MOUNT THORLEY WARKWORTH

2020 Annual Groundwater Review

Prepared for:

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BASIS OF REPORT

DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
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APPENDICES

1 Introduction

1.1 Overview

The Mount Thorley Warkworth (MTW) mining complex is located approximately 15 km south-west of Singleton, NSW. As part of compliance with mine approval conditions, routine groundwater monitoring is conducted across MTW, and the data reviewed and analysed on an annual basis. The annual groundwater review is required for:

- Warkworth Mine in accordance with Condition 25 of the Warkworth Consent (SSD 6464) Statement of Commitments; and
- Mt Thorley Mine in accordance with Condition 27 of Development Consent (SSD 6465)

MTW commissioned SLR Consulting Pty Ltd (SLR) to review the groundwater monitoring data for the 2020 calendar year. This report presents groundwater monitoring data collected at the MTW complex and discusses the impact of mining on the groundwater regime.

1.2 Scope

The scope of work for this review included analysis of monitoring data and reporting. This report presents:

- Site background:
  - Legislative requirements and conditions relevant to groundwater;
  - Mine activities over reporting period;
  - Hydrogeological regime; and
  - Groundwater monitoring network and program.
- Data review:
  - Review and illustration (i.e. hydrographs) of groundwater level trends;
  - Review and illustration (i.e. hydrographs) of groundwater quality trends; and
  - Comparison of water level and quality trends to relevant trigger levels and natural trends (i.e. surface water levels and rainfall).
- Review of numerical groundwater model predictions and comparison to observed groundwater levels.
- Discussion of groundwater impacts and compliance over the reporting period and provision of recommendations (where required).

2 MTW Complex

The following section provides a summary of known activities conducted across the complex that relate to the annual groundwater review. The general site layout is presented in **Figure 2-1**.

2.1 Mine Operations

Table 2-1 presents a summary of mine areas across MTW and activities conducted during 2020.

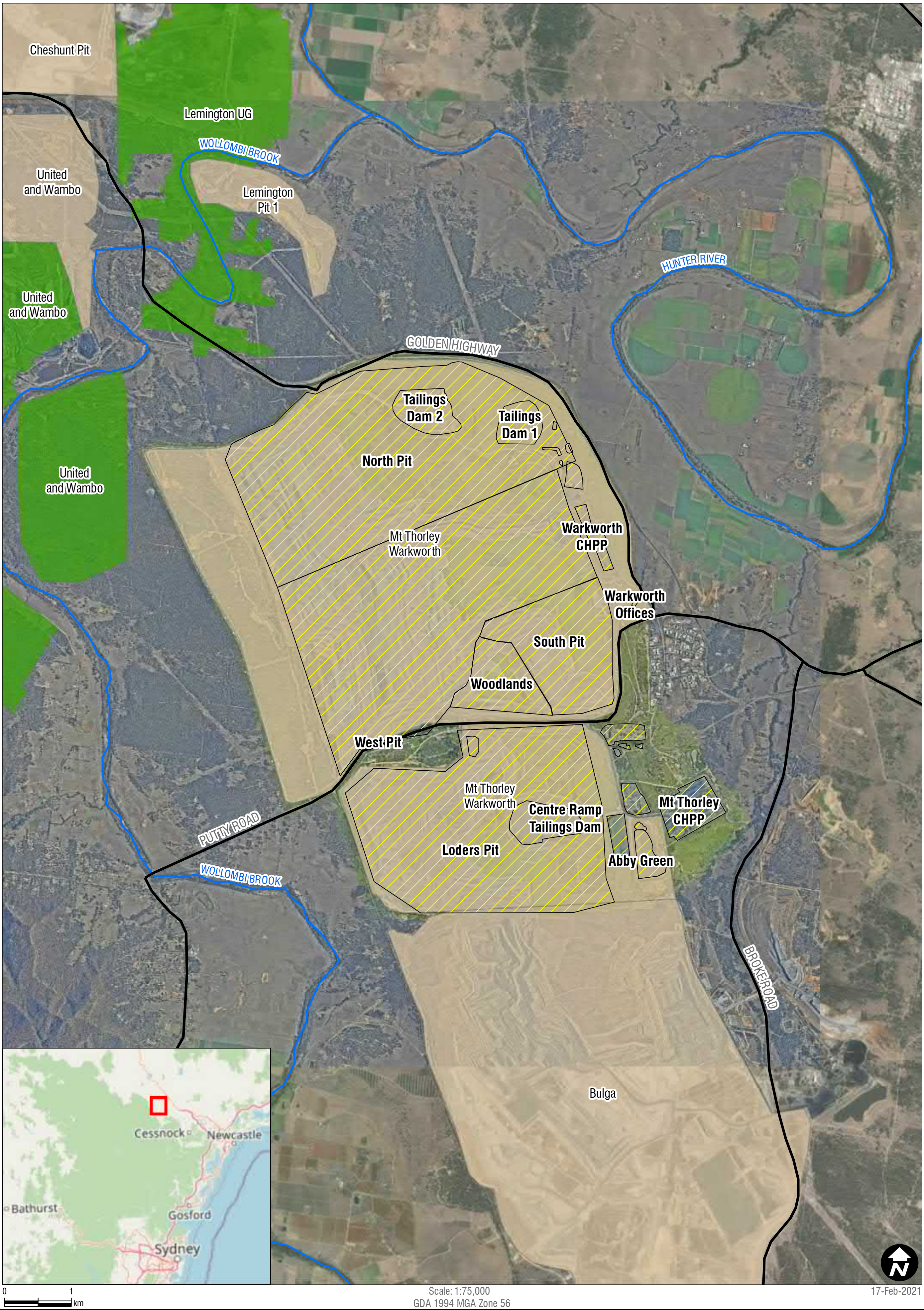
Table 2-1 Summary of MTW Activities

Mine Area	Site	2020 Activities
North Pit	Warkworth	Rehabilitation works appear to have been undertaken on eastern portion of pit footprint (according to aerial imagery).
West Pit	Warkworth	Rehabilitation works appear to have been undertaken on eastern portion of pit footprint
South Pit	Warkworth	No active mining, rehabilitation works in place.
Loders Pit	Mt Thorley	Rehabilitation works appear to have been undertaken on eastern portion of pit footprint
Abby Green Pit	Mt Thorley	No mining active, rehabilitation works in place.

A range of tailings storage facilities (TSF) are present across MTW, as summarised in **Table 2-2**.

Table 2-2 Summary of approved tailings storage facilitates at MTW

Area	Location	Status
Tailings Dam 1 (Dam 32N)	North Pit – Warkworth. Tailings dam located overlying spoil, within backfilled pit.	Inactive, tailings dam rehabilitated.
Tailings Dam 2 (Dam 33N)	North Pit – Warkworth. Tailings dam located overlying spoil, within backfilled pit.	Inactive, excess standing water actively decanted in 2017 and rehabilitation commenced. Capping of the tailings dam continued during the period.
Centre Ramp Tailings Dam (Dam 17S)	Loders Pit – Mt Thorley. Tailings dam located overlying spoil, within backfilled pit.	Active
Abbey Green Tailings Dam (Dam 4S)	Abbey Green – Mt Thorley. Tailings dam located overlying spoil, within backfilled pit.	Active
Mini-strip Tailings Dam	Loders Pit – Mt Thorley. Tailings dam located overlying spoil, within backfilled pit.	Active
Loders Pit North	Loders Pit- Mount Thorley. Tailings dam located in-pit.	In development – infrastructure set up over 2020 with deposition to commence in 2021



Main road
Major watercourses
MTW Infrastructure
Mine Areas
Open Cut
Underground

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Locality Map

Figure 2-1

2.2 Groundwater Impacts

Groundwater impacts associated with the approved operations are presented within the:

- Warkworth Mine Modification Groundwater Impact Assessment (AGE, 2013);
- Warkworth Continuation 2014 Groundwater Assessment (AGE, 2014a);
- Mount Thorley Operations 2014 Groundwater Assessment (AGE, 2014b);
- Mount Thorley and Warkworth Mines, Long Term Approvals Model Update (AGE, 2015).

The most recent groundwater assessment that captures operations across MTW was the Long Term Approvals Model Update (AGE, 2015). The groundwater assessment involved updating the numerical groundwater model developed in 2014 as part of the continuation projects. Updates included recalibration of the model to site observations and updating the mine plans. AGE (2015) reported on predicted impacts associated with approved operations. The approved operations included mining at North Pit, West Pit and Loders Pit until 2035, as well as surrounding non-MTW mining operations (i.e. Wambo Coal). Groundwater conditions and groundwater response to approved mining, as reported by AGE (2015), indicated:

- Groundwater within the hard rock units (i.e. Whittingham Coal Measures) is directly intercepted by approved operations at MTW, with a peak take of 275 ML/year predicted for Warkworth and 298 ML/year predicted for Mt Thorley;
- Groundwater within the confined to semi-confined Permian coal measures became depressurised around the area of active mining;
- There is no direct interception of groundwater within the ‘highly productive’ alluvium for active mine operations at MTW;
- With depressurisation of the coal measures, the model predicted a reduction in upward seepage to the ‘highly productive’ alluvium along the Hunter River and Wollombi Brook, referred to as ‘indirect take’. Peak indirect take:
  - From the Wollombi Brook alluvium (Hunter Unregulated) was predicted to be 16.7 ML/year for Warkworth and 11.3 ML/year for Mt Thorley;
  - From the Hunter River alluvium (Hunter Regulated) was predicted to be 3.5 ML/year for Warkworth and 0.6 ML/year for Mt Thorley;

Groundwater licenses have been obtained for the approved operations, as discussed in **Section 2.3**. Management and monitoring requirements of potential groundwater related impacts from approved operations are captured within the development consent conditions. These conditions are addressed within the site Water Management Plan (WMP), which was revised in April 2020. Further discussion on the monitoring and management requirements is included within **Section 5.**

2.3 Groundwater Licensing

Under the *Water Act 1912* and *Water Management Act 2000*, adequate water licences are required for approval of the mine developments. Groundwater licenses held for MTW are outlined in **Table 2-3**. Water licence details have been obtained from the WMP which was revised on 30th April 2020.

Table 2-3 MTW Groundwater Licenses

Licence Number	Description	WSP	Water Source - Management Zone	Approved Extraction (ML)
40464 20AL218784	Mt Thorley Excavations	North Coast Fractured and Porous Rock	Permian Coal Seams	180
40465 20AL218785	Warkworth Excavations			750
18558 20AL208627	-	Hunter Unregulated and Alluvial Water Sources	Lower Wollombi Brook Water Source	50
18469 20AL218784	-			245
19022 20AL209903	Sandy Hollow Creek		Singleton Water Source	60
10543 20AL201239	To Oakhampton Rail Bridge	Hunter River Regulated Water Source	Zone 2b Hunter River from Wollombi Brook Junction to downstream extent of the Hunter Regulated River	1,009
963 20AL201242	Warkworth Farm – Hunter River Pump			243
971 20AL201258				270
1008 20AL201341				243
995 20AL201302	Appledale Farm – Hunter River Pump			243
1009 20AL201343				435

2.4 Groundwater Conditions

In accordance with the development consent approval conditions and statement of commitments (SOC) to the 2014 continuation project approval, Yancoal are required to prepare and implement a WMP to the satisfaction of the Director-General. **Table 2-4** presents a summary of the relevant groundwater conditions and SOC's from the 2020 WMP. The table identifies where the conditions relating to routine groundwater monitoring for 2020 have been addressed.

Table 2-4 Groundwater Conditions within WMP

<table>
<tr><th>Condition</th><th>Details</th><th>Where Addressed</th></tr>
<tr><td>Sch. 3, Cond. 24 for Mt Thorley (SSD-6465)

Sch. 3, Cond. 26 for Warkworth (SSD-6464)</td><td>Design, install and maintain emplacements to prevent offsite migration of saline groundwater seepage</td><td>See Section 6 for discussion of groundwater quality.

WMP and surface water review</td></tr>
<tr><td>Sch. 3, Cond. 25(b) for Mt Thorley (SSD-6465)

Sch. 3, Cond. 27(b) for Warkworth (SSD-6464)</td><td>Groundwater Management Plan, which includes detailed baseline data on groundwater levels, yield and quality in the region, and privately-owned groundwater bores, that could be affected by the development</td><td>See WMP. As per WMP, no privately-owned groundwater bores on non-mine owned land were identified as having groundwater levels decline by over 2 m due to the approved operations.</td></tr>
<tr><td>Sch. 3, Cond. 25(b) for Mt Thorley (SSD-6465)

Sch. 3, Cond. 27(b) for Warkworth (SSD-6464)</td><td>Groundwater Management Plan, which includes groundwater assessment criteria, including trigger levels for investigating any potentially adverse groundwater impacts</td><td>See Section 5.3 for triggers and Section 6.4 for discussion on site water quality results against trigger levels.</td></tr>
<tr><td rowspan="4">Sch. 3, Cond. 25(b) for Mt Thorley (SSD-6465)

Sch. 3, Cond. 27(b) for Warkworth (SSD-6464)</td><td>Groundwater Management Plan which includes a program to monitor and report on:</td><td></td></tr>
<tr><td>Groundwater inflows to the open cut pits;</td><td>See WMP</td></tr>
<tr><td>The seepage/leachate from water storages, emplacements, backfilled voids and final voids;</td><td>See WMP and surface water review and see Section 6 for discussion of groundwater quality.</td></tr>
<tr><td>The impacts of the development on:
regional and local (including alluvial) aquifers;
groundwater supply of potentially affected landowners;
groundwater dependent ecosystems and riparian vegetation;
base flows to Loders Creek (Mt Thorley) and Wollombi Brook (Warkworth);</td><td>See Section 6 for discussion on groundwater monitoring results for 2019. As per WMP, no privately-owned bores identified as potentially impacted.
See ecology review for discussion on ecosystems and vegetation.</td></tr>
</table>

Condition	Details	Where Addressed
Sch. 3, Cond. 25(b) for Mt Thorley (SSD-6465) Sch. 3, Cond. 27(b) for Warkworth (SSD-6464)	Groundwater Management Plan which includes a plan to respond to any exceedances of the groundwater assessment criteria;	Trigger exceedances are discussed in **Section 6.**
Sch. 3, Cond. 25(b) for Mt Thorley (SSD-6465) Sch. 3, Cond. 27(b) for Warkworth (SSD-6464)	Groundwater Management Plan which includes a program to validate the groundwater model for the development, including an independent review of the model with every independent environmental audit, and compare the monitoring results with modelled predictions.	Numerical model last updated in 2015 as discussed in **Section 2.2**. Comparison between observed and modelled groundwater levels undertaken in **Section 6.6.**.
SOC Warkworth Continuation 2014 EIS Table 22.1 Groundwater	Updates to current groundwater monitoring programme: • installation of nested monitoring bores along the Wollombi Brook (PZ10, PZ11, PZ12); and • installation of monitoring bores with the Warkworth Sands system as part of an update to the existing Warkworth Sands Ephemeral Perched Aquifer Management Plan within the MTW WMP.	Bores installed in 2016, see **Section 5** for details on the monitoring program.
	Mine seepage monitoring programme: • recording of the time, location and estimated volume of any unexpected increased groundwater outflow from the highwall and endwall; • measurement of water pumped from the mine, preferably using flow meters or other suitable gauging apparatus; • correlation of rainfall records with mine seepage records so groundwater and surface water can be separated;	See mine water balance and surface water review.
	Data management and reporting: • establishment of trigger levels; • quarterly review of groundwater levels and field water quality against trigger levels, with site-specific investigations initiated; • formal review of depressurisation of coal measures and alluvium would be undertaken annually by a suitably qualified hydrogeologist; • annual reporting (including all water level and water quality data); and • all groundwater data being stored in a database customised for MTW with suitable QA/QC controls.	Quarterly reviews conducted as part of routine groundwater monitoring by external contractors AECOM. Review of groundwater level and quality changes presented in **Section 6**. Data stored within database held by Yancoal.
	Future model iterations: • assess the validity of the model predictions every three years; and • incorporate into the model and revise predictions, if required.	Model predictions assessed in **Section 6.6.**
	Licensing: • retain and obtain appropriate water licences, as required, to account for modelled take.	**Section 2.3** and **Section 6.5**

Condition	Details	Where Addressed
SOC Mount Thorley Operations 2014 EIS Table 21.1 Groundwater	A site specific investigation into trigger level exceedance would be undertaken if: • professional judgement determines that the single deviation or a developing trend could result in environmental harm; or • three consecutive measurements exceed trigger values.	See **Section 6.4** for discussion on site water quality results against trigger levels.
	Data management and reporting: • establishment of trigger levels; • quarterly review of groundwater levels and field water quality against trigger levels, with site specific investigations initiated; and • all groundwater data being stored in a database customised for MTW with suitable QA/QC controls.	Trigger levels presented in **Section 5.3**. Quarterly reviews conducted as part of routine groundwater monitoring by external contractors AECOM. Data stored within database held by Yancoal.
	Licensing: • retain and obtain appropriate water licences, as required, to account for modelled take.	**Section 2.3**

Groundwater monitoring is to be conducted in accordance with the Groundwater Monitoring Program (GMP) outlined within Appendix C of the WMP. The program outlines groundwater monitoring frequency, parameters to be tested and groundwater triggers for electrical conductivity (EC) and pH. Further discussion on the GMP and triggers is included in **Section 5**.

3 Hydrogeological Setting

This section presents a brief summary of the hydrogeological setting for MTW. This includes discussion on climate, terrain, drainage, geology and groundwater-bearing units.

3.1 Climate, Terrain and Drainage

3.1.1 Climate

The climate of the MTW region can be classed as temperate and is characterised by hot summers and mild dry winters. Rainfall data from the Bureau of Meteorology (BoM) Station 61191 Bulga (South Wambo) was used as this provides the longest record of data in the area from 1959 to present. **Table 3-1** shows the average monthly rainfall calculated since 1959 and for the year 2020.

Table 3-1 Long Term Average and 2020 Climate Data

Rainfall (mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Average Historical	87.0	86.1	67.7	45.9	39.9	43.9	30.6	34.3	38.6	55.0	61.5	73.5	**664.0**
2020 Rainfall	65.4	197.6	130.6	43.0	16.6	30.6	66.2	42.4	45.8	96.6	43.4	192.0	**970.2**

A cumulative rainfall departure (CRD) plot is provided as **Figure 3-1** to illustrate long term climate trends in the MTW area, based on average monthly rainfall data. The CRD graphically shows trends in recorded rainfall compared to long-term averages (1959 to 2020 inclusive) and provides a historical record of relatively wet and dry periods. A rising trend in slope in the CRD graph indicates periods of above average rainfall, whilst a declining slope indicates periods when rainfall is below average. A level slope indicates average rainfall conditions.

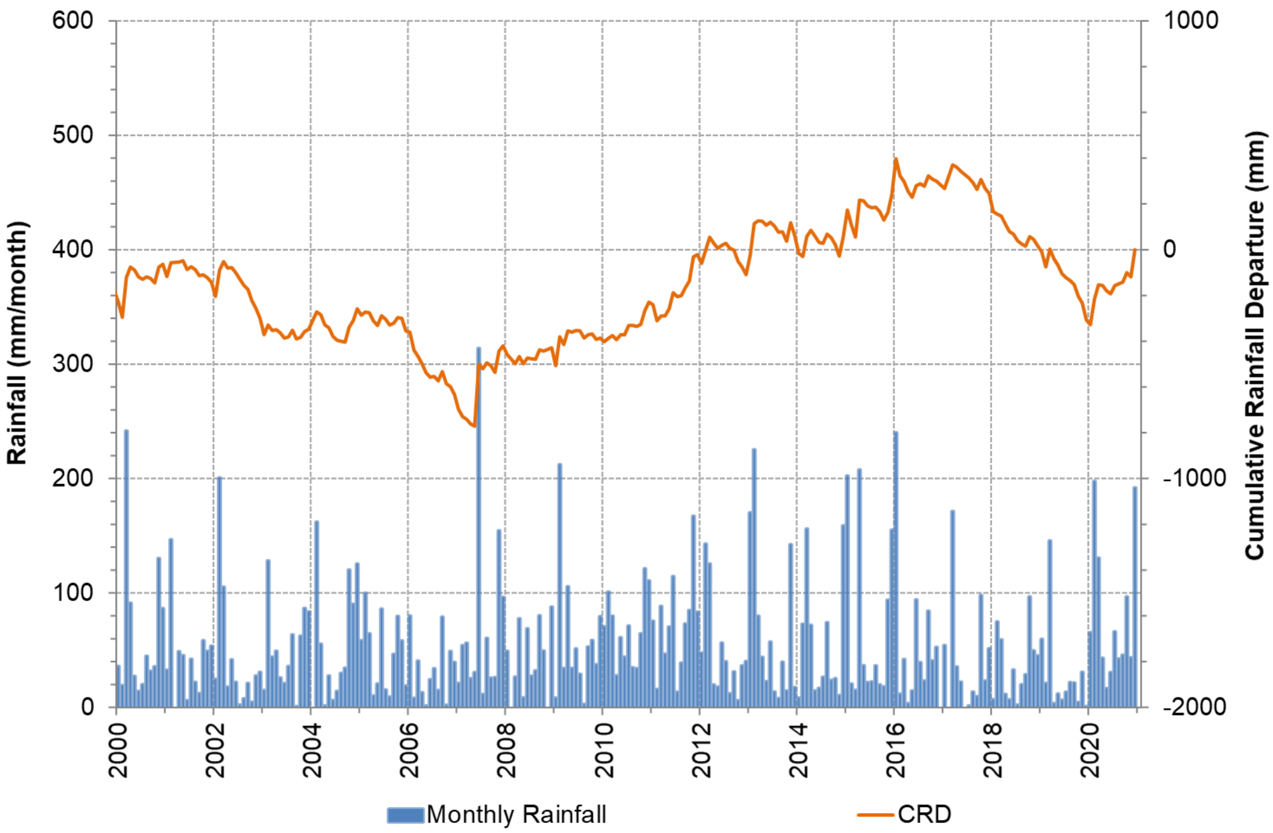


Figure 3-1 Cumulative Rainfall Departure and Monthly Rainfall

As shown in **Figure 3-1**, the region has generally experienced below average rainfall from 2017 to the end of 2019. During 2020, significant above average monthly rainfall was received in February to March and December, leading to increases in the CRD.

3.1.2 Terrain and Drainage

Ground elevations at MTW range between 35 m Australian Height Datum (mAHD) along the Hunter River alluvial plains and 100 mAHD west of MTW. Minor ephemeral drainage features are also present around MTW (i.e. Loders Creek, Sandy Hollow Creek, Doctors Creek), draining into the Hunter River.

Real time stream flow data is monitored along the Hunter River and Wollombi Brook at NSW Department of Primary Industries (DPI) Water gauging stations via the Hunter Integrated Telemetry System (HITS). Time series river water elevations (mean level above zero gauge elevation) is presented in **Figure 3-2** for three HITS stations (Hunter River @ Mason Dieu, Hunter River @ Long Point and Wollombi Brook @ Warkworth).

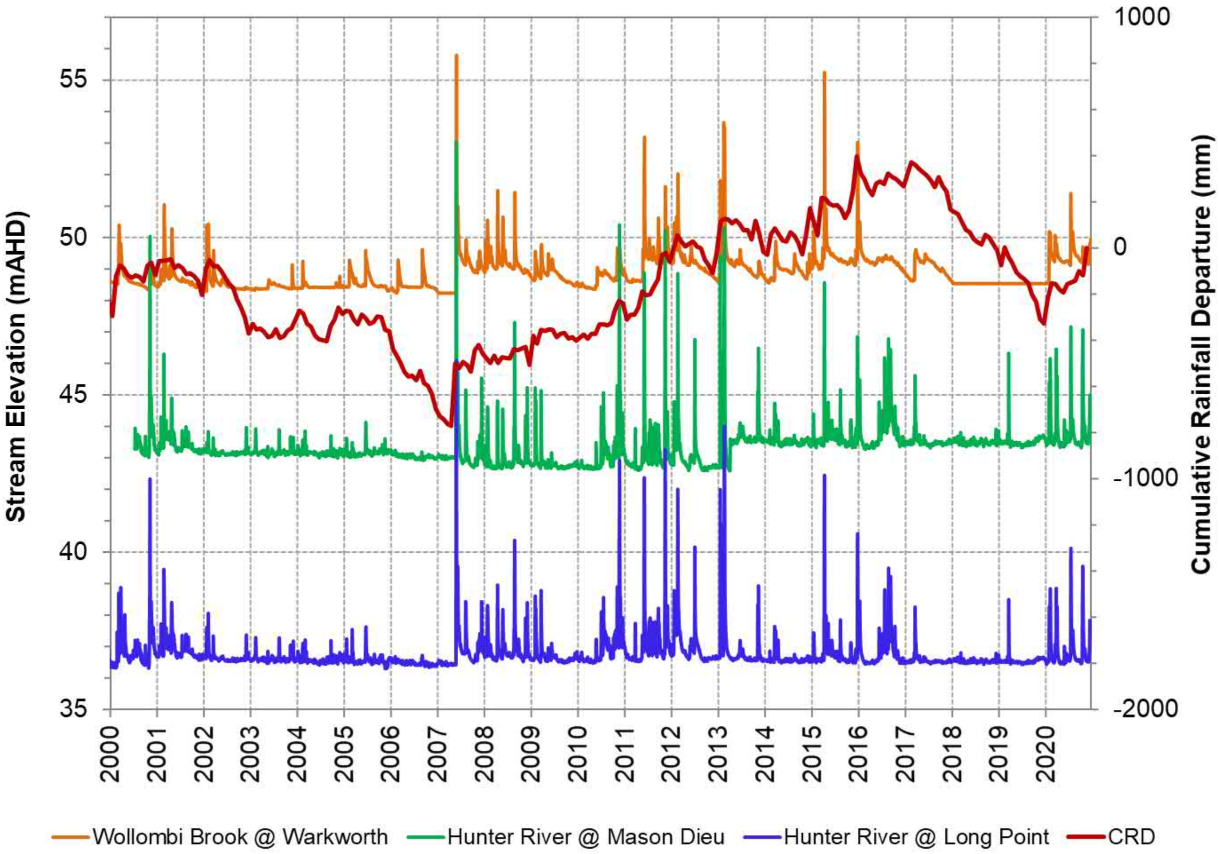


Figure 3-2 Surface Water Levels

As shown in **Figure 3-2**, during 2020 stream elevations within the Hunter River remained generally stable (approximately 36.4 mAHD at Long Point; 43.3 mAHD at Mason Dieu) with the exception of seasonal fluctuations (up to approximately 40.0 mAHD at Long Point and 47.0 mAHD at Mason Dieu) in response to rainfall events. Glenbawn Dam is located approximately 135 km upstream of the project area. Daily regulated releases of the dam storage are undertaken to maintain flow and environmental quality of the Hunter River.

Figure 3-2 shows that during 2020, stream elevations within Wollombi Brook fluctuated within a range from approximately 48.5 mAHD to 51.0 mAHD. The zero gauge for Warkworth station (Station 210004) is set at 47.755 mAHD, meaning that water levels were recorded mostly from 1-3 m above the zero gauge in 2020. In contrast to the previous year where no flows were recorded in the Wollombi Brook, stream discharges were recorded from May to December 2020. Time series data of total rainfall against discharge volumes for Wollombi Brook is presented in **Figure 3-3**. A delay in Wollombi Brook discharge can be seen in May 2020 despite the significant rainfall received from January to March 2020. This delayed response is likely related to initial recharge to the lowered water table in the alluvium occurring before any significant stream flow can follow.

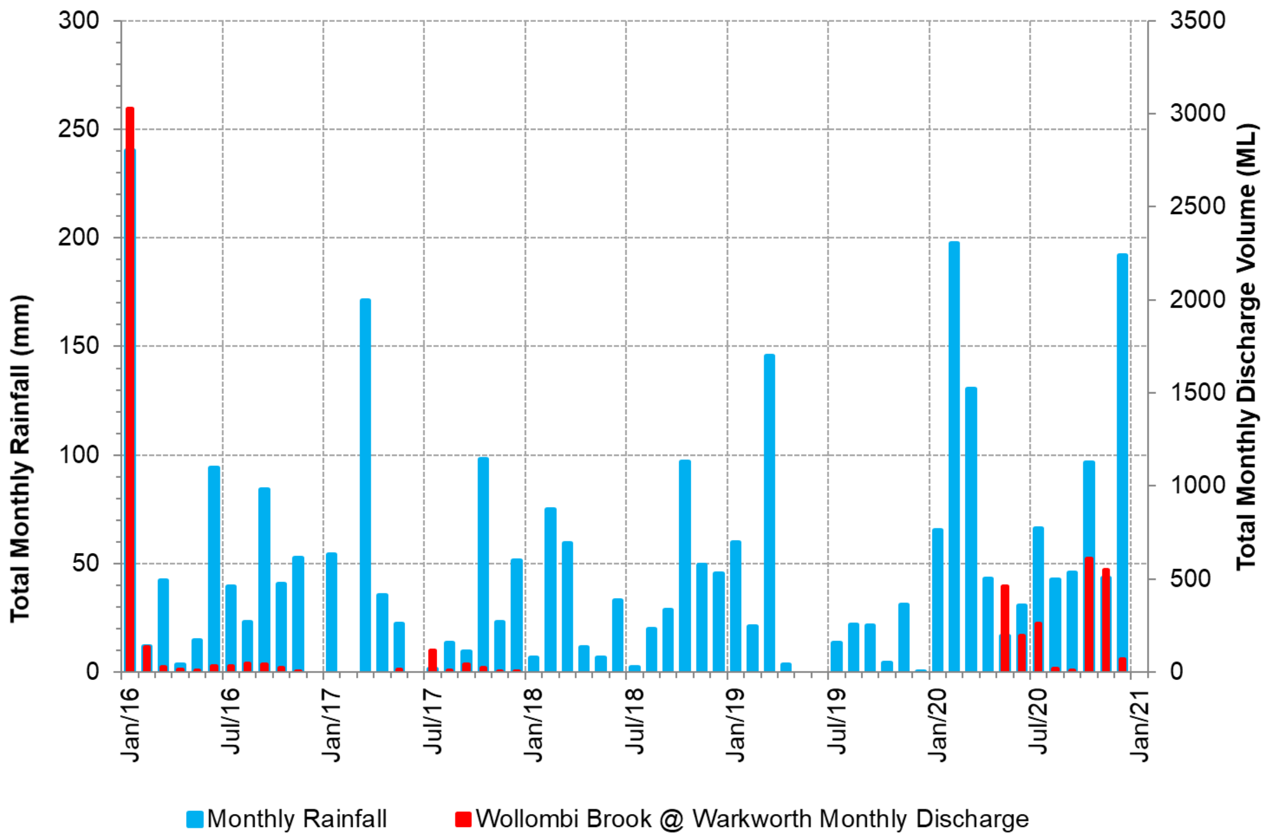


Figure 3-3 Wollombi Brook Monthly Surface Water Flow Volumes vs Monthly Rainfall

3.2 Geology

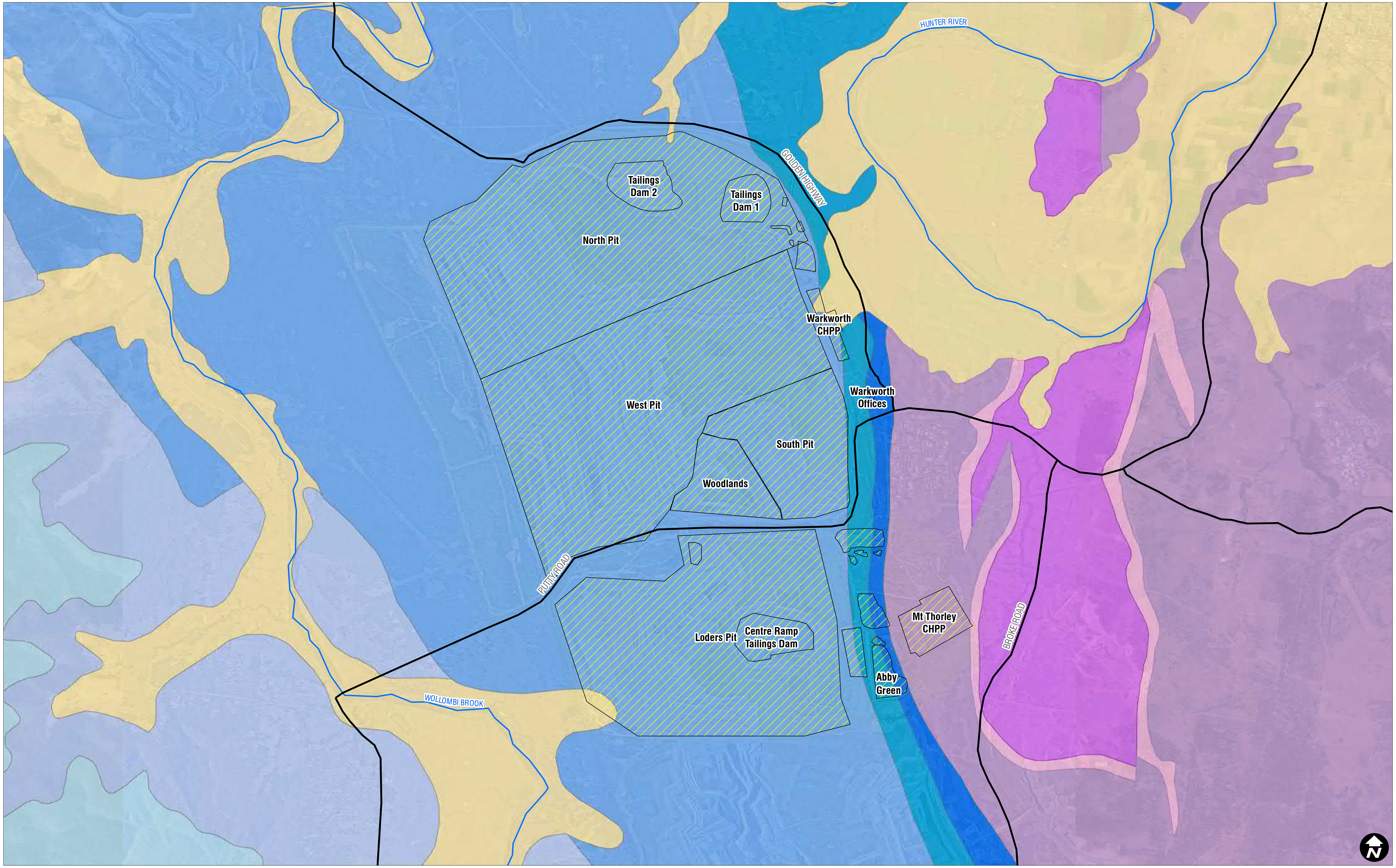
MTW lies within the Hunter Coalfields, which are dominated by the Permian aged Whittingham Coal Measures of the Sydney Basin. The Whittingham Coal Measures are made up of the Jerrys Plains Sub-group and Vane Sub-group. These units comprise economic coal seams along with overburden and interburden consisting of sandstone, siltstone, tuffaceous mudstone and conglomerate. The Whittingham Coal Measures are truncated to the east by the Hunter-Mooki Thrust Fault and occur at MTW as stratified (layered) sequences that dip at a shallow angle (2° to 5°) to the south-west. The coal seams subcrop to the east of MTW.

Along the Hunter River and Wollombi Brook thin Quaternary alluvial deposits unconformably overlie the Permian strata. The alluvial deposits comprise surficial fine-grained sediments (i.e. silts and clays). Along major watercourses (i.e. Hunter River and Wollombi Brook) the surficial sediments overlie basal sands and gravels.

Table 3-2 presents a summary of site geology and **Figure 3-4** presents a map of the geology of the MTW site and surrounds.

Table 3-2 MTW Generalized Stratigraphy

Age	Stratigraphic Unit		Description
Cainozoic	Quaternary sediments - alluvium (Qa)	Surficial alluvium (Qhb)	Shallow sequences of clay, silty sand and sand.
		Productive basal sands/gravel (Qha)	Basal sands and gravels along major watercourses (i.e. Hunter River).
	Silicified weathering profile (Czas)		Silcrete
	Alluvial terraces (Cza)		Silt, sand and gravel
Jurassic	Volcanics (Jv)		Flows, sills and dykes
Permian	Whittingham Coal Measures	Jerrys Plains Sub-group (Pswj)	Coal bearing sequences interbedded with sandstone and siltstone. Coal seams (youngest to oldest) include Whybrow Seam, Redbank Creek Seam, Wambo Seam, Whynot Seam, Blakefield Seam, Glen Munro Seam, Woodlands Hill Seam, Arrowfield Seam, Bowfield Seam, Warkworth Seam, Mt Arthur Seam, Piercefield Seam, Vaux Seam, Broonie Seam and Bayswater Seam.
		Archerfield Sandstone	Lithic sandstone marker bed.
		Vane Sub-group (Pswv)	Coal bearing sequences interbedded with sandstone and siltstone. Coal seams (youngest to oldest) include Lemington Seam, Pikes Gully Seam, Arties Seam, Liddell Seam, Barrett Seam and Hebden Seam.



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- Main road
- Major watercourses
- MTW Infrastructure

Hunter Coalfields 100k Geology
- Qa - Quaternary Alluvium
- Rn - Narrabean Group
- Psl - Newcastle Coal Measures
- Pswj - Jerrys Plains Subgroup
- Pms - Muree Sandstone
- Pswv - Archerfield Ss. Vane Subgroup
- Pswc - Saltwater Creek Formation
- Pmm - Mulbring Siltstone
- Pmb - Branxton Formation

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Surface Geology

Figure 3-4

4 Groundwater Units

The principal groundwater units at MTW and its immediate surrounds are the productive alluvium associated with the Hunter River and Wollombi Brook, the Permian coal seams of the Whittingham Coal Measures and associated regolith material. Description of the groundwater units was derived from historical groundwater assessment reports, discussed in **Section 2.2**.

4.1 Regolith

Regolith material has been identified in the east of the project area overlying the Permian coal measures to depths of around 5 m. The material is clay rich comprising clays, sandy clays and minor clayey sands with permeability ranging from approximately 3.3×10^{-5} m/day to 9.5×10^{-3} m/day. The material has previously been categorised as alluvium. The regolith is recharged by rainfall infiltration and potential seepage from mine infrastructure.

4.2 Alluvium

The Quaternary alluvium is an unconfined groundwater system that is recharged by rainfall infiltration, streamflow and upward leakage from the underlying stratigraphy, particularly in undisturbed areas (i.e. away from active mining). The potentiometric surface and flow direction within the alluvium is a subdued reflection of topography. Groundwater within the Hunter River alluvium flows in a southerly direction, while water within the Wollombi Brook alluvium flows in a north to north-easterly direction towards the Hunter River.

Regionally, the Hunter River and Wollombi Brook are predominantly gaining water from the surrounding alluvium, as well as from rainfall and regulated flow (i.e. dam releases). However, there are also areas where the rivers recharge the underlying alluvium. These losing conditions can occur around areas of active mining, where the hydraulic gradient is increased due to depressurisation of the underlying coal measures. Losing conditions also occur within the more topographically elevated tributaries of the main water courses, where the water table is deeper and not connected directly to the streams.

While “less productive” groundwater within the surficial alluvium (Qhb **Table 3-2**) does not meet the ANZECC & ARMCANZ (2000) water quality guidelines for stock water supply, the “highly productive” alluvium (basal sands and gravels (Qha **Table 3-2**)) is considered suitable for stock water supply from a water quality perspective. However, most agricultural producers (crop and cattle) utilise surface water resources (Hunter River and Wollombi Brook) in preference to alluvial groundwater.

Aeolian sands referred to as the Warkworth Sands are present north to north-west of North Pit, and within a small area to the south-west of Loders Pit. The Warkworth Sands comprise fine-grained sands to a thickness of approximately 3 m. The unit overlies clay rich regolith material, which apparently forms a perched aquifer recharged from rainfall infiltration (AGE, 2014a). The Warkworth Sands supports woodland (Warkworth Sands Woodland), which is classified as an Endangered Ecological Community (EEC) under the *Threatened Species Conservation Act* 1995 and Critically Endangered (CE) under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

4.3 Permian Coal Measures

The Whittingham Coal Measures outcrop across the north to east of MTW. The coal measures form unconfined groundwater systems at outcrop, becoming semi-confined to confined as they dip towards the south-west.

Recharge occurs from direct rainfall to the ground surface, infiltrating into the formations through the thin soil cover and weathered profile. The coal measures also occur at subcrop in localised zones beneath alluvium associated with the Hunter River and Wollombi Brook, where the unit is recharged by downward seepage where gradients promote this flow.

The coal seams are typically moderately to slightly permeable, whilst the hydraulic conductivity of the interburden material is generally less than coal seams but is more variable, depending on the predominance of fractures in the rock mass. The hydraulic conductivity of the coal seams generally decreases with depth due to the closure of the cleats with increasing stratigraphic pressure. Conglomerates and weathered sandstone can be present to depths of around 16 m, with hydraulic conductivity of approximately 1.2×10^{-3} m/day to 9.5×10^{-2} m/day.

The direction of groundwater flow for the Whittingham Coal Measures is influenced by the local geomorphology and structural geology, as well as the long history of mining within the region which has significantly altered groundwater flow paths within the Permian units. Groundwater flow in the Permian aquifers on a regional scale follows the regional topography, flowing in a north-easterly direction. However, on a local scale groundwater levels show drawdown impacts associated with the extensive active mining areas. Groundwater discharge from the Whittingham Coal Measures currently occurs as discharge to active mining and abstraction bores, as well as upward seepage to the Quaternary alluvium where hydraulic gradients promote this flow.

There is no significant usage of groundwater from the Permian coal measures, likely due to:

- Poor water quality that generally exceeds ANZECC & ARMCANZ (2000) water quality guidelines for stock supply;
- The presence of perennial surface water flows (Hunter River and Wollombi Brook); and
- The more productive alluvial aquifer.

5 Groundwater Monitoring

5.1 Groundwater Monitoring Program

Groundwater monitoring is conducted at MTW in accordance with the MTW WMP. The monitoring results are used to establish and monitor trends in physical and geochemical parameters of surrounding groundwater potentially influenced by mining.

The monitoring program at MTW measures the Standing Water Level (SWL) in monitoring bores, reported as groundwater elevations (mAHD). The data is compared against background data, EIS predictions and historical trends as a means of assessing MTW related impacts to the quantity of groundwater in the various aquifers. The monitoring program at MTW also assesses the quality of groundwater against background data and historical trends. Groundwater quality is evaluated through the parameters of pH and EC. On a periodic basis (nominally once per annum) a comprehensive suite of analytes is measured, including major anions, cations and metals. Prior to sampling for comprehensive analysis, bore purging is undertaken to ensure a representative sample is collected.

Groundwater quality monitoring data is reviewed on a quarterly basis. The review involves a comparison of measured pH and EC results against internal trigger values which have been derived from the historical data set. Trigger limits are calculated as the 95th percentile maximum value (EC and pH) and the 5th percentile minimum value (pH only) from data collected since 2011. Trigger levels have been set based on target stratigraphy. A site specific investigation will be initiated where three consecutive measurements of EC or pH exceed trigger values or where professional judgement determines that a single deviation or a developing trend could result in environmental harm.

The groundwater monitoring network has been installed progressively over the life of the operations at MTW and acquired through land purchase. In relation to the WMP the groundwater monitoring network at MTW comprises 60 open standpipe bores installed into various geologic units. As outlined within the WMP, bores are grouped based on geology, as summarised below:

- Regolith;
- Hunter River alluvium;
- Wollombi Brook alluvium;
- Aeolian Warkworth Sands;
- Whittingham Coal Measures:
    - Redbank Seam;
    - Wambo Seam;
    - Blakefield Seam;
    - Woodlands Hill Seam;
    - Bowfield Seam;
    - Warkworth Seam;
    - Vaux Seam; and
    - Bayswater Seam.

- Shallow Overburden

In addition, 20 vibrating wire piezometers (VWPs) with a total of 80 sensors are present across the site. Only 10 of the 20 VWPs are listed in Table 1 of the groundwater monitoring programme. However, based on discussion with site personnel and review of the data it is understood some of the VWP sensors may not be fully operational due to a range of factors (i.e. batteries and age). Details of each of the MTW monitoring bores as well as each bore's respective monitoring program are provided in **Appendix A** and the location of the bores are presented in **Figure 5-1**.

In Q4 2019 and Q1 2020 an additional four VWPs were installed at MTW as part of ongoing site investigations. These bores are not included within the compliance network within the WMP, but details on the bores are presented in **Table 5-1** below for background reference. It is recommended that new VWPs should be reviewed and added to the WMP compliance network where appropriate.

Table 5-1 2020 VWP Construction Details Summary

Bore ID	Easting(s) GDA94 z56	Northing(s) GDA94 z56	Ground RL (m AHD)	Sensor Depth (m bTOC)	Target Aquifer	Comments
WD660_P1	314483	6388918	67.09	508.98	Bayswater Floor	Installed on 15th November 2019. P2 - Gradual increase in pressure from December 2019 onwards. Pressure drop prior to December 2019 likely due to cement grout curing/setting. Groundwater pressures in P2 slowly building up to equilibrium.
WD660_P2				476.98	Bayswater Seam	
WD660_P3				434.98	Vaux / Broonie Interburden	
WD660_P4				407.98	Vaux Seam	
WD660_P5				363.98	Mt Arthur Seam	
WD660_P6				245.49	Woodlands Hill Seam	
WD660_P7				121.99	Wambo Seam	
WD662_P1	315437	6387859	72.65	495.99	Bayswater Floor	Installed 19th January 2020. P4 – Gradual increase in pressure from 20th February 2020 but now stable. Significant decrease in pressure since October 2020. P7 – Failed shortly after installation.
WD662_P2				475.99	Bayswater Seam	
WD662_P3				457.49	Broonie / Bayswater Interburden	
WD662_P4				401.49	Vaux Seam	
WD662_P5				384.99	Mt Arthur / Piercefield Interburden	
WD662_P6				351.49	Warkworth Seam	
WD662_P7				89.5	Overburden	
WD663_P1	314343	6391971	83.85	432.602	Bayswater Floor	Installed on 31st January 2020. All sensors working.
WD663_P2				416.634	Bayswater Seam	
WD663_P3				389.698	Broonie / Bayswater Interburden	
WD663_P4				346.818	Vaux Seam	
WD663_P5				324.427	Piercefield / Vaux Interburden	
WD663_P6				306.5375	Mt Arthur Seam	

Bore ID	Easting(s) GDA94 z56	Northing(s) GDA94 z56	Ground RL (m AHD)	Sensor Depth (m bTOC)	Target Aquifer	Comments
WD663_P7				266.285	Mt Arthur / Warkworth Interburden	
WD663_P8				236.412	Warkworth Seam	

As outlined in **Appendix A**, full laboratory water quality analysis is required to be conducted for 60 bores, on an annual basis. The full water quality analysis includes:

- Total dissolved solids (TDS);
- Major ions (Ca, Cl, K, Na, SO_4 (or S), CO_3);
- Total alkalinity, bicarbonate alkalinity, carbonate alkalinity, hydroxide alkalinity; and
- Total metals (Al, As, B, Cd, Cu, Hg, Mg, Ni, Pb, Se, and Zn).

Six of the 60 bores are also analysed for total metals Mo, V and Cr, as shown in **Appendix A.** Discussion on the groundwater monitoring network is presented in **Section 6**.

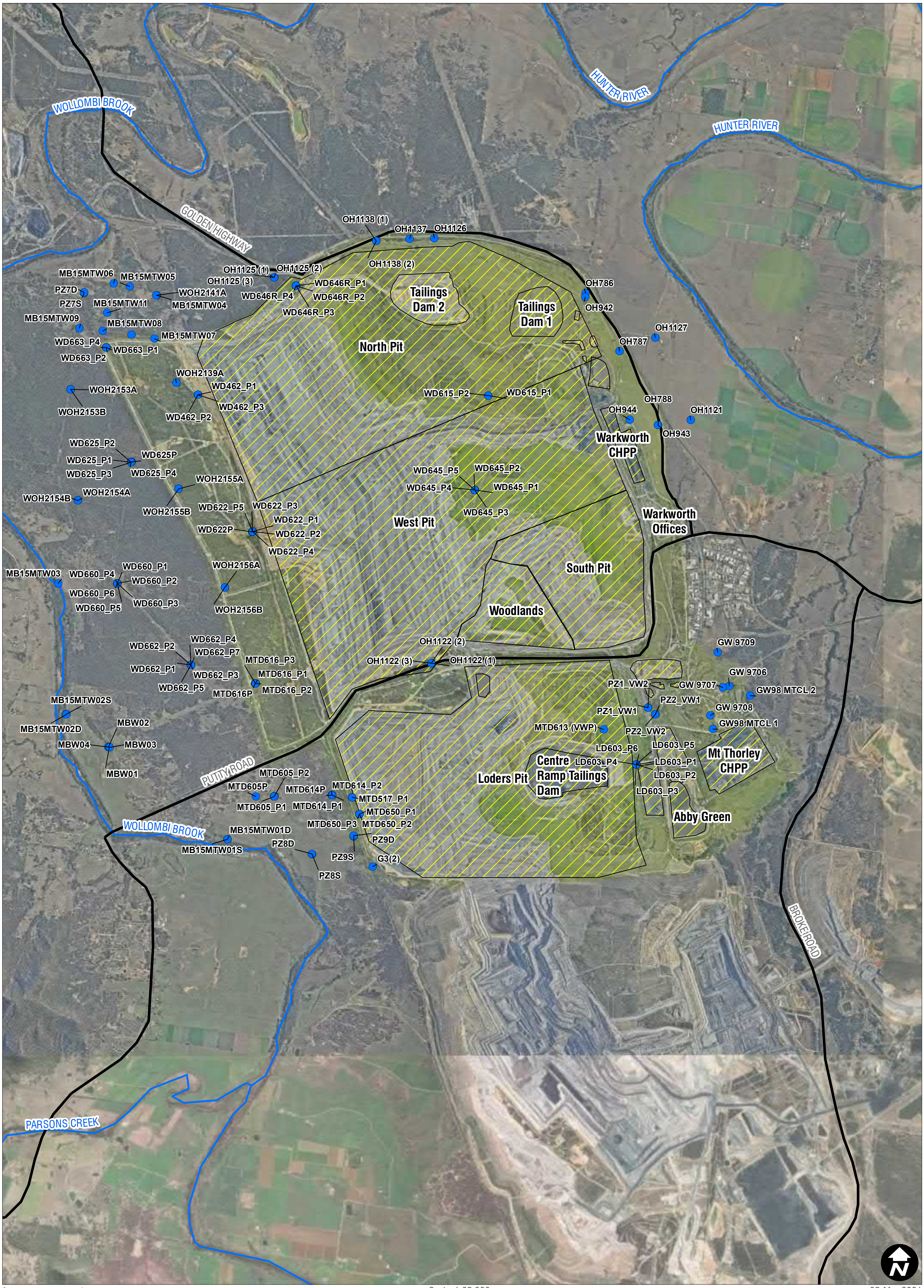
5.2 Groundwater Monitoring Methodology

MTW engages field contractors AECOM to carry out sampling and analysis. Sampling is required to be undertaken in accordance with relevant Australian Standards and other regulatory guidelines. Samples are analysed by laboratories that are National Association of Testing Authorities (NATA) accredited or equivalent for the parameters being analysed.

The WMP states that sampling is to be undertaken in accordance with AS 5667.1:-1998, *Guidance on the Design of Sampling Programs, Sampling Techniques and the Preservation and Handling of Samples and AS 5667.11-1998, Guidance on Sampling of Groundwaters*. Groundwater bores are purged prior to sample extraction for all samples requiring comprehensive laboratory analysis.

From review of the contractors sampling field sheets, it is understood that the quarterly and annual groundwater samples for the majority of bores are collected following purging either by using a Solinist low flow pump or bailer (3x casing volumes where possible) and water levels and field parameters (i.e. EC and pH) monitored. This approach is considered consistent with *AS 5667.1:-1998.* For bores with 25 mm and 32 mm casing, it is understood that the sample is collected following the purging using a bailer with a one-way check valve at the bottom of the bailer. Bores are purged until the field parameters stabilise and then they are sampled.

For the remaining bores (WOH1239A, WOH2141A, WOH2153A, WOH1254A, WOH2155A, WOH2156A, WD622P, MBW02 and MBW03) it is understood that the quarterly and annual groundwater samples are collected as grab samples using a disposable bailer. As outlined within *AS 5667.11-1998*, mineral material can accumulate within boreholes. Therefore, to collect representative groundwater samples the bore should be purged (4 to 6 times the well volume) and water quality parameters stabilised before sampling.



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Scale: 1:65,000
GDA 1994 MGA Zone 56

05-Mar-2021

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Groundwater Monitoring Points
Main Roads
Major Watercourses
MTW_Pits

Sheet Size : A4

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Mt Thorley Warkworth
2020 Annual Groundwater Review
Groundwater Monitoring Network

Figure 5-1

5.3 Groundwater Triggers

The WMP includes groundwater assessment criteria, including water quality trigger levels for investigating potentially adverse groundwater impacts. Trigger levels were initially revised in the March 2016 version of the WMP and were established based on the 95th percentile of baseline data for EC and based on the 5th and 95th percentiles for pH. The trigger levels as presented in the 2020 revised WMP are summarised in **Table 5-2**.

Groundwater quality measurements from the site monitoring bores have been compared to the relevant trigger levels in **Section 6.4**.

Table 5-2 Groundwater Quality Triggers Based on Monitoring Location

Location	Target Seam/ Stratigraphy	EC (95th) µS/cm	pH (5th)	pH (95th)
OH786	Regolith*	1,311	6.7	7.7
OH787	Regolith*	18,467	7.2	7.7
OH788	Hunter River Alluvium	12,234	7.0	7.9
OH942	Regolith*	25,435	6.5	6.9
OH943	Hunter River Alluvium	8,395	7.1	7.6
PZ7S	Aeolian Warkworth Sands	1,749	6.7	7.5
PZ8S	Wollombi Brook Alluvium	15,086	6.5	7.0
PZ9S	Wollombi Brook Alluvium	16,197	6.8	7.0
PZ7D	Shallow Overburden	17,488	6.8	8.0
PZ8D	Shallow Overburden	17,488	6.8	8.0
PZ9D	Shallow Overburden	17,488	6.8	8.0
MTD616P	Shallow Overburden	17,488	6.8	8.0
MTD614P	Shallow Overburden	17,488	6.8	8.0
MBW02	Shallow Overburden	17,488	6.8	8.0
MB15MTW01D	Shallow Overburden	17,488	6.8	8.0
MTD605P	Shallow Overburden	17,488	6.8	8.0
MB15MTW02D	Shallow Overburden	17,488	6.8	8.0
MB15MTW03	Shallow Overburden	17,488	6.8	8.0
WD625P	Woodlands Hill / Whybrow	12,086	7.1	7.3
WOH2153A	Redbank	15,948	7.0	7.9
WOH2154A	Redbank	15,948	7.0	7.9
WOH2155A	Redbank	15,948	7.0	7.9
WOH2156A	Redbank	15,948	7.0	7.9
WOH2153B	Wambo	14,080	7.0	7.8
WOH2154B	Wambo	14,080	7.0	7.8
WOH2155B	Wambo	14,080	7.0	7.8
WOH2156B	Wambo	14,080	7.0	7.8
WD622P	Wambo	14,080	7.0	7.8

Location	Target Seam/ Stratigraphy	EC (95th) µS/cm	pH (5th)	pH (95th)
MBW04	Wambo	14,080	7.0	7.8
WOH2139A	Blakefield	15,106	6.6	7.9
OH1122 (1)	Blakefield	15,106	6.6	7.9
OH1125 (1)	Blakefield	15,106	6.6	7.9
OH1125 (3)	Bowfield	14,656	6.6	6.9
OH1138 (1)	Warkworth	19,995	6.0	7.0
OH1138 (2)	Warkworth	19,995	6.0	7.0
OH1121	Vane Subgroup†	17,765	6.7	7.1
OH1126	Vaux	17,765	6.7	7.1
OH1137	Vaux	17,765	6.7	7.1
OH1127	Vane Subgroup†	23,000	6.6	7.5
GW 9706	Bayswater	23,000	6.6	7.5
GW 9707	Bayswater	23,000	6.6	7.5
GW 9708	Bayswater	23,000	6.6	7.5
GW 9709	Bayswater	23,000	6.6	7.5
GW98MTCL1	Bayswater	23,000	6.6	7.5
GW98MTCL2	Bayswater	23,000	6.6	7.5
WOH2141A	Whynot Seam	10,527	7.5	7.8

Note: * *Bore located outside extent of mapped alluvium and bore logs and site geology shows the bore actually intersects regolith material not Hunter River Alluvium as categorised within WMP*

† *Bore located outside extent of mapped Jerry's Plains Subgroup and likely intersects underlying Vane Subgroup as per 1:25k geological mapping*

5.4 Trigger Investigations

No formal trigger investigations were completed in 2020. A review of the monitoring network is however currently being completed In response to recommendations made within the annual review however for 2019, SLR (2020).

6 Monitoring Results

6.1 Data Recovery

6.1.1 Standpipe monitoring bores

Over 2020, groundwater monitoring was carried out at 60 standpipe monitoring bores across MTW. No water level or quality data was collected from ten of the monitoring bores during 2020 due to them being dry. The bores and sites with a data capture rate of less than 100 per cent are outlined in **Table 6-1**.

Table 6-1 Groundwater Monitoring Data Recovery for standpipe bores

Location	Type	Data Recovery	Comments
OH943	WQ	0%	Insufficient water for field test and lab sample – March, June, September and December 2020
OH944	WL and WQ	0%	Bore dry during 2020
PZ9S	WQ	0%	Insufficient water for field test and lab sample – March, June, September and December 2020
MB15MTW04	WL and WQ	0%	Bore dry during 2020
MB15MTW05	WL and WQ	0%	Bore dry during 2020
MB15MTW06	WL and WQ	0%	Bore dry during 2020
MB15MTW07	WL and WQ	0%	Bore dry during 2020
MB15MTW08	WL and WQ	0%	Bore dry during 2020
MB15MTW09	WL and WQ	0%	Bore dry during 2020
MB15MTW10	WL and WQ	0%	Bore dry during 2020
MB15MTW11	WL and WQ	0%	Bore dry during 2020
OH1125 (2)	WL and WQ	0 %	Bore dry during 2020
OH1137	WL and WQ	0%	Bore dry during 2020
WOH2156B	WQ	25%	Insufficient water for lab sample and field test – February, May, and November 2020

6.1.2 VWPs and data loggers

Groundwater levels are recorded by site VWPs and data loggers installed in select monitoring bores. Level data was successfully downloaded from 20 of the VWP sites and 19 of the loggers. Sites where data collection issues have been encountered are outlined in **Table 6-2** and **Table 6-3** for data loggers and VWPs, respectively. Further work to check the VWPs and monitoring bore loggers are working correctly (i.e. check / replacing batteries and logger depths) is ongoing.

Table 6-2 Logger Data Recovery

Bore ID	Serial Number	Comments
PZ8S	2118429	New logger installed in June 2020. No issues so far.

Bore ID	Serial Number	Comments
PZ8D	2118425	New logger installed in June 2020. No issues so far.
PZ9S	2053704	Water level was below base of logger in 2019. Logger appears to have been lowered (previous wire length was 6.26 m – currently at 6.80 m).
PZ7S	2016488	Errors in readings from May 2020 onwards, likely faulty logger. Recommend replacing logger.
PZ7D	2053695	2019 data did not match manual dip measurements. It was suspected that the logger install depth may be different to the reported depth – further investigation confirmed wire length of 10.80 m matches records. Manual dip measurements matches logger data in 2020.
MB15MTW02S	2053694	2019 data did not match manual dip measurements. It was suspected that the logger install depth may be different to the reported depth – further investigation confirmed wire length of 10.04 m does not match 9.90 m on record; however, a logger install depth of 9.71 m provides the most accurate match for 2020 data when applied to 21 November 2019 onwards.
MB15MTW02D	2039901	Erroneous data from old logger from June 2018 to February 2020. New logger installed on 17 March 2020. Appears to be working fine with manual dips matching.

Table 6-3 VWP Data Recovery

Location	Sensor (s)	Comments
WD622	1 to 5	Data erroneous prior to June 2020. VWP interface replaced on 25 June 2020 and all sensors now logging.
PZ2	1 & 2	No longer exists.
MTD605	5 & 6	Sensor 5 data erroneous from January 2020 – otherwise rest of 2020 data is fine. Sensor 6 data erroneous from 23/06/19 – potential sensor failure. Recommend replacement.
MTD613	2	No data from sensor 2. Investigate if sensor 2 has ever been installed.
MTD614	3 to 5	Data erroneous – potential sensor failure.
MTD650	1 to 5	Frequent erroneous data records for all sensors. No access to site in November 2020 as too close to high wall, so data until April 2020.
WD609A	1	Pre-2019 data appears highly fluctuating. Some erroneous trends and fluctuations until 2019. 2020 data mostly appears fine but gradual declining trend observed.
WD645	1 & 5	Frequent data errors from March 2020 onwards. Recommend replacement/ removal of sensor 1 and further investigation and possible replacement/ removal of sensor 5.
WD646R	2 & 5	Frequent erroneous data since installation in sensor 2. Recommend replacement/ removal. Frequent errors were observed in sensor 5 prior to September 2020, but only occasional error after this date – further investigation recommended.
WD662	7	Sensor 7 failed shortly after installation. Recommend replacement/ removal.
WD462	1 to 3	Sensor data does not appear to be collected anymore.
PZ1	1 & 2	Sensor 2 logger replaced in June 2019. Sensor 1 and 2 depths and calibration details unknown

6.2 Monitoring network review

Overall, the current monitoring network and program is generally adequate for satisfying current monitoring requirements of the WMP. There is good spatial coverage of monitoring locations across the site, with multiple bores and VWP sensors installed into each relevant aquifer unit when taken into account the installation of additional VWPs in 2019 and 2020. It is recommended that the Groundwater Management Plan be updated to incorporate these additional VWPs, remove destroyed/erroneous monitoring points and to more clearly identify the purpose of each bore based on its location and construction. Compliance conditions should also be updated to align with the revised network and identified purpose of bores.

6.3 Water Levels

A summary of the water level results is provided for each of the main water bearing units (regolith, alluvium and Permian coal measures) below. Routine water level readings for 2020 are presented in **Appendix B**.

6.3.1 Regolith

In the 2018 annual environmental monitoring report (SLR, 2019) a review of the construction depths for bores previously identified as intersecting the Hunter River Alluvium in the WMP was undertaken. The review found that three bores (OH786, OH787 and OH942) are in fact screened within regolith material, i.e. surficial clays and shallow, deeply-weathered Permian coal measures.

Over 2020, groundwater within the regolith bores occurred at depths of between 0.27 m and 14.03 m below top of casing (mbTOC). **Figure 6-3** presents the historical groundwater levels for all three regolith bores, along with rainfall trends (CRD) and stream elevations recorded at the Hunter River stream gauges at Mason Dieu and Long Point.

The greatest fluctuations in groundwater elevation were recorded for bore OH786 with a total bore depth of 7.1 m bgl, which intersects the shallow regolith east of TD1 and Dam 1N. Groundwater elevations within OH786 have fluctuated over time but generally show a decline since 2016. This may relate to climate trends and reduced rainfall recharge, or potentially relate to cessation of storage within TD1 from 2012 and water storage in Dam 1N. Historical water levels in this bore have indicated that in periods of above average rainfall, the magnitude of fluctuations is less (e.g. 2007 to 2012). After 2012, although the CRD slopes upwards, the period from 2012 to 2016 was not as wet as the previous 6 years – degree of fluctuation in groundwater levels became larger – indicating insufficient recharge to the bore. OH786 appears to have been dry most of the time from 2017 to 2019 which corresponded to the negative slope in CRD (i.e. drought). Groundwater elevations have rebounded during 2020; however, there is still consistently insufficient water in the bore after purging to sample for the full suite of analytes. The last full suite analysis was undertaken in June 2016. It is therefore recommended that the monitoring methodology be reviewed along with bore logs to devise the most appropriate method for attaining water quality samples. It is also recommended that a data logger be deployed to better understand groundwater level fluctuations in the regolith and potential influences from surface water and water storages.

OH787 exhibited a decreasing trend in groundwater elevation during 2020, despite the above average rainfall received early and later in the year. There appears to be historical influence from pumping of nearby bores (large drawdown fluctuations from 2007 to 2010) and a lack of response or delayed response to rainfall. This is possibly due to the lack of connection with alluvium and low permeability of the weathered material in which this bore is screened (identified in SLR, 2019).

Similar to OH787, OH942 has declined in water level over the long term (since 2014), with minor seasonal fluctuations as a delayed response to recharge. Over 2020, despite the above average rainfall, only a 2 cm rise in groundwater level occurred between March 2020 and June 2020, before a decline in groundwater level continued (an additional 9 cm of decrease from June to December 2020).

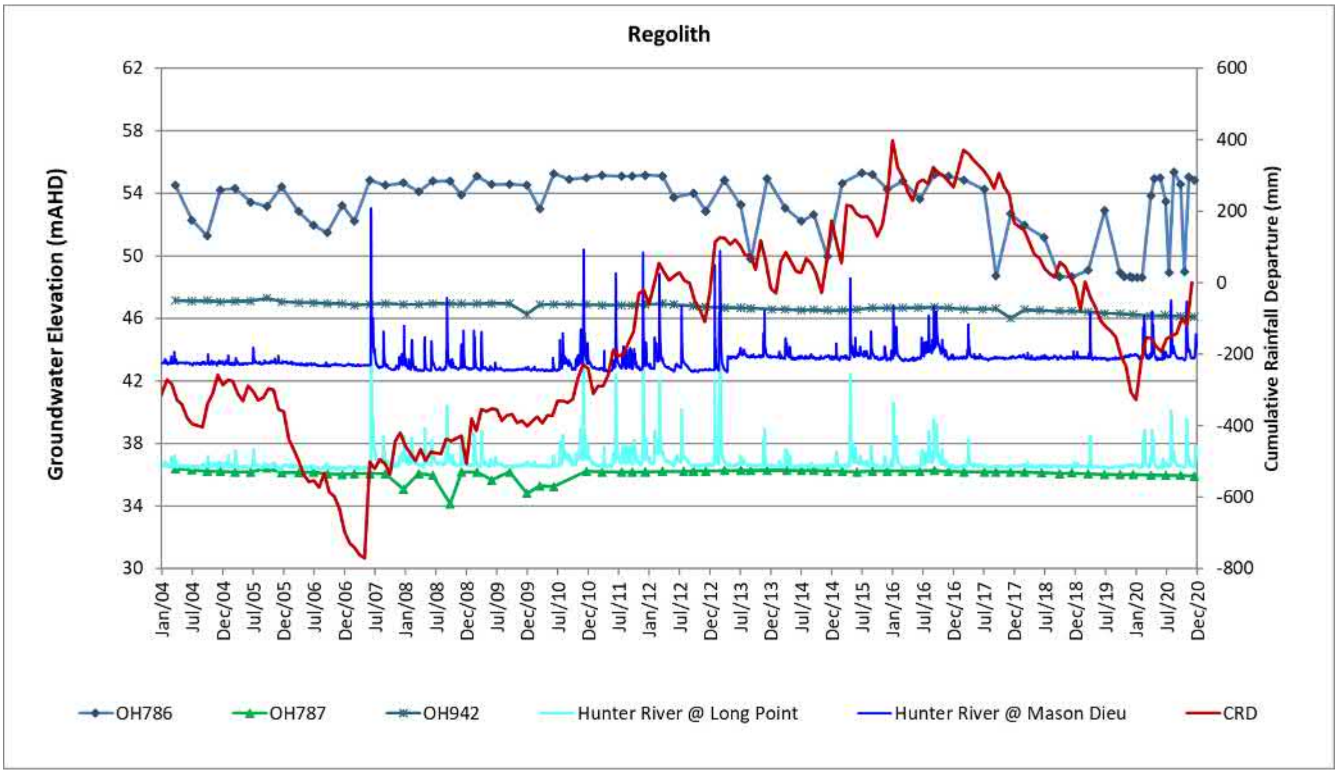

Figure 6-1 Groundwater Levels – Regolith

6.3.2 Alluvium

Groundwater level trends are discussed below for the Warkworth Sands, alluvium along the Hunter River and alluvium along Wollombi Brook.

6.3.2.1 Warkworth Sands

Bores within the Warkworth Sands include PZ7S and MB15MTW04 to MB15MTW11. All bores within the Warkworth Sands are equipped with dataloggers that are set to record groundwater levels on a four-hourly basis with the exception of PZ7S which is six-hourly. Levels recorded using loggers were compensated using barometric levels recorded at the MTW site at hourly intervals. The hourly readings are currently not taken 'on the hour', e.g. at 3:45:31am. It is recommended to set these readings to match all other loggers. It is worth noting that barometric levels used to compensate the 2018 data was sourced from the neighbouring Bulga Mine which resulted in a degree of 'noise' in the readings.

Bore PZ7 is a nested bore of two separate standpipes, with PZ7S constructed within the Warkworth Sands to 11.1 m depth bgl (screened internal unknown), and PZ7D constructed within the shallow overburden material to a total depth of 30.5 m bgl (screened interval unknown). Historical water level data for the bores is presented in **Figure 6-2**. **Figure 6-2** shows that groundwater elevations within the coal measures at PZ7D have historically been slightly higher than levels in the overlying Warkworth Sands, indicating a potential upward gradient. Between 2016 and 2019 this gradient has reduced, with levels within the Warkworth Sands and shallow overburden showing similar elevations and longer-term declining trends. **Figure 6-2** shows that during 2020 groundwater levels within the Warkworth Sands and shallow overburden material at PZ7S and PZ7D, respectively started to recover, likely in response to above average rainfall received in February and March 2020. A delayed recovery response is seen in the manually measured water level at PZ7S. The data collected by the logger in PZ7S was erroneous from June 2020 onwards; therefore, the short-term water level response to rainfall was not able to be examined. As recommended in the previous annual review, further investigation into the local ground conditions bore construction details and condition of the nested bore should be undertaken, to understand the interaction between the two bore depths. The logger in PZ7S should be replaced with an operating logger.

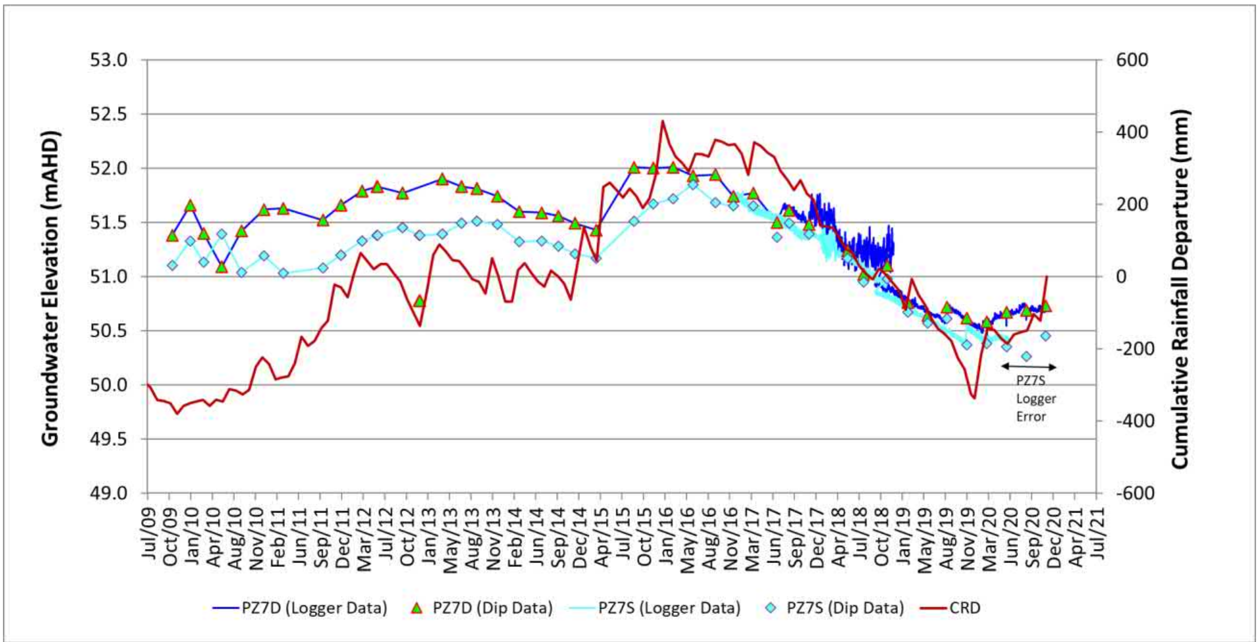

Figure 6-2 Groundwater Levels – Warkworth Sands Bore PZ7S and PZ7D

Bores MB15MTW04 to MB15MTW11 were generally recorded as dry since construction in 2016, as such no hydrographs have been created. An exception to this was bore MB15MTW06, which has historically shown a groundwater level response to rainfall events. Bore MB15MTW06 was recorded as dry throughout 2019 and 2020, which generally corresponds with the below average rainfall recorded between 2016 and 2019. With likely above average rainfall conditions following those observed in 2020, MB15MTW06 may yield water again. Close monitoring of this bore should be maintained.

6.3.2.2 Hunter River Alluvium

Three bores within the monitoring network intersect alluvium along the Hunter River, including OH788, OH943 and OH944. During 2020, bore OH944 was dry, with water levels recorded at or below the base of the bore. According to available bore construction details, bore OH944 is 8.2 m deep and historical monitoring records indicate that the bore has often been dry or had insufficient water present to sample since 2011.

Of the bores with water present, alluvial groundwater levels were measured at depths of between 9.65 m and 10.06 mbTOC during 2020. **Figure 6-3** presents the historical groundwater elevations for all three Hunter River alluvium bores, along with rainfall trends (CRD) and stream elevations recorded at the Hunter River stream gauges at Mason Dieu and Long Point. As shown in **Figure 6-3**, groundwater levels have remained relatively stable at bores OH788 and OH943 since monitoring commenced in 2004, with less than 0.5 m variation in levels recorded. The very slight decline in water level observed between early 2017 and late 2019 for both bores has been attributed to below average rainfall received in the same period. This declining trend appears to have stabilised as a result of above average rainfall received in 2020 and water levels are beginning to recover since December 2020. There appears to be minor correlation between CRD and water levels in MB15MTW01S and MB15MTW02S – especially when assessed together with river elevations. Higher frequency of above average rainfall (seen as a steeper positive trending CRD) and frequent river flows correlate well with periods of peak groundwater levels (e.g. March 2012 and June 2013). Less frequent above average rainfall (seen as a gradual positive trending CRD) and less frequent river flows result in lower magnitude of groundwater rise (e.g. March 2016). As recommended in the previous annual review, the construction and geology at the two bores should be reviewed to verify whether their target geology is alluvium or weathered Permian coal measures.

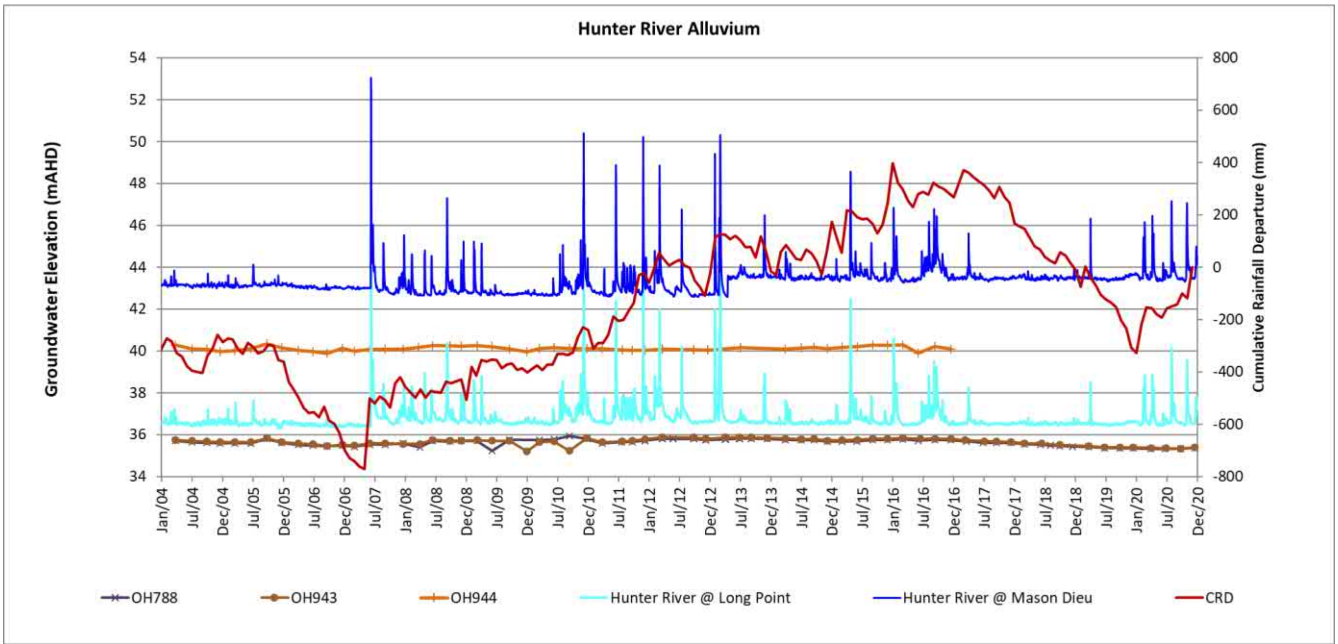

Figure 6-3 Groundwater Levels – Hunter River Alluvium

6.3.2.3 Wollombi Brook Alluvium

Five bores intersect the alluvium along the Wollombi Brook: G3, PZ8S, PZ9S, MB15MTW01S, and MB15MTW02S. Each of these bores are nested sites with two separate standpipes in separate boreholes, the shallower screened in the alluvium, the deeper in the underlying overburden material of the Permian coal measures.

Groundwater elevation trends for bores west of MTW (MB15MTW01 and MB15MTW02) are presented in **Figure 6-4,** which includes rainfall trends (CRD) and stream elevations for Wollombi Brook as recorded at Bulga. Groundwater levels at the two locations are recorded with data loggers and manual dip readings. It should be noted that due to data logger failure, groundwater elevation data for MB15MTW02D between June 2018 and March 2020 is inaccurate and has not been included in **Figure 6-4**. Manual dip readings should be used during this period instead, to provide a basic indication of changes to groundwater levels. Logger data from May to September 2020 had multiple error readings; hence, has not been included in this assessment. Furthermore, the logger in MB15MTW03 was not able to be downloaded during Q4 of 2020. Further investigation into the condition of this logger should be undertaken and the logger replaced if found to be faulty. Manual water levels have been included in **Figure 6-4** and any other discussion.

Prior to 2020, groundwater levels in the Wollombi Brook Alluvium bores were gradually declining along with decreasing CRD due to ongoing below average rainfall. Over 150 mm of rainfall was received in February and March 2020 combined, resulting in flows in Wollombi Brook. River level fluctuations in the Wollombi Brook at Bulga appears closely mirrored by groundwater levels. The largest fluctuations as a result of recharge occur in MB15MTW02S and is followed by MB15MTW01S, both screened in the Wollombi Brook Alluvium and are located adjacent to Wollombi Brook.

Figure 6-4 shows that during 2020, alluvial groundwater elevations along Wollombi Brook are below stream elevations most of the time for the Wollombi Brook alluvial bores (e.g. MB15MTW02S) with the exception of MB15MTW01S in periods of high rainfall and peak surface water levels (e.g. during February and April 2020) – indicating losing conditions during theses times. Groundwater levels steadily increased following the peaks in stream elevation, indicating recharge to groundwater. Discharge of groundwater or baseflow is likely occurring when groundwater levels are above stream elevations, e.g. from April to July 2020. It should be noted that groundwater elevations in MB15MTW01S and MB15MTW01D are very close and suggest that for most of 2020 there was either a very slight upwards flow gradient at this location or no gradient. A slight downwards gradient only occurs after significant rainfall and during peak stream flow. An example of this is seen at the end of July 2020 which lasts no more than five days and resulted in approximately 2 cm of head difference between the alluvium and underlying shallow overburden.

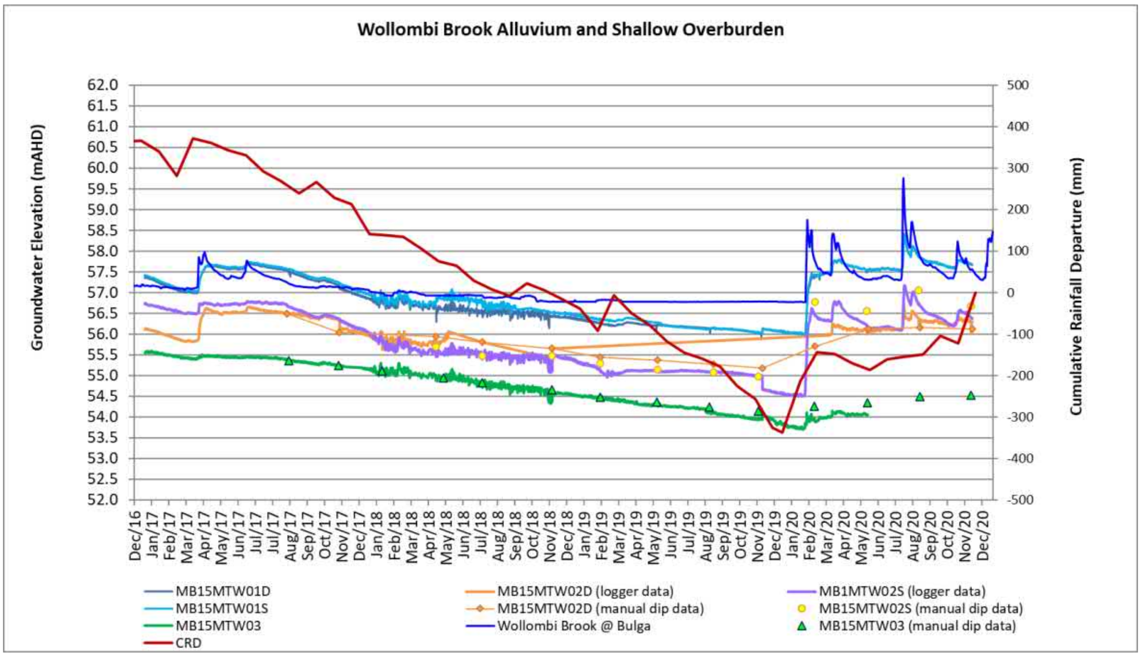

Figure 6-4 Groundwater Levels – Wollombi Brook Alluvium MB15MTW01 and MB15MTW02

Figure 6-4 Error! Reference source not found. shows that alluvial groundwater elevations have generally been higher than the groundwater levels in underlying overburden material, indicating a downward flow gradient. The exception to this is bore site MB15MTW02 where the alluvial groundwater elevations have been marginally lower than the underlying overburden material, indicating a potential upward flow gradient. During 2020, in response to above average rainfall, groundwater elevations in MB15MTW02S have largely remained above MB15MT02D, leading to a potential downwards flow gradient, and likely recharge to the underlying overburden material via the alluvium. A slight and gradual increase in groundwater elevation of no more than 0.5 m occurred during 2020 at MB15MTW02S, which is significantly lower than that at MB15MTW01S, despite both being screened in the Wollombi Brook Alluvium and similarly distanced from the Wollombi Brook.

Trends between the alluvium and underlying shallow overburden material follow similar trends along Wollombi Brook. This contrasts with observations further away from the Wollombi Brook, as discussed below.

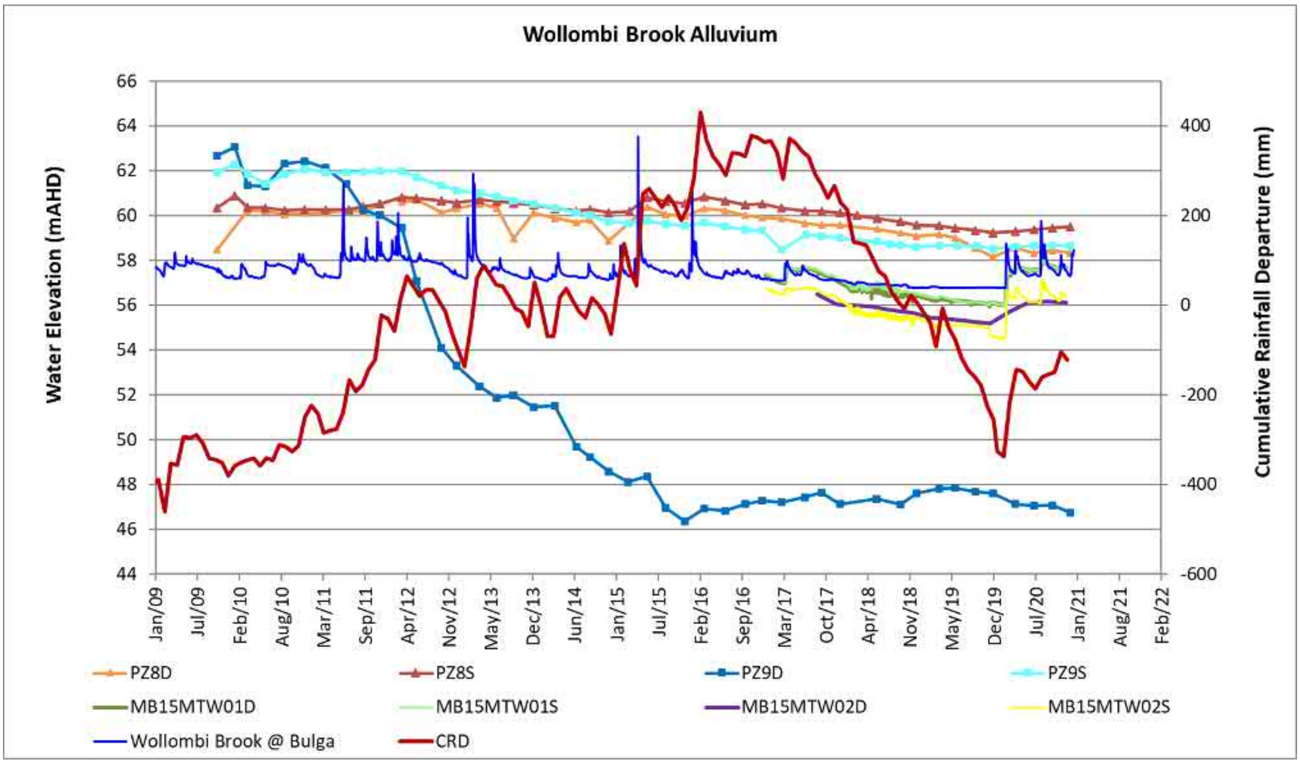

Figure 6-5 Groundwater Levels – Wollombi Brook Alluvium Bores PZ8, PZ9, MB15MTW01 and MB15MTW02

Groundwater elevations trends for bores over 600 m from Wollombi Brook, at the south-western end of site (PZ8 and PZ9), are presented in **Figure 6-5**Error! Reference source not found.. Trends for the MB15MTW alluvial bores are also included for comparison. The graph also includes rainfall trends (CRD) and stream elevations for Wollombi Brook as recorded at Bulga. As with the bores adjacent to Wollombi Brook, Error! Reference source not found. shows a general decline in groundwater levels within the alluvium during the three-year drought period, with most bores responding to the February and March 2020 above average rainfall with groundwater elevations recovering.

It is also noted that groundwater levels within shallow overburden bore PZ9D declined from commencement of monitoring in 2009 to 2016. Between 2016 and 2017 groundwater levels gradually rose before becoming more stable over 2019. Bore PZ9D is positioned closest to the active operations at Loders Pit. The decline in groundwater levels within the shallow overburden material (e.g. at PZ9D from 2010 to 2015) likely reflects depressurisation from mining, as predicted as part of the mine approvals (AGE, 2014b). Both PZ9S and PZ9D are shallow, with total bore depths of 7 m and 24 m, respectively. The difference in groundwater trends in these bores highlights the limited vertical hydraulic connection between the Permian coal measures and surficial sediments at this location.

6.3.3 Permian Coal Measures

Groundwater level trends for the Permian coal measures are discussed in stratigraphic order in **Section 6.3.3.1** to **Section 6.3.3.9** below. This includes further discussion on the shallow overburden, shallow coal seams (Whybrow, Redbank Creek and Wambo seams), Blakefield Seam, Bowfield Seam, Warkworth Seam, Vaux Seam and Bayswater Seam.

6.3.3.1 Shallow Overburden

Ten monitoring bores intersect the shallow overburden material, including PZ7D, PZ8D, PZ9D, MTD605P, MTD614P, MTD616P, MBW02, MB15MTW01D, MB15MTW02D, and MB15MTW03. Groundwater level trends for bores nested with alluvial bores (PZ7D, PZ8D, PZ9D, MB15MTW01D, and MB15MTW02D) are discussed in **Section 0** with single bore MB15MTW03 is also shown in **Figure 6-4** for comparison. The general decline in groundwater elevations previously observed in MB15MTW03 during 2019 have begun trending upwards since 2020 (**Figure 6-4**).

Groundwater elevation trends for bores MTD605P, MTD614P, MTD616P, and MBW02 are presented in **Figure 6-6**. **Figure 6-6** shows stable to slightly declining groundwater levels within the shallow overburden material. The exception to this is bore MTD616P in which slightly increasing groundwater levels were recorded between January 2018 and May 2020. Subsequent groundwater elevations have declined and stabilised at approximately 71.4 mAHD. Given the CRD generally declined from 2017 to 2019, it would not be expected that groundwater elevations would rise. As reported in the previous annual review, no land use changes, or activities are known to have occurred near the bore that may have caused this rising trend. Further investigation into site conditions around MTD616P should be undertaken to confirm this.

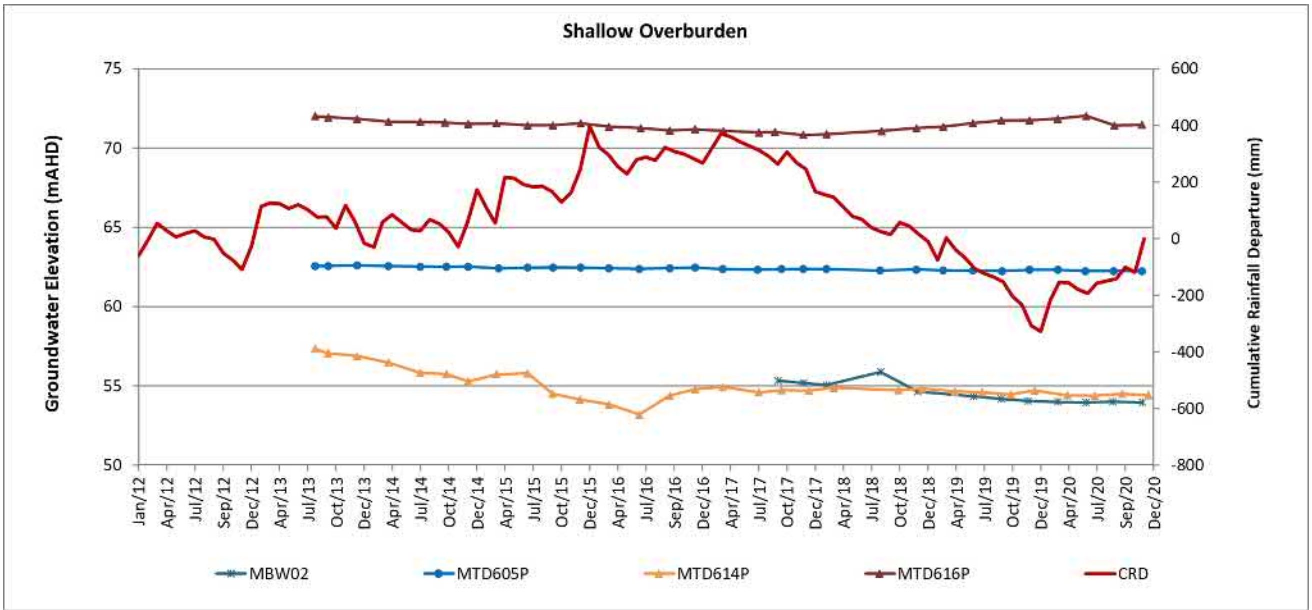

Figure 6-6 Hydrograph of Shallow Permian Coal Measures

6.3.3.2 Whybrow, Redbank Creek and Wambo Seams

Historical groundwater elevation trends for bores intersecting the shallow coal seams (Whybrow, Redbank Creek and Wambo seams) are presented in **Figure 6-7**. The graph shows that although larger seasonal fluctuations occurred in some bores during 2020 compared to the previous year, generally long term trends have remained similar to the previous year.

Groundwater elevations at WD625P (Whybrow ~1.4 km from pit), WOH2153B (Wambo ~2.1 km from pit) and WOH2154B (Wambo ~2.3 km from pit) remained relatively similar throughout 2019 and 2020. This is likely due to the distance that these bores are from the pit.

Groundwater elevations in the following bores increased significantly with above average rainfall and continued declining subsequently – likely exhibiting responses to depressurisation of the coal seams as a result of mining operations:

- WOH2154A (Redbank)
- WOH2155A (Redbank)
- WD622P (Wambo)
- WOH2156A (Redbank)

The following bores follow relatively different trends compared to other bores discussed above:

- WOH2156B (Wambo) – had been stable during 2019 but groundwater level decline began in 2020 and continued with at an increased rate towards the end of 2020
- WOH2155B (Wambo) – gradual decline had been ongoing since 2017, with rate of decline increasing in mid-2020 and stabilising towards the end of 2020

WOH2156B and WOH2155B are similarly distanced from pit disturbance and are in the same seam. WOH2156B has a much higher groundwater elevation at ~68 mAHD compared to ~58 mAHD at WOH2155B, ~55 mAHD at WOH2154B and ~45 mAHD at WD622P. Groundwater elevation in these bores suggest that the general flow direction is from west towards the river; however, with depressurisation of aquifers, there is also local flow towards the pit disturbance.

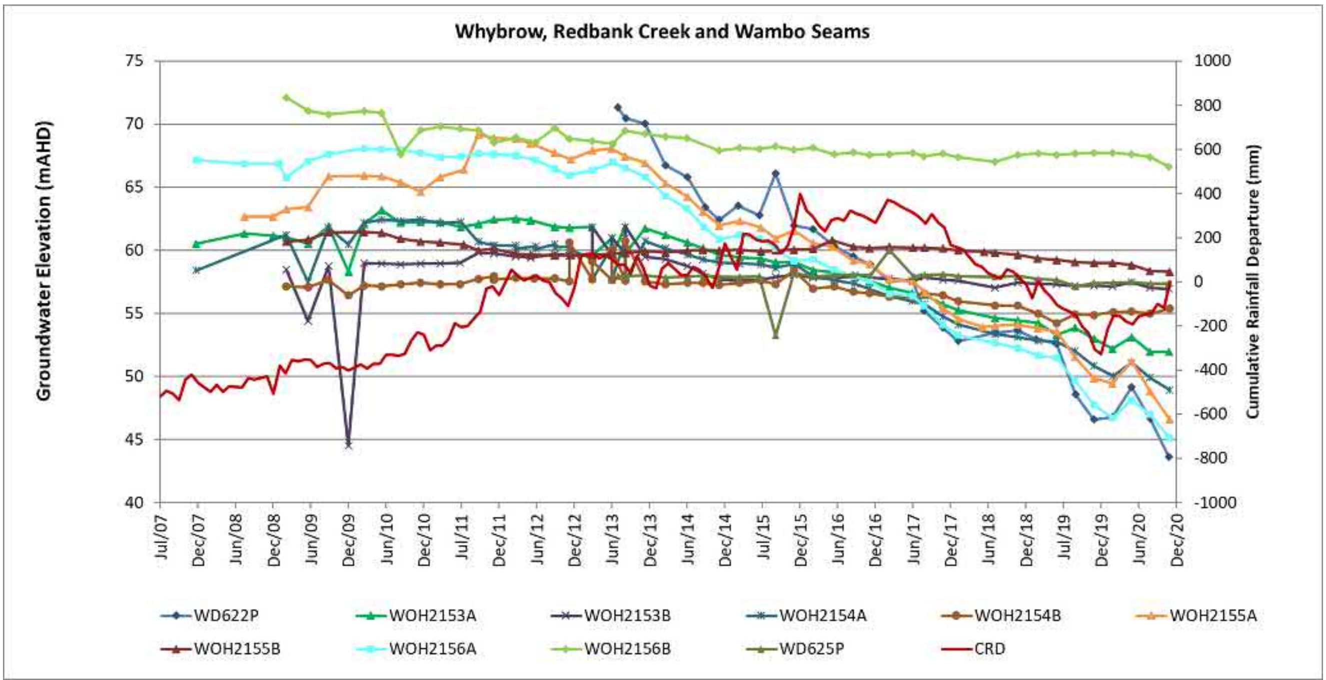

Figure 6-7 Hydrograph of Whybrow, Wambo and Redbank Creek Seams

Groundwater elevation trends for VWP sensors installed within the Whybrow and Wambo seams are presented in **Figure 6-8** and **Figure 6-9,** respectively. The Whybrow Seam hydrograph shows that groundwater elevations have remained relatively stable throughout 2020, with the exception of a minor decline in MTD614 S1 of ~1 m. These trends are similar to those observed in the Whybrow Seam standpipe monitoring bores mentioned above. Groundwater elevations in the Wambo Seam recovered temporarily following above average rainfall in February and March 2020. Despite this temporary relief, the declining trends continued over the rest of the year as a result of coal seam depressurisation. It should be noted that 'noise' (short-term fluctuations of up to 2 m) observed in water level data from MTD605 Sensor 2 since mid-2018 and MTD616 P1 over the entire dataset may indicate faulty VWP sensors. This is especially likely since MTD614 Sensor 1 located approximately 800 m to the east of MTD605 does not exhibit the same fluctuations, and such frequent fluctuations would not be related to rainfall or stream water level fluctuations. Further investigation into the condition of MTD616 P1 and MTD605 S2 sensors should be undertaken before the sensor should be replaced.

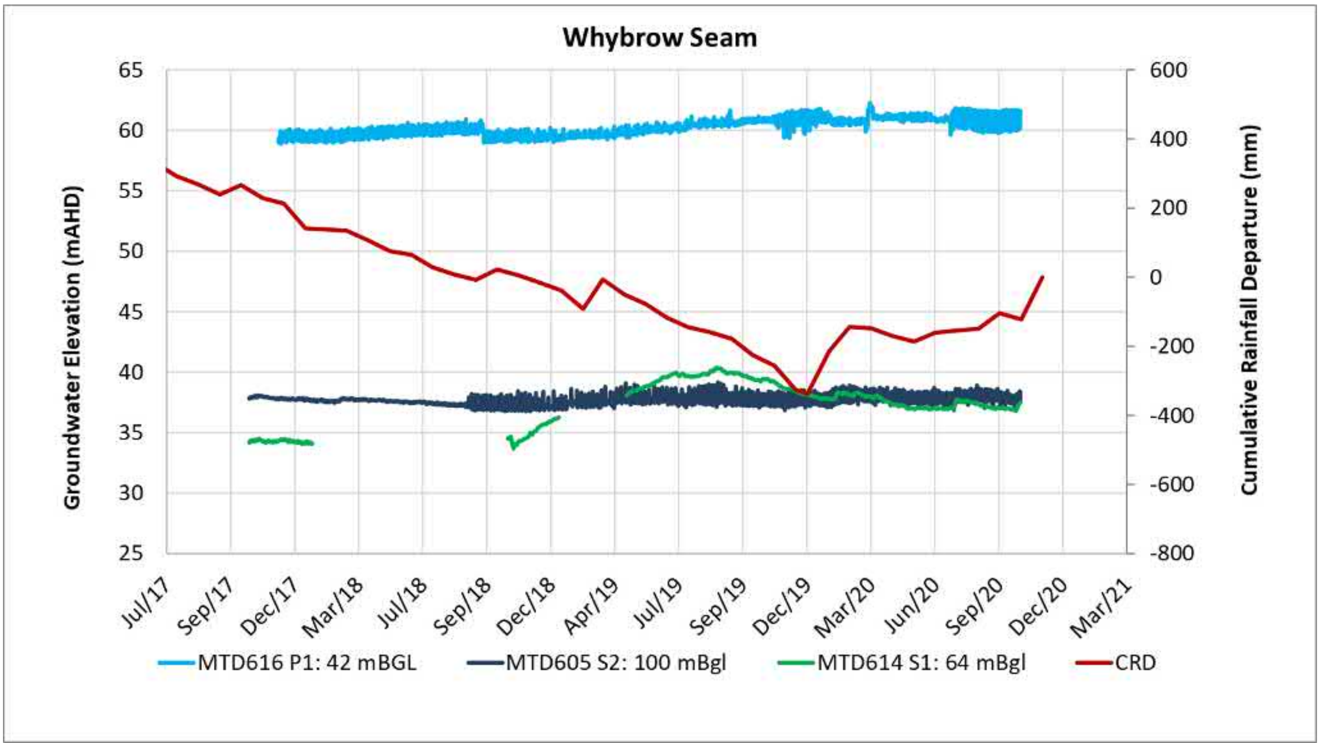

Figure 6-8 VWP Hydrograph of Whybrow Seam

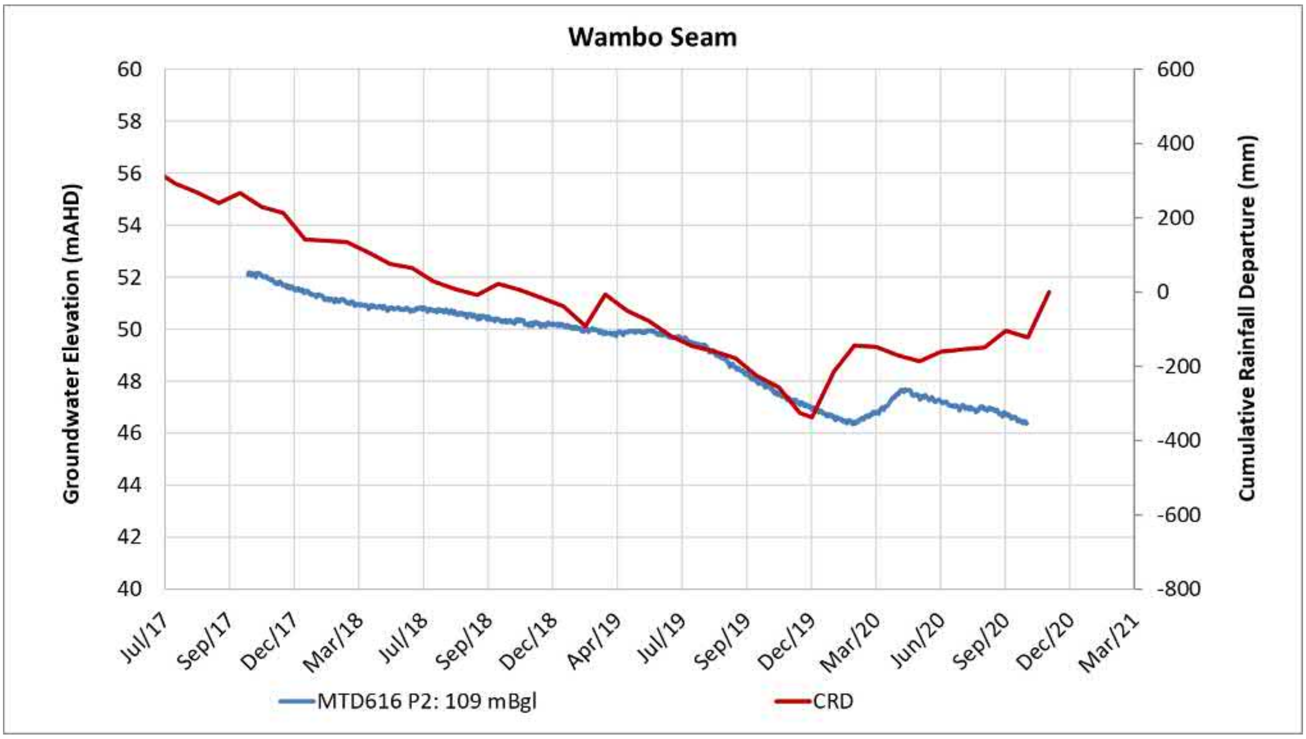

Figure 6-9 VWP Hydrograph of Wambo Seam

6.3.3.3 Blakefield Seam

Historical groundwater elevation trends for bores intersecting the Blakefield Seam are presented in **Figure 6-10**. The graph shows that during 2020 groundwater elevations ranged between 32.85 mAHD and 51.76 mAHD.

Contrary to the previous year's trends, groundwater elevations at OH1125(1) temporarily increased following above average rainfall in February and March 2020. Levels subsequently declined gradually back to a similar elevation to pre-increase levels. Rainfall had very minimal impact on groundwater elevations in OH1222(1) in early 2020. Groundwater levels in this bore continuously declined in 2020. Groundwater elevations in WOH2139A was relatively stable during the first half of 2020, until an approximately 2 m decline occurred in August; however, in November 2020 groundwater elevations returned to similar levels to those observed in the first half of 2020. This could be attributed to the above average rainfall event that was received in December 2020.

Groundwater elevation trends for VWP sensors installed within the Blakefield Seam are presented in **Figure 6-11**. The graph shows that during 2020 groundwater elevations within the seam slightly declined at MTD605 (corresponding to likely depressurisation of coal seams) but remained relatively stable at MTD614 S2 (possibly due to some recharge from rainfall infiltration and cross-aquifer interaction).

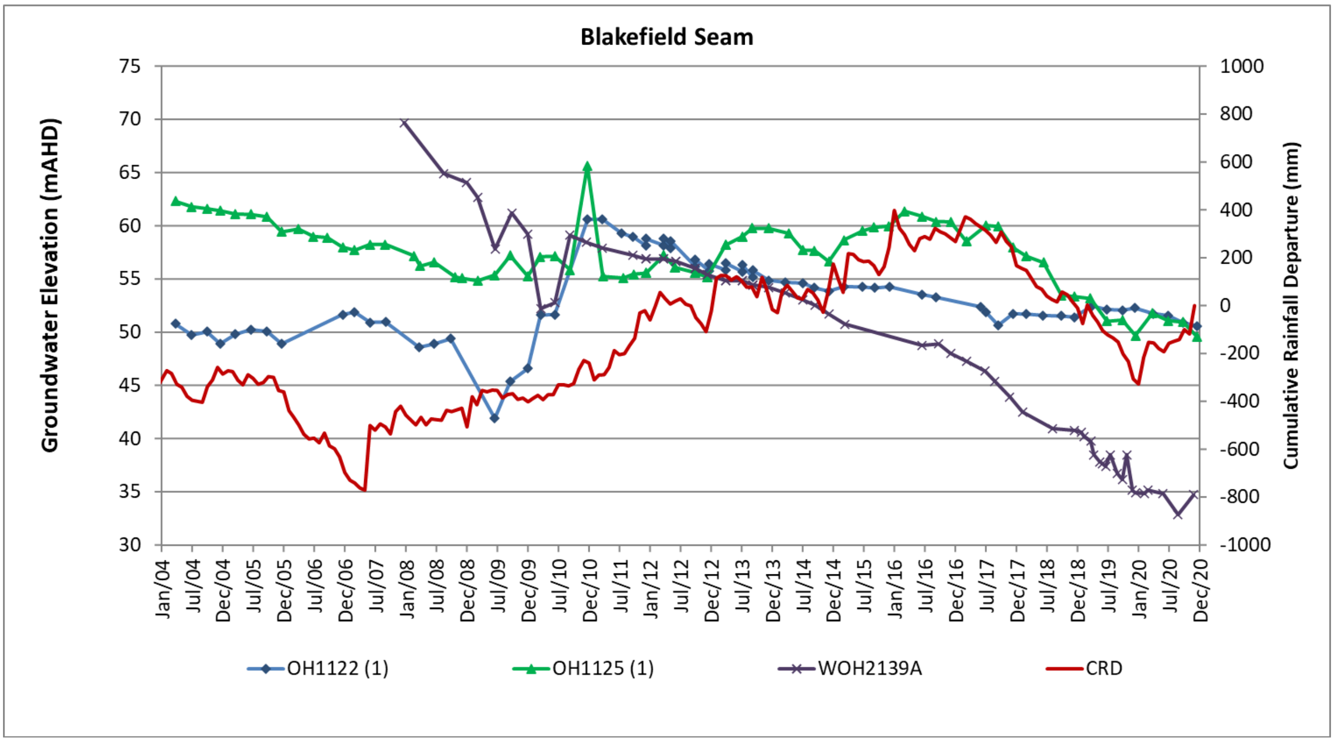

Figure 6-10 Hydrograph of Blakefield Seam

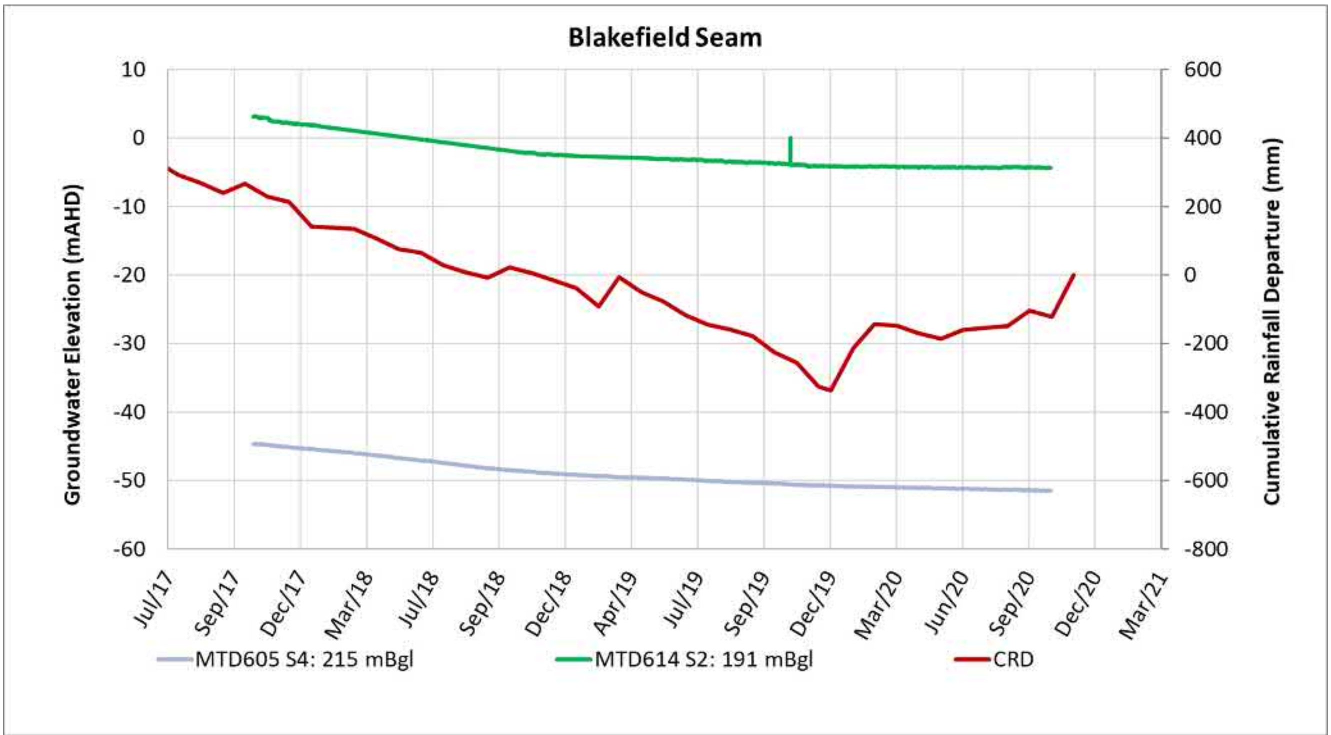

Figure 6-11 VWP Hydrograph of Blakefield Seam

6.3.3.4 Woodlands Hill Seam

Groundwater elevation trends for VWP sensors installed within the Woodlands Hill Seam are presented in **Figure 6-12**. The graph shows that in 2020 groundwater elevations within the seam at VWP WD625 were variable – possibly due to factors such as water storage activities and underground mining activities at Wambo, whereas at VWP MTD616 P3 groundwater elevations continued to decline for the first half of the year in 2020, but stabilised at ~17.3 mAHD during the latter half of 2020. MTD616 is located to the north west of Loders Pit and west of West Pit. The decreasing groundwater elevations are likely due to dewatering of the coal seam from mining of these pits. Stabilisation of groundwater elevations could indicate cessation of depressurisation of the Woodlands Hill Seam and/or increase in recharge from rehabilitated pits that had intercepted this coal seam.

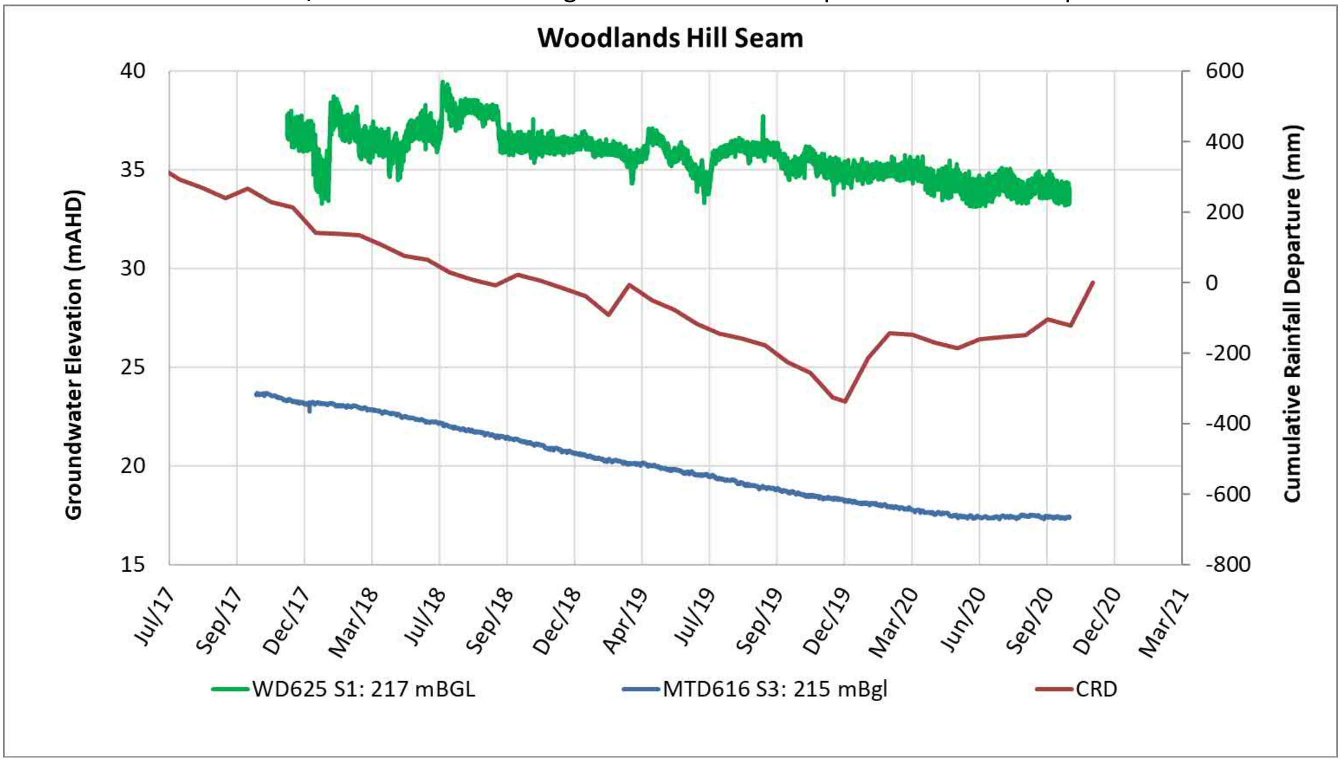

Figure 6-12 VWP Hydrograph of Woodlands Hill Seam

6.3.3.5 Bowfield Seam

Historical groundwater elevation trends for bores intersecting the Bowfield Seam are presented in **Figure 6-13**. The graph shows that during 2020 groundwater elevations in Bore OH1125(3) initially increased from 28.98 mAHD in January 2020 to 39.11 mAHD in May 2020. Further fluctuations occurred over the course of the year until the bore resumed a declining trend towards the end of the year at a rate ranging from -1.6 to -2.5 m/month. Bore OH1125(3) is located directly to the north of North Pit and the decline may relate to drawdown towards active mining within the pit to the south. As mentioned in the previous annual review, the trend may also be influenced by abstraction from LUG Bore located approximately 1.25 km to the north west. The LUG bore intersects the historical Lemington Underground workings, which mined through the deeper Mt Arthur Seam. The groundwater level drawdown observed in the latter part of 2020 may be a combination of the effects of mining of the North Pit and licenced abstraction from the LUG bore.

The targeted formation of bore OH1125(2) (shown also in **Figure 6-13**) is not currently known. This bore has been recorded as dry since 2012. No data was available for this reporting period but it is assumed that this bore is still dry.

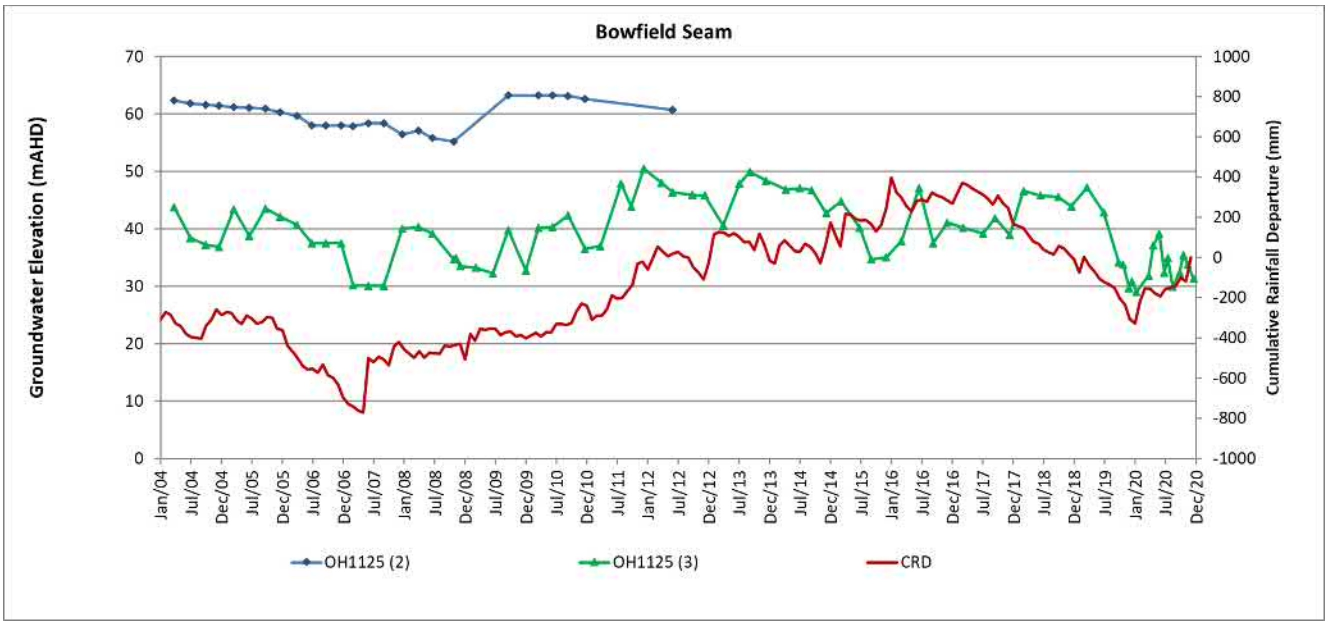

Figure 6-13 Hydrograph of Bowfield Seam

6.3.3.6 Warkworth Seam

Historical groundwater level trends for nested bores at OH1338 (1 and 2) intersecting the Warkworth Seam at bore OH1138 at two different depths (24.8 m and 42.8 m, respectively) are presented in **Figure 6-14**. The graph shows that during 2020 groundwater elevations ranged between 55.33 mAHD and 60.03 mAHD and levels declined by up to 0.36 m in the shallower bore and up to 0.79 m in the deeper bore. The bore is located north of North Pit and the decline may relate to drawdown towards active mining within the pit to the south-west. The trend may also be influenced by abstraction from LUG Bore approximately 1.25 km to the north-west (as similarly could be the case for OH1125(3)).

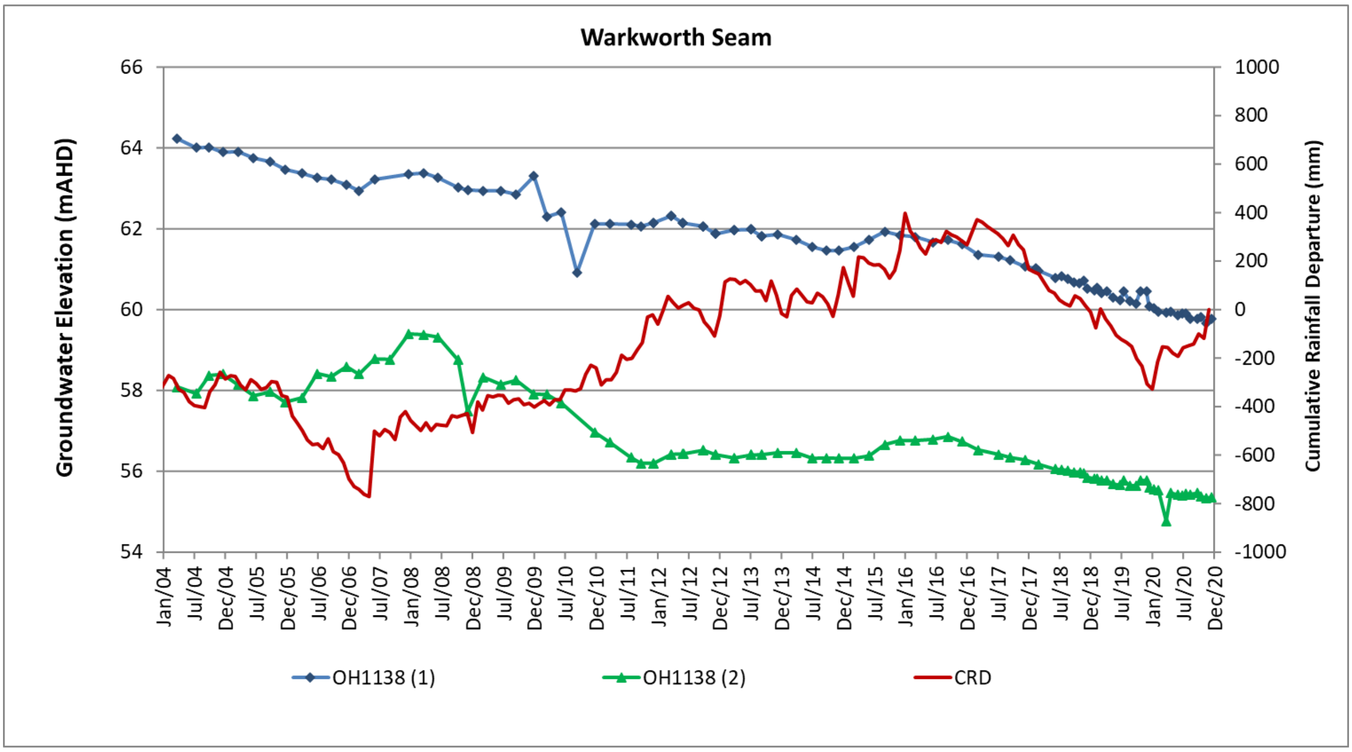

Figure 6-14 Hydrograph of Warkworth Seam

6.3.3.7 Mt Arthur and Piercefield Seams

Historical groundwater elevation trends for VWP sensors intersecting the Mt Arthur and Piercefield coal seams are presented in **Figure 6-15** and **Figure 6-16** respectively. At MTD605 water level data was erroneous from November 2019 to January 2020. After this period, data has been available, showing a continuous decline in groundwater elevation towards 0 mAHD during October 2020.

Figure 6-15 shows that during 2020, the decline in groundwater elevation for MTD616 P4 stabilised temporarily at approximately 11.5 mAHD, as did WD625 S2 at approximately 34.1 mAHD. The long-term stable elevations observed in WD625 suggest that depressurisation of the coal seams associated with North Pit are not influencing groundwater levels within the Mt Arthur seam at this location.

Figure 6-16 shows that following gradual groundwater level recovery within the Piercefield Seam during 2019, groundwater elevation in WD615 S1 has stabilised at a level of approximately 25.6 mAHD during 2020. VWP WD615 is located along the southern boundary of North Pit, within a rehabilitated area of the pit. The VWP sensor WD625 S2 is located in the seam underlying the mined coal seam at this location. The increase in groundwater elevation within the Piercefield Seam is potentially an indication of recharge from the overlying spoil as groundwater recovery takes place in the rehabilitated areas.

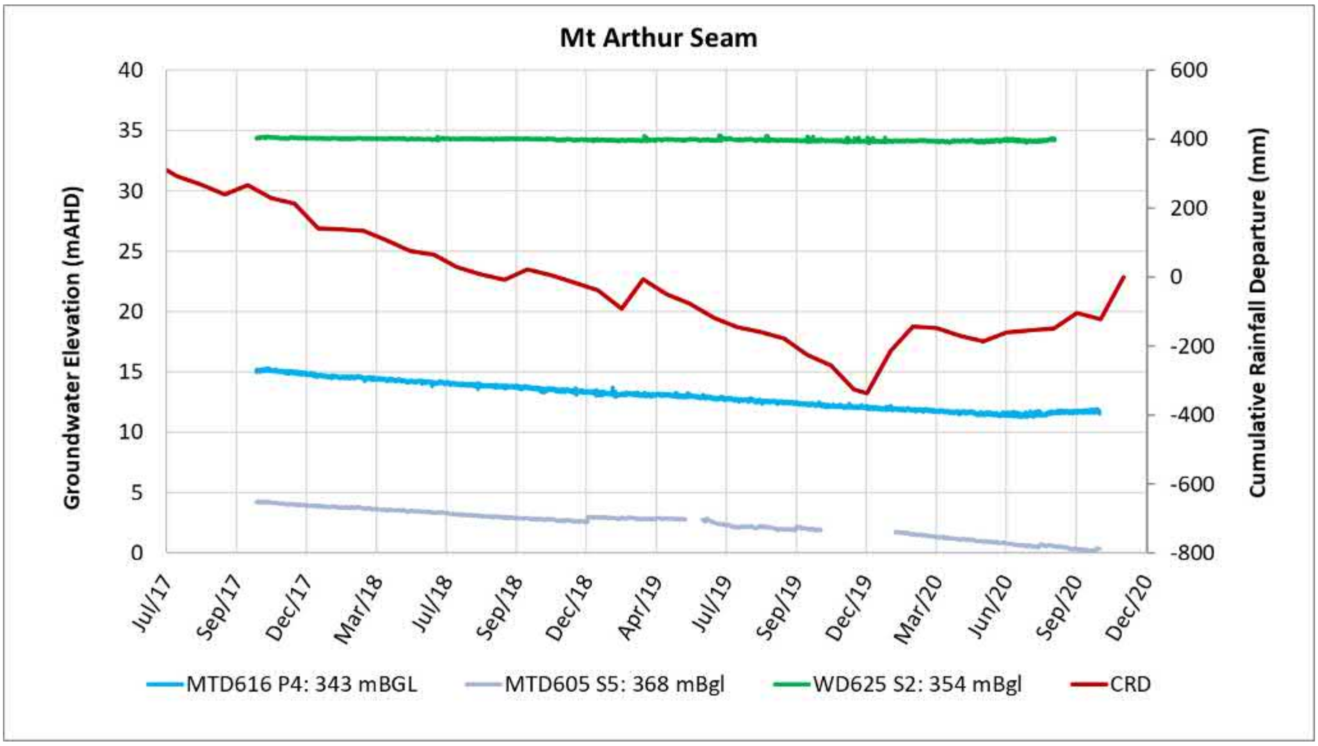

Figure 6-15 VWP hydrograph of Mt Arthur Seam

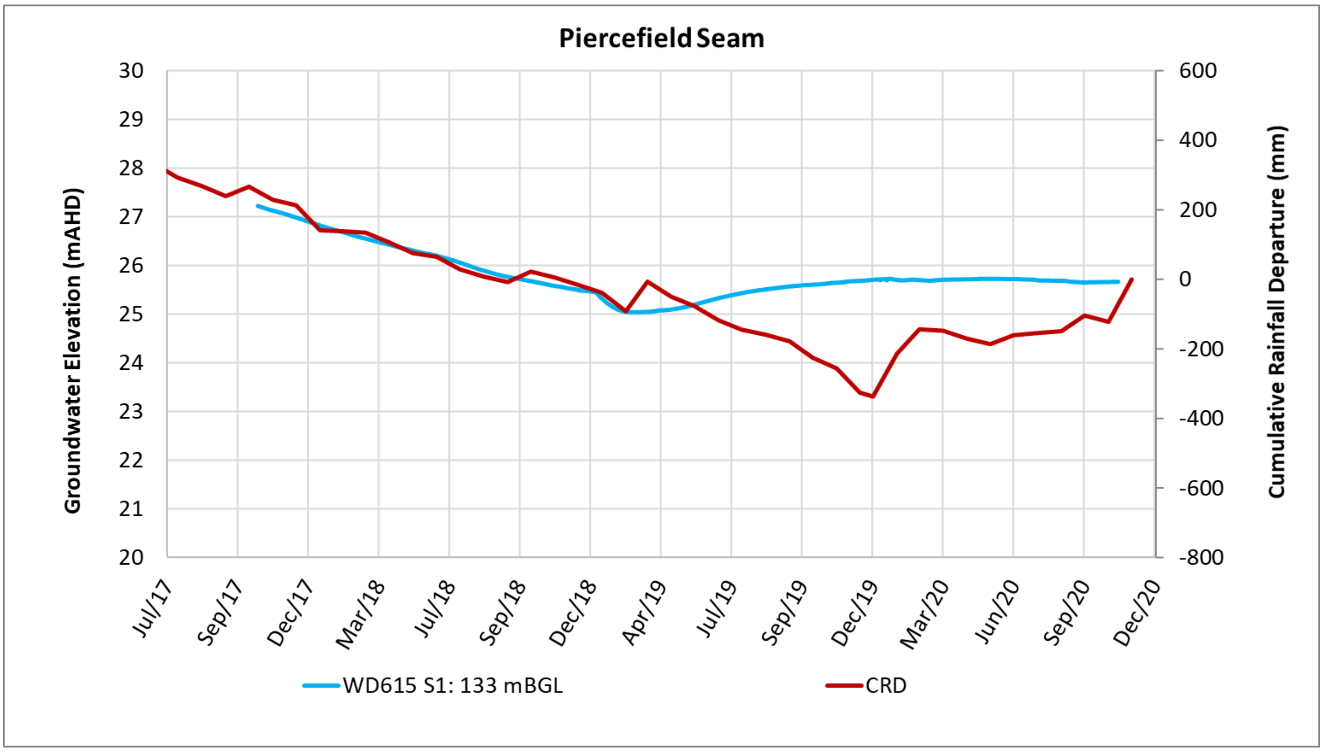

Figure 6-16 VWP hydrograph of Piercefield Seam

6.3.3.8 Vaux Seam

Historical groundwater elevation trends for bores intersecting the Vaux Seam around MTW are presented in **Figure 6-17**. The graph shows that during 2020 groundwater elevations within the Vaux Seam, north of North Pit, (OH1126) ranged between 45.71 mAHD and 46.01 mAHD. OH1137 has remained dry from September 2019 onwards. These trends are similar to trends observed within the Warkworth Seam, which may relate to depressurisation of the coal seams below the actively mined seams at MTW, or due to surrounding mine operations that target the Vaux Seam.

Groundwater elevations within bore OH1121 remained stable over 2020. This bore is located upgradient (east) of MTW and is reported in the WMP to intersect the shallow Vaux Seam (20 m depth). However, as noted in the previous annual review, upon review of the geology map (**Figure 3-4**) the Jerry's Plains Subgroup that the Vaux Seam is within is not present at this location. Therefore, the condition and construction details of the bore should be further reviewed.

Groundwater level trends for VWP sensors installed within the Vaux Seam are presented in **Figure 6-18** and **Figure 6-19**. WD625 is located to the west of North Pit, MTD605 is located to the west of Loders Pit and MTD616 is located to the south west of West Pit.

The sensor for MTD605 (S6) appears to have failed in June 2016 and the logger stopped in June 2019 according to the summary notes provided to SLR. It is recommended that this sensor is replaced. MTD616 P5 has declined approximately 4 m between 2017 and 2020 (**Figure 6-18**). The overall rate of decline appears to be at a steady rate; however, water levels exhibit sinusoidal fluctuations that are likely related to pumping and recovery of water levels in the Vaux Seam. The water level in MTD605 S6 was also following a declining trend, but not dropping at the same rate (approximately 1.6 m between 2017 and 2019). The overall trends observed at these two VWPs are similar to those seen in OH1126 and OH1137 (mentioned above). Therefore, it is also likely that these bores are influenced by surrounding mine operations that target the Vaux Seam. The VWP data from WD625 S3 indicates that only 12 cm of decline has been recorded in the Vaux Seam over the three years of monitoring at this location (**Figure 6-19**).

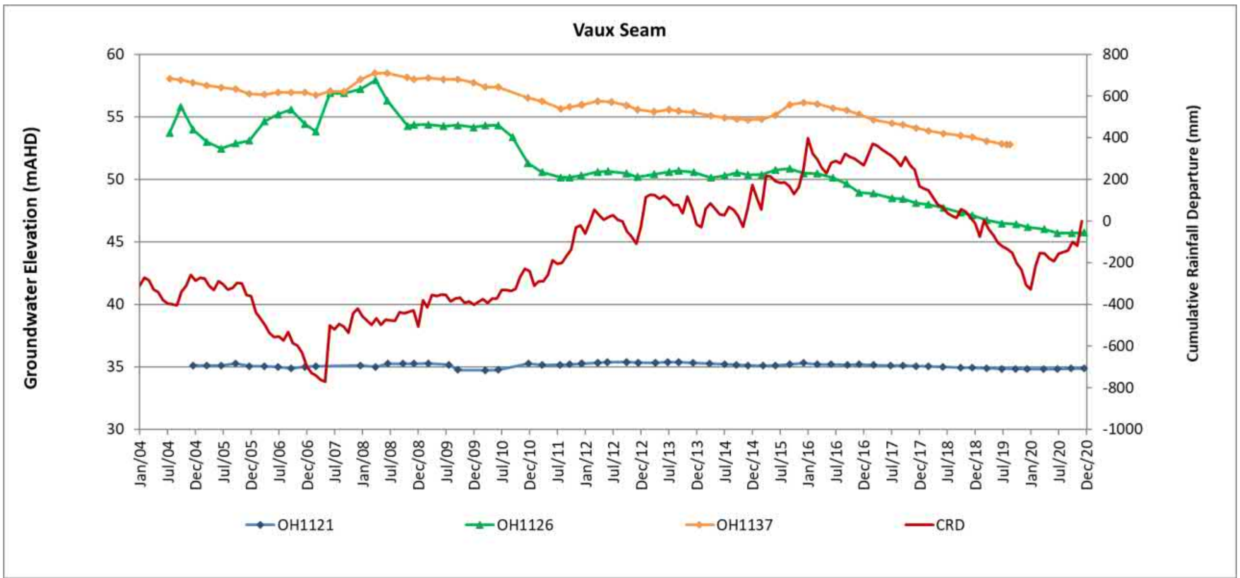

Figure 6-17 Hydrograph of Vaux Seam

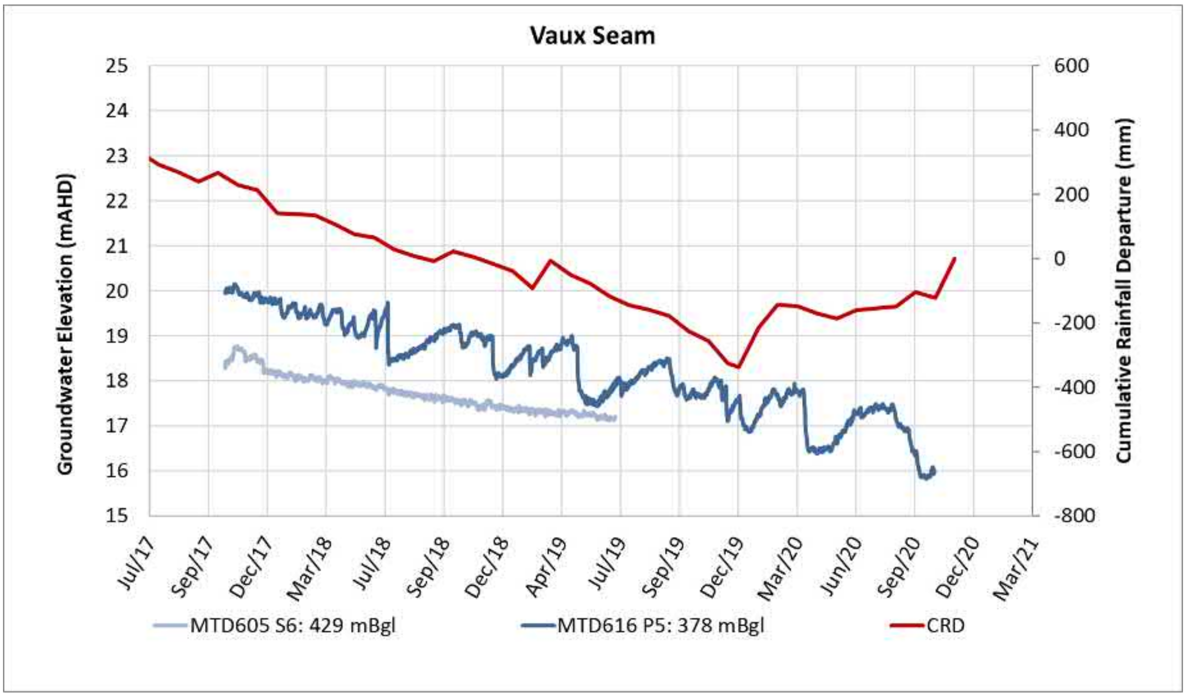

Figure 6-18 VWP hydrograph of MTD616 P5 and MTD605 S6 (Vaux Seam)

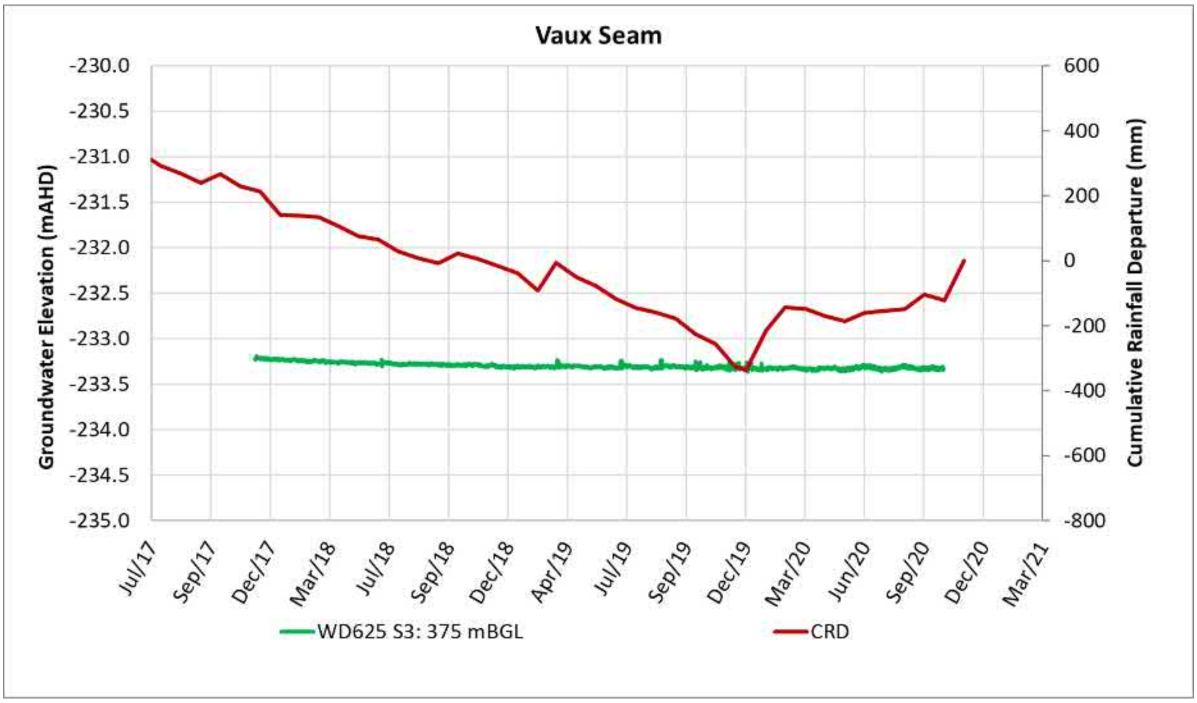

Figure 6-19 VWP hydrograph of WD625 S3 (Vaux Seam)

6.3.3.9 Bayswater Seam

Historical groundwater elevations trends for bores intersecting the Bayswater Seam that are south east of South Pit at MTW are presented in **Figure 6-20**. The graph shows that groundwater elevations at bores including GW98 MTCL 2, GW98 MTCL 1, GW 9706, GW 9708, GW 9707, GW 9709 and OH1127, remained either relatively stable or have increased during 2020. Groundwater elevations ranged between 35.24 mAHD and 68.54 mAHD. All bores presented in **Figure 6-20** are located to the south east of South Pit. Past trends in these bores have been a very gradual long-term decline, even throughout a seven-year period of above average annual rainfall (seen as a positive trend in the CRD). This could potentially be related to depressurisation of the Bayswater Seam by surrounding mining operations that target this seam.

Groundwater elevation trends for VWP sensors installed around the site at MTW within the Bayswater Seam are presented in **Figure 6-21**, **Figure 6-22**, and **Figure 6-23**. During 2020 the following observations were noted with regard to groundwater elevations:

- Decline of 1 m during 2020 in MTD605 S7.
- Decline of 0.5 m during 2020 in MTD616 P6.
- Upwards trend in WD615 S2, with ~5 m of increase when excluding the frequent sinusoidal fluctuations over the 2020 monitoring period (Note: range of groundwater elevations in 2020 was ~12.5 m).
- Gradual decline in WD625 S4 of less than 0.1 m during 2020.

With the exception of WD615 all VWP locations are situated to the west of the main mine pits (North Pit, West Pit and Loders Pit). WD615 is located within the eastern portion of the North Pit. The increase in groundwater elevations observed in WD615 corresponds with the increasing elevations observed within the Piercefield Seam at the same location. The increase may be an indication of recovering groundwater levels within rehabilitated areas of the North Pit resulting in recharge to the underlying coal seams. This is supported by the sinusoidal fluctuations mentioned above for WD615 S2, which appears to be related to a delayed response to rainfall and lack of rainfall (see the CRD in **Figure 6-22**). The declining water levels in MTD605 S7 and MTD616 P6 over the reporting period could potentially be attributed to depressurisation of the Bayswater Seam by surrounding mining operations that target this seam.

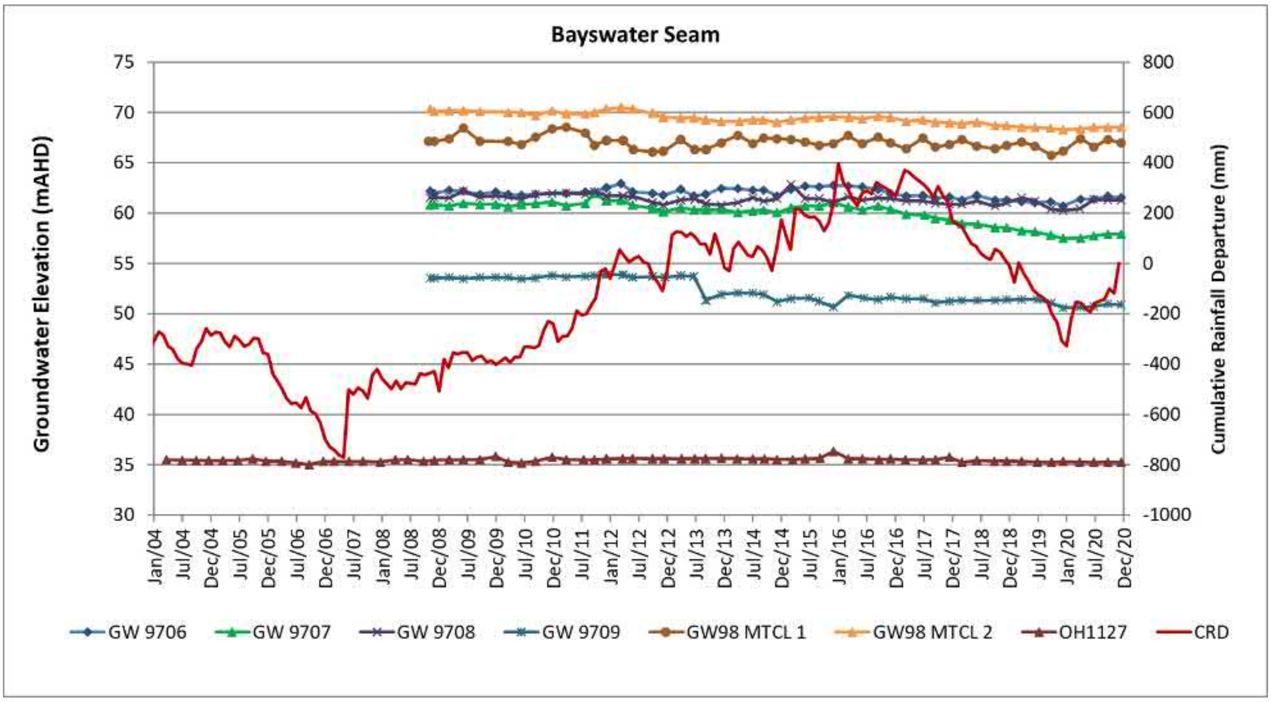

Figure 6-20 Hydrograph of Bayswater Seam

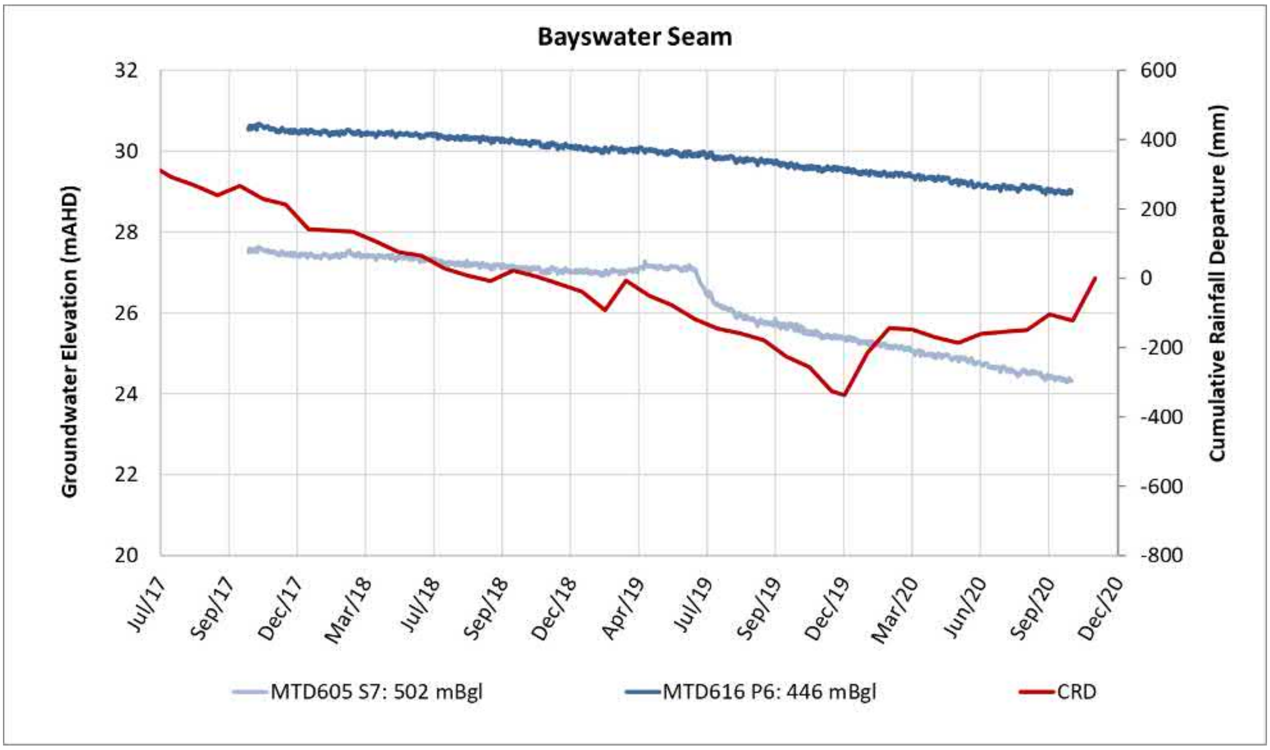

Figure 6-21 VWP hydrograph of Bayswater Seam

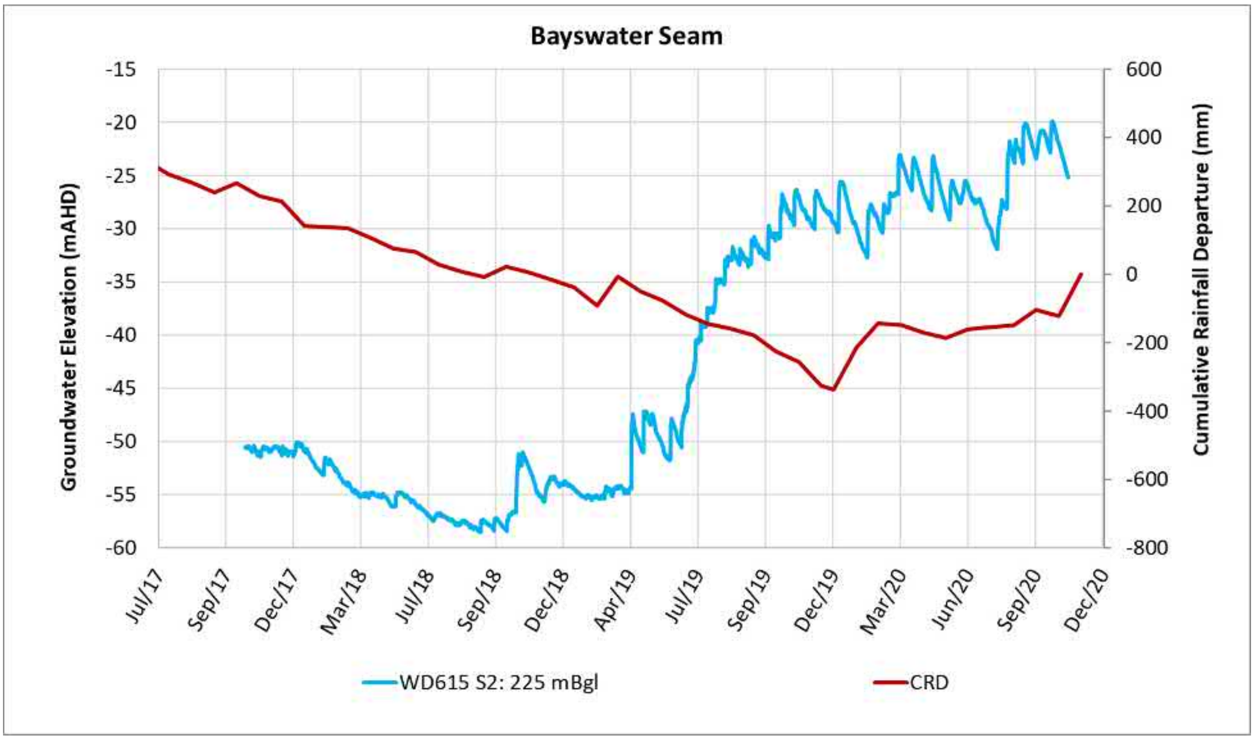

Figure 6-22 VWP Hydrograph for WD615 S2 (Bayswater Seam)

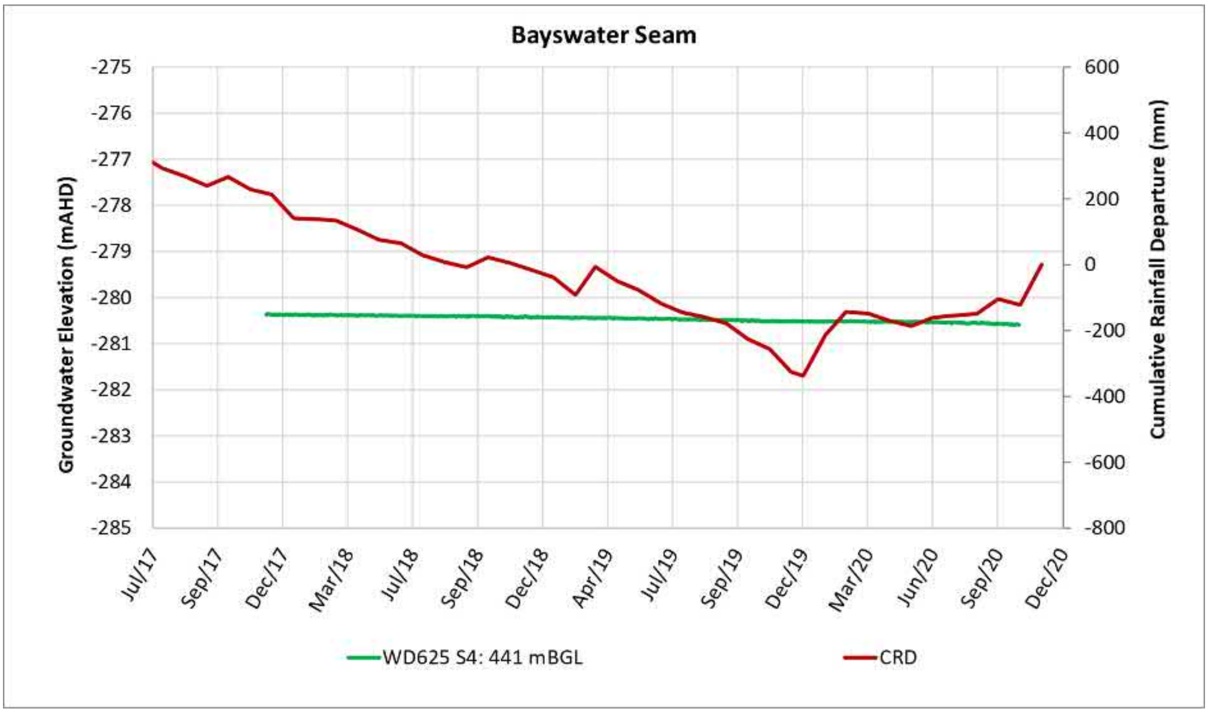

Figure 6-23 VWP Hydrograph for WD625 S4 (Bayswater Seam)

6.4 Water Quality

A summary of the water quality results are provided for each of the main water-bearing units (regolith, alluvium and Permian coal measures) below. Routine EC and pH readings and historical trends are presented in **Appendix B** and **Appendix C**, respectively.

6.4.1 Regolith

Over the 2020 monitoring period, triggers were exceeded for the following bores within the regolith:

- Bore OH786: Groundwater samples collected exceeded the upper pH trigger level of 7.7 in Q2; and
- Bore OH787: Groundwater samples collected exceeded the EC trigger level of 18,467 µS/cm in Q1, Q2, Q3 and Q4.

The exceedance observed in the sample collected from bore OH786 occurred in June 2020 with a pH value of 8.0. Historical pH values observed in OH786 prior to the exceedance have ranged from 6.7 to 7.9; therefore, this exceedance was slightly above historical records. Previous exceedances of EC at this bore attributed elevated EC to below average rainfall conditions and potentially suspended solids in the sample due to sediment accumulation at the bottom of the bore. It is unlikely that this pH exceedance was also related to suspended sediments as the data suggests that there is no correlation between higher pH values and high EC. The higher pH in Q2 may potentially be attributed to the equipment (i.e. slightly out of calibration at the time of sampling); the sampling methodology or simply due to natural variation. Given that the subsequent Q3 and Q4 pH values were below the upper trigger limit, the Q2 exceedance is believed to be an anomaly and is not indicative of a long term change to groundwater quality at this bore.

The exceedances observed in samples collected from bore OH787 occurred during every quarter of 2020. Historical EC readings indicate a gradual increasing trend from 2016 onwards, while at the same time exhibiting seasonal fluctuations likely related to rainfall. The highest EC concentration was measured in September 2020 at 19,610 µS/cm and is slightly above historical levels. This trend may relate to the area having received below average rainfall from 2017 to 2019, resulting in almost drying out of the bore and associated nearby regolith. As mentioned in the previous annual review, groundwater levels were recorded at OH787 between 13.90 m and 14.03 m depth, which are above the reported base of the bore (15.05 m depth). Available construction details indicate the screen extends to 12.1 m. This difference in reported bore depths may suggest that a sump exists, potentially influencing results. As per the previous year’s recommendation, a review of the bore condition and construction is required to verify the bore depth.

6.4.2 Alluvium

During 2020, routine monitoring of EC and pH were conducted for most alluvial monitoring bores on a quarterly basis. Exceptions to this were:

- OH944: The bore was recorded as dry throughout 2020;
- OH943 and PZ9S: The bores were recorded as having insufficient water for sampling throughout 2020; and

Bores targeting the Warkworth Sands MB15MTW04 to MB15MTW11 were recorded as dry throughout 2020. Alluvial groundwater quality in 2020 varies between the different units, as discussed below:

- Warkworth Sands: EC of the groundwater samples collected ranges between 1,441 µS/cm and 1,599 µS/cm and pH ranges between 6.7 and 6.9 for bore PZ7S.

- Hunter River: EC of the groundwater samples collected ranges between 12,080 µS/cm and 13,760 µS/cm and pH was consistently at 7.0 throughout the year (OH788 only);
- Regolith: EC of the groundwater samples collected ranges between 560 µS/cm and 25,100 µS/cm and pH ranges between 6.6 and 8.0; and
- Wollombi Brook: EC of the groundwater samples collected ranges between 14,520 µS/cm and 15,220 µS/cm and pH ranges between 6.6 and 6.7

Discussion of water quality trends and triggers are included for each alluvial unit from **Section 6.4.2.1** to **Section 6.4.2.3**.

Full water quality analysis was conducted for the site alluvial bores in accordance with the WMP. Exceptions to this include:

- Bores MB15MTW04 to MB15MTW11 and OH944 were dry throughout 2020;
- OH944 was dry; and
- OH943 and PZ9S had insufficient water available for sampling.

Full water quality data from groundwater collected from site alluvial bores is presented in **Appendix D** and summarised below:

- Total aluminium: values ranged from below the limit of reporting 0.06 mg/L to 18.9 mg/L (PZ7S);
- Total arsenic: values ranged from below the LOR of 0.001 mg/L to 0.008 mg/L (PZ7S);
- Total cadmium: all values were recorded as below the LOR of 0.0001 mg/L except PZ7S (0.0002 mg/L);
- Total copper: values ranged from below the LOR of 0.001 mg/L to 0.069 mg/L (PZ7S);
- Total lead: concentrations were below the limit of reporting of less than 0.001 mg/L, except for PZ7S with a total lead concentration of 0.039 mg/L;
- Total nickel: values ranged from 0.001 mg/L to 0.054 mg/L (PZ7S);
- Total selenium: all concentrations were below the LOR of 0.01 mg/L;
- Total zinc: all concentrations below the limit of reporting or less than 0.01 mg/L, except for bore PZ7S that recorded a total selenium concentration of 0.167 mg/L;
- Total boron: concentrations were generally below the LOR of 0.05, except for bores MB01 and OH788 (0.08 mg/L and 0.09 mg/L, respectively); and
- Total mercury: all concentrations were reported below the LOR of 0.0001 mg/L.

6.4.2.1 Warkworth Sands

Over the 2020 monitoring period, no groundwater samples collected from bores within the Warkworth Sands Alluvium exceeded any trigger levels.

6.4.2.2 Hunter River Alluvium

Over the 2020 monitoring period, in groundwater samples collected the following triggers were exceeded for the bores within the Hunter River alluvium:

- Bore OH788 exceeded the EC trigger level of 12,234 µS/cm in Q1, Q3 and Q4.

Over 2020 SWL in bore OH788 was relatively stable ranging between 10.01 m and 10.06 m bgl. The depth of bore OH788 is reported as 22.1 m with the screen depth reported as 21.6 m. Following recommendations made in the 2018 AEMR, the sampling methodology for the quarterly monitoring changed from a grab sample to low flow. The increase in EC concentrations observed over 2019 may be as a result of this change. Lower than average rainfall over 2019 may also contribute to an increase in EC concentrations within the Hunter River Alluvium. This may have resulted in reduced recharge and therefore less fresh water entering the system. In 2020, during which above average rainfall was recorded, a reduction in EC along with slightly lower pH values has occurred which is acceptable (as rainfall is fresh and generally has a pH of on average ~5.6).

6.4.2.3 Wollombi Brook Alluvium

Over the 2020 monitoring period, the following triggers were exceeded in groundwater samples collected from bores within the Woollombi Brook alluvium:

- Bore PZ8S recorded EC above the trigger limit of 15,086 µS/cm Q3.

The exceedance of the EC trigger at PZ8S was marginal, with a measured EC value of 15,220 µS/cm which is 134 µS/cm higher than the trigger. As observed over the previous monitoring period, groundwater elevations in PZ8S had been continuously declining, until recharge occurred in March 2020. This recharge event resulted in a continuous water level increase at PZ8S during 2020. Rather than seeing a freshening effect on groundwater, EC increased instead. Increased EC is unlikely to be the result of upwards movement of groundwater from underlying shallow overburden as the vertical gradient is downwards at PZ8. Furthermore, the lateral groundwater flow direction is towards the open cut mine, so a likely source of higher EC water could be from the west of PZ8S, e.g. Wollombi Brook. This could very likely be from evapo-concentration of Wollombi Brook water which gets flushed through the alluvium towards PZ8S with the onset of rainfall and stream flow. Nonetheless, in Q4 EC declined, supporting the initial flush of slightly more saline water through the alluvial system.

6.4.3 Permian Coal Measures

Routine monitoring of EC and pH in groundwater samples collected was conducted for all monitoring bores intersecting the Permian coal measures and overburden material on a quarterly basis over 2020. Exceptions to this include:

- OH1125(2) which could not be sampled as the bore was dry over 2020;
- OH1137 which was dry over 2020; and
- WOH2156B which had insufficient water for sampling in Q1, Q2, and Q4.

Groundwater quality for the Permian Coal Measures in 2020 varied between the different units, as discussed below.

- In 2020, in groundwater samples collected from within the shallow overburden material of the Permian coal measures recorded EC that ranged between 1,610 µS/cm and 17,910 µS/cm and pH ranges between 5.8 and 7.7.
- During 2020, in groundwater samples collected from within the Permian coal measures recorded EC that ranged between 1,530 µS/cm and 23,100 µS/cm and pH ranges between 5.9 and 8.0.

In accordance with the WMP full water quality analysis was conducted for the bores targeting the Permian coal measures. The exceptions are outlined above. Full water quality data is presented in **Appendix D** and summarised below:

Full water quality data from groundwater collected from bores within the shallow overburden:

- Total aluminium: concentrations ranged from below the LOR of 0.01 mg/L to 1.69 mg/L (PZ9D);
- Total arsenic: concentrations ranged from below the LOR of 0.001 mg/L to 0.024 mg/L (PZ9D);
- Total cadmium: all bores reported concentrations which were below the LOR of 0.0001 mg/L;
- Total copper concentrations ranged from below the LOR of 0.001 mg/L to 0.191 mg/L (PZ9D);
- Total lead concentrations ranged from below the LOR of 0.001 mg/L to 0.022 mg/L (PZ9D);
- Total nickel concentrations ranged from below the LOR of 0.001 mg/L to 0.152 mg/L (PZ8D);
- Total selenium: concentrations were below the LOR of 0.01 mg/L for all bores;
- Total zinc: concentrations ranged from below the LOR of 0.005 mg/L to 0.347 mg/L (PZ9D);
- Total boron: concentrations ranged from 0.08 mg/L to 0.3 mg/L (MTD605P); and
- Total mercury: concentrations were below the LOR of 0.0001 mg/L for all bores.

Full water quality data from groundwater collected from bores within the Permian Coal Measures:

- Total aluminium: concentrations ranged from below the LOR of 0.01 mg/L to 24 mg/L (WOH2153B);
- Total arsenic: concentrations ranged from below the LOR of 0.001 mg/L to 0.009 mg/L (OH1126);
- Total cadmium: concentrations ranged from below the LOR of 0.0001 mg/L to 0.0009 mg/L (OH1138(1));
- Total copper concentrations ranged from below the LOR of 0.001 mg/L to 0.041 mg/L (OH1127);
- Total lead concentrations ranged from below the LOR of 0.001 mg/L to 0.052 mg/L (OH1126);
- Total nickel concentrations ranged from below the LOR of 0.001 mg/L to 0.026 mg/L (OH1126);
- Total selenium: concentrations were below the LOR of 0.01 mg/L for all bores except GW98 MTCL 1 which recorded a concentration of 0.02 mg/L;
- Total zinc: concentrations ranged from below the LOR of 0.005 mg/L to 1.2 mg/L (OH1126);
- Total boron: concentrations ranged from below the LOR of 0.05 mg/L to 0.42 mg/L (GW9707); and
- Total mercury: concentrations were below the LOR of 0.0001 mg/L for all bores with the exception of (OH1138(1)) which recorded a concentration of 0.0018 mg/L.

6.4.3.1 Shallow Overburden Trigger Exceedances

Over the 2020 monitoring period, the following triggers were exceeded in groundwater samples collected from bores within the shallow overburden.

- Bore MTD605P recorded an EC above the trigger level of 17,488 µS/cm throughout 2020;
- Bore MTD616P below the lower pH trigger level of 6.8 throughout 2020.
- Bore MB15MTW01D recorded a pH below the lower trigger level of 6.8 throughout 2020.

6.4.3.2 Permian Coal Measures Trigger Exceedances

Over the 2020 monitoring period, the following triggers were exceeded in groundwater samples collected from bores within the Permian coal measures:

- Bore WD625P exceeded the EC trigger level of 12,086 µS/cm in Q1 and Q4.
- Bore GW9709 recorded EC marginally above the trigger level of 23,000 µS/cm in Q3.
- Bore WOH2141A exceeded the EC trigger level of 10,527 µS/cm in Q1, Q2 and Q4.
- Bore WOH2153A recorded pH values above the upper trigger level of 7.9 in Q1, Q2 and Q3.
- Bore WOH2139A recorded pH values above the upper trigger level of 7.9 in Q3.
- Bore OH1138 (1) recorded pH values below the lower trigger value of 6 in Q1 and Q3.
- Bore GW98MTCL2 below the lower pH trigger level of 6.6 in Q2 and Q4.

Further discussion on EC and pH trends for bores WOH2139A and OH1138(1) is included below.

Bore WOH2139A is located directly west of North Pit and intersects the Blakefield Seam with a total bore depth of 98 m. All pH results including quarterly and additional monthly monitoring results were above the upper trigger limit throughout 2020 and have been since August 2017. EC concentrations for bore WOH2139A were below the trigger throughout 2020; however, a significant increase in EC of 6,350 µS/cm was also observed between March and October 2017. Comparison of the data shows that changes in pH and EC are generally inversely proportional to variation in groundwater level, i.e. increasing as water levels decrease and vice versa. The trends for pH and EC in comparison to the SWL in the bore are presented in **Figure 6-24** and **Figure 6-25**. Given the proximity of WOH2139A to North Pit, the changes in water quality in relation to changes in water levels is expected.

The EC and pH values for bore WOH2139A are slightly different to those recorded in the other monitoring bores intersecting the Blakefield Seam (OH1122 (1) and OH1125 (1)). Within the monitoring network bore OH1125 (1) is located directly to the north of the North Pit, with bore OH1122 (1) located directly to the south of the West Pit. Review of historical and 2020 water quality data shows that pH and EC within the Blakefield Seam are variable at different locations within the unit, e.g. EC ~14,000 µS/cm at OH1125(1) and ~12,000 µS/cm at OH1122(1). It is possible for post-2017 water in WOH2139A to appear more similar to the other Blakefield Seam bores. There is potential for movement of groundwater and mixing of different water qualities given the larger hydraulic gradients in the aquifer caused by depressurisation and the groundwater system move towards a new equilibrium (physically and chemically). As recommended in the previous annual review, a review of the construction details and lithological logs for each bore should be undertaken to confirm that each bore is targeting the Blakefield Seam. A review of sampling techniques should be undertaken as it was previously identified that grab samples were taken at WOH2139A, whereas bore OH1122 (1) has been sampled using full purge techniques. The difference in techniques may therefore result in the variability in quality observed between the bores.

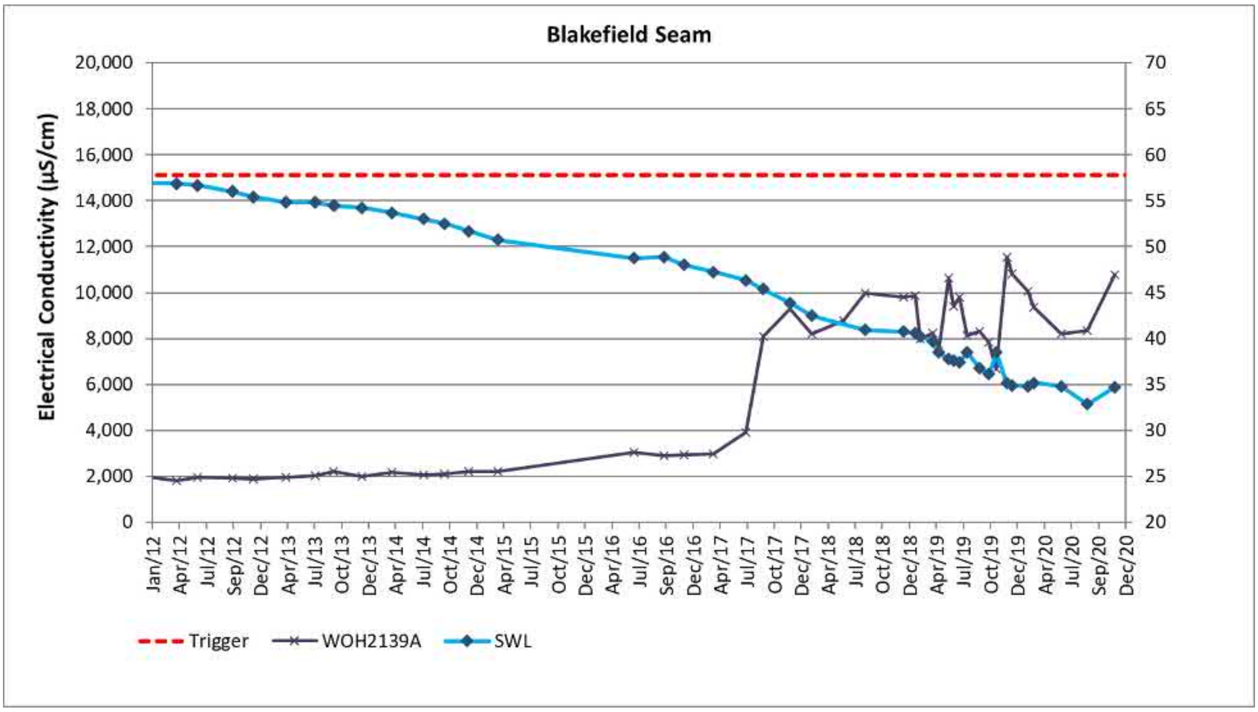

Figure 6-24 Electrical Conductivity and SWL Trends at WOH2139A

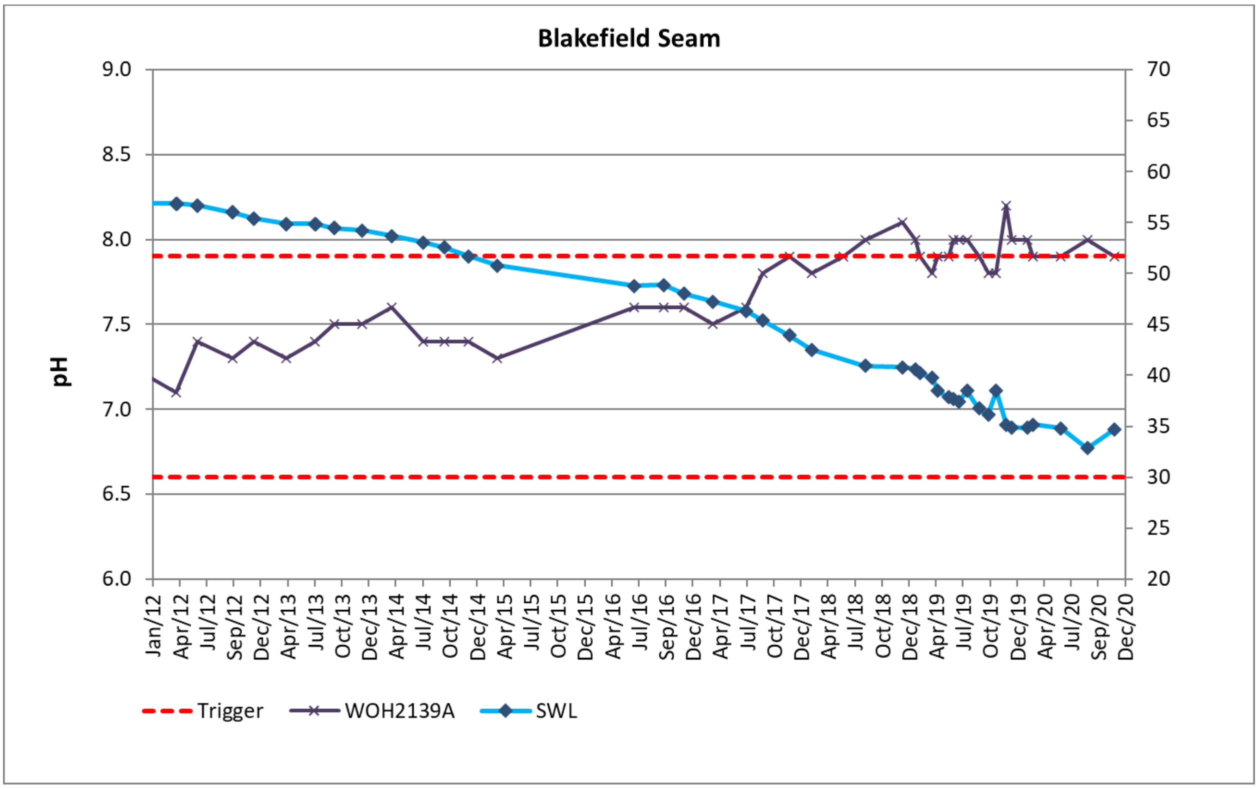

Figure 6-25 pH and SWL Trends at WOH2139A

Bore OH1138 is constructed as a nested bore with two discrete 32 mm PVC standpipes within the one borehole, both of which target the shallow Warkworth Seam. OH1138(1) is apparently screened from 20.8 m to 24.8 m depth and OH1138(2) is apparently screened from 38.8 m to 42.8 m depth. The bores are located on the north side of North Pit. Trends in water quality for the two bores are presented in **Figure 6-26.**

Exceedances of the lower trigger level for pH (6.3) has been ongoing since September 2017. Measured pH values during 2020 have remained relatively stable, although slightly lower than those recorded in 2019. Apart from the historical shift in pH values below the lower trigger level, there are no discernible ongoing trends. A comparison of groundwater elevations in OH1138(1) and OH1138 (2) indicate a potential downwards flow gradient at this location. This means there is potential for flow between the two depths within the Warkworth Seam; however, it does not indicate potential for impact to occur from a source at the ground surface. As discussed previously in the annual review for 2019, assessment of water quality data from the adjacent surface water dam 27N resulted in no clear correlation to trends in OH1138. Further assessment of groundwater flow directions and a detailed assessment of pH measurements in other monitoring bores in the network and within the Warkworth Seam could help in better understanding the changes that have occurred to the water quality in this bore. Additionally, the triggers for OH1138(1) should be revised to allow for detection of new trends and potential impact.

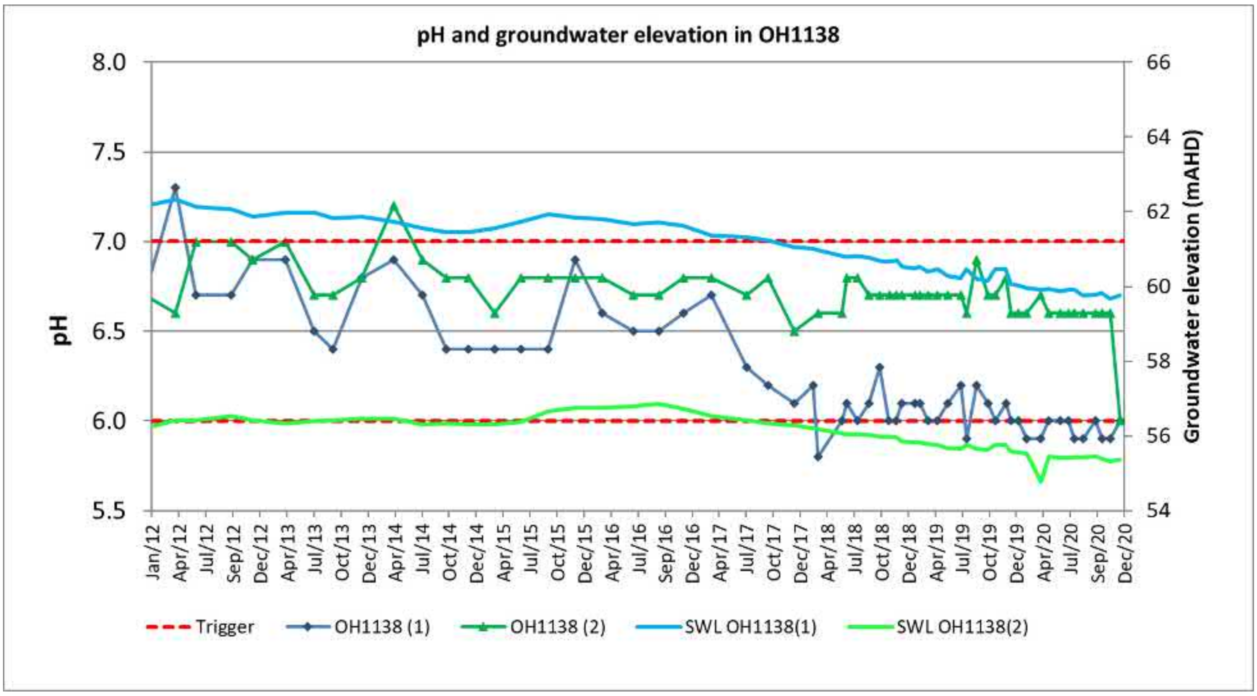

Figure 6-26 Water Quality Trends at OH1138(1) and OH1138(2)

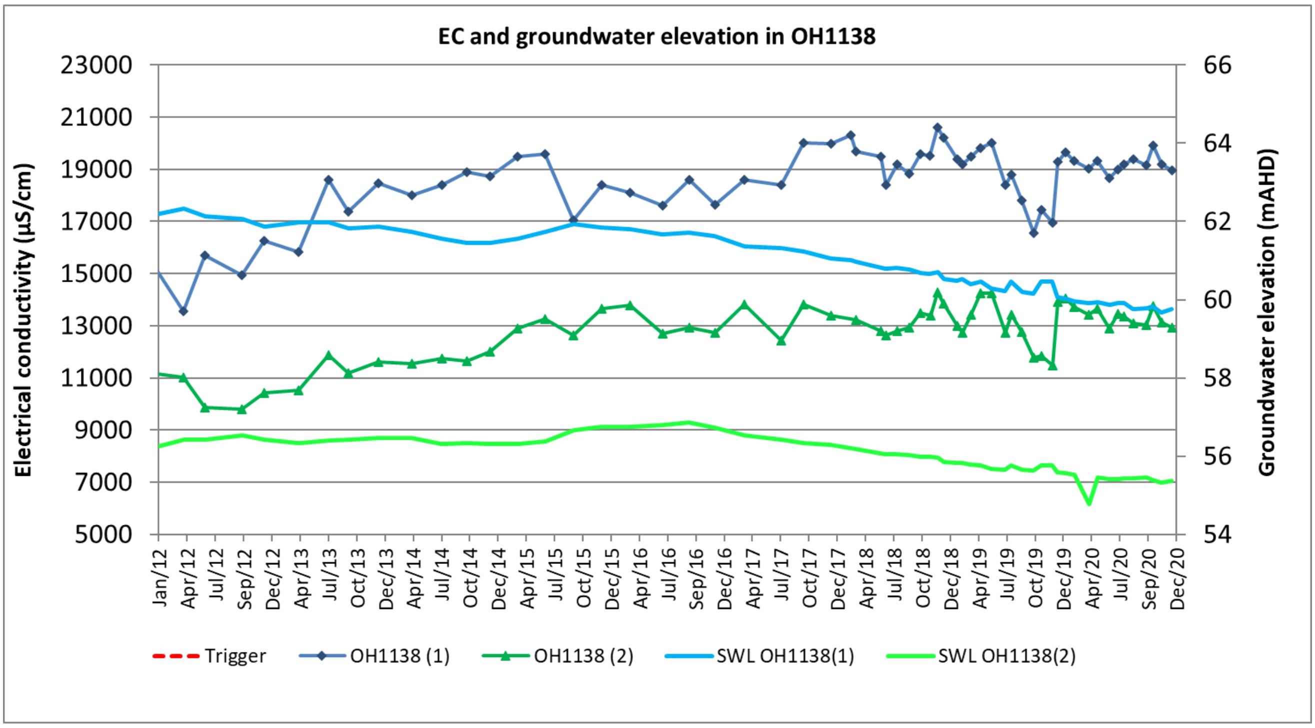

Figure 6-27 Electrical Conductivity and SWL Trends at OH1138(1) and OH1138(2)

6.5 Groundwater Take

Interception of groundwater occurs at site due to a range of activities, including direct interception of groundwater with mining activities, and indirect interception via induced inter-formation flows due to depressurisation of the Permian coal measures. Each activity and the estimated groundwater take for the various water sources is discussed below. Note, the information presented does not capture the full mine water balance but only a summary of available information provided to SLR.

6.5.1 Groundwater Inflows to Mine Operations

A numerical groundwater model was developed for MTW and updated by AGE (2015). The model was calibrated up to 2014 conditions and replicates mine progression to year 2035. As discussed in **Section 2.2**, AGE (2015) present predicted groundwater take (direct and indirect) from the various groundwater sources. AGE (2015) report that MTW operations were predicted to intercept up to approximately 500 ML of water from the North Coast Fractured and Porous Rock water source. AGE (2015) report that the predicted indirect interception of water, via inter-formational flows due to depressurisation of the Permian coal measures, for 2020 was approximately:

- 3.5 ML from the Hunter River Regulated Water Source;
- 11.5 ML from the Hunter Unregulated and Alluvial Water Sources; and
- 210 ML from the North Coast Fractured and Porous Rock water source.

6.5.2 Surface Water Abstraction

Over 2020, surface water was abstracted from the Hunter River in accordance with licence conditions. Metered volumes recorded by Yancoal show 1,455.2 ML of water was pumped from the Hunter River over the 2020 calendar year.

6.5.3 Groundwater Abstraction

Lemington Underground (LUG) bore is an abstraction bore at the Hunter Valley Operations. The bore is constructed into the abandoned LUG mine void underlying HVO and is licensed to take up to 1,800 ML of water from the North Coast Fractured and Porous Rock aquifer (WAL 39798) per water year (July to June). The licenses are held by HVO but utilised by MTW as part of a water sharing agreement.

The bore is equipped with a flow meter, with total monthly abstraction documented. Based on the flow volumes recorded from July 2019 to June 2020 a total of 1,475.2 ML of water was abstracted from the LUG bore, which is within the licensed allocation of 1,800 ML/year.

6.5.4 Summary of Water Take For 2020

Water take from the various groundwater and surface water sources associated with MTW are presented in **Table 6-4** for the 2020 calendar year. Abstraction volumes from the LUG bore are not presented within **Table 6-4** as they are reported through HVO’s licencing and reporting processes.

Table 6-4 Predicted Groundwater Take (ML) for 2020

	Hunter Regulated	Hunter Unregulated	North Coast Fractured and Porous Rock
Mt Thorley Pit Excavation	~0.5	~5.5	~80
Warkworth Pit Excavation	~3.0	~6.0	~130
Surface Water Abstraction	1,455.2	0	-
Total	**1,458.7**	**11.5**	**210**

As shown in **Table 6-4**, over the 2020 reporting year the total take under the Hunter River Regulated water source was estimated at 1,458.7 ML, total take from Hunter Unregulated water source was estimated at 11.5 ML and 210 ML from the North Coast Fractured and Porous Rock water source. These volumes are within the licensed volumes (see **Section 2.3**) for each water source.

6.6 Verification Model Predictions

In accordance with Schedule 3 Condition 26(b) (Mount Thorley SSD 6465) and Condition 27 (b) (Warkworth SSD 6464), the WMP includes requirements to review the numerical groundwater model every 3 years, comparing monitoring results with modelled predictions. The original numerical groundwater model for MTW was developed in 2014 as part of the Continuation Project (AGE, 2014a and AGE, 2014b). The model was developed using MODFLOW-SURFACT code to simulate groundwater response to mining over time. The model comprises 16 layers with 98,644 cells (76,089 active) per model layer. The numerical groundwater model was updated in 2015 by AGE (2015), with changes made to the model design (i.e. mine progress, extent of alluvium, flood levee and final void) and the hydraulic parameters recalibrated.

SLR were provided with the AGE (2015) numerical groundwater model predictions, which have been graphed against observed groundwater levels at the site in **Appendix E**. Review of the trends has identified that the predicted groundwater level trends generally correspond to trends within observed data. However, at a few of the bores and VWP sensors the model predicted less drawdown than observed, as discussed below:

- GW9707, GW9708, and GW9709 – groundwater observations recorded a decline from 2017 and through 2020 in the range of 1 m and 2.5 m compared to stable levels within the model. The model replicated the bores as being within layer 16 (basement) but construction details indicate the bores are within the shallow (<30 m deep) weathered Bayswater Seam.
- OH1123 – groundwater observations indicate a rapid decline in groundwater levels from 2014, while the model predicted a more gradual decline in groundwater levels. The difference appears to relate to actual mine progression, model cell discretisation and influence from abstraction from LUG Bore not captured in the model.
- OH1126, OH1137, and OH1138_2 – the bores intersect shallow (13 m to 53 m depth) Permian coal measures (Warkworth Seam and Vaux Seam) to the north of North Pit. The bores record a general decline in groundwater levels since 2008, while the model predicted a rise in groundwater levels. This difference may relate to how the model replicates recovery within the rehabilitated spoil at North Pit. The difference may also relate to influence of licenced groundwater abstraction from the Lemington Underground Bore that is not replicated within the model.

- WD462_P1 – is a VWP sensor that targets the Vaux Seam to the west of North Pit, which is mined down to the shallow Mt Arthur Seam. The VWP recorded a decline about 6 m in groundwater levels since July 2015, while the model predicted about 1 m decline in groundwater levels. As outlined within the AGE (2014a) groundwater assessment report, this likely relates to depressurisation of the seams below the base of the pit as well as cumulative impacts from surrounding operations.
- WOH2153A, WOH2154A, WOH2155A, and WOH2156A – all four bores are reported to intersect the Redbank Creek Seam at depths of between 30 m and 70 m. This seam is not present within the numerical groundwater model; therefore, the bores are represented in the model as intersecting the lower permeability interburden material in Layer 4.
- Recent trends in observed data vary from modelled at VWPs WD625_P3, WD615_P2, MTD605_P2, MTD605_P3, MTD605_P6, MTD605_P7, MTD613, MTD518, and WD609. The observed data appears inconsistent with historical trends and may reflect errors in data conversion.
- In contrast bore PZ9D was predicted to have higher drawdown than observed. The cause for discrepancy may relate to changes in mine scheduling and how pre-stripping and backfilling was captured within the model.

Overall, the numerical model appears to adequately replicate observed changes in groundwater levels for 2020 at most bores. However, work should be conducted to further refine the model predictions, as follows:

- Better match between actual mine progression and predicted mine progression (including spoil emplacement) for operations at MTW and surrounding mine operations;
- Include the licenced groundwater abstraction from LUG bore within the model;
- Include current climate and streamflow trends, as well as incorporate data from the installed bores (i.e. MB15MTW bores);
- Review calibrated parameters for spoil and vertical hydraulic conductivity within the Permian coal measures;
- Review monitoring bore construction details and confirm water bearing zones being monitored;
- Review the model structure and compare to the site geological model and available drill data; and
- Review data collected from VWPs including construction details and calibration certificates.

7 Conclusions and Recommendations

7.1 Conclusions

This annual groundwater review covers data collected over 2020 and was completed in compliance with:

- Warkworth Mine in accordance with Schedule 3 Condition 27 of the Warkworth Consent (SSD 6464); and
- Mt Thorley Mine in accordance with Schedule 3 Condition 25 of Development Consent (SSD 6465)

During 2020, operations across MTW included active mining at North Pit, Loders Pit and West Pit. Tailings Dam 1 has been rehabilitated, and Tailings Dam 2 is undergoing rehabilitation.

Review of climate data indicates that the region has experienced significant above average rainfall in February to March 2020 and in December 2020. Stream levels fluctuated throughout the year in Wollombi Brook in response to rainfall and surface water flows.

The groundwater bore network at MTW has been installed progressively over the life of the operations and acquired through land purchase. In accordance with the WMP 60 open standpipe bores require routine SWL and quality monitoring. The WMP also requires routine SWL monitoring of 10 VWPs, however based on discussion with site personnel and review of the data it is understood some of the VWP sensors may not be fully operational due to a range of factors (i.e. batteries, pressurisation of sensors above their working limit). To ensure that water level data continues to be collected across all aquifer units a review of all bores and VWPs in which logger / sensor failures have been reported should be undertaken. The review should include an assessment into whether the faulty logger / sensor can be repaired or whether replacement / rectification works are required.

Available VWP and monitoring bore logger data was reviewed to assess trends in groundwater levels over 2020. The data indicates that where saturated, groundwater elevations within the alluvium have started trending upwards in line with climate and stream flow trends. Groundwater within the Permian coal measures were mostly declining after exhibiting temporary head increases following above average rainfall events. Where observed, the decreasing elevations are believed to be attributed to depressurisation of the coal seams in relation to mining activities. The groundwater drawdown appears in line with the predicted drawdown with the coal measures around active mine areas.

As per the WMP, pH and EC concentrations are monitored on a quarterly basis at nominated bores, with a larger suite of analytes reviewed annually. Review of water quality results and comparison to trigger levels for EC and pH identified several trigger exceedances over 2020. It was identified that groundwater samples collected from several bores exceeded triggers for EC and pH; however, 2020 readings were in line with historical trends for these bores. It is also noted that MTW's sampling methodology for 2020 has remained the same as 2019 following changes made in response to annual review recommendations in 2018. It is recommended that a review of the triggers be undertaken in light of the revised sampling methodology. Groundwater quality trends outside of historical trends were observed for bore OH1138 and WOH2139A, which likely relate to potential movement of groundwater and mixing of different water qualities given the larger hydraulic gradients in the aquifer caused by depressurisation and the groundwater system moving towards a new equilibrium (physically and chemically).

In 2020, monitoring of the groundwater bore network was generally conducted in accordance with the GMP outlined within the WMP. Following recommendations made in the 2018 Annual Review, quarterly sampling methodologies were changed in 2019 and continued to be implemented in 2020, to be in general accordance with relevant standards. Annual water quality samples were also collected in general accordance with relevant standards. The exception to this was generally for cases where the condition of the bores (i.e. 32 mm casing) inhibited the ability to collect representative samples. Grab samples have been taken for monitoring bores WOH1239A, WOH2141A, WOH2153A, WOH1254A, WOH2155A, WOH2156A, WD622P, MBW02 and MBW03 within the network. This approach is not in line with industry standards and may not provide a representative water quality sample. The justification for this methodology should be reviewed to determine if more suitable methods (i.e. full purge or low flow) can be applied. A review into the requirement of these bores for the collection of water quality data for the WMP should be undertaken. If it is found that the continued collection of water quality data is required from a bore and suitable sampling methods cannot be adopted, then bore rectification works should be considered.

During 2020 water level and water quality readings were not taken at 14 bore locations due to a range of factors, such as dry or blocked bore conditions, insufficient water available due to purging methodology and access restrictions.

Quantification of groundwater take was undertaken based on reported volumes estimated for approved operations by AGE (2015) and metered abstraction volumes from bores and surface water pumps. Based on this, over the 2020 reporting year the total take under the Hunter Regulated water source was estimated at 1,458.7 ML. Total take from Hunter Unregulated water source was estimated at 11.5 ML and 210 ML from the North Coast Fractured and Porous Rock water source.

Comparison of observed groundwater levels against predicted levels generated from the numerical groundwater model were made. Overall, the numerical model was found to have adequately replicated observed changes in groundwater levels for 2020. Where modelled and observed values were significantly different, it was largely found that the difference in values could be attributed to differences in actual and predicted site conditions (i.e. climatic conditions, changes to mine progression / activities etc). A number of recommendations are therefore related to updating the model including a review of VWP data and construction, better matching of actual mine progression, inclusion of the LUG bore abstraction and the inclusion of current climate and streamflow trends.

Overall, the current monitoring network and program is generally adequate for satisfying current monitoring requirements of the WMP. There is good spatial of coverage of monitoring locations across the site, with multiple bores and VWP sensors installed into each relevant aquifer unit. To ensure this is maintained a network review should be undertaken with the purpose of identifying existing monitoring infrastructure that may need rectification or replacement due to potential impacts from current and future mining.

7.2 Recommendations

Based on review of the available data for 2020, the following recommendations have been made:

- Review the groundwater monitoring network and program to more clearly identify the purpose of each bore based on its location and construction, and align the compliance conditions to this purpose. Including inclusion of newly installed monitoring points and removal or replacement of bores/sensors from the program that have been identified as destroyed/erroneous.
- Check surveyed ground and casing elevations for bores including MBW6A and OH1125 (2).
- Check standpipe stickup measurements for MTD605P, MTD614P and MTD616P.

- Check VWPs and monitoring bore loggers are working correctly (i.e. check/replace batteries and logger depths) and adjust the site barometric logger to log on the hour (i.e. 9 am, 10 am, 11 am etc.).
- Recommended VWP sensor investigations and replacements/ removal include:
  - WD645 S1 (replace/ remove) and S5 (investigate first);
  - WD646R S2 (replace/ remove) and S5 (investigate first);
  - MTD605 S2 (investigate first) and S6 (replace/ remove); and
  - MTD616 P1 (investigate first – particularly noting the correct naming convention and sensor depth as there have been a range of names for this array of VWPs relating to different depths, e.g. P1, sensor 1, S1, VW1 etc.).
- Investigate ground conditions, bore construction and logger data for nested bore PZ7S and PZ7D.
- Installation of data logger within bore OH786 and replacement of logger for PZ7S.
- Review of logger installation depths for MB15MTW02S as the currently verified depth is not providing accurate water levels compared to manual dipped measurements. The standpipe stickup should also be checked for MB15MTW02S.
- Investigate the condition of the logger in MB15MTW03 and replace logger if it is found to be faulty.
- The monitoring methodology and bore logs should be assessed to devise a suitable method for attaining water quality samples. This is important as the last full water quality suite analysis undertaken for OH786 was in June 2016.
- Review the bore condition and construction records to verify the total bore depth for OH787.
- Review the bore logs for MB15MTW01S and MB15MTW02S to determine whether target geology is alluvium or weathered Permian coal measures.
- Review bore logs for OH1121 to determine if the bore has been installed in the Vaux Seam which according to geology map should not be present at this location.
- Further investigation into site conditions around MTD616P should be undertaken to confirm that no land use changes or activities have caused rising groundwater level trends in this bore.
- Review of groundwater quality triggers to ensure they are reasonable and adequately capture historical trends for bores and account for changing climate conditions.
- Continue to update the numerical groundwater model to account for climate trends and actual mine progression activities that have evolved since the initial model development.

8 References

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APPENDIX A

Groundwater Monitoring Program

ID	Easting	Northing	Top of Casing Elevation (mAHD)	Bore Depth (m bTOC)	Geology	Groundwater Monitoring Program			
						Water Level	EC	pH	Full WQ
OH786a	320542	6392674	55.7	7.1	Regolith	Q	Q	Q	A
OH787	320982	6391921	50.0	12.1	Regolith	Q	Q	Q	A*
OH788	321482	6390967	45.4	22.1	Hunter River Alluvium	Q	Q	Q	A
OH942	320536	6392622	55.8	13.2	Regolith	Q	Q	Q	A*
OH943	321476	6390963	45.0	9.9	Hunter River Alluvium	Q	Q	Q	A
OH944	321113	6391035	47.9	8.2	Hunter River Alluvium	Q	Q	Q	A
G3(2)	317787	6385253	73.0	4.1	Wollombi Brook Alluvium				
PZ8S	317002	6385411	65.8		Wollombi Brook Alluvium	Q	Q	Q	A
PZ9S	317542	6385642	65.4	6.9	Wollombi Brook Alluvium	Q	Q	Q	A
MB15MTW01S	315909	6385605			Wollombi Brook Alluvium	Q	Q	Q	A
MB15MTW02S	313823	6387224			Wollombi Brook Alluvium	Q	Q	Q	A
MBW01	314379	6386796	62.4	11.0	Alluvium	Q	Q	Q	A
PZ7S	314055	6392671	58.4	11.1	Aeolian Warkworth Sands	Q	Q	Q	A
MB15MTW04	314993	6392645		6.5	Warkworth Sands	Q	Q	Q	A
MB15MTW05	314645	6392758		6.9	Warkworth Sands	Q	Q	Q	A
MB15MTW06	314438	6392801		6.9	Warkworth Sands	Q	Q	Q	A
MB15MTW07	314965	6392085		6.8	Warkworth Sands	Q	Q	Q	A
MB15MTW08	314296	6392182		6.8	Warkworth Sands	Q	Q	Q	A
MB15MTW09	313995	6392219		3.1	Warkworth Sands	Q	Q	Q	A
MB15MTW10	314667	6392134		3.7	Warkworth Sands	Q	Q	Q	A
MB15MTW11	314352	6392417		6.9	Warkworth Sands	Q	Q	Q	A
PZ7D	314057	6392684	58.4	30.5	Shallow Overburden	Q	Q	Q	A
PZ8D	317001	6385418	65.8	37.0	Shallow Overburden	Q	Q	Q	A
PZ9D	317541	6385652	65.5	24.0	Shallow Overburden	Q	Q	Q	A
MTD616P	316269	6387618	77.8	29.0	Shallow Overburden	Q	Q	Q	A
MTD614P	317259	6386175	72.6	30.0	Shallow Overburden - Conglomerate	Q	Q	Q	A
MBW02	314373	6386798	62.6	60.4	Shallow Overburden	Q	Q	Q	A
MB15MTW01D	315910	6385604			Shallow Overburden? Alluvium?	Q	Q	Q	A
MTD605P	316279	6386156	77.4	42.0	Shallow Overburden - sandstone	Q	Q	Q	A
MB15MTW02D	313823	6387219			Shallow Overburden? Alluvium?	Q	Q	Q	A
MB15MTW03	313722	6388917		22.7	Shallow Overburden - Wollombi alluvium?	Q	Q	Q	A
WD625P	314669	6390487	76.4	31.0	Whybrow Seam	Q	Q	Q	A
WOH2153A	313881	6391429	68.3	42.6	Redbank Crk Seam	Q	Q	Q	A
WOH2154A	313976	6389990	68.9	69.4	Redbank Crk Seam	Q	Q	Q	A
WOH2155A	315278	6390138	74.6	46.0	Redbank Crk Seam	Q	Q	Q	A
WOH2156A	315874	6388866	80.4	31.5	Redbank Crk Seam	Q	Q	Q	A
WOH2153B	313881	6391429	68.3	62.4	Wambo Seam	Q	Q	Q	A
WOH2154B	313976	6389990	68.9	98.0	Wambo Seam	Q	Q	Q	A
WOH2155B	315278	6390138	74.6	73.1	Wambo Seam	Q	Q	Q	A
WOH2156B	315874	6388866	80.4	80.1	Wambo Seam	Q	Q	Q	A
WD622P	316229	6389585	84.5	55.0	Wambo Seam	Q	Q	Q	A
MBW04	314368	6386800	62.4	162.0	Wambo	Q	Q	Q	A
WOH2139A	315249	6391511	91.7	96.0	Blakefield	Q	Q	Q	A*
OH1122 (1)	318545	6387886	100.6	49.6	Blakefield Seam	Q	Q	Q	A*
OH1122 (2)	318545	6387886	100.6	112.6	Woodlands Hill Seam				
OH1122 (3)	318545	6387886	100.6	152.6	Bowfield Seam				
OH1125 (1)	316511	6392875	86.2	40.0	Blakefield	Q	Q	Q	A*

ID	Easting	Northing	Top of Casing Elevation (mAHD)	Bore Depth (m bTOC)	Geology	Groundwater Monitoring Program			
						Water Level	EC	pH	Full WQ
OH1125 (2)	316511	6392875	86.2	25.3	Unknown - Blakefield?	Q	Q	Q	A*
OH1125 (3)	316511	6392875	86.2	62.7	Bowfield Seam	Q	Q	Q	A*
OH1138 (1)	317835	6393346	70.7	24.8	Warkworth Seam	Q	Q	Q	A
OH1138 (2)	317835	6393346	70.7	42.8	Warkworth Seam	Q	Q	Q	A
OH1121	321902	6391030	45.6	20.3	Vane Subgroup	Q	Q	Q	A
OH1126	318586	6393387	64.5	52.5	Vaux	Q	Q	Q	A
OH1137	318266	6393377	67.9	17.8	Vaux	Q	Q	Q	A
OH1127	321444	6392097	51.2	29.0	Vane Subgroup	Q	Q	Q	A
GW 9706	322404	6387589	64.2	21.2	Bayswater	Q	Q	Q	A
GW 9707	322319	6387569	63.9	21.0	Bayswater	Q	Q	Q	A
GW 9708	322158	6387209	73.1	29.6	Bayswater	Q	Q	Q	A
GW 9709	322251	6388026	60.3	21.0	Bayswater	Q	Q	Q	A
GW98MTCL1	322188	6387032	77.8	19.7	Bayswater	Q	Q	Q	A
GW98MTCL2	322669	6387462	79.5	27.6	Bayswater	Q	Q	Q	A
WOH2141A	314989	6392647	91.6	45.6	Whynot Seam	Q	Q	Q	A
PZ1_VW1	321350	6387310	72.1	41.0	Mt Arthur Seam (Shallow)	Q			
PZ1_VW2	321350	6387310	72.1	42.0	Mt Arthur Seam (Deep)	Q			
PZ2_VW1	321445	6387218	68.1	48.6	Mt Arthur Seam (Shallow)	Q			
PZ2_VW2	321445	6387218	68.1	49.6	Mt Arthur Seam (Deep)	Q			
WD609A	318803	63922	129.9	110.0	Spoil	Q			
WD615_P1	319281	6391347	160.0	133.0	Piercefield Seam	Q			
WD615_P2	319281	6391347	160.0	225.0	Bayswater Seam	Q			
WD625_P1	314663	6390483	76.4	217.0	Woodlands Hill	Q			
WD625_P2	314663	6390483	76.4	354.0	Mt Arthur Seam	Q			
WD625_P3	314663	6390483	76.4	375.0	Vaux Seam	Q			
WD625_P4	314663	6390483	76.4	441.0	Bayswater Seam	Q			
WD622_P1	316236	6389588	84.5	54.0	Wambo Seam	Q			
WD622_P2	316236	6389588	84.5	165.0	Woodlands Hill Seam	Q			
WD622_P3	316236	6389588	84.5	314.0	Mt Arthur Seam	Q			
WD622_P4	316236	6389588	84.5	334.0	Vaux Seam	Q			
WD622_P5	316236	6389588	84.5	408.0	Bayswater Seam	Q			
MTD616_P1	316274	6387621	77.7	42.0	Whybrow Seam	Q			
MTD616_P2	316274	6387621	77.7	109.0	Wambo Seam	Q			
MTD616_P3	316274	6387621	77.7	215.0	Woodlands Hill Seam	Q			
MTD616_P4	316274	6387621	77.7	343.0	Mt Arthur Seam	Q			
MTD616_P5	316274	6387621	77.7	378.0	Vaux Seam	Q			
MTD616_P6	316274	6387621	77.7	446.0	Bayswater Seam	Q			
MTD613 (VWP)	320778	6387025	150.5	384.0	Broonie/Bayswater Seam?	Q			
MTD605_P1	316512	6386159	77.1	58.0	Weathered OB over Whybrow	Q			
MTD605_P2	316512	6386159	77.1	100.0	Whybrow Seam	Q			
MTD605_P3	316512	6386159	77.1	149.0	IB btw Wambo and Whynot	Q			
MTD605_P4	316512	6386159	77.1	215.0	Blakefield Seam	Q			
MTD605_P5	316512	6386159	77.1	368.0	Mt Arthur Seam	Q			
MTD605_P6	316512	6386159	77.1	429.0	Vaux Seam	Q			
MTD605_P7	316512	6386159	77.1	502.0	Bayswater Seam	Q			
MTD614_P1	317265	6386174	72.4	64.0	Whybrow Seam	Q			
MTD614_P2	317265	6386174	72.4	191.0	Glen Munro Seam	Q			
MTD614_P3	317265	6386174	72.4	342.0	Mt Arthur Seam	Q			
MTD614_P4	317265	6386174	72.4	383.0	Vaux Seam	Q			

ID	Easting	Northing	Top of Casing Elevation (mAHD)	Bore Depth (m bTOC)	Geology	Groundwater Monitoring Program			
						Water Level	EC	pH	Full WQ
MTD614_P5	317265	6386174	72.4	453.0	Bowfield Seam	Q			
WD456 (VWP)			100.6		Bayswater Seam	Q			
WD462_P1	315529	6391358	101.7	354.6	Vaux Seam	Q			
WD462_P2	315529	6391358	101.7	354.6	Bowfield Seam	Q			
WD462_P3	315529	6391358	101.7	354.6	Woodlands Hill Seam	Q			
MTD517_P1	317521	6386147	77.3		Mt Arthur Seam	Q			
MTD517_P2	317521	6386147	77.3		Woodlands Hill Seam	Q			
MTD517_P3	317521	6386147	77.3		Wambo Seam	Q			
MTD518_P1	316512	6386156	80.0		Mt Arthur Seam	Q			
MTD518_P2	316512	6386156	80.0		Blakefield/Woodlands Hill Seam	Q			
MTD518_P3	316512	6386156	80.0		Wambo Seam	Q			
MBW03	314387	6386794	62.4	84.2	Whybrow Seam	Q	Q	Q	A
MBW6A						Q	Q	Q	A

Notes:

TOC – top of casing
Q – Quarterly
A – Annual
 # Comprehensive analysis includes metals Mo, V and Cr

APPENDIX B

Groundwater Level and Quality Readings 2020

Bore ID	Target Geology	EC Trigger 95th	pH Trigger 5th –95th		Q1				Q2				Q3				Q4			
					SWL mbTOC	SWL mAHD	pH	EC	SWL mbTOC	SWL mAHD	pH	EC	SWL mbTOC	SWL mAHD	pH	EC	SWL mbTOC	SWL mAHD	pH	EC
OH786	Regolith	1311	6.7	7.7	1.8	53.85	7.2	872	2.15	53.5	**8**	892	1.07	54.58	7.2	**560**	0.84	54.81	7.3	748
OH787	Regolith	18467	7.2	7.7	13.98	35.98	7.5	**19450**	14	35.96	7.6	**18830**	14.01	35.95	7.3	**19610**	14.03	35.93	7.4	**19370**
OH788	Hunter River Alluvium	12234	7	7.9	10.05	35.33	7	**13760**	10.06	35.32	**7**	12080	10.04	35.34	**7**	**12270**	10.01	35.37	**7**	**12340**
OH942	Regolith	25435	6.5	6.9	9.58	46.17	6.6	25100	9.56	46.19	6.6	23900	9.6	46.15	6.6	24700	9.65	46.1	6.6	24800
OH943	Hunter River Alluvium	8395	7.1	7.6	9.66	35.38	-	-	9.69	35.35	-	-	9.7	35.34	-	-	9.65	35.39	-	-
OH944	Hunter River Alluvium																			
G3(2)	Wollombi Brook Alluvium																			
PZ8S	Wollombi Brook Alluvium	15086	6.5	7	6.46	59.29	6.7	14520	6.38	59.37	6.6	14940	6.3	59.45	6.7	**15220**	6.24	59.51	6.6	14690
PZ9S	Wollombi Brook Alluvium	16197	6.8	7	6.82	58.61	-	-	6.78	58.65	-	-	6.77	58.66	-	-	6.78	58.65	-	-
MB15MTW01S	Wollombi Brook Alluvium				5.82	57.508	6.7	1395	5.69	57.638	6.5	1467	5.38	57.948	6.5	1892	5.46	57.868	6.5	2110
MB15MTW02S	Wollombi Brook Alluvium				5.34	56.78	6.7	2610	5.56	56.56	6.9	2200	5.06	57.06	6.8	2190	5.44	56.68	6.9	1942
PZ7S	Aeolian Warkworth Sands	1749	6.7	7.5	8.06	50.38	6.7	1599	8.09	50.35	6.7	1491	8.18	50.26	6.9	1570	7.99	50.45	6.8	1441
MBW01	Alluvium				6.17	56.22	7.3	17480	6.2	56.19	7.3	17380	6.17	56.22	7.3	17750	6.15	56.24	7.3	18160
MB15MTW04	Warkworth Sands																			
MB15MTW05	Warkworth Sands																			
MB15MTW06	Warkworth Sands																			
MB15MTW07	Warkworth Sands																			
MB15MTW08	Warkworth Sands																			
MB15MTW09	Warkworth Sands																			
MB15MTW10	Warkworth Sands																			
MB15MTW11	Warkworth Sands																			

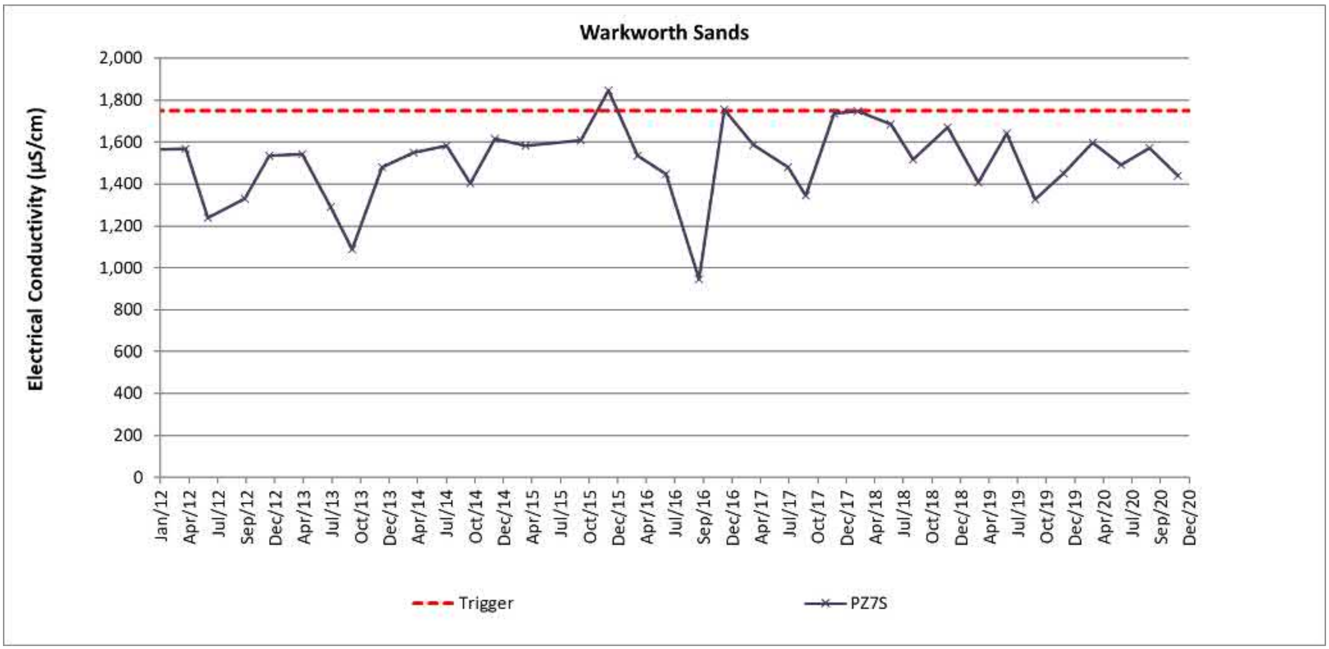
Bore ID	Target Geology	EC Trigger 95th	pH Trigger 5th –95th		Q1				Q2				Q3				Q4			
					SWL mbTOC	SWL mAHD	pH	EC	SWL mbTOC	SWL mAHD	pH	EC	SWL mbTOC	SWL mAHD	pH	EC	SWL mbTOC	SWL mAHD	pH	EC
PZ7D	Shallow Overburden	17488	6.8	8	7.84	50.58	7.4	1727	7.75	50.67	7.6	1752	7.73	50.69	7.6	1749	7.69	50.73	7.6	1741
PZ8D	Shallow Overburden	17488	6.8	8	7.22	58.55	7.4	8880	7.44	58.33	7.2	8550	7.33	58.44	7.5	8980	7.44	58.33	7.4	8690
PZ9D	Shallow Overburden	17488	6.8	8	18.4	47.12	7.1	15100	18.47	47.05	7	10190	18.44	47.08	7	10540	18.78	46.74	7	10490
MTD616P	Shallow Overburden	17488	6.8	8	5.96	71.86	**6.7**	15200	5.77	72.05	6.8	14920	6.38	71.44	6.8	14340	6.35	71.47	**6.7**	14330
MTD614P	Shallow Overburden - Conglomerate	17488	6.8	8	18.19	54.4	7.4	6500	18.2	54.39	7.2	6400	18.09	54.5	7.5	6670	18.19	54.4	7.2	6780
MBW02	Shallow Overburden	17488	6.8	8	8.63	53.98	7.2	11900	8.65	53.96	7.2	12370	8.61	54	7.2	10950	8.65	53.96	7.1	11330
MB15MTW01D	Shallow Overburden?	17488	6.8	8	6	57.333	**5.4**	976	5.79	57.543	**5.9**	2470	5.49	57.843	**5.8**	1610	5.69	57.643	**5.9**	1675
MTD605P	Shallow Overburden - sandstone	17488	6.8	8	15.04	62.32	7.2	**17910**	15.1	62.26	7.1	**17510**	15.11	62.25	7.3	**17780**	15.1	62.26	7.2	**17830**
MB15MTW02D	Shallow Overburden?	17488	6.8	8	6.31	55.701	7.6	10210	5.89	56.121	7.6	9910	5.85	56.161	7.6	9560	5.89	56.121	7.7	9970
MB15MTW03	Shallow Overburden?	17488	6.8	8	6.65	54.267	6.9	13150	6.58	54.337	6.9	12740	6.43	54.487	6.9	12520	6.39	54.527	6.8	12810
WD625P	Whybrow Seam	12086	7.1	7.3	18.98	57.42	7.2	**12230**	18.93	57.47	7.2	12020	19.05	57.35	7.1	11950	19.03	57.37	7.2	**12470**
MBW03	Whybrow Seam				8.32	54.05	7.2	9940	8.24	54.13	7.2	10550	8.15	54.22	7.2	10350	8.22	54.15	7.2	10390
WOH2153A	Redbank Crk Seam	15948	7	7.9	16.07	52.19	**8**	2650	15.13	53.13	**8**	2610	16.32	51.94	**8**	2570	16.3	51.96	7.9	2740
WOH2154A	Redbank Crk Seam	15948	7	7.9	18.87	50.02	7.6	4860	17.8	51.09	7.6	4800	19	49.89	7.6	4660	19.95	48.94	7.5	4960
WOH2155A	Redbank Crk Seam	15948	7	7.9	25.1	49.45	7.3	8890	23.36	51.19	7.3	8910	25.73	48.82	7.2	8730	27.94	46.61	7.2	9170
WOH2156A	Redbank Crk Seam	15948	7	7.9	33.69	46.69	7	15120	32.26	48.12	7.1	14800	33.41	46.97	7	14580	35.24	45.14	7	15050
WOH2153B	Wambo Seam	14080	7	7.8	11.13	57.13	7.3	1673	10.8	57.46	7.3	1629	11.24	57.02	7.1	1530	11.33	56.93	7	1576
WOH2154B	Wambo Seam	14080	7	7.8	13.79	55.1	7.4	8770	13.75	55.14	7.4	8690	13.92	54.97	7.4	8660	13.53	55.36	7.2	9150
WOH2155B	Wambo Seam	14080	7	7.8	15.55	59	7.6	5680	15.71	58.84	7.6	5500	16.19	58.36	7.6	5490	16.24	58.31	7.4	7190

Bore ID	Target Geology	EC Trigger 95th	pH Trigger 5th –95th		Q1				Q2				Q3				Q4			
					SWL mbTOC	SWL mAHD	pH	EC	SWL mbTOC	SWL mAHD	pH	EC	SWL mbTOC	SWL mAHD	pH	EC	SWL mbTOC	SWL mAHD	pH	EC
WOH2156B	Wambo Seam	14080	7	7.8	12.67	67.71	-	-	12.76	67.62	-	-	12.98	67.4	7.4	13770	13.76	66.62	-	-
WD622P	Wambo Seam	14080	7	7.8	37.7	46.76	7.4	8970	35.31	49.15	7.4	8500	37.84	46.62	7.3	8450	40.85	43.61	7.3	8560
MBW04	Wambo	14080	7	7.8	12.91	49.52	7.5	13060	13.15	49.28	7.6	12920	13.16	49.27	7.5	12820	13.35	49.08	7.3	13320
WOH2139A	Blakefield	15106	6.6	7.9	56.55	35.16	7.9	9350	56.89	34.82	7.9	8210	58.86	32.85	**8**	8350	57	34.71	7.9	10800
OH1122 (1)	Blakefield Seam	15106	6.6	7.9	48.8	51.75	7.1	12230	48.99	51.56	7.1	12420	49.66	50.89	7.1	12530	49.96	50.59	7	12200
OH1125 (1)	Blakefield	15106	6.6	7.9	34.44	51.76	6.7	13720	35.11	51.09	6.7	14590	35.26	50.94	6.7	13970	36.64	49.56	6.7	14020
OH1125 (2)	Unknown																			
OH1125 (3)	Bowfield Seam	14656	6.6	6.9	54.31	31.89	6.8	13730	53.79	32.41	6.7	14100	53.9	32.3	6.7	14230	54.93	31.27	6.8	13850
OH1138 (1)	Warkworth	19995	6	7	10.8	59.92	**5.9**	19020	10.81	59.91	6	18990	10.81	59.91	**5.9**	19180	10.95	59.77	6	18960
OH1138 (2)	Warkworth	19995	6	7	15.95	54.77	6.7	13420	15.31	55.41	6.6	13460	15.28	55.44	6.6	13360	15.36	55.36	6	12930
OH1121	Vane Subgroup	17765	6.7	7.1	10.82	34.82	7	8900	10.82	34.82	7	8300	10.78	34.86	6.9	8950	10.78	34.86	6.9	10000
OH1126	Vaux	17765	6.7	7.1	18.51	46.01	6.8	14790	18.81	45.71	6.8	15100	18.81	45.71	6.7	13640	18.79	45.73	6.7	14290
OH1137	Vaux	17765	6.7	7.1																
OH1127	Vane Subgroup	23000	6.6	7.5	15.95	35.27	6.9	11950	15.96	35.26	6.9	11750	15.95	35.27	6.8	12350	15.98	35.24	6.9	12040
GW 9706	Bayswater	23000	6.6	7.5	2.84	61.4	6.8	4340	2.85	61.39	6.9	4510	2.56	61.68	7	4710	2.73	61.51	6.9	4750
GW 9707	Bayswater	23000	6.6	7.5	6.39	57.54	6.7	20100	6.2	57.73	6.9	19600	5.98	57.95	6.9	21200	6.03	57.9	7	20700
GW 9708	Bayswater	23000	6.6	7.5	12.71	60.43	6.7	13890	11.79	61.35	6.7	12410	11.84	61.3	6.7	13060	11.82	61.32	6.7	12880
GW 9709	Bayswater	23000	6.6	7.5	9.69	50.64	6.7	21500	9.58	50.75	6.8	21100	9.37	50.96	7	**23100**	9.45	50.88	**6.8**	**22700**
GW98MTCL1	Bayswater	23000	6.6	7.5	10.33	67.42	7.1	6500	11.15	66.6	7.1	6120	10.42	67.33	7.2	6160	10.8	66.95	7.2	5970
GW98MTCL2	Bayswater	23000	6.6	7.5	11.1	68.37	6.6	16380	10.96	68.51	**6.5**	16370	10.93	68.54	6.6	16620	10.94	68.53	**6.5**	16450
WOH2141A	Whynot Seam	10527	7.5	7.8	44.58	47.01	7.8	**10940**	44.71	46.88	7.8	**10580**	44.75	46.84	7.7	9980	44.48	47.11	7.7	**10650**
MBW6A					7.4		6.3	780	7.07		6.5	684	6.7		6.6	492	6.92		6.5	512

***Note**: SWL – standing water level*
mbTOC – meters below top of casing
NS – Casing elevation not surveyed
"-" – insufficient water

APPENDIX C

Groundwater Quality Graphs


Warkworth Sands
Electrical Conductivity (µS/cm)
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
Jan/12
Apr/12
Jul/12
Sep/12
Dec/12
Apr/13
Jul/13
Oct/13
Dec/13
Apr/14
Jul/14
Oct/14
Dec/14
Apr/15
Jul/15
Oct/15
Dec/15
Apr/16
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Oct/17
Dec/17
Apr/18
Jul/18
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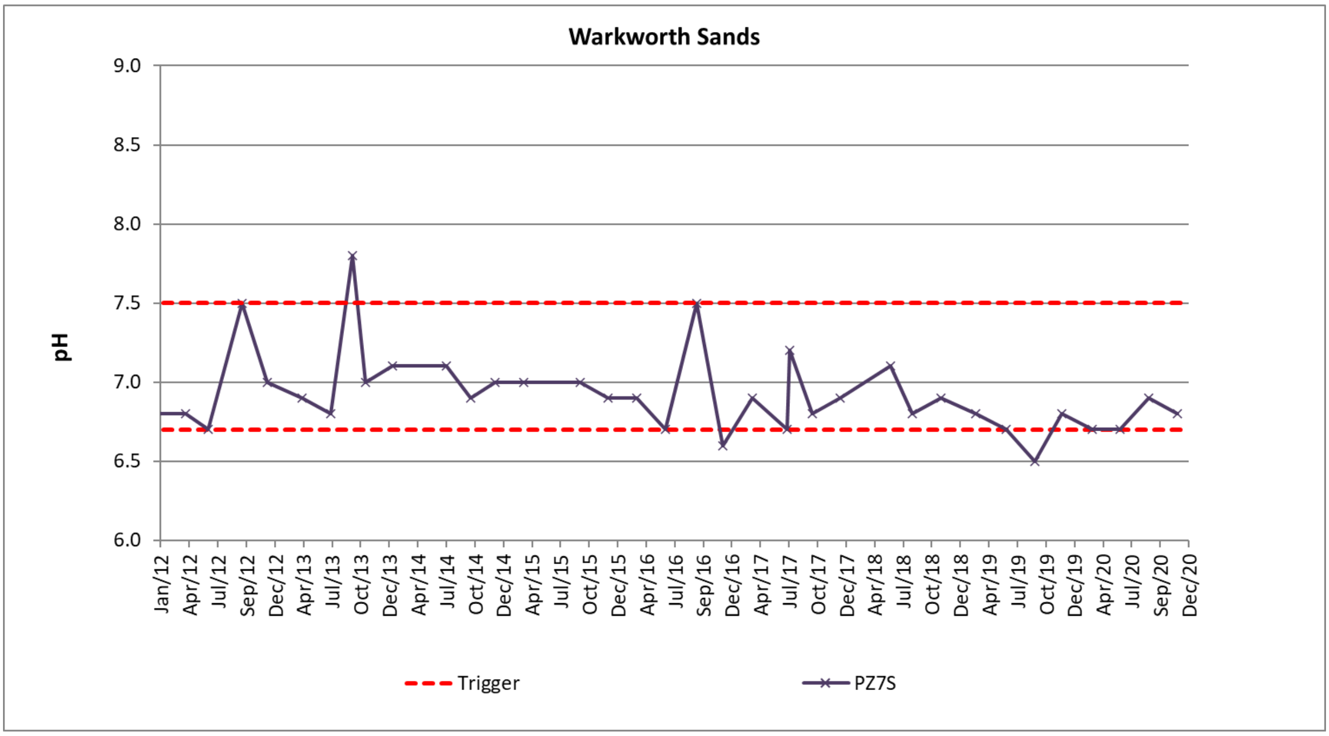
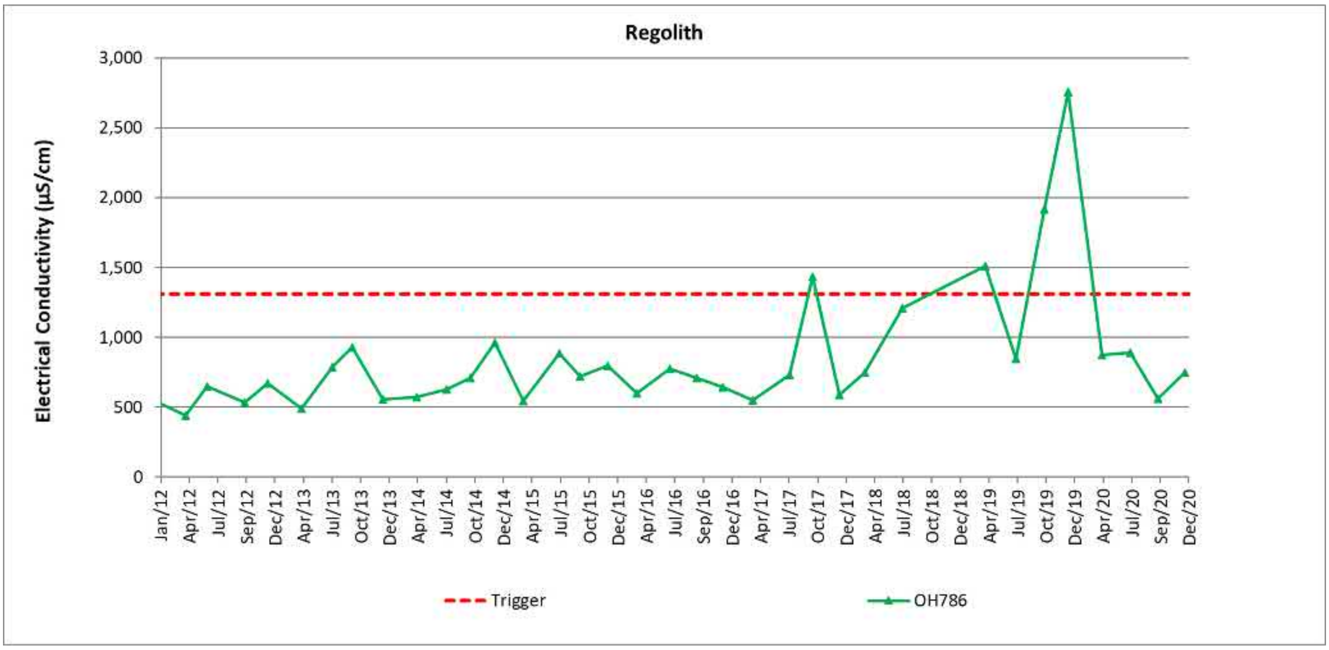
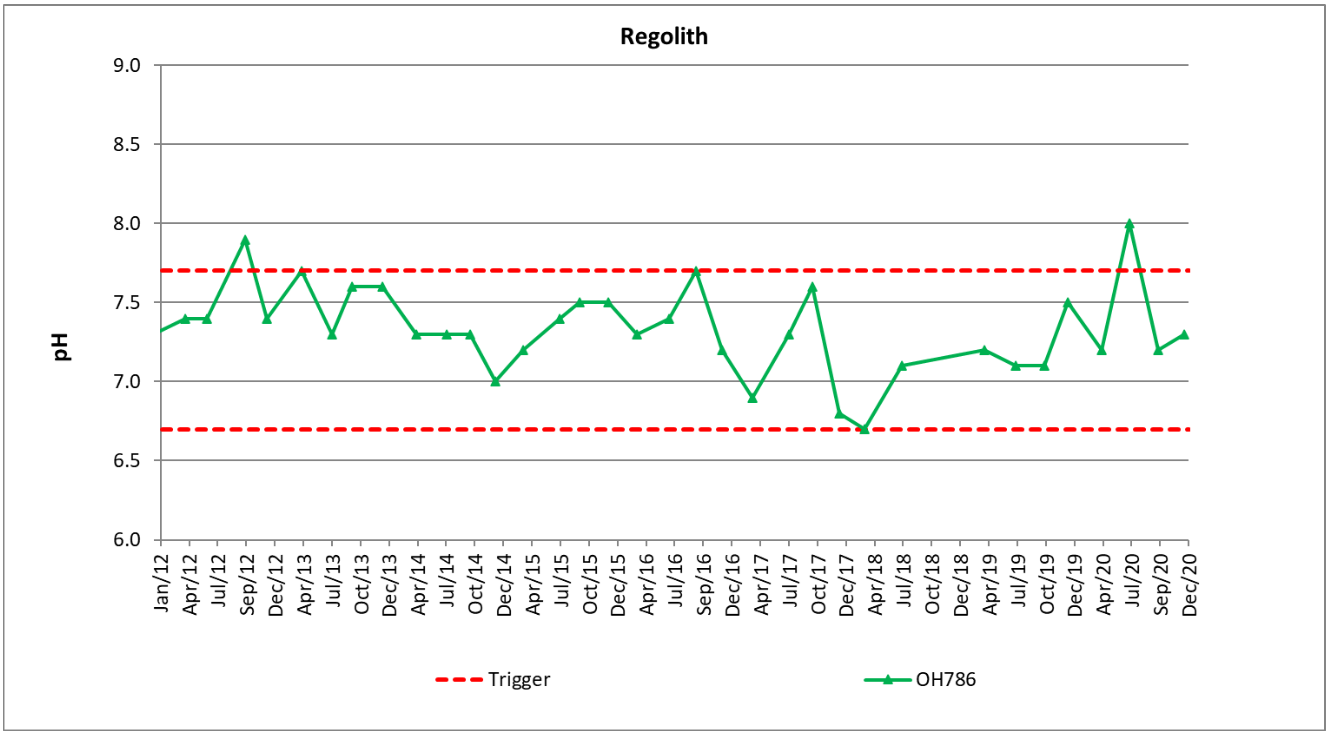
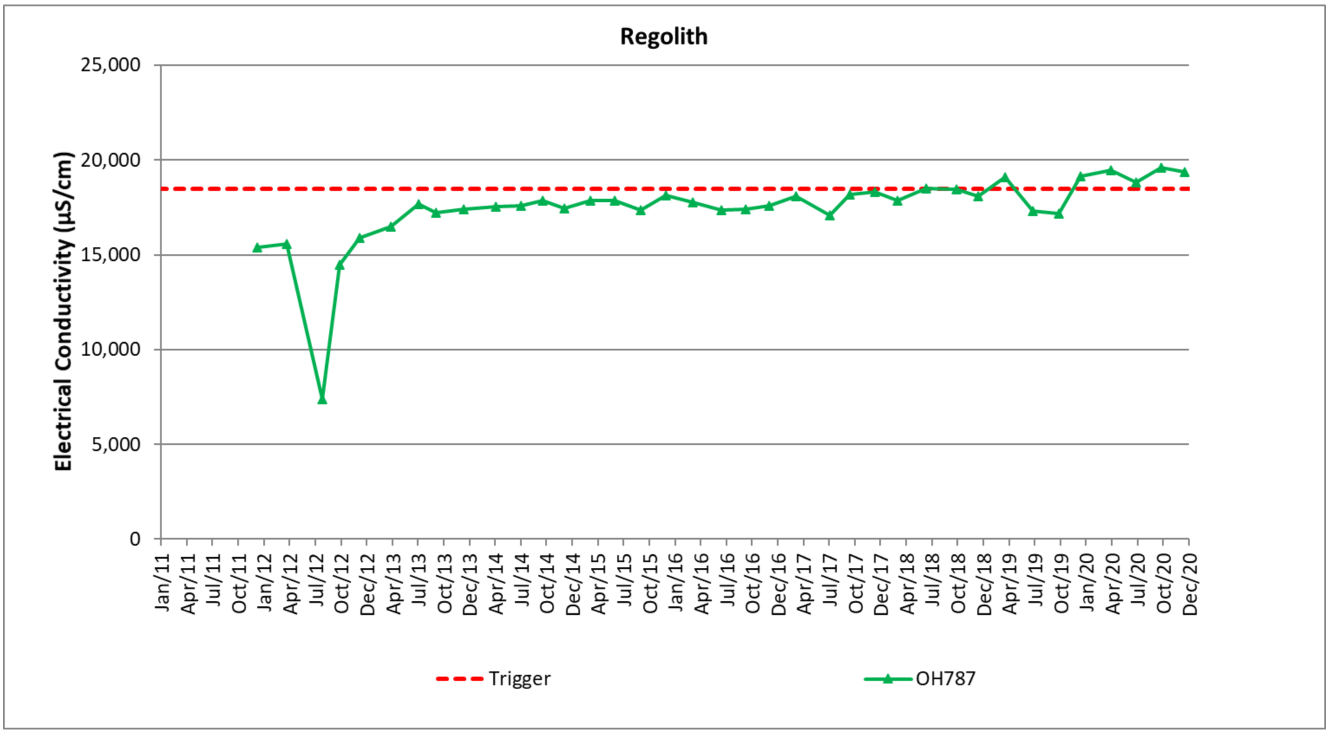
Jul/20
Sep/20
Dec/20
Trigger
PZ7S


Warkworth Sands
pH
9.0
8.5
8.0
7.5
7.0
6.5
6.0
Jan/12
Apr/12
Jul/12
Sep/12
Dec/12
Apr/13
Jul/13
Oct/13
Dec/13
Apr/14
Jul/14
Oct/14
Dec/14
Apr/15
Jul/15
Oct/15
Dec/15
Apr/16
Jul/16
Sep/16
Dec/16
Apr/17
Jul/17
Oct/17
Dec/17
Apr/18
Jul/18
Oct/18
Dec/18
Apr/19
Jul/19
Oct/19
Dec/19
Apr/20
Jul/20
Sep/20
Dec/20
Trigger
PZ7S


Regolith
Electrical Conductivity (µS/cm)
3,000
2,500
2,000
1,500
1,000
500
0
Jan/12
Apr/12
Jul/12
Sep/12
Dec/12
Apr/13
Jul/13
Oct/13
Dec/13
Apr/14
Jul/14
Oct/14
Dec/14
Apr/15
Jul/15
Oct/15
Dec/15
Apr/16
Jul/16
Sep/16
Dec/16
Apr/17
Jul/17
Oct/17
Dec/17
Apr/18
Jul/18
Oct/18
Dec/18
Apr/19
Jul/19
Oct/19
Dec/19
Apr/20
Jul/20
Sep/20
Dec/20
Trigger
OH786


Regolith
pH
9.0
8.5
8.0
7.5
7.0
6.5
6.0
Jan/12
Apr/12
Jul/12
Sep/12
Dec/12
Apr/13
Jul/13
Oct/13
Dec/13
Apr/14
Jul/14
Oct/14
Dec/14
Apr/15
Jul/15
Oct/15
Dec/15
Apr/16
Jul/16
Sep/16
Dec/16
Apr/17
Jul/17
Oct/17
Dec/17
Apr/18
Jul/18
Oct/18
Dec/18
Apr/19
Jul/19
Oct/19
Dec/19
Apr/20
Jul/20
Sep/20
Dec/20
Trigger
OH786


Regolith
Electrical Conductivity (µS/cm)
25,000
20,000
15,000
10,000
5,000
0
Jan/11
Apr/11
Jul/11
Oct/11
Jan/12
Apr/12
Jul/12
Oct/12
Dec/12
Apr/13
Jul/13
Oct/13
Dec/13
Apr/14
Jul/14
Oct/14
Dec/14
Apr/15
Jul/15
Oct/15
Jan/16
Apr/16
Jul/16
Oct/16
Dec/16
Apr/17
Jul/17
Oct/17
Dec/17
Apr/18
Jul/18
Oct/18
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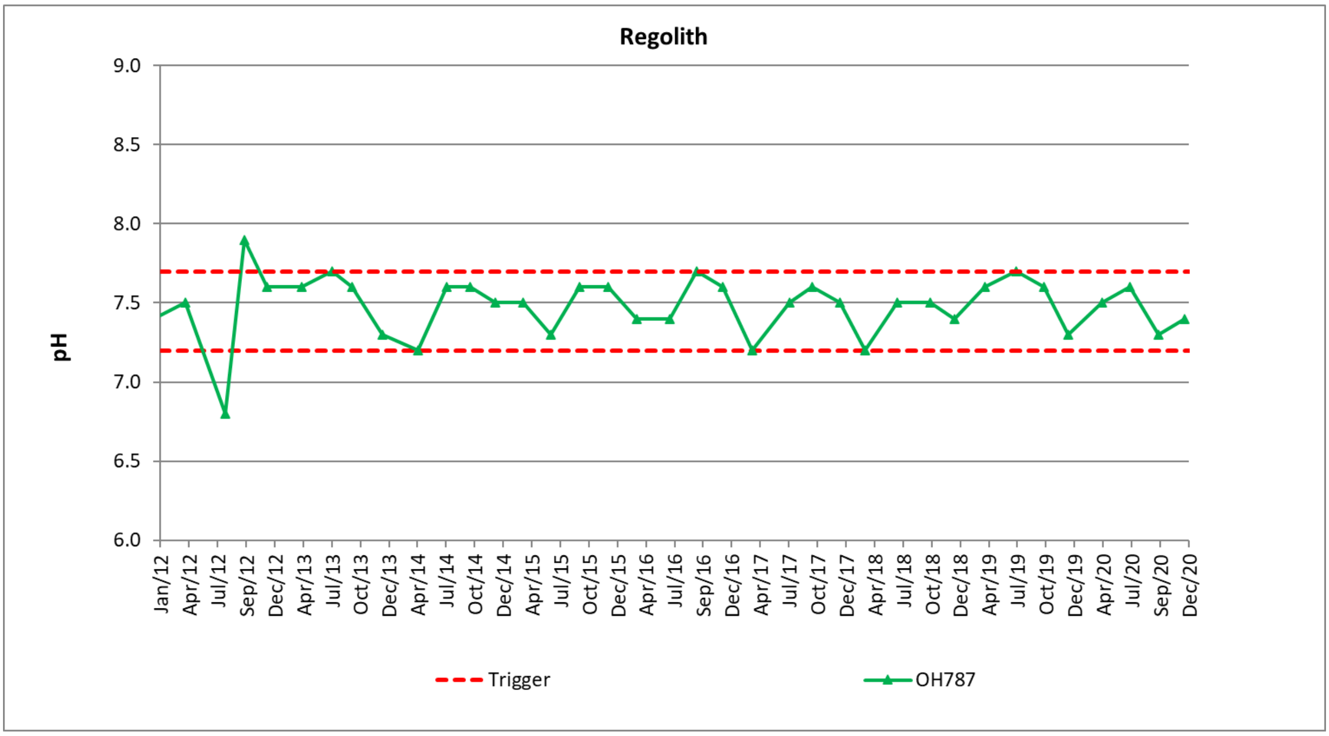
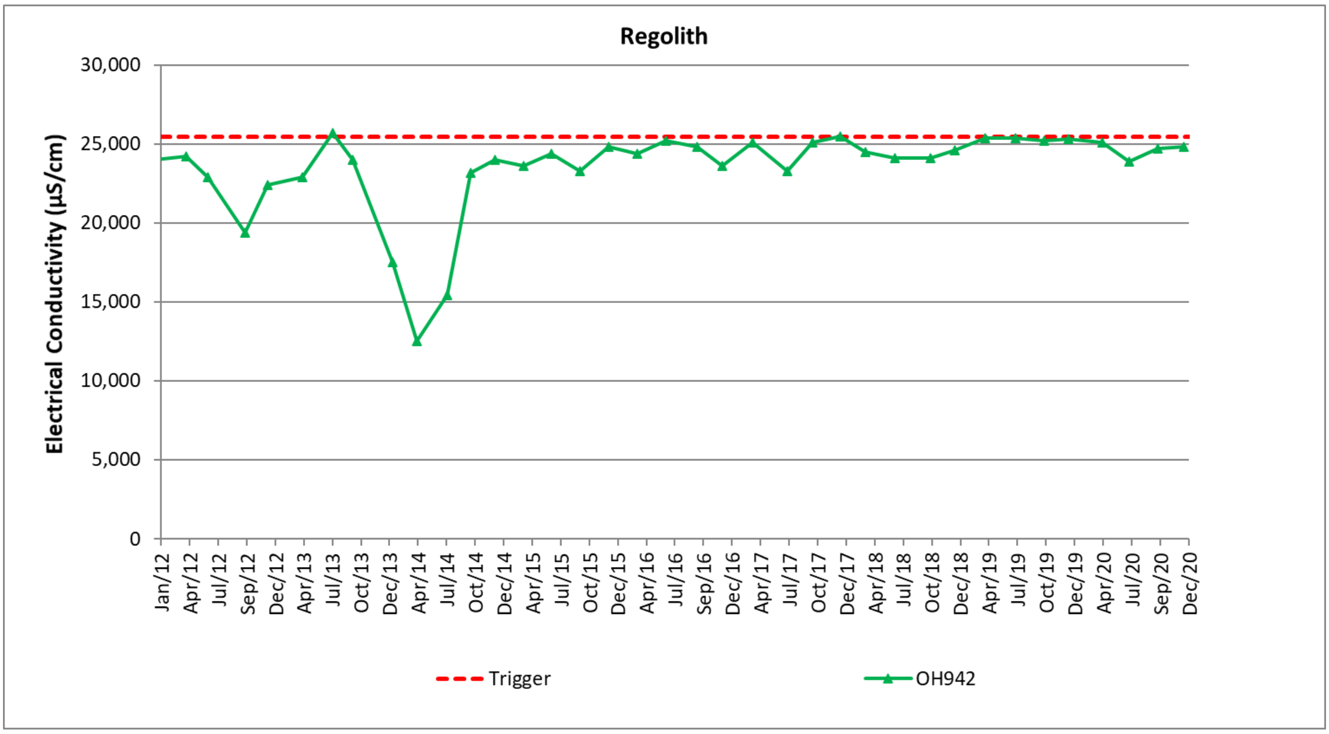
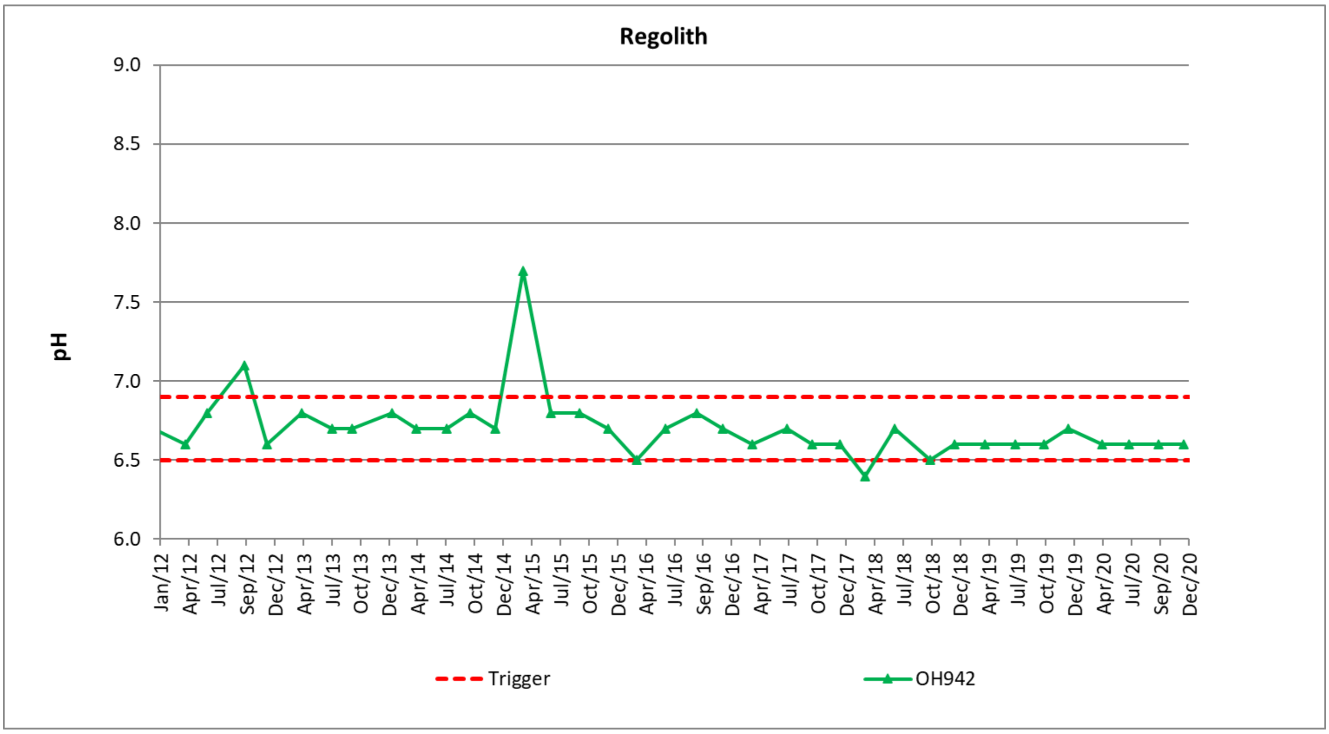
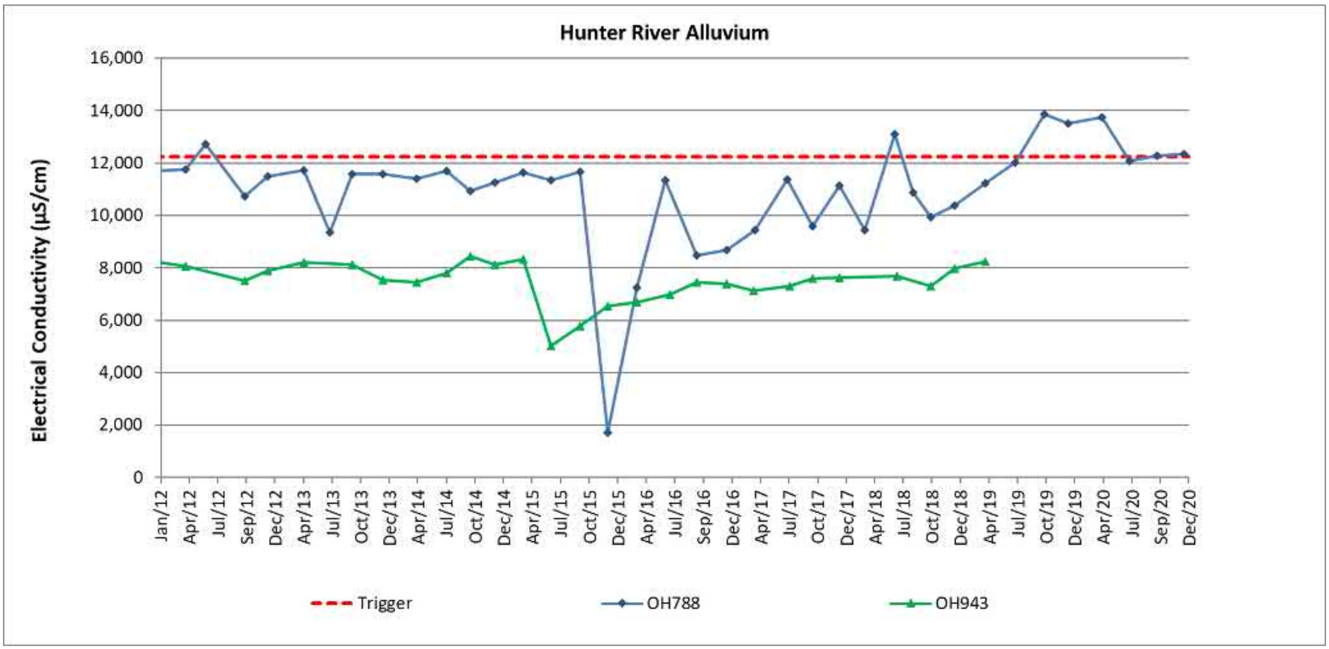
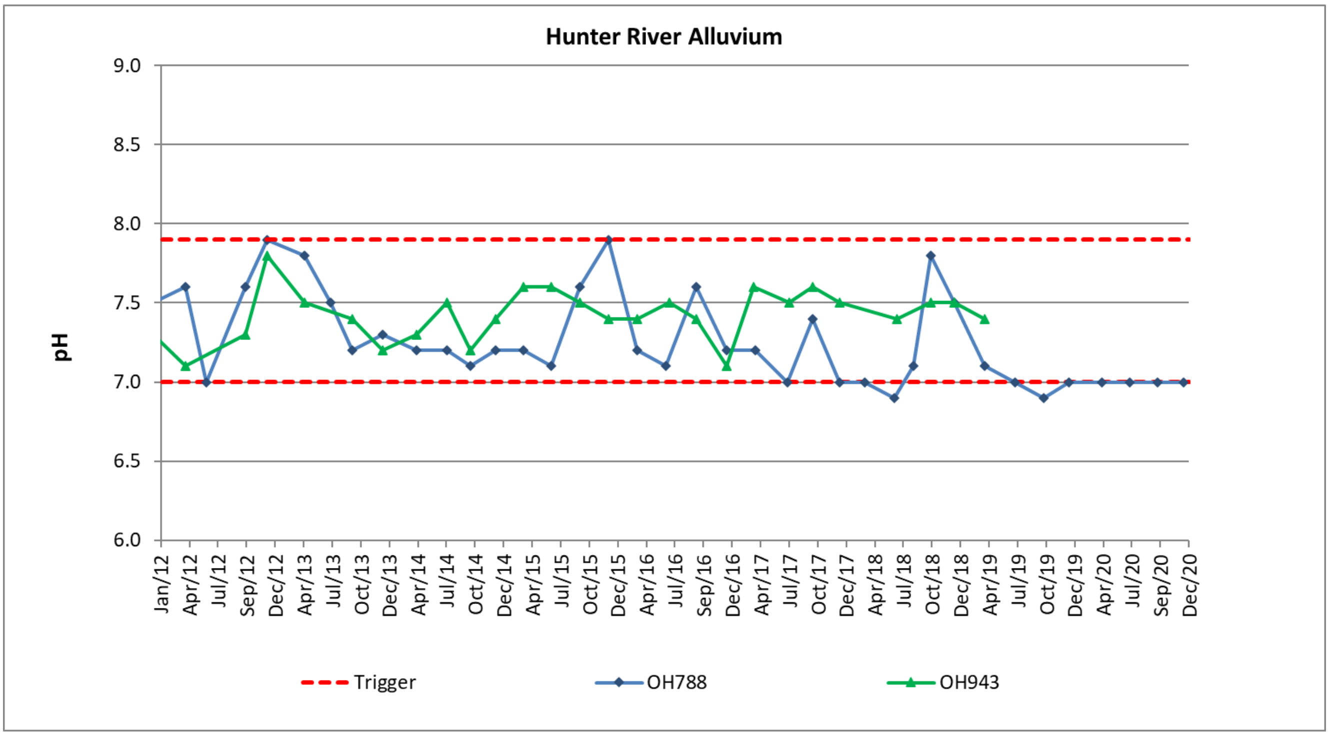
Apr/19
Jul/19
Oct/19
Jan/20
Apr/20
Jul/20
Oct/20
Dec/20
Trigger
OH787

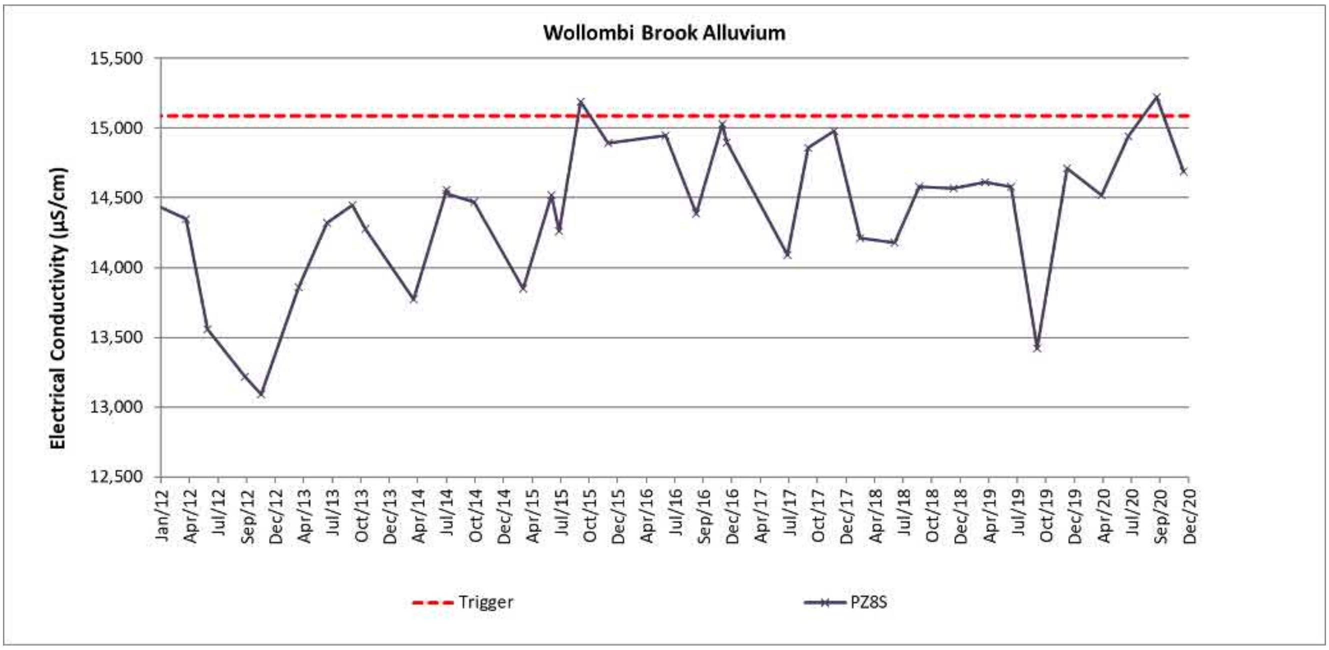

Regolith
pH
9.0
8.5
8.0
7.5
7.0
6.5
6.0
Jan/12
Apr/12
Jul/12
Sep/12
Dec/12
Apr/13
Jul/13
Oct/13
Dec/13
Apr/14
Jul/14
Oct/14
Dec/14
Apr/15
Jul/15
Oct/15
Dec/15
Apr/16
Jul/16
Sep/16
Dec/16
Apr/17
Jul/17
Oct/17
Dec/17
Apr/18
Jul/18
Oct/18
Dec/18
Apr/19
Jul/19
Oct/19
Dec/19
Apr/20
Jul/20
Sep/20
Dec/20
Trigger
OH787


Regolith
Electrical Conductivity (µS/cm)
30,000
25,000
20,000
15,000
10,000
5,000
0
Jan/12
Apr/12
Jul/12
Sep/12
Dec/12
Apr/13
Jul/13
Oct/13
Dec/13
Apr/14
Jul/14
Oct/14
Dec/14
Apr/15
Jul/15
Oct/15
Dec/15
Apr/16
Jul/16
Sep/16
Dec/16
Apr/17
Jul/17
Oct/17
Dec/17
Apr/18
Jul/18
Oct/18
Dec/18
Apr/19
Jul/19
Oct/19
Dec/19
Apr/20
Jul/20
Sep/20
Dec/20
Trigger
OH942


Regolith
pH
9.0
8.5
8.0
7.5
7.0
6.5
6.0
Jan/12
Apr/12
Jul/12
Sep/12
Dec/12
Apr/13
Jul/13
Oct/13
Dec/13
Apr/14
Jul/14
Oct/14
Dec/14
Apr/15
Jul/15
Oct/15
Dec/15
Apr/16
Jul/16
Sep/16
Dec/16
Apr/17
Jul/17
Oct/17
Dec/17
Apr/18
Jul/18
Oct/18
Dec/18
Apr/19
Jul/19
Oct/19
Dec/19
Apr/20
Jul/20
Sep/20
Dec/20
Trigger
OH942


Hunter River Alluvium
Electrical Conductivity (µS/cm)
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Jan/12
Apr/12
Jul/12
Sep/12
Dec/12
Apr/13
Jul/13
Oct/13
Dec/13
Apr/14
Jul/14
Oct/14
Dec/14
Apr/15
Jul/15
Oct/15
Dec/15
Apr/16
Jul/16
Sep/16
Dec/16
Apr/17
Jul/17
Oct/17
Dec/17
Apr/18
Jul/18
Oct/18
Dec/18
Apr/19
Jul/19
Oct/19
Dec/19
Apr/20
Jul/20
Sep/20
Dec/20
Trigger
OH788
OH943


Hunter River Alluvium
pH
9.0
8.5
8.0
7.5
7.0
6.5
6.0
Jan/12
Apr/12
Jul/12
Sep/12
Dec/12
Apr/13
Jul/13
Oct/13
Dec/13
Apr/14
Jul/14
Oct/14
Dec/14
Apr/15
Jul/15
Oct/15
Dec/15
Apr/16
Jul/16
Sep/16
Dec/16
Apr/17
Jul/17
Oct/17
Dec/17
Apr/18
Jul/18
Oct/18
Dec/18
Apr/19
Jul/19
Oct/19
Dec/19
Apr/20
Jul/20
Sep/20
Dec/20
Trigger
OH788
OH943


Wollombi Brook Alluvium
Electrical Conductivity (µS/cm)
15,500
15,000
14,500
14,000
13,500
13,000
12,500
Jan/12
Apr/12
Jul/12
Sep/12
Dec/12
Apr/13
Jul/13
Oct/13
Dec/13
Apr/14
Jul/14
Oct/14
Dec/14
Apr/15
Jul/15
Oct/15
Dec/15
Apr/16
Jul/16
Sep/16
Dec/16
Apr/17
Jul/17
Oct/17
Dec/17
Apr/18
Jul/18
Oct/18
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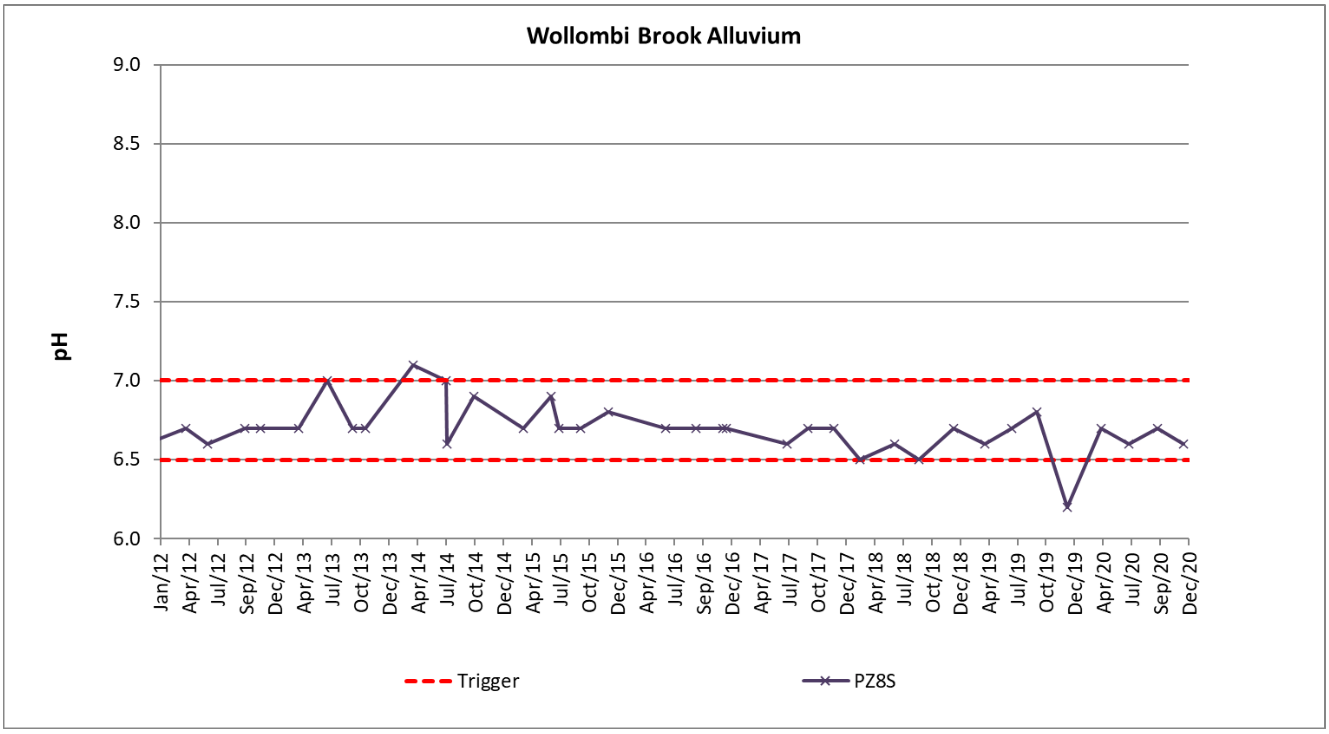
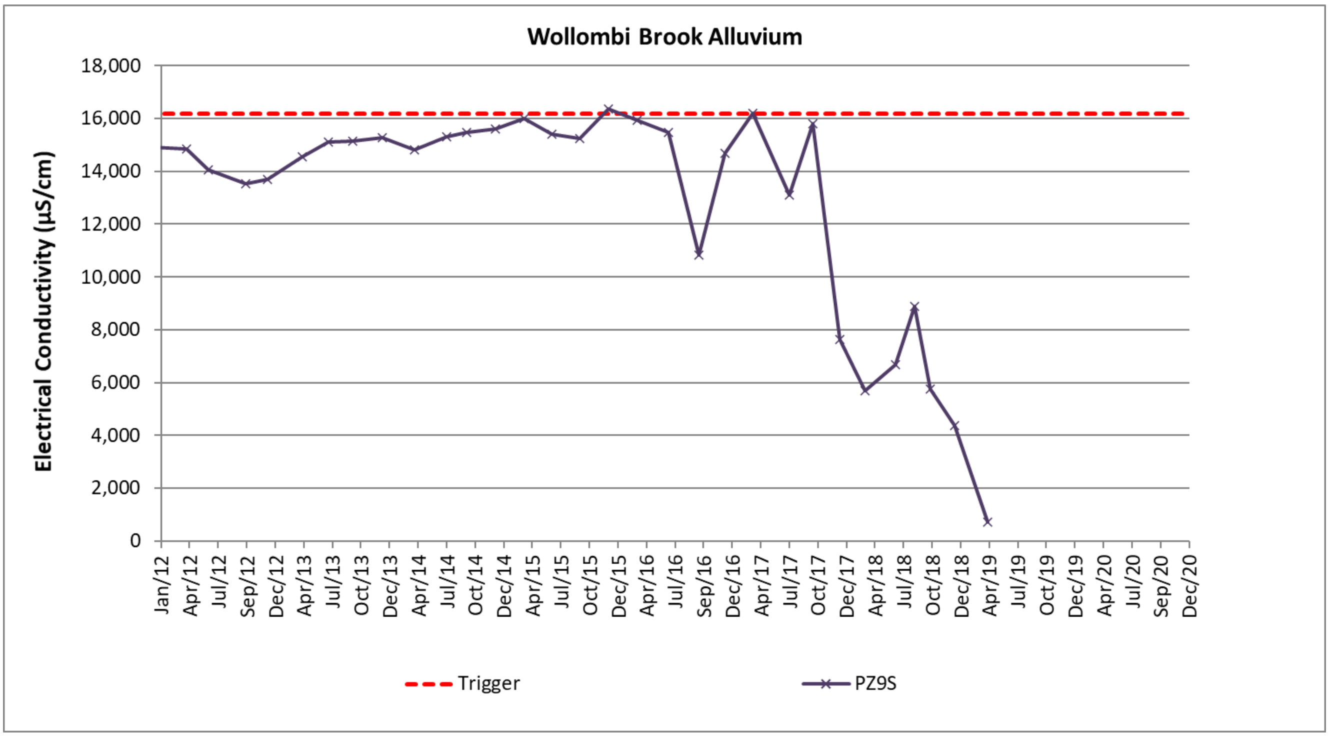
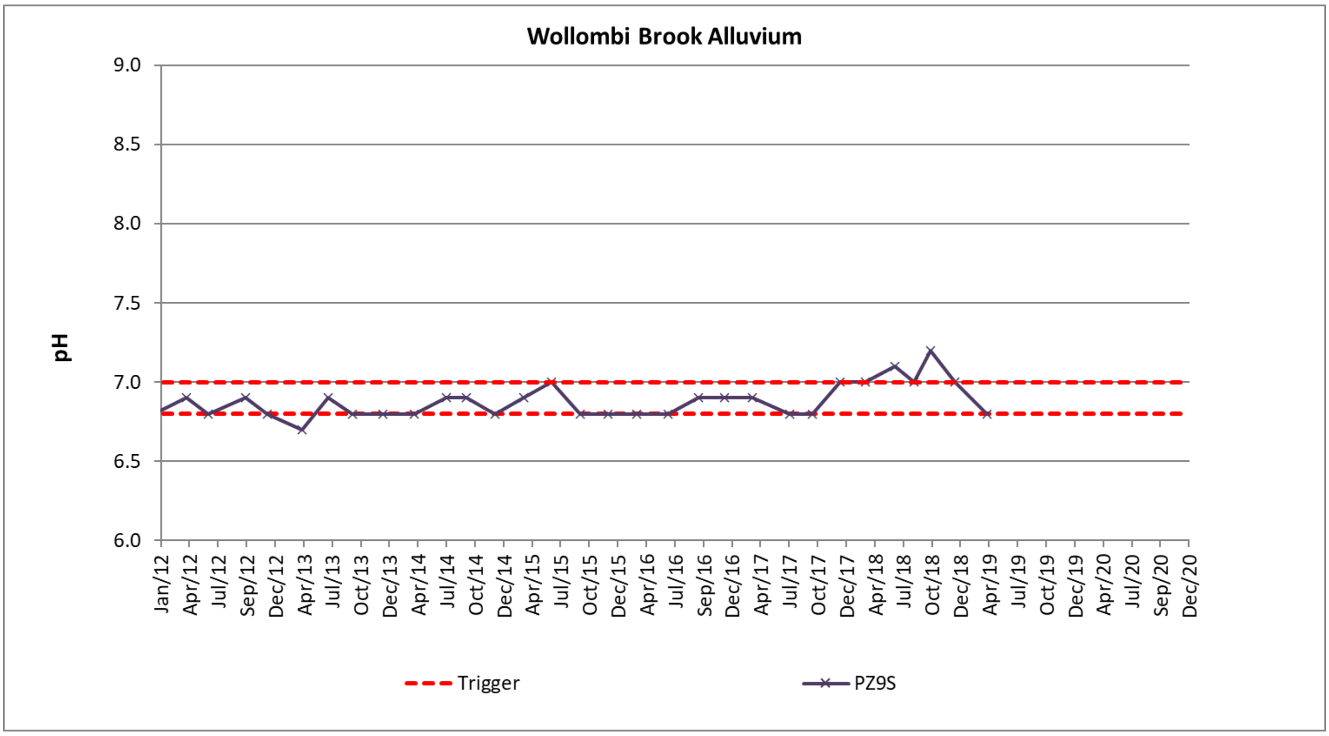
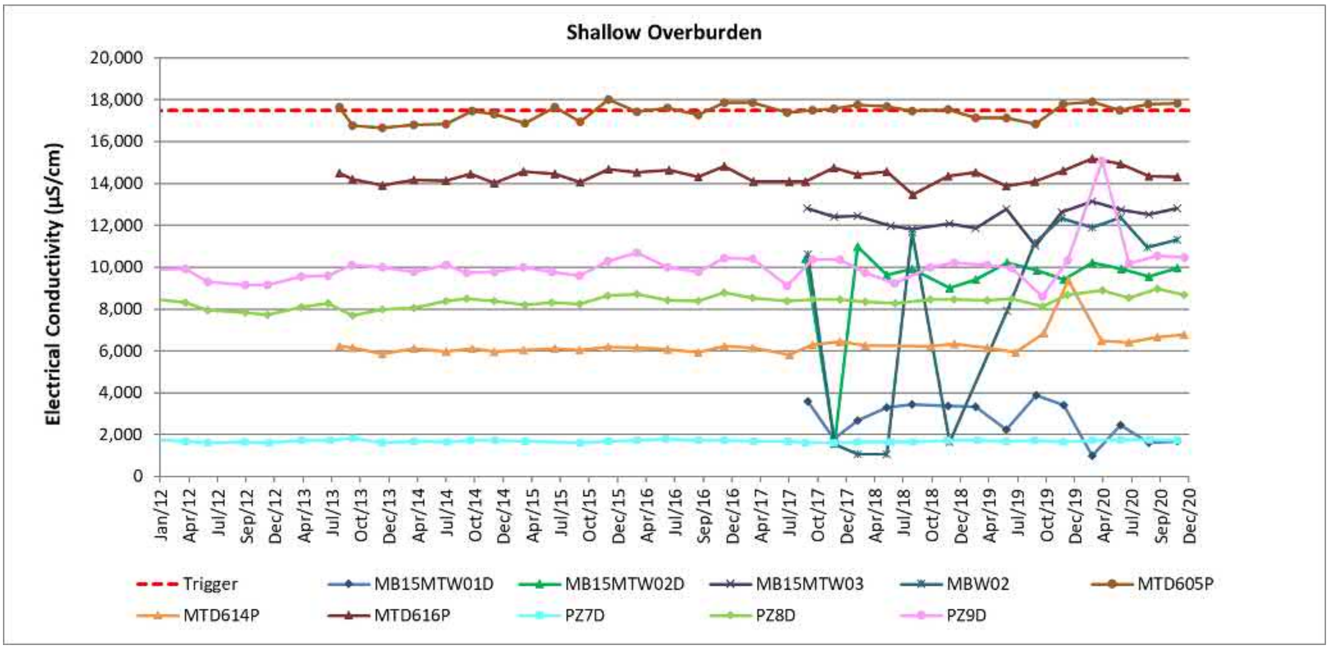
Apr/19
Jul/19
Oct/19
Dec/19
Apr/20
Jul/20
Sep/20
Dec/20
Trigger
PZ8S

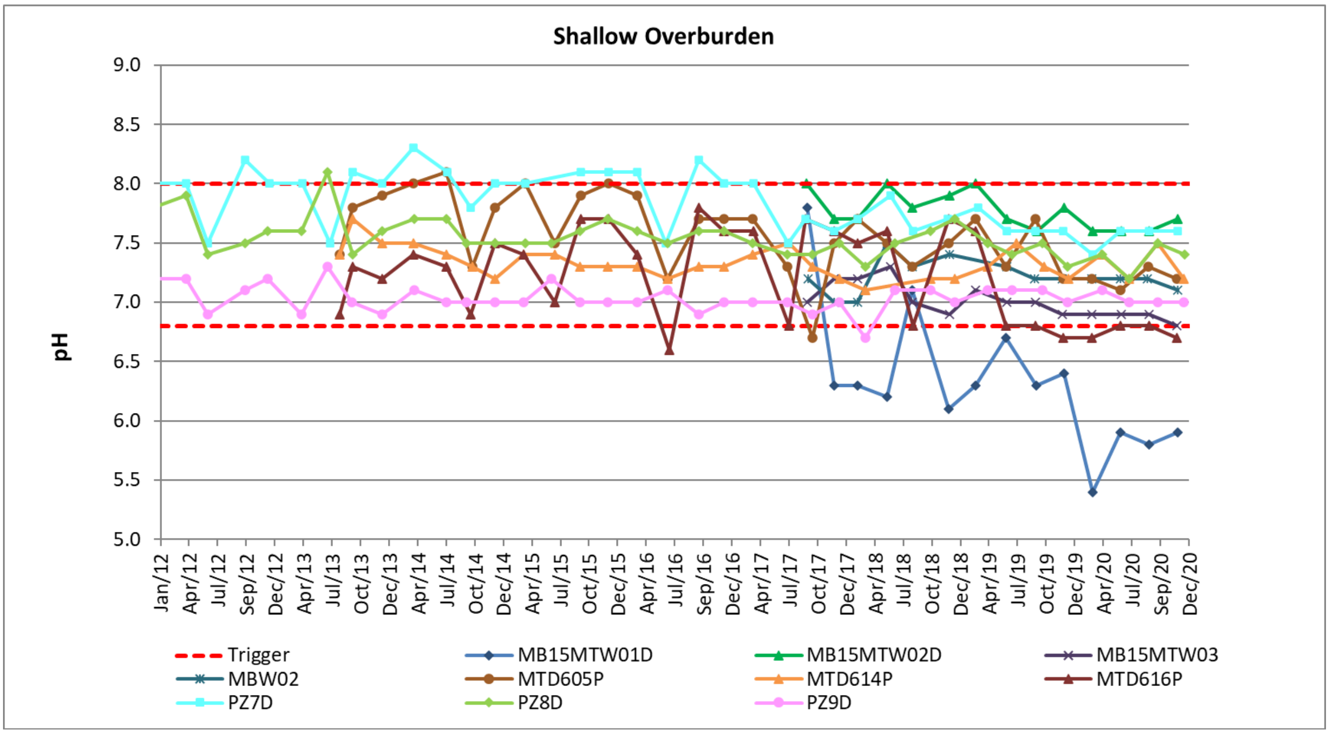

Wollombi Brook Alluvium
pH
9.0
8.5
8.0
7.5
7.0
6.5
6.0
Jan/12
Apr/12
Jul/12
Sep/12
Dec/12
Apr/13
Jul/13
Oct/13
Dec/13
Apr/14
Jul/14
Oct/14
Dec/14
Apr/15
Jul/15
Oct/15
Dec/15
Apr/16
Jul/16
Sep/16
Dec/16
Apr/17
Jul/17
Oct/17
Dec/17
Apr/18
Jul/18
Oct/18
Dec/18
Apr/19
Jul/19
Oct/19
Dec/19
Apr/20
Jul/20
Sep/20
Dec/20
Trigger
PZ8S


Wollombi Brook Alluvium
Electrical Conductivity (µS/cm)
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Jan/12 Apr/12 Jul/12 Sep/12 Dec/12 Apr/13 Jul/13 Oct/13 Dec/13 Apr/14 Jul/14 Oct/14 Dec/14 Apr/15 Jul/15 Oct/15 Dec/15 Apr/16 Jul/16 Sep/16 Dec/16 Apr/17 Jul/17 Oct/17 Dec/17 Apr/18 Jul/18 Oct/18 Dec/18 Apr/19 Jul/19 Oct/19 Dec/19 Apr/20 Jul/20 Sep/20 Dec/20
Trigger
PZ9S

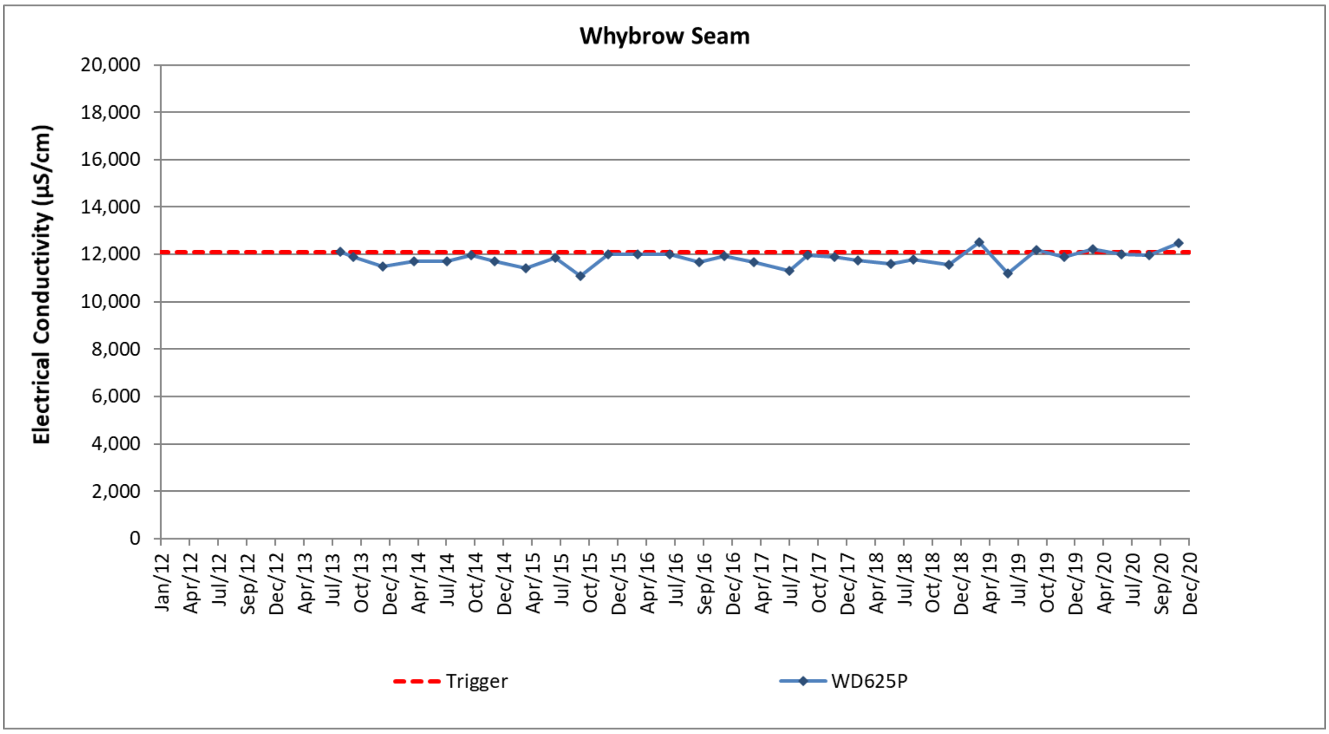

Wollombi Brook Alluvium
pH
9.0
8.5
8.0
7.5
7.0
6.5
6.0
Jan/12 Apr/12 Jul/12 Sep/12 Dec/12 Apr/13 Jul/13 Oct/13 Dec/13 Apr/14 Jul/14 Oct/14 Dec/14 Apr/15 Jul/15 Oct/15 Dec/15 Apr/16 Jul/16 Sep/16 Dec/16 Apr/17 Jul/17 Oct/17 Dec/17 Apr/18 Jul/18 Oct/18 Dec/18 Apr/19 Jul/19 Oct/19 Dec/19 Apr/20 Jul/20 Sep/20 Dec/20
Trigger
PZ9S

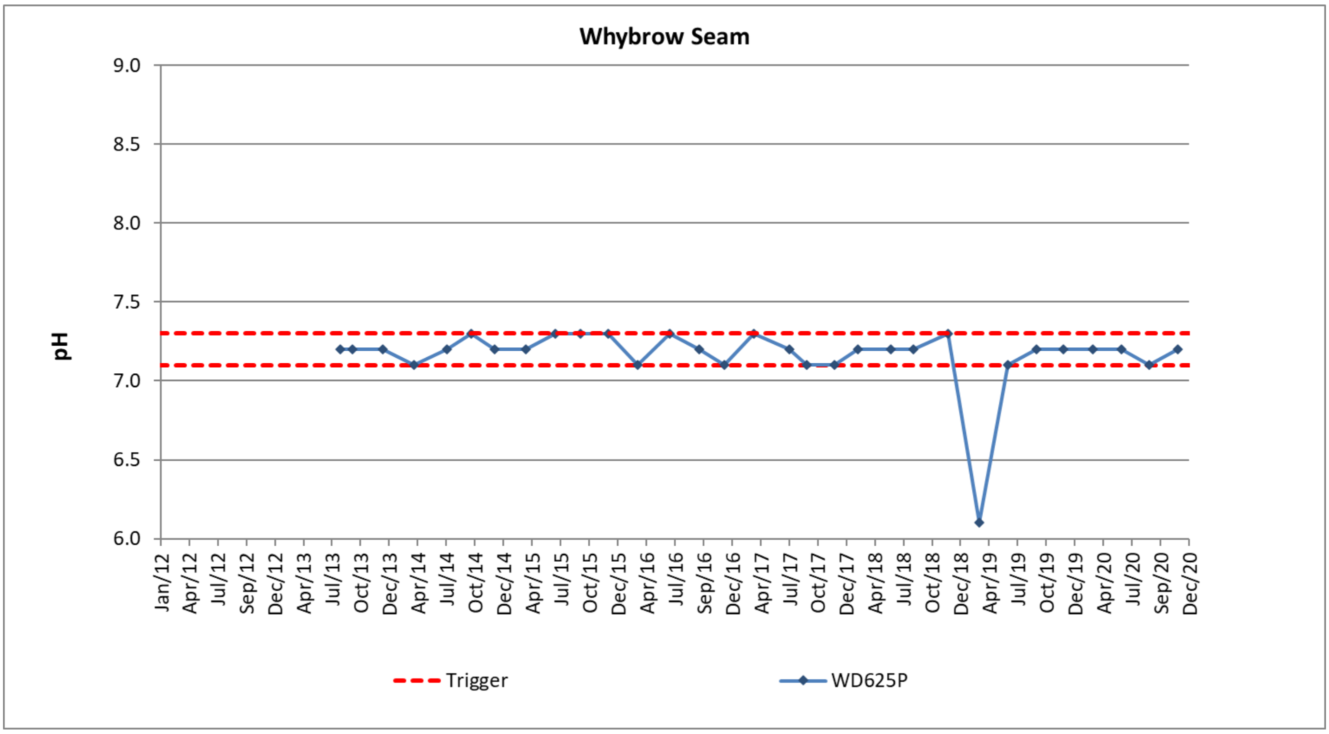


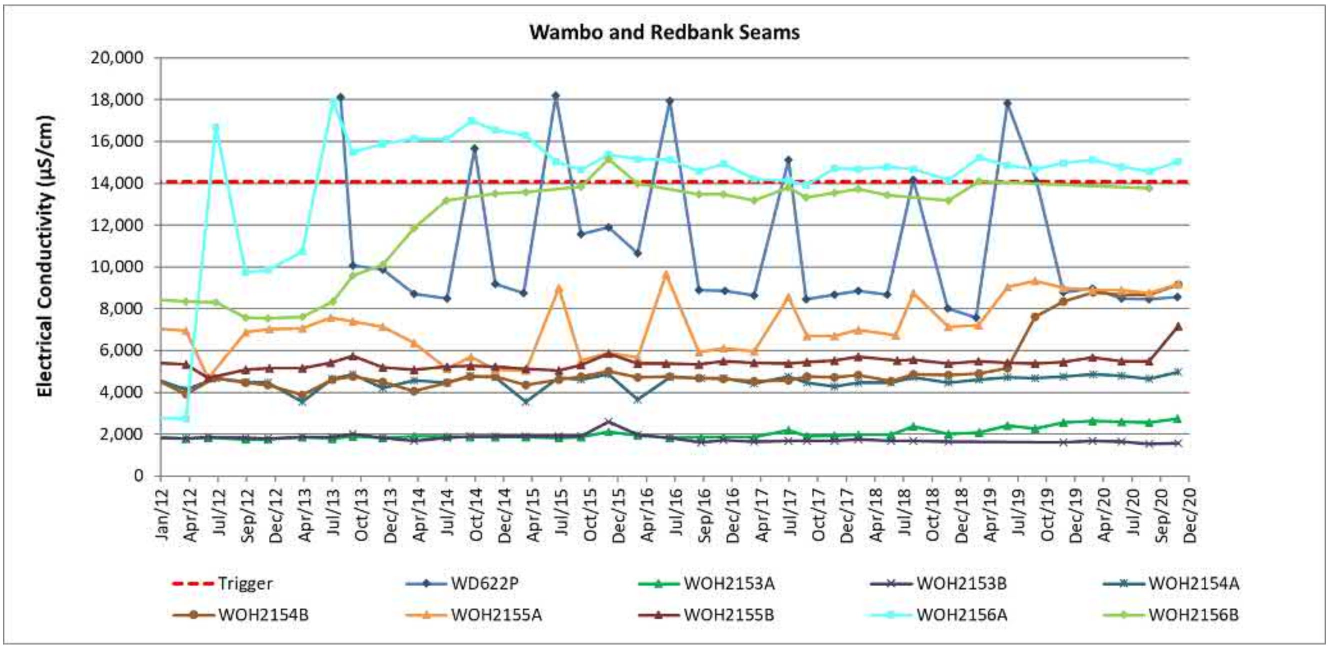
Shallow Overburden
Electrical Conductivity (µS/cm)
20,000
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Jan/12
Apr/12
Jul/12
Sep/12
Dec/12
Apr/13
Jul/13
Oct/13
Dec/13
Apr/14
Jul/14
Oct/14
Dec/14
Apr/15
Jul/15
Oct/15
Dec/15
Apr/16
Jul/16
Sep/16
Dec/16
Apr/17
Jul/17
Oct/17
Dec/17
Apr/18
Jul/18
Oct/18
Dec/18
Apr/19
Jul/19
Oct/19
Dec/19
Apr/20
Jul/20
Sep/20
Dec/20
Trigger
MB15MTW01D
MB15MTW02D
MB15MTW03
MBW02
MTD605P
MTD614P
MTD616P
PZ7D
PZ8D
PZ9D

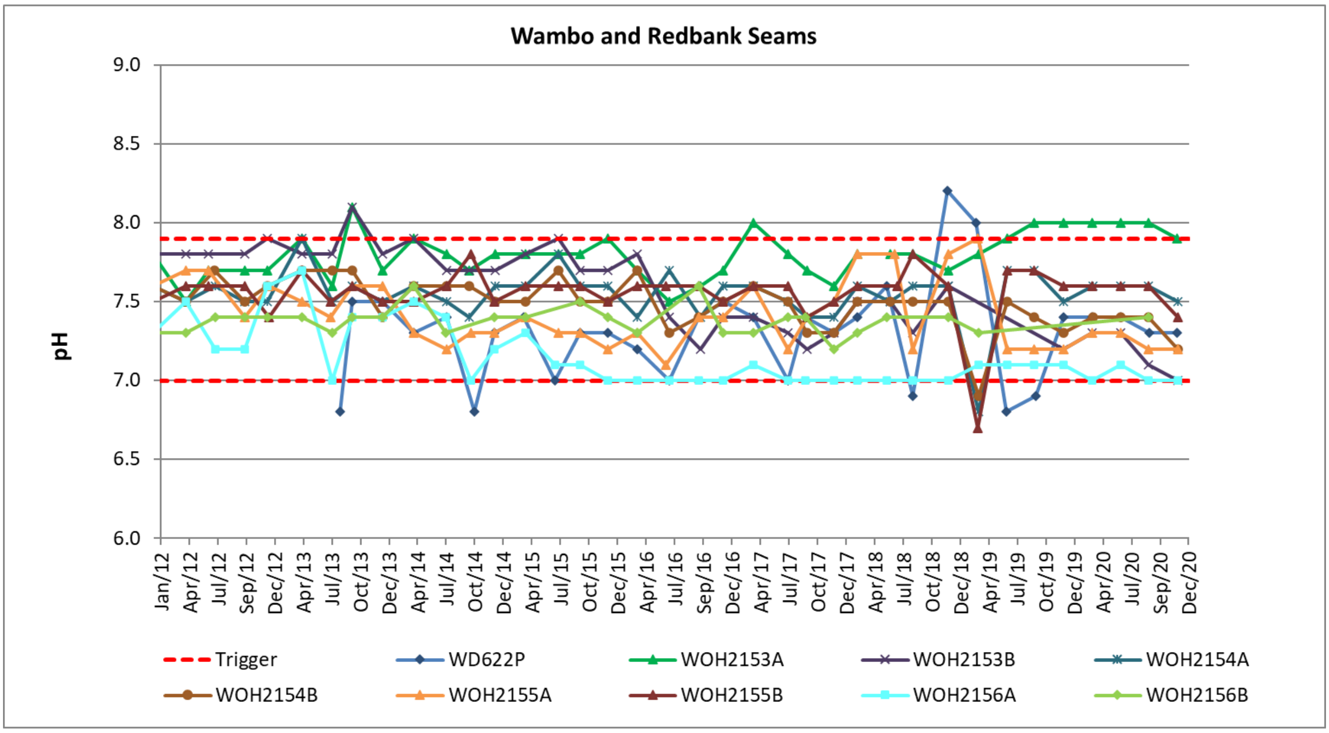


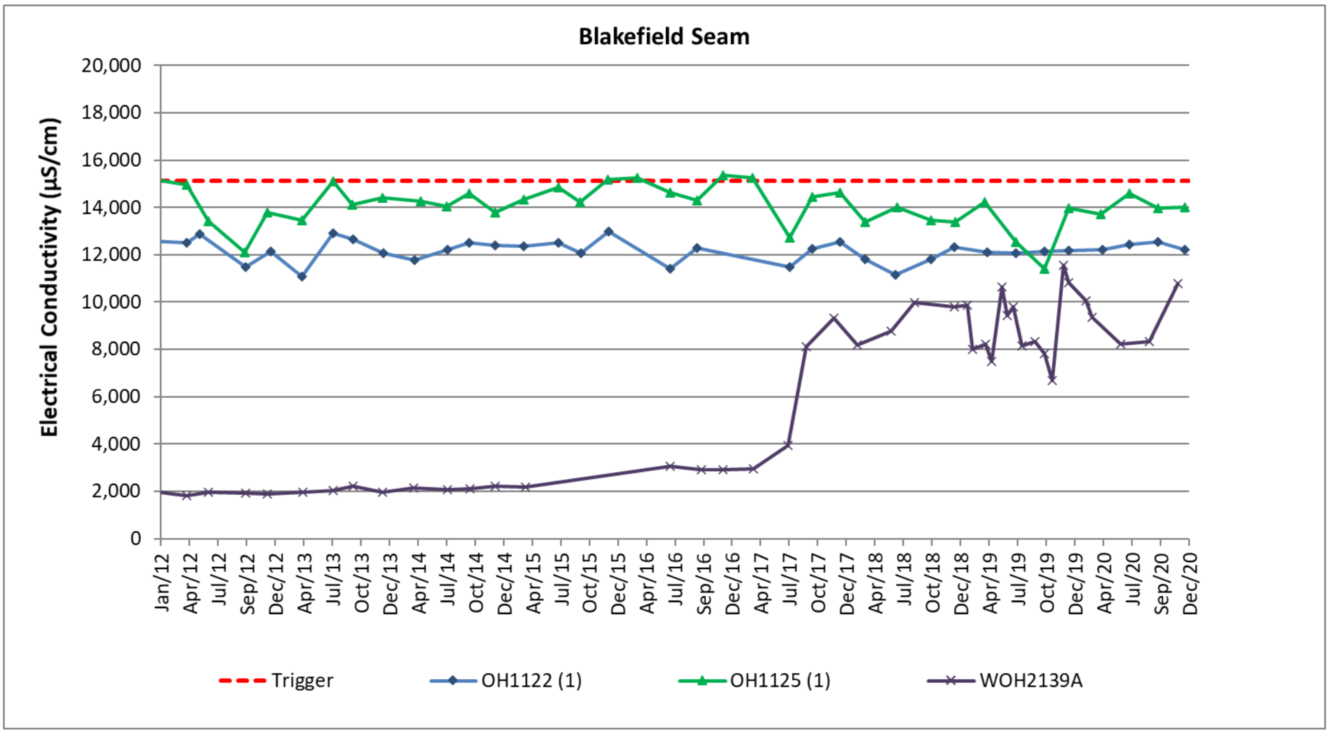
Shallow Overburden
pH
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
Jan/12
Apr/12
Jul/12
Sep/12
Dec/12
Apr/13
Jul/13
Oct/13
Dec/13
Apr/14
Jul/14
Oct/14
Dec/14
Apr/15
Jul/15
Oct/15
Dec/15
Apr/16
Jul/16
Sep/16
Dec/16
Apr/17
Jul/17
Oct/17
Dec/17
Apr/18
Jul/18
Oct/18
Dec/18
Apr/19
Jul/19
Oct/19
Dec/19
Apr/20
Jul/20
Sep/20
Dec/20
Trigger
MB15MTW01D
MB15MTW02D
MB15MTW03
MBW02
MTD605P
MTD614P
MTD616P
PZ7D
PZ8D
PZ9D


Whybrow Seam
Electrical Conductivity (µS/cm)
20,000
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Jan/12
Apr/12
Jul/12
Sep/12
Dec/12
Apr/13
Jul/13
Oct/13
Dec/13
Apr/14
Jul/14
Oct/14
Dec/14
Apr/15
Jul/15
Oct/15
Dec/15
Apr/16
Jul/16
Sep/16
Dec/16
Apr/17
Jul/17
Oct/17
Dec/17
Apr/18
Jul/18
Oct/18
Dec/18
Apr/19
Jul/19
Oct/19
Dec/19
Apr/20
Jul/20
Sep/20
Dec/20
Trigger
WD625P

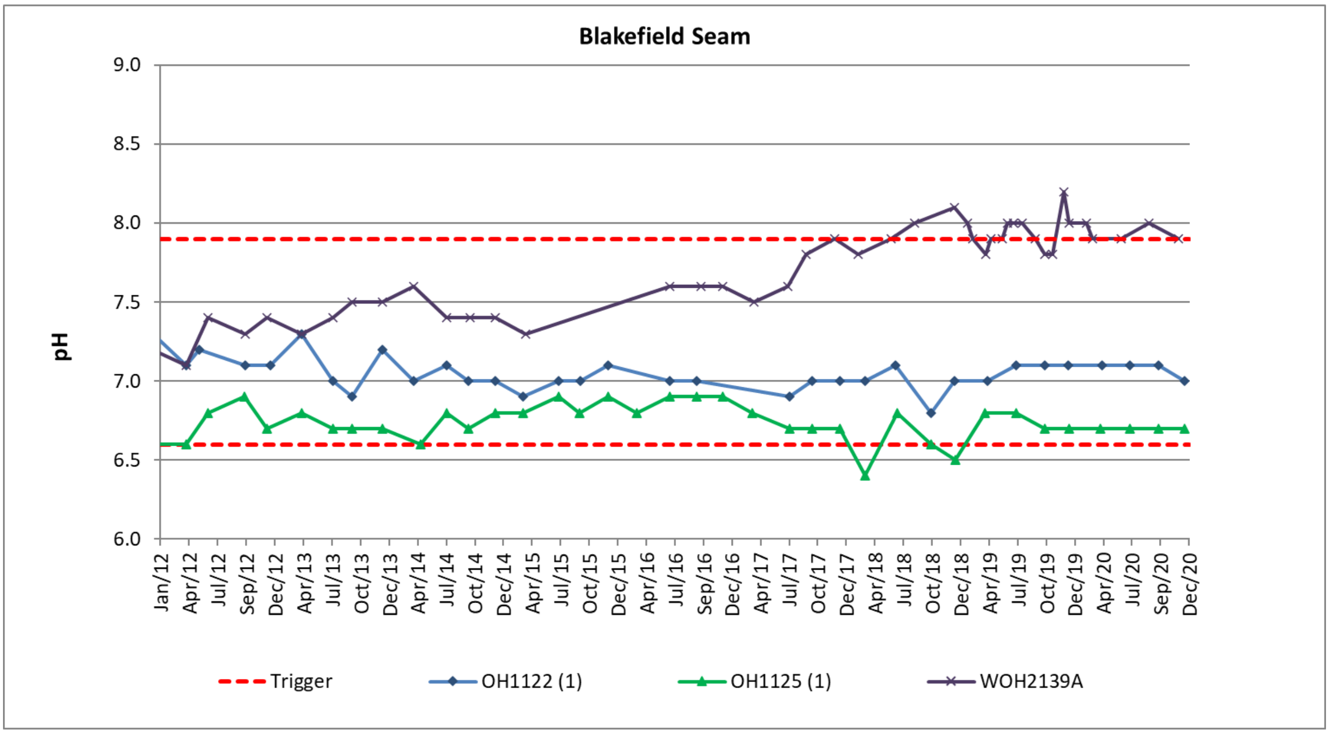

Whybrow Seam
pH
9.0
8.5
8.0
7.5
7.0
6.5
6.0
Jan/12
Apr/12
Jul/12
Sep/12
Dec/12
Apr/13
Jul/13
Oct/13
Dec/13
Apr/14
Jul/14
Oct/14
Dec/14
Apr/15
Jul/15
Oct/15
Dec/15
Apr/16
Jul/16
Sep/16
Dec/16
Apr/17
Jul/17
Oct/17
Dec/17
Apr/18
Jul/18
Oct/18
Dec/18
Apr/19
Jul/19
Oct/19
Dec/19
Apr/20
Jul/20
Sep/20
Dec/20
Trigger
WD625P


Wambo and Redbank Seams
Electrical Conductivity (µS/cm)
20,000
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Jan/12
Apr/12
Jul/12
Sep/12
Dec/12
Apr/13
Jul/13
Oct/13
Dec/13
Apr/14
Jul/14
Oct/14
Dec/14
Apr/15
Jul/15
Oct/15
Dec/15
Apr/16
Jul/16
Sep/16
Dec/16
Apr/17
Jul/17
Oct/17
Dec/17
Apr/18
Jul/18
Oct/18
Dec/18
Apr/19
Jul/19
Oct/19
Dec/19
Apr/20
Jul/20
Sep/20
Dec/20
Trigger
WD622P
WOH2153A
WOH2153B
WOH2154A
WOH2154B
WOH2155A
WOH2155B
WOH2156A
WOH2156B

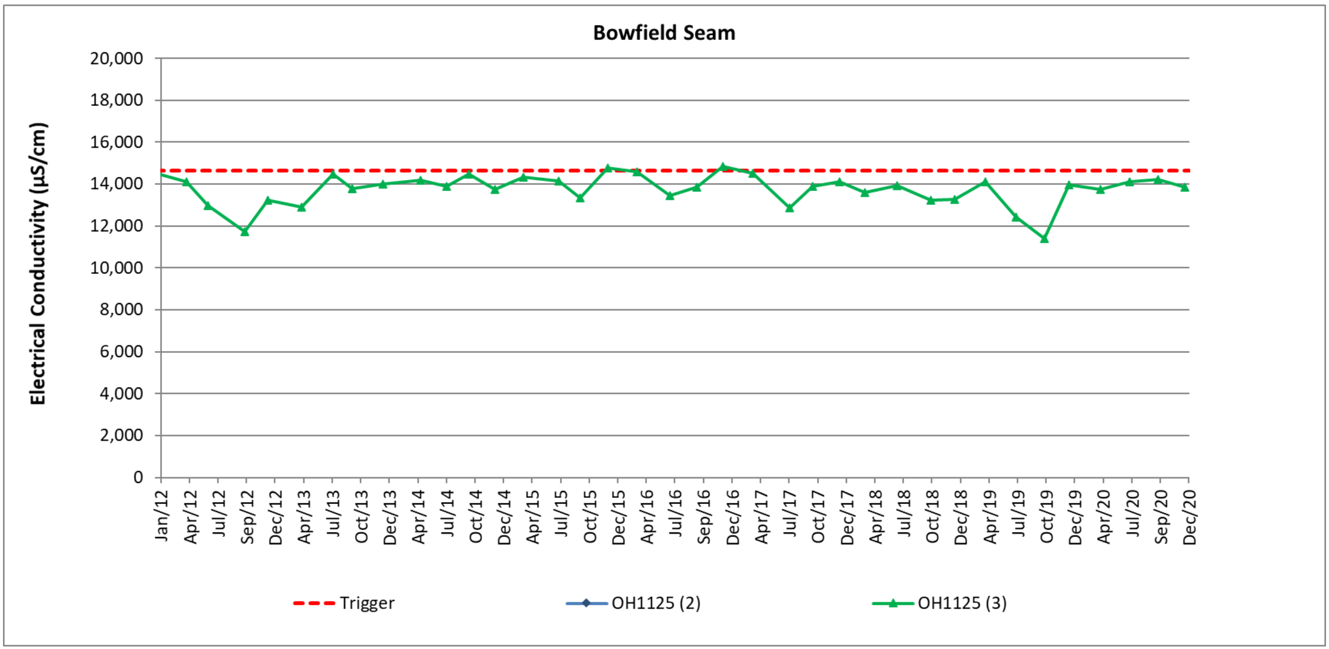

Wambo and Redbank Seams
pH
9.0
8.5
8.0
7.5
7.0
6.5
6.0
Jan/12
Apr/12
Jul/12
Sep/12
Dec/12
Apr/13
Jul/13
Oct/13
Dec/13
Apr/14
Jul/14
Oct/14
Dec/14
Apr/15
Jul/15
Oct/15
Dec/15
Apr/16
Jul/16
Sep/16
Dec/16
Apr/17
Jul/17
Oct/17
Dec/17
Apr/18
Jul/18
Oct/18
Dec/18
Apr/19
Jul/19
Oct/19
Dec/19
Apr/20
Jul/20
Sep/20
Dec/20
Trigger
WD622P
WOH2153A
WOH2153B
WOH2154A
WOH2154B
WOH2155A
WOH2155B
WOH2156A
WOH2156B

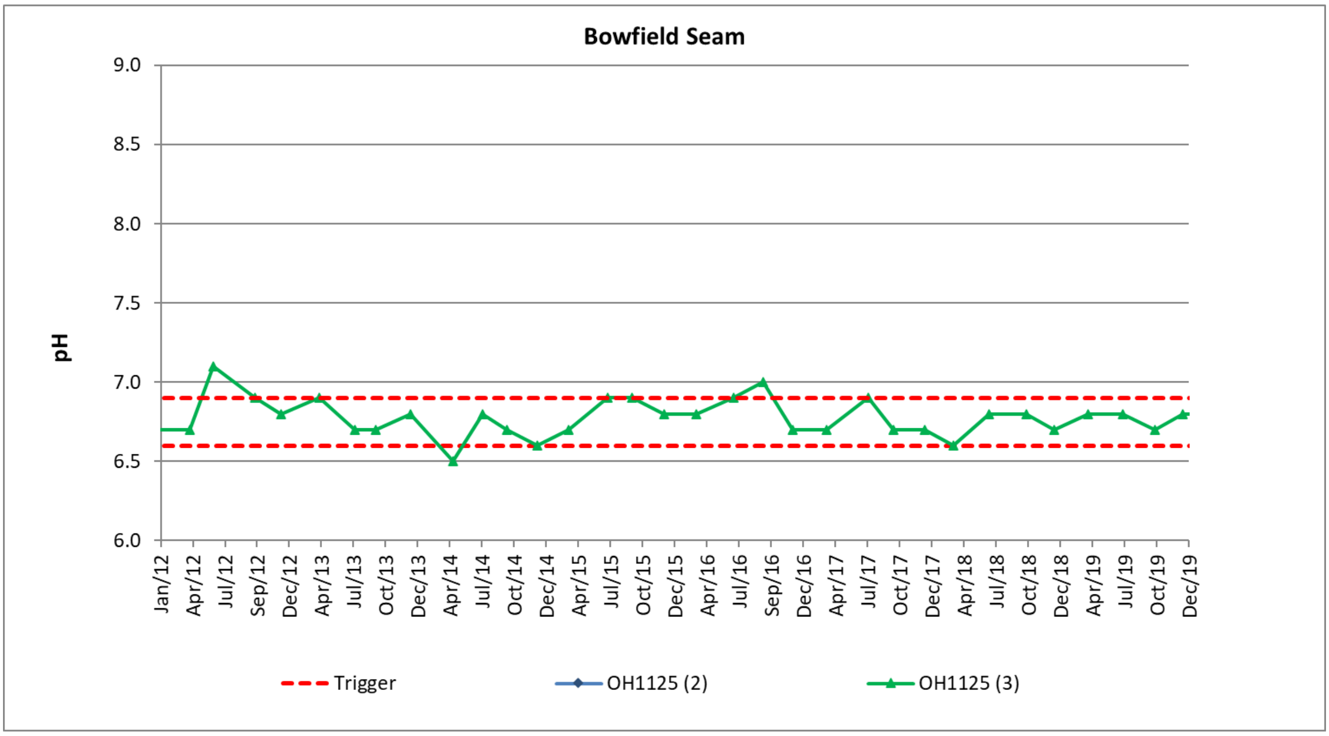


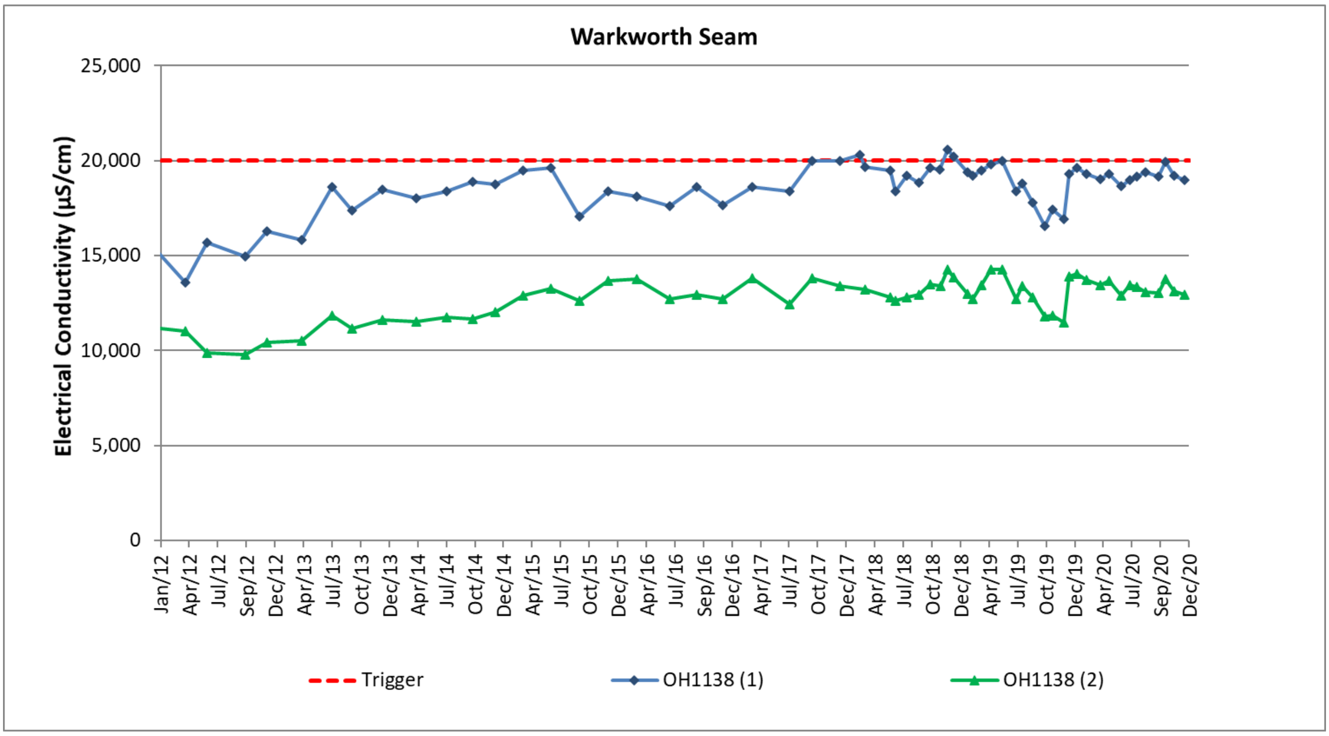
Blakefield Seam
Electrical Conductivity (µS/cm)
20,000
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Jan/12 Apr/12 Jul/12 Sep/12 Dec/12 Apr/13 Jul/13 Oct/13 Dec/13 Apr/14 Jul/14 Oct/14 Dec/14 Apr/15 Jul/15 Oct/15 Dec/15 Apr/16 Jul/16 Sep/16 Dec/16 Apr/17 Jul/17 Oct/17 Dec/17 Apr/18 Jul/18 Oct/18 Dec/18 Apr/19 Jul/19 Oct/19 Dec/19 Apr/20 Jul/20 Sep/20 Dec/20
Trigger
OH1122 (1)
OH1125 (1)
WOH2139A

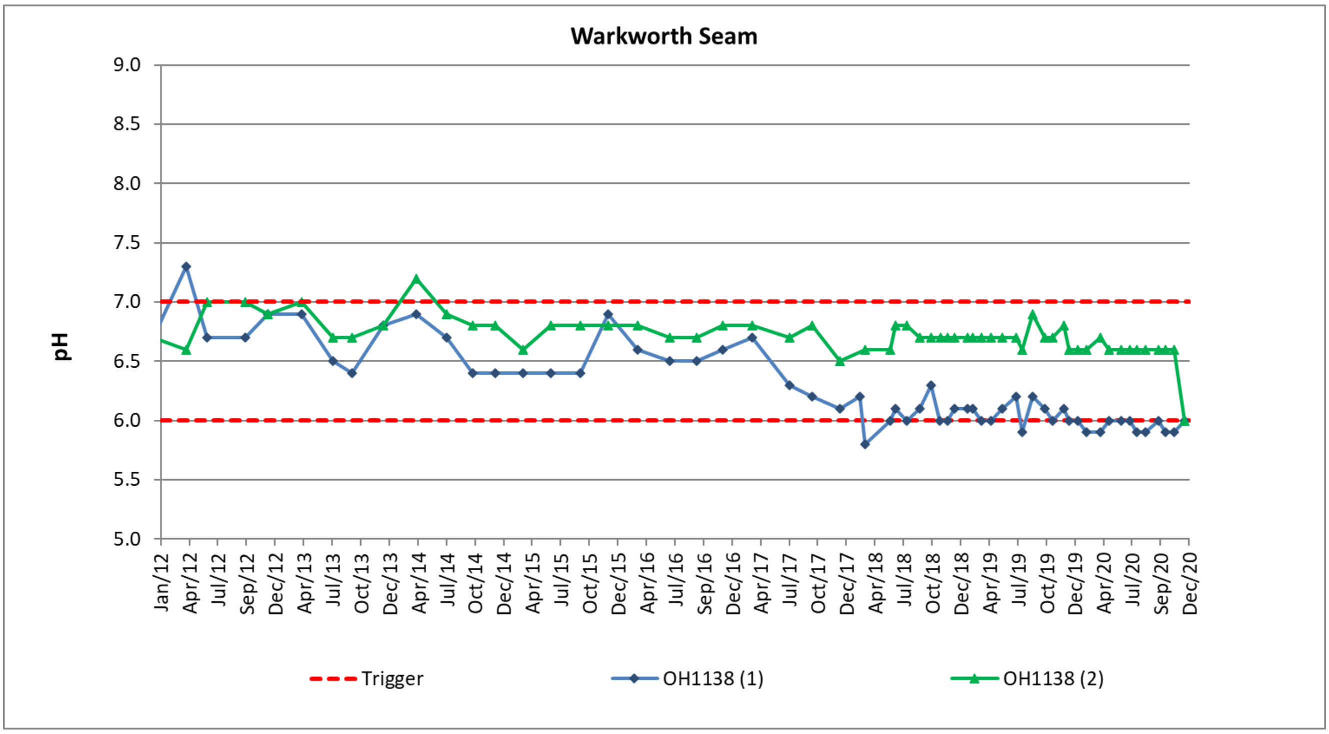


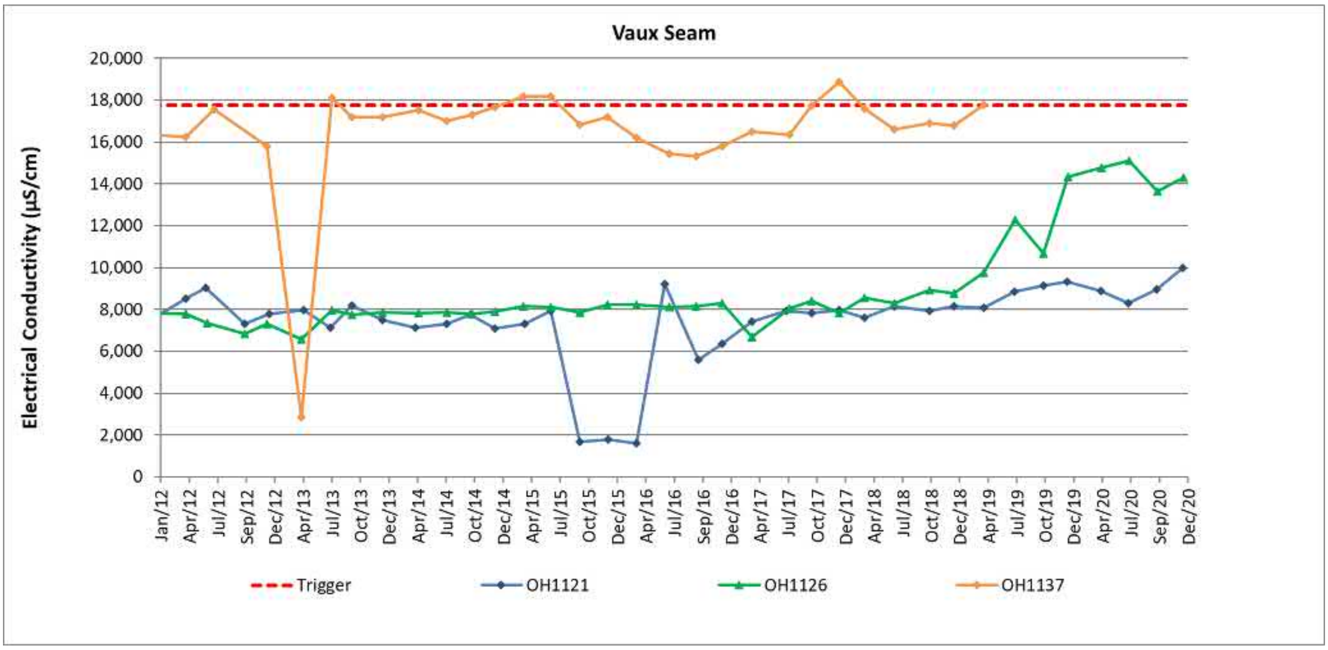
Blakefield Seam
pH
9.0
8.5
8.0
7.5
7.0
6.5
6.0
Jan/12 Apr/12 Jul/12 Sep/12 Dec/12 Apr/13 Jul/13 Oct/13 Dec/13 Apr/14 Jul/14 Oct/14 Dec/14 Apr/15 Jul/15 Oct/15 Dec/15 Apr/16 Jul/16 Sep/16 Dec/16 Apr/17 Jul/17 Oct/17 Dec/17 Apr/18 Jul/18 Oct/18 Dec/18 Apr/19 Jul/19 Oct/19 Dec/19 Apr/20 Jul/20 Sep/20 Dec/20
Trigger
OH1122 (1)
OH1125 (1)
WOH2139A


Bowfield Seam
Electrical Conductivity (µS/cm)
20,000
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Jan/12
Apr/12
Jul/12
Sep/12
Dec/12
Apr/13
Jul/13
Oct/13
Dec/13
Apr/14
Jul/14
Oct/14
Dec/14
Apr/15
Jul/15
Oct/15
Dec/15
Apr/16
Jul/16
Sep/16
Dec/16
Apr/17
Jul/17
Oct/17
Dec/17
Apr/18
Jul/18
Oct/18
Dec/18
Apr/19
Jul/19
Oct/19
Dec/19
Apr/20
Jul/20
Sep/20
Dec/20
Trigger
OH1125 (2)
OH1125 (3)


Bowfield Seam
pH
9.0
8.5
8.0
7.5
7.0
6.5
6.0
Jan/12
Apr/12
Jul/12
Sep/12
Dec/12
Apr/13
Jul/13
Oct/13
Dec/13
Apr/14
Jul/14
Oct/14
Dec/14
Apr/15
Jul/15
Oct/15
Dec/15
Apr/16
Jul/16
Sep/16
Dec/16
Apr/17
Jul/17
Oct/17
Dec/17
Apr/18
Jul/18
Oct/18
Dec/18
Apr/19
Jul/19
Oct/19
Dec/19
Trigger
OH1125 (2)
OH1125 (3)


Warkworth Seam
Electrical Conductivity (µS/cm)
25,000
20,000
15,000
10,000
5,000
0
Jan/12
Apr/12
Jul/12
Sep/12
Dec/12
Apr/13
Jul/13
Oct/13
Dec/13
Apr/14
Jul/14
Oct/14
Dec/14
Apr/15
Jul/15
Oct/15
Dec/15
Apr/16
Jul/16
Sep/16
Dec/16
Apr/17
Jul/17
Oct/17
Dec/17
Apr/18
Jul/18
Oct/18
Dec/18
Apr/19
Jul/19
Oct/19
Dec/19
Apr/20
Jul/20
Sep/20
Dec/20
Trigger
OH1138 (1)
OH1138 (2)


Warkworth Seam
pH
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
Jan/12
Apr/12
Jul/12
Sep/12
Dec/12
Apr/13
Jul/13
Oct/13
Dec/13
Apr/14
Jul/14
Oct/14
Dec/14
Apr/15
Jul/15
Oct/15
Dec/15
Apr/16
Jul/16
Sep/16
Dec/16
Apr/17
Jul/17
Oct/17
Dec/17
Apr/18
Jul/18
Oct/18
Dec/18
Apr/19
Jul/19
Oct/19
Dec/19
Apr/20
Jul/20
Sep/20
Dec/20
Trigger
OH1138 (1)
OH1138 (2)


Vaux Seam
Electrical Conductivity (µS/cm)
20,000
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Jan/12
Apr/12
Jul/12
Sep/12
Dec/12
Apr/13
Jul/13
Oct/13
Dec/13
Apr/14
Jul/14
Oct/14
Dec/14
Apr/15
Jul/15
Oct/15
Dec/15
Apr/16
Jul/16
Sep/16
Dec/16
Apr/17
Jul/17
Oct/17
Dec/17
Apr/18
Jul/18
Oct/18
Dec/18
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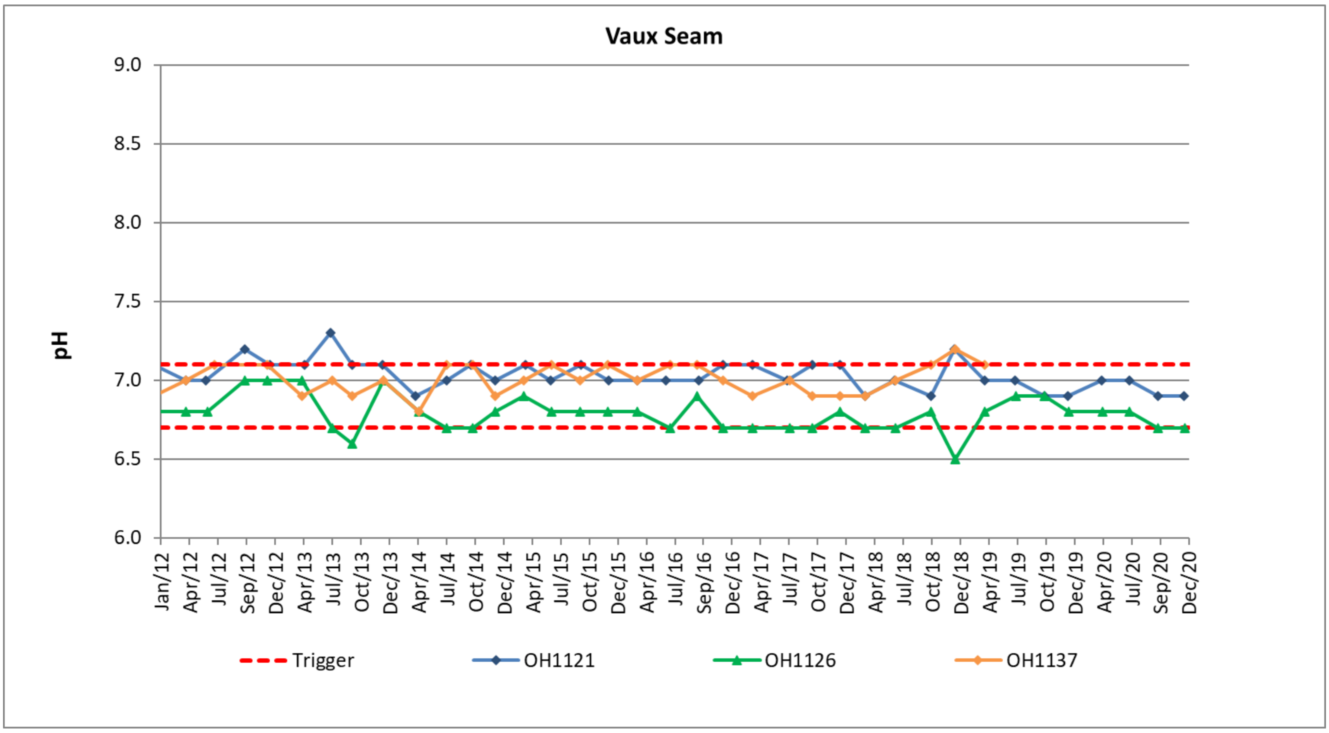
Dec/19
Apr/20
Jul/20
Sep/20
Dec/20
Trigger
OH1121
OH1126
OH1137


Vaux Seam
pH
9.0
8.5
8.0
7.5
7.0
6.5
6.0
Jan/12
Apr/12
Jul/12
Sep/12
Dec/12
Apr/13
Jul/13
Oct/13
Dec/13
Apr/14
Jul/14
Oct/14
Dec/14
Apr/15
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Apr/18
Jul/18
Oct/18
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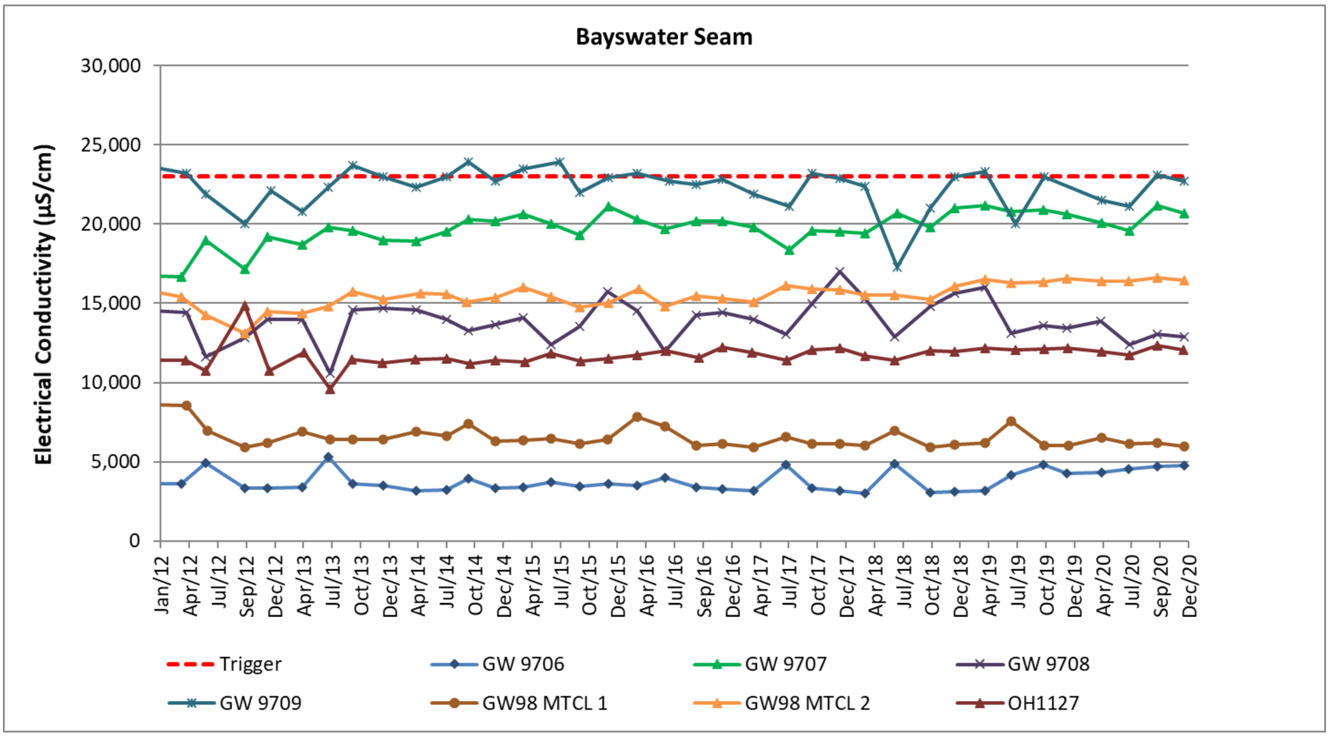
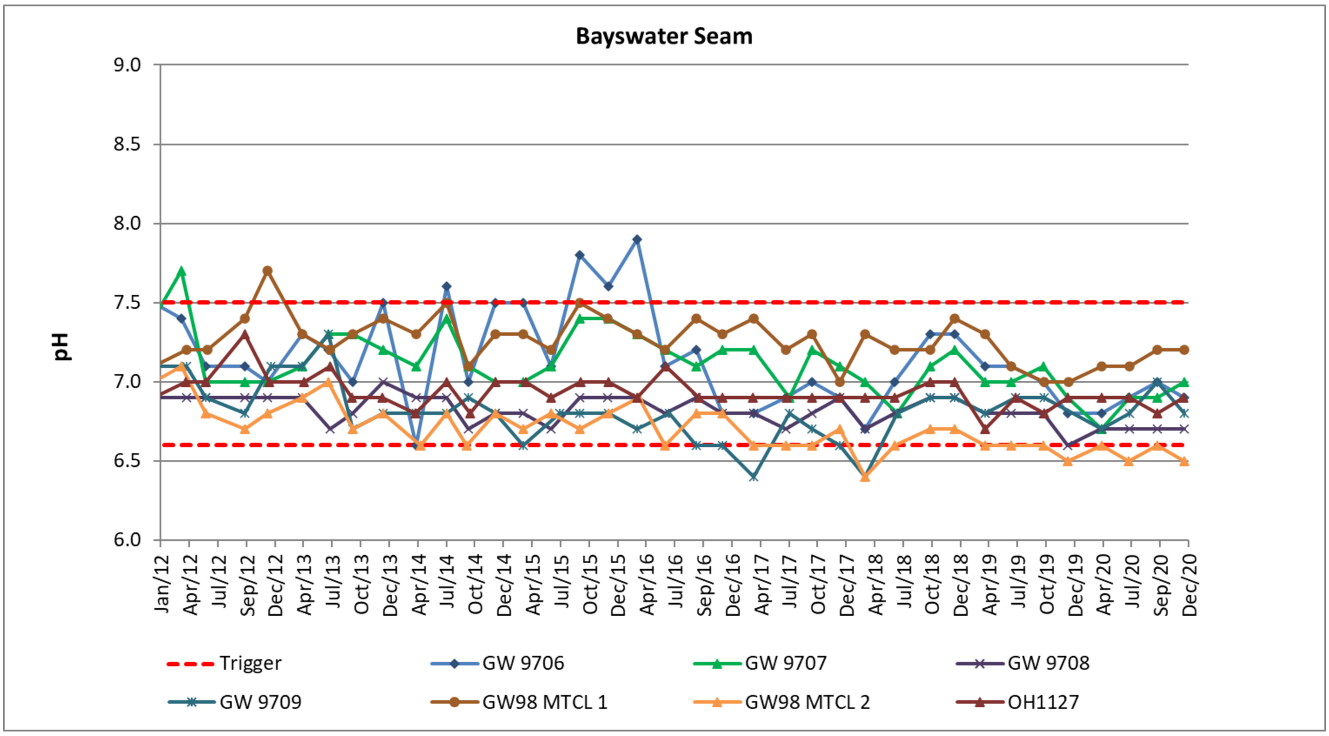
Dec/19
Apr/20
Jul/20
Sep/20
Dec/20
Trigger
OH1121
OH1126
OH1137


Bayswater Seam
Electrical Conductivity (µS/cm)
Trigger
GW 9706
GW 9707
GW 9708
GW 9709
GW98 MTCL 1
GW98 MTCL 2
OH1127


Bayswater Seam
pH
Trigger
GW 9706
GW 9707
GW 9708
GW 9709
GW98 MTCL 1
GW98 MTCL 2
OH1127

APPENDIX D

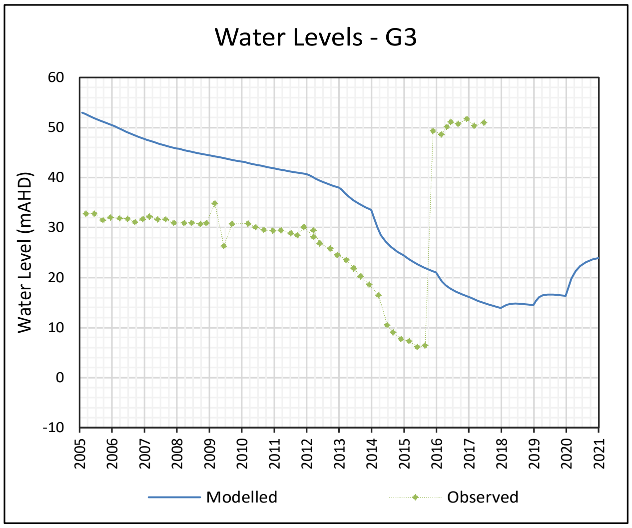
Full Water Quality Data 2020

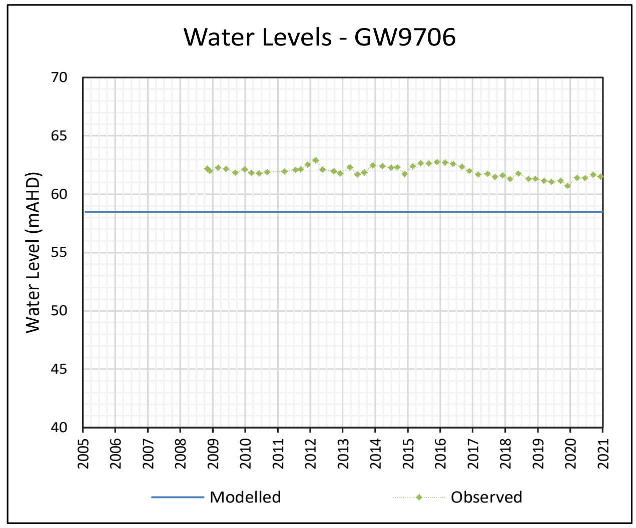
Station	Geology	Time	Date	SWL RL Calc	pH Field	EC Field (uS/cm (25TRef))	Water Temp (Deg C)	Comment	TDS - Total (mg/l)	Hydroxide Alkalinity as CaCO3	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3	Total Alkalinity as CaCO3	Acidity as CaCO3	SO4 - Total (mg/l)	Cl- (mg/l)	Ca - Total (mg/l)
PZ7S	Aeolian Warkworth Sands	8:45	27-05-2020	50.35	6.7	1,491	20.8										
MB15MTW04	Warkworth Sands	12:15	29-05-2020	#N/A				Dry									
MB15MTW05	Warkworth Sands	12:00	29-05-2020	#N/A				Dry									
MB15MTW06	Warkworth Sands	11:45	29-05-2020	#N/A				Dry									
MB15MTW07	Warkworth Sands	13:00	29-05-2020	#N/A				Dry									
MB15MTW08	Warkworth Sands	13:40	29-05-2020	#N/A				Dry									
MB15MTW09	Warkworth Sands	0.58	43980.0	#N/A				Dry									
MB15MTW09	Warkworth Sands	0.52	44070.0	#N/A				Dry									
MB15MTW09	Warkworth Sands	0.55	44161.0	#N/A				Dry									
MB15MTW10	Warkworth Sands		43888.0	#N/A				No access - waiting on gate construction									
MB15MTW10	Warkworth Sands	0.55	43980.0	#N/A				Dry									
MB15MTW10	Warkworth Sands	0.51	44070.0	#N/A				Dry									
MB15MTW10	Warkworth Sands	0.53	44161.0	#N/A				Dry									
MB15MTW11	Warkworth Sands	0.37	43888.0	#N/A				Dry									
MB15MTW11	Warkworth Sands	0.52	43980.0	#N/A				Dry									
MB15MTW11	Warkworth Sands	0.49	44070.0	#N/A				Dry									
MB15MTW11	Warkworth Sands	0.55	44159.0	#N/A				Dry									
OH786	Regolith	9:25	26-05-2020	55.01													
OH786	Regolith	8:50	26-06-2020	53.50	8.0	892	19.1	g water level after high rainfall in Feb 20. Insufficent sample for lab analysis									
OH787	Regolith	8:40	26-06-2020	35.96	7.6	18,830	18.1		11600	<1	<1	1550	1550	34	356	6460	69
OH788	Hunter River Alluvium	13:25	24-06-2020	35.32	7.0	12,080	19.9	Suspended solids	7180	<1	<1	1480	1480		375	3980	99
OH943	Hunter River Alluvium	8:30	26-06-2020	35.35				Purged 27/03/2020. Insufficient water for sampling									
OH944	Hunter River Alluvium	13:30	22-06-2020	#N/A				Dry									
MB15MTW01S	Wollombi Brook Alluvium	12:05	25-05-2020	57.64	6.5	1,467	19.6										
MB15MTW02S	Wollombi Brook Alluvium	12:05	26-05-2020	56.56	6.9	2,200	20.7										
PZ8S	Wollombi Brook Alluvium	8:20	23-06-2020	59.37	6.6	14,940	19.7		8790	<1	<1	677	677		566	4920	126
PZ9S	Wollombi Brook Alluvium	10:45	23-06-2020	58.65				Insufficient Water									
MBW01	Alluvium	0.37	43887.0	56	7.3	17480	22.1										
MBW01	Alluvium	0.48	43978.0	56	7.3	17380	21.6										
MBW01	Alluvium	0.51	44064.0	56	7.3	17750	19.1		10700	<1	<1	1540	1540		472	5320	36
MB15MTW01D	Shallow Overburden? Alluvium?	13:45	27-05-2020	57.54	5.9	2,470	19.8	Purged 25/05/2020									
MB15MTW02D	Shallow Overburden? Alluvium?	14:25	29-05-2020	56.12	7.6	9,910	20.2	Purged 26/05/20									
MB15MTW03	Shallow Overburden - Wollombi alluvium?	9:15	28-05-2020	54.34	6.9	12,740	19.3										
MBW02	Shallow Overburden	12:45	27-05-2020	53.96	7.2	12,370	20.4										
MTD605P	Shallow Overburden - sandstone	13:10	25-05-2020	62.26	7.1	17,510	19.1										
MTD614P	Shallow Overburden - Conglomerate	11:10	23-06-2020	54.39	7.2	6,400	19.8		3800	<1	<1	1820	1820		113	1220	39
MTD616P	Shallow Overburden	9:40	26-05-2020	72.05	6.8	14,920	20.6										
PZ7D	Shallow Overburden	9:45	27-05-2020	50.67	7.6	1,752	21										
PZ8D	Shallow Overburden	8:50	23-06-2020	58.33	7.2	8,550	22.6		5000	<1	<1	1590	1590		<1	1710	32
PZ9D	Shallow Overburden	10:35	23-06-2020	47.05	7.0	10,190	18.5	Purged 22/06/2020	8010	<1	<1	1120	1120		442	3130	182
GW 9706	Bayswater	13:30	23-06-2020	61.39	6.9	4,510	19.0		2880	<1	<1	511	511		879	719	111
GW 9707	Bayswater	9:10	26-06-2020	57.73	6.9	19,600	18.9	Purged 22/06/2020	16200	<1	<1	687	687		5120	4940	461
GW 9708	Bayswater	8:15	24-06-2020	61.35	6.7	12,410	18.6	DTW Checked and EC checked	10600	<1	<1	738	738		5310	1620	537
GW 9709	Bayswater	9:40	26-06-2020	50.75	6.8	21,100	18.2	Purged 22/06/2020	17900	<1	<1	884	884		5680	5660	530
GW98 MTCL 1	Bayswater	0.388888889	26-06-2020	66.6	7.1	6120	18.3	Purged 22/06/2020	3940	<1	<1	936	936		832	1040	49
GW98 MTCL 2	Bayswater	11:55	23-06-2020	68.51	6.5	16,370	20.3		12400	<1	<1	654	654		4610	4090	637
OH1127	Vane Subgroup	10:10	24-06-2020	35.26	6.9	11,750	19.7		6710	<1	<1	2000	2000		<1	3550	151
OH1122 (1)	Blakefield Seam	8:40	25-06-2020	51.56	7.1	12,420	19.3		7340	<1	<1	1560	1560		547	3530	86
OH1125 (1)	Blakefield	10:10	25-06-2020	51.09	6.7	14,590	17.9		9280	<1	<1	978	978	90	694	4510	252
OH1125 (3)	Bowfield Seam	9:05	26-05-2020	39.11													
OH1125 (3)	Bowfield Seam	10:15	25-06-2020	32.41	6.7	14,100	17.7		9410	<1	<1	958	958	87	692	4480	260
WOH2139A	Blakefield	0.541666667	28-05-2020	34.82	7.9	8,210	22.1										
WOH2154A	Redbank Crk Seam	0.486111111	28-05-2020	51.09	7.6	4,800	20.6										
WOH2155A	Redbank Crk Seam	0.447916667	28-05-2020	51.19	7.3	8,910	20.2										
WOH2156A	Redbank Crk Seam	0.420138889	28-05-2020	48.12	7.1	14,800	22.1										
OH942	Regolith	11:50	24-06-2020	46.19	6.6	23,900	21		16200	<1	<1	728	728		1030	8350	176
OH1121	Vane Subgroup	10:50	24-06-2020	34.82	7.0	8,300	18.8		4860	<1	<1	694	694		227	2640	157
OH1126	Vaux	13:05	25-06-2020	45.71	6.8	15,100	20.2		9510	<1	<1	1110	1110	93	801	4690	154
OH1137	Vaux?	13:30	25-06-2020	#N/A				Dry									
MBW04	Wambo Seam	13:00	27-05-2020	49.28	7.6	12,920	23.3										
WD622P	Wambo Seam	0.5625	28-05-2020	49.15	7.4	8,500	21.2	Suspended solids									
WOH2154B	Wambo Seam	0.489583333	28-05-2020	55.14	7.4	8,690	19.3										
WOH2155B	Wambo Seam	0.659722222	28-05-2020	58.84	7.6	5,500	18.8										
WOH2156B	Wambo Seam	0.423611111	28-05-2020	67.62				Insufficient water									
OH1138 (1)	Warkworth Seam	9:50	29-05-2020	59.87	6.0	18,670	19.6										
OH1138 (1)	Warkworth Seam	12:05	25-06-2020	59.91	6.0	18,990	16.8		12700	<1	<1	238	238		425	7070	162
OH1138 (2)	Warkworth Seam	10:40	29-05-2020	55.42	6.6	12,910	19.1										
OH1138 (2)	Warkworth Seam	12:35	25-06-2020	55.41	6.6	13,460	18.2		9170	<1	<1	772	772		608	4490	517
MBW03	Whybrow Seam	12:35	27-05-2020	54.13	7.2	10,550	21.3	Gas Bubbles									
WD625P	Whybrow Seam	0.475694444	28-05-2020	57.47	7.2	12,020	19.3	Purged 26/05/2020									
WOH2141A	Whynot Seam	0.517361111	29-05-2020	46.88	7.8	10,580	22	Suspended solids									
MBW6A	0	13:10	26-05-2020	#N/A	6.5	684	21.2										

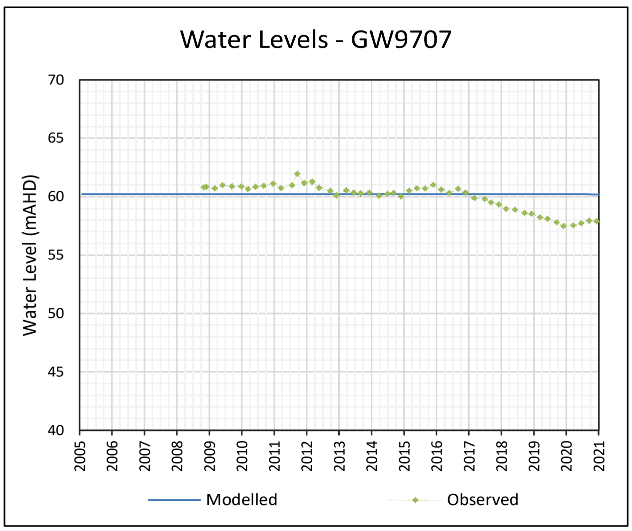
Station	Geology	Time	Date	Mg - Total (mg/l)	Na - Total (mg/l)	K - Total (mg/l)	Al - Total (mg/l)	As - Total (mg/l)	Cd - Total (mg/l)	Cu - Total (mg/l)	Pb - Total (mg/l)	Ni - Total (mg/l)	Se (mg/l)	Zn - Total (mg/l)	B (mg/l)	Hg - Total (mg/l)	Mo (mg/l)	V (mg/l)	Cr (mg/l)	F (mg/l)	Nitrogen Ammonia (mg/l)	Nitrite (mg/l)
PZ7S	Redbank Crk Seam	8:45	27-05-2020																			
MB15MTW04	Warkworth Seam	12:15	29-05-2020																			
MB15MTW05	Whynot Seam	12:00	29-05-2020																			
MB15MTW06	Hunter River Alluvium	11:45	29-05-2020																			
MB15MTW07	Bayswater	13:00	29-05-2020																			
MB15MTW08	Bayswater	13:40	29-05-2020																			
MB15MTW09	Shallow Overburden - Conglomerate	0.58	43980.0																			
MB15MTW09	Shallow Overburden - Conglomerate	0.52	44070.0																			
MB15MTW09	Redbank Crk Seam	0.55	44161.0																			
MB15MTW10	Bowfield Seam		43888.0																			
MB15MTW10	Shallow Overburden	0.55	43980.0																			
MB15MTW10	Vane Subgroup	0.51	44070.0																			
MB15MTW10	Regolith	0.53	44161.0																			
MB15MTW11	Warkworth Seam	0.37	43888.0																			
MB15MTW11	Wollombi Brook Alluvium	0.52	43980.0																			
MB15MTW11	Vane Subgroup	0.49	44070.0																			
MB15MTW11	00-01-1900	0.55	44159.0																			
OH786	Wambo Seam	9:25	26-05-2020																			
OH786	Warkworth Seam	8:50	26-06-2020																			
OH787	Regolith	8:40	26-06-2020	271	3890	53	0.44	0.002	<0.0001	0.004	0.002	0.006	<0.01	0.044	0.11	<0.0001	<0.001	0.01				
OH788	Bayswater	13:25	24-06-2020	280	2700	45	0.06	0.002	<0.0001	<0.001	<0.001	0.001	<0.01	<0.005	0.09	<0.0001						
OH943	Alluvium	8:30	26-06-2020																			
OH944	Vane Subgroup	13:30	22-06-2020																			
MB15MTW01S	Shallow Overburden	12:05	25-05-2020																			
MB15MTW02S	Wambo Seam	12:05	26-05-2020																			
PZ8S	Blakefield	8:20	23-06-2020	320	2930	12	0.1	0.001	<0.0001	0.01	<0.001	0.004	<0.01	<0.005	<0.05	<0.0001						
PZ9S	Vaux	10:45	23-06-2020																			
MBW01	Warkworth Sands	0.37	43887.0																			
MBW01	Blakefield	0.48	43978.0																			
MBW01	Wambo Seam	0.51	44064.0	196	3830	42	1.32	<0.001	<0.0001	<0.001	<0.001	0.011	<0.01	<0.005	0.08	<0.0001						
MB15MTW01D	Whybrow Seam	13:45	27-05-2020																			
MB15MTW02D	Warkworth Seam	14:25	29-05-2020																			
MB15MTW03	Wambo Seam	9:15	28-05-2020																			
MBW02	Redbank Crk Seam	12;45	27-05-2020																			
MTD605P	Whybrow Seam	13:10	25-05-2020																			
MTD614P	Regolith	11:10	23-06-2020	134	1320	19	0.77	0.005	<0.0001	0.027	0.006	0.007	<0.01	0.085	0.14	<0.0001						
MTD616P	Aeolian Warkworth Sands	9:40	26-05-2020																			
PZ7D	Wambo Seam	9:45	27-05-2020																			
PZ8D	Blakefield Seam	8:50	23-06-2020	42	2120	11	0.11	0.01	<0.0001	0.007	<0.001	0.152	<0.01	<0.005	0.24	<0.0001						
PZ9D	Bowfield Seam	10:35	23-06-2020	314	1830	27	1.69	0.024	<0.0001	0.191	0.022	0.044	<0.01	0.347	0.09	<0.0001						
GW 9706	Vane Subgroup	13:30	23-06-2020	98	880	12	<0.01	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.01	<0.005	0.14	<0.0001						
GW 9707	Regolith	9:10	26-06-2020	722	3740	37	0.2	0.001	0.0002	0.005	0.002	0.009	<0.01	0.051	0.42	<0.0001						
GW 9708	Vaux?	8:15	24-06-2020	501	2400	39	0.02	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.01	<0.005	0.27	<0.0001						
GW 9709	Bowfield Seam	9:40	26-06-2020	810	4150	40	1.26	0.002	<0.0001	0.004	0.004	0.012	<0.01	0.022	0.32	<0.0001						
GW98 MTCL 1	Warkworth Seam	0.388888889	26-06-2020	87	1220	25	0.23	<0.001	0.0002	0.003	0.001	0.002	0.02	0.031	0.16	<0.0001						
GW98 MTCL 2	Hunter River Alluvium	11:55	23-06-2020	588	2900	65	0.06	<0.001	<0.0001	<0.001	<0.001	0.002	<0.01	0.006	0.22	<0.0001						
OH1127	Warkworth Seam	10:10	24-06-2020	148	2630	18	0.02	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.01	<0.005	0.15	<0.0001						
OH1122 (1)	Bayswater	8:40	25-06-2020	349	2190	54	1.43	0.002	<0.0001	0.007	0.009	0.005	<0.01	0.171	0.14	<0.0001	<0.001	<0.01				
OH1125 (1)	Regolith	10:10	25-06-2020	556	1990	40	0.32	0.002	<0.0001	0.004	0.002	0.01	<0.01	0.041	0.08	<0.0001	<0.001	<0.01				
OH1125 (3)	Shallow Overburden - Wollombi alluvium?	9:05	26-05-2020																			
OH1125 (3)	Regolith	10:15	25-06-2020	560	1970	40	3.3	0.004	<0.0001	0.016	0.015	0.01	<0.01	0.291	0.08	<0.0001	<0.001	0.02				
WOH2139A	Warkworth Sands	0.541666667	28-05-2020																			
WOH2154A	Warkworth Sands	0.486111111	28-05-2020																			
WOH2155A	Warkworth Sands	0.447916667	28-05-2020																			
WOH2156A	Warkworth Sands	0.420138889	28-05-2020																			
OH942	Bayswater	11:50	24-06-2020	811	4890	42	5.1	0.001	<0.0001	0.004	0.001	0.007	<0.01	0.007	0.09	0.0005	<0.001	0.01				
OH1121	Warkworth Seam	10:50	24-06-2020	174	1580	13	0.02	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.01	<0.005	0.11	<0.0001						
OH1126	Hunter River Alluvium	13:05	25-06-2020	376	2680	61	11.1	0.009	0.0003	0.041	0.052	0.026	<0.01	1.2	0.09	<0.0001						
OH1137	Bowfield Seam	13:30	25-06-2020																			
MBW04	Redbank Crk Seam	13:00	27-05-2020																			
WD622P	Shallow Overburden? Alluvium?	0.5625	28-05-2020																			
WOH2154B	Warkworth Sands	0.489583333	28-05-2020																			
WOH2155B	Warkworth Sands	0.659722222	28-05-2020																			
WOH2156B	Warkworth Sands	0.423611111	28-05-2020																			
OH1138 (1)	Shallow Overburden	9:50	29-05-2020																			
OH1138 (1)	Warkworth Seam	12:05	25-06-2020	802	2780	115	4.19	0.004	0.0009	0.006	0.008	0.024	<0.01	0.04	<0.05	0.0011						
OH1138 (2)	Wollombi Brook Alluvium	10:40	29-05-2020																			
OH1138 (2)	Warkworth Seam	12:35	25-06-2020	461	1730	34	1.29	0.003	<0.0001	0.015	0.009	0.004	<0.01	0.011	<0.05	<0.0001						
MBW03	Wambo Seam	12:35	27-05-2020																			
WD625P	Warkworth Sands	0.475694444	28-05-2020																			
WOH2141A	Bayswater	0.517361111	29-05-2020																			
MBW6A	Shallow Overburden	13:10	26-05-2020																			

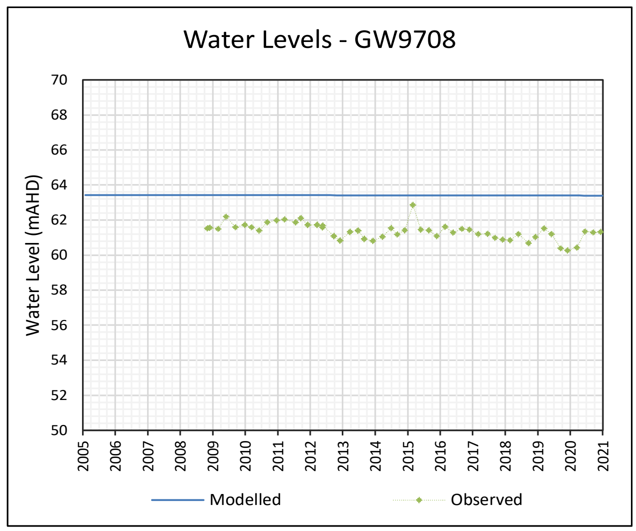
APPENDIX E

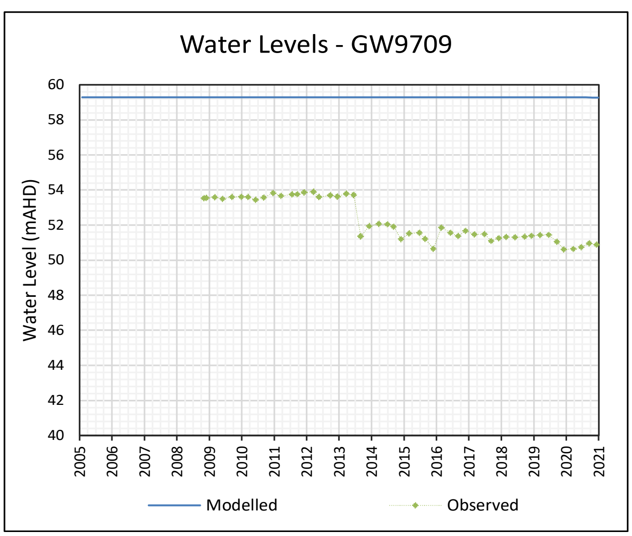
Model Verification Hydrographs

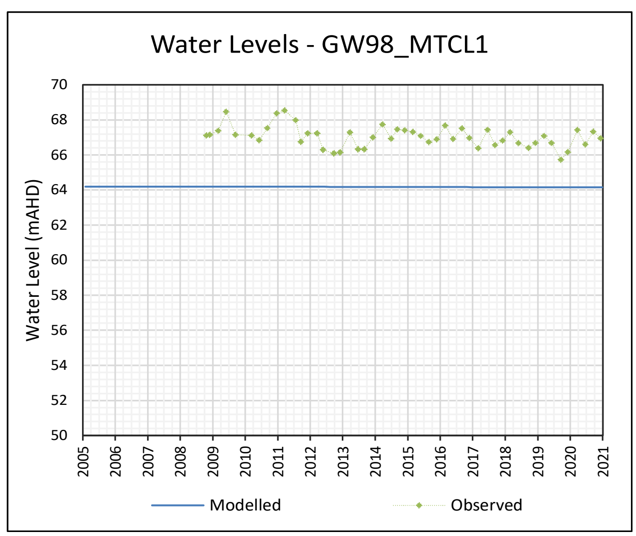

Water Levels - G3
Water Level (mAHD)
Modelled
Observed

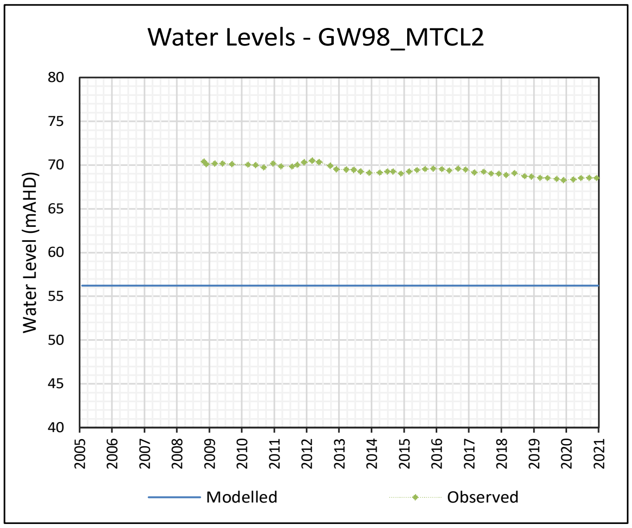

Water Levels - GW9706
Water Level (mAHD)
Modelled
Observed

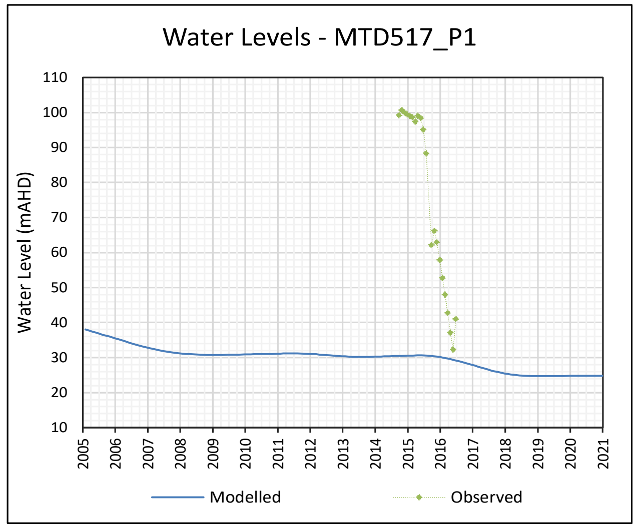

Water Levels - GW9707
Water Level (mAHD)
Modelled
Observed

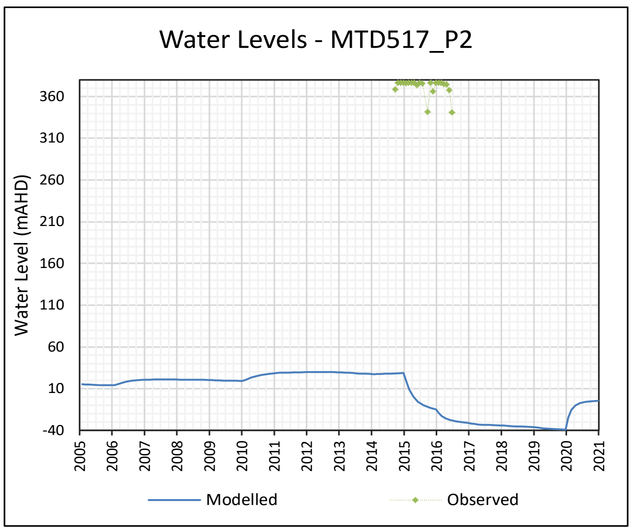

Water Levels - GW9708
Water Level (mAHD)
Modelled
Observed

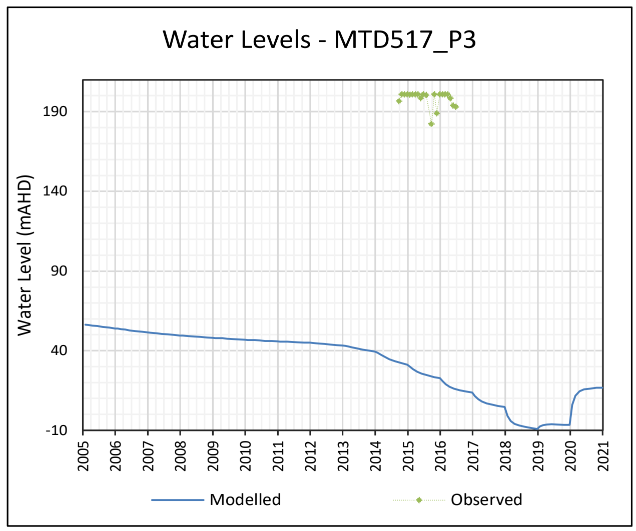

Water Levels - GW9709
Water Level (mAHD)
Modelled
Observed

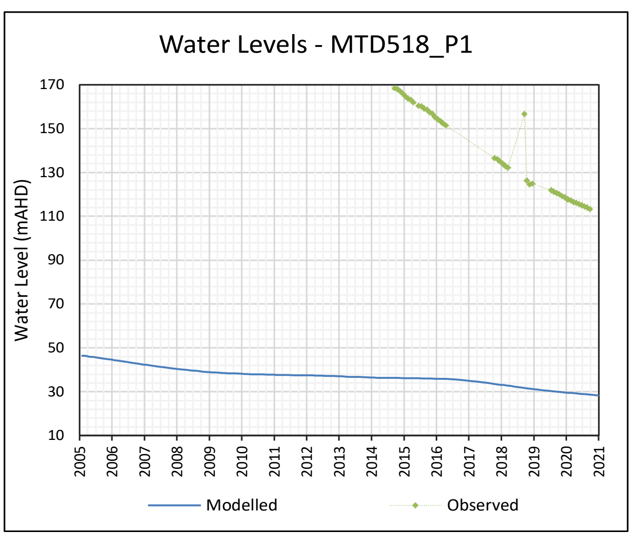

Water Levels - GW98_MTCL1
Water Level (mAHD)
Modelled
Observed

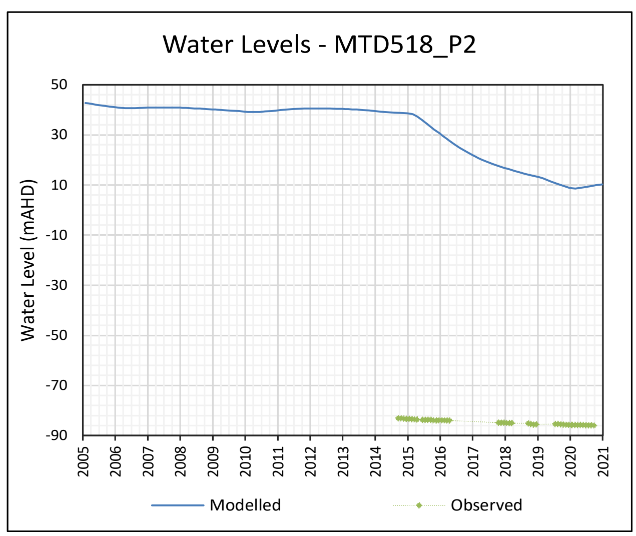

Water Levels - GW98_MTCL2
Water Level (mAHD)
Modelled
Observed

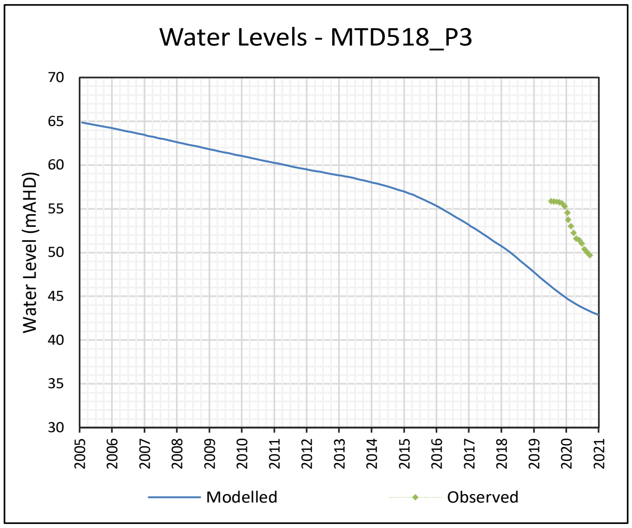

Water Levels - MTD517_P1
Water Level (mAHD)
Modelled
Observed

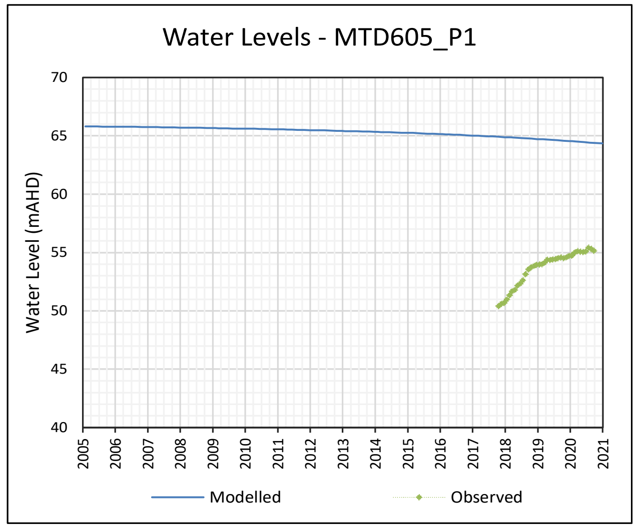

Water Levels - MTD517_P2
Water Level (mAHD)
Modelled
Observed

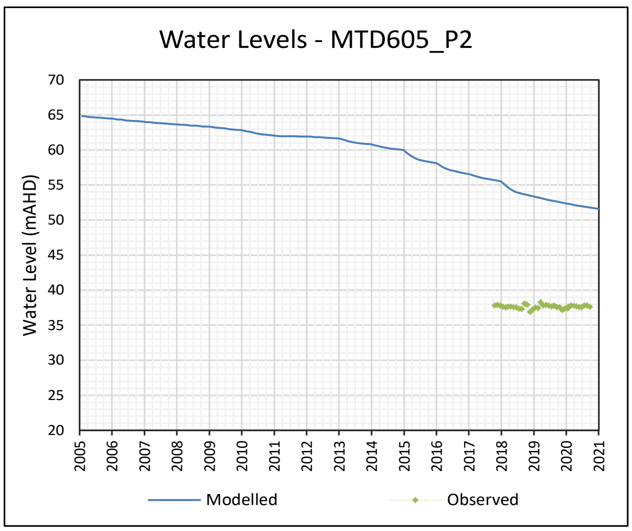

Water Levels - MTD517_P3
Water Level (mAHD)
Modelled
Observed

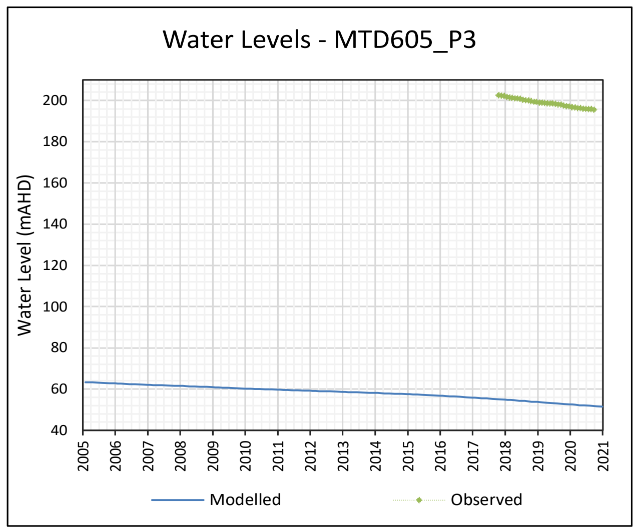

Water Levels - MTD518_P1
Water Level (mAHD)
Modelled
Observed

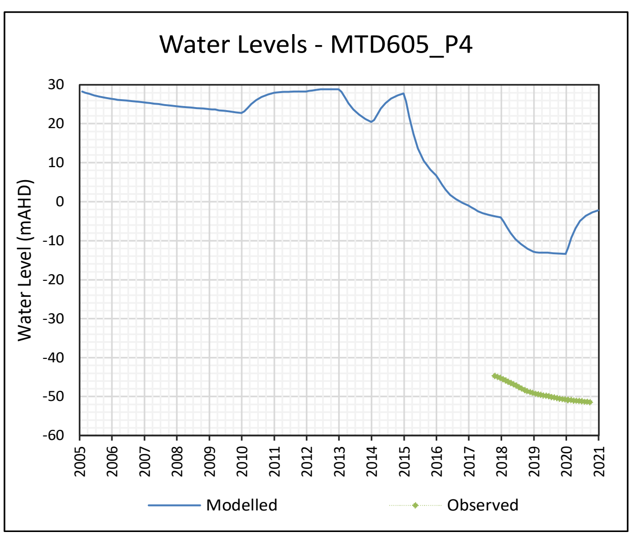

Water Levels - MTD518_P2
Water Level (mAHD)
Modelled
Observed

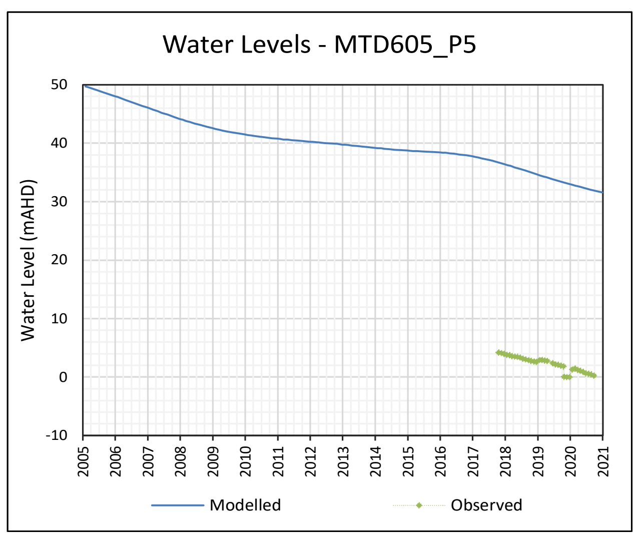

Water Levels - MTD518_P3
Water Level (mAHD)
Modelled
Observed

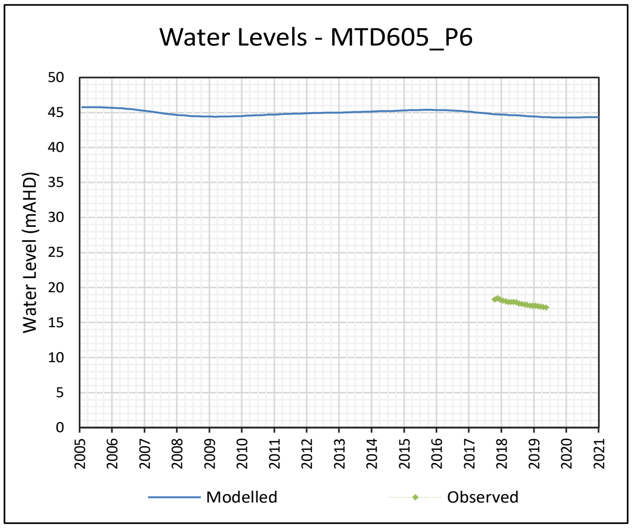

Water Levels - MTD605_P1
Water Level (mAHD)
Modelled
Observed

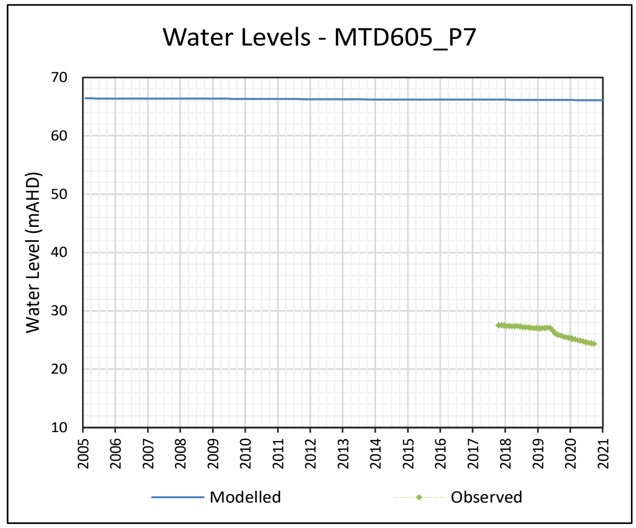

Water Levels - MTD605_P2
Water Level (mAHD)
Modelled
Observed

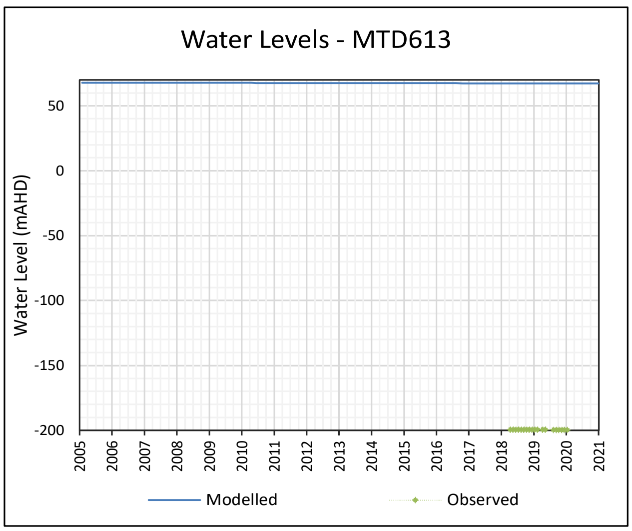

Water Levels - MTD605_P3
Water Level (mAHD)
Modelled
Observed

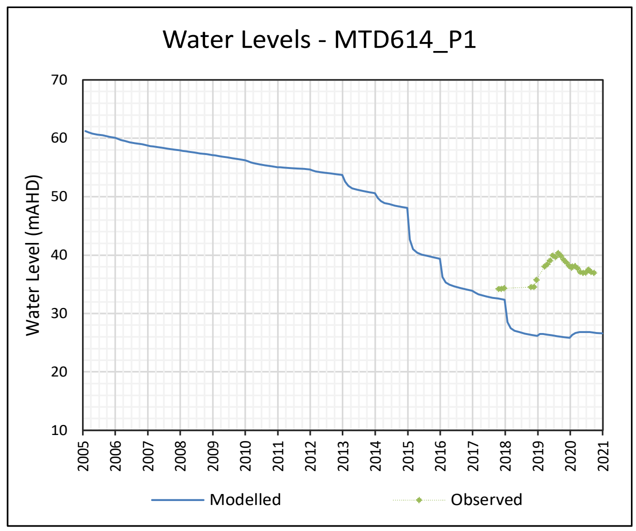

Water Levels - MTD605_P4
Water Level (mAHD)
Modelled
Observed

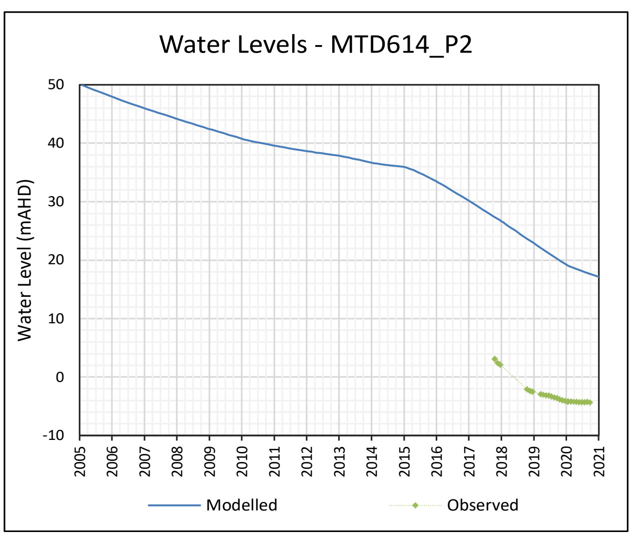

Water Levels - MTD605_P5
Water Level (mAHD)
Modelled
Observed

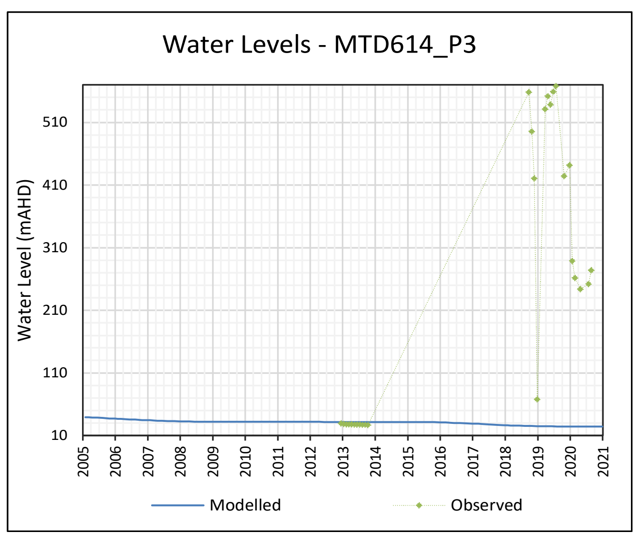

Water Levels - MTD605_P6
Water Level (mAHD)
Modelled
Observed

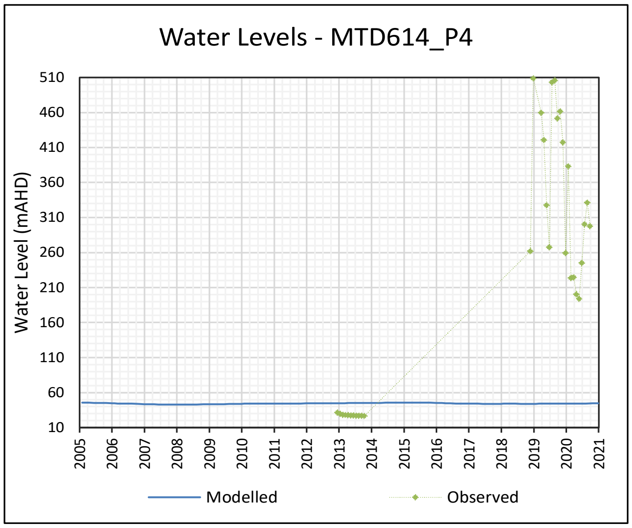

Water Levels - MTD605_P7
Water Level (mAHD)
Modelled
Observed

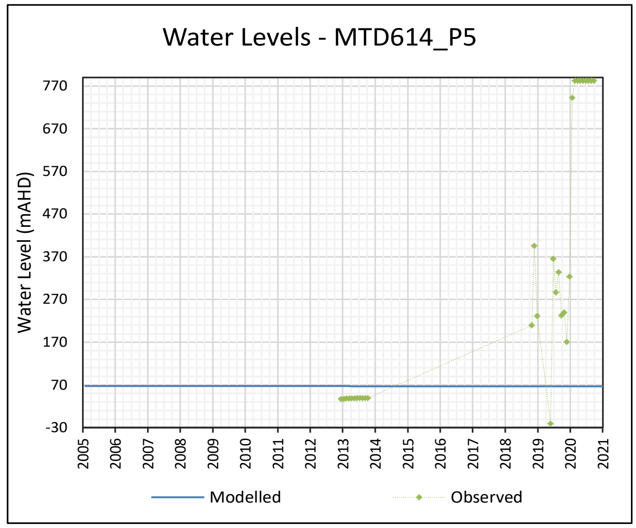

Water Levels - MTD613
Water Level (mAHD)
Modelled
Observed

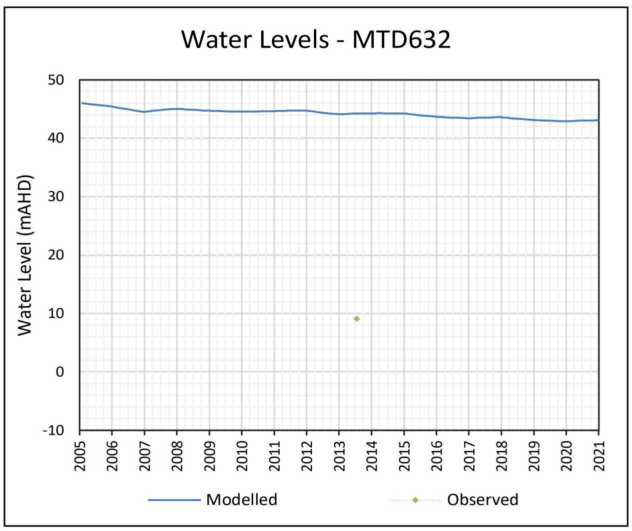

Water Levels - MTD614_P1
Water Level (mAHD)
Modelled
Observed

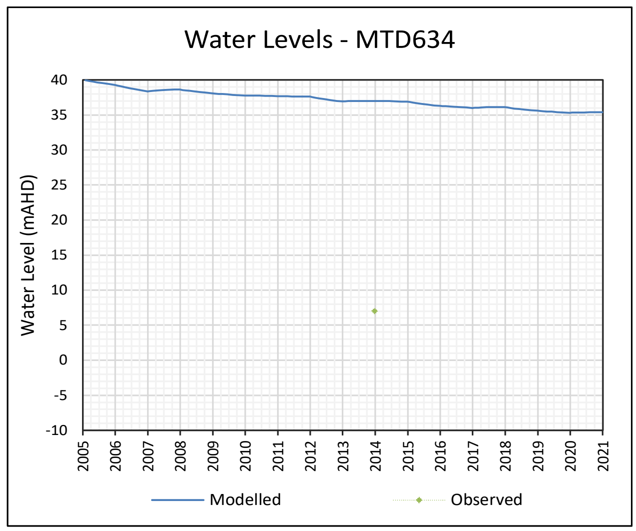

Water Levels - MTD614_P2
Water Level (mAHD)
Modelled
Observed

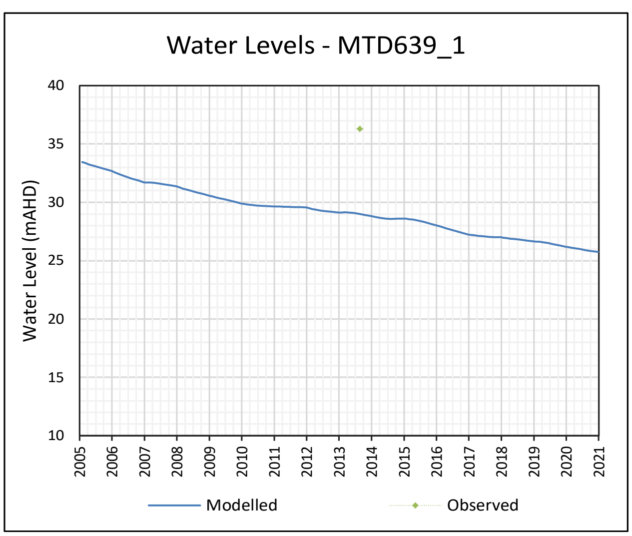

Water Levels - MTD614_P3
Water Level (mAHD)
Modelled
Observed

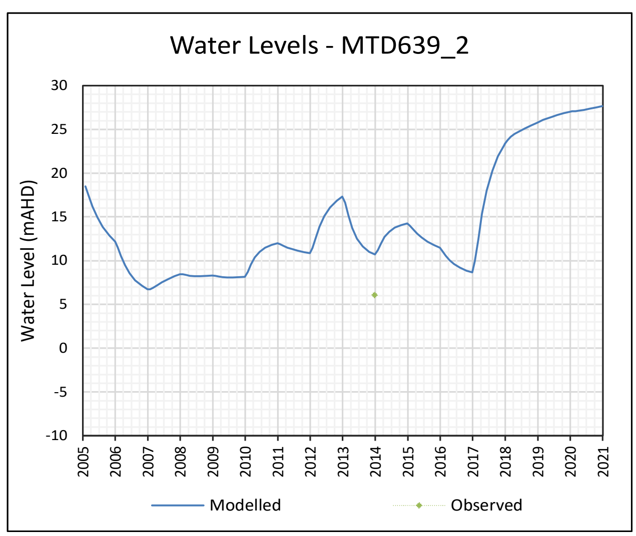

Water Levels - MTD614_P4
Water Level (mAHD)
510
460
410
360
310
260
210
160
110
60
10
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Modelled
Observed

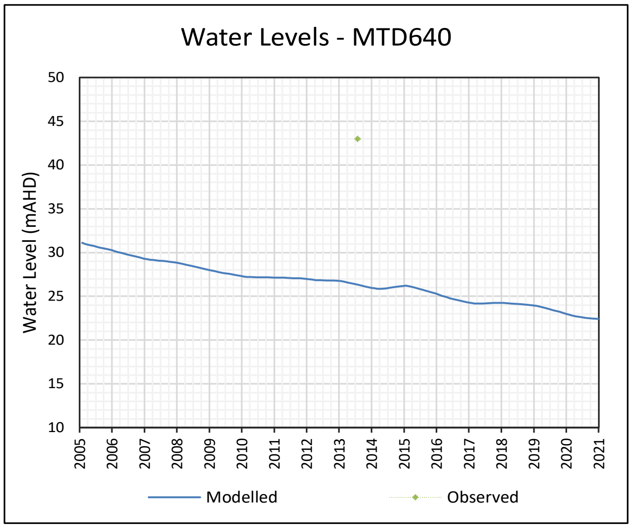

Water Levels - MTD614_P5
Water Level (mAHD)
770
670
570
470
370
270
170
70
-30
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Modelled
Observed

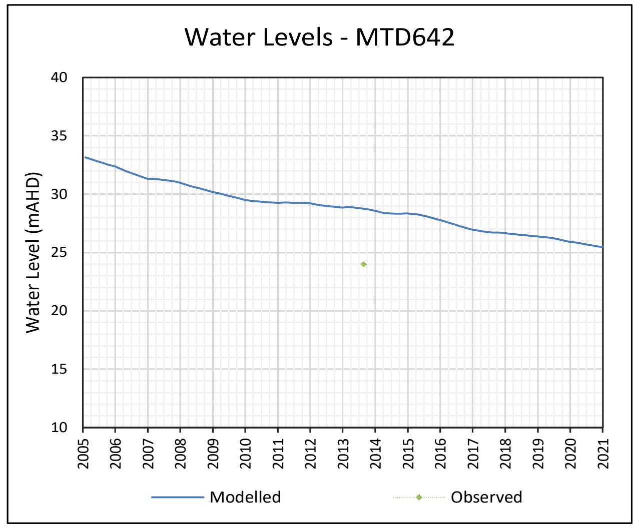

Water Levels - MTD632
Water Level (mAHD)
50
40
30
20
10
0
-10
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Modelled
Observed

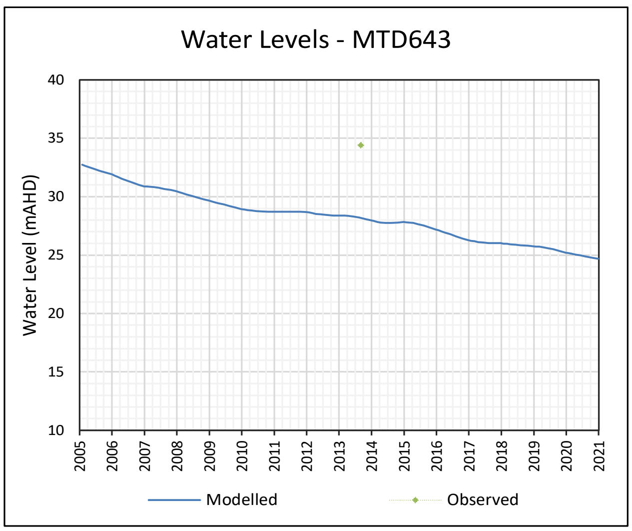

Water Levels - MTD634
Water Level (mAHD)
40
35
30
25
20
15
10
5
0
-5
-10
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Modelled
Observed

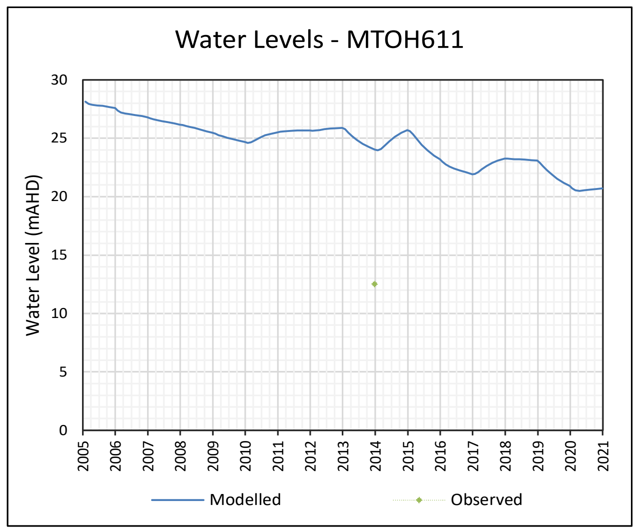

Water Levels - MTD639_1
Water Level (mAHD)
40
35
30
25
20
15
10
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Modelled
Observed

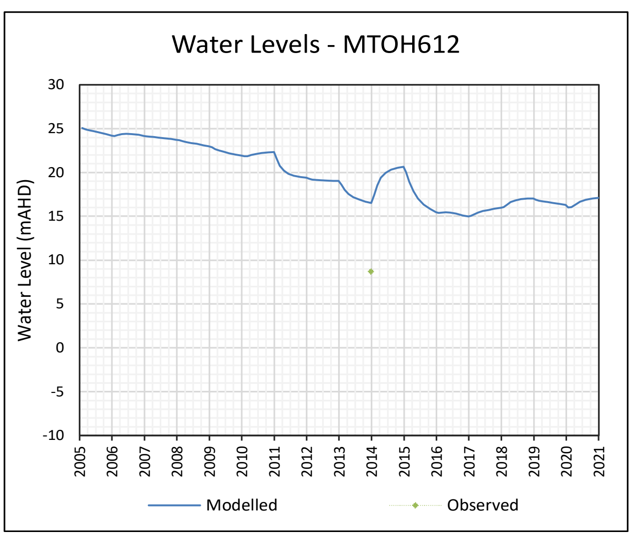

Water Levels - MTD639_2
Water Level (mAHD)
30
25
20
15
10
5
0
-5
-10
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Modelled
Observed

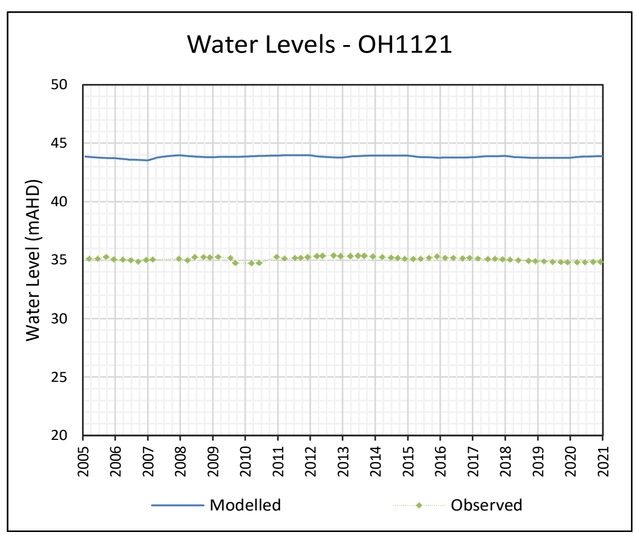

Water Levels - MTD640
Water Level (mAHD)
Modelled
Observed

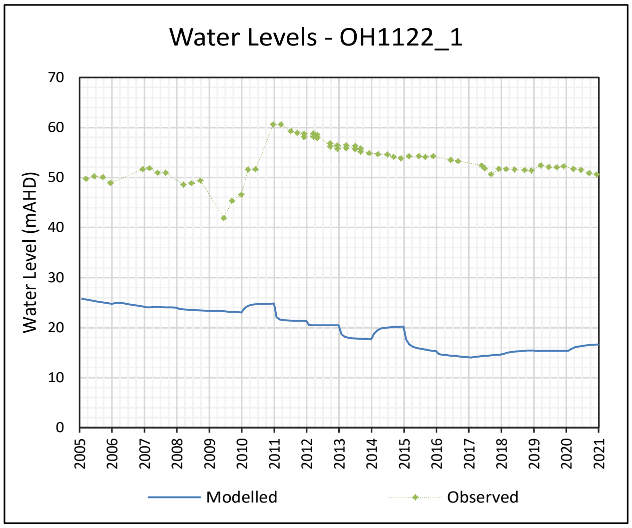

Water Levels - MTD642
Water Level (mAHD)
Modelled
Observed

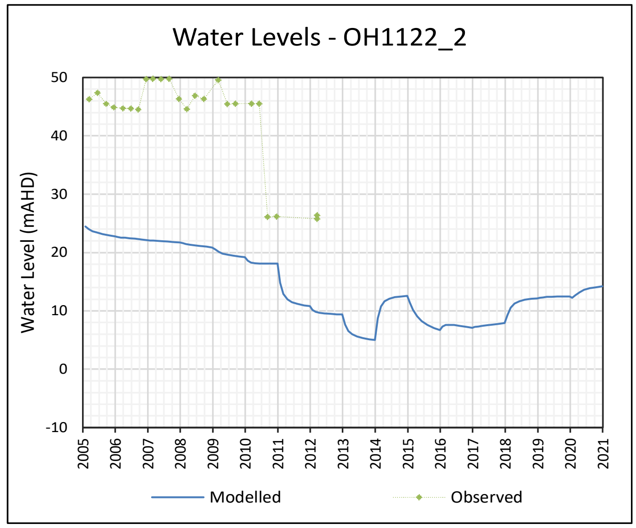

Water Levels - MTD643
Water Level (mAHD)
Modelled
Observed

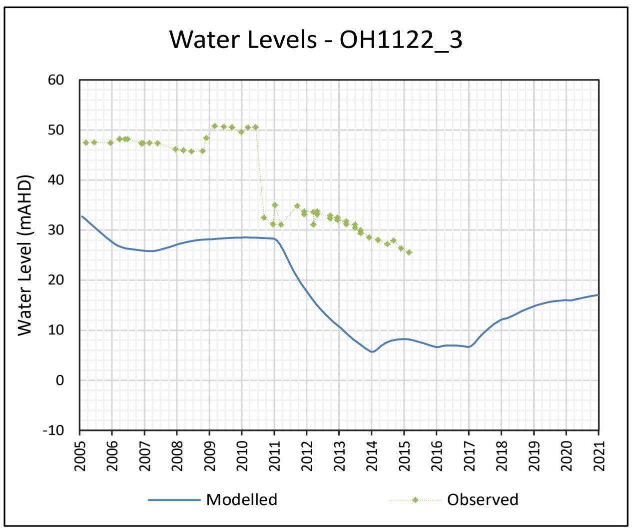

Water Levels - MTOH611
Water Level (mAHD)
Modelled
Observed

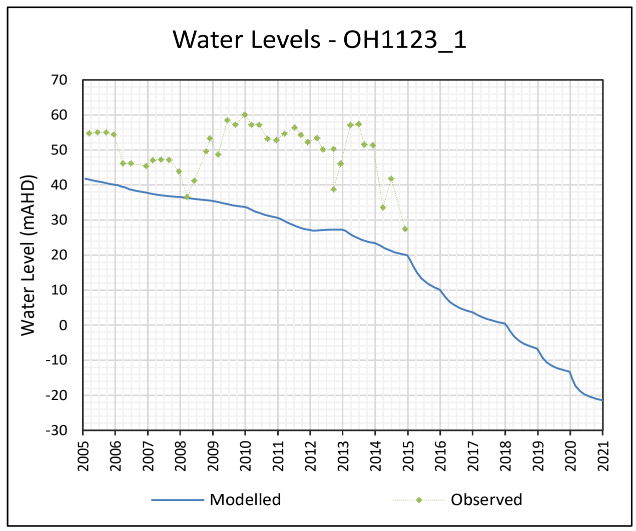

Water Levels - MTOH612
Water Level (mAHD)
Modelled
Observed

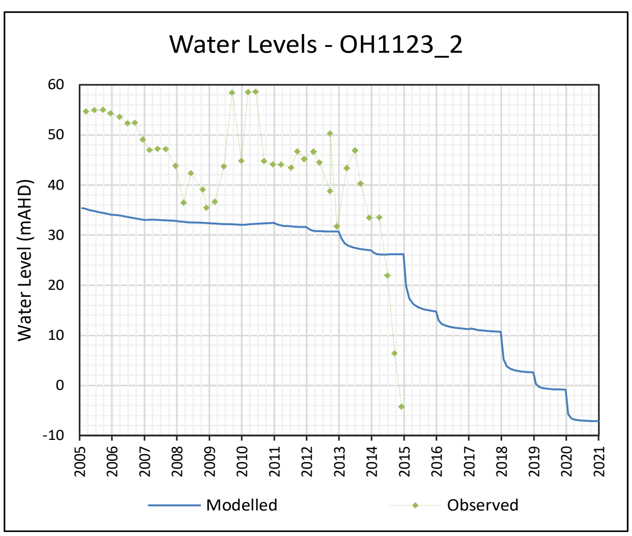

Water Levels - OH1121
Water Level (mAHD)
Modelled
Observed

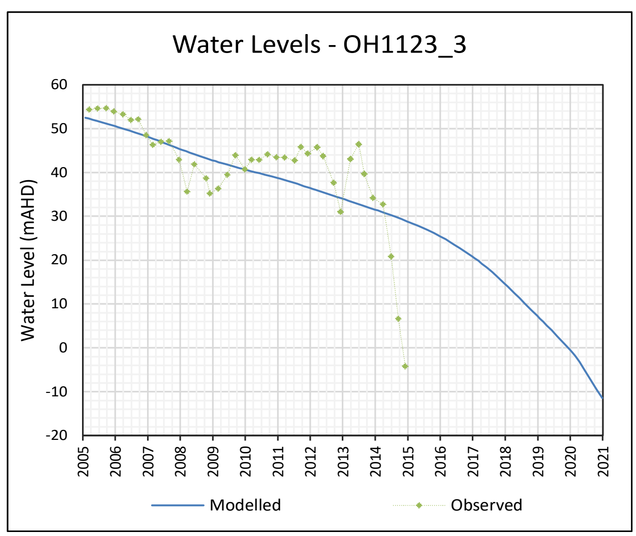

Water Levels - OH1122_1
Water Level (mAHD)
Modelled
Observed

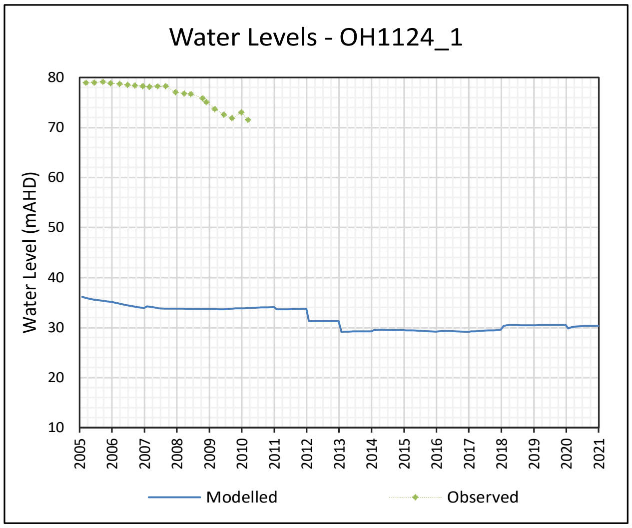

Water Levels - OH1122_2
Water Level (mAHD)
Modelled
Observed

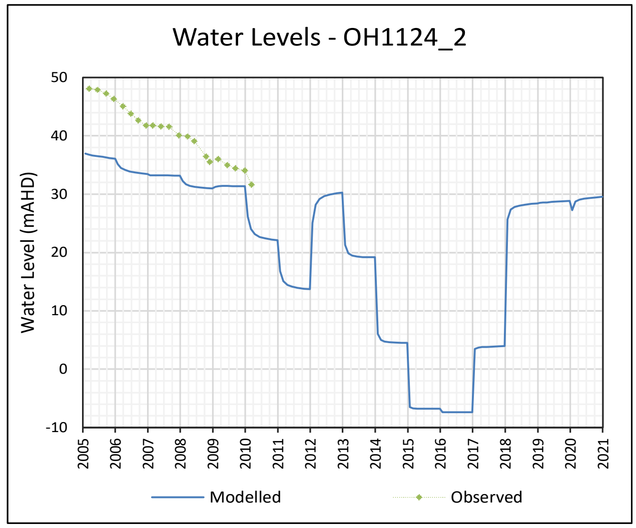

Water Levels - OH1122_3
Water Level (mAHD)
Modelled
Observed

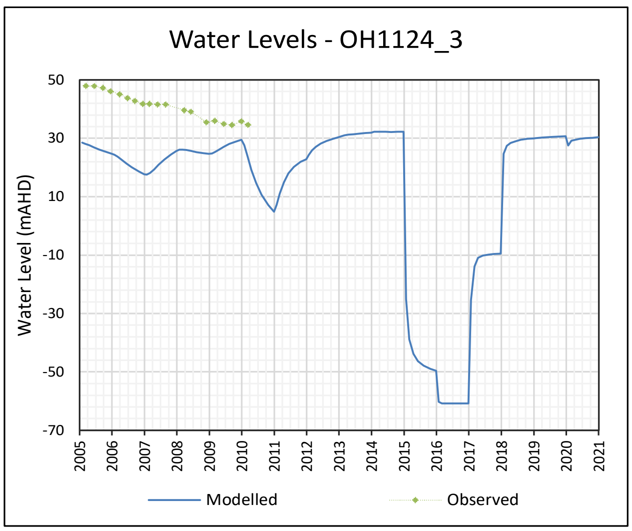

Water Levels - OH1123_1
Water Level (mAHD)
Modelled
Observed

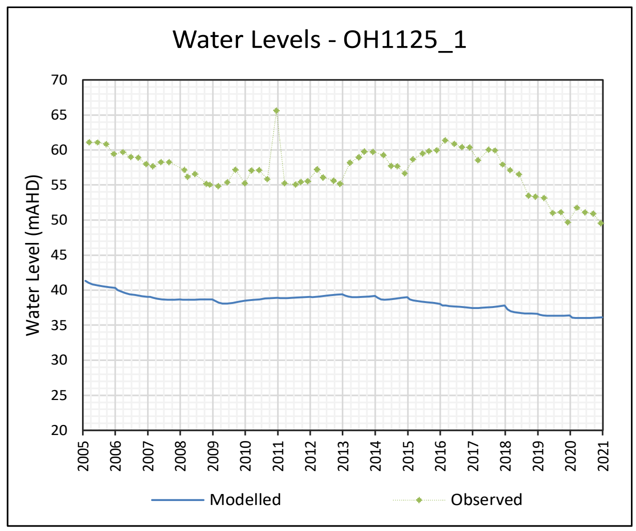

Water Levels - OH1123_2
Water Level (mAHD)
Modelled
Observed

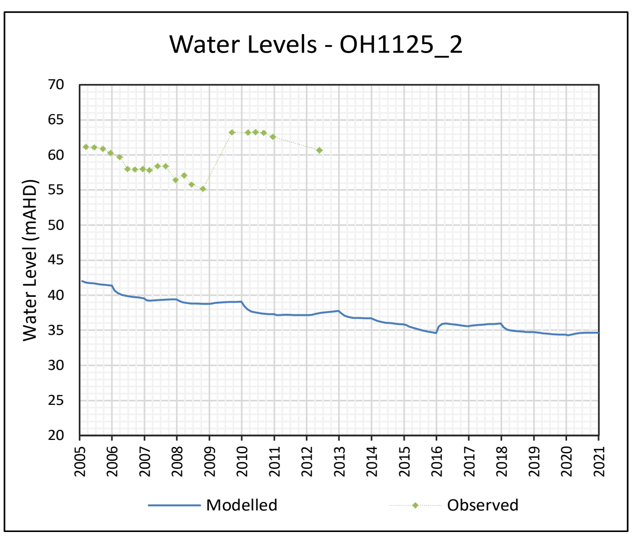

Water Levels - OH1123_3
Water Level (mAHD)
Modelled
Observed

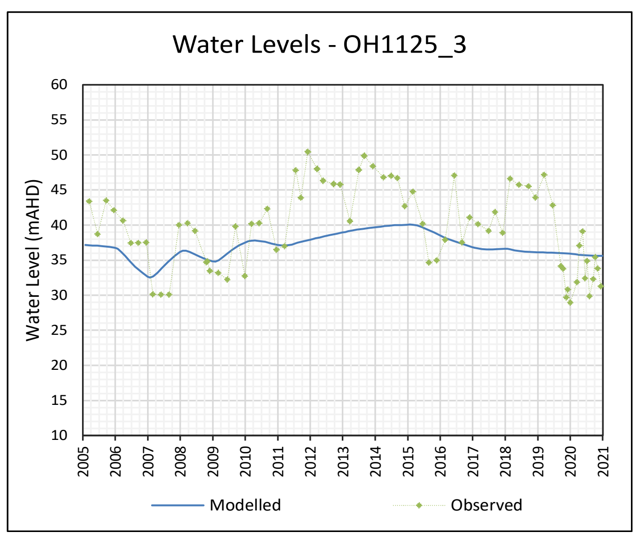

Water Levels - OH1124_1
Water Level (mAHD)
80
70
60
50
40
30
20
10
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Modelled
Observed

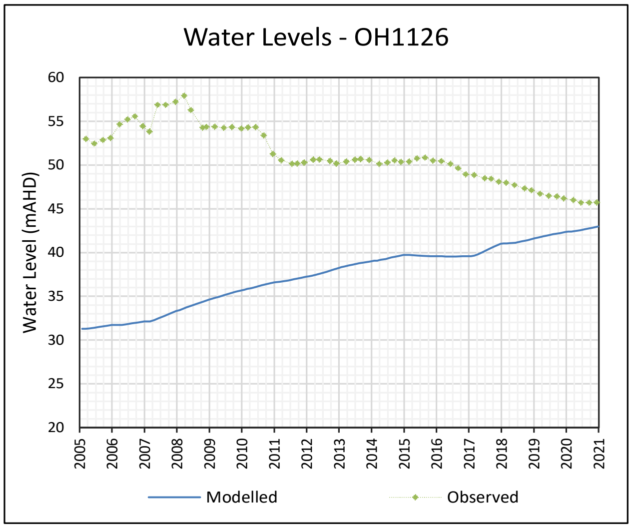

Water Levels - OH1124_2
Water Level (mAHD)
50
40
30
20
10
0
-10
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Modelled
Observed


Water Levels - OH1124_3
Water Level (mAHD)
50
30
10
-10
-30
-50
-70
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Modelled
Observed


Water Levels - OH1125_1
Water Level (mAHD)
70
65
60
55
50
45
40
35
30
25
20
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Modelled
Observed


Water Levels - OH1125_2
Water Level (mAHD)
70
65
60
55
50
45
40
35
30
25
20
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Modelled
Observed


Water Levels - OH1125_3
Water Level (mAHD)
60
55
50
45
40
35
30
25
20
15
10
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Modelled
Observed


Water Levels - OH1126
Water Level (mAHD)
60
55
50
45
40
35
30
25
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2005
2006
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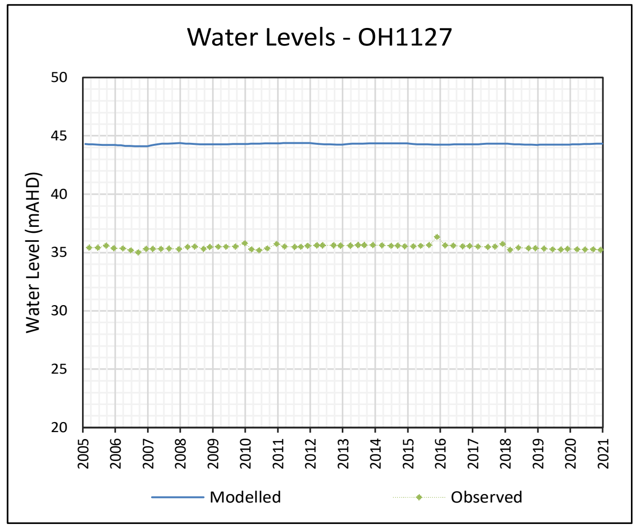
2020
2021
Modelled
Observed


Water Levels - OH1127
Water Level (mAHD)
50
45
40
35
30
25
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2005
2006
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2011
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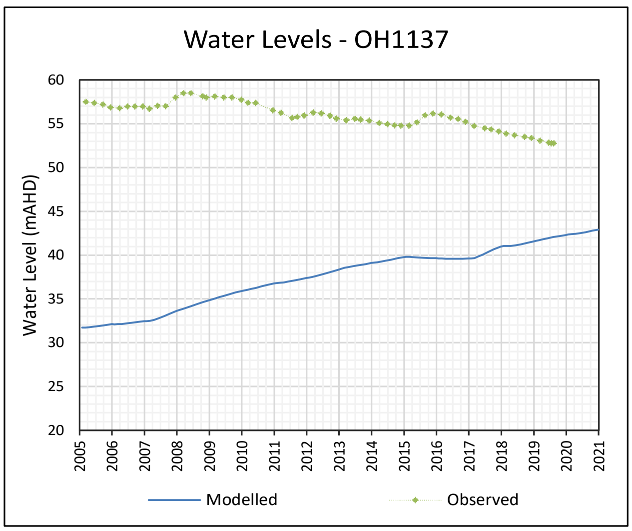
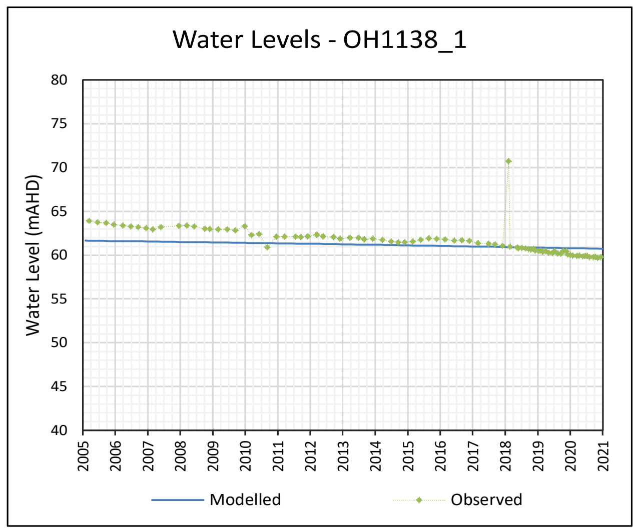
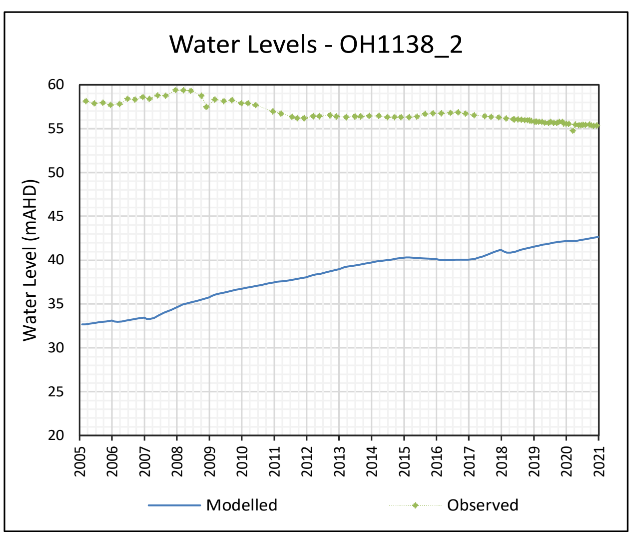
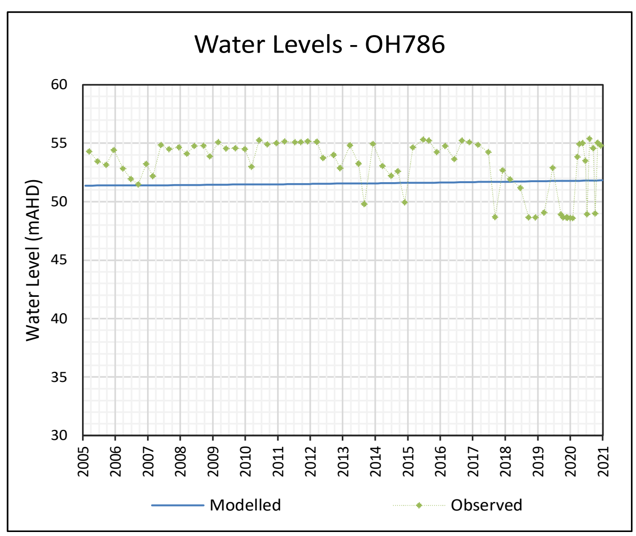
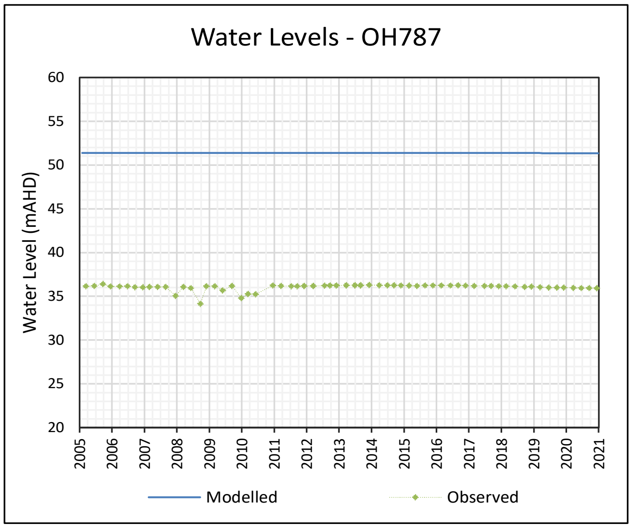
2015
2016
2017
2018
2019
2020
2021
Modelled
Observed

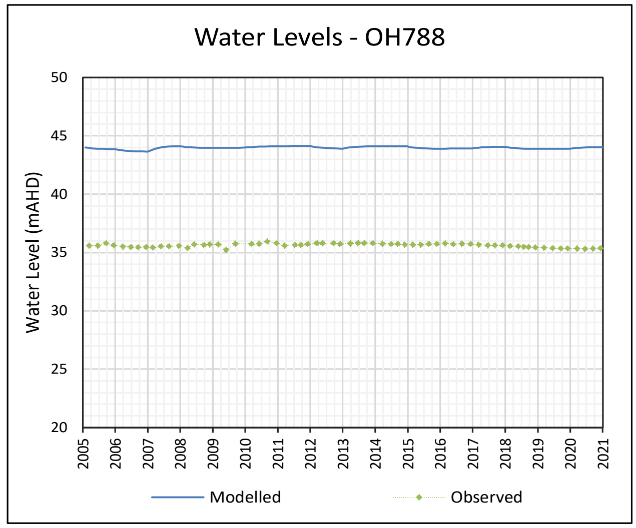

Water Levels - OH1137
Water Level (mAHD)
60
55
50
45
40
35
30
25
20
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Modelled
Observed

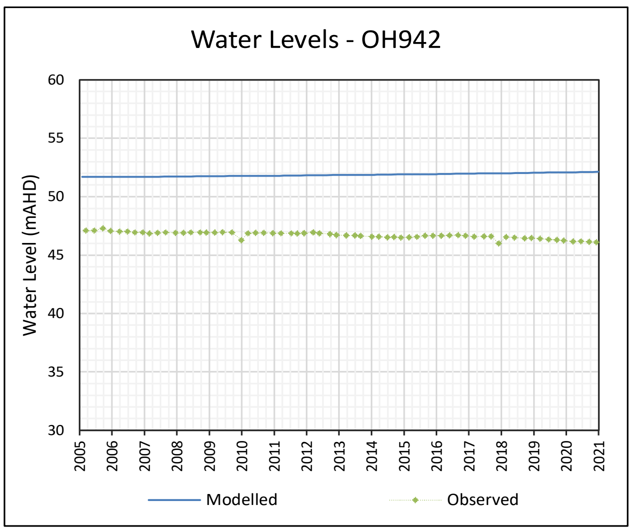

Water Levels - OH1138_1
Water Level (mAHD)
80
75
70
65
60
55
50
45
40
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Modelled
Observed

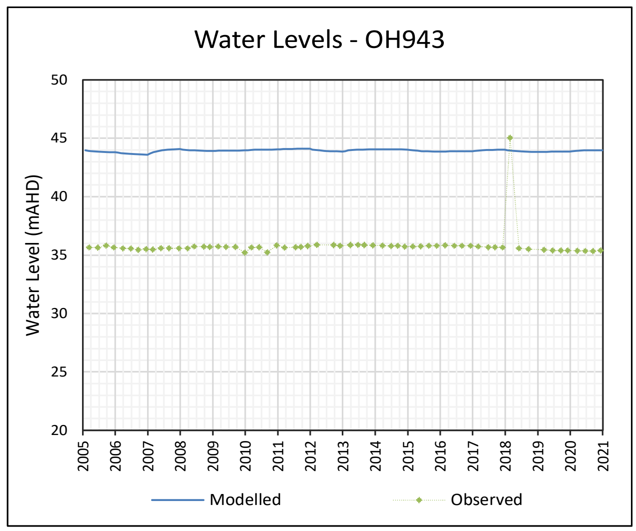

Water Levels - OH1138_2
Water Level (mAHD)
60
55
50
45
40
35
30
25
20
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Modelled
Observed

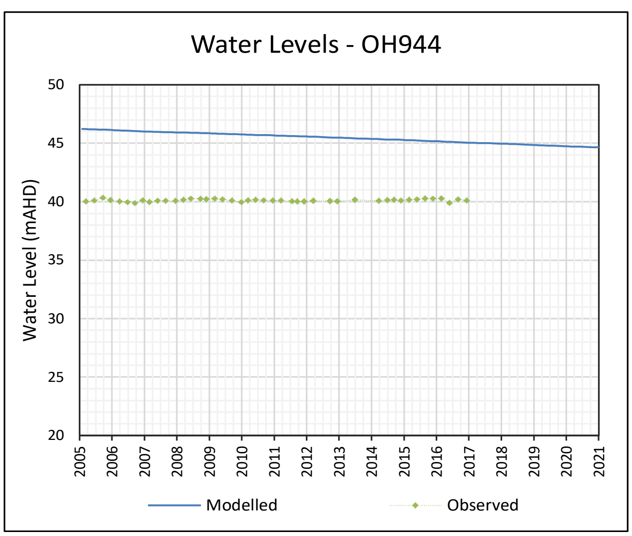

Water Levels - OH786
Water Level (mAHD)
60
55
50
45
40
35
30
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Modelled
Observed

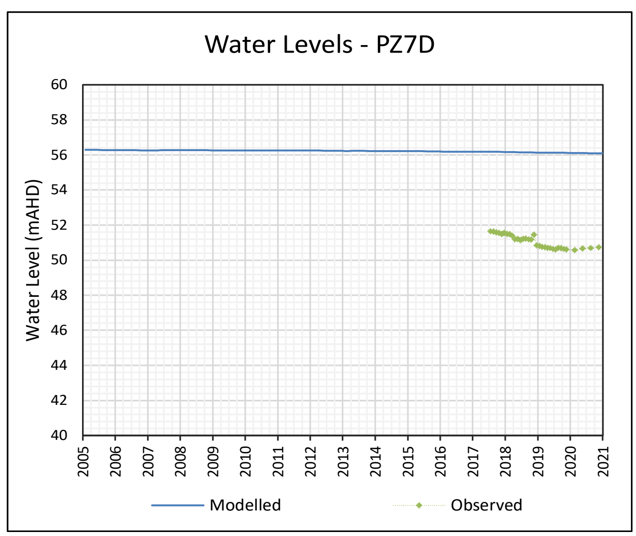

Water Levels - OH787
Water Level (mAHD)
Modelled
Observed

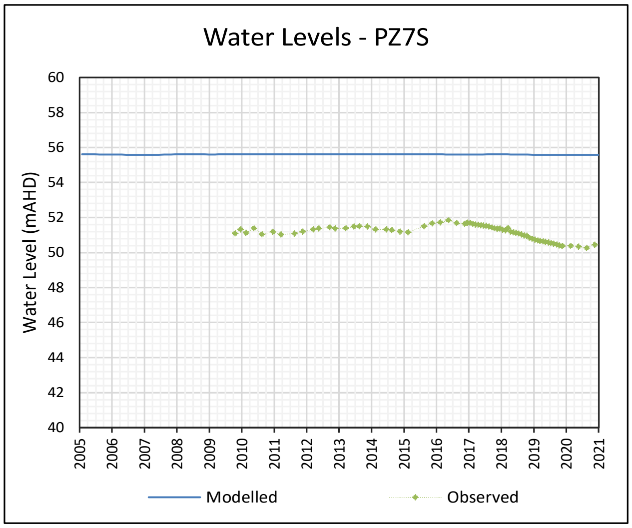

Water Levels - OH788
Water Level (mAHD)
Modelled
Observed

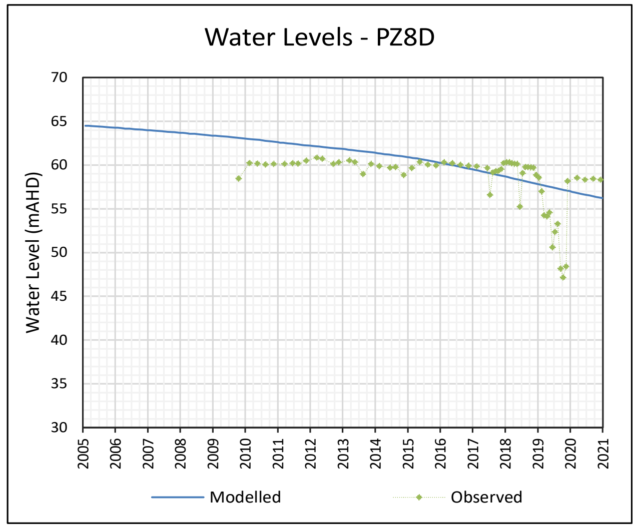

Water Levels - OH942
Water Level (mAHD)
Modelled
Observed

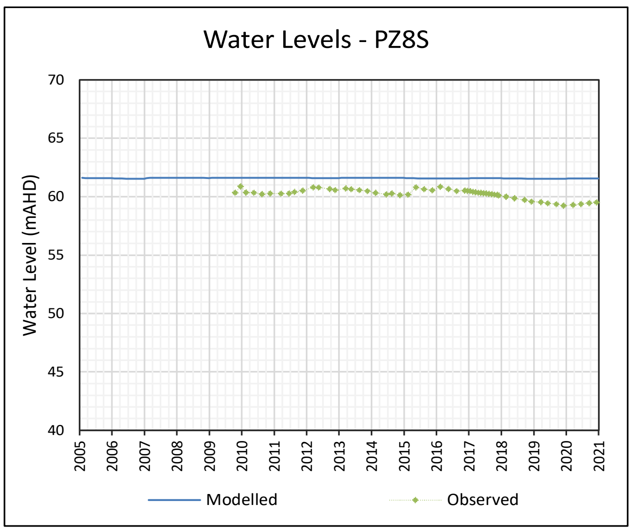

Water Levels - OH943
Water Level (mAHD)
Modelled
Observed

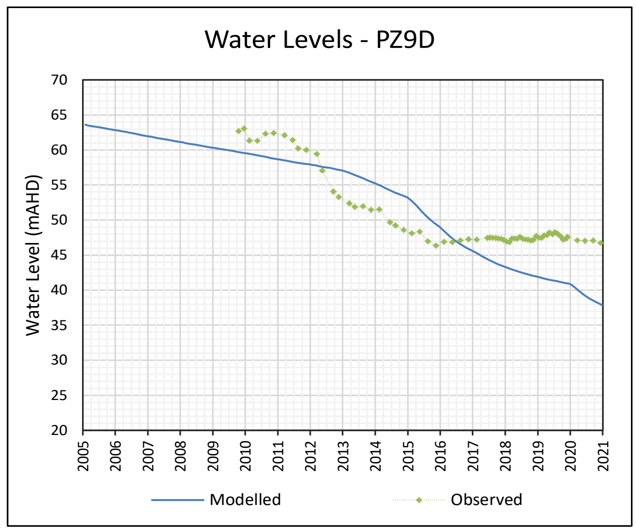

Water Levels - OH944
Water Level (mAHD)
Modelled
Observed

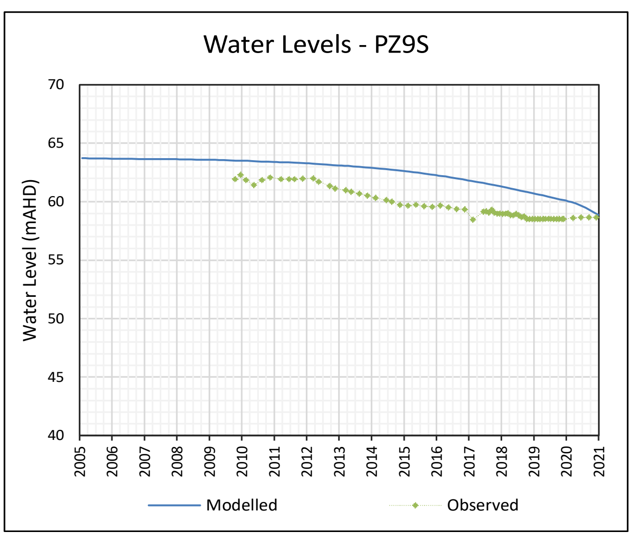

Water Levels - PZ7D
Water Level (mAHD)
Modelled
Observed

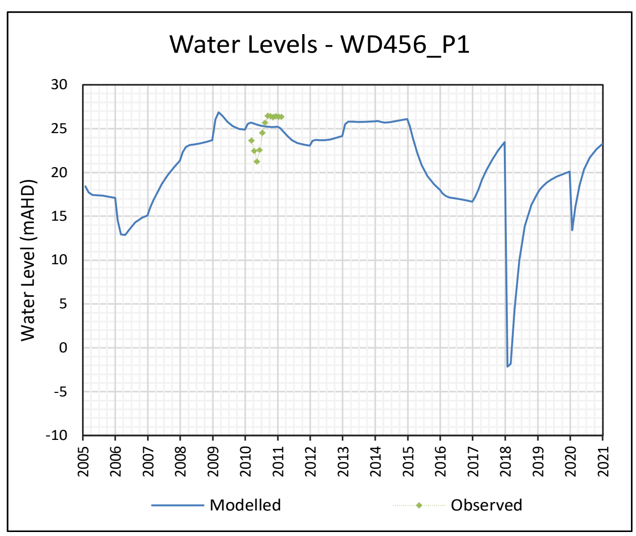

Water Levels - PZ7S
Water Level (mAHD)
Modelled
Observed

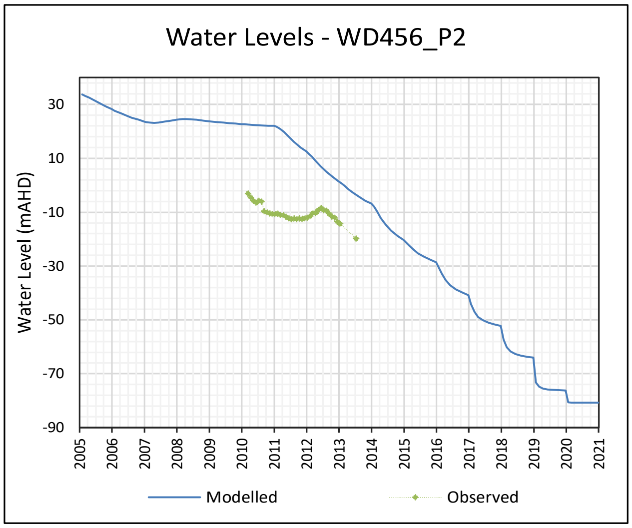

Water Levels - PZ8D
Water Level (mAHD)
Modelled
Observed

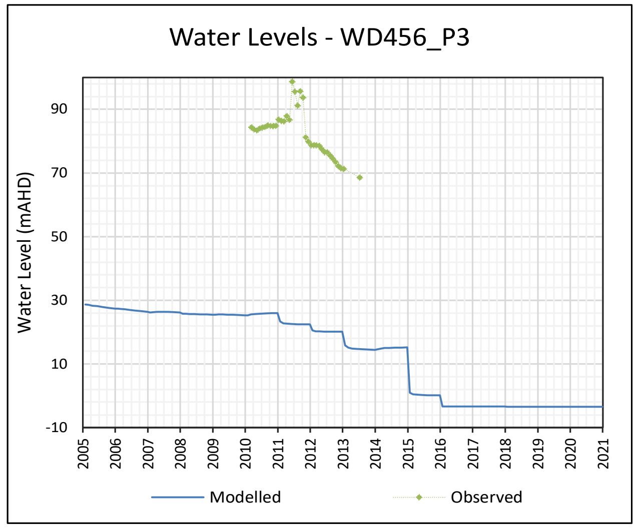

Water Levels - PZ8S
Water Level (mAHD)
Modelled
Observed

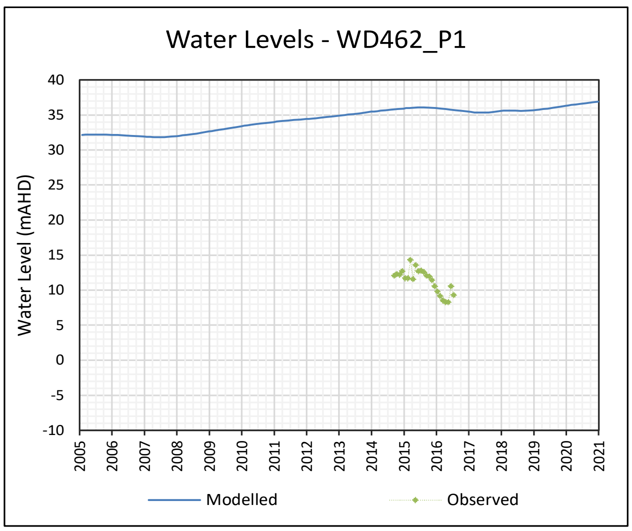

Water Levels - PZ9D
Water Level (mAHD)
Modelled
Observed

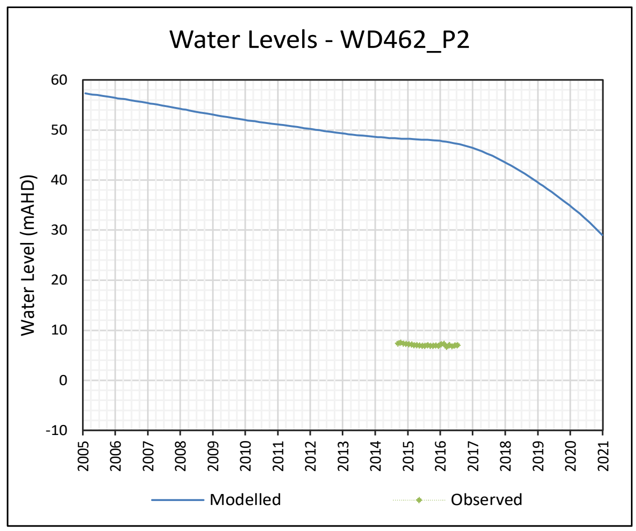

Water Levels - PZ9S
Water Level (mAHD)
Modelled
Observed

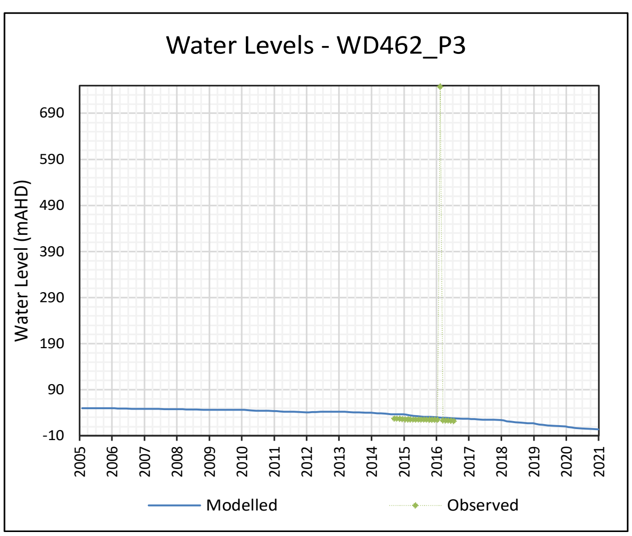

Water Levels - WD456_P1
Water Level (mAHD)
Modelled
Observed

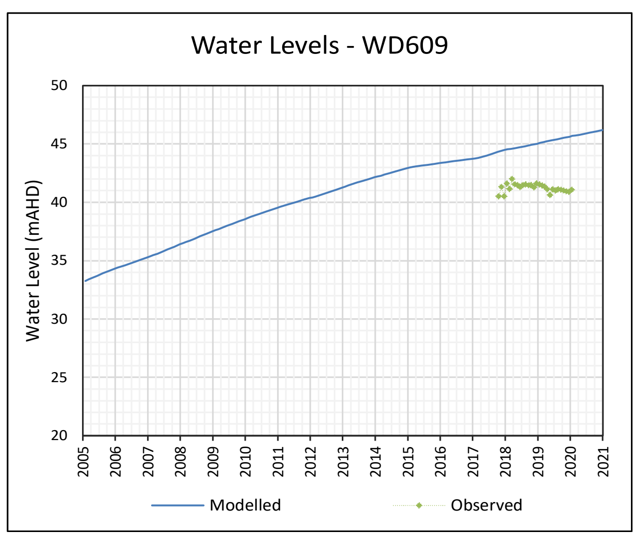

Water Levels - WD456_P2
Water Level (mAHD)
Modelled
Observed

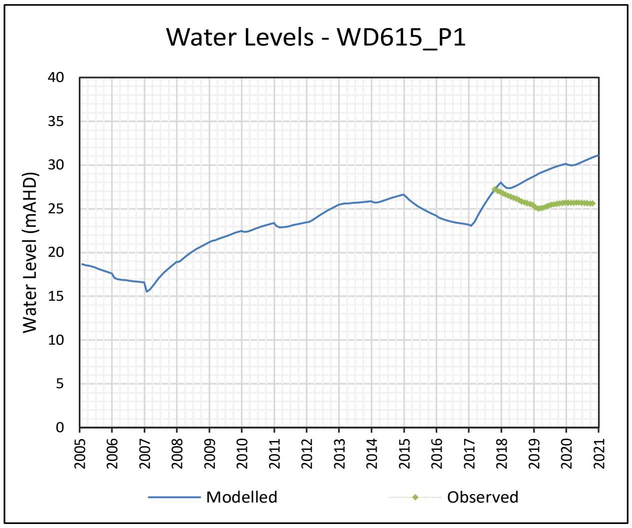

Water Levels - WD456_P3
Water Level (mAHD)
Modelled
Observed

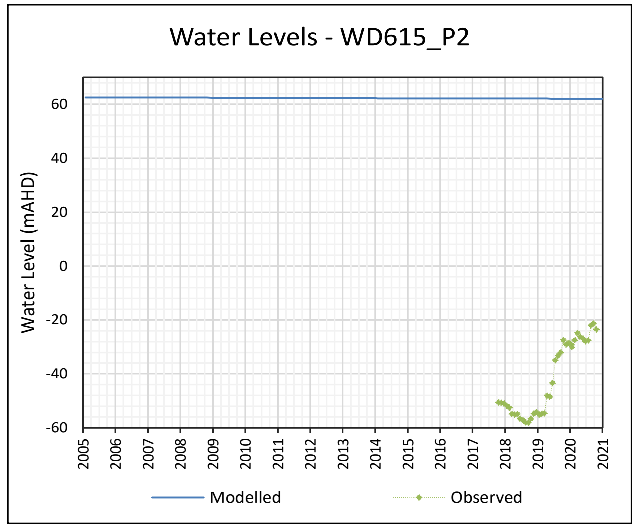

Water Levels - WD462_P1
Water Level (mAHD)
Modelled
Observed

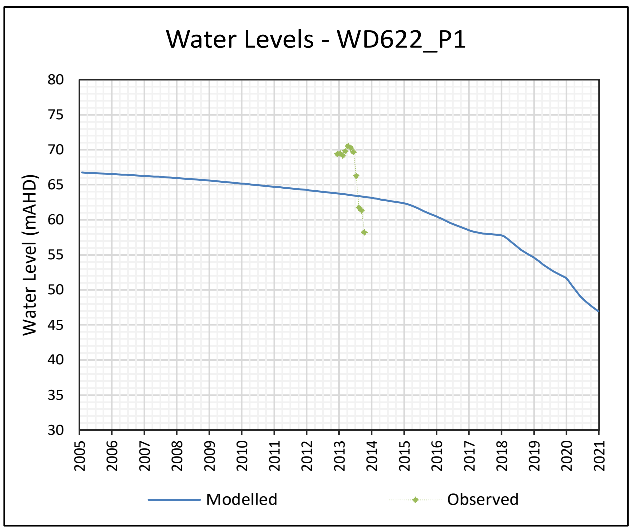

Water Levels - WD462_P2
Water Level (mAHD)
Modelled
Observed

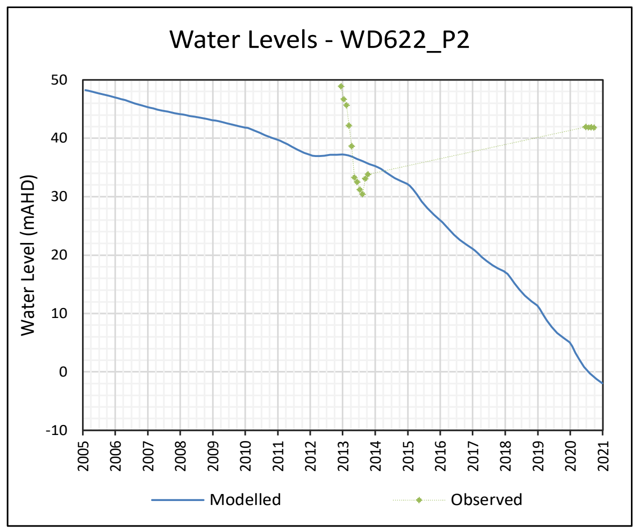

Water Levels - WD462_P3
Water Level (mAHD)
Modelled
Observed

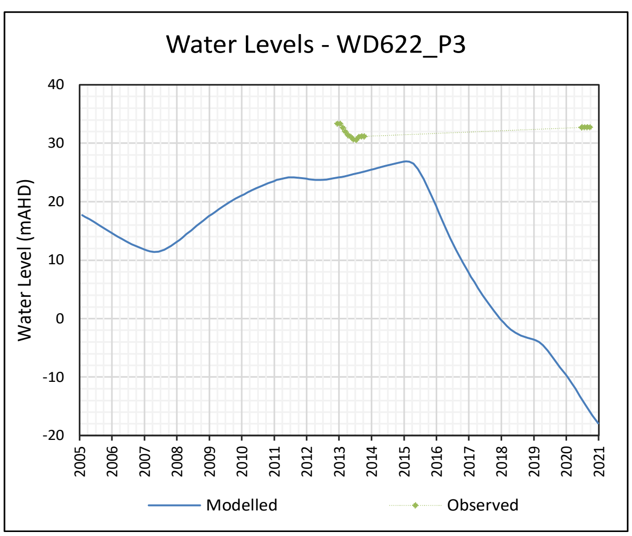

Water Levels - WD609
Water Level (mAHD)
Modelled
Observed

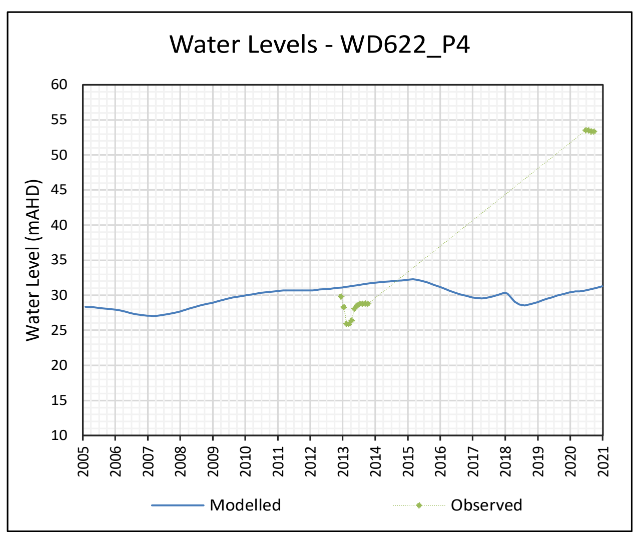

Water Levels - WD615_P1
Water Level (mAHD)
Modelled
Observed

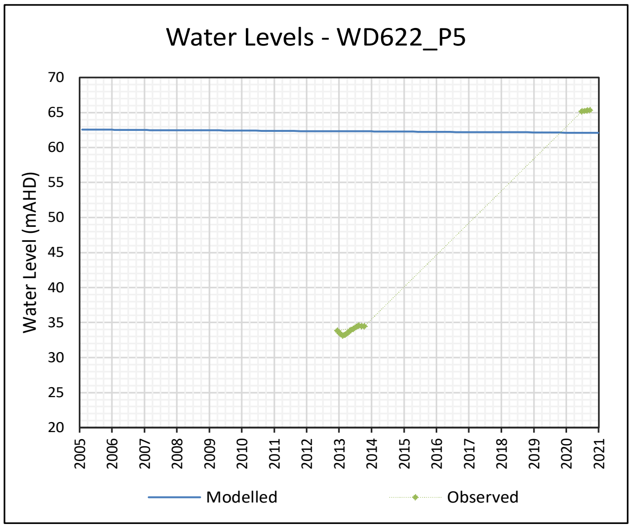

Water Levels - WD615_P2
Water Level (mAHD)
Modelled
Observed

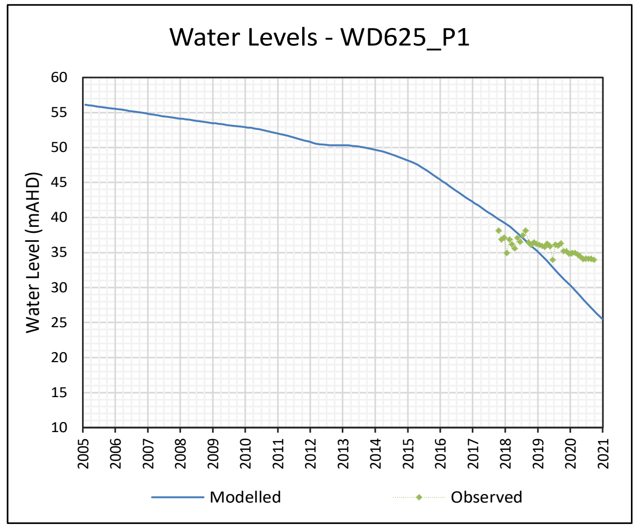

Water Levels - WD622_P1
Water Level (mAHD)
Modelled
Observed

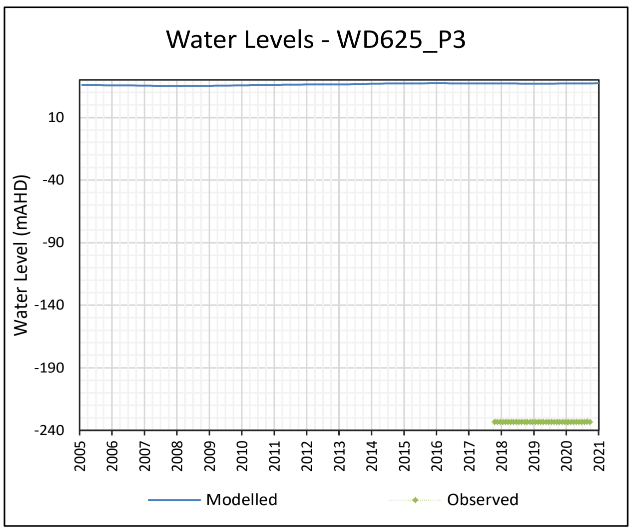

Water Levels - WD622_P2
Water Level (mAHD)
Modelled
Observed

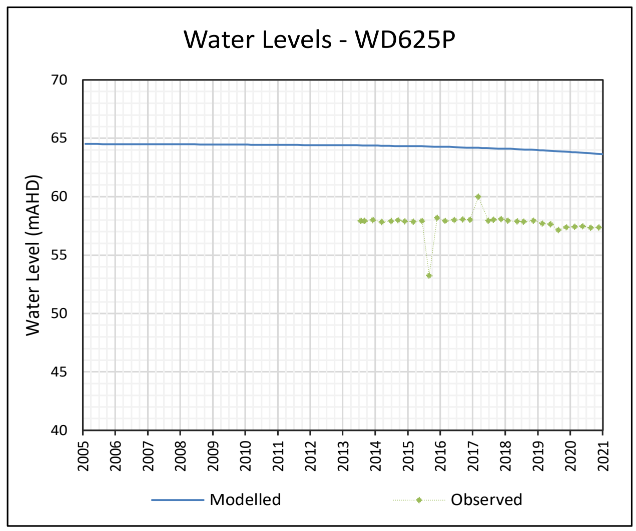

Water Levels - WD622_P3
Water Level (mAHD)
Modelled
Observed

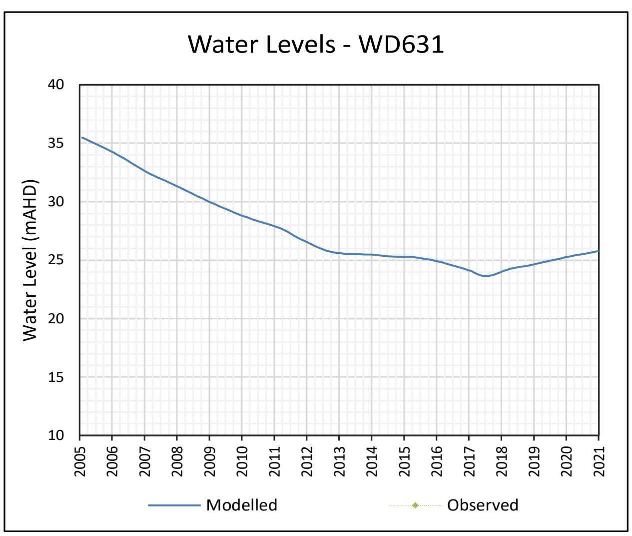

Water Levels - WD622_P4
Water Level (mAHD)
Modelled
Observed

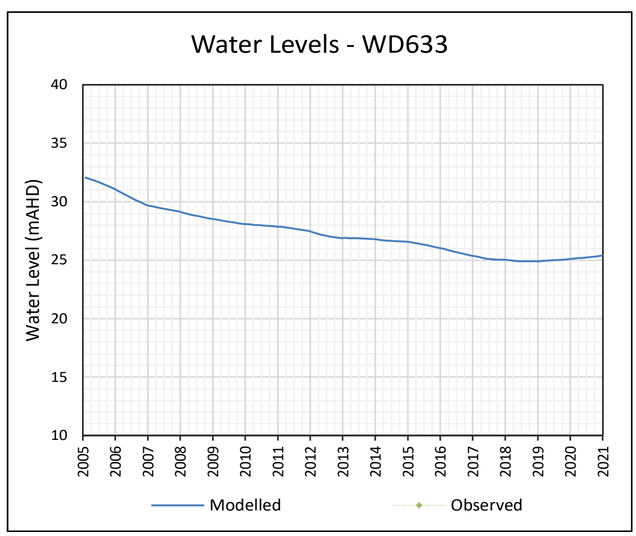

Water Levels - WD622_P5
Water Level (mAHD)
Modelled
Observed

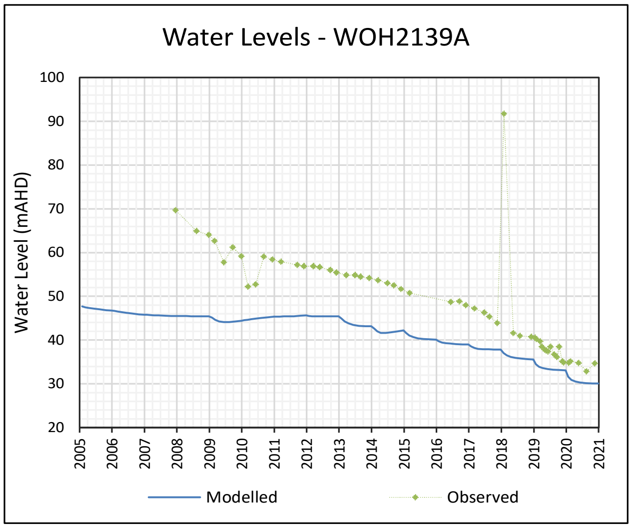

Water Levels - WD625_P1
Water Level (mAHD)
Modelled
Observed

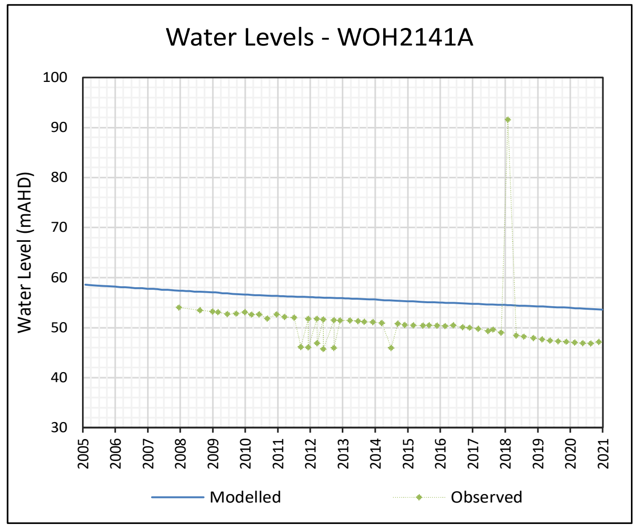

Water Levels - WD625_P3
Water Level (mAHD)
Modelled
Observed

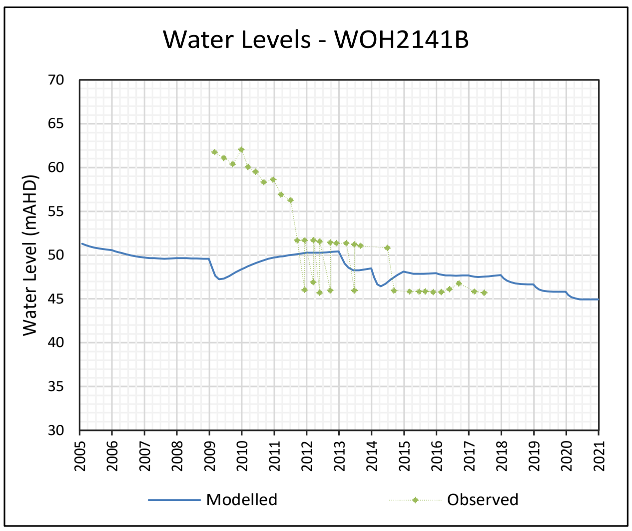

Water Levels - WD625P
Water Level (mAHD)
Modelled
Observed

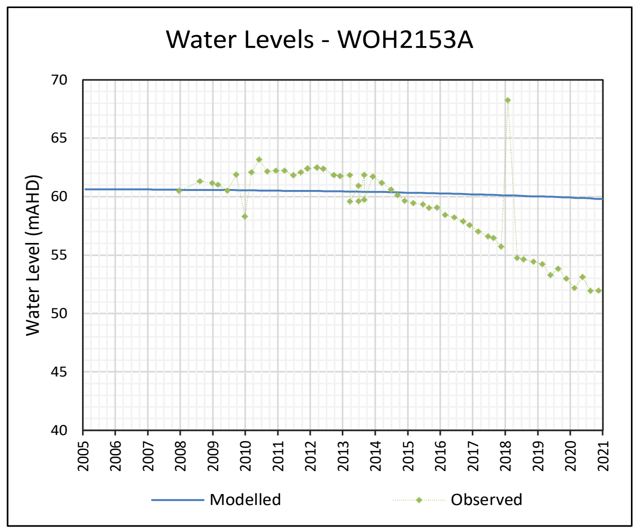

Water Levels - WD631
Water Level (mAHD)
Modelled
Observed

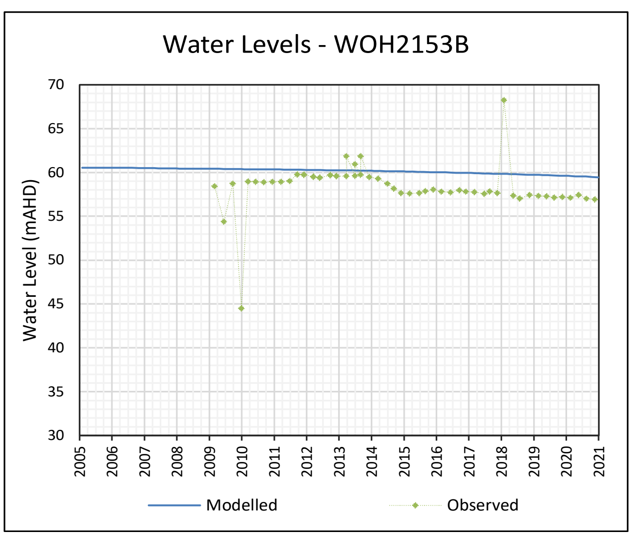

Water Levels - WD633
Water Level (mAHD)
Modelled
Observed

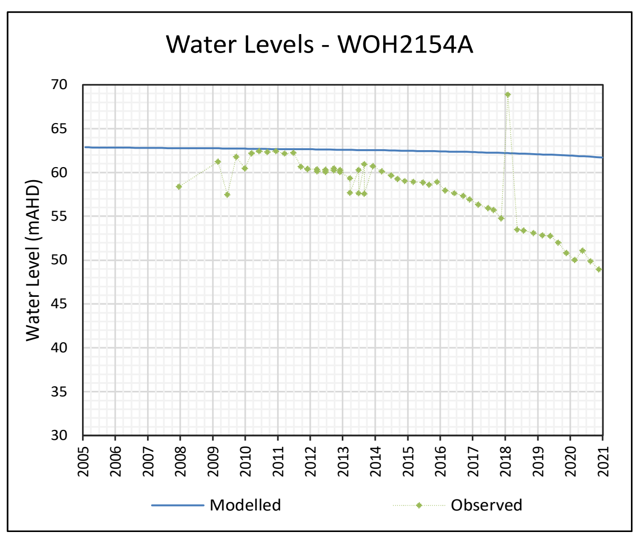

Water Levels - WOH2139A
Water Level (mAHD)
Modelled
Observed

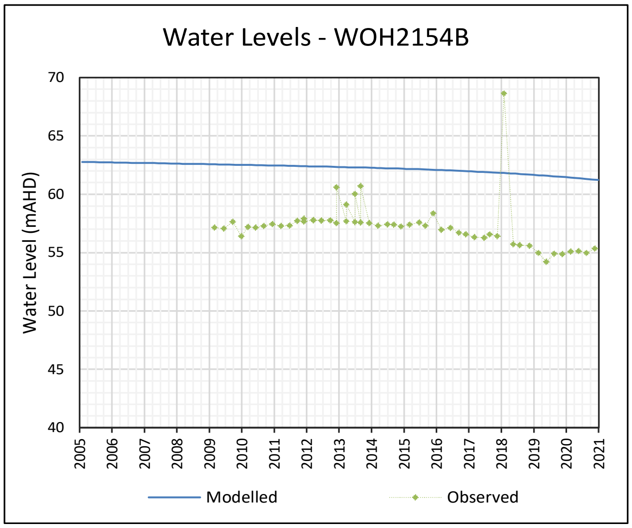

Water Levels - WOH2141A
Water Level (mAHD)
Modelled
Observed

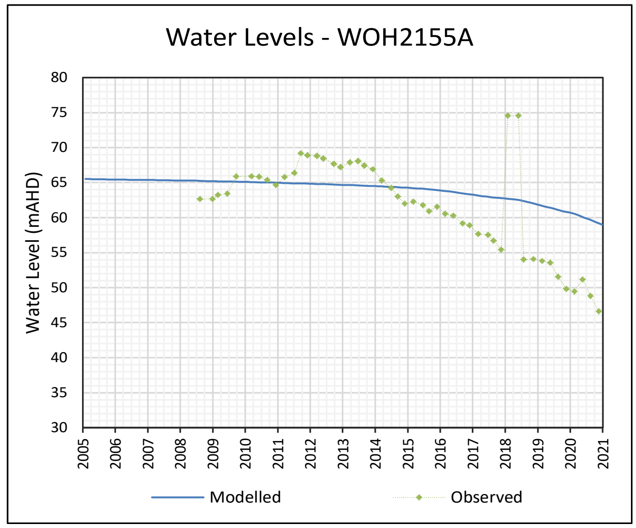

Water Levels - WOH2141B
Water Level (mAHD)
Modelled
Observed

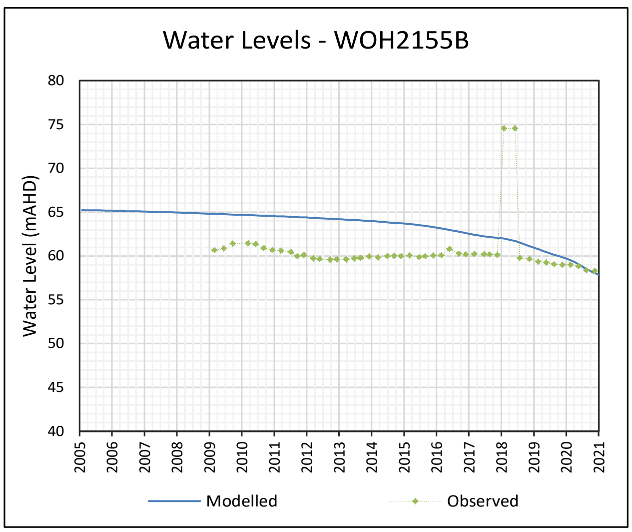

Water Levels - WOH2153A
Water Level (mAHD)
Modelled
Observed

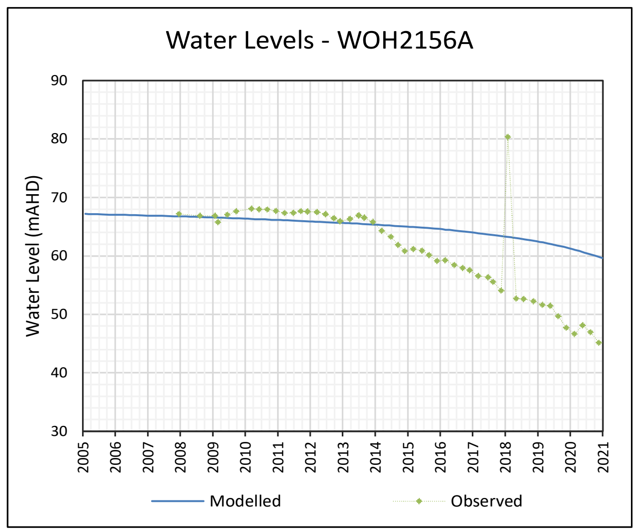

Water Levels - WOH2153B
Water Level (mAHD)
Modelled
Observed

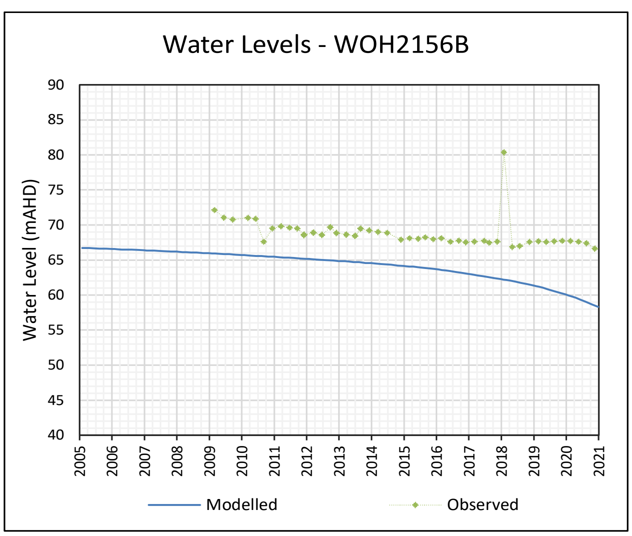

Water Levels - WOH2154A
Water Level (mAHD)
Modelled
Observed


Water Levels - WOH2154B
Water Level (mAHD)
70
65
60
55
50
45
40
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Modelled
Observed


Water Levels - WOH2155A
Water Level (mAHD)
80
75
70
65
60
55
50
45
40
35
30
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Modelled
Observed


Water Levels - WOH2155B
Water Level (mAHD)
80
75
70
65
60
55
50
45
40
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Modelled
Observed


Water Levels - WOH2156A
Water Level (mAHD)
90
80
70
60
50
40
30
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Modelled
Observed


Water Levels - WOH2156B
Water Level (mAHD)
90
85
80
75
70
65
60
55
50
45
40
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Modelled
Observed

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