Groundwater

The conceptual model developed of the hydrogeological regime at Metropolitan Coal supports three distinct groundwater systems, including:

- Perched groundwater system – generally above and independent of the regional groundwater table.
- Shallow groundwater system – the shallow groundwater system is separate from the perched groundwater system and defines a regional water table.
- Deep groundwater system – although the shallow and deep groundwater systems are connected, low permeability of the Bald Hill Claystone provides a degree of isolation between the Hawkesbury Sandstone that hosts shallow groundwater and the underlying Bulgo Sandstone and deeper formations that host deep groundwater.

Metropolitan Coal's groundwater monitoring program includes monitoring of:

- swamp groundwater levels;
- shallow groundwater levels;
- deep groundwater levels/pressures;
- groundwater quality;
- inspections of mine workings; and
- mine water make.

Swamp Groundwater Levels

Groundwater monitoring of upland swamps has involved the use, where practicable, of paired piezometers, one in the swamp substrate and one sandstone piezometer. Piezometers have been installed in the following upland swamps overlying Longwalls 20-22 and in control locations (Figure 1):

- Valley side Swamps 16/17 (S16/S17) overlying Longwalls 20-22 (sandstone piezometer to a depth of 10 metres [m]).
- Valley side Swamp 25 (S25) overlying Longwalls 20-22 (swamp substrate piezometer to a depth of 0.9 m and sandstone piezometer to a depth of 10 m).
- Valley side Swamp 101 (S101) (control - swamp substrate piezometer to a depth of 0.9 m and sandstone piezometer to a depth of 10 m).
- In-valley Swamp 20 (S20) overlying Longwalls 20-22 (swamp substrate piezometer to a depth of 0.9 m and sandstone piezometers to depths of 4 m and 10 m).
- Headwater Swamp Woronora River 1 (WRSWAMP1) (control - swamp substrate piezometer to a depth of 0.9 m and sandstone piezometers to depths of 4 m and 10 m).

Longer-term groundwater level data for upland swamps has also been acquired with single swamp substrate piezometers at sites SWAMP1, SWAMP2 and SWAMP3, and paired piezometers at sites SWAMP4 and SWGW1 (Figure 1).

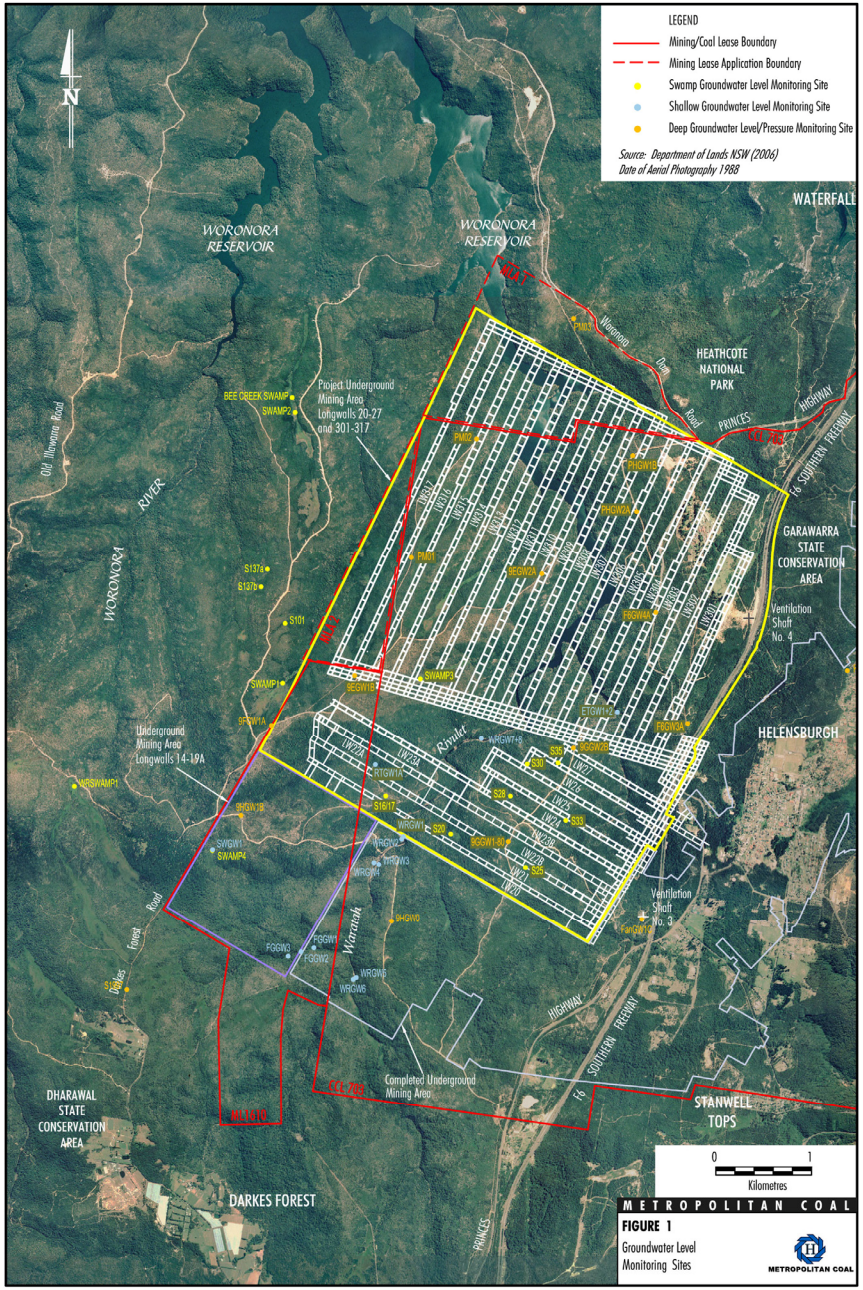
The swamp groundwater monitoring results are described in the Biodiversity Environmental Monitoring Summary.

Shallow Groundwater Levels

Continuous water level monitoring of shallow groundwater levels has been conducted at sites WRGW1 and WRGW2 along Waratah Rivulet upstream of Longwall 20, site RTGW1A on Tributary B over Longwall 22A, site WRGW7 and WRGW8 along Waratah Rivulet approximately 800 m downstream of Longwall 22, and sites ETGW1 and ETGW2 on the Eastern Tributary approximately 1.8 km downstream of Longwall 22 (Figure 1).

Sites WRGW1 and WRGW2 are located on opposite banks of the Waratah Rivulet, to the immediate south of Longwall 20 (Figure 1) and show comparable information over the reporting period. 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. No similar response was observed with the passage of Longwall 20 a year earlier. Water levels recovered by about 0.5 m at the end of 2012 but fell again slightly (by about 0.3 m) when the Longwall 22A face was closest to the monitoring sites (at a distance of approximately 500 m).

All Waratah Rivulet piezometers (i.e. WRGW1 to WRGW8, Figure 1) show the same dynamic responses to stream flow interaction and rainfall, with rapid response to rainfall events. Downgradient site WRGW8 does not exhibit the rapid recession observed at the other sites on the rivulet. Upgradient sites (WRGW3 to WRGW6) have the greater response amplitude.



The downgradient sites on the Eastern Tributary (ETGW1 and ETGW2) (Chart 2) had a decrease in water level of about 2 m in the first three months of the reporting period (August to December 2012), due to drier conditions. In 2013 the piezometers responded to a period of higher rainfall by rising 2-3 m. The variations at these sites are not related to mining.

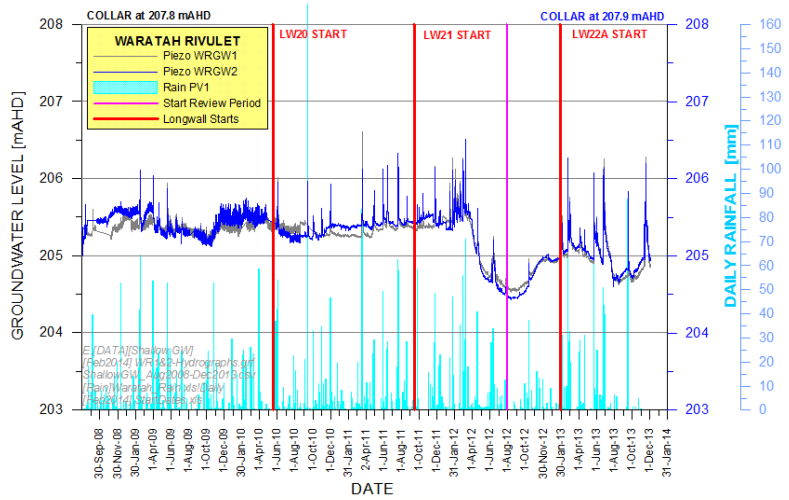


Chart 1 Shallow Groundwater Hydrographs on at WRGW1 and WRGW2

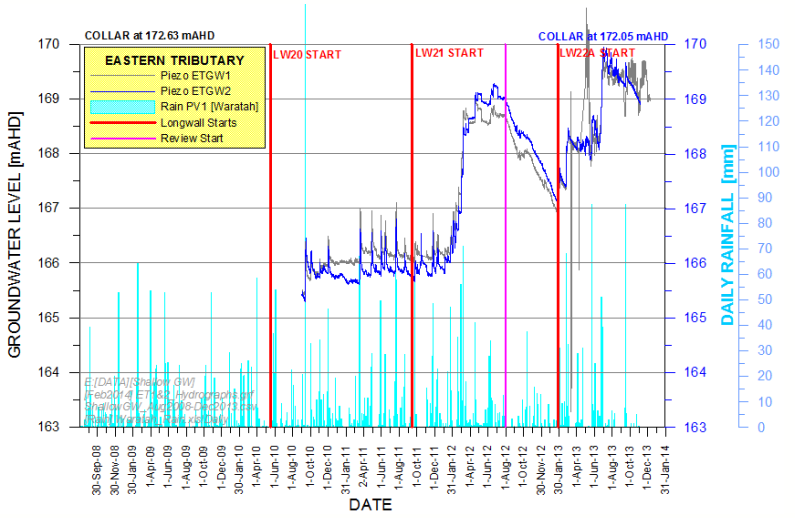


Chart 2 Shallow Groundwater Hydrographs at ETGW1 and ETGW2

Deep Groundwater Levels/Pressures

Continuous groundwater level/pressure monitoring has been conducted at bores 9EGW1B, 9EGW2A, 9FGW1A, 9GGW1B, 9GGW2B, 9HGW0 (Longwall 10 Goaf Hole), 9HGW1B, PHGW1B, PHGW2A, PM01, PM02, PM03, F6GW3A and F6GW4A (Figure 1).

The measured vertical hydraulic head profiles for these bores have been examined and selected stable bores compared against the predicted vertical hydraulic head profiles by Dr Noel Merrick, 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 Environmental Assessment (EA);
- sites close to old workings at Helensburgh show substantial depressurisation with depth, consistent with the Project EA; and
- the pressure reductions with depth agree well with model predictions.

Groundwater Quality

Shallow groundwater quality has been sampled monthly at sites WRGW1, WRGW2 and WRGW7 along the Waratah Rivulet, site RTGW1A adjacent to Tributary B and site ETGW1 on the Eastern Tributary.

Water quality parameters sampled include electrical conductivity, pH, redox potential, calcium, magnesium, sodium, potassium, chloride, sulphate, bicarbonate, barium, strontium, manganese, iron, zinc, cobalt and aluminium. The samples collected for the analysis of cations, anions and metals have been field filtered.

The key observations at the Waratah Rivulet groundwater quality monitoring sites are:

- Iron concentrations are usually in the 1 - 10 milligrams/litre (mg/L) range.
- Peak value iron concentrations of 14 mg/L have occurred at WRGW1 and WRGW2, with a peak of 12 mg/L in the reporting period.
- Manganese concentrations are always less than 1 mg/L.
- Groundwater is generally acidic with pH usually between pH 5.5 and 7.
- Aluminium was below the detection limit in all samples.
- There is no evidence of irregular behaviour during the mining of Longwall 21 (from September 2011) or Longwall 22 (from January 2013).

Inspections of Mine Workings and Mine Water Make

Metropolitan Coal conducts inspections of mine workings and monitors mine water make as indicators of potential connective cracking from the surface to the mine.

The inspections of mine workings have not identified any abnormal water flows from the goaf, geological structure, or strata generally.

Monitoring of the mine water balance includes calculation of the inferred water make. 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 run-of-mine coal). The average daily water make during the reporting period was 0.081 megalitres per day (ML/day) (Chart 3).

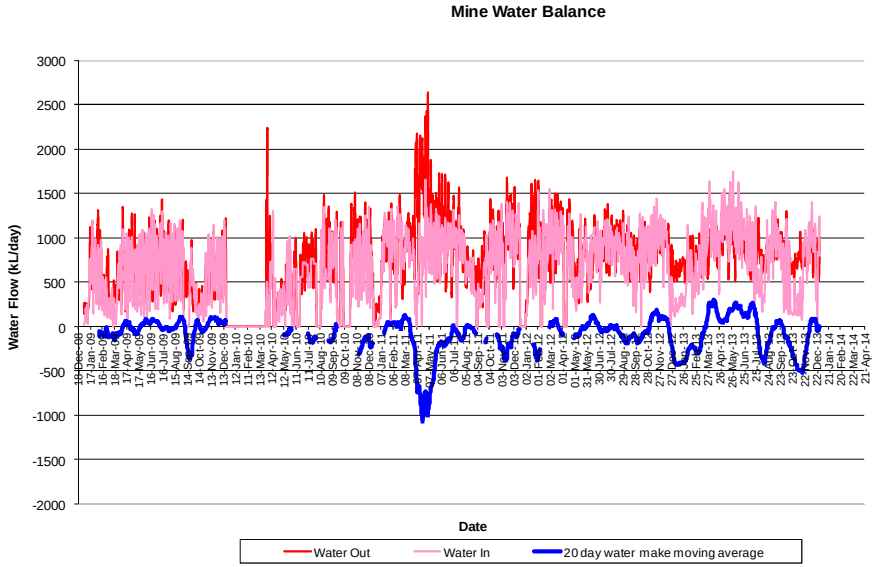


Chart 3 Estimated Daily Mine Water Make

Assessment of Environmental Performance

The monitoring results were used to assess the Project against the water resource and watercourse performance indicators relevant to groundwater. The assessment indicated that none of the performance indicators were exceeded:

- *Visual inspection does not identify abnormal water flow from the goaf, geological structure, or the strata generally.*
- *The 20-day average mine water make does not exceed 2 ML/day.*
- *Significant departures from the predicted envelope of vertical potentiometric head profiles at Bores 9FGW1B and 9GGW1B do not occur.*
- *The water tables measured at Bores 9FGW1B and 9GGW1B 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 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).*

Accordingly, none of the performance measures relevant to groundwater were exceeded during the reporting period:

- *No connective cracking between the surface and the mine.*
- *Negligible leakage from the Woronora Reservoir.*