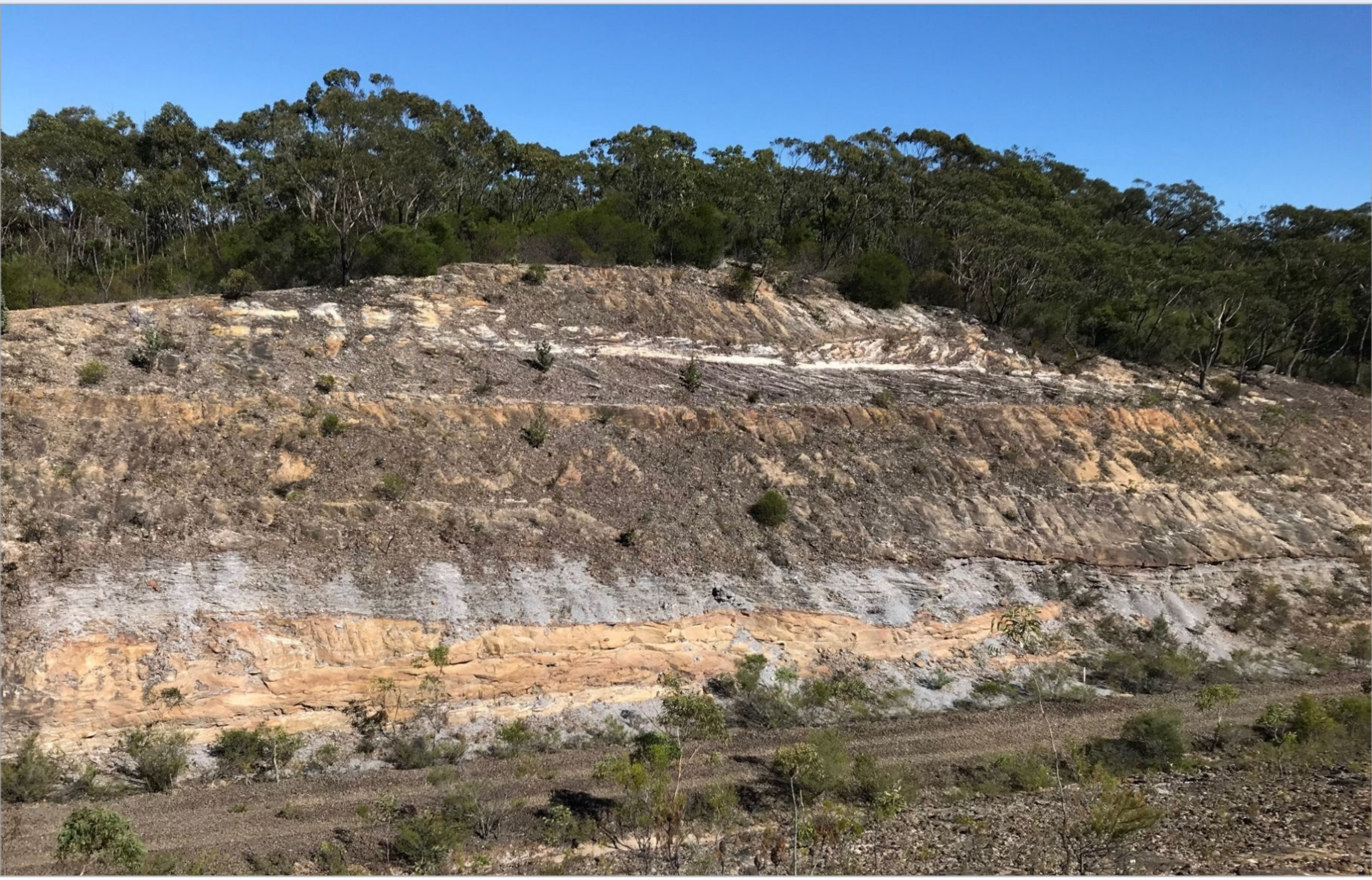
South32 - Illawarra Metallurgical Coal

DENDROBIUM MINE

End of Panel Groundwater Assessment for Longwall 16 (Area 3B)



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QUALITY CONTROL

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EXECUTIVE SUMMARY

This report provides an assessment of the hydrogeological effects of Longwall 16 extraction in Area 3B at Dendrobium Mine, as required under the conditions of mining approval. Extraction of Longwall 16 commenced on 20/2/2020 and was completed on 4/11/2020. Longwall 16 is the eighth panel to be extracted in Area 3B, with an extracted length of 1864 m, a void width of 305 m (including first workings) and a cutting height of up to 3.9 m.

The average daily inflow to Area 3B during Longwall 16 extraction was 3.82 ML/day and total mine inflow was 6.59 ML/day. Compared with the previous longwall, the total mine inflow increased by 15% whereas the inflow in Area 3B decreased by ~ 5%. The increase in total mine inflow is mainly due to an increase of inflow in Area 2. Total mine inflow remains below numerical model predictions. From 2016 there is an apparent correlation between large rainfall events and peaks in mine inflow. The amplitude of the rainfall-related peaks accounts for approximately 7 to 10% of the inflow in Area 3B. To date, the concentration of tritium (an isotopic indicator of modern water) in Area 3B mine inflow water is consistent with a negligible to minor component of modern water.

Groundwater salinity (as indicated by Electrical Conductivity – EC) shows a general increase with depth below the surface. Of the groundwater samples collected in 2020, none recorded EC that was >20% lower than the previous year. It is recommended that all accessible monitoring bores with sampling pumps be sampled during 2021.

Mining of Longwall 16 resulted in continued depressurisation of the target coal seam and overlying strata. The observed changes in groundwater levels are in line with (or less than) numerical model predictions, including piezometers installed in the barrier zone between Lake Avon and Area 3B. As expected, the greatest depressurisation is within the Wongawilli Coal Seam, and decreases with height above the seam.

IMC continued its investigation into the height of fracturing above longwalls, with installation of a post-mining hole over Longwall 16 (in addition to those over Longwalls 6,7, 9, 12, 13, 14 and 15). Investigations to date have found that mining-induced fracturing, including high-angle fracturing is highly variable but appears to extend to the surface in both Area 3A and 3B. Piezometers installed after longwall extraction indicate significant depressurisation throughout all strata, with complete depressurisation throughout the Hawkesbury Sandstone (HBSS) in most holes. Holes in both areas show positive pressure heads in some sensors in the upper CVSS and BACS and evidence for localised perching and groundwater recovery above the goaf. However shallow groundwater levels remain below pre-mining levels.

Investigation of the hydrogeology of the Elouera Fault continued in 2020. Six inclined cored holes have been drilled at two sites along the fault, four of which have intersected the fault plane. Narrow-spaced packer testing across the fault zone indicates that permeable zones are discontinuous on a scale of tens of metres and the fault does not form a continuous conduit to groundwater flow.

Piezometers installed along the barrier zone between Lake Avon and extracted longwalls in Area 3B show declines in piezometric heads to levels below contemporaneous water levels in Lake Avon. The observed levels imply hydraulic gradients away from the lake and towards the mine adjacent to extracted longwalls. Testing of strata permeability before and after mining of adjacent longwalls indicates that permeability increases by at least an order of magnitude at some locations as a result of strata movement, with minor change in strata permeability at other locations. Seepage losses from Lake Avon have been estimated by regional and local scale numerical models to be in the range 0.09 to 0.51 ML/day as at the end of Longwall 16. The estimates are within the tolerable loss limit of 1 ML/day prescribed by Dams Safety NSW and supported by the declining mine inflow rates to Area 3B during the extraction of Longwalls 12 to 16 adjacent to Lake Avon.

1. INTRODUCTION

Illawarra Metallurgical Coal (IMC) operates the Dendrobium underground coal mine, located approximately 12 km west of Wollongong (NSW) in the Southern Coalfield (Figure 1). IMC is required under the conditions of mining approval to submit regular reviews of the local hydrological data, including groundwater level and quality, and potential seepage losses from stored water.

IMC operates an extensive network of groundwater monitoring sensors (piezometers), groundwater sampling pumps and down-hole geotechnical instruments. Groundwater data from more than 800 active piezometers at >200 monitoring bores is updated monthly via telemetry or collected by IMC field teams.

This End of Panel (EoP) assessment reviews groundwater level and quality monitoring data up to one month after the completion of Longwall 16 (cumulative). Data are assessed against baseline and impact criteria defined in the Trigger Action Response Plan (TARP) which forms part of the Subsidence Management Plan for Area 3B (BHPBilliton, 2015) and the Groundwater management plans contained therein.

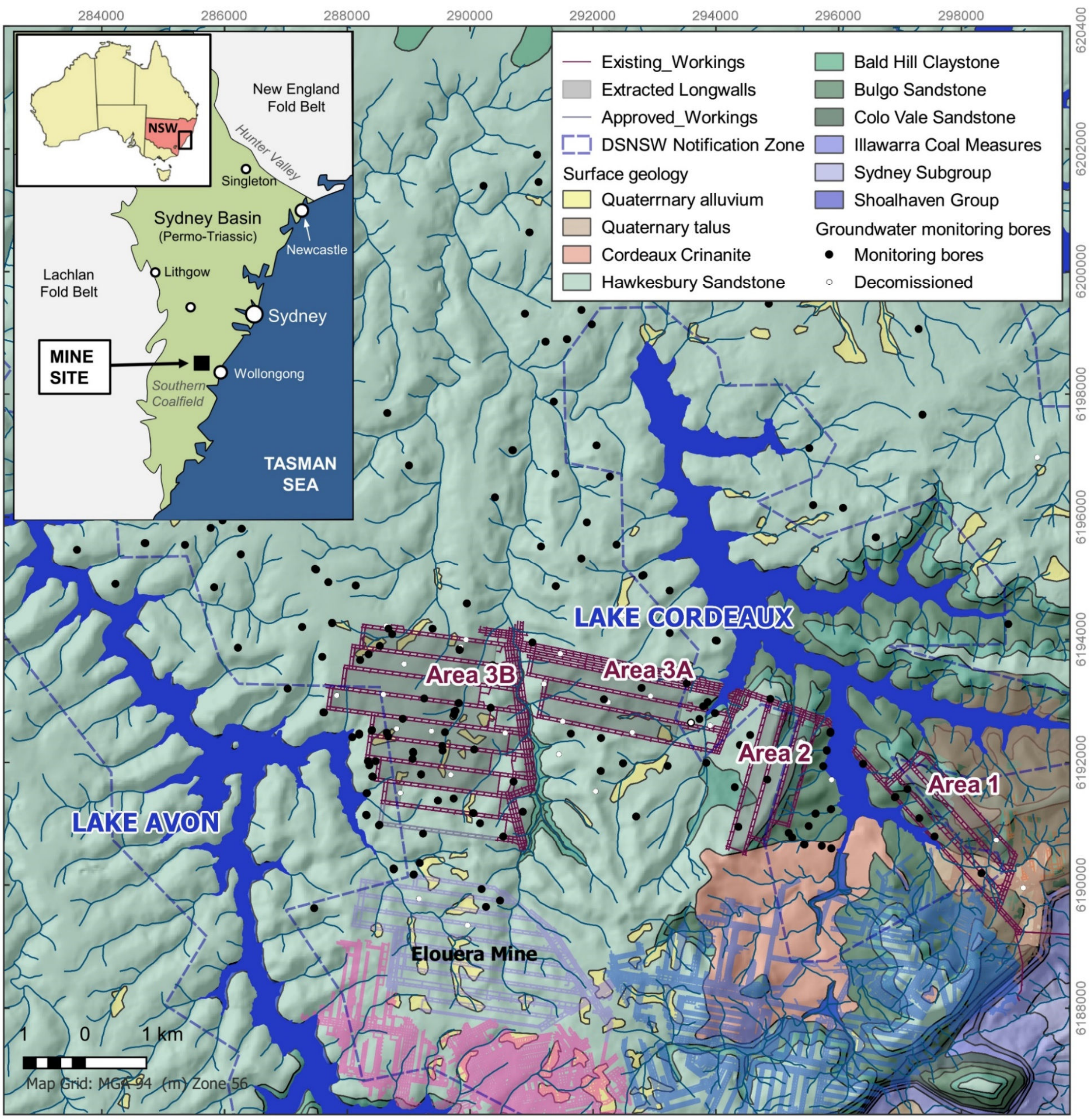

Figure 1. Location of Dendrobium Mine and surface geology

1.1 Longwall 16

Longwall mining at Dendrobium has been carried out in three designated areas: Area 1 (east of Lake Cordeaux), Area 2 (west of Lake Cordeaux), and Areas 3A and 3B (between Lake Cordeaux and Lake Avon). Coal is extracted from the Wongawilli Seam in Areas 1 through 3B. Previous workings in the Wongawilli Seam are located to the south at Elouera and Nebo, and to the east at Kemira. The overlying Bulli Seam was mined previously at Mt Kembla to the east of and partially overlapping Area 1.

Extraction of Longwall 16 commenced on 20/2/2020 and was completed on 4/11/2020. Longwall 16 is the eighth panel to be extracted in Area 3B, with an extracted length of 1864 m, a void width of 305 m (including first workings) and a cutting height of up to 3.9 m.

1.2 WaterNSW feedback on previous EOP report

WaterNSW reviewed the Longwall 15 End of Panel reports and provided comments to the NSW Department of Planning Industry and Environment in a letter dated 18/9/2020. Comments relevant to the groundwater assessment and actions taken are listed in Table 1.

Table 1. Comments on previous End of Panel reports by WaterNSW

WaterNSW comment	Response
It is clear from the information provided that significant and/or complete depressurisation is occurring throughout all strata, including in the Hawkesbury Sandstone (HBSS). It is acknowledged that drawdown in the HBSS reduces with distance, however it is not considered negligible until at least 1.2 km from the goaf footprint.	Noted.
WaterNSW recommends that more recent groundwater models are used for the groundwater assessment of LW15 and future LWs	Addressed. The most recent groundwater model (2020) is used for this assessment of the effects of Longwall 16.
WaterNSW recommends installation of: ▪ a monitoring bore and VWP array and groundwater sampling pumps between LW15 and Wongawilli Creek (S2487); and ▪ monitoring bores at Swamp 35 to the south of Area 3B, with sensors within the sandstone substrate (S2490, S2490A)	Addressed. VWP Installations completed: ▪ S2487 (2019) ▪ S2490 / S2490A (2019)

1.3 Hydrogeology

Dendrobium Mine is located within the Southern Coalfield which is one of the five major coalfields that lie within the Sydney Geological Basin. The stratigraphy of the Southern Sydney Basin is shown in Figure 2. The Basin is primarily a Permo-Triassic sedimentary rock sequence, underlain by undifferentiated sediments of Carboniferous and Devonian age. The Bulli and Wongawilli Coal Seams are the primary target seams in the top part of the Illawarra Coal Measures. The Coal Measures are overlain by Triassic sandstones, siltstones and claystones of the Narrabeen Group and the Hawkesbury Sandstone (HBSS). The HBSS is the dominant outcropping formation across the mine area, but lower stratigraphic units (Bald Hill Claystone (BHCS), Narrabeen Group) are exposed in deeply incised parts of Wongawilli Creek and along the south-eastern shores of Lake Cordeaux.

The hydrogeology of the area is described in previous groundwater assessments associated with Dendrobium Mine (e.g. Coffey, 2012; HydroSimulations, 2016; Parsons Brinckerhoff, 2014), and summarised below.

Three main groundwater systems are recognised:

1. Perched groundwater systems associated with swamps and shallow sandstone. These may be ephemeral and/or disconnected from the deeper groundwater systems;
2. Shallow groundwater systems: layered water-bearing zones within the saturated HBSS; and
3. Deeper groundwater systems within the Narrabeen Group and the Illawarra Coal Measures.

Recharge to the aquifer systems is primarily from rainfall infiltration through outcropping formations, generally the HBSS in the western half of the Dendrobium mine area and the Bulgo Sandstone (BGSS) in the eastern half. There will be some recharge from the Reservoirs and streams to host formations at times of high water level and creek flooding.

Strong topographic relief and recharge drive vertical groundwater flow near the ground surface, but at depth the alternation of aquifers and aquitards promotes horizontal groundwater flow at the base of permeable units. In general, groundwater flow in shallow systems is strongly influenced by local topographical features such as streams and lakes, whereas deeper groundwater systems are influenced by regional topographic and drainage patterns (Toth 2009). Regional groundwater flow in the deeper sandstone units (pre-development) is predominantly northwest, towards the Nepean River system and away from the Illawarra escarpment.

Discharge from the (shallow) groundwater systems occurs naturally at the surface to creeks and to the reservoir as baseflow and seeps, and by evapotranspiration through vegetation. Along the escarpment to the south-east of Dendrobium Mine, groundwater discharge appears as seeps in cliff faces at the junction of formations with contrasting permeability.

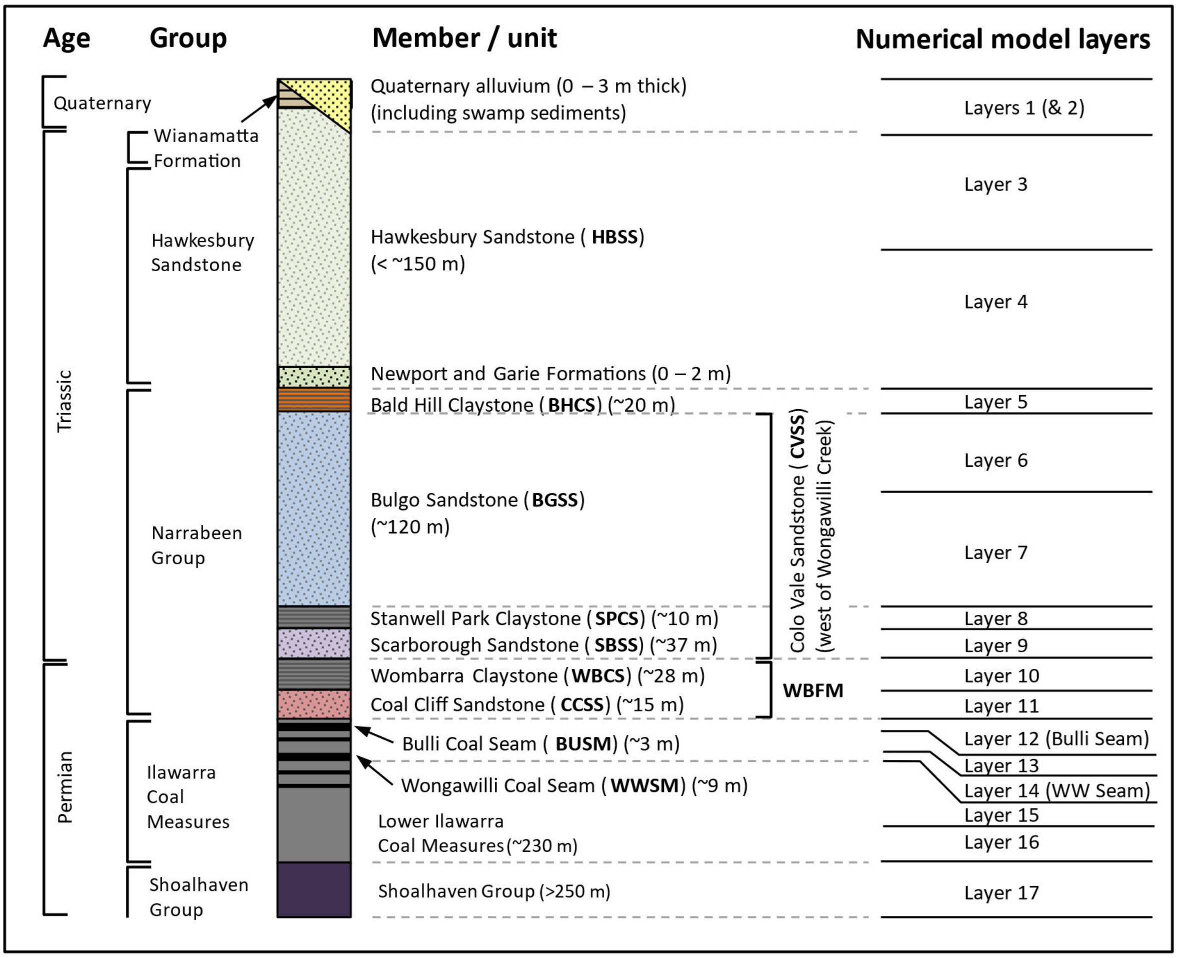

Figure 2. Generalised stratigraphy of the Southern Coalfield

1.4 Effects of mining

Underground mining activities result in depressurisation of the surrounding geological strata and drawdown of groundwater levels near the mine. Groundwater drawdown may result in impacts to surface water systems such as streams and wetlands that are partially sustained by groundwater discharge. The extent and distribution of mine-related drawdown is related to aquifer parameters such as hydraulic conductivity and storage coefficients; but also the extent of strata deformation and fracturing that extends above and outside of the mine workings.

Extraction of coal using longwall methods commonly results in ground subsidence and associated deformation and fracturing of overlying strata (Peng and Chiang 1984; Whittaker and Reddish 1989). Fracturing is most intense and vertically connected immediately above the collapsed longwall (goaf), and grades upwards through zones of less fractured strata (Booth 2002). Fracturing of the overburden can cause significant changes in aquifer characteristics such as permeability and storage, and potentially can provide pathways for vertical groundwater movement between shallow groundwater and surface water systems and underground mines (McNally and Evans 2007; Advisian 2016). The height to which vertically connected (and free-draining) fracture networks extend above the mined seam is therefore important in assessing potential impacts of longwall mining on groundwater and surface water systems.

Several authors have developed empirical approaches to estimating the height of connected fracturing or complete groundwater drainage above longwalls; for example, Forster 1995; Guo *et al.* 2007; Mills 2011; Tammetta 2013; Ditton & Merrick 2014. These methods have been used at numerous coal mines in NSW to provide guidance on the height of fracturing (or depressurisation) for the development of numerical groundwater impact models. It is important to note that the terms used by the authors are not equivalent; Tammetta refers to the "height of desaturation" (more precisely, complete depressurisation); Ditton and Merrick refer to a "zone of continuous cracking" (Zone A), and Mills refers to a zone of large downward movement (Zone 2).

At Dendrobium, the methods of Ditton and Merrick (2014) and Tammetta (2013) yield estimates that are significantly different from each other. A review of longwall subsidence fracturing at Dendrobium by consultants PSM (2017) concluded that fracturing above the (305 m wide) panels in Area 3B likely extends to the surface (Galvin 2017; PSM 2017), consistent with the predictions of the Tammetta model at Dendrobium Area 3B, and recent investigations by IMC.

The Independent Expert Panel for Mining in the Catchment (IEPMC) was established in 2018 to provide advice to government on impacts of mining activities in the Greater Sydney Water Catchment Special Areas, with a focus on risks to quantity of water (IEPMC 2019a, b). In relation to hydrogeological impacts and height of fracturing, the Panel considers that:

"…*changes in ground behaviour and fracturing, permeability and the lateral extent of affected areas occur gradationally rather than as step changes. The so-called 'fractured zone' is a misnomer. Fracturing still develops above this zone and may be connected. Due largely to the different interests and focus of geoscience and engineering disciplines, zones defining mining-induced rock deformation do not necessarily align with zones defining groundwater response to mining.*

Since 2018 IMC has carried out targeted investigations into the height of fracturing and groundwater conditions above completed longwalls at Dendrobium Mine. Investigation holes have been drilled above existing Longwalls 12 to 16 in Area 3B and Longwalls 6 and 7 in Area 3A, allowing assessment of effects above longwalls of different width. The main findings of the investigation are summarised in Section 3.2.1.

1.5 Numerical groundwater impact model

Regional numerical modelling by Coffey (Coffey 2012) supported the *Area 3B Subsidence Management Plan* (SMP) application and subsequent approval. The model has been revised and updated several times since 2012 to better represent subsidence fracturing and to allow assessment of shallow groundwater within swamps and baseflow to streams (HydroSimulations 2016). The current model was developed by Watershed Hydrogeo (2020) using an unstructured grid and MODFLOW-USG. The model includes historical mining at Dendrobium and surrounding mines, and proposed developments at Dendrobium Mine Areas 5 and 6 to the north of Area 3B.

The vertical extent of layers used to simulate the regional groundwater systems in the latest numerical model are shown in Figure 2. An East-West cross section showing the modelled stratigraphy is presented in Figure 3.

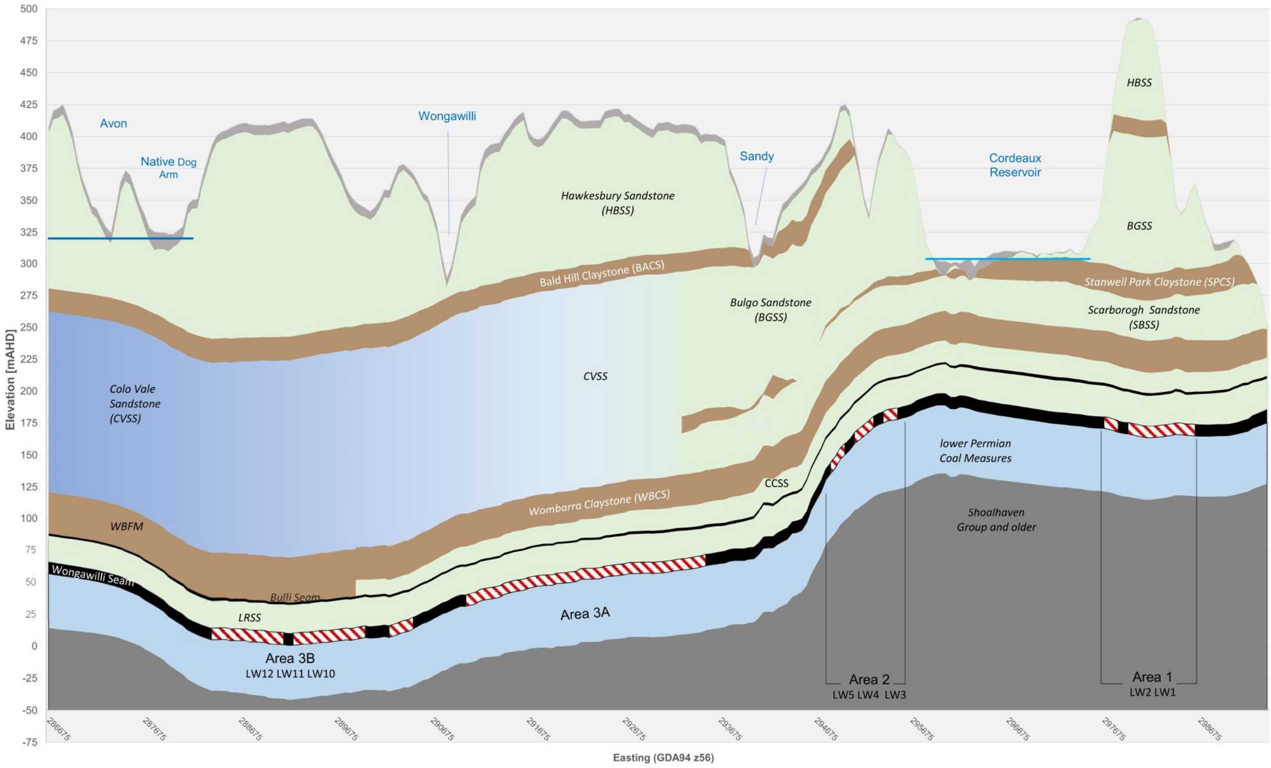

Figure 3. Geological cross-section (east-west) through Dendrobium Mine

2. MONITORING DATA

This section presents the monitoring data available for the groundwater assessment and supports the discussion of the observed hydrological behaviour presented in Section 3.

2.1 Management Plan

Groundwater monitoring at Dendrobium Mine is conducted in accordance with the "Dendrobium Colliery Area 3B SMP Groundwater Management Plan" (South32 2012) and the Area 3B Subsidence Management Plan (BHP Billiton 2015). The aims of the Groundwater Management Plan are to:

- Monitor groundwater levels and quality, commencing at least one year prior to mining affecting the system;
- Project potential groundwater changes during mining (short term) and post-mining (long term) with particular attention to the effect of changes to groundwater regime, impact on the catchment yield and interaction with the stored waters;
- Identify hydraulic characteristics of overlying and intercepted groundwater systems, and determine changes to groundwater systems due to coal extraction and dewatering operations;
- Report any pumping tests and groundwater/surface water simulation studies; and
- Collect water level data from relevant groundwater-monitoring locations.

2.2 Groundwater monitoring network

The groundwater-monitoring locations for Areas 3B are shown in Figure 4. A list of all monitoring bores installed at Dendrobium is included in Appendix A. There are approximately 204 active monitoring bores located across the Dendrobium mine lease, containing over 810 piezometers, excluding those that are decommissioned or no longer monitored. During 2020, new monitoring bores were installed (and or instrumented) as shown in Table 2:

Table 2. Groundwater monitoring installed in 2020

Bore ID	Location details	MGA mE	MGA mN	Max sensor depth (m)	VWP sensors	TDR cable
S2378C	Area 3B Avon Dam AD4	288411	6191776	165	1	
S2478B	Area 3B Waterfall 54	290618	6190486	96	4	Yes
S2490/A	Area 3B Swamp 35B	289172	6190364	79	3	
S2493	Area 3B Longwall 17 over goaf	289659	6191107	275	8	Yes
S2498	Area 5 Shaft	287945	6195167	327	8	
S2503	Area 5	285565	6193965	379	10	
S2504	Area 5 Shaft	287831	6195162	327	8	
S2508/A	Area 3C	290986	6194967	365	10	Yes
S2510	Area 3B Longwall 16 over goaf	288857	6191511	285	8	
S2511	Area 5	288158	6197109	391	9	
S2514	Area 3C	292474	6194443	312	9	Yes

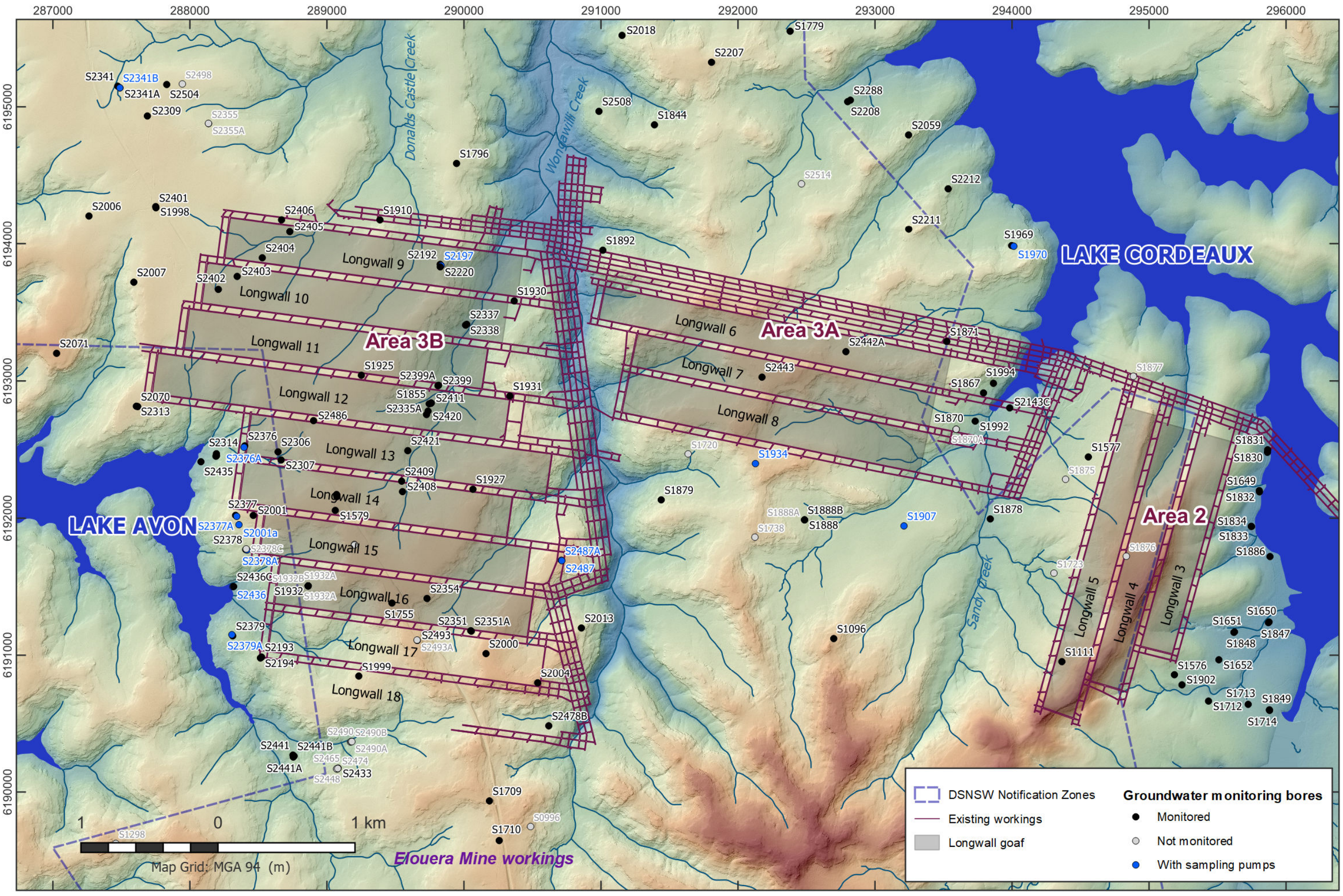

Figure 4. Deep groundwater monitoring network around Areas 2, 3A and 3B

2.3 Deep groundwater levels

Deep groundwater levels are monitored using one or more piezometers installed within monitoring bores. Monitoring bores typically have an index number with an 'S' prefix such as S2314, within which piezometers may be installed at multiple depth levels (e.g. S2314_128m). In most cases, the piezometers are vibrating wire piezometers (VWP) that are fully grouted into the bore hole. The sensors contain a sensitive diaphragm that deforms in response to subtle changes in pore pressure that are transmitted through the connected pores of the grout from the adjacent geological strata. VWP sensors are commonly used in deep mining and geotechnical applications where the strata permeability is low and conventional (standpipe) piezometers are impractical (Mikkelson and Green 2003; Contreras *et al.* 2008).

Standpipe piezometers, consisting of a slotted open casing, are used in a small number of locations and are best suited to monitoring of relatively shallow groundwater systems within moderate to high permeability strata (e.g. swamp sediments and shallow HBSS). Automated loggers record groundwater pressures each hour (typically). The recorded data are subsequently converted to fluid pressure head (m) and potentiometric head (mAHD).

Deep groundwater responses to mining are assessed primarily through the use of time-series hydrographs for multi-level piezometer sites (VWPs). Most VWPs at Dendrobium suffer from electromagnetic noise which causes spurious spikes in the data records. Noisy data are filtered and removed where practical. Hydrographs and analysis are presented in Section 3.1.

Hydrographs are plotted in terms of ***piezometric head*** (mAHD) and ***pressure head*** (m H_2O). Piezometric head can be thought of as the theoretical level to which water would rise in a bore that is open to an aquifer at a given elevation and is calculated by adding the measured pore pressure (at the VWP, expressed in m of water) to the elevation of the sensor (in m AHD). The potentiometric head in a confined aquifer system can be (and often is) different to the water table elevation at the same location.

Hydrographs presented in this assessment include surface water hydrographs for the nearest water supply reservoir (Lake Cordeaux for Area 3A and Lake Avon for Area 3B hydrographs). Note also that individual hydrograph traces are presented as dotted lines at times when the pressure head is below a threshold of 2 m. The ***pressure head*** is the absolute pore pressure at the sensor expressed in m of water. When the pressure head is below that threshold it is an indication that the rock matrix is approaching complete depressurisation at the location of the sensor and, given the uncertainty in pressure measurements, may be totally or partially desaturated. Both piezometric and pressure head hydrographs are presented in Appendix B.

Assessment of the spatial distribution of piezometric head and pressure drawdown over the reporting period is carried out using annotated and coloured symbols on a map. ***Drawdown*** (in metres) is simply the difference in potentiometric head between a reference date and the end of the current reporting period.

In response to feedback from WaterNSW (2019) and to better represent groundwater conditions in the HBSS, the calculation of drawdown and presentation of data was revised in 2019. In this assessment the reference date is November 2009, immediately prior to the start of mining at Area 3A. This date was selected because very few piezometers were operational in Area 3B prior to 2009. The following procedure was used to calculate groundwater drawdown.

- Piezometric head and pressure head data were tabulated from the Dendrobium VWP database. Data were reduced to daily observations using a median of sub-daily data.
- The median head at each operational sensor was obtained for the last 3 months of the recently completed longwall and the last three months of Longwall 5 (ending in November 2009). This approach is used to capture sensors with records that fall slightly short of the end of panel.
- The average head was calculated for each of five subunits: middle HBSS, lower HBSS, upper BGSS, lower BGSS and SBSS. This allows piezometric heads to be compared at bore locations where sensors are set at inconsistent depths. The subunits also correspond to the subunits used in the regional numerical model (HydroSimulations 2016), allowing direct comparison with model predictions.
- For bores that were installed after 2009, the piezometric head in 2009 was spatially interpolated from sensors within each subunit that were active at that time (using kriging).
- Drawdown was calculated for each subunit as the difference between median heads at the end of the recently completed longwall and the end of Longwall 5 (either observed or interpolated).
- Where one or more of the sensors in the subunit recorded less than 1 m of pressure head (assumed to be near desaturation), the drawdown is recorded as a minimum. Those locations are highlighted on the relevant spatial plots.

- Sensor data for decommissioned or damaged bores are not extrapolated. Locations that have been decommissioned, damaged or for which data are otherwise unavailable at the time of reporting are not included in analysis.

Spatial plots are presented and discussed in Section 3.3.

2.4 Mine water balance

All movements of water via pumping stations is monitored and controlled in real-time through the System Control and Data Acquisition (SCADA) system and used to calculate a daily mine Water Balance. The Water Balance is an accurate measure of all water that enters, circulates and leaves the mine, including via air moisture and coal moisture content. Mine water seepage (groundwater inflow), which cannot be directly measured, is determined by mass balance for each goaf and is therefore known to a reasonable accuracy. Key metrics of the Mine Water Balance are reported against Trigger Action Response Plan (TARP) levels to Dams Safety NSW fortnightly.

In this assessment, the estimated groundwater inflow component of the mass balance is presented as time-series hydrographs and compared with rainfall trends and model predictions. Analysis of water balance trends for the reporting period is presented in Section 3.

2.5 Groundwater chemistry

Groundwater chemistry sampling sites relevant to this assessment are shown in Figure 4 (blue symbols). Currently there are eight sampling bores in Area 3B containing 20 individual sampling pumps screened within the Hawkesbury and Balgo Sandstone. Most sampling sites are located between the mined and planned longwalls of Area 3B and the eastern shore of Lake Avon. The SBSS is monitored at two locations: S1886 (Area 2) and S1870 (Area 3C).

In addition to samples collected from bores, groundwater samples are routinely collected from underground workings, inter-seam boreholes and flooded adjacent mine workings, as described in the *Underground Water Sampling and Analysis Procedure* (DENP0048). Water is analysed for chemistry (major and minor ions), and isotopes of carbon and hydrogen. Weekly water samples are taken from the current longwall panel (roof and face) and from water pumped from the goaf. Monthly water samples are taken from the main discharge points of the mine and from completed longwall panels. The results of the sampling are reviewed each month and reported to Dams Safety NSW. More than 3,400 water samples have been collected and analysed at Dendrobium Mine since 2004 (including > 1100 tritium analyses), providing an extensive database for ongoing assessment and a basis for chemically characterising waters from various sources.

In this assessment, average field electrical conductivity (EC), is used as a general indicator of water quality (salinity). Water salinity varies according to its source (see Figure 5) and, in general, groundwater salinity tends to increase with the depth below the surface; groundwater in the HBSS tends to be relatively fresh (average EC ~ 170 µS/cm) whereas mine seepage water is distinctly more brackish (average EC of seepage in Areas 3A and 3B ~ 2200 µS/cm). Beneficial water use categories based on the ANZECC water quality guidelines (ANZECC 2000) are shown for reference only. Groundwater quality is assessed further in Section 3.5.

Samples collected from bores can sometimes be influenced by drilling water, residual grout or bentonite leachate from the construction of the piezometer. Typically, this is indicated by elevated or anomalous EC, pH, sulfate, or Ca/Na ratios. Samples that show chemical evidence of influence by grout or bentonite are excluded from assessment.

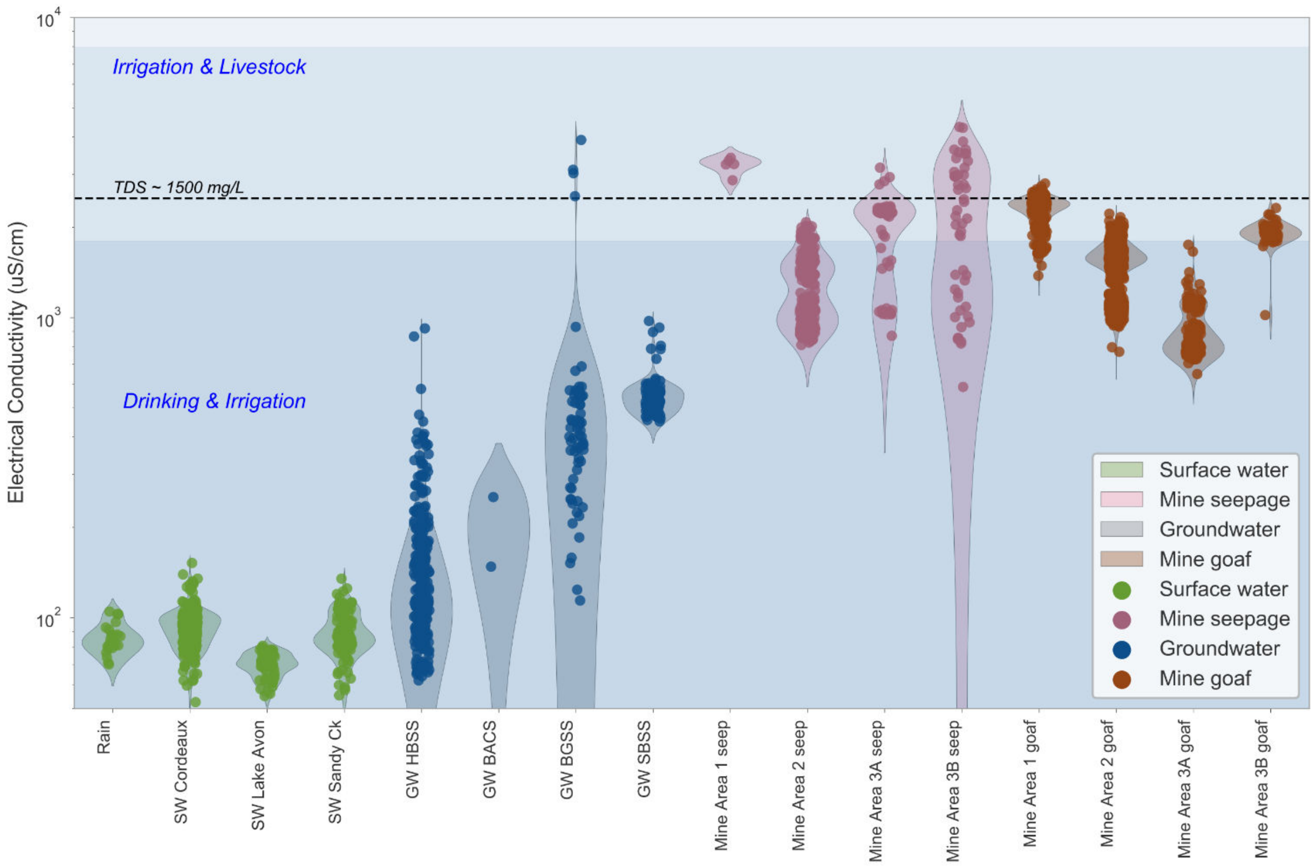

Figure 5. Violin plot showing the range in EC of surface water, groundwater and mine inflow

3. ASSESSMENT OF GROUNDWATER RESPONSE TO MINING

3.1 Mine water balance

Table 3 presents mine inflow statistics (as indicated by pump-out data) for each Area for the period over which Longwall 16 was extracted (20/02/2020 to 4/11/2020). The average daily inflow to Area 3B during Longwall 16 extraction was 3.82 ML/day which represents approximately 60% of total mine inflow for the period (compared with 70% for Longwall 15). Compared with the previous longwall, the total mine inflow increased by 15% whereas the inflow in Area 3B decreased by ~ 5%. The increase in total mine inflow is mainly due to an increase of inflow in Area 2 (Table 3).

Table 3. Dendrobium Mine Inflow during the Extraction of Longwall 16 (in ML/day)

STATISTIC	AREA 1	AREA 2	AREA 3A	AREA 3B	TOTAL
MEAN	0.33	1.59	0.85	3.82	6.59
STANDARD DEVIATION	0.00	0.78	0.67	1.09	1.35
MINIMUM	0.33	0.46	0.00	0.00	0.45
MAXIMUM	0.33	3.82	6.99	6.04	9.34
MEAN (previous Longwall 15)	*0.33*	*0.72*	*0.68*	*4.03*	*5.75*

Time-series plot of total groundwater inflow to Dendrobium Mine (all mine areas) as determined from the mine water balance is shown in Figure 6 as daily volumes in kilolitres (kL/d) and as a 30-day moving median. The total mine water balance has increased steadily from 2010 as mining progressed with peak mine inflows correlating closely with periods of high rainfall.

The mine water balances for Areas 3A and 3B are shown in Figure 7. Groundwater ingress to Area 3B increased steadily since the start of mining in that area (2013), initially correlating with the total area mined. However, the rate of increase has declined (flattened) during the mining of Longwall 12 and Longwall 13 and the water balance decreased during the extraction of Longwall 14 and Longwall 15. This overall trend reflects a declining groundwater inflow per unit area mined due to progressive depressurisation of the surrounding strata by previous mining (a decline in driving head). The decline in groundwater inflow to Area 3B during Longwall 14 and Longwall 15 is likely to be partly due to the unusually dry conditions during 2018-2019. As of Longwall 12, peaks in inflow to Area 3B appear to correlate with periods of high rainfall with a lag time of between two and three months. Prior to Longwall 12, the influence of rainfall on the water balance was less distinct.

Groundwater ingress to Area 3A has declined by more than 50% as mining has progressed in Area 3B. The correlation of inflow peaks to major rainfall events in Area 3A has become less distinct since the end of Longwall 12.

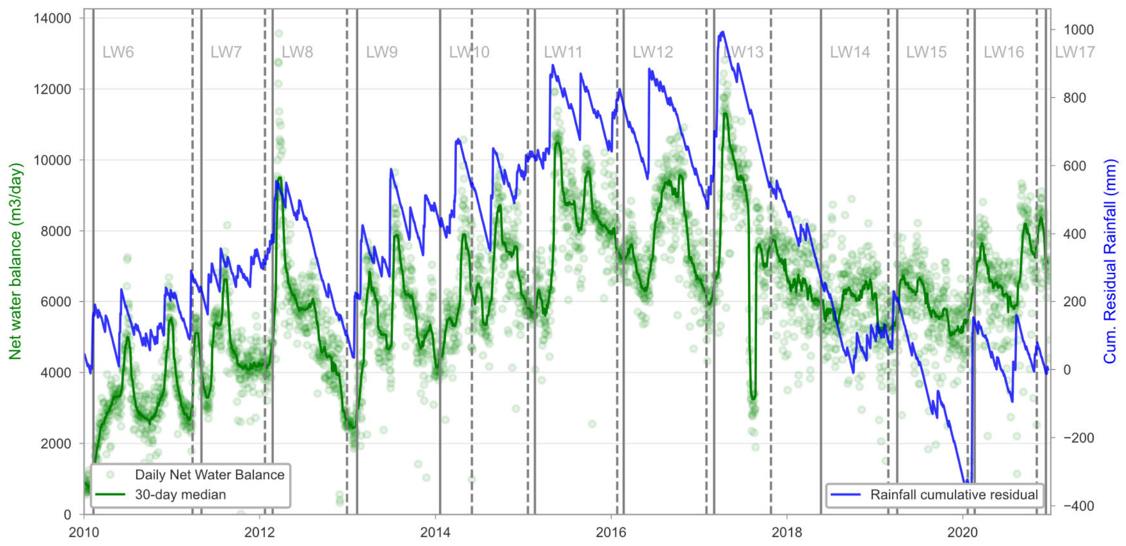

Figure 6. Groundwater inflow from water balance for all mine areas (kL/day)

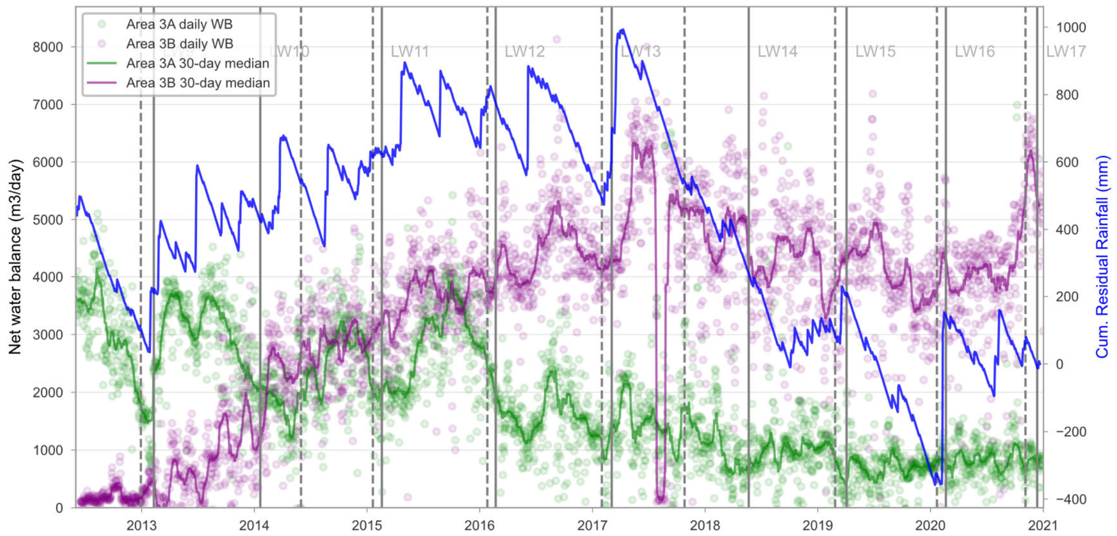

Figure 7. Groundwater inflow to the mine for Areas 3A and 3B (kL/d)

3.1.1 Estimates of the surface water component of mine inflow

The correlation of inflow peaks with periods of high rainfall at Area 3B implies that there is a rainfall (or surface water) induced component to mine inflow. Two approaches are used to assess the proportion of mine inflow at Area 3B that may be attributed to rainfall or surface water:

1. Baseflow separation approach, whereby the volume related to the inflow peaks is estimated as a fraction of the total inflow for a given period. Baseflow is a concept borrowed from stream flow analysis whereby the baseflow represents the component of stream flow due to groundwater discharge, as opposed to the 'quick flow' component of rainfall runoff represented by the hydrograph peaks.

2. Isotopic tracer approach, whereby a tracer of modern water (in this case, tritium) is used to detect and estimate the proportion of rainfall or surface water in mine inflow samples.

The two approaches assess surface water input in different ways and will not necessarily yield similar results. The baseflow separation approach estimates the inflow component related to high rainfall events. Those events result in a rise in groundwater levels or piezometric head (within porous rock and fracture networks) which drive transient increases in mine inflow. However, the water itself may be largely or entirely derived from the release of (old) groundwater storage[1] unless there are direct and rapid pathways between the surface and the goaf. This appears to be the case for Area 3B inflows and contrasts with observations at Area 2, as evidenced below.

A base-flow separation analysis of Area 3B water balance data is shown in Figure 8. The daily water balance data (grey circles) is highly variable due to the nature of pumping cycles in the underground mine and the trend is best represented as a 30-day moving average (the blue line). The moving average clearly defines peaks in net mine inflow following the large rainfall events in 2015, 2016 and 2017, with a two to three-month delay. There was no obvious peak in April/May 2020 following the very large rainfall event in February 2020; however, a large peak in water balance at Area 3B is noted towards the end of 2020.

Applying digital stream baseflow separation filters to the water balance data is problematic due to the high variability of the data (including negative values). Therefore, the baseflow component has been approximated using a LOWES trend line (LOcally WEighted regression Smoothing; Cleveland 1979), translated to correspond with most of the troughs in the moving average. The potential rainfall-induced inflow component is defined by the difference between the two curves (blue shading). Using this method, the rainfall-induced component of inflow during Longwall 16 was 7%, compared with 10% during Longwall 15, and 7% during Longwall 14. A peak in inflow was emerging at the time of reporting, falling just outside the current assessment period.

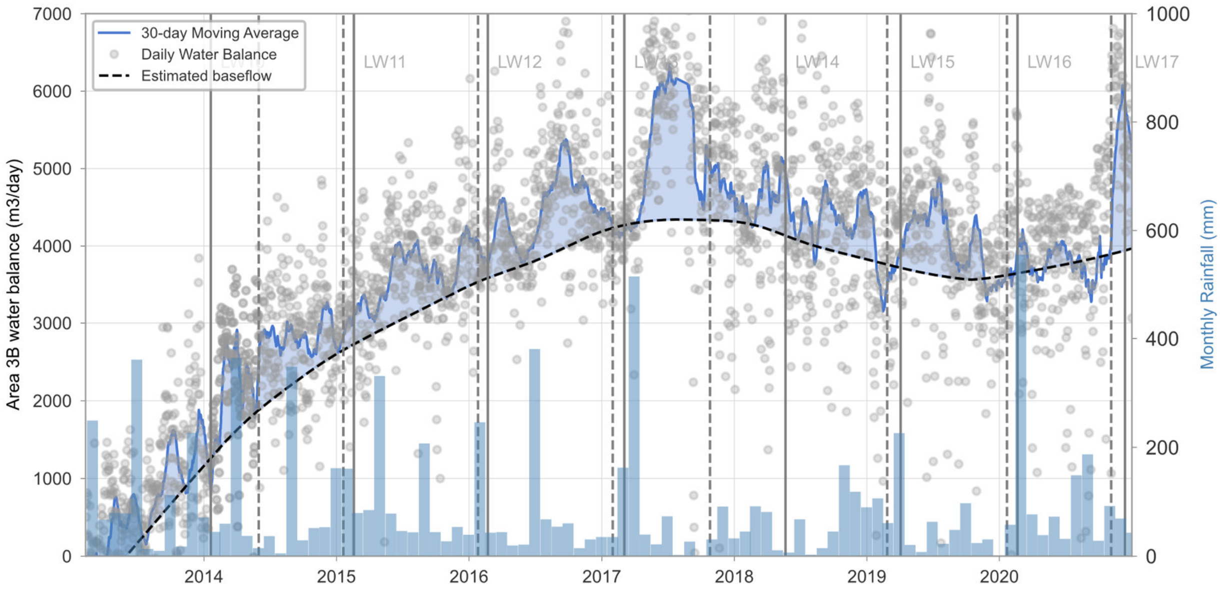

Figure 8. Estimate of potential surface water component to Area 3B water balance

[1] Note that the volume of groundwater storage above the longwall footprint alone is significant. Unconfined or drainable groundwater storage would be in the order of 7 GL per longwall (assuming an average longwall goaf area of 610,000 m2, a Specific Yield of 3% averaged over all strata and an average saturated thickness of 370 m in Area 3B). Confined or elastic storage would be small in comparison; in the order of 20 ML (assuming a Specific Storage coefficient of around 10^{-6} m^{-1}; David *et al.* 2017). At the average mine inflow rate per longwall, complete drainage of the column (ignoring lateral groundwater flow) would take in the order of 20 years. Old groundwater storage release is likely to dominate mine inflow for many years.

The modern water component in mine inflow is monitored by analysing tritium in samples collected from goaf inflow and development seepage water samples. The results are reported monthly to Dams Safety NSW. Tritium is an isotope of hydrogen (^3H), generated in the atmosphere through interactions with cosmic rays and through past atmospheric nuclear weapons testing (Clark 2015). Tritium is incorporated into water molecules in rainfall and enters groundwater systems through recharge (rainfall and stream-bed infiltration). Tritium decays exponentially according to its half-life (12.32 years) and is typically only detectable in surface water samples and in groundwater that recharged within 4 to 5 half-lives (50 to 70 years). Detection of tritium above deep groundwater baseline levels in mine inflow samples would indicate a component of modern water in the sample (as it does for samples from Area 2).

Tritium is widely assumed to be a conservative tracer in that it is not significantly sorbed or otherwise retarded during groundwater transport (e.g. Cendón *et al.* 2014; Štamberg *et al.* 2014). However, a recent review by ANSTO (2018), commissioned by South32, concluded that tritium may undergo diffusive exchange with (and therefore loss to) zones of older groundwater. While the effect has not been quantified in terms of typical groundwater pathways at Dendrobium, it is important to consider when assessing tritium results. Despite possible diffusive losses, tritium remains an important and unambiguous indicator of modern water when tritium is detected above baseline levels.

A timeseries plot of tritium in groundwater samples from Area 3B goaf (at the outflow point) is shown in Figure 9. Tritium in samples collected from Area 3B goaf outflow is typically within or close to baseline concentrations in deep groundwater (represented by the shaded area below 0.2 TU in Figure 9, from HGEO 2020), implying that the component of modern water in mine inflow to Area 3B is very low - likely less than 9% which is the 90th percentile estimate based on binary mixing calculations. Samples are collected approximately monthly; however, analysis and reporting of results from ANSTO can take 6 to 12 months. The most recent analysis is from a sample collected on 18/11/2019. Results for samples collected during Longwall 16 are pending.

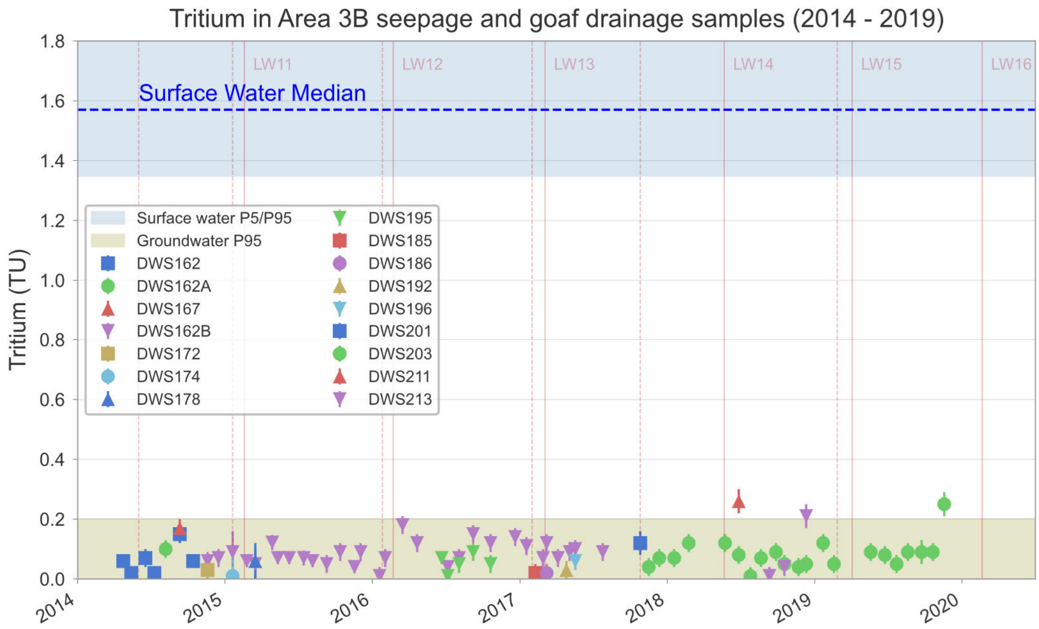

Figure 9. Tritium concentration in water samples from Area 3B (from HGEO, 2020)

3.2 Deep groundwater levels – time-series hydrographs

Representative hydrographs from VWP arrays are presented and discussed below. Hydrograph plots are presented in Appendix B (Piezometric head and pressure head hydrographs).

3.2.1 Area 3B: Strata above mined longwalls

Piezometer cables in bores located above the footprint of a longwall are usually sheared or the sensors rendered inoperable by ground movements associated with mining and there is rarely a continuous record of groundwater pressures after the longwall has passed the monitoring location. Therefore, it is useful to consider groundwater monitoring data from locations above longwalls in two groups:

1. Baseline monitoring of groundwater levels as the longwall approached the monitoring location (until the cables shear). The most useful locations for this purpose are S1910, S1911, S1914, S1925, S1929, S2412, and S2192; and

2. Monitoring established over the goaf following the passage of the longwall. Currently operational locations include: S2220, S2306, S2337/S2338 and S2335A. Since 2018, a number of new piezometer arrays were installed over previously mined longwalls 6, 7, 12, 13, 14, 15 and 16.

Prior to being mined beneath:

Review of hydrographs from piezometers installed above longwalls prior to being mined beneath show evidence of depressurisation at the coal seams before mining started at Area 3A and years before mining started in Area 3B (Appendix B). Depressurisation of most overlying strata is apparent from the start of mining at Area 3A and the rate of depressurisation increased as mining moved to Area 3B, and with every successive longwall in Area 3B. Depressurisation is generally greater in the deeper formations. Transient pressure *increases* are also common as the longwall approaches or passes nearby the monitoring site and these reflect compression and relaxation of the strata as the subsidence wave passes (Booth 2002) (most recently seen in S2436 immediately after the start of Longwall 16). Piezometer cables typically shear when the longwall passes within 10 m of the location, but at some sites shearing has occurred when the longwall was up to 660 m away (e.g. S1929).

The last observations prior to shearing at S1911 and S1914 (for example) show strong depressurisation throughout the strata, with some horizons in the CVSS at, or close to, zero pressure head. However, some sensors continue to record positive pressure heads indicating incomplete drainage of some strata or fractured rock domains above the goaf.

After being mined beneath:

Since 2018 IMC has carried out investigation drilling above extracted longwalls (Longwalls 6, 7, 12, 13, 14, 15 and 16) to characterise the height of fracturing and assess groundwater conditions in strata above the longwall goaf (HGEO 2020d, c). Ten sites were drilled as part of the investigation, adding to five sites drilled as part of previous investigations above extracted longwalls (Longwall 9, Swamp 1b and WC21). A pre-longwall hole has been drilled near the midline of planned Longwall 17 (hole S2493), which will be re-drilled and tested following longwall extraction. These investigations now provide a good understanding of fracturing and depressurisation above extracted longwalls at Dendrobium. The height of fracturing investigation report was reviewed by Professor Bruce Hebblewhite. The main findings are summarised below:

- In both Areas 3A and 3B, mining-induced fracturing, including high-angle fracturing is highly variable but appears to extend to the surface. The density of fracturing generally decreases with height above the goaf, with anomalous fracturing within the Bald Hill Claystone and below 120 m above the goaf. On average, the density of fracturing above the 249 m wide longwalls is less than that above the 305 m wide longwalls (although the profiles are variable).

- In most over-goaf holes, fractures display a weak preferred orientation parallel to the longwall face within 100 to 200 m above the goaf, transitioning upward to lower-angle or bedding plane fractures above that height. One hole drilled above a longwall pillar shows a weak preferred orientation parallel to the longwall (length), again transitioning upward into lower-angle structures above 100-200 m.

- All holes drilled above extracted longwalls show a significant increase in permeability throughout the profile. Packer tests indicate an increase in permeability of 2 to 3 orders of magnitude relative to pre-mining conditions. At the centreline of Longwall 12 (S2420) there is an anomalous zone of apparently unaffected (near median) permeability in the upper CVSS and Bald Hill Claystone (BACS). Above the pillar zone between Longwall 11 and Longwall 12, packer tests indicate distinctly lower post-longwall permeability than the centreline holes throughout all strata.

- Changes in vertical permeability cannot be measured directly from packer testing. The decrease in high-angled fractures with height above the goaf implies that, while vertical permeability is likely enhanced throughout all strata, the ratio of vertical to horizontal permeability will also decrease with height above the goaf.

- VWPs installed after longwall extraction indicate significant depressurisation throughout all strata, with near-zero pressure heads recorded in most piezometers. Complete depressurisation is recorded throughout the HBSS in most holes drilled above goaf. Holes in both areas show positive pressure heads in some sensors in the upper CVSS and BACS, indicating localised perching or incomplete drainage of fractured rock domains.

- Perched horizons are most extensive in strata between the upper CVSS and lower HBSS and above longwalls extracted three or more years ago (HGEO 2020c). Increasing groundwater level trends in some sensors imply that the that rate of recharge exceeds the rate of downward drainage at those perched horizons and that not all rainfall that infiltrates at the surface reports directly to the goaf as mine inflow. Initial calculations suggest that the rate and magnitude of the groundwater storage increase may be significant in terms of the overall catchment and mine water balances.

In the context of previous models, it is interpreted that the height of connected fracturing (and depressurisation) extends to the surface in Areas 3A and 3B and likely also in Areas 1 and 2. Observations from this investigation are most consistent with the empirical model of Tammetta (2013); however, observations of localised perching and recovery above extracted longwalls suggests the height of connected fracturing is variable across the site.

3.2.2 Area 3B: Strata outside mined longwalls

In this section, data from piezometers located outside the current mined longwall footprint are discussed (excluding the Avon monitoring bores which are discussed below). These include bores installed within planned mining Areas 5 and 6. Refer to hydrographs in Appendix B.

Piezometers located to the north and west, and within 1 km of the longwall footprint (S1910, S1892, S1998 / S2401, S2006 and S2007) show a gradual decline in groundwater pressures in most strata with the rate of decline increasing with depth and proximity to the longwall. Those observations are consistent with the gradual expansion of a drawdown cone away from the mine and are in line with numerical modelling predictions. The most strongly affected strata are within 500 m of extracted longwalls (S1910, S1892). At S2006 (1 km west of Longwall 9) piezometric head deceased to their lowest level in most strata towards the end of Longwall 14 and have shown recovery in levels during Longwalls 15 and 16 in mid-HBSS, BGSS and SBSS.

Monitoring bores installed in Area 5 show that drawdown is minor at distances greater than 1.2 to 1.5 km from Area 3B. At S2341 (1.2 km), there is some evidence for depressurisation in the deeper sandstone strata; however, all sensors show piezometric head at an elevation corresponding to the HBSS. Similar piezometric levels are observed at S2352 (2.3 km), S2342 (2.6 km), S2345 (3.5 km) and S2340 (4.7 km). At those relatively distant locations, piezometric head within the HBSS is typically above 320 m AHD (and above the level of Lake Avon), whereas levels within the BGSS and SBSS have heads < 300 m AHD and display broadly hydrostatic profiles. This condition has not significantly changed during the extraction of Longwall 16.

Piezometers located to the south of the active longwalls in Area 3B (in bores S1932, S2001, S2194) show more pronounced depressurisation in the mid- to deep stratigraphic levels with some strata pressures dropping to zero well in advance of the longwall. It is likely that those piezometers are affected by depressurisation from the Elouera Mine to the south, as well as drawdown from Dendrobium Mine, an effect that is predicted from numerical groundwater modelling. Sensors in S2001 and S1932 bores showed accelerated declines in pressure during Longwall 14 extraction and again after Longwall 15. S1932 was decommissioned prior to Longwall 16 passing beneath it in early 2020 and was replaced by S2510 after the longwall passed. The datalogger at S2194 suffered a malfunction towards the end of Longwall 14, possibly due to lightning strike, and was replaced. Since replacement, piezometric heads in most strata recovered significantly during Longwall 15 with depressurisation resuming in the lower CVSS during Longwall 16. This response is unusual given the approach of mining and, if not associated with maintenance of the logger, may represent compression effects associated with subsidence.

3.2.3 Avon reservoir bores

A series of monitoring bores were installed along the barrier zone between Lake Avon reservoir and Area 3B to characterise the strata permeability before and/or after mining of adjacent longwall panels and to provide ongoing groundwater monitoring. Holes are typically re-drilled and tested following extraction of the adjacent longwall(s). Those observations provide critical information to allow more accurate calculation and modelling of potential seepage losses from the reservoir(s) to the mine. Results of drilling, permeability testing and monitoring have been reported as the investigation has expanded and hole re-drilling has been completed (e.g. SCT 2015b, 2016; HGEO 2017, 2018a). A recent review of data was reported by HGEO (2020a) after the re-drilling of hole S2378C at site AD4 following the extraction of Longwall 16. Monitoring bores that are installed and operational at the end of Longwall 16 are listed in Table 4 with a summary of recent observations.

Table 4. Observations at piezometers between Lake Avon and Area 3B

Site	Hole	Monitoring	Comments
AD1	S2313	VWP: 49 m, 131 m, 182 m TDR Installed 31/10/2015	150 m southwest of Longwall 12. Groundwater levels in all sensors declined following extraction of Longwall 12 adjacent to the site. Piezometric head in the two deepest sensors have remained below the level of Lake Avon since the start of monitoring. The shallowest piezometer (49 m) has declined slightly since 2017 but remains above Lake Avon FSL, possibly representing a perched water table.
AD2	S2314	VWP: 29 m, 75 m, 128 m TDR Installed 13/11/2015	Groundwater levels in all sensors declined following extraction of Longwall 12. The deepest sensor (128 m) shows depressurisation responses to Longwalls 12 to 15 and gradual recovery during Longwalls 15 and 16. The piezometric head in all three sensors is below Lake Avon FSL.

Site	Hole	Monitoring	Comments
AD3	S2377	VWP: 27 m, 112 m, 187 m Pumps: 34 m, 115 m, 200 m TDR Installed 21/5/2018	Piezometric levels in the deeper two sensors are below Lake Avon FSL and showed little additional response to Longwall 16. The shallowest sensor (27.1 m) likely records a perched water table within the HBSS. It shows a decline in head over the last year and is approaching zero pressure head. The lower HBSS sensor (112 m) declined to near-zero pressure head during Longwall 16.
AD4	S2378	VWP: 30 m, 90 m, 164 m Pumps: 29 m, 70 m, 164 m TDR Installed 14/11/2017	The deeper two sensors (90 m and 164 m) show strong compression and depressurisation responses to Longwalls 13 to 16. Piezometric levels at the base of the HBSS have declined from near the Lake Avon FSL to >20 m below the FSL since Longwall 13.
AD5	S2379	VWP: 30 m, 50 m, 108 m TDR Installed 22/2/2018	Site AD5 is furthest from active longwall mining in Area 3B. The deepest two sensors (50 m and 108 m) record increasing piezometric head in the HBSS and BGSS since 2018. The uppermost sensor (30m) has recorded near-zero pressure head since 2018 and may be in unsaturated strata. A sharp decrease in head at 50 m depth was observed toward the end of Longwall 16.
AD6	S2376	VWP: 29 m, 107 m, 169 m Pumps: 29 m, 107 m, 169 m Installed 6/10/2017	Site AD6 is located within 10 m of Longwall 13 footprint. Piezometric levels in the deeper two sensors are below Lake Avon FSL and showed little additional response to Longwall 16 (but a small response to heavy rain in February 2020). The shallowest sensor (29 m) has recorded near-zero pressure head since 2018 and likely represents desaturation of the strata.
AD7	S2435	VWP: 25 m, 60 m, 100 m Pumps: 29 m, 64 m, 116 m Installed 12/11/2018	Site AD7 is located within 40 m of the lake shore. The piezometric head in all three sensors is below the Lake Avon FSL and current lake level. There was a rise of several metres in all sensors following the heavy rain in February and September 2020 which also corresponds to similar rises in lake level. The lower HBSS sensor (100 m) recorded a rising trend relative to other sensors during Longwall 16.
AD8	S2436	VWP: 25 m, 65 m, 93 m, 35.1 m, 45.9 m Pumps: 35 m, 90 m Installed 19/11/2018	Site AD8 is located within metres of the lake edge at FSL. Groundwater levels at the base of the HBSS have declined to below the FSL and current lake level. Four out of five sensors showed a compressive response to the start of Longwall 16 in addition to a response to rainfall and increasing lake level in February 2020. The deepest sensor (93 m; CVSS) showed sharp but transient depressurisation following the start of Longwall 16 which was not observed in the shallower sensors.

In summary, piezometers installed along the barrier zone between Lake Avon and extracted longwalls in Area 3B show declines in piezometric heads to levels below contemporaneous water levels in Lake Avon. The observed levels imply hydraulic gradients away from the lake and towards the mine adjacent to extracted longwalls; however, gradients remain towards the lake beyond the influence of the extracted longwalls. Perched aquifers are apparent in upper parts of the HBSS which can persist after mining.

A plot of model predicted piezometric head versus observed head at piezometers adjacent to lake Avon as of the end of Longwall 16 is shown in Figure 10. The plot shows that for most piezometers, observed head is similar to, or higher than, the numerical model prediction. Therefore, the model predictions are generally accurate as of Longwall 16 or tend to over-estimate groundwater drawdown. A notable exception is S2376_107 m (AD6) which is within 10 m of Longwall 13 goaf footprint.

Note also S2436_25m (AD8) located near the lake edge. Anomalous responses at AD8 were investigated and additional piezometers installed in 2019. The investigation concluded that piezometric head is highly variable within the HBSS at this site, and that there is no evidence for a connective vertical fault controlling anomalous drawdown (HGEO 2019).

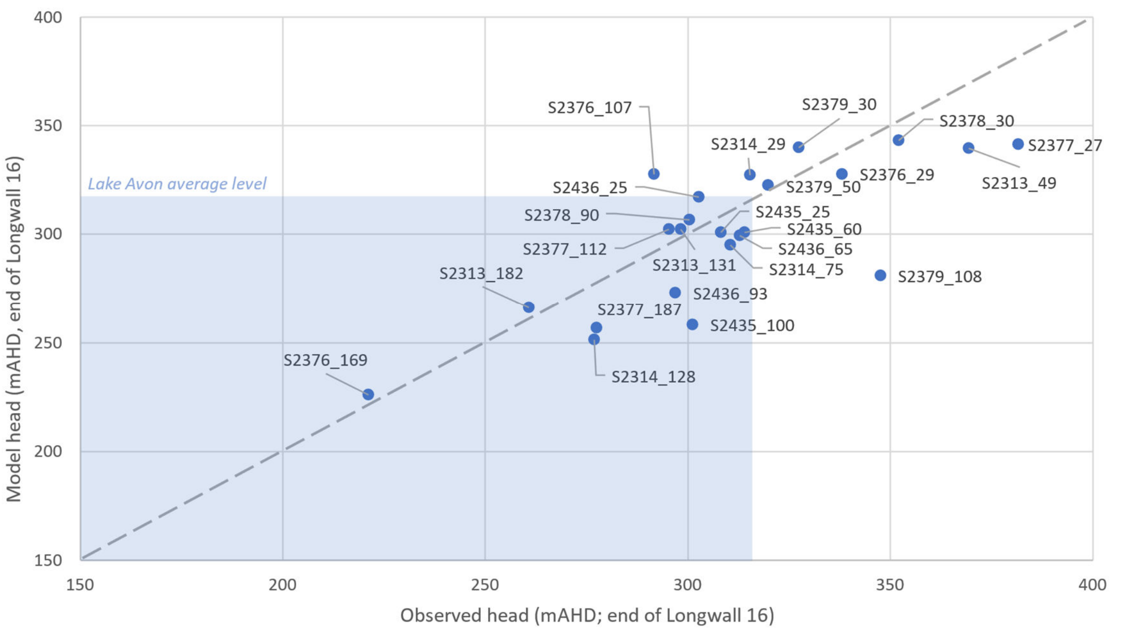

Figure 10. Modelled versus observed piezometric head for Avon Dam monitoring sites

Hydraulic gradients away from the lake imply groundwater flow from the lake to the mine and seepage loss from the lake. The rate of seepage loss is governed by the hydraulic gradient and permeability (measured and expressed as hydraulic conductivity) of the intervening strata which has been tested prior to mining (at most sites) and following extraction of longwalls. Estimates of seepage loss have been calculated using several approaches, including regional and local scale numerical models (see Section 3.4.3, below)

Figure 11 is a summary of hydraulic conductivity in the HBSS in the elevation range between the top and base of Lake Avon at each site, updated to reflect the results of the post-Longwall 16 testing at site AD4. At five of the eight sites, testing was carried out both before and after the adjacent longwall was extracted (AD1, AD2, AD3, AD4 and AD8), and at a further two sites the tests were carried out only after the adjacent longwalls were extracted (AD6 and AD7). Measurements of hydraulic conductivity from packer testing are shown with a logarithmic scale (y-axis) versus radial distance from the nearest longwall (x-axis). The grey band represents the 10 to 90 percentile range for numerous packer tests carried out in pre-mining HBSS. The plot shows that at three locations (AD2,AD7 and AD8), post-mining strata permeability extends one to two orders of magnitude higher than pre-mining conditions as a result of bedding plane movements and strata stress relief beyond the goaf footprint. However, at four locations (AD1, AD3, AD4 and AD6), testing after mining shows strata permeability that remains largely within the P10-P90 range for non-mining affected HBSS.

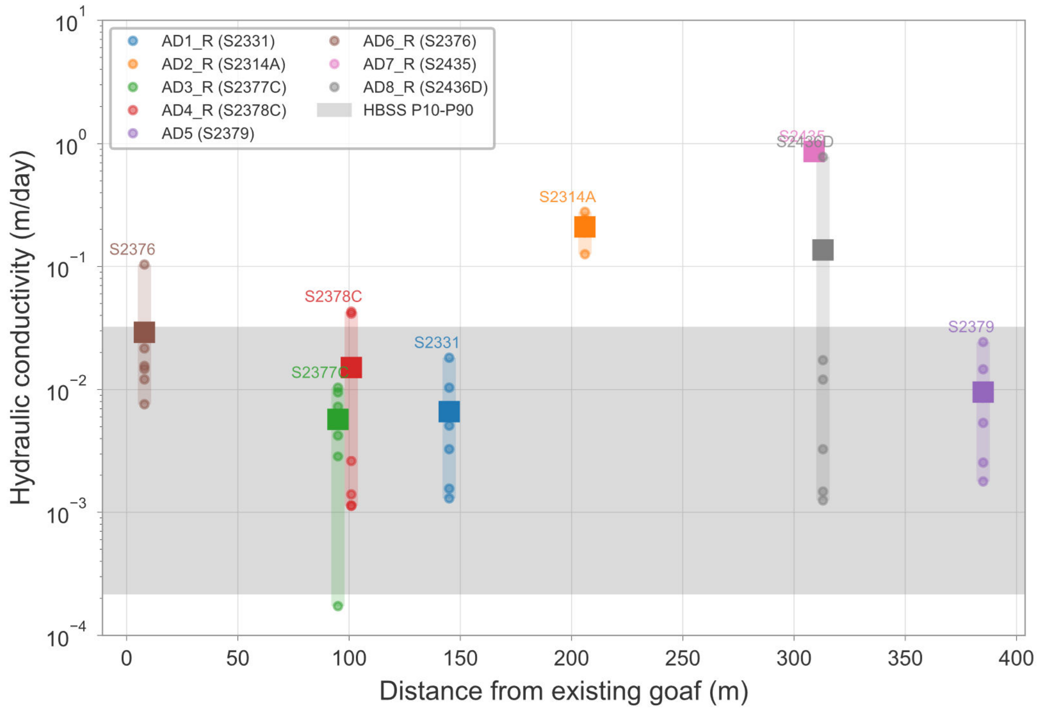

Figure 11. Permeability tests in Avon Dam bores.

At Site AD4, packer testing carried out following Longwall 15 (S2378B) and Longwall 16 (S2378C) show similar features. Most tests plot within the normal range for strata unaffected by mining. Elevated permeability is observed in strata between 22 and 46 m depth and between 70 m and 82 m depth. The average permeability in the depth range between the Lake FSL and the lake base is 0.74 orders of magnitude (OM) higher in the most recent testing than in the pre-mining tests.

There is no simple correlation between permeability increase and proximity to goaf, implying that strata fracturing (including bedding plane shear) and strata stress changes is influenced by other factors such as topography and associated phenomena (valley closure) as was suggested by SCT (2015a).

3.2.4 Potentially transmissive geological structures

Geological structures such as faults and fracture zones have the potential to form conduits for groundwater flow to the mine and transmit drawdown to receptors distant from the mine. The permeability structure of faults is related to the internal structure, rock type, the prevailing stress regime and post-movement mineralisation of the fault zone (Bense *et al.* 2013). Such factors can lead to a range of possible permeability structures, including a barrier to flow; a conduit to flow; or a complex conduit-barrier system whereby a fine-grained core may impede transverse flow and the damaged (outer) zone may promote enhanced flow along the fault. Complex barrier-window scenarios can arise where strata of varying permeability and thickness are variably off-set along the fault and fine-grained material from claystone units may be smeared along the core zone (Yielding *et al.* 1997).

A geological assessment, including mapped and potential structures was carried out prior to mining in Area 3B (BHP Billiton 2013). The geology between Avon Reservoir and Area 3B mine workings was further assessed by South32 (2018) and the geology associated with proposed Longwall 18 by South32 (2020). A combination of exploration techniques including; surface exploration boreholes, aeromagnetic and seismic surveys, surface mapping, underground in-seam drilling and underground mapping have been used to build the geological model in the area.

During 2020, IMC commissioned consultants SRK to carry out an assessment of faults and surface lineaments above and around Dendrobium Mine (SRK 2020). The assessment included a review of the existing information relating to faults and lineaments, and analysis of mine subsidence data (LiDAR) to determine if surface subsidence is controlled by or reactivates mapped surface lineaments. The study identified several very minor linear anomalies directly above mined longwall panels in Area 3B, with none identified in Areas 2 or 3A. The study concluded that the potential for reactivation of lineaments extending outside the planned mining areas was assessed as low.

In a separate assessment, HGEO (2020e) carried out an assessment of the spatial relationship between piezometric response in vibrating wire piezometers (anomalous drawdown compared with predictions) and proximity to known or inferred geological structures. The study concluded that anomalous drawdown responses are not correlated with mapped structural features. Rather, they are randomly distributed amongst active monitoring bores and with respect to mapped structural features. This is consistent with the observations in the underground mine that any large inflows of groundwater are typically not associated with mapped linear features such as igneous dykes and faults.

Doyle (2007) and Tonkin and Timms (2015) concluded that virtually all faults encountered in first workings near supply reservoirs in the Southern Coalfield produce no, or very minor inflows. The low transmissivity of faults is attributed to the discontinuous nature of most faults, infill by impermeable clay minerals, and high regional horizontal stress. Historical high inflow events (e.g. the Blue Panel, Wongawilli Colliery) have been associated with mining cover depths of less than 100 m leading to insufficient lateral offset from the reservoir because this offset was based on angle of draw and not a minimum offset distance.

Notwithstanding the above, the potential for reactivation of fault zones during mine subsidence and subsequent connection with surface water bodies should not be discounted. The Elouera Fault located immediately south of Area 3B is of particular interest with respect to the development of planned Longwall 18. Results of an ongoing investigation into the hydrogeology of the Elouera Fault are summarised below.

Elouera Fault (Native Dog Creek Tributary 1)

The northern tributary to Native Dog Creek (NDT1) runs broadly parallel to, and north of, the mapped trace of the Elouera Fault (at seam level). The Elouera Fault zone is a complex fault comprising three distinct but (structurally) connected fault zones and several splay structures. The main fault plane dips to the south at between 53 and 63° (based on recent drilling) and offsets the Wongawilli Seam by up to 40 m (downfaulted to the south). The fault trace is projected to intersect the surface on the northern slopes of the NDT1 valley. Recent drilling has identified the fault within the CVSS and drilling at Swamp 35 intersected a fault zone likely associated with Elouera Fault within the lower part of the HBSS. As yet, no surface trace of the fault has been identified in outcrop.

Hydrogeological investigations are currently underway to assess the structural and hydrogeological characteristics of the Elouera Fault zone, and its potential to provide a connection between Lake Avon and the proposed longwalls. Six inclined cored holes have been drilled at two sites along the fault, four of which have intersected the fault plane. Preliminary results of the investigation were reported by HGEO (2020f) and are summarised below:

- Elouera Fault is characterised by multiple fault cores within a broad fractured (damaged) zone that ranges between 8 m and 31 m thick (true thickness). The fault cores are planar features comprising infill of clay or pulverized rock (fault gauge or fault breccia) measuring between centimetres and several tens of centimetres thick. The fault damage zones are characterised by elevated fracture frequency compared with holes drilled outside the influence of faulting and mine subsidence.

- Narrow-spaced packer testing across the Elouera Fault shows a highly variable permeability structure (and overall average permeability) between drill sites and between closely adjacent holes at the same site. The data indicate that permeable zones are discontinuous on a scale of tens of metres and the fault does not form a continuous conduit to groundwater flow. The highest average permeability was observed at the shallowest fault intersection (upper CVSS).
- The BACS, a regionally important aquitard, is not completely offset and maintains continuity across the fault. The major stratigraphic units (Hawkesbury Sandstone [HBSS] and CVSS) are largely continuous across the fault with minor displacement relative to their thickness. Analysis of the effects of offsetting minor lithologies across the fault indicates that the fault likely represents a weak barrier to transverse (north-south) groundwater flow (a decrease in permeability of ~0.3 to ~0.5 orders of magnitude). Shale and clay smear is unlikely to contribute significantly to the barrier effect.
- Groundwater levels observed in open holes at Site 2 and piezometers at Site 3 are above the level of Lake Avon within the HBSS and ~215 m above the water level in the adjacent Elouera Mine workings. Given that the Elouera Fault is intersected by most of the investigation holes, and is intersected by the Elouera Mine workings, these observations imply that 1) groundwater gradients within the HBSS are towards Lake Avon; 2) depressurisation of deeper strata due to previous mining at Elouera to the south and current mining in Area 3B to the north has not resulted in depressurisation of the HBSS via the fault; and 3) the fault zone is not a significant conduit to flow.

Further hydrogeological testing is currently underway, including:

- Sampling of groundwater from the fault zone for chemical and isotopic analysis.
- Cross-hole tracer testing using saline water, heat and/or tracer dyes, similar to the testing carried out above Longwall 9 in 2014.

Once testing is complete, the holes will be equipped with piezometer arrays and TDR cables to assess progressive depressurisation across the fault and to detect reactivation due to mining in Area 3B.

3.3 Deep groundwater levels – spatial patterns

The spatial distribution of piezometric heads and drawdown in piezometric head due to mining is shown in the following figures:

1. Bores where there are one or more sensors within the HBSS that record near-zero pressure head (assumed to be desaturated; Figure 12);
2. The change (drawdown) in average piezometric head between the end of Longwall 5 (November 2009) and the end of Longwall 16 (Figure 13 to Figure 17); and
3. The piezometric head in the lower HBSS relative to the Lake Avon FSL and recent lake levels (Figure 14).

For piezometers that ceased operation within the last two years, or where there are gaps in the data, values have been extrapolated (or interpolated) as appropriate. Piezometers that have been inactive for 2 years or more are excluded from the analysis. It should be noted that calculations of drawdown since 2009 are subject to uncertainty because of the inconsistency in the depths of sensors within each geological unit between monitoring bores.

3.3.1 Spatial distribution in groundwater drawdown

Maps of observed and estimated drawdown are shown for subunits within the HBSS, BGSS (and stratigraphic equivalent within the CVSS), and the SBSS. Analysis concentrates on the Triassic sandstone formations since those units are most relevant to connected surface water processes; drawdown in the Wongawilli and Bulli coal seams is shown in time series plots (hydrographs). The coal seams, being typically more permeable than the host coal measures and overlying Narrabeen Group, depressurise well in advance of mining, defining a broad zone of drawdown around current mining areas that coalesces with residual drawdown from neighbouring historic mines.

Analysis of drawdown in the HBSS focusses on the lower 70 m of the formation (lower HBSS). Comparison of drawdown in the upper and middle parts of the formation is problematic and potentially misleading (an underestimate) because of the number of sensors within desaturated strata. The number of sensors that record zero or near-zero (< 2 m H_2O pressure head) is shown in Figure 12. It is common for bores located above extracted longwalls to show near-zero pressure head conditions in multiple sensors implying drawdown of head below those sensors. The typical depth to water on the plateau areas prior to mining was in the order of 25 to 30 m. Therefore, sensors that are at less than 15 m depth are plotted separately (as green symbols) since it is more likely that those sensors would be desaturated under natural conditions.

Within the lower HBSS, maximum drawdown in the order of 40 to 50 m is observed in piezometer arrays above and immediately surrounding extracted longwalls. However, review of individual hydrographs (Appendix A) indicates that most strata above extracted longwalls are fully depressurised and perching is common. Therefore, drawdown values above extracted longwalls should be considered as minima. Drawdown in the HBSS reduces rapidly away from the mined longwalls with heads sustained by rainfall recharge. Note that in some monitoring bores (e.g. S1879, S1934) pressure head values suggest there are multiple perched aquifers and therefore calculated head and drawdown values for a geological unit would be averages of those perched heads. Bores at which a groundwater increase is recorded relative to 2009 ("negative drawdown") are shown as zero, A number of piezometers recorded groundwater recovery relative to the baseline in 2020 due to the high rainfall.

Piezometric head in the lower HBSS compared with the water level in Lake Avon is shown in Figure 14. It is apparent that most bores located between extracted longwalls in Area 3B and Lake Avon record piezometric heads that are below the current lake level, consistent with a gradient away from the reservoir as described previously. It should be noted that some bores contain sensors at higher stratigraphic levels that record piezometric head above the lake level (e.g. S2313_49 m) and therefore the hydraulic gradient within the barrier zone varies with both location and elevation. In addition, there is evidence for minor perched water tables persisting in some sensors.

Observations of piezometric head in the BGSS are mainly restricted to near the extracted and planned longwalls (Figure 15 and Figure 16). Drawdown exceeding 70 m and up to 150 m is estimated at several bores (e.g. S2486). Drawdown decreases away from the mined areas such that less than 25 m of drawdown is estimated at distances of 1.2 km or more north of Area 3B (S2341, S2006). Significant depressurisation is expected in the BGSS (and units below) due to subsidence-related fracturing extending upwards from the goaf into these units.

The SBSS (Figure 17) is depressurised in the vicinity of the mined areas. As with the BGSS, estimated drawdown decreases to the northwest with distance from Area 3B; however, depressurisation of ~74 m is observed to the northeast (S2059) due to residual drawdown from neighbouring mines.

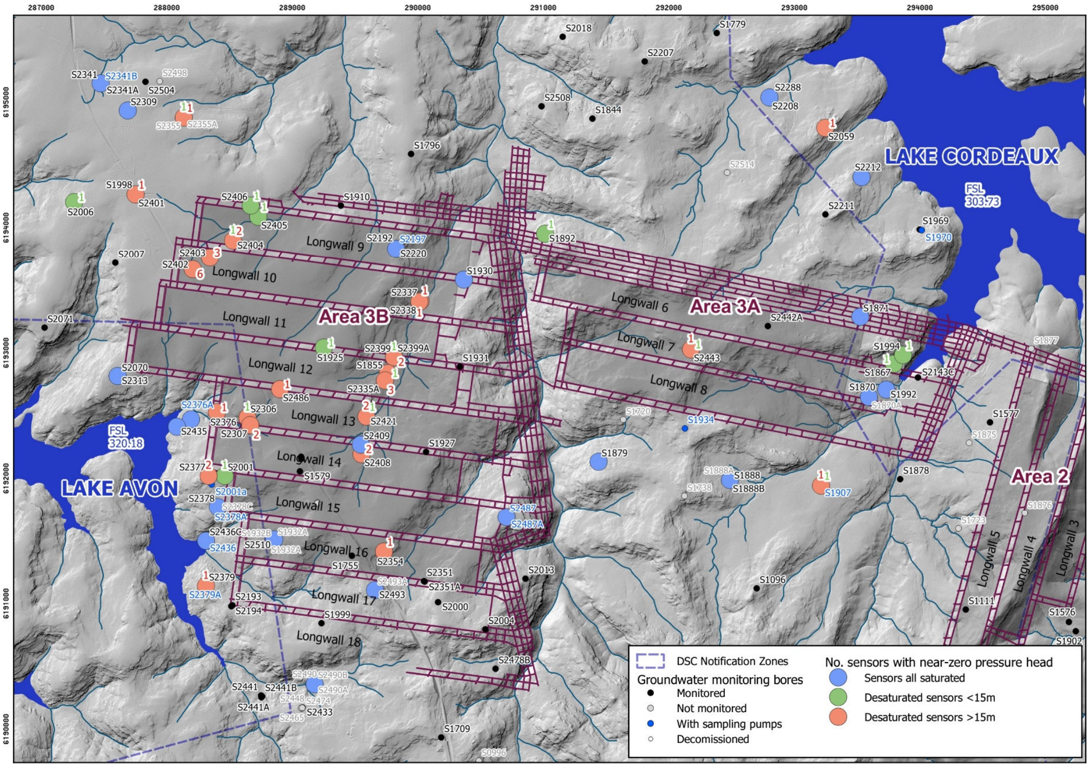

Figure 12. Sensors recording desaturated conditions in the Hawkesbury Sandstone (2020

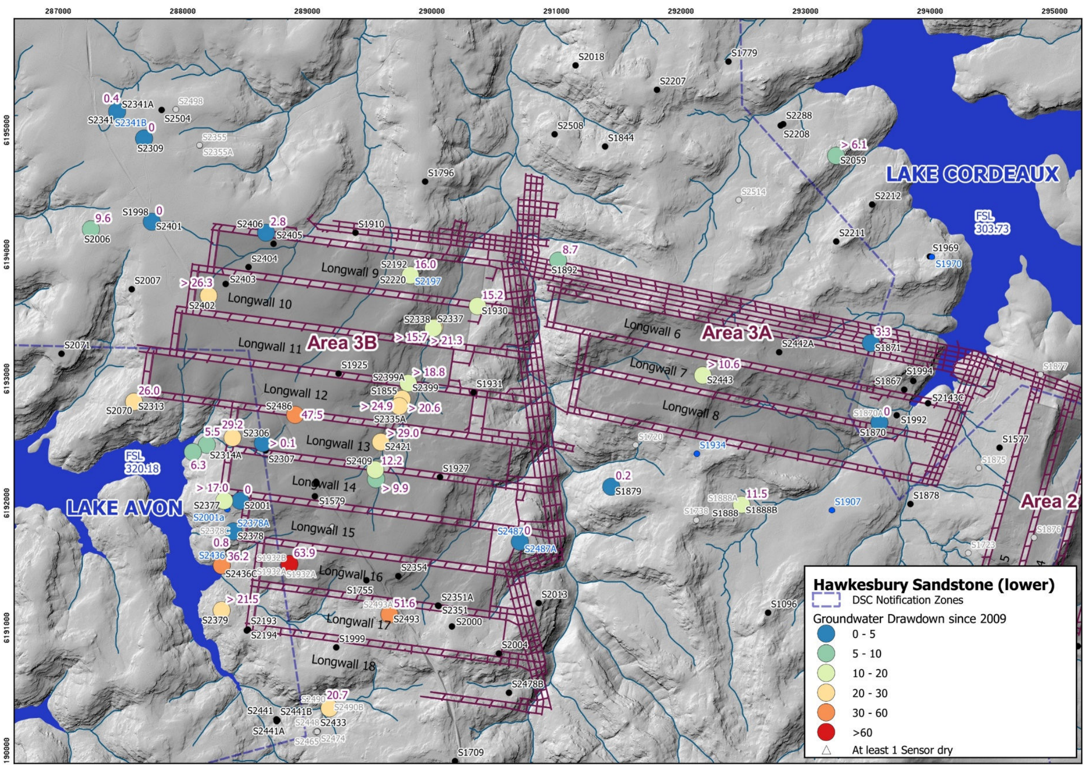

Figure 13. Drawdown in piezometric head in the lower Hawkesbury Sandstone (2009-2019)

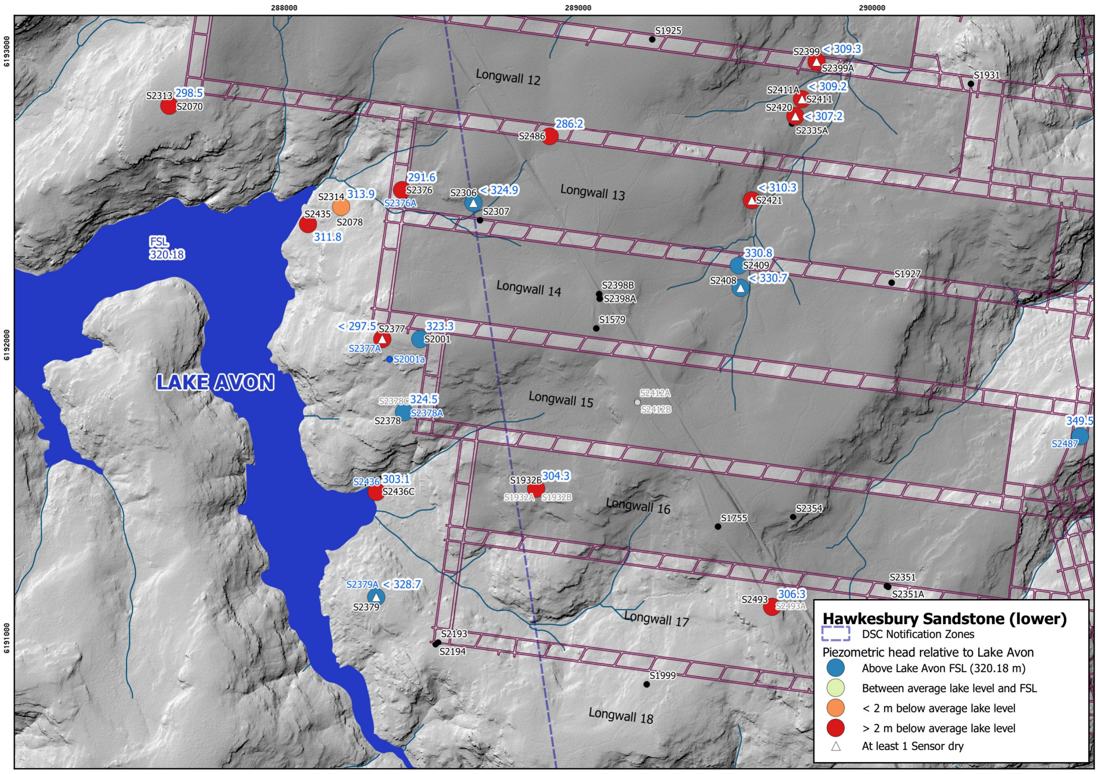

Figure 14. Piezometric head in the lower Hawkesbury Sandstone relative to Lake Avon

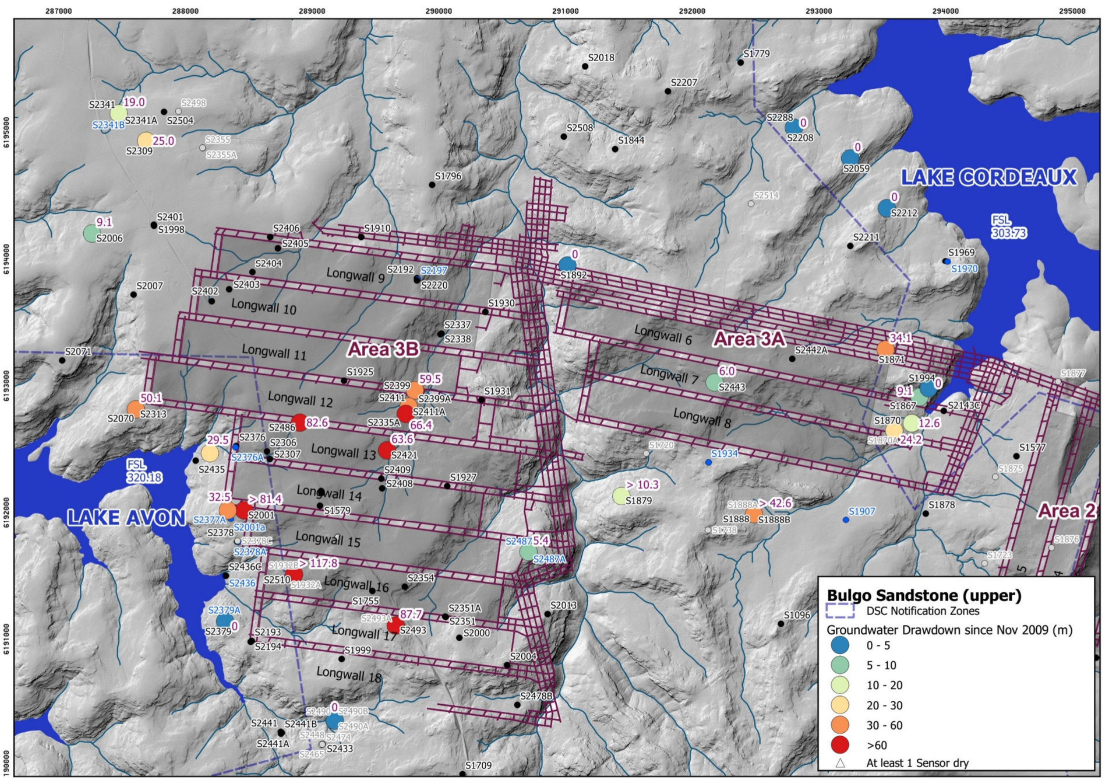

Figure 15. Drawdown in piezometric head in the upper Bulgo Sandstone (2009-2019)

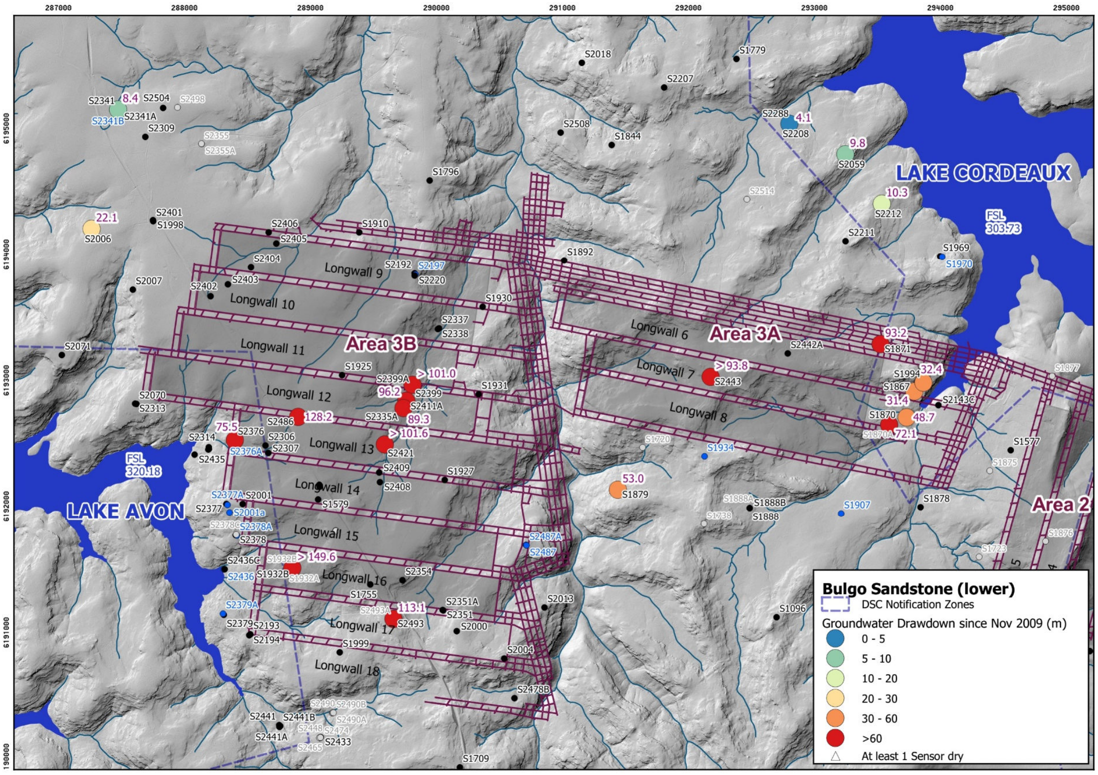

Figure 16. Drawdown in piezometric head in the lower Bulgo Sandstone (2009-2019)

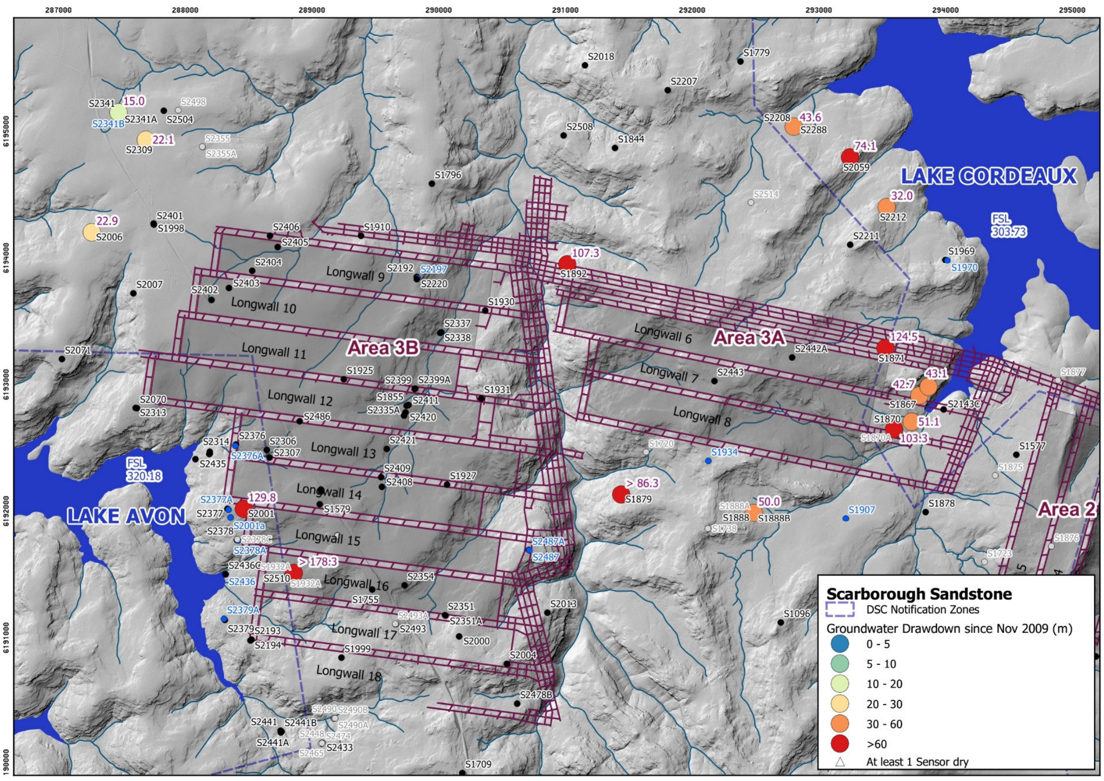

Figure 17. Drawdown in piezometric head in the Scarborough Sandstone (2009-2019)

3.4 Comparison with model predictions

3.4.1 Deep groundwater levels

In this section observed deep groundwater levels are compared with those predicted in the most recent groundwater impact model for Dendrobium Mine (Watershed Hydrogeo 2020). The comparison was carried out by extracting the predicted heads at representative sensors as of the end of Longwall 16 from the original model output files (provided to HGEO by Watershed Hydrogeo), and plotting those heads against the observed heads (as presented in Section 3.3). It is therefore an independent assessment of the ongoing accuracy of the groundwater model predictions.

Figure 18 is a plot of the modelled and observed heads as of the end of Longwall 16. The data are coloured according to the formation, and bores that are located adjacent to Lake Avon are highlighted Avon (The “Avon Dam” holes, S2313, S2314, S2376, S2377, S2378, S2379, S2435, S2436, and holes S2001, S2194). Data for an accurate and well-calibrated model should cluster along the diagonal 1:1 line. Points plotting below the line indicate that observed heads are higher than predicted (i.e. the model over-predicts drawdown and is conservative), while points that plot above the line indicate that the model under-predicts drawdown at those locations.

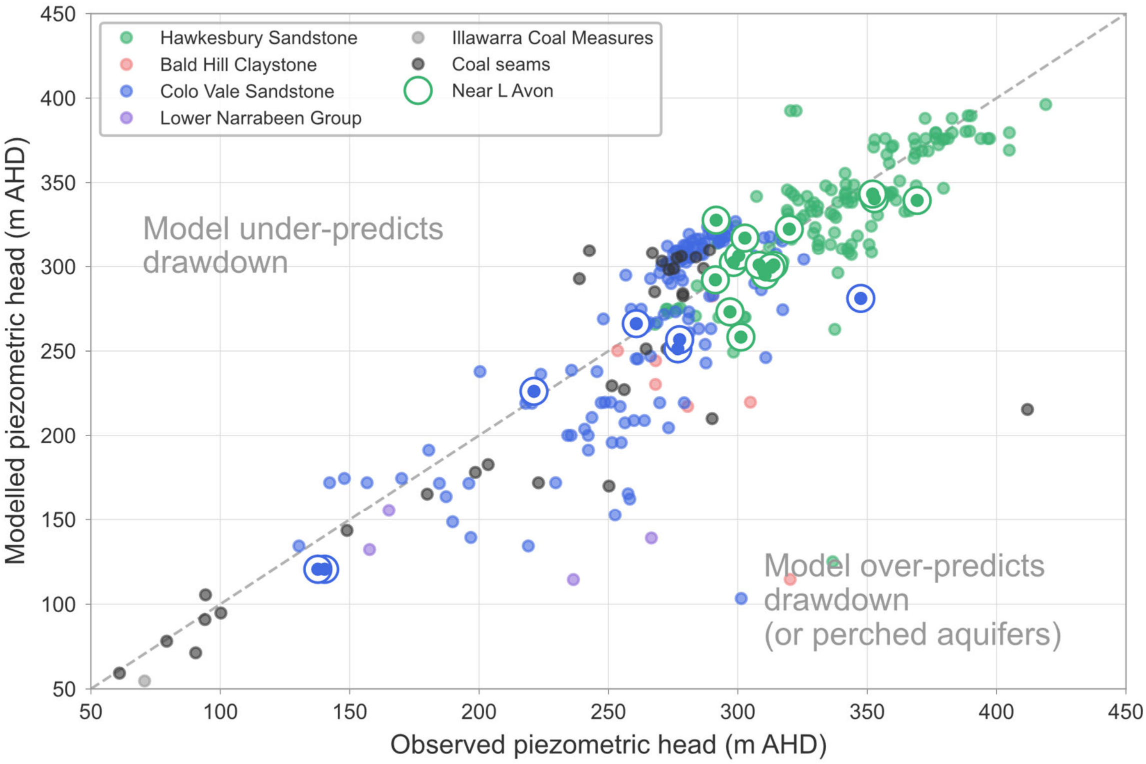

Figure 18. Observed versus model predicted heads at the end of Longwall 16

The following are concluded from the comparison in Figure 18:

- 57% of the observed-modelled piezometric head pairs plot below the 1:1 line indicating that the model is mostly conservative with respect to predicted groundwater drawdown impacts.
- Model predictions for piezometers in the HBSS plot close to the 1:1 line, particularly those in the range 280 to 350 m head, corresponding to the elevation range for watercourses in Area 3B.

- Model and observed heads for piezometers within the HBSS adjacent to Lake Avon plot close to the 1:1 line. Observed heads within this barrier zone are therefore generally in line with model predictions.

3.4.2 Mine water balance

Figure 19 is a plot of the modelled and observed groundwater inflow to Area 3B during the extraction of Longwalls 9 to 16. The numerical model is set up with stress periods corresponding to the originally planned longwall start and end dates (approximately yearly). The plot shows that the numerical model simulates groundwater inflow to Area 3B accurately up to Longwall 13 (mid-2017). From approximately mid-2017, the model simulated groundwater inflow continues to increase in line with the cumulative area mined, whereas the mine water balance records a decline in groundwater inflow to Area 3B to 2020. The reason for the disparity between simulated and observed mine inflow is not clear, however it may be related to the mine approaching strata that was depressurised by Elouera Mine immediately south of Area 3B.

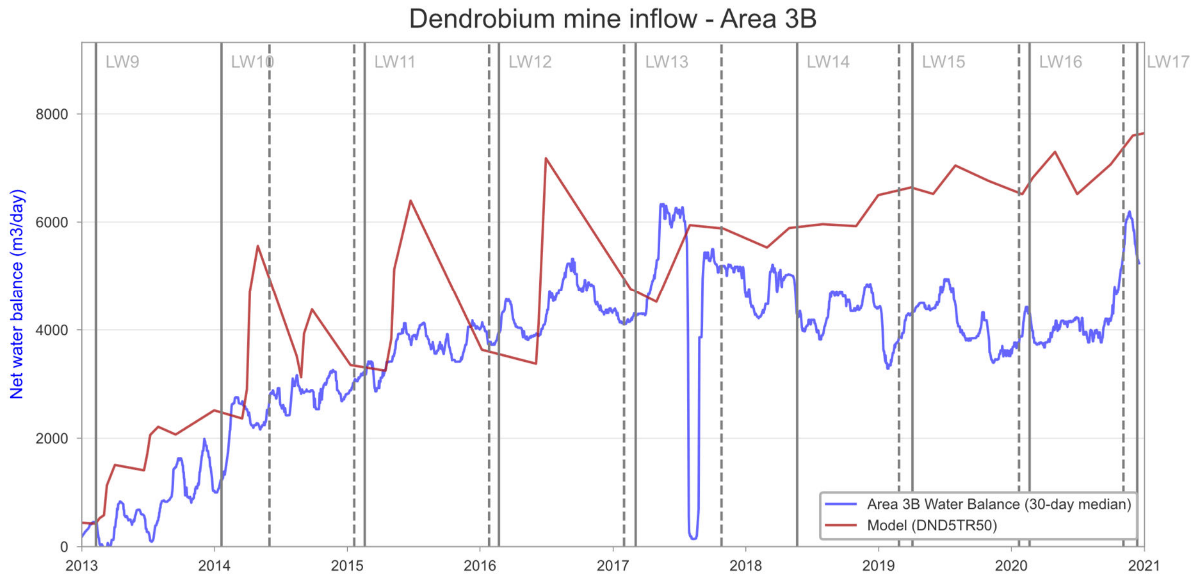

Figure 19. Observed versus model predicted mine groundwater inflow to mine Area 3B

3.4.3 Seepage loss from Lake Avon

The actual rate of seepage loss from Lake Avon cannot be measured directly and can only be estimated by calculation (using for example, Darcy's Law) or by numerical modelling. All estimates rely on assumptions relating to the permeability and hydraulic head distribution within the sandstone barrier zone between the lake and the mine.

Estimates of the net loss (seepage) from Lake Avon as of the end of Longwall 18, based on the regional groundwater model range between **0.09 and 0.45 ML/day** (Watershed Hydrogeo 2020). This loss comprises induced leakage from, and reduced seepage to, the Lake, relative to pre-mining conditions. The estimated range is within the tolerable loss limit of 1 ML/day prescribed by Dams Safety NSW (DSC 2014).

The regional groundwater model of Watershed Hydrogeo (2020) contains estimates of permeability for geological strata that are based on numerous packer tests across the model domain. The permeability parameters were then refined where necessary during the history-matching ("model calibration") process to match predicted piezometric heads with observed heads. As seen in the previous section, the model continues to perform well in terms of providing conservative estimates of drawdown at the regional and catchment scales, and mine inflow.

Since the development of the regional groundwater model detailed hydrogeological investigations have been carried out within the barrier zone between Lake Avon and Dendrobium Area 3B. These investigations included testing of permeability both prior to, and following, extraction of the adjacent longwall panels (Longwalls 12 – 16). The investigations showed that valley-closure movements and strata stress changes related to mine subsidence has resulted in an increase in strata permeability within the HBSS (HGEO 2020a). The investigation found that strata permeability increases by at least an order of magnitude at some locations, but with little or no apparent change in strata permeability at other locations (see Section 3.2.3).

A local-scale numerical model was developed by HGEO (2018b) to assess the effect of the observed strata permeability changes (and variability) on estimates of seepage from Lake Avon. The model was developed using MODFLOW-USG and comprised 10 layers. The permeability of each layer was defined by interpolating the measured (post-mine) permeability from packer tests at each test bore site (Figure 20). An average post-mining hydraulic gradient was applied to produce an estimate of seepage loss per km length of lake shoreline.

The model was revised in September 2020 to include the most recent testing of strata permeability following extraction of Longwall 16 (HGEO 2020a). The revised model estimates a seepage loss of 0.33 ML/day/km of shoreline. This equates to a seepage loss of ~0.51 ML/day adjacent to Longwalls 12 to 16, slightly higher than the range of estimates from regional scale numerical modelling but within the same order of magnitude (0.09 and 0.45 ML/day). The slightly higher estimate from the local-scale model reflects the conservative assumptions used, such as uniform steady state flow towards the mine and complete desaturation above the longwall goaf.

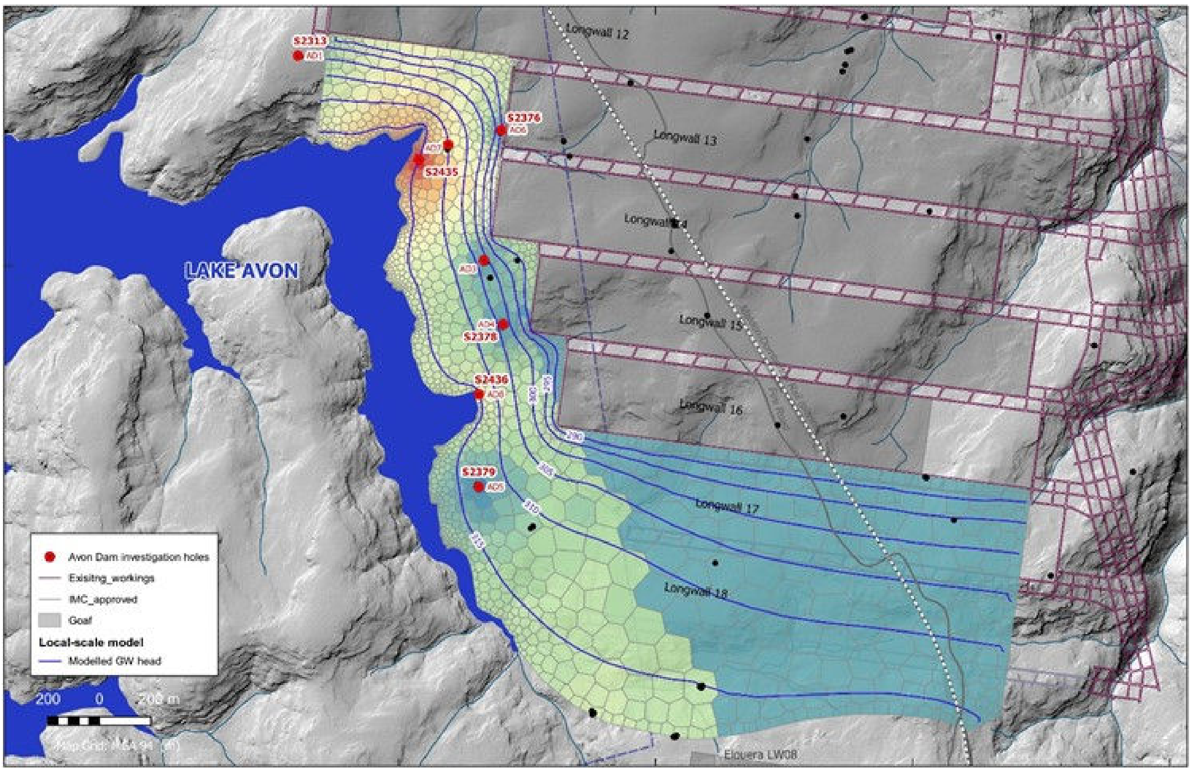

Figure 20. Map showing the layout of the local-scale numerical model (colour shading represents variation in K)

The mine water balance for Area 3B shows that the mean groundwater inflow to the area has plateaued and decreased during extraction of longwalls adjacent to Lake Avon (Section 3.1, Figure 8). Therefore, it is apparent that the increase in seepage from the lake is insufficient to compensate for the decline in groundwater inflow to the mine due to strata depressurisation and low rainfall conditions between 2017 and 2020. In addition, low levels of tritium in mine water pumped from the Area 3B goaf is consistent with a small or negligible component of modern water seepage (< 9%; Section 3.1.1). The tolerable loss limit of 1 ML/day prescribed by Dams Safety NSW equates to ~26% of the inflow to Area 3B. A modern water component of that magnitude would be evident from isotopic tracers (tritium and carbon-14) and the water balance.

3.5 Groundwater chemistry

Previous reviews have shown that there is no clear spatial pattern in the distribution of groundwater quality in HBSS and BGSS bores. Groundwater salinity- measured using electrical conductivity (EC) for all samples collected from monitoring bores in Areas 3A and 3B are summarised in Table 5. As with previous reviews, the groundwater salinity tends to increase with depth. Not all bores were accessed for sampling during Longwall 16. However, of the samples collected, none recorded EC that was >20% lower than the previous year. It is recommended that all accessible monitoring bores with sampling pumps be sampled during 2021.

Samples collected from bore S2377 at depth 113 m reported lower EC during Longwall 15 than the previous longwall. The bore is located adjacent to the Avon Reservoir and follow-up sampling was recommended in the Longwall 15 End of Panel assessment. Sampling during Longwall 16 returned an EC value slightly higher than during Longwall 15.

Table 5. Summary of EC measurements at monitoring bores

Bore ID	Depth (m)	Unit	Area	Mean EC (µS/cm)		
				LW14	LW15	LW16
S1870	10	HBSS	Den 3A		80	
S1870	16.5	HBSS	Den 3A		87	
S1879	10	HBSS	Den 3A		75	
S1879	58	HBSS	Den 3A		233	
S1888	10	HBSS	Den 3A		102	
S1932	10	HBSS	Den 3B			
S1932	98	HBSS	Den 3B			
S1934	55	HBSS	Den 3A		115	
S2001	63	HBSS	Den 3B			183
S2001	106	HBSS	Den 3B			
S2313	54	HBSS	Den 3B	76		
S2313	138	HBSS	Den 3B	122		
S2314	30	HBSS	Den 3B	184		
S2314	75	HBSS	Den 3B	193	158	144
S2340	65	HBSS	Den 5		386	
S2340	137	HBSS	Den 5		2020	
S2341A	98	HBSS	Den 5	189		
S2341A	149	HBSS	Den 5	247		
S2361	70	HBSS	Den 5	272		
S2365	68	HBSS	Den 5	329		
S2376	30	HBSS	Den 3B		123	
S2376	102	HBSS	Den 3B		193	
S2377	34	HBSS	Den 3B	101		88
S2377	113	HBSS	Den 3B	126	88	94
S2378	29	HBSS	Den 3B	132		
S2378	89	HBSS	Den 3B	172	149	155
S2379	47	HBSS	Den 3B	82	86	
S1879	200	BGSS	Den 3A		639	
S2313	194	BGSS	Den 3B	524		
S2314	128	BGSS	Den 3B	409	380	381
S2321	198	BGSS	Den 5			
S2340	215	BGSS	Den 5		129	
S2341A	228	BGSS	Den 5	1400		
S2376	169	BGSS	Den 3B		396	
S2378	164	BGSS	Den 3B	153		
S2379	128	BGSS	Den 3B	291	484	
S2436	35	BGSS	Den 3B		222	188
S2436	90	BGSS	Den 3B		4910*	480
S1870	160	SBSS	Den 3A		319	
S1886	22	SBSS	Den 2	410	486	596
S1886	30	SBSS	Den 2	416	524	696
S1886	38	SBSS	Den 2	530	621	719

Note: * Results affected by bentonite pack near pump intake and not reported

4. CONCLUSION

The following conclusions are made with respect to the assessment of groundwater conditions following the completion of Longwall 15:

- The average daily inflow to Area 3B during Longwall 16 extraction was 3.82 ML/day and total mine inflow was 6.59 ML/day. Compared with the previous longwall, the total mine inflow increased by 15% whereas the inflow in Area 3B decreased by ~ 5%. The increase in total mine inflow is mainly due to an increase of inflow in Area 2. Total mine inflow remains below numerical model predictions.
- There is an apparent lag of two to three months between high rainfall events and peak inflow to Area 3B. The amplitude of the variation due to rainfall accounts for approximately 7% of the total inflow during Longwall 16. The concentration of tritium (an isotopic indicator of modern water) in Area 3B mine inflow water remains low and consistent with a negligible or minor modern water component.
- Groundwater salinity (as indicated by Electrical Conductivity – EC) shows a general increase with depth below the surface. Of the groundwater samples collected in 2020, none recorded EC that was >20% lower than the previous year. It is recommended that all accessible monitoring bores with sampling pumps be sampled during 2021.
- Mining of Longwall 16 resulted in continued depressurisation of the target coal seam and overlying strata. The observed changes in groundwater levels are generally in line with numerical model predictions that support mining approvals. Importantly, for piezometers installed in the barrier zone between Lake Avon and Area 3B, observed head is similar to, or higher than, the numerical model prediction. Therefore, the model predictions are generally accurate as of Longwall 16 or tend to over-estimate groundwater drawdown.
- IMC continued its investigation into the height of fracturing above longwalls, with installation of a post-mining hole over Longwall 16 (in addition to those over Longwalls 6, 7, 9, 12, 13, 14 and 15). Investigations to date have found that mining-induced fracturing, including high-angle fracturing is highly variable but appears to extend to the surface in both Area 3A and 3B. Piezometers installed after longwall extraction indicate significant depressurisation throughout all strata, with complete depressurisation throughout the Hawkesbury Sandstone (HBSS) in most holes. Drawdown in the HBSS reduces with distance and is typically negligible at distances greater than 1.2 km from the goaf footprint.
- Holes in both areas show positive pressure heads in some sensors in the upper CVSS and BACS and evidence for localised perching and groundwater recovery above the goaf. However shallow groundwater levels remain below pre-mining levels.
- Piezometers installed along the barrier zone between Lake Avon and extracted longwalls in Area 3B show declines in piezometric heads to levels below contemporaneous water levels in Lake Avon. The observed levels imply hydraulic gradients away from the lake and towards the mine adjacent to extracted longwalls. Testing of strata permeability before and after mining of adjacent longwalls indicates that permeability increases by at least an order of magnitude at some locations as a result of strata movement, with minor change in strata permeability at other locations.
- Seepage losses from Lake Avon have been estimated by regional and local scale numerical models to be in the range 0.09 to 0.51 ML/day as at the end of Longwall 16. The estimates are within the tolerable loss limit of 1 ML/day prescribed by Dams Safety NSW and supported by the declining mine inflow rates to Area 3B during the extraction of Longwalls 12 to 16 adjacent to Lake Avon.

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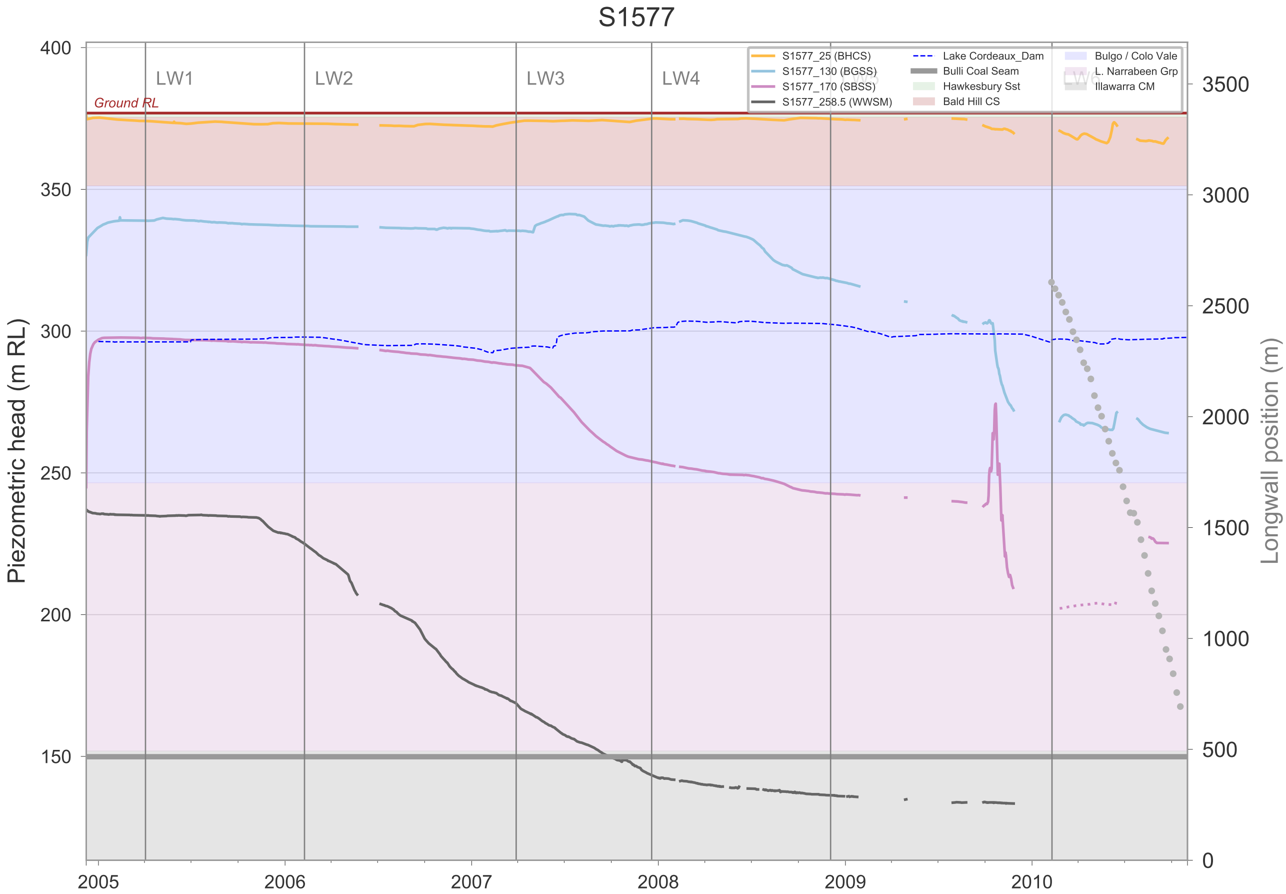
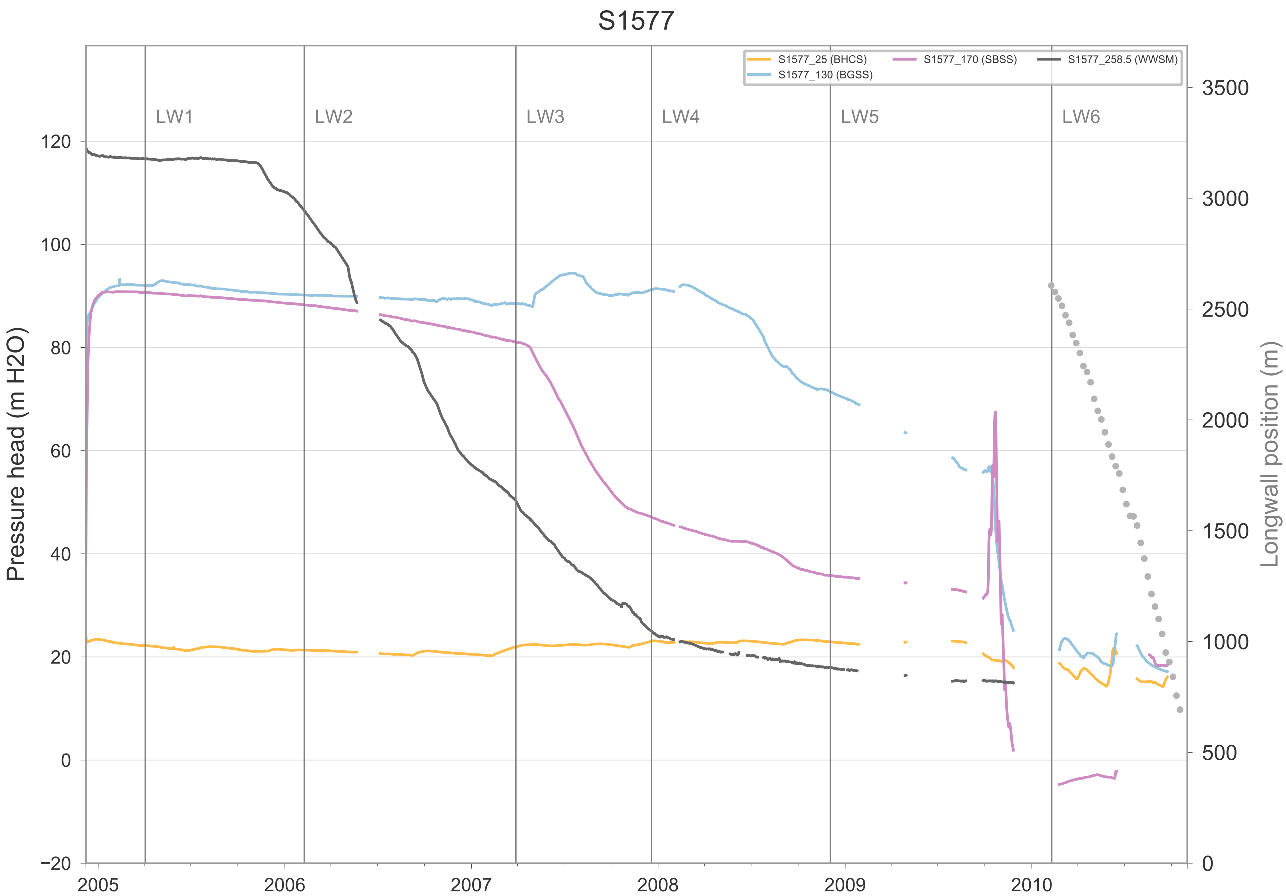
APPENDIX A: List of monitoring bores

Bore ID	Alt_Name	MGA_mE	MGA_mN	Col_RL	Mine_Area	Sensors	First_record	Last_record	Years	%with_data
S1577	Dendrobium DDH 38	294558.0	6192446.6	376.9	Den 2	4	8/12/2004	23/09/2010	5.8	81.3
S1709	DC Elouera DDH 8	290186.4	6189934.4	434.3	Den Other	8	28/02/2005	4/05/2020	15.2	82.2
S1710	DC Elouera DDH 9	290258.0	6189645.7	432.5	Den Other	3	19/05/2005	1/06/2020	15	88.3
S1719	DC Dendrobium DDH 56	291202.0	6193277.0	413.6	Den 3A	1	16/06/2005	18/02/2010	4.7	91.9
S1739	DC Dendrobium DDH 62	289683.6	6191798.7	423.7	Den 3B	1	2/09/2005	19/01/2019	13.4	71.3
S1755	DC Dendrobium DDH64	289475.4	6191380.2	433.3	Den 3B	2	10/01/2006	24/04/2020	14.3	73.8
S1758	Dendrobium DDH 65	288586.6	6193106.9	408.8	Den 3B	2	26/01/2006	10/06/2014	8.4	72.1
S1796	Dendrobium DDH 69	289946.6	6194587.4	398.6	Den 3B	1	5/04/2006	11/09/2020	14.4	62.1
S1800	Dendrobium DDH 70	289933.4	6193996.5	392.5	Den 3B	2	25/04/2006	31/08/2011	5.4	90.4
S1844	Dendrobium DDH 76	291391.1	6194868.8	375.6	Den 3C	2	22/08/2006	29/11/2020	14.3	66.3
S1845	Dendrobium DDH 77	291464.0	6193770.0	399.7	Den 3A	2	29/11/2006	4/01/2010	3.1	90.6
S1855	Dendrobium DDH 82	289746.5	6192833.2	366.6	Den 3B	2	11/12/2006	27/07/2016	9.6	88.8
S1867	ED Dendrobium DDH 84	293792.6	6192912.5	346.0	Den 3A	11	20/03/2007	30/11/2020	13.7	93.2
S1870	ED Dendrobium DDH 85	293593.2	6192648.2	351.5	Den 3A	12	2/02/2007	30/09/2020	13.7	90.7
S1871	ED Dendrobium DDH 86	293525.0	6193287.1	375.6	Den 3A	12	17/02/2007	30/11/2020	13.8	90.3
S1878	ED Dendrobium DDH 91	293842.3	6191994.3	337.1	Den 3A	11	24/04/2007	7/02/2020	12.8	95.2
S1879	ED Dendrobium DDH 92	291440.3	6192133.4	379.7	Den 3A	12	7/06/2007	30/11/2020	13.5	80.7
S1885	ED Dendrobium DDH 93	291504.4	6192667.9	420.0	Den 3A	12	7/06/2007	17/05/2012	4.9	91
S1886	ED Dendrobium PDH 94	295883.8	6191719.6	307.5	Den 2	1	23/03/2007	18/06/2020	13.2	87.9
S1888	ED Dendrobium DDH 96	292486.5	6191987.4	381.3	Den 3A	8	31/05/2007	30/11/2020	13.5	71
S1889	ED Dendrobium DDH 97	292244.8	6192980.4	435.4	Den 3A	8	2/06/2007	10/08/2011	4.2	92
S1890	ED Dendrobium DDH 98	292637.3	6192490.5	407.1	Den 3A	8	31/07/2007	7/08/2012	5	100
S1892	ED Dendrobium DDH 99	291014.1	6193952.0	356.1	Den 3A	8	7/08/2008	30/11/2020	12.3	41.6
S1902	ED Dendrobium DDH 100	295241.3	6190779.8	343.1	Den 2	4	4/10/2007	19/06/2020	12.7	90.7
S1907	ED Dendrobium DDH 103	293212.2	6191943.1	371.9	Den 3A	8	25/01/2008	30/11/2020	12.9	88
S1908	ED Dendrobium DDH 104	288925.9	6193601.4	405.7	Den 3B	8	16/05/2008	1/05/2014	6	79.7
S1910	EDEN105	289387.4	6194176.3	377.2	Den 3B	8	29/08/2008	5/03/2019	10.5	76.5
S1911	EDEN106	288802.8	6192549.4	405.2	Den 3B	12	15/05/2008	24/05/2017	9	96.7
S1914	EDEN107	289370.0	6192511.9	414.5	Den 3B	7	29/04/2008	10/08/2017	9.3	79.4
S1925	ED Dendrobium DDH 108	289251.6	6193041.1	416.7	Den 3B	8	4/08/2008	10/09/2020	12.1	86.7
S1926	ED Dendrobium DDH 109	289660.4	6193444.9	409.0	Den 3B	8	27/08/2008	8/08/2014	5.9	96.3
S1927	ED Dendrobium DDH 110	290066.0	6192211.0	414.8	Den 3B	8	16/05/2008	23/01/2017	8.7	88.9
S1929	ED Dendrobium DDH 111	290010.6	6193398.1	337.7	Den 3B	8	27/08/2008	8/08/2014	5.9	97
S1930	ED Dendrobium DDH 112	290367.3	6193582.9	353.1	Den 3B	12	27/05/2008	21/01/2021	12.7	82.5
S1931	ED Dendrobium DDH 113	290335.6	6192889.9	396.4	Den 3B	9	11/08/2008	7/05/2020	11.7	79.9
S1932	ED Dendrobium DDH 114	288863.3	6191505.4	396.1	Den 3B	11	31/08/2008	10/03/2020	11.5	89.8
S1934	ED Dendrobium DDH 115	292128.0	6192398.0	427.5	Den 3A	4	5/12/2009	17/03/2020	10.3	56.7
S1969	EDEN118	293998.1	6193985.7	368.5	Den 3C	11	12/08/2009	5/12/2016	7.3	94.5
S1992	EDEN119	293732.1	6192706.8	339.1	Den 3A	8	10/05/2009	30/11/2020	11.6	97
S1994	EDEN120	293865.2	6192982.4	345.5	Den 3A	8	13/01/2009	30/11/2020	11.9	62.3
S1995	EDEN121	288212.4	6193662.3	404.5	Den 3B	2	12/06/2009	28/01/2014	4.6	65.6
S1998	EDEN122	287750.6	6194273.1	410.5	Den 3B	2	11/06/2009	15/01/2020	10.6	63.5
S1999	EDEN123	289232.8	6190843.7	406.4	Den 3B	2	10/07/2009	15/01/2020	10.5	82
S2000	EDEN124	290161.4	6191011.2	442.0	Den 3B	2	10/07/2009	14/12/2020	11.4	73.3
S2001	EDEN125	288462.6	6192020.0	413.9	Den 3B	10	6/08/2009	1/12/2020	11.3	95.9
S2002	EDEN126	288633.4	6194222.1	400.0	Den 3B	2	21/07/2009	19/02/2012	2.6	85.3
S2003	EDEN127	290571.1	6192478.0	409.4	Den 3B	2	4/08/2009	1/03/2014	4.6	10.8
S2004	EDEN128	290538.5	6190794.8	443.5	Den 3B	2	14/10/2010	9/06/2020	9.7	0
S2006	EDEN129	287263.2	6194204.3	409.1	Den 3B	10	24/07/2009	30/11/2020	11.4	72
S2007	EDEN130	287590.8	6193718.9	405.8	Den 3B	2	17/06/2009	14/01/2020	10.6	65.7
S2009	EDEN131	287828.2	6193092.0	402.5	Den 3B	10	10/08/2009	24/03/2016	6.6	24.1
S2013	EDEN134	290857.7	6191198.2	399.7	Den 3B	2	22/07/2009	14/12/2020	11.4	64.9
S2059	EDEN148	293245.7	6194795.1	380.8	Den 3C	11	16/08/2011	30/11/2020	9.3	55
S2070	EDEN150	287619.3	6192813.2	414.7	Den 3B	2	15/05/2013	14/01/2020	6.7	82.3
S2078	EDEN154	288190.0	6192451.9	342.0	Den 3B	2	20/06/2010	13/03/2017	6.7	96.7
S2192	S2192	289826.7	6193848.7	389.3	Den 3B	6	25/03/2013	18/11/2014	1.7	34.8
S2194	S2194	288514.9	6190978.8	371.1	Den 3B	11	13/04/2013	22/06/2020	7.2	95.1
S2208	S2208	292801.1	6195037.3	344.1	Den 3C	8	19/12/2014	31/10/2020	5.9	99.8
S2211	S2211	293247.0	6194106.0	397.7	Den 3C	2	2/10/2013	1/11/2020	7.1	92.5
S2212	S2212	293534.8	6194402.9	369.2	Den 3C	10	11/10/2013	31/10/2020	7.1	98.2
S2220	S2220 (AQ5)	289827.2	6193830.7	388.1	Den 3B	3	12/11/2014	31/12/2020	6.1	99.9
S2306	Swamp Bore 3 (adjacent)	288643.3	6192483.7	395.5	Den 3B	4	16/09/2015	31/10/2020	5.1	97.4
S2307	Swamp Bore 4	288665.9	6192424.6	394.5	Den 3B	4	16/09/2015	1/11/2020	5.1	98.1
S2309	Dendrobium S2309_R	287689.9	6194933.2	412.0	Den 3D	10	15/07/2015	31/10/2020	5.3	96.3
S2312	Dendrobium S2312	284450.1	6196150.7	409.4	Den 3D	10	12/08/2015	31/10/2020	5.2	79.4
S2313	Avon 1	287609.0	6192815.5	415.3	Den 3B	3	31/10/2015	31/12/2020	5.2	91.5
S2314	Avon 2	288193.5	6192470.3	342.4	Den 3B	3	13/11/2015	31/12/2020	5.1	96.3

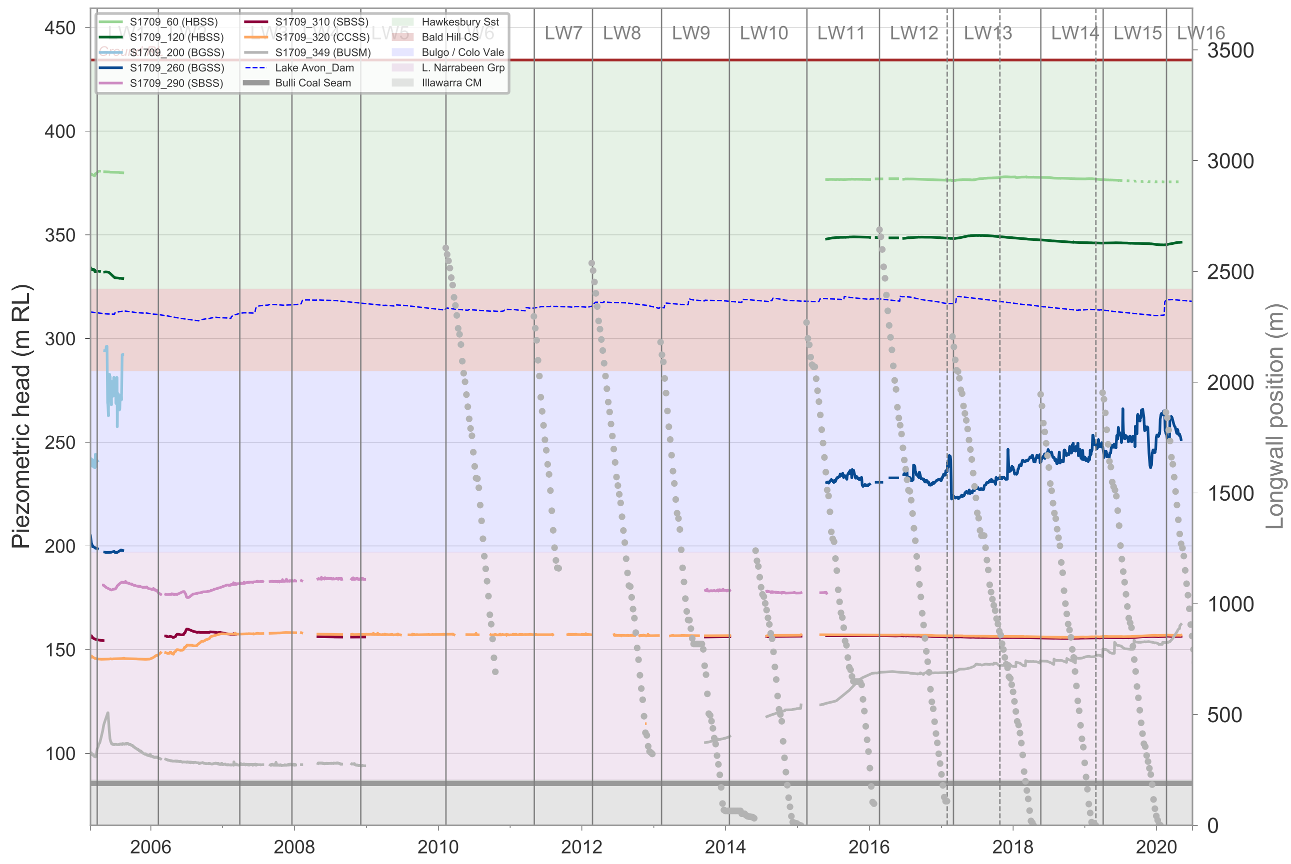
Bore ID	Alt_Name	MGA_mE	MGA_mN	Col_RL	Mine_Area	Sensors	First_record	Last_record	Years	%with_data
S2321	Dend S2321	284710.0	6195575.5	411.0	Den 3D	2	12/08/2016	31/10/2020	4.2	85.5
S2325	Dend S2325	283596.2	6195466.7	433.5	Den 3D	8	6/09/2016	31/10/2020	4.2	94.3
S2333	Dend s2333 (D-A3C-14-12)	290697.1	6197087.4	310.9	Den 3C	10	8/10/2016	10/09/2020	3.9	95.9
S2335	WC21Project Hole1Site 2	289725.4	6192748.7	372.6	Den 3B	5	19/10/2016	12/11/2016	0.1	96
S2336	WC21Hole2,Site2	289721.9	6192758.1	372.4	Den 3B	2	21/10/2016	20/07/2017	0.7	81.3
S2337	WC21Project Hole1Site 5	290021.0	6193411.9	336.1	Den 3B	3	25/11/2016	31/10/2020	3.9	90.6
S2338	WC21Hole2,Site5	290012.2	6193406.7	336.1	Den 3B	3	24/11/2016	31/10/2020	3.9	90.6
S2340	D-A5-25	285468.1	6197978.9	396.9	Den 3D	9	7/12/2016	31/10/2020	3.9	90.9
S2341	D-A5-28	287473.5	6195149.8	401.6	Den 3D	10	7/12/2016	31/10/2020	3.9	99.9
S2341A	D-A5-28A	287489.0	6195138.2	402.6	Den 3C	4	21/12/2016	31/10/2020	3.9	94.1
S2342	D-A5-12	287953.2	6196755.8	403.2	Den 3D	10	23/12/2016	31/10/2020	3.9	97.7
S2345	D-A5-19	285356.8	6196094.9	402.0	Den 3D	12	29/04/2017	31/10/2020	3.5	97.1
S2348	D-A5-17	286450.5	6196461.9	396.3	Den 3D	13	11/08/2017	3/09/2020	3.1	72.6
S2351	S14-04	290049.6	6191178.2	402.8	Den 3B	2	1/09/2017	21/01/2021	3.4	86.4
S2352	D-A5-6	286264.6	6195393.3	408.8	Den 3C	10	27/04/2017	31/12/2020	3.7	76.4
S2354	S14_05	289730.9	6191413.7	424.6	Den 3B	1	7/09/2017	31/12/2020	3.3	100
S2355	A5_S85_DBH	288136.2	6194877.8	396.6	Den 3C	5	5/08/2017	3/09/2020	3.1	100
S2357	A5-S100_DBH	286809.6	6196991.8	394.0	Den 3C	4	29/07/2017	3/09/2020	3.1	87.9
S2359	D-A5-5	285354.6	6195547.7	403.6	Den 3C	10	11/08/2017	31/12/2020	3.4	62.7
S2361	A5_S109_DBH	286277.9	6195810.7	402.4	Den 3C	4	24/06/2017	3/09/2020	3.2	70.4
S2362	A5_S110_DBH	285772.9	6195823.0	399.9	Den 3C	4	23/06/2017	3/09/2020	3.2	80
S2364	A5_S103_DBH	285982.8	6196782.1	395.0	Den 3C	4	14/11/2017	3/09/2020	2.8	59.5
S2365	A5_101/102_DBH	286042.3	6196448.9	399.2	Den 3C	5	4/09/2017	3/09/2020	3	100
S2366	A6_S113_DBH	291865.1	6200199.1	358.6	Den 3D	4	23/05/2018	15/05/2020	2	100
S2367	A6_S117_DBH	291630.7	6199726.5	356.1	Den 3D	4	23/05/2018	15/05/2020	2	100
S2370	D-A5-2	285554.8	6196642.7	375.6	Den 3C	10	12/05/2018	17/09/2020	2.4	61.2
S2371	A6_S116_DBH	291977.5	6199135.2	351.2	Den 3C	4	23/05/2018	15/05/2020	2	100
S2372	A6_S115_DBH	291576.9	6198891.4	373.5	Den 3C	4	23/05/2018	15/05/2020	2	100
S2373	A6_S112_DBH	292043.2	6200899.2	359.0	Den 3C	4	7/10/2017	9/06/2020	2.7	100
S2374	A6_S83_DBH	291114.8	6201461.1	324.4	Den 3C	4	24/05/2018	15/05/2020	2	100
S2376	Avon 6	288400.4	6192527.0	367.8	Den 3B	3	6/10/2017	14/12/2020	3.2	100
S2377	Avon 3	288333.4	6192020.4	408.2	Den 3B	3	2/06/2018	1/01/2021	2.6	100
S2378	Avon 4	288407.4	6191770.9	379.3	Den 3B	3	15/11/2017	1/01/2021	3.1	84.5
S2379	Avon 5	288312.9	6191140.5	356.6	Den 3B	3	17/07/2018	14/12/2020	2.4	47.2
S2398	LW14_1	289073.2	6192164.3	420.2	Den 3B	8	11/05/2018	15/08/2018	0.3	100
S2398B	LW14-1 post extraction Redrill	289070.9	6192172.6	418.0	Den 3B	8	8/03/2019	31/12/2020	1.8	91.1
S2399	LW12_1	289810.5	6192965.1	355.1	Den 3B	8	3/05/2018	21/09/2020	2.4	82.4
S2401	Den01b_R1	287752.2	6194264.9	411.1	Den 3B	6	16/11/2018	14/12/2020	2.1	89.7
S2402	Den01b_R2	288207.8	6193666.6	403.4	Den 3B	6	6/07/2018	14/12/2020	2.4	88.4
S2403	Den01b_R3	288345.1	6193761.1	400.7	Den 3B	6	16/11/2018	14/12/2020	2.1	93.4
S2404	Den01b_R4	288528.6	6193896.8	396.2	Den 3B	6	22/11/2018	14/12/2020	2.1	93.5
S2405	Den01b_R5	288729.5	6194087.6	386.1	Den 3B	6	17/11/2018	14/12/2020	2.1	93.4
S2406	Den01b_R6	288669.1	6194176.5	396.6	Den 3B	6	17/11/2018	14/12/2020	2.1	93.5
S2408	GW14-2	289552.1	6192193.4	398.1	Den 3B	7	3/10/2018	31/12/2020	2.2	97.8
S2409	GW14-3	289546.1	6192269.7	394.6	Den 3B	6	3/10/2018	31/12/2020	2.2	92
S2411	LW12_2	289761.1	6192837.7	364.0	Den 3B	8	5/07/2018	31/10/2020	2.3	98.9
S2412	LW15-1	289201.1	6191807.4	427.3	Den 3B	8	12/05/2018	17/06/2019	1.1	97
S2412B	GW15-1	289201.6	6191803.7	425.2	Den 3B	8	18/12/2019	30/11/2020	1	98.6
S2420	LW12-3	289738.4	6192780.0	367.8	Den 3B	8	3/10/2018	22/08/2020	1.9	100
S2421	LW13-1	289590.4	6192492.2	381.8	Den 3B	8	8/02/2019	30/11/2020	1.8	78.7
S2435	AD7	288080.8	6192411.6	328.2	Den 3B	3	21/11/2018	31/12/2020	2.1	100
S2436	AD8	288313.8	6191499.7	320.3	Den 3B	5	4/12/2018	14/12/2020	2	95.6
S2438		287944.9	6197535.1	399.3	Den 3C	9	23/11/2018	30/11/2020	2	100
S2442A	S2442A-SandyCreek	292788.5	6193213.2	407.6	Den 3A	6	14/03/2019	30/11/2020	1.7	100
S2443	Sandy Creek series	292176.0	6193027.4	426.7	Den 3A	6	3/08/2019	20/11/2020	1.3	75.2
S2486	GW-12-4	288902.8	6192710.7	412.1	Den 3B	7	18/12/2019	29/11/2020	1	100
S2487	GW15-2	290707.0	6191689.0	435.3	Den 3B	5	28/11/2019	1/01/2021	1.1	58.9
S2490	Swamp 35B	289178.0	6190358.0	347.6	Den 3B	4	31/01/2020	14/12/2020	0.9	79.6
S2493	LW17_1	289659.3	6191107.3	434.8	Den 3B	9	2/04/2020	30/11/2020	0.7	100
S2510	LW16_2	288856.8	6191510.6	393.7	Den 3B	8	3/11/2020	30/11/2020	0.1	100

APPENDIX B: Groundwater hydrographs

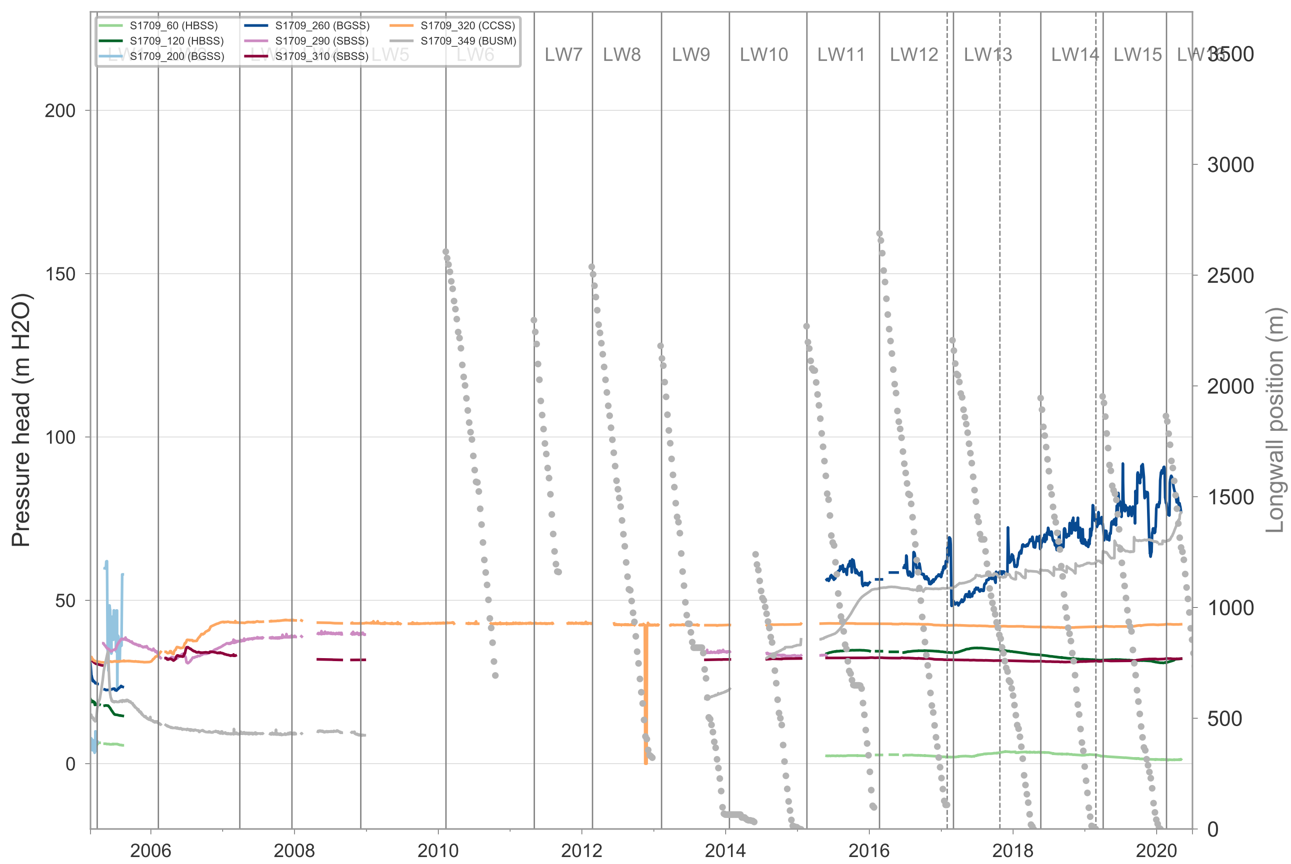

S1577
S1577_25 (BHCS)
S1577_130 (BGSS)
S1577_170 (SBSS)
S1577_258.5 (WWSM)
Lake Cordeaux_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
LW1
LW2
LW3
LW4
Ground RL
Piezometric head (m RL)
Longwall position (m)
2005
2006
2007
2008
2009
2010

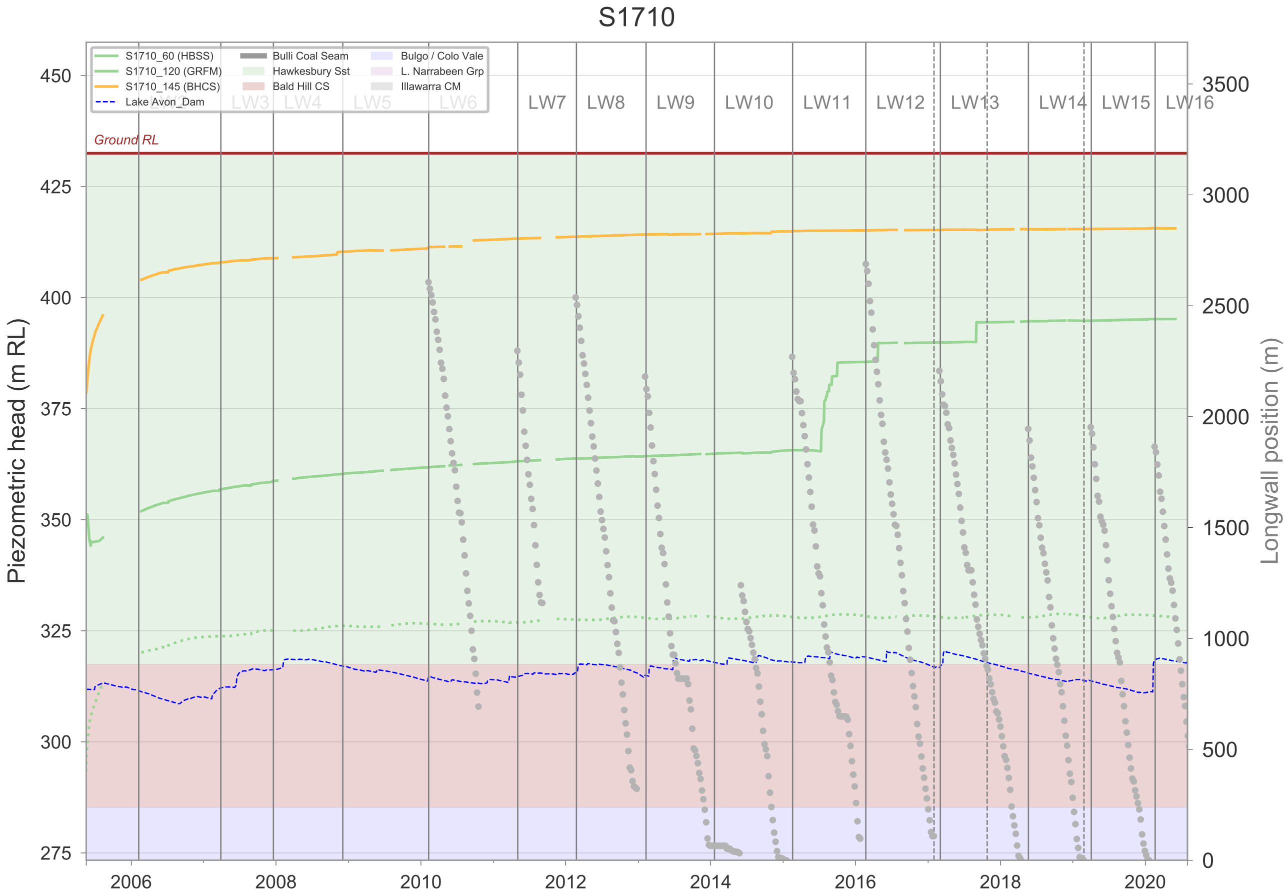

S1577
S1577_25 (BHCS)
S1577_130 (BGSS)
S1577_170 (SBSS)
S1577_258.5 (WWSM)
LW1
LW2
LW3
LW4
LW5
LW6
Pressure head (m H2O)
Longwall position (m)
2005
2006
2007
2008
2009
2010

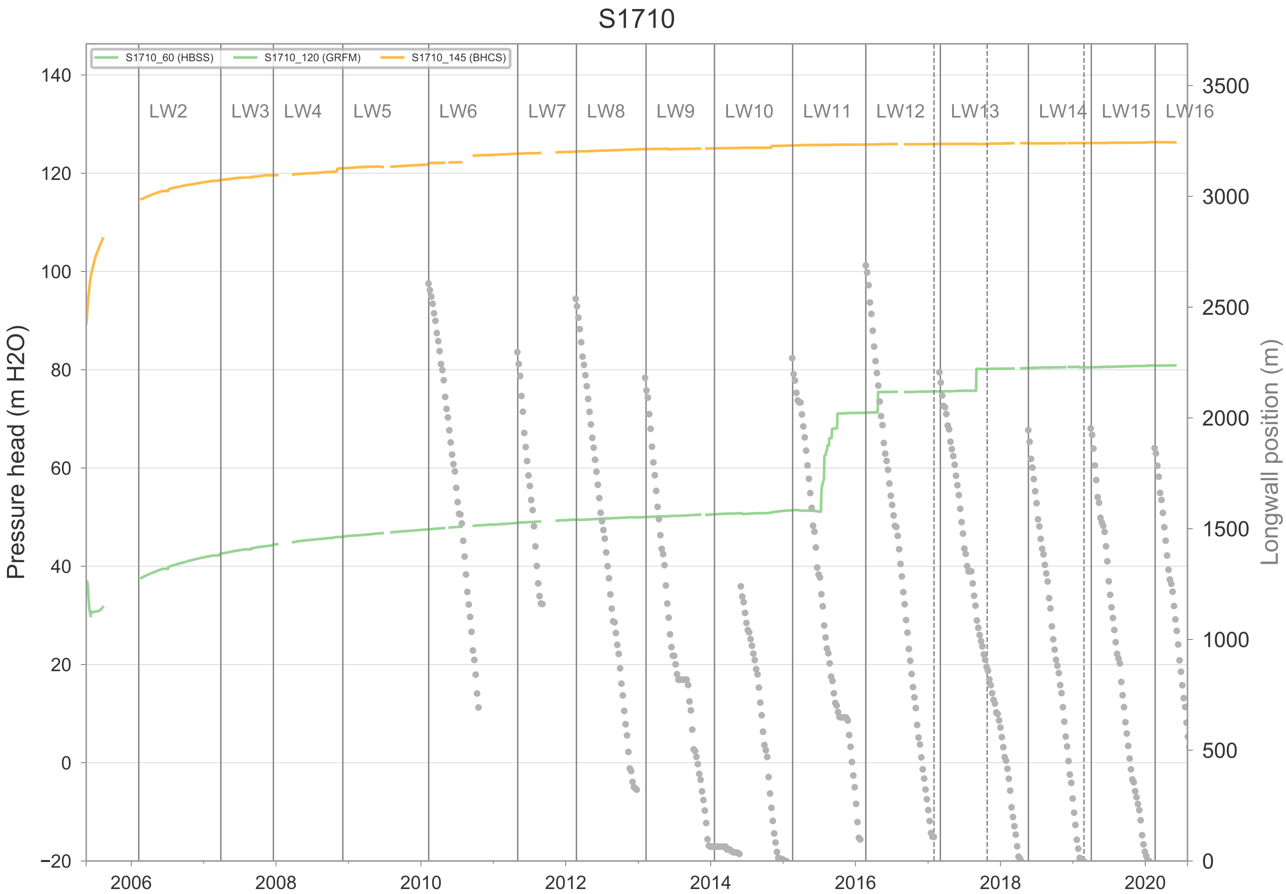
S1709

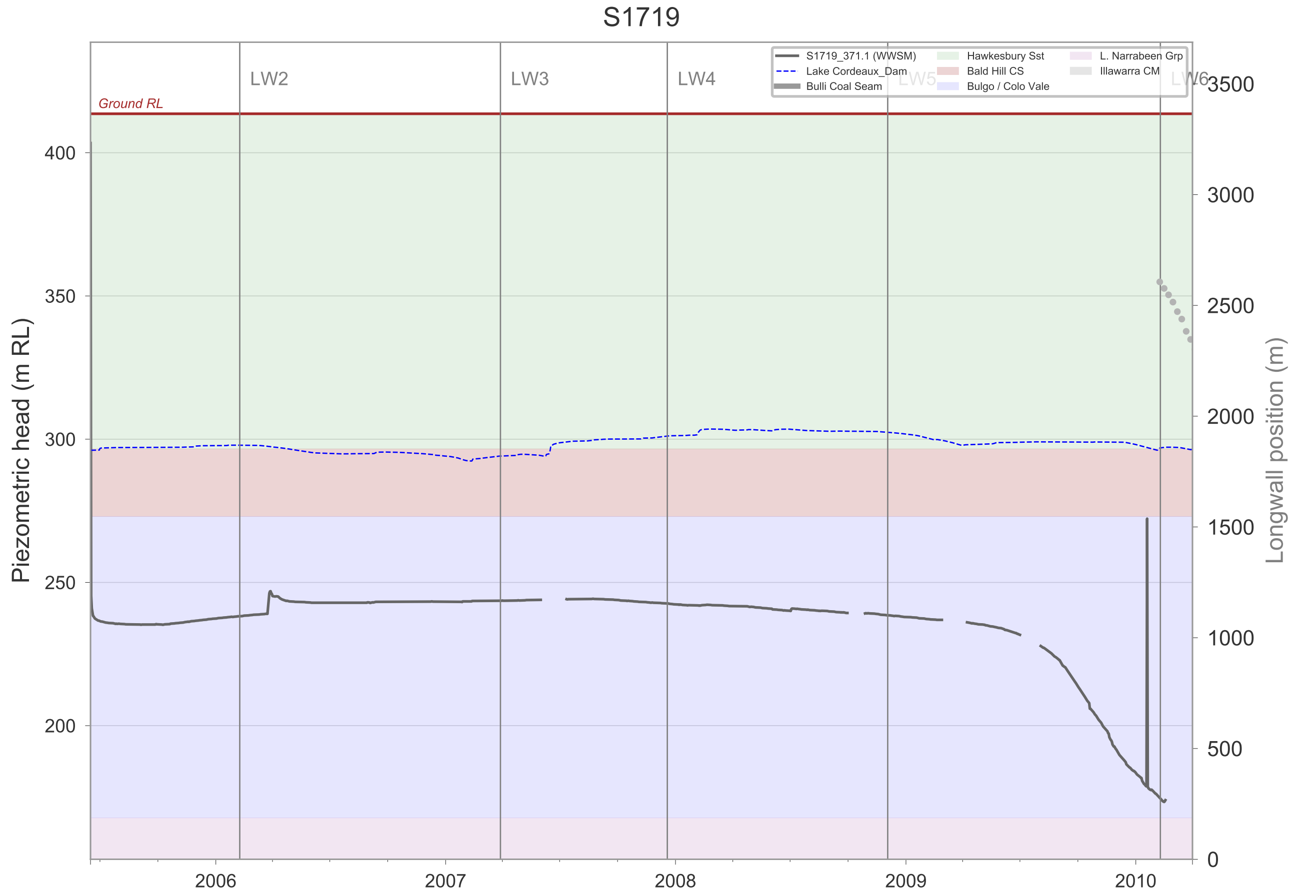

S1709_60 (HBSS)
S1709_120 (HBSS)
S1709_200 (BGSS)
S1709_260 (BGSS)
S1709_290 (SBSS)
S1709_310 (SBSS)
S1709_320 (CCSS)
S1709_349 (BUSM)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
LW7
LW8
LW9
LW10
LW11
LW12
LW13
LW14
LW15
LW16
Piezometric head (m RL)
Longwall position (m)

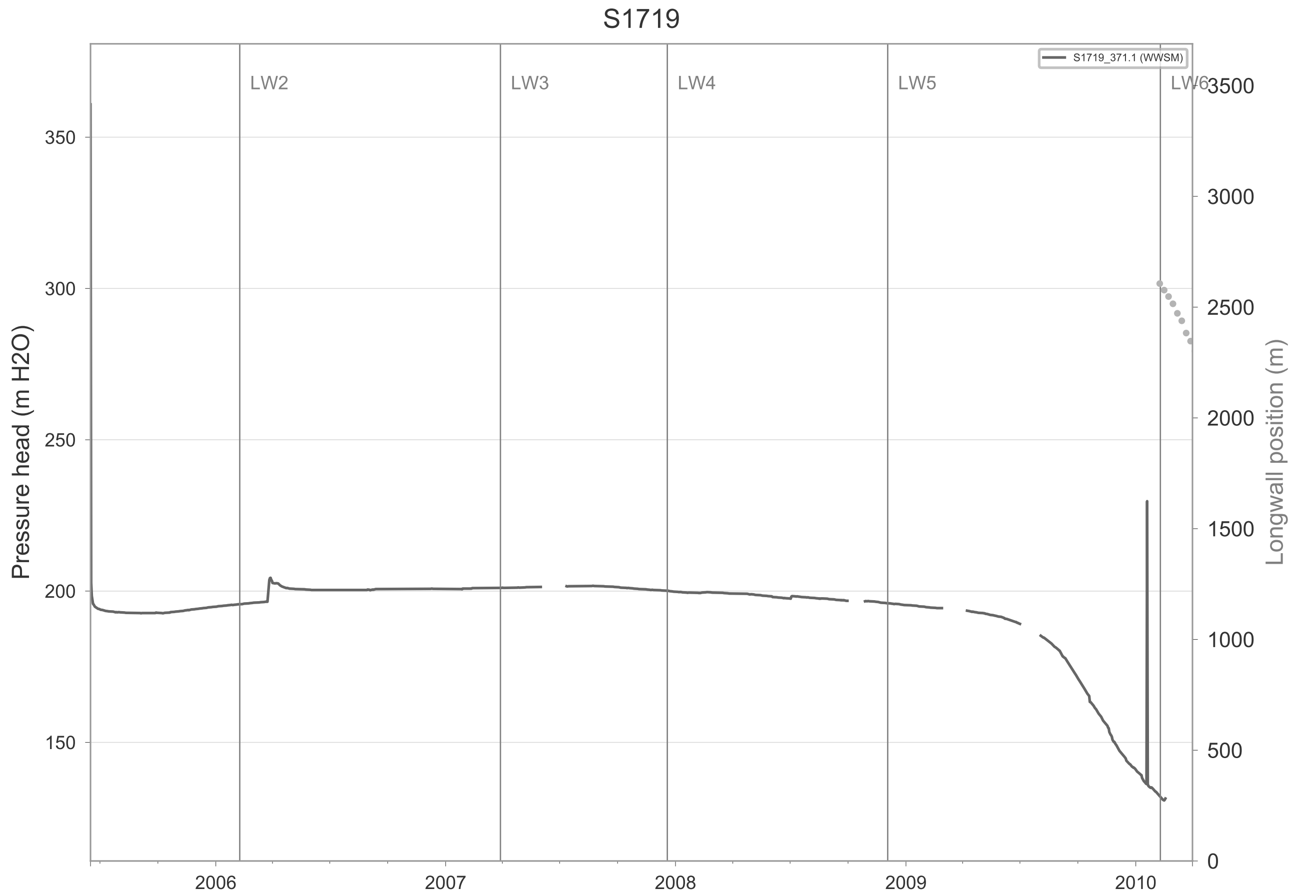
S1709

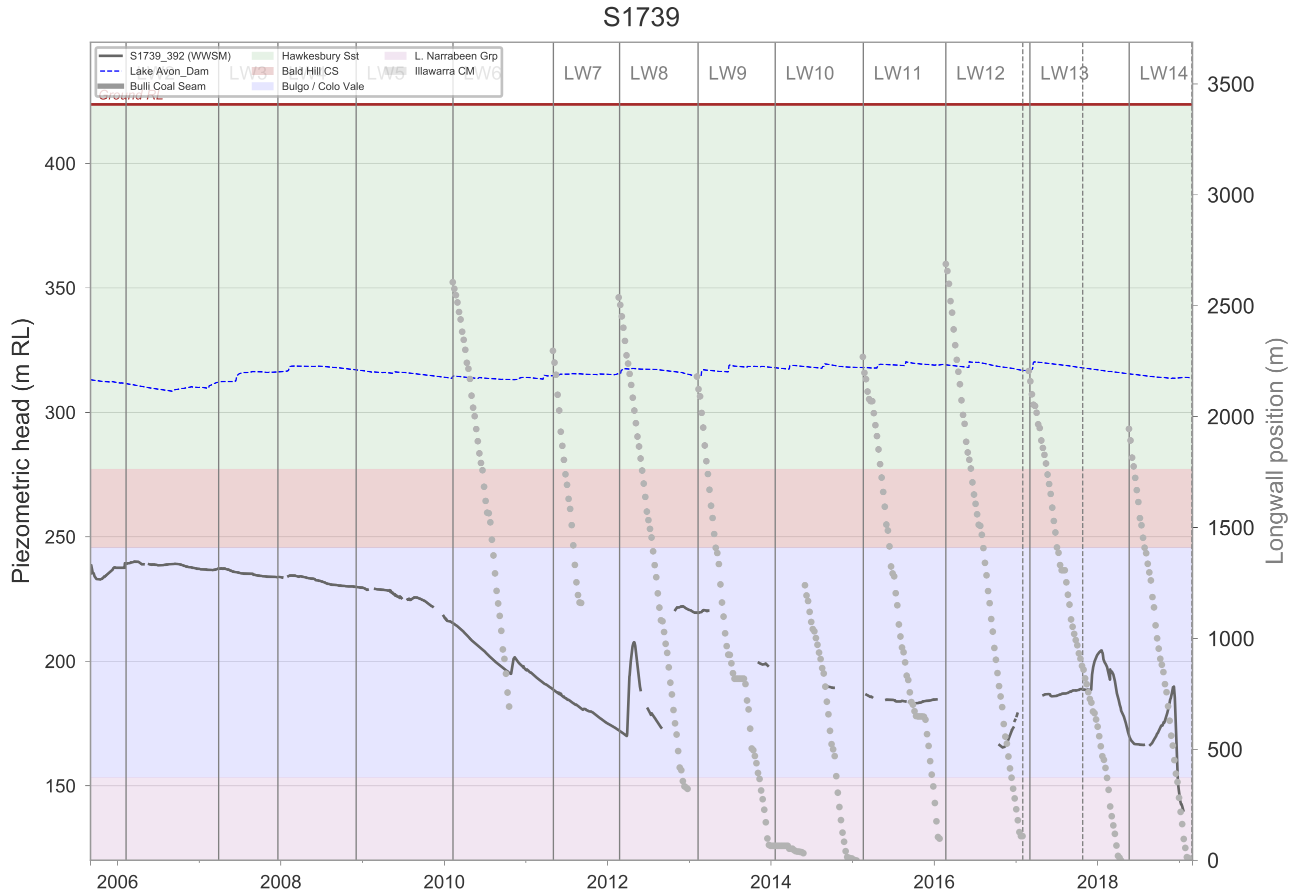

S1709_60 (HBSS)
S1709_120 (HBSS)
S1709_200 (BGSS)
S1709_260 (BGSS)
S1709_290 (SBSS)
S1709_310 (SBSS)
S1709_320 (CCSS)
S1709_349 (BUSM)
LW7
LW8
LW9
LW10
LW11
LW12
LW13
LW14
LW15
LW16
Pressure head (m H2O)
Longwall position (m)

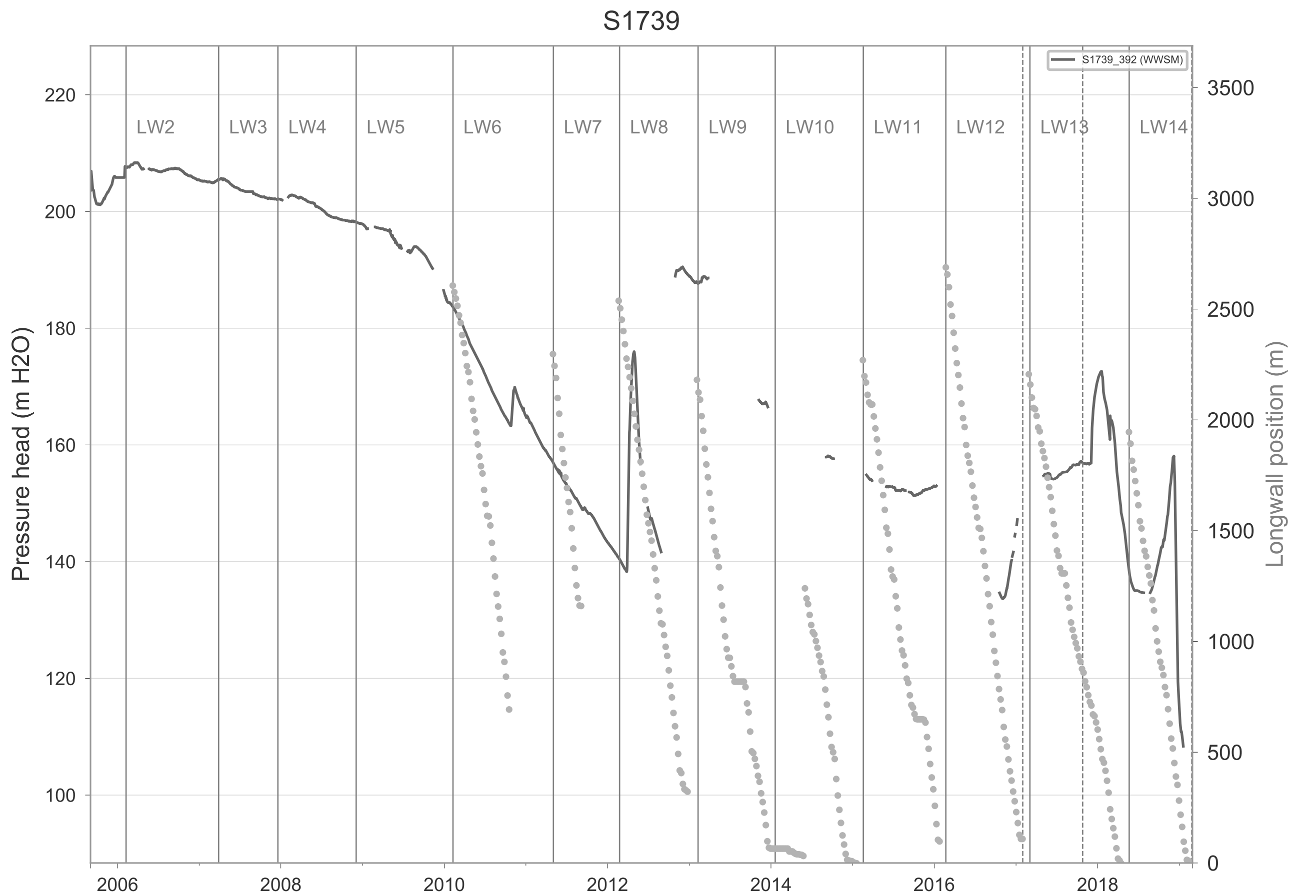

S1710
S1710_60 (HBSS)
S1710_120 (GRFM)
S1710_145 (BHCS)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
Ground RL
LW3
LW4
LW5
LW6
LW7
LW8
LW9
LW10
LW11
LW12
LW13
LW14
LW15
LW16
Piezometric head (m RL)
Longwall position (m)
450
425
400
375
350
325
300
275
3500
3000
2500
2000
1500
1000
500
0
2006
2008
2010
2012
2014
2016
2018
2020

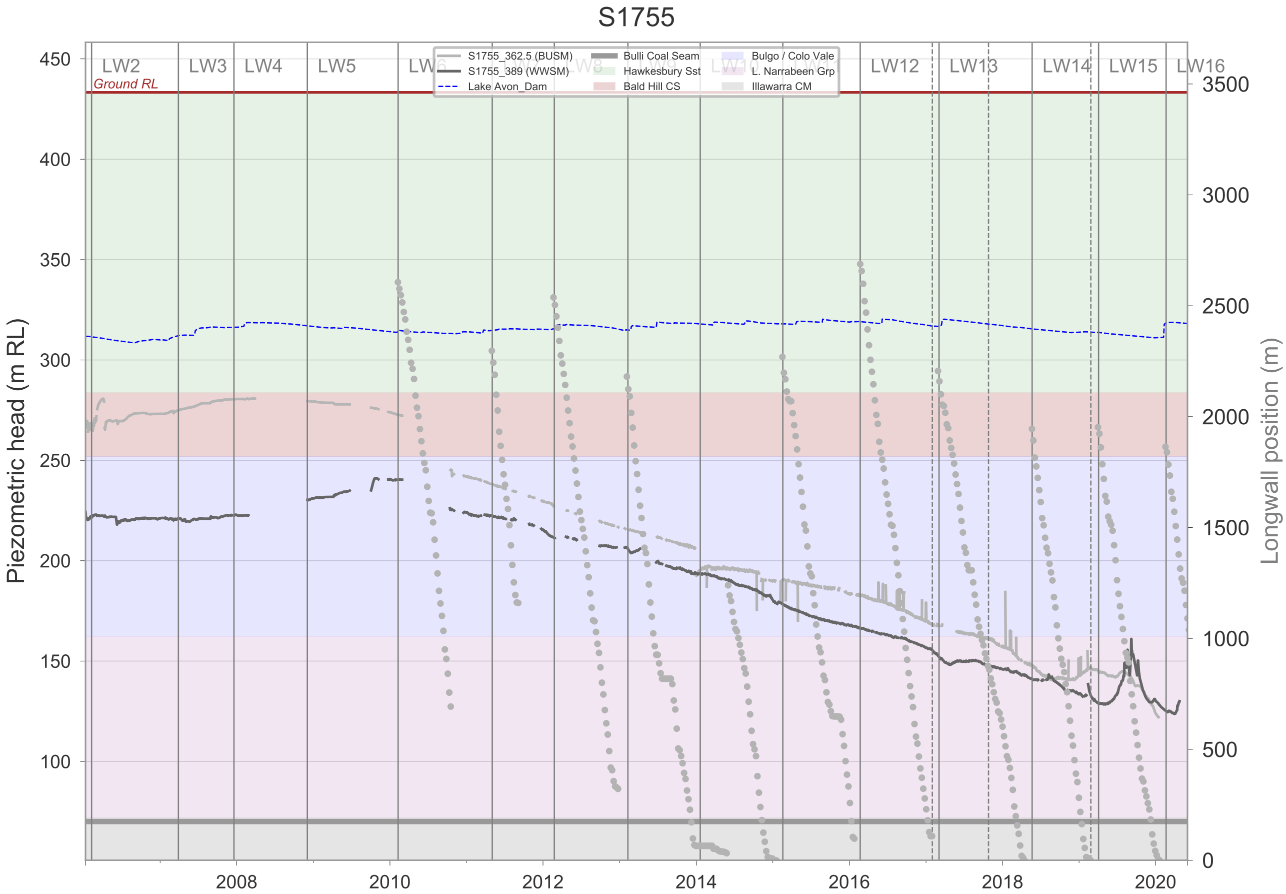

S1710
S1710_60 (HBSS)
S1710_120 (GRFM)
S1710_145 (BHCS)
LW2
LW3
LW4
LW5
LW6
LW7
LW8
LW9
LW10
LW11
LW12
LW13
LW14
LW15
LW16
Pressure head (m H2O)
Longwall position (m)
140
120
100
80
60
40
20
0
−20
3500
3000
2500
2000
1500
1000
500
0
2006
2008
2010
2012
2014
2016
2018
2020

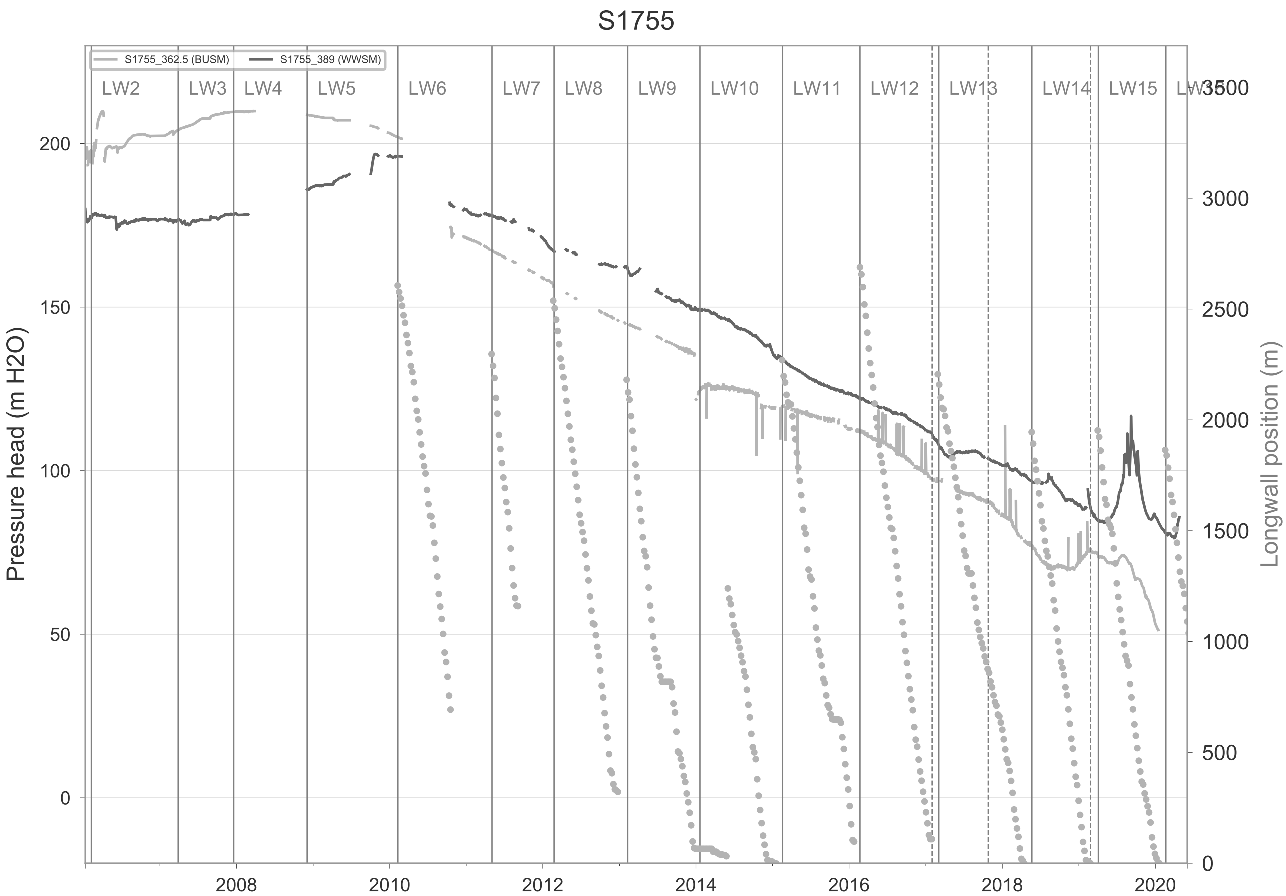

S1719
S1719_371.1 (WWSM)
Lake Cordeaux_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
LW2
LW3
LW4
LW5
LW6
Ground RL
Piezometric head (m RL)
Longwall position (m)
400
350
300
250
200
3500
3000
2500
2000
1500
1000
500
0
2006
2007
2008
2009
2010


S1719
S1719_371.1 (WWSM)
LW2
LW3
LW4
LW5
LW6
Pressure head (m H2O)
Longwall position (m)
350
300
250
200
150
3500
3000
2500
2000
1500
1000
500
0
2006
2007
2008
2009
2010

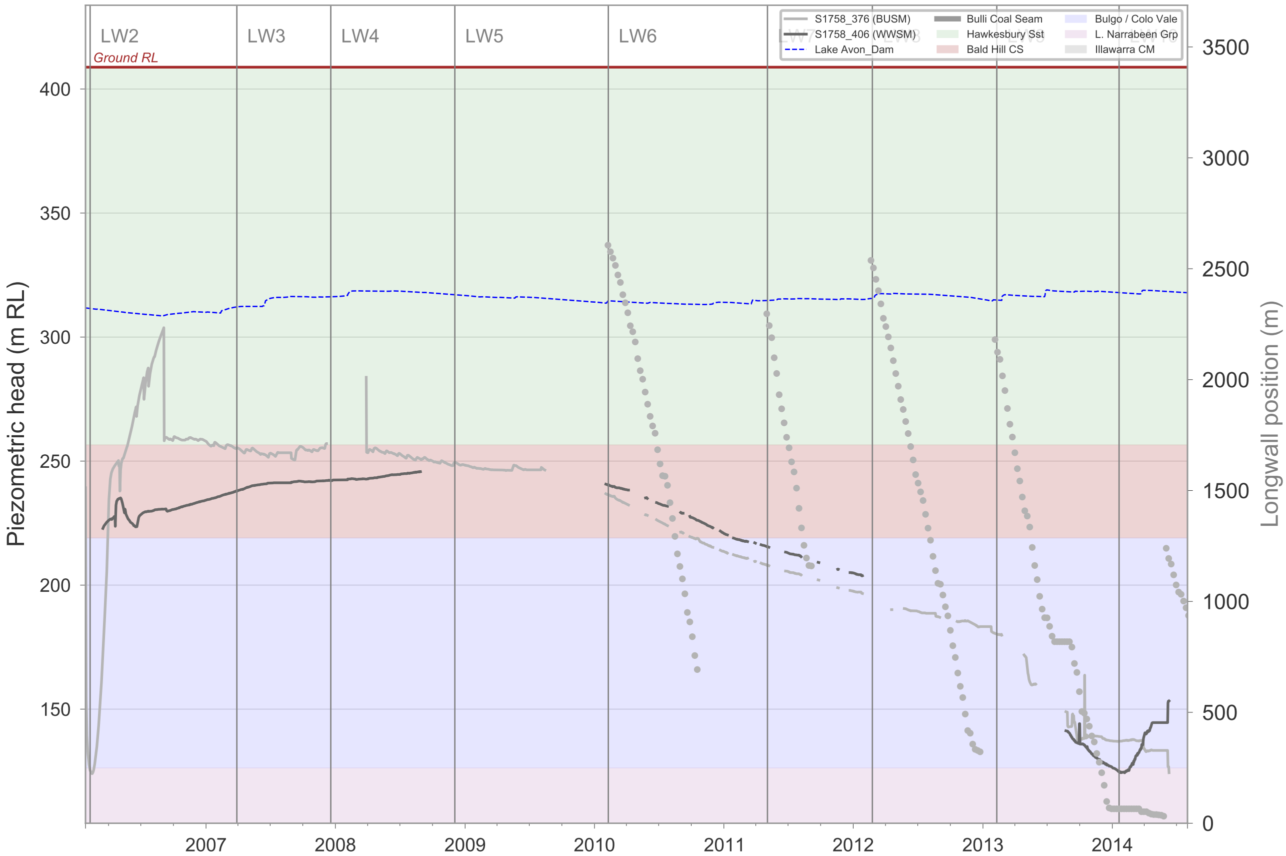

S1739
S1739_392 (WWSM)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
Ground RL
LW7
LW8
LW9
LW10
LW11
LW12
LW13
LW14
Piezometric head (m RL)
Longwall position (m)
2006
2008
2010
2012
2014
2016
2018


S1739
S1739_392 (WWSM)
LW2
LW3
LW4
LW5
LW6
LW7
LW8
LW9
LW10
LW11
LW12
LW13
LW14
Pressure head (m H2O)
Longwall position (m)
2006
2008
2010
2012
2014
2016
2018

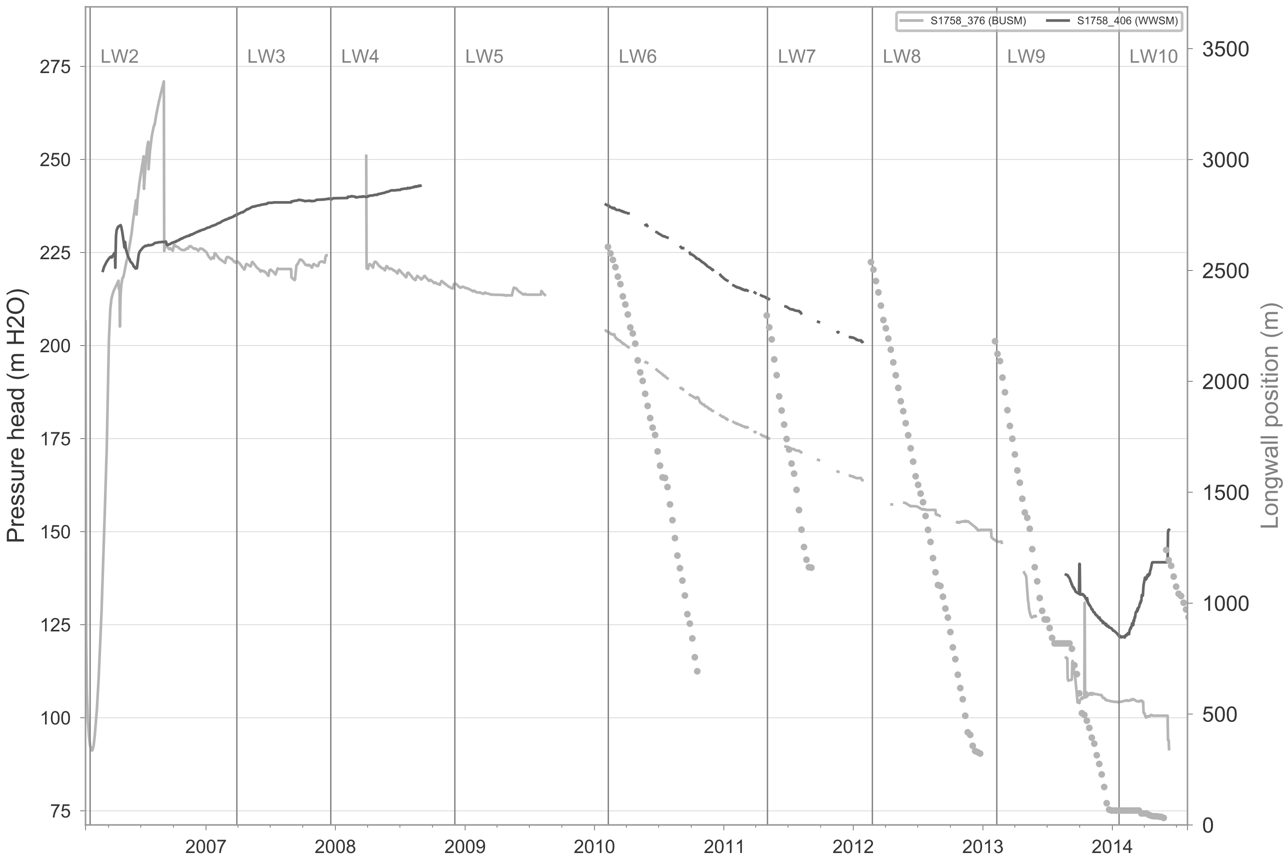

S1755
S1755_362.5 (BUSM)
S1755_389 (WWSM)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
Ground RL
LW2 LW3 LW4 LW5 LW6 LW7 LW8 LW9 LW10 LW11 LW12 LW13 LW14 LW15 LW16
Piezometric head (m RL)
Longwall position (m)
450 400 350 300 250 200 150 100
3500 3000 2500 2000 1500 1000 500 0
2008 2010 2012 2014 2016 2018 2020

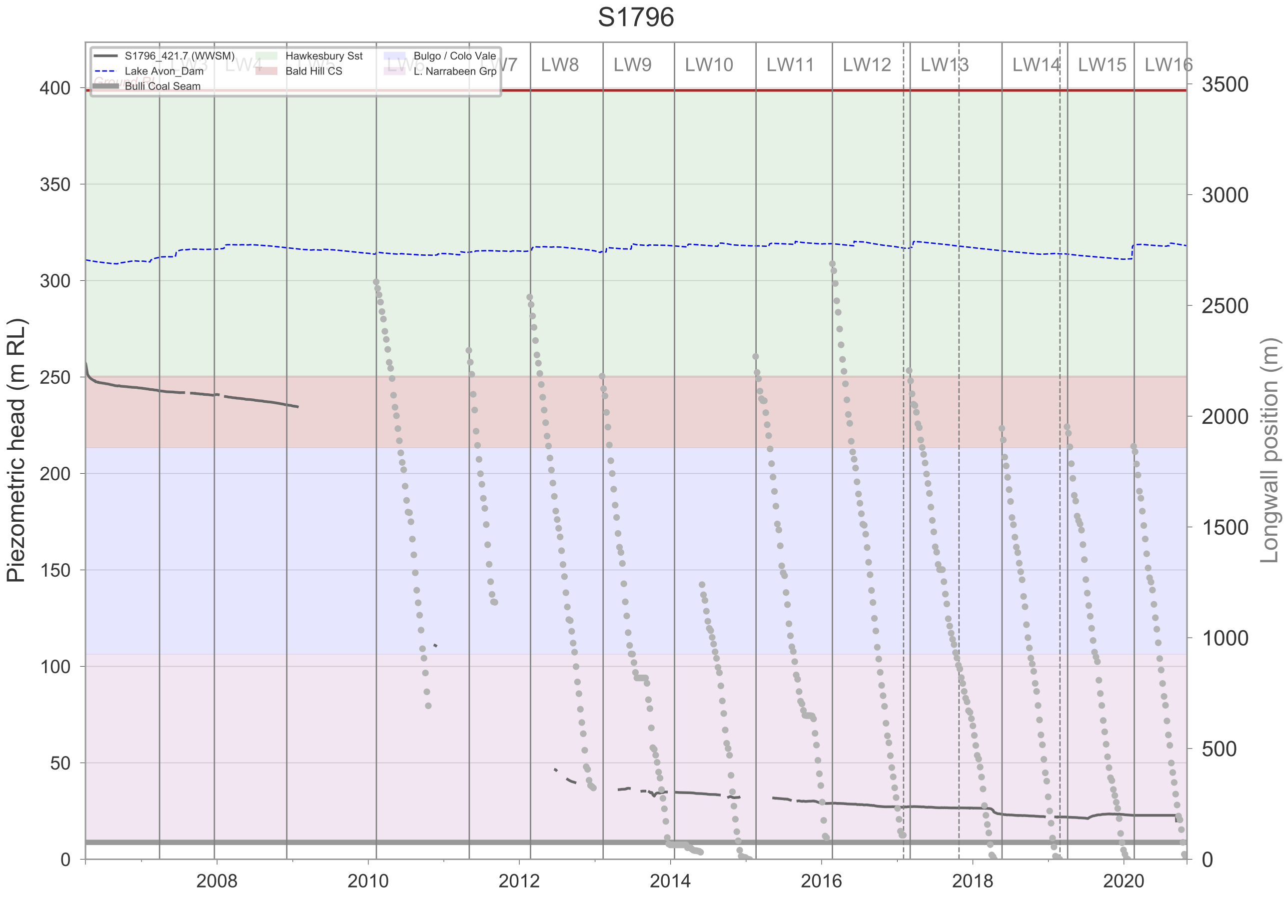

S1755
S1755_362.5 (BUSM)
S1755_389 (WWSM)
LW2 LW3 LW4 LW5 LW6 LW7 LW8 LW9 LW10 LW11 LW12 LW13 LW14 LW15 LW16
Pressure head (m H2O)
Longwall position (m)
200 150 100 50 0
3500 3000 2500 2000 1500 1000 500 0
2008 2010 2012 2014 2016 2018 2020

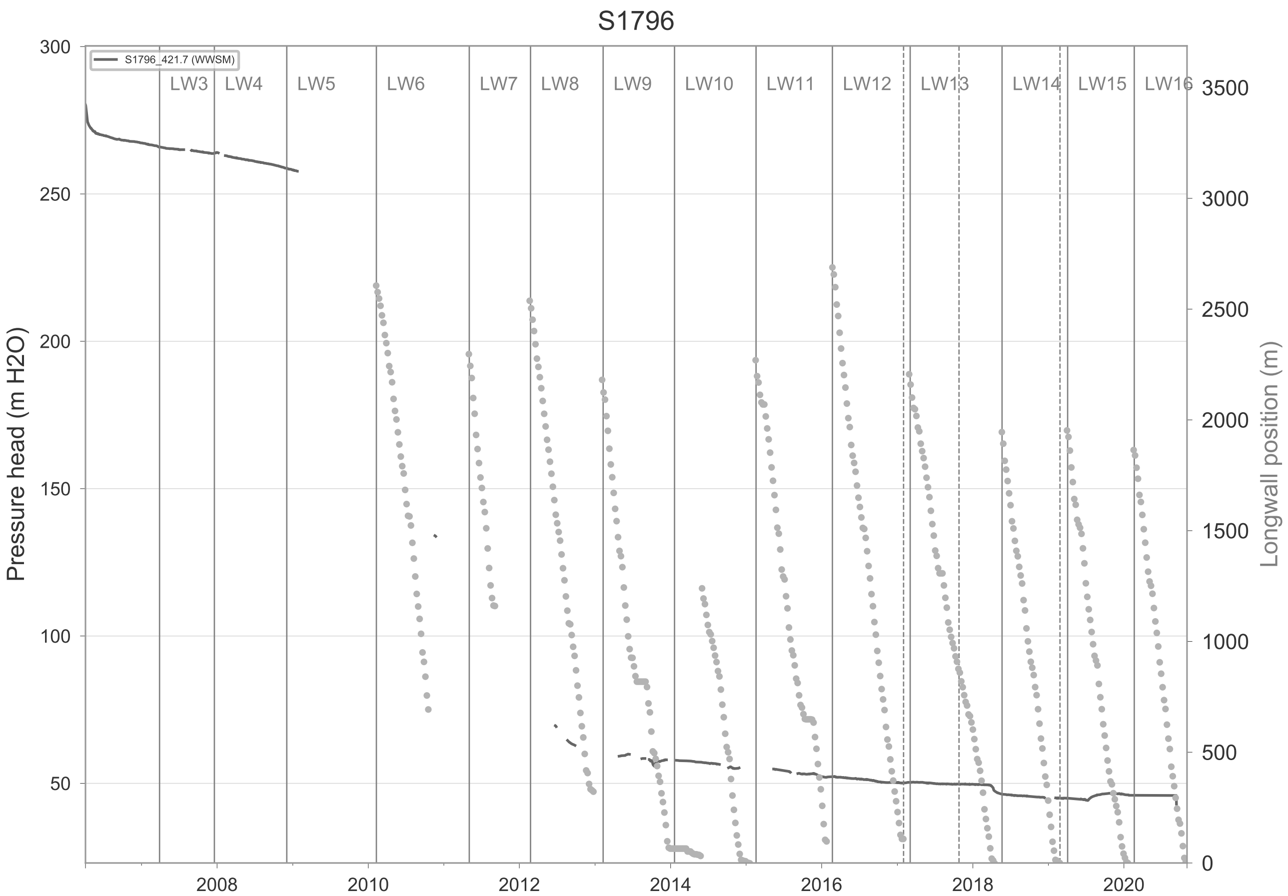
S1758

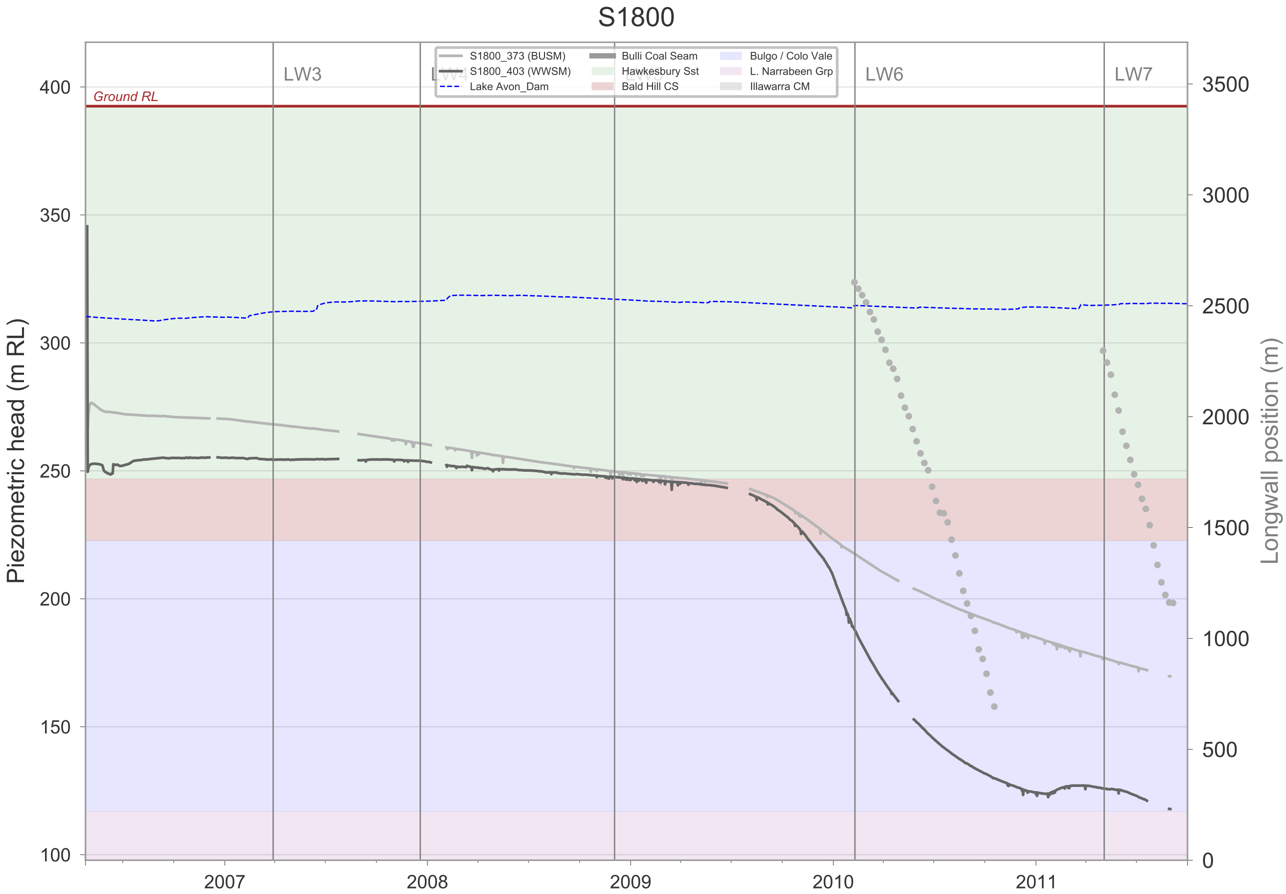

LW2
LW3
LW4
LW5
LW6
Ground RL
S1758_376 (BUSM)
S1758_406 (WWSM)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
Piezometric head (m RL)
Longwall position (m)
400
350
300
250
200
150
3500
3000
2500
2000
1500
1000
500
0
2007
2008
2009
2010
2011
2012
2013
2014

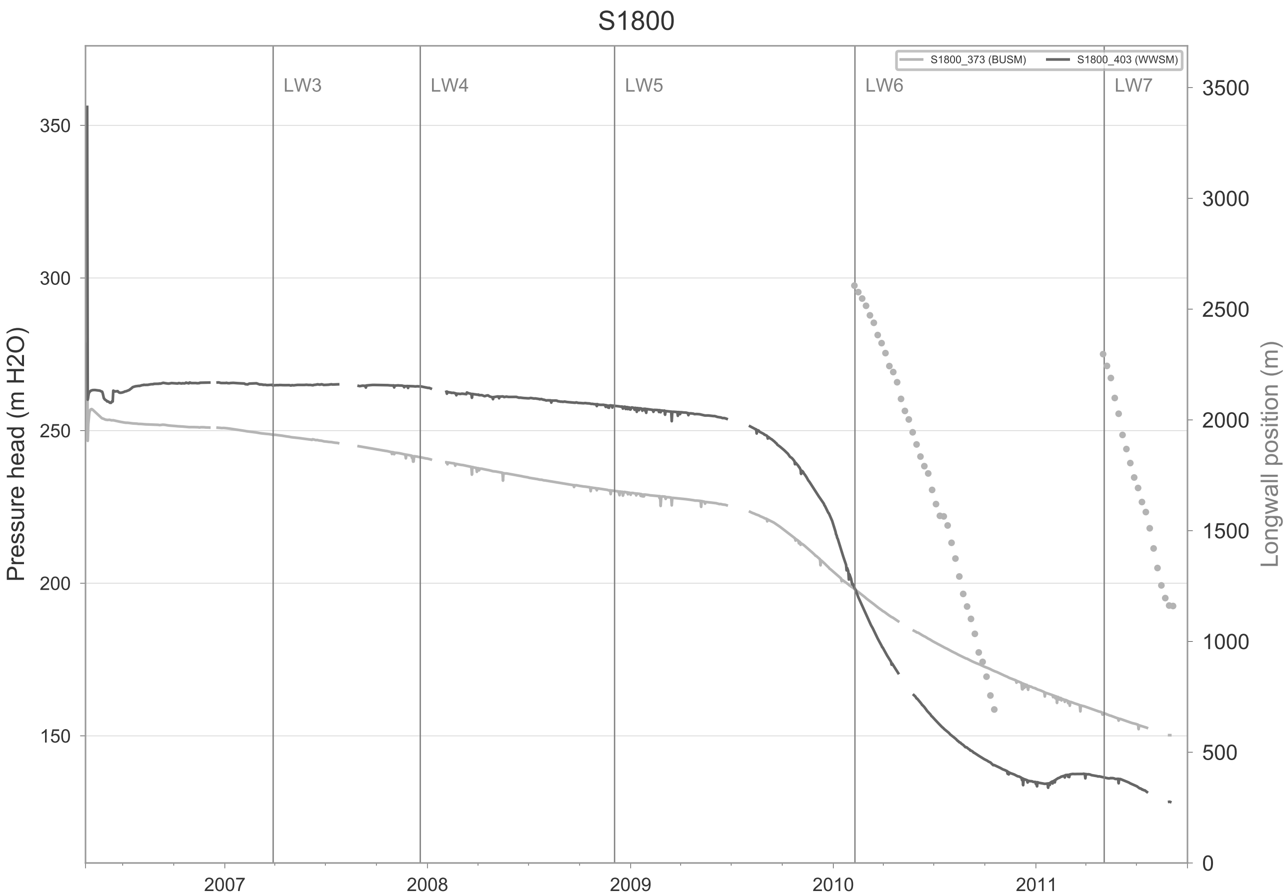
S1758


S1758_376 (BUSM)
S1758_406 (WWSM)
LW2
LW3
LW4
LW5
LW6
LW7
LW8
LW9
LW10
Pressure head (m H2O)
Longwall position (m)
275
250
225
200
175
150
125
100
75
3500
3000
2500
2000
1500
1000
500
0
2007
2008
2009
2010
2011
2012
2013
2014

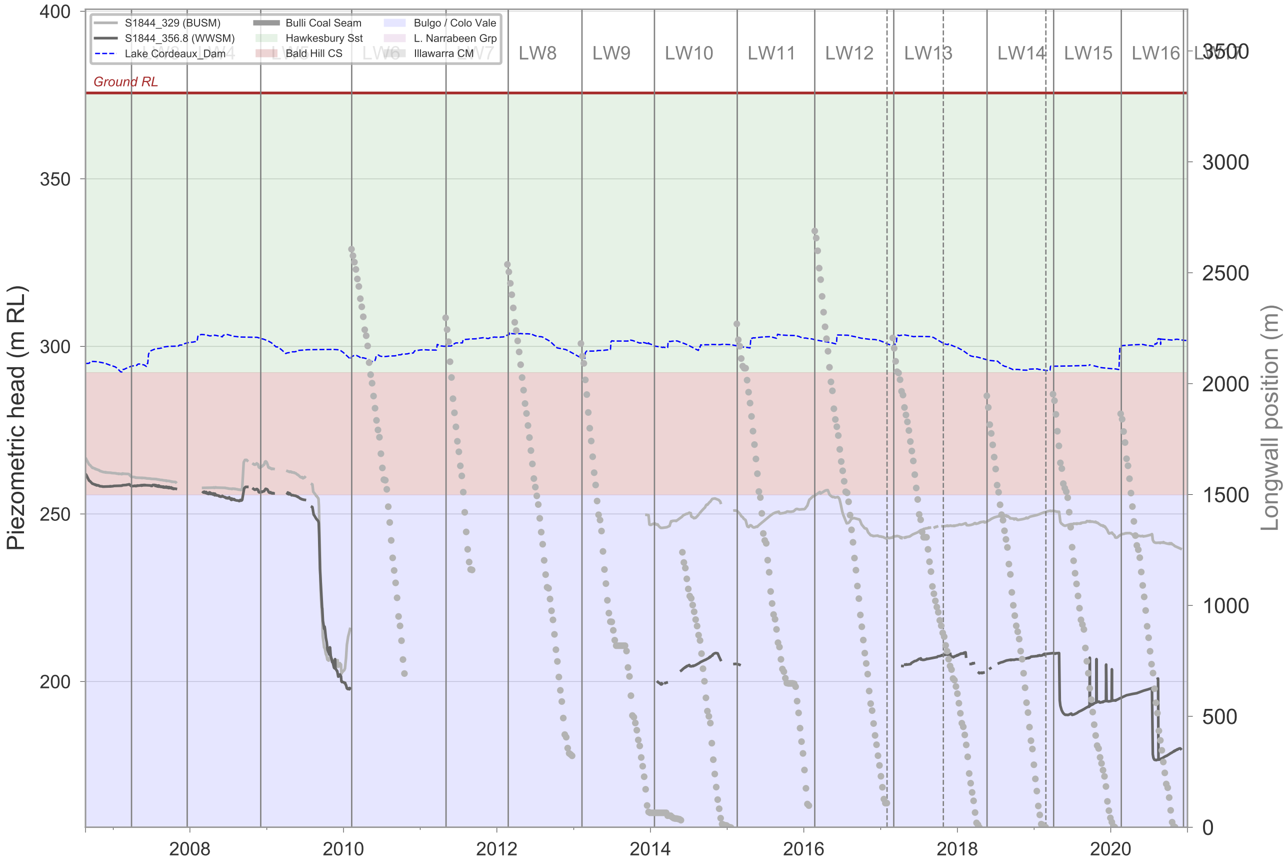

S1796
S1796_421.7 (WWSM)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
LW8
LW9
LW10
LW11
LW12
LW13
LW14
LW15
LW16
Piezometric head (m RL)
Longwall position (m)
2008
2010
2012
2014
2016
2018
2020


S1796
S1796_421.7 (WWSM)
LW3
LW4
LW5
LW6
LW7
LW8
LW9
LW10
LW11
LW12
LW13
LW14
LW15
LW16
Pressure head (m H2O)
Longwall position (m)
2008
2010
2012
2014
2016
2018
2020

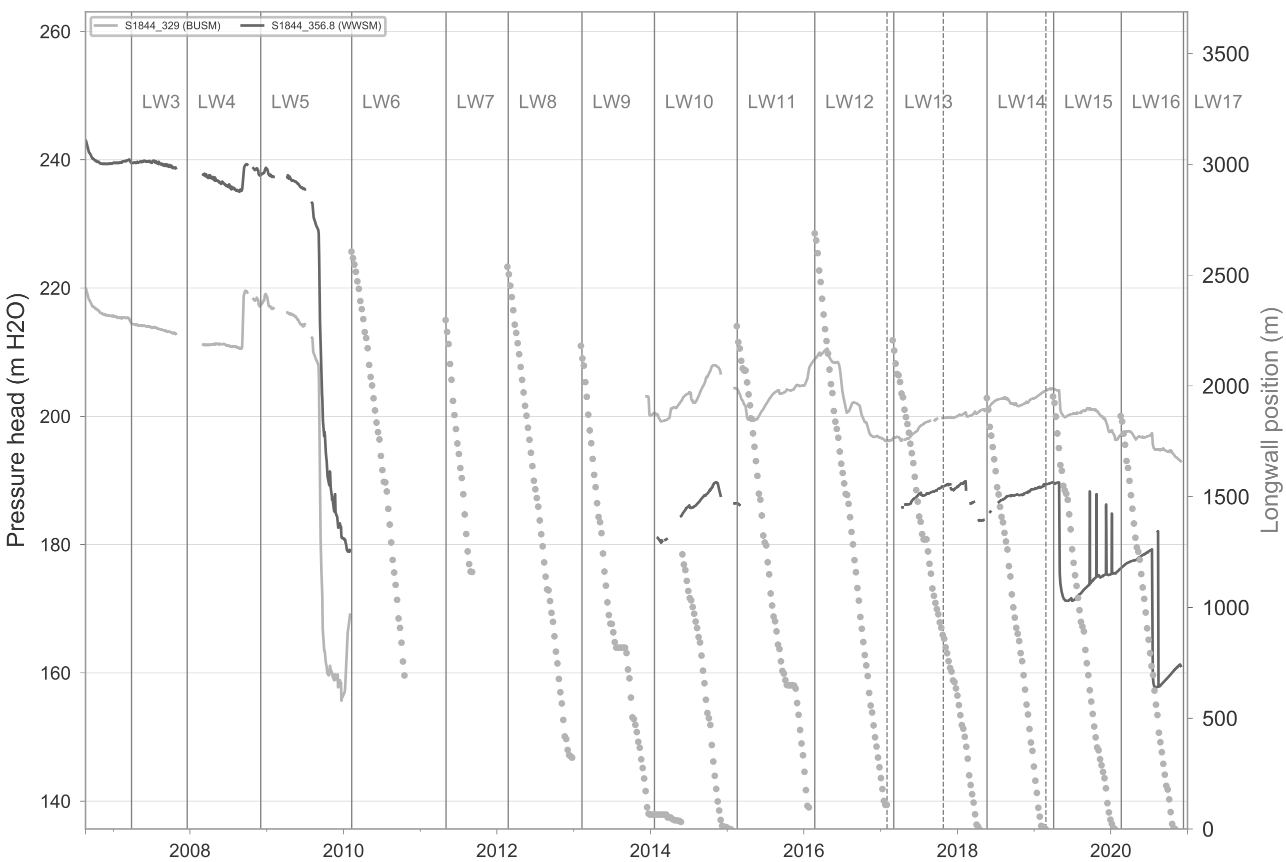

S1800
S1800_373 (BUSM)
S1800_403 (WWSM)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
Ground RL
LW3
LW6
LW7
Piezometric head (m RL)
Longwall position (m)
2007
2008
2009
2010
2011


S1800
S1800_373 (BUSM)
S1800_403 (WWSM)
LW3
LW4
LW5
LW6
LW7
Pressure head (m H2O)
Longwall position (m)
2007
2008
2009
2010
2011

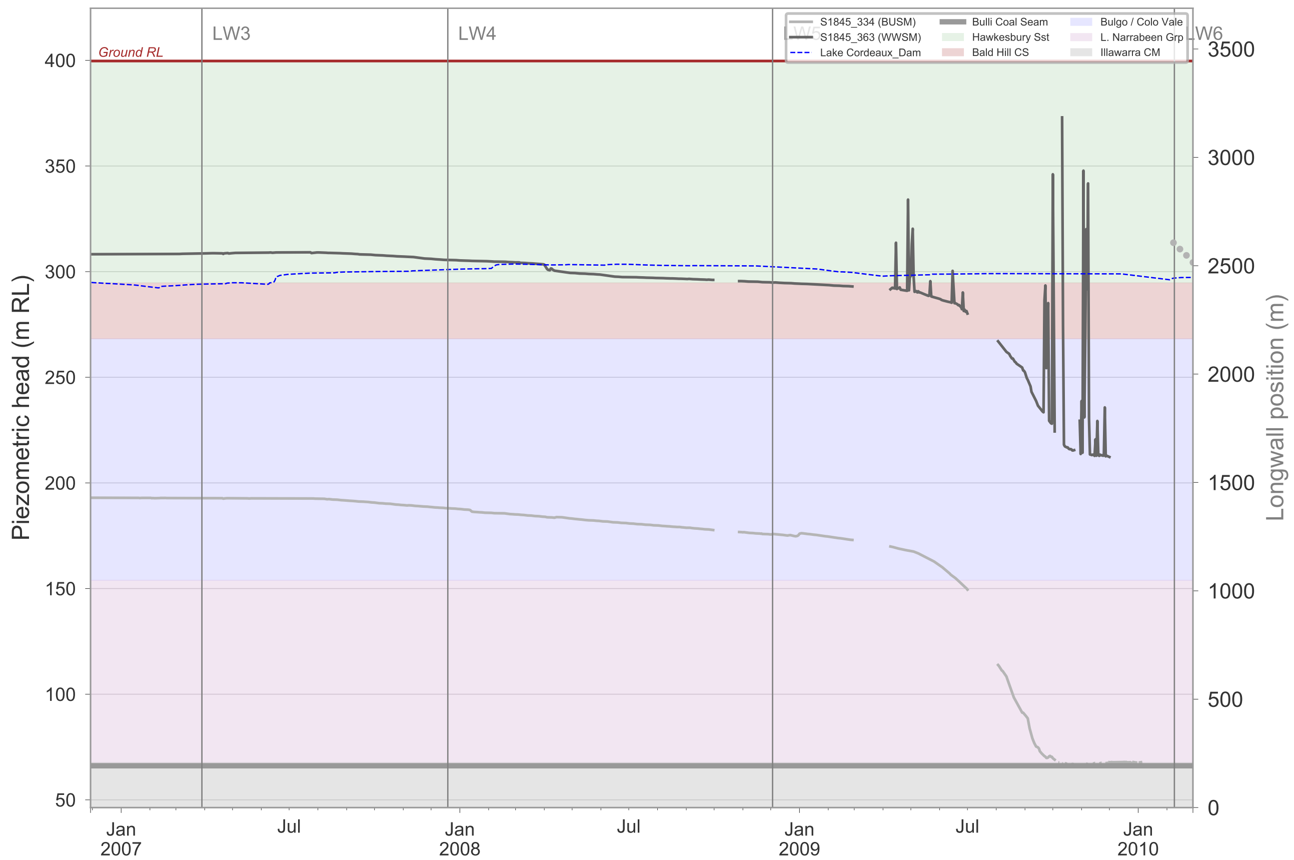
S1844


S1844_329 (BUSM)
S1844_356.8 (WWSM)
Lake Cordeaux_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
Ground RL
LW8
LW9
LW10
LW11
LW12
LW13
LW14
LW15
LW16
LW17
Piezometric head (m RL)
Longwall position (m)
400
350
300
250
200
3500
3000
2500
2000
1500
1000
500
0
2008
2010
2012
2014
2016
2018
2020

S1844

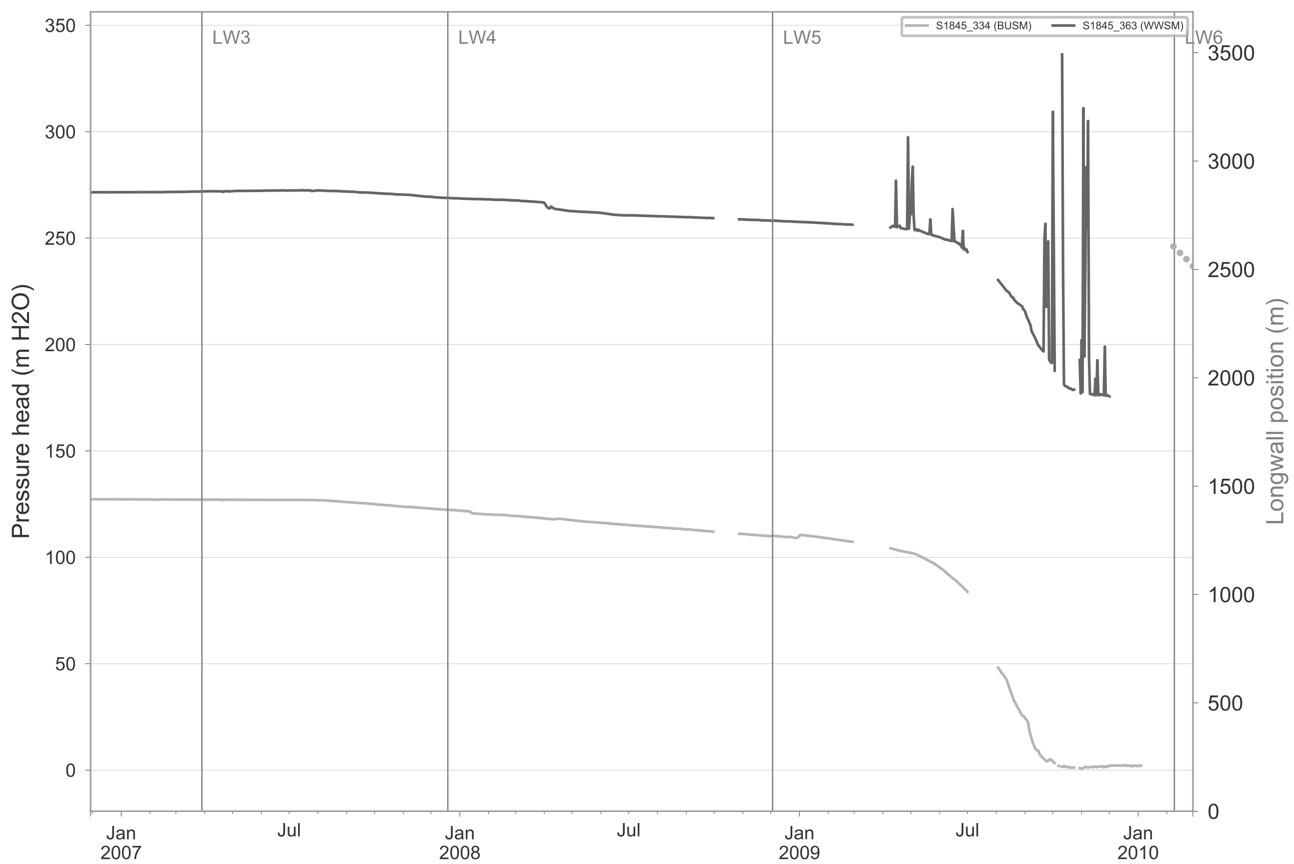

S1844_329 (BUSM)
S1844_356.8 (WWSM)
LW3
LW4
LW5
LW6
LW7
LW8
LW9
LW10
LW11
LW12
LW13
LW14
LW15
LW16
LW17
Pressure head (m H2O)
Longwall position (m)
260
240
220
200
180
160
140
3500
3000
2500
2000
1500
1000
500
0
2008
2010
2012
2014
2016
2018
2020

S1845

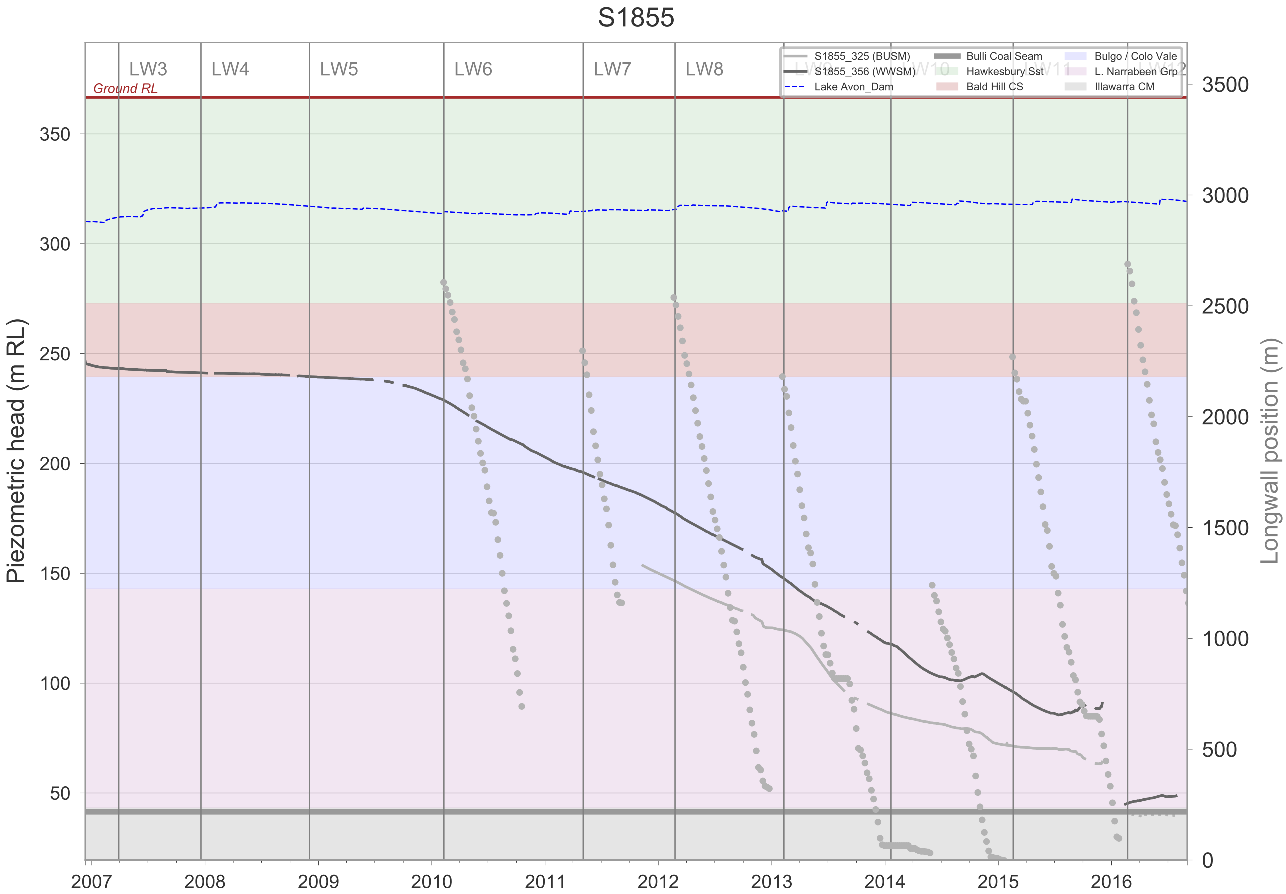


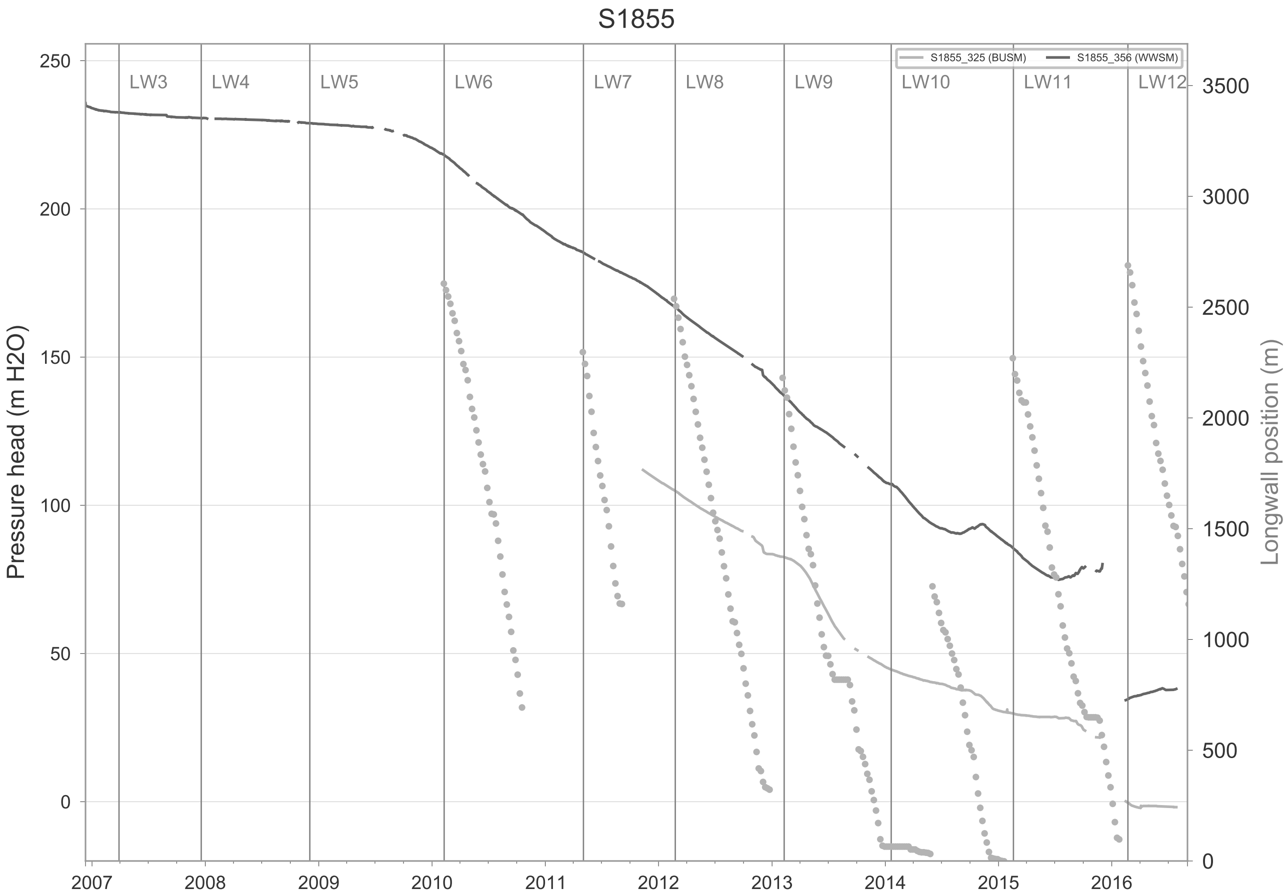
Ground RL
LW3
LW4
LW6
S1845_334 (BUSM)
S1845_363 (WWSM)
Lake Cordeaux_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
Piezometric head (m RL)
Longwall position (m)
Jan 2007
Jul
Jan 2008
Jul
Jan 2009
Jul
Jan 2010

S1845

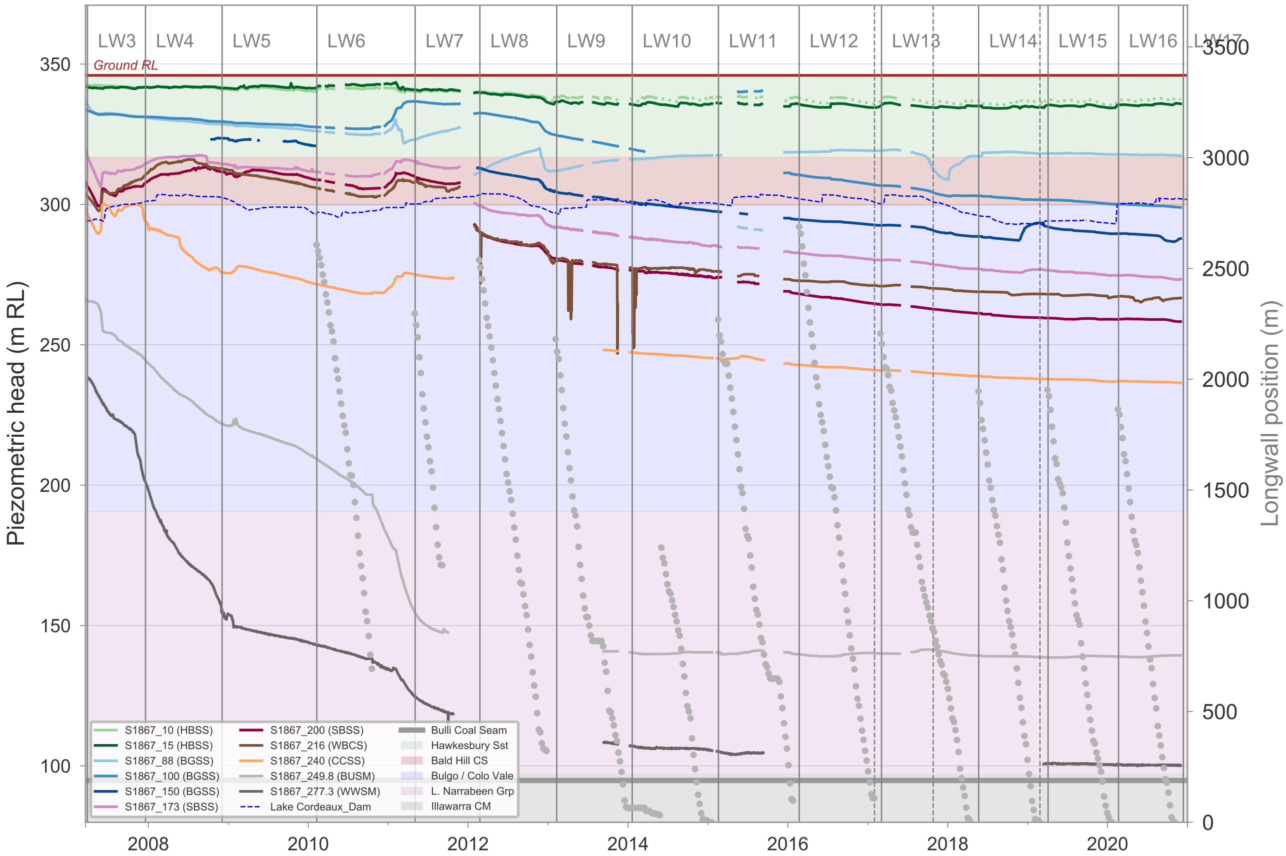


LW3
LW4
LW5
LW6
S1845_334 (BUSM)
S1845_363 (WWSM)
Pressure head (m H2O)
Longwall position (m)
Jan 2007
Jul
Jan 2008
Jul
Jan 2009
Jul
Jan 2010

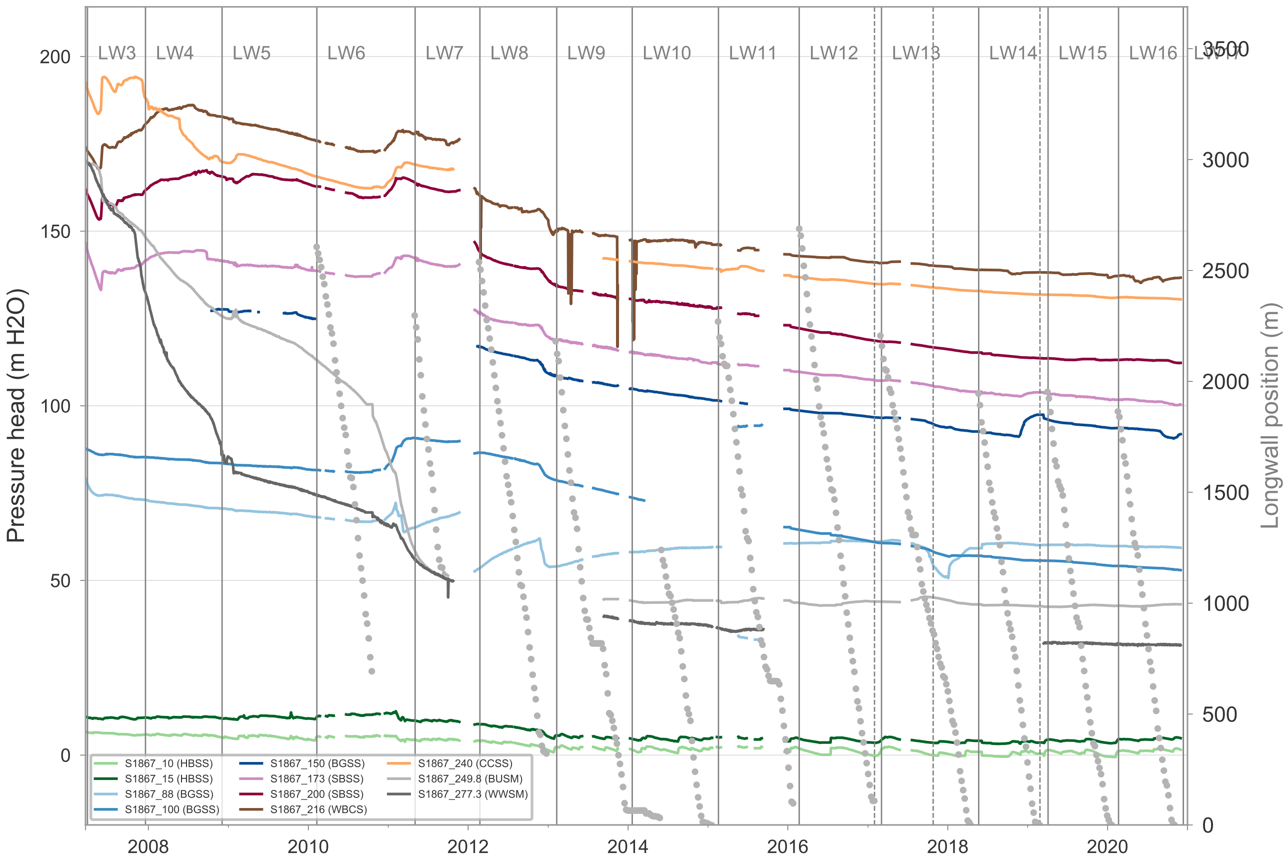

S1855
LW3
LW4
LW5
LW6
LW7
LW8
Ground RL
S1855_325 (BUSM)
S1855_356 (WWSM)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
Piezometric head (m RL)
Longwall position (m)
350
300
250
200
150
100
50
3500
3000
2500
2000
1500
1000
500
0
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016

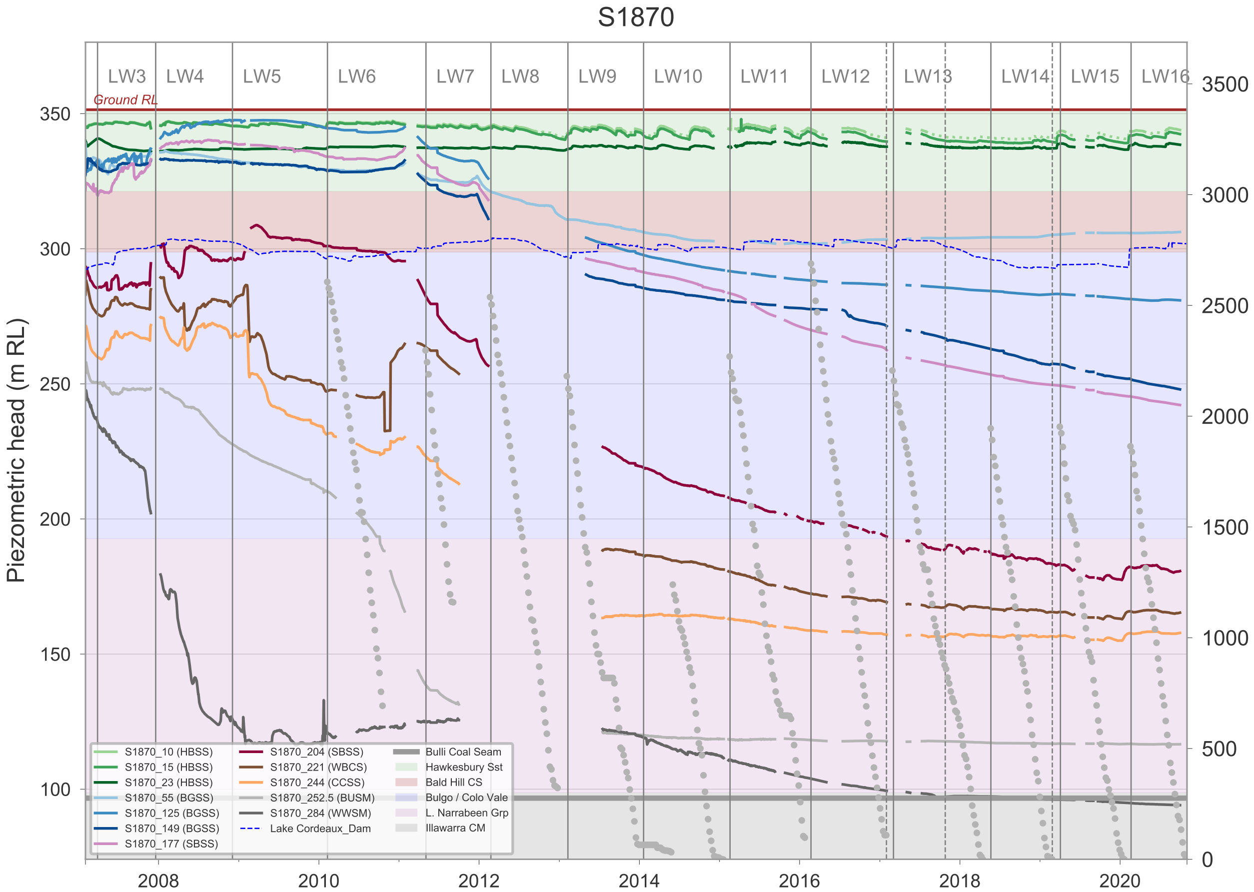

S1855
S1855_325 (BUSM)
S1855_356 (WWSM)
LW3
LW4
LW5
LW6
LW7
LW8
LW9
LW10
LW11
LW12
Pressure head (m H2O)
Longwall position (m)
250
200
150
100
50
0
3500
3000
2500
2000
1500
1000
500
0
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016

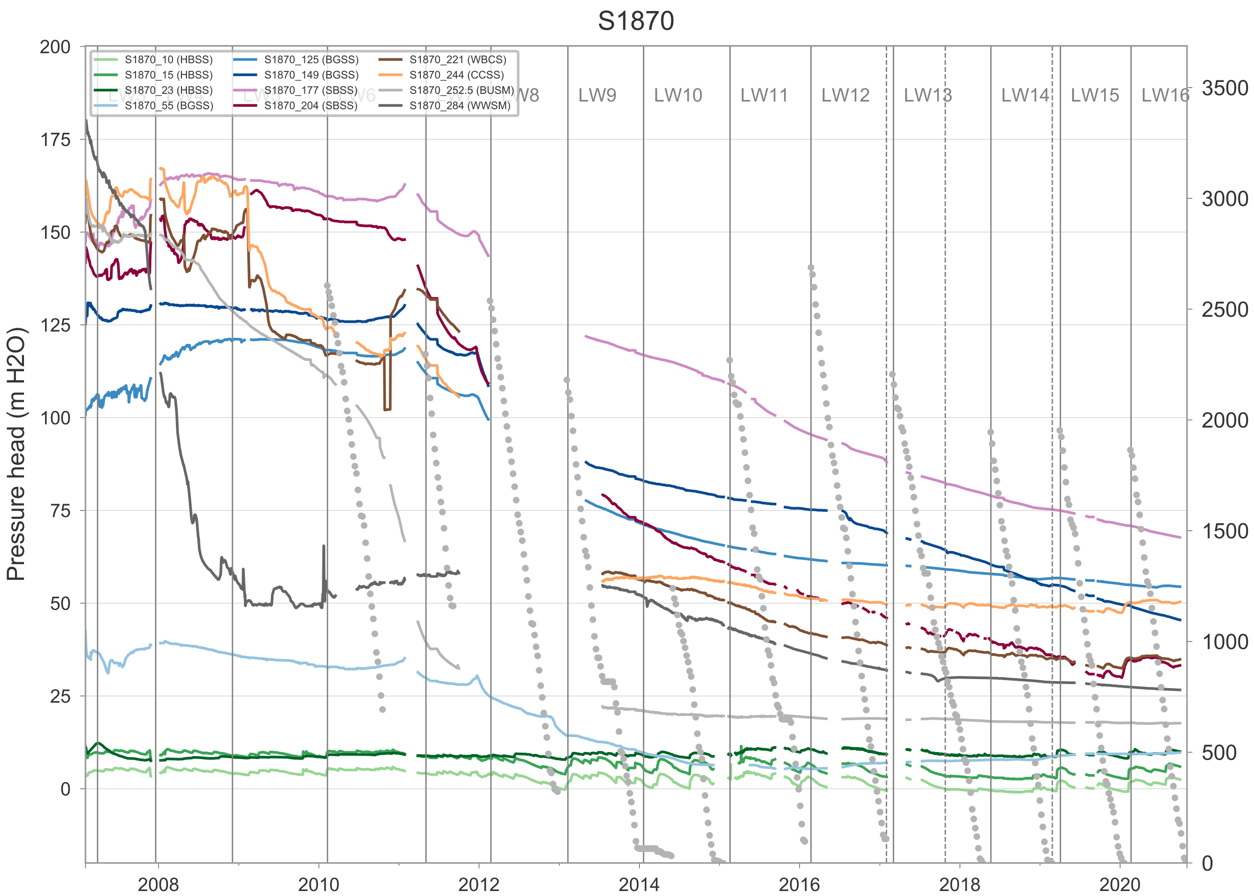
S1867

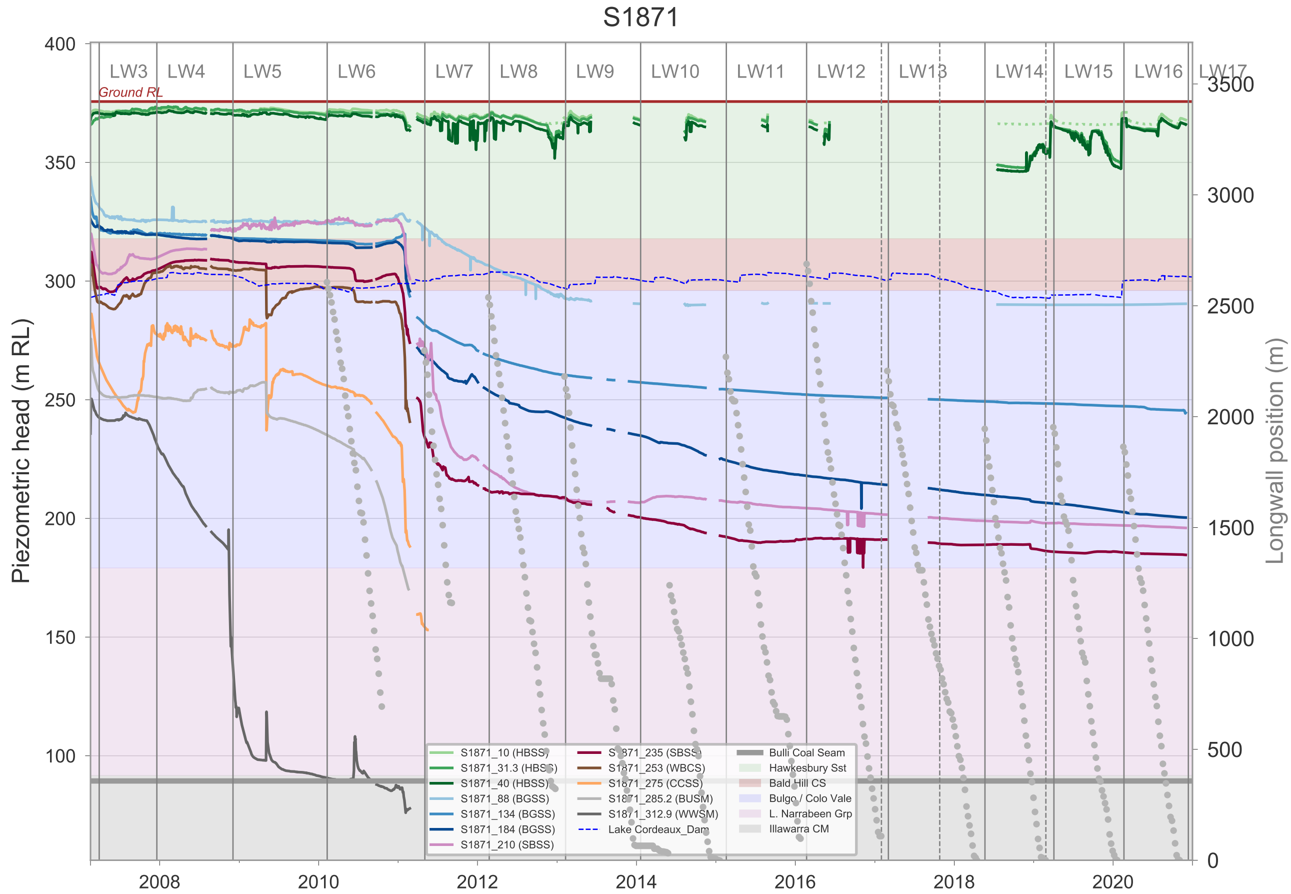

LW3
LW4
LW5
LW6
LW7
LW8
LW9
LW10
LW11
LW12
LW13
LW14
LW15
LW16
LW17
Ground RL
Piezometric head (m RL)
Longwall position (m)
S1867_10 (HBSS)
S1867_15 (HBSS)
S1867_88 (BGSS)
S1867_100 (BGSS)
S1867_150 (BGSS)
S1867_173 (SBSS)
S1867_200 (SBSS)
S1867_216 (WBCS)
S1867_240 (CCSS)
S1867_249.8 (BUSM)
S1867_277.3 (WWSM)
Lake Cordeaux_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
2008
2010
2012
2014
2016
2018
2020

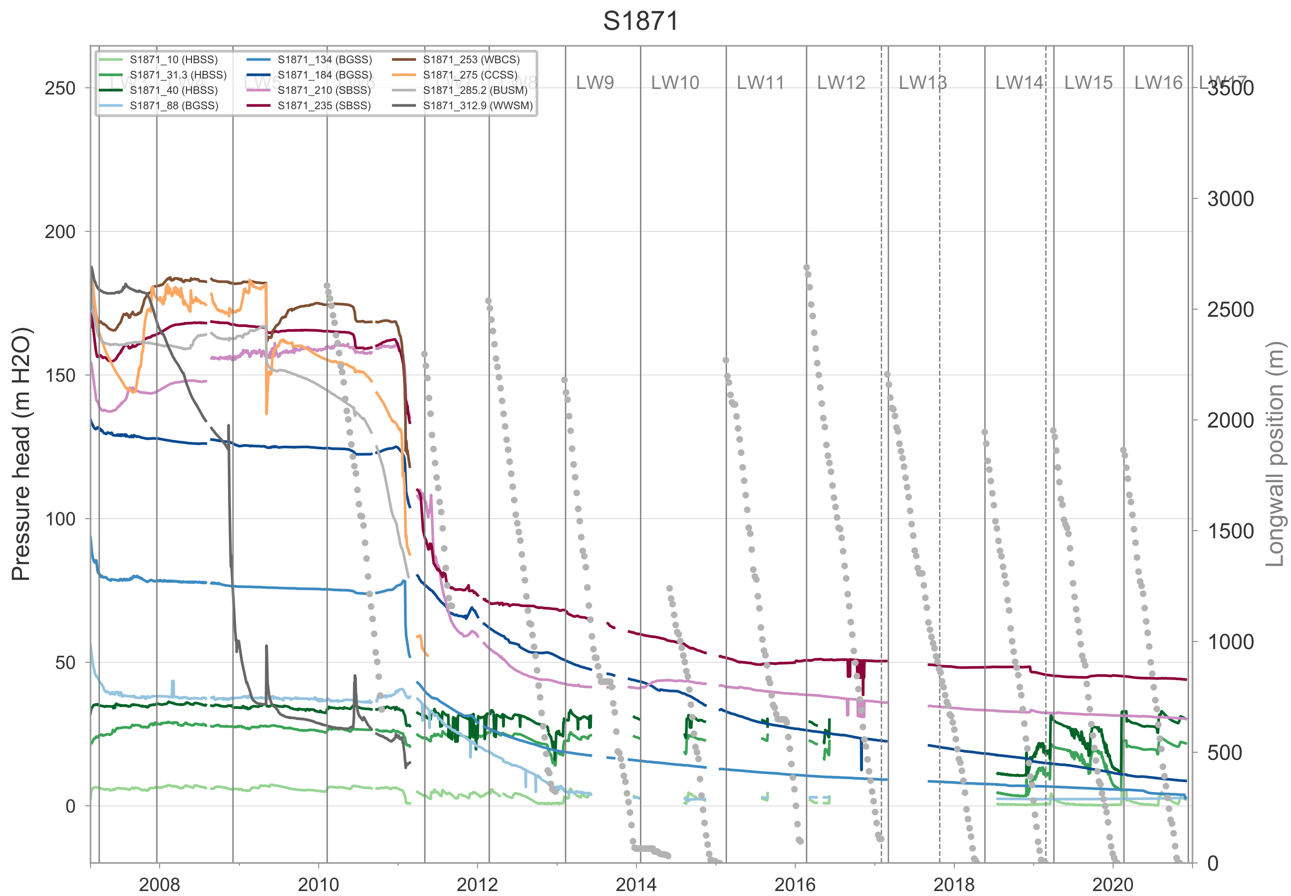
S1867

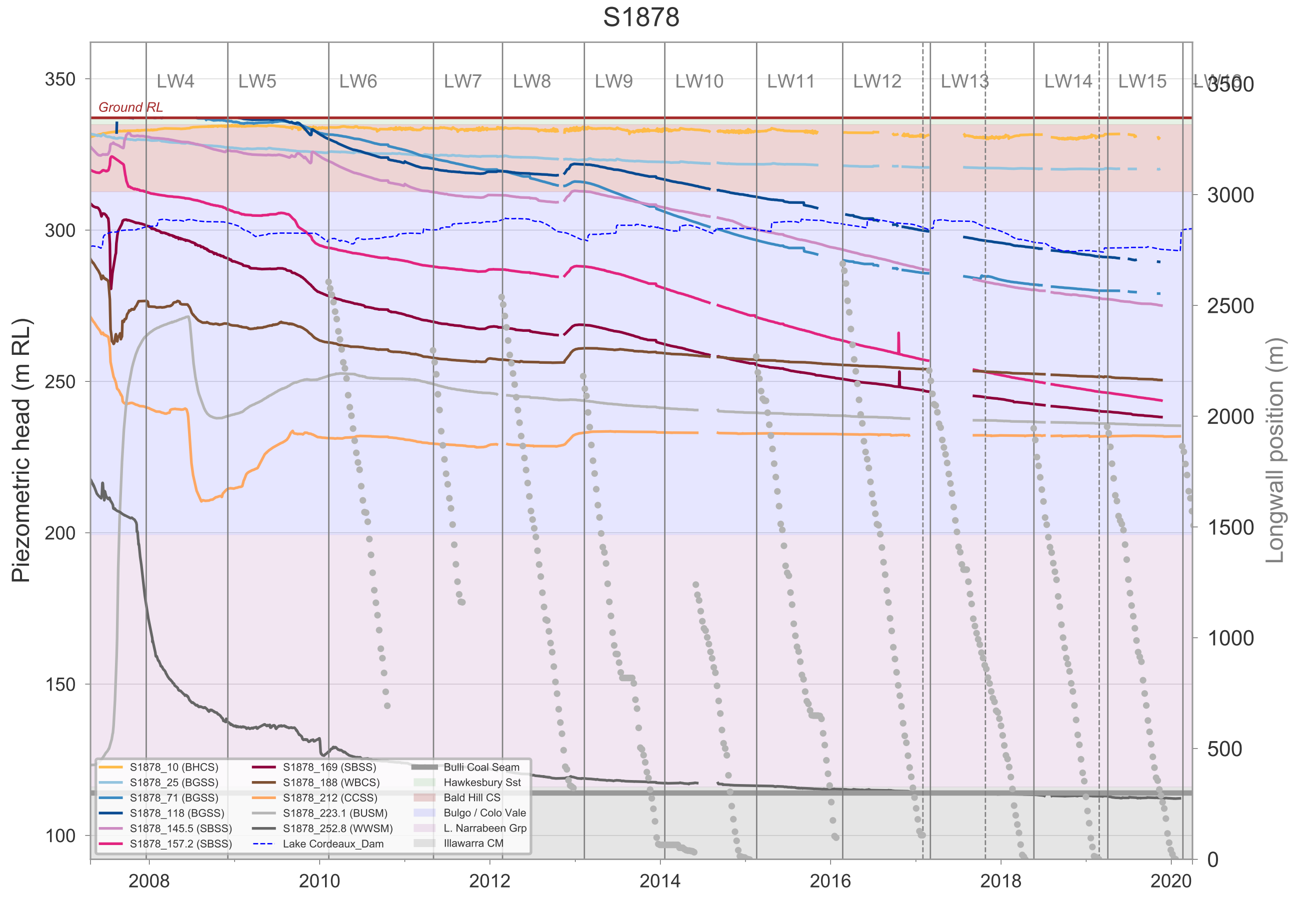

LW3
LW4
LW5
LW6
LW7
LW8
LW9
LW10
LW11
LW12
LW13
LW14
LW15
LW16
LW17
Pressure head (m H2O)
Longwall position (m)
S1867_10 (HBSS)
S1867_15 (HBSS)
S1867_88 (BGSS)
S1867_100 (BGSS)
S1867_150 (BGSS)
S1867_173 (SBSS)
S1867_200 (SBSS)
S1867_216 (WBCS)
S1867_240 (CCSS)
S1867_249.8 (BUSM)
S1867_277.3 (WWSM)
2008
2010
2012
2014
2016
2018
2020

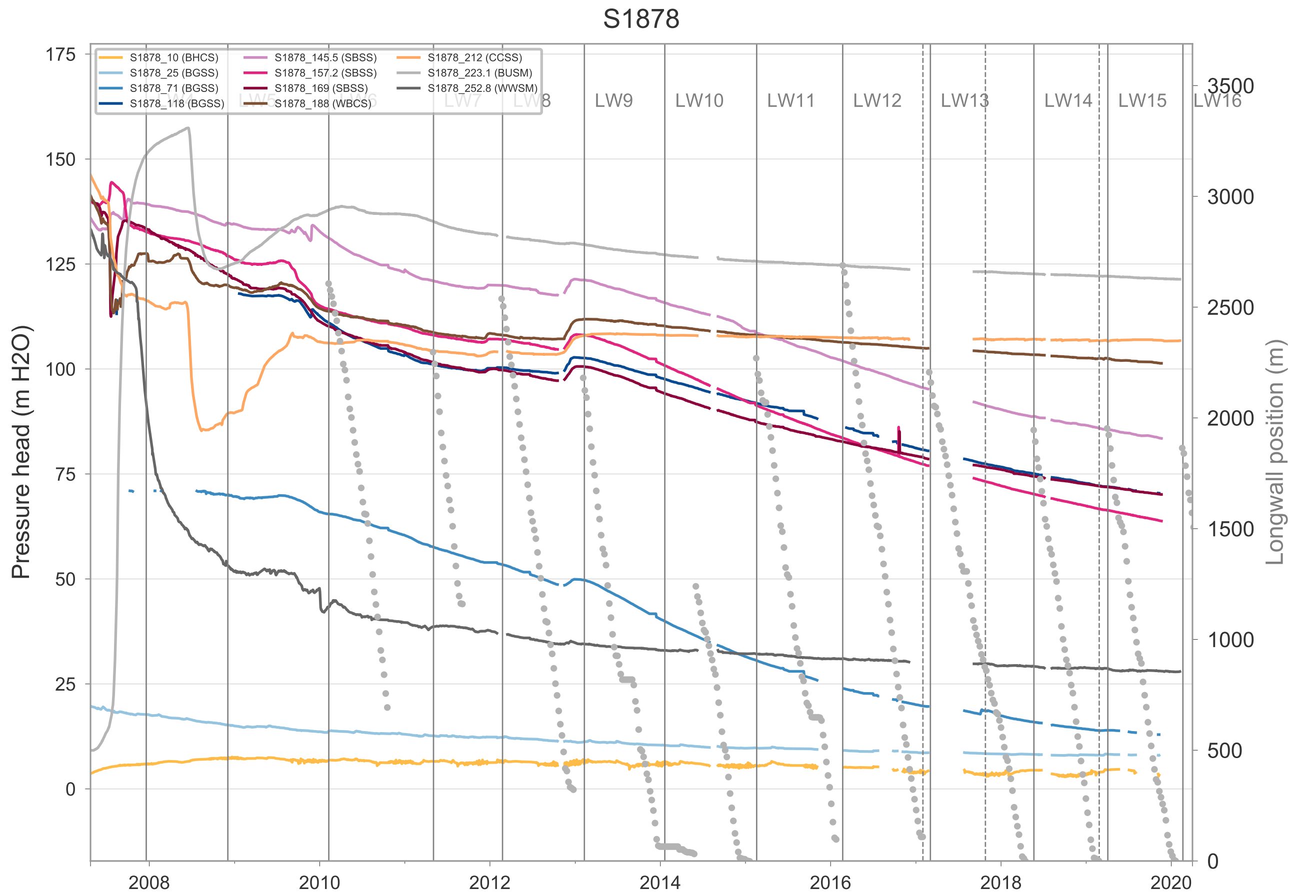

S1870
LW3
LW4
LW5
LW6
LW7
LW8
LW9
LW10
LW11
LW12
LW13
LW14
LW15
LW16
Ground RL
Piezometric head (m RL)
Longwall position (m)
S1870_10 (HBSS)
S1870_15 (HBSS)
S1870_23 (HBSS)
S1870_55 (BGSS)
S1870_125 (BGSS)
S1870_149 (BGSS)
S1870_177 (SBSS)
S1870_204 (SBSS)
S1870_221 (WBCS)
S1870_244 (CCSS)
S1870_252.5 (BUSM)
S1870_284 (WWSM)
Lake Cordeaux_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
2008
2010
2012
2014
2016
2018
2020

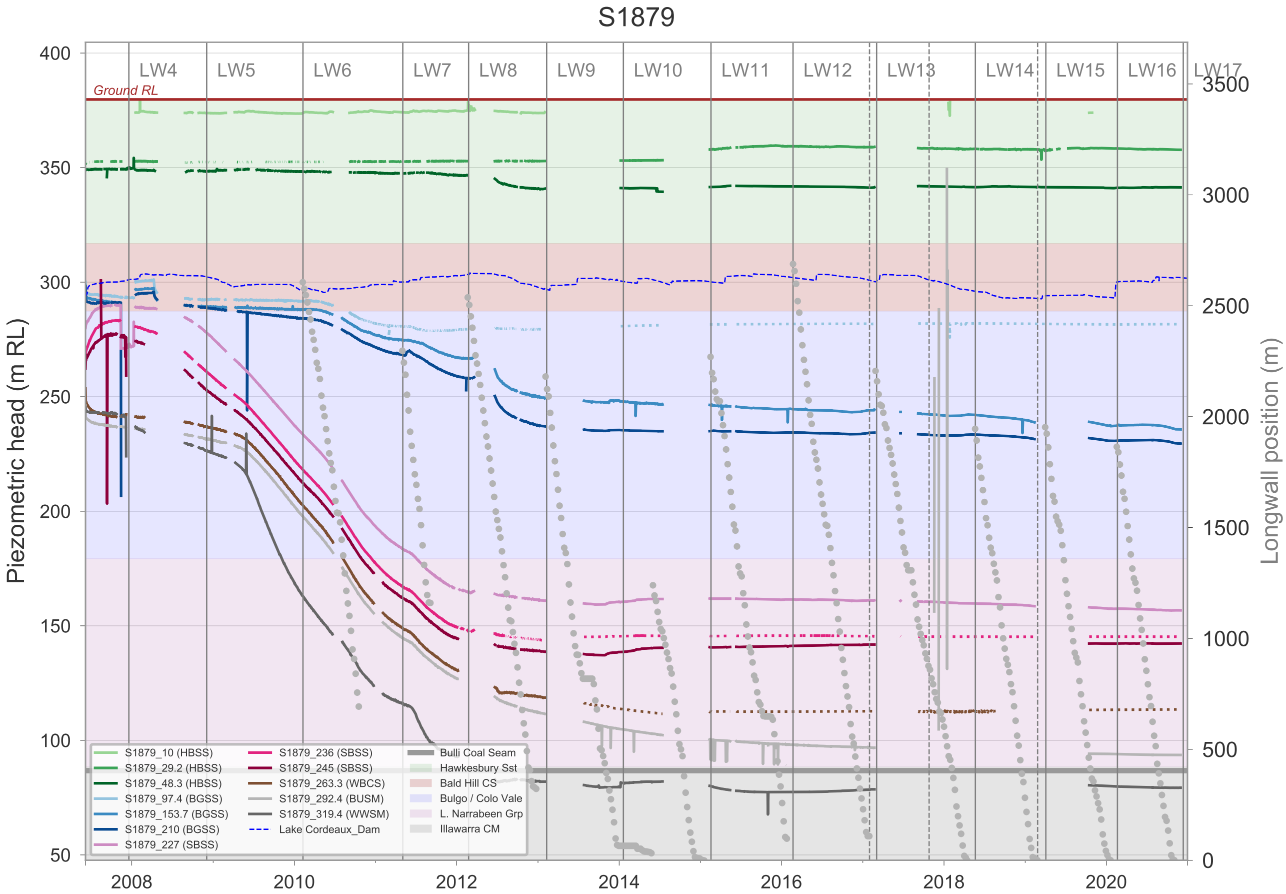

S1870
LW9
LW10
LW11
LW12
LW13
LW14
LW15
LW16
Pressure head (m H2O)
Longwall position (m)
S1870_10 (HBSS)
S1870_15 (HBSS)
S1870_23 (HBSS)
S1870_55 (BGSS)
S1870_125 (BGSS)
S1870_149 (BGSS)
S1870_177 (SBSS)
S1870_204 (SBSS)
S1870_221 (WBCS)
S1870_244 (CCSS)
S1870_252.5 (BUSM)
S1870_284 (WWSM)
2008
2010
2012
2014
2016
2018
2020

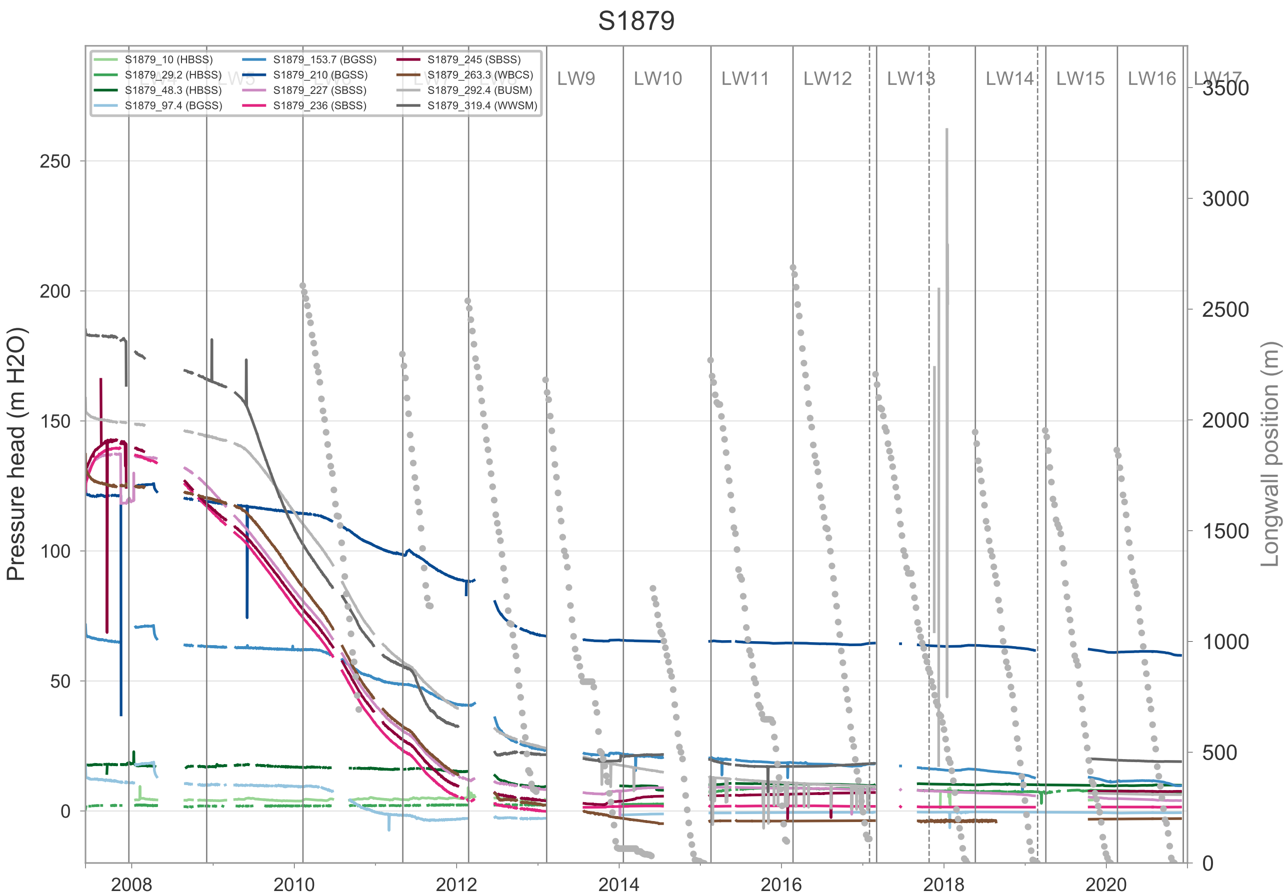

S1871
Piezometric head (m RL)
Longwall position (m)
LW3
LW4
LW5
LW6
LW7
LW8
LW9
LW10
LW11
LW12
LW13
LW14
LW15
LW16
LW17
Ground RL
S1871_10 (HBSS)
S1871_31.3 (HBSS)
S1871_40 (HBSS)
S1871_88 (BGSS)
S1871_134 (BGSS)
S1871_184 (BGSS)
S1871_210 (SBSS)
S1871_235 (SBSS)
S1871_253 (WBCS)
S1871_275 (CCSS)
S1871_285.2 (BUSM)
S1871_312.9 (WWSM)
Lake Cordeaux_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM


S1871
Pressure head (m H2O)
Longwall position (m)
S1871_10 (HBSS)
S1871_31.3 (HBSS)
S1871_40 (HBSS)
S1871_88 (BGSS)
S1871_134 (BGSS)
S1871_184 (BGSS)
S1871_210 (SBSS)
S1871_235 (SBSS)
S1871_253 (WBCS)
S1871_275 (CCSS)
S1871_285.2 (BUSM)
S1871_312.9 (WWSM)
LW9
LW10
LW11
LW12
LW13
LW14
LW15
LW16
LW17

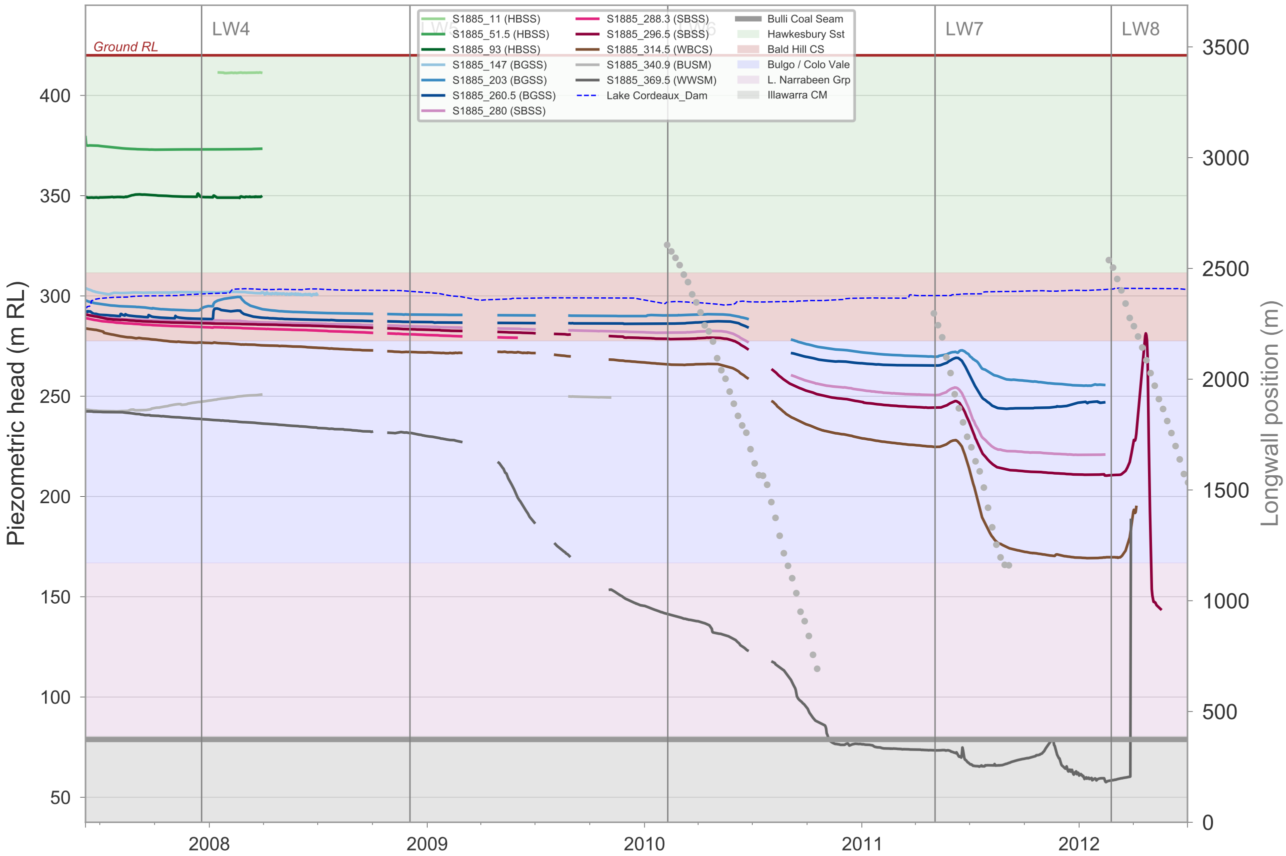

S1878
Ground RL
LW4
LW5
LW6
LW7
LW8
LW9
LW10
LW11
LW12
LW13
LW14
LW15
LW16
Piezometric head (m RL)
Longwall position (m)
S1878_10 (BHCS)
S1878_25 (BGSS)
S1878_71 (BGSS)
S1878_118 (BGSS)
S1878_145.5 (SBSS)
S1878_157.2 (SBSS)
S1878_169 (SBSS)
S1878_188 (WBCS)
S1878_212 (CCSS)
S1878_223.1 (BUSM)
S1878_252.8 (WWSM)
Lake Cordeaux_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
2008
2010
2012
2014
2016
2018
2020


S1878
S1878_10 (BHCS)
S1878_25 (BGSS)
S1878_71 (BGSS)
S1878_118 (BGSS)
S1878_145.5 (SBSS)
S1878_157.2 (SBSS)
S1878_169 (SBSS)
S1878_188 (WBCS)
S1878_212 (CCSS)
S1878_223.1 (BUSM)
S1878_252.8 (WWSM)
LW9
LW10
LW11
LW12
LW13
LW14
LW15
LW16
Pressure head (m H2O)
Longwall position (m)
2008
2010
2012
2014
2016
2018
2020

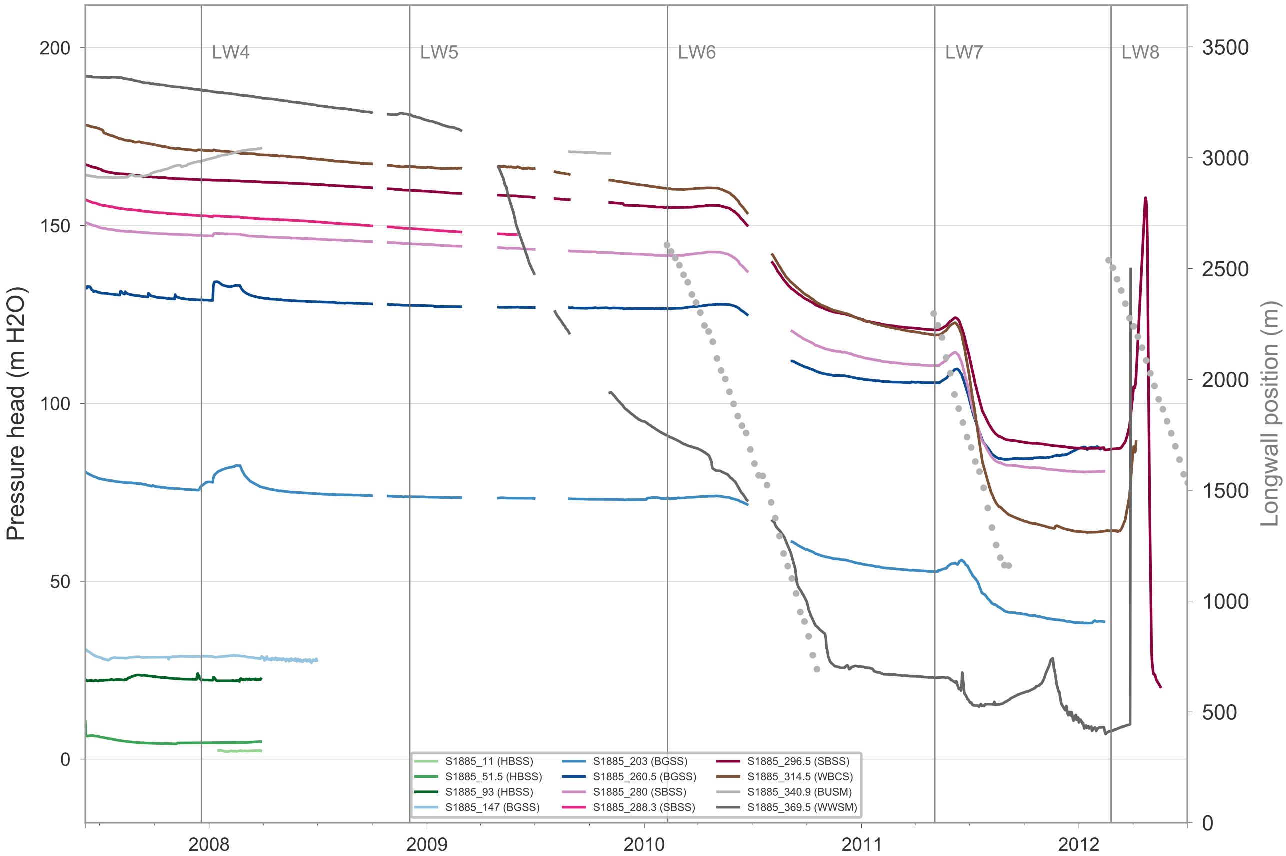

S1879
LW4
LW5
LW6
LW7
LW8
LW9
LW10
LW11
LW12
LW13
LW14
LW15
LW16
LW17
Ground RL
Piezometric head (m RL)
Longwall position (m)
S1879_10 (HBSS)
S1879_29.2 (HBSS)
S1879_48.3 (HBSS)
S1879_97.4 (BGSS)
S1879_153.7 (BGSS)
S1879_210 (BGSS)
S1879_227 (SBSS)
S1879_236 (SBSS)
S1879_245 (SBSS)
S1879_263.3 (WBCS)
S1879_292.4 (BUSM)
S1879_319.4 (WWSM)
Lake Cordeaux_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM


S1879
LW9
LW10
LW11
LW12
LW13
LW14
LW15
LW16
LW17
Pressure head (m H2O)
Longwall position (m)
S1879_10 (HBSS)
S1879_29.2 (HBSS)
S1879_48.3 (HBSS)
S1879_97.4 (BGSS)
S1879_153.7 (BGSS)
S1879_210 (BGSS)
S1879_227 (SBSS)
S1879_236 (SBSS)
S1879_245 (SBSS)
S1879_263.3 (WBCS)
S1879_292.4 (BUSM)
S1879_319.4 (WWSM)

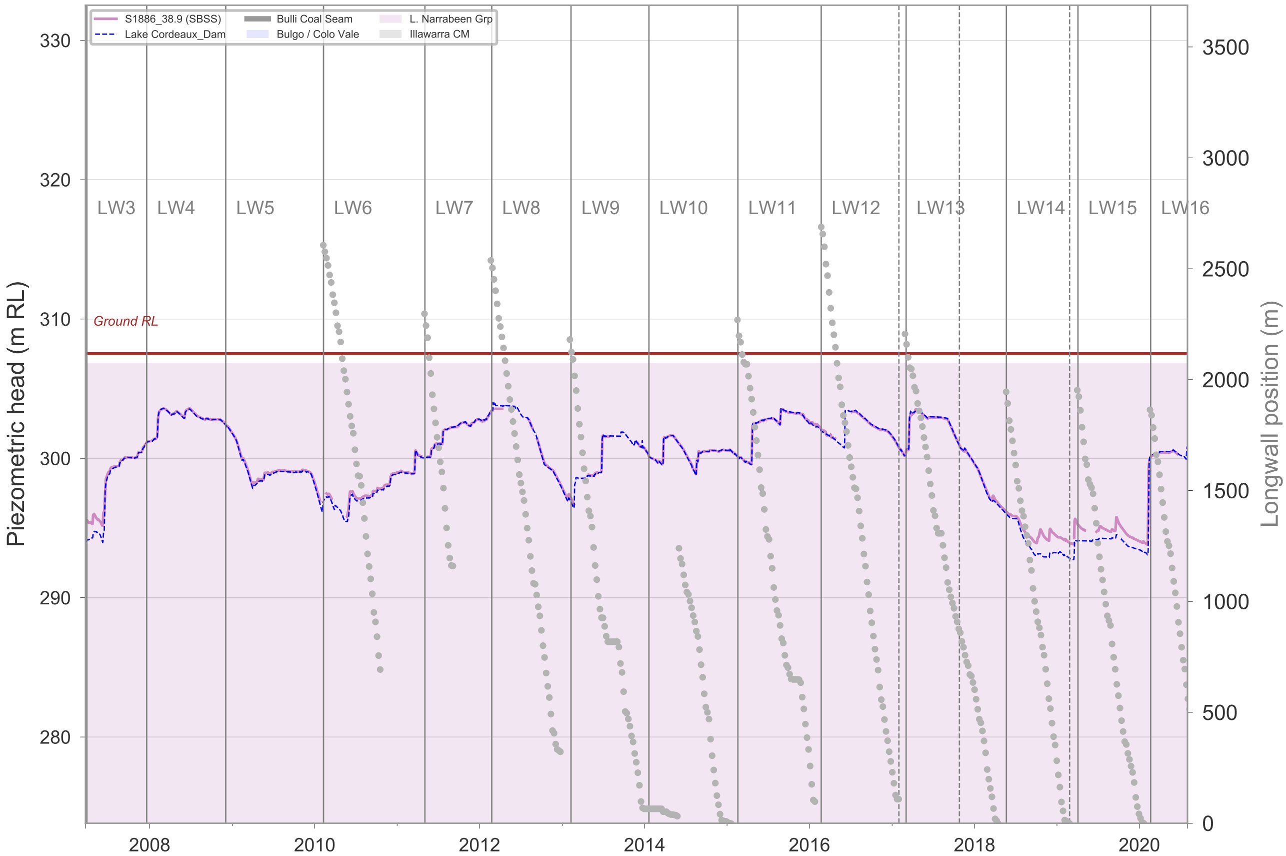
S1885


Ground RL
LW4
LW7
LW8
S1885_11 (HBSS)
S1885_51.5 (HBSS)
S1885_93 (HBSS)
S1885_147 (BGSS)
S1885_203 (BGSS)
S1885_260.5 (BGSS)
S1885_280 (SBSS)
S1885_288.3 (SBSS)
S1885_296.5 (SBSS)
S1885_314.5 (WBCS)
S1885_340.9 (BUSM)
S1885_369.5 (WWSM)
Lake Cordeaux_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
Piezometric head (m RL)
Longwall position (m)
400
350
300
250
200
150
100
50
3500
3000
2500
2000
1500
1000
500
0
2008
2009
2010
2011
2012

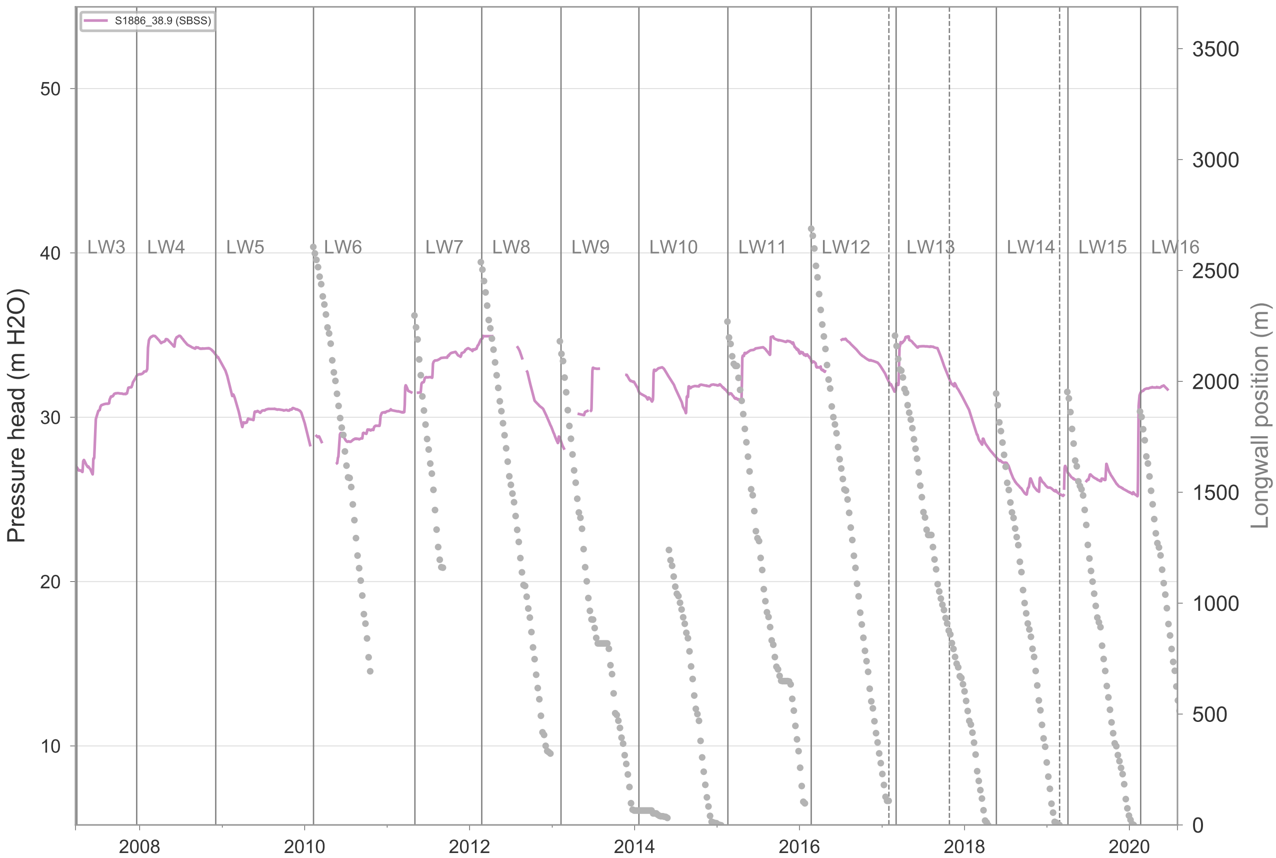
S1885


LW4
LW5
LW6
LW7
LW8
S1885_11 (HBSS)
S1885_51.5 (HBSS)
S1885_93 (HBSS)
S1885_147 (BGSS)
S1885_203 (BGSS)
S1885_260.5 (BGSS)
S1885_280 (SBSS)
S1885_288.3 (SBSS)
S1885_296.5 (SBSS)
S1885_314.5 (WBCS)
S1885_340.9 (BUSM)
S1885_369.5 (WWSM)
Pressure head (m H2O)
Longwall position (m)
200
150
100
50
0
3500
3000
2500
2000
1500
1000
500
0
2008
2009
2010
2011
2012

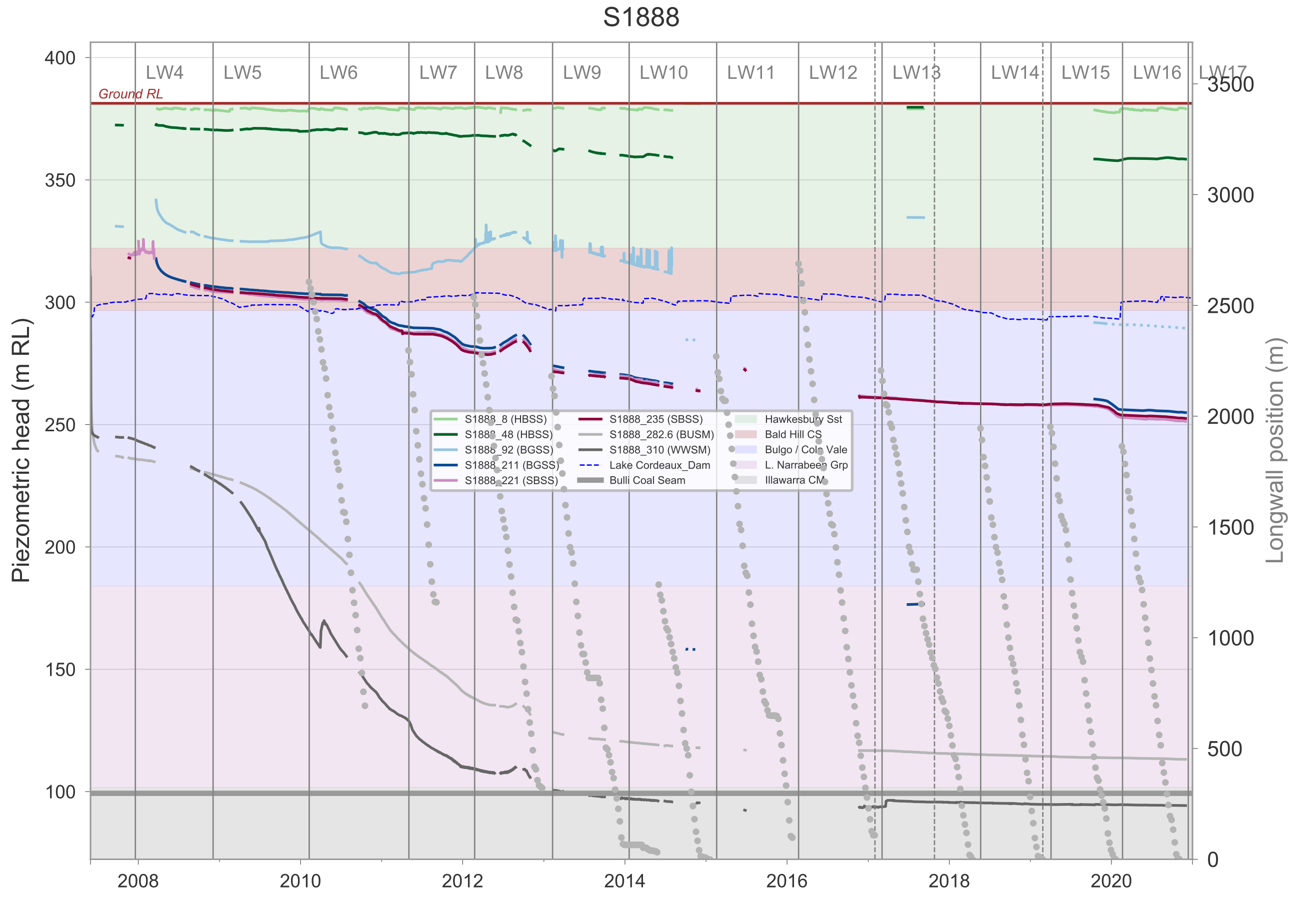
S1886

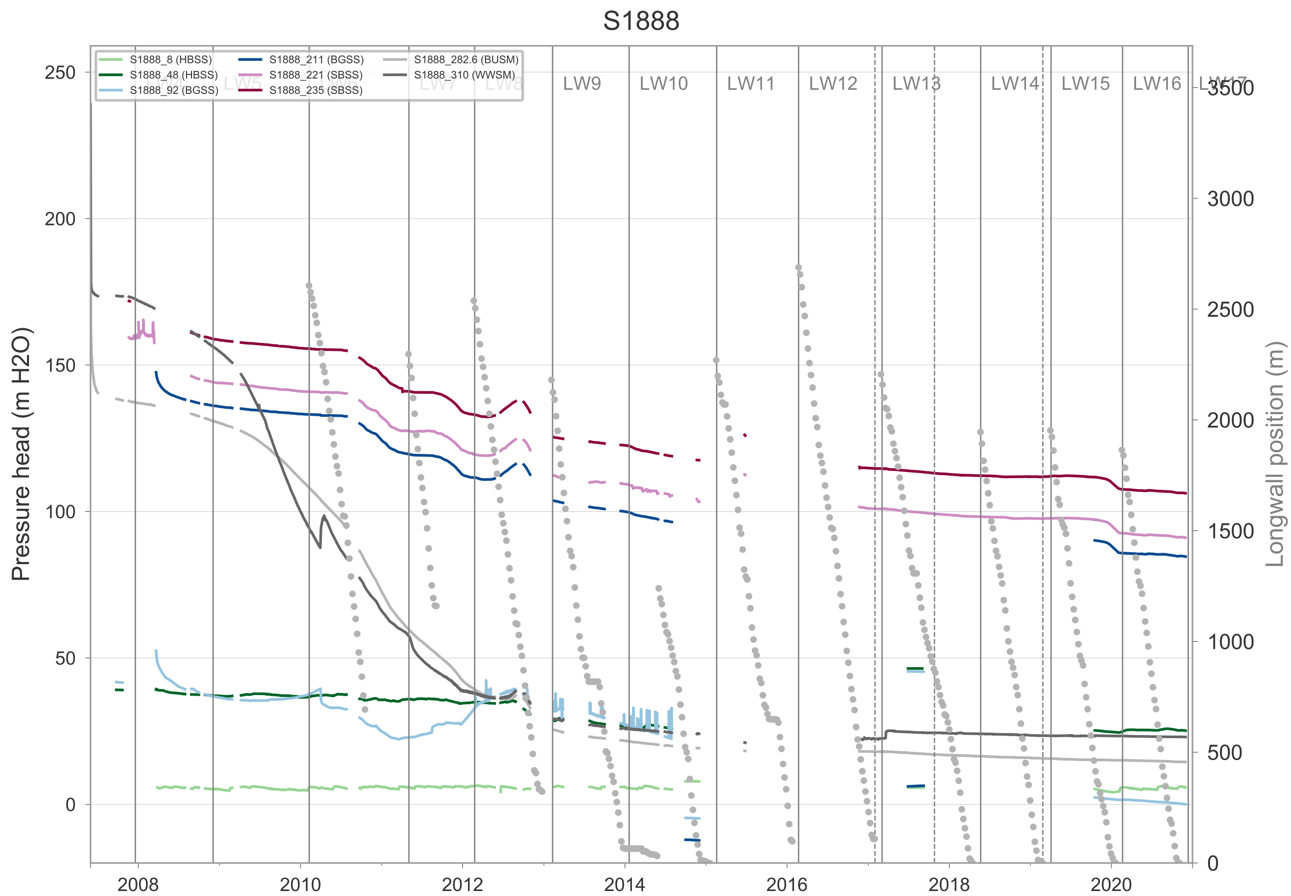

S1886_38.9 (SBSS)
Lake Cordeaux_Dam
Bulli Coal Seam
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
Ground RL
LW3 LW4 LW5 LW6 LW7 LW8 LW9 LW10 LW11 LW12 LW13 LW14 LW15 LW16
Piezometric head (m RL)
330
320
310
300
290
280
Longwall position (m)
3500
3000
2500
2000
1500
1000
500
0
2008 2010 2012 2014 2016 2018 2020

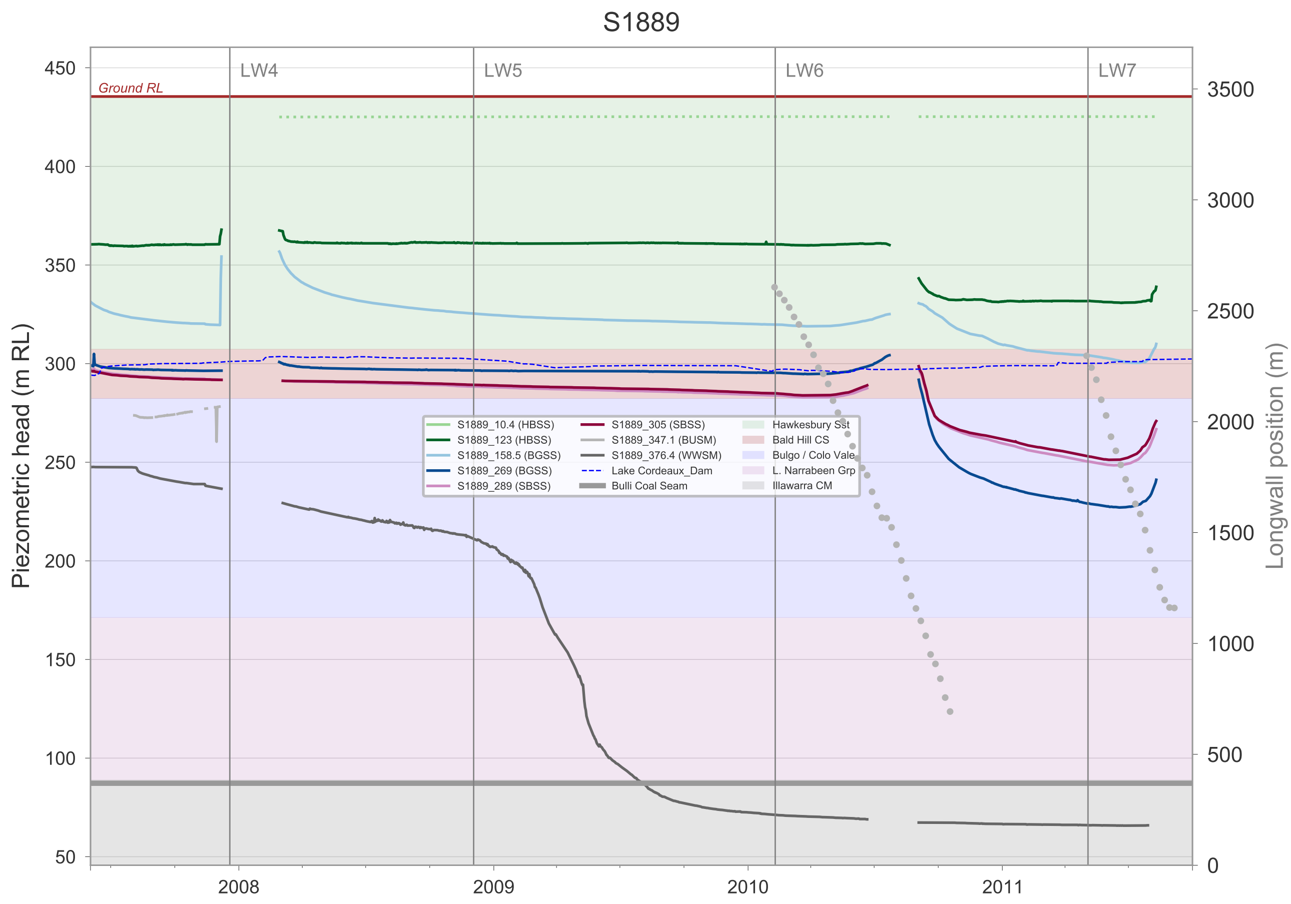
S1886

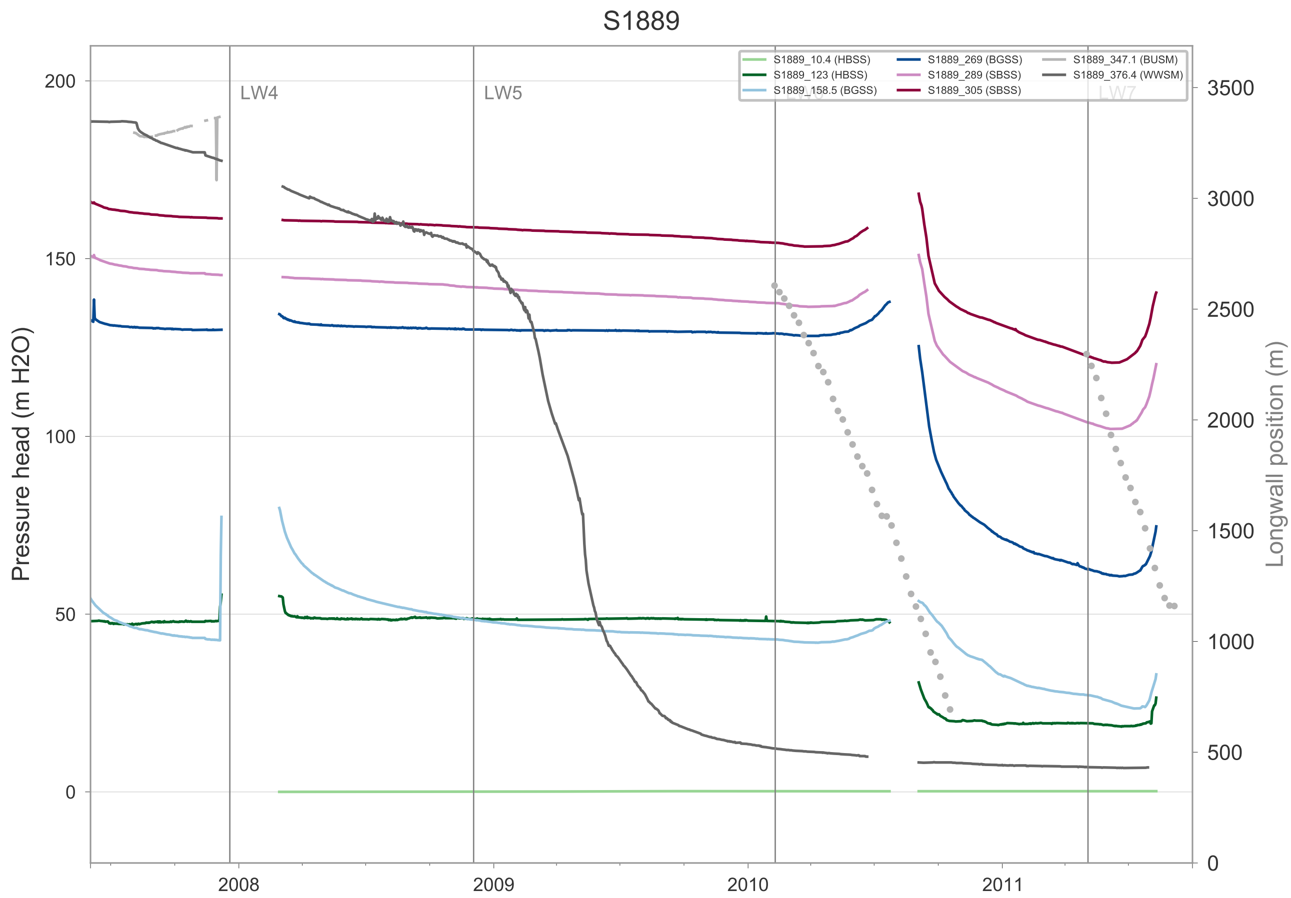

S1886_38.9 (SBSS)
LW3 LW4 LW5 LW6 LW7 LW8 LW9 LW10 LW11 LW12 LW13 LW14 LW15 LW16
Pressure head (m H2O)
50
40
30
20
10
Longwall position (m)
3500
3000
2500
2000
1500
1000
500
0
2008 2010 2012 2014 2016 2018 2020

Groundwater hydrographs

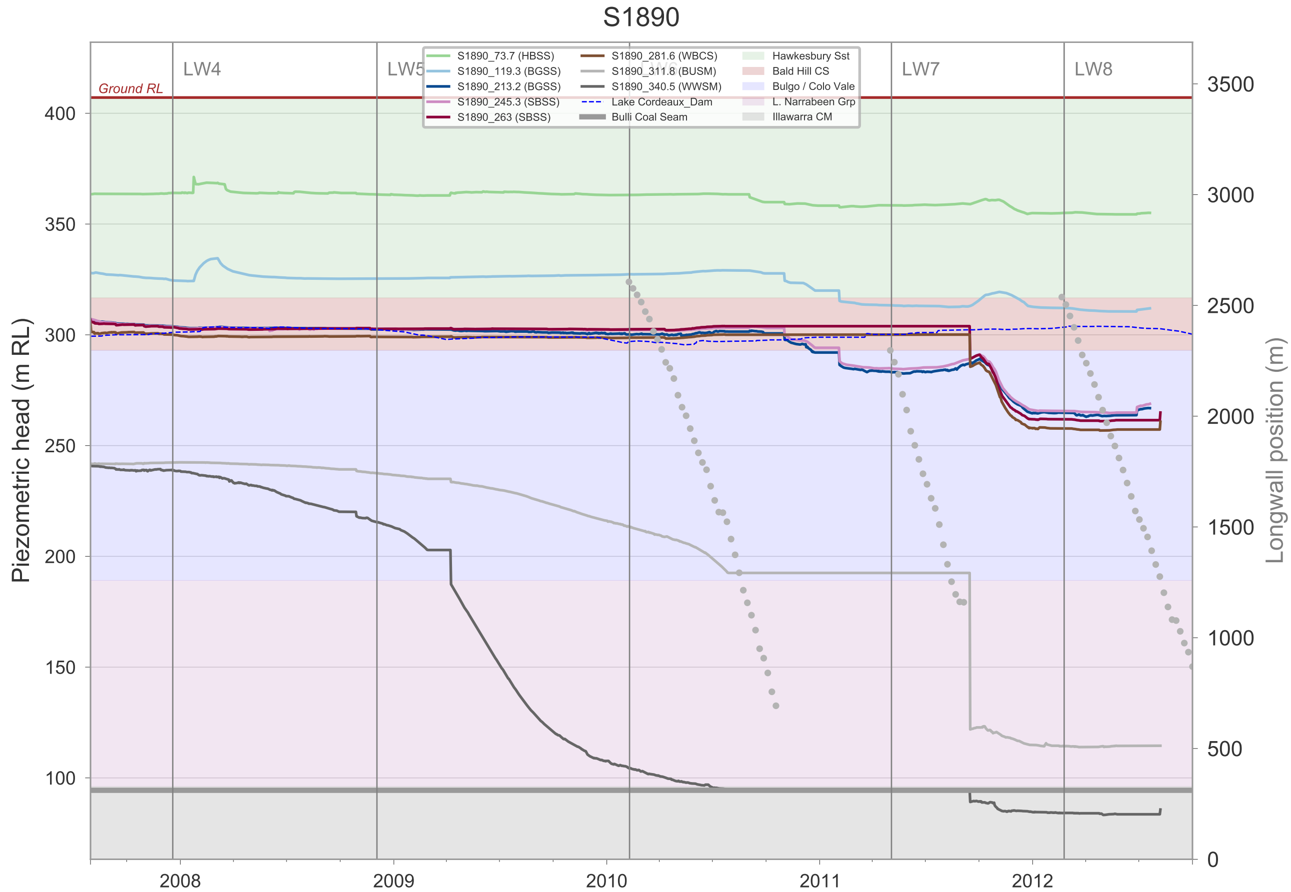


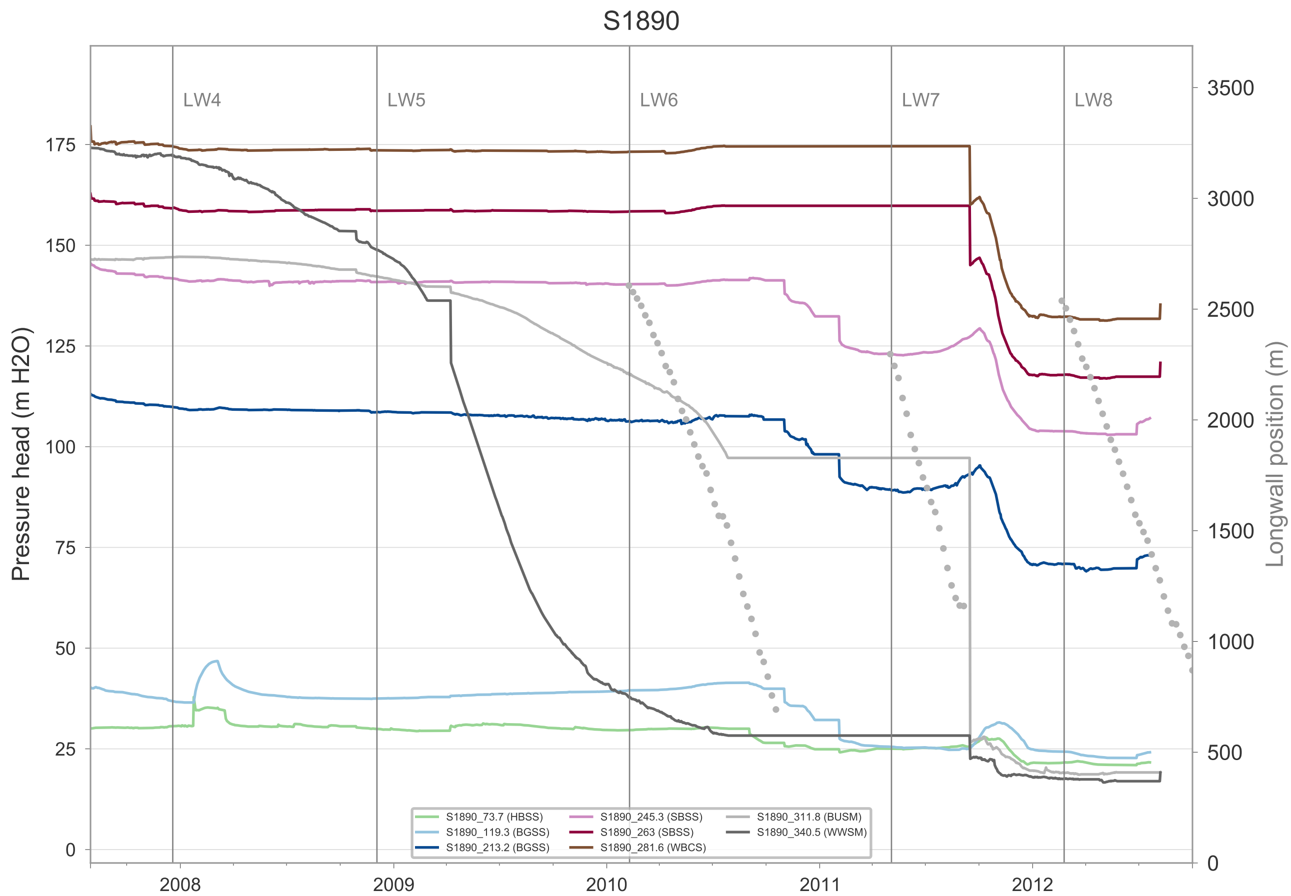


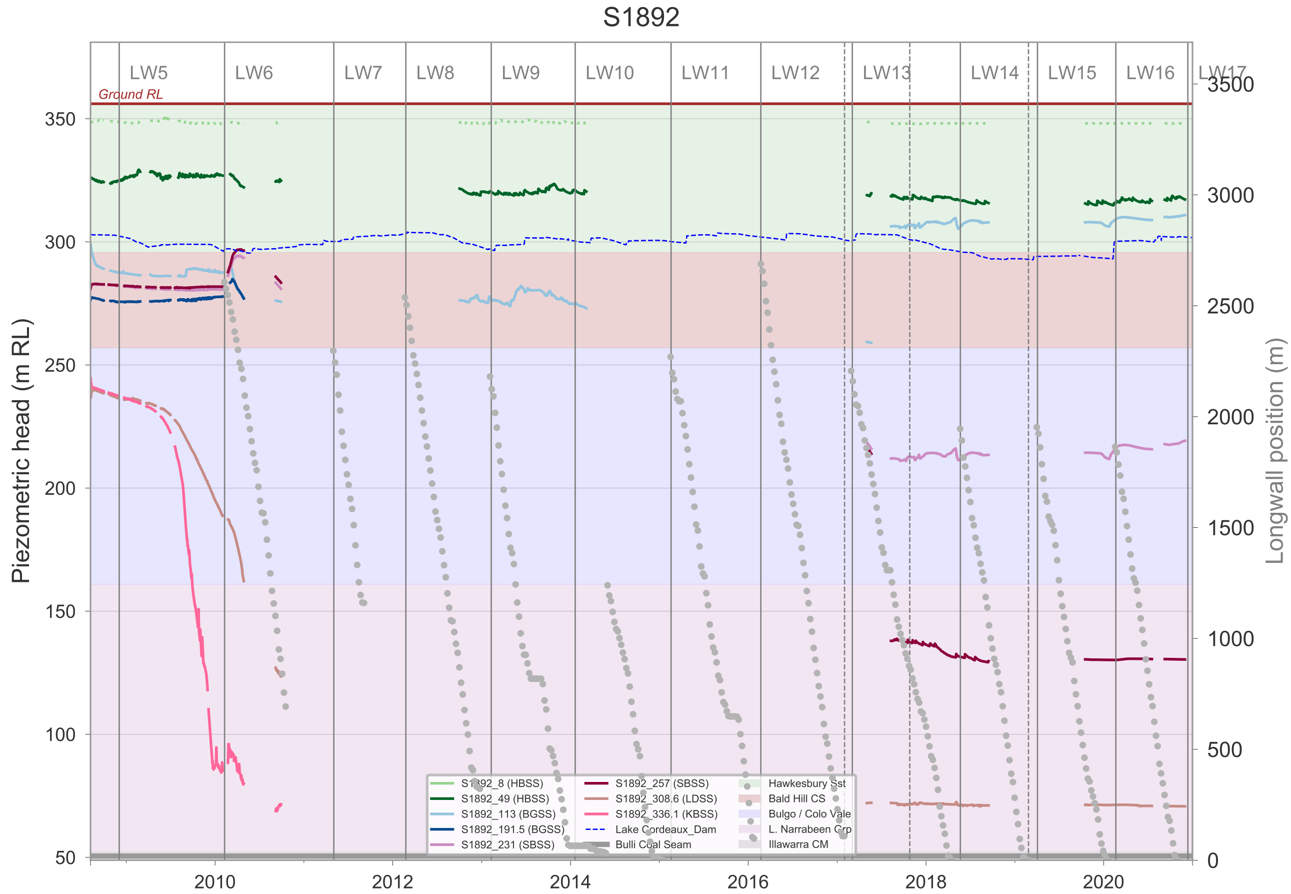

S1889
Piezometric head (m RL)
Longwall position (m)
Ground RL
LW4
LW5
LW6
LW7
450
400
350
300
250
200
150
100
50
3500
3000
2500
2000
1500
1000
500
0
2008
2009
2010
2011
S1889_10.4 (HBSS)
S1889_123 (HBSS)
S1889_158.5 (BGSS)
S1889_269 (BGSS)
S1889_289 (SBSS)
S1889_305 (SBSS)
S1889_347.1 (BUSM)
S1889_376.4 (WWSM)
Lake Cordeaux_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM

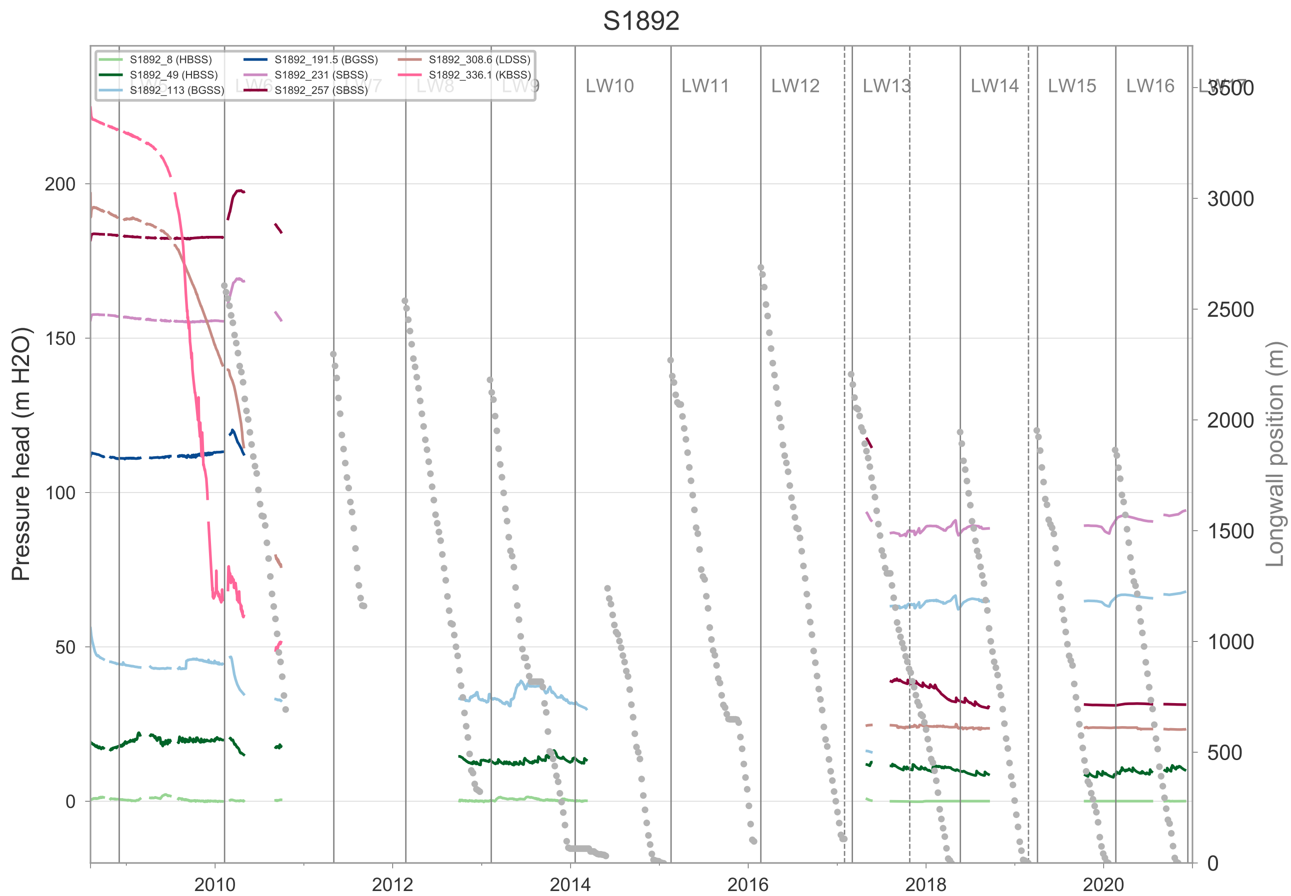

S1889
Pressure head (m H2O)
Longwall position (m)
LW4
LW5
LW7
200
150
100
50
0
3500
3000
2500
2000
1500
1000
500
0
2008
2009
2010
2011
S1889_10.4 (HBSS)
S1889_123 (HBSS)
S1889_158.5 (BGSS)
S1889_269 (BGSS)
S1889_289 (SBSS)
S1889_305 (SBSS)
S1889_347.1 (BUSM)
S1889_376.4 (WWSM)

Groundwater hydrographs

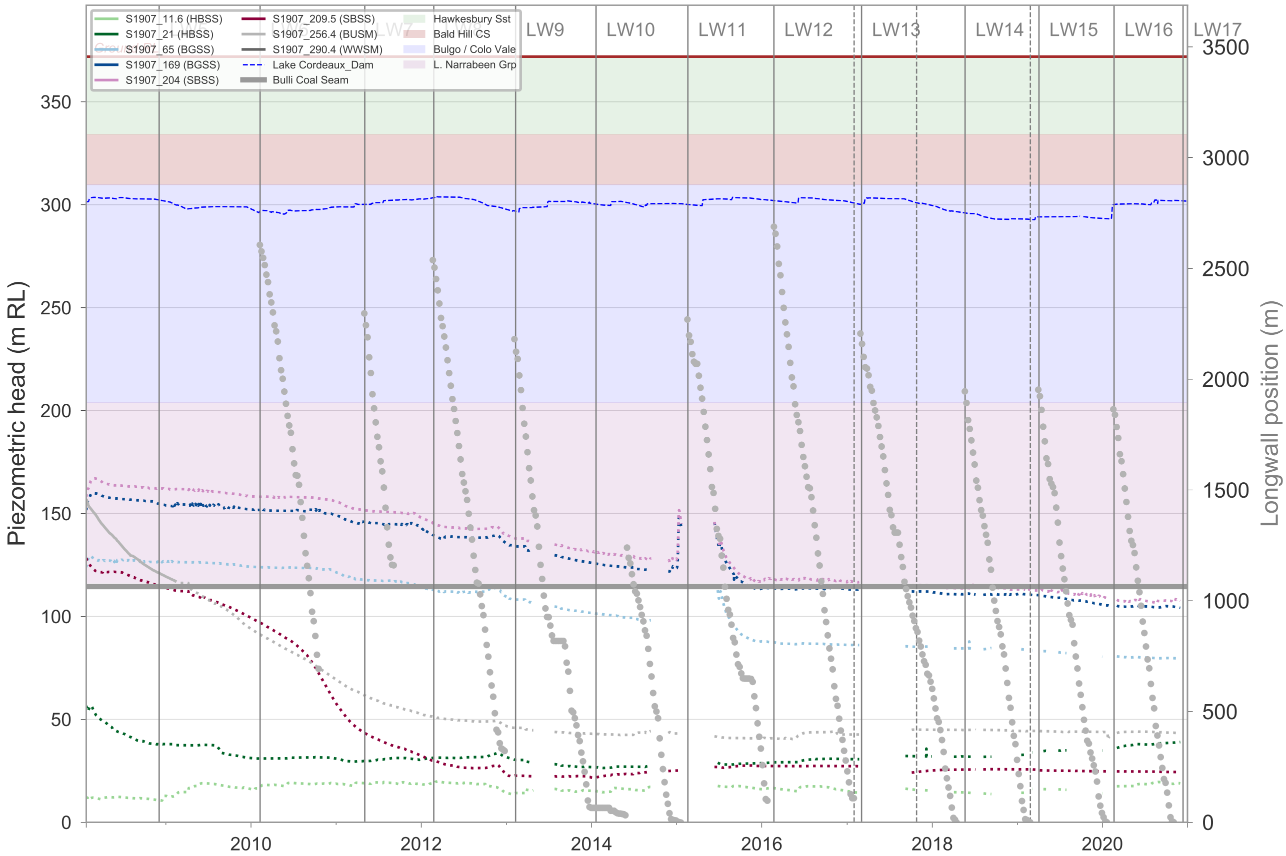




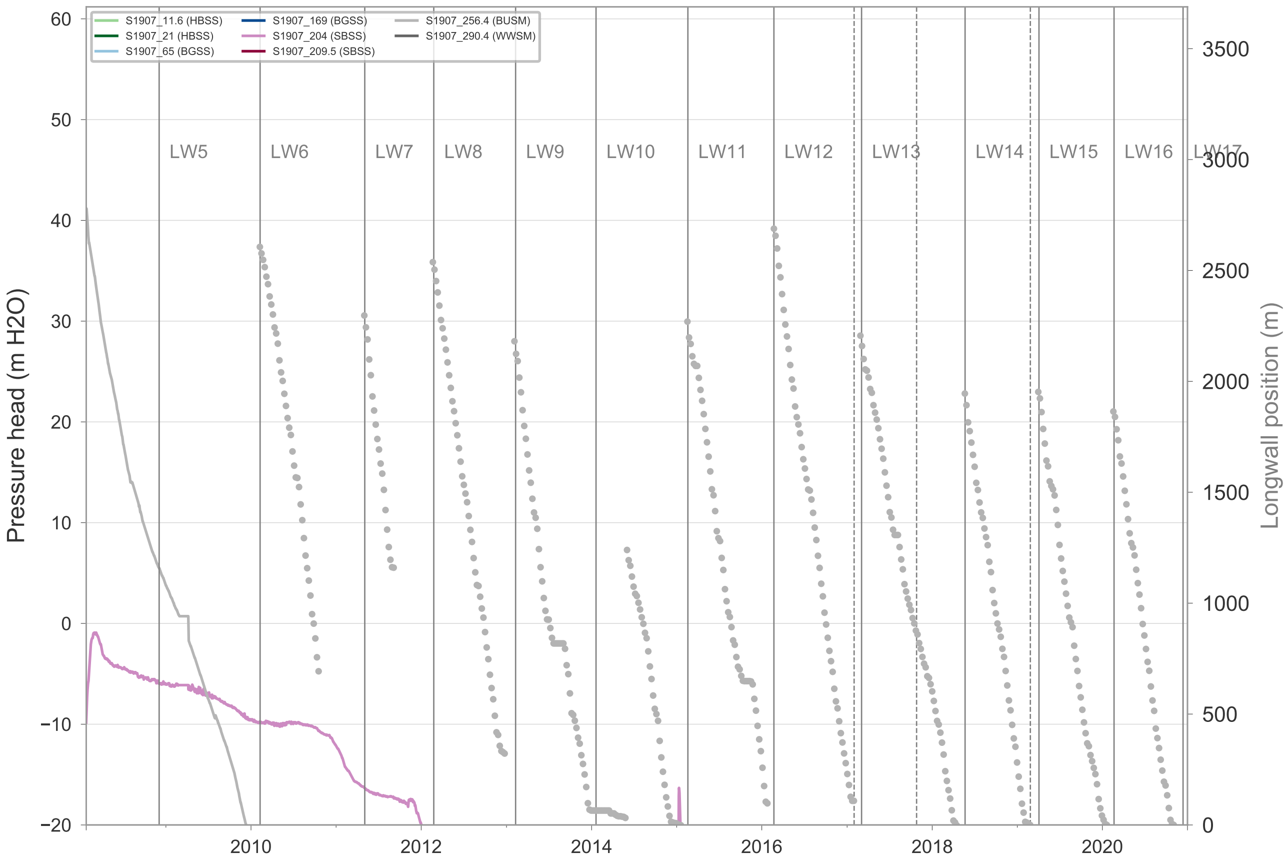

S1892
LW5
LW6
LW7
LW8
LW9
LW10
LW11
LW12
LW13
LW14
LW15
LW16
LW17
Ground RL
Piezometric head (m RL)
Longwall position (m)
S1892_8 (HBSS)
S1892_49 (HBSS)
S1892_113 (BGSS)
S1892_191.5 (BGSS)
S1892_231 (SBSS)
S1892_257 (SBSS)
S1892_308.6 (LDSS)
S1892_336.1 (KBSS)
Lake Cordeaux_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM

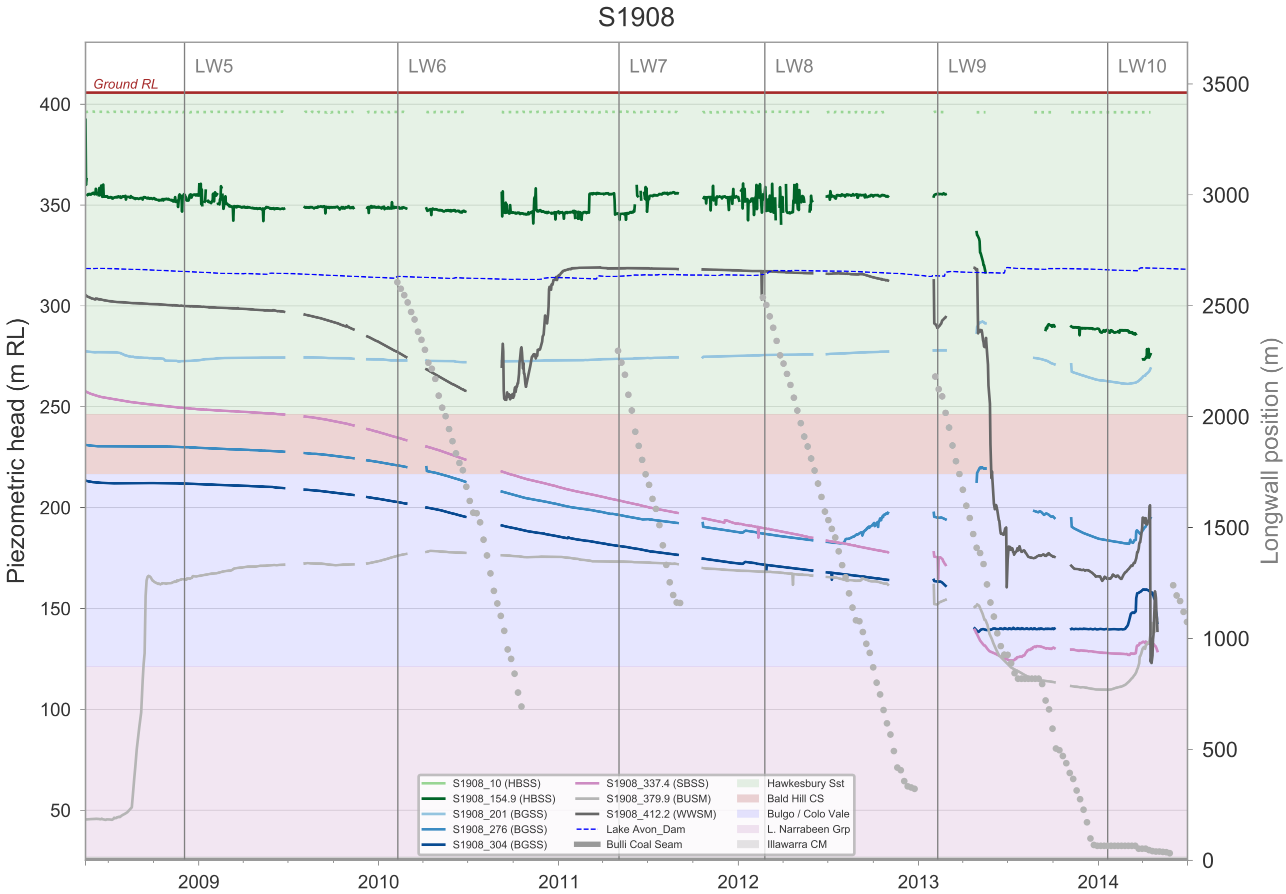

S1892
LW10
LW11
LW12
LW13
LW14
LW15
LW16
LW17
Pressure head (m H2O)
Longwall position (m)
S1892_8 (HBSS)
S1892_49 (HBSS)
S1892_113 (BGSS)
S1892_191.5 (BGSS)
S1892_231 (SBSS)
S1892_257 (SBSS)
S1892_308.6 (LDSS)
S1892_336.1 (KBSS)

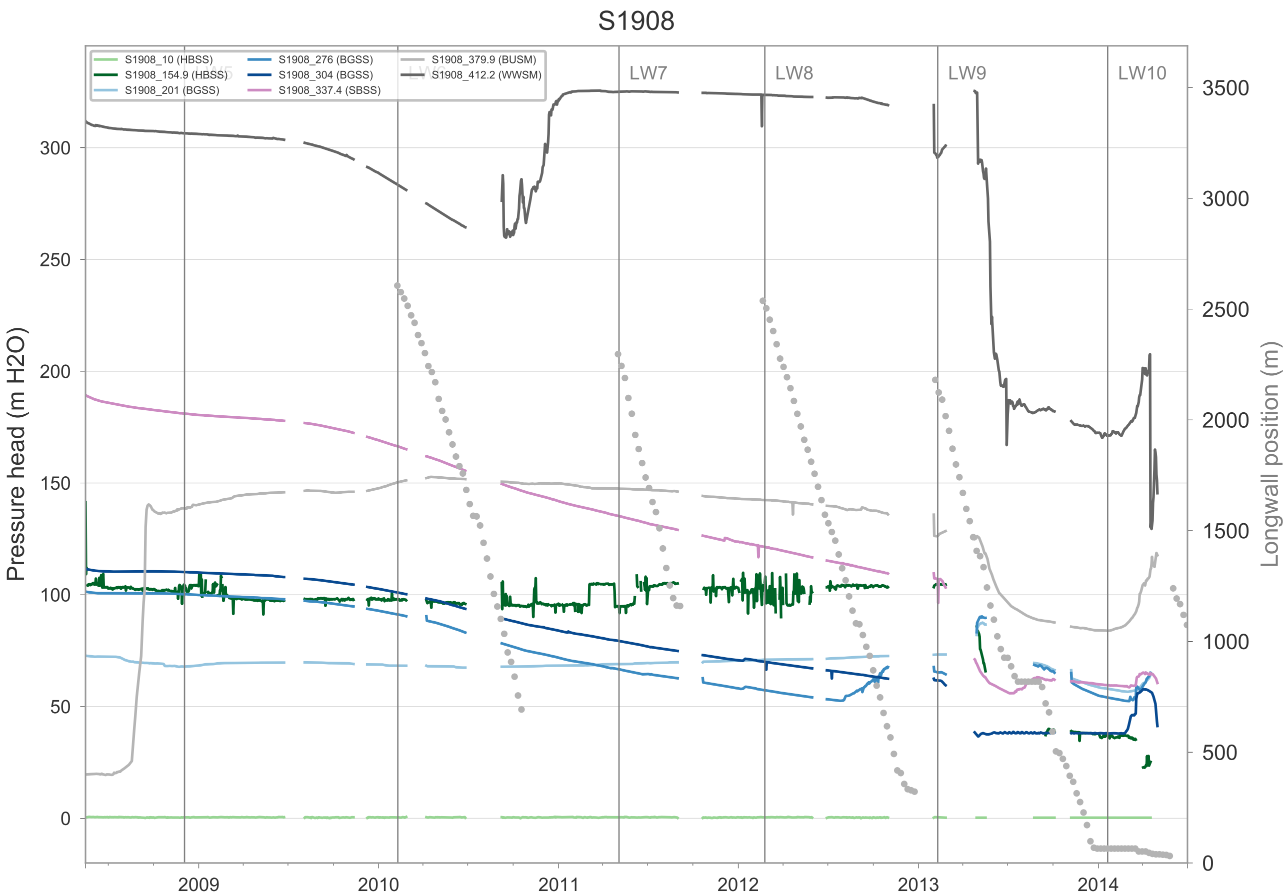
S1907

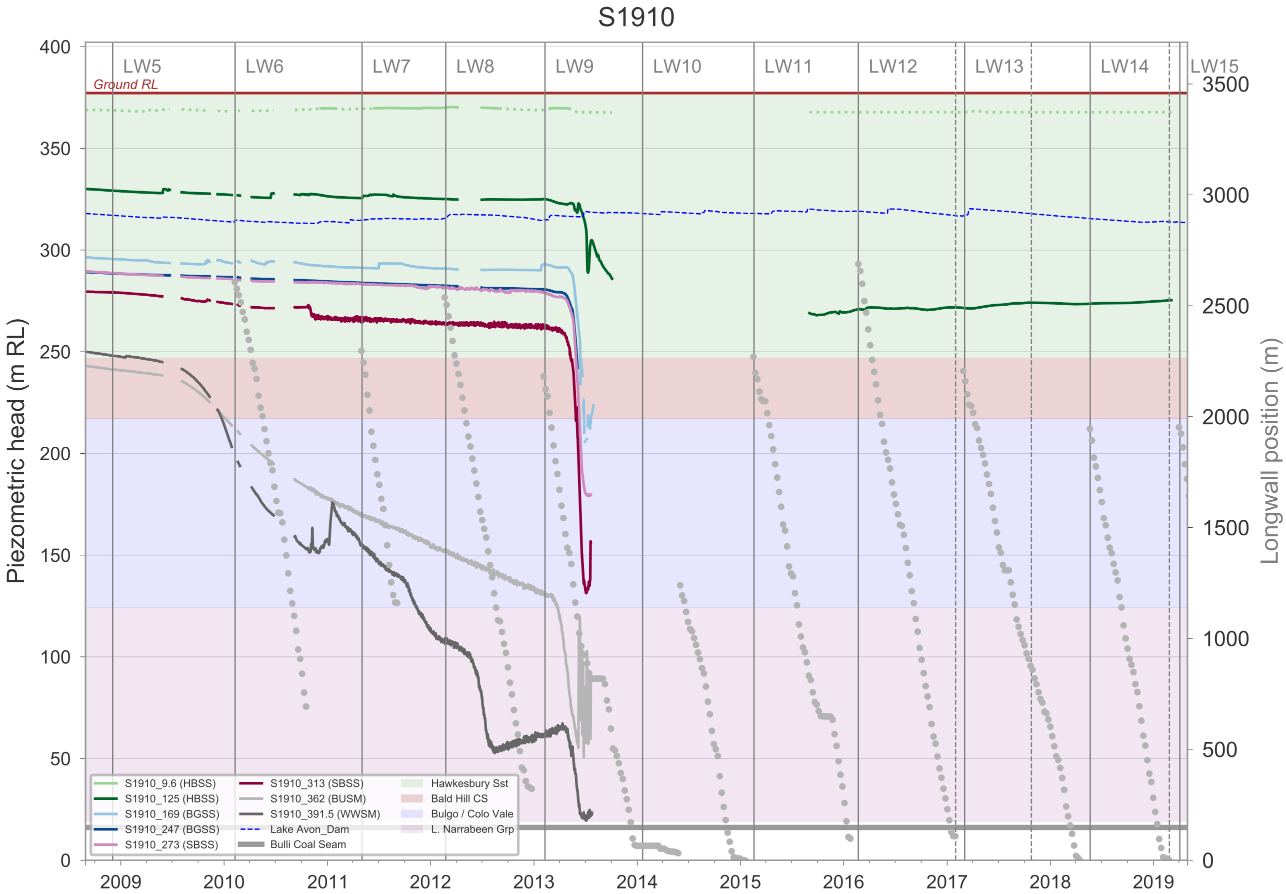

S1907_11.6 (HBSS)
S1907_21 (HBSS)
S1907_65 (BGSS)
S1907_169 (BGSS)
S1907_204 (SBSS)
S1907_209.5 (SBSS)
S1907_256.4 (BUSM)
S1907_290.4 (WWSM)
Lake Cordeaux_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
LW9
LW10
LW11
LW12
LW13
LW14
LW15
LW16
LW17
Piezometric head (m RL)
Longwall position (m)
0
50
100
150
200
250
300
350
500
1000
1500
2000
2500
3000
3500
2010
2012
2014
2016
2018
2020

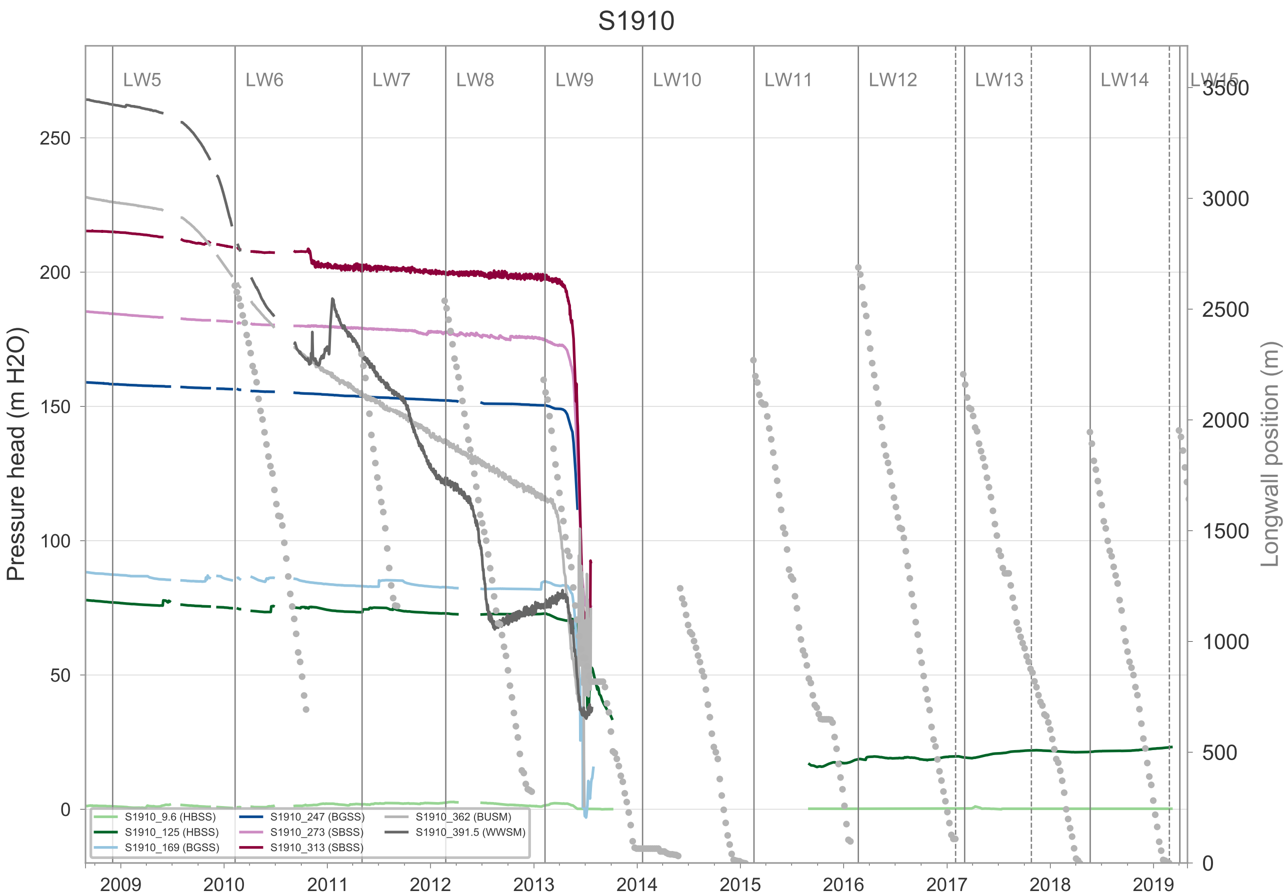
S1907


S1907_11.6 (HBSS)
S1907_21 (HBSS)
S1907_65 (BGSS)
S1907_169 (BGSS)
S1907_204 (SBSS)
S1907_209.5 (SBSS)
S1907_256.4 (BUSM)
S1907_290.4 (WWSM)
LW5
LW6
LW7
LW8
LW9
LW10
LW11
LW12
LW13
LW14
LW15
LW16
LW17
Pressure head (m H2O)
Longwall position (m)
−20
−10
0
10
20
30
40
50
60
500
1000
1500
2000
2500
3000
3500
2010
2012
2014
2016
2018
2020

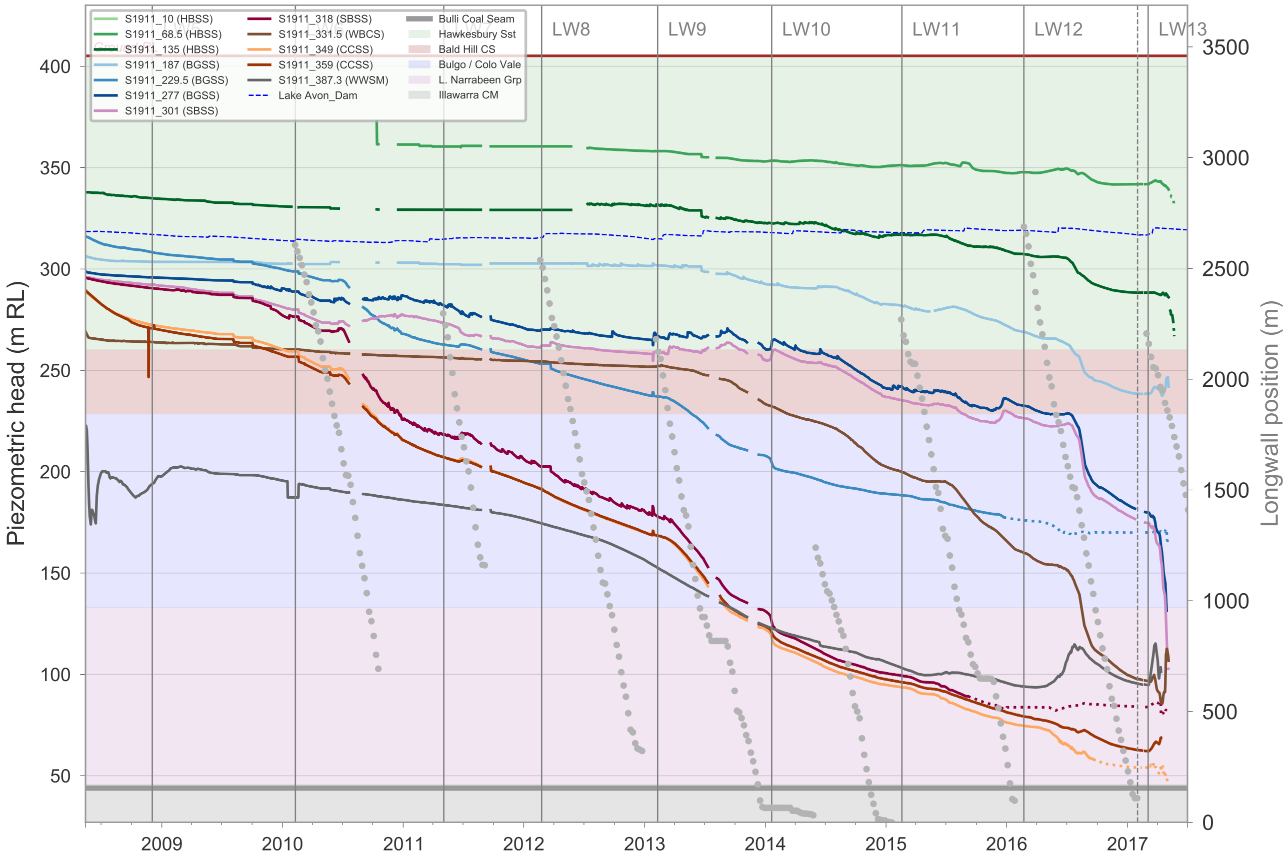

S1908
Ground RL
LW5
LW6
LW7
LW8
LW9
LW10
Piezometric head (m RL)
Longwall position (m)
S1908_10 (HBSS)
S1908_154.9 (HBSS)
S1908_201 (BGSS)
S1908_276 (BGSS)
S1908_304 (BGSS)
S1908_337.4 (SBSS)
S1908_379.9 (BUSM)
S1908_412.2 (WWSM)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
2009
2010
2011
2012
2013
2014


S1908
S1908_10 (HBSS)
S1908_154.9 (HBSS)
S1908_201 (BGSS)
S1908_276 (BGSS)
S1908_304 (BGSS)
S1908_337.4 (SBSS)
S1908_379.9 (BUSM)
S1908_412.2 (WWSM)
LW7
LW8
LW9
LW10
Pressure head (m H2O)
Longwall position (m)
2009
2010
2011
2012
2013
2014


S1910
LW5
LW6
LW7
LW8
LW9
LW10
LW11
LW12
LW13
LW14
LW15
Ground RL
Piezometric head (m RL)
Longwall position (m)
S1910_9.6 (HBSS)
S1910_125 (HBSS)
S1910_169 (BGSS)
S1910_247 (BGSS)
S1910_273 (SBSS)
S1910_313 (SBSS)
S1910_362 (BUSM)
S1910_391.5 (WWSM)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019

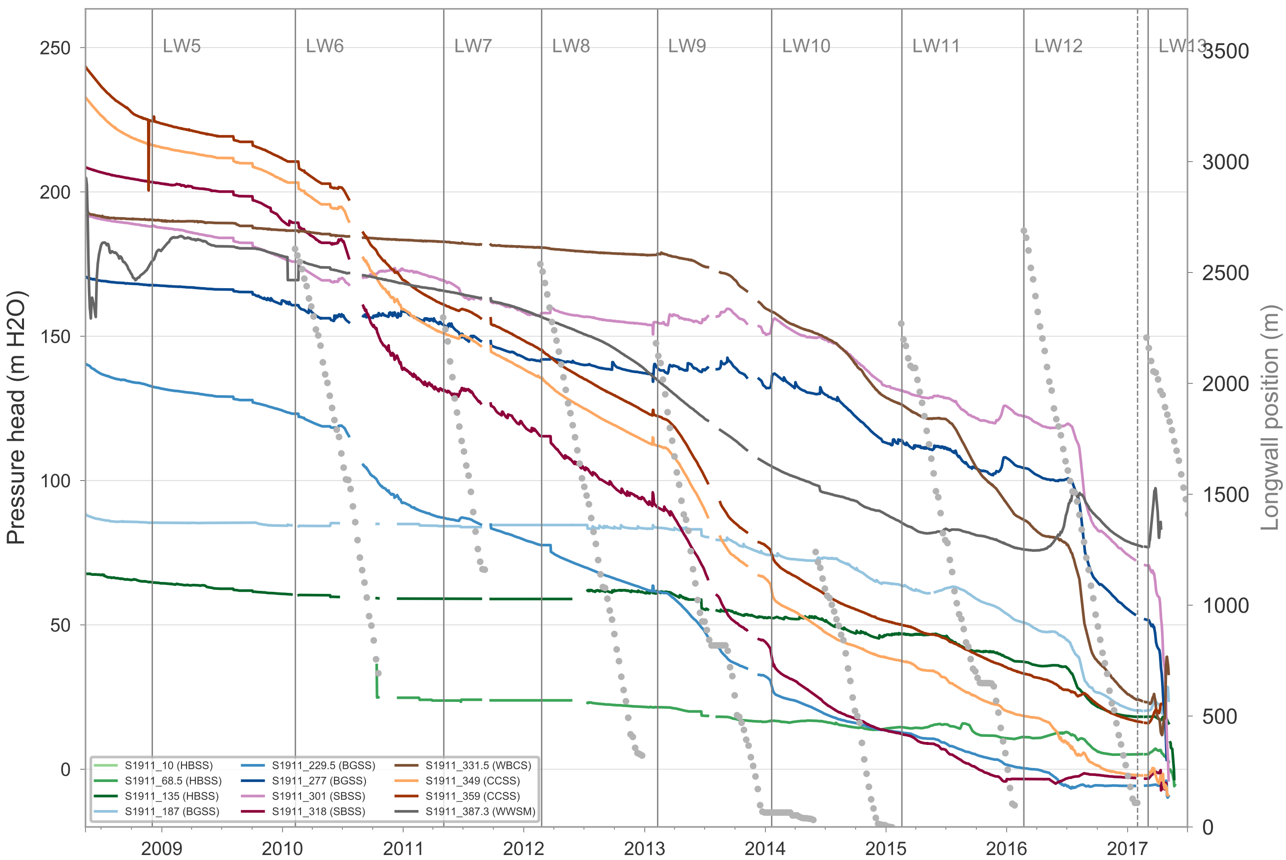

S1910
LW5
LW6
LW7
LW8
LW9
LW10
LW11
LW12
LW13
LW14
LW15
Pressure head (m H2O)
Longwall position (m)
S1910_9.6 (HBSS)
S1910_125 (HBSS)
S1910_169 (BGSS)
S1910_247 (BGSS)
S1910_273 (SBSS)
S1910_313 (SBSS)
S1910_362 (BUSM)
S1910_391.5 (WWSM)
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019

S1911



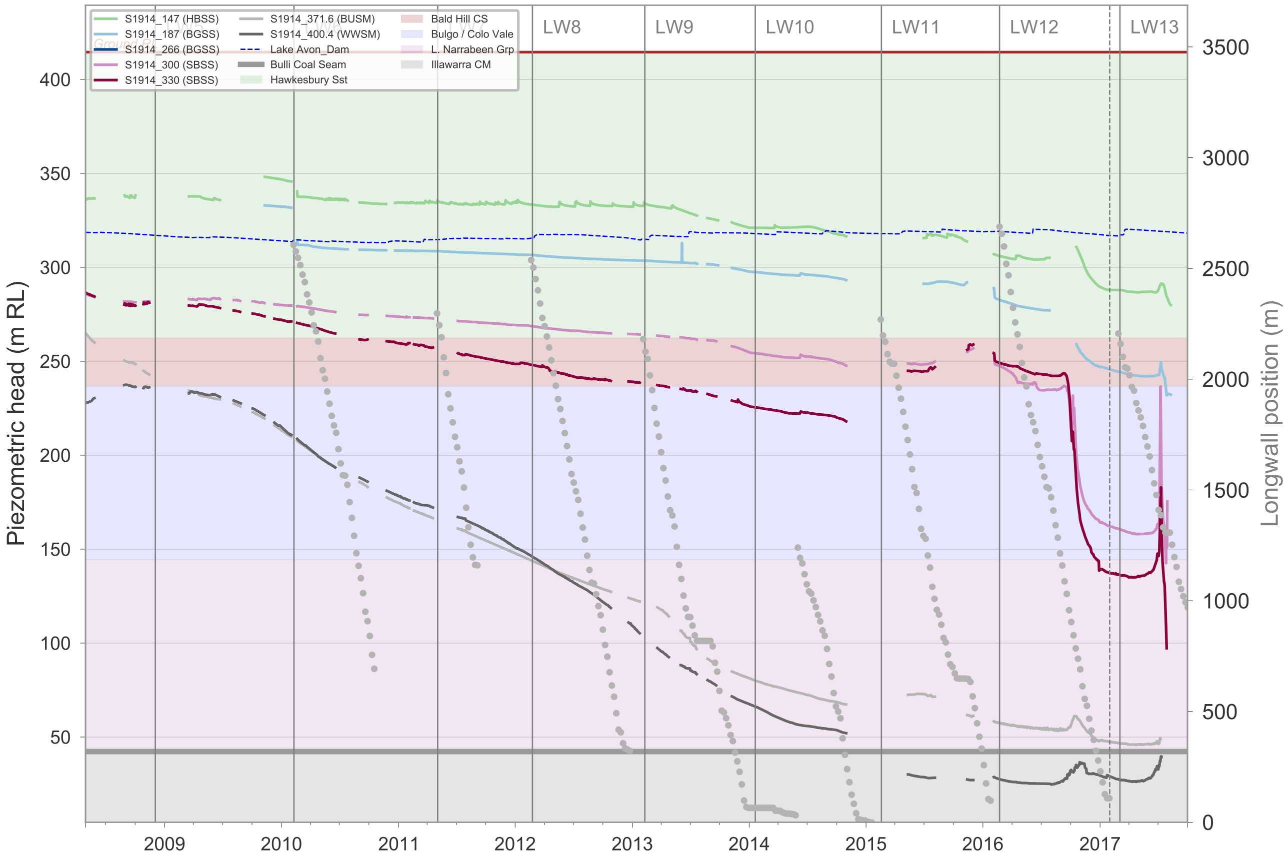
S1911_10 (HBSS)
S1911_68.5 (HBSS)
S1911_135 (HBSS)
S1911_187 (BGSS)
S1911_229.5 (BGSS)
S1911_277 (BGSS)
S1911_301 (SBSS)
S1911_318 (SBSS)
S1911_331.5 (WBCS)
S1911_349 (CCSS)
S1911_359 (CCSS)
S1911_387.3 (WWSM)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
LW8
LW9
LW10
LW11
LW12
LW13
Piezometric head (m RL)
Longwall position (m)

S1911

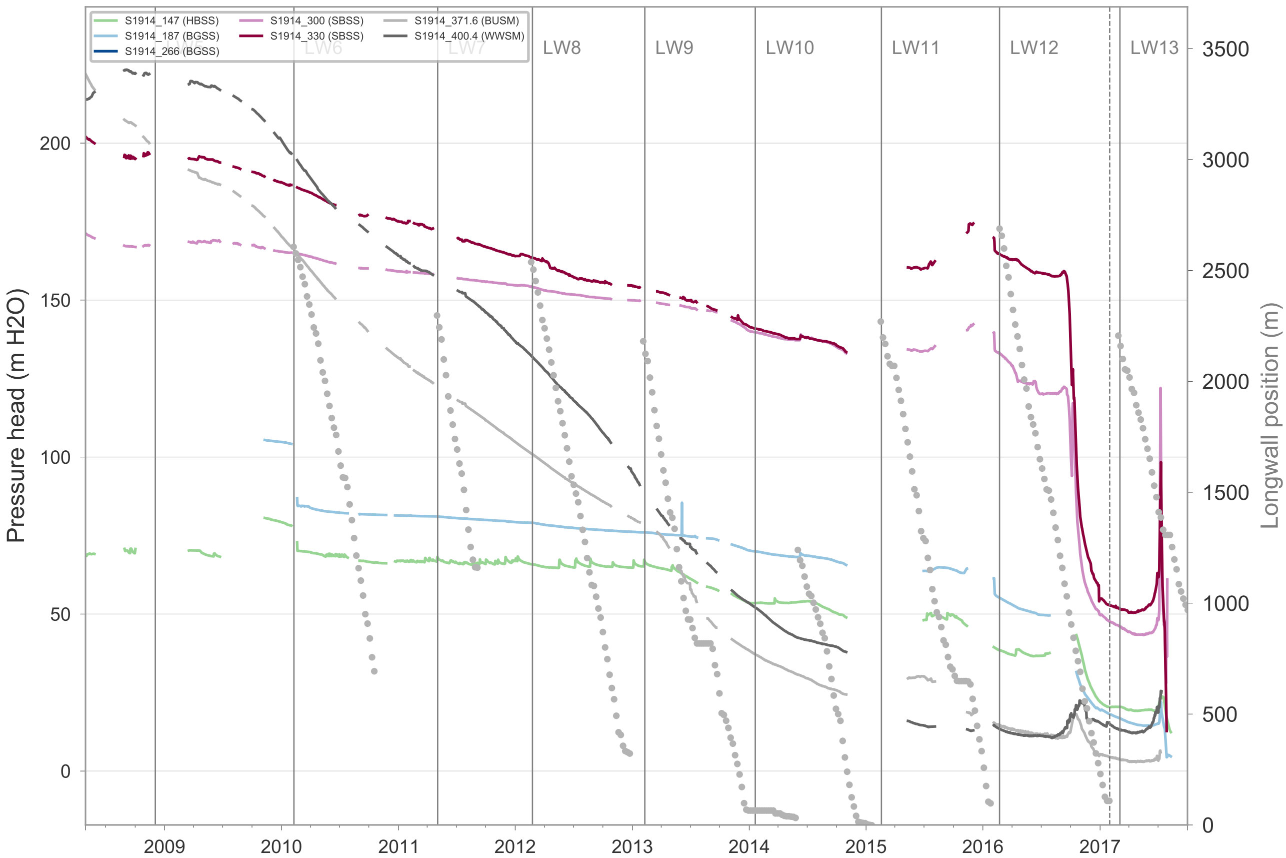


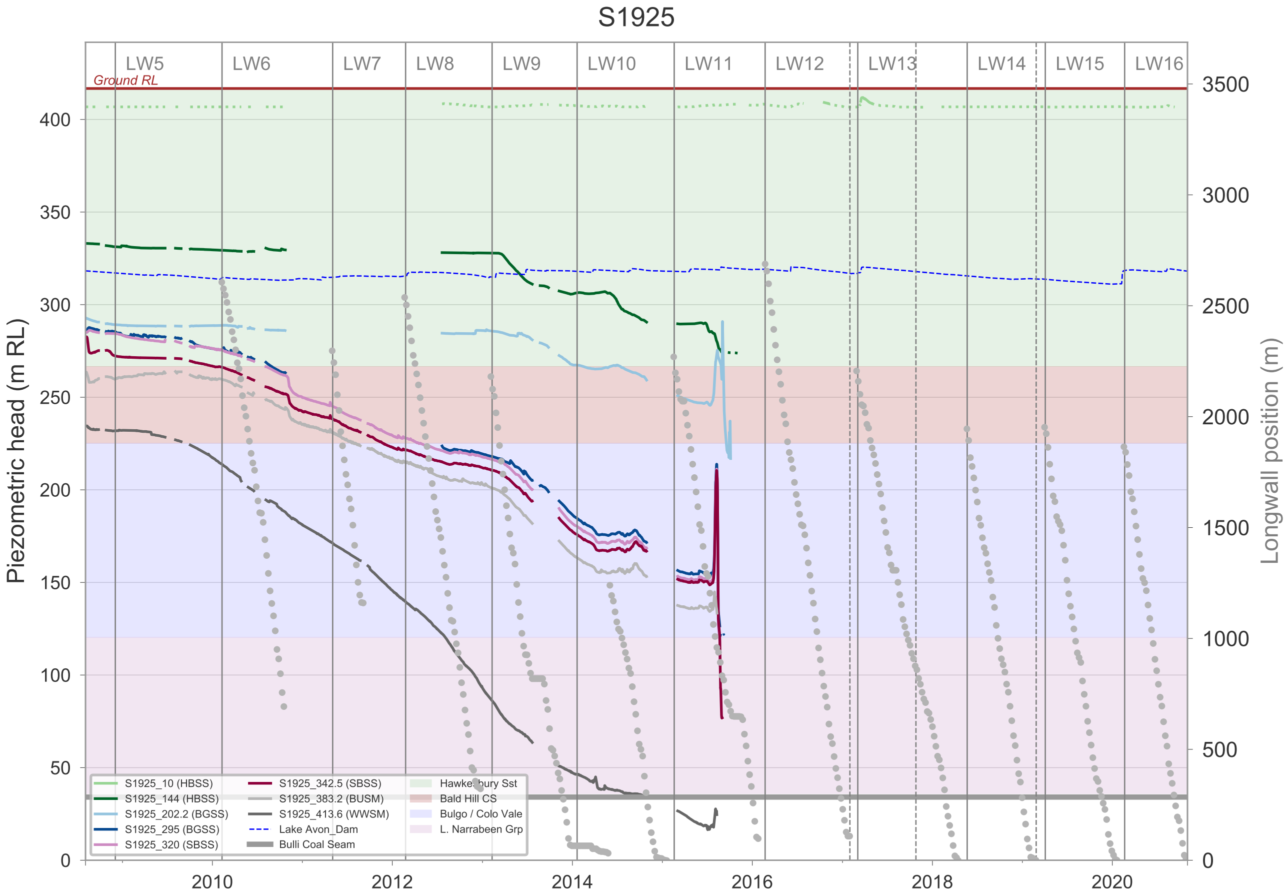
LW5
LW6
LW7
LW8
LW9
LW10
LW11
LW12
LW13
S1911_10 (HBSS)
S1911_68.5 (HBSS)
S1911_135 (HBSS)
S1911_187 (BGSS)
S1911_229.5 (BGSS)
S1911_277 (BGSS)
S1911_301 (SBSS)
S1911_318 (SBSS)
S1911_331.5 (WBCS)
S1911_349 (CCSS)
S1911_359 (CCSS)
S1911_387.3 (WWSM)
Pressure head (m H2O)
Longwall position (m)

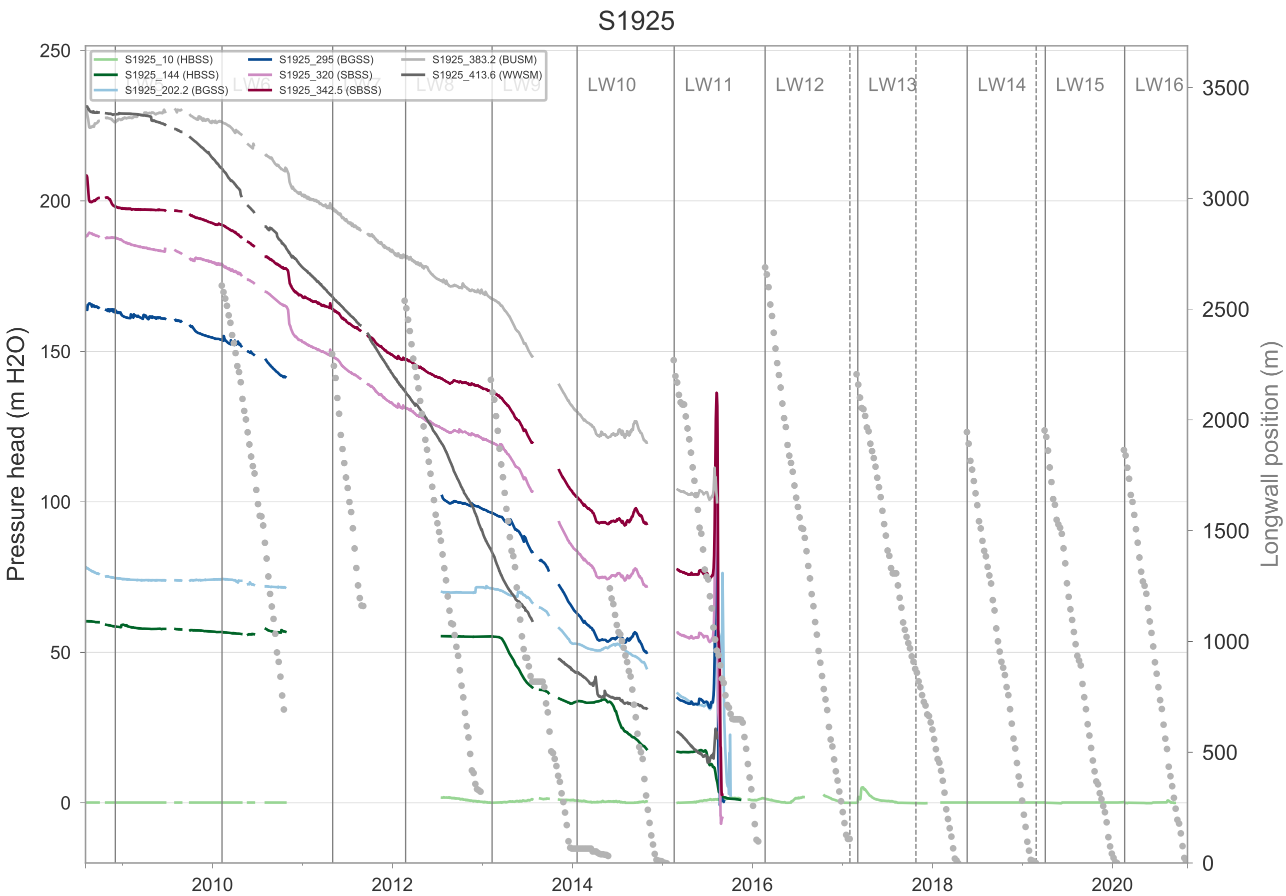
S1914

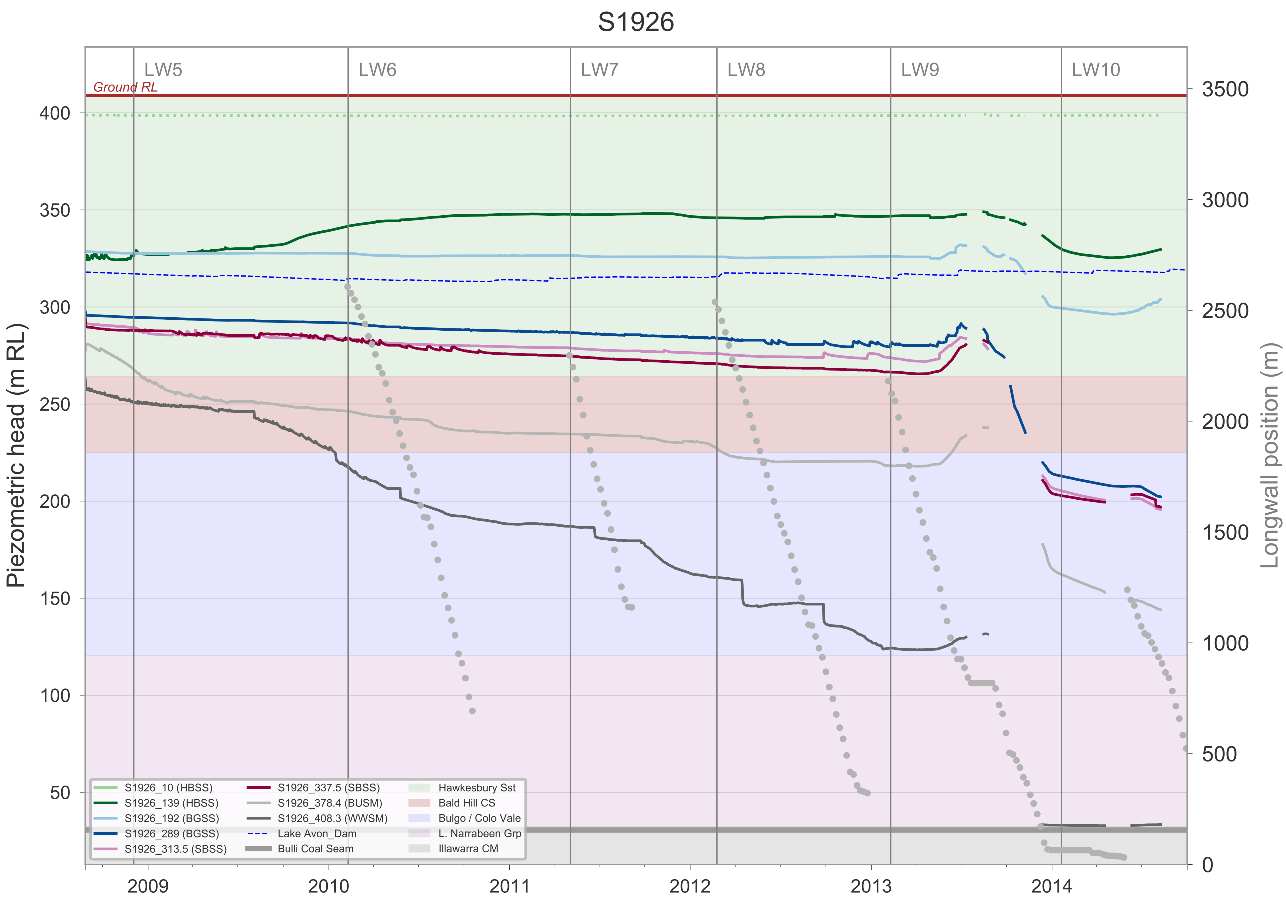

S1914_147 (HBSS)
S1914_187 (BGSS)
S1914_266 (BGSS)
S1914_300 (SBSS)
S1914_330 (SBSS)
S1914_371.6 (BUSM)
S1914_400.4 (WWSM)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
LW8
LW9
LW10
LW11
LW12
LW13
Piezometric head (m RL)
Longwall position (m)
400
350
300
250
200
150
100
50
3500
3000
2500
2000
1500
1000
500
0
2009
2010
2011
2012
2013
2014
2015
2016
2017

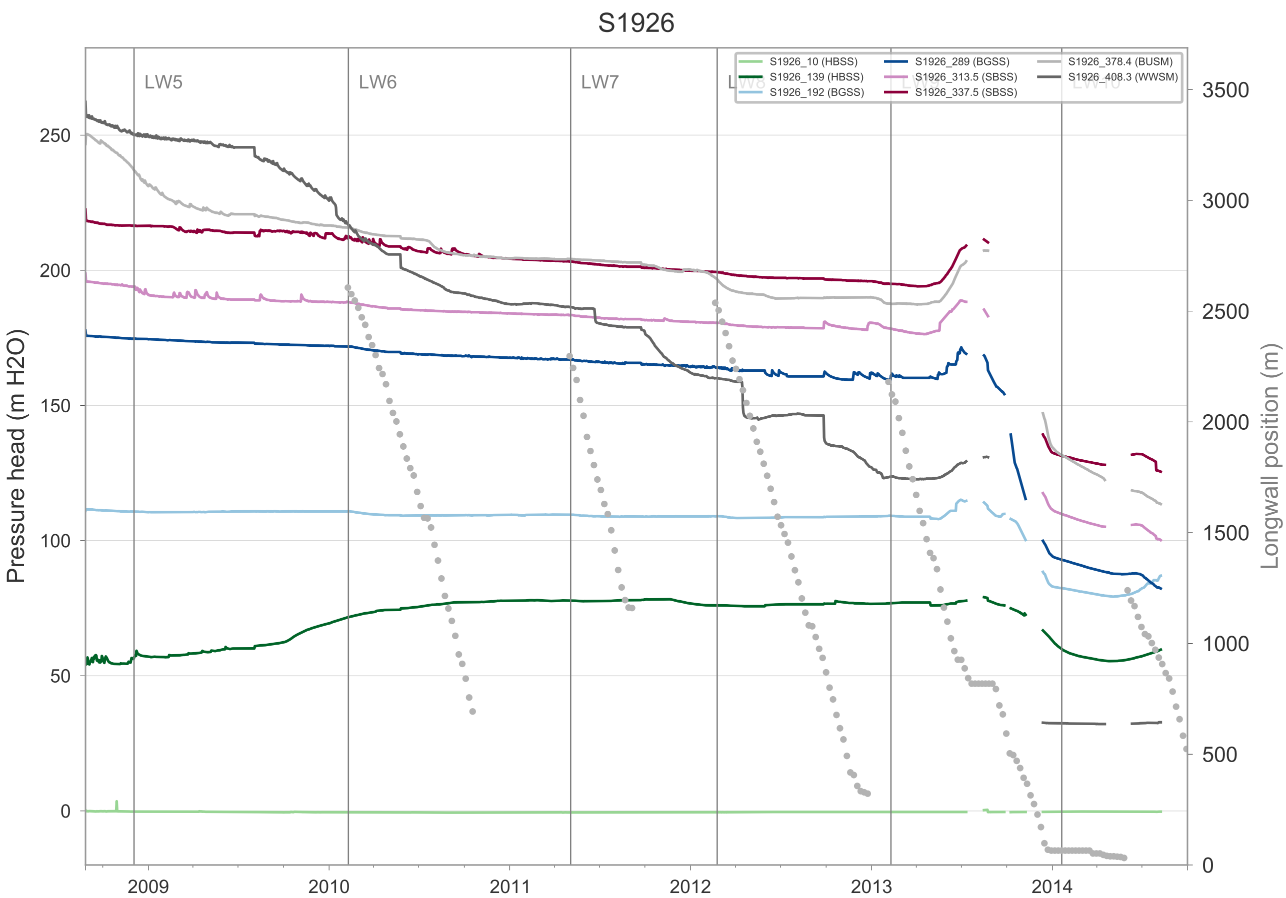
S1914

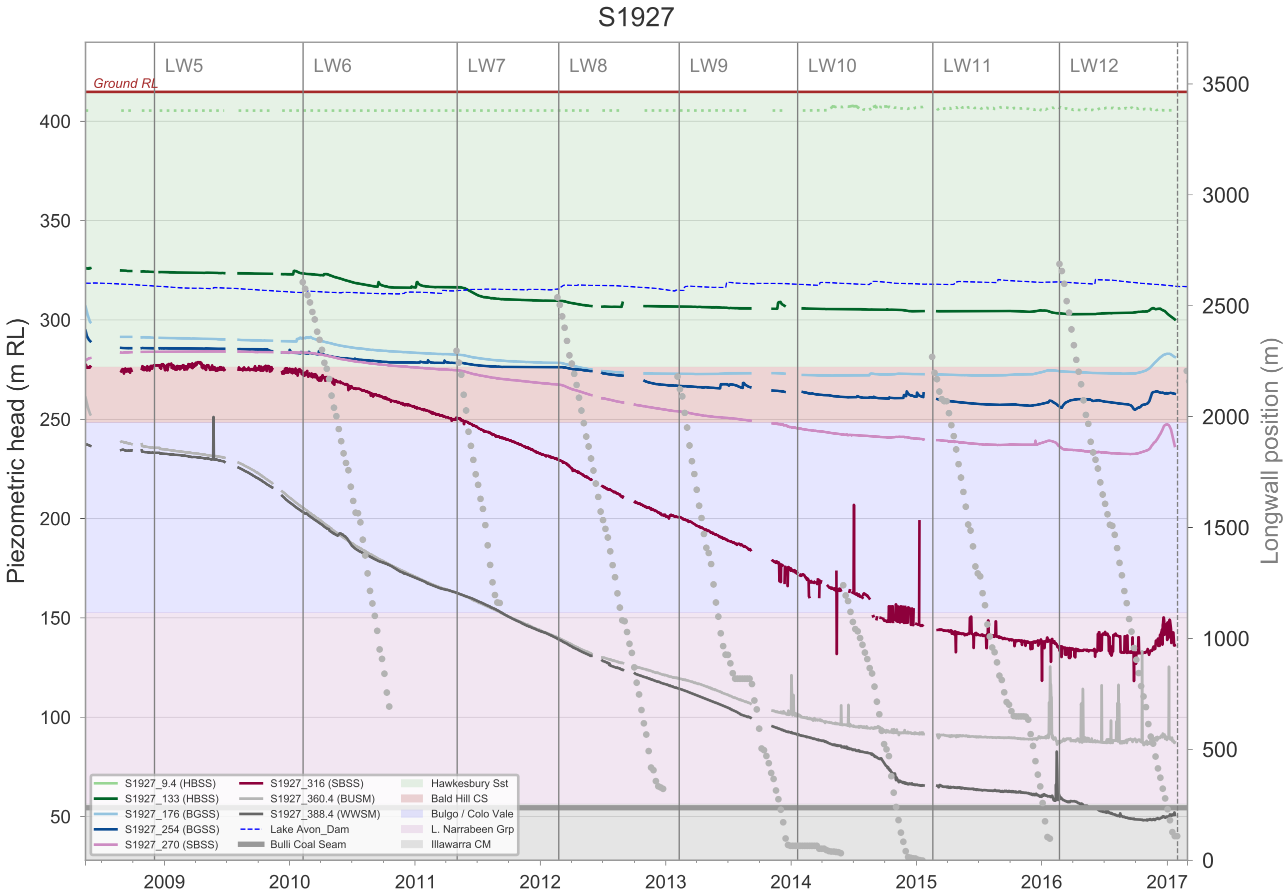

S1914_147 (HBSS)
S1914_187 (BGSS)
S1914_266 (BGSS)
S1914_300 (SBSS)
S1914_330 (SBSS)
S1914_371.6 (BUSM)
S1914_400.4 (WWSM)
LW8
LW9
LW10
LW11
LW12
LW13
Pressure head (m H2O)
Longwall position (m)
200
150
100
50
0
3500
3000
2500
2000
1500
1000
500
0
2009
2010
2011
2012
2013
2014
2015
2016
2017

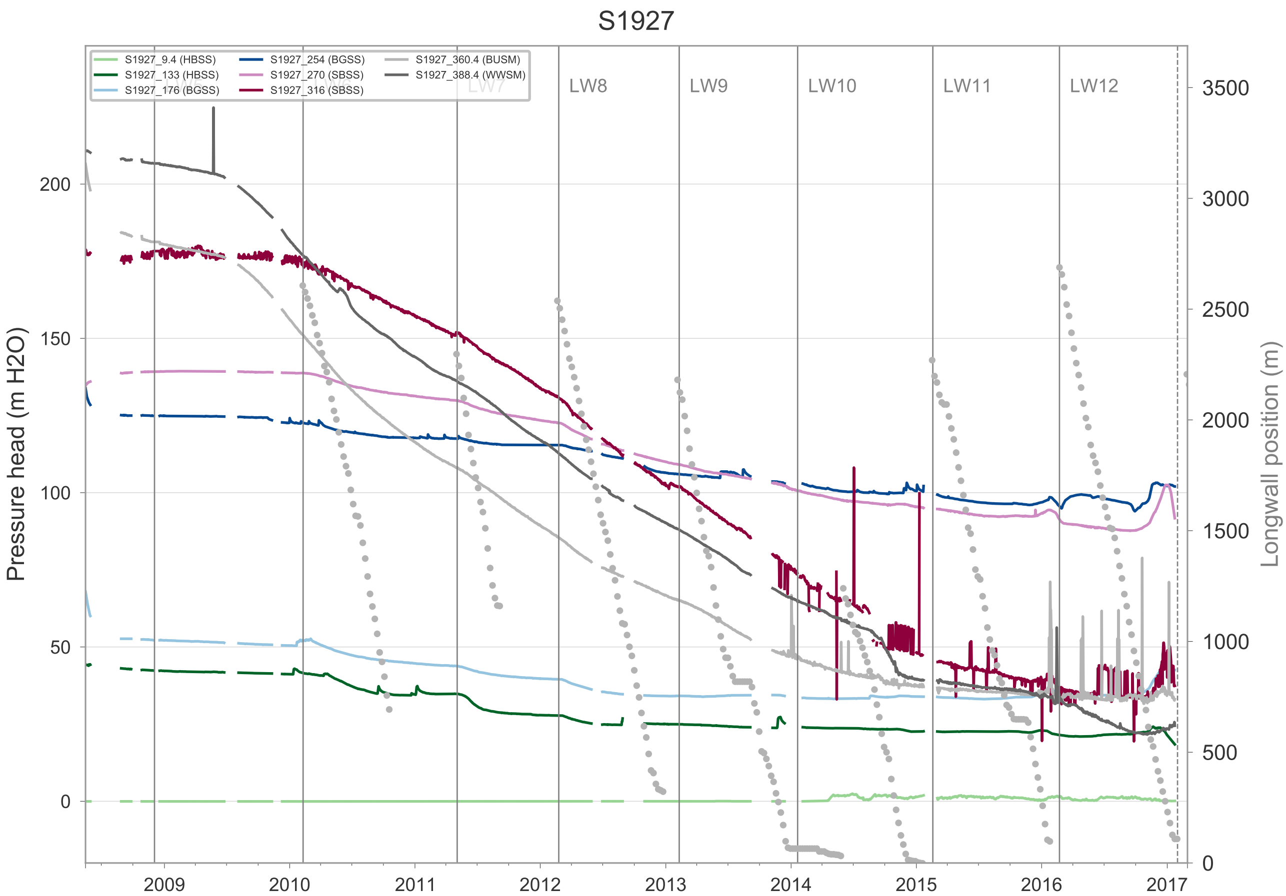

S1925
LW5
LW6
LW7
LW8
LW9
LW10
LW11
LW12
LW13
LW14
LW15
LW16
Ground RL
Piezometric head (m RL)
Longwall position (m)
S1925_10 (HBSS)
S1925_144 (HBSS)
S1925_202.2 (BGSS)
S1925_295 (BGSS)
S1925_320 (SBSS)
S1925_342.5 (SBSS)
S1925_383.2 (BUSM)
S1925_413.6 (WWSM)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
2010
2012
2014
2016
2018
2020


S1925
LW10
LW11
LW12
LW13
LW14
LW15
LW16
Pressure head (m H2O)
Longwall position (m)
S1925_10 (HBSS)
S1925_144 (HBSS)
S1925_202.2 (BGSS)
S1925_295 (BGSS)
S1925_320 (SBSS)
S1925_342.5 (SBSS)
S1925_383.2 (BUSM)
S1925_413.6 (WWSM)
2010
2012
2014
2016
2018
2020

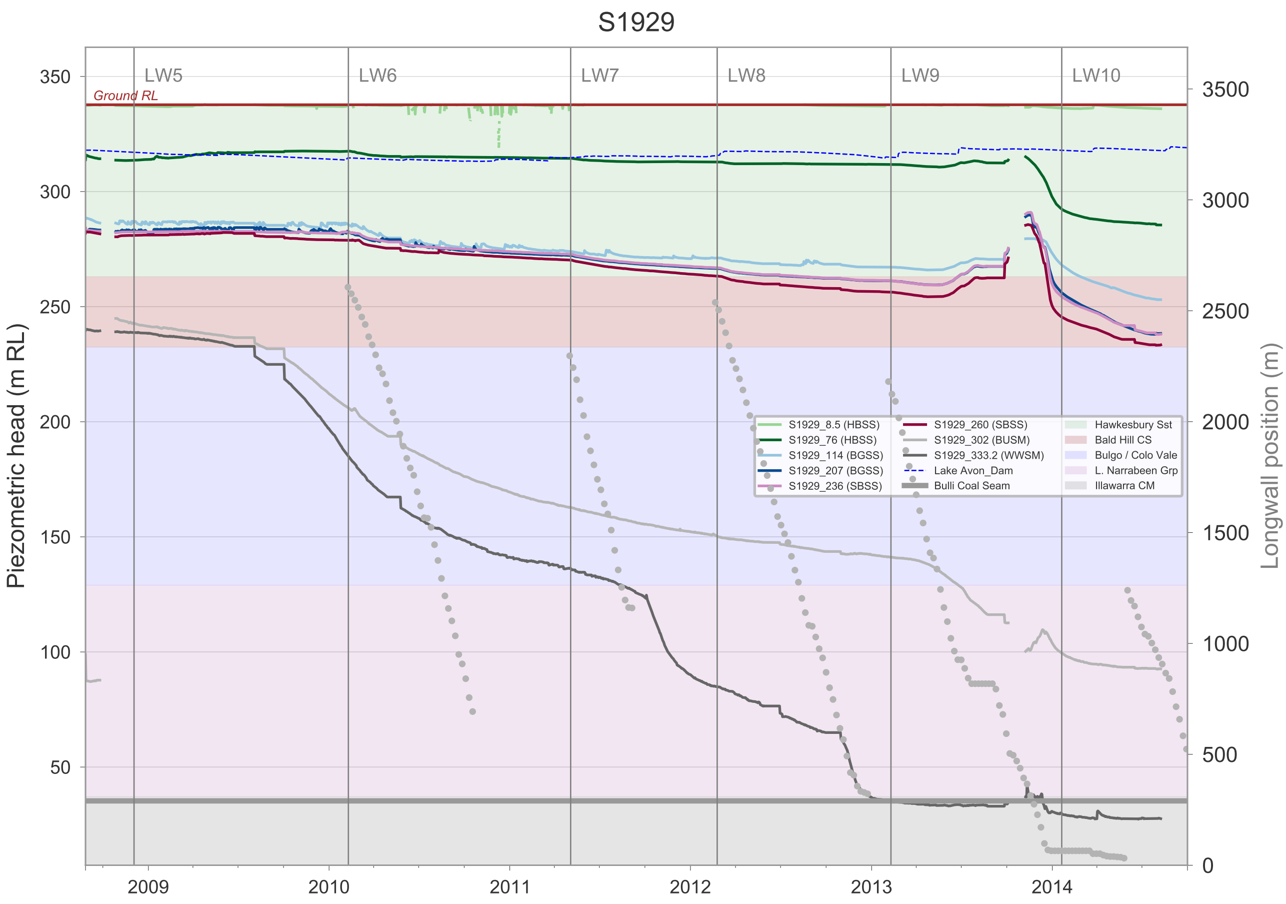

S1926
LW5
LW6
LW7
LW8
LW9
LW10
Ground RL
Piezometric head (m RL)
Longwall position (m)
S1926_10 (HBSS)
S1926_139 (HBSS)
S1926_192 (BGSS)
S1926_289 (BGSS)
S1926_313.5 (SBSS)
S1926_337.5 (SBSS)
S1926_378.4 (BUSM)
S1926_408.3 (WWSM)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
2009
2010
2011
2012
2013
2014

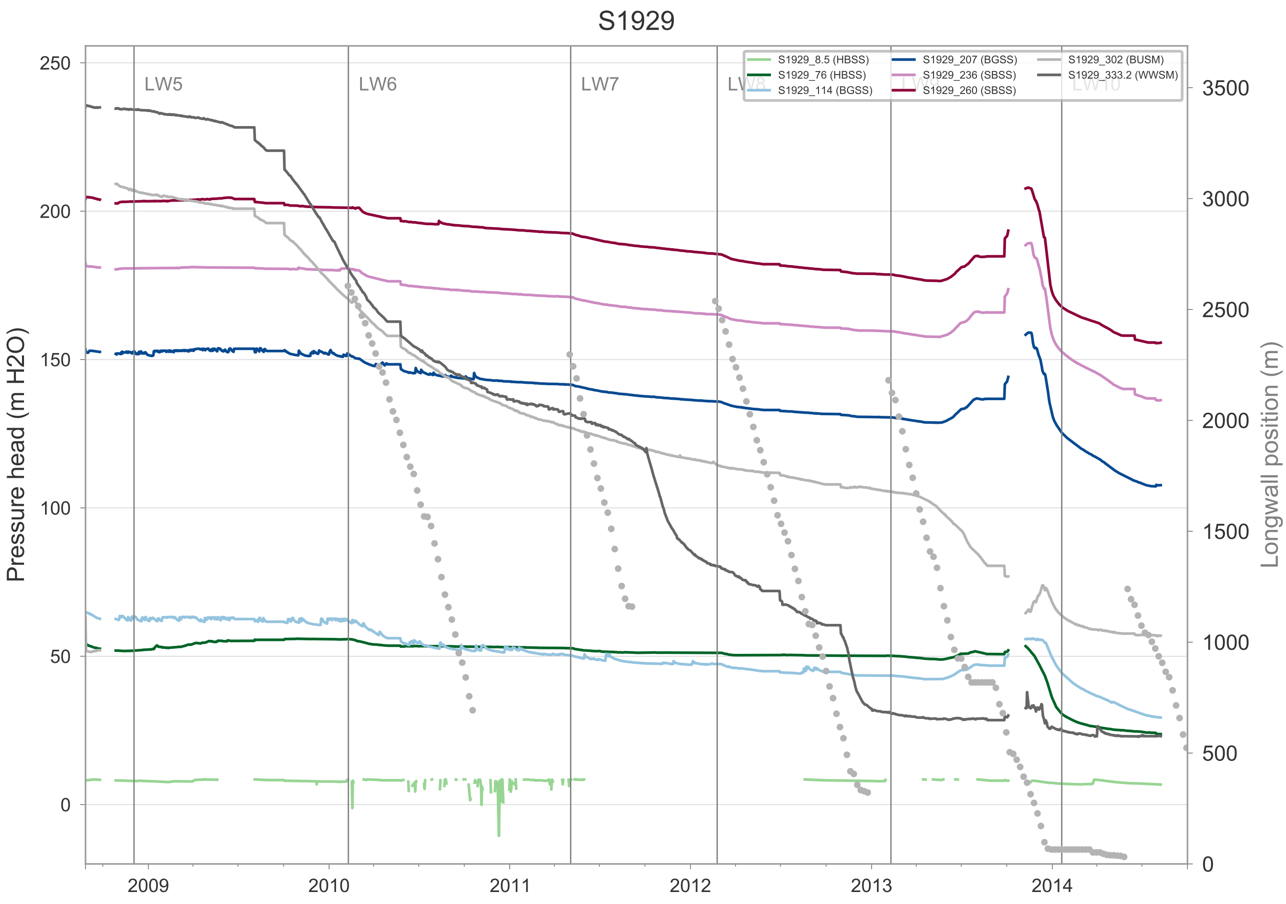

S1926
LW5
LW6
LW7
Pressure head (m H2O)
Longwall position (m)
S1926_10 (HBSS)
S1926_139 (HBSS)
S1926_192 (BGSS)
S1926_289 (BGSS)
S1926_313.5 (SBSS)
S1926_337.5 (SBSS)
S1926_378.4 (BUSM)
S1926_408.3 (WWSM)
2009
2010
2011
2012
2013
2014

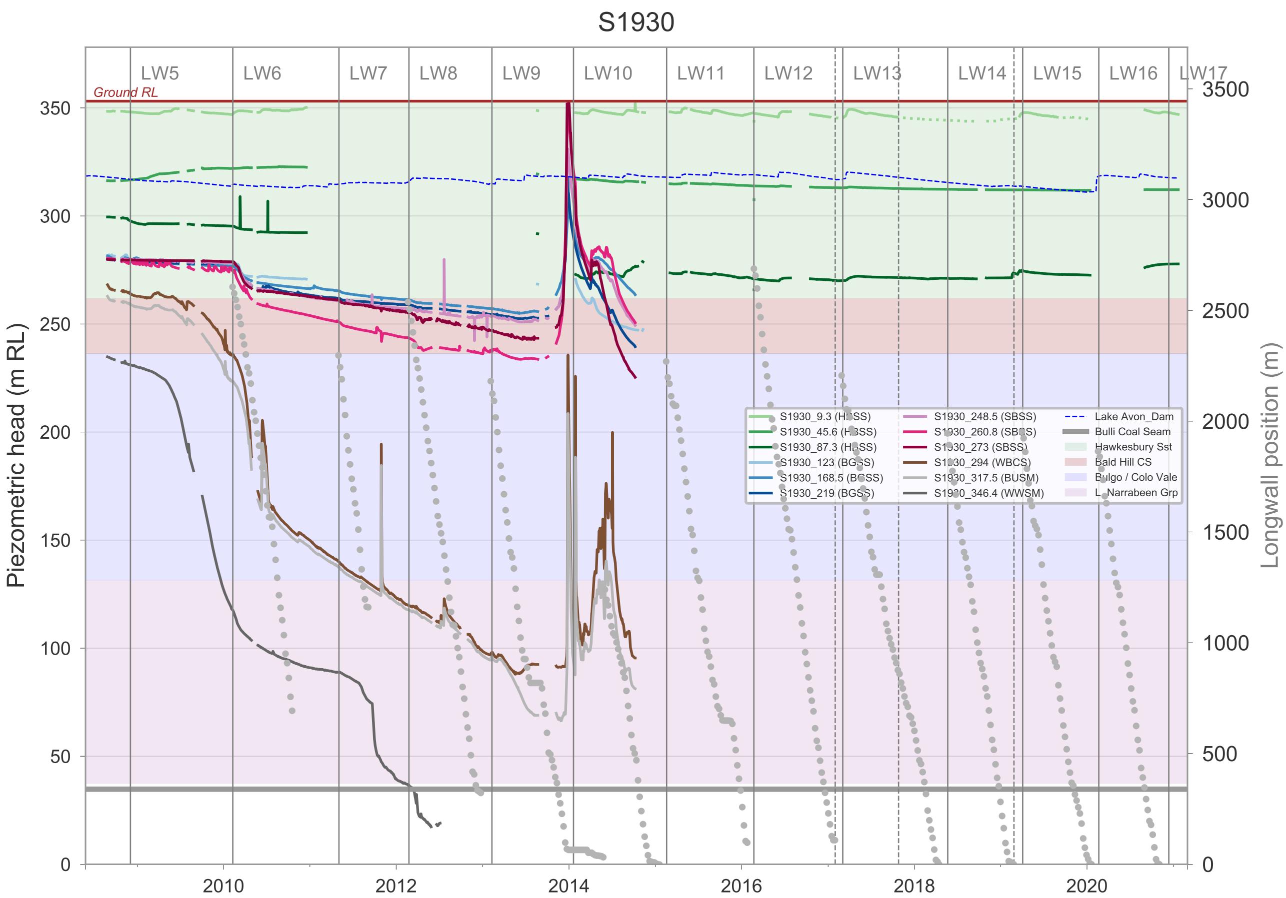

S1927
LW5
LW6
LW7
LW8
LW9
LW10
LW11
LW12
Ground RL
Piezometric head (m RL)
Longwall position (m)
S1927_9.4 (HBSS)
S1927_133 (HBSS)
S1927_176 (BGSS)
S1927_254 (BGSS)
S1927_270 (SBSS)
S1927_316 (SBSS)
S1927_360.4 (BUSM)
S1927_388.4 (WWSM)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
2009
2010
2011
2012
2013
2014
2015
2016
2017

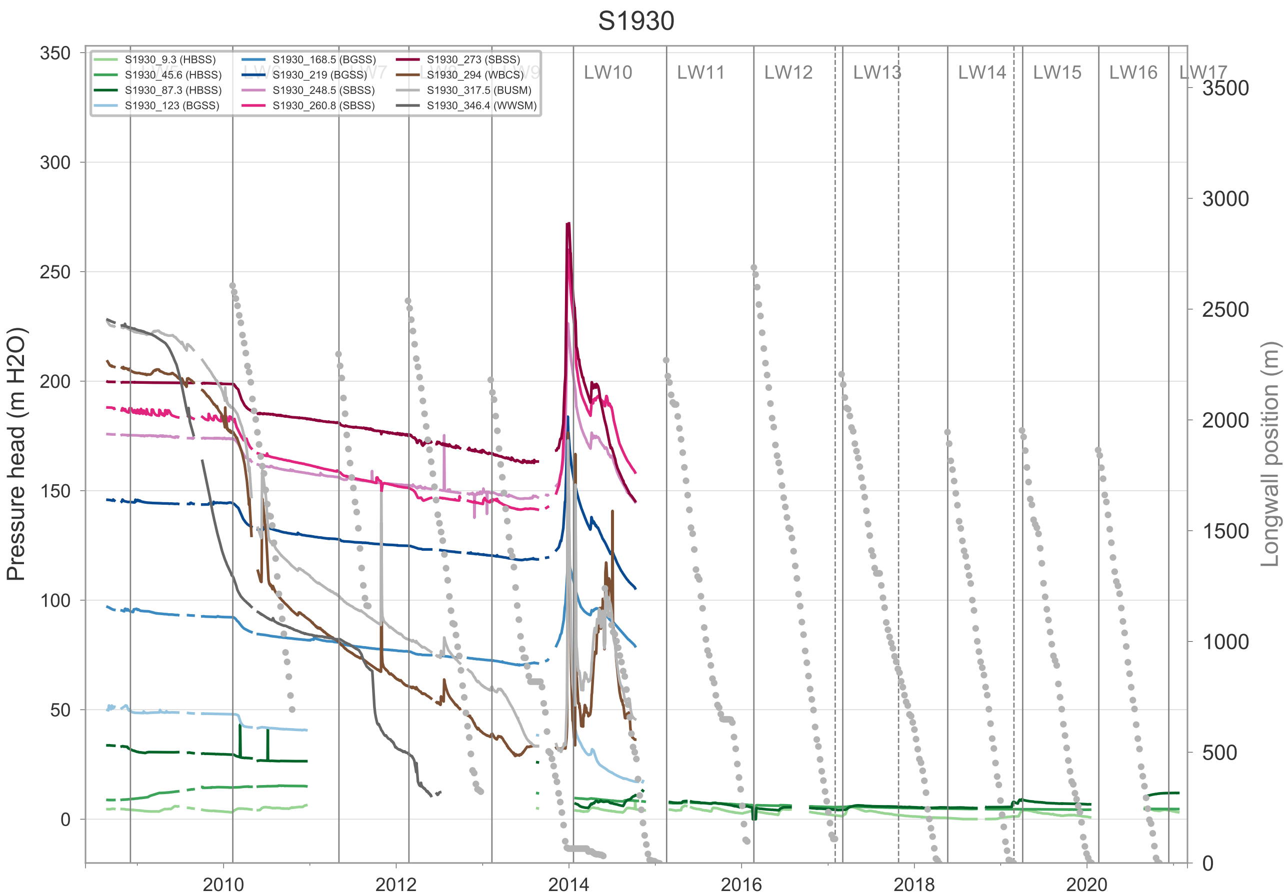

S1927
LW8
LW9
LW10
LW11
LW12
Pressure head (m H2O)
Longwall position (m)
S1927_9.4 (HBSS)
S1927_133 (HBSS)
S1927_176 (BGSS)
S1927_254 (BGSS)
S1927_270 (SBSS)
S1927_316 (SBSS)
S1927_360.4 (BUSM)
S1927_388.4 (WWSM)
2009
2010
2011
2012
2013
2014
2015
2016
2017

Groundwater hydrographs

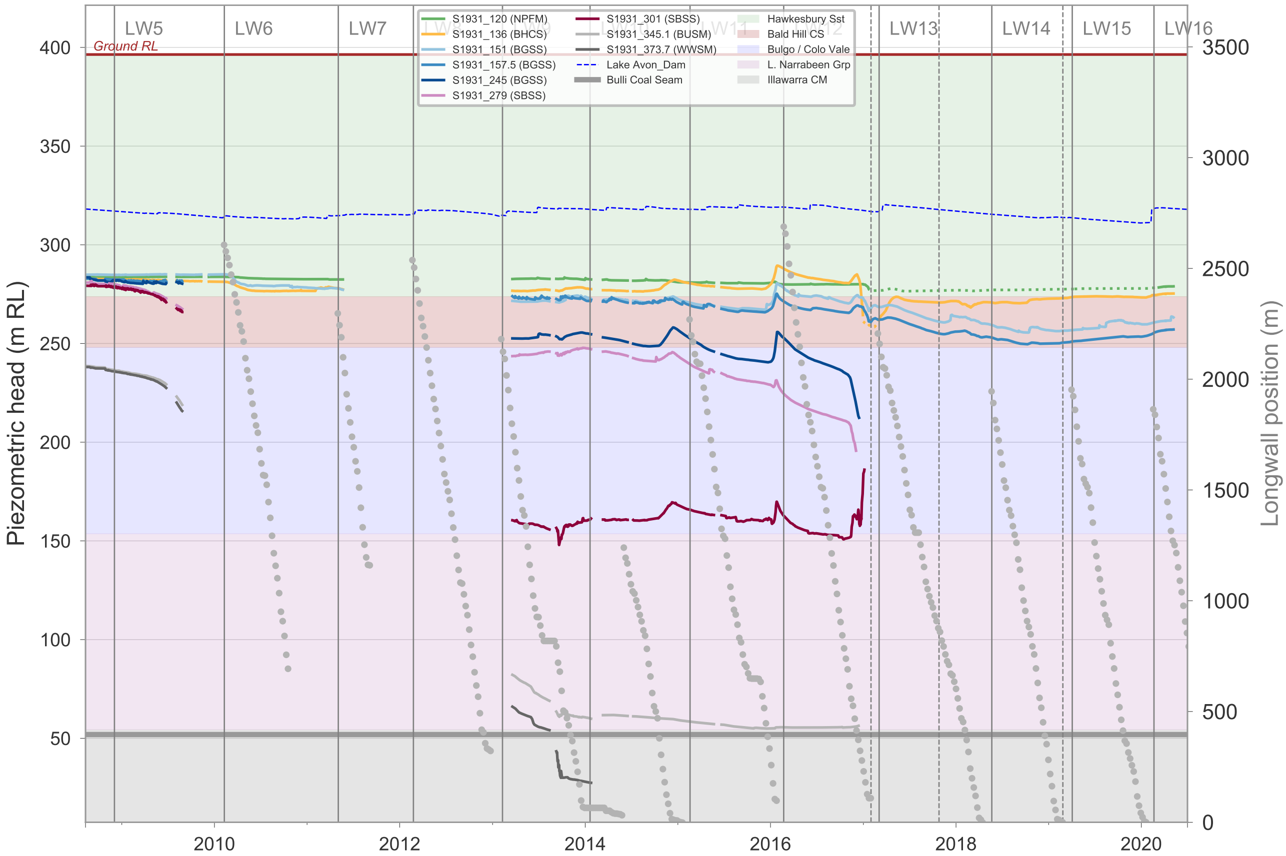




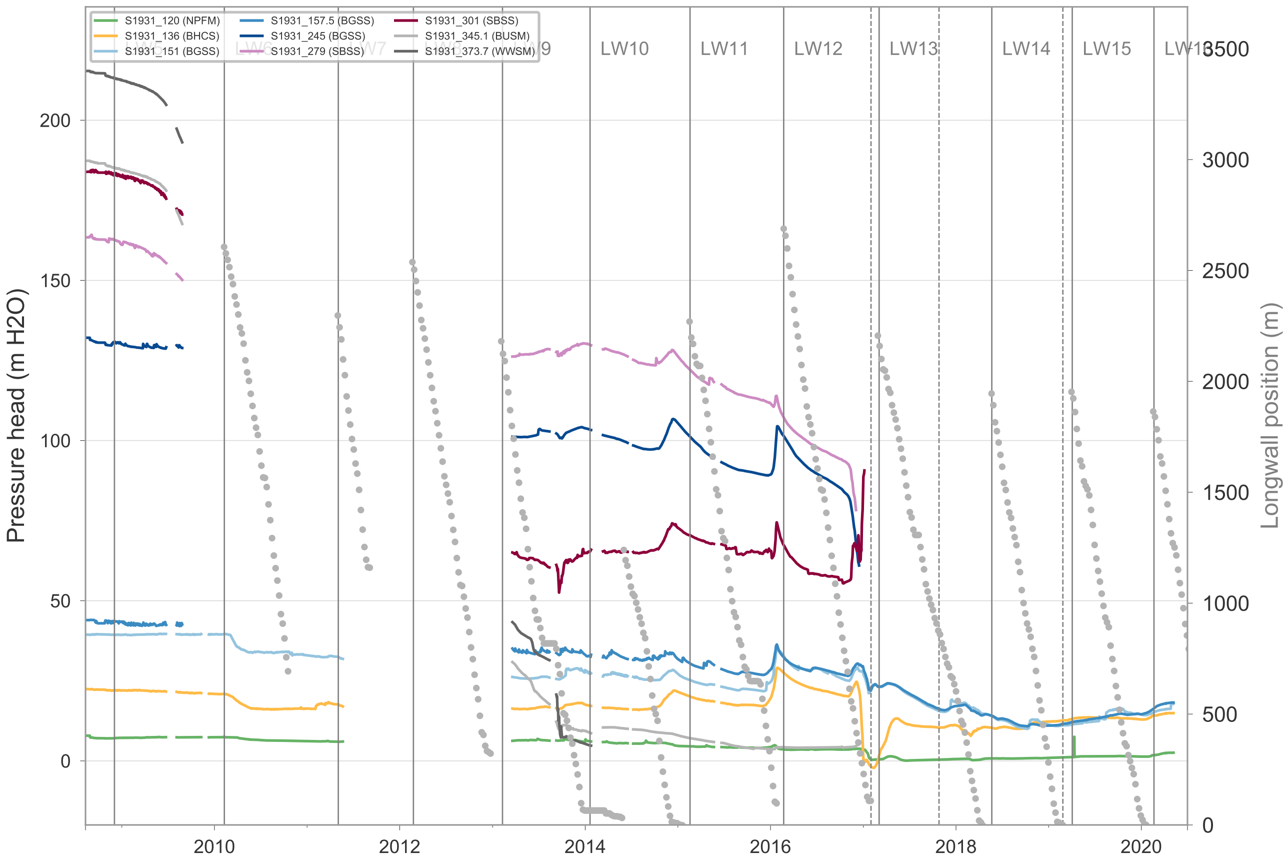

S1930
LW5
LW6
LW7
LW8
LW9
LW10
LW11
LW12
LW13
LW14
LW15
LW16
LW17
Ground RL
Piezometric head (m RL)
Longwall position (m)
S1930_9.3 (HBSS)
S1930_45.6 (HBSS)
S1930_87.3 (HBSS)
S1930_123 (BGSS)
S1930_168.5 (BGSS)
S1930_219 (BGSS)
S1930_248.5 (SBSS)
S1930_260.8 (SBSS)
S1930_273 (SBSS)
S1930_294 (WBCS)
S1930_317.5 (BUSM)
S1930_346.4 (WWSM)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
0
50
100
150
200
250
300
350
500
1000
1500
2000
2500
3000
3500
2010
2012
2014
2016
2018
2020

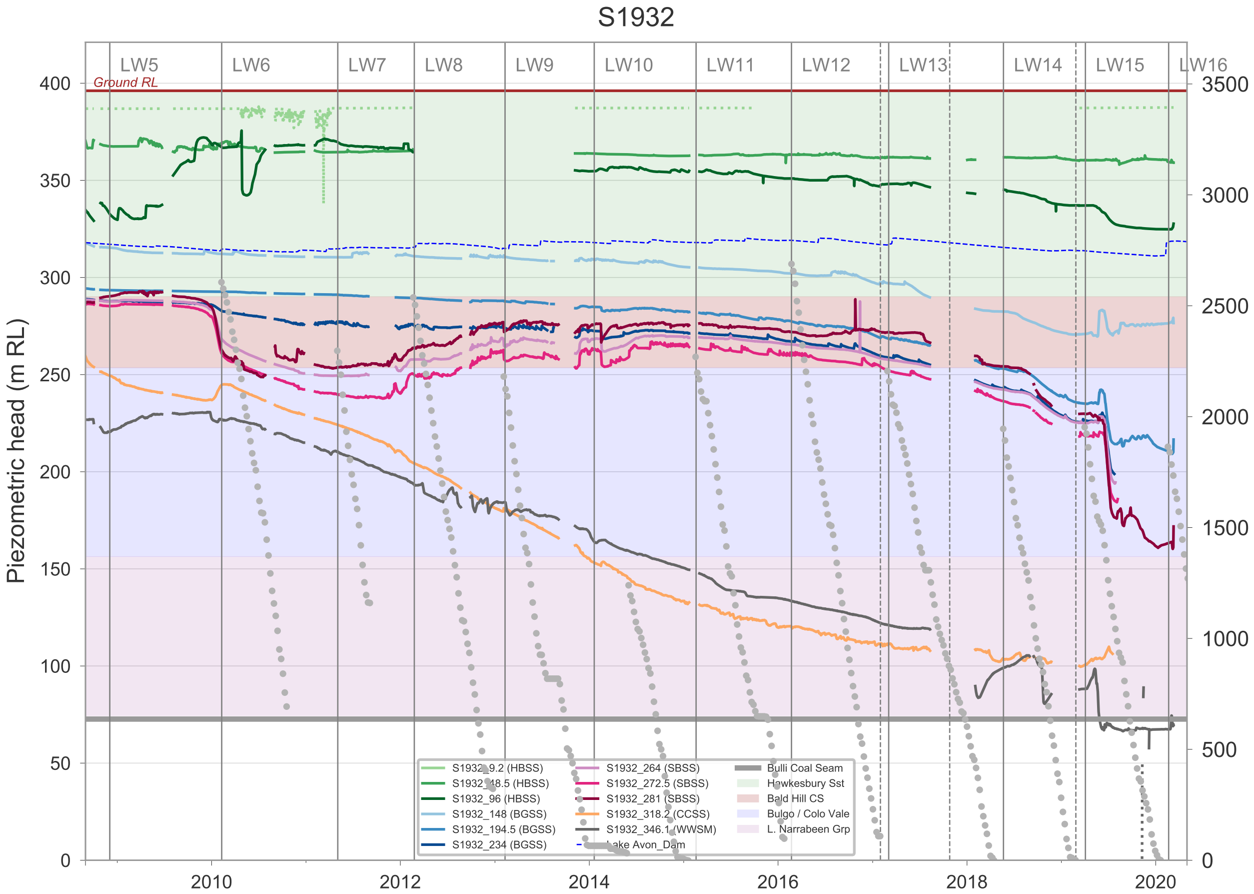

S1930
LW10
LW11
LW12
LW13
LW14
LW15
LW16
LW17
Pressure head (m H2O)
Longwall position (m)
S1930_9.3 (HBSS)
S1930_45.6 (HBSS)
S1930_87.3 (HBSS)
S1930_123 (BGSS)
S1930_168.5 (BGSS)
S1930_219 (BGSS)
S1930_248.5 (SBSS)
S1930_260.8 (SBSS)
S1930_273 (SBSS)
S1930_294 (WBCS)
S1930_317.5 (BUSM)
S1930_346.4 (WWSM)
0
50
100
150
200
250
300
350
500
1000
1500
2000
2500
3000
3500
2010
2012
2014
2016
2018
2020

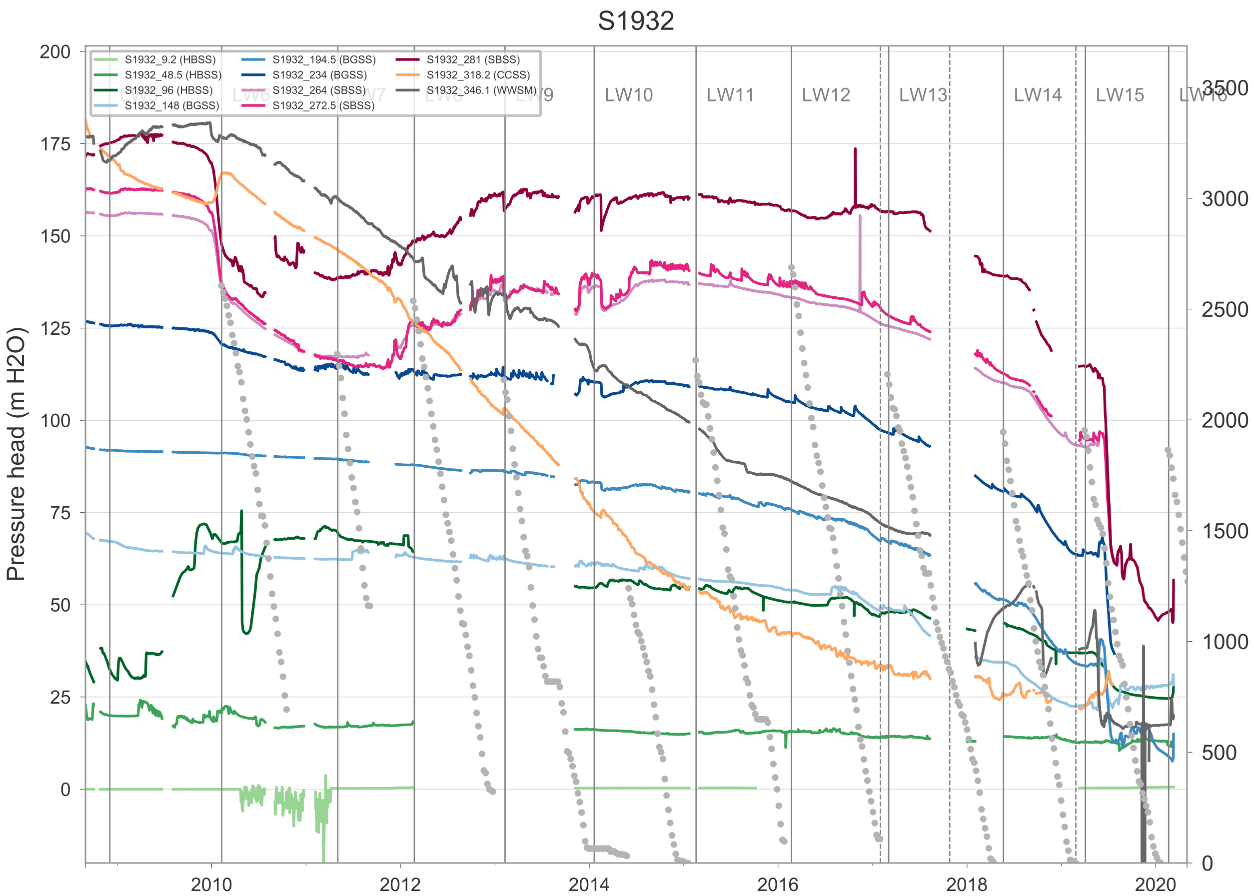
S1931

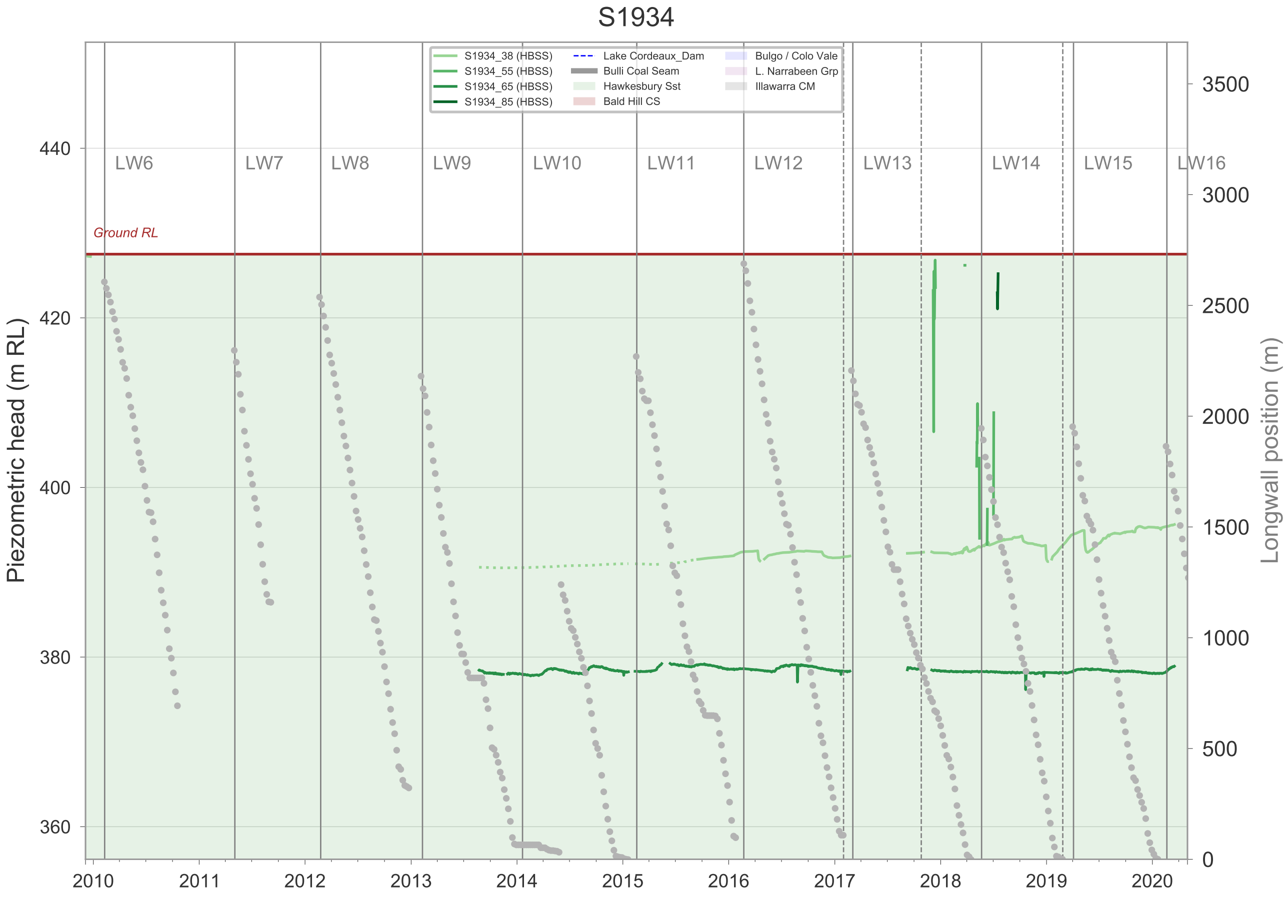

LW5
LW6
LW7
LW13
LW14
LW15
LW16
Ground RL
S1931_120 (NPFM)
S1931_136 (BHCS)
S1931_151 (BGSS)
S1931_157.5 (BGSS)
S1931_245 (BGSS)
S1931_279 (SBSS)
S1931_301 (SBSS)
S1931_345.1 (BUSM)
S1931_373.7 (WWSM)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
Piezometric head (m RL)
Longwall position (m)
2010
2012
2014
2016
2018
2020

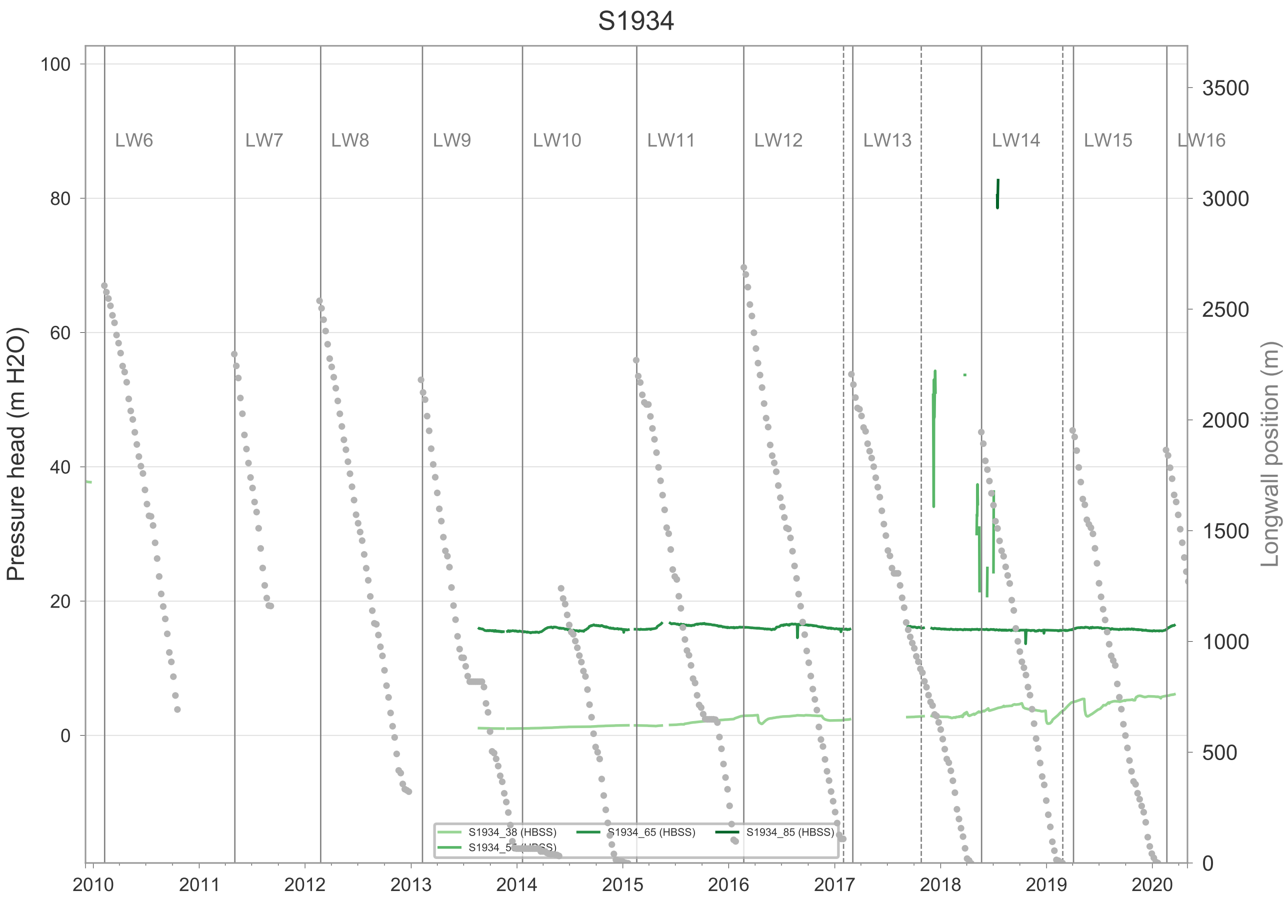
S1931

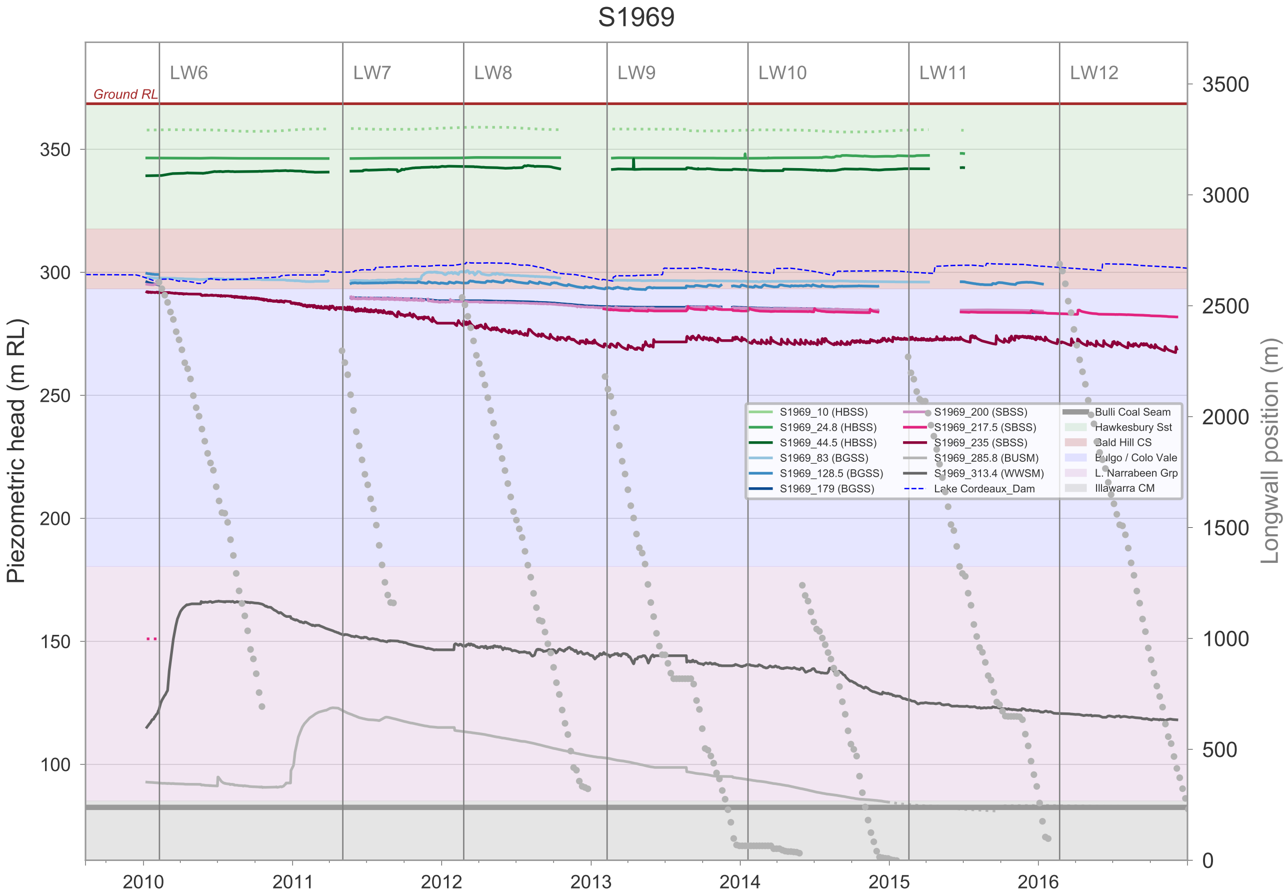

S1931_120 (NPFM)
S1931_136 (BHCS)
S1931_151 (BGSS)
S1931_157.5 (BGSS)
S1931_245 (BGSS)
S1931_279 (SBSS)
S1931_301 (SBSS)
S1931_345.1 (BUSM)
S1931_373.7 (WWSM)
LW10
LW11
LW12
LW13
LW14
LW15
LW16
Pressure head (m H2O)
Longwall position (m)
2010
2012
2014
2016
2018
2020

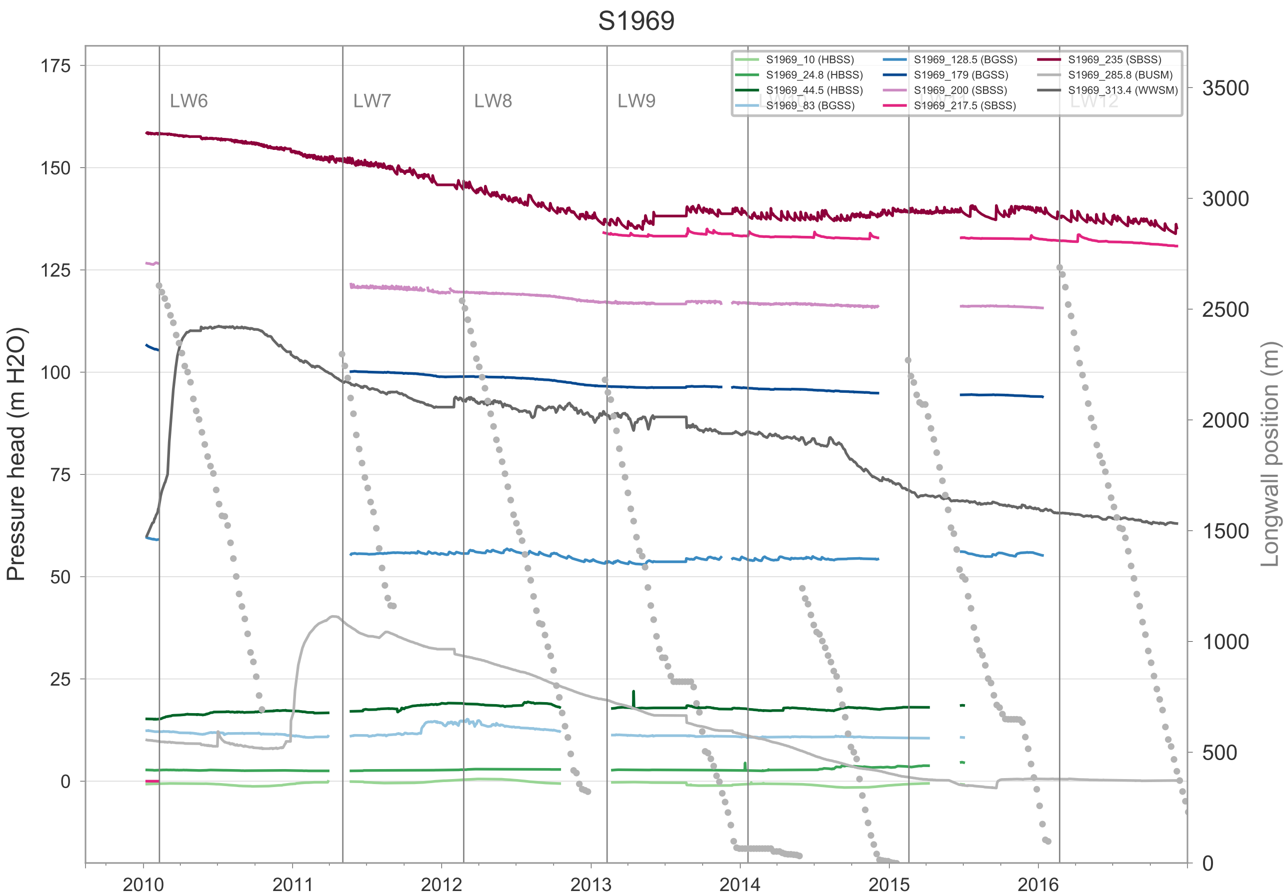

S1932
LW5
LW6
LW7
LW8
LW9
LW10
LW11
LW12
LW13
LW14
LW15
LW16
Ground RL
Piezometric head (m RL)
Longwall position (m)
S1932_9.2 (HBSS)
S1932_48.5 (HBSS)
S1932_96 (HBSS)
S1932_148 (BGSS)
S1932_194.5 (BGSS)
S1932_234 (BGSS)
S1932_264 (SBSS)
S1932_272.5 (SBSS)
S1932_281 (SBSS)
S1932_318.2 (CCSS)
S1932_346.1 (WWSM)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
2010
2012
2014
2016
2018
2020

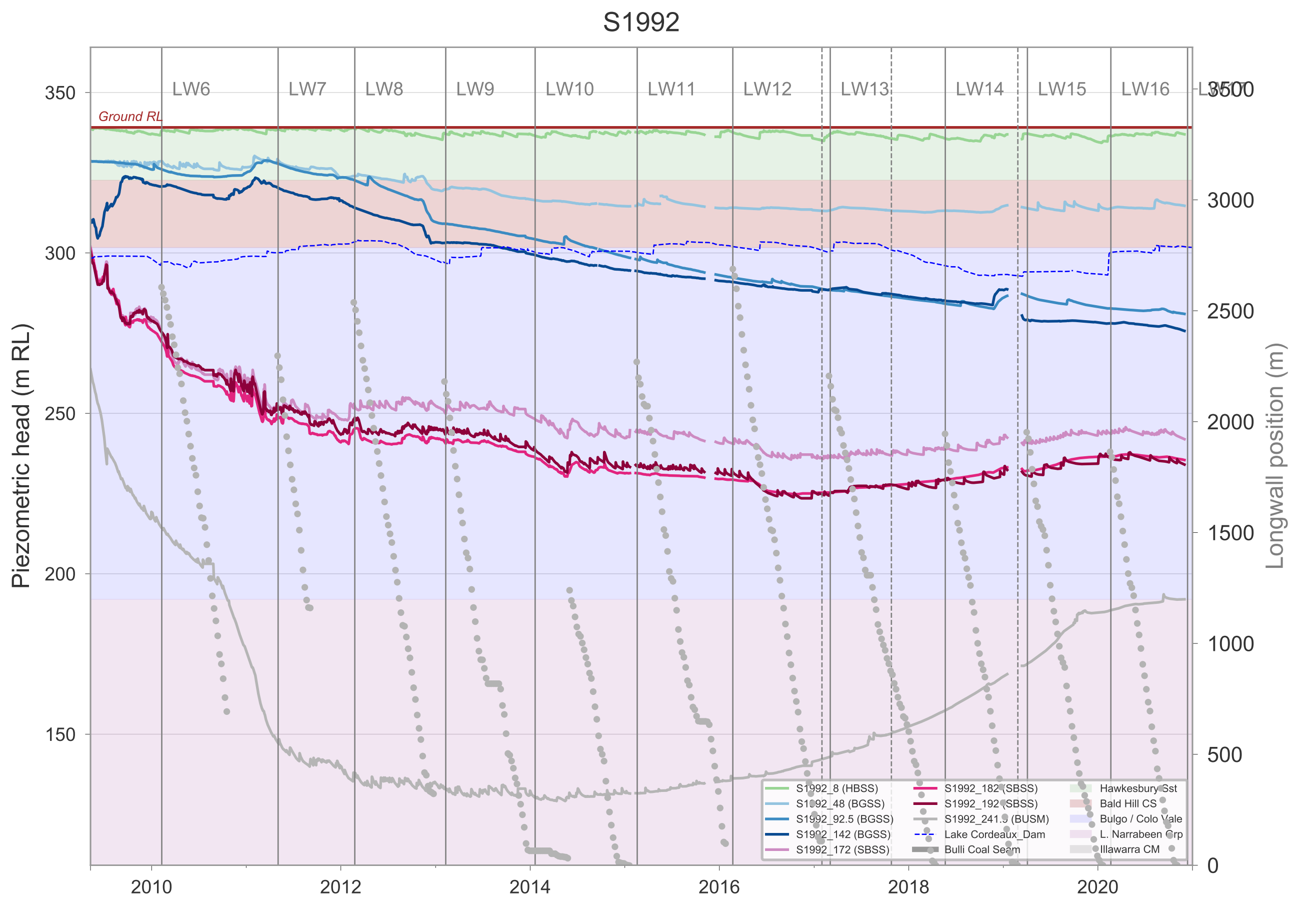

S1932
S1932_9.2 (HBSS)
S1932_48.5 (HBSS)
S1932_96 (HBSS)
S1932_148 (BGSS)
S1932_194.5 (BGSS)
S1932_234 (BGSS)
S1932_264 (SBSS)
S1932_272.5 (SBSS)
S1932_281 (SBSS)
S1932_318.2 (CCSS)
S1932_346.1 (WWSM)
LW10
LW11
LW12
LW13
LW14
LW15
LW16
Pressure head (m H2O)
Longwall position (m)
2010
2012
2014
2016
2018
2020

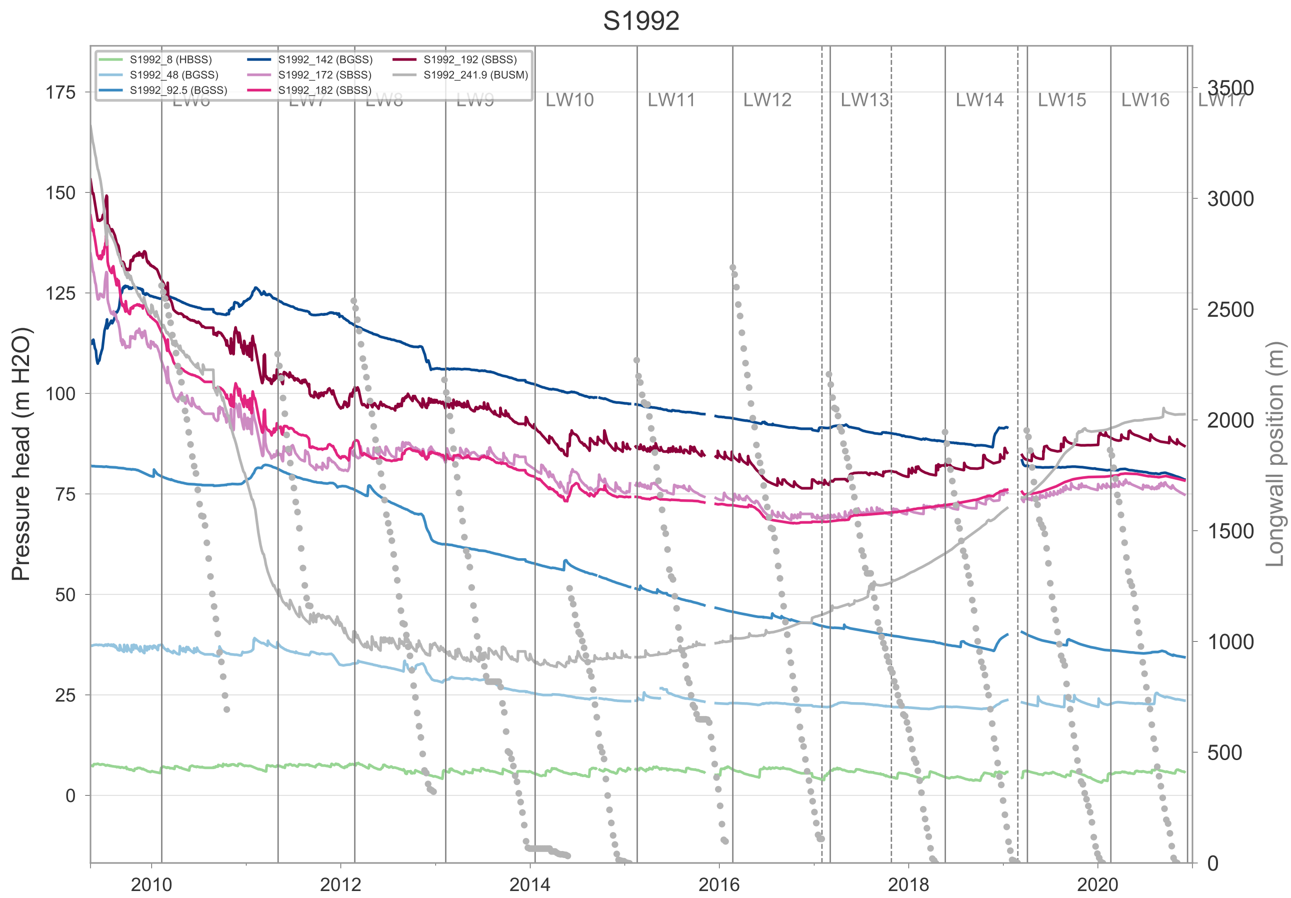

S1934
S1934_38 (HBSS)
S1934_55 (HBSS)
S1934_65 (HBSS)
S1934_85 (HBSS)
Lake Cordeaux_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
LW6
LW7
LW8
LW9
LW10
LW11
LW12
LW13
LW14
LW15
LW16
Ground RL
Piezometric head (m RL)
Longwall position (m)
440
420
400
380
360
3500
3000
2500
2000
1500
1000
500
0
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020

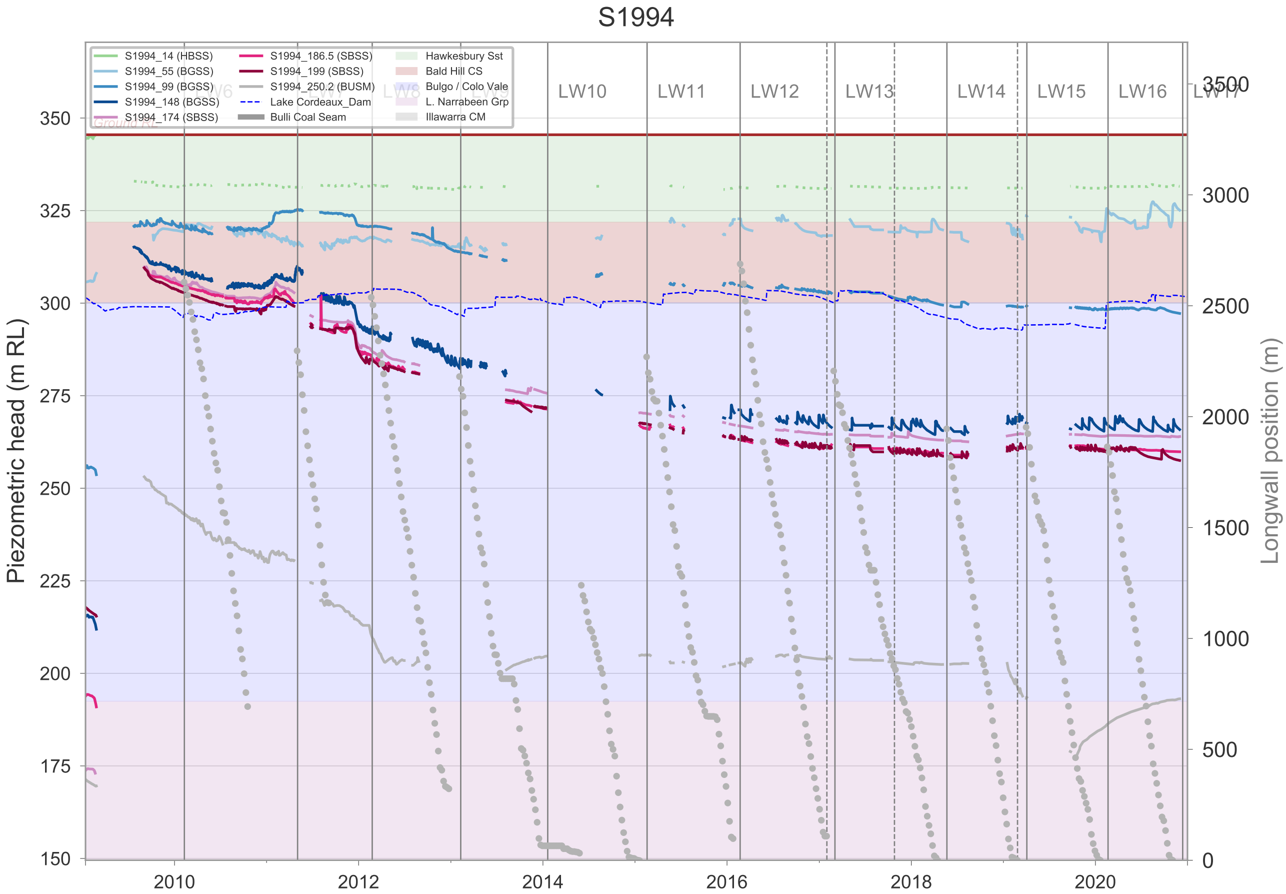

S1934
LW6
LW7
LW8
LW9
LW10
LW11
LW12
LW13
LW14
LW15
LW16
Pressure head (m H2O)
Longwall position (m)
100
80
60
40
20
0
3500
3000
2500
2000
1500
1000
500
0
S1934_38 (HBSS)
S1934_65 (HBSS)
S1934_85 (HBSS)
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020

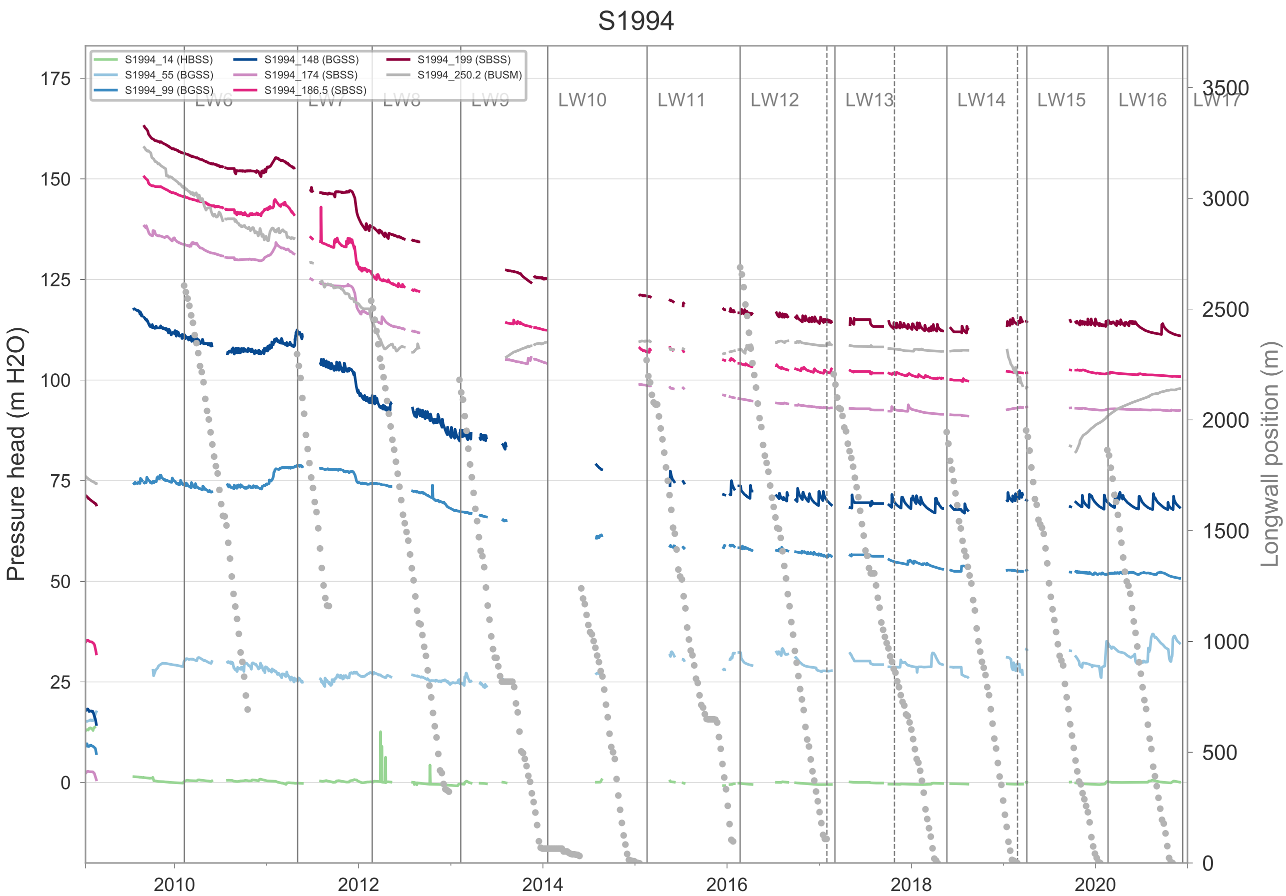

S1969
LW6
LW7
LW8
LW9
LW10
LW11
LW12
Ground RL
Piezometric head (m RL)
Longwall position (m)
S1969_10 (HBSS)
S1969_24.8 (HBSS)
S1969_44.5 (HBSS)
S1969_83 (BGSS)
S1969_128.5 (BGSS)
S1969_179 (BGSS)
S1969_200 (SBSS)
S1969_217.5 (SBSS)
S1969_235 (SBSS)
S1969_285.8 (BUSM)
S1969_313.4 (WWSM)
Lake Cordeaux_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
2010
2011
2012
2013
2014
2015
2016

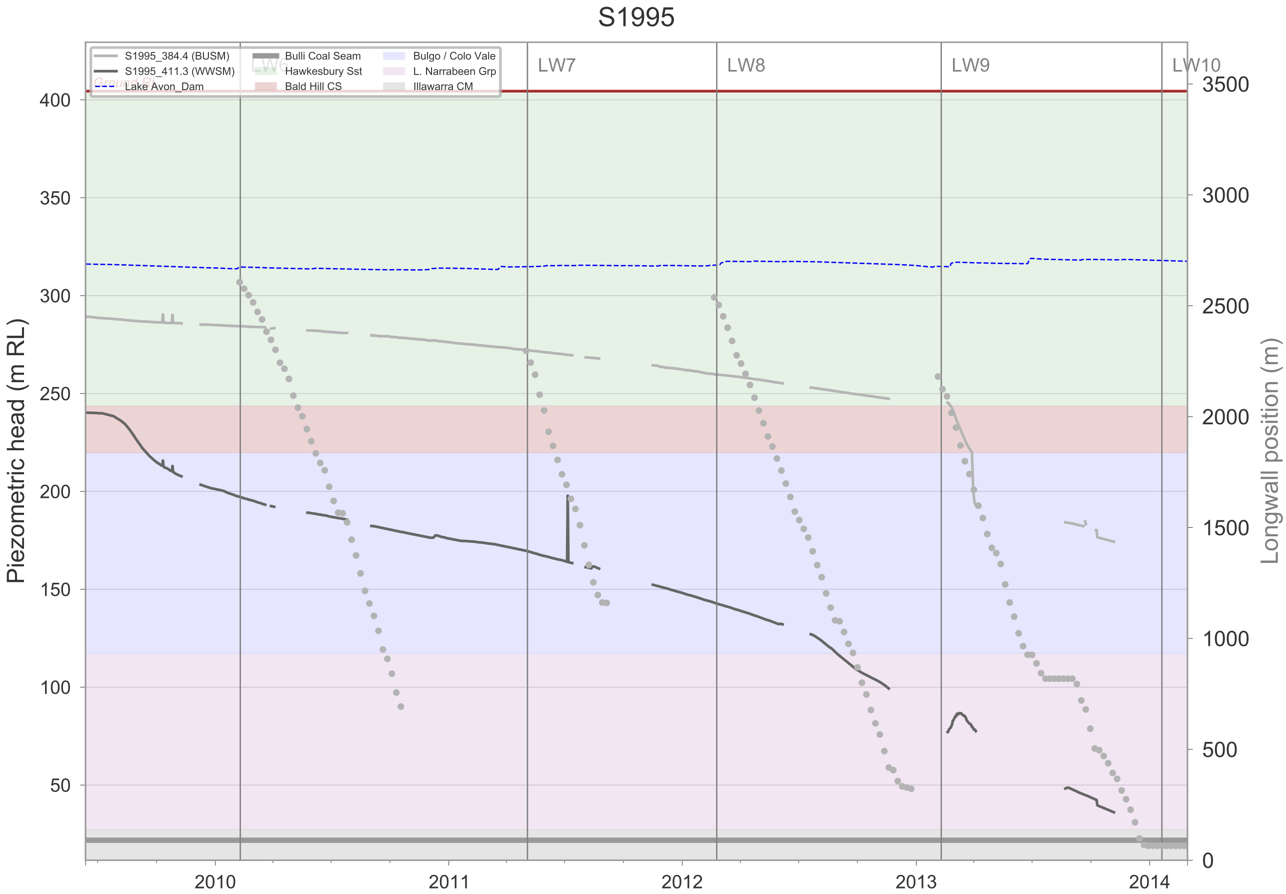

S1969
LW6
LW7
LW8
LW9
LW12
Pressure head (m H2O)
Longwall position (m)
S1969_10 (HBSS)
S1969_24.8 (HBSS)
S1969_44.5 (HBSS)
S1969_83 (BGSS)
S1969_128.5 (BGSS)
S1969_179 (BGSS)
S1969_200 (SBSS)
S1969_217.5 (SBSS)
S1969_235 (SBSS)
S1969_285.8 (BUSM)
S1969_313.4 (WWSM)
2010
2011
2012
2013
2014
2015
2016

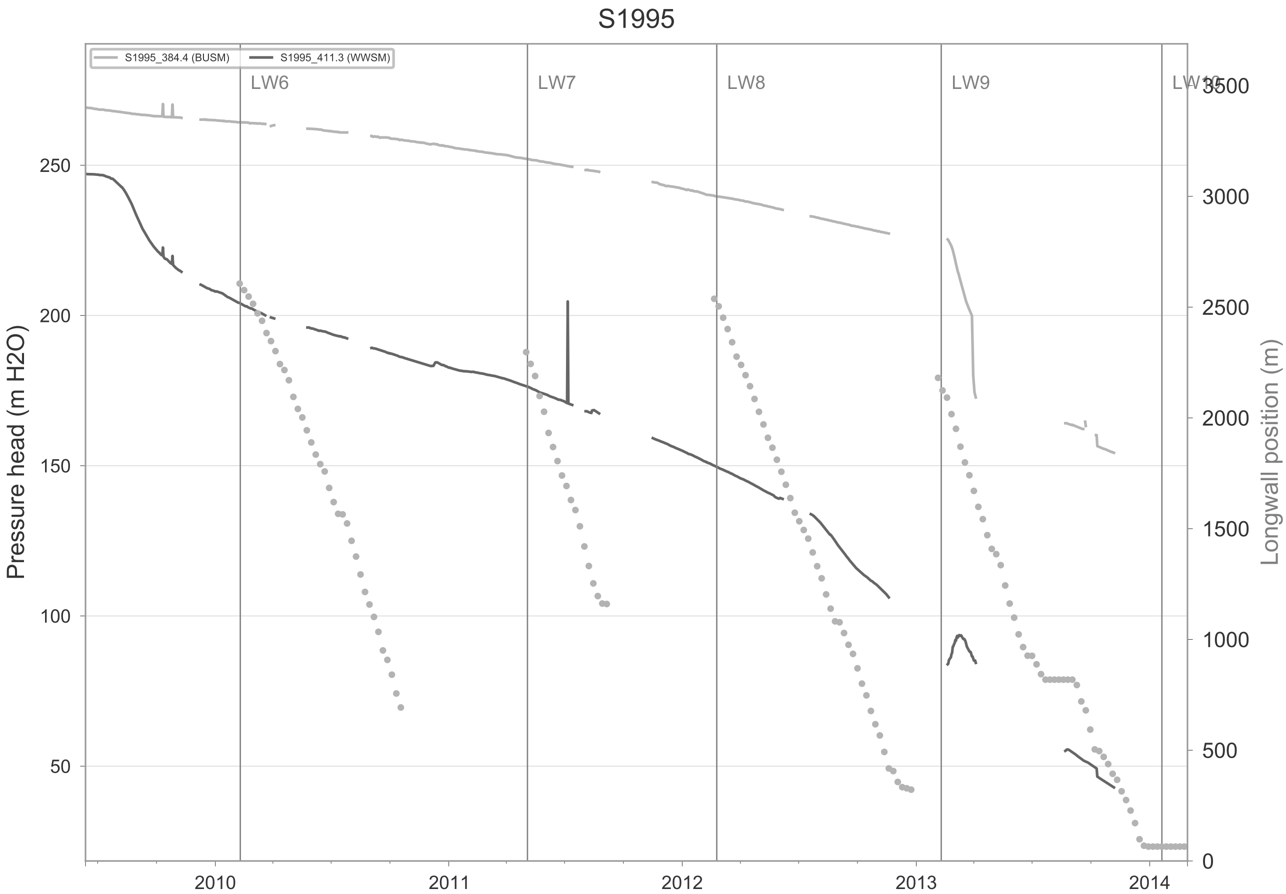

S1992
LW6
LW7
LW8
LW9
LW10
LW11
LW12
LW13
LW14
LW15
LW16
LW17
Ground RL
Piezometric head (m RL)
Longwall position (m)
S1992_8 (HBSS)
S1992_48 (BGSS)
S1992_92.5 (BGSS)
S1992_142 (BGSS)
S1992_172 (SBSS)
S1992_182 (SBSS)
S1992_192 (SBSS)
S1992_241.9 (BUSM)
Lake Cordeaux_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
2010
2012
2014
2016
2018
2020

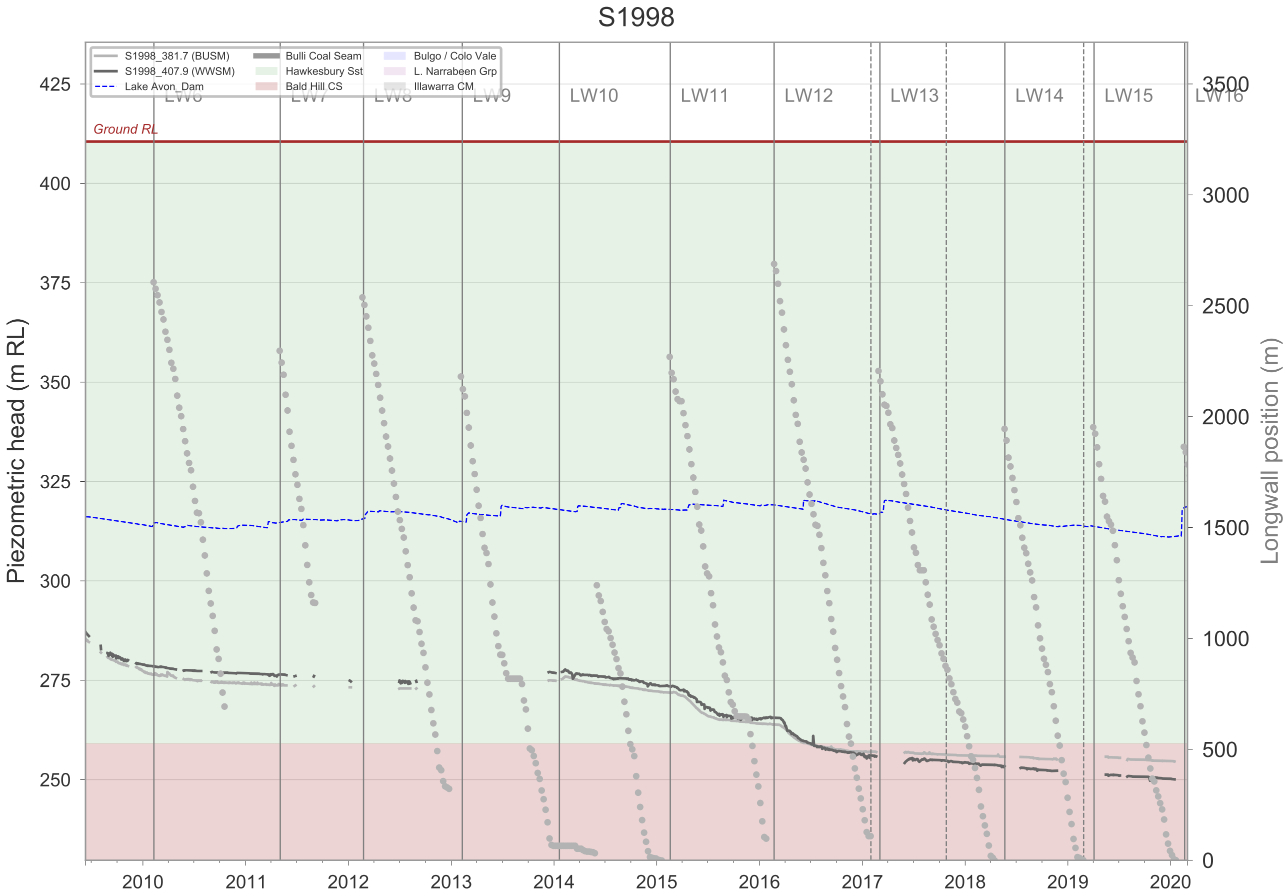

S1992
S1992_8 (HBSS)
S1992_48 (BGSS)
S1992_92.5 (BGSS)
S1992_142 (BGSS)
S1992_172 (SBSS)
S1992_182 (SBSS)
S1992_192 (SBSS)
S1992_241.9 (BUSM)
LW10
LW11
LW12
LW13
LW14
LW15
LW16
LW17
Pressure head (m H2O)
Longwall position (m)
2010
2012
2014
2016
2018
2020

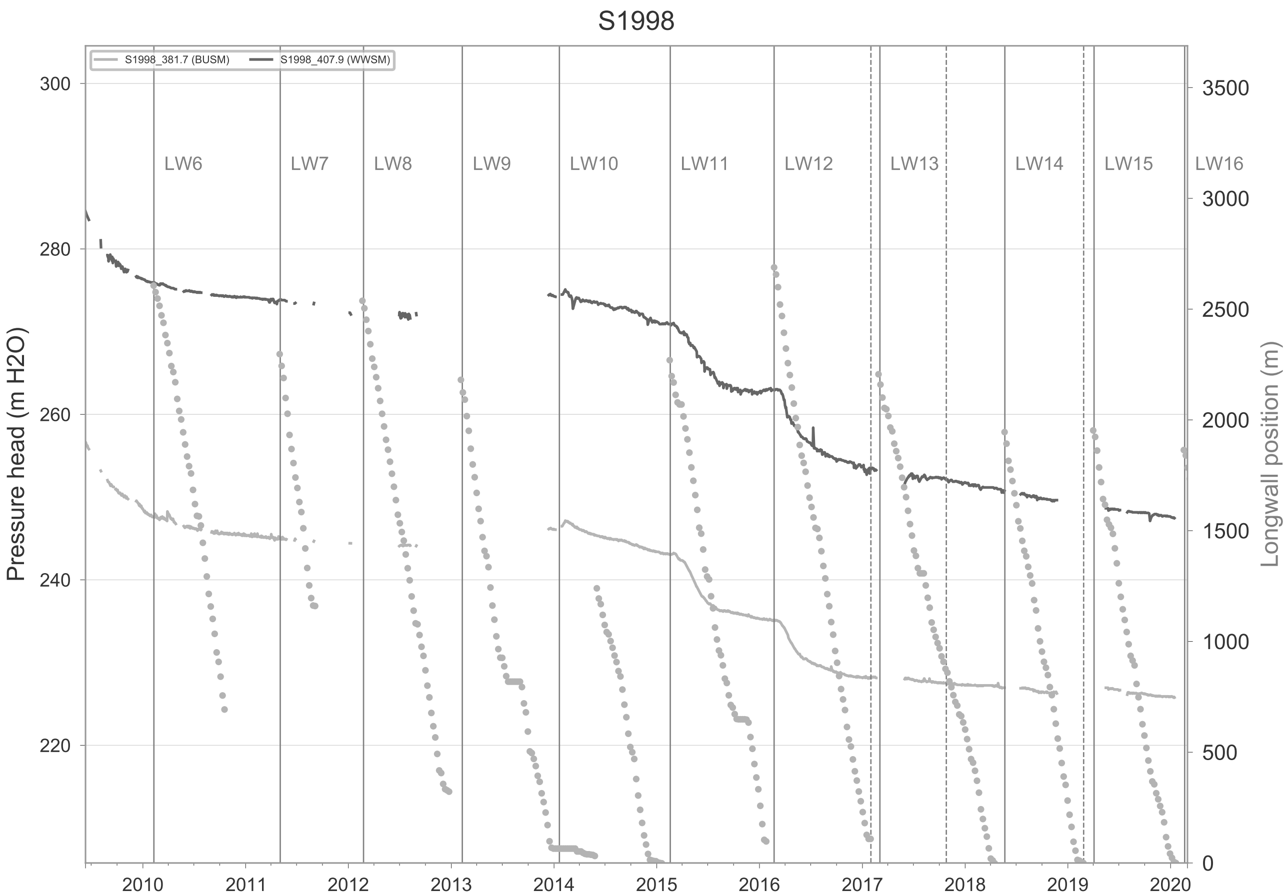

S1994
S1994_14 (HBSS)
S1994_55 (BGSS)
S1994_99 (BGSS)
S1994_148 (BGSS)
S1994_174 (SBSS)
S1994_186.5 (SBSS)
S1994_199 (SBSS)
S1994_250.2 (BUSM)
Lake Cordeaux_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
Ground RL
LW6
LW7
LW8
LW9
LW10
LW11
LW12
LW13
LW14
LW15
LW16
LW17
Piezometric head (m RL)
Longwall position (m)
2010
2012
2014
2016
2018
2020

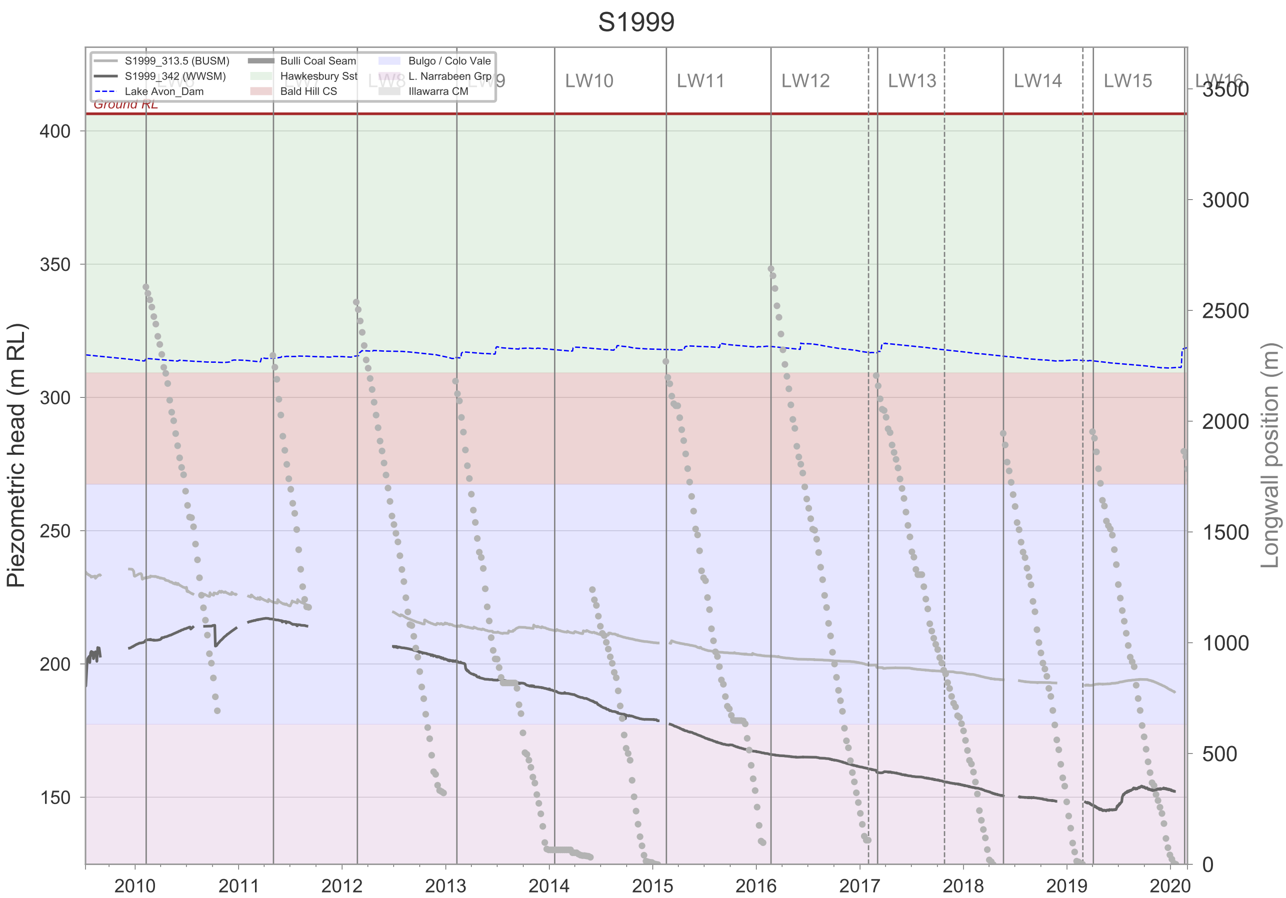

S1994
S1994_14 (HBSS)
S1994_55 (BGSS)
S1994_99 (BGSS)
S1994_148 (BGSS)
S1994_174 (SBSS)
S1994_186.5 (SBSS)
S1994_199 (SBSS)
S1994_250.2 (BUSM)
LW6
LW7
LW8
LW9
LW10
LW11
LW12
LW13
LW14
LW15
LW16
LW17
Pressure head (m H2O)
Longwall position (m)
2010
2012
2014
2016
2018
2020

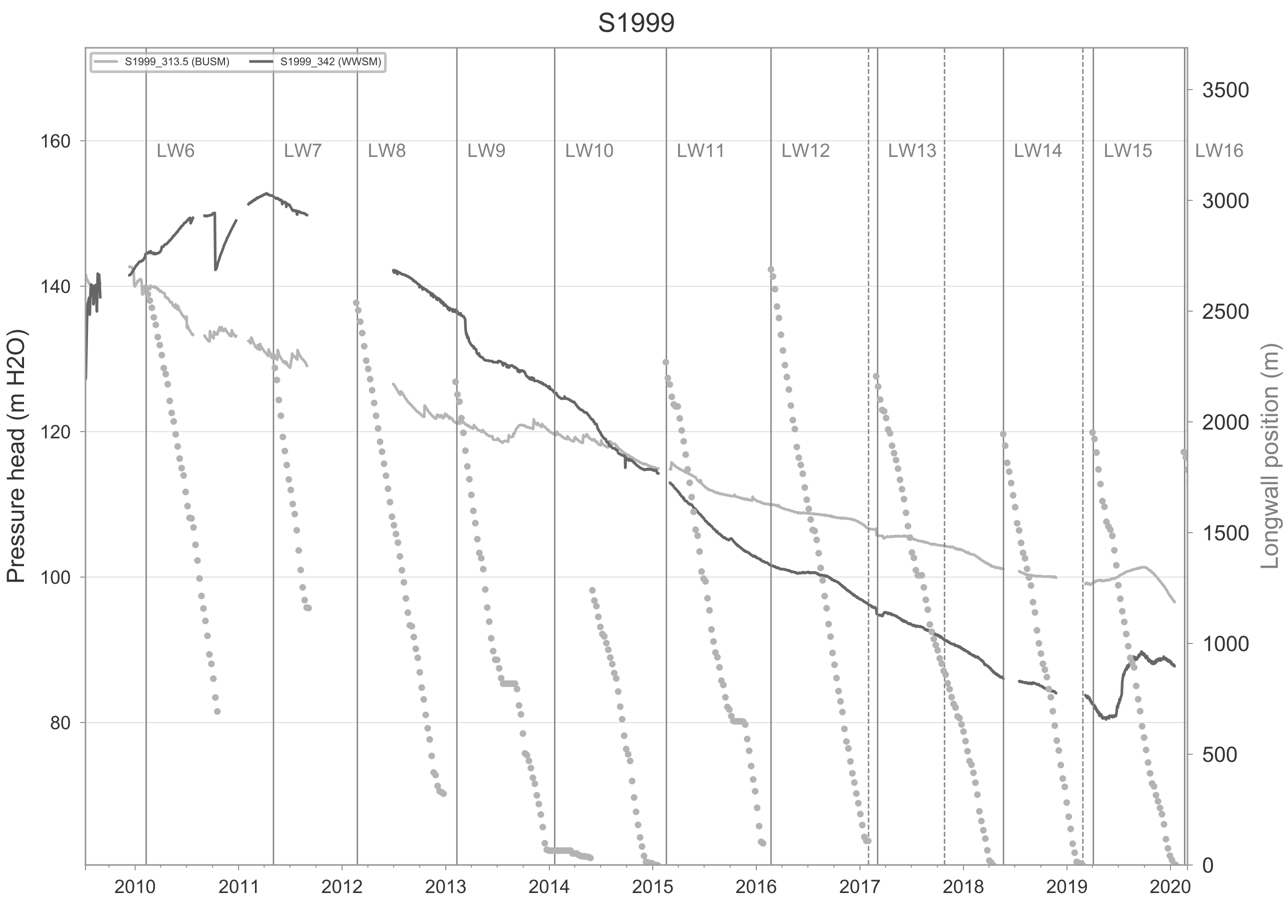

S1995
S1995_384.4 (BUSM)
S1995_411.3 (WWSM)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
LW7
LW8
LW9
LW10
Piezometric head (m RL)
Longwall position (m)
400
350
300
250
200
150
100
50
3500
3000
2500
2000
1500
1000
500
0
2010
2011
2012
2013
2014


S1995
S1995_384.4 (BUSM)
S1995_411.3 (WWSM)
LW6
LW7
LW8
LW9
LW10
Pressure head (m H2O)
Longwall position (m)
250
200
150
100
50
3500
3000
2500
2000
1500
1000
500
0
2010
2011
2012
2013
2014

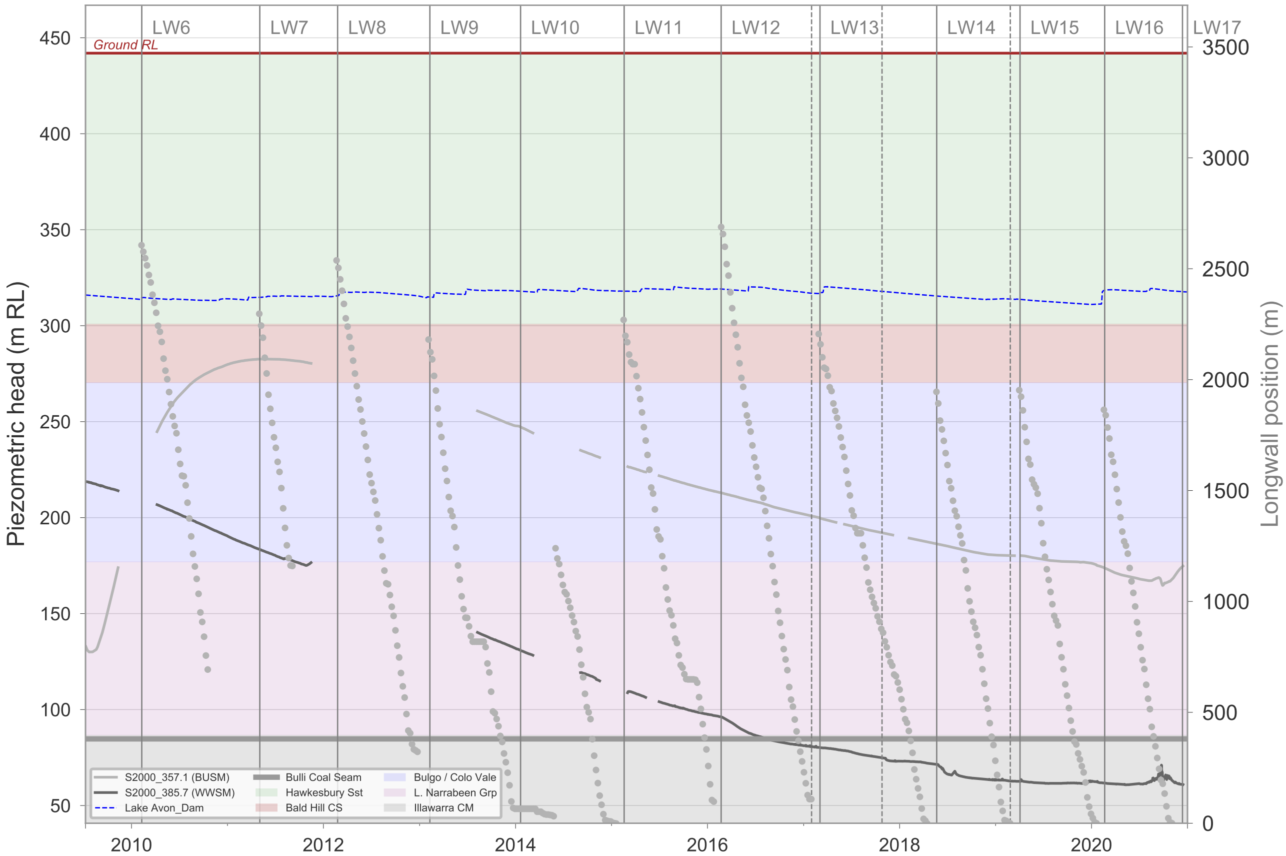

S1998
S1998_381.7 (BUSM)
S1998_407.9 (WWSM)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
Ground RL
LW6
LW7
LW8
LW9
LW10
LW11
LW12
LW13
LW14
LW15
LW16
Piezometric head (m RL)
Longwall position (m)
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020


S1998
S1998_381.7 (BUSM)
S1998_407.9 (WWSM)
LW6
LW7
LW8
LW9
LW10
LW11
LW12
LW13
LW14
LW15
LW16
Pressure head (m H2O)
Longwall position (m)
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020

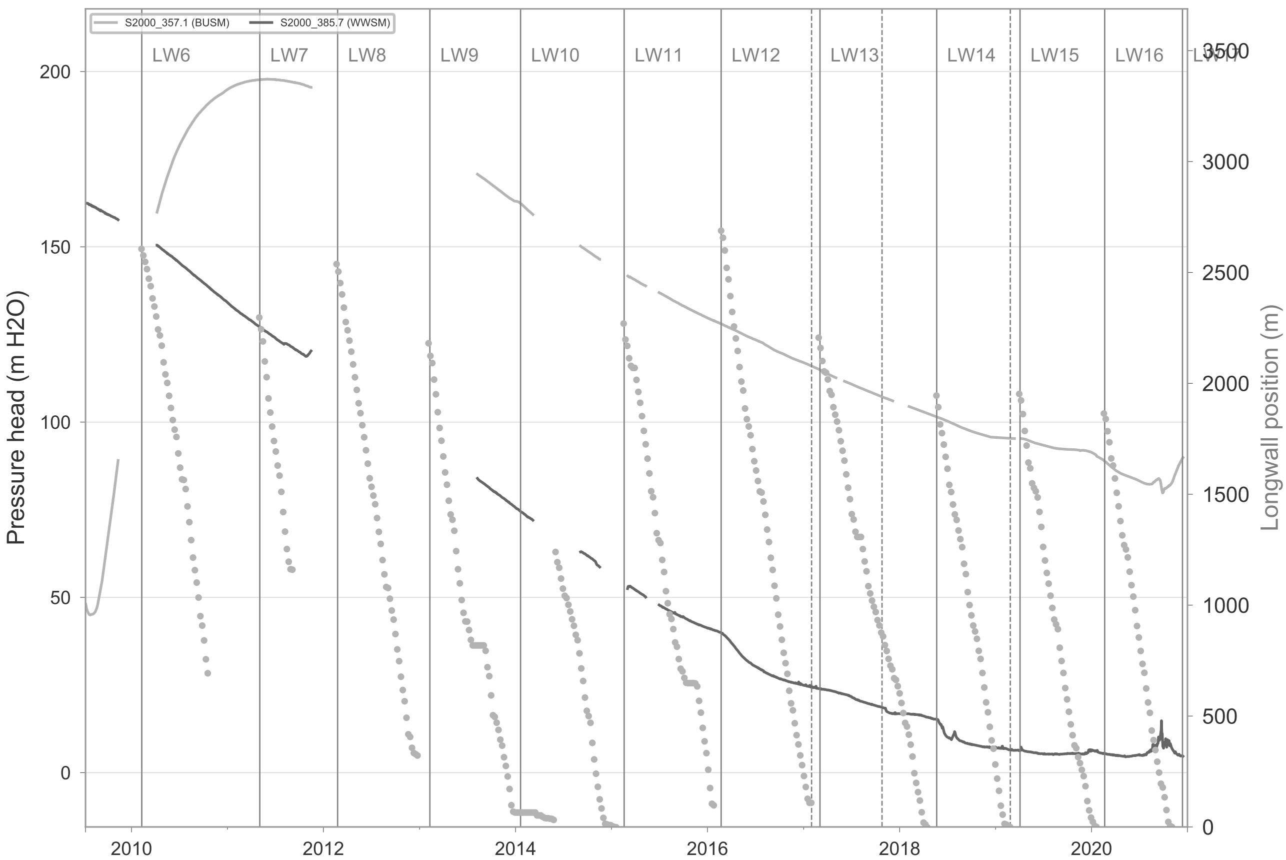

S1999
S1999_313.5 (BUSM)
S1999_342 (WWSM)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
Ground RL
LW10
LW11
LW12
LW13
LW14
LW15
Piezometric head (m RL)
Longwall position (m)
400
350
300
250
200
150
3500
3000
2500
2000
1500
1000
500
0
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020


S1999
S1999_313.5 (BUSM)
S1999_342 (WWSM)
LW6
LW7
LW8
LW9
LW10
LW11
LW12
LW13
LW14
LW15
LW16
Pressure head (m H2O)
Longwall position (m)
160
140
120
100
80
3500
3000
2500
2000
1500
1000
500
0
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020

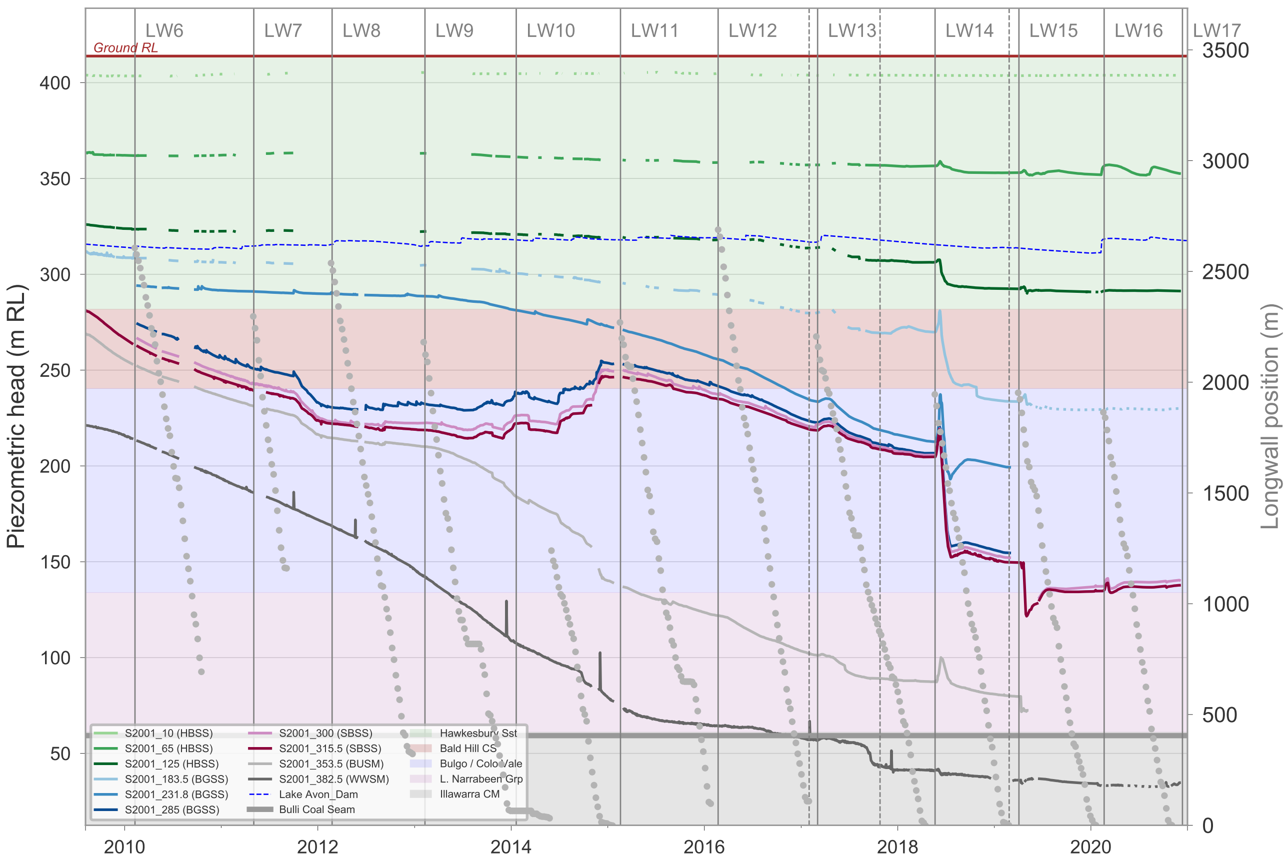
S2000


LW6
LW7
LW8
LW9
LW10
LW11
LW12
LW13
LW14
LW15
LW16
LW17
Ground RL
Piezometric head (m RL)
Longwall position (m)
S2000_357.1 (BUSM)
S2000_385.7 (WWSM)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
2010
2012
2014
2016
2018
2020

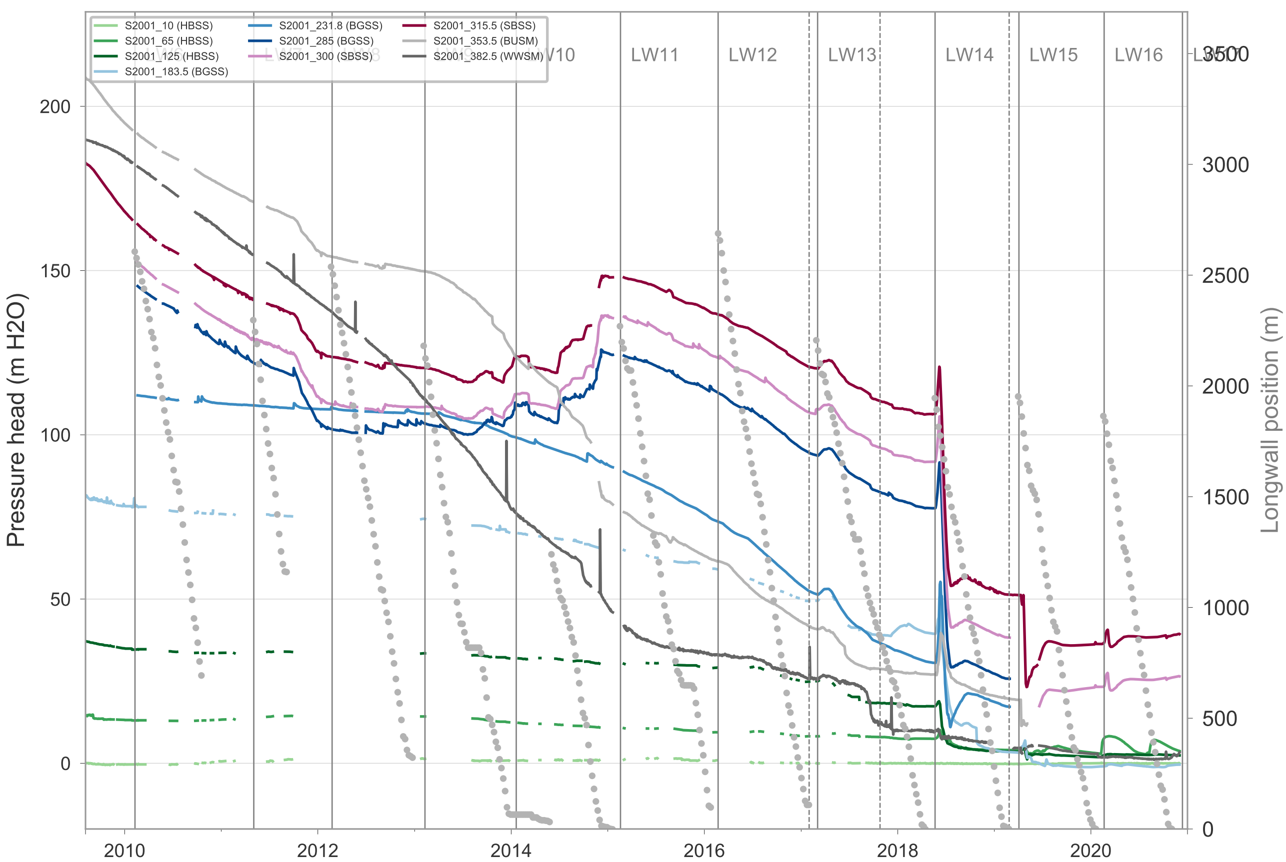
S2000

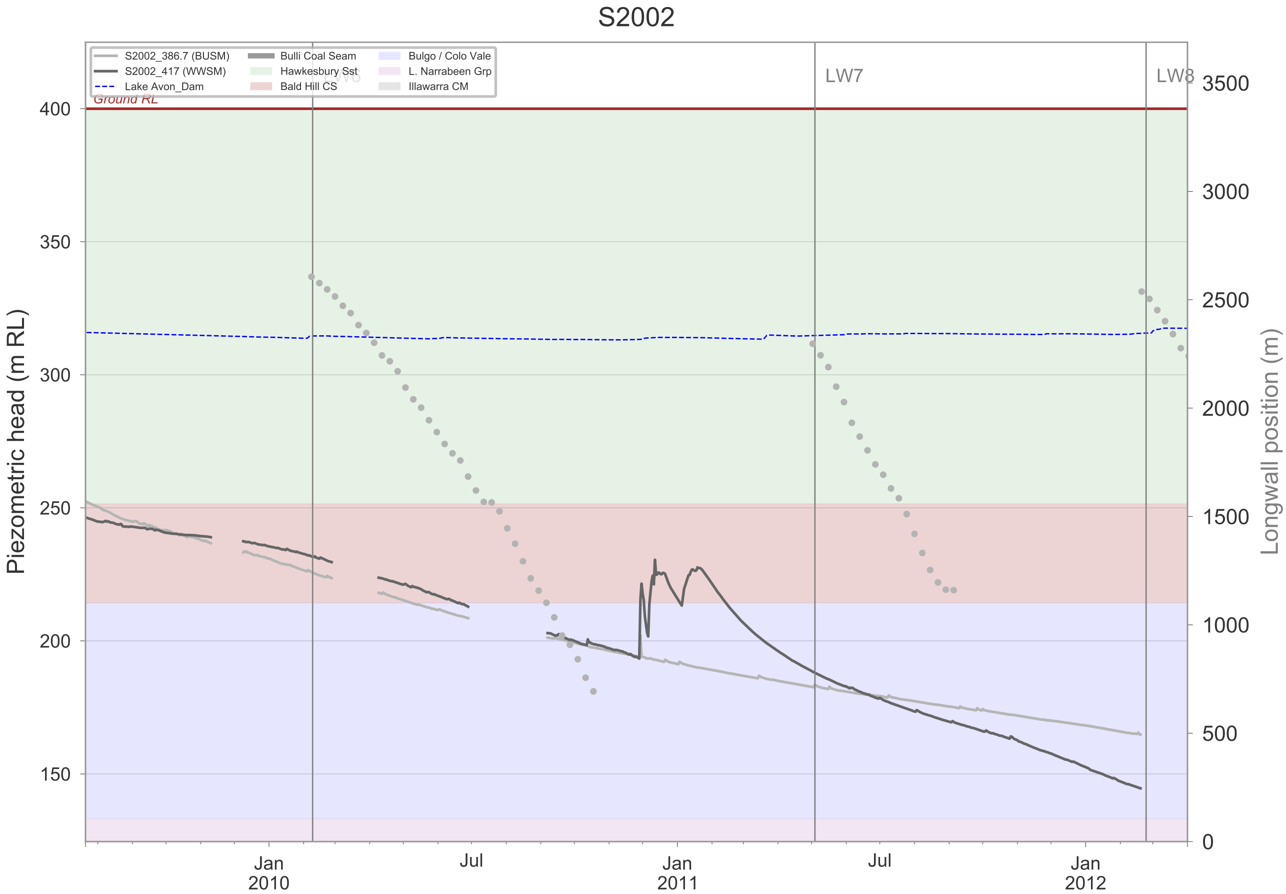

S2000_357.1 (BUSM)
S2000_385.7 (WWSM)
LW6
LW7
LW8
LW9
LW10
LW11
LW12
LW13
LW14
LW15
LW16
LW17
Pressure head (m H2O)
Longwall position (m)
2010
2012
2014
2016
2018
2020

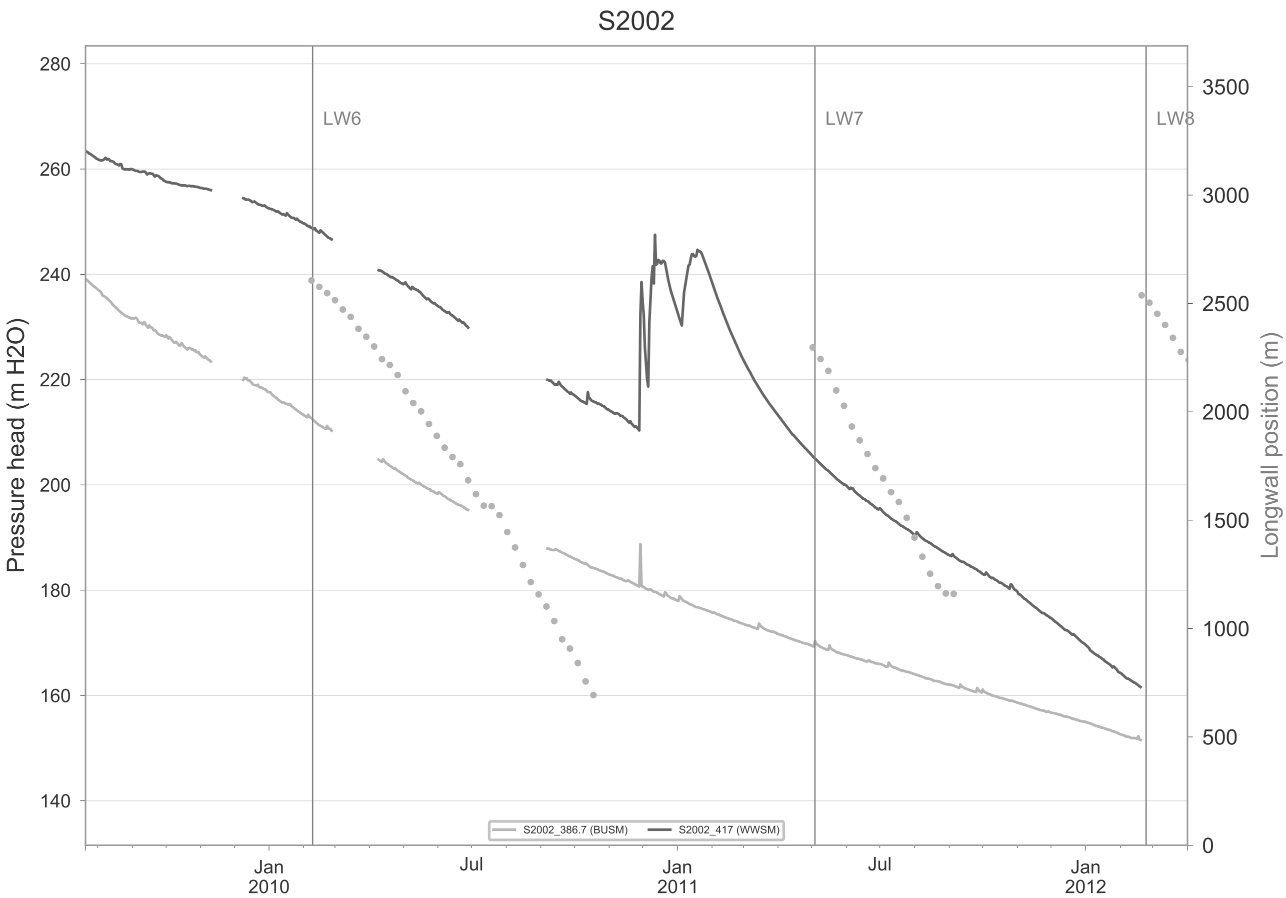
S2001

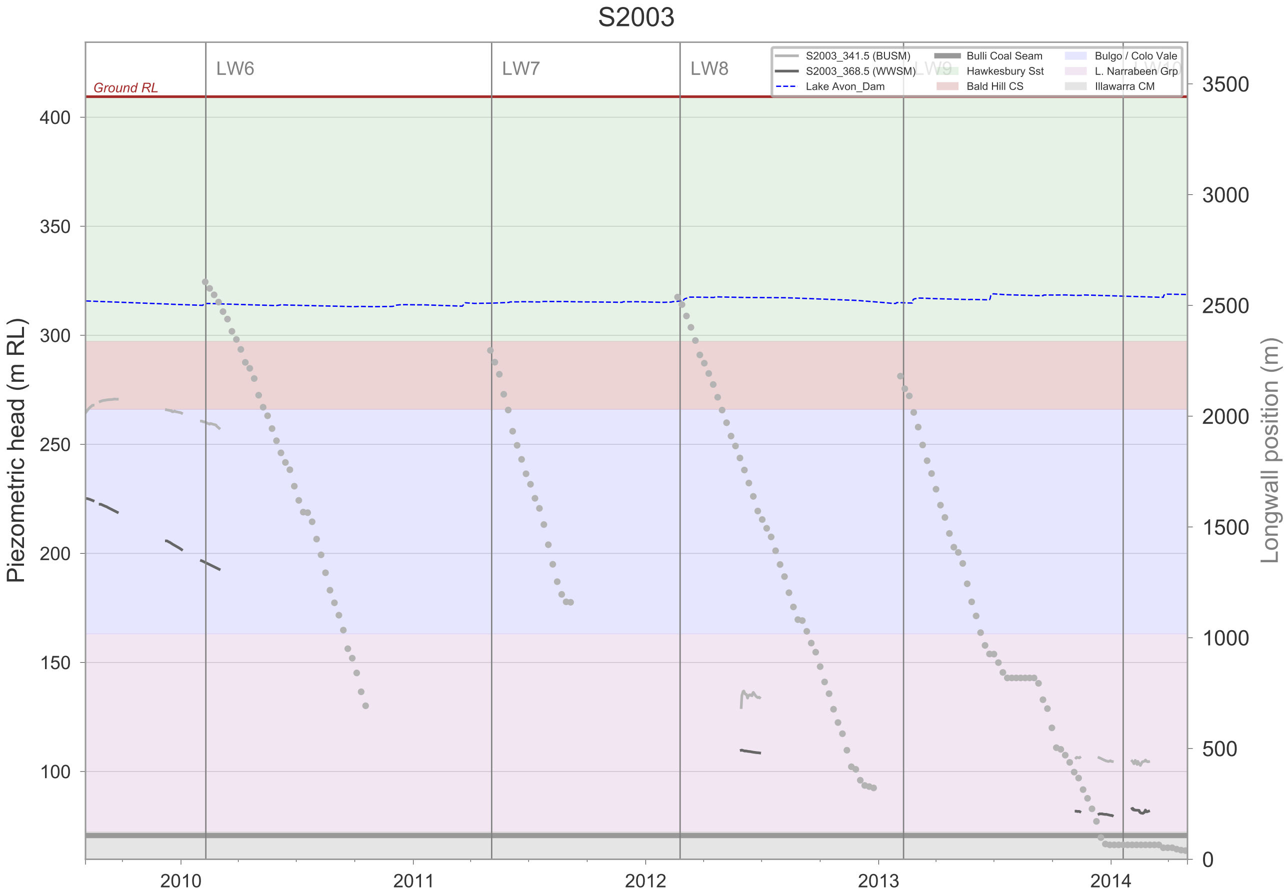

LW6
LW7
LW8
LW9
LW10
LW11
LW12
LW13
LW14
LW15
LW16
LW17
Ground RL
Piezometric head (m RL)
Longwall position (m)
S2001_10 (HBSS)
S2001_65 (HBSS)
S2001_125 (HBSS)
S2001_183.5 (BGSS)
S2001_231.8 (BGSS)
S2001_285 (BGSS)
S2001_300 (SBSS)
S2001_315.5 (SBSS)
S2001_353.5 (BUSM)
S2001_382.5 (WWSM)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM

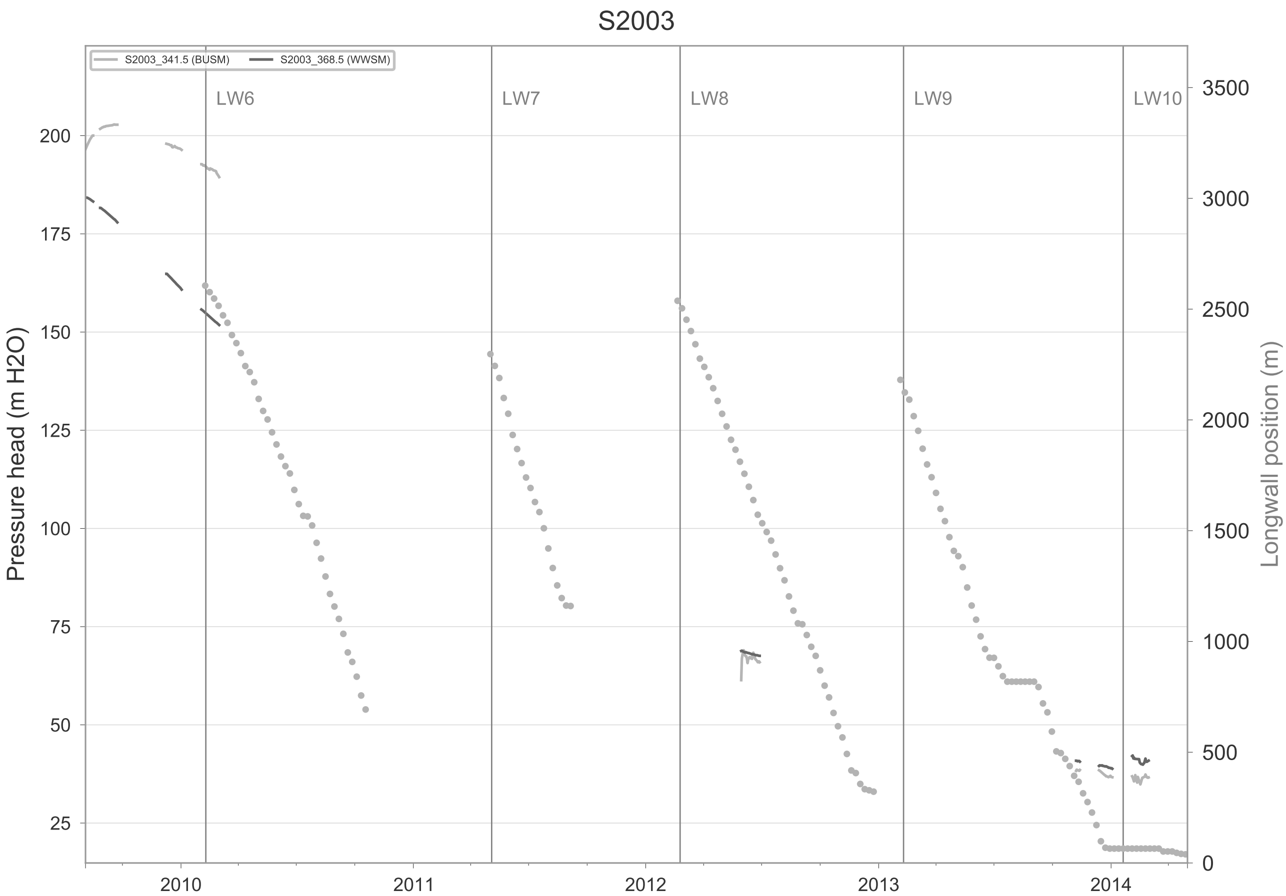
S2001


LW11
LW12
LW13
LW14
LW15
LW16
Pressure head (m H2O)
Longwall position (m)
S2001_10 (HBSS)
S2001_65 (HBSS)
S2001_125 (HBSS)
S2001_183.5 (BGSS)
S2001_231.8 (BGSS)
S2001_285 (BGSS)
S2001_300 (SBSS)
S2001_315.5 (SBSS)
S2001_353.5 (BUSM)
S2001_382.5 (WWSM)

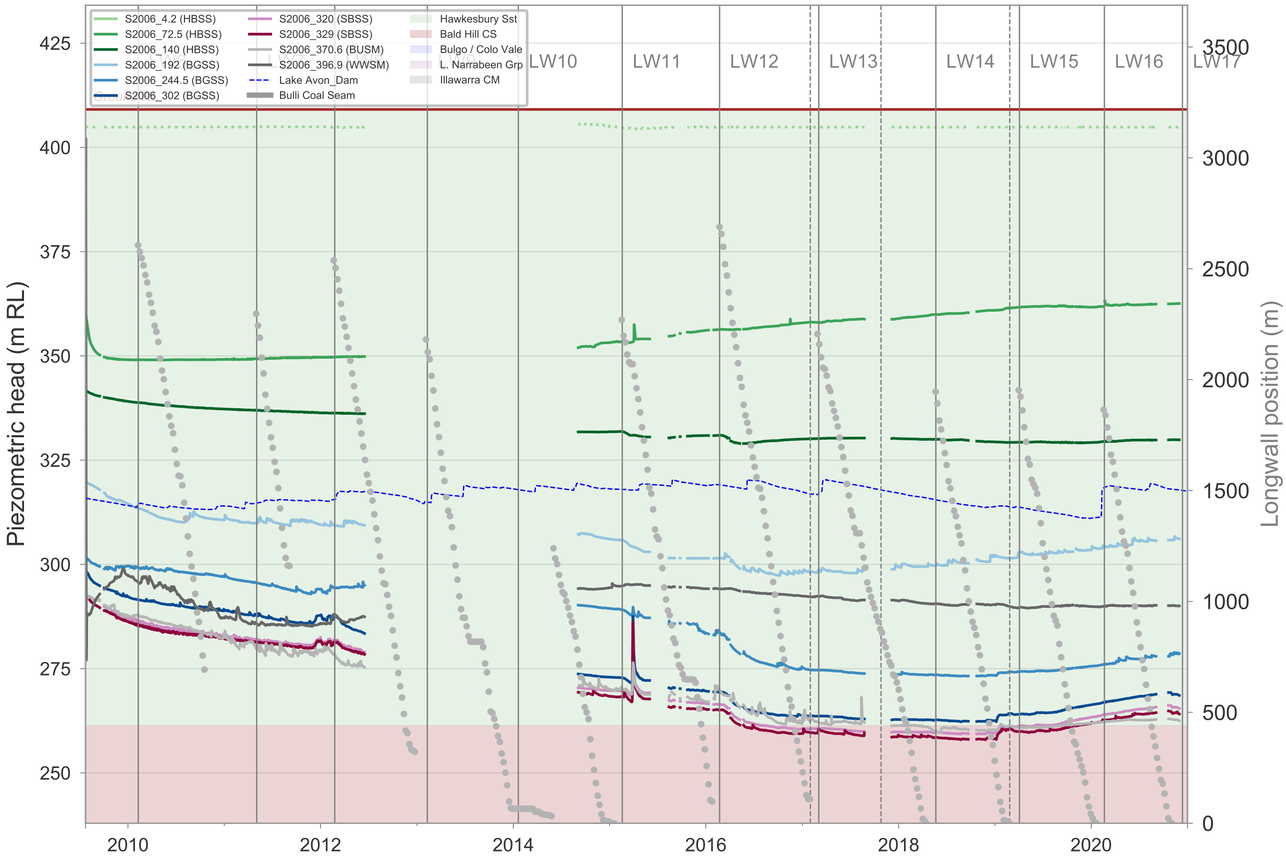

S2002
S2002_386.7 (BUSM)
S2002_417 (WWSM)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
Ground RL
LW7
LW8
Piezometric head (m RL)
Longwall position (m)
Jan 2010
Jul
Jan 2011
Jul
Jan 2012


S2002
LW6
LW7
LW8
Pressure head (m H2O)
Longwall position (m)
S2002_386.7 (BUSM)
S2002_417 (WWSM)
Jan 2010
Jul
Jan 2011
Jul
Jan 2012

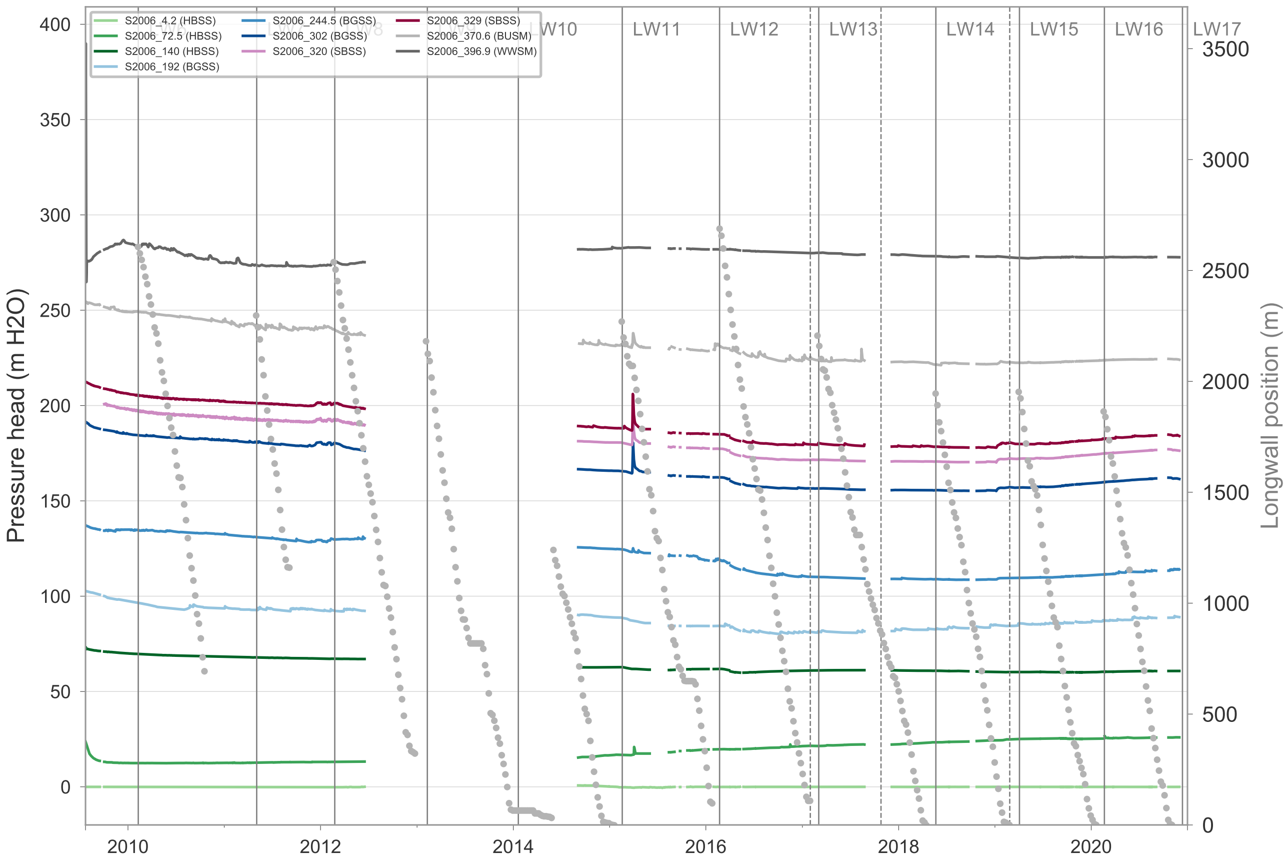

S2003
LW6
LW7
LW8
Ground RL
S2003_341.5 (BUSM)
S2003_368.5 (WWSM)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
Piezometric head (m RL)
Longwall position (m)
2010
2011
2012
2013
2014

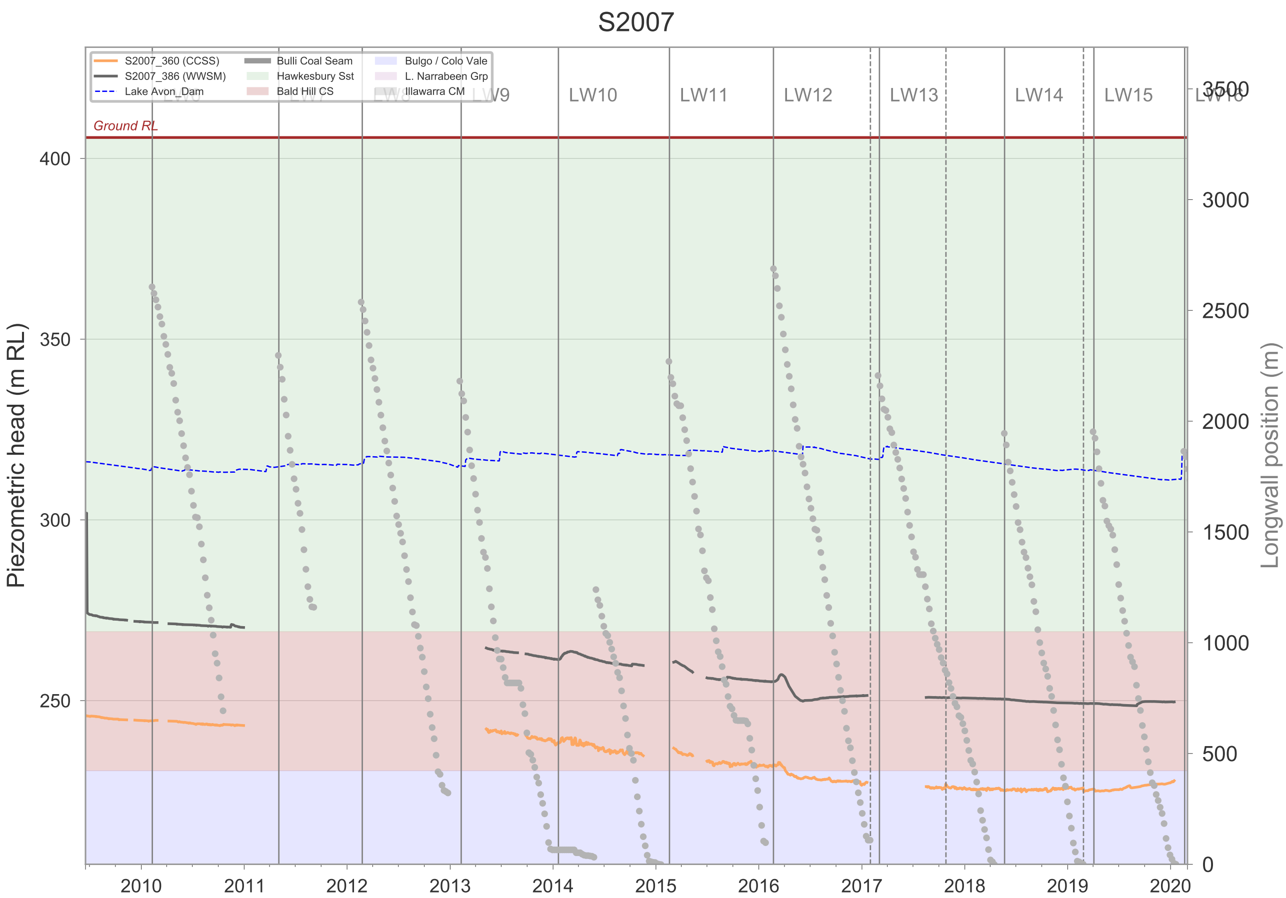

S2003
S2003_341.5 (BUSM)
S2003_368.5 (WWSM)
LW6
LW7
LW8
LW9
LW10
Pressure head (m H2O)
Longwall position (m)
2010
2011
2012
2013
2014

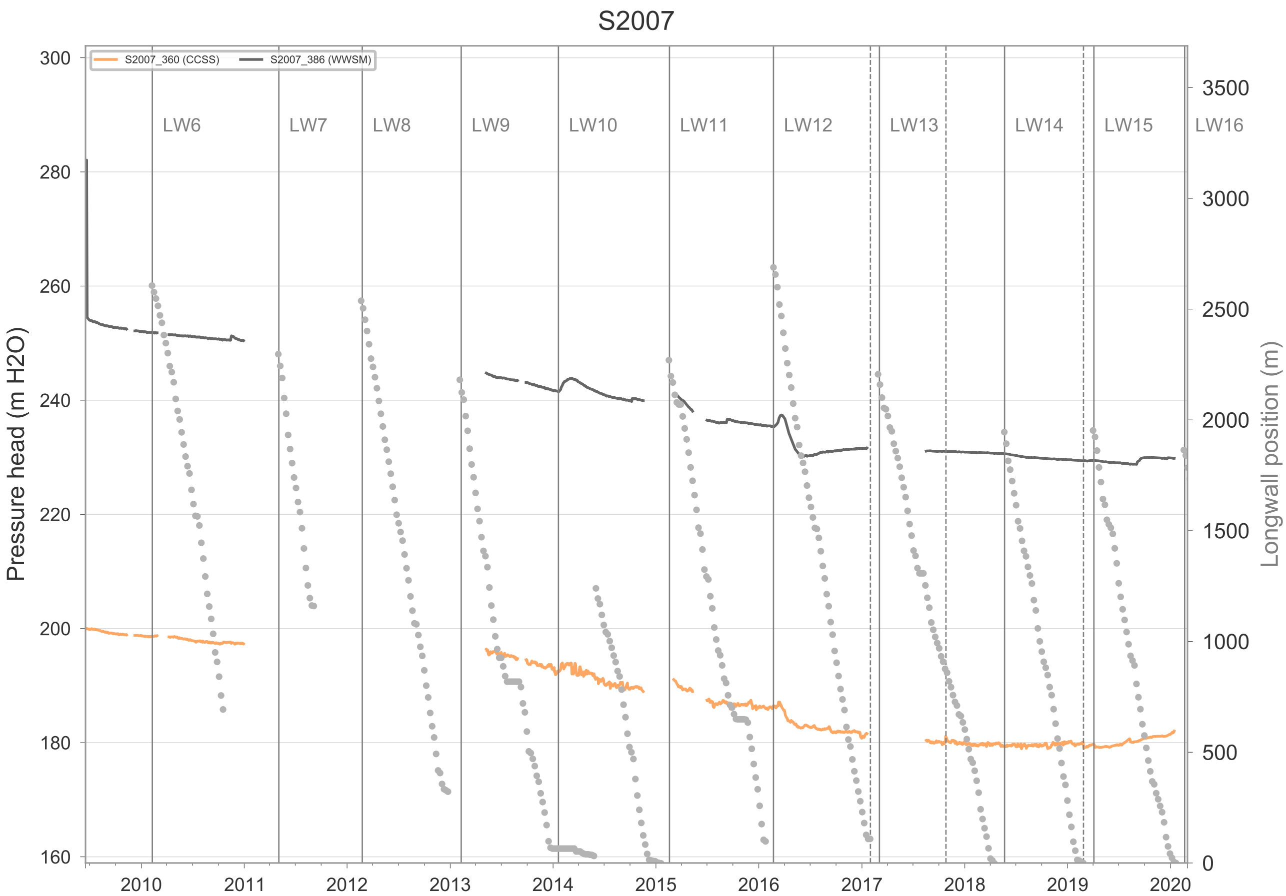
S2006

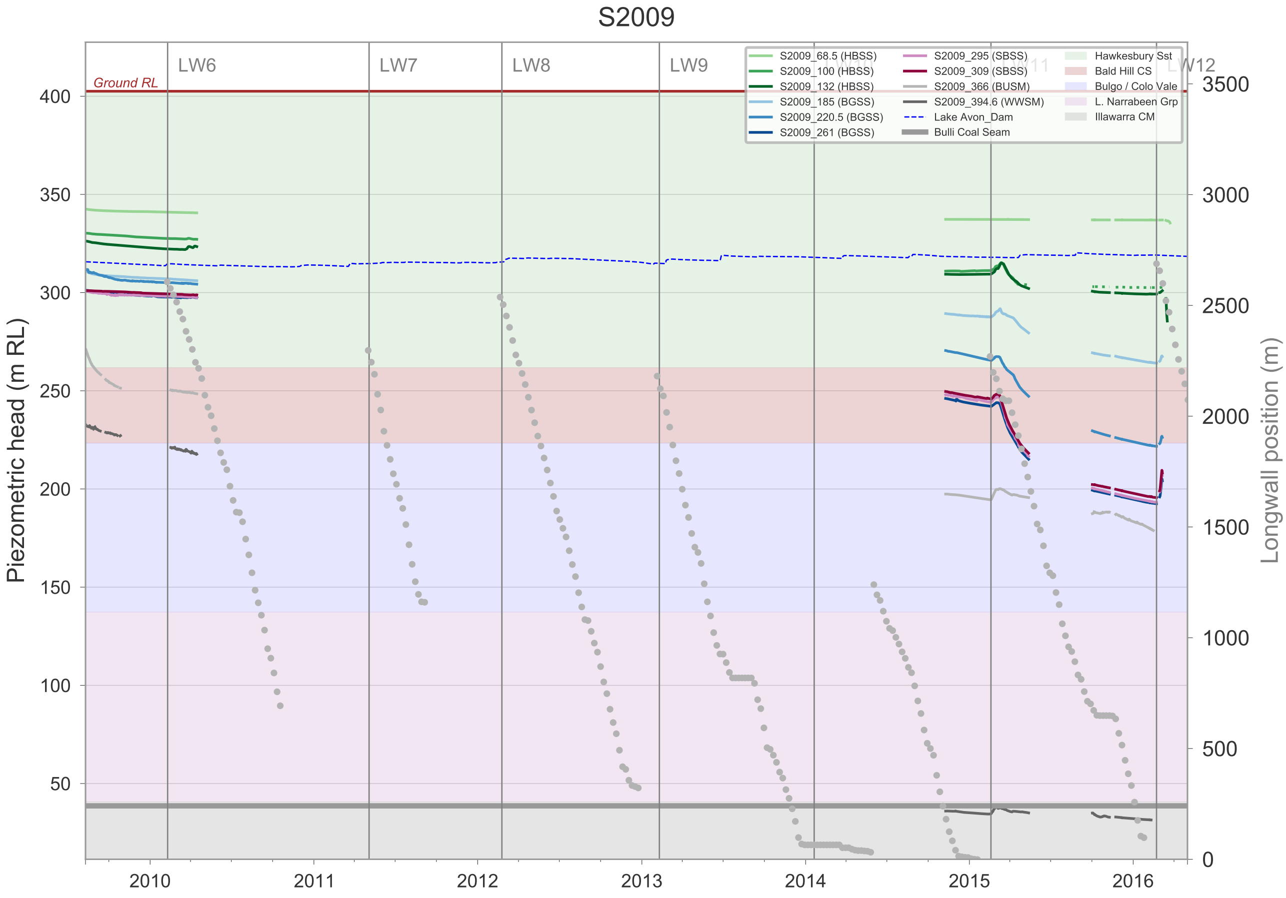

S2006_4.2 (HBSS)
S2006_72.5 (HBSS)
S2006_140 (HBSS)
S2006_192 (BGSS)
S2006_244.5 (BGSS)
S2006_302 (BGSS)
S2006_320 (SBSS)
S2006_329 (SBSS)
S2006_370.6 (BUSM)
S2006_396.9 (WWSM)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
LW10
LW11
LW12
LW13
LW14
LW15
LW16
LW17
Piezometric head (m RL)
Longwall position (m)

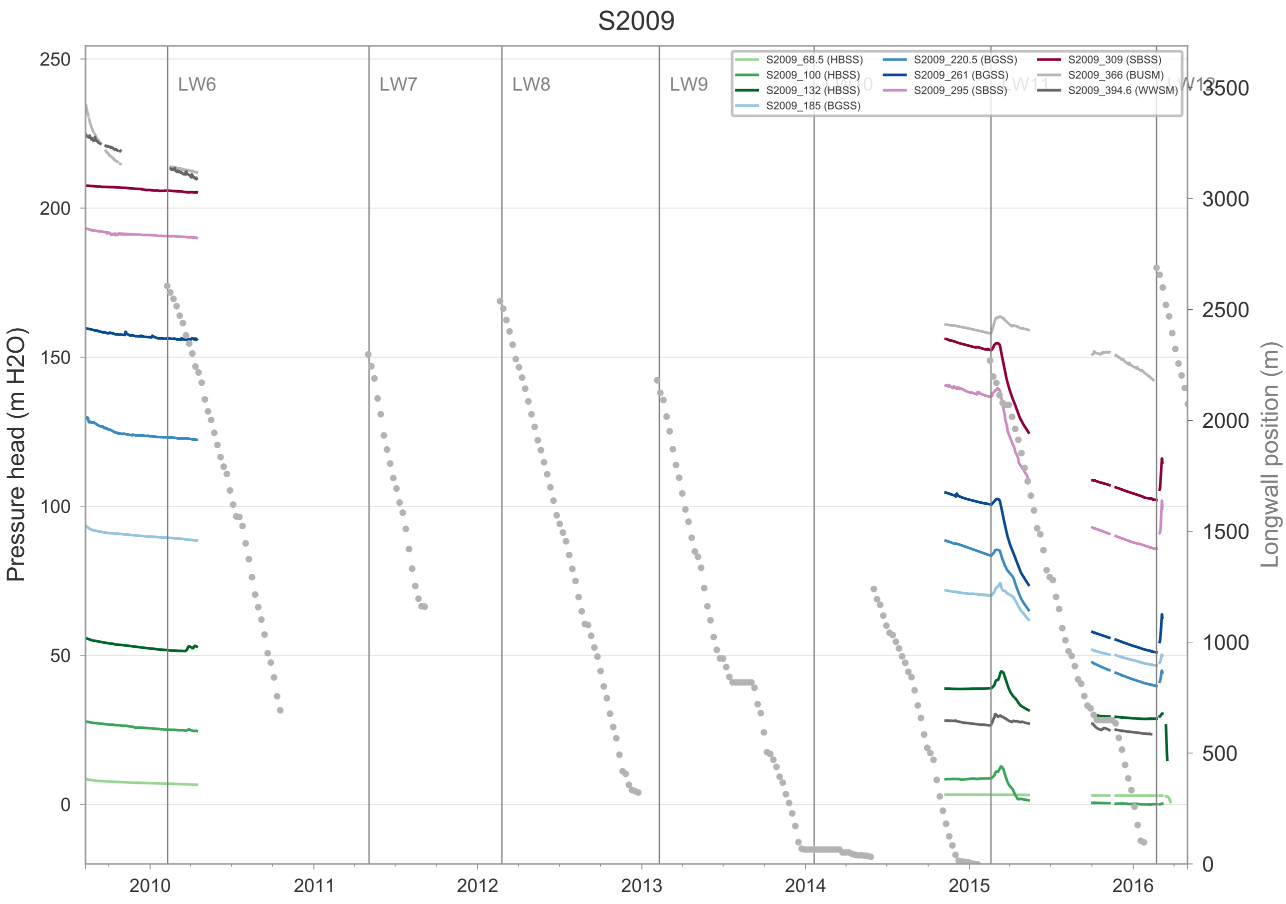
S2006

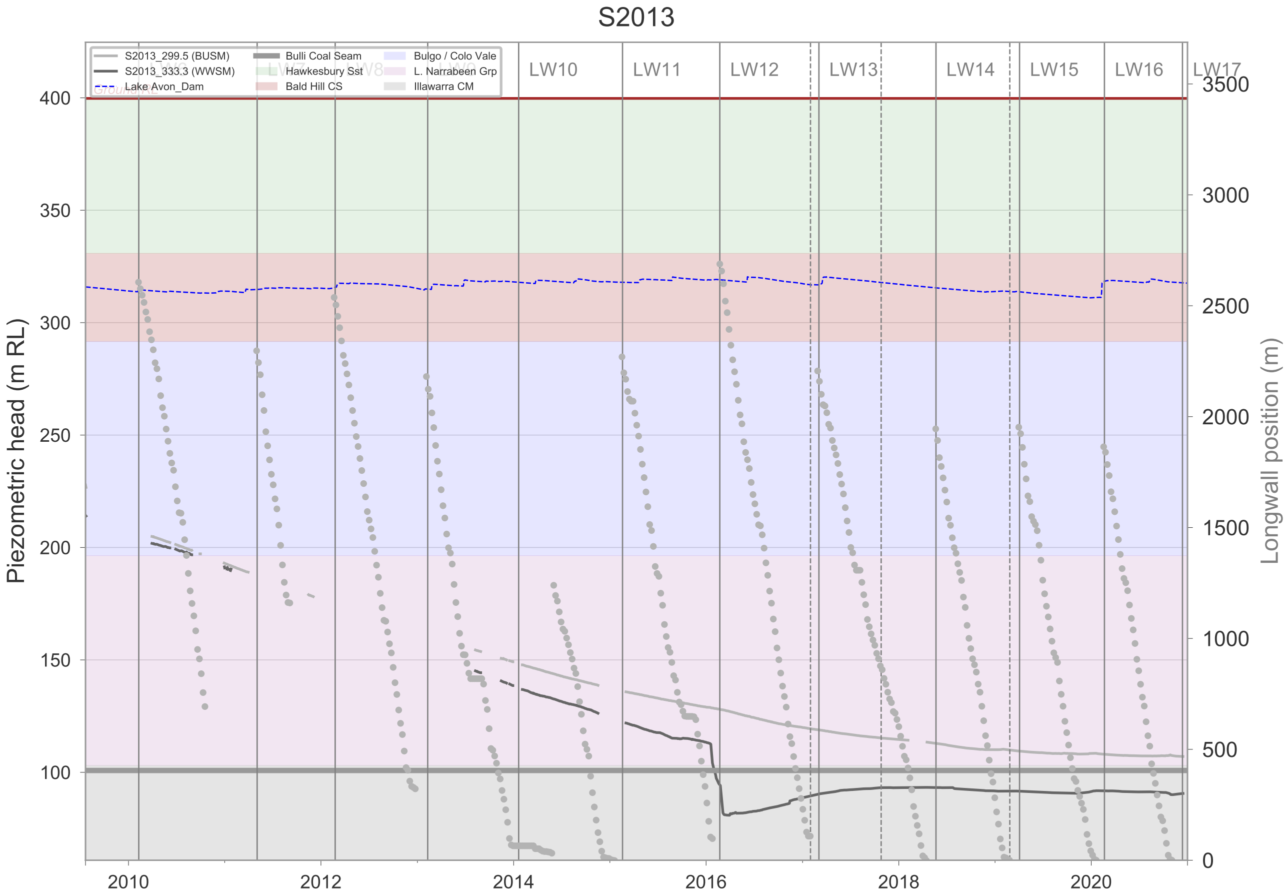

S2006_4.2 (HBSS)
S2006_72.5 (HBSS)
S2006_140 (HBSS)
S2006_192 (BGSS)
S2006_244.5 (BGSS)
S2006_302 (BGSS)
S2006_320 (SBSS)
S2006_329 (SBSS)
S2006_370.6 (BUSM)
S2006_396.9 (WWSM)
LW10
LW11
LW12
LW13
LW14
LW15
LW16
LW17
Pressure head (m H2O)
Longwall position (m)

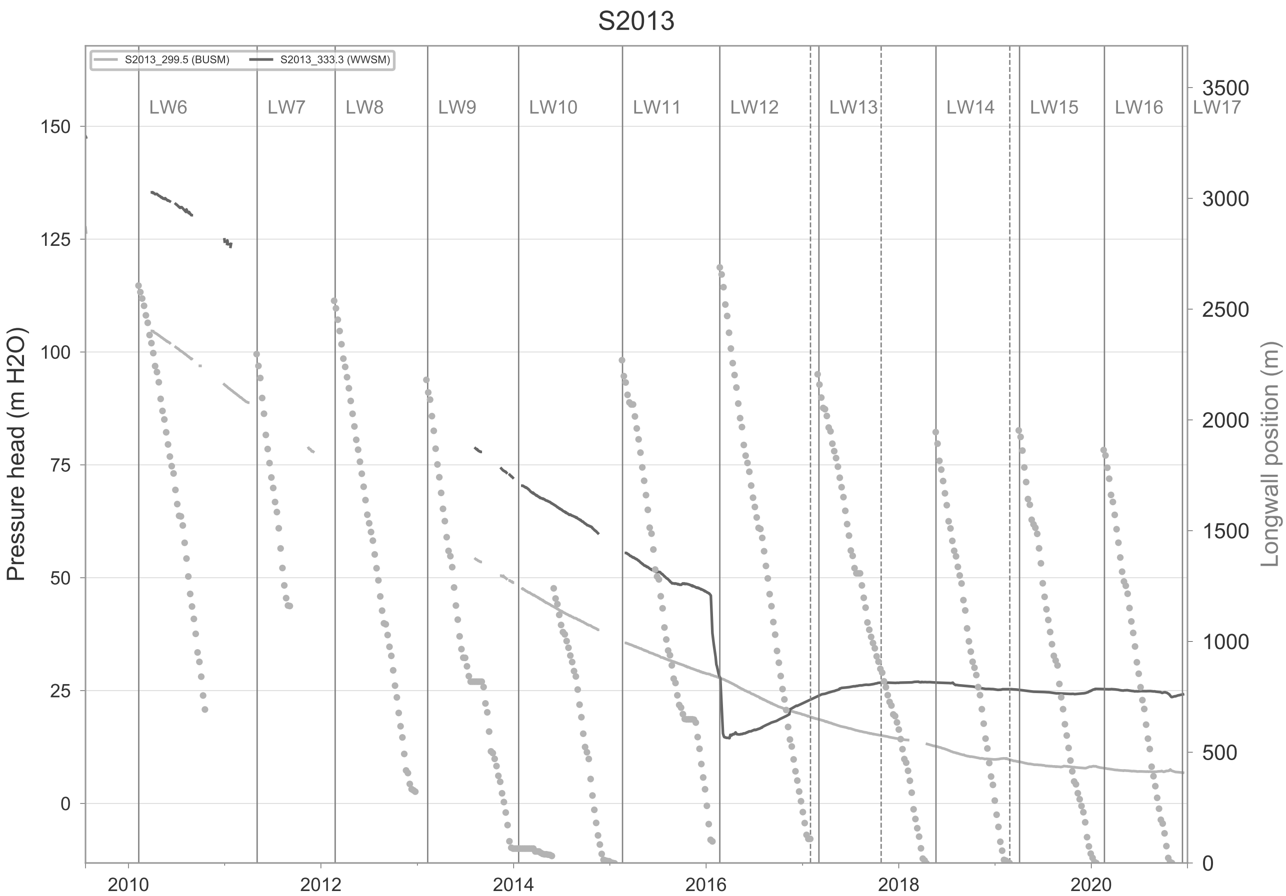

S2007
S2007_360 (CCSS)
S2007_386 (WWSM)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
Ground RL
LW9
LW10
LW11
LW12
LW13
LW14
LW15
LW16
Piezometric head (m RL)
Longwall position (m)
400
350
300
250
3500
3000
2500
2000
1500
1000
500
0
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020

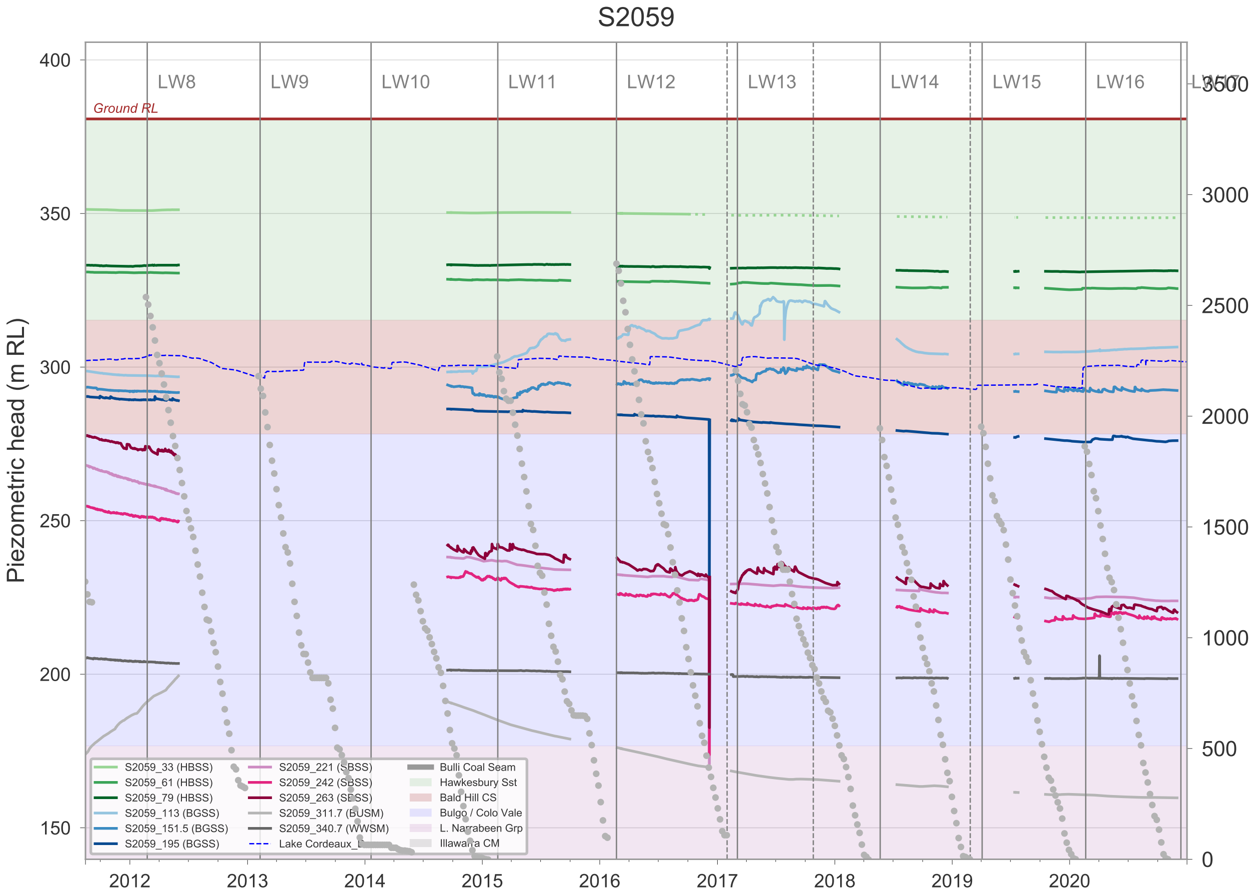

S2007
S2007_360 (CCSS)
S2007_386 (WWSM)
LW6
LW7
LW8
LW9
LW10
LW11
LW12
LW13
LW14
LW15
LW16
Pressure head (m H2O)
Longwall position (m)
300
280
260
240
220
200
180
160
3500
3000
2500
2000
1500
1000
500
0
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020

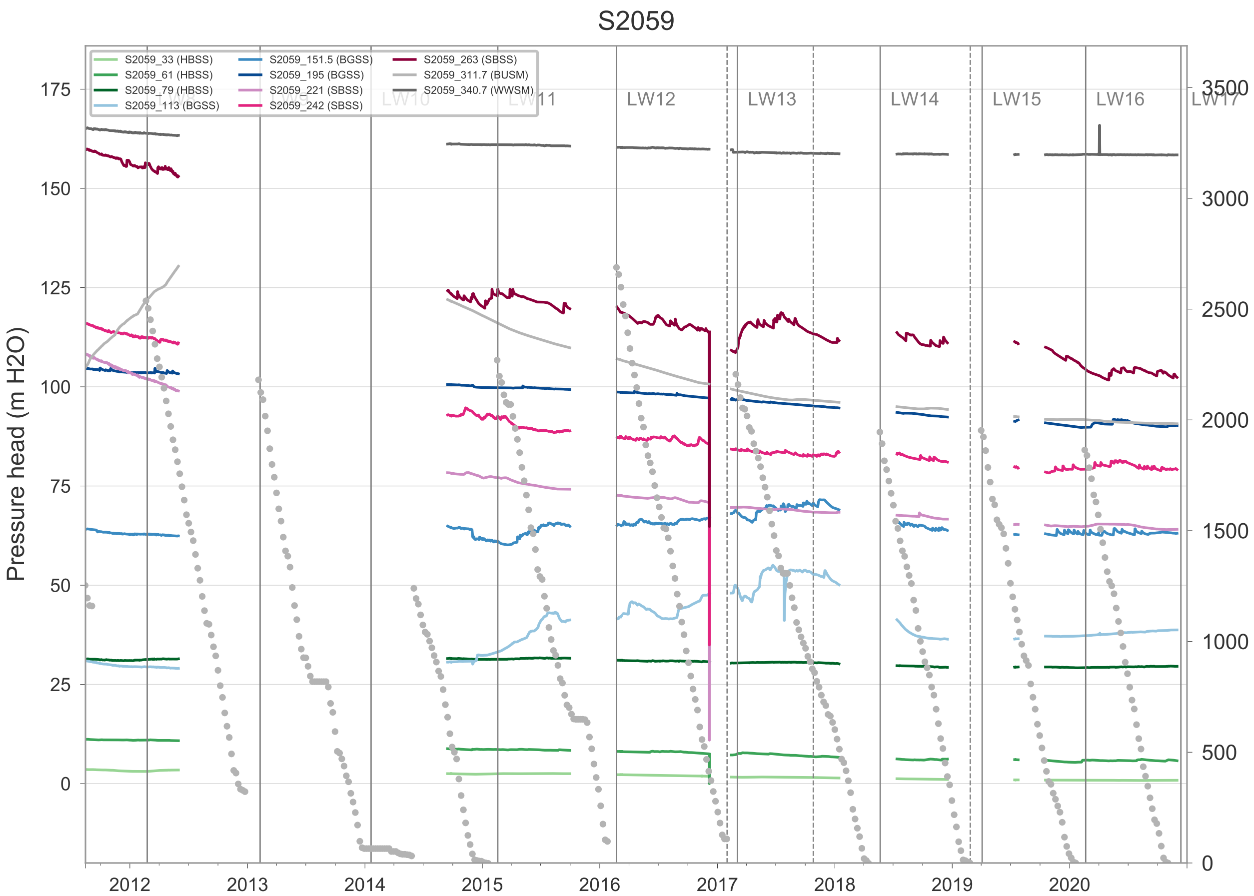

S2009
Piezometric head (m RL)
Longwall position (m)
Ground RL
LW6
LW7
LW8
LW9
LW12
S2009_68.5 (HBSS)
S2009_100 (HBSS)
S2009_132 (HBSS)
S2009_185 (BGSS)
S2009_220.5 (BGSS)
S2009_261 (BGSS)
S2009_295 (SBSS)
S2009_309 (SBSS)
S2009_366 (BUSM)
S2009_394.6 (WWSM)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM


S2009
Pressure head (m H2O)
Longwall position (m)
LW6
LW7
LW8
LW9
S2009_68.5 (HBSS)
S2009_100 (HBSS)
S2009_132 (HBSS)
S2009_185 (BGSS)
S2009_220.5 (BGSS)
S2009_261 (BGSS)
S2009_295 (SBSS)
S2009_309 (SBSS)
S2009_366 (BUSM)
S2009_394.6 (WWSM)

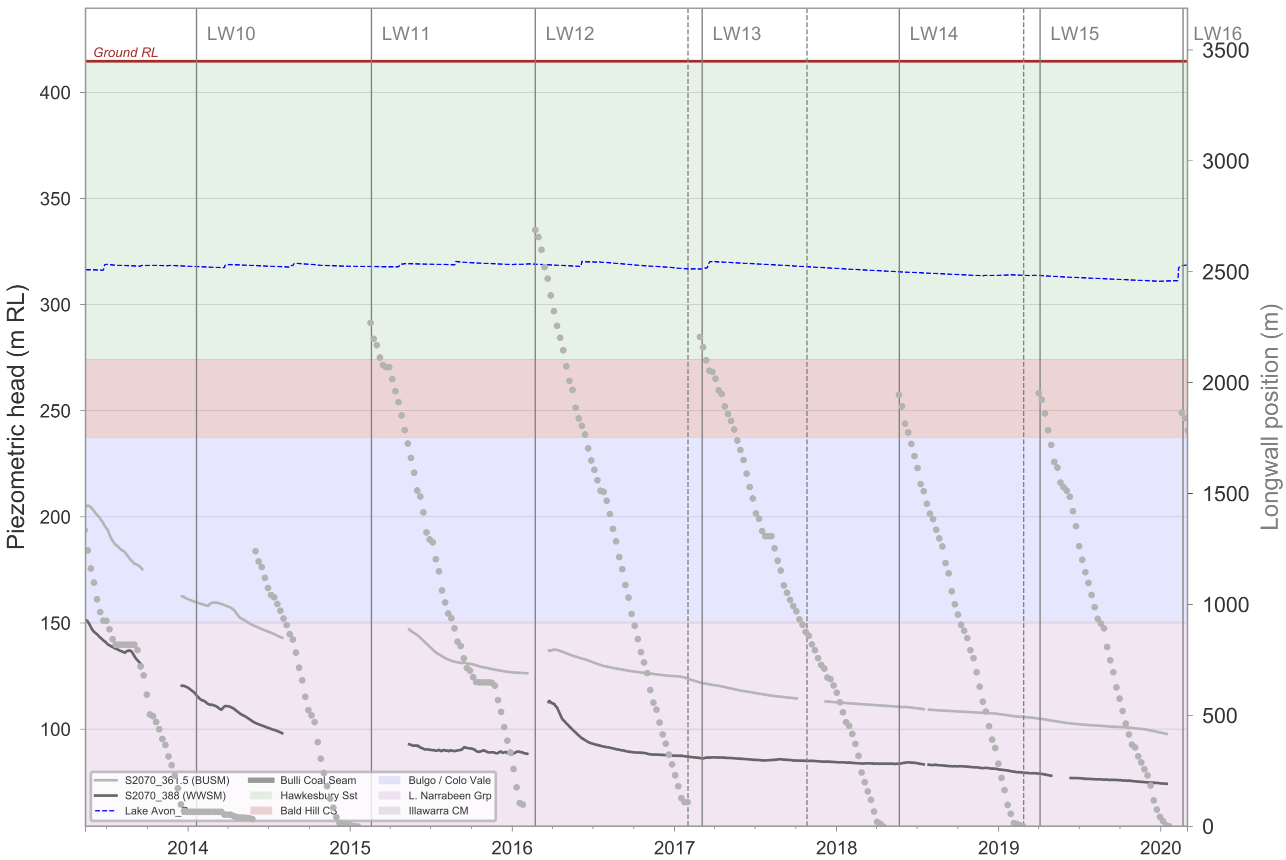

S2013
S2013_299.5 (BUSM)
S2013_333.3 (WWSM)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
LW10
LW11
LW12
LW13
LW14
LW15
LW16
LW17
Piezometric head (m RL)
Longwall position (m)
400
350
300
250
200
150
100
3500
3000
2500
2000
1500
1000
500
0
2010
2012
2014
2016
2018
2020


S2013
S2013_299.5 (BUSM)
S2013_333.3 (WWSM)
LW6
LW7
LW8
LW9
LW10
LW11
LW12
LW13
LW14
LW15
LW16
LW17
Pressure head (m H2O)
Longwall position (m)
150
125
100
75
50
25
0
3500
3000
2500
2000
1500
1000
500
0
2010
2012
2014
2016
2018
2020


S2059
Piezometric head (m RL)
Longwall position (m)
Ground RL
LW8
LW9
LW10
LW11
LW12
LW13
LW14
LW15
LW16
LW17
S2059_33 (HBSS)
S2059_61 (HBSS)
S2059_79 (HBSS)
S2059_113 (BGSS)
S2059_151.5 (BGSS)
S2059_195 (BGSS)
S2059_221 (SBSS)
S2059_242 (SBSS)
S2059_263 (SBSS)
S2059_311.7 (BUSM)
S2059_340.7 (WWSM)
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
2012
2013
2014
2015
2016
2017
2018
2019
2020

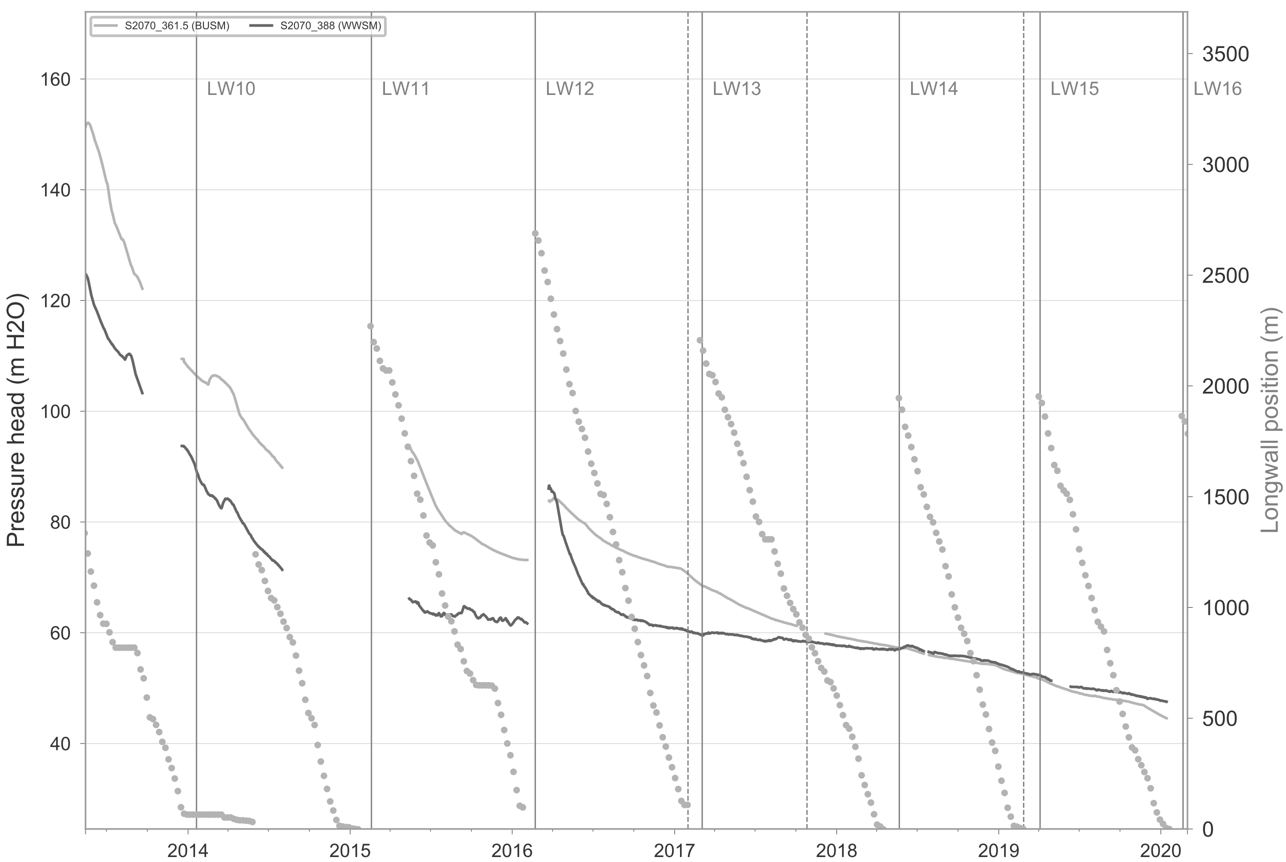

S2059
Pressure head (m H2O)
Longwall position (m)
S2059_33 (HBSS)
S2059_61 (HBSS)
S2059_79 (HBSS)
S2059_113 (BGSS)
S2059_151.5 (BGSS)
S2059_195 (BGSS)
S2059_221 (SBSS)
S2059_242 (SBSS)
S2059_263 (SBSS)
S2059_311.7 (BUSM)
S2059_340.7 (WWSM)
LW12
LW13
LW14
LW15
LW16
LW17
2012
2013
2014
2015
2016
2017
2018
2019
2020

S2070

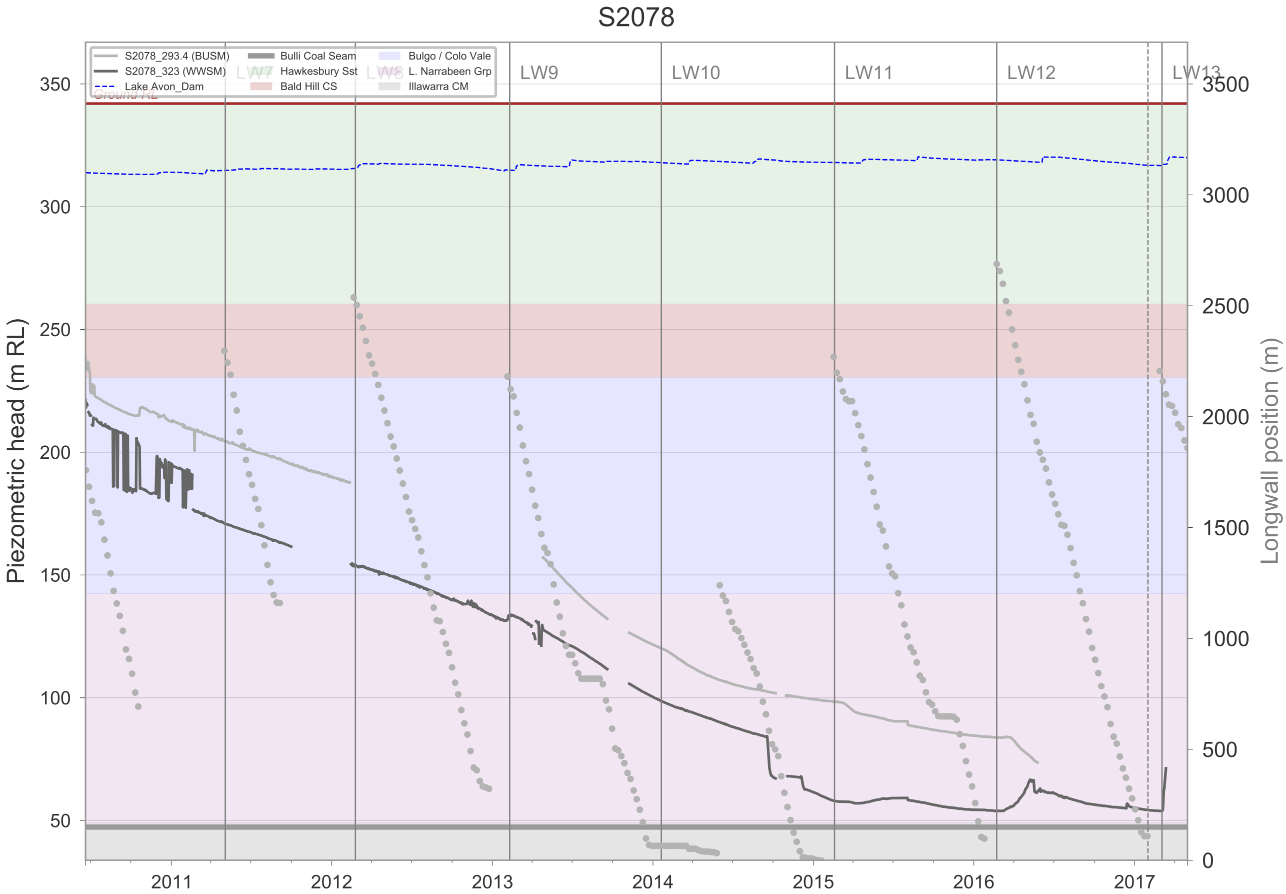


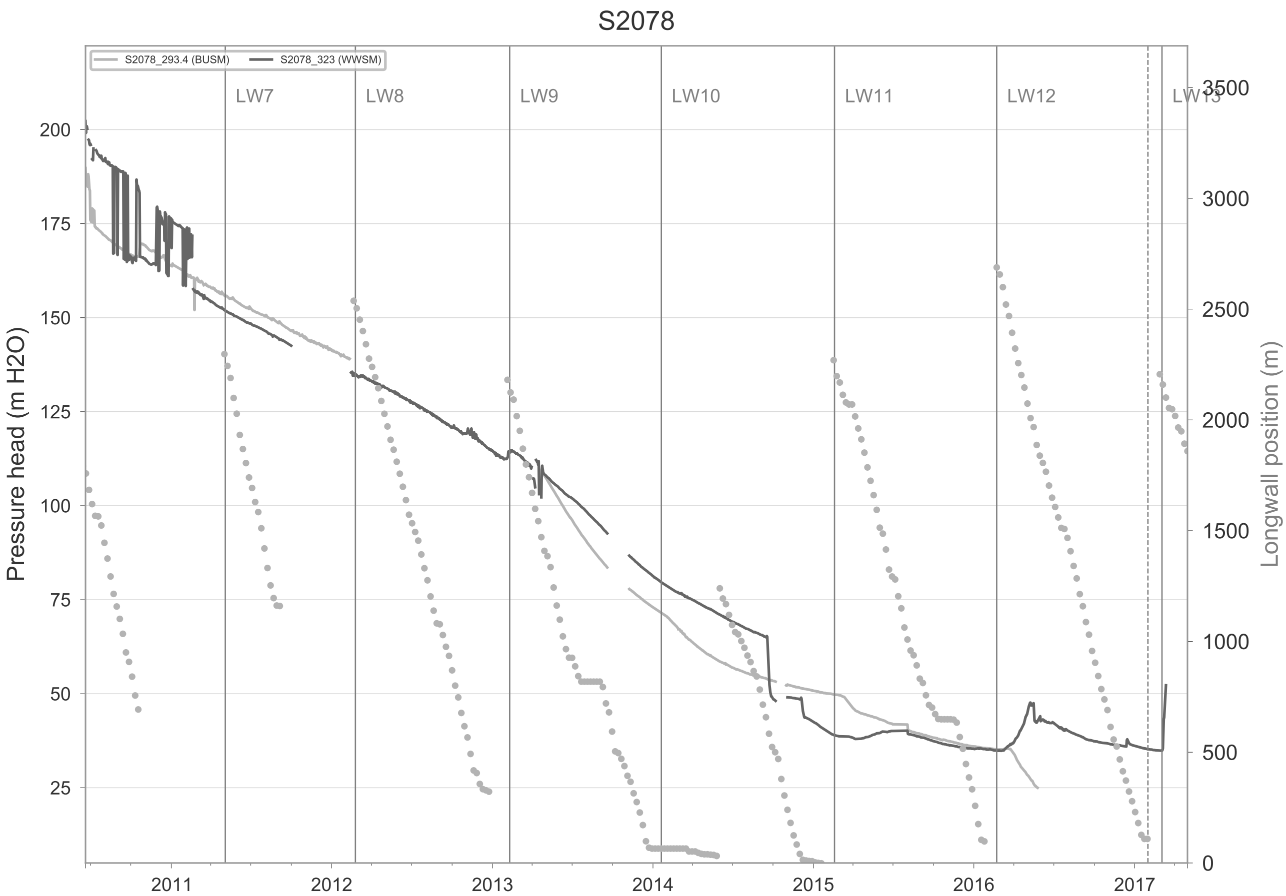
Ground RL
LW10
LW11
LW12
LW13
LW14
LW15
LW16
Piezometric head (m RL)
Longwall position (m)
400
350
300
250
200
150
100
3500
3000
2500
2000
1500
1000
500
0
2014
2015
2016
2017
2018
2019
2020
S2070_361.5 (BUSM)
S2070_388 (WWSM)
Lake Avon
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM

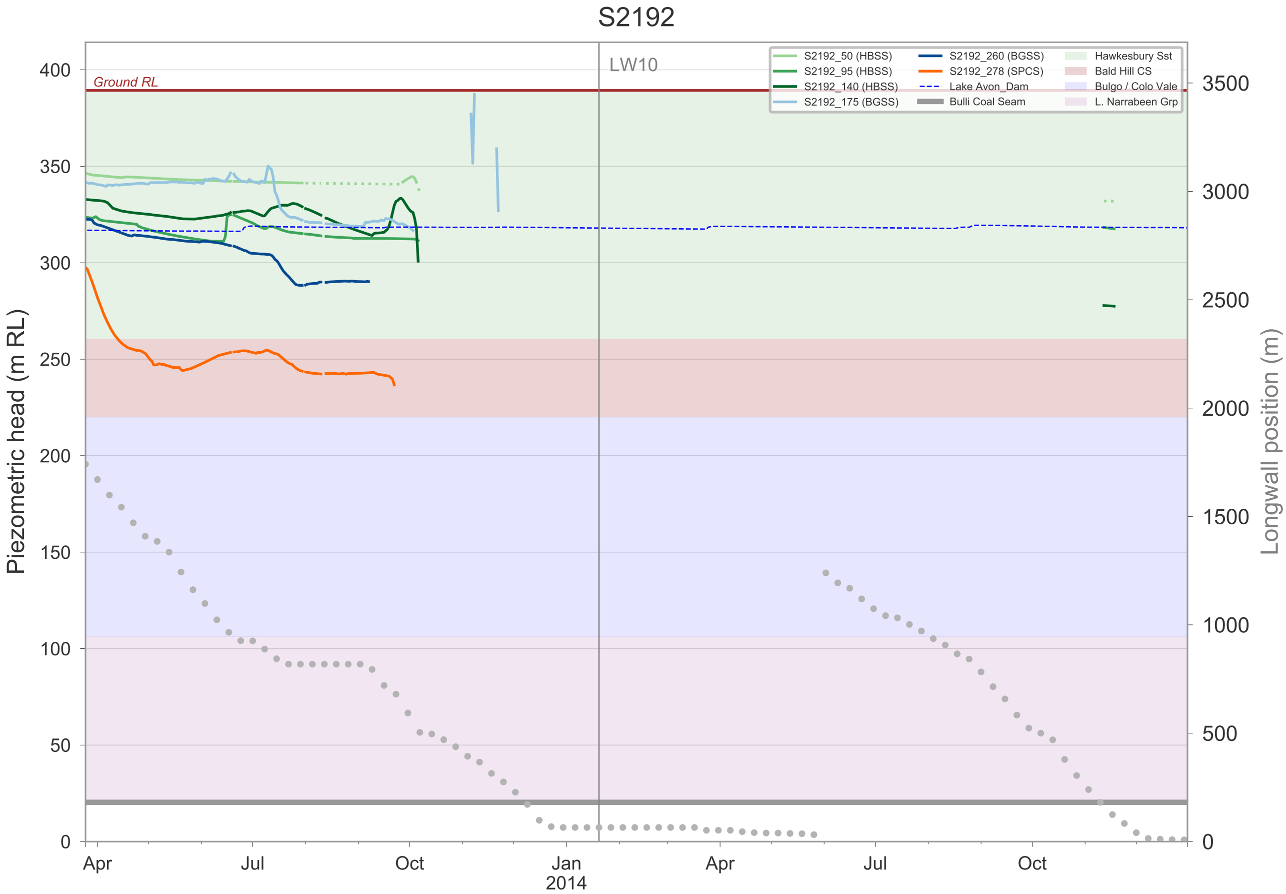
S2070

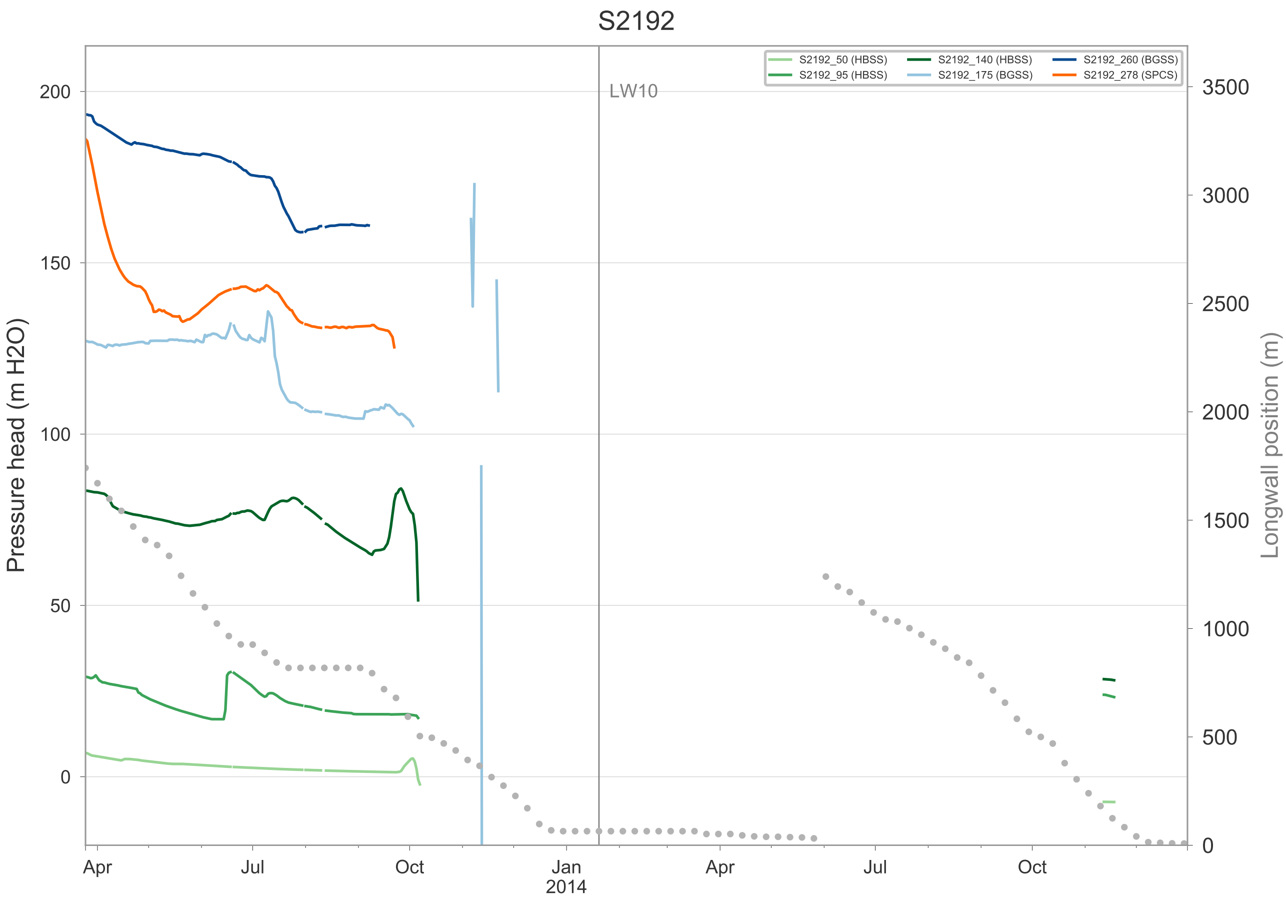


S2070_361.5 (BUSM)
S2070_388 (WWSM)
LW10
LW11
LW12
LW13
LW14
LW15
LW16
Pressure head (m H2O)
Longwall position (m)
160
140
120
100
80
60
40
3500
3000
2500
2000
1500
1000
500
0
2014
2015
2016
2017
2018
2019
2020

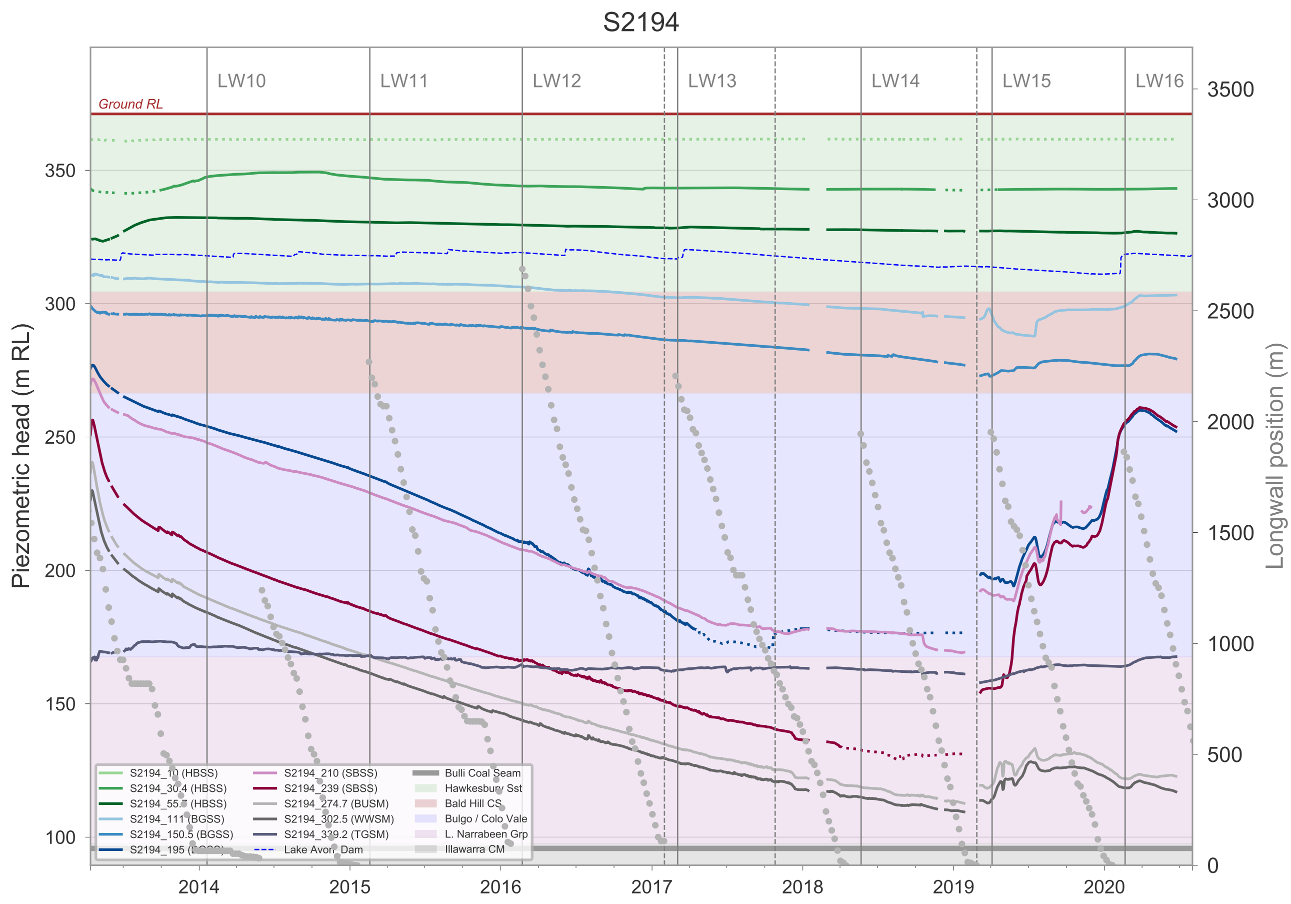

S2078
S2078_293.4 (BUSM)
S2078_323 (WWSM)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
Ground RL
LW7
LW8
LW9
LW10
LW11
LW12
LW13
Piezometric head (m RL)
Longwall position (m)
2011
2012
2013
2014
2015
2016
2017

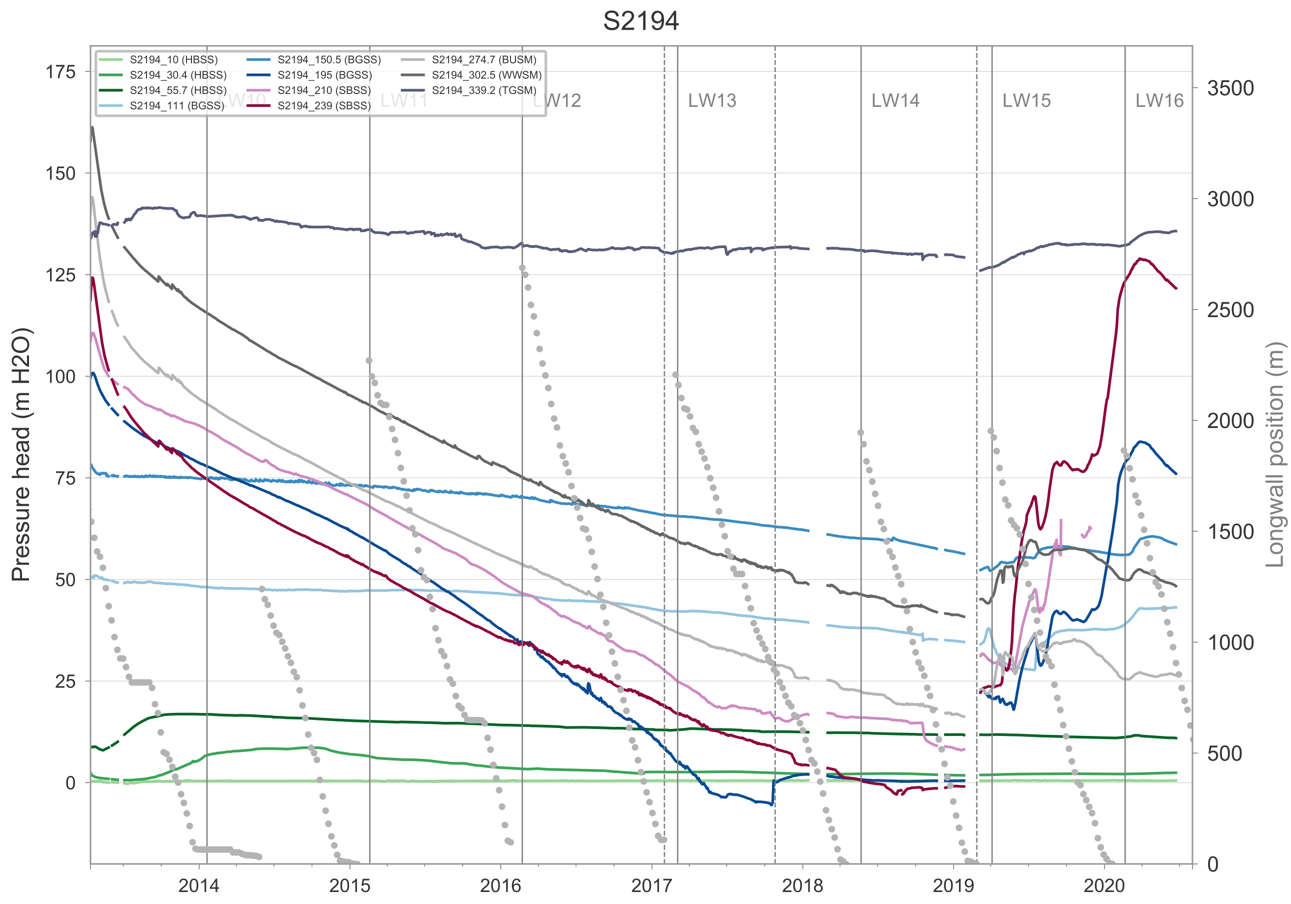

S2078
S2078_293.4 (BUSM)
S2078_323 (WWSM)
LW7
LW8
LW9
LW10
LW11
LW12
LW13
Pressure head (m H2O)
Longwall position (m)
2011
2012
2013
2014
2015
2016
2017


S2192
LW10
Ground RL
S2192_50 (HBSS)
S2192_95 (HBSS)
S2192_140 (HBSS)
S2192_175 (BGSS)
S2192_260 (BGSS)
S2192_278 (SPCS)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Piezometric head (m RL)
Longwall position (m)
Apr
Jul
Oct
Jan
2014
Apr
Jul
Oct

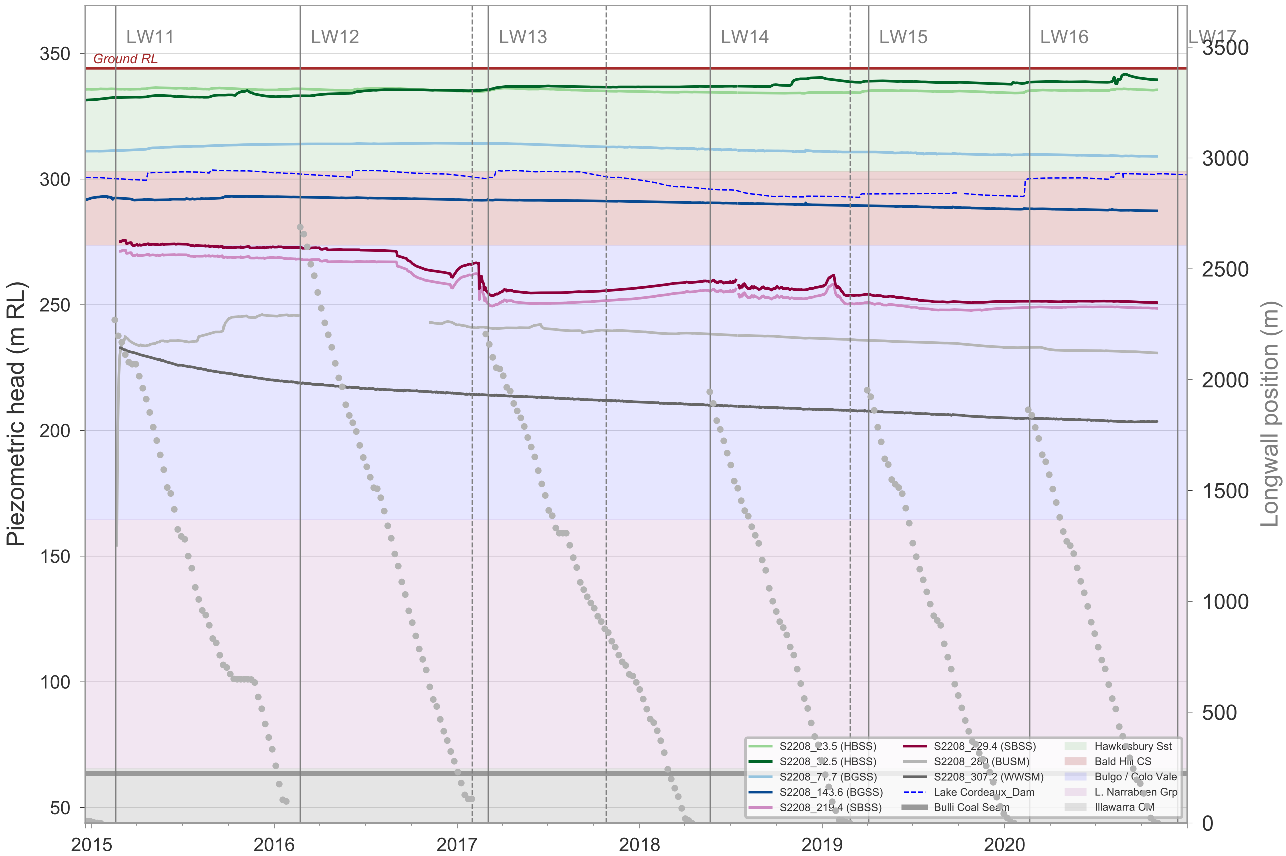

S2192
LW10
S2192_50 (HBSS)
S2192_95 (HBSS)
S2192_140 (HBSS)
S2192_175 (BGSS)
S2192_260 (BGSS)
S2192_278 (SPCS)
Pressure head (m H2O)
Longwall position (m)
Apr
Jul
Oct
Jan
2014
Apr
Jul
Oct

Groundwater hydrographs

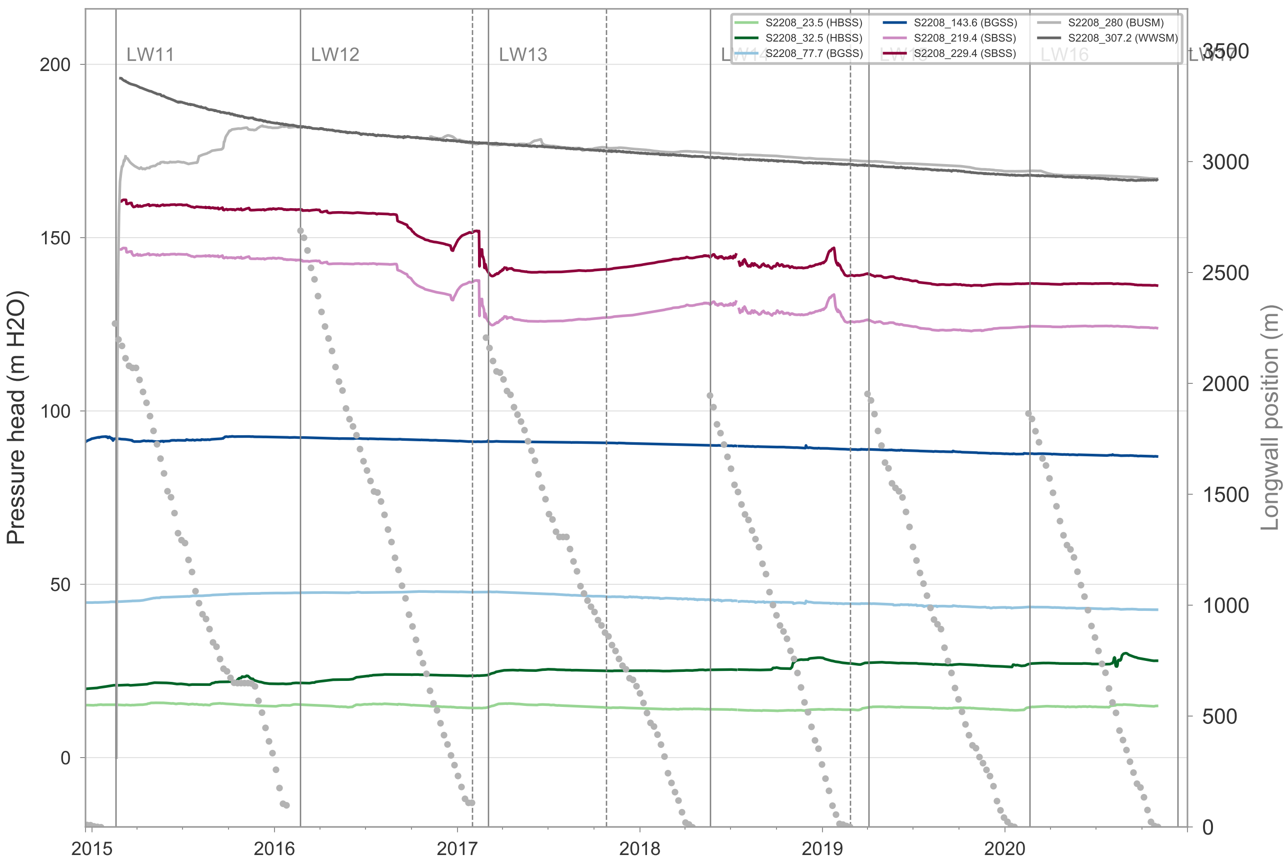




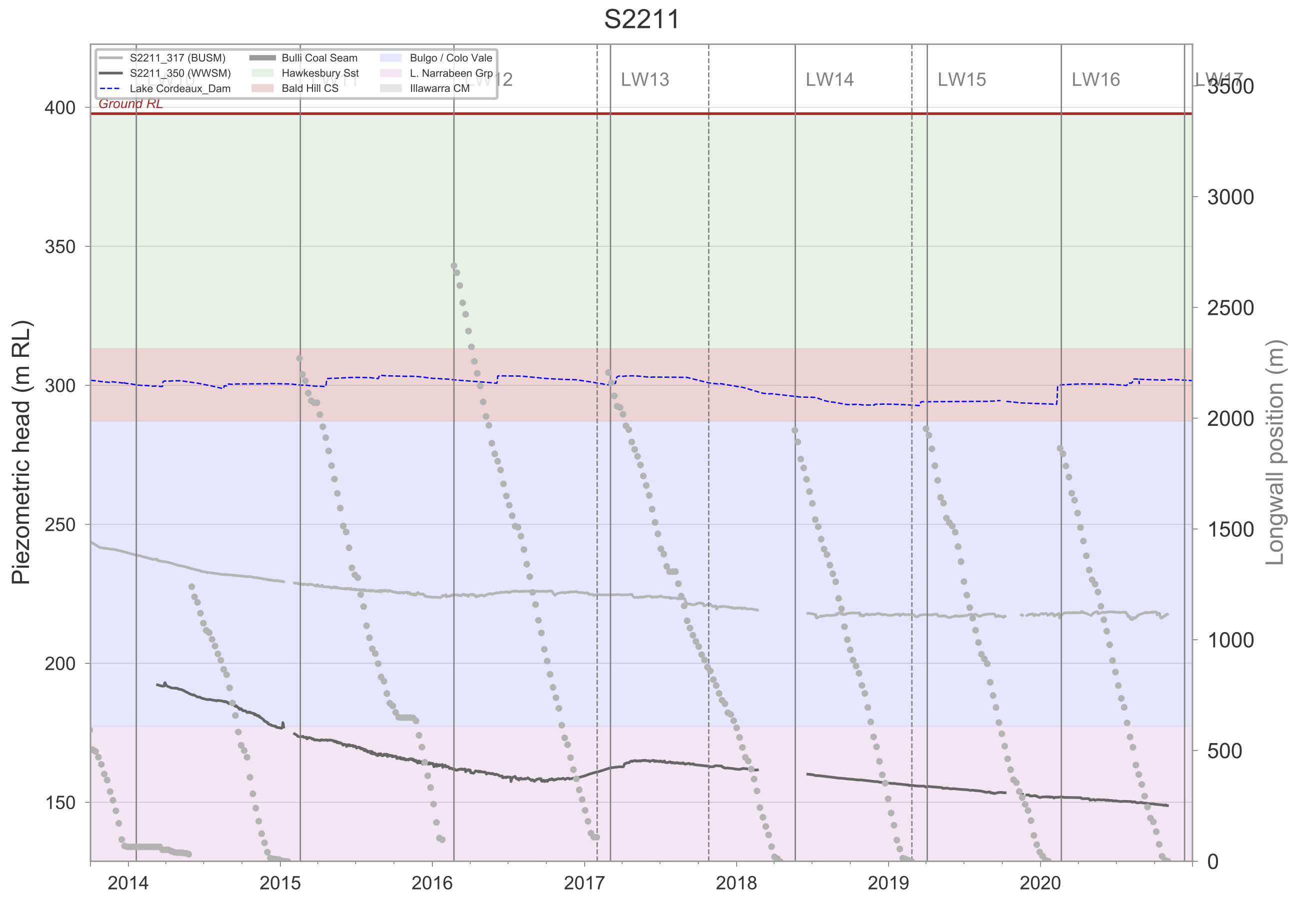
S2208

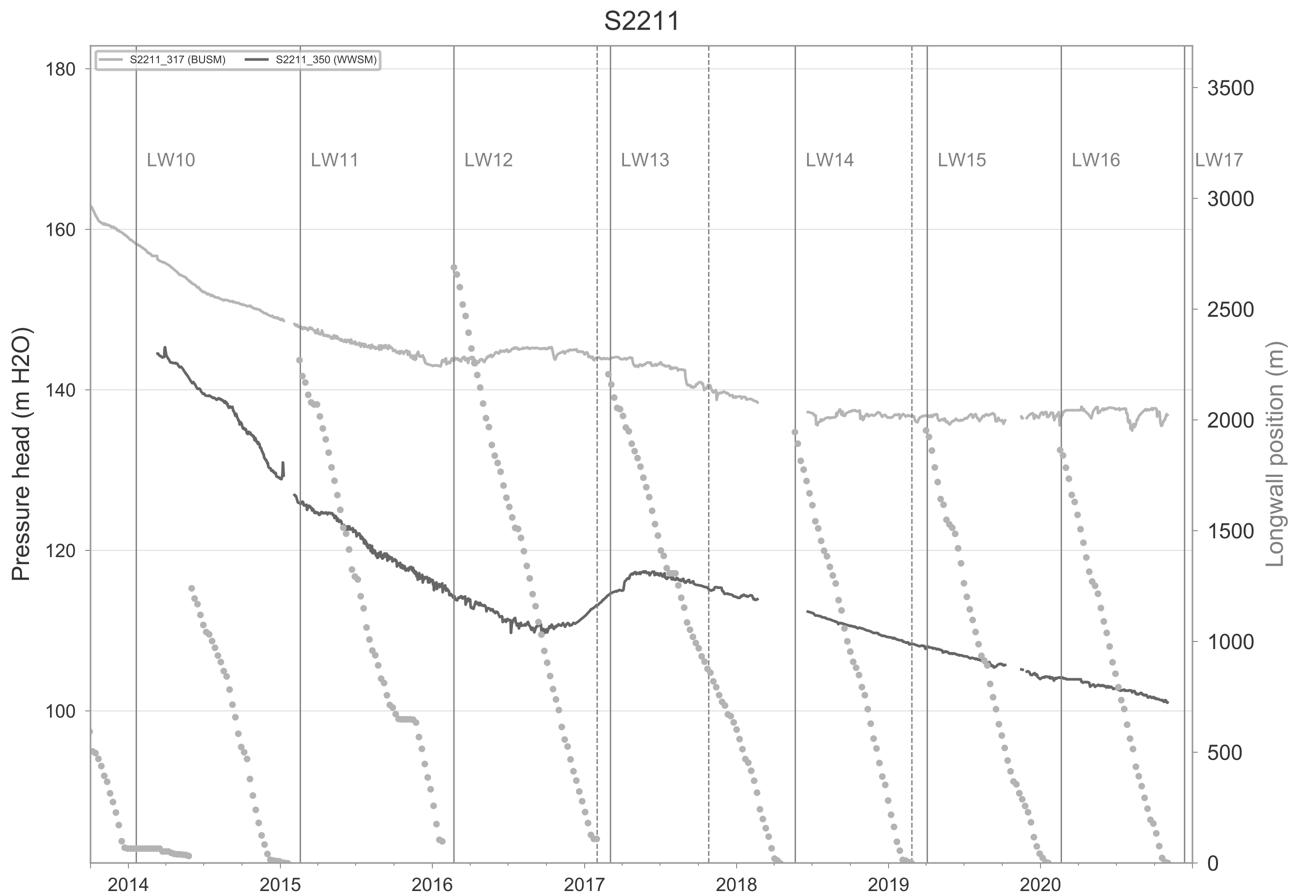

LW11
LW12
LW13
LW14
LW15
LW16
LW17
Ground RL
350
300
250
200
150
100
50
3500
3000
2500
2000
1500
1000
500
0
2015
2016
2017
2018
2019
2020
Piezometric head (m RL)
Longwall position (m)
S2208_23.5 (HBSS)
S2208_32.5 (HBSS)
S2208_77.7 (BGSS)
S2208_143.6 (BGSS)
S2208_219.4 (SBSS)
S2208_229.4 (SBSS)
S2208_280 (BUSM)
S2208_307.2 (WWSM)
Lake Cordeaux_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM

S2208

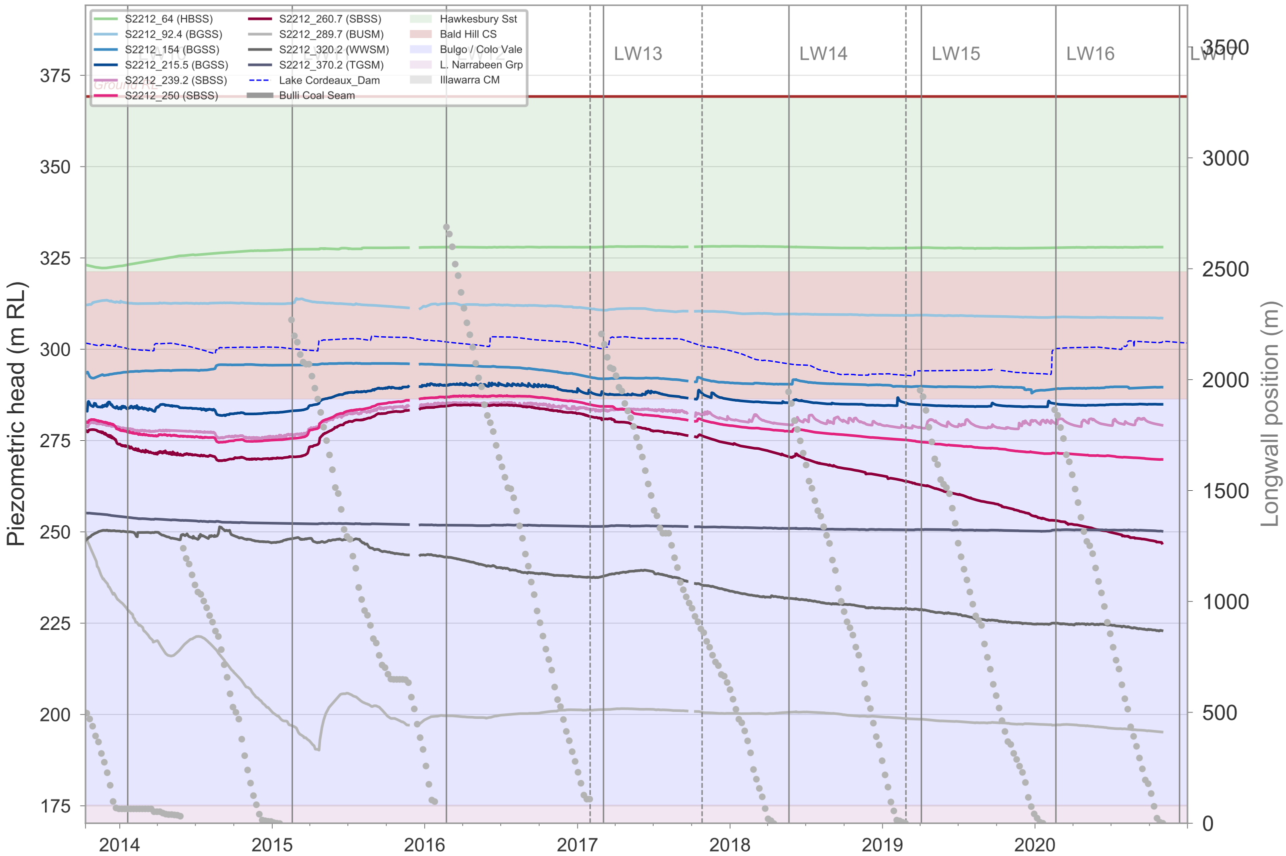

LW11
LW12
LW13
200
150
100
50
0
3500
3000
2500
2000
1500
1000
500
0
2015
2016
2017
2018
2019
2020
Pressure head (m H2O)
Longwall position (m)
S2208_23.5 (HBSS)
S2208_32.5 (HBSS)
S2208_77.7 (BGSS)
S2208_143.6 (BGSS)
S2208_219.4 (SBSS)
S2208_229.4 (SBSS)
S2208_280 (BUSM)
S2208_307.2 (WWSM)

Groundwater hydrographs

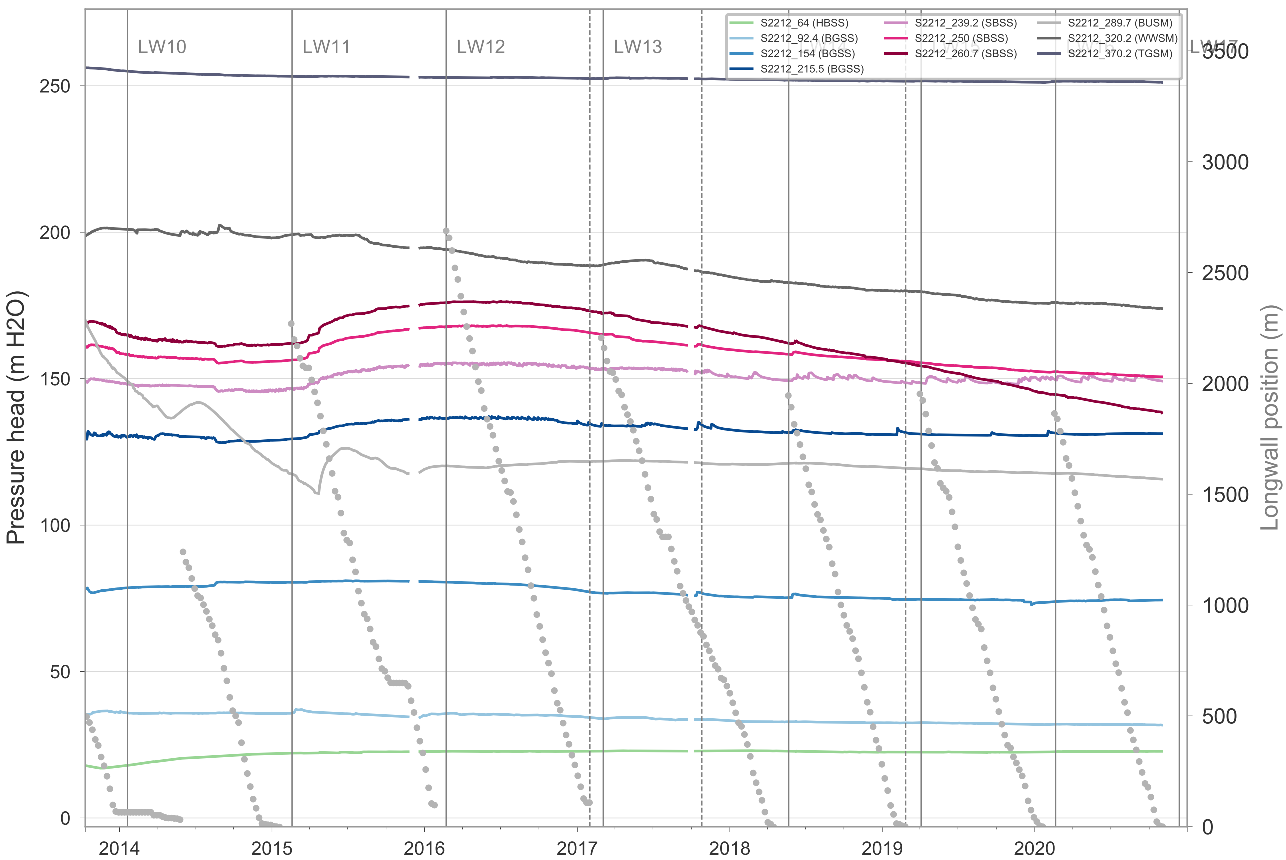


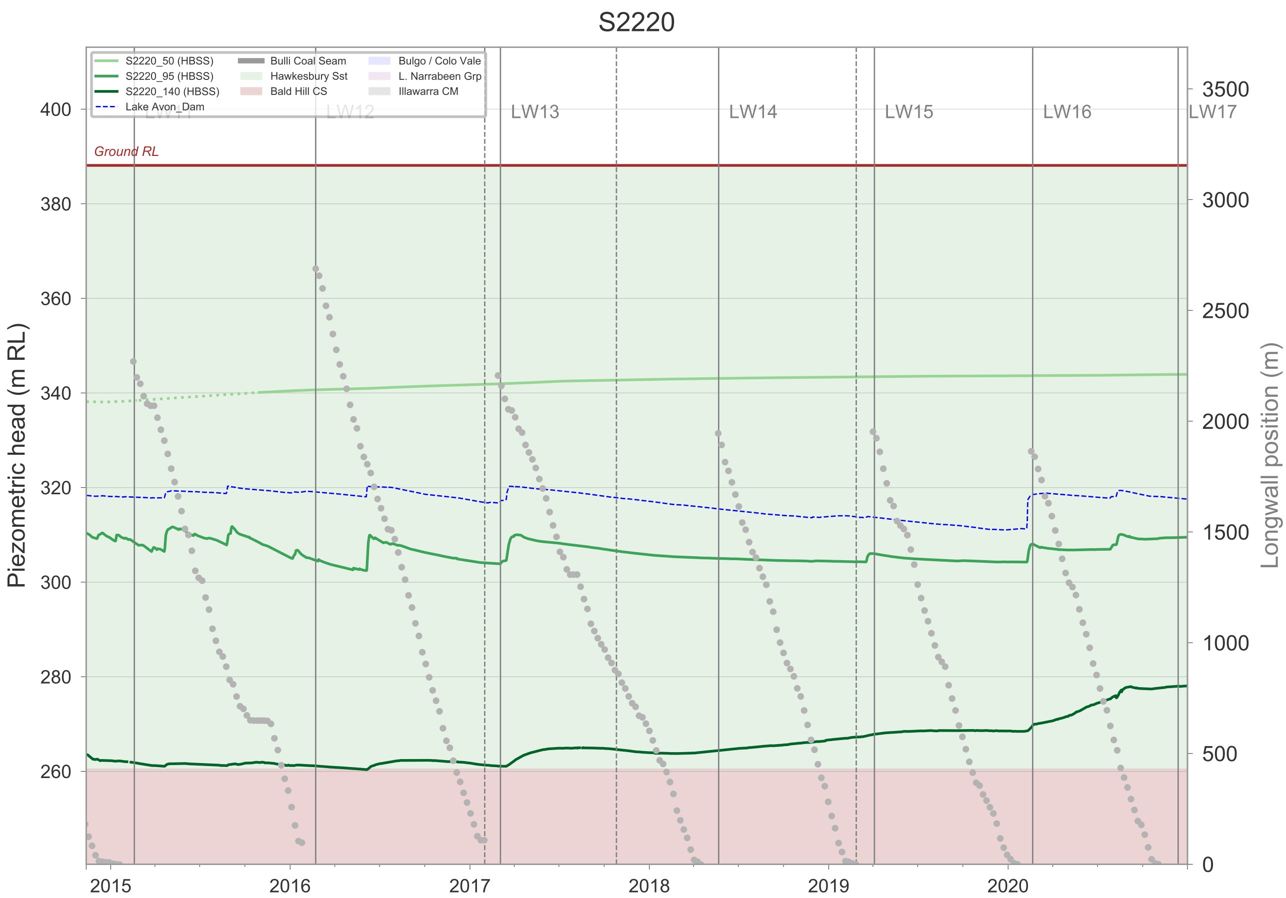


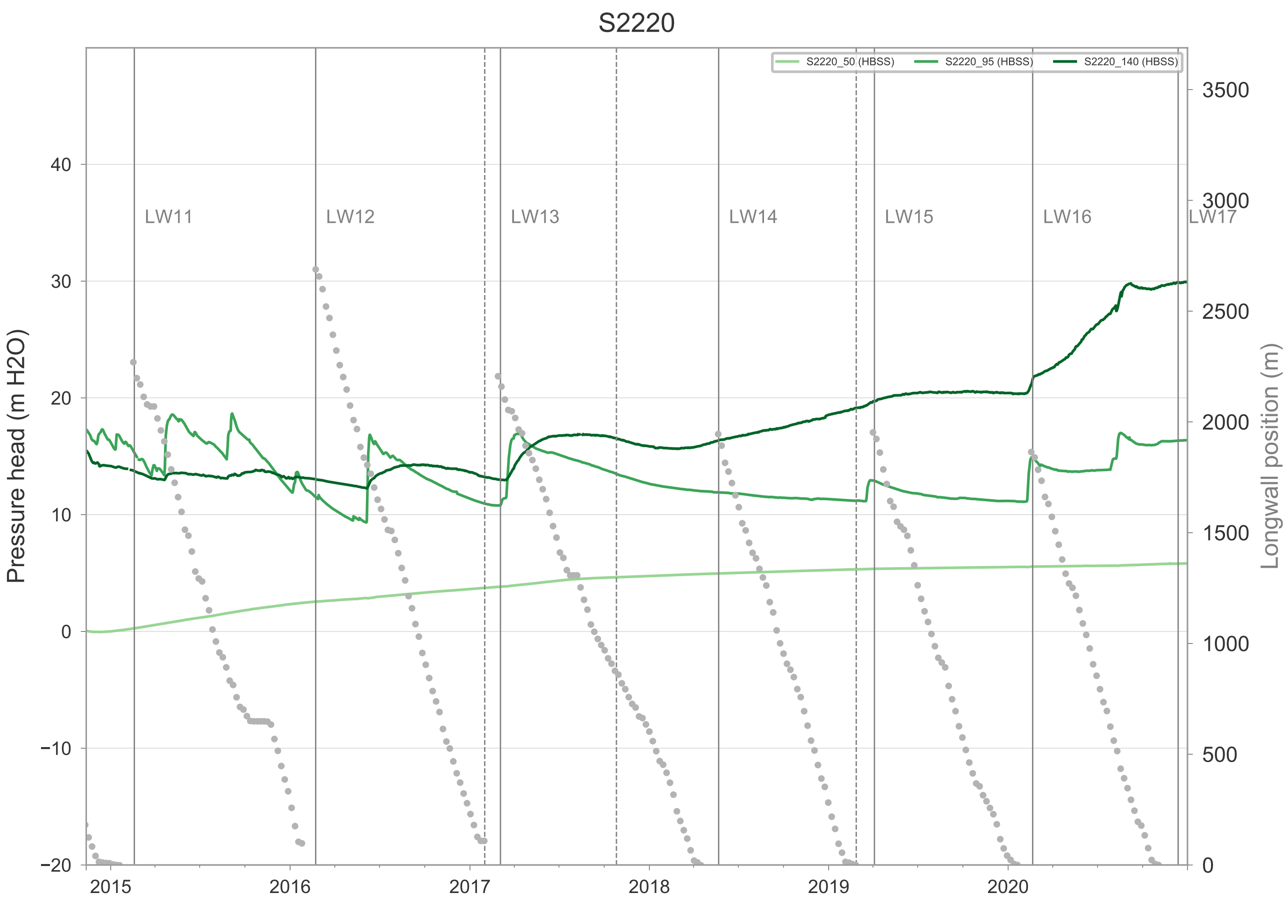
S2212

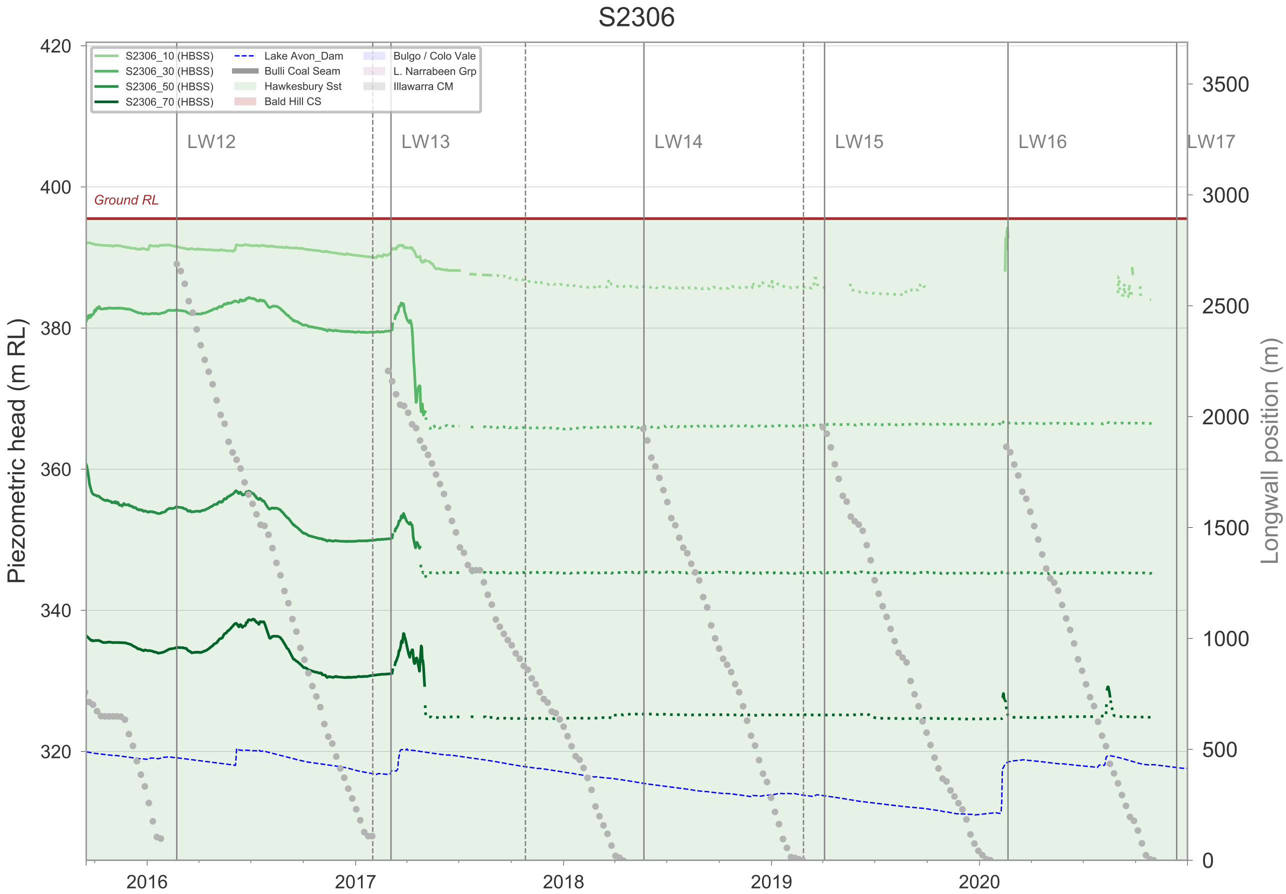

S2212_64 (HBSS)
S2212_92.4 (BGSS)
S2212_154 (BGSS)
S2212_215.5 (BGSS)
S2212_239.2 (SBSS)
S2212_250 (SBSS)
S2212_260.7 (SBSS)
S2212_289.7 (BUSM)
S2212_320.2 (WWSM)
S2212_370.2 (TGSM)
Lake Cordeaux_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
LW13
LW14
LW15
LW16
LW17
Piezometric head (m RL)
Longwall position (m)
2014
2015
2016
2017
2018
2019
2020

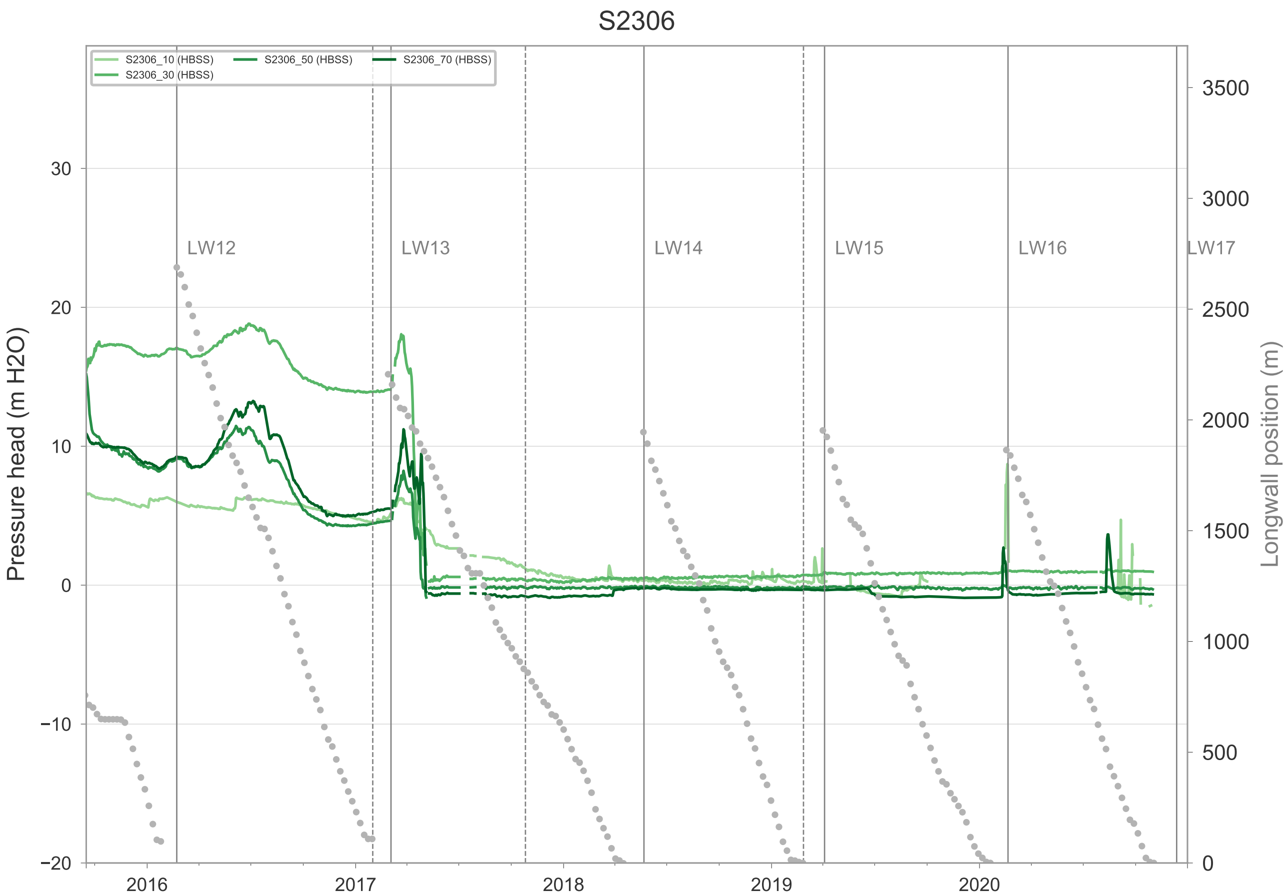
S2212


S2212_64 (HBSS)
S2212_92.4 (BGSS)
S2212_154 (BGSS)
S2212_215.5 (BGSS)
S2212_239.2 (SBSS)
S2212_250 (SBSS)
S2212_260.7 (SBSS)
S2212_289.7 (BUSM)
S2212_320.2 (WWSM)
S2212_370.2 (TGSM)
LW10
LW11
LW12
LW13
LW17
Pressure head (m H2O)
Longwall position (m)
2014
2015
2016
2017
2018
2019
2020

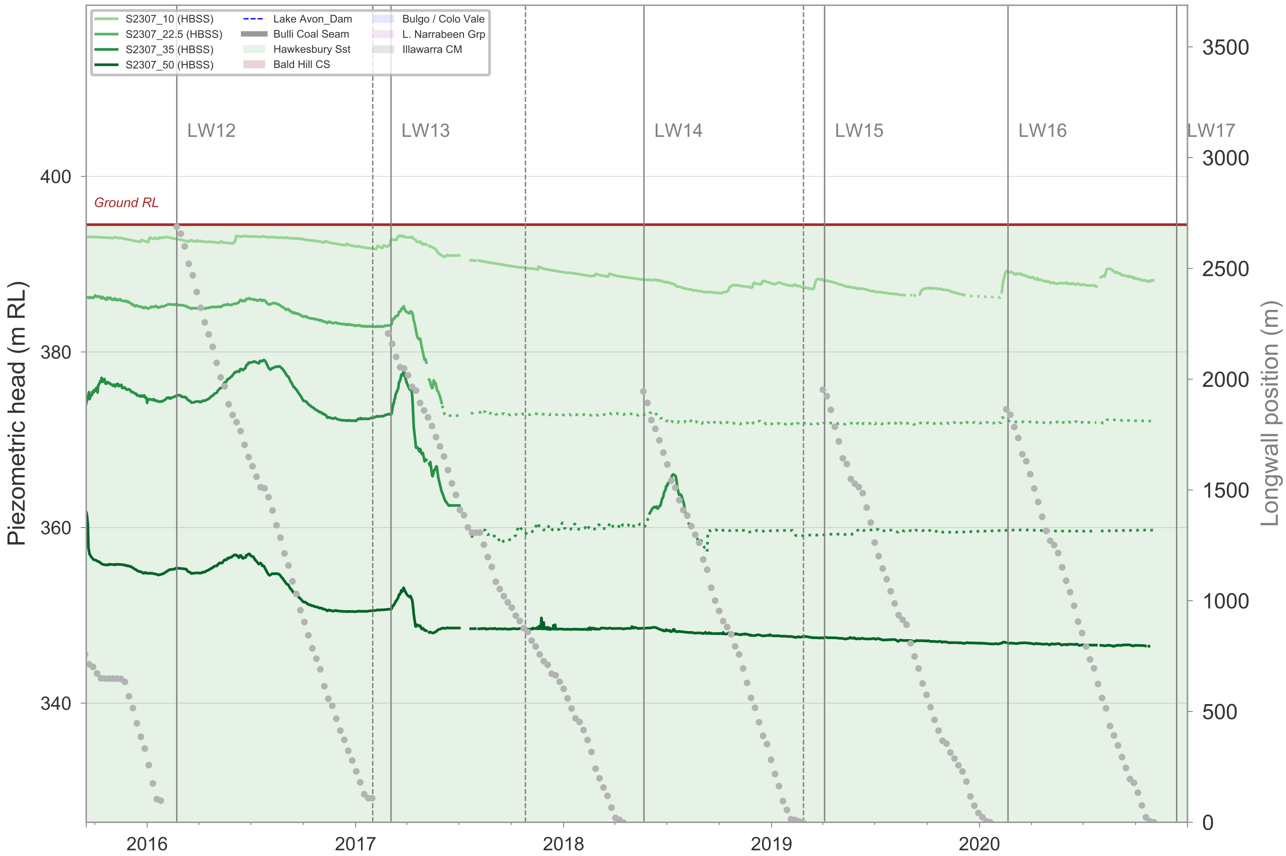

S2220
S2220_50 (HBSS)
S2220_95 (HBSS)
S2220_140 (HBSS)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
Ground RL
LW13
LW14
LW15
LW16
LW17
Piezometric head (m RL)
Longwall position (m)
400
380
360
340
320
300
280
260
3500
3000
2500
2000
1500
1000
500
0
2015
2016
2017
2018
2019
2020


S2220
S2220_50 (HBSS)
S2220_95 (HBSS)
S2220_140 (HBSS)
LW11
LW12
LW13
LW14
LW15
LW16
LW17
Pressure head (m H2O)
Longwall position (m)
40
30
20
10
0
−10
−20
3500
3000
2500
2000
1500
1000
500
0
2015
2016
2017
2018
2019
2020


S2306
S2306_10 (HBSS)
S2306_30 (HBSS)
S2306_50 (HBSS)
S2306_70 (HBSS)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
Ground RL
LW12
LW13
LW14
LW15
LW16
LW17
Piezometric head (m RL)
Longwall position (m)
420
400
380
360
340
320
3500
3000
2500
2000
1500
1000
500
0
2016
2017
2018
2019
2020

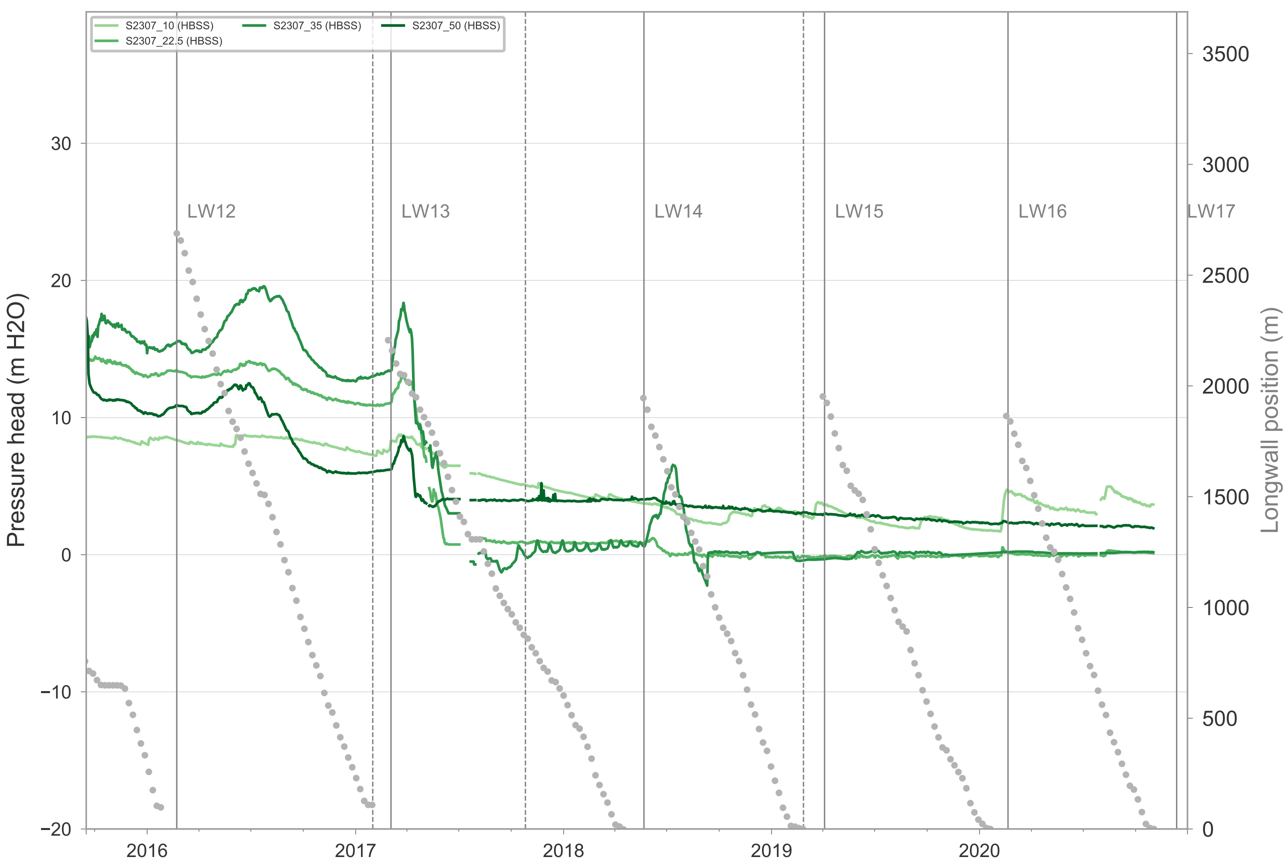

S2306
S2306_10 (HBSS)
S2306_30 (HBSS)
S2306_50 (HBSS)
S2306_70 (HBSS)
LW12
LW13
LW14
LW15
LW16
LW17
Pressure head (m H2O)
Longwall position (m)
30
20
10
0
−10
−20
3500
3000
2500
2000
1500
1000
500
0
2016
2017
2018
2019
2020

S2307

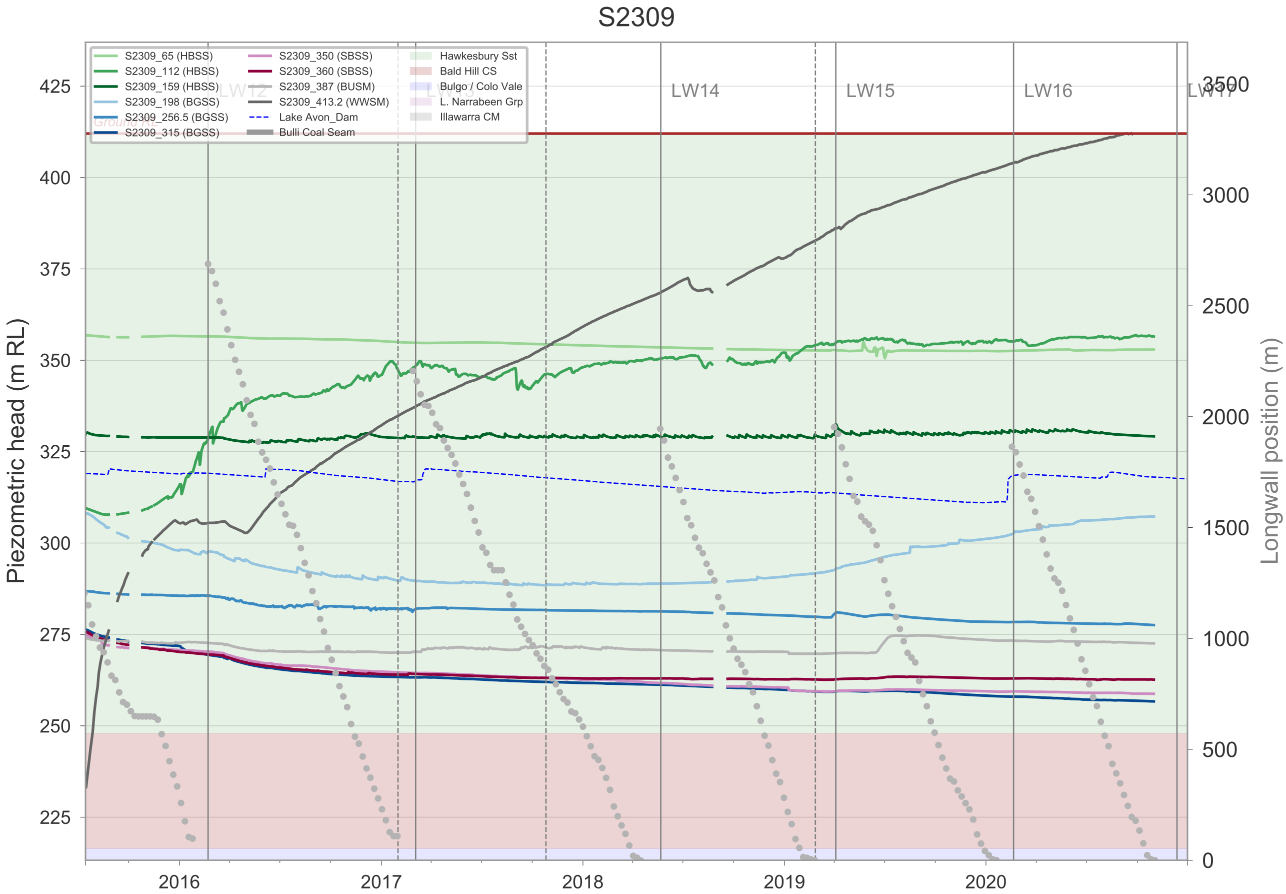


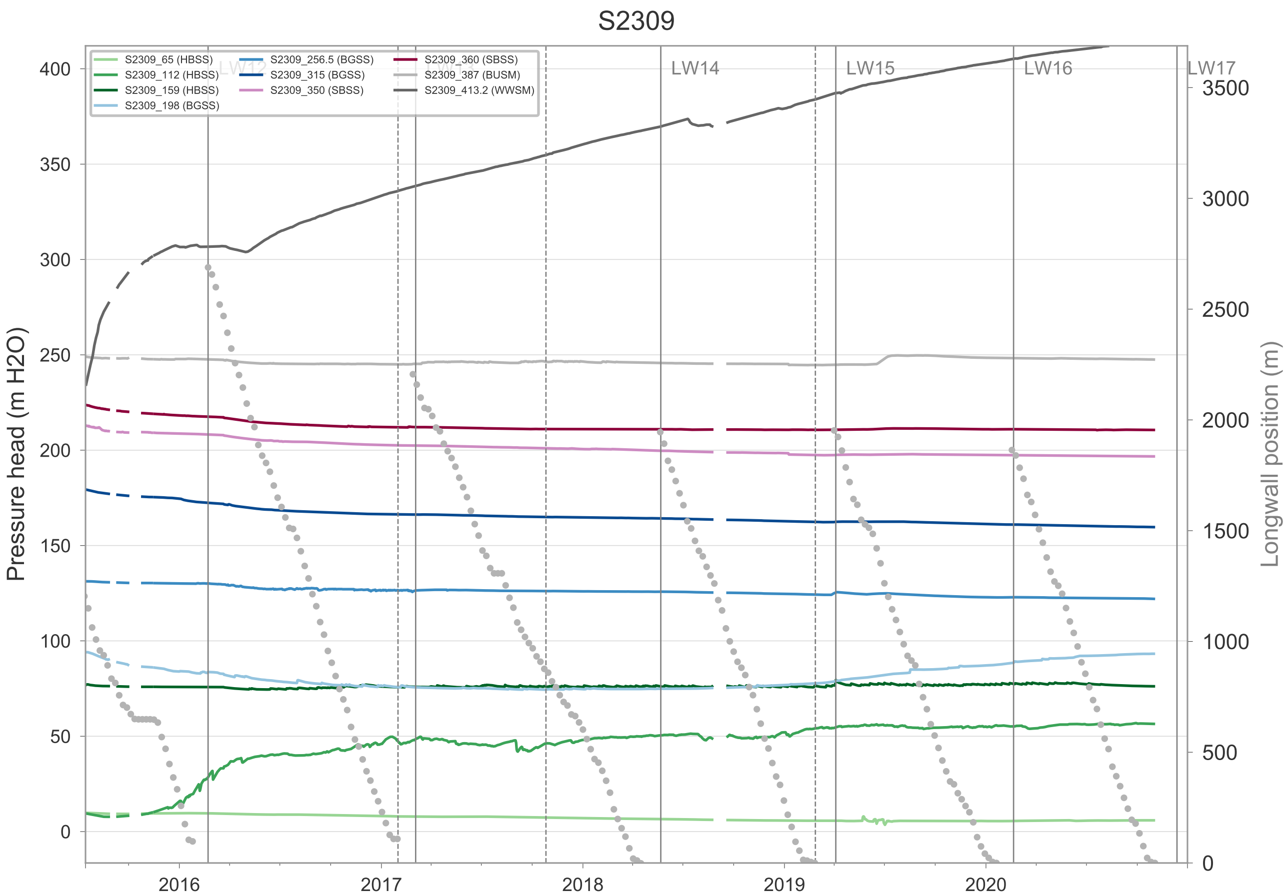
S2307_10 (HBSS)
S2307_22.5 (HBSS)
S2307_35 (HBSS)
S2307_50 (HBSS)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
LW12
LW13
LW14
LW15
LW16
LW17
Ground RL
Piezometric head (m RL)
Longwall position (m)
400
380
360
340
3500
3000
2500
2000
1500
1000
500
0
2016
2017
2018
2019
2020

S2307

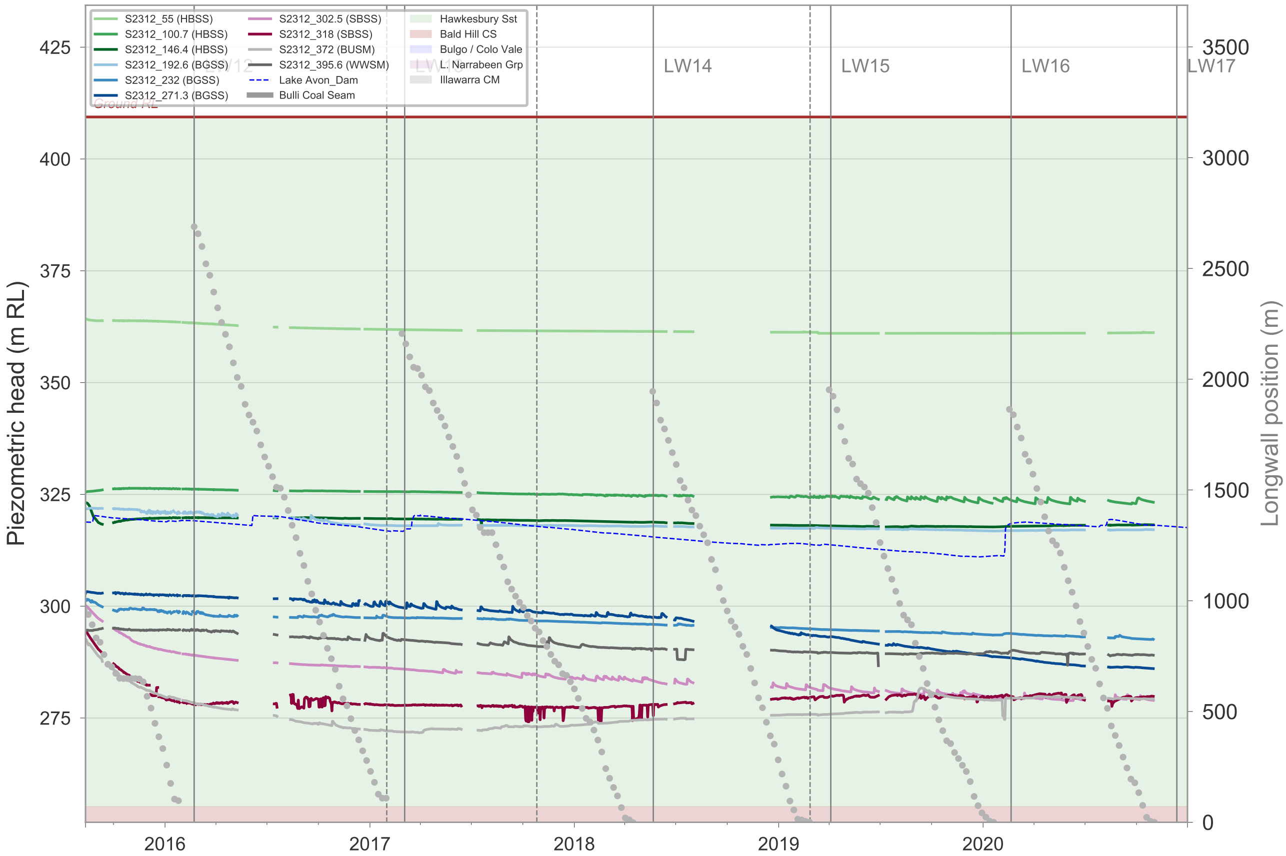


S2307_10 (HBSS)
S2307_22.5 (HBSS)
S2307_35 (HBSS)
S2307_50 (HBSS)
LW12
LW13
LW14
LW15
LW16
LW17
Pressure head (m H2O)
Longwall position (m)
30
20
10
0
−10
−20
3500
3000
2500
2000
1500
1000
500
0
2016
2017
2018
2019
2020


S2309
S2309_65 (HBSS)
S2309_112 (HBSS)
S2309_159 (HBSS)
S2309_198 (BGSS)
S2309_256.5 (BGSS)
S2309_315 (BGSS)
S2309_350 (SBSS)
S2309_360 (SBSS)
S2309_387 (BUSM)
S2309_413.2 (WWSM)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
LW14
LW15
LW16
LW17
Piezometric head (m RL)
Longwall position (m)
2016
2017
2018
2019
2020

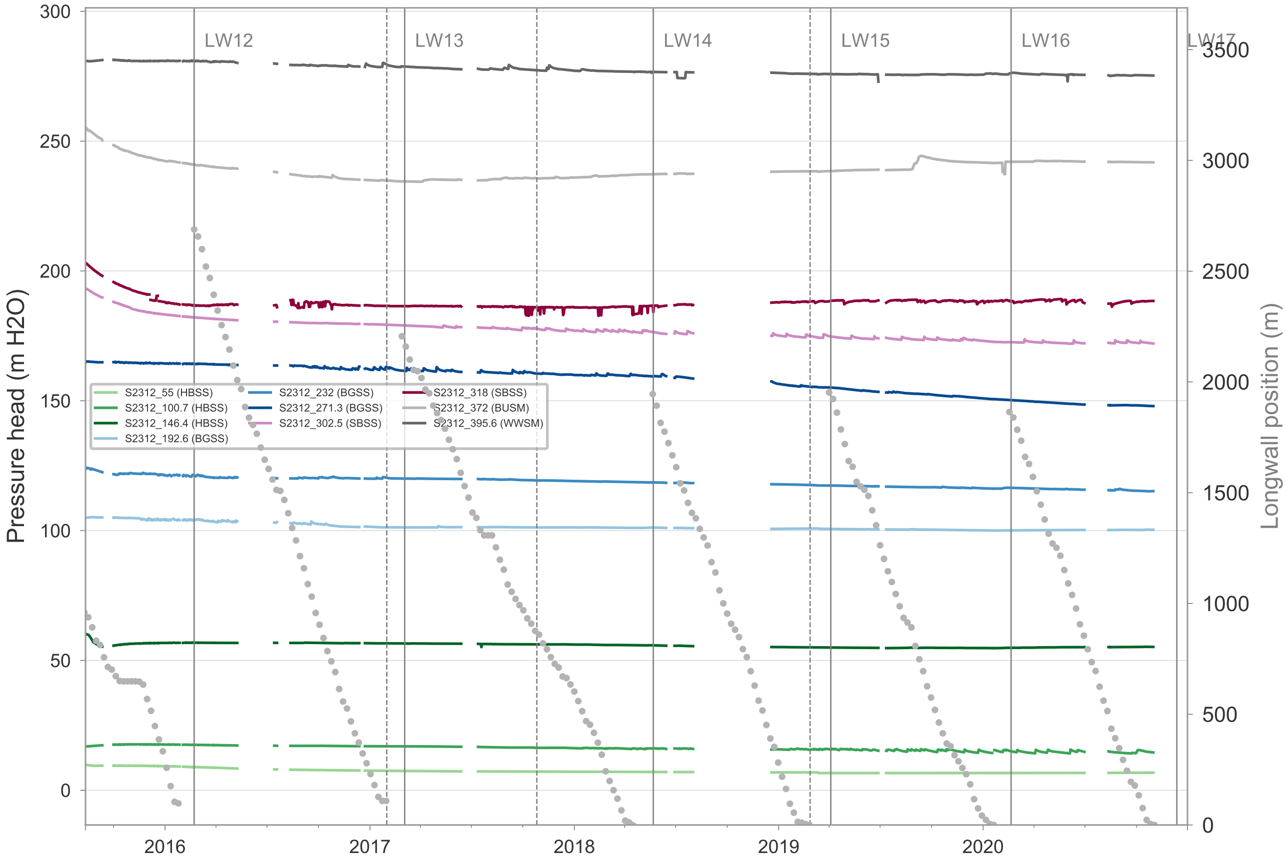

S2309
S2309_65 (HBSS)
S2309_112 (HBSS)
S2309_159 (HBSS)
S2309_198 (BGSS)
S2309_256.5 (BGSS)
S2309_315 (BGSS)
S2309_350 (SBSS)
S2309_360 (SBSS)
S2309_387 (BUSM)
S2309_413.2 (WWSM)
LW14
LW15
LW16
LW17
Pressure head (m H2O)
Longwall position (m)
2016
2017
2018
2019
2020

S2312



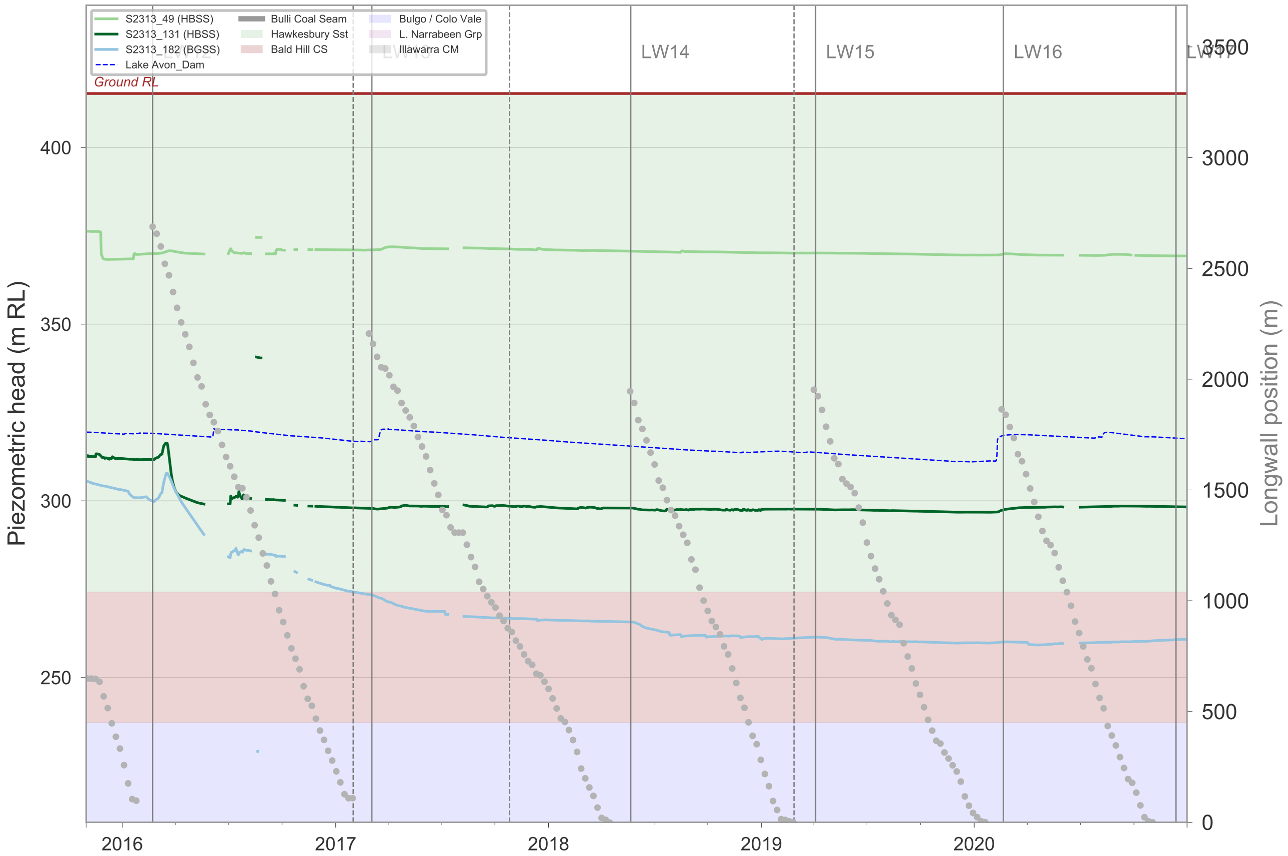
S2312_55 (HBSS)
S2312_100.7 (HBSS)
S2312_146.4 (HBSS)
S2312_192.6 (BGSS)
S2312_232 (BGSS)
S2312_271.3 (BGSS)
S2312_302.5 (SBSS)
S2312_318 (SBSS)
S2312_372 (BUSM)
S2312_395.6 (WWSM)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
LW14
LW15
LW16
LW17
Piezometric head (m RL)
Longwall position (m)
2016
2017
2018
2019
2020

S2312

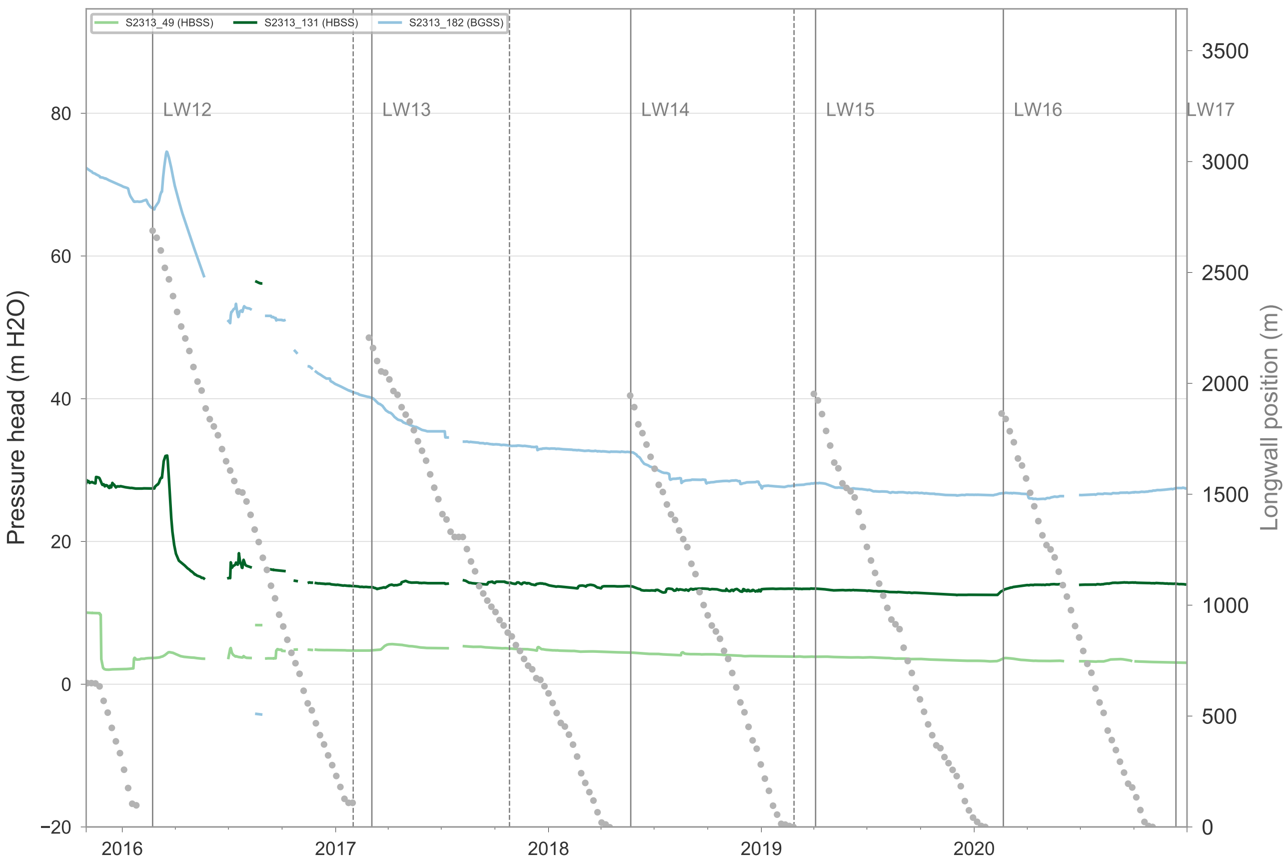


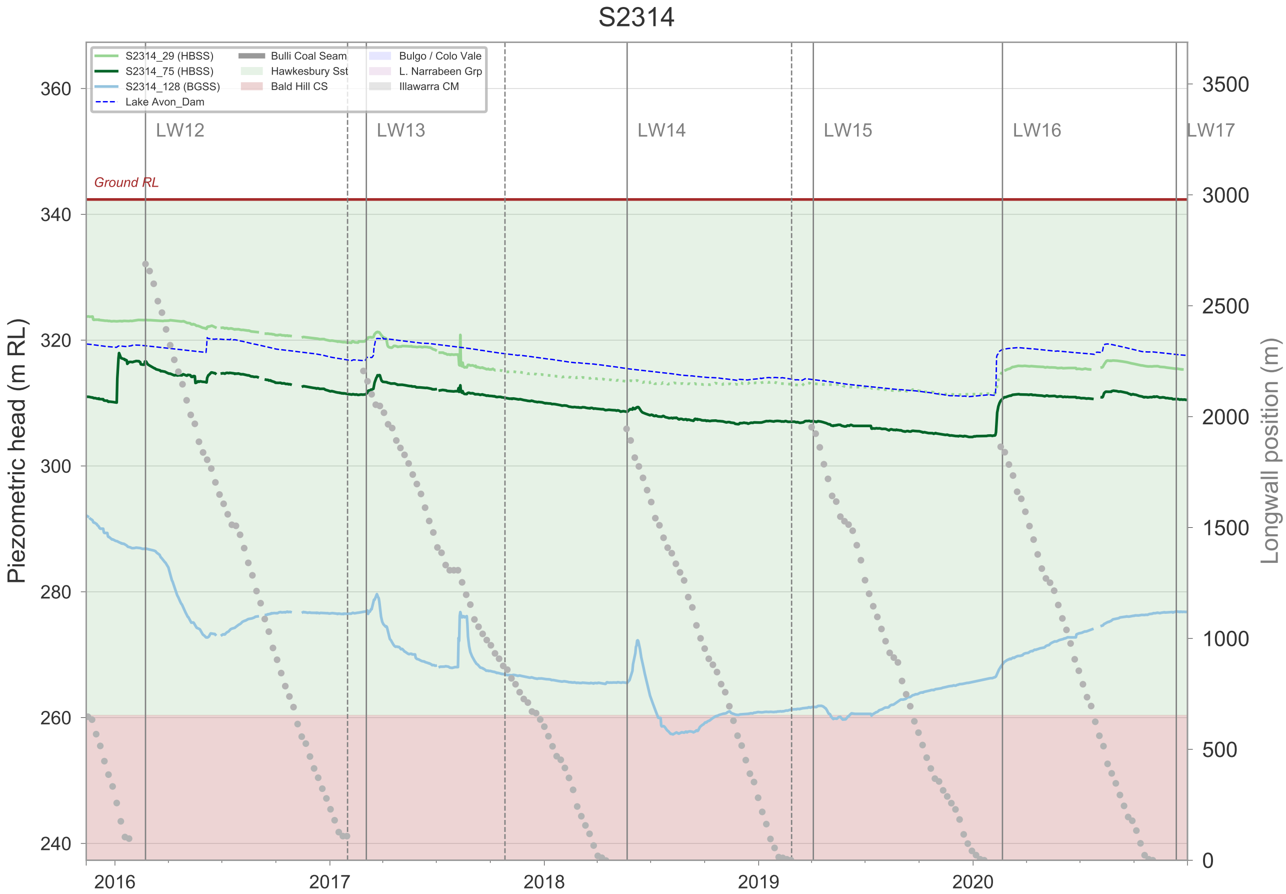
LW12
LW13
LW14
LW15
LW16
LW17
S2312_55 (HBSS)
S2312_100.7 (HBSS)
S2312_146.4 (HBSS)
S2312_192.6 (BGSS)
S2312_232 (BGSS)
S2312_271.3 (BGSS)
S2312_302.5 (SBSS)
S2312_318 (SBSS)
S2312_372 (BUSM)
S2312_395.6 (WWSM)
Pressure head (m H2O)
Longwall position (m)
2016
2017
2018
2019
2020

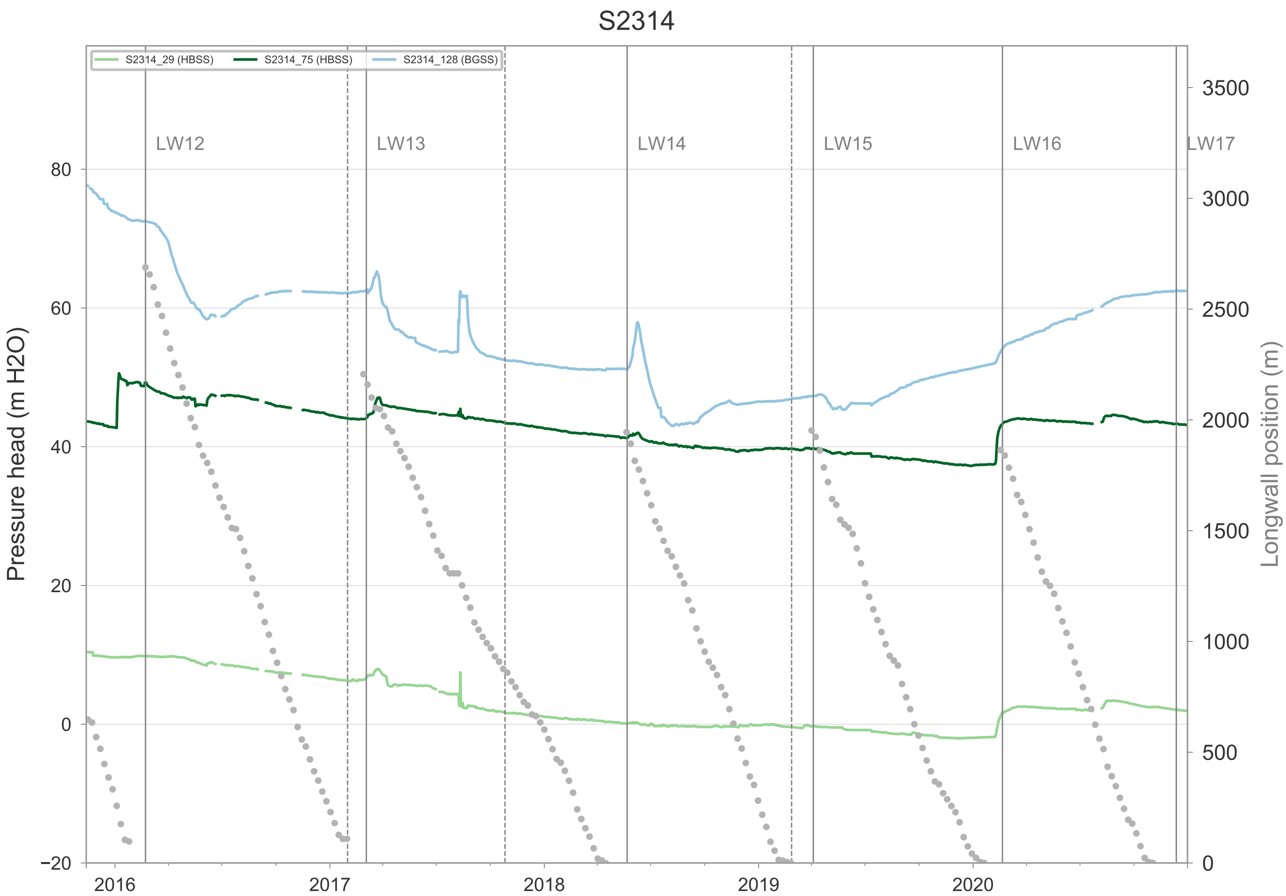
S2313

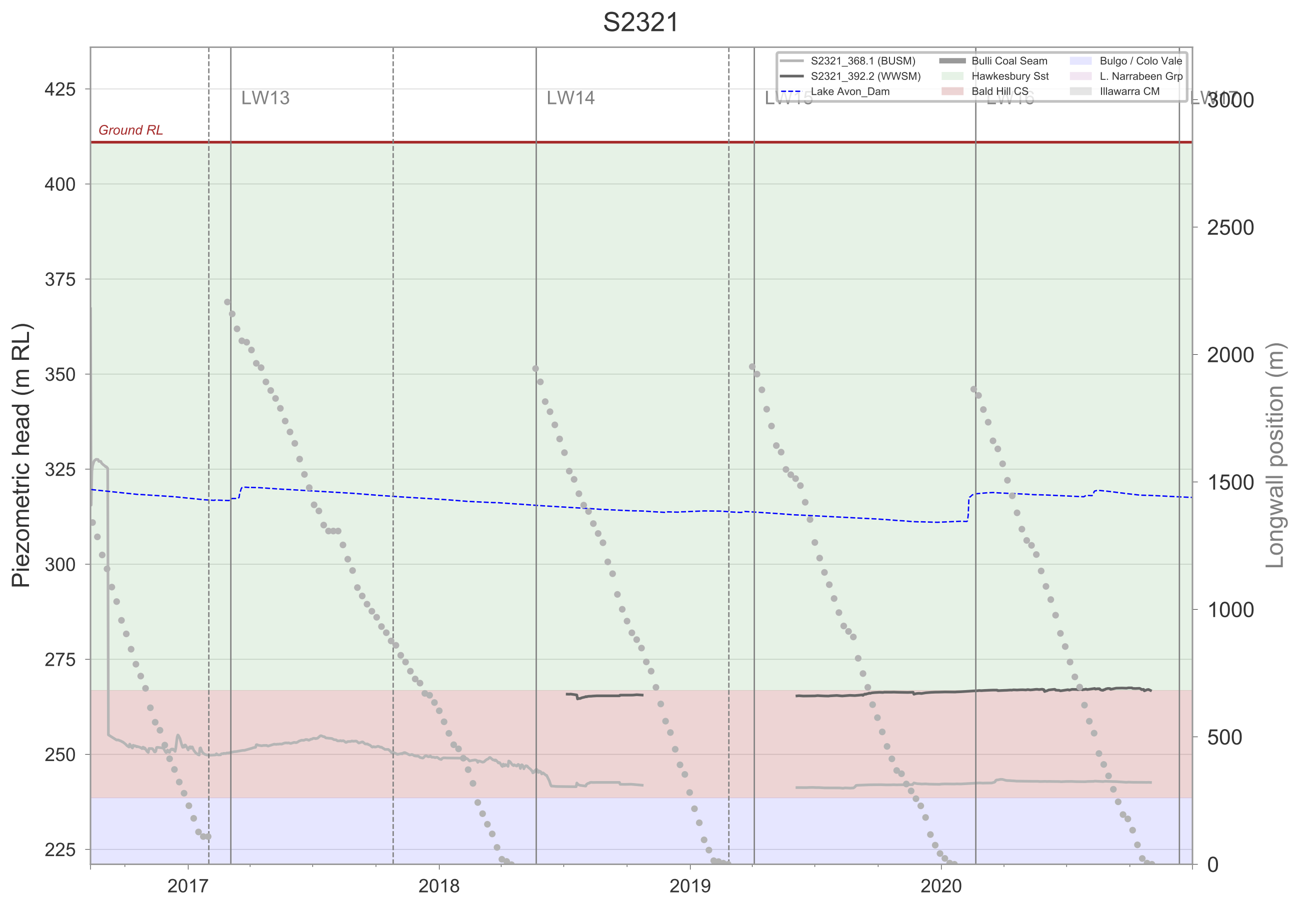

S2313_49 (HBSS)
S2313_131 (HBSS)
S2313_182 (BGSS)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
Ground RL
LW14
LW15
LW16
LW17
Piezometric head (m RL)
Longwall position (m)
400
350
300
250
3500
3000
2500
2000
1500
1000
500
0
2016
2017
2018
2019
2020

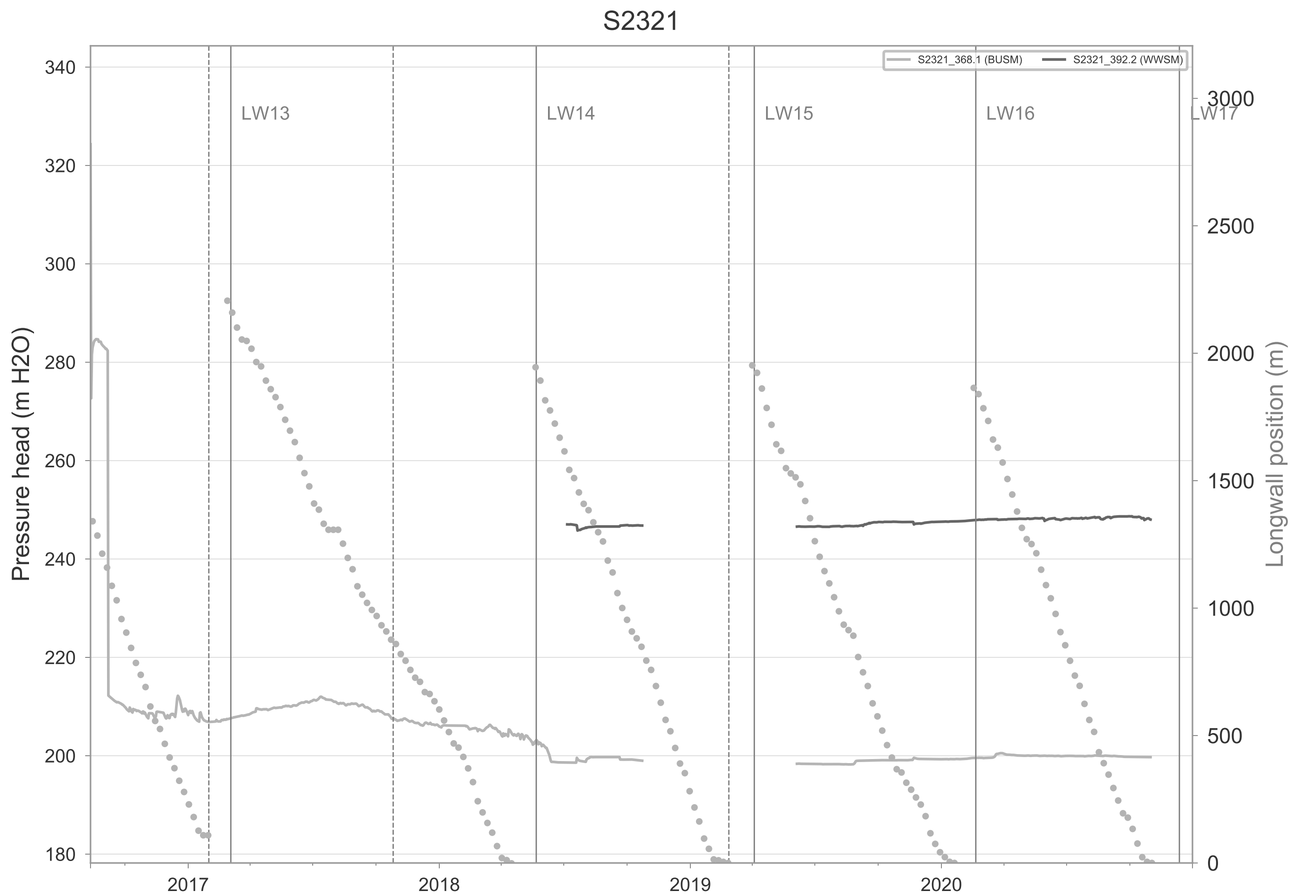
S2313


S2313_49 (HBSS)
S2313_131 (HBSS)
S2313_182 (BGSS)
LW12
LW13
LW14
LW15
LW16
LW17
Pressure head (m H2O)
Longwall position (m)
80
60
40
20
0
−20
3500
3000
2500
2000
1500
1000
500
0
2016
2017
2018
2019
2020


S2314
S2314_29 (HBSS)
S2314_75 (HBSS)
S2314_128 (BGSS)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
Ground RL
LW12
LW13
LW14
LW15
LW16
LW17
Piezometric head (m RL)
Longwall position (m)
2016
2017
2018
2019
2020

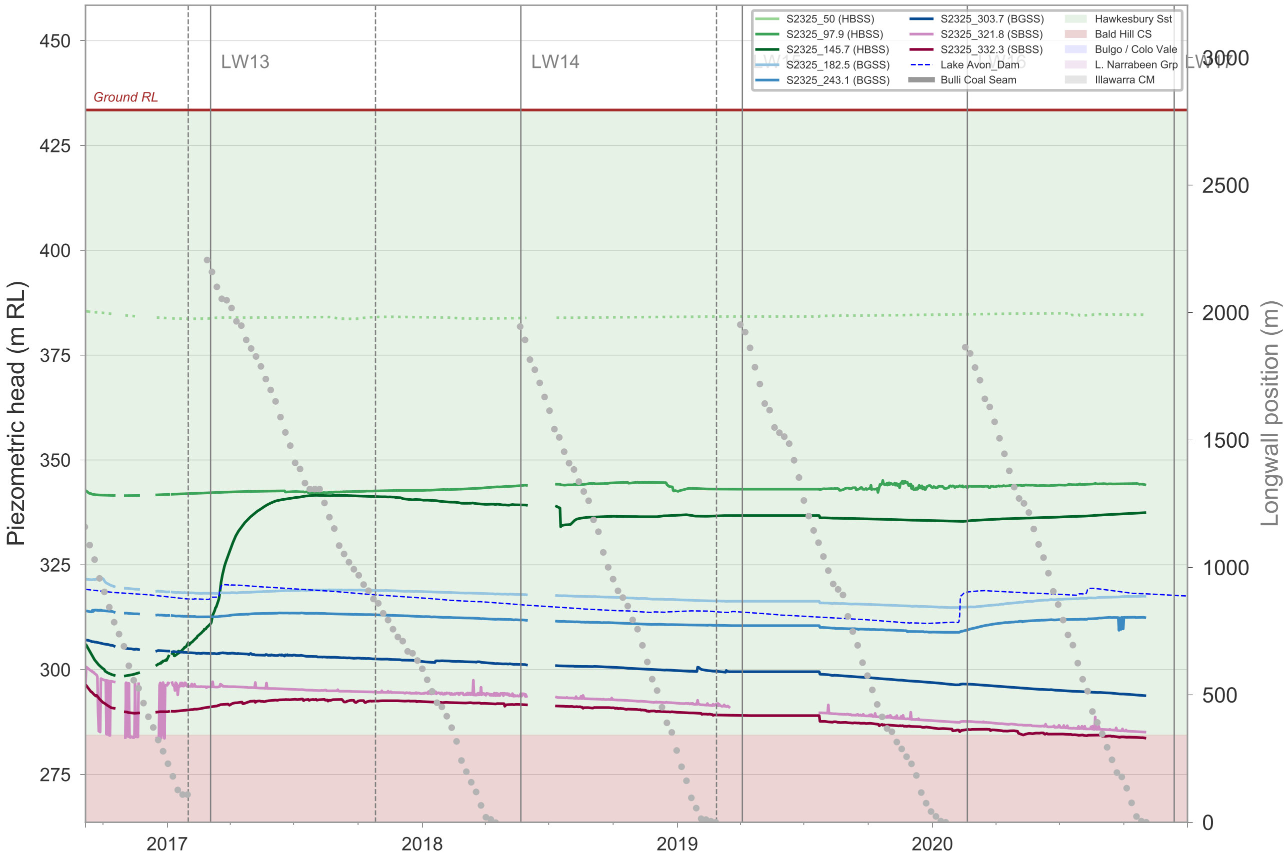

S2314
S2314_29 (HBSS)
S2314_75 (HBSS)
S2314_128 (BGSS)
LW12
LW13
LW14
LW15
LW16
LW17
Pressure head (m H2O)
Longwall position (m)
2016
2017
2018
2019
2020


S2321
Piezometric head (m RL)
Longwall position (m)
Ground RL
LW13
LW14
S2321_368.1 (BUSM)
S2321_392.2 (WWSM)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
425
400
375
350
325
300
275
250
225
3000
2500
2000
1500
1000
500
0
2017
2018
2019
2020

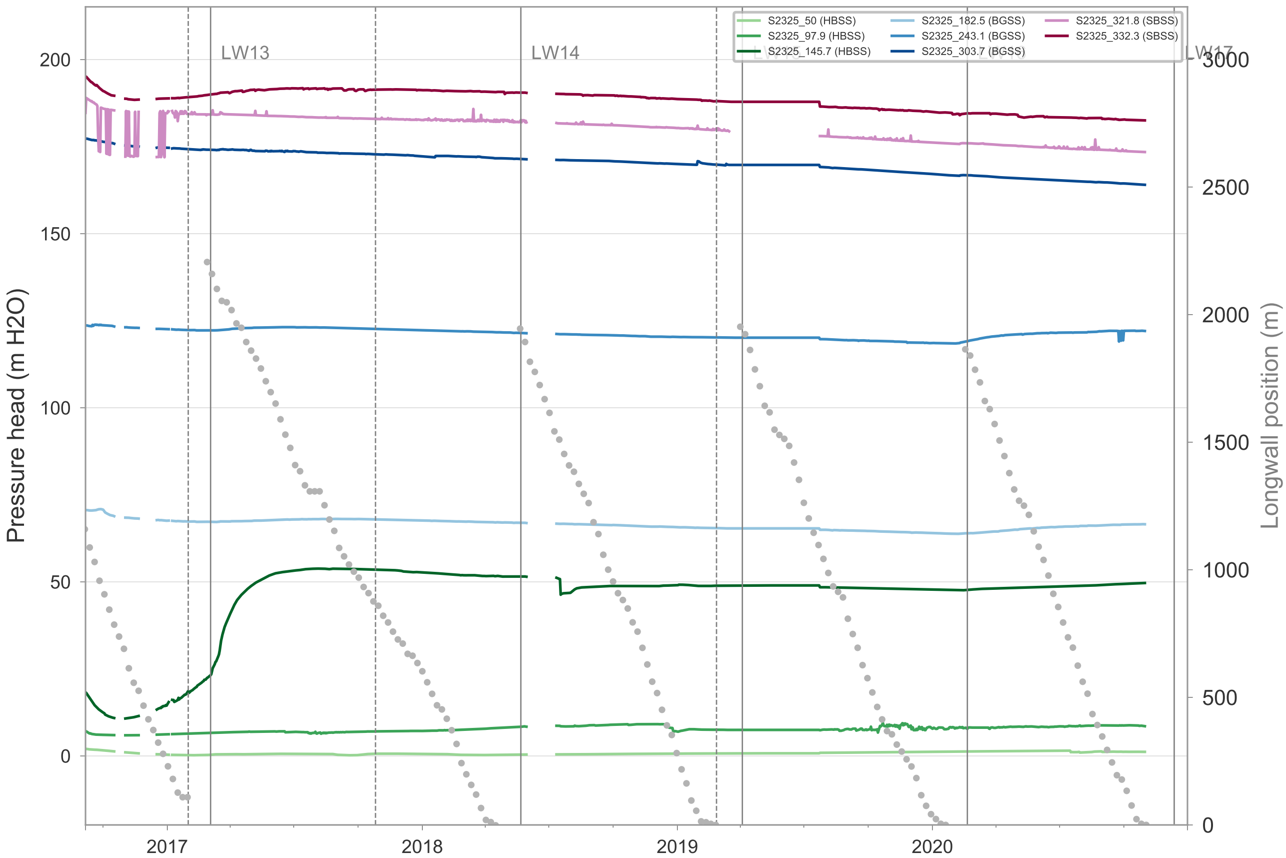

S2321
Pressure head (m H2O)
Longwall position (m)
S2321_368.1 (BUSM)
S2321_392.2 (WWSM)
LW13
LW14
LW15
LW16
LW17
340
320
300
280
260
240
220
200
180
3000
2500
2000
1500
1000
500
0
2017
2018
2019
2020

Groundwater hydrographs

S2325

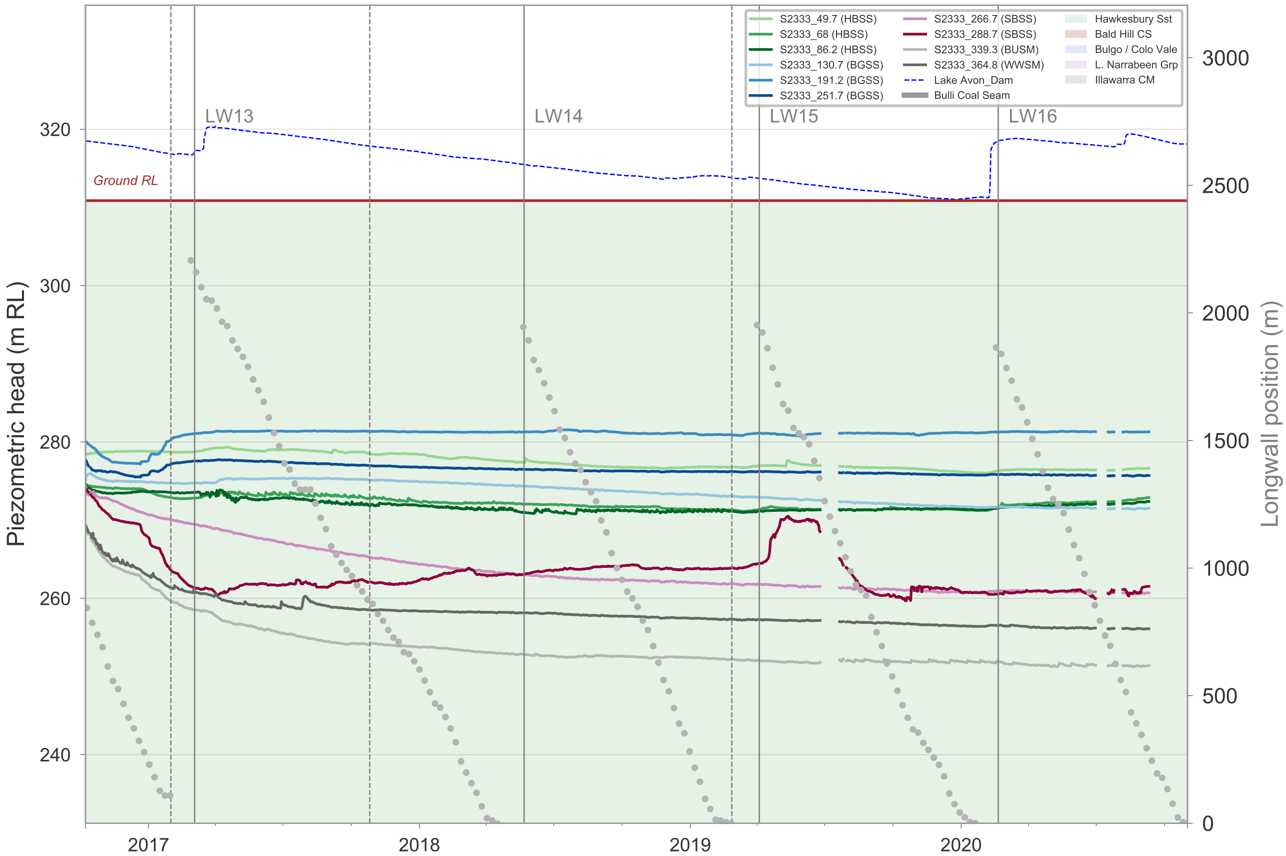


S2325

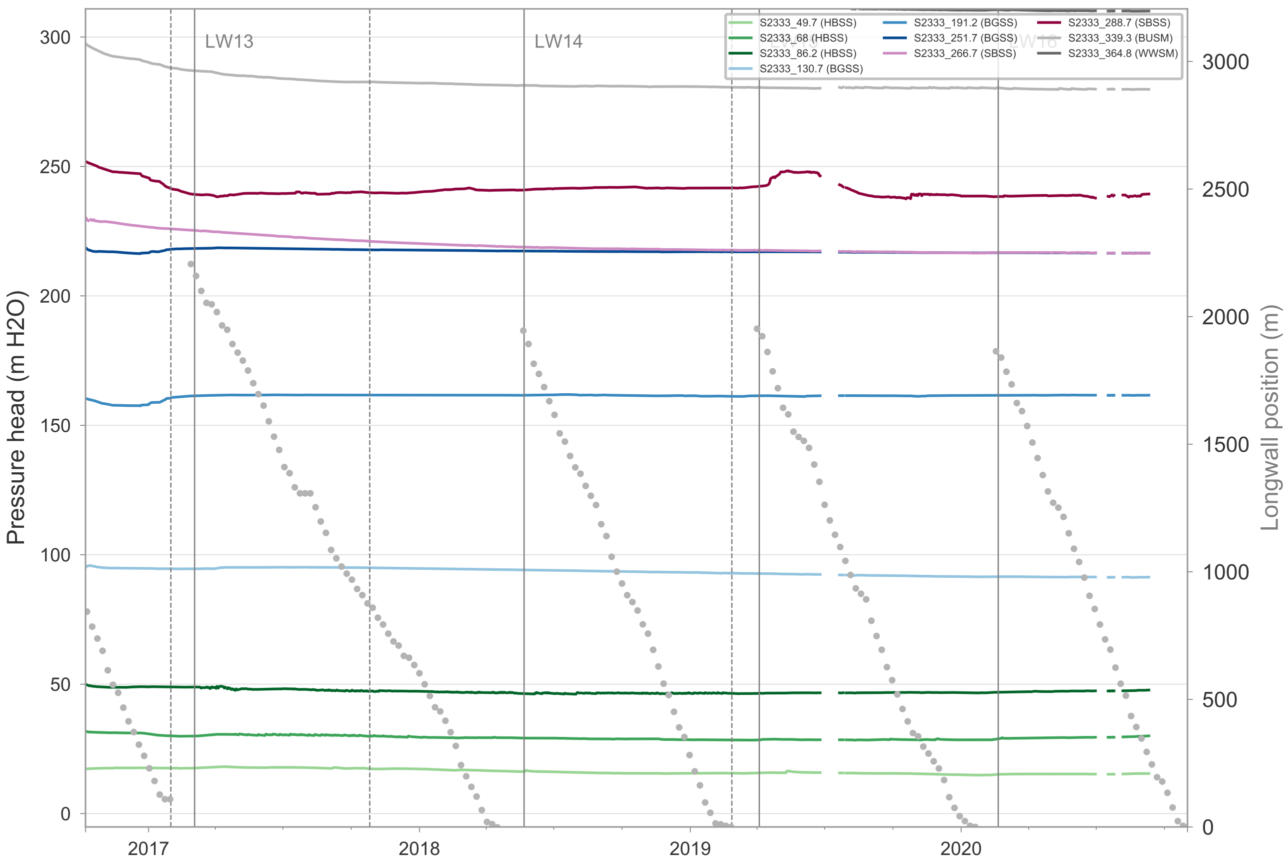


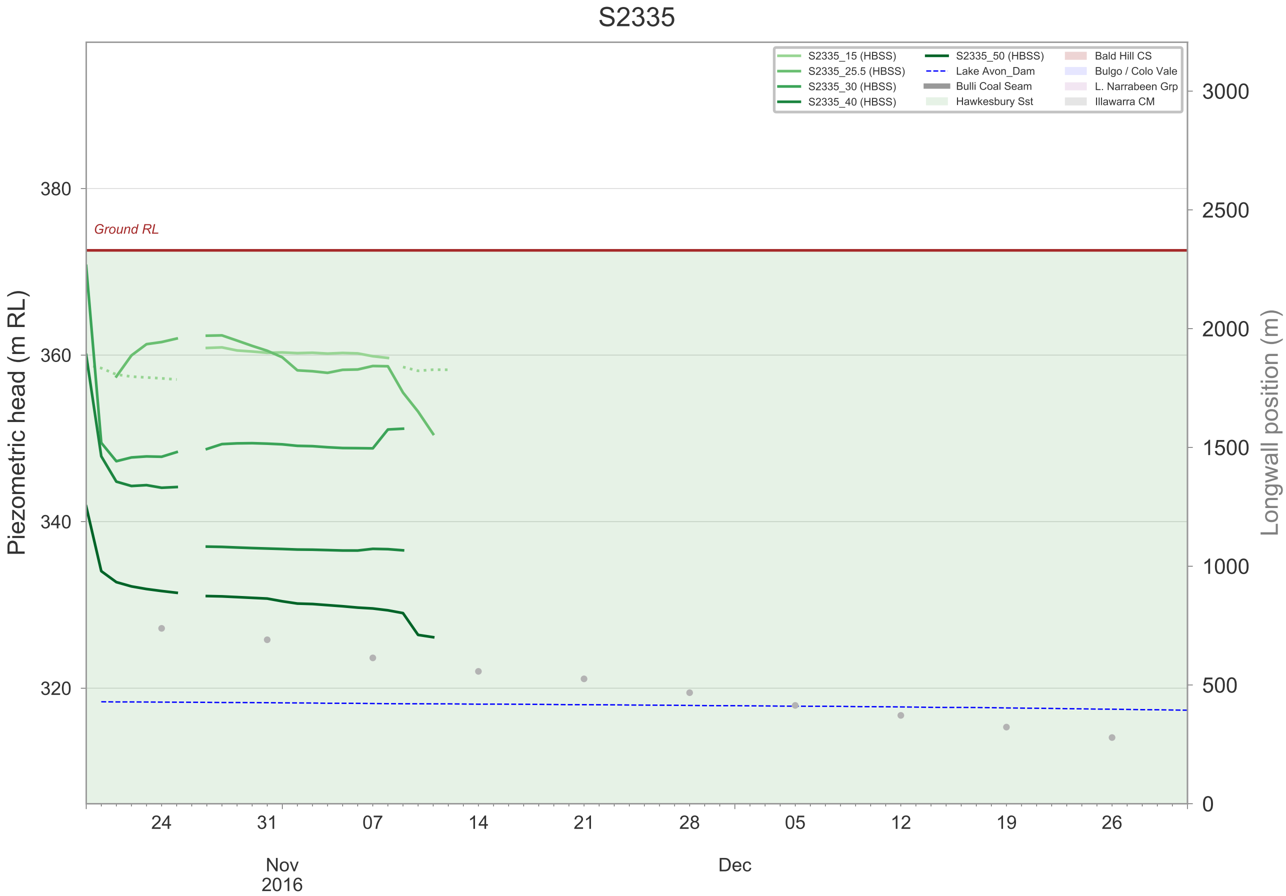
Groundwater hydrographs

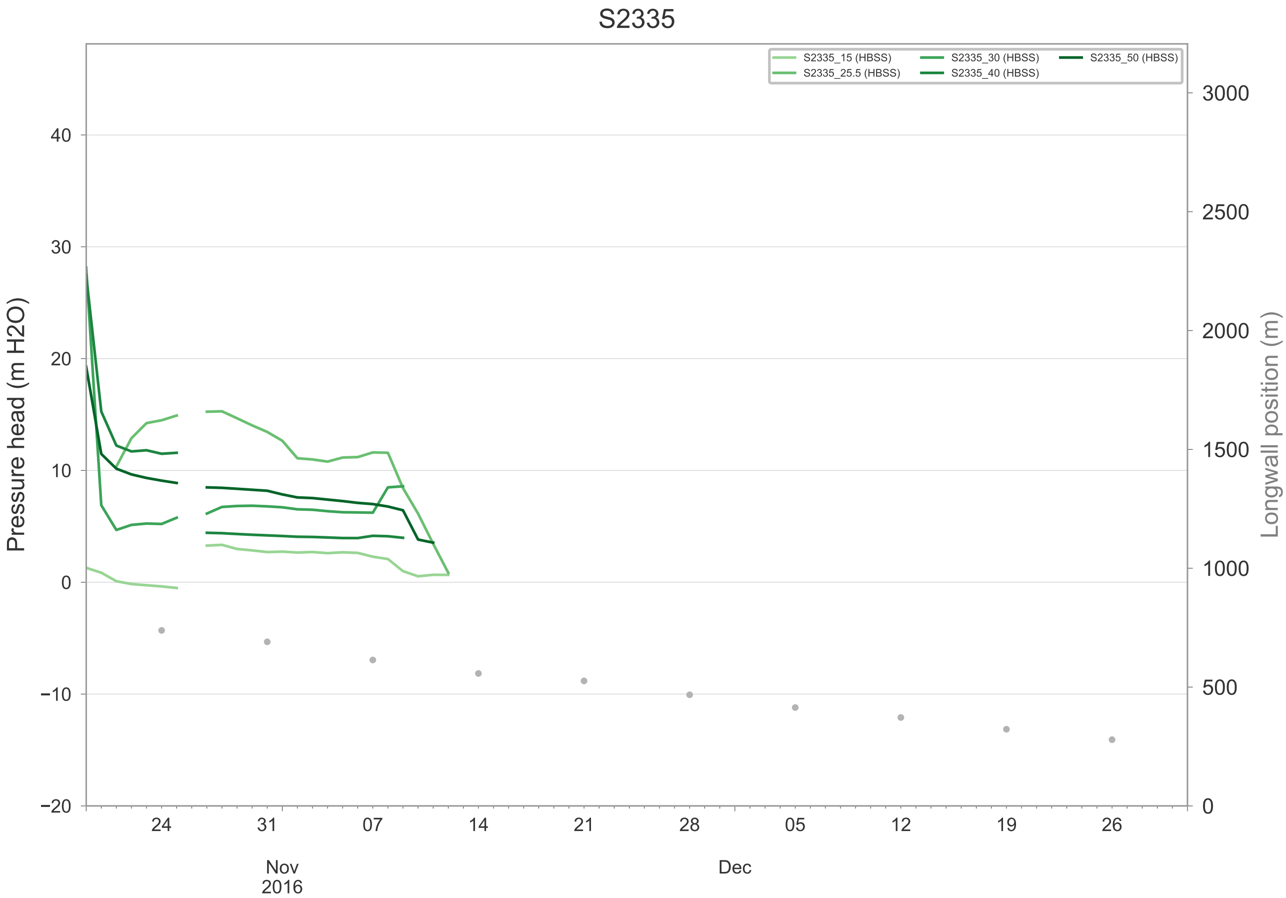
S2333



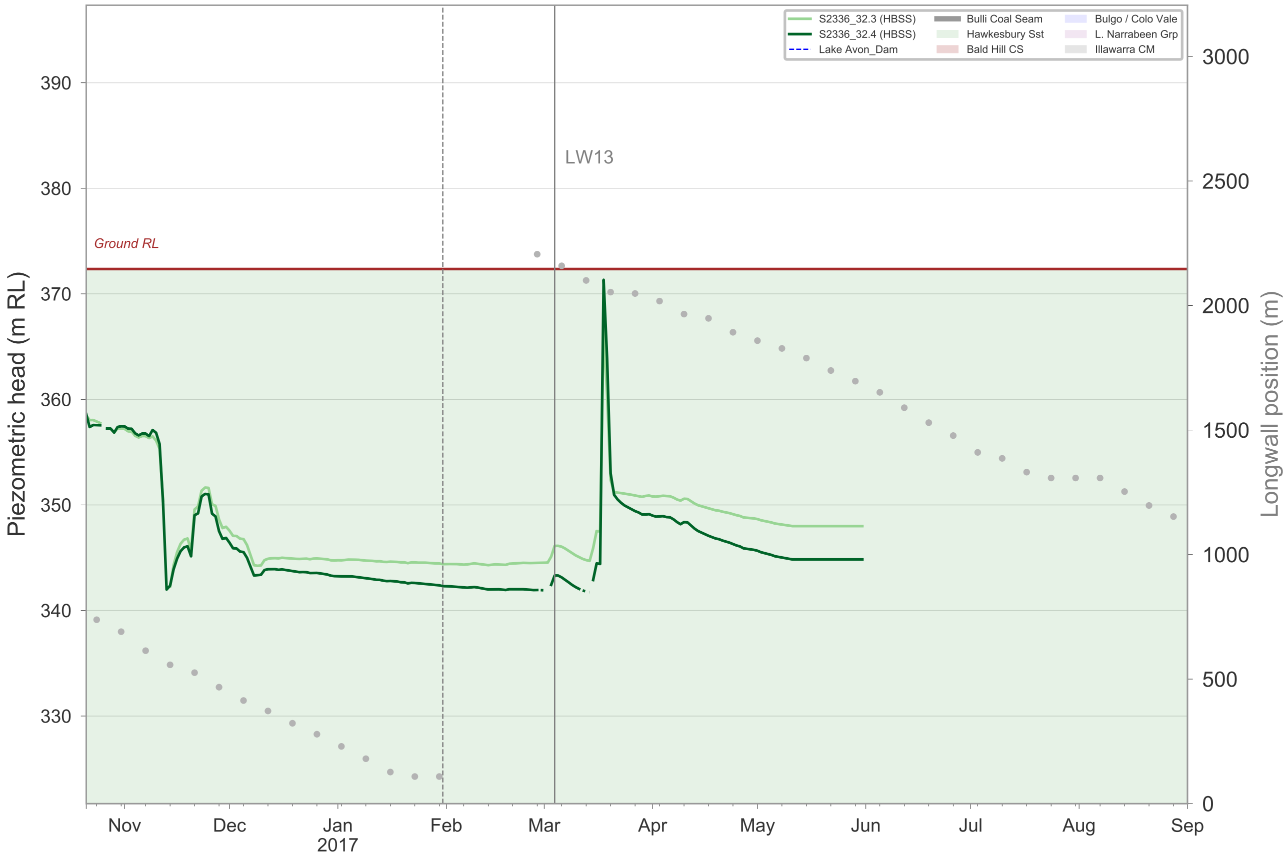
S2333



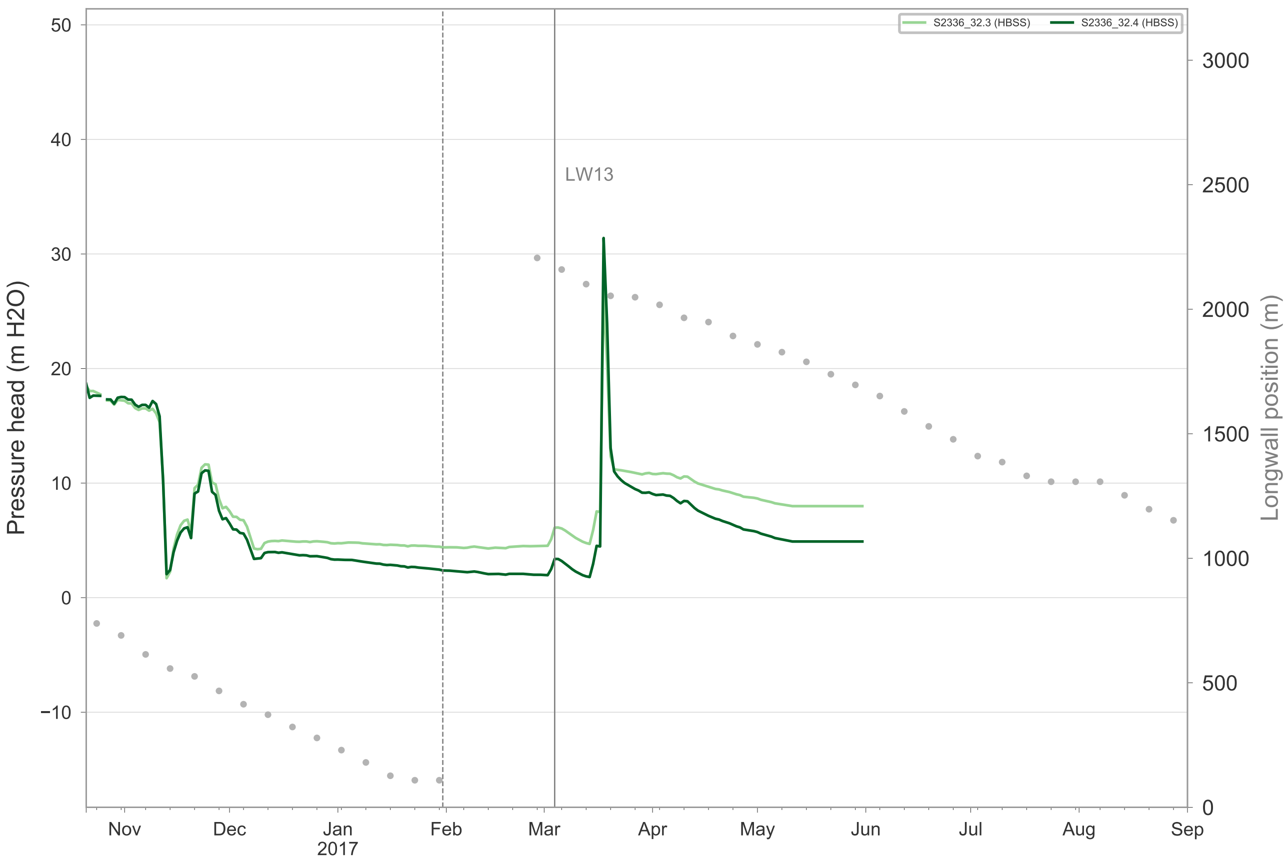

S2335
S2335_15 (HBSS)
S2335_25.5 (HBSS)
S2335_30 (HBSS)
S2335_40 (HBSS)
S2335_50 (HBSS)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
Ground RL
Piezometric head (m RL)
Longwall position (m)
380
360
340
320
3000
2500
2000
1500
1000
500
0
24
31
07
14
21
28
05
12
19
26
Nov
2016
Dec

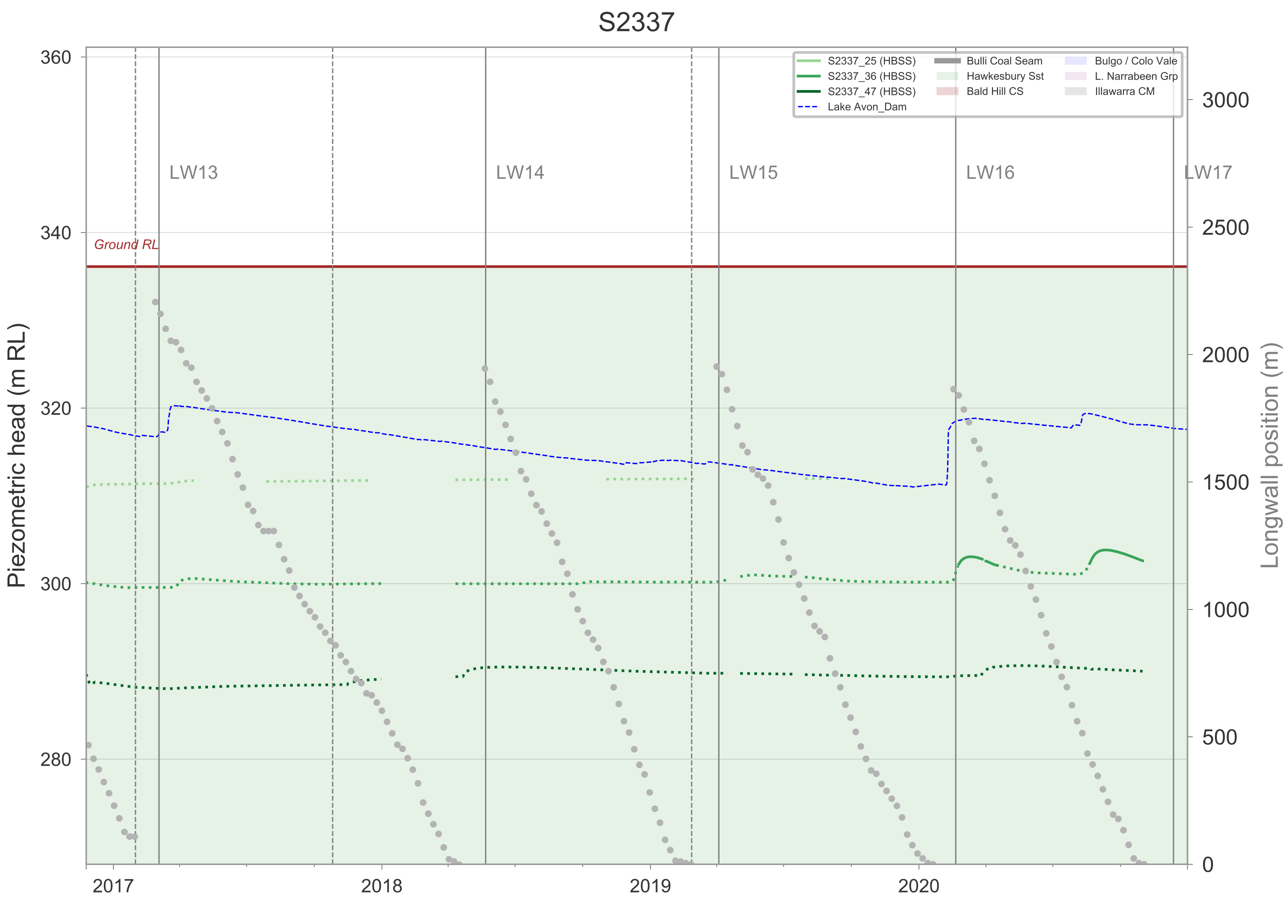

S2335
S2335_15 (HBSS)
S2335_25.5 (HBSS)
S2335_30 (HBSS)
S2335_40 (HBSS)
S2335_50 (HBSS)
Pressure head (m H2O)
Longwall position (m)
40
30
20
10
0
−10
−20
3000
2500
2000
1500
1000
500
0
24
31
07
14
21
28
05
12
19
26
Nov
2016
Dec

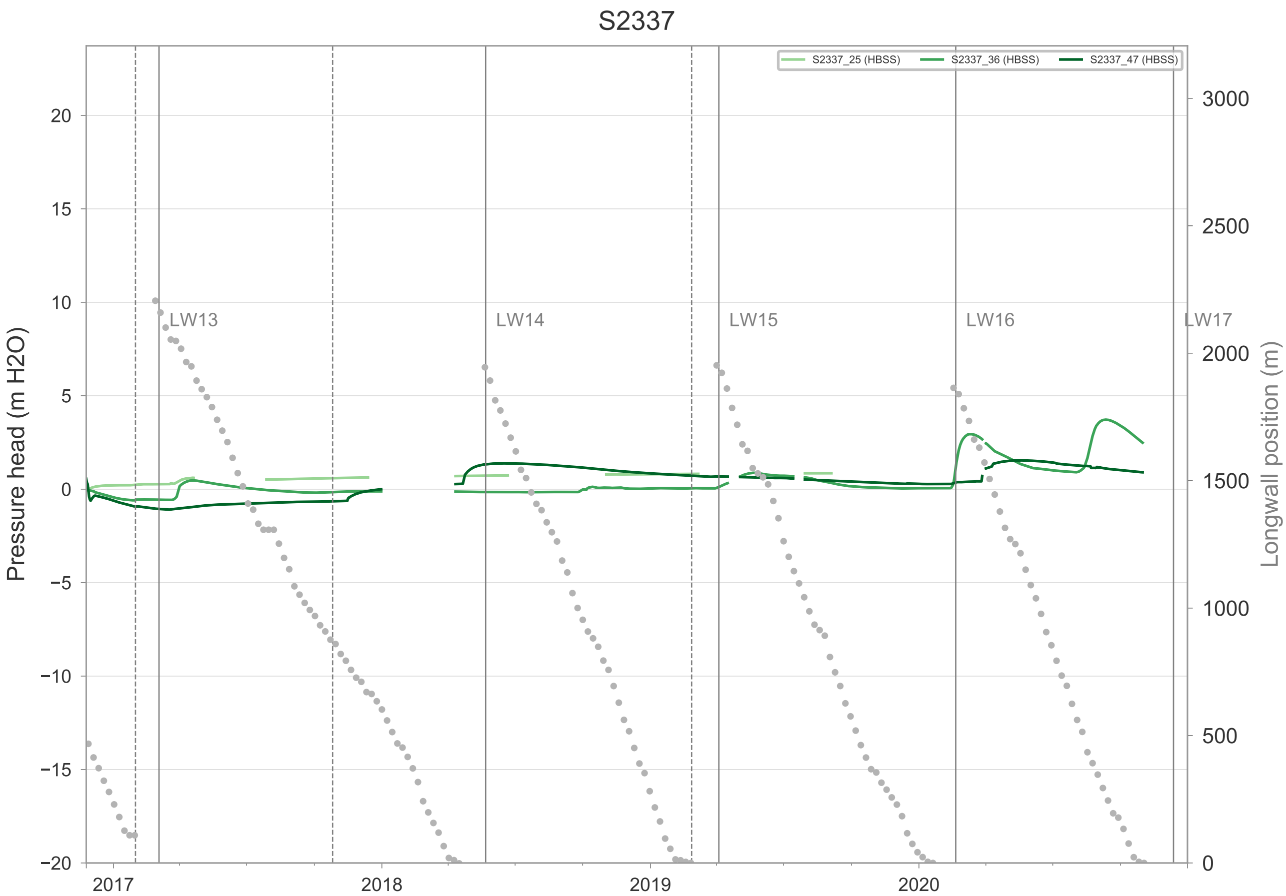
S2336

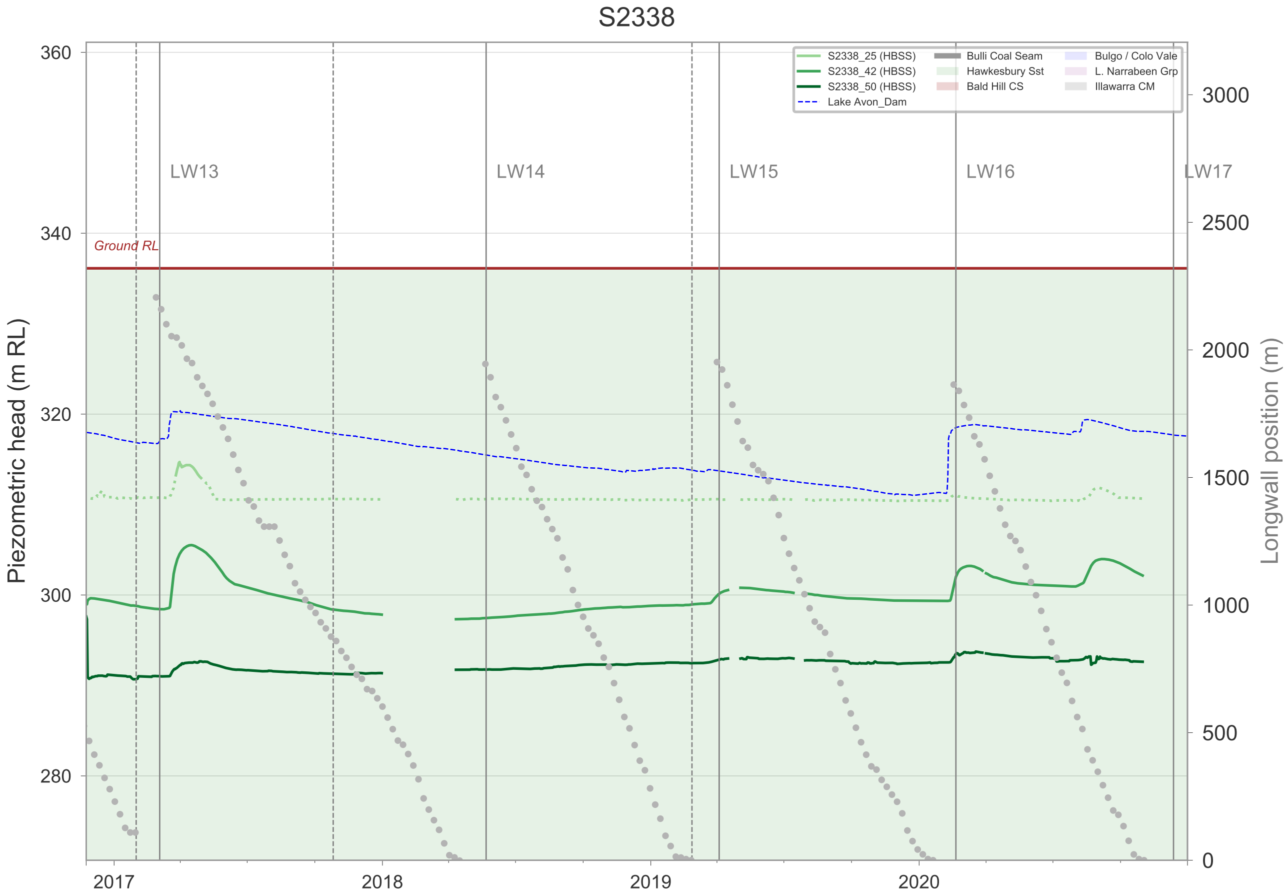

S2336_32.3 (HBSS)
S2336_32.4 (HBSS)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
Ground RL
LW13
Piezometric head (m RL)
Longwall position (m)
Nov
Dec
Jan
2017
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep

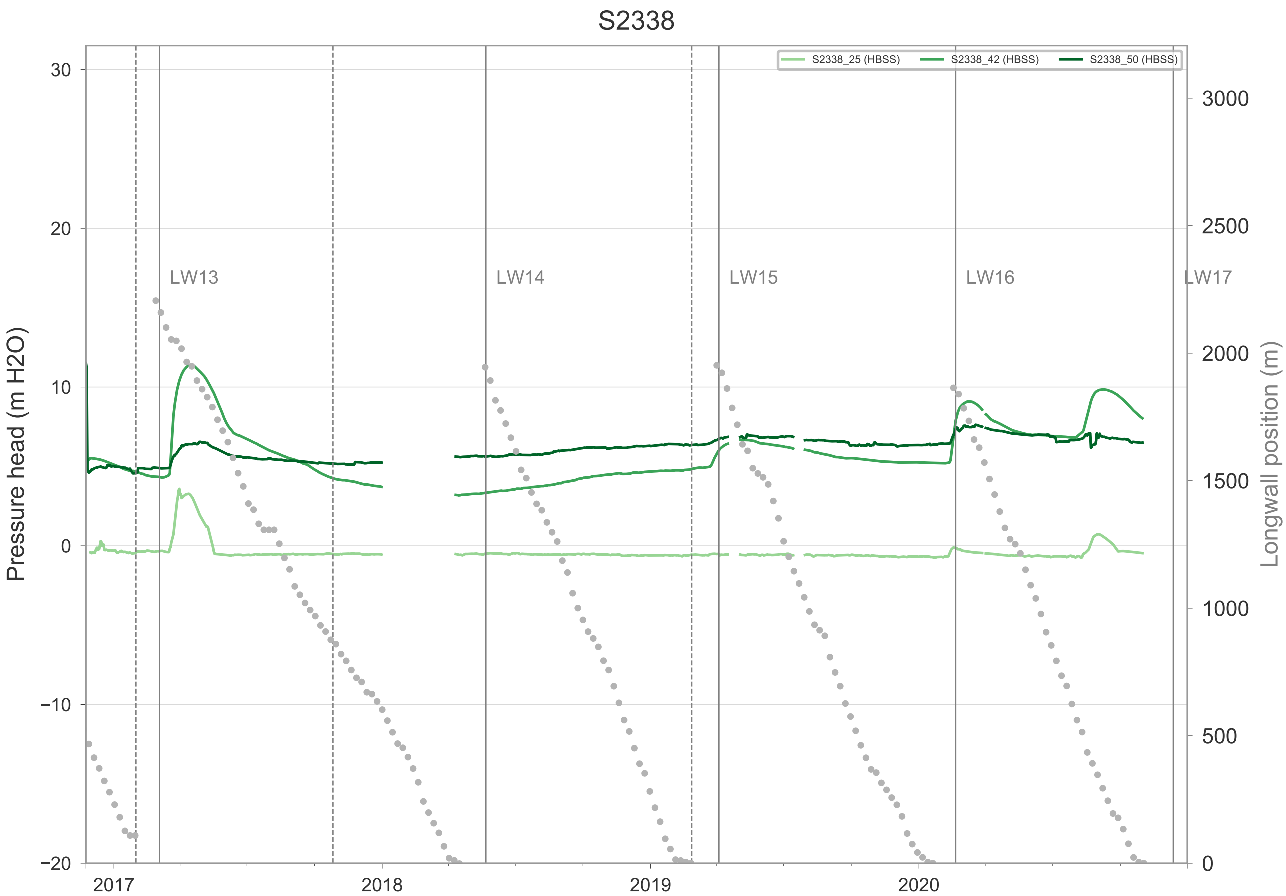
S2336

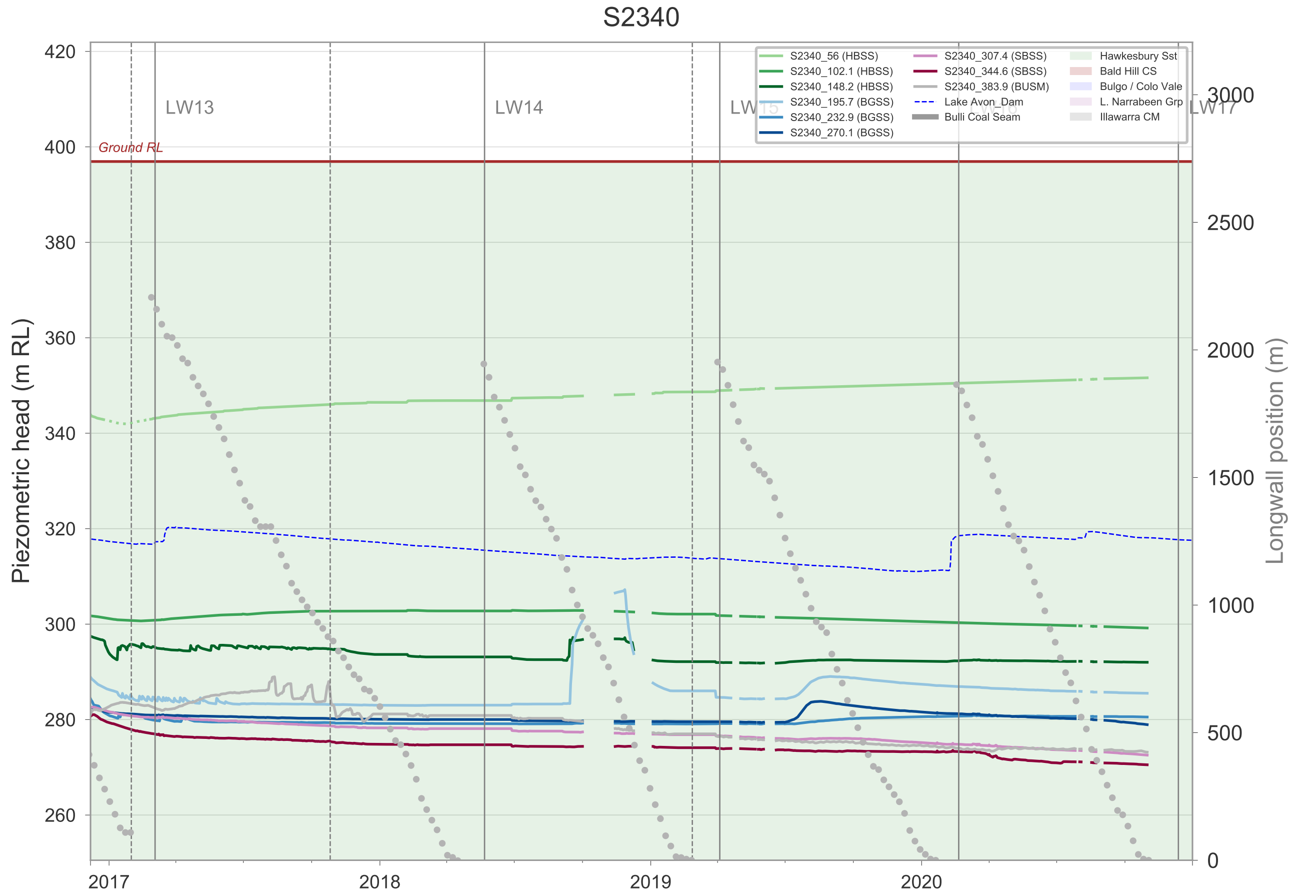

S2336_32.3 (HBSS)
S2336_32.4 (HBSS)
LW13
Pressure head (m H2O)
Longwall position (m)
Nov
Dec
Jan
2017
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep

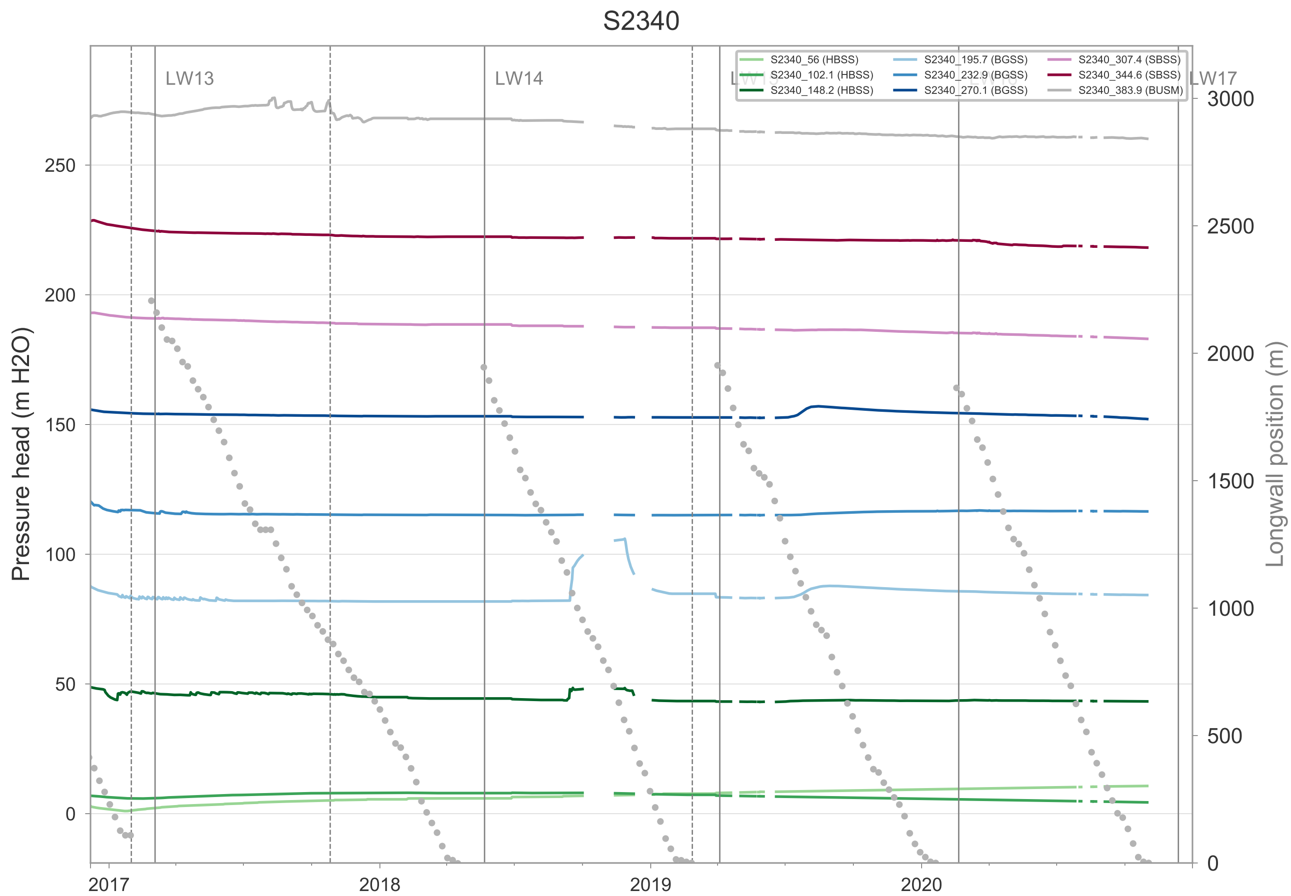

S2337
S2337_25 (HBSS)
S2337_36 (HBSS)
S2337_47 (HBSS)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
LW13
LW14
LW15
LW16
LW17
Ground RL
Piezometric head (m RL)
Longwall position (m)
360
340
320
300
280
3000
2500
2000
1500
1000
500
0
2017
2018
2019
2020

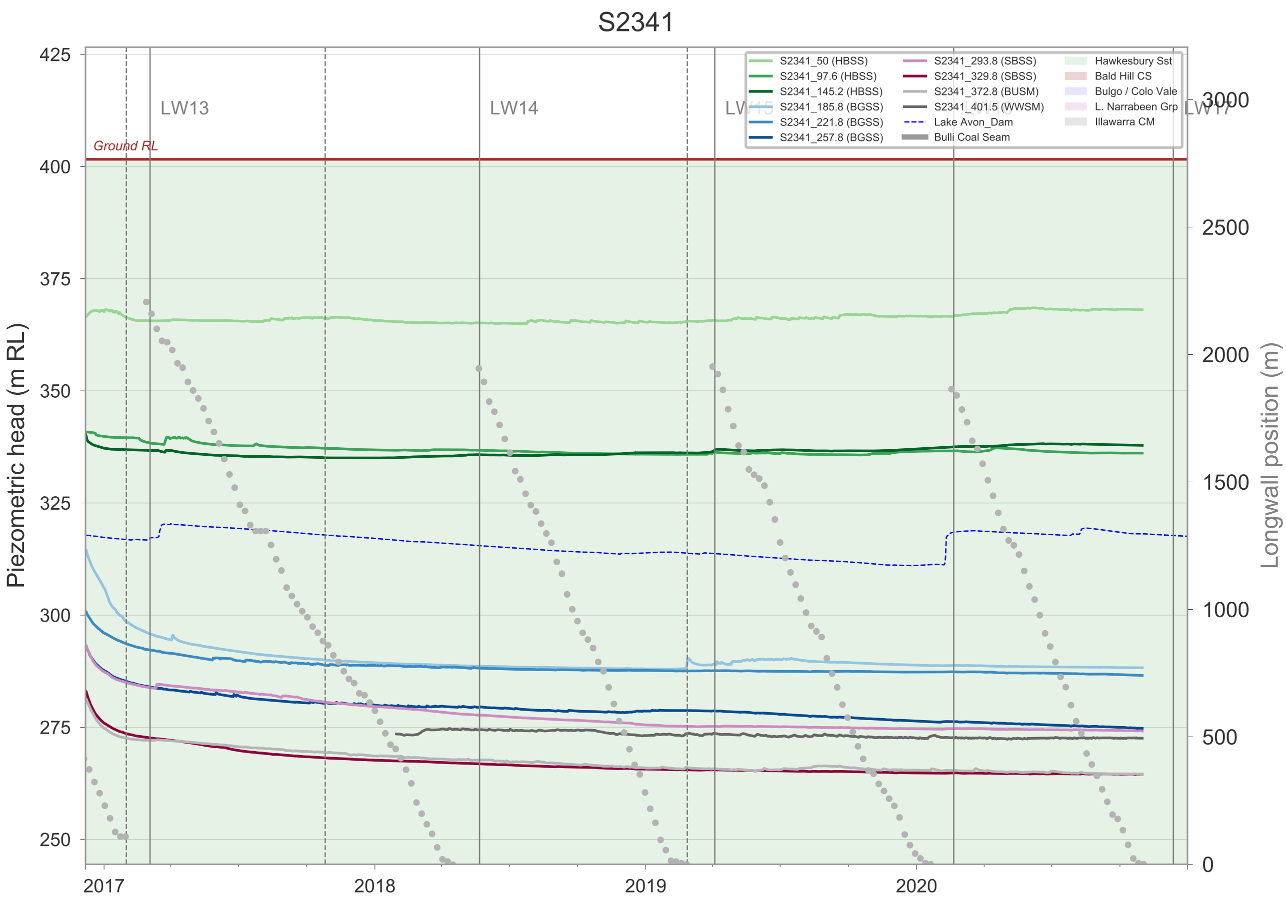

S2337
S2337_25 (HBSS)
S2337_36 (HBSS)
S2337_47 (HBSS)
LW13
LW14
LW15
LW16
LW17
Pressure head (m H2O)
Longwall position (m)
20
15
10
5
0
−5
−10
−15
−20
3000
2500
2000
1500
1000
500
0
2017
2018
2019
2020

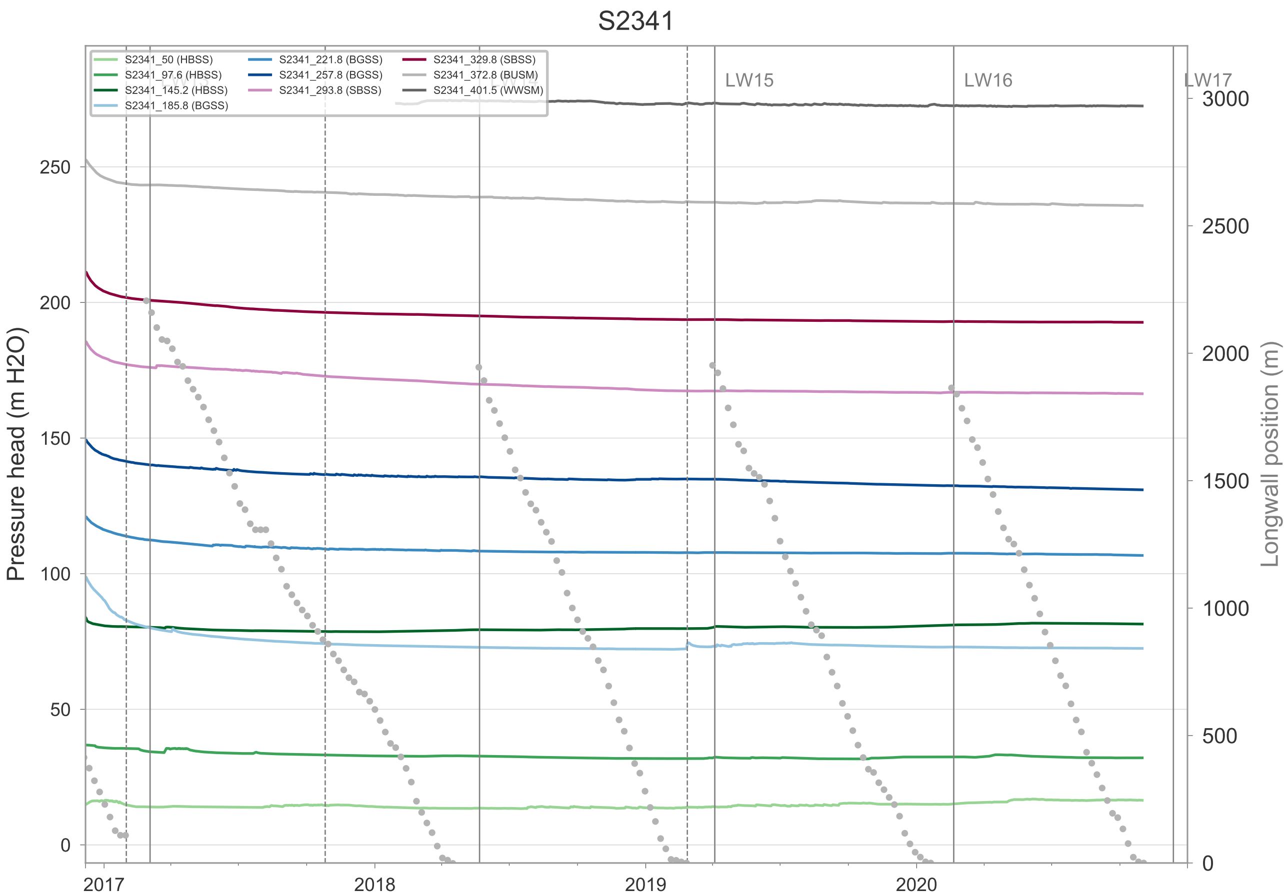

S2338
S2338_25 (HBSS)
S2338_42 (HBSS)
S2338_50 (HBSS)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
LW13
LW14
LW15
LW16
LW17
Ground RL
Piezometric head (m RL)
Longwall position (m)
360
340
320
300
280
3000
2500
2000
1500
1000
500
0
2017
2018
2019
2020

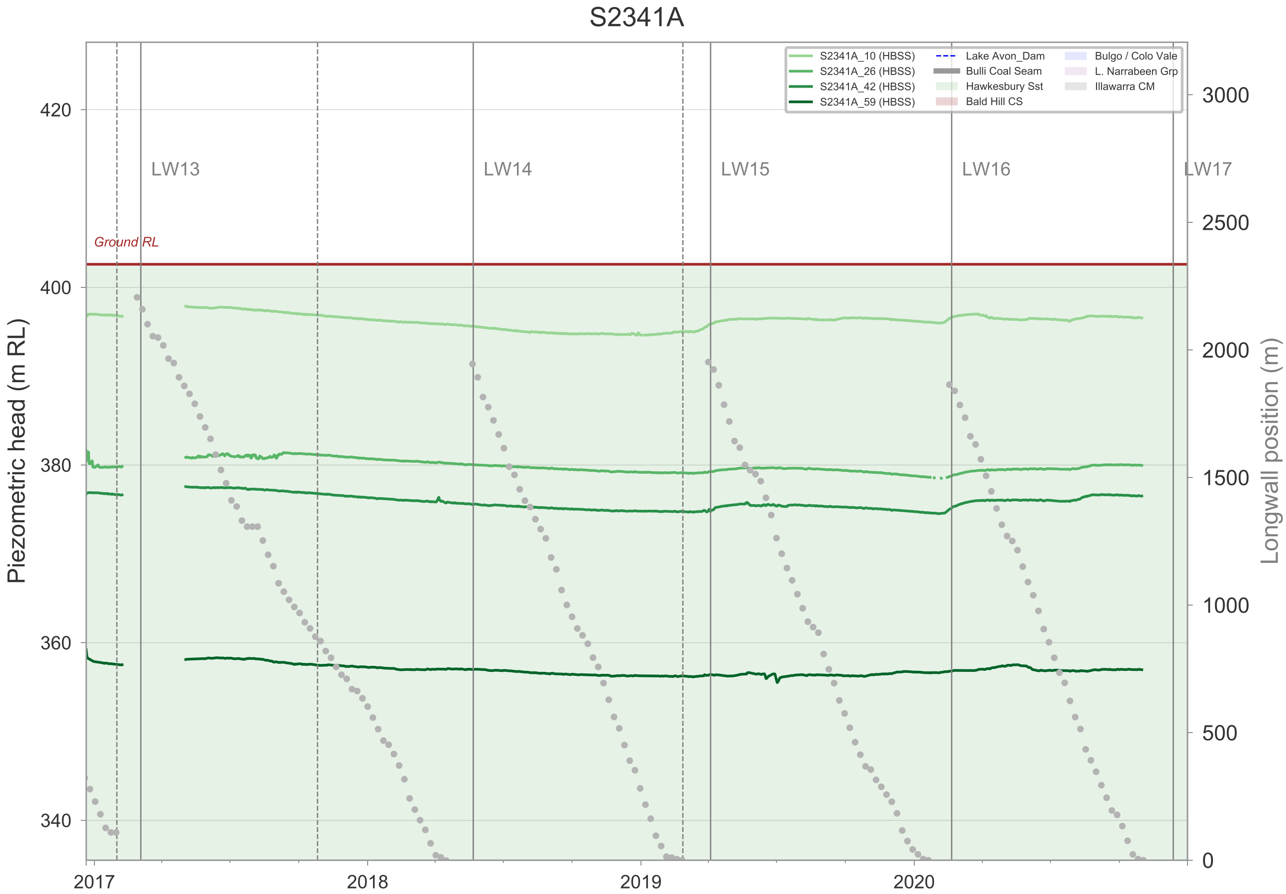

S2338
S2338_25 (HBSS)
S2338_42 (HBSS)
S2338_50 (HBSS)
LW13
LW14
LW15
LW16
LW17
Pressure head (m H2O)
Longwall position (m)
30
20
10
0
−10
−20
3000
2500
2000
1500
1000
500
0
2017
2018
2019
2020

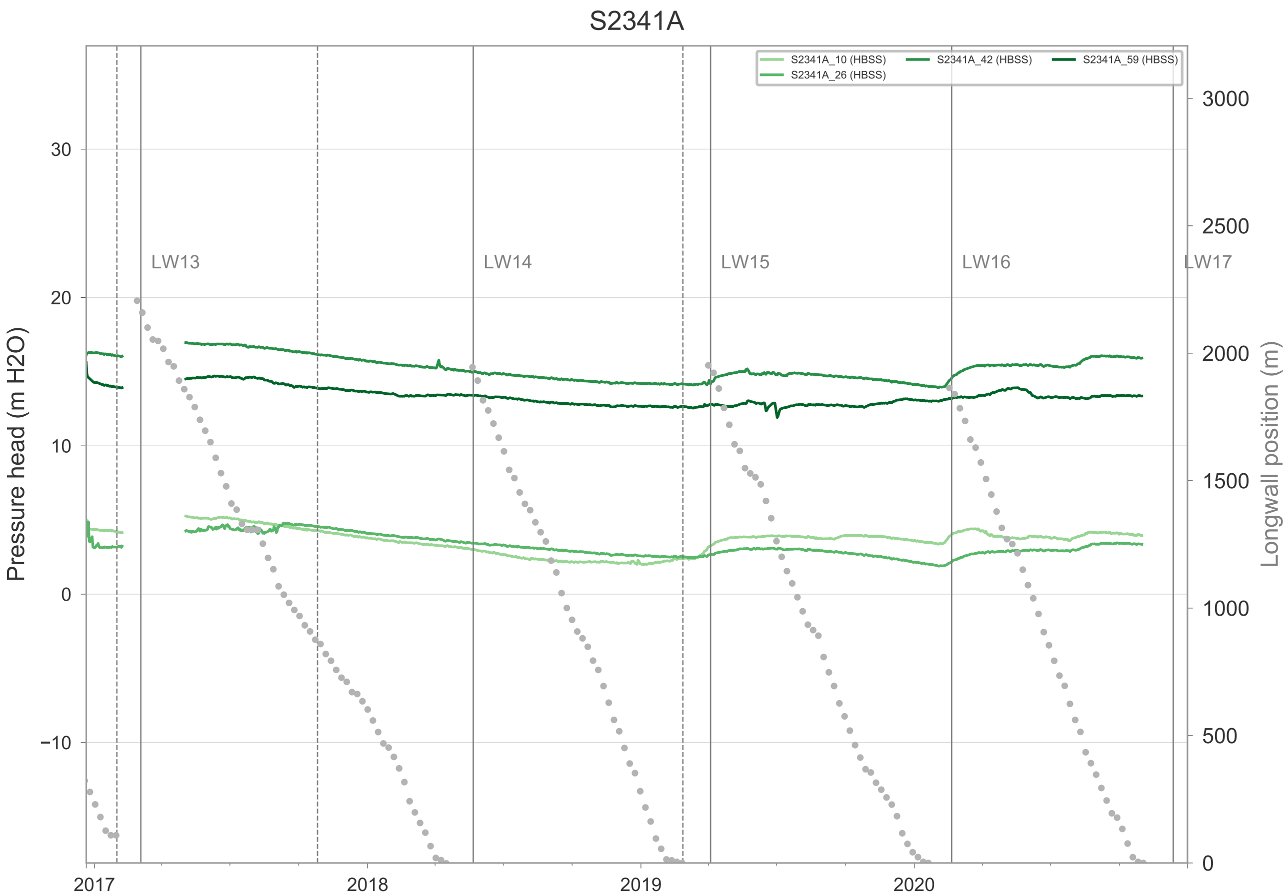

S2340
Piezometric head (m RL)
Longwall position (m)
Ground RL
LW13
LW14
LW15
LW17
S2340_56 (HBSS)
S2340_102.1 (HBSS)
S2340_148.2 (HBSS)
S2340_195.7 (BGSS)
S2340_232.9 (BGSS)
S2340_270.1 (BGSS)
S2340_307.4 (SBSS)
S2340_344.6 (SBSS)
S2340_383.9 (BUSM)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
420
400
380
360
340
320
300
280
260
3000
2500
2000
1500
1000
500
0
2017
2018
2019
2020

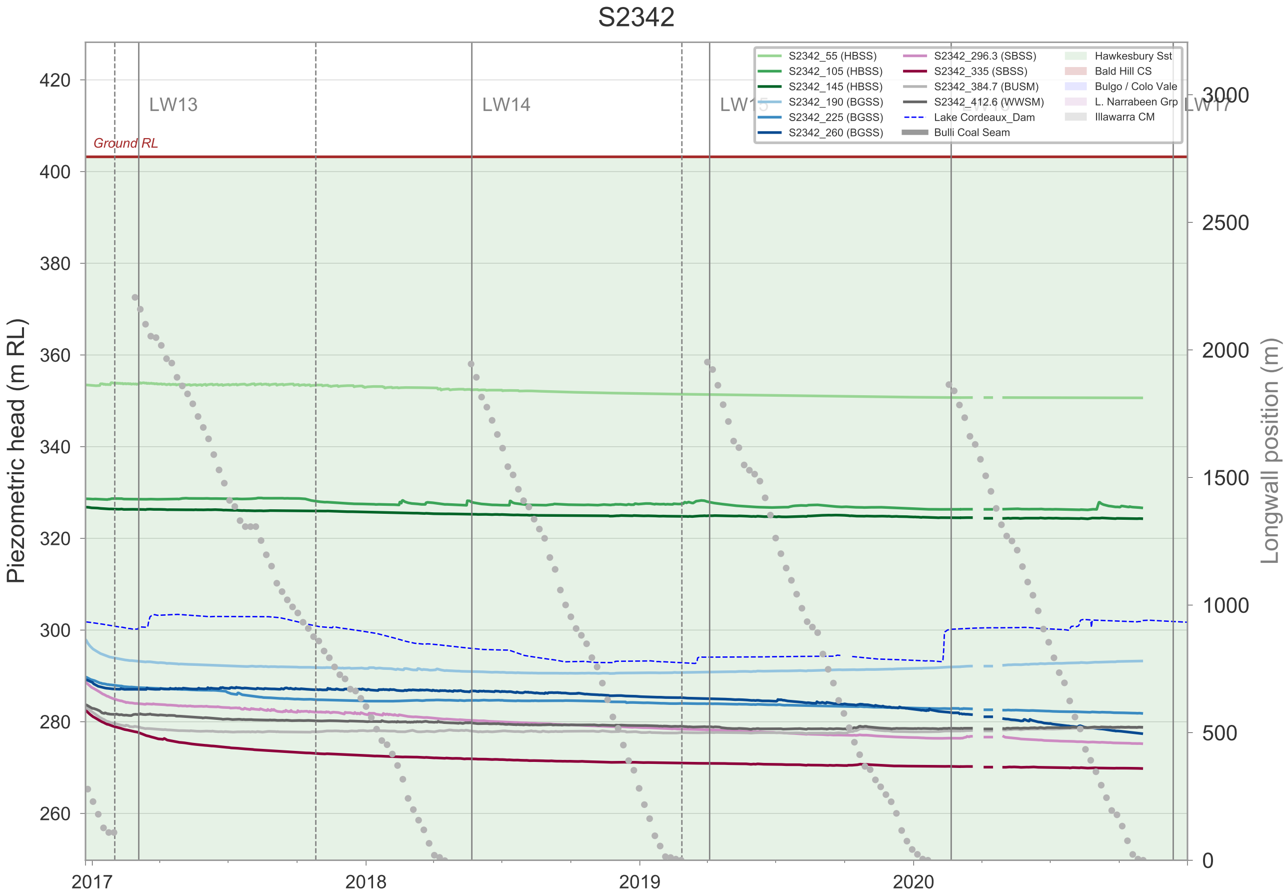

S2340
Pressure head (m H2O)
Longwall position (m)
LW13
LW14
LW17
S2340_56 (HBSS)
S2340_102.1 (HBSS)
S2340_148.2 (HBSS)
S2340_195.7 (BGSS)
S2340_232.9 (BGSS)
S2340_270.1 (BGSS)
S2340_307.4 (SBSS)
S2340_344.6 (SBSS)
S2340_383.9 (BUSM)
250
200
150
100
50
0
3000
2500
2000
1500
1000
500
0
2017
2018
2019
2020

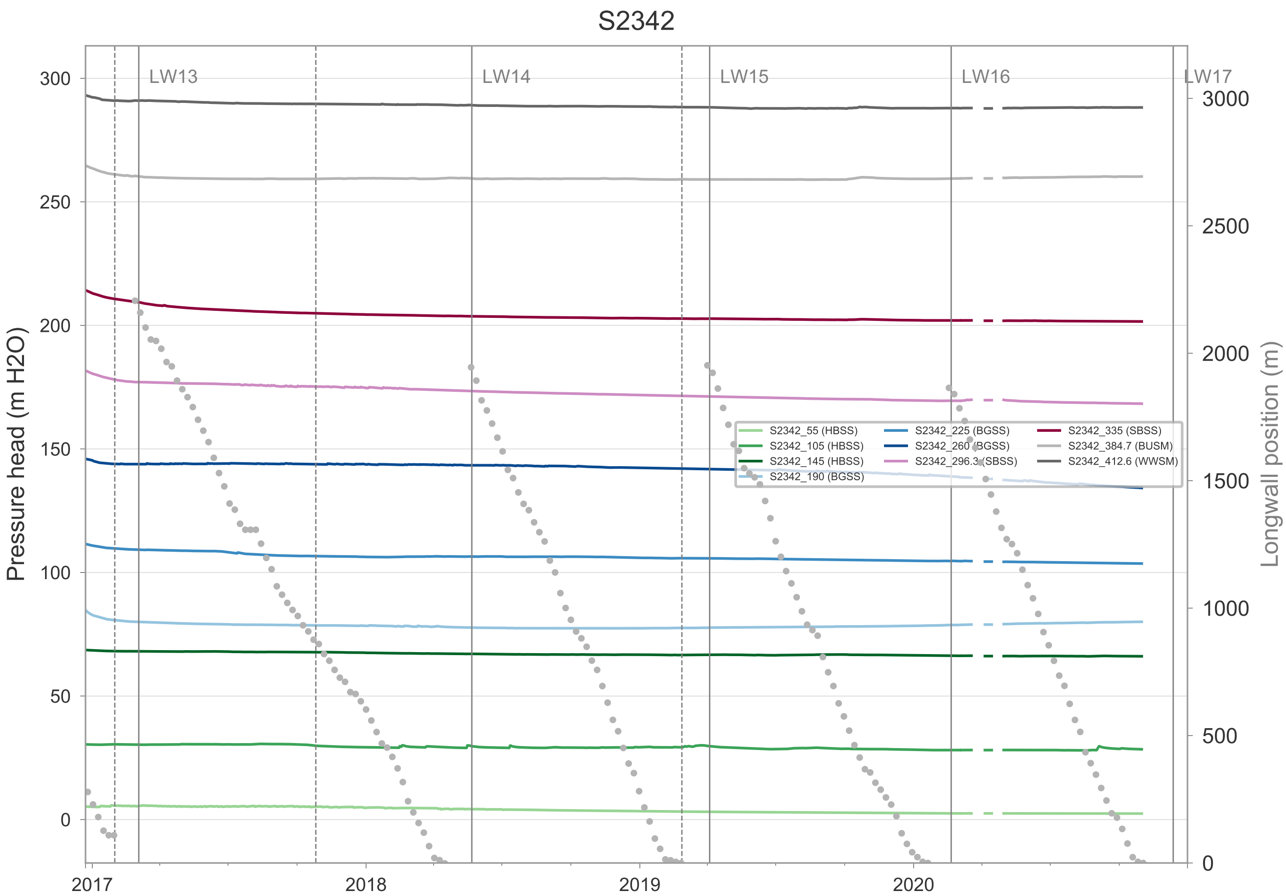

S2341
Piezometric head (m RL)
Longwall position (m)
LW13
LW14
LW15
LW16
LW17
Ground RL
S2341_50 (HBSS)
S2341_97.6 (HBSS)
S2341_145.2 (HBSS)
S2341_185.8 (BGSS)
S2341_221.8 (BGSS)
S2341_257.8 (BGSS)
S2341_293.8 (SBSS)
S2341_329.8 (SBSS)
S2341_372.8 (BUSM)
S2341_401.5 (WWSM)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM


S2341
Pressure head (m H2O)
Longwall position (m)
LW15
LW16
LW17
S2341_50 (HBSS)
S2341_97.6 (HBSS)
S2341_145.2 (HBSS)
S2341_185.8 (BGSS)
S2341_221.8 (BGSS)
S2341_257.8 (BGSS)
S2341_293.8 (SBSS)
S2341_329.8 (SBSS)
S2341_372.8 (BUSM)
S2341_401.5 (WWSM)

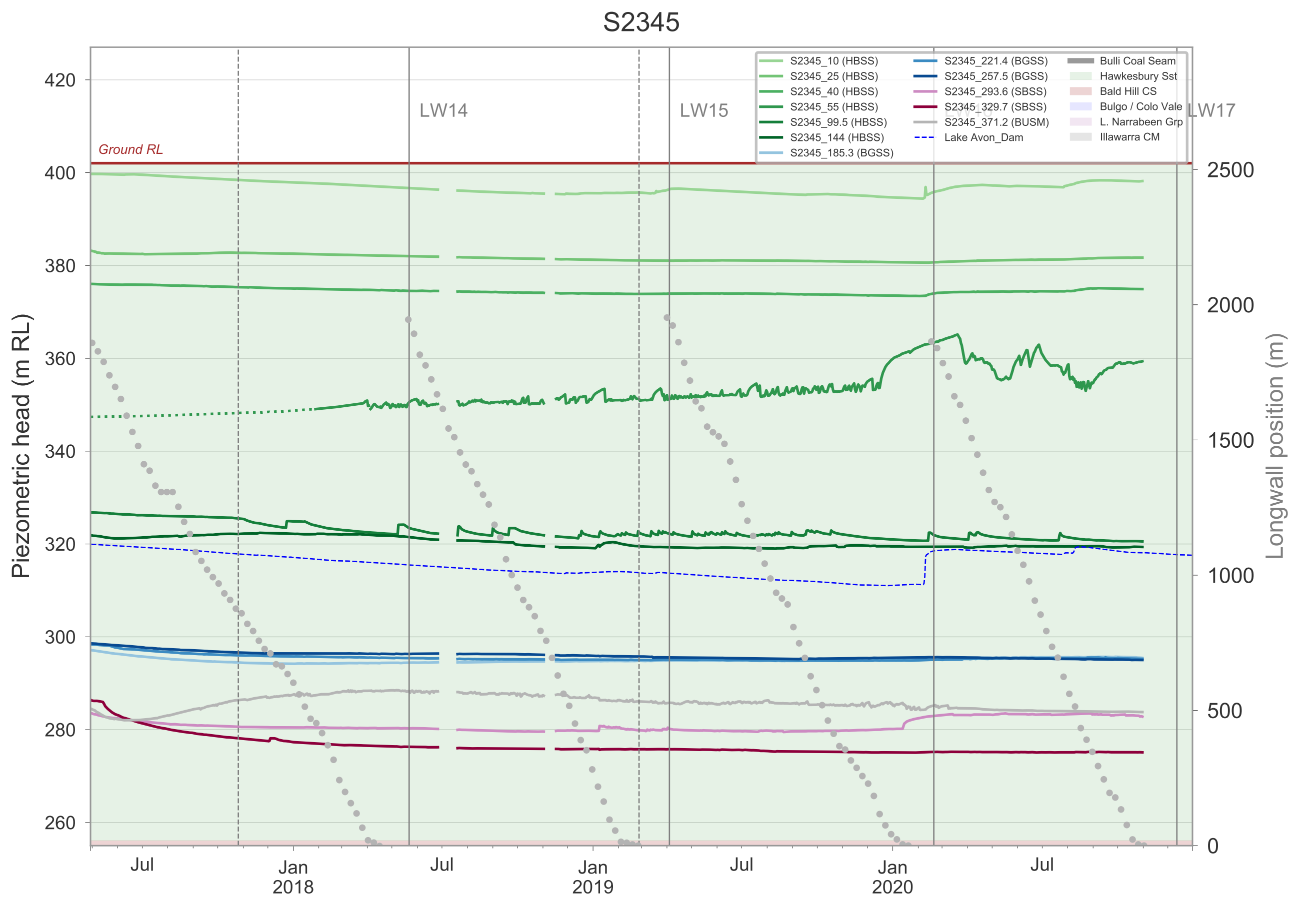

S2341A
S2341A_10 (HBSS)
S2341A_26 (HBSS)
S2341A_42 (HBSS)
S2341A_59 (HBSS)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
LW13
LW14
LW15
LW16
LW17
Ground RL
Piezometric head (m RL)
Longwall position (m)
420
400
380
360
340
3000
2500
2000
1500
1000
500
0
2017
2018
2019
2020

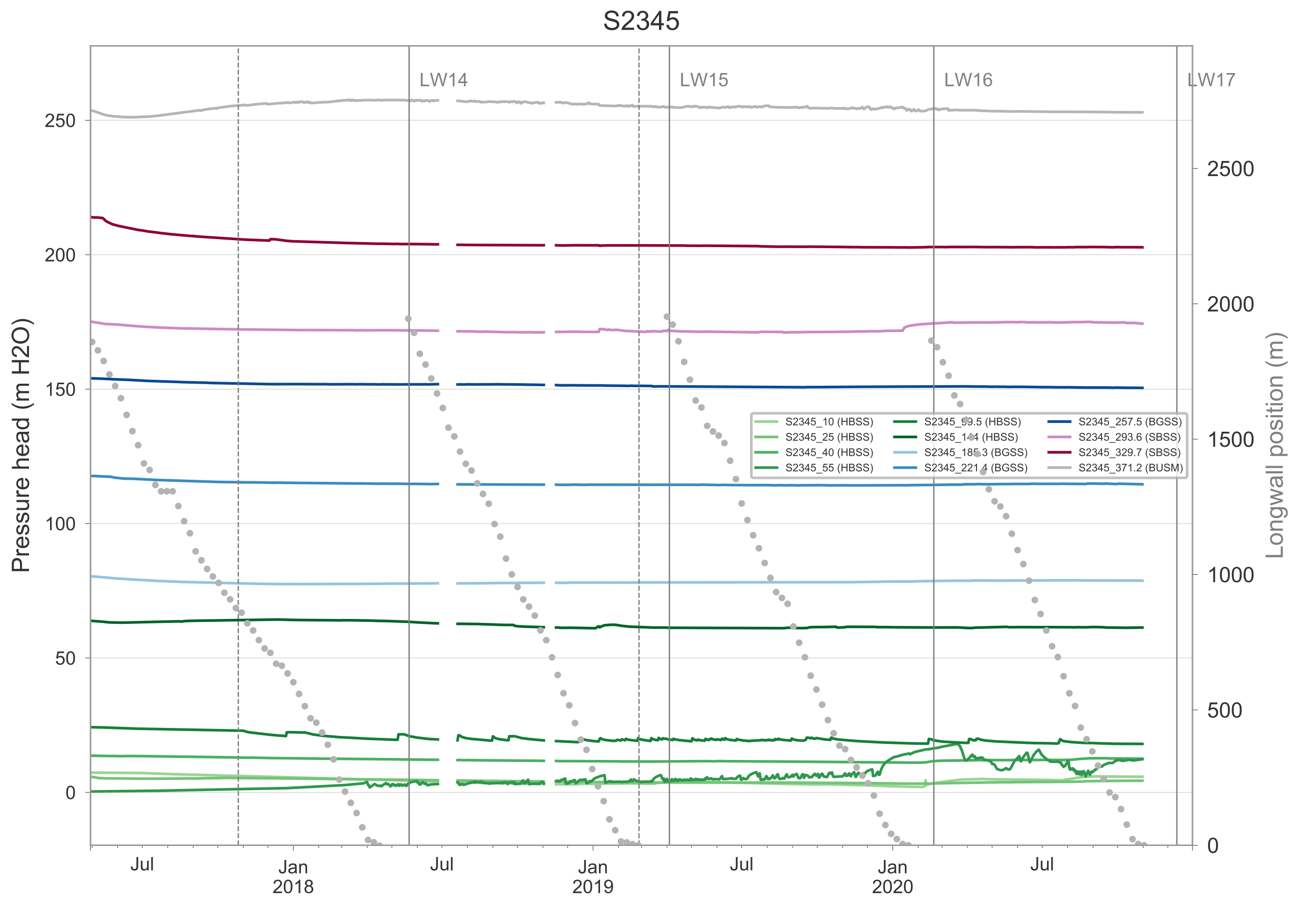

S2341A
S2341A_10 (HBSS)
S2341A_26 (HBSS)
S2341A_42 (HBSS)
S2341A_59 (HBSS)
LW13
LW14
LW15
LW16
LW17
Pressure head (m H2O)
Longwall position (m)
30
20
10
0
−10
3000
2500
2000
1500
1000
500
0
2017
2018
2019
2020


S2342
Piezometric head (m RL)
Longwall position (m)
LW13
LW14
LW15
LW16
LW17
Ground RL
S2342_55 (HBSS)
S2342_105 (HBSS)
S2342_145 (HBSS)
S2342_190 (BGSS)
S2342_225 (BGSS)
S2342_260 (BGSS)
S2342_296.3 (SBSS)
S2342_335 (SBSS)
S2342_384.7 (BUSM)
S2342_412.6 (WWSM)
Lake Cordeaux_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
2017
2018
2019
2020

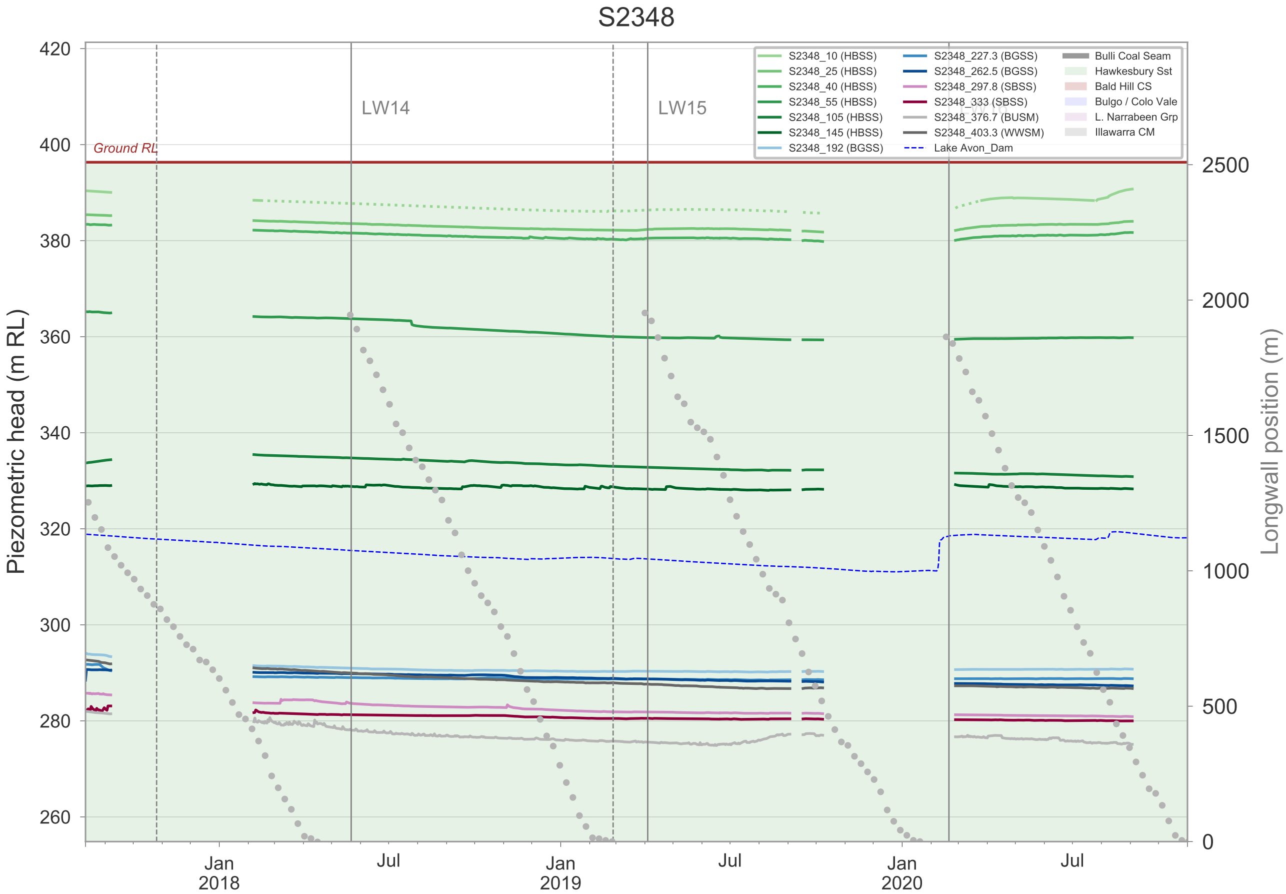

S2342
Pressure head (m H2O)
Longwall position (m)
LW13
LW14
LW15
LW16
LW17
S2342_55 (HBSS)
S2342_105 (HBSS)
S2342_145 (HBSS)
S2342_190 (BGSS)
S2342_225 (BGSS)
S2342_260 (BGSS)
S2342_296.3 (SBSS)
S2342_335 (SBSS)
S2342_384.7 (BUSM)
S2342_412.6 (WWSM)
2017
2018
2019
2020

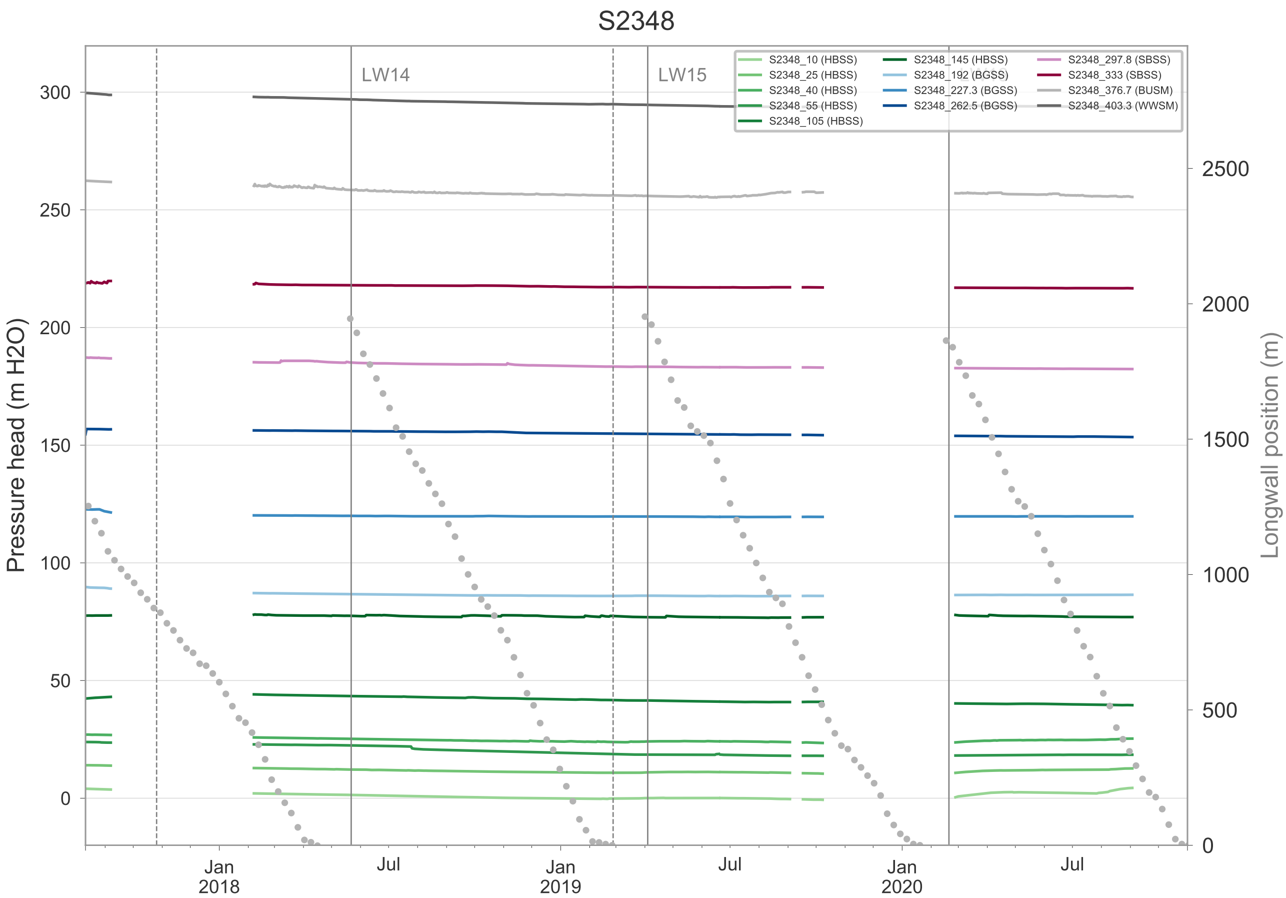
Groundwater hydrographs



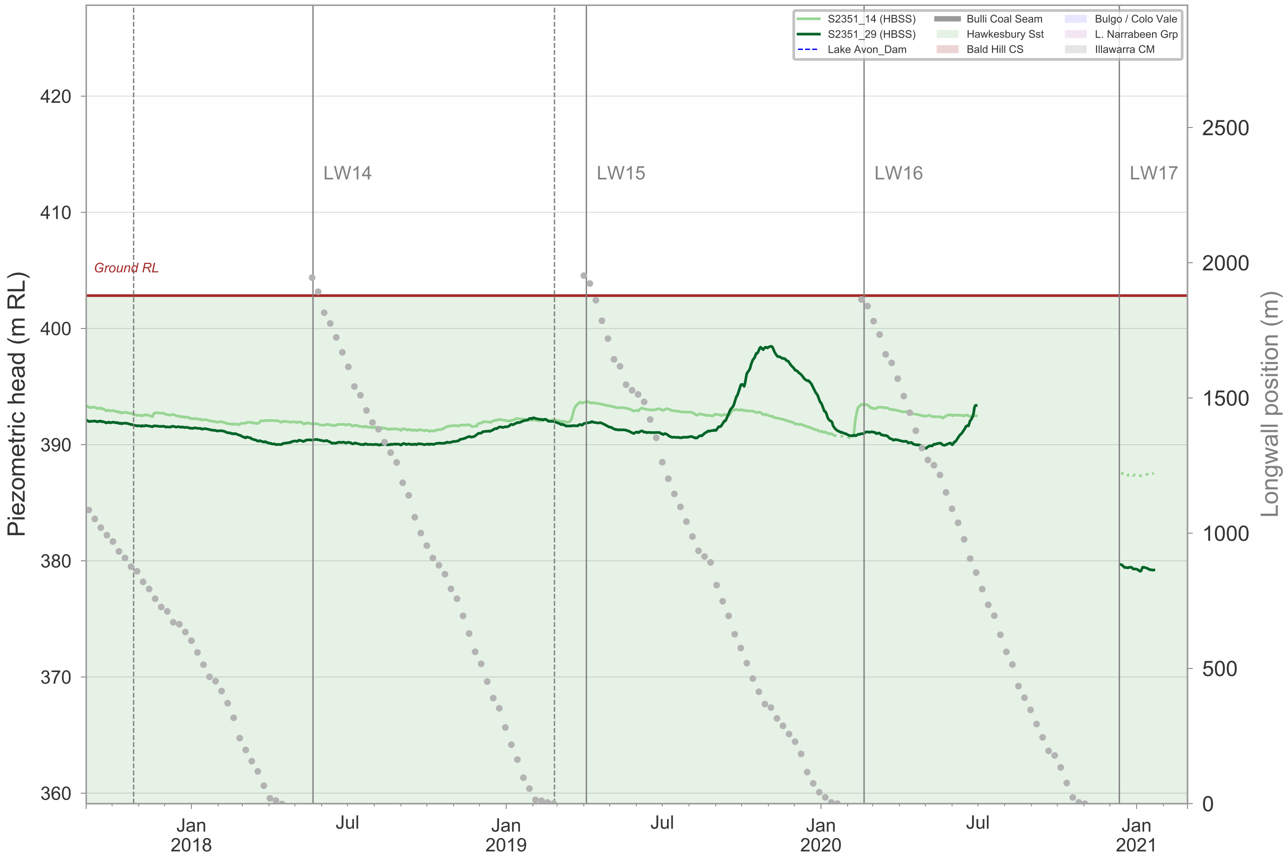


Groundwater hydrographs

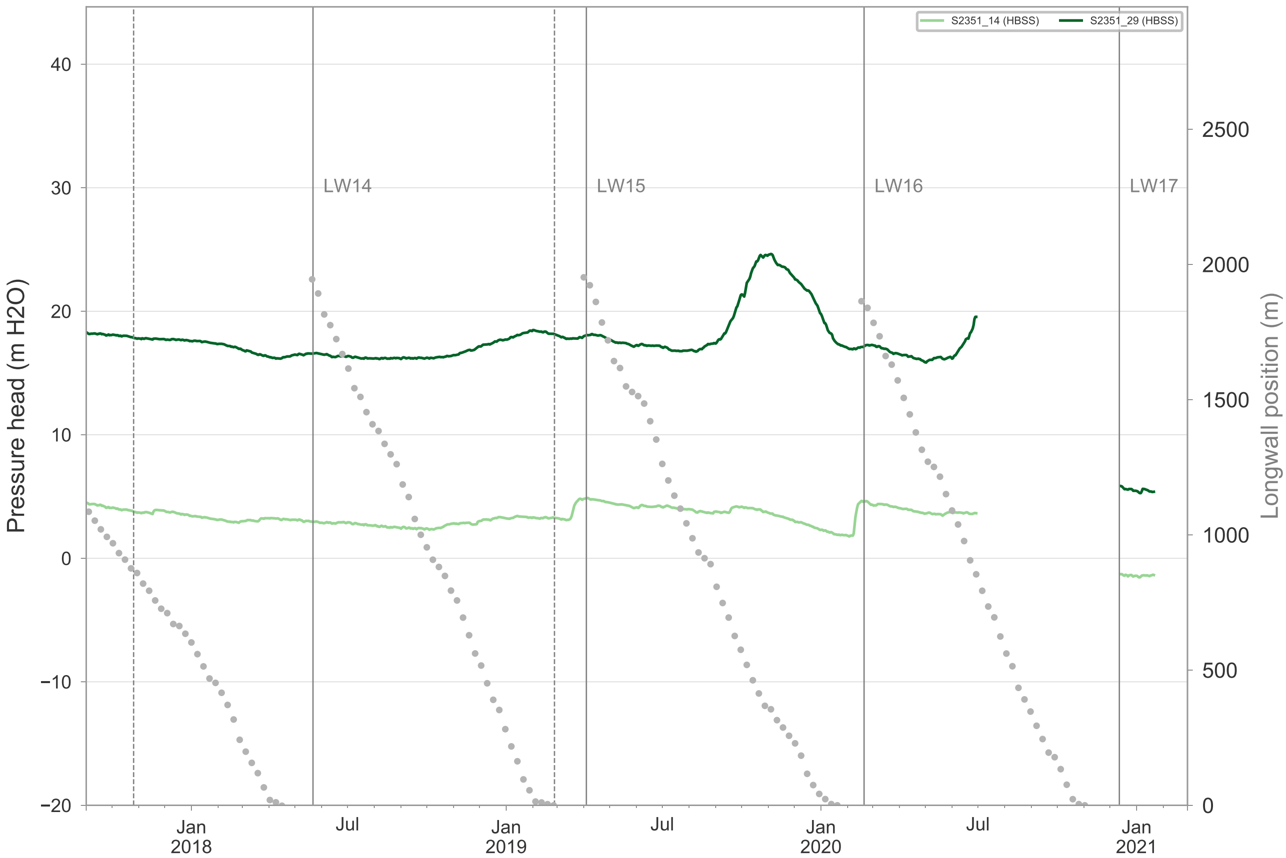




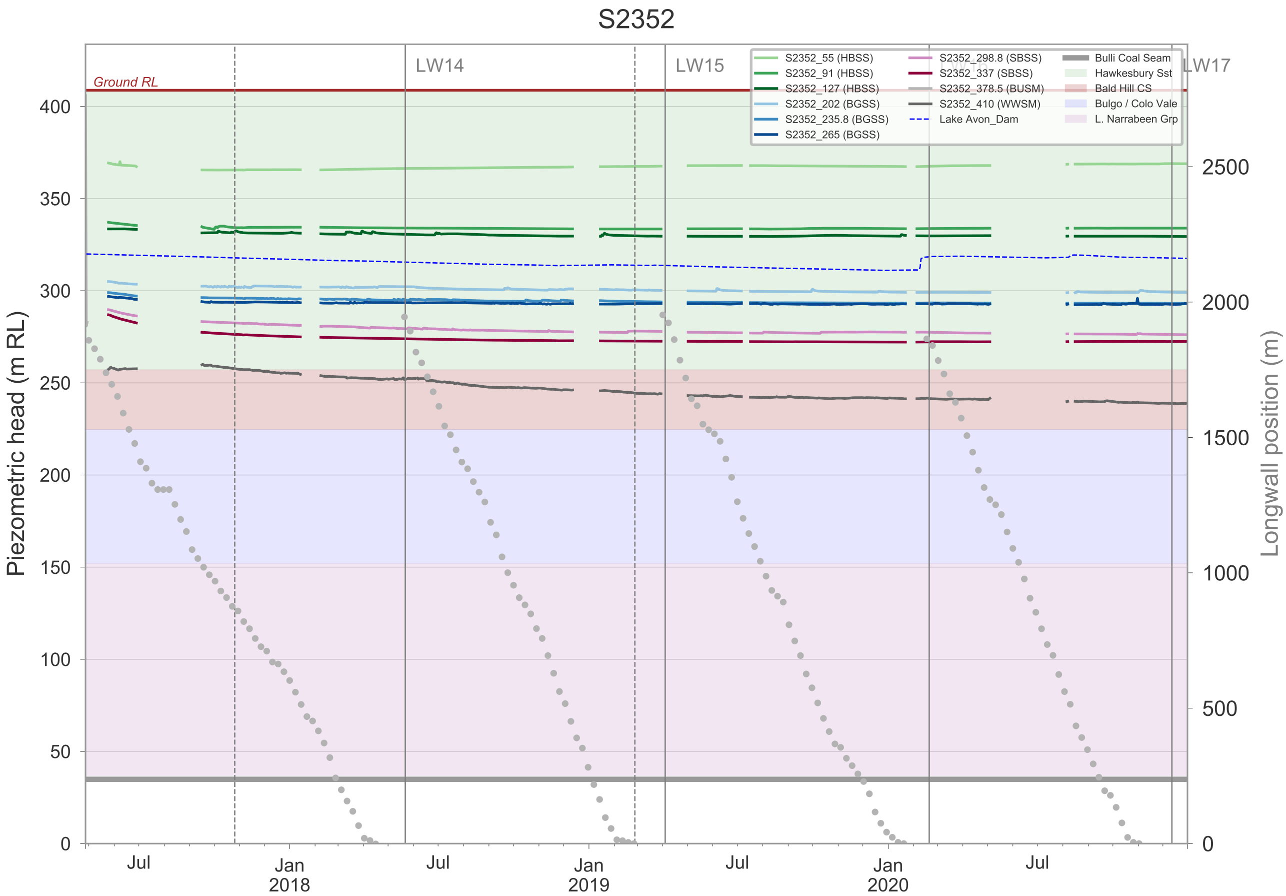
S2351

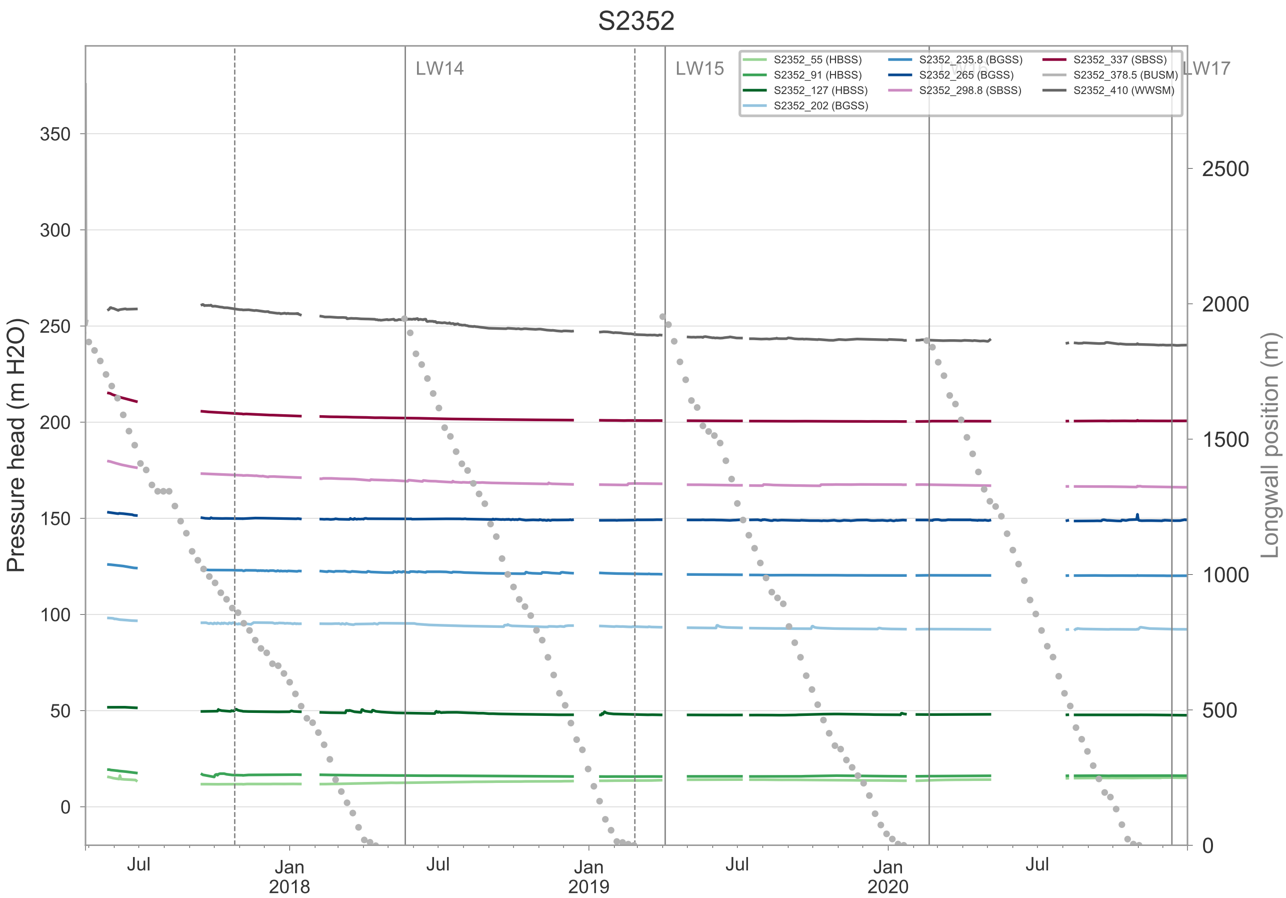

S2351_14 (HBSS)
S2351_29 (HBSS)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
LW14
LW15
LW16
LW17
Ground RL
Piezometric head (m RL)
Longwall position (m)
Jan 2018
Jul
Jan 2019
Jul
Jan 2020
Jul
Jan 2021

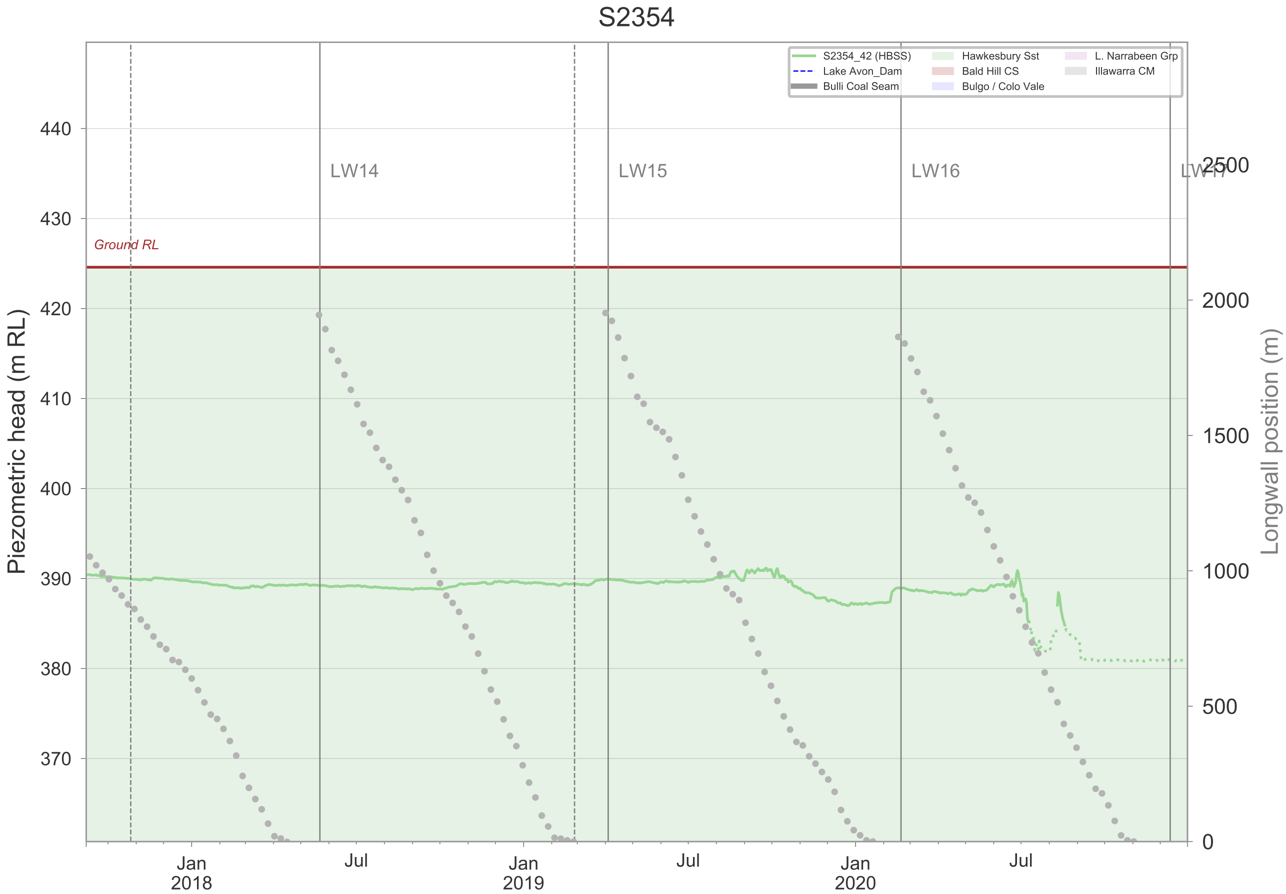
S2351

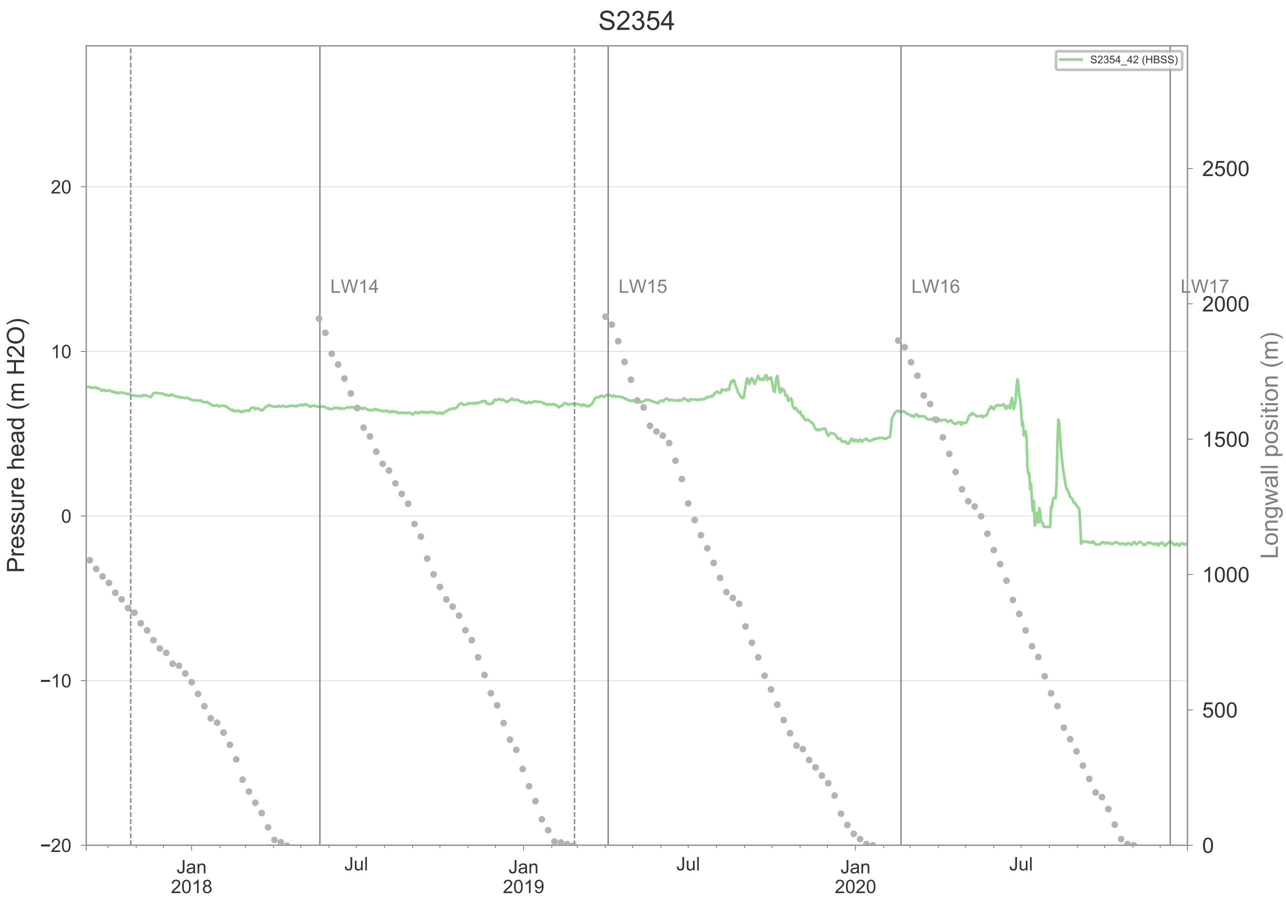

S2351_14 (HBSS)
S2351_29 (HBSS)
LW14
LW15
LW16
LW17
Pressure head (m H2O)
Longwall position (m)
Jan 2018
Jul
Jan 2019
Jul
Jan 2020
Jul
Jan 2021

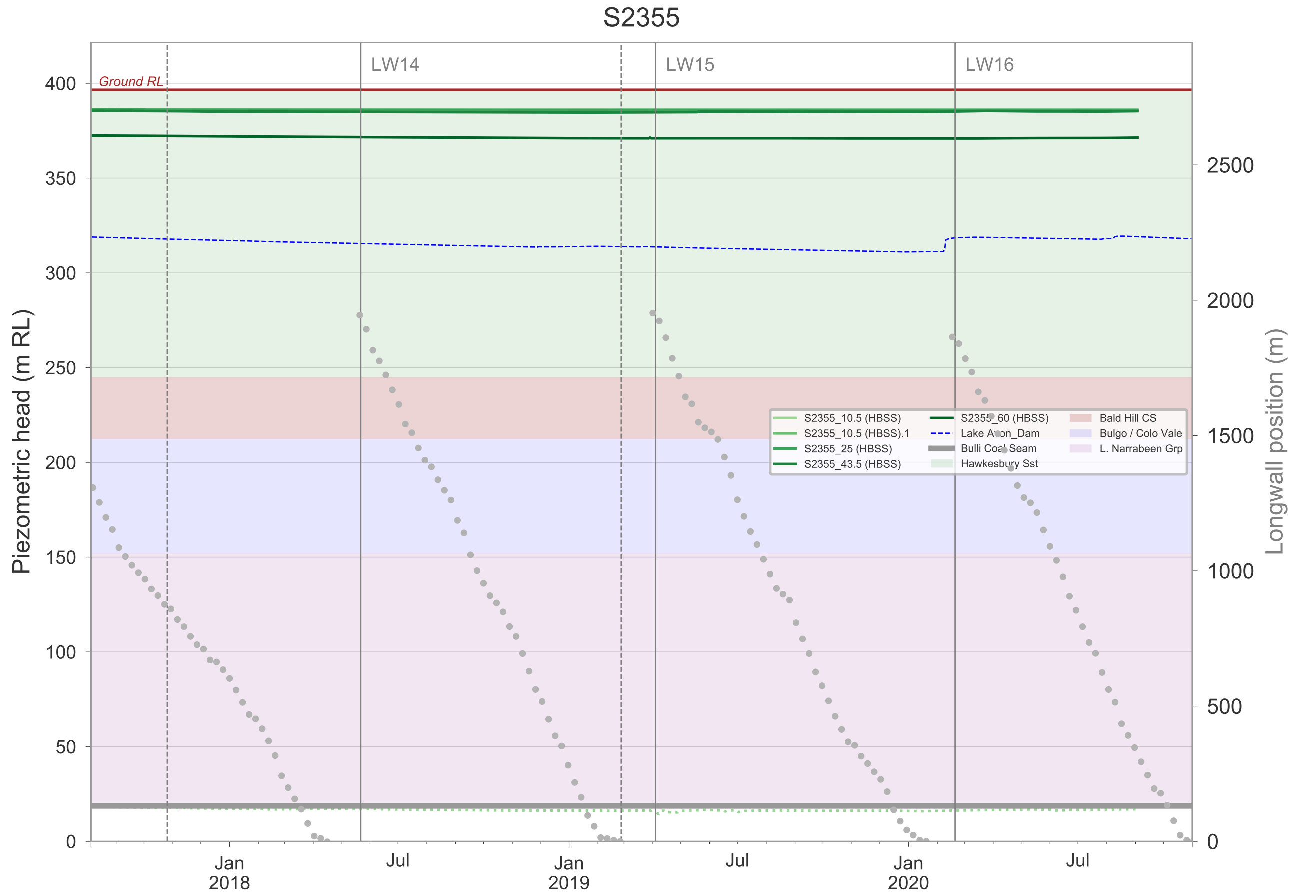
Groundwater hydrographs

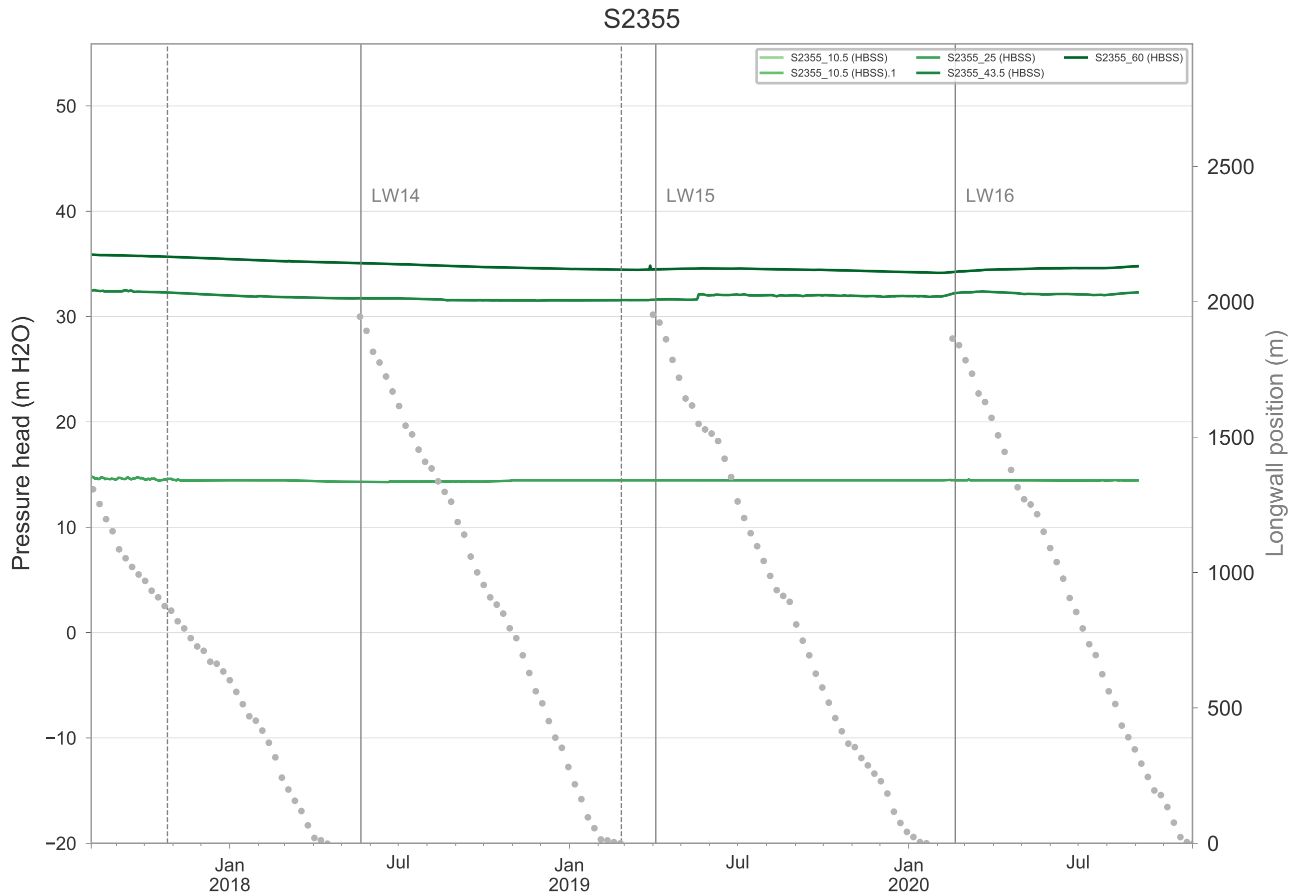


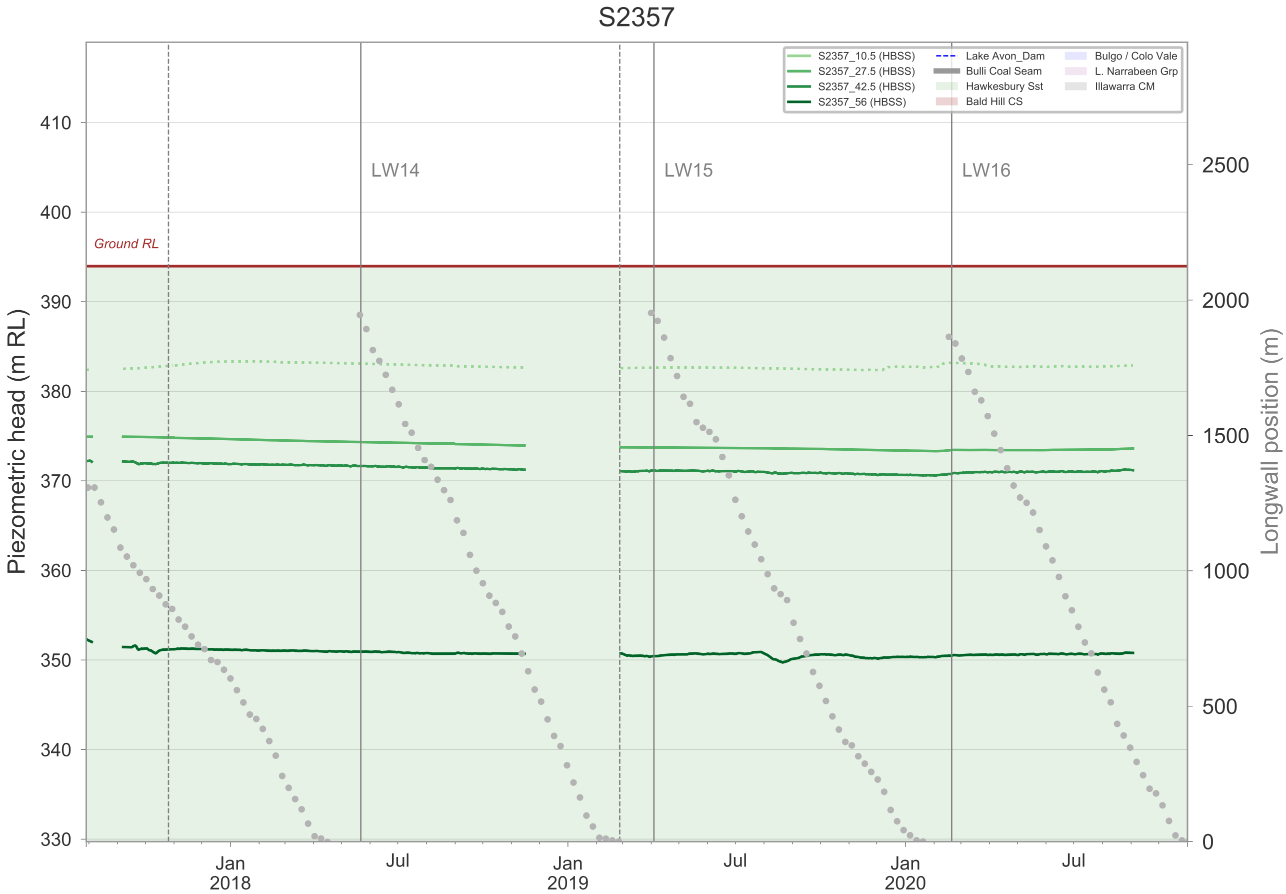


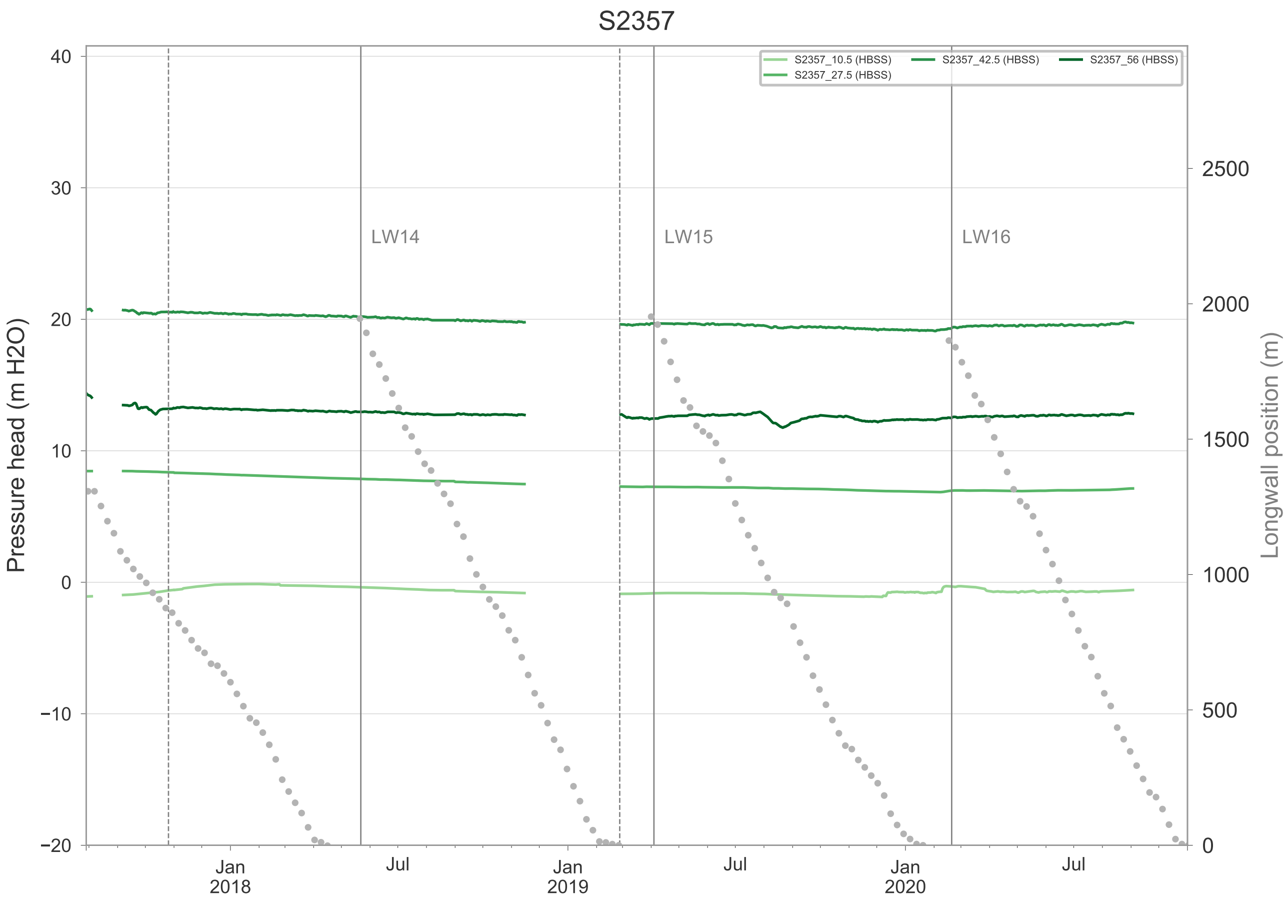

S2354
S2354_42 (HBSS)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
Ground RL
LW14
LW15
LW16
LW17
Piezometric head (m RL)
Longwall position (m)
Jan 2018
Jul
Jan 2019
Jul
Jan 2020
Jul

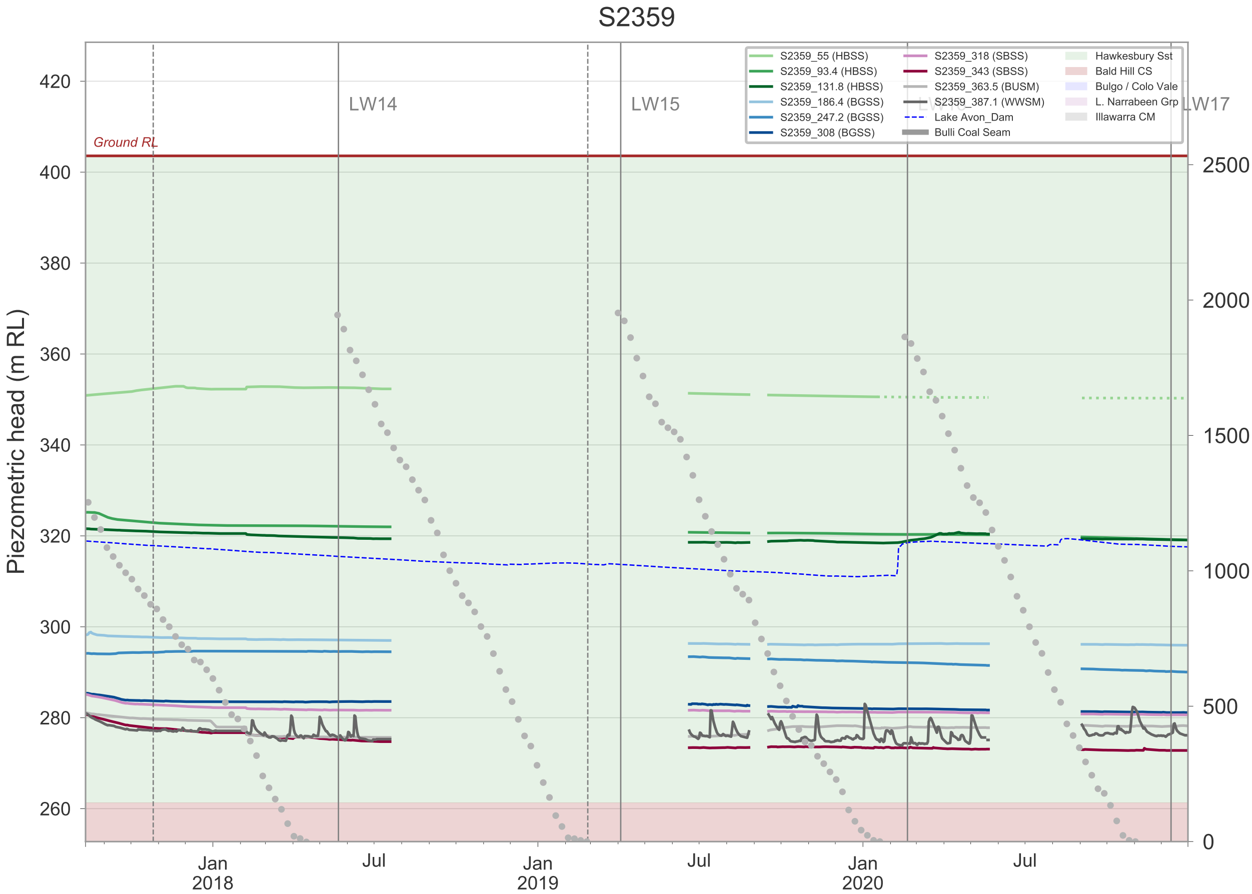

S2354
S2354_42 (HBSS)
LW14
LW15
LW16
LW17
Pressure head (m H2O)
Longwall position (m)
Jan 2018
Jul
Jan 2019
Jul
Jan 2020
Jul

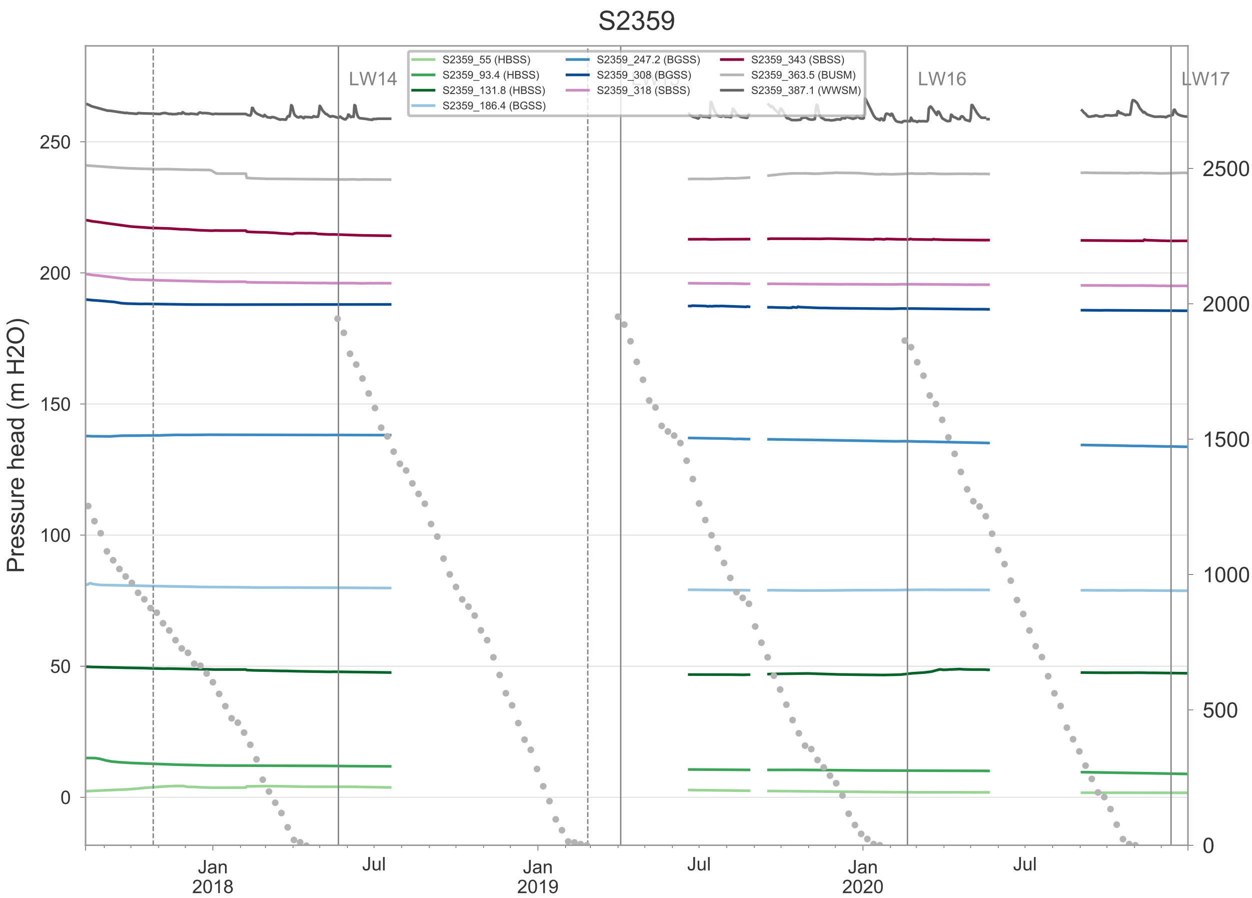

S2355
Ground RL
LW14
LW15
LW16
Piezometric head (m RL)
Longwall position (m)
0
50
100
150
200
250
300
350
400
500
1000
1500
2000
2500
Jan
2018
Jul
Jan
2019
Jul
Jan
2020
Jul
S2355_10.5 (HBSS)
S2355_10.5 (HBSS).1
S2355_25 (HBSS)
S2355_43.5 (HBSS)
S2355_60 (HBSS)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp

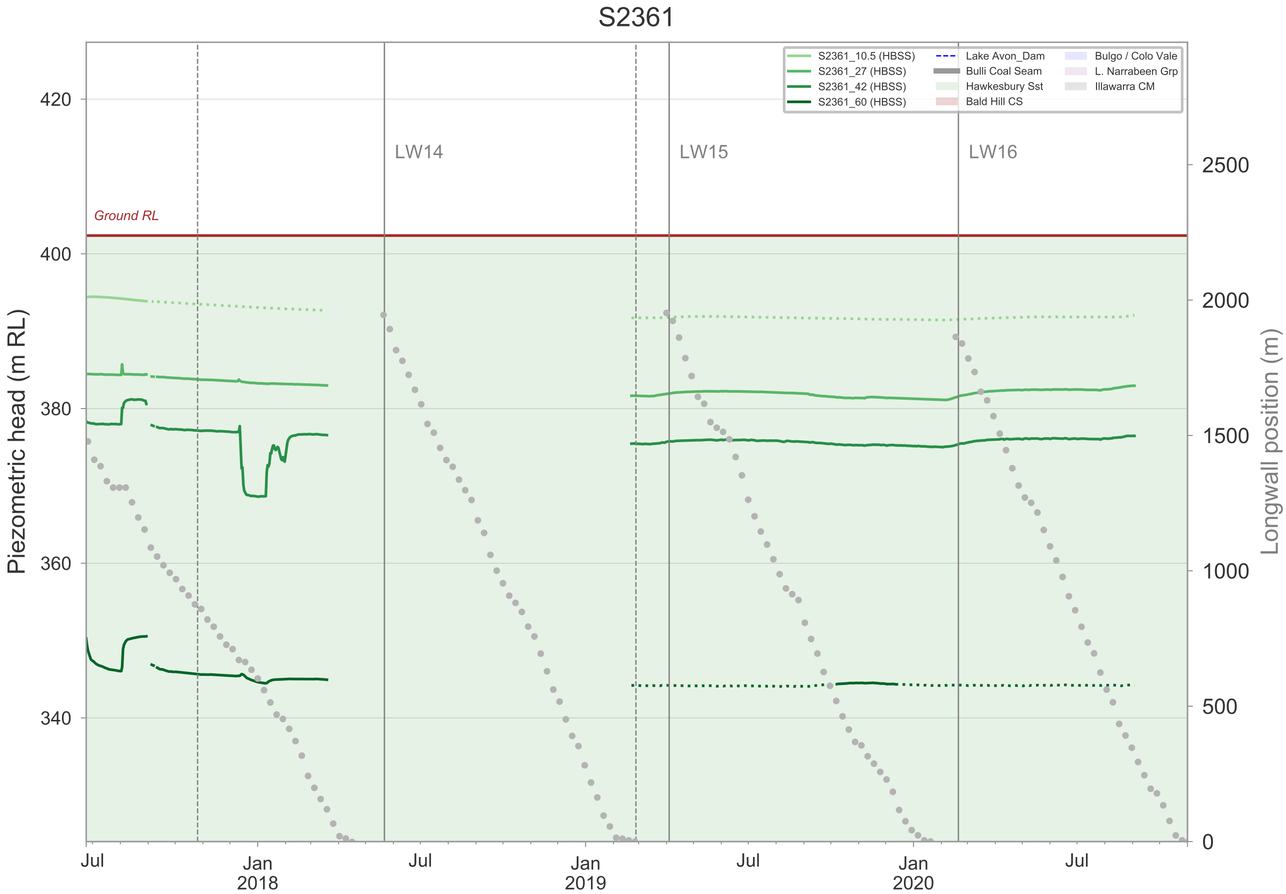

S2355
LW14
LW15
LW16
Pressure head (m H2O)
Longwall position (m)
−20
−10
0
10
20
30
40
50
0
500
1000
1500
2000
2500
Jan
2018
Jul
Jan
2019
Jul
Jan
2020
Jul
S2355_10.5 (HBSS)
S2355_10.5 (HBSS).1
S2355_25 (HBSS)
S2355_43.5 (HBSS)
S2355_60 (HBSS)

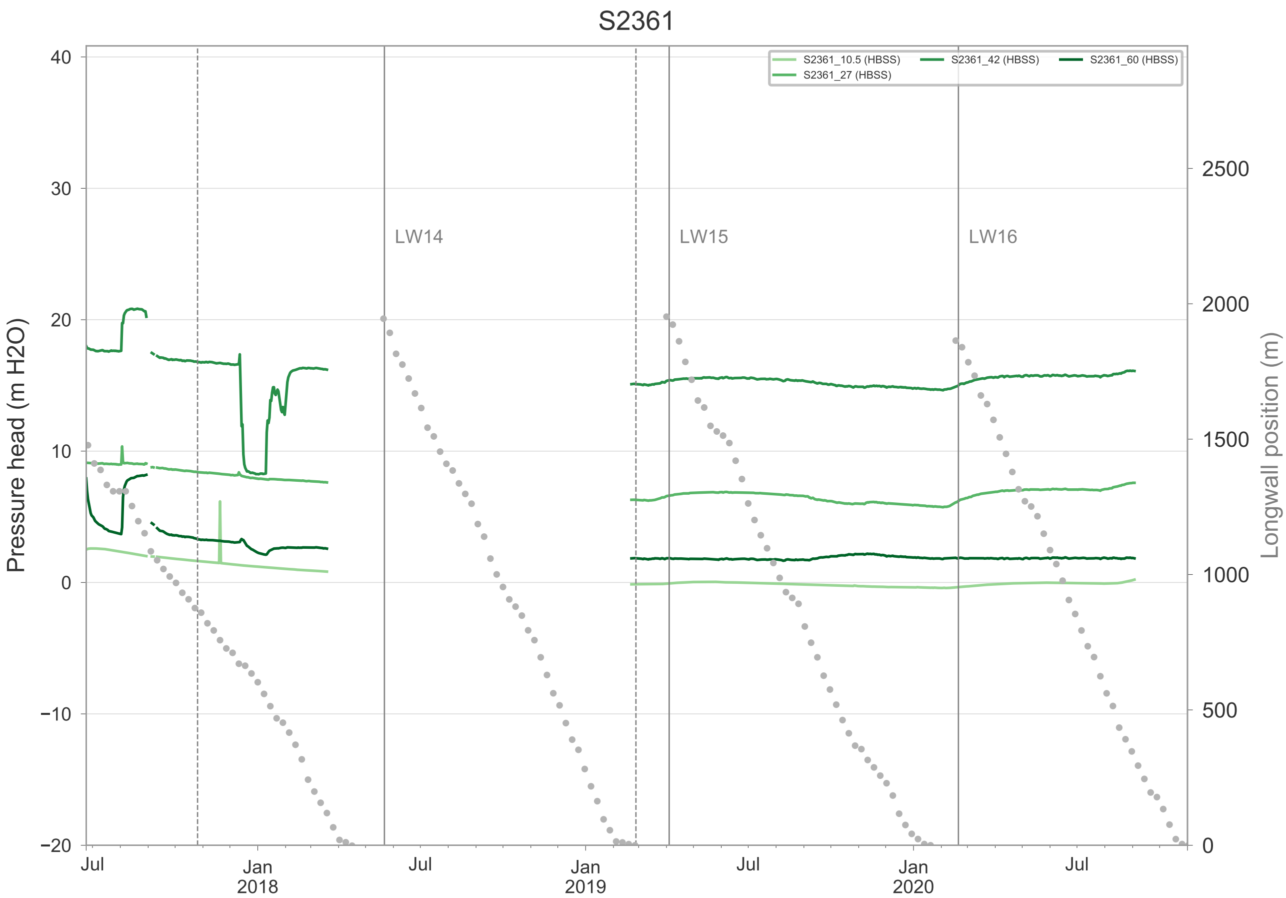

S2357
S2357_10.5 (HBSS)
S2357_27.5 (HBSS)
S2357_42.5 (HBSS)
S2357_56 (HBSS)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
LW14
LW15
LW16
Ground RL
Piezometric head (m RL)
Longwall position (m)
Jan 2018
Jul
Jan 2019
Jul
Jan 2020
Jul


S2357
S2357_10.5 (HBSS)
S2357_27.5 (HBSS)
S2357_42.5 (HBSS)
S2357_56 (HBSS)
LW14
LW15
LW16
Pressure head (m H2O)
Longwall position (m)
Jan 2018
Jul
Jan 2019
Jul
Jan 2020
Jul

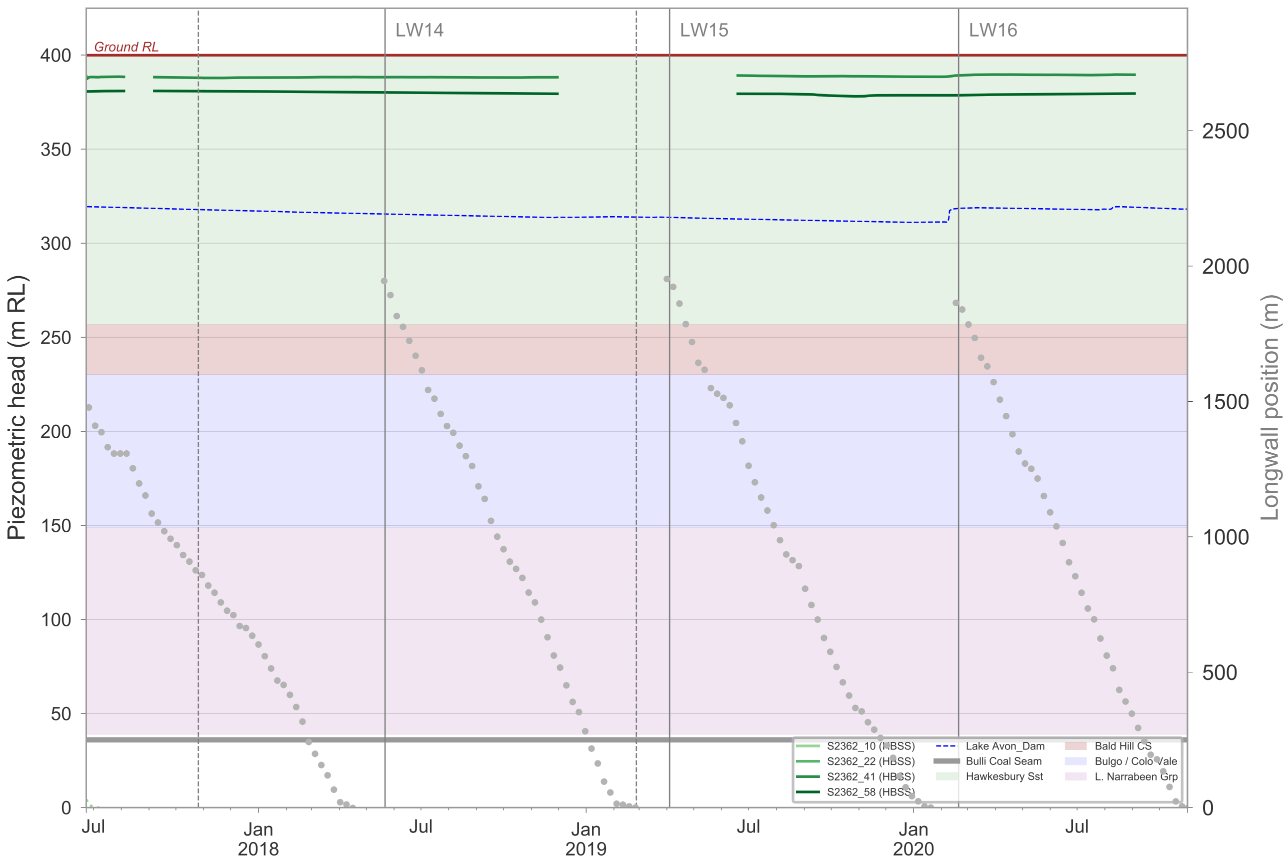

S2359
Piezometric head (m RL)
Longwall position (m)
Ground RL
LW14
LW15
LW17
S2359_55 (HBSS)
S2359_93.4 (HBSS)
S2359_131.8 (HBSS)
S2359_186.4 (BGSS)
S2359_247.2 (BGSS)
S2359_308 (BGSS)
S2359_318 (SBSS)
S2359_343 (SBSS)
S2359_363.5 (BUSM)
S2359_387.1 (WWSM)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
420
400
380
360
340
320
300
280
260
2500
2000
1500
1000
500
0
Jan 2018
Jul
Jan 2019
Jul
Jan 2020
Jul


S2359
Pressure head (m H2O)
Longwall position (m)
LW14
LW16
LW17
S2359_55 (HBSS)
S2359_93.4 (HBSS)
S2359_131.8 (HBSS)
S2359_186.4 (BGSS)
S2359_247.2 (BGSS)
S2359_308 (BGSS)
S2359_318 (SBSS)
S2359_343 (SBSS)
S2359_363.5 (BUSM)
S2359_387.1 (WWSM)
250
200
150
100
50
0
2500
2000
1500
1000
500
0
Jan 2018
Jul
Jan 2019
Jul
Jan 2020
Jul


S2361
S2361_10.5 (HBSS)
S2361_27 (HBSS)
S2361_42 (HBSS)
S2361_60 (HBSS)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
LW14
LW15
LW16
Ground RL
Piezometric head (m RL)
Longwall position (m)
420
400
380
360
340
2500
2000
1500
1000
500
0
Jul
Jan
2018
Jul
Jan
2019
Jul
Jan
2020
Jul

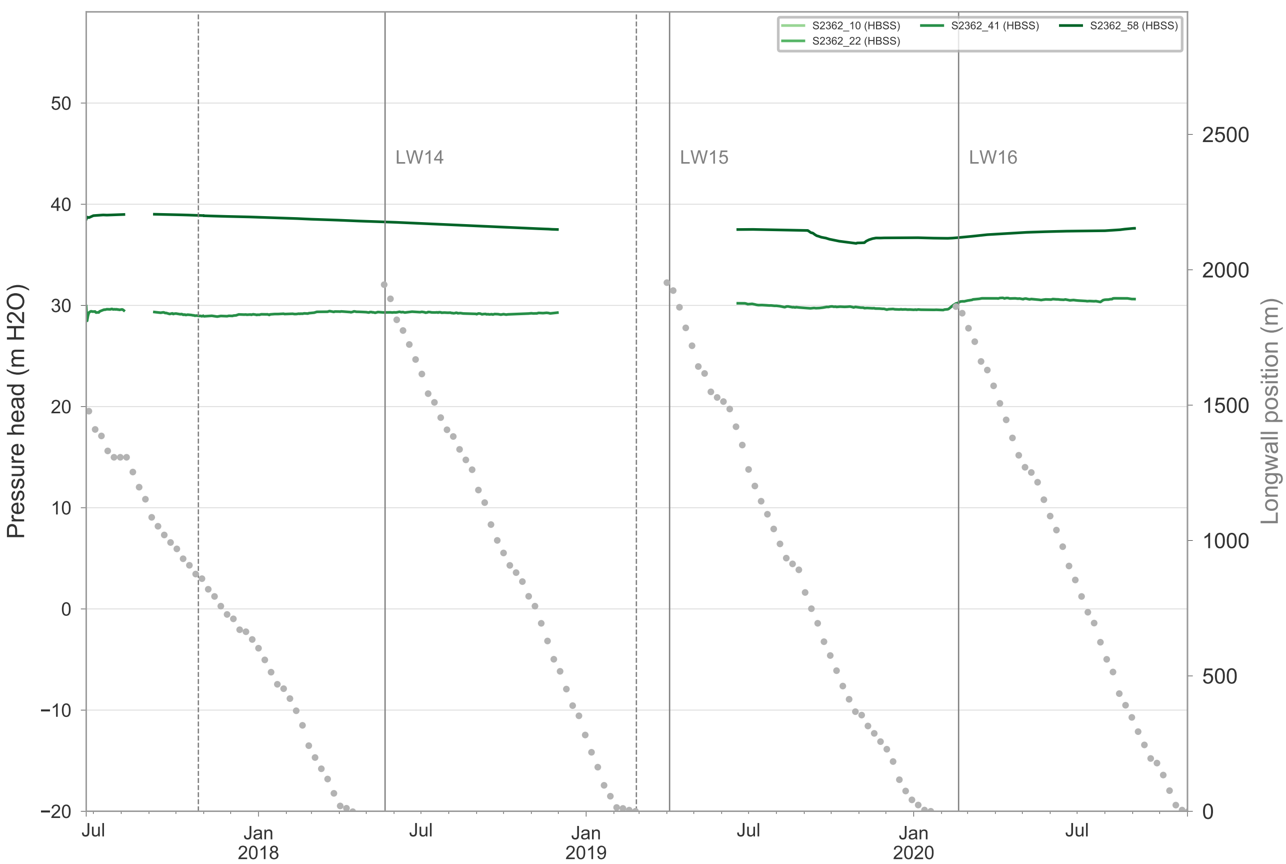

S2361
S2361_10.5 (HBSS)
S2361_27 (HBSS)
S2361_42 (HBSS)
S2361_60 (HBSS)
LW14
LW15
LW16
Pressure head (m H2O)
Longwall position (m)
40
30
20
10
0
−10
−20
2500
2000
1500
1000
500
0
Jul
Jan
2018
Jul
Jan
2019
Jul
Jan
2020
Jul

S2362



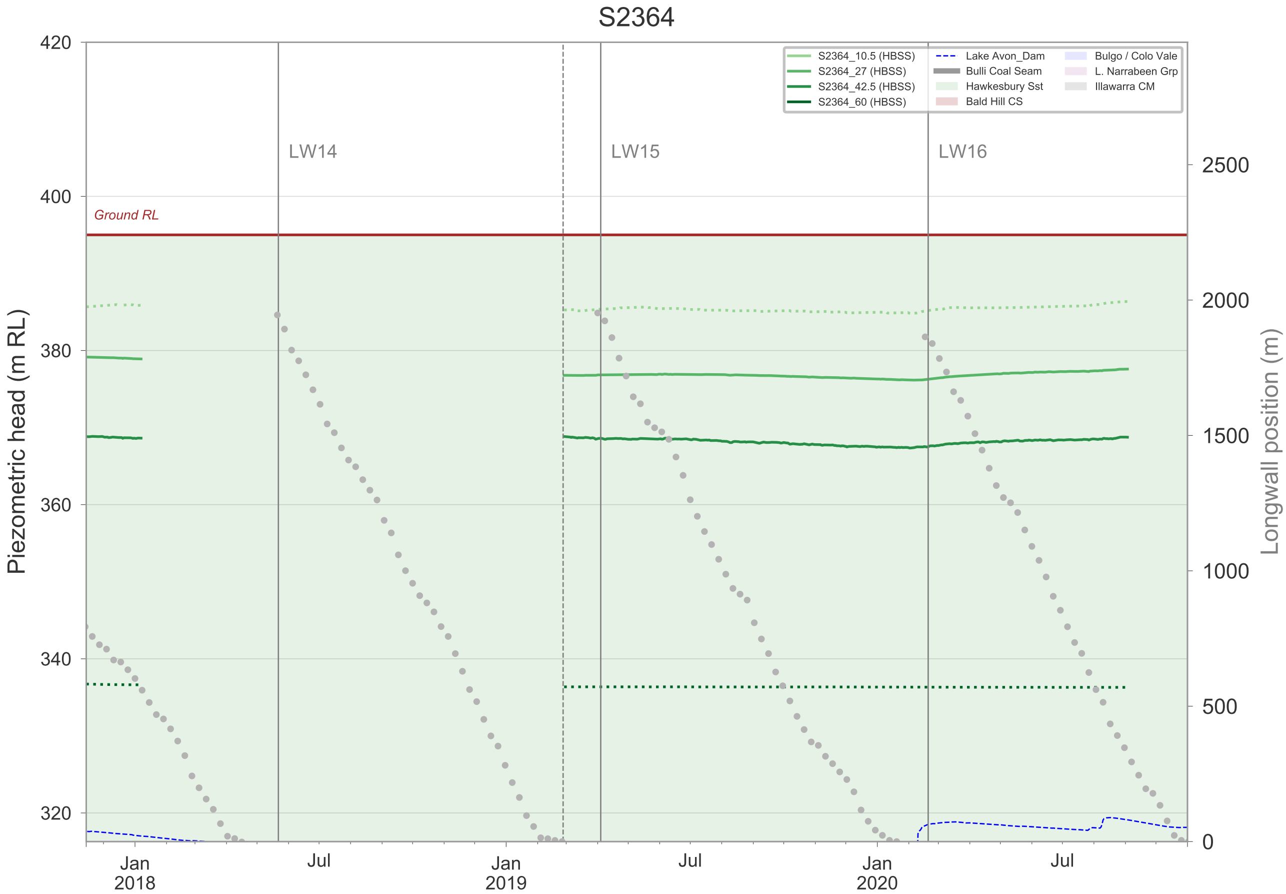
Ground RL
LW14
LW15
LW16
Piezometric head (m RL)
Longwall position (m)
400
350
300
250
200
150
100
50
0
2500
2000
1500
1000
500
0
Jul
Jan
2018
Jul
Jan
2019
Jul
Jan
2020
Jul
S2362_10 (HBSS)
S2362_22 (HBSS)
S2362_41 (HBSS)
S2362_58 (HBSS)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp

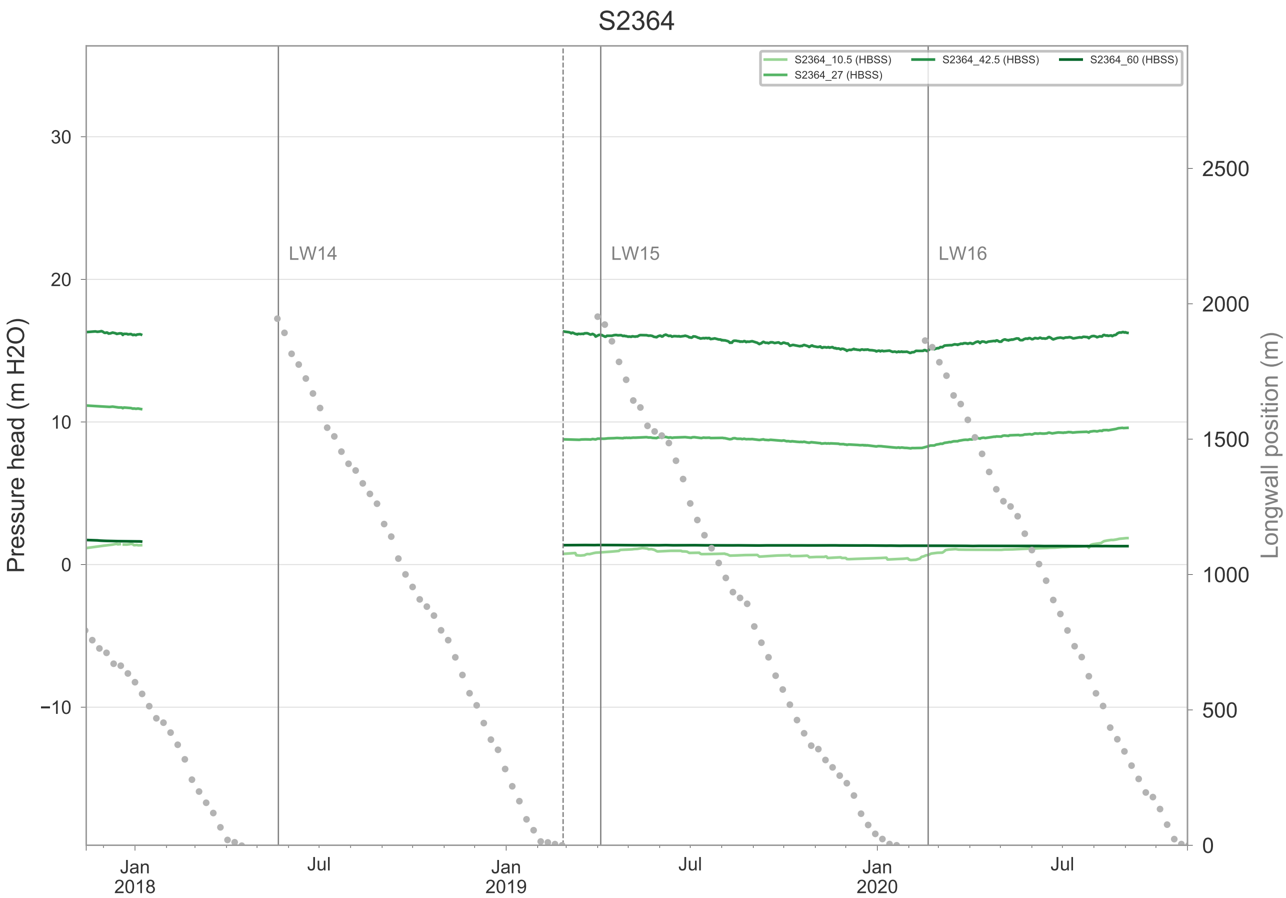
S2362



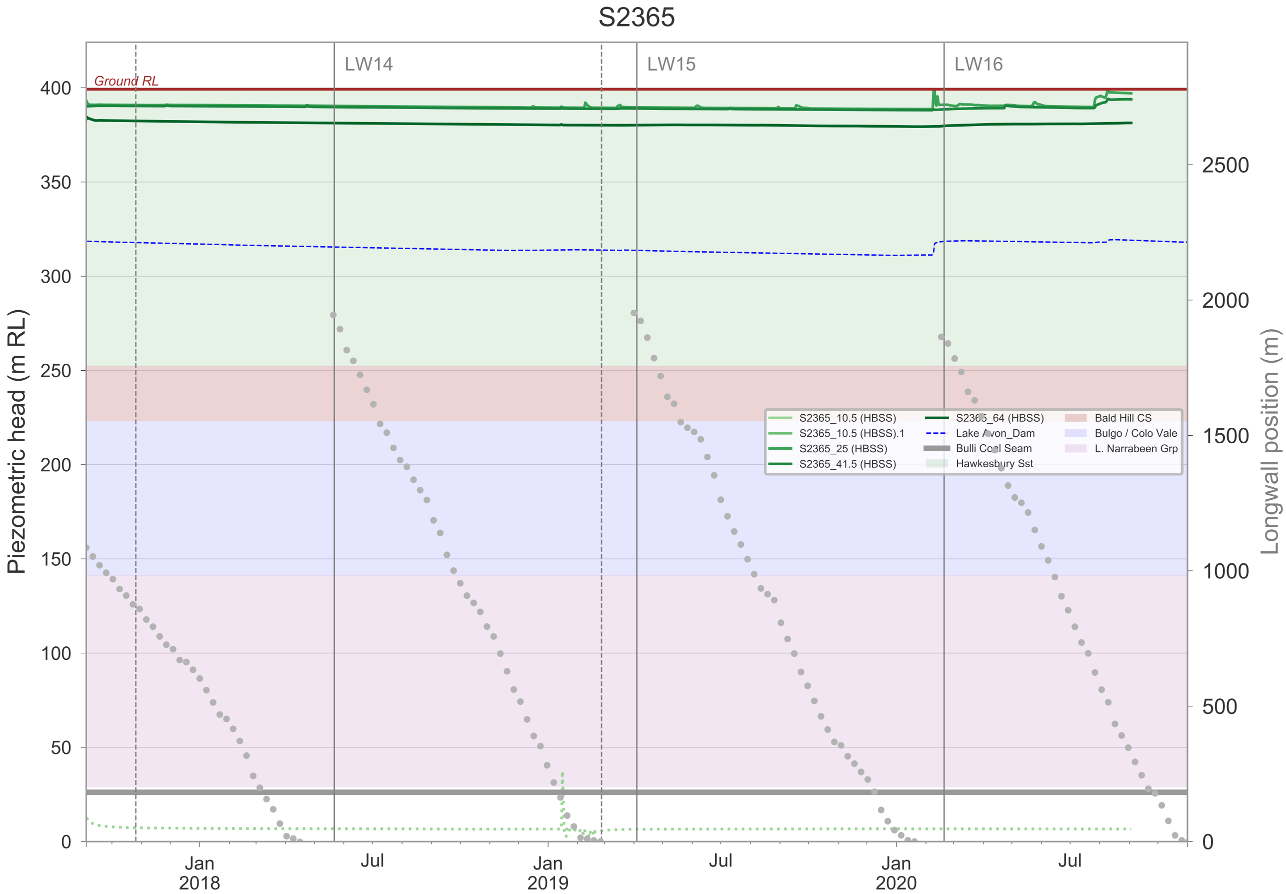
S2362_10 (HBSS)
S2362_22 (HBSS)
S2362_41 (HBSS)
S2362_58 (HBSS)
LW14
LW15
LW16
Pressure head (m H2O)
Longwall position (m)
50
40
30
20
10
0
−10
−20
2500
2000
1500
1000
500
0
Jul
Jan
2018
Jul
Jan
2019
Jul
Jan
2020
Jul

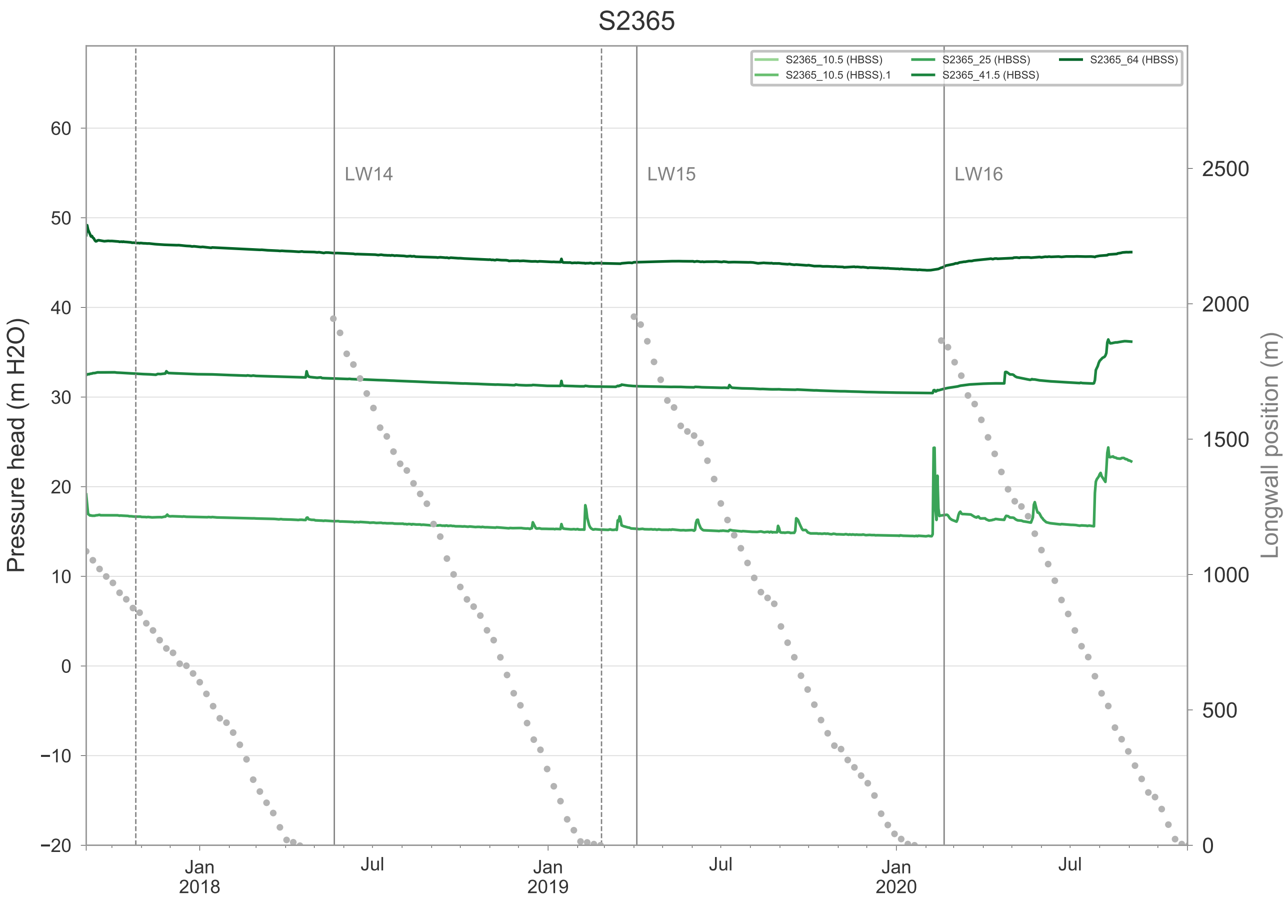
Groundwater hydrographs



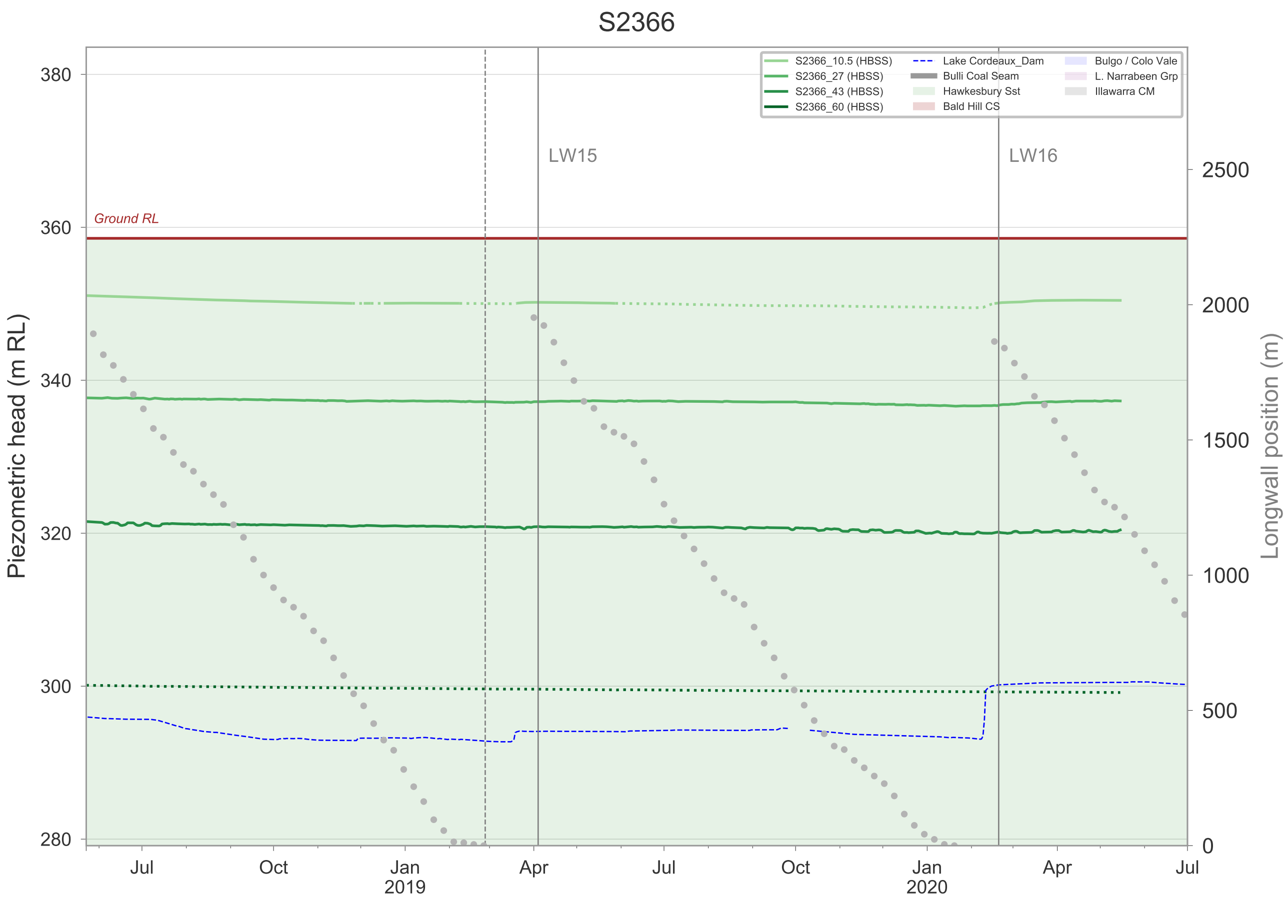


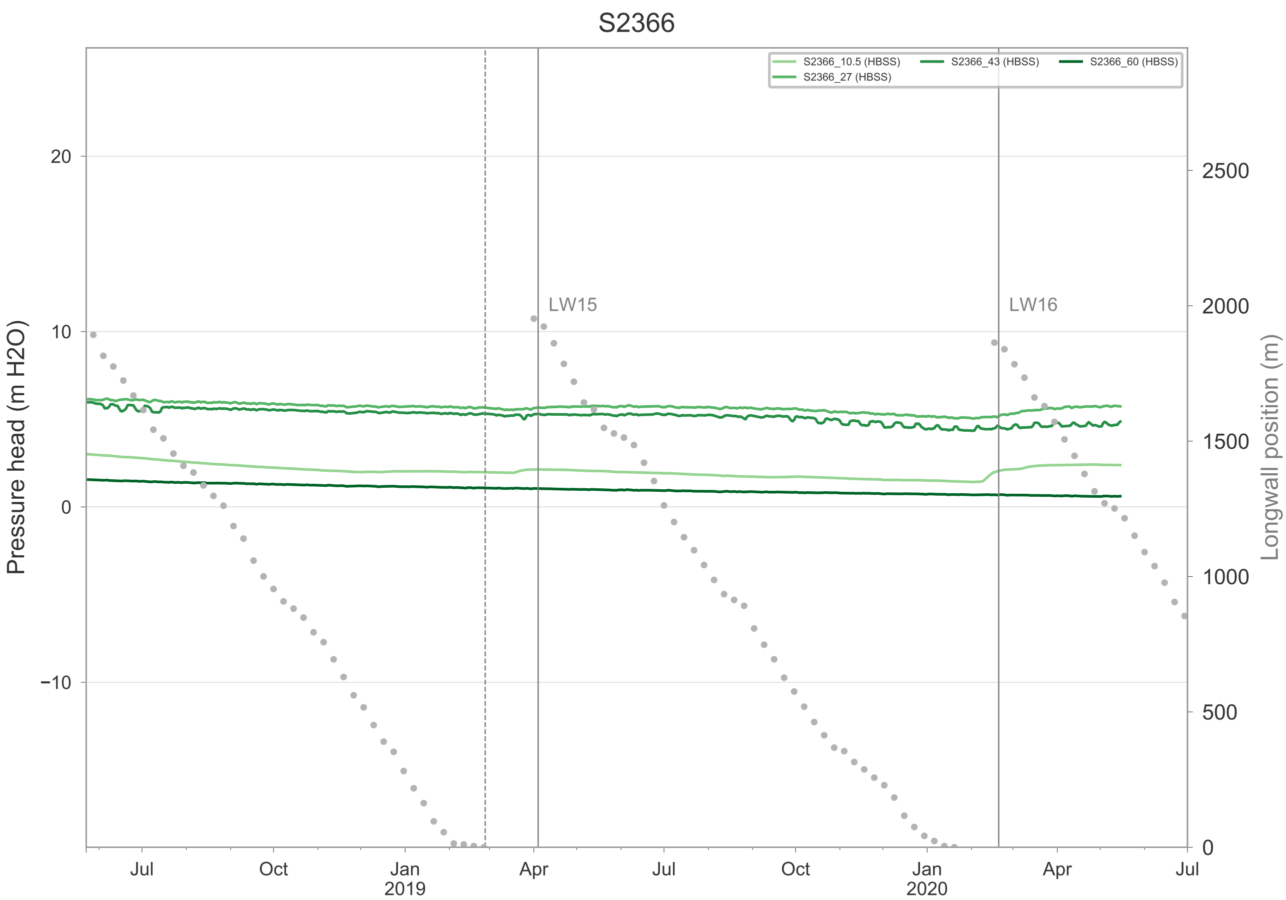
Groundwater hydrographs



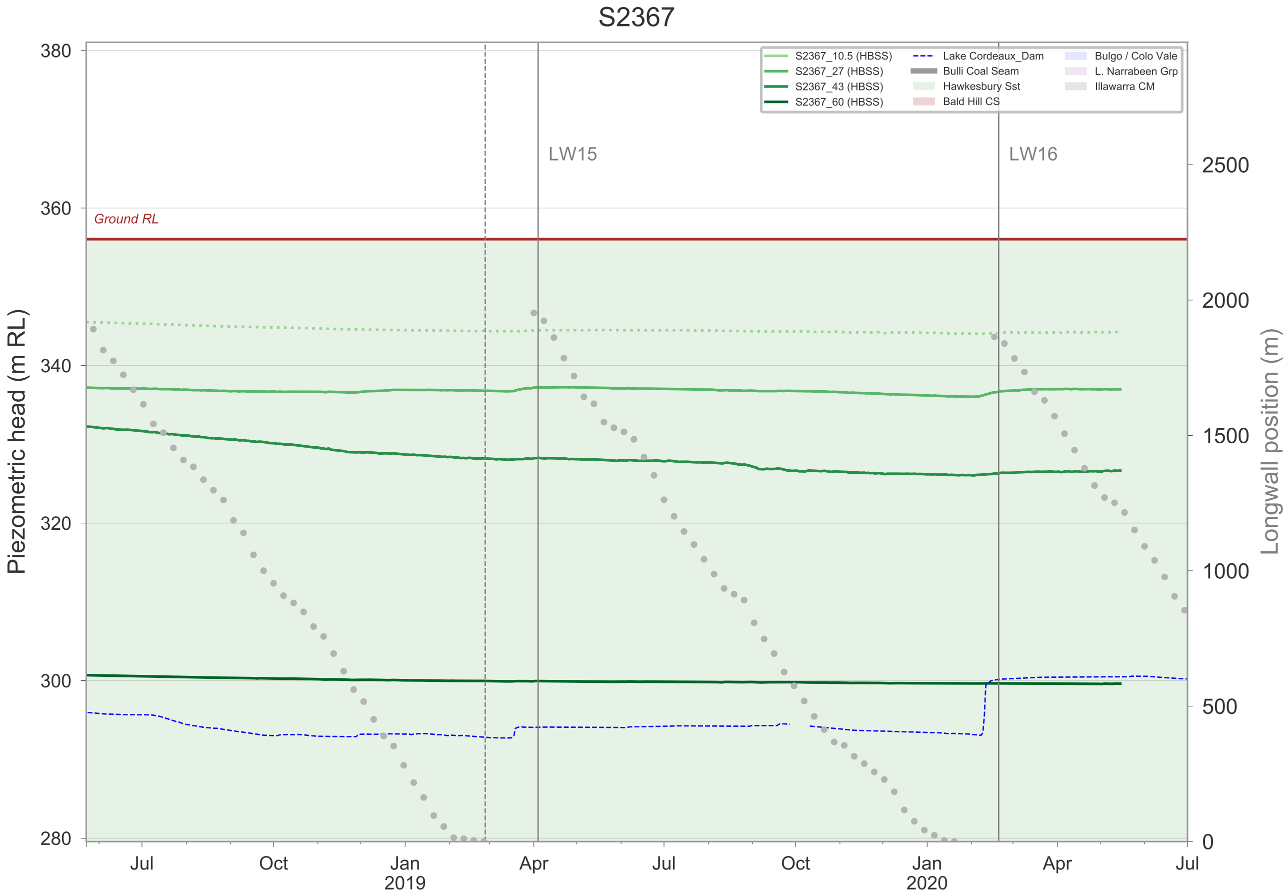


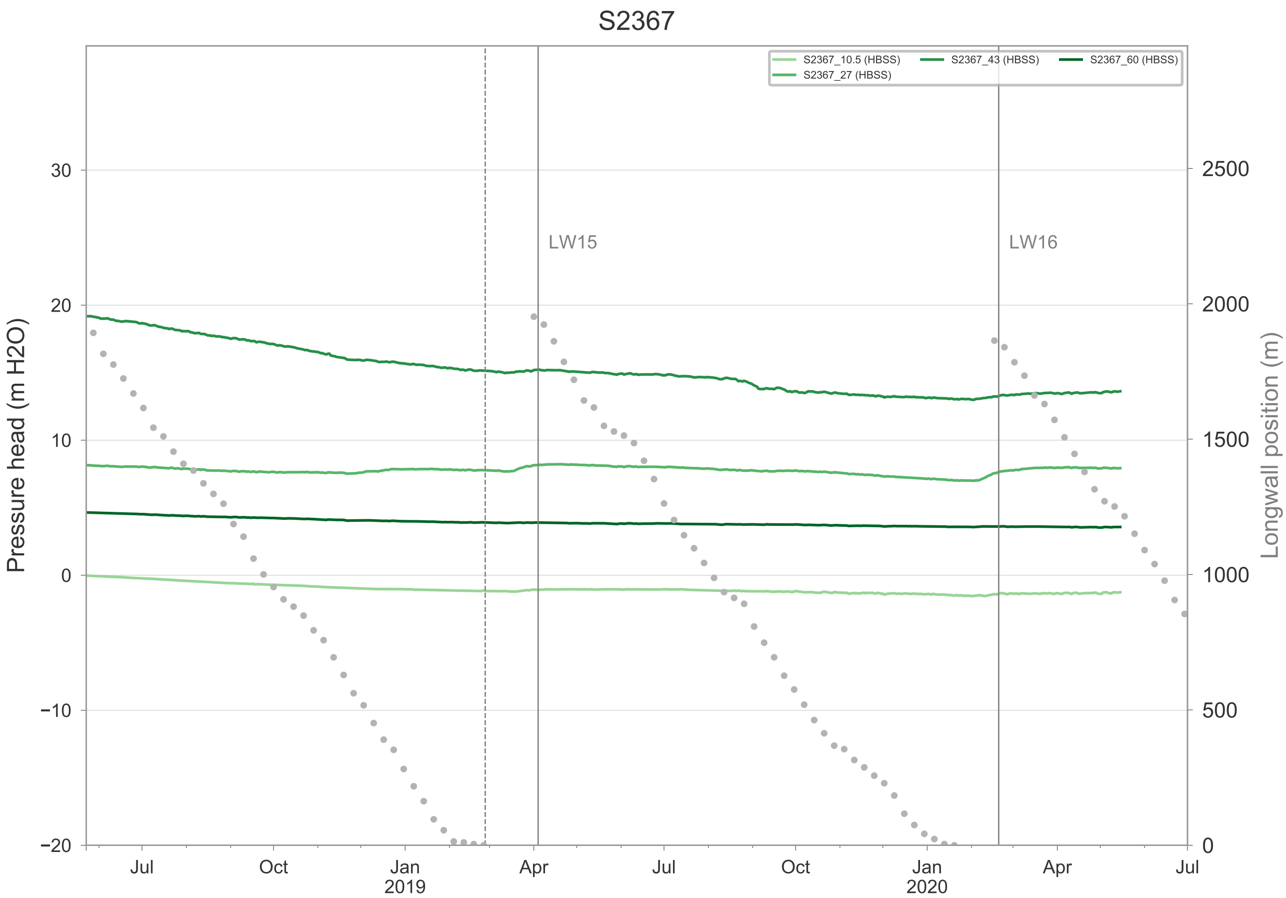
Groundwater hydrographs

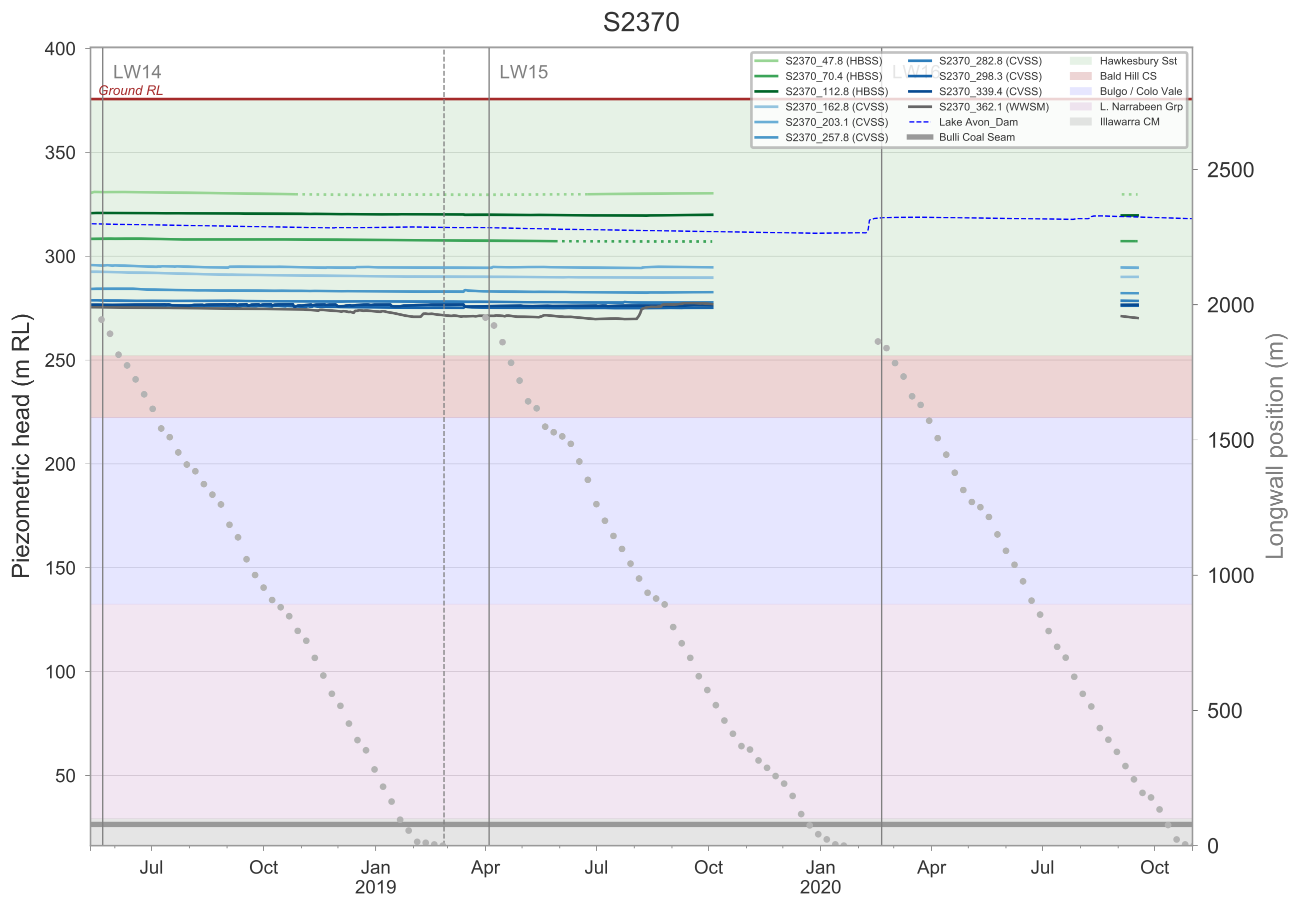


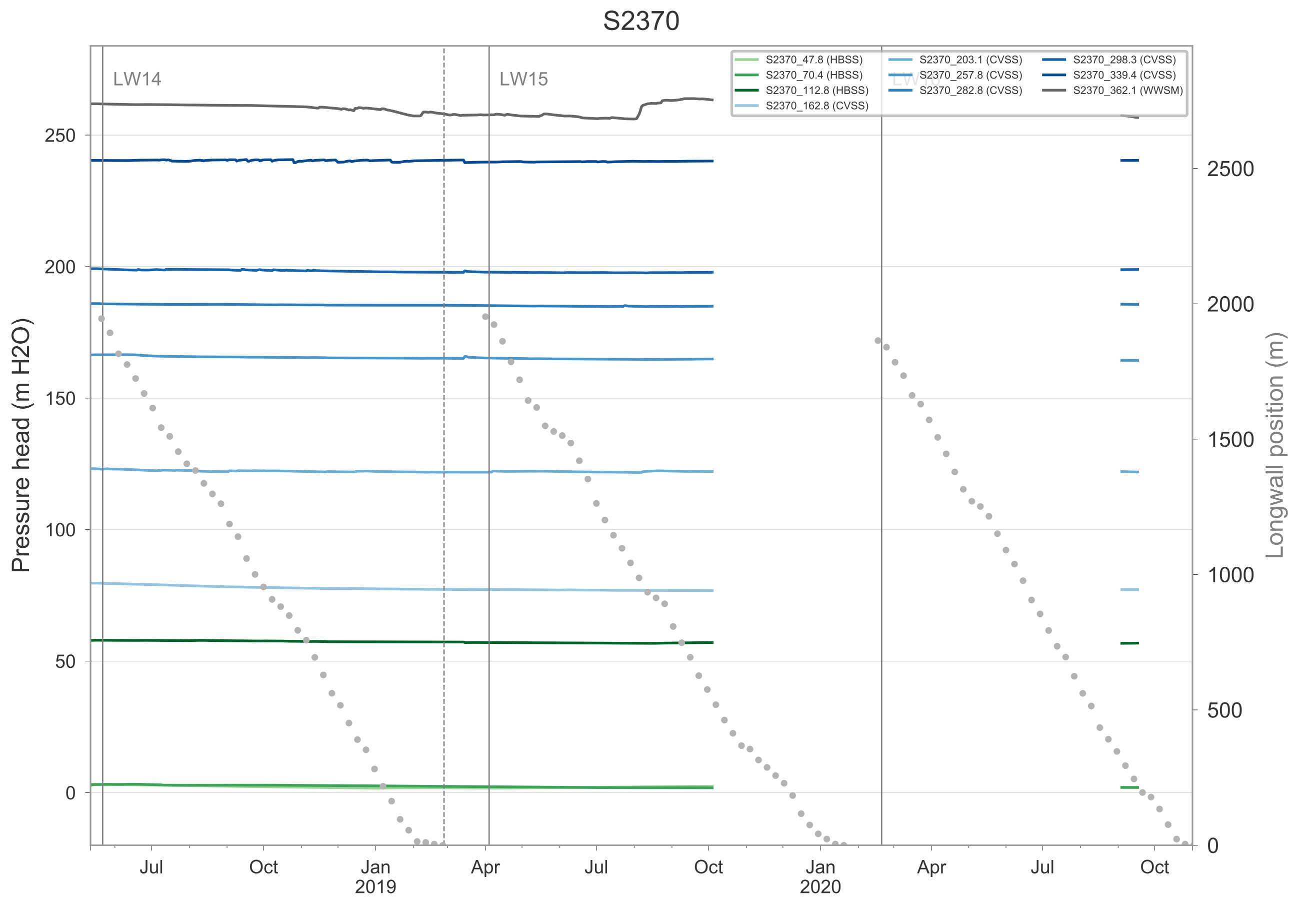


Groundwater hydrographs

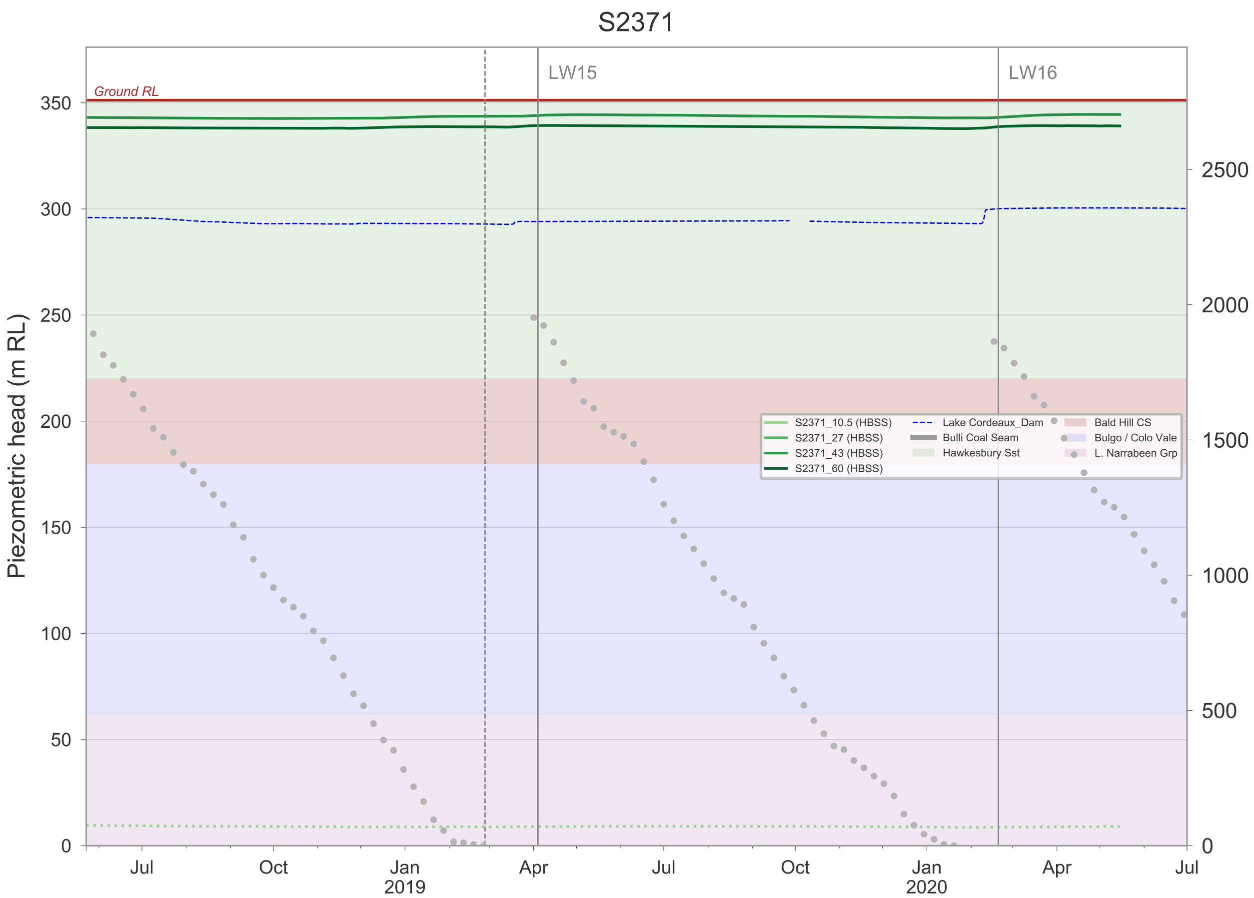


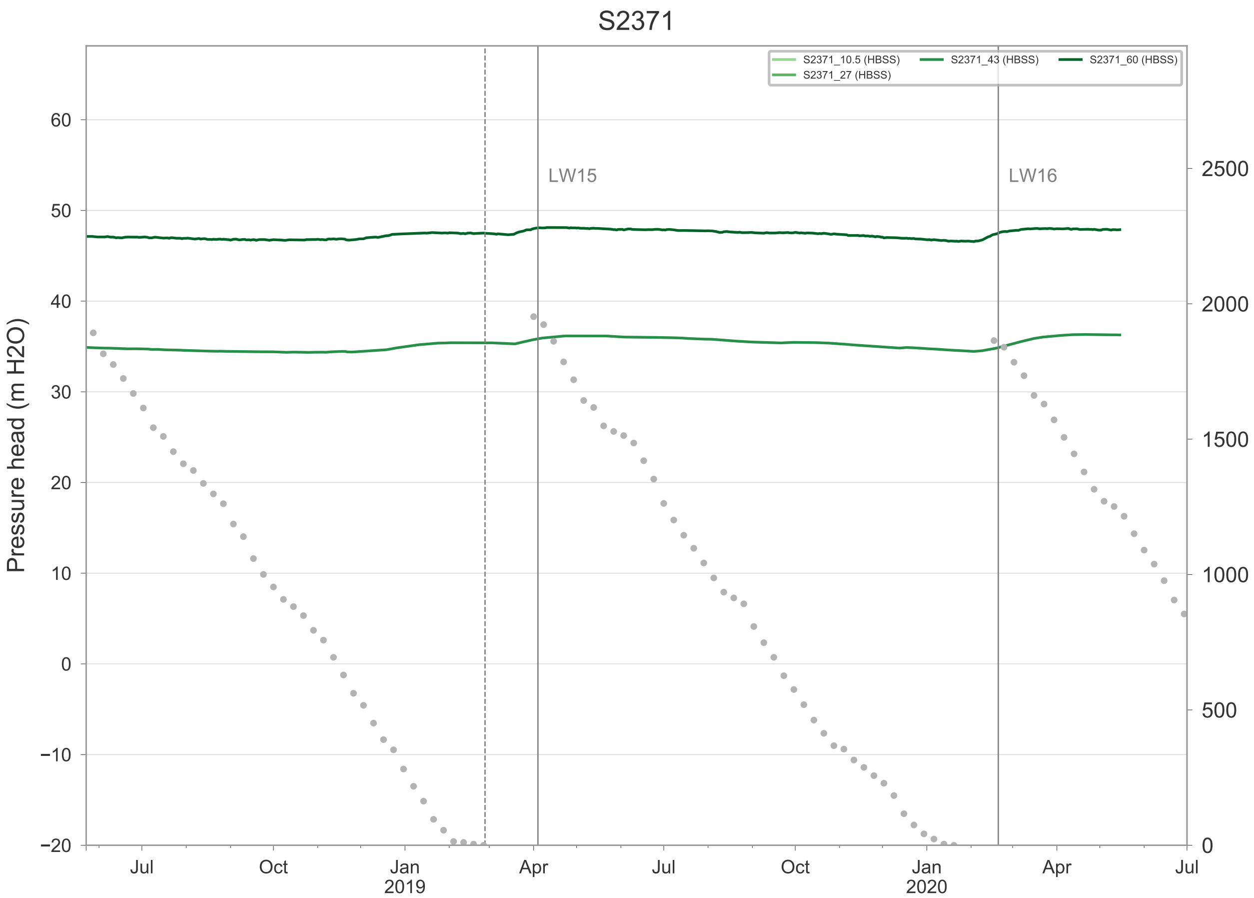


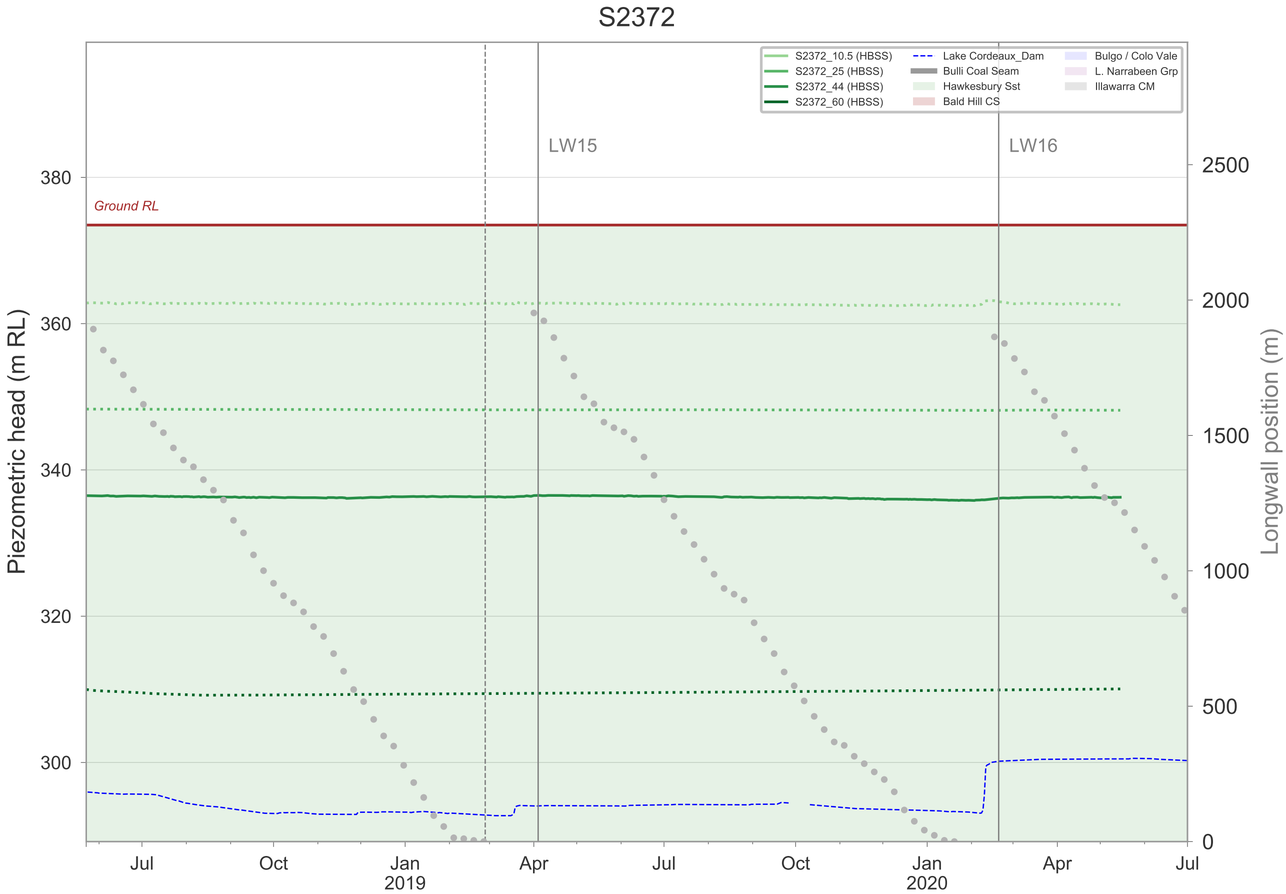

S2370
LW14
LW15
Ground RL
Piezometric head (m RL)
Longwall position (m)
S2370_47.8 (HBSS)
S2370_70.4 (HBSS)
S2370_112.8 (HBSS)
S2370_162.8 (CVSS)
S2370_203.1 (CVSS)
S2370_257.8 (CVSS)
S2370_282.8 (CVSS)
S2370_298.3 (CVSS)
S2370_339.4 (CVSS)
S2370_362.1 (WWSM)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
400
350
300
250
200
150
100
50
2500
2000
1500
1000
500
0
Jul
Oct
Jan
2019
Apr
Jul
Oct
Jan
2020
Apr
Jul
Oct

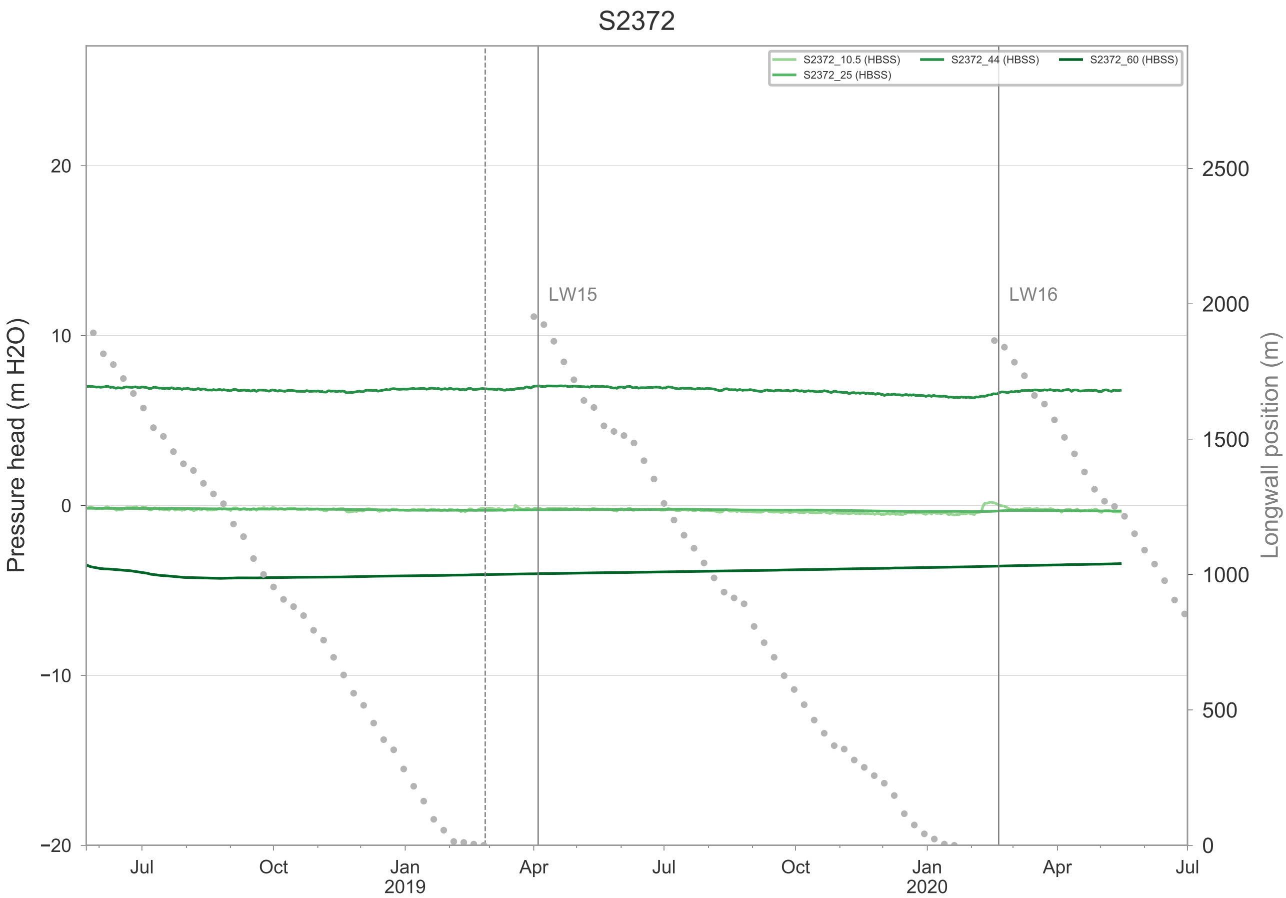

S2370
LW14
LW15
Pressure head (m H2O)
Longwall position (m)
S2370_47.8 (HBSS)
S2370_70.4 (HBSS)
S2370_112.8 (HBSS)
S2370_162.8 (CVSS)
S2370_203.1 (CVSS)
S2370_257.8 (CVSS)
S2370_282.8 (CVSS)
S2370_298.3 (CVSS)
S2370_339.4 (CVSS)
S2370_362.1 (WWSM)
250
200
150
100
50
0
2500
2000
1500
1000
500
0
Jul
Oct
Jan
2019
Apr
Jul
Oct
Jan
2020
Apr
Jul
Oct

Groundwater hydrographs

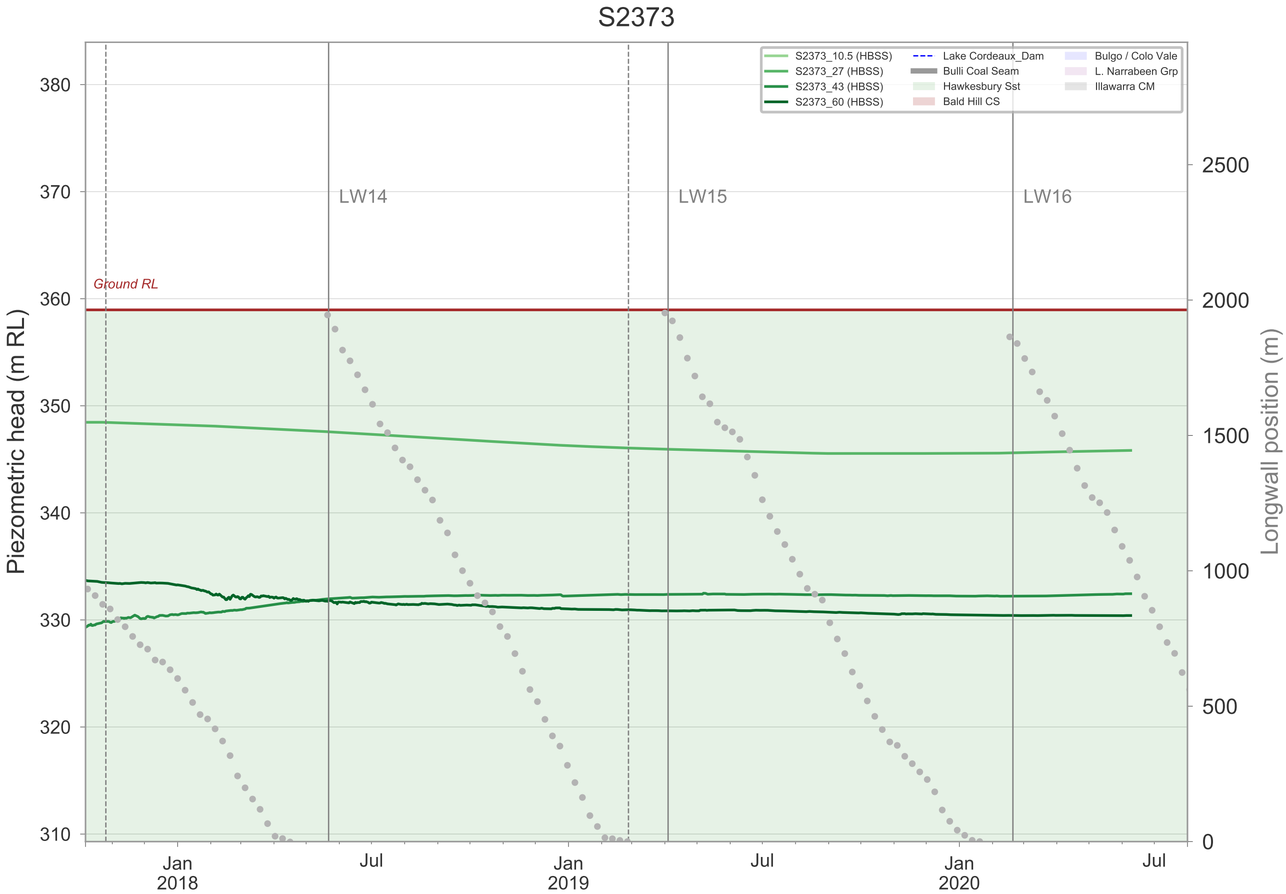


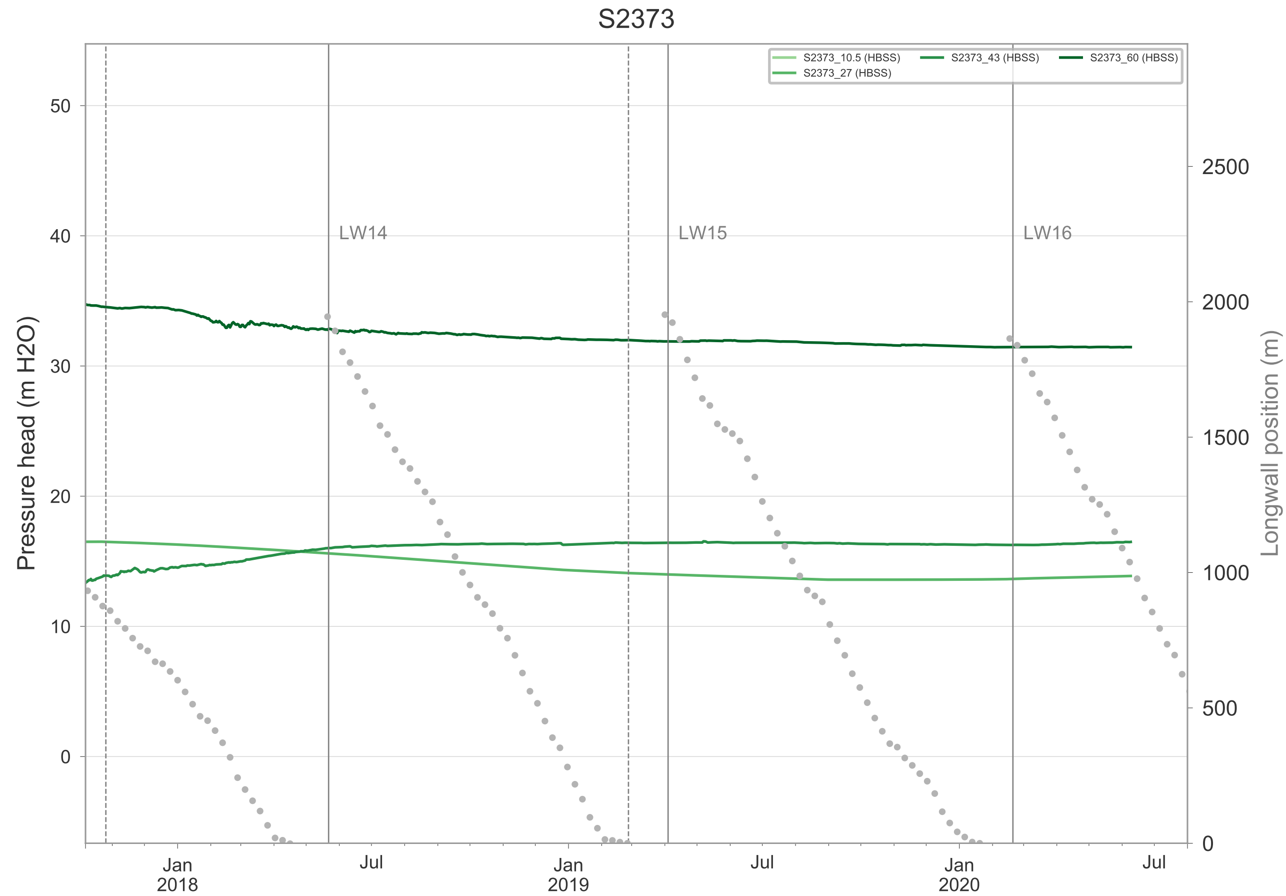


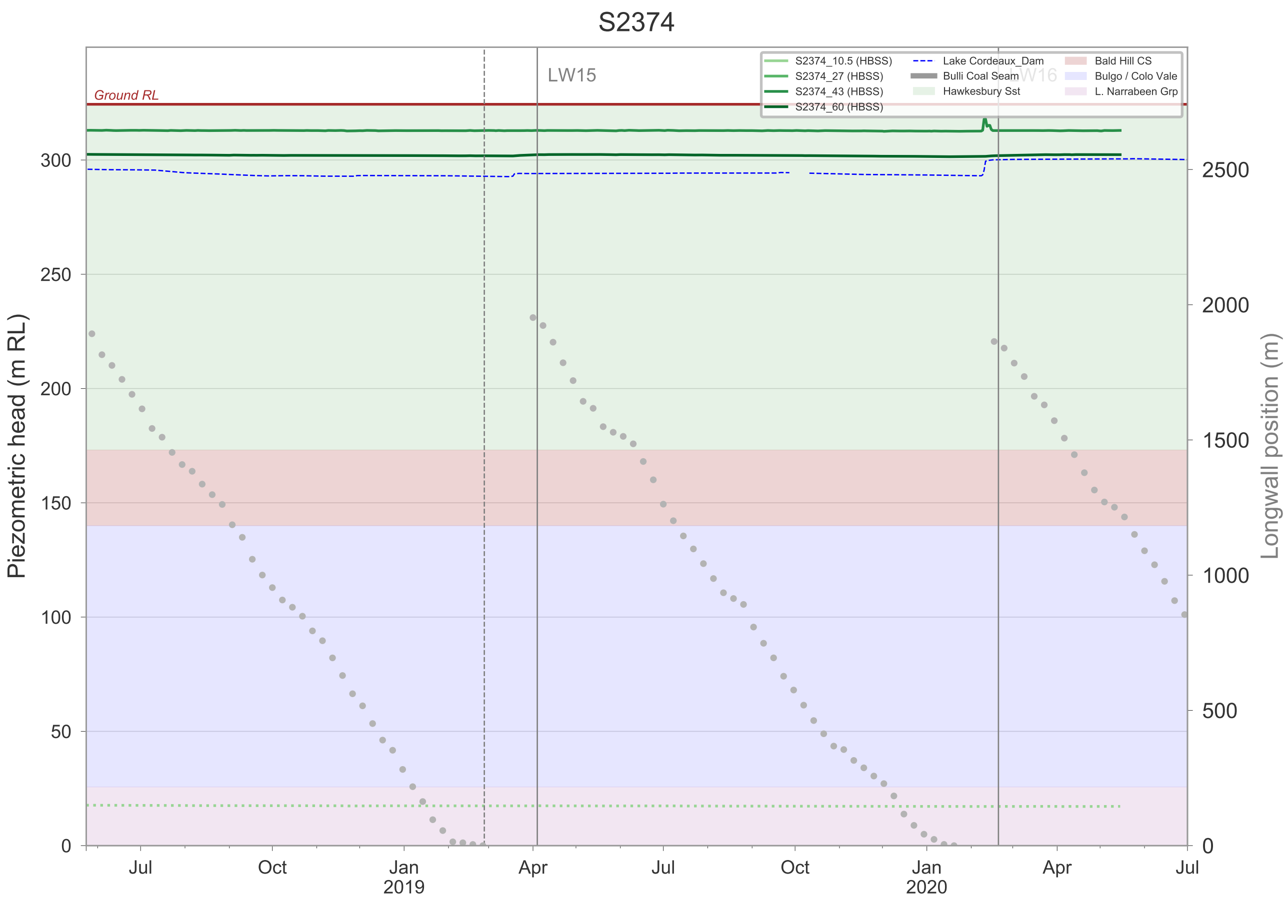

S2372
S2372_10.5 (HBSS)
S2372_25 (HBSS)
S2372_44 (HBSS)
S2372_60 (HBSS)
Lake Cordeaux_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
LW15
LW16
Ground RL
Piezometric head (m RL)
Longwall position (m)
380
360
340
320
300
2500
2000
1500
1000
500
0
Jul
Oct
Jan
2019
Apr
Jul
Oct
Jan
2020
Apr
Jul

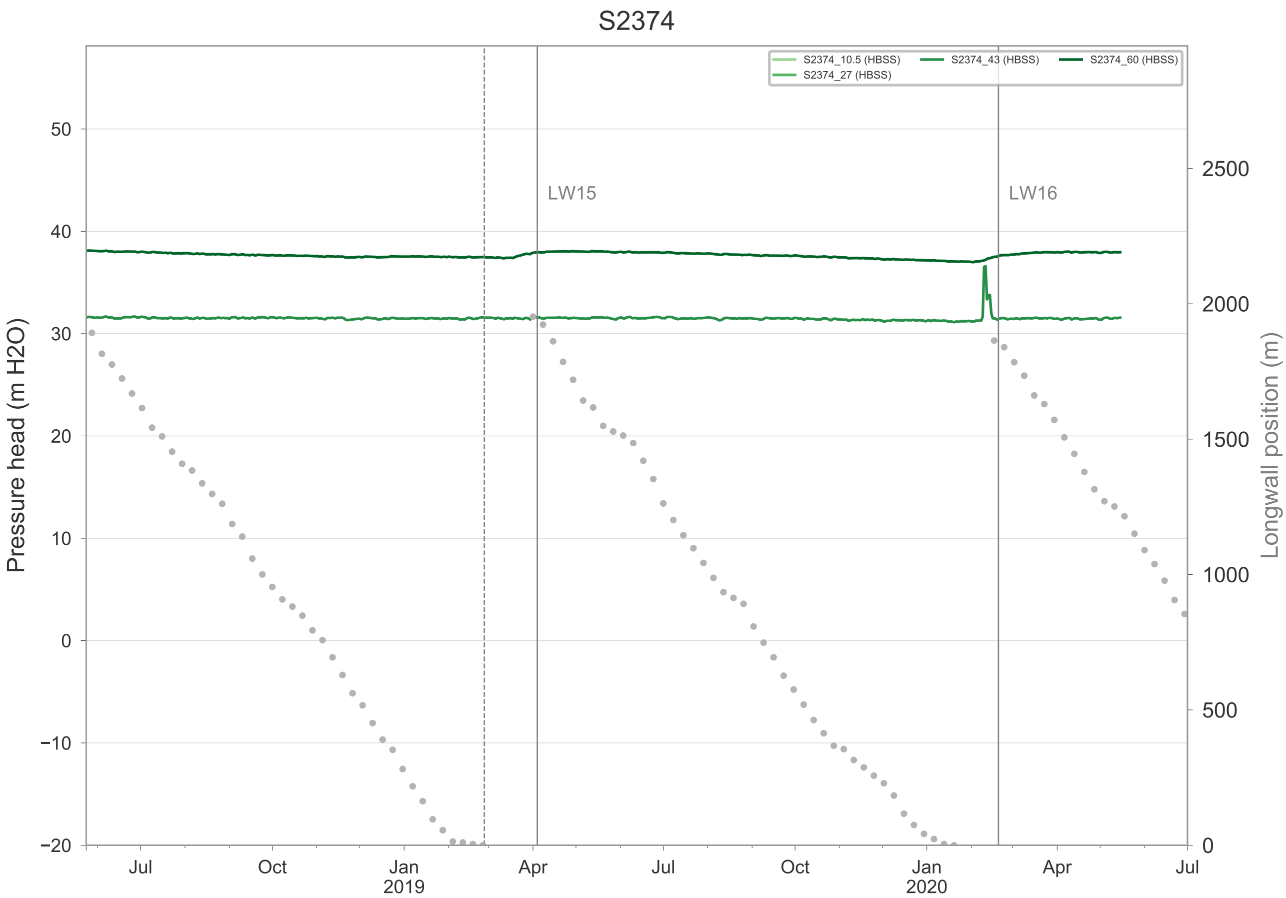

S2372
S2372_10.5 (HBSS)
S2372_25 (HBSS)
S2372_44 (HBSS)
S2372_60 (HBSS)
LW15
LW16
Pressure head (m H2O)
Longwall position (m)
20
10
0
−10
−20
2500
2000
1500
1000
500
0
Jul
Oct
Jan
2019
Apr
Jul
Oct
Jan
2020
Apr
Jul

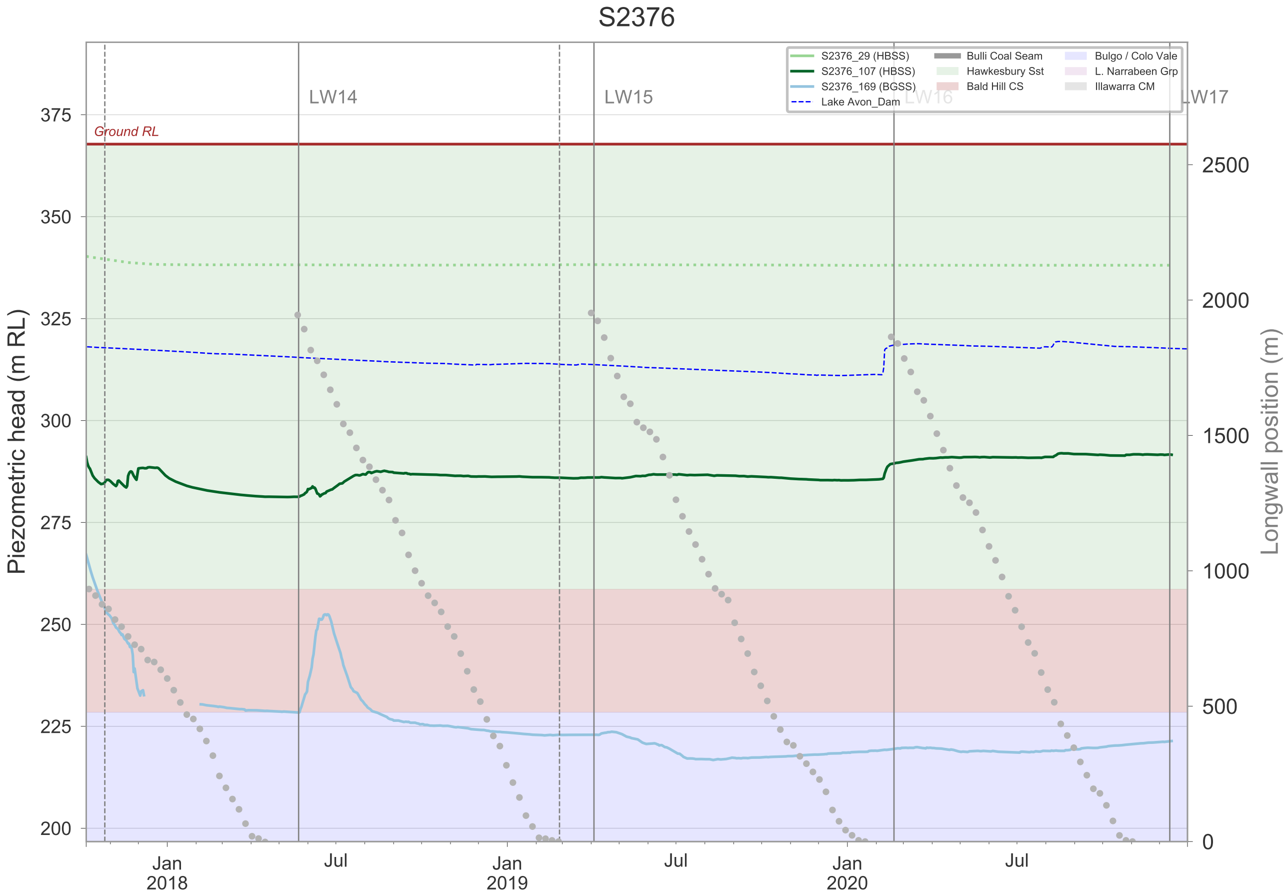
Groundwater hydrographs

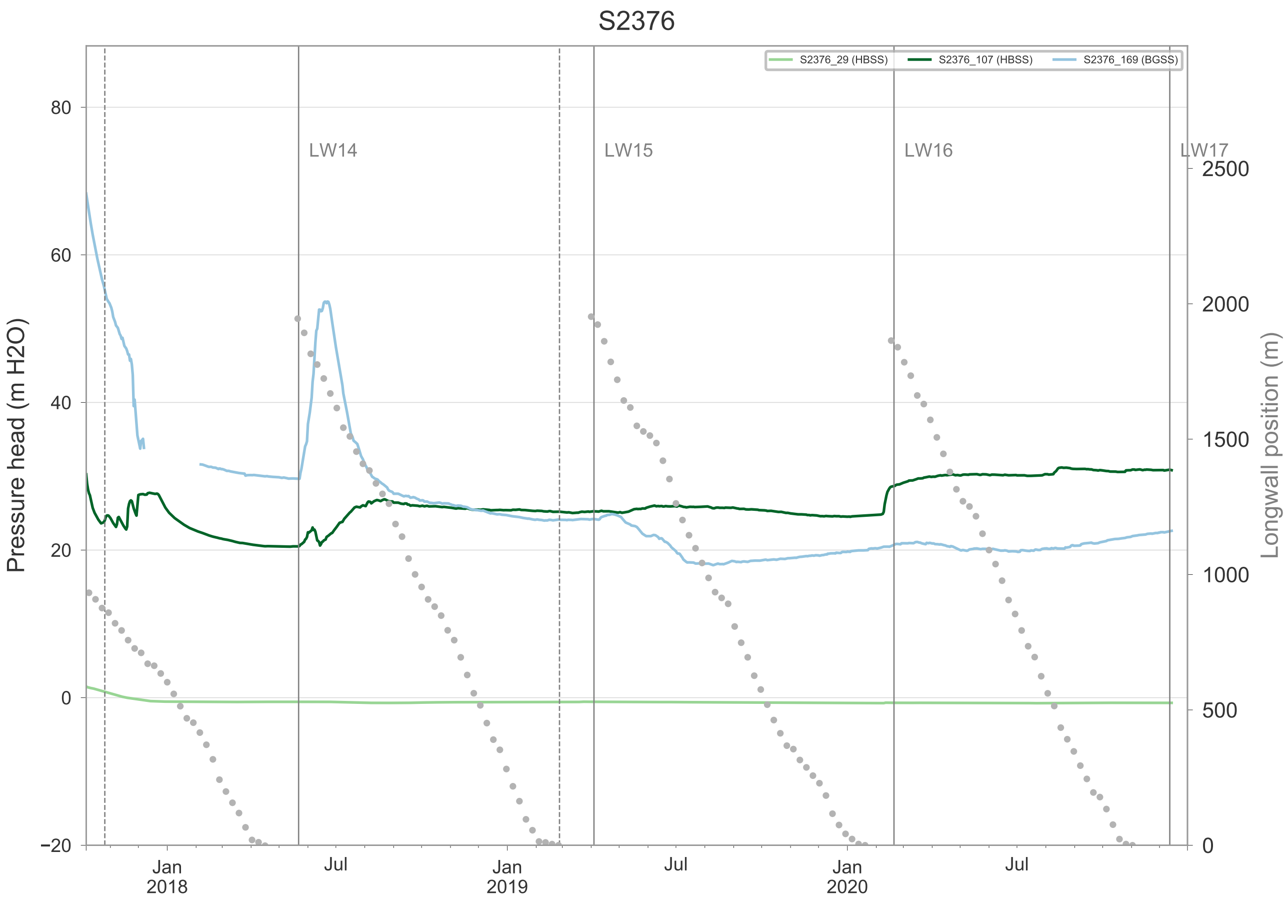


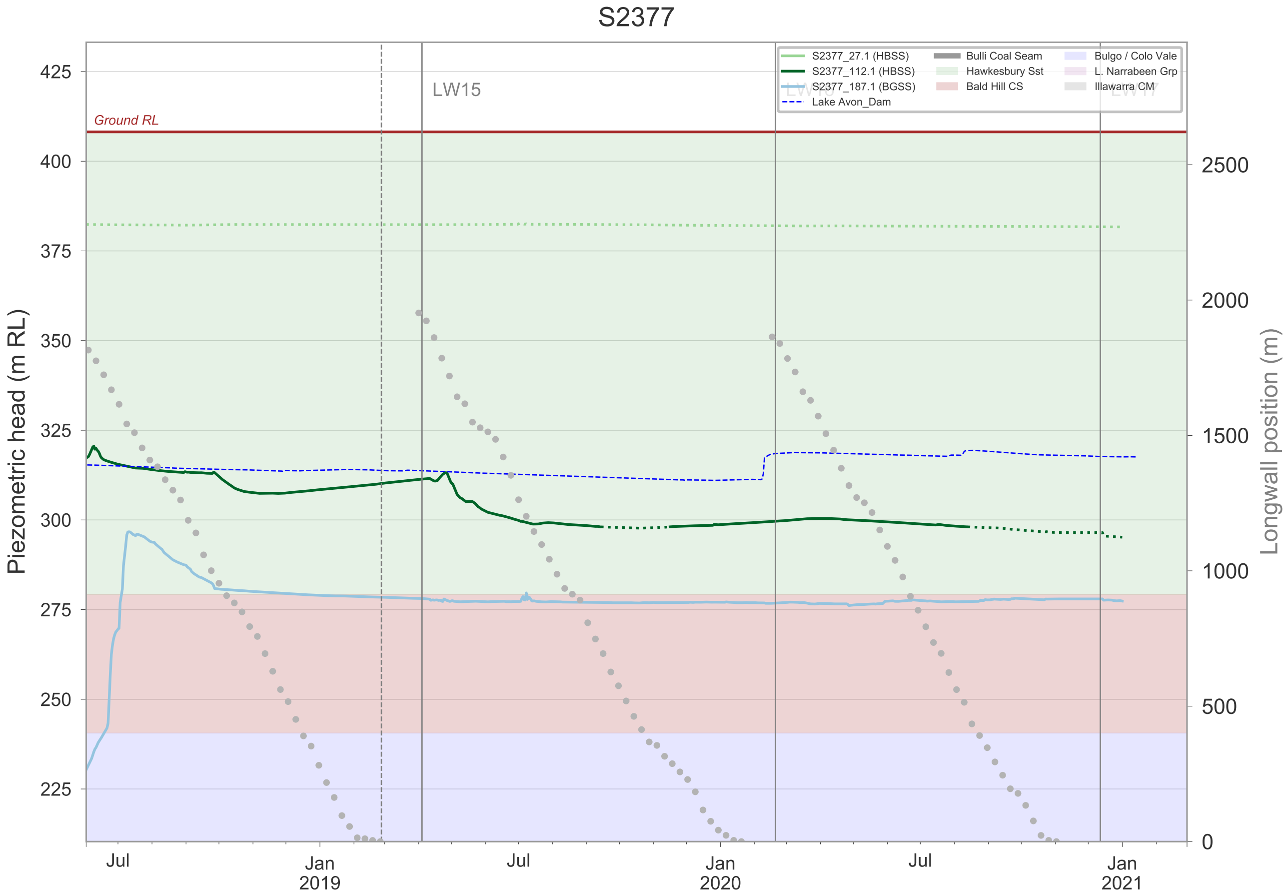


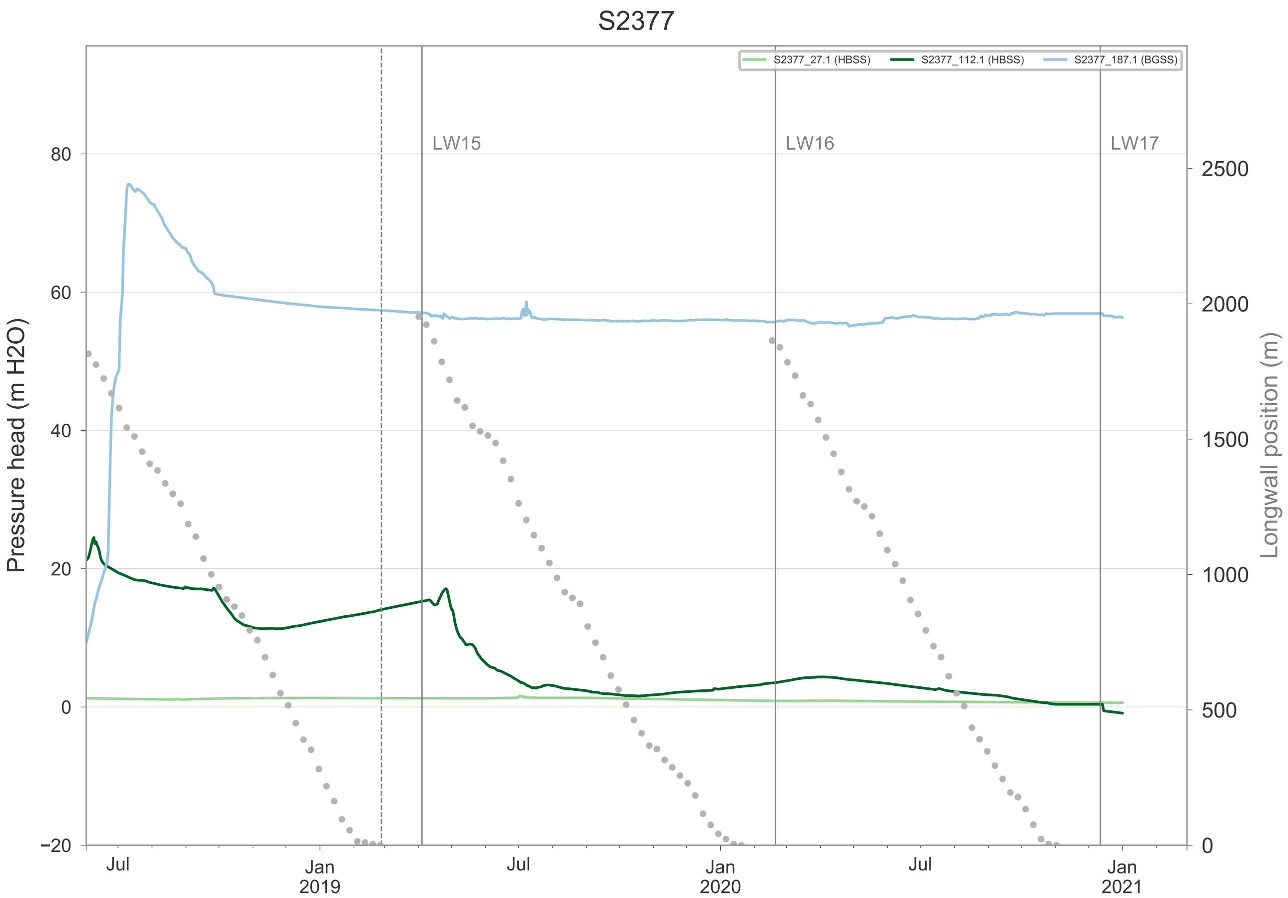

S2374
S2374_10.5 (HBSS)
S2374_27 (HBSS)
S2374_43 (HBSS)
S2374_60 (HBSS)
Lake Cordeaux_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Ground RL
LW15
LW16
Piezometric head (m RL)
Longwall position (m)
Jul
Oct
Jan
2019
Apr
Jul
Oct
Jan
2020
Apr
Jul


S2374
S2374_10.5 (HBSS)
S2374_27 (HBSS)
S2374_43 (HBSS)
S2374_60 (HBSS)
LW15
LW16
Pressure head (m H2O)
Longwall position (m)
Jul
Oct
Jan
2019
Apr
Jul
Oct
Jan
2020
Apr
Jul

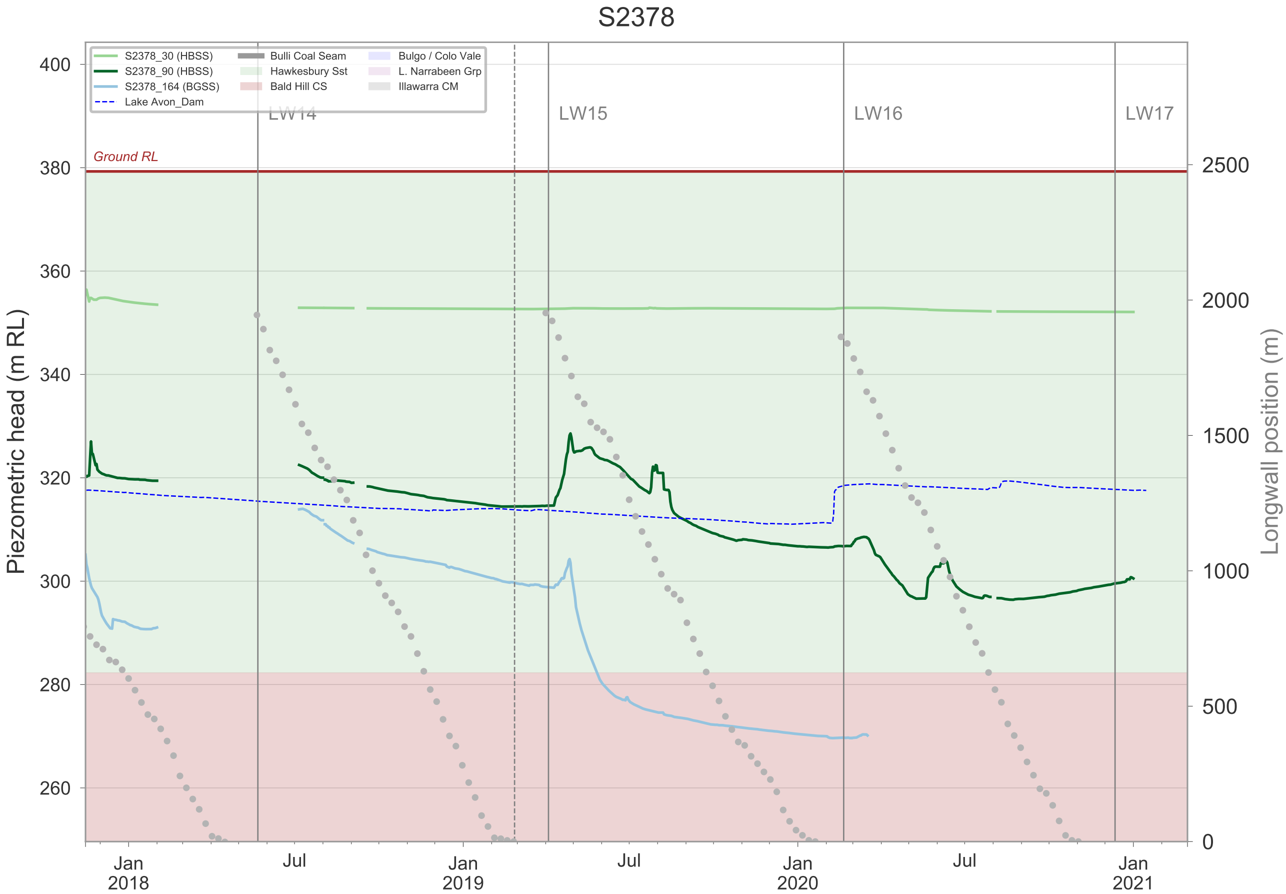

S2376
S2376_29 (HBSS)
S2376_107 (HBSS)
S2376_169 (BGSS)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
LW14
LW15
LW16
LW17
Ground RL
Piezometric head (m RL)
Longwall position (m)
375
350
325
300
275
250
225
200
2500
2000
1500
1000
500
0
Jan 2018
Jul
Jan 2019
Jul
Jan 2020
Jul

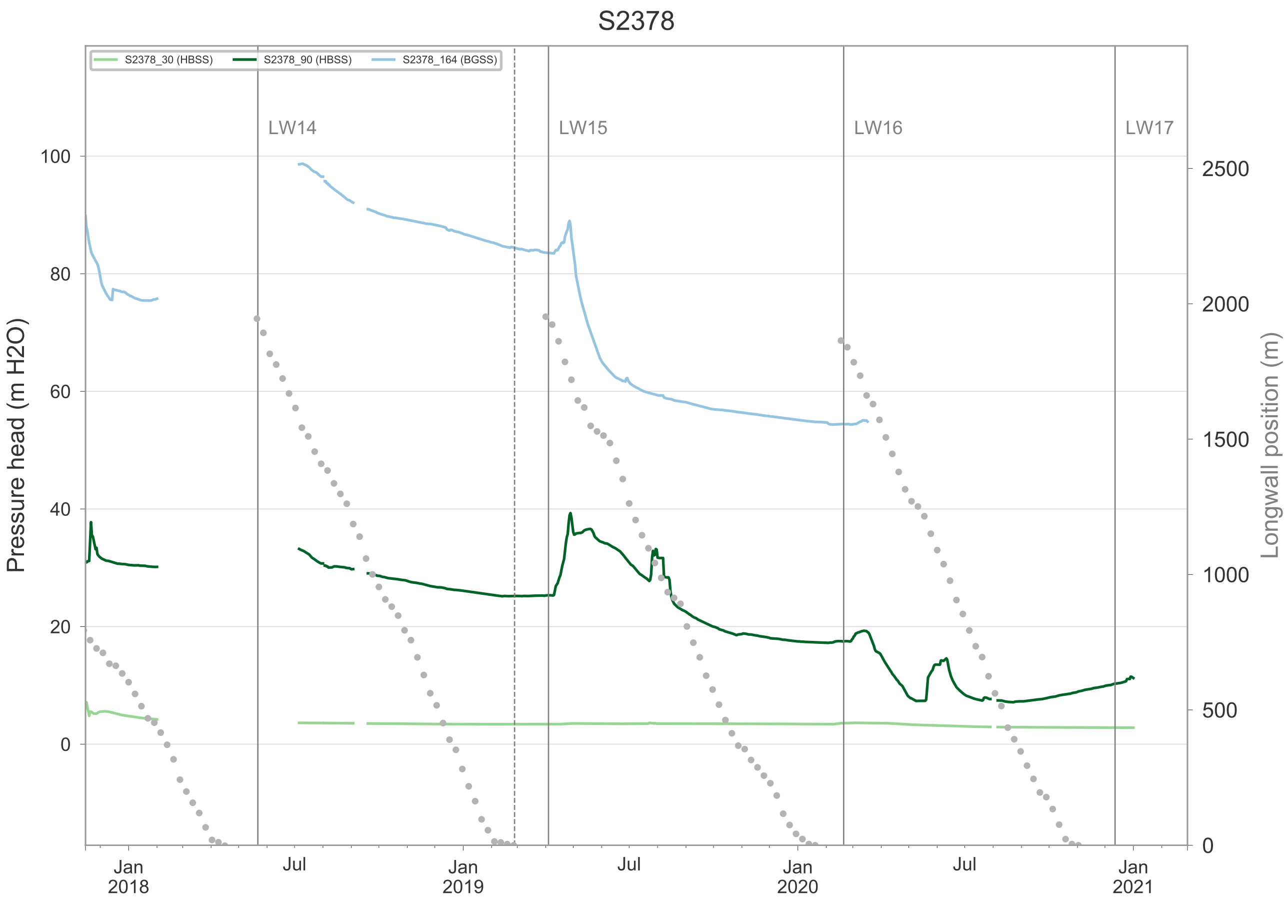

S2376
S2376_29 (HBSS)
S2376_107 (HBSS)
S2376_169 (BGSS)
LW14
LW15
LW16
LW17
Pressure head (m H2O)
Longwall position (m)
80
60
40
20
0
−20
2500
2000
1500
1000
500
0
Jan 2018
Jul
Jan 2019
Jul
Jan 2020
Jul


S2377
LW15
Ground RL
S2377_27.1 (HBSS)
S2377_112.1 (HBSS)
S2377_187.1 (BGSS)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
Piezometric head (m RL)
Longwall position (m)
Jul
Jan 2019
Jul
Jan 2020
Jul
Jan 2021

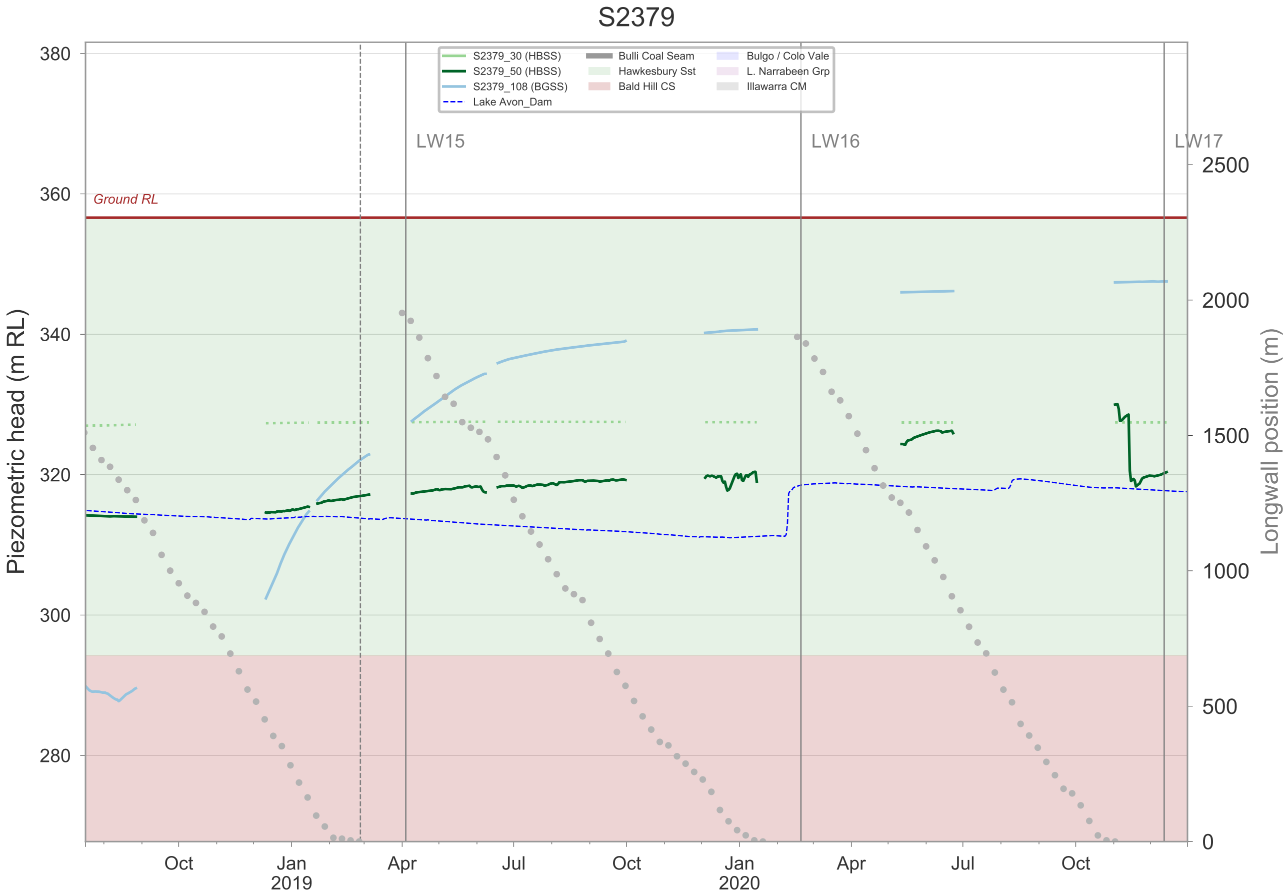

S2377
S2377_27.1 (HBSS)
S2377_112.1 (HBSS)
S2377_187.1 (BGSS)
LW15
LW16
LW17
Pressure head (m H2O)
Longwall position (m)
Jul
Jan 2019
Jul
Jan 2020
Jul
Jan 2021

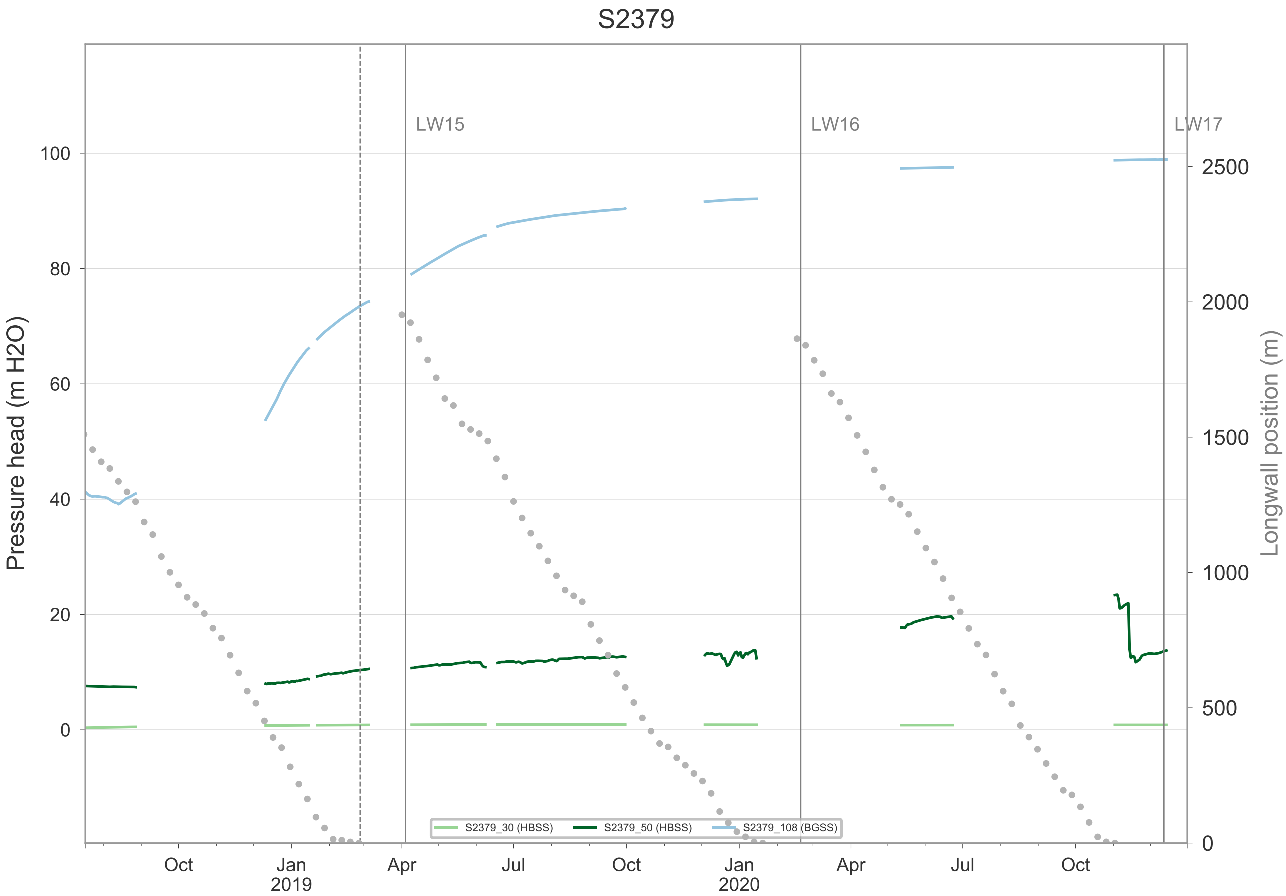
Groundwater hydrographs



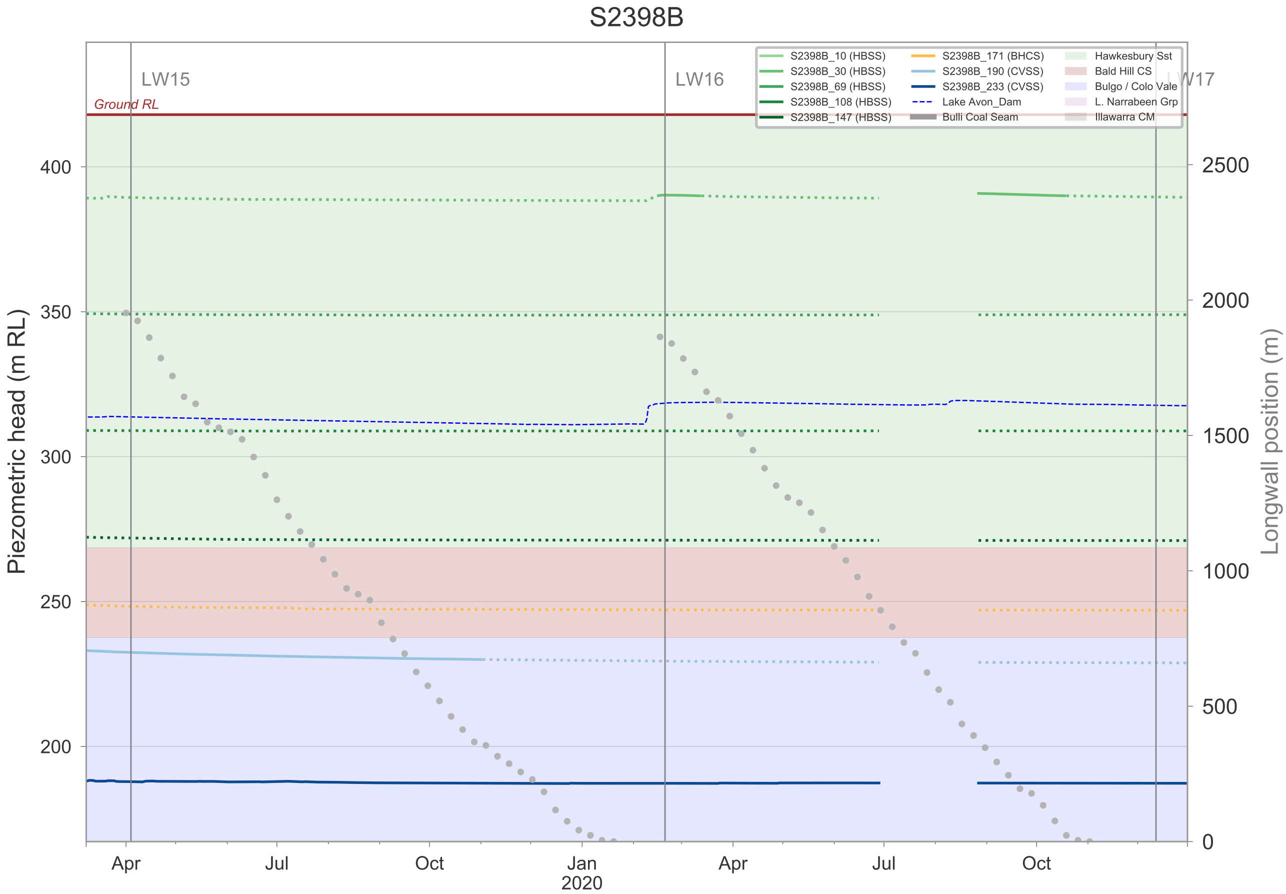


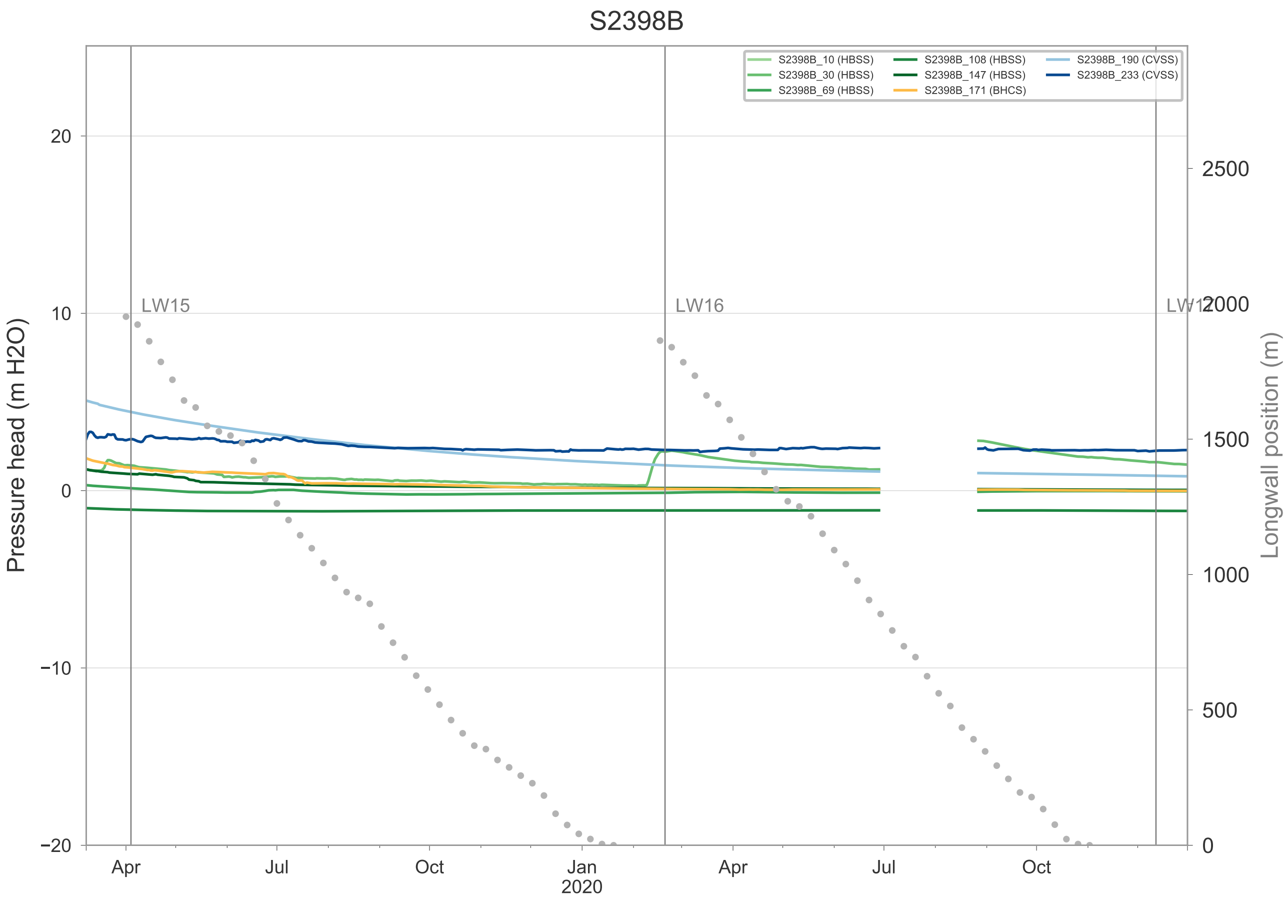
Groundwater hydrographs



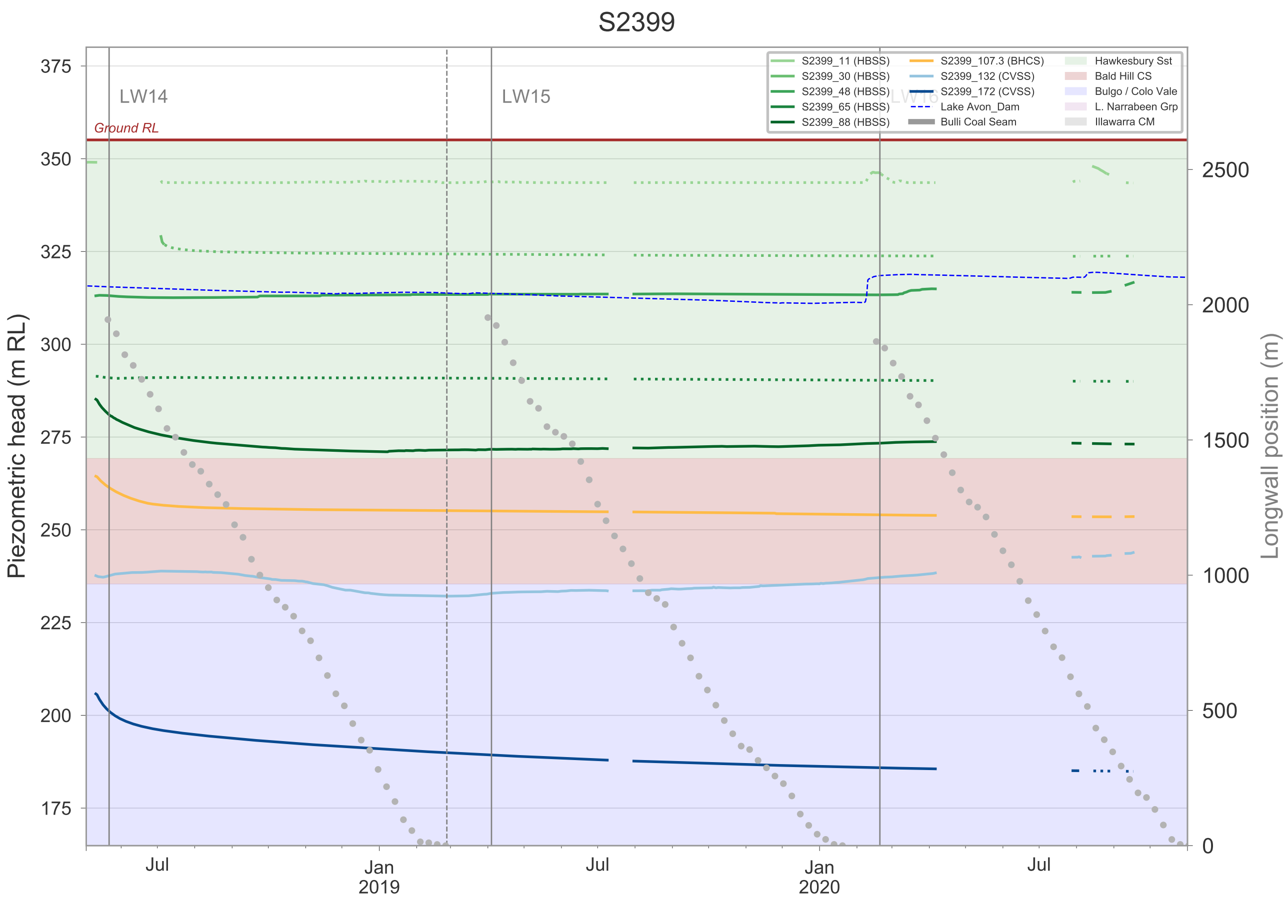


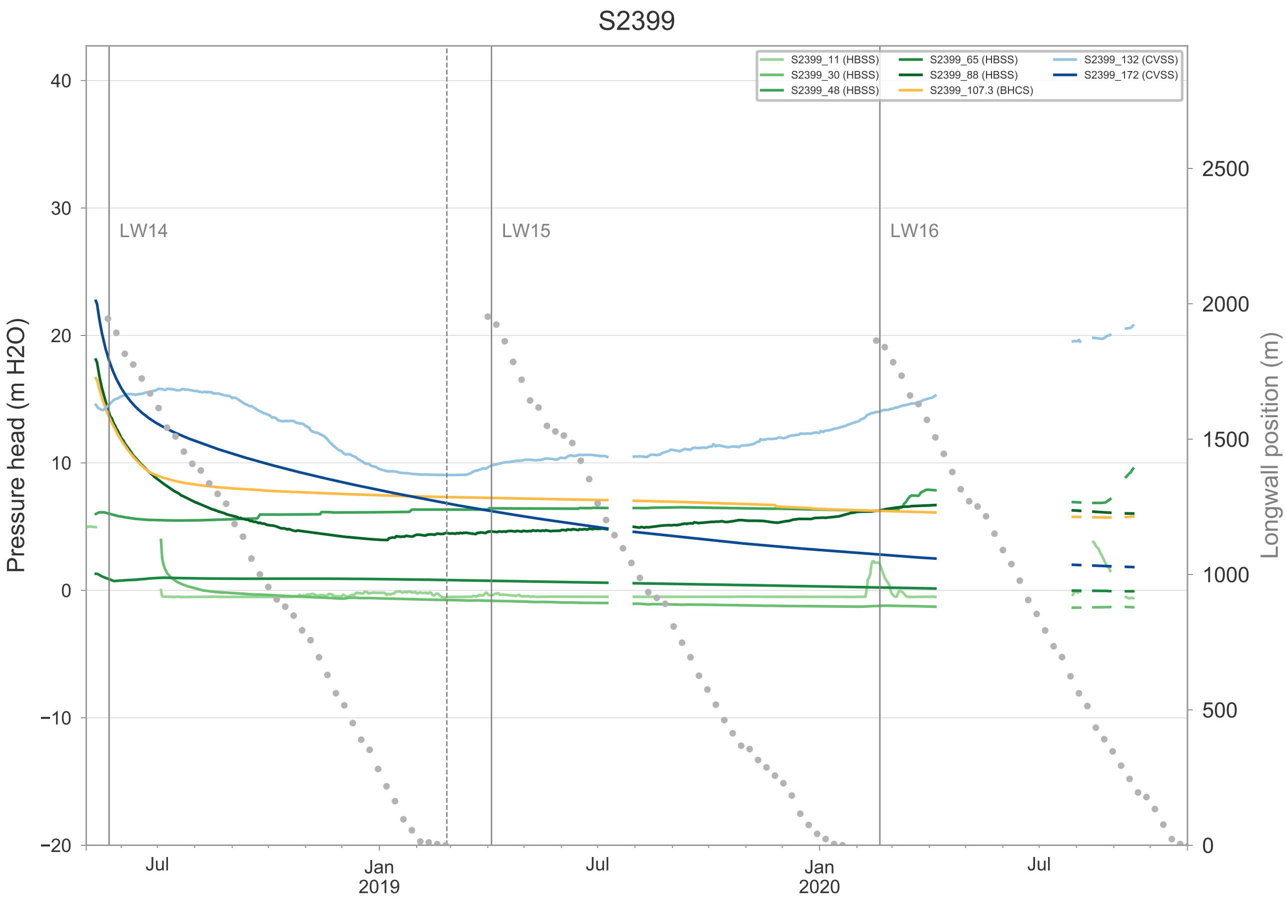
Groundwater hydrographs

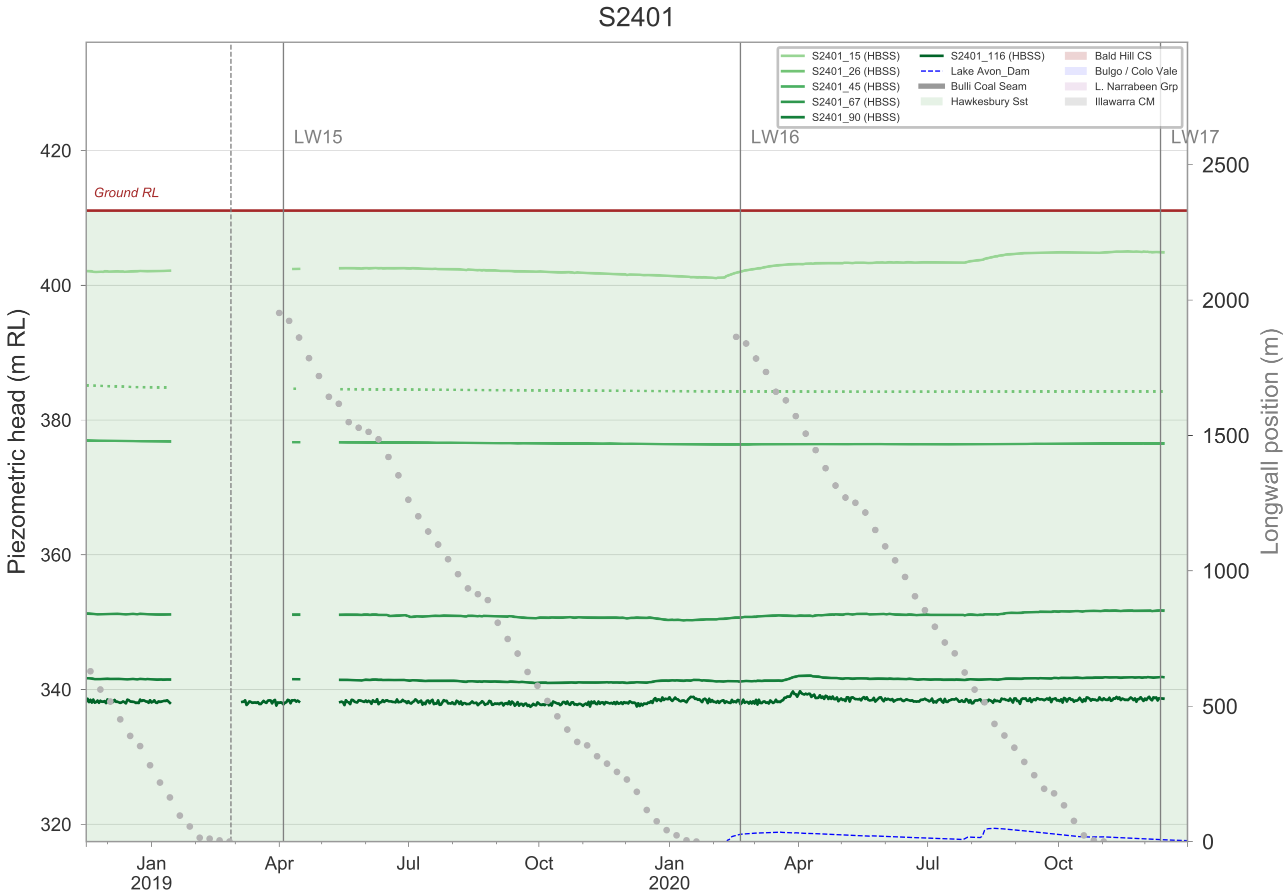


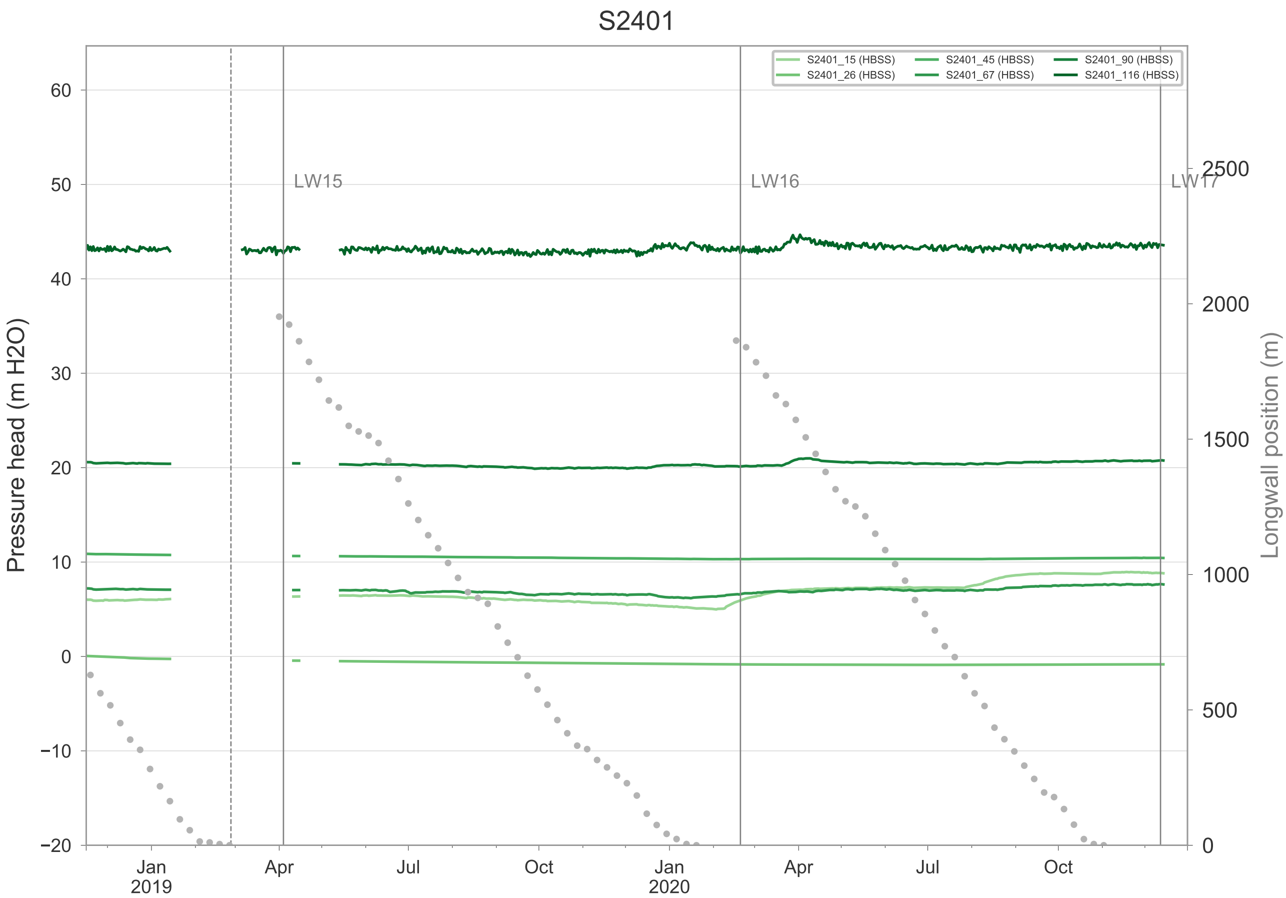


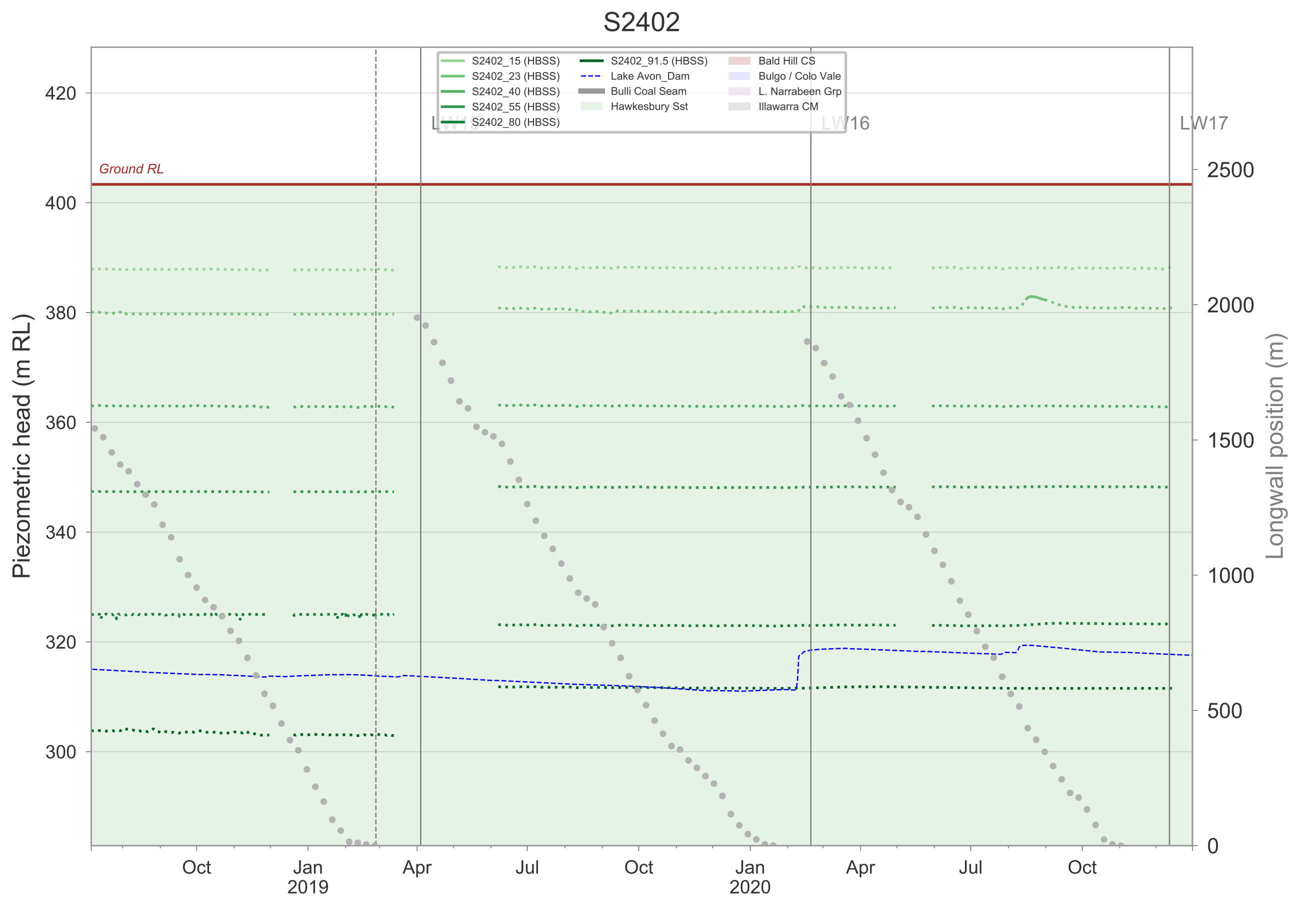
Groundwater hydrographs

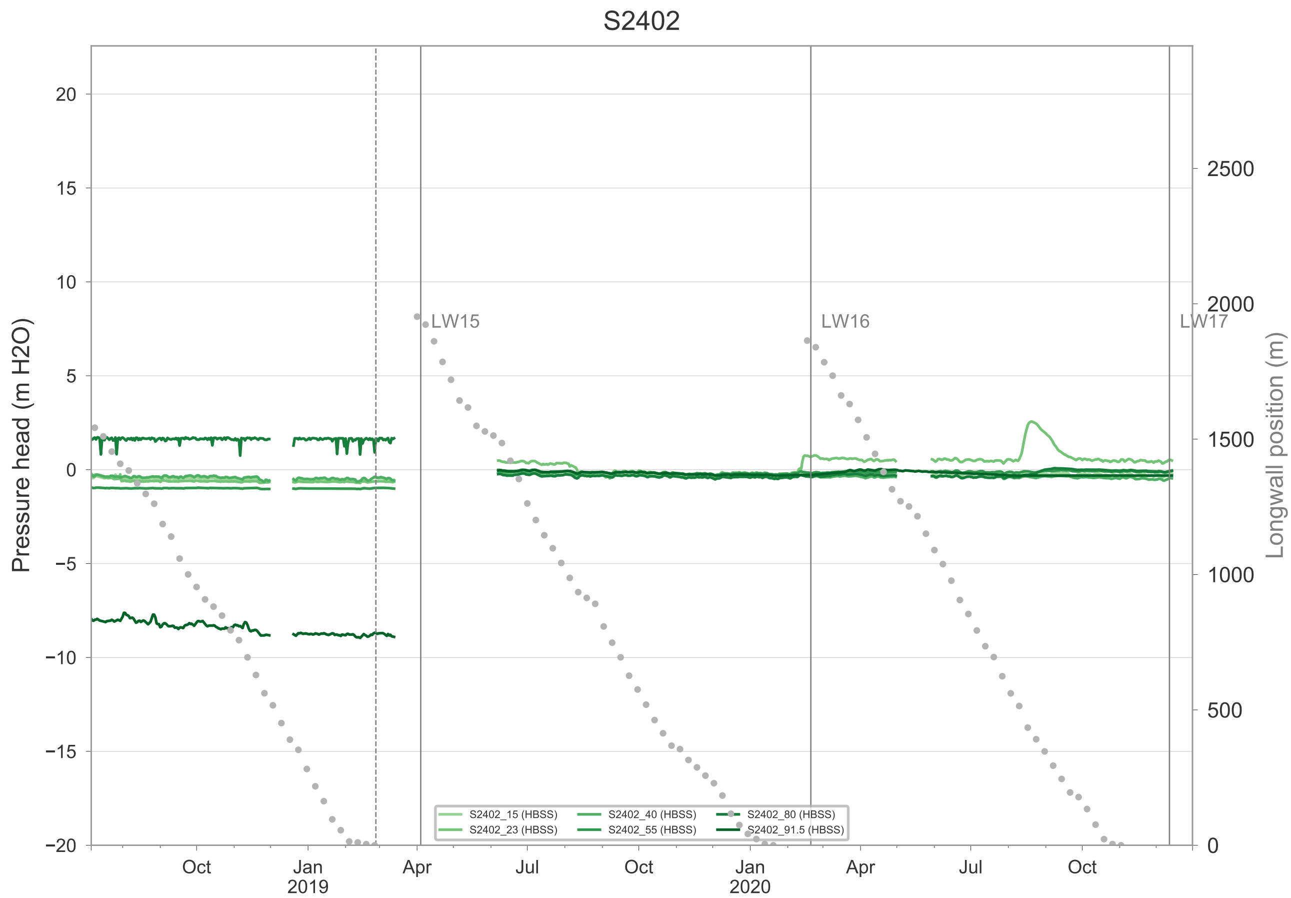




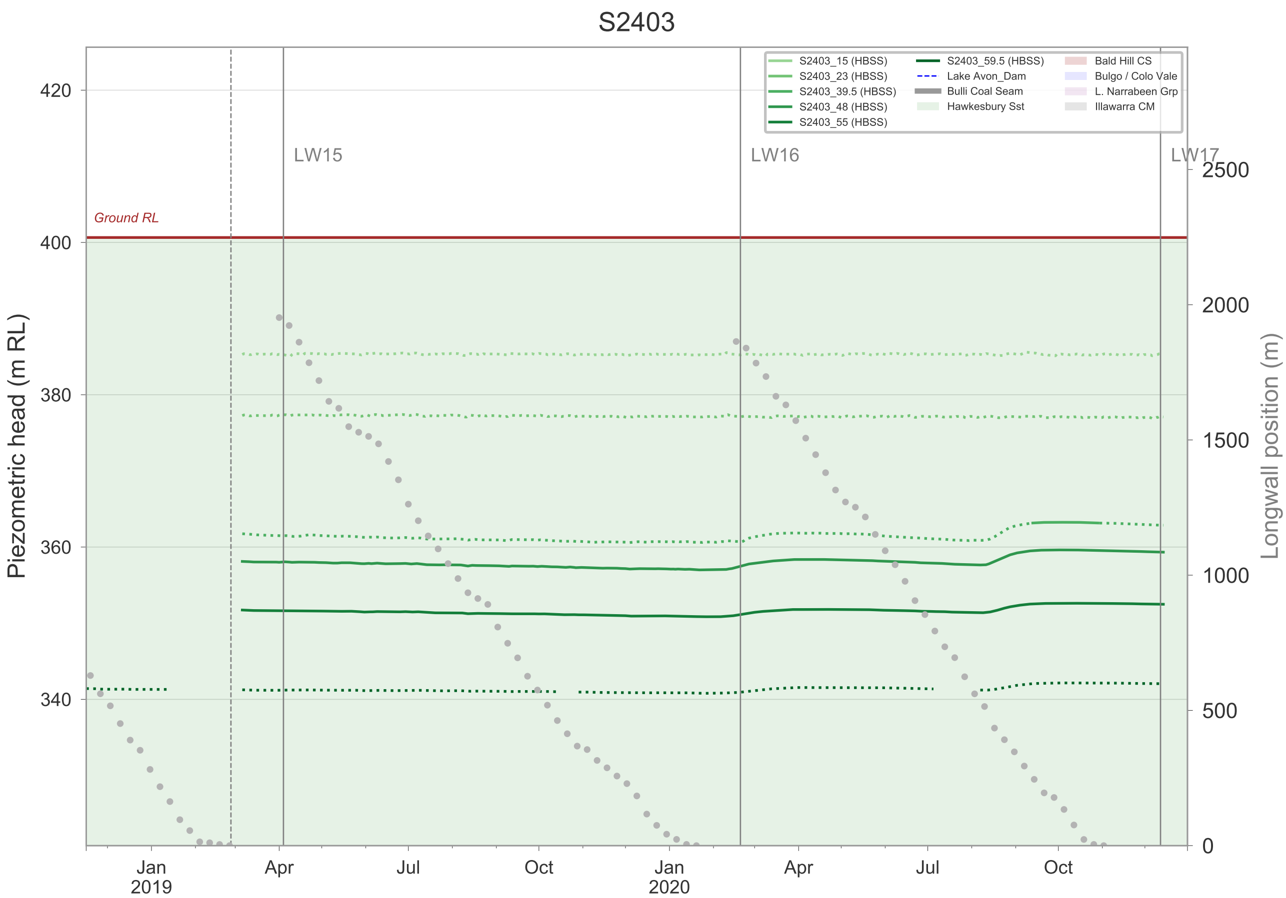

S2401
S2401_15 (HBSS)
S2401_26 (HBSS)
S2401_45 (HBSS)
S2401_67 (HBSS)
S2401_90 (HBSS)
S2401_116 (HBSS)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
LW15
LW16
LW17
Ground RL
Piezometric head (m RL)
Longwall position (m)
Jan 2019
Apr
Jul
Oct
Jan 2020
Apr
Jul
Oct

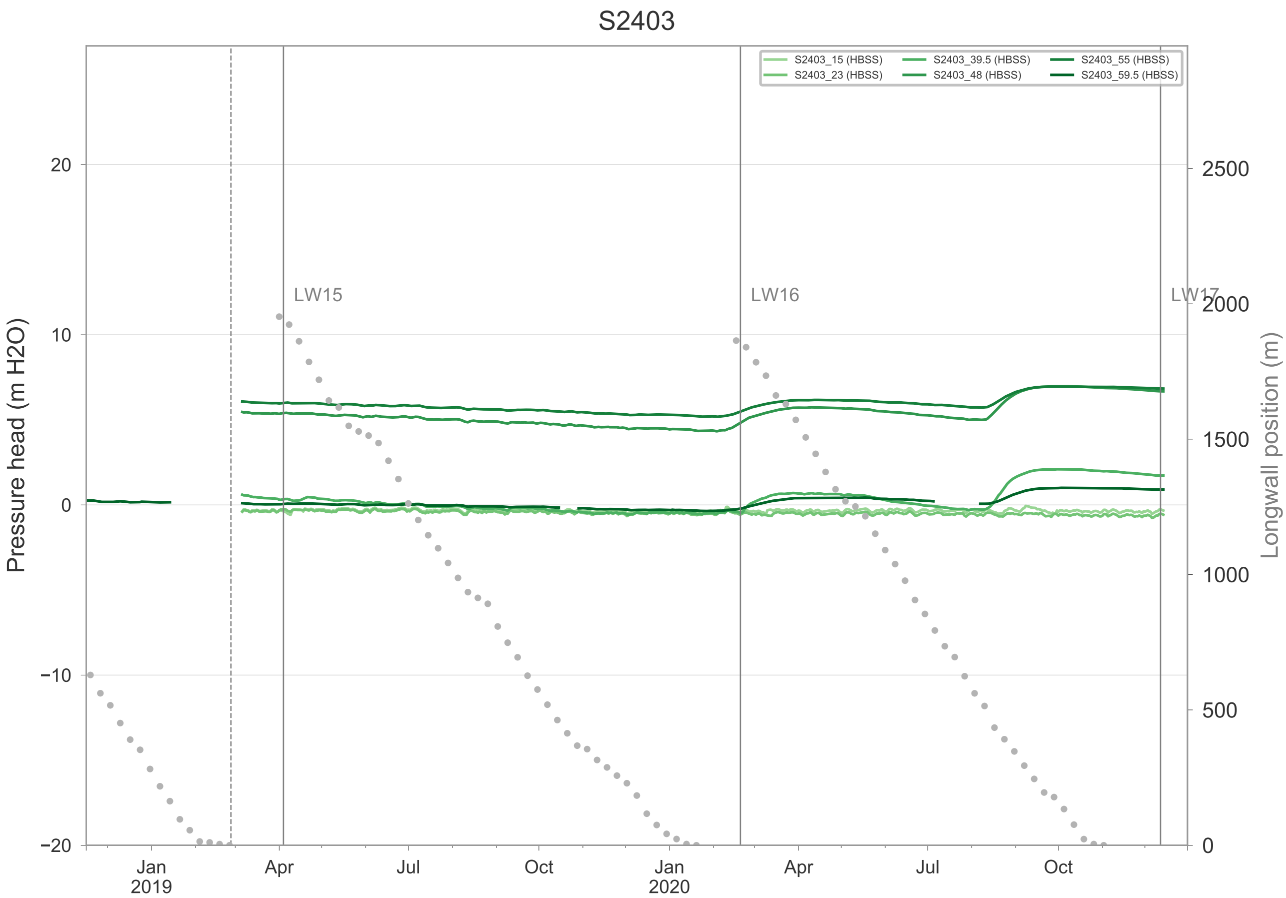

S2401
S2401_15 (HBSS)
S2401_26 (HBSS)
S2401_45 (HBSS)
S2401_67 (HBSS)
S2401_90 (HBSS)
S2401_116 (HBSS)
LW15
LW16
LW17
Pressure head (m H2O)
Longwall position (m)
Jan 2019
Apr
Jul
Oct
Jan 2020
Apr
Jul
Oct

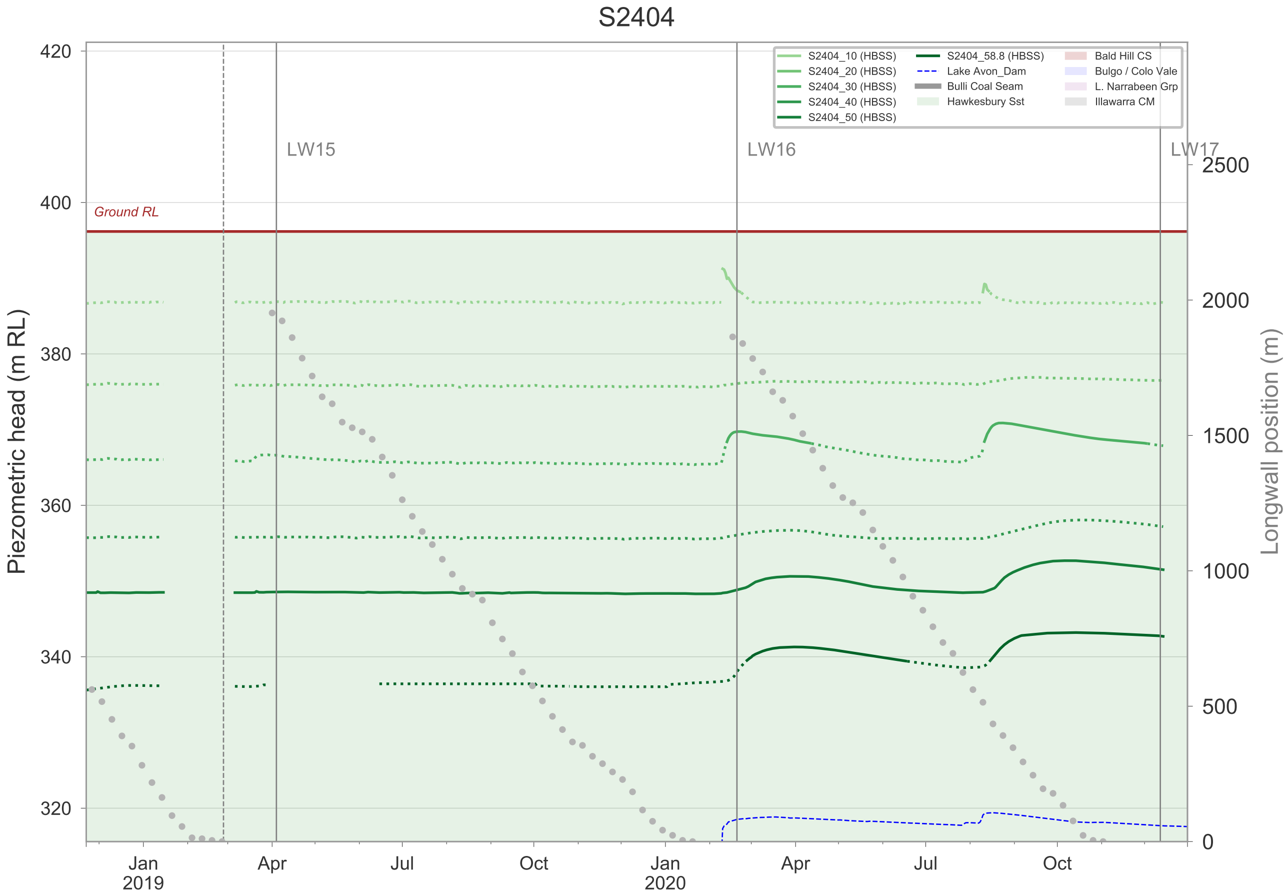

S2402
S2402_15 (HBSS)
S2402_23 (HBSS)
S2402_40 (HBSS)
S2402_55 (HBSS)
S2402_80 (HBSS)
S2402_91.5 (HBSS)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
LW16
LW17
Ground RL
Piezometric head (m RL)
Longwall position (m)
Oct
Jan
2019
Apr
Jul
Oct
Jan
2020
Apr
Jul
Oct

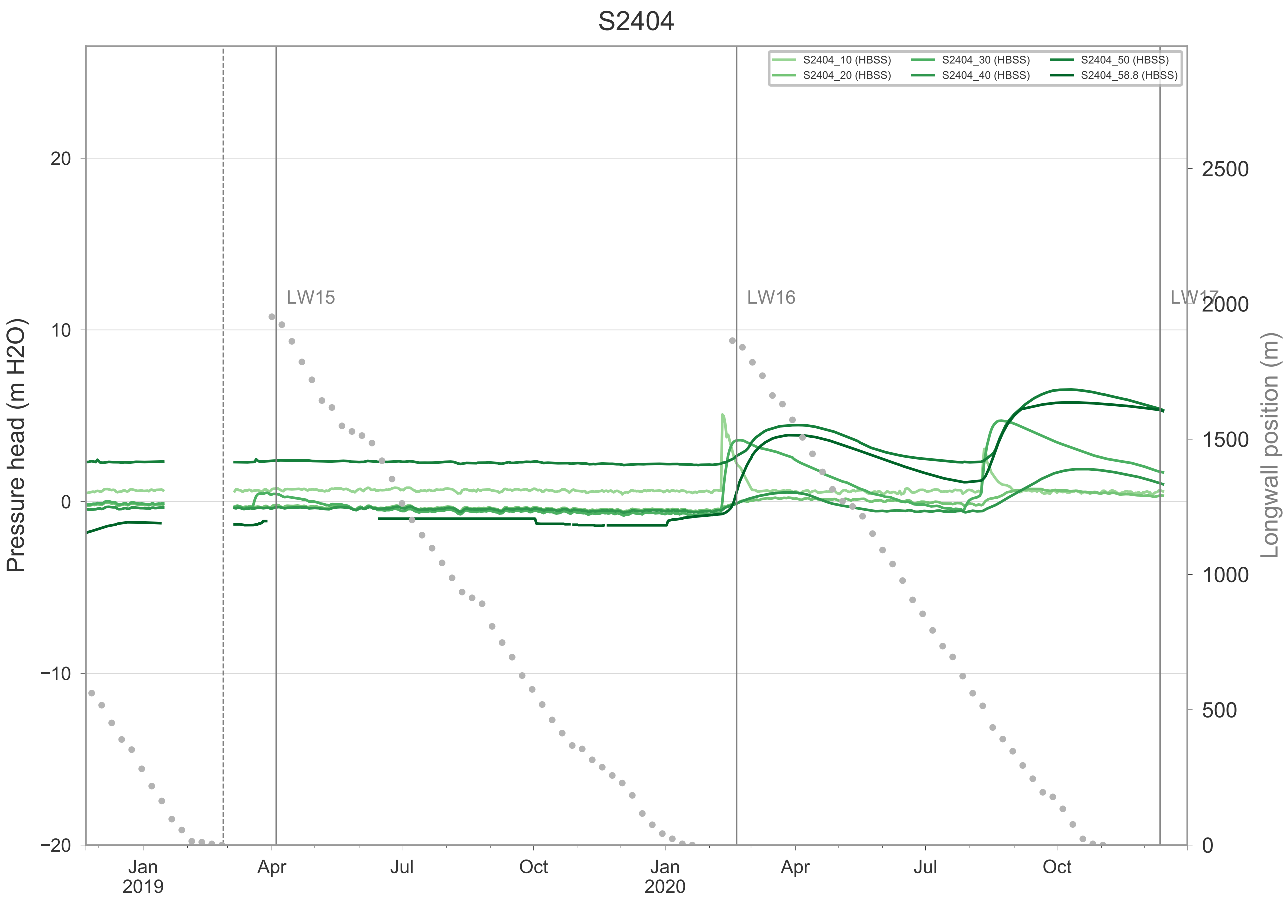

S2402
LW15
LW16
LW17
S2402_15 (HBSS)
S2402_23 (HBSS)
S2402_40 (HBSS)
S2402_55 (HBSS)
S2402_80 (HBSS)
S2402_91.5 (HBSS)
Pressure head (m H2O)
Longwall position (m)
Oct
Jan
2019
Apr
Jul
Oct
Jan
2020
Apr
Jul
Oct

Groundwater hydrographs

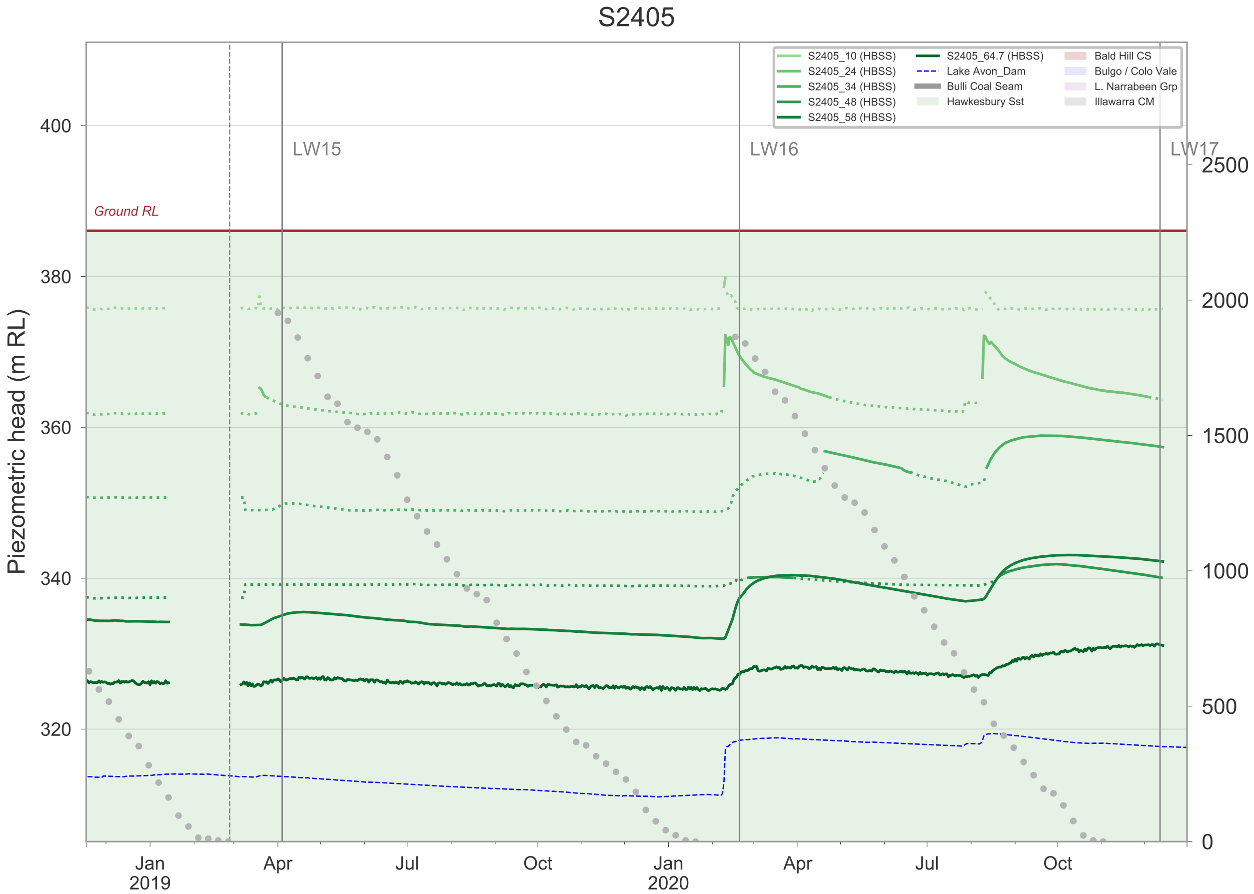


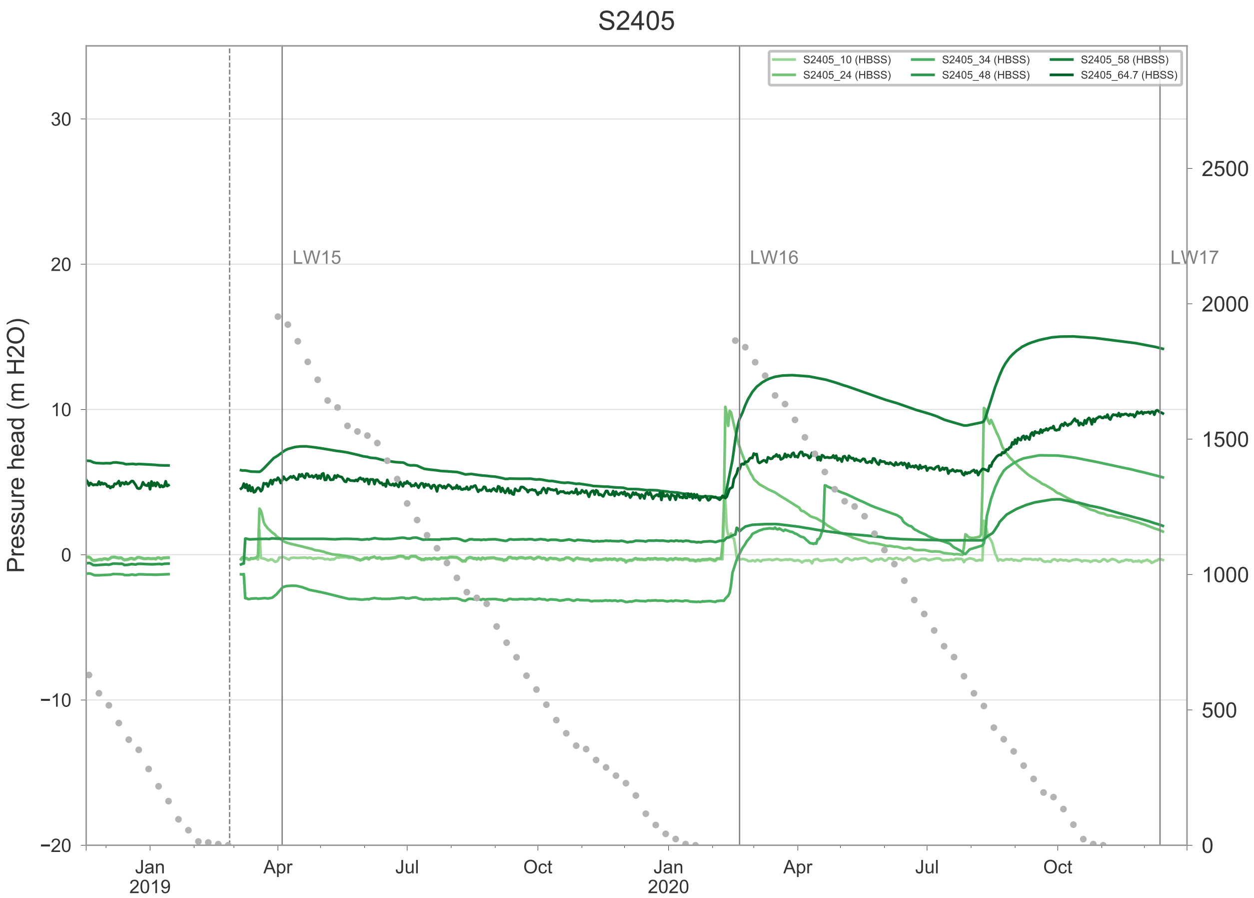



S2404
S2404_10 (HBSS)
S2404_20 (HBSS)
S2404_30 (HBSS)
S2404_40 (HBSS)
S2404_50 (HBSS)
S2404_58.8 (HBSS)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
LW15
LW16
LW17
Ground RL
Piezometric head (m RL)
Longwall position (m)
420
400
380
360
340
320
2500
2000
1500
1000
500
0
Jan 2019
Apr
Jul
Oct
Jan 2020
Apr
Jul
Oct

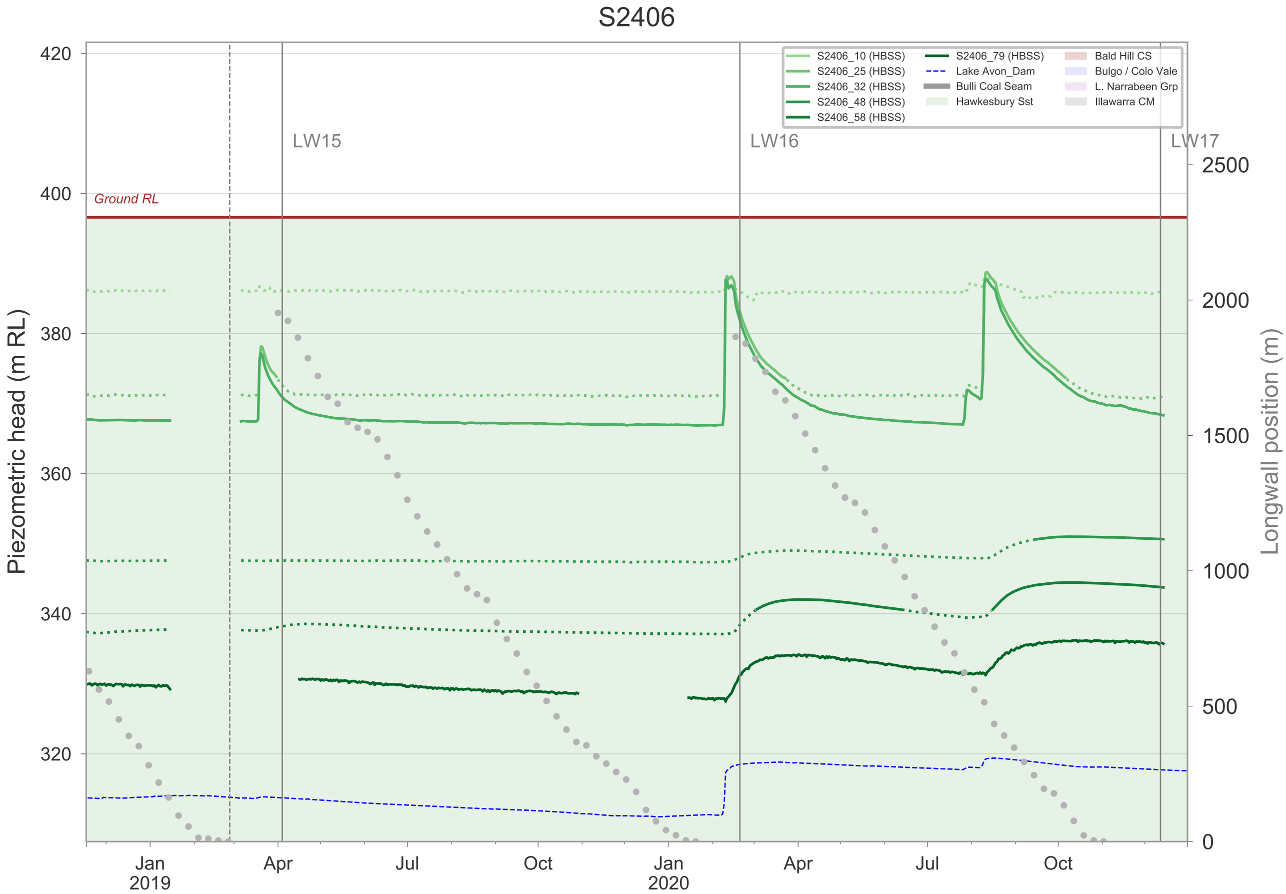

S2404
S2404_10 (HBSS)
S2404_20 (HBSS)
S2404_30 (HBSS)
S2404_40 (HBSS)
S2404_50 (HBSS)
S2404_58.8 (HBSS)
LW15
LW16
LW17
Pressure head (m H2O)
Longwall position (m)
20
10
0
−10
−20
2500
2000
1500
1000
500
0
Jan 2019
Apr
Jul
Oct
Jan 2020
Apr
Jul
Oct

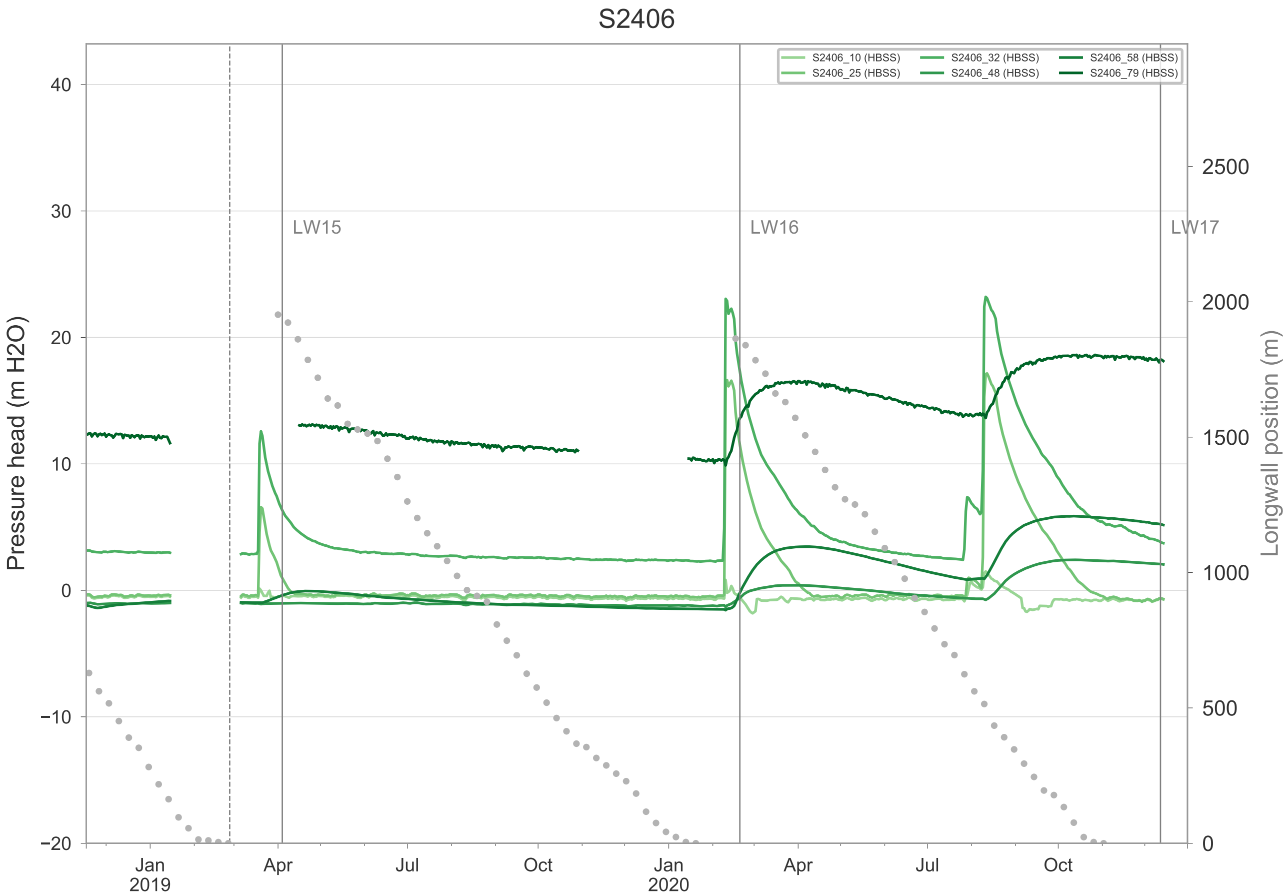
Groundwater hydrographs





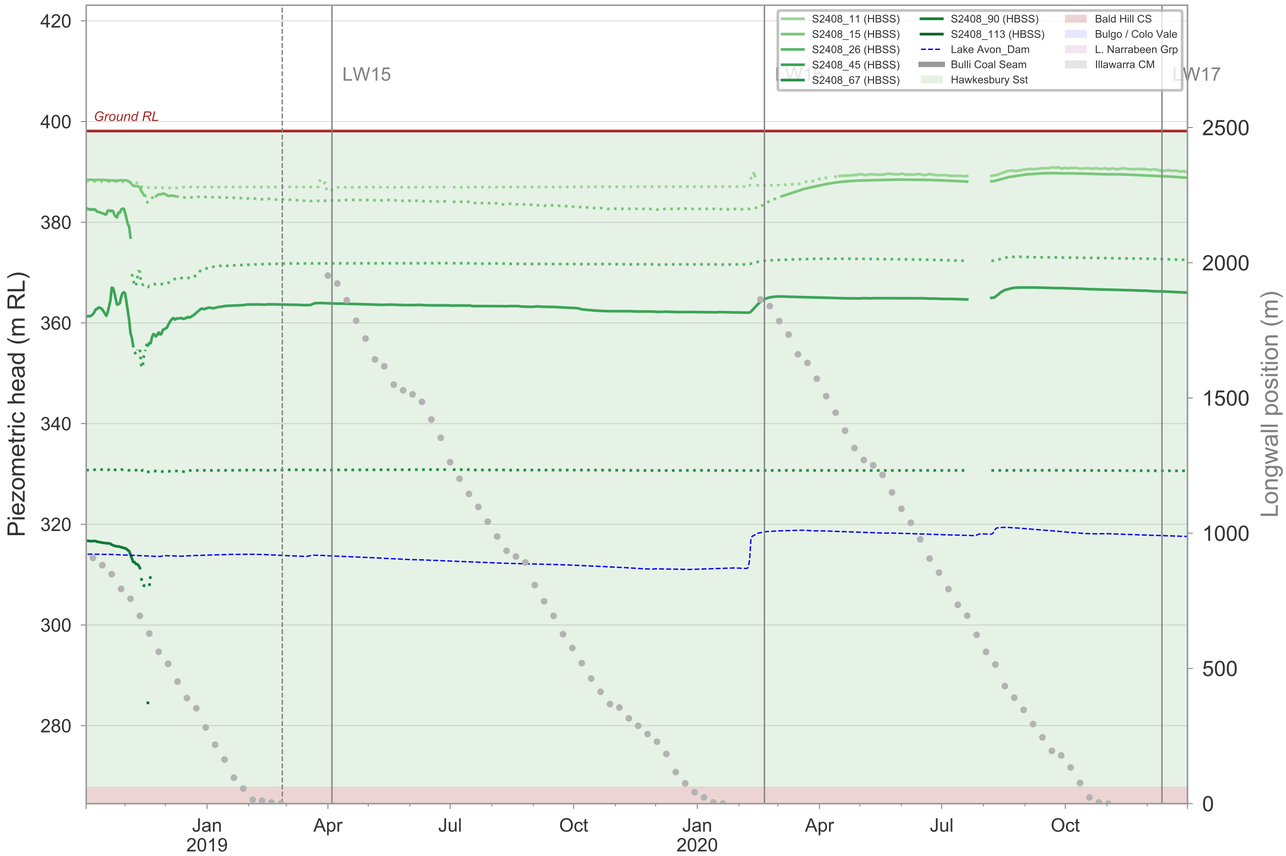
Groundwater hydrographs



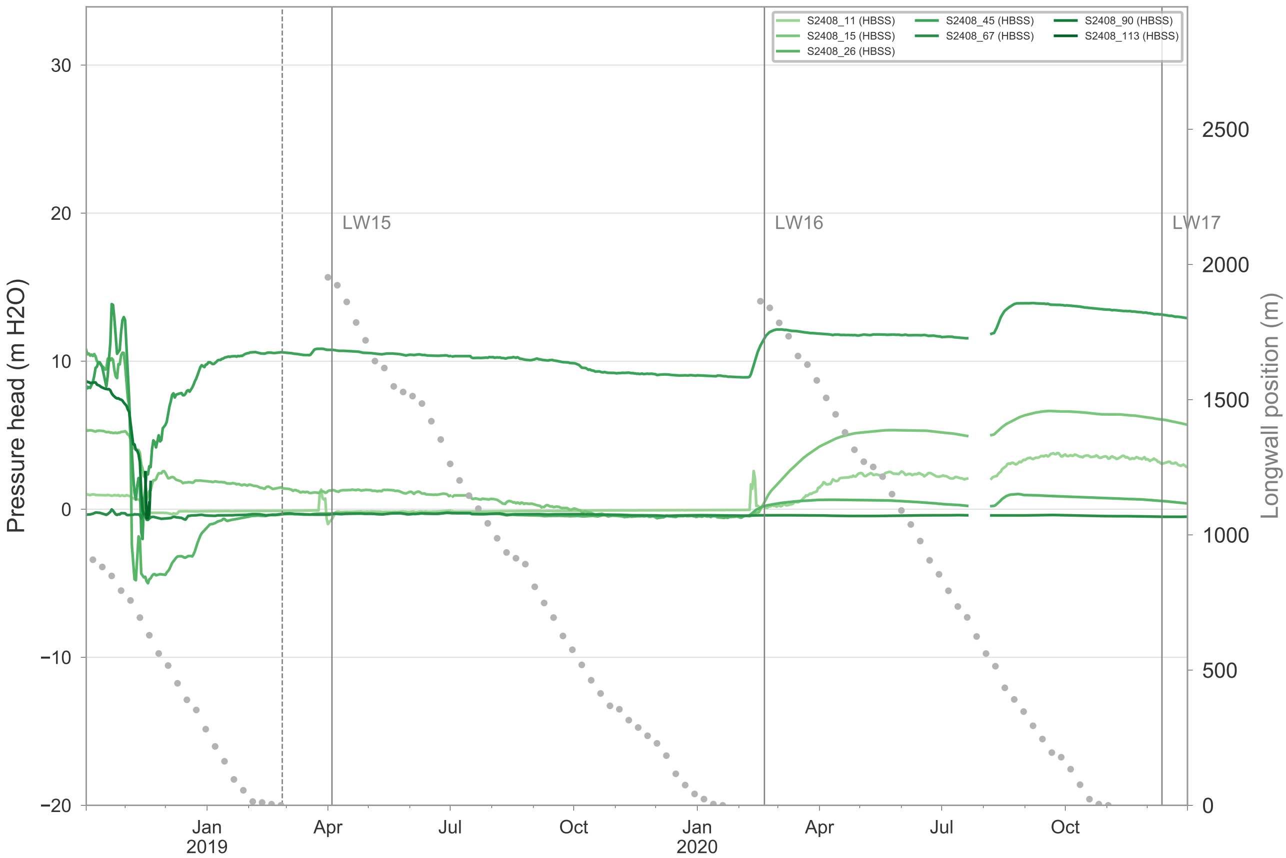


Groundwater hydrographs

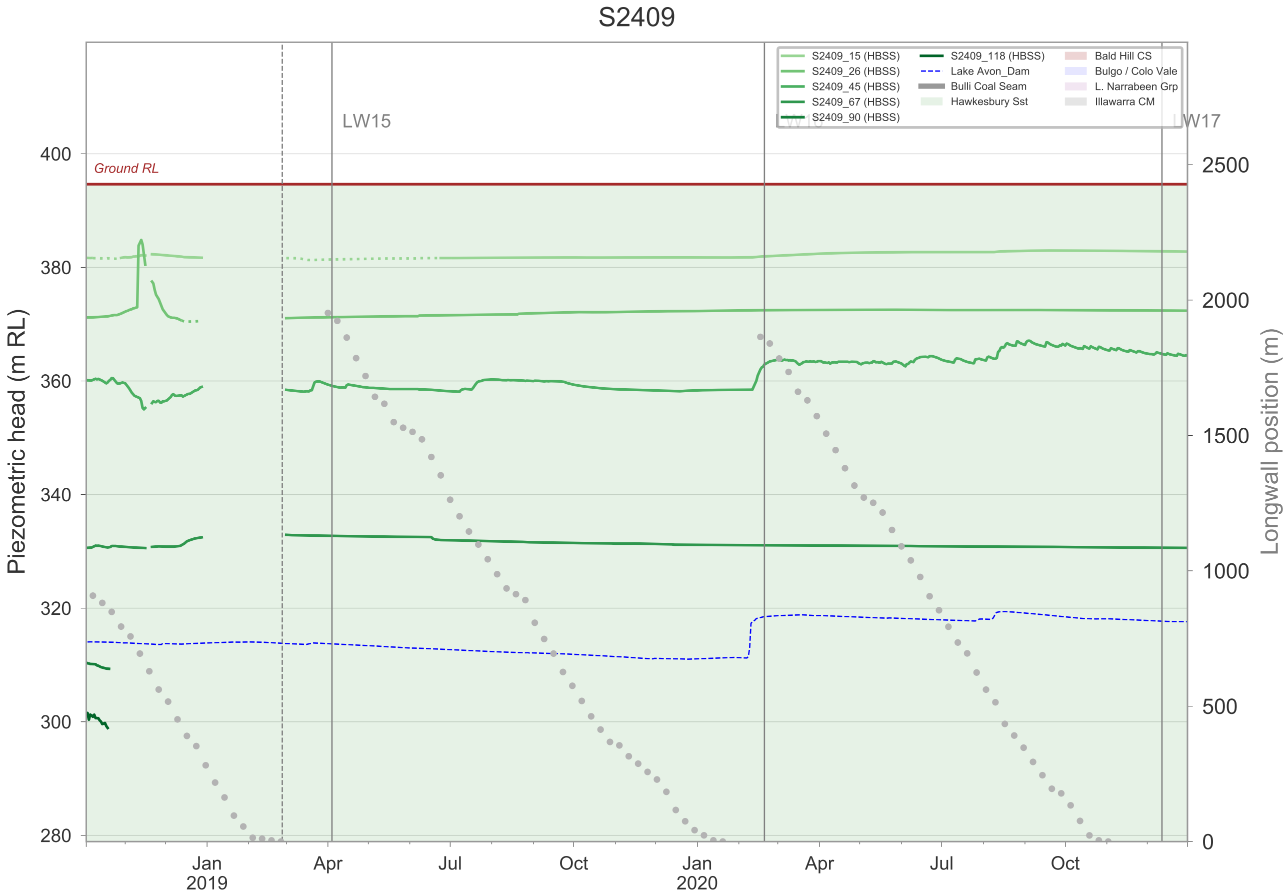
S2408

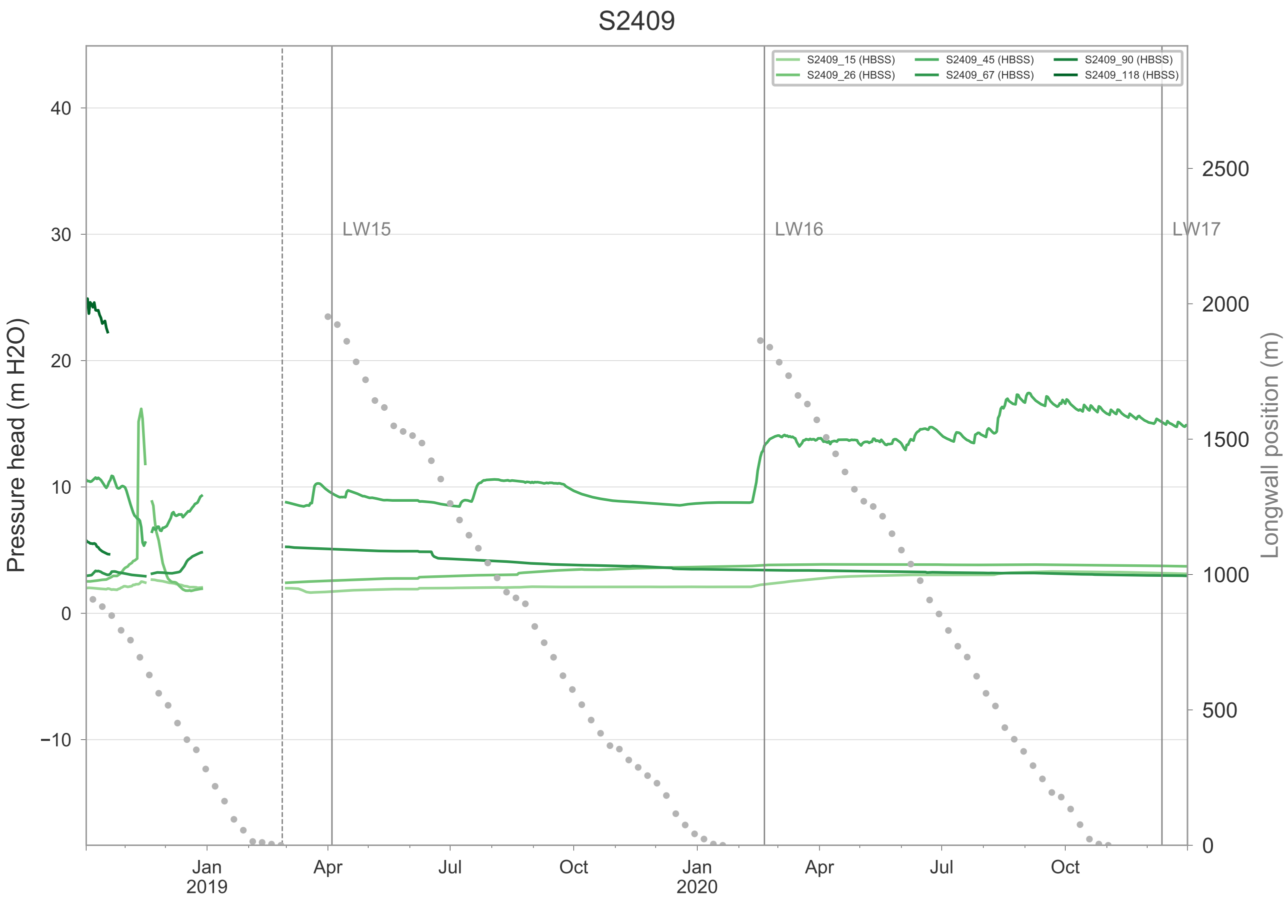


S2408

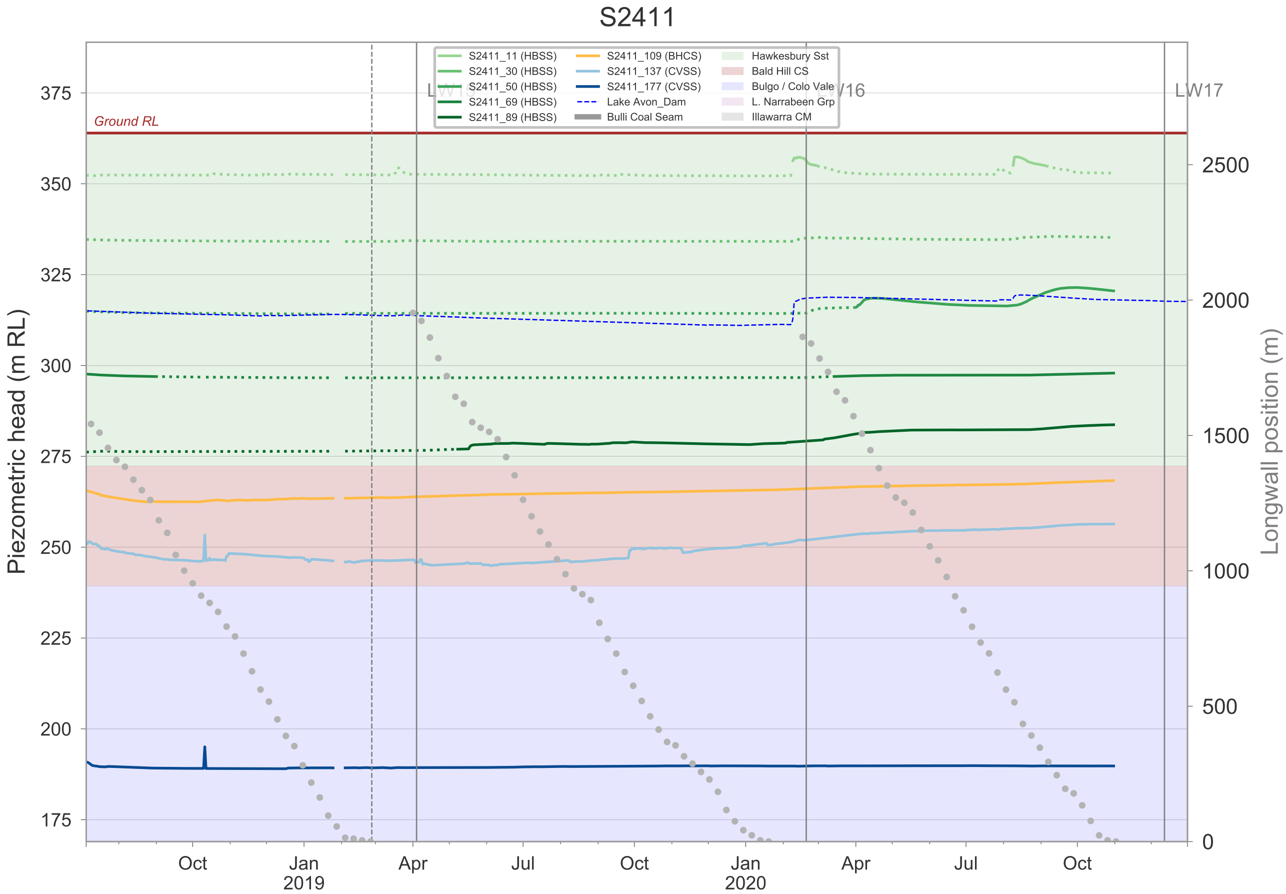


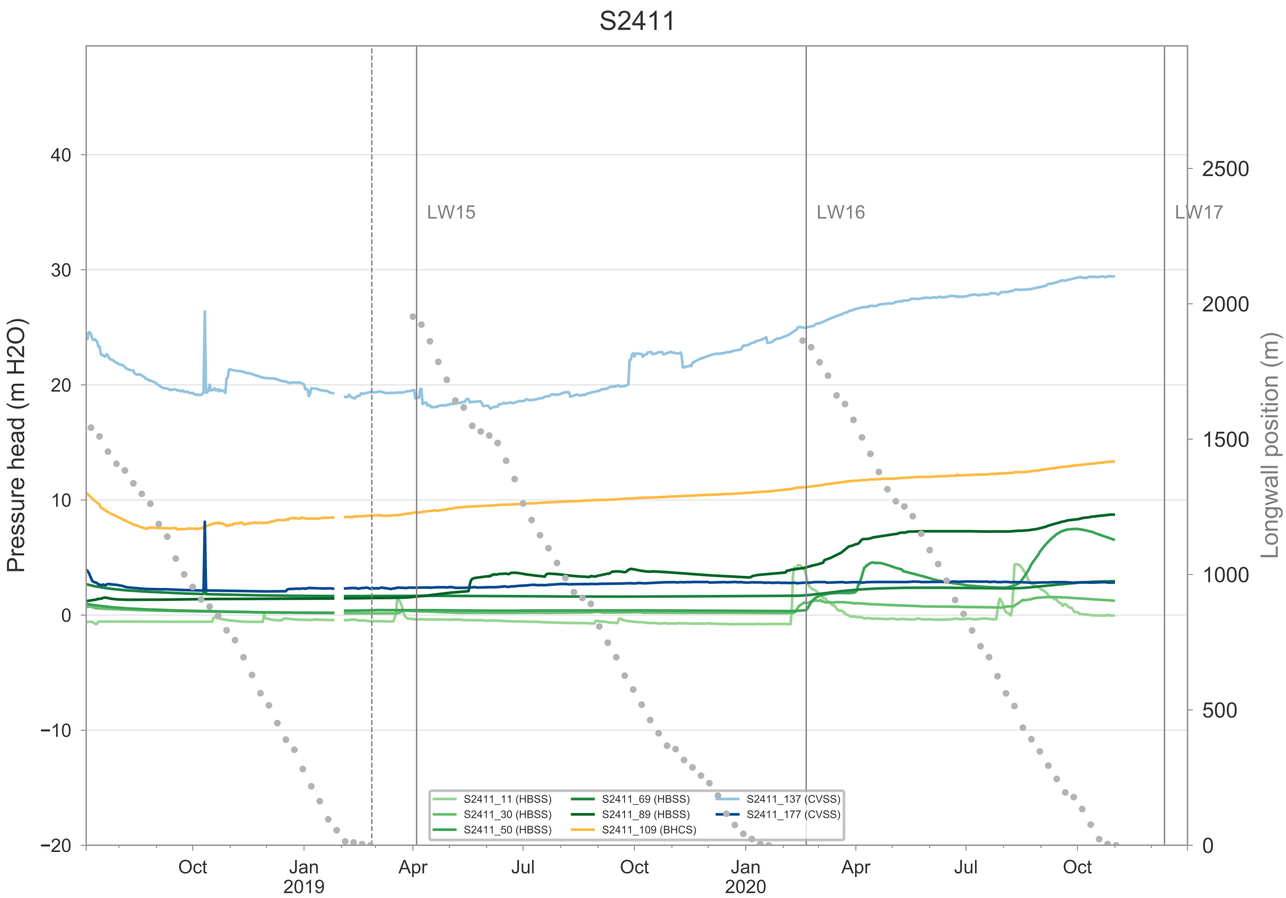
Groundwater hydrographs

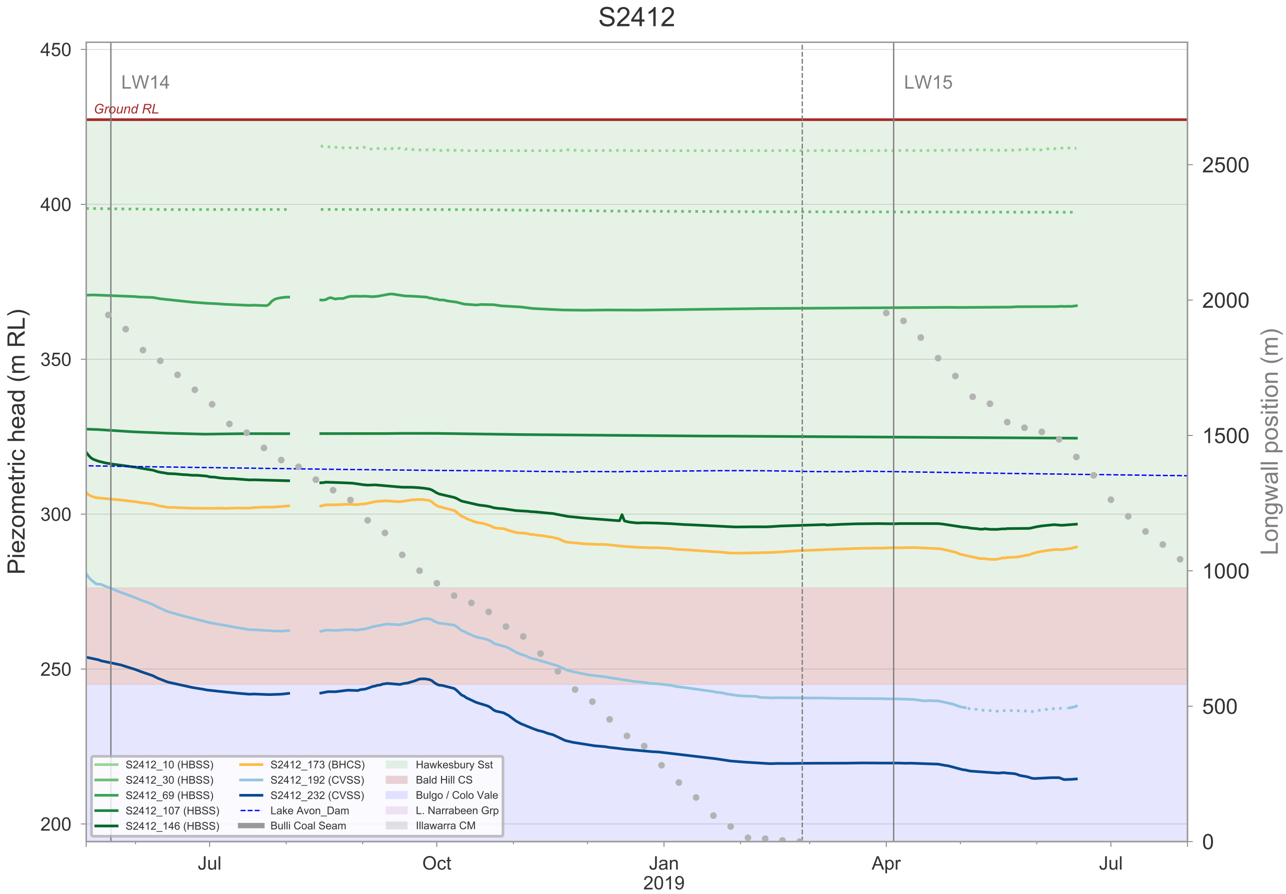


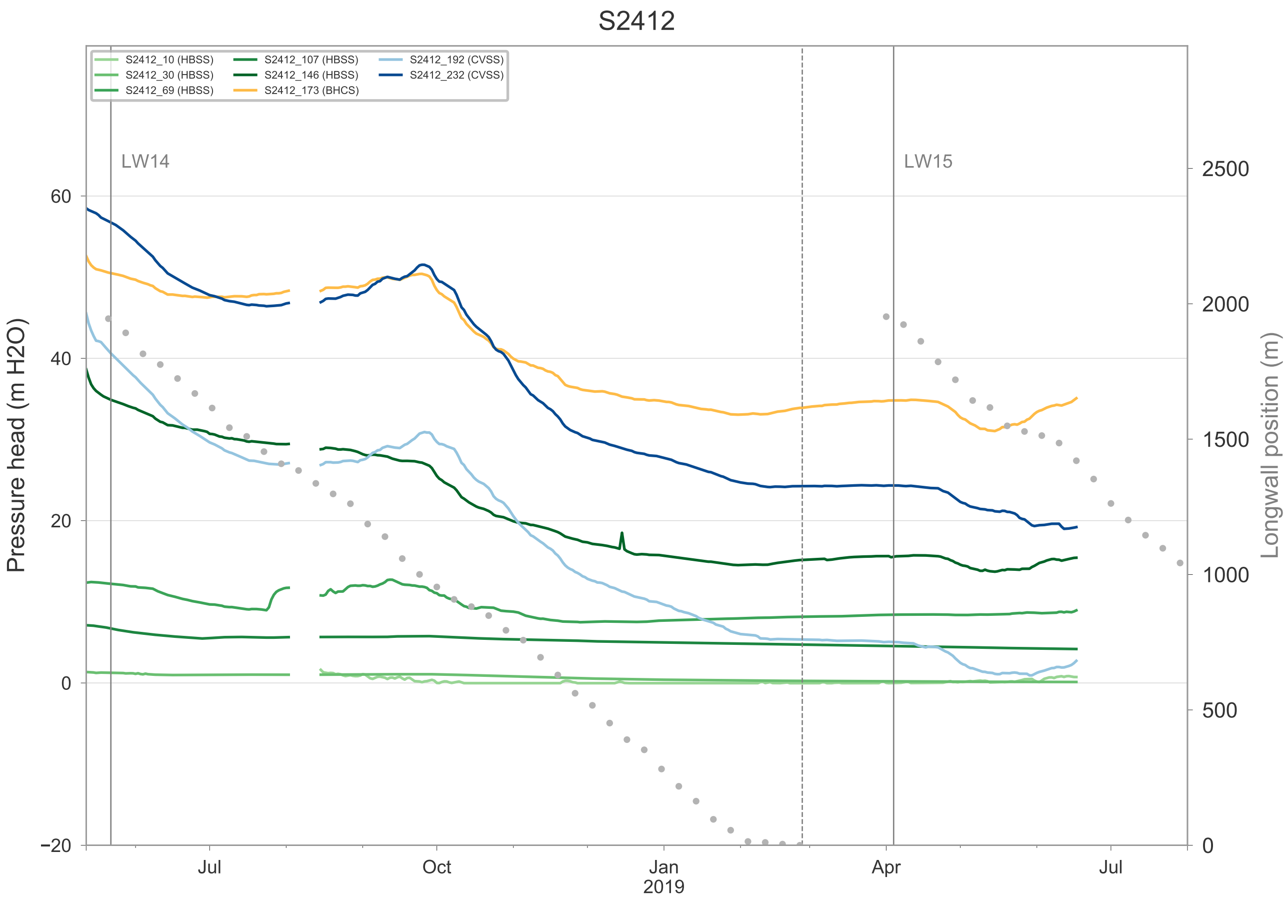


Groundwater hydrographs

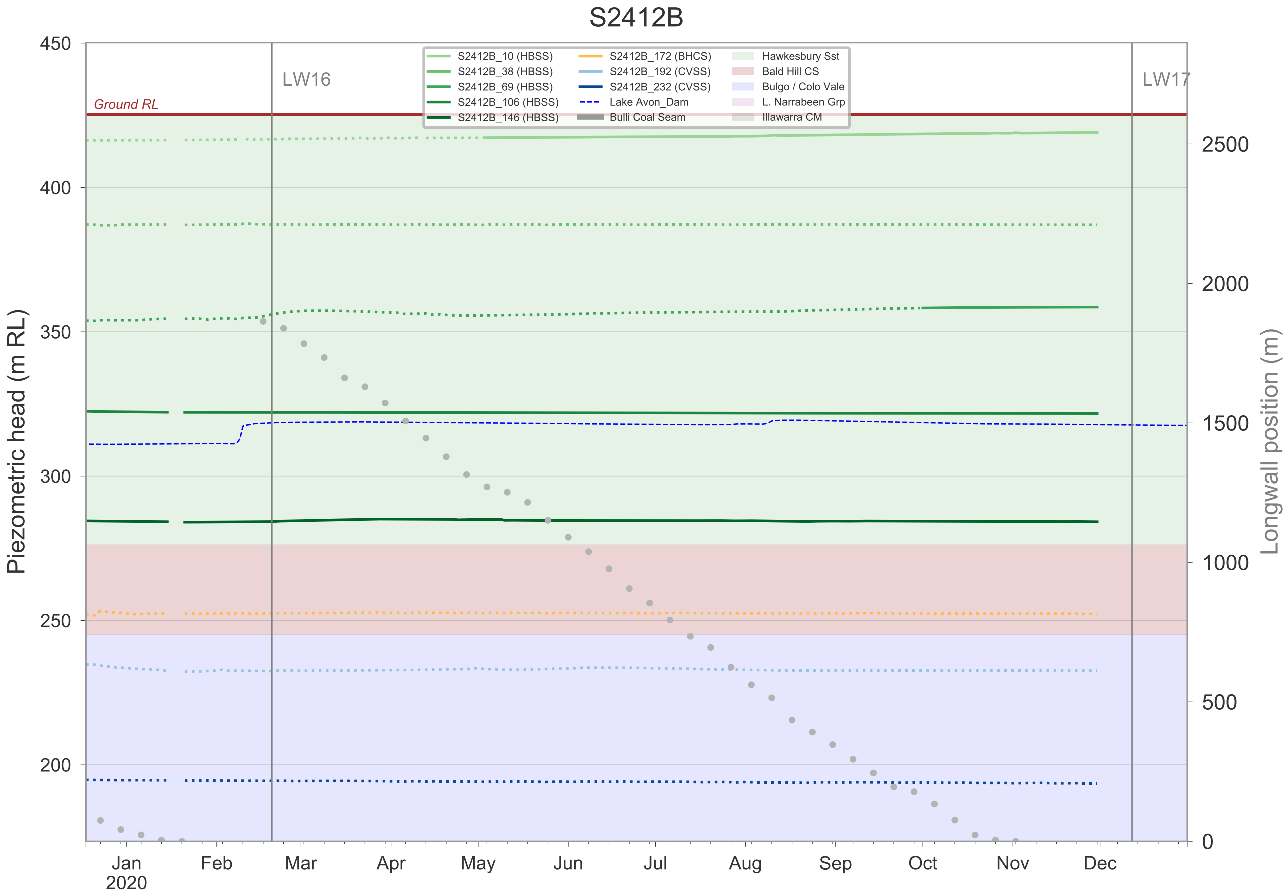


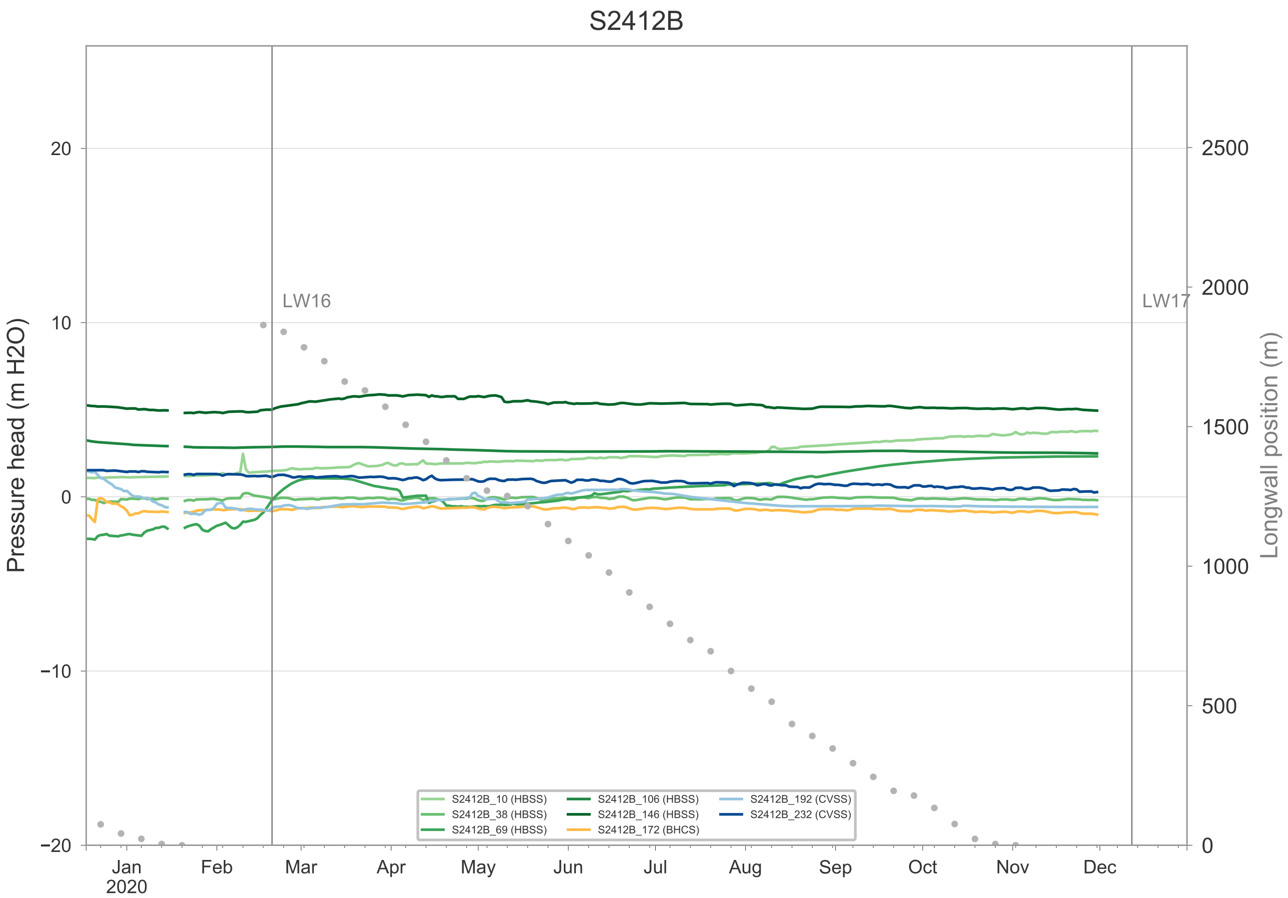


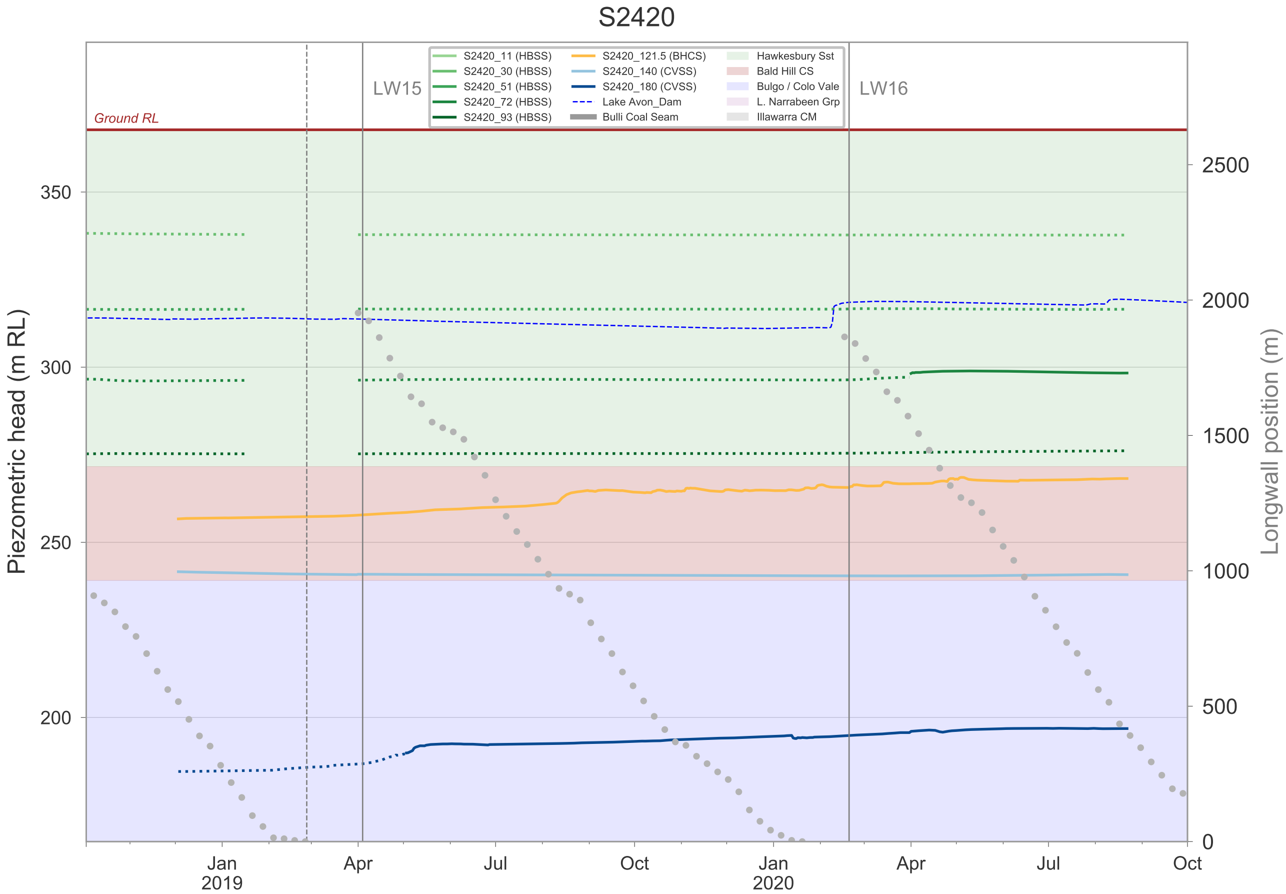

S2412
LW14
LW15
Ground RL
Piezometric head (m RL)
Longwall position (m)
450
400
350
300
250
200
2500
2000
1500
1000
500
0
Jul
Oct
Jan
2019
Apr
Jul
S2412_10 (HBSS)
S2412_30 (HBSS)
S2412_69 (HBSS)
S2412_107 (HBSS)
S2412_146 (HBSS)
S2412_173 (BHCS)
S2412_192 (CVSS)
S2412_232 (CVSS)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM

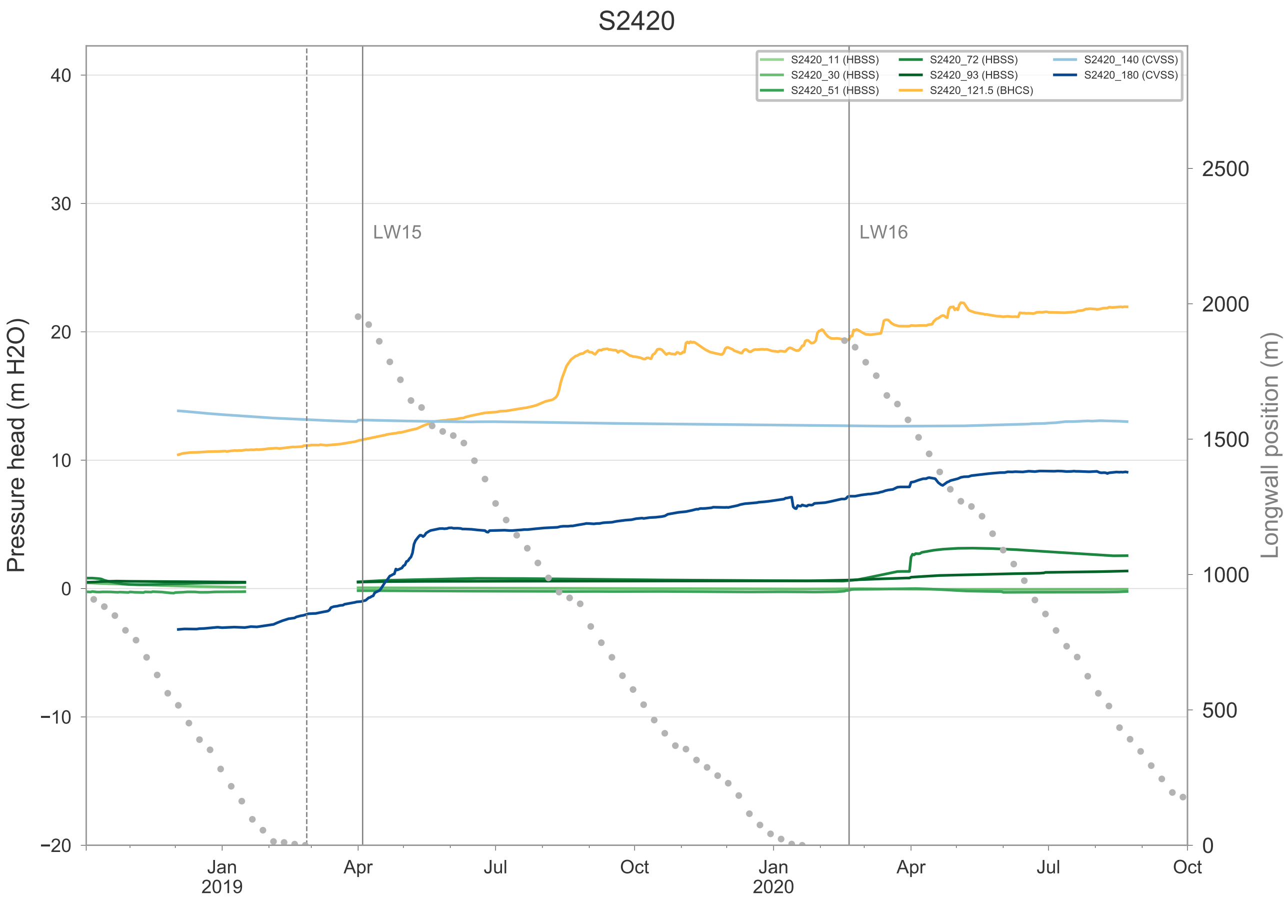

S2412
S2412_10 (HBSS)
S2412_30 (HBSS)
S2412_69 (HBSS)
S2412_107 (HBSS)
S2412_146 (HBSS)
S2412_173 (BHCS)
S2412_192 (CVSS)
S2412_232 (CVSS)
LW14
LW15
Pressure head (m H2O)
Longwall position (m)
60
40
20
0
−20
2500
2000
1500
1000
500
0
Jul
Oct
Jan
2019
Apr
Jul

Groundwater hydrographs

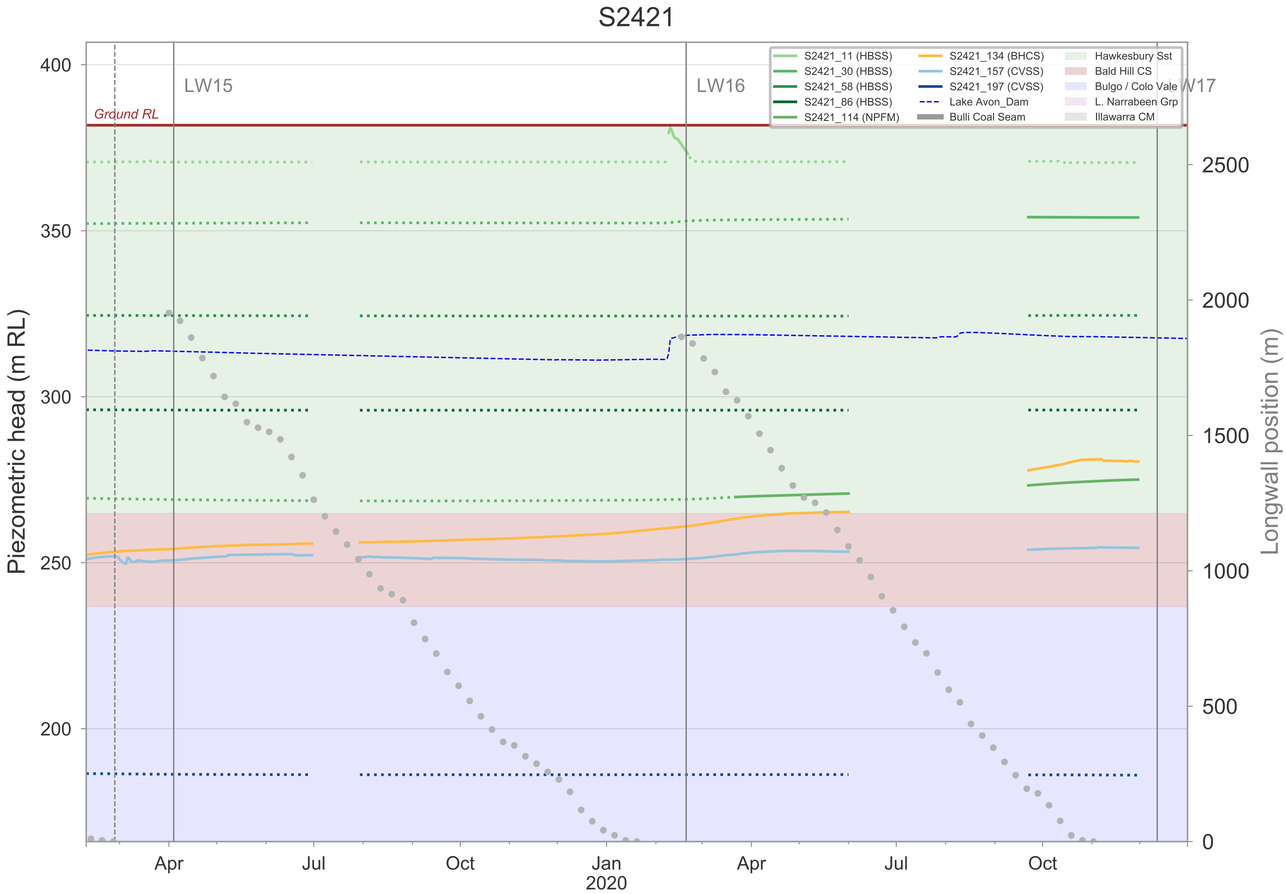


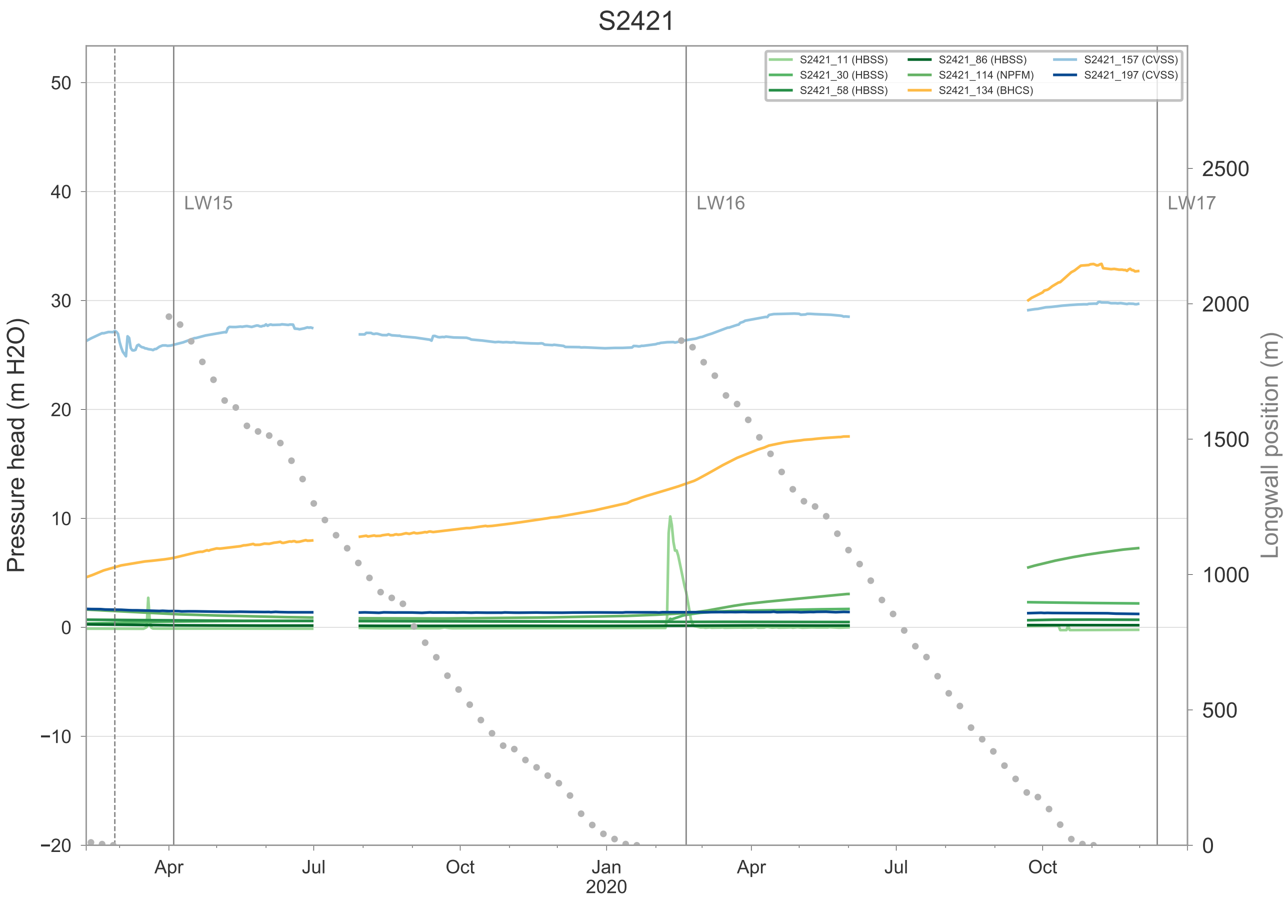



S2420
Ground RL
LW15
LW16
S2420_11 (HBSS)
S2420_30 (HBSS)
S2420_51 (HBSS)
S2420_72 (HBSS)
S2420_93 (HBSS)
S2420_121.5 (BHCS)
S2420_140 (CVSS)
S2420_180 (CVSS)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
Piezometric head (m RL)
Longwall position (m)
Jan 2019
Apr
Jul
Oct
Jan 2020
Apr
Jul
Oct

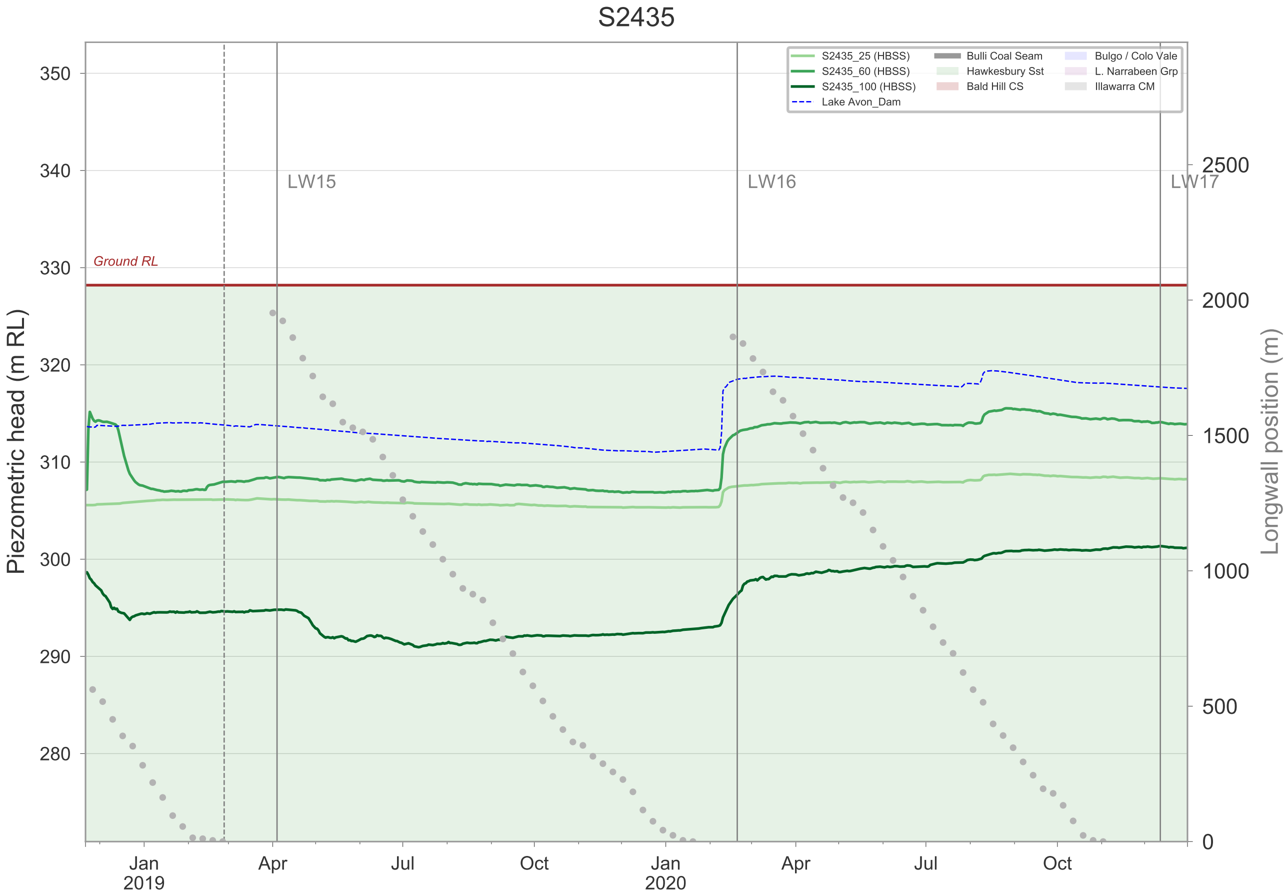

S2420
LW15
LW16
S2420_11 (HBSS)
S2420_30 (HBSS)
S2420_51 (HBSS)
S2420_72 (HBSS)
S2420_93 (HBSS)
S2420_121.5 (BHCS)
S2420_140 (CVSS)
S2420_180 (CVSS)
Pressure head (m H2O)
Longwall position (m)
Jan 2019
Apr
Jul
Oct
Jan 2020
Apr
Jul
Oct

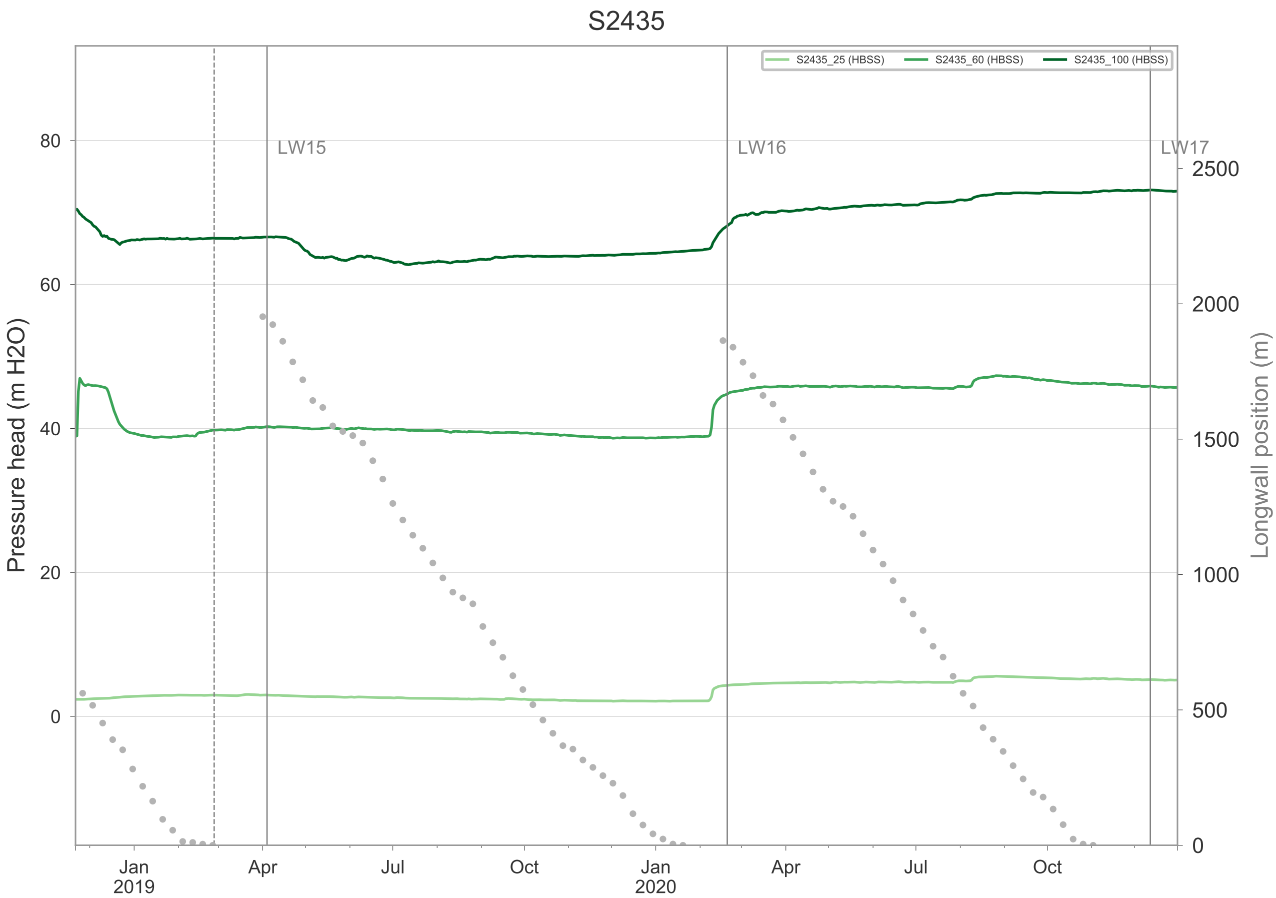
Groundwater hydrographs





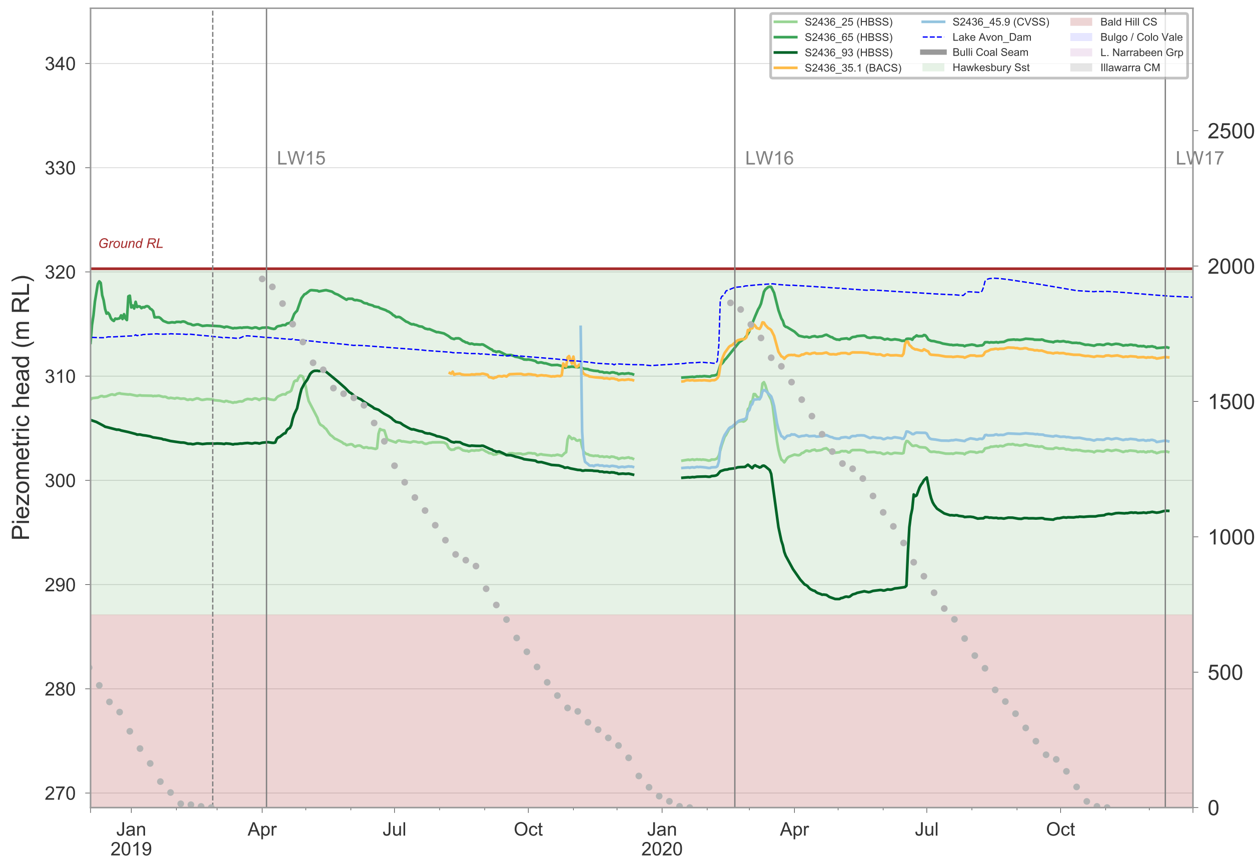
Groundwater hydrographs



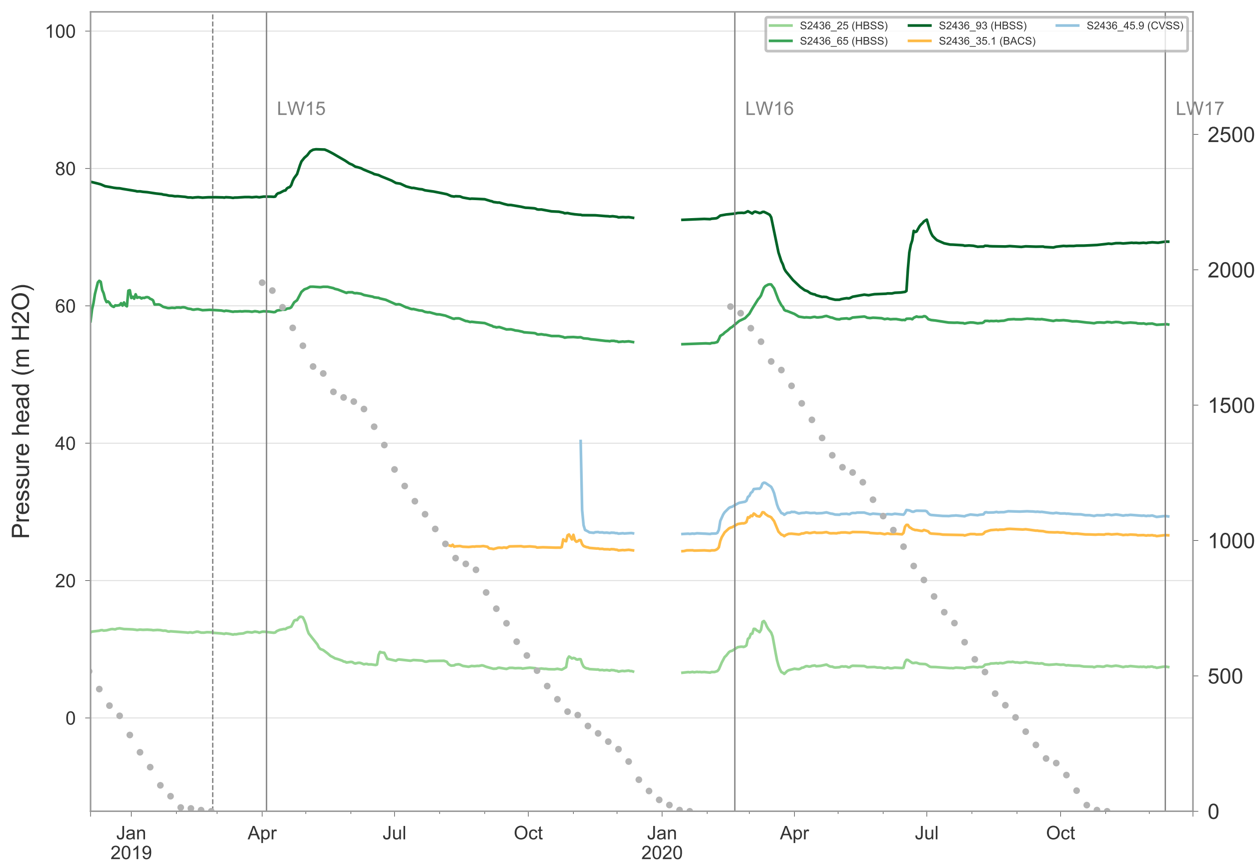


Groundwater hydrographs

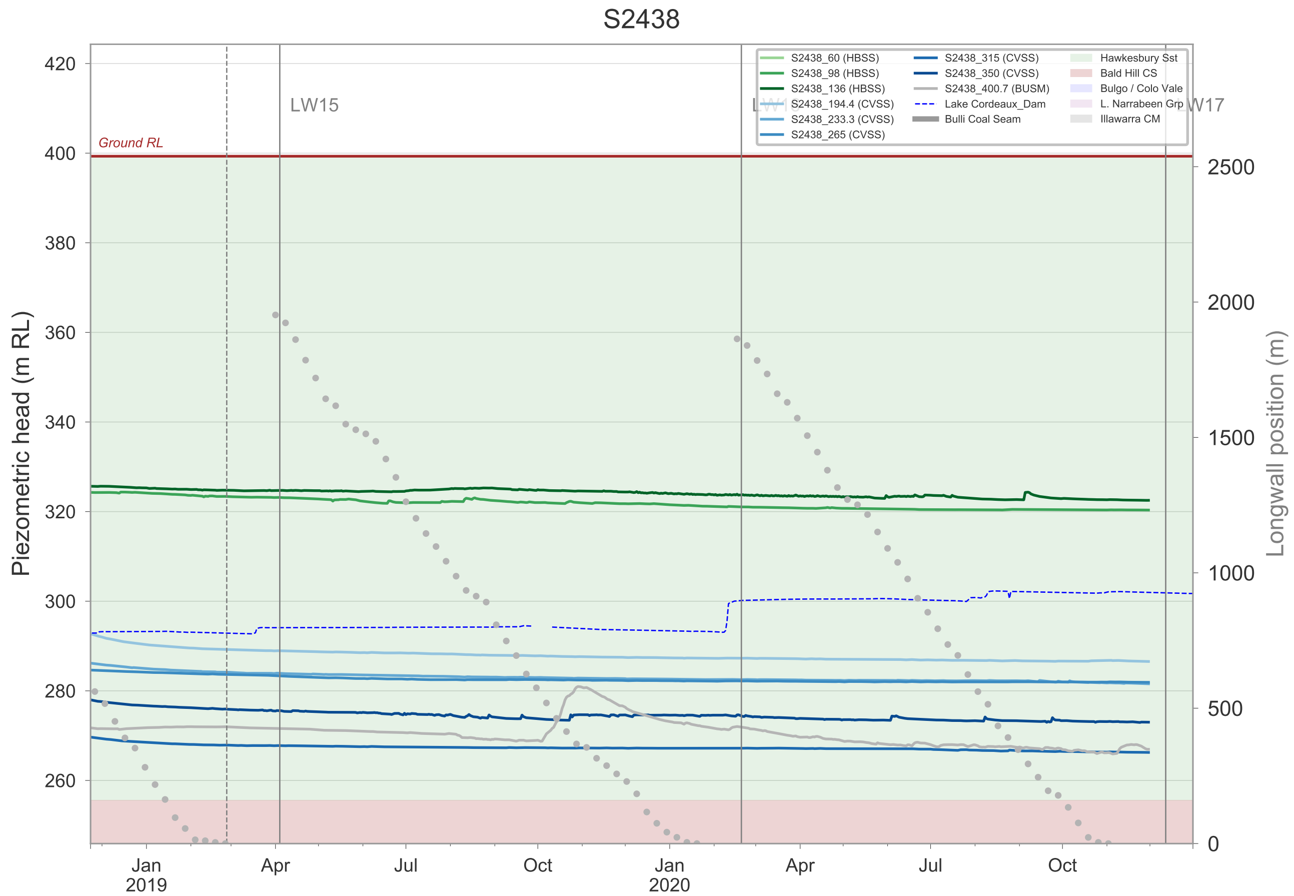
S2436

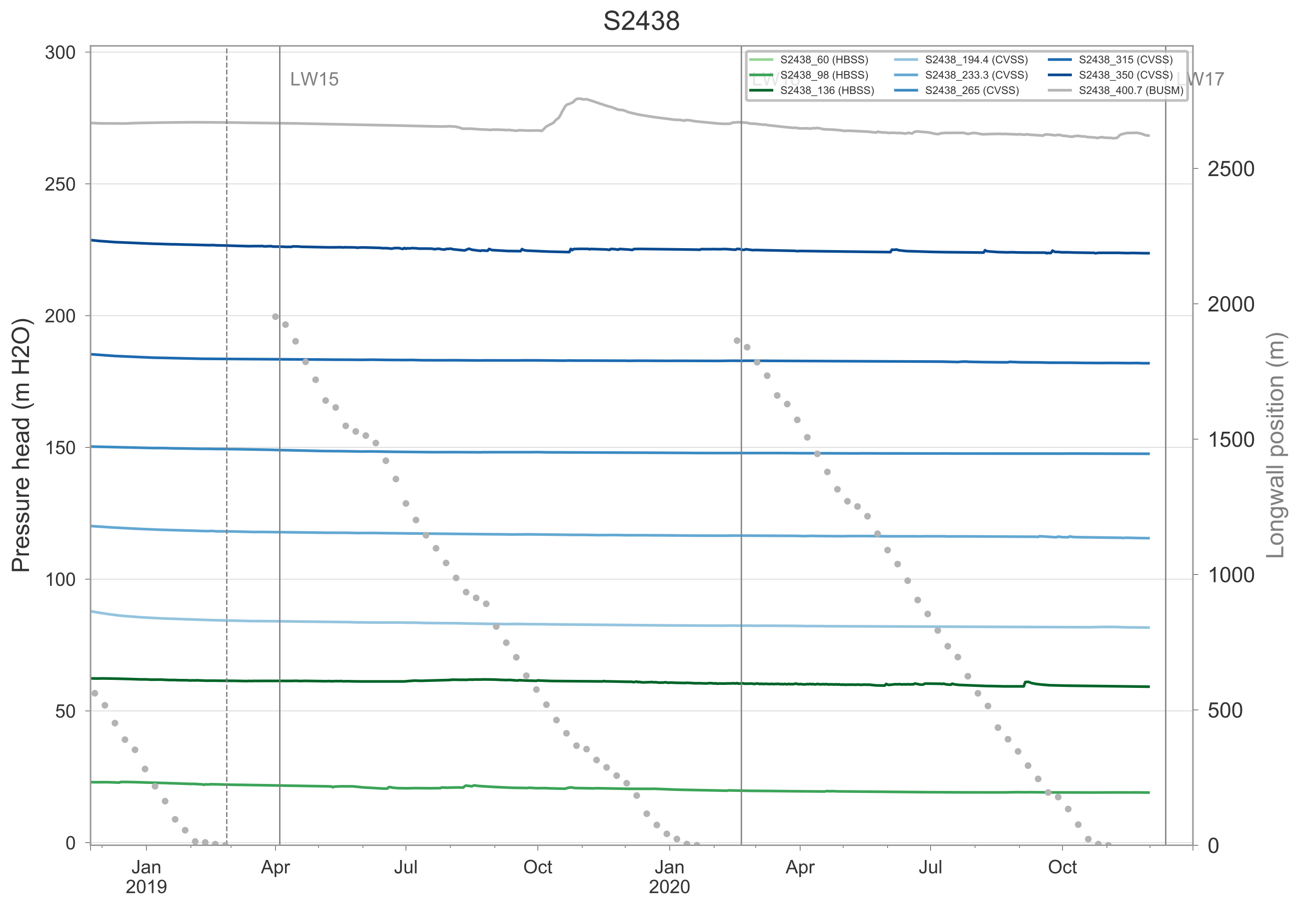


S2436

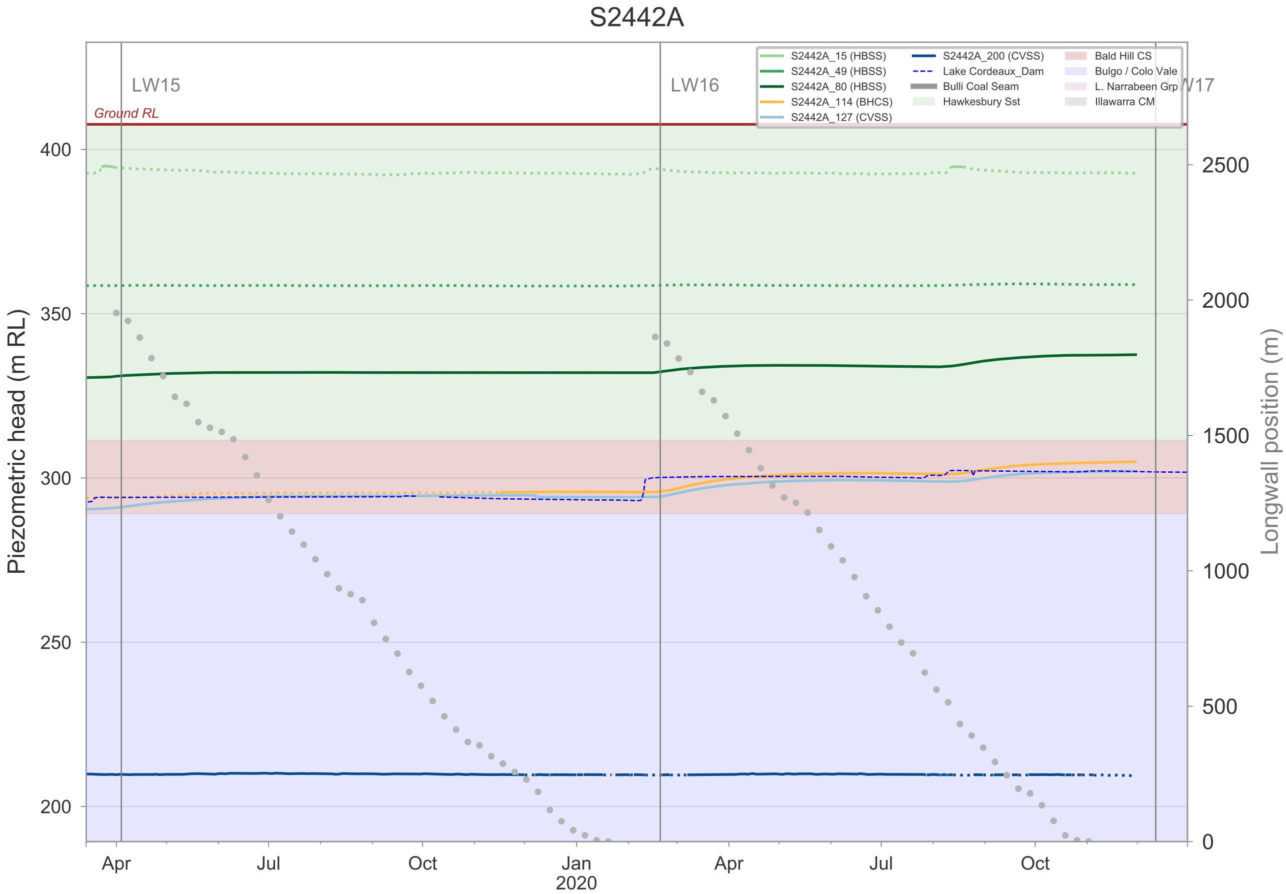


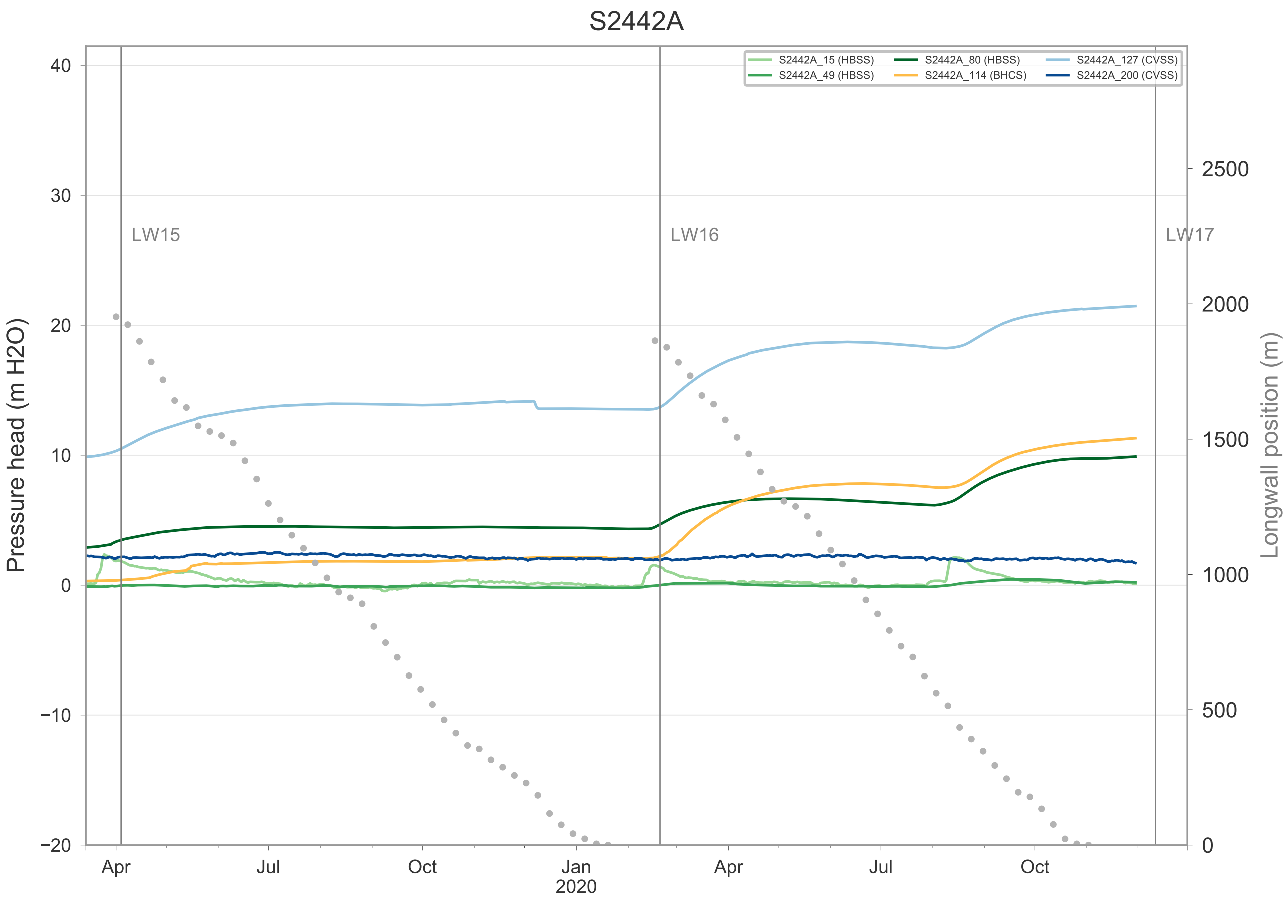
Groundwater hydrographs



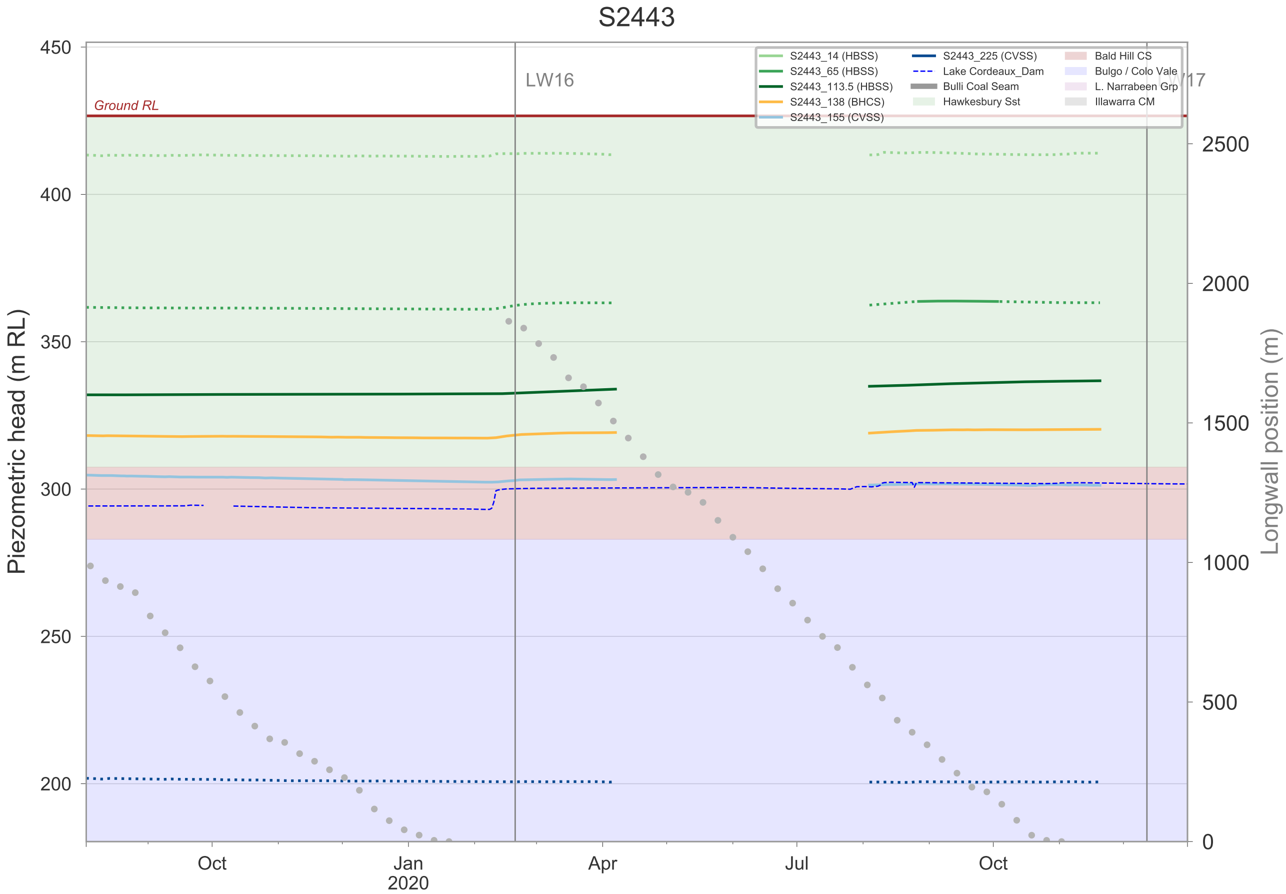


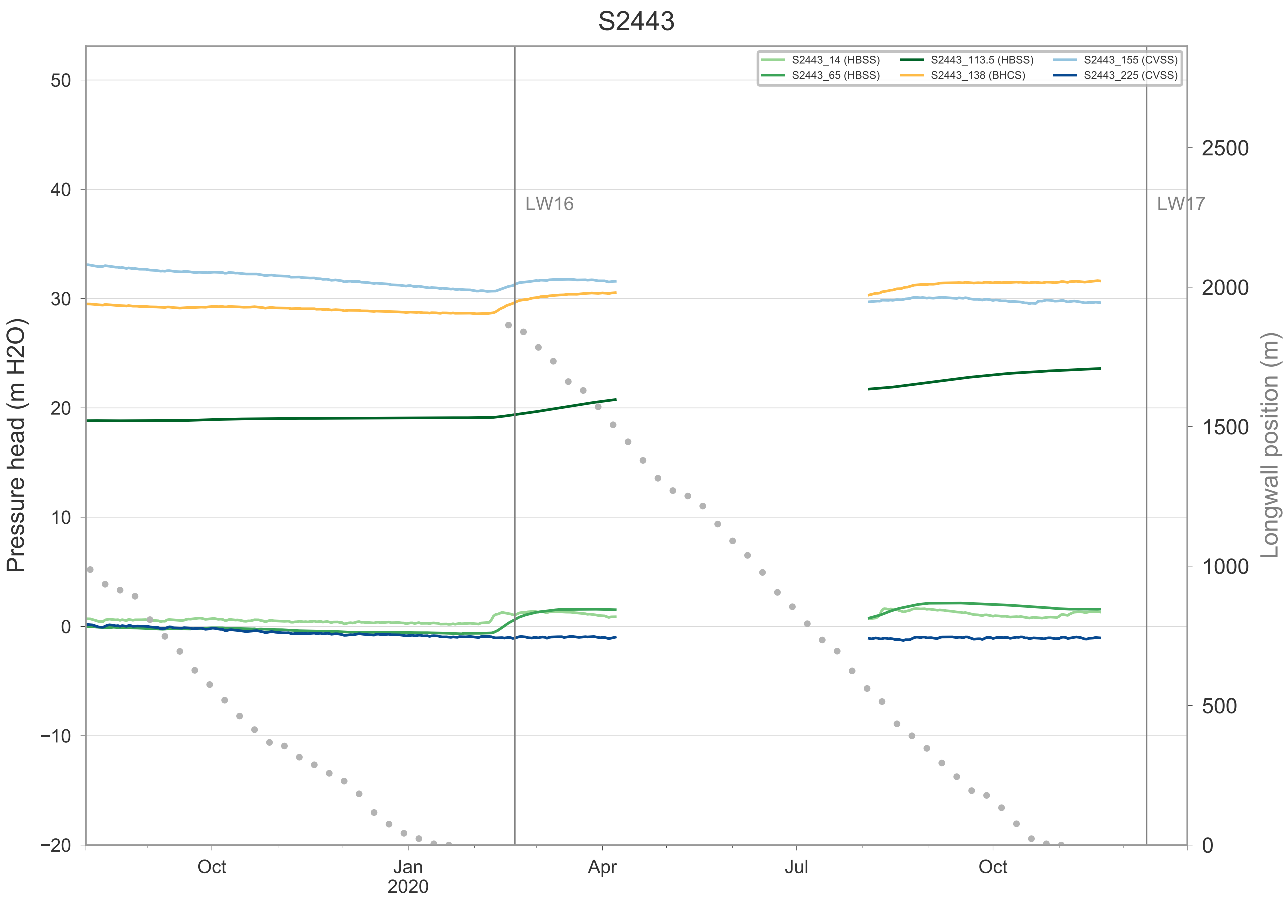
Groundwater hydrographs



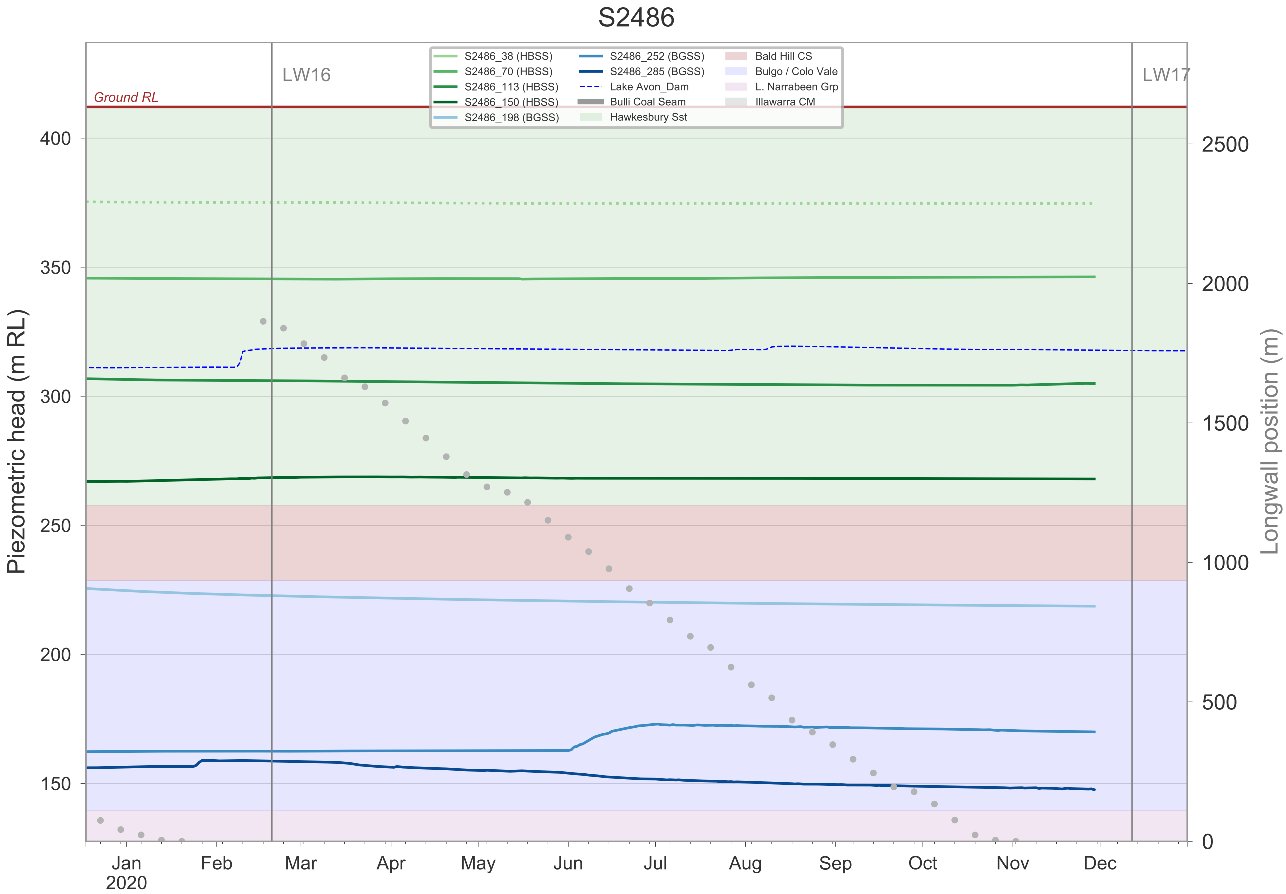


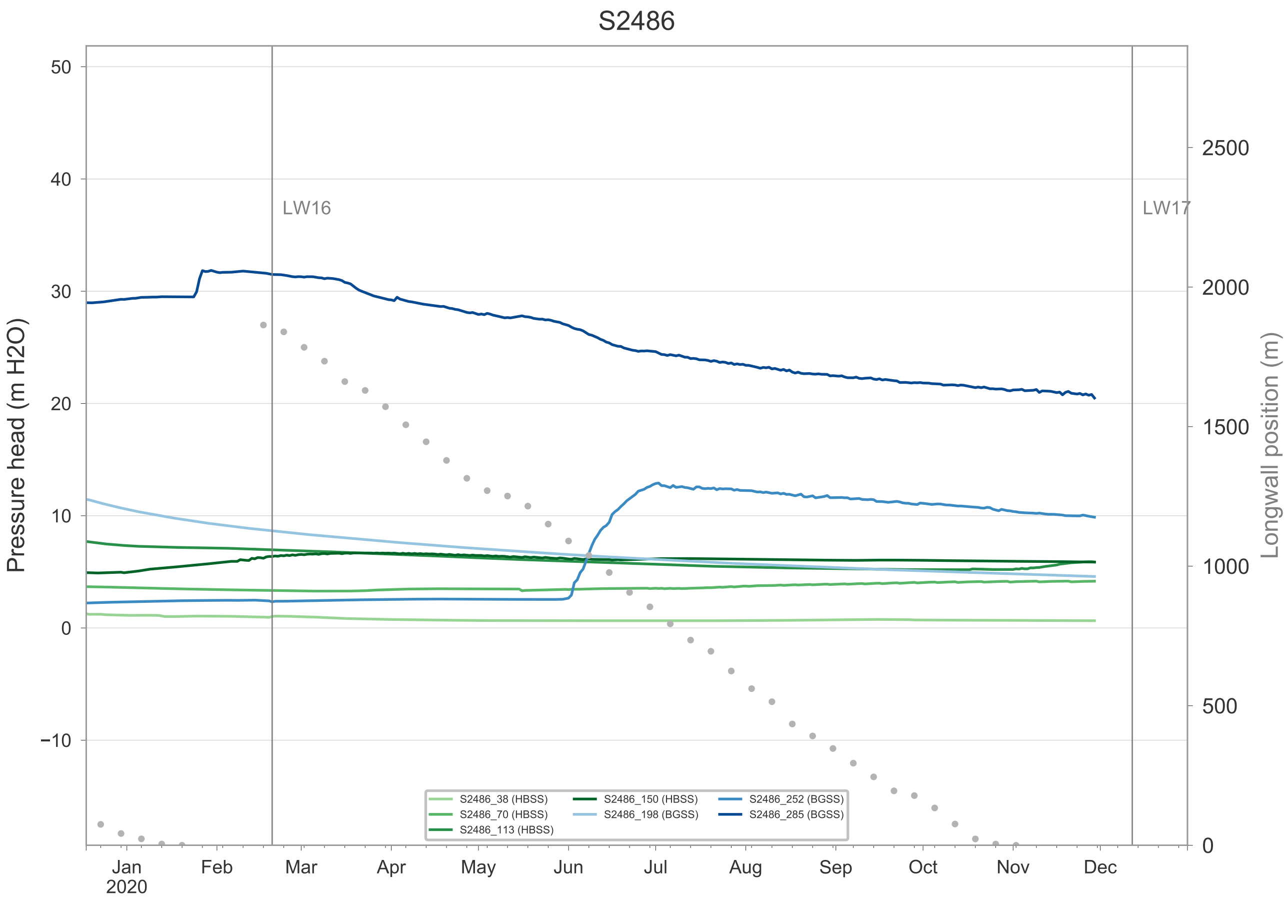
Groundwater hydrographs



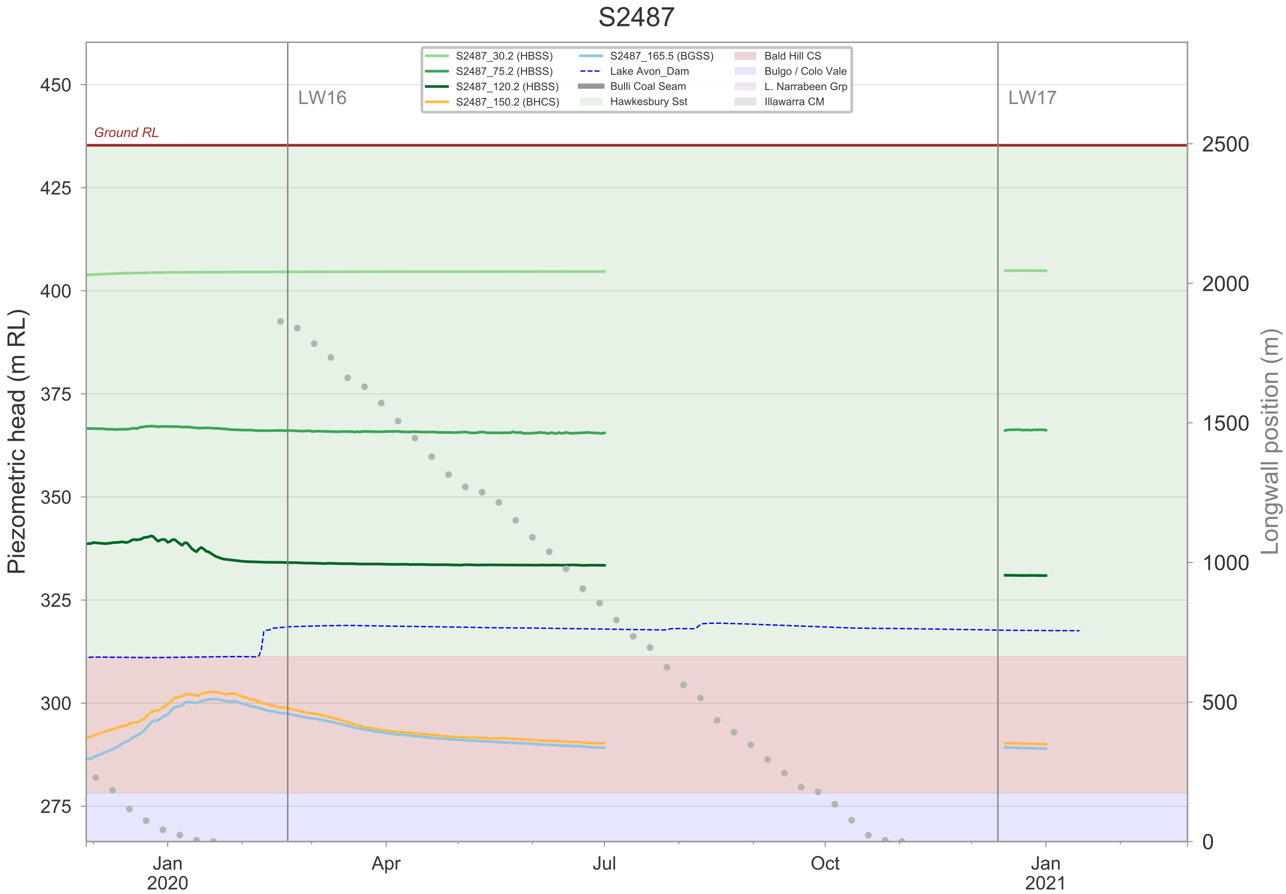


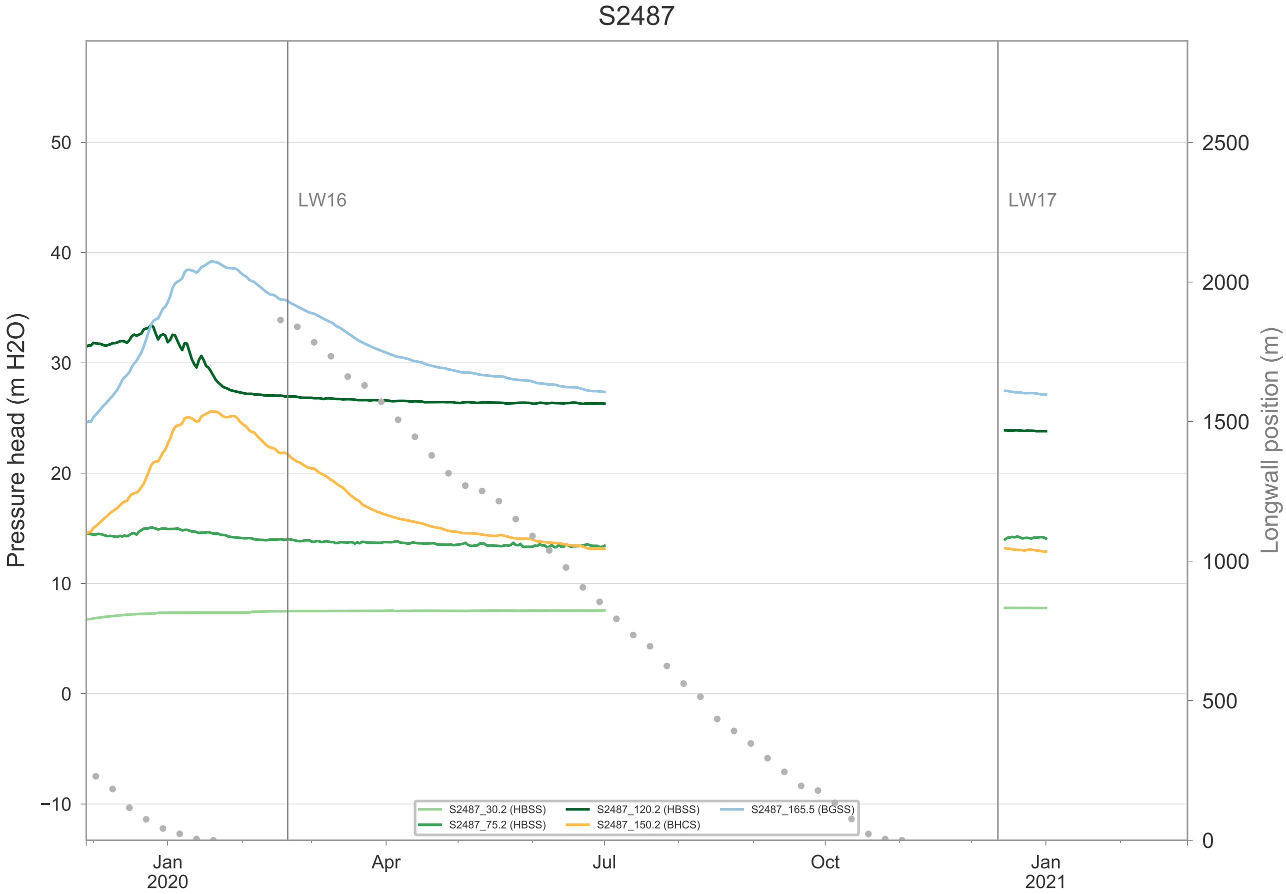
Groundwater hydrographs



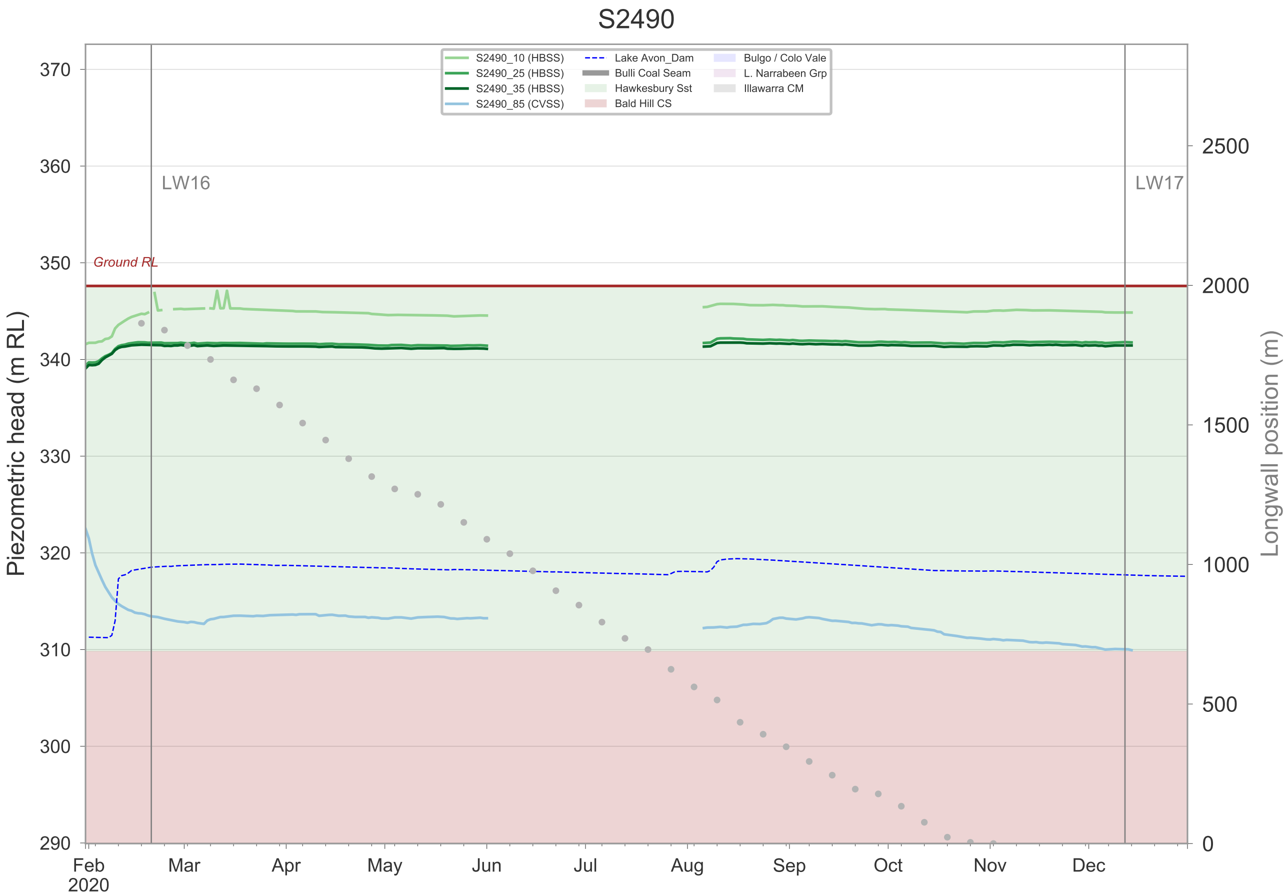


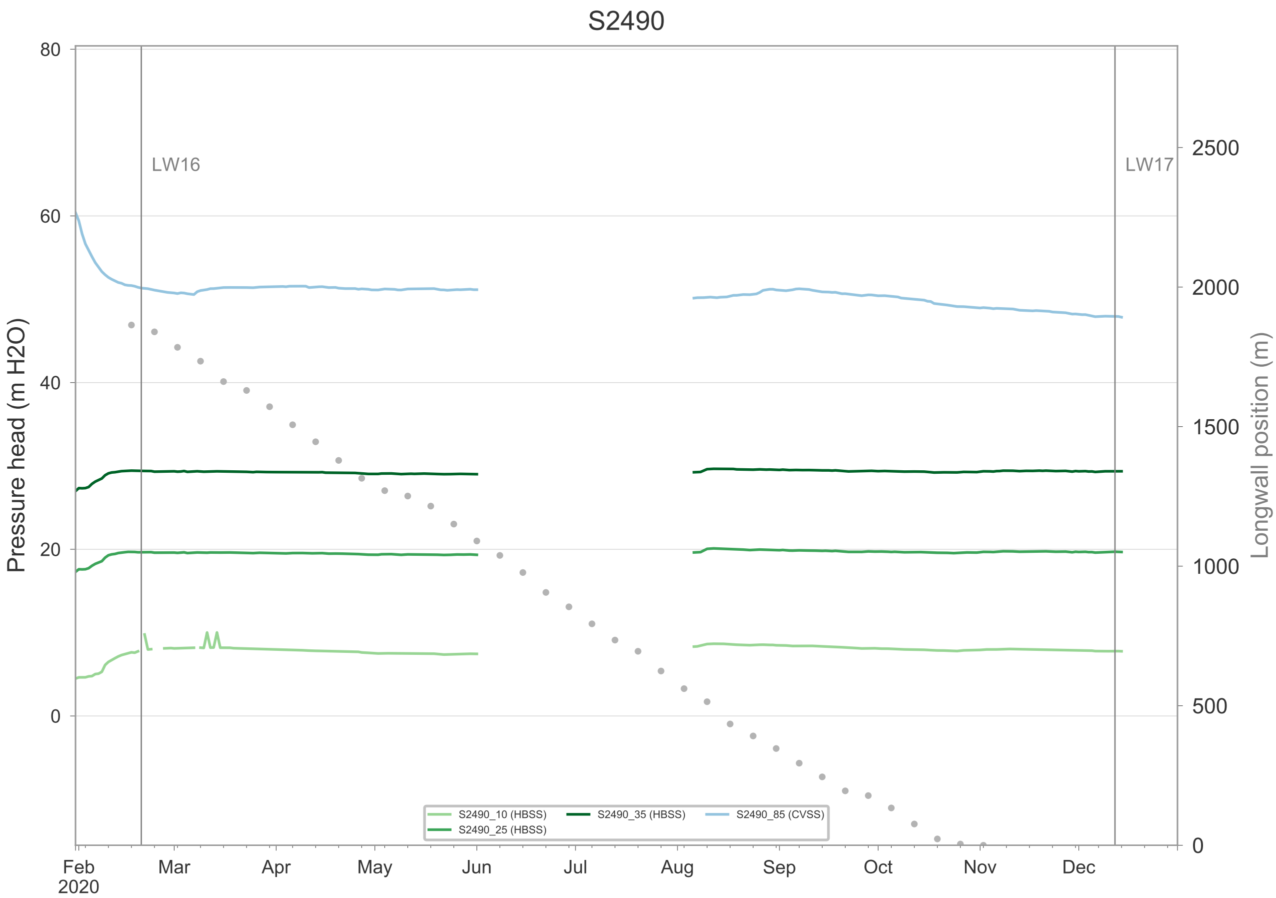
Groundwater hydrographs

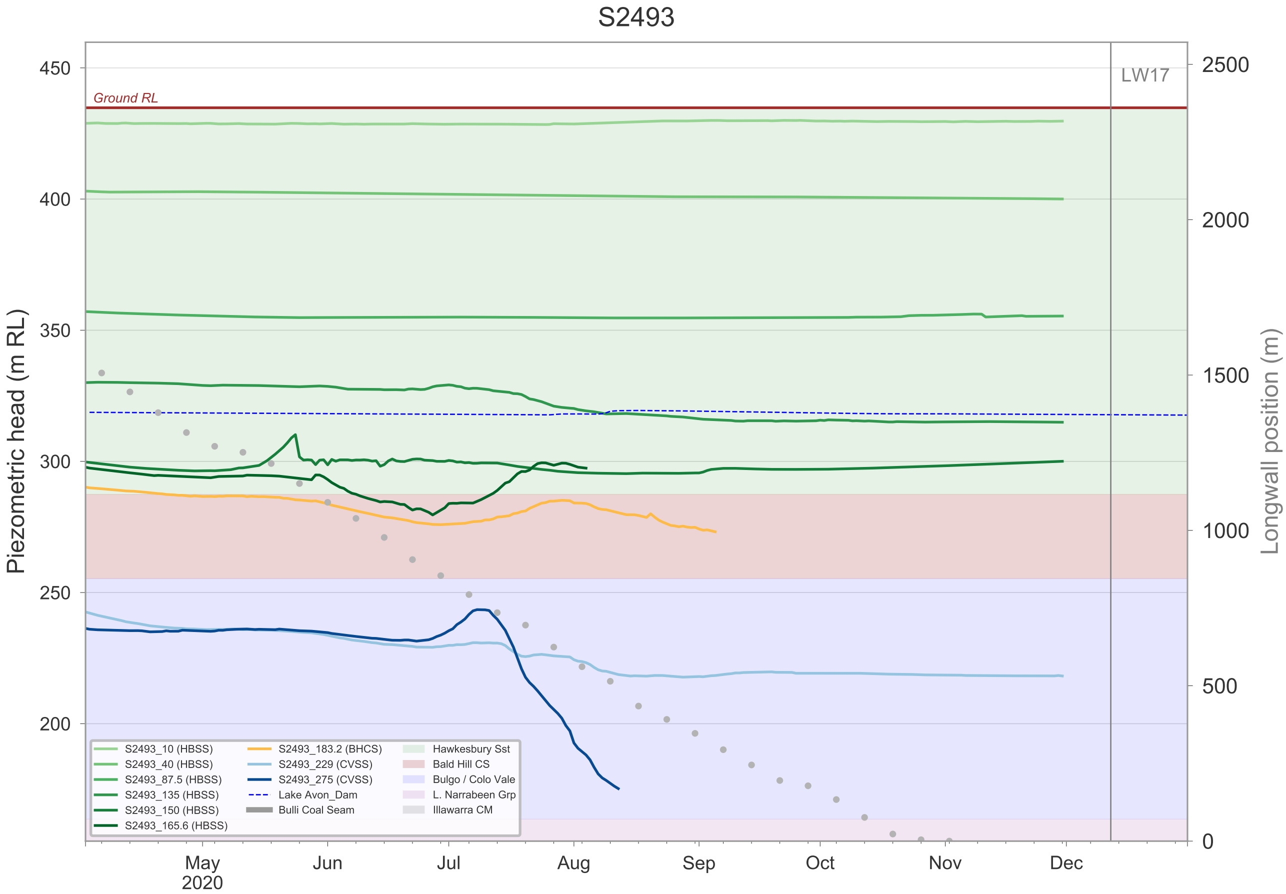


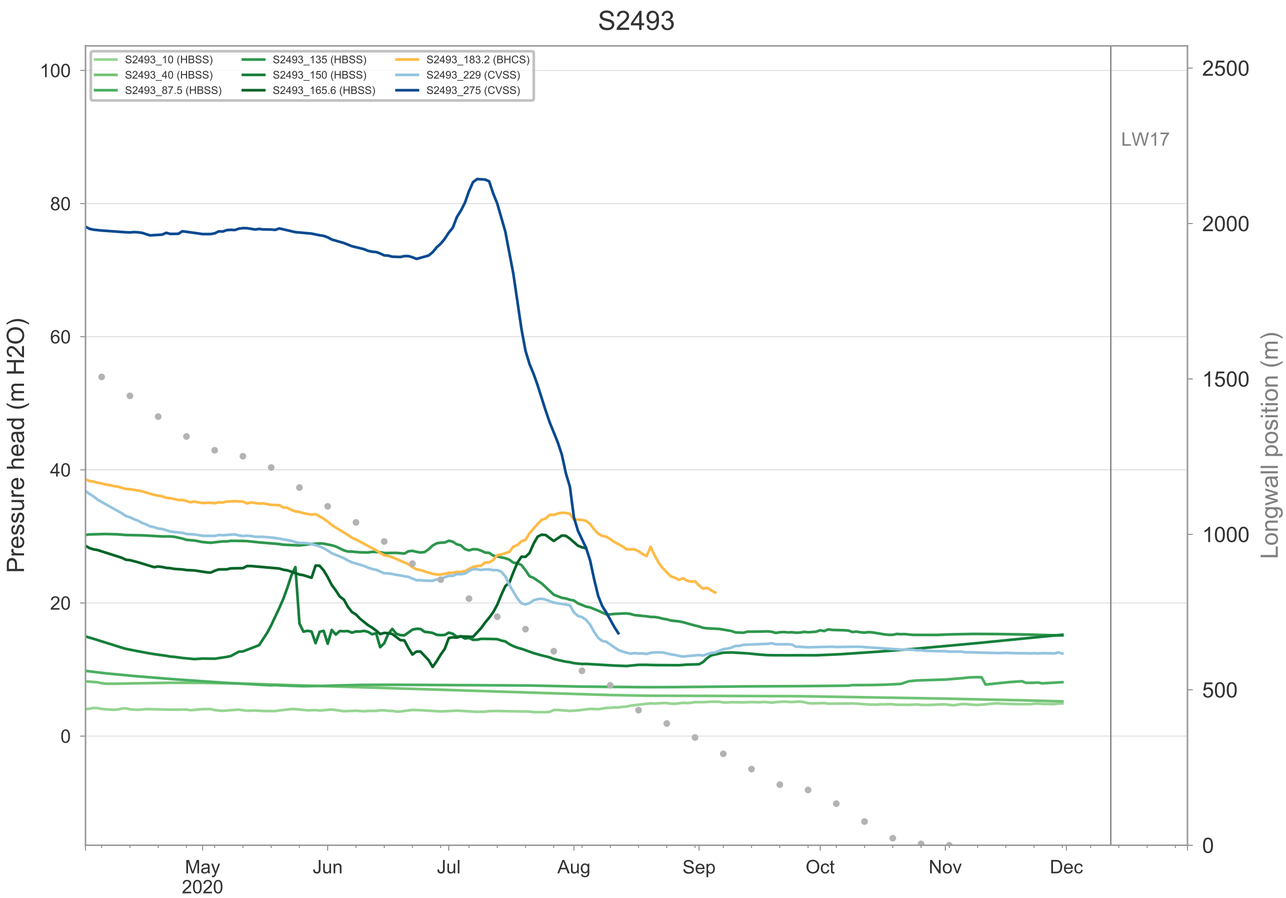


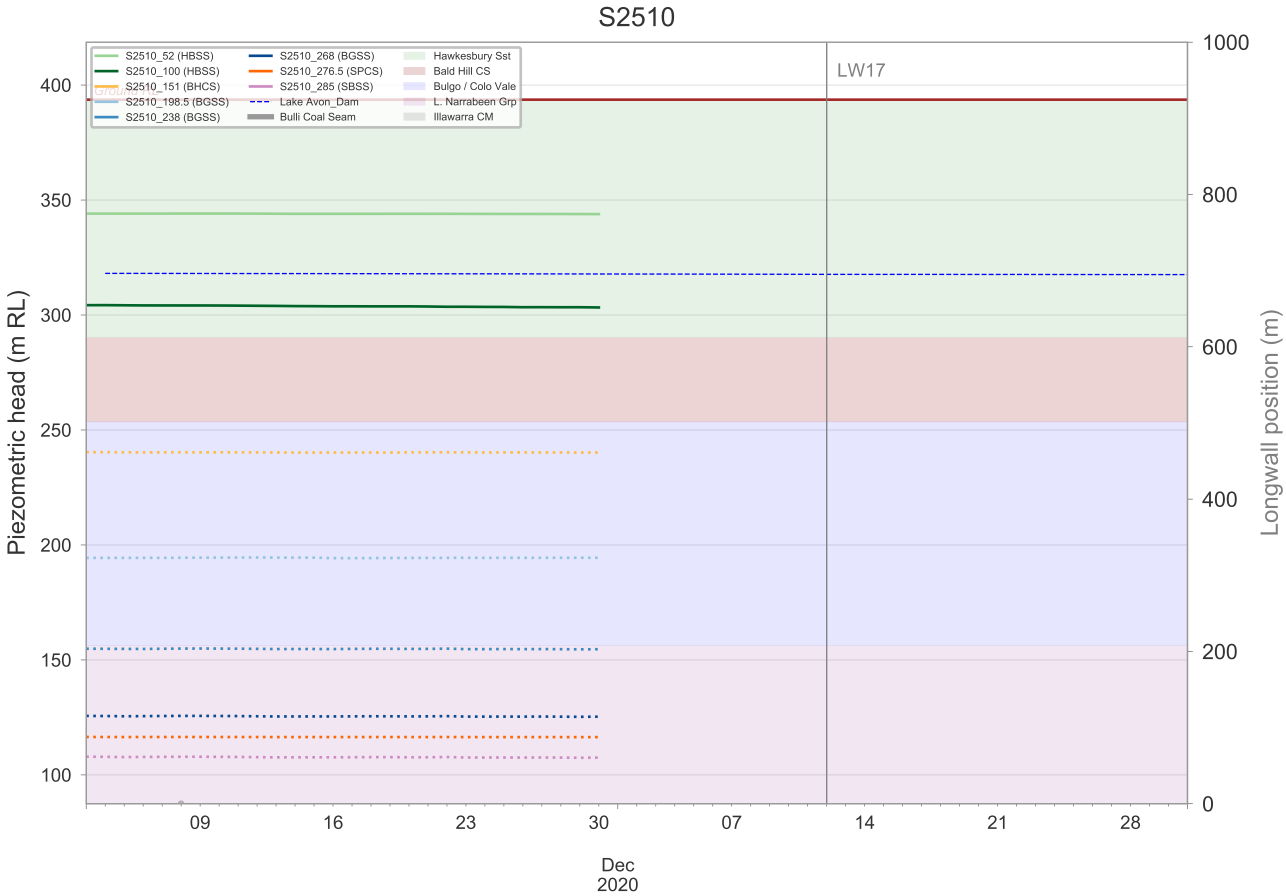
Groundwater hydrographs

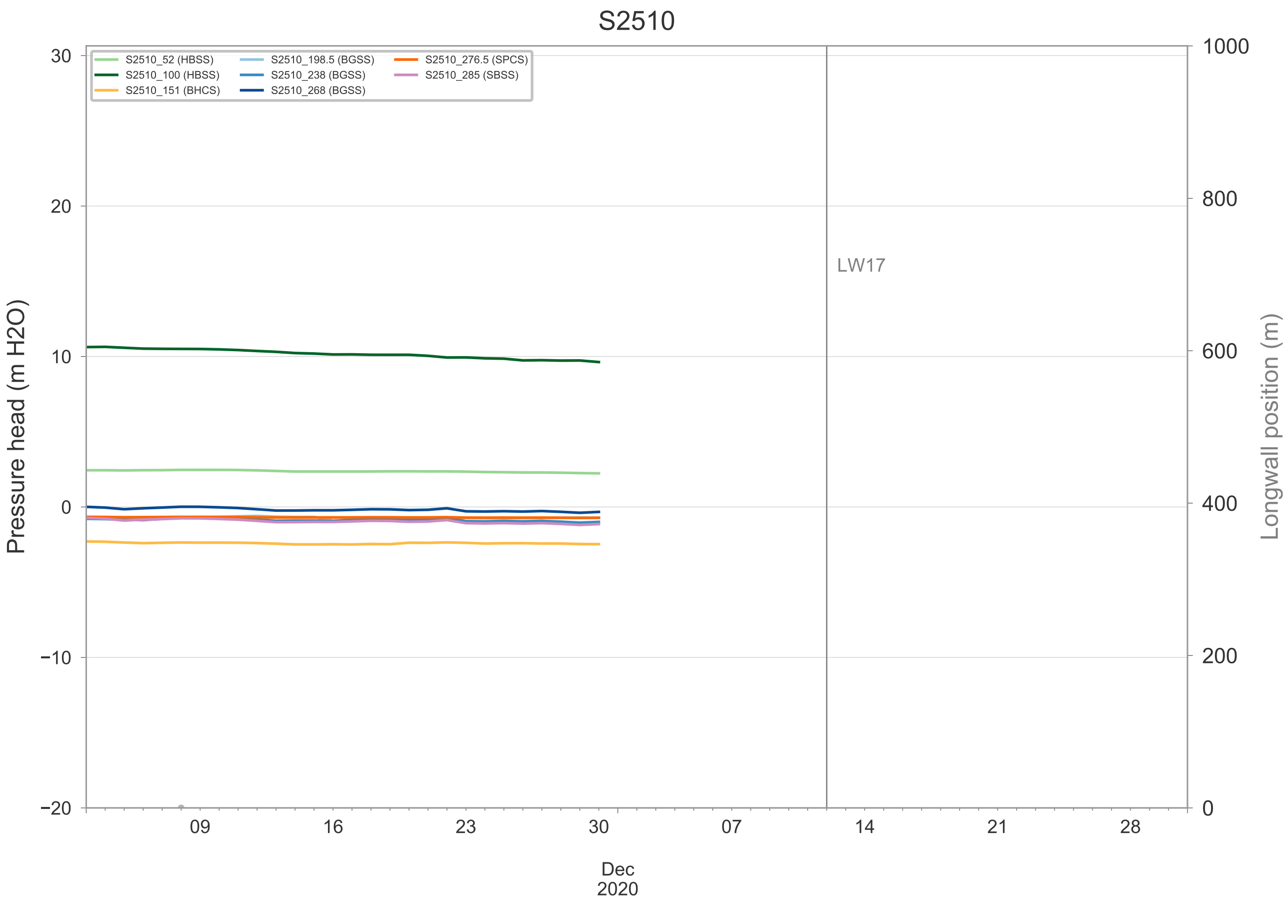





S2493
Piezometric head (m RL)
Longwall position (m)
Ground RL
LW17
450
400
350
300
250
200
2500
2000
1500
1000
500
0
May
2020
Jun
Jul
Aug
Sep
Oct
Nov
Dec
S2493_10 (HBSS)
S2493_40 (HBSS)
S2493_87.5 (HBSS)
S2493_135 (HBSS)
S2493_150 (HBSS)
S2493_165.6 (HBSS)
S2493_183.2 (BHCS)
S2493_229 (CVSS)
S2493_275 (CVSS)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM


S2493
Pressure head (m H2O)
Longwall position (m)
LW17
100
80
60
40
20
0
2500
2000
1500
1000
500
0
May
2020
Jun
Jul
Aug
Sep
Oct
Nov
Dec
S2493_10 (HBSS)
S2493_40 (HBSS)
S2493_87.5 (HBSS)
S2493_135 (HBSS)
S2493_150 (HBSS)
S2493_165.6 (HBSS)
S2493_183.2 (BHCS)
S2493_229 (CVSS)
S2493_275 (CVSS)


S2510
S2510_52 (HBSS)
S2510_100 (HBSS)
S2510_151 (BHCS)
S2510_198.5 (BGSS)
S2510_238 (BGSS)
S2510_268 (BGSS)
S2510_276.5 (SPCS)
S2510_285 (SBSS)
Lake Avon_Dam
Bulli Coal Seam
Hawkesbury Sst
Bald Hill CS
Bulgo / Colo Vale
L. Narrabeen Grp
Illawarra CM
Ground RL
LW17
Piezometric head (m RL)
400
350
300
250
200
150
100
Longwall position (m)
1000
800
600
400
200
0
09
16
23
30
07
14
21
28
Dec
2020


S2510
S2510_52 (HBSS)
S2510_100 (HBSS)
S2510_151 (BHCS)
S2510_198.5 (BGSS)
S2510_238 (BGSS)
S2510_268 (BGSS)
S2510_276.5 (SPCS)
S2510_285 (SBSS)
LW17
Pressure head (m H2O)
30
20
10
0
−10
−20
Longwall position (m)
1000
800
600
400
200
0
09
16
23
30
07
14
21
28
Dec
2020