not intersect this aquifer, with the closest occurrence of the Alluvial aquifer occurring approximately 2 km from the southernmost proposed mining area. Oakey Creek is an ephemeral watercourse located approximately 10 km to the south-east of the revised Project area and has been characterised in previous studies as a losing stream, i.e. water flow in the creek is not derived from groundwater, but rather shallow alluvial groundwater receives recharge from the creek.

Tertiary Basalt Aquifer

Tertiary Basalts are present in the north and west of the revised Project site and become more prevalent to the west of the revised Project site, varying in thickness up to 90 m. These occurrences are the result of Tertiary lava flows which have infilled pre-Tertiary age palaeo channels (ancient former drainage systems). The basalts are discrete lava flows interbedded with clay horizons which have the potential to act as aquitards (impermeable layers) within the basalt aquifer.

NAC currently draws groundwater from the basalt aquifer for potable water supply under a licensed allocation of 160 ML/year. In general, NAC only uses around 11 ML/year from the basalt aquifer for potable water production (based on recorded 2012 abstraction). The basalt aquifer is used by local landowners, predominantly to the west of the site, for private water supply.

Walloon Coal Measures Aquifer

The Walloon Coal Measures consist of grey and light grey shales, siltstones, fine clayey sandstones, carbonaceous shales, mudstones and coal seams. The coal seams are laterally continuous but are characterised by rapid lateral variation of the interseam sediment thickness. The Walloon Coal Measures comprises three major coal intervals – Waipanna, Acland-Sabine and Balgowan. The revised Project site will extract coal from the Acland-Sabine interval of the Lower Walloon Coal Measures.

The Walloon Coal Measures is a subartesian aquifer within the GAB of particular interest with regard to potential groundwater impacts from mining activities, as it is continuous across the revised Project site and surrounding area, and is widely exploited by surrounding properties for water supply.

At its deepest point the revised Project will mine down to approximately 75 m below ground surface (i.e. as the deepest economically recoverable coal). The Mine currently utilises groundwater that seeps into the active mine pits from the coal measures, mainly for dust suppression purposes.

Marburg Sandstone Aquifer

The Marburg Sandstone is a confined subartesian aquifer. It underlies the Walloon Coal Measures and consists of sandstone, minor coal, and conglomerate rock types. The productive water bearing units are interbedded with low permeability rock units such as mudstone, siltstone and shale.

Aquitards (low permeability strata) within and below the overlying Walloon Coal Measures act as effective confining layers for the Marburg Sandstone aquifer which occurs at a depth of approximately 150 mBGL within the revised Project site, generally 75 m below the bottom of active mine pits.

In the past, the Mine regularly extracted groundwater from the Marburg Sandstone aquifer for coal washing. This practice has been significantly reduced following a water supply agreement with the Toowoomba Regional Council (TRC) for the supply of recycled water from the Wetalla Water Reclamation Facility (WWRF). Groundwater levels in the Marburg Sandstone aquifer in the vicinity of the revised Project site have and are predicted to continue to recover as a result of the significant reduction in abstraction.

Helidon Sandstone Aquifer

The Helidon Sandstone aquifer lies approximately 500–600 m below ground level at the revised Project site and is isolated from the overlying aquifers by the relatively impermeable Evergreen Formation which is approximately 200 m thick. This subartesian aquifer is extensive within the area and is utilised for a number of large commercial/industrial abstractions within this portion of the Eastern Downs GMA (e.g. Beef City Abattoir).

In the past, the Mine regularly extracted groundwater from the Helidon Sandstone aquifer primarily for coal washing purposes. This practice has been significantly reduced following a water supply agreement with the TRC for the supply of recycled water from the WWRF. NAC will maintain its licence arrangements for the Helidon Sandstone aquifer as an emergency water supply. To facilitate this arrangement, NAC will run periodic abstraction campaigns up to a total of approximately 30 ML/year to keep pumping equipment operational. Groundwater levels in the Helidon Sandstone aquifer in the vicinity of the revised Project site are predicted to recover as a result of the significant reduction in abstraction.

As a condition of NAC's abstraction licence, groundwater modelling has been required to evaluate the impact of abstraction from the Helidon Sandstone aquifer and its interaction with other abstractions from this aquifer within the Eastern Downs GMA. This information has been reported to the then Department of Environment and Resource Management (DERM).

Based on the depth of the Helidon Sandstone Aquifer and the presence of a significant aquitard (Evergreen Formation), the mining of coal across the revised Project site is not anticipated to have any impact on water levels in this aquifer.

2.2. Current and Future Groundwater Use at the Mine

The Mine's main operational water supply is recycled water from the WWRF, which has been secured for the life of the revised Project through a long term agreement with the TRC. NAC also supplements its operational water supply with recycled water from its in-pit tailings dam, limited extraction from shallow groundwater sources (e.g. Tertiary Basalt for potable supply), and surface water captured in environmental and other dams. As previously explained, prior to the agreement with the TRC, groundwater was the main water source for the Mine.

NAC currently holds water licences to extract groundwater from the Tertiary Basalt, the Marburg Sandstone, and the Helidon Sandstone aquifers. NAC's actual groundwater abstraction from the Helidon Sandstone aquifer is well below its 710 ML allocation, with a recorded usage of about 17 ML in 2012.

The current allocation from the Marburg Sandstone aquifer is 271 ML/year. NAC reduced its original allocation of 571 ML/year from the Marburg Sandstone aquifer during 2009. Groundwater abstraction for 2012 amounted to 10.5 ML from the Marburg Sandstone. As explained previously, NAC has a licence to extract 160 ML/year from the Tertiary Basalt, but utilises around 11 ML/year.

Groundwater abstraction from the Marburg and Helidon Sandstone aquifers has reduced to a small percentage of the licensed allocation with the commissioning of the WWRF pipeline in 2009. As a result, the revised Project's dependence on the local Eastern Downs GMA is minimal, with the usage figures for 2012 being representative of future usage (including for the revised Project), alleviating potential long term pressure on these aquifers. The abstraction of water from the Tertiary Basalt aquifer for potable use at the revised Project site will continue at 2012 rates of around 11 ML/year. All NAC's groundwater abstraction is conducted within its legal allocated limits under the *Water Act 2000*.

2.3. Groundwater Use around the revised Project Site

A search of the Department of Natural Resources and Mines (DNRM) bore database was conducted to identify groundwater bores in the vicinity of the revised Project site. **Table 2-1** summarises the bores identified from the DNRM database within a zone extending 8 km beyond the revised Project's mining lease application area (50232). The location of all bores outside the revised Project area, including the current Mine site, is shown on **Figure 2-1** and **Figure 2-2**. It should be noted that it is considered highly likely that other non-registered bores may also exist.

Table 2-1 DNRM Database - Bores within 8 km of New Acland Coal Mine[1]

Aquifer	Existing bores	Proposed bores
Quaternary Alluvium	159	0
Tertiary Basalt	81	0
Walloon Coal Measures	132	1
Marburg Sandstone	44	0
Helidon Sandstone	1	0
Not defined[2]	413	26
Total:	857	

Notes: 1. Not including bores listed as 'abandoned and destroyed'.

2. The DNRM database only identifies the source aquifers for around 50% of the bores within 8km of the mining leases.

The Walloon Coal Measures aquifer supplies both fresh and brackish water and is utilised extensively in the vicinity of the revised Project site for stock and domestic supply. It is considered likely that a large proportion of the bores identified in **Table 2-1**, for which source aquifer details are not available, abstract water from the Walloon Coal Measures aquifer. The DNRM bore data suggest that this aquifer generally produces yields between 0.1 L/sec and 5.4 L/sec, on average lower than yields from other aquifers in the database search area. Water quality is generally listed in the DNRM database as "potable" with some occurrences of "brackish" water for this aquifer.

Figure 2-1 shows a concentration of bores that abstract from the Oakey Creek Alluvium, which occurs 3-5km south and south-east of the revised Project site. Limited data on water quality in the Oakey Creek Alluvium indicates that the water is generally 'potable', as qualitatively listed in the DNRM database.

The expanse of Tertiary Basalt to the west and north-west of the revised Project site supports water supplies for stock watering and potable supply. Groundwater in the Tertiary Basalt aquifer is generally of potable quality. The yield from the basalt bores ranges from 0.1 L/sec to 15.6 L/sec but is typically less than 3 L/sec, and is highly dependent on the degree of fracturing encountered. Exploration activities by NAC's sister company, New Hope Exploration Pty Ltd, observed that water storage within the Tertiary Basalt aquifer was discretely located in association with fracture zones within the basalt. It is considered likely that some of the bores identified in **Table 2-1** for which the source aquifer is not defined intersect the Tertiary Basalt aquifer.

The majority of the Marburg Sandstone bores are located to the east of the revised Project site (**Figure 2-1**). The DNRM bore database shows that this aquifer is generally qualitatively listed in the database as being of 'potable' quality, and yields range from 0.4 L/sec to 10.7 L/sec. It is considered likely that some of the bores identified in **Table 2-1** for which the source aquifer is not defined intersect the Marburg Sandstone aquifer.

The nearest bore (apart from those owned and operated by NAC) which abstract from the Helidon Sandstone aquifer is located 6.5 km south of the revised Project site in the area of the Oakey township. Other known bores in accessing the Helidon Sandstone are located approximately 15 km to the east (Toowoomba Cooby Dam Bore and Hampton Irrigators), and 15 km to the south (Beef City Abattoir) of the revised Project site.

2.4. Predicted Impacts on Groundwater Levels and Users

As excavation of the revised Project's active mine pits proceeds below the Walloon Coal Measure's water table, groundwater will discharge into the pits. Dewatering of the Walloon Coal Measures aquifer will result in the lowering of groundwater levels in the aquifer in the immediate vicinity of the revised Project site. Groundwater levels in the Tertiary Basalt and Marburg Sandstone aquifers around the revised Project site will also be affected by dewatering the Walloon Coal Measures due to induced through-flow and leakage of groundwater from these aquifers to the Walloon Coal Measures.

Mining is planned to advance in a general north to south direction for the revised Project. The active mine pits will be excavated as a progressive series of strips that advance across the Walloon Coal Measures aquifer (resource area). As each active mine pit (new strip) advances, the previous strip is backfilled with mined material and rehabilitated. Following cessation of mining, groundwater will continue to discharge to the rehabilitated final voids, driven by evaporative discharge from the pit lakes that will form in the voids. A steady state equilibrium will be reached where the pit lake levels recover to an equilibrium where evaporation from the lakes balances groundwater inflow, at a level below that of the pre-mining water table.

The revised Project's EIS (SKM 2013) included the development and calibration of a transient groundwater flow model to predict groundwater drawdown in the surrounding aquifers over the life of the revised Project and following closure. The model is subdivided vertically into four separate layers which represent the separate hydrogeological units. The revised Project's timescale extends to 2030 and is incorporated within the model by using mining zones which are activated according to the mining schedule and de-activated as they are rehabilitated.

Impacts on groundwater levels will vary spatially over time as the mined area migrates across the revised Project site. The model predicts the greatest impacts on groundwater levels surrounding the revised Project will occur around 2030 at the end of mining. This corresponds to the Life of Mine Plan when the deepest areas of working will result in the most widespread drawdown.

Full details of the model, model calibration, predicted impacts on groundwater over the life of the revised Project are presented in Chapter 6 Groundwater Resources of the revised Project's EIS (SKM 2013) and the associated modelling report.

Predicted Impacts on the Walloon Coal Measures and Tertiary Basalt Aquifers – 2030

The predicted drawdown in the Walloon Coal Measures and Tertiary Basalt aquifers for the year 2030, which represents both the end of mining and the time of maximum predicted impact from the revised Project's operation, is presented in **Figure 2-1.** The figure shows the composite drawdown contours for layer 2 of the groundwater model which represents both the upper Walloon Coal Measures and the Tertiary Basalt aquifers which are considered to be hydraulically connected. The extent of the basalt represented within the model is presented within this figure.

Figure 2-1 shows that drawdowns in excess of 5 m outside of the revised Project site are restricted to areas less than 3 km to the west and southwest. There are only 24 bores beyond the revised Project boundary that are predicted to experience drawdowns from mining activity greater than 5 m for the time of deepest working across the widest area (2030). This number of bores assumes that those bores in the DNRM database without defined source aquifers abstract water from the Walloon Coal Measures aquifer or the Tertiary Basalt aquifer. A shallower drawdown of between 2 and 5 m in the Walloon Coal Measures aquifer or the Tertiary Basalt aquifer is reasonably widespread to the west of the revised Project site, extending up to 7km from the lease boundaries.

Drawdowns of the order predicted in the Walloon Coal Measures and Tertiary Basalt aquifers are not considered to be significant in terms of affecting the yield or access to groundwater in existing bores abstracting from these aquifers. Importantly, current investigations demonstrate that the existing utilisation of groundwater sourced from the Walloon Coal Measures and Tertiary Basalt aquifers should not be significantly impacted by the revised Project.

Predicted Impacts on the Marburg Sandstone Aquifer – 2030

Figure 2-2 presents the predicted drawdown in the Marburg Sandstone aquifer for the year 2030, which represents both the end of mining and the time of maximum predicted impact from the revised Project's operation. The Marburg Sandstone aquifer is situated approximately 75 m below the lowest level of working in the Walloon Coal Measures aquifer. Drawdowns are predicted to be much less in this aquifer beneath the active mine pits and do not exceed 3 m. Low levels of drawdown in the Marburg Sandstone aquifer (more than 1 m) are expected to propagate up to 5 km from the revised Project site.

Figure 2-2 indicates a limited number of Marburg Sandstone bores in the immediate vicinity of the revised Project site. However, it is acknowledged that some of the bores from the DNRM database shown on **Figure 2-1** that have no details of their source aquifer may abstract from the Marburg Sandstone aquifer.

Drawdowns of the order predicted in the Marburg Sandstone aquifer are not considered to be significant in terms of affecting the yield or access to groundwater in existing bores abstracting from the Marburg Sandstone aquifer. Importantly, current investigations demonstrate that the existing third party utilisation of groundwater sourced from the Marburg Sandstone aquifer should not be impacted by the revised Project.

Predicted Impacts on the Helidon Sandstone Aquifer

The Helidon Sandstone aquifer is not represented in the groundwater model as it lies some 200 m below the base of the Marburg Sandstone aquifer, and separating these two units is the relatively impermeable Evergreen Formation. The revised Project site is therefore not anticipated to have any significant impact on the Helidon Sandstone aquifer. NAC's current abstraction from this aquifer has substantially reduced prior to the revised Project's implementation resulting in the recovery of groundwater levels and the alleviation of some resource pressure on this GAB aquifer.

Impacts on Groundwater Levels – Post Mining

After cessation of mining in 2030, groundwater levels are predicted to gradually recover so that for the most part there is less than 5 m residual drawdown outside the revised Project's boundaries. Recovery to pre-mining conditions throughout the revised Project site is limited by evapotranspirative losses from the depressed landforms (rehabilitated final voids). Due to the high regional potential evapotranspiration rate, groundwater discharge to the depressed landforms is predicted continue at a rate only slightly less (3.5 ML/day) to that in the last year of mine operation. Drawdown adjacent the last areas to be mined is predicted to remain relatively high (approximately 20 to 30 m) due to the ongoing evaporation-driven groundwater discharge into the depressed landforms. A pit lake is expected to form within the Manning Vale West depressed landform, but a lake may not form to any significant degree in the Willeroo depressed landform and is not expected to form at all in the Manning Vale East depressed landform. Groundwater level recovery within the depressed landforms remains at to 30 to 40 m below the level of the pre-mining water table in the long term, due to the ongoing evapotranspirative groundwater discharge. As a result, the depressed landforms form a depression of the potentiometric surface within the vicinity of the depressed landforms and act as a groundwater sink that will not permit any pooled water within or adjacent to the depressed landforms to flow outwards into the regional groundwater system.

The 1 m drawdown extent is predicted to remain at approximately 7 km from the revised Project boundary at its greatest (western) extent in the long term post-mining due to ongoing evapotranspiration-driven groundwater discharge to the depressed. However, the groundwater system is expected to recover post-mining to a new steady state-equilibrium such that no additional groundwater impacts are expected other than those that exist at the end of mining in 2030.

Impacts on Groundwater Quality

The drawdown of groundwater levels in the Walloon Coal Measures aquifer around the revised Project's depressed landforms will result in the movement of groundwater towards these depressed landforms. The aquifers surrounding the revised Project site will continue to receive recharge via the same processes that occurred prior to the operational phase of the revised Project (via rainfall infiltration over time). Therefore, the groundwater quality in the vicinity of the revised Project site is not anticipated to be affected as a result of mining.

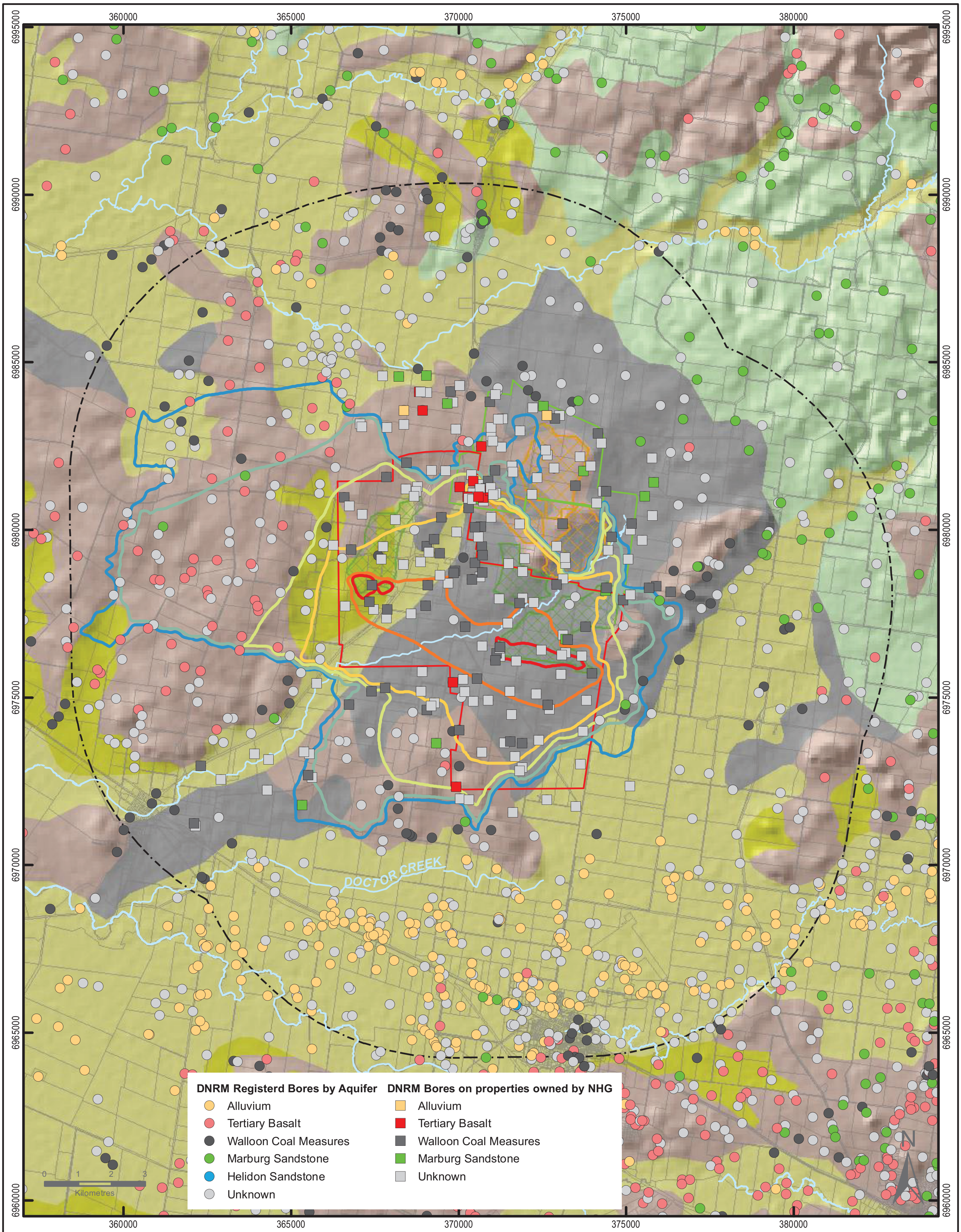
As the Marburg Sandstone aquifer is confined by the overlying Walloon Coal Measures, the potential for impacts on water quality within this aquifer from the revised Project's mining activity is considered negligible.

The operational phase of the revised Project is not expected to impact on groundwater quality.

Water captured within the revised Project's depressed landforms (former final voids) possesses the potential to be saline owing to inflows of saline groundwater from the Walloon Coal Measures aquifer. This captured water may be further concentrated over time due to the region's high evaporation rate which exceeds the rate of groundwater inflow. Similarly, dilution of the captured water is expected during extended periods of rainfall. The depressed landforms will act as groundwater sinks with a permanent drawdown relative to the surrounding aquifer, and as a result, will not permit pooled water to flow outwards into the regional system. Therefore, any pooled saline water should remain confined within the depressed landforms and not have an impact on the water quality of the surrounding aquifers.

From an acid rock drainage perspective, it is unlikely that any water captured in the revised Project's depressed landforms will become acidic from oxidation of pyrites in the Walloon Coal Measures aquifer because of the neutralising effect of the surrounding sediments which are naturally alkaline. To date, NAC has not experienced any occurrences of acid rock drainage at New Acland Coal Mine.

Groundwater quality will continue to be monitored throughout the life of the revised Project to identify trends and assess whether impacts are occurring over time.



LEGEND
Predicted Drawdown Contour (m)
- 1
- 2
- 5
- 10
- 20
- 30

- Watercourse
- New Acland Coal Mine - Stage 3
- New Acland Coal Mine Stage 3 - 8km Buffer
- New Acland Coal Mine
- Cadastre
- Stage 3 Pit Areas
- Existing Permission

Dominant Geology
- Basalt (Tm)
- Alluvium (Qa)
- Colluvium (TQs)
- Walloon Subgroup (Jw)
- Marburg Sandstone (Jbm)

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NEW ACLAND COAL MINE
STAGE 3 PROJECT

Figure 1 - Predicted Drawdown in the Walloon Coal Measures & Tertiary Basalt 2030 (End of Mining)

Scale 1:150,000 on A4
Projection: Australian Geodetic Datum – Zone 56 (AGD84)

Path: I:\QENV2\Projects\QE06644\Spatial\ArcGIS\01_Figures\01_SEIS\GroundwaterManagementPlan\130823_NewHope_Groundwater_GWMIMP_Figure1_PredictedDrawdownWCM2030.mxd

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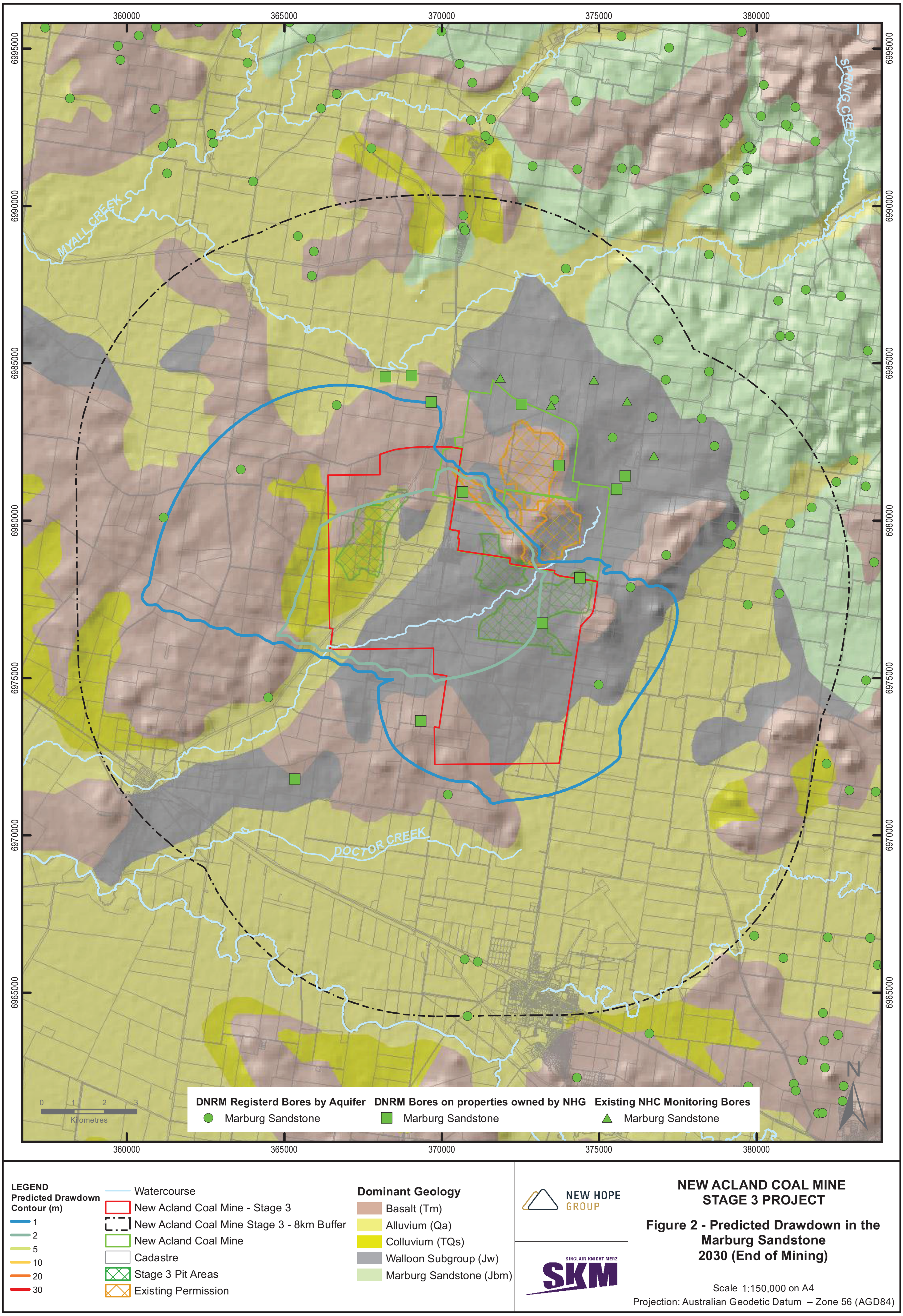

NEW HOPE GROUP

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NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 2 - Predicted Drawdown in the Marburg Sandstone 2030 (End of Mining)

Scale 1:150,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

Produced: 23/08/2013 Path: I:\QENV2\Projects\QE06644\Spatial\ArcGIS\01_Figures\01_SEIS\GroundwaterManagementPlan\130823_NewHope_GroundwaterGWMIMP_Figure2_PredictedDrawdownMarburgSst2030.mxd

3. Groundwater Monitoring Program

3.1. Existing Groundwater Conditions

Baseline groundwater monitoring was undertaken as part of the revised Project's EIS (SKM 2013). The methodology undertaken for the assessment of groundwater resources included:

- the review of geological, hydrogeological and groundwater quality data collected for the current Mine;
- the review of other background data available on local hydrogeology and groundwater use;
- the installation of four production and 11 observation bores to characterise the local hydrogeology around the revised Project site;
- the undertaking of aquifer pumping tests to determine aquifer parameters; and
- the formulation of a hydrogeological conceptual model to serve as the basis for a numerical model.

The detail of the baseline groundwater assessment is presented within Chapter 6 Groundwater Resources of the revised Project's EIS (SKM 2013).

Baselines have been defined for monitoring bores associated with the groundwater monitoring program for existing operations at New Acland Coal Mine. Long term monitoring of bores for the expanded groundwater monitoring program which covers the revised Project will be undertaken to establish bore-specific groundwater level and quality baselines. The Life of Mine Plan will allow sufficient time for parameter baselines to be established in advance of any potential impacts from mining across the revised Project area.

Groundwater Levels in the Walloon Coal Measures across the revised Project Site

Groundwater level data for the Walloon Coal Measures aquifer across the revised Project site indicate that currently the general direction of groundwater flow is southerly, falling from an elevation of around 430 mAHD in the north to 390 mAHD in the south. This direction of flow is consistent with a fall in the topographic elevation and geological dip across the revised Project Site. The long term data for monitoring bores indicate that the current mining operations on ML 50170 (Stage 1) and ML50216 (Stage 2) are not currently having a significant drawdown impact on groundwater levels in the Walloon Coal Measures aquifer within the revised Project site.

Groundwater Quality

A groundwater monitoring program is currently undertaken in accordance with EA EPML00335713 for the current mining operation. This monitoring has provided sufficient data to define bore-specific baseline concentrations for the monitored parameters, and these are detailed in the regular groundwater monitoring reports prepared by independent consultants, Waste Solutions Australia (WSA). NAC's current groundwater monitoring program is regulated by the the Department of Environment and Heritage Protection (DEHP). In 2012, WSA prepared a comprehensive review of groundwater quality monitoring undertaken to date at the Mine in order to review and if necessary establish new groundwater quality background limits. This report is presented as **Appendix A**.

Walloon Coal Measures Aquifer

Water quality for the Walloon Coal Measures aquifer shows typically neutral to slightly alkaline pH, with values generally falling within the potable range (6.5 to 8.5). Electrical conductivity (EC) values range from 530 µS/cm to 11,700 µS/cm but more typically range from 3,000 µS/cm to 6,000 µS/cm, reflecting the slightly brackish to brackish nature of the groundwater where naturally occurring sodium and chloride are the dominant ions. The majority of the bores currently monitored have total dissolved solids (TDS) levels below 4,000 mg/L, which indicates the quality is suitable for watering livestock. At TDS levels between 4,000 mg/L and 10,000 mg/L, animals may have an initial reluctance to drink but should adapt to these conditions without adverse effects.

Water supplies from Walloon Coal Measures aquifer include some of potable quality but the typically brackish nature of the groundwater from this aquifer means supplies are mainly used for stock watering.

Tertiary Basalt Aquifer

The bores in the Tertiary Basalt aquifer currently monitored under the existing groundwater monitoring program yield water of essentially neutral pH (between 7.0 and 8.0). Salinity in the Tertiary Basalt aquifer is generally lower than the Walloon Coal Measures aquifer, with EC and TDS ranging from 1,400 µS/cm to 4,300 µS/cm and 870 mg/L to 2,900 mg/L, respectively.

3.2. Groundwater Monitoring Program

The groundwater monitoring program for the revised Project combines the current monitoring program for the existing Mine with an extended network of monitoring bores enclosing the revised Project area. Data collected from the groundwater monitoring program will:

- be operated in accordance with the revised Project's approved EA;
- be collated into six monthly and annual reviews of groundwater monitoring;
- be used in the continued development and refinement of groundwater impact assessment criteria and investigation triggers;
- enable verification and refinement of the groundwater modelling predictions presented in the revised Project's EIS (SKM 2013); and
- be collated into a database that will be made available to the administering authority on request.

The groundwater monitoring program conforms to Conditions C21 to C33 of the current EA EMPL00335713 for New Acland Coal Mine. **Table 3-1** summarises the bores that will be monitored, monitoring parameters, and frequency. The groundwater monitoring program combines the existing monitoring bores together with an additional 15 bores that have been installed around the revised Project area. In addition, a further 14 bores will be added to the monitoring network which brings the total number of bores included in the groundwater monitoring program to 44. Proposed additional monitoring bore locations have been chosen based on model drawdown predictions and presence of aquifers and receptors of interest. The monitoring program for new bores will be established prior to the commencement of the revised Project's mining schedule to ensure there is sufficient baseline information on groundwater levels and quality for those bores.

Table 3-1 Groundwater Monitoring Schedule

Monitoring Point	Aquifer	Parameter and Monitoring Frequency
Bores monitored under current monitoring program (Compliance and Reference bores)		
2289P	Coal Measures	Groundwater levels: **monthly**. Groundwater quality: **six monthly** to include: Al, As, Ca, Se, Cl, Cu, F, Fe, Total N, K, Mg, Mn, Na, SO4, HCO3, TDS, EC, pH
2291P	Coal Measures	
18P	Coal Measures	
25P	Basalt	
26P	Coal Measures	
27P	Coal Measures	
28P	Coal Measures	
843	Basalt	
848	Coal Measures	
81P	Coal Measures	
82P	Coal Measures	
83P	Coal Measures	
84P	Basalt	
BMH1	Basalt	
CSMH1	Coal Measures	
Existing Stage 3 monitoring bores to be incorporated into the revised Project's monitoring program		
109P	Basalt	Groundwater levels: **monthly**. Groundwater quality: **six monthly** to include: Al, As, Ca, Se, Cl, Cu, F, Fe, Total N, K, Mg, Mn, Na, SO4, HCO3, TDS, EC, pH
112PGC	Coal Measures	
114P	Coal Measures	
116P	Coal Measures	
119PGC	Coal Measures	
120WB	Coal Measures	
121WB	Coal Measures	

Monitoring Point	Aquifer	Parameter and Monitoring Frequency
Proposed additional monitoring points which will be monitored as part of the revised Project's monitoring program		
1A	Basalt	Groundwater levels: **monthly**. Groundwater quality: **six monthly** to include: Al, As, Ca, Se, Cl, Cu, F, Fe, Total N, K, Mg, Mn, Na, SO4, HCO3, TDS, EC, pH
1B	Coal Measures	
2A	Basalt	
2B	Coal Measures	
3A	Basalt	
3B	Coal Measures	
4A	Basalt	
4B	Coal Measures	
4C	Marburg Sandstone	
5A	Oakey Creek Alluvium	
5B	Coal Measures	
6	Coal Measures	
7A	Basalt	
7B	Coal Measures	
8	Mine Pit Backfill	

Aluminium (Al), Arsenic (As), Selenium (Se), Copper (Cu), Fluorine (F), Iron (F), Total Nitrogen (Total N), Manganese (Mn); Calcium (Ca), Chloride (Cl), Potassium (K), Magnesium (Mg), Sodium (Na), Sulphate (SO4), Bicarbonate (HCO3), Carbonate (CO3), Total Dissolved Solids (TDS), Electrical Conductivity (EC); Acidity/Alkalinity (pH).

The locations of the monitoring bores in **Table 3-1** are presented in **Figure 3-1**. The final location of the proposed additional bores may vary slightly depending on land access and proximity to local groundwater users. These bores will be individually identified in accordance with the bore naming convention at the revised Project site.

The existing Mine EA reference bores (BMH1 and CSMH1) are located within the predicted zone of groundwater drawdown from operation of the revised Project. NAC will accordingly re-assess the location of these reference bores and if necessary install new reference bores outside the revised Project's predicted zone of groundwater drawdown.

The groundwater monitoring network will:

- be installed and maintained by a person possessing appropriate qualifications and experience in the fields of hydrogeology and groundwater monitoring program design to be able to competently make recommendations about these matters;

- be constructed in accordance with methods prescribed in the latest edition of "Minimum Construction Requirements for Water Bores in Australia" (National Uniform Drillers Licensing Committee, 2012) by an appropriately qualified driller; and
- include a sufficient number of 'bores of compliance' that are located at an appropriate distance from potential sources of impact from mining activities and provide the following:
  - representative groundwater samples from the uppermost aquifer;
  - background water quality in hydraulically up-gradient or background bore(s) that have not been affected by any mining activities conducted by NAC; and
  - the quality of groundwater down gradient of potential sources of contamination including groundwater passing the relevant bore(s) of compliance.

Groundwater monitoring will be undertaken by appropriately qualified personnel. Groundwater level measurements, sample collection, storage and transportation will be undertaken in accordance with procedures conforming to the current industry standard: AS/NZS 5667.1, .11 1998.

The data gathered from the groundwater monitoring program will be collated into a database which will include:

- a site plan showing sample locations;
- tabulated results of the monitoring compared with applicable background/trigger levels;
- all data collected during each monitoring round;
- a record of chain of custody of the samples from sampling through to analysis;
- laboratory analysis certificates;
- groundwater monitoring program reports, and
- a description of the procedures, methods and calculations used.

Groundwater sample analysis will continue to be undertaken by a laboratory accredited by the National Association of Testing Authorities (NATA). Field measurement of water quality parameters is undertaken using appropriate field equipment that is maintained and calibrated in accordance with the manufacturer's recommendations.

- Data collected from landholder bores, wells, and waterholes will be used in conjunction with the groundwater impact investigation procedure to determine if contingency measures are required.

Alluvium

- The nearest alluvium with significant groundwater supplies is associated with Oakey Creek in the south-west of the revised Project site. A new monitoring bore installed at location 5A (**Figure 3-1**) will monitor groundwater levels and quality in the Oakey Creek Alluvium. Groundwater levels in the coal measures between the active mine pits and the Oakey Creek Alluvium will be monitored at bores 119PGC and 116P and directly beneath the alluvium at Location 5B.

Basalt

- Eight basalt bores will be monitored, including five new bores strategically located in areas of predicted drawdown and/or sensitive receptors (**Figure 3-1**). Groundwater levels will be monitored on a monthly basis and samples will be collected and submitted for the analytical suite set out in **Table 3-1** every six months.

Coal Measures

- The groundwater monitoring program includes 22 coal measures bores of which seven are new (**Table 3-1** and **Figure 3-1**). Groundwater levels will be monitored on a monthly basis and samples will be collected and submitted for the analytical suite set out in **Table 3-1** every six months.

Marburg Sandstone

The Mine currently abstracts groundwater from the Marburg Sandstone aquifer for the purpose of coal washing. NAC currently possesses an allocation of 271 ML/year for this aquifer. For the revised Project's future operation, abstraction from the Marburg Sandstone aquifer will range around 10 ML/year for maintenance purposes. A new groundwater monitoring bore will be installed southwest of the revised Project site to monitor this aquifer and confirm predictions of minimal impacts.

Landholder Bores

NAC will undertake a landholder bore assessment program to characterise each and every private bore predicted to be impacted by operation of the revised Project. The assessment program will collect information such as bore condition, usage, source aquifer, and water level and quality information. Following this assessment program, groundwater monitoring will be undertaken at selected landholder bores surrounding the revised Project site, following consultation with relevant landholders. Primarily this will include monitoring of groundwater levels and quality in order to assess potential impacts from mine dewatering. Landholder bores targeted for monitoring will primarily be those taking water from the coal measures and basalt but may include some bores in the Marburg Sandstone or alluvial aquifers.

3.3. Groundwater Impact Prediction, Validation and Review

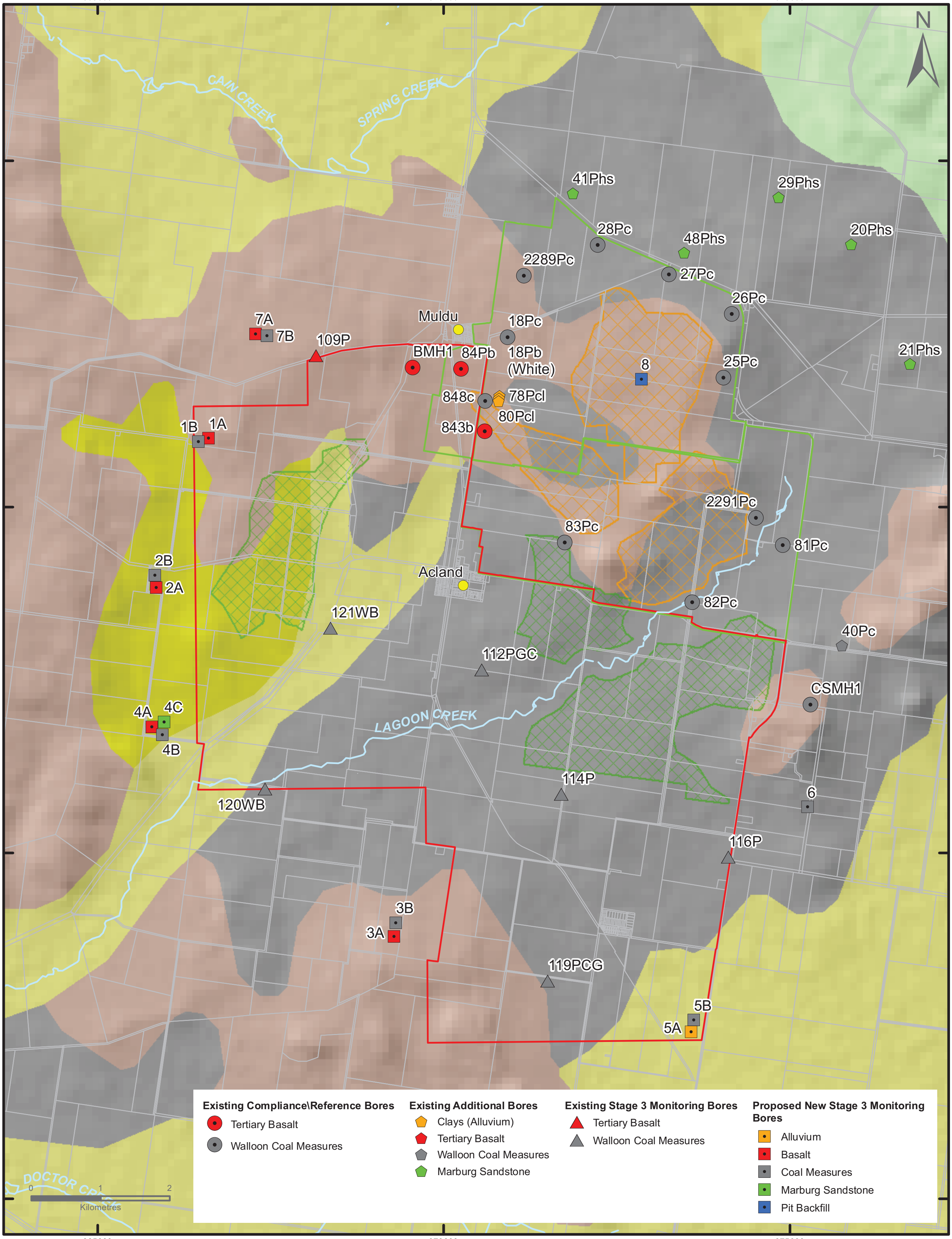
Chapter 6 Groundwater Resources of the revised Project's EIS (SKM 2013) included the development of a multilayer time variant groundwater flow model to simulate the effects of mining activities on the local aquifers and to estimate the potential quantity of groundwater inflow to the active mine pits and depressed landforms

During the life of the revised Project, data collected through the groundwater monitoring program, will be used to update and refine this model and it's predictions to reflect the actual activities undertaken on site (e.g. mine development and sump locations) and the results of regular groundwater monitoring.

The need to review and update the revised Project's model will depend on the stage of the revised Project's mine development, changes in the depth of working, and availability and results of new monitoring data. For example, at the conclusion of the installation program for new monitoring bores for the revised Project, the data collected from the monitoring program will be used to immediately refine the model and produce a revised impact assessment. **Table 3-2** presents the proposed schedule for groundwater impact prediction, validation and review. The results of any groundwater model verification and refinement, or the justification that this action is not necessary, will be documented, and as required, presented to DEHP (regulatory authority under the *Environmental Protection Act 1994*) and/or NRM (regulatory authority under the *Water Act 2000*).

Table 3-2 Schedule for Groundwater Impact Prediction, Validation and Review

Model Revision	Timing
Initial Review	At the conclusion of the revised monitoring network installation program
2nd Review	After one (1) year of operation of the revised Project
3rd and subsequent Reviews	Every three (3) years or if deemed necessary under the Groundwater Impact Investigation Procedure as described in **Section 4.2**



LEGEND

- Towns and Localities
- Watercourse
- New Acland Coal Mine
- New Aland Coal Mine-Stage 3
- Existing Permission
- Stage 3 Pit Areas
- Cadastre

Dominant Geology

- Basalt (Tm)
- Alluvium (Qa)
- Colluvium (TQs)
- Walloon Subgroup (Jw)
- Marburg Sandstone (Jbm)

NEW HOPE GROUP

SINCLAIR KNIGHT MERZ SKM

NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 3 - Proposed Monitoring Locations

Scale 1:75,000 on A4
Projection: Australian Geodetic Datum – Zone 56 (AGD84)

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4. Groundwater Impact Triggers and Investigation Protocols

4.1. Groundwater Impact Criteria and Triggers

Groundwater monitoring will be undertaken for the revised Project in accordance with the groundwater monitoring program. Impact assessment criteria for groundwater levels and quality, where not already established, will be developed using statistical analysis of the baseline data and the predicted effects presented in the revised Project's EIS (SKM 2013).

Triggers will be used to determine if the groundwater impact investigation procedure should be initiated.

These triggers include:

- breaching of relevant conditions of the EA;
- substantial variance from the predicted groundwater drawdown effects presented in the revised Project's EIS (SKM 2013) or subsequent impact assessment updates; or
- when a legitimate complaint is received from a local landholder who is a groundwater user.

4.1.1. Groundwater Quality Triggers

Nine bores (18P, 27P, 28P, 843, 848, 81P, 82P, 83P and 84P) within the groundwater monitoring program have had background concentrations defined for the water quality parameters set out in **Table 4-1**. The upper and lower background concentrations were defined on the basis of six-monthly sampling over a four-year period and are reported in **Appendix A**. The groundwater monitoring requirements of the current EA EPML00335713 for the Mine sets limits for each of the water quality parameters included within the groundwater monitoring program (**Table 4-1**).

Table 4-1 Groundwater Quality Monitoring Limits

Parameter	Limit
Aluminium (Al) Arsenic (As) Selenium (Se) Copper (Cu) Fluoride (F) Iron (Fe) Total nitrogen (N) Manganese (Mn)	+ / - 20% of background concentration
Calcium (Ca) Chloride (Cl) Potassium (K) Magnesium (Mg) Sodium (Na)	+ / - 10% of background concentration

Parameter	Limit
Sulphate (SO4) Bicarbonate (HCO3) TDS	
Electrical conductivity (EC, µS/cm)	+/- 0.5 for coal measures aquifers, +/-1 for basalt aquifers

Groundwater quality monitoring limits for new monitoring bores (including all Stage 3 monitoring bores) will be established and used following collection of a minimum of three years of data and appropriate analysis. As groundwater quality limits are established, they will be used in reporting requirements.

4.1.2. Groundwater Level Triggers

The current groundwater level trigger set out in EA EPML00335713 – C26 for current mining operations will continue to apply. The EA states:

"..on lease groundwater levels must be monitored and compared with two bores located off-lease and within the same aquifer. The difference in the variation of drawdown from on-lease bores compared to the variation in off-lease bores within any one month sampling period should be no greater than one metre. Where a difference of more than one metre is identified and that difference is not the result of pumping of licensed bores, the administering authority must be notified within 14 days of completion of monitoring".

Four off lease Tertiary Basalt aquifer monitoring bores and five off lease Walloon Coal Measures aquifer monitoring bores will form an essential component of the 44 monitoring bores included in the groundwater monitoring program.

Groundwater level triggers will also be set on the basis of predicted drawdown in the Walloon Coal Measures and Tertiary Basalt aquifers. The selection of key monitoring bores will be based on at least two years of monthly groundwater level monitoring data. Modelled predictions of drawdown in the Walloon Coal Measures and Tertiary Basalt aquifers at these locations will be defined. When 75% of the predicated drawdown at these monitoring bores has been observed for three consecutive monthly monitoring events, the groundwater impact investigation protocol will be triggered.

4.1.3. Landholder Complaints

In the event that a legitimate groundwater-related complaint is received from a local landholder, the relevant data will be reviewed by an appropriately qualified person who will determine if the groundwater impact investigation protocol should be initiated. Each new complaint will be compiled into a register and updated as required based on the management actions completed. The complaints register will be maintained for audit purposes.

4.2. Groundwater Impact Investigation Procedure

The groundwater impact investigation procedure will be implemented in response to an exceedence of a relevant trigger (groundwater quality or groundwater level) or a legitimate complaint from a landholder (groundwater related). The relevant data set will be reviewed by an appropriately qualified environmental specialist who will determine if further investigation is necessary. The groundwater impact investigation procedure will follow the following framework.

- If a trigger or trend is identified in a data set, the first step will be to verify the data if it appears anomalous. A resample/re-test/re-measure will be conducted where appropriate.
- Where monitoring results indicate that a groundwater level has breached the reporting trigger, the administering authority must be notified within 14 days of completion of monitoring or as otherwise stated in the revised Project's EA.
- In relation to groundwater quality triggers, if the groundwater contaminant trigger levels defined in Table 2 are exceeded then an investigation into the potential for environmental harm will be completed and sent to the administering authority within 3 months of receiving the analysis results (Condition C29 EPML00335713).
- Once the validity of the breach in groundwater level triggers or a landholder complaint has been verified, a preliminary assessment will be undertaken by an appropriately qualified specialist involving the evaluation of the monitoring results/complaint in conjunction with mining activities being undertaken at the time, baseline groundwater monitoring results, groundwater data for surrounding locations, local use of groundwater, the prevailing and preceding meteorological conditions, and other factors affecting the local hydrogeological regime.
- The preliminary investigation may deem that further additional investigation and monitoring is required to determine the cause of the 'activation' of the trigger and whether or not it is directly related to mining activities.
- If the investigations deem that triggers have been 'activated' as a result of mining activities, contingency measures may need to be implemented.
- Additional monitoring may be implemented to measure the effectiveness of contingency measures (i.e. if deemed necessary).
- In the event that trigger levels or impact assessment criteria continue to be exceeded, further investigations may be undertaken (i.e. a process of continual improvement or adjustment of the relevant triggers if warranted).
- The results of any breaches of trigger levels and investigations will be documented for reporting and audit purposes.
- If a definite case of material or serious environmental harm or the potential for material or serious environmental harm is clearly established by a groundwater investigation into an exceedance of a relevant trigger (groundwater quality or groundwater level) or a legitimate complaint, NAC will ensure the notification requirements of Section 320 of the *Environmental Protection Act 1994* are fully addressed.

4.3. Mitigation

In the event that a formal groundwater investigation conclusively identifies that the revised Project's mining operations have adversely impacted a neighbouring groundwater user (affected groundwater user), NAC will attempt in 'good faith' to negotiate suitable mitigation measures in a timely manner to rectify the identified groundwater problem. NAC may involve an appropriately qualified environmental specialist to assist with development of the mitigation measures. The development of suitable mitigation measures will be based on the outcomes of an appropriate scientific investigation.

Possible mitigation measures that may be applied by NAC include:

- the refurbishment of an existing groundwater bore;
- the installation of a new groundwater bore;
- the establishment of an alternative water supply arrangement; and/or
- the use of another mutually agreed form of mitigation.

NAC will ensure as a minimum that the proposed mitigation measures are acceptable to the affected groundwater user, and if acceptable, will enter into a legal agreement for the installation of the proposed mitigation measures at NAC's expense. NAC will also ensure the proposed mitigation measures are commensurate with the identified groundwater loss.

NAC may be required to install interim mitigation measures until the permanent mitigation measures have been developed and installed. As required, NAC will seek agreement with the affected groundwater user and pay all reasonable cost for the use of any interim mitigation measures.

If agreement cannot be reached with the affected groundwater user in relation to the proposed mitigation measures, NAC will facilitate some form of legal disputes resolution for the matter.

NAC will ensure the administering authority is fully advised about the details and progress of these types of groundwater matters.

NAC is committed to rectifying all groundwater problems that are legitimately attributed to the revised Project's mining operations through proper scientific evaluation, in an appropriate timeframe, using accepted and practical mitigation measures, and to the satisfaction of the affected groundwater user.

4.4. Groundwater Complaints Management Process

Groundwater complaints that are believed to be attributed to the operation of New Acland Coal Mine (Mine) should be immediately reported to NAC. Groundwater complaints may be reported verbally by telephone (1 800 882 142 or Oakey Community Office: 07 4691 3445) or in writing using e-mail (community@newhopegroup.com.au) or letter (New Acland Coal Pty Ltd, PO Box 47, Ipswich, Qld 4305). NAC has provided its near neighbours with general and special 24 hour contact numbers. NAC will continue this practice for the revised Project.

The general details of the groundwater complaint need to be provided at the time of reporting the complaint to NAC. NAC will make all reasonable efforts to ensure the reported groundwater complaint is managed in a timely and appropriate manner. NAC's Environmental Officer (EO) is responsible for environmental complaints management at the Mine.

NAC will record the details of the groundwater complaint in the Mine's complaint database (register) and review this information. As required, NAC will re-contact the complainant about the groundwater complaint to obtain all the necessary details to decide the next course of action. Depending on the severity of the groundwater complaint, NAC as a courtesy may also advise the Toowoomba Office of the DEHP about the matter. As required, the New Hope Group's Corporate Environmental Team may assist with management of the groundwater complaint.

NAC's investigation of the groundwater complaint is designed to establish the legitimacy of the complaint, and if legitimate, whether the Mine is directly or indirectly responsible for the complaint. If current evidence or further scientific investigation establishes NAC is responsible for the groundwater complaint, NAC will advise the complainant, the Toowoomba Office of the DEHP and follow the mitigation strategy outlined in Section 4.4 of this Plan. If current evidence or further scientific investigation establishes NAC is not responsible for the groundwater complaint, NAC will advise the complainant in a timely manner, and depending on circumstances, the Toowoomba Office of the DEHP.

At the cessation of the complaint investigation process, NAC will record all the relevant details about the groundwater complaint in the Mine's complaint database, including all management actions undertaken, the final outcomes of the complaint investigation process, the details of any required follow-up or on-going management actions, and whether the complaint is 'closed off' to the satisfaction of the complainant. NAC maintains the Mine's complaint database for issue analysis, regulatory and audit purposes.

Importantly, NAC is committed to working with its near neighbours to resolve genuine issues as they arise in relation to the operation of the Mine.

5. Review and Improvement Process

5.1. Review of the Groundwater Monitoring and Impact Management Plan

NAC will conduct an annual review of the environmental performance of the revised Project. The annual review will address the performance of the GMIMP and will:

- include a comprehensive review of the monitoring results and complaints records for the revised Project over the year, including a comparison of these results against the:
- relevant statutory requirements, limits or performance measures/criteria,
- monitoring results of previous years, and
- relevance to the revised Project's EA;
- identify any non-compliance over the last year, and describe what actions were (or are being) taken to ensure compliance;
- identify any trends in the monitoring data over the life of the revised Project;
- identify any discrepancies between the predicted and actual impacts of the revised Project, and analyse the potential cause of any significant discrepancies (Validate model);
- describe mitigation measures that have or are being implemented to address breaches of any groundwater impact triggers; and
- review the condition and extent of the groundwater monitoring network in the context of meeting its objectives.

Over the lifespan of the revised Project (approximately 16 years of working) and the post closure monitoring period, it is inevitable that groundwater monitoring bores will become unserviceable and need to be replaced. NAC will proactively maintain the groundwater monitoring network, replacing bores as necessary, and use the regular review of monitoring data to inform the location of additional monitoring bores, if required.

As required, NAC may update or revise the GMIMP based on the outcomes of the annual review process. The DEHP will be consulted in relation to any significant changes to the GMIMP and as necessary will be re-issued any new versions of the document.

Appendix A Waste Solutions Australia (2012) - Establishment of Groundwater Quality Background Limits