GUJARAT NRE COKING COAL LIMITED
A.B.N. 28 111 244 896
NRE No 1 Colliery

NRE No.1 Colliery

Wonga East – Longwalls 4 & 5 EP/SMP

LW 5 WATER MANAGEMENT PLAN

Document Version	Revision				Revision Notes
	Date	Author	Checked	Release Date	
Rev 0	16.11.2012	A. Dawkins			Initial Draft
Rev 1	27.11.2012	A. Dawkins	D. Clarkson K. Prajapati		Update groundwater monitoring
Rev 2	21.12.2012	K. Prajapati	D. Clarkson	21.12.2012	Incorporate Minor Changes
Rev 3	15.02.2013	K. Prajapati	K. Prajapati	27.02.2013	Incorporate Comments from SCA

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GLOSSARY OF TERMS AND ABBREVIATIONS

Abbreviations	
NRE	Gujarat NRE Coking Coal Limited
DoP&I	Department of Planning & Infrastructure
ROM	Run of Mine
Mtpa	Million tonnes per annum
OEH	Office of Environment and Heritage
DRE	NSW Department of Trade and Investment, Regional Infrastructure and Services, Division of Resources and Energy, Industry Co-ordination Unit
NOW	NSW Office of Water
SCA	Sydney Catchment Authority
UNRTHMZ	Upper Nepean River Tributaries Headwaters Management Zone
m	Metre
km	Kilometre
mm/m	Millimetre per metre
mbgl	Metres below ground level
BHPBIC	BHP Billiton Illawarra Coal
BSO	Bulli Seam Operations
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
ANZECC	Australian and New Zealand Environment and Conservation Council
DLWC	NSW Department of Land and Water Conservation
MDBC	Murray-Darling Basin Commission
WMA, 2000	*NSW Water Management Act, 2000*
SWCM Act, 1998	Sydney Water Catchment Management Act 1998
GDE	Groundwater dependent ecosystems
AWD	Available water determinations
LIDAR	Light detection and ranging
My	Milion years
MGA	Mercator Grid Australia
VWP	Vibrating wire piezometer
EC	Electrical conductivity
µS/cm	Micro siemens per centimetre
mg/L	Milligrams per litre
ROM	Run of mine
DSC	Dam Safety Committe
FEFLOW	Finite element flow
AWBM	Australian water balance model
TARP	Trigger Action Response Plan
AEMR	Annual Environmental Management Reports

1 INTRODUCTION

1.1 Project Background

Gujarat NRE Coking Coal Ltd (NRE) operates the NRE No.1 Colliery in the Southern Coalfield of New South Wales (NSW). The mine is located at Russell Vale approximately 8 km north of Wollongong and 70 km south of Sydney, within the local government areas (LGAs) of Wollongong and Wollondilly in the Illawarra region of NSW.

On 13 October 2011, the Project Approval (MP 10_0046) for the No.1 Colliery Preliminary Works Project was granted by the Minister for Planning under Section 75(J) of the *Environmental Planning and Assessment Act 1979* (EP&A Act). This approval allows NRE to continue its operations at the mine including the extraction of coal up to 1 million tonnes per annum and upgrade of and improvements to surface facilities, in addition to first workings and transport of coal to the Port Kembla Coal Terminal for shipment as required.

NRE intends to expand its mining operations at No.1 Colliery and has submitted an application for a Underground Expansion Project (MP 09_0013) which is currently under assessment by the Department of Planning and Infrastructure (DoP&I). In order to ensure the ongoing viability of the mine while awaiting the necessary approvals, NRE lodged a concurrent Subsidence Management Plan (SMP) application for the extraction of Longwalls 4 and 5 to the Department of Trade and Investment, Division of Resources and Energy (referred to herein as DRE). The SMP approval for Longwall 4 was granted on 26 March 2012 by DRE, however, approval for Longwall 5 was not granted.

NRE lodged a section 75W (s75W) Modification Application to Project Approval (MP 10_0046), located within the approved Preliminary Works 'Application Area', to modify the Preliminary Works Approval (MP 10_0046) to include:

- Amending the reference to the use of maingates (MGs) 4 and 5 from exploratory driveages to operational gateroads;
- The extraction of coal using longwall mining techniques from Longwall (LW) 4 in accordance with the approved SMP;
- The extraction of coal using longwall mining techniques from Longwall (LW) 5; and
- Development of maingates (MGs) 6, 7 and 8.

The proposed longwalls are wholly contained within the Sydney Catchment Authority (SCA) controlled Metropolitan Catchment Area, which is used to provide drinking water to Sydney and Wollongong. The longwalls lie outside the Dam Safety Committee (DSC) Notification Area for Cataract reservoir, with the reservoir high water mark located approximately 600 m northwest of Longwall 5.

This Water Management Plan (WMP) has been prepared in support of an Extraction Plan (EP), as required by ***Condition 7/Schedule 3*** of Project Approval (MP 10_0046). This WMP builds on the LW4 WMP prepared in support of the SMP application for extraction of LW4.

This Water Management Plan (WMP) relates to the following locations;

- extraction of Longwall WE-A2-LW5, as well as,
- development of maingates, 6, 7 and 8.

The proposed workings, as shown in **Drawing 1,** are wholly contained within the Sydney Catcment Authority (SCA) controlled Metropolitan Catchment Area, which is used to provide drinking water to Sydney and Wollongong, whilst the secondary extraction workings lie outside the Dam Safety Committee (DSC) Notification Area for Cataract reservoir.

Figure 1 shows this plan's position within the NRE Environmental Management Structure.

Environmental Management Structure

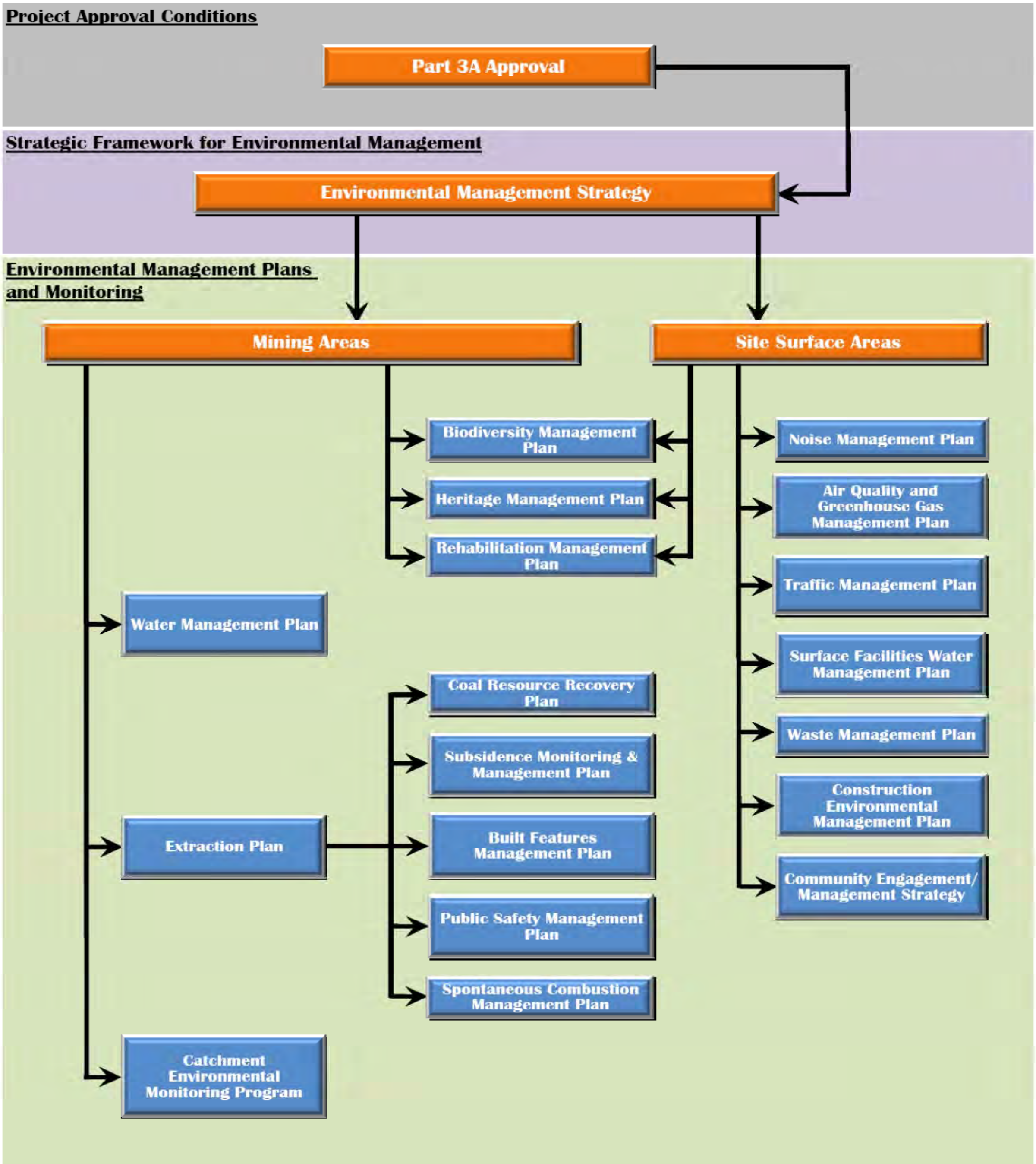


Figure 1 - Environmental Management Structure

1.2 Purpose and Scope

The Water Management Plan (WMP) relates to the streams, upland swamps and "basement" groundwater systems which may be subjected to subsidence effects or impacts due to the proposed extraction area.

This plan applies to the following features overlying or adjacent to the proposed extraction area:

- Cataract Creek;
- Hawkesbury Sandstone groundwater systems;
- Cataract River swamp Crus1;
- Cataract Creek swamps Ccus3, 4, 5, 6, 9 and Ccus10;
- Bellambi Creek swamp Bcus12, and
- Cataract reservoir.

The location of the proposed extraction area, the stream catchments, creek monitoring sites, swamp and piezometer locations are shown in **Drawing 2**.

This Plan addresses:

- impact assessment and how the subsidence impact limits will be met;
- monitoring;
- reporting;
- trigger levels to initiate implementation of management, remedial or contingency measures;
- implementation of remedial or contingency measures to stream, swamp or groundwater systems should adverse mining induced degradation be observed;
- access to streams, swamps and piezometers; and
- rehabilitation of stream, swamp or groundwater systems and access routes, if required.

The aim of the plan is to:

- monitor stream stability, flows, pool heights and stream water quality as well as groundwater and swamp levels and water quality within the potentially subsidence affected areas;
- assess potential changes to streams, swamps and groundwater systems before, during and after mining;
- assess the potential impact on catchment yield;
- assess the effects, if any, on the stored waters within Cataract reservoir;
- identify hydraulic characteristics of the groundwater and swamp systems within the vicinity of the proposed workings subsidence area;
- determine potential changes to stream, swamp and groundwater systems due to coal extraction and mine dewatering operations; and to
- report on any stream, swamp or groundwater impact simulation studies.

1.3 Distribution

This Plan will be prepared in consultation with, and copies will be distributed to the:

- Department of Planning and Infrastructure (DoP&I);
- Division of Resources and Energy (DRE);
- Sydney Catchment Authority (SCA);
- NSW Office of Water (NOW);
- Office of Environment and Heritage (OEH); and
- Wollongong City Council (WCC).

NRE will make this Plan publicly available on the NRE website and will be responsible for its maintenance. A hard copy will also be kept at the NRE No.1 Colliery, Bellambi Lane, Russell Vale.

Any revisions undertaken will be the responsibility of NRE and any notifications sent accordingly. NRE will not be responsible for maintaining uncontrolled copies beyond ensuring the most recent version is maintained on NRE's computer system, website, and hard copy at the NRE No.1 Colliery, Bellambi Lane, Russell Vale.

1.4 Consultation

This Plan was prepared in consultation with the regulatory agencies.

Consultation in accordance with ***Condition 38/Schedule 3*** of the Project Approval has been undertaken as part of the NRE No.1 Colliery WMP prepared for the overall No.1 Colliery Preliminary Works Project.

Responses were received from DoP&I, DRE & WCC and their comments were taken into account when compiling this document.

2 REPORT STRUCTURE

The remainder of this WMP is structured as follows:

Section 3: Outlines the statutory requirements applicable to the WMP.

Section 4: Outlines the proposed mining for this proposal.

Section 5: Details the general baseline data.

Sections 6, 7 and 8: Detail the baseline data for the streams, swamps and groundwater.

Section 9: Outlines previous subsidence effects in the NRE1 lease area.

Sections 10 to 12: Outline the potential stream, swamp and groundwater impacts from the proposal.

Section 13: Discusses performance measures and indicators that will be used to assess the Project.

Section 14: Describes the stream monitoring program.

Section 15: Describes the groundwater monitoring program, which includes swamps, basement groundwater and mine inflow monitoring.

Section 16: Describes the surface and groundwater response plan, including the management, remediation and mitigation measures that will be implemented to reduce potential impacts as well as the Contingency Plan to manage any unpredicted impacts and their consequences.

Section 17: Describes the protocols for the handling of incidents, complaints and non-conformances.

Section 18; Details how the Plan will be implemented, managed, reviewed and updated.

3 STATUTORY REQUIREMENTS

3.1 Project Approval

Condition 7/ Schedule 3 of the Project Approval requires the preparation of a WMP as a component of an Extraction Plan for second workings. Approval condition 7(h1) states:

Extraction Plan

7. The Proponent shall prepare and implement an Extraction Plan for all second workings on site to the satisfaction of the Director-General. This plan must:
…
(h1) include appropriate references to:

- *water resources, biodiversity values and heritage values managed under the Water Management, Biodiversity and Heritage Management Plans required under Conditions 29,35 and 38 of Schedule 3 and;*

programs, procedures, management measures and the like required under those plans;

3.2 Licences and Leases

In addition to the requirements of the Project Approval, all activities at or in association with the Gujarat NRE No.1 Colliery will be undertaken in accordance with the licences, permits and leases which have been issued or are pending as outlined in **Table 3.1**.

Table 3.1 - Licences, Permits and Leases

Licence/Approval	Document No.	Issue Date/Expiry Date
Consolidated Coal Lease Renewal	745	27/12/1990 – 30/12/2023
Mining Purposes Lease	271	09/05/1991 – 09/05/2033
Mining Lease	1575	22/3/2012 – 22/3/2029
Pillar Extraction Approval T&W Mains	C90/0146(G) C91/0146(H) C01/009	31/10/2001 23/01/2002 28/06/2001
Approval to mine P&O Panels (first workings)	10.123.081	7/01/2005
DC for Thin Seam Mining P/L	D1096/01	19/09/2001
EPA Licence	12040	Current
EPA Approval for Storm Water Control Dam	90/6041 (280.021C/21)	10/08/1992
DC for Storm Water Control Dam and Water Treatment	D91/551	17/06/1992
Dangerous Goods Licence	NDG021269	14/11/2012 - 01/11/2013
SPCC Approval for Stage 3	90/4711 (280021C/20)	04/09/1992
DC for Russell Vale Waste Emplacement	D89/839	11/04/1990

Licence/Approval	Document No.	Issue Date/Expiry Date
DC for Demolition of Washery	D2004/32	14/12/2004
Mining operations Plan (MOP)		01/01/2008 – 31/12/2017
Preliminary Works Major Project	MP10_0046	13/10/2011 – 13/10/2014
Complying Development Certificate – Bath House	1091/11	07/11/2011
SMP Approval – Longwall 4	11/3941	26/03/2012 – 31/03/2015
Water Extraction Licence	To be determined	Submitted to NoW in January 2009
EPBC Act approval	EPBC 2011/5891	12/01/2012

3.3 Relevant Legislation and Guidelines

Gujarat will conduct the Project consistent with the approval conditions and any other legislation that is applicable.

The following Acts that are directly applicable to the surface water and groundwater aspects of the proposed Preliminary Works mining are the:

- *Protection of the Environment Operations Act, 1997*
- *Sydney Water Catchment Management Act, 1998*
- *Dams Safety Act, 1978*
- *Fisheries Management Act, 1994*
- *Water Act, 1912*
- *Water Management Act, 2000*

All relevant licences or approvals required under these Acts will be obtained as required.

3.4 Guidelines and Policies

This plan has been prepared with reference to the following documents:

Streams

- Approved Methods for the Sampling and Analysis of Water Pollutants in NSW (Department of Environment and Conservation [DEC], 2004);
- A Rehabilitation Manual for Australian Streams (Land and Water Resources Research and Development Corporation and Cooperative Research Centre for Catchment Hydrology [LWRRDC and CRCCH, 2000);and
- The Design of a Hydrological and Hydrogeological Monitoring Program to Assess the Impact of Longwall Mining in SCA Catchments.

Groundwater

- National Water Quality Management Strategy Guidelines for Groundwater Protection in Australia (ARMCANZ/ANZECC);
- NSW State Groundwater Policy Framework Document (NSW Department of Land and Water Conservation [DLWC]);
- NSW State Groundwater Quality Protection Policy (DLWC);
- NSW State Groundwater Quantity Management Policy (DLWC) Draft;
- NSW Groundwater Dependent Ecosystem Policy (DLWC);
- Murray-Darling Basin Commission Groundwater Quality Sampling Guidelines Technical Report No 3 (MDBC);
- Murray-Darling Basin Commission. Groundwater Flow Modelling Guideline (MDBC); and
- Draft Groundwater Monitoring Guidelines for Mine Sites Within the Hunter Region (DIPNR).

4 PROPOSED MINING

4.1 Wonga East and Cataract Reservoir Area

The Wonga East workings are located to the east of Cataract reservoir, with the proposed north east / south west trending Wonga East panels subdivided into Area 1 to the east, and Area 2 to the west of Mount Ousley Road.

The separation between Area 1 and Area 2 is designed to avoid potential subsidence impacts to the freeway.

Longwall WE-A2-LW4 in the Wongawilli Seam was mined between 20/04/2012 and 21/09/2012, and was located at 310 – 340m below surface, with a 145m width and an extraction height of 3.1m.

Table 4.1 is summarised the dimensions of the Longwall WE-A2-LW5.

Table 4.1 - LongwallWE-A2-LW5 Dimensions

Workings	Width (rib to rib) (m)	Pillar Width (m)	Max. Length (m)	Depth of Cover (m)
WE-A2-LW5	145	65	845	272 - 280

The original planned length of WE-A2-LW4 and WE-A2-LW5 as shown in the Preliminary Works Environmental Assessment (Gujarat, 2012) has been shortened as shown in **Figure 2**.

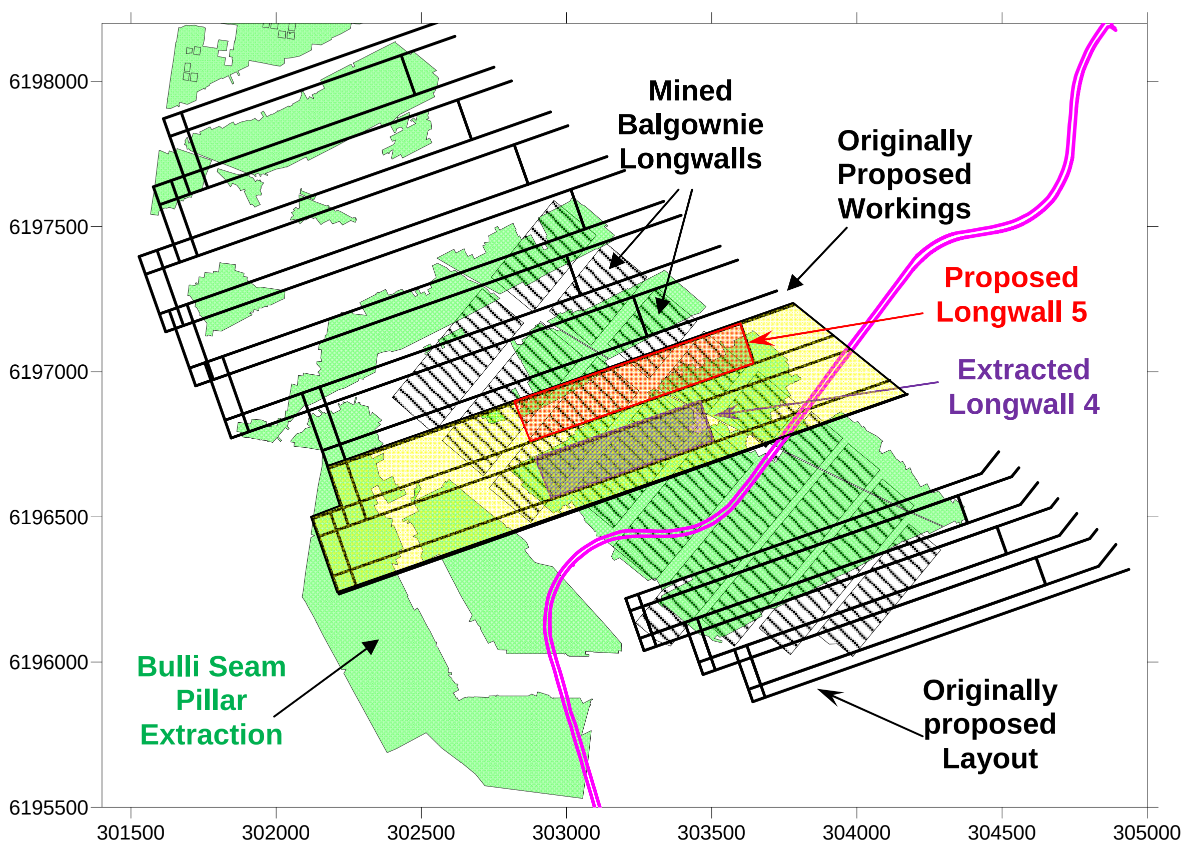


Figure 2 - Proposed Workings, Bulli Seam Pillar Extraction and Balgownie Longwalls

Longwall WE-A2-LW5 and maingates 6, 7 and 8 are located underneath an area of previous Bulli Seam first workings and pillar extraction, as well as Balgownie Seam longwalls.

Although up to 4th order stream channels and headwater swamps Crus1 as well as Ccus3, 4, 5, 6 and Ccus10 overlie the proposed first workings, as shown in **Drawing 2**, there will be no observable subsidence of these natural features in relation to installation of the first workings.

4.2 Proposed Adjacent Mining

The Environmental Assessment for the BHPBIC Bulli Seam Operations (BSO) initially contained longwall workings in the Appin Area 2 Extended and Appin Area 3 Extended areas, which were located at least 1100m north of the Gujarat Lease (BHPB, 2009).

In a subsequent revision, these workings were removed from the Bulli Seam Operations Preferred Project Report (BHPB, 2010).

No other mining is currently proposed in the vicinity of NRE No.1 Colliery.

5 GENERAL INFORMATION

5.1 Previous Mining at Wonga East

Longwall mining in the Wongawilli Seam and the Balgownie Seam as well as bord / pillar and full pillar extraction of the Bulli Seam under Cataract Creek and its catchment has previously been conducted, with no current observed adverse impacts on creeks or swamps over the subsided areas.

5.1.1 Bulli Seam

The Bulli Seam was initially mined up to 80 years ago in a relatively disordered bord and pillar pattern with roadways driven approximately 5m wide and approximately 25m wide pillars, which in some cases were split diagonally.

Subsequent pillar extraction of up to 490m wide occurred, with the actual extent being recorded as accurately as historical survey records permit.

It was noted during subsequent extraction of the Balgownie longwalls that ground conditions matched the recorded mine workings in the Bulli Seam.

5.1.2 Balgownie Seam

The Balgownie longwalls were extracted after and beneath the Bulli Seam in the 1970s and 1980s.

The Balgownie Seam was approximately 1.35m thick, although the mining height may have been slightly greater. Panel widths ranged from 144 - 186m and pillars were 25 - 40m for a 280 - 290m depth of cover, with the mining face being relocated around a north-west trending hard dyke.

At Wonga East, the Bulli Seam overlies the Balgownie Seam by approximately 6 - 8m, whilst the Balgownie Seam overlies the Wongawilli Seam by approximately 10 - 15m.

Monitoring over the 150 - 190m wide Balgownie Seam longwalls indicated subsidence of approximately 0.55m above the chain pillars and sag over the panels of up to 0.8m, for a maximum of 1.4m. Strains up to 3mm/m were measured above large Bulli pillars and up to 6mm/m above Bulli Seam extraction areas, with tilts up to 10mm/m.

Following extraction of the Balgownie Seam, subsidence between 0.6 – 0.8m developed where large pillars and barriers were left in the Bulli Seam, with sag between the pillars and above the Balgownie longwalls of approximately 0.2m.

Vertical subsidence above the pillars averaged about 0.55m.

5.1.3 Wongawilli Seam

Longwall WE-A2-LW4 was mined between 20/04/2012 and 21/09/2012. The panel was located 310 – 340m below surface, with a 145m width and an extraction height of 3.1m.

Maximum subsidence of 1.3m, along with maximum strain of 4.3mm/m (tensile) and 3.4mm/m (compressive) and a maximum tilt of 26.8mm/m were observed over the panel, whilst tensile cracking was observed near the longwall centreline, parallel to the longwall face, and in the pavement of Mt Ousley Road.

Subsidence was constrained within the panel footprint, despite the Bulli and Balgownie seams being mined immediately above WE-A2-LW4, which indicates that the previous mining has reduced the bridging characteristics of the overburden to make it more compliant and less able to span the single panel.

Total cumulative subsidence is estimated to be;

- 1m from the Bulli Seam;
- 0.5 – 1.3m from the Balgownie Seam (depending on the actual location); and
- 1.3m from WE-A2-LW4, for a total of up to 3.6m.

The observations from mining WE-A2-LW4 were incorporated into an updated subsidence prediction assessment for the Wonga East longwalls (Seedsman, 2012).

No evidence of pillar run is present for the Bulli Seam, whilst the pillar extraction areas in the Bulli Seam are fully subsided (SCT Operations, 2012).

The observed cracking is consistent with general experience of mining in steep terrain and is likely to be associated with an equal amount of compression across Cataract Creek, with movement likely to have been taken up on a horizontal shear plane at or near the base of the valley.

An inspection of Cataract Creek, in October 2012 did not reveal evidence of stream bed cracking, loss of pool holding capacity, development of ferruginous springs or changes in stream water quality.

No adverse effect on tributary stream outflow, groundwater levels or stream / groundwater quality was observed on swamp Ccus6 or tributary CT1 due to the subsidence or cracking over WE-A2-LW4.

Packer testing in bore GW1, which is located 345m east of longwall WE-A2-LW4, indicates the Bulgo Sandstone has gradually reducing permeability with depth, whilst the Stanwell Park Claystone has a lower permeability than the overlying Bulgo Sandstone or the underlying Scarborough Sandstone (SCT Operations, 2012).

Below the third VWP at 45mbgl, the pressure gradient diverges from hydrostatic, which is consistent with low level downward flow. At approximately 140mbgl a reduction in pore pressure was observed with increasing depth consistent with the top of a more hydraulically connected fracture network above the Balgownie Seam longwall goaf.

The pressure profile indicates that the vertical flow rate is likely to be relatively insignificant in comparison with rainfall recharge, but the magnitude of downward flow indicated by this profile depends on the hydraulic conductivity of the overburden strata.

The phreatic groundwater gradient through NRE-A, GW1 and GW1A to Cataract Creek indicates the groundwater essentially follows the ground surface, and that the creek has a “gaining” relationship to the regional groundwater.

It should also be noted that the <1.0m wide, highly weathered dyke that is located 210m east of GW1, between the bore and WE-A2-LW4, does not appear to be acting as a groundwater flow barrier.

5.1.4 Adjacent Mining

The Bulli Seam has been mined in adjoining workings by BHP Billiton Illawarra Coal (BHPBIC) and its predecessors at the;

- Cordeaux Colliery to the immediate south of the Gujarat lease using longwall extraction, and the; and
- Bulli Colliery to the immediate north-east of the Gujarat lease by predominantly bord and pillar methods, with lesser longwall extraction.

Appin, West Cliff and North Cliff workings, which are at least 2.6km north of the Gujarat lease on the northern side of the Cataract River, are far enough away to be of no influence on the Study Area.

5.2 Geology

NRE No. 1 Colliery is situated at the southern end of the Permo-Triassic (225-270 Million years old) Sydney Basin within the Illawarra Coal Measures, which contains the Bulli Seam. The Bulli Seam is underlain by the Balgownie and Wongawilli seams.

Isolated exposures of Hawkesbury Sandstone are present along stream beds and banks as well as in isolated outcrops outside of the sedge / upland swamps within the Project Area as shown in **Figure 3**.

Isolated outcrops of Wianamatta Shale are present in more elevated country to the north, and downstream of the Project Area.

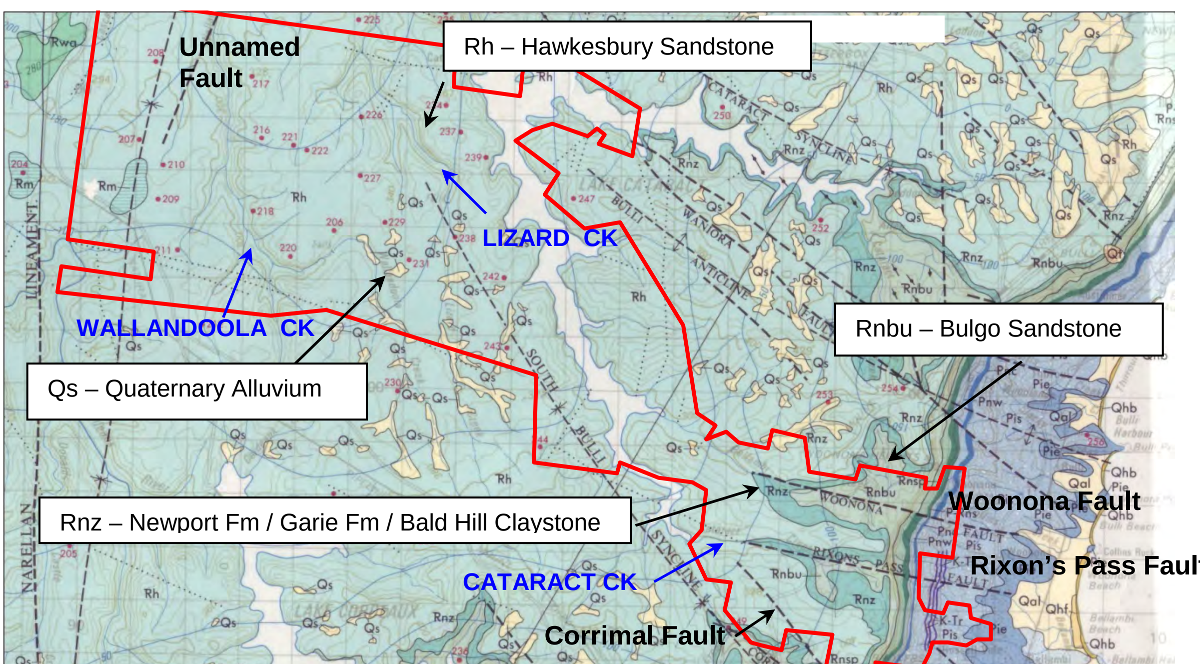


Figure** 3 - **Regional Surface Geology

The stratigraphic sequence within the Project Area comprises the following:

- **Wianamatta Shale** - isolated outliers of the shale located north of the Project Area.
- **Hawkesbury Sandstone** - Isolated outcrops consisting of thickly bedded or massive quartzose sandstone with grey shale lenses up to several metres thick. The maximum geological thickness is about 155m to 175m below ground level (bgl). Finer grained siltstone and shale facies along with bedding discontinuities are present that would form vertical flow barriers.
- **Newport and Garie Formations** - present to approximately 160m to 180m bgl within the approximately 230m thick Narrabeen Group. The Newport Formation consists of interbedded grey shales and sandstones whilst the Garie Formation consists of cream to brown, massive, characteristically oolitic claystone.
- **Bald Hill Claystone** - present to approximately 185m to 205m bgl, brownish-red "chocolate shale", which is a physically weak but is relatively “plastic”. It is easily recognised as a marker horizon and has a near constant thickness in the Project Area. The Bald Hill Claystone is a major barrier to vertical groundwater flow and divides the groundwater systems above and below the claystone.
- **Bulgo Sandstone** - present to approximately 350m to 405m bgl, thickly bedded, medium to coarse grained lithic sandstone with occasional beds of conglomerate or shale.
- **Stanwell Park Claystone** - present to approximately 355m bgl with greenish-grey mudstones and sandstones.
- **Scarborough Sandstone** - present to approximately 385m bgl, medium to coarse grained lithic sandstone with occasional beds of conglomerate or shale
- **Wombarra Claystone** - has similar properties to the Stanwell Park Claystone.
- **Coal Cliff Sandstone** - basal shales and mudstones that overly the Bulli Seam.
- **Illawarra Coal Measures** - interbedded shales, mudstones, lithic sandstones and ten named seams. The 3m thick Bulli Seam (approximately 391m to 447m bgl) is the the uppermost mineable seam and has been worked extensively in the northern portion of the Southern Coalfield. The Bulli Coal is the target seam in the Project Area.

5.3 Basement Hydrogeology

NRE No. 1 Colliery is situated at the southern end of the Permo-Triassic (225-270 My) Sydney Basin within the Illawarra Coal Measures, which contains the Bulli Seam, Balgownie Seam and the underlying Wongawilli Seam.

Due to the steep topography and limited alluvium within the storage area of Cataract Reservoir, there is no notable groundwater bearing stream based alluvium in the study area.

Quaternary unconsolidated alluvial and colluvial sediments are also present within headwater swamps, which are generally less than 2m thick, and comprise humic and clayey sands overlying weathered Hawkesbury Sandstone.

Outside of the upland swamps, there are no alluvial deposits of any significance within the Gujarat lease except for possibly within, or under, Cataract Reservoir.

Recharge to the groundwater system is from rainfall and lateral groundwater flow. Although groundwater levels are sustained by rainfall infiltration, they are also controlled by ground surface topography and stream flows.

A local groundwater mound develops beneath sandstone hills with eventual discharge into incised creeks and waterbodies.

Loss by evapotranspiration through vegetation where the water table is within a few metres of the ground surface occurs within upland swamps and outcropping sandstone.

The only recognised economic aquifer in the area is the Hawkesbury Sandstone.

The Hawkesbury Sandstone is a low yield aquifer of generally good quality beneath the Woronora Plateau and the Illawarra Plateau.

Four main aquifer systems are present in the Study Area, namely:

- unconsolidated, perched, ephemeral, colluvial, aquifers within upland swamps where excess rainfall produces a highly variable, perched water table within the swamps and outcropping sandstone, which is independent of the regional Hawkesbury Sandstone water table. As the swamps are essentially rainfall-fed, their water levels fluctuate with climatic conditions;
- perched, ephemeral aquifers with a dual matrix porosity, as well as having tortuous flow paths in joint / fracture / bedding planes or dyke related flow systems of the shallow Hawkesbury Sandstone, which is generally within 20m of the surface;
- dual matrix porosity with tortuous flow paths in joint / fracture / bedding plane or dyke related systems within the deeper Hawkesbury Sandstone The shallow groundwater system is hydraulically separate from the perched groundwater system and defines the regional water table; and
- a deep groundwater system below the semi-confining Bald Hill Claystone, which provides a degree of isolation between the Hawkesbury Sandstone and the underlying Bulgo Sandstone and deeper formations in a variable sequence of mudstone / shale semi confining layers along with low yielding aquifers in sandstones and coal seams.

The Bald Hill Claystone has been partially eroded into the underlying Bulgo Sandstone in the valley of Cataract Creek, downstream of the freeway, whilst it is present over the plateau areas at Wonga East as shown in **Figure 4**.

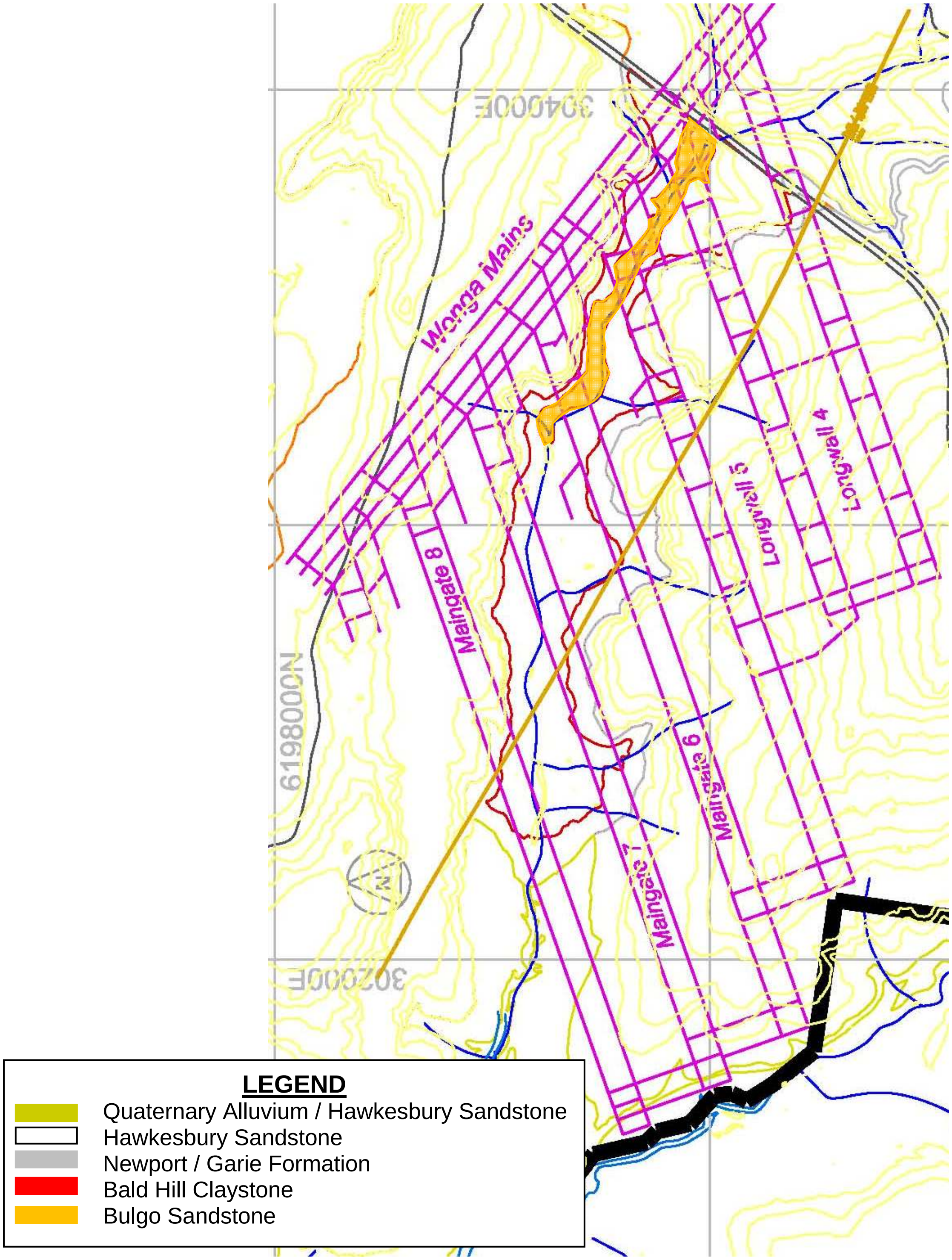


Figure 4 - Wonga East Surface Geology

5.3.1 Overburden Hydraulic Characteristics

Borehole packer tests, downhole geophysics, piezometer installation and pump out tests have been used to establish the strata permeability, groundwater levels and water quality in conjunction with the underground monitoring of water quantity and quality data in the workings.

The data from these investigations is used to identify potential effects on the local groundwater system due to coal extraction and dewatering operations.

Further details are contained in the groundwater assessment being prepared for the NRE No.1 colliery Major Expansion Project (Geoterra, in prep.).

5.4 Upland Swamps

Upland swamps are accumulations of colluvial and alluvial, medium to coarse grained sand, moving under gravity from ridges and “steps” into the stream network along with sediment formed by insitu bedrock weathering.

Upland swamps in the Gujarat lease area have relatively small upstream catchments, with their saturation being a function of storage in the sandy sediments, accumulated organic matter and rain events. The storage and water transmission characteristics of the surrounding and underlying Hawkesbury Sandstone is critical in sustaining these environments.

The upland swamps also occur in either headwater tributary valleys that are characteristically derived from colluvial sand movement from Hawkesbury Sandstone dominated ridgelines, or along the riparian zone of the major creeks.

They are only located within areas underlain by Hawkesbury Sandstone, which provides a low permeability base on which the swamp sediments and organic matter accumulate and do not form on Wianamatta or Narrabeen Group sediments.

Regional groundwater flow within the Hawkesbury Sandstone is largely horizontal, as vertical permeability is low.

Due to their gentle slope, only the larger swamps contain open channels, which are generally short and located at the downstream end, whilst a series of discontinuous elongated pools can be present further upstream in headwater valleys.

Mudstone bands within the strata can provide an impermeable barrier that restricts vertical surface water infiltration through the sandstone, and can limit recharge to groundwater systems beneath the band.

The swamps are not located close to the edge of signifcant cliff scarps, as is the case for “hanging” swamps in the Blue Mountains, and as such there are no “hanging” swamps in the Gujarat lease area.

Upland swamps generally are located within gently-sloping, trough shaped valleys, but can extend onto steep slopes or benches on valley sides. They are more extensive where the plateau is least dissected, and are more confined to headwater tributaries in more dissected catchments.

The central axes of the swamps are generally saturated, though the margins and central sections may dry out, particularly after extended dry periods.

The sand and humic material, which increases the swamps water-holding capacity, store and subsequently discharges rainfall infiltration, groundwater seeps and low-flow runoff into the local streams. Rainfall saturates the swamp and drains slowly due to the low slopes on a low permeability base as the average rainfall generally exceeds evaporation.

Sediments below and laterally lensing into the carbonaceous material are variable in nature and can be composed of fine to medium grained sands which are usually well sorted, light grey in colour and contain bands with a higher clay content, and clayey sands, which are usually mottled red-orange due to insitu weathering.

The sediments accumulate in upstream areas and are transported to the downstream areas, whilst the marginal slopes are generally smoother and flatter than the higher areas, tending to be steep and distinctly stepped.

Upland swamps can be subdivided into “valley fill” or “headwater” upland swamps, however, no valley fill swamps are present at Wonga East.

SCA approval for ten (10) swamp piezometers at Wonga East was obtained prior to installation at locations shown in **Drawing 2**.

5.5 Structural Geology

5.5.1 Structures Mapped at Surface

Faults indicated by the 1:100,000 scale mapping (Geological Survey of NSW, 1985) as outcropping in the WMP area include the:

- west-north west / east-south east trending Rixons Pass and Woonoona Faults; and
- north west / south east trending unnamed splay off the Corrimal Fault to the south of Cataract Creek.

Although the Rixon’s Pass Fault is shown at surface on the 1:100,000 geological map to be sub-parallel to Cataract Creek, no trace of it has been identified in the Bulli or Balgownie workings.

West-north west / east-south east trending creek lines that potentially mark the surface outcrop of the Rixon’s Pass Fault can be seen in **Figure 5**, with the creeks located to the north of Longwalls WE-A2-LW4 and LW5.

The proposed Wonga East workings are located to the south of the major SE / NW Corrimal Fault structure.

Outside of the mine workings, the exact location, throw and inclination of the faulted zones are not accurately known at depth, as their position is based on extrapolation of drill hole and workings intersections.

Based on past mining experience, the faults in the Bulli / Balgownie workings are essentially dry, with some localised ponding, and therefore are not anticipated to provide enhanced permeability fluid pathways in the mining area.

5.5.2 Bulli and Balgownie Seam Igneous Intrusions

Variable thickness dykes intruded along the same fault trends have been identified within the Gujarat lease area.

The southern bord and pillar workings in the Bulli Seam at Wonga East are bound by an up to approximately 30m wide east west trending dyke.

A southeast - northwest trending dyke on the southern boundary of Mining Lease ML1575 was intersected in the Cordeaux workings, which are from 20 - 40m south of the NRE No.1 workings.

An outcropping, highly weathered dyke has been mapped over over Longwalls WE-A2-LW4 and :LW5 at Wonga East

No water inrush has been reportedly associated with faults or dykes in the Bulli or Balgownie workings (S Wilson, pers comm).

No diatremes are identified in the WMP area.

Figure 5 - Wonga East Surface Structures

5.6 Climate

The study area is within a warm temperate region with significant variation to the west in temperature and precipitation due to topographic effects and the proximity to Illawarra Escarpment and the coast.

Rainfall varies from a maximum of 1800mm/year in the east to 1000mm/year in the west of the Study Area, with maximum rainfall in Autumn to Winter.

A plot of rainfall recorded at Cordeaux Colliery since January 2002, which is located to the immediate north of the NRE No. 1 lease area, is shown in **Figure 6**.

The plateau generally experiences cooler temperatures than the coast, with an average diurnal range from 21.5°C in January to 12.5°C in Winter.

A BHPBIC rainfall gauge is operating at the Cordeaux Colliery, whilst the BoM have a weather station at Bellambi, to the east of the escarpment.

Gujarat installed a weather station at the NRE No.1 mine (No.4 shaft) to the west of Cataract Reservoir in 2009 that monitors rainfall, wind speed & direction, humidity, temperature and barometric pressure.

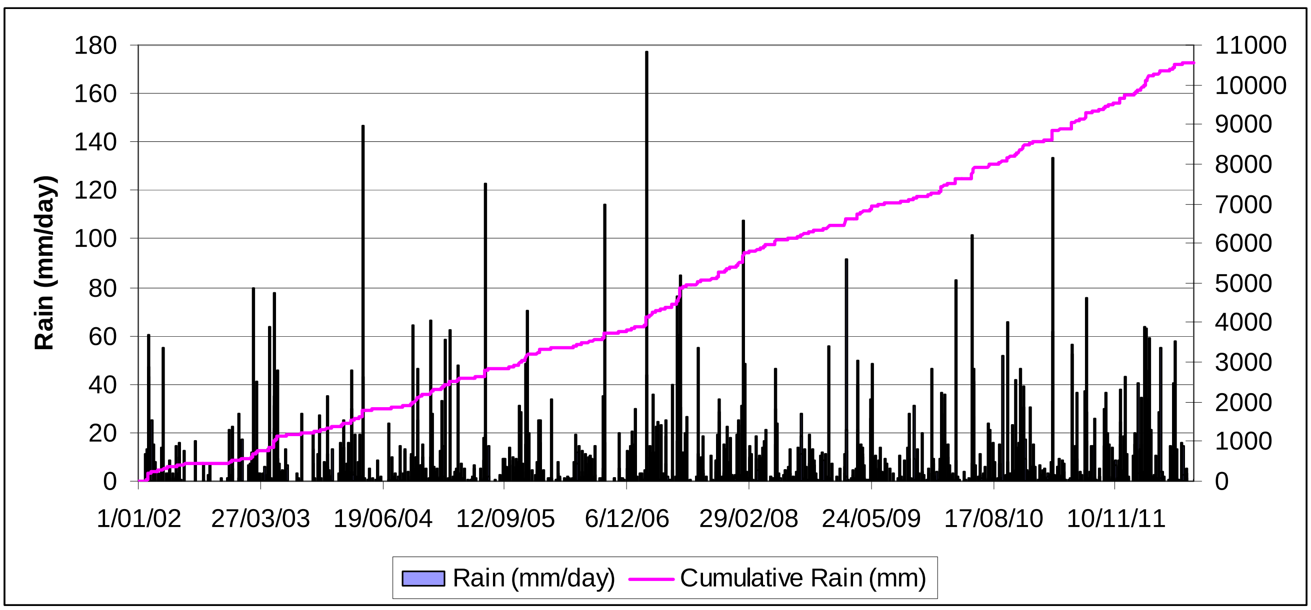


Figure 6 - Daily Rainfall

6 STREAM BASELINE DATA

This section outlines the stream catchment features and monitoring that has been conducted in the vicinity of the WMP area.

6.1 Cataract Creek

6.1.1 Geomorphology

A LIDAR survey was flown with an accuracy of 0.55m and contored at 1m intervals to determine the current surface topography in the study area as shown in **Figure 7.**

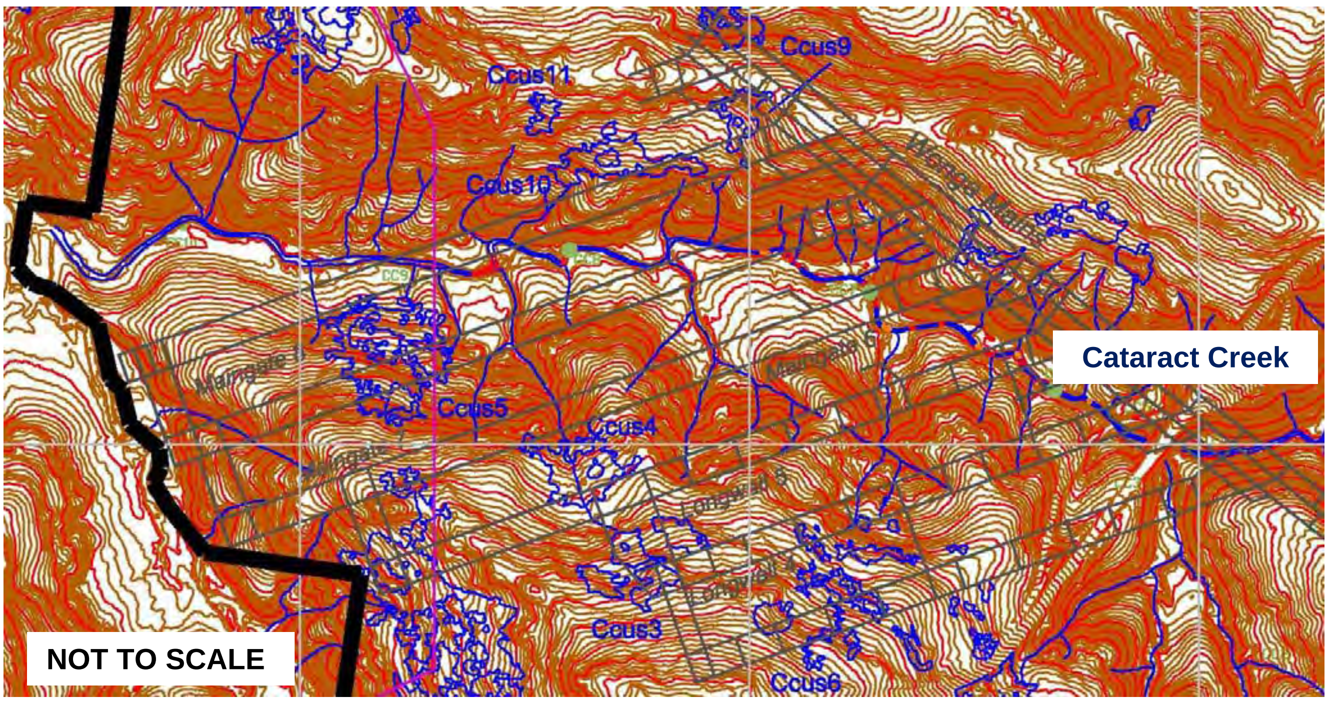


Figure 7 - 1m Contour Topography over the WMP area

Cataract Creek flows to the west into Cataract Reservoir at Wonga East Area 2.

The Schedule 2, 4th order (DIPNR, 2005) Cataract Creek channel does not overlie longwalls WE-A2-LW4 or LW5, but does overly maingates 6, 7 and 8 as shown in **Drawing 1**.

The main channel and tributaries have been undermined by longwalls in the Balgownie Seam as well as bord and pillar / pillar extraction in the overlying Bulli Seam.

Longwall WE-A2-LW4, which was extracted in the Wongawilli Seam, does not underlie the main channel of Cataract Creek.

The main channel of Cataract Creek has eroded sequentially into the Hawkesbury Sandstone, Newport and Garie Formations and Bald Hill Claystone, with the Bald Hill Claystone being exposed in the lower reach of the creek, upstream of the reservoir. The Bulgo Sandstone is exposed in Cataract Creek, downstream of the freeway as shown in **Figure 4**.

Cataract Creek flows directly into Cataract Reservoir over the western section of Wonga East, Area 2, whilst its headwaters are located immediately to the west of the Illawarra Escarpment.

The creek is not regulated by any dams or weirs.

The creek is relatively steep, particularly in its headwaters, with a reducing gradient with distance downstream, and flows through a series of short pools, sandy reaches, rock bars and boulder fields as shown in **Table 6.1** and **Figure 8**.

Table 6.1 - Cataract Creek Gradient

Stream Reach	Vertical Fall (m)	Distance (m)	Gradient
Headwater to CC2	87	865	0.101
CC2 to CC3	8	535	0.015
CC3 to CC5	1	110	0.009
CC5 to CC6	4	635	0.006
CC6 to CC9	5	1250	0.004
CC9 to CC10	4	435	0.009
CC10 to Cataract Dam	1	375	0.003

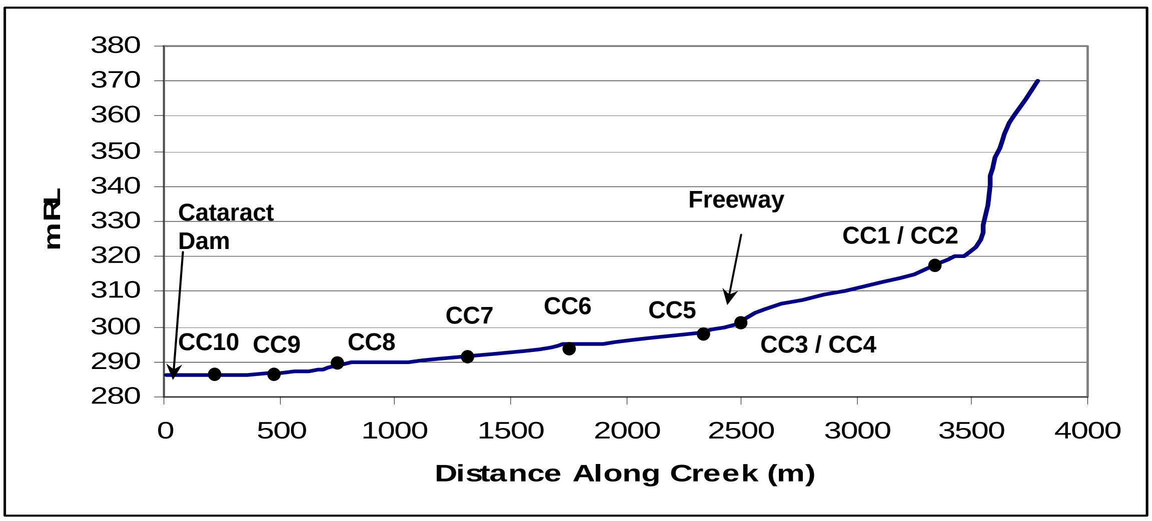


Figure* 8 *- Cataract Creek Stream Reach

Cataract Creek is characterised by two steeply sloping headwater valleys monitored by Sites CC1 and CC2, which flow to sites CC3 and CC4 before joining as a single stream at CC5.

The headwater tributaries have eroded through the Hawkesbury Sandstone and, in the deeper eroded areas, through to the Bald Hill Claystone, and potentially the Bulgo Sandstone.

Detailed stream bed mapping between CC5 and CC9 identified a series of long elongated pools that are constrained by low (<0.5m high) shallow rock bars, which predominate in the upper to mid section, along with occasional, gravel sized riffle sections that also predominate in the upper to mid section of the study reach.

Significant reaches of sandy based substrate dominate between CC7 and CC9, which has developed in an eroded, interspersed shale and sandstone sequence compared to the Hawkesbury Sandstone.

A limited number of rock bar constrained pools are present between CC7 and CC9, although two moderate sized, <1-2m deep pools have developed at significant bends at rock bars CcRB13 and CcRB14 as shown in **Figure 9**.

Well developed, primarily rainforest based shrubs, grasses and trees dominate along the creek banks.

No waterfalls or highly stepped zones are present in the creek.

The stream bed and banks of the plateau streams are well vegetated and do not show significant erosion or bank instability. Heavily vegetated rainforest is developed from the edge of the escarpment to downstream of the freeway, which transgresses into heavily wooded forest between the freeway and the dam.

The photographs shown in **Plate 1** indicate the typical nature of the rock bars and riffles and pools in the reach between CC5 and CC9.

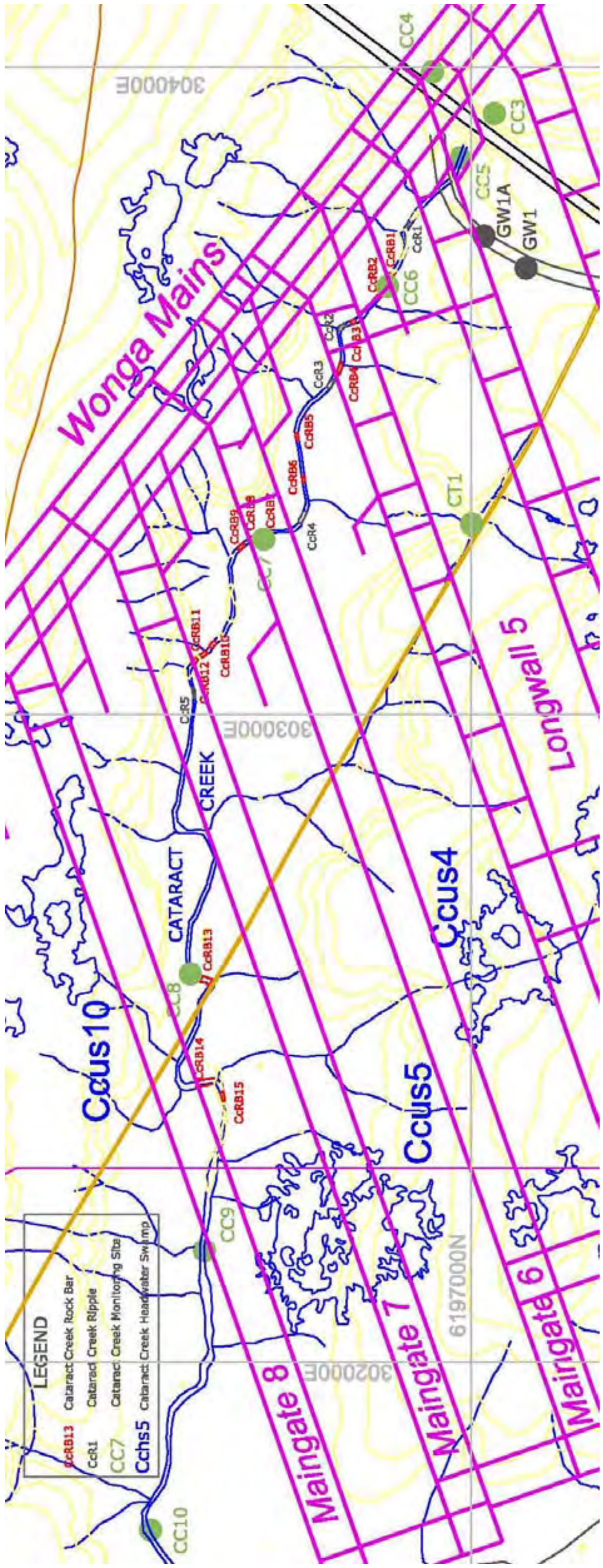


Figure 9 - Cataract Creek CC5 to CC10 Stream Reach Mapping

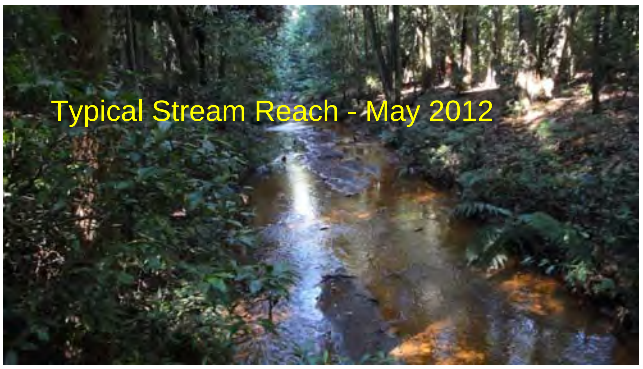


PLATE 1 – Typical Cataract Creek Rock Bars, Riffles and Stream Reach

Details of the regular stream water quality and water level monitoring locations in Cataract Creek are shown in **Table 6.2**, with photographs shown in **Plate 2**.

Table 6.2 - Cataract Creek Stream Monitoring Sites

SITE	E (MGA)	N (MGA)	DESCRIPTION
CC1	304893	6196615	Tributary draining east of the escarpment to the east of proposed Panel A1 LW2
CC2	304107	6196418	Tributary draining east of the escarpment over proposed Panel A1 LW3
CC3	303937	6196961	Nthn tributary junction east of freeway, between proposed Panels A1 LW3 and A2 LW4
CC4	303964	6196992	Sthn tributary junction east of freeway, between proposed Panels A1 LW3 and A2 LW4
CC5	303852	6197005	Start of main Cataract Ck channel west of freeway upstream of proposed panel A2 LW5
CC6	303645	6197145	Adjacent to proposed Longwall 5
CC7	303299	6196994	Adjacent to proposed Longwall 6, downstream of tributary CT1
CC8	302595	6197425	Over Longwall 8
CC9	303175	6197415	Upstream of dam high water level over proposed panel A2 LW9
CC10	302740	6197503	Creek site within creek high water level on western edge of proposed panel A2 LW9
Crus1c	302310	6196620	Surface water discharge from swamp Ccus1
Ccus3c	302830	6196915	Surface water discharge from swamp Ccus3
Ccus4c	302625	6196915	Surface water discharge from swamp Ccus4
SP1c	303275	6196995	Surface water runoff down slope of shallow piezometers SP1
CD1	301257	6198280	Cataract Reservoir to north of Cataract Creek, outside of the Application Area

NOTE: *Co-ordinates supplied from GPS*

PLATE 2A - Cataract Creek Monitoring Sites

PLATE 2B - Cataract Creek Monitoring Sites

The CC1 – CC5 and CD1 monitoring sites were installed by Geoterra Pty Ltd (Geoterra) in August 2008, and were regularly monitored on a bi-monthly basis up until Gujarat NRE Coking Coal Pty Ltd (Gujarat) took over management and implementation of the NRE1 project field work in July 2010.

CT1 was installed in a 2nd order tributary by Gujarat in April 2012.

Stream water level, flow and water quality stations are in the process of being installed by Gujarat between CC6 and CC8.

The Ccus2, 3, 4, 5, 6, Crus1 and Bcus4 swamp and 1st order creek monitoring sites were installed by Geoterra in March 2012, with ongoing management of field work and laboratory analysis being conducted by Gujarat.

A detailed summary of stream and swamp water monitoring locations, parameters and commencement dates is contained in **Appendix A.**

6.1.2 Stream Flow and Pool Levels

The 2nd order tributaries between Sites CC1 - CC4 and CC2 - CC3 have not been observed to dry out since monitoring began in July 2008, although they usually contain ferruginous precipitates.

The fourth order stream channel between CC5 and CC9 has also been continuously flowing.

Downstream of CC5 the creek water becomes sequentially clearer, although ferruginous precipitation can be observed along the entire reach down to the headwaters of the dam.

Tributary CT1 has a notable development of ferruginous sandy sediment and discoloured runoff, and has often been observed to raise the ferruginous discolouration downstream of its confluence with Cataract Creek, upstream of site CC7.

No adverse effects on stream flow continuity or stream ponding have been observed in Cataract Creek.

No obvious mining induced cracking of rock bars and loss of pool holding capacity has been observed between CC5 and CC9.

Pool height water level monitoring, which commenced in November 2010 under the management of Gujarat, is conducted at sites CC3, CC4 and CC7, whilst CT1 was initiated in April 2012 as shown in **Figure 10**.

Volumetric stream flow monitoring using either the cross sectional / flow velocity or temporary box notch weirs was initiated at CC3 and CC4 by Gujarat during April 2012. Additional sites are currently being installed by Gujarat at CC6, 7 and 8.

The recent and historic water level data will be used to convert the historic and future stream height data into volumetric flow once the flow / duration curves have been sufficiently developed.

Sites CC3 and CC4 both overly the Bulli seam pillar extraction and the Balgownie longwalls, whilst CT1 overlies Bulli seam bord and pillar workings.

All pools between Sites CC1 and CC9 do not show an enhanced pool drainage rate, and have not dried up during the monitoring period.

The tributary monitored by CT1, which drains off the longwalls WE-A2-LW4 and LW5 catchment area has been observed to dry out after extended lack of runoff, however the pools still generally hold low pond levels and do not show total drainage due to subsurface cracking.

Recently, Cataract Reservoir has inundated Cataract Creek to approximately 100m upstream of CC9, although it has extended to approximately 75m downstream of CC9 since regular monitoring began in July 2008. As a result, flow monitoring at CC9 was temporarily discontinued until the dam level fell below the monitoring site.

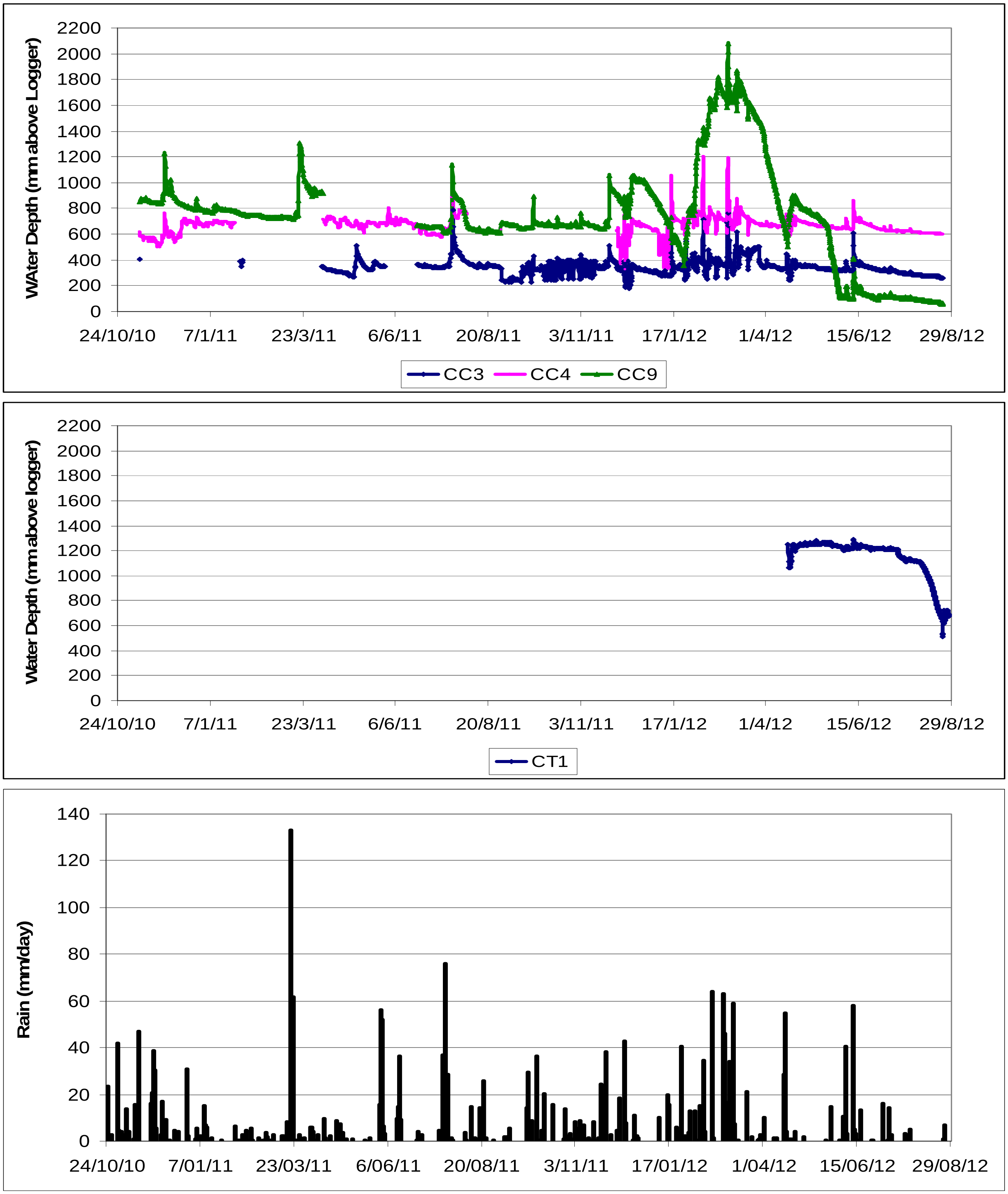


Figure 10 - Cataract Creek and Tributary Pool Depths

Since July 2008, CC10 has been permanently inundated by the dam and has not been regularly monitored.

The dam spill height is at 289.87m AHD (T Schultz, pers comm.)

6.1.3 Stream Water Chemistry

A summary of both field and laboratory analytical monitoring results conducted is contained in **Appendix B**.

The CC1 – CC9 and CD1 monitoring sites were installed by Geoterra Pty Ltd (Geoterra) in August 2008, and were regularly monitored on a bi-monthly basis up until Gujarat NRE Coking Coal Pty Ltd (Gujarat) took over management and implementation of the NRE1 project field work, monitoring and laboratory analyses in July 2010.

The Ccus3c, 4c, 5c, 6c, Crus1 and SP1c swamp outflow, 1st order creek monitoring sites were installed by Geoterra in March 2012, with ongoing field work and laboratory analysis management being conducted by Gujarat.

In addition to the current bi-monthly stream water depth, stream flow and stream water quality monitoring, photographic records of each monitoring site are taken during each field trip.

In general, enhanced rainfall in the catchment has the effect of reducing salinity, marginally raising pH, increasing dissolved oxygen, diluting ferruginous discolouring (or deposition), diluting major metals and generally increasing nutrients, with the degree of change relating to the degree and duration of rainfall runoff dilution in the stream.

Cataract Creek's overall pH ranges from 4.39 to 6.91, with a median of 5.56 upstream at CC1, along with a relatively "flat" trend at all other sites of from 6.1 to 6.3 as shown in **Figure 11**.

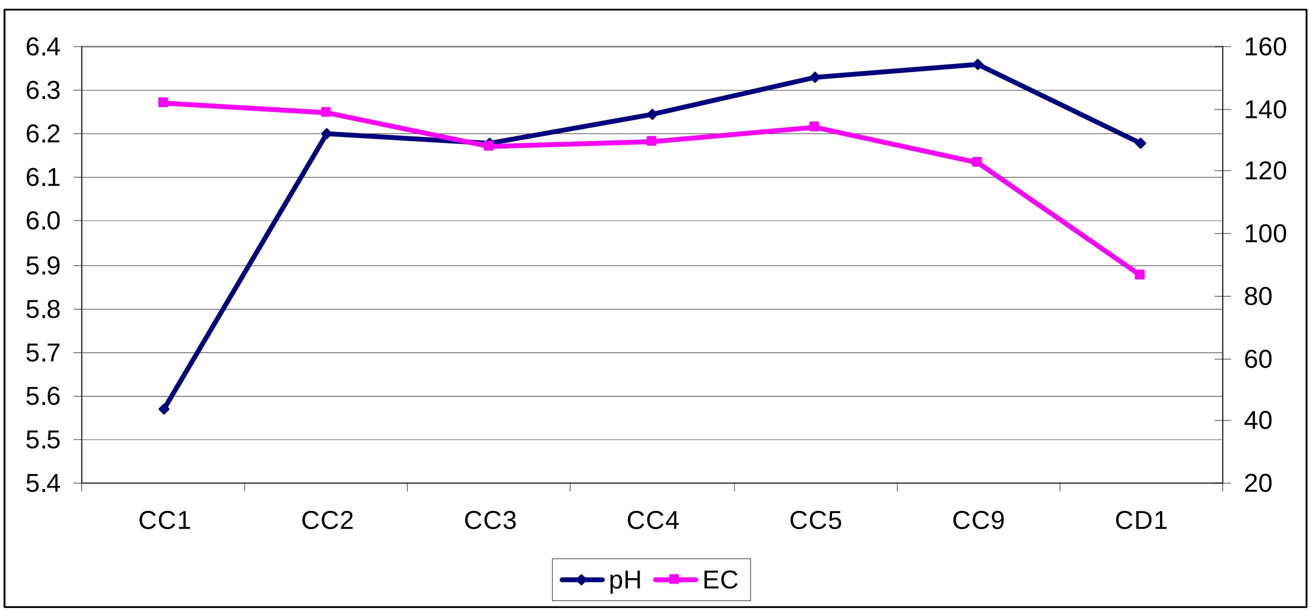


Figure 1 - Cataract Creek Median pH and Salinity

The stream's pH is outside the ANZECC 2000 South Eastern Australia Upland Stream criteria, which is not uncommon in natural catchments draining off Hawkesbury Sandstone in the Southern Coalfields.

The median creek salinity ranges from 130 - 145µS/cm, with a minor decrease with distance downstream as shown in **Figure 12**.

All 2nd order or higher tributaries and the main channel of Cataract Creek have been observed to have intermittent to perennial flow.

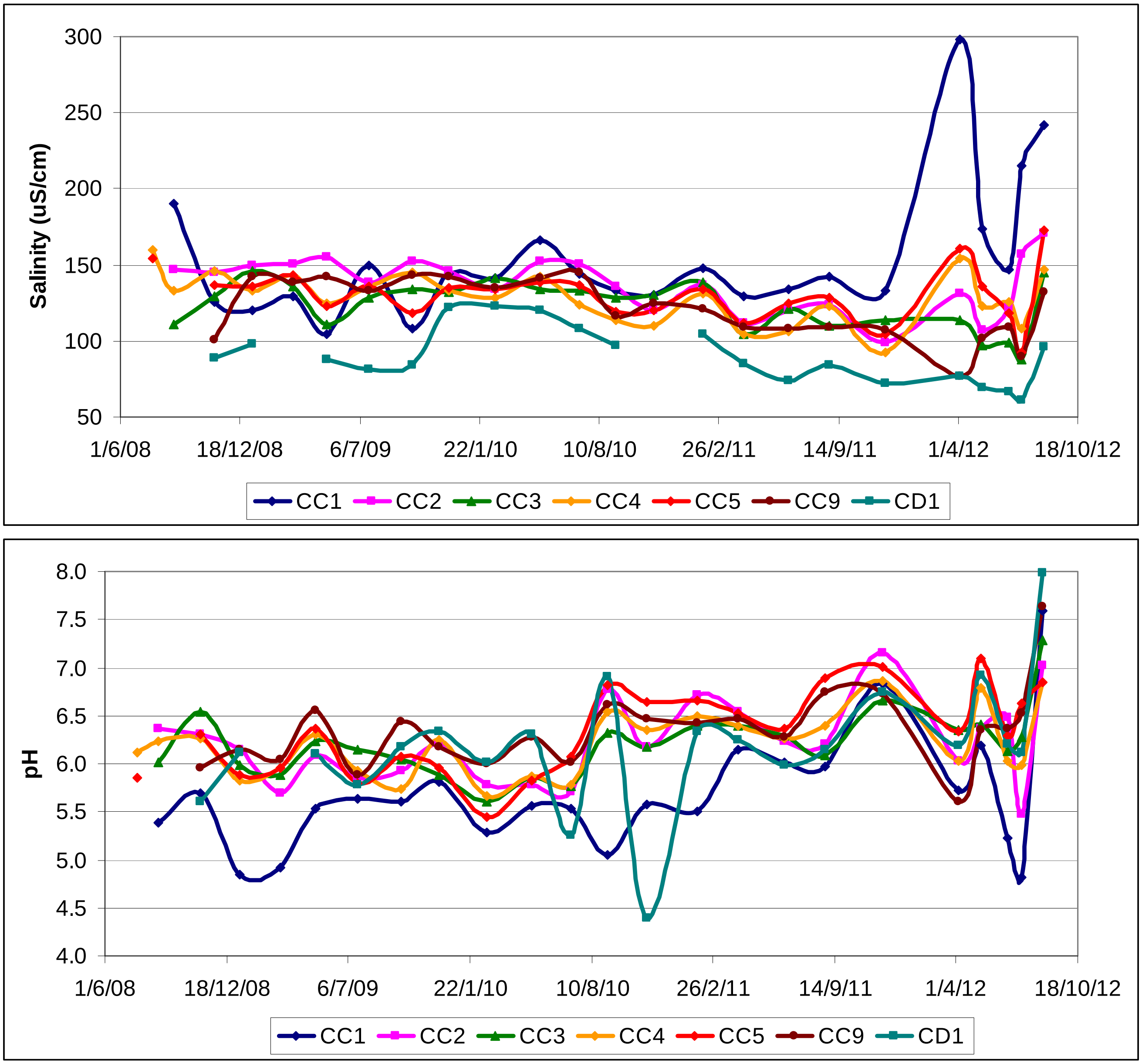


Figure 12 - Cataract Creek Field Water Chemistry

As shown in **Figure 13**, filtered iron levels are generally unchanged with flow downstream.

Hydrous ferruginous seeps are relatively common in Cataract Creek, although their exact inflow location has not yet been identified as ferruginous precipitation is relatively ubiquitous in the creek both upstream and downstream of the freeway.

Due to the lack of pre mining data, it is not possible to ascertain whether the ferruginous seeps are caused by, or related to, historic mine subsidence.

Total and filtered median iron discharges into Cataract Reservoir at LC9 are 0.96mg/L and 0.26mg/L respectively.

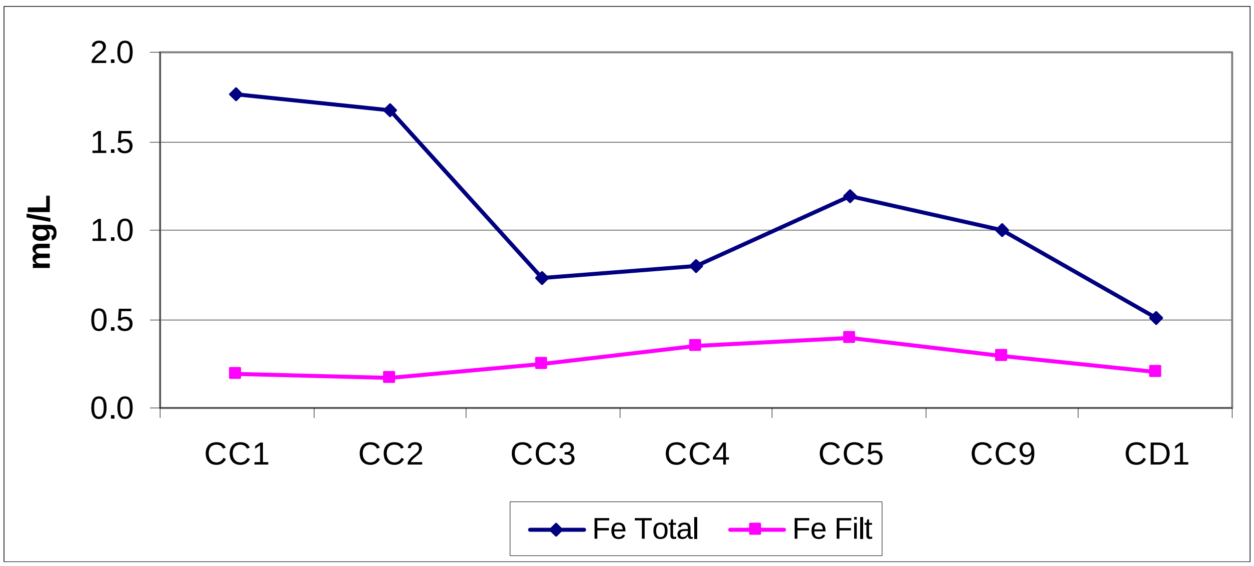


Figure 2 - Cataract Creek Median Iron Levels

Figure 14 illustrates that median total manganese peaks at CC2, whilst filtered manganese has a general reduction with flow downstream.

Total and filtered median manganese discharge at CC9 into Cataract reservoir is 0.08g/L and 0.01mg/L respectively, compared to the ANZECC 2000 criteria of 1.9mg/L.

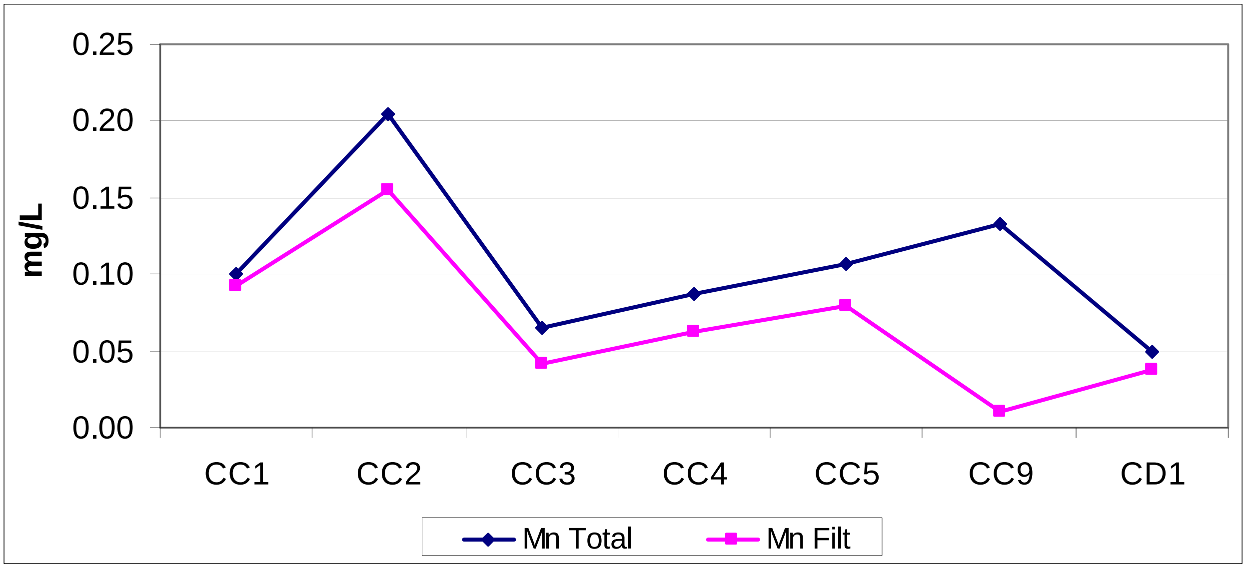


Figure 3 - Cataract Creek Median Manganese Levels

A peak in sulfate is present in the CC2 / CC3 tributary as shown in **Figure 15** which could represent the dissolution of sulfuric acid following iron sulfide weathering as a result of shallow subsurface flow through cracks in the subsided and cracked basement strata, and / or weathering of the exposed Bald Hill Claystone and overlying shale / claystone dominated units.

A peak is also present at CC5 where the (CC1 - CC4 and CC2 - CC3) tributaries join.

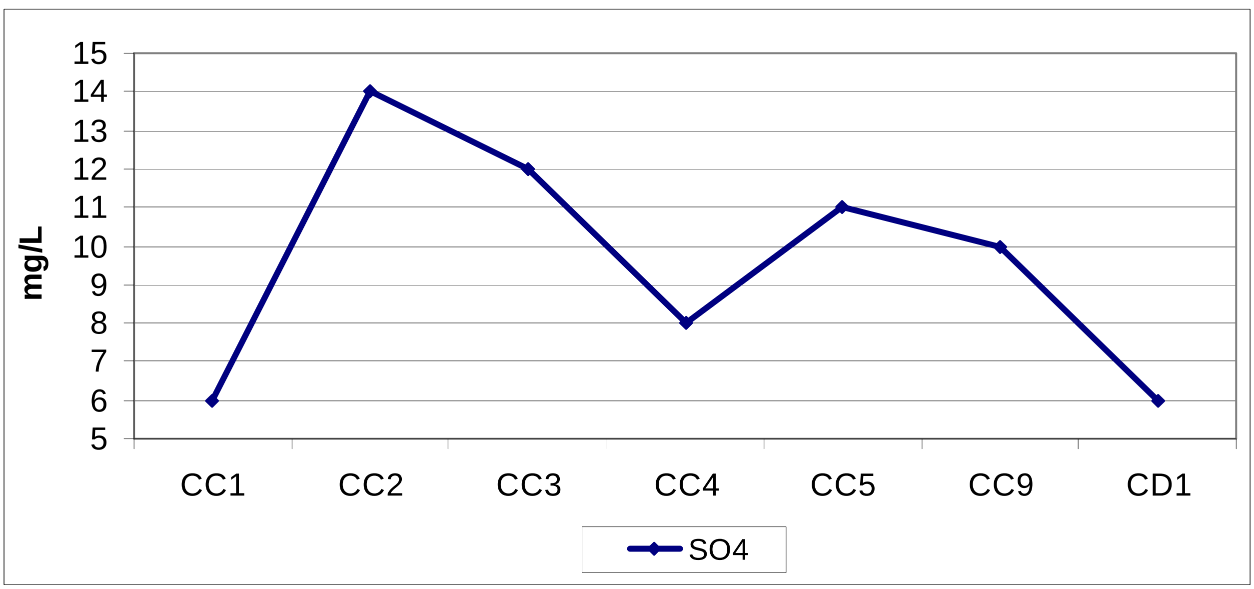


Figure 4 - Cataract Creek Median Sulfate Levels

In summary, monitoring to date indicates the creek is within the acceptable range for potable water, however is generally outside the ANZECC 2000 South Eastern Australia Upland Stream Criteria for pH and can be above the ANZECC 2000 95% Species Protection Level for Freshwater Aquatic Ecosystem Guidelines depending on the flow conditions at the time of sampling for:

- filtered zinc at CC1, CC4 and CD1, with a high variability;
- total phosphorous at all sites, generally;
- total nitrogen, at all sites, infrequently;
- occasionally filtered copper; and
- aluminium on only one occasion (CC1 on 2/12/11), as although some values exceed 55µg/L, they do not exceed the ANZECC 200 criteria as they are below pH 6.5.

Where the ferruginous deposits occur, the stream water quality can exceed ANZECC 2000 criteria between CC1 and CC5 for:

- filtered copper up to 0.004mg/L, very infrequently;
- filtered zinc up to 0.12mg/L, infrequently;
- total nitrogen up to 1.9mg/L, very occasionally;
- total phosphorous up to 0.27 mg/L, occasionally; and
- with a gradually rising pH with distance downstream from 5.54 – 6.1 and a relatively static salinity of 141µS/cm.

Where the creek discharges into Cataract Reservoir at CC9, the only parameters above ANZECC criteria level have been:

- filtered zinc, rarely at 0.09mg/L;
- total nitrogen, infrequently at 0.4 – 0.6mg/L;
- total phosphorous, infrequently, ranging from 0.04 – 0.08mg/L;
- pH of 6.1; and
- salinity of 98µS/cm.

Monitoring of field and laboratory water quality and general observation of the stream flow commenced in March 2012 and is conducted in the first order gully drainage sites Crus1c, Ccus3c and Ccus4c, which are downstream of upland swamps Crus1, Ccus3 and Ccus4.

Monitoring at these sites is conducted when there is flowing or ponded water in the ephemeral drainage gullies.

6.1.4 Channel Stability and Erosion

No evidence of stream bed cracking, flow loss or adverse effects on pool levels has been observed in Cataract Creek in areas undermined by the Bulli or Balgownie workings.

6.2 Cataract River Stream Flow

Stream flow, height and water quality monitoring installations were installed by Gujarat on 12 April 2012 at locations shown in **Drawing 1**, and as summarised in **Table 6.3**.

Table 6.3 - Cataract River Stream Monitoring Sites

SITE	E (MGA)	N (MGA)	DESCRIPTION
CR1	303905	6195540	Upstream of Freeway
CR2	302175	6195745	At SCA weir flow monitoring site, downstream of Freeway
CR3	301915	6196130	Upstream of Swamp Crhs1
CR4	301780	6196770	Within high water section of Cataract Reservoir

NOTE: *Co-ordinates supplied from GPS*

The Cataract River catchment has not been fully inspected to date as longwalls WE-A2-LW4 and LW5 will not impact on the creek bed, and therefore no detailed comment can be made as yet on the geomorphology, stream flow, pool and water quality conditions of the reach between the freeway and the reservoir.

6.3 Hydrological Modelling

Rainfall, evaporation and gauged stream flow data have been used to derive a hydrological model of the Study Area and surrounds to provide quantitative hydrologic model simulations for the comparison and assessment of the possible hydrologic effects of the mining at the NRE No. 1 colliery.

The AWBM rainfall – runoff model focussed on assessing the potential effects of groundwater depressurisation and stream bed upsidence to provide a quantitative assessment of the significance of any stream flow changes due to undermining the study catchments.

This enabled mining affected catchments to be compared with similar, local, unaffected catchments to determine if any change in the magnitude of key hydrologic parameters occurred, or could occur. The modelling could also be used in the future to measure any changes associated with self-sealing or anthropogenic remedial effects.

In brief, the modelling indicated that subsidence induced cracking could potentially affect streamflow in the reaches overlying and downstream of the proposed workings, although the anticipated stream flow losses would have very little impact on Lake Cataract water storage volume. In addition, the impacts would be restricted to short reaches where flow infiltrates into cracks in the bed, then remerges further downstream. However, based on the available subsidence assessments, it is not possible to excatly define the potential magnitude of these losses or the lengths of streams likely to be impacted.

7 SWAMP BASELINE DATA

There are more swamps at Wonga East than discussed in this section, however only swamps relevant to the proposed works are discussed here. Further details are available in (Biosis, 2012).

7.1 Ccus3

Ccus3 is a northerly draining swamp with no defined channel located in the south western headwaters of Cataract Creek which partially overlies WE-A2-LW5, and has an average gradient of 0.09.

It has a maximum 275m depth of cover, with longwalls WE-A2-LW4 and LW5 having a proposed 145m extraction width with 60m wide pillars.

Field investigations and installation of swamp piezometer PCc3 identified that the soil profile is relatively shallow, contains minimal humic material and is generally dry.

Numerous attempts were made within the swamp to identify a suitable location for a piezometer, however, as the swamp is principally dry, with a shallow weathered sandy clay colluvial soil over shallow weathered sandstone, and essentially has no development of a moist humic layer, with numerous sandstone outcrops, the site for PCc3 was finally chosen as the best available location.

7.2 Ccus4

Ccus4 is a northerly draining banksia thicket based swamp with no defined channel located in the south western headwaters of Cataract Creek and overlies the Maingate 6 first workings, with an average gradient of 0.07.

Field investigations and installation of swamp piezometer PCc4 identified that the soil profile is relatively shallow, contains minimal humic material and is generally dry.

Numerous attempts were made within the swamp to identify a suitable location for a piezometer, however, as the swamp is principally dry, with a shallow weathered sandy clay colluvial soil over shallow weathered sandstone, and essentially has no development of a moist humic layer, with numerous sandstone outcrops, the site for PCc4 was finally chosen as the best available location.

7.3 Ccus5

Ccus5 is a northerly draining banksia /tea tree thicket based swamp with no defined channel located in the south western headwaters of Cataract Creek. It overlies maingate 7 and 8 first workings, with an average gradient of 0.12 and is composed of a series of swamps located on “steps” in the valley slopes.

Field investigations and installation of swamp piezometer PCc5A and PCc5B identified that the soil profile is relatively shallow, contains humic material and has been gradually drying out since the piezometers were installed due to lack of rainfall recharge.

7.4 Ccus9

Ccus9 is a southerly draining banksia thicket swamp with no defined channel located in the northern headwaters of Cataract Creek which overlies the Wonga Mains first workings, with an average gradient of 0.09.

7.5 Ccus10

Ccus10 is a southerly draining banksia / tea tree thicket swamp with no defined channel located in the northern headwaters of Cataract Creek which partially overlies the Maingate 8 first workings, with an average gradient of 0.09.

7.6 Bcus12

Bcus12 is a southerly draining banksia / tea tree thicket and restioid / cyperoid heath swamp with no defined channel located in the northern headwaters of Cataract Creek which partially overlies the Wonga Mains first workings, with an average gradient of 0.17.

7.7 Crus1

Crus1 is a westerly draining swamp with no defined channel that is located in the headwaters of Cataract River.

Although it lies within the WMP area, it has negligible potential to be subsided by the proposed first workings of maingate 6 as shown in **Drawing 1**, and has an average gradient of 0.112.

Field investigations and installation of the swamp piezometer PCr1 identified that the soil profile is relatively shallow and has a moist, humic sandy / clay substrate.

7.8 Swamp Piezometers

Shallow piezometers have been installed as detailed in **Table 7.1** at locations shown in **Drawing 2**.

The open standpipe piezometers were installed by Geoterra from March to April 2012, with ongoing management and implementation of the NRE1 project field work and monitoring conducted by Gujarat.

7.9 Shallow Weathered Hawkesbury Sandstone Piezometers

Shallow piezometers have been installed in the shallow weathered Hawkesbury Sandstone / soil profiles within elevated areas of the Cataract Creek catchment as detailed in **Table 7.1** at locations SP1 and SP2 as shown in **Drawing 1**.

The SP1 and SP2 open standpipe piezometers were installed by Geoterra in March 2012, with ongoing management and implementation of the NRE1 project field work and monitoring being conducted by Gujarat.

Table 7.1 - Wonga East Swamp Piezometers

Bore	Swamp	Installed	E	N	Total Depth (mbgl)	Intake Screen (m)	Intake Lithology
PCc2	**Ccus2**	May 12	303745	6146080	1.60	1.1 – 1.6	humic sandy clay / wthrd sast
		May 12	303735	6196100	-	Dry at 0.75	weathered sandstone
		May 12	303730	6196080	-	Dry at 0.75	weathered sandstone
PCc3	**Ccus3**	Mar 12	302820	6196810	1.2	0.7 – 1.2	sandy clay / wthrd sast
PCc4	**Ccus4**	Mar 12	302615	6196925	0.9	0.4 – 0.9	sandy clay / wthrd sast
PCc5A	**Ccus5**	May 12	302110	6197150	1.24	0.7 – 1.2	humic sandy clay / wthrd sast
		May 12	302135	6197155	-	Dry at 0.3	weathered sandstone
		May 12	302135	6197160	-	Dry at 0.5	weathered sandstone
		May 12	302105	6197130	-	Dry at 1.6	weathered sandstone
PCc5B	**Ccus5**	May 12	302245	6197250	1.31	0.8 – 1.3	humic sandy clay / wthrd sast
PCc6	**Ccus6**	Mar 12	303165	6196790	1.2	0.7 – 1.2	weathered sast
PCr1	**Crus1**	Mar 12	302330	6196625	0.55	0.3 – 0.55	humic sandy clay / wthrd sast
PB4	**Bcus4**	May 12	302485	6198060	0.6	0.25 – 0.6	humic sandy clay / wthrd sast
SP1	**No swamp**	Mar 12	303245	6196955	0.60	0.1 – 0.6	sandy clay / wthrd sast
SP2	**No swamp**	Mar 12	302830	6196905	1.05	0.55 – 1.05	sandy clay / wthrd sast

NOTE: AMG co-ords based on GPS readings shading indicates dry bore with no piezometer
SP1 shallow soil / weathered sandstone piezometer No.1

7.10 Groundwater Levels

7.10.1 Swamps

Since monitoring commenced in mid March 2012, the water levels in swamp Crus1 (monitored by PCr1) has been gradually declining, whilst swamp Crus3 (via PCc3) has been dry and Ccus4 (via PCc4) has been relatively stable as shown in **Figure 16**.

7.10.2 Shallow Sandstone

Since monitoring commenced in mid March 2012, the water level in the shallow sandstone piezometer SP1 has been gradually declining, whilst SP1 and SP2 have been dry as shown in **Figure 16**.

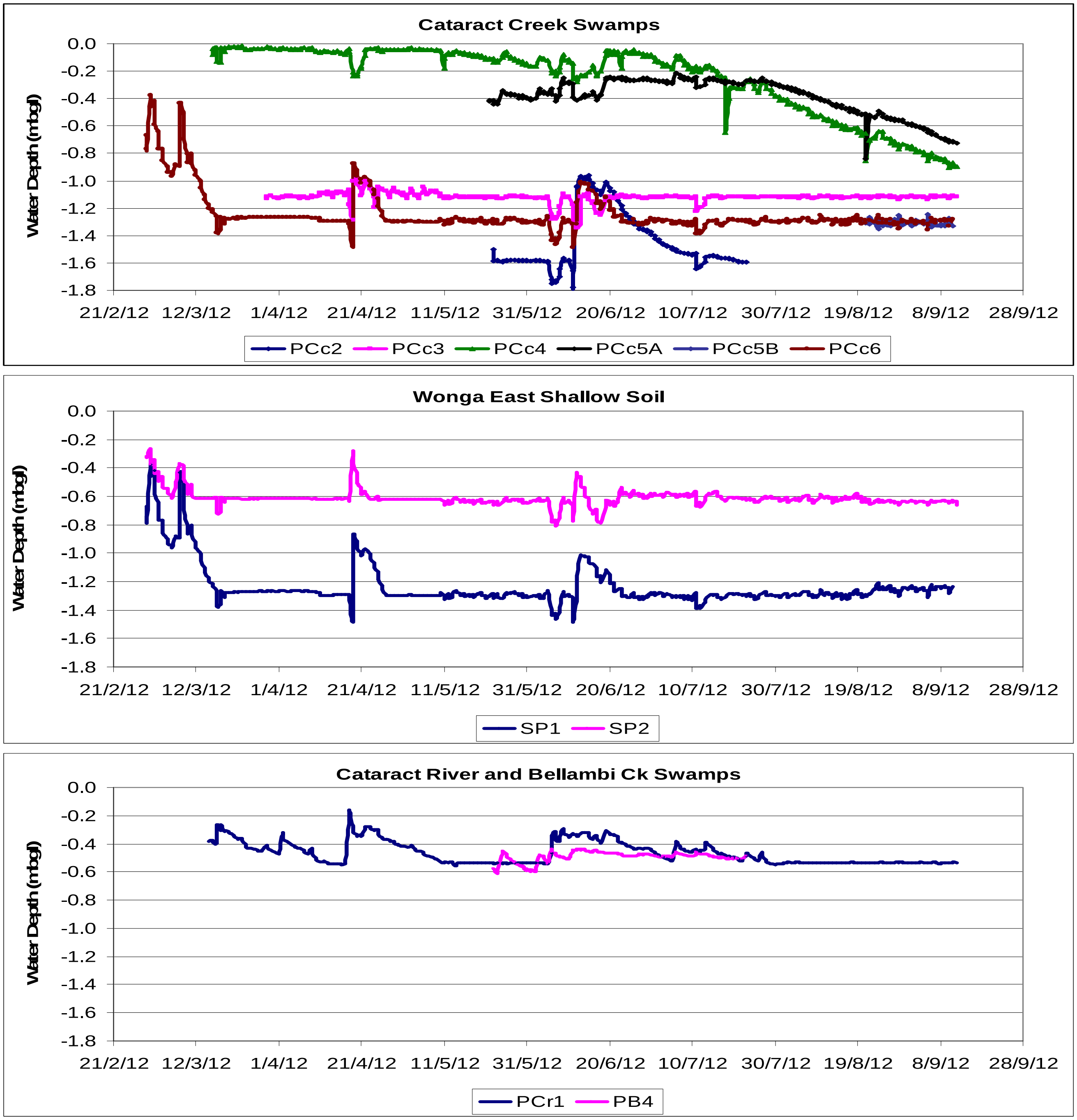


Figure 5 - Wonga East Swamp and Shallow Sandstone Groundwater Levels

7.10.3 Paired Wonga East Swamp and Basement Water Levels

Paired swamp and Hawkesbury Sandstone water level monitoring at PCc2 and the open standpipe piezometer NRE-A is shown in **Figure 17**.

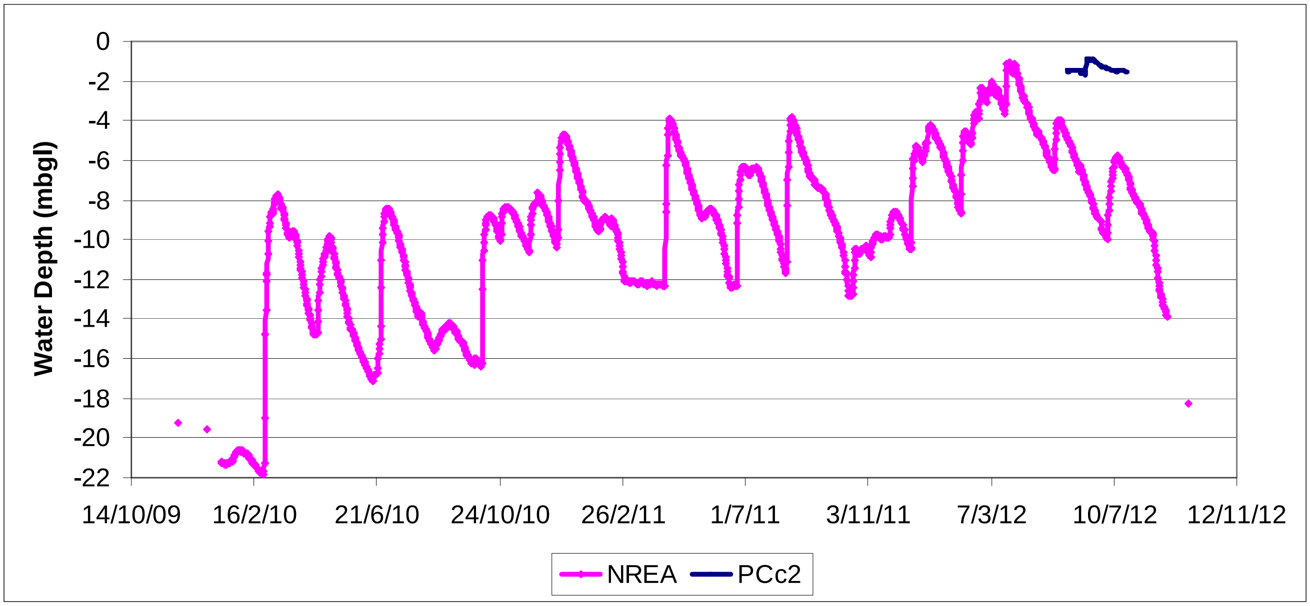


Figure 6 - Swamp Ccus2 and Hawkesbury Sandstone NRE-A Water Levels

7.11 Groundwater Quality

7.11.1 Swamps and Shallow Sandstone

The Cataract Creek, Bellambi Creek and Cataract River swamps at Wonga East have electrical conductivities ranging from 70 – 170µS/cm, with the salinity varying in relationship to rainfall recharge that occurs prior to sampling, along with the degree of brackish seepage from the weathered Hawkesbury Sandstone.

The pH ranges from 3.8 – 7.3 as shown in **Figure 24**.

Monitoring indicates the swamp salinity is within the acceptable range for potable water, however it is generally outside the ANZECC 2000 South Eastern Australia Upland Stream criteria for pH and can be above the ANZECC 2000 95% Species Protection Level for Freshwater Aquatic Ecosystem Guidelines, as shown in **Appendix B,** for:

- filtered copper, lead, zinc, nickel, and occasionally aluminium (where its pH exceeds 6.5, which it rarely occurs); and
- total nitrogen, and total phosphorous.

Figure 7 - Swamp and Shallow Sandstone Water Quality

7.11.2 Swamp Discharge and 1st Order Creek Water Quality

Initial sampling in March 2012 as shown in **Table 7.2** indicates the swamp discharge water quality is acidic (pH 4.17 – 4.94) and fresh (124 - 162µS/cm) and can exceed the ANZECC 2000 95% Species Protection Level for Freshwater Aquatic Ecosystem Guidelines for zinc as shown in **Appendix B**.

Although aluminium can exceed 55µg/L, it does not exceed the ANZECC 2000 proviso pH of 6.5.

Table 7.2 - Swamp Discharge Water Quality

Bore	pH	EC (µS/cm)
Crhs1 (c)	4.51	106
Cchs3 (c)	4.17	162
Cchs4 (c)	4.94	124

Initial sampling in March 2012 as shown in **Table 7.3** indicates the 1st order stream water quality, downstream of SP1 and SP2 piezometers is acidic (pH 4.61 – 4.97) and fresh (63 - 66µS/cm) and can exceed the ANZECC 2000 95% Species Protection Level for Freshwater Aquatic Ecosystem Guidelines for zinc as shown in **Appendix B**.

Although aluminium can exceed 55µg/L, it does not exceed the ANZECC 2000 proviso pH of 6.5.

Table 7.3 - SP1 and SP2 1st Order Stream Water Quality

Bore	pH	EC (µS/cm)
SP1 (c)	4.61	63
SP2 (c)	4.97	66

8 BASEMENT GROUNDWATER DATA

8.1 Seeps and Springs

No groundwater springs or seeps have been directly observed over the proposed mining area, however, seeps are likely to be present along Cataract Creek, although their exact entry point into the creek are not known, particularly in the headwater tributaries where ferruginous seeps have been observed.

As part of the ongoing monitoring outlined in the monitoring section of this report, any groundwater springs and seeps that are observed will be monitored as part of the water management plan.

If any seeps or springs are observed, or noted to change, the changes will be recorded on the surface water field monitoring sheets as required.

8.2 Piezometers

The current and proposed groundwater monitoring plan has been developed using data and findings from a preliminary version of the NRE No.1 Colliery groundwater assessment (Geoterra, in prep.) following an adequacy assessment by the NSW government regulators.

The current monitoring program was determined in association with:

- groundwater and swamp water level and water quality monitoring, data collation and interpretation
- conceptual groundwater model development;
- predictive numerical groundwater modelling, and;
- predicted impact assessment.

Basement groundwater levels and water quality are monitored, recorded in a central database and interpreted at least quarterly from piezometers in drill holes NRE-A, NRE-B, NRE-C and NRE-D, which contain either (or both) open standpipe and vibrating wire piezometer (VWP) arrays.

All monitoring locations are shown in **Drawing 1** and summarised in **Tables 8.1** and **8.2.**

The piezometers were installed in December 2009 at varying depths to monitor the overburden in the vicinity of Longwalls WE-A2-LW4 and LW5, after obtaining SCA approval. Groundwater levels or pressures are recorded at least 12 hourly, whilst field groundwater parameters (pH, EC) are monitored at least bi-monthly, with water samples sent for a full laboratory analysis at least annually.

Due to the limited access in the SCA controlled catchment, and to limit disturbance to the catchment, all drilling has been positioned along cleared access tracks, whilst the piezometer sites were offset from the longwalls to ensure the piezometer would not be sheared off during subsidence.

Water pressure and temperature sensors provide continuous measurement of water levels, whilst samples are collected by either low flow pumping or bailing at key horizons.

Groundwater level and water quality changes are used to provide baseline data as well as to assess any potential overburden impacts from mining. The monitoring is used to:

- identify the pre-mining groundwater regime,
- prepare impact assessments,
- monitor the mining impacts on groundwater,
- provide a basis for Triggered Action Response Plans, and to;
- monitor the effects due to mining and to provide a basis to develop action plans, if required.

In addition, the overburden groundwater monitoring is coupled with water transfer monitoring in the underground workings.

Rainfall data is currently obtained from the BHPBIC weather station at Cordeaux Colliery along with a station at the NRE1 Shaft No.4 site and the Bureau of Meteorology station at Bellambi.

The NRE-A, NRE-C, NRE-D open standpipe, as well as NRE-A, NRE-B and NRE-D vibrating wire piezometers, were installed by Gujarat in November 2009. Gujarat is conducting the ongoing management and implementation of the field work and monitoring.

GW1 (VWP) and GW1A (open standpipe) bores were installed in August 2012.

Table 8.1 - Wonga East Open Standpipe Piezometers

Bore	Installed	E	N	Mining Domain	Total Depth (m)	Screen Interval (mbgl)	Hydraulic Conductivity (m/day)	Screened Interval Transmissivity (m^2/day)	Standing Water Level (mbgl)
NRE A	21/11/09	303692	6196033	Wonga East	47	24 - 47	0.011	0.276	19.21 – 22.37
NRE C	3/12/09	303233	6198797	Wonga East	24	18 – 24	0.017	0.121	12.82 – 14.31
NRE D	6/11/09	301870	6198509	Wonga East	52	40 - 52	0.038	0.495	27.21 – 30.73
GW1A	22/8/12	303742	6196983	Wonga East	27	21 - 27	Not tested	Not tested	24.0

Table 8.2 - Wonga East Vibrating Wire Piezometers

Piezometer	E	N	TD mbgl	Intakes (mbgl)
NRE A VWP	303680	6196034	153	45(mid HS) 60(low HS) 75(up BS) 140(mid BS)
NRE B	303939	6197567	170	27.5(low HS) 43(up BS) 63(mid BS) 168(SPCS)
NRE D VWP	301875	6198493	176	33(mid HS) 60(low HS) 73(BHCS) 135(mid BS)
GW1	303693	6196913	107.1	18 (HS) 30 (HS) 45 (BHCS) 63 (BS) 93 (BS) 125 (BS) 140 (SPCS) 165 (SS)

NOTE: HS - Hawkesbury Sandstone BHCS - Bald Hill Claystone BS - Bulgo Sandstone SPCS - Stanwell Park Claystone SS - Scarborough Sandstone

8.3 Groundwater Levels and Pressures

Plots of standing water level, vibrating wire piezometer pressure head and groundwater quality data to date is presented in **Figure 19.**

The open standpipe piezometer NRE-A (which overlies both pillar extracted Bulli Seam and the Balgownie Seam longwalled area) shows a variable water level which is relatively responsive to rainfal recharge.

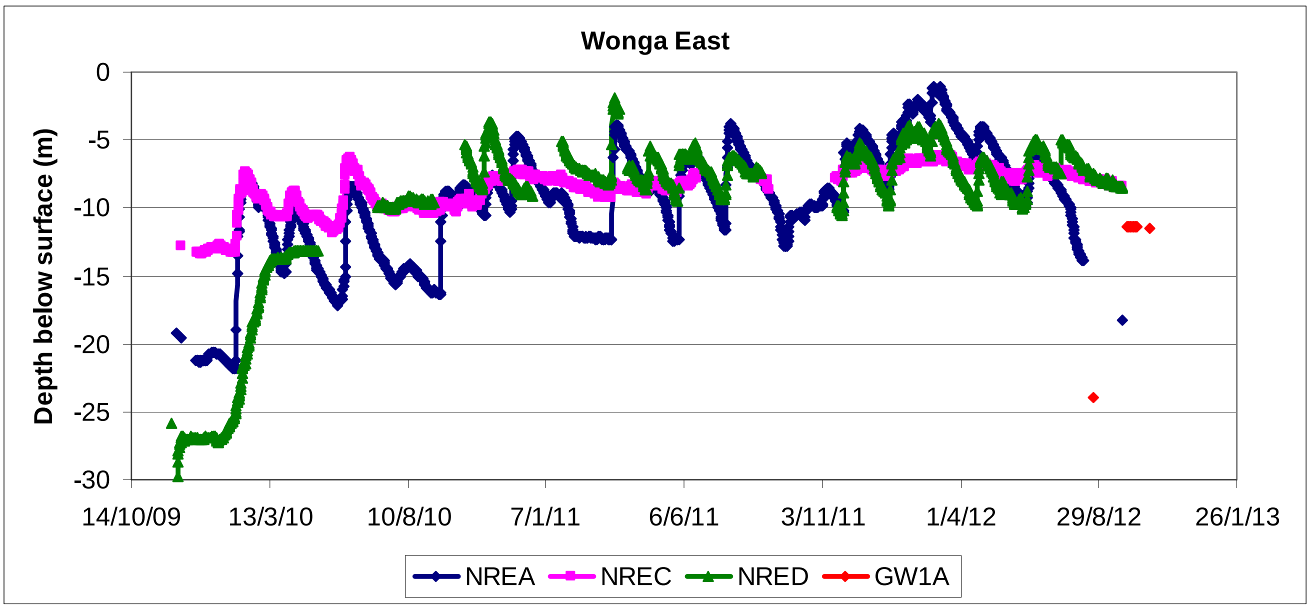
NRE-C, which overlies the bord and pillar extracted Bulli Seam to the north of the NRE No.1 colliery workings is also responsive, but less so than NRE-A.

NRE-D, which also overlies only the bord and pillar extracted Bulli Seam workings has a relatively muted response to rainfall recharge.

The Wonga East piezometers are relatively responsive to rainfall, and vary by up to 17.05m as shown in **Table 8.3**.

Table 8.3 - Wonga East Hawkesbury Sandstone Water Level Variability

Piezometer	First Water Intercept (mbgl)	Water Level Range (mbgl)	Water Level Variability (m)
NRE A	24.0	7.77 - 21.68	13.91
NRE C	18.0	7.49 – 13.30	5.81
NRE D	40.0	9.90 – 26.94	17.04
GW1A	27.0	24 - TBA	TBA



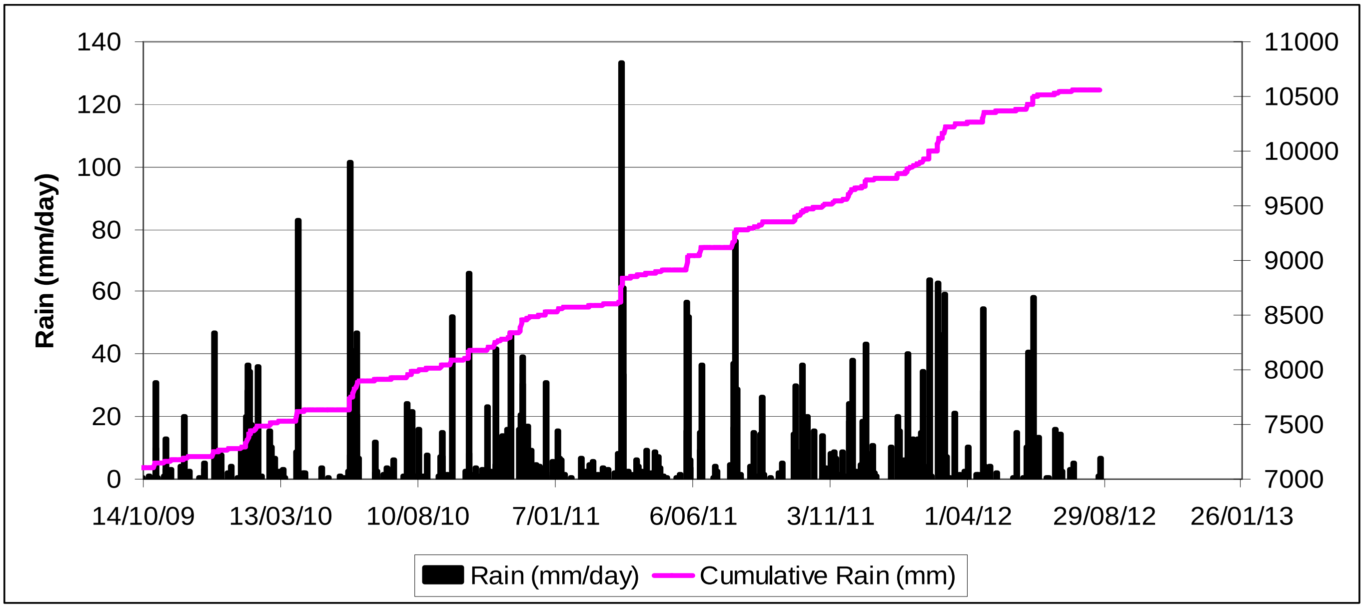


Figure 8 - Wonga East Open Standpipe Groundwater Levels and Rainfall

Figure 20 shows the water head pressure variability in the vibrating wire piezometer arrays at NRE-A, NRE-B and NRE-D.

Multi level piezometers have been installed at selected depths between the Upper Hawkesbury Sandstone and the Stanwell Park Claystone since July 2009 in three bores at Wonga East.

In December 2009 the pressure head in NRE-A rose between the lower Hawkesbury Sandstone and the Bald Hill Claystone indicating a potential groundwater flow up into the Hawkesbury Sandstone, then sequentially reduced below the Bald Hill Claystone indicating a downward flow gradient.
A similar situation is observed between the Newport Formation and the Bald Hill Claystone in NRE-D, where groundwater pressure gradients indicate a potential flow from the Bald Hill Claystone to the Newport Formation, and a downward flow gradient from the Bald Hill Claystone to underlying lithologies.

NRE-B shows a downward flow gradient through the stratigraphic profile.

Figure 20 indicates a general flow at Wonga East from the escarpment to Cataract Reservoir.

The head pressure versus depth and the water level plots shown in **Figure 21** indicates that:

- within the NRE-A vibrating wire piezometers, which are installed over the southern edge of the Balgownie longwalls and Bulli Seam pillar extraction area, the 45mbgl intake water level trace in the mid Hawkesbury Sandstone is reduced in comparison to the lower Hawkesbury Sandstone (60mbgl) and upper Bulgo Sandstone (75mbgl) intake levels, although the 45, 60 and 75mgbl water levels all trend in a similar manner in response to rainfall recharge. The mid Bulgo Sandstone intake at 140mbgl, beneath the Bald Hill Claystone, has a dampened response to rainfall recharge;
- hydrostatic pressure is not present in the Hawkesbury Sandstone and Bald Hill Claystone intakes, although resumes in the Bulgo Sandstone and Stanwell Park Claystone at NRE-B

over unmined ground. The response of the intakes to rainfall is currently not available as a lighting strike destroyed the logger on February 5, 2010. The logger has since been repaired and replaced; and

- hydrostatic pressure is present in the Hawkesbury Sandstone in NRE-D, which is located over bord and pillar workings in the Bulli Seam, and absent in and below the Bald Hill Claystone and mid Bulgo Sandstone. The water level trends show a very limited response to rainfall in the 33mbgl mid Hawkesbury Sandstone intake, a limited response in the 60mbgl lower Hawkesbury Sandstone intake and a moderated response in the 73mbgl Bald Hill Claystone intake. Very limited response to rainfall recharge occurs in the 135mbgl mid Bulgo Sandstone, beneath the Bald Hill Claystone.

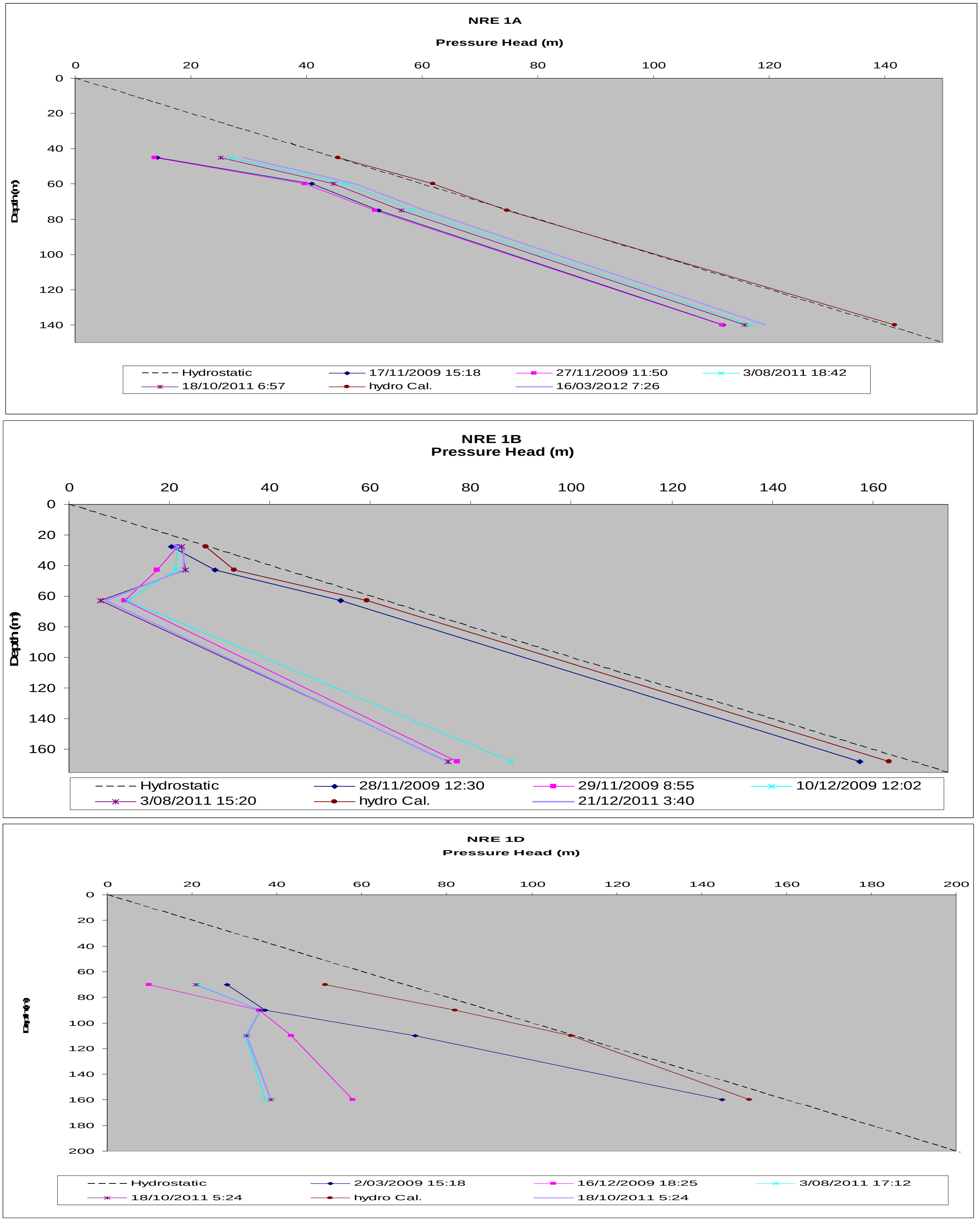


Figure 9 - Wonga East VWP Pressure Head Vs Depth

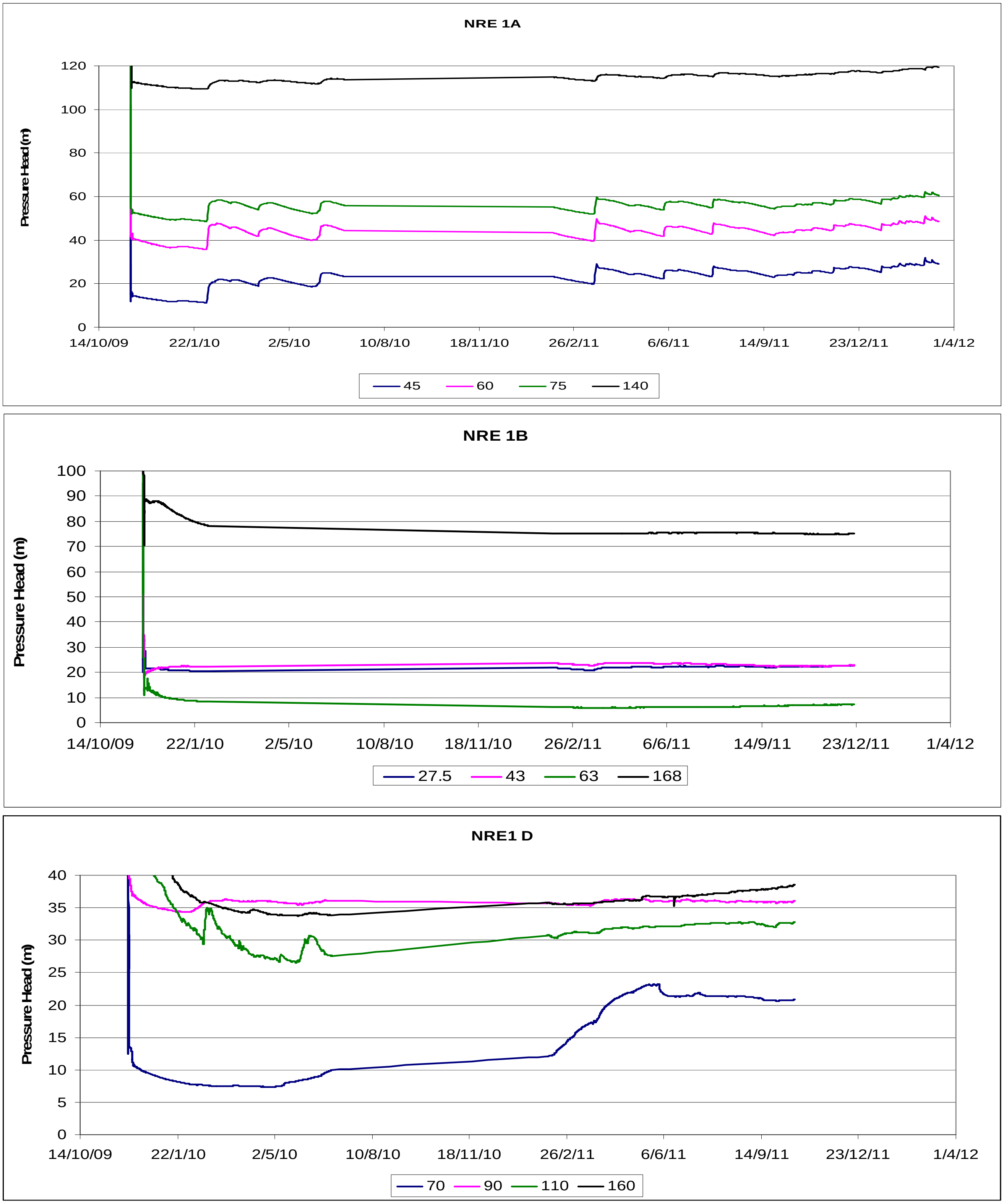


Figure 10 - Wonga East Pressure Heads

Figure 22 illustrates the salinity (electrical conductivity, or EC) and pH of the Wonga East basement piezometers which are completed in the Hawkesbury Sandstone.

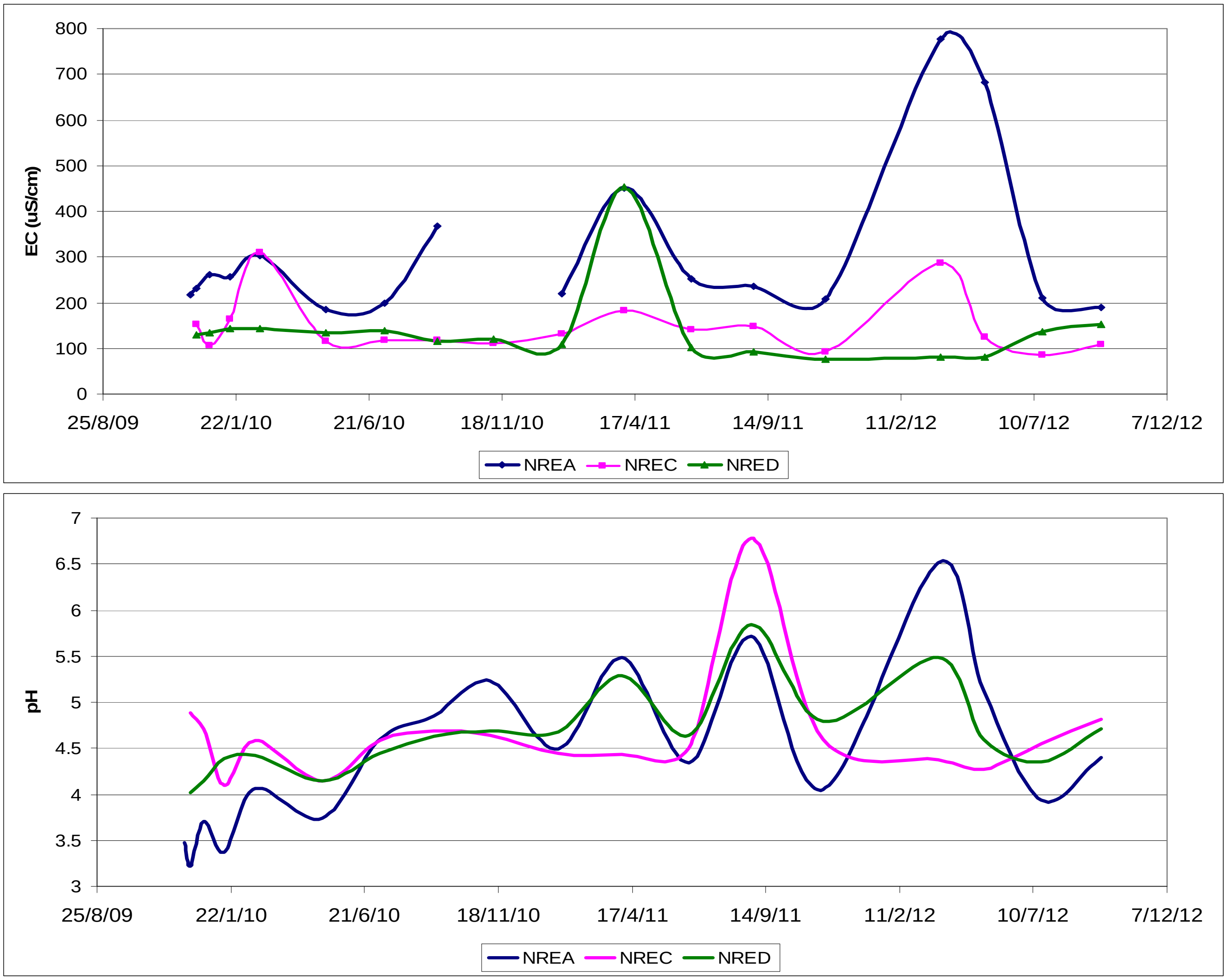


Figure 22 - Wonga East Groundwater Salinity and pH

8.4 Private Bores

No private bores are located within the proposed extraction area.

8.5 Underground Dewatering

Gujarat NRE No.1 has an established mine dewatering system with a capacity of approximately 0.46L/s (1.2 ML per month) capacity, with the underground monitoring using a "water balance" to quantify total inflows and outflows and thereby assess groundwater inflows to the workings.

Water pumped into the workings is measured at the Wonga B Portal.

The export of water in ventilation air is monitored and accounted for through use of intrinsically safe hygrometers at intake and return airways which monitor wet and dry temperature in conjunction with air velocity and cross sectional area.

Water extracted in `Run of Mine' coal uses a microwave analyser to monitor coal moisture on the ROM belt, which, in conjunction with coal tonnage allows the water removed from the mine with the ROM coal to be calculated.

Three flow meters are used for the daily water balance calculations which monitor daily totals, with the results of the water balance being internally reviewed and reported to the DSC each month.

A definitive assessment of groundwater inflows to the underground workings is hampered, by water transfer into, around, and out of the mine. However, no distinctive recurring relationship between high rainfall events and increases in mine pump out volumes is apparent with the available data.

Monitoring by Gujarat of the mine water pumped out of the Wonga East workings in the Balgownie / Bulli workings at 27 cut through is shown in **Figure 23**.

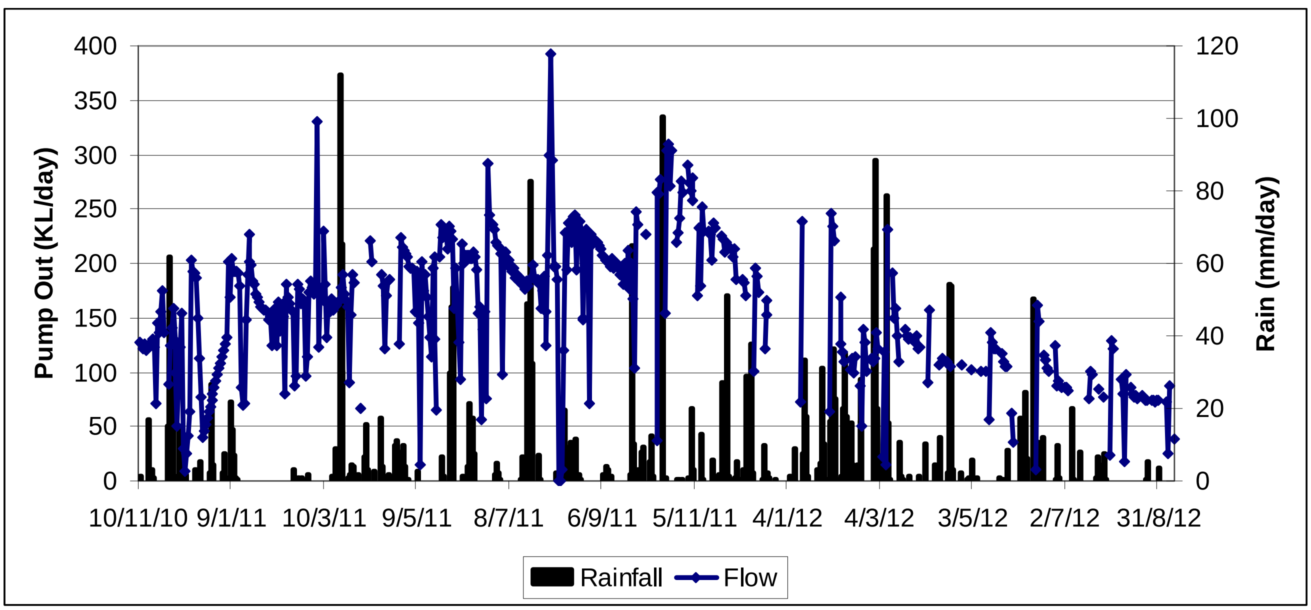


Figure 23 - Mine Water Pumped From Wonga East at 27 Cut Through

8.6 Groundwater Modelling

A FEFLOW regional groundwater model has been prepared for the entire Gujarat lease area and surrounds, which can be updated as additional data and understanding of the groundwater system is obtained (Geoterra, in prep).

The model was developed in accordance with the best practice as outlined in the Murray-Darling Basin Commission's Groundwater Flow Modelling Guideline which is adopted nationally as a *de facto* standard for Australian conditions.

The model was calibrated against known standing water levels and pressure heads in the overburden above the proposed workings, with lithological layers based on interpretation of coal and groundwater drilling geological data.

Basement piezometer data was used to develop groundwater elevation contour maps and inferred flow directions at multiple depths within the overburden, as well as vertical hydraulic gradient patterns.

The model was extended to take into account the regional effects of depressurisation from neighbouring current and decommissioned mines.

It was used to predict the potential overburden depressurisation above the existing and proposed longwalls at both Wonga East (Areas 1 and 2) and Wonga West (Areas 3 and 4); as well as mine inflows and stream baseflow changes as mining proceeds.

The simulated groundwater inflow to Areas 1 and 2, which contains Longwalls WE-A2-LW4 and LW5, is predicted to rise from the current 0.2ML/day to 1.4ML/day, whilst groundwater levels in the upper Hawkesbury Sandstone are predicted to depressurise by less than 5m and flow in Cataract Creek is predicted to decline by approximately 0.07ML/day once all longwalls in Wonga East Area 2 are completed (Golder Associates, 2012).

In brief, the modelling indicated that at Wonga East, the Bulgo Sandstone has been previously subsided and fractured due to existing workings and that the proposed workings may be depressurised by 10 - 20m near-surface.

9 PREVIOUS SUBSIDENCE EFFECTS IN THE VICINITY OF THE PROPOSED WORKINGS

The previous operators of NRE No.1 Colliery, as well as the decommissioned BHP Billiton Cordeaux Colliery to the south of NRE No.1 have undermined sections of both Lizard and Wallandoola Creeks, whilst Cataract Creek was only undermined by the previous operators to NRE No.1.

Up to 1.3m of subsidence was generated by extraction of the Bulli Seam in the 200, 300 and 500 series longwalls to the west of and beneath Cataract Reservoir (Seedsman Geotechnics, 2010).

Bord and pillar extraction of the Bulli Seam along with longwalls in the Balgownie Seam was conducted to the east of Cataract Reservoir as shown in **Figure 2**.

In the 200 series longwalls, no subsidence was measured with 190m wide panels and 35m wide chain pillars, whilst the same layout to the north in the 300 series panels, 0.9m of subsidence was recorded. Longwall mining generated a maximum vertical subsidence of 1.1m for 155m wide longwalls with 30m wide pillars, whilst the 205m wide panels in Cordeaux Colliery with 30m wide chain pillars generated up to 1.3m of subsidence (Seedsman Geotechnics Pty Ltd, 2012).

Microseismic monitoring at Bellambi West indicated that rock fracturing extended to approximately 100m above the Bulli Seam, whilst vibrating wire piezometer monitoring between longwalls 501 and 502 indicates that the hydraulic integrity of the Bulli Seam and the Hawkesbury Sandstone was not adversely affected (Seedsman Geotechnics Pty Ltd, 2012).

No publicly available pre and post mining surveys of creek flow, creek water quality, groundwater levels or groundwater quality are known to be available over the BHPB Cordeaux or Bulli mine workings.

The following sections outlined the observed effects of subsidence due to the previous extraction of the Bulli Seam and the underlying Balgownie Seam in the Study Area.

9.1 Cataract Creek

Cataract Creek overlies the north west / south east and south west / north east oriented bord and pillar workings in the Bulli Seam as well as the south west / north east oriented longwalls in the underlying Balgownie Seam.

The first and second order tributaries containing Sites CC1 to CC4 have been continuously flowing during all site visits and have not been observed to dry out, although they contain ferruginous precipitates.

The third order stream channel between CC5 and CC9 has also been continuously flowing, although only CC5 shows ferruginous precipitation.

Downstream of CC5 the creek water becomes sequentially clearer with flow downstream, although inflow from CT1 can increase the ferruginous turbidity in the stream after prolonged rainfall.

No evidence of stream bed cracking, flow loss or adverse effects on pool levels has been observed in Cataract Creek in the areas undermined by the Bulli Seam or Balgownie Seam workings.

9.2 Upland Swamps

No adverse effects have been observed on the shallow, ephemeral, perched, colluvial groundwater systems or groundwater seepage to streams within (or from) any upland swamps within the NRE No.1 lease area due to extraction of the Bulli or Balgownie Seam workings.

It is also noteworthy that the Southern Coalfield Inquiry Panel was also not made aware of any significant impacts on headwater swamps caused by mining subsidence.

Most known impacted swamps are valley infill swamps. However, at all sites inspected by the Panel, there had been a range of other environmental factors in play including evidence or pre existing scour pools, previous initiation of erosion, concurrent drought, and subsequent heavy rainfall and / or severe bushfires. The sequence of events was not clear in relation to the swamp impacts (drying, erosion, and scouring, water table drop, burning, vegetation succession etc.). The Panel therefore could not be certain that subsidence either initiated or contributed to the damage at these swamps (NSW Department of Planning, 2008).

10 POTENTIAL STREAM IMPACTS

10.1 Cataract River

Cataract River overlies the Bulli Seam bord and pillar workings.

There are no predicted subsidence effects impacts or consequences on the channel of Cataract River due to the proposed workings.

10.2 Cataract Creek

10.2.1 Subsidence

Cataract Creek overlies the Bulli Seam bord and pillar workings, Bulli Seam pillar extraction as well as the underlying Balgownie Seam longwalls.

The potential subsidence effects on Cataract Creek from the proposed workings are summarised in **Table 10.1**.

Table 10.1 - Predicted Cataract Creek Subsidence

Stream Reach	Subsidence (m)	Tilt (mm/m)	Strain (mm/m)
Adjacent to LW4	<0.02	<1.0	<1.0 to -1.0
Adjacent to LW5	<0.02	<1.0	<1.0 to <-1.0
Maingates 6, 7 and 8	<0.02	<1.0	<1.0 to -1.0

10.2.2 Main Channel Stream Flow

A potential risk to the integrity of stream flow and connectivity in Cataract Creek could be present in the area to the east of longwall WE-A2-LW5 that may potentially undergo <0.02m of subsidence and <1mm/m of tensile strain.

Valley closure of up to 100mm and upsidence of up to 60mm may also occur (Seedsman Geotechnics, 2012).

As shown in **Figure 4**, the stream bed in the reach adjacent to longwalls WE-A2-LW4 and LW5, along with the first workings over Maingate 6 and part of Maingate 7, is comprised of Bulgo Sandstone. The Bald Hill Claystone is exposed in the lower reach over Maingate 7 and over Maingate 8.

Stream reaches flowing over the massive Bulgo Sandstone may respond differently to the impacts observed with the cross bedded Hawkesbury Sandstone, whilst reaches over the Bald Hill Claystone may not experience the same degree of surface cracking as observed over the sandstone reaches due to the enhanced ductility of the clay based lithologies.

Beneath the plateau area of the multi seam mined Bulli and Balgownie workings, between Cataract Creek and Bellambi Creek, extraction of the proposed workings is modelled to generate up to 4m of depressurisation in the upper Hawkesbury Sandstone at the end of mining Area 2 (Geoterra, 2012).

The modelled, localised reduction is anticipated to reduce the regional phreatic surface gradient from the plateau to the creek, as well as toward Cataract reservoir, thereby potentially reducing baseline seepage volumes to the creek and dam.

It is also possible that, if they exist, the location of seepage points in the stream bed may be relocated up to 4m lower in elevation in the catchment.

Based on interpreted local groundwater contours (Geoterra, 2012) the 4m modelled reduction in the phreatic surface over the proposed workings represents a change in gradient toward Cataract reservoir from 0.0212 to 0.0196.

On the basis that there is no direct free drainage flow path to the workings, which is supported by water balance investigations and assessment of the post subsidence response in the pressure head and packer test data from GW1 and GW1A bores adjacent to the mined panel WE-A2-LW4 (Geoterra, 2012), the water level decline is anticipated to be temporary, as the water table is anticipated to recover once the mining at Wonga East has been completed.

Groundwater modelling predicts a 0.06ML/day reduction in stream flow in Cataract Creek at the end of mining Area 2, rising to 0.07ML/day after Wonga West Area 4 is completed.

As there is no predicted vertical drainage connection from the stream bed to the proposed workings (Seedsman Geotechnics, 2012), and where the Bald Hill Claystone is not eroded into, or through, and with no change in its semi-confining properties following extraction of the proposed workings, it is assessed that the modelled stream flow reduction of 0.06 – 0.07ML/day would be accommodated within the secondary porosity generated through bedding plane separation and fracturing of the Hawkesbury Sandstone and upper Bulgo Sandstone. The additional stored water would flow under gravity, and with a delay, discharge either to a downstream reach of Cataract Creek, Cataract River or Bellambi Creek and subsequently into Cataract Reservoir.

Based on the assessment that no free drainage to the workings is generated following extraction of the Wongawilli East longwalls, it is assessed there would be no net loss to the water volume flowing into the SCA water storage at Cataract Reservoir.

Stream flow modelling (WRM Water & Environment, 2012) indicates the average daily flow from Cataract Creek to Cataract reservoir is 11.73ML/day. Therefore, a 0.06 – 0.07ML/day flow reduction represents approximately 0.5 – 0.6% of the Cataract Creek flow into the reservoir.

10.2.3 Rock Bars

Low potential risk to the integrity of rock bar constrained pools could be present in the area adjacent to longwall WE-A2-LW5.

As shown in **Figure 9** and **Plate 3**, the rock bars constraining pool levels in the vicinity of WE-A2-LW5 are CcRB1, 2, 3 and CcRB4.

Plate 3 - WE-A2-LW5 Rock bar Constrained Pools

10.2.4 Tributary Flow and Pool Levels

Tributary CT1 which overlies the proposed 20mm subsidence zone over WE-A2-LW5 is at risk of subsidence related stream bed cracking, enhancement of stream bed underflow, discharge of ferruginous springs and reduced stream water quality at its confluence with Cataract Creek.

No adverse effects on stream flow or water quality were observed in CT1, which drains out of swamp Ccus6, due to subsidence, however a reduced outflow (with no adverse effects on tributary pool water holding capacity) was observed due to the lack of rainfall / runoff in the catchment during the period of, and prior to, WE-A2-LW4 extraction.

It is not anticipated, however, that the total volume of water entering Cataract Creek will be adversely affected due to the proposed workings.

10.2.5 Stream Water Quality

Cataract Creek between CC5 and CC7 can currently be affected, and discoloured, by ferruginous seepage that originates upstream of the freeway, as well as discharges out of tributary CT1, with the ferruginous seepage being more prevalent during low flow periods. However no significant adverse effects on stream water quality, pH, salinity, or dissolved oxygen are apparent from monitoring conducted to date.

During a field inspection on 23/10/2012, tributary CT1 was observed to have significant levels of ferruginous sludge intermixed with sand / clay sediments that had been built up over a number of years. Although the tributary was not flowing (but was ponded) at the time, it is apparent that a significant degree of ferruginous seepage is discharged from this tributary into Cataract Creek when it is flowing as shown in **Plate 4**.

Due to the predicted lack of cracking in the main Cataract Creek stream bed, no observable adverse effects on stream water quality are anticipated between CC5 and CC7.

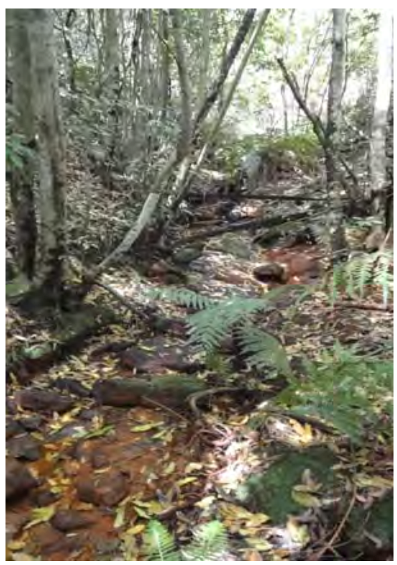


PLATE 4 - Tributary CT1 Ferruginous Deposits

11 POTENTIAL SWAMP IMPACTS

Headwater swamp Ccus3, which partially overlies WE-A2-LW5, and Ccus6, which overlies the previously extracted longwall WE-A2-LW4, have the potential to undergo subsidence related bedrock cracking due to extraction of WE-A2-LW5.

However, Ccus3 has been dry, and Ccus6 has been essentially dry, since monitoring began in March 2012.

As a result, it is considered that the risk of adverse effects on swamp water levels, drainage, reduction of discharge to downstream gullies and on water quality are low, and that the total volume of water entering Cataract Creek from the headwater swamps will not be observably affected due to the proposed workings.

A detailed significance and risk assessment of the Cataract Creek swamps is contained in (Biosis, 2012).

12 POTENTIAL GROUNDWATER IMPACTS

12.1 Shallow Hawkesbury Sandstone and Newport /Garie Formation Interface Aquifers

Surface cracking resulting from mine subsidence within the perched Hawkesbury Sandstone groundwater system, and any shallow, perched, ephemeral aquifers that may be present at the interface between the Hawkesbury Sandstone and the Newport / Garie Formations may occur. However, it is not expected to result in an observable increase in transfer of surface water to the underlying regional aquifer over the proposed panels.

12.2 Hawkesbury Sandstone Aquifers and Stream Flow to Cataract Reservoir and Cataract River

The Hawkesbury Sandstone has been affected by previous subsidence over the Bulli, Balgownie and Wongawilli Seam workings, however, Cataract Creek has been observed to contain continuous baseflow since monitoring began in July 2008.

At the substantial depths of cover over longwalls WE-A2-LW4 and LW5 (267 - 284m), connective cracking from the secondary workings to the surface is not anticipated.

Due to the lack of subsidence over Maingates 6, 7 and 8, connective carcking from the workings to the surface is not anticipated.

The depressurisation effects described below for the deep groundwater system is not anticipated to propagate up through to the Hawkesbury Sandstone or Newport / Garie Formations, where the Bald Hill Claystone is present and maintains its semi-confining characteristics.

However, up to 5m of depressurisation in the Hawkesbury Sandstone is predicted, which may generate up to 0.07ML/day reduction in flow to Cataract Creek, once all of the proposed panels in Wonga East are mined.As connective cracking is not predicted between the mine and the surface, negligible loss of groundwater yield to Cataract Reservoir is anticipated.

The risk of any significant loss of groundwater to the workings is very low unless a major geological discontinuity such as a fault or dyke is activated or encountered during mining and provides a direct hydraulic connection between the surface and the mine.

Based on mapping of the dyke that crosses over longwall WE-A2-LW5, and observations that it has been completely weathered to illite / montmorillonite clays, it is npot anticipated that undermining of this structure will enable enhanced permeability, or connection to the underlying workings, to occur.

The mining layout has been planned so that no known major faults are intersected or re-activated over longwalls WE-A2-LW4 or LW5.

12.3 Deep Aquifers

Immediately above a mined seam, the roof collapses into the void to form a caved “goaf” and an overlying increased permeability and porosity zone.

Experience at NRE No. 1 Colliery suggests that substantial depressurisation of the deep fractured zone is restricted to less than 85m from the top of the goaf, while transient pressure effects have been observed to propagate to about 185m above the goaf.

A pronounced increase in vertical hydraulic gradient in the deep system over the longwalls is observed.

Above the goaf, substantial changes in fracture porosity and permeability due to opening up current joints, as well as development of new fractures and bed separation is observed. Permeability increases accompany reductions in lateral hydraulic gradients, with associated changes in groundwater levels and pressures.

Pronounced changes in groundwater levels can occur without any significant drainage into a mine, particularly from the Narrabeen Group sandstones.

Groundwater discharge to the mined seam would occur from above and below the seam in proportion to local permeabilities.

Groundwater modelling indicates recovery of deep pressures will occur over many decades after mining finishes.

Given the considerable depth of mining and the restricted panel width in the project area, and the absence of geological structures that may cause enhanced connectivity to the workings, it is anticipated that a constrained zone will develop above the workings, precluding a direct hydraulic connection between the mine workings and the surface.

12.4 Mine Inflow

Groundwater modelling indicates that the current inflows to the existing Wonga East Bulli and Balgownie Seam workings is 0.25ML/day, and at the end of mining all proposed panels at Wonga East, the predicted inflows may rise to 1.4ML/day (Geoterra, in prep.).

12.5 Pillar Run

An risk assessment conducted for the potential for pillar run associated with the seconadry extraction of Longwall 4 (KNJ Consultants, 2012) idnetified the following:

- Stored waters of Cataract Dam - Hazard does not exist;
- Cataract River - Hazard does not exist;
- Cataract Creek - Possible Low Risk; and
- Upland Swamps – Possible Low Risk.

As a result, there is no anticipated risk of pillar run for the above mentioned features from the proposed workings.

13 STREAM, SWAMP AND GROUNDWATER PERFORMANCE MEASURES

As the streams, swamps and groundwater systems are all hydrologically interconnected at NRE No. 1, the following performance measures apply equally across the three interconnected systems.

The proposed extraction will conform to the relevant preformance criteria outlined below:

Catchment Yield to Cataract Reservoir

- negligible reduction to the quality or quantity of water resources reaching the reservoir; and
- no connective cracking between the surface and the mine.

Cataract Reservoir

- negligible leakage from the reservoir; and
- negligible reduction in the water quality of the reservoir.

Cataract Creek

- negligible diversion of flows or changes in the natural drainage behaviour of pools;
- negligible gas realeases and iron staining;
- negligible increase in water cloudiness;
- negligble increase in bank erosion;
- negligble increase in sediment load; and
- negligble reduction in the volume of water reporting to reservoir.

Cataract Creek Upland Swamp 4 (CCUS 4) and Cataract River Upland Swamp (CRUS 1)

- negligible change in the size of swamps;
- negligible change in the functioning of swamps;
- negligible change to the composition or distribution of species within swamps; and
- negligible drainage of water from swamps or redistribution of water within swamps.

Cataract Creek Upland Swamp 3 (CCUS 3)

- No greater than subsidence impact or environmental consequences than predicted in EA – Mod 1.

Negligible is defined as being *small and unimportant, such as to be not worth considerig.*

The Performance measures will be achieved through adherence to the procedures and methods oulined in the Trigger Action Remediation Plan contained in **Appendix C**.

If a performance criteria:

- has been exceeded or is likely to be exceeded, an assessment will be made against the performance criteria;
- is likely to be exceeded if management measures are not implemented, the mine will implement suitable management measures and continue to monitor; and
- is considered likely to have been exceeded or is likely to be exceeded,.

The mine will implement suitable contingency measures and continue to monitor the relevant sites in consultation with the DRE (Director Environmental Sustainability and Land Use, Principal Subsidence Engineer) as well as the SCA, DECCW and NOW.

14 STREAM MONITORING PROGRAM

The following proposed monitoring program has been designed to be consistent with the SCA's guideline *Design of a Hydrological and Hydrogeological Monitoring Program to Access the Impacts of Longwall Mining in SCA Catchments*, and has been prepared in consultation with relevant stakeholders.

14.1 Streams

14.1.1 Cataract Creek

Cataract Creek will be monitored during the installation of longwall WE-A2-LW5 and Maingates 6, 7 and 8 first workings for the parameters outlined in the following sections at the sites and frequency outlined in **Table 14.1**.

Table 14.1 - Proposed Cataract Creek Monitoring

SITE	Frequency	Parameters
CD1	Monthly	dam water quality / photos
CC1	Monthly	water quality / photos / visual inspection
CC2	Monthly	water quality/ photos / visual inspection
CC3	Monthly	water quality / flow / pool depth / photos/ visual inspection
CC4	Monthly	water quality / flow / pool depth / photos/ visual inspection
CC5	monthly / weekly*	water quality / photos / visual inspection
CC6	monthly / weekly*	water quality / flow / pool depth / photos / visual inspection
CC7	monthly / weekly*	water quality / flow / pool depth / photos / visual inspection
CC8	monthly / weekly*	water quality / flow / pool depth / photos / visual inspection
CC9	monthly / weekly*	water quality / flow / pool depth / photos / visual inspection
CT1	monthly / weekly*	water quality / flow / pool depth / photos / visual inspection
CRUS1	Monthly	water quality / flow / photos / visual inspection
CCUS3	Monthly	water quality / flow / photos / visual inspection
CCUS4	Monthly	water quality / flow / photos / visual inspection

NOTE: ***Weekly monitoring will commence when WE-A2-LW5 is within 100m of Cataract Creek**

Cataract Creek monitoring locations are shown in **Drawing 2**.

14.1.2 Cataract River

Upstream, midstream and downstream monitoring locations were initiated in the Cataract River to installation of water quality, water flow and pool depth in April 2012, with the sites to be monitored for the parameters, sites and frequency as outlined in **Table 14.2** and described in the following sections.

Note, no observable subsidence is anticipated in the channel of Cataract River due to extraction of secondary workings at Wonga East.

Cataract Creek monitoring locations are shown in **Drawing 2**.

Table 14.2 - Proposed Cataract River Monitoring

SITE	Frequency	Parameters
CR1	Bi monthly	water quality, flow and pool depth, photos, visual inspection
CR2	Bi monthly	water quality, flow and pool depth, photos, visual inspection
CR3	Bi monthly	water quality, flow and pool depth, photos, visual inspection
CR4	Bi monthly (when not flooded)	water quality, flow and pool depth, photos, visual inspection

14.1.3 Stream Flow and Pool Depths

Daily automated monitoring of selected pool depths in Cataract Creek and Cataract River will be conducted as outlined in **Tables 14.1** and **14.2** and will be compared to rainfall monitored in the local area as outlined in the following sections.

Stream water levels will be monitored with pressure transducers set at 2 hourly intervals for sites downstream of the freeway, and 6 hourly for sites upstream of the freeway, which will be downloaded monthly at sites being undermined by secondary extraction.

The 2 hourly readings for sites downstream of the freeway will be required during extraction of WE-A2-LW5.

Whilst the longwall is not being extracted, all loggers can be set at 6 hourly intervals, with monthly downloads.

The monitoring sites will be located at permanently wet locations and where the stream bed status, flow characteristics and site logistics allow for volumetric flow measurement.

Monitoring will assess the inputs from catchment runoff and flow variations within the WMP area before, during and after the extraction period, particularly during low flows.

The collected data will enable review any observable changes that develop.

Use of portable / dismountable flow gauging equipment that does not adversely affect the stream ecology may be required to obtain quantitative flow data for hydrologic assessment.

In the eventuality that SCA approval for stream pool depth / flow monitoring equipment is not received prior to 1 month before longwall WE-A2-LW5 is due to be extracted, “concrete” nails should be installed at a suitable location at each rock bar constrained pool to enable measurement of the pool height / depth.

14.1.4 Stream and Cataract Reservoir Water Quality

Water quality monitoring will be conducted before, during and after the period of extraction of the components associated with the proposed works.

Field studies will monitor sites weekly whilst a longwall is within 200m of a stream, and monthly at other times during active extraction of a relevant panel.

Monitoring teams will visit main channel sites that will be observed for identifiable inputs from catchment runoff and all key water quality parameter variations during, and for an appropriate period, after mining.

Monitoring will be conducted for the following parameters:

- field pH, electrical conductivity, dissolved oxygen, oxidation / reduction potential and temperature;
- total dissolved solids and total suspended solids;
- Na / Ca / Na / K / SO4 /Mg / Cl / F;
- total alkalinity;
- dissolved organic carbon;
- total / filterable Fe, Mn, Al;
- total / filterable Ni, As, Li, Ba, Sr, Cu, Pb, Zn ; and
- total nitrogen and total phosphorous.

Stream water level, or spot flow monitoring and sampling should be conducted at all locations in the same catchment, on the same day.

All samples will be collected in appropriately cleaned and prepared equipment, stored in appropriately cleaned and rinsed sample containers, then transported and analysed according to ANZECC 2000 standards, with 0.45µm filtering and nitric acid preservation to less than pH 2 for metals samples.

14.1.5 Channel Stability and Erosion

Subsidence is not anticipated to induce bed or bank erosion in the streams overlying the proposed works.

As the creek banks are well vegetated, or comprises exposed sandstone, no significant change is anticipated and it is not envisaged that stream bed or bank remediation will be required due to subsidence associated with the project components.

During each site visit, photographic records will be taken at each monitoring site, and other relevant sites as required.

Any changes to the current state will be visually monitored after significant stream flow events, and if adverse subsidence / uplift effects occur, a specific management and rehabilitation plan should be developed for the affected areas.

14.1.6 Bedload Movement

If erosion occurs in a stream, it may cause an increase in bedload movement in and downstream of the subsidence area, which will be visually monitored during and after significant flow events.

Significant bedload movement is not anticipated and therefore stream bed or bank management and rehabilitation is not anticipated to be required.

14.1.7 Stream Gradient

It is not anticipated that significant observable change will occur due to subsidence and that stream gradient rehabilitation measures will not be required in the main stream channels.

14.1.8 Riparian Vegetation

Riparian vegetation will be visually monitored over the proposed mining area before and after any stream is undermined, particularly after significant flow events.

As no adverse effect on the riparian vegetation is anticipated, no rehabilitation measures are anticipated.

14.1.9 Wonga East Baseline Stream Surveys

A comprehensive visual and photographic survey of Cataract Creek was conducted between monitoring sites CC5 to CC9 in April and October 2012, before and after extraction of WE-A2-LW4. Aspects assessed included:

- site dimensions and co-ordinates;
- nature and orientation of any stream bed / bank cracking;
- nature and location of any ferruginous seeps;
- description of any gas being released;
- presence of stream bed scouring;
- stream water turbidity or discolouration;
- presence of any underflow; and
- any rock bar characteristics.

The relevant reach of Cataract River will be inspected at a later date as the river has not been affected by the current extraction of longwall WE-A2-LW4, and will not be affected by the extraction of longwall WE-A2-LW5 or Maingates 6, 7 and 8.

The Cataract Creek reach between CC5 and CC9 will be fully re-inspected at the completion of WE-A2-LW5 extraction, however, it will also be inspected each time the survey team walks the creek to access the monitoring sites.

14.1.10 Visual Inspection and Photographic Records

A comprehensive visual inspection and photographic record of each monitoring site will be collected each time a site is visited, at a frequency determined by the proposed monitoring schedule, which relates to the proximity of the longwall to a creek.

14.2 Meteorology

At a minimum, daily rainfall data will be collated from the:

- BHPBIC gauge at Cordeaux Colliery;
- BoM weather station at Bellambi; and
- Gujarat NRE weather station at the No.4 shaft.

The mine based data will be supplemented by climate data from any SCA owned monitoring equipment, as required.

A pan evaporimeter will also be established in the Wonga East catchment.

14.3 Reporting

Progress against the requirements of this Plan will be reported regularly to the DoP&I and other relevant agencies as required by the Project Approval.

Reporting will be made available in accordance with the requirements *of* ***Condition 7/Schedule 3*** of the Project Approval.

15 GROUNDWATER MONITORING PROGRAM

This groundwater monitoring program has been developed with reference to the baseline swamp and basement groundwater data outlined previously in this document.

15.1 Swamps

Water level and water quality monitoring in the Wonga East swamps was initiated in March 2012 at locations shown in **Drawing 2**, and specifically in open standpipe piezometers PCr1, PCc3, PCc4, PCc5A, PCc5B, PCc6, PCr1 and PBc4 in swamps overlying, or in the vicinity of, the proposed works as listed below:

- Crus1;
- Ccus3, 4, 5 and 6;
- Crus1; and
- Bcus4.

Although no subsidence effects are predicted for any of the swamps, shallow water level and water quality monitoring of the swamp via open standpipe piezometers will be conducted as shown in **Table 15.1**.

The monitoring program is proposed to provide both baseline and ongoing assessments of any changes in the subject swamps.

Observation of the status of incision and/or widening of flow lines, humic soil / peat competency, surface water loss or redirection will be made along with channel slope measurement using a manual inclinometer at locations where signifcant slope changes, if any, are predicted.

A comprehensive analysis and reporting of all monitoring data relevant for each swamp will be provided in the AEMR and / or in an End of Panel Report as required by consent conditions.

15.1.1 Shallow Groundwater and Swamp Water Levels

The surface above the proposed Wonga East project areas is characterised by drainage basins separated by steep ridges which flow to either Cataract Creek or Cataract River, then to Cataract Reservoir.

Knowledge of the interaction between water infiltration mechanisms of sediments and swamps on the ridges, slopes and depressions, as well as their water storage capacity, transmission properties, underlying strata and the surface water system enables assessment of potential subsidence effects in this area on the headwater swamps.

Monitoring water levels in the shallow sandstone open standpipe piezometers SP1, SP2, as well as the swamp piezometers PCr1, PCc3, PCc4, PCc5A, PCc5B, PCc6, PCr1 and PBc4 will be used to assess surface water / shallow groundwater interactions and to monitor water depth in surficial lithologies in the Cataract Creek catchment.

The paired swamp piezometers, shallow sandstone piezometers, as well as gully flow and / or pool level monitoring will be used to assess the dynamic response to stream flow and rainfall, and any water level reduction due to mining in the perched and hydraulically isolated (from the regional Hawkesbury Sandstone) ephemeral aquifers.

The piezometers were installed with pressure transducers to monitor water depth at least 6 hourly, and will be downloaded monthly.

During the logger downloads, the field pH and EC will be measured with calibrated hand held meters, whilst regular sampling will be conducted for laboratory analysis where water samples are available.

The data will enable correlation between swamp or shallow sandstone water levels and any direct leakage, if any, from a swamp or humic soils to the underlying sandstone, and/or direct rain recharge to adjacent sandstone followed by lateral groundwater flow to beneath a swamp or shallow soils.

15.1.2 Swamp Channel Flow, Water Quality and Pool Levels

Where pools exist within or immediately downstream of a swamp for sufficient time (ie for more than a few days), the pool water level will be monitored in selected pools at least every 6 hours with weekly downloads during undermining and monthly downloads, along with manual measurement against a reference nail at other times.

After the development of a flow rating curve, where there is sufficient data, the level can be converted to volumetric stream flow.

At each pool, field pH, EC, ORP, ^{o}C and DO will also be measured weekly during active subsidence and at least monthly at other times.

In, addition, water samples will be collected monthly for laboratory analysis, where sufficient water is available, and tested for the same water quality parameters as outlined for streams to indicate any changes that may have been caused by subsidence fracturing of the sandstone or erosional changes.

Rainfall will be monitored with a nearby automatic rain gauge.

15.2 Shallow Groundwater and Swamp Water Quality

At each swamp, field pH, EC, ORP, ^{o}C and DO will be measured weekly during active subsidence and monthly at other times in the following swamps:

- Ccus2, 3, 4, 5 and 6;
- Crus1; and
- Bcus4.

In, addition, monthly shallow groundwater and swamp water quality sampling for laboratory analysis will be conducted from piezometers installed in the swamps for the same water quality parameters outlined for streams.

Table 15.1 - Proposed Swamp Monitoring

Aspect	Locations	Frequency	Purpose
Subsidence, strain, tilt and valley closure	Along specified surveys lines	In accordance with approved survey management plan	To measure valley closure at rockbar
Swamp piezometer water levels	PCc2, 3, 4, 5A, 5B, 6 SP1, 2 PCr1 PB4	Logged at minimum 6 hour frequency and downloaded on a weekly basis (weather permitting) during undermining,with monthly download at other times.	To measure the swamp groundwater levels
Swamp surface water outflow	Downstream of; Ccus2, 3, 4, 5, 6 Crus1 Bcus4	Logged at 6 hour intervals and downloaded on a weekly basis during undermining and monthly at other times (where downstream pools are present)	To monitor flow discharging out of swamps
Swamp Pool level	Ccus2, 3, 4, 5, 6 Crus1 Bcus4	Logged at 6 hour intervals and downloaded on a weekly basis during undermining and monthly at other times	To measure pool water level in the swamps
Swamp surface water outflow quality	Ccus2, 3, 4, 5, 6 Crus1 Bcus4	Weekly monitoring of pH, EC, temp, DO and ORP when a swamp is being undermined (where a discrete water outflow is present) and monthly at other times, as well as monthly laboratory analyses	To measure field and laboratory water quality discharging out of a swamp
Swamp Piezometer field water quality	PCc2, 3, 4, 5A, 5B, 6 SP1, 2 PCr1 PB4	Weekly monitoring of pH, EC when a swamp is being undermined (where a discrete water outflow is present) and monthly at other times, as well as monthly laboratory analyses	To measure field and laboratory water quality changes, if any, at various locations due to undermining
Observational monitoring	Ccus2, 3, 4, 5, 6 Crus1 Bcus4	Weekly when longwalls are undermining a swamp and monthly at other times	To determine if ground disturbance including: surface cracks, surface flow diversion, erosion detachment, transport or deposition, upsidence and tunnel erosion formation, peat drying, or gradient change occurs
Ecosystem Functionality	Ccus2, 3, 4, 5, 6 Crus1 Bcus4	Every 6 months	To determine any statistical change in flora and/or fauna

15.3 Basement Groundwater

As outlined in **Table 15.2**, basement groundwater level / head pressure data will be monitored in the open standpipe piezometers:

- NRE A, C, D; and
- GW1A.

as well as the multi level vibrating wire piezometers:

- NRE-A (vwp);
- NRE-B (vwp);
- NRE-D (vwp); and
- GW1.

The piezometers are installed with pressure transducers reading at least 12 hourly, and will be downloaded monthly.
During the monthly logger download, the field pH and EC will be measured from the open standpipe piezometers with calibrated hand held meters, whilst sampling will be conducted for laboratory analysis of the waters on a 6 monthly basis.

The measured vertical hydraulic head profiles for bores with vibrating wire piezometer arrays (NRE-A, B, D and GW1), as well as the open standpipe water levels in NRE-A, C, D and GW1A will be compared against the predicted water levels.

15.4 Mine Water

The NRE No. 1 colliery has developed procedures as part of an In-Rush Hazard Management Plan to manage the potential risk of in-rush from:

- water stored in adjacent workings;
- water stored in Gujarat workings;
- mining under surface water bodies; and
- intersection with bores or gas drainage holes.

Monitoring associated with the In-Rush Hazard Management Plan also assists with the identification of water accumulation as mining progresses.

Table 15.2 - Proposed Groundwater Monitoring

Aspect	Locations	Frequency	Purpose
Open Standpipe Piezometer water levels	NRE-A, C, D and GW1A	Logged at 12 hour frequency and downloaded bi monthly basis, and monthly when a piezometer is being undermined.	To measure the basement groundwater levels
Vibrating Wire Piezometer water head pressures	NRE-A, B, D and GW1	Logged at 12 hour frequency and downloaded bi monthly basis, and monthly when a piezometer is being undermined.	To measure the basement groundwater head pressures
Open Standpipe Piezometer field water quality	NRE A, C, D and GW1A	Monthly monitoring of pH and EC when a bore is being undermined, bi monthly at other times	To measure field groundwater quality changes, if any, at various locations due to undermining
Open Standpipe groundwater laboratory analysis	NRE A, C, D and GW1A	Six monthly sampling and laboratory analysis for parameters outlined in the TARP	To measure detailed groundwater quality changes, if any, at various locations due to undermining

15.5 Reporting

Progress against the requirements of this Plan will be reported regularly to the DoP&I and other relevant agencies as required by the Project Approval.

Reporting will be made available in accordance with the requirements *of* ***Condition 7/Schedule 3*** of the Project Approval.

16 SURFACE AND GROUNDWATER RESPONSE PLAN

16.1 TARPS

The stream, swamp and shallow groundwater Trigger Action Response Plan (TARP), as presented in **Appendix C**, have been designed specific for this WMP to illustrate how the various predicted subsidence impacts, monitoring components, performance measures, and responsibilities are structured to achieve compliance with the relevant statutory requirements, and the framework for management and contingency actions.

The TARP system provides a simple, transparent and useable reference of the monitoring of environmental performance and the implementation of management and/or contingency measures.

The TARPs are designed with consideration of baseline conditions and predicted subsidence impacts and comprises the following:

- Trigger levels from monitoring to assess performance; and
- Triggers that flag implementation of contingency measures.

The framework for the various components of this WMP illustrate how the various predicted subsidence impacts, monitoring components, performance measures and responsibilities are structured to achieve compliance with the relevant statutory requirements, along with the framework for management and contingency actions.

The TARPs are designed to identify, assess and respond to stream, swamp or groundwater impacts (including impacts greater than predicted) in the longwall WE-A2-LW% and Maingates 6, 7 and 8 mining area.

They provide a transparent method to monitor the environmental performance and, where required, implement management and/or contingency measures where the components of the proposed monitoring will serve to alert the mine if an abnormal problem does, or potentially may, exist.

The Principal TARPs represent actions to be taken where a defined trigger is exceeded and requires corrective management in consultation with stakeholders to manage an observed impact in accordance with relevant approvals.

Monitoring of environmental aspects provide the key data to determine if there is a requirement for mitigation or rehabilitation.

Specialist investigations and reports may include:

- analysis of trends;
- assessment of any impacts against predictions;
- assessing the cause of any change or impact;
- assessing options for management and mitigation;
- assessment for the need for contingent measures;
- providing recommended changes to this plan; and

- stakeholder consultation.

The TARPs will be reviewed and any improvement opportunities will be proposed within each End of Panel report.

Management actions will be implemented if a subsidence impact exceeding the predictions has been identified. Some measures, such as grouting, would be implemented following the completion of the majority of subsidence movements in that area.

All environmental management will be undertaken in accordance with the process described in **Figure 24.**

16.1.1 Trigger Levels

The proposed stream, swamp and groundwater triggers are based on baseline monitoring and anticipated subsidence effects as shown in **Appendix C**, with monitoring changes and / or specific triggers continuing to be developed as monitoring matures and refined in consultation with key stakeholders and subject to approval by SCA and other relevant departments.

Where a trigger is exceeded, the cause and effect should be investigated and a management plan developed if the cause is directly related to mining. The use of soft engineering works will be considered in consultation with the SCA and other relevant agencies.

Refined triggers will be proposed, where required, within End of Panel or Annual Environmental Management Reports (AEMR).

16.2 Response to TARP Criteria Exceedances

The TARP Plan outlines what actions will be taken in the case where exceedances of the surface water, stream health, swamp or groundwater impact assessment criteria occur.

Site specific mitigation, or corrective management action (CMA) plans, may be required, and may include:

- description of the impact to be managed;
- results of the investigations;
- aims and objections for the plan;
- specific actions required to mitigate/manage the issue;
- timeframes for implementation;
- roles and responsibilities;
- identification of and gaining appropriate approvals from government agencies; and
- providing a cnsultation and communication plan.

The mitigation or remediation plans will outline methods to ensure that ongoing impacts reduce to levels below the impact assessment criteria as quickly as possible.

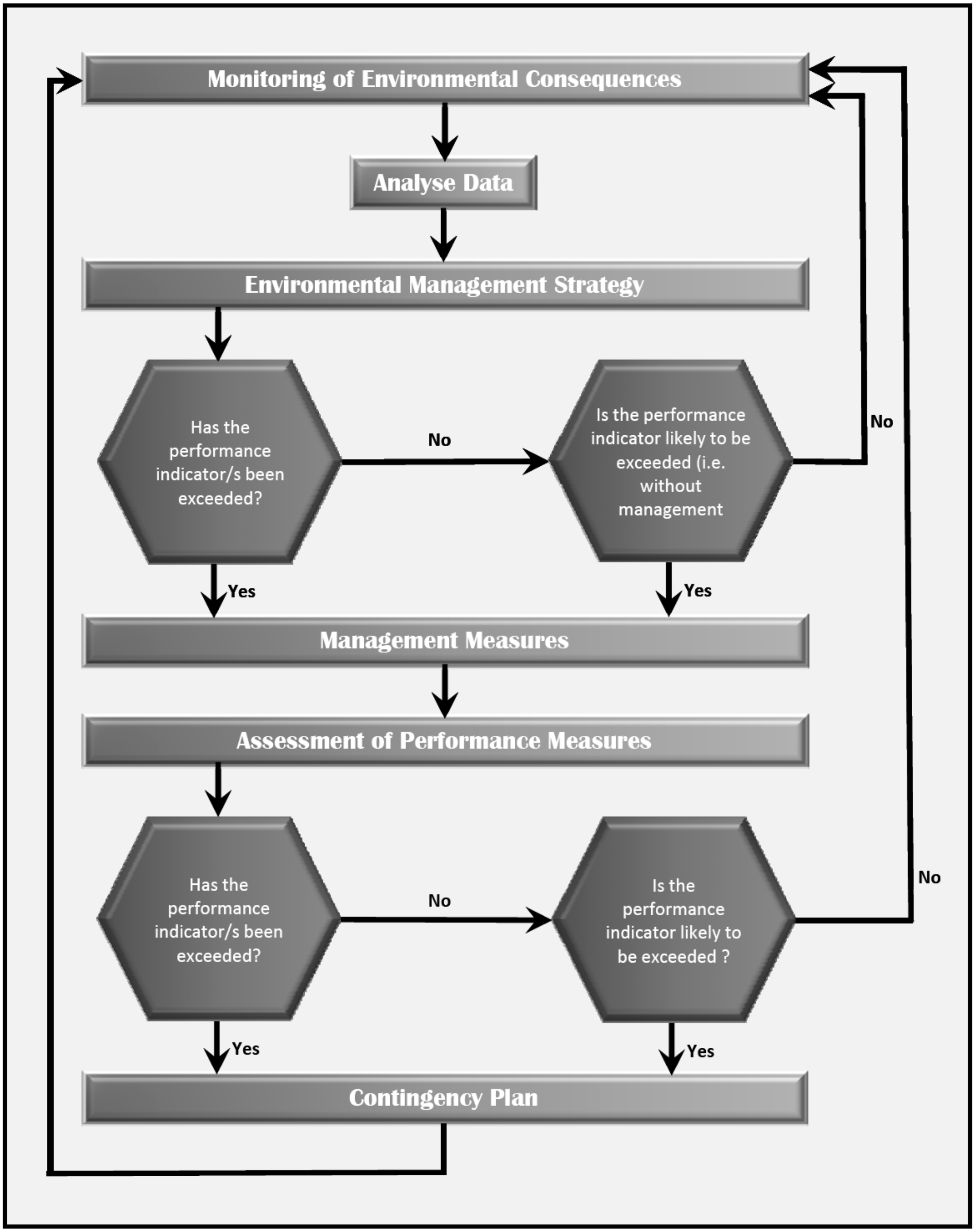


Figure 11 - Management Process

16.3 General Contingency Issues

Subsidence rehabilitation programs have successfully been implemented by BHPBIC and Metropolitan Coal in the Georges River and Waratah Rivulet, where rehabilitation focused on grouting mining induced fractures and strata dilation to reinstate the water holding capacity of the bedrock using PUR and other grout materials (BHPBIC, 2010).

In these cases, systematic and/or valley related movements resulted in the fracturing and dilation of underlying stream strata above the extraction area and generated localised diversion of flow or pool leakage.

Injection grouting was used in the Georges River to successfully rehabilitate a river reach undermined by West Cliff Colliery. Where pool bases and controlling rockbars were rehabilitated using this method continuity of flow was achieved (BHPBIC, 2010).

NRE will actively consult with its colleagues in the Southern Coalfield in relation to these new and emerging technologies.

Should rehabilitation be necessary, the best option will be identified and, with approval, will be implemented.

All works in the Metropolitan Special Area requires SCA approval, and there is a requirement for compliance with the Sydney Catchment Authority Water Supply Catchment Special Areas Standard Conditions for Entry (SCA, 2001).

These requirements ensure strict limits are placed on any impacts associated with undertaking rehabilitation works on SCA land.

Access to the catchment is subject to SCA authorisation in dry weather. Therefore proposed monitoring frequencies may be delayed due to wet weather, whilst notification and investigation timeframes are from when triggers have been confirmed by the Technical Services manager.

The management program provides a basis for the design and implementation of any mitigation and remediation, whilst monitoring of the area's environmental aspects will provide key data when determining any requirement for mitigation or rehabilitation.

In the event that the observed parameters or impacts exceed or are considered likely to exceed the performance measures detailed in the TARPS contained in **Appendix C**, NRE will implement the following Contingency Plan:

- The observation will be reported to NRE's Environment and Community Manager within 24 hours.
- The observation will be recorded.
- NRE will report any exceedance of the performance measure immediately to the DoP&I and other relevant stakeholders.
- NRE will assess the exceedances referred to in the relevant TARP and where appropriate, implement safety measures in accordance with the appropriate Management Plan/s.

- The Environment and Community Manager will investigate any potential contributing factors and identify an appropriate action plan to manage the identified impact(s), in consultation with specialists and/or relevant agencies if necessary.
- NRE will identify an appropriate action plan to manage the identified impact(s), in consultation with other specialists and/or key stakeholders.
- NRE will submit the proposed course of action to the DoP&I for approval.
- NRE will implement the approved course of action to the satisfaction of the DoP&I.
- NRE will continue to monitor performance with the new action plan in place and, if successful will formalise these actions as part of a revised Management Plan.

Contingency measures will be developed in consideration of the specific circumstances of the issue and the assessment of consequences as outlined below.

16.4 Site Access

None of the creeks or swamps over the project components are readily accessible, apart from on foot along currently cleared walking or, possibly, by motor bike, multi wheeled 'gators' or rubber tracked mini-excavators with some clearing required, after approval from the SCA.

Any vehicle used will need to have sufficient capability to carry supplies/equipment to the required site and to assist with the implementation and installation of the contingency measures.

Helicopters would probably be required to sling material directly to where it is needed, with staging from No.4 shaft.

Use of the limited tracks would require vegetation to be trimmed, with all removed / cut vegetation salvaged to assist with future track rehabilitation in accordance with SCA requirements.

Upon completion of mining, and with agreement that the application of contingency measures within any swamp or streambed is no longer necessary, any remaining tracks will be rehabilitated in accordance with SCA approvals.

Materials required for the implementation of contingency measures can be temporally stored at No. 4 shaft or the cleared ventilation shaft area on Fire Road 7D or Firte Road 8.

The materials can be transported in bulk to staging points, pending transport to relevant swamps.

16.5 Stream Mitigation and Remediation

The aims of the stream mitigation and remediation measures include:

- conducting remediation works that protect to the greatest practicable extent the ecological values of the area;
- repairing aesthetic values where necessary;
- reducing the interaction of surface and groundwater flow where enhanced through mining;
- having creeks and pools function in a similar manner to the pre-impact state;
- having surface flows and pool water quality continue to provide suitable aquatic habitat;

- re-establishing the ecological values to a similar state to before mining;
- creeks and catchments yielding similar water quantity and quality following mining,; and
- monitoring and reporting effectiveness of the program.

During mine planning, the proposed longwall WE-A2-LW5 secondary extraction layout was set back from Cataract Creek to reduce the likelihood of significant impacts, such as major fracturing leading to draining of pools.

If required, a pre-emptive measure to reduce stream impacts is through the reduction of subsidence, such as through leaving barriers of coal to support the surface through the hierarchy of "avoid / minimise / mitigate".

Changing a mine layout can have significant flow-on impacts to mine planning and scheduling as well as the mine's economic viability which need to be taken into account when assessing options.

In relation to the main issue of surface water diversion into sub-beds and geochemical effects, the major mitigation measure is to set back longwalls from the creek to avoid or minimise subsidence induced impacts.

Examples of potential corrective management actions are discussed below.

16.5.1 Natural Stream Remediation

Subsidence cracks in stream beds can seal through natural erosion and deposition.

The sediment nature, dynamics and flow permanence in a stream will determine the rate and degree of sealing, and in some circumstances, the natural process may be insufficient to protect the stream and anthropogenic rehabilitation may be required.

16.5.2 Stream Hand Mortaring

Where stream flow transfer is observed through joints or fractures, they can be sealed using a variety of products, some of which can be applied in wet conditions or under water and are normally applied using small held-held equipment in localised situations.

Should large fractures occur in the base of a pool, they can be sealed with hand placed cement grout and natural oxides, such as occurred at Marhnyes Holey, prior to pattern grouting (BHPBIC, 2010).

16.5.3 Stream Injection Grouting

Where creeks are fractured and have a limited ability to naturally seal, it may be necessary to conduct remedial measures which usually include grouting to return surface water flow back to the stream bed.

Grout can be delivered by small handheld or truck-mounted equipment for deeper holes, with angled, vertical or horizontal drilling techniques utilised to position the grout.

The engineering techniques are well established and used in the mining and construction industries and are readily adapted to rehabilitation activities.

A number of grouts are available, including cement, pulverised ash and chemical grouts, with or without fillers (such as sand, gravel or vegetable fibres).
The choice of grout will be determined based on the nature and extent of the fracturing, the surface/ground water interaction and the objectives of the rehabilitation program.

The rehabilitation has the potential to cause adverse environmental impacts through the materials used as well as disturbance associated with access and will be carefully planned to avoid contamination of watercourses.

Coffer dams or bunds can be built to isolate the grouting operations and collect any materials spillage for later off site disposal at mixing points.

The materials used in these processes are non-toxic, environmentally inert and do not significantly impact upon the natural habitats of aquatic species.

16.5.4 Stream Pattern Grouting

Large fractured reaches of a stream may be sealed using grid pattern grouting.

A range of specialist grouts and techniques can be used including cement, bentonite, mixes, micro fine cements and sodium silicate-based grouts. The selection of a particular grout includes an analysis of potential aquatic ecosystem toxicity.

A number of passes is generally required to seal the subsurface, which involves grout and/or filler injection into the voids, with the intention being to achieve a low permeability `layer' below the stream to restore flow and pool water levels.

Grout holes are drilled at a 1 x 1m to 2 x 2m spacing, with small hand held tools used to minimise the potential environmental impact which are powered by compressed air distributed to the work area from a compressor.

Once specially designed packers are installed at the surface, grout is injected sequentially into the holes at a low pressure from a small tank and mixed and pumped according to the preferred grout design.

A grout of high viscosity will be used if vertical fracturing is present as it has a faster setting time, with lower viscosities used if cross-linking is noted.

Once the grout has been installed the packers are removed and the area is cleaned.

After the grout hardens the area may be in-filled with additional holes targeting areas of significant grout take that were identified in previous passes.

Once the grout take in the area is reduced and the material has cured, the grouted section of the pool is allowed to fill with water and is monitored.

The process is iterative and relies on detailed monitoring of grout injection quantities, backpressure analysis and water holding capacities to attain the desired end point, with the choice of grout being dependent upon the permeability of the rock.

16.5.5 Deep Angled Hole Grouting Under Streams

Where access difficulties make pattern grouting inappropriate, i.e., where a pool has not totally drained, directional drilled holes used for grouting may be installed at a distance away from the pool.

The grout usually comprises 2% bentonite and general purpose cement with a specific gravity of 1.57 delivered to the directionally drilled holes through a packer system with pumping continuing until the grout returns to the top of the delivery holes.

Regular inspections are undertaken throughout and following the operation to ensure there are no significant releases of grout into the river.

16.5.6 Stream Permeation Grouting

Permeation grouting involves the introduction of grout and filling materials into an individual pool or a stream flow, where the material is drawn into and seals voids in the creek bed.

16.5.7 Impermeable Blankets or Linings Under Streams

Impermeable blankets or linings involves the installation of a waterproof lining to a pool to prevent loss of water into the underlying voids, with a variety of materials available, depending on site-specific circumstances.

16.5.8 Curtain grouting of Stream Beds

Curtain grouting involves installation of a grout curtain to the depth of fracturing to create an impermeable barrier to bypass flow, with a variety of materials available, depending on site-specific circumstances.

16.5.9 Stream Surface Treatment

Where cracking develops and natural sealing is not viable, the cracks may require forking over and compacting of alluvial or colluvial sedimentary deposits to prevent subsequent erosion.

Larger cracks may require more work, with mulch or other protection used to prevent the development of erosion channels, with the surface protection remaining in place until revegetation stabilises the disturbed area.

Some cases may require the use of gravel or sand to fill up to surface then revegetation with local native plants.

Such rehabilitation measures have the potential to cause impact through the materials used and the disturbance associated with access and therefore, considerable care and relevant approvals will be obtained to ensure the protection of the environment.

16.5.10 Ferruginous Springs with Possible Acidic and/or Heavy Metal Components

The effect of ferruginous springs can be mitigated by placing coarse limestone downstream of the spring to increase pH, increase stream aeration and to initiate precipitation of dissolved iron.

The effect of ferruginous springs is generally aesthetic and does not generally pose an adverse risk to stream ecology due to the relatively short length and high gradient of the Study Area streams, as well as the substantial dilution and dispersion that occurs at the confluence with Cataract Reservoir.

Liming of streams with granular agricultural grade limestone ($CaC0_3$) is generally preferred to restore aquatic ecosystems under stress from acidification and Fe / Mn / heavy metal precipitation at the point of emergence. Placement of limestone would provide a continual reactive surface for:

- Neutralisation of excessive acidity;
- Localised precipitation of Fe and Mn hydrous oxides with adsorptive removal of potential eco-toxic trace metals;
- Increasing he hardness of the water and encouraging settling of dispersed sodic 2:1 layer clays; and
- Accelerating natural remediation of cracks in the base pools.

Limestone is relatively insoluble above pH 6.5 and the calcium and carbonate alkalinity dissolution products are non-toxic and will have no effect on the reservoir's water quality.

Precipitation of hydrous iron and manganese oxides from ferruginous springs can also be addressed through manually placed rocks obtained from local outcrops positioned at the emergence point. This can increase turbulence as well as oxidation rates and precipitation of hydrous oxides and allow downstream flow to ameliorate the effects.

16.5.11 Riparian Land Stability

Specific actions to address subsidence impacts on cliffs and steep slopes will be developed and implemented where adverse subsidence impacts occur.

Rock falls from cliff lines and slope slippage could be precipitated by the levels of movement that have been predicted, particularly where rocks and slopes are marginally stable.

Remediation requirements for mining related rock falls and slippage would be to the satisfaction of DRE and SCA. Measures may include:

- Surface water management measures to minimise sediment mobilisation;
- Erosion and sedimentation control measures to minimise downstream effects;
- Revegetation of disturbed areas;
- Preventive measures such as removal or stabilisation of loose boulders and scaling of loose rocks from cliff faces; and
- Filling and mulching over large cracks to prevent the development of erosion channels.

16.5.12 Stream Gas Release

A typical driver of gas release at the surface is pressure changes, dilation and/or fracturing of the rock mass and associated release with groundwater flow to the surface.

Grouting can reduce these associated gas flows.

In all circumstances in the Southern Coalfield the gas releases have diminished over time, ranging from months to years, with long running releases significantly reducing over time.

Where vegetation is impacted by gas, the affected area can be revegetated once the gas has ceased or reduced to an extent where vegetation is no longer affected.

16.5.13 Stream Specific Contingency Measures

In the event that the observed parameters or impacts exceed or are considered likely to exceed the performance measures detailed in the Plan, NRE will implement the following Contingency Plan, where:

- The observation will be reported to the Environment and Community Manager within 24 hours.
- The observation will be recorded.
- NRE will report any exceedance of the performance measure to the DoP&I and other relevant stakeholder as soon as practicable after NRE becomes aware of the exceedance.
- NRE will assess the exceedances referred to in the relevant TARP and where appropriate, implement safety measures in accordance with the appropriate Management Plan/s.
- The Environment and Community Manager will investigate any potential contributing factors and identify an appropriate action plan to manage the identified impact(s), in consultation with specialists and/or relevant agencies if necessary.
- NRE will identify an appropriate action plan to manage the identified impact(s), in consultation with other specialists and/or key stakeholders.
- NRE will submit the proposed course of action to the DoP&I for approval.
- NRE will implement the approved course of action to the satisfaction of the DoP&I.
- NRE will continue to monitor performance with the new action plan in place and, if successful will formalise these actions as part of the Management Plan.

Contingency measures will be developed in consideration of the specific circumstances of the issue and the assessment of consequences.

Contingency options will be implemented if it is demonstrated the environmental, water or safety impacts are greater than predicted, with the management framework involving the following components:

- Identifying features/values of significance and impact prediction to determine the range of possible events and impacts;
- Risk assessment in terms of determining the probability and consequence of an event occurring;

- Defining triggers and trigger levels for features/values affected and/or the identified events/impacts;
- Defining and implementing environmental monitoring;
- Identifying responses/actions to be taken when different triggers and trigger levels are reached, including response measures and actions relating to avoidance, minimisation, mitigation and compensation and contingency plans and emergency responses;
- Identifying roles and responsibilities of various stakeholders; and
- Assessing measured and predicted impacts as mining progresses for features/values affected and implement responses/actions identified based on triggers and various predefined trigger levels being exceeded. Impacts need to be assessed based on the significance, extent, scale or longevity of impact and practical aspects of mitigation/rehabilitation.

With the provision of contingency measures, there is the potential to cause secondary impacts through the introduction of materials to the area or any disturbance associated with the activity.
Considerable care and relevant approvals will be obtained to ensure the protection of the environment as such works are executed.

Contingency measures would be monitored to confirm maintenance of the ecological values of the area and to confirm that measures in place to manage secondary impacts are effective.

It is possible that a longwall could gradually affect only a small area and that the remainder, being unaffected, will continue to provide unaffected habitats for terrestrial and aquatic species immediately adjacent to impacted areas. To minimise the impacts associated with subsidence and rehabilitation works a number of measures can be implemented. These include:

- Relocation of fauna and fish;
- Temporary maintenance of individual species such as watering aquatic plants;
- Provision of compensatory habitat;
- Timing of works;
- Staged work programs; and
- Altering mining methods or modifying the mining area.

If pools are substantially drained, large aquatic fauna can be relocated to ensure they are not significantly impacted prior to rehabilitation being completed in consultation with SCA, DPI Fisheries and other agencies as required.

If rehabilitation of aquatic habitats is required, a catalogue of the habitat will be developed and used in site preparation to assist with rehabilitation. Boulders and logs can be removed during site preparation and returned to pre-disturbance positions.

Stockpiling rocks and logs adjacent to the watercourse and marking pre-disturbance positions with a nontoxic marking paint assist this process.

Larger aquatic plants can be removed during site preparation in a non-destructive manner (i.e. by shovel) which allows the macrophytes to be stored off-site and replanted on completion of works.

Patches of aquatic vegetation that do not need to be removed, but are left stranded by a fall in water level, could be watered until water levels are restored.

16.6 Swamp Mitigation and Remediation

The potential sites for the remedial measures including bedrock crack grouting, coir log dam construction or water spreading structures are where the predicted increase in surface grade exceeds 1% and at possible cracking zones.Director General's approval required prior to commencement of any swamp mitigation techniques.

Grout injection may be applicable at swamp controlling rockbars.

Upsidence induced tunnel erosion may occur in close proximity to a swamp channel as they are the lowest point where stress concentrations occur.

The prime objective of erosion control structures is to maintain the swamp saturated water level and to enable overland flow to permeate into the swamp. A secondary benefit is to capture eroded sediment and restore an incised stream to the surrounding intact peat level.

Installation of erosion control works can be completed within a few weeks with readily available materials that can be delivered to site within approximately one week.

Erosion control and water spreading involves soft-engineering materials that contribute to and function as part of the swamp, but eventually degrade and are integrated into the swamp. This approach is ecologically sustainable in that all the materials used can break down and become part of the organic component of the swamp.

This also removes the requirement for any post-rehabilitation removal of structures or materials.
Contingency measures to mitigate the impacts of swamp degradation are summarised in **Table 16.1** and described in the following sections.

Table 16.1 - Proposed Swamp Contingency Measures

Swamp Degradation Mechanism	Mitigation measure
Stream bed cracking	Sand/cement fill
Cracking of controlling rockbar	Injection grouting
Knick point erosion control	Square coir log dam
Desiccation	Water spreading

16.6.1 Sealing of Swamp Cracks

Where bedrock controlled channels in swamps are adversely impacted and where there is limited ability for cracks to seal naturally, the cracks can be sealed by using appropriate and approved cement (or alternative) grouts, with or without approved additives that are placed where the cracks divert flow from the channel.

Grout can be used with or without fillers such as clean sand.

The objective used to gauge the success of any remedial works will be the attainment of at least 90% of the baseline flow measured under similar climatic conditions.

Generally, small quantities of grout are required which can be mixed on site and placed by hand held equipment.

Such operations have the potential to result in additional environmental impacts and are carefully planned to avoid contamination of watercourses. Set up and mixing areas will be restricted to cleared access tracks or other open areas.

Bunds can contain local spillage at mixing points, and where required, temporary cofferdams can be built downstream of grouting sites to collect spilled materials for appropriate disposal off-site.

The selection of grouting materials is based on ensuring that there is no significant impact to water quality or the ecology of the stream.

16.6.2 Swamp Injection Grouting

Injection grouting involves the delivery of grout through holes drilled into the controlling rockbar of a swamp.

A variety of grouts and filler materials can be injected into the voids with the intention being to achieve a low permeability `layer' below any affected pool, and / or the full depth of a controlling rockbar.

Grouts may be injected through grout rods to seal voids in or under swamp sediments or peat as was used at Pool 16 and 17 in the Georges River where 2 m of loose sediment was grouted through using purpose built grouting pipes (BHPBIC, 2010).

Grouting holes are drilled in a pattern in the same manner as described for pattern grouting streams, with the equipment sited on cleared access tracks, with hoses run out to the controlling rockbar.

Once mechanical packers have been installed at the surface, grout is injected into at low pressure from a tank located at a clear access location.

All equipment can be transported with vehicles capable of travelling on the access tracks.

If necessary, equipment or materials can be flown to the seismic lines by a helicopter staging from No. 4 shaft.

No large equipment is necessary within the swamp.

In the Georges River the majority of pools were sealed with two to three grout passes (BHPBIC, 2010).

If flow diversion through a swamp rockbar occurs and lowers the surrounding shallow groundwater table, it may be more appropriate to implement alternative grouting techniques such as a deep grout curtain.

Rockbar grouting should preferentially be undertaken at the completion of subsidence.

16.6.3 Swamp Knick Point Control

Post subsidence swamps may have incised flow lines eroded into the underlying sandstone, with any increased flow potentially continuing the vertical and headward horizontal erosion of a peaty flow line

Subsidence may also concentrate flow in the lower swamp, leading to possible development and collapse of peat tunnels into eroding channels that eventually join with the existing incised main flow line.

Erosion channels can create preferred flow paths and dewater the surrounding swamp sediments.
Coir log dams can be installed at knick points in the channelised flow paths or at the inception of tunnel / void spaces. Square coir logs used for the construction of small dams were developed specifically for swamp rehabilitation and have been successfully used during a number of swamp rehabilitation programs in the Blue Mountains and Snowy Mountains (BHPBIC, 2010).

A trench is cut into the peat / organic soil so the first layer sits on the underlying substrate or such that the top of the first coir log is at ground level.

As the coir log dam silts up, they are regularly added to by the placement of additional logs until the pooled water is at or above the eroded channel bank level, with the logs held by wooden stakes bound with wire.

The coir log dam slows the flow in the entrenched drainage lines so they silt up, which then flows through the swamp, not around it.

The dams are constructed at intervals down the eroded or entrenched flow line, then added to until the pooled water is at or above the level of the bank of the entrenched stream, or the peatbed of the swamp. At this point the stream becomes a net contributor to the swamp and does not drain water away.
Where increased filtering of flows is required the coir logs can be wrapped in jute fibre matting.

16.6.4 Swamp Water Spreading

Maintenance of swamp moisture can be enhanced by water spreading with long coir logs and hession `sausages' linked together across the contour so that water builds up behind them and slowly seeps through the water spreaders.

The spreaders would be installed as required within shallow trenches in the swamp and along the higher margins.

16.6.5 Swamp Contingency Measures

A site specific rehabilitation action plan detailing the location and works to be implemented will be prepared following any identification of mining induced swamp degradation that exceeds specified triggers.

The plan will be circulated to relevant stakeholders for comment and approval prior to finalisation.
All works and environmental controls will be approved by the SCA prior to implementation.

16.7 Groundwater Mitigation and Remediation

16.7.1 Mine Inflows

Application of an appropriate technique to manage an abnormal inflow to the mine will be determined by agreement with all stakeholders based on the advice of hydrogeologists and ground consolidation technical experts.

The mine has used materials in ground control applications and inflow control applications in the past and will apply these as appropriate to regain control of inflows should the need arise.

Selection of the optimum application and combination of materials and techniques will depend on the nature and magnitude of the inflow, technical advice and on stakeholder input.

The NRE No. 1 mine would work closely with specialist ground support and PUR injection companies with appropriate experience in chemical injection techniques for consolidation of unstable and porous ground and in the use of such measures to control ground water flows.

The mine's water inrush plan details methodologies relating to grout and PUR-based solutions to localised inflow situations and defines the capability of each product used for ground consolidation and water control, MSDS documents, technical specifications as well as case studies of applications where each product and sealing technique would be most effective.

Pro-active responses based on projected inflows mean that actions may be considered and planned at the time, with reference to pre-planned scenarios. In addition to underground sealing of inflows it may be practical to undertake sealing works from the surface, depending on specific environmental factors related to the proposed work.

Triggers that will initiate the decision to use such remedial techniques are defined in **Appendix C.**

With ongoing projections of inflows over the entire longwall block based on the data available at any point in the progress of each longwall, the Review Team will take appropriate early remedial action that is anticipated to negate the need to activate the defined response to an actual trigger.

PUR and grout is available at short notice. However, with the exception of localised occurrences, it is not considered to be necessary to maintain stocks of materials as these may be very circumstance-specific, and, with the time afforded by forward projection of inflows, their application and acquisition should not be a matter of urgency.

Ground consolidation would be made available to be rapidly deployed to water control activities if necessary.

Operators will be trained to conduct supporting activities for contract drillers and PUR injection personnel.

16.7.2 Mine Sealing

The installation of seals to isolate areas can be conducted as specific mining areas are completed, with the seals containing monitoring, drainage and sampling facilities to allow water accumulation behind the seals to be monitored, sampled and managed while current areas are mined.

The final sealing of the mine requires bulkheads to be installed that ensure that any water reporting to the mine will be controlled.

Trigger mechanisms that will initiate the decision to abandon other remedial techniques and commence the installation of bulkheads either to isolate areas or to seal the mine are defined as part of the mine closure plan.

16.8 Offsets

The proposed workings, and the commitments proposed in the Environmental Assessment were designed to avoid or minimise significant impacts to major creeks, swamps and any associated groundwater dependent ecosystems.

Comprehensive management and monitoring programs have been proposed to rapidly evaluate and remediate any significant impact to the natural features within the proposal area.

It is predicted that any mining induced impacts will be of a minor nature and at a local scale.

The monitoring and management plan contains considerable amounts of data, interpretation and analysis of many aspects of the environment and are generated and made available in accordance with the project approval conditions. This assists land and conservation managers to understand the nature and function of this landscape and the environmental values therein.

The specific measures included within this management plan have been developed to restore ecological and other values of the Special Areas.

Specific methods for offsets for loss of water quality, loss of flow to SCA storages, clearing or other ground disturbance, and any adverse impacts on groundwater dependent ecosystems or riparian vegetation located within and adjacent to the potential subsidence area caused by mining activities will be provided to the SCA on a case by case basis.

Gujarat will provide a suitable offset/s to compensate for the impact to the satisfaction of the SCA and the Director-General of DoP&I if either the contingency measures implemented by Gujarat fail to remediate the impact or if the SCA or DoP&I Director-General determines that it is not reasonable or feasible to remediate the impact.

17 INCIDENTS, COMPLAINTS AND NON-CONFORMANCES

17.1 Incidents

The Project Approval defines an 'incident' to be "*a set of circumstances that causes or threatens to cause material harm to the environment, and/or breaches or exceeds the limits or performance measures/criteria in this Approval*."

Incidents will be managed through established NRE procedures in as detailed the Project Environmental Management Strategy (PEMS).

In accordance with ***Condition 6/Schedule 5*** NRE will notify the Director-General and any other relevant agencies of any incident:

- At the earliest opportunity if the incident has caused, or has the potential to cause significant risk of material harm to the environment.
- As soon as practicable in all other cases.

A detailed report of the incident shall be provided to DoP&I within 7 days of the incident occurring.

17.2 Complaints Handling

Complaints will be managed through established NRE procedures as detailed in the PEMS.

As required by ***Condition 10/Schedule 5*** of the Project Approval a copy of a complaints register (updated on a Monthly basis) will be kept on the NRE website. A summary of complaints will be available to regulatory authorities on request and provided in the Annual Environmental Management Reports (AEMRs).

17.3 Non-Conformance Protocol

NRE will manage and report non-compliances relevant against statutory requirements in accordance with an established protocol developed as a component of the Environmental Management Strategy.

Compliance with all approvals, plans and procedures will be the responsibility of all personnel (staff and contractors) employed on or in association with NRE No.1 Colliery, and will be promoted through direct consultation and direction of the Mine's Operations Manager.

Regular inspections and/or internal audits will be undertaken as required by suitably qualified personnel under the direction of the Environment and Community Manager, to identify any remediation/rectification work required, and areas of actual or potential non-compliance.

A Compliance Register ***Compliance Register (EMS RV APP 003 & EMS WW APP 003)*** will be established to monitor compliance against development consent criteria, mining leases etc.

Non-compliances identified through the Compliance Register are to be reported, with corrective actions implemented.

A review of NRE's compliance with all conditions of the Project Approval, mining leases and all other approvals and licences will be undertaken prior to (and included within) each Annual Review. The Annual Review will be made publicly available on NRE's website.

18 PLAN ADMINISTRATION

18.1 Roles and Responsibilities

Environment and community management is regarded as part of the responsibilities of all Colliery personnel. The roles and function of the main personnel responsible for the implementation of environmental and community management including the plans, procedures and action plans contained in this EMS are outlined in ***NREG EMS PRO005 Environmental Roles and Responsibilities*****.**

18.2 Resources Required

In accordance with the ***NRE 001NRE Environmental Policy*** Management shall ensure that the appropriate resources are made available to achieve the implementation of this Plan.

It is the role of the Environment and Community Manager to ensure that these requirements are communicated to NRE Management.

18.3 Training

All training and inductions conducted are to be undertaken as per the ***NRE 012 Training procedures*****.**

18.3.1 Staff Training

Staff training will be undertaken as detailed in the EMS. This consists of three levels of training applicable to different types of staff:

Level 1 –High level training on environmental requirement – Management
Level 2 – Operational level training – Project Managers, Supervisors, Surface Personnel
Level 3 – Basic environmental awareness – Underground staff

18.3.2 Inductions

All contractors and associated subcontractors will be required to participate in site induction prior to the commencement of work. As a minimum, the induction is to include:

- An overview of the Cardinal Rules, Environment Policy and EMS requirements.
- Environmental incident and community compliant reporting requirements.
- Environmental emergency contact details.

In the event that there are specific environmental management requirements relating to a contractor's work activities, details of these requirements are to be issued to the contractor in writing as a part of the induction.

Records, which detail the attendees, content of the induction/training as well as any additional information provided, will be maintained.

In addition to the induction program, training will be provided as deemed necessary to contractors to provide them with the knowledge, skills and awareness to minimise environmental impact. At a minimum this should include:

- Contractors whose activities are not directly supervised by Colliery personnel.
- Contractors whose activities are ongoing and have the potential to result in an environmental incident (e.g. stockpile contractors).

18.4 Record Keeping and Control

Environmental records are to be managed in accordance with the ***NRE 010 Document and Data Control procedure*****.**

All records of the EMS will be stored so that they are readily retrievable and suitably protected from deterioration or loss. Archiving will be managed in accordance with the ***NRE 010 Document and Data Control procedure*****.**

A master copy of each EMS document including all appendices and supporting information is to be held in the office of the E&C Department.

18.5 Plan Revision

18.5.1 Annual Review

In accordance with ***Condition 3/Schedule 5*** of the Project Approval, an Annual Review of the environmental performance of the Project will be undertaken and annually thereafter.

The Annual Review will:

- Describe the works carried out in the past year, and the works proposed to be carried out over the next year.
- Include a comprehensive review of the monitoring results and complaints records of the Project over the past year, including a comparison of these results against the:
    - relevant statutory requirements, limits or performance measures/criteria;
    - monitoring results of previous year/s; and
    - relevant predictions in the EA.
- Identify any non-compliance over the last year, and describe what actions were (or are being) taken to ensure compliance.
- Identify any trends in the monitoring data over the life of the Project.
- Identify any discrepancies between the predicted and actual impacts of the Project, and analyse the potential cause of any significant discrepancies.
- Describe what measures will be implemented over the next year to improve the environmental performance of the Project.

18.5.2 Auditing

In accordance with ***Condition 8/ Schedule 5*** of the Project Approval an Independent Environmental Audit will be undertaken by a suitably qualified auditor and include experts in any field specified by the Director-General within 12 months of the approval and every three years after that.

This audit must:

- Be conducted by a suitably qualified, experienced and independent team of experts whose appointment has been endorsed by the Director-General.
- Include consultation with the relevant agencies.
- Assess the environmental performance of the project and assess whether it is complying with the requirements in this approval and any relevant EPL or Mining Lease (including any assessment, plan or program required under these approvals).
- Review the adequacy of strategies, plans or programs required under the abovementioned approvals.
- Recommend measures or actions to improve the environmental performance of the project, and/or any strategy, plan or program required under these approvals.

18.5.3 Plan Revision

In accordance with ***Condition 4/ Schedule 5*** of Project Approval, this Plan will be reviewed within three months of the submission of:

- The submission of an annual review
- The submission of an incident report
- The submission of an audit
- Any modification to the conditions of approval (unless the conditions require otherwise)

The revision status of this plan is indicated on the title page of each copy. Revisions to any documents listed within this Plan will not necessarily constitute a revision of this document. The distribution of controlled copies is described in **Section 1.3**.

19 REFERENCES

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Appendix A - Water Monitoring Summary

Environmental Aspect	Site	Parameter	Monitoring Parameters	Commencement Date
3rd order or higher streams	CC1	pH EC 0^c Eh DO	Field meter	August 2008
(Wonga East)		major ins / metal nutrients	Laboratory analysis	August 2008
		visual inspections	photography	August 2008
		stream water height	photography	August 2008
	CC2	pH EC 0^c Eh DO	Field meter	August 2008
		major ins / metal nutrients	Laboratory analysis	August 2008
		visual inspections	photography	August 2008
		stream water height	photography	August 2008
	CC3	pH EC 0^c Eh DO	Field meter	August 2008
		major ins / metal nutrients	Laboratory analysis	August 2008
		visual inspections	photography	August 2008
		stream water height / volume	water level logger	November 2010
	CC4	pH EC 0^c Eh DO	Field meter	August 2008
		major ins / metal nutrients	Laboratory analysis	August 2008
		visual inspections	photography	August 2008
		stream water height / volume	water level logger	November 2010
	CC5	pH EC 0^c Eh DO	Field meter	August 2008
		major ins / metal nutrients	Laboratory analysis	August 2008
		visual inspections	photography	August 2008
		stream water height	photography	August 2008
	CC6	pH EC 0^c Eh DO	Field meter	being installed
		major ins / metal nutrients	Laboratory analysis	being installed
		visual inspections	photography	being installed
		stream water height	photography	being installed
	CC7	pH EC 0^c Eh DO	Field meter	being installed
		major ins / metal nutrients	Laboratory analysis	being installed
		visual inspections	photography	being installed
		stream water height	photography	being installed

Environmental Aspect	Site	Parameter	Monitoring Parameters	Commencement Date
	CC8	pH EC 0^c Eh DO	Field meter	being installed
		major ins / metal nutrients	Laboratory analysis	being installed
		visual inspections	photography	being installed
		stream water height	photography	being installed
	CC9	pH EC 0^c Eh DO	Field meter	August 2008
		major ins / metal nutrients	Laboratory analysis	August 2008
		visual inspections	photography	August 2008
		stream water height / volume	Water level logger	November 2010
	CC10	pH EC 0^c Eh DO	Field meter	August 2008
		major ins / metal nutrients	Laboratory analysis	August 2008
		visual inspections	photography	August 2008
		visual inspections	photography	May 2012
		stream water height / volume	Water level logger	December 2011
1st / 2nd order tributaries	Crus1c	pH EC 0^c Eh DO	Field meter	March 2012
(Wonga East)		major ins / metal nutrients	Laboratory analysis	March 2012
		visual inspections	photography	March 2012
		stream water height	photography	March 2012
	Ccus3c	pH EC 0^c Eh DO	Field meter	March 2012
		major ins / metal nutrients	Laboratory analysis	March 2012
		visual inspections	photography	March 2012
		stream water height	photography	March 2012
	Ccus4c	pH EC 0^c Eh DO	Field meter	March 2012
		major ins / metal nutrients	Laboratory analysis	March 2012
		visual inspections	photography	March 2012
		stream water height	photography	March 2012

Environmental Aspect	Site	Parameter	Monitoring Parameters	Commencement Date
	SP1c	pH EC 0^c Eh DO	Field meter	March 2012
		major ins / metal nutrients	Laboratory analysis	March 2012
		visual inspections	photography	March 2012
		stream water height	photography	March 2012
	CT1	pH EC 0^c Eh DO	Field meter	April 2012
		major ins / metal nutrients	Laboratory analysis	April 2012
		visual inspections	photography	April 2012
		stream water height	photography	April 2012
Cataract Reservoir	CD1	pH EC 0^c Eh DO	Field meter	August 2008
(Wonga East)		major ins / metal nutrients	Laboratory analysis	August 2008
		visual inspections	photography	August 2008
		dam water height	photography	August 2008
Upland swamps	Crus1	pH EC 0^c Eh DO	field meter	March 2012
(Wonga East)	(via PCr1)	major ins / metal nutrients	laboratory analysis	March 2012
		visual inspections	photography	March 2012
		Swamp water height	water level logger	March 2012
	Ccus2	pH EC 0^c Eh DO	field meter	May 2012
	(via PCc2)	major ins / metal nutrients	laboratory analysis	May 2012
		visual inspections	photography	May 2012
		Swamp water height	water level logger	May 2012
	Ccus3	pH EC 0^c Eh DO	field meter	March 2012
	(via PCc3)	major ins / metal nutrients	laboratory analysis	March 2012
		visual inspections	photography	March 2012
		Swamp water height	water level logger	March 2012
	Ccus4	pH EC 0^c Eh DO	field meter	March 2012
	(via PCc4)	major ins / metal nutrients	laboratory analysis	March 2012
		visual inspections	photography	March 2012
		Swamp water height	water level logger	March 2012

Environmental Aspect	Site	Parameter	Monitoring Parameters	Commencement Date
	Ccus5	pH EC 0^c Eh DO	field meter	May 2012
	(via PCc5A)	major ins / metal nutrients	laboratory analysis	May 2012
		visual inspections	photography	May 2012
		Swamp water height	water level logger	May 2012
	Ccus5	pH EC 0^c Eh DO	field meter	May 2012
	(via PCc5B)	major ins / metal nutrients	laboratory analysis	May 2012
		visual inspections	photography	May 2012
		Swamp water height	water level logger	May 2012
	Ccus6	pH EC 0^c Eh DO	field meter	March 2012
	(via PCc6)	major ins / metal nutrients	laboratory analysis	March 2012
		visual inspections	photography	March 2012
		Swamp water height	water level logger	March 2012
	Bcus4	pH EC 0^c Eh DO	field meter	May 2012
	(via PB4)	major ins / metal nutrients	laboratory analysis	May 2012
		visual inspections	photography	May 2012
		Swamp water height	water level logger	May 2012
Shallow Weathered Sandstone	SP1	pH EC 0^c Eh DO	field meter	March 2012
(Wonga East)		major ins / metal nutrients	laboratory analysis	March 2012
		visual inspections	photography	March 2012
		Swamp water height	water level logger	March 2012
	SP2	pH EC 0^c Eh DO	field meter	March 2012
		major ins / metal nutrients	laboratory analysis	March 2012
		visual inspections	photography	March 2012
		Swamp water height	water level logger	March 2012

Environmental Aspect	Site	Parameter	Monitoring Parameters	Commencement Date
Basement Groundwater	NRE A	water level	water level logger	November 2009
(open standpipe)		pH EC 0^c	field meter	November 2009
		major ins / metal nutrients	laboratory analysis	November 2009
	NRE C	water level	water level logger	November 2009
		pH EC 0^c	field meter	November 2009
		major ins / metal nutrients	laboratory analysis	November 2009
	NRE D	water level	water level logger	November 2009
		pH EC 0^c	field meter	November 2009
		major ins / metal nutrients	laboratory analysis	November 2009
	GW1A	water level	water level logger	August 2012
		pH EC 0^c	field meter	August 2012
		major ins / metal nutrients	laboratory analysis	August 2012
Vibrating Wire Piezometer Arrays	NREA	water head pressure	VWP’s	November 2009
	NREB	water head pressure	VWP’s	November 2009
	NREC	water head pressure	VWP’s	November 2009
	NRED	water head pressure	VWP’s	November 2009
	GW1	water head pressure	VWP’s	August 2012

Appendix B - Water Chemistry Analyses

ANZECC													1.90	1.90	0.001	0.003	0.008	0.011	0.055	0.024 (III) / 0.013(V)					0.3	0.02	
		TDS	**Na**	**Ca**	**K**	**Mg**	**Cl**	**F**	**SO4**	**HCO3**	**Fe**	**Fe Filt**	**Mn**	**Filt Mn**	**Filt Cu**	**Filt Pb**	**Filt Zn**	**Filt Ni**	**Filt Al**	**Filt As**	**Filt Li**	**Filt Ba**	**Filt Sr**	**DOC**	**Tot N**	**Tot P**	**Si**
28/08/08	**CC1**	86	23	2.5	1.0	4.7	44.0	0.1	8	5	2.20	0.11	0.04	0.04	0.001	0.001	0.007	0.010	0.03	0.010	0.001	0.010	0.030	1	0.1	0.01	
5/11/08	**CC1**	82	21	2.1	1.0	3.7	38.0	0.1	6	4	2.60	0.82	0.19	0.19	0.001	0.001	0.006	0.010	0.10	0.010	0.003	0.010	0.020	3	0.7	0.11	
9/01/09	**CC1**	62	14	2.6	0.1	3.7	32.0	0.1	4	3	2.10	0.02	0.20	0.20	0.004	0.001	0.120	0.010	0.03	0.010	0.001	0.040	0.070	2	0.1	0.04	
17/03/09	**CC1**	68	17	2.1	0.6	3.3	32.0	0.2	5	11	13.00	0.02	0.07	0.06	0.001	0.001	0.006	0.010	0.04	0.010	0.001	0.010	0.020	1	0.2	0.01	
14/05/09	**CC1**	68	17	2.1	1.9	3.7	30.0	0.1	6	10	2.40	0.04	0.10	0.09	0.001	0.001	0.008	0.010	0.04	0.010	0.002	0.020	0.020	2	0.8	0.06	
23/07/09	**CC1**	110	19	13.0	0.9	6.0	40.0	0.1	8	38	0.31	0.10	0.01	0.01	0.001	0.001	0.010	0.010	0.04	0.010	0.006	0.030	0.060	2	0.1	0.01	
2/10/10	**CC1**	58	13	2.3	0.5	3.3	28.0	0.1	5	3	3.00	0.07	0.09	0.07	0.001	0.001	0.005	0.010	0.03	0.010	0.010	0.008	0.023	3	0.3	0.03	
2/12/09	**CC1**	65	16	2.5	0.6	3.4	32.0	0.1	5	6	7.10	0.53	0.10	0.06	0.001	0.001	0.010	0.010	0.04	0.010	0.010	0.016	0.016	2	0.1	0.04	
18/02/10	**CC1**	76	20	1.7	0.8	3.1	37.0	0.1	6	6	1.50	0.17	0.10	0.06	0.001	0.001	0.007	0.010	0.03	0.010	0.003	0.019	0.015	4	0.1	0.01	
5/05/10	**CC1**	73	22	1.6	0.9	2.8	40.0	0.1	6	5	1.10	0.02	0.08	0.01	0.001	0.001	0.010	0.010	0.04	0.010	0.010	0.012	0.017	1	0.3	0.01	
8/07/10	**CC1**	78	21	1.9	0.6	3.8	39.0	0.1	6	5	0.48	0.02	0.08	0.08	0.003	0.001	0.021	0.010	0.04	0.010	0.002	0.015	0.023	1	0.1	0.01	
6/09/10	**CC1**	118	15	2.0	1.0	3.0	21.0	0.1	12	1	0.35	0.14	0.11	0.11	0.002	0.001	0.006	0.002	0.18	0.001	0.001	0.010	0.015	1	0.1	0.01	
11/11/10	**CC1**	72	19	2	1.0	3	32	0.1	7	7	0.67	0.21	0.08	0.082	0.001	0.001	0.005	0.002	0.09	0.001	0.001	0.011	0.022	2	0.5	0.05	5.69
31/01/11	**CC1**	74	20	2	1.0	3	41	0.1	5	5	2.56	0.59	0.148	0.146	0.001	0.001	0.008	0.002	0.1	0.001	0.001	0.01	0.021	2	0.4	0.1	4.17
8/04/11	**CC1**	79	17	2	1.0	3	38	0.1	6	2	0.56	0.38	0.119	0.117	0.001	0.001	0.009	0.002	0.08	0.001	0.001	0.012	0.026	2	0.1	0.1	5.58
23/06/11	**CC1**	159	22	2	1.0	3	38	0.1	6	2	0.33	0.24	0.1	0.096	0.001	0.001	0.009	0.002	0.11	0.001	0.001	0.014	0.02	1	0.1	0.1	4.69
30/08/11	**CC1**	72	20	2	1.0	3	40	0.1	5	5	0.25	0.22	0.1	0.106	0.001	0.001	0.008	0.002	0.11	0.001	0.001	0.012	0.019	1	0.1	0.01	5.28
2/12/11	**CC1**	135	21	2	2.0	3	38	0.1	9	3	0.49	0.25	0.166	0.164	0.003	0.001	0.049	0.004	0.13	0.001	0.002	0.013	0.022	4	0.1	0.01	5.55
5/04/12	**CC1**	139	25	3	1.0	4	57	0.1	8	1	2.03	1.32	0.235	0.226	0.002	0.001	0.021	0.003	0.09	0.001	0.001	0.018	0.031	1	2	0.04	5.96
11/05/12	**CC1**	98	32	3	1	5	55	0.1	9	2	2.14	0.65	0.188	0.174	0.001	0.001	0.024	0.003	0.08	0.001	0.001	0.018	0.031	1	0.6	0.5	5.55

	ST Dev	29	4	2.4	0.4	0.8	8.3	0.0	2	8	2.98	0.34	0.06	0.06	0.001	0.000	0.026	0.004	0.04	0.005	0.003	0.008	0.014	1	0.5	0.11	0.59
	Max	159	32	13.0	2.0	6.0	57.0	0.2	12	38	13.00	1.32	0.24	0.23	0.004	0.001	0.120	0.010	0.18	0.010	0.010	0.040	0.070	4	2.0	0.50	5.96
	Min	58	13	1.6	0.1	2.8	21.0	0.1	4	1	0.25	0.02	0.01	0.01	0.001	0.001	0.005	0.002	0.03	0.001	0.001	0.008	0.015	1	0.1	0.01	4.17
	Median	77	20	2.1	1.0	3.3	38.0	0.1	6	5	1.77	0.19	0.10	0.09	0.001	0.001	0.009	0.010	0.06	0.010	0.001	0.013	0.022	2	0.1	0.04	5.55

ANZECC													1.90	1.90	0.001	0.003	0.008	0.011	0.055	0.024 (III) / 0.013(V)					0.3	0.02	
		TDS	Na	Ca	K	Mg	Cl	F	SO4	HCO3	Fe	Fe Filt	Mn	Filt Mn	Filt Cu	Filt Pb	Filt Zn	Filt Ni	Filt Al	Filt As	Filt Li	Filt Ba	Filt Sr	DOC	Tot N	Tot P	Si
28/08/08	**CC2**	80	14	6.7	1.2	5.0	22.0	0.1	16	25	0.85	0.05	0.01	0.01	0.001	0.001	0.004	0.010	0.01	0.010	0.001	0.010	0.060	2	0.1	0.01	
5/11/08	**CC2**	77	14	5.9	1.1	4.7	21.0	0.1	14	23	0.33	0.07	0.01	0.01	0.001	0.001	0.002	0.010	0.02	0.010	0.011	0.070	0.050	2	0.3	0.04	
9/01/09	**CC2**	72	13	5.9	0.4	4.6	20.0	0.1	13	25	49.00	0.02	0.51	0.01	0.001	0.001	0.008	0.010	0.01	0.010	0.013	0.070	0.080	3	1.9	0.27	
17/03/09	**CC2**	80	17	6.0	1.0	4.7	23.0	0.2	14	34	2.10	0.02	0.03	0.01	0.001	0.001	0.001	0.010	0.01	0.010	0.012	0.050	0.050	2	0.2	0.01	
14/05/09	**CC2**	94	19	6.6	1.0	5.6	23.0	0.1	19	32	0.55	0.04	0.05	0.01	0.001	0.001	0.001	0.010	0.01	0.010	0.015	0.040	0.040	2	0.2	0.01	
23/07/09	**CC2**	89	15	8.2	1.2	5.8	28.0	0.1	18	21	0.39	0.11	0.20	0.19	0.001	0.001	0.005	0.010	0.01	0.010	0.015	0.070	0.030	1	0.1	0.01	
2/10/10	**CC2**	75	16	5.6	0.9	4.9	22.0	0.1	14	27	0.86	0.04	0.04	0.02	0.001	0.001	0.001	0.010	0.02	0.010	0.013	0.055	0.047	1	0.1	0.01	
2/12/09	**CC2**	75	15	6.2	0.9	5.0	22.0	0.1	14	27	9.80	0.20	0.53	0.02	0.001	0.001	0.003	0.010	0.01	0.010	0.010	0.060	0.046	2	0.1	0.07	
18/02/10	**CC2**	69	15	2.9	0.7	3.5	26.0	0.1	10	12	5.30	0.08	0.21	0.13	0.001	0.001	0.010	0.010	0.01	0.010	0.002	0.040	0.031	6	0.2	0.01	
5/05/10	**CC2**	79	19	4.9	1.0	4.2	26.0	0.1	15	25	1.40	0.05	0.04	0.01	0.001	0.001	0.003	0.010	0.01	0.010	0.007	0.051	0.041	1	0.4	0.02	
8/07/10	**CC2**	77	15	5.4	0.9	5.2	24.0	0.1	14	28	3.70	0.18	0.04	0.01	0.001	0.001	0.002	0.010	0.01	0.010	0.010	0.049	0.037	1	0.1	0.02	
6/09/10	**CC2**	117	14	6.0	1.0	4.0	21.0	0.1	12	24	0.95	0.15	0.19	0.18	0.001	0.001	0.010	0.002	0.02	0.001	0.010	0.102	0.051	1	0.1	0.01	
10/11/10	**CC2**	65	12	4	1.0	4	25	0.1	13	16	1.62	0.43	0.27	0.274	0.001	0.001	0.015	0.004	0.01	0.001	0.008	0.092	0.041	1	0.1	0.11	7.27
31/01/11	**CC2**	79	14	6	1.0	4	27	0.1	14	21	0.94	0.23	0.187	0.185	0.004	0.001	0.033	0.004	0.01	0.001	0.012	0.102	0.049	4	0.2	0.05	7.36
8/04/11	**CC2**	72	12	5	1.0	4	23	0.1	12	12	1.73	0.6	0.318	0.308	0.001	0.001	0.01	0.004	0.01	0.001	0.009	0.096	0.039	1	0.1	0.16	7.44
23/06/11	**CC2**	153	16	6	1.0	4	36	0.1	12	11	2.02	0.75	0.324	0.298	0.001	0.001	0.011	0.005	0.01	0.001	0.009	0.102	0.04	1	0.2	0.01	6.87
30/08/11	**CC2**	81	14	6	1.0	4	23	0.1	13	11	0.54	0.52	0.265	0.262	0.001	0.001	0.006	0.004	0.01	0.001	0.01	0.099	0.042	1	0.1	0.01	8.33
2/12/11	**CC2**	107	13	3	1.0	3	22	0.1	13	8	1.77	0.73	0.274	0.269	0.001	0.001	0.028	0.006	0.05	0.001	0.008	0.07	0.028	2	0.1	0.01	6.57
5/04/12	**CC2**	98	12	4	1.0	4	21	0.1	16	4	3.14	1	0.437	0.411	0.001	0.001	0.012	0.005	0.01	0.001	0.009	0.102	0.038	1	0.8	0.05	7.81
11/05/12	**CC2**	60	14	5	1	4	19	0.1	13	15	3.36	0.8	0.396	0.382	0.001	0.001	0.008	0.004	0.01	0.001	0.011	0.104	0.04	1	2.4	2.65	7.02
	ST Dev	21.1	2.0	1.3	0.2	0.7	3.7	0.0	2.1	8.4	10.70	0.32	0.17	0.14	0.001	0.000	0.009	0.003	0.01	0.005	0.004	0.027	0.011	1.3	0.6	0.59	0.55
	Max	153.0	19.0	8.2	1.2	5.8	36.0	0.2	19.0	34.0	49.00	1.00	0.53	0.41	0.004	0.001	0.033	0.010	0.05	0.010	0.015	0.104	0.080	6.0	2.4	2.65	8.33
	Min	60.0	12.0	2.9	0.4	3.0	19.0	0.1	10.0	4.0	0.33	0.02	0.01	0.01	0.001	0.001	0.001	0.002	0.01	0.001	0.001	0.010	0.028	1.0	0.1	0.01	6.57
	Median	79.0	14.0	5.9	1.0	4.1	23.0	0.1	14.0	22.0	1.68	0.17	0.21	0.15	0.001	0.001	0.007	0.010	0.01	0.010	0.010	0.070	0.041	1.0	0.2	0.02	7.32

ANZECC													1.90	1.90	0.001	0.003	0.008	0.011	0.055	0.024 (III) / 0.013(V)					0.3	0.02	
		TDS	Na	Ca	K	Mg	Cl	F	SO4	HCO3	Fe	Fe Filt	Mn	Filt Mn	Filt Cu	Filt Pb	Filt Zn	Filt Ni	Filt Al	Filt As	Filt Li	Filt Ba	Filt Sr	DOC	Tot N	Tot P	Si
28/08/08	**CC3**	69	12	5.1	1.0	4.3	21.0	0.1	16	12	0.92	0.17	0.03	0.02	0.001	0.001	0.004	0.010	0.01	0.010	0.010	0.080	0.030	1	0.1	0.01	
5/11/08	**CC3**	70	12	4.5	0.9	4.2	21.0	0.1	14	13	0.34	0.20	0.03	0.01	0.001	0.001	0.002	0.010	0.04	0.010	0.007	0.060	0.040	2	0.2	0.12	
9/01/09	**CC3**	66	12	4.6	0.1	4.6	22.0	0.1	12	14	1.20	0.06	0.05	0.01	0.001	0.001	0.005	0.010	0.01	0.010	0.008	0.060	0.060	2	0.1	0.04	
17/03/09	**CC3**	73	14	4.8	0.8	4.2	24.0	0.1	14	18	0.87	0.11	0.02	0.01	0.001	0.001	0.001	0.010	0.02	0.010	0.008	0.040	0.040	2	0.1	0.01	
14/05/09	**CC3**	85	17	5.4	0.6	4.9	27.0	0.1	15	24	0.43	0.04	0.04	0.01	0.001	0.001	0.005	0.010	0.01	0.010	0.008	0.090	0.050	2	0.1	0.01	
23/07/09	**CC3**	78	15	5.3	1.0	4.8	27.0	0.1	14	14	0.69	0.09	0.02	0.01	0.001	0.001	0.006	0.010	0.01	0.010	0.011	0.060	0.060	1	0.1	0.01	
2/10/10	**CC3**	69	15	4.5	0.9	4.3	23.0	0.1	15	16	0.35	0.16	0.02	0.02	0.001	0.001	0.004	0.010	0.01	0.010	0.004	0.050	0.037	2	0.1	0.01	
2/12/09	**CC3**	66	14	4.9	0.9	4.3	22.0	0.1	13	17	0.98	0.36	0.14	0.01	0.001	0.001	0.004	0.010	0.02	0.010	0.002	0.051	0.037	2	0.1	0.01	
18/02/10	**CC3**	73	18	2.5	0.6	3.2	34.0	0.1	6	9	1.40	0.08	0.10	0.08	0.001	0.001	0.011	0.010	0.01	0.010	0.003	0.025	0.024	3	0.2	0.01	
5/05/10	**CC3**	72	16	4.1	0.8	3.7	27.0	0.1	14	15	0.51	0.07	0.01	0.01	0.001	0.001	0.004	0.010	0.01	0.010	0.004	0.040	0.032	1	0.1	0.01	
8/07/10	**CC3**	72	14	4.8	0.7	4.3	24.0	0.1	14	16	0.33	0.04	0.01	0.01	0.001	0.001	0.005	0.010	0.01	0.010	0.009	0.045	0.034	1	0.1	0.01	
6/09/10	**CC3**	107	15	3.0	1.0	3.0	26.0	0.1	5	11	0.75	0.42	0.07	0.07	0.001	0.001	0.005	0.001	0.19	0.001	0.001	0.023	0.027	1	0.2	0.01	
10/11/10	**CC3**	77	16	3	1.0	3	26	0.1	7	5	0.5	0.29	0.066	0.065	0.002	0.001	0.03	0.002	0.05	0.001	0.001	0.02	0.024	1	0.3	0.03	6.02
31/01/11	**CC3**	80	17	3	1.0	3	39	0.1	5	21	1	0.51	0.083	0.084	0.001	0.001	0.005	0.001	0.04	0.001	0.001	0.023	0.027	1	0.1	0.01	5.18
8/04/11	**CC3**	80	15	3	1.0	3	33	0.1	6	5	0.71	0.44	0.089	0.086	0.001	0.001	0.006	0.001	0.05	0.001	0.001	0.019	0.024	1	0.3	0.2	6.32
23/06/11	**CC3**	132	20	3	1.0	3	31	0.1	6	6	0.52	0.33	0.07	0.067	0.001	0.001	0.005	0.001	0.04	0.001	0.001	0.019	0.023	1	0.1	0.01	4.93
30/08/11	**CC3**	78	19	3	2.0	3	35	0.1	6	5	0.34	0.32	0.063	0.064	0.001	0.001	0.014	0.002	0.03	0.001	0.001	0.02	0.023	1	0.1	0.02	5.76
2/12/11	**CC3**	87	13	3	1.0	3	21	0.1	11	5	1.88	0.62	0.283	0.274	0.003	0.001	0.023	0.004	0.04	0.001	0.004	0.048	0.022	1	0.4	0.01	5.79
5/04/12	**CC3**	83	11	3	1.0	3	21	0.1	9	8	2.04	0.73	0.354	0.322	0.001	0.001	0.015	0.003	0.03	0.001	0.005	0.052	0.025	1	0.4	0.04	6.58
11/05/12	**CC3**	99	13	3	1	3	19	0.1	12	9	2.21	0.67	0.305	0.283	0.001	0.001	0.016	0.003	0.03	0.001	0.006	0.054	0.025	1	3.7	3.93	5.86

ST Dev	16.0	2.4	1.0	0.3	0.7	5.6	0.0	4.0	5.6	0.58	0.22	0.10	0.10	0.000	0.000	0.008	0.004	0.04	0.005	0.003	0.021	0.012	0.6	0.8	0.87	0.54
Max	132.0	20.0	5.4	2.0	4.9	39.0	0.1	16.0	24.0	2.21	0.73	0.35	0.32	0.003	0.001	0.030	0.010	0.19	0.010	0.011	0.090	0.060	3.0	3.7	3.93	6.58
Min	66.0	11.0	2.5	0.1	3.0	19.0	0.1	5.0	5.0	0.33	0.04	0.01	0.01	0.001	0.001	0.001	0.001	0.01	0.001	0.001	0.019	0.022	1.0	0.1	0.01	4.93
Median	77.5	15.0	3.6	1.0	3.5	25.0	0.1	12.0	12.5	0.73	0.25	0.06	0.04	0.001	0.001	0.005	0.010	0.03	0.010	0.004	0.047	0.029	1.0	0.1	0.01	5.83

ANZECC													1.90	1.90	0.001	0.003	0.008	0.011	0.055	0.024 (III) / 0.013(V)					0.3	0.02	
		TDS	Na	Ca	K	Mg	Cl	F	SO4	HCO3	Fe	Fe Filt	Mn	Filt Mn	Filt Cu	Filt Pb	Filt Zn	Filt Ni	Filt Al	Filt As	Filt Li	Filt Ba	Filt Sr	DOC	Tot N	Tot P	Si
28/08/08	**CC4**	75	17	3.8	1.0	4.0	32.0	0.1	8	9	0.52	0.12	0.01	0.01	0.001	0.001	0.001	0.010	0.03	0.010	0.006	0.060	0.030	1	0.1	0.01	
5/11/08	**CC4**	71	15	3.6	1.0	3.7	30.0	0.1	6	10	1.30	0.42	0.02	0.01	0.001	0.001	0.002	0.010	0.08	0.010	0.002	0.030	0.030	3	0.3	0.06	
9/01/09	**CC4**	66	15	4.1	0.2	3.6	30.0	0.1	4	14	6.70	0.39	0.17	0.02	0.002	0.001	0.011	0.010	0.01	0.010	0.001	0.040	0.050	3	0.1	0.06	
17/03/09	**CC4**	74	17	4.0	0.9	3.7	31.0	0.1	5	19	2.90	0.67	0.02	0.01	0.001	0.001	0.001	0.010	0.03	0.010	0.002	0.030	0.030	3	0.1	0.01	
14/05/09	**CC4**	72	16	3.8	0.7	4.1	29.0	0.1	7	15	1.10	0.11	0.03	0.01	0.001	0.001	0.001	0.010	0.02	0.010	0.002	0.020	0.020	3	0.2	0.01	
23/07/09	**CC4**	81	20	3.8	0.9	4.0	34.0	0.1	8	14	0.58	0.11	0.03	0.03	0.001	0.001	0.004	0.010	0.02	0.010	0.003	0.030	0.030	1	0.1	0.01	
2/10/10	**CC4**	72	18	4.3	1.0	4.1	31.0	0.1	5	19	1.60	0.19	0.06	0.04	0.001	0.001	0.002	0.010	0.03	0.010	0.002	0.034	0.033	3	0.2	0.01	
2/12/09	**CC4**	63	16	3.8	1.0	3.6	27.0	0.1	6	17	1.30	0.77	0.05	0.01	0.001	0.001	0.003	0.010	0.02	0.010	0.003	0.032	0.029	3	0.1	0.01	
18/02/10	**CC4**	70	15	3.2	0.5	3.5	28.0	0.1	9	12	1.80	0.12	0.20	0.19	0.001	0.001	0.012	0.010	0.02	0.010	0.002	0.036	0.026	3	0.1	0.01	
5/05/10	**CC4**	75	19	3.7	0.8	3.6	35.0	0.1	10	11	0.77	0.11	0.01	0.01	0.001	0.001	0.002	0.010	0.01	0.010	0.001	0.024	0.025	1	0.1	0.01	
8/07/10	**CC4**	70	18	3.6	0.7	3.8	33.0	0.1	7	14	0.67	0.14	0.01	0.01	0.001	0.001	0.014	0.010	0.02	0.010	0.005	0.042	0.034	1	0.1	0.01	
6/09/10	**CC4**	101	12	4.0	1.0	4.0	24.0	0.1	12	13	0.60	0.32	0.18	0.17	0.001	0.001	0.021	0.001	0.01	0.001	0.005	0.059	0.032	1	0.1	0.01	
10/11/10	**CC4**	70	12	4	1.0	3	25	0.1	11	11	0.75	0.38	0.23	0.238	0.001	0.001	0.022	0.004	0.02	0.001	0.005	0.054	0.029	1	0.1	0.04	5.38
31/01/11	**CC4**	67	13	4	1.0	3	30	0.1	13	9	0.83	0.26	0.201	0.195	0.001	0.001	0.017	0.003	0.01	0.001	0.006	0.057	0.031	1	0.6	0.01	6.21
8/04/11	**CC4**	41	12	4	1.0	3	24	0.1	10	8	1.11	0.58	0.328	0.315	0.001	0.001	0.016	0.004	0.03	0.001	0.004	0.053	0.026	2	0.2	0.05	7.79
23/06/11	**CC4**	130	15	4	1.0	3	22	0.1	10	7	1.05	0.53	0.268	0.241	0.001	0.001	0.017	0.004	0.02	0.001	0.005	0.057	0.027	1	0.1	0.02	5.79
30/08/11	**CC4**	65	14	4	1.0	3	24	0.1	11	7	0.4	0.38	0.205	0.199	0.001	0.001	0.017	0.003	0.02	0.001	0.006	0.055	0.027	1	0.1	0.01	6.9
2/12/11	**CC4**	111	18	3	1.0	3	29	<0.1	8	4	0.36	0.18	0.087	0.084	0.001	0.001	0.015	0.002	0.06	0.001	0.002	0.018	0.022	2	0.1	0.01	5.16
5/04/12	**CC4**	98	16	3	1.0	3	37	<0.1	6	5	0.73	0.42	0.096	0.093	0.001	0.001	0.009	0.002	0.04	0.001	0.001	0.021	0.026	1	0.1	0.03	5.69
11/05/12	**CC4**	109	19	3	1	3	33	0.1	7	5	0.54	0.38	0.088	0.088	0.001	0.001	0.006	0.002	0.03	0.001	0.001	0.022	0.025	1	0.7	0.7	5

ST Dev	20.6	2.4	0.4	0.2	0.4	4.1	0.0	2.5	4.5	1.41	0.20	0.10	0.10	0.000	0.000	0.007	0.004	0.02	0.005	0.002	0.015	0.006	1.0	0.2	0.15	0.95
Max	130.0	20.0	4.3	1.0	4.1	37.0	0.1	13.0	19.0	6.70	0.77	0.33	0.32	0.002	0.001	0.022	0.010	0.08	0.010	0.006	0.060	0.050	3.0	0.7	0.70	7.79
Min	41.0	12.0	3.0	0.2	3.0	22.0	0.1	4.0	4.0	0.36	0.11	0.01	0.01	0.001	0.001	0.001	0.001	0.01	0.001	0.001	0.018	0.020	1.0	0.1	0.01	5.00
Median	72.0	16.0	3.8	1.0	3.6	30.0	0.1	8.0	11.0	0.80	0.35	0.09	0.06	0.001	0.001	0.010	0.010	0.02	0.010	0.003	0.035	0.029	1.0	0.1	0.01	5.74

ANZECC													1.90	1.90	0.001	0.003	0.008	0.011	0.055	0.024 (III) / 0.013(V)					0.3	0.02	
		TDS	Na	Ca	K	Mg	Cl	F	SO4	HCO3	Fe	Fe Filt	Mn	Filt Mn	Filt Cu	Filt Pb	Filt Zn	Filt Ni	Filt Al	Filt As	Filt Li	Filt Ba	Filt Sr	DOC	Tot N	Tot P	Si
5/11/08	CC5	75	14	4.9	0.9	4.1	26.0	0.1	11	15	1.40	0.50	0.03	0.01	0.001	0.001	0.003	0.010	0.06	0.010	0.001	0.040	0.040	3	0.1	0.07	
9/01/09	CC5	70	13	5.5	0.1	4.0	23.0	0.1	11	19	2.30	0.05	0.12	0.01	0.002	0.001	0.004	0.010	0.02	0.010	0.006	0.050	0.060	2	0.1	0.04	
17/03/09	CC5	75	14	5.1	0.9	4.2	26.0	0.1	12	20	5.10	0.18	0.03	0.01	0.001	0.001	0.001	0.010	0.02	0.010	0.004	0.030	0.040	2	0.1	0.01	
14/05/09	CC5	74	16	5.4	0.6	5.0	26.0	0.1	11	21	0.73	0.11	0.03	0.02	0.001	0.001	0.004	0.010	0.01	0.010	0.009	0.040	0.040	2	0.2	0.01	
23/07/09	CC5	80	16	5.2	1.0	4.9	29.0	0.1	12	16	1.50	0.09	0.02	0.01	0.001	0.001	0.003	0.010	0.01	0.010	0.010	0.040	0.030	1	0.1	0.02	
2/10/10	CC5	82	16	4.9	0.8	4.4	29.0	0.1	14	19	0.62	0.17	0.03	0.02	0.001	0.001	0.003	0.010	0.01	0.010	0.006	0.042	0.034	2	0.1	0.01	
2/12/09	CC5	67	15	5.0	0.9	4.3	24.0	0.1	11	19	1.30	0.47	0.15	0.01	0.001	0.001	0.003	0.010	0.02	0.010	0.005	0.040	0.034	2	0.1	0.01	
18/02/10	CC5	70	15	3.8	0.5	3.5	28.0	0.1	9	13	2.70	0.09	0.84	0.19	0.001	0.001	0.010	0.010	0.02	0.010	0.001	0.035	0.025	2	0.4	0.01	
5/05/10	CC5	75	17	4.4	0.8	3.7	30.0	0.1	11	14	3.40	0.10	0.08	0.01	0.001	0.001	0.012	0.010	0.04	0.010	0.003	0.089	0.047	2	0.1	0.01	
8/07/10	CC5	75	16	4.4	0.7	4.3	27.0	0.1	13	17	8.30	0.06	0.10	0.01	0.001	0.001	0.002	0.010	0.02	0.010	0.009	0.032	0.027	1	0.1	0.04	
6/09/10	CC5	101	12	4.0	1.0	4.0	20.0	0.1	12	6	1.14	0.29	0.20	0.19	0.001	0.001	0.033	0.003	0.02	0.001	0.005	0.050	0.033	1	0.1	0.01	
10/11/10	CC5	89	14	4	1.0	3	22	0.1	13	1	0.92	0.51	0.202	0.209	0.001	0.001	0.033	0.003	0.02	0.001	0.004	0.044	0.03	2	0.1	0.13	7.24
31/01/11	CC5	66	15	4	1.0	3	34	0.1	9	24	1.65	0.53	0.212	0.194	0.001	0.001	0.014	0.002	0.02	0.001	0.004	0.044	0.031	1	0.3	0.08	6.18
8/04/11	CC5	43	13	4	1.0	3	25	0.1	9	8	1.19	0.57	0.274	0.272	0.001	0.001	0.024	0.003	0.03	0.001	0.003	0.044	0.024	2	0.2	0.01	7.59
23/06/11	CC5	148	19	4	1.0	3	27	0.1	8	7	1.06	0.48	0.169	0.137	0.001	0.001	0.009	0.002	0.03	0.001	0.002	0.031	0.027	1	0.2	0.02	5.51
30/08/11	CC5	80	18	4	1.0	3	35	0.1	6	6	0.46	0.44	0.081	0.08	0.001	0.001	0.008	0.002	0.02	0.001	0.001	0.022	0.025	1	0.1	0.01	5.79
2/12/11	CC5	111	17	4	1.0	3	25	0.1	10	5	0.75	0.4	0.146	0.137	0.002	0.001	0.039	0.003	0.06	0.001	0.002	0.025	0.022	3	0.1	0.03	5.17
5/04/12	CC5	88	16	3	1.0	3	37	0.1	5	3	0.82	0.4	0.107	0.1	0.001	0.001	0.006	0.002	0.03	0.001	0.001	0.021	0.029	1	0.4	0.05	5.74
11/05/12	CC5	99	19	4	2	3	32	0.1	8	8	0.58	0.39	0.107	0.104	0.001	0.001	0.006	0.002	0.03	0.001	0.002	0.023	0.026	1	0.3	0.13	5.12

ST Dev	21.7	2.0	0.7	0.4	0.7	4.5	0.0	2.4	6.9	1.93	0.19	0.18	0.09	0.000	0.000	0.012	0.004	0.01	0.005	0.003	0.015	0.009	0.7	0.1	0.04	0.92
Max	148.0	19.0	5.5	2.0	5.0	37.0	0.1	14.0	24.0	8.30	0.57	0.84	0.27	0.002	0.001	0.039	0.010	0.06	0.010	0.010	0.089	0.060	3.0	0.4	0.13	7.59
Min	43.0	12.0	3.0	0.1	3.0	20.0	0.1	5.0	1.0	0.46	0.05	0.02	0.01	0.001	0.001	0.001	0.002	0.01	0.001	0.001	0.021	0.022	1.0	0.1	0.01	5.12
Median	75.0	16.0	4.0	1.0	3.7	27.0	0.1	11.0	14.0	1.19	0.39	0.11	0.08	0.001	0.001	0.006	0.010	0.02	0.010	0.004	0.040	0.030	2.0	0.1	0.02	5.77

ANZECC													1.90	1.90	0.001	0.003	0.008	0.011	0.055	0.024 (III) / 0.013(V)					0.3	0.02	
		TDS	Na	Ca	K	Mg	Cl	F	SO4	HCO3	Fe	Fe Filt	Mn	Filt Mn	Filt Cu	Filt Pb	Filt Zn	Filt Ni	Filt Al	Filt As	Filt Li	Filt Ba	Filt Sr	DOC	Tot N	Tot P	Si
5/11/08	**CC9**	52	13	2.4	0.8	2.5	20.0	0.1	5	14	1.50	0.82	0.04	0.01	0.001	0.001	0.001	0.010	0.08	0.010	0.003	0.020	0.020	6	0.6	0.08	
9/01/09	**CC9**	68	12	6.7	0.1	4.1	22.0	0.1	9	25	1.80	0.28	0.02	0.01	0.001	0.001	0.003	0.010	0.01	0.010	0.005	0.060	0.110	2	0.1	0.06	
17/03/09	**CC9**	80	16	5.5	1.0	4.1	25.0	0.1	11	28	1.00	0.21	0.02	0.01	0.001	0.001	0.001	0.010	0.03	0.010	0.003	0.050	0.040	2	0.1	0.01	
14/05/09	**CC9**	81	17	5.7	0.7	4.7	27.0	0.1	12	21	0.49	0.03	0.02	0.01	0.001	0.001	0.001	0.010	0.01	0.010	0.009	0.030	0.030	2	0.1	0.01	
23/07/09	**CC9**	78	17	5.4	0.9	4.5	29.0	0.1	11	18	0.74	0.09	0.01	0.01	0.001	0.001	0.003	0.010	0.02	0.010	0.007	0.050	0.030	1	0.1	0.04	
2/10/10	**CC9**	69	15	5.0	0.9	4.3	23.0	0.1	13	22	0.42	0.12	0.01	0.01	0.001	0.001	0.001	0.010	0.01	0.010	0.008	0.056	0.040	2	0.1	0.01	
2/12/09	**CC9**	71	14	5.5	1.0	4.2	23.0	0.1	11	20	1.70	0.34	0.11	0.01	0.001	0.001	0.003	0.010	0.02	0.010	0.002	0.051	0.039	2	0.1	0.01	
18/02/10	**CC9**	72	16	3.9	0.6	3.4	29.0	0.1	8	15	1.90	0.24	0.30	0.11	0.001	0.001	0.009	0.010	0.03	0.010	0.001	0.043	0.028	3	0.4	0.01	
5/05/10	**CC9**	64	17	3.2	0.7	2.7	26.0	0.1	7	17	1.40	0.03	0.03	0.01	0.001	0.001	0.003	0.010	0.02	0.010	0.002	0.042	0.033	1	0.1	0.01	
8/07/10	**CC9**	70	15	4.5	0.7	4.0	25.0	0.1	11	19	0.83	0.05	0.02	0.01	0.001	0.001	0.001	0.001	0.01	0.010	0.007	0.041	0.033	1	0.1	0.01	
7/09/10	**CC9**	90	13	4.0	1.0	4.0	25.0	0.1	11	8	0.70	0.34	0.14	0.13	0.001	0.001	0.008	0.001	0.02	0.001	0.004	0.062	0.036	1	0.1	0.02	
11/11/10	**CC9**	62	14	4	1.0	3	23	0.1	13	1	0.66	0.23	0.148	0.002	0.004	0.014	0.029	0.001	0.03	0.001	0.144	0.001	0.051	1	1.2	0.11	4.81
31/01/11	**CC9**	96	14	4	1.0	3	32	0.1	8	26	1.04	0.3	0.133	0.125	0.001	0.001	0.005	0.001	0.01	0.001	0.005	0.056	0.035	2	0.4	0.11	6.02
8/04/11	**CC9**	53	13	4	1.0	3	24	0.1	8	8	1	0.4	0.239	0.222	0.001	0.001	0.009	0.002	0.03	0.001	0.003	0.048	0.025	2	0.3	0.02	8.04
23/06/11	**CC9**	100	18	4	1.0	3	25	0.1	8	9	0.92	0.83	0.208	0.19	0.002	0.001	0.01	0.002	0.07	0.001	0.003	0.052	0.028	1	0.1	0.02	5.52
30/08/11	**CC9**	66	15	4	1.0	3	26	0.1	9	14	0.37	0.36	0.158	0.163	0.001	0.001	0.008	0.002	0.02	0.001	0.003	0.053	0.029	1	0.1	0.01	6.49
2/12/11	**CC9**	91	15	4	1.0	3	20	0.1	10	8	0.62	0.29	0.171	0.167	0.001	0.001	0.018	0.002	0.04	0.001	0.004	0.041	0.025	2	0.1	0.01	5.75
5/04/12	**CC9**	51	10	1	1.0	1	16	0.1	3	2	2.45	0.69	0.417	0.067	0.001	0.001	0.008	0.001	0.11	0.001	0.001	0.009	0.01	5	1.2	0.07	2.13
11/05/12	**CC9**	96	15	4	1	3	20	0.1	10	9	1.16	0.29	0.212	0.192	0.001	0.001	0.012	0.002	0.02	0.001	0.004	0.051	0.028	1	0.1	0.01	5.64

	TDS	Na	Ca	K	Mg	Cl	F	SO4	HCO3	Fe	Fe Filt	Mn	Filt Mn	Filt Cu	Filt Pb	Filt Zn	Filt Ni	Filt Al	Filt As	Filt Li	Filt Ba	Filt Sr	DOC	Tot N	Tot P	Si
ST Dev	15.2	2.0	1.3	0.2	0.9	3.8	0.0	2.6	7.9	0.57	0.24	0.11	0.08	0.001	0.003	0.007	0.004	0.03	0.005	0.032	0.017	0.020	1.4	0.4	0.03	1.67
Max	100.0	18.0	6.7	1.0	4.7	32.0	0.1	13.0	28.0	2.45	0.83	0.42	0.22	0.004	0.014	0.029	0.010	0.11	0.010	0.144	0.062	0.110	6.0	1.2	0.11	8.04
Min	51.0	10.0	1.0	0.1	1.0	16.0	0.1	3.0	1.0	0.37	0.03	0.01	0.00	0.001	0.001	0.001	0.001	0.01	0.001	0.001	0.001	0.010	1.0	0.1	0.01	2.13
Median	71.0	15.0	4.0	1.0	3.0	25.0	0.1	10.0	15.0	1.00	0.29	0.13	0.01	0.001	0.001	0.005	0.002	0.02	0.010	0.004	0.050	0.030	2.0	0.1	0.01	5.70

ANZECC		TDS	Na	Ca	K	Mg	Cl	F	SO4	HCO3	Fe	Fe Filt	Mn	Filt Mn	Filt Cu	Filt Pb	Filt Zn	Filt Ni	Filt Al	Filt As	Filt Li	Filt Ba	Filt Sr	DOC	Tot N	Tot P	Si
ANZECC													1.90	1.90	0.001	0.003	0.008	0.011	0.055	0.024 (III) / 0.013(V)					0.3	0.02	
5/04/12	CT1	42	8	1	1.0	2	13	0.1	9	2	6.88	2.87	0.343	0.254	0.001	0.001	0.033	0.004	0.17	0.001	0.002	0.038	0.019	4	0.3	0.01	4.98
11/05/12	CT1	73	11	2	1	3	16	0.1	15	3	4.6	3.38	0.427	0.406	0.001	0.001	0.023	0.004	0.03	0.001	0.003	0.077	0.026	1	0.3	0.24	5.77

	TDS	Na	Ca	K	Mg	Cl	F	SO4	HCO3	Fe	Fe Filt	Mn	Filt Mn	Filt Cu	Filt Pb	Filt Zn	Filt Ni	Filt Al	Filt As	Filt Li	Filt Ba	Filt Sr	DOC	Tot N	Tot P	Si
ST Dev	21.9	2.1	0.7	0.0	0.7	2.1	0.0	4.2	0.7	1.61	0.36	0.059	0.107	0.000	0.000	0.007	0.000	0.10	0.000	0.001	0.028	0.005	2.1	0.0	0.16	0.56
Max	73.0	11.0	2.0	1.0	3.0	16.0	0.1	15.0	3.0	6.88	3.38	0.427	0.406	0.001	0.001	0.033	0.004	0.17	0.001	0.003	0.077	0.026	4.0	0.3	0.24	5.77
Min	42.0	8.0	1.0	1.0	2.0	13.0	0.1	9.0	2.0	4.60	2.87	0.343	0.254	0.001	0.001	0.023	0.004	0.03	0.001	0.002	0.038	0.019	1.0	0.3	0.01	4.98
Median	57.5	9.5	1.5	1.0	2.5	14.5	0.1	12.0	2.5	5.74	3.13	0.385	0.330	0.001	0.001	0.028	0.004	0.10	0.001	0.003	0.058	0.023	2.5	0.3	0.13	5.38

ANZECC		TDS	Na	Ca	K	Mg	Cl	F	SO4	HCO3	Fe	Fe Filt	Mn	Filt Mn	Filt Cu	Filt Pb	Filt Zn	Filt Ni	Filt Al	Filt As	Filt Li	Filt Ba	Filt Sr	DOC	Tot N	Tot P	Si
ANZECC													1.90	1.90	0.001	0.003	0.008	0.011	0.055	0.024 (III) / 0.013(V)					0.3	0.02	
28/08/08	CD1	52	12	1.8	0.8	2.1	21.0	0.1	6	7	0.42	0.31	0.02	0.02	0.004	0.001	0.009	0.010	0.05	0.010	0.001	0.010	0.030	5	0.3	0.01	
5/11/08	CD1	46	12	1.3	0.8	1.8	19.0	0.1	6	7	0.46	0.28	0.02	0.01	0.001	0.001	0.001	0.010	0.03	0.010	0.001	0.010	0.020	7	1.1	0.10	
9/01/09	CD1	44	11	1.9	0.4	2.3	20.0	0.1	3	5	0.79	0.07	0.03	0.02	0.001	0.001	0.007	0.010	0.03	0.010	0.001	0.090	0.070	5	0.8	0.04	
14/05/09	CD1	60	17	1.6	1.1	2.3	21.0	0.1	6	17	0.40	0.03	0.07	0.04	0.001	0.001	0.009	0.010	0.01	0.010	0.007	0.020	0.030	5	0.4	0.01	
23/07/09	CD1	78	21	3.3	0.9	2.5	25.0	0.1	7	30	0.20	0.07	0.06	0.04	0.001	0.001	0.020	0.010	0.03	0.010	0.001	0.020	0.050	3	0.1	0.01	
2/10/10	CD1	55	14	2.0	0.7	2.5	23.0	0.1	6	7	0.22	0.12	0.02	0.01	0.001	0.001	0.002	0.010	0.01	0.010	0.002	0.005	0.025	3	0.3	0.01	
2/12/09	CD1	63	14	3.7	1.2	3.0	24.0	0.1	6	17	2.50	0.92	0.17	0.01	0.001	0.001	0.002	0.010	0.01	0.010	0.001	0.041	0.029	4	0.3	0.01	
18/02/10	CD1	61	14	2.9	0.5	2.7	26.0	0.1	6	10	1.40	0.20	0.17	0.07	0.001	0.001	0.007	0.010	0.02	0.010	0.002	0.026	0.019	4	0.1	0.01	
5/05/10	CD1	65	15	2.5	0.6	2.8	27.0	0.1	6	12	0.57	0.03	0.02	0.07	0.001	0.001	0.004	0.010	0.02	0.010	0.001	0.020	0.020	2	0.2	0.01	
8/07/10	CD1	54	14	2.3	0.7	2.3	22.0	0.1	6	9	0.20	0.06	0.01	0.01	0.001	0.001	0.015	0.010	0.02	0.010	0.001	0.040	0.027	4	0.1	0.01	
6/09/10	CD1	86	13	2.0	1.0	2.0	21.0	0.1	5	4	0.64	0.22	0.05	0.04	0.001	0.001	0.005	0.001	0.03	0.001	0.001	0.020	0.019	4	0.4	0.01	
11/11/10	CD1	70	12	2	1.0	2	24	0.1	7	4	0.26	0.18	0.055	0.001	0.001	0.079	0.014	0.001	0.06	0.001	0.057	0.005	0.014	7	0.8	0.05	0.94
31/01/11	CD1	44	13	1	1.0	2	26	0.1	5	12	0.37	0.13	0.039	0.027	0.001	0.001	0.007	0.002	0.02	0.001	0.001	0.009	0.014	5	0.3	0.02	1.08
8/04/11	CD1	58	11	2	1.0	2	21	0.1	10	1.0	0.8	0.29	0.105	0.092	0.001	0.001	0.007	0.001	0.04	0.001	0.001	0.01	0.012	6	3.7	0.21	1.97
23/06/11	CD1	99	15	2	1.0	2	22	0.1	4	3	0.51	0.17	0.05	0.033	0.001	0.001	0.005	0.001	0.08	0.001	0.001	0.013	0.012	4	0.3	0.06	2.6
30/08/11	CD1	35	12	1	1.0	2	16	0.1	4	2	0.22	0.21	0.039	0.038	0.001	0.001	0.005	0.001	0.08	0.001	0.001	0.01	0.011	4	0.1	0.01	1.54
2/12/11	CD1	66	12	1	1.0	2	20	0.1	5	2	0.67	0.3	0.066	0.055	0.002	0.001	0.022	0.001	0.07	0.001	0.001	0.009	0.011	5	1.2	0.05	1.37
5/04/12	CD1	42	9	1	1.0	1	16	0.1	3	2	0.7	0.33	0.074	0.058	0.002	0.001	0.023	0.001	0.12	0.001	0.001	0.008	0.01	5	3.2	0.04	1.98
11/05/12	CD1		11	1	1	2	17	0.1	4	8	0.67	0.36	0.077	0.068	0.001	0.001	0.006	0.001	0.14	0.001	0.001	0.008	0.01	5	0.9	0.54	1.98

	TDS	Na	Ca	K	Mg	Cl	F	SO4	HCO3	Fe	Fe Filt	Mn	Filt Mn	Filt Cu	Filt Pb	Filt Zn	Filt Ni	Filt Al	Filt As	Filt Li	Filt Ba	Filt Sr	DOC	Tot N	Tot P	Si
ST Dev	16.2	2.6	0.8	0.2	0.4	3.3	0.0	1.6	7.1	0.54	0.20	0.05	0.03	0.001	0.018	0.007	0.005	0.04	0.005	0.013	0.020	0.015	1.3	1.0	0.13	0.55
Max	99	21	3.7	1.2	3.0	27.0	0.1	10	30	2.50	0.92	0.17	0.09	0.004	0.079	0.023	0.010	0.14	0.010	0.057	0.090	0.070	7	3.7	0.54	2.60
Min	35	9	1.0	0.4	1.0	16.0	0.1	3	1	0.20	0.03	0.01	0.00	0.001	0.001	0.001	0.001	0.01	0.001	0.001	0.005	0.010	2	0.1	0.01	0.94
Median	59	13	2.0	1.0	2.0	21.0	0.1	6	7	0.51	0.20	0.05	0.04	0.001	0.001	0.007	0.010	0.03	0.010	0.001	0.010	0.019	5	0.3	0.01	1.76

ANZECC													**1.90**	**1.90**	**0.001**	**0.003**	**0.008**	**0.011**	**0.06**	**0.024 (III) / 0.013(V)**					**0.3**	**0.02**	
		TDS	**Na**	**Ca**	**K**	**Mg**	**Cl**	**F**	**SO4**	**HCO3**	**Fe**	**Fe Filt**	**Mn**	**Filt Mn**	**Filt Cu**	**Filt Pb**	**Filt Zn**	**Filt Ni**	**Filt Al**	**Filt As**	**Filt Li**	**Filt Ba**	**Filt Sr**	**DOC**	**Tot N**	**Tot P**	**Si**
12/04/12	**CR1**	42	7	1	1	1	12	0.1	2	1	1.7	1.4	0.039	0.036	0.001	0.001	0.011	0.002	0.54	0.002	0.001	0.003	0.004	6	0.2	0.06	3.39
14/05/12	**CR1**	40	9	1	1	1	14	0.1	4	3	1.82	1.55	0.055	0.045	0.001	0.001	0.01	0.002	0.46	0.002	0.001	0.003	0.005	5	1.2	1.32	2.96
13/04/12	**CR2**	85	15	4	1	3	23	0.1	6	10	1	0.51	0.116	0.115	0.001	0.001	0.008	0.001	0.07	0.001	0.002	0.042	0.028	2	0.7	0.04	5.77
14/05/12	**CR2**	74	14	3	1	2	21	0.1	6	8	1.1	0.47	0.133	0.114	0.001	0.001	0.009	0.001	0.07	0.001	0.002	0.046	0.03	2	0.7	0.52	4.86
13/04/12	**CR3**	79	13	3	1	2	20	0.1	5	9	1.11	0.36	0.151	0.143	0.001	0.001	0.008	0.002	0.06	0.001	0.002	0.046	0.032	1	0.6	0.02	5.61
8/05/12	**CR3**	99	14	4	1	3	22	0.1	6	8	0.93	0.26	0.115	0.096	0.001	0.001	0.128	0.001	0.06	0.001	0.002	0.036	0.026	1	0.2	0.03	4.95
17/04/12	**CR4**	49	10	1	1	1	17	0.1	4	8	1.78	0.72	0.107	0.086	0.002	0.001	0.388	0.001	0.1	0.001	0.001	0.01	0.012	6	0.4	0.07	2.04

Appendix C - Trigger Action Response Plan

Longwall 5 – Groundwater, Swamp and Stream Trigger Action Response Plan

Feature	MONITORING			MANAGEMENT	
	Prior to Mining	During Mining	Post Mining	Trigger	Action
Swamp Discharge **Downstream of Ccus2, 3, 4, 5, 6** **Crus1** **Bcus4**	Minimum continuous 6 hourly pool water level recording using automatic logger, where logistically suitable locations are present, with levels converted to flow by calculation of ratings curves using measured cross sections at the swamp discharge monitoring point Bi-Monthly logger download and manual measurement of pool depth at reference point	Minimum continuous 6 hourly pool water level recording using automatic logger, where logistically suitable locations are present, with levels converted to flow by calculation of ratings curves using measured cross sections at the swamp discharge monitoring point Weekly logger download during swamp undermining, with manual measurement of pool depth at reference point then monthly until completion of Longwall	Minimum continuous 6 hourly pool water level recording using automatic logger for an agreed period (minimum 1 year) after the swamp is undermined, where logistically suitable locations are present, with levels converted to flow by calculation of ratings curves using measured cross sections at the swamp discharge monitoring point Bi-Monthly logger download and manual measurement of pool depth for an agreed period (minimum 1 year) after the swamp is undermined and the longwall has passed over 200m from the nearest swamp edge	**NORMAL** No observable mining induced change **WITHIN PREDICTION** Fracturing of bedrock in ephemeral drainage lines that are directly undermined >3 mth lowering of pool water levels or swamp seepage discharge reduction greater than baseline variability **EXCEEDS PREDICTIONS** Fracturing of bedrock in ephemeral drainage lines that are not directly undermined Redirection of surface flows with <3 month reduction of pool levels or swamp discharge	Continue monitoring program, discuss in end of panel report or AEMR as required. Continue monitoring program, discuss in end of panel report or AEMR as required. Immediately inform DRE Director Environmental Sustainability and Land Use, Principal Subsidence Engineer and SCA, DoPI & OEH Instigate investigation within 1 week of trigger exceedance being noted Engage specialist to investigate and report on the cause of trigger exceedances where the cause may not be directly related to lack of rainfall recharge Investigation of possible mitigation measures in consultation with SCA / NOW Prepare and implement a site mitigation/action plan in consultation with SCA / NOW if necessary Report on mitigation as soon as practicable. Report in Annual Review
Swamp	Bi-Monthly field water quality analysis (EC,	Weekly field water quality analysis (EC,	Bi-Monthly field water quality analysis (EC,	**NORMAL**	

NOTE: the TARP triggers and management actions have been determined to achieve the performance outcomes outlined in the accompanying water management plan text

Feature	MONITORING			MANAGEMENT	
	Prior to Mining	During Mining	Post Mining	Trigger	Action
Groundwater quality **Piezometers** **PCc2, 3, 4, 5A, 5B, 6** **SP1, 2** **PCr1** **PBc4**	pH, temp, DO & ORP) Laboratory analysis – every four months TDS, Na, K, Ca, Mg, F, Cl, SO4, HCO3, NO3, Total N, Total P, Cu, Pb, Zn, Ni, Fe, Mn, As, Se, Cd, (filtered)	pH, temp, DO & ORP) whilst swamp is being undermined then monthly until completion of longwall Laboratory analysis – every month whilst swamp is being undermined for TDS, Na, K, Ca, Mg, F, Cl, SO4, HCO3, NO3, Total N, Total P, Cu, Pb, Zn, Ni, Fe, Mn, As, Se, Cd, (filtered)	pH, temp, DO & ORP) after swamp is undermined for an agreed period (minimum 1 year) Laboratory analysis – every four months for an agreed period (minimum 1 year) after mining is completed in LW5	No observable mining induced change **WITHIN PREDICTION** Short term increase in salinity or reduction in pH outside of variability observed in similar swamps, with the effect not persisting after a > 2 year ARI rainfall event **EXCEEDS PREDICTIONS** Increase in salinity or reduction in pH outside of variability observed in similar swamps, with the effect persisting after a > 2 year ARI rainfall event	Continue monitoring program, discuss in end of panel report or AEMR as required. Continue monitoring program, discuss in end of panel report or AEMR as required. Immediately inform DRE Director Environmental Sustainability and Land Use, Principal Subsidence Engineer , SCA, DoPI & OEH Notify technical specialists immediately Site visit with stakeholders within 1 mth Record photographically immediately Review monitoring program within 2 weeks and review accordingly Inform SCA, DoP, OEH & DRE of investigation results Prepare and implement a site mitigation/action plan within 1 month (pending stakeholder availability) and seek approvals from key agencies if required Complete works asap Additional post works monitoring and reporting within 1 mth as required Discuss in EoP or AEMR reports as required
Basement Groundwater quality **Open Standpipe**	Bi- Monthly field water quality analysis (EC, pH) Laboratory analysis every twelve months	Monthly field water quality analysis (EC, pH) whilst bore is being actively undermined Laboratory analysis	Bi-Monthly Field water quality analysis (EC, pH) until Wonga East Area 2 mining is completed, and then as required based on	**NORMAL** No observable mining induced change **WITHIN PREDICTION**	Continue monitoring program, discuss in end of panel report or AEMR as required. Continue monitoring program, discuss in end of panel

NOTE: the TARP triggers and management actions have been determined to achieve the performance outcomes outlined in the accompanying water management plan text

Feature	MONITORING			MANAGEMENT	
	Prior to Mining	During Mining	Post Mining	Trigger	Action
Piezometers **NRE A, C, D** **GW1A**	TDS, Na, K, Ca, Mg, F, Cl, SO4, HCO3, NO3, Total N, Total P, Cu, Pb, Zn, Ni, Fe, Mn, As, Se, Cd, (filtered)	every six months for TDS, Na, K, Ca, Mg, F, Cl, SO4, HCO3, NO3, Total N, Total P, Cu, Pb, Zn, Ni, Fe, Mn, As, Se, Cd, (filtered)	WMP modification Laboratory analysis every twelve months TDS, Na, K, Ca, Mg, F, Cl, SO4, HCO3, NO3, Total N, Total P, Cu, Pb, Zn, Ni, Fe, Mn, As, Se, Cd, (filtered	Short term increase in salinity or reduction in pH outside of baseline variability, with the effect not persisting after a significant rainfall recharge event **EXCEEDS PREDICTIONS** Increase in salinity or reduction in pH outside of baseline variability, with the effect persisting after a significant rainfall recharge event	report or AEMR as required. Immediately inform DRE Director Environmental Sustainability and Land Use, Principal Subsidence Engineer Discuss requirement, need and potential cost / benefit of a mitigation / action plan with stakeholders
Swamp Groundwater Levels **Piezometers** **PCc2, 3, 4, 5A, 5B, 6** **SP1, 2** **PCr1** **PBc4**	Minimum continuous 12 hourly water level recording using automatic logger Bi- monthly logger download and dip meter	Minimum continuous 6 hourly water level recording using automatic logger Weekly download and dip meter while swamp is being actively undermined then monthly download and dip meter until completion of longwall	Minimum continuous 12 hourly water level recording using automatic logger for an agreed period (minimum 1 year) after the swamp is undermined Bi- monthly logger download and dip meter for an agreed period (minimum 1 year) after the swamp is undermined	**NORMAL** No observable mining induced change **WITHIN PREDICTION** Short term water level reduction greater than variability observed in similar swamps and effect not persisting after a > 2 year ARI rainfall event **EXCEEDS PREDICTIONS** Piezometer becomes, or stays, dry where it has not done so previously	Continue monitoring program, discuss in end of panel report or AEMR as required. Continue monitoring program, discuss in end of panel report or AEMR as required. Immediately inform DRE Director Environmental Sustainability and Land Use, Principal Subsidence Engineer Instigate investigation within 1 week of trigger exceedance being noted Engage hydrogeologist to investigate and report on the cause of trigger exceedances where the cause may not be directly related to lack of rainfall recharge Inform SCA, DoPI, OEH & DRE of investigation outcomes

NOTE: the TARP triggers and management actions have been determined to achieve the performance outcomes outlined in the accompanying water management plan text

Feature	MONITORING			MANAGEMENT	
	Prior to Mining	During Mining	Post Mining	Trigger	Action
					Investigation of possible mitigation measures in consultation with SCA / NOW Prepare and implement a site mitigation/action plan in consultation with SCA / NOW if necessary Report on mitigation as soon as practicable. Report in Annual Review
Hawkesbury Sandstone Groundwater Levels piezometers NRE A, C, D **GW1A**	Minimum continuous 12 hourly water level recording using automatic logger Bi- monthly logger download and dip meter	Minimum continuous 12 hourly water level recording using automatic logger Monthly logger download and dip meter whilst bore is being actively undermined	Minimum continuous 12 hourly water level recording using automatic logger for a period agreed between the mine operator and the relevant regulators (minimum 1 year) after the bore is undermined Bi- monthly logger download and dip meter for an agreed period (minimum 1 year) after the swamp is undermined	**NORMAL** No observable mining induced change **WITHIN PREDICTION** up to 10m water level reduction for < 2 months **EXCEEDS PREDICTIONS** **>**10m water level reduction for > 2 months	Continue monitoring program, discuss in end of panel report or AEMR as required. Continue monitoring program, discuss in end of panel report or AEMR as required. Immediately inform DRE Director Environmental Sustainability and Land Use, Principal Subsidence Engineer Discuss requirement, need and potential cost / benefit of a mitigation / action plan with stakeholders
Hawkesbury Sandstone Groundwater Pressures **VWPs** **NRE A, B, D, GW1**	Minimum continuous 12 hourly water level recording using automatic logger Bi- monthly logger download and dip meter	Minimum continuous 12 hourly water level recording using automatic logger Monthly logger download whilst bore is being actively undermined	Minimum continuous 12 hourly water level recording using automatic logger for a period agreed between the mine operator and the relevant regulators (minimum 1 year) after the bore is undermined Bi- monthly logger download and dip	**NORMAL** No observable mining induced change **WITHIN PREDICTION** up to 10m water pressure reduction for < 2 months **EXCEEDS PREDICTIONS** **>**10m water pressure reduction for	Continue monitoring program, discuss in end of panel report or AEMR as required. Continue monitoring program, discuss in end of panel report or AEMR as required. Immediately inform DRE Director Environmental Sustainability and Land Use, Principal Subsidence

NOTE: the TARP triggers and management actions have been determined to achieve the performance outcomes outlined in the accompanying water management plan text

Feature	MONITORING			MANAGEMENT	
	Prior to Mining	During Mining	Post Mining	Trigger	Action
			meter for an agreed period (minimum 1 year) after the bore is undermined	> 2 months	Engineer D iscuss requirement, need and potential cost / benefit of a mitigation / action plan with stakeholders
Inflow into mine or hydraulic connectivity between a 3rd order or higher stream and the workings	Daily volumetric flow monitoring of mine inflow and discharge Water quality analysis of any anomalous inflow event.	Daily volumetric flow monitoring of mine inflow and discharge Water quality analysis of any anomalous inflow event , with the method and parameters to be defined depending on what is being investigated, (i.e. major / minor elements, isotopes, algae etc)	Daily volumetric monitoring of mine inflow and discharge Water quality analysis of any anomalous inflow event with the method and parameters to be defined depending on what is being investigated, (i.e. major / minor elements, isotopes, algae etc)	**NORMAL** No observable mining induced change **WITHIN PREDICTIONS** Mine pump out volume within historic monitored range **EXCEEDS PREDICTIONS** Increase in water discharge of >1ML/day for 7 successive days from active mining areas which are suspected to be as a result of mine subsidence and excluding elevated inflows due to high rain events over the entire Wonga East workings	Continue monitoring program, discuss in end of panel report or AEMR as required. Continue monitoring program, discuss in end of panel report or AEMR as required. Immediately inform DRE Director Environmental Sustainability and Land Use, Principal Subsidence Engineer Instigate investigation within 1 week of trigger exceedance being noted Engage hydrogeologist to investigate and report on the cause of trigger exceedances where the cause may not be directly related to an anomalous increase in rainfall recharge Inform SCA, DoPI, OEH & DRE of investigation outcomes discuss requirement, need and potential cost / benefit of a mitigation / action plan with stakeholders If required, prepare and implement a site mitigation/action plan in consultation with SCA / NOW if necessary Report on mitigation as soon as practicable. Report in Annual Review
Stream Water	Monthly field water	Weekly field water	Bi-Monthly field water	**NORMAL**	Continue monitoring program, discuss in end of panel

NOTE: the TARP triggers and management actions have been determined to achieve the performance outcomes outlined in the accompanying water management plan text

Feature	MONITORING			MANAGEMENT	
	Prior to Mining	During Mining	Post Mining	Trigger	Action
Quality **Sites** **CD1, CC1 – CC9 & CT1**	quality analysis (EC, pH, DO, ORP, temp) Monthly Lab Analysis TDS, TSS,Na, K, Ca, Mg, F, Cl, SO4, HCO3, NO3, Total N, Total P, Cu, Pb, Zn, Ni, Fe, Mn, As, Li, Ba, (total/filtered) DOC, Tot. Alkalinity Monthly photo point recording for observable iron hydroxide staining	quality analysis while mining within 100m of any 3rd order stream or higher in a relevant actively undermined stream reach Monthly Lab analysis while mining within 100m of 3rd order stream or higher in a relevant actively undermined stream reach Weekly photo point recording for observable iron hydroxide staining while mining within 100m of 3rd order stream or higher in a relevant actively undermined stream reach	quality analysis for agreed period (minimum 1 yr) Bi-Monthly Lab analysis for agreed period (minimum 1 yr) Bi Monthly photo point recording for observable iron hydroxide staining for agreed period (minimum 1 yr) after mining is completed in LW5	No observable mining induced change	report or AEMR as required.
				WITHIN PREDICTIONS (effect <2 mths) within baseline variability or water quality reduction over minimum 2 month period , i.e. EC > 200uS/cm pH < 4.5 Fe (Tot) > 10mg/L Mn (tot) > 0.8mg/L Al (tot) > 0.2mg/L Zn (filt) > 0.12mg/L SO4 (filt) > 20mg/L Increase in stream Fe hydroxide precipitation compared to baseline	Continue monitoring program, review monitoring frequency, discuss in end of panel report or AEMR as required.
				EXCEEDS PREDICTIONS Significant reduction compared to baseline and predicted impacts over >2mths, i.e. EC > 250uS/cm pH < 4.0 Fe (Tot) > 15mg/L Mn (tot) > 1.0mg/L Al (tot) > 0.4mg/L Zn (filt) > 0.2mg/L SO4 (filt) > 25mg/L > 2 STD deviation reduction in water quality at downstream monitoring site compared to baseline and / or significant observable increase in FeOOH precipitate compared to baseline visual observations	Immediately inform DRE Director Environmental Sustainability and Land Use, Principal Subsidence Engineer Notify technical specialists immediately Site visit with stakeholders within 1 mth Record photographically immediately Collect laboratory samples within 2 weeks and analyse for standard analytes Review sampling program within 1 mth and review accordingly Inform SCA, DoP, OEH & DRE of investigation Prepare and implement a site mitigation/action plan within 1 month (pending stakeholder availability) and seek approvals from key agencies if required Complete works asap and additional post works monitoring / reporting within 1 mth as required

NOTE: the TARP triggers and management actions have been determined to achieve the performance outcomes outlined in the accompanying water management plan text

Feature	MONITORING			MANAGEMENT	
	Prior to Mining	During Mining	Post Mining	Trigger	Action
					Discuss in EoP or AEMR reports as required
Stream Flow / Water Level **Sites** **CD1, CC3,4,6,7,8,9** **CT1**	Minimum continuous 6 hourly water level recording using automatic logger with bi- monthly download Minimum continuous 2 hourly with monthly download when longwall is < 500m from monitoring site	Minimum continuous hourly water level recording using automatic logger with weekly download while mining within 100m of a 3rd order stream or higher in a relevant actively undermined stream reach	Minimum continuous 6 hourly water level recording using automatic logger with bi- monthly download for agreed period (minimum 1 yr) after mining is completed in LW5	**NORMAL** No observable mining induced change **WITHIN PREDICTIONS (< 2mths)** **-** within baseline variability or temporary reduction over < 2mth period for pool levels and stream flow, considering rainfall / runoff variability. **WITHIN PREDICTIONS (>2 mths)** fracturing of bedrock in directly undermined channels pool level / flow decline <20% during mining compared to baseline for > 2 mths **EXCEEDS PREDICTIONS** fracturing of bedrock in stream reach not directly undermined re-direction of surface water flows and pool level / flow decline >20% during mining compared to baseline for > 2mths, considering rainfall / runoff variability	Continue monitoring program, discuss in end of panel report or AEMR as required. Continue monitoring program, discuss in end of panel report or AEMR as required. Continue monitoring program, review monitoring frequency, discuss in end of panel report or AEMR as required. Immediately inform DRE Director Environmental Sustainability and Land Use, Principal Subsidence Engineer Inform SCA, DoPI & OEH Notify technical specialists immediately Site visit with stakeholders within 1 mth Record photographically immediately Review monitoring program within 2 weeks and review accordingly Inform SCA, DoP, OEH & DRE of investigation results Prepare and implement a site mitigation/action plan within 1 month (pending stakeholder availability) and seek approvals from key agencies if required Complete works asap

NOTE: the TARP triggers and management actions have been determined to achieve the performance outcomes outlined in the accompanying water management plan text

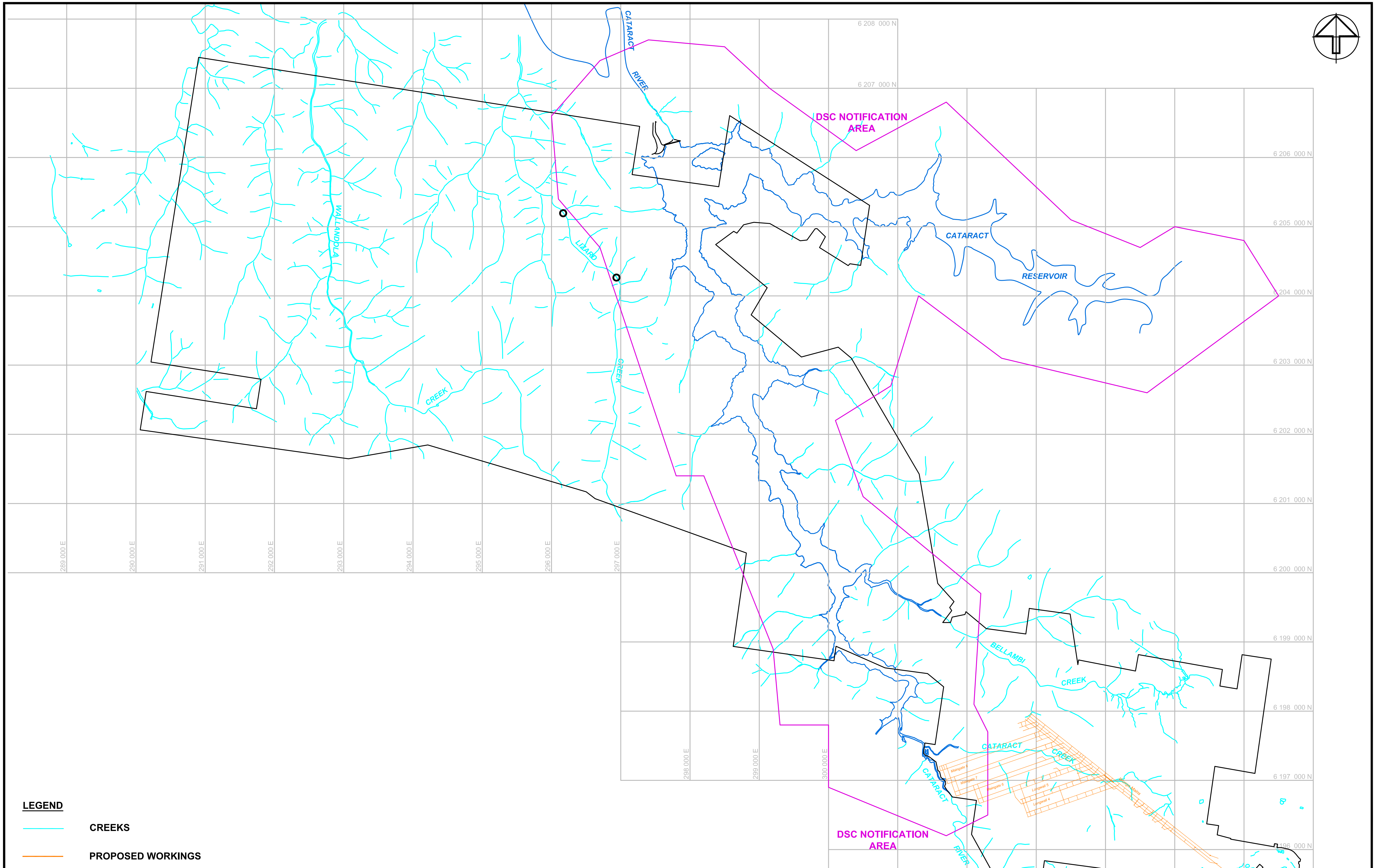
Feature	MONITORING			MANAGEMENT	
	Prior to Mining	During Mining	Post Mining	Trigger	Action
					Additional post works monitoring and reporting within 1 month as required Discuss in EoP or AEMR reports as required
General Stream sites CD1, CC1 – CC9, CT1	Monthly observations for at least two months prior to mining using photo points	Weekly observations while mining within 100 m of 3rd order stream or higher using photo points in a relevant actively undermined stream reach	Bi – Monthly observations for an agreed period (minimum 1 yr) after mining is completed in LW5 using photo points	**NORMAL** No observable mining induced change	Continue monitoring program, discuss in end of panel report or AEMR as required.
				WITHIN PREDICTIONS No observable change to stream bed or bank; erosion turbidity iron staining algal growth vegetation compared to baseline conditions	Continue monitoring program, discuss in end of panel report or AEMR as required.
				EXCEEDS PREDICTIONS Observable increase in stream bed or bank; erosion turbidity iron staining algal growth vegetation compared to pre mining conditions	Immediately inform DRE Director Environmental Sustainability and Land Use, Principal Subsidence Engineer Inform SCA, DoPI & OEH Notify technical specialists immediately Site visit with stakeholders within 1 mth Record photographically immediately Review monitoring program within 2 weeks and review accordingly Inform SCA, DoP, OEH & DRE of investigation results Prepare and implement a site mitigation/action plan within 1 month (pending stakeholder availability) and seek approvals from key agencies if required Complete works asap Additional post works monitoring and reporting within 1

NOTE: the TARP triggers and management actions have been determined to achieve the performance outcomes outlined in the accompanying water management plan text

Feature	MONITORING			MANAGEMENT	
	Prior to Mining	During Mining	Post Mining	Trigger	Action
					month as required Discuss in EoP or AEMR reports as required
Rainfall **Sites – Bellambi BoM / Wonga East / Cordeaux / No. 4 Shaft**	Continuous daily rainfall monitoring	Continuous daily rainfall monitoring	Continuous daily rainfall monitoring	n/a	n/a

NOTE: the TARP triggers and management actions have been determined to achieve the performance outcomes outlined in the accompanying water management plan text

Drawings



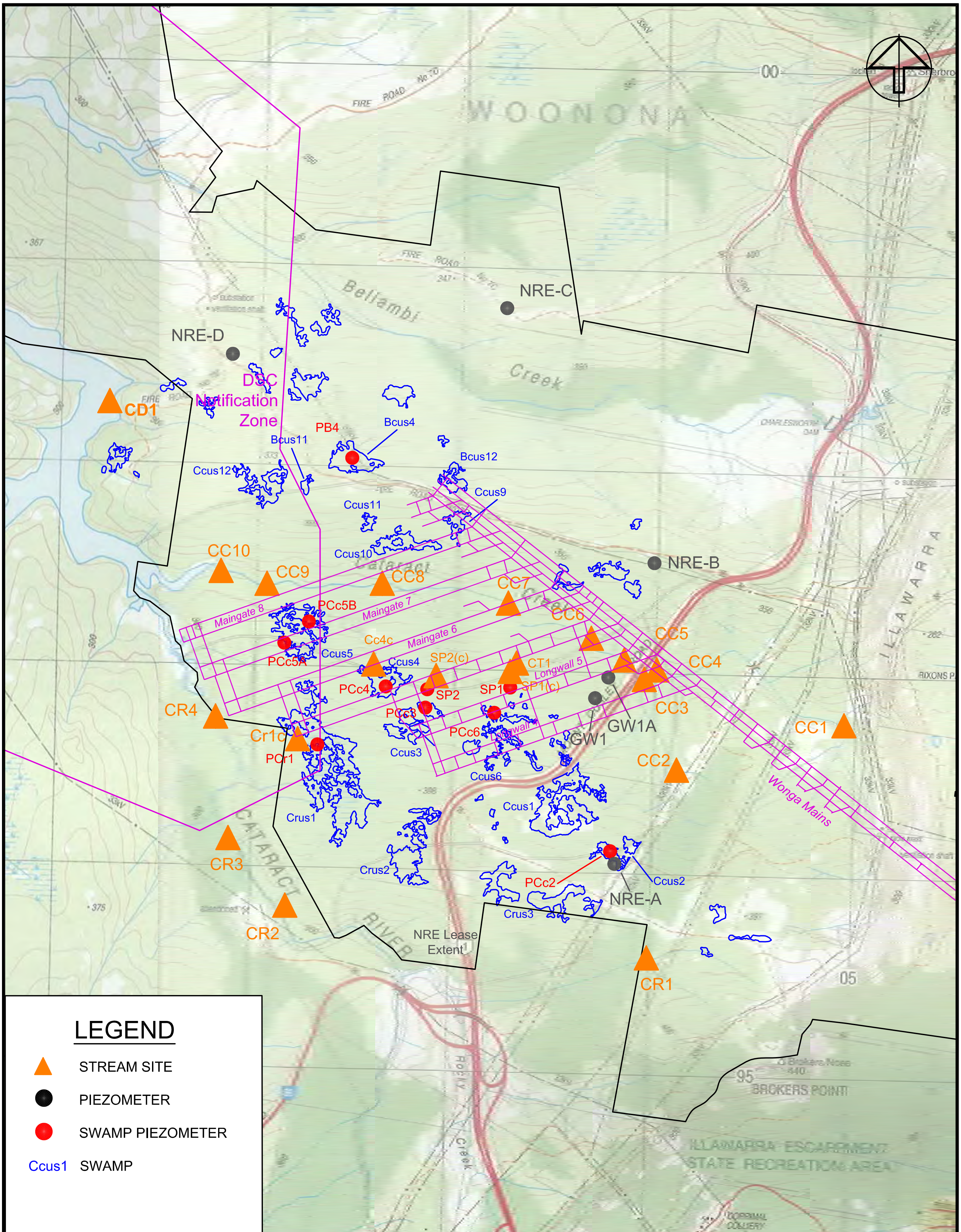
PROJECT:	NRE4-R1
DRAWN:	A. DAWKINS
DATE:	15 NOV 2012
SCALE:	1:5 000

GUJARAT NRE COKING COAL LTD
NRE No.1 COLLIERY

PROPOSED WONGA EAST WORKINGS

GeoTerra

DRAWING 1



LEGEND

- ▲ STREAM SITE
- ● PIEZOMETER
- ● SWAMP PIEZOMETER
- Ccus1 SWAMP

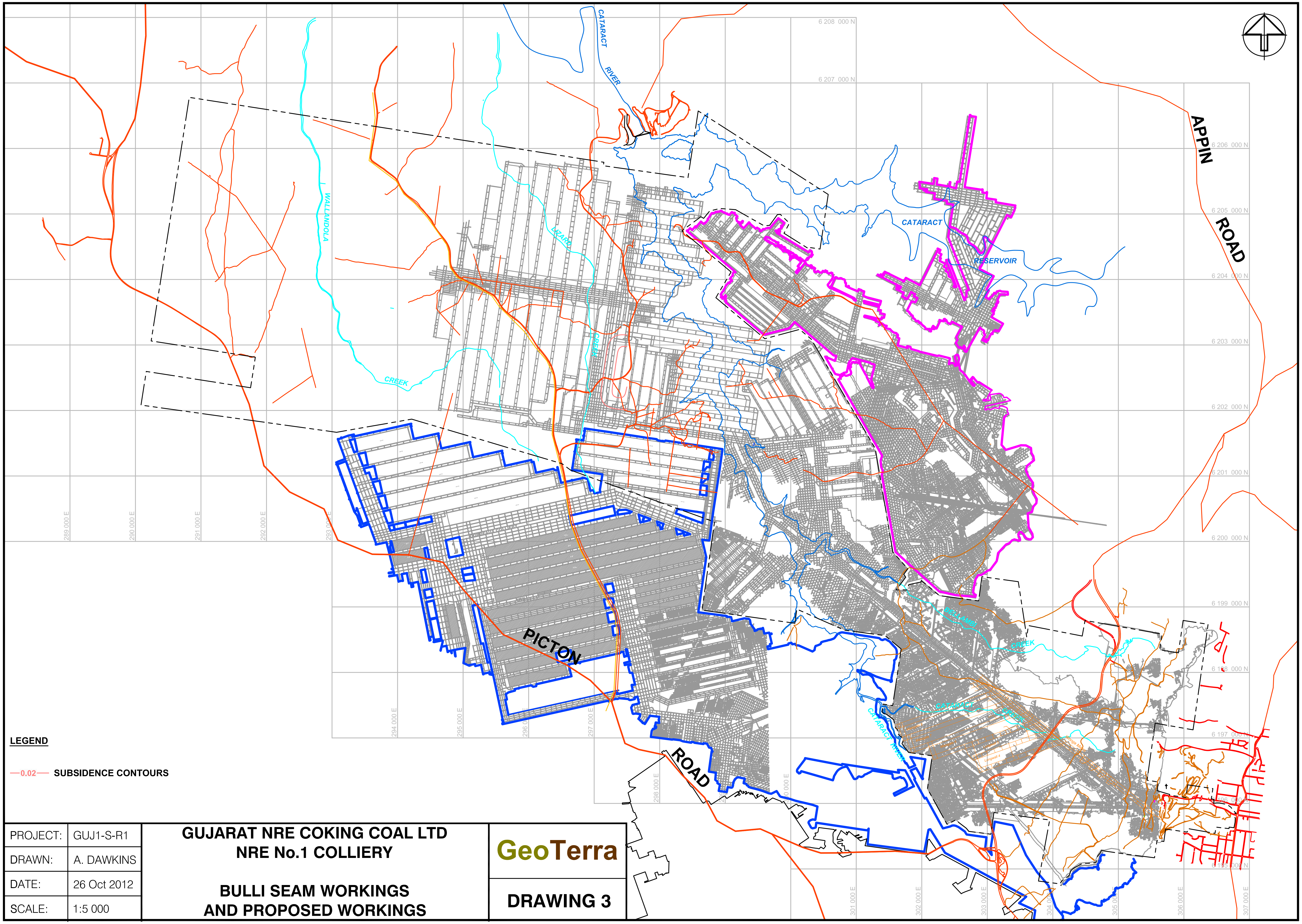
PROJECT:	NRE4- R1
DRAWN:	A. DAWKINS
DATE:	15 Nov 2012
SCALE:	1:250

GUJARAT NRE COKING COAL LTD
NRE No. 1 COLLIERY

Longwall WE-A2-LW5, Maingates 6, 7 and 8
Wonga East Water Monitoring Locations

GeoTerra

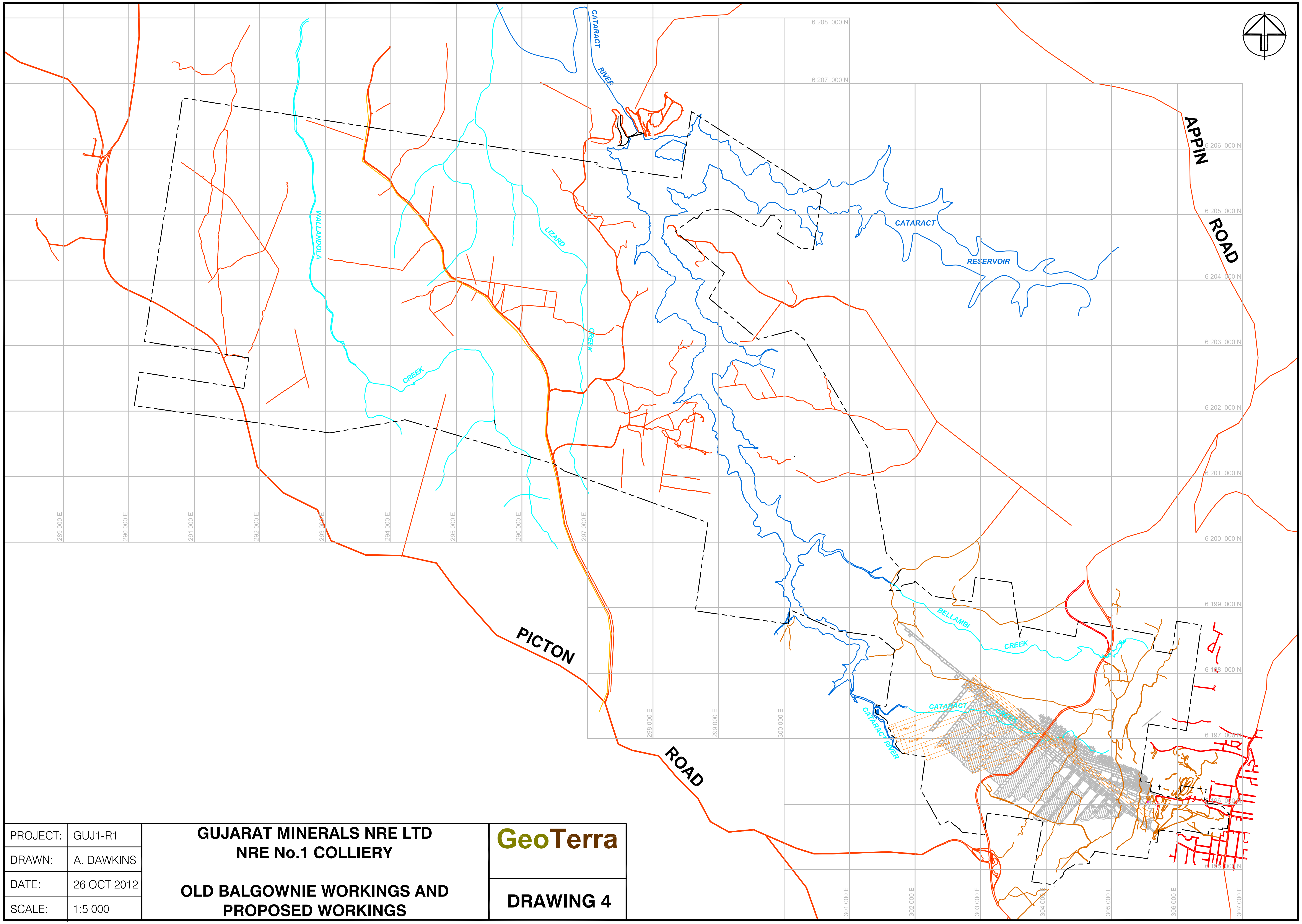
DRAWING 2



LEGEND

—0.02— SUBSIDENCE CONTOURS

PROJECT:	GUJ1-S-R1	GUJARAT NRE COKING COAL LTD NRE No.1 COLLIERY BULLI SEAM WORKINGS AND PROPOSED WORKINGS	GeoTerra DRAWING 3
DRAWN:	A. DAWKINS		
DATE:	26 Oct 2012		
SCALE:	1:5 000		



PROJECT:	GUJ1-R1	GUJARAT MINERALS NRE LTD NRE No.1 COLLIERY OLD BALGOWNIE WORKINGS AND PROPOSED WORKINGS	GeoTerra	
DRAWN:	A. DAWKINS			
DATE:	26 OCT 2012		DRAWING 4	
SCALE:	1:5 000			