BlueSphere ENVIRONMENTAL

Oaky Creek

Underground Water Impact Report

Prepared for:

Oaky Creek Coal

5 November 2015

Oaky Creek

Underground Water Impact Report

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Definitions

The following definitions have been used for the purposes of this Underground Water Impact Report (UWIR).

Aquitard	A water-saturated sediment or rock whose permeability is so low it cannot transmit any useful amount of water. An aquitard allows some measure of leakage between the aquifer interval it separates.
Aquifer	A water-saturated geologic unit that is capable of transmitting significant or usable quantities of Groundwater under ordinary hydraulic gradients.
Confined Aquifer	Exists where the groundwater is bounded between layers of impermeable substances like clay or dense rock. When tapped by a well, water in confined aquifers is forced up, sometimes above the soil surface. This is how a flowing artesian well is formed.
Confining Layer / Unit	Geologic material with little permeability or hydraulic conductivity. Water does not pass through this layer or the rate of movement is extremely slow.
CMA	Cumulative Management Area
CPW	Controlled pressure well for gas drainage through cased and sealed wells
CSG	Coal Seam Gas
DEHP	Department of Environment and Heritage Protection (previously part of DERM)
DNRM	Department of Natural Resources and Mines (previously part of the Department of Environment and Resource Management DERM)
Hydraulic Conductivity	The ease with which water moves through soil or rock. A coefficient ("K") depends on the physical properties of formation and fluid. "K" is the rate of flow per unit cross-sectional area under the influence of a unit gradient, and has the dimension of length3/length2 x time or length/time (e.g. m/s).
Hydraulic Gradient	The change in hydraulic head or water level over a distance. Usually expressed in metres/metre. For example, a hydraulic gradient of 0.01 indicates a one-metre drop in water level over a distance of 100 m. The hydraulic gradient is the driving force that causes groundwater to flow.
Hydraulic Head	A measure of the groundwater pressure in an aquifer. Hydraulic head is determined from water level measurements in wells.

Hydrogeology	The science that relates geology, fluid movement (i.e. water) and geochemistry to understand water residing under the earth's surface. Groundwater as used here includes all water in the zone of saturation beneath the earth's surface, except water chemically combined in minerals.
Hydrogeochemistry	The study of the chemical processes and reactions that govern the composition of water in relation to its interaction with rocks, other water bodies, and soils. It also covers the role of water in the cycles of matter and energy that transport the Earth's chemical components in time and space, and their interaction with the hydrosphere and atmosphere.
Hydrostratigraphic Unit	Geological units that are not solely based on lithologic characteristics but also include characteristics related to water movement, occurrence and storage
Lithology	The systematic description of sediment and rocks, in terms of composition, texture and internal structure
Losing stream	A stream that is losing water to (or recharging) the groundwater system. The same stream could be both a gaining stream and a losing stream, depending on the conditions.
Monitoring Well	A constructed controlled point of access to an aquifer which allows groundwater observations. Small diameter observation wells are generally called piezometers.
OCC	Oaky Creek Coal
Permeability	A physical property of the porous medium. Has dimensions Length2. When measured in cm2, the value of permeability is very small, therefore more practical units are commonly used - Darcy (D) or millidarcy (mD). One Darcy is equivalent to 9.86923×10_9 cm^2. (2) A measure of the ability of a porous medium to transmit a fluid (any fluid). Similar to hydraulic conductivity that describes the ability of a porous medium to transmit water specifically.
P&G Act, 2004	Petroleum and Gas (Production and Safety) Act 2004
PL	Petroleum Lease
QWC	Queensland Water Commission
RL	Reduced Level - Groundwater levels given with respect to height above sea-level (i.e. given in mAHD).
SCMA	Surat Cumulative Management Area
Stratigraphy	The study of the sequence of layered geologic deposits based on their spatial positions, depositional sequence in time, and correlations across different localities.
SIS	Surface to inseam - cased and sealed surface to coal seam gas drainage bores
SWL	Standing Water Level – the measured depth to groundwater (m) below a reference point, from the top of bore casing

Unconfined Aquifer	A permeable bed only partly filled with water and overlying a layer of lower hydraulic conductivity. Its upper boundary is formed by a free water table where pore pressure is equal to atmospheric pressure. Water in a well penetrating an unconfined aquifer does not, in general, rise above the water surface.
UWIR	Underground Water Impact Report
VPW	Vertical production well – negative pressure gas and moisture drainage well
Watertable	The upper surface of groundwater of the level below which the soil is saturated with water.
Well	An excavation or structure created in the ground by digging, driving, boring or drilling to access water in the subsurface
Wellbore	The physical hole that makes up the well, and can be cased, open or a combination of both.
XCQ	Xstrata Coal Queensland
Yield	The quantity of water removed, or able to be removed from a well

1 Introduction and Background

1.1 Introduction

The Oaky Creek Coal (OCC) mining complex is located approximately 100 kilometres northeast of Emerald in Central Queensland, Australia (see Figure 1). The complex is managed by Glencore Coal Queensland as the principal holder of the site Environmental Authority EPML00942413 (EA), on behalf of the OCC joint venture partners (Glencore Coal Queensland Pty Ltd, ICRA OC Pty Ltd, Itochu Coal Resources Australia Pty Ltd and Sumisho Coal Australia Pty Ltd).

Surface mining commenced at OCC in 1982, with underground operations starting in late 1990. Currently underground mining operations are conducted at the Oaky No.1 Underground Mine (current life of mine 2018) and the Oaky North Underground Mine (current life of mine 2038), using continuous miners to develop underground first workings followed by longwall extraction methods. The Surface Operations are composed of the Coal Handling & Preparation Plant (CHPP) with associated coal handling and stockpile areas, and an extensive open cut mining area currently under care and maintenance. Progressive rehabilitation is being completed on open cut mining spoil to reduce the site's disturbance in these areas. Coal product is transported by rail to eastern sea ports in Mackay and Gladstone for export to overseas markets.

While the site maintains several Mining Lease tenements for the purpose of coal extraction, it also maintains two petroleum licences (PL 237 and PL 324) (refer Figure 2), held for the extraction and use of coal seam gas, which is drained both pre and post mining to enable safe underground coal extraction to proceed. Under Chapter 3 of the *Water Act 2000*, petroleum tenure holders have responsibilities to prepare an Underground Water Impact Report (UWIR) unless the petroleum licence(s) are within a declared Cumulative Management Area (CMA), in which case it is the responsibility of the Queensland Water Commission (QWC) to prepare the UWIR. At the time of preparing this report, PL 237 and PL 324 were not located within a CMA.

Xstrata Coal prepared a UWIR for PL237 and PL324 in December 2012 (Xstrata Coal, 2012), which came into effect on 27 February 2013. This new UWIR reflects the revised current understanding of the groundwater systems and processes beneath the OCC operation based on more recent analysis, assessment and interpretation of geologic and hydrogeologic data. It supercedes the original UWIR prepared by Xstrata Coal in December 2012. The proposed term of this new UWIR is three years (2015 – 2018).

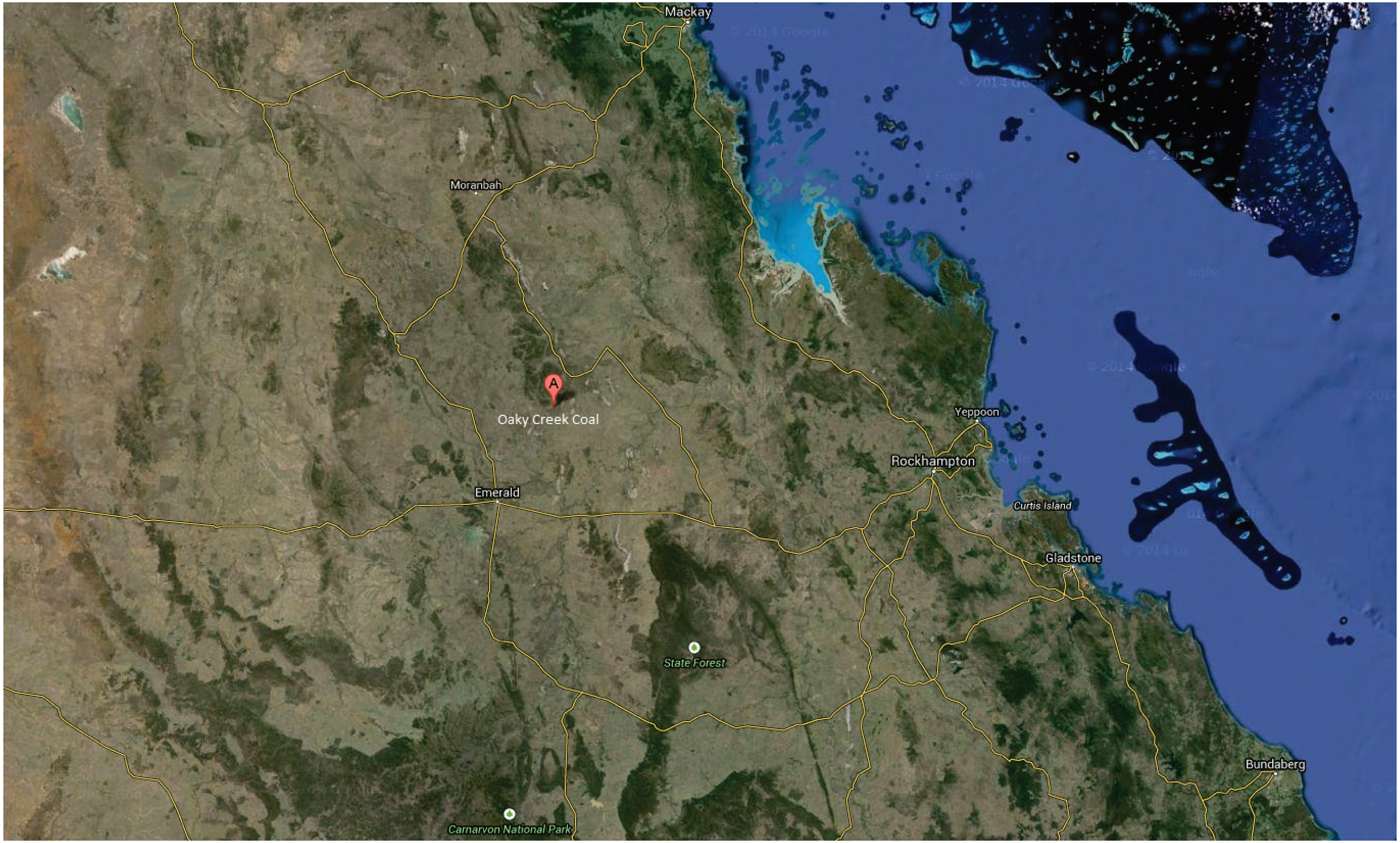

Figure 1 Oaky Creek Coal Regional Location Plan

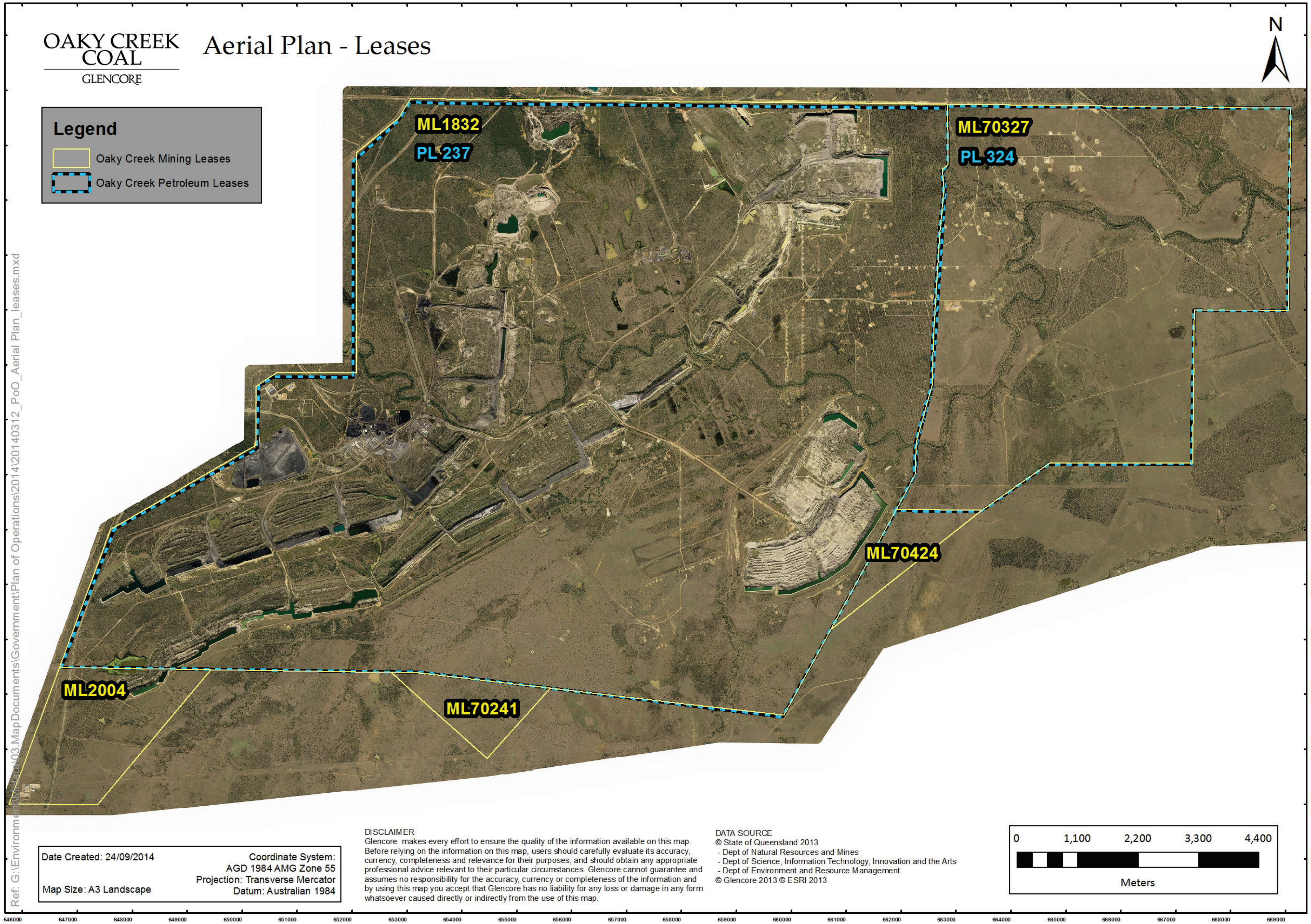

Figure 2 Oaky Creek Coal Tenure Map

1.2 Background

Mining commenced at the OCC operation in 1982, initially involving open cut dragline operations and then underground longwall operations at Oaky No.1 Mine (refer Figure 3) in 1990. Development for a second underground longwall operation commenced at Oaky Creek North Mine (refer Figure 3) in 1995. A third underground longwall operation was established at the Alliance Mine by a joint venture subcontracted to OCC.

Present day mining involves the two underground operations at Oaky No.1 and Oaky Creek North mines. Future underground mining is planned in the south-east of the Oaky No.1 Mine and in the east of the Oaky Creek North Mine.

To ensure explosive atmospheres do not occur and therefore facilitate a safe underground mining environment, gas is removed primarily from the German Creek coal seam via OCCs gas drainage methods. The extracted gas is then flared or used to generate electricity which is on-sold by an independent supplier. The removal of gas prior to, during and after longwall mining is a mine safety requirement, which is managed by a dedicated site team.

As a result of the gas drainage process, some groundwater contained within the German Creek coal seam that is degassed is also removed.

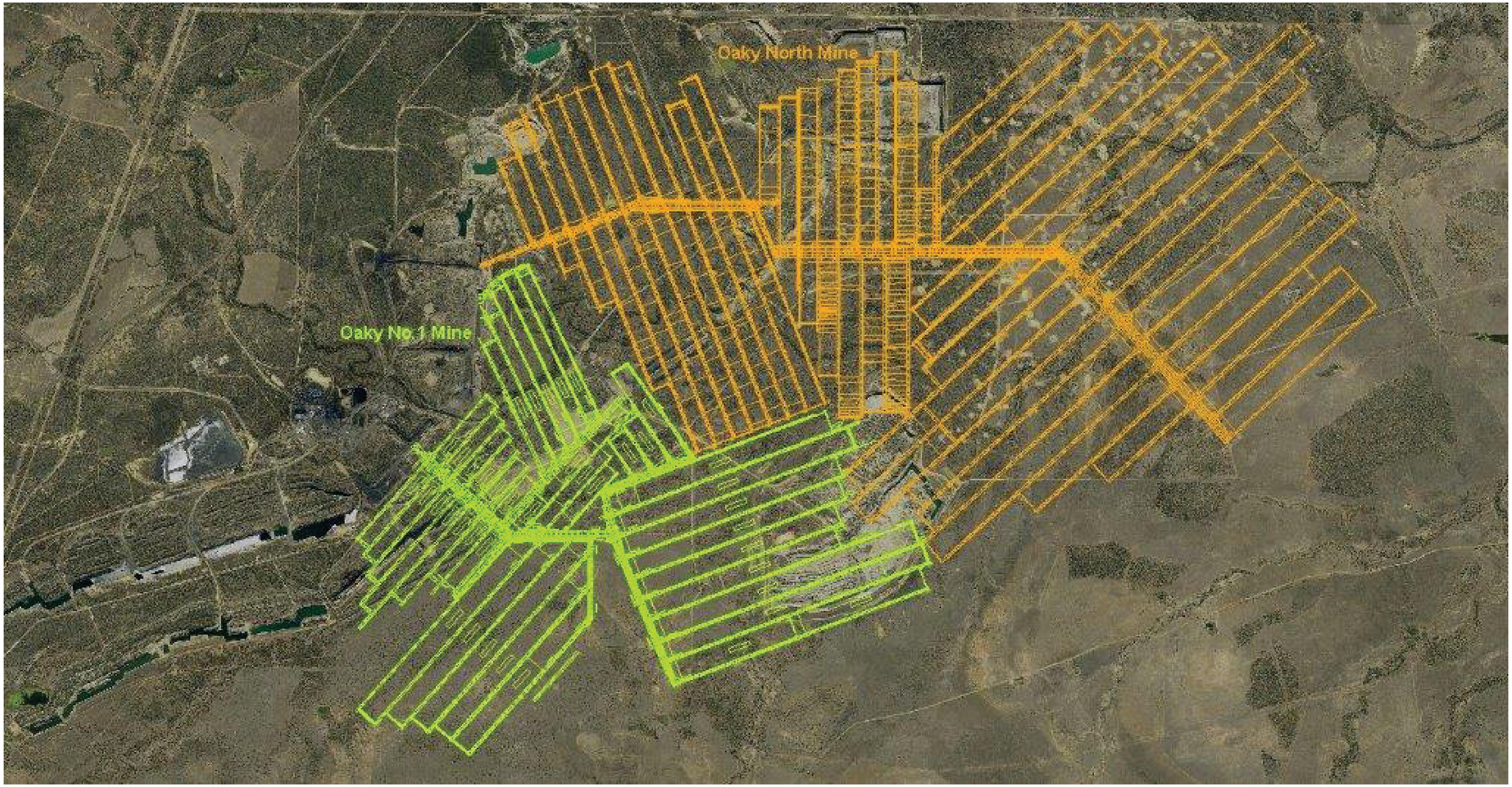

Figure 3 Layout & Nomenclature of Oaky Creek Coal Operations

1.3 Report Structure

This report presents an updated UWIR for PLs 237 and 324. Table 1 summarises those sections of this UWIR that relate to the provisions of Chapter 3 of the *Water Act 2000*, where applicable.

Table 1 Report Structure

<table>
<tr><th>Chapter 3 Water Act 2000 Provision</th><th colspan="2">Sub-provision</th><th>Report Section</th></tr>
<tr><td rowspan="2">S376 (a) - for the area to which the report relates—</td><td colspan="2">(i) the quantity of water produced or taken from the area because of the exercise of any previous relevant underground water rights; and</td><td>Section 5.2</td></tr>
<tr><td colspan="2">(ii) an estimate of the quantity of water to be produced or taken because of the exercise of the relevant underground water rights for a 3-year period starting on the consultation day for the report;</td><td>Section 5.3</td></tr>
<tr><td rowspan="5">S376 (b) - for each aquifer affected, or likely to be affected, by the exercise of the relevant underground water rights—</td><td colspan="2">(i) a description of the aquifer; and</td><td>Section 4.4</td></tr>
<tr><td colspan="2">(ii) an analysis of the movement of underground water to and from the aquifer, including how the aquifer interacts with other aquifers; and</td><td>Sections 4.4, 6.1.4 and 6.2.2</td></tr>
<tr><td colspan="2">(iii) an analysis of the trends in water level change for the aquifer because of the exercise of the rights mentioned in paragraph (a)(i); and</td><td>Sections 6.1.2 and 6.2.1</td></tr>
<tr><td colspan="2">(iv) a map showing the area of the aquifer where the water level is predicted to decline, because of the taking of the quantities of water mentioned in paragraph (a), by more than the bore trigger threshold within 3 years after the consultation day for the report;</td><td>Section 7.1</td></tr>
<tr><td colspan="2">(v) a map showing the area of the aquifer where the water level is predicted to decline, because of the exercise of relevant underground water rights, by more than the bore trigger threshold at any time;</td><td>Section 7.1</td></tr>
<tr><td colspan="3">S376 (c) a description of the methods and techniques used to obtain the information and predictions under paragraph (b);</td><td>Section 3</td></tr>
<tr><td colspan="3">S376 (d) a summary of information about all water bores in the area shown on a map mentioned in paragraph (b)(iv), including the number of bores, and the location and authorised use or purpose of each bore;</td><td>Section 4.3.2</td></tr>
<tr><td rowspan="2">S376 (e) a program for—</td><td colspan="2">(i) conducting an annual review of the accuracy of each map prepared under paragraph (b)(iv) and (v); and</td><td>Section 7.2</td></tr>
<tr><td colspan="2">(ii) giving the chief executive a summary of the outcome of each review, including a statement of whether there has been a material change in the information or predictions used to prepare the maps;</td><td>Section 7.2</td></tr>
<tr><td>S376 (f) a water monitoring strategy;</td><td>S378 (1) A responsible entity’s water monitoring strategy must include the following for each immediately affected area and long-term affected area identified in its underground water impact report or final report—</td><td>(a) a strategy for monitoring—
(i) the quantity of water produced or taken from the area because of the exercise of relevant underground water rights; and
(ii) changes in the water level of, and the quality of water in, aquifers in the area because of the exercise of the rights;</td><td>Section 8</td></tr>
</table>

Chapter 3 *Water Act 2000* Provision	Sub-provision		Report Section
		(b) the rationale for the strategy;	
		(c) a timetable for implementing the strategy;	
		(d) a program for reporting to the commission about the implementation of the strategy.	
	S378 (2) The strategy for monitoring mentioned in subsection (1)(a) must include—	(a) the parameters to be measured; and	
		(b) the locations for taking the measurements; and	
		(c) the frequency of the measurements.	
	S378 (3) If the strategy is prepared for an underground water impact report, the strategy must also include a program for the responsible tenure holder or holders under the report to undertake a baseline assessment for each water bore that is—	(a) outside the area of a petroleum tenure; but	
		(b) within the area shown on the map prepared under section 376(b)(v).	
	S378 (4) If the strategy is prepared for a final report, the strategy must also include a statement about any matters under a previous strategy that have not yet been complied with.		
S376 (g) a spring impact management strategy;			Section 9
S376 (h) if the responsible entity is the commission—	(i) a proposed responsible tenure holder for each report obligation mentioned in the report; and		NA
	(ii) for each immediately affected area—the proposed responsible tenure holder or holders who must comply with any make good obligations for water bores within the immediately affected area;		NA
S376 (i) other information or matters prescribed under a regulation.			NA

2 Legislation

The key pieces of legislation relevant to the management of groundwater from petroleum activities conducted by OCC under PL 237 and PL 324 are the:

- Petroleum and Gas (Production and Safety) Act 2004
- Water Act 2000

The Queensland *Petroleum and Gas (Production and Safety) Act 2004* (P&G Act 2004) regulates coal seam gas activities and governs groundwater management in relation to coal seam gas development.

Under the P&G Act 2004, the petroleum tenure holder may take or interfere with groundwater to the extent that is necessary and unavoidable during the course of an activity authorised under the petroleum tenure (Section 185 Underground water rights). However, the P&G Act 2004 requires tenure holders to comply with the underground water obligations specified in the Chapter 3 of the *Water Act 2000*.

Chapter 3 of the Queensland *Water Act 2000* provides 'for the management of impacts on underground water caused by the exercise of underground water rights by petroleum tenure holders'. This objective is partly achieved by providing a regulatory framework that requires petroleum tenure holder to prepare UWIRs. Section 376 of the Queensland *Water Act 2000* details what an UWIR must include.

On 26 November 2014, the Water Reform and Other Legislation Amendment Bill 2014 was passed by Queensland Parliament. One of the aims of this water reform is better management of the impact of the resources sector on groundwater.

To help achieve the above aim, it is proposed that a more consistent framework be established for underground water rights for the resource sectors, and for the management of impacts on underground water due to their activities. Relevant key transitional arrangements from the commencement of the new arrangement include:

- All mining leases and mineral development licences will have a right to take "associated" water, regardless of whether they are in a groundwater regulated area or not. A general make good obligation will also apply from commencement for all areas.
- Existing mines that are lawfully dewatering (with or without a licence) will not need to complete a baseline assessment plan or an UWIR. (Licenced operations will, however, need to continue to comply with the conditions on the licence).
- An existing mine in a groundwater-unregulated area, which starts dewatering at some time after commencement, will not need to complete a baseline assessment plan or an UWIR.

3 Summary of Methods

Preparation of this UWIR has been based on the following methods:

- A review of publicly available and relevant regional baseline data, maps and reports as well as relevant reports on previous groundwater-related investigations at OCC.
- Site reconnaissance's to inspect key site hydrogeological features.
- Assessment and analysis of stratigraphic and structural data in the site geological resource model. Maps and cross-sections illustrating outcropping and sub-surface geology and the relationship to underground mining operations and activities have been prepared.
- Review and update of the previous site hydrogeological conceptual model.
- Assessment of available groundwater level and quality data from the site groundwater monitoring network, and groundwater production data using the following presentation techniques:
  - Hydrographs showing groundwater level trends and rainfall trends using the cumulative deviation from mean rainfall.
  - Piper diagrams showing different hydrochemical signatures of waters.
  - Tables of field water quality measurements and production data.

A numerical model was not developed for this UWIR for several reasons, including:

- A lack of available spatial (location and depth) and temporal site data.
- The likely low risk of impact to useable groundwater systems and their beneficial users.
- Cost for the likely limited additional understanding and hence, benefit.

4 Geological and Hydrogeological Setting

4.1 Regional Geology

The following description on the regional geology is based on Xstrata Coal (2012) and Esterle et al (2002).

4.1.1 Bowen Basin Development

The coal bearing central Queensland Bowen Basin (refer Figure 4) is a large sedimentary basin stretching from Collinsville in the north to Theodore in the south.

Coal seams found in this area range from early Permian to middle Triassic and all produce an assortment of coal types and products.

Evolution of the Bowen Basin took place over the pre-existing Palaeozoic sediments of the Drummond Basin and the Anakie Block. The basin was initiated through rifting along the continental margin during the early Permian, which created a number of fault bound basins that became filled with sediment and volcanics (Esterle et al. 2002).

Rifting ceased through the mid Permian and subsidence and marine dominated conditions took over. During the mid to late Permian the basin had filled with sediments that resulted in the creation of the Moranbah Coal Measures to the north and the German Creek Formation to the south. The deposition of the late Permian coal measures led to foreland loading that controlled subsidence until the resumption of eastern subduction during the middle Triassic. The eastern subduction compressed sediments and closed the basin. Extensive deformation was caused during the mid Triassic compressional phase, which is responsible for the formation of the Jellinbah and Duaringa Fault Zones as well as significant structure along the Comet Ridge (Esterle et al 2002).

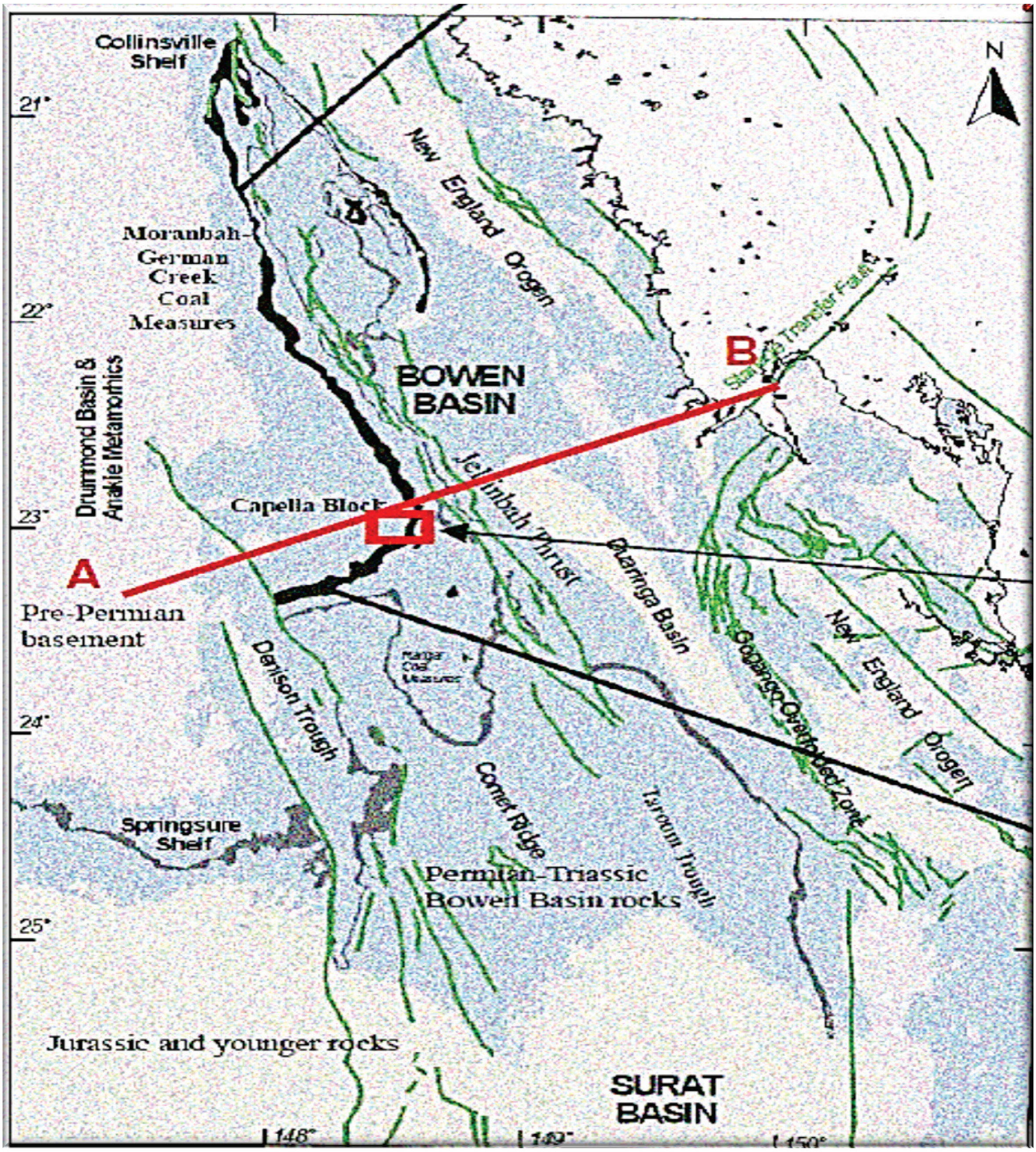

Figure 4 Bowen Basin Regional Geology

4.1.2 Stratigraphy and Structure

The regional stratigraphy is summarised in Table 2 and is shown on Figure 5 (surface geology) and Figure 6 (sub-surface/consolidated geology).

Table 2 Regional Stratigraphy (after Xstrata Coal, 2012)

Age	Group	Formation	Description	Seams	Mines
Quaternary			Unconsolidated sand and clay, with basal gravel and pebbles		
Tertiary			Tertiary deposits include basalt, sediments of the Duaringa Formation, and high-level Tertiary alluvium		
Triassic		Rewan Formation	Sandstones and siltstones, in places red or green		
Permian	Blackwater Group	Rangal Coal Measures	Grey siltstones, mainly fine grained sandstones, mudstones and coal	Roper 1 Roper 2 Middlemount Tralee 1 Tralee 2 Pisces 1 Pisces 2	• Foxleigh • Lake Lindsay • Oak Park • German Creek East
		Burngrove Formation	Siltstones, claystones, sandstones, and coal; often with tuffaceous banding	Burngrove A Burngrove B Burngrove C	
		Fair Hill Formation	Lithic and feldspathic labile sandstone with minor siltstone, mudstone, and sub-economic coal seams	Hercules Canis Lepus Fair Hill	
	Unconformity				
	Back Creek Group	MacMillan Formation	Sandstone, siltstone, shale, mudstone	None	
		German Creek Formation	Sandstone, siltstone, mudstone, coal	Pleiades Aquila Tieri Corvus 1 Corvus 2 German Creek German Creek Lower	• German Creek Colliery (Southern and Central Collieries, Grasstree Mine) • Oaky Creek
		Ingelara Formation			
		Freitag Formation			

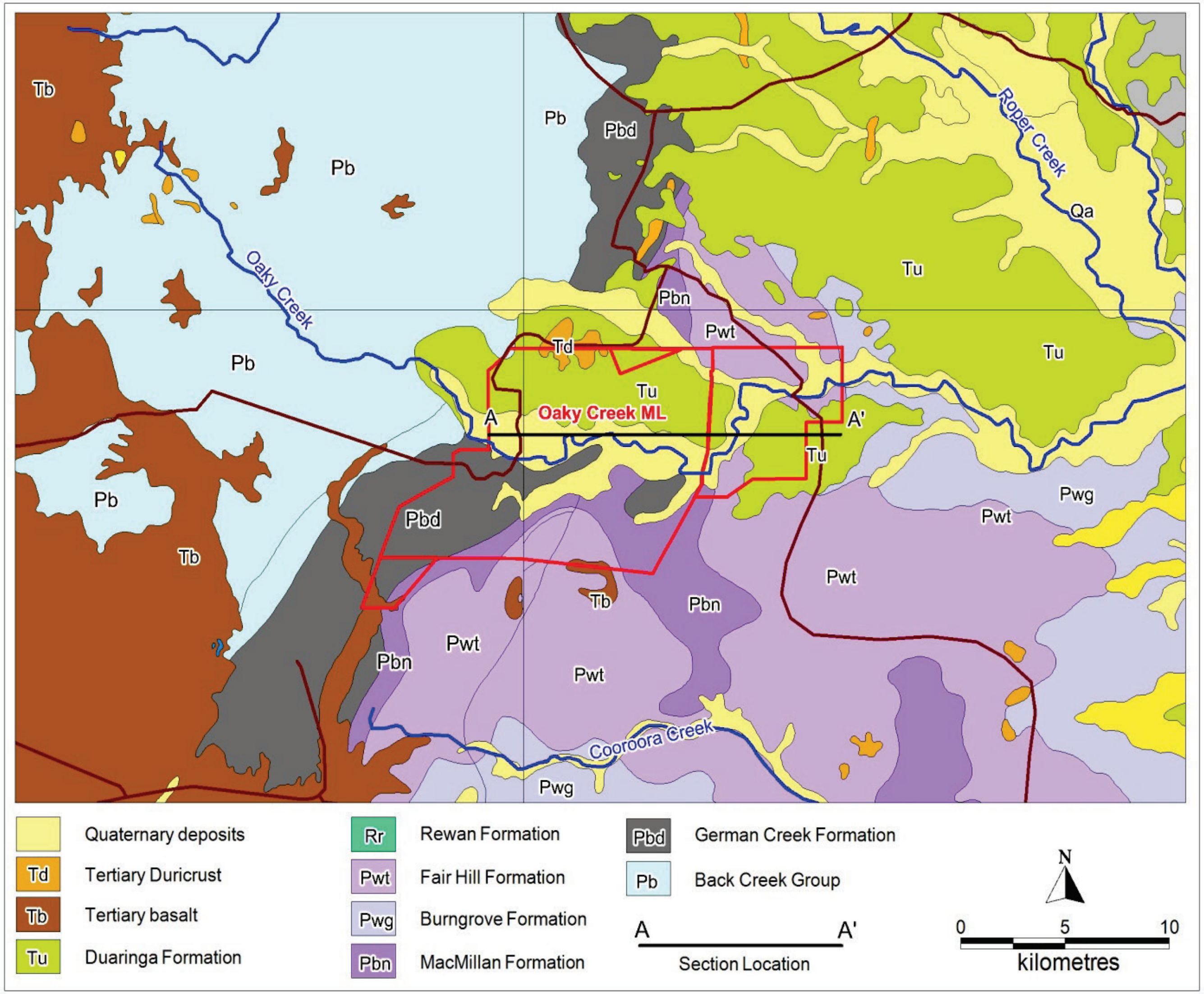

Figure 5 Surface Geology

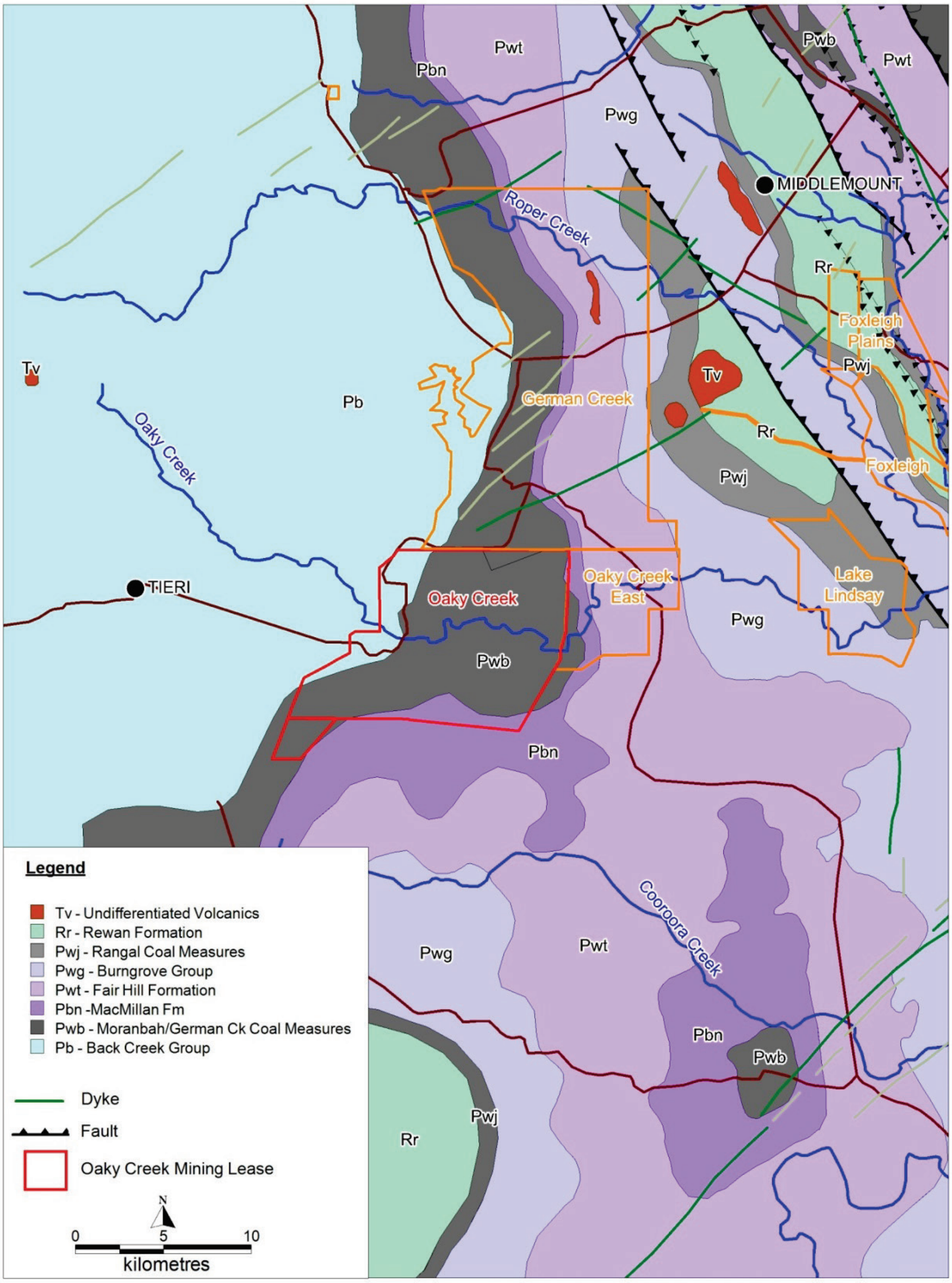

Figure 6 Sub-surface/consolidated Geology

There are four major Permian stratigraphic units which occur at and within the vicinity of OCC. These are (from oldest to youngest), the:

- Freitag Formation;
- Ingelara Formation;
- German Creek Formation, and

- MacMilllan Formation

Unconformably overlying the MacMillan Formation, are the late Permian Fairhill and Burngrove Formations.

A number of major fault structures occur in the area, including the Grasstree Fault Zone (in the German Creek Mine area), and the Jellinbah and Yarrabee faults to the west and east of the Foxleigh Mine (refer Figure 6). These faults disrupt the stratigraphic sequence.

4.2 Site Geology

The major stratigraphic units at OCC are of Permian age and include (from oldest to youngest):

- German Creek Formation
- MacMillan Formation
- Fairhill Formation

Figure 7 shows a cross-section of the major stratigraphic units at OCC (the location of the section is shown on Figure 5).

The German Creek Formation contains eight main coal seams including the Aquila and German Creek coal seams which are the economic coal seams mined at OCC. The German Creek Coal Seam is the target of the underground mining operations. The German Creek Formation is underlain by the Ingelara Formation (Permian age) which comprises carbonaceous siltstone with pyritic coaly laminae and large interbedded sandstone and siltstone units (Xstrata Coal, 2011).

Dome and basin structures are prominent across the German Creek Formation. Coal seams often thin across the top of domes, thicken through basins and dip in a south-easterly direction. Jointing is common and can range from tightly closed joints up to 10 mm (Xstrata Coal, 2011).

The presence of dykes and sills at OCC is limited. The Maywin North Dyke is exposed in the German Creek and Aquila open cut pits and an altered dyke was intersected in the Oaky North workings (EGIS, 2002). A north-east to south-west dyke has also been intersected in the Oaky East area (Xstrata Coal, 2011).

A thin veneer of Tertiary alluvial sediments (Duaringa Formation) comprising claystone, siltstone and sandstone overlies the Permian sediments (in the northern half of the site) which are in turn overlain by Quaternary alluvial sediments. Quaternary alluvial sediments are also present in the southern half of the site and overlie either the German Creek or MacMillan formation. The Quaternary sediments are confined to the present day drainage and paleochannel systems (EGIS, 2002).

Xstrata Coal (2011) reported that the German Creek Seam thickness varies from >5m to less than 0.5m across the lease (Figure 7). Seam thinning has occurred across an extensive area as shown by available data, indicating that there has been a major seaward shift in the strandline at a point during the deposition. There are a number of roof and floor splits that are well correlated throughout the subcrop area of the German Creek Seam as they are the main contributors to the seam thinning. However, as the seam moves away from the sub-crop in an east to southeast direction the splits cease and a relatively constant thickness is maintained.

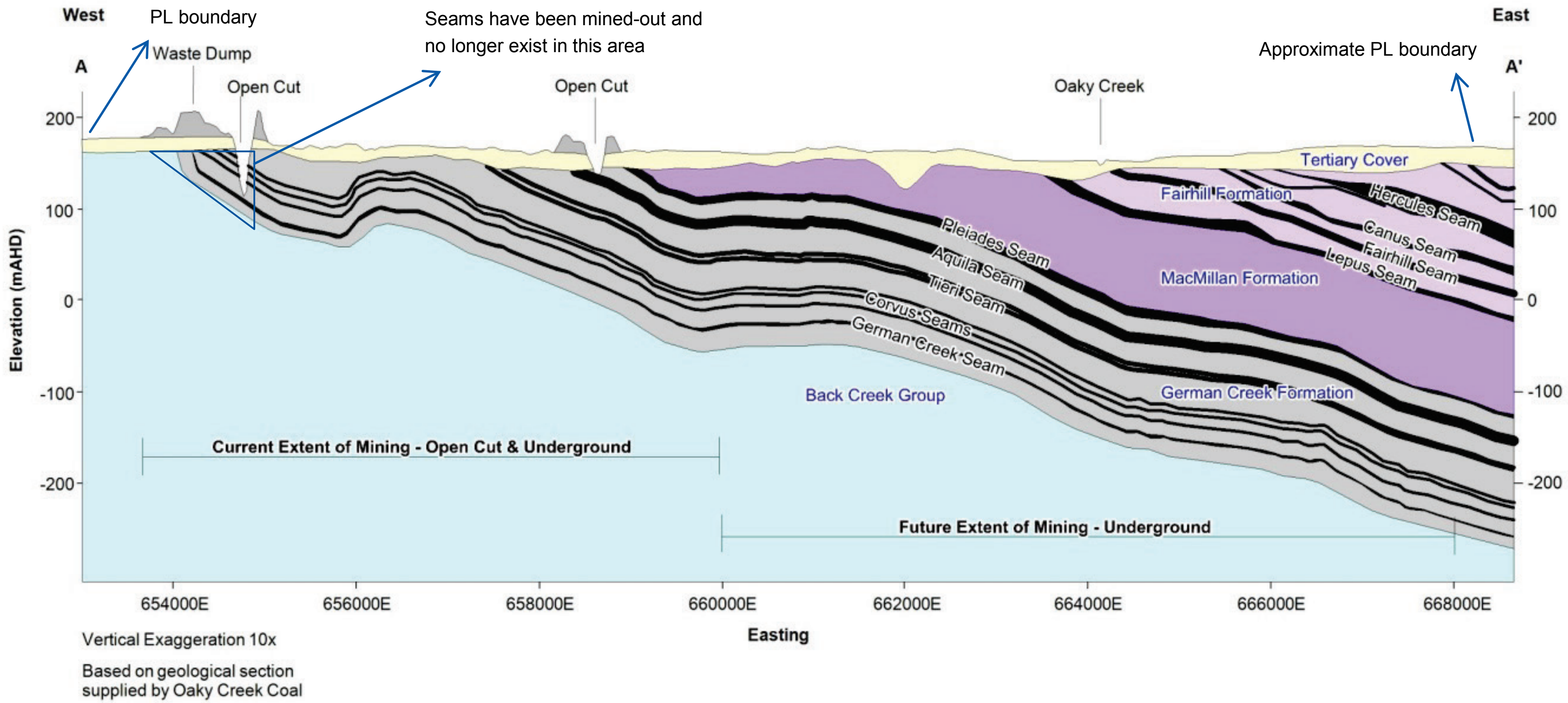

Figure 7 Major Stratigraphic Units at Oaky Creek Coal

4.3 Regional Hydrogeology

The following description on the regional hydrogeology is based on Xstrata Coal (2012) and Worley Parsons (2010).

4.3.1 Groundwater Systems

Regionally, groundwater occurs within the following Bowen Basin geological units:

- Quaternary alluvium
- Tertiary sediments
- Permian coal measures

The Triassic Rewan Group consists mostly of low porosity and permeability mudstone, siltstone and lithic sandstone of fluvial, lacustrine and aeolian origin and is largely considered an aquitard, with the exception of some sandier basal lenses.

Worley Parsons (2010) reported that all of the Bowen Basin water-bearing geological units including, and below, the Rewan Group basal sands behave as confined water-bearing systems that contain water of poor quality in contrast to the hydrogeological system of the Great Artesian Basin (GAB).

4.3.2 Groundwater Uses

BlueSphere (2014) conducted a review of regional groundwater uses based on previous reports and assessments as well as undertook a search in late 2013 of nearby registered groundwater bores. A summary of this review is provided below. Results of the nearby groundwater bore search are shown on Figure 8.

Peter Hollingsworth & Associates (1978) reported that due to the poor quality of groundwater, there was very little use of groundwater and its potential beneficial uses were limited.

EGIS (2002) undertook a groundwater database search that extended approximately 25 km from the centre of the Oaky Creek Mine. Results of the EGIS (2002) search are summarised below.

- 57 registered bores were reported in the search area.
- The depth of the bores ranged from 9 m to 218 m deep.
- The use of the bores primarily included stock, domestic and investigation.
- The closest bore to the mine Lease was approximately 5 km away south of Lease ML 2004, which was more than 7.5 km from the closest mine workings.
- The majority of the bores are located to the south-west with a further four bores located to the west and north-west (up hydraulic gradient – refer Sections 6.1.4 and 6.2.2) of the OCC operation in Tertiary basalts. The closest bore in the Tertiary basalt is Bore 132764, which is around 5 km south of the south-western corner of PL237.
- Two bores (103243 and 103242) exist down hydraulic gradient at 9.5 km and 11.5 km respectively to the east of MDL 163 (now ML 70327), which is over 15 km to the east of the present extent of mine workings.
- The groundwater quality in bores screened in the Tertiary basalts was noted to generally be of good quality (and often suitable for potable use) with a typical groundwater salinity as total dissolved solids (TDS) of 1 000 mg/L. It is highlighted that the OCC operation has had no interaction with the Tertiary basalts. Further discussion on the hydraulic connectivity between the site aquifers and the basalts is provided in Section 4.4.5.
- The groundwater salinity as TDS in bores that intersected Permian strata (including coal measures) was noted to generally be brackish or saline, and where quantified, reported to be in the order of 10 000 mg/ L.

The database search undertaken as part of BlueSphere (2014) review showed a further bore (136628) down hydraulic gradient and closer to ML 70327 than bore 103243 at around 4 km. It is reported as targeting the Blackwater Group, which includes the Fairhill Formation.

It is further understood, based on a more recent study by AGE (2015), that:

- Only bores RN 89346 and RN 38324 (located approximately 5 km to the south of the mine site) are owned by agricultural landholders.
- The majority of remaining bores are either owned by mines, or state government, including:
  - Two very old shallow wells on German Creek and within German Creek Mine (RN 67067 and RN 67068) that were dug for the original Grass Tree Property and have since been abandoned.
  - Two shallow alluvial monitoring bores (RN 132465 and RN 132466) installed along Oaky Creek within the Oaky Creek Mine site for OCC monitoring purposes.
  - Bore RN 13001001 located approximately 1.3 km west of the mine site is a government monitoring bore.
  - Bore RN 136628, located approximately 4.7 km to the east of the mine site for which the ownership status is unknown.
  - 24 monitoring bores installed at the Gregory Crinum Mine.
- Stock and domestic bores have not required a licence in the past and the database may not contain all of the bores in the region. However, the presence of significant additional private water bores in the region was considered unlikely given the dominance of mining in the region and the generally saline nature of the groundwater.

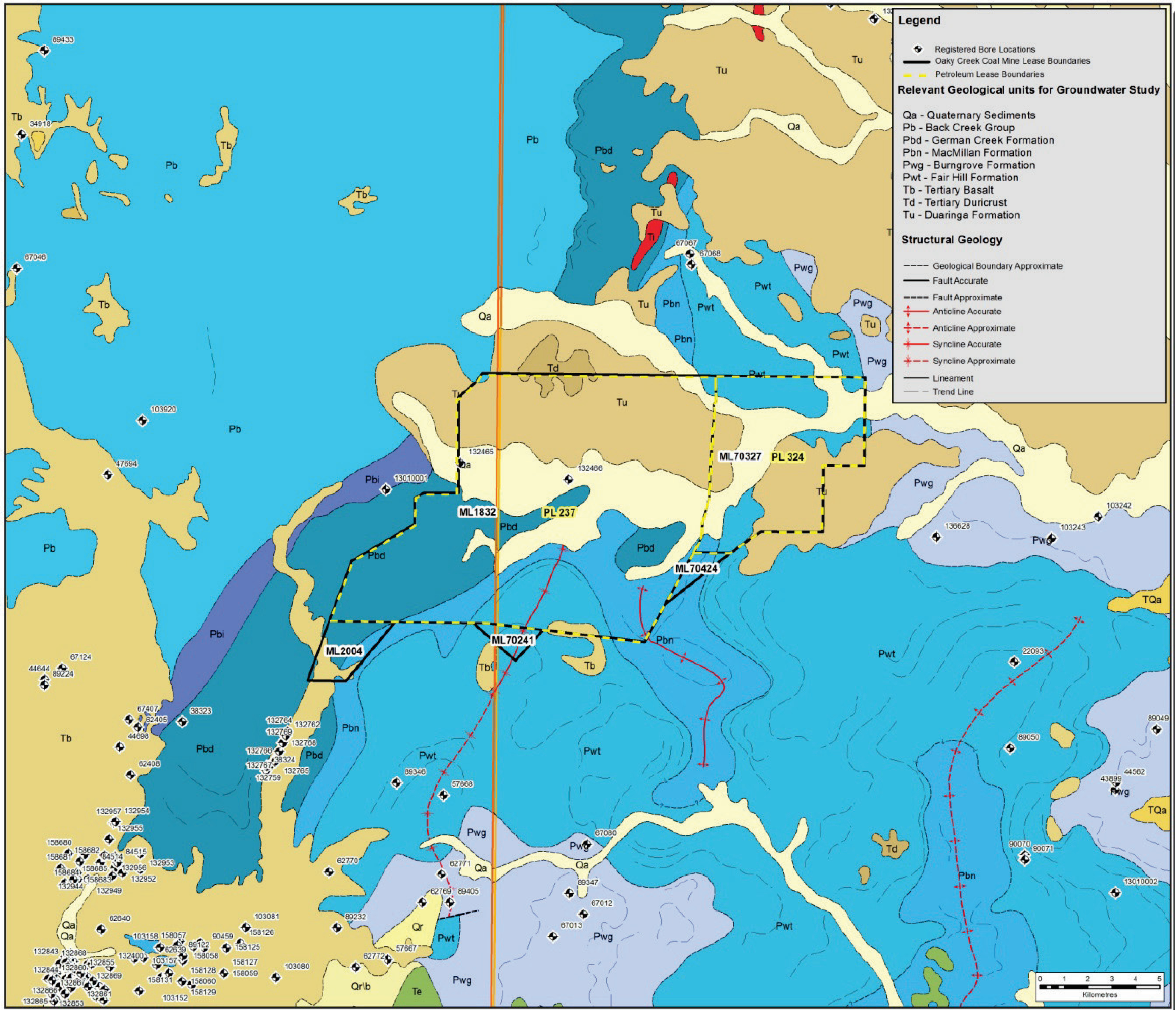

Figure 8 Regional Groundwater Uses

4.4 Site Hydrogeology

4.4.1 Updated Site Hydrogeological Conceptual Model

An updated site hydrogeological conceptual model based on a recent review of available geological and hydrogeological information is shown on Figure 9.

Locally, groundwater occurs within present-day drainage deposits (Quaternary Alluvium), Permian Coal Measures and possibly the Tertiary sediments (shown as “Alluvial Cover” on Figure 9), where these sediments are present in the northern half of the site. A brief overview of the groundwater systems is presented in the following sub-sections. Further discussion on the groundwater systems including their physical and chemical characteristics is provided in Section 6.

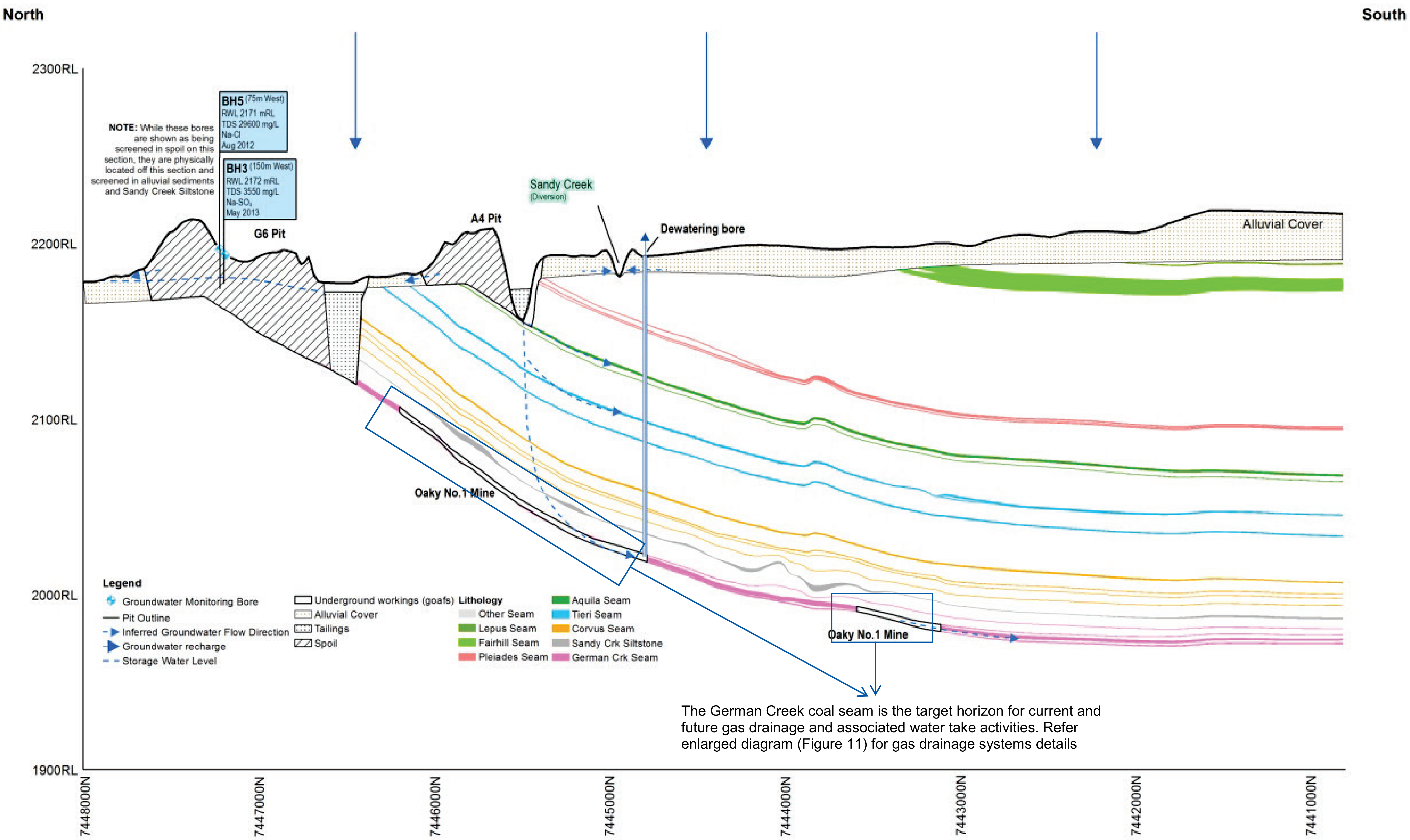

Figure 9 Updated Site Hydrogeological Model

4.4.2 Quaternary Alluvium

Groundwater in the Quaternary Alluvium water-bearing unit is found within alluvial deposits associated with channel deposits, floodplain deposits, and tributaries of Oaky Creek. The extent of these deposits is shown on Figure 5.

EGIS (2002) suggests that as the Quaternary alluvial sediments are associated with present-day drainage, groundwater occurrences in these sediments would be localised and discontinuous, typically only recharged by ephemeral creek flow events (short duration, only several days each year).

4.4.3 Tertiary Sediments

Groundwater in the Tertiary sediments occurs within the Duaringa Formation, which comprises mudstone, sandstone, conglomerate, siltstone, oil shale, and lignite. The extent of the Tertiary sediments is shown on Figure 5 and the thickness on Figure 7 and Figure 9.

There are no known bores screened in the Tertiary sediments based on the results of a search of registered groundwater bores (refer Section 4.3.2) and therefore no available groundwater yield information for this formation. Further, no documentation has been sighted on reported observations of substantial flows of water from these sediments to the pits, which is consistent with observations made during a site visit as part of the BlueSphere (2014) review.

On the basis of the above, groundwater yields and volumes would not be expected to be appreciable. Combined with the fact that these sediments are generally less than 20 m thick and relatively localised (i.e. mostly occur on-site), these sediments are not likely to constitute a significant exploitable aquifer system, although this assessment should be confirmed during the planned groundwater investigations (refer Section 7.1.3). It is possible that these sediments are only saturated following extreme 'wet' periods and flood.

4.4.4 Permian Coal Measures

Groundwater typically occurs preferentially within the coal seams including the German Creek coal seam which is the target horizon for the site gas drainage and associated water take system as the interburden is generally of relatively lower permeability (JBT Consulting, 2012). The location of gas drainage holes is shown on Figure 12.

JBT Consulting (2012) identified three main hydrostratigraphic zones within the Permian coal measures as follows:

- Zone 1 – the upper weathered overburden which, based on drilling results, is assumed to act as an aquitard.
- Zone 2 – the interburden sandstone and siltstone which has a permeability an order of magnitude lower than the coal seams and is estimated to be up to 350 m thick.
- Zone 3 – the coal seams with a combined thickness of up to 45 m.

The Permian coal measures have been mined-out near the western boundary of OCCs mining and petroleum lease tenements as illustrated on the stratigraphic section on Figure 7 (also refer to Figure 5 for the location of the section relative to the Mining Lease tenements).

4.4.5 Aquifer Interconnectivity

Groundwater in the Permian coal measures is not expected to be hydraulically connected to groundwater in the overlying Tertiary sediments or Quaternary alluvium. This is because there are multiple intervening interburden layers of relatively lower permeability (as reported by JBT Consulting, 2012) with a combined thickness that is greater than the thicknesses of the coal seams combined and the Tertiary and Quaternary sequences.

Groundwater found in the Tertiary basalts located to the south and west of the mine would not be hydraulically connected to the site coal measures targeted by the OCC operations. These basalts typically occur further west of where the site coal measures outcrop (i.e. are not present) and/or likely at substantially shallower depths such that there would be significant thickness of intervening low permeability material. Further, groundwater in the basalts is likely to be controlled by fractures, which are typically localised and not well developed (i.e. low yielding which is consistent with stock and domestic types of usage as noted in Section 4.3.2), further limiting any potential for hydraulic connection with other water-bearing systems.

Underground extraction of coal using longwall mining methods such as those used to extract coal from the German Creek coal seam at OCC results in subsidence of overlying strata and can lead to fracturing and development of preferential pathways. Bai and Kendorski (1995) developed a model of subsidence cracking zones (refer Figure 10), which has been applied to other longwall mining operations in the Bowen Basin. Under this model, subsidence cracking can be characterised by the following zones:

- Constrained zone, which is unaffected by subsurface subsidence cracking.
- Dilated (or discontinuous cracking) zone where there are no changes in vertical permeability, but potential for changes in horizontal permeability and storativity.
- Fractured (or continuous cracking) zone where changes in vertical and horizontal permeability are possible.

The heights of each of the zones are related to the thickness of the extracted coal. The thickness of the mined German Creek at OCC is up to 4.5 m and therefore the expected maximum height of the fractured zone above the longwall panels would be around 135 m (i.e. 30 times the extracted coal thickness) based on the Bai and Kendorski (1995) model.

The depth of cover above the longwall panels that mine the German Creek coal seam increases in a south-easterly direction, consistent with dip. Hence, it is possible that fracturing could extend up into the Tertiary sediments where longwall panels are present in the most western parts of the site and the depth of cover is relatively thin (refer Figure 3 and Figure 7). The Tertiary sediments in these areas are not likely to contain appreciable volumes of groundwater (refer Section 4.4.3) or constitute a significant exploitable aquifer system. Hence, the potential impact from the risk of fracturing is not considered significant nor relevant to petroleum lease activities, the subject of this report, as any potential impact would be from a direct result of mining lease activities.

Sufficient depth of cover exists above longwall panels where these occur beneath creek systems such that fracturing in the base of the creek systems is not considered likely.

Where tension cracks have developed to surface, these are typically remediated by ripping and compaction to help prevent infiltration of surface waters.

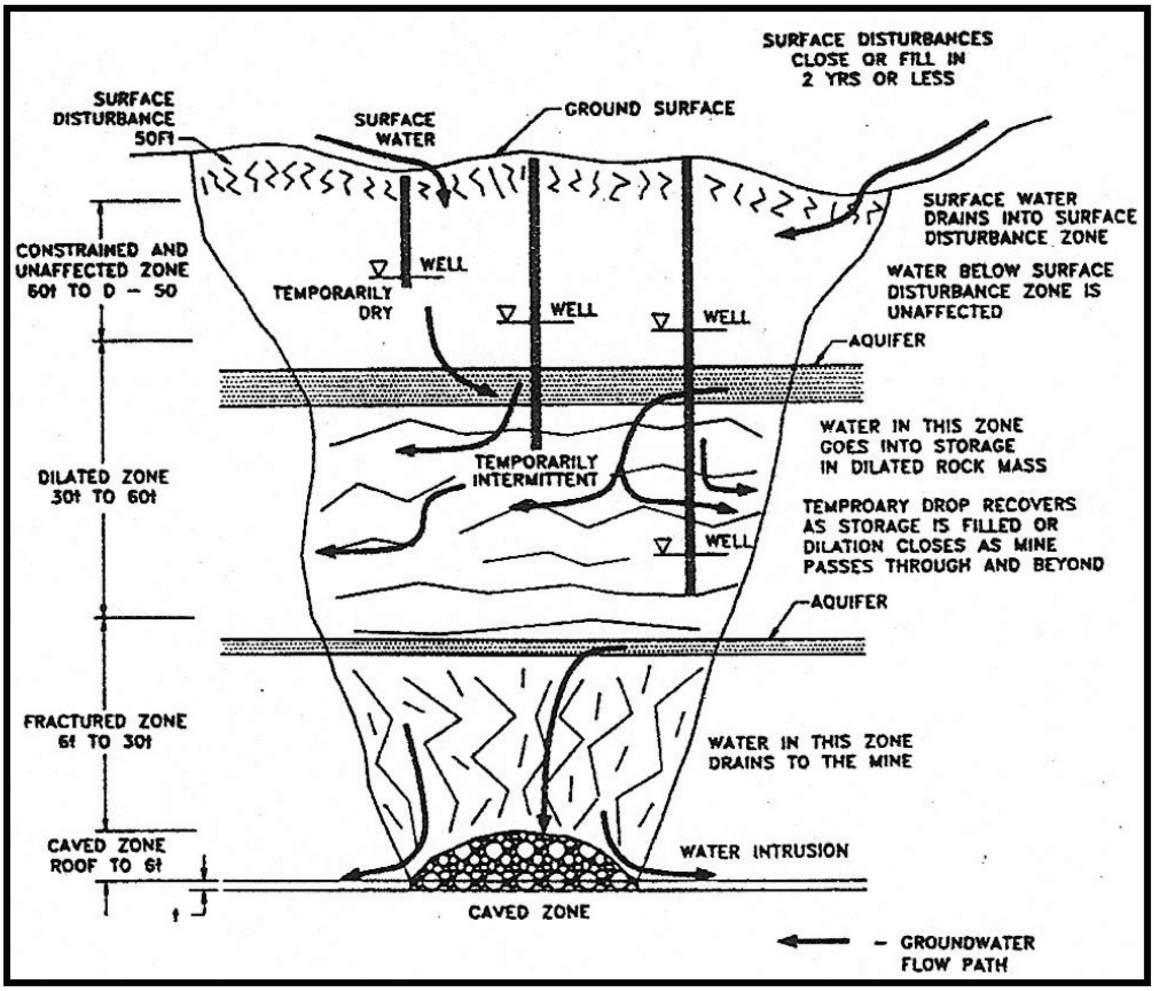

Figure 10 Subsidence cracking model developed by Bai and Kendorski (1995)

4.4.6 Summary

The site groundwater systems are not considered significant and useable water resources due to either being localised, low yielding, having poor quality groundwater or a combination of these. The Permian coal measures targeted by the OCC operations are not considered to be hydraulically connected to overlying and surrounding groundwater systems that are typically exploited for small volumes of water required for stock and domestic and/or agricultural purposes in the area.

5 Part A – Underground Water Extractions

5.1 General

Gas is removed primarily from the German Creek coal seam via OCCs gas drainage methods to ensure explosive atmospheres do not occur and therefore enable a safe underground mining environment. The extracted gas is then flared or used to generate electricity. The removal of gas prior to longwall mining is a mine safety requirement.

OCC employs three gas drainage methods; surface to inseam (SIS), underground inseam (UIS) and goaf wells (surface to seam level wells targeting the caved in goaf zone where the coal seam was before coal extraction).

Of these gas drainage methods only the SIS system, consisting of the vertical production well (VPW) (controlled pressure well or CPW until developed) and end-of-hole (EOH) bores, and underground inseam boreholes remove gas and any moisture/water present (refer Figure 11). Slant (SIS), VPW/CPW and EOH wells are sealed and grouted from the surface to the coal seam which prevents water infiltration and removal from outside the target area.

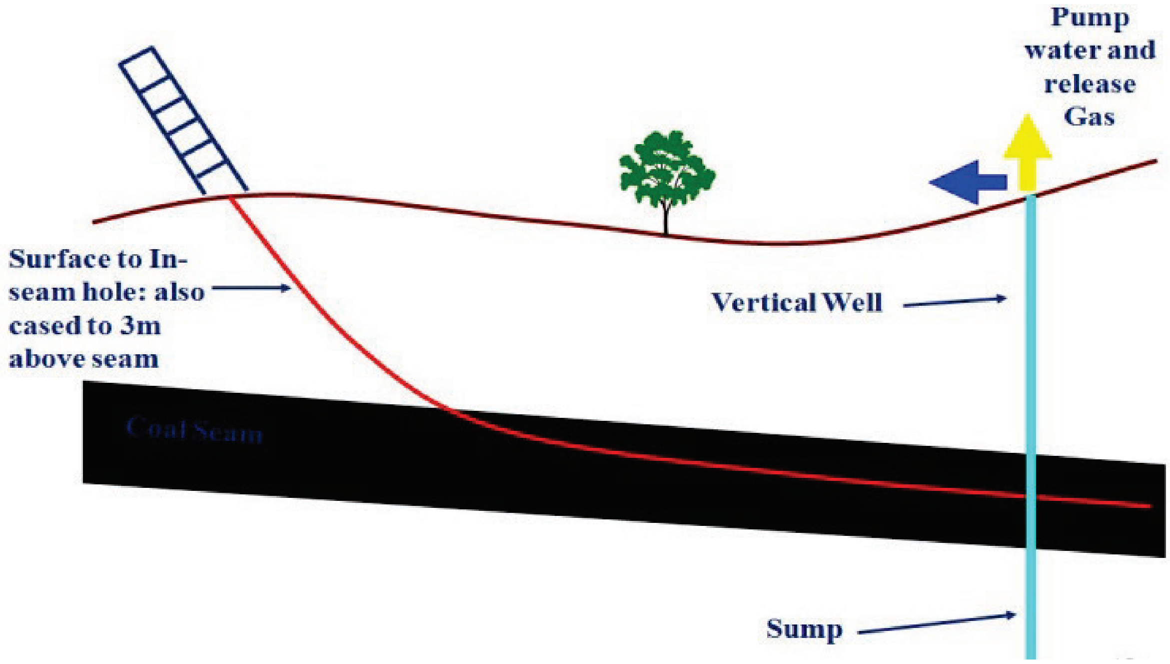

Figure 11 SIS Gas Drainage System Diagram

The majority of historic VPWs are located on PL237. Further SIS gas drainage systems are proposed as mining activities expand into PL324. The locations of VPWs are shown on Figure 12.

The installation of an extensive network of gas abatement infrastructure including gas capture pipelines and flare plants (as part of the site's work to reduce emissions), has resulted in a significant increase in the number of VPWs installed since 2011/12.

Produced water has historically been measured in a number of ways including calculations involving pump capacity and hours of operation, flow meters and automated monitoring via submersible data loggers.

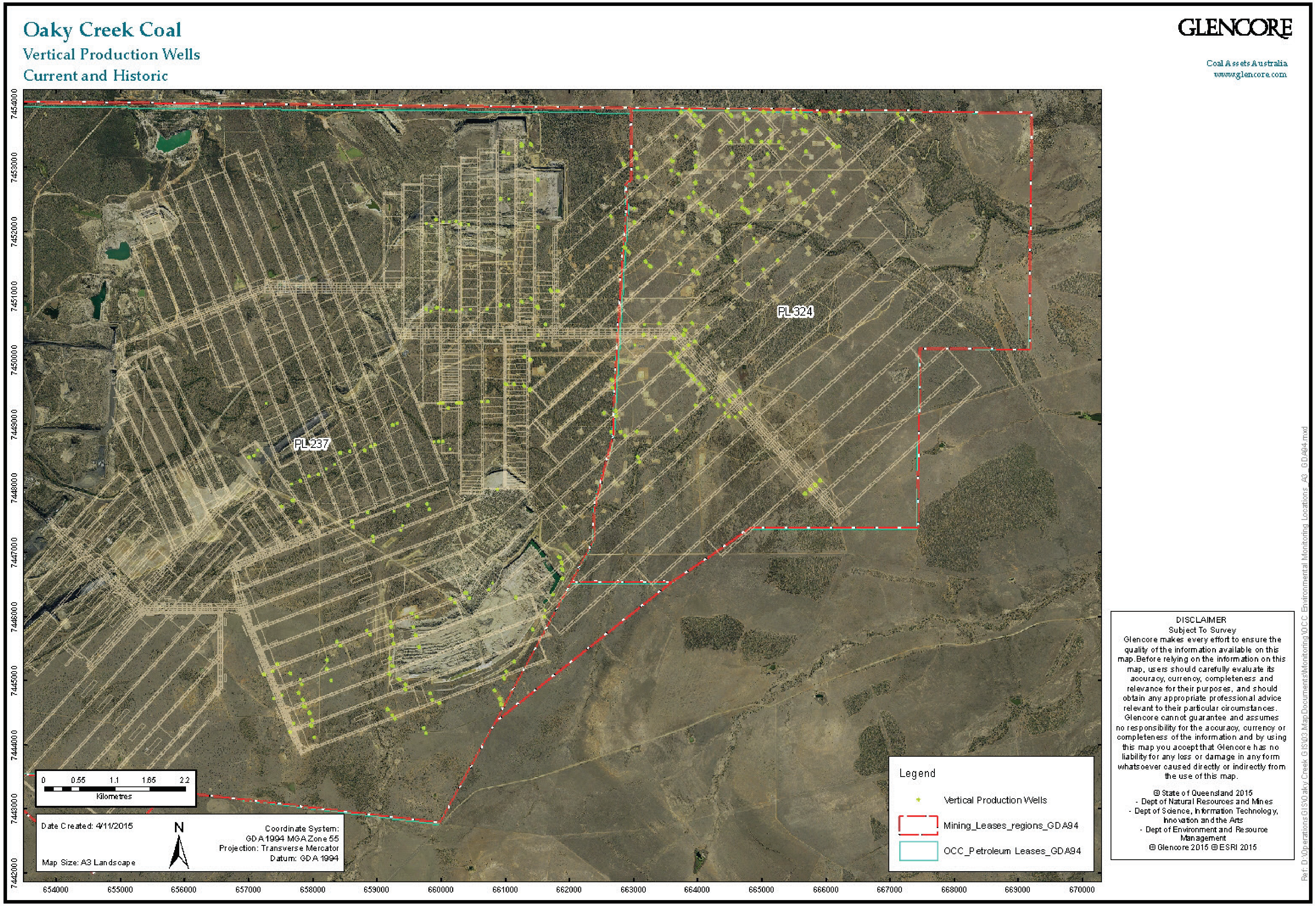

Figure 12 Gas Drainage Hole Location Plan

5.2 Previous Underground Water Extractions

For the 2014 UWIR Annual Update, BlueSphere (2014a) estimated the volume of groundwater pumped as part of OCCs gas drainage program for the period 28 February 2013 to 27 February 2014, based on pumping data provided by OCC. The total volume of groundwater pumped during this period was estimated to be 96.8 megalitres (ML) from 70 VPWs on an annual averaged basis. Monthly breakdowns of these pumped volumes of groundwater are provided in Table 3.

Table 3 Groundwater Pumping (28/2/13 to 31/12/14)

Month	Estimated Volume of Pumped Groundwater (ML)	
	2013	2014
January		7.1
February	0.2	5.8
March	6.2	6.5
April	5.6	6.3
May	6.9	7.2
June	6.8	8.6
July	10.0	7.9
August	9.9	7.0
September	9.5	6.1
October	10.0	3.4
November	9.1	4.4
December	9.1	4.7

The estimated volume of water pumped the previous year as reported in Xstrata Coal (2012) was 11.5 ML from 77 VPWs and 37.34 ML for the 10 year period 2002 to 2012 from 168 VPWs. The reason for the increase in produced water volumes are unclear, but may be partly due to different estimation methods. The current estimation method involves using pump speed and pump run-time information, and a pump efficiency of 80 percent, which OCC considers to be more accurate than the previous estimation method. The pump specification is provided in Appendix A.

OCC has also estimated the water production from its gas drainage program for the period 1 March to 31 December 2014. The total volume of groundwater pumped during this period was estimated to be 62.1 ML. Monthly breakdowns of these pumped volumes of groundwater are also provided in Table 3.

OCC has advised that groundwater extracted for gas drainage purposes represents less than 1 percent of the contributions to the mine water management system.

5.3 Future Underground Water Extractions

OCC has estimated the quantity of water to be produced from 2015 to 2018. Future water extraction will occur from the German Creek coal seams.

Table 4 summaries the underground water extraction predictions by OCC for the period 2015 to 2018 as part of OCCs planned gas drainage program. These predictions are based on the following empirical method:

- Data analyses involving:
    - Consolidating the existing water flow information from the different sources.

  - Identifying different gas drainage hole types representative of current and future gas drainage program campaigns.
  - Identifying a representative water flow for each of the different gas drainage hole types.
- Categorising future gas drainage holes into the different hole types.
- Developing a flow profile on the basis of the identified SIS drilling schedule and flow profiles for each of the individual gas drainage holes.

Table 4 Groundwater Pumping (2015 to 2018 inclusive)

Year	Predicted Volume of Pumped Groundwater (ML)
2015	108.9
2016	82.9
2017	43.4
2018	31.7
TOTAL	266.9

6 Part B – Aquifer Information and Underground Water Flow

6.1 Shallow Groundwater Systems

6.1.1 Monitoring Network

A relatively shallow network of groundwater monitoring sites has been established on the OCC site to facilitate the collection of physical and chemical information for the shallow groundwater systems. This monitoring program is required by the site's Environmental Authority for the Mining Leases. The monitoring sites are shown on Figure 13 (after SRK, 2014). Groundwater monitoring site details are summarised in Table 5.

Bores screened in siltstone are interpreted as targeting the Sandy Creek Siltstone unit which overlies the German Creek coal seam. BH12 was established as a control bore (hydraulically) up-gradient of the site to assist assessments of potential impacts on groundwater from OCCs operations. BH13 and BH14 were installed in the vicinity of tailings storage facilities to determine potential impacts on groundwater from the tailings GHD (2012a).

Table 5 Summary of Groundwater Monitoring Site Details (after GHD, 2012a and Xstrata Coal, 2012)

Bore ID	Purpose	Date Drilled	Total Depth (m)	Easting	Northing	Measuring Point RL (mAHD)	Interpreted Lithology
BH2	Determine groundwater impacts from surface TSF	14/11/02	19.2	651273	7447642	195.88	Siltstone
BH3	Determine groundwater impacts from G6 pollution pond and G6 tailings disposal	18/11/02	17.9	652891	7447039	183.06	Residual Soil
BH4		17/11/02	16.7	652750	7447070	184.46	Residual Soil
BH5		16/11/02	24.0	652971	7447100	184.45	Siltstone
BH6	Determine groundwater impacts from primary settlement pond	14/11/02	4.6	653163	7448376	178.42	Alluvium
BH7	Assess potential for discharge of groundwater to Oaky Creek and potential impact on surface water	14/11/02	5.8	653406	7448538	174.12	Alluvium
BH8	Determine groundwater impacts from	15/11/02	31.4	653762	7449739	179.07	Siltstone
BH9		19/11/02	29.0	653832	7449949	190.26	Siltstone

Bore ID	Purpose	Date Drilled	Total Depth (m)	Easting	Northing	Measuring Point RL (mAHD)	Interpreted Lithology
BH10	decommissioned waste dump and assess local groundwater flow direction	18/11/02	29.5	653908	7449847	190.71	Siltstone
BH11	Monitor down hydraulic gradient effects of mine operations	2008	13.8	656799	7449590	169.75	Siltstone
BH12	Background bore	2008	30	652154	7449909	181.61	Siltstone
BH13	Assess the G5 pollution pond and tailing disposal impact on the ground water	2008	17	652114	7445917	184.47	Siltstone
BH14		2008	17	650840	7445434	N/A	N/A

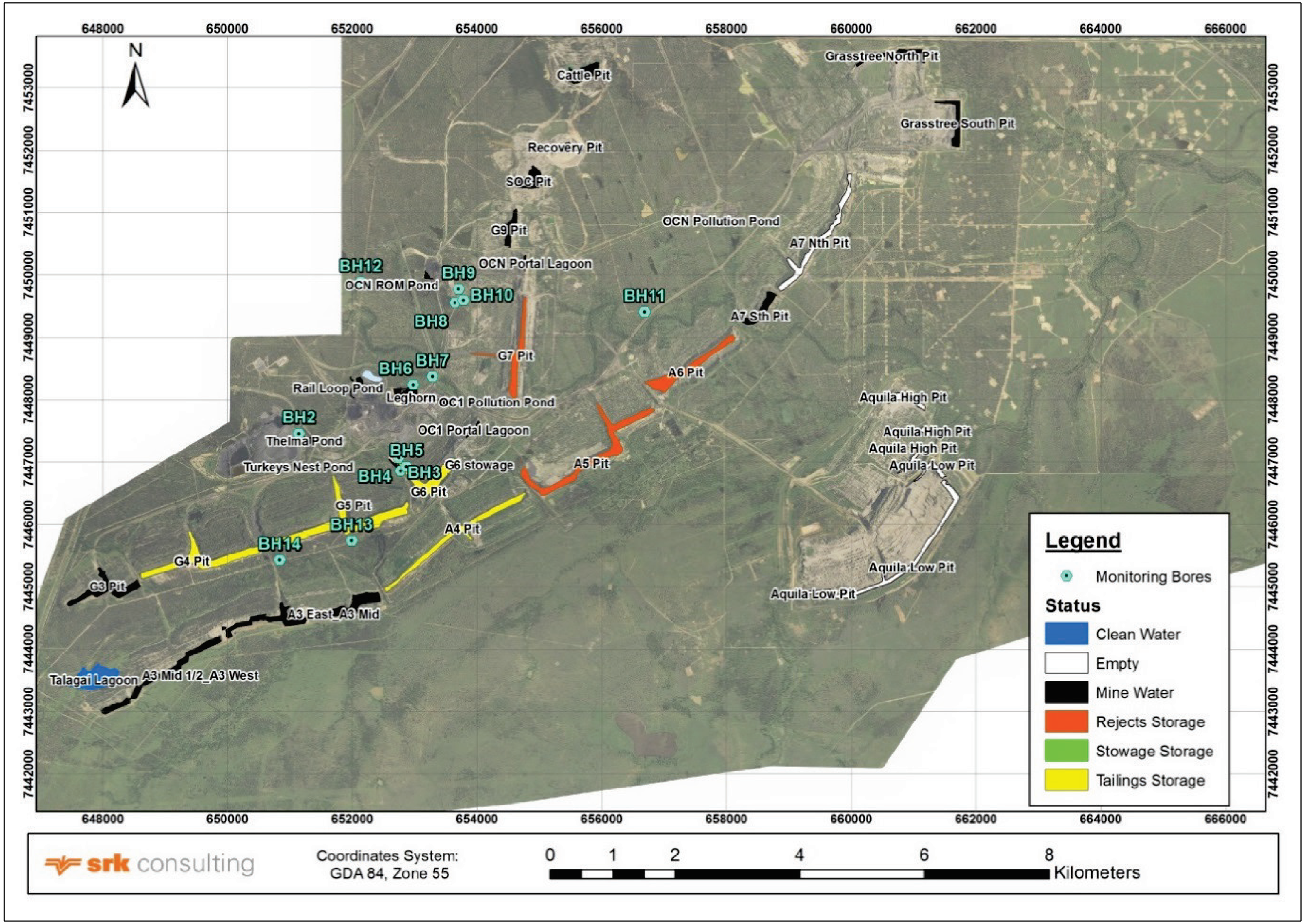

Figure 13 Groundwater Monitoring Network Plan

6.1.2 Groundwater Levels

Groundwater level data for the shallow groundwater monitoring network is shown on Figure 14 and provided in Appendix B.

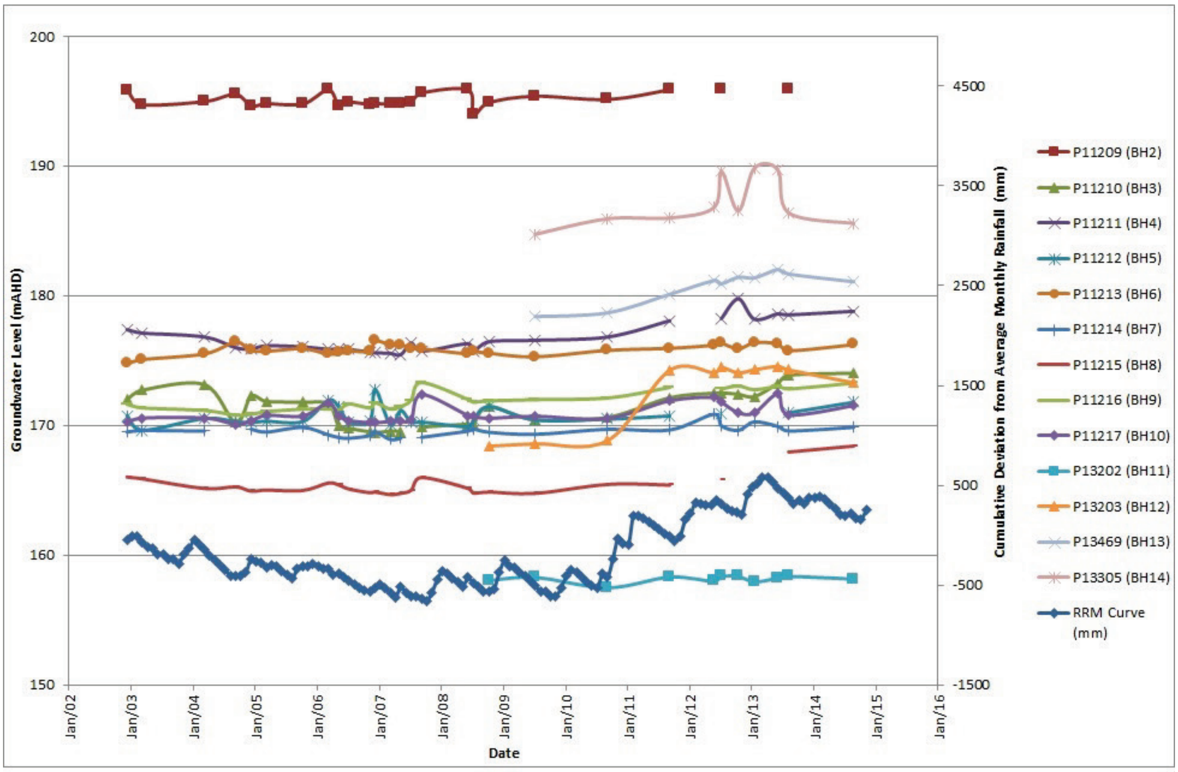

Figure 14 Shallow Groundwater Monitoring Bore Hydrographs

Bore hydrographs show relatively stable water levels until at least mid-2009. Hydrographs for BH3, BH4, BH13 and BH14 show an overall upward trend in groundwater elevations from around mid-2009. Hydrographs for BH8 and BH12 show an overall upward trend from late 2010.

OCC compares groundwater level data with the rainfall residual mass (RRM) curve (refer Figure 14) to assess the relationship between groundwater levels and rainfall.

Xstrata (2012) reported an overall reducing RRM curve from early 2001 to mid-2007, followed by an overall rising RRM curve from mid-2007 to 2013, although the rate of rise is relatively greater from mid-2009. The groundwater level trends typically show a similar pattern to the trend observed for the RRM curve. A number of bores recorded water level rises following 2010/2011 wet season rainfall. On the basis of this data, Xstrata (2012) concluded that shallow water levels are dominated by rainfall recharge and water levels in the creeks at site.

The shallow groundwater system (in areas where monitoring occurs) is not hydraulically connected to the underlying Permian strata as there is no evidence of declining groundwater level trends to suggest influences from dewatering associated with the site gas drainage program. However, it is possible that some observed groundwater level changes may be partly influenced by other site activities, such as seepage from pits and ponds, particularly where monitoring bores are located in close proximity to such infrastructure.

Xstrata (2012) reported drawdowns of 20m from 1978 to 2002. These comparisons appear to have been made using interpreted water level information from exploration holes and different datasets (the 1978 water level interpretations were based on 470 exploration holes while the 2002 interpretations were based on over 800 holes). Interpretations of water levels from exploration holes can potentially be erroneous as more than one water-bearing horizon may be present. Further, these drawdowns were considered to be due to dewatering activities associated with the mine workings and not necessarily due to gas drainage activities, the subject of this report.

6.1.3 Groundwater Quality

OCC provides groundwater quality data to DEHP annually in accordance with Condition 60 of its Environmental Authority.

Groundwater salinity as TDS is variable and possibly reflects the heterogeneity of the shallow aquifer matrix and/or site activities. TDS results reported in Xstrata (2012) range from around 200 mg/L in background bore BH12 (October 2012) to around 31 000 mg/L in BH5 (April 2004 and 2005 and August 2007 and 2009).

Groundwater pH data presented in Xstrata Coal (2012) indicates the shallow groundwater to be acidic to neutral. GHD (2012b) reported that groundwater in the shallow alluvial monitoring bores tended to occur within two distinct hydrochemical signatures; a sodium-sulphate chemical signature for BH3, BH6 and BH7 and a sodium-chloride signature for bores BH2, BH4, BH5 and BH8 to BH12. Relatively higher proportions of sulphate can indicate mine-related influences.

6.1.4 Groundwater Movement

Recharge to the shallow alluvial sediments is expected to occur from infiltration of rainfall in outcropping areas including areas further exposed as a result of mining.

Groundwater flow is topographically controlled with flow occurring in a broad easterly direction consistent with the direction of stream drainage (refer Figure 15; after SRK, 2014).

Following extreme rainfall and flood events, groundwater in the shallow alluvial sediments may temporarily discharge to the surface water systems. OCC has advised that regular surface water quality monitoring from the site creek systems does not indicate contamination of ephemeral surface flows.

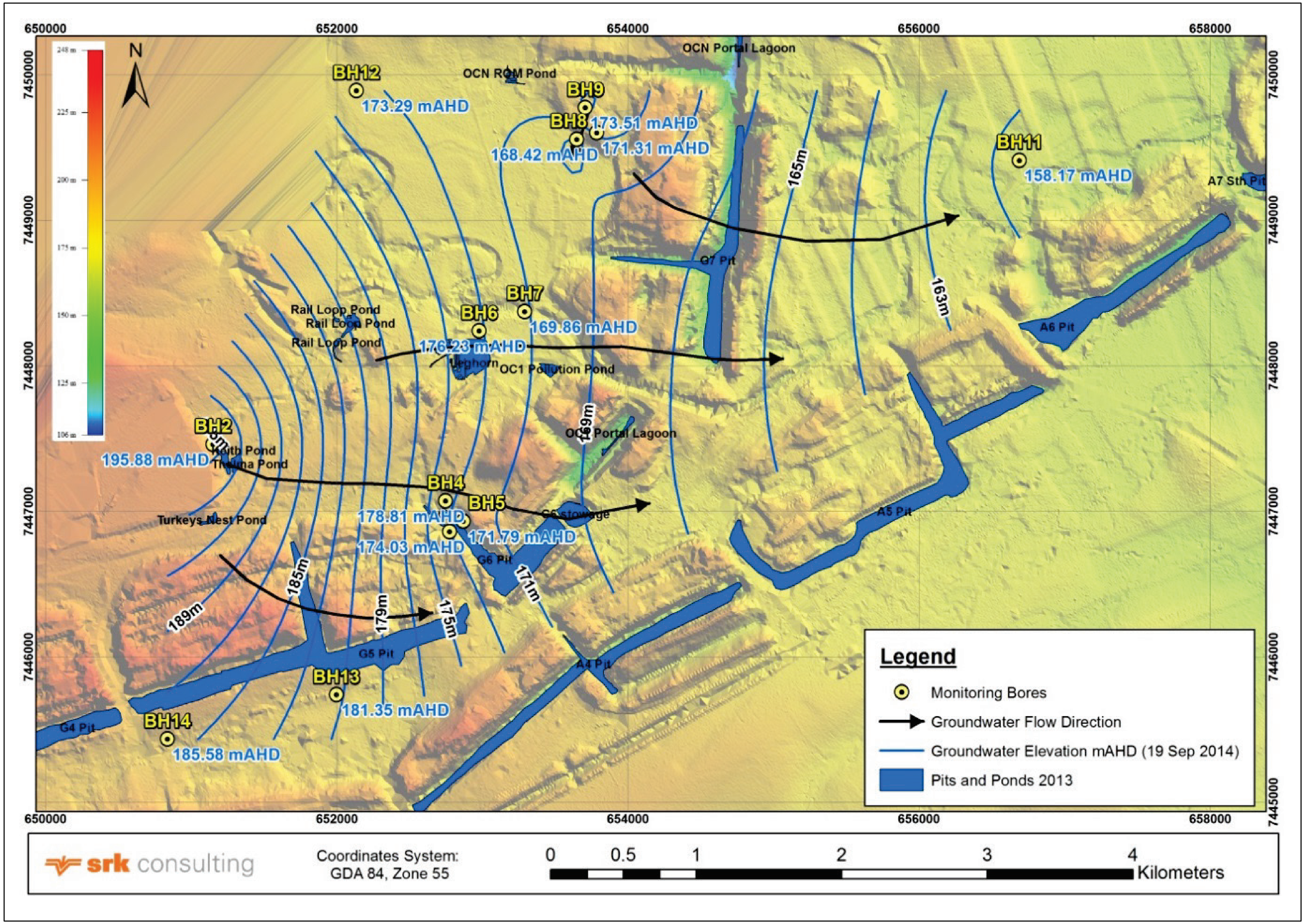

Figure 15 Groundwater flow direction as of 19 September 2014 (after SRK, 2014)

6.2 Deeper Groundwater Systems (Permian Coal Measures)

6.2.1 Physical and Chemical Information

No groundwater level or quality information is available for the Permian sediments, but the occurrence of groundwater in at least the German Creek coal seam sediments is known from drilling and installation of gas drainage holes. EGIS (2002) reports, based on previous investigations, the more prominent occurrences of groundwater in the Permian coal seams including the Aquila, Tieri 1 (the shallower seam of the Tieri seams) and German Creek.

EGIS (2002) considered the Permian coal measures to be the most continuous and laterally extensive hydrostratigraphic layer beneath the site. Hydraulic conductivities are reported to be in the order of 10^{-8} to 10^{-7} m/sec (EGIS, 2002 and Xstrata Coal, 2012).

6.2.2 Groundwater Movement

Recharge to the Permian sediments is expected to occur from infiltration of rainfall where these sediments subcrop (refer Figure 7 and Figure 9), particularly beneath alluvial sediments associated with present day drainage. Recharge to the German Creek coal seam would be expected to occur from downward leakage of water from overlying coal seam water-bearing horizons as well as water stored in pit voids where the seam has been mined and the right hydraulic conditions exist, i.e. pit water elevations are higher than the German Creek coal seam groundwater elevations.

Groundwater in the Permian coal measures is expected to flow from recharge areas in a south-easterly direction, consistent with dip direction. The inferred direction of groundwater movement in the shallow alluvial deposits is considered to be in a typically easterly direction, consistent with the general direction of surface water drainage.

Downward movement of water from pit voids to the underlying Permian coal seams (e.g Aquila, Tieri 1 and German Creek) and underground workings may be expected under the right hydraulic conditions.

The following factors may influence groundwater movement:

- Structures such as domes and basins and the presence of dykes and sills.
- Cracking/fracturing associated with subsidence.
- Removal of groundwater from goafs and longwall operations.
- Depressurisation of the German Creek coal seam during development of underground operations for gas drainage purposes.
- Increased recharge as a result of more exposed aquifer surface area from surface mining and less runoff due to disturbance of the natural catchments and an increase in their infiltration and retention capacities.
- Seepage from water storages as well as potential seepage from rehabilitated and non-rehabilitated spoils.
- Filling and emptying of water storages.

As part of the Australian Coal Association Research Program (ACARP) project on "*The Influence of Subsidence Cracking on Longwall Extraction*" (Project No. C5016), the maximum measured groundwater inflow during heading development in the German Creek Seam at Oaky No. 1 Underground Mine was 5 L/s. Maximum additional inflow resulting from intersection of faults was 2 L/s. This is more than twice the equivalent rate of estimated outflows from gas drainage activities for the period 8 February 2013 to 27 February 2014, i.e. 96.8ML or approximately 3 L/s.

7 Part C – Predicted Water Level Declines for Affected Aquifers

7.1 Assessment

7.1.1 Shallow Groundwater Systems

Hydrographs of groundwater elevations in the shallow monitoring bores (refer Figure 14) show typically relatively stable water levels. BH3, BH4, BH12, BH13 and BH14 show an overall upward groundwater elevation trend from around mid-2009. The shallow water levels are dominated by rainfall recharge and water levels in the site creeks. This is based OCCs on-going comparison of groundwater level data with the rainfall residual mass (RRM) curve as reported in Xstrata (2012). The shallow groundwater system (in areas where monitoring occurs) is not considered to be hydraulically connected to the underlying Permian strata as there is no evidence to suggest influences from dewatering associated with the site gas drainage program.

7.1.2 Deeper Groundwater Systems

As site degassing and associated dewatering activities occur in the deeper groundwater systems, strategically located and targeted groundwater monitoring bores would be required to assess potential impacts on these deeper groundwater systems.

Previously, groundwater level observations from the shallow monitoring bores supported by groundwater levels, interpreted from geophysical logging of exploration holes, have been used to generate groundwater elevation contour maps. These groundwater elevation contour maps have then been used as part of the basis for assessing potential groundwater level declines. As the exploration holes were often uncased, more than one water-bearing horizon may be present which could introduce errors. However, given the current and predicted future underground water extraction volumes and rates compared to groundwater inflows (refer Section 6.2.2) and depth of dewatering, substantial additional declines in the current groundwater levels from site degassing and associated dewatering activities are not expected.

As gas drainage and dewatering activities expand into proposed mining areas, the extent of drawdown from dewatering is also expected to expand. As suggested above, the extent of drawdown is not expected to be substantial based on predicted water extraction volumes and rates as well as the expected lack of significant hydraulic connection between the German Creek coal seam, overlying and surrounding aquifers, and depth of cover (refer Section 4.4.5). Further, the deeper Permian groundwater is of poor quality and limited potential beneficial use (refer Section 4.3.2).

7.1.3 Immediately and Long Term Affected Areas

An immediately affected area (IAA) is defined as an area where the predicted water level declines by more than the applicable bore trigger threshold within three years. A long term affected area (LTAA) is as an area where the predicted water level declines at any time by more than the applicable bore trigger threshold. The bore trigger thresholds are:

- 5 m for a consolidated aquifer.
- 2 m for an unconsolidated aquifer.

Based on available information and the current conceptual understanding, an IAA or LTAA is not predicted to occur as a result of the gas drainage activities.

This is because the extent of drawdown in the German Creek coal seam (considered to be a consolidated aquifer) is not expected to be substantial. It is also highlighted that there are no known records of existing users targeting the Permian Coal measures near the site.

Further, there is likely to be limited hydraulic connection with overlying and surrounding Quaternary and Tertiary unconsolidated aquifers. Existing users that target overlying or surrounding groundwater systems such as the Tertiary basalts are either located at some distance from the site (typically 5 km or greater) or not down-hydraulic gradient (i.e. south-east) of the site such that make-good assessments would not be required.

While a numerical groundwater model would assist with predicting the occurrence of IAAs and/or LTAAs, the development of such a model at this time is not considered a cost effective option due to the likely low risk of impact to useable groundwater systems and their beneficial users, a lack of available data and the likely limited additional understanding that would be gained from such a exercise.

OCC proposes that analytical modelling using estimated extraction rates and aquifer hydraulic parameters be conducted to predict water level drawdowns for the next review.

Further, OCC plans to better understand the potential impacts from its operations on the groundwater environment. A program of works to drill and construct strategically located monitoring bores in water-bearing horizons targeted by the site degassing and dewatering activities has been prepared by SRK (2015). Groundwater level data collected from such bores would further assist the interpolation and interpretation of groundwater elevation information across the OCC operation, although the influence of groundwater extractions for gas drainage purposes on groundwater elevations, trends and movement is likely to be relatively minor given it only represents only a minor component of the site water production.

A conceptual geological block model has also been developed as part of the SRK (2015) work, which is planned to be upgraded in the future to a numerical groundwater model once further groundwater data has been obtained.

7.2 Annual Review

OCC will prepare and submit an annual review of the UWIR each year 20 days after the anniversary date of this new UWIR (based on a calendar year reporting period). The annual reviews will report actual production of all VPWs on PL324 and PL237. These reviews will note any increases or decreases in underground water extraction volumes and comment on any observed or expected impacts on local aquifers.

Methodologies and modelling techniques will be examined and their appropriateness re-evaluated. At this time, no IAA or LTAA is predicted. However, future reviews will review the validity of this assessment. Any material changes in the information or predictions used in future reviews will be documented if no IAA or LTAA is determined. In-addition, should an IAA or LTAA be determined in the future, maps of these areas will be prepared.

A summary of the review outcomes will be provided to the Chief Executive of DEHP as per s376 (e) (ii) of the *Water Act 2000*.

8 Part D – Water Monitoring Strategy

8.1 General

While no IAA or LTAA is predicted at this time and there is no requirement for a water monitoring strategy, OCCs current groundwater monitoring objectives and strategy have been presented in the following sub-sections for information purposes only.

An updated water monitoring strategy, consistent with the relevant provisions of Chapter 3 of the *Water Act 2000*, specifically Section 378, will be established as part of the program of works developed to assist OCC to better understand the potential impacts from its operations on the groundwater environment (refer Section 7.1).

8.2 Groundwater Monitoring Objectives

The current groundwater monitoring objectives include:

- Determining groundwater quality status and trends.
- Establishing and/or modifying groundwater monitoring standards.
- Identifying any impacted groundwater.
- Identifying causes and sources of water quality problems.
- Implementing groundwater quality protection programs (as required).
- Determining interactive relationships between groundwater and surface waters.
- Evaluating effectiveness of groundwater protection programs.
- Determining groundwater draw-down and recharge rates.
- Installation of monitoring piezometers as mining activities expand across the mining leases.

8.3 Groundwater Monitoring Strategy

8.3.1 Strategy Overview

OCCs current groundwater monitoring strategy includes two critical stages, development and operations, both of which are reviewed annually. The two stages are comprised of individual components, as follows:

- Development:
  - Monitoring program design.
  - Monitoring network installation.
- Operation:
  - Monitoring network maintenance.
  - Groundwater sampling.
  - Groundwater sample analyses.
  - Groundwater analyte data management.
  - Groundwater analyte data interpretation.
  - Communication of groundwater monitoring results.
  - Monitoring program evaluation and redesign.

8.3.2 Monitoring Parameters

The following physical and chemical parameters are routinely monitored:

- Standing water levels
- Field parameters (temperature, specific conductance, pH, dissolved oxygen, and alkalinity)
- Major inorganic ions (Ca, Mg, Na, K, Cl, SO_4) and total dissolved solids (TDS)
- Nutrients (NO2 + NO3, ammonium, orthophosphate)
- Dissolved organic carbon (DOC)

Additional water quality parameters are sometimes monitored depending on the objectives of a specific program and only when there is a reasonable expectation that 1) a specific pollutant may be present, 2) when core indicators indicate contamination, or 3) to support a special study such as screening for potential pollutants of concern. These indicators typically include one or more of the following groups of analytes:

- Pesticides
- Volatile organic compounds (VOCs)
- Metals and trace elements

8.3.3 Monitoring, Assessment and Reporting Frequencies

Annual groundwater quality monitoring (as required by the site's Mining Lease EA) is conducted on the 13 monitoring bores listed in Table 5. Measurements of standing water levels are conducted quarterly.

All groundwater monitoring data is assessed annually including an assessment of the suitability of the monitoring network. An annual report is provided to the administering authority to fulfil OCCs reporting requirements.

8.3.4 Quality Assurance

A Quality Assurance/Quality Control (QA/QC) program is implemented to provide reliable groundwater monitoring data. The QA/QC program is conducted in accordance with relevant Queensland government guidelines and Australian Standard AS 4482.12005.

8.3.5 Data Management

All data collected by OCC including data received from NATA accredited laboratories is entered into a data management systems designed by OCC for efficient data storage, retrieval, and accessibility. All groundwater monitoring bores are geo-spatially referenced for integration into the existing, GIS-based groundwater management datasets.

9 Part E – Spring Impact Management Strategy

A spring is defined in the *Water Act 2000* Schedule 4 as "the land to which water rises naturally from below ground and the land over which the water then flows".

GIS information for springs provided on the Queensland Spatial Catalogue website was interrogated to determine the location of possible springs within a 5 km radius of its mining lease boundaries.

No registered springs were identified within the search area. The nearest registered spring is located around 85 km southeast of the OCC operation (refer Figure 16).

OCC also undertook consultation with landholders, which did not reveal any anecdotal evidence to suggest the presence of springs within the immediate vicinity of the OCC operation.

Based on this information, further consideration of potential impacts to springs including a spring impact management strategy is not considered warranted.

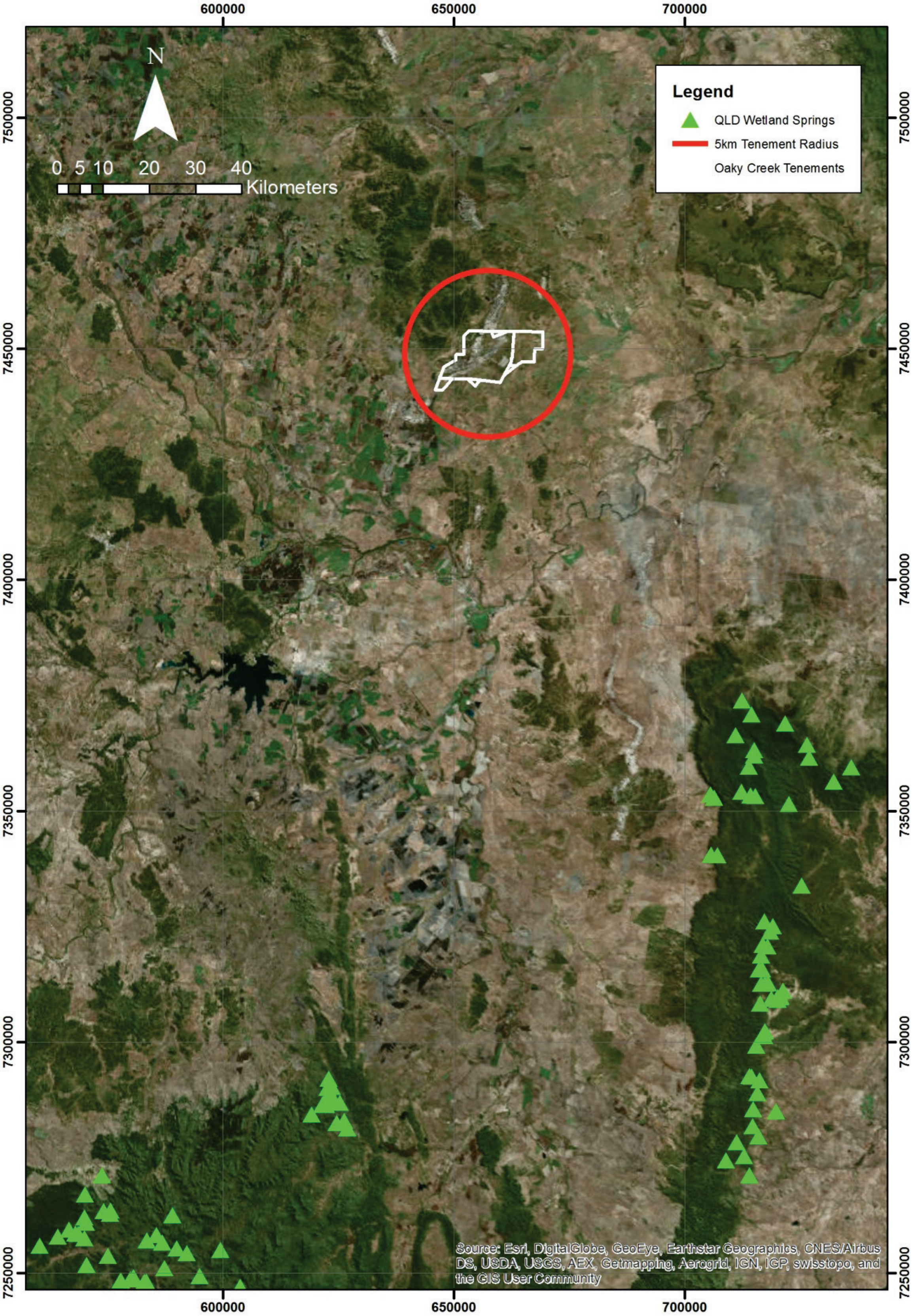

Figure 16 Location Plan of Registered Wetlands/Springs

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11 Limitations

This report was prepared for the sole use of Oaky Creek Coal and should not be relied upon by any other person. None of BlueSphere Environmental Pty Ltd or any of its related entities, employees or directors (each a BlueSphere Person) owes a duty of care (whether in contract, tort, statute or otherwise) to any third party with respect to or in connection with this report and no BlueSphere Person accepts any liability for any loss or damage suffered or costs incurred arising out of or in connection with the use this report by any third party.

The report has been prepared with the objectives and scope of work outlined in the proposal 22 May 2014. The work was carried out in accordance with the Glencore Coal Assets Australia Purchase Order Terms and Conditions.

The conclusions and recommendations provided in this report are based on available information and it is possible that different conclusions and recommendations could be made should new information become available, or with changing site conditions over time. These opinions, conclusions and recommendations are subject to uncertainty given the potentially complex nature of any subsurface environment. Variation in soil and groundwater conditions may vary significantly between the specific sampling and testing locations and other locations at the site.

The report will not be updated if anything occurs after the date of this report and Bluesphere Environmental Pty Ltd will not be obliged to inform any person of any matter arising or coming to its attention after that date.

Appendix A

Pump Specification

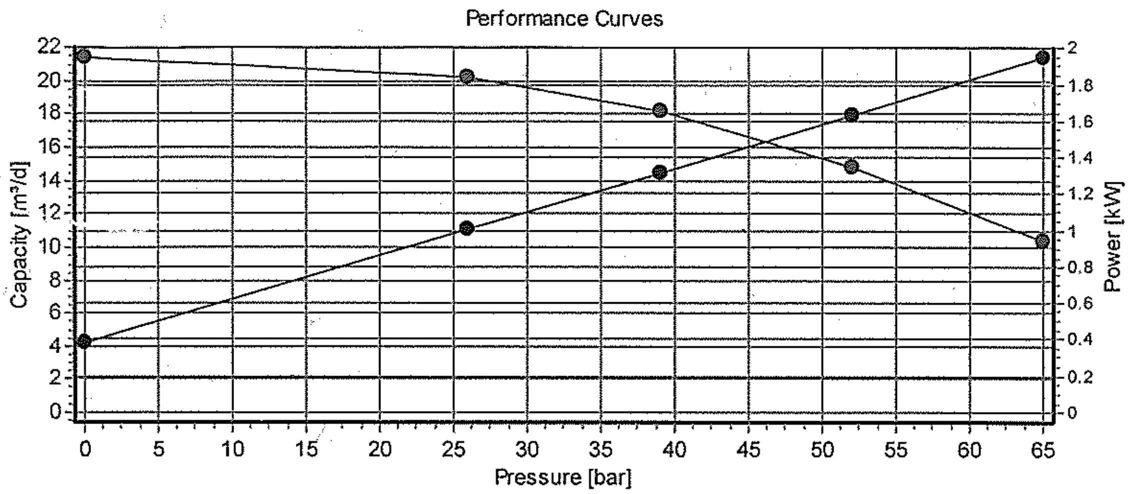
NETZSCH do Brasil

NETZSCH

Performance Curves and Efficiency of PCP - 36016

Type:	NTZ 278*065ST7.0	Order-No:	L30003949					
Rotor No:	134M474	Temp. size:	P04					
Stator No:	1303X4316	Quality:	286					
Liquid:	WATER	Viscosity [cPs]:	1	Liquid Temp. [°C]: 50		Stator Surface Temp. [°C]: 25		

*Tests are performed according NETZSCH standard NdB147 unless otherwise defined.
*Torque is calculated and power is a derivate of them.



Speed [rpm]	Pressure [bar]	Capacity [m³/d]	Torque [Nm]	Power [kw]	Power [hp]	Eff.Vol [%]	Eff.Total [%]
300	0	21.42	12	0.38	0.51	100	0
300	26	20.21	32	1.01	1.35	94	60
300	39	18.14	42	1.32	1.77	85	62
300	52	14.79	52	1.63	2.19	69	54
300	65	10.33	62	1.95	2.61	48	40

Measurement Instruments

Flow Meter	MDV-21
Tachometer	TC-34
Thermometer	T-86
Pressure Transducer	TRP-20

Obs.:

Test Bench: 50

Date: 5/14/2013

Test Time: 45 Min.

Tester: LUCAS

Approved by technician:

Appendix B

Groundwater Level Monitoring Data

Groundwater Level - Metres Below Ground Level (mbgl)

Month	P11208 (BH1)	P11209 (BH2)	P11210 (BH3)	P11211 (BH4)	P11212 (BH5)	P11213 (BH6)	P11214 (BH7)	P11215 (BH8)	P11216 (BH9)	P11217 (BH10)	P13202 (BH11)	P13203 (BH12)	P13469 (BH13)	P13305 (BH14)
Easting (GDA 66)	NA	651150	652778	652750	652872	652980	653292	653651	653710	653788	656691	652137	652000	650840
Northing (GDA66)	NA	7447460	7446859	7447070	7446931	7448239	7448372	7449555	7449773	7449600	7449411	7449890	7445739	7445434
Measuring Point RL (mAHD)	232.87	195.88	183.06	184.46	184.45	178.42	174.12	179.07	190.26	190.71	169.746	181.613	184.473	190.219
Stick up elevation (mAGL)	NA	0	0.57	0.78	0.8	0.71	0.62	0.57	0.59	0.3	0.4	0.68	0.37	0.21
Jan-03	Dry	0.02	11.05	7.069	13.7	3.66	4.62	13.04	18.63	20.44	-	-	-	-
Apr-03	Dry	1.14	10.34	7.33	14.81	3.34	4.51	13.18	18.9	20.14	-	-	-	-
Apr-04	Dry	0.911	9.902	7.639	13.916	2.902	4.553	13.921	19.106	20.133	-	-	-	-
Oct-04	Dry	0.35	12.82	8.46	14.15	2	Dry	13.8	19.46	20.6	-	-	-	-
Jan-05	Dry	1.25	10.8	8.55	14.22	2.63	4.4	14.13	19.4	20.35	-	-	-	-
Apr-05	Dry	1.077	11.198	8.319	14.124	2.701	4.625	14.051	19.189	19.925	-	-	-	-
Nov-05	Dry	1.1	11.27	8.4	14.14	2.5	4.27	14.08	19	19.98	-	-	-	-
Apr-06	Dry	0	11.4	8.58	12.51	2.92	4.84	13.5	18.99	19	-	-	-	-
Jun-06	Dry	1.236	13.095	8.538	13.026	2.838	5.042	13.656	19.041	19.964	-	-	-	-
Aug-06	Dry	0.95	13.28	8.6	14.18	2.68	5.1	13.97	18.6	20.33	-	-	-	-
Dec-06	Dry	1.14	13.55	8.8	14.1	2.7	4.9	14.25	18.9	20.5	-	-	-	-
Jan-07	Dry	1.07	13.6	8.86	11.67	1.9	4.6	14.2	18.5	20.5	-	-	-	-
Apr-07	Dry	1.1	13.5	8.9	14.4	2.2	5.2	14.4	19	20.4	-	-	-	-
Jun-07	Dry	1.06	13.5	9	13.3	2.2	5.1	14.3	18.8	20.4	-	-	-	-

Month	P11208 (BH1)	P11209 (BH2)	P11210 (BH3)	P11211 (BH4)	P11212 (BH5)	P11213 (BH6)	P11214 (BH7)	P11215 (BH8)	P11216 (BH9)	P11217 (BH10)	P13202 (BH11)	P13203 (BH12)	P13469 (BH13)	P13305 (BH14)
Aug-07	Dry	0.988	Blocked	8.098	14.215	2.475	Dry	14.058	18.301	20.26	-	-	-	-
Oct-07	Dry	0.25	13.18	8.73	14.18	2.5	5.03	13.08	16.95	18.32	-	-	-	-
Jul-08	Dry	0	12.95	8.15	14.55	2.9	4.55	13.92	18.25	19.95	-	-	-	-
Aug-08	Dry	1.95	12.951	8.762	14.055	2.723	4.389	14.28	18.462	20.033	-	-	-	-
Nov-08	Dry	1	11.6	8	13	2.85	4.64	14.2	18.36	20.15	11.7	13.2	-	-
Aug-09	Dry	0.5	12.63	7.89	14.02	3.124	4.8	14.3	18.27	20	11.46	13.02	6.08	5.48
Oct-10	Rehabbed	0.75	12.43	7.64	13.96	2.63	4.41	13.61	18.138	20.16	12.25	12.775	5.785	4.28
Oct-11	Rehabbed	0	10.92	6.38	13.72	2.47	4.46	13.66	17.32	18.805	11.43	7.36	4.36	4.22
Jun-12	Rehabbed	Not located	10.57	Not dipped	Not dipped	2.23	3.249	Not dipped	Not dipped	18.54	11.76	7.55	3.301	3.409
Aug-12	Rehabbed	0	10.55	6.21	13.53	2.09	4.15	13.25	17.45	18.91	11.39	7.14	3.55	0.65
Nov-12	Rehabbed	Casing broken at GL	10.65	4.69	Not dipped	2.51	4.49	Not dipped	17.21	19.72	11.37	7.55	3.04	3.68
Feb-13	Rehabbed	Casing broken at GL	10.83	6.27	Not dipped	2.04	3.84	Not dipped	17.5	19.74	11.8	7.32	3.09	0.38
Jun-13	Rehabbed	Casing broken at GL	9.81	5.85	Not dipped	2.125	4.19	Not dipped	17.245	18.275	11.51	7.055	2.45	0.512
Sep-13	Rehabbed	0	9.185	5.93	13.46	2.655	4.545	11.115	17.435	19.885	11.385	7.325	2.8	3.83
Sep-14	NA	11.63	9.03	5.65	12.66	2.19	4.26	10.65	16.99	19.18	11.58	8.32	3.39	4.64

Groundwater Level - Metres Australian Height Datum (mAHD)

Month	P11208 (BH1)	P11209 (BH2)	P11210 (BH3)	P11211 (BH4)	P11212 (BH5)	P11213 (BH6)	P11214 (BH7)	P11215 (BH8)	P11216 (BH9)	P11217 (BH10)	P13202 (BH11)	P13203 (BH12)	P13469 (BH13)	P13305 (BH14)
Easting (GDA66)	NA	651150	652778	652750	652872	652980	653292	653651	653710	653788	656691	652137	652000	650840
Northing (GDA66)	NA	7447460	7446859	7447070	7446931	7448239	7448372	7449555	7449773	7449600	7449411	7449890	7445739	7445434
Measuring Point RL (mAHD)	232.87	195.88	183.06	184.46	184.45	178.42	174.12	179.07	190.26	190.71	169.746	181.613	184.473	190.219
Stick up elevation (mAGL)	NA	0	0.57	0.78	0.8	0.71	0.62	0.57	0.59	0.3	0.4	0.68	0.37	0.21
Jan-03	Dry	195.86	172.01	177.391	170.75	174.76	169.5	166.03	171.63	170.27				
Apr-03	Dry	194.74	172.72	177.13	169.64	175.08	169.61	165.89	171.36	170.57				
Apr-04	Dry	194.969	173.158	176.821	170.534	175.518	169.567	165.149	171.154	170.577				
Oct-04	Dry	195.53	170.24	176	170.3	176.42		165.27	170.8	170.11				
Jan-05	Dry	194.63	172.26	175.91	170.23	175.79	169.72	164.94	170.86	170.36				
Apr-05	Dry	194.803	171.862	176.141	170.326	175.719	169.495	165.019	171.071	170.785				
Nov-05	Dry	194.78	171.79	176.06	170.31	175.92	169.85	164.99	171.26	170.73				
Apr-06	Dry	195.88	171.66	175.88	171.94	175.5	169.28	165.57	171.27	171.71				
Jun-06	Dry	194.644	169.965	175.922	171.424	175.582	169.078	165.414	171.219	170.746				
Aug-06	Dry	194.93	169.78	175.86	170.27	175.74	169.02	165.1	171.66	170.38				
Dec-06	Dry	194.74	169.51	175.66	170.35	175.72	169.22	164.82	171.36	170.21				
Jan-07	Dry	194.81	169.46	175.6	172.78	176.52	169.52	164.87	171.76	170.21				
Apr-07	Dry	194.78	169.56	175.56	170.05	176.22	168.92	164.67	171.26	170.31				
Jun-07	Dry	194.82	169.56	175.46	171.15	176.22	169.02	164.77	171.46	170.31				

Month	P11208 (BH1)	P11209 (BH2)	P11210 (BH3)	P11211 (BH4)	P11212 (BH5)	P11213 (BH6)	P11214 (BH7)	P11215 (BH8)	P11216 (BH9)	P11217 (BH10)	P13202 (BH11)	P13203 (BH12)	P13469 (BH13)	P13305 (BH14)
Aug-07	Dry	194.892		176.362	170.235	175.945		165.012	171.959	170.45				
Oct-07	Dry	195.63	169.88	175.73	170.27	175.92	169.09	165.99	173.31	172.39				
Jul-08	Dry	195.88	170.11	176.31	169.9	175.52	169.57	165.15	172.01	170.76				
Aug-08	Dry	193.93	170.109	175.698	170.395	175.697	169.731	164.79	171.798	170.677				
Nov-08	Dry	194.88	171.46	176.46	171.45	175.57	169.48	164.87	171.9	170.56	158.046	168.413		
Aug-09	Dry	195.38	170.43	176.57	170.43	175.296	169.32	164.77	171.99	170.71	158.286	168.593	178.393	184.739
Oct-10	Rehabbed	195.13	170.63	176.82	170.49	175.79	169.71	165.46	172.122	170.55	157.496	168.838	178.688	185.939
Oct-11	Rehabbed	195.88	172.14	178.08	170.73	175.95	169.66	165.41	172.94	171.905	158.316	174.253	180.113	185.999
Jun-12	Rehabbed		172.49			176.19	170.871			172.17	157.986	174.063	181.172	186.81
Aug-12	Rehabbed	195.88	172.51	178.25	170.92	176.33	169.97	165.82	172.81	171.8	158.356	174.473	180.923	189.569
Nov-12	Rehabbed		172.41	179.77		175.91	169.63		173.05	170.99	158.376	174.063	181.433	186.539
Feb-13	Rehabbed		172.23	178.19		176.38	170.28		172.76	170.97	157.946	174.293	181.383	189.839
Jun-13	Rehabbed		173.25	178.61		176.295	169.93		173.015	172.435	158.236	174.558	182.023	189.707
Sep-13	Rehabbed	195.88	173.875	178.53	170.99	175.765	169.575	167.955	172.825	170.825	158.361	174.288	181.673	186.389
Sep-14	NA		174.03	178.81	171.79	176.23	169.86	168.42	173.27	171.53	158.166	173.293	181.083	185.579