APPENDIX D
SURFACE WATER ASSESSMENT

HYDROLOGY AND WATER MANAGEMENT CONSULTANTS

Gilbert & Associates Pty Ltd

REPORT

WILPINJONG COAL MINE MODIFICATION

Surface Water Assessment

Prepared for: **Wilpinjong Coal Pty Limited**

Jul-13

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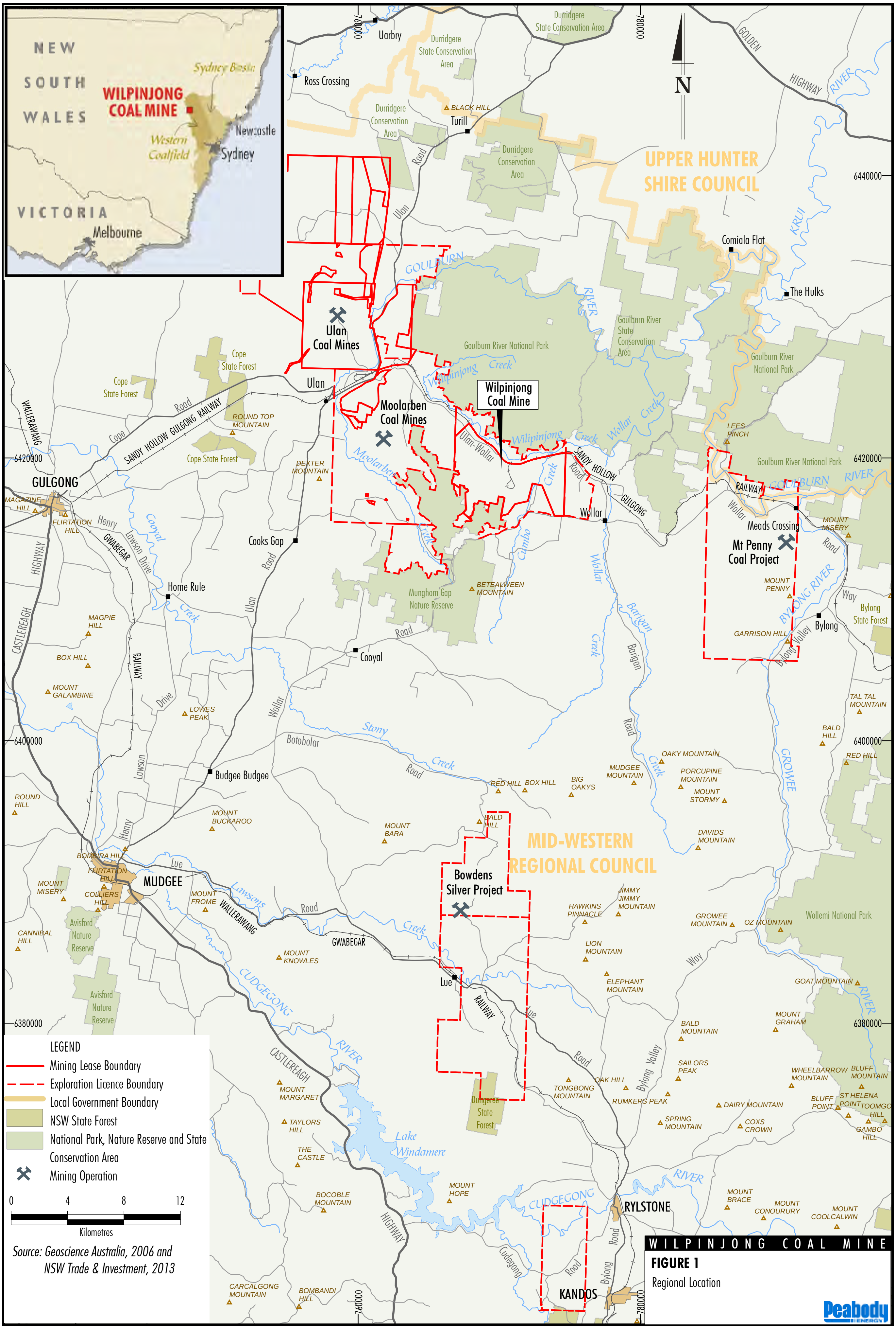
1.0 INTRODUCTION

1.1 Project Overview

Wilpinjong Coal Pty Limited (WCPL), a wholly owned subsidiary of Peabody Energy Australia Pty Limited (Peabody), owns the Wilpinjong Coal Mine which is located some 40 kilometres (km) north-east of Mudgee (refer Figure 1). Until recently mining was conducted under contract by Thiess. In the future mining will be conducted directly by Peabody. WCPL is proposing to modify its Project Approval (PA 05-0021) under section 75W of the New South Wales (NSW) *Environmental Planning and Assessment Act, 1979* (the Modification). Key aspects of the Modification including pit extensions are illustrated on Figure 2.

Following a review of mine planning, Coal Handling and Preparation Plant (CHPP) capacity, waste rock bulking factors, planned building and demolition works and light vehicle servicing requirements, WCPL has determined that a number of minor alterations to the approved Wilpinjong Coal Mine are required, including:

- Development of incremental extensions to the existing open cut pits (Figure 2) that would extend the open cuts by approximately 70 hectares (ha) and would result in the recovery of approximately 3 million tonnes (Mt) of additional run-of-mine (ROM) coal.
- Higher rates of annual waste rock production (from 28 million bank cubic metres [Mbcm] to approximately 33.3 Mbcm) in order to maintain approved ROM coal production.
- Minor CHPP upgrades to improve fine coal reject management (installation of a tailings belt filter press [BFP]) and an increase in the rate of ROM coal beneficiation in the CHPP to approximately 9 million tonnes per annum (Mtpa).
- Upgrade of the existing Reverse Osmosis (RO) Plant to a Water Treatment Facility with the addition of pre-filtration and flocculation/dosing facilities to improve plant efficiency.
- Amendment of the waste emplacement strategy to include:
  - development of an elevated waste rock emplacement landform (up to approximately 450 metres (m) Australian Height Datum [AHD]) within the Pit 2 area (Figure 2);
  - disposal of some inert building and demolition waste that is produced from off-site building demolition in the approved mine waste rock emplacements; and
  - co-disposal of fine coal reject material produced by the BFP with coarse rejects.
- Operation of a light vehicle servicing workshop at an existing farm shed that is located in the north of the Project area (Figure 2).



WILPINJONG COAL MINE

FIGURE 1

Regional Location

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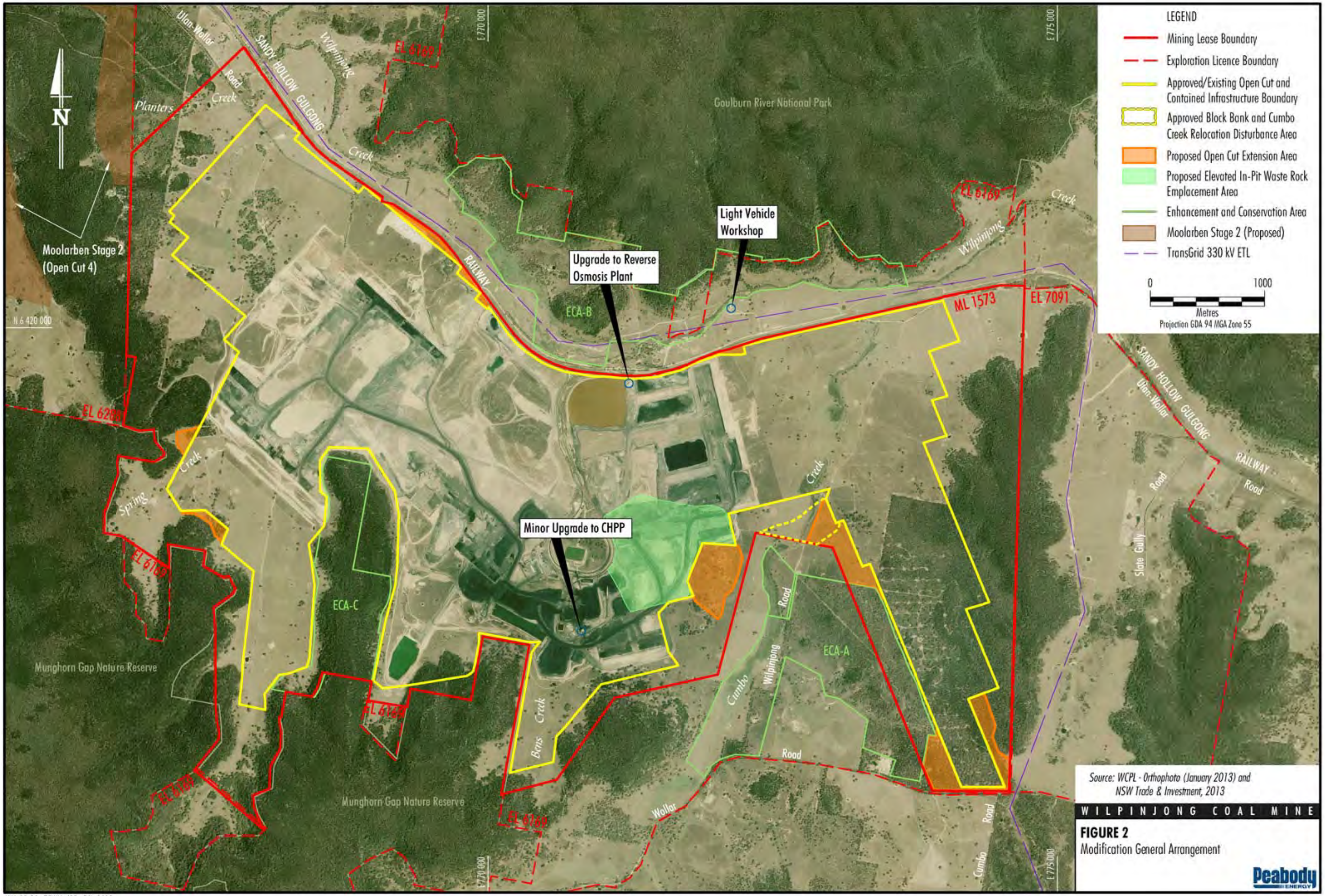

FIGURE 2
Modification General Arrangement

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There is no material alteration proposed to the approved maximum ROM coal mining rate (15 Mtpa), saleable product rate (12.5 Mtpa), operational workforce or 21 year mine life, which sees the mine operating until 2026.

Coal would continue to be washed at the existing CHPP, with the product coal railed to export and domestic markets. A portion of ROM coal would bypass the CHPP (i.e. would not need washing). Tailings material from the CHPP would initially continue to be deposited as a pumped slurry into nearby remnant void storages until 2014 after which time a tailings BFP may be commissioned, which would effectively dewater the tailings to produce a filter "cake" which would be transported by truck for co-disposal with coarse reject in the in-pit waste rock emplacements. This would have the benefits of removing the need to develop additional tailings storages following commissioning of the BFP, as well as reducing the net make-up water demand for the CHPP (refer Section 3.2.4) (provisions for tailings storages would be maintained for future contingency purposes). Overburden and other mining waste, including the reject material from the CHPP, would continue to be placed in areas adjacent to and within completed open cut areas.

Water for the CHPP, dust suppression and other non-potable uses would be obtained from a variety of sources, including mine water storage dams, decommissioned open cuts, active open cuts, recovery from the tailings storages and from the BFP.

1.2 Study Requirements and Scope

This Surface Water Assessment report has been prepared to support an Environmental Assessment (EA) for the Modification. This Surface Water Assessment includes a revised site water management system and balance based on revised mine sequencing to incorporate the Modification. The assessment also addresses the issues raised by government agencies during the consultation process and the surface water related issues identified in an Environmental Risk Assessment (ERA) facilitated for the Modification.

An ERA was undertaken to identify key potential environmental issues for further assessment in the EA (Safe Production Solutions, 2013). The risk assessment team included a representative from Gilbert & Associates Pty Ltd.

The key potential surface water related issues identified in the ERA (Appendix K of the EA) are summarised below.

- Potential for seepage/runoff from incremental mine disturbance areas bypassing the water management system and migrating off-site with subsequent downstream impacts.
- Potential failure or reduced effectiveness of upslope diversions and/or water treatment facilities rendering mine water balance calculations incorrect or causing unlicensed off-site impact.

This Surface Water Assessment describes the design, construction and operational requirements for the water management system that would mitigate the key surface water related issues identified in the ERA.

The Surface Water Assessment has drawn on the results of a hydrogeological study completed for the Modification by HydroSimulations (2013). WCPL provided information on the existing mining and processing operations including the mine plan layout. WCPL also provided information on proposed future operations and the future layout of the site including the Modification.

A number of key guidelines have been considered in assessing impact including:

- *National Water Quality Management Strategy: Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (Australian and New Zealand Environment and Conservation Council [ANZECC] and Agriculture and Resource Management Council of Australia and New Zealand [ARMCANZ], 2000a) (herein referred to as the 'Guidelines').
- *National Water Quality Management Strategy: Australian Guidelines for Water Quality Monitoring and Reporting* (ANZECC/ARMCANZ, 2000b).
- Using the ANZECC Guideline and Water Quality Objectives in NSW (NSW Department of Environment and Conservation [DEC], 2006a).
- State Water Management Outcomes Plan (NSW Department of Natural Resources, 2002).[1]
- NSW Government Water Quality and River Flow Environmental Objectives (DEC, 2006b).
- NSW *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources, 2009.*

[1] The State Water Management Outcomes Plan (2002) was a statutory document under the *Water Management Act, 2000* that set the overarching policy, targets and strategic outcomes for the development, conservation, management and control of NSW water sources. The Plan expired in 2007 but many of the principles and targets remain relevant.

2.0 EXISTING SURFACE WATER HYDROLOGY

2.1 Site Location, Topography, Land Use and Drainage

The Wilpinjong Coal Mine is located in the upper Goulburn River valley. The topography of the mine area comprises predominantly alluvial/colluvial flats lying between the escarpment of the Munghorn Gap Nature Reserve to the south and the Wilpinjong Creek floodplain to the north. Surface elevations range from approximately RL 470 m AHD along the edge of the sandstone plateaus and hill slopes of the Munghorn Gap Nature Reserve to about RL 360 m AHD in the north-east of the mine area which borders the Gulgong-Sandy Hollow railway. The northern side of the Wilpinjong Creek catchment is bounded by the sandstone escarpment of the Goulburn River National Park (refer Figure 2).

The dominant non-mining land use of the local area is cattle and sheep grazing with intermittent cropping principally for fodder.

Surface water drainage from the mine area flows from south to north to Wilpinjong Creek via a series of small streams. The streams are semi-perennial, spring fed streams in their upper reaches near the Munghorn Gap Nature Reserve, transitioning to wide, ill-defined ephemeral drainages in the lower reaches near Wilpinjong Creek. The more prominent of these streams have been named on the regional 1:25,000 scale topographic map as Planters Creek, Spring Creek, Narrow Creek and Bens Creek (refer Figure 2 for current locations). Some of these streams (e.g. Narrow Creek) have been diverted or intercepted by the approved mining operations (refer Section 3.2.1).

The headwaters of Wilpinjong Creek are in the Goulburn River National Park (refer Figure 3). It initially flows westward toward Ulan and then flows south-east, joining a tributary from the south (Murragamba Creek) before continuing south-east to the north of the ML 1573. Wilpinjong Creek ultimately flows eastwards into Wollar Creek which joins the Goulburn River in the Goulburn River National Park. The Goulburn River joins the Hunter River at Denman (Figure 3 Inset). Wilpinjong Creek is incised into the valley floor and forms a series of semi-permanent soaks fed primarily from drainage from the surrounding alluvial plain and colluvium which is recharged by runoff from the adjacent sandstone plateau. There are areas of reed growth along the creek bed which form wide swampy areas in places. Vegetation on the banks and overbank areas is predominantly grass with occasional trees and little in-stream vegetation.

Apart from Wilpinjong Creek, the largest drainage feature in the mine area is Cumbo Creek which drains an area of some 70 square kilometres (km^2) in total including some of the eastern parts of the mine area. A significant section of the lower reaches of Cumbo Creek is to be relocated as part of approved mining operations. In accordance with the Project Approval, WCPL is preparing a Cumbo Creek Relocation Plan that will include:

- a vision statement for the creek relocation;
- an assessment of the water quality, ecological, hydrological and geomorphic baseline conditions in Cumbo Creek;
- the detailed design and specifications for the creek relocation;

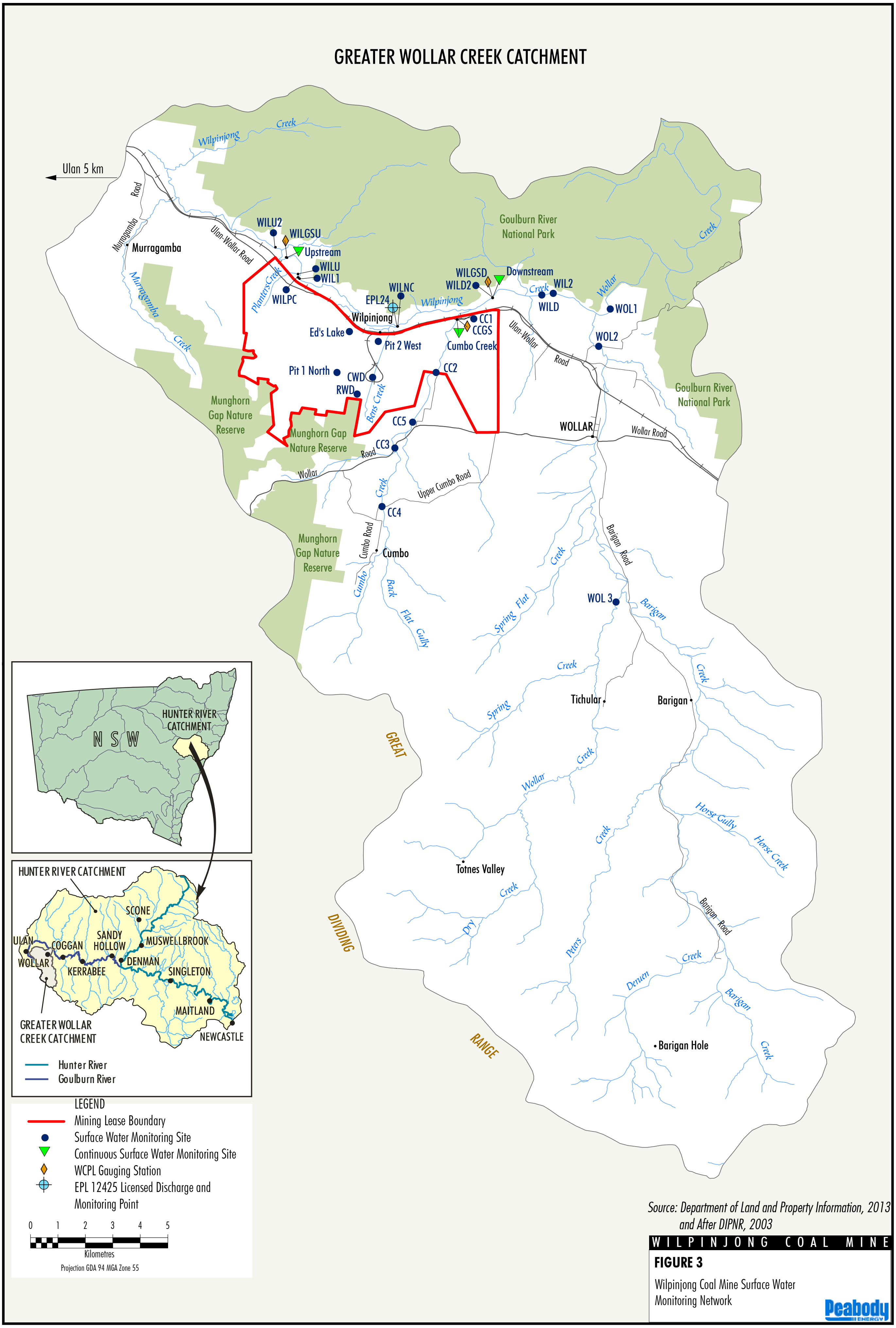


FIGURE 3

Wilpinjong Coal Mine Surface Water Monitoring Network

WIL-12-12_75WMod12_SW_202E

- a construction program for the creek relocation, describing how the work would be staged, and integrated with mining operations;
- a revegetation program for the relocated creek using a range of suitable native species;
- water quality, ecological, hydrological and geomorphic performance and completion criteria for the creek relocation based on the assessment of baseline conditions; and
- a program to monitor and maintain the water quality, ecological, hydrological and geomorphic integrity of the creek relocation.

2.2 Climate

The Wilpinjong area experiences a temperate climate with an average annual rainfall of 627 millimetres (mm). Long-term historical rainfall data is available from numerous established Bureau of Meteorology (BoM) stations in the surrounding region. The closest station with a long-term record is located in Wollar (Barigan St) (station number 62032 with records available from 1901). Rainfall statistics calculated for this and other stations in the area are summarised in Table 1, together with data from WCPL's site weather station.

Table 1
Summary of Mean Rainfall Statistics

Month	Gulgong Post Office (BoM 62013)*		Wollar (Barigan St) (BoM 62032)*		Data Drill**		WCPL Weather Station	
	Rainfall (mm)	No. Rain Days	Rainfall (mm)	No. Rain Days	Rainfall (mm)	No. Rain Days	Rainfall (mm)	No. Rain Days
No. Years	132		112		124		7	
January	70.5	5.9	66.6	5.0	69.3	9.5	52.3	6.8
February	62.4	5.5	62.9	4.6	64.8	8.7	78.2	11.3
March	54.8	5.2	51.9	4.4	51.9	7.9	50.7	7.6
April	44.2	4.6	38.9	3.8	37.8	7.5	31.3	8.6
May	45.4	5.8	38.1	4.1	43.5	8.5	32.3	8.1
June	50.5	7.3	43.9	4.8	46.5	10.3	63.5	13.0
July	49.3	7.8	42.9	5.2	45.8	11.4	43.6	13.1
August	46.5	7.0	41.6	4.9	45.6	10.5	35.5	8.4
September	46.8	6.7	40.9	4.6	46.4	9.7	42.3	8.3
October	56.2	6.7	51.9	5.4	55.9	10.0	39.9	7.9
November	60.1	6.3	55.8	5.1	58.0	9.9	75.6	10.4
December	67.5	6.4	59.3	5.1	61.4	10.0	114.9	11.4
Annual	652.6	75	588.9	57	627.1	114	660.3	115

* Data source: BoM (2013) Climate Data Online.

** Silo Data Drill (http://www.longpaddock.qld.gov.au/silo/) for location 32 21'S 149 51'E.

Whilst rainfall is spread throughout the year, it is on average higher in the summer months and occurs on fewer days (i.e. is more intense). The highest recorded monthly rainfall at Wollar was 391.5 mm recorded in February 1955, which included the highest daily rainfall total of 180.8 mm. The highest daily rainfalls have been recorded during summer (December to February) and in June. The maximum rainfalls recorded in most of the rest of the year have, by comparison, been significantly lower (refer Table 2).

Table 2
Summary of Monthly Rainfall Statistics – mm
(Wollar 62032 [Barigan St] – 1901 to 2012)*

Month	Mean	Median	10th Percentile	90th Percentile	Highest Monthly	Lowest Monthly	Highest Daily
January	66.6	60.4	10.6	134.0	209.6	0.0	102.9
February	62.9	46.8	3.5	144.6	391.5	0.0	180.8
March	51.9	39.3	1.0	112.1	224.5	0.0	85.6
April	38.9	29.5	0.7	78.2	221.9	0.0	81.4
May	38.1	26.9	1.3	100.2	182.5	0.0	55.4
June	43.9	32.2	5.6	86.9	263.9	0.0	105.4
July	42.9	36.6	5.0	93.2	175.2	0.0	68.1
August	41.6	38.7	9.6	78.2	146.4	0.0	55.0
September	40.9	36.4	4.5	88.3	135.9	0.0	72.6
October	51.9	47.8	5.9	98.0	228.5	0.0	69.1
November	55.8	51.4	3.3	121.6	278.0	0.0	68.0
December	59.3	47.0	7.5	131.4	229.9	0.0	104.0
Annual	**588.9**	**596.8**	**364.5**	**835.2**			

* Data source: BoM (2012) Climate Data Online.

Average monthly pan evaporation data for the mine area and the nearest BoM stations are provided in Table 3.

Table 3
Summary of Mean Monthly Pan Evaporation - mm

Month	Data Drill*	Scone SCS**	Mumbil (Burrendong Dam)***
January	232.0	217.6	237.2
February	183.1	173.8	191.0
March	161.9	154.1	162.2
April	108.9	106.3	104.1
May	69.0	68.9	62.6
June	47.8	48.5	40.5
July	53.1	57.1	42.1
August	77.6	84.5	60.6
September	109.5	117.5	88.9
October	154.6	155.8	133.5
November	186.6	182.5	182.0
December	231.3	218.6	226.4
Annual	**1,619**	**1,582**	**1,524**

* Silo Data Drill (http://www.longpaddock.qld.gov.au/silo/) for location 32 21'S 149 51'E for period 1970 to current (data interpolated from surrounding stations).

** BoM data for station 61089 (1950 – present) located approximately 90 km to the east north-east, 8.6% of data set was missing.

*** BoM data for station 62003 (1955 – present) located approximately 80 km to the west south-west, 8.2% of the data set was missing.

A comparison between monthly average rainfall (Table 1) and monthly average pan evaporation (Table 3) indicates that the area experiences an excess of pan evaporation over rainfall in all months. There is however significant variability in rainfall and there would be periods when rainfall would exceed evaporation, particularly in winter months.

2.3 Catchments and Streamflow

The Wilpinjong Coal Mine is located wholly within the headwaters of the Goulburn River catchment which itself lies within the Hunter River catchment, which is one of the six major regulated river basins in NSW.

Streamflow data for regional (NSW Office of Water [NOW]) gauging stations were summarised in the Wilpinjong Coal Project Environmental Impact Statement (EIS) (WCPL, 2005). The nearest gauged stream at the time was Wollar Creek at Wollar (GS 210082, operated 1969 – 1997) and the data from this station was used to develop a catchment yield model for the local streams in the mine area. The available data indicated that runoff (total catchment yield) is a small percentage of rainfall – approximately 2.4% on average for GS 210082.

WCPL has established gauging stations on Wilpinjong Creek both upstream and downstream of ML1573 and on Cumbo Creek near the northern boundary of ML1573 (refer Figure 3). These stations comprise automated stream depth monitors which were established originally in 2005, with streamflow ratings (relationship between flow depth and flow rate) established since that time. The most consistent and extensive streamflow data set appears to be for the Wilpinjong Creek upstream gauging station (WILGSU), for which data are available from May 2007. Figure 4 shows the recorded streamflow hydrograph for WILGSU for 2007-2009, while Figure 5 shows the recorded hydrograph for both WILGSU and the Wilpinjong Creek downstream gauging station (WILGSD) for 2011-2013. Streamflow is plotted on a logarithmic scale to more clearly show low flow periods and is expressed on a per unit catchment area basis to allow direct comparison between the two gauging station records. Figure 6 shows the recorded flow duration curve for WILGSU for its full period of record, while the flow duration curves for the two gauging stations for the concurrent flow period 2012 – 2013 are plotted on Figure 7.

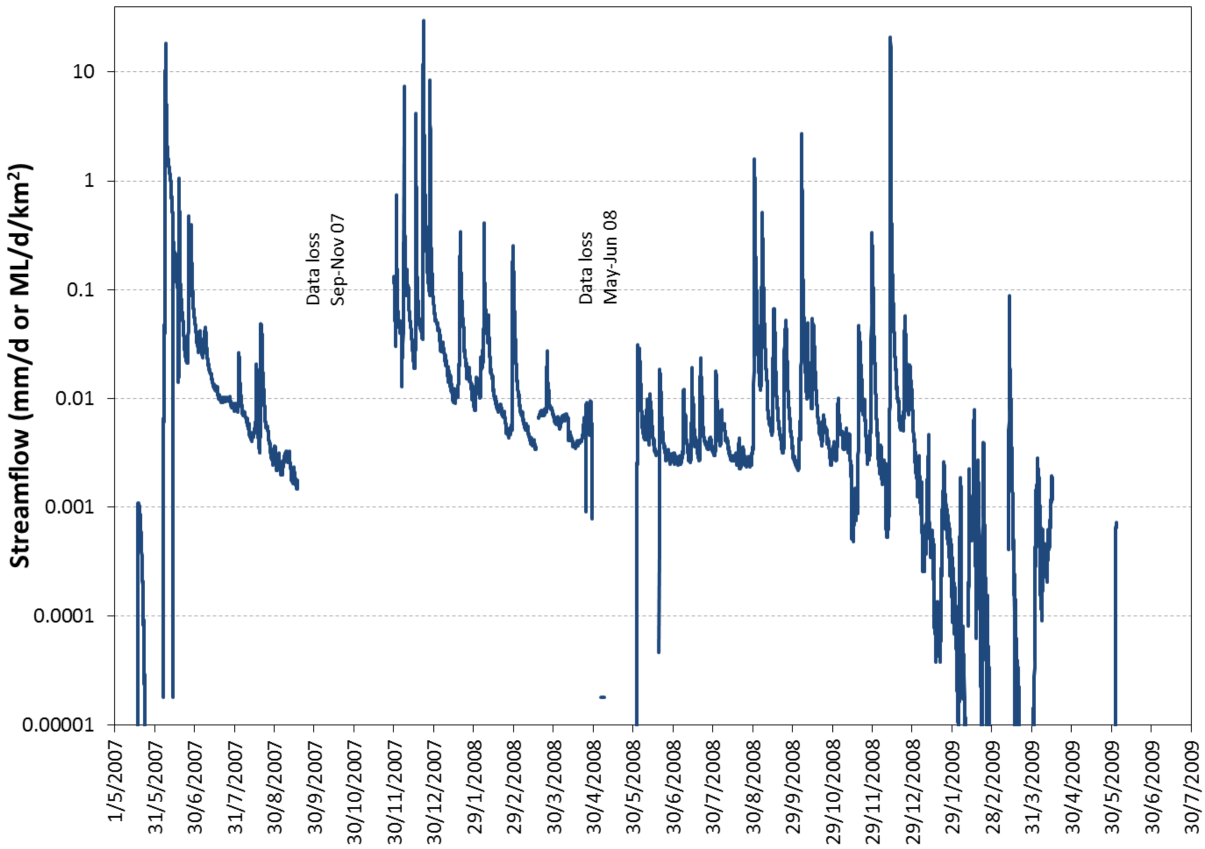


Figure 4 Recorded Streamflow Hydrograph – WILGSU 2007 - 2009

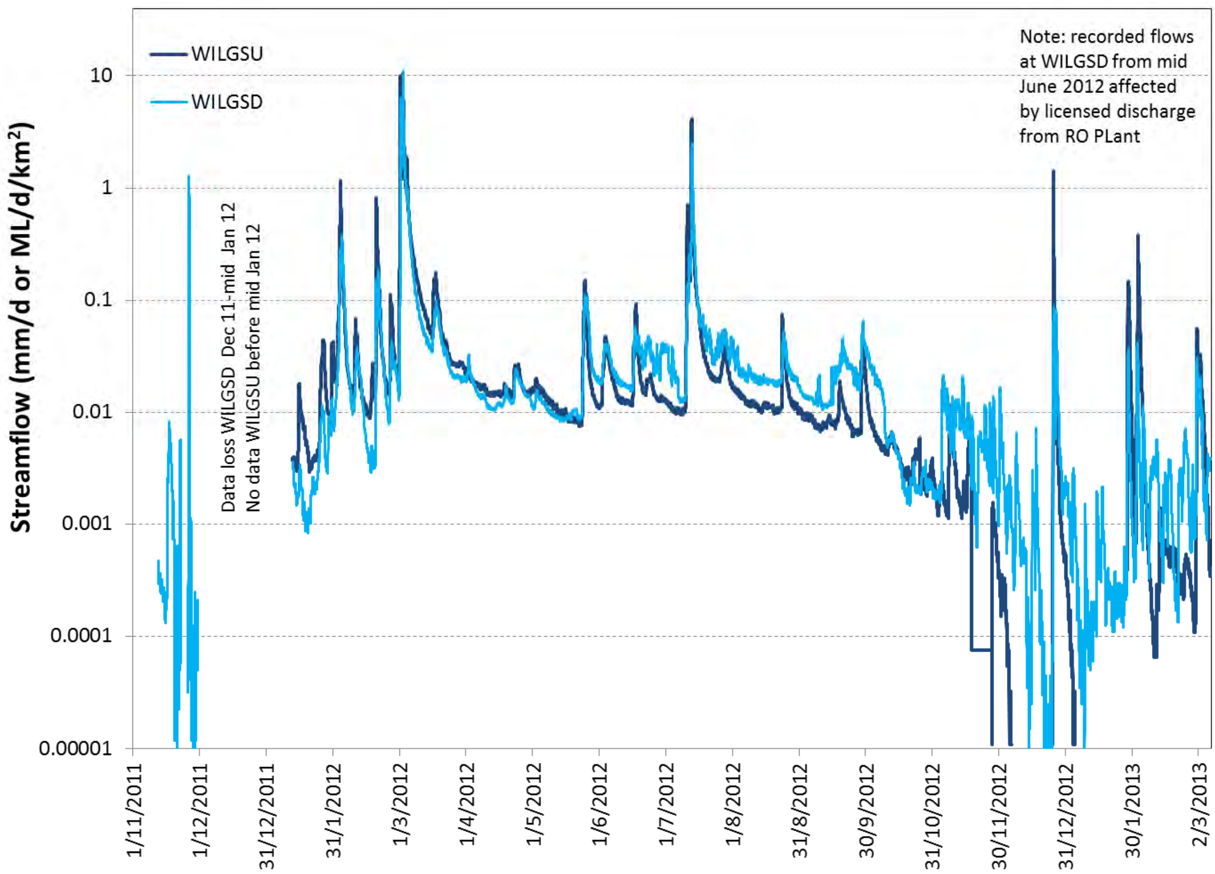


Figure 5 Recorded Streamflow Hydrograph – WILGSU & WILGSD 2011-2013

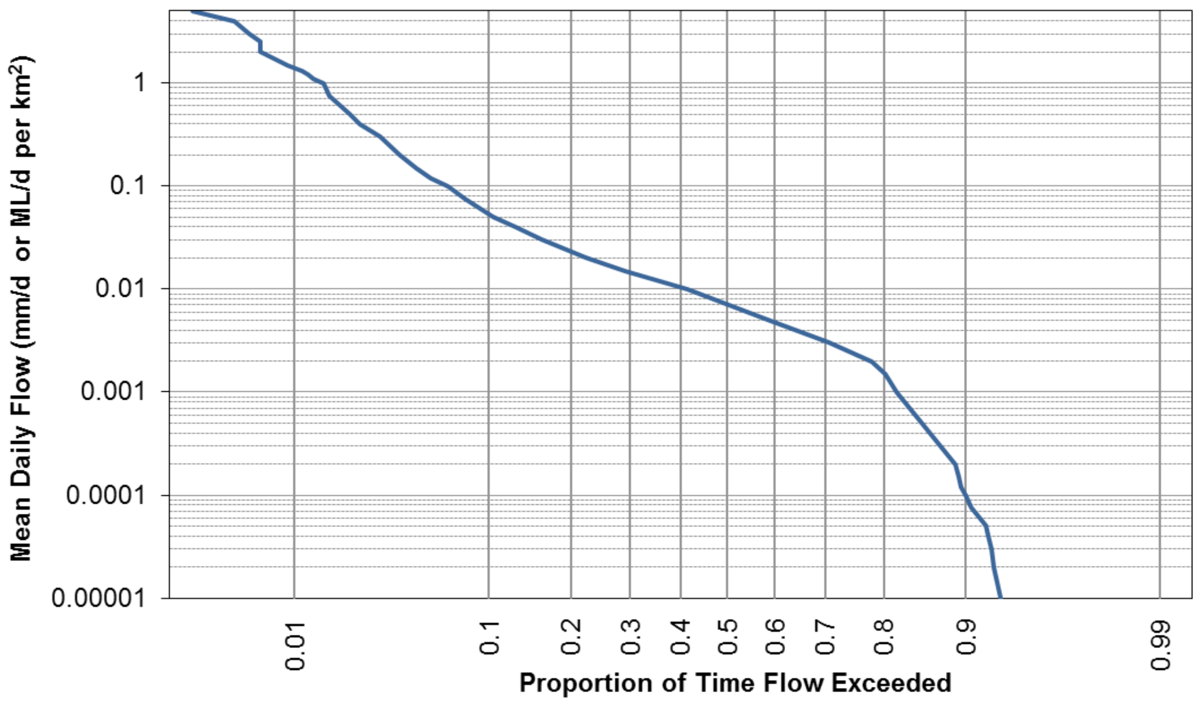


Figure 6 Recorded Flow Duration Curve – WILGSU for Full Period of Record

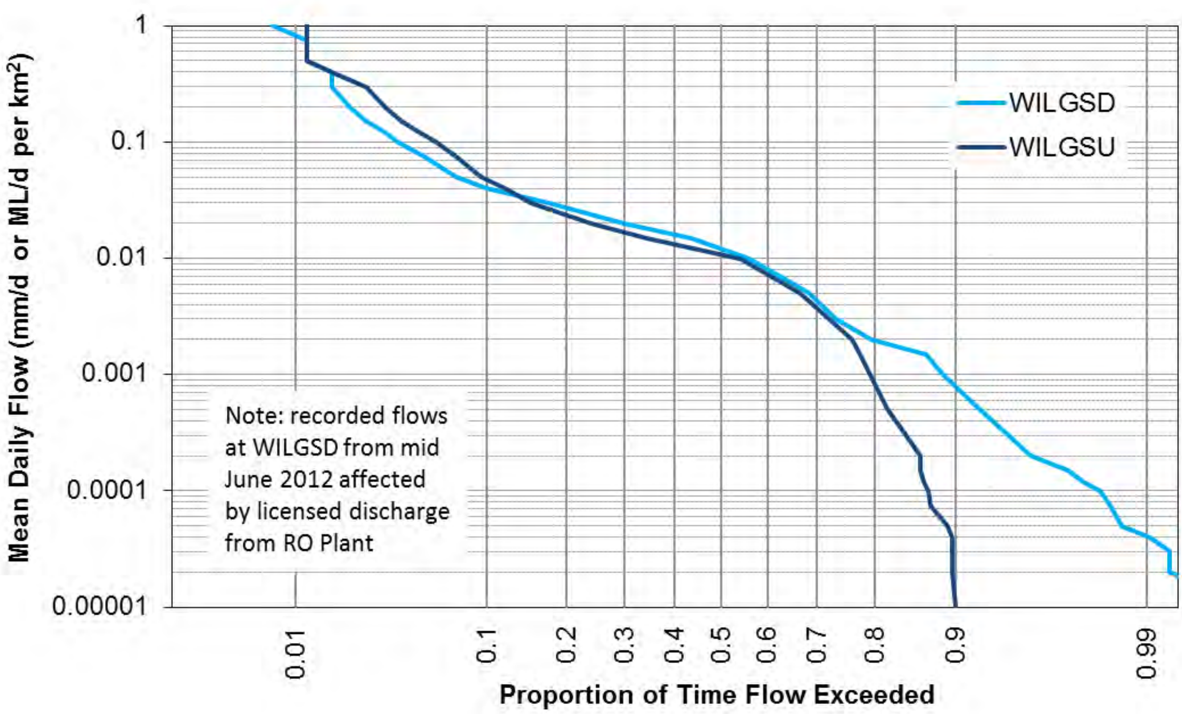


Figure 7 Recorded Flow Duration Curves – Wilpinjong Creek 2012 - 2013

The following points are worthy of note from the data presented in Figures 4 to 7:

- Wilpinjong Creek is ephemeral, with zero flow recorded at WILGSU approximately 6% of the time.
- Analysis of the hydrograph in Figure 5 indicates a significant baseflow component in the WILGSU flow, averaging approximately 30% of total flow.
- A significant transmission loss was evident in both hydrographs (as a steep drop in plotted flow rate) particularly in late summer and autumn and likely related to evapotranspiration from in-stream vegetation.
- The flow at both gauging stations is quite similar, but comparison is complicated by the presence of licensed discharge from the Wilpinjong RO Plant from June 2012 onwards (refer also Section 3.2.2). The RO Plant discharge appears to sustain low flows at WILGSD (departure between flow duration curves evident in Figure 7). Prior to commencement of licensed discharge, the flows per unit catchment area at the two gauging stations were very similar, with, if anything, more frequent low flows at WILGSD.

Analysis of recorded data confirms that Wilpinjong Creek and Cumbo Creek are ephemeral, with flow ceasing for extended periods of dry weather, particularly following periods of elevated temperatures. Data from the WILGSU station also confirm that runoff is a small percentage of rainfall – averaging approximately 3% for the period of available data. Applying this runoff rate using an average annual rainfall of 627 mm (refer Section 2.2) to the pre-mining Wilpinjong Creek catchment at WILGSD (190 km^2), gives an estimated mean annual flow in Wilpinjong Creek downstream of the Wilpinjong Coal Mine of 3,574 megalitres

(ML). With 30% of flow comprising baseflow as indicated above, the estimated baseflow rate in Wilpinjong Creek at this point is approximately 2.9 megalitres per day (ML/d), which is generally consistent with the 2.5 ML/d estimated in the EIS (WCPL, 2005).

The pre-mine catchment areas of Wilpinjong and Cumbo Creeks have been reduced by the development of open cut pits as part of the approved Wilpinjong Coal Mine (refer Table 4). The upper reaches of Wilpinjong Creek would also be affected by the development of the Moolarben Coal Project Stage 2 should it be approved.

Table 4
Local Catchments – Summary Details

	Total Catchment Area prior to mining (km^2)*	Current Catchment Area (as of December 2012) (km^2)†
Wilpinjong Creek at WILGSU	81	81
Wilpinjong Creek at WILGSD	190	175
Cumbo Creek at CCGS**	70.3	70.0

* Derived from regional 1:25,000 scale topographic mapping.
† Using a 2012 contour plan supplied by Thiess mining contractors.
** CCGS – Cumbo Creek Gauging Station

Proposed upslope diversions (refer Section 3.2.1) will generally result in an increase in the catchment area reporting to WILGSD, while there will be a reduction in the catchment area of Cumbo Creek during mining (refer Section 5.1).

A simple investigation trigger has been developed that targets streamflow losses between upstream and downstream in Wilpinjong Creek that are outside of the EIS (WCPL, 2005) predicted loss range - based on comparison of upstream and downstream gauging station data. The maximum predicted flow loss in Wilpinjong Creek in the EIS (WCPL, 2005) was 11% of average annual flow downstream of the mine lease area – upstream of the Wollar Creek confluence – due to the predicted catchment excision due to mining.

Where the trigger is met WCPL would conduct a more detailed investigation of potential streamflow loss and implement contingency measures if required as a result of the detailed investigation.

The trigger would be met if $V_{ds} < F \times V_{us}$

Where:

V_{ds} is the daily average flow at WILGSD over the assessment period;

V_{us} is the daily average flow at WILGSU over the assessment period;

F = (1 - 0.11) x downstream catchment area (216 km^2) / upstream catchment area (89 km^2);

hence - F = 2.16.

Assessments against the flow loss trigger are planned to be undertaken quarterly using flow data recorded for the previous 12 month period which will result in these factors being averaged to reduce the incidence of false triggering, which could be caused by short term effects during prolonged low or high flow. The trigger would be refined if additional data becomes available, such as from any new gauging stations. An analysis of the available flow data to the 7th of March 2013 shows that the trigger would not have been triggered.

2.4 Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources

The surface water resources associated with the Wilpinjong Coal Mine area fall wholly within the Wollar Creek Water Source, in the Goulburn River Extraction Management Unit of the *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources, 2009* (the Hunter Unregulated Water Sharing Plan) made under section 50 of the *Water Management Act, 2000*. The plan commenced on 1 August 2009 and applies to 31 July 2019.

The vision for the Hunter Unregulated Water Sharing Plan includes the following:

> "…*to provide sustainable and integrated management of these water sources for the benefit of both present and future generations."*

The plan defines access conditions for water extraction and rules for extracting water, including limiting the long-term average extraction of water and the amount of water that can be extracted on a daily basis from different flow classes. The Wilpinjong Coal Mine (including the proposed Modification) does not directly extract water from any unregulated water source within the Hunter Unregulated Water Sharing Plan area.

2.4.1 Surface Water Users

The EIS (WCPL, 2005) indicated that there were four privately owned properties with frontage to Wilpinjong Creek and with rights to extract water for stock and domestic purposes. All these properties have subsequently been acquired by WCPL. There are no known licences issued for extraction of water from Wilpinjong Creek (WCPL, 2005). There is no privately owned land on Wollar Creek downstream of the Wilpinjong Creek confluence (note the majority is within Goulburn River National Park – refer Figure 3).

As of June 2013, no surface water related complaints have been received by WCPL.

2.4.2 Harvestable Right

Landholders in most rural areas of NSW have a legal right to harvest a proportion of the rainfall runoff on their property. This harvestable right is administered by limiting the capacity of all dams used to harvest water to a maximum allowable capacity - related to the area of the land holding. This is based on 10% of the average annual regional rainfall runoff and takes into account local evaporation rates and rainfall periods.

WCPL owns a total of 18,026 ha of land in the Wollar Creek catchment. Therefore, the total maximum harvestable right capacity is calculated to be 1,262 ML.

The regulations (made under the *NSW Water Management Act, 2000*) relating to harvestable right exempt the following dams:

1 Dams solely for the control or prevention of soil erosion:
   (a) from which no water is reticulated (unless, if the dam is fenced off for erosion control purposes, to a stock drinking trough in an adjoining paddock) or pumped, and
   (b) the structural size of which is the minimum necessary to fulfil the erosion control function, and
   (c) that are located on a minor stream.
2 Dams solely for flood detention and mitigation:
   (a) from which no water is reticulated or pumped, and
   (b) that are located on a minor stream.
3 Dams solely for the capture, containment and recirculation of drainage and/or effluent, consistent with best management practice…to prevent the contamination of a water source, that are located on a minor stream.

None of the storages on-site are used to harvest runoff from land and all storages are used to contain potentially contaminated drainage, mine water or effluent in accordance with "best management practice" or are used to control soil erosion. It is concluded therefore that all of these storages would be exempt from consideration as a component of the harvestable right calculation.

2.5 Water Quality

2.5.1 Monitoring Program

WCPL have conducted an extensive water quality monitoring program and have compiled a database of water quality observations with site data from 2004 onwards. Monitoring locations include sites on Wilpinjong Creek, Cumbo Creek, Wollar Creek, and on-site water storages. Water quality monitoring is predominantly undertaken by grab sampling, however continuous monitoring of electrical conductivity (EC) and pH occurs at the WCPL gauging stations on Wilpinjong Creek and Cumbo Creek. The surface water quality monitoring locations are shown on Figure 3. Table 5 lists the sites along with monitored parameters and period of data record.

Table 5
Summary of Wilpinjong Coal Mine Surface Water Quality Monitoring Program

Site Name	Site Description	Frequency	Typical Suite of Parameters	Period of Record[1]
WIL-U	Wilpinjong Creek approximately 100 m upstream of Planters Creek Confluence	Monthly	pH, EC, sulphate, turbidity	20/2/2006-11/9/2012
WIL-U2	Wilpinjong Creek upstream of Planters Creek confluence	Monthly	pH, EC, sulphate, turbidity	4/1/2010 – 11/9/2012
WIL 1	Wilpinjong Creek Downstream of Planters Creek confluence	Intermittent	Acidity, alkalinity, metals, chloride, pH, EC, total magnesium, total potassium, sodium, sulphate, total nitrogen, total phosphorous, TDS, TSS, turbidity	1/7/2004 – 20/1/2006
WIL-PC	Wilpinjong Creek at Planters Creek Confluence	Monthly	pH, EC, sulphate, turbidity	20/2/2006 – 11/9/2012
WIL-NC	Wilpinjong Creek at Narrow Creek confluence	Monthly	pH, EC, sulphate, turbidity	4/1/2010 – 11/9/2012
WIL-D2	Wilpinjong Creek downstream of Cumbo Creek confluence	Monthly	pH, EC, sulphate, turbidity	4/1/2010 – 11/9/2012
WIL-D	Wilpinjong Creek downstream of Cumbo Creek confluence	Monthly	pH, EC, sulphate, turbidity	20/2/2006 – 11/9/2012
WIL 2	Wilpinjong Creek downstream of Cumbo Creek confluence	Intermittent	Acidity, alkalinity, metals, chloride, dissolved oxygen, pH, EC, total magnesium, total potassium, sodium, sulphate, total nitrogen, total phosphorous, TSS, turbidity	30/6/2004 – 20/1/2006
WILGSU	Wilpinjong Creek upstream Gauging Station	Continuous	pH, EC, level	8/6/2006 – 7/3/2013
WILGSD	Wilpinjong Creek downstream Gauging Station	Continuous	pH, EC, level	3/8/2005 – 7/3/2013
CC1	Cumbo Creek at Gauging Station (approximately 500 m upstream of confluence with WIlpinjong Creek)	Monthly	pH, EC, sulphate, turbidity	30/6/2004 – 11/9/2012
CC2	Cumbo Creek at ML1573 upstream boundary	Monthly	pH, EC, sulphate, turbidity	30/6/2004 – 11/9/2012
CC3	Cumbo Creek at Wollar Road	Monthly	pH, EC, sulphate, turbidity	30/6/2004 – 11/9/2012

Table 5 (Continued)
Summary of Wilpinjong Coal Mine Surface Water Quality Monitoring Program

Site Name	Site Description	Frequency	Typical Suite of Parameters	Period of Record[1]
CC4	Cumbo Creek at Upper Cumbo Road	Monthly	Acidity, alkalinity, calcium, chloride, pH, EC, total magnesium, total potassium, sodium, sulphate, total nitrogen	30/6/2004 – 28/11/2005
CC5	Cumbo Creek between ML1573 boundary and Wollar Road	Intermittent	Acidity, alkalinity, metals, chloride, pH, EC, total magnesium, total potassium, sodium, sulphate, total nitrogen, total phosphorous, TSS, turbidity	30/6/2004 – 27/6/2005
CCGS	Cumbo Creek Gauging Station	Continuous	pH, EC, level	15/2/2006 – 7/3/2013
WOL1	Wollar Creek downstream of confluence with Wilpinjong	Monthly	pH, EC, sulphate, turbidity	10/9/2004 – 12/7/2012
WOL2	Wollar Creek upstream of confluence with Wilpinjong Creek	Monthly	pH, EC, sulphate, turbidity	30/6/2004 – 11/9/2012
WOL3	Wollar Creek upstream of confluence with Barigan Creek	Intermittent	Acidity, alkalinity, metals, chloride, pH, EC, total magnesium, total potassium, sodium, sulphate, total nitrogen, total phosphorous, TSS, turbidity	12/7/2004 – 20/1/2006
Sediment Dams	Site Storages mainly near and downstream of CHPP	Monthly	pH, EC, sulphate, turbidity	23/1/2008 – 13/6/2012
Clean Water Dam (CWD)	Site Water Storage	Monthly	pH, EC, sulphate, turbidity	23/1/2008 – 13/6/2012
Recycled Water Dam (RWD)	Site Water Storage	Intermittent	pH, EC, sodium. sulphate	23/1/2008 – 13/6/2012
Pit 1 North	Open Cut Pit Water	Monthly	pH, EC, sodium. sulphate	3/2/2008 – 6/1/2010
Pit 2 West	Site Water Storage	Intermittent	Alkalinity, metals, chloride, pH, EC, total iron, sulphate, TDS, TSS, total phosphorus, turbidity	1/1/2011 – 10/9/2012
Ed's Lake	Site Water Storage	Intermittent	pH, EC, sulphate, turbidity	6/1/2010 – 13/6/2012

1 Represents total period of record of monitoring at site. Not all parameters have been monitored for the complete period of record.

Note: TDS = Total dissolved solids.
TSS = Total suspended solids.

2.5.2 Local Creeks

Surface water quality data from the Wilpinjong Coal Mine database has been compared to the Guidelines (ANZECC and ARMCANZ, 2000a), which provides a framework for water quality assessment and management (refer Table 6).

Average pH, EC, turbidity and sulphate data from the Wilpinjong Coal Mine database were compared with guideline trigger values for protection of aquatic ecosystems in south-eastern Australian upland rivers and guideline values for Primary Industries water supplies (livestock drinking water quality). Table 6 provides summary statistics for these parameters for sites upstream and downstream of the Wilpinjong Coal Mine. Exceedances of the guideline trigger values can be as a result of natural catchment conditions and/or land use modification (including mining and non-mining related changes). Water quality monitoring time series plots are shown in Appendix A.

Table 6
Summary of Water Quality Data – Local Creeks

Monitoring Site[1]/Guideline		pH	EC (µS/cm)	Turbidity (NTU)	Sulphate (mg/L)
Wilpinjong Creek Upstream (Sites WIL-U2, WIL-U, WIL 1, WIL-PC)	Average	7.1	1,566	25	75
	Minimum	5.1	150	2	2
	Maximum	8.9	12,190	210	1,760
	No. Samples	157	131	115	135
	% Exceedence[2]	13	92	25	-
Wilpinjong Creek Downstream (Sites WIL-NC, WIL-D2, WIL 2, WILD)	Average	7.7	2,707	22	559
	Minimum	6.4	450	1	26
	Maximum	9.3	7,450	270	1,650
	No. Samples	169	143	124	151
	% Exceedence[2]	17	100	19	-
Cumbo Creek (Sites CC1, CC2, CC3, CC4, CC5)	Average	7.9	4,803	5.3	1,626
	Minimum	6.7	100	0.1	18
	Maximum	9.4	10,500	94	4,625
	No. Samples	204	179	131	181
	% Exceedence[2]	18	100	19	-
Wollar Creek (Sites WOL1, WOL2, WOL3)	Average	7.8	2,000	12	346
	Minimum	6.2	90	0.9	7
	Maximum	9.9	6,540	200	1,500
	No. Samples	176	157	107	154
	% Exceedence[2]	34	91	10	-
ANZECC (2000) Guideline Trigger Values	Protection of Aquatic Ecosystems	6.5 - 8.0	30 - 350	2-25	-
	Primary Industries (Livestock Drinking Water)	6 - 9	950	-	1,000 - 2,000

1 Refer Figure 3.

2 Percentage of samples that are outside the aquatic ecosystem guideline range for slightly disturbed south-east Australia NSW Upland Rivers (ANZECC and ARMCANZ, 2000a).

Note: µS/cm = microsiemens per centimetre.
NTU = Nephelometric Turbidity Units.
mg/L = milligrams per litre.

Average pH in local creeks has a tendency towards slightly alkaline levels. Average EC (a measure of salinity) was elevated in all creeks, particularly Cumbo Creek in which a maximum EC of 10,500 µS/cm has been recorded. This is likely due to the contribution of saline baseflow from the coal measures in the area. Figure 8 shows a plot of recorded EC in grab samples at all sites on Wilpinjong Creek. No obvious trend is evident in the data with time, although EC is typically higher in downstream grab samples.

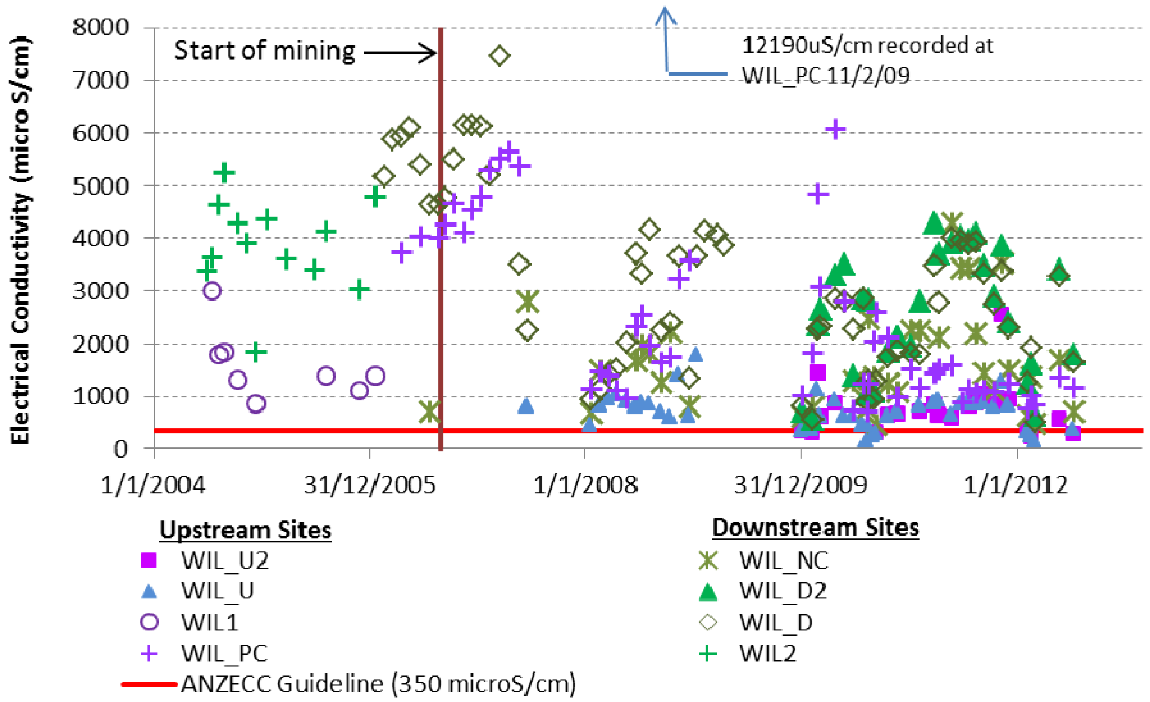


Figure 8 Recorded EC in Wilpinjong Creek Grab Samples

The trend of an increase in EC in Wilpinjong Creek from upstream to downstream is also evident in recorded data from the continuous monitoring at the Wilpinjong Creek gauging stations both prior to and following the start of mining – refer Figure 9. This may be at least partly due to the influence of inflow from Cumbo Creek which typically has a higher salinity than Wilpinjong Creek (refer below). It may also be due to naturally saline groundwater contribution to baseflow between the upstream and downstream monitoring points.

Recorded sulphate data shows similar behaviour, with average values in Wilpinjong Creek below the ANZECC and ARMCANZ (2000a) Primary Industries guideline value, while average values in Cumbo Creek are above the lower bound ANZECC and ARMCANZ (2000a) guideline value.

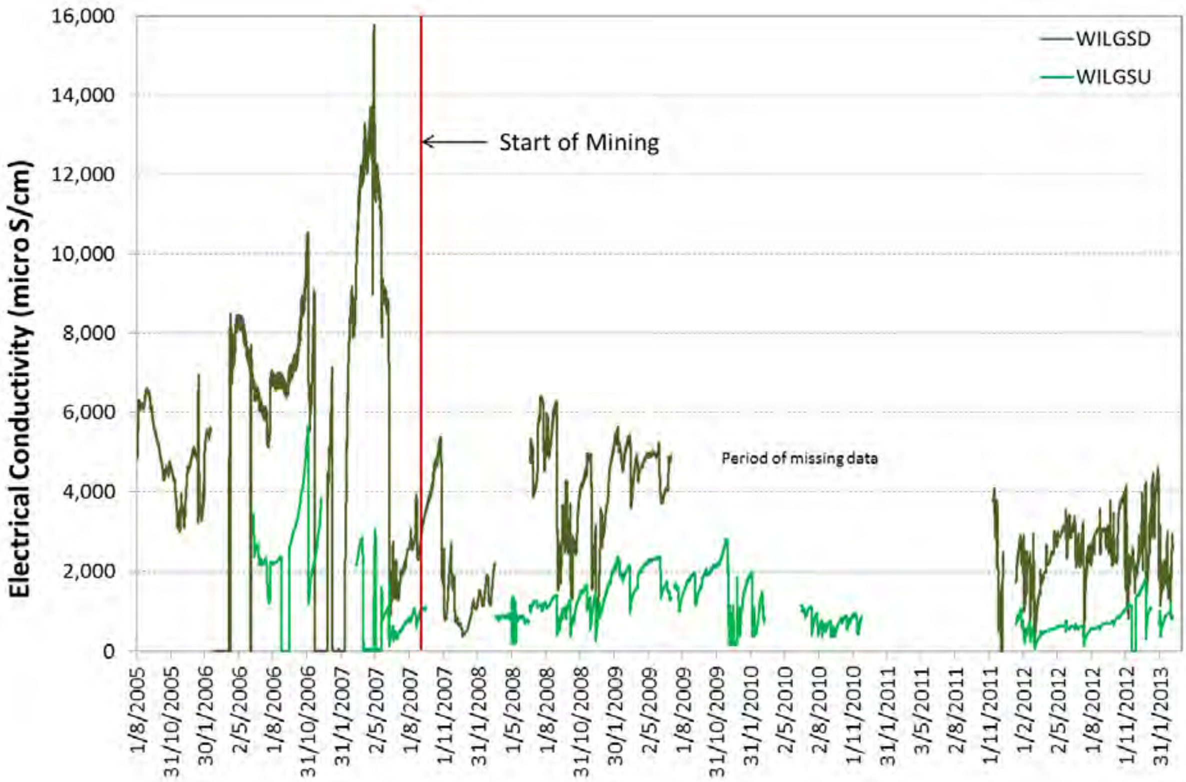


Figure 9 Recorded EC at Wilpinjong Creek Gauging Stations

Figure 10 shows a plot of recorded EC in grab samples at all sites on Cumbo Creek. There does not appear to be any obvious trend with distance along the creek, however EC values appear to have decreased with time.

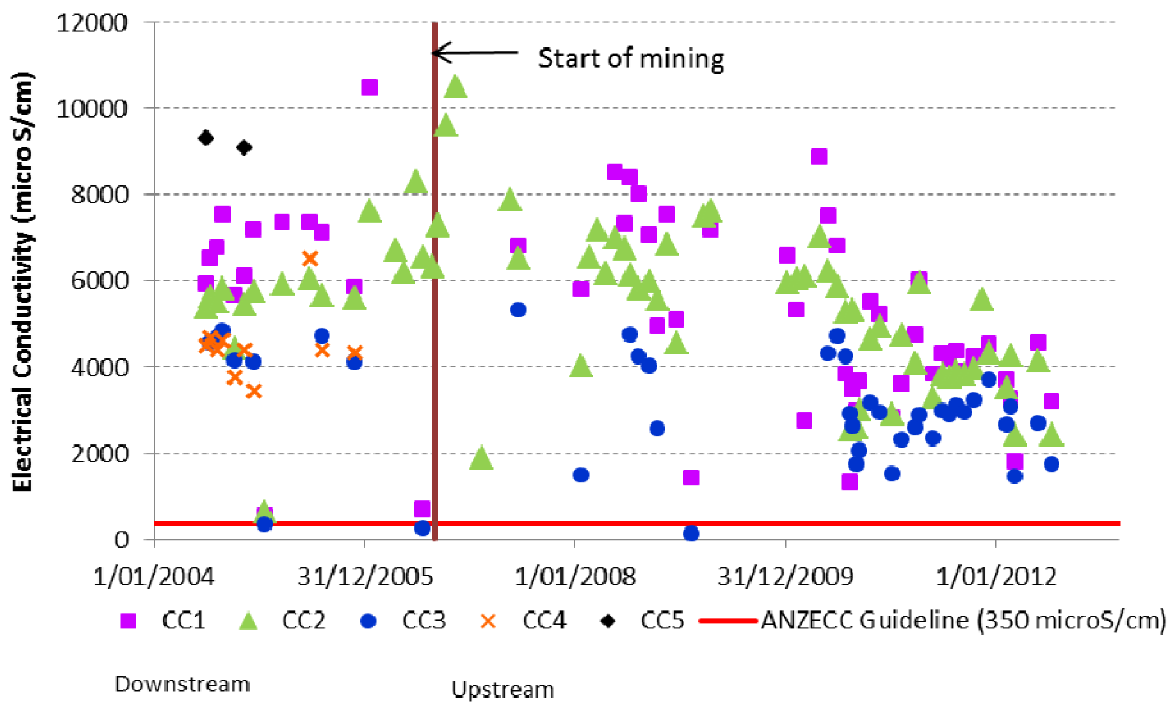


Figure 10 Recorded EC in Cumbo Creek Grab Samples

On the basis of the available data, there does not appear to be any discernible change in Wilpinjong Creek, Cumbo Creek or Wollar Creek pH, EC and sulphate concentrations since the commencement of mining.

2.5.3 Mine Water Storages

Table 7 summarises monitored water quality in monitored mine water storages at the Wilpinjong Coal Mine. Water quality monitoring time series plots are shown in Appendix A. Mine water storages had average pH values between 6.8 and 7.7. Average EC ranged between 2,118 and 2,757 µS/cm while average turbidity values ranged between 6 and 132 NTU. The turbidity was observed to be greatest in the sediment dams with a turbidity range between 0.6 and 3,100 NTU compared to the other mine water storages which had a range between 0.8 and 140 NTU. Average sulphate concentrations ranged between 695 and 1,995 mg/L.

Table 7
Summary of Water Quality Data – Mine Water Storages

Monitoring Site[1]		pH	EC (µS/cm)	Turbidity (NTU)	Sulphate (mg/L)
Pit 2 West	Average	6.8	2,642	-	-
	Minimum	6.1	2,520	-	-
	Maximum	7.4	3,170	-	-
	No. Samples	17	17	-	-
CWD	Average	7.3	2,757	6	1,338
	Minimum	3.8	2,030	0.8	1,000
	Maximum	8.5	3,420	20.3	1,590
	No. Samples	28	28	28	16
RWD	Average	7.7	2,698	9	1,201
	Minimum	6.9	1,890	1	887
	Maximum	8.5	3,250	34	1,420
	No. Samples	48	48	28	17
Pit 1 North	Average	7.4	3,067	45	1,995
	Minimum	6.2	2,310	7.3	1,250
	Maximum	9.5	4,060	140	2,460
	No. Samples	14	14	14	4
Ed's Lake	Average	7.2	2,118	13	695
	Minimum	4.1	560	1.4	138
	Maximum	7.7	3,320	50.3	1,590
	No. Samples	23	25	12	13
Sediment Dams	Average	7.6	2,364	132	912
	Minimum	3.8	80	0.6	21
	Maximum	9.3	5,700	3,100	1,740
	No. Samples	229	229	229	121

[1] Refer Figure 3.

Low recorded pH values in the Sediment Dams were measured in one dam (SCD3 – located at the northern end of the rail loop) during the first quarter of 2008 (during this period values were recorded from 3.8 to 4.5). Recorded SCD3 pH values subsequently rose from April 2008 onwards. The lowest recorded pH value in the remaining Sediment Dams did not fall below 5.6. The highest Sediment Dam pH value of 9.3 was recorded in SCD1, located adjacent to the product coal stockpile, along with other relatively high pH values recorded during 2008. Recorded pH values in SCD1 have subsequently fallen and have not risen above 8.3.

The minimum pH value of 4.1 in Ed's Lake was recorded on a single occasion in 2010 – the next lowest value was 6.9. A number of low pH values were recorded in the CWD from April to September 2010, ranging from 3.8 to 4.4. Prior to and after this time recorded pH values have been higher, not falling below 6.3.

A single elevated value of pH (9.5) was recorded in Pit 1 in March 2009 – remaining recorded values have not risen above 8.0.

The recorded ranges of EC, turbidity and sulphate are typical for open cut coal mining operations.

3.0 SURFACE WATER MANAGEMENT

3.1 Open Cut Development

As currently approved, open cut development would occur in six open cuts, designated as Pits 1 to 6. Advancing mine pits will generally be backfilled with overburden as mining progresses. A future indicative order of pit development incorporating the proposed pit extensions is illustrated in Figure 11. Fine rejects (tailings) disposal has to date occurred in remnant voids at the northern ends of Pit 1 (TD1 and 2) and Pit 2 (TD3, TD4 and TD5). Future tailings disposal is planned for at least two more remnant voids (TD6 and TD7) within the Pit 2 area. Thereafter additional voids within the Pit 1 and Pit 5 areas may be used (and completely filled) or a tailings belt filter press (BFP) commissioned (part of the Modification), which would dewater the tailings to a degree sufficient to enable the product to be combined with coarse rejects and transported by truck for co-disposal into in-pit waste emplacements. The commissioning of a tailings BFP would significantly reduce the makeup water demand of the CHPP (refer Section 3.2.4).

Consistent with the approved mine, two final voids are planned at the end of 2026 – at the northern limit of Pit 3 and south of Pit 6.

3.2 Water Management System

The mine water management system is based on the collection, storage and use of water collected from areas used for the mining and handling of coal and mine waste rock. These areas include:

- open cut pits;
- non-rehabilitated or partially rehabilitated portions of the waste rock dumps;
- tailings disposal areas;
- coal handling areas (i.e. ROM pad, CHPP, haul roads); and
- runoff from undisturbed areas which cannot be diverted around mine areas and therefore report to one of the above areas.

3.2.1 Drainage from Undisturbed Catchments

The generation of mine water is controlled by the interception and diversion of runoff from undisturbed and rehabilitated landforms around mining areas where practicable. Diversions are proposed to be developed progressively as required over the life of the mine in accordance with the open pit mining progression. The conceptual layout of diversions for the remainder of the mine life is shown on Figure 11.

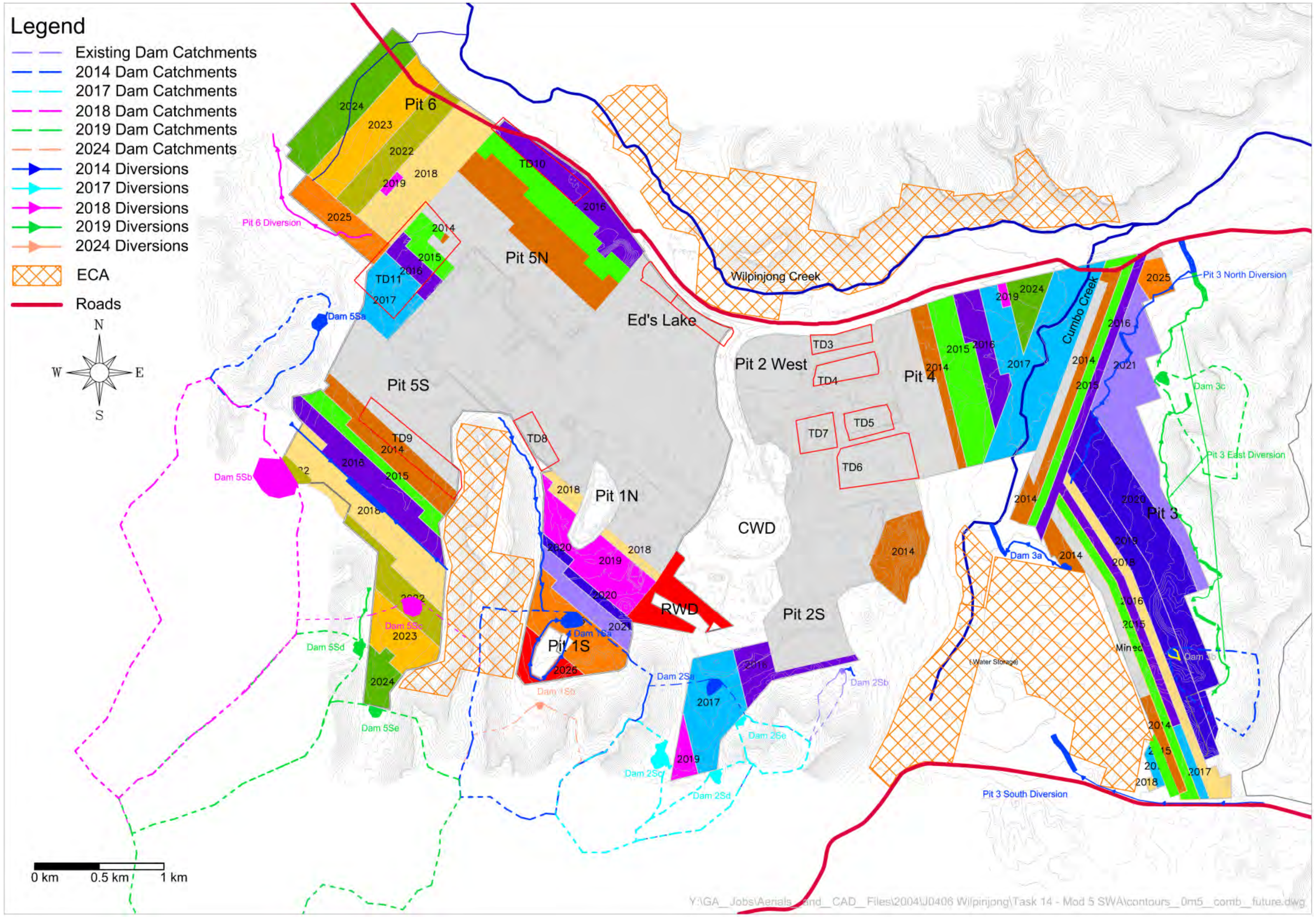


Figure 11 Future Open Cut Development and Conceptual Layout of Upslope Diversions

To the south of Pits 1, 2, 5 and 6, diversions of the headwaters of Spring Creek, Narrow Creek and Bens Creek are proposed comprising “contour” drains (constructed at low longitudinal gradient) which would discharge to diversion dams. Accumulated water in these upslope diversion dams would be discharged in between runoff events by either pumping or gravity flow through pipelines located either around or through the mining operations to stabilised outfalls, ultimately reporting to either Wilpinjong Creek or Cumbo Creek. An existing diversion at the southern end of Pit 5 (refer Figure 11) has effectively prevented flow from an upslope catchment into Pit 5. A similar system is proposed for diversion of runoff from upslope (east) of Pit 3, however this system would involve fewer diversion dams and more contour drains and rockfill-lined drop structures.

All diversions would be constructed outside of Enhancement and Conservation Areas (ECA).

The only changes to the upslope diversions that would result from the extension to open cut pit areas proposed as part of the Modification (refer also Figure 2) would occur south of Pit 3 as follows:

- Diversion Dam 3a and associated outflow drain and drop structure to Cumbo Creek; and
- Pit 3 South Diversion and associated drop structure.

The final locations and form of upslope diversion works would be subject to progressive detail design and/or survey and would be designed in accordance with the Erosion and Sediment Control Plan prepared in consultation with NOW. Consistent with the EIS (WCPL, 2005), the design capacity of these diversion works would depend on:

- the size and nature (e.g. soil type) of the upslope catchment;
- the design life of the diversion; and
- the consequences of a breach.

Depending on the above, the design capacity would range from the peak flow generated by the 2-year average recurrence interval (ARI) rainfall through to that generated by the 100-year ARI. Diversions would be designed to be stable (non-eroding) at the design flows. Stabilisation would be achieved by design of appropriate channel cross-sections and gradients and the use of channel lining with grass or rockfill as required.

3.2.2 Water Management System Description

The mine water management system is shown in schematic form on Figure 12 and will be progressively developed as water management requirements for open cut pit development and rehabilitation change over time. There would be no significant change to the mine water management system as a result of the Modification, other than obviating the need for additional future tailings storages due to the commissioning of a tailings BFP (refer Section 3.1).

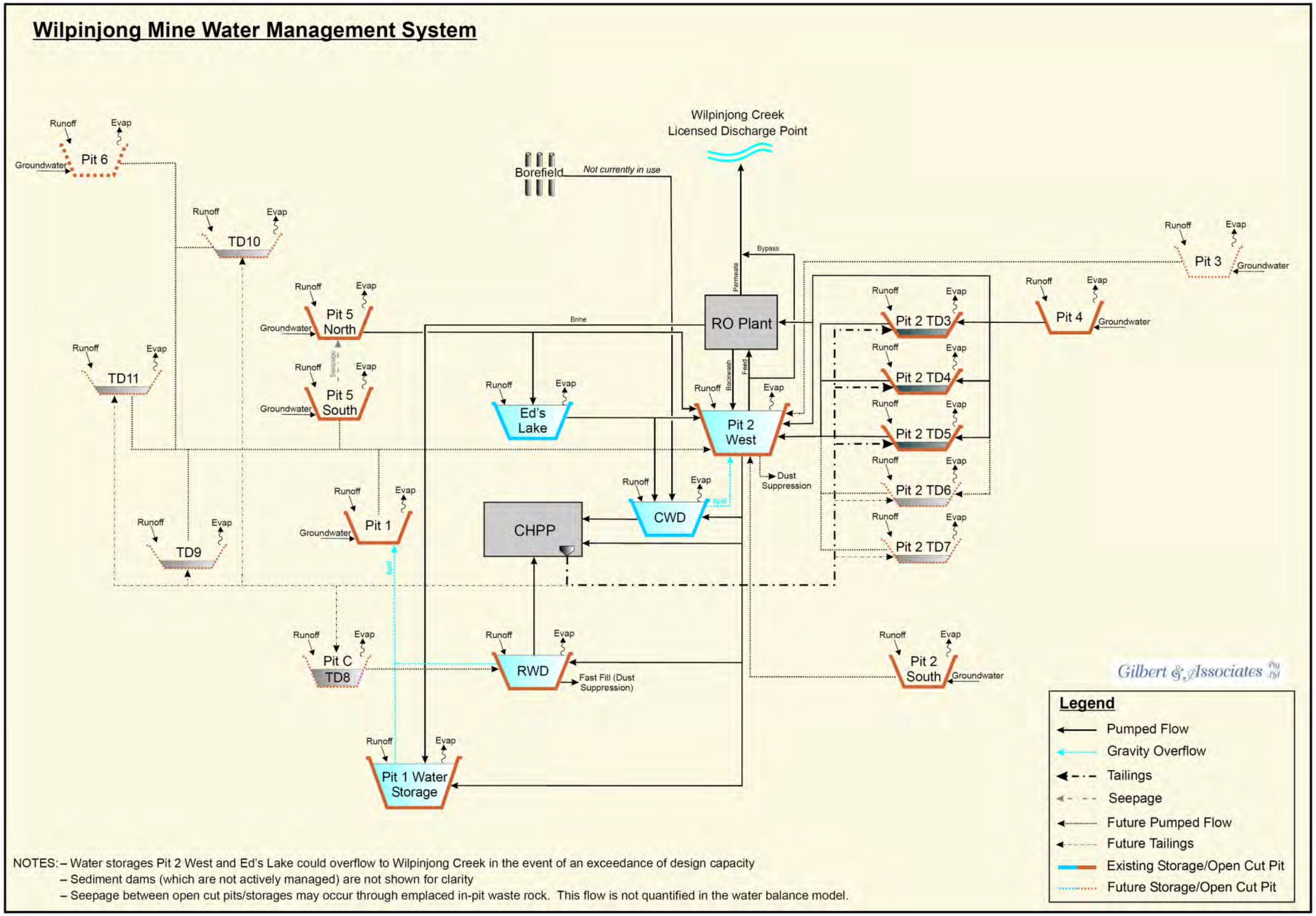


Figure 12 Mine Water Management System

The main components of the system include the following (refer Figure 12):

- Pit 2 West is a remnant void in the north-west corner of Pit 2 and is the main mine water storage, receiving pumped inflow from open cut pits and other water storages. Pit 2 West is a supplementary supply source for the CHPP and provides water to other storages and for treatment prior to licensed discharge (refer below). Pit 2 West has an estimated capacity of 3,977 ML, including estimated storage capacity in the pore space of the adjacent in-pit waste rock emplacement.
- The Recycle Water Dam (RWD) provides water for haul road dust suppression via a "fastfill" point, as well as supplementary supply to the CHPP. The RWD is principally supplied by pumped transfer from Pit 2 West. The RWD has an estimated capacity of 432 ML. The proposed open cut pit development (Figure 11) would see this storage intersected by the Pit 1 open cut in approximately 2026.The CWD is an above-ground water storage constructed within the rail loop. It is the principal source of supply for the CHPP. The CWD is supplied by pumped transfer from Pit 2 West and Ed's Lake. The CWD has an estimated capacity of 47 ML.
- Ed's Lake is a small storage dam within the mined out northern end of Pit 1 that receives runoff from partially rehabilitated waste rock emplacement and other active mining areas. It is used as a staging storage for water pumped from Pit 5 North, principally to Pit 2 West. It has an estimated capacity of 50 ML.
- A series of tailings storages have been constructed within remnant open cut pit voids (refer Section 3.1 above). In the past supernatant water has been recovered for re-use from the tailings storages by pumping, however the current storage TD5 does not pond water and seepage is believed to occur from this storage north to Pit 2 West.
- Upslope clean water diversions to divert runoff from areas undisturbed by mining and related activities.
- A pit dewatering system, which allows removal of water from open cut pit sumps to Pit 2 West. This will be expanded as additional open cut pits are developed. Active pumping from open cut pits on the southern side of the mine area (e.g. Pit 5 South) does not presently occur – likely because of limited groundwater inflow and seepage of any accumulated rainfall runoff to the northern end of the mine (e.g. Pit 5 North). However, in the event of prolonged or intense rainfall, dewatering from these open cut pits may also need to occur.
- An RO water treatment plant located adjacent to Pit 2 West. Feed water is supplied to this facility principally from Pit 2 West, with supplementary supply direct from open cut pits. RO Plant permeate is discharged to Wilpinjong Creek in accordance with the requirements of Environment Protection Licence (EPL)12425 which prescribes water quality (maximum 500 µS/cm EC) and daily discharge volume (maximum 5 ML/d) limits. Permeate is mixed with a proportion of feed water prior to discharge to meet the applicable discharge criteria. Backwash from the RO Plant is discharged to Pit 2 West, while brine is pumped to Pit 1 Water Storage.

- Pit 1 Water Storage is a remnant void located at the southern end of the Pit 1 area. The current main purpose of this water storage is to store RO Plant brine. Pit 1 Water Storage has an estimated capacity of 535 ML. The proposed open cut pit development (Figure 11) would see this storage intersected by the Pit 1 open cut in approximately 2025. In the final year of mining it is assumed that RO Plant brine would be discharged to Pit 2 West.

Potable water would continue to be trucked to the site to supply drinking water and ablution facilities in the office and crib areas. Sewage treatment would continue to occur at a domestic sewage treatment facility located near the mine administration area and at the CHPP septic system. Treated effluent would continue to be irrigated in accordance with the EPL.

3.2.3 Water Supply Sources

The mine water supply system consists of collection of runoff from open cut mining areas, groundwater inflows to the open cut pits, runoff collected from associated disturbance areas (including waste rock emplacements), water recovered from settling tailings and supply from the approved water supply borefield (not currently in use). The approved Wilpinjong Coal Mine includes a water supply borefield of up to 19 production bores located to the north of the mine area Five existing production bores have been developed to date and are licensed to each provide up to 110 ML annually (equivalent to 3.5 litres per second [L/s] if pumped continuously). Additional production bores would be established as required over the life of the mine.

It is understood that WCPL also has an in principle agreement with the nearby Ulan Coal Mines to source excess water from this mining operation (by pipeline) if required in the future. Any such pipeline would be subject to separate environmental assessment and approval.

The water supply system for the Wilpinjong Coal Mine incorporating the Modification will remain substantially unchanged. The majority of the mine make-up water supply requirements will be met by dewatering of the open cut mining areas and rainfall runoff (refer Section 4.3.1). Sumps excavated in the floor of each open cut as part of routine mining operations will capture both runoff from surrounding disturbed areas and groundwater inflow. Groundwater inflows to the open cut pits are predicted to vary over the mine life and have been estimated by HydroSimulations (2013).

Supernatant water will continue to be recovered from tailings storages (remnant open cut voids) until commissioning of the tailings BFP. Water recovered from the tailings BFP would be internally recycled within the CHPP, reducing make-up demand (refer Section 3.2.4).

3.2.4 Water Supply Requirements

The main water usage for the mine is and will continue to be associated with the washing of ROM coal in the CHPP. CHPP make-up water is required to replace water pumped out with thickened tailings slurry (or, in the future, tailings BFP filter cake) and also due to moisture increases in product coal and coarse reject material as a by-product of site processing of ROM coal. CHPP makeup demand is therefore a function of these moistures as well as future planned CHPP ROM coal feed rates and the rates of production of product coal, coarse reject and tailings. Table 8 summarises estimated future production rates, calculated from data supplied by WCPL.

Table 8
Wilpinjong Coal Mine CHPP Production Schedule

Year	CHPP Feed |(Mt)*	CHPP Product (Mt)*	Coarse Reject (Mt)*	Tailings (Dry Mt)
2013	9.00	5.54	3.50	0.56
2014	9.00	5.67	2.79	0.54
2015	8.50	5.35	2.63	0.51
2016	8.50	5.35	2.63	0.51
2017	8.50	4.76	3.23	0.51
2018	8.33	4.66	3.17	0.50
2019	4.42	2.48	1.67	0.27
2020	4.14	2.32	1.57	0.25
2021	4.31	2.41	1.63	0.26
2022	4.53	2.31	1.95	0.27
2023	4.08	2.04	1.80	0.24
2024	4.02	2.01	1.77	0.24
2025	2.66	1.33	1.17	0.16
2026	1.81	0.91	0.80	0.11

* Tabulated tonnages are total tonnes at the CHPP feed moisture content given below (to enable direct comparison).

The following key typical material moisture contents that relate to operation of the CHPP were advised by WCPL:

- ROM coal feed: 7.5% w/w.
- Product coal: 10.32% w/w.
- Coarse reject: 14.65% w/w.
- Tailings slurry without BFP: 66.8% w/w (33.2% solids concentration).
- Tailings filter cake with BFP: 35% w/w.

Total future CHPP makeup demand was calculated based on the above data. Figure 13 shows the variation in calculated CHPP demand over the remaining mine life both with and without the addition of the tailings BFP. Figure 13 shows that CHPP demand is anticipated to approximately halve as a result of the commissioning of the tailings BFP.

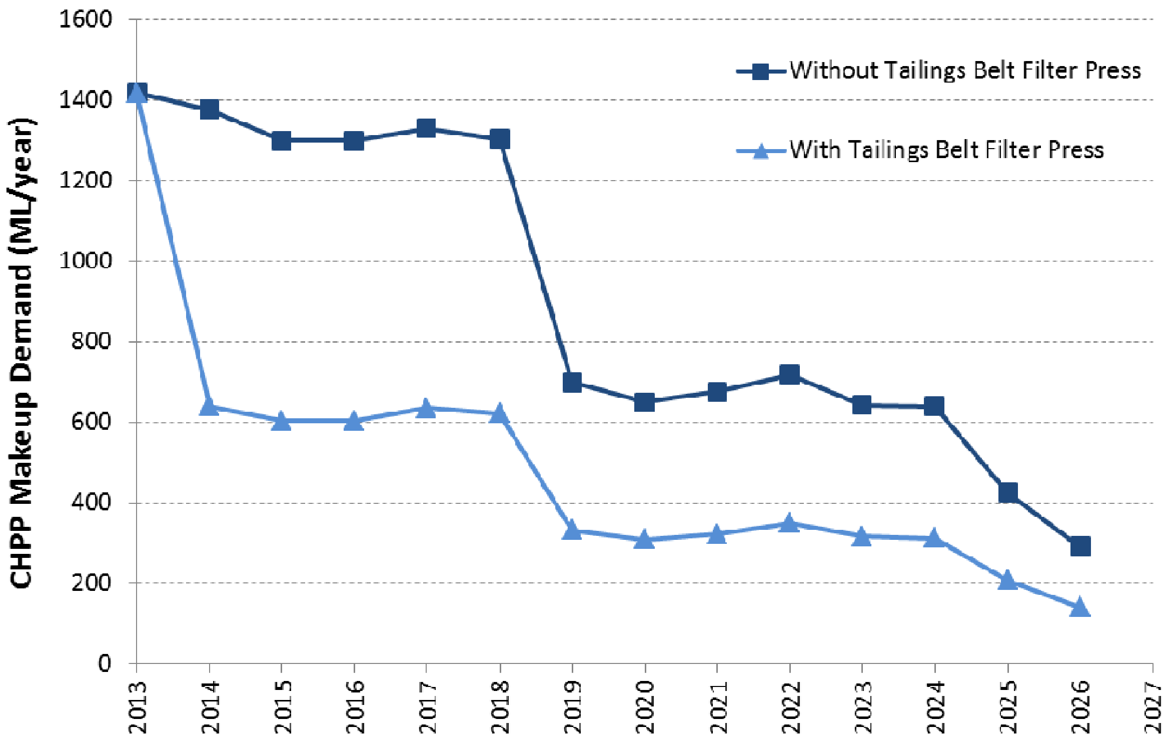


Figure 13 Calculated CHPP Water Demand with Time

The other main water usage on site comprises water for dust suppression on haul roads. Monitored haul road water usage for the last two operating years (2011-2012) provided by Thiess (mining contractors) was compared with predicted usage calculated based on haul road area and evaporation rate multiplied by a factor (calibration variable). Figure 14 shows the comparison between monitored and the calculated rate based on daily pan evaporation rates multiplied by 1.3. The monitored and calculated rates both show a seasonal trend in haul road water use with lower water use over the winter period.

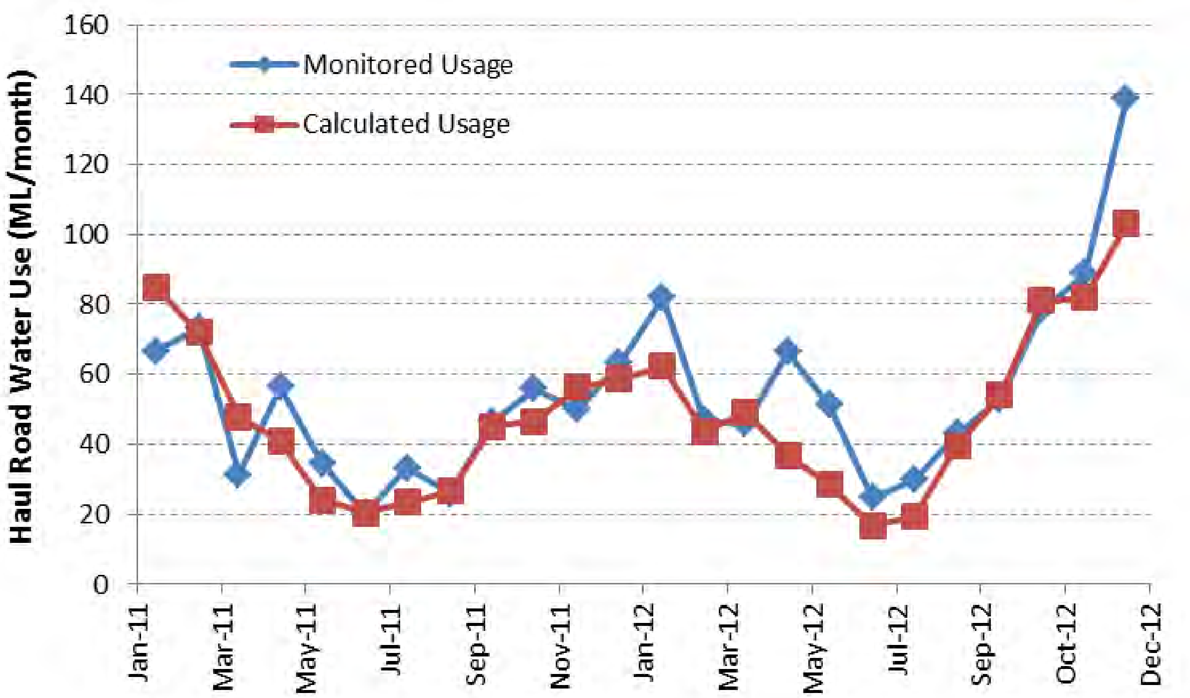


Figure 14 Monitored and Calculated Haul Road Water Use 2011–2012

The future haul road demand has been calculated based on the above rate and estimated future haul road lengths. Figure 15 shows average simulated daily haul road demands based on haul road areas provided by WCPL and monthly evaporation rates.

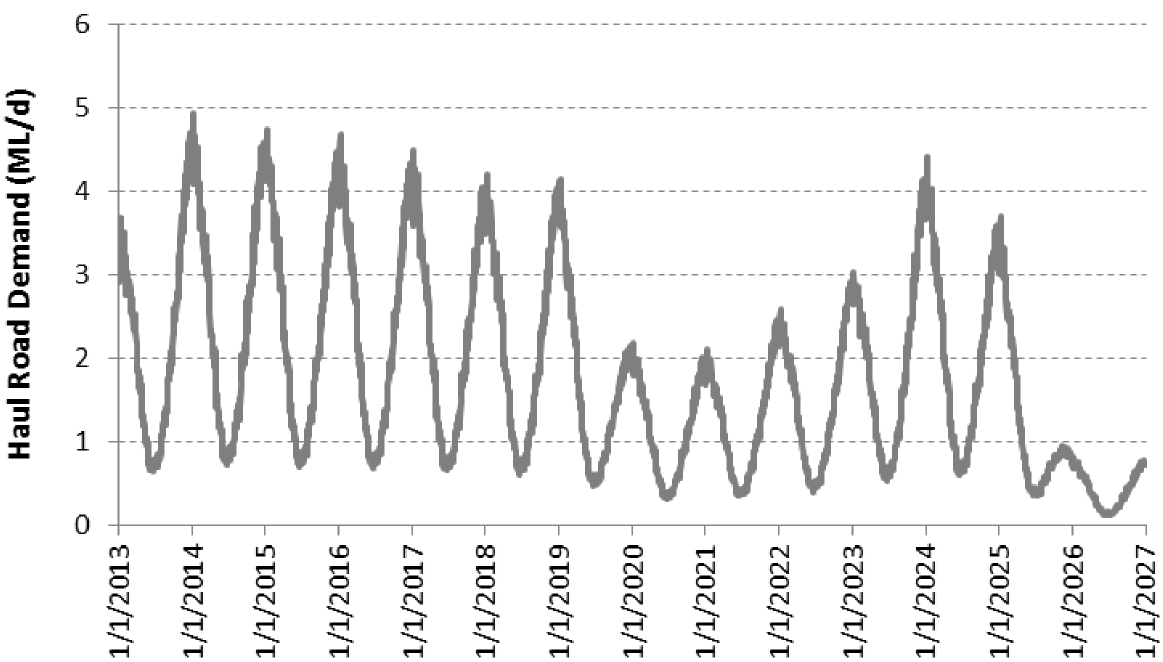


Figure 15 Calculated Average Haul Road Water Demand with Time

Where practicable, mine water supply is and will continue to be prioritised as follows:

1. Internal recycling of water within the CHPP (thickener overflow, tailings BFP filtrate).

2. Capture of runoff from active mine operational areas (i.e. CHPP, facilities and stockpile areas).

3. Dewatering of active open cut mining areas including groundwater inflows, upslope runoff and infiltration/runoff from adjacent mine waste rock emplacements. Recovery of supernatant waters and seepage collected from tailings disposal areas.

4. Dewatering of inactive open cut mining areas (including mine water storages) including groundwater inflows, upslope runoff and infiltration/runoff from adjacent mine waste rock emplacements.

5. Licensed extraction from mine water supply bores.

3.2.5 Operational Management and Objectives

The water management system would operate predominantly as a closed, self-contained system. The water balance of the system would fluctuate with climatic conditions and as the extent and status of the mining operation evolves over time. Depending on the climatic conditions that are experienced during the mine life and the ability to temporarily store water in mine water storages, tailings storages and open cut pits, there may be periods where licensed discharge of treated water to Wilpinjong Creek may be required to manage surplus water. Under these circumstances, water would continue be discharged following RO Plant treatment in accordance with EPL12425.

There may also be periods when the availability of water on-site is such that RO Plant treatment and licensed discharge would cease, and there may also be a need to source water externally from the approved water supply borefield or from the nearby Ulan Coal Mines under agreement.

The water management system would continue to evolve over time to meet the changing requirements of the mine. The successful performance of the water management system, as with any mine water management system, would involve forward planning and having a combination of adequate water infrastructure and the necessary management and monitoring procedures in place to achieve the performance objectives.

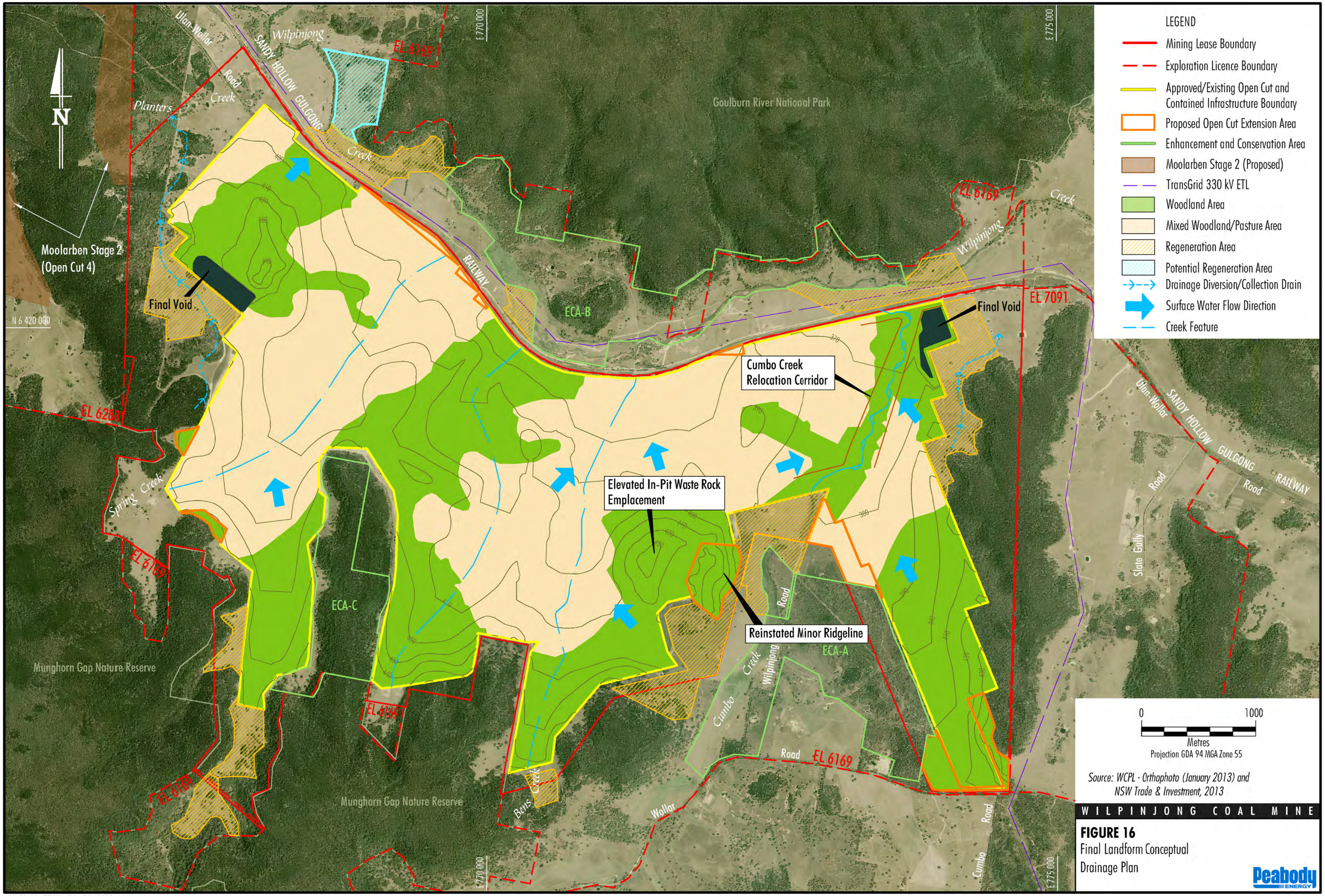
Consistent with the EIS (WCPL, 2005), the broad aims of the system are:

1. Efficient use of water based on the concepts of 'reduce, reuse and recycle'.
2. Avoiding or minimising contamination of clean water streams and catchments.
3. Protecting downstream water quality for beneficial uses.

The broad design objectives of the water management system are:

1. To maintain a low risk of an uncontrolled release of mine water (water that has come in contact with active mining and operational areas) to the downstream environment over the remaining mine life.
2. To minimise risks of disruption to mining operations by efficient mine dewatering.
3. To achieve a high volumetric water supply reliability for the CHPP and for dust suppression.
4. To provide the effective diversion of upslope runoff around mine disturbance areas.

Until rehabilitated landforms have satisfactorily stabilised, runoff from these areas would be directed to open cut pits or mine water storages for use on site. Once stabilised, rehabilitated landforms would be allowed to free drain and contribute runoff to Wilpinjong and Cumbo Creeks. The post mining landform plan (at the completion of mining), remains largely unchanged from that proposed in the EIS (WCPL, 2005), however, it would include some increased elevation in-pit waste rock emplacement landforms – refer Figure 16.



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4.0 SIMULATED PERFORMANCE OF WATER MANAGEMENT SYSTEM

4.1 System Simulation Model Description and Assumptions

The ability of the water management system to achieve its operational objectives was assessed by simulating the dynamic behaviour of its water balance over the entire mine life under the variable climatic conditions that may be encountered. The water balance model developed for the Wilpinjong Coal Mine simulates all the inflows, outflows, transfers and changes in storage of water on-site on a continuous basis from the beginning of 2013 to the end of 2026 (the end of mining). The general components and linkages of the water management system simulated by the model are shown in schematic form on Figure 12.

The model simulates the water (mass) balance of all existing and proposed storages on a sub-daily time interval. The model was set up to run over a large number of different climatic sequences compiled from the historical regional record (rainfall Data Drill – refer Section 2.2) from 1889 onwards. Each sequence comprised a 14-year period (2013 to 2026 inclusive). The sequences were formed by “moving” along the historical record one year at a time with the first sequence comprising the first 14 years in the record. The second sequence comprised years 2 to 15 in the record while the third sequence comprised years 3 to 16 and so on. The start and end of the historical record was ‘linked’ so that additional sequences which included years from both the beginning and end of the historical record were combined to generate additional climate sequences. Using this methodology 124, 14-year sequences of daily rainfall and evaporation were formulated for use in the model simulations. The results from all sequences were used to generate water storage volume estimates and other relevant water balance statistics. This method effectively includes all recorded historical climatic events in the water balance model, including high, low and median rainfall periods.

The model included simulation of licensed discharge (including RO Plant permeate) to Wilpinjong Creek. It was assumed that a discharge daily volume of 3.5 ML/d would be discharged from the start of 2014, while for the remainder of 2013 discharge at a reduced rate (averaging 0.61 ML/d – based on current RO Plant operation) was assumed. It was further assumed that if the total volume of water held on site in all storages and open cut pits fell below 2,500 ML, the RO Plant and licensed discharge would cease operation and not recommence until the total volume of water held in all storages rose above 3,200 ML. Notwithstanding the above, it was also assumed that the RO Plant would operate for at least one month per year (assumed to be June) to maintain serviceability of the plant (refer also Section 5.1).

The Australian Water Balance Model (AWBM) (Boughton, 2004) was used to simulate runoff from rainfall on the various catchments and landforms across the mine area. The AWBM is a nationally-recognised catchment-scale water balance model that estimates streamflow from rainfall and evaporation. Modelling of the following seven different sub-catchment types was undertaken:

- Natural Surface/Undisturbed.
- Mine waste rock (overburden) Emplacements.
- Partially Rehabilitated Areas (with little vegetation).

- Rehabilitated Areas (well grassed).
- Hardstand/Roads.
- Open Cut/Mine.
- Tailings.

AWBM parameters for undisturbed areas were derived by calibrating the AWBM against recorded streamflow in Wilpinjong Creek at WILGSU (refer Section 2.3). Parameters for the remaining sub-catchments were initially taken from literature-based guideline values or experience with similar projects. These were then adjusted on the basis of calibration (refer Section 4.2).

WCPL have undertaken to implement the following system upgrades to mitigate the risk of spill from Ed's Lake that have been incorporated into the site water balance model:

- Increase (double) the pump rate from Ed's Lake by the end of 2013.
- Cease using Ed's Lake as a staging storage by mid-2014 and increase (double) the pump rate from Pit 5 North.

4.1.1 Catchment Areas

Catchment areas were calculated from future mining stage plans developed using an annual mine development plan provided by WCPL, together with the conceptual upslope diversions described in Section 3.2.1. Figure 17 shows the variation in calculated total catchment area (catchment reporting to mine water storages and open cut pits) over the mine life. Figure 17 shows that the calculated mine total catchment would peak at 16.6 km^2 in 2018.

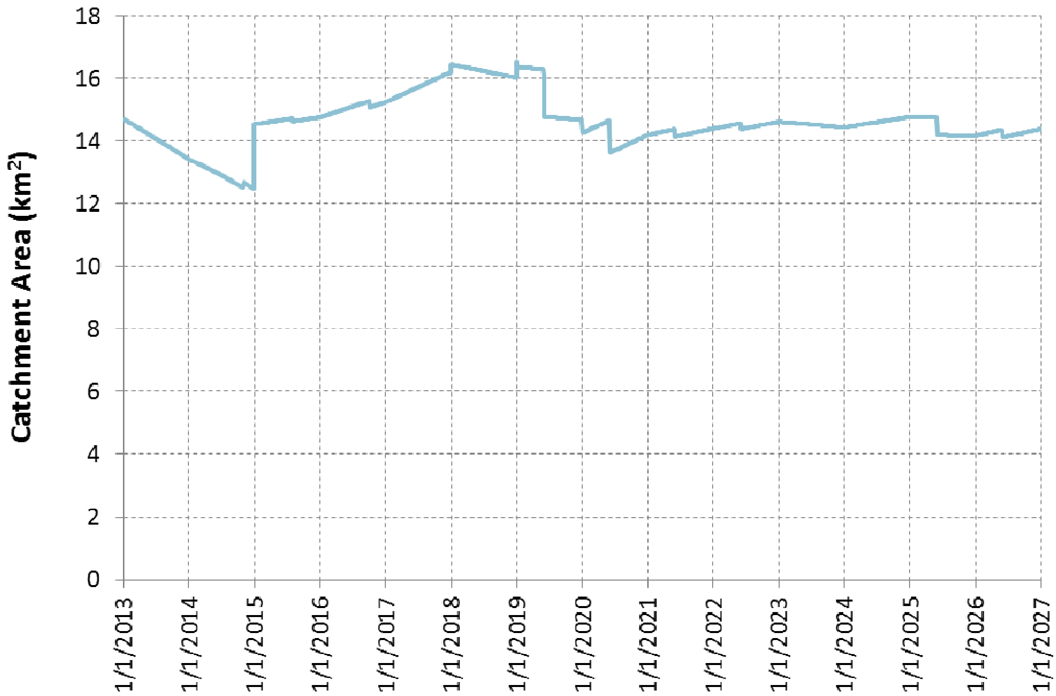

Figure 17 Mine Catchment Area Change with Time

4.1.2 CHPP

Total CHPP demand was calculated based on advised ROM coal (CHPP feed), rejects and product moistures and the CHPP feed and production rates given in Table 8 (refer Section 3.2.4). Figure 13 (Section 3.2.4) shows the variation in calculated CHPP demand over the remaining mine life both with and without the addition of a tailings BFP – varying from a peak of approximately 1,400 ML per annum (ML/annum) to less than 200 ML/annum.

4.1.3 Haul Roads

Future haul road demand has been calculated based on monitored usage rates and haul road lengths estimated from future mining stage plans (refer Section 3.2.4). Calculated average demand was 624 ML/annum with average daily rates varying from less than 0.5 ML/d to 5 ML/d with significant seasonal variation (refer Figure 15 – Section 3.2.4).

4.1.4 Storage Volumes

Storage volumes calculated by the model were used to calculate storage surface area (i.e. water area) based on storage volume-area-level relationships for each water storage which were derived from supplied contour plans or which were provided directly by Thiess mining contractors. Evaporation from storages is calculated in the model by multiplying storage surface area by daily pan evaporation rate. A pan factor of 0.9 was used in the model for all storages (except the tailings storages and open cut pits), to allow for the typically lower evaporation from open water bodies compared to evaporation pans. A pan factor of 1.1 was used for the tailings storages because the tailings are dark with low reflectance, which typically increases the effective evaporation rate. A pan factor of 0.8 was used for open cut pits because of the effects of shading and reduced wind at depth.

4.1.5 Groundwater Inflows

Groundwater inflows to open cut pits were included in the water balance model. Predicted groundwater inflows varying with time were provided by HydroSimulations (2013) – refer Table 9. The predicted average 14-year groundwater inflow rate for the remaining mine life is 1,028 ML/annum. Losses due to evaporation of seepage from the highwall of each open cut were allowed for in the water balance model.

Table 9
Predicted Groundwater Open Cut Pit Inflow Rates (HydroSimulations, 2013)

Year	Predicted Inflow Rates at Start of Given Year (ML/d)					
	Pit 1	**Pit 2**	**Pit 3**	**Pit 4**	**Pit 5***	**Pit 6**
2011	0.00	0.04	0.00	0.00	1.12	0.00
2012	0.00	0.00	0.00	0.55	2.01	0.00
2013	0.00	0.00	1.84	0.75	2.18	0.00
2014	0.00	0.00	1.81	0.74	2.31	0.00
2015	0.00	0.00	2.09	1.03	2.48	0.00
2016	0.00	0.00	1.70	0.92	2.39	0.00
2017	0.00	0.00	0.52	1.86	0.50	0.00
2018	0.00	0.00	0.00	0.00	0.25	2.29
2019	0.00	0.00	0.00	0.46	0.00	0.27
2020	0.00	0.00	0.07	0.00	0.00	0.00
2021	0.00	0.00	1.73	0.00	0.00	0.00
2022	0.00	0.00	0.00	0.00	0.00	2.18
2023	0.00	0.00	0.00	0.00	0.00	2.64
2024	0.00	0.00	0.00	1.35	0.00	2.81
2025	0.00	0.00	1.21	0.00	0.11	0.91
2026	0.00	0.00	0.00	0.00	0.00	0.00

* Assumed to be Pit 5 North (refer Figure 11).

Monitoring data provided by Thiess mining contractors indicates that approximately 3,800 ML was held in the mine water storages at the start of January 2013. This was taken as the starting condition in the model.

4.2 Model Calibration

Continuous monitoring data was not available to calibrate the water balance model on individual water storage behaviour (refer Section 8.0 for recommendations for future monitoring). Instead calibration was undertaken by comparing model estimates of total water volume stored in all site storages against water volumes estimated from weekly or daily site records for the 2 year period 2011 to 2012. The following data was used in model calibration:

- Recorded daily rainfall data from the WCPL weather station.
- Daily pan evaporation data sourced from the Silo Data Drill.
- Open cut pit and mine water storage catchment areas estimated from contour plans supplied at quarterly intervals by Thiess mining contractors and periodic aerial photos supplied by WCPL.
- Recorded weekly water storage water levels provided by Thiess mining contractors, which were used along with storage volume-area-level relationships for each water storage to estimate water storage volumes over the two year period. It was assumed stored water volumes in open cut pits (not recorded) were relatively small.
- Recorded daily CHPP water supply volumes provided by Thiess mining contractors.

- Daily CHPP feed and product tonnages provided by Thiess mining contractors. Tailings tonnages were calculated based on an assumed 6% of feed. Recoverable tailings water was assumed to be 20% of water pumped with tailings.
- Recorded weekly (approximately) haul road dust suppression water usage volumes provided by Thiess mining contractors.
- Recorded RO Plant daily discharge volumes, converted to feed volumes by assuming discharge is 70% of feed.
- Recorded licensed emergency discharge daily volumes from mine water storages in early 2011 provided by Thiess mining contractors.
- Groundwater inflow estimates to open cut pits provided by HydroSimulations (2013) – refer Table 9.

AWBM parameters (for sub-catchments other than natural surface/undisturbed) and groundwater inflow rates were adjusted iteratively to improve the match between modelled and estimated actual total water volume.

Groundwater inflow estimates provided by HydroSimulations are based on average rainfall conditions, while rainfall prior to the calibration period was quite high (150 mm and 231 mm in November and December 2010 respectively). Therefore adjustment of groundwater inflow rates was undertaken. Groundwater inflow rates were increased by up to 2.5 times the rates provided, with highest values in the first year of the calibration period (2011). Figure 18 below shows modelled and estimated actual total water volume both without and with adjustment of groundwater inflow rates.

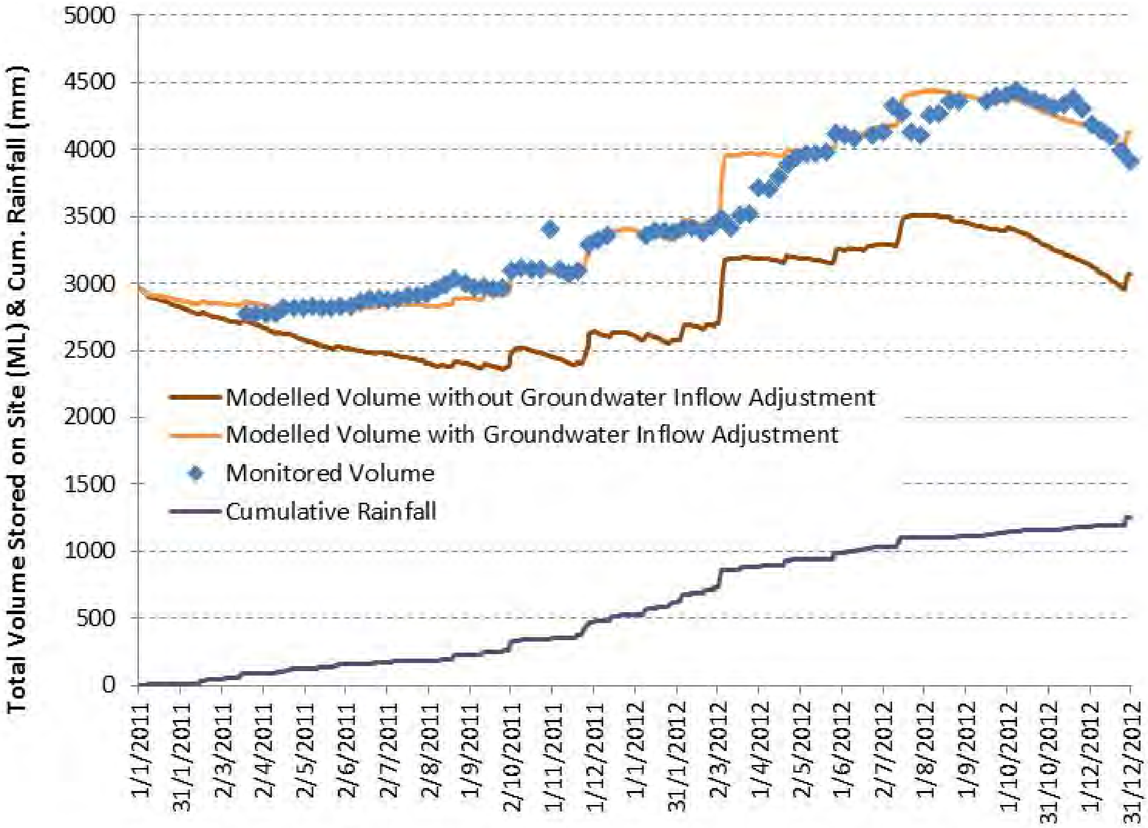

Figure 18 Modelled and Estimated Actual Total Volume with and without Groundwater Inflow Adjustment

The adjusted AWBM parameters derived from the calibration were used in subsequent simulation of future water management system performance. No adjustment of groundwater inflows was made in these simulations, however the sensitivity of model predictions to increased groundwater inflow rate has been assessed (Section 4.3.5).

4.3 Simulated Future System Performance

4.3.1 Overall Water Balance

Figures 19 and 20 below summarise model predicted system inflows and outflows for the remaining mine life, both with and without the tailings BFP, averaged over all climatic sequences.

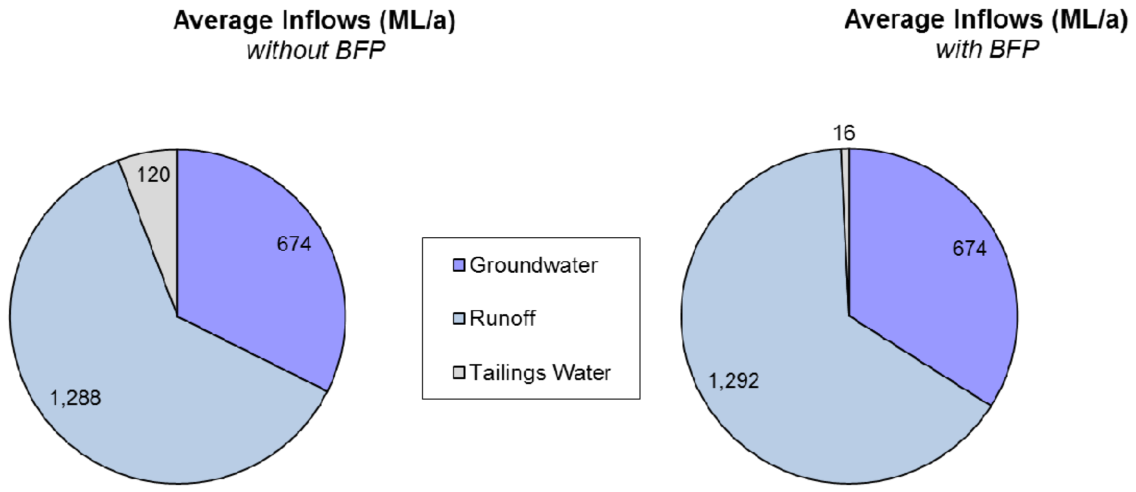

Figure 19 Average Model System Inflows

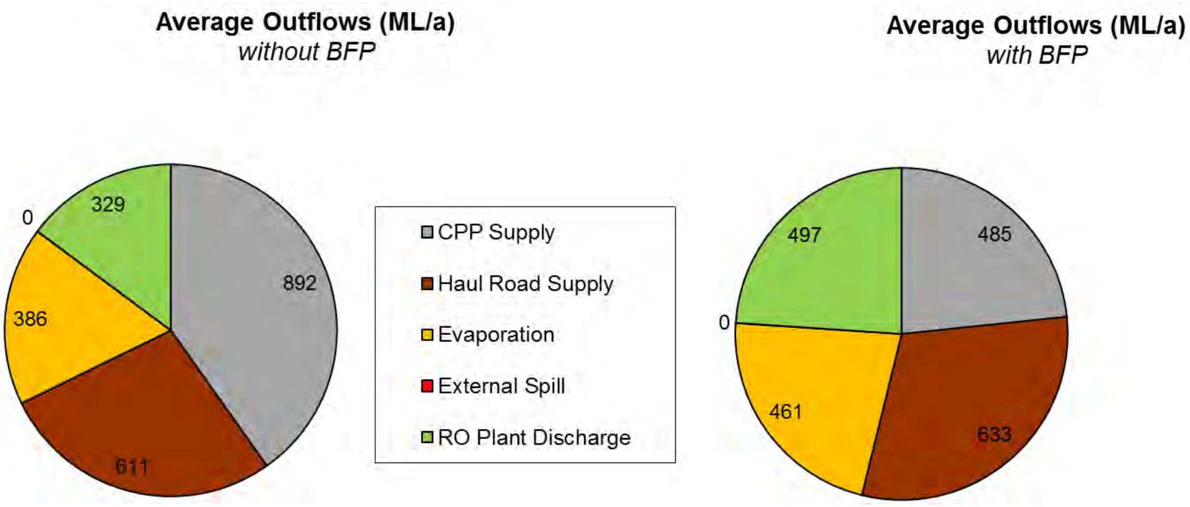

Figure 20 Average Model System Outflows

Predicted average inflows total 2,082 ML/annum without the tailings BFP and 1,982 ML/annum with the BFP. Average predicted outflows total 2,218 ML/ annum without the tailings BFP and 2,077 ML/annum with the tailings BFP. The difference between the inflows and outflows represents change in storage at the Wilpinjong Coal Mine between the start of the prediction period (2013) and the end of mining (2026). Note that the groundwater values given in Figure 19 represent the modelled groundwater inflow after allowing for in-pit evaporation and are therefore less than the values in Table 9.

Model results for the remaining mine life for high rainfall (90th percentile), median and low rainfall (10th percentile) sequences were obtained from model results and are summarised in Table 10 below.

Table 10
Water Balance Model Results
(Averaged over Mine Life ML/annum)

	10th Percentile Rainfall Sequence (Dry)		**Median Rainfall Sequence**		**90th Percentile Rainfall Sequence (Wet)**	
	*Without BFP**	*With BFP*	*Without BFP*	*With BFP*	*Without BFP*	*With BFP*
Inflows						
Catchment Runoff	1221	1220	1329	1332	1547	1543
Groundwater	670	671	673	673	674	674
Tailings Water	120	16	119	16	121	16
Outflows						
CHPP Use	901	486	892	486	894	486
Truckfill (Dust Suppression) Use	660	663	634	668	602	629
Evaporation	384	442	393	474	418	481
Licensed Discharge to Wilpinjong Creek	228	437	266	394	432	589
Spill off site	2†	2†	0	0	0	0

* Belt Filter Press.
† Refer discussion in Section 4.3.3.

Figure 21 shows the model predicted statistical distributions of total volume of water held in all storages (including open cut pits) versus time for the mine life. The 90-percentile plot is that volume that is predicted to have a 10% chance of being exceeded at any point in time (i.e. a 90% chance of non-exceedance). The 10-percentile plot is that volume that is predicted to have a 90% chance of being exceeded at any point in time. The median plot has a 50% chance of being exceeded at any point in time.

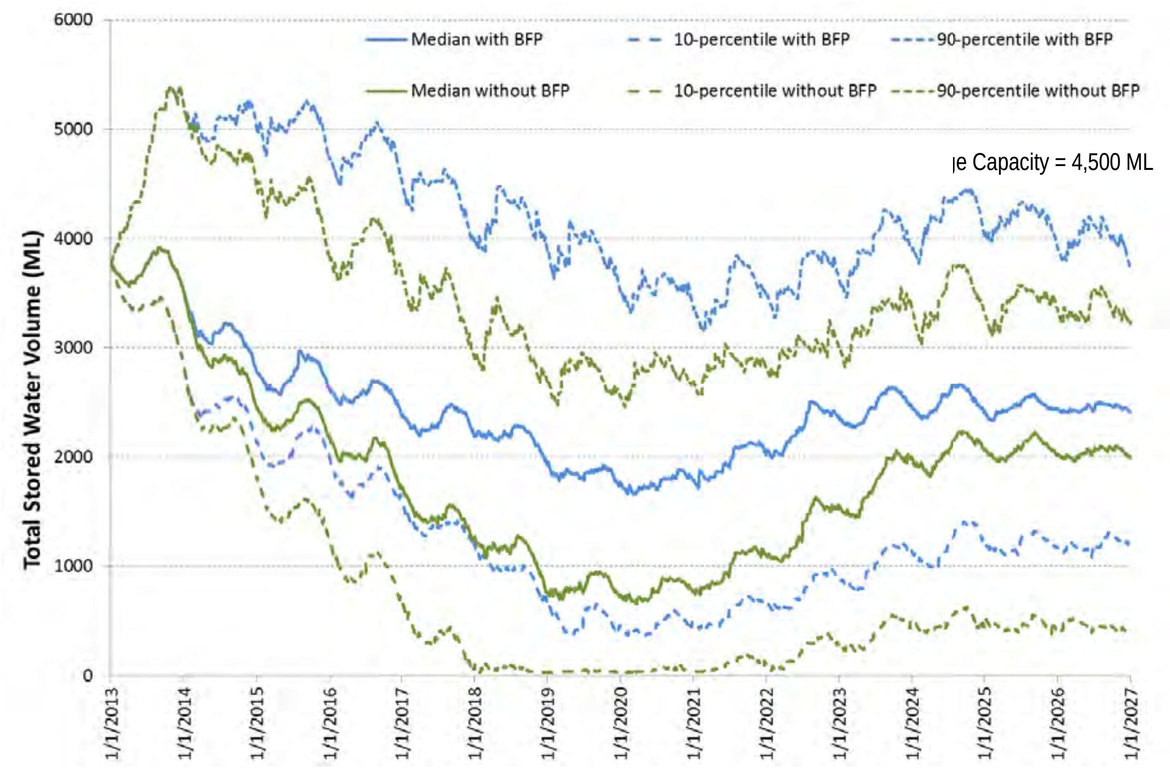

Figure 21 Predicted Total Stored Water Volume

4.3.2 Water Supply Reliability

Predicted water supply reliability has been calculated as volume supplied divided by demand volume (averaged over the simulation period) for the CHPP and haul road dust suppression. Average reliability is averaged over all sequences and over the 14 year remaining mine life, maximum reliability refers to the highest reliability in any one 14 year period (averaged over the 14 years) and minimum reliability is the lowest reliability in any 14 year period (also averaged over the 14 years). Table 11 summarises predicted supply reliabilities.

Table 11
Predicted Water Supply Reliability

	CHPP Supply			**Haul Road Dust Suppression Supply**		
	Minimum	*Average*	*Maximum*	*Minimum*	*Average*	*Maximum*
Without BFP	89.5%	98.0%	>99.9%*	82.3%	96.3%	>99.9%*
With BFP	96.7%	99.9%	>99.9%*	92.3%	99.7%	>99.9%*

* The inherent uncertainty in the representativeness of low rainfall periods in the historical climate data set used in the model precludes the use of the term "100%".

There is very low predicted risk of CHPP water supply shortfall prior to 2016 – mainly due to the significant volume of water currently stored on site. There is a higher risk of supply shortfall in years after 2016. As stored water volume falls, WCPL may need to implement sourcing of water from licensed water supply bores to maintain a storage "reserve" and supply reliability in line with the above predictions.

Ongoing reviews of the mine water balance will provide updated information on future supply reliability, which is inherently highly influenced by site rainfall. It is recommended that such reviews occur annually. Depending on the results of these reviews, WCPL could also initiate sourcing of additional water supply under agreement with the nearby Ulan Coal Mines (subject to separate environmental assessment and approval).

4.3.3 Water Containment

The predicted risk of spill from water storages off site is very low, provided that water is transferred between site storages to maintain adequate freeboard in those storages that would spill to Wilpinjong Creek. Although priority sourcing of water is undertaken from the active mine open cut pits, if there is no available capacity elsewhere, the model assumes water remains within the active open cut pits (refer also Section 4.3.4).

The daily water balance model predicts that some spill may occur under exceptionally high rainfall events – some spill was predicted to occur in 15% of simulated climatic sequences. All predicted spills occur from Ed's Lake which has an estimated capacity of 50 ML with a catchment area of approximately 1.7 km^2 (as at late 2012). The majority of the catchment of this dam comprises waste rock emplacement areas that have or are undergoing rehabilitation. Spill from Ed's Lake would (as at early 2013) flow to former tailings storage TD2, which is undergoing progressive rehabilitation, rather than off site, however once this tailings storage is fully rehabilitated (likely sometime in late 2013) spill could flow to Wilpinjong Creek. Ed's Lake is currently used as a staging storage for water transfer from Pit 5 North to the Pit 2 West water storage and such water transfer would not occur during runoff-producing wet weather that could lead to dam spill. It is likely therefore that the water quality of Ed's Lake during exceptionally high rainfall would be related directly to runoff water quality from its catchment.

In accordance with the requirements of the Project Approval (Conditions 42 and 43) a Final Void Management Plan and Mine Closure Plan are to be prepared for the Wilpinjong Coal Mine. It is recommended that mine water balance reviews conducted over the last five years of mining operations include modelling of the predicted water and salinity balance of the final voids.

4.3.4 Risk of Mining Disruption

The potential risk of disruption to mining has been assessed by tracking the number of days in each climatic sequence where the volume of water held in each active open cut pit exceeded 200 ML (an arbitrary volume chosen to represent conditions which *could* lead to mining disruption). Table 12 shows the predicted days per year that this volume is exceeded for each open cut pit averaged over all years and climatic sequences, while Table 13 shows the highest number of days per year in any one 13-year climatic sequence (averaged over that climatic sequence).

Table 12
Predicted Average Days per Year With in Excess of 200 ML Open Cut Pit Water Volume

	Pit 1	Pit 2 South	Pit 3	Pit 4	Pit 5 North	Pit 5 South	Pit 6
Without BFP	3	0	5	0	7	5	1
With BFP	5	0	10	0	15	8	7

Table 13
Predicted Maximum Average Days per Year (in Any One 13-Year Climatic Sequence) With in Excess of 200 ML Open Cut Pit Water Volume

	Pit 1	Pit 2 South	Pit 3	Pit 4	Pit 5 North	Pit 5 South	Pit 6
Without BFP	41	6	52	0	98	25	27
With BFP	43	9	87	0	167	41	94

4.3.5 Sensitivity Analysis

As indicated in Section 4.2, it appears that groundwater inflow rates are sensitive to prevailing or recent rainfall. Therefore the sensitivity of water balance results, in terms of predicted total water stored and risk of mining disruption, was assessed by simulating groundwater inflows increased by a factor of 1.5 and 2.5 (the maximum factor used in the model calibration – refer Section 4.2). Figure 22 shows predicted total volume of water held in all storages (including open cut pits) versus time for the mine life for these simulations, which were undertaken assuming the BFP is commissioned in 2014.

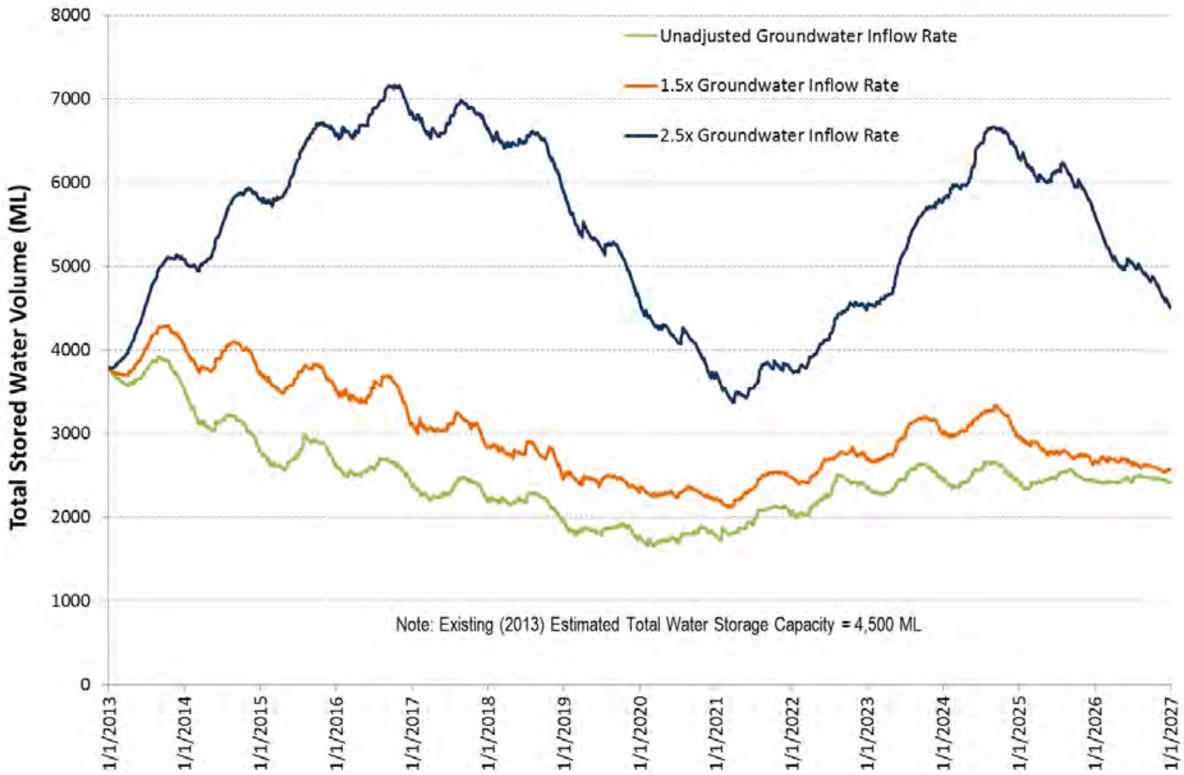

Figure 22 Predicted Median Total Stored Water Volume – Sensitivity to Groundwater Inflow Rate

Figure 22 indicates that the predicted median volume of water stored increases significantly with higher groundwater inflow rates.

Table 14 shows the predicted days per year that a 200 ML volume is exceeded in each open cut pit averaged over all years and climatic sequences for the unadjusted groundwater inflows and with groundwater inflows increased by a factor of 1.5 and 2.5.

Table 14
Predicted Average Days per Year With in Excess of 200 ML Open Cut Pit Water Volume – Sensitivity to Groundwater Inflow

Groundwater Inflow Case	Pit 1	Pit 2 South	Pit 3	Pit 4	Pit 5 North	Pit 5 South	Pit 6
Unadjusted	5	0	7	0	7	8	13
Increased by Factor of 1.5	6	4	22	2	45	8	30
Increased by Factor of 2.5	8	11	46	11	155	8	76

Table 14 indicates that the risk of mining disruption (as measured by the number of days the predicted pit water volume is above 200 ML) increases markedly in Pit 6, Pit 5 North and Pit 3 at higher groundwater inflow rates.

5.0 ASSESSMENT OF THE MODIFICATION SURFACE WATER IMPACTS

The potential impacts of the Modification on local and regional surface water resources are:

- Changes to flows in local creeks due to expansion and subsequent capture and use of drainage from mine area catchments (i.e. an increase in the area captured within the mine area).
- Changes to flows in Wilpinjong Creek due to continued licensed discharge within the existing daily licensed discharge rate and water quality limit of EPL12425.
- Potential for export of contaminants (principally sediments and soluble salts) in mine area runoff and accidental spills from containment storages (principally sediments, soluble salts, oils and greases), causing degradation of local and regional water courses.
- Changes in salinity in Wilpinjong Creek during periods of licensed discharge from the RO Plant.

It is not anticipated that there will be any effect on water management or water quality due to the proposed disposal of inert building and demolition waste in waste rock emplacement areas.

Flood bunds may be necessary along some sections of the down slope (northern) end of open cut voids to mitigate against inflows from major flooding in Wilpinjong Creek and backwater in tributary drainages (e.g. Planters Creek). Given that the pit limits for the open cut mining operation are set-back from the Sandy Hollow-Gulgong Railway embankment, any flood bunds would not impede active flood flows and would have negligible effect on floodplain storage in Wilpinjong Creek. A flood modelling study has been undertaken (Gilbert & Associates, 2007) for a reach of Wilpinjong Creek from adjacent to Pit 1 downstream, including Cumbo Creek adjacent to Pit 4 and Pit 3. The study predicted peak 100-year ARI flood levels in these creek reaches. It is recommended that the flood study be extended upstream along Wilpinjong Creek adjacent to Pit 5 and Pit 6. The results of flood modelling should be used to assess the required level of any flood bunds.

5.1 Flow Regime in Wilpinjong and Cumbo Creeks

The effect of surface runoff capture from the Modification open cut extension areas and revised site water management system will have a direct effect on flows (catchment yield) in local creeks. The change in contributing catchment areas are summarised in Table 15 below. Note that there are no known licensed or riparian surface water users on Wilpinjong or Wollar Creeks downstream of the Wilpinjong Coal Mine (refer Section 2.4.1).

Table 15
Changes to Contributing Catchment of Local Creeks

Creek/ Location	Total Catchment Area prior to Mining (km^2)	Catchment Area for Maximum Extents of Mine without Modification (km^2)	Catchment Area for Maximum Extents of Mine with Modification (km^2)	Change due to Modification (km^2)
Wilpinjong Creek just upstream of Cumbo Creek	121.1	102.3	102.3	0.01
Wilpinjong Creek just upstream of Wollar Creek	217.5	193.9	193.4	0.48
Cumbo Creek just upstream of Wilpinjong Creek	71.1	66.4	65.9	0.47

The incremental effect of the maximum catchment area changes proposed as part of the Modification (summarised in Table 15) would be negligible in terms of change in streamflow in both Wilpinjong and Cumbo Creeks, even when considered in isolation from predicted reductions in baseflow.

In terms of reduced baseflow in Wilpinjong Creek, HydroSimulations (2013) have predicted a maximum reduction of 0.36 ML/d in 2025, with a predicted reduction of 0.33 ML/d in 2018 at the time the catchment area of the approved mine reaches a maximum (refer Figure 17). There is negligible difference between predicted baseflow reductions with and without the Modification. The above baseflow reductions are significantly less than those predicted as part of the EIS (WCPL, 2005), which peaked at 0.66 ML/d in mine year 14 (2021).

In terms of reduced baseflow in Cumbo Creek, HydroSimulations (2013) have predicted a maximum reduction of 0.08 ML/d in 2017, with a negligible difference between predicted baseflow reductions with and without the Modification. Assuming the same flow per unit catchment area in Cumbo Creek as in Wilpinjong Creek, the mean annual flow in Cumbo Creek just upstream of Wilpinjong Creek is estimated to be[2] 1,240 ML. The reduction of baseflow in Cumbo Creek is therefore likely to have a negligible effect on mean creek flow.

Part of the Modification involves the implementation of a tailings BFP, with consequent reduction in CHPP water demand (refer Section 3.2.4) and therefore a predicted increase in the duration that the RO Plant will be operational (refer Section 4.3). Water balance model predictions indicate that on average, for the remaining mine life, the increase in RO Plant discharge would be 168 ML/annum (ranging between 33 ML/annum and 291 ML/annum in all climatic sequences)[3].

[2] With a catchment area of 65.9 km^2 – for maximum extents of mine with modification.
[3] This assumes RO Plant operation of at least one month (30 days) per year in all years.

This represents an increase of 5% in mean annual flow in Wilpinjong Creek at the Wollar Creek confluence, which (with reference to Table 15 above) would eliminate, on average, the minor reduction in flow caused by the Modification due to increased maximum catchment excision. It should be noted that this increase in flow is averaged over the period of the remaining mine life, rather than at the maximum extents of the mine, and that there is likely to be periods of time in a given year (even with the tailings BFP in operation) when the RO Plant is not in operation and there would be no licensed discharge.

The maximum predicted flow loss in Wilpinjong Creek in the EIS (WCPL, 2005) was 11% of average annual flow downstream of the mining lease area – upstream of the Wollar Creek confluence. The maximum predicted flow loss in Wilpinjong Creek (assessed using flow data from WILGSU – refer Section 2.3) for the Wilpinjong Coal Mine, including the Modification, as a result of the combined effects of maximum catchment area excision (Table 15 above), predicted baseflow reduction and minimum licensed (RO Plant) discharge give an estimated flow loss in Wilpinjong Creek of 11% on an average annual basis. Therefore, there is negligible difference in predicted flow loss in Wilpinjong Creek as a result of the Modification.

In terms of cumulative impacts, the nearest existing or proposed mines within the Goulburn River catchment are the existing Ulan Coal Mines, the Moolarben Coal Mines (both located upstream near the headwaters of the Goulburn River, outside the Wilpinjong Creek catchment), the proposed Moolarben Coal Project Stage 2 and the Mt Penny Coal Project (located downstream near Coggan). Only the Moolarben Coal Project Stage 2 lies within the catchment area of Wilpinjong Creek. In terms of downstream impacts, the Moolarben Coal Project Stage 2 Preferred Project Report (Hansen Bailey, 2012) states that "…*it is expected that the Preferred Project will not significantly impact on environmental flows downstream from the Stage 2 Project boundary*". The Goulburn River at the Wollar Creek confluence has an estimated catchment area of 1,149 km^2 (WCPL, 2005) and therefore the effect of the minor catchment area reductions which would be caused by the Modification (given in Table 15) would be negligible at this point, both when considered in isolation and cumulatively with the Ulan Coal Mines, the Moolarben Coal Mines and the Moolarben Coal Project Stage 2. The Goulburn River at Coggan has an estimated catchment area of 3,340 km^2 (WCPL, 2005), with a mean annual flow of 67,373 ML. Again, the effect of the catchment area reductions of the Modification and the changes in licensed discharge at this point would be negligible.

5.2 Release of Contaminants in Drainage Off-Site

Runoff from areas of pre-strip and rehabilitation which has not yet fully established would be directed to either open cut pits, water storages or sediment dams. Any sediment dams would be designed in accordance with the Erosion and Sediment Control Plan and the provisions for sediment retention basins in Landcom (2004) and Department of Environment and Climate Change (DECC, 2008).

The existing and proposed mine water management system (Section 3.2) would be designed to maintain a low risk of an uncontrolled release of mine water. Water balance modelling has indicated, however, that some spill has the potential to occur under exceptionally high rainfall events from Ed's Lake if additional controls are not implemented. Upslope diversion drains would be designed to minimise the risk of erosion due to high flow velocities by appropriate design of grades, cross-sections and use of vegetation and/or rip-rap. Energy dissipation drop structures would form a component of the detailed design. Energy dissipators and/or level spreaders would be constructed at the outfalls of all diversion drains and pipelines. Sediment controls would be designed in accordance with the Erosion and Sediment Control Plan and Landcom (2004) guidelines.

5.3 Salinity in Wilpinjong Creek Due to Licensed Discharge

No change to the maximum licensed daily discharge rate of 5 ML/d is proposed as part of the Modification. However, the average volume of licensed discharge from the RO Plant for the remaining mine life is anticipated to rise as a result of the Modification, based on an increase in the duration that the RO Plant is in use. The maximum allowable EC in licensed discharge is 500 µS/cm (EPL12425). The continuously recorded average EC at WILGSD for the full period of available data (refer Figure 9) is approximately 5,400 µS/cm, while for the 2012-2013 period it is approximately 2,500 µS/cm. Therefore under most conditions, RO Plant discharge would lead to some decrease in Wilpinjong Creek salinity.

Wilpinjong Creek displays typical behaviour with EC reducing with increasing flow rate (refer Figure 23). For example during a high flow event in early March 2012, the recorded flow rate at WILGSD peaked at approximately 1,950 ML/d while recorded EC fell to 281 µS/cm, which is below the licensed discharge EC of 500 µS/cm. During such low salinity periods, RO Plant discharge would be subject to significant dilution. During the March 2012 peak flow, if RO Plant discharge had been occurring at the maximum licensed rate and EC, the resulting increase in EC at WILGSD would have been less than 1 µS/cm (i.e. negligible).

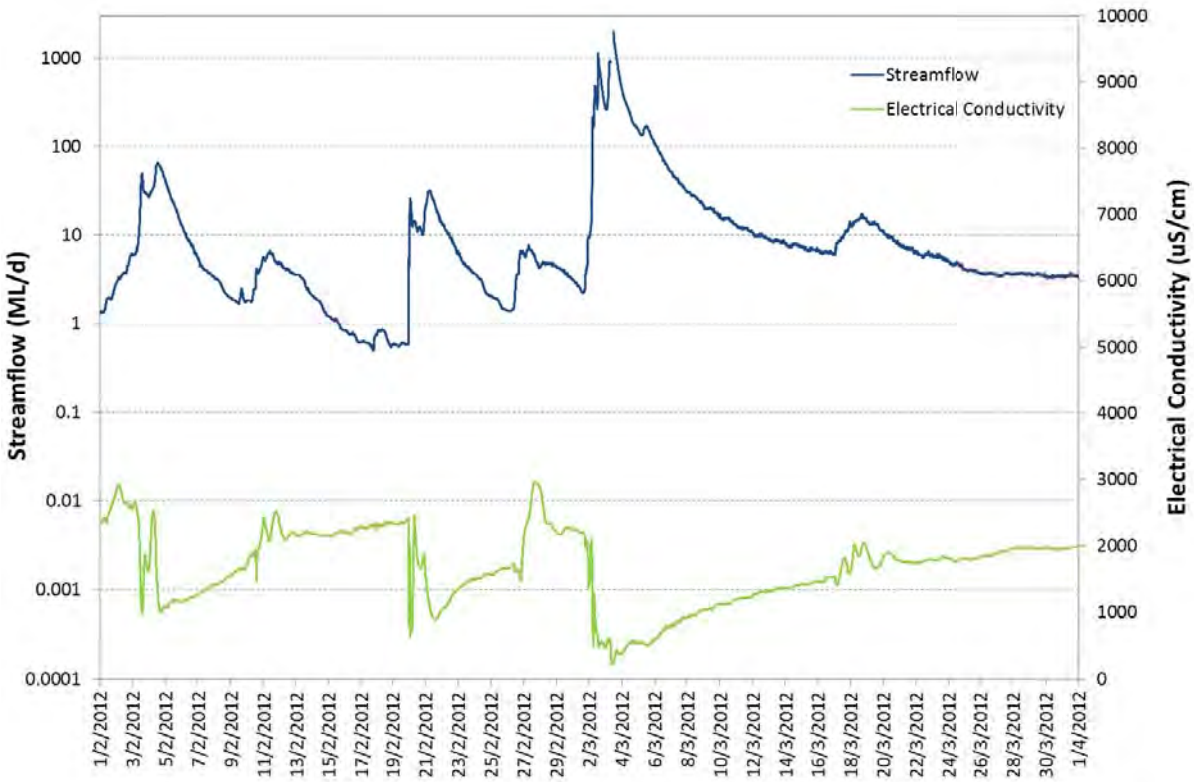

Figure 23 Recorded Streamflow and EC at WILGSD – Early 2012

5.4 Post Mining Surface Water Impacts

The post mining landform plan (at the completion of mining), remains largely unchanged from that proposed in the EIS (WCPL, 2005), however, it would include some increased elevation in-pit waste rock emplacement landforms. A conceptual final landform drainage plan is presented on Figure 16.

There would be no change to the catchment area reporting to the final voids and hence no change to the final void water balance as a result of the Modification.

6.0 EFFECTS OF CLIMATE CHANGE

Recent (post 1950) changes to temperature are evident in many parts of the world including Australia. The Intergovernmental Panel on Climate Change (IPCC, 2007) has, in its most recent (fourth) assessment, concluded that:

> "*most of the observed increase in globally averaged temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations. Discernible human influences now extend to other aspects of climate, including ocean warming, continental average temperatures, temperature extremes and wind patterns.*

Predicting future climate using global climate models is now undertaken by a large number of research organizations around the world. In Australia much of this effort has been conducted and co-ordinated by the Commonwealth Scientific and Industrial Research Organisation (CSIRO). CSIRO has published a comprehensive assessment of future climate change effects on Australia (CSIRO, 2007). CSIRO has included assessments based on the predictions from 23 selected climate models from research organisations around the world. Model predictions were made for a range of different future greenhouse emission scenarios adopted by the IPCC.

CSIRO has used predictions of future climate from these various models to formulate probability distributions for a range of climate variables including temperature, rainfall potential evaporation, snow cover and drought. The model predictions are made relative to 1990 conditions at 5 yearly increments between 2030 and 2100. Predictions for 2030 are relatively insensitive to future emission scenarios because they largely reflect greenhouse gases that have already been emitted. Longer term predictions become increasingly more sensitive to future emission scenarios.

More recently, the CSIRO has developed (and is in the process of completing) the 'Representative Climate Futures' software tool (Whetton, et al., 2012). This allows analysis of future climate data sets to be confined to models which best represent a 'representative' climate future – e.g. that which is "most likely".

6.1 Future Rainfall and Evaporation

Predictions of future rainfall in south-eastern Australia are generally for reduced annual rainfall, but increased daily rainfall and a higher number of dry days per year. Future annual rainfall and evaporation change predictions for the Hunter Valley area have been provided by the CSIRO using the Representative Climate Futures tool (Whetton, et al. 2012) for the A1Fi emission scenario[4] for a range of climate change models. The spatial extent to which these results refer is the land area contained in the 5 degree grid centred on 32.5°N, 151.5°E.

[4] A1Fi emission scenario refers to expected emissions for a future characterised by very rapid economic growth, global population that peaks in mid-century and declines thereafter and a substantial reduction in regional differences in per capita income. It assumes rapid introduction of new and more efficient technologies but emphasises fossil-fuel intensity.

Although this may be regarded to be quite a large area, it is believed that the predictions are unlikely to vary significantly through the area, because:

1. The climate change values themselves are averaged from *global* climate models with resolutions ranging from 125 km to 400 km (refer Chapter 4 of CSIRO, 2007); and
2. The range of change in potential evaporation for this region of Australia under the A1Fi scenario does not vary greatly spatially across a 5 degree grid (refer Chapter 5 of CSIRO, 2007).

Using the Climate Futures tool, projected changes to rainfall, temperature and evaporation for 2030 and 2090 were first undertaken using the full range of available climate models. These were then recalculated whereby models not simulating some climate processes well (in this region) were removed from the assessment (Irving, et al., 2011). The recalculated data sets (using 18 climate models) were then used in the assessment as representing the 'most likely' case.

The predicted annual average changes in rainfall and potential evaporation obtained are summarised as follows:

- By 2030:
  - Average predicted change in rainfall: -1.9%;
  - Average predicted change in evaporation: 3.1%;
- By 2090:
  - Average predicted change in rainfall: -8.2%;
  - Average predicted change in evaporation: 13.6%.

Based on the above, there would be a small decrease in rainfall in the future, with a significant increase in evaporation, particularly by 2090. This would lead to a decrease in rainfall excess (rainfall minus evaporation) of 272 mm (or a 27% decrease).

6.2 Water Management Implications of Climate Change Predictions

The implications of climate change predictions on water management are unlikely to be significant over the mine life because they are small compared to the natural climatic variability.

Longer term climate change predictions do however have potential implications for post mine water management and specifically the water balance of the final voids (refer WCPL, 2005). In this regard the currently most accepted scenarios would see a reduction in overall rainfall, an increase in evaporation and a corresponding decrease in rainfall excess. This would translate to reduced surface water runoff inflows to the voids and reduced incident rainfall over the surface of the voids. There would also be increased evaporation loss for the void surfaces and as a consequence lower average water levels in the voids.

7.0 CONCLUSIONS

The following conclusions are made as a result of this surface water assessment:

1. There are no known water access licences on or privately-owned land bordering Wilpinjong and Wollar Creeks downstream of the Wilpinjong Coal Mine area. Therefore there would continue to be no impacts on private water users on these creeks from the Wilpinjong Coal Mine, including the Modification.
2. On the basis of available recorded data, there does not appear to be any discernible change in Wilpinjong Creek, Cumbo Creek or Wollar Creek pH, EC and sulphate concentrations since the commencement of mining.
3. Only minor changes to proposed upslope diversions would result from the extension to open cut pit areas proposed as part of the Modification south of Pit 3.
4. The water supply requirement for the mine would reduce as part of the Modification, with the commissioning of a tailings BFP. This would improve mine water supply reliability and reduce the rate that water would need to be sourced from the licensed borefield. However the period of operation of the RO Plant and the need to maintain licensed discharge to Wilpinjong Creek would likely increase as a result. Notwithstanding this, the Modification would not change the existing daily licensed discharge rate and water quality limit of EPL12425.
5. The post mining landform plan (at the completion of mining), remains largely unchanged from that proposed in the EIS (WCPL, 2005), however, it would include some increased elevation in-pit waste rock emplacement landforms. There would be no change to the catchment area reporting to the final voids and hence no change to the final void water balance as a result of the Modification.
6. The daily water balance model predicts that some spill may occur under exceptionally high rainfall events from Ed's Lake.
7. The incremental effect of the maximum catchment area changes proposed as part of the Modification would be negligible in terms of change in streamflow in both Wilpinjong and Cumbo Creeks. The continued and more prevalent operation of the RO Plant would increase mean annual flow in Wilpinjong Creek and eliminate, on average, the minor reduction in flow caused by the Modification due to increased maximum catchment excision.
8. Under most conditions, RO Plant discharge would lead to some decrease in Wilpinjong Creek salinity. During high flow periods in Wilpinjong Creek, when the salinity fell below that of the licensed discharge, RO Plant discharge would be subject to significant dilution and the resulting downstream increase in salinity would be negligible.
9. The implications of future climate change predictions on water management are unlikely to be significant over the mine life because they are small compared to the natural climatic variability. Longer term climate change predictions would translate to reduced surface water runoff inflows to the planned final voids and reduced incident rainfall over the surface of the voids, together with increased evaporation loss and as a consequence, lower average water levels in the voids.

8.0 SURFACE WATER MONITORING AND OTHER RECOMMENDATIONS

It is recommended that WCPL undertake annual water balance reviews to examine the site water supply status and the potential requirement to activate supply from the licensed borefield or source other supplementary water supplies to achieve WCPL water supply reliability targets.

The following recommendations are made in regard to flow and water inventory monitoring to enable water balance model calibration:

- Install network of electromagnetic flow meters (with remote reading/recording capability - to office or control room) between all pumped storages. Where flow meters exist, calibration of these should be checked.
- Install water level sensors (with remote reading/recording capability - to office or control room) in main mine water storages to continuously record stored water level.
- Undertake updated survey of RL-volume relationships for key storages to ensure that recorded water levels provide accurate estimates of stored water volume.

In regard to water quality monitoring, the EIS (WCPL, 2005) identified measured concentrations of copper and zinc occasionally above ANZECC and ARMCANZ (2000a) guideline trigger values for the 80% protection level for aquatic ecosystems. It is recommended that analysis for these metals be undertaken at sampling points on Wilpinjong, Cumbo and Wollar Creeks at quarterly intervals in the future.

It is recommended that flood modelling of Wilpinjong Creek be extended upstream to adjacent to Pit 5 and Pit 6 to assess the need for and level of any flood bunding.

9.0 REFERENCES

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Appendix A
Water quality monitoring time series plots

CONTENTS

FIGURES

A1 CREEK WATER QUALITY - CUMBO CREEK

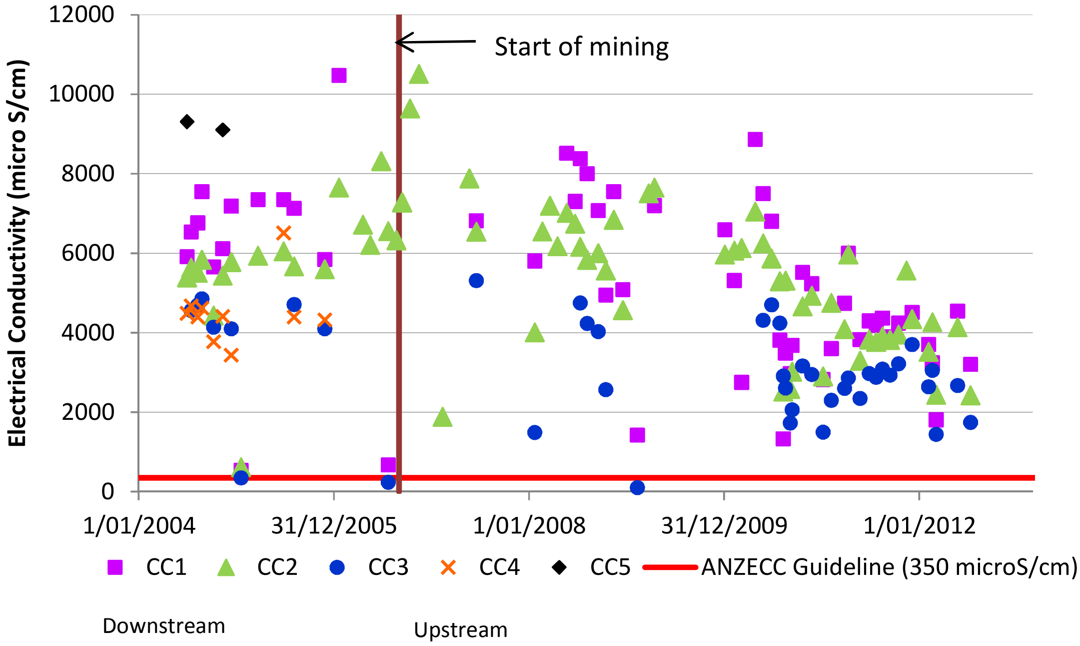

Figure A- 1 Cumbo Creek – Electrical Conductivity

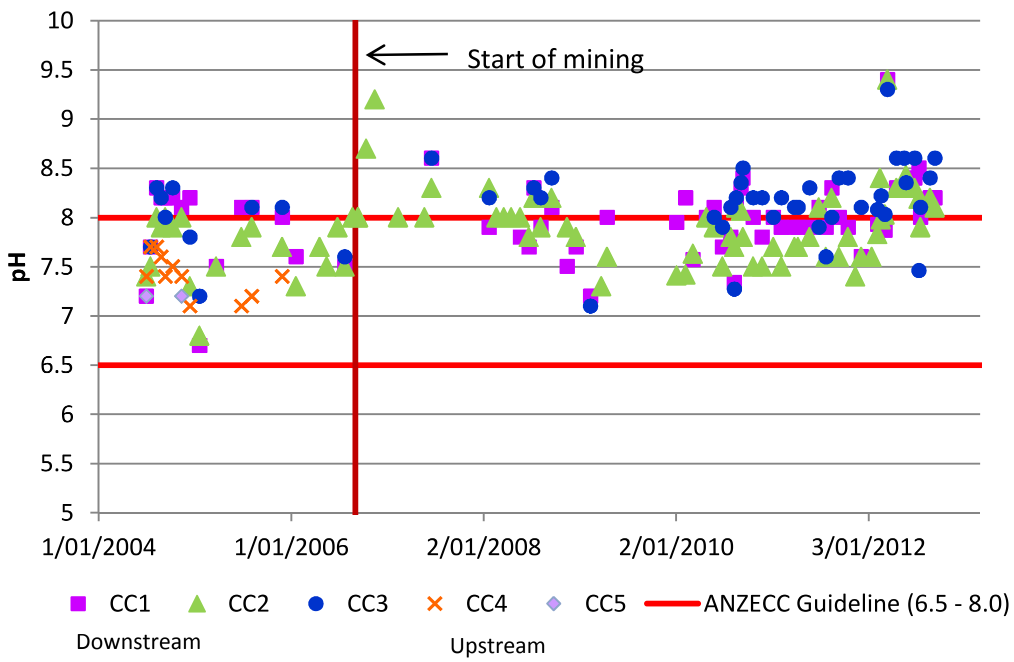

Figure A- 2 Cumbo Creek – pH

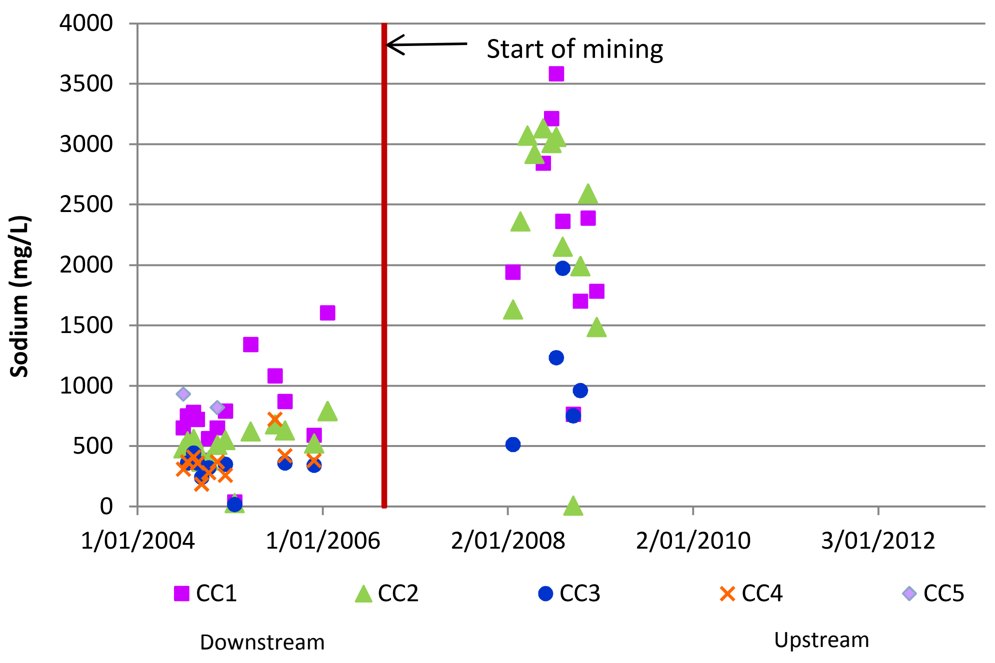

Figure A- 3 Cumbo Creek – Dissolved Sodium

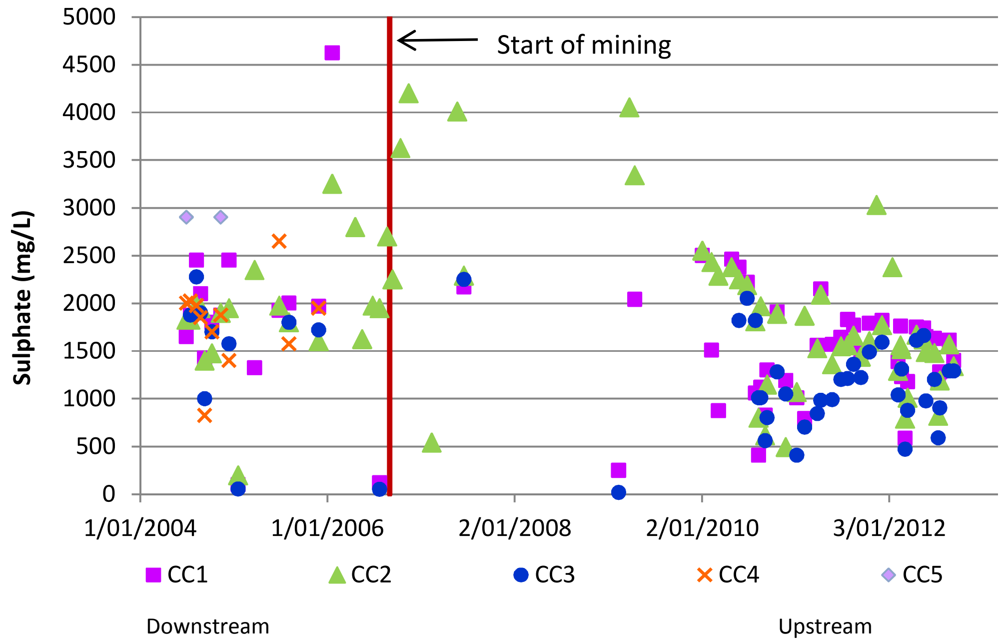

Figure A- 4 Cumbo Creek – Dissolved Sulphate

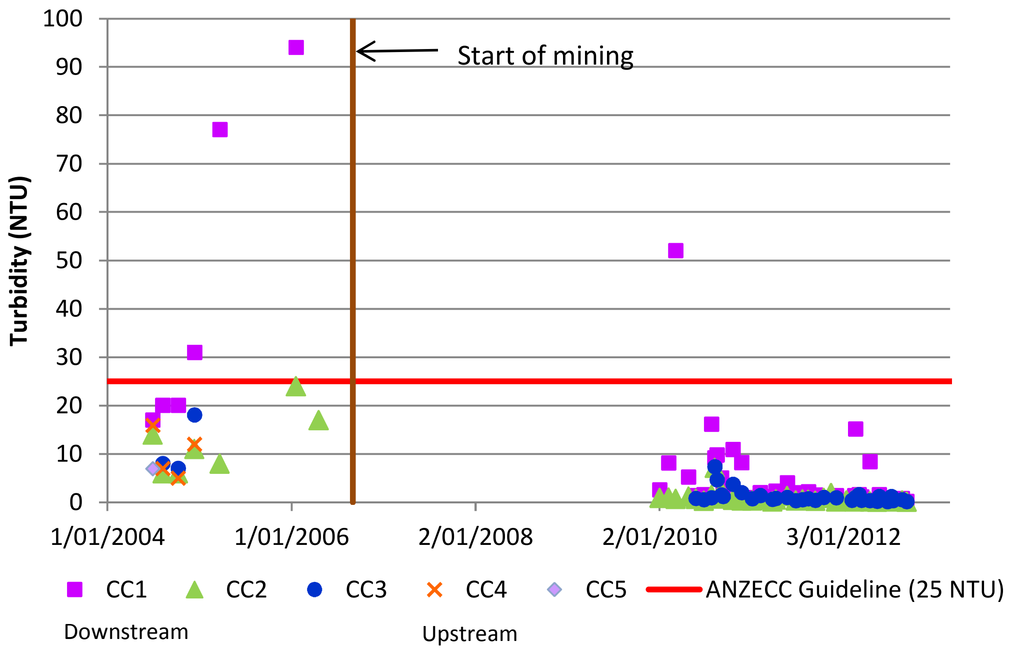

Figure A- 5 Cumbo Creek – Turbidity

A2 CREEK WATER QUALITY - WILPINJONG CREEK

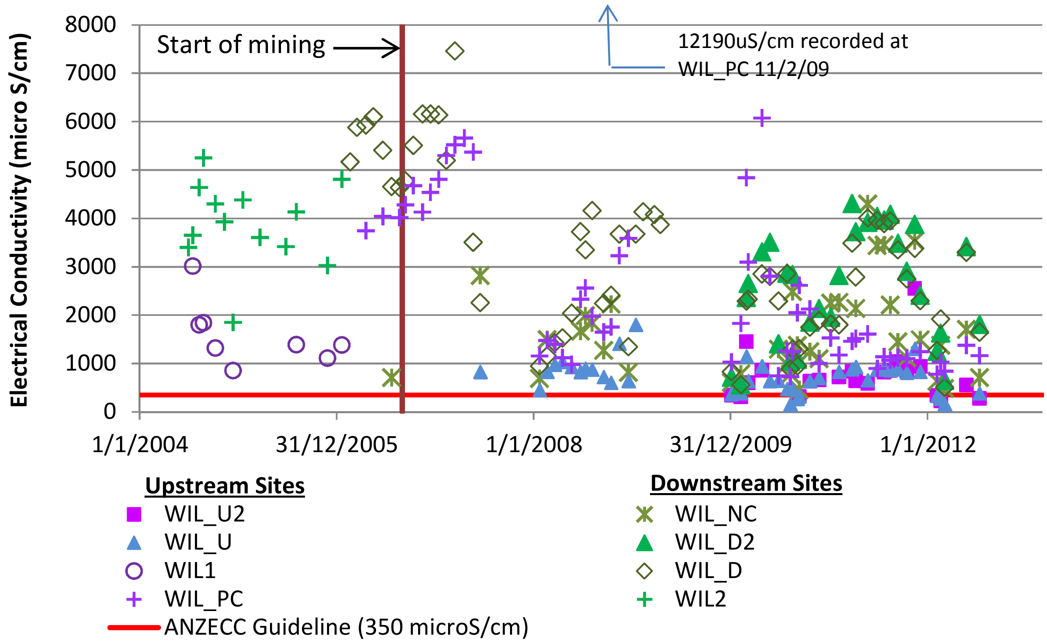

Figure A- 6 Wilpinjong Creek – Electrical Conductivity

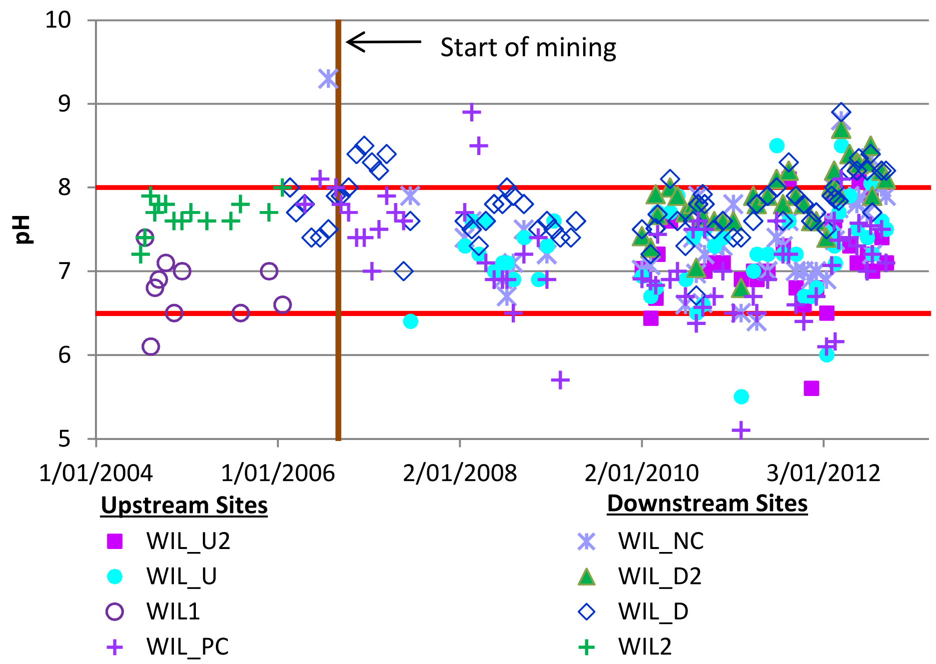

Figure A- 7 Wilpinjong Creek – pH

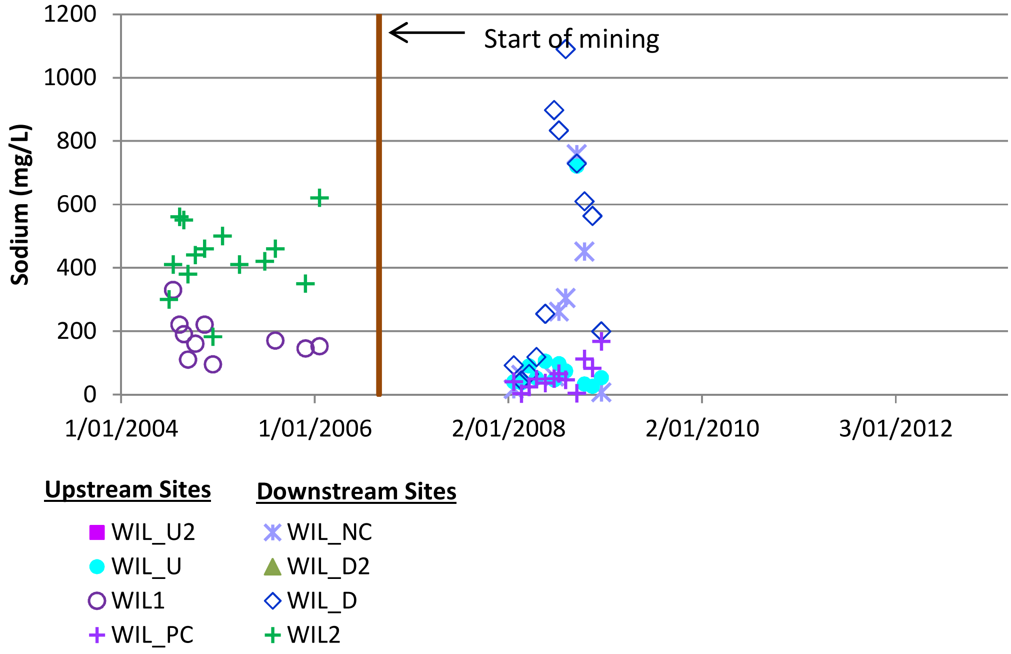

Figure A- 8 Wilpinjong Creek – Dissolved Sodium

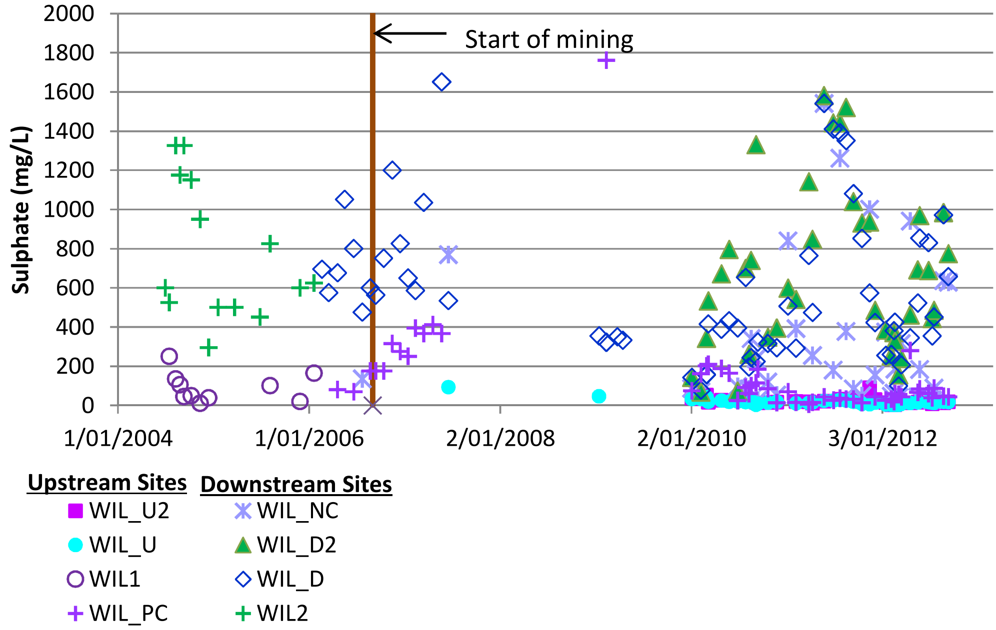

Figure A- 9 Wilpinjong Creek – Sulphate

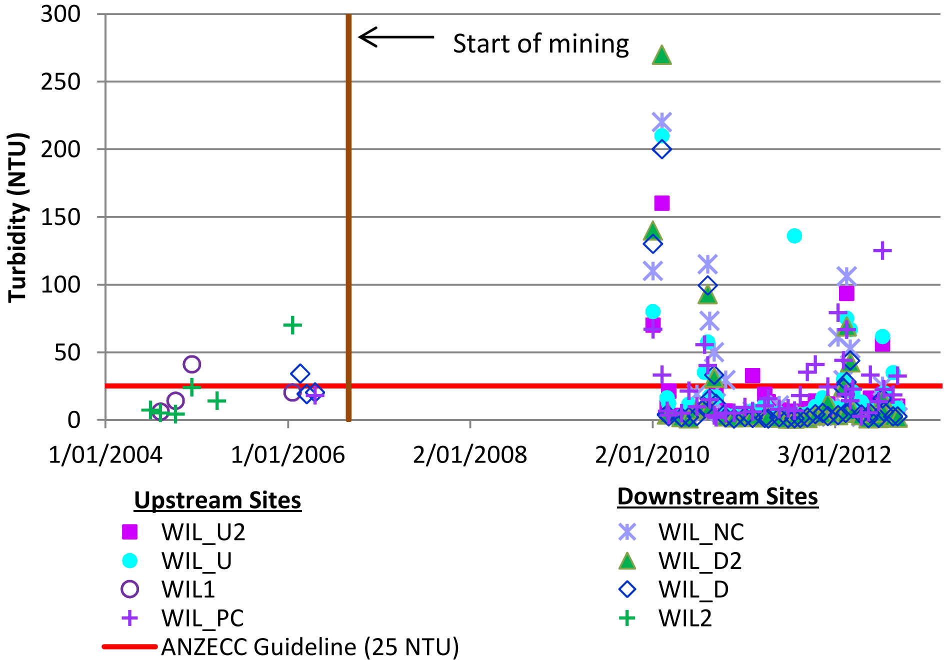

Figure A- 10 Wilpinjong Creek – Turbidity

A3 CREEK WATER QUALITY – WOLLAR CREEK

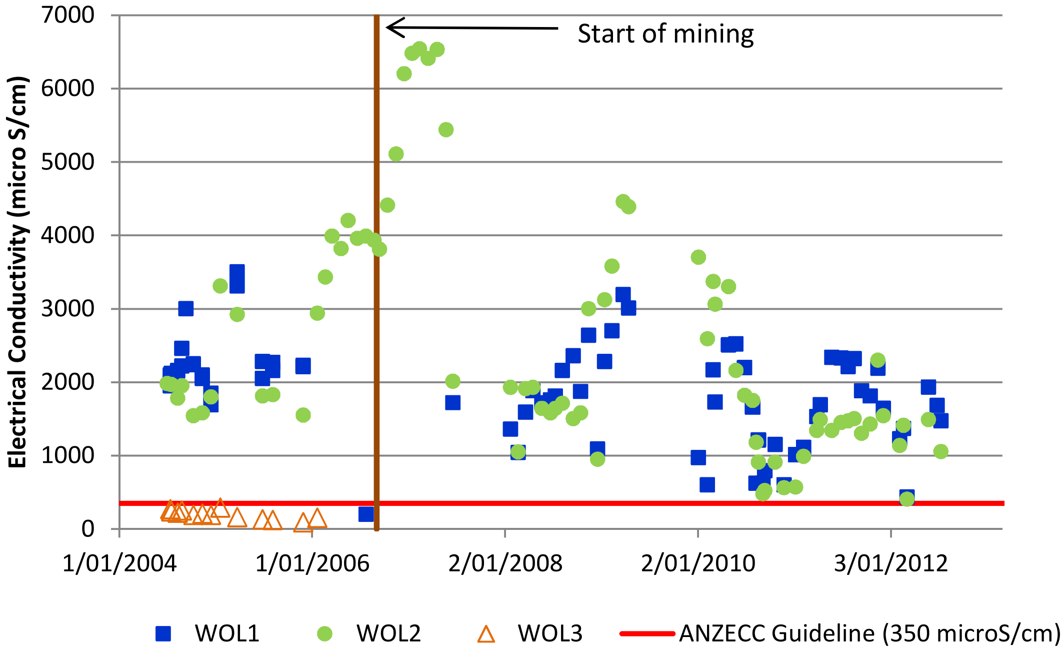

Figure A- 11 Wollar Creek – Electrical Conductivity

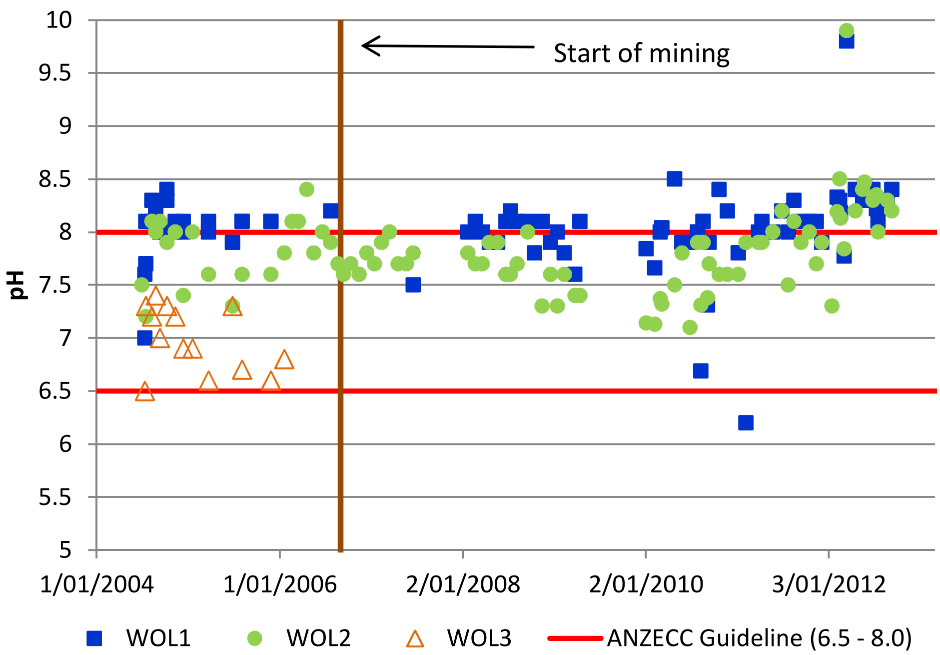

Figure A- 12 Wollar Creek – pH

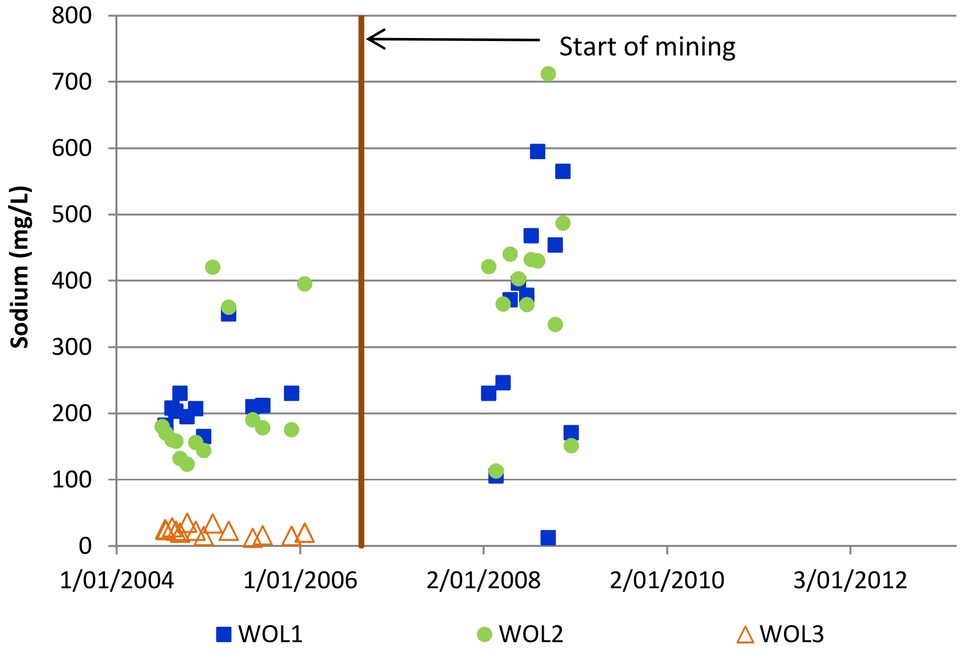

Figure A- 13 Wollar Creek – Dissolved Sodium

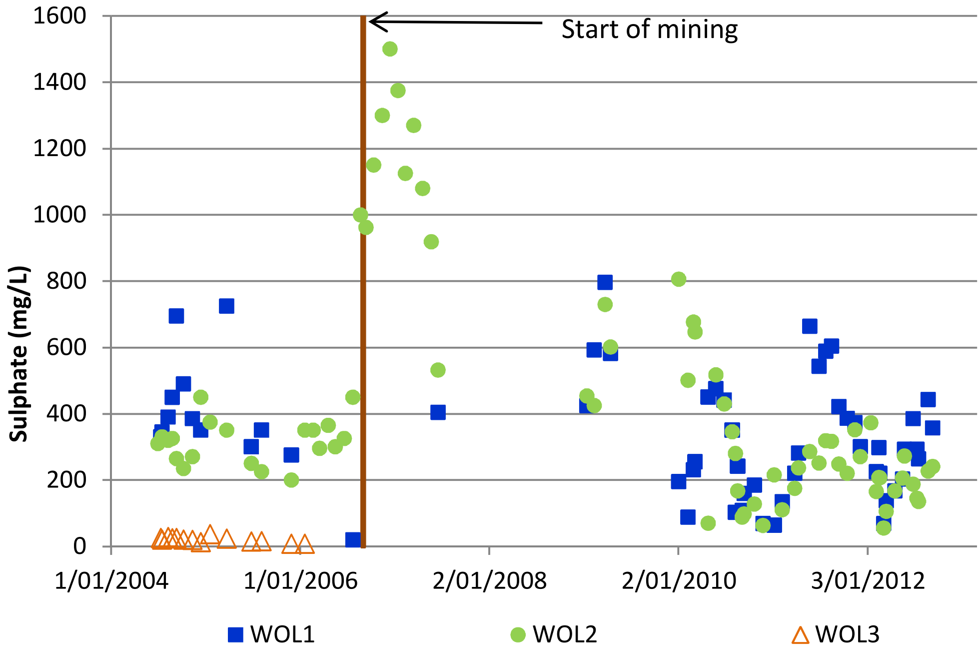

Figure A- 14 Wollar Creek – Sulphate

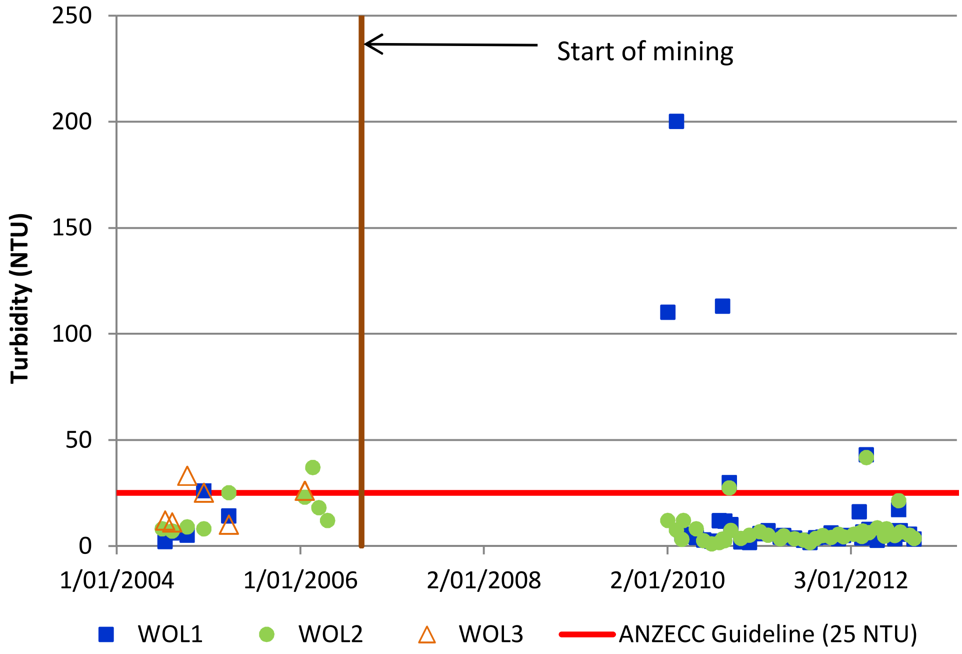

Figure A- 15 Wollar Creek – Turbidity

A4 SITE WATER QUALITY DATA

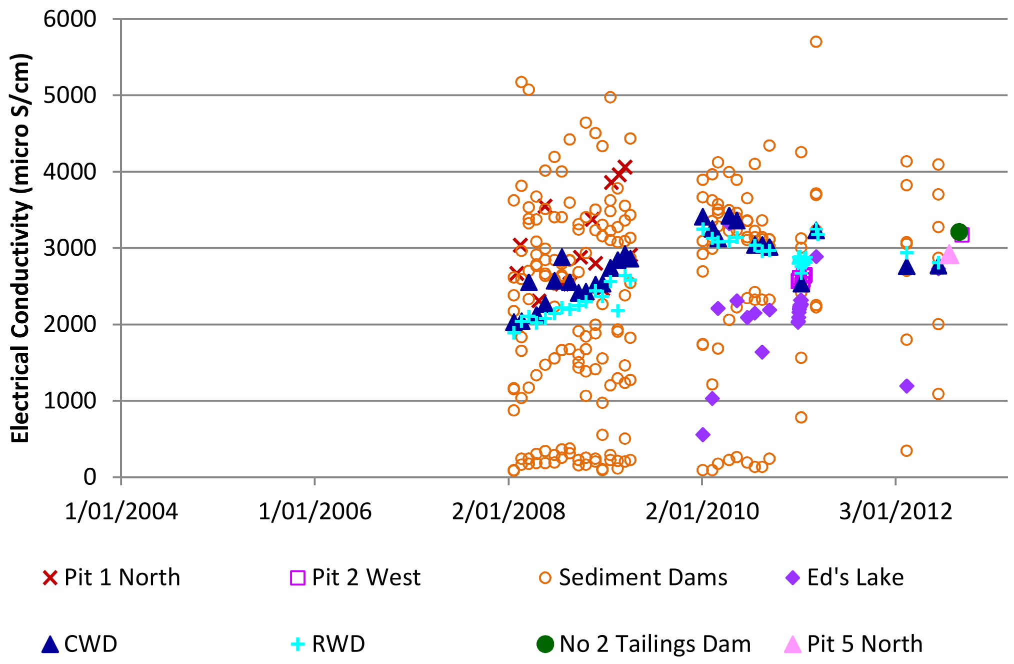

Figure A- 16 Site Water Storages – Electrical Conductivity

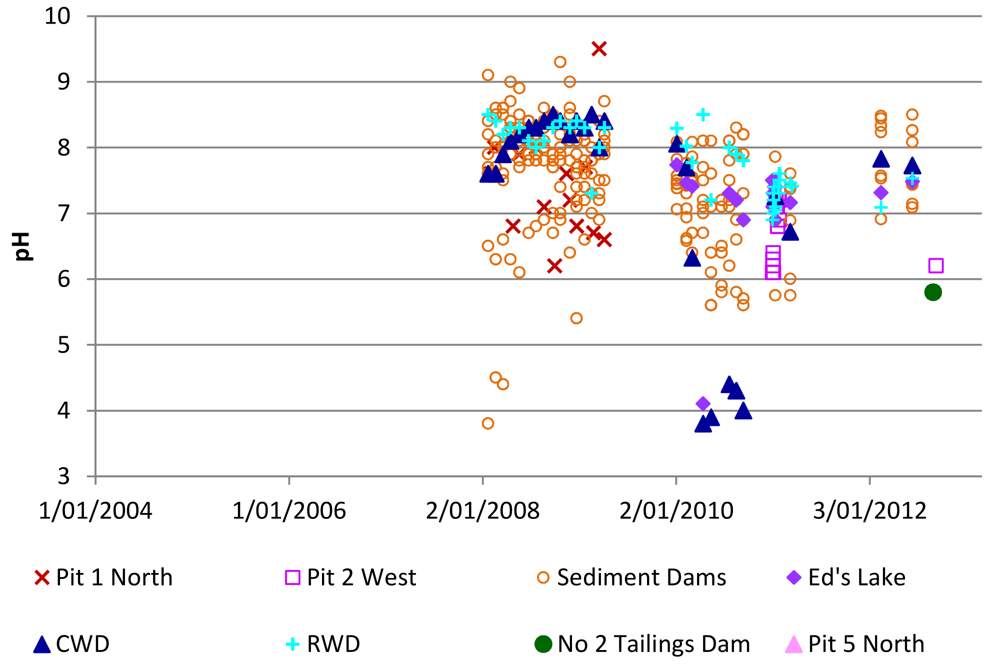

Figure A- 17 Site Water Storages – pH

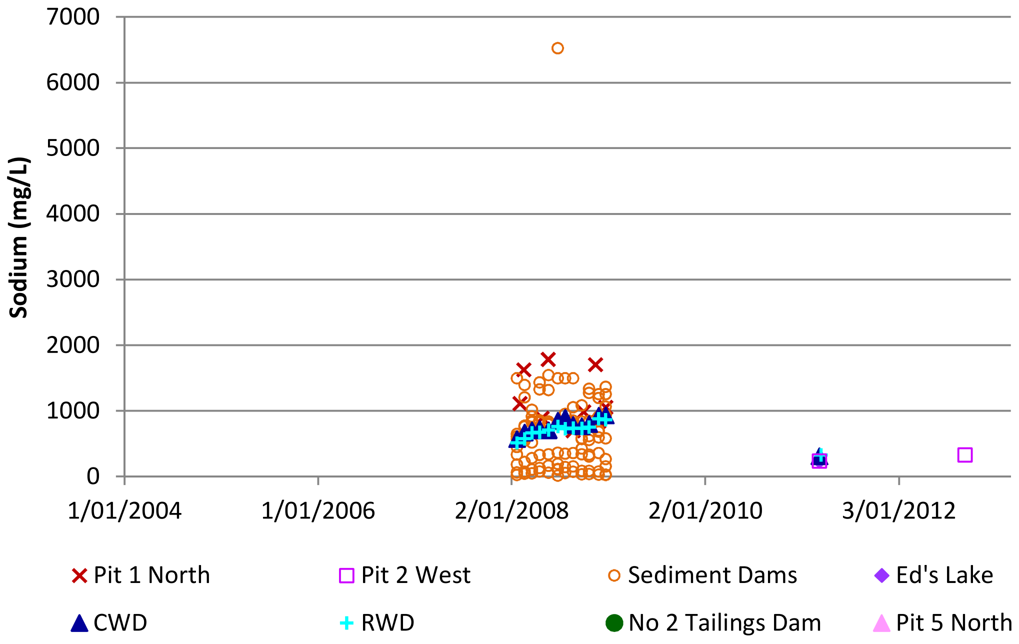

Figure A- 18 Site Water Storages – Dissolved Sodium

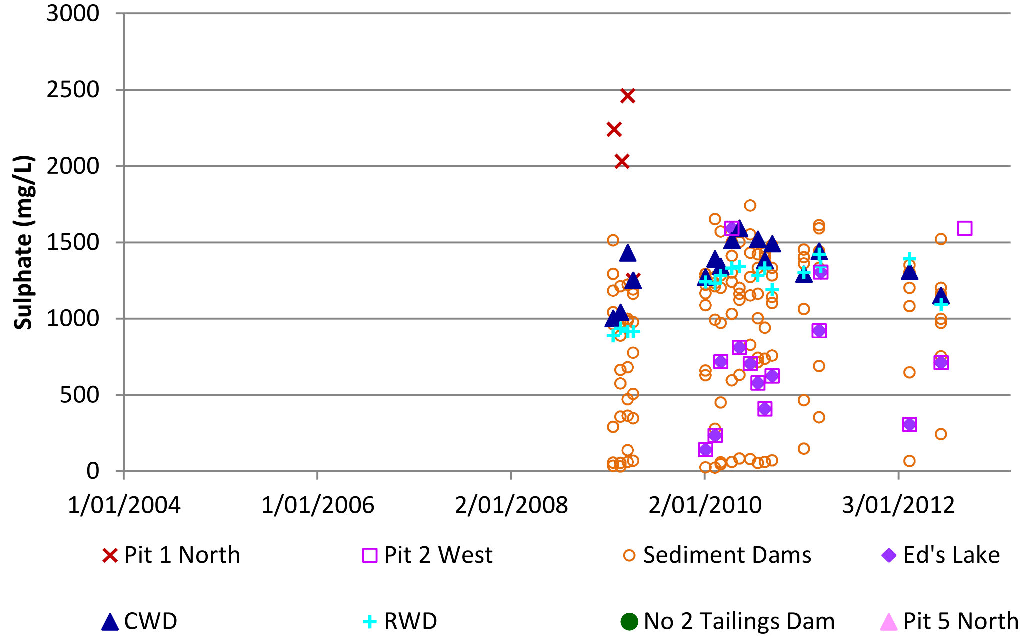

Figure A- 19 Site Water Storages - Sulphate

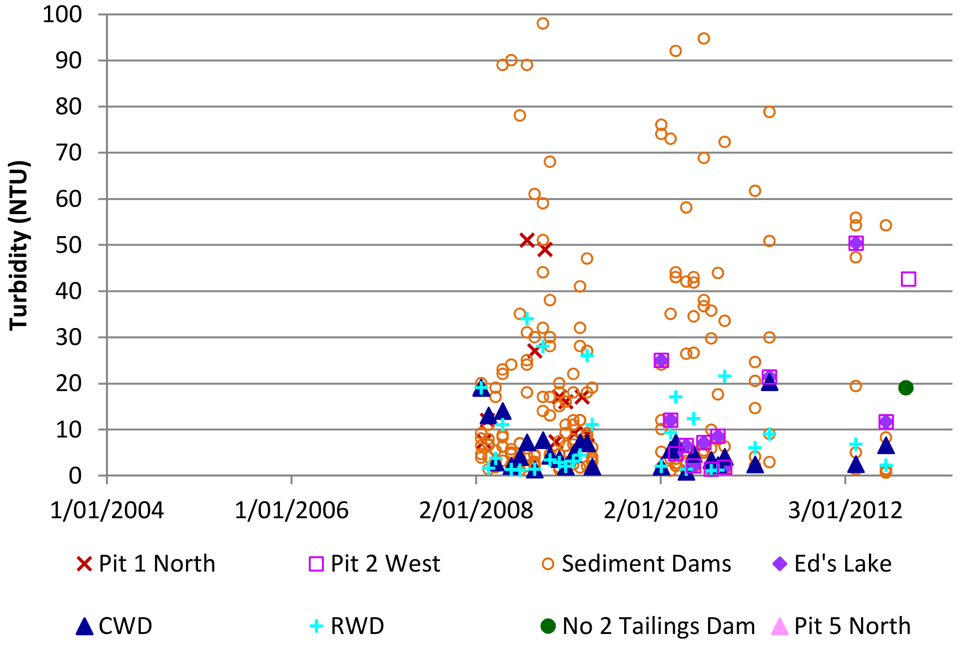

Figure A- 20 Site Water Storages – Turbidity