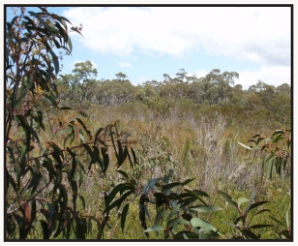
METROPOLITAN COAL

SIX MONTHLY REPORT



1 JULY TO 31 DECEMBER 2014

Peabody ENERGY

METROPOLITAN COAL

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EXECUTIVE SUMMARY

Metropolitan Coal is wholly owned by Peabody Energy Australia Pty Ltd (Peabody), and is located adjacent to the township of Helensburgh and approximately 30 kilometres north of Wollongong in New South Wales (NSW).

Metropolitan Coal was granted approval for the Metropolitan Coal Project (the Project) by the Minister for Planning under Section 75J of the NSW *Environmental Planning and Assessment Act, 1979* on 22 June 2009. A copy of the Project Approval is available on the Peabody website (http://www.peabodyenergy.com.au).

The Project comprises the continuation, upgrade and extension of underground coal mining operations and surface facilities at Metropolitan Coal. The Approved underground mining Project layout is shown on Figure ES-1.

The Metropolitan Coal Environmental Management Structure is shown on Figure ES-2. Consistent with the Environmental Management Structure and in accordance with Condition 6, Schedule 3 of the Project Approval, Metropolitan Coal prepares Extraction Plans for specific mining domains as mining progresses.

In accordance with Condition 9(c), Schedule 3 of the Metropolitan Coal Longwalls 23-27 Extraction Plan Approval, this Six Monthly Report has been prepared to report on impacts and environmental monitoring results associated with the Longwalls 23-27 Extraction Plan. This report presents data for the period 1 July to 31 December 2014. Longwall 23 extraction commenced in May 2014 and was 629 m from completion as at 31 December 2014.

No Project-related exceedances of performance measures associated with underground mining of Longwalls 23-27 occurred during the reporting period. During the reporting period, three performance indicators associated with underground mining of Longwalls 23-27 were exceeded, as summarised in Table ES-1.

Table ES-1
Longwalls 23-27 Performance Indicators Exceeded during the Reporting Period

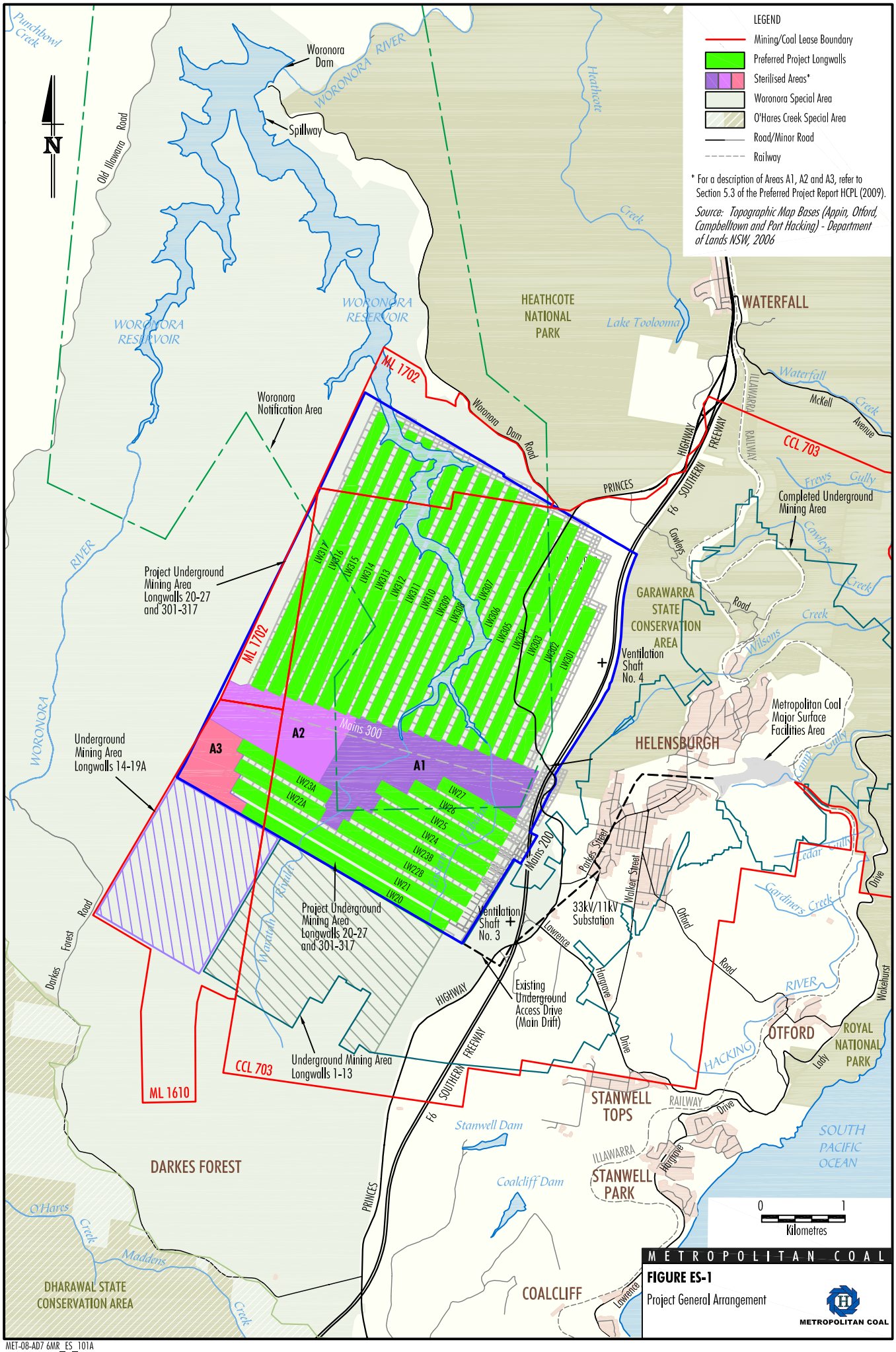
Environmental Aspect	Longwalls 23-27 Performance Indicator Exceeded	Comment
Surface Water	*Changes in the quality of water entering Woronora Reservoir are not significantly different post-mining compared to pre-mining concentrations that are not also occurring at control site WOWQ2*	Exceedance of the performance indicator at site WRWQ9 triggered an assessment against the performance measure, *Negligible reduction to the quality of water resources reaching the Woronora Reservoir*. The performance measure was not exceeded.
	Visual observations of gas releases in Pool P on the Waratah Rivulet indicate the gas releases have increased beyond those observed up to 17 April 2014	Exceedance of the performance indicator at Pool P triggered assessment against the performance measure, *Negligible environmental consequences (that is, no diversion of flows, no change in the natural drainage behaviour of pools, minimal iron staining, and minimal gas releases) on the Waratah Rivulet between the full supply level of the Woronora Reservoir and the maingate of Longwall 23 (upstream of Pool P).* The performance measure was not exceeded.

Table ES-1 (Continued)
Longwalls 23-27 Performance Indicators Exceeded during the Reporting Period

Environmental Aspect	Longwalls 23-27 Performance Indicator Exceeded	Comment
Biodiversity	*Impacts to riparian vegetation are expected to be localised and limited in extent, similar to the impacts previously experienced at the Metropolitan Colliery*	Exceedance of the performance indicator at site MRIP02 on Waratah Rivulet (overlying Longwall 21) and sites MRIP09 and MRIP05 on the Eastern Tributary (overlying Longwalls 20 and 21) triggered an assessment against the performance measure, *Negligible impact on threatened species and populations.* The performance measure was not exceeded.

The Six Monthly Report includes:

- A description of the environmental performance of water, biodiversity, land, Aboriginal heritage, built features and public safety management during the underground mining of Longwalls 23-27.
- A comprehensive review of the monitoring results associated with underground mining during the reporting period.
- Identification of trends in the monitoring data during the reporting period.
- Assessment of environmental performance against the performance indicators and performance measures during the reporting period.
- Revised characterisation of performance indicators and performance measures according to the relevant Trigger Action Response Plans.
- A description of rehabilitation management in the underground mining area and associated monitoring.



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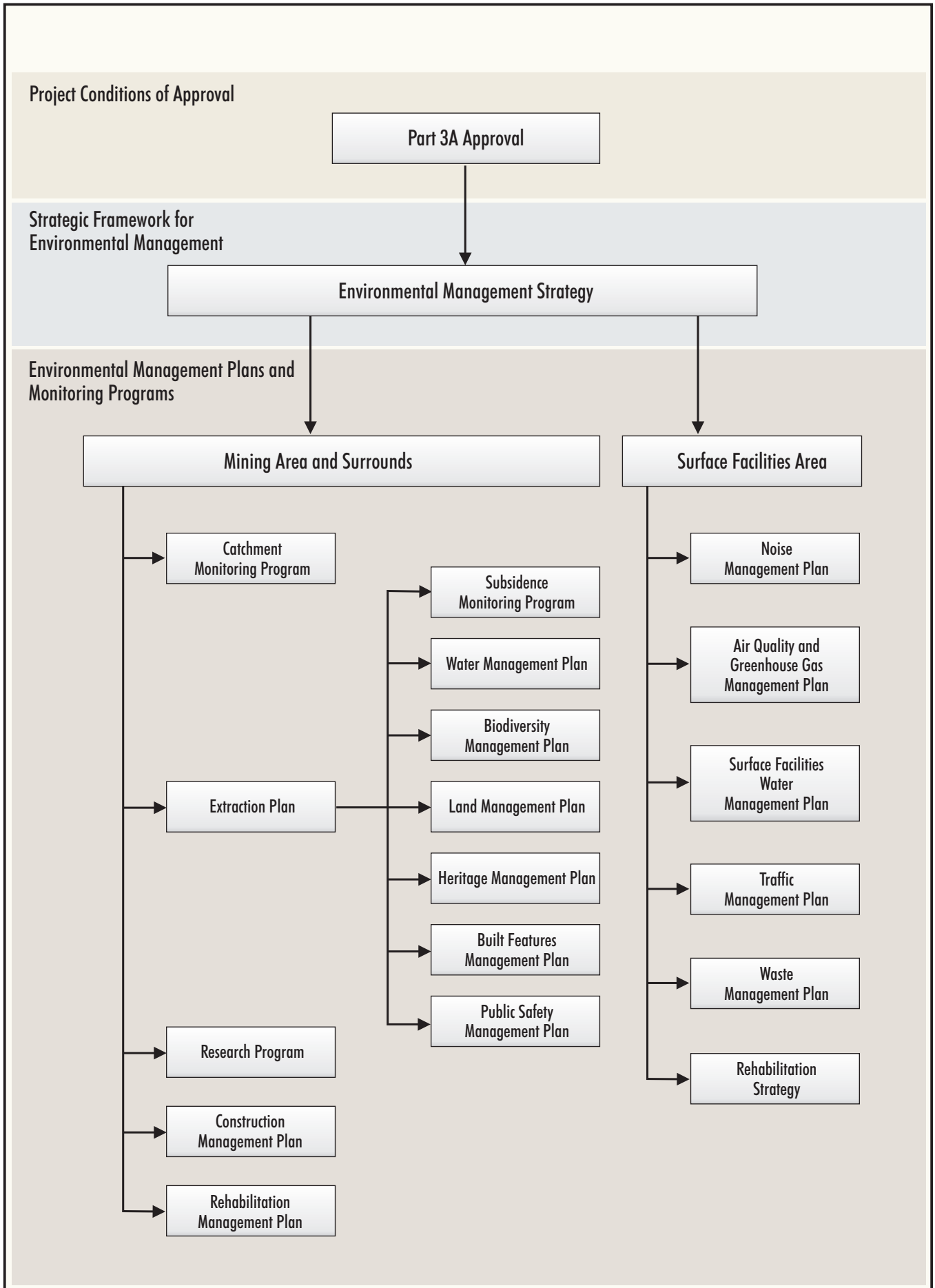

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FIGURE ES-2
Environmental Management Structure

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1 INTRODUCTION

Metropolitan Coal is wholly owned by Peabody Energy Australia Pty Ltd (Peabody), and is located adjacent to the township of Helensburgh and approximately 30 kilometres (km) north of Wollongong in New South Wales (NSW) (Figure 1). Metropolitan Coal is located within Consolidated Coal Lease (CCL) 703, Mining Lease (ML) 1610 and ML 1702. Metropolitan Coal is one of the earliest established and longest continually running coal mining operations in Australia, with a history dating back to the 1880s.

Metropolitan Coal was granted approval for the Metropolitan Coal Project (the Project) by the Minister for Planning under Section 75J of the NSW *Environmental Planning and Assessment Act, 1979* (EP&A Act) on 22 June 2009. The Project comprises the continuation, upgrade and extension of underground coal mining operations and surface facilities at Metropolitan Coal. The approved underground mining Project layout is shown on Figure 2. The Project Approval authorises mining for a period of 23 years from its date of issue and sets the regulatory framework therein.

The Metropolitan Coal Environmental Management Structure is shown on Figure 3. It includes the Metropolitan Coal Environmental Management Strategy (Metropolitan Coal, 2011), developed to provide the strategic context for environmental management at Metropolitan Coal, and management plans and monitoring programs applicable to the underground mining area or mine's surface facilities area.

Consistent with the Environmental Management Structure and in accordance with Condition 6, Schedule 3 of the Project Approval, Metropolitan Coal prepares Extraction Plans for specific mining domains as mining progresses. Extraction Plans are developed to monitor, manage and remediate the effects of longwall extraction at Metropolitan Coal. Metropolitan Coal was granted approval for the Metropolitan Coal Longwalls 23-27 Extraction Plan (Metropolitan Coal, 2014a) on 9 April 2014. The extraction of Longwall 23 commenced in May 2014 and was 629 m from completion as at 31 December 2014 (Figure 4).

1.1 PURPOSE AND SCOPE

In accordance with Condition 9(c), Schedule 3 of the Metropolitan Coal Longwalls 23-27 Extraction Plan Approval, this Six Monthly Report has been prepared to report on impacts and environmental monitoring results associated with the Longwalls 23-27 Extraction Plan.

Condition 9(c), Schedule 3 states:

Monitoring and Reporting Requirements

9. The Proponent shall implement a monitoring and reporting procedure that contains the following elements:

...

c) six-monthly reporting of all impacts and environmental monitoring results, including:

- *a comprehensive summary of all impacts, including a revised characterisation according to the relevant TARP(s);*
- *any proposed actions resulting from Triggers being met in the TARP, or other actions;*
- *assessment of compliance with all relevant performance measures and indicators;*
- *a comprehensive summary of all quantitative and qualitative environmental monitoring results, including landscape monitoring, water quality data, water flow and pool level data, piezometer readings, etc;*

...

Notes:

- *The Director-General may agree to a lesser frequency for the bi-monthly and six-monthly reporting set out above, if subsidence impacts and environmental consequences at the mine are relatively rare and benign in character.*
- *There is no need to include results of the monitoring of subsidence effects within bi-monthly and six-monthly reports to P&I. However, a summary of subsidence effects monitoring results should be included in the Annual Review.*
- *Other regular reports may be required by other agencies for their own purposes, such as reports to the Dams Safety Committee and regular reports assessing impacts of mining close to sensitive built features. P&I expects to receive copies of reports of these types.*

As Condition 9(c), Schedule 3 of the Project Approval is specific to the Metropolitan Coal Longwalls 23-27 Extraction Plan (Metropolitan Coal, 2014a), impacts on environmental monitoring results associated with other Metropolitan Coal activities (such as those at the major surface facilities area) are not included in this Six Monthly Report.

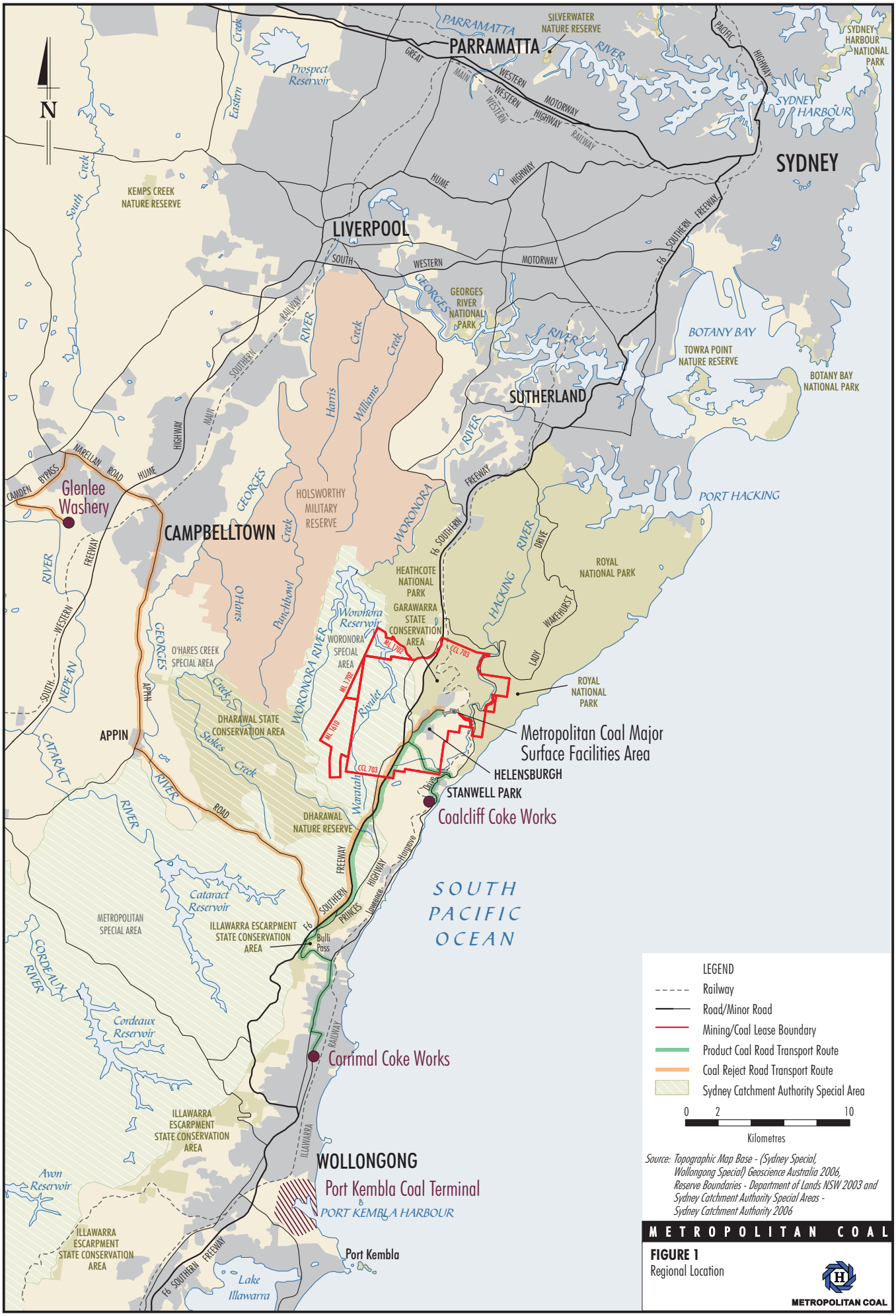
This report presents data for the period 1 July 2014 to 31 December 2014. The status of Longwalls 23-27 development at the end of the reporting period is shown on Figure 4.

1.2 STRUCTURE OF THE REPORT

The remainder of this report is structured as follows:

- Section 2 describes the environmental performance of water management during the mining of Longwalls 23-27.
- Section 3 describes the environmental performance of biodiversity management during the mining of Longwalls 23-27.
- Section 4 describes the environmental performance of land management during the mining of Longwalls 23-27.
- Section 5 describes the environmental performance of heritage management during the mining of Longwalls 23-27.
- Section 6 describes the environmental performance of built features management during the mining of Longwalls 23-27.
- Section 7 describes the management of public safety during the mining of Longwalls 23-27.
- Section 8 summarises rehabilitation management in the underground mining area and associated monitoring.
- Section 9 lists the references cited.

Sections 2 to 7 include a comprehensive review of monitoring results, identification of trends in the monitoring data, assessment of environmental performance (against the performance indicators and measures) and a revised characterisation according to the relevant Trigger Action Response Plans (TARPs).



Source: Topographic Map Base - (Sydney Special, Wollongong Special) Geoscience Australia 2006, Reserve Boundaries - Department of Lands NSW 2003 and Sydney Catchment Authority Special Areas - Sydney Catchment Authority 2006

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FIGURE 1
Regional Location

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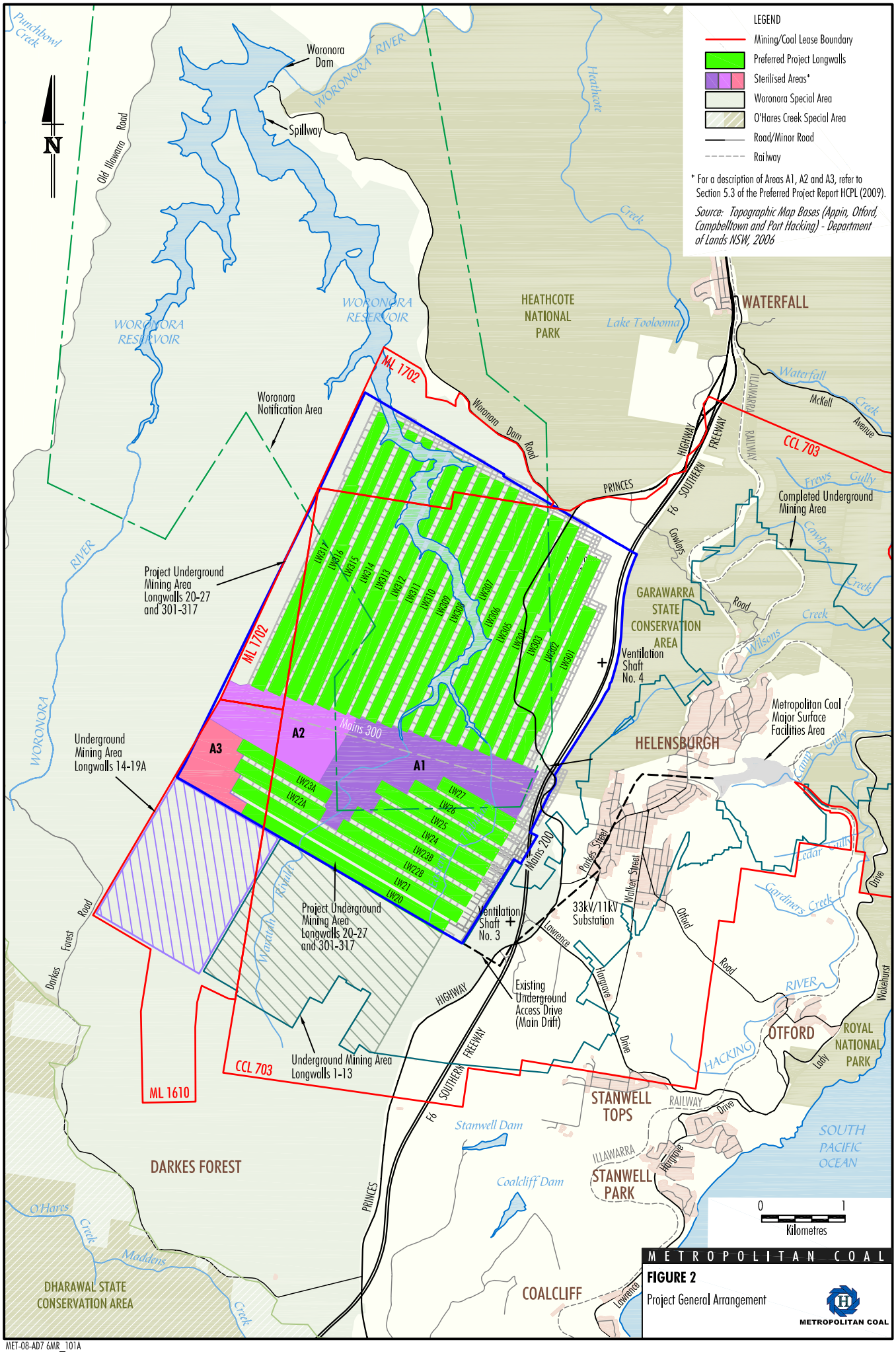

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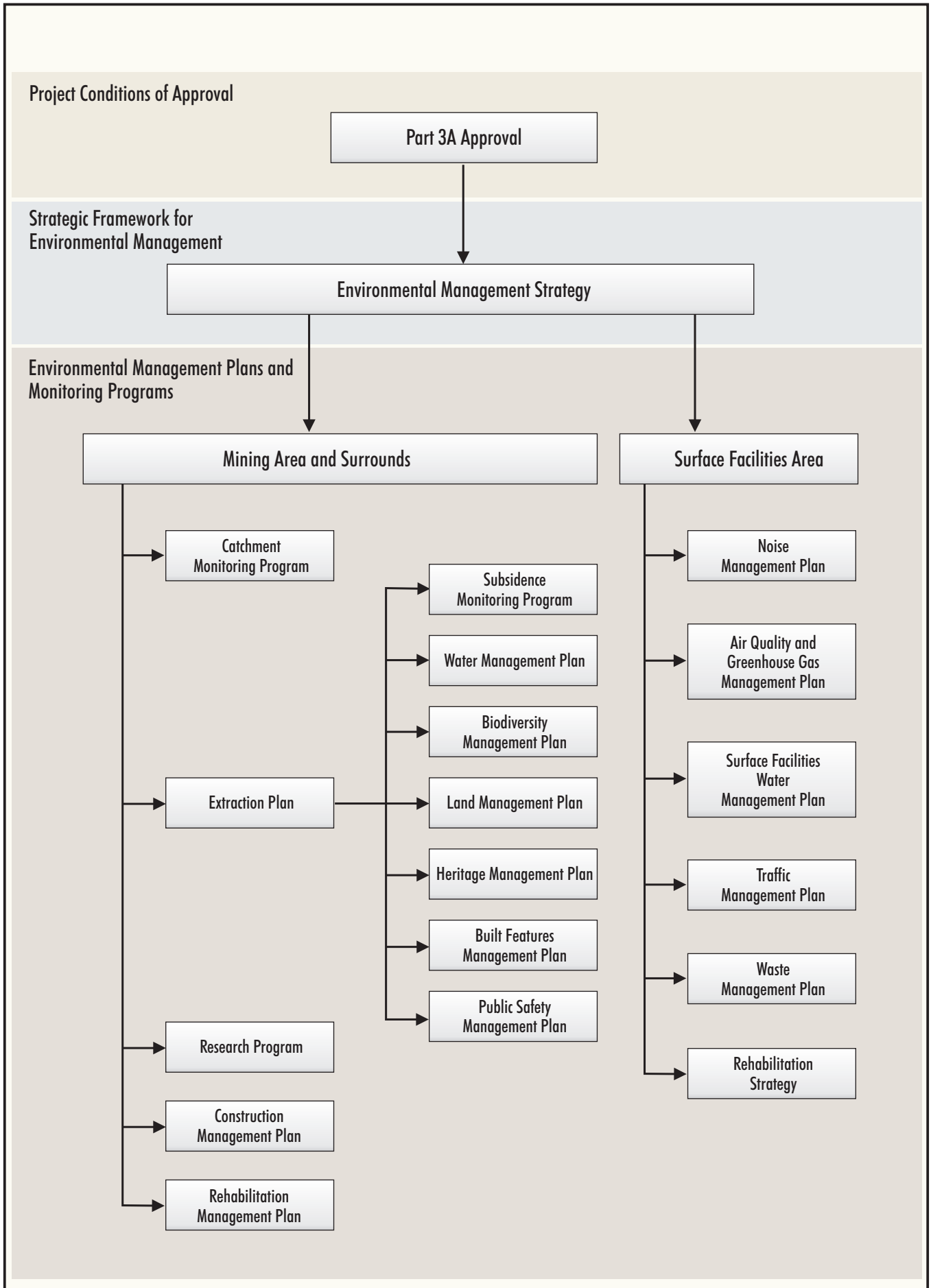

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FIGURE 3
Environmental Management Structure

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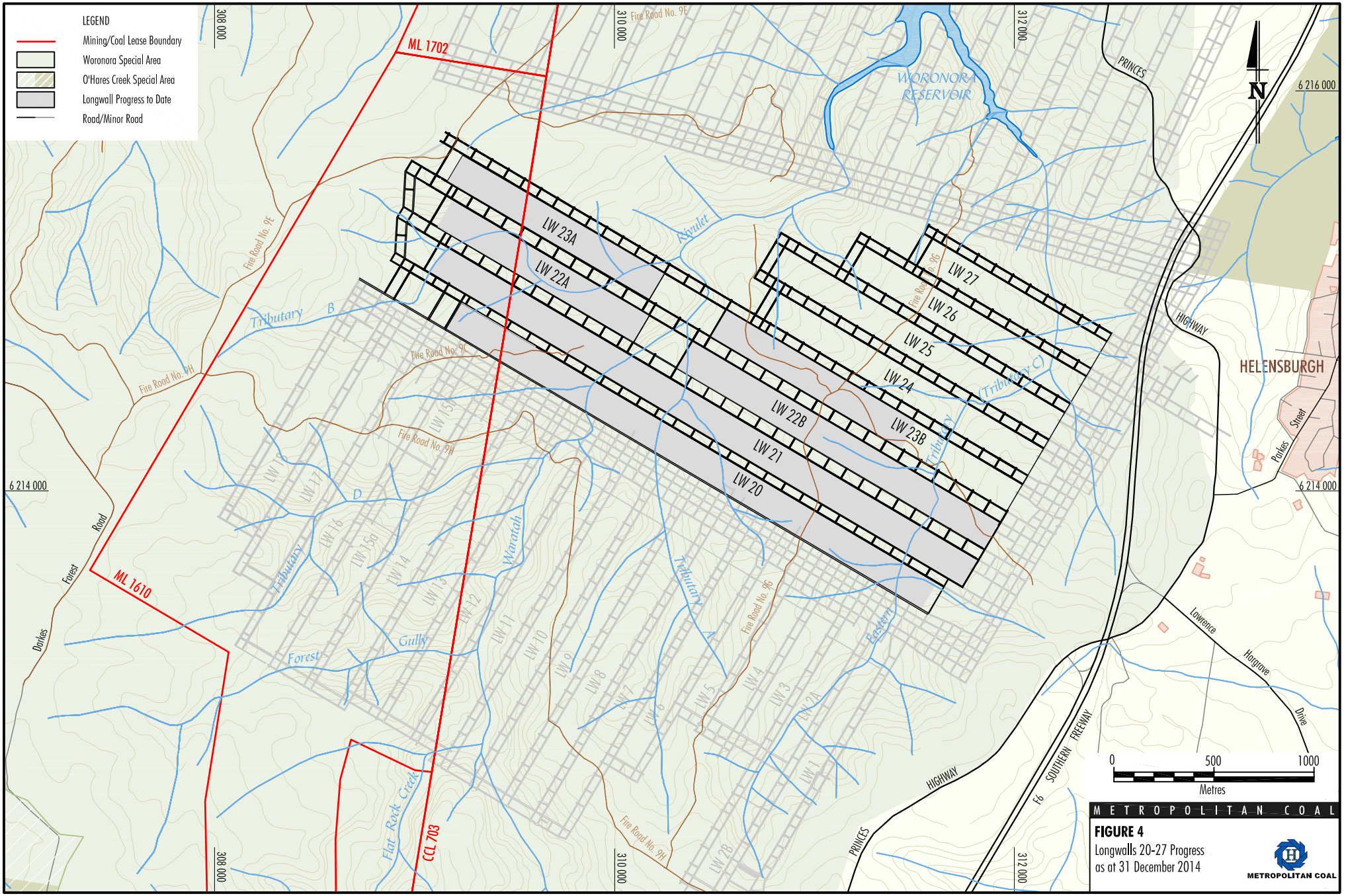

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FIGURE 4

Longwalls 20-27 Progress as at 31 December 2014

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2 WATER MANAGEMENT

2.1 BACKGROUND

The Metropolitan Coal Longwalls 23-27 Water Management Plan (Metropolitan Coal, 2014b) was prepared to manage the potential environmental consequences of the Metropolitan Coal Longwalls 23-27 Extraction Plan on watercourses (including the Woronora Reservoir), aquifers and catchment yield in accordance with Condition 6, Schedule 3 of the Project Approval.

2.2 MONITORING

2.2.1 Stream Features

Visual and photographic surveys along Waratah Rivulet and Eastern Tributary (from within the 35° angle of draw of Longwalls 23-27 to the Woronora Reservoir full supply level) have been conducted monthly when Longwall 23 has been within 400 m of the relevant stream, and will be conducted within three months of the completion of each longwall. Longwall 23 was approximately 629 m from completion as at 31 December 2014 (Figure 4).

Visual inspections and photographic surveys along Tributary A and Tributary B (within the 35° angle of draw of Longwalls 23-27) will also be conducted within three months of the completion of each longwall.

The visual and photographic surveys record:

- the location, approximate dimensions (length, width and depth), and orientation of surface cracks (specifically whether cracks are developed perpendicular to the stream flow or are controlled by rock joints or other factors, etc.);
- the nature of iron staining (e.g. whether isolated or across the entire streambed);
- the extent of iron staining (e.g. length of stream affected);
- description of gas release (e.g. isolated bubbles or continuous stream and type of gas [methane or carbon dioxide]);
- the nature of scouring, for example the depth of scouring, type of soil exposed, any obvious vegetation impact, potential for severe erosion, etc.;
- water discoloration or opacity if present;
- natural underflow if evident (i.e. evidence of surface flows either entering or existing the sub-surface domain via surface cracks in the streambed);
- rock bar characteristics such as extent of cracking, seepage, underflow;
- whether any actions are required (e.g. implementation of management measures, incident notification, implementation of appropriate safety controls, review of public safety, etc.); and
- any other relevant information.

Global positioning system (GPS) coordinates are recorded where appropriate (e.g. of particular observations and associated photographs).

The monthly surveys record the above parameters by exception (i.e. where they differ to the baseline visual and photographic record). During the reporting period monthly surveys of the Waratah Rivulet were conducted from July to September 2014 and of the Eastern Tributary in December 2014.

No new surface cracking was observed at pools on the Waratah Rivulet during the reporting period, with the exception of Pool N. Pool N ceased to flow from 18 June 2014 to 15 August 2014 and in late November 2014. When the pool was dry, cracking was evident at the bottom of Pool N. Iron staining was noted at a number of rockbars and/or pools on the Waratah Rivulet. No iron staining was observed in Pool P and isolated iron staining was observed in Pool Q (at the northern end), Pool R (particularly during times of low rainfall) and Pool S. No scouring, exposed soil or severe erosion was identified along the Waratah Rivulet. Discolouration was observed in all pools (i.e. Pools N to W) except Pools R and S. There was also accumulation of algae observed at rock bar P and Pools Q, R and S which increased during times of low rainfall.

No new surface cracking or gas releases were noted on the Eastern Tributary during the reporting period. Iron staining was observed downstream to rock the bar of Pool ETAQ.

A detailed photographic record of Waratah Rivulet, Eastern Tributary, Tributary A and Tributary B will be conducted within three months of Longwall 23 completion.

During the reporting period, gas releases in the Waratah Rivulet relevant to the monitoring of Longwalls 23-27 (i.e. within the 35° angle of draw of Longwalls 23-27) have been observed in Pools O and P (Figure 5). In accordance with the Metropolitan Coal Longwalls 23-27 Water Management Plan, the following actions were undertaken once the gas release was identified:

- monitoring conducted weekly to determine the extent of the gas releases;
- gas concentration monitoring; and
- identification of any observable environmental effects (e.g. impacts to riparian vegetation or fish).

Gas releases in Pool O were previously observed from April 2012 to December 2013. Gas releases continued to be observed in Pool O from December 2013 until late February 2014, from mid April to mid May 2014, and from September to December 2014.

Gas releases in Pool P were identified for the first time in February 2014 and continued to the end of the reporting period.

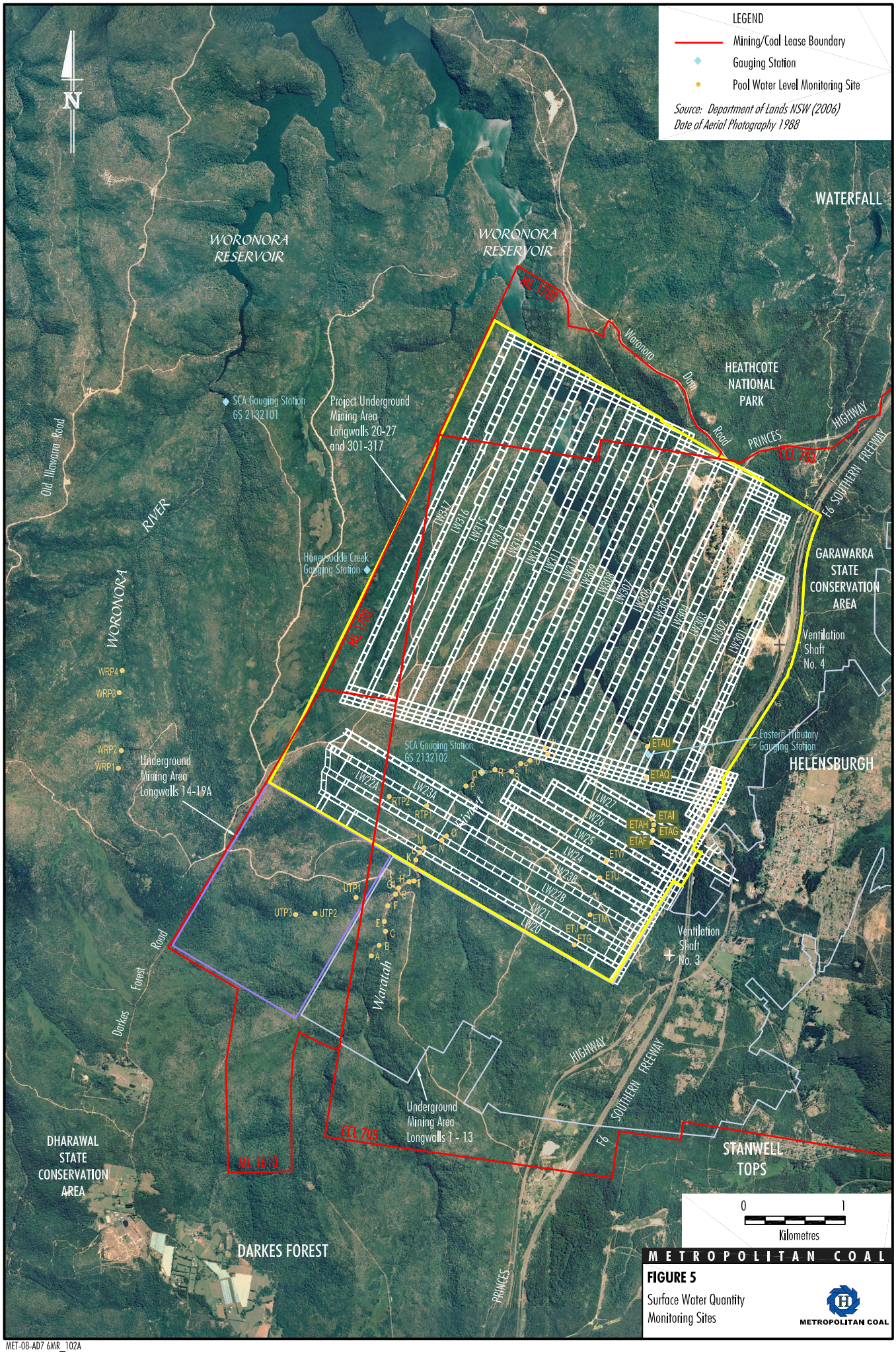
Monitoring indicates that the gas releases were predominantly comprised of methane. No environmental effects resulting from the gas releases (such as riparian vegetation dieback or dead fish) have been observed.

2.2.2 Surface Water Flow

Surface water flow monitoring for Longwalls 23-27 includes continuous flow monitoring at (Figure 5):

- the existing SCA-owned gauging station on the Waratah Rivulet, close to the inundation limits of the Woronora Reservoir (GS2132102);
- the existing SCA-owned gauging station on the Woronora River, close to the inundation limits of the Woronora Reservoir (GS2132101) (control site);
- the existing OEH gauging station on O'Hares Creek at Wedderburn (GS213200) (control site);
- the existing Metropolitan Coal-owned gauging station on the Eastern Tributary, close to the inundation limits of the Woronora Reservoir; and
- the existing Metropolitan Coal-owned gauging station on Honeysuckle Creek (control site).

Numerical catchment models for the Waratah Rivulet and the Woronora River and O'Hares Creek control catchments have been developed using the nationally recognised AWBM (Boughton, 2004).



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The AWBM is a catchment-scale water balance model that estimates streamflow from rainfall and evaporation.

Metropolitan Coal has received updates from the SCA in relation to the flow rating curves, recent gaugings and revised flow data for the Waratah Rivulet and Woronora River gauging stations. A review by Gilbert & Associates has indicated there are some discrepancies in flows generated using the SCA's current rating curves for the Waratah Rivulet and Woronora River gauging stations which compromise the existing surface water model calibrations and Metropolitan Coal's ability to confidently assess the performance indicator for the quantity of water resources reaching the Woronora Reservoir. Metropolitan Coal is seeking to remedy this situation by regenerating the current flow records from the Waratah Rivulet and Woronora River gauging stations using amended rating relationships developed by Metropolitan Coal. Re-calibrated catchment models will be developed by Gilbert & Associates for the Waratah Rivulet and Woronora River gauging stations in the next reporting period. As a result of the current flow data discrepancies it is considered inappropriate to use the current flow data in the performance indicator assessment for the quantity of water resources reaching the Woronora Reservoir.

A review of the rating curve for the gauging station on O'Hares Creek at Wedderburn has also been conducted during the reporting period. A re-calibrated catchment model will also be developed for the O'Hares Creek gauging station at Wedderburn in the next reporting period.

As described in the Metropolitan Coal Catchment Monitoring Program, catchment models will be developed for the Eastern Tributary and Honeysuckle Creek gauging stations once a suitable period of data has been collected.

2.2.3 Pool Water Levels

Water levels in a number of pools on the Waratah Rivulet (Pools A, B, C, E, F, G, G1, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V and W), Eastern Tributary (Pools ETG, ETJ, ETM, ETU, ETW, ETAF, ETAG, ETAH, ETAI, ETAQ and ETAU), Tributary B (Pools RTP1 and RTP2) and Woronora River (Pools WRP1, WRP2, WRP3 and WRP4) have been either manually monitored on a daily basis or monitored using a continuous water level sensor and logger for Longwalls 23-27 (Figure 5).

The pool water level monitoring results for Waratah Rivulet are discussed in Section 8.3.2 in relation to the initiation of stream remediation.

The pool water level monitoring results for Pools ETAF, ETAG, ETAH, ETAI, ETAQ and ETAU on the Eastern Tributary are discussed in Sections 2.3.7 and 8.3.2.

The pool water level monitoring results for Pools RTP1 and RTP2 on Tributary B and Pools ETG, ETJ, ETM, ETU and ETW on the Eastern Tributary are described below.

The water level in Pool RTP1 on Tributary B is shown on Chart 1. The recorded water level hydrograph for Pool RTP1 indicates that there was a datum shift in August 2012 but that it flowed continuously over the period of available data including the reporting period.

The water level in Pool RTP2 on Tributary B is shown on Chart 2. The recorded water level hydrograph for Pool RTP2 indicates that water levels have fallen below its 'normal' low flow level, which is assumed to be near or below its cease to flow level. The large, short duration, fluctuations recorded at this site prior to 2010 makes pool level interpretation difficult. The aquatic ecology surveys (refer Section 3.2.4) on Tributary B have observed that pools at or in the vicinity of Pool RTP2 almost completely drained of water in spring 2012 and since then, pools have been mostly dry with no surface-flow.

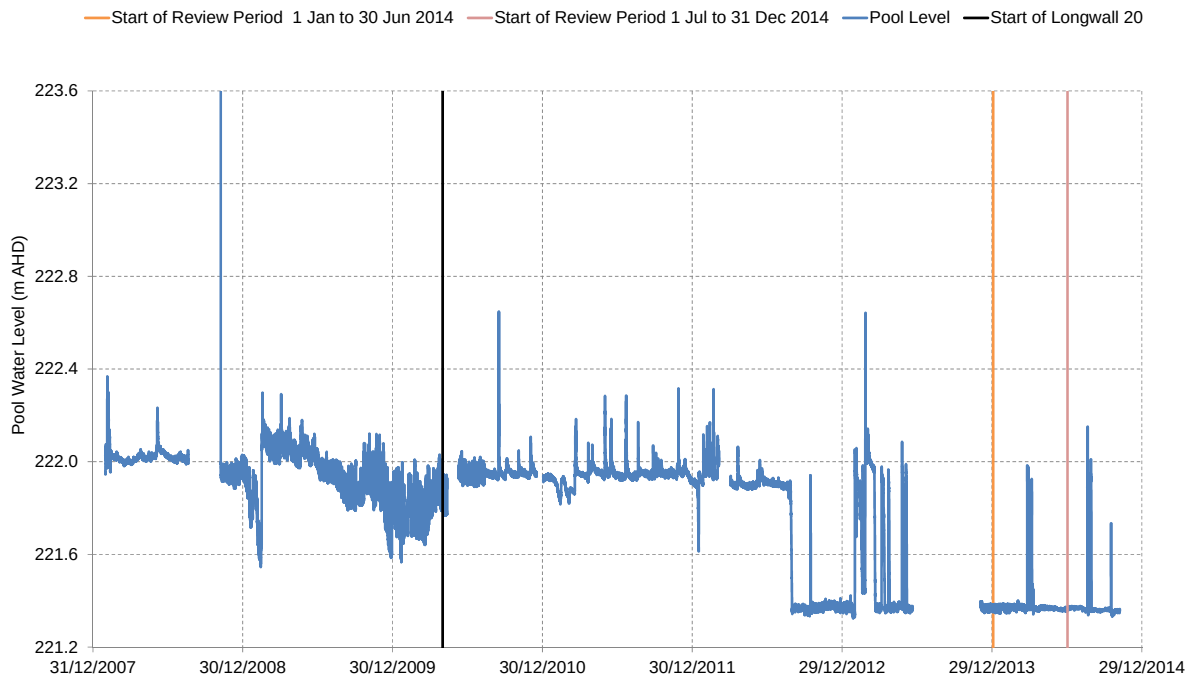


Chart 1 Water Level Hydrograph – Tributary B Pool RTP1

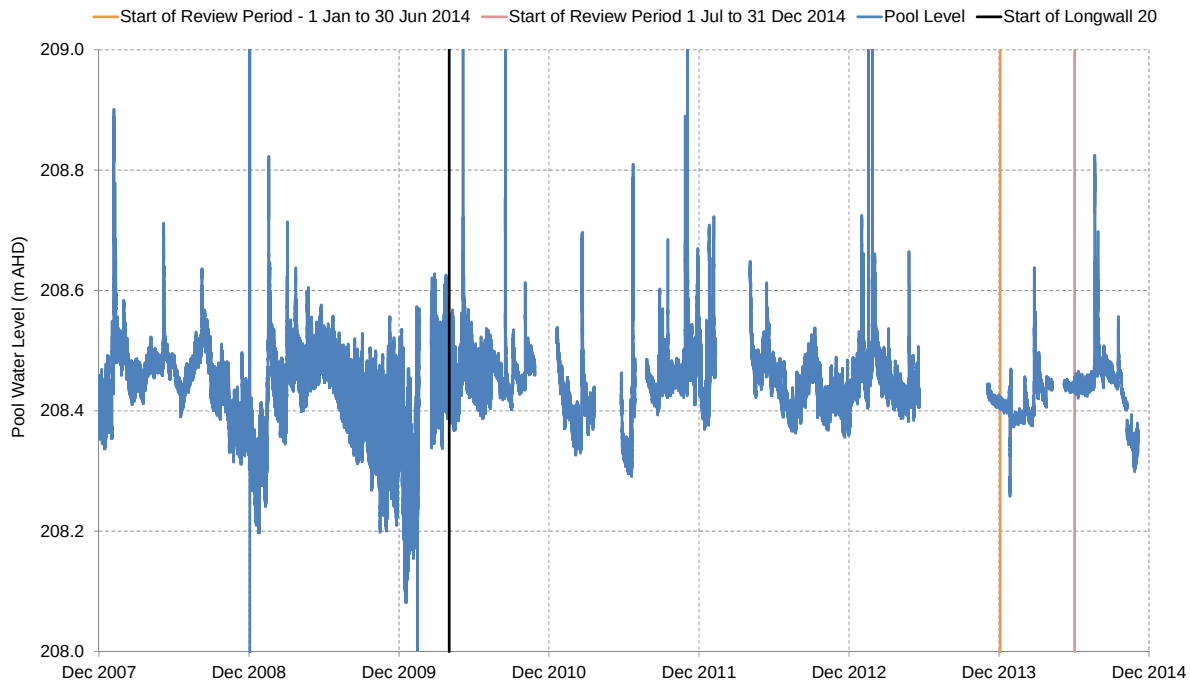


Chart 2 Water Level Hydrograph – Tributary B Pool RTP2

The water levels in Pools ETG, ETJ, ETM, ETU and ETW on the Eastern Tributary are shown on Charts 3 to 7.

Water levels in Pool ETG have remained above the cease to flow level throughout the reporting period. Water levels in Pool ETG were recorded as being below the cease to flow level in early 2014, however the sudden fall, and then subsequent sudden rise in water level indicate that the fall in water level corresponded to a period where the level datum on the water level sensor shifted (which can occur during the downloading of data) rather than a real cease to flow event (Chart 3).

During the reporting period the water level in Pools ETJ and ETM appear to have fallen below the pool's cease to flow level between 29 July and 17 August 2014 (Chart 4) and 3 to 17 August 2014 (Chart 5), respectively. Flows recorded at the gauging station on Eastern Tributary (Charts 4 and 5) show that the falls below the cease to flow levels corresponded to a prolonged period of low flow. Further investigation of the accuracy of the cease to flow levels will be conducted in the next reporting period.

Water levels in Pools ETU and ETW were above the cease to flow levels during the reporting period (Charts 6 and 7).

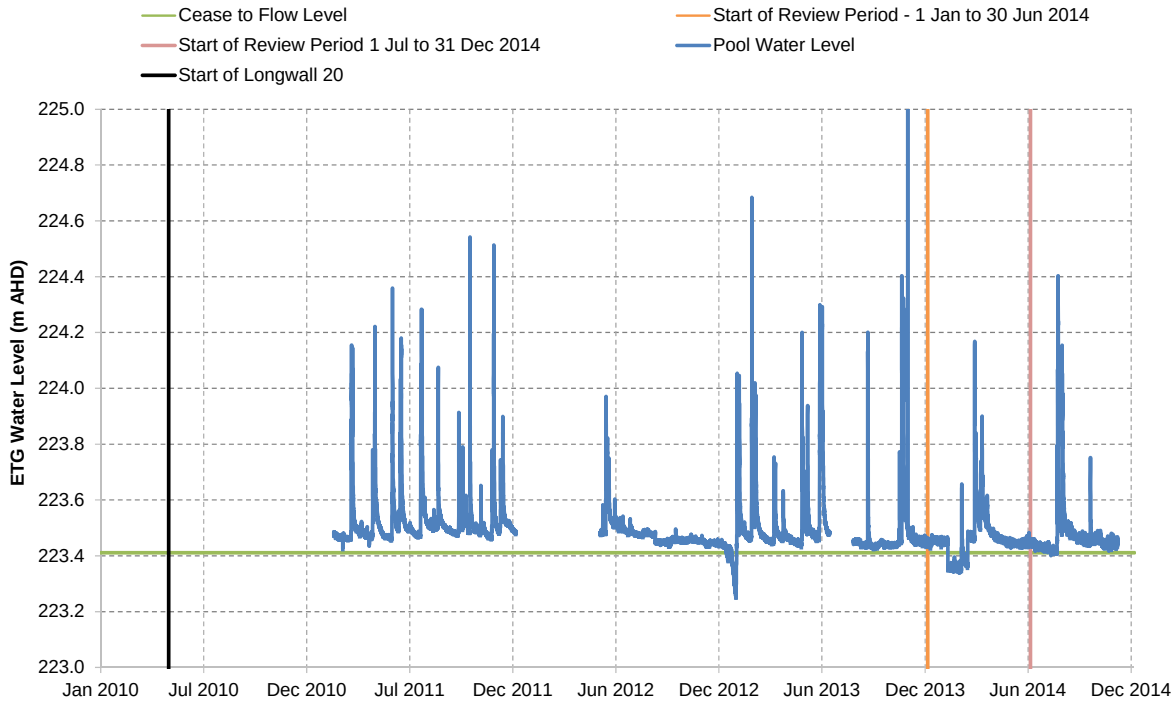


Chart 3 Water Level Hydrograph - Eastern Tributary Pool ETG

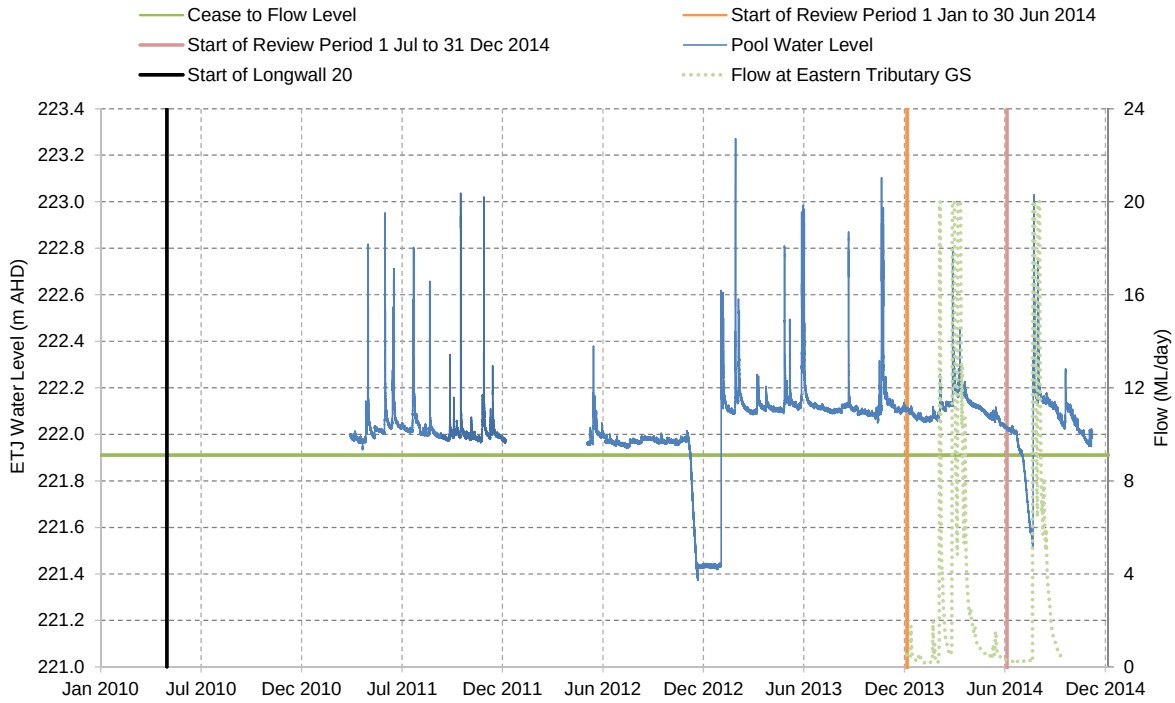


Chart 4 Water Level Hydrograph - Eastern Tributary Pool ETJ

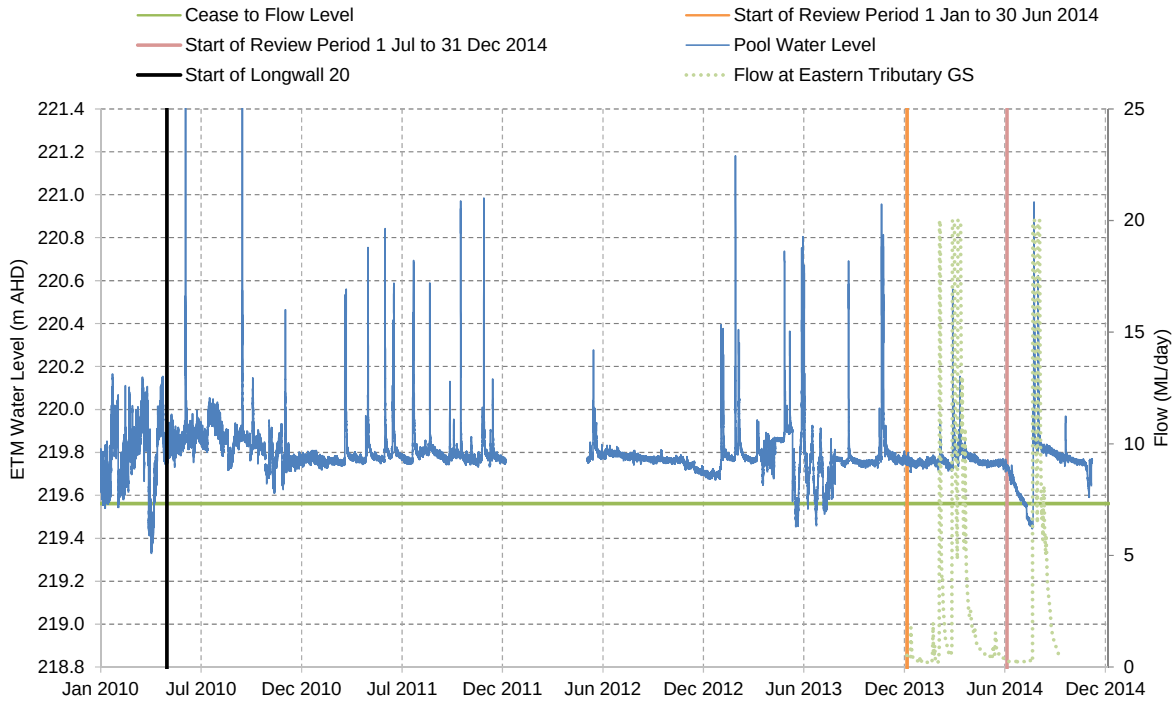


Chart 5 Water Level Hydrograph - Eastern Tributary Pool ETM

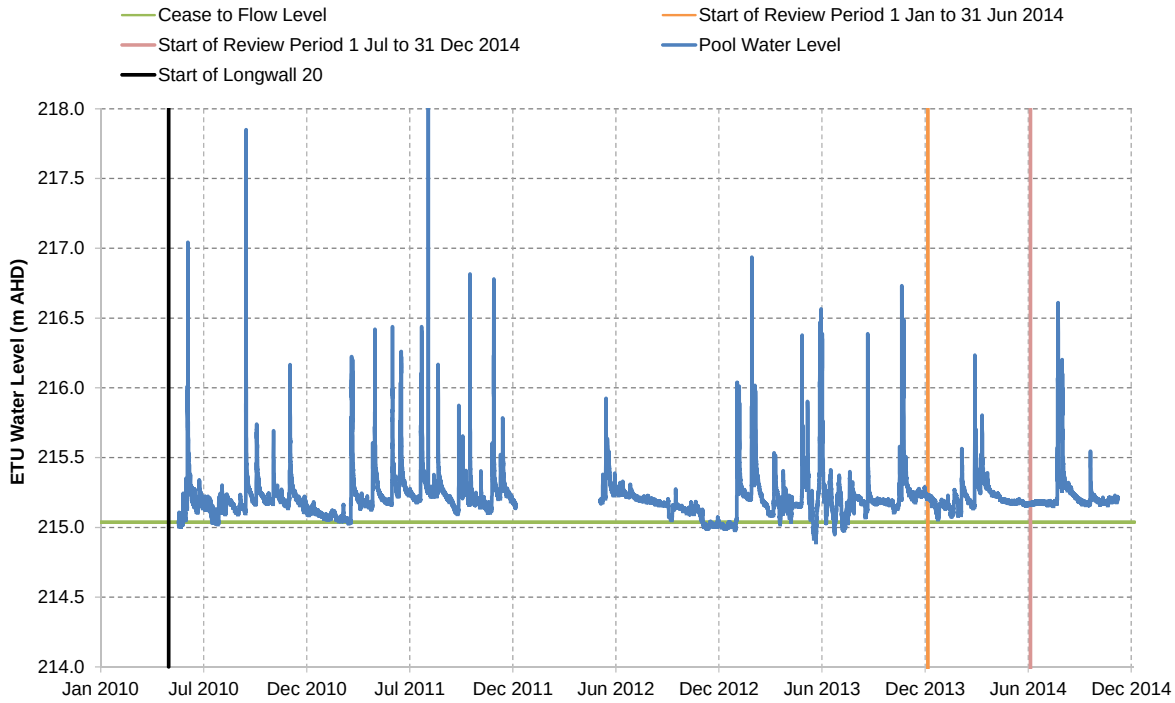


Chart 6 Water Level Hydrograph - Eastern Tributary Pool ETU

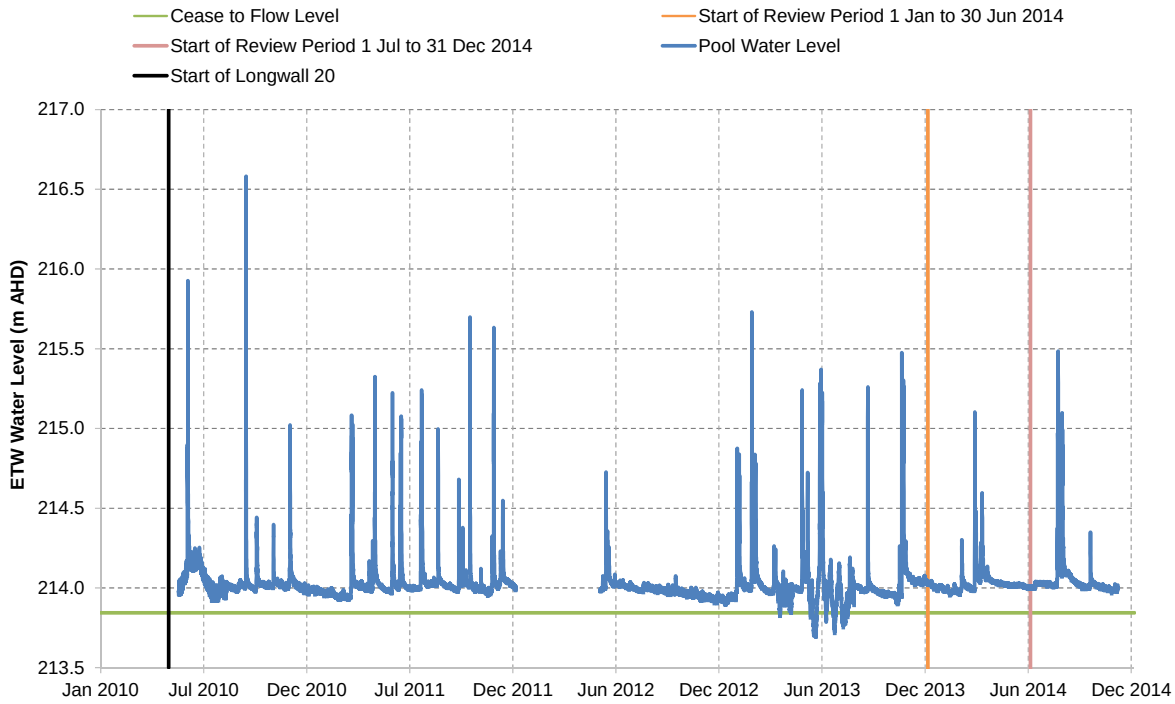


Chart 7 Water Level Hydrograph - Eastern Tributary Pool ETW

Pools P, Q, R, S, T, U, V and W on Waratah Rivulet are visually inspected on a weekly basis when mining of Longwalls 23-27 is within 400 m of these pools. Longwall 23 was within 400 m of Pools P, Q and/or R on Waratah Rivulet from July to September 2014. The visual inspections indicated the water levels in Pools P, Q and/or R on Waratah Rivulet remained above the cease to flow level.

Pools ETAF to ETAQ on the Eastern Tributary will be visually inspected on a weekly basis when mining of Longwalls 23-27 is within 400 m of these pools. Longwall 23 did not come within 400 m of Pools ETAF to ETAQ during the reporting period.

All pools between Pool ETG and Pool ETAQ on the Eastern Tributary are inspected monthly when mining of Longwalls 23-27 is within 400 m of the Eastern Tributary. Pools between Pool ETG and Pool ETAQ on the Eastern Tributary were inspected in December 2014 when Longwall 23 came within 400 m of Pools ETM, ETU and ETW. The visual inspections indicated the water levels in Pools ETG to ETAQ on Eastern Tributary remained above their cease to flow level.

Pool ETAU will be inspected monthly when mining is within 400 m of the Eastern Tributary during extraction of Longwall 27.

2.2.4 Stream Water Quality

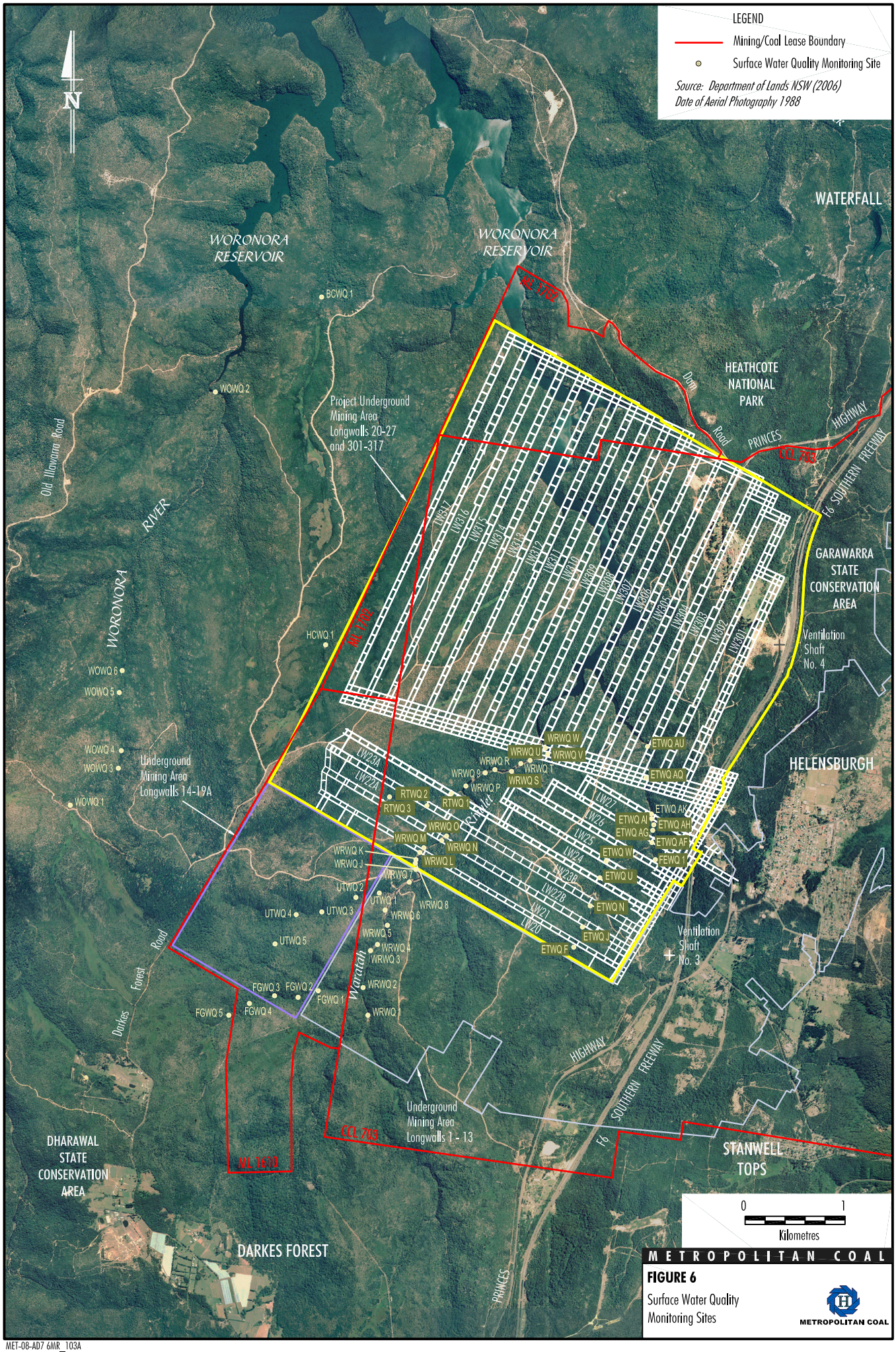
Surface water quality sampling has been conducted monthly at the following sites on Waratah Rivulet, Tributary B, Tributary D, Eastern Tributary, Far Eastern Tributary, Honeysuckle Creek, Bee Creek and the Woronora River (Figure 6) in accordance with the Longwalls 23-27 Water Management Plan:

- sites WRWQ 2, WRWQ 6, WRWQ 8, WRWQ 9, WRWQ M, WRWQ N, WRWQ P, WRWQ R, WRWQ T and WRWQ W on the Waratah Rivulet;
- site RTWQ 1 on Tributary B;
- site UTWQ 1 on Tributary D;
- sites ETWQ F, ETWQ J, ETWQ N, ETWQ U, ETWQ W, ETWQ AF, ETWQ AH, ETWQ AQ and ETWQ AU on the Eastern Tributary;
- site FEWQ 1 on the Far Eastern Tributary;
- site HCWQ 1 on Honeysuckle Creek;
- site BCWQ 1 on Bee Creek; and
- control sites WOWQ 1 and WOWQ 2 on the Woronora River.

Water quality parameters sampled include electrical conductivity (EC), pH, redox potential (Eh), dissolved oxygen (DO), turbidity, calcium (Ca), magnesium (Mg), sodium (Na), potassium (K), chloride (Cl), sulphate (SO_4), bicarbonate (HCO_3), total nitrogen (Ntot), total phosphorus (Ptot), nitrate (NO_3), barium (Ba), strontium (Sr), manganese (Mn), iron (Fe), zinc (Zn), cobalt (Co) and aluminium (Al). Samples collected for metal analysis have been field filtered.

Unfiltered water quality samples are also collected at a select number of sites on the Waratah Rivulet, Eastern Tributary and Woronora River and analysed for total iron.

Consistent with the Metropolitan Coal Longwalls 23-27 Water Management Plan, the key parameters of interest are pH, EC, dissolved aluminium, dissolved iron and dissolved manganese. The results of these key water quality parameters are graphically presented for the sites listed above on Charts A1 to A35 of Appendix A. Monitoring results for other sites on Waratah Rivulet, Tributary B, Tributary D, Eastern Tributary, Far Eastern Tributary, Honeysuckle Creek, Bee Creek, and the Woronora River are also shown on Charts A1 to A35 of Appendix A to show trends over the length of the streams.


LEGEND
Mining/Coal Lease Boundary
Surface Water Quality Monitoring Site
Source: Department of Lands NSW (2006)
Date of Aerial Photography 1988
N
WORONORA RESERVOIR
WORONORA RESERVOIR
WATERFALL
BCWQ 1
WOWQ 2
Project Underground Mining Area Longwalls 20-27 and 301-317
ML 1562
ML 1610
CCL 703
HEATHCOTE NATIONAL PARK
Dam
Road
PRINCES
HIGHWAY
F6 SOUTHERN FREEWAY
Old Illawarra Road
RIVER
WORONORA
HCWQ 1
WOWQ 6
WOWQ 5
WOWQ 4
WOWQ 3
WOWQ 1
Underground Mining Area Longwalls 14-19A
GARAWARRA STATE CONSERVATION AREA
Ventilation Shaft No. 4
HELENSBURGH
Ventilation Shaft No. 3
RTWQ 1
RTWQ 2
RTWQ 3
UTWQ 1
UTWQ 2
UTWQ 3
UTWQ 4
UTWQ 5
FGWQ 1
FGWQ 2
FGWQ 3
FGWQ 4
FGWQ 5
WRWQ 1
WRWQ 2
WRWQ 3
WRWQ 4
WRWQ 5
WRWQ 6
WRWQ 7
WRWQ 8
WRWQ 9
WRWQ J
WRWQ K
WRWQ L
WRWQ M
WRWQ N
WRWQ O
WRWQ P
WRWQ R
WRWQ S
WRWQ T
WRWQ U
WRWQ V
WRWQ W
ETWQ AF
ETWQ AG
ETWQ AH
ETWQ AI
ETWQ AJ
ETWQ AK
ETWQ AQ
ETWQ AU
ETWQ F
ETWQ J
ETWQ N
ETWQ U
ETWQ W
FEWQ 1
Forest Road
Darkes
Waratah
HIGHWAY
SOUTHERN FREEWAY
F6
Underground Mining Area Longwalls 1 - 13
DHARAWAL STATE CONSERVATION AREA
DARKES FOREST
STANWELL TOPS
PRINCES
0
1
Kilometres
METROPOLITAN COAL
FIGURE 6
Surface Water Quality Monitoring Sites
METROPOLITAN COAL
MET-08-AD7 6MR_103A

With the following exceptions water quality data over the reporting period has generally been within the typical ranges seen in the historic recorded water quality data:

- An elevated dissolved iron concentration wase recorded at site ETWQ N on the Eastern Tributary in October 2014.
- The previous trend of increasing pH and EC at the downstream sampling sites on Tributary B appear to have plateaued. Dissolved manganese at these sites appears to be trending upward relative to the historical concentrations but still remain relatively low. Dissolved manganese trended down at sampling site RTWQ2 and trended up at sampling site RTWQ1 downstream.

2.2.5 Woronora, Nepean and Cataract Reservoir Water Quality

Metropolitan Coal has sourced water quality data for the Woronora Reservoir, Nepean Reservoir and Cataract Reservoir from the SCA in accordance with a data exchange agreement.

Results of the analysis of this data are presented in Section 2.3.5.

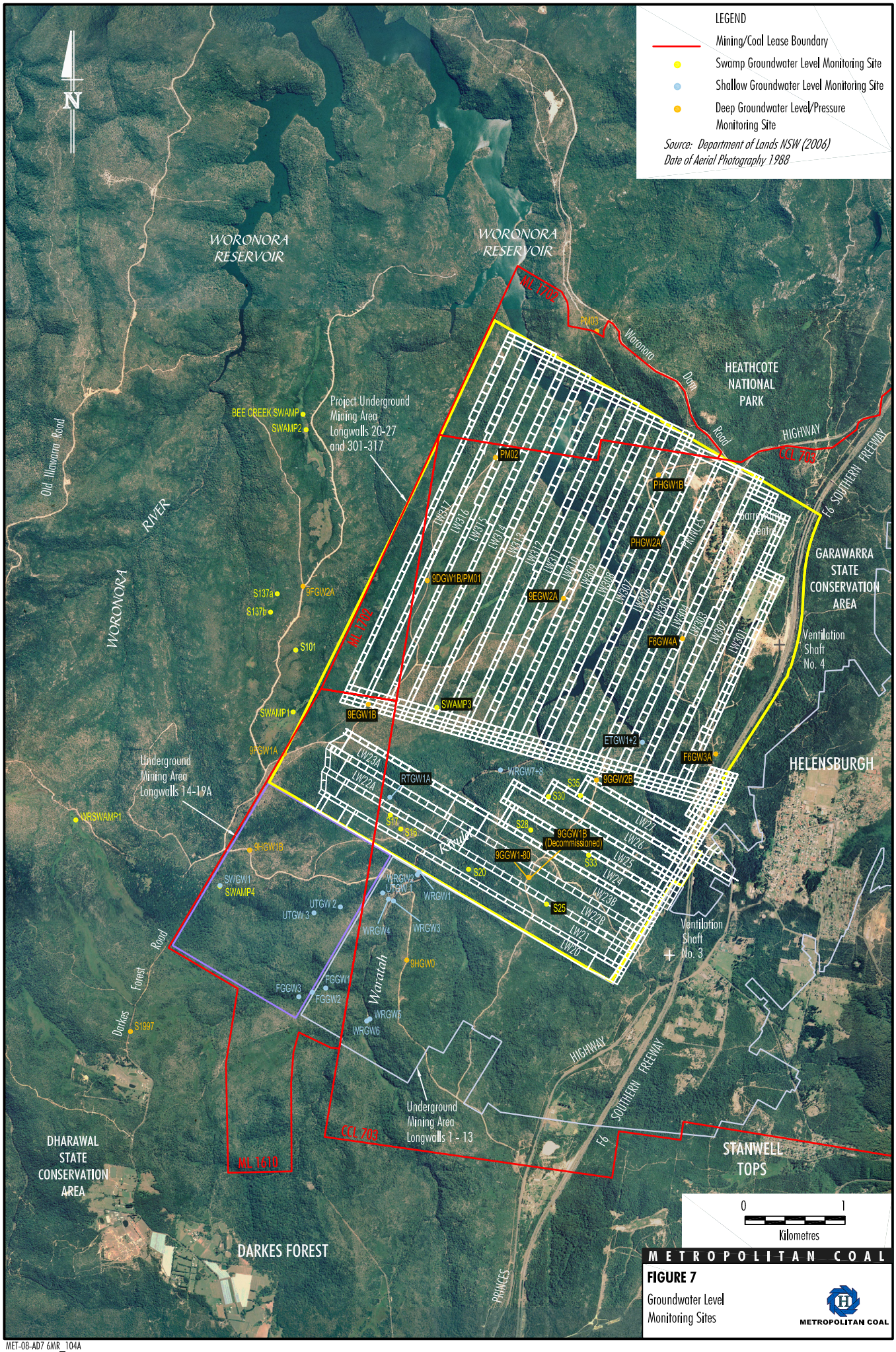
2.2.6 Swamp Groundwater Levels

Upland swamp groundwater monitoring for Longwalls 23-27 is described in Section 3.2.2.

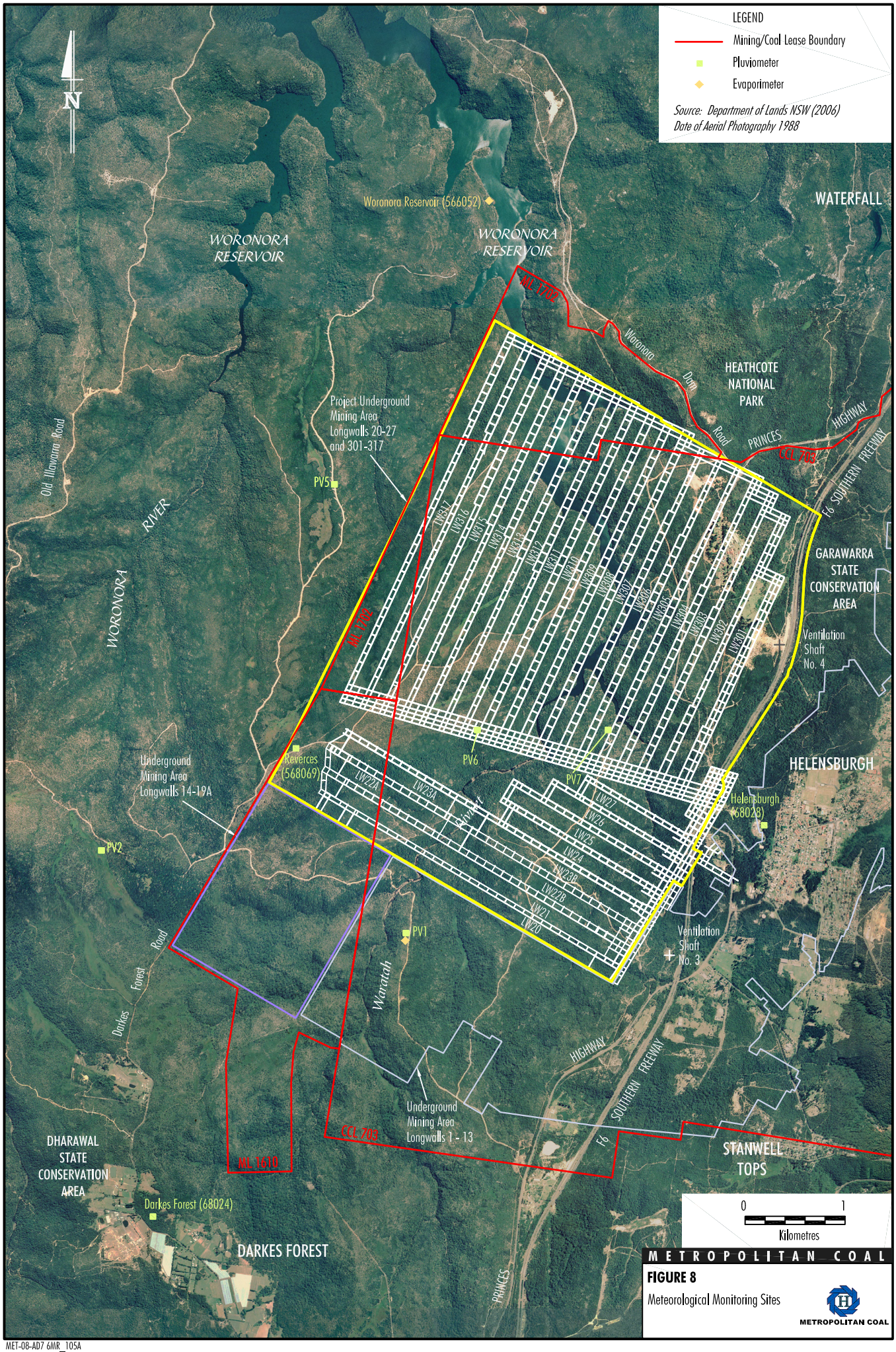
2.2.7 Shallow Groundwater Levels

The results of continuous shallow groundwater level monitoring conducted at sites WRGW1, WRGW2 and WRGW7 along Waratah Rivulet, site RTGW1A on Tributary B (to May 2014), and sites ETGW1 and ETGW2 on the Eastern Tributary (Figure 7) are described for the reporting period below.

Sites WRGW1 and WRGW2 are located on opposite banks of the Waratah Rivulet, to the immediate south of Longwall 20 (Figure 7). The groundwater monitoring results for sites WRGW1 and WRGW2 are shown on Chart 8 and are compared with rainfall events and rainfall trends over a period of six years as recorded at the Waratah Rivulet catchment PV1 pluviometer (Figure 8). Sites WRGW1 and WRGW2 show comparable information over the reporting period, with rapid response to rainfall events. At the time of passage of the Longwall 21 mining face past the piezometer sites (March 2012), the measured groundwater levels dropped by about 1 m. As wet conditions prevailed at the time, this was not a climatic effect. This conclusion is supported by the observation that none of the other Waratah Rivulet piezometers showed a similar response at this time. The passage of Longwall 20 a year earlier had no obvious effect at WRGW1 or WRGW2. Water levels recovered by about 0.5 m at the end of 2012 but fell again slightly (by about 0.3 m) in 2013 when the Longwall 22A face was closest to the monitoring sites (at a distance of approximately 500 m). The water levels at sites WRGW1 and WRGW2 started to drop shortly before the start of Longwall 23A due to a dry period from May to July 2014. They continued to fall (by about 0.6 m) until heavy rainfall occurred from 18 to 20 August 2014. Throughout the reporting period, the water levels at sites WRGW1 and WRGW2 have correlated closely with rainfall trends (as indicated by the residual mass curve on Chart 8) and have not shown any response to mining.



MET-08-AD7 GMR_104A



MET-08-AD7 6MR_105A

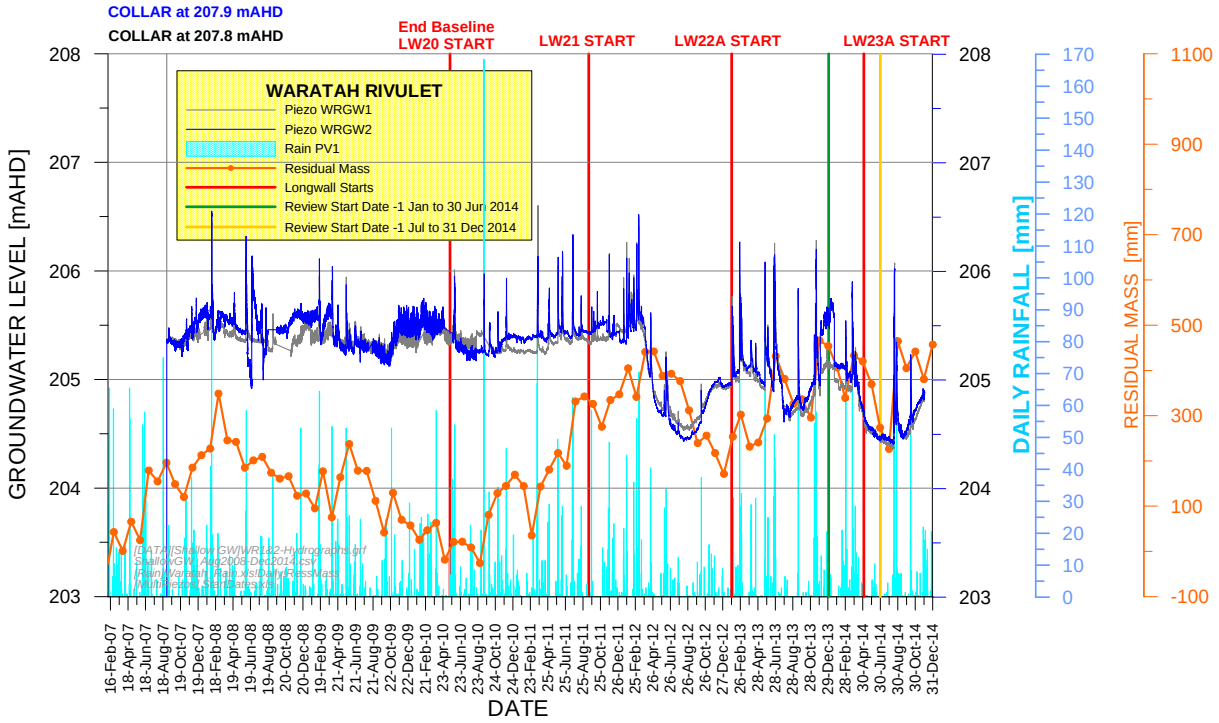


Chart 8 Shallow Groundwater Hydrographs on Waratah Rivulet at WRGW1 and WRGW2

The shallow groundwater level data that is available for Site WRGW7 on the Waratah Rivulet (Chart 9) indicates there is good correlation between the response at WRGW7 and rainfall trend, and good evidence of stream-aquifer interaction for Waratah Rivulet flow events. Site WRGW7 is located approximately 400 m downstream of Longwall 23 (Figure 7). There is a period in which data is missing for site WRGW7 as a result of multiple events of vandalism, which has included removal of the diver sensors. Metropolitan Coal has installed locked monuments at the site to reduce the risk of future vandalism.

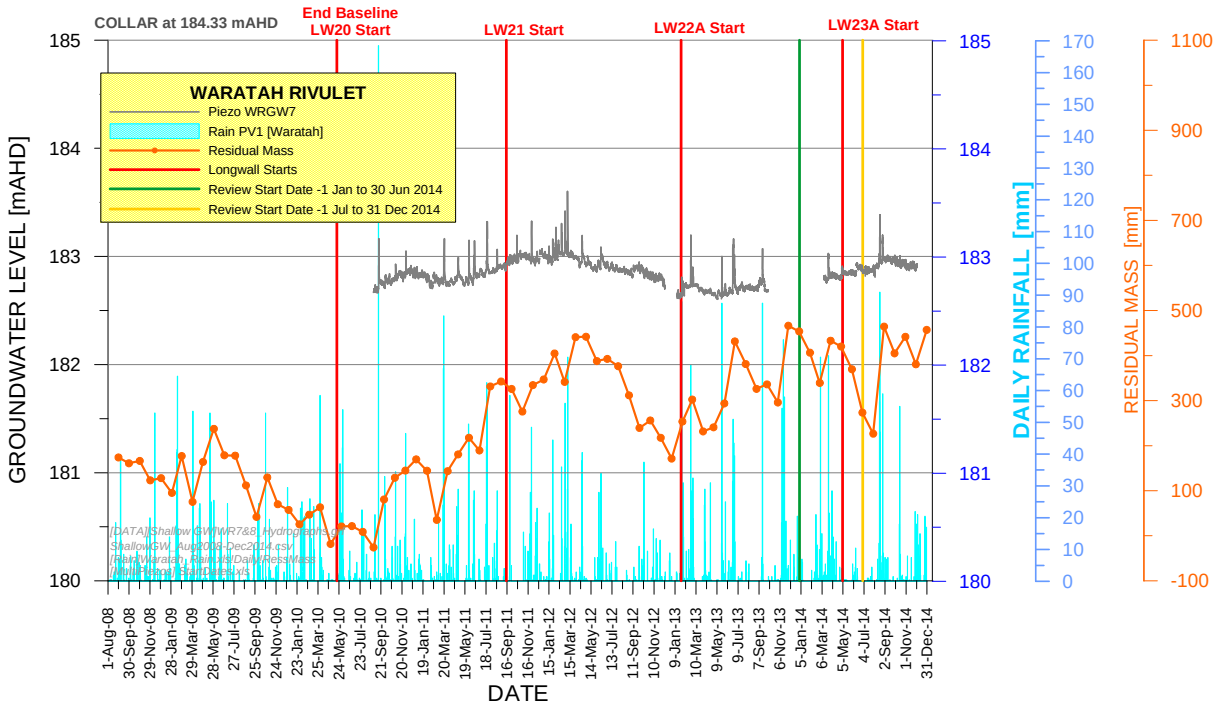


Chart 9 Shallow Groundwater Hydrograph on Waratah Rivulet at WRGW7

Site RTGW1A is located over Longwall 22A. Longwall 22A passed site RTGW1A in May 2013. Around this time the groundwater levels dropped approximately 4 m lower than experienced in the preceding dry period throughout 2012 (Chart 10) as a result of mining. Up until May 2014 the base level remained low but rapid rises in water level (of about 8 m) occurred in response to heavy rainfall events. Due to bore failure, bore RTGW1A has not been able to be dipped since December 2013. The diver was able to be downloaded up until May 2014.

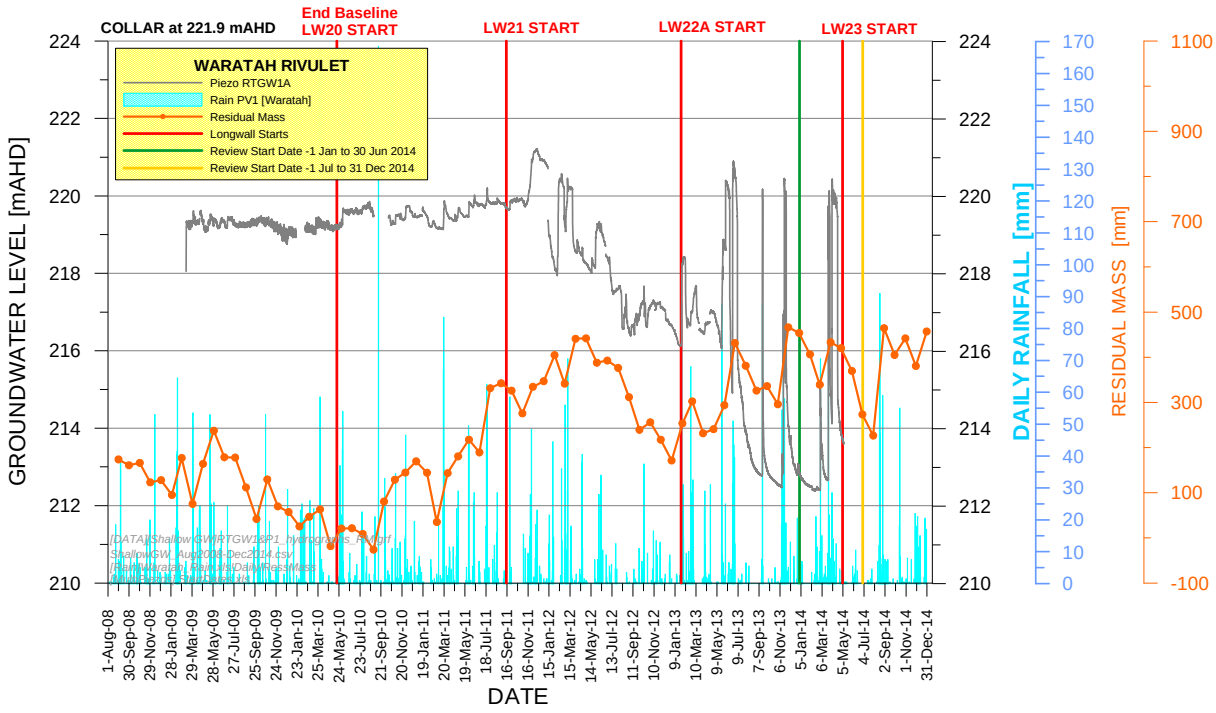


Chart 10 Shallow Groundwater Hydrograph on Tributary B at RTGW1A

At the Eastern Tributary sites ETGW1 and ETGW2, which are located approximately 1.4 km downstream of Longwall 23, shallow groundwater levels have previously followed the rainfall trends closely (Chart 11), and have continued to do so during the reporting period. The variations at these sites are unrelated to mining.

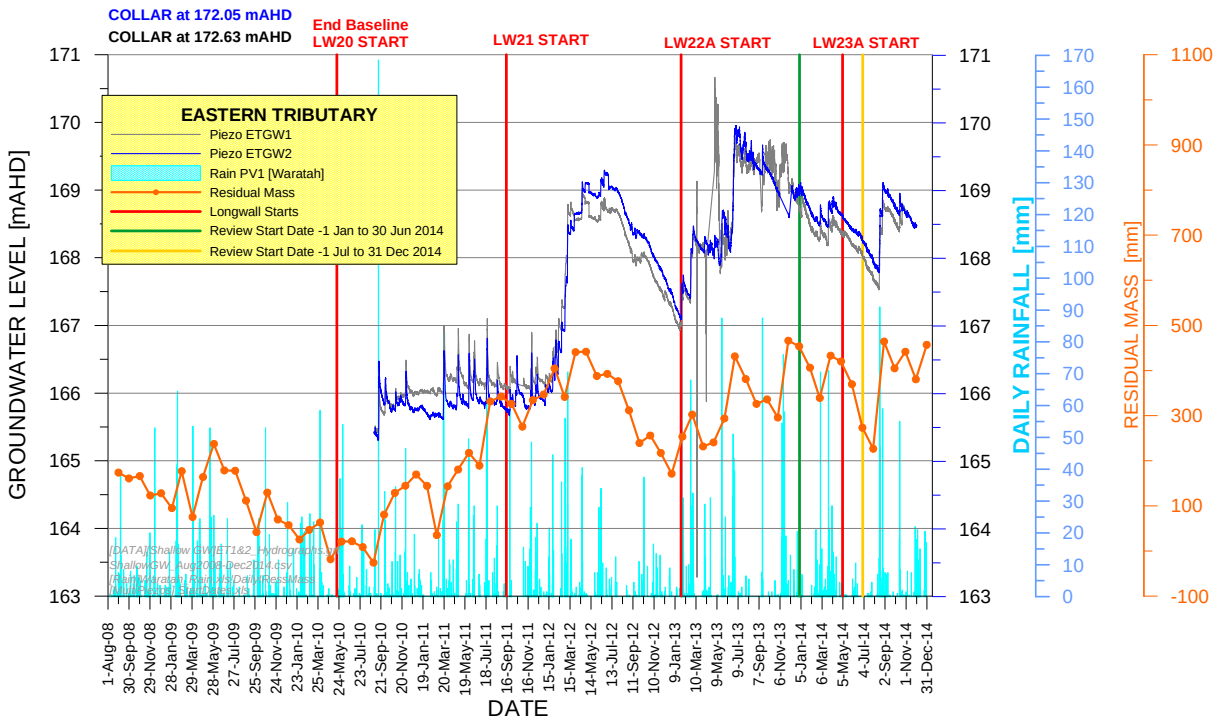


Chart 11 Shallow Groundwater Hydrograph on Eastern Tributary at ETGW1 and ETGW2

2.2.8 Deep Groundwater Levels/Pressures

Continuous groundwater level/pressure monitoring has been conducted at bores 9HGW0 (Longwall 10 Goaf Hole), 9EGW1B, 9FGW1A, 9GGW1-80, 9GGW2B, 9HGW1B, PM02, PM01, 9EGW2A, PM03, PHGW1B, PHGW2A, F6GW3 and F6GW4 in accordance with the Longwalls 23-27 Water Management Plan (Figure 7).

The results of deep groundwater level monitoring for the reporting period are described below.

The time-series head variations and vertical head differences for these bores have been examined (Charts 12 to 25), with the following outcomes:

- very few installations are providing unreliable data;
- the vibrating wire piezometers that had been slow to stabilise since installation, particularly those installed in claystones, are now generally stable;
- sites close to current mining show significant depressurisation with depth, consistent with the Project EA (Helensburgh Coal Pty Ltd, 2008); and
- sites close to old workings at Helensburgh show substantial depressurisation with depth, consistent with the Project EA.

The monitoring sites closest to Longwalls 23-27 are bore 9EGW1B (approximately 300 m north of Longwall 23A) and bore 9GGW2B (above Longwall 27 headings) (Figure 7).

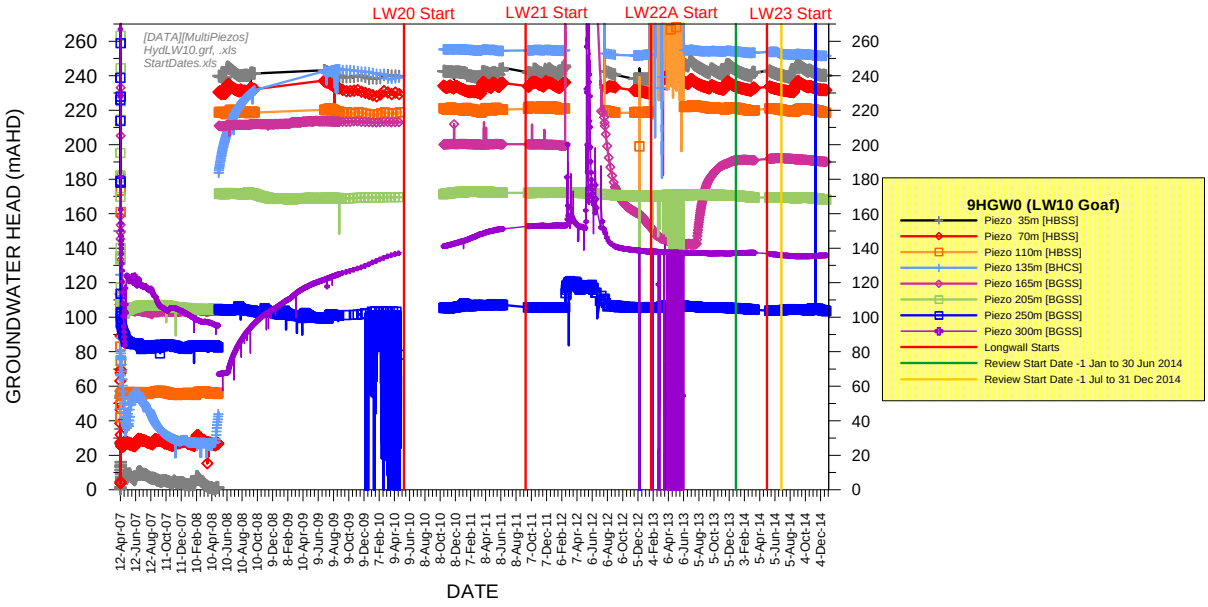


Chart 12 Time Variations in Potentiometric Heads at 9HGW0

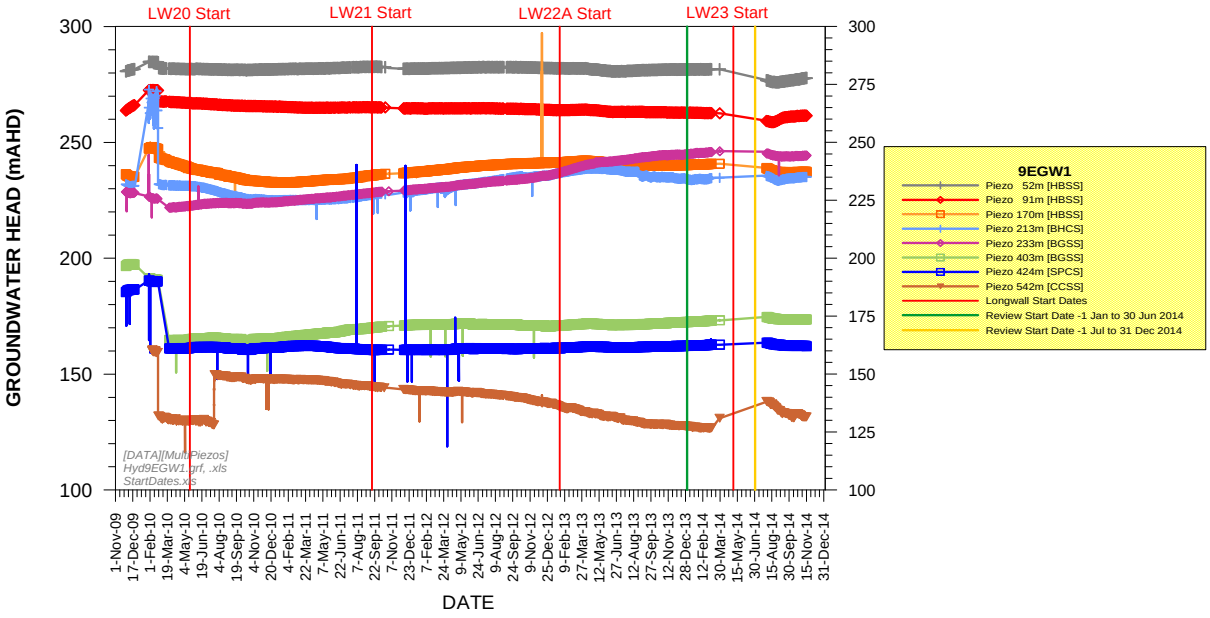


Chart 13 Time Variations in Potentiometric Heads at 9EGW1B

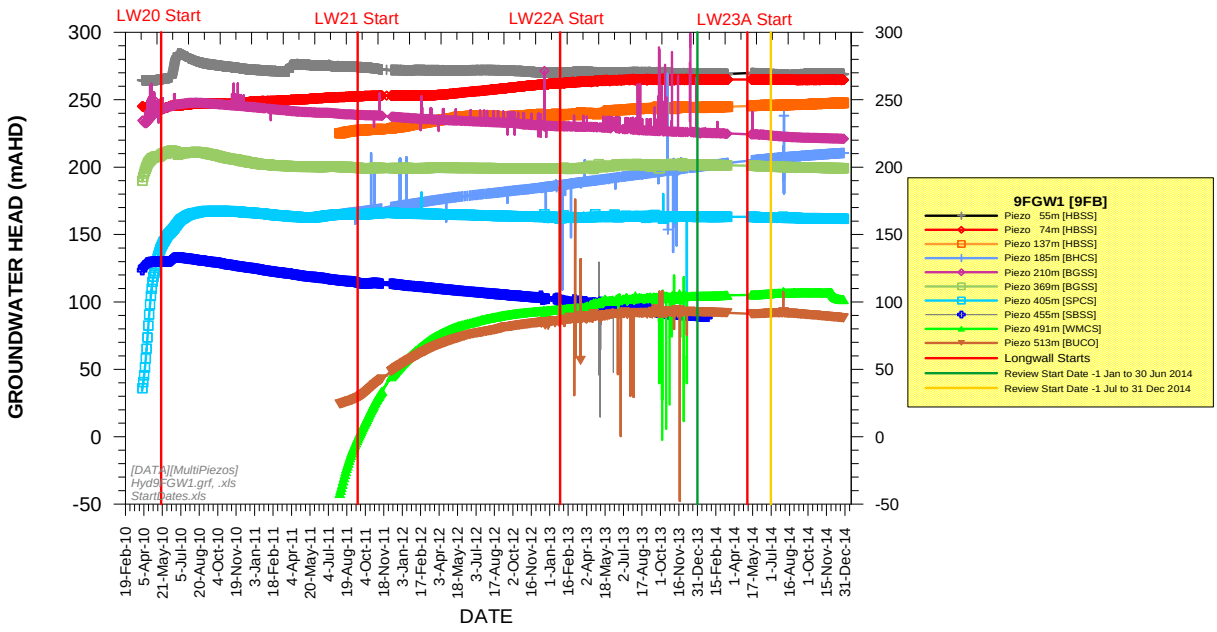


Chart 14 Time Variations in Potentiometric Heads at 9FGW1A

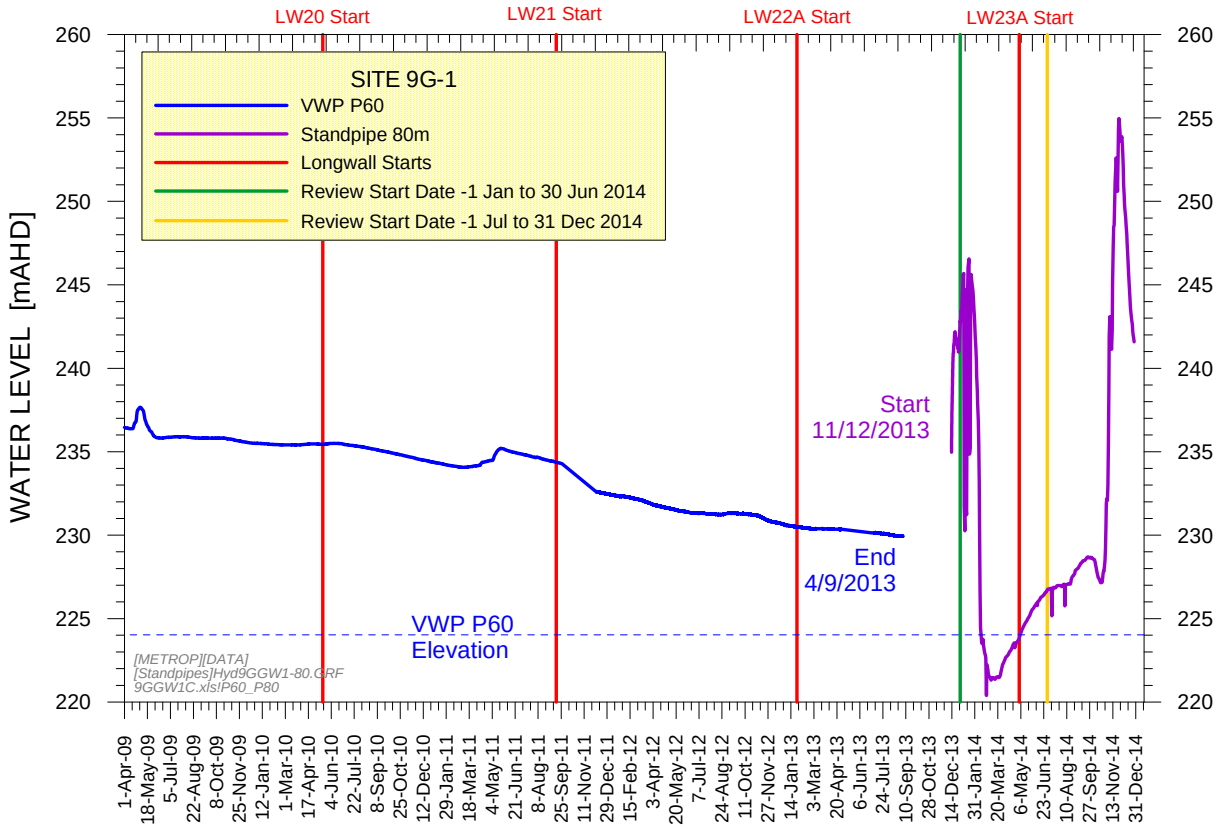


Chart 15 Time Variations in Water Table at Standpipe 9GGW1-80 and Decommissioned Vibrating Wire Piezometer 9GGW1-60

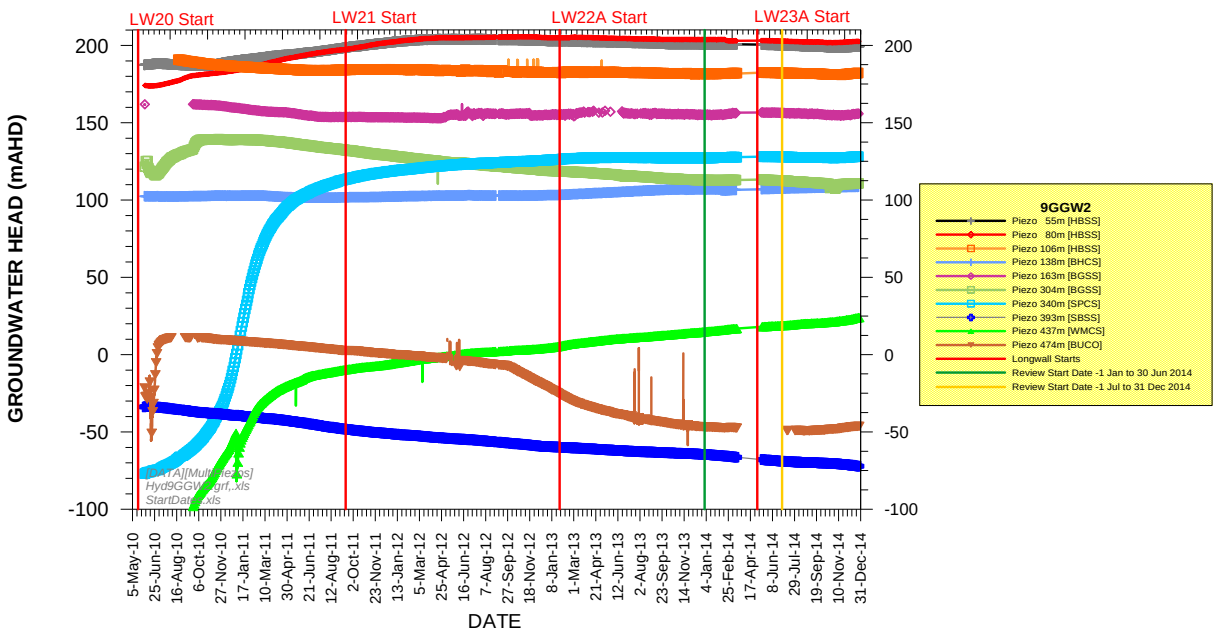


Chart 16 Time Variations in Potentiometric Heads at 9GGW2B

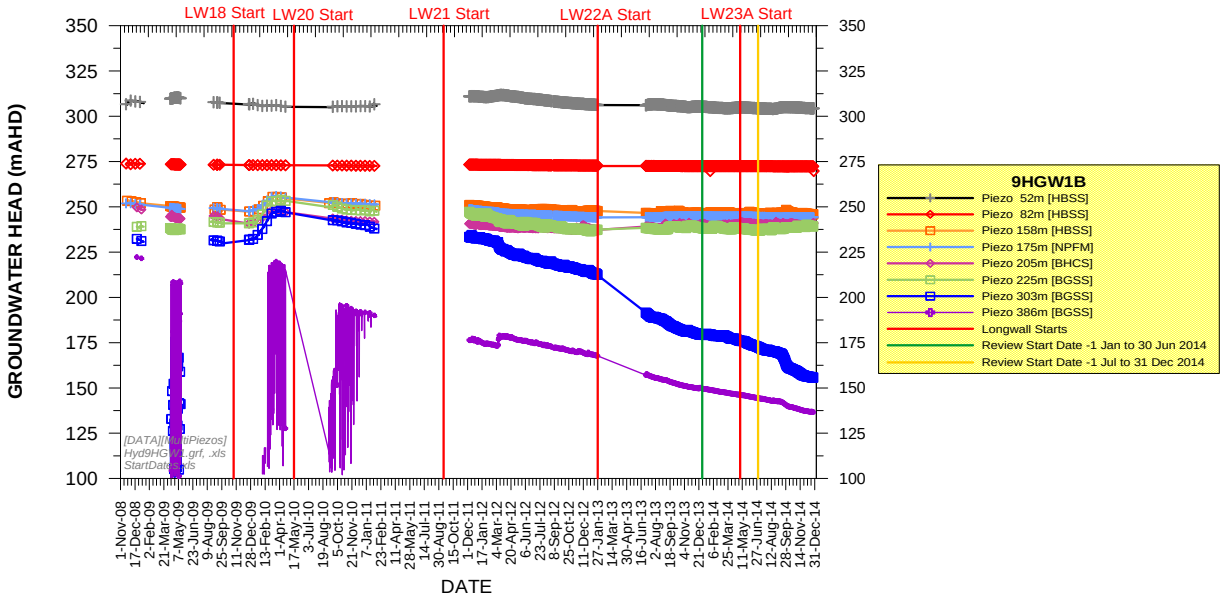


Chart 17 Time Variations in Potentiometric Heads at 9HGW1B

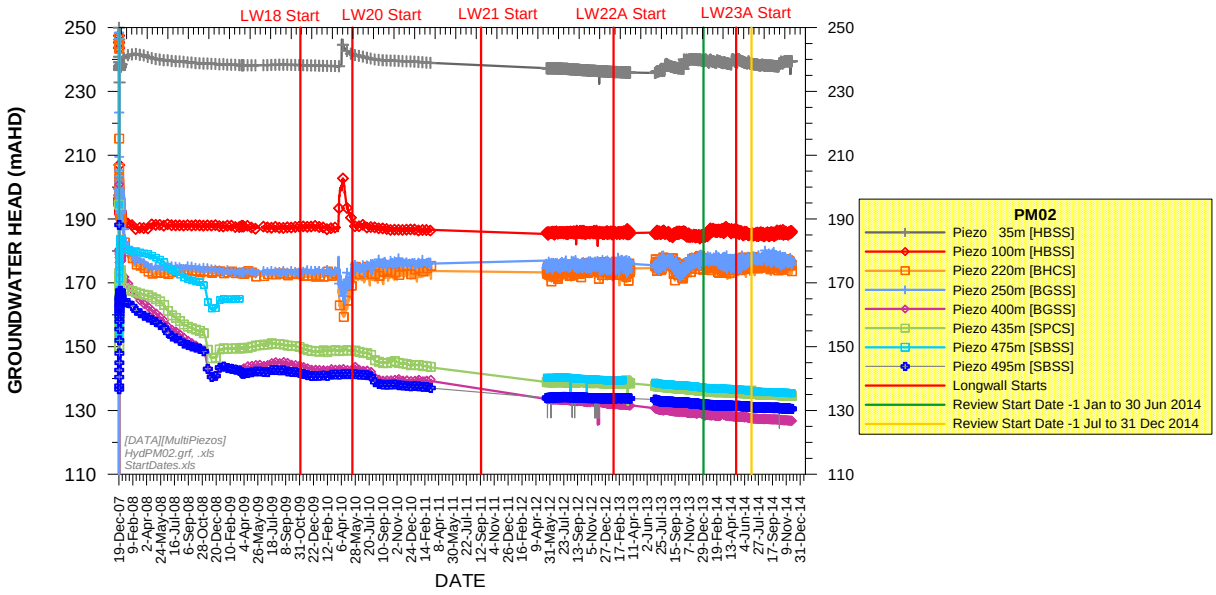


Chart 18 Time Variations in Potentiometric Heads at PM02

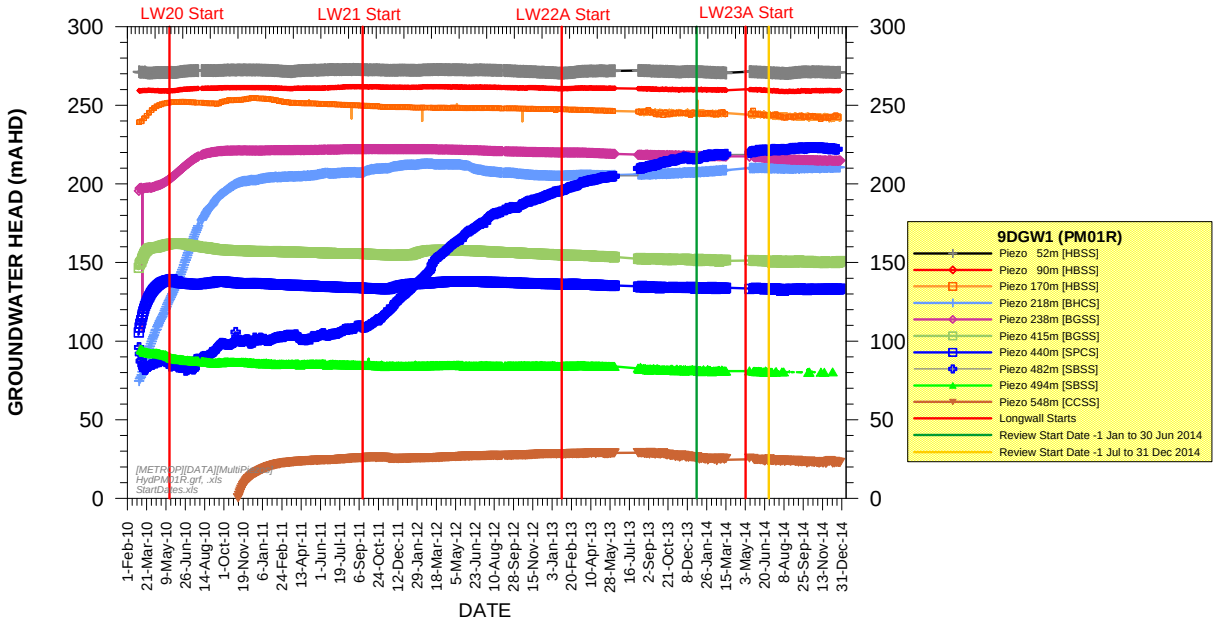


Chart 19 Time Variations in Potentiometric Heads at PM01

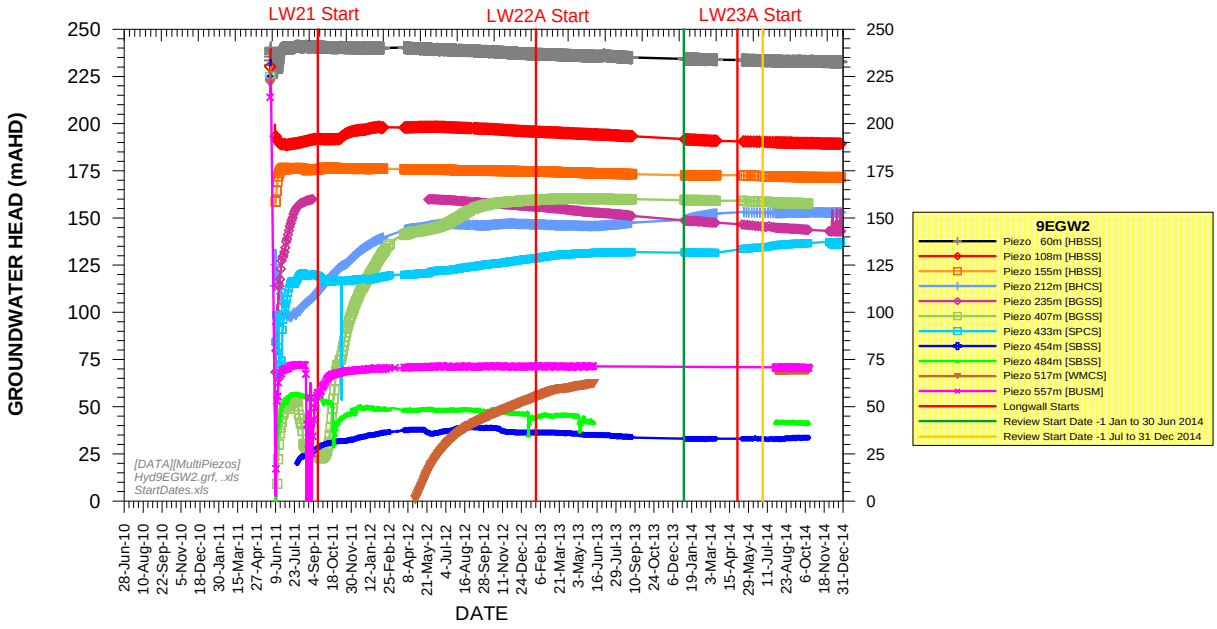


Chart 20 Time Variations in Potentiometric Heads at 9EGW2A

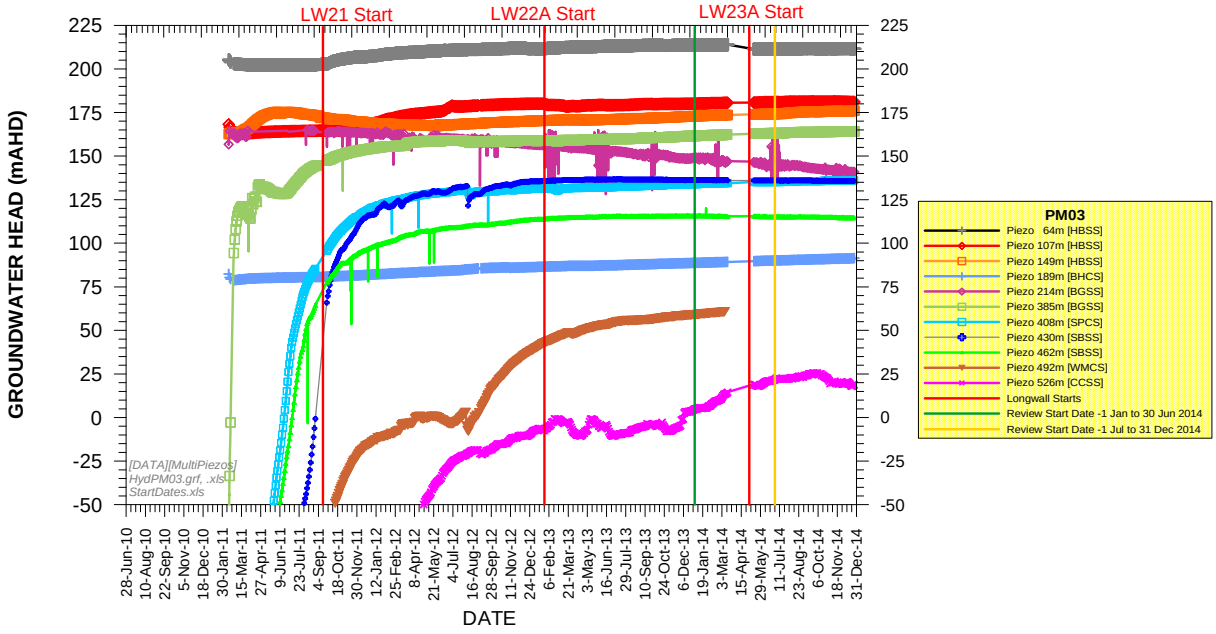


Chart 21 Time Variations in Potentiometric Heads at PM03

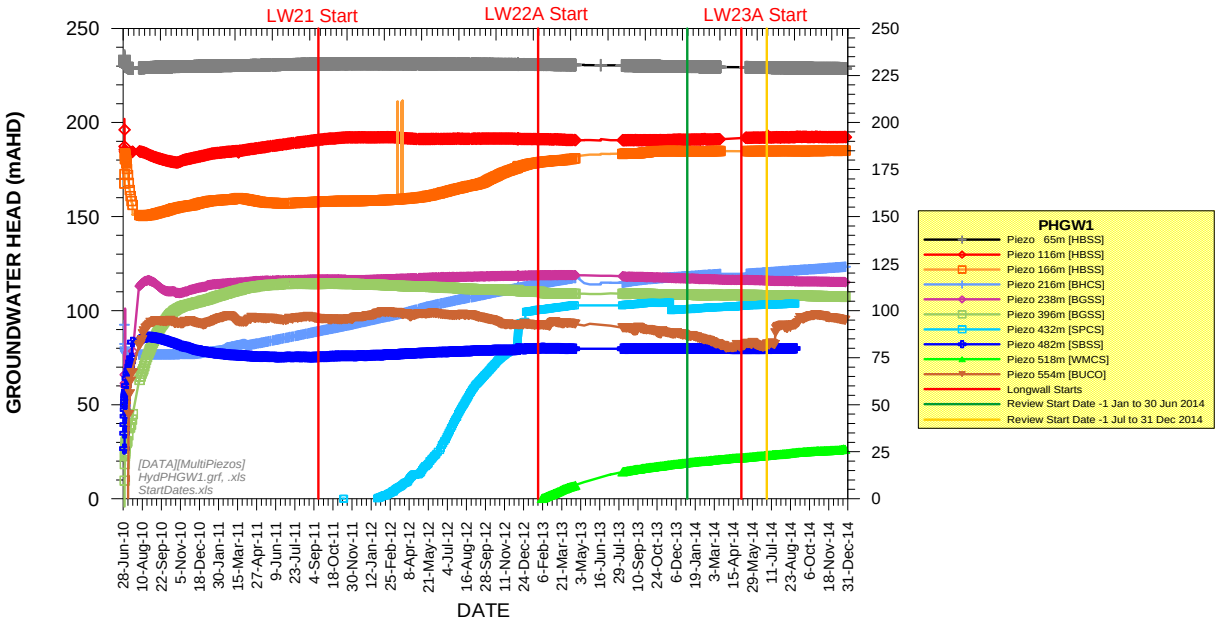


Chart 22 Time Variations in Potentiometric Heads at PHGW1B

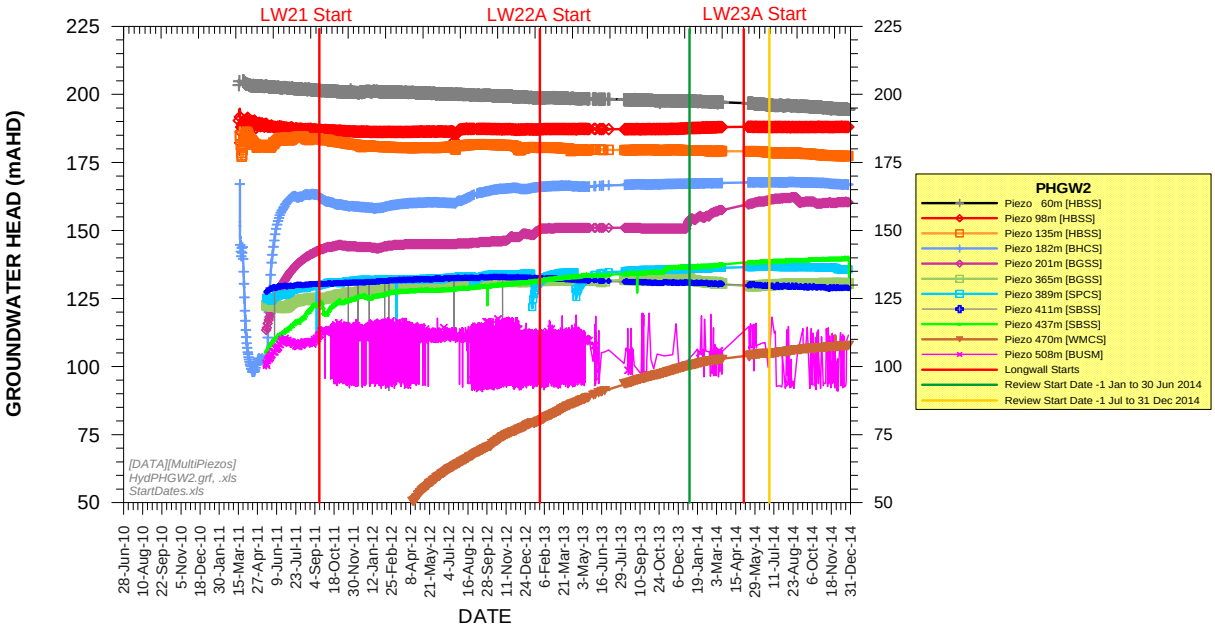


Chart 23 Time Variations in Potentiometric Heads at PHGW2A

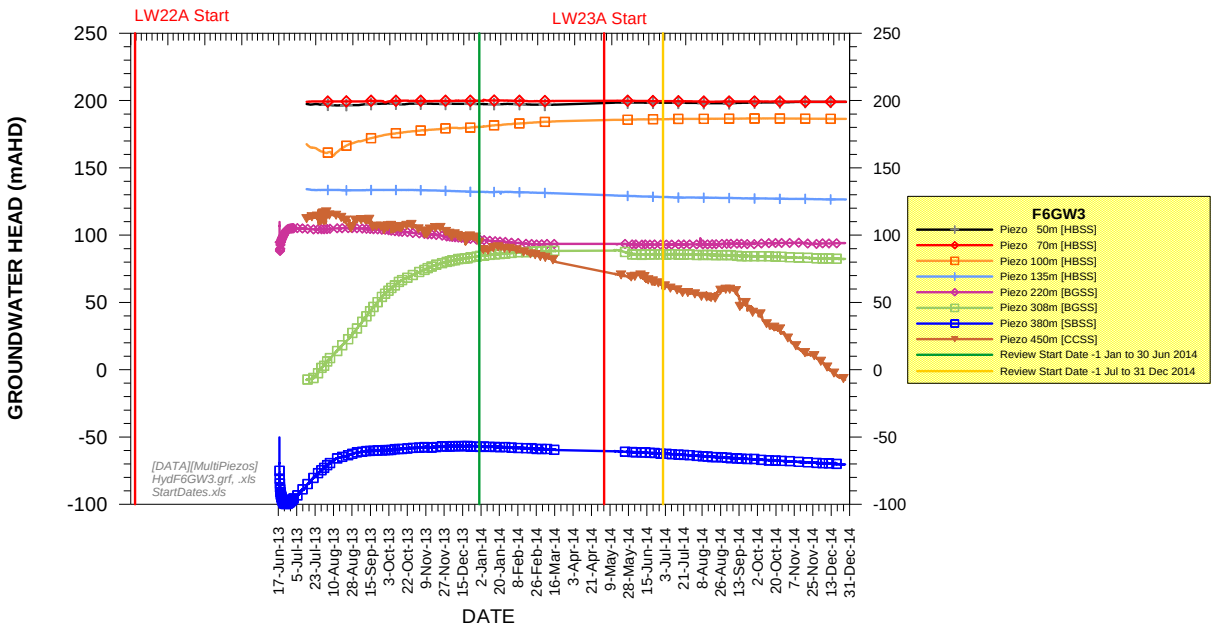


Chart 24 Time Variations in Potentiometric Heads at F6GW3

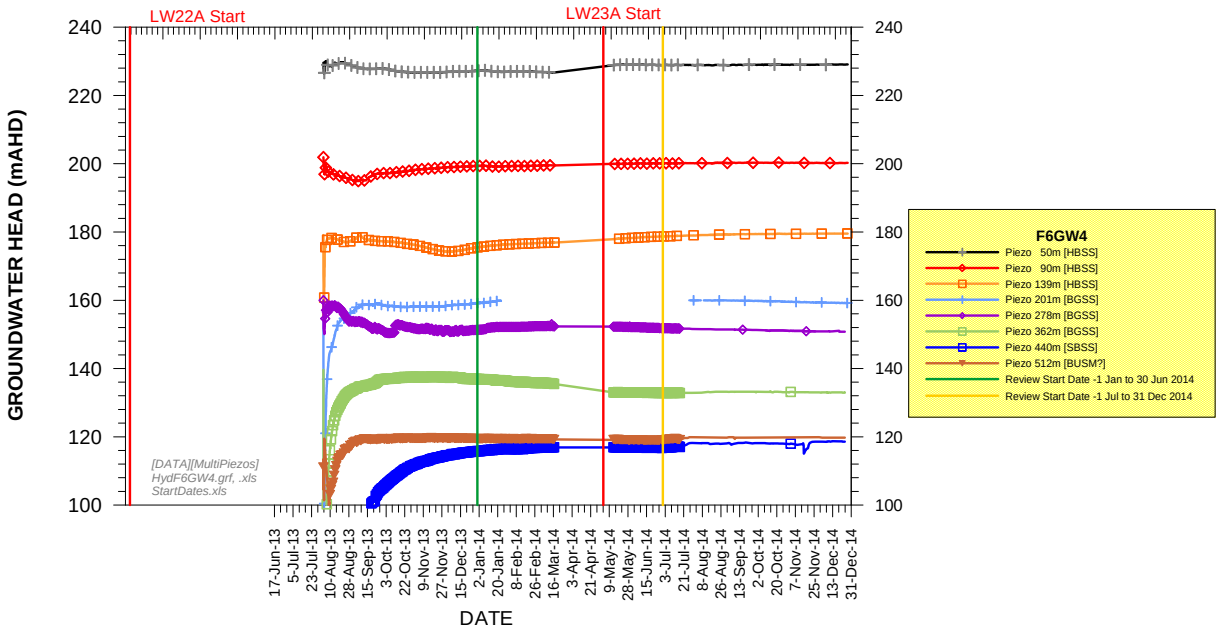


Chart 25 Time Variations in Potentiometric Heads at F6GW4

The time-series record for bore 9EGW1B is shown on Chart 13. This shows fairly stable heads that decline with depth. The deepest piezometer (542 m in Coal Cliff Sandstone) retains about 360 m pressure head, which has been declining slowly since the commencement of Longwall 20 due to far-field depressurisation. Prior to the commencement of Longwall 23A in May 2014, the groundwater head rose unexpectedly by about 11 m and then receded by about 7 m in response to a possible mining effect.

The time-series record for bore 9GGW2B is shown on Chart 16. As the hydrographs show inconsistent head variations with depth, some of the piezometers are unreliable. Gradual depressurisation is evident only in two of the three deepest piezometers (393 m in Scarborough Sandstone; 474 m in Bulli Coal seam). The pressure heads remained at about 80 m and 187 m respectively at the end of December 2014, with no apparent response to mining at the Bulli Seam level.

A qualitative assessment of data quality for the vibrating wire piezometer hydrographs in Charts 12 to 25 is presented in Table 1 in terms of "unreliable" and "unstable" responses. Reliability was assessed by considering consistency in the variation of groundwater heads with depth. Instability was assessed in terms of expected trends over the reporting period. The assessment finds that 72 percent (%) of the vibrating wire piezometer records are currently providing useful data, with 19% considered to be unreliable and 9% unstable.

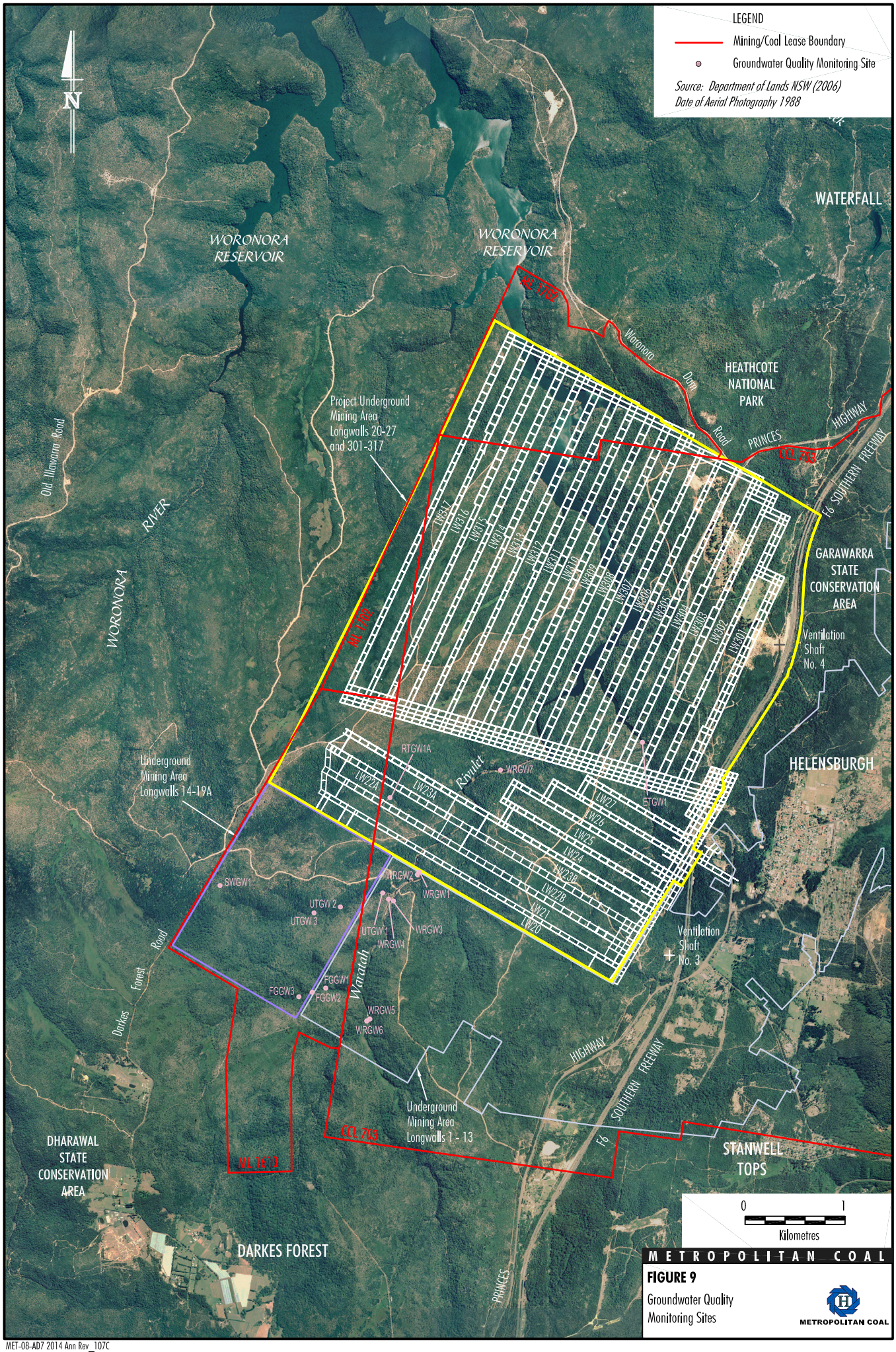
Table 1
Qualitative Assessment of Vibrating Wire Piezometer Data Quality

Site	Number of Vibrating Wire Piezometers	Number of Useful Vibrating Wire Piezometers	Number of Unstable Vibrating Wire Piezometers	Number of Unreliable Vibrating Wire Piezometers
9HGWO	8	6	0	2
9EGW1	8	6	1	1
9FGW1	10	5	3	2
9GGW2	10	6	1	3
9HGW1	8	6	0	2
PM02	8	7	0	1
PM01R	10	8	0	2
9EGW2	11	7	0	4
PM03	11	7	1	3
PHGW1	10	7	2	1
PHGW2	11	7	3	1
F6GW3	8	7	0	1
F6GW4	8	8	0	0
Total	121	87	11	23

2.2.9 Groundwater Quality

The results of shallow groundwater quality monitoring at sites WRGW1, WRGW2 and WRGW7 along the Waratah Rivulet, and sites ETGW1 and ETGW2 on the Eastern Tributary (Figure 9) are described below.

Water quality parameters sampled include EC, pH, Eh, Ca, Mg, Na, K, Cl, SO_4, HCO_3, Ba, Sr, Mn, Fe, Zn, Co and Al. The samples collected for the analysis of metals have been field filtered.



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Monitoring results for Fe, Mn and pH levels at sites WRGW1, WRGW2 and WRGW7 are provided on Charts 26 to 28. Monitoring results for sites WRGW3 to WRGW6 are also shown on Charts 26 to 28 to show trends over the length of the Waratah Rivulet. Rainfall events over a period of six years, as recorded at the Waratah Rivulet catchment PV1 pluviometer (Figure 8), provide a context for the substantial fluctuations in parameters; however, there is no obvious relationship with rainfall.

The key observations at the Waratah Rivulet groundwater quality monitoring sites (WRGW1 to WRGW7) are:

- Fe concentrations are usually in the 1 - 10 milligrams per litre (mg/L) range, with the exception of sites WRGW1 and WRGW2. A peak Fe concentration of 12 mg/L occurred at WRGW1 and WRGW2 in the first half of 2014. A peak concentration of 10.0 mg/L occurred at WRGW2 in the second half of 2014, with the corresponding concentration at WRGW1 being 5.2 mg/L (Chart 26). Higher Fe concentrations were recorded at site WRGW7 than previous reporting periods. However, they remain within the range previously observed at upstream sites.
- Mn concentrations are always less than 1 mg/L (Chart 27). A peak Mn concentration of 0.85 mg/L occurred at WRGW1 in the first half of 2014 and a peak concentration of 0.69 mg/L occurred at WRGW3 in the second half of 2014 (Chart 27).
- Fe and Mn concentrations increase with distance downstream to WRGW1 and WRGW2 and then decrease (relative to sites WRGW1 and WRGW2) with distance downstream to WRGW7.
- Groundwater is generally acidic with pH usually between pH 5.5 and 7. Occasional excursions in excess of pH 9 and less than pH 5 in prior reporting periods are unsustained outliers. In 2014, values were predominantly in the pH 5.5 - 6.5 range.
- Aluminium was below the detection limit in all samples.

The observations are consistent with those reported previously.

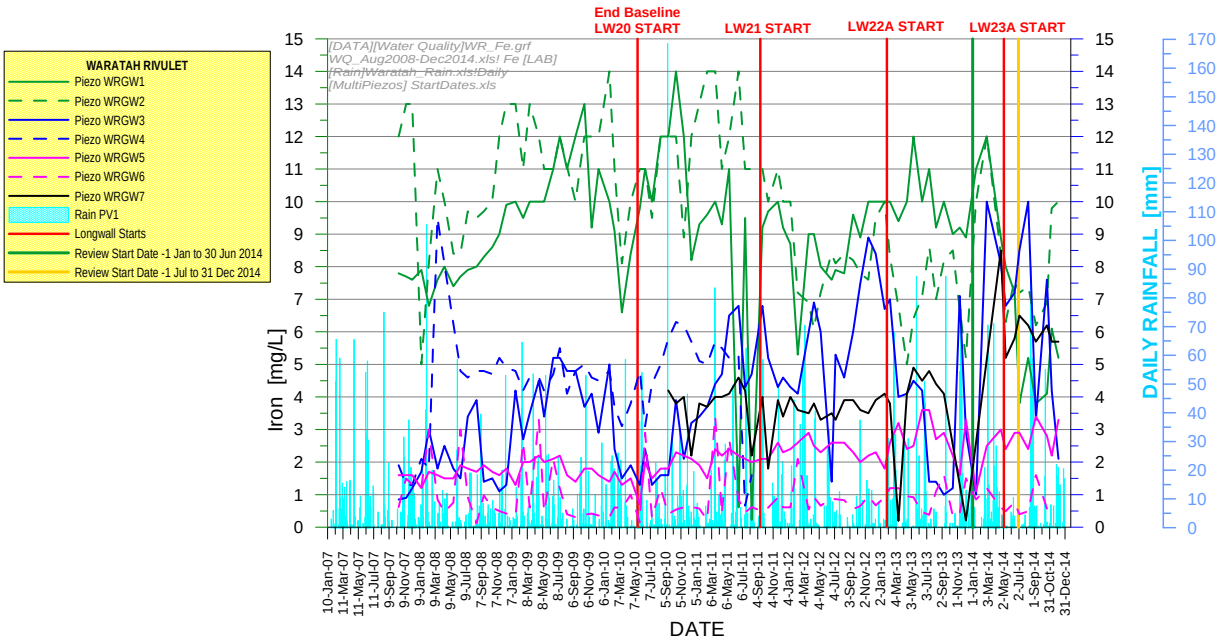


Chart 26 Iron Concentrations at WRGW1 to WRGW7

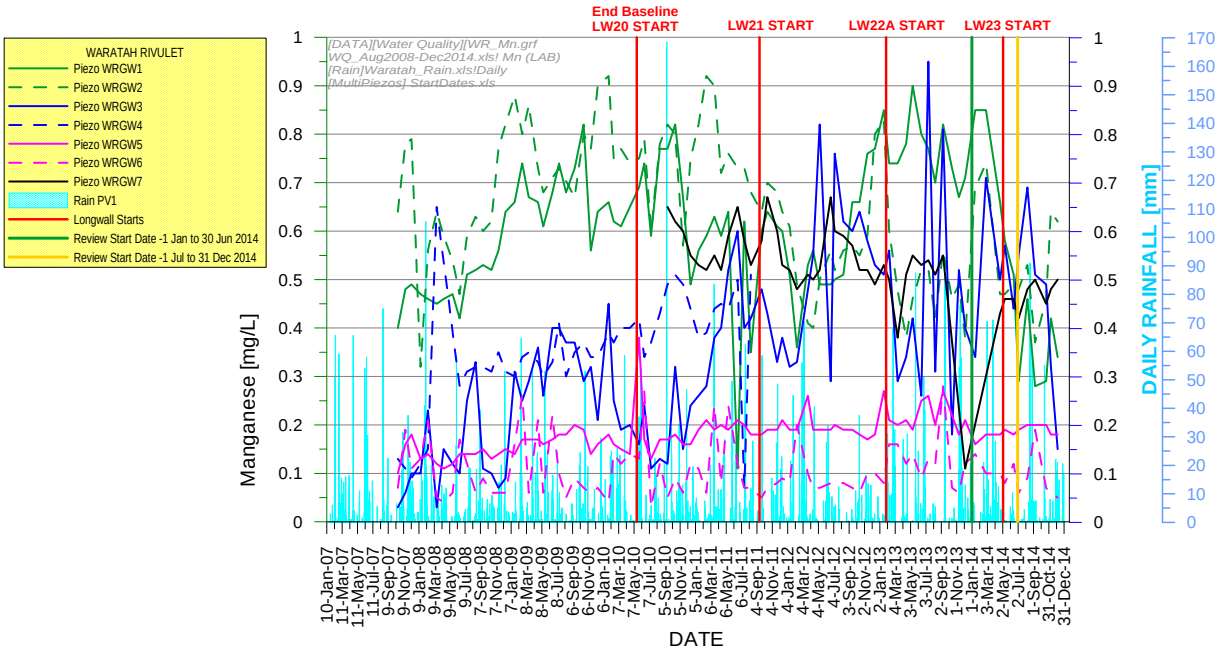


Chart 27 Manganese Concentrations at WRGW1 to WRGW7

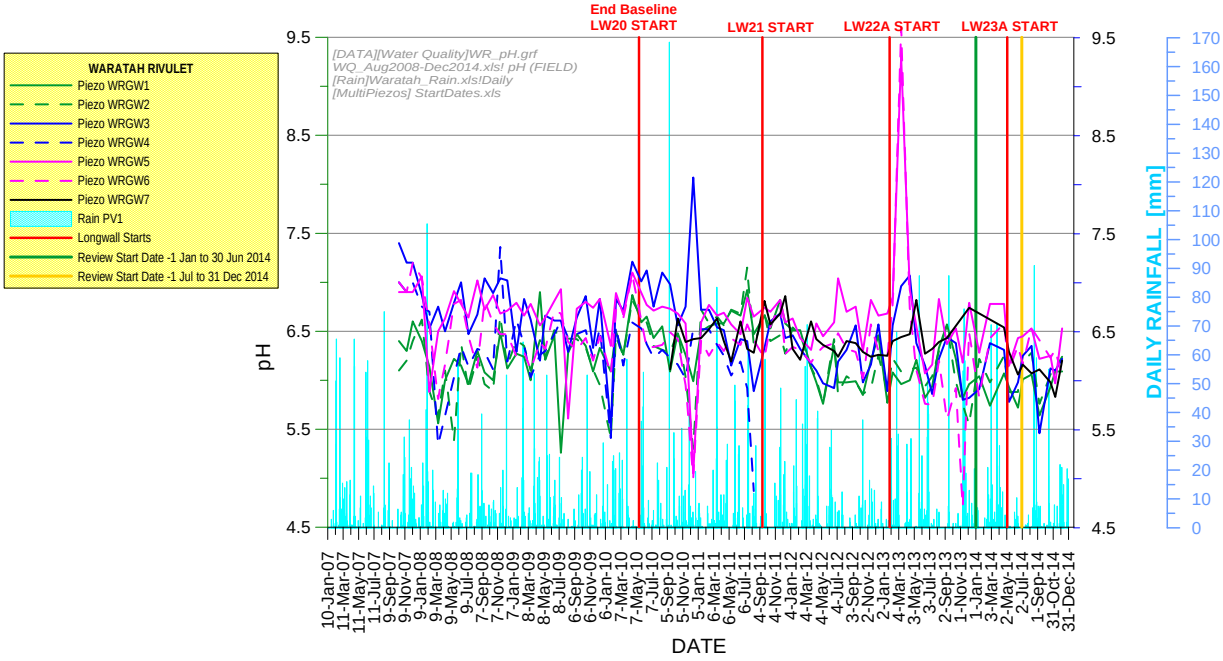


Chart 28 pH Levels at WRGW1 to WRGW7

Site RTGW1A on Tributary B (over Longwall 22A) has not been able to be sampled for groundwater quality since December 2013 as a result of bore failure.

Groundwater quality at the two Eastern Tributary sites (ETGW1, ETGW2) is shown on Charts 29 to 31 for Fe, Mn and pH, respectively. Rainfall events over a period of six years, as recorded at the Waratah Rivulet catchment PV1 pluviometer (Figure 8), provide a context for the mild fluctuations in parameters; however, there is no obvious relationship with rainfall. Fe concentrations are high, ranging from 12 to 14 mg/L (Chart 29). Mn concentrations are low at both sites, and have ranged between 0.47 and 0.60 mg/L in the first half of 2014 (Chart 30). In the second half of 2014, Mn concentrations ranged between 0.47 and 0.63 mg/L (Chart 30). Al was below the detection limit in all samples. The groundwater is generally acidic, predominantly between pH 5.3 and pH 5.9 in the reporting period (Chart 31). However, one instance of pH less than 5 occurred at ETGW1 which did not occur at ETGW2 (Chart 31).

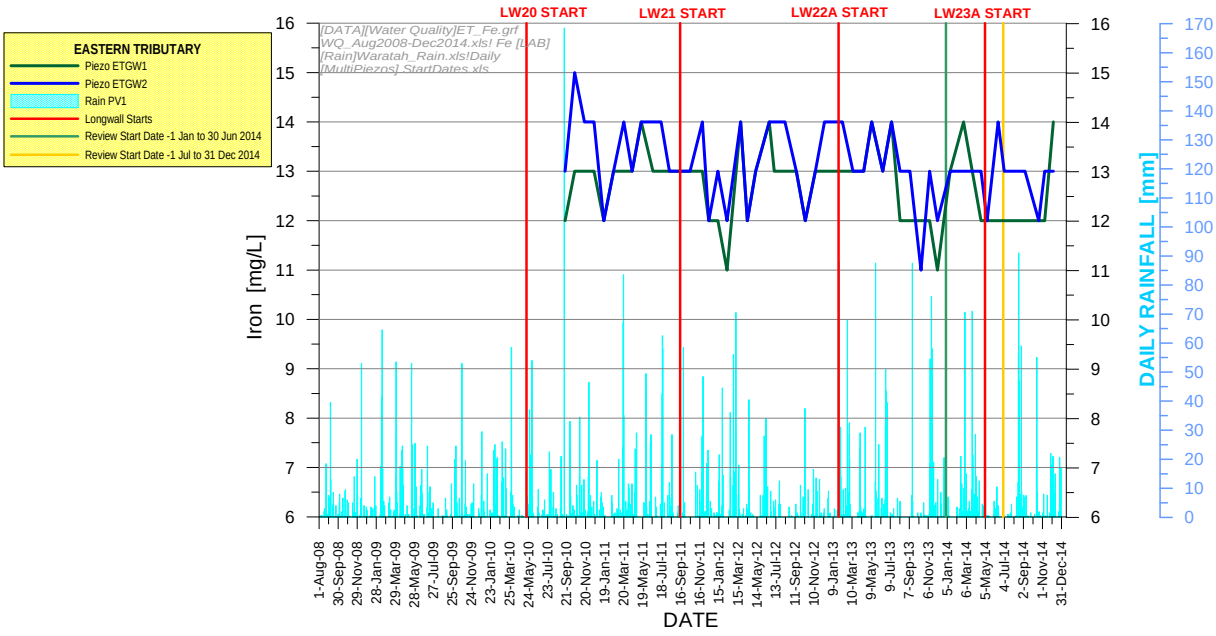


Chart 29 Iron Concentrations at ETGW1 and ETGW2

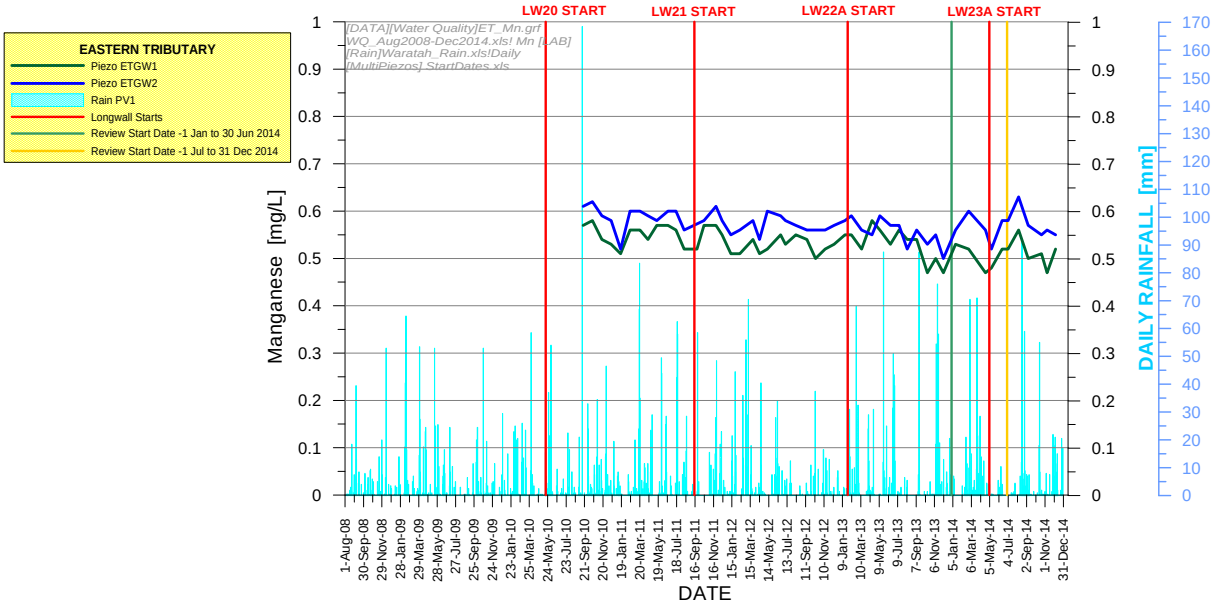


Chart 30 Manganese Concentrations at ETGW1 and ETGW2

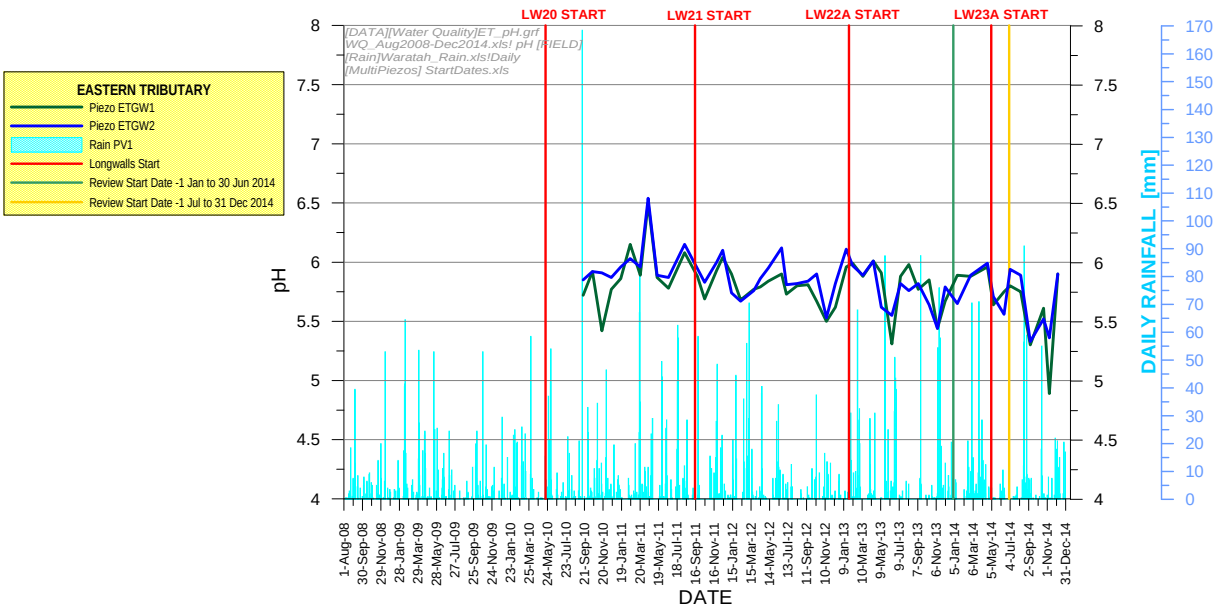


Chart 31 pH Levels at ETGW1 and ETGW2

2.2.10 Inspections of Mine Workings

Metropolitan Coal has developed an In-rush Hazard Management Plan required by the NSW *Coal Mines Health and Safety Regulation, 2006* to manage the potential risk of water in-rush. In addition to shift inspections conducted by statutory officials that report on any abnormal conditions at the working face and in outbye areas, Metropolitan Coal conducts statutory weekly inspections of development workings to identify water accumulations. A weekly audit of the statutory inspections is conducted by the shift undermanager. In the event the statutory inspection identifies the potential for in-rush, an investigation is conducted by the Senior Mine Supervisor on that shift and reported to the Mine Manager.

The mine inspections did not identify any abnormal water flows from the goaf, geological structure, or strata generally during the reporting period.

2.2.11 Mine Water Make

In accordance with the Metropolitan Coal Longwalls 23-27 Water Management Plan, Metropolitan Coal has also monitored the mine water balance. The inferred water make (i.e. groundwater that has seeped into the mine through the strata) has been calculated from the difference between total mine inflows (reticulated water into the mine, moisture in the downcast ventilation, and the *in-situ* coal moisture content) and total mine outflows (reticulated water out of the mine, moisture in the exhaust ventilation, and moisture in the ROM coal).

Monitoring of the mine water balance comprises:

- Metered water reticulated into the mine (recorded continuously and downloaded monthly).
- Metered water reticulated out of the mine (recorded continuously and downloaded monthly).
- Manual measurement of moisture content into and out of the mine through the mine ventilation system using a digital psychrometer. The frequency of readings will be as follows:
  - every hour over a 9 hour period on two occasions during a 12 month period;
  - daily (week day) except public holidays or other circumstances (access, fan maintenance, etc.) that prevent readings to be taken; and
  - once per week as a minimum.
- Measurement of the *in-situ* moisture content of the coal during channel sampling for coal quality.
- Measurement of the moisture content of ROM coal conveyed out of the mine at the drift portal using an automated moisture scanner. A fully automated data acquisition system records and stores the data.

Water Make Calculation Assumptions

The inferred water make (i.e. groundwater that has seeped into the mine through the strata) is calculated from the difference between total mine inflows (reticulated water into the mine, moisture in the downcast ventilation, and the *in-situ* coal moisture content) and total mine outflows (reticulated water out of the mine, moisture in the exhaust ventilation, and moisture in the ROM coal).

Given the large fluctuations in daily water usage and the cycle period for water entering the mine, being used by machinery, and draining to sumps for return pumping to the surface, a 20 day average is used to provide a more reliable estimate of water make.

The estimated daily mine water make during the reporting period is shown on Chart 32. The following assumptions were made in the estimation of water make:

- Where metered data was unavailable, no estimation of daily water make was calculated and the graph shows a gap.
- Where no air moisture measurement for the downcast ventilation was available for a given day, the average of all measured values was used (0.156 megalitres per day [ML/day]).
- Where no ROM coal moisture content was available for a given day, the average of all measured values was used (6.78%).
- The *in-situ* coal moisture content was assumed to be 1.5%.

The 20 day average daily mine water make was less than 2 ML/day during the reporting period.

Note that the increased water make during the period April 2011 to July 2011 was a result of dewatering of old workings in advance of the 200 Mains Panel.

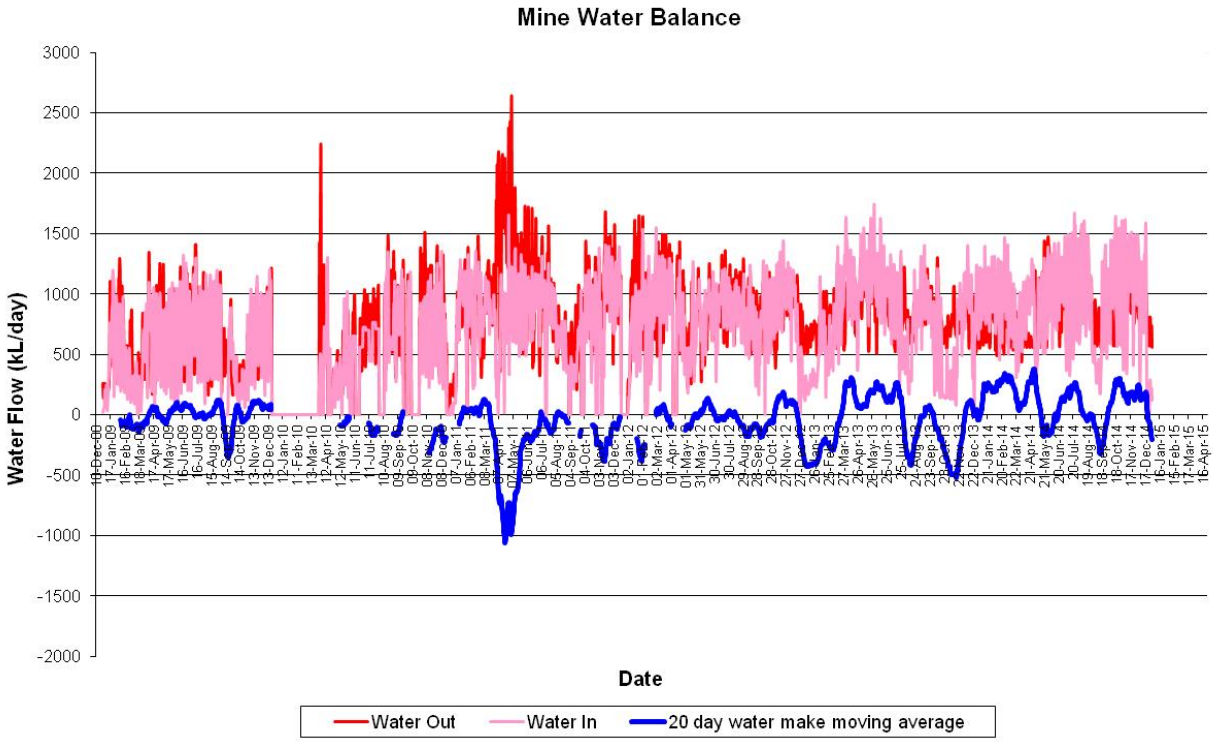


Chart 32 Estimated Daily Mine Water Make

2.3 ASSESSMENT OF ENVIRONMENTAL PERFORMANCE

The performance indicators and subsidence impact performance measures described below have been developed to address the predictions of subsidence impacts and environmental consequences on water resources and watercourses included in the Project EA, Preferred Project Report (PPR) (Helensburgh Coal, 2009) and Metropolitan Coal Longwalls 23-27 Extraction Plan.

2.3.1 Quantity of Water Resources Reaching the Woronora Reservoir

Surface water flow monitoring is conducted at the SCA-owned gauging stations on the Waratah Rivulet (GS2132102) and Woronora River (GS2132101) and at the OEH gauging station on O'Hares Creek at Wedderburn (GS213200).

Water flow data is analysed to assess whether the performance indicator below has been exceeded.

Analysis against Performance Indicator

Performance Indicator:

Changes in the quantity of water entering Woronora Reservoir is not significantly different post-mining compared to pre-mining, that is not also occurring in the control catchment(s).

Consistent with the Metropolitan Coal Longwalls 23-27 Water Management Plan, data is analysed to assess whether a statistically significant reduction in the quantity of water entering Woronora Reservoir in the post-mine period relative to the pre-mine period has occurred, that has not also occurred in the control catchment(s), specifically:

- The monitored flow rates on Waratah Rivulet and the control catchments are integrated over successive 14 day periods for comparison with the corresponding integrated flows (14 day totals) predicted by the AWBM models of the same catchments.
- The ratio of total monitored flow divided by AWBM predicted flow is calculated at 14 day intervals commencing at the end of the baseline period and advancing from the commencement of Longwall 20.

The performance indicator is considered to have been exceeded if the median of the ratios for the sliding 1 year period in the Waratah Rivulet falls below the 20th percentile of the baseline data, unless the same is also occurring in data for the control sites.

Metropolitan Coal received updates from the SCA in relation to the flow rating curves, recent gaugings and revised flow data for the Waratah Rivulet and Woronora River gauging stations. A review by Gilbert & Associates has indicated there are some discrepancies in flows generated using the SCA's current rating curves for the Waratah Rivulet and Woronora River gauging stations which compromise Metropolitan Coal's ability to confidently assess the performance indicator for quality of water resources reaching the Woronora Reservoir.

Metropolitan Coal is seeking to remedy this situation by regenerating the current flow records from the Waratah Rivulet and Woronora River gauging stations using amended rating relationships developed by Metropolitan Coal. Re-calibrated catchment models will be developed by Gilbert & Associates for the Waratah Rivulet and Woronora River gauging stations in the next reporting period.

A review of the rating curve for the gauging station on O'Hares Creek at Wedderburn has also been conducted during the reporting period. A re-calibrated catchment model will also be developed for the O'Hares Creek gauging station at Wedderburn in the next reporting period.

Analysis against Subsidence Impact Performance Measure

Consistent with the Metropolitan Coal Longwalls 23-27 Water Management Plan, if data analysis indicates the performance indicator has been exceeded or is likely to be exceeded, an assessment is made against the following subsidence impact performance measure.

Subsidence Impact Performance Measure:

Negligible reduction to the quantity of water resources reaching the Woronora Reservoir.

The subsidence impact performance measure is considered to have been exceeded if analysis of the monitoring and modelling results confirms that the Project has resulted in a greater than negligible reduction in the quantity of water resources reaching the Woronora Reservoir.

The performance indicator will be assessed following re-calibration of the catchment models.

2.3.2 Quality of Water Resources Reaching the Woronora Reservoir

Water quality sampling is conducted on the Waratah Rivulet (site WRWQ9), Eastern Tributary (ETWQ AU[1]) and Woronora River (WOWQ2), near the inflow points to the Woronora Reservoir (Figure 6). The field filtered[2] water quality data has been analysed for key water quality parameters of relevance to water supply, namely:

- iron;
- aluminium; and
- manganese.

Monitoring of water quality in areas subject to mining indicates that the effects of subsidence on water quality have been most noticeable in iron, manganese, and to a lesser extent, aluminium (Gilbert & Associates, 2008).

Water quality data from sites WRWQ9 and ETWQ AU is analysed against monitoring data collected at both sites in the baseline period and against water quality data collected from site WOWQ2 on the Woronora River. Data analysis is conducted to assess whether the performance indicator below has been exceeded.

Analysis against Performance Indicator

Performance Indicator:

Changes in the quality of water entering Woronora Reservoir are not significantly different post-mining compared to pre-mining concentrations that are not also occurring at control site WOWQ2.

During the reporting period Metropolitan Coal revised the Metropolitan Coal Longwalls 23-27 Water Management Plan (Version D) to include changes to the analysis of this water quality performance indicator in response to the Evans & Peck (2012; 2013) peer review recommendations. As these revisions have not yet been approved, the currently approved analysis methods have been used to assess the water quality performance indicator, with the exception of the assessment for site ETWQ AU which has used an extended baseline period for the assessment of the performance indicator (detailed further below).

Consistent with the existing approved Metropolitan Coal Longwalls 23-27 Water Management Plan, the performance indicator is considered to have been exceeded if data analysis indicates a statistically significant change in the quality of water post-mining of Longwall 20. Specifically if:

- any water quality parameters exceed the baseline mean plus two standard deviations for two consecutive months; or
- the sliding 12 month mean for any water quality parameter exceeds the baseline mean plus one standard deviation; and
- there was not a similar increase in the same measure(s) at the control site.

[1] It is noted that site ETWQ AU was recently thought to be in the same location as site ETWQ2 that is used in the performance indicator for Longwalls 20-22, however this is not the case. Site ETWQ2 is the same as site ETWQ U shown on Figure 6, situated downstream of Longwalls 20-22. Site ETWQ AU is considered to be the most appropriate site for the assessment of Longwalls 23-27 as it is situated near to the inflow point to the Woronora Reservoir and downstream of Longwalls 23-27 (Figure 6).

[2] The field filtered concentrations are taken to be equivalent to the dissolved fraction.

Assessment of Water Quality at Site WRWQ9

Plots showing the concentrations of dissolved iron, dissolved aluminium and dissolved manganese recorded at sampling site WRWQ9 in relation to the baseline mean plus two standard deviations are shown on Charts 33 to 35. Charts 36 to 38 show the concentrations of dissolved iron, dissolved aluminium and dissolved manganese recorded at control site WOWQ2 in comparison to the baseline mean plus two standard deviations[3].

There were no exceedances of the baseline mean plus two standard deviations for two consecutive months for dissolved iron, dissolved aluminium or dissolved manganese in Waratah Rivulet at WRWQ9 during the reporting period (Charts 33 to 35). There were also no exceedances of the baseline mean plus two standard deviations levels for two consecutive months for dissolved iron, dissolved aluminium or dissolved manganese at the control site WOWQ2 during the reporting period (Charts 36 to 38).

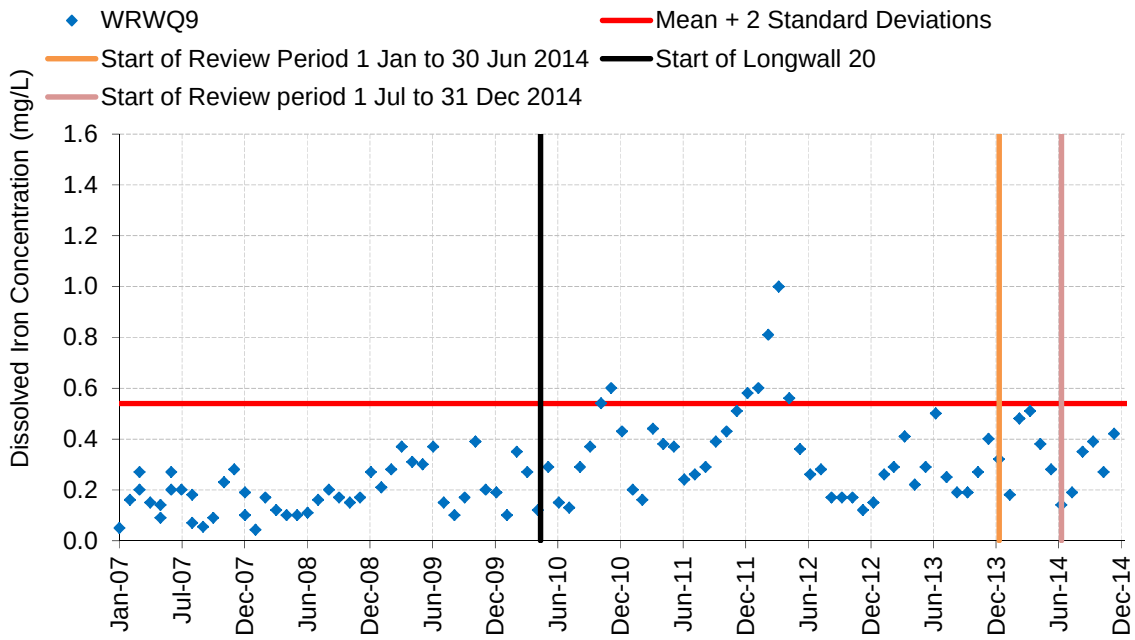


Chart 33 Dissolved Iron Concentrations in Waratah Rivulet at WRWQ9

[3] Note, since previous reporting the charts have been updated to include the additional baseline data available since September 2006 for site WRWQ9 and since October 2007 for site WOWQ2 in response to the SCA's comments on the revised Longwalls 20-22 and Longwalls 23-27 Water Management Plans.

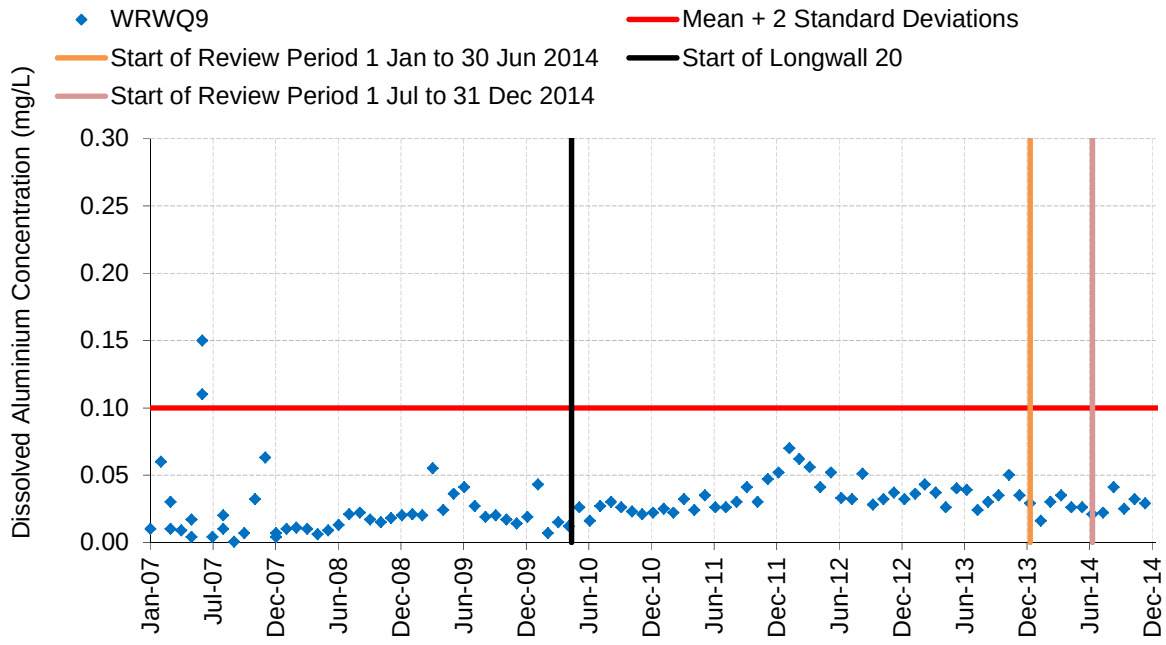


Chart 34 Dissolved Aluminium Concentrations in Waratah Rivulet at WRWQ9

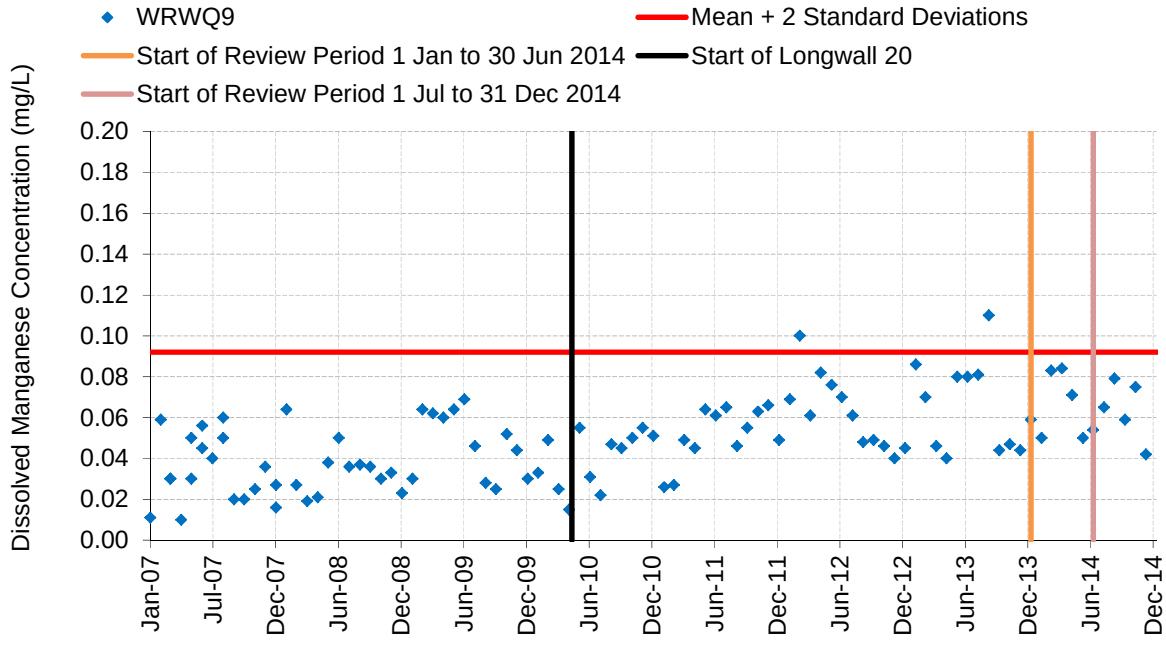


Chart 35 Dissolved Manganese Concentrations in Waratah Rivulet at WRWQ9

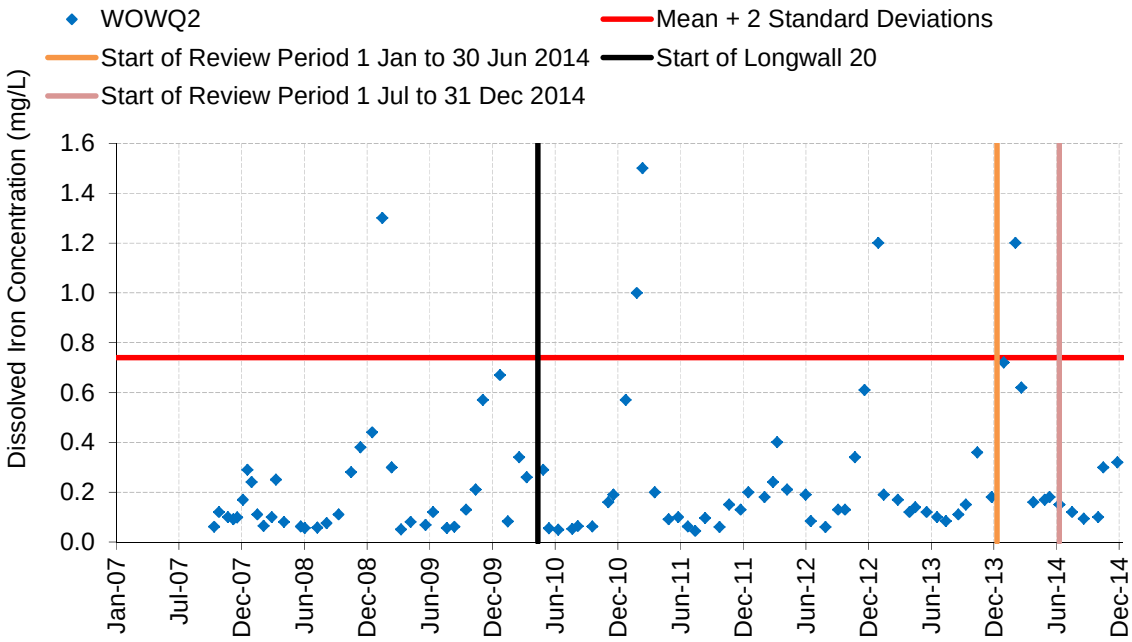


Chart 36 Dissolved Iron Concentrations in Woronora River at WOWQ2

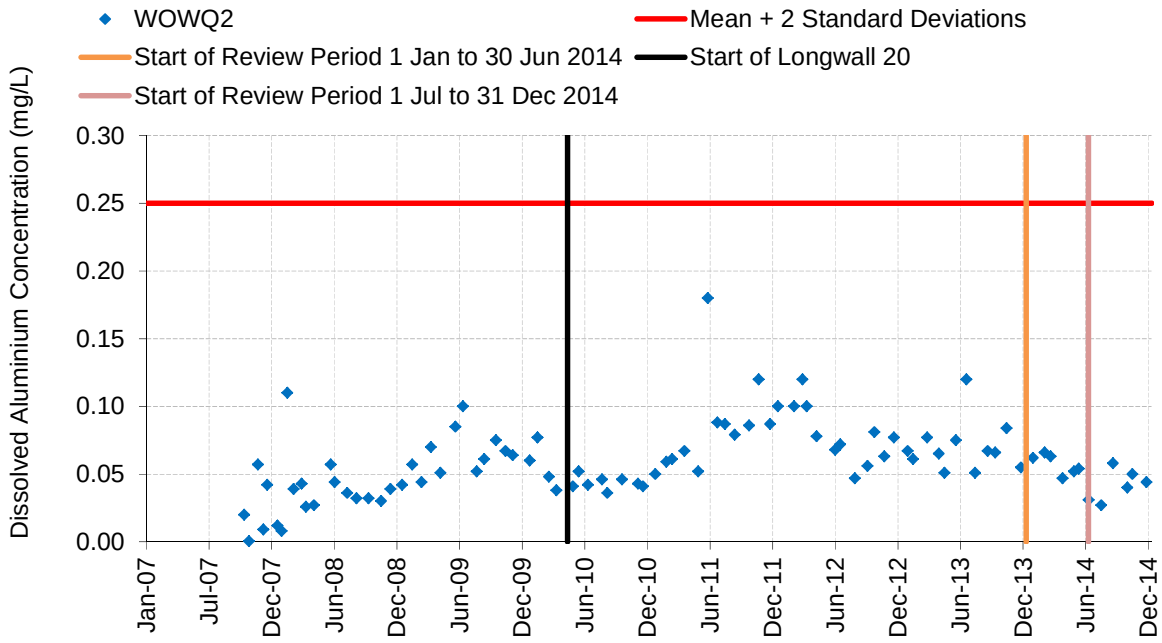


Chart 37 Dissolved Aluminium Concentrations in Woronora River at WOWQ2

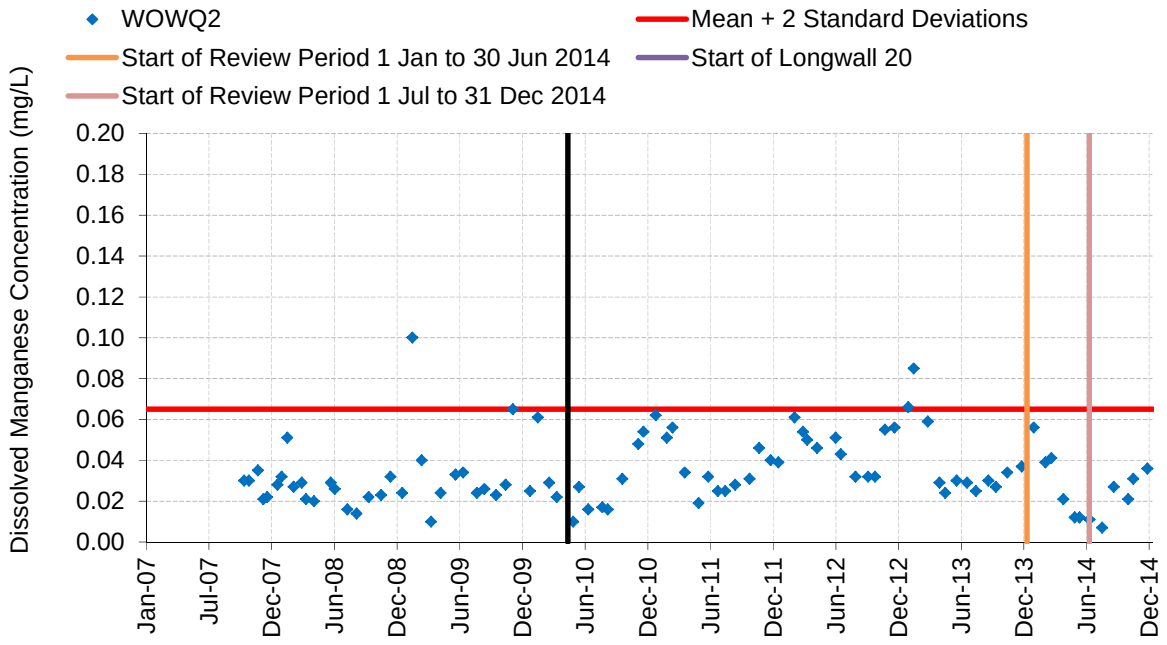


Chart 38 Dissolved Manganese Concentrations in Woronora River at WOWQ2

Plots showing the sliding 12 month mean of the dissolved iron, dissolved aluminium and dissolved manganese concentrations recorded at site WRWQ9 are shown on Charts 39 to 41. For comparison, plots showing the sliding 12 month mean for the same water quality parameters at control site WOWQ2 are shown on Charts 42 to 44. Each plot shows the baseline mean plus one standard deviation value[4].

The sliding 12 month mean at WRWQ9 exceeded the baseline mean plus one standard deviation for dissolved iron for three months and for dissolved manganese for six months during the reporting period (Charts 39 and 41). The sliding 12 month mean at WRWQ9 did not exceed the baseline mean plus one standard deviation for dissolved aluminium (Chart 40). The sliding 12 month mean for dissolved iron, dissolved aluminium and dissolved manganese at control site WOWQ2 did not exceed the baseline mean plus one standard deviation during the reporting period (Charts 42 to 44).

[4] Note, since previous reporting the charts have been updated to include the additional baseline data available since September 2006 for site WRWQ9 and since October 2007 for site WOWQ2 in response to the SCA's comments on the revised Longwalls 20-22 and Longwalls 23-27 Water Management Plans.

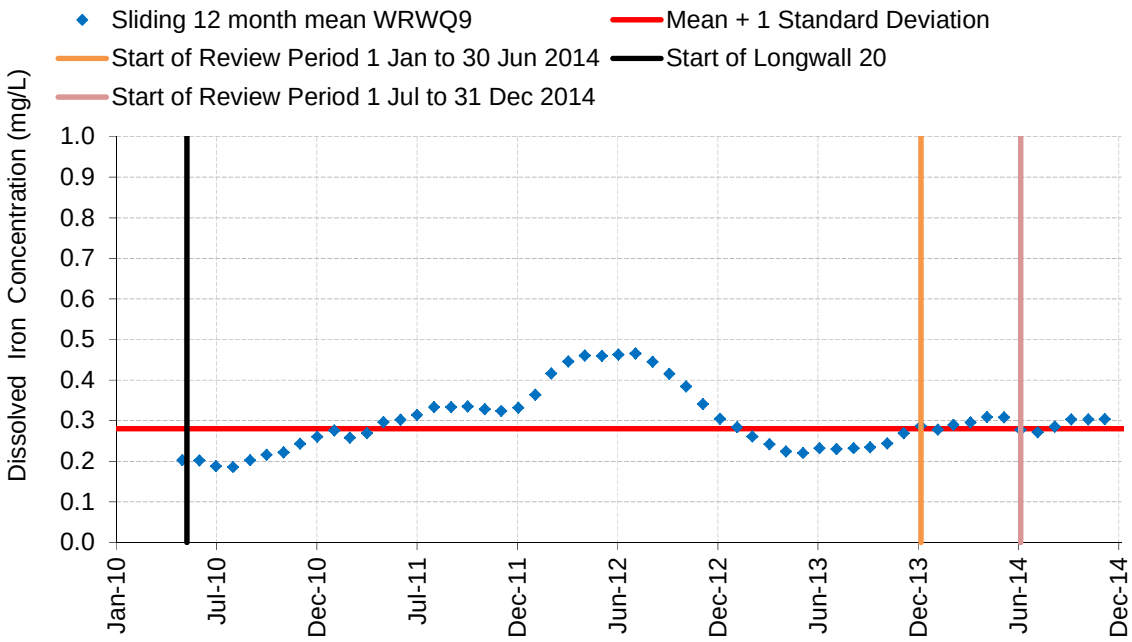


Chart 39 Sliding 12 Month Mean of Dissolved Iron Concentrations in Waratah Rivulet at WRWQ9

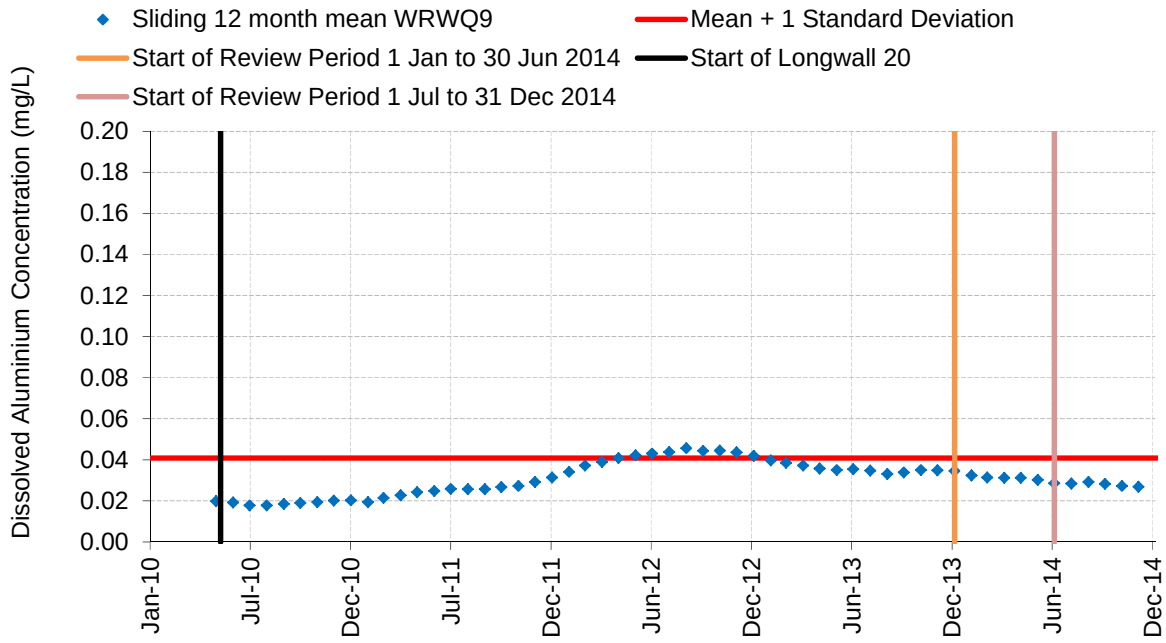


Chart 40 Sliding 12 Month Sliding Mean of Dissolved Aluminium Concentrations in Waratah Rivulet at WRWQ9

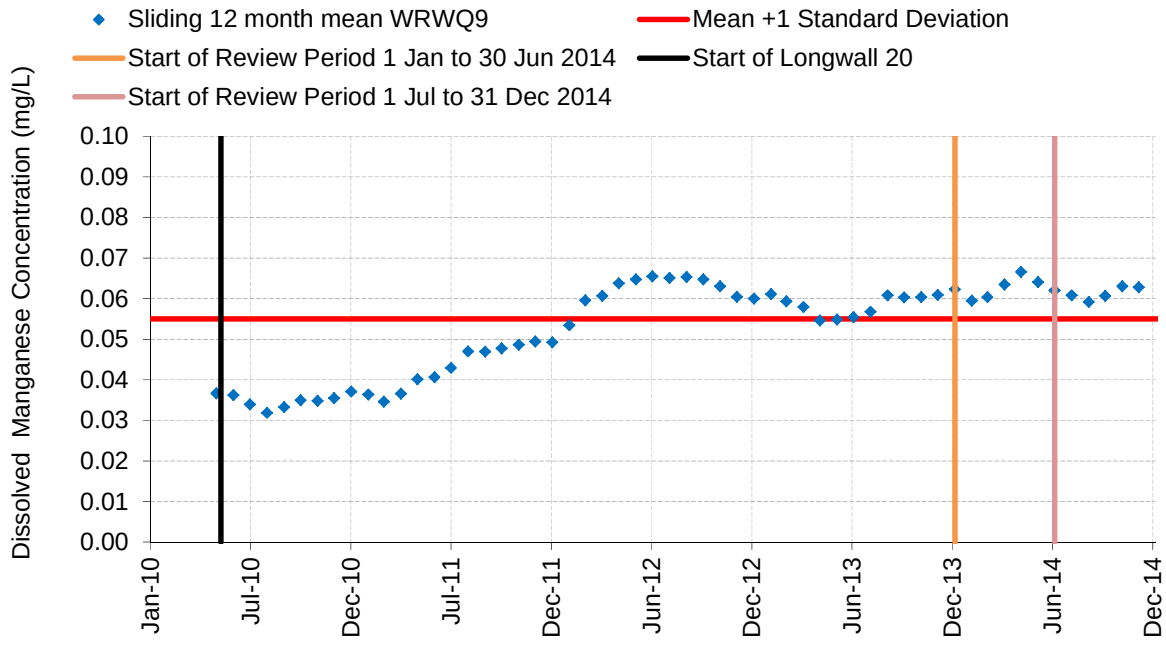


Chart 41 Sliding 12 Month Mean of Dissolved Manganese Concentrations in Waratah Rivulet at WRWQ9

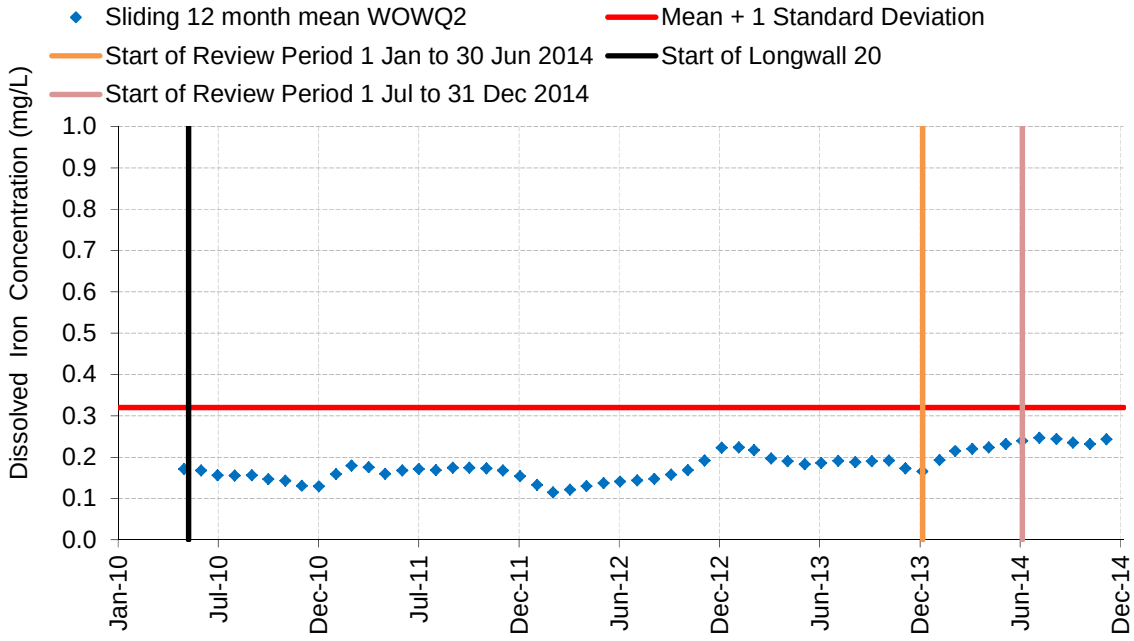


Chart 42 Sliding 12 Month Mean of Dissolved Iron Concentrations in Woronora River at WOWQ2

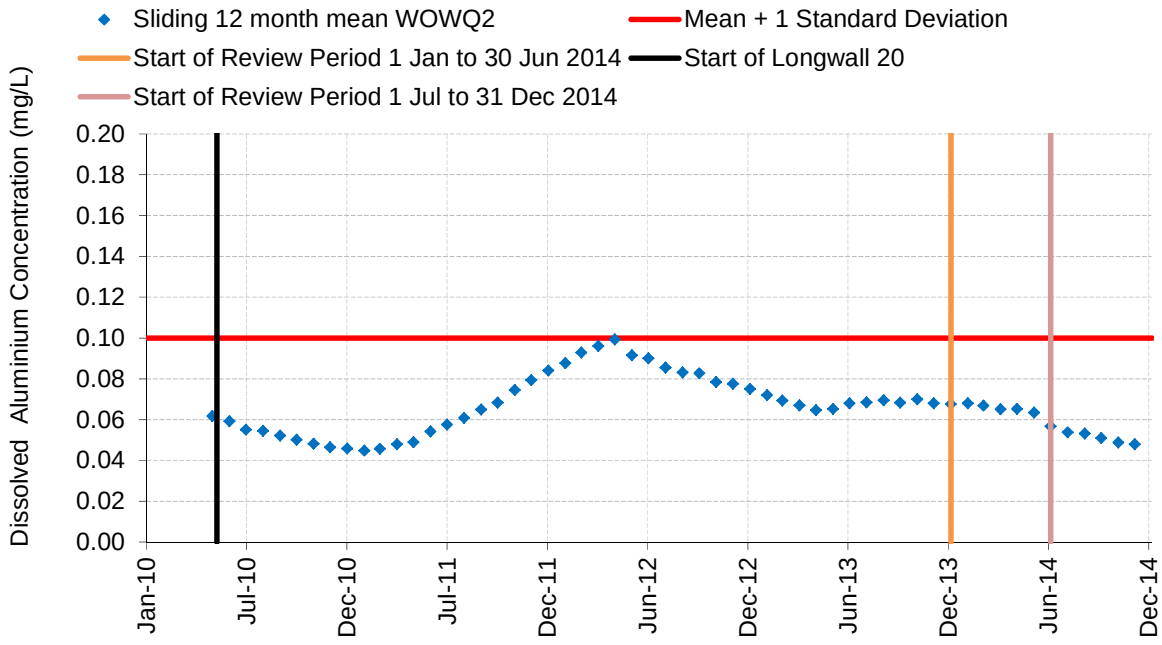


Chart 43 Sliding 12 Month Mean of Dissolved Aluminium Concentrations in Woronora River at WOWQ2

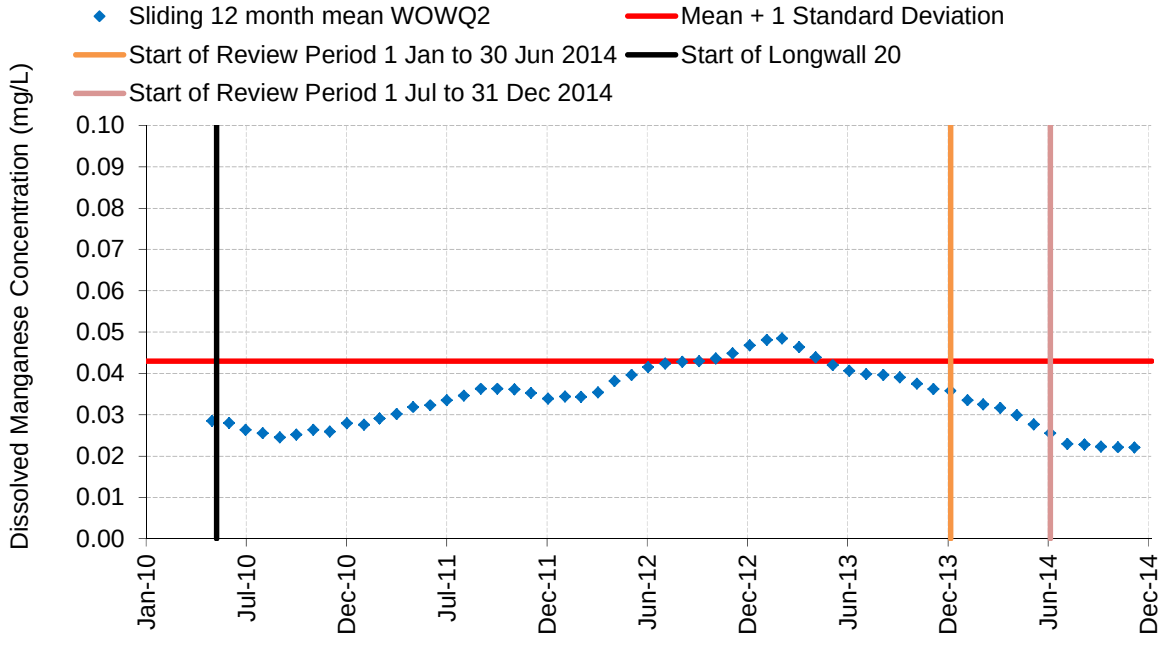


Chart 44 Sliding 12 Month Mean of Dissolved Manganese Concentrations in Woronora River at WOWQ2

Assessment of Water Quality at Site ETWQ AU

Plots showing the concentrations of dissolved iron, dissolved aluminium and dissolved manganese recorded at site ETWQ AU are shown on Charts 45 to 47. Charts 45 to 47 show the dissolved concentrations in relation to a baseline mean plus two standard deviations value calculated using data prior to the commencement of Longwall 20 (i.e. four measurements only, consistent with the currently approved Longwalls 23-27 Water Management Plan) and a baseline mean plus two standard deviations value calculated using data prior to potential subsidence effects from Longwall 20 on the Eastern Tributary (consistent with the revised Longwalls 23-27 Water Management Plan [Version D])[5].

Charts 48 to 50 show the concentrations of dissolved iron, dissolved aluminium and dissolved manganese recorded at control site WOWQ2 in comparison to the two baseline mean plus two standard deviation values (i.e. one calculated using data prior to the commencement of Longwall 20 [i.e. four measurements only] and one calculated using data collected prior to potential subsidence effects from Longwall 20 on the Eastern Tributary).

Assessment against the performance indicator has been conducted using the baseline mean plus two standard deviations value calculated using data prior to potential subsidence effects from Longwall 20 on the Eastern Tributary (i.e. the *Mean + 2 Standard Deviations Extended Period* shown on Charts 45 to 47 and Charts 48 to 50).

Dissolved iron, dissolved aluminium and dissolved manganese concentrations did not exceed the baseline mean plus two standard deviations value for two consecutive months during the reporting period at site ETWQ AU (Charts 45 to 47). There were also no exceedances of the baseline mean plus two standard deviations for two consecutive months for dissolved iron, dissolved aluminium or dissolved manganese at the control site WOWQ2 during the reporting period (Charts 48 to 50).

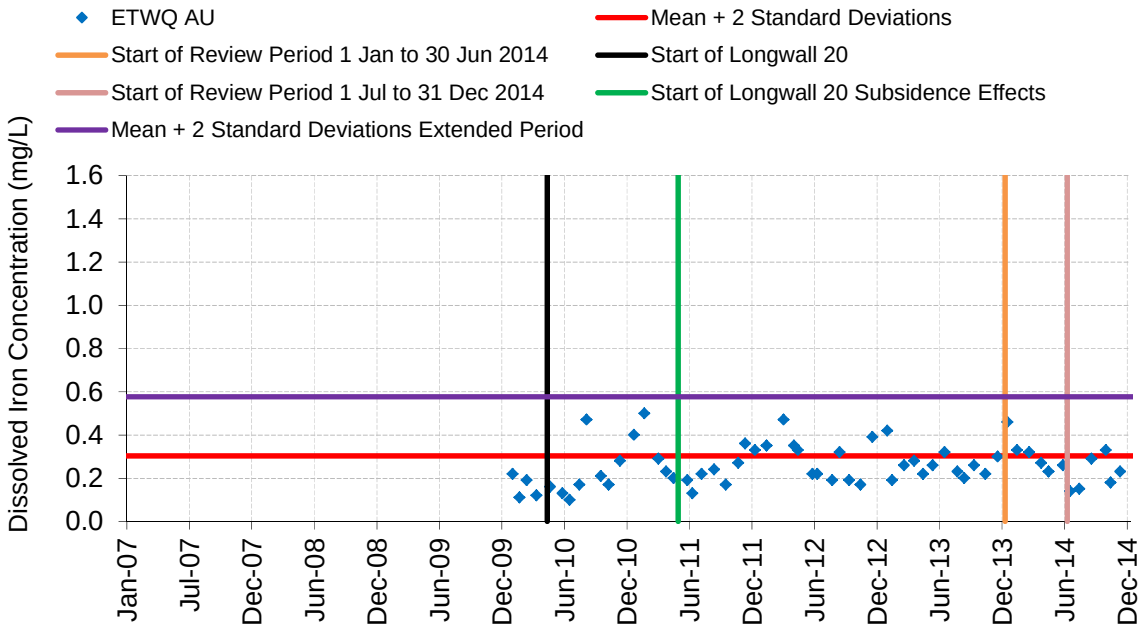


Chart 45 Dissolved Iron Concentrations in Eastern Tributary at ETWQ AU

[5] Baseline is considered to be prior to subsidence effects occurring from Longwall 20 on the relevant environmental feature. An extended baseline period has been used for site ETWQ AU (baseline data includes data prior to 26 May 2011) on the basis of negligible subsidence effects.

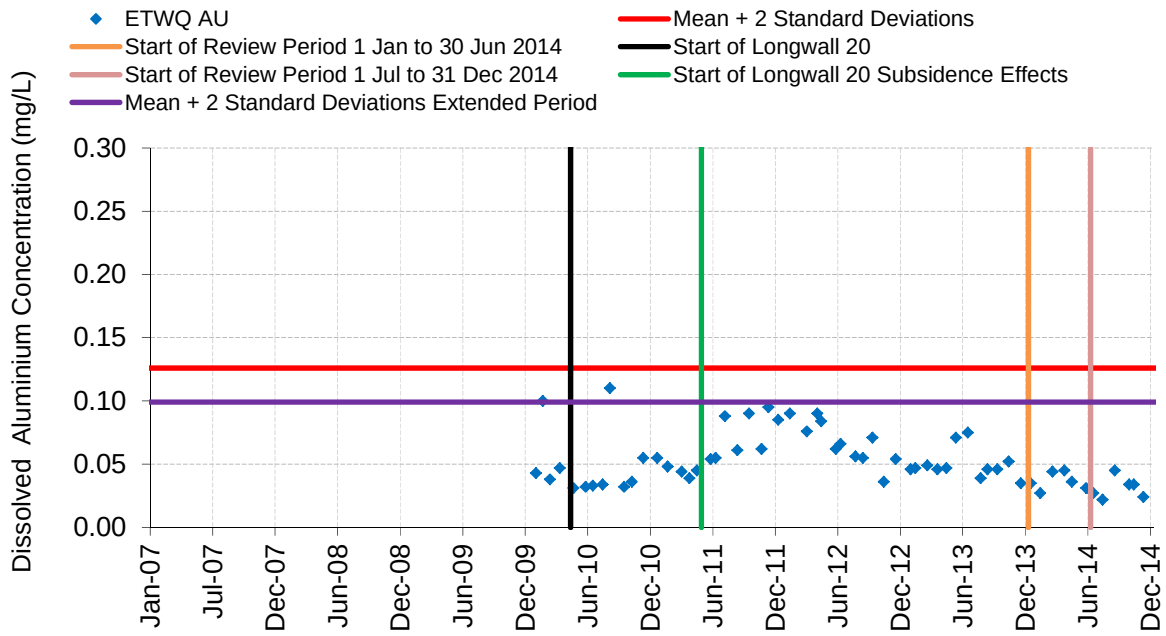


Chart 46 Dissolved Aluminium Concentrations in Eastern Tributary at ETWQ AU

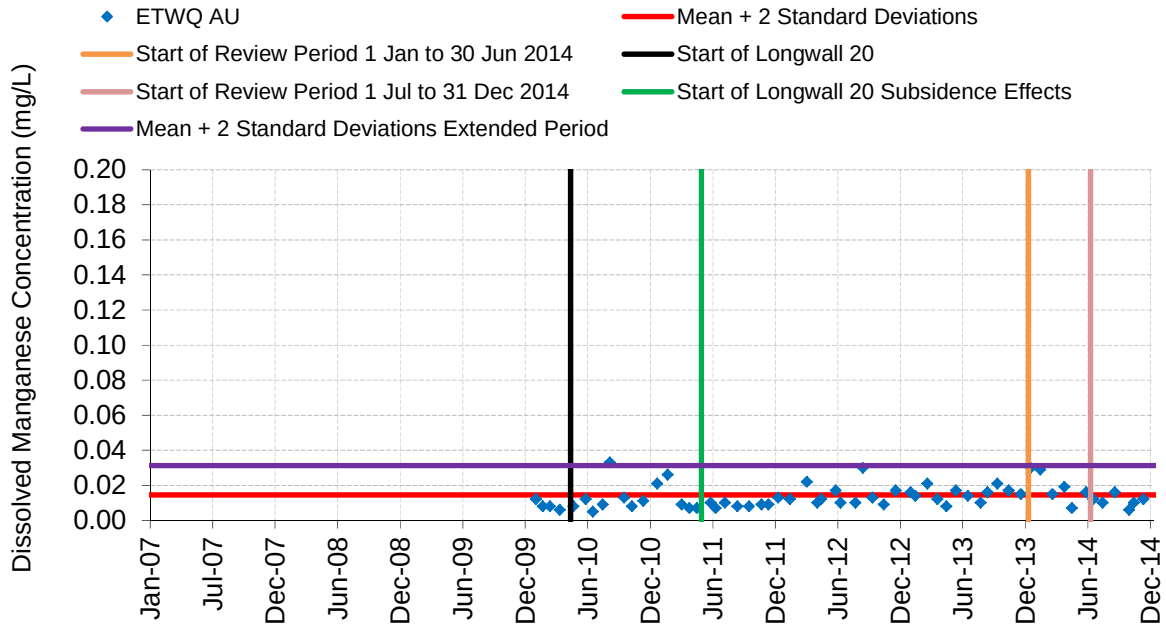


Chart 47 Dissolved Manganese Concentrations in Eastern Tributary at ETWQ AU

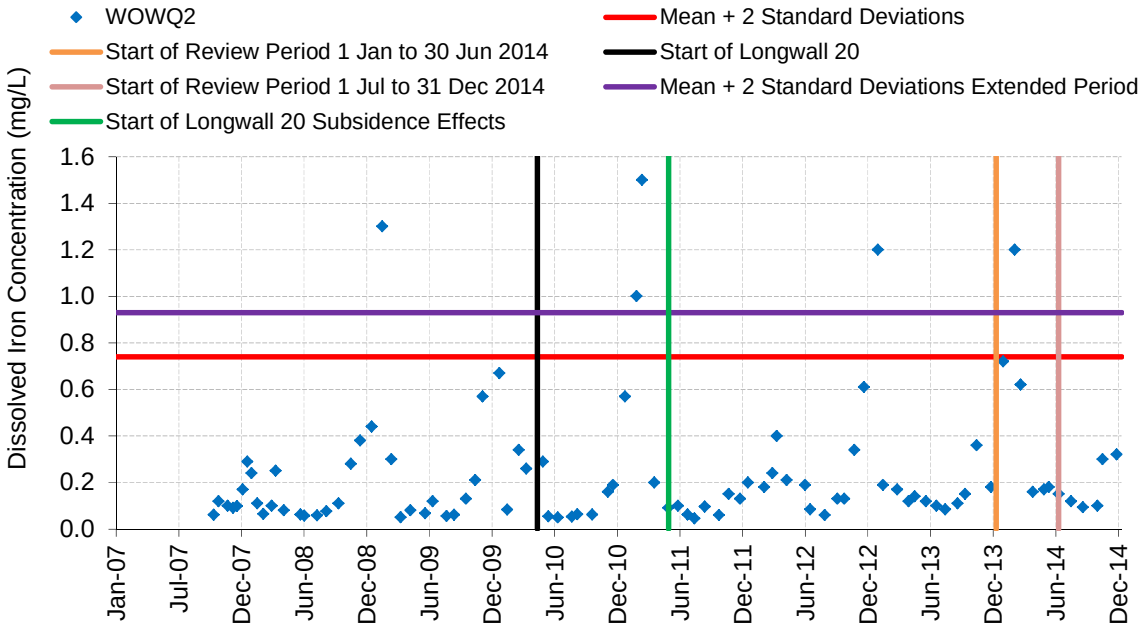


Chart 48 Dissolved Iron Concentrations in Woronora River (WOWQ2)

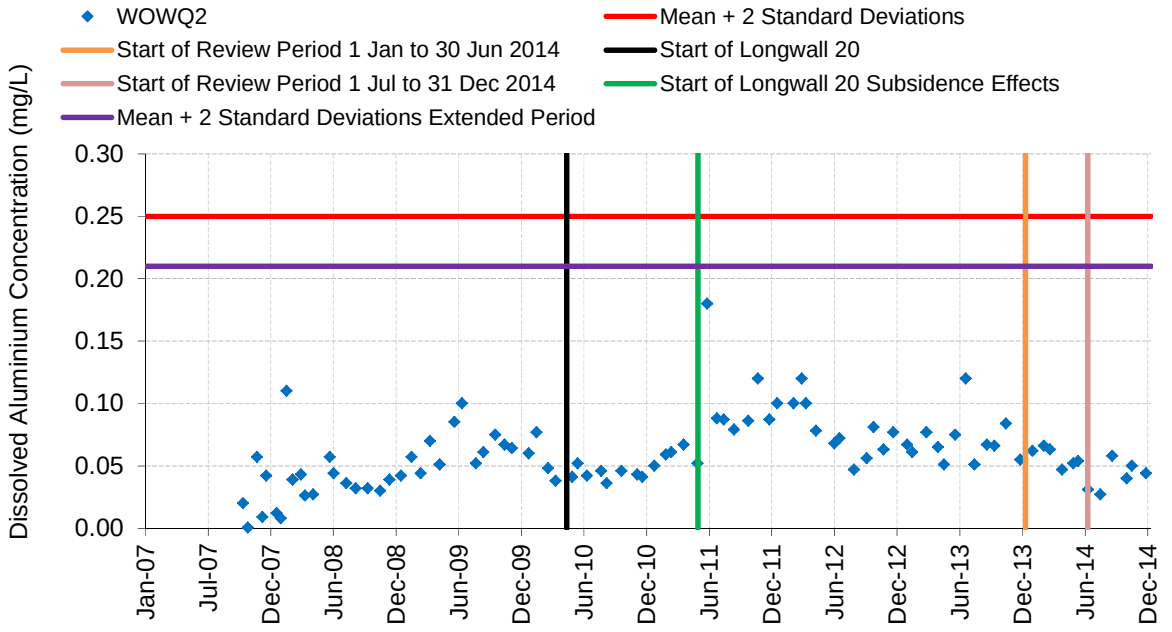


Chart 49 Dissolved Aluminium Concentrations in Woronora River (WOWQ2)

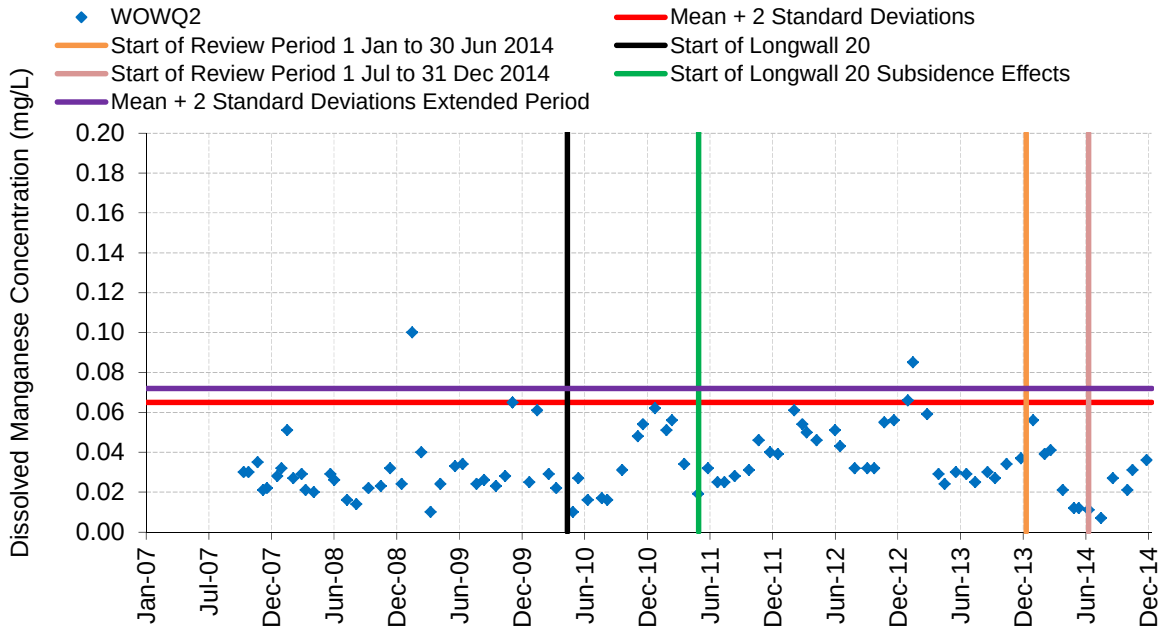


Chart 50 Dissolved Manganese Concentrations in Woronora River (WOWQ2)

Plots showing the sliding 12 month mean of dissolved iron, dissolved aluminium and dissolved manganese concentrations recorded at site ETWQ AU are shown on Charts 51 to 53. Charts 51 to 53 show the dissolved concentrations in relation to a baseline mean plus one standard deviations value calculated using data prior to the commencement of Longwall 20 (i.e. four measurements only, consistent with the currently approved Longwalls 23-27 Water Management Plan) and a baseline mean plus one standard deviations value calculated using data prior to potential subsidence effects from Longwall 20 on the Eastern Tributary (consistent with the revised Longwalls 23-27 Water Management Plan [Version D])[6].

For comparison, Charts 54 to 56 show the sliding 12 month mean for the same water quality parameters at control site WOWQ2. Each plot shows the two mean plus one standard deviation values (i.e. one calculated using data prior to the commencement of Longwall 20 and one calculated using data collected prior to potential subsidence effects from Longwall 20 on the Eastern Tributary).

Assessment against the performance indicator has been conducted using the baseline mean plus one standard deviations value calculated using data prior to potential subsidence effects from Longwall 20 on the Eastern Tributary (i.e. the *Mean + 1 Standard Deviations Extended Period* shown on Charts 51 to 53 and Charts 54 to 56).

The 12 month sliding means of dissolved iron, dissolved aluminium and dissolved manganese concentrations did not exceed the baseline mean plus one standard deviation at site ETWQ AU (Charts 51 to 53) or control site WOWQ2 (Charts 54 to 56) during the reporting period. It is noted that the 12 month sliding mean of dissolved aluminium exceeded the baseline mean plus 1 standard deviation at site ETWQ AU during the period April to November 2012 (Chart 52). There was a similar trend in the 12 month sliding mean at both sites WRWQ9 (Chart 40) and WOWQ2 (Charts 43 and 55). The 12 month sliding mean has generally decreased at all three sites since then. This suggests that the elevated levels recorded during this period were widespread and not indicative of any ongoing trend.

[6] Baseline is considered to be prior to subsidence effects occurring from Longwall 20 on the relevant environmental feature. An extended baseline period has been used for site ETWQ AU (baseline data includes data prior to 26 May 2011) on the basis of negligible subsidence effects.

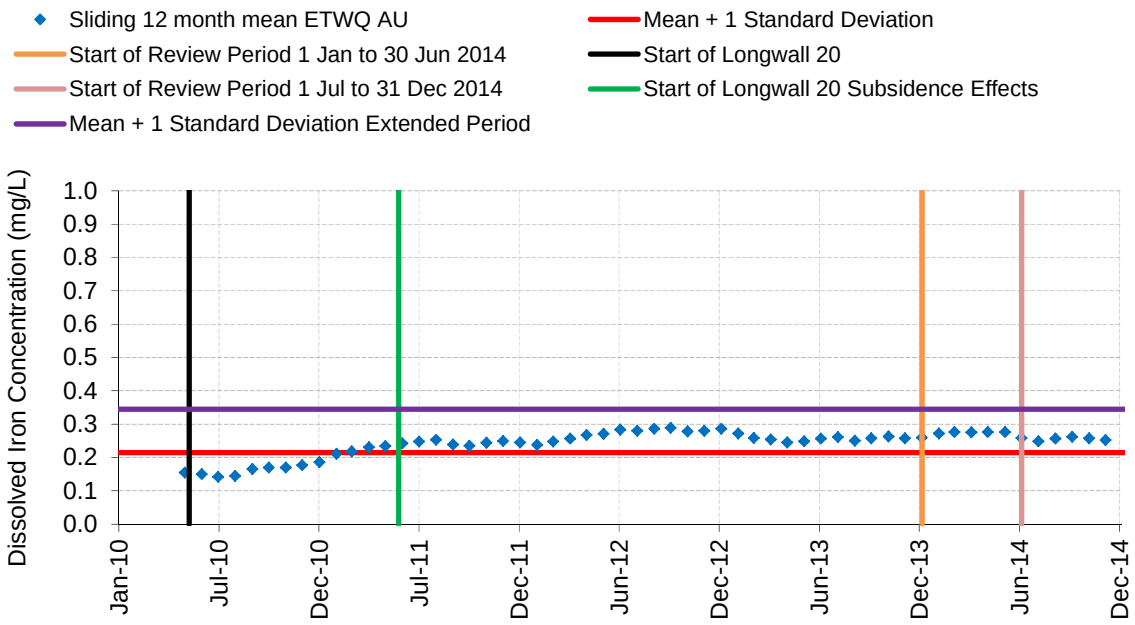


Chart 51 Sliding 12 Month Mean of Dissolved Iron Concentrations in Eastern Tributary at ETWQ AU

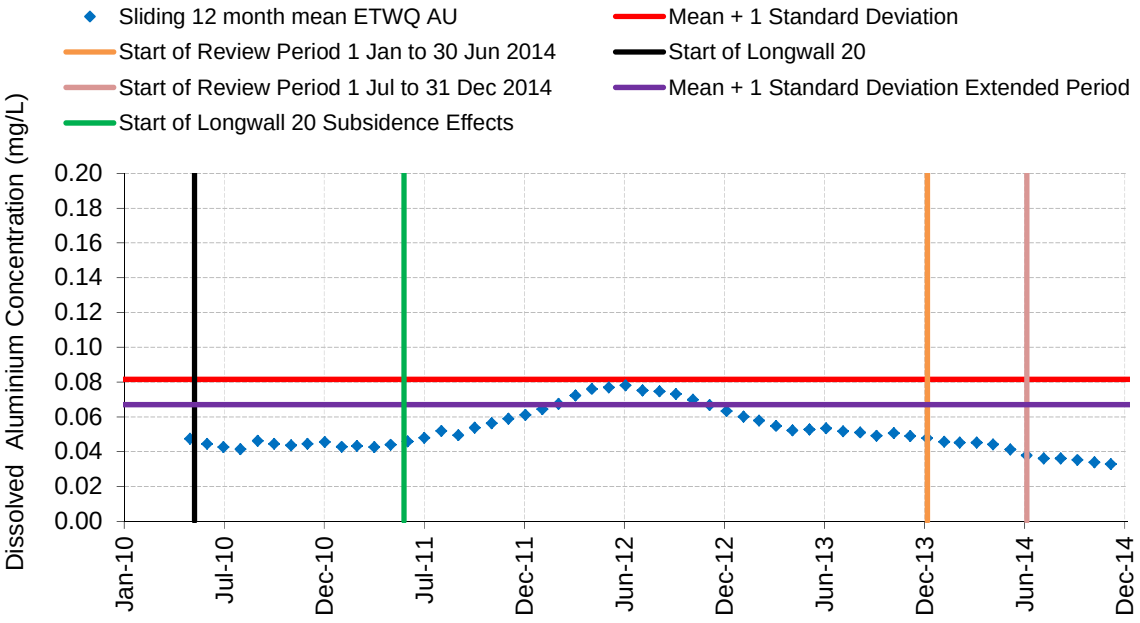


Chart 52 Sliding 12 Month Mean of Dissolved Aluminium Concentrations in Eastern Tributary at ETWQ AU

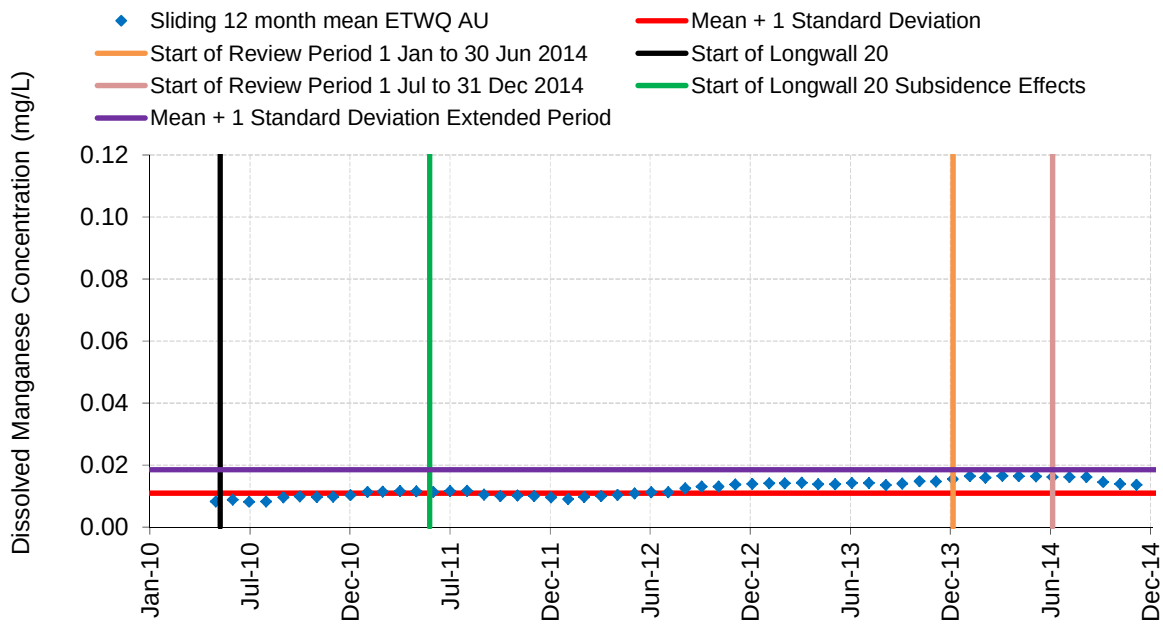


Chart 53 Sliding 12 Month Mean of Dissolved Manganese Concentrations in Eastern Tributary at ETWQ AU

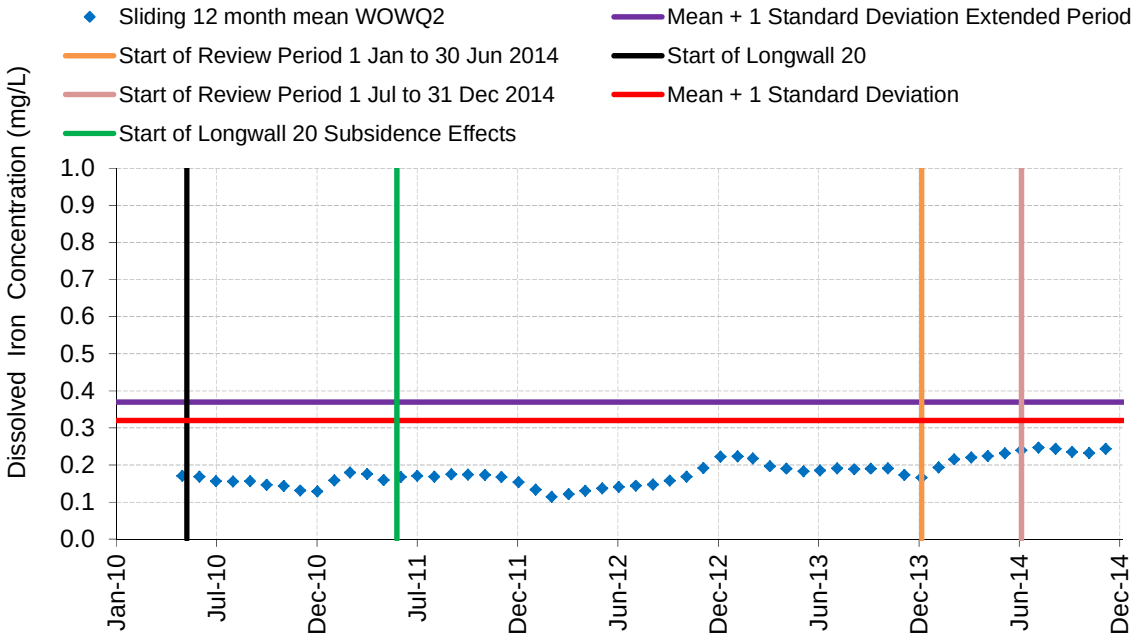


Chart 54 Sliding 12 Month Mean of Dissolved Iron Concentrations in Woronora River at WOWQ2

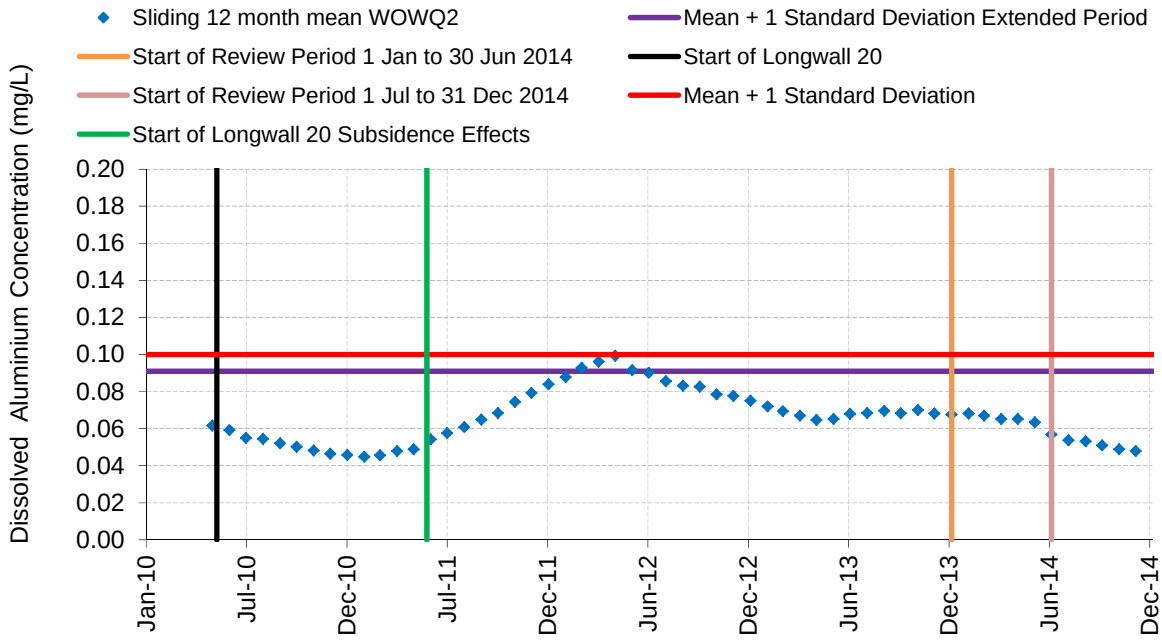


Chart 55 Sliding 12 Month Mean of Dissolved Aluminium Concentrations in Woronora River at WOWQ2

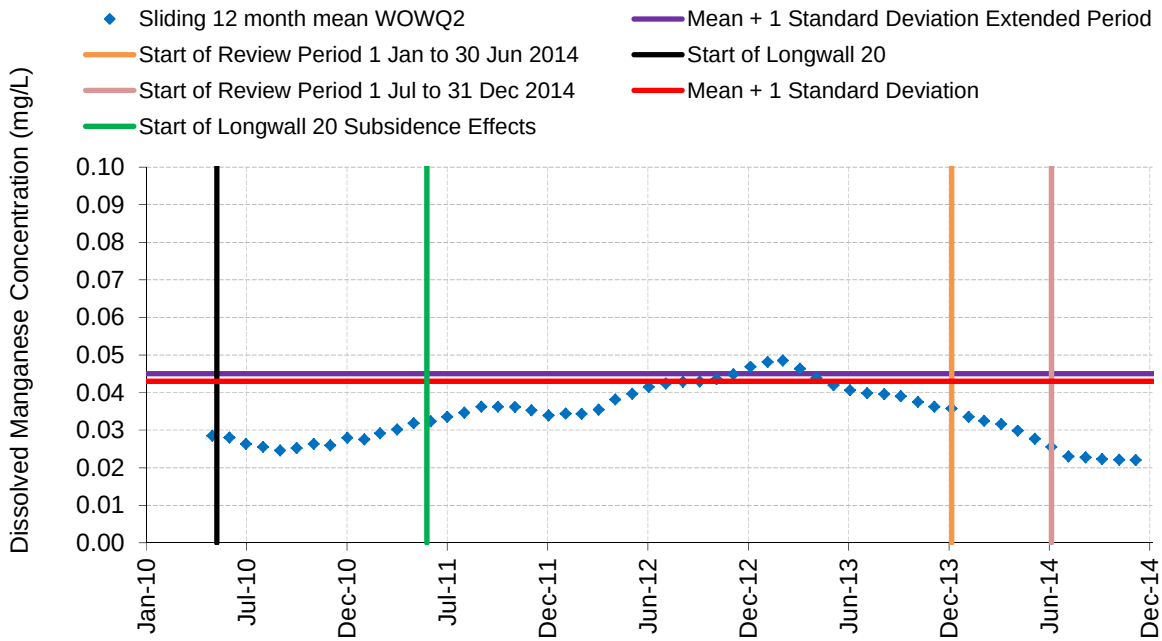


Chart 56 Sliding 12 Month Mean of Dissolved Manganese Concentrations in Woronora River at WOWQ2

Analysis against Subsidence Impact Performance Measure

Consistent with the Metropolitan Coal Longwalls 23-27 Water Management Plan, if data analysis indicates the performance indicator has been exceeded or is likely to be exceeded, an assessment is made against the following subsidence impact performance measure.

Subsidence Impact Performance Measure

Negligible reduction to the quality of water resources reaching the Woronora Reservoir.

Assessment of Water Quality at Site WRWQ9

As the performance indicator was exceeded for dissolved iron and dissolved manganese at site WRWQ9 (as a result of the sliding 12 month mean exceeding the mean plus one standard deviation), an assessment against the subsidence impact performance measure at Waratah Rivulet has been conducted (Charts 39 and 41).

The sliding 12 month mean for dissolved iron at WRWQ9 was higher during the period from August 2011 to November 2012 than the current reporting period (Chart 39). It is also noted that the dissolved iron concentrations at WRWQ9 (Chart 33) were below the mean plus two standard deviations during the reporting period.

Similarly, the sliding 12 month mean for dissolved manganese at WRWQ9 ranged between 0.0590 mg/L and 0.067 mg/L in 2014 (Chart 41). The sliding 12 month mean for dissolved manganese for the period from May to October 2012 reached a maximum concentration of 0.065 mg/L in July 2012 and ranged between 0.064 and 0.065 mg/L for the remainder of the exceedance period (Chart 41).

It is also noted that the dissolved manganese concentrations at WRWQ9 (Chart 35) were below the mean plus two standard deviations during the reporting period.

Assessment of the earlier exceedances against the subsidence impact performance measure was carried out as part of the Metropolitan Coal 2012 Annual Review (Metropolitan Coal, 2012) and Metropolitan Coal 2013 Annual Review/AEMR (Metropolitan Coal, 2013). The assessments concluded that the subsidence impact performance measure, *Negligible reduction to the quality of water resources reaching the Woronora Reservoir,* had not been exceeded in either 2012 or 2013. Independent peer reviews of those assessments by Evans & Peck (2012 and 2013), a specialist approved by the Department of Planning and Infrastructure (now the DP&E), agreed that no exceedance of the subsidence impact performance measure had occurred.

The exceedances of the sliding 12 month mean concentrations of dissolved iron and dissolved manganese at Waratah Rivulet during the reporting period are considered to be negligible.

The performance indicator was not exceeded for dissolved iron, dissolved aluminium and dissolved manganese at site ETWQ AU during the reporting period.

As described above, Metropolitan Coal has revised the Metropolitan Coal Longwalls 23-27 Water Management Plan (Version D) to include changes to the analysis of this water quality performance indicator in response to the Evans & Peck (2012; 2013) peer review recommendations. These changes include removing the sliding 12 month mean, which is less responsive than the mean/standard deviation trigger, and which has a tendency to falsely trigger an exceedance. Metropolitan Coal has proposed to replace the sliding 12 month mean with an assessment against a six month median.

2.3.3 Connective Cracking between the Surface and the Mine

Analysis against Performance Indicator 1

Performance Indicator 1: *Visual inspection does not identify abnormal water flow from the goaf, geological structure, or the strata generally.*

The performance indicator is considered to have been exceeded if visual inspections identify abnormal water flow from the goaf, geological structure, or the strata generally.

The mine inspections did not identify any abnormal water flows from the goaf, geological structure, or strata.

This performance indicator was not exceeded during the reporting period.

Analysis against Performance Indicator 2

Performance Indicator 2: *The 20-day average mine water make does not exceed 2 ML/day.*

The performance indicator is considered to have been exceeded if data analysis indicates the 20 day average mine water make exceeds 2 ML/day.

The 20 day average daily mine water make was less than 2 ML/day during the reporting period.

This performance indicator was not exceeded during the reporting period.

Analysis against Performance Indicator 3

Performance Indicator 3: *Significant departure from the predicted envelope of the vertical potentiometric head profile at Bore 9GGW2B does not occur.*

The performance indicator is considered to have been exceeded if the measured potentiometric head profile is inconsistent in shape or lies significantly to the left of the predicted high-inflow model curve.

Bore 9GGW2B is located above Longwall 27 headings. The vertical head profiles for 9GGW2B are shown on Chart 57. As the measured head profile at site 9GGW2B has not changed appreciably since the commencement of Longwall 23 in May 2014, there is no evidence of an incremental effect to date from Longwall 23. The measured head profiles at 14 July 2014, representative of the previous six month reporting period (1 January to 30 June 2014) are almost identical with the profiles measured at 28 December 2014, representative of this six month reporting period (1 July to 31 December 2014).

The performance indicator has not been exceeded because the measured potentiometric head profiles are consistent in shape and do not lie significantly to the left of the predicted high-inflow model curve.

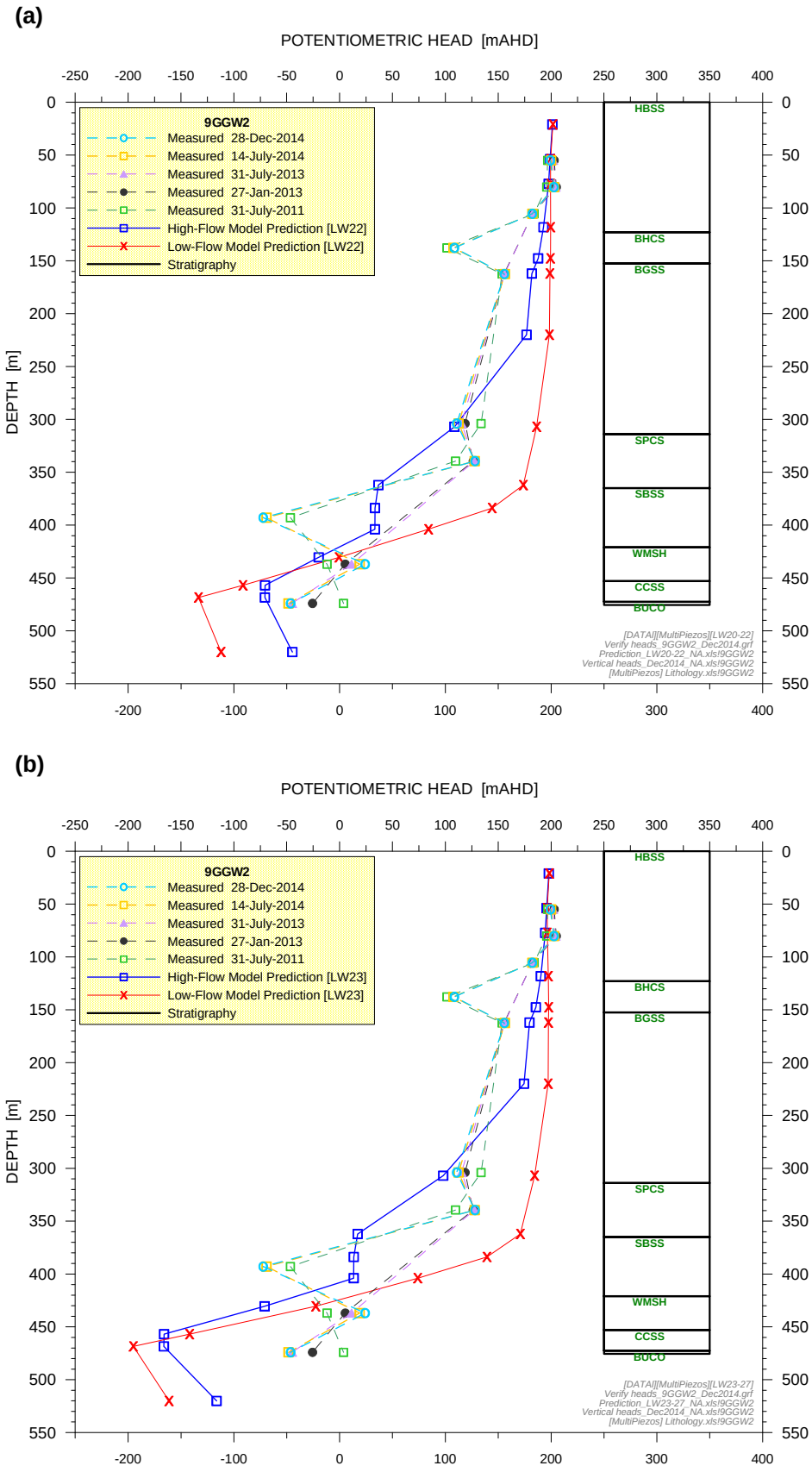


Chart 57 **Measured and Simulated Potentiometric Head Profiles at Indicator Site 9GGW2B (a) simulated at the end of Longwall 22 and (b) simulated at the end of Longwall 23**

Analysis against Performance Indicator 4

Performance Indicator 4: *The water tables measured at Bores 9FGW1A and 9GGW1-80 are higher than the water levels of streams crossed by a transect along Longwall 22 (i.e. a hydraulic gradient exists from each bore to the nearest watercourse).*

The performance indicator relevant to Longwalls 23-27 is considered to have been exceeded if data analysis indicates that a hydraulic gradient is not maintained between each bore and its neighbouring watercourse (i.e. the water table level at each bore is to be higher than the surface water levels in the streams), specifically if:

- the average water level measured at the 55 m piezometer at 9FGW1A is lower than the floor level of Tributary B (241.7 mAHD); or
- the average water level measured at the 80 m piezometer at 9GGW1-80 is lower than the floor level of Eastern Tributary (224.7 mAHD).

The transect on Chart 58 provides an illustration of relative ground and water levels on transect A-A' along Longwall 22 through indicator sites 9FGW1A and 9GGW1-80. The transect from west to east crosses Tributary B (twice), Waratah Rivulet, Tributary A and the Eastern Tributary. The water level at site 9FGW1A is about 29 m higher than the elevation of the nearest downgradient watercourse (Tributary B). At site 9GGW1-80, the water level is about 18 m higher than Eastern Tributary (to its east) but is nearly 40 m higher than Tributary A (to its west).

The performance indicator has not been exceeded because the average water levels measured in the two piezometers are above the floor levels of the nearest streams.

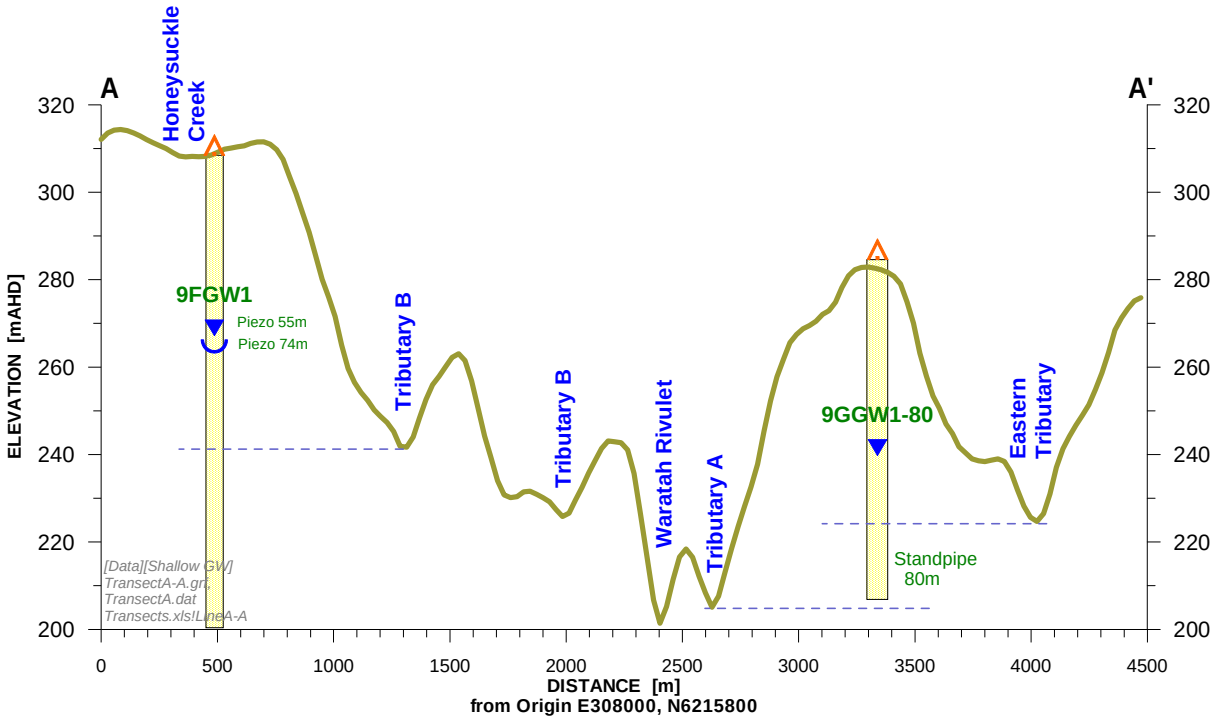


Chart 58 Topographic Transect A-A' along Longwall 22 and Hawkesbury Sandstone Water Levels at 28 December 2014

2.3.4 Leakage from the Woronora Reservoir

Analysis against Performance Indicator

Performance Indicator: *The groundwater head of Bores 9GGW2B and PM02 is higher than the water level of Woronora Reservoir (i.e. a hydraulic gradient exists from the bores to the Woronora Reservoir).*

The performance indicator is considered to have been exceeded if the 7-day average potentiometric head at the uppermost piezometer is less than the reservoir water level for one week.

The 7-day average groundwater levels in the uppermost piezometers in the Hawkesbury Sandstone at sites 9GGW2B and PM02 are presented on Chart 59. Comparison with the maximum possible Woronora Reservoir water level shows a current clearance (at end of December 2014) of approximately 30 m at 9GGW2B and approximately 70 m at PM02. The shallow groundwater levels are well above reservoir level.

The performance indicator has not been exceeded because the 7-day average water table levels have not fallen below the reservoir water level.

Analysis against Subsidence Impact Performance Measure

Consistent with the Metropolitan Coal Longwalls 23-27 Water Management Plan, if data analysis indicates the performance indicator has been exceeded or is likely to be exceeded, an assessment will be made against the following subsidence impact performance measure.

Subsidence Impact Performance Measure: *Negligible leakage from the Woronora Reservoir.*

The performance indicator was not exceeded during the reporting period.

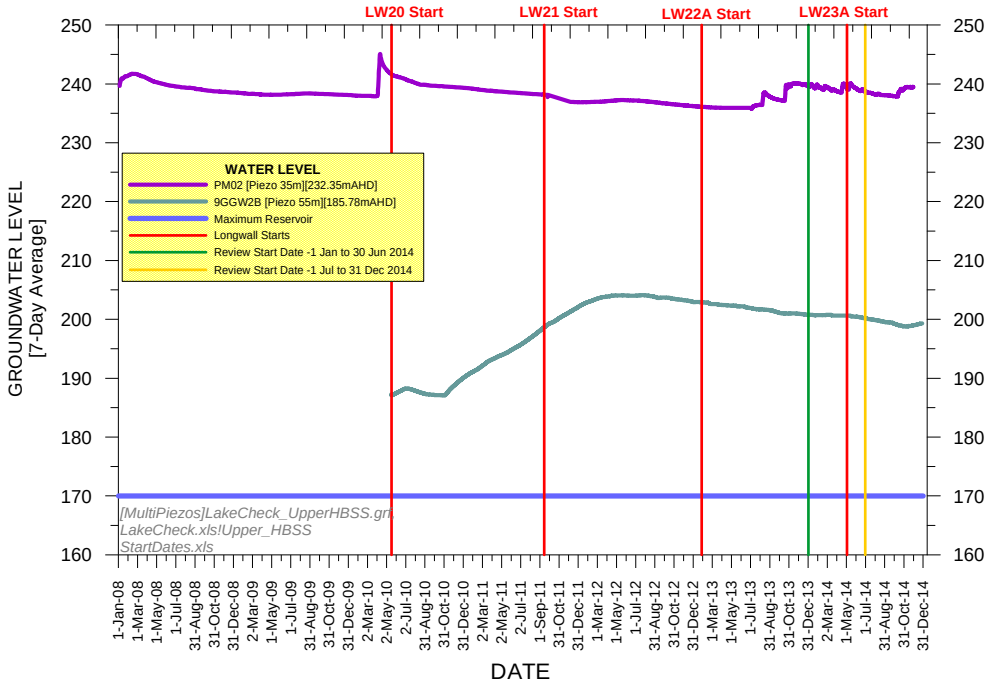


Chart 59 7-day Average Shallow Hawkesbury Sandstone Groundwater Levels at PM02 and 9GGW2B

2.3.5 Woronora Reservoir Water Quality

Metropolitan Coal has sourced surface water quality data for the Woronora Reservoir (site DW01), Cataract Reservoir (site DCA1) and Nepean Reservoir (site DNE1) from the SCA in accordance with a data exchange agreement. Consistent with the monitoring of water reaching the Woronora Reservoir (Section 2.3.2), the water quality data has been analysed for key water quality parameters of relevance to water supply and the effects of subsidence, namely:

- iron;
- manganese; and
- aluminium.

Data analysis is conducted to assess whether the performance indicator below has been exceeded.

Performance Indicator:

Changes in the quality of water in the Woronora Reservoir are not significantly different post-mining compared to pre-mining concentrations that are not also occurring in the Nepean Reservoir (control site).

Metropolitan Coal has revised the Metropolitan Coal Longwalls 23-27 Water Management Plan (Version D) to include changes to the analysis of this water quality performance indicator in response to the Evans & Peck (2012; 2013) peer review recommendations. As these revisions have not yet been approved, the currently approved analysis methods have been used to assess the water quality performance indicator.

Water quality data from site DW01 collected following the commencement of Longwall 20 is analysed against monitoring data collected at site DW01 prior to the commencement of Longwall 20 and against water quality data collected from the Nepean Reservoir at site DNE1. Data from the Cataract Reservoir is also sourced from the SCA and considered in the analysis of reservoir water quality.

Consistent with the existing approved Metropolitan Coal Longwalls 23-27 Water Management Plan, the performance indicator is considered to have been exceeded if data analysis indicates a statistically significant change in the quality of water post-mining of Longwall 20. Specifically if:

- any water quality parameter's exceed the baseline mean plus two standard deviations for two consecutive months; or
- the sliding 12 month mean for any water quality parameter exceeds the baseline mean plus one standard deviation; and
- there was not a similar increase in the same measure at the control site.

Charts 60 to 62 show the concentrations of total iron, total aluminium and total manganese recorded at site DC01 in the Woronora Reservoir after the commencement of Longwall 20 compared to the baseline mean plus two standard deviations[7]. The concentrations of total iron, total aluminium and total manganese did not exceed the baseline mean plus two standard deviations during the reporting period (Charts 60 to 62).

[7] Note, while Charts 60 to 62 only show pre-Longwall 20 data from December 2009, all available baseline data has been used to calculate the mean plus two standard deviations for the total iron, total aluminium and total manganese concentrations.

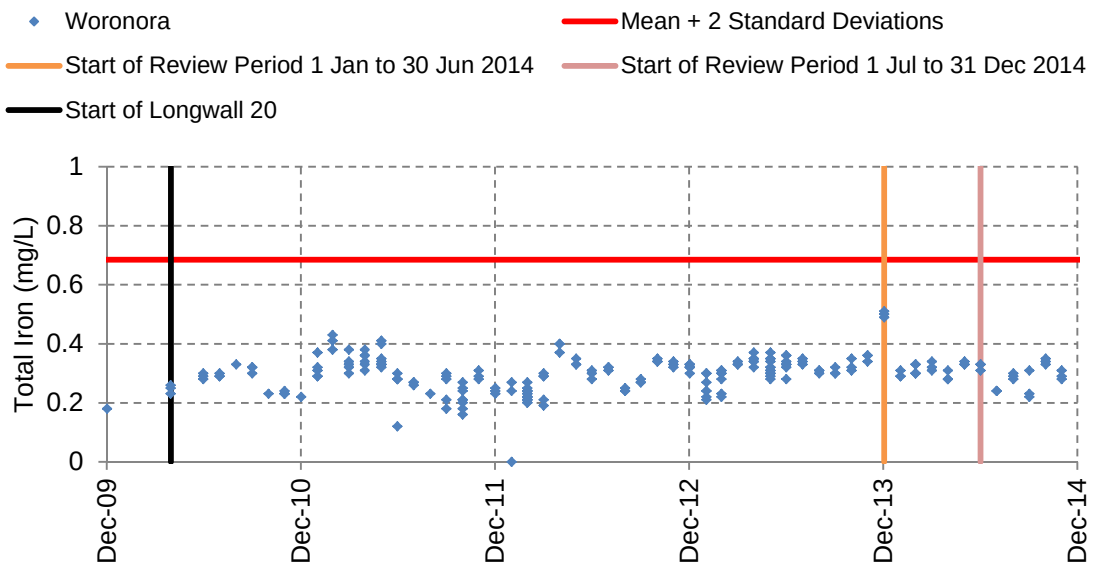


Chart 60 Total Iron Concentrations in Woronora Reservoir

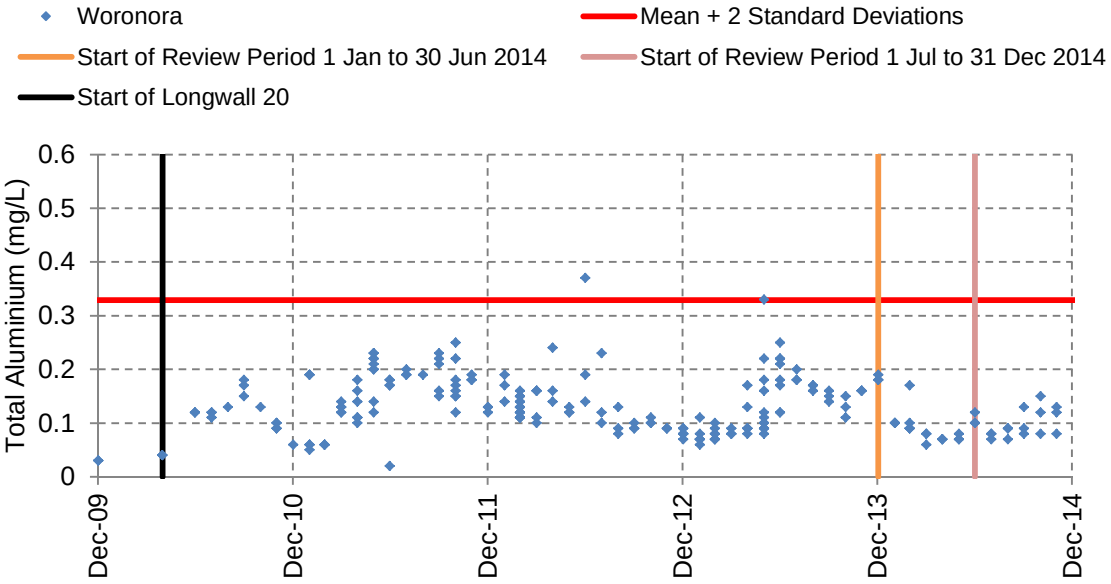


Chart 61 Total Aluminium Concentrations in Woronora Reservoir

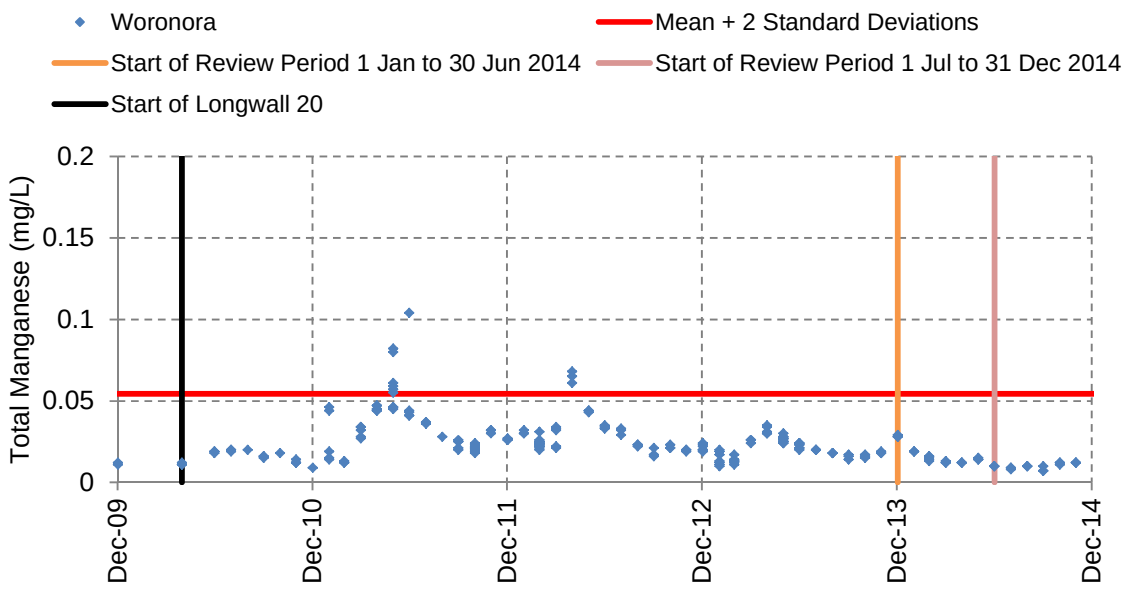


Chart 62 Total Manganese Concentrations in Woronora Reservoir

Charts 63 to 65 show the sliding 12 month mean concentrations for total iron, total aluminium and total manganese recorded at site DW01 in the Woronora Reservoir after the commencement of Longwall 20. The sliding 12 month mean concentrations of total iron, total aluminium and total manganese did not exceed the baseline mean plus one standard deviation during the reporting period (Charts 63 to 65). As a result, the performance indicator was not exceeded during the reporting period.

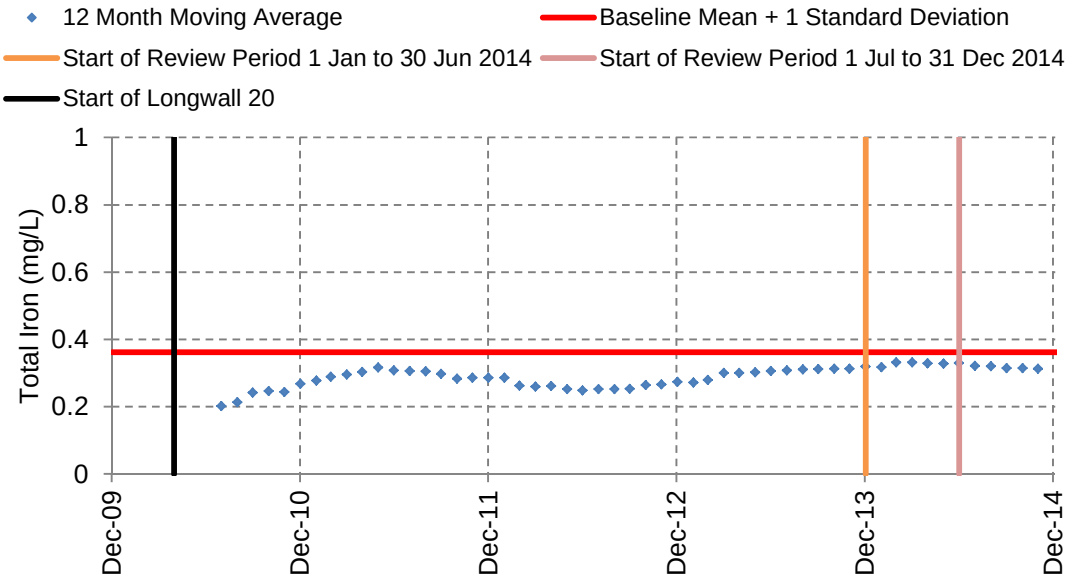


Chart 63 Sliding 12 Month Mean of Total Iron Concentration in Woronora Reservoir

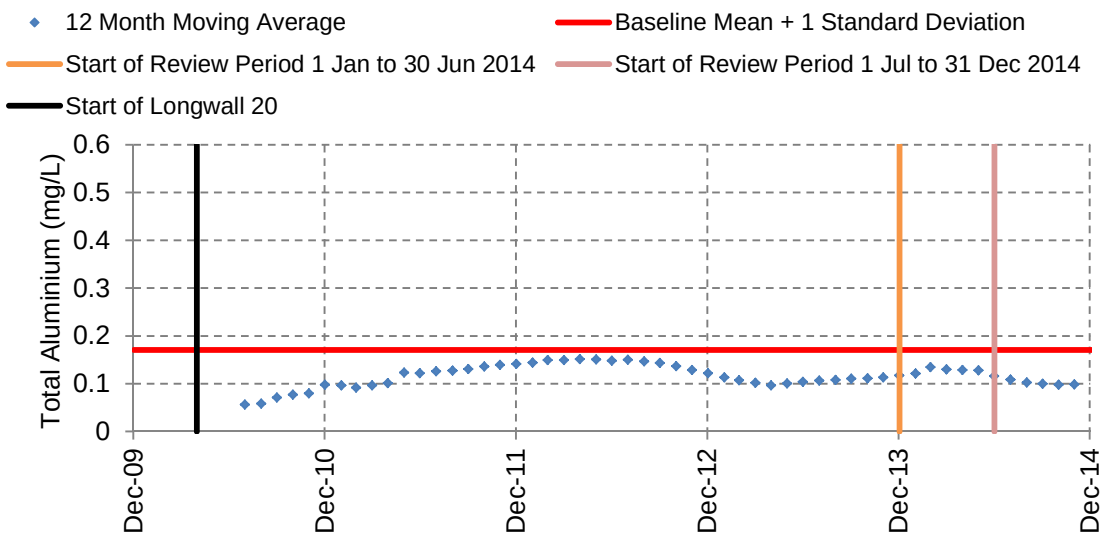


Chart 64 Sliding 12 Month Mean of Total Aluminium Concentration in Woronora Reservoir

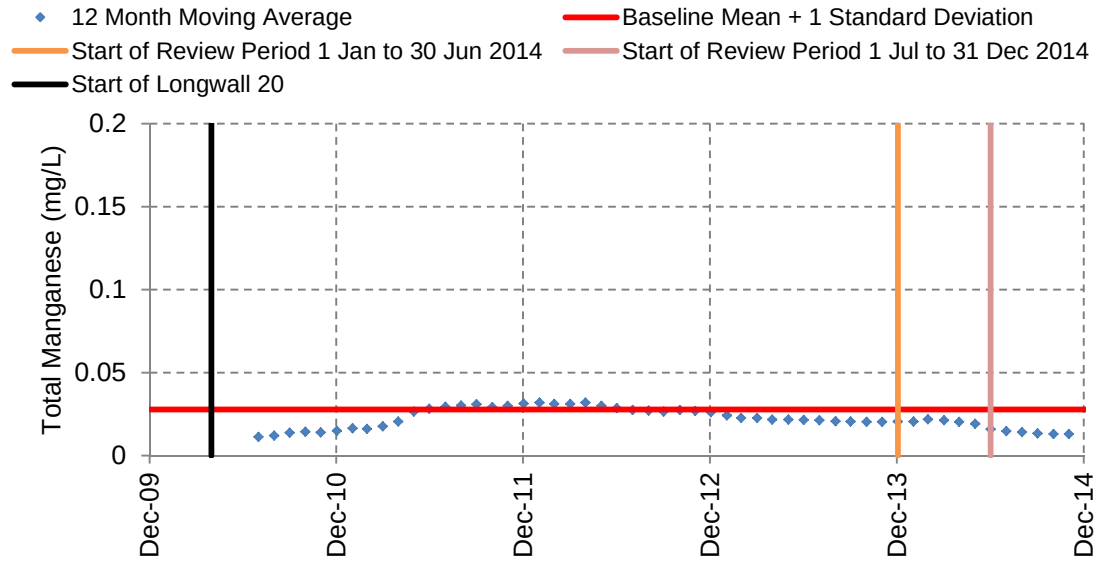


Chart 65 Sliding 12 Month Mean of Total Manganese Concentration in Woronora Reservoir

As described above, Metropolitan Coal has revised the Metropolitan Coal Longwalls 23-27 Water Management Plan (Version D) to include changes to the analysis of this water quality performance indicator in response to the Evans & Peck (2012; 2013) peer review recommendations. These changes include removing the sliding 12 month mean, which is less responsive and has the potential to falsely trigger an exceedance. Metropolitan Coal has proposed to replace the sliding 12 month mean with an assessment that incorporates both concentration and the duration that concentrations (greater than the baseline mean of specific water quality parameters) have remained above those concentrations.

Analysis against Subsidence Impact Performance Measure

Consistent with the Metropolitan Coal Longwalls 23-27 Water Management Plan, if data analysis indicates the performance indicator has been exceeded or is likely to be exceeded, an assessment is made against the following subsidence impact performance measure.

Subsidence Impact Performance Measure:

Negligible reduction in the water quality of Woronora Reservoir.

The performance indicator was not exceeded during the reporting period.

2.3.6 Waratah Rivulet Downstream of the Maingate of Longwall 23

Table 1 of the Project Approval requires the Project to result in:

> *Negligible environmental consequences (that is, no diversion of flows, no change in the natural drainage behaviour of pools, minimal iron staining and minimal gas releases) on the Waratah Rivulet between the full supply level of the Woronora Reservoir and the maingate of Longwall 23 (upstream of Pool P).*

Pools P, Q, R, S, T, U, V and W on Waratah Rivulet are situated downstream of maingate 23, and approximately 110 m, 370 m, 290 m, 170 m, 242 m, 298, 340 m and 400 m beyond the nearest secondary extraction of Longwalls 23-27, respectively (Figure 5).

Pools P and T on the Waratah Rivulet terminate by flowing through and below their respective rock bars. Pools Q, R and S on the Waratah Rivulet terminate at rock bars. Pools U and W on the Waratah Rivulet terminate in boulder fields and are not characterised by flow over rock bars. Pool V on the Waratah Rivulet terminates in a rock bar characterised by partial flow over the rock bar and partial flow through and below the rock bar.

The methods used to assess the performance of the Project against the subsidence impact performance measure are described below.

<u>No Diversion of Flows or Change in the Natural Drainage Behaviour of Pools</u>

Pools P, Q, R, S, T, U, V and W (Figure 5) are visually inspected on a weekly basis when mining of Longwalls 23-27 is within 400 m of the pools to observe whether any changes to the natural drainage behaviour of the pools have occurred.

Observations include:

- evidence of new cracking within the stream bed or rock bar (where relevant);
- whether the pools continue to flow over, through and/or below the rock bars (where relevant);
- whether surface flow is evident along the length of Pools P and T prior to flowing through/below the rock bars;
- whether surface flow is evident along the length of Pools Q, R and S prior to flowing over the rock bars;
- whether surface flow is evident along the length of Pool V prior to flowing over/through/below the rock bar; and
- whether surface flow is evident along the length of Pools U and W prior to flowing through the downstream boulder field.

During the reporting period Longwall 23 was within 400 m of Pools P, Q and/or R in July, August and September 2014.

The water depth in Pools P, Q, R, S, T, U, V and W on the Waratah Rivulet (Figure 5) and at control pools WRP1, WRP2, WRP3 and WRP4 on the Woronora River are continuously monitored using a water depth sensor and logger.

Assessment against Performance Indicators

Visual inspections of Pools P, Q, R, S, T, U, V and W are conducted on a weekly basis when mining of Longwalls 23-27 is within 400 m of the pool and assessed against the following performance indicator:

> *No change to the natural drainage behaviour of Pools P, Q, R, S, T, U, V and W. Specific indicators include: no new cracking in the stream bed of pools or rock bars (where relevant); continual flow over/through/below the rock bars/terminal boulder fields of pools such that water is ponded upstream; and continual surface water flow along the length of the pools.*

The performance indicator is considered to have been exceeded if the natural drainage behaviour is altered such that either: mining induced cracking is evident in the stream bed or rock bar of Pools P, Q, R, S, T, U, V or W (where relevant); or water ceases to be ponded upstream of the rock bars/terminal boulder fields of Pools P, Q, R, S, T, U, V or W; or surface flow ceases along the length of Pools P, Q, R, S, T, U, V or W. If visual observation indicates a potential impact to the natural drainage behaviour of Pools P, Q, R, S, T, U, V or W, then pools downstream, and the control pools on the Woronora River (i.e. Pools WRP1, WRP2, WRP3 and WRP4) will be inspected and an assessment is made against the subsidence impact performance measure.

During the reporting period Longwall 23 was within 400 m of Pools P, Q and/or R in July, August and September 2014. The weekly visual observations indicated there was no change to the natural drainage behaviour of these pools.

Water level data for Pools P, T and V is also downloaded monthly and assessed against the following performance indicator:

> *Analysis of water depth data for Pools P, T and V (when mining is within 400 m of the pools) indicates the water depth is at or above the pool's previous minimum (i.e. when mining is beyond 400 m of the pools).*

The performance indicator is considered to have been exceeded if the water depth in Pools P, T, or V (when mining is within 400 m of the pools) has been below the pool's previous minimum (i.e. when mining is beyond 400 m of the pools). If data analysis indicates the water depth in Pools P, T, or V (when mining is within 400 m of the pools) has been below the pool's previous minimum (i.e. when mining is beyond 400 m of the pools), pools downstream on Waratah Rivulet and the control pools on Woronora River will be analysed and an assessment will be made against the performance measure.

During the reporting period Longwall 23 was within 400 m of Pool P from July to September 2014. The recorded water level hydrographs for Pools P, T and V (shown on Charts B18, B22 and B24 in Appendix B) indicate the pools did not cease flowing and that they exhibited natural behaviour during the reporting period.

Water level data for Pools Q, R and S is also downloaded monthly and assessed against the following performance indicator:

> *Analysis of water depth data for Pools Q, R and S on Waratah Rivulet indicates the water depths are above that required to maintain water over the downstream rock bar.*

The performance indicator is considered to have been exceeded if the water depth in Pools Q, R or S has been below that required to maintain water over the downstream rock bar. If data analysis indicates water depths in Pools Q, R or S have been below that required to maintain water over the downstream rock bar, pools downstream on the Waratah Rivulet and the control pools on Woronora River will be analysed and an assessment will be made against the subsidence impact performance measure.

During the reporting period Longwall 23 was within 400 m of Pools Q and/or R from July to September 2014. Recorded water level hydrographs, including the reporting period, for Pools Q, R and S are shown on Charts 66 to 68. Recorded water levels in Pools Q, R and S have remained above their cease to flow levels over the reporting period. As a result, the performance indicator has not been exceeded.

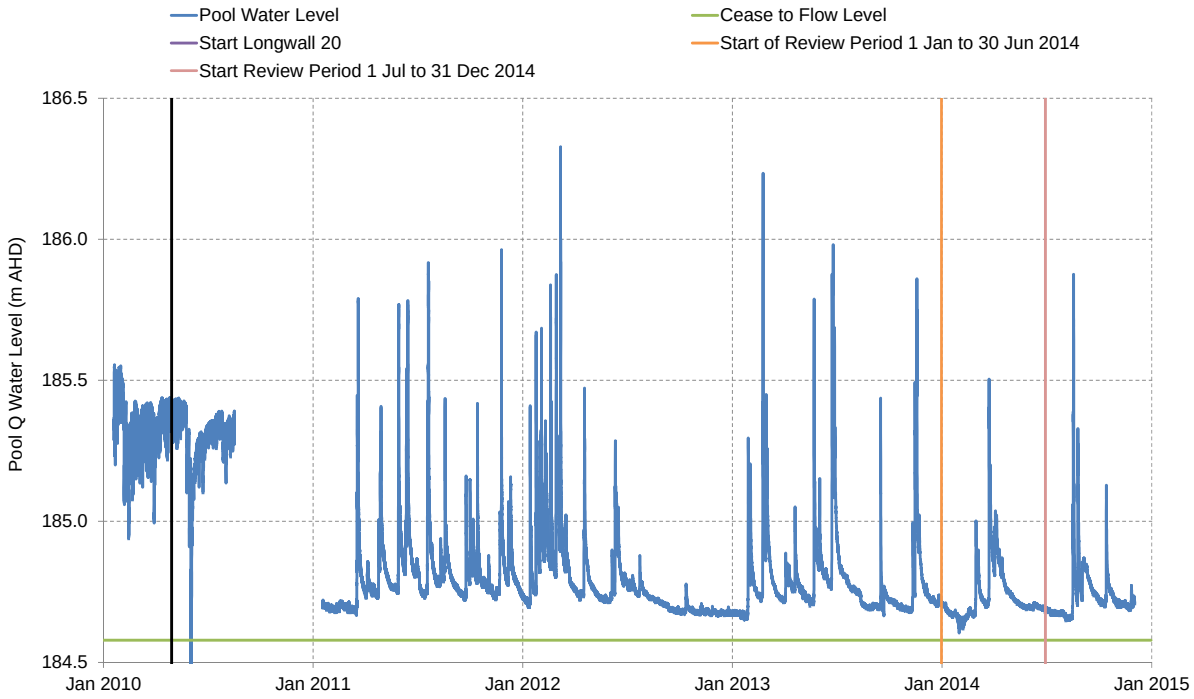


Chart 66 Pool Q Water Level Hydrograph

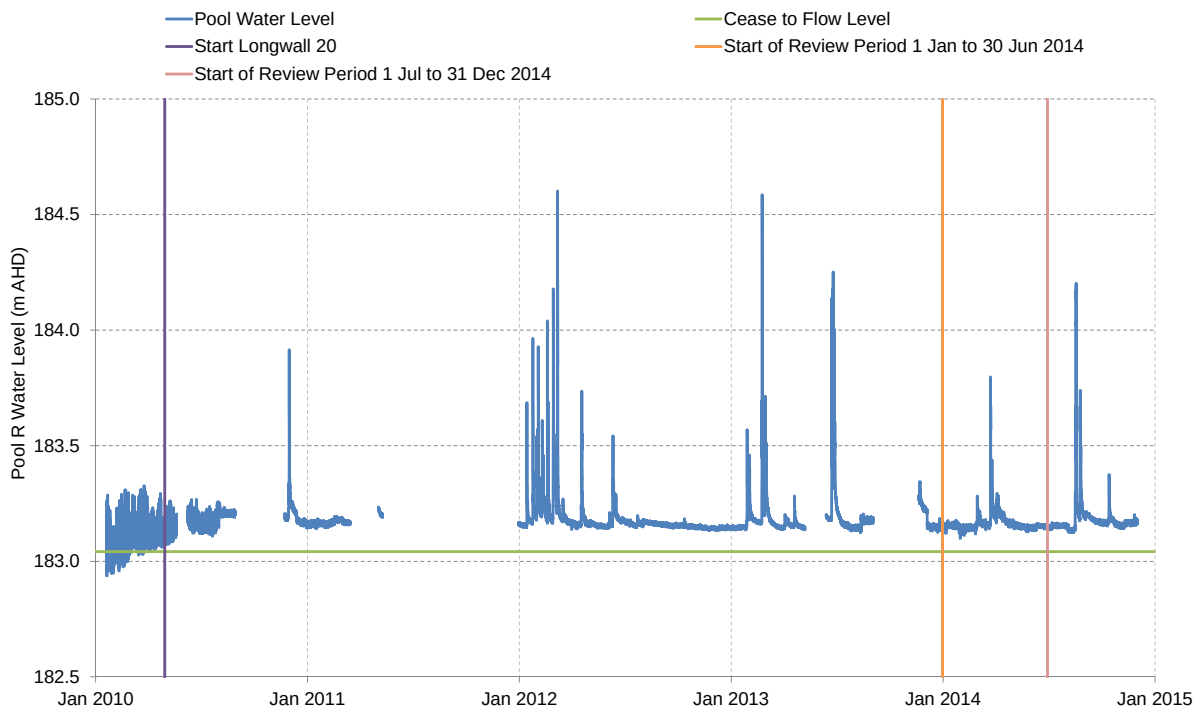


Chart 67 Pool R Water Level Hydrograph

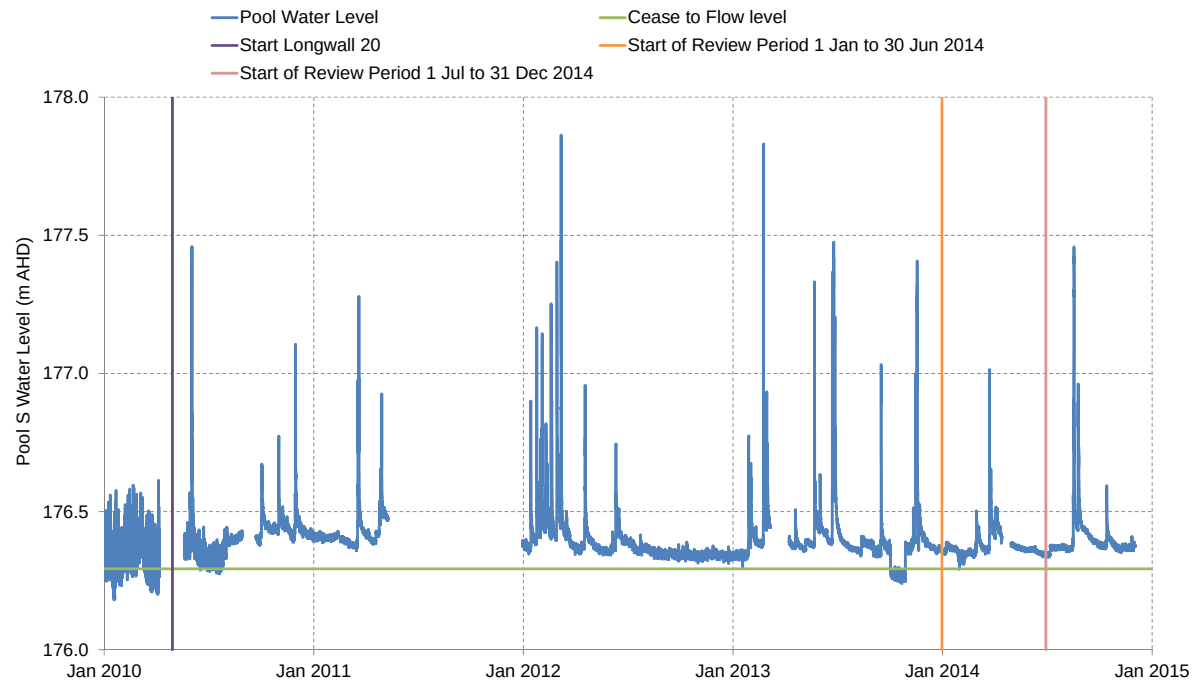


Chart 68 Pool S Water Level Hydrograph

Assessment against Performance Measure

The performance measure, *negligible environmental consequences (that is, no diversion of flows, no change in the natural drainage behaviour of pools ….)*, will be considered to have been exceeded if analysis of water depth data indicates that changes in the drainage behaviour are statistically different from:

- pre-mining conditions (i.e. when mining is greater than 400 m from the pools); and
- the behaviour of downstream unaffected pools;

as a result of the Project and the change in drainage behaviour cannot be explained by climatic conditions.

As described above, the various performance indicators for no diversion of flows or change in the natural drainage behaviour of pools were not exceeded during the reporting period.

Minimal Iron Staining

Under certain conditions the cracking of stream beds and underlying strata has the potential to result in changes in water quality, particularly ferruginous springs and/or development of iron bacterial mats.

Previous experience on the Waratah Rivulet at Metropolitan Coal indicates that areas of the substratum have been covered by iron flocculent material for several hundred metres downstream of mine subsidence fractures.

Visual and photographic surveys of the Waratah Rivulet downstream of maingate 23 to the Woronora Reservoir full supply level are conducted monthly when mining is within 400 m of the stream, and will be conducted within three months of the completion of each longwall. Longwall 23 was approximately 629 m from completion as at 31 December 2014 (Figure 4).

Assessment against Performance Indicator

Consistent with the Metropolitan Coal Longwalls 23-27 Water Management Plan, visual surveys assess whether the following performance indicator has been exceeded:

> *Visual inspection of the Waratah Rivulet between the full supply level of the Woronora Reservoir and Pool P does not show significant changes in the extent or nature of iron staining that isn't also occurring in the Woronora River (control site).*

The performance indicator is considered to have been exceeded if there is significant change in the extent or nature of iron staining in the Waratah Rivulet between maingate 23 and full supply level, and a similar change is not also occurring in the Woronora River (control site).

Longwall 23 was within 400 m of the Waratah Rivulet from July to September 2014. The visual inspections of the Waratah Rivulet between the full supply level of the Woronora Reservoir and Pool P did not show significant changes in the extent or nature of iron staining.

If visual observations indicate significant changes to the nature or extent of iron staining in the Waratah Rivulet between maingate 23 and full supply level, the downstream reach of the Waratah Rivulet will be inspected and an assessment will be made against the performance measure.

Assessment against Performance Measure

The performance measure, *negligible environmental consequences (that is, … minimal iron staining,...)* will be considered to have been exceeded if analysis of the monitoring results confirms that the Project has resulted in a significant change to the nature or extent of iron staining on the Waratah Rivulet downstream of maingate 23 and cannot be explained by climatic conditions.

The performance indicator for iron staining was not exceeded during the reporting period.

Minimal Gas Releases

Visual and photographic surveys of the Waratah Rivulet downstream of maingate 23 to the Woronora Reservoir full supply level have been conducted monthly when Longwall 23 was within 400 m of the stream (from July to September 2014), and will be conducted within three months of the completion of each longwall.

Assessment against Performance Indicator

Consistent with the Metropolitan Coal Longwalls 23-27 Water Management Plan, visual surveys conducted in the previous Six Monthly reporting period assessed whether the following performance indicator had been exceeded:

> *No gas releases observed at Pools P to W on the Waratah Rivulet.*

Visual inspections conducted by Metropolitan Coal identified gas releases in Pool P (intermittent bubbles, approximately 50 m from the top of the pool) in February 2014 (prior to the commencement of Longwall 23).

In accordance with the Metropolitan Coal Longwalls 23-27 Water Management Plan an assessment was made against the subsidence impact performance measure, *minimal gas releases*, and the results of the assessment are presented below.

Assessment against Performance Measure

Metropolitan Coal commissioned Gilbert & Associates to conduct the assessment of the Pool P gas release against the performance measure. Gilbert & Associates' assessment concluded the gas releases at Pool P were considered to be minimal.

Metropolitan Coal commissioned Evans & Peck to conduct a peer review of Gilbert & Associates assessment. The peer review by Evans & Peck also concluded that the performance measure had not been exceeded.

Assessment against Revised Performance Indicator

Consistent with the revised Metropolitan Coal Longwalls 23-27 Water Management Plan (Version D), subsequent visual surveys (i.e. those conducted following the Gilbert & Associates and Evans & Peck performance assessments) have assessed whether the following performance indicators have been exceeded:

> *Visual observations of gas releases in Pool P on the Waratah Rivulet indicate the gas releases have increased beyond those observed up to 17 April 2014.*
>
> *No gas releases observed at Pools Q to W on the Waratah Rivulet.*

Longwall 23 was within 400 m of the Waratah Rivulet from July to September 2014. No gas releases were observed at Pools Q to W during the reporting period.

Gas releases in Pool P were identified for the first time in February 2014 and continued to the end of the reporting period. The revised performance indicator for Pool P was not exceeded up to and including August 2014 as the gas releases did not increase beyond those observed at Pool P up to 17 April 2014 (which were assessed by Gilbert & Associates).

An exceedance of the revised gas release performance indicator was identified in September 2014 at a location referred to as Pool P2, situated further downstream in Pool P from the previous gas release location (referred to as Pool P1). The increased gas release coincided with the completion of Longwall 23A, which was within 100 m of Pool P.

Assessment against Performance Measure

Metropolitan Coal commissioned Dr Barry Noller (The University of Queensland) to conduct an assessment of the Pool P gas releases against the performance measure. Dr Barry Noller's assessment concluded that the performance measure had not been exceeded as the potential impacts on water quality associated with the observed gas releases are negligible. Laboratory analysis of water collected from Pool P indicates the gas releases are not contributing carbon dioxide to the Waratah Rivulet, however are contributing low concentrations of methane to the Waratah Rivulet. The dissolved methane (which represents organic matter in the water) is not contributing to the total organic carbon concentrations found in the Waratah Rivulet, as evidenced by the water quality monitoring results for Pool P, other pools with gas releases, as well as pools with no gas releases.

Metropolitan Coal commissioned Dr Steve Perrens (Advisian [previously Evans & Peck]) to conduct a peer review of Dr. Barry Noller's assessment. Dr Steve Perrens was approved by the Department of Planning and Infrastructure (now the DP&E) to act as the peer reviewer in November 2011. Dr Steve Perrens also concluded that the performance measure had not been exceeded.

The gas releases in Pool P have not increased beyond those observed and assessed in September/October 2014 by Dr Barry Noller from The University of Queensland. Sporadic bubbling continues to occur at Pool P1, while gas releases at Pool P2 ceased in November 2014.

2.3.7 Eastern Tributary Downstream of Maingate 26

Table 1 of the Project Approval requires the Project to result in:

> *Negligible environmental consequences over at least 70% of the stream length (that is, no diversion of flows, no change in the natural drainage behaviour of pools, minimal iron staining and minimal gas releases) on the Eastern Tributary between the full supply level of the Woronora Reservoir and the maingate of Longwall 26.*

Pool ETAF on the Eastern Tributary is situated above maingate 26, Pools ETAG and ETAH above Longwall 27, Pools ETAI, ETAJ and ETAK above maingate 27 and Pools ETAL to ETAU are situated downstream of maingate 26 (Figure 5). The stream length of the Eastern Tributary between maingate 26 and the full supply level of the Woronora Reservoir is approximately 950 m. Accordingly, the Project cannot have greater than negligible environmental consequences over more than approximately 285 m of the Eastern Tributary between maingate 26 and the full supply level of the Woronora Reservoir.

The methods used to assess the performance of the Project against the subsidence impact performance measure are described below.

No Diversion of Flows or Change in the Natural Drainage Behaviour of Pools

Pools ETAF to ETAU (Figure 5) are visually inspected on a weekly basis when mining of Longwalls 23-27 is within 400 m of the pools to observe whether any changes to the natural drainage behaviour of the pools have occurred.

Observations include:

- evidence of new cracking within the stream bed or rock bar (where relevant);
- whether the pools continue to flow over, through and/or below the rock bars (where relevant); and
- whether surface flow is evident along the length of the pools prior to flowing over/through/below the rock bars or boulder fields.

During the reporting period, the mining of Longwall 23 had not advanced to within 400 m of Pools ETAF to ETAU.

The water depth in Pools ETAF, ETAG, ETAH, ETAI, ETAQ and ETAU on the Eastern Tributary (Figure 5) and at control pools WRP1, WRP2, WRP3 and WRP4 on the Woronora River are continuously monitored using a water depth sensor and logger.

Assessment against Performance Indicators

Visual inspections of Pools ETAF to ETAU are conducted on a weekly basis when mining is within 400 m of the pools and assessed against the following performance indicator:

> *No change to the natural drainage behaviour of at least 70% of the stream length (from Pools ETAF to ETAU). Specific indicators include: no new cracking in the stream bed of pools or rock bars (where relevant); continual flow over/ through/below the rock bars/terminal boulder fields such that water is ponded upstream (where relevant); and continual surface water flow along the length of the pools.*

The performance indicator is considered to have been exceeded if the natural drainage behaviour is altered over more than 30% of the relevant stream length such that either: mining induced cracking is evident in the stream bed or rock bars of Pools ETAF to ETAU; or water ceases to be ponded upstream of rock bars/terminal boulder fields; or surface flow ceases along the length of pools. If visual observation indicates a potential impact to the natural drainage behaviour of more than 30% of the stream length (from Pools ETAF to ETAU), then pools downstream, and the control pools on the Woronora River (i.e. Pools WRP1, WRP2, WRP3 and WRP4) will be inspected and an assessment will be made against the subsidence impact performance measure.

During the reporting period, the mining of Longwall 23 had not advanced to within 400 m of Pools ETAF to ETAU.

Water level data for Pool ETAI is downloaded monthly and assessed against the following performance indicator:

> *Analysis of water depth data for Pool ETAI (when mining is within 400 m of the pool) indicates the water depth is at or above the pool's previous minimum (i.e. when mining is beyond 400 m of the pools).*

The performance indicator is considered to have been exceeded if the water depth in Pool ETAI (when mining is within 400 m of the pool) has been below the pool's previous minimum (i.e. when mining is beyond 400 m of the pool).

If data analysis indicates the water depth in Pool ETAI (when mining is within 400 m of the pool) has been below the pool's previous minimum (i.e. when mining is beyond 400 m of the pool), pools downstream on the Eastern Tributary and the control pools on Woronora River will be analysed and an assessment will be made against the performance measure.

During the reporting period, the mining of Longwall 23 had not advanced to within 400 m of Pool ETAI.

Assessment against Performance Measure

The performance measure, *negligible environmental consequences over at least 70% of the stream length (that is, no diversion of flows, no change in the natural drainage behaviour of pools ….)*, will be considered to have been exceeded if analysis of available water depth data and visual inspections indicates that changes in the drainage behaviour are statistically different from:

- pre-mining conditions (i.e. when mining is greater than 400 m from the pools); and
- the behaviour of downstream unaffected pools;

over more than 30% of the relevant stream length as a result of the Project and the change in drainage behaviour cannot be explained by climatic conditions.

As described above, the various performance indicators for no diversion of flows or change in the natural drainage behaviour of pools were not exceeded during the reporting period.

Minimal Iron Staining

Under certain conditions the cracking of stream beds and underlying strata has the potential to result in changes in water quality, particularly ferruginous springs and/or development of iron bacterial mats.

Previous experience on the Waratah Rivulet at Metropolitan Coal indicates that areas of the substratum have been covered by iron flocculent material for several hundred metres downstream of mine subsidence fractures.

Visual and photographic surveys of the Eastern Tributary downstream of maingate 26 to the Woronora Reservoir full supply level are conducted monthly when mining is within 400 m of the stream, and will be conducted within three months of the completion of each longwall.

Assessment against Performance Indicator

Consistent with the Metropolitan Coal Longwalls 23-27 Water Management Plan, the visual surveys assess whether the following performance indicator has been exceeded:

> *No significant change to the extent or nature of iron staining over more than 30% of the Eastern Tributary between maingate 26 and the Woronora Reservoir full supply level, that isn't also occurring in the Woronora River (control site).*

The performance indicator is considered to have been exceeded if there is significant change in the extent or nature of iron staining over more than 30% of the Eastern Tributary between maingate 26 and the full supply level of the Woronora Reservoir, and a similar change is not also occurring in the Woronora River (control site).

Longwall 23 was within 400 m of the Eastern Tributary in December 2014. The visual inspections of the Eastern Tributary between maingate 26 and the Woronora Reservoir full supply level did not show a significant change in the extent or nature of iron staining over more than 30% of the Eastern Tributary.

If visual observations indicate significant changes to the nature or extent of iron staining in the Eastern Tributary between maingate 26 and full supply level, the downstream reach of the Eastern Tributary will be inspected and an assessment will be made against the performance measure.

Assessment against Performance Measure

The performance measure, *negligible environmental consequences over at least 70% of the stream length (that is, … minimal iron staining,...)* will be considered to have been exceeded if analysis of the monitoring results confirms that the Project has resulted in a significant change to the nature or extent of iron staining on the Eastern Tributary between maingate 26 and the full supply level of the Woronora Reservoir and cannot be explained by climatic conditions.

The performance indicator for iron staining was not exceeded during the reporting period.

Minimal Gas Releases

Visual and photographic surveys of the Eastern Tributary between maingate 26 and the Woronora Reservoir full supply level has been conducted monthly when mining has been within 400 m of the Eastern Tributary, and will be conducted within three months of the completion of each longwall.

Assessment against Performance Indicator

Consistent with the Metropolitan Coal Longwalls 23-27 Water Management Plan, the visual surveys assess whether the following performance indicator has been exceeded:

> *Gas releases observed over less than 30% of the Eastern Tributary between the full supply level of the Woronora Reservoir and Pool ETAF.*

If the visual surveys indicate the performance indicator has been exceeded, an assessment will be made against the subsidence impact performance measure.

Longwall 23 was within 400 m of the Eastern Tributary in December 2014. No gas releases were observed on the Eastern Tributary between the full supply level of the Woronora Reservoir and Pool ETAF.

Assessment against Performance Measure

The performance measure, *negligible environmental consequences over at least 70% of the stream length (that is, … minimal gas releases)*, will be assessed by considering if the gas releases observed have resulted in greater than minimal gas releases.

The performance measure is exceeded if analysis of the monitoring results confirms that the Project has resulted in greater than minimal gas releases in more than 30% of the Eastern Tributary downstream of maingate 26.

The performance indicator for gas releases was not exceeded during the reporting period.

2.4 TARP CHARACTERISATION

The TARP characterisation for Longwalls 23-27 water management during the reporting period is provided in Table 2. In summary, two performance indicators were exceeded during the reporting period. Exceedance of the performance indicators triggered an assessment against the relevant performance measures. The performance measures were not exceeded during the reporting period.

Table 2
TARP Characterisation – Longwalls 23-27 Water Management

Monitoring Components	Subsidence Impact Performance Indicator(s)	Subsidence Impact Performance Indicator Exceeded?	Resulting Actions	Subsidence Impact Performance Measure	Subsidence Impact Performance Measure Exceeded?
Surface Water Flow (Section 2.2.2)	*Changes in the quantity of water entering Woronora Reservoir is not significantly different post-mining compared to pre-mining, that is not also occurring in the control catchment(s)* (Section 2.3.1)	Assessment deferred. The performance indicator cannot be validly assessed as a result of current discrepancies in flows generated by the existing rating curves used for the Waratah Rivulet and Woronora River gauging stations.	Metropolitan Coal to remedy the situation by regenerating the current flow records from the Waratah Rivulet and Woronora River gauging stations using amended rating relationships to be developed by Metropolitan Coal. Re-calibrated catchment models will be developed for the Waratah Rivulet and Woronora River gauging stations.	*Negligible reduction to the quantity of water resources reaching the Woronora Reservoir*	-
Water Quality Reaching Woronora Reservoir (Section 2.2.4)	*Changes in the quality of water entering Woronora Reservoir are not significantly different post-mining compared to pre-mining concentrations that are not also occurring at control site WOWQ2* (Section 2.3.2)	Yes	Assessment against the performance measure conducted by Gilbert & Associates and included in Section 2.3.2.	*Negligible reduction to the quality of water resources reaching the Woronora Reservoir*	No
Connective Cracking (Sections 2.2.8, 2.2.10 and 2.2.11)	*Visual inspection does not identify abnormal water flow from the goaf, geological structure, or the strata generally* (Section 2.3.3)	No	Continue monitoring	*No connective cracking between the surface and the mine*	No
	The 20-day average mine water make does not exceed 2 ML/day (Section 2.3.3)	No	Continue monitoring	*No connective cracking between the surface and the mine*	No
	Significant departure from the predicted envelope of vertical potentiometric head profile at Bore 9GGW2B does not occur (Section 2.3.3)	No	Continue monitoring		No
	The water tables measured at Bores 9FGW1A and 9GGW1-80 are higher than the water levels of streams crossed by a transect along Longwall 22 (i.e. a hydraulic gradient exists from each bore to the nearest watercourse) (Section 2.3.3)	No	Continue monitoring		No

Table 2 (Continued)
TARP Characterisation – Longwalls 23-27 Water Management

Monitoring Components	Subsidence Impact Performance Indicator(s)	Subsidence Impact Performance Indicator Exceeded?	Resulting Actions	Subsidence Impact Performance Measure	Subsidence Impact Performance Measure Exceeded?
Leakage from the Woronora Reservoir (Section 2.3.4)	*The groundwater head of Bores 9GGW2B and PM02 is higher than the water level of Woronora Reservoir (i.e. a hydraulic gradient exists from the bores to the Woronora Reservoir)* (Section 2.3.4)	No	Continue monitoring	*Negligible leakage from the Woronora Reservoir*	No
Water Quality of Woronora Reservoir (Section 2.2.5)	*Changes in the quality of water in the Woronora Reservoir are not significantly different post-mining compared to pre-mining concentrations, that are not also occurring in the Nepean Reservoir (control site)* (Section 2.3.5)	No	Continue monitoring	*Negligible reduction in the water quality of Woronora Reservoir*	No
Waratah Rivulet Environmental Consequences (Sections 2.2.1 and 2.2.3)	*No change to the natural drainage behaviour of Pools P, Q, R, S, T, U, V and W. Specific indicators include: no new cracking in the stream bed of pools or rock bars (where relevant); continual flow over/ through/below the rock bars/terminal boulder fields of pools such that water is ponded upstream; and continual surface water flow along the length of the pools (Section 2.3.6)*	No	Continue monitoring	*Negligible environmental consequences (that is, no diversion of flows, no change in the natural drainage behaviour of pools, minimal iron staining, and minimal gas releases) on the Waratah Rivulet between the full supply level of the Woronora Reservoir and the maingate of Longwall 23 (upstream of Pool P)*	No
	Analysis of water depth data for Pools P, T and V (when mining is within 400 m of the pools) indicates the water depth is at or above the pool's previous minimum (i.e. when mining is beyond 400 m of the pools) (Section 2.3.6)	No	Continue monitoring		No
	Analysis of water depth data for Pools Q, R and S on Waratah Rivulet indicates the water depths are above that required to maintain water over the downstream rock bar (Section 2.3.6)	No	Continue monitoring		No
	Visual inspection of the Waratah Rivulet between the full supply level of the Woronora Reservoir and Pool P does not show significant changes in the extent or nature of iron staining that isn't also occurring in the Woronora River (control site) (Section 2.3.6)	*No*	Continue monitoring		No

Table 2 (Continued)
TARP Characterisation – Longwalls 23-27 Water Management

Monitoring Components	Subsidence Impact Performance Indicator(s)	Subsidence Impact Performance Indicator Exceeded?	Resulting Actions	Subsidence Impact Performance Measure	Subsidence Impact Performance Measure Exceeded?
Waratah Rivulet Environmental Consequences (Sections 2.2.1 and 2.2.3) continued	*Visual observations of gas releases in Pool P on the Waratah Rivulet indicate the gas releases have increased beyond those observed up to 17 April 2014* (Section 2.3.6)	Yes	Assessment against the performance measure conducted by Dr. Barry Noller (University of Queensland) for Pool P. Peer review of the assessment conducted by Evans & Peck also concluded the performance measure had not been exceeded.	*Negligible environmental consequences (that is, no diversion of flows, no change in the natural drainage behaviour of pools, minimal iron staining, and minimal gas releases) on the Waratah Rivulet between the full supply level of the Woronora Reservoir and the maingate of Longwall 23 (upstream of Pool P)*	No
	No gas releases observed at Pools Q to W on the Waratah Rivulet (Section 2.3.6)	No	Continue monitoring		No
Eastern Tributary Environmental Consequences (Sections 2.2.1 and 2.2.3)	*No change to the natural drainage behaviour of at least 70% of the stream reach (from Pools ETAF to ETAU). Specific indicators include: no new cracking in the stream bed of pools or rock bars (where relevant); continual flow over/through/below the rock bar of pools/terminal boulder fields such that water is ponded upstream; and continual surface water flow along the length of pools* (Section 2.3.7)	No	Continue monitoring	*Negligible environmental consequences over at least 70% of the stream length (that is, no diversion of flows, no change in the natural drainage behaviour of pools, minimal iron staining, and minimal gas releases) on the Eastern Tributary between the full supply level of the Woronora Reservoir and the maingate of Longwall 26*	No
	Analysis of water depth data for Pool ETAI on the Eastern Tributary (when mining is within 400 m of the pool) indicates the water depth is at or above the pool's previous minimum (i.e. when mining is beyond 400 m of the pool) (Section 2.3.7)	No	Continue monitoring		No
	No significant change to the extent or nature of iron staining over more than 30% of the Eastern Tributary between maingate 26 and full supply level (Section 2.3.7)	No	Continue monitoring		No
	Gas releases observed over less than 30% of the Eastern Tributary between maingate 26 and full supply level, that is not also occurring in the Woronora River (control site) (Section 2.3.7)	No	Continue monitoring		No

3 BIODIVERSITY MANAGEMENT

3.1 BACKGROUND

The Metropolitan Coal Longwalls 23-27 Biodiversity Management Plan (Metropolitan Coal, 2014c) has been prepared to manage the potential environmental consequences of the Metropolitan Coal Longwalls 23-27 Extraction Plan on aquatic and terrestrial flora and fauna, with a specific focus on swamps, in accordance with Condition 6, Schedule 3 of the Project Approval.

3.2 MONITORING

3.2.1 Upland Swamp Vegetation Monitoring

Thirteen upland swamps, *viz*. Swamps 19, 23, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35 and 36[8] occur above or immediately adjacent to Longwalls 23-27 (Figure 10). Two swamp substrate characterisation studies have also been conducted to contribute to Metropolitan Coal's understanding of the ecological, hydrological and geomorphic processes of swamps over Longwalls 23-27.

With the exception of Swamp 28, which supports Banksia Thicket and in the lower portion of the swamp Tea Tree Thicket, all the swamps over Longwalls 23-27 comprise either Banksia Thicket or Restioid Heath, or a combination of the two. Transitions between Restioid Heath and Banksia Thicket are thought to be driven by fire frequency.

The upland swamp vegetation monitoring program includes visual monitoring, transect/quadrat monitoring and monitoring of indicator species, as described below.

Visual Inspections

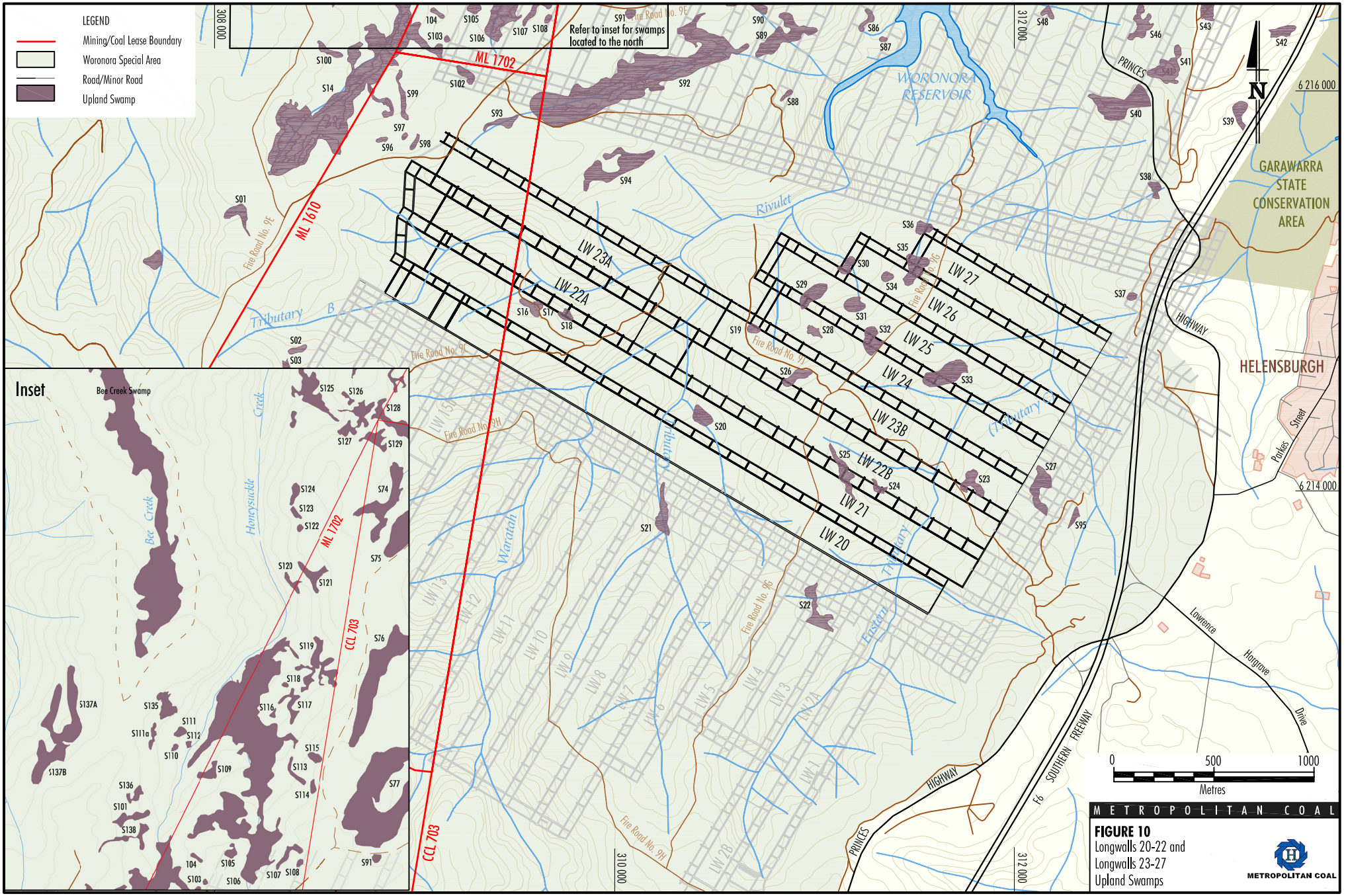
Visual inspections are conducted monthly of Swamps 19, 23, 26, 27, 28, 30, 31, 32, 33, 34, 35, 36, 93, 94, 96, 97 and 98 overlying or adjacent to Longwalls 23-27 for the period of time that Longwalls 23-27 are within 400 m of the swamp to record evidence of potential subsidence impacts.

Visual inspections of the swamps overlying and immediately adjacent to Longwalls 23-27 and at the control swamps (Swamps 101, 111a, 125, 135, 136, 137a, 137b, 138, Bee Creek Swamp, Woronora River 1, Woronora River South Arm and Dahlia Swamp) (Figures 10 and 11) are also conducted at the same time as the vegetation surveys.

Traverses covering the majority of the extent of the swamp are conducted to record:

- cracking of exposed bedrock areas and/or swamp sediments;
- areas of increased erosion, particularly along any existing drainage lines;
- any changes in water colour;
- changes in vegetation condition, including areas of senescing vegetation that appear unusual; and
- the amount of seepage at the time of inspection, relative to recent rainfall events.

[8] Thirteen swamps mapped by Bangalay Botanical Surveys (2008) are located above or immediately adjacent to Longwalls 23-27, namely, Swamps 19, 23, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35 and 36 (Figure 10). Swamp 29 (Figure 10) is mapped as Sedgeland-heath Complex (Bangalay Botanical Surveys, 2008; National Parks and Wildlife Service, 2003), however field inspections by Eco Logical Australia for the Longwalls 23-27 vegetation monitoring program indicated that this is not a swamp. The vegetation is similar to sandstone heath woodland, being dominated by *Angophora costata, Corymbia gummifera* and *Eucalyptus oblonga,* with an understorey of *Banksia ericifolia, Acacia ulicifolia, Leptospermum trinervium, Kunzea ambigua, Dillwynia retorta* and *Schoenus ericetorum*. Accordingly, no further consideration of Swamp 29 is given (in the context of it being an upland swamp).



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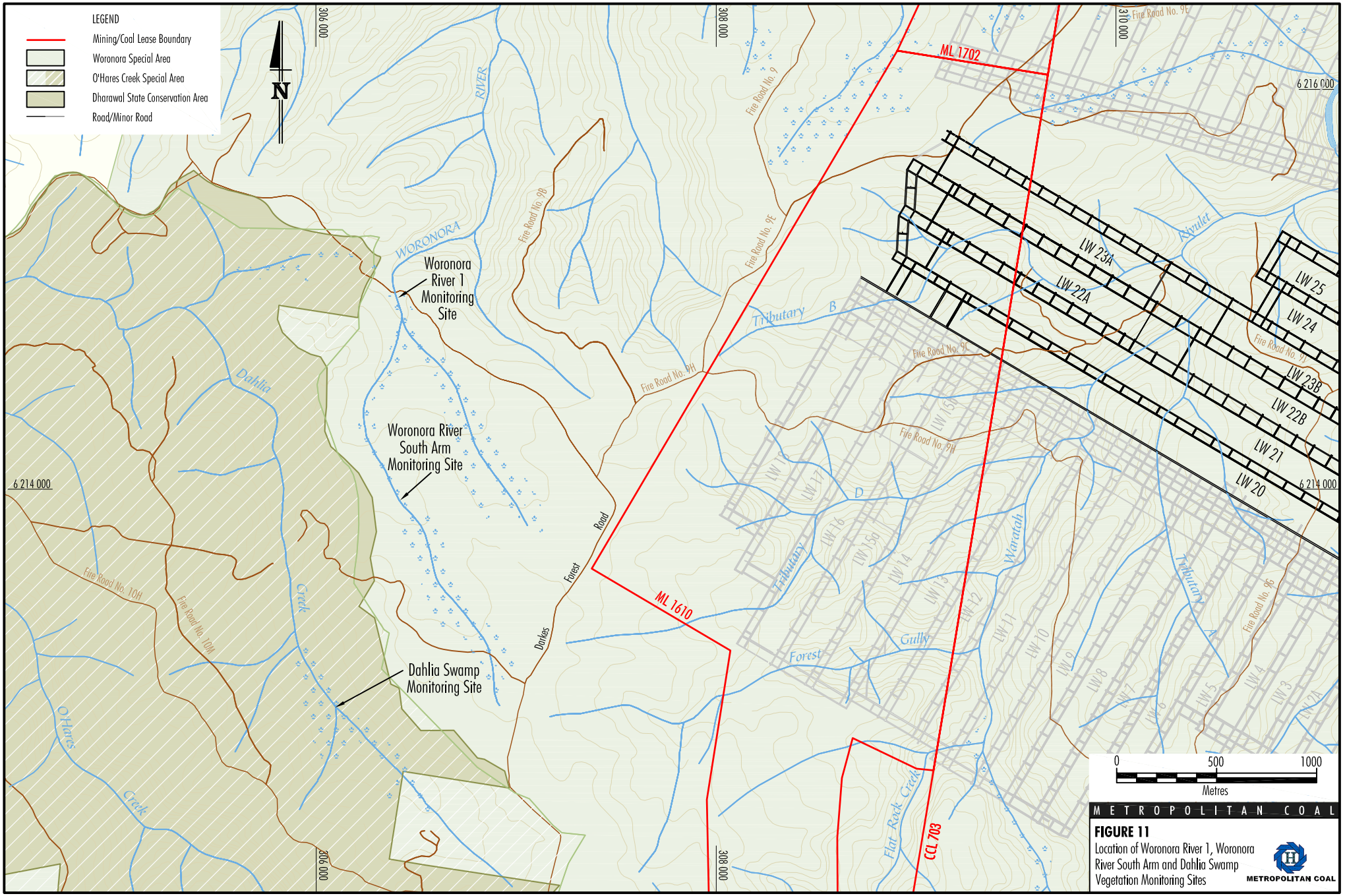

METROPOLITAN COAL

FIGURE 11

Location of Woronora River 1, Woronora River South Arm and Dahlia Swamp Vegetation Monitoring Sites

METROPOLITAN COAL

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Photographs of any cracking, erosion, water colour changes and vegetation senescence are taken concurrently with a description of the magnitude and extent of the observations, and appropriate GPS readings. Seepage is documented by photographs of flow over exposed surfaces.

Swamps overlying and immediately adjacent to Longwalls 23-27 have been inspected monthly by Metropolitan Coal when mining was within 400 m of the swamps. No major cracking of exposed bedrock areas or swamp sediments was observed during the visual inspections by Metropolitan Coal. Similarly, no areas of increased erosion, changes in water colour or changes in vegetation condition were observed. The amount of seepage observed during the visual inspections was relative to rainfall events prior to the inspections.

Visual inspections by Eco Logical Australia have been conducted biannually since spring 2010 in Swamps 19, 27, 28, 30, 31, 32, 33, 34, 35, 36, 93, 94, 96, 97, 98, 135, 136, 137a, 137b, 138 and Bee Creek Swamp. Visual inspection monitoring at Swamps 23, 26, 101, 111a and 125 has been conducted biannually since spring 2008 as a component of the Longwalls 20-22 upland swamp vegetation monitoring program. Surveys conducted up to and including the spring 2013 survey represent baseline surveys.

A summary of the visual observations by Eco Logical Australia up to spring 2013 (i.e. prior to the commencement of Longwall 23) is provided in the Metropolitan Coal Six Monthly Report, 1 January to 30 June 2014.

The following provides a summary of the visual observations made during traverses covering the majority of the extent of each swamp by Eco Logical Australia in autumn 2014 (i.e. during the mining of Longwall 23).

- No cracking of exposed bedrock areas or swamp sediments was observed in either longwall or control swamps, other than where minor cracks in exposed bedrock identified during the baseline surveys, considered to be a weathering artefact, occur (Swamps 23, 26 and 31).
- No areas of active erosion were observed within any of the longwall upland swamps in autumn 2014. Areas of erosion were limited to control swamps, specifically in areas of bare earth without vegetation cover within Swamps 101, 111a and 138 and within the drainage line in Swamp 125. In these locations the observed erosion was minor and limited in extent.
- For the restioid heath and banksia thicket swamps, the occurrence of seepage in autumn 2014 was variable within longwall and control swamps. In longwall swamps the amount of seepage observed ranged from absent or minor (Swamps 26, 28, 95, 96, 97 and 98) to moderate (Swamp 27), to common or abundant (Swamps 23, 30, 33, 35, 93 and 94). Similarly within control swamps seepage ranged from absent (Swamps 101, 136 and Bee Creek Swamp) to minor (Swamps 111a and 125) to common or abundant (Swamps 135, 137a, 137b and 138).
- In autumn 2014 the larger headwater swamps supporting Tea Tree Thicket vegetation (control sites Woronora River 1, Woronora River South Arm and Dahlia Swamp) were wetter than the small Tea Tree Thicket vegetation component of longwall Swamp 28. No seepage or water ponding was observed within longwall Swamp 28. For the control sites supporting Tea Tree Thicket (Woronora River 1, Woronora River South Arm and Dahlia Swamp) the swamp sediments were damp with minor amounts of ponded water observed within Woronora River 1 and Dahlia Swamp.
- Across all upland swamps, no changes in water colour or areas of water ponding were observed in either longwall or control swamps in autumn 2014. Within Swamp 35, the abundant seepage was observed to have a metallic sheen on the water surface which separated upon disturbance. This observation has been previously noted following seasonally wet periods in both longwall and control sites including longwall Swamps 19 (autumn 2012), 27 (spring 2011), 30 and 35 (autumn 2012) and control Swamps 101, 137a and 138 (autumn 2012).

- For the restioid heath and banksia thicket swamps, vegetation at both longwall and control sites was found to be generally in good condition in autumn 2014 with no unusual areas of vegetation senescence observed. Some isolated dieback and senescence of individuals occurred throughout all longwall and control swamps. Exceptions to the generally good condition of vegetation within upland swamps in autumn 2014 included the following observations:
  - Small areas containing scattered senescent shrubs were observed adjacent to rocky areas within several longwall and control swamps (Swamps 19, 30, 33, 35, 94, 135, 137a and 137b). These areas of senescence were limited in extent (e.g. up to three senescent individuals observed in Swamp 135). The senescence was observed in areas adjacent to exposed sandstone where soil depth is very shallow and at the lower areas of swamps where saturation of soils occurs more regularly. The observed senescence is attributed to frequent and continued inundations of the shallow soils which restricts uptake of oxygen by plant roots. This senescence was observed within longwall and control swamps and is not attributed to the mining of Longwalls 23-27.
  - Scattered senescent individuals of *Petrophile pulchella,* or individuals with yellowing foliage, were observed in several longwall and control upland swamps (Swamps 35, 101, 111a, 125, 137a and 138). This senescence was also observed within longwall and control swamps during the baseline monitoring period. Healthy individuals of *Petrophile pulchella* were observed within these swamps and were interspersed with senescent individuals.
  - *Phyllota phylicoides, Hakea gibbosa* and *Acacia myrtifolia* were observed senescing in Swamp 93 in autumn 2014. The extent and degree of dieback remains similar to that observed during baseline monitoring surveys.
- For the Tea Tree Thicket swamps, vegetation of both longwall (lower portion of Swamp 28) and control swamps was found to be generally in good condition in autumn 2014. Exceptions to the generally good condition of vegetation included the following:
  - *Banksia robur* was frequently observed in Condition 4 (minor dieback) within the lower portion of Swamp 28. This species was also frequently observed in Condition 4 within control swamps Woronora River 1 and Woronora River South Arm. *Banksia robur* was observed in Condition 5 (healthy) in the remaining control site, Dahlia Swamp. The minor dieback of *Banksia robur* observed within the longwall and selected control swamps presented as leaf herbivory and discolouration, which was also recorded in baseline monitoring surveys.
  - Dieback of the understorey species *Empodisma minus* and *Gleichenia microphylla* was observed within the lower portion of longwall swamp 28. Within the lower portion of Swamp 28, the condition of *Empodisma minus* ranged from Condition 2 (many dead stems) to Condition 3 (some dead branches) while *Gleichenia microphylla* ranged from Condition 2 to condition 4 (minor dieback). These species were also recorded with dieback within control swamps, however the level of dieback and its extent was generally less than in Swamp 28. The dieback within Swamp 28 was also observed within baseline surveys and was attributed to the dense mid-storey vegetation shading the understorey. The drier conditions within Swamp 28, relative to control swamps, which has been observed since monitoring began in spring 2010, may also contribute to the increased dieback within Swamp 28 compared to the control sites.

Transect/Quadrat Monitoring

Transect and quadrat monitoring is conducted in Swamps 28, 30, 33, 35 and 94 overlying or adjacent to Longwalls 23-27 and in a selection of control swamps.

Transect and quadrat monitoring is conducted biannually of:

- Banksia Thicket and/or Restioid Heath vegetation – in Swamps 28 (upper portion), 30, 33, 35 and 94 overlying or adjacent to Longwalls 23-27, and in control Swamps 101, 111a, 125, 135, 136, 137a, 137b, 138 and Bee Creek Swamp (Figure 10); and
- Tea Tree Thicket vegetation – in lower portion of Swamp 28 overlying Longwalls 23-27, and in control swamps Woronora River 1, Woronora River South Arm and Dahlia Swamp (Figures 10 and 11).

Transect/quadrat monitoring by Eco Logical Australia has been conducted biannually since spring 2010 in Swamps 28, 30, 33, 35, 94, 135, 136, 137a, 137b, 138 and Bee Creek Swamp. Transect/quadrat monitoring by Eco Logical Australia in Swamps 101, 111a and 125 has been conducted biannually since spring 2008 as a component of the Longwalls 20-22 upland swamp vegetation monitoring program. Surveys conducted up to and including the spring 2013 survey represent baseline surveys.

Each swamp has been monitored with three transects, with the exception of Swamp 28 and Tea Tree Thicket control swamps Woronora River 1, Woronora River South Arm and Dahlia Swamp. Swamp 28 is a small valley-side swamp which supports Banksia Thicket in the upper portion of the swamp and Tea Tree Thicket in the lower portion of the swamp. Vegetation within Swamp 28 has been monitored along two transects, one within the Banksia Thicket and one within Tea Tree Thicket vegetation within this swamp. The Tea Tree Thicket control swamps Woronora River 1, Woronora River South Arm and Dahlia Swamp have been monitored with a single transect, owing to the much larger size of the control swamps.

For the Restioid Heath/Banksia Thicket swamps, assessments have been made on 1 square metre (m^2) quadrats centred on the transect line every 5 m starting from 0 m. For the Tea Tree Thicket swamps, assessments have been made on 1 m^2 quadrats located upslope of the transect line with one quadrat edge located on the line as a means of avoiding the impacts of vegetation trampling as a result of access into these thickly vegetated swamps. As for Restioid Heath/Banksia Thicket swamps, assessments are made every 5 m starting from 0 m.

The data collected for each quadrat includes:

- vegetation structure;
- dominant species;
- estimated cover and height for each stratum;
- full floristics;
- estimated cover abundance for each species using seven point Braun-Blanquet scale; and
- condition/health rating for each species in the quadrat[9].

Permanent photo points have been established along each transect.

[9] Condition Rating: Healthy – 5; Minor dieback – 4; Some dead branches – 3; Many dead stems – 2; Severe damage/ dieback – 1.

The results of the transect/quadrat monitoring surveys conducted up to spring 2013 (i.e. prior to the commencement of Longwall 23) are provided in the Metropolitan Coal Six Monthly Report, 1 January to 30 June 2014. The results of the transect/quadrat surveys conducted in autumn 2014 (i.e. during the mining of Longwall 23) are provided in the following sections.

Vegetation Structure, Dominant Species and Estimated Cover/Abundance for each Stratum

The vegetation structure, dominant species and estimated cover/abundance for each stratum has been variable across all seasons with variations recorded between sites, seasons and strata. This variability is considered to reflect both the natural variations in the height and cover/abundance of vegetation structural layers through time, as well as the subjective nature of the data collection. Within the variability of this dataset, a general trend towards increasing height and cover/abundance of vegetation structural layers has occurred from spring 2010 to autumn 2014 across longwall and control sites.

In autumn 2014 the height and cover abundance and of the structural layers was generally similar to that observed in spring 2013 with minor decreases and increases occurring in some sites and no changes in the vegetation height and density of structural layers at other sites. Although variable, the height and cover abundance of each stratum continue to steadily increase as plants grow, although the rate of increase is relatively slow and not always detectable from one season to the next when values are similar and subject to surveyor bias.

Species Richness

Species richness within all monitored upland swamps from spring 2010 to autumn 2014 is presented on Charts 69 and 70. Species richness has generally been similar between the valley side swamps supporting Restioid Heath and Banksia Thicket sites with species richness in these vegetation types consistently higher than the swamps supporting Tea Tree Thicket.

Generally, small fluctuations in species richness have occurred within individual swamps between seasons. At several swamps small decreases in species richness were observed from spring 2010 to spring 2013 (including Swamps 33, 35, 94, 125, 137b, 138 and the Tea Tree Thicket of Swamp 28). Similar small changes in species richness were recorded in autumn 2014 consistent with the fluctuations observed within the baseline monitoring period. All observed changes in species richness are considered to represent natural fluctuations in response to weather, population dynamics, seasonality of survey and natural disturbances including grazing by fauna species.

Cover/Abundance and Condition

Fluctuations in species cover/abundance were recorded across all sites within the baseline period (spring 2010 to spring 2013) and in autumn 2014 (after the commencement of Longwall 23). No patterns of increasing or decreasing cover/abundance were identified in relation to individual species across sites or groups of species (i.e. swamp indicator species, generalist species, shrubs, ground covers) within sites.

Fluctuations in vegetation condition were recorded across all sites within the baseline period (spring 2010 to spring 2013) and in autumn 2014. Generally, vegetation within Restioid Heath, Banksia Thicket and Tea Tree Thicket swamps was in a healthy condition. Vegetation with dieback ranging from Condition 4 (minor dieback) to Condition 3 (some dead branches) was noted occasionally in individuals at all longwall and control sites. Species with dieback in the baseline period and/or autumn 2014 survey included *Acacia* spp., *Banksia ericifolia* subsp*. ericifolia, B. marginata, Banksia oblongifolia, Banksia robur, Dillwynia floribunda, Isopogon* spp., *Sprengelia incarnata, Symphionema paludosa, Viminaria juncea,* and the groundcover species *Actinotus minor, Chordifex fastigiatus, Empodisma minus, Lepidosperma filiforme* and *Schoenus brevifolius.* Within Tea Tree Thicket sites, the fern *Gleichenia microphylla*, was also observed with dieback in multiple sites and seasons.

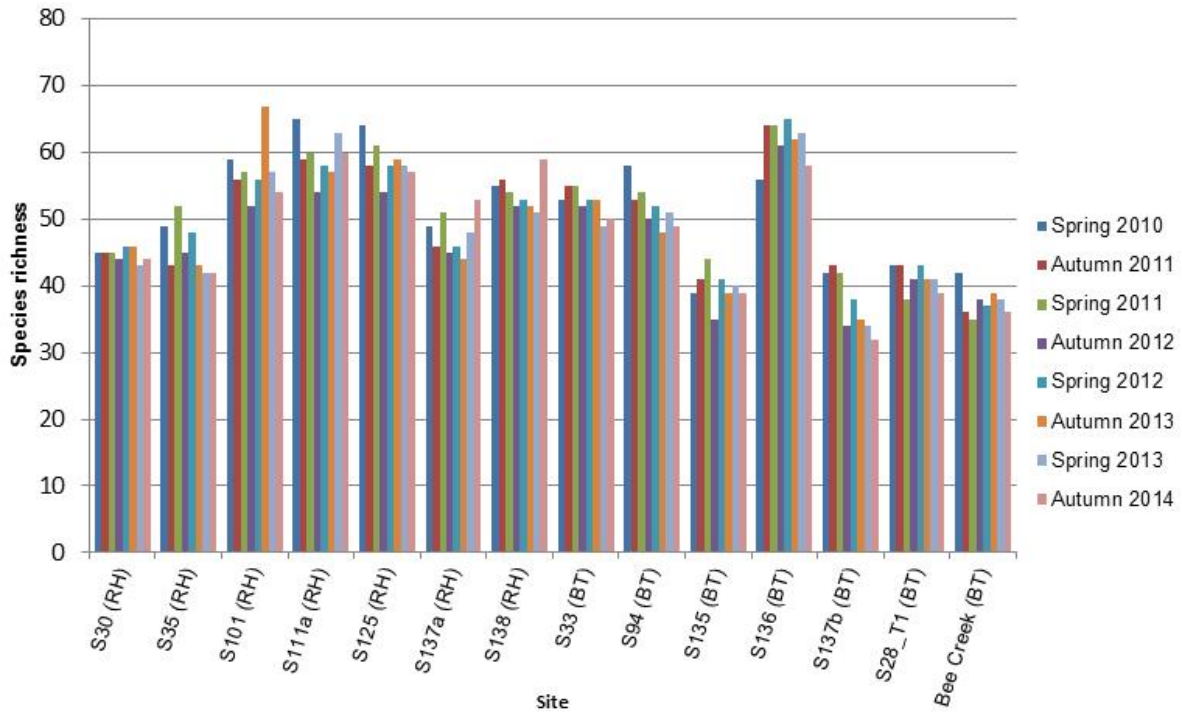


Chart 69 Species Richness within Restioid Heath/Banksia Thicket Swamps

RH = Restioid Heath; BT = Banksia Thicket

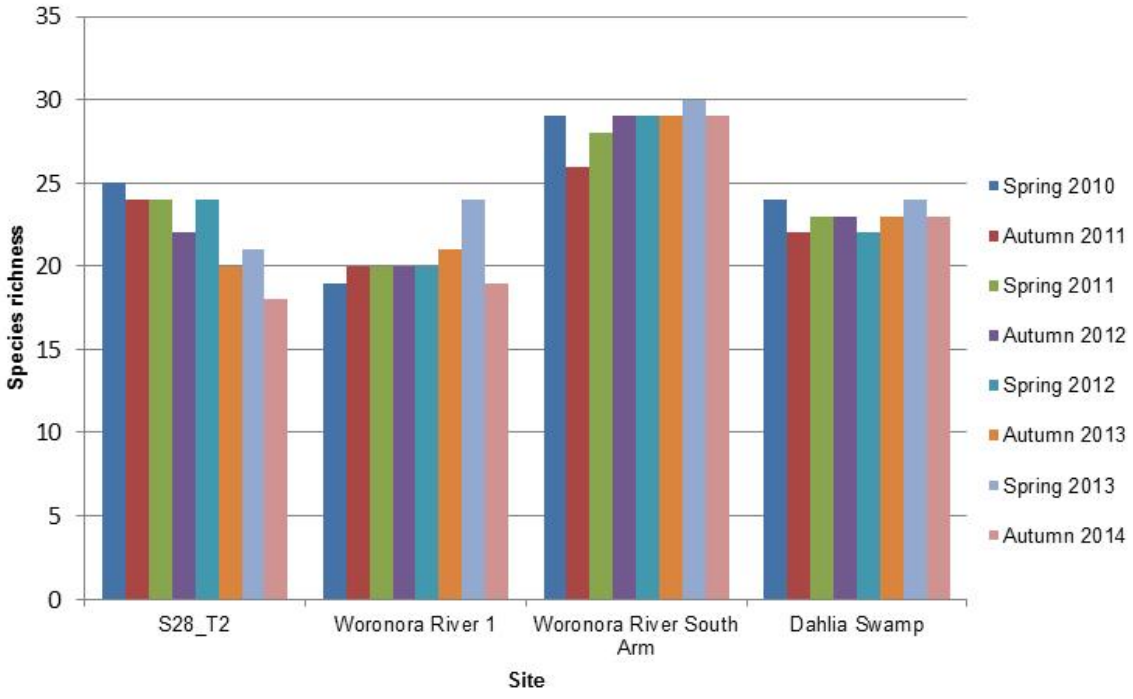


Chart 70 Species Richness within Tea Tree Thicket Swamps

Indicator Species Monitoring

Twenty tagged individuals of *Epacris obtusifolia*, *Sprengelia incarnata* and *Pultenaea aristata* have been monitored in each of the following Restioid Heath/Banksia Thicket swamps:

- *Epacris obtusifolia* – longwall Swamps 19, 30, 33, 35 and 94, and control Swamps 101, 111a, 125 and 137a, 137b and 138.
- *Sprengelia incarnata* – longwall Swamps 19, 30, 33, 35 and 94, and control Swamps 101, 125, 135, 136, 137a and 138.
- *Pultenaea aristata* – longwall Swamps 19, 30, 33, 35 and 94, and control Swamps 101, 111a, 135, 136,137a and 138.

Twenty tagged individuals of *Banksia robur* and *Callistemon citrinus* have also been monitored in the Tea Tree Thicket vegetation of longwall Swamp 28 and at the associated control sites (Woronora River 1, Woronora River South Arm and Dahlia Swamp).

Population monitoring of indicator species has been conducted biannually since spring 2010 at Swamps 19, 30, 33, 35, 94, 135, 136, 137a, 137b and 138. Population monitoring of indicator species at control Swamps 101, 111a and 125 has been conducted biannually since spring 2009 as a component of the Longwalls 20-22 upland swamp vegetation monitoring program. Surveys conducted up to and including the spring 2013 survey represent baseline surveys.

Population monitoring data collected includes a condition/health rating and a reproductive rating for each plant.

A summary of the results of population monitoring for the baseline surveys conducted up to spring 2013 (i.e. prior to the commencement of Longwall 23) is provided in the Metropolitan Coal Six Monthly Report, 1 January to 30 June 2014. A summary of the results of the population moniotirng in autumn 2014 (i.e. following the commencement of Longwall 23) is provided in the following sections.

Vegetation Condition[10]

Over the entire baseline monitoring period (i.e. all surveys up to and including spring 2013), and across all Restioid Heath/Banksia Thicket swamps, there has been a general decrease in the mean vegetation condition of the tagged indicator species (Charts 71 to 73). This decrease has occurred at both longwall and control Restioid Heath/Banksia Thicket swamps. Where potential differences were observed, as indicated by non-overlapping confidence intervals, the scale of these differences were generally small (less than 1) with mean vegetation condition generally being greater at control swamps than longwall swamps. The results for autumn 2014 are generally similar to those for autumn 2013 and/or spring 2013.

The mean vegetation condition of tagged indicator species within Tea Tree Thicket vegetation has been variable between longwall and control swamps for individual species (Charts 74 and 75). The mean vegetation condition of *Banksia robur* within the single longwall swamp (Swamp 28) has been below that within control swamps in autumn 2011, spring 2011, autumn 2012, autumn 2013, spring 2013 and autumn 2014, as indicated by non-overlapping confidence intervals. The mean vegetation condition of *Banksia robur* in Swamp 28 decreased in autumn 2013 to autumn 2014. For *Callistemon citrinus*, mean vegetation condition within Swamp 28 has been greater than in control swamps across all seasons except autumn 2011, although the differences have been generally small (less than 1).

[10] For Charts 71 to 75 Vegetation Condition (VC) and Reproductive Status (RS) scores, and the Control and Longwall RS scores, were incorrectly labelled in the Metropolitan Coal Six Monthly Report, 1 January to 30 June 2014.

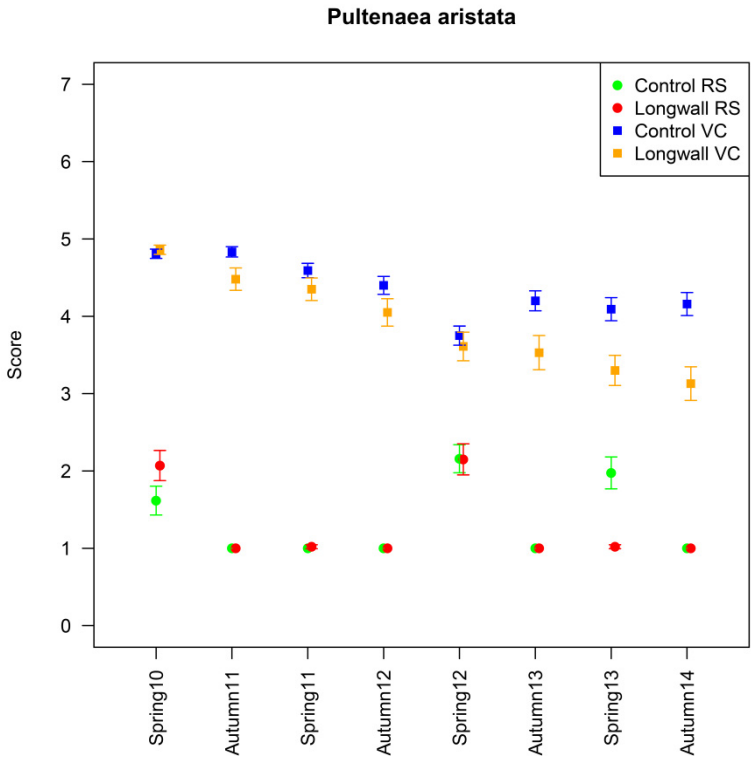


Chart 71 **Mean Scores for Vegetation Condition (VC) and Mean Reproductive Status (RS) for the Indicator Species, *Pultenaea aristata***

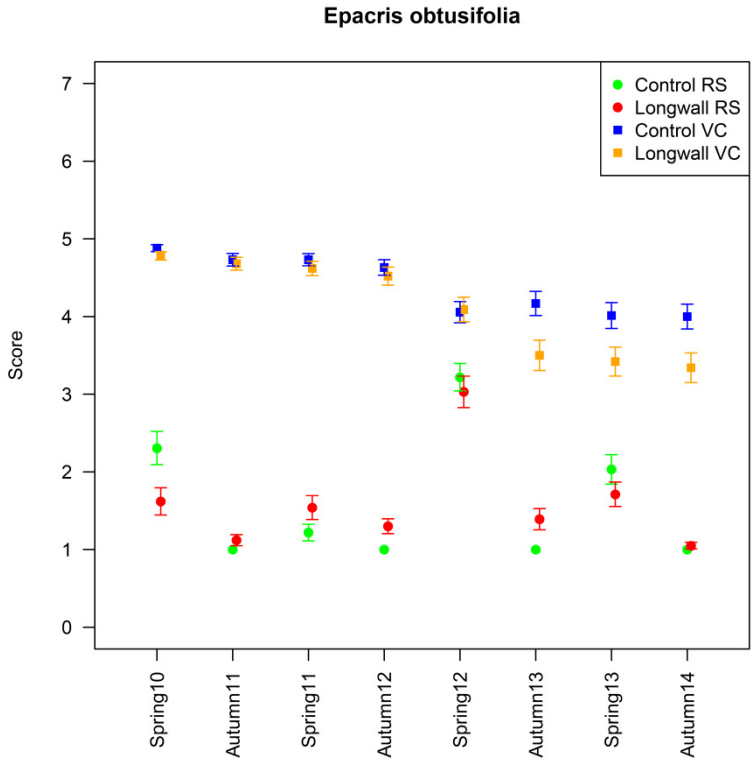


Chart 72 **Mean Scores for Vegetation Condition (VC) and Mean Reproductive Status (RS) for the Indicator Species, *Epacris obtusifolia***

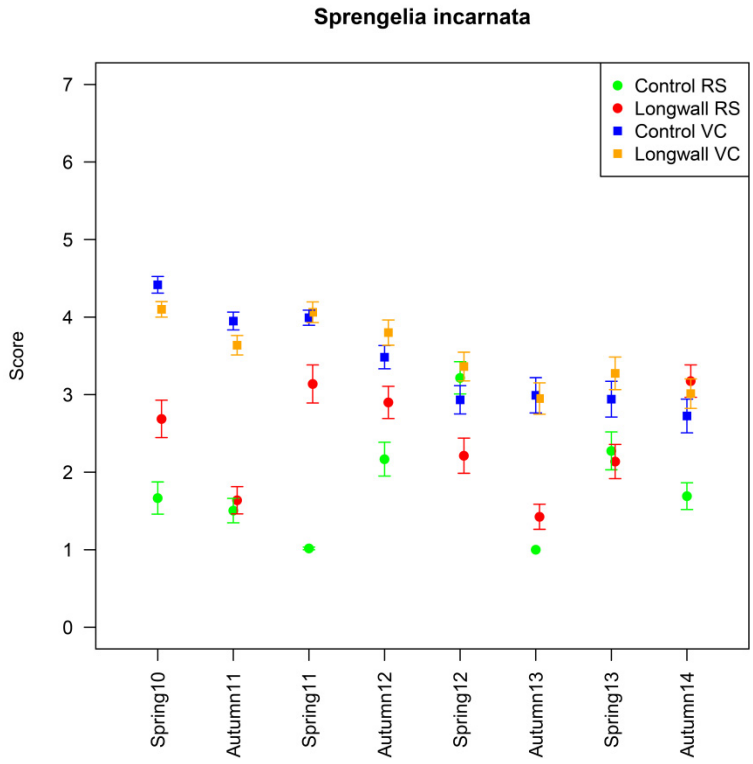


Chart 73 **Mean Scores for Vegetation Condition (VC) and Mean Reproductive Status (RS) for the Indicator Species, *Sprengelia incarnata***

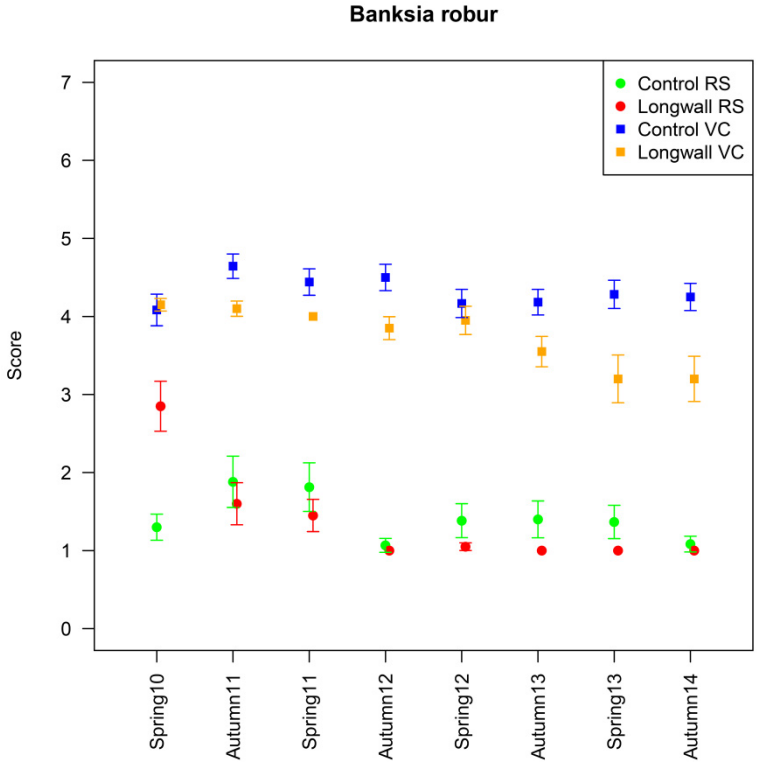


Chart 74 **Mean Scores for Vegetation Condition (VC) and Mean Reproductive Status (RS) for the Indicator Species, *Banksia robur***

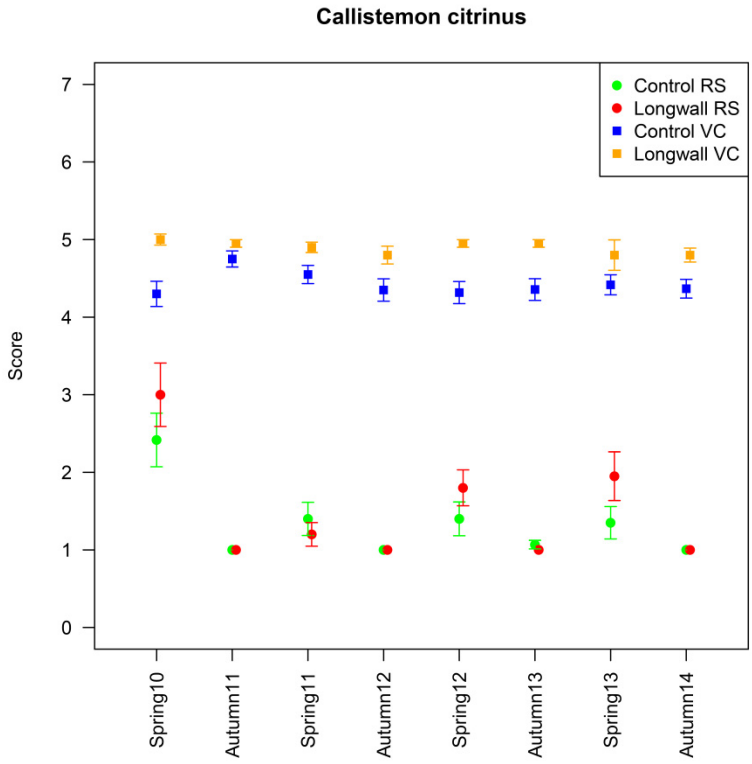


Chart 75 Mean Scores for Vegetation Condition (VC) and Mean Reproductive Status (RS) for the Indicator Species, *Callistemon citrinus*

Reproductive Status[11]

The flowering status of tagged indicator species, as recorded in the reproductive scale, shows that limited flowering was recorded across all species across the entire baseline monitoring period (i.e. up to and including spring 2013) and in autumn 2014 (Charts 71 to 75). The infrequent recording of flowering plants of indicator species is thought to be related to the timing of surveys which do not coincide with peak flowering periods[12].

Within Restioid Heath and Banksia Thicket swamps the mean reproductive status of tagged indicator species has generally been variable when comparing longwall and control valley side swamps. Potential differences, as indicated by non-overlapping confidence intervals, were observed in individual seasons for all species (Charts 71 to 73). Generally, the scale of these differences was small (less than 1) although larger differences were observed for *Pultenaea aristata* in spring 2013 (greater mean reproductive status at control swamps) and *Sprengelia incarnata* in spring 2010 and autumn 2014 (greater mean reproductive status at longwall sites). Where larger differences in reproductive status were observed, they did not appear to be related to vegetation condition. The results for the mean reproductive status of all tagged indicator species within Restioid Heath and Banksia Thicket swamps in autumn 2014 are similar to that observed for the baseline monitoring period (Charts 71 to 73).

[11] For Charts 71 to 75 Vegetation Condition (VC) and Reproductive Status (RS) scores, and the Control and Longwall RS scores, were incorrectly labelled in the Metropolitan Coal Six Monthly Report, 1 January to 30 June 2014.

[12] Surveys are conducted during the months of autumn and spring as specified in the Metropolitan Coal Longwalls 23-27 Biodiversity Management Plan. The peak flowering times for each of the indicator species do not necessarily coincide with the survey period, although some flowering does occur during this time.

Within Tea Tree Thicket swamps mean reproductive status was generally similar between longwall and control swamps, as indicated by overlapping confidence intervals, for both *Banksia robur* and *Callistemon citrinus* (Charts 74 and 75). For those seasons where mean reproductive status was different between the single longwall swamp (Swamp 28) and control swamps, the scale of these differences was generally small with the exception of *Banksia robur* in spring 2010, where mean reproductive status at Swamp 28 was greater than control swamps. Within Tea Tree Thicket swamps the mean reproductive status in autumn 2014 was similar between longwall and control swamps for both *Banksia robur* and *Callistemon citrinus* with very little flowering observed for either of these species (Charts 74 and 75). The results for autumn 2014 are similar to the results for the autumn surveys conducted during the baseline monitoring period (Charts 74 and 75).

3.2.2 Upland Swamp Groundwater Monitoring

Groundwater monitoring of upland swamps has involved the use, where practicable, of paired piezometers, one in the swamp substrate and one sandstone piezometer. Where a swamp substrate piezometer has not been practicable to install due to the depth of the swamp sediments, deeper piezometers have been installed in the shallow sandstone.

Groundwater monitoring of upland swamps has included the monitoring of:

- Paired piezometers (i.e. one swamp substrate piezometer to a depth of approximately 1 m and one sandstone piezometer to a depth of approximately 10 m), located in Swamp 28 overlying Longwalls 23-27.
- Paired piezometers (i.e. one swamp substrate piezometer to a depth of approximately 1 m and one sandstone piezometer to a depth of approximately 10 m), located in Swamp 30 overlying Longwalls 23-27.
- Paired piezometers (i.e. one swamp substrate piezometer to a depth of approximately 1 m and one sandstone piezometer to a depth of approximately 10 m), located in Swamp 33 overlying Longwalls 23-27.
- Paired piezometers (i.e. one swamp substrate piezometer to a depth of approximately 1 m and one sandstone piezometer to a depth of approximately 10 m), located in Swamp 35 overlying Longwalls 23-27.
- Paired piezometers (i.e. one swamp substrate piezometer to a depth of approximately 1 m and one sandstone piezometer to a depth of approximately 10 m), located in control Swamp 137 (at site 137a).
- Paired piezometers (i.e. one swamp substrate piezometer to a depth of approximately 1 m and one sandstone piezometer to a depth of approximately 10 m), located in control Swamp 137 (at Site 137b).
- Paired piezometers (i.e. one swamp substrate piezometer to a depth of approximately 1 m and one sandstone piezometer to a depth of approximately 10 m), located in control swamp Bee Creek Swamp.

The hydrographs at the three control swamps (Swamp 137a, Swamp 137b and Bee Creek Swamp [Figures 7, 10 and 11]) are shown on Charts 76 to 78, respectively. All sites are well away from mining, but longwall start dates are included on the charts to facilitate comparison with swamp responses within the mining footprint of Longwalls 23-27. The rainfall residual mass curve is included as a guide to the influence of rainfall on groundwater responses.

All swamp substrate sites show intermittent saturation in agreement with rainfall trends. At Swamps 137a and 137b the water tables are always separated, generally by 2-4 m, and groundwater flow direction is downwards. The two swamps have similar long durations with no saturation in the swamp substrate. From mid-October 2014, the sensor at Swamp 137a has provided erroneous data; the cause is being investigated. Erroneous data obtained for the 1 m substrate piezometer in Swamp 137b prior to November 2013 is not shown on Chart 77.

At the Bee Creek Swamp, the swamp has perched water conditions most of the time except for a period of dryness from February to March 2014 and May to August 2014. From the commencement of monitoring to late January 2014, the 10 m sandstone piezometer has not responded as expected to rainfall events. However, in the current reporting period, the sensor appears to have settled down and the responses are now as expected as they correlate well with rainfall trends. There are clear climatic recessions from January to March 2014, and from July to August 2014. However, as the water level is unusually high, the 10 m piezometer will be investigated in the next sampling round. The data suggest upwards flow from sandstone to the swamp, with a head difference of about 1.5 m typically.

Hydrographic responses for the monitored swamps overlying Longwalls 23-27 (Swamp 28, Swamp 30, Swamp 33 and Swamp 35) are shown on Charts 79 to 82. As the observed fluctuations in water levels are all consistent with the rainfall trend, there are no mining effects on the swamp substrate or sandstone piezometers. Data obtained up to 30 June 2014 is considered to represent baseline data for these swamps.

The excavation front for Longwall 23B passed alongside piezometers at Swamp 28 and Swamp 33 in October 2014 and December 2014, respectively. Swamp 28 is located above Longwall 24 and Swamp 33 is located above Longwalls 24 and 25 (Figure 10). Swamps 30 and 35 are located at a greater distance from Longwall 23, above Longwall 26 and Longwalls 26 and 27, respectively (Figure 10).

In all cases, the sandstone heads are lower than the perched water levels in the swamps, indicating the potential for downward flow of water. The separation between the water tables is generally 0.5 m to 2 m across the four sites. All swamps have intermittent saturation with occasional periods of dryness.

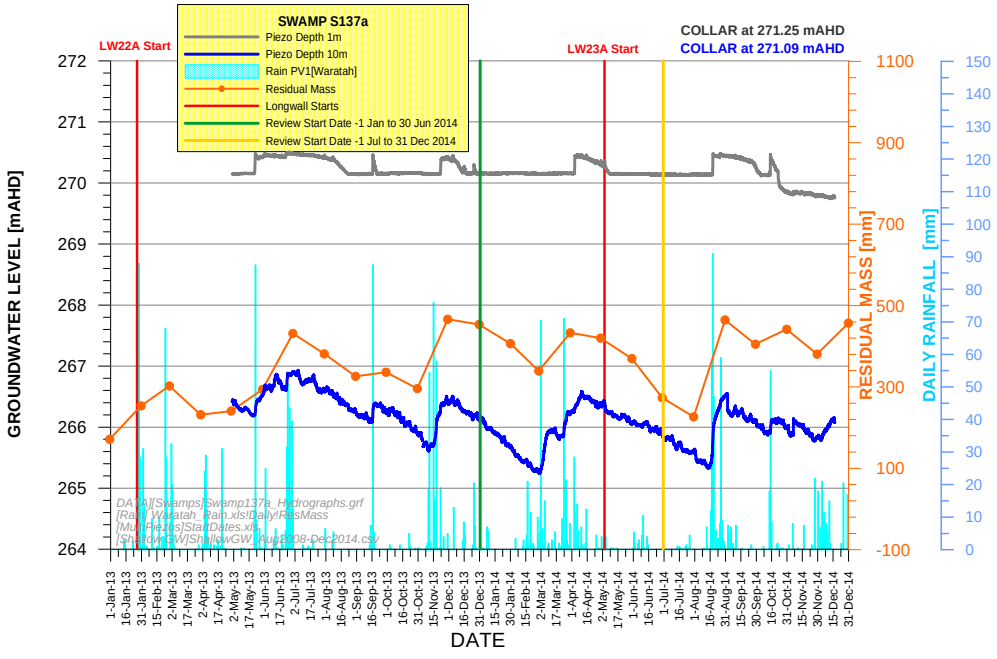


Chart 76 Groundwater Hydrographs at Control Swamp 137a

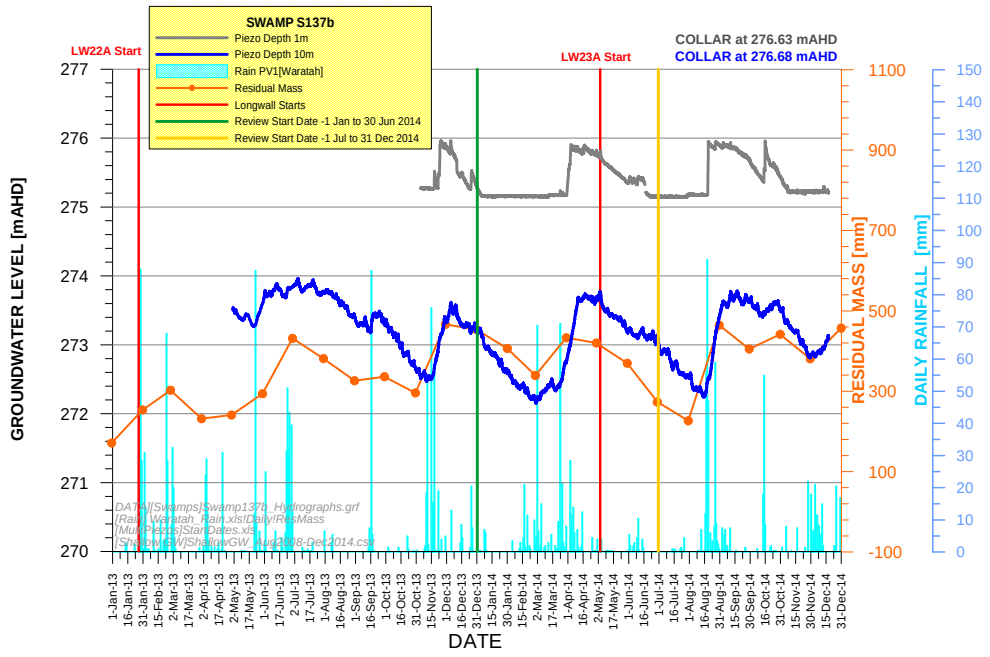


Chart 77 **Groundwater Hydrographs at Control Swamp 137b**

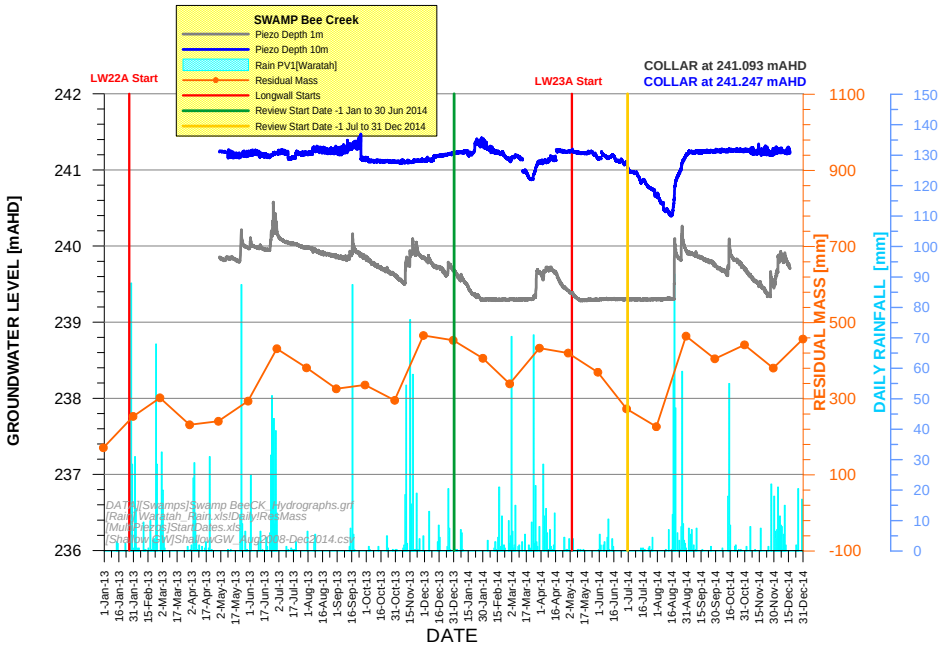


Chart 78 **Groundwater Hydrographs at Bee Creek Control Swamp**

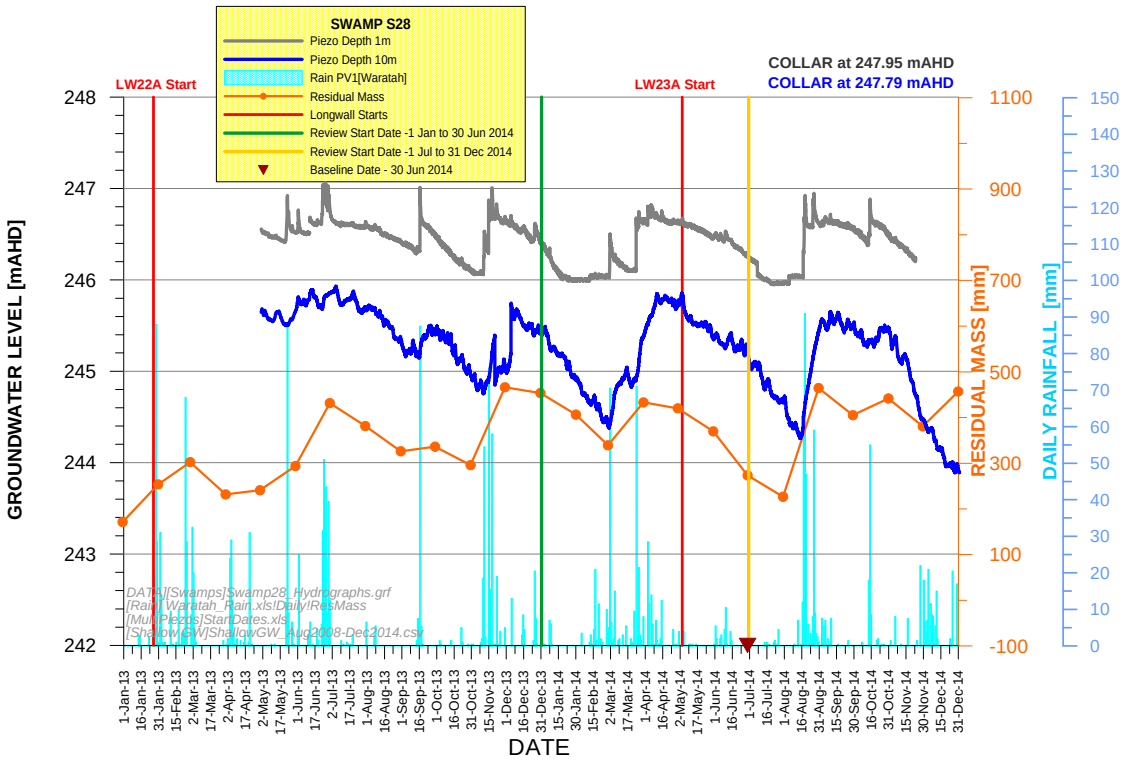


Chart 79 **Groundwater Hydrographs at Swamp 28**

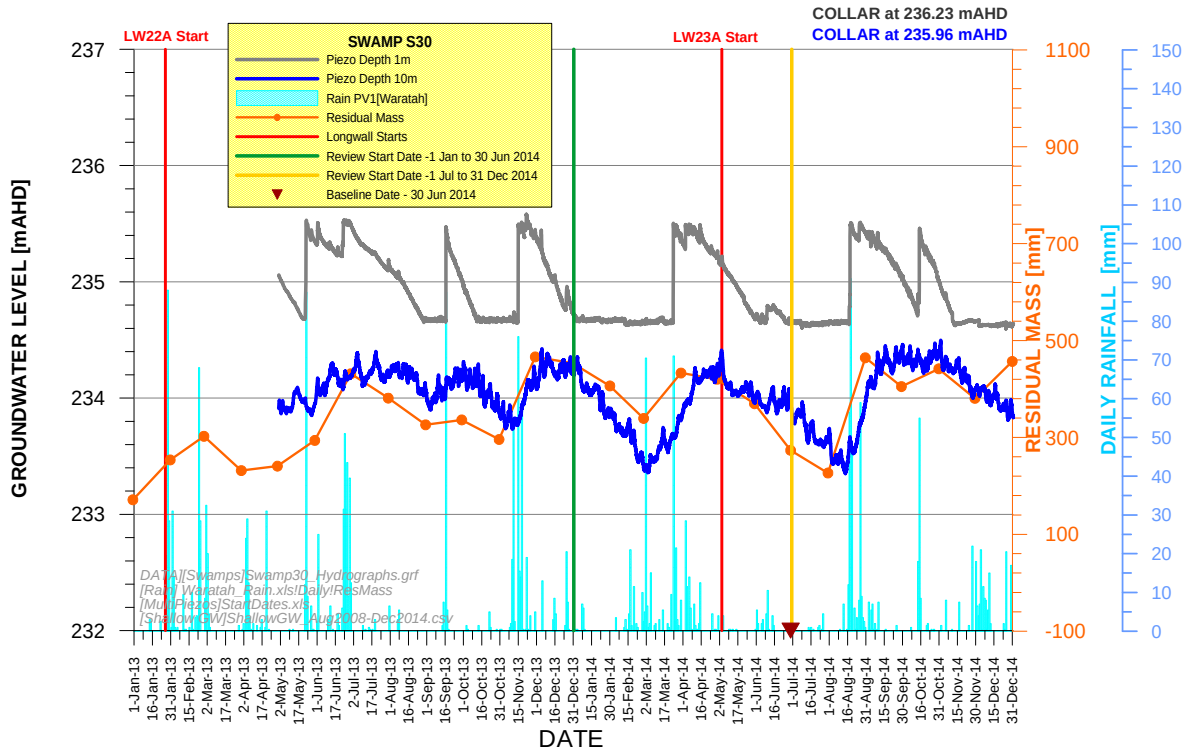


Chart 80 **Groundwater Hydrographs at Swamp 30**

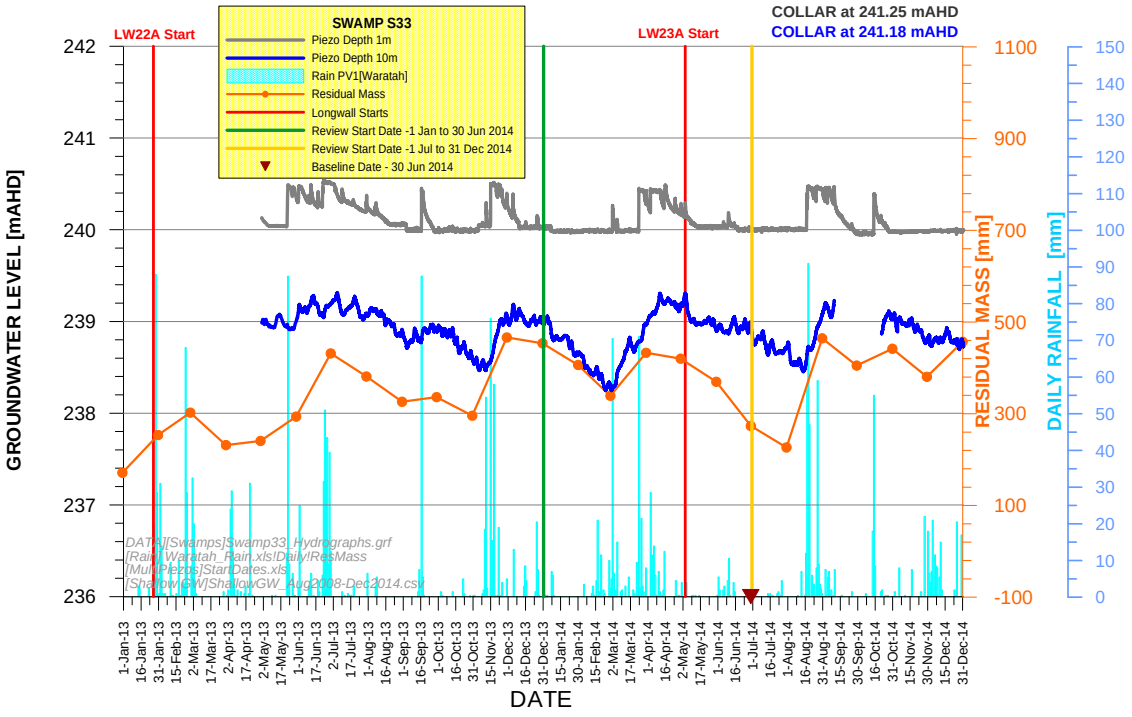


Chart 81 **Groundwater Hydrographs at Swamp 33**

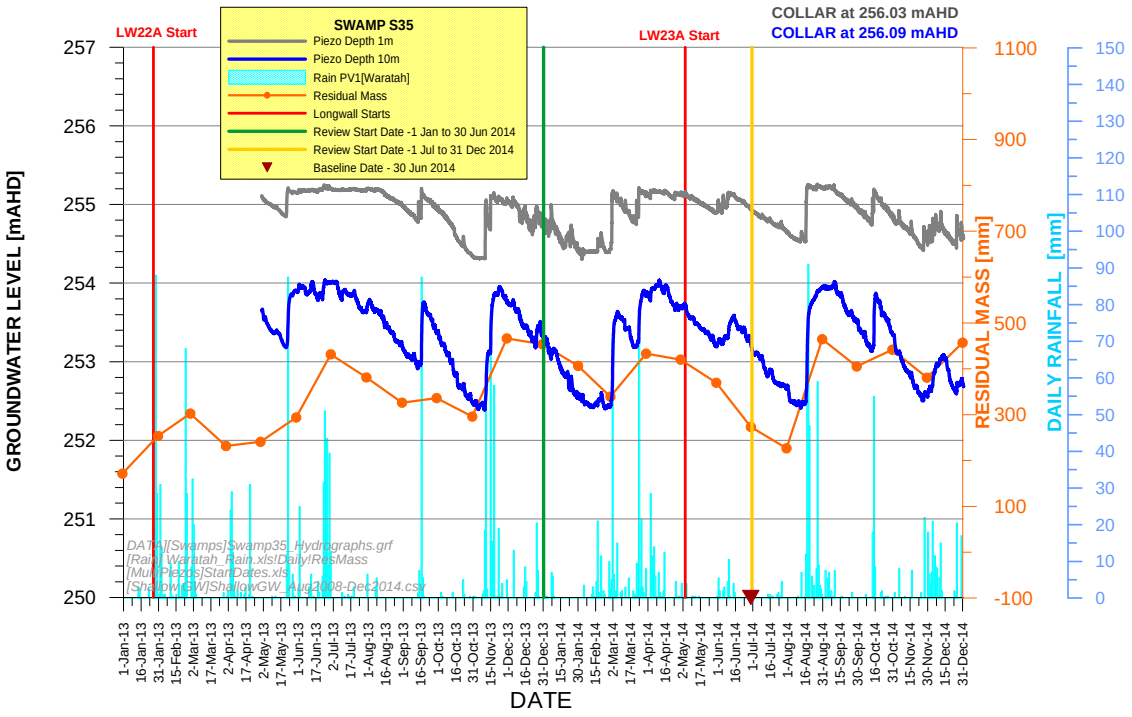


Chart 82 **Groundwater Hydrographs at Swamp 35**

3.2.3 Riparian Vegetation Monitoring

The riparian vegetation monitoring program includes visual, quadrat, transect and indicator species monitoring of riparian vegetation on the Waratah Rivulet and Eastern Tributary, as described below.

Visual Inspections

Visual inspections of riparian areas are conducted biannually in locations adjacent to riparian vegetation monitoring sites (longwall sites MRIP01, MRIP02, MRIP05, MRIP06, MRIP09, MRIP11 and MRIP12 and control sites MRIP03, MRIP04, MRIP07, MRIP08 and MRIP10) (Figure 12), and areas traversed whilst accessing the monitoring sites, to record:

- areas of new water ponding;
- any cracking or rock displacement; and
- changes in vegetation condition, including areas of senescing vegetation that appear unusual.

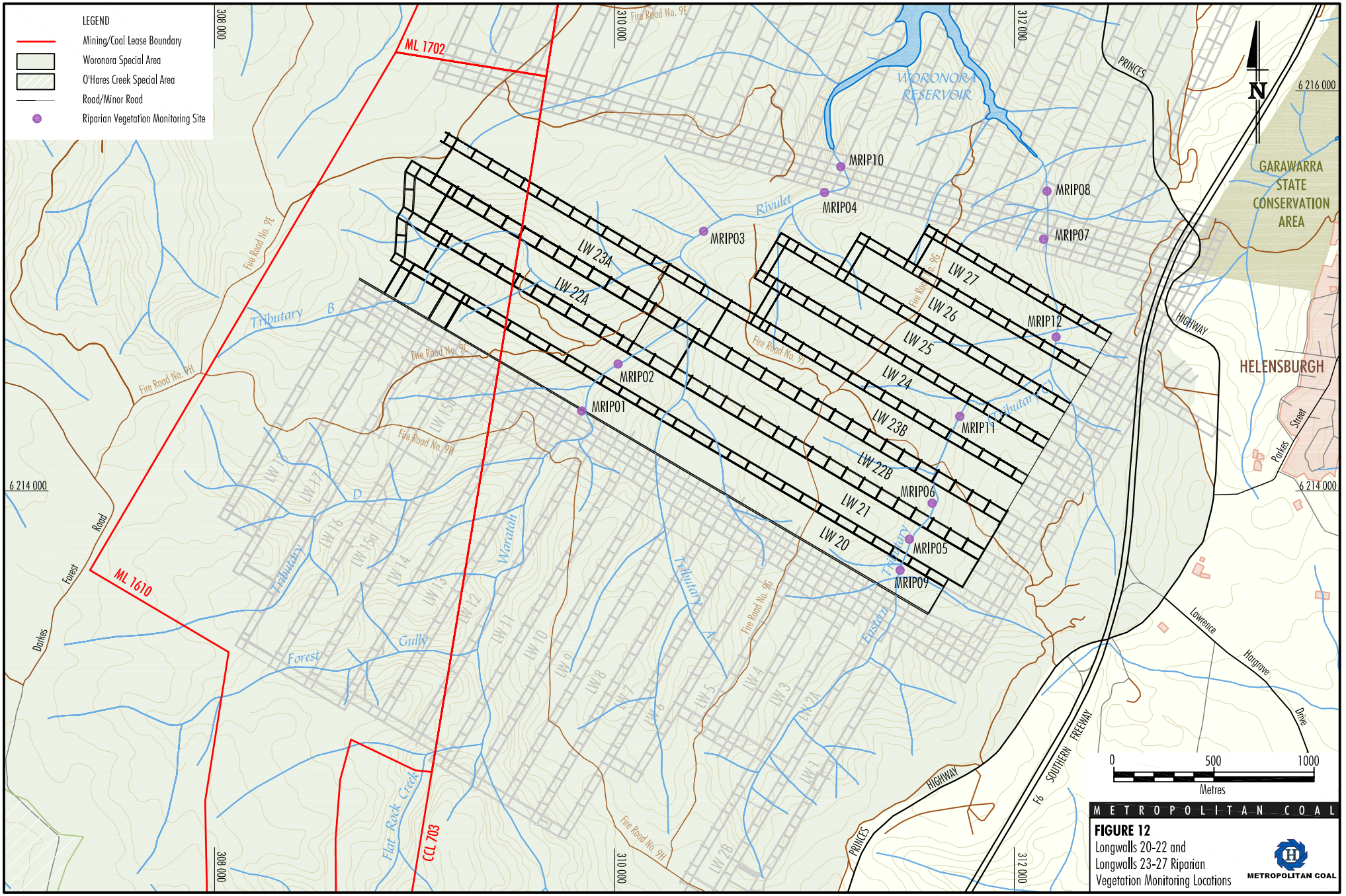
Visual inspections have been conducted biannually since spring 2010 at sites MRIP11 and MRIP12. Visual inspections have been conducted biannually since spring 2008 at the remainder of the sites as a component of the Longwalls 20-22 riparian vegetation monitoring program. Surveys conducted up to and including the spring 2013 survey were conducted prior to the commencement of Longwall 23.

The Metropolitan Coal Six Monthly Report, 1 January to 30 June 2014 reported on the results of the riparian visual inspection monitoring conducted by Eco Logical Australia for the spring 2013 vegetation survey.

The following provides a summary of the results of visual inspections conducted of sites MRIP01 to MRIP10 in autumn 2014.

- Vegetation was generally observed in good condition across and adjacent to the riparian monitoring sites. Exceptions to the generally good condition of riparian vegetation included:
  - Isolated and scattered individuals observed with dieback across all sites.
  - Within site MRIP02 vegetation dieback along the edge of the Waratah Rivulet remained evident in autumn 2014 with dieback observed at a greater distance from the water's edge due to the dieback of some large shrubs. Some of the riparian (dead) vegetation was inundated by water in spring 2013 and autumn 2014 (inundation first observed in autumn 2013); the extent and depth of inundation increased in autumn 2014 relative to spring 2013.

    Dieback occurred in ground cover plants and mid layer shrub species, including *Gleichenia microphylla, Sticherus flabellatus* var. *flabellatus, Leptospermum polygalifolium, Allocasuarina littoralis* and the riparian indicator species *Lomatia myricoides*.
  - Dieback of groundcover and shrub layer vegetation was recorded at site MRIP05 on the Eastern Tributary in autumn 2014 with inundation of vegetation near the water's edge also observed at this time. Dieback was recorded across a greater number of species in autumn 2014 compared to spring 2013 including *Lomatia myricoides, Schoenus melanostachys, Acacia longifolia* subsp. *longifolia*, *Hakea teretifolia, Tristania neriifolia, Prostanthera linearis, Allocasuarina littoralis, Baeckea linifolia, Banksia ericifolia* subsp. *ericifolia*, *Gleichenia microphylla* and *Sporadanthus gracilis*.



METROPOLITAN COAL

FIGURE 12
Longwalls 20-22 and Longwalls 23-27 Riparian Vegetation Monitoring Locations

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  - In spring 2013 dieback of groundcover vegetation along the water's edge at site MRIP09 was observed includ*ing Gleichenia microphylla*. Additionally, scouring of bank sediments and inundation of streamside vegetation was observed in an area downstream of site MRIP09. Individuals *of Allocasuarina littoralis, Hakea teretifolia, Banksia ericifolia* sub*sp. ericifolia and Lomatia myricoides* were observed to be dead in the area of inundation. In autumn 2014 dieback of vegetation downstream from site MRIP09 in association with inundation included additional individuals and species including groundcover and shrubs such *as Acacia longifolia subsp. longifolia, Allocasuarina littoralis, Lomatia myricoides, Hakea salicifolia, Banksia ericifolia subsp. ericifolia, Gleichenia microphylla, Sporadanthus gracilis and Bauera rubioides.*
  - Downstream from site MRIP08, some *Gleichenia microphylla* was observed with dieback ranging from severe (Condition 1) to many dead stems (Condition 2) in spring 2013, although new growth was also present. No dieback was recorded for this species at MRIP08 in autumn 2014.

- As reported in the Metropolitan Coal Six Monthly Report, 1 January to 30 June 2014, cracking of streamside rocky areas at the downstream end of MRIP01 was first observed during the autumn 2011 survey. Cracking of streamside rocky areas were first observed between longwall sites MRIP01 and MRIP02 during the autumn 2012 survey. Further inspections in spring 2012 indicated that the existing cracking had remained stable. During autumn 2013, a piece of cracked bedrock at the downstream end of MRIP01 had been transported downstream by higher water flows, while the cracking between sites MRIP01 and MRIP02 had increased slightly in width compared to the spring 2012 observations. No dieback of vegetation was observed in the areas adjacent to the cracked bedrock. No new areas of cracked bedrock were observed within streamside rocky areas in spring 2013 or autumn 2014.
- Scouring of the stream bank and erosion of sediments was observed across all riparian monitoring sites in spring 2013 and autumn 2014, attributed to high water flows in early 2013 and subsequent high water flows since early 2013. The extent of bank scouring was generally minor.
- Riparian areas that had not previously been inundated were observed to be inundated in spring 2013 and autumn 2014 at sites MRIP05 and MRIP09. Additionally, areas of inundated vegetation at MRIP02, observed in autumn 2013 remained inundated in spring 2013 and autumn 2014. The extent and depth of inundation at sites MRIP02, MRIP05 and MRIP09 increased in autumn 2014 compared to spring 2013.

The following provides a summary of the results of visual inspections conducted of sites MRIP11 and MRIP12 (the additional sites on the Eastern Tributary over Longwalls 23-27) in autumn 2014, compared to the control sites (MRIP03, MRIP04, MRIP07, MRIP08 and MRIP10) (Figure 12).

- No areas of altered water ponding were observed within sites MRIP11, MRIP12 or control sites prior to the commencement of Longwall 23 or in autumn 2014.
- Signs of erosion and scouring of sediments from stream bank areas were observed across all riparian monitoring sites, including sites MRIP11 and MRIP12 and was attributed to successive flooding in association with heavy rainfall from spring 2010 to autumn 2012 and in autumn 2013. The extent of bank scouring was generally minor.
- No areas of cracked or displaced bedrock were observed within sites MRIP11 and MRIP12 prior to the commencement of Longwall 23 or in autumn 2014.

- Vegetation has generally been in good condition within sites MRIP11 and MRIP12 prior to the commencement of Longwall 23 and in autumn 2014. Isolated individuals with some level of dieback have been observed within sites MRIP11 and MRIP12 and at the control sites downstream of Longwalls 23-27 prior to the commencement of Longwall 23 and in autumn 2014. The dieback is attributed to flooding impacts and natural causes. The first flooding event occurred in spring 2010 after a considerable dry period. Streamside vegetation was impacted at all sites and flood-swept and prone vegetation, sediment deposition, woody flood debris dams and bank scouring and erosion was commonly observed. Subsequent high water flows have continued to impact all sites over the subsequent surveys seasons.

Transect/Quadrat Monitoring

A permanent quadrat (20 m x 2 m) and permanent transect (50 m x 2 m, i.e. a 30 m extension of each quadrat) have been used to monitor riparian vegetation on the Waratah Rivulet and Eastern Tributary at (Figure 12)[13]:

- sites MRIP01, MRIP02, MRIP05 and MRIP06 overlying Longwalls 20-22;
- sites MRIP11 and MRIP12 overlying Longwalls 23-27; and
- sites MRIP03, MRIP04, MRIP07 and MRIP08 downstream of Longwalls 23-27.

The data collected along each transect includes the occurrence of weed species (species and location) and a condition/health rating for each plant along the transect.

The data collected for each quadrat includes:

- vegetation structure;
- dominant species;
- estimated cover and height for each stratum;
- full floristics;
- estimated cover abundance for each species using seven point Braun-Blanquet scale; and
- condition/health rating for each species in the quadrat.

Permanent photo points have been established for each quadrat and along each transect.

Quadrat and transect monitoring has been conducted biannually since spring 2010 at sites MRIP11 and MRIP12. Quadrat and transect monitoring has been conducted biannually since spring 2008 at the remainder of the sites as a component of the Longwalls 20-22 riparian vegetation monitoring program. Surveys conducted up to and including the spring 2013 survey were conducted prior to the commencement of Longwall 23.

The Metropolitan Coal Six Monthly Report, 1 January to 30 June 2014 reported on the results of the spring 2013 riparian quadrat and transect monitoring conducted by Eco Logical Australia. The following provides a summary of the results of riparian quadrat and transect monitoring conducted in autumn 2014.

[13] Note that no quadrat or transect monitoring is conducted at sites MRIP09 and MRIP10. These sites were established for the purpose of visual inspections and indicator species monitoring.

Vegetation Structure, Dominant Species and Estimated Cover/Abundance for each Stratum

In autumn 2014, the precent cover and height of the structural layers was generally similar to that recorded in the preceding season. Across all seasons (since surveys commenced in spring 2008), the vegetation structure, dominant species and estimated cover/abundance for each stratum has varied between sites and between seasons within sites. Results have generally fluctuated with no clear trend towards increasing or decreasing height or cover/abundance for individual strata across multiple seasons. These fluctuations are considered to reflect both the natural variations in the height and cover/abundance of vegetation structural layers through time (including in response to flooding impacts), as well as the subjective nature of the data collection.

The exception to the above is site MRIP02 on Waratah Rivulet where dieback of streamside vegetation has been observed including an associated shift in dominant species of the ground layer. This is considered to be attributable to the water loss experienced at this site in spring 2012 and altered water levels observed after this time, including periods where the vegetation at site MRIP02 has been submerged or inundated.

Species Richness

Sites MRIP01 to MRIP10

Species richness was generally higher at sites during the period spring 2008 – spring 2009 followed by reduced species richness in the period autumn 2010 – autumn 2014 (Chart 83). The decrease in species richness occurred at both longwall and control sites and coincides with a period of drier conditions (spring 2008 – spring 2009) changing to wetter conditions, with floods occurring in the wetter seasons since autumn 2010. An exception is site MRIP07 where an increase in species richness was recorded in spring 2013 and autumn 2014.

Sites MRIP11 and MRIP12

Species richness within riparian monitoring sites MRIP11 and MRIP12 over Longwalls 23-27 and riparian control sites (MRIP03, MRIP04, MRIP07 and MRIP08) is presented on Chart 84. Species richness has fluctuated within both longwall and control sites including relatively large decreases from spring 2011 to autumn 2012 at site MRIP11 and from autumn 2011 to spring 2011 at site MRIP12. These relatively large fluctuations in species richness, and the smaller ones observed at these sites and control sites, represent natural fluctuations in response to climatic changes, the cryptic nature of some flora species, individual plant population dynamics and natural disturbances including floods.

In autumn 2014 species richness within riparian monitoring sites MRIP11 and MRIP12 was within the range of values recorded at each site during surveys conducted prior to the commencement of Longwall 23. At both these sites species richness in autumn 2014 remained below that observed in spring 2010 and autumn 2011, although was comparable to values observed in other pre-Longwall 23 surveys.

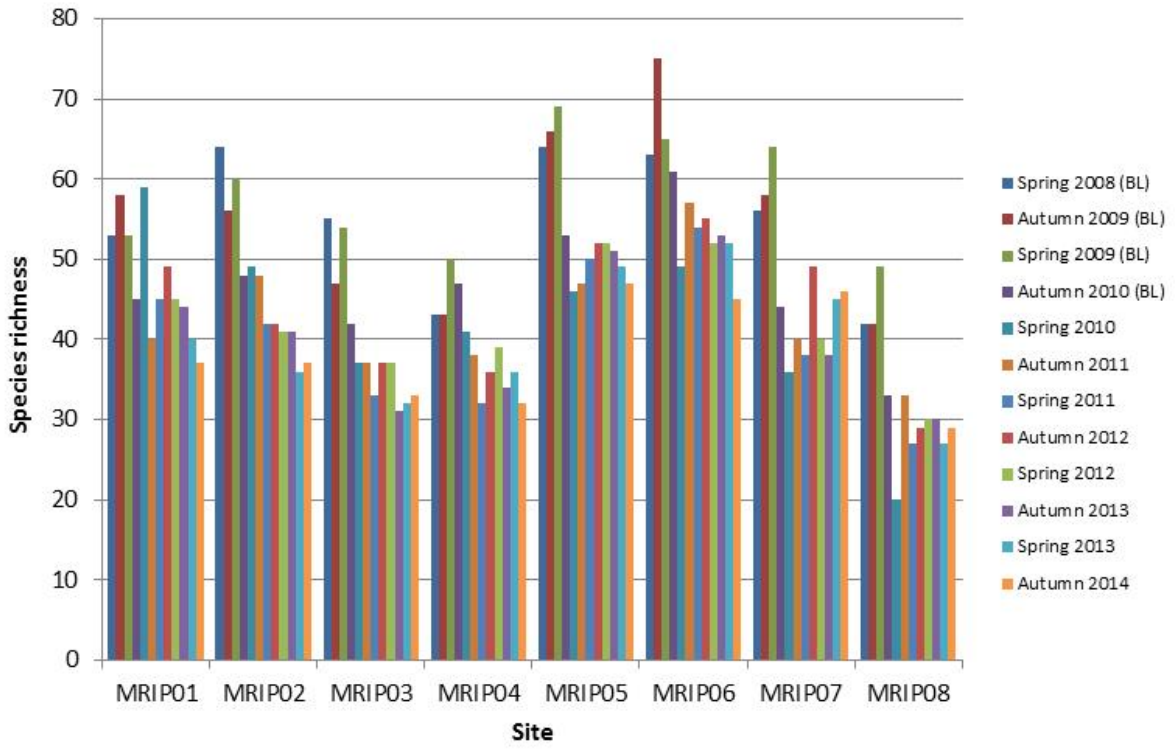


Chart 83 Species Richness in Riparian Monitoring Sites across all Seasons

Baseline seasons are indicated by 'BL'. Longwall sites – sites MRIP01, MRIP02, MRIP05 and MRIP06. Control sites – sites MRIP03, MRIP04, MRIP07 and MRIP08.

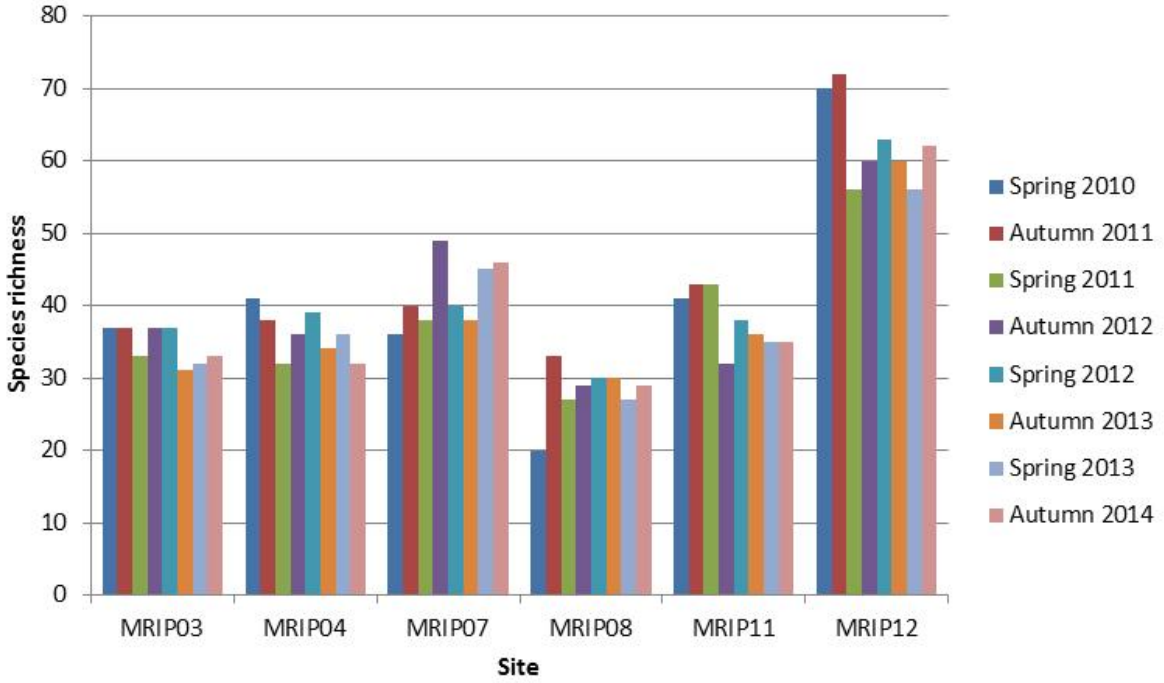


Chart 84 Species Richness within Riparian Monitoring Sites, Spring 2010 to Autumn 2014

Cover/Abundance and Condition for each Species

Sites MRIP01 to MRIP10

Fluctuations in species cover/abundance were recorded across all sites. No patterns of increasing or decreasing cover/abundance were identified in relation to individual species across sites or groups of species (i.e. riparian species, generalist species, shrubs, ground covers) within sites, with the exception of site MRIP02 where dieback of streamside vegetation has been recorded along a narrow strip. The foliage cover of *Gleichenia microphylla* at site MRIP02 has been recorded under 5% in all seasons since dieback was first recorded in spring 2012, including autumn 2014. The cover of *Gleichenia microphylla* at MRIP02 was recorded at between 20-50% for the three seasons prior to dieback being observed (i.e. in autumn 2011, spring 2011, autumn 2012). Similar declines in cover abundance have also been observed for *Bauera rubioides* at this site.

With the exception of longwall sites MRIP02 and MRIP05, in spring 2013 and autumn 2014 vegetation at both longwall and control sites was generally in a healthy condition (Condition 5) and only occasionally with minor dieback (Condition 4), and rarely with some dead branches (Condition 3) or many dead stems (Condition 2). Species including *Bauera rubioides*, *Gleichenia* spp., *Pteridium esculentum*, *Sticherus flabellatus* var. *flabellatus*, *Chordifex fastigiatus, Lasiopetalum ferrugineum*, *Tristania neriifolia, Grevillea diffusa subsp. diffusa*, *Viminaria juncea* and *Banksia oblongifolia* were observed with some level of dieback at multiple sites, though the majority of individuals were recorded in a good condition across all sites.

Sites MRIP11 and MRIP12

Fluctuations in species cover/abundance were recorded across all sites prior to the commencement of Longwall 23 and in autumn 2014. No patterns of increasing or decreasing cover/abundance were identified in relation to individual species across sites or groups of species (i.e. riparian indicator species, generalist species, shrubs, ground covers) within sites.

Fluctuations in vegetation condition were recorded across all sites prior to the commencement of Longwall 23 and in autumn 2014. Generally, vegetation within the riparian monitoring sites was in a healthy condition pre-Longwall 23 and in autumn 2014, with the vast majority of species and individuals recorded in a healthy condition (Condition 5). Vegetation with dieback ranging from Condition 4 (minor dieback) to Condition 1 (severe dieback) was noted occasionally in individuals at all longwall and control sites prior to the commencement of Longwall 23. Species with dieback included *Acacia terminalis*, *Acacia longifolia* subsp. *longifolia*, *Banksia* spp., *Gleichenia microphylla*, *Lomandra fluviatilis* and *Schoenus melanostachys*.

In autumn 2014, observations of vegetation with dieback at sites MRIP11 and MRIP12 were mostly limited to individuals with minor dieback (Condition 4) and in species which were observed with similar levels of dieback prior to the commencement of Longwall 23. Exceptions included a dead individual of *Hakea gibbosa* and dead branches of *Eucalyptus piperita* within site MRIP12 (Condition 3), both of which were recorded in a healthy condition throughout the pre-Longwall 23 monitoring period. Additionally, the exotic grass species *Andropogon virginicus* was recorded with many dead stems (Condition 2) within site MRIP12 in autumn 2014.

Indicator Species Monitoring

Three indicator species have been selected for monitoring riparian vegetation of Waratah Rivulet and the Eastern Tributary, namely, *Prostanthera linearis*, *Schoenus melanostachys* and *Lomatia myricoides*. Twenty tagged individuals have been monitored at each monitoring site:

- sites MRIP01, MRIP02, MRIP05, MRIP06 and MRIP09 overlying Longwalls 20-22;
- sites MRIP11 and MRIP12 overlying Longwalls 23-27; and
- sites MRIP03, MRIP04, MRIP07, MRIP08[14] and MRIP10 downstream of Longwalls 23-27.

Population monitoring of indicator species has been conducted biannually since spring 2010 at sites MRIP11 and MRIP12. Population monitoring of indicator species at the remainder of the sites has been conducted biannually since spring 2008 as a component of the Longwalls 20-22 riparian vegetation monitoring program. Surveys conducted up to and including the spring 2013 survey were conducted prior to the commencement of Longwall 23.

Population monitoring data collected includes a condition/health rating and a reproductive rating for each plant.

The Metropolitan Coal Six Monthly Report, 1 January to 30 June 2014 reported on the results of the riparian indicator species monitoring conducted by Eco Logical Australia for the spring 2013 vegetation survey. A summary of the results for autumn 2014 is presented below.

Sites MRIP01 to MRIP10

In autumn 2014 the mean vegetation condition for tagged riparian indicator species was similar for longwall and control sites, as indicated by overlapping confidence intervals (Charts 85 to 87)[15]. The mean vegetation condition decreased in autumn 2014 at both longwall and control sites in comparison to the previous surveys. The following differences in mean reproductive status were observed between longwall and control sites in autumn 2014:

- *Prostanthera linearis*, higher mean reproductive status score for longwall sites than control sites (Chart 86); and
- *Schoenus melanostachys* (higher mean reproductive status score for longwall sites than control sites (Chart 87).

Generally the mean reproductive scores for *Prostanthera linearis* and *Lomatia myricoides* were low with very little flowering observed, while moderate flowering was observed for *Schoenus melanostachys*.

[14] Note: Only 10 individuals of *Prostanthera linearis* were available for tagging at site MRIP08.

[15] Note: For Charts 84 to 86 Control and Longwall Reproductive Status (RS) scores were incorrectly labelled in previous Metropolitan Coal Annual Review/AEMR and Six Monthly reporting.

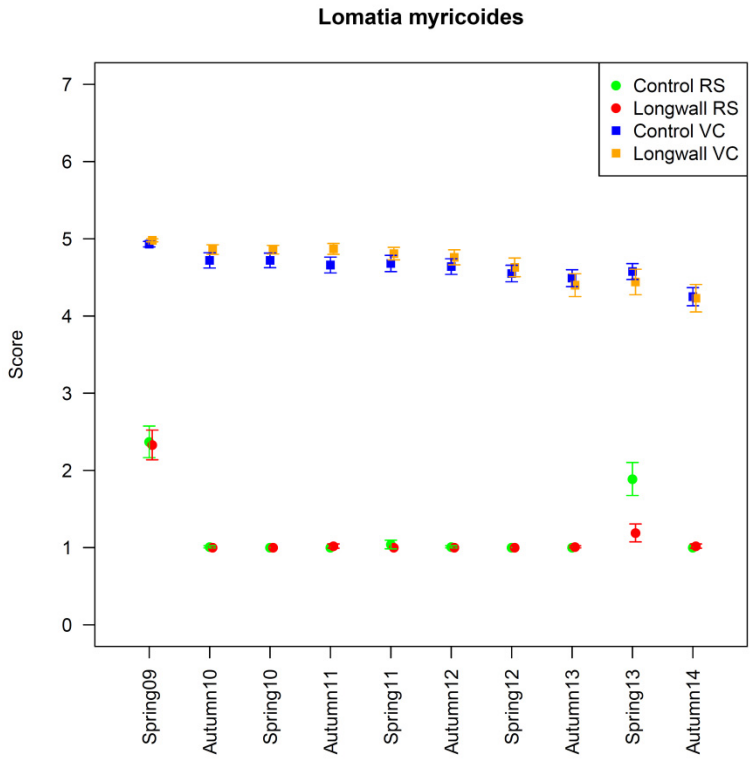


Chart 85 **Mean Scores for Vegetation Condition (VC) and Mean Reproductive Status (RS) for the Indicator Species, *Lomatia myricoides***

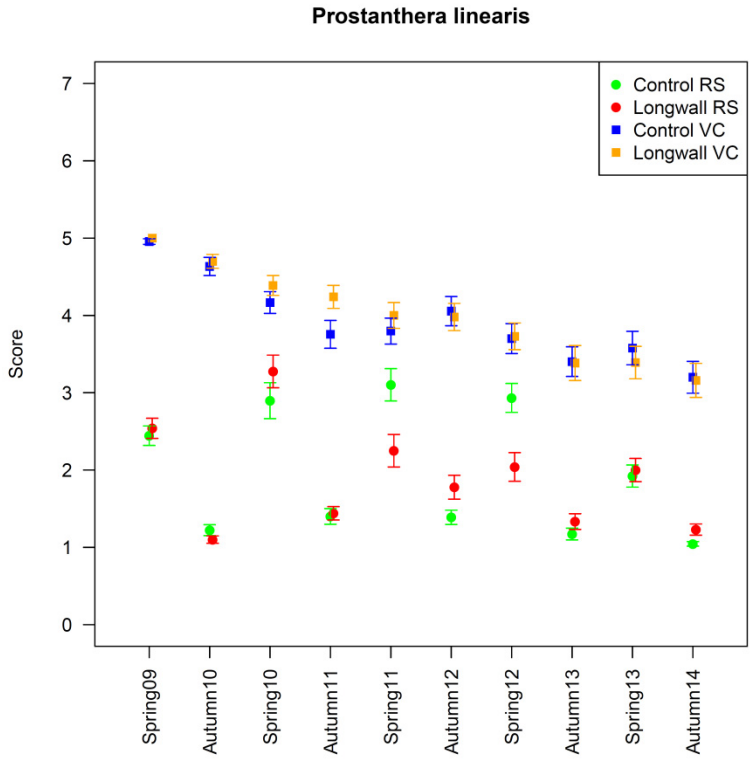


Chart 86 **Mean Scores for Vegetation Condition (VC) and Mean Reproductive Status (RS) for the Indicator Species, *Prostanthera linearis***

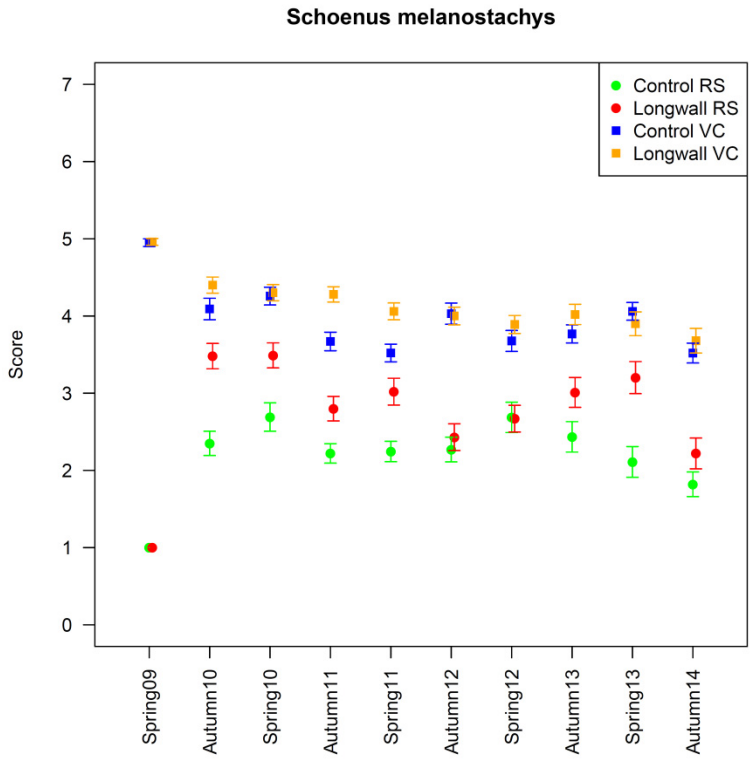


Chart 87 Mean Scores for Vegetation Condition (VC) and Mean Reproductive Status (RS) for the Indicator Species, *Schoenus melanostachys*

In autumn 2014 a total of 67 individuals of the tagged riparian indicator species were recorded as dead or Condition 1 (severe dieback), including 57 individuals recorded as dead or Condition 1 prior to autumn 2014. A total of 10 new individuals were recorded as dead or Condition 1 in autumn 2014, while one individual (Tag I38 *Schoenus melanostachys* at MRIP02) was recorded in an improved condition in autumn 2014 after being recorded in Condition 1 in spring 2013.

Of the 67 individuals recorded as dead or Condition 1 in autumn 2014, 44 were located within longwall sites and 23 were located within control sites, as follows:

- *Prostanthera linearis*, 47 plants (27 longwall and 20 control);
- *Lomatia myricoides*, 11 plants (10 longwall and 1 control); and
- *Schoenus melanostachys*, 9 plants (7 longwall and 2 controls).

Sites MRIP11 and MRIP12

The following provides a summary of the population monitoring results of the biannual surveys to include sites MRIP11 and MRIP12 (the additional sites on the Eastern Tributary over Longwalls 23-27) from spring 2010 to spring 2013 (prior to the commencement of Longwall 23) and in autumn 2014 (at the commencement of Longwall 23), compared to the control sites. Charts 88 to 90 provide an update of Charts 85 to 87 to include the results from sites MRIP11 and MRIP12 obtained since spring 2010[16].

[16] Note: Some corrections have been made to Charts 87 to 89 since the Metropolitan Coal Six Monthly Report, 1 January to 30 June 2014 due to incorrect labelling and the inclusion of LW 20-22 longwall indicator species data.

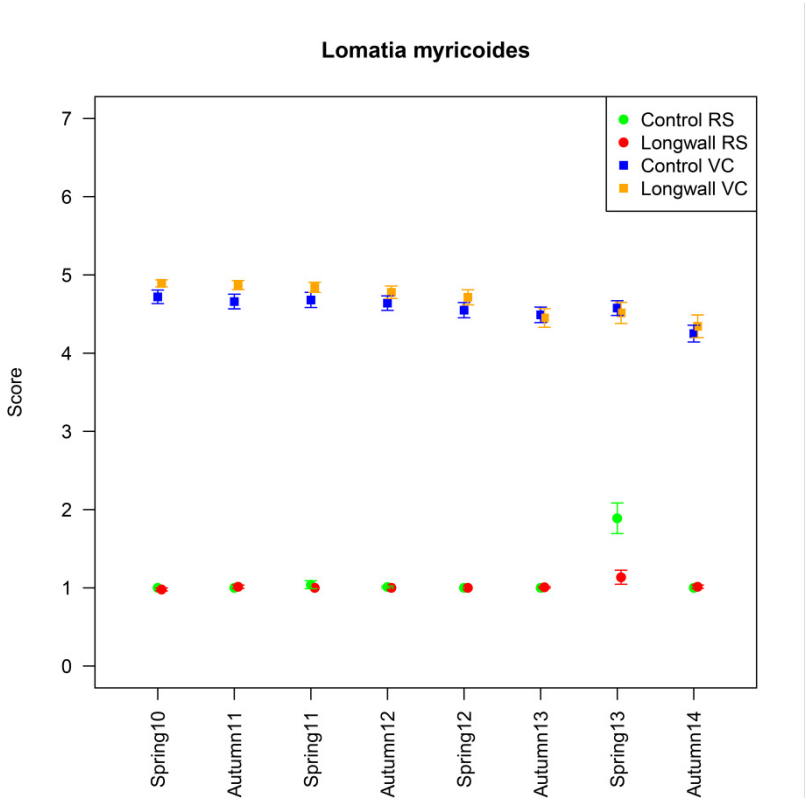


Chart 88 **Mean Scores for Vegetation Condition (VC) and Mean Reproductive Status (RS) for the Indicator Species, *Lomatia myricoides***

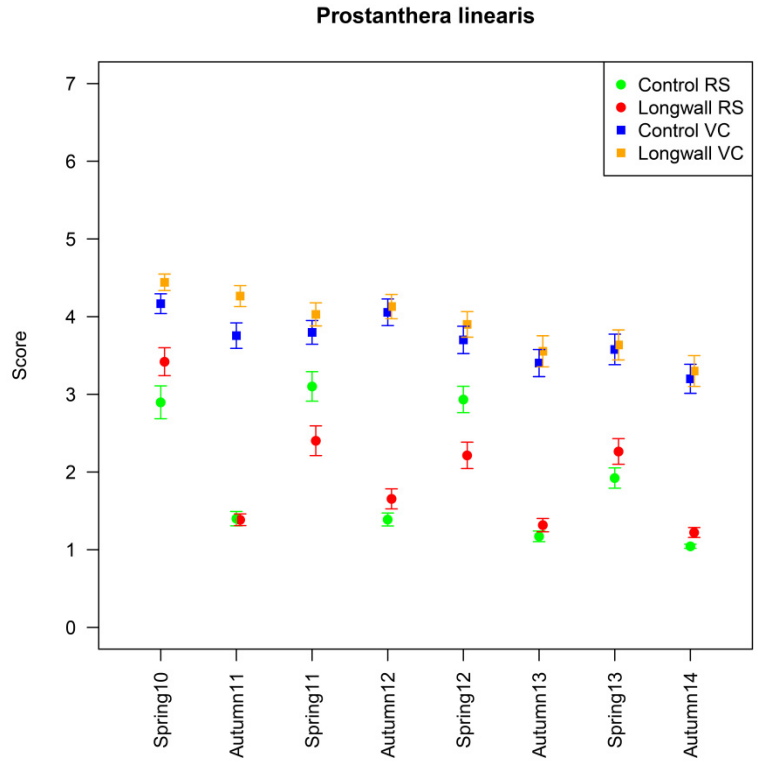


Chart 89 **Mean Scores for Vegetation Condition (VC) and Mean Reproductive Status (RS) for the Indicator Species, *Prostanthera linearis***

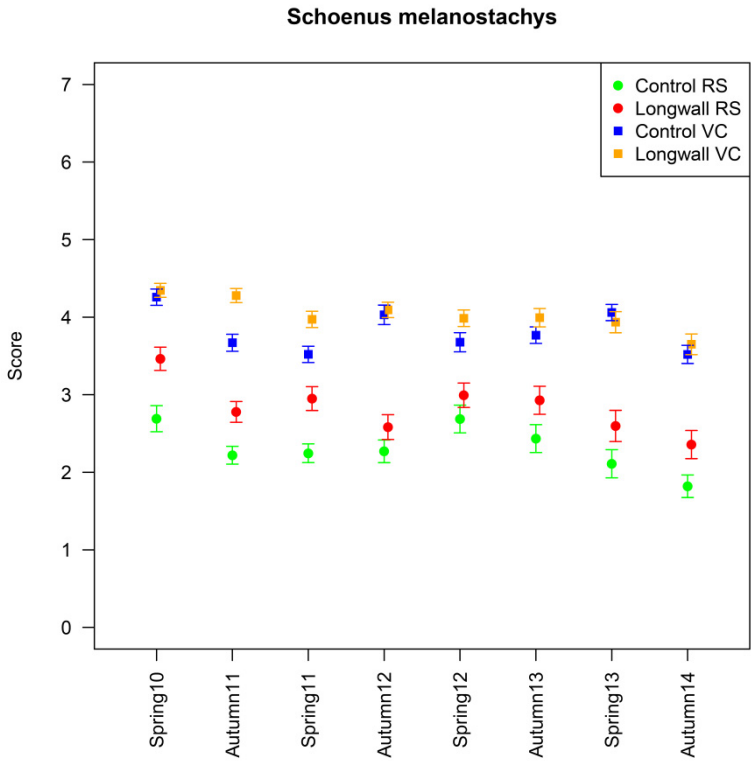


Chart 90 Mean Scores for Vegetation Condition (VC) and Mean Reproductive Status (RS) for the Indicator Species, *Schoenus melanostachys*

Vegetation Condition

Prior to the commencement of Longwall 23 (up to and including spring 2013) mean vegetation condition was generally similar between longwall and control sites for *Lomatia myricoides, Prostanthera linearis* and *Schoenus melanostachys* in each season, as indicated by overlapping confidence intervals (Charts 88 to 90). Exceptions to the generally similar mean vegetation condition for these tagged indicator species at longwall and control sites included *Prostanthera linearis* in autumn 2011 and *Schoenus melanostachys* in autumn 2011 and spring 2011 where mean vegetation condition was higher at longwall sites than control sites, although the size of the difference was generally small.

In autumn 2014 the mean vegetation condition for tagged riparian indicator species was similar between longwall and control sites for all species as indicated by overlapping confidence intervals (Charts 88 to 90). The mean vegetation condition for both longwall and control sites in autumn 2014 was lower than previous seasons for *Lomatia myricoides* and *Prostanthera linearis* and similar to previous surveys for *Schoenus melanostachys*.

Reproductive Status

The flowering status of tagged indicator species, as recorded in the reproductive scale, shows that across the entire monitoring period limited flowering was recorded across all species (Charts 88 to 90). The infrequent recording of flowering plants of indicator species is thought to be related to the timing of surveys which do not coincide with peak flowering periods.

Generally, mean reproductive status was similar between longwall and control sites for *Lomatia myricoides* (Chart 88), as indicated by overlapping confidence intervals, with the exception of spring 2013 where mean reproductive status was higher at control sites than longwall sites. For *Prostanthera linearis* and *Schoenus melanostachys* results were more variable (Charts 89 and 90). The mean reproductive status for *Prostanthera linearis* generally varied, in some surveys being higher at control sites and other surveys being higher at longwall sites (Chart 89). The mean reproductive status for *Schoenus melanostachys* was always higher at longwall sites than control sites (Chart 90).

3.2.4 Aquatic Biota and their Habitats

Metropolitan Coal assesses subsidence impacts and environmental consequences on aquatic habitats in accordance with the Metropolitan Coal Longwalls 23-27 Water Management Plan (Section 2). Surface water monitoring includes monitoring of surface water flow, pool water levels, surface water quality, iron staining and gas release. Observations of surface cracking, iron staining and gas release are also made during the conduct of the aquatic ecology surveys.

The aquatic ecology monitoring program for Longwalls 23-27 has been designed to:

- monitor subsidence-induced impacts on aquatic ecology (referred to as stream monitoring); and
- monitor the response of aquatic ecosystems to the implementation of stream remediation works (referred to as pool monitoring).

The design of the monitoring programs uses a “Beyond BACI” type experimental design and focuses on representative sampling within streams and pools in the Longwalls 23-27 mining area and in suitable control streams and pools not subject to mine subsidence.

Stream Monitoring

Surveys of aquatic habitat characteristics, water quality, aquatic macroinvertebrates and aquatic macrophytes have been carried out bi-annually (autumn and spring).

Monitoring has been carried out at two sampling sites (approximately 100 m long) at the following stream sampling locations:

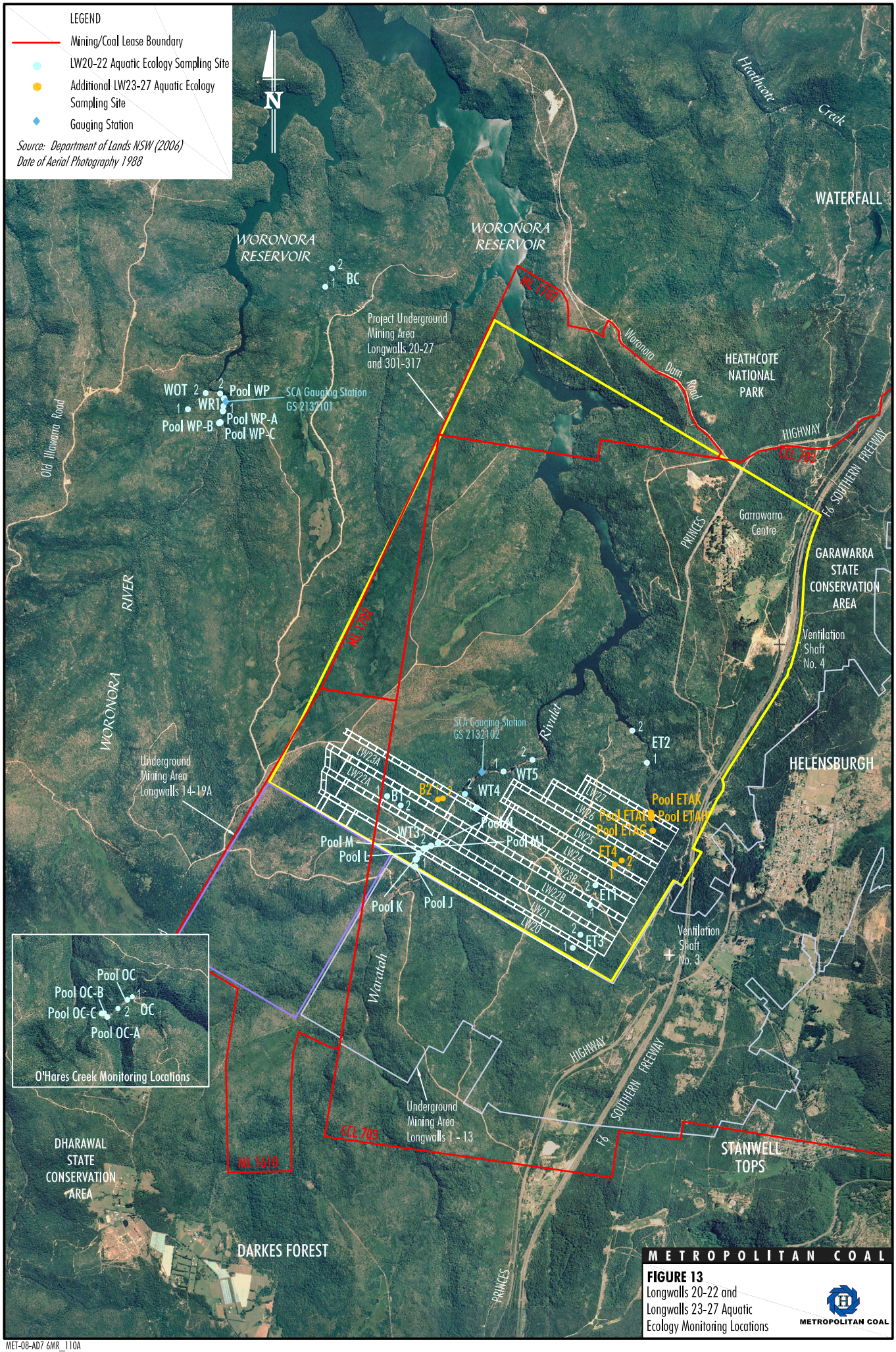
- Location C1 and C4[17] on Tributary C/Eastern Tributary and B2 on Tributary B overlying Longwalls 23-27.
- Location C2[17] on Tributary C/Eastern Tributary downstream of Longwalls 23-27.
- Control locations: WR1 on Woronora River; OC on O’Hares Creek; BC on Bee Creek; and WOT on Woronora Tributary.

The approximate locations of the sampling sites are shown on Figure 13.

The methods used to survey aquatic biota and their habitats at each site are:

- Stream characteristics are recorded in accordance with the AUSRIVAS protocol (including, visual assessment of stream width and depth, composition of the substratum, riparian conditions, signs of disturbance, water quality and percentage cover of the substratum by algae).

[17] Locations C1, C2 and C4 are referred to as Locations ET1, ET2 and ET4 in the *Metropolitan Coal Longwalls 20-22 Biodiversity Management Plan* and on Figure 13.



METROPOLITAN COAL

FIGURE 13
Longwalls 20-22 and Longwalls 23-27 Aquatic Ecology Monitoring Locations

METROPOLITAN COAL

MET-08-AD7 6MR_110A

- Water quality sampling is conducted for electrical conductivity, dissolved oxygen, pH, temperature, turbidity, oxygen reduction potential, alkalinity, total phosphorous and total nitrogen to provide information relevant to water quality at the time of sampling.
- Aquatic macroinvertebrate sampling is conducted using the AUSRIVAS protocol, as well as quantitative sampling where three replicate macroinvertebrate samples are collected within each site using timed sweeps.
- The distribution of submerged and emergent (occurring in-stream and in the riparian zone) aquatic macrophytes are estimated along each sampling location by assigning a cover class to each species. The cover classes are: (1) one plant or small patch (i.e. few), (2) not common, growing in a few places (i.e. scattered), and (3) widespread (i.e. common). In addition, an assessment of the in-stream (i.e. submerged and emergent) aquatic vegetation is made within each site by estimating the relative abundance (i.e. percentage cover) of aquatic macrophytes within five haphazardly placed 0.25 m^2 quadrats, using a stratified sampling technique.

Surveys have been carried out at Location C4 on Tributary C and Location B2 on Tributary B from spring 2009 to autumn 2014. Locations C1 and C2 on Tributary C, Location WR1 on the Woronora River, Location OC on O'Hares Creek, Location BC on Bee Creek and Location WOT on the Woronora Tributary have been monitored since spring 2008 (as a component of the Longwalls 20-22 aquatic ecology monitoring program).

A summary of the stream monitoring survey results obtained prior to the commencement of Longwall 23 (i.e. up to and including spring 2013) by BIO-ANALYSIS Pty Ltd is provided in the Metropolitan Coal Six Monthly Report, 1 January to 30 June 2014. A summary of the stream monitoring survey results for autumn 2014 (i.e. during the mining of Longwall 23)[18] is presented below.

Stream Characteristics

For the first time since sampling commenced in spring 2009, there was evidence of iron staining at Locations C1 and C4 on Tributary C/Eastern Tributary in autumn 2014. To date (i.e. autumn 2014), no cracking of the stream or bank sandstone substratum has been observed at those locations. Neither cracking of the stream substratum or algal/iron floc has been observed at sampling Location C2 since sampling commenced in spring 2009.

To date, no evidence of mining related subsidence (i.e. cracking of the stream substratum or an algal/iron floc) has been observed at sampling Location B2.

Macroinvertebrate Assemblages

In summary, the results indicate that generally, the structure of assemblages of macroinvertebrates are typical of Hawkesbury sandstone environments. Table 3 presents the AUSRIVAS Band results for each site as a result of sampling aquatic macroinvertebrates using the AUSRIVAS protocol. Fewer families of macroinvertebrates than expected were commonly collected from all sites sampled (including control sites), compared to control sites selected by the AUSRIVAS model (Table 3).

Charts 91a and 91b present the Principal Coordinates Analysis (PCoA) plots for macroinvertebrates at each sampling location on each sampling occasion using the quantitative sampling data. Temporal and spatial variability in the structure of assemblages of macroinvertebrates was observed at all locations.

[18] For sampling locations at which monitoring commenced in spring 2008, the results are included in the Principal Coordinates Analysis (PCoA) plots in Charts 91 and 94. Charts 92, 93, 95 and 96 include survey data from spring 2009 to autumn 2014.

Table 3
Band Levels Generated by the AUSRIVAS Model for Sites within Locations Sampled as Part of the Longwalls 23-27 Stream Monitoring Program

System	Site Code	Sp-09	Aut-10	Sp-10	Aut-11	Sp-11	Aut-12	Sp-12	Aut-13	Sp-13	Aut-14
Tributary C	C1-1	B	B	C	C	B	B	C	A	D	C
	C1-2	C	B	B	B	C	A	B	C	C	A
	C2-1	B	C	C	B	C	C	B	C	C	C
	C2-2	B	C	C	C	D	B	C	C	C	C
	C4-1	B	B	C	B	D	B	B	C	C	B
	C4-2	B	B	C	C	B	C	C	C	B	A
Tributary B	B2-1	C	B	C	C	B	B	D	A	B	B
	B2-2	C	C	C	B	B	C	B	C	C	C
Bee Creek	BC1	C	B	C	C	D	C	A	B	B	C
	BC2	D	B	C	B	B	B	B	C	B	C
Woronora Tributary	WOT1	-*	B	C	C	B	C	B	A	B	C
	WOT2	D	C	C	C	C	B	A	C	C	C
Woronora River	WR1-1	C	B	C	C	C	C	B	C	C	C
	WR1-2	C	B	C	C	C	C	B	B	B	C
O'Hares Creek	OC1	B	A	B	B	A	A	A	B	C	B
	OC2	B	B	B	B	B	C	C	B	C	B

* Sites not sampled due to insufficient aquatic habitat.

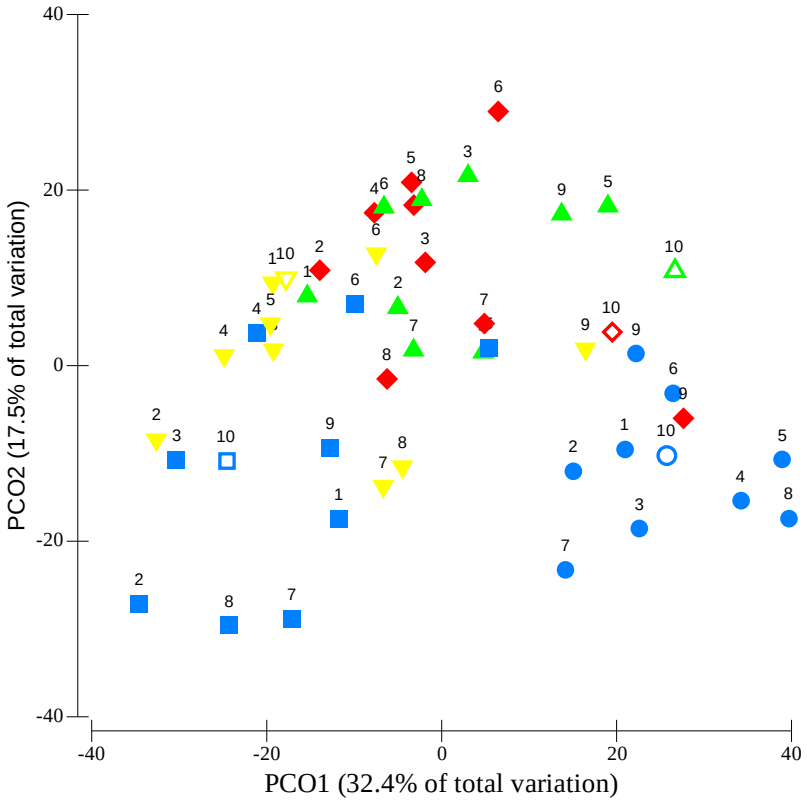


Chart 91a Principal Coordinates Analysis (PCoA) plot of macroinvertebrate data for three locations on Tributary C: Location C1 (green triangles); Location C2 (yellow triangles); and Location C4 (red diamonds) and two control locations (Woronora River: blue squares and O'Hare's Creek: blue circles) for each time of sampling (*n*= 6) from spring 2009 (T1). Filled symbols: 'Before' commencement of Longwall 23; Empty symbols: 'After' commencement of Longwall 23.

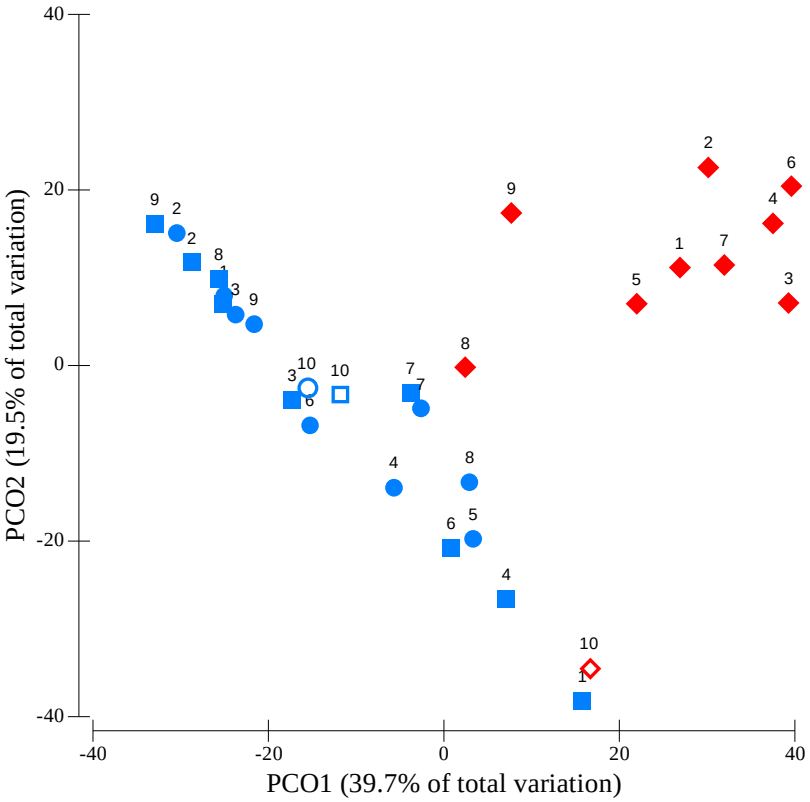


Chart 91b Principal Coordinates Analysis (PCoA) plot of macroinvertebrate data collected at one location on Tributary B (i.e. Location B2) and two control locations (Bee Creek and Woronora Tributary) for each time of sampling (*n*= 6) from spring 2009 (T1). Red symbols: Tributary B; Blue squares: Bee Creek; Blue circles: Woronora Tributary. Filled symbols: 'Before' commencement of Longwall 23; Empty symbols: 'After' commencement of Longwall 23.

Charts 92a to 92d present the mean diversity of macroinvertebrates, mean abundance of macroinvertebrates, mean number of Leptophlebiidae and mean number of Atyidae at each location sampled on Tributary C/Eastern Tributary (i.e. Locations C1, C2 and C4) and at the control locations (i.e. Woronora River and O'Hares Creek) using the quantitative sampling data.

Charts 93a to 93d present the mean diversity of macroinvertebrates, mean abundance of macroinvertebrates, mean number of Leptophlebiidae and mean number of Atyidae at Tributary B (i.e. Location B2) and the control locations (i.e. Bee Creek and Woronora Tributary), respectively, using the quantitative sampling data.

In general, the most abundant macroinvertebrate taxon collected include the freshwater shrimp family, Atyidae, and the mayfly family, Leptophlebiidae.

There have been differences in the structure of assemblages of macroinvertebrates at Locations C1, C3 and C4 on Tributary C/Eastern Tributary and the control locations sampled along the Woronora River and O'Hares Creek since the commencement of sampling. The structure of the assemblage at Location C4 on the last two sampling occasions (i.e. spring 2013 and autumn 2014) differed from assemblages collected at that location previously. Since sampling commenced, assemblages of macroinvertebrates at the O'Hares Creek location appear to be considerably different from those at the other locations sampled.

There have also been differences in the structure of assemblages of macroinvertebrates at Location B2 on Tributary B and the control locations sampled along Bee Creek and the Woronora Tributary since the commencement of sampling (Chart 91b). Assemblages collected at Location B2 in autumn 2013 (T8), spring 2013 (T9) and autumn 2014 (T10) also differed from assemblages collected at Location B2 on previous sampling occasions (Chart 91b). Mean macroinvertebrate diversity and abundance in autumn 2014 was low when compared to previous surveys at Location B2 and at the control locations (Charts 93a and 93b). Few Leptophlebiidae and no Atyidae were also recorded at Location B2 in autumn 2014 (Charts 93c and 93d). At the time of the autumn 2014 sampling, stream water was clear and free of sediment and no evidence of surface cracking, iron staining or gas releases was noted, consistent with previous sampling events.

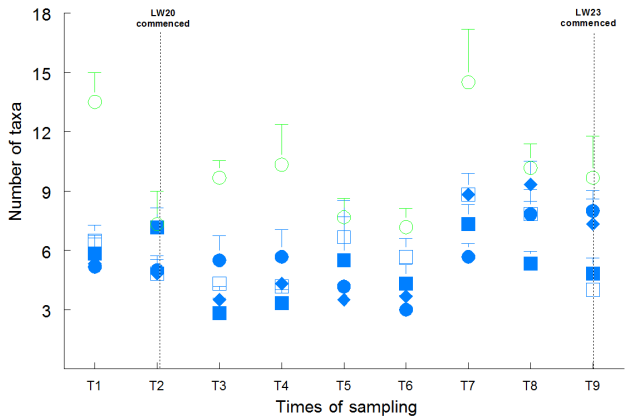


Chart 92a Mean (+SE) Macroinvertebrate Diversity, Stream Monitoring – Tributary C

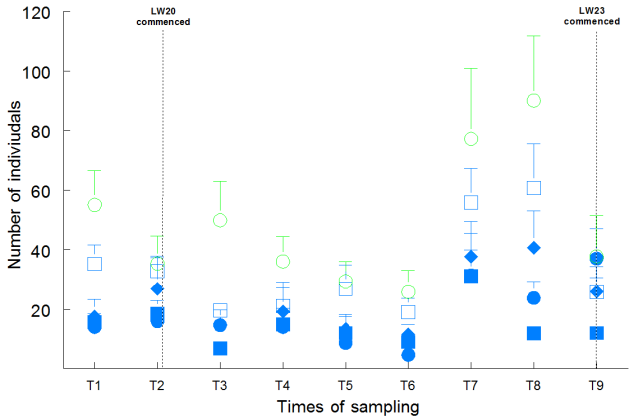


Chart 92b Mean (+SE) Macroinvertebrate Abundance, Stream Monitoring – Tributary C

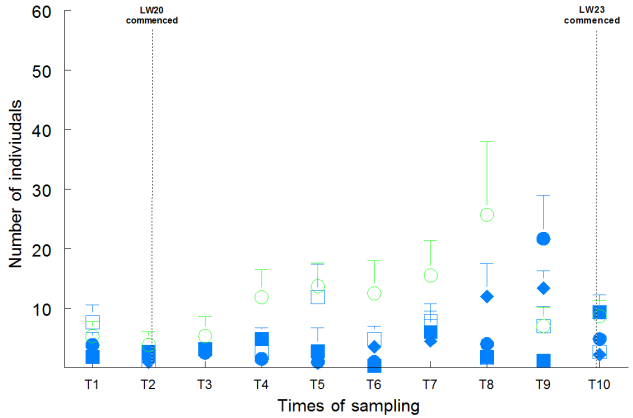


Chart 92c Mean (+SE) Number of Leptophlebiidae, Stream Monitoring- Tributary C

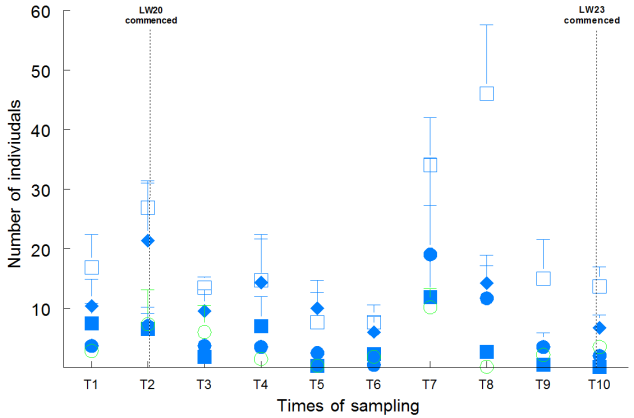


Chart 92d Mean (+SE) Number of Atyidae, Stream Monitoring – Tributary C

Key: Tributary C/Eastern Tributary (Location C1: solid squares; Location C2: solid diamond; Location C4: solid circles) and the control locations (Woronora River: empty square; O'Hares Creek: empty circle) (*n* = 6). Time 1 = spring 2009, T2 = autumn 2010, etc.

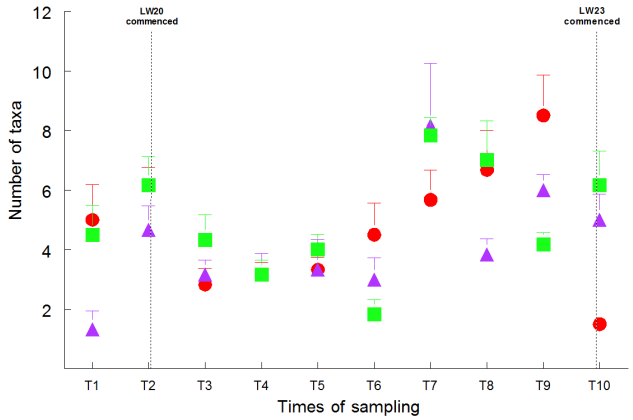


Chart 93a Mean (+SE) Macroinvertebrate Diversity, Stream Monitoring – Tributary B

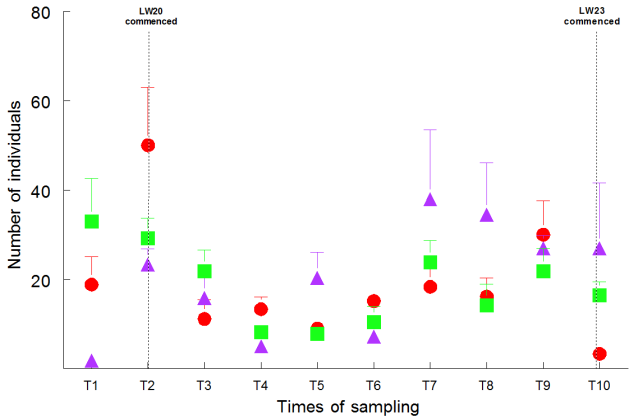


Chart 93b Mean (+SE) Macroinvertebrate Abundance, Stream Monitoring – Tributary B

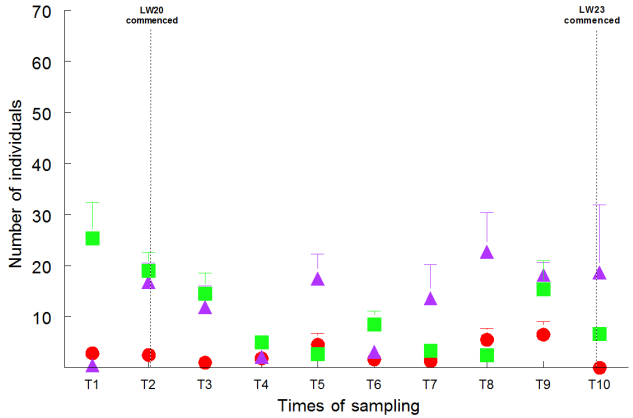


Chart 93c Mean (+SE) Number of Leptophlebiidae, Stream Monitoring- Tributary B

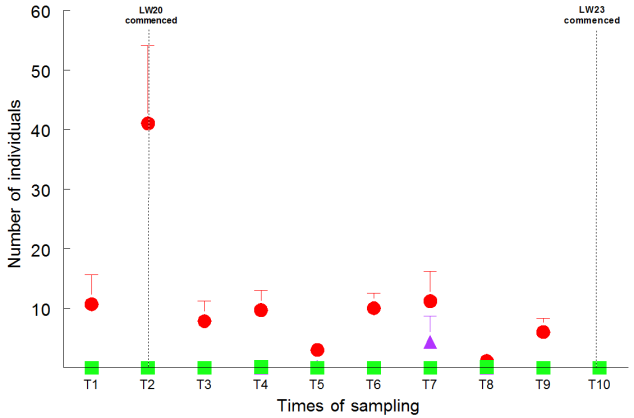


Chart 93d Mean (+SE) Number of Atyidae, Stream Monitoring – Tributary B

Key: Tributary B, Location B2 (circles) and the control locations (Bee Creek: triangles; Woronora Tributary: squares) (*n* = 6). Time 1 = spring 2009, T2 = autumn 2010, etc.

Macrophyte Assemblages

Over the entire sampling period, the following floating attached species and/or submerged species of macrophytes (i.e. instream macrophytes) have been recorded:

- *Triglochin procerum* at sampling Locations WR1 and OC;
- *Chara/Nitella* spp. has commonly been recorded at Locations C1, C2, C4, WR1 and OC; and
- *Myriophyllum pedunculatum* at Location WR1.

A temporal comparison of the aquatic macrophyte data has been carried out for the locations sampled up to and including autumn 2014. Charts 94a and 94b presents the PCoA plots for macrophytes at each sampling location using the quantitative sampling data. Temporal and spatial variability in the structure of assemblages of macrophytes was observed at all locations.

Charts 95a and 95b present the mean diversity of macrophytes and mean percentage cover of macrophytes, respectively, at each location sampled on Tributary C/Eastern Tributary (i.e. Locations C1, C2 and C4) and at the control locations (i.e. Woronora River and O'Hares Creek) using the quantitative sampling data.

Charts 96a and 96b present the mean diversity of macrophytes and mean percentage cover of macrophytes, respectively, at the location sampled along Tributary B and the control locations (i.e. Bee Creek and Woronora Tributary), respectively, using the quantitative sampling data.

Examination of the data show that there have been differences in the structure of assemblages of macrophytes between all of the locations sampled on Tributary C/Eastern Tributary (C1, C2 and C4) and the control locations sampled on the Woronora River and O'Hares Creek since the commencement of sampling (Chart 94a). The presence of the floating-attached species, *Triglochin procerum,* at the control locations but not at locations sampled in Tributary C/Eastern Tributary contributes greatly to observed differences. Assemblages of macrophytes at all locations (including control locations) sampled in autumn 2014 (Time 10), grouped separately from the assemblages at those locations on previous sampling occasions.

Similar species (i.e. *Gleichenia dicarpa* and *Lepidosperma filiforme*) contributed to the structure of assemblages of macrophytes at Location B2 on Tributary B and the control locations sampled along Bee Creek and the Woronora Tributary.

Pool Monitoring

The pool monitoring program includes bi-annual (autumn and spring) monitoring of aquatic macroinvertebrates and macrophytes in pools to allow the response of aquatic ecosystems to the implementation of future stream remediation works on Tributary C to be assessed.

Monitoring has been carried out at the following pools:

- Large pool (defined as pools >40 m in length), Pool ETAH on Tributary C/Eastern Tributary overlying Longwalls 23-27.
- Smaller pools (defined as pools <40 m in length) Pools ETAG, ETAK and ETAI on Tributary C/Eastern Tributary overlying Longwalls 23-27.
- One larger control pool on Woronora River (Pool WP) and one larger control pool on O'Hares Creek (Pool OC).
- Three smaller control pools on Woronora River (Pools WP-A, WP-B and WP-C) and three smaller control pools on O'Hares Creek (Pools OC-A, OC-B and OC-C).

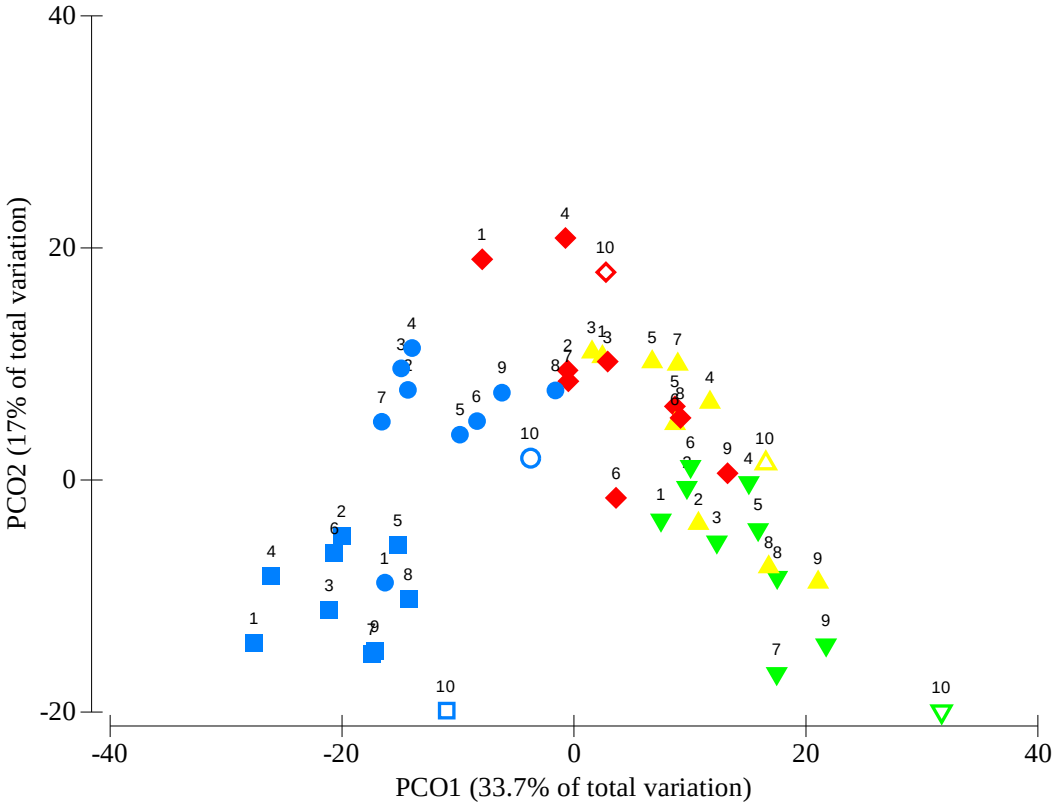


Chart 94a Principal Coordinates Analysis (PCoA) plots of macrophyte data for three locations on Tributary C: Location C1 (green triangles); Location C2 (yellow triangles); and Location C4 (red diamonds) and two control locations (Woronora River: blue squares and O'Hare's Creek: blue circles) for each time of sampling (*n*= 10) from spring 2009 (T1). Filled symbols: 'Before' commencement of Longwall 23; Empty symbols: 'After' commencement of Longwall 23.

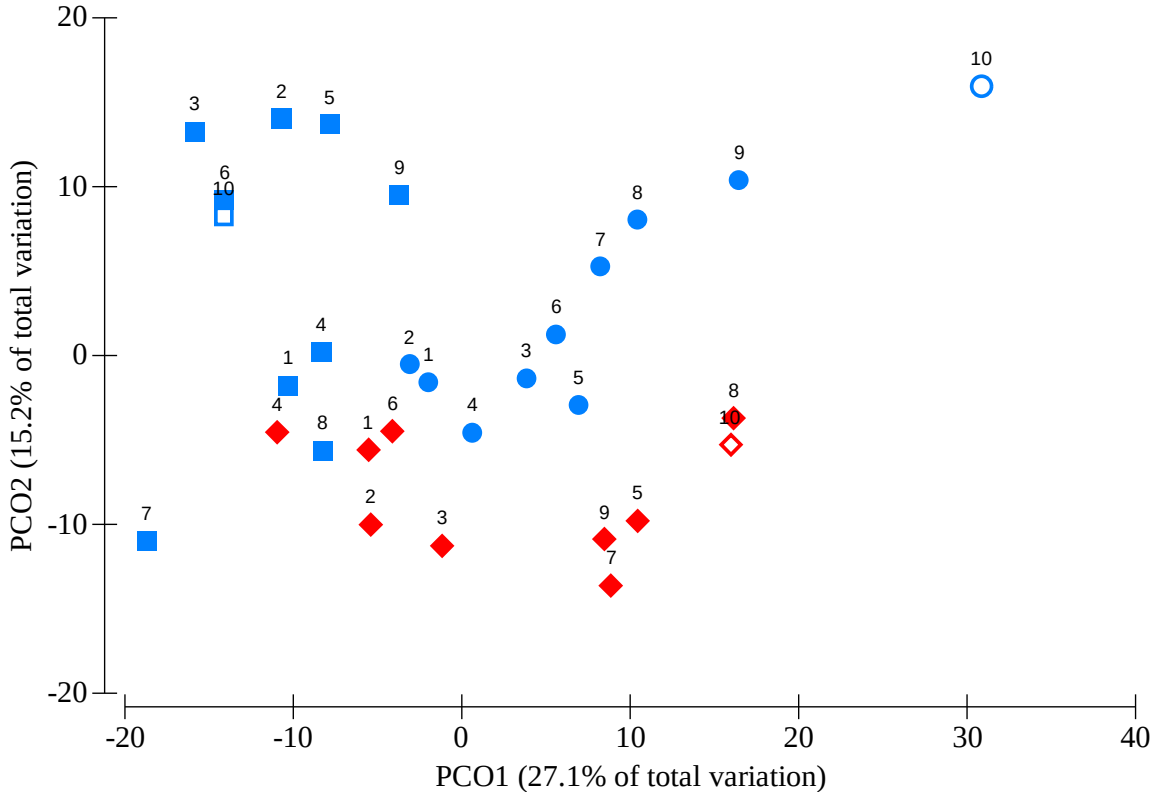


Chart 94b Principal Coordinates Analysis (PCoA) plot of macrophyte data collected at one location on Tributary B (i.e. Location B2) and two control locations (Bee Creek and Woronora Tributary) for each time of sampling (*n*= 10) from spring 2009 (T1). Red symbols: Tributary B; Blue squares: Bee Creek; Blue circles: Woronora Tributary. Filled symbols: 'Before' commencement of Longwall 23; Empty symbols: 'After' commencement of Longwall 23.

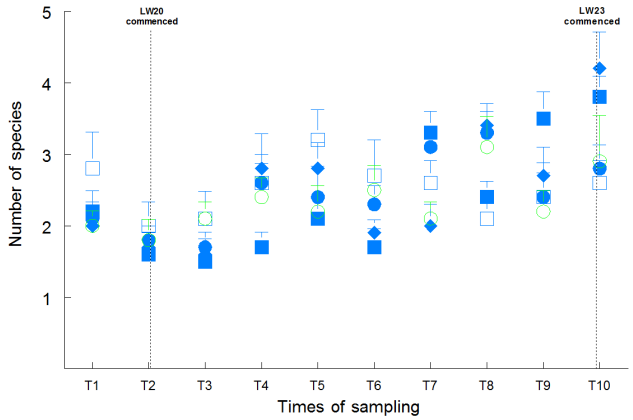


Chart 95a Mean (+SE) Macrophyte Diversity, Stream Monitoring, Tributary C

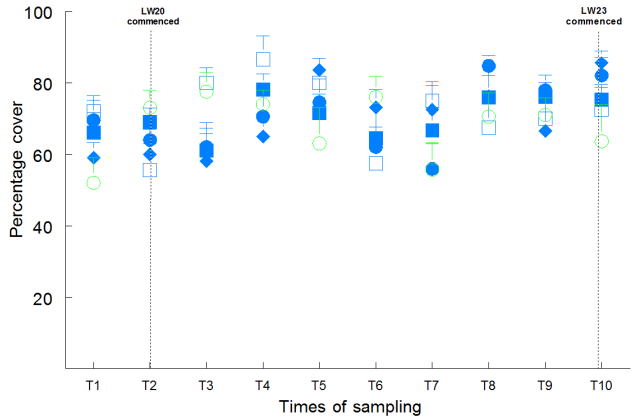


Chart 95b Mean (+SE) Macrophyte Cover, Stream Monitoring, Tributary C

Key: Tributary C/Eastern Tributary (Location C1: solid squares; Location C2: solid diamond; Location C4: solid circles) and the control locations (Woronora River: empty squares; O'Hares Creek: empty circles) (*n* = 10).

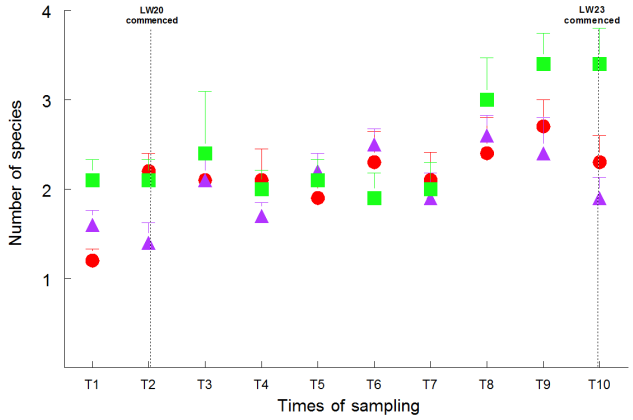


Chart 96a Mean (+SE) Macrophyte Diversity, Steam Monitoring, Tributary B

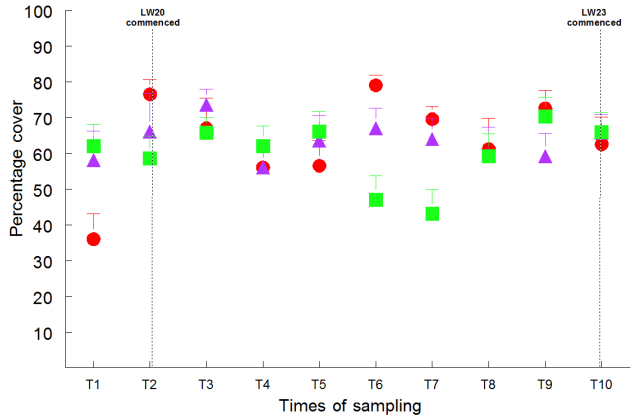


Chart 96b Mean (+SE) Macrophyte Cover, Stream Monitoring, Tributary B

Key: Tributary B (circles) and the control locations (Bee Creek: triangles; Woronora Tributary: squares) (*n* = 10).
Time 1 = spring 2009, T2 = autumn 2009, etc.

The approximate locations of the sampling sites are shown on Figure 13.

Sampling is carried out at two random sites within the larger pools and at one site within the smaller pools.

Within each site in each pool, aquatic macroinvertebrates and macrophytes are sampled using the same quantitative techniques described for stream monitoring above. The AUSRIVAS sampling technique is not used for macroinvertebrate sampling in the pool monitoring.

Quantitative estimates of aquatic macrophytes (i.e. emergent, floating attached and/or submerged species of aquatic plants) are collected at one site at each small pool and at two sites at each large pool. In addition, the spatial distribution of floating attached and/or submerged macrophytes (e.g. *Myriophyllum penduculatum* and *Triglochin procerum*) is mapped in each pool, to provide a visual comparison of their distribution through time.

Surveys have been carried out at Pools ETAH, ETAG, ETAK and ETAI on Tributary C/Eastern Tributary since spring 2009. Surveys have been carried out at control Pools WP, WP-A, WP-B, WP-C, OC, OC-A, OC-B and OC-C since spring 2008 (as a component of the Longwalls 20-22 aquatic ecology monitoring program).

A summary of the pool monitoring survey results from spring 2009 to spring 2013 (i.e. prior to the commencement of Longwall 23) is provided in the Metropolitan Coal Six Monthly Report, 1 January to 30 June 2014. A summary of the pool monitoring survey results in autumn 2014 (i.e. during the mining of Longwall 23) is presented below.

Stream Characteristics

To date, there has been no evidence of subsidence-induced surface cracking, iron staining or gas releases at any of the pools sampled on Tributary C.

Macroinvertebrate Assemblages

A temporal comparison of the aquatic macroinvertebrate data has been carried out for the pools sampled from spring 2009 to autumn 2014.

Chart 97 presents the PCoA plot for macroinvertebrates at the larger pools using the quantitative sampling data. Charts 98a and 98b present the mean diversity of macroinvertebrates and mean abundance of macroinvertebrates respectively, at the larger pools using the quantitative sampling data.

Chart 99 presents the PCoA plot for macroinvertebrates at the smaller pools using the quantitative sampling data. Charts 100a and 100b present the mean diversity of macroinvertebrates and mean abundance of macroinvertebrates at the smaller pools, respectively, using the quantitative sampling data.

The results indicate there have been differences in the structure of assemblages of macroinvertebrates collected among the large and small pools sampled since the commencement of sampling (Charts 97 and 99). In particular, macroinvertebrate assemblages in the large pool sampled on O'Hares Creek grouped separately from the pools sampled on Tributary C/Eastern Tributary and the Woronora River.

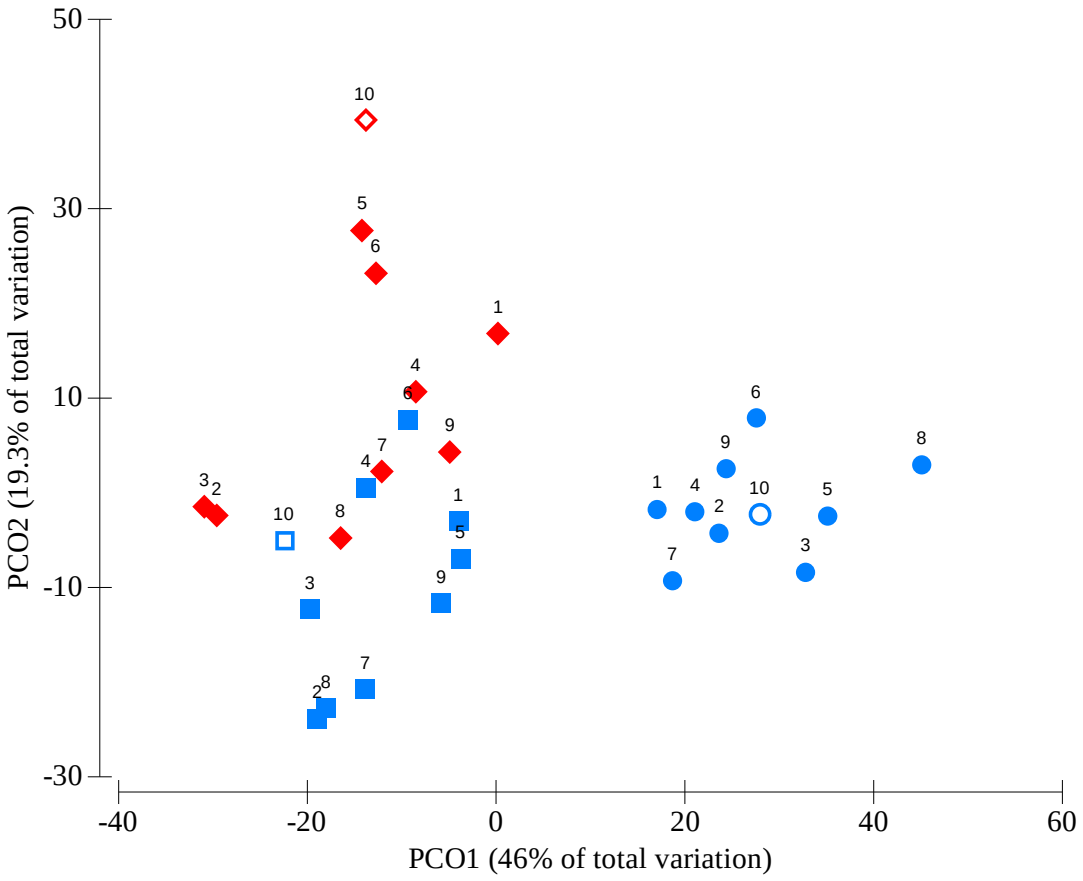


Chart 97 Principal Coordinates Analysis (PCoA) plot of macroinvertebrate data (standardized) for large Pool ETAH on Tributary C (red diamonds) and two large control pools: Woronora River (blue squares) and O'Hares Creek (blue circles) for each time of sampling (*n* = 6), from spring 2009 (T1). Filled symbols: 'Before' commencement of Longwall 23; Empty symbols: 'After' commencement of Longwall 23.

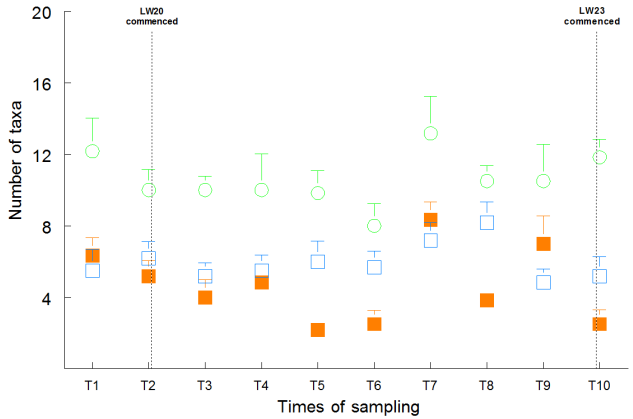


Chart 98a Mean (+SE) Macroinvertebrate Diversity, Large Pool Monitoring

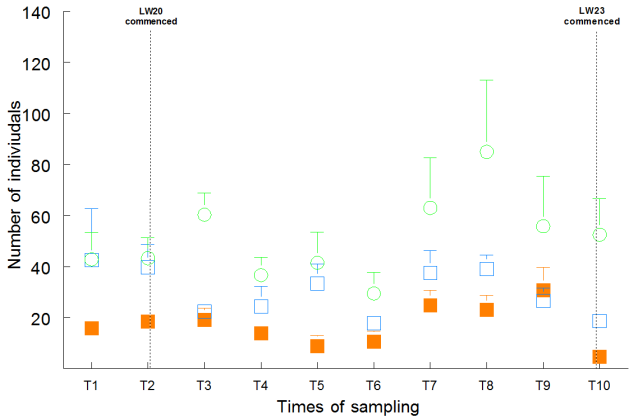


Chart 98b Mean (+SE) Macroinvertebrate Abundance, Large Pool Monitoring

Key: Pool ETAH on Tributary C: solid orange squares and the control pools (Woronora River Pool: open blue squares, O'Hares Creek Pool: open green circles). Sampling of Pool ETAH commenced spring 2009 (*n* = 6).

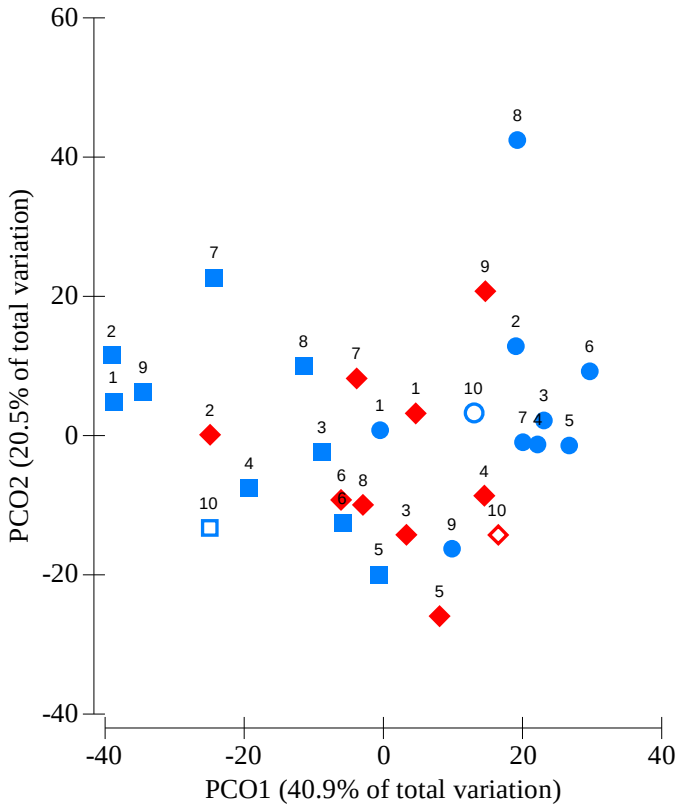


Chart 99 Principal Coordinates Analysis (PCoA) plots of macroinvertebrate data (standardized) for small pools on Tributary C (red diamonds) and small control pools on Woronora River (blue squares) and O'Hare's Creek (red circles) for each time of sampling (*n*= 9), from spring 2009 (T1). Filled symbols: 'Before' commencement of Longwall 23; Empty symbols: 'After' commencement of Longwall 23.

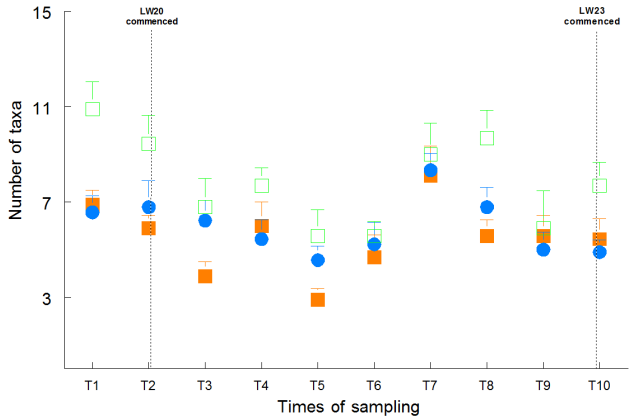


Chart 100a Mean (+SE) Macroinvertebrate Diversity, Small Pool Monitoring

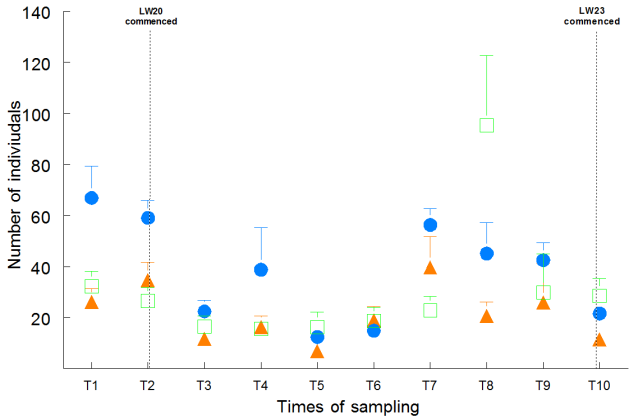


Chart 100b Mean (+SE) Macroinvertebrate Abundance, Small Pool Monitoring

Key: Tributary C pools: solid orange squares or triangles and the control pools (Woronora River Pool: solid blue circles, O'Hares Creek Pool: open green circles). Sampling of Pools commenced spring 2009 (*n* = 6).

Macrophyte Assemblages

A temporal comparison of the aquatic macrophyte data has been carried out for the pools sampled from spring 2009 to autumn 2014.

Chart 101 presents the PCoA plots for macrophytes at the larger pools using the quantitative sampling data. Charts 102a and 102b present the mean diversity and mean abundance of macrophytes at the larger pools using the quantitative sampling data.

Chart 103 presents PCoA plots for macrophytes at the smaller pools, using the quantitative sampling data. Charts 104a and 104b present the mean diversity and mean abundance of macrophytes at the smaller pools, respectively, using the quantitative sampling data.

The results indicate differences in the structure of assemblages of macrophytes collected among the large and small pools sampled since the commencement of sampling. In particular, assemblages in the large and small pools sampled on Tributary C/Eastern Tributary grouped separately from the large and small pools sampled along the Woronora River and O'Hares Creek (Charts 101 and 103).

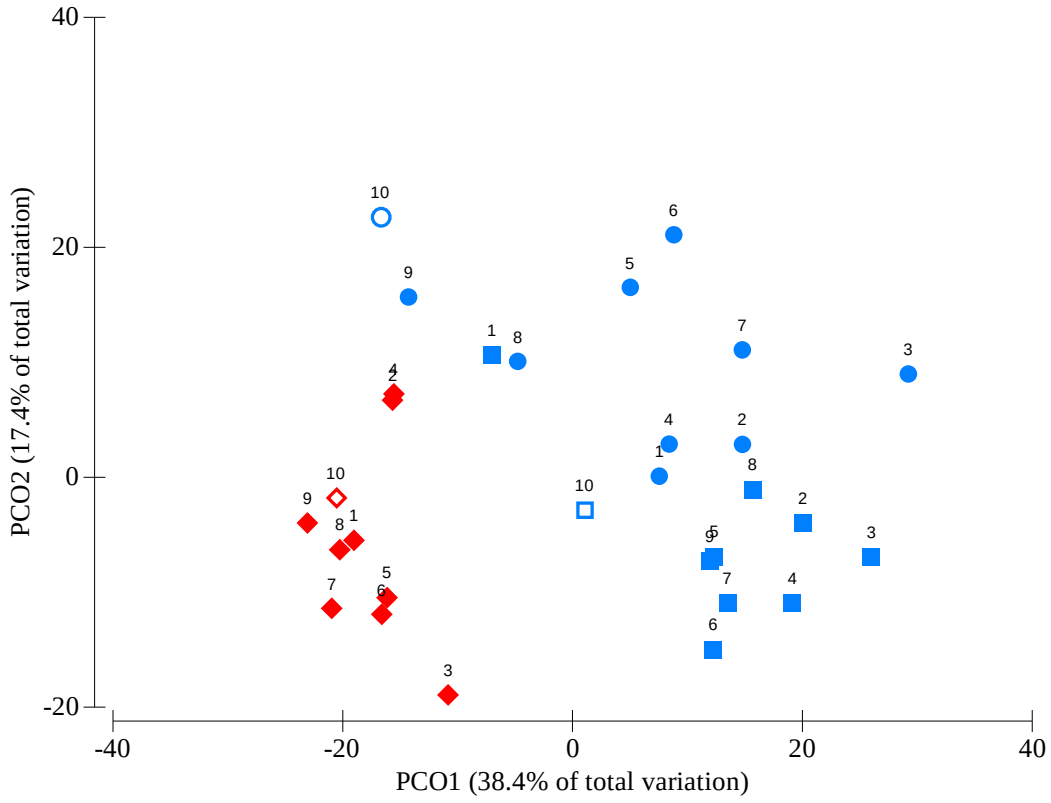


Chart 101 Principal Coordinates Analysis (PCoA) plots of macrophyte data for large pools in Tributary C (red diamonds) and two control streams: Woronora River (blue squares) and O'Hares Creek (blue circles) (*n*=10), from spring 2009 (T1). Filled symbols: 'Before' commencement of Longwall 23; Empty symbols: 'After' commencement of Longwall 23.

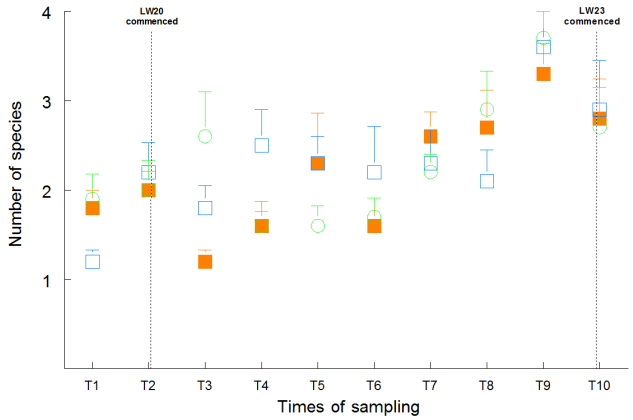


Chart 102a Mean (+SE) Macrophyte Diversity, Large Pool Monitoring

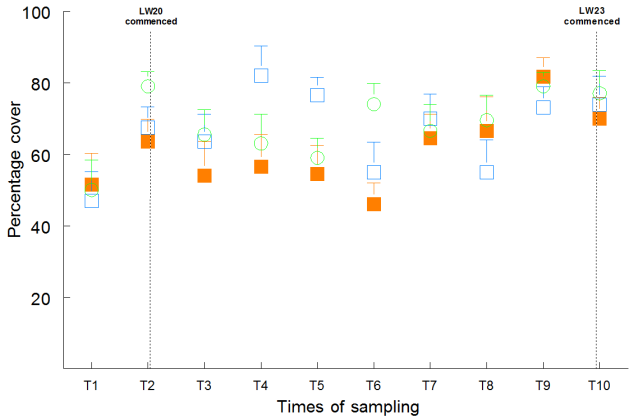


Chart 102b Mean (+SE) Macrophyte Percentage Cover, Large Pool Monitoring

Key: Pool ETAH on Tributary C: solid orange squares and the control pools (Woronora River Pool: open blue squares, O'Hares Creek Pool: open green circles). Sampling of Pools commenced spring 2009 (*n* = 10). Time 1 = spring 2009, T2 = autumn 2010, etc.

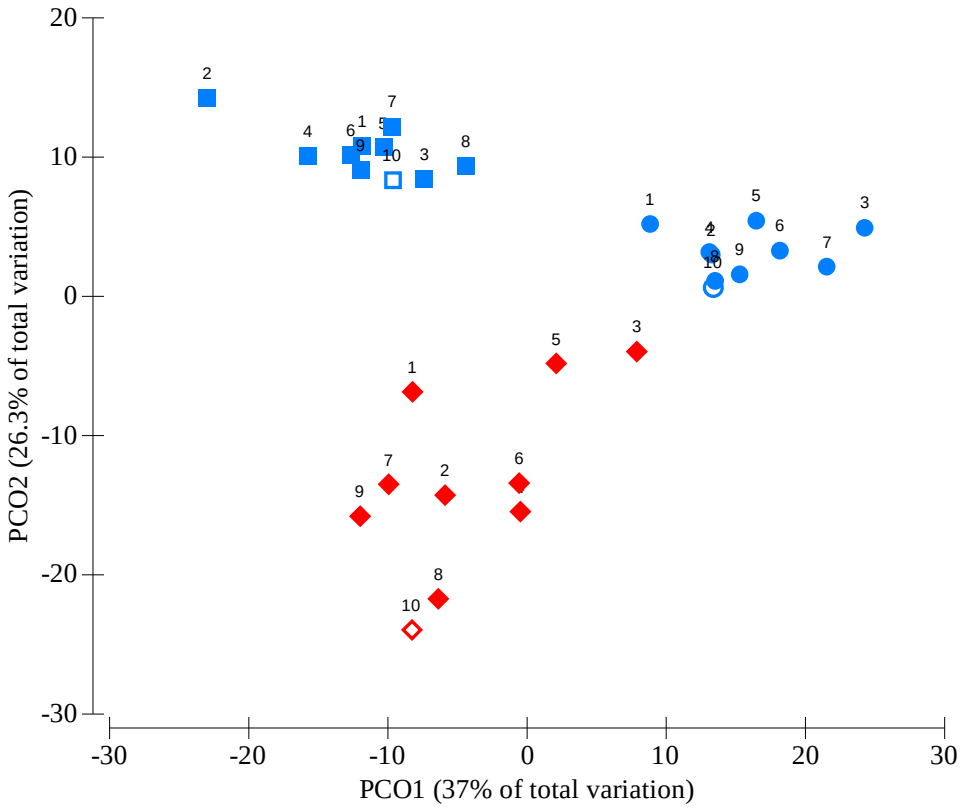


Chart 103 Principal Coordinates Analysis (PCoA) plots of macrophyte data (standardized) for small pools on Tributary C (red diamonds) and small control pools on Woronora River (blue squares) and O'Hare's Creek (blue circles) for each time of sampling (*n*= 9) from spring 2009 (T1). Filled symbols: 'Before' commencement of Longwall 23; Empty symbols: 'After' commencement of Longwall 23.

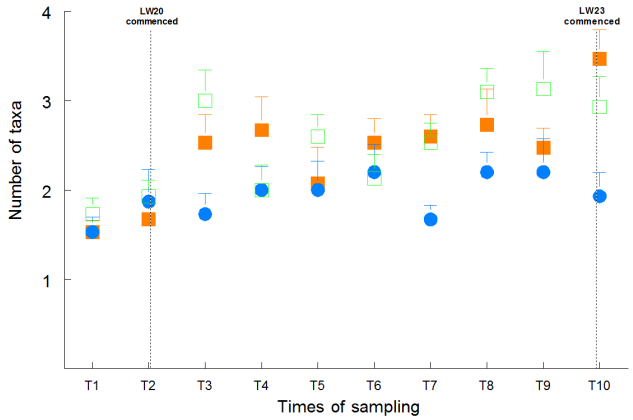


Chart 104a Mean (+SE) Macrophyte Diversity, Small Pool Monitoring

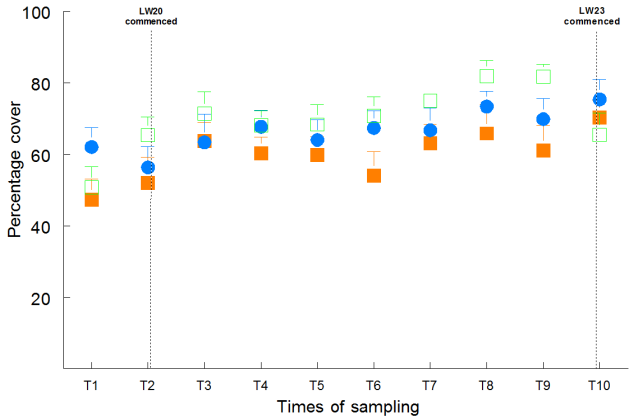


Chart 104b Mean (+SE) Macrophyte Abundance, Small Pool Monitoring

Key: Tributary C pools: solid orange squares and the control pools (Woronora River Pool: solid blue circles, O'Hares Creek Pool: open green circles). Sampling of Pools from spring 2009 (*n* = 15). Time 1 = spring 2009, T2 = autumn 2010, etc.

3.2.5 Amphibian Surveys

A monitoring program has been developed for Longwalls 23-27 to monitor amphibian species, with a focus on the habitats of the Giant Burrowing Frog (*Heleiporus australiiacus*) and Red-crowned Toadlet (*Pseudophryne australis*) associated with tributaries.

Five test sites overlying Longwalls 23-27 and five control sites are surveyed annually in spring/summer (i.e. October to February) during suitable weather conditions. The approximate locations of the sampling sites in relation to longwall panels are shown on Figure 14.

Each site is surveyed once during a standard one hour general area day search (early morning and late afternoon) supplemented by an evening 60 minute search/playback session using hand held spotlights and head lamps.

Species are assigned to the following relative abundance categories for tadpole and adult stages:

- 0 = no sightings;
- 1 = one sighting of adult or tadpole stage;
- UC = uncommon (i.e. 2 to 10 individuals), adult or tadpole stage;
- MC = moderately common (i.e. 11 to 20 individuals), adult or tadpole stage;
- C = common (i.e. 21 to 40 individuals), adult or tadpole stage; and
- A = abundant (>40 individuals), adult or tadpole stage.

Baseline monitoring was conducted in spring/summer 2010, 2011, 2012 and 2013. At the time of the spring/summer 2010 to 2013 surveys, the test sites had not yet been undermined (Longwall 23 commenced in May 2014).

The results of the four surveys to date (2010 - 2013) are summarised in the Metropolitan Coal Six Monthly Report, 1 January to 30 June 2014. The results of the spring/summer 2014 survey will be provided in the next Six Monthly Report.

3.3 ASSESSMENT OF ENVIRONMENTAL PERFORMANCE

3.3.1 Analysis against Performance Indicator 1 – Vegetation in Upland Swamps

Analysis against Performance Indicator 1

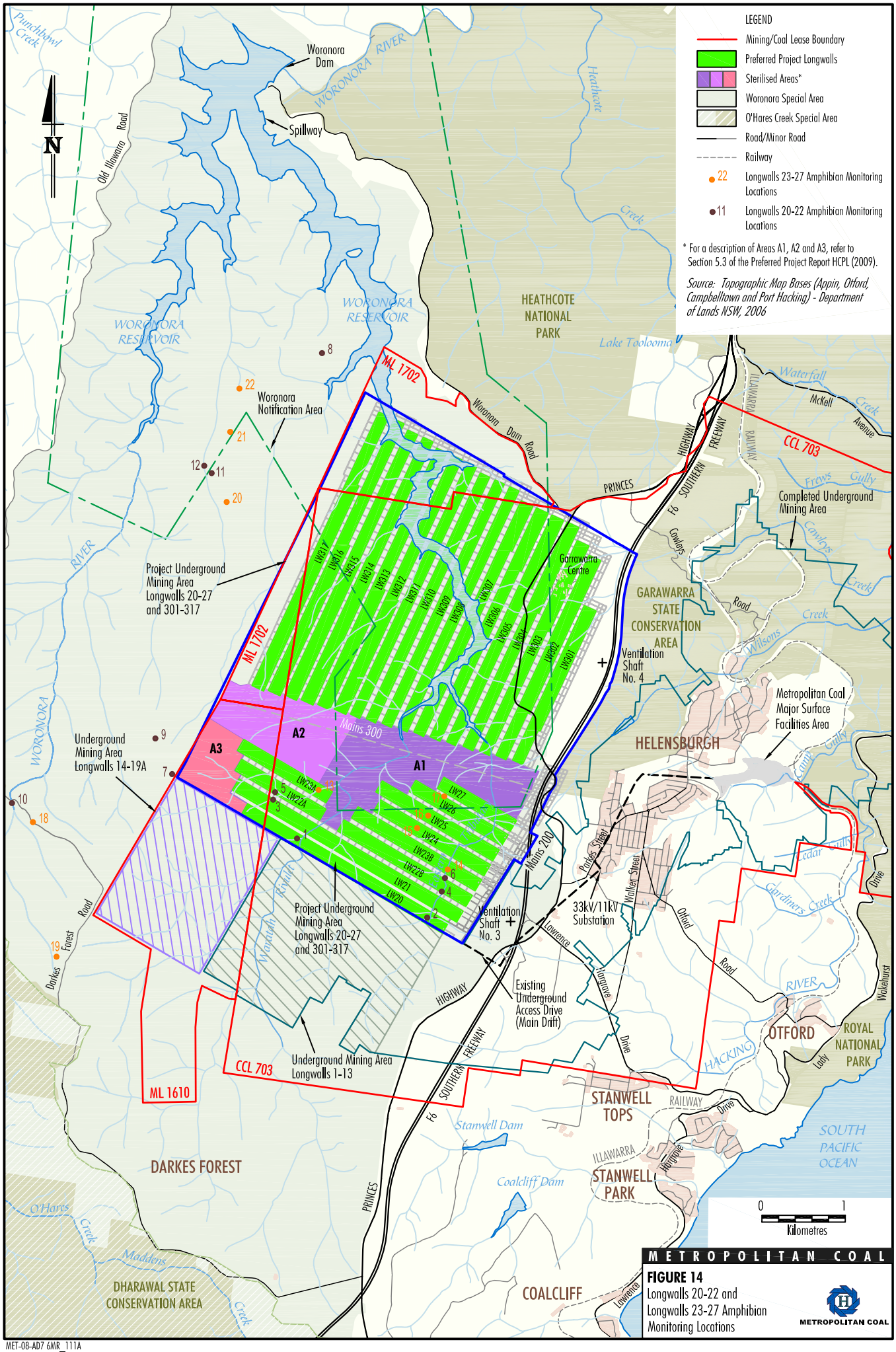
> **Performance Indicator 1:** *The vegetation in upland swamps is not expected to experience changes significantly different to vegetation in control swamps.*

This indicator is considered to have been exceeded if:

- data indicates a declining trend in the condition of swamp vegetation; or
- data analysis indicates statistically significant changes in vegetation between the mined and control swamps.

Detailed analysis of the above performance indicator is provided in Section 3.2.1. In summary:

- Visual inspections of upland swamp vegetation indicate that the upland swamp vegetation performance indicator has not been exceeded (i.e. the observations have not identified a declining trend in the condition of vegetation in swamps overlying Longwalls 23-27 that were not also observed in the control swamps).



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- Analysis of quadrat/transect data indicates that the upland swamp performance indicator '*The vegetation in upland swamps is not expected to experience changes significantly different to changes in control swamps'* has not been exceeded.
- Analysis of indicator species data indicates that the upland swamp performance indicator '*The vegetation in upland swamps is not expected to experience changes significantly different to changes in control swamps'* has not been exceeded.

3.3.2 Analysis against Performance Indicator 2 – Swamp Groundwater Levels in Upland Swamps

Analysis against Performance Indicator 2

Performance Indicator 2: *Surface cracking within upland swamps resulting from mine subsidence is not expected to result in measurable changes to swamp groundwater levels when compared to control swamps or seasonal variations in water levels experienced by upland swamps prior to mining.*

This indicator is considered to have been exceeded if data analysis indicates statistically significant changes in swamp substrate groundwater levels (i.e. if the seven day moving average data lie outside two standard deviations from the mean established for the full length of record [i.e. to 30 June 2014]).

The performance assessment for Swamp 28 is illustrated on Chart 105. The bandwidth for the Swamp 28 swamp substrate piezometer is about 0.9 m which is restrained by the recurrent dry episodes in 2013 and the first half of 2014. The water table in the substrate piezometer during the reporting period correlates well with the rainfall trends (Chart 79 in Section 3.2.2). During the reporting period, the water levels did not exceed the +2σ and -2σ limit, except a dry occasion in July 2014 where water levels touched the -2σ limit. A similar dry episode occurred during the baseline period and Charts 76 to 78 in Section 3.2.2 show that the three control swamps were also dry at this time. The face of Longwall 23B (started September 2014) passed Swamp 28 during October 2014. There is no indication of a mining effect at this time.

The bandwidth for the Swamp 30 substrate piezometer is 1.2 m (Chart 106). Despite the intermittent dry conditions over the reporting period, the minimum value of the seven day average of substrate water levels always remains higher (about 0.24 m) than the -2σ limit. Swamp water levels correlate well with the rainfall trends (Chart 80 in Section 3.2.2) and do not show any mining impact of Longwall 23B (about 450 m to the south-west). As all swamp substrate groundwater levels have remained within the bandwidth, there is no exceedance of the performance indicator for Swamp 30. However, as the standard deviation of the 1 m piezometer water levels is 0.30 m, all recorded levels (including the bottom of the hole) lie within the 2σ bandwidth. Technically, it is not possible for the -2σ trigger to be exceeded. As a result, the bandwidth is proposed to be redefined as 5%/95% exceedance levels so that a drying-out of the hole would be regarded as an exceedance of the performance indicator in the event a similar trend was not observed at the control swamp. Similar dry episodes occurred during the baseline period and Charts 76 to 78 in Section 3.2.2 show that the three control swamps were also mostly dry at these times. The dashed bandwidth in Chart 106 shows that the lower percentile coincides with the minimum recorded levels, presumably the bottom of the hole (which is 1.62 m below the surveyed collar level). Assessment using the 5th and 95th percentiles, and comparison with baseline period behaviour and control swamp behaviour, indicates that the performance indicator has not been exceeded.

The Swamp 33 performance assessment is illustrated on Chart 107. It has a bandwidth of 0.7 m and substrate water levels remain in the +2σ and -2σ limit over the reporting period. The water levels (piezometer 1m) maintain a steady position over the time with occasional wetting conditions occurring that match well with the rainfall.

The face of Longwall 23B (started September 2014) would have passed Swamp 33 during December 2014. There is no indication of a mining effect at this time. However, as the standard deviation of the 1 m piezometer water levels is 0.16 m, all recorded levels (including the bottom of the hole) lie within the 2σ bandwidth. Technically, it is not possible for the -2σ trigger to be exceeded. As a result, the bandwidth is proposed to be redefined as 5%/95% exceedance levels so that a drying-out of the hole would be regarded as an exceedance of the performance indicator in the event a similar trend was not observed at the control swamp. Similar dry episodes occurred during the baseline period and Charts 76 to 78 in Section 3.2.2 show that the three control swamps were also mostly dry at these times. The dashed bandwidth in Chart 107 shows that the lower percentile coincides with the minimum recorded levels, presumably the bottom of the hole (which is 1.31 m below the surveyed collar level). Assessment using the 5th and 95th percentiles, and comparison with baseline period behaviour and control swamp behaviour, indicates that the performance indicator has not been exceeded.

The performance assessment for Swamp 35 is illustrated on Chart 108. The bandwidth limit is 1 m. In January 2014, during a dry time, there was a minor excursion of the substrate water level beyond the -2σ limit. A similar dry episode occurred during the baseline period and Charts 76 to 78 in Section 3.2.2 show that the three control swamps were dry also at this time. After that the swamp maintained waterlogged conditions except in mid-July 2014 and at the end of November 2014 when water levels dropped a little in response to lack of rain. As with other swamps overlying Longwalls 23-27, it also correlated with the rainfall trend (Chart 82 in Section 3.2.2). This monitoring site is about 600 m from Longwall 23B.

In summary, the performance indicator for upland swamp groundwater levels has not been exceeded for Swamps 28, 30, 33 or 35. While data analysis indicates statistically significant changes in swamp substrate groundwater levels have occurred, analysis of seasonal variations in water levels experienced in the baseline period, and at the control swamps, indicates that the excursions are not mining effects.

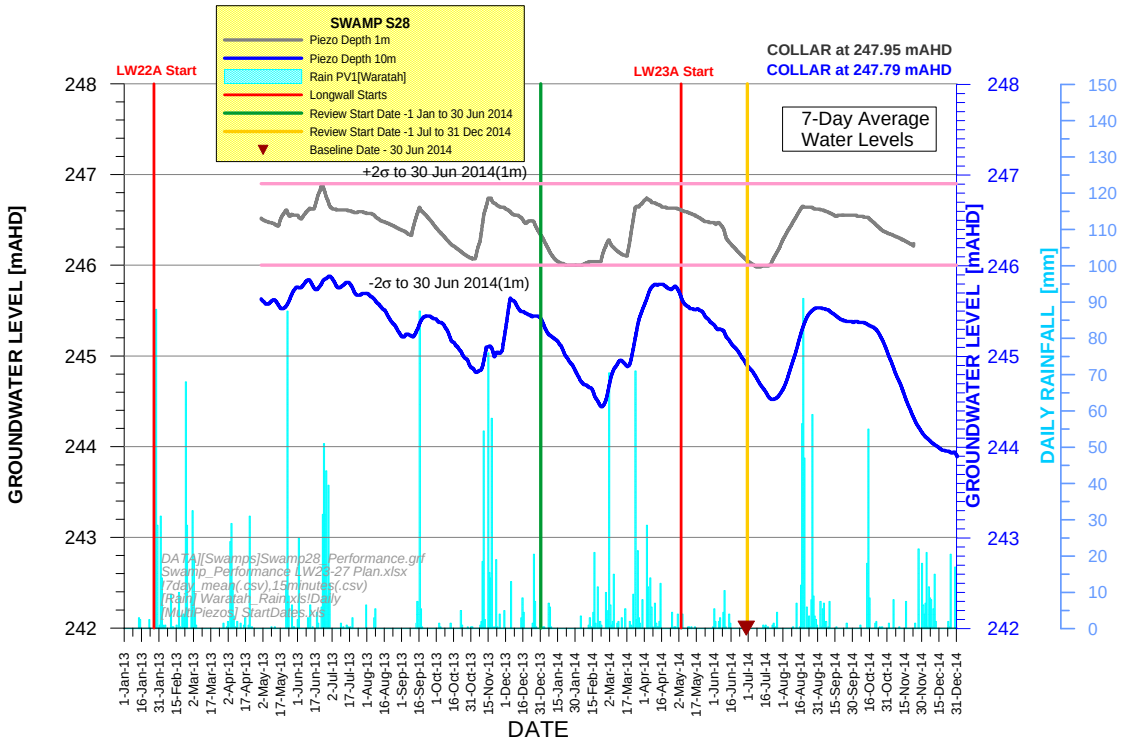

Chart 105 Performance Assessment of Groundwater Hydrograph at Swamp 28

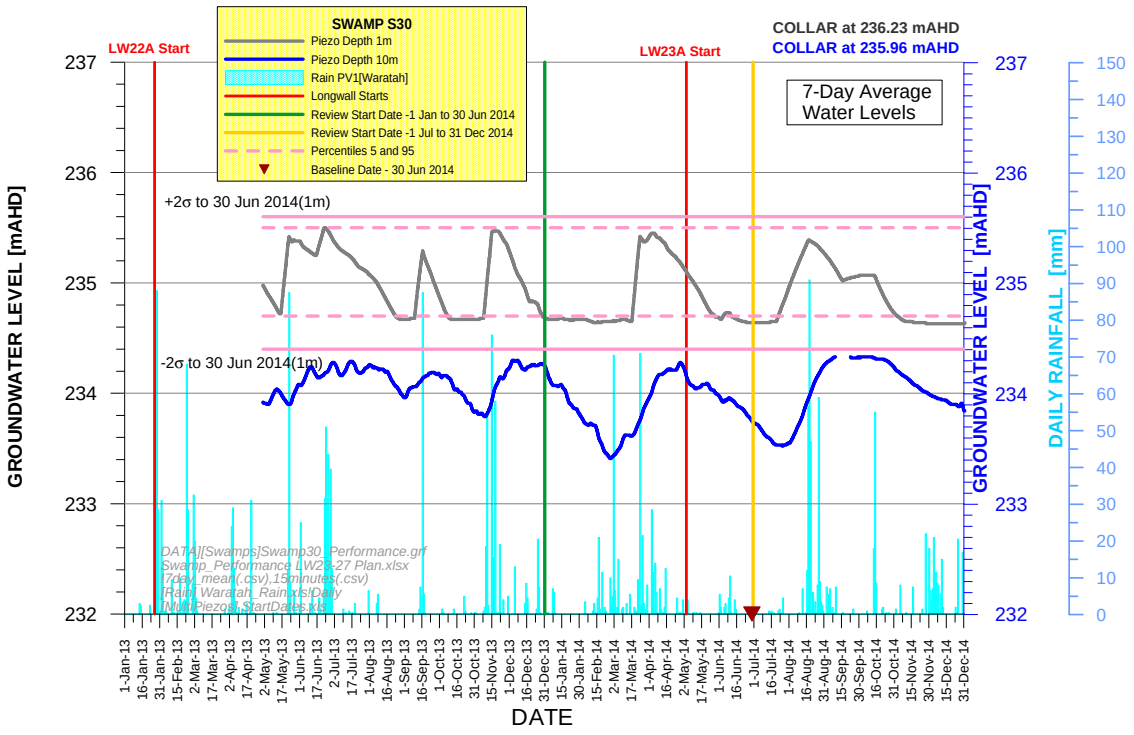

Chart 106 Performance Assessment of Groundwater Hydrograph at Swamp 30

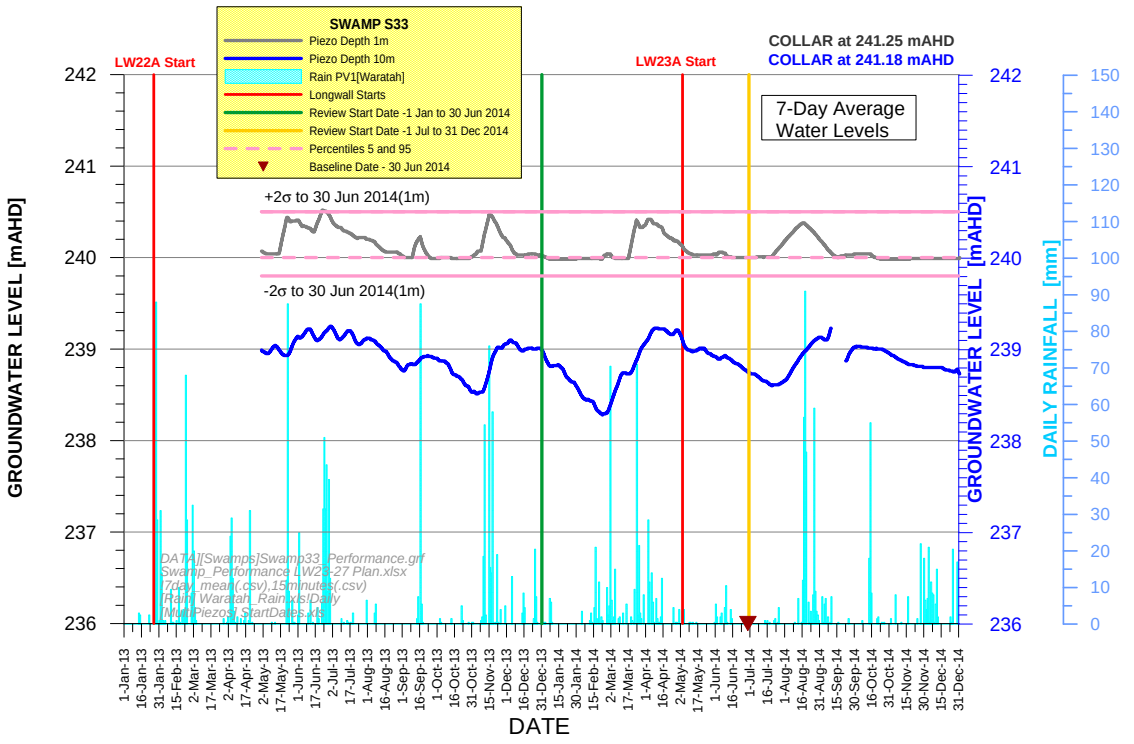

Chart 107 Performance Assessment of Groundwater Hydrograph at Swamp 33

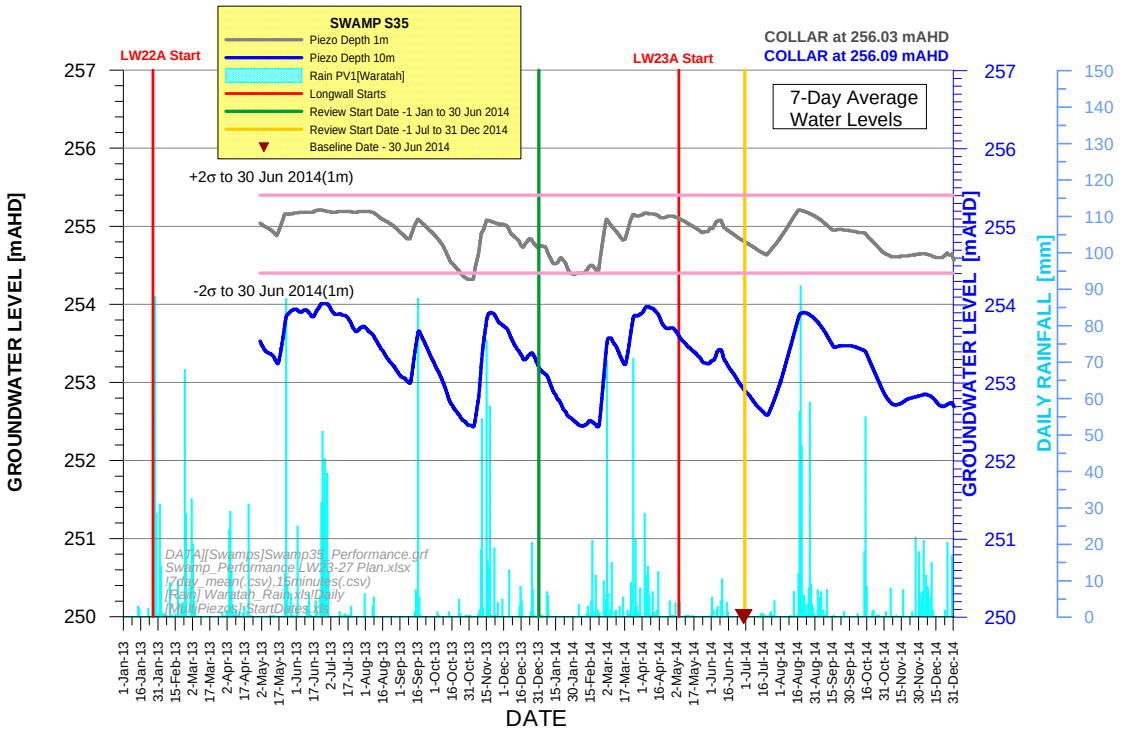

Chart 108 Performance Assessment of Groundwater Hydrograph at Swamp 35

3.3.3 Analysis against Performance Indicator 3 – Riparian Vegetation

Analysis against Performance Indicator 3

Performance Indicator 3: *Impacts to riparian vegetation are expected to be localised and limited in extent, similar to the impacts previously experienced at the Metropolitan Coal.*

This indicator is considered to have been exceeded if:

- visual inspections identify vegetation dieback greater than 50 cm from the stream; or
- data analysis indicates the riparian vegetation has not recovered after one year of the completion of stream remediation on Waratah Rivulet.

Section 3.2.3 indicates that visual inspections of riparian vegetation identified vegetation dieback greater than 50 cm from the Waratah Rivulet at site MRIP02 (overlying Longwalls 20-22) in the spring 2013 vegetation survey (prior to the commencement of Longwall 23) (as reported in the Metropolitan Coal Six Monthly Report, 1 January to 30 June 2014) and autumn 2014. During the autumn 2014 survey, riparian vegetation dieback greater than 50 cm from the Eastern Tributary was also identified between sites MRIP09 and MRIP05 on the Eastern Tributary. As a result the performance indicator has been exceeded.

In accordance with the Metropolitan Coal Longwalls 23-27 Biodiversity Management Plan, Dr. Colin Bower (FloraSearch) and Dr. David Goldney (Cenwest Environmental Services) were commissioned by Metropolitan Coal to undertake an assessment against the subsidence impact performance measure, *Negligible impact on threatened species and populations,* and the results of the assessment are summarised below.

No endangered flora or fauna populations listed under the NSW TSC Act are known to occur within 600 m of Longwalls 20-22 and Longwalls 23-27 secondary extraction or in the surrounding area. As a result, the performance measure, *Negligible Impact on threatened populations,* has not been exceeded.

In relation to threatened species, a number of threatened flora and fauna species listed under the NSW TSC Act or Commonwealth EPBC Act are known to occur, or have the potential to occur within 600 m of Longwalls 20-22 and Longwalls 23-27 secondary extraction or in the surrounding area.

Consistent with the Metropolitan Coal Longwalls 23-27 Biodiversity Management Plan, the key assessment considerations taken into account to assess whether there has been a greater than negligible impact on threatened species are:

1. *What is the nature of the environmental consequence (e.g. the potential for adverse impacts on upland swamps, riparian vegetation, slopes and ridgetops or aquatic habitats)?*
2. *What are the potential factors that may have contributed to the environmental consequence (e.g. the degree of subsidence effects, ineffective management measures or prevailing climatic conditions)?*
3. *Which threatened species have the potential to be impacted?*
4. *What are the potential impacts on the lifecycle of the potential threatened species (e.g. foraging, breeding/reproduction, nesting, shelter and movement/dispersal)?*
5. *What are the potential impacts on the habitat of the potential threatened species (e.g. area affected)?*
6. *Has the habitat connectivity of the threatened species been affected (e.g. loss of stream pool habitat connectivity)?*
7. *What actions, if any, are most appropriate to mitigate the impacts and/or to minimise future impacts?*

Threatened Flora

Six threatened flora species listed under the NSW TSC Act were recorded in the baseline flora survey for the Project EA (Helensburgh Coal, 2008), namely, *Acacia bynoeana* (Bynoe's Wattle), *Astrotricha crassifolia* (Thick-leaf Star-hair), *Epacris purpurascens* var*. purpurascens, Leucopogon exolasius, Melaleuca deanei* (Deane's Paperbark) and *Pultenaea aristata* (Prickly Bush-pea). An additional threatened flora species, *Acacia baueri* subsp. *aspera*, was subsequently identified in the underground mining area by Eco Logical Australia.

Three of these, the Thick-leaf Star-hair, the Prickly Bush-pea and *Leucopogon exolasius*, have potential to occur in riparian vegetation. The Prickly Bush-pea is a widespread and common species in the Metropolitan Coal underground mining area and surrounds (Helensburgh Coal, 2008). The Thick-leaf Star-hair most often occurs on lower slopes above water courses and is uncommon in the underground mining area. *Leucopogon exolasius* generally occurs on broad flood-prone parts of watercourses on the lowest slopes or in sparsely vegetated sand deposits. None of these species has been recorded on riparian monitoring sites on the Waratah Rivulet or Eastern Tributary, or within the areas affected by dieback which are regularly traversed as part of the flora monitoring program.

Previous threatened flora species assessment, for exceedances of the riparian vegetation performance indicator at site MRIP02 on the Waratah Rivulet, since spring 2012 was conducted by FloraSearch in January 2014.

Dr. Colin Bower (FloraSearch) inspected riparian vegetation of Waratah Rivulet and Eastern Tributary on 30 September 2014. Despite extensive survey and observation by qualified personnel, no threatened flora species are known to occur in the area of affected vegetation.

Increased ponding at site MRIP02 on the Waratah Rivulet and at sites MRIP05 and MRIP09 on the Eastern Tributary from subsidence has resulted in prolonged inundation of streamside vegetation causing death of terrestrial shrubs and ground cover species. No evidence of decline in the health of any threatened species was observed. Since the Thick-leaf Star-hair, Prickly Bush-pea and *Leucopogon exolasius* are not known to occur in the area impacted, no impacts on the species are expected. Habitat connectivity for the Thick-leaf Star-hair, the Prickly Bush-pea and *Leucopogon exolasius* has not been affected and is unlikely to be affected. The area affected is limited, narrow and unlikely to restrict the movements of propagules of these plants or their pollinators. The affected area is surrounded by potential habitat for the three species such that habitat connectivity would not be significantly reduced.

The assessment by Dr. Colin Bower concluded that the impact performance measure, *Negligible Impact on threatened species and populations,* had not been exceeded for threatened flora species.

Threatened Fauna

Thirteen threatened fauna species were recorded within the underground mining area and surrounds including two frog, one reptile, five bird and five mammal species during baseline surveys conducted for the Project EA (Helensburgh Coal, 2008). Of these, only two species are considered likely to potentially be present in riparian zone habitat, namely, the Red-crowned Toadlet (*Pseudophryne australis*) and the Giant Burrowing Frog (*Heleiporus australiacus*).

The Red-crowned Toadlet mainly occupies the upper parts of ridges, usually being restricted to within about 100 m of the ridgetop. Favoured microhabitats for shelter sites are under flat sandstone rocks ('bush-rock') either resting on bare rock or damp loamy soils. Red-crowned Toadlets have also been found under logs on soil, and beneath thick ground litter. Red-crowned Toadlets do not usually live along permanent flowing water courses occurring in gullies, instead preferring permanently moist soaks or areas of dense ground vegetation or litter along or near headwater stream beds. The main vegetation communities found in association with this species are open woodland and heath communities that are typical for Hawkesbury and Narabeen geology. The Project area and/or surrounds is considered to contain high quality habitat for the Red-crowned Toadlet.

The Red-crowned Toadlet is a relatively long-lived species (8-10 years) and is able to withstand prolonged periods of drought through its nocturnal, semi-fossorial lifestyle and use of moist microhabitat refugia. The Red-crowned Toadlet has a unique terrestrial reproductive strategy: small nests are formed within decomposing accumulated leaf matter and clutch sizes are small, consisting of around 20-24 large eggs. The nests retain the eggs through the early stages of tadpole development; then rainfall events flush the embryos from the nest, and tadpoles complete development within transient pools. The timing of follow up rain events and duration of temporary pools is critical to reproductive success and therefore recruitment is usually in low numbers. Egg hatching times vary between 15-120 days. Larval development can vary from 31-180 days depending on environmental conditions.

The northern populations of the Giant Burrowing Frog are largely confined to sandstone ridgetop habitat and broader upland valleys, where the species is associated with small headwater creek lines and slow flowing to intermittent creek lines in undisturbed areas. The vegetation in these areas is typically woodland, open woodland and heath, with riparian components in and along the sides of early order streams. The species may also utilise upland swamps as a component of the range of habitats it is able to exploit. Much of the Giant Burrowing Frog's existence is spent burrowed underground sometimes beneath deep leaf-litter or in earth-filled rock crevices interspersed with brief periods of activity throughout the year during rainy weather. Adults usually mate in a burrow adjacent to a stream relying on subsequent rainfall events to wash the eggs into a pool or small stream.

Previous threatened fauna species assessment, for exceedances of the riparian vegetation performance indicator at site MRIP02 since spring 2012, was conducted by Cenwest Environmental Services in January 2014.

Dr. David Goldney (Cenwest Environmental Services) inspected riparian vegetation of Waratah Rivulet and Eastern Tributary on 30 September 2014. Death and/or senescence of riparian plants has been observed at site MRIP02 on the Waratah Rivulet and at sites MRIP05 and MRIP09 on the Eastern Tributary due to increased ponding resulting in prolonged inundation of the riparian vegetation as a result of subsidence. If present in the riparian zone, the Red-crowned Toadlet and Giant Burrowing Frog would likely be in very low numbers and in what is effectively marginal habitat for both species. The potential impacts on the lifecycle of the two threatened species are likely to be negligible to non-existent.

The assessment by Dr. David Goldney concluded that the subsidence impact performance measure, *Negligible Impact on threatened species and populations,* has not been exceeded for threatened fauna species.

3.3.4 Analysis against Performance Indicator 4 – Southern Sydney Sheltered Forest on Transitional Sandstone Soils in the Sydney Basin Bioregion EEC

Analysis against Performance Indicator 4

Performance Indicator 4: *Subsidence effects at the occurrences of the Southern Sydney Sheltered Forest on Transitional Sandstone Soils in the Sydney Basin Bioregion EEC situated approximately 300 to 500 m to the east of Longwalls 23-27 are expected to be negligible.*

This indicator is considered to have been exceeded if the assessment of subsidence parameters indicates the subsidence effects at the occurrences of the Southern Sydney Sheltered Forest on Transitional Sandstone Soils in the Sydney Basin Bioregion EEC situated to the east of Longwalls 23-27 are an order of magnitude above those predicted.

Subsidence effects in the area to the east of Longwalls 23-27 at the occurrences of the Southern Sydney Sheltered Forest on Transitional Sandstone Soils in the Sydney Basin Bioregion EEC are within subsidence predictions. The performance indicator has not been exceeded.

3.3.5 Analysis against Performance Indicator 5 – Aquatic Macroinvertebrate and Macrophyte Assemblages

Analysis against Performance Indicator 5

Performance Indicator 5: *The aquatic macroinvertebrate and macrophyte assemblages in streams and pools are not expected to experience long-term impacts as a result of mine subsidence.*

This indicator will be considered to have been exceeded if data analysis indicates significant changes in relation to reference places before (i.e. pre-mining) to after (i.e. post-mining) mining of Longwalls 23-27:

- occur in the aquatic macroinvertebrate and macrophyte assemblages in streams at Locations C1, C4 and B2 after the completion of Longwall 303; and
- occur in the aquatic macroinvertebrate and macrophyte assemblages at Pools ETAG, ETAH, ETAI and ETAK after one year of the completion of stream remediation on Tributary C/Eastern Tributary.

This performance indicator will be assessed and reported on in future Six Monthly Reports or Annual Reviews and AEMR/Rehabilitation Reports, subsequent to monitoring conducted after the completion of Longwall 303 and one year after the completion of stream remediation on Eastern Tributary.

3.3.6 Analysis against Performance Indicator 6 – Amphibian Assemblage

Analysis against Performance Indicator 6

Performance Indicator 6: *The amphibian assemblage is not expected to experience changes significantly different to the amphibian assemblage at control sites.*

This indicator is considered to have been exceeded if data analysis identifies a significant decline in the amphibian population.

The test sites had not been undermined at the time of the 2010 to 2013 spring/summer surveys (Longwall 23 commenced in May 2014). The amphibian species diversity and abundance data are consistent with population variations and cycles in response to seasonal variations.

The performance indicator will be assessed using the 2014 spring/summer survey results in the Six Monthly Report for the period 1 January to 30 June 2015.

3.3.7 Subsidence Impact Performance Measures included in the Land Management Plan and Water Management Plan

Subsidence impact performance measures of relevance to the Metropolitan Coal Longwalls 23-27 Biodiversity Management Plan are also contained in the Metropolitan Coal Longwalls 23-27 Land Management Plan and Metropolitan Coal Longwalls 23-27 Water Management Plan. In the event the subsidence impacts observed exceed the land subsidence impact performance measure or an applicable water resource/water course subsidence impact performance measure, Metropolitan Coal will conduct a review of potential impacts on flora, fauna, and their habitats in accordance with the Metropolitan Coal Longwalls 23-27 Biodiversity Management Plan.

Subsidence impact performance measures of relevance to the Metropolitan Coal Longwalls 23-27 Biodiversity Management Plan are outlined in Table 4. None of the subsidence impact performance measures of relevance to the Metropolitan Coal Longwalls 23-27 Biodiversity Management Plan have been exceeded during the reporting period.

Table 4
Other Subsidence Impact Performance Measures of Relevance to the Longwalls 23-27 Biodiversity Management Plan

Water Resources	
Catchment yield to the Woronora Reservoir	*Negligible reduction to the quality or quantity of water resources reaching the Woronora Reservoir* *No connective cracking between the surface and the mine*
Woronora Reservoir	*Negligible leakage from the Woronora Reservoir* *Negligible reduction in the water quality of Woronora Reservoir*
Watercourses	
Waratah Rivulet between the full supply level of the Woronora Reservoir and the maingate of Longwall 23 (upstream of Pool P)	*Negligible environmental consequences (that is, no diversion of flows, no change in the natural drainage behaviour of pools, minimal iron staining, and minimal gas releases)*
Eastern Tributary between the full supply level of the Woronora Reservoir and the maingate of Longwall 26	*Negligible environmental consequences over at least 70% of the stream length (that is no diversion of flows, no change in the natural drainage behaviour of pools, minimal iron staining and minimal gas releases)*
Land	
Cliffs	*Less than 3% of the total length of cliffs (and associated overhangs) within the mining area experience mining induced rock fall*

3.3.8 Swamps 76, 77 and 92

Subsidence Impact Performance Measure:

Swamps 76, 77 and 92 - Set through condition 4

Metropolitan Coal is not permitted to undermine Swamps 76, 77 and 92 without the written approval of the Director-General. Swamps 76, 77 and 92 will not be undermined by Longwalls 23-27.

Swamps 76, 77 and 92 will be subject to assessment in future Extraction Plan(s) and future Biodiversity Management Plans.

3.4 TARP CHARACTERISATION

The TARP characterisation for Longwalls 23-27 biodiversity management during the reporting period is provided in Table 5.

In summary, one performance indicator was exceeded: *Impacts to riparian vegetation are expected to be localised and limited in extent, similar to the impacts previously experienced at the Metropolitan Colliery* (as described in Section 3.3.3).

Exceedance of the performance indicator triggered an assessment against the performance measure. The performance measure was not exceeded during the reporting period.

Table 5
TARP Characterisation – Longwalls 23-27 Biodiversity Management

Monitoring Components	Subsidence Impact Performance Indicator(s)	Subsidence Impact Performance Indicator Exceeded?	Resulting Actions	Subsidence Impact Performance Measure	Subsidence Impact Performance Measure Exceeded?
Upland Swamps Vegetation Monitoring (Section 3.2.1)	*The vegetation in upland swamps is not expected to experience changes significantly different to vegetation in control swamps* (Section 3.3.1)	No	Continue monitoring	*Negligible impact on threatened species and populations*	No
Upland Swamps Groundwater Monitoring (Section 3.2.2)	*Surface cracking within upland swamps resulting from mine subsidence is not expected to result in measurable changes to swamp groundwater levels when compared to seasonal variations in water levels experienced by upland swamps prior to mining or control swamps* (Section 3.3.2)	No	Continue monitoring		No
Riparian Vegetation (Section 3.2.3)	*Impacts to riparian vegetation are expected to be localised and limited in extent, similar to the impacts previously experienced at Metropolitan Coal* (Section 3.3.3)	Yes – performance indicator exceeded at site MRIP02 on the Waratah Rivulet (overlying Longwalls 20-22) and between sites MRIP09 and MRIP05 on the Eastern Tributary	Assessment against the performance measure conducted by FloraSearch (flora) and Cenwest Environmental Services (fauna) and included in Section 3.3.3 Continue monitoring		No
Southern Sydney Sheltered Forest on Transitional Sandstone Soils in the Sydney Basin Bioregion EEC (Section 3.3.4)	*Subsidence effects at the occurrences of the Southern Sydney Sheltered Forest on Transitional Sandstone Soils in the Sydney Basin Bioregion EEC situated approximately 300 to 500 m to the east of Longwalls 23-27 are expected to be negligible* (Section 3.3.4)	No	Continue monitoring		No
Aquatic Biota (Section 3.2.4)	*The aquatic macroinvertebrate and macrophyte assemblages in streams and pools are not expected to experience long-term impacts as a result of mine subsidence* (Section 3.3.5)	No[1]	Continue monitoring		No
Amphibian Monitoring (Section 3.2.5)	*The amphibian assemblage is not expected to experience changes significantly different to the amphibian assemblage at control sites* (Section 3.3.6)	No	Continue monitoring		No

[1] Note the performance indicator will be assessed after the completion of Longwall 303 and one year after the completion of stream remediation on Eastern Tributary.

4 LAND MANAGEMENT

4.1 BACKGROUND

The Metropolitan Coal Longwalls 23-27 Land Management Plan (Metropolitan Coal, 2014d) was prepared to manage the potential environmental consequences of the Metropolitan Coal Longwalls 23-27 Extraction Plan on cliffs, overhangs, steep slopes and land in general, in accordance with Condition 6, Schedule 3 of the Project Approval.

4.2 MONITORING

4.2.1 Steep Slopes and Land in General

Opportunistic visual inspections for subsidence impacts on steep slopes and land in general are conducted by Metropolitan Coal and its contractors as part of routine works conducted in the catchment. Specific details that are noted and/or photographed during the inspections include:

- the location, approximate dimensions (length, width and depth), and orientation of surface tension cracks;
- the location of the surface tension crack in relation to fire trails;
- the location and approximate dimensions of rock falls (e.g. rock ledges that occur along the Waratah Rivulet and the Eastern Tributary);
- whether any actions are required (for example – implementation of management measures, initiation of the Contingency Plan, incident notification, implementation of appropriate safety controls, review of public safety etc.); and
- any other relevant information.

The date of the observation, details of the observer and the location of longwall extraction are also documented.

No surface tension cracks or rock falls were observed within 600 m of Longwalls 23-27 secondary extraction during the reporting period.

4.2.2 Cliffs and Overhangs

Visual inspections are conducted monthly for the period of time that longwall extraction takes place within 400 m of sites COH2, COH3, COH4, CHO5, COH6, COH6A, COH7, COH8, COH9, COH10, COH14, COH15 and COH16 (Figure 15) and following the completion of each longwall to record evidence of potential subsidence impacts. Specific details that are noted and/or photographed during the inspections include:

- the date of the inspection;
- the location of longwall extraction (i.e. the longwall chainage);
- the location of the cliff instability (i.e. freshly exposed rock face and debris scattered around the base of the cliff or overhang) relative to the cliff face or overhang;
- the nature and extent of the cliff instability (including an estimate of volume);
- the length of the cliff instability;
- other relevant aspects such as water seepage (which can indicate weaknesses in the rock);

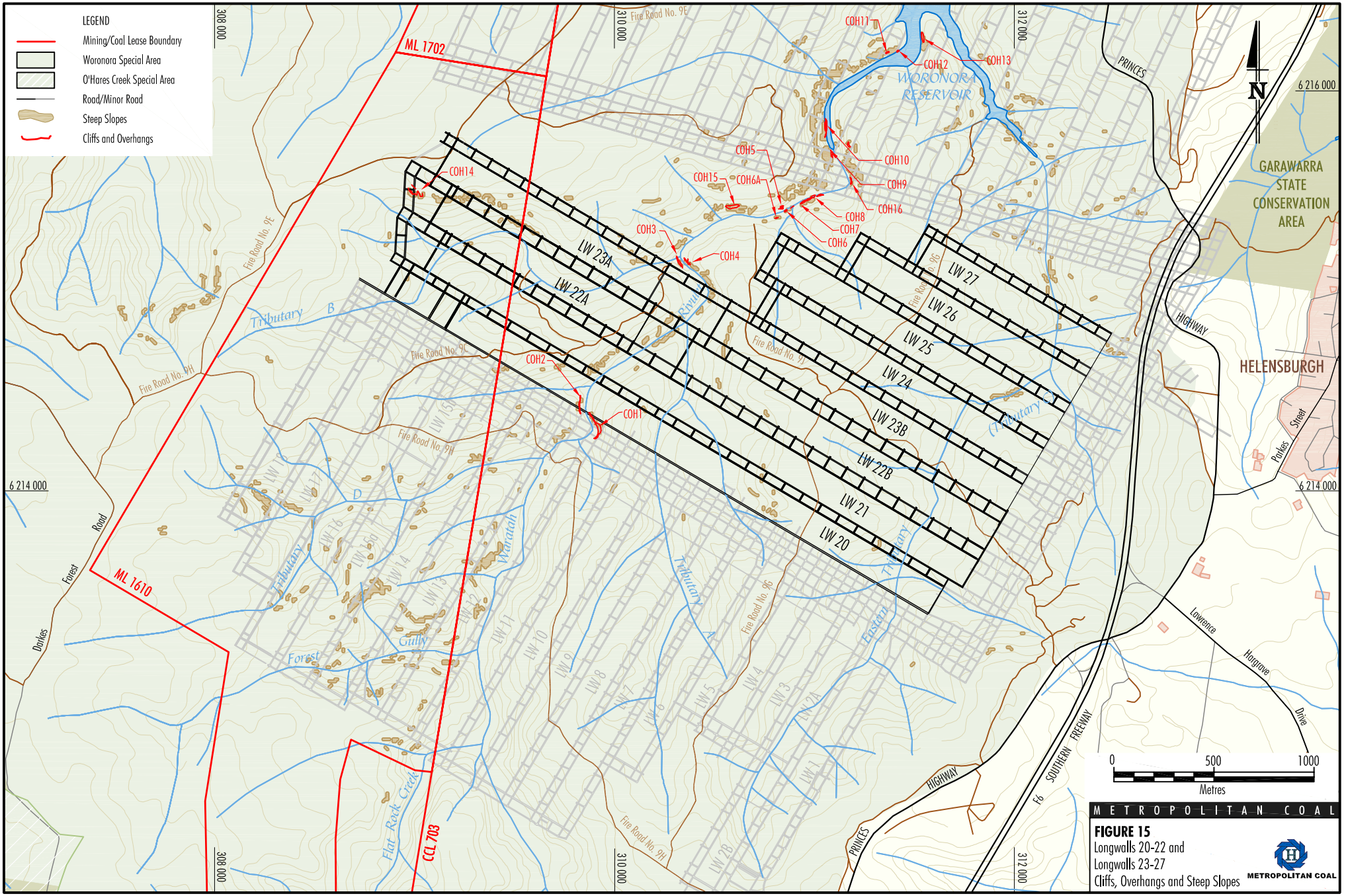

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FIGURE 15
Longwalls 20-22 and
Longwalls 23-27
Cliffs, Overhangs and Steep Slopes

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- whether any actions are required (for example – implementation of management measures, initiation of the Contingency Plan, incident notification, implementation of appropriate safety controls, review of public safety etc); and
- any other relevant information.

Longwall 23 did not advance to within 400 m of sites COH2, CHO5, COH6, COH6A, COH7, COH8, COH9, COH10, COH14, COH15 and COH16 during the reporting period. Notwithstanding, Metropolitan Coal conducted opportunistic visual inspections of sites COH5, COH6 and COH15 in August, September and October 2014 and of sites COH7 and COH8 in August 2014.

Visual inspections of sites COH3 and COH4 were conducted in August, September and October 2014 when Longwall 23 extraction was within 400 m of these sites.

No cliff instabilities (i.e. freshly exposed rock face and debris scattered around the base of the cliff or overhang) or areas of water seepage in excess of that expected to result from rainfall conditions, to those reported previously for site COH2 (in the Metropolitan Coal 2013 Annual Review/AEMR), were evident at any of the sites.

4.3 ASSESSMENT OF ENVIRONMENTAL PERFORMANCE

The performance indicator and subsidence impact performance measure described below have been developed to address the predictions of subsidence impacts and environmental consequences on land included in the Project EA, PPR and Metropolitan Coal Longwalls 23-27 Extraction Plan.

4.3.1 Steep Slopes and Land in General

Analysis against Performance Indicator

Performance Indicator: *Steep slopes and land in general are expected to experience surface tension cracking no greater than 0.1 m wide and 25 m in length.*

The subsidence impact assessment in the Metropolitan Coal 23-27 Land Management Plan indicates that the size and extent of surface cracking at the steep slopes is expected to be similar to that observed during the extraction of previous longwalls at the Colliery (i.e. where surface cracking up to approximately 25 m long and 0.1 m wide has been observed).

As described in Section 4.2.1, no surface tension cracks, were observed within 600 m of Longwalls 23-27 secondary extraction during the reporting period.

The performance indicator was not exceeded during the reporting period.

4.3.2 Cliffs and Overhangs

Analysis against Subsidence Impact Performance Measure

Subsidence Impact Performance Measure:

Less than 3% of the total length of cliffs (and associated overhangs) within the mining area experience mining-induced rock fall.

The Metropolitan Coal Longwalls 23-27 Land Management Plan indicates the approximate overall length of cliffs and overhangs within the mining area (Table 6). The mining area is defined by the Project Approval and is shown on Figure 2 of this report (labelled Project Underground Mining Area Longwalls 20-27 and 301-317).

Table 6
Length of Cliffs and Overhangs within the Mining Area

Site	Approximate Overall Length (m)
COH1	143
COH2	95
COH3	55
COH4	19
COH5	35
COH6	35
COH6A	10
COH7	50
COH8	40
COH9	30
COH10	50
COH11	35
COH12	40
COH13	50
COH14	45
COH15	20
COH16	30
Total Length	772

Table 6 indicates the total length of cliffs and associated overhangs within the mining area is approximately 772 m. The total length of cliffs and associated overhangs within the mining area to experience cliff instability (i.e. the exposure of a fresh face of rock and debris scattered around the base of the cliff or overhang) is to be less than 23 m.

The Metropolitan Coal 2013 Annual Review/AEMR reported a small rock fall (approximately 1.5 m long, 0.5 m wide and approximately 0.5 m^3) at site COH2. No other rock falls at the cliff or overhang sites have been recorded.

The subsidence impact performance measure has not been exceeded.

4.4 TARP CHARACTERISATION

The TARP characterisation for Longwalls 23-27 land management during the reporting period is provided in Table 7. In summary, neither the performance indicator nor the performance measure were exceeded during the reporting period.

Table 7
TARP Characterisation – Longwalls 23-27 Land Management

Monitoring Components	Subsidence Impact Performance Indicator	Subsidence Impact Performance Indicator Exceeded?	Resulting Actions	Subsidence Impact Performance Measure	Subsidence Impact Performance Measure Exceeded?
Steep Slopes and Land in General	*Steep slopes and land in general are expected to experience surface tension cracking no greater than 0.1 m wide and 25 m in length.*	No	No management measures required. Continue monitoring.	-	-
Cliffs and Overhangs	-	-	-	*Less than 3% of the total length of cliffs (and associated overhangs) within the mining area experience mining-induced rock fall.*	No

5 HERITAGE MANAGEMENT

5.1 BACKGROUND

The Metropolitan Coal Longwalls 23-27 Heritage Management Plan (Metropolitan Coal, 2014e) was prepared to manage the potential environmental consequences of the Metropolitan Coal Longwalls 23-27 Extraction Plan on Aboriginal heritage sites or values in accordance with Condition 6, Schedule 3 of the Project Approval.

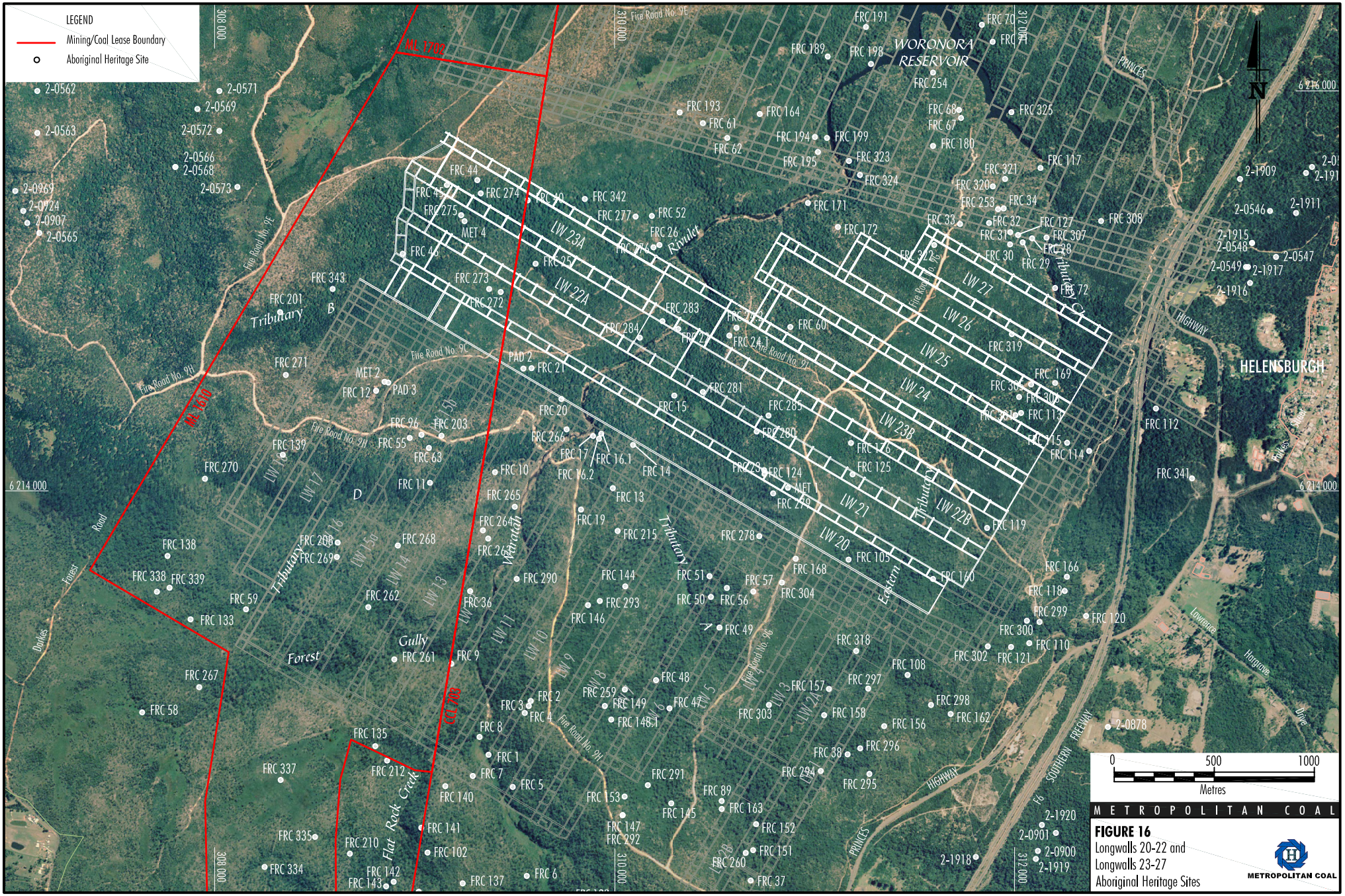
5.2 MONITORING

A monitoring program has been established to monitor the impacts and consequences of Project related subsidence on Aboriginal heritage sites located within the 35º Angle of Draw of Longwalls 23-27 (Figure 16) and any sites at which the Longwalls 23-27 Heritage Management Plan monitoring program indicates change due to mining induced subsidence.

The first round of monitoring for Longwalls 23-27 (Round 1) will include all Aboriginal heritage sites located within the 35º Angle of Draw for Longwalls 22 and 23 (i.e. Longwalls 23A and 23B) and any sites at which the Metropolitan Coal Longwalls 20-22 Heritage Management Plan monitoring program indicates continued change due to mining induced subsidence. Round 1 will be undertaken between three to six months following the completion of Longwall 23B (anticipated to occur in April 2015).

Specific details that will be recorded during the monitoring program include:

- the date of monitoring;
- the location of longwall extraction (i.e. the longwall chainage) at the time of monitoring;
- comparison of the physical characteristics of the site at the time of monitoring against the previous monitoring and the baseline record (detail/quantify any changes observed);
- inspections of rock surfaces for cracking and/or exfoliation and/or blockfall since the previous monitoring and against the baseline record;



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- inspection of art motifs for damage or deterioration since the previous monitoring and against the baseline record;
- identification of any natural deterioration processes (e.g. fire, vegetation growth and water seepage);
- detailed description and quantification of any changes noted during the completion of the above tasks;
- a photographic record of any changes noted during monitoring (taken at the same position and distance as baseline record to allow comparison over time);
- whether any follow-up actions are required to be considered (e.g. implementation of management or initiation of the Contingency Plan, etc.); and
- any other relevant information.

5.3 ASSESSMENT OF ENVIRONMENTAL PERFORMANCE

The subsidence impact performance measure has been developed to address the predictions of subsidence impacts and environmental consequences on Aboriginal heritage included in the Project EA, PPR and Metropolitan Coal Longwalls 23-27 Extraction Plan.

The Longwalls 23-27 Aboriginal heritage monitoring results will be used to assess the Project against the Aboriginal heritage subsidence impact performance measure:

> *Less than 10% of Aboriginal heritage sites within the mining area are affected by subsidence impacts.*

The first round of Longwalls 23-27 Aboriginal heritage monitoring (i.e. Round 1) will be conducted between three to six months following the completion of Longwall 23B (anticipated to occur in April 2015).

5.4 TARP CHARACTERISATION

The TARP characterisation for Longwalls 23-27 Aboriginal heritage management during the reporting period is provided in Table 8. The performance measure will be assessed following the completion of the Longwalls 23-27 Round 1 Aboriginal heritage surveys.

Table 8
TARP Characterisation – Longwalls 23-27 Aboriginal Heritage Management

Monitoring Component	Subsidence Impact Performance Measure	Subsidence Impact Performance Measure Exceeded?
Aboriginal Heritage Sites	*Less than 10% of Aboriginal heritage sites within the mining area are affected by subsidence impacts.*	No. To be assessed following the completion of the Longwalls 23-27 Round 1 Aboriginal heritage surveys.

6 BUILT FEATURES MANAGEMENT

6.1 BACKGROUND

The Metropolitan Coal Longwalls 23-27 Built Features Management Plan (Metropolitan Coal, 2014f) was developed to manage the potential environmental consequences of the Metropolitan Coal Longwalls 23-27 Extraction Plan on built features in accordance with Condition 6, Schedule 3 of the Project Approval. The Longwalls 23-27 Built Features Management Plan was developed in consultation with the relevant asset owner.

6.2 MONITORING

Site inspections were conducted prior to the commencement of secondary extraction of Longwall 20 to establish the condition of the infrastructure items. Site inspections were also conducted prior to the commencement of Longwall 23 in accordance with the Metropolitan Coal Longwalls 23-27 Built Features Management Plan.

A monitoring program has been implemented to monitor subsidence impacts on the following infrastructure at the various frequencies described in the Metropolitan Coal Longwalls 23-27 Built Features Management Plan:

- Endeavour Energy infrastructure;
- Nextgen infrastructure;
- TransGrid infrastructure;
- Optus infrastructure;
- Telstra infrastructure;
- RMS infrastructure;
- RailCorp infrastructure;
- Sydney Water infrastructure; and
- Wollongong City Council.

Monitoring relevant to each Built Features Management Plan has been conducted in accordance with each Plan.

No impact to any built feature was evident over the reporting period.

6.3 ASSESSMENT OF ENVIRONMENTAL PERFORMANCE

The results of the subsidence impact monitoring in relation to the built features subsidence impact performance measures are provided below.

Specific performance measures have been developed for the various infrastructure items and are outlined in the Metropolitan Coal Longwalls 23-27 Built Features Management Plan.

Built Features Subsidence Impact Performance Measure

The Project Approval requires Metropolitan Coal not to exceed the following built features subsidence impact performance measure:

Safe, serviceable and repairable, unless the owner and the MSB agree otherwise in writing.

Longwall 23 commenced in May 2014. The built features subsidence impact performance measure was not exceeded during the reporting period.

Heritage Subsidence Impact Performance Measure – Garrawarra Centre Historical or Heritage Significance Items

The Project Approval also requires Metropolitan Coal not to exceed the following heritage subsidence impact performance measure for items of heritage or historical significance at the Garrawarra Centre:

> *Negligible damage (fine or hairline cracks that do not require repair), unless the owner of the item and the appropriate heritage authority agree otherwise in writing.*

The Garrawarra Complex is located more than 2.5 km from Longwalls 23-27 and at this distance no measurable systematic or non-systematic subsidence movements were indicated.

6.4 TARP CHARACTERISATION

The TARP characterisation for Longwalls 23-27 built features management during the reporting period is provided in Table 9. In summary, no performance measures were exceeded during the reporting period.

Table 9
TARP Characterisation – Longwalls 23-27 Built Features Management

Monitoring Component	Subsidence Impact Performance Measure	Subsidence Impact Performance Measure Exceeded?
Built Features	*Safe, serviceable and repairable, unless the owner and the MSB agree otherwise in writing.*	No
	Negligible damage (fine or hairline cracks that do not require repair), unless the owner of the item and the appropriate heritage authority agree otherwise in writing.	No

7 PUBLIC SAFETY MANAGEMENT

7.1 BACKGROUND

The Metropolitan Coal Longwalls 23-27 Public Safety Management Plan (Metropolitan Coal, 2014g) was prepared to manage the potential consequences of the Metropolitan Coal Longwalls 23-27 Extraction Plan on public safety within the underground mining areas in accordance with Condition 6, Schedule 3 of the Project Approval.

7.2 MONITORING

Hazards identified in relation to public access to the underground mining area that may arise as a result of the Metropolitan Coal Longwalls 23-27 Extraction Plan include:

- damage to fire trails (e.g. cracks);
- dislodgement of rocks onto fire trails or roads;
- dislodgement of rocks from cliffs and overhangs;
- entrapment by fire caused by locked gates;

- vehicle collision with monitoring equipment located near fire trails;
- slips, trips and falls by visitors to the tributaries; and
- snake bite, spider bite or other animal encounter.

Monitoring of cliffs and overhangs, steep slopes and land in general has been conducted for subsidence impacts in accordance with the Metropolitan Coal Longwalls 23-27 Land Management Plan, and of infrastructure items in accordance with the Metropolitan Coal Longwalls 23-27 Built Features Management Plan. No subsidence impacts were identified during the reporting period that were considered to pose a risk to public safety.

Further, no safety incidents were reported by visitors, personnel or contractors to Metropolitan Coal in the underground mining area during the reporting period.

7.3 ASSESSMENT OF ENVIRONMENTAL PERFORMANCE

The monitoring results have been used to assess the Project against the public safety performance indicator and the built features subsidence impact performance measure for Longwalls 23-27 below.

Analysis against Performance Indicator

Performance Indicator: *Public safety will be ensured in the event that any hazard to the general public arising from subsidence effects becomes evident.*

No subsidence impacts were identified during the reporting period that were considered to pose a risk to public safety.

Analysis against Subsidence Impact Performance Measure

Subsidence Impact Performance Measure:

Safe, serviceable and repairable, unless the owner and the MSB agree otherwise in writing.

Neither the performance indicator, nor the built features subsidence impact performance measure were exceeded during the reporting period.

7.4 TARP CHARACTERISATION

The TARP characterisation for Longwalls 23-27 public safety management during the reporting period is provided in Table 10. In summary, neither the performance indicator nor the performance measure were exceeded during the reporting period.

Table 10
TARP Characterisation – Longwalls 23-27 Public Safety

Monitoring Component	Subsidence Impact Performance Indicator	Subsidence Impact Performance Indicator Exceeded?	Resulting Actions	Subsidence Impact Performance Measure	Subsidence Impact Performance Measure Exceeded?
Public Safety	*Public safety will be ensured in the event that any hazard to the general public arising from subsidence effects becomes evident.*	No	None required	*Safe, serviceable and repairable, unless the owner and the MSB agree otherwise in writing*.	No

8 REHABILITATION

8.1 BACKGROUND

A Metropolitan Coal Rehabilitation Management Plan (Metropolitan Coal, 2014h) has been prepared for the underground mining area for areas requiring rehabilitation or remediation measures including surface disturbance areas and stream pool/rock bar remediation in accordance with Condition 4, Schedule 6 of the Project Approval.

8.2 REHABILITATION AND REMEDIATION MEASURES

8.2.1 Surface Disturbance Areas

A Rehabilitation Management Plan – Surface Disturbance Register is used to manage the implementation of rehabilitation measures.

No surface disturbance areas were rehabilitated during the reporting period.

8.2.2 Stream Pool/Rock Bar Remediation

Metropolitan Coal recently revised the Metropolitan Coal Rehabilitation Management Plan (Version E) to include an improved stream remediation methodology. The revised Metropolitan Coal Rehabilitation Management Plan was approved by the DRE in May 2014 and stream remediation activities commenced at Pool F in June 2014. Stream remediation activities at Pool F have included verification of the fracture network by test drilling and calliper testing to establish ground conditions; hydraulic pressure testing and down hole calliper survey to inform and verify the grouting works; and drilling and injection of grout (polyurethane resin) to create a grout curtain. Associated activities have included the mobilisation, placement and operation of equipment and the implementation of a variety of environmental management measures.

Following the conduct of stream remediation activities at Pool F, stream remediation activities will be conducted at Flat Rock Crossing (Pools G and G1), anticipated to commence in May 2015.

8.3 MONITORING

8.3.1 Surface Disturbance Areas

Some surface disturbance areas will be able to be rehabilitated during the life of the Project (e.g. monitoring sites no longer required), while other surface disturbance areas will likely remain until after the completion of mining operations.

Once a surface disturbance area is no longer being utilised, monitoring will be conducted to assess:

- where appropriate, whether equipment/infrastructure items have been removed;
- whether the area is tidy or rubbish removal is required;
- whether erosion and sediment controls are required and if so, the effectiveness of those installed;
- the presence of weeds and the need for the implementation of weed control measures;
- where appropriate, whether vegetation is re-establishing naturally or whether active revegetation is required; and

- if active revegetation is conducted, whether vegetation is establishing.

No surface disturbance areas were rehabilitated during the reporting period as the majority of disturbance pertained to the installation of environmental monitoring sites which are a life of mine asset. These sites will be rehabilitated to appropriate standards following cessation of mining.

In accordance with the Metropolitan Coal Rehabilitation Management Plan, the Rehabilitation Management Plan – Surface Disturbance Register is used to monitor the performance of the measures implemented to rehabilitate surface disturbance areas.

8.3.2 Stream Pool/Rock Bar Remediation

Monitoring of Pool Water Levels

Water levels in pools on the Waratah Rivulet and Eastern Tributary are monitored in accordance with the Metropolitan Coal Catchment Monitoring Program and Metropolitan Coal Longwalls 23-27 Water Management Plan.

Monitoring of Waratah Rivulet Pools

Stream remediation is initiated at pools/rock bars on Waratah Rivulet between the downstream edge of Flat Rock Swamp and the full supply level of the Woronora Reservoir if the water level in a pool falls below its cease to overflow level (i.e. stops overflowing), except as a result of climatic conditions.

An assessment of the monitored pool water levels on Waratah Rivulet between Flat Rock Swamp and the full supply level of the Woronora Reservoir has been conducted, as described below.

Pools A, B, C, E, F, G, G1, H and I on the Waratah Rivulet are situated in the completed mining area (i.e. overlying Longwalls 1 to 13) between Flat Rock Swamp and the tailgate of Longwall 20 (Figure 12). As a result of previous mining, the water levels in pools upstream of Flat Rock Crossing (i.e. Pools A to F) and immediately downstream of Flat Rock Crossing (Pools G and G1) have previously been impacted by mine subsidence as described in the Metropolitan Coal Rehabilitation Management Plan (i.e. the pool water level has fallen below the cease to flow level). Water level monitoring of Pools A, B, C, E, F, G, G1, H and I are shown on Charts B1 to B9 in Appendix B. A description of water levels in each pool compared to its cease to flow level is provided below.

Most recently, Pool A stopped overflowing its downstream rock bar between 7 December 2012 and 25 January 2013 and Pool B stopped overflowing from the 28 December 2012 to the 25 January 2013. The water levels in both pools have remained above their cease to flow levels since that time and throughout the reporting period (Charts B1 and B2 in Appendix B).

During the reporting period water levels in Pool C did not fall below the cease to flow level (Chart B3 in Appendix B) the most recent fall below cease to flow level was between the 6 and the 8 November 2013.

Water levels in Pool E did not fall below its cease to flow level during the reporting period, the most recent fall being between the 10 and 25 January 2013 (Chart B4 in Appendix B).

Water levels in Pool F did not fall below the cease to flow level during the reporting period, the most recent fall being between the 2 January and 25 January 2013 (Chart B5 in Appendix B).

Water levels in Pool G regularly fell below the cease to flow level throughout the reporting period (Chart B6 in Appendix B).

Water levels in Pool G1 did not fall below the cease to flow level during the reporting period, the most recent fall being between the 10 and 25 January 2013 (Chart B7 in Appendix B).

Water level records in Pool H and Pool I indicate that these pools have not fallen below their cease to flow levels (Chart B8 and B9 in Appendix B).

In summary, all pools except Pool G (which fell below its cease to flow level regularly throughout the reporting period) remained above their cease to flow levels during the reporting period. Pools H and I have not fallen below their cease to flow levels over the period of available water level data.

Stream remediation activities have previously been undertaken at Pools A and F on the Waratah Rivulet. The rock bars at Pools A and F are considered to largely control the pools located upstream of these rock bars. As a result, Metropolitan Coal anticipates that the restoration of surface flow and pool holding capacity at Pools A and F will restore the surface flow and pool holding capacity of pools between Flat Rock Swamp and Pool F. Metropolitan Coal will assess whether stream remediation is required at any additional pools/rock bars between Flat Rock Swamp and Pool F once stream remediation activities at Pools A and F have been completed. As described in Section 8.2.2, stream remediation activities will be conducted at Flat Rock Crossing (Pools G and G1) following the conduct of stream remediation activities at Pool F.

Automatic pool water level monitoring is also conducted for Pools A and F and for pools further downstream of Flat Rock Crossing (Pools J, K, L, M, N, O, P, Q, R, S, T, U, V and W). The recorded water level responses in pools are presented on Chart B10 to B25 in Appendix B. Where available[19], the surveyed cease to flow levels of the pools are also shown on Chart B10 to B25 in Appendix B[20].

Recorded water levels in Pools A, F, J[21], K[22], L, M, P, Q, R, S[23] and V (Charts B10 to B15, Charts B18 to B21, and Chart B24 in Appendix B) did not fall below the surveyed cease to flow levels during the reporting period. This and the shape of the recorded water level hydrographs in these pools suggest they exhibited natural behaviour.

As reported previously, visual observations by Metropolitan Coal personnel indicated Pool N ceased overflowing in early September 2012 (during a period of missing water level data) (Chart B16 in Appendix B). Recorded water levels in Pool N show several periods where the water level fell rapidly and then rose rapidly - notably in the period 8 November 2012 and 22 February 2013 and again between 20 February 2014 and 23 March 2014. This behaviour is understood to be due to the water level in the pool falling below the water logger. Metropolitan Coal's visual inspections of Pool N indicate that Pool N ceased to flow and/or the pool was dry over the period 18 June 2014 to 15 August 2014 and in late November 2014 during the reporting period.

[19] Surveyed cease to flow levels are available for Pools A, J, K, L, M, N, P, Q, R, S and V.

[20] Charts in Appendix B do not show all data available since the commencement of monitoring for Pool A (Chart B10), Pool F (Chart B11), Pool J (Chart B12), Pool L (Chart B14), Pool M (Chart B15), Pool N (Chart B16), Pool O (Chart B17), Pool P (Chart B18), Pool R (Chart B20) and Pool S (Chart B21) as the early recorded pool water level responses in these pools during low flow periods were affected by daily temperature fluctuations, but were otherwise consistent with natural pool behaviour (as described in the Metropolitan Coal 2010 Annual Review [Metropolitan Coal, 2010d]). Metropolitan Coal upgraded the pool water level meter instrumentation in order to remove the effects of daily temperature fluctuations.

[21] As reported in the Metropolitan Coal 2013 Annual Review/AEMR, water levels in Pool J appeared to have fallen below the pool cease to flow level. Given the natural shape of the recorded pool water level hydrographs It was concluded that either the sensor datum was incorrect or the surveyed cease to flow level was incorrect. A subsequent re-survey of the pool cease to flow level has confirmed that recorded water levels in Pool J have not fallen below the pool's cease to flow level.

[22] As reported in the Metropolitan Coal 2013 Annual Review/AEMR, Pool K ceased over-flowing between the 10 and 22 January 2013, however based on similarity with the pools on the Woronora River the pool water levels were considered to reflect natural behaviour.

[23] As reported in the Metropolitan Coal 2013 Annual Review/AEMR, the Pool S water level appeared to have fallen below its cease to flow level during the period between 2 and 29 October 2013, however the rapid drop in water level at the start of this period and equally rapid rise at the end of this period indicates water level sensor malfunction.

Pools O, T, U and W do not have established surveyed cease to flow levels because these pools do not have 'solid' rock-bar controls, however the shape of the recorded pool water level hydrographs in all pools suggest that these pools exhibited natural behaviour during the reporting period. Recorded water levels in Pool O fell to relatively low levels on two occasions in February 2014 consistent with other falls in the December 2012 to January 2013 period (Chart B17 in Appendix B). These types of water level responses have been observed in control pools on Woronora River and are consistent with water level responses in pools with open boulder-field controls and pools with naturally highly fractured (permeable) rock-bars. The lowest recorded water level in Pool O was higher than the historical minimum and is consistent with what is considered natural drainage behaviour for this pool.

Monitoring of Eastern Tributary Pools

On the Eastern Tributary, surface flow and pool holding capacity is required to be restored over 70% of the stream length between the maingate of Longwall 26 and the full supply level of the Woronora Reservoir. Pools ETAF to ETAU on the Eastern Tributary are situated between maingate 26 and the full supply level. Pools ETAF, ETAH, ETAI, ETAQ and ETAU are monitored continuously with a data logger.

Stream remediation will be triggered at Pools ETAF to ETAU if the assessment of monitoring results indicates the performance measure:

> *negligible environmental consequences over at least 70% of the stream length (that is, no diversion of flows, no change in the natural drainage behaviour of pools, …….) on the Eastern Tributary between the full supply level of the Woronora Reservoir and the maingate of Longwall 26.*

has been exceeded.

Monitoring of the Eastern Tributary is described in Section 2.2.3 and the triggering of stream remediation at Pools ETAF to ETAU is described in Section 2.3.7.

8.3.3 Assessment of Environmental Performance

8.3.3.1 Surface Disturbance Areas

Analysis against Performance Indicators

Metropolitan Coal will assess the progress of the rehabilitation measures against the following performance indicators:

> *Redundant equipment/infrastructure items have been removed.*
>
> *The site is neat and tidy (i.e. it does not contain any rubbish).*
>
> *No weed management measures are required.*
>
> *No erosion or sediment control measures are required.*
>
> *Where appropriate, native vegetation is naturally regenerating or active revegetation is establishing.*
>
> *No further active revegetation measures are required.*

The progress of the rehabilitation will be recorded in the Rehabilitation Management Plan – Surface Disturbance Register and reported in future Six Monthly Reports or Annual Review and AEMR/Rehabilitation Reports.

Analysis against Rehabilitation Objective

When appropriate, an assessment of the site will be made against the rehabilitation objective for other land affected by the Project, *viz*. *Restore ecosystem function, including maintaining or establishing self-sustaining native ecosystems: comprised of local native plant species; with a landform consistent with the surrounding environment*.

The rehabilitation objective will be considered to have been met if:

- the site contains self-sustaining native vegetation (i.e. the vegetation is able to sustain itself, without the implementation of any management measures);
- the vegetation is healthy;
- the native vegetation is comprised of local native plant species, as assessed by a suitably qualified botanist;
- ecosystem function is considered to have been restored (i.e. ecosystem processes [water cycle, nutrient cycle and energy interception] at site scale are functioning well); and
- the landform is consistent with the surrounding environment.

The assessment will be recorded in the Rehabilitation Management Plan – Surface Disturbance Register and the progress of rehabilitation will be reported in future Six Monthly Reports or Annual Review and AEMR/Rehabilitation Reports.

8.3.3.2 Stream Pool/Rock Bar Remediation

Analysis against Performance Indicators

Metropolitan Coal will assess the progress of the stream remediation measures against the following performance indicator:

> *Analysis of water level recession rates for a pool indicates a similar pool behaviour to that which existed prior to being impacted by subsidence.*

The water level recession rates performance indicator will be considered to have been met if data analysis indicates there is not a statistically significant change in pool water level recession rates after stream remediation, compared to pool water level recession rates prior to the triggering of stream remediation. Analysis of water level recession rates will be conducted following completion of stream remediation measures.

Pool A on the Waratah Rivulet is situated in the completed Longwalls 1 to 13 mining area downstream of Flat Rock Swamp (Figure 12). A substantial grout curtain at Pool A was established along the length of the river cross section in early 2012 and permeability testing of the structure in June 2012 indicated a low hydraulic conductivity. In June 2012 drill rigs, site shed, product lines and related stream remediation equipment was removed from the site. Water level monitoring of Pool A is shown on Chart B1 in Appendix B. Since June 2012, Pool A stopped overflowing its downstream rock bar between 7 December 2012 and 25 January 2013 and has remained above its cease to flow level since that time. The reference pools WRP2, WRP3 and WRP4 on Woronora River also ceased overflowing during the same December 2012 to January 2013 period. The cease to flow behaviour of pools on Waratah Rivulet would have been influenced by the same period of low flow. Metropolitan Coal will continue to monitor pool water levels in Pool A and will conduct an analysis of the stream remediation activities at Pool A against the stream remediation performance indicator detailed in the Rehabilitation Management Plan once a significant period of drier climatic conditions has been experienced.

Pool F on the Waratah Rivulet is situated in the completed Longwalls 1 to 13 mining area and approximately 200 m upstream of Flat Rock Crossing (Figure 12). Metropolitan Coal conducted trial stream remediation activities at Pool F (also known as the WRS4 rock bar), which involved the drilling of holes and injection of polyurethane (PUR) grout into sub-surface fractures and associated activities, in consultation with the SCA from March to May 2008. Associated activities included the mobilisation, placement and operation of equipment and the implementation of a variety of environmental management measures. The objective of the trial was to investigate the effectiveness of the PUR grouting products and associated injection methods in reducing the hydraulic conductivity of the fractured rock mass. As anticipated, further subsidence movement at Pool F occurred subsequent to the trial. Subsequent drilling and grout injection activities at Pool F were conducted from June 2011 to May 2012. During the reporting period, stream remediation activities at Pool F were conducted from June to December 2014 and will continue in the next reporting period. Water level monitoring of Pool F is shown on Chart B5 (manual observations) and Chart B11 (automatic monitoring) in Appendix B. Water levels in Pool F did not fall below the cease to flow level during the reporting period, the most recent fall being between the 2 January and 25 January 2013.

The rock bars at Pools A and F are considered to largely control the pools located upstream of these rock bars. As a result, Metropolitan Coal anticipates that the restoration of surface flow and pool holding capacity at Pools A and F will restore the surface flow and pool holding capacity of pools between Flat Rock Swamp and Pool F. Metropolitan Coal will assess whether stream remediation is required at any additional pools/rock bars between Flat Rock Swamp and Pool F once stream remediation activities at Pools A and F have been completed.

Analysis against Rehabilitation Objective

The rehabilitation objective for the Waratah Rivulet between the downstream edge of Flat Rock Swamp and the full supply level of the Woronora Reservoir and the Eastern Tributary between the maingate of Longwall 26 and the full supply level of the Woronora Reservoir, *viz. Restore surface flow and pool holding capacity as soon as reasonably practicable*, will be assessed using the results of the assessment of the performance indicator and progress reported in Six Monthly Reports or Annual Review and AEMR/Rehabilitation Reports.

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Metropolitan Coal (2014a) *Metropolitan Coal Longwalls 23-27 Extraction Plan*.

Metropolitan Coal (2014b) *Metropolitan Coal Longwalls 23-27 Water Management Plan.*

Metropolitan Coal (2014c) *Metropolitan Coal Longwalls 23-27 Biodiversity Management Plan.*

Metropolitan Coal (2014d) *Metropolitan Coal Longwalls 23-27 Land Management Plan*.

Metropolitan Coal (2014e) *Metropolitan Coal Longwalls 23-27 Heritage Management Plan*.

Metropolitan Coal (2014f) *Metropolitan Coal Longwalls 23-27 Built Features Management Plan*.

Metropolitan Coal (2014g) *Metropolitan Coal Longwalls 23-27 Public Safety Management Plan.*

Metropolitan Coal (2014h) *Metropolitan Coal Rehabilitation Management Plan*.

National Parks and Wildlife Service (2003) *The Native Vegetation of the Woronora, O'Hares and Metropolitan Catchments.* NSW National Parks and Wildlife Service, Hurstville.

APPENDIX A

SURFACE WATER QUALITY MONITORING RESULTS FOR SELECT SITES - pH, ELECTRICAL CONDUCTIVITY, DISSOLVED IRON, DISSOLVED MANGANESE AND DISSOLVED ALUMINIUM

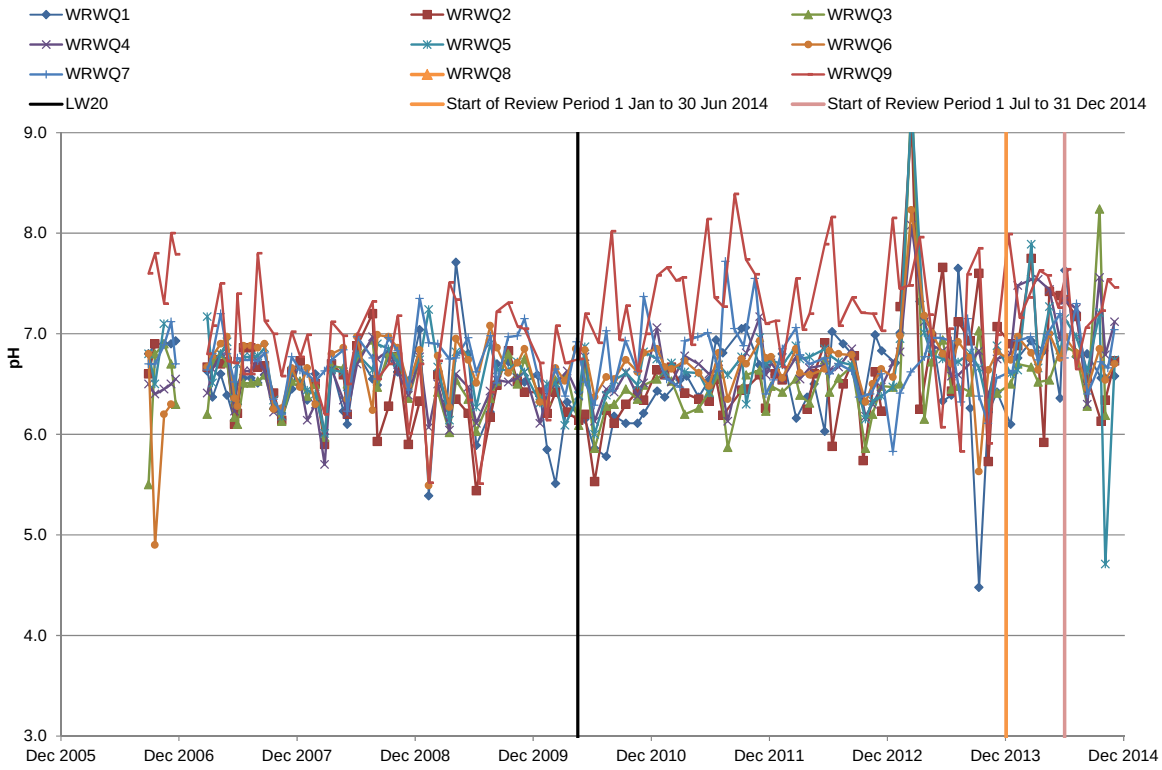

Chart A1 pH Levels Waratah Rivulet

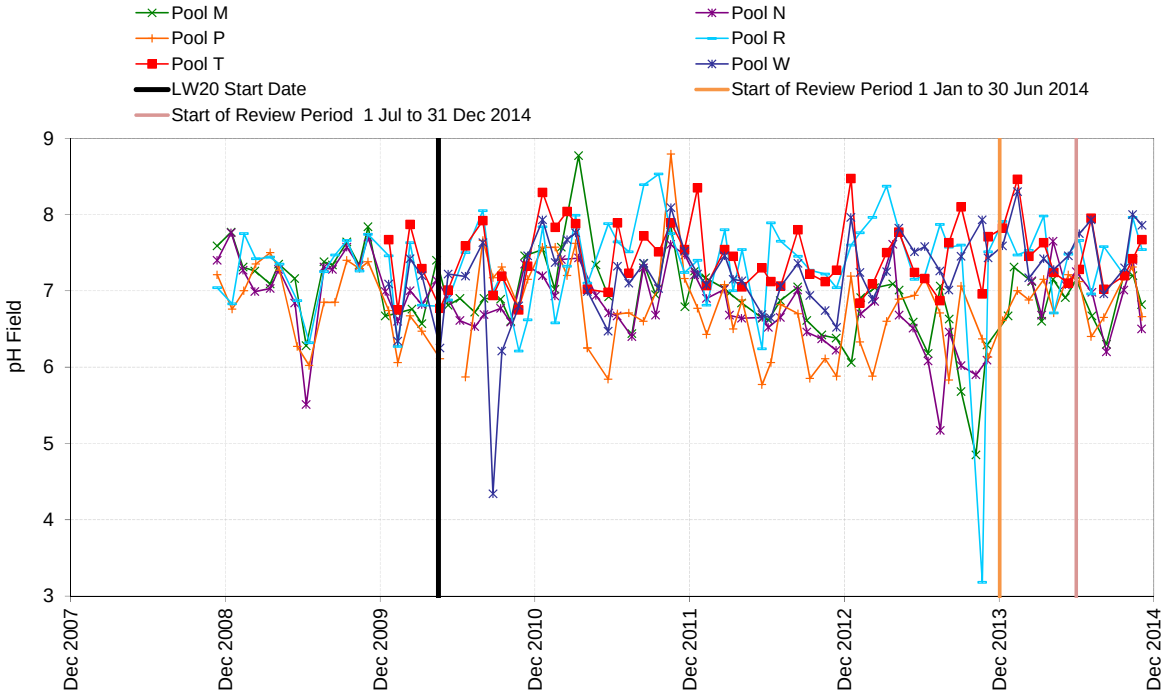

Chart A2 pH Levels Pools on Waratah Rivulet

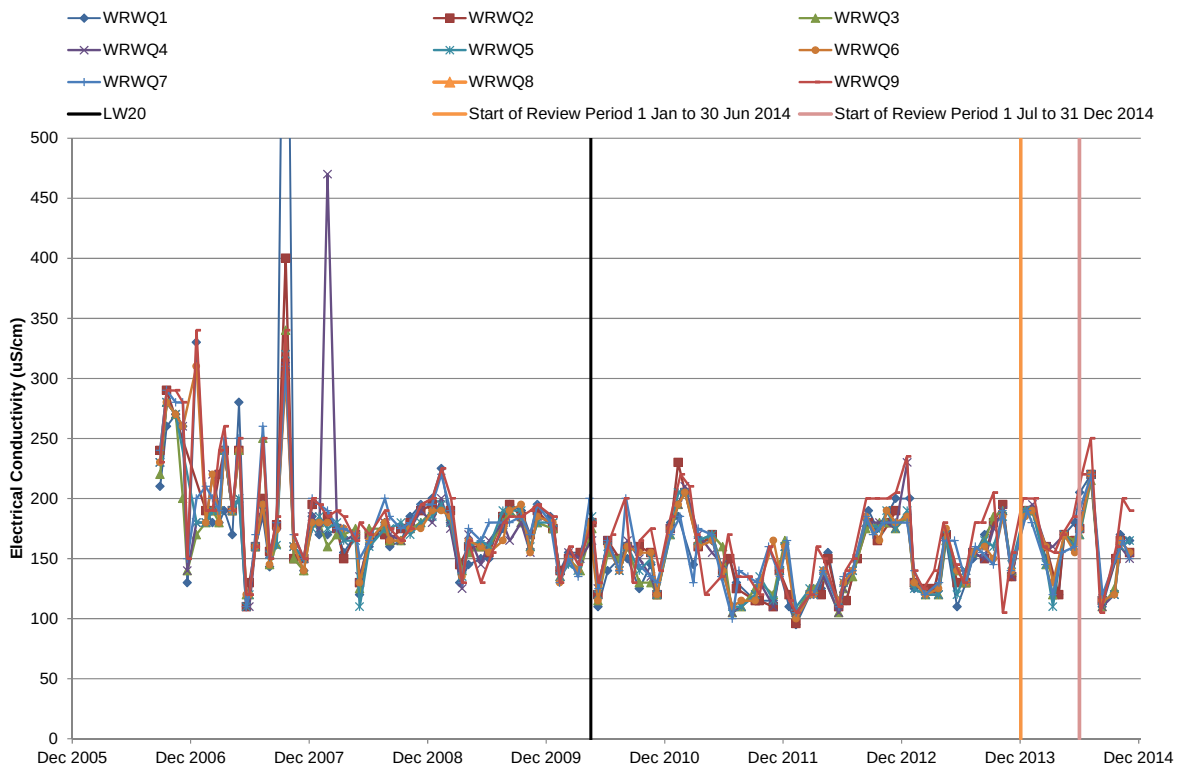

Chart A3 Electrical Conductivity (EC) Waratah Rivulet

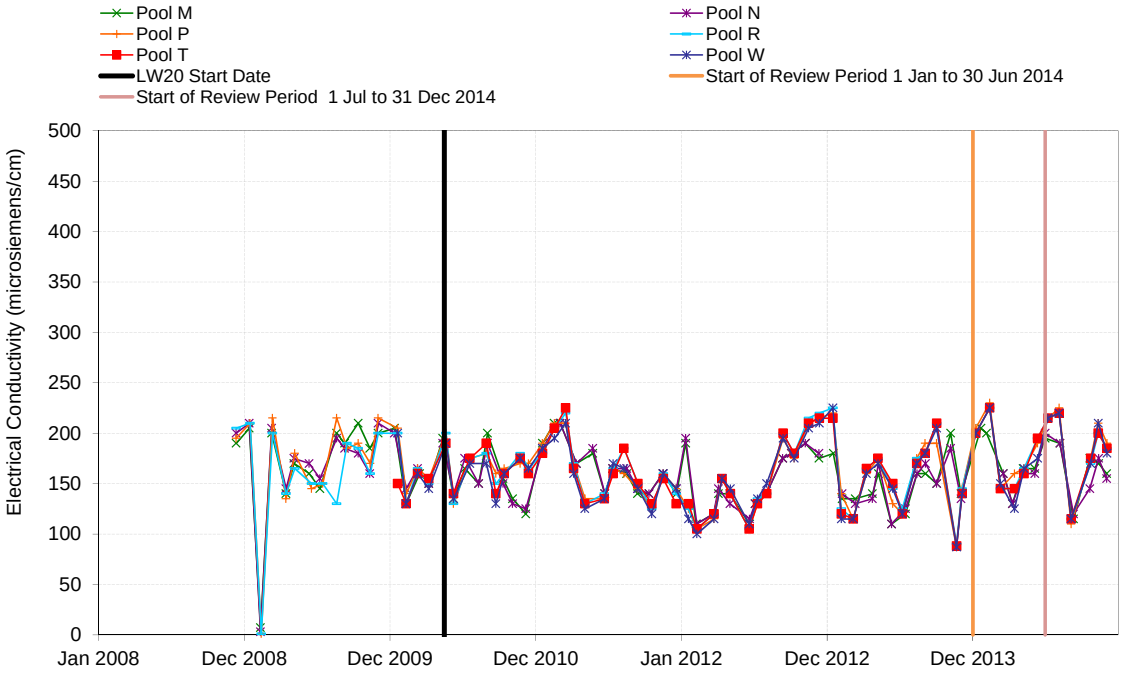

Chart A4 Electrical Conductivity (EC) Pool on Waratah Rivulet

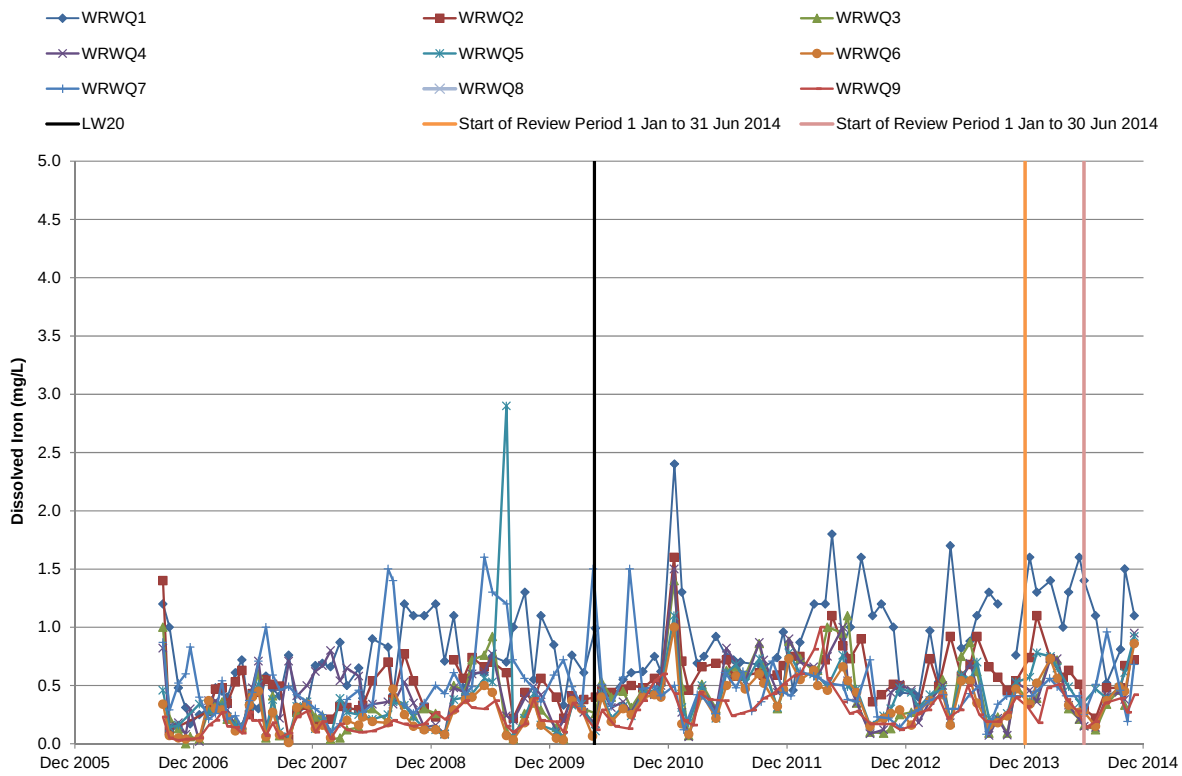

Chart A5 Dissolved Iron Concentrations Waratah Rivulet

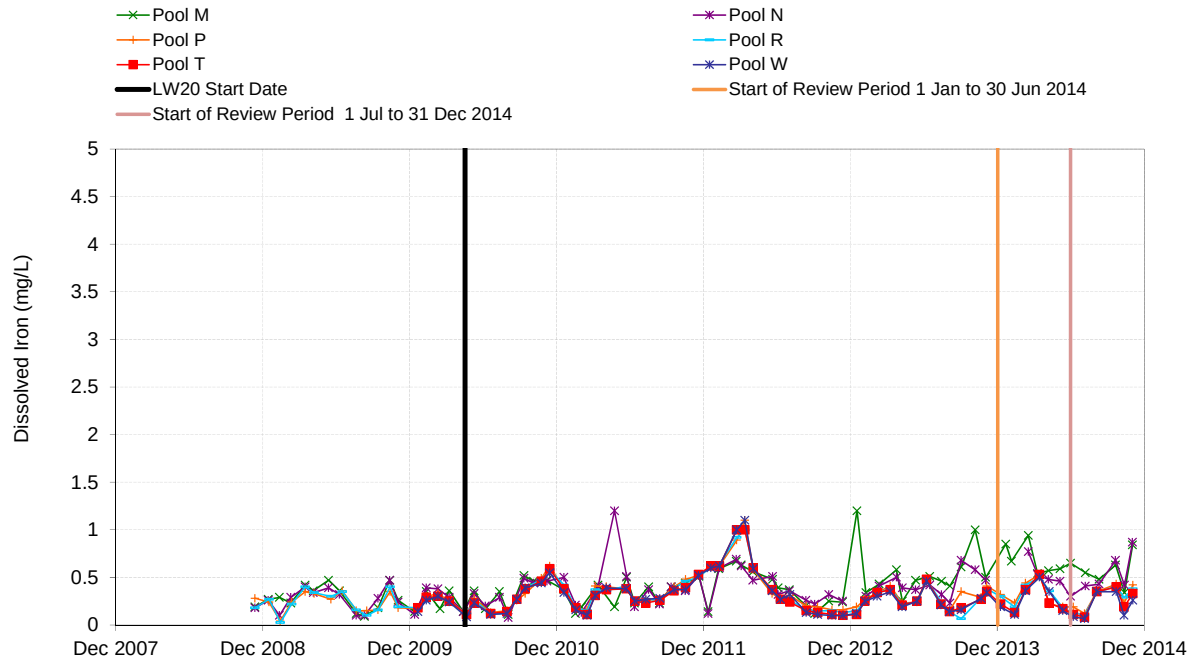

Chart A6 Dissolved Iron Pools on Waratah Rivulet

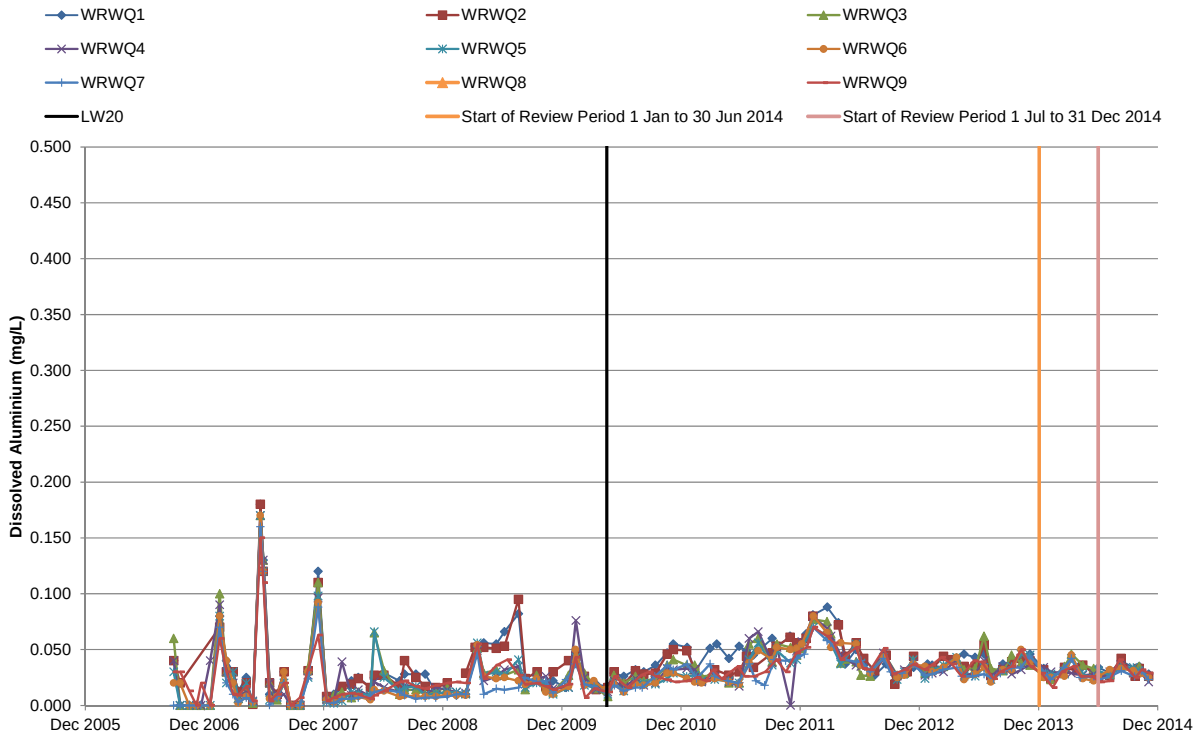

Chart A7 Dissolved Aluminium Concentrations Waratah Rivulet

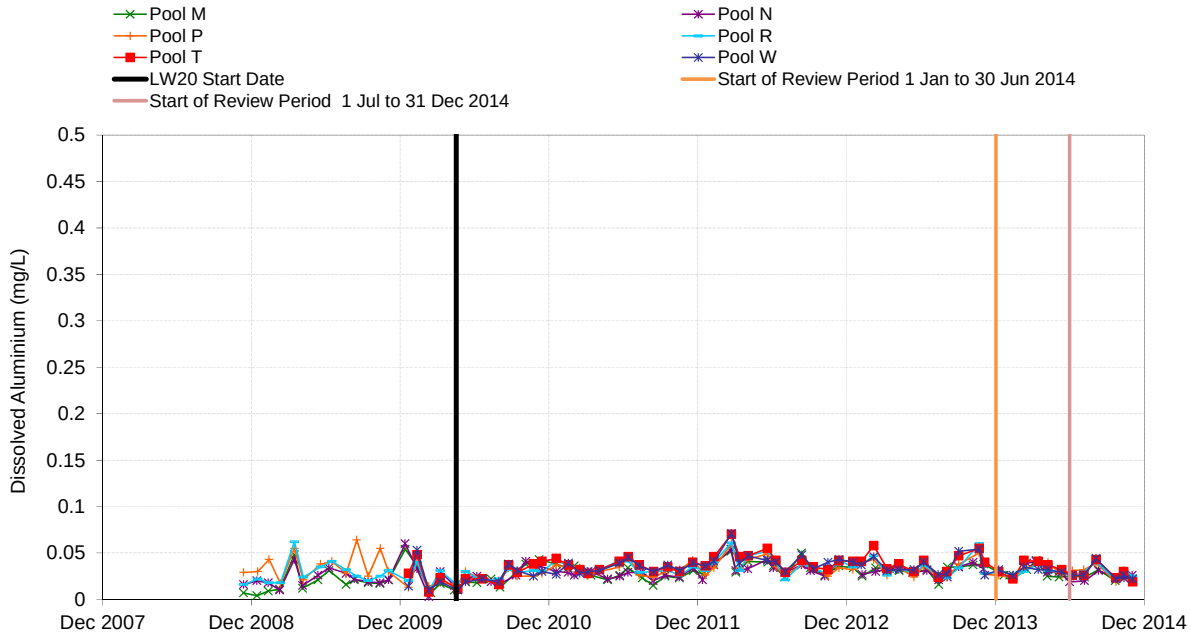

Chart A8 Dissolved Aluminium Pools on Waratah Rivulet

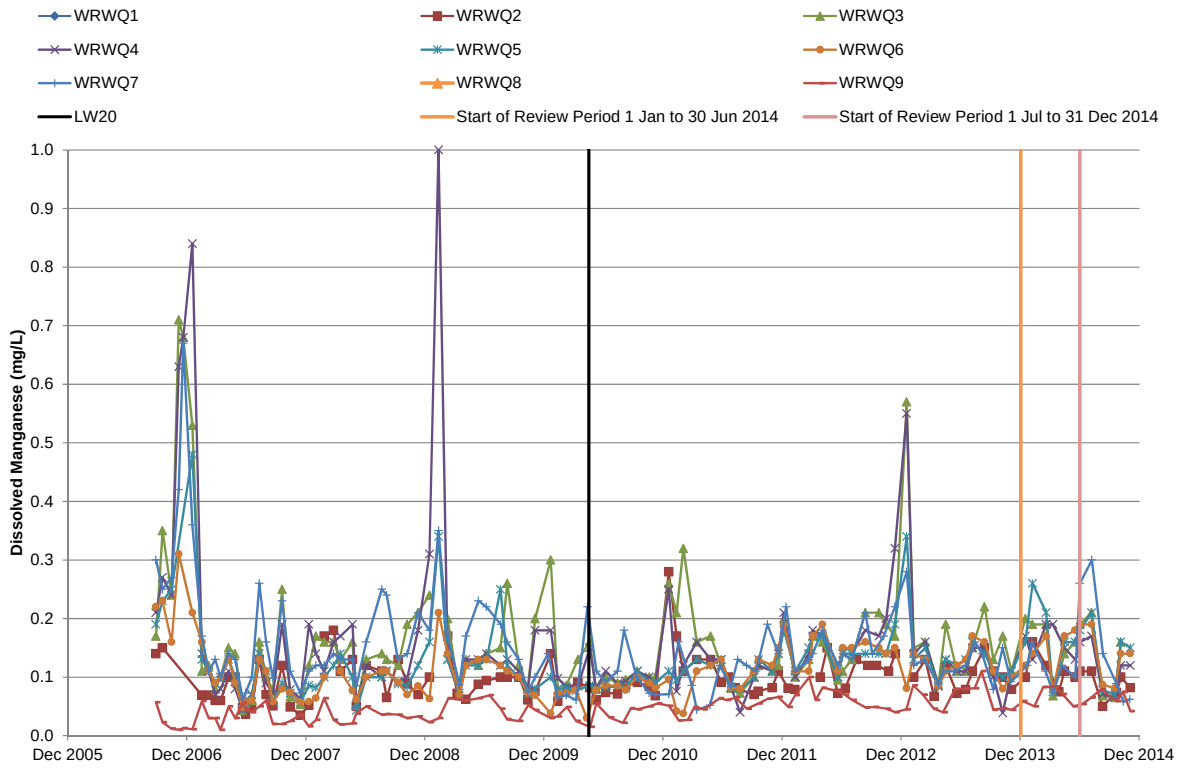

Chart A9 Dissolved Manganese Concentrations Waratah Rivulet

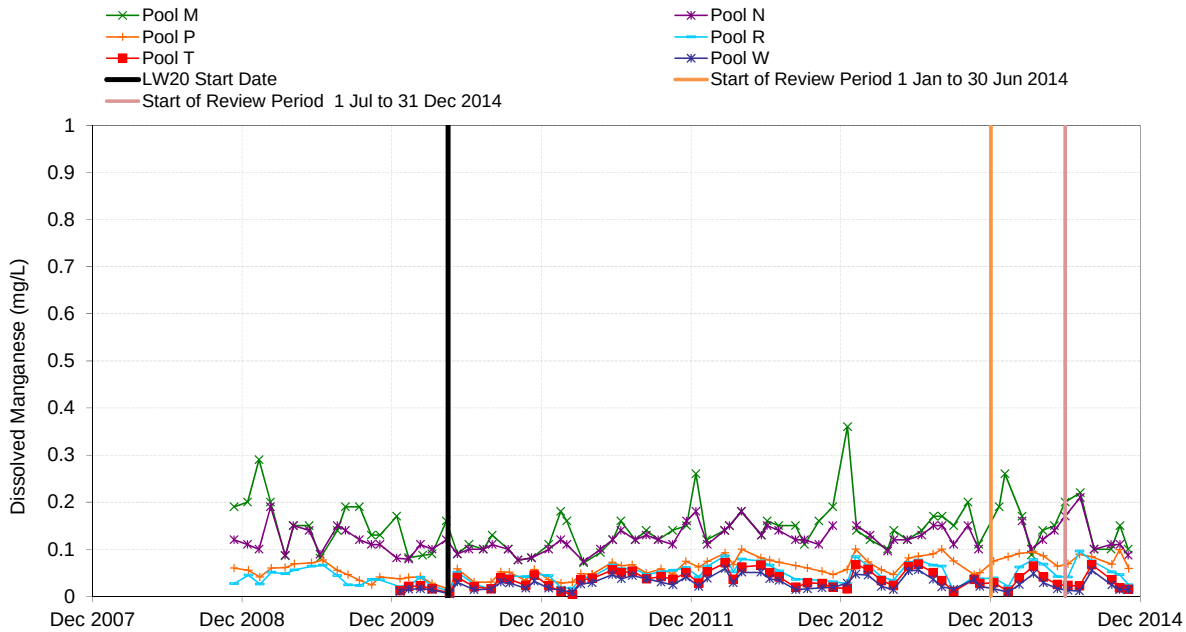

Chart A10 Dissolved Manganese Pools on Waratah Rivulet

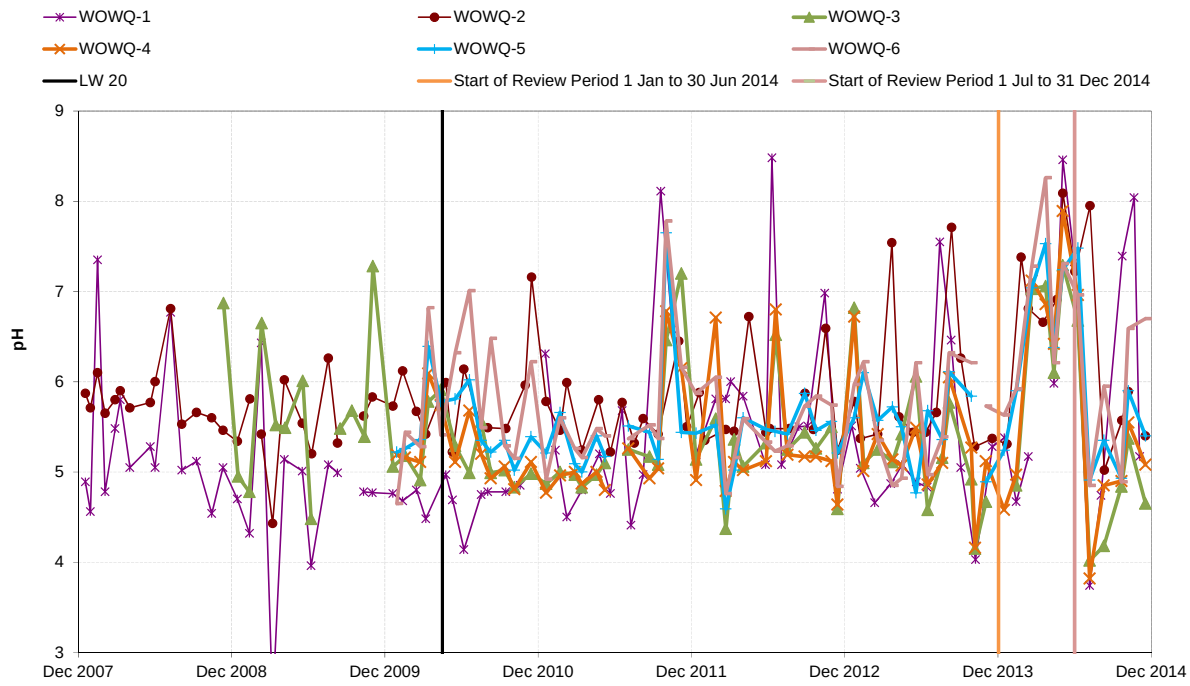

Chart A11 pH Levels Woronora River

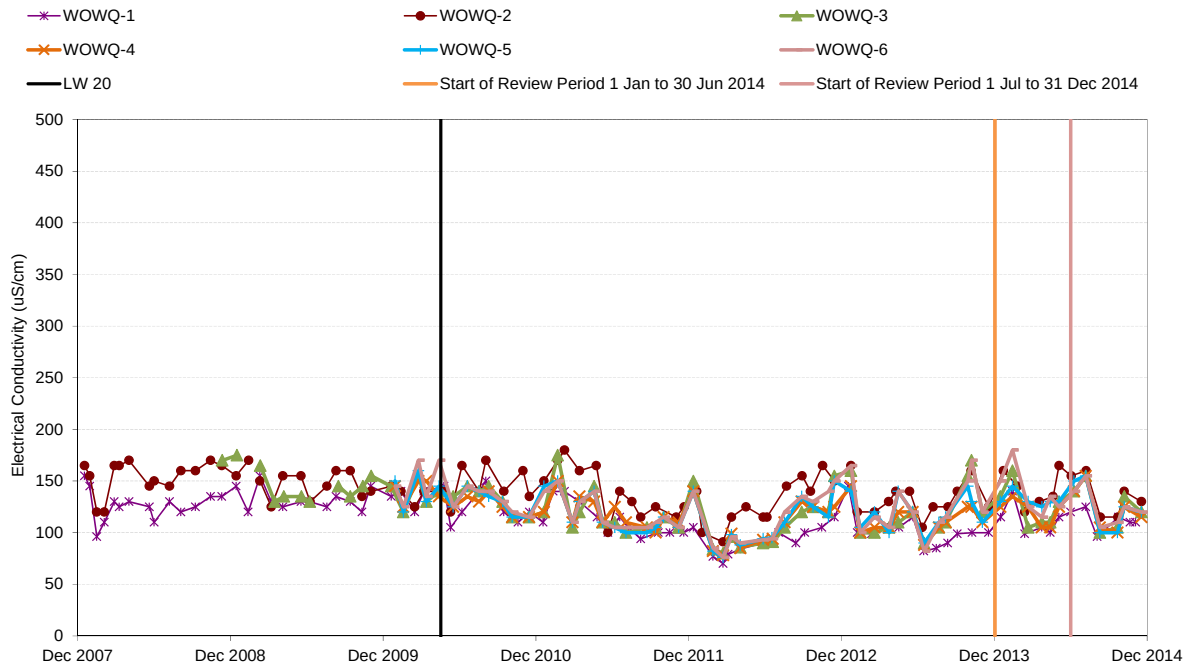

Chart A12 Electrical Conductivity (EC) Woronora River

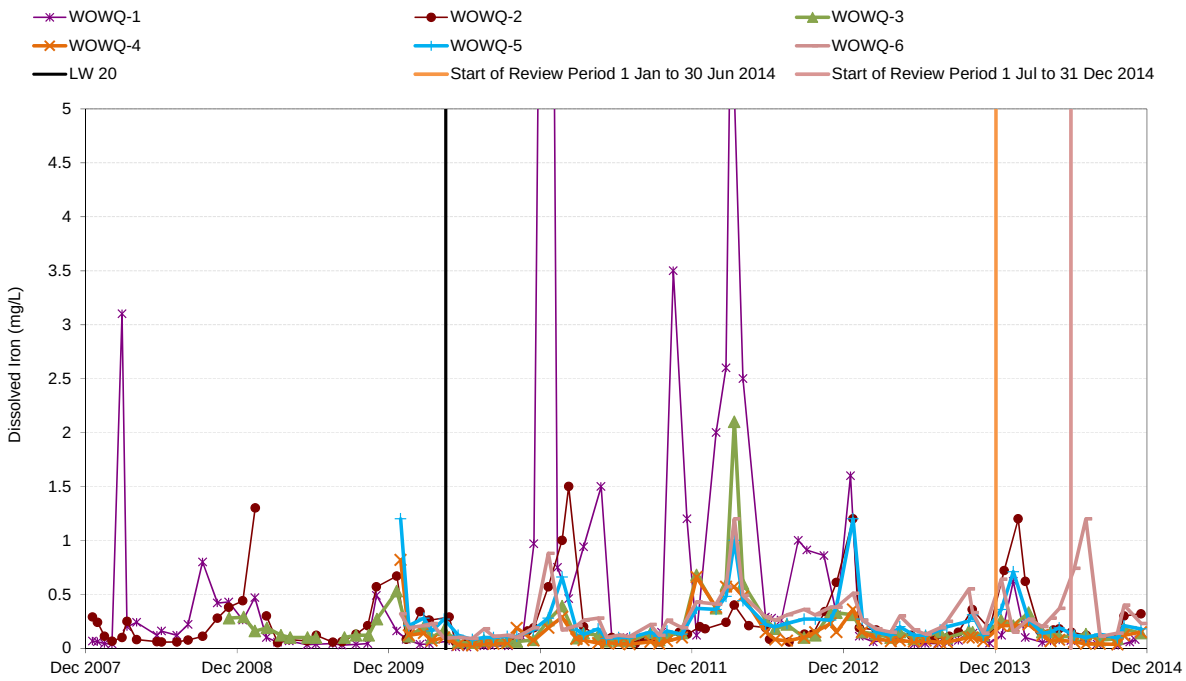

Chart A13 Dissolved Iron Concentrations Woronora River

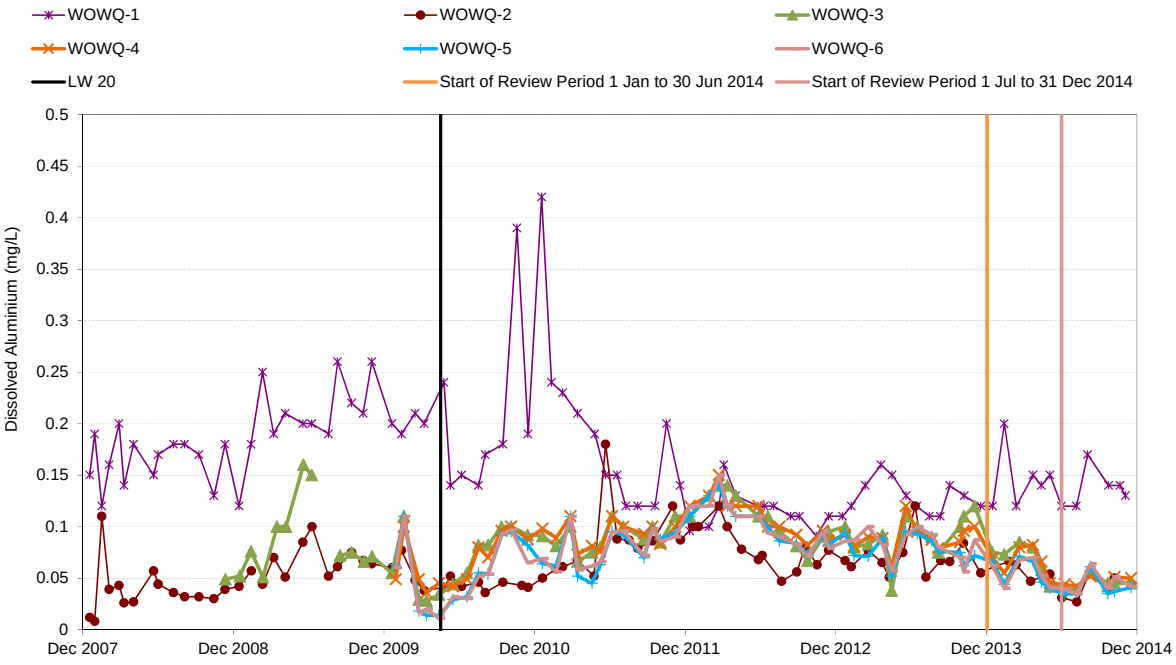

Chart A14 Dissolved Aluninium Concentrations Woronora River

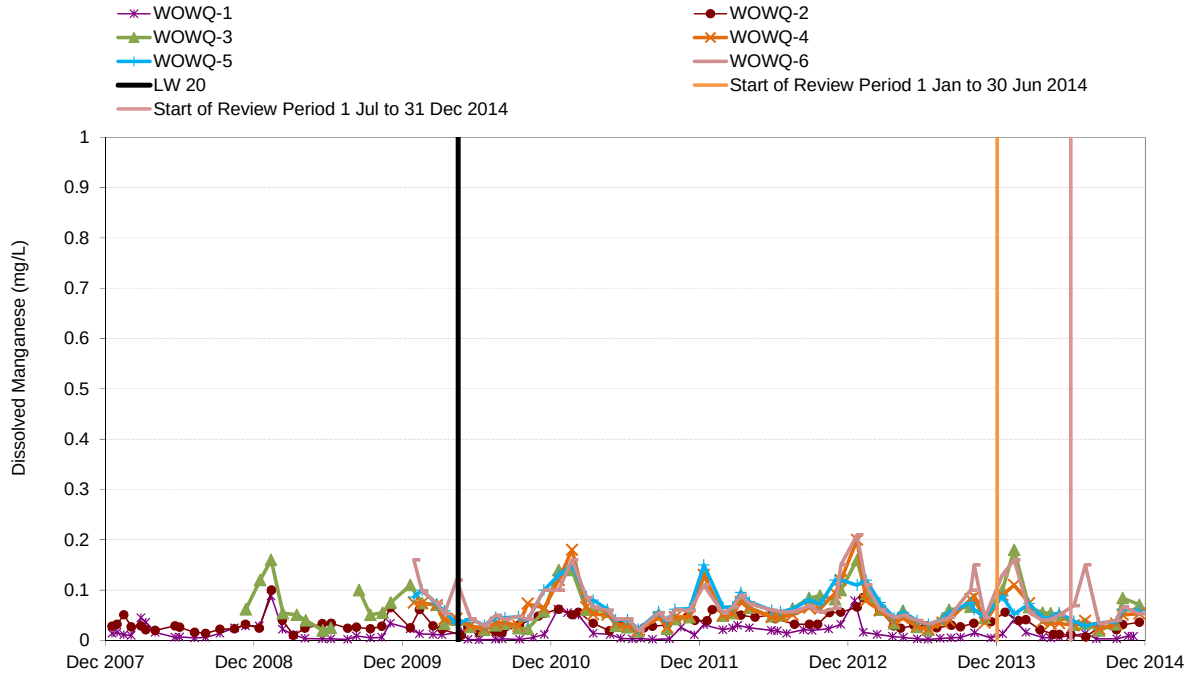

Chart A15 Dissolved Manganese Concentrations Woronora River

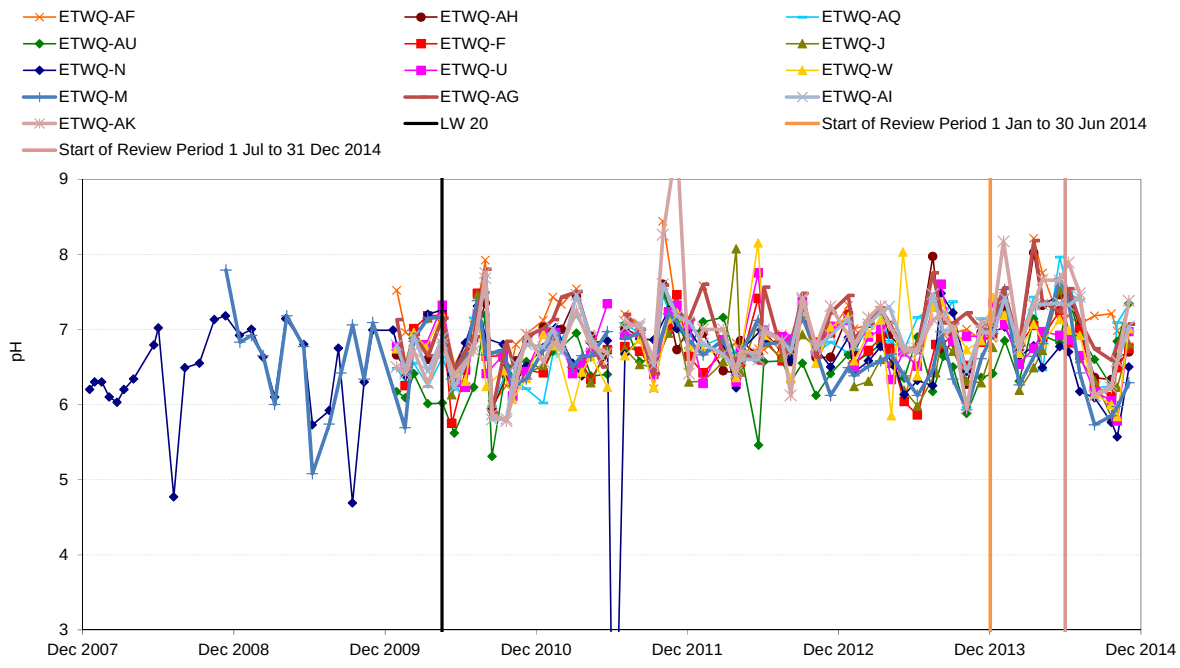

Chart A16 pH Levels Eastern Tributary

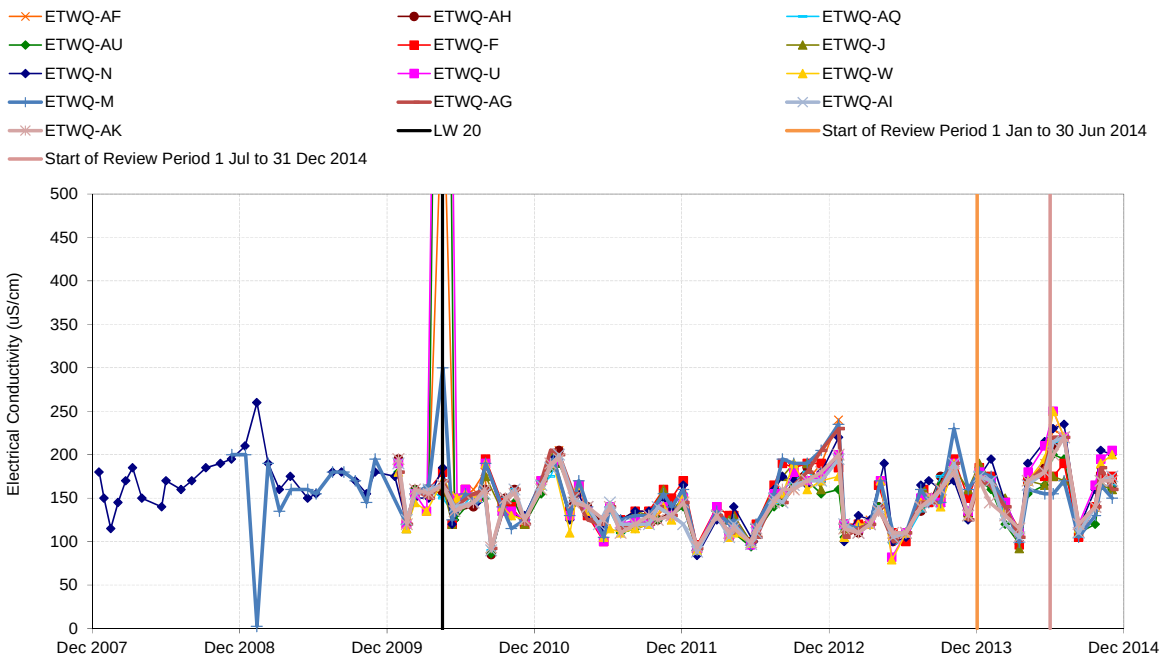

Chart A17 Electrical Conductivity (EC) Eastern Tributary

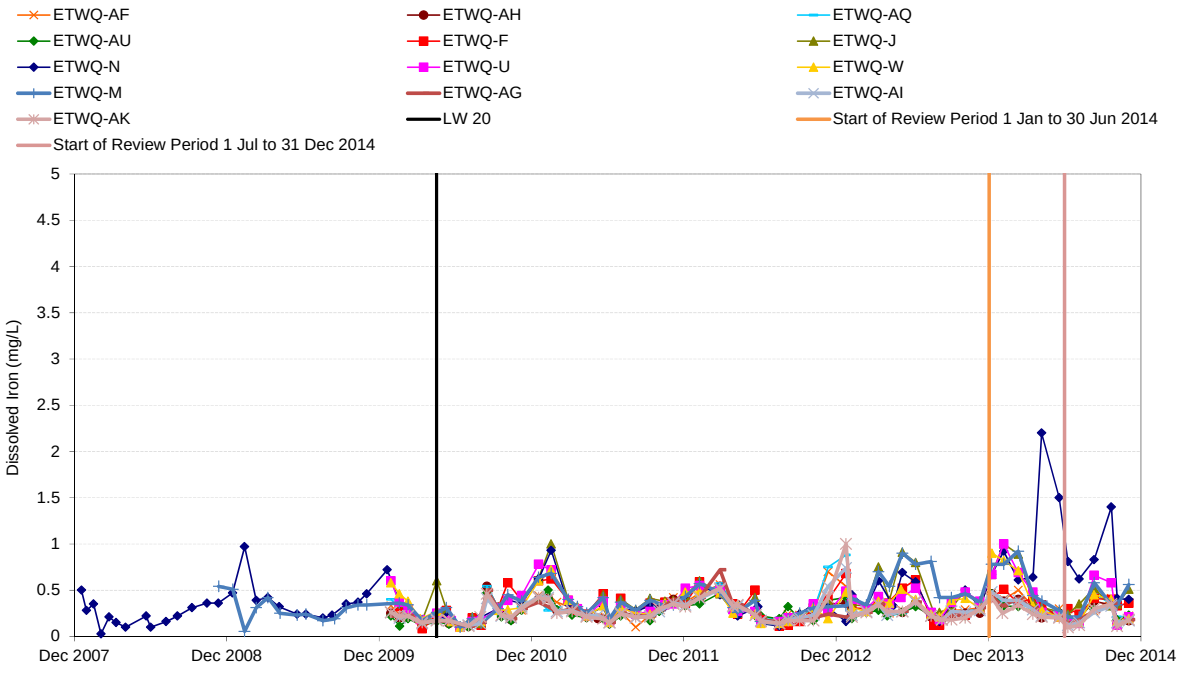

Chart A18 Dissolved Iron Concentrations Eastern Tributary

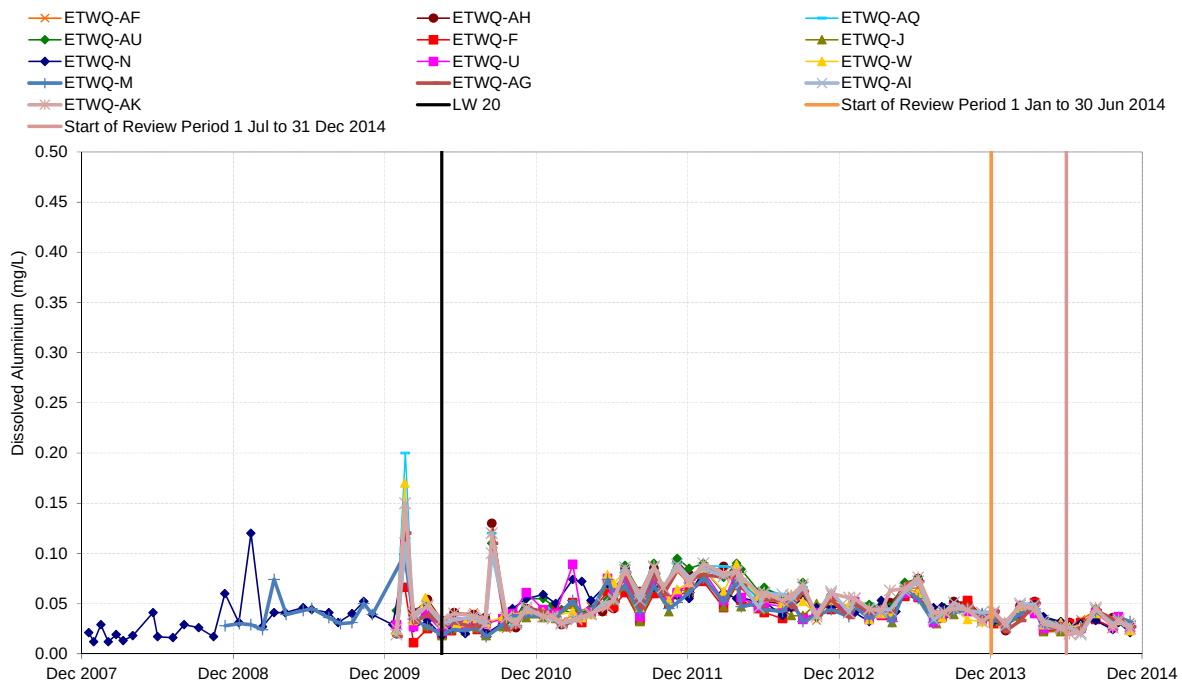

Chart A19 Dissolved Aluminium Concentrations Eastern Tributary

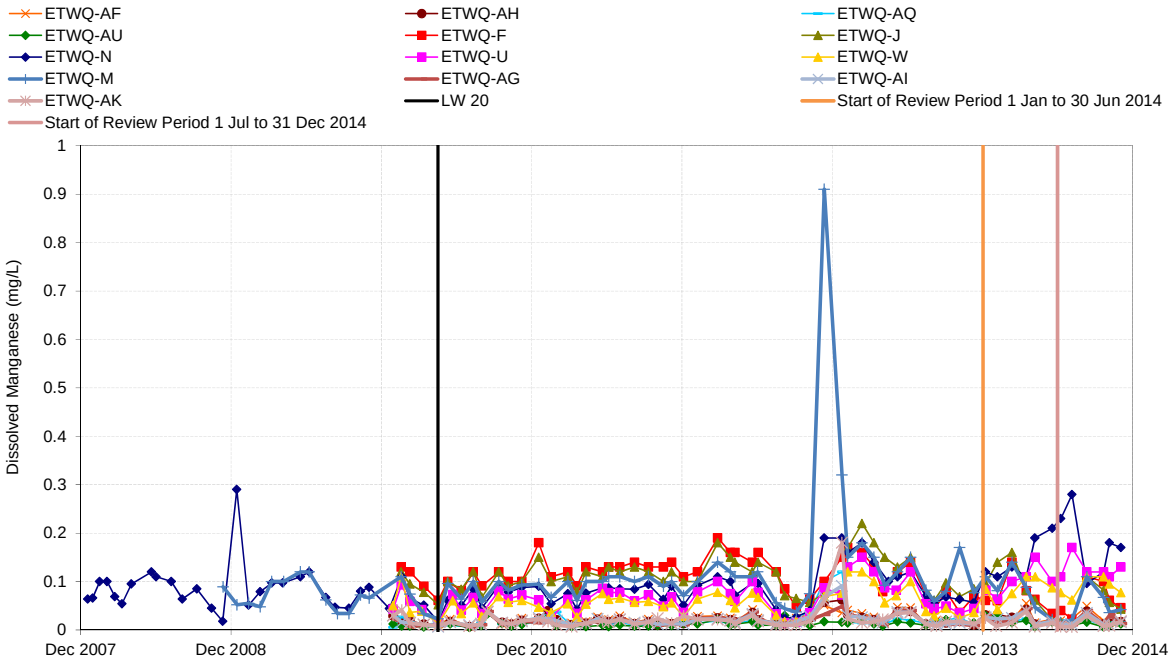

Chart A20 Dissolved Manganese Concentrations Eastern Tributary

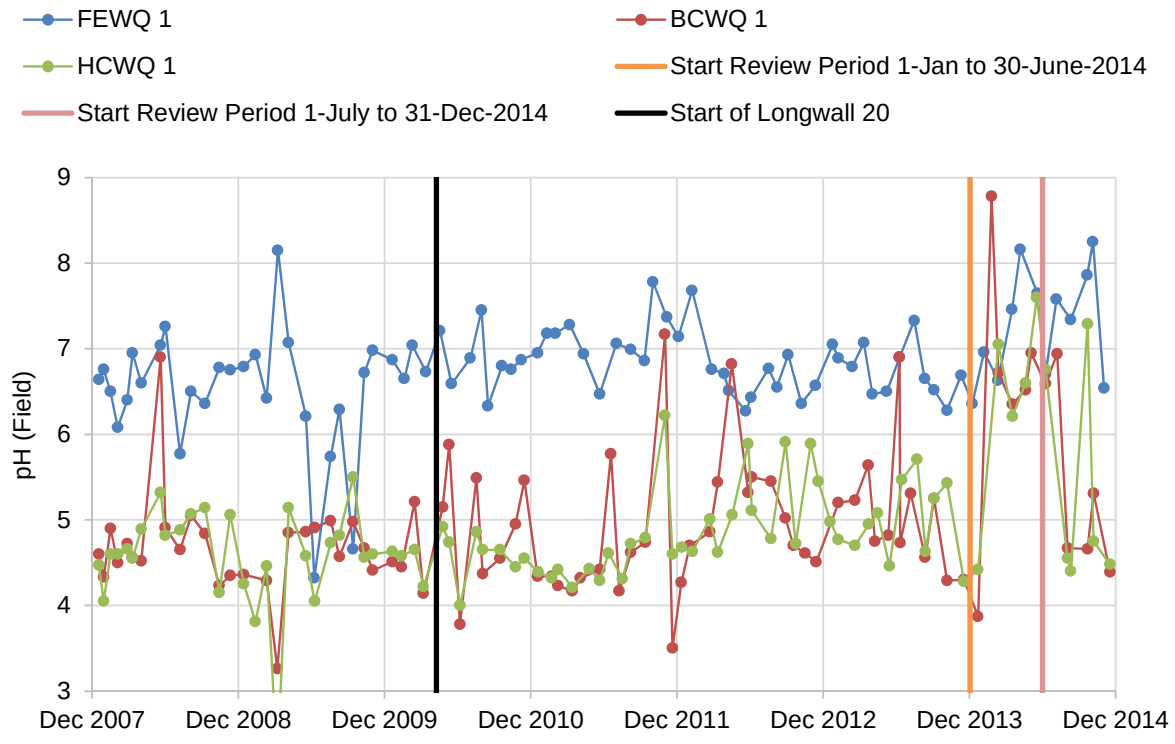

Chart A21 pH Levels Far Eastern Tributary, Bee Creek and Honeysuckle Creek

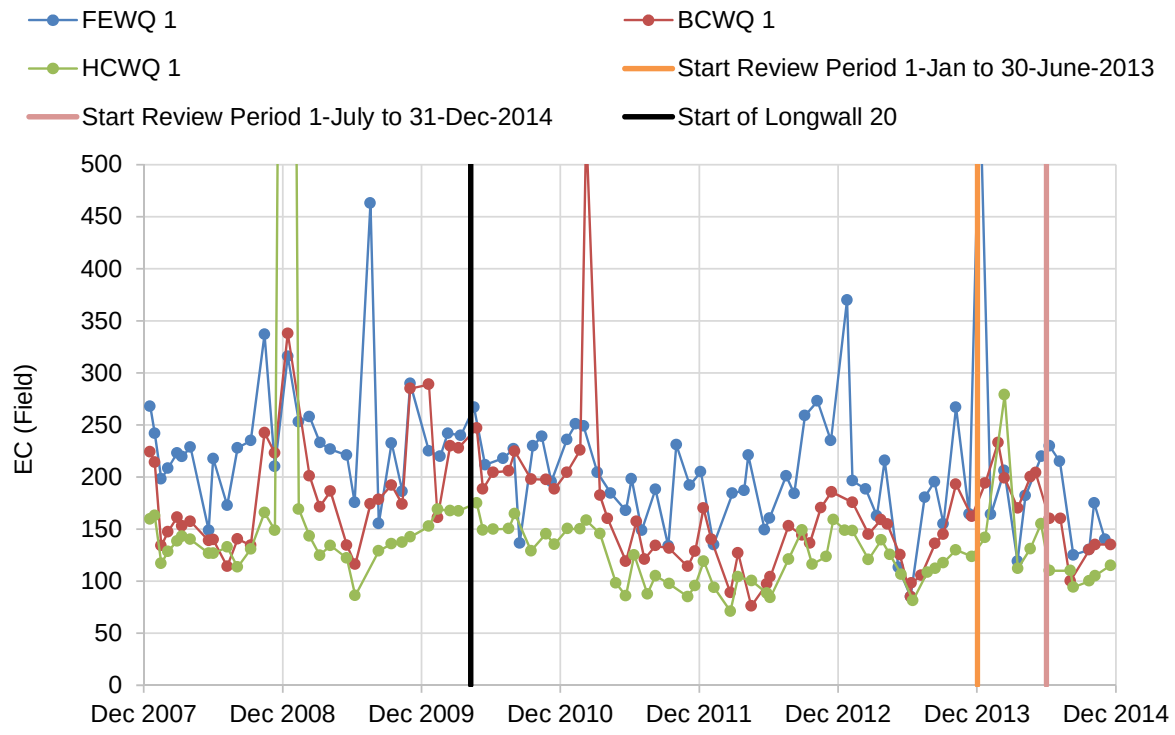

Chart A22 Electrical Conductivity (EC) Far Eastern Tributary, Bee Creek and Honeysuckle Creek

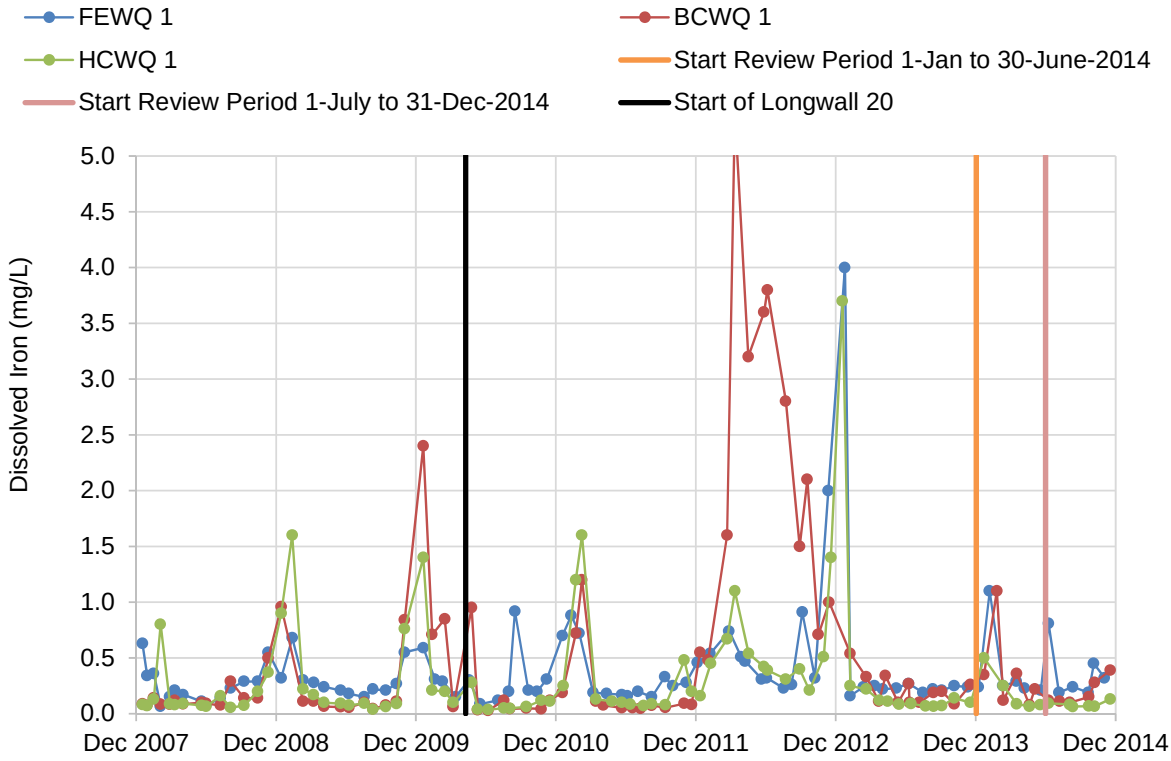

Chart A23 **Dissolved Iron Concentrations Far Eastern Tributary, Bee Creek and Honeysuckle Creek**

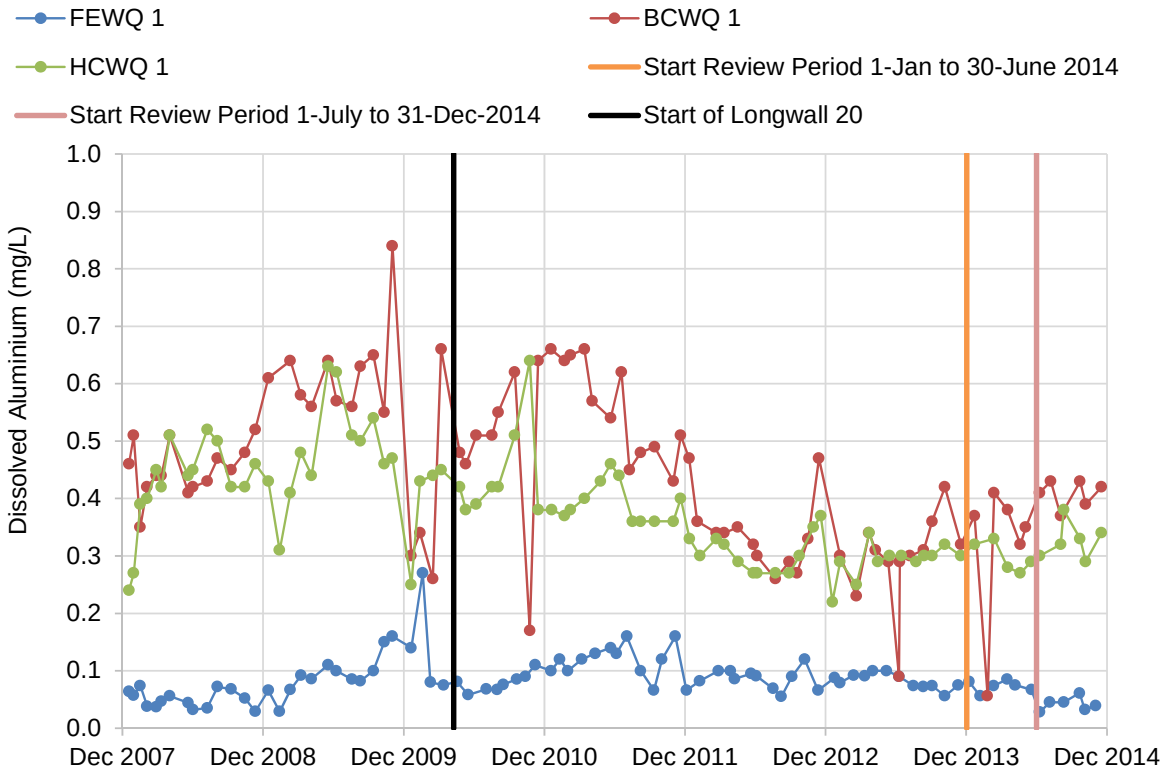

Chart A24 **Dissolved Aluminium Concentrations Far Eastern Tributary, Bee Creek and Honeysuckle Creek**

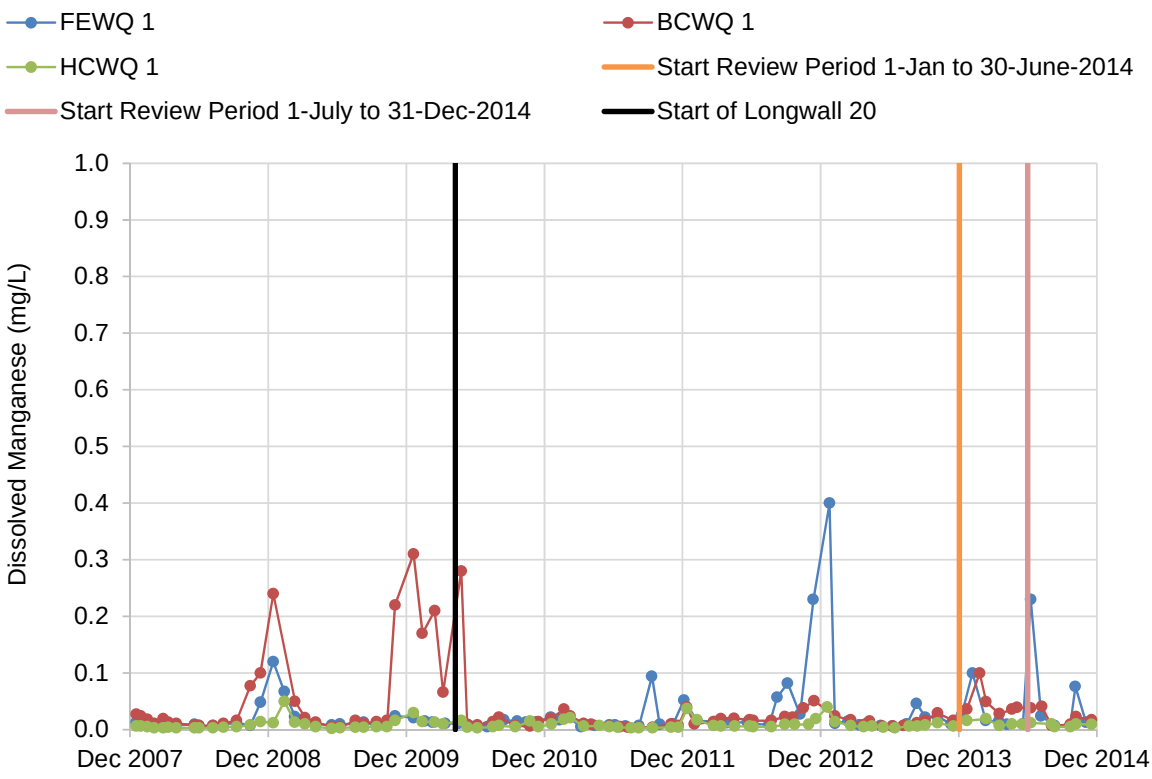

Chart A25 **Dissolved Manganese Concentrations Far Eastern Tributary, Bee Creek and Honeysuckle Creek**

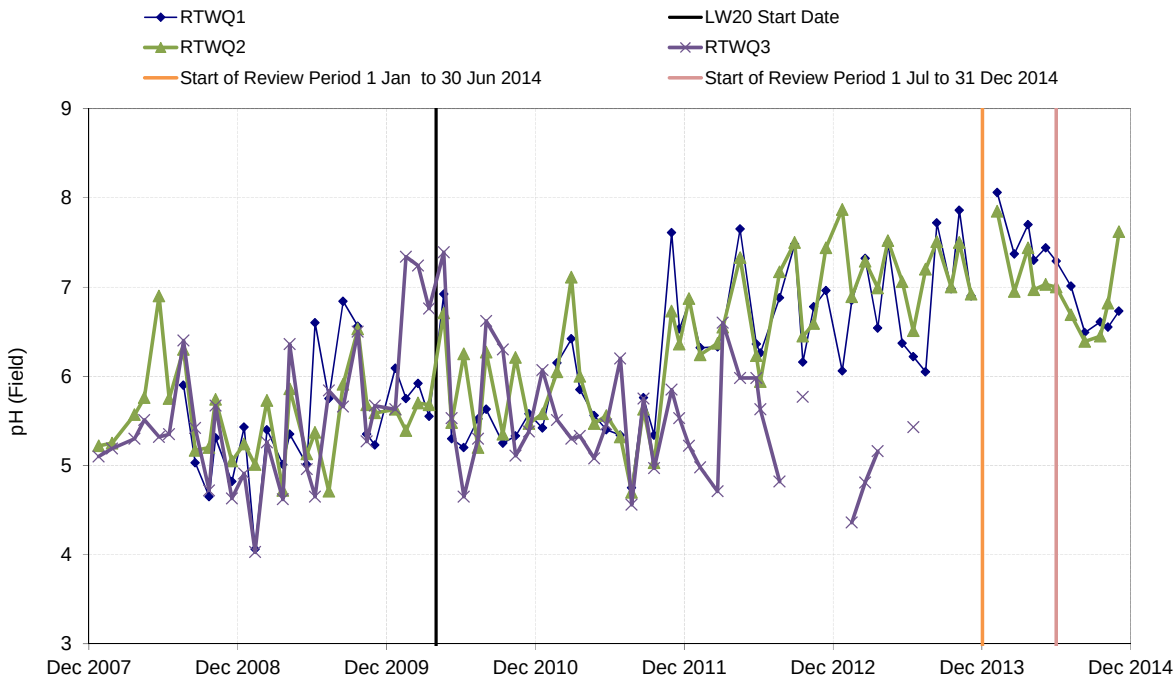

Chart A26 **pH Levels Tributary B**

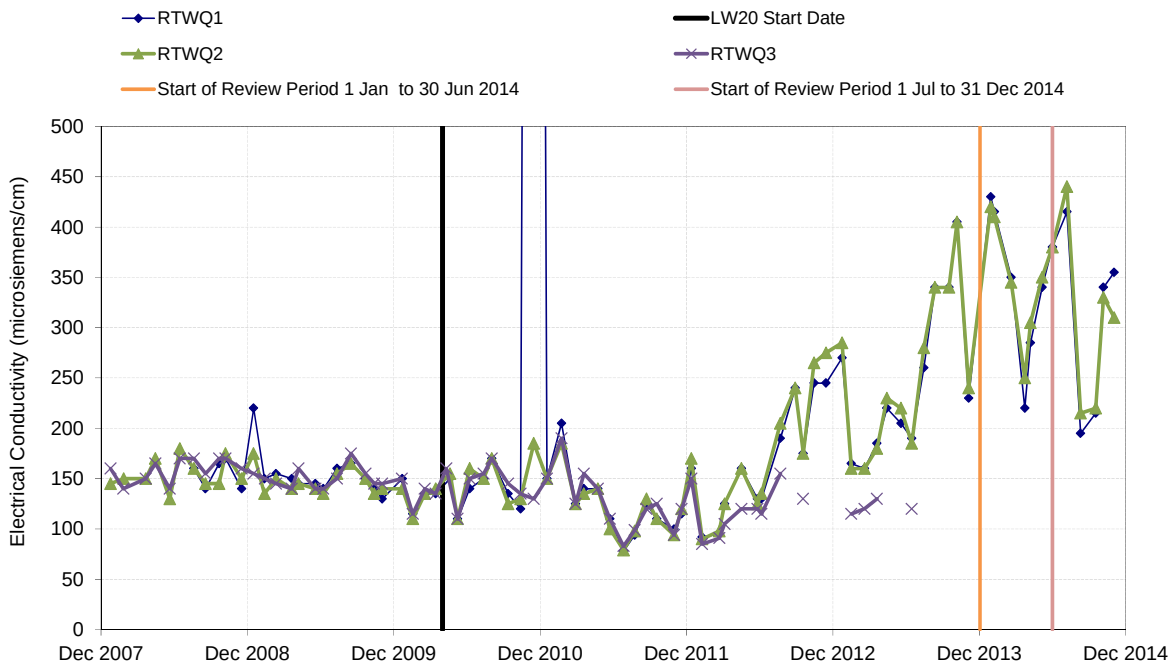

Chart A27 Electrical Conductivity (EC) Tributary B

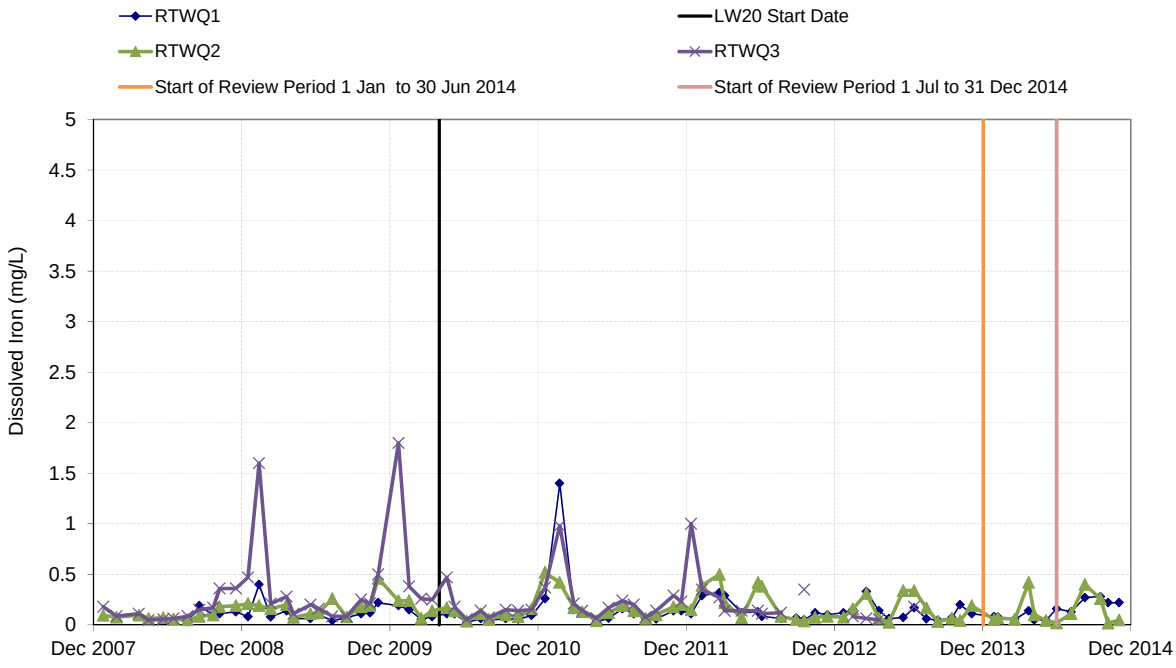

Chart A28 Dissolved Iron Tributary B

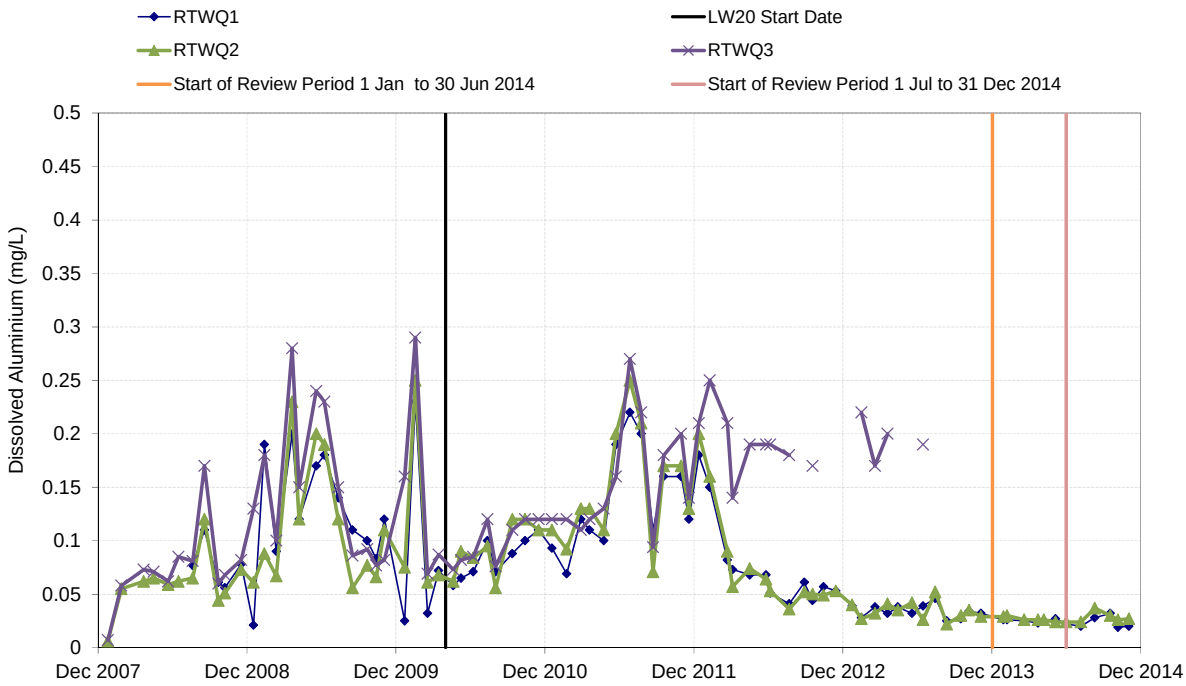

Chart A29 Dissolved Aluminium Tributary B

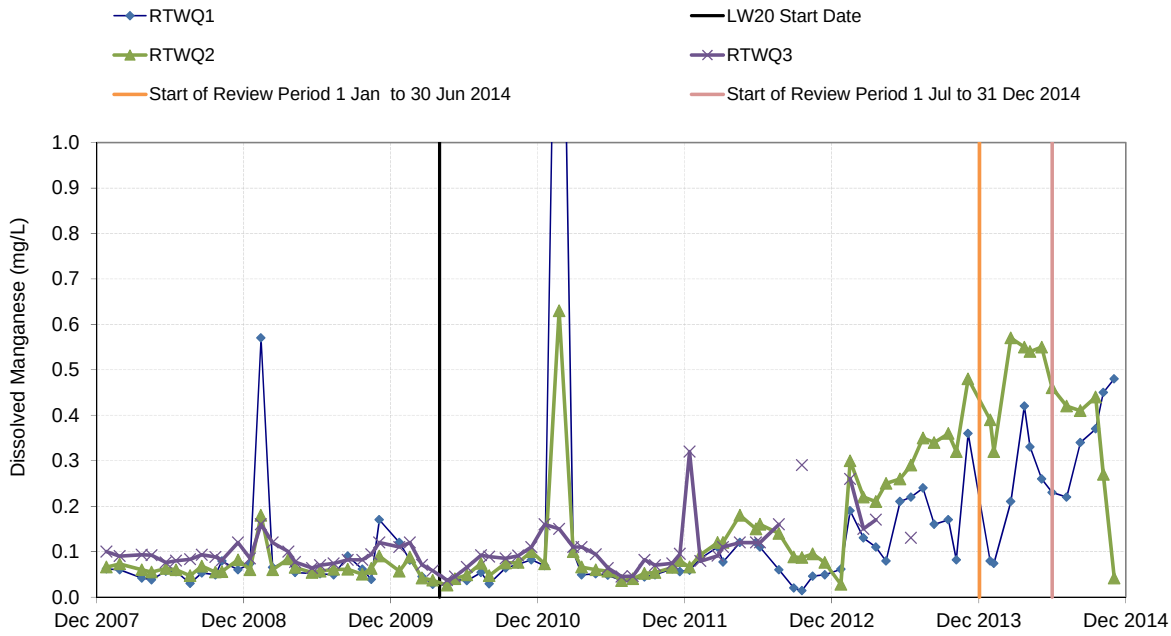

Chart A30 Dissolved Manganese Tributary B

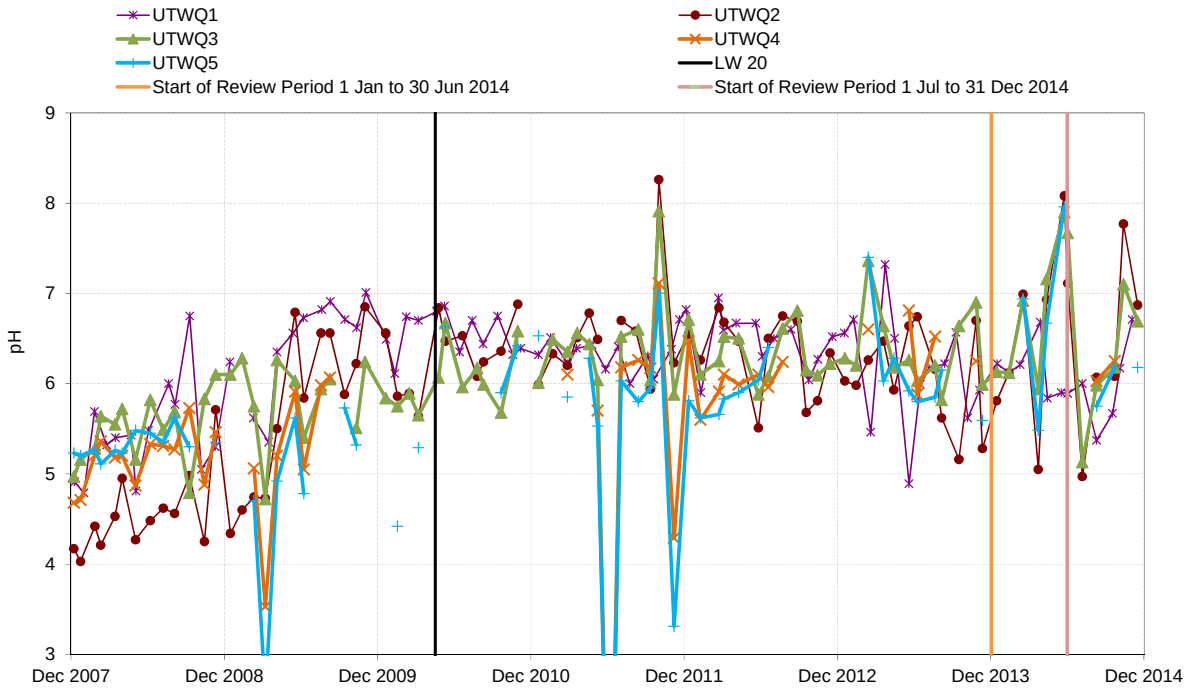

Chart A31 pH Levels Tributary D

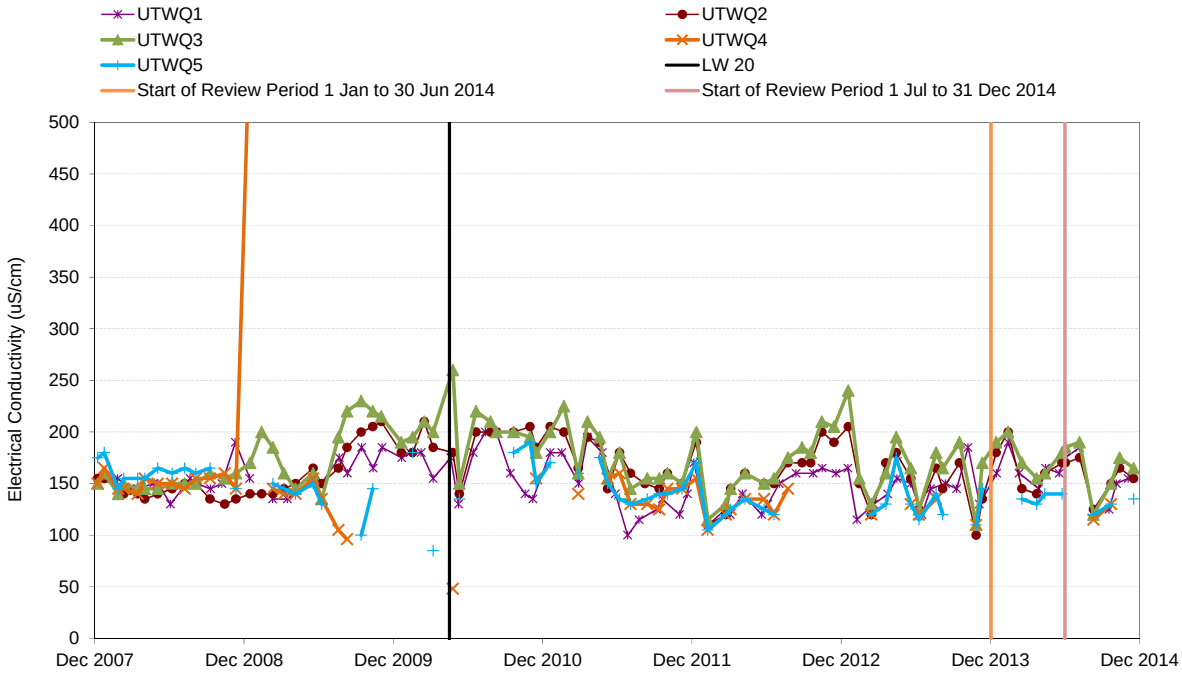

Chart A32 Electrical Conductivity (EC) Tributary D

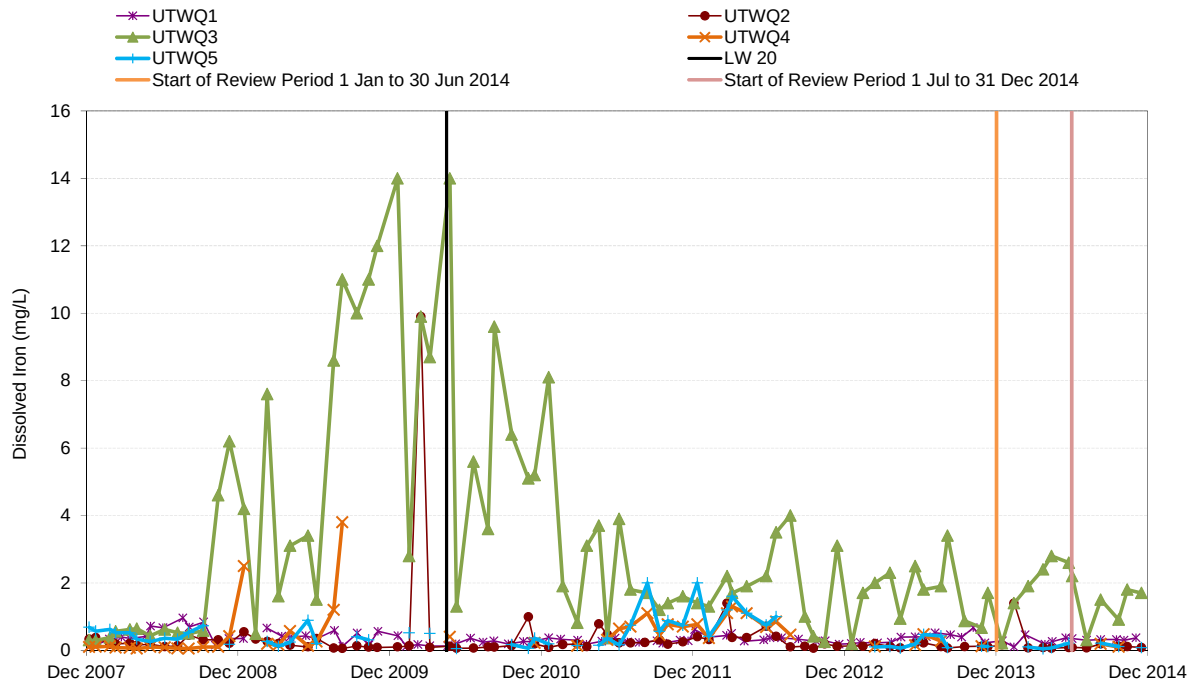

Chart A33 Dissolved Iron Tributary D

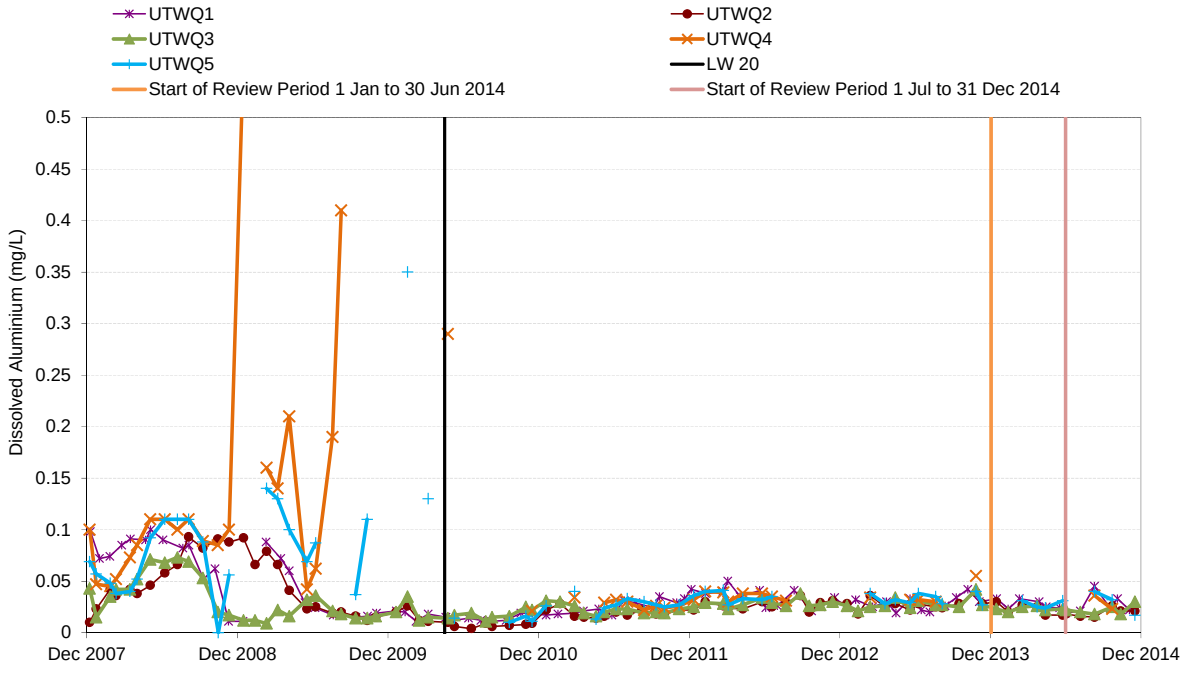

Chart A34 Dissolved Aluminium Tributary D

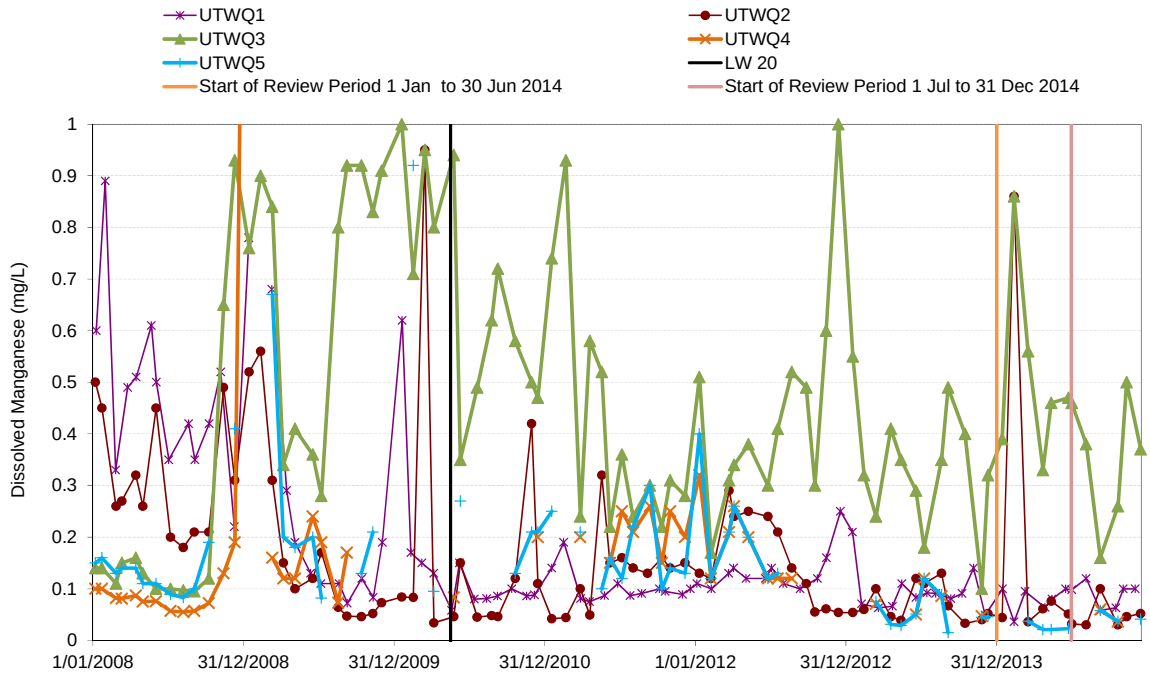

Chart A35 Dissolved Manganese Tributary D

APPENDIX B

WARATAH RIVULET POOL WATER LEVEL MONITORING RESULTS

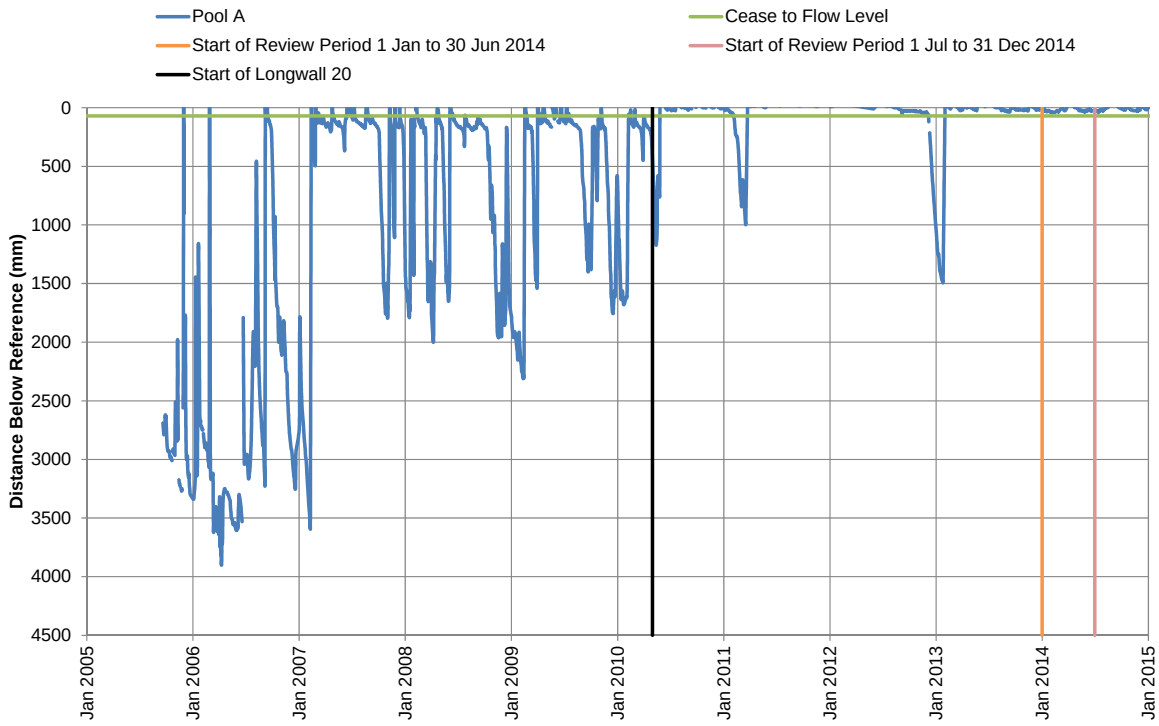

Chart B1 Waratah Rivulet Pool A Water Level Observations Compared with Cease to Flow Level

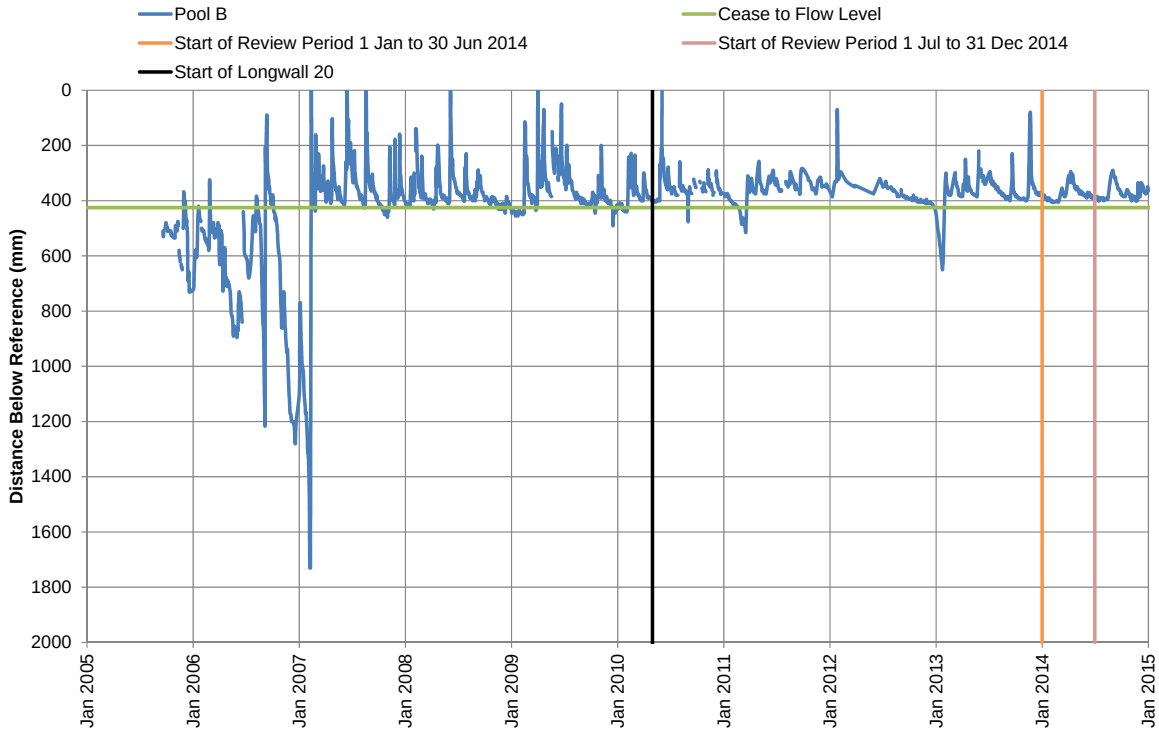

Chart B2 Waratah Rivulet Pool B Water Level Observations Compared with Cease to Flow Level

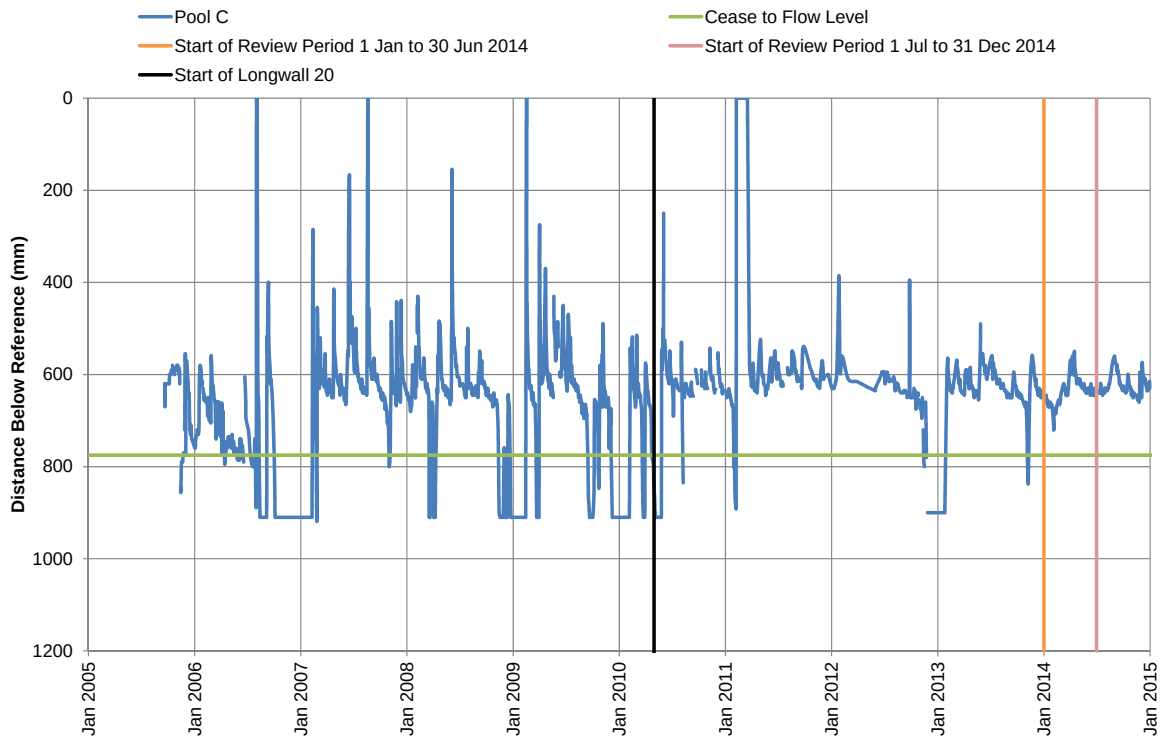

Chart B3 Waratah Rivulet Pool C Water Level Observations Compared with Cease to Flow Level

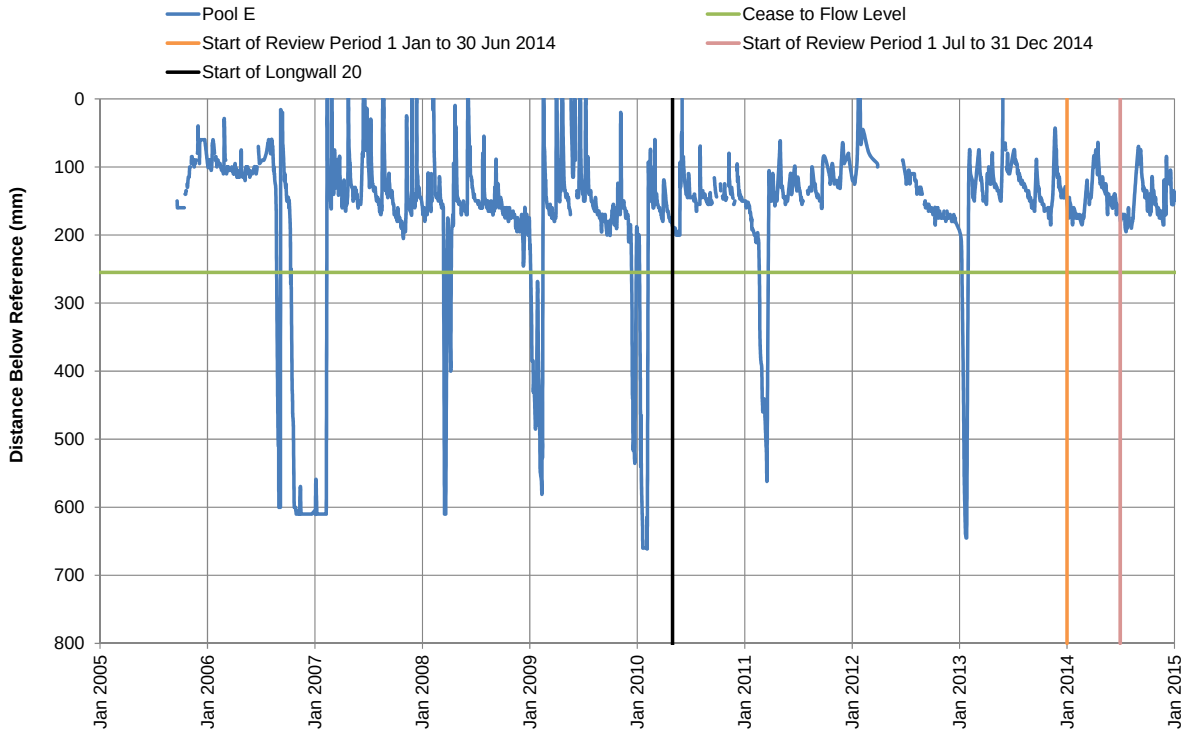

Chart B4 Waratah Rivulet Pool E Water Level Observations Compared with Cease to Flow Level

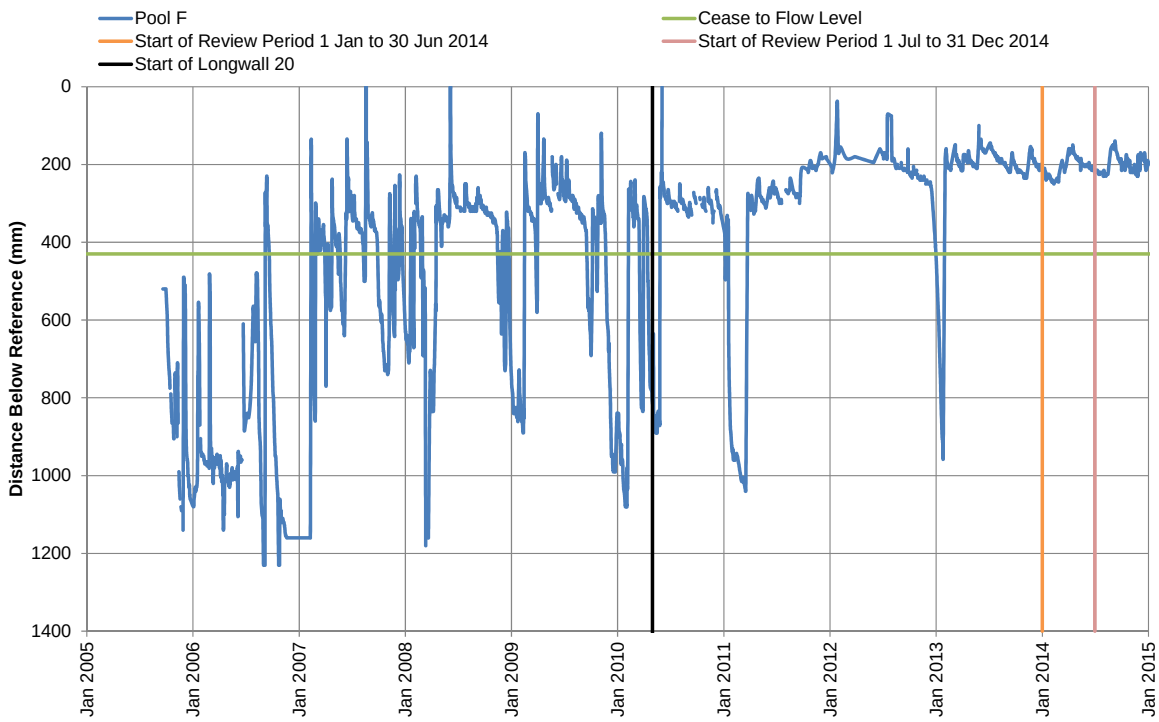

Chart B5 Waratah Rivulet Pool F Water Level Observations Compared with Cease to Flow Level

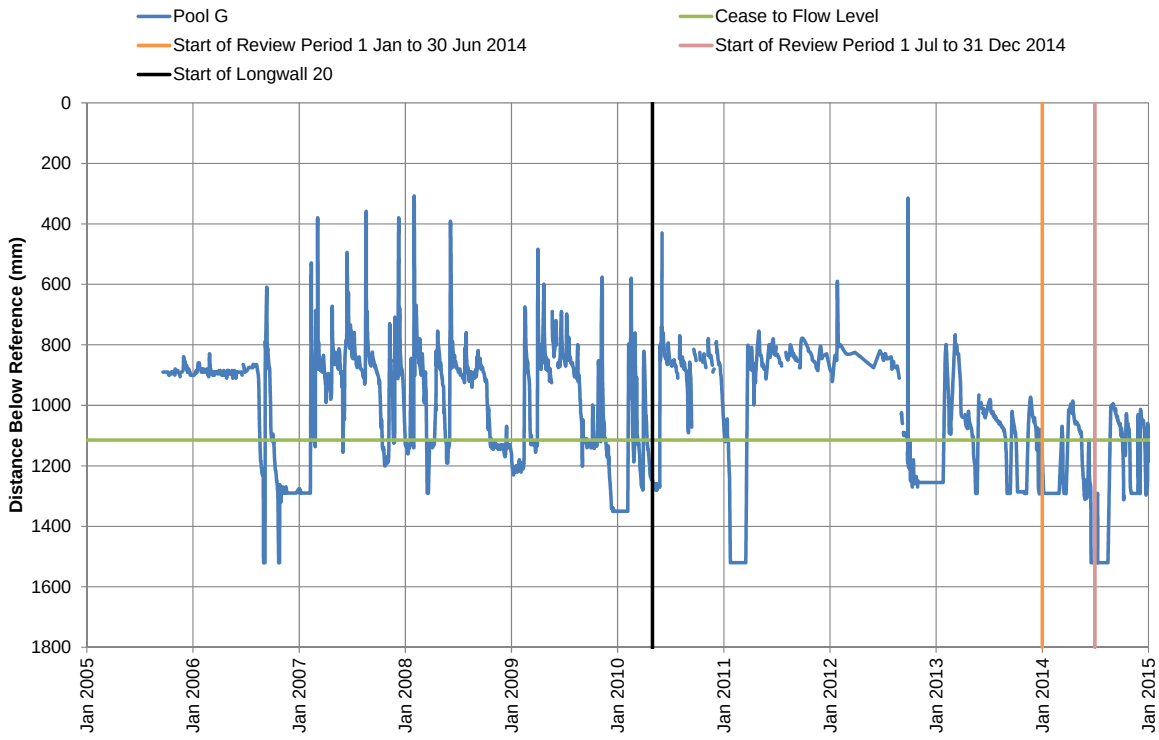

Chart B6 Waratah Rivulet Pool G Water Level Observations Compared with Cease to Flow Level

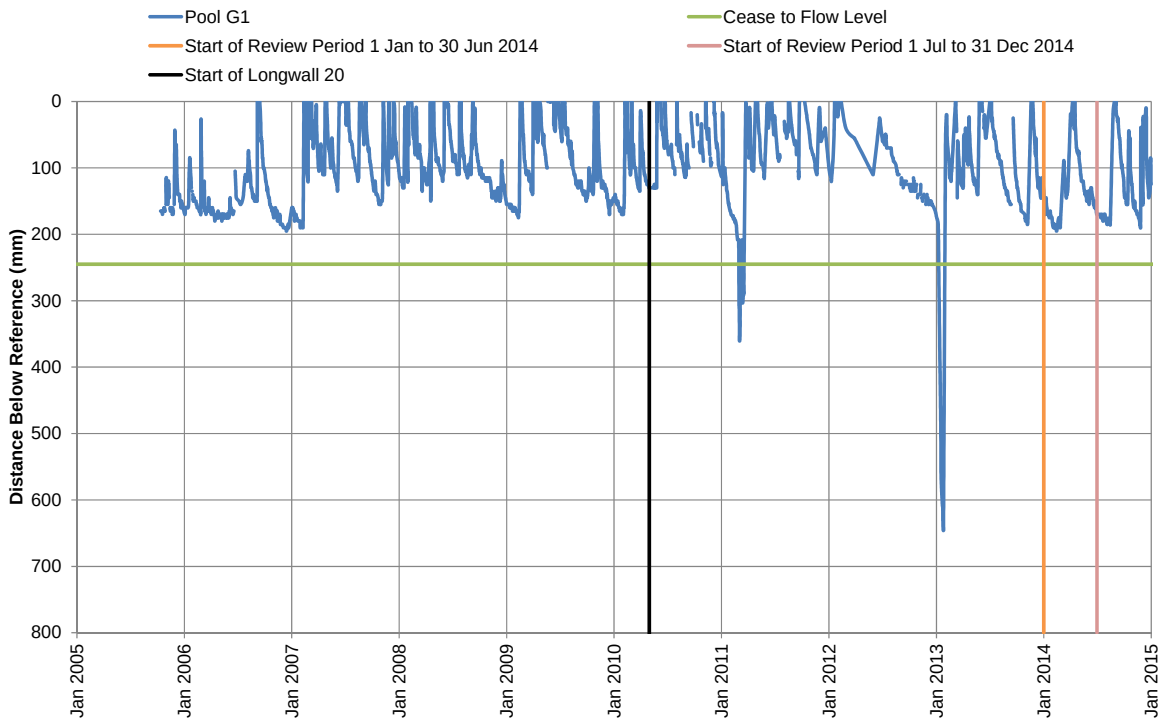

Chart B7 Waratah Rivulet Pool G1 Water Level Observations Compared with Cease to Flow Level

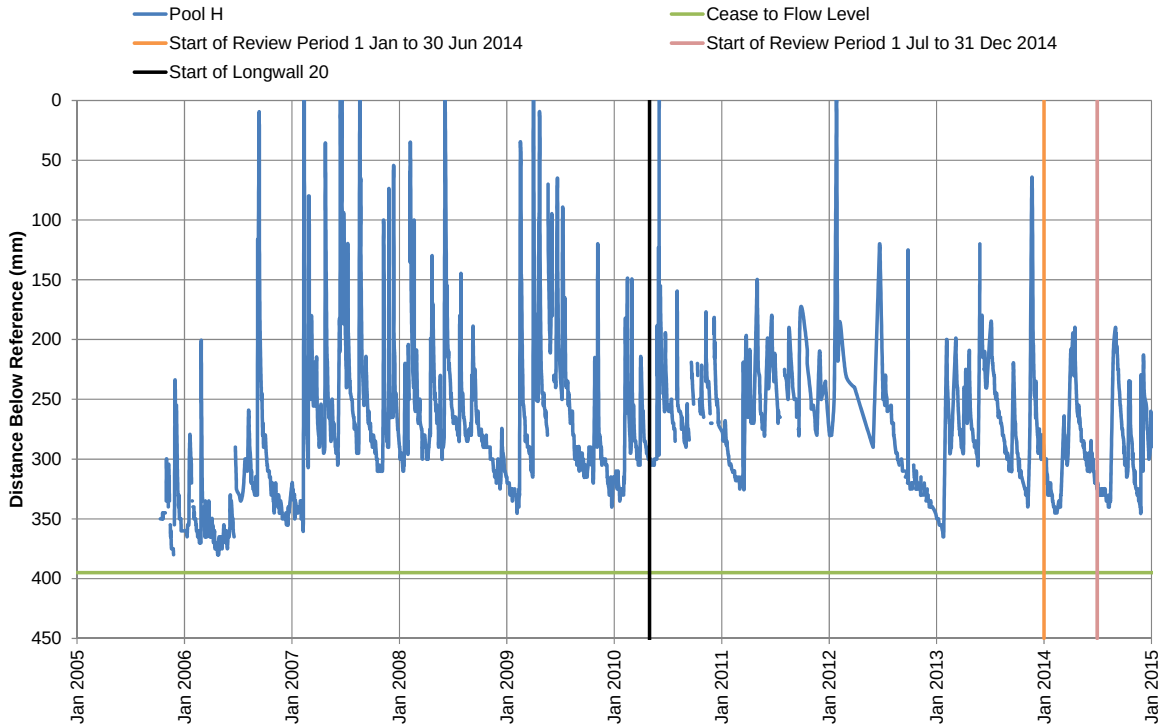

Chart B8 Waratah Rivulet Pool H Water Level Observations Compared with Cease to Flow Level

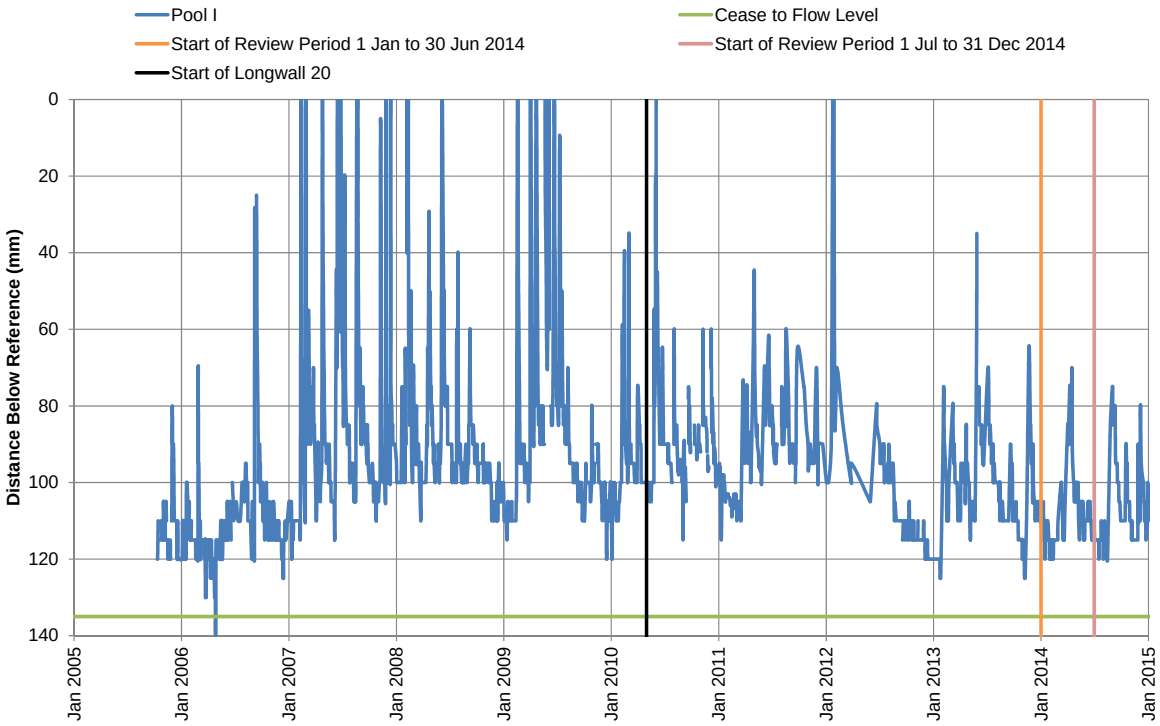

Chart B9 Waratah Rivulet Pool I Water Level Observations Compared with Cease to Flow Level

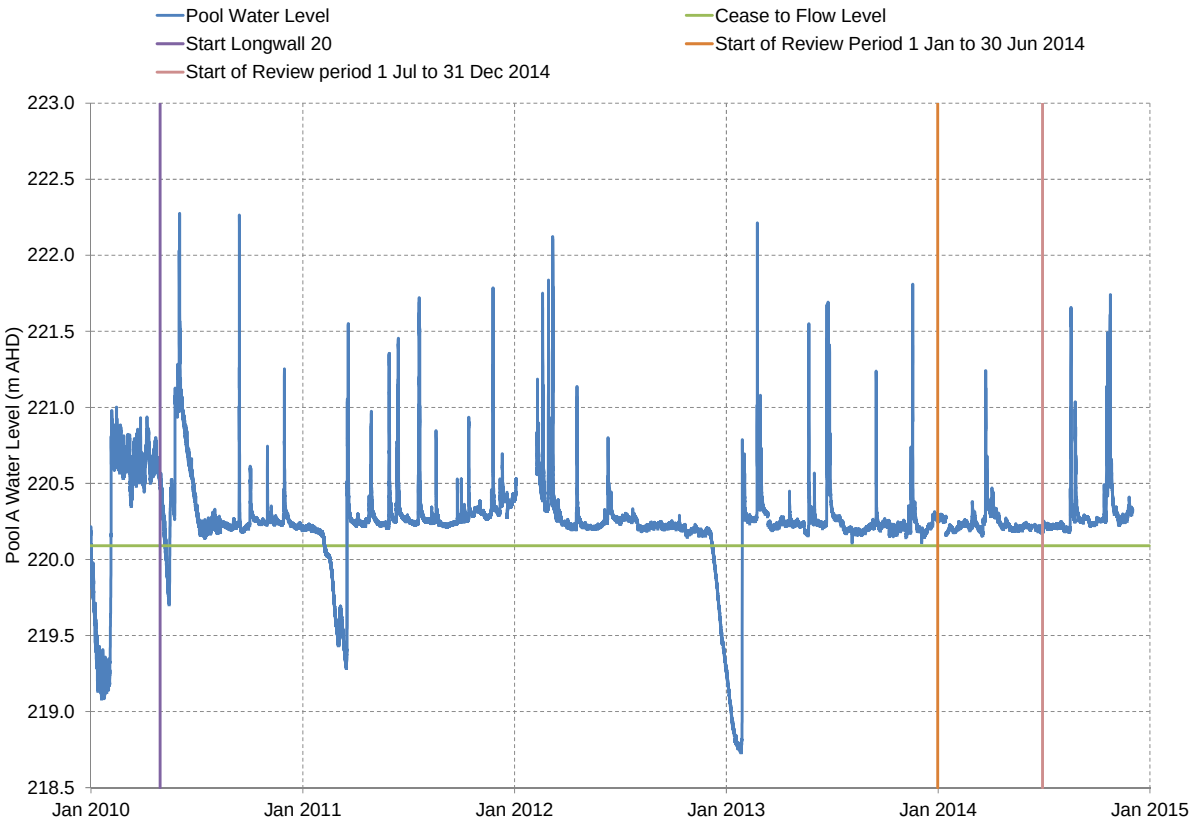

Chart B10 Waratah Rivulet Pool A - Recorded Pool Water Level

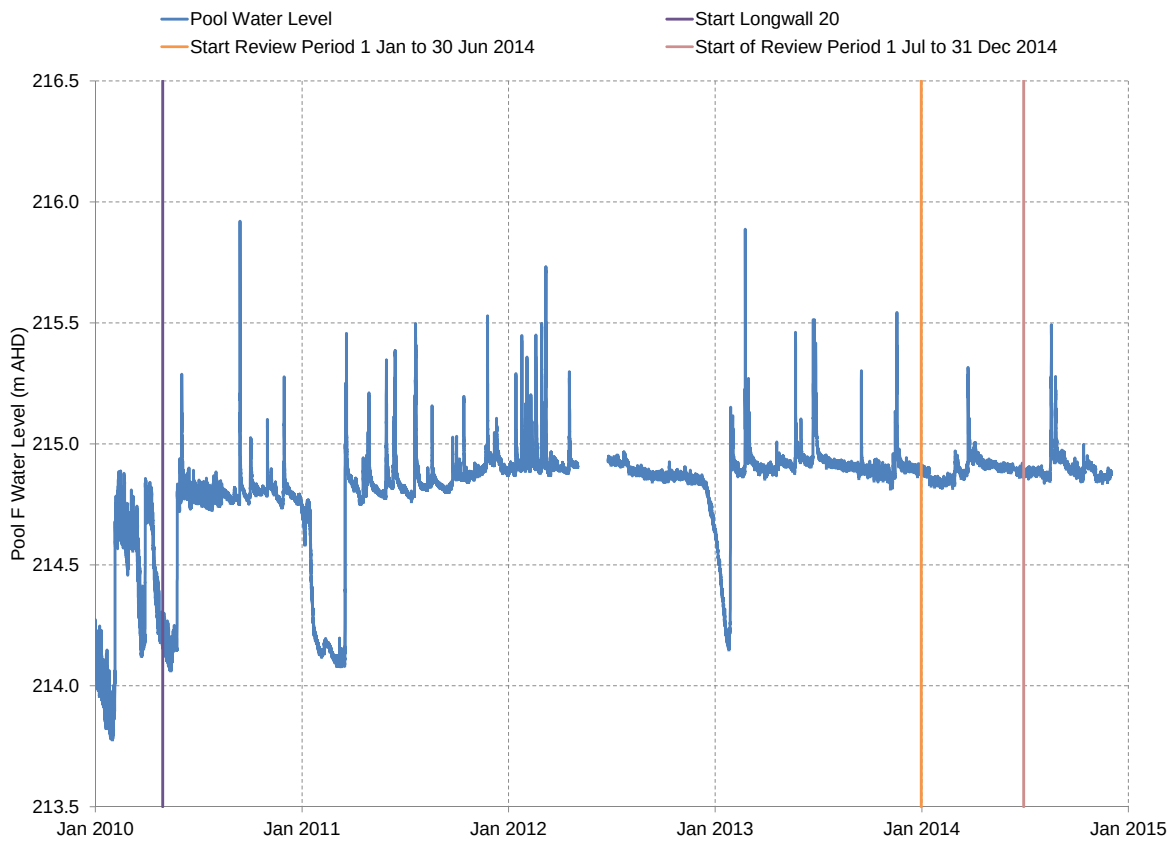

Chart B11 Waratah Rivulet Pool F - Recorded Pool Water Level

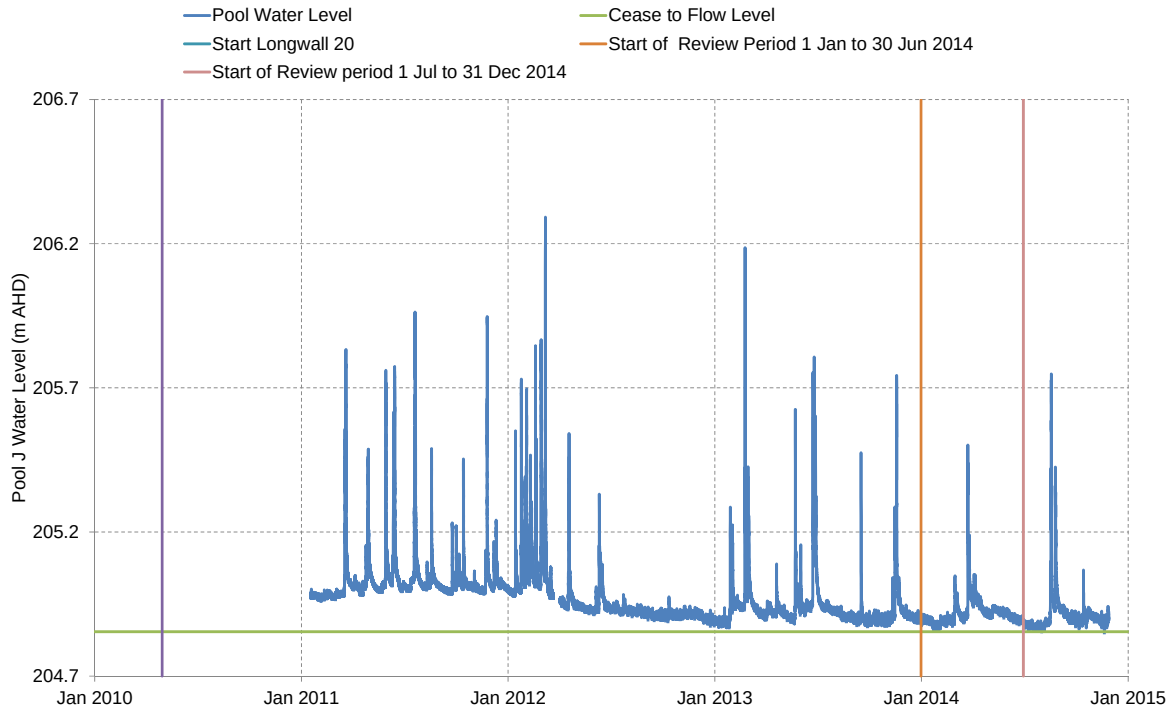

Chart B12 Waratah Rivulet Pool J - Recorded Pool Water Level

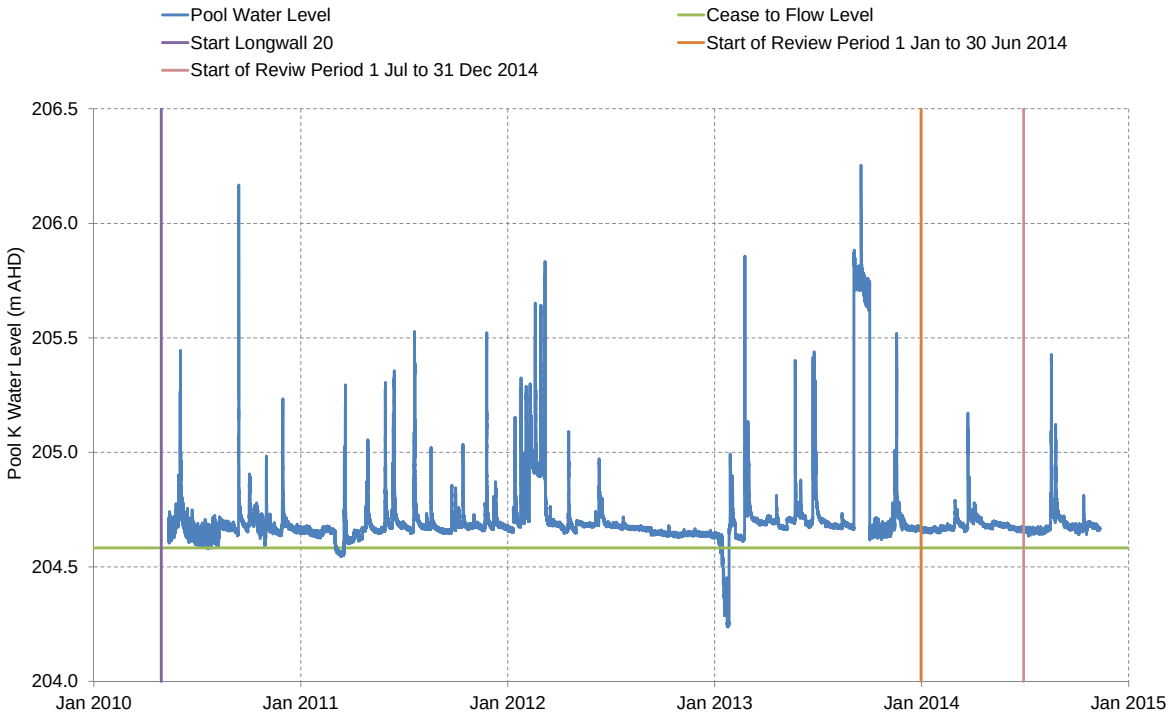

Chart B13 Waratah Rivulet Pool K - Recorded Pool Water Level

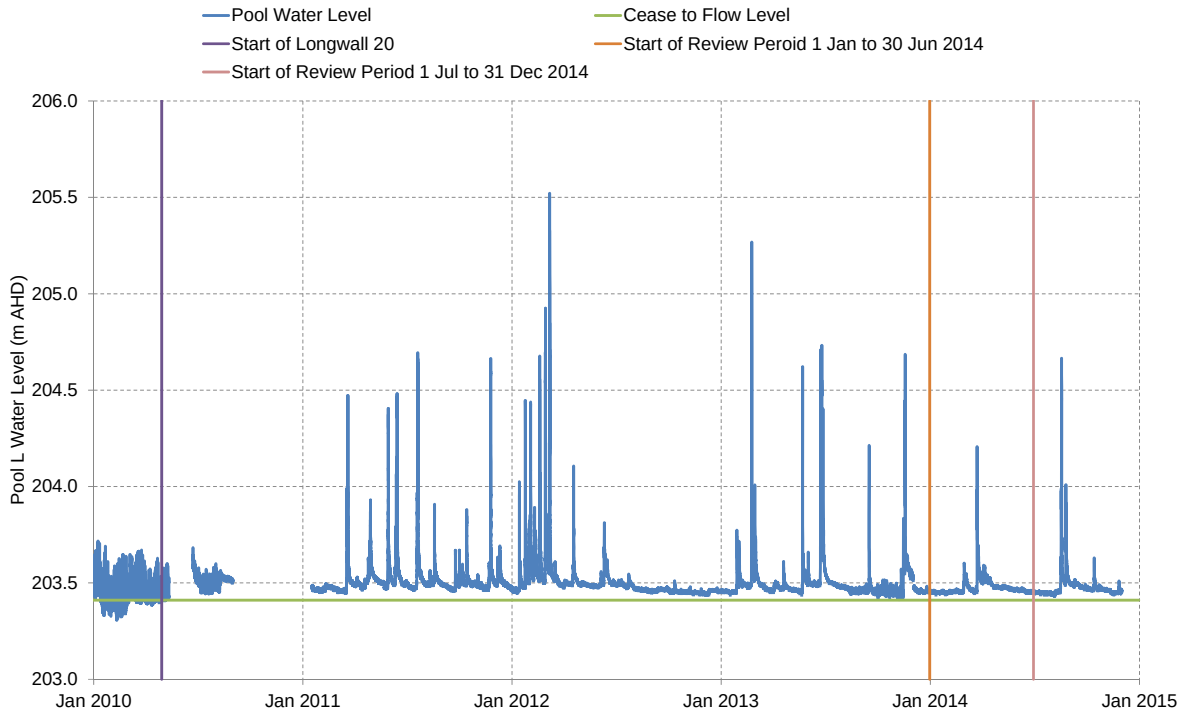

Chart B14 Waratah Rivulet Pool L - Recorded Pool Water Level

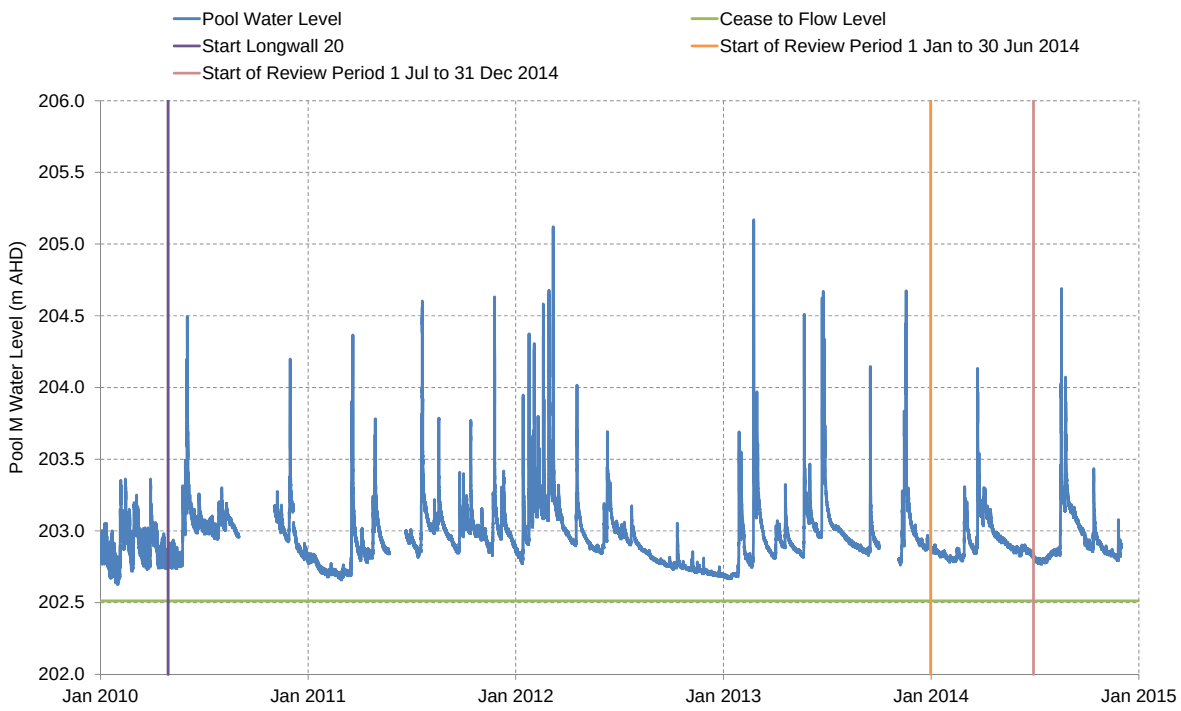

Chart B15 Waratah Rivulet Pool M - Recorded Pool Water Level

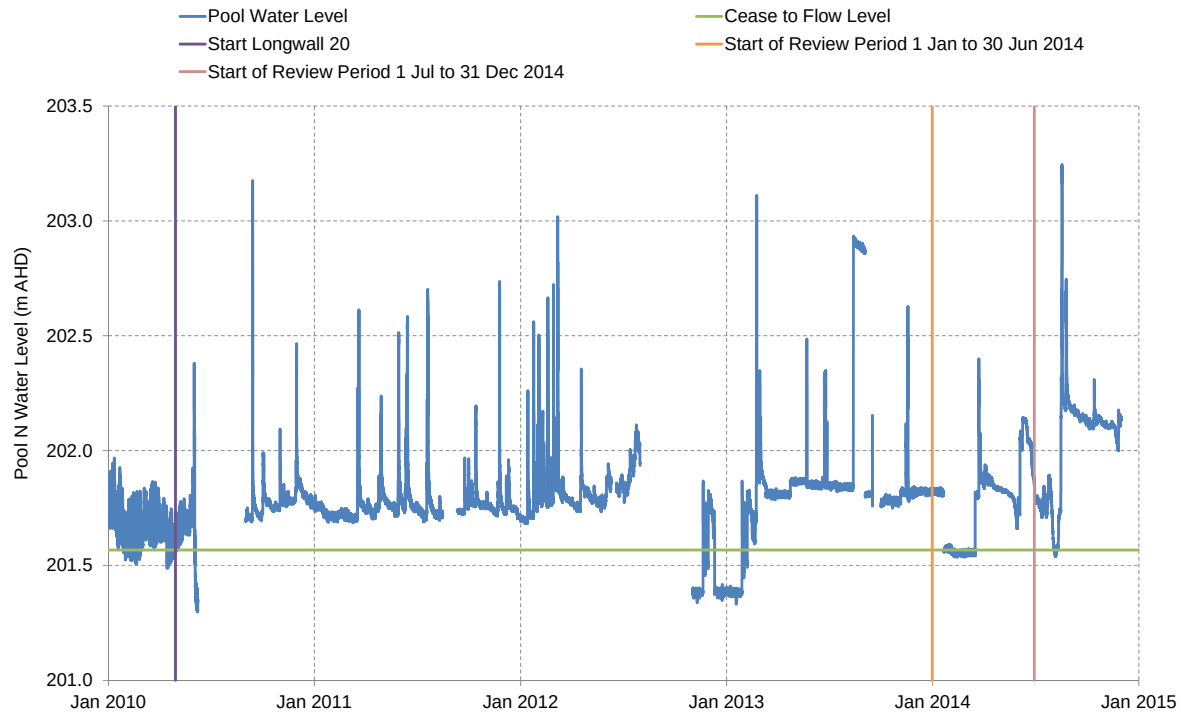

Chart B16 Waratah Rivulet Pool N - Recorded Pool Water Level

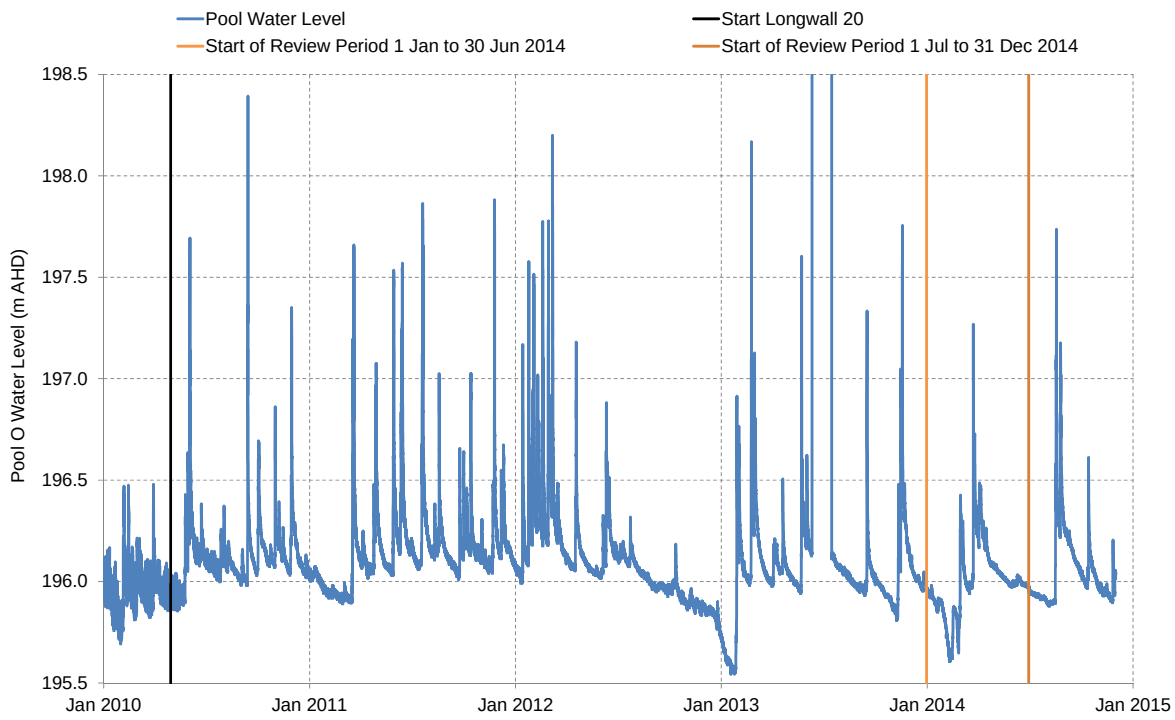

Chart B17 Waratah Rivulet Pool O - Recorded Pool Water Level

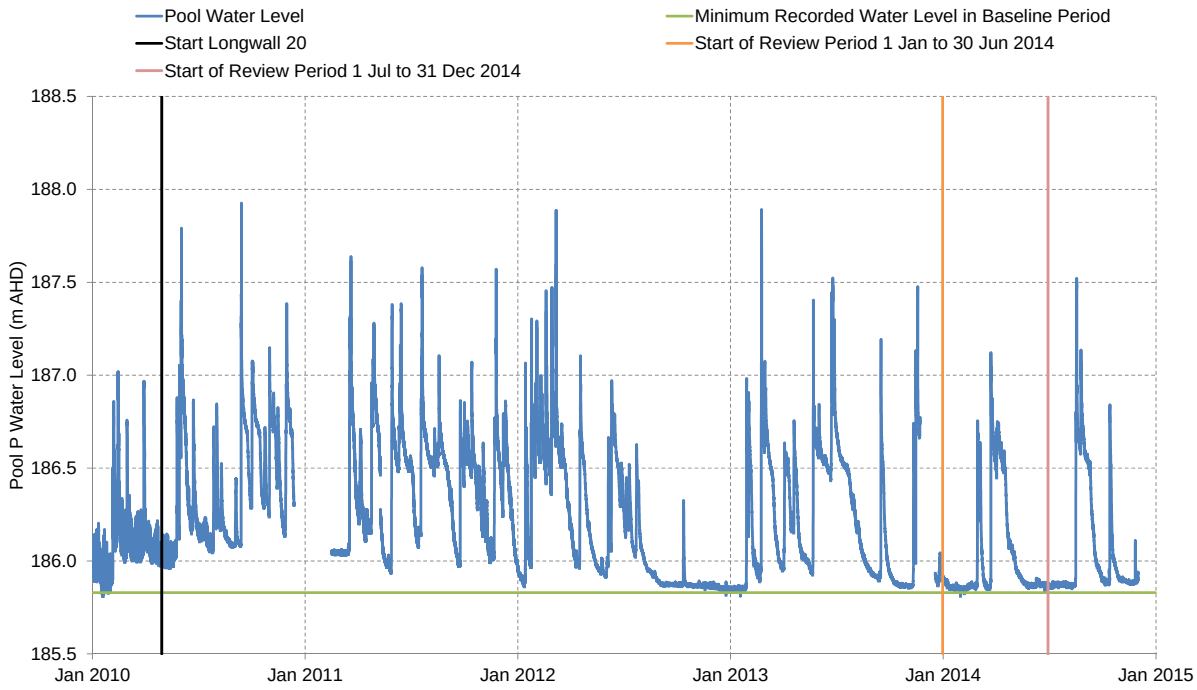

Chart B18 Waratah Rivulet Pool P - Recorded Pool Water Level

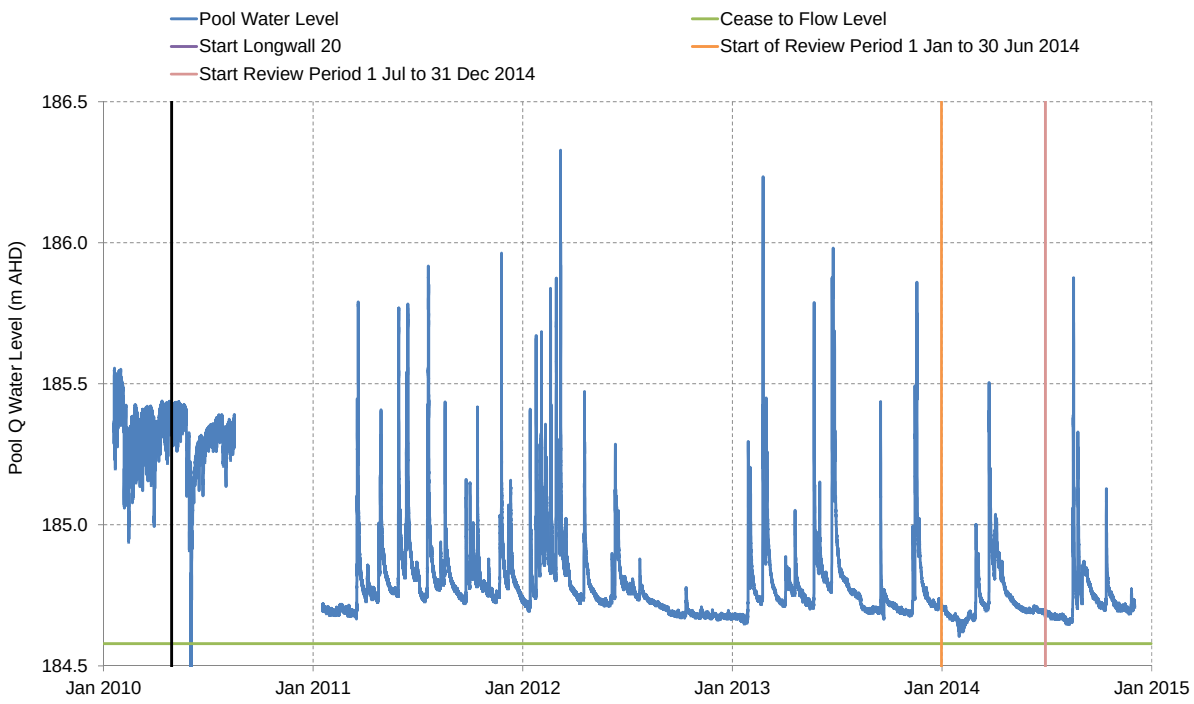

Chart B19 Waratah Rivulet Pool Q - Recorded Pool Water Level

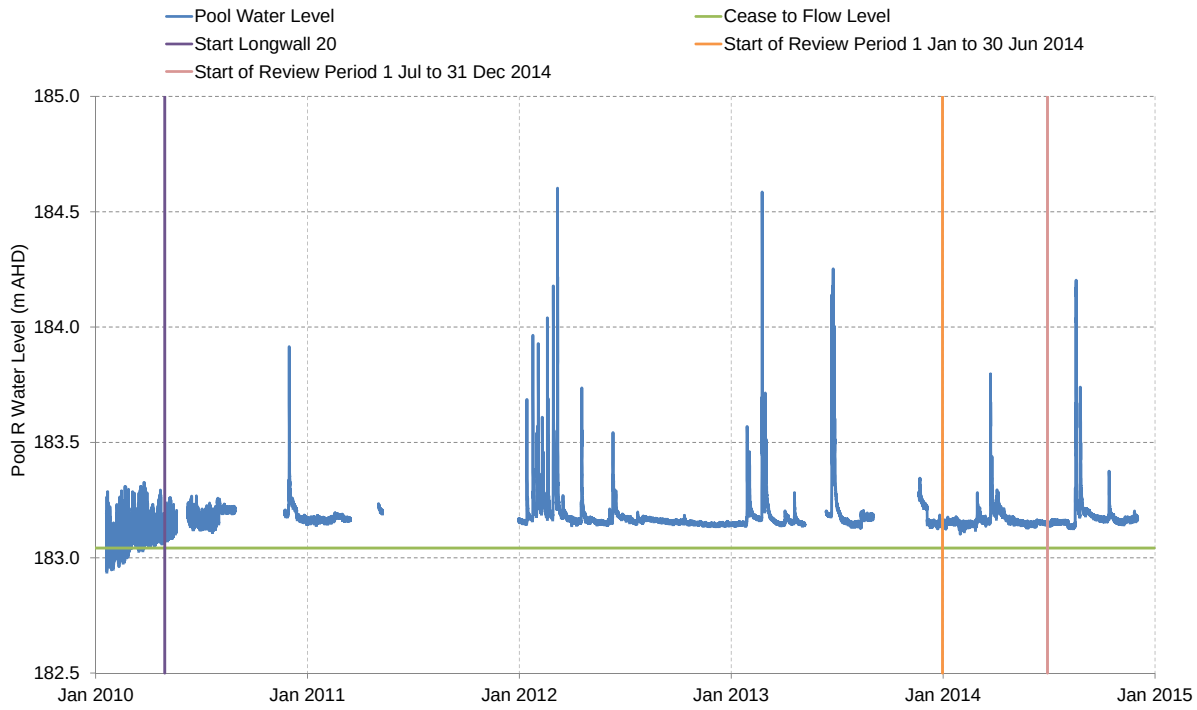

Chart B20 Waratah Rivulet Pool R - Recorded Pool Water Level

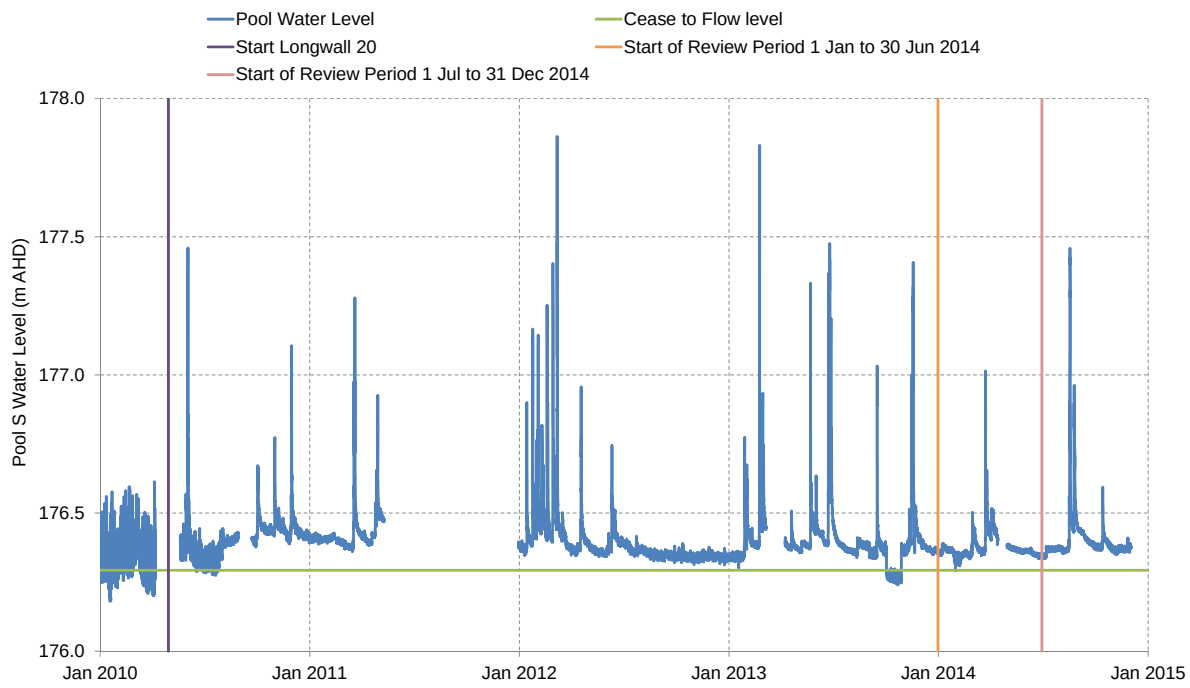

Chart B21 Waratah Rivulet Pool S - Recorded Pool Water Level

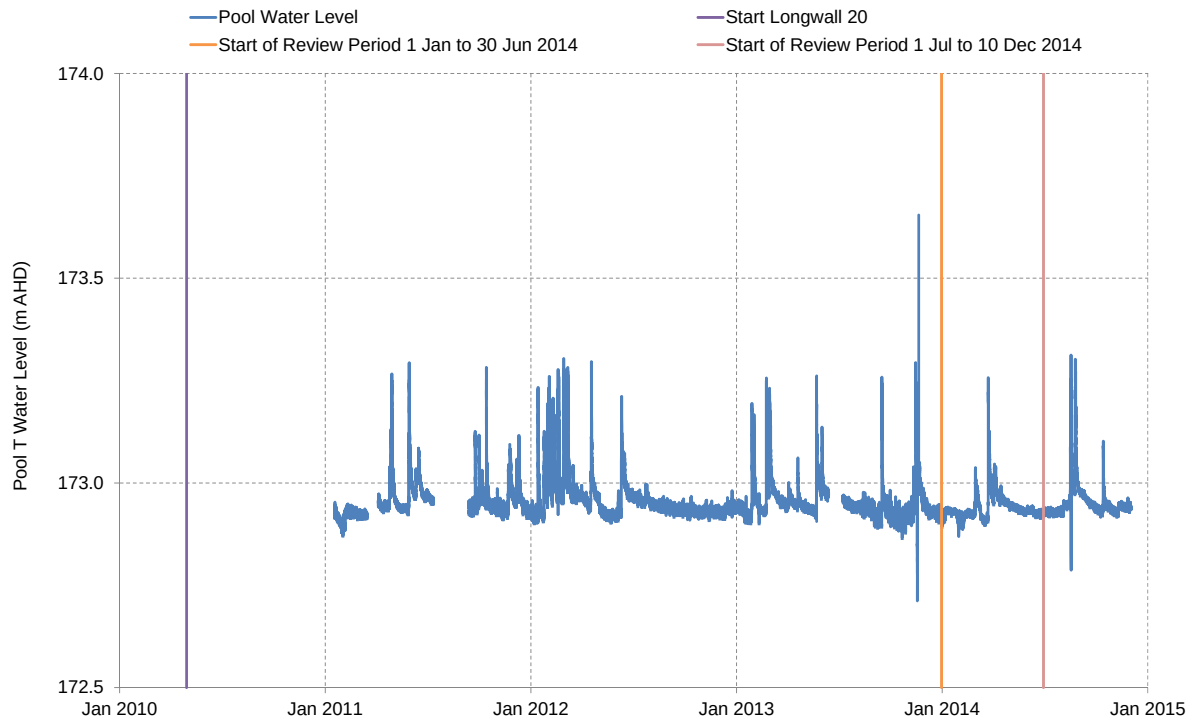

Chart B22 Waratah Rivulet Pool T - Recorded Pool Water Level

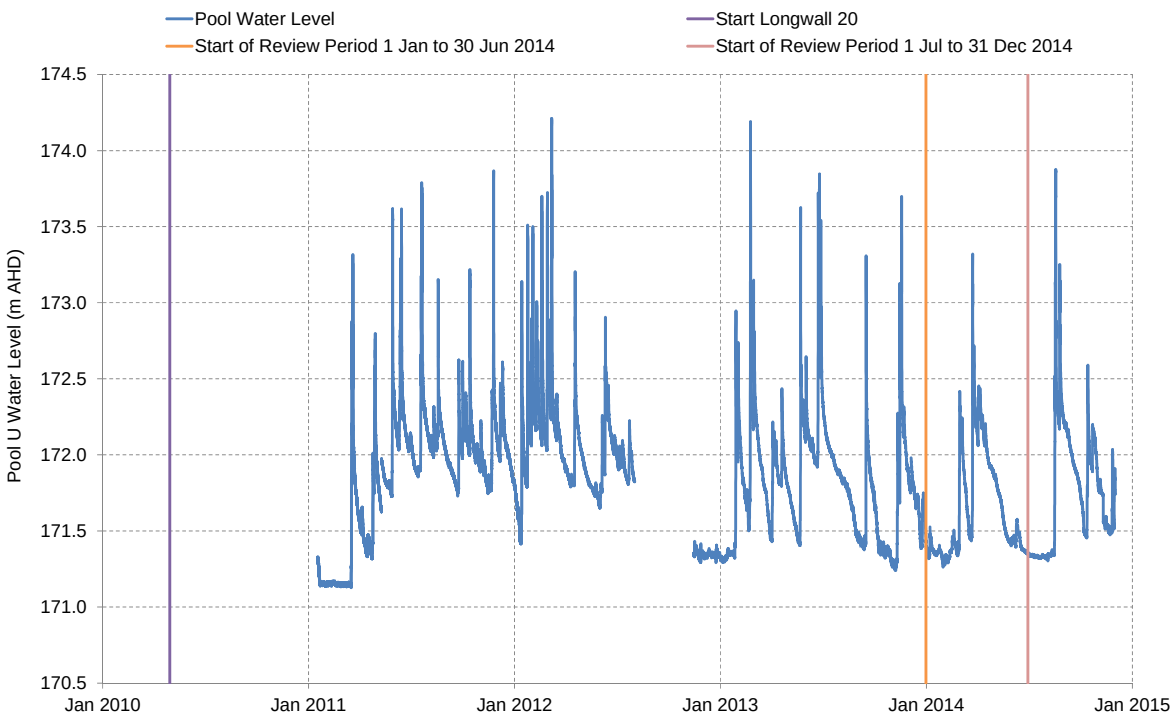

Chart B23 Waratah Rivulet Pool U - Recorded Pool Water Level

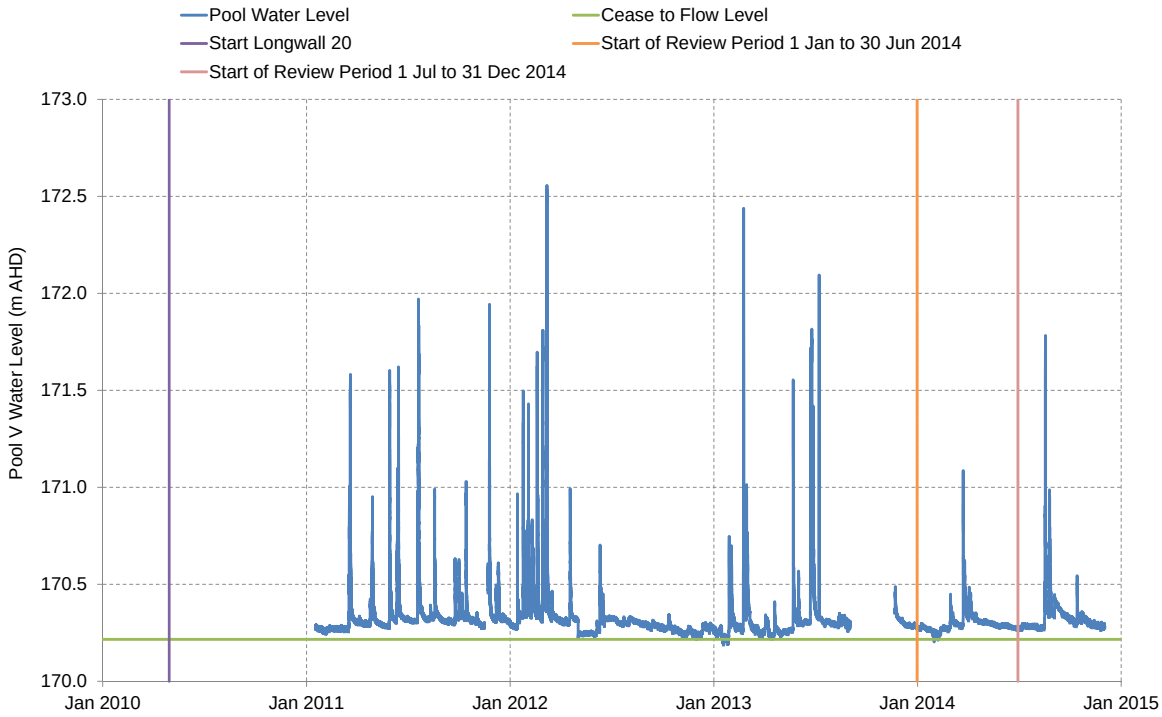

Chart B24 Waratah Rivulet Pool V - Recorded Pool Water Level

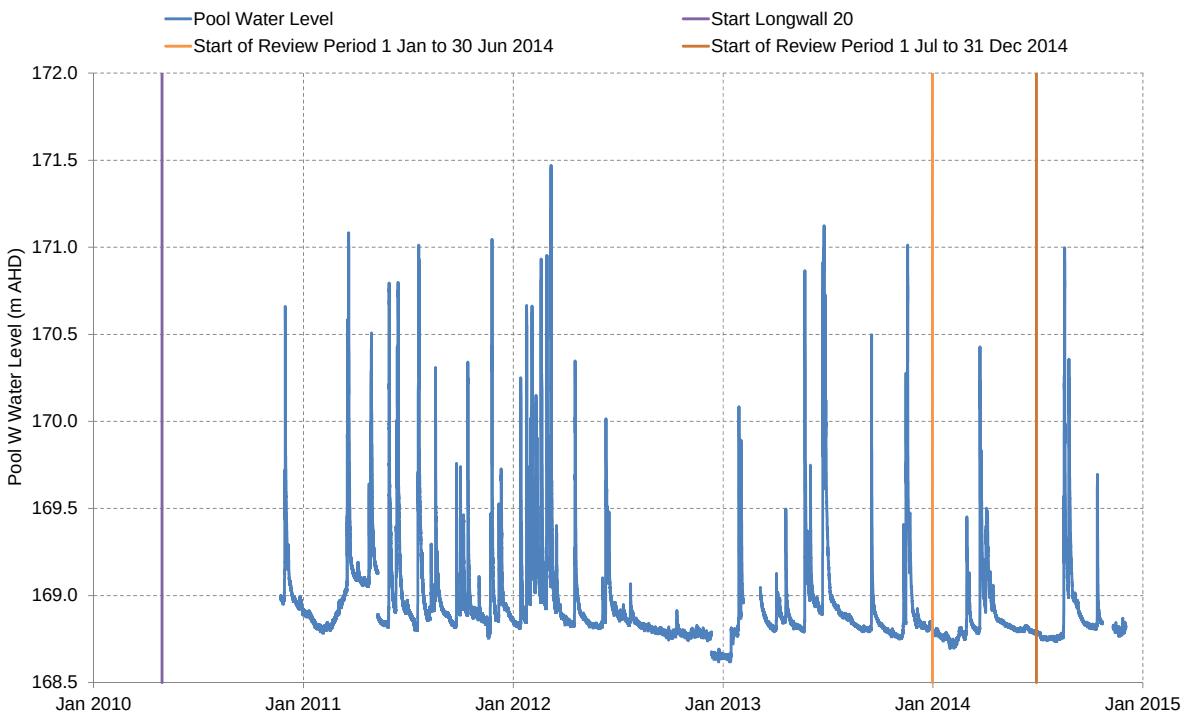

Chart B25 Waratah Rivulet Pool W - Recorded Pool Water Level