United Wambo Open Cut Coal Mine Project Annual Review

GLENCORE

Period: 1 January 2020 to 31 December 2020

Name of Operation under DA-410-11-2002-i	United Collieries
Name of Operation under SSD 7142	United Wambo Open Cut Coal Mine
Name of Operator under DA-410-11-2002-i	United Collieries Pty Limited
Name of Operator under to SSD 7142	United Collieries Pty Limited
Development Consent / Project Approval #	DA-410-11-2002-i SSD 7142
Name of holder of Development Consent DA-410-11-2002-i	United Collieries Pty Ltd
Name of holder of Development Consent SSD 7142	United Collieries Pty Ltd
Mining Lease #	CCL775, ML1572, CL374, ML1574, CL397, ML1402, CCL743
Name of holder of Mining Lease	Construction Forestry Maritime Mining And Energy Union - Mining & Energy Division (CFMEU) Wambo Coal Pty Limited
Water Licences United	WAL 18445 Redbank Creek Bywash pump WAL 10541 Hunter River Pump WAL 18549 Wollombi Brook Pump
Name of holder of Water Licences	Construction Forestry Mining And Energy Union - Mining & Energy Division
RMP start date – SSD 7142 Consent RMP end date – SSD 7142 Consent	1 December 2020 31 December 2022
Annual Review start date	1 January 2020
Annual Review end date	31 December 2020

I, Aislinn Farnon, certify that this annual report is a true and accurate record of the compliance status of United Collieries for the period January to December 2020 and that I am authorised to make this statement on behalf of United Collieries.

Note.

a) *The Annual Review is an 'environmental audit' for the purposes of section 122B(2) of the Environmental Planning and Assessment Act 1979. Section 122E provides that a person must not include false or misleading information (or provide information for inclusion in) an audit report produced to the Minister in connection with an environmental audit if the person knows that the information is false or misleading in a material respect. The maximum penalty is, in the case of a corporation, $1 million and for an individual,*
$250,000.

b) *The Crimes Act 1900 contains other offences relating to false and misleading information: section 192G (Intention to defraud by false or misleading statement—maximum penalty 5 years imprisonment); sections 307A, 307B and 307C (False or misleading applications/information/documents—maximum penalty*
2 years imprisonment or $22,000, or both).

Name of authorised reporting officer	Aislinn Farnon
Title of authorised reporting officer	Environment and Community Manager

Signature of authorised reporting officer	
Date	28/07/2021 (Revised)

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1 STATEMENT OF COMPLIANCE

Table 1-1 and **Table 1-2** outline the compliance status of operations at United Wambo Joint Venture (United Wambo) against the relevant approval conditions during the reporting period.

Table 1-1 Statement of Compliance

Were all conditions of the relevant approval(s) complied with?	
Development Consent (DA-410-11-2002-i)	**Yes**
SSD 7142	**No**
Environment Protection Licence (3141)	**No**

Table 1-2 Non- Compliance Status – United Wambo

Relevant Approval	Condition/ Legislative Reference	Condition Description (Summary)	Compliance Status	Details of Non-compliance	Corrective Action/s	Where Addressed in AEMR
SSD 7142	Schedule 3 Condition B8	Blast Monitoring	Non-Compliant	At 12:28pm on 24 September 2020, United Wambo Joint Venture (UWJV) fired a blast which resulted in a ground vibration of 167.06mm/s at a portable blast monitor located adjacent to a 66kV transmission suspension tower owned by Ausgrid. The blasting criteria for transmission suspension towers as specified in Table 2 of SSD 7142 is 100mm/s.	Increased the site constant (K-factor) to allow for an enhanced factor of safety. Increased the number of vibration monitoring points near infrastructure to assist in confirming/establishing an accurate site K-factor, including placing additional monitors at set short distances behind shots before reaching infrastructure sensitive receivers. Engaged consultants to analyse vibration monitoring results and assist in confirming/establishing the site K-factor.	10.2
EPL 3141	Condition L4.2	Blast Monitoring	Non-Compliant	On Thursday 5 November 2020 one blast event UTD-S02-RL50-38 was fired at 13:09:49 in the United Wambo Joint Venture Starter Pit with an overpressure of 128.1 dB recorded at the BM02. This exceeded condition L4.2 of EPL 3141 which does not allow overpressure to exceed 120 dB (lin peak) at any time.	A letter requesting the removal BM02 from EPL3141 was sent to the EPA on 6 November 2020 (refer to **Section 10.2** for further details).	10.2
EPL 3141	Condition M2.2	Air Quality Monitoring	Non-Complaint	On 15 and 21 January and 4 December 2020 HVAS01 failed to collect TSP samples. On 4 December 2020 HVAS02 failed to collect TSP samples.	The HVAS failure was investigated and the cause was determined to be a localised power outage. Future failures will be investigated, and	10.2
SSD 7142	Schedule 2 Condition A30					

Relevant Approval	Condition/ Legislative Reference	Condition Description (Summary)	Compliance Status	Details of Non-compliance	Corrective Action/s	Where Addressed in AEMR
					corrective actions taken as required.	
EPL 3141 SSD 7142	Condition M2.3 Schedule 2 Condition A30	Air Quality Monitoring	Non-Compliant	As a result of storms, Ausgrid maintenance, monitor replacements, power outages and communication errors the real time air quality monitors (TEOMs) ceased logging for varying lengths of time. As a result, they failed to collect >75% of the daily data. And a valid 24-hour average of could not be calculated. AQ01: 12 May 2020 AQ02: 26-28 September 2020 AQ03: 19 February 2020, 17 June 2020, 1-2 June 2020, 27 September 2020, 13 October 2020 AQ04: 26-27 July 2020, 29 July 2020, 17 September 2020	Following the varying outages of the real time monitors, the cause was investigated. The real time monitoring network is monitored remotely and maintenance by an external technical contractor to minimise the downtime of any real time monitoring units. Regular preventative maintenance and calibration will continue on all real time monitors.	10.2
EPL 3141	Condition M2.1	Effluent Quality Monitoring	Non-Compliant	Quarterly effluent quality sample was missed during Quarter 1 of 2020 due to no sampling location on the sewage treatment plant.	Sampling location was installed for quarter 2 of 2020.	10.2

Table 1-3 Compliance Status Categories

Risk Level	Colour Code	Description
High	Non-Compliant	Non-compliance with potential for significant environmental consequences, regardless of the likelihood of occurrence
Medium	Non-Compliant	Non-compliance with potential for serious environmental consequences, but is unlikely to occur; or potential for moderate environmental consequences, but is likely to occur
Low	Non-Compliant	Non-compliance with potential for moderate environmental consequences, but is unlikely to occur; or potential for low environmental consequences, but is likely to occur
Administrative non-compliance	Non-Compliant	Non-compliance which does not result in any risk of environmental harm

2 INTRODUCTION

2.1 Project Overview - SSD 7142

In November 2014, Glencore Coal Assets Australia (GCAA) and Peabody Energy agreed to form a 50:50 Joint Venture project combining the existing open cut operations at Wambo Coal (Peabody) with a proposed open cut at United. The Joint Venture realises significant operational synergies by combining Wambo's existing open cut operation with United's adjacent reserves into a single managed operation using available infrastructure capacity at Wambo. The location of the United Wambo is shown on **Figure 1**.

The United Wambo Joint Venture Project Team commenced the EIS process during 2014 to assess the potential impacts of the new operations. In 2016 the Environmental Impact Statement (EIS) for the United Wambo Open Cut Coal Mine Project (SSD 7142) (the Project) was submitted to the Department of Planning Industry and Infrastructure (DPIE) formerly the Department of Planning and Environment (DPE) in August 2016.

During 2017, a Response to Submissions report was prepared addressing the public and government agency submissions made on the EIS. On 12 December 2017, DPIE released the Preliminary Assessment Report on the Project.

The Project was referred to the then Planning Assessment Commission (PAC) (now Independent Planning Commission (IPC)) by the Minister for Planning on 28 November 2017 to carry out a review of the Project and to conduct a public hearing. The public hearing was held on 8 February 2018.

The IPC issued its Review Report on 26 March 2018 and a Response to the IPC Review Report was submitted by United Wambo in July 2018. DPIE completed the Final Assessment Report and referred the Project for determination to the IPC in November 2018. The IPC held a second public meeting on 7 February 2019.

The project was approved by the IPC under SSD 7142 on 29 August 2019 with operations commencing on 6 January 2020. Further information on the Project can be found on the NSW Major Projects website (http://majorprojects.planning.nsw.gov.au/index.pl?action=view_job&job_id=7142) or the IPC website (http://ipcn.nsw.gov.au/projects/2017/12/united-wambo-open-cut-coal-mine-project-mod-3-and-mod-16).

The Project is to be undertaken in the following stages:

- Phase 1A – construction works at United open cut mine;
- Phase 1B – continuation of construction works and commencement of mining operations at United open cut mine;
- Phase 2 – mining operations at the United open cut mine and Wambo open cut mine; and
- Phase 3 – the cessation of open cut mining operations and mine closure.

As of 31 December 2020, the Project is in Phase 2. Details on the activities undertaken under SSD 7142 during 2020 are provided in **Section 4**.

2.2 Project Overview – DA-410-11-2002-i

United Collieries (United) was an underground coal mine previously under care and maintenance located 16 kilometres west of Singleton in the Upper Hunter Valley of New South Wales.

Figure 1 – Regional Location Plan

From July 1989 until July 1992, United operated a small open cut and auger mining operation extracting from the Whynot and Wambo seams. In 1991, a resource swap was affected with the neighbouring Wambo Coal Pty Ltd (Wambo) mine, which enabled Wambo to secure greater open cut reserves and United to secure greater underground reserves.

Underground mining operations commenced in January 1992 within the Woodlands Hill seam using a continuous miner with shuttle cars. In May 1994, bord and pillar development with the "Cut and Flit" mining system was introduced. Pillar extraction operations commenced in October 1995 using a continuous miner, shuttle cars and mobile roof supports. In late 1996, the mine expanded to two development units and one pillar extraction unit. In 1997, a chain haulage system was introduced to increase production.

In May 2002, longwall mining commenced at United. The main components of the longwall mining equipment consisted of a shearer, armoured face conveyor and hydraulic roof supports. The majority of United underground mining operations lie beneath Wambo's open cut operations (Wambo) and under United's Surface Colliery Holding boundary.

United was purchased by Glencore Coal Australia in 1997 and then Xstrata Coal Australia Pty Limited in 2002. Since 2002 United has been owned in a joint venture comprising 95% Glencore and 5% Construction, Forestry, Maritime, Mining and Energy Union – Mining and Energy Division (CFMMEU).

The CFMMEU is the holder of CCL775 on behalf of United. The CFMMEU is also co-holder with Wambo Coal Pty Limited's authorisation for the A444 area. Other coal mines operating in the Warkworth region are Mount Thorley Warkworth Open Cut Operations, Wambo Coal and Hunter Valley Operations.

Following an assessment of geotechnical constraints, United's plans to mine Longwall panel 11 were abandoned, and subsequently Xstrata announced the suspension of mining operations at United would occur following the extraction of Longwall panel 10. Mining of Longwall panel 10 was completed in February 2010, and since then United has entered into a care and maintenance period while the potential for future mining was investigated.

When operational, Run of Mine (ROM) coal at United was put through the Coal Handling and Preparation Plant (CHPP). Product coal was then transported to the Wambo rail load-out facility via an internal haul road. The product coal was stockpiled at the rail load-out facility and loaded onto trains bound for the Port of Newcastle for export.

In May 2013, Xstrata Plc completed a merger with Glencore International Plc forming Glencore Xstrata. In May 2014, Glencore Xstrata changed its name to Glencore plc. Glencore's Australian coal businesses including United are maintained under GCAA. United continued on care and maintenance under DA-410-11-2002-i until operations commenced under SSD 7142 on 6 January 2020.

DA-410-11-2002-i will be surrendered during 2021 in accordance with Condition A16 of SSD 7142.

2.3 Site Contacts

Contact details for key personnel are provided in **Table 2-1** below.

Table 2-1 Contact Details for Key Mine Personnel

Name	Role	Telephone	Email
Gary Wills	Operations Manager	0429 900 814	gary.wills@glencore.com.au
Aislinn Farnon	Environment and Community Manager	0429 306 208	Aislinn.Farnon@glencore.com.au
Sean Pigott	Environment and Community Co-ordinator	0400 238 506	Sean.Pigott@glencore.com.au
Community Complaints and Enquiries		1800 801 440	
Website		https://www.glencore.com.au/operations-and-projects/coal/current-operations/united-wambo-open-cut	

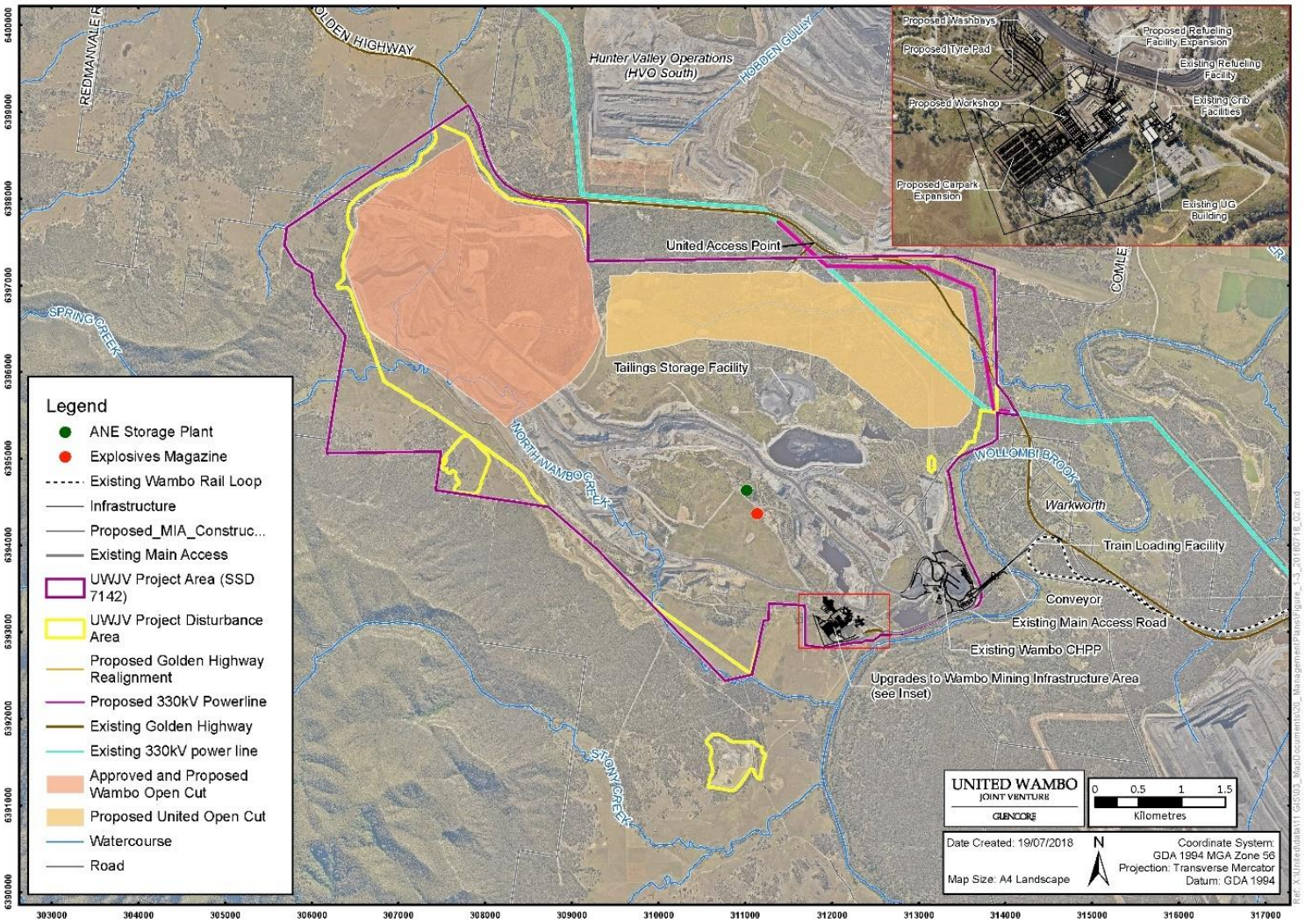

Figure 2 – Site Layout Under SSD 7142

3 APPROVALS

3.1 Approvals for United Wambo

Leases, licences and approvals that regulate operations at the site are listed in **Table 3-1** below. The relevant approvals will change over the next couple of years with the implementation of SSD 7142.

Table 3-1 Approvals Relating to United Wambo

Regulatory Authority	Instrument	Date of Issue	Expiry Date	Comments
Resources Regulator	CCL 775	2 September 1992	2 Mar 2033	Renewal issued May 2014
	ML 1572	21 December 2005	21 December 2026	Renewal issued 21 December 2005
	CL 374	6 December 1991	21 March 2026	Renewal issued 17 January 2007
	Authorisation A444	4 October 2007	16 May 2021	Renewal issued 17 January 2019 Jointly held by CFMMEU and Wambo
	Exploration Lease 7211	29 September 2008	29 September 2019	Renewal sought
	S.100 Emplacement Area Augmentation C99/0845	15 July 2008		Tailings Dam 2 Raise Level
	Surface Disturbance Notice Approval (Authorisation A444)	17 September 2009		

Regulatory Authority	Instrument	Date of Issue	Expiry Date	Comments
	s.126 Emplacement Area – New waste emplacement area C99/0845	9 March 2005		Emplacement Area 2
	s.126 Emplacement Area – Extension to area	30 January 2001		Emplacement Area 1
	s.126 Emplacement Area Approval C99/0845	22 October 1999		Emplacement Area 1 – emplacement activities until December 2002
	Sublease Agreement	21 November 2003	-	Relates to CCL743 and ML1402. Continues until the expiration of either the Wambo or United leases.
Resources Regulator	United Wambo Rehabilitation Management Plan (Phase 2)	1 December 2020	31 December 2022	Covers operations for Phase 2 under SSD 7142.
	United Wambo Rehabilitation Management Plan (Phase 1)	18 December 2019	31 December 2020	Covers operations for Phase 1A and 1B under SSD 7142. Amendment A was approved 8 July 2020. Note if Phase 1 is not completed by the expiry date then the RMP end date will be extended.
Department of Planning Infrastructure and Environment (DPIE) Formerly the Department of Planning and Environment (DPE)	Development Consent DA 410-11-2002i	21 November 2003	Mining Operations December 2012	Eight modifications have been made to DA 410-11-2002i. Mining was not permitted after 2012 however the Development Consent remains current until the site has been rehabilitated. DA 410-11-2002i will be relinquished by 30 June 2021 as approved by DPIE.
	State Significant Development (SSD) 7142	29 August 2019	1 August 2042	Operations commenced 6 Jan 2020 – no works undertaken under this consent during 2019.

Regulatory Authority	Instrument	Date of Issue	Expiry Date	Comments
Environment Protection Authority	Environment Protection Licence (EPL) 3141	30 November 1999	Anniversary Date: 30 November	Current issue dated January 2013 Note: The EPL was varied three times during the reporting period.
NSW Environment, Energy and Science	S87 Care and Control Permit #3062	05 March 2009		ISEMS/AHIMS Permit #: 10913446/2997
Water NSW	WAL 18445 Redbank Creek Bywash pump	14 March 2008	13 March 2023	Replaces 20SL050992 200ML 20WA208714 Industrial
	WAL 10541 Hunter River Pump	01 January 2007	Perpetuity	Replaces 20SL060222 300ML 20WA200928 Water Supply
	WAL 18549 Wollombi Brook Pump	05 November 2007	19 November 2022	Replaces 20SL050670 100ML 20WA208706 Industrial
Singleton Council	4094/2010	3 May 2010	30 June 2021	Office Administration

3.2 Summary of Consents, Leases and Licenses

Table 3-2, **Table 3-3** and **Table 3-4** below summarise conditions relating to annual reporting and the AEMR within the SSD 7142, Development Consent DA-410-11-2002-i and CCL775.

Table 3-2 Compliance with SSD 7142

Condition No.	Consent Condition	AEMR Section
E11 – Annual Review	By the end of March each year, after the commencement of development, or other timeframe agreed by the Planning Secretary, a report must be submitted to the Department reviewing the environmental performance of the development, to the satisfaction of the Planning Secretary. This review must:	AEMR
	(a) describe the development (including any rehabilitation) that was carried out in the previous calendar year, and the development that is proposed to be carried out over the current calendar year;	4 and 7
	(b) report on the progress of biodiversity credits retirements and the associated actual versus proposed surface disturbance for each stage;	6.5.2
	(c) report on the progress of implementing reasonable and feasible diesel emissions reduction measures for the Project;	6.4.2
	(d) include a comprehensive review of the monitoring results and complaints records of the development over the previous calendar year, including a comparison of these results against the: (i) relevant statutory requirements, limits or performance measures/criteria; (ii) requirements of any plan or program required under this consent; (iii) monitoring results of previous years; and (iv) relevant predictions in the document/s listed in condition A2(c);	6
	(e) identify any non-compliance or incident which occurred in the previous calendar year, and describe what actions were (or are being) taken to rectify the non-compliance and avoid reoccurrence;	1, 6 and 10
	(f) evaluate and report on: (i) the effectiveness of the noise and air quality management systems; and (ii) compliance with the performance measures, criteria and operating conditions in this consent;	6.2.3, 6.4.3 1
	(g) identify any trends in the monitoring data over the life of the development;	6
	(h) identify any discrepancies between the predicted and actual impacts of the development, and analyse the potential cause of any significant discrepancies; and	6
	(i) describe what measures will be implemented over the next calendar year to improve the environmental performance of the development.	6

Condition No.	Consent Condition	AEMR Section
E16 - Access to Information	Before the commencement of Phase 1A, until the completion of all rehabilitation required under this consent, the Applicant must: (a) make the following information and documents (as they are obtained, approved or as otherwise stipulated within the conditions of this consent) publicly available on its website: (xi) the Annual Reviews of the development.	This document.
Condition B40 – Water Supply	The Applicant must report on water extracted from the site each year (direct and indirect) in the Annual Review, including water taken under each water licence.	6.8
B52 (v) – Groundwater Management Plan	(vi) a protocol to report on the measures, monitoring results and performance criteria identified above, in the Annual Review referred to in condition E11.	6.9
B49 - Waste	(d) monitor and report on the effectiveness of the waste minimisation and management measures in the Annual Review referred to in condition E11.	6.7

Table 3-3 Compliance with Development Consent DA-410-11-2002-i

Condition No.	Consent Condition	AEMR Section
Schedule 6, Condition 5 – Annual Reporting	Within 12 month of this consent, and annually thereafter, the applicant shall submit an AEMR to the Director General and relevant agencies. The report must:	AEMR
	(j) identify the standards and performance measures that apply to the development;	6
	(k) describe the works carried out in the last 12 months;	4 and 5
	(l) describe the works to be carried out in the next 12 months;	4, 6 and 11
	(m) include a summary of complaints received during the past year, and compare this to complaints received in previous years;	8
	(n) include a summary of monitoring results for the development during the last year;	6
	(o) include an analysis of these monitoring results against the relevant: • impact assessment criteria/limits; • monitoring results from previous years; and • predictions in the EIS;	6
	(p) identify any trends in monitoring results over the life of the development;	6
	(q) identify any non- compliance during the previous year; and	1

Condition No.	Consent Condition	AEMR Section
	(r) describe what actions were, or are being taken to ensure compliance.	6
Schedule 6, Condition 10 – Access to Information	The Applicant shall:	-
	(a) Keep detailed records of the: • Amount of coal produced each year; and • Number of coal haulage truck movements generated each day by the development; and	4
	(b) Include these records in the AEMR.	4
Schedule 4, Condition 32- Site Water Balance	Each year, the Applicant shall: (a) Review the site water balance for the development against the predictions in the EIS; (b) Recalculate the site water balance for the development; and (c) Report on the results of this review in the AEMR.	6.8
Schedule 4 Condition 47 - Reporting	The Applicant shall include a progress report on the implementation of the compensatory habitat proposal in the AEMR.	7.2

Table 3-4 Compliance with Mining Lease CCL775

Condition No.	Consent Condition	AEMR Section
Condition 4 f)	The lease holder must prepare a Rehabilitation Report to the satisfaction of the Minister. The report must: i) provide a detailed review of the progress of rehabilitation against the performance measures and criteria established in the approved MOP;	7
	ii) be submitted annually on the grant anniversary date (or at such other times as agreed by the Minister); and	7
	iii) be prepared in accordance with any relevant annual reporting guidelines published on the Department's website www.resources.nsw.gov.au/environment. *Note: The Rehabilitation Report replaces the Annual Environmental Management Report.*	7

4 OPERATIONS SUMMARY

4.1 Mining Operations

This Annual Review is required to report on the production operations of the mine, and these are summarised in **Table 4-1.**

Table 4-1 Production Summary

Material	Approved Limit	2019 (actual)	2020 (actual)	2021 (forecast) – operations under SSD 7142
Waste Rock/Overburden (Bank Cubic Metre (BCM))	NA	0	6,193,677	39,262,914
ROM Coal/Ore (tonnes)	10Mt / year (SSD 7142)	0	608,941	6,596,661
Coarse Reject (tonnes)	NA	0	0	0
Fine Reject (Tailings) (tonnes)	NA	0	0	0
Saleable Product (tonnes)	14.7Mt transported from the Complex	0	358,976	4,443,998

4.1.1 Mining Operations – SSD 7142

United Wambo comprises of mining within two open cut pits - a new open cut coal mine at United, known as the United Open Cut, and the existing open cut operations at Wambo, known as the Wambo Open Cut. Operations at United Wambo occurred in three Phases during 2020 as defined by SSD 7142; Phase 1A, Phase 1B and Phase 2.

4.1.1.1 Phase 1A

Phase 1A commenced on the 6th January 2020 involving construction works and development of the United Starter Pit. Extraction of material from the United Starter Pit commenced under Phase 1A in May 2020.

Phase 1A, included the following activities:

- Salvage of Aboriginal artefacts;
- Clearing of vegetation to facilitate construction and mining activities;
- Construction and use of the Construction Infrastructure Areas (CIA);
- Upgrades to the Mine Infrastructure Area (MIA) at Wambo including the construction of a new workshop, fuel farm, administration offices, carpark;
- Construction of water management infrastructure including three mine water dams (U1, U2 and U3), the Northern Clean Water Drain and water pipelines;
- Installation of erosion and sediment controls;
- Construction of the realigned 330kV, 66kV and 11kV power lines;
- Development of the United open cut starter pit including the blasting of material;
- Construction of mine haul roads and access roads from mine spoil won from the starter pit; and
- Installation of lighting to allow 24/7 operations.

Further details on the construction activities undertaken at United Wambo are provided in **Section 4.2.**

Mining within the Wambo Open Cut during Phase 1A was undertaken by Wambo under DA 305-7-2003 and will be reported on in the Wambo Coal Annual Review.

Figure 3 – Drilling within the United Starter Pit

4.1.1.2 Phase 1B

Mining operations commenced under Phase 1B of SSD 7142 on 20 July 2020.

Phase 1B, which included the following activities:

- Continuation of Phase 1A activities; and
- Commencement of mining operations at United, including the emplacement of overburden into the emplacement areas and the stockpiling of ROM coal at the RL106 stockpile.

Mining within the Wambo Open Cut during Phase 1B was undertaken by Wambo under DA 305-7-2003.

4.1.1.3 Phase 2

Phase 2 of SSD 7142 commenced on the 1 December 2020, with activities within both the United Open Cut and the Wambo Open Cut undertaken by the United Wambo Joint Venture, managed by Glencore.

Mining at Wambo Open Cut continued within the Montrose Pit, with development of access to the Montrose Ridge being undertaken late in 2020.

Mining continued within the United Open Cut, with continued development of the United Starter Pit and the main United Open Cut box cut in late 2020. Development of the emplacement areas within the

RL106 dump continued. During Phase 2, coal mined from both the United and Wambo pits was transported to the main ROM Stockpile.

4.1.2 Mining Operations – DA 410-11-2002i

All mining in 2020 was undertaken under SSD 7142.

4.2 Construction Activities

4.2.1 Water Management Infrastructure

Construction of the key water management infrastructure has been completed. The major infrastructure constructed includes:

- Two large mine water dams to capture dirty and mine water:
    - U2 Dam, a 390ML dam, has been constructed upstream of the United Open Cut to capture water from the overburden dumps and to protect the pit from water inflow down Redbank Creek; and
    - U3 Dam, a 232ML dam, has been constructed to capture water from the overburden dumps to prevent offsite discharge into Wollombi Brook;
- A clean water drain has been constructed north of the United Open Cut to convey clean water around the mining areas and return it to the downstream environment in Redbank Creek. The drain has been rehabilitated and is currently being monitored prior to release back into Redbank Creek; and
- A flood levee bank has been constructed downstream of the United Open Cut on Redbank Creek. The levee has been designed to prevent flood waters from Wollombi Brook entering the pit in a 1 in 1000 year storm event.

Along with these major structures, a significant amount of pumping and pipe infrastructure has also been installed. A new Water Fill Point has been constructed for the United Open Cut.

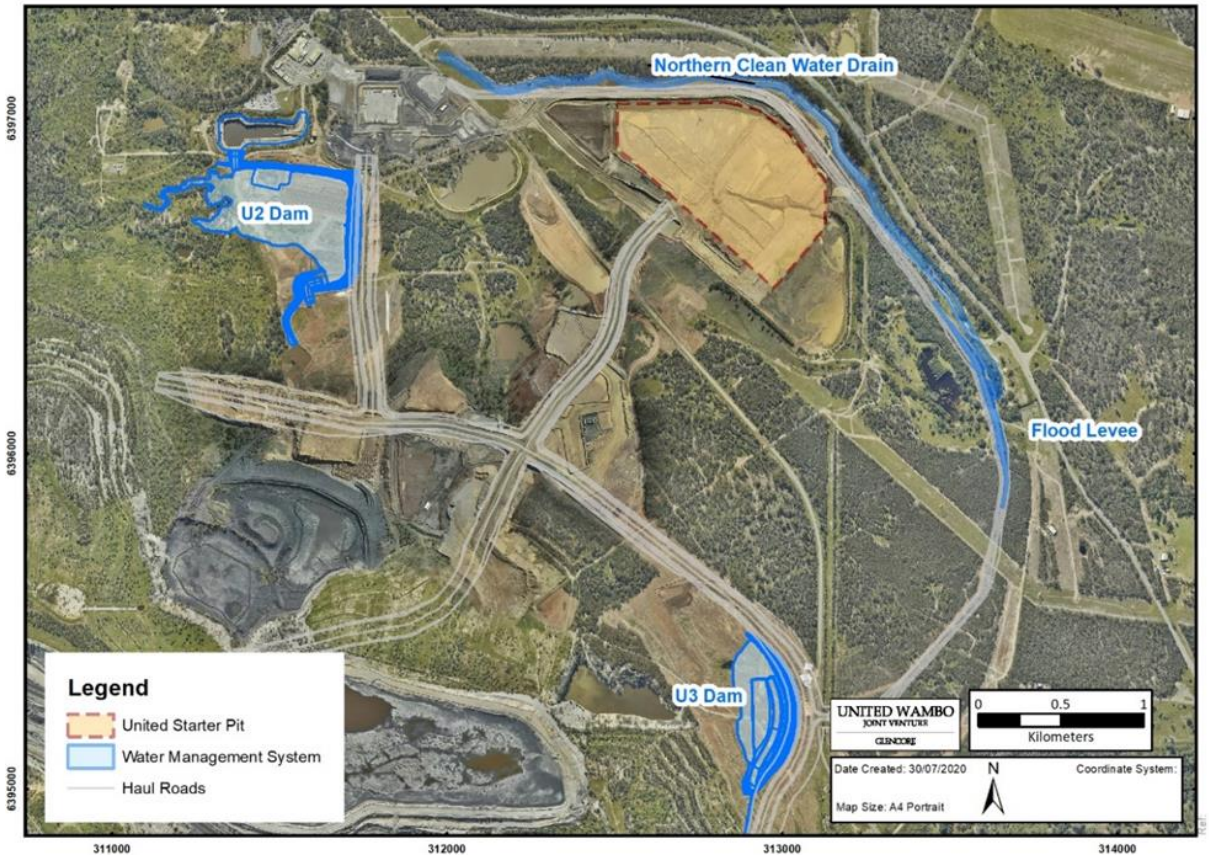

Figure 4 – Water Management Infrastructure

Figure 5 – Completed U2 Dam

4.2.2 Powerline Infrastructure

The Project required a number of high voltage powerlines to be relocated to allow the mine to be developed. The following works occurred during 2020:

- Relocation of the Liddell to Newcastle 330 kV alignment. Works for this included the clearing of vegetation from the easement, the construction of ten new towers and the stringing of the new towers:
- Relocation of the Ausgrid 66 kV (6011) feeder alignment. These works include the clearing of the easement and construction and stringing of 27 new transmission poles; and
- Relocation and construction of additional Ausgrid 11 kV (48066) powerlines.

Figure 6 – Construction of a tower for the 330kV relocation

4.2.3 Mine Infrastructure Area

A new mine infrastructure area has been constructed for the United Wambo Joint Venture. It is located adjacent to the existing Wambo Mine Infrastructure Area and included;

- Bulk Earthworks with ~200,000 m³ of excavation works;
- Construction of new wash facilities for both heavy and light vehicles;
- Construction of new maintenance facilities including a 5 bay workshop;
- New fuels and lubricants dispensing system piped to all new and existing service areas;
- Construction of new offices, bath house and facilities with modular building modules;
- New state of the art sewage and grey water treatment plant; and
- Ancillary facilities including carparks / lighting / access gates / emergency services.

Significant works were undertaken during 2020, including all bulk earthworks and substantial construction of the new infrastructure. The MIA is due to be completed in May 2021.

Figure 7 – Construction of the new Mine Infrastructure Area during November 2020

4.2.4 Demolition Activities

Demolition and removal of surface infrastructure associated with the former United Underground was undertaken during 2020. The following surface infrastructure was removed:

- United Coal Preparation Plant;
- Thickener Tank;
- Removal of residual coal from stockpile;
- All conveyors; and
- Crushing Station and Surge Bin.

The former infrastructure areas have been utilised as temporary workshop areas, equipment assembly pads, construction offices and construction laydown areas.

Figure 8 – Demolition of the United Coal Preparation Plant

4.3 Other Operations

4.3.1 Hours of Operations

4.3.1.1 SSD 7142 - Construction Hours

During Phase 1A, construction works were undertaken 24 hours a day 7 days a week.

4.3.1.2 SSD 7142 – Operational Hours

During Phase 2 operations, the site operates 24-hour per day 7 days a week.

4.3.2 Reject and Tailings Management

4.3.2.1 Reject and Tailings – DA-410-11-2002-i

The coarse rejects emplacement area is currently in a stage of rehabilitation. There are two tailings emplacement areas at United (Tailings Dams 1 and 2).

These tailings dams were previously used for storage of tailings and coarse rejects from the CHPP. No tailings disposal is currently occurring in these tailings dams. Since tailings emplacement ceased in 2010, Tailings Dams 1 and 2 were managed to permit desiccation until the commencement of rehabilitation.

During 2020, detailed capping plans were developed in consultation with the relevant regulatory agencies, with the High Risk Activity approval received late in 2020. Capping works commenced in March 2021.

All tailings associated with the United Wambo open cut operations will be managed by Wambo.

4.3.2.2 Reject and Tailings - SSD 7142

During Phase 1A and 1B, no coal produced from the United Open Cut was processed by the Wambo CHPP.

During Phase 2, ROM coal mined in the United and Wambo Open Cuts is hauled to the ROM pad located near the Wambo CHPP. Coal hauled to the ROM pad can be placed directly into the ROM bin or placed onto the main ROM coal stockpile. ROM coal is crushed and washed at the Wambo CHPP and a product coal stockpile is used to stockpile product coal, prior to reclaim and loading to trains for transport off site. The Wambo CHPP is managed by Wambo under DA 305-7-2003 MOD 16 and the Wambo MOP / RMP.

Tailings from the Wambo CHPP is placed within an approved tailings storage facility. The tailings are currently placed within the Inpit Tailing Storage Facility (TSF) or the Main Homestead Pit TSF. Layers of heavily flocculated tailings may also be placed onto the Hunter TSF and the Northeast TSF to assist with the capping of these facilities.

Coarse rejects from coal preparation will be transported by truck to the open cut overburden emplacement areas for emplacement and subsequent covering by overburden material.

4.3.3 Exploration Management

Drilling in the period was undertaken for the installation of four vibrating wire piezometers (VWP) in the north-eastern highwall of the United Open Cut targeting southwest to southeast dipping thrust faults. An additional two standpipe piezometers were installed to allow for groundwater sampling and analysis.

A small programme of four drill holes targeting the limit of oxidation (LOX) for the open cut was also completed in the period.

The VWPs aim to provide longer-term groundwater pore pressure data for these thrust faults, which are a geotechnical risk with the potential to cause highwall failure as the faults 'daylight' in later stages of the mine plan. As mining advances, it is proposed to drill horizontal dewatering drain holes at various seam levels to depressurise these thrust faults and the VWPs will provide real time monitoring of the pore pressure as mining advances.

In 2020, Wambo undertook drilling on A444, details of which will be provided in the 2020 Wambo Annual Review.

4.3.4 Mine Subsidence

As mining operations were suspended at United in 2010, no additional subsidence from underground mining operations has occurred in 2020. There was no subsidence remediation during 2020.

4.4 Next Reporting Period

Table 4-2 outlines the forecast operations for the next reporting period.

Table 4-2 Forecast Operations for the Next Reporting Period

Aspect	Forecast for Next Reporting Period
Pit expansion areas	Further development of the United Open Cut, including commencing within the main box cut area and continuation of mining within the Starter Pit. All material from United Open Cut is hauled to out of pit emplacement areas. Expansion of mining operations within the Wambo Open Cut, including development of the Montrose ridge and development of the final landform with the emplacement areas.
Infrastructure development/upgrades	Construction of the United Wambo JV Mine Infrastructure Area will be completed during 2021. The 330kV powerlines will be removed during March / April 2021.
Mining fleet upgrades	New mining equipment, including excavators, haul trucks, rubber-tyred dozers, watercarts and loaders, will continue to be commissioned over the next few years.

5 ACTIONS REQUIRED FROM PREVIOUS AEMR

The actions required as an outcome of the previous 2019 AEMR, and their current status, are detailed in **Table 5-1** These actions were commitments from United.

Table 5-1 2019 AEMR Actions and Feedback

Action	Comment by United Wambo
United Colliery Proposed Actions from 2019 AEMR	
CHPP demolition	CHPP and overhead conveyors demolished in Q1 2020
Environmental monitoring, land management and rehabilitation maintenance.	Continued
Commencement of construction activities and mining operations for the United Wambo Joint Venture Project.	Commenced 6 Jan 2020
Undertake targeted weed control in areas identified during monitoring.	Weed control undertaken
Rehabilitation Management Strategy	Approved before Phase 2 as per SSD 7142 requirements
Preparation of Phase 2 RMP / MOP	Approved before Phase 2 as per SSD 7142 requirements
Phase 2 is expected to commence when United Open Cut deliver first coal to Wambo CHPP	Phase 2 commenced 1 December 2020
Feedback	
A response from DPIE – RR was received on the 26 June 2020 confirming acceptance of the 2019 Annual Review.	No actions required

6 ENVIRONMENTAL PERFORMANCE

The Annual Review Guideline (DPE 2015) requires summarising the outcomes achieved during the reporting period for key environmental aspects.

It should be noted that the 2020 Annual Review will include EIS predictions from:

- *United Wambo Open Cut Coal Mine Project – Environmental Impact Statement* (Umwelt, 2016);
- *United Wambo Open Cut Coal Project – Response to Submissions Part A* (Umwelt, 2017);
- *United Wambo Open Cut Coal Project – Response to Submissions Part B* (Umwelt, 2017a);
- *United Wambo Open Cut Coal Project – Response to Independent Planning Commission Recommendations* (Umwelt, 2018).

All monitoring locations for United Wambo are shown in **Figure 9 and 10.**

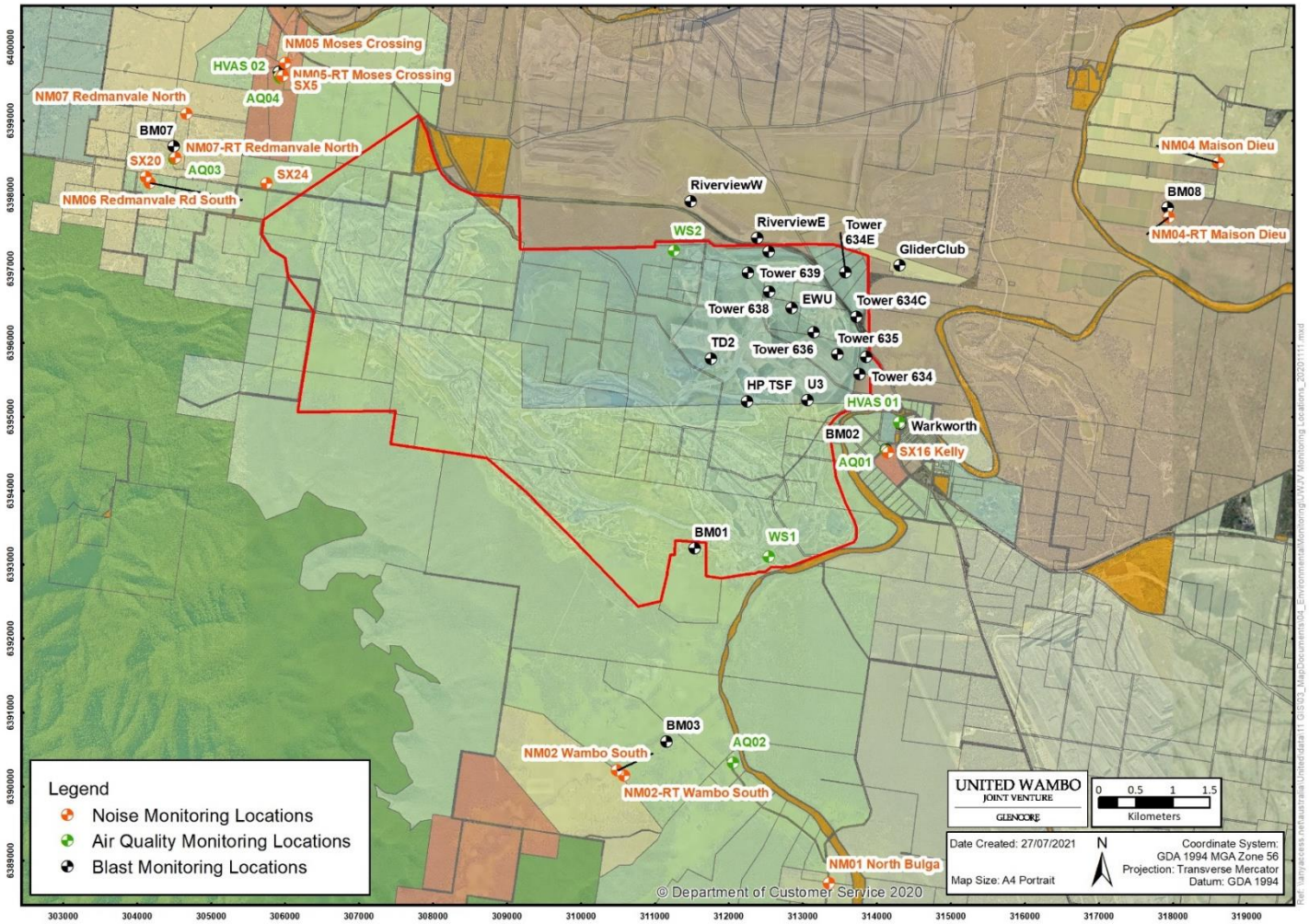

Figure 9 – United Wambo Air Quality, Noise and Blast Monitoring Locations

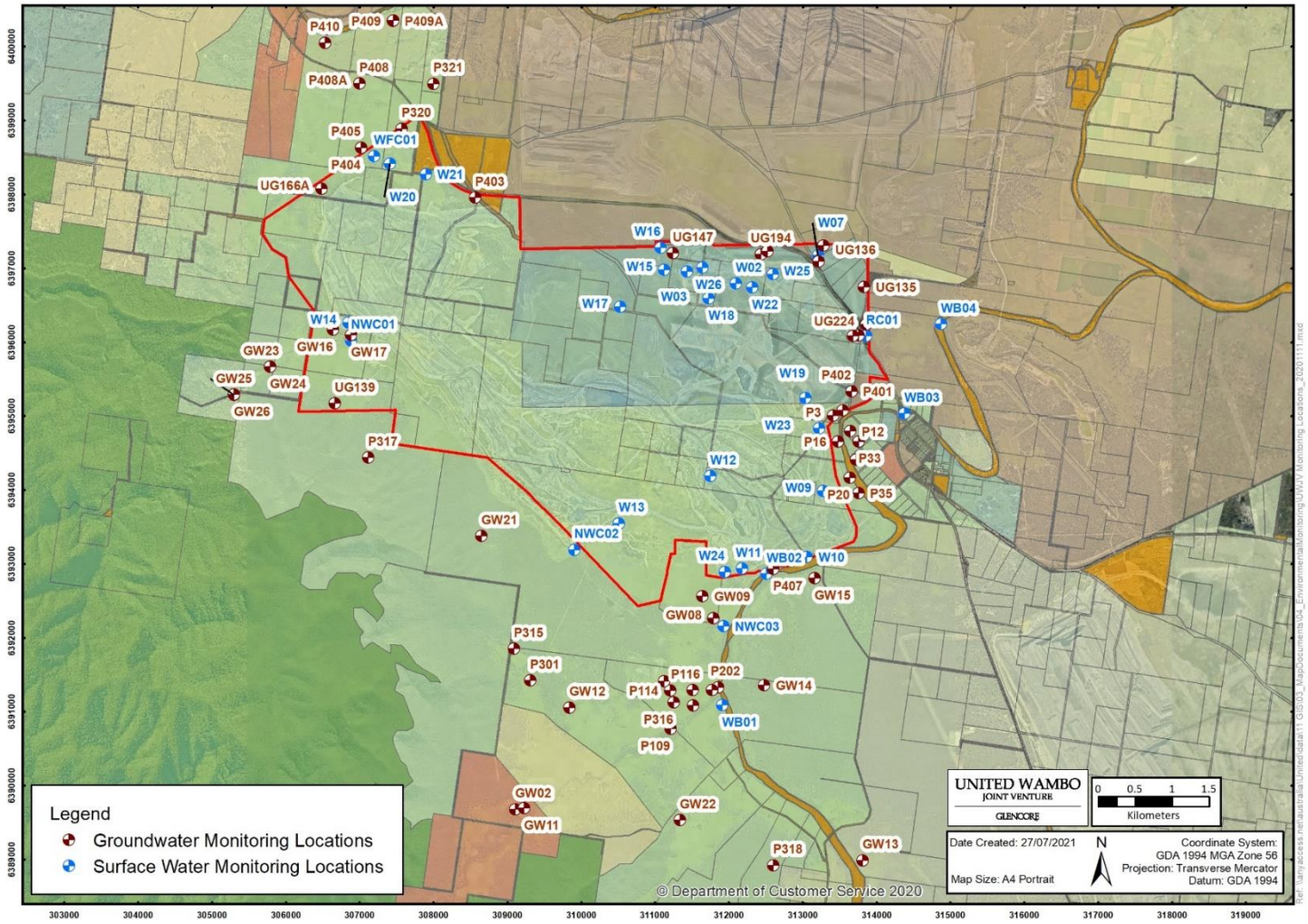

Figure 10 - United Wambo Surface Water and Groundwater Monitoring Locations

6.1 Meteorological Data

Meteorological monitoring was undertaken at two Meteorological stations during the annual review year. From the Wambo Coal Main Meteorological station (M6) until April, and then from the newly installed United Wambo meteorological station (M7) located just north of the south-west of United Open Cut, as shown in **Figure 9**. A summary of the 2020 meteorological data is provided in **Table 6-1**.

Table 6-1 Yearly Summary of 2020 Meteorological Data

	Temperature °C			Windspeed m/s			Rainfall mm	No. of Rain days >1mm
Date	Min	Av.	Max	Min	Av.	Max	Total	
January	18.4	26.4	44.5	0.0	1.8	26.3	45.4	6
February	14.1	23.8	43.5	0.0	1.8	35.9	179.4	12
March	11.2	20.5	36.4	0.0	1.5	6.5	110.0	7
April	6.3	18.5	28.8	0.0	1.4	9.5	58.0	5
May	3.6	13.8	24.8	0.0	2.0	11.1	19.2	4
June	3.8	12.1	21.0	0.0	2.1	14.4	38.8	6
July	3.2	12.0	21.7	0.0	2.3	12.8	77.4	7
August	2.3	12.1	23.6	0.0	3.1	15.1	36.2	6
September	6.1	16.3	28.4	0.0	2.5	20.3	36.0	5
October	8.7	19.0	31.8	0.0	2.3	18.1	97.8	5
November	10.6	21.5	41.0	0.0	2.5	14.5	30.2	3
December	12.0	21.6	37.9	0.0	2.7	14.1	144.4	13

The maximum temperature in 2020 was 44.5 degrees Celsius(°C) which is the same when compared to 44.5 degrees in 2019. In 2020 there was an increase in total rainfall with 876.8 mm compared with 387mm in 2019. This is above the long-term average for rainfall in the area. There was a small increase in wind speed in 2020 (annual average of 2.9m/s) from 2019 (annual average of 2.1m/s).

6.2 Noise

6.2.1 Environmental Management

Noise monitoring is undertaken in accordance with the *United Wambo Noise Management Plan*.

The location of noise monitoring sites is shown on **Figure 9**. The monitoring program includes:

- Monthly attended night-time monitoring at six sites;
- Real time noise monitoring at four sites; and
- Additional monitoring as initiated by alarms or in response to community concerns.

The real-time monitoring network assists with the management of noise impacts from mining operations. Monitors are operated at locations representative of nearest private residences detailed as Noise Assessment Groups (NAGs) at South Wambo, Mason Dieu, Moses Crossing and Redmonvale Road. Data is recorded continuously to allow key operational personnel to monitor noise from operations and if necessary, undertake appropriate mitigation measures. The real time noise monitors notify appropriate personnel via an SMS message system when monitoring results indicate noise levels at surrounding sensitive receivers are approaching, or have exceeded, relevant noise criteria.

A fleet monitoring system that records the location and activity of all major equipment in real time is operated onsite. The fleet monitoring system in combination with the real time noise monitoring program facilitates the implementation of appropriate noise mitigation measures. Should DPIE or the EPA request data relating to equipment use, United Wambo will provide the required data within 72 hours of receiving the request.

6.2.1.1 Management Measures:

United Wambo implements noise management measures in accordance with the *Noise Management Plan.* The management measures are summarised below:

- Reasonable and feasible noise attenuation measures are undertaken on key items of plant and equipment that is reused from the current Wambo Open Cut operations or other controls achieving the same overall noise outcome;
- Reasonable and feasible noise attenuation measures are undertaken on new plant and equipment that has the potential to contribute to the Project's noise level;
- 'Silent horns' are used to communicate with trucks and smart broadband 'Quacker' reversing alarms;
- Bunds constructed in strategic locations along haul roads are implemented to shield trucks and equipment on exposed sections of the haul road ramps;
- The drop height of the first load into truck bodies is managed to minimise impact noise from the material;
- Noise management training is provided for key employees to facilitate effective noise management;
- Regular inspection and maintenance of noise attenuation systems are undertaken;
- A process for periodic review of noise performance of the equipment fleet is implemented. Noise performance will be reviewed as per manufacture specifications or on a 3-year rolling average;
- Systems are implemented that identify adverse meteorological conditions which are likely to result in elevated noise impacts; and
- Production machines are progressively shut down or relocated in elevated locations under adverse meteorological conditions if real time noise monitoring indicates potential noise impact.

6.2.2 Approved Criteria

SSD 7142 noise criteria was adopted during 2020 for Phase 1A and Phase 2. This is summarised in the **Table 13**.

Table 6-2 SSD 7142 Operational Noise Criteria

Noise Assessment Group	Noise Assessment Location	Day	Evening	Night	Night
		L_{Aeq} (15 min)	L_{Aeq} (15 min)	L_{Aeq} (15 min)	L_{A1} (1 min)
Area 1 - North Bulga	R003	38	36	36	46
	R006	37	35	35	45
	R007, R379	36	35	35	45
	All other privately-owned residences	35	35	35	45
Area 2 - South Wambo	R025	39	38	38	48
	All other privately-owned residences	35	35	35	45
Area 3 - Warkworth Village	All privately-owned residences	44	44	43	53
Area 4 - Maison Dieu	All privately-owned residences	52	52	41	51
Area 5 - Moses Crossing	R039	46	46	46	56
	R016	45	45	45	55
	R017	44	44	44	54
	R043 43 43 43 53	43	43	43	53
	R050C	41	41	41	51
	R050A	41	40	40	50
	R044	41	40	39	49
	All other privately-owned residences 41 40 38 48	41	40	38	48

Noise Assessment Group	Noise Assessment Location	Day	Evening	Night	Night
		L_{Aeq} (15 min)	L_{Aeq} (15 min)	L_{Aeq} (15 min)	L_{A1} (1 min)
Area 6 - Redmanvale	R320	40	40	40	50
	R033, R343	40	40	39	49
	R042	40	40	38	48
	R029, R345	40	40	37	47
	R048	39	39	39	49
	R030, R049, R163	39	39	38	48
	R075	39	39	37	47
	R041B	38	38	38	48
	R344, R346	38	38	37	47
	R348	38	38	36	46
	R041A	37	37	37	47
	All other privately-owned residences	35	35	35	45
Area 7 - Jerrys Plains	All privately-owned residences	40	40	36	46
All other areas	All privately-owned residences	35	35	35	45

6.2.3 Key Environmental Performance

6.2.3.1 Attended Noise Monitoring

United Wambo engaged an acoustic consultant to undertake monthly attended noise monitoring during the reporting period. Night-time operations did not commence until May 2020 under SSD 714, as such, only daytime operations occurred under SSD 7142 therefore attended noise monitoring during the night time period was not applicable during the months of January, February, March and April. Attended noise monitoring results include locations required by the United Wambo Noise Management Plan, and EPL3141.

Attended noise monitoring was completed once per month for the remainder of the reporting period. United Wambo was determined to be inaudible between May and Oct 2020. United Wambo complied with relevant noise criteria for all measurements recorded in 2020.

Table 6-3 is a summary of attended noise monitoring for 2020. Results are presented as the maximum noise levels recorded from United Wambo at each location during the reporting period and have been compared to relevant noise criteria specified under EPL3141.

Detailed monitoring results are provided in Monthly Noise Monitoring Reports available on the United Wambo website.

Table 6-3 Summary of Attended Noise Monitoring Data – 2020 (May - December)

Location	NAG	United Wambo Noise Monitoring Results - dBA (Max)		United Wambo Project Specific Noise Criteria - dBA	
		LAeq(15minute)	LA1(1minute)	LAeq(15minute)	LA1(1minute)
NM01	1	30	37	36	46
NM02	2	29	33	38	48
NM04	4	IA	IA	41	51
NM05	5	32	39	46	56
NM06	6	<25	<25	37	47
NM07	7	30	35	39	49

There was one noise complaint during 2020. Refer to **Section 8.3** for further details.

6.2.4 EIS Predictions

The United Wambo Open Cut Coal Mine Project (August 2016) modelled operation scenarios for years 2, 6, 11 and 16 of the conceptual mine plan. As outlined in **Section 4.1.1.1**, United Wambo was in Phase 1 construction until the 1st of December 2020.

The EIS predicted that noise criteria would be met at the majority on NAG under those years modelled for operations. The exception were residence in Mosses Crossing (Area 5) in Year 2, which were predicted 2dB higher than original noise criteria. Attended noise monitoring results in 2020 did not identify any exceedance of criteria and are below those predicted in the EIS for night time operations. Proposed Improvements

Noise management will be undertaken as per the Noise Management Plan which has been approved by DPIE under Condition B5 of SSD 7142.

During 2020 several proposed improvements were undertaken. Following the commencement of Phase 2, United Wambo began the following improvements:

- Reviewing the efficacy of the real time noise monitors;
- Upgrading old real-time noise monitors; and
- Review of noise model predictions to improve the mine planning process.

The above improvements are part of United Wambo's commitment to continuous improvement. These improvements are on-going and are review on an as needed basis.

6.3 Blasting

6.3.1 Environmental Management

Blasting is undertaken in accordance with the *Blast Management Plan (Glencore 2020e)* to ensure blast related impacts, including ground vibration, airblast overpressure, flyrock, fume, dust and misfire are minimised on the local community, infrastructure and heritage sites to the extent required by SSD 7142 and EPL 3141.

6.3.1.1 Management Measures

United Wambo implements blast management measures in accordance with the *Blast Management Plan* (Glencore 2020e) outlined in **Table 1-1** of the Blast Management and Mitigation Measures. The management measures are summarised below:

- Perform a detailed Blast Design and loading to be undertaken for each blast to meet the required criteria and minimise impact on the environment;
- Use a modified blast design when appropriate for example around identified geological features (including geological faults, series of joints, dykes etc) to avoid potential flyrock incident or when blasting through old underground workings;
- Implement the Pre-Blast Assessment Protocol including various meteorological assessments and notification procedures;
- Implement the Road Closure Management Plan where blasting is to occur within 500 m of a public road;
- Coordinate blast times between the United Wambo pits and HVO to avoid concurrent blasting;
- Detailed liaison and risk management between United Wambo, Wambo UG and HVO when blasting will occur within 500m boundary or when potentially affecting by flyrock, fumes, dust or other areas beyond the 500m zone (e.g. equipment movement); and
- Develop a safe management system for location and handling of misfires.

6.3.1.2 Approval Criteria

Condition B8 of Part B in SSD 7142 and Condition L4 of Section 3 in EPL 3141 outline the blasting criteria adopted for airblast overpressure and ground vibration during 2020 for Phase 1A, Phase 1B and Phase 2. This criterion is in place for human comfort for residences on privately owned land, the prevention of structural damage of heritage sites and infrastructure, and to minimise ground vibration at public infrastructure. The monitoring locations and criteria are summarised in **Table 6-4.**

Table 6-4 Residence on privately owned land Monitoring Locations and Criteria

Monitoring Locations	Airblast overpressure (dB Lin Peak)	Ground Vibration (mm/s)	Allowable exceedance
South Wambo BM03 / EPA ID 19	115	5	5% of the total number of blasts over a calendar year
Moses Crossing BM05 / EPA ID 20			
Redmanvale BM07 / EPA ID 21	120	10	0% of the total number of blasts over a calendar year
Maison Dieu BM08 / EPA ID 22			

Table 6-5 Heritage Blasting Monitoring Locations and Criteria

Monitoring Locations	Airblast overpressure (dB Lin Peak)	Ground Vibration (mm/s)	Allowable exceedance
St Phillips Church BM02	NA	5	0%
Wambo Homestead BM01	120	10	0%
All other heritage items[1] BM02	133	5	0%

[1] beyond those predicated in SSD 7142 and generally in accordance with the EIS. Includes the Former Warkworth Public School, Piggery and Butcher's Hut, former Queen Victoria Inn, and Springwood Homestead. For the Montrose property and Shearing Shed, and Dog-leg Fence see section 10.1.3 of the *Blast Management Plan (Glencore 2020e)*.

Table 6-6 Infrastructure Monitoring Locations and Criteria

Monitoring Locations	Airblast overpressure (dB Lin Peak)	Ground Vibration (mm/s)	Allowable exceedance
Hunter Valley Gliding Club GliderClub[1]	133	25	0%
Warkworth Shooting Complex BM02[2]			
HVO Infrastructure - occupied BM02[2]			
HVO surface infrastructure – unoccupied[3]	133	100	0%

[1] This monitor is the representative monitoring location.

[2] Monitor installed 9 June 2020.

[3] No specific sites monitored under this consent condition. Monitoring locations committed to in the Blast Management Plan (Glencore 2020e) are considered representative. Note United Wambo monitors other infrastructure (ie. transmission towers) closer to the pit with lower criteria.

Table 6-7 Public Infrastructure Monitoring Locations and Criteria

Monitoring Locations	Ground Vibration (mm/s)	Allowable exceedance
Transmission suspension towers[1] Transmission tension towers[1]	100 50	0%
Prescribed dams[2]	50 *(unless otherwise directed by the DSC)*	0%
Public Roads[3] Telecommunication infrastructure and cables[3]	100	0%

All other public infrastructure[3]	50 *(or a limit determined by the structural design methodology AS 2187.2 – 2006, or its latest version, or other alternative limit for public infrastructure, to the satisfaction of the Planning Secretary)*	0%

[1] Transmission suspension and tension towers were monitored as per SSD consent conditions using representative sites and/or portable monitors when blasting was in close proximity.

[2] Prescribed dams were monitored as per SSD 7142 consent conditions. This includes Wambo Tailings Dam (North East Tailings Dam), HVO Riverview Void Inpit Water Storage 2, United Tailings Dam 2, United Tailings Dam 2, and Wambo Hunter Pit Tailings Dam (HPTD). These prescribed dams were monitored all year round except for HPTD which was monitored from 01 June 2020 when mining began within 500m.

[3] No specific sites monitored under this consent condition. Monitoring locations committed to in the Blast Management Plan (Glencore 2020e) are considered representative.

Table 6-8 Offensive Blast Fumes

Condition	Details
Condition L4.5 of Section 3 in EPL 3141	offensive blast fume must not be emitted from the premises. Definition: Offensive blast fume means post-blast gases from the detonation of explosives at the premises that by reason of their nature, duration, character or quality, or the time at which they are emitted, or any other circumstances: 1. are harmful to (or likely to be harmful to) a person that is outside the premises from which it is emitted, or; 2. interferes unreasonably with (or is likely to interfere unreasonably with) the comfort or repose of a person who is outside the premises from which it is emitted.

6.3.2 Key Environmental Performance

Forty-nine (49) blasts from United Wambo Open Cut Coal Mine Project were monitored during 2020. As per B10 and B11 of SSD 7142, all blasting on site was between 9am and 5pm (Monday to Saturday inclusive) and there was less than 3 single blast events a day and less than 15 single blast events a week, averaged over a calendar year. As per L4.5 of EPL 3141, no offensive blast fumes were emitted from the premises.

Monitoring data was collected at all locations outlined in the SSD 7142 and EPL 3141 consent conditions. The approved monitoring locations BM01, BM02, BM03, BM05, BM07 and BM08 (as shown in **Figure 9** – United Wambo Air Quality, Noise and Blast Monitoring Locations) are reported on in this Annual Review, as committed to in the *Blast Management Plan (Glencore 2020e)*. Summarised monitoring data for these locations are provided in **Table 6-9** to **Table 6-11**.

Table 6-9 Residence on Privately Owned Land Monitoring Data

Monitoring Location		Airblast Overpressure Level dBL (Lin Peak)				Ground Vibration ppv (mm/s)			
Name	Monitor	Average	Max	Results >115 dBL	Results >120 dBL	Average	Max	Results >10 mm/s	Results >5 mm/s
South Wambo EPA ID 19	BM03	84.6	107.0	0%	0%	0.1	0.2	0%	0%
Moses Crossing EPA ID 20	BM05	91.4	110.2	0%	0%	0.0	0.2	0%	0%
Redmanvale EPA ID 21	BM07	88.7	111.0	0%	0%	0.0	0.1	0%	0%
Maison Dieu EPA ID 22	BM08	98.6	112.1	0%	0%	0.1	0.4	0%	0%

As per the blasting criteria outlined in SSD 7142 consent conditions, there were no blasting exceedances for airblast overpressure or ground vibration for residences on privately owned land during the 2020 calendar year, as seen in **Table 6-9**.

Table 6-10 Heritage Monitoring Data

Monitoring Location		Airblast Overpressure Level dBL (Lin Peak)				Ground Vibration ppv (mm/s)		
Name	Monitor	Average	Max	Results >120 dBL	Results >133 dBL	Average	Max	Results >5 mm/s
St Phillips Church	BM02	NA	NA	NA	NA	0.7	2.4	0%
Wambo Homestead	BM01	95.1	108.5	0%	0%	0.1	0.3	0%
All other heritage items	BM02	103.4	128.1	NA	0%	0.7	2.4	0%

There were no blasting exceedances in airblast overpressure or ground vibration for heritage locations during the 2020 calendar year, as seen in **Table 6-10**.

Table 6-11 Infrastructure Monitoring Data

Monitoring Location		Airblast Overpressure Level dBL (Lin Peak)			Ground Vibration ppv (mm/s)		
Name	Monitor	Average	Max	Results >133 dBL	Average	Max	Allowable exceedance
Hunter Valley Gliding Club	Glider Club	108.1	122.6	0%	0.8	2.9	0%
Warkworth Shooting Complex	BM02	103.3	128.1	0%	0.7	2.4	0%
HVO Infrastructure - occupied	BM02	103.3	128.1	0%	0.7	2.4	0%
Transmission suspension tower	634C, 635, 636, EWU, 638, 639, Portable 1, MD70081, MD70045	NA	NA	NA	10.8	167.1	NA
Transmission tension tower	MD70081, MD70045	NA	NA	NA	16.1	30.6	NA
Prescribed dams	HPTD, TD2, HVO Riverview East/West	NA	NA	NA	2.4	30.2	NA
Public Roads[1] Telecommunication infrastructure and cables	Portable 1, 634, 634C	NA	NA	NA	7.8	42.9	NA
All other public infrastructure							NA

[1] Monitors located adjacent to transmission suspension towers located between the approved pit shell and the Golden Highway are considered representative of public roads, telecommunication infrastructure.

United Wambo monitored blasting criteria at several locations considered to be representative of infrastructure surrounding the mine site. During the 2020 reporting period, there were zero airblast overpressure exceedances and one ground vibration exceedance recorded. For more detail regarding the ground vibration exceedance event please see **Section 1** and **10.2**.

6.3.3 Long Term Effects

Long term effects will be reporting on in 2021, using 2020 as the first year of baseline data.

6.3.3.1 EIS Predictions

A ground vibration predictive model and an airblast overpressure predictive model was developed to determine potential blasting impacts for the EIS. A range of blast scenarios were modelled. The results of the blasting impact assessment indicate that ground vibration and air blast overpressure levels can be managed to meet relevant blast emission criteria at all sensitive receiver locations through appropriate blast design. As discussed below there were two blast exceedances within the reporting period.

6.3.4 Proposed Improvements

Blast management will be undertaken as per *Blast Management Plan (Glencore 2020e)* which has been approved by DPIE under Condition 21 of SSD 7142.

There was one non-compliance in relation to the SSD 7142 blasting criteria for Transmission Suspension Towers at 12:28pm on 24 September 2020 (see Section 1 and 10 for further details). The following improvements to blasting management have been identified during an external investigation as follows:

- Continue to issue blast designs for review before implementation by Dyno Nobel - a third party industry professional;
- Increase the site constant (K-factor) to allow for an enhanced factor of safety;
- Increase the number of vibration monitoring points near infrastructure to assist in confirming/establishing an accurate site K-factor, including placing additional monitors at set short distances behind shots before reaching infrastructure sensitive receivers; and
- Engage consultants to analyse vibration monitoring results and assist in confirming/establishing the site K-factor.

There was also another exceedance of EPL 3141. On Thursday 5 November 2020 one blast event UTD-S02-RL50-38 was fired at 13:09:49 in the United Wambo Joint Venture Starter Pit with an overpressure of 128.1 dB recorded at the BM02. This exceeded condition L4.2 of EPL 3141 which does not allow overpressure to exceed 120 dB (lin peak) at any time.

6.3.5 Blast Fume Monitoring Trial

The blast fume monitoring program will be submitted to the EPA by 30 June 2021 and the blast fume monitoring trial will be completed within two years of commencement of Phase 2.

6.4 Air Quality

6.4.1 Environmental Management

Air Quality monitoring is undertaken in accordance with the United Wambo *Air Quality and Greenhouse Gas Management Plan*.

The location of air quality monitoring sites is shown on **Figure 9**. The monitoring program includes:

- Continuous monitoring of PM_{10} at 4 sites;
- Continuous monitoring of $PM_{2.5}$ at 2 sites;
- High Volume Air Sampler (HVAS) monitoring every 6 days (continuously for 24 hours) at 2 sites; and
- Continuous Meteorological monitoring at 2 sites.

Each real time air quality monitoring unit is fitted with alarming capabilities that can advise mining personnel that air quality at the monitor has reached the trigger levels. Alarms are sent via SMS and email to relevant United Wambo staff to notify that air quality is reaching / or has reached the predetermined limit. In such an event, action can then be taken to modify operations where practical as per the United Wambo Dust TARP.

Note: HVAS 01 and HVAS 02 are owned and operated by HVO, with results forwarded to United Wambo monthly.

6.4.2 Management Measures

The principal sources of atmospheric dust emissions from activities at United Wambo during operation are associated with:

- Disturbance from mining, exploration and drilling works;
- Wind-blown dust from exposed surfaces; and
- Vehicle movements on the internal unsealed hardstand areas or access roads around the site.

United Wambo implements dust and greenhouse gas management measures in accordance with the *Air Quality and Greenhouse Gas Management Plan*. The management measures are summarised in **Table 6-12**.

Table 6-12 Greenhouse Gas Mitigation Measures

Mitigation Measure	Application at United Wambo	Status
Limiting the length of material haulage routes to reduce diesel usage and associated emissions	Length of haulage routes has been optimised to minimise dust, noise, fuel use and improve operating efficiency.	Ongoing as part of the mine planning processes.
Optimising ramp gradients to reduce diesel usage and associated emissions	Ramp gradients have been optimised according to pit geometry parameters and mobile equipment performance characteristics.	Ongoing as part of the mine planning processes.
Continually improve the fuel efficiency of haul trucks operating at the mine to reduce diesel usage and associated emissions	United Wambo will seek opportunities to use the existing trucks currently in use at Wambo and from within the Glencore and Peabody groups to maximise the life of this equipment. Where new trucks are purchased during the life of the Project, fuel/energy efficiency will be considered in the selection criteria. Haul road design parameters such as gradient and haul length are optimised resulting in the efficient haulage of overburden per unit of fuel consumed.	Following integration United Wambo incorporated 23 existing pieces of gear (excavators, haul trucks, and ancillaries) from Wambo to maximise the life of the equipment. Selection of new trucks considered fuel/energy efficiency. 5 new trucks were delivered in 2020, all met Tier 4 emission standards.

Mitigation Measure	Application at United Wambo	Status
Payload management to reduce diesel usage and associated emissions	Payload will be constantly monitored and actively managed to maintain efficiency, over time reducing the overall diesel consumption of the mine and, thereby, reducing GHG emissions.	Ongoing. Payload targets were set for all trucks at United Wambo and are fitted with an onboard management system to optimise payload size. United Wambo developed an Excavator Operator Guideline to consider payload management.
Increasing haul truck payload to reduce the number of truck loads required and consequently reduce diesel usage and associated emissions	Truck tray capacity will be reviewed as part of the efficient management of the operation, including the option of fitting custom-built trays to maximise payloads. Payload will also be maximised by blasting strategies that optimise material size characteristics.	Payload study completed to optimise new 930E-5 tray designs.
Improving rolling resistance of haul roads to reduce diesel usage and associated emissions	Haul roads are planned to be constructed on solid rock rather than on soil or subsoil material where practical.	Ongoing as part of the mine planning processes and maintenance strategies.
Reducing idling times to reduce diesel usage and associated emissions	Reducing idle times will be an ongoing performance measure. Initiatives to reduce idle times will continue to be introduced over the life of the Project. A reduction in idle times will improve fuel consumption rates per volume of material moved.	United Wambo has implemented a fleet management system to reduce queue time. In addition, multiple dumps are operated simultaneously (where practical) to reduce queue time.
Scheduling activities so that equipment operation is optimised to reduce energy usage and associated emissions	Scheduling activities to optimise equipment operation will be a routine activity. United will prepare long, medium and short term plans to optimise production. Over time, this will reduce the overall diesel consumption of the mine and, thereby, reduce greenhouse gas emissions.	Ongoing as part of the mine planning processes.
Seek to continually improve the fuel efficiency and diesel emissions of mine equipment during the purchase of new equipment	United Wambo will seek opportunities to use the existing equipment currently in use at Wambo and from within the Glencore and Peabody groups to maximise the life of this equipment. Where new equipment is purchased during the life of the Project; fuel/energy efficiency and reasonable and feasible diesel emissions reduction technology will be considered in the selection criteria.	Following integration United Wambo incorporated 23 existing pieces of gear (excavators, haul trucks, and ancillaries) from Wambo to maximise the life of the equipment. Selection of new trucks considered fuel/energy efficiency. 5 new trucks were delivered in 2020, all met Tier 4 emission standards.
Blasting strategies to improve extraction and processing energy use efficiency and reduce associated emissions	Blast management practices will be employed to size material for optimum payloads and minimise the need for secondary treatment of waste material.	Blasts during 2020 were designed to minimise rehandling of material. During the reporting period secondary treatment of blasted material was not required.
Maximising resource recovery efficiency to maximise energy use efficiency and reduce associated emissions	Long, medium and short term operational plans will be developed to optimise the recovery of approved resources.	Ongoing as part of the mine planning processes.
Working machines to their upper design performance to optimise energy usage and associated emissions	Glencore's business objectives support and promote effective equipment utilisation and performance rates, resulting in improved fuel consumption rates per volume of material moved.	Ongoing as part of the mine planning processes.
Preventing unnecessary water ingress to reduce pump energy usage and associated emissions	The surface water management system is designed to maximise separation of clean and dirty water systems. Clean water will be diverted away from mining areas, consistent with the mine water management system design outlined in the EIS.	A clean water drain was constructed in 2020 to move clean water around the open cut pit and back into Redbank Creek. The drain will not be opened to the creek until it is stable and water can be released.
In-pit servicing to reduce diesel usage associated with transporting equipment	Equipment will be serviced in pit, where practical, reducing unnecessary unproductive travel time and energy use.	In-pit servicing was completed where practical during 2020 and will continue into 2021.

Mitigation Measure	Application at United Wambo	Status
High efficiency workshop lighting	New workshop areas will use high efficiency lighting, reducing energy use.	Construction of new workshop continued in 2020. Energy efficient LED lighting was installed in the new workshop.
High efficiency heating, ventilation, and cooling (HVAC) systems for administrative buildings	New administration buildings will use high efficiency HVAC systems reducing energy use.	Construction of new administration buildings continued in 2020. HVAC systems installed are new and inverter types utilised will minimise energy wastage.

6.4.3 Approval Criteria – SSD 7142

Air quality criteria is included as Condition B25 of SSD 7142 and is reproduced in **Table 6-13**.

It is noted that SSD 7142 was approved on 29 August 2019 and included changes to the former air quality criteria. Changes to air quality criteria and monitoring and how it will be applied to this Annual Review has been included below:

- Requirement to monitor deposited dust was removed;
- PM_{10} annual criteria modified from 30 µg/m^3 to 25 µg/m^3 and has been adopted for the purpose of this Annual Review;
- PM_{10} and TSP annual criteria now exclude extraordinary events;
- PM_{10} 24-hr average criteria changed from total impact to incremental impact and no longer excludes extraordinary events; and
- $PM_{2.5}$ annual and 24-hour average criteria was included.

Table 6-13 Air Quality Criteria

Pollutant	Averaging period	Criterion
Particulate Matter <10 mm (PM_{10})	Annual	[a,c]25 mg/m^3
	24 hour	[b]50 mg/m^3
Particulate Matter <2.5 mm ($PM_{2.5}$)	Annual	[a,c]8 mg/m^3
	24 hour	[b]25 mg/m^3
Total suspended particulate (TSP) matter	Annual	[a,c]90 mg/m^3

[a] Total impact (i.e. incremental increase in concentrations due to the development plus background concentrations due to all other sources).

[b] Incremental impact (i.e. incremental increase in concentrations due to the development on its own).

[c] Excludes extraordinary events such as bushfires, prescribed burning, dust storms, fire incidents or any other activity agreed by the Planning Secretary

In 2020, there were 24 days declared as “extraordinary air quality events” by DPIE. The predominant cause of these extraordinary events was smoke associated with the 2019/2020 bushfires. In addition, drought conditions early in 2020 contributed to the high dust levels in the vicinity of United Wambo. **Table 6-14** presents a list of the extraordinary event days in 2020 as declared by DPIE.

Table 6-14 Extraordinary Days listed by DPIE

Month	Day(s)
Jan	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 15, 20, 21, 23, 24, 25
Feb	1, 2, 3, 19
Mar	-
Apr	-
May	-
Jun	-
Jul	-
Aug	19
Sep	-
Oct	-
Nov	29
Dec	-

6.4.4 Key Environmental Performance

Historic dust deposition gauges were removed from the monitoring network in 2020 due to being superseded with more contemporary air quality monitoring equipment. The United Wambo air quality monitoring program added two continuous $PM_{2.5}$ monitoring units (TEOMs) during 2020.

A list of air quality monitoring sites, parameters and frequencies are provided in **Table 6-15**.

Table 6-15 Air Quality Monitoring Sites

Monitoring site (s)	Indicator (s)	Equipment Type	Frequency
HVAS 01, HVAS 02	TSP	HVAS	Six-day cycle
AQ02 and AQ04	PM_{10}	TEOM	Continuous
AQO1 and AQ03	PM_{10} and $PM_{2.5}$	TEOM	Continuous
WS1, WS2	Meteorology	Met Station	Continuous

High Volume Air Samplers

Table 6-16 presents a summary of HVAS monitoring results and compares annual averages for TSP against consent criteria.

Table 6-16 HVAS Results at United for 2020

Gauge	Annual Average (µg/m^3)
	TSP (µg/m^3)
Consent Criteria	90[1]
HVAS 01	70.8
HVAS 02	70.3

1 – Excludes extraordinary events such as bushfires, prescribed burning, dust storms, fire incidents or any other activities agreed by the Planning Secretary.

During 2020 the maximum HVAS TSP (excluding extraordinary events) was 214.0 µg/m^3 (at HVAS 02) During 2020 the average HVAS TSP result for HVAS 01 was 70.8 µg/m^3 and 70.3 µg/m^3 at HVAS 02. This represented a decrease at HVAS 01 of 9.2 µg/m^3 when compared against the 2019 average of 80.0 µg/m^3.

As shown in **Table 6-16** Annual TSP averages were within criteria limits of 90 µg/m^3. It should be noted that the current TSP annual average criteria detailed in **Table 6-13** excludes extraordinary events from the average.

During the reporting period HVAS01 failed to collect data on the 15 and 21 January and 4 December 2020, and HVAS02 failed to collect data on the 4 December 2020. For further detail see Section 1 and Section 10.

HVAS samplers no longer record PM_{10} as the TEOMs captures this data.

Continuous Monitoring

A summary of the recorded PM_{10} levels at the TEOM units is presented in **Table 6-17**. The number of days that exceeded the consent criterion is also shown. During the reporting period TEOM units failed to collect valid data on several occasions for varying lengths of time, as a result <75% of the daily data was not collected. During these occurrences, a valid 24-hour average was not able to be calculated. For additional details please see Section 1 and Section 10.

Table 6-17 provides a summary of the annual average and maximum 24-hour PM_{10} and 24-hour $PM_{2.5}$ averages recorded at TEOM units in 2020**.**

The annual average PM_{10} concentrations were below the relevant criterion of 25µg/m³ at AQ01, AQ02, AQ03 and AQ04 in 2020. Additionally, the annual average $PM_{2.5}$ concentrations were below the relevant criterion of 8µg/m³ at AQ01 and AQ03 in 2020.

As presented in **Table 6-17**, the maximum 24-hour average PM_{10} concentrations were above the relevant criterion of 50µg/m^3. The majority of these elevated levels occurred on days considered to be extraordinary events (e.g. bushfires, dust storms, etc). However, the SSD 7142 24-hour average PM_{10} criterion applies to the incremental impact (i.e. incremental increase in concentrations due to the development on its own) and no longer excludes extraordinary events. Investigations were undertaken following every measured exceedance of the 24-hour average PM_{10} criterion (see **Table 6-13**). All investigations indicated that United Wambo contributed less than 50µg/m^3 to the elevated 24-hour PM_{10} level recorded and considered to be complaint with SSD 7142 Condition B25.

As presented in **Table 6-17**, the maximum 24-hour average $PM_{2.5}$ concentrations did not exceed the relevant criterion of 25µg/m^3.

Table 6-17 Summary of TEOM Sampling Results – 2020 Maximum 24 Hour Average and Number of Exceedances

Annual average					Maximum 24 hour averages			
Gauge	**$PM_{2.5}$ (µg/m^3)[1]**	**Number of days exceeding criterion**	**PM_{10} (µg/m^3)[1]**	**Number of days exceeding criterion**	**$PM_{2.5}$ (µg/m^3)[1]**	**Number of days exceeding criterion**	**PM_{10} (µg/m^3)**	**Number of days exceeding criterion**
Consent Criteria	8	-	25	-	25		50	-
AQ02	-	-	16.7	-	-		132.5	13
AQ03[3]	4.1	-	13.0	-	14.8	0	137.8	9
AQ01[2]	5.2	-	17.7	-	16.5	0	106.1	11
AQ04	-	-	17.2	-	-		131.4	9

[1] Excluding extraordinary events

[2] AQ01 was replaced on the 18 June 2020 by D5-Kelly (still referred to as AQ01). PM_{10} results have been calculated using values from AQ01 until 18 June 2020 and values from D-5 Kelly (AQ01) from 19 June – 31 December 2020. Note AQ01 did not start recording $PM_{2.5}$ results until 19 June 2020. Therefore, $PM_{2.5}$ results including annual averages only include data from 19 June to 31 December 2020.

[3] $PM^{2.5}$ was not installed at AQ03 until 2 July 2020. Therefore, $PM_{2.5}$ results including annual averages only include data from 3 July to 31 December 2020.

The elevated days in 2020 were investigated to determine the likely cause of the elevated level. The likely primary cause of each elevated day was determined and are summarised in **Table 6-18 Summary of elevated particulate days**

Date	Monitors above 24-hour Criteria	Primary Cause of Elevated Levels
1/01/2020	AQ01, AQ02, AQ03, AQ04	Bushfire smoke.
3/01/2020	AQ02, AQ04	Bushfire smoke.
4/01/2020	AQ01, AQ02, AQ03, AQ04	Bushfire smoke.
5/01/2020	AQ01, AQ02, AQ03, AQ04	Bushfire smoke.

Date	Monitors above 24-hour Criteria	Primary Cause of Elevated Levels
6/01/2020	AQ01	Bushfire smoke. Missing data due to lightning strike power outage at units.
7/01/2020	AQ02	Bushfire smoke.
8/01/2020	AQ01, AQ02, AQ03, AQ04	Bushfire smoke.
11/01/2020	AQ01, AQ02, AQ03, AQ04	Bushfire smoke.
12/01/2020	AQ01, AQ02, AQ03, AQ04	Bushfire smoke.
22/01/2020	AQ04	Poor regional air quality.
23/01/2020	AQ01, AQ02, AQ04	Bushfire smoke and strong winds
24/01/2020	AQ03	Bushfire smoke and strong winds
25/01/2020	AQ01, AQ03	Bushfire smoke.
2/02/2020	AQ02, AQ04	Bushfire smoke.
4/02/2020	AQ01, AQ03	Poor regional air quality.
24/04/2020	AQ02	Unknown source. 0.0 µg/m³ contribution from United Wambo.
20/06/2020	AQ01	A leak in the TEOM air filtering system.
19/08/2020	AQ02,	Dust storm.

6.4.5 Long Term Trends

TSP and PM_{10}

Long- term annual average HVAS results for TSP and PM_{10} at United Wambo in 2020 are shown in **Table 6-18**.

Table 6-18 Long- term Minimum, Maximum and Annual Average High Volume Air Sampler Results (TSP and PM_{10})

High Volume Air Samplers (µg/m³)												
	TSP						PM_{10}					
	Kilburnie South (HVAS02)			Warkworth (EPA ID 8) (HVAS 01)			Kilburnie South (HVAS 02)[1]			Warkworth (EPA ID 8) (HVAS 01)[1]		
	MIN	MAX	AVG.	MIN	MAX	AVG.	MIN	MAX	AVG	MIN	MAX	AVG.
2010				13.2	82.7	40.7				6.9	37.5	18.2
2011				13.0	140.0	49.8				4.0	59.8	19.8
2012				8.0	143	50.7				4.0	68.0	19.3
2013				8.0	141.0	55.7				2.0	63.0	21.6
2014				13.0	147.0	53.9				3.0	75.0	22.6
2015				10.0	166.0	51.8				2.0	39.0	16.1
2016				8.0	132.0	50.1				3.0	40.0	15.3
2017				19.0	159.0	65.0				3.0	46.0	19.0
2018				22.0	186.0	79.9				3.0	62	23.7
2019 (All Data)				12.0	214.0	80.0				2.0	163.0	32.0
2019 (Extraordinary removed)				12.0	196.0	74.0				2.0	68.0	22.0
2020 (All Data)	5.0	322.0	83.0	24.0	214.0	75.6	2.0	128.8	33.2	9.6	85.6	30.2
2020 (Extraordinary removed)	5.0	214.0	70.3	24.0	144.0	70.8	2.0	85.6	28.1	9.6	57.6	28.3

1 PM_{10} results for 2020 were calculated using 0.4 multiplied by the corresponding TSP result for HV01 and HVAS 02.

Annual average HVAS results for both TSP and PM_{10} have shown a moderate level of variability throughout the period of 2010 to 2020. As discussed previously, HVAS monitors do not record PM_{10} as of 2020. However, PM_{10} results have been calculated using TSP values at both HVAS01 and HVAS 02 based on results of a study. The study on co-located TSP and PM_{10} monitors conducted in the Hunter Valley by the NSW Minerals Council (2010) indicated that dust generated from predominately coal mining sources has long-term average PM_{10} concentrations that are approximately 40% of the corresponding TSP concentration (or equivalently, TSP concentrations are approximately 2.5 times PM_{10} concentrations). This ratio was found to be reasonably accurate for long-term averages (e.g. annual averages).

The average value for HVAS TSP showed a decrease compared to 2018 and 2019 when extraordinary events were included. When all extraordinary events were included 2020 saw a slight increase in the minimum value compared to previous years while the maximum value was identical with 2019. When extraordinary events were excluded, TSP average results were slightly higher than the 2017 values with a decrease in average results of 9.1 µg/m³ from 2018 (79.9 µg/m³) to 2020 (70.8 µg/m³). There was also increases associated with PM_{10} at HVAS 01, with the average PM_{10} increasing compared to data from 2010 – 2019 when extraordinary events were included and excluded. The average PM_{10} result recorded for 2020 including and excluding extraordinary events was 33.2 µg/m³ and 28.1 µg/m³ respectively. It must be highlighted that PM_{10} results at HVAS 01 and HVAS02 are not true results but rather ratios calculated from the corresponding TSP results.

There are several factors which can affect long term dust trends including rainfall, bushfires and activities completed by surrounding mine operations. It must be noted that a considerable number of TSP values which exceeded criteria occurred during regional bushfire events in early 2020 (see **Table 6-14**).

The annual averages for TSP and PM_{10} have remained below the Development Consent criteria of 90µg/m^3 and 30µg/m^3 (now 25 µg/m^3 as of 2020) from 2010-2018. TSP remained within the development Consent criteria during 2019 while PM_{10} exceeded the annual average criteria for the first time when extraordinary events were included in the data. When extraordinary events were not included the result was 22.0 µg/m^3 which was below the former PM_{10} annual average criteria of 30µg/m^3. As of May 2019, there were no longer any private residences in Warkworth so the criteria for PM_{10} and TSP did not apply. During 2020 the annual average for TSP remained below the Development Consent Criteria of 90µg/m^3.

6.4.6 Comparison of Performance Against Criteria

The United Wambo Open Cut Coal Mine Project (August 2016) modelled operation scenarios for years 2, 6, 11 and 16 of the conceptual mine plan. As outlined in **Section 4.1.1.1**, United Wambo was in Phase 1 construction until the 1st of December 2020. A comparison of air quality monitoring results and those predicted in the EIS for Year 2 is summarised below.

The EIS predicted that cumulative annual average PM^{10} criteria would be met at all surrounding private residences with the exception of one residential receiver at Warkworth Village. This resident is within acquisition rights. Monitoring did not report an exceedance of that predicted in the EIS. Cumulative Maximum 24Hr PM^{10} 24 hr concentrations were predicted to exceed on at least one occasion a year. Monitoring results identified that Maximum PM^{10} 24 hr was exceeded on a number of occasions.

The EIS did not predict any exceedance of TSP at any private resident. Monitoring in 2020 concurs with this prediction.

One receiver in Warkworth village was predicted to experience exceedance of $PM^{2.5}$ criteria. There were no exceedances of $PM^{2.5}$ Annual Average or Maximum 24hr concentration.

6.4.7 Proposed Improvements

Air Quality management will be undertaken as per the Air Quality and Greenhouse Gas Management Plan (AQGHGMP) which is Condition B29 of SSD 7142. The United Wambo $PM_{2.5}$ real time monitoring

campaign will be reviewed in 2021 as Phase 2 operations did not commence until December 2020. This review will also take into consideration fuel consumption at United Wambo to allow for any re-calculation and assessment of any changes in $PM_{2.5}$ for the baseline estimates provided in the United Wambo AQGHGMP.

United Wambo will also maintain awareness of new technologies for air quality impact mitigation through participation in relevant industry groups.

6.5 Biodiversity

6.5.1 EIS Predictions

There are six Plant Community Types (PCTs) identified across 10 condition classes within the Additional Disturbance Area, as identified in the Biodiversity Assessment Report completed for the Project. Eight of the vegetation zones conform to Threatened Ecological Communities (TECs) listed under the state *Biodiversity Conservation Act, 2016* (BC Act) and the Commonwealth *Environment Protection Biodiversity Conservation Act 1999* (EPBC Act). The PCTs and listed TECs identified within the Project Area are summarised in **Table 6-19.**

Table 6-19 Vegetation Communities

PCT/BVT Number	PCT/Vegetation Zone	Area (ha)	Condition	Threatened Ecological Communities
1598/HU812	Forest Red Gum grassy open forest on floodplains of the lower Hunter	0.29	Moderate to Good	*Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions EEC* (BC Act)
1602/HU816	Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest of the central and lower Hunter	29.42	Moderate to Good – Plantation/ Rehabilitation	*Central Hunter Ironbark – Spotted Gum – Grey Box Forest in NSW North Coast and Sydney Basis Bioregion EEC* (BC Act) 1.17 ha *Central Hunter Valley Eucalypt Forest and Woodland CEEC* (EPBC Act)
1655/HU869	Grey Box - Slaty Box shrub - grass woodland on sandstone slopes of the upper Hunter and Sydney Basin	1.56	Moderate to Good	*Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion* VEC (BC Act) 1.13 ha *Central Hunter Valley Eucalypt Forest and Woodland CEEC* (EPBC Act)
1691/HU905	Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter	93.70	Low Condition – Derived Native Grassland	10.49 ha *Central Hunter Valley Eucalypt Forest and Woodland CEEC* (EPBC Act)
		146.09	Moderate to Good	*Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions* (BC Act) 143.46 ha *Central Hunter Valley Eucalypt Forest and Woodland CEEC* (EPBC Act)
		80.07	Moderate to Good – Cooba Open Shrubland	NA

PCT/BVT Number	PCT/Vegetation Zone	Area (ha)	Condition	Threatened Ecological Communities
		26.55	Moderate to Good – Regeneration	*Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions EEC* (BC Act) 22.79 ha *Central Hunter Valley Eucalypt Forest and Woodland CEEC* (EPBC Act)
		0.08	Moderate to Good – Thinned Canopy	*Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions EEC* (BC Act) 0.08 ha *Central Hunter Valley Eucalypt Forest and Woodland CEEC* (EPBC Act)
1692/HU906	Bull Oak grassy woodland of the central Hunter Valley	117.43	Moderate to Good	3.10 ha *Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions EEC* (BC Act) 10.19 ha *Central Hunter Valley Eucalypt Forest and Woodland CEEC* (EPBC Act)
1731/HU945	Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley	31.50	Moderate to Good	NA

United Wambo has approval to retire biodiversity credits progressively based on the staging of native vegetation disturbance in line with the progressive development of the mine. The three stages of disturbance being proposed are approximately seven-year stages, and are referred to as Stage 1, Stage 2 and Stage 3. An overview of the current proposed Stage 1, Stage 2 and Stage 3 credit requirements are provided in **Table 6-20**.

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Table 6-20 Staged Offsetting Requirements

Impacted Feature	STAGE 1 Credits Required	STAGE 2 Credits Required	STAGE 3 Credits Required	Total
Central Hunter Valley Eucalypt Forest and Woodland CEEC under the EPBC Act	11,287	2,570	620	**14,477**
Hunter Floodplain Red Gum Woodland EEC under the BC Act	0	20	0	**20**
Central Hunter Ironbark - Spotted Gum - Grey Box Forest EEC under the BC Act	1,424	0	0	**1,424**
Central Hunter Grey Box - Ironbark Woodland EEC under the BC Act	356	101	0	**457**
HU905 - Narrow-leaved Ironbark - Grey Box grassy Woodland of the Central and Upper Hunter	3,562	1,344	1	**4,907**
HU906 - Bull Oak Grassy Woodland of the Central Hunter Valley	2,973	0	0	**2,973**
HU945 - Swamp Oak - Weeping Grass Grassy Riparian Forest of the Hunter Valley	1,844	281	0	**2,125**
Southern Myotis (*Myotis Macropus*)	15	547	0	**562**
TOTAL ECOSYSTEM CREDITS	**21,446**	**4,316**	**621**	**26,383**
TOTAL SPECIES CREDITS	**15**	**547**	**0**	**562**

As per the detailed Assessments of Significance prepared for the EPBC Referral, Central Hunter Valley Eucalypt Forest and Woodland critically endangered ecological community (CEEC) was found to be significantly impacted as a result of the Project. Following submission of the Referral, the following MNES were considered by DoEE to be potentially significantly impacted by the Project:

- Central Hunter Valley Eucalypt Forest and Woodland CEEC;
- Regent honeyeater (*Anthochaera phrygia*);
- Swift parrot (*Lathamus discolor*); and
- Spotted-tailed quoll (*Dasyurus maculatus maculatus*).

The United Wambo was determined as being a Controlled Action requiring approval under the EPBC Act from the Commonwealth Minister for the Environment due to its potential impact on the previously listed matters of national environmental significance (threatened species and ecological communities). EPBC Approval 2015-7600 was granted by the Commonwealth Minister for the Environment on 5 December 2019 and allows United Wambo to clear a specified area of listed threatened species and ecological community to commence the United Wambo Project. In accordance with Condition 10 of EPBC Approval 2015-7600, a compliance report has been prepared and included as **Appendix 1**.

Table 6-21 provides a summary of the key impacts for each of the MNES.

Table 6-21 MNES Impacts

MNES	Impact Area (ha) ALL STAGES
Central Hunter Valley Eucalypt Forest and Woodland CEEC	246.8 (known habitat)
Regent honeyeater (*Anthochaera phrygia*)	203.7 (potential habitat)
Swift parrot (*Lathamus discolor*)	203.7 (potential habitat)
Spotted-tailed quoll (*Dasyurus maculatus maculatus*)	352.9 (potential habitat)

6.5.2 Key Environmental Performance

Disturbance

During 2020, the United Wambo Open Cut Project commenced, with 250 hectares of disturbance being undertaken for the development of the United Open Cut mining areas, construction areas and overburden emplacement areas. A comparison of the actual disturbance during 2020 and the predicted Stage 1 (i.e. Years 1-7) is provided in **Table 6-22**.

Table 6-22 Proposed Stage 1 vs Actual to Date Disturbance

Impacted Feature	Stage 1 Proposed Disturbance (ha)	Stage 1 Proposed Credits	2020 Actual Disturbance (ha)	2020 Actual Credits Impacted
Central Hunter Valley Eucalypt Forest and Woodland CEEC under the EPBC Act	195.54	11,287	121.50	7129
Hunter Floodplain Red Gum Woodland EEC under the BC Act	0	0	0	0
Central Hunter Ironbark - Spotted Gum - Grey Box Forest EEC under the BC Act	28.25	1,424	21.15	1066
Central Hunter Grey Box - Ironbark Woodland EEC under the BC Act	6.28	356	2.49	130
HU905 - Narrow-leaved Ironbark - Grey Box grassy Woodland of the Central and Upper Hunter	120.34	3,562	47.35	1398
HU906 - Bull Oak Grassy Woodland of the Central Hunter Valley	51.05	2,973	40.90	2382

Impacted Feature	Stage 1 Proposed Disturbance (ha)	Stage 1 Proposed Credits	2020 Actual Disturbance (ha)	2020 Actual Credits Impacted
HU945 - Swamp Oak - Weeping Grass Grassy Riparian Forest of the Hunter Valley	27.33	1,844	16.60	1120
Southern Myotis (*Myotis Macropus*)	0.2	15	0	0

Weed and Pest Management

During 2020 United Wambo focussed primarily on targeting weeds in the future clearing areas and rehabilitation areas.

Species targeted in the 2020 weed management activities by the weed management contractor included:

- African Olive (*Olea europaea* subsp. *cuspidata*);
- Mother-of-Millions (*Byrophyllum delagoense*) – Noxious Weed Class 3;
- Prickly Pear (*Opuntia stricta*); and
- African Boxthorn (*Lycium ferocissimum)* – Weed of National Significance (WONS).

Species targeted in the 2020 vertebrate pest management activities undertaken by the pest management contractors included:

- Red Fox (*Vulpes vulpes*);
- Wild Dogs (*Canis familiaris*); and
- Feral Pigs.

United Wambo contacted residents within 1km of the baiting program via letter and email detailing the timing of the programs and the precautions to take in regard to keeping domestic animals safe.

6.5.3 Long Term Trends

Long term trends will be reported commencing 2021 when a baseline has been established.

6.5.4 Management Measures

Measures to Minimise Direct Impacts on Biodiversity

As per the approved United Wambo *Biodiversity Management Plan*, the management measures described in **Table 6-23**.

Table 6-23 Biodiversity Management Measures

Action	2020 Measures
Minimise the impacts of the development on biodiversity	Suitably experienced personnel undertook pre-clearance surveys and tree-felling supervision for all clearing areas. Suitable biological resources, including fallen trees and seed resources, were salvaged from some of the clearing areas piror to removal of vegetation. All vegetation is mulched and incorporated into the topsoil. A Weed Action Plan was developed and implemented. See Section above. Dog baiting and trapping was undertaken as per above.
Manage the remnant vegetation and fauna habitat at the site	Clear delineation of the clearing disturbance footprints to avoid accidental clearance beyond the areas approved for disturbance Weed and pest management as per above.
Employee Education and Training	All employees and contractors are provided with an awareness of biodiversity values of United Wambo and requirements of the BMP in relation to site operations through the site induction process.

Biodiversity Offset Strategy

United Wambo has approval to retire biodiversity credits progressively based on the staging of native vegetation disturbance in line with the progressive development of the mine. The three stages of disturbance being proposed are approximately seven year stages, and are referred to as Stage 1, Stage 2 and Stage 3.

Condition B56 of the United Wambo Open Cut Coal Mine (United Wambo) Development Consent SSD 7142 has the requirement for United Wambo to retire the Stage 1 biodiversity credits as specified in Table 5 of Condition B55 of SSD 7142 within 12 months of commencing Phase 1A of the development, that being 6 January 2021.

Condition B56 also states that the Applicant must notify the Planning Secretary of its intention to satisfy Stage 1 credits using Ecological Mine Rehabilitation and provide details of the particular ecosystem credits proposed to be satisfied in this manner within 12 months of commencing Phase 1A.

The biodiversity credit requirements listed in Condition B55 were calculated using the BioBanking Assessment Methodology (BBAM). Following the commencement of the Biodiversity Conservation Act 2016 and the completion of savings and transitional arrangements, BBAM credits can no longer be created. Following consultation with the Biodiversity and Conservation Division (BCD), the Biodiversity Conservation Trust (BCT) and the DPIE, it has been determined that United Wambo must retire credits created under the Biodiversity Assessment Method (BAM credits).

In a letter dated 18 September 2020, Joe Thompson, Director Hunter Central Coast Branch, BCD, has proposed the following process to address the issues regarding the retirement of the proposed offset credits:

1. *Establish Biodiversity Stewardship Agreements across the proposed offset lands for Stage 1 (or all stages) of the project to generate BAM offset credits. Data already collected from BBAM plots across the offset sites will require supplementation with new BAM data collected from each plot.*

2. *Once all Stage 1 (or all stages) Biodiversity Stewardship Agreements have been established, apply for an 'assessment of reasonable equivalence' to have the BBAM credits for the development footprint changed to BAM credits.*

Once steps 1 and 2 above are completed United Wambo will be able to compare the BAM credit obligation for the project with the BAM credits generated by the Biodiversity Stewardship Sites of the project and be able to retire the credits.

To allow time to complete the process proposed by BCD, United Wambo requested an extension from the Planning Secretary of the timeframe specified in Condition B56 from 12 months to 24 months, i.e. from 6 January 2021 until 6 January 2022. This extension was granted on 20 October 2020.

United Wambo have secured 94 per cent of the required offset credits for Stage 1 of the Project according to an assessment of biodiversity credits under the former FBA process using the BioBanking assessment methodology. This provides 'like for like' credit allocation between the credits required and those created since the Project was assessed using the former FBA methodology.

The remaining offset credits will be retired in accordance with Condition B56 and United Wambo will notify the Planning Secretary of its intention to satisfy Stage 1 credits using Ecological Mine Rehabilitation and provide details of the particular ecosystem credits proposed to be satisfied in this manner by 6 January 2022.

Biodiversity credits related to the EPBC Act-listed Central Hunter Valley Eucalypt Forest and Woodland CEEC are proposed to be retired in a like-for-like manner. That is, all biodiversity credits generated from land-based offsets represent the CEEC either as currently conforming to, or will be restored to be, the community.

Where possible throughout the construction and operation of the Project, native vegetation areas will be avoided to minimise the loss of habitats and reduce the future offset credit requirement for the Project. The staged approach allows United Wambo to benefit from any reductions in disturbance area through a reduction in biodiversity credits that need to be retired. This creates a situation which will drive focus on opportunities to continue to minimise disturbance throughout the life of the mining operation.

Prior to the commencement of Stage 2, United Wambo will undertake a review of the disturbance undertaken during Stage 1 to identify areas where disturbance has been avoided. Disturbance that has been avoided will be used to offset the future staged credit requirements.

6.5.5 Proposed Improvements

The BMP will be revised and resubmitted once the credits have been retired.

6.6 Heritage

6.6.1 EIS Predictions

6.6.1.1 Aboriginal Heritage

A survey for the United Wambo Joint Venture Project EIS (Umwelt, 2016) was carried out in 2015 with a total of approximately 139 person days. The Aboriginal heritage surface survey recorded 25 new artefact scatters, 20 extensions to previously recorded sites and 34 isolated finds. This surface survey was followed by eight test excavations, with surprisingly sparse results. 192 artefacts were recovered, with an average of 1.25 artefacts per excavation square, which is an extremely low density of artefacts.

6.6.1.2 European Heritage Sites

A detailed heritage impact statement was conducted in 2016 for the proposed United Wambo Joint Venture Project (Umwelt, 2016). In consultation with Enviro Strata (the blasting consultant) it was determined that items further than 2 kilometres from the Project Area would not be affected by blasts. As such, the search for this assessment was limited to a conservative distance of 3 kilometres. Three historic heritage items were identified as being within this zone, but outside the Project Area. These are Wambo Homestead, St Philips Church Warkworth and the Former Queen Victoria Inn (ruins). There were also items of historic interest located within the Project Area, which are the Dog- leg Fence and the former House Site. Also in the within the vicinity of the Project Area are Springwood Homestead, Montrose Property, the former Warkworth Public School and Piggery and Butcher's Hut.

6.6.2 Key Environmental Performance

6.6.2.1 Aboriginal Heritage

In accordance with the United Wambo Aboriginal Cultural heritage Management Plan, 120 Aboriginal heritage sites were salvaged during 2020. The salvage was completed in two stages, with stage one being carried out between January and March and stage two occurring in November. The technical report documenting the salvage is due for completion in May 2021 and will be made available on the United Wambo Joint Venture website once finalised. **Figure 11** shows the sites which were salvaged and those that remain in the United Wambo Project Area.

In November 2020, a survey of the Aboriginal heritage sites remaining within the United Wambo Project Area was conducted in order to ground-truth the location and condition of these sites and to recommend measures to be implemented to ensure that these sites are preserved in the landscape. These recommended measures will be implemented by United Wambo during 2021.

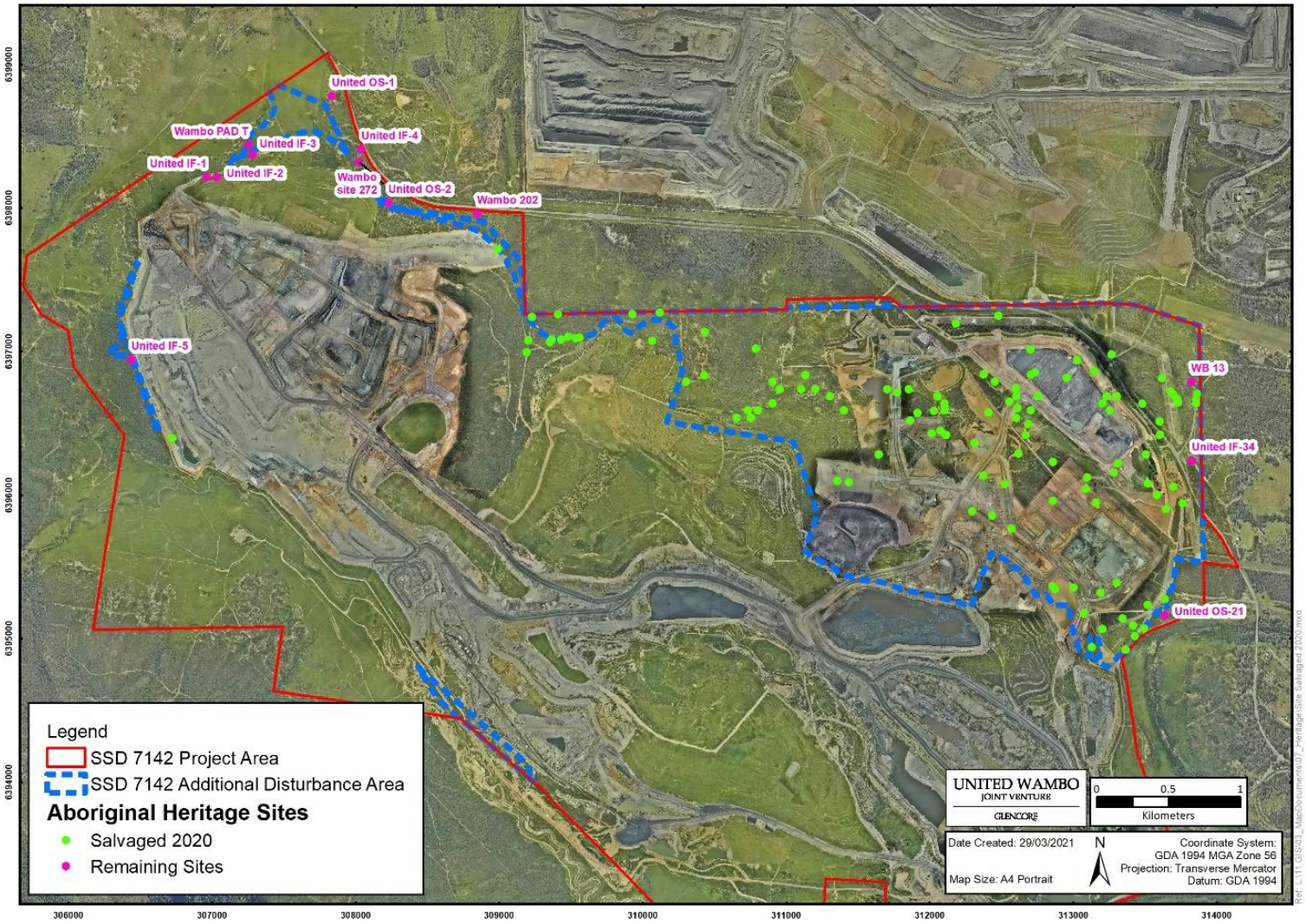


Figure 11 – Aboriginal Heritage Sites

6.6.2.2 Historic Heritage Sites

Table 6-24 below contains a summary of the activities that were conducted during 2020, in accordance with the United Wambo Historic Heritage Management Plan (HHMP).

Table 6-24 HHMP Management Measures

Mitigation/Management Measure	HHMP Section
A detailed photographic archival recording of the shearing shed and creamery was undertaken in accordance with Heritage Branch guidelines *Photographic Recording of Heritage Items Using Film or Digital Capture* (2006) prior to any physical impacts occurring to the item.	8.5.3
The archival record of the shearing shed and creamery was submitted to DPIE, the Heritage Council, and the relevant local Council libraries.	8.5.3
As a result of the property's susceptibility to damage from ground vibration a photographic/archival recording of the Shearing Shed on the Montrose property was undertaken in accordance with Heritage Branch guidelines *Photographic Recording of Heritage Items Using Film or Digital Capture* (2006) prior to any blasting being undertaken as part of the Project that may exceed 5 mm/s.	8.6.1
As part of the archival recording, further research was undertaken of the Montrose property, to better understand the history of occupation and use of the property.	8.6.1
The archival record recording of the Shearing Shed on the Montrose property was submitted to DPIE, the Heritage Council, and the relevant local Council libraries.	8.6.1
Subject to discussions with the landowner, United Wambo undertook an inspection of the former Warkworth Public School	8.6.2

No disturbance was associated with Historic Heritage items during 2020.

6.6.3 Management Measures

United Wambo will continue to monitor Aboriginal heritage sites in accordance with the United Wambo Aboriginal Cultural Heritage Management Plan (ACHMP), as required by condition B79 of SSD 7142, as well as the recommendations arising from the survey of the remaining sites conducted in November 2020. For management measures and salvage methods refer to Table 1 and Section 6 of the ACHMP respectively.

United Wambo will continue to manage all non-Aboriginal heritage items in accordance with the United Wambo Historical Heritage Management Plan (HHMP), which is required by condition B82 of SSD 7142. For mitigation and management measures refer to Table 1 and Section 7 of the HHMP.

6.7 Waste Management

Waste management practices at United Wambo are based on the waste management hierarchy of reuse, recycle and as a last resort, dispose.

The overall aim of the waste management system at United Wambo is to minimise waste being disposed from the site, but also to maximise resource use where possible. Waste is managed, tracked and reported monthly to the United Wambo Environment and Community Coordinator and also entered into the Sustainability Database for tracking and reporting purposes.

Further detail regarding waste management at United Wambo is within the Environmental Management Strategy (EMS).

General Waste and Recycling

Waste generated at United Wambo is managed in accordance with the EMS. Paper, cardboard and scrap steel are all recycled. United Wambo currently has a total waste management system which includes training, segregation, disposal and reporting.

Sewage Treatment and Disposal

United Wambo currently have an Envirocycle system which services the main pit top facilities including the administration area, stores and bathhouse. The sewage system is serviced on a regular basis by licensed contractors.

Hydrocarbon Management

In 2020, United Wambo continued to remove the unwanted materials and machinery form site.

6.7.1 Summary of Waste Performance in 2020

United have been tracking waste across the site. In 2020 United Wambo disposed a total of 1,122,612 kg of waste from site, a significant increase of 142,586 kg from 2019. This is due to the demolition of the CHPP and associated infrastructure removed as part of the United Wambo Project and the disposal of this waste described in **Section 4.2**. A detailed breakdown of waste disposal is contained within **Table 6-25**.

Hazardous Recycled waste increased significantly from 7,495 kg in 2019 to 138, 410 kg in 2020. Non - Hazardous Recycled waste also significantly increased from 68,741 kg in 2019 to 728,694 kg in 2020. Hazardous Disposal increased from zero in 2019 to 16,473 kg in 2020, while Non - Hazardous Disposal increased significantly from 66,350 kg to 239,035 kg. As United Wambo began operating during the reporting period this significant increase is expected. An increasing trend is expected to continue into the next reporting period (2021).

Table 6-25 2018, 2019 and 2020 Waste Performance Comparison at United Collieries (now United Wambo)

Waste Source	2018	2019	2020
Hazardous Recycled (kg)			
Lead batteries	-	532	-
Oil	900	5,800	79,378

Waste Source	2018	2019	2020
Oily Water	-	-	30,552
Oil Filters	-	-	6,040
Chemicals	208	-	4,456
Waste Coolant	-	-	8,786
Contaminated Sludge	-	-	5,620
Waste grease	-	144	1,052
Empty drums	582	-	1,916
E-waste	92	1,019	610
Total	**1,786**	**7,495**	**138,410**
Non-Hazardous Recycled (kg)			
Paper and cardboard	1,630	1,285	8,305
Scrap Steel	192,480	55,920	26,430
Timber	-	5,840	17,460
Confidential Documents	295	196	1,246
Effluent	-	5,500	606,400
Tyres	-	-	53
Concrete	-	-	68,800
Total	**194,405**	**68,741**	**728,694**
Hazardous Disposal (kg)			
Oily Rags	-	-	1,502
Chemicals	420	Nil	97
Asbestos	Nil	Nil	14,020
Total	**420**	**Nil**	**16,473**
Non-Hazardous Disposal (kg)			
Mixed solid waste	61,220	66,350	239,035
Total	**61,220**	**66,350**	**239,035**
Total Offsite Waste Disposed (kg)	**61,640**	**69,022**	**255,508**
Total Offsite Waste Recycling (kg)	**196,191**	**76,236**	**867,104**
Total Offsite Waste (kg)	**257,831**	**142,586**	**1,122,612**
Total Offsite Waste Recycling as a Percentage (%)	**76.09**	**53.47**	**77.24**

6.7.2 Management Measures

United Wambo undertook waste management in accordance with waste criteria under conditions B91 and B92 of SSD 742 during 2020.

Management measures included:

- Weekly removal of general waste including scrap by a licenced contractor;
- Weekly inspections are undertaken to monitor the implementation of the Waste Management Plan;
- Additional training of relevant personnel highlighting any waste management issues; and

- Assessment and appropriate management of specific wastes such as contaminated wastes.

The weekly inspections showing general site compliance indicates the current waste management measures applied at United Wambo are generally effective.
United Wambo reviews its waste minimisation strategy on an as needs basis.

6.7.3 Proposed Improvements

As the site continues to transition to an operational site in 2021 the waste associated with operational activities is expected to increase. No new improvements to waste management is expected during 2021.

United Wambo will continue to implement the current management measures to ensure effectiveness of the waste management system.

6.8 Surface Water

6.8.1 Environmental Management

United Wambo implements surface water monitoring in accordance with the *United Wambo Water Management Plan* and the *United Wambo Surface Water Management Plan*.

The purpose of surface water quality monitoring at United Wambo is to:

- Monitor surface water quality and levels to detect potential impacts on surrounding catchment users;
- Satisfy performance criteria (**Section 6.8.3**); and
- Collect data which will be used in the continued development and refinement of surface water investigation triggers (**Section 10.2.2** of the *United Wambo Surface Water Management Plan*) and provide input to the site water balance and salt balance (**Table 6-29**).

The location of water monitoring sites is shown on **Figure 9**. The monitoring program includes:

- Monthly water quality monitoring including flow status (refer **Table 6-36 - 40**);
- Annual speciation analysis;
- Annual water stability monitoring;
- Additional monitoring in accordance with the Investigation Protocol if performance deviated from background trends; and
- Additional monitoring/ investigations in accordance with the Trigger Action Response Plan if surface water results exceed criteria.

United Wambo uses evaporation to control stored volumes of 'dirty water' on site and maintain free board in storages to capture runoff from disturbed areas during storm events. Evaporation is maximised by increasing surface area by storing 'dirty water' in numerous dams.

6.8.2 Management Measures

United Wambo implements surface water management measures in accordance with the *Surface Water Management Plan*. The management measures are summarised below:

- Surplus water will be discharged as required and in accordance with Wambo's EPL 529 and consistent with the provisions of the Hunter River Trading Scheme (HRSTS). Discharges will be monitored prior to release to ensure compliance with the requirements of the HRSTS and in accordance with EPL condition;
- Wastewater from onsite facilities, including sewage, is collected and treated on site by a number of aerated wastewater treatment plants, which are licensed by Singleton Council;
- Generic training on the aspects of the *Surface Water Management Plan* is provided to all employees and contractors through the Site Familiarisation process. Selected site personnel, whose duties directly involve the management of water at United Wambo, will undertake specific training in regard to site Operational Procedures which incorporate water management measures;
- Storage dams and pits are sampled monthly. Data from this monitoring is used for operational purposes and is reported internally as required;
- The water levels in the former United Underground are monitored on a regular basis to maintain understanding of the volume of water stored with the workings; and
- Validated data from the monitoring program is entered into the GCAA Environmental Monitoring Database (EMD).

Details of complaints relating to surface water will be provided to relevant mine planning and production personnel to assist in the improvement of management practices, where relevant. A summary of the complaints received by the community will be reported in this document.

6.8.3 Surface Water Criteria

Surface water criteria is available for the four sites described in **Table 6-26**. While sampling occurs at additional points onsite, those listed in **Table 6-26** are the only offsite locations monitored and are therefore reflective of environmental impacts. All other locations are onsite dams used for early indications of changes and are not reflective of environmental impacts. The impact assessment criteria for surface water quality are summarised in **Table 6-26.**

Table 6-26 Surface Water Quality Criteria

Site ID	Site Description	Sample Count	pH		EC (µs/cm)[2]	TSS (mg/L)[2]	TDS (mg/L)[2]
			Lower	Upper			
WB04	Wollombi Brook – Downstream	-	6.5	8.5	2,200	50[1]	–[1]
NWC03	North Wambo Creek - Downstream	57	7.3	8.0	2,350	15	1,270
RC01	Redbank Creek - Downstream	70	7.9	8.3	8,456	26	–[1]
WFC01	Waterfall Creek	39	7.3	7.9	435	582	646

1 – There is no historical data available for TDS for RC01. As there is no ANZECC criteria set for TDS, no limits have been identified for this RC01. A default of 50 mg/L TSS has been utilised for WB04 until the site-specific criteria is developed.

2 – Criteria represents the maximum value.

No site-specific surface water quality criteria has been generated for metals/metalloids, due to limited data set for the monitoring locations. United Wambo propose to develop site specific criteria when sufficient data is available. In the interim, default 95% species protection ANZECC trigger values for slightly to moderately disturbed freshwater ecosystems Australia have been adopted as the impact assessment criteria and is reproduced in **Table 6-27.**

Table 6-27 ANZECC Criteria for Metals and Metalloids

Parameter	ANZECC Criteria (µg/L)	Parameter	ANZECC Criteria (µg/L)	Parameter	ANZECC Criteria (µg/L)	Parameter	ANZECC Criteria (µg/L)
Aluminium (Al)	55	Manganese (Mn)	1,900	Lead (Pb)	3.4	Calcium (Ca)	N/A

Parameter	ANZECC Criteria (µg/L)	Parameter	ANZECC Criteria (µg/L)	Parameter	ANZECC Criteria (µg/L)	Parameter	ANZECC Criteria (µg/L)
Arsenic (As)	24	Nickel (Ni)	11	Potassium (K)	N/A	Barium (Ba)	N/A
Cobalt (Co)	N/A	Selenium (Se)	11	Silver (Ag)	0.05	Magnesium (Mg)	N/A
Copper (Cu)	1.4	Zinc (Zn)	8	Flouride (Fl)	N/A	Cadmium (Cd)	0.2
Iron (Fe)	N/A	Mercury (Hg)	0.6	Boron (B)	370	Sodium (Na)	N/A

Annual Speciation Results

In accordance with the *Surface Water Monitoring Plan*, speciation monitoring is undertaken annually at United Wambo surface water monitoring locations in December. Speciation monitoring is assessed against criteria in **Table 6-27**. A summary of the surface water results for 2020 are presented in **Table 6-28**. It is noted that monitoring point NWC03, RC01 and WFC01 were not able to be sampled during December 2020 as the monitoring locations were dry. All relevant parameters measured at WB04 during December 2020 met criteria listed in **Table 6-27**.

Table 6-28 Annual Speciation Results

Site ID	WB04	NWC03*	RC01*	WFC01*
Aluminium (Al)	0.02	-	-	-
Arsenic (As)	<0.001	-	-	-
Cobalt (Co)	<0.001	-	-	-
Copper (Cu)	<0.001	-	-	-
Iron (Fe)	1.08	-	-	-
Manganese (Mn)	0.497	-	-	-
Nickel (Ni)	0.001	-	-	-
Selenium (Se)	<0.01	-	-	-
Zinc(Zn)	<0.005	-	-	-
Mercury (Hg)	<0.0001	-	-	-
Lead (Pb)	<0.001	-	-	-

Site ID	WB04	NWC03*	RC01*	WFC01*
Potassium (K)	5	-	-	-
Silver (Ag)	<0.001	-	-	-
Flouride (Fl)	0.1	-	-	-
Boron (B)	<0.05	-	-	-
Calcium (Ca)	13	-	-	-
Barium (Ba)	0.043	-	-	-
Magnesium (Mg)	14	-	-	-
Cadmium (Cd)	<0.0001	-	-	-
Sodium (Na)	73	-	-	-
Total phosphorous (P)	<0.01	-	-	-
Nitrite	<0.01	-	-	-
Nitrate	<0.01	-	-	-
Total Kjeldahl Nitrogen (TKN)	0.5	-	-	-
Total nitrogen (Total N)	0.5	-	-	-
Ions - Chloride (Cl)	126	-	-	-
Bicarbonate (CaCO3)	87	-	-	-
Sulphate (SO4)	15	-	-	-

*Dry during 2020.

Water Balance

The United Wambo Complex water balance and salt balance were updated at the end of 2020. The revised water and salt balance summaries, showing annual average volumes of inputs and outputs, is shown in **Table 6-29** and **Table 6-31.**

Table 6-29 United Wambo JV Water Balance – 2020 Update Annual Averages

Water Balance	**Annual Averages**
Water Sources	**Volume (ML)**
Transfer from Wambo	179
Rainfall/Runoff	452
Open Cut Seepage	573
Total Water Inputs (I)	**1,204**
Water Usage	**Volume (ML)**
Dust Suppression	200
Transfer to Wambo	10
Potable Water	0.5
Total Water Usage (U)	
Water Loss	**Volume (ML)**
Evaporation – Mine Water	98
Seepage	0
Total Losses (L)	**98**
Change in Storage	**Volume (ML)**
Initial (January 2020)	70
Final (December 2020)	256
Change in Storage (S)	**186**

Table 6-30 United Wambo JV Salt Balance – 2020 Update Annual Averages

Site Salt Balance	**Annual Averages**
Inputs	**Salt (t)**
Runoff	280
Groundwater (ROM coal)	117
Groundwater (Seepage)	3,656
Total	4,053
Outputs	Salt (t)
Dust suppression	1,198
Groundwater (ROM coal)	117
Total	1,314
Balance	2,738

6.8.4 Key Environmental Performance

6.8.4.1 Surface Water Monitoring Locations

As part of the United Wambo project, surface water monitoring points from United and Wambo have been grouped together. Many of the water quality monitoring points have been renamed for management under United Wambo. For detailed information regarding current and former surface water sites including name changes refer to the *United Wambo Surface Water Management Plan*.

Table 6-31 outlines the water monitoring locations for United Wambo.

Table 6-31 Surface Water Monitoring Locations for United

Site	Sample Count	Creek Monitoring Location
WB01	No longer accessible	Wollombi Brook - Upstream
WB02	11	Wollombi Brook - Pumps
WB03	12	Wollombi Brook - Warkworth
WB04	12	Wollombi Brook - Downstream
NWC01	No Flow	North Wambo Creek - Upstream
NWC02	10	North Wambo Creek - Midstream
NWC03	21	North Wambo Creek - Downstream
RC01	3	Redbank Creek - Downstream
WFC01	No Flow	Waterfall Creek
W02	12	Dam 2
W03	12	United UG Boxcut
W04	11	Dam 3
W07	11	Dam 14
W08	-	C11 Void
W09	10	CHPP Dams
W10	11	Process Water Dam
W11	12	Wambo MIA Box Cut Dam
W12	1	Homestead Pit
W13	12	West Cut Dam
W14	1	Montrose Pit Inflows
W15	11	Dam 7
W16	10	Dam 15
W17	-	Wombat Dam
W18	4	U2
W19	3	U3

6.8.4.2 Surface Water Monitoring Results

The 2020 surface water monitoring results at United Wambo are shown in **Table 6-32 to Table 6-35.** Note analysis of monitoring data occurs for the offsite locations listed in **Table 6-26** (WB04, NWC03, RC01 and WFC01 which are monitored monthly). Data from all other monitoring locations including storage dams and pits (monitored monthly) is used for operational purposes and is reported internally and is therefore not analysed in this document. Parameters measured are pH, EC, TSS and TDS.

Table 6-32 Creek Water Monitoring Results – pH (2020)

Surface Water Monitoring Site	Minimum	Maximum	Average
WB01	No longer accessible		
WB02	6.3	7.6	7.1
WB03	6.9	7.7	7.2
WB04	6.9	7.5	7.2
NWC01	No flow		
NWC02	7.2	7.8	7.7
NWC03	6.9	7.4	7.3
RC01	7.3	7.4	7.4
WFC01	No Flow		
W02	8.2	9.0	8.5
W03	8.4	9.1	8.7
W04	7.3	8.5	8.0
W07	6.7	9.7	7.8
W08	-	-	-
W09	8.0	9.2	8.9
W10	8.0	9.0	8.7
W11	7.9	9.0	8.4
W12	9.2	9.2	9.2
W13	8.7	9.0	8.8
W14	8.9	8.9	8.9
W15	7.0	8.6	7.6
W16	7.5	8.7	8.2
W17	-	-	-
W18	8.4	8.8	8.6
W19	9.1	9.2	9.1

Creek water monitoring results for pH at WB04 in 2020 was within criteria, with all results falling between 6.9 and 7.5. The minimum pH result (6.9) recorded at NWC03 during 2020 was below the minimum criteria of 7.3. The majority of pH results were similar or slightly below the minimum threshold with the average pH result being 7.3. The minimum pH result (7.3) recorded at RC01 was below the minimum threshold of 7.9. It must be noted that RC01 was dry during the majority of 2020 with results only captured on 3 occasions with all of those being below the minimum threshold. WFC01 was not flowing

during 2020 and therefore water quality results could not be recorded. pH results were generally comparable to last year's Annual Review period.

Table 6-33 Creek Water Monitoring Results – Electrical Conductivity (EC µs/cm) – 2020

Surface Water Monitoring Site	Minimum	Maximum	Average
WB01	No longer accessible		
WB02	190	838	567
WB03	253	2,060	721
WB04	255	844	593
NWC01	No flow		
NWC02	284	628	496
NWC03	314	861	585
RC01	475	686	573
WFC01	No flow		
W02	626	2,410	1,237
W03	810	2,480	1,176
W04	857	1,210	1,036
W07	381	784	524
W08	-	-	-
W09	1,110	8,310	4,613
W10	2,580	12,300	5,845
W11	538	721	614
W12	7,420	7,420	7,420
W13	3,320	6,930	5,857
W14	2,400	2,400	2,400
W15	228	454	283
W16	165	341	237
W17	-	-	-
W18	845	1,440	1,174
W19	5,210	6,790	5,757

EC results were variable during 2020 with a range of 255 µs/cm to 861 µs/cm across WB04, NWC03 and RC01. The average EC results during 2020 were 593 µs/cm, 585 µs/cm and 573 µs/cm for WB04, NWC03 and RC01 respectively. There were no exceedances of site-specific EC criteria during 2020.

Overall, EC results at each site have been consistently variable over the long term, and 2020 results are similar to past trends.

Table 6-34 Creek Water Monitoring Results – Total Suspended Solids (TSS) – mg/L - 2020

Surface Water Monitoring Site	Minimum	Maximum	Average
WB01	No longer accessible		
WB02	7	13	10
WB03	5	12	8
WB04	6	8	7
NWC01	No flow		
NWC02	21	900	320
NWC03	5	98	20
RC01	25	25	25
WFC01	No flow		
W02	6	65	34
W03	16	1,730	445
W04	7	46	15
W07	5	39	14
W08	-	-	-
W09	22	170	81
W10	11	312	75
W11	5	45	17
W12	12	12	12
W13	10	33	20
W14	16	16	16
W15	6	15	10
W16	12	114	33
W17	-	-	-
W18	67	328	196
W19	16	116	66

The average 2020 TSS result at WB04 was 8 mg/L and values ranged from 6-8 mg/L (all well below the maximum criteria of 50 mg/L). The average 2020 TSS result at NWC03 was 20 mg/L and values ranged from 5-98 mg/L. All results excluding the 98 mg/L recorded in February 2020 were below the criteria of 15 mg/L.

The average 2020 TSS result at RC01 was 309 mg/L and values ranged from 25-461 mg/L. Two of the three results sampled were well above the maximum criteria value of 26 mg/L. Two samples, April and May, were taken from small pools of water during no flow conditions. These high values are likely due to sediment being mixed with the samples due to low water levels and therefore not representative of water leaving site.

Table 6-35 Creek Water Monitoring Results – Total Dissolved Solids (TDS) – mg/L - 2020

Surface Water Monitoring Site	Minimum	Maximum	Average
WB01	No longer accessible		
WB02	170	470	344
WB03	176	448	338
WB04	181	434	336
NWC01	No flow		
NWC02	-	-	-
NWC03	-	-	-
RC01	8	640	370
WFC01	No flow		
W02	515	1,380	787
W03	856	2,910	1,603
W04	687	916	742
W07	298	904	413
W08	-	-	-
W09	1,550	6,130	3,840
W10	2,540	5,200	3,661
W11	324	406	366
W12	5,100	5,100	5,100
W13	3,470	4,710	4,283
W14	1,380	1,380	1,380
W15	124	404	209
W16	168	294	230
W17	-	-	-
W18	1,010	2,060	1,595
W19	2,730	4,480	3,827

TDS was an addition to surface water quality parameters assessed during 2020 and was therefore not reported in the 2019 United Annual Review.

The average 2020 TDS result at WB04 was 336 mg/L and values ranged from 181-434 mg/L. TDS criteria has not yet been developed for WB04.

TDS was not recorded at NWC03 during 2020.

The average 2020 TDS result at RC01 was 370 mg/L and values ranged from 8-640 mg/L. TDS criteria has not yet been developed for RC01.

6.8.4.3 Watercourse Stability Monitoring

Baseline watercourse stability monitoring was undertaken in 2020. Photo monitoring points were set up in Wollombi Brook, Redbank Creek and Waterfall Creek. The program will involve taking photos at each location upstream and downstream and identifying any changes in any of the following:

- Stream and riparian vegetation cover;
- Bed condition;
- Active erosion points; and
- Potential areas of instability determined by the creek line inspections.

This monitoring will be undertaken annually and all photos will be filed on the United Wambo server for comparison. If upon a desktop review there are noticeable changes, further investigations will take place. Investigations will take place in the field, on location, and must include (but not limited to.):

- Current meteorological conditions;
- Meteorological conditions for the last 12 months;
- Any identified structure changes (i.e fallen trees, erosion, evidence of a high flow event); and
- Has there been any unauthorised anthropogenic activities.

If through a field investigation the cause of the changes cannot be determined, a suitability qualified individual will be engaged to assist in the investigation.

Baseline photos were taken in June 2020 prior to the commencement of mining. Photos will be taken from the same location in 2021 and the findings will be presented in the next Annual Review.

6.8.5 Water Performance Measures

A comparison of United Wambo's compliance with the water performance measures in Condition B49 of SSD 7142 is provided in **Table 6-36.**

Table 6-36 - Water Management Performance Measures

Feature	Performance Measure	
Water management – General	• Maintain separation between clean, dirty and mine water • Minimise the use of clean and potable water • Maximise water recycling, reuse and sharing opportunities • Minimise the use of make-up water from external sources • Design, install, operate and maintain water management infrastructure in a proper and efficient manner	• United Wambo separates the clean, dirty and mine water in accordance with the Water Management Plan • United Wambo's main source of water usage is for dust suppression. Water used by United Wambo for dust suppression is sourced from mine and dirty water collected, maximising reuse and minimising the use of clean water and externally sourced water

Feature	Performance Measure	
Alluvial aquifers (including Wollombi Brook alluvium)	• Negligible impacts to the alluvial aquifer beyond those predicted in the document/s listed in condition A2(c), including: – negligible change in groundwater levels; and – negligible impact to other groundwater users including, • Maintain appropriate setbacks in accordance with the Aquifer Interference Policy (DPI, 2012)	• No impacts on the alluvial aquifiers have been identified. See Annual Groundwater Review in Appendix 3 • Setbacks from alluvial aquifiers are in accordance with the Aquifer Interference Policy (DPI, 2012)
Erosion and sediment control works	• Design, install and maintain erosion and sediment controls in accordance with the guidance series Managing Urban Stormwater: Soils and Construction – Volume 1 (Landcom, 2004) and 2E Mines and Quarries (DECC, 2008) • Design, install and maintain any infrastructure within 40 metres of watercourses in accordance with the guidance series for Controlled Activities on Waterfront Land (DPI Water, 2012) • Design, install and maintain any creek crossings generally in accordance with the Fisheries NSW Policy and Guidelines for Fish Habitat Conservation and Management (DPI, 2013) and Why Do Fish Need To Cross The Road? Fish Passage Requirements for Waterway Crossings (NSW Fisheries, 2003)	• All erosion and sediment control measures installed at United Wambo are compliant with the Blue Book and the United Wambo Erosion and Sediment Control Management Plan • Works within 40 metres of Redbank Creek, such as construction of the flood levee and Northern Drain, were undertaken in accordance with the guidance series for Controlled Activities on Waterfront Land (DPI Water, 2012) • No creek crossing were installed in 2020
Clean water diversions and storage infrastructure	• Design, install and maintain the clean water system to capture and convey the 100 year ARI flood event • Maximise, as far as reasonable, the diversion of clean water around disturbed areas on the site, except where clean water is captured for use on the site	• Northern Clean Water Drain constructed to convey water from north of United Open Cut around to Redback Creek
Flood Levees	• Design, install and maintain appropriate flood levees to protect mining areas from a 1,000 year ARI flood event and to ensure no adverse effect on roads or privately-owned land	• Flood levee constructed to account for 1,000 year ARI flood event in Wollombi Brook
Sediment dams	• Design, install and maintain sediment dams in accordance with the guidance series Managing Urban Stormwater: Soils and Construction – Volume 1 (Landcom, 2004) and 2E Mines and Quarries (DECC, 2008) and the requirements under the POEO Act or Protection of the Environment Operations (Hunter River Salinity Trading Scheme) Regulation 2002	• All sediment dams have been constructed to comply with the Blue book and POEO Act requirements, including the MIA Sediment Dam, Plover Sediment Dam and Redbank Creek Coffer Dam
Above-ground mine water storages	• Design, install and maintain mine water storage infrastructure to avoid unlicensed or uncontrolled discharge of mine water • Designed to contain the 100 year ARI storm event	• All mine water storages at United Wambo have been constructed to capture the 100 year ARI. All mine water dams managed by

Feature	Performance Measure	
	and minimise permeability	United Wambo spill into the open cut pit rather than discharge offsite
Tailings storages	• Design and maintain tailings storage areas to encapsulate and prevent the release of tailings seepage/leachate	• Tailings management is undertaken by Wambo on behalf of the United Wambo JV. The United Tailings Dams 1 and 2 are decommissioned and are currently being capped.
Overburden emplacements	• Design, install and maintain emplacements to encapsulate and prevent migration of tailings, acid forming and potentially acid forming materials, and saline and sodic material • Design, install and maintain out-of-pit emplacements to prevent and/or manage long term saline seepage	• Overburden emplacement areas at United Wambo are all designed and maintained to contain all run off and seepage with dams or open cut voids
Chemical and hydrocarbon storage	• Chemical and hydrocarbon products to be stored in bunded areas in accordance with the relevant Australian Standard	• Hydrocarbon storage areas are bunded in accordance with Australian Standards and are subject to regular inspection and management.
Creek diversion and restoration works	• Diverted creek lines are hydraulically and geomorphologically stable • Incorporate erosion control measures based on vegetation and engineering revetments • Incorporate persistent/permanent pools for aquatic habitat • Revegetate with suitable native species	• No creek diversion or restoration works undertaken during 2020
Aquatic, riparian and groundwater dependent ecosystems	• Negligible environmental consequences beyond those predicted in the document/s listed in condition A2(c) • Maintain or improve baseline channel stability • Develop site-specific in-stream water quality objectives in accordance with the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC & ARMCANZ, 2000) and Using the ANZECC Guidelines and Water Quality Objectives in NSW (DEC, 2006)	• Baseline GDE monitoring, channel stability and stygofauna monitoring have been undertaken in 2020.

6.8.6 Long Term Trends

United has longterm data from surface water monitoring locations since 2004.

Traditionally SW1-SW5 have been assed against pH, EC and TSS over a long time period. However, during the United Wambo Joint Venture the names of these sites were changed (see **Table 6-37**).

Table 6-37 Current and Former Surface Water Monitoring Sites

Former Surface Water Monitoring Site	Current Surface Water Monitoring Site
SW1	WB01
SW3	WB02
SW4	WB03
SW2	NWC03
SW5	RC01

Of SW1-SW5 (now WB01-RC01) only NWC03 (former SW2) and RC01 (former SW05) are assessed against surface water quality criteria. For the prosperity of long-term trends this Annual Review has assessed the former SW1-SW5 sites.

Minimum and maximum surface water monitoring results for pH remained within the ANZECC Guideline criteria at most sites during the reporting period. This is generally consistent with historical data since 2004. Average pH results at WB03, NWC03 and RC01 in 2020 were within the long - term range of 6.5 to 8.9. The minimum value at WB02 (6.3) fell outside the ANZECC criteria of 6.5. Note WB01 is no longer accessible.

Minimum and maximum surface water monitoring results for EC in 2020 have remained within the longterm data trends. This shows that EC, while variable, has produced consistent results over the long-term.

Minimum and maximum surface water monitoring results for TSS in 2020 have remained within the longterm data trends. NWC03 showed a high level of variability with the minimum and maximum ranging from 5 mg/L to 98 mg/L. Similarly, RC01 showed high variability with the minimum and maximum ranging from 25 mg/L to 461 mg/L. WB02 has historically had a high amount of variability for TSS, with the minimum and maximum ranging from 1 mg/L to 504 mg/L since 2004. However, 2020 revealed stable results with a minimum of 7 mg/L and a maximum of 13 mg/L. The TSS levels for WB03 are less variable with longterm results ranging from 1 mg/L to 109 mg/L since 2004. The minimum and maximum recorded at WB03 during 2020 were 5 mg/L and 12 mg/L respectively.

TDS was added to the surface water quality parameters assessed during 2020. Therefore, the 2020 Annual Review will determine baseline values for TDS. WB02 recorded TDS results ranging from a minimum of 170 mg/L to a maximum of 470 mg/L. WB03 recorded TDS results ranging from a minimum of 176 mg/L to a maximum of 448 mg/L. NWC03 did not record TDS during 2020. RC01 recorded TDS results ranging from a minimum of 8 mg/L to a maximum of 640 mg/L. Longterm surface water monitoring graphs are illustrated in **Appendix 2**.

6.8.7 Comparison of Performance Against Criteria

A detailed assessment of potential impacts to surface waters was undertaken for the EIS. The highest risks to downstream surface water quality as documented in the EIS included:

- Discharge of mine water;
- Overflow or failure of sediment ponds (dirty water); and
- Spillage or overflow of tailings.

6.8.8 Water Take

Condition B40 of United Wambo's Development Consent (SSD 7142) requires that the Annual Review is to report on water extracted from the site each year (both direct and indirect).

Table 6-38 outlines the direct water take from water licences for the operations in accordance with the requirement of the Annual Review Guideline (DPE 2015).

Table 6-38 Water Take Summary for United - 2020

Water Licence Number	Water Sharing Plan, Source and Management Zone (as applicable)	Entitlement (ML)	Passive Take/Inflows (ML)	Active Pumping (ML)	TOTAL (ML)
WAL 18445 Redbank Creek Bywash pump	Hunter Unregulated and Alluvial Water Sources	200	0	0	0
WAL 10541 Hunter River Pump		300	0	0.63	0.63
WAL 18549 Wollombi Brook Pump		100	0	0	0

below provides the total indirect take for United Wambo during 2020. Sources include rainfall runoff collected in site water storages and mining areas, potable water imported to site for use, water transferred from a third party (Wambo) and groundwater.

Table 6-39 Total indirect take for United Wambo - 2020

Source	Volume of Take (ML)
Rainfall Runoff	752.9
Transfer from Wambo	16.87
Potable Water Trucked to Site	0.5
Open Cut Seepage	40[1]

1 - Excavation of the United Open Cut starter pit began in May 2020, with groundwater take from rock sources (Permian coal measures) likely to be consistent with or less than take estimates from mining year two, up to approximately 40 ML.

6.8.9 Water Licencing Status

An update on the licencing status of storage dams at United has been included in the Annual Review based on feedback from DPI Water in the 2017 Annual Review (14 March 2017). The licensing status of these structures are provided below in **Table 6-40**, differentiating between those exempt, within harvestable right or accounted for via a Water Access Licence (WAL).

Table 6-40 Storage Dam Licencing Status

Dam	Licencing Status
Dam 2	Exempt - Pollution control structure
Dam 7	Harvestable Rights
Dam 9	Harvestable Rights
Dam 10	Harvestable Rights
Dam 11	Exempt - Pollution control structure
Dam 13	Harvestable Rights

Dam	Licencing Status
Dam 14	Harvestable Rights
Dam 15a	Harvestable Rights
Dam 15b	Harvestable Rights
Dam 15c	Harvestable Rights
Turkeys Nest	Exempt - Pollution control structure
U2	Exempt - Pollution control structure
U3	Exempt - Pollution control structure

6.8.10 Discharge Summary

As outlined previously there are no licensed discharge points at United Wambo. There were no offsite discharges at United Wambo during 2020. Wambo will monitor water quality and volume for licensed discharges in accordance with the licensed discharge limits and requirements relevant to monitoring conditions of EPL 529 and the HRSTS. Results will be shared with United Wambo as required.

6.8.11 Salinity Trading Scheme Credit Use

United Wambo is part of the Hunter River Salinity Trading Scheme (HRSTS) however the site does not have any Salinity Trading Scheme Credits, and there is no licensed discharge point.

6.9 Groundwater

Groundwater monitoring is conducted at United Wambo in accordance with the GWMP and the United Wambo Open Cut and Wambo Water Monitoring Program (WMP) (Peabody, 2020).

The purpose of groundwater monitoring at UWJV is to monitor groundwater quality and levels to detect potential impacts on surrounding groundwater users, consumptive or environmental, and assess the performance of the mine against the performance indicators to ensure that relevant legislative and policy requirements are met.

The UWJV groundwater monitoring network defined in the GWMP is comprised of 27 bores and 11 vibrating wire piezometers (VWPs) with a total of 55 sensors installed at VWP arrays.

Groundwater monitoring has been undertaken bi-monthly for groundwater levels (reported as a groundwater elevation in metres above Australian Height Datum (mAHD) and basic water quality (pH and EC). UWJV also undertake comprehensive annual groundwater quality monitoring of 12 analytes including; pH, EC, Total dissolved solids (TDS), Sodium, Potassium, Calcium, Magnesium, Chloride, Nitrate, Sulfate, Hardness, and Bicarbonate.

6.9.1 Environmental Management

United Wambo implements surface water monitoring in accordance with the *United Wambo Water Management Plan* and the *United Wambo Groundwater Water Management Plan*.

6.9.2 Management Measures

United Wambo implements groundwater management measures in accordance with the *Ground Water Management Plan*. The management measures are summarised below:

- Design, install and maintain above-ground mine water storage infrastructure to avoid unlicensed or uncontrolled discharge of mine water to the offsite environment.

- Above-ground mine water storages designed to contain the 100 year ARI storm event and minimise permeability.
- Operate underground water storages in a manner that minimises impacts.
- New tailings storage areas will be designed and maintained to encapsulate and prevent the release of tailings seepage/leachate.
- Design, install and maintain new emplacements to encapsulate and prevent migration of tailings, acid forming and potentially acid forming materials, and saline and sodic material.
- Design, install and maintain new out-of-pit emplacements to prevent and/or manage long term saline seepage.
- Chemical and hydrocarbon products is stored in bunded areas in accordance with the relevant Australian Standard.
- Maintain or improve baseline channel stability.
- Generic training on the aspects of the GWMP is provided to all employees and contractors through the GCAA Generic Surface Induction and the Site Familiarisation process.
- Regular workforce communication days and toolbox talks allow for discussion of the objectives and requirements of this and any other relevant Plans.
- Selected site personnel whose duties directly involve the management of water at United Wambo undertake specific training with respect to site Operational Procedures which incorporate water management measures.

The location of water monitoring sites is shown on **Figure 9**.

6.9.3 Groundwater Monitoring Locations

The network has been established to ensure that a long-term monitoring capability exists, that monitors key groundwater units and with adequate spatial and vertical depth coverage across the site. **Table 6-41** outlines the groundwater monitoring program, including parameters and frequency, that was in place at United Wambo during 2020.

Table 6-41 Groundwater Monitoring Program

Stratigraphy	Group	Sites (Bore ID)	Parameters Monitored	Frequency
Alluvial Sediment	North Wambo Creek Alluvium	GW08, GW09, GW10.2, GW16, GW17, GW24 and GW26	Water level, pH and Field EC	Every 2nd Month
			Comprehensive Suite	Annually
	Wambo Creek Alluvium	GW02, GW11, P106 and P109	Water level, pH and Field EC	Every 2nd Month
			Comprehensive Suite	Annually
	East Wollombi Brook Alluvium	P12, P13 and GW15	Water level, pH and Field EC	Every 2nd Month
			Comprehensive Suite	Annually
	West Wollombi Brook Colluvium	P16 and P20	Water level, pH and Field EC	Every 2nd Month
			Comprehensive Suite	Annually
	Stoney Creek alluvium/colluvium	P315	Water level, pH and Field EC	Every 2nd Month
		P301	Comprehensive Suite	Annually

Stratigraphy	Group	Sites (Bore ID)	Parameters Monitored	Frequency
Regolith / Shallow Weathered Sandstone	Regolith/Shallow Weathered Sandstone Wollombi Brook	GW13 and GW14	Water level, pH and Field EC	Every 2nd Month
			Comprehensive Suite	Annually
	Regolith/Shallow Weathered Sandstone Wombo Creek	P114, P116 and P109	Water level, pH and Field EC	Every 2nd Month
			Comprehensive Suite	Annually
	Regolith/Shallow Weathered Sandstone North Wombo Creek	GW23, GW25, GW17 and GW10.2	Water level, pH and Field EC	Every 2nd Month
			Comprehensive Suite	Annually
Permian Coal Measures	Overburden/Interburden	GW21, GW22, P202, P206, P28, P29, P1, and P2	Water level, pH and Field EC	Every 2nd Month
			Comprehensive Suite	Annually
	Coal Seams	P402	Water level, pH and Field EC	Every 2nd Month
			Comprehensive Suite	Annually

6.9.4 Groundwater Monitoring Findings

Groundwater monitoring is undertaken in accordance with the United Wambo procedures for environmental monitoring and evaluation outlined in the United Wambo Environmental Management Strategy.

Table 6-42 Summary of Groundwater Monitoring Results – 2020 Annual Averages

Unit	Bore ID	Water Level (mbGS)			pH			EC (µS/cm)		
		Min	Ave	Max	Min	Ave	Max	Min	Ave	Max
North Wambo Creek Alluvium	GW08	2.8	4.6	7.6	5.0	7.2	8.4	1371	1875	2248
	GW09	2.5	4.2	7.1	6.5	7.7	8.8	287	1072	1937
	GW10.2									
	GW16	4.1	8.4	12.6	6.6	7.5	8.1	294	805	1540
	GW17	6.6	10.8	13.5	6.9	7.1	7.6	4610	5160	5500
	GW24	4.4	7.8	10.1	5.9	6.4	7.0	433	1443	3340
	GW26	5.2	7.6	8.9	6.6	7.1	7.4	746	1075	1363
Wambo Creek Alluvium	GW02	4.7	7.1	9.8	6.3	7.0	8.4	248	572	908
	GW11	3.7	5.4	9.9	6.6	7.1	8.2	372	536	691
	P106	4.2	8.6	15.1	6.2	7.1	8.6	391	660	1100
	P109	3.1	5.5	9.0	6.0	6.9	8.7	142	624	1164
East Wollombi Brook Alluvium	P12	3.9	7.1	9.0	6.1	7.1	9.7	312	1537	6150
	P13	3.3	7.3	8.8	5.4	6.5	8.6	543	1101	1980
	GW15	9.5	11.0	12.3	6.3	7.0	7.5	521	648	879
West Wollombi Brook Alluvium	P16	6.3	7.9	9.9	6.4	7.3	8.1	5240	8701	18200
	P20	6.0	7.9	9.2	6.5	7.3	8.1	1000	8689	18500
	P315	3.8	7.1	9.4	3.7	6.5	8.1	257	453	4141

Unit	Bore ID	Water Level (mbGS)			pH			EC (µS/cm)		
		Min	Ave	Max	Min	Ave	Max	Min	Ave	Max
Stoney Creek alluvium/ colluvium	P301	7.2	13.9	20.1	5.8	6.6	7.6	360	5824	9270
Regolith/Shallow Weathered Sandstone Wollombi Brook	GW13	4.8	5.9	12.9	6.7	7.0	7.3	288	3274	4820
	GW14	9.5	9.7	9.9						
Regolith/Shallow Weathered Sandstone Wombo Creek	P114	3.0	6.5	10.9	6.3	7.1	8.7	417	2243	10360
	P116	1.9	5.9	8.3	6.1	7.0	8.0	454	2560	6570
	P109	3.1	5.5	9.0	6.0	6.9	8.7	142	624	1164
Regolith/Shallow Weathered Sandstone North Wombo Creek	GW23	3.0	5.1	8.3	6.6	7.1	7.3	540	1668	4880
	GW25	3.9	4.4	5.7	6.6	7.0	7.1	921	1003	1068
	GW17	6.6	10.8	13.5	6.9	7.1	7.6	4610	5160	5500
	GW10.2									
Permian Overburden/ Interburden	GW21	36.1	36.6	36.7	7.2	7.2	7.2	16050	16125	16200
	GW22	21.5	35.5	36.8	7.4	8.2	8.5	6110	6773	7330
	P202	3.3	8.6	10.3	6.4	7.3	8.0	382	5064	10520
	P206	5.0	18.9	24.9	6.8	7.7	8.6	481	2216	5560
	P28	3.0	7.0	13.2	5.8	7.2	9.0	1240	1981	3060
	P29	1.7	19.7	28.6	8.1	9.2	9.9	3130	5345	8070
	P1	24.7	26.7	29.1	6.5	7.0	8.2	1251	7923	9960
	P2	22.4	25.7	30.5	6.3	7.0	8.4	15	15654	20170
Permian Coal Seams	P402	24.4	25.4	26.0	7.4	7.6	7.7	1129	8520	12280

Trend analysis was undertaken for all the monitored bores in the United Wambo Joint Venture Annual Review 2020 report (provided as an **Appendix 3**). A summary of the key findings are provided below:

- Alluvial Bores
  - Typical strong relationship between climatic conditions and water levels
  - Above average rainfall in 2020 resulted in flow events in ephemeral watercourses and consequential increased leakage to groundwater and increased direct rainfall recharge causing overall water level increased
  - Some impacts of mining are evident with water level rise subdued at some sites
  - EC in some cases showed a marked ‘freshening’ with decline in E attributed to increased mixing with fresher water via leakage from watercourses and rainfall recharge.
  - pH was typically relatively stable

- Regolith Bores
  - Typically similar trends to alluvial bores, though the magnitude of groundwater level change in response to the above average annual rainfall is more subdued
  - EC in some cases showed a marked ‘freshening’ with decline in E attributed to increased mixing with fresher water via leakage from watercourses and rainfall recharge.
  - pH was typically relatively stable

- Permian Interburden/Overburden
  - upstream to mine operations, groundwater levels associated with the Whybrow Seam interburden show a good correlation to rainfall recharge events
  - some impacts of hidotrical and current mining apparent

- Permian Coal Seam
  - No long-term record exists for this bore so analysis can only be done on the 2020 data. A decrease in water groundwater level occurred over 2020, likely indicative of mining activity and commensurate drawdown

6.9.5 Long Term Groundwater Trends

Long-term hydrographs and time-series data for each bore is provided in **Appendix 3**.

Typically groundwater trends mimic long-term cumulative rainfall deviation trends, with a more pronounced response to rainfall patterns experienced in the Alluvial sediments. The NSW drought, 2017 – 2020 shows corresponds with typically declining groundwater levels, with recovery occurring in 2020 in line with the above average annual rainfall experienced.

Groundwater EC in the alluvials also responds to rainfall variations, with freshening seen in 2020 after a period of stable or increasing EC associated with the NSW drought and lower levels of recharge, via both rainfall and increased flow in ephemeral watercourses.

Groundwater quality, both EC and pH are relatively stable, or within natural fluctuations in the regolith and Permian bores.

6.9.6 Groundwater Monitoring Trigger Levels

Trigger levels are used to initiate investigations into the groundwater levels or groundwater quality at UWJV. The trigger levels, as specified by the United Wambo Groundwater Monitoring Program (UWJV, 2019), are based on statistical analysis of pre-mining baseline monitoring data.

For groundwater levels, a response is triggered when depth to groundwater increases above the 90th percentile (and not related to seasonal variability) over three consecutive bi-monthly observations. Triggers for EC and pH occur when three consecutive bi-monthly observations (a 6-month period) exceed the specified trigger level (90th percentile).

Table 6-43 Groundwater Level and Groundwater Quality Trigger Levels (UWJV, 2019), with highlighted cells showing 2020 breaches in trigger levels

		Groundwater Level (mAHD)		Groundwater Quality		
		Maximum (10th percentile depth)	**Minimum (90th percentile depth)**	**EC (µS/cm)**	**pH Minimum**	**pH Maximum**
Alluvial Monitoring Bores						
GW02	Wambo Creek Alluvium	74.2	71.5	657	5.7	7.3
GW08[2]	North Wambo Creek Alluvium	57.2	53.5	1980	3.3	7.9
GW09[2]	North Wambo Creek Alluvium	Dry since 2016	Dry since 2016	Dry since 2016	Dry since 2016	Dry since 2016
GW11	Wambo Creek Alluvium	73.7[5]	71	626	4	7.4
GW13	Regolith/Shallow Weathered Sandstone Wollombi Brook	57.66[5]	56.26	4447	4.9	7.1

		Groundwater Level (mAHD)		Groundwater Quality		
GW15	Wollombi Brook (east) Alluvium	52.16	50.96	726	10.2	7.3
GW16[3]	North Wambo Creek Alluvium	108.118	101.218	1145	5	7.7
GW17[3]	North Wambo Creek Alluvium	103.142	98.242	5542	8.2	7.2
P12	Wollombi Brook (east) Alluvium	48.9	47.5	1002	6.3[5]	7.7
P16	Wollombi Brook (west) Alluvium	50.48[5]	48.88	10510	7	7.7
P20	Wollombi Brook (west) Alluvium	50.2	49.1	10364	7.2	7.6
P106	Wambo Creek Alluvium	54.47	51.47	674	6.6	7.4
P109	Wambo Creek Alluvium	58.04	56.24	801	4.4	7.4
P114	Wambo Creek Alluvium	56.04[5]	54.14	7096	5.4	7.4
P116	Regolith/Shallow Weathered Sandstone Wombo Creek	54.24[5]	52.24	2076[5]	4.8	7.4
Offsite Bedrock Monitoring Bores						
GW21	Overburden	85.49[5]	85.19	ND	ND	ND
GW22	Overburden	54.255	52.455	7028	8.1	8.4
P11	Overburden	41.4	39.8	ND	6.7	7.5
P202	Overburden	52.7	51.3	8368	6.7	7.7
P206	Overburden	44.4[5]	39.6	2372	7.3	8.1
P404[4]	Overburden	ND	ND	ND	ND	ND
P405[4]	Overburden	ND	ND	ND	ND	ND

[2]WCPL has installed replacement bores for GW08 and GW09. Trigger levels will be established for these bores based on modelled groundwater levels and will replace the GW08 and GW09 in this table.
[3]GW16 and GW17 are located upstream of the North Wambo Creek Diversion and in close proximity to the approved open cut. There are no groundwater users located in the vicinity of North Wambo Creek upstream of the North Wambo Creek Diversion. Therefore, a trigger level for these two bores is not considered warranted. Monitoring data will be reviewed annually at these bores.
[4] ND – No historical data
[5] Trigger has been breached

Throughout 2020 seven bores recorded groundwater level trigger exceedances, as summarised below;

- GQ13 – below trigger since 2013, steady decline since late 2011 however recovery seen in 2020. The subdued reaction to the above average rainfall in 2020 and the steady decline may indicate influence of the advancing Warkworth Open Cut;

- GW15 - all groundwater level observations at bore GW15 were below the 90th percentile trigger level, longer-term decline experienced but subdues response to above average annual rainfall in 2020 may indicate response to mining activities however further investigation in required;

- P16 - While some of the decline in groundwater level at P16 could be attributed to the low rainfall conditions as part of the 2017 to early 2020 NSW drought, excavation at Glen Munro Pit appears to have caused additional drawdown in the order of 1.2 m. Groundwater levels have increased during 2020, to 1.5m higher than late-2019 levels, however groundwater levels are still lower than the 90th percentile water level from the baseline period, likely indicating an ongoing mining impact on this bore;

- P114 and P116 - These bores are screened across both the alluvial sediments and regolith which does not satisfy the *Minimum Construction Requirements For Water Bores In Australia* (NUDLC, 2020) and will be removed from the monitoring program;

- GW21 – consistently dry and requires quality check; and

- P206 - screened in the Permian Coal measures and appears to be previously impacted by historical Homestead-Wollemi underground mining. Current observations show water levels approximately 15 m lower than those in the late 1990's. Given the expected disturbed nature of Permian Coal Measures the institution of trigger levels may prompt additional investigative works that do not add value. Alterations to the groundwater system are to be expected whilst mining this unit and have been understood through modelling. Rather than trigger levels, comparison to expected outcomes of the modelling may be a more productive way to monitor the impacts on the Permian Coal Measures.

One bore exceeded EC maximum trigger level, being P116, which has been experiencing long term relatively steady increase in EC, and excluding one data point in mid-2019 has been consistently above the trigger level since 2018.

Bore P12, screened in the Wollombi Brook Alluvium, recorded pH levels below the minimum trigger level for majority of 2020, except for one data point at which it exceeded the upper trigger level. The groundwater at this site has shown significant variation over time and the 2020 pH measurements are not outside the long-term variation experienced. Groundwater has been below the lower trigger level since 2013 and between 2008 – 2013

6.9.7 Water Licencing Requirements

United Wambo has a combined total entitlement of up to 370 ML/year assuming full allocation under the Hunter Unregulated and Alluvial WSP (Lower Wollombi Water Source), and up to 1,306 ML/year high security surface water under the Hunter Regulated WSP (Hunter River). In addition, entitlements held by United Wambo for water take from the Permian groundwater system under the North Coast Fractured and Porous Rock WSP, are 1947 ML/year.

Water entitlements and peak project take volumes from groundwater sources based on modelling results from the UWJV EIS (AGE, 2016), are shown in **Table 6-44**.

Table 6-44 Water Take Summary for United - 2020

Licence Number	Holder	Entitlement [1]	Project Water Take (ML/year) [4]
Groundwater: Lower Wollombi Brook Water Source[2]			
WAL23897	Wambo	70 unit shares	40
WAL18549	United	100 unit shares	
WAL18445	United	200 unit shares	
Groundwater: Porous Rock Water Source[3]			
WAL42373	Wambo	1549 unit shares	633

WAL41532	Wambo	98 unit shares	
WAL41510	United	300 unit shares	

Note: WAL = water access licence, ML/year = megalitres per year.

[1] one unit share is equivalent to 1 ML/year unless reductions are in place via an annual available water determination

[2] water source under the Hunter Unregulated and Alluvial Water Sources water sharing plan (WSP) 2009

[3] water source under the North Coast Fractured and Porous Rock Groundwater Sources WSP 2016

[4] predicted peak annual project water take over life of mine based on AGE (2016) groundwater modelling

Excavation of the United Open Cut starter pit began in 2020, with groundwater take from rock sources (Permian coal measures) likely to be consistent with or less than take estimates from mining year two, approximately 40 ML. This has been inferred by comparing the mine progression simulated in the EIS groundwater assessment (AGE, 2016) and the actual disturbance footprint at the end of 2020. This take is under the maximum predicted take of 633 ML/yr that was predicted to occur in year seven of the project and within the entitlement volumes of the Sydney Basin – North Coast Porous Rock Water Source water licences.

Alluvial take due to excavation of the United Wambo operations has also been inferred for year two of mining operations as predicted in the EIS (AGE, 2016). Data indicates no additional take from Wollombi Brook Alluvium is predicted at this stage of operations and is therefore less than the maximum predicted take of 40 ML/yr and within the entitlement volumes of the Lower Wollombi Brook Water Source water licences.

6.9.8 Stygofauna Monitoring

To fulfil the monitoring requirements as per the GWMP UWJV committed to monitoring stygofauna in the alluvial aquifers within (or near to subject to bore suitability) the predicted drawdown areas every three years. Preliminary assessments undertaken in 2015 (Umwelt 2016) showed that stygofauna exists in small isolated populations within the shallow alluvial aquifers in the area surrounding the project, including those associated with Wollombi Brook and North Wambo Creek.

A second study was undertaken in 2016, and the most recent in 2019. The stygofauna survey and assessment recorded an absence in subterranean fauna on this occasion within the shallow alluvials in the Study Area. A risk assessment for the current ecological conditions and the risk from current and proposed development indicated that the ecological values of the aquifers and the stygofauna community are low.

To mitigate any potential risks, if groundwater monitoring indicates that impacts are greater than predicted within the shallow alluvial aquifers surrounding the Project Area, more regular monitoring for stygofauna will be triggered. Of the seven bores sampled during the 2019 event, four are trigger bores for the UWJV. Of these four bores, two did breach lower trigger levels for the groundwater level (P116 and P16).

6.9.9 GDE Monitoring

The Groundwater Dependant Ecosystem Study, required by Condition B51 of SSD 7142 to be completed within 12 months of commencement, was completed in January 2021 (Umwelt, 2021). Key findings relevant to this review are provided below:

- The water table at GDE1 was inferred as being >10 m below surface, indicating that vegetation in the downstream reaches of Redbank Creek is unlikely to be reliant on the broader groundwater system, but may access saturate shallow clays and localised perched aquifers along the creek line that are recharged during flood events;

- The Lemington South Pit 1 final void may be limiting any upward leakage of Permian groundwater into the alluvium near GDE1;

- Limited groundwater monitoring sites target the alluvium near GDE1. The GDE Study (Umwelt, 2021) recommends the installation of an additional shallow bore near Redbank Creek to characterise the potential shallow water table within the alluvium or underlying weathered sandstone in the area. United Wambo will undertake investigation into identifying a suitable location and whether suitable agreements and approvals can be entered into to enable a bore to be installed;

- The water table at GDE2 is measured from 4 to 9 m below surface and is likely shallow enough to enable uptake by larger vegetation and trees; and

- Bores currently managed by United Wambo or Wambo exist adjacent to GDE2 (P12, P15, P16, P401. P402 and BH1).

The GDE Study (Umwelt, 2021) has provided a framework for monitoring and analysis of groundwater level and quality data near GDE1 and GDE2 that will enable assessment against the following performance measures specific to GDEs and groundwater (**Table 6-45**).

Table 6-45 Groundwater Performance Measures – GDE (Umwelt, 2021)

Aspect	Performance Measure	Performance Indicator/ Trigger	Response
Aluvial Aquifers	Negligible change in groundwater level (compared to predicted impacts)	90th percentile (and not related to seasonal variability) over three consecutive months	TARP – Groundwater Level
	Negligible change in groundwater quality that could impact on GDE health	90th percentile for EC 10th to 90th percentile for pH 90th percentile for sulfate For at least one parameter for more than three consecutive months	TARP – Groundwater Quality

Note: TARP – Trigger Action Response Plan – as outlined within the approved groundwater management plan

6.9.10 Reporting against Groundwater Performance

The 2020 groundwater monitoring is to be compared against the Groundwater Performance Measures (UWJV 2020), as presented in **Table 6-46.**

Table 6-46 Groundwater Performance Measures and response

Aspect	Performance Measures	Performance Indicator/Trigger	Response	Overall Compliance
Alluvial aquifers	Negligible change in groundwater level (compared to predicted impacts[1])	90th percentile (and not related to seasonal variability) over three consecutive months.	TARP – Groundwater Level	Trigger levels breached in a number of bores with further investigation pending
	Negligible change in groundwater quality	Groundwater quality concentrations outside of adopted trigger values (Table 7-3) for at least one parameter for more than three consecutive months.	TARP – Groundwater Quality	Trigger exceeded in one bore, further investigation to be undertaken

Aspect	Performance Measures	Performance Indicator/Trigger	Response	Overall Compliance
Bedrock aquifers	Negligible change in groundwater level (compared to predicted impacts[1])	90th percentile (and not related to seasonal variability) over three consecutive months. No trigger adopted for monitoring sites within the project area.	TARP – Groundwater Level	Compliance achieved – no triggers breached in bedrock
	Negligible change in groundwater quality	pH of 6.5 to 8.5 EC < 17,500 µS/cm	TARP – Groundwater Quality	Water level trigger breached, pending further discussion regarding suitability of trigger.

6.9.11 Proposed Improvements

A series of recommendations has been provided to promote the best practice for fulfilling the requirements of the GWMP and WMP, including;

- Series of bores identified as requiring decommissioning and replacing;
    - P106 noted as obstructed; and
    - P109, P114 and P116 are screened across multiple aquifers.
- Investigate condition of groundwater bores:
    - GW15 – review bore condition and validity of data, confirm screened geology;
    - GW14 and GW21 – long-term dry bore, review condition; and
    - GW17 – review lithology to confirm screened geology.
- Finalise review of VWP data for presentation and analysis;
- It is noted that the groundwater trigger action response plan (TARP) mentions the trigger to be "over three consecutive months" (UWJV, 2019 – Appendix B). This should be amended to "over three consecutive bi-monthly observations" (a 6 month period);
- P13, P28 and P29 only have one monitoring record for 2020 and should be reinstated to the monitoring program;
- Groundwater bores GW23, GW24, GW25 and GW26 have some confusion around their identification and should be reviewed to confirm data referring to correct bore;
- It is noted that the 10th percentile pH triggers specified in Table 5-3 of UWJV (2019) are incorrect and likely to have been duplicated from Table 5-2. It is recommended that this table be amended to reflect the correct triggers;
- Review and analysis of all groundwater quality data (including major ions, metals and alkalinity);
- Review of groundwater levels against updated model results when model outputs finalised;
- Review of trigger levels for bores screened in the Permian Coal measures as may be more suitable to use model outputs to inform risks;

- Further investigation into quality trigger breaches (EC and pH) to identify potential cause – review additional hydrochemistry available (full suite of parameters), review trigger levels to ensure suitable for each bore given long-term periods below triggers;

- Review of bores exceeding groundwater level triggers against model outputs when finalised and against any comparable VWP data to confirm validity of record and inform investigation; and

- A more detailed investigation into the potential requirement for additional stygofauna monitoring given the breach of trigger levels in two of the sampled bores.

7 REHABILITATION

A figure of existing rehabilitation is shown in **Appendix 4**. No additional rehabilitation is proposed in 2021.

7.1 Summary of Rehabilitation During Reporting Period

No rehabilitation was undertaken during the reporting period. There was a total of 250 hectares of new disturbance undertaken at United Wambo during 2020 for the United Open Cut mining areas and Project construction areas. An additional 44.6 hectares of previously rehabilitated areas were re-disturbed during 2020. Areas of disturbance are shown in **Figure 12**.

A comparison of rehabilitation results against preliminary closure criteria are outlined in **Table 7-1**:

Table 7-1 Review of Rehabilitation Against Preliminary Closure Criteria

Post Mining Land Use (Final Land Use Domain)	Rehabilitation Objectives		Completion Criteria	Activities in 2020
Native Ecosystem (CEEC/EEC) **or** **Native Vegetation (non CEEC/EEC)** **or** **Agricultural Land Use**	All Domains	Infrastructure Management	Removal of all services (power, water, communications) that have been connected on the site as part of the operation	Infrastructure associated with old United Underground operations were removed during 2020.
			All demolition work has been carried out in accordance with AS2601-2001: The Demolition of Structures, or its latest version	Demolition of the United Underground infrastructure was undertaken in accordance with AS2601-2001.
			Heritage obligations (e.g. development consent under the Environmental Planning and Assessment Act 1979, approvals under the Heritage Act 1977, etc) have been met (e.g. archival recording, building retention or building demolition with footings preserved)	No heritage obligations associated with removed infrastructure. Details of heritage activities undertaken during 2020 are provided in **Section 6.6**.
			Removal of all plant, equipment and associated infrastructure including processing facilities, stockpile areas, rail infrastructure and loading facilities, underground hydrocarbon storage tanks, office complex, portable offices, exploration core samples, storage racks, samples	Infrastructure associated with old United Underground operations were removed during 2020.
			Removal of all footings or removal to a certain depth (less than 0.3 metres)	All footings associated with the United Coal Preparation Plant and overhead conveyors were removed and processed onsite.

Post Mining Land Use (Final Land Use Domain)	Rehabilitation Objectives		Completion Criteria	Activities in 2020
			Removal of all water management infrastructure (including pumps, pipes and power)	Not applicable during 2020.
			Contamination will be appropriately remediated so that appropriate guidelines for land use are met, e.g. Health Investigation Level of the National Environment Protection (Assessment of Site Contamination) Measure (1999)	Areas of known contamination, including the material previously excavated from the United UG workshop areas, were appropriately remediated and disposed of.
			All drill cores have been removed and either taken to authorised storage or disposal location	Not applicable during 2020.
			Surveying and sealing of all drill holes, boreholes and gas wells in accordance with departmental guidelines and relevant standards	Not applicable during 2020.

Post Mining Land Use (Final Land Use Domain)	Rehabilitation Objectives		Completion Criteria	Activities in 2020
Native Ecosystem (CEEC/EEC) **or** **Native Vegetation (non CEEC/EEC)** **or** **Agricultural Land Use**	All Domains	Infrastructure to Remain All infrastructure that is to remain as part of the final land use is safe	Where applicable, necessary approvals are in place (e.g. development consent under the Environmental Planning and Assessment Act 1979) where buildings and infrastructure are to be retained as part of final land use	Not applicable during 2020.
			Potential hazards (e.g. electrical, mechanical) have been effectively isolated	Not applicable during 2020.
			Access tracks that are to remain are in a trafficable condition that is suitable for their intended purposes	Not applicable during 2020.
			Heritage obligations as required under the Environmental Planning and Assessment Act 1979, Heritage Act 1977, etc. have been met (e.g. archival recording, building retention and restoration)	Details of heritage activities undertaken during 2020 are provided in Section 6.6.
			The structural integrity of the infrastructure is suitable and safe for use as part of the intended final land use	Not applicable during 2020.
			Appropriate security measures have been implemented to minimise the potential for unauthorised access during the period that the site is transitioned to the intended final land use	Not applicable during 2020.
			Where practical, exposed carbonaceous material will be removed and co-disposed within the mining voids or suitably capped in situ	All carbonaceous material from the old United UG coal stockpiles were scraped up and stockpiled onsite for future processing or disposal.

Post Mining Land Use (Final Land Use Domain)	Rehabilitation Objectives		Completion Criteria	Activities in 2020
			If any underground pipelines or other infrastructure are to remain in situ, they do not pose a hazard for the intended final land use Note: if any underground pipelines or other infrastructure are to remain in situ in areas to be returned for agriculture – cropping they are at a depth >0.5m	Not applicable during 2020.

Post Mining Land Use (Final Land Use Domain)	Rehabilitation Objectives		Completion Criteria	Activities in 2020
Native Ecosystem (CEEC/EEC) **or** **Native Vegetation (non CEEC/EEC)** **or** **Agricultural Land Use**	All Domains	<u>Land Contamination</u> There is no residual soil contamination on site that is incompatible with the final land use or that poses a threat of environmental harm	Contamination will be appropriately remediated to a condition that does not pose a threat of environmental harm or constrain the final land use	United Wambo has two bioremediation areas that remediates contaminated material.
		<u>Landform Stability</u> The final landform is stable and does not present a risk of environmental harm downstream/downslope of the site or a safety risk to the public/stock/native fauna	Minimal erosion that would not require moderate to significant ongoing care and maintenance works Any areas of active erosion are within the parameters for safe and stable landform Discharge points from rehabilitated landform to natural channels are stable	No rehabilitation undertaken in 2020. No erosion maintenance works required. Ongoing monitoring of rehabilitated areas will be undertaken.
			Drainage structures (including drainage lines established in the final landform) are stable and there is no evidence of overtopping or significant scouring as a result of runoff	No rehabilitation undertaken in 2020. No erosion maintenance works required. Ongoing monitoring of rehabilitated areas will be undertaken.
		<u>Tailings Storage Areas</u> The tailings storage facilities on site will be capped to minimise the potential for exposure of	Residual waste materials stored on site (e.g. tailings dams) will be appropriately contained/encapsulated so it does not pose any threat of environmental harm or constrain the intended final land use	The Capping Strategy for the United Tailings Dams 1 and 2 was prepared and approved during 2020. Capping works commenced in Q1 2021.

Post Mining Land Use (Final Land Use Domain)	Rehabilitation Objectives		Completion Criteria	Activities in 2020
		potentially environmentally sensitive tailings material in the rehabilitated landform	The tailings storage facilities on site will be capped and reshaped to be free-draining to minimise the potential for exposure of potentially environmentally sensitive tailings material in the rehabilitated landform	The Capping Strategy for the United Tailings Dams 1 and 2 was prepared and approved during 2020. Capping works commenced in Q1 2021.
			Tailings storage areas have been capped in accordance with an approved Detailed Capping Design	The Capping Strategy for the United Tailings Dams 1 and 2 was prepared and approved during 2020. Capping works commenced in Q1 2021.
			Tailings storage areas have been capped and there is no occurrence of spontaneous combustion within the final landform	The Capping Strategy for the United Tailings Dams 1 and 2 was prepared and approved during 2020. Capping works commenced in Q1 2021.
		Bushfire The risk of bushfire and impacts to the community, environment and infrastructure has been addressed as part of rehabilitation	Appropriate bushfire hazard controls (where required) have been implemented on the advice from the NSW Rural Fire Service	United Wambo has a Bushfire Management Plan that is implemented onsite.
		Surface Water Quality Runoff water quality is similar to, or better than, the pre-mining disturbance runoff water quality	Runoff water quality from rehabilitation areas represent an acceptable level of change from a background condition (baseline study)	Water quality monitoring includes sediment dams that receive run off from rehabilitated areas. Results show trends towards background levels in watercourses.
			Water quality in all storages left on site (other than final voids) is suitable for the approved final land use	Water quality monitoring includes sediment dams that receive run off from rehabilitated areas. Results show trends towards background levels in watercourses.

Post Mining Land Use (Final Land Use Domain)	Rehabilitation Objectives		Completion Criteria	Activities in 2020
			Water quality in any approved final voids does not pose a risk to the final land use	No final voids as of 2020.
		<u>Groundwater Quality & Regime</u> The risk to important groundwater assets (GDE's, Alluvial Aquifers, Landholder bores) has been addressed by the rehabilitation	Groundwater quality and groundwater regime are within range as predicted in environmental assessments and in accordance with water sharing plans and water allocations held by the site	See **Section 6.10** for information regarding groundwater impacts.
		<u>Water Approvals</u> Structures that take water are appropriately licensed	Licenses held, where required	See **Section 6.12** for details on water licensing.

Post Mining Land Use (Final Land Use Domain)	Rehabilitation Objectives		Completion Criteria	Activities in 2020
Ecological Rehabilitation	All Domains	Ecological Rehabilitation Objective 1 The vegetation composition of the rehabilitation is recognisable as the target vegetation community (e.g. plant community type (PCT) contained within the NSW Vegetation Information System) Native plant species are characteristic of the target plant community(s) Note: Recognisable is defined as "Diagnostic species present for each Growth form for PCT/TEC using the scientific description of the PCT available on Bionet. Lists of diagnostic species are available through the listing criteria."	Native plant species are characteristic of the target plant community(s) Notes: "Characteristic of target plant community" is defined as "50% of all species in each Growth Form (i.e. trees, shrubs, grasses, forbs and ferns and other) that are known and accepted to form part of the PCT/TEC against benchmark value"	No Ecological Rehabilitation completed onsite as of 2020.

Post Mining Land Use (Final Land Use Domain)	Rehabilitation Objectives		Completion Criteria	Activities in 2020
		Ecological Rehabilitation Objective 2 The vegetation structure of the rehabilitation is recognisable as, or is trending towards the target plant community (e.g. plant community type (PCT) contained within the NSW Vegetation Information System) Note: "Trending Towards the target plant community" requires use of time series data to show canopy height and cover for each Growth Form against benchmark value range (or successional benchmarks)	Cover and height range of all Growth Forms are characteristic of, or trending towards, the target plant community(s)	No Ecological Rehabilitation completed onsite as of 2020.
		Ecological Rehabilitation Objective 3 Levels of ecosystem function have been established that	Growing media status is “suitable” for the target plant community(s) establishment, and indicators of nutrient cycling are “suitable” for sustaining the target plant community	No Ecological Rehabilitation completed onsite as of 2020.

Post Mining Land Use (Final Land Use Domain)	Rehabilitation Objectives		Completion Criteria	Activities in 2020
		demonstrate the rehabilitation is self-sustainable OR is trending towards the target plant community (e.g. plant community type (PCT) contained within the NSW Vegetation Information System)	Plant recruitment is “suitable” for sustaining the target plant community(s) Suitable means: trees and shrubs: evidence of flowering and seeds or second generation juveniles. At least one individual less than 5cm DBH present per plot as per BAM short lived growth forms, including grasses, herbs and forbs: requires demonstration of persistence over time including series monitoring and monitoring of reproductive structures (e.g. buds, flowers and fruit)	No Ecological Rehabilitation completed onsite as of 2020.
			Plant competition is “suitable” for sustaining the target plant community(s) Suitable means: 1. weeds: demonstrated decline in cover of high threat weeds measured as a moving average over time. Cover of high threat weeds within range measured at reference sites	No Ecological Rehabilitation completed onsite as of 2020.

Post Mining Land Use (Final Land Use Domain)	Rehabilitation Objectives		Completion Criteria	Activities in 2020
			Animal habitat is characteristic of the target plant community(s) (as measured by the above composition, structural and functional components)	No Ecological Rehabilitation completed onsite as of 2020.

Post Mining Land Use (Final Land Use Domain)	Rehabilitation Objectives		Completion Criteria	Activities in 2020
Native Vegetation **(Open Woodland)**	All Domains	Vegetation Composition	Rehabilitation areas contain flora species assemblages characteristic of each Growth Form for the target native vegetation communities (currently HU905 and HU816)	No rehabilitation completed under SSD 7142 as of 2020.
		The rehabilitation is self-sustainable	Evidence of flowering and seeds or second generation juveniles for trees and shrubs, or likely to be, based on comparable older rehabilitation sites	No rehabilitation completed under SSD 7142 as of 2020.
		Habitat features incorporated	Habitat features (e.g. logs, rocks and nest boxes), including structures suitable for target species are incorporated into rehabilitation areas at required densities, as required by Approvals Native rehabilitation areas provide a range of structural features (e.g. trees, shrubs, ground cover, developing litter layer, etc.)	No rehabilitation completed under SSD 7142 as of 2020.
		Connectivity established	Habitat corridors are established and consistent with target vegetation community compositions, as required by Approvals	No rehabilitation completed under SSD 7142 as of 2020.
		Target fauna assemblages and habitat in rehabilitation areas	Monitoring confirms target native fauna species are recorded utilising rehabilitation areas or habitat suitable for target species is present, as required by Approvals	No rehabilitation completed under SSD 7142 as of 2020.

Post Mining Land Use (Final Land Use Domain)	Rehabilitation Objectives		Completion Criteria	Activities in 2020
Agricultural Land Use	All Domains	Revegetation is sustainable for the long term and only requires maintenance that is consistent with the intended final land use	Land and Soil Capability classification or Agricultural Land Classification criteria met Rehabilitation areas comprise palatable grasses and legumes appropriate to the district and suitable for cattle grazing Weed presence is within range found analogue sites and does not present a risk to the intended final land use Cropping/Pasture establishment is in good health and provides adequate cover Cropping yields from rehabilitated areas is similar to adjacent cropping land Ground cover (vegetation, leaf litter, mulch) is greater than 70%	No rehabilitation completed under SSD 7142 as of 2020.
			Appropriate and reliable access to water for livestock Appropriate shade and shelter for livestock (i.e. wooded/treed areas) during extreme weather conditions	No rehabilitation completed under SSD 7142 as of 2020.

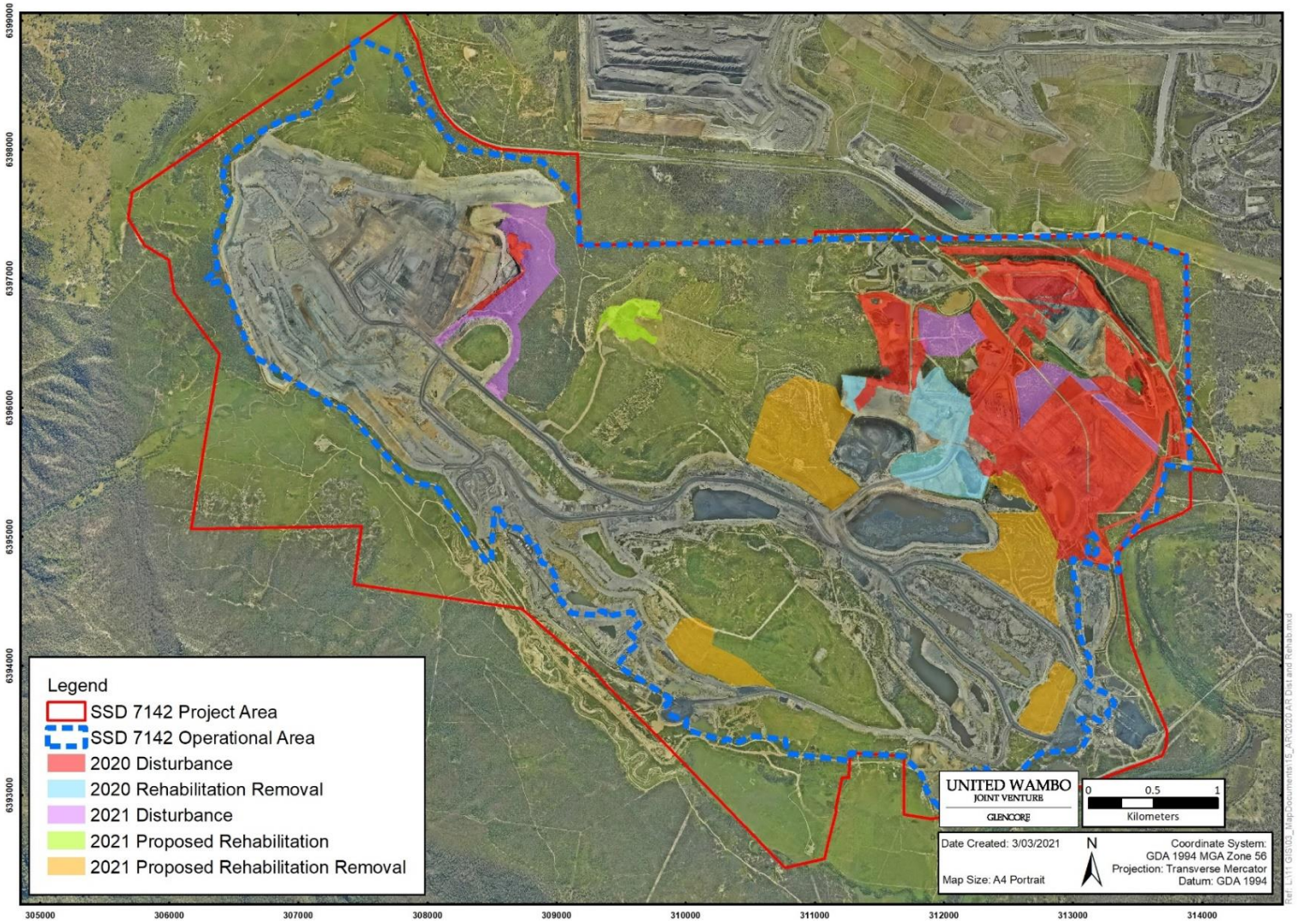


Figure 12 – Disturbance and Rehabilitation for 2020 and 2021 at United Wambo

7.2 Rehabilitation Status

No rehabilitation at United Wambo has received sign off from the Resources Regulator for having successfully met the rehabilitation objectives and completion criteria. A summary of rehabilitation is outlined in **Table 7-2.**

Table 7-2 Rehabilitation Status

Mine Area Type	Previous Reporting Period (Actual)	This Reporting Period (Actual)	Next Reporting Period (Forecast)
	Year 2019 (ha)	Year 2020 (ha)	Year 2021 (ha)
A. Total Mine Footprint *Note: As of 1 December 2020. United Wambo became responsible for the Wambo Open Cut mining areas*	238.9	1,980.4	2,049.6
B. Total Active Disturbance	105.2	1,377	1,510
C. Land Being Prepared for Rehabilitation	0	0	9.9
D. Land Under Active Rehabilitation	58.9	603.4	539.6
E. Completed Rehabilitation	0	0	9.9
Other Areas *Note the 2019 areas included 56.3 Ha for previous subsidence management area and 18.5 Ha for compensatory habitat area. These have now been removed under SSD 7142 and will no longer count towards the total area*	74.8	0	0

Definitions of Rehabilitation Areas

Total mine footprint *includes all areas within a mining lease that either have at some point in time or continue to pose a rehabilitation liability due to mining and associated activities. As such it is the sum of total active disturbance, decommissioning, landform establishment, growth medium development, ecosystem establishment, ecosystem development and relinquished lands (as defined in DRE MOP/RMP Guidelines). Please note that subsidence remediation areas are excluded.*

Total active disturbance *includes all areas ultimately requiring rehabilitation such as: on-lease exploration areas, stripped areas ahead of mining, infrastructure areas, water management infrastructure, sewage treatment facilities, topsoil stockpile areas, access tracks and haul roads, active mining areas, waste emplacements (active/unshaped/in or out-of-pit), and tailings dams (active/unshaped/uncapped).*

Land being prepared for rehabilitation *– includes the sum of mine disturbed land that is under the following rehabilitation phases – decommissioning, landform establishment and growth medium development (as defined in DRE MOP/RMP Guidelines).*

Land under active rehabilitation *- includes areas under rehabilitation and being managed to achieve relinquishment – includes the following rehabilitation phases as described in the DRE MOP/RMP Guidelines – "ecosystem and land use establishment" (area seeded OR surface developed in accordance with final land use) and "ecosystem and land use sustainability" (revegetation assessed as showing signs of trending towards relinquishment OR infrastructure development).*

Completed rehabilitation *– requires formal sign-off by DRE that the area has successfully met the rehabilitation land use objectives and completion criteria.*

7.2.1 Rehabilitation Trials and Research

A Groundwater Dependent Ecosystem (GDE) study was undertaken in 2020 to outline the hydrological and hydrogeological setting of the site, characterise the GDEs and their reliance on groundwater and surface water. It also identified the potential risks to GDEs from the Project and development of performance criteria.

Baseline information was compared to determine whether there has been any deterioration in the floristic condition of GDEs resulting from mining-induced impacts to groundwater.

GDEs identified as having the greatest potential to be impacted by United Wambo (outside of the United Wambo Disturbance Area) included the following vegetation communities:

- Central Hunter Swamp Oak Forest;
- Hunter Floodplain Red Gum Woodland Complex;
- Hunter Valley River Oak Forest;
- River Flat Eucalypt Forest;
- Stands of individual river red gum trees (Eucalyptus camaldulensis); and
- Warkworth Sands Woodland.

The monitoring program involved a combination of floristic plot sampling in accordance with BAM, with sites distributed across sites GDE1 and GDE2. Recommendations from the assessment are detailed in Section 5.0 of *United Wambo Groundwater Dependent Ecosystem Study* (Umwelt 2021).

The report was submitted to DPIE Water in January 2021 and is awaiting comment.

7.3 Actions for Next Reporting Period – Rehabilitation

As per the United Wambo Rehabilitation Management Plan, 9.9 hectares of rehabilitation will be undertaken in 2021, comprising of previous stockpile and disturbance areas associated with the Wambo Open Cut.

65.3 hectares of new disturbance will be undertaken in 2021. 136 hectares of previously rehabilitated areas will be redisturbed for the development of the overburden emplacement areas.

Rehabilitation and disturbance for 2021 is shown in **Figure 12**.

During 2021, United Wambo will undertake a detailed review of the existing rehabilitation at Wambo Open Cut to identify which areas will and will not be redisturbed during the life of the project. Areas that will remain will be reviewed against the proposed final land use and, if required, action plans will be developed to meet the required land use types.

The Annual Review Guideline (DPE 2015) requires the Annual Review to outline the rehabilitation actions proposed during the next reporting period. These actions are detailed in **Table 7-3**.

Table 7-3 Actions for the Next Reporting Period

Action	Site Comment
Undertake 9.9 hectares of rehabilitation.	Commitment from United Wambo Rehabilitation Management Plan.
Undertake review of existing Wambo Open Cut rehabilitation areas	Areas will be reviewed against life of mine plans and final land use. Any areas not planned to be redisturbed will have action plans developed, if required.

8 COMMUNITY

8.1 Community Engagement Activities

United Wambo operates a Community Consultative Committee (CCC) in accordance with Schedule 2, Condition A19 of the United Wambo SSD 7142.

During 2020, United provided information to the community through the Wambo CCC to provide updates on the United Wambo Project. The United Wambo CCC was also be provided the completed 2020 AEMR.

The following community engagements were undertaken in 2020:

- A $2.65M Voluntary Planning Agreement with Singleton Council finalised;
- CCC Meetings held 25 May, 8 August and 7 December;
- Community Newsletters distributed in February and August 2020;
- Community Working Group held on 9 September 2020;
- Community Information Nights held on 19 February and 9 September 2020;
- Community Perception Survey open from 9 September – 9 October 2020;
- Various consultation meetings with nearby residents regarding mitigation works at their properties, exploration, structural assessment, locations of noise monitors; and
- Tank cleaning and inspection program for local residents.

8.2 Community Contributions

- The following community contributions were made by United Wambo in 2020:
    - Donation to Ron Stokes for publishing his book on the Dairy Carriers of the Singleton area, ‘A Bygone Era’;
    - Contribution to the Singleton Beef and Land Management for their Weed Identification and Management Workshops;
    - Donation to the Singleton Singers for Choir Director, Pianist and hall hire; and
    - Donation to Wildlife Aid for native animal enclosures for volunteer carers.

8.3 Complaints

Three complaints were received during the reporting period. These included:

- 21 October 2020 relating to traffic;
- 5 December 2020 relating to lighting; and
- 8 December 2020 relating to noise.

All complaints were addressed with the appropriate actions including modifying operations where required.

United received one complaint in both 2019 and 2018 but have not received any complaints previously to this since 2009. This was expected due to the site being on care and maintenance – i.e. no complaints due to lack of activities.

United Wambo will continue to monitor complaint trends. United Wambo operates a 24 hour community Complaints and Enquiries Hotline to ensure that any community concerns can be recorded and responded to as soon as possible. The community hotline number is 1800 801 440. The number is

advertised on United Wambo website at https://www.glencore.com.au/operations-and-projects/coal/current-operations/united-wambo-open-cut.

9 INDEPENDENT ENVIRONMENTAL AUDIT

Schedule 2 Part E Condition E12 of SSD 7142 refers to the requirement to complete an Independent Environmental Audit within one year of commencement of development and every three years after.

The most recent Independent Environmental Audit was completed by Jacobs, with onsite auditing completed on 17 and 18 December 2018. The final report was supplied to United on 20 February 2019.

Jacobs outlined that generally, the level of compliance was good, consistent with the low level of activity on the site. All key recommendations by Jacobs for the next audit period have been completed.

Condition E12 of SSD – 7142 has the following requirement for an IEA:

Within one year of commencement of development under this consent, and every three years after, unless the Planning Secretary directs otherwise, the Applicant must commission and pay the full cost of an Independent Environmental Audit of the development.

The latest Independent Environmental Audit commenced on 25 November 2020 with the final Report submitted on 24 March 2021. As the audit findings were not available until March 2021, the Independent Environmental Audit findings will be reported in the next Annual Review.

10 INCIDENTS AND NON-COMPLIANCES DURING THE REPORTING PERIOD

10.1 Summary of Incidents

Incidents and non-compliances which are considered as low risk of environmental harm are detailed in this section.

10.2 Summary of Non-Compliances

10.2.1 Blasting

Blast Exceedance – 66Kv Vibration

At 12:28 pm on 24 September 2020, United Wambo Joint Venture (UWJV) fired a blast which resulted in a ground vibration of 167.06mm/s at a portable blast monitor located adjacent to a 66kV transmission suspension tower owned by Ausgrid. This blast was an exceedance of SSD-7142 blast criteria of 100mm/s for 66kV transmission suspension tower.

United Wambo informed the CCC of the blast exceedance via letter on 1 October 2020 in accordance with Condition D6 of SSD 7142.

United Wambo informed DPIE of the blast exceedance on 1 October 2020. A Request for Additional Information (RFAI) was received from the DPIE on 27 October 2020 with regard to the provision of any correspondence with the community or the infrastructure owner concerning the exceedance and the outcomes from further analysis of the potential causes of the exceedance. United Wambo confirmed that there were no community complaints or concerns received from Ausgrid in relation to this blast.

The investigation concluded that the exceedance was the result of a number of two probable causes, the ‘beat frequency’ effect related to the initiation of the blast holes and the unintended movement of saturated soft ground around the portable blast monitor which was located adjacent to Redbank Creek and within the deep alluvium extents. Improvements in blast management following the incident are detailed in **Section 6.3.4**Error! Reference source not found.

On the 30 September 2020 the transmission line was de-energised and in the following weeks the transmission tower was removed as part of the United Wambo transmission tower relocation work that was required for the development of the United Open Cut. As a result of the relocation of transmission suspension towers, reoccurrence of a vibration exceedance is considered a low risk.

Blast EPL Non-Compliance – Warkworth Overpressure

On Thursday 5 November 2020 one blast event UTD-S02-RL50-38 was fired at 13:09:49 in the United Wambo Joint Venture Starter Pit with an overpressure of 128.1 dB recorded at the BM02. This exceeded condition L4.2 of EPL 3141 which does not allow overpressure to exceed 120 *dB* (lin peak) at any time.

All other blast-monitoring locations were below EPL 3141 and SSD 7142 blasting criteria, and no community complaint was received as a result of the blast event.

There are no residences on privately owned land in Warkworth Village and it is not a condition of the SSD 7142 Development Consent that blast monitoring is required to be conducted in this area for the

purposes of residences on privately owned land, therefore BM02 should be removed from EPL 3141. A letter requesting the removal BM02 from EPL3141 was sent to the EPA on 6 November 2020 with the subsequent EPL Variation including its removal.

10.2.2 Air Quality

Real Time Monitoring - <75% daily data collection

On the dates listed in **Table 10-1** the TEOMs failed to obtain a valid sample for varying lengths of time. The failure to obtain the samples was a result of varying causes, including unplanned power outages, mechanical and software issues, and planned maintenance. As a result of the missing data a sample capture percentage of <75% for the day occurred on each of the dates identified, therefore a valid 24-hour average could not be calculated. The specific cause and subsequent response taken to rectify the issues related to each outage has been included in **Table 10-1**.

Table 10-1 Summary of Missing Data for Real Time Monitoring

Monitor	Date	Cause	Comment
AQ01	12/05/2020	Localised power outage	Following power outage, the unit was inspected by the environmental contractors to ensure no damage occurred.
	02/12/2020	Localised power outage /Pump failure	Following power outage, the unit was inspected by environmental contractors. During inspection it was noted the pump had been damaged. The pump was replaced.
AQ02	26-28/09/2020	Pump failure	On 28/09/2020 it was noted that the unit was not operating correctly over the weakened. Unit was inspected by the environmental contractors and it was noted that the pump faulty. The pump was replaced.
AQ03	19/02/2020	Localised power outage	Following power outage, the unit was inspected by the environmental contractors to ensure no damage occurred.
	17/06/2020	Maintenance	Unit was temporarily taken offline for maintenance prior to installation of a new unit, resulting in <75% daily data.
	01-02/07/2020	Maintenance	Unit was taken offline to replace with a new monitoring unit. Delays in labour resulted in a prolonged installation of new monitor. Resulting in <75% daily data for both days.
	22/09/2020	Localised power outage	Following power outage, the unit was inspected by the environmental contractors to ensure no damage occurred.
	13/10/2020	Maintenance	Unit was taken offline to complete scheduled maintenance.
	02-04/12/2020	Pump failure	Following power outage, the unit was inspected by environmental contractors. During inspection it was noted the pump had been damaged. The pump was replaced.

Monitor	Date	Cause	Comment
	24-31/12/2020	Localised power outage	Localised storm tripped the electrical breaker on monitor and modem required a reset. Due to timing of event, environmental technicians were on annual leave. Following their return, the unit was inspected, and electrical breaker was reset to rectify the issue.
AQ04	26-27/07/2020	Software error	It was noted that every 3rd reading was not recording, environmental technicians restarted the unit and the error was corrected.
	29/07/2020	Software error	Similar to the events on 26-27/07/2020, every 3rd reading was not recorded, the environmental technicians reset the unit
	17/09/2020	Maintenance	Unit was taken offline to complete scheduled maintenance

High Volume Air Sampler – Missed TSP Sample

As previously mentioned in Section 6.4.1, HVAS 01 and HVAS 02 are owned and operated by HVO, with results forwarded to United Wambo monthly.

On the 15 and 21 January and the 4 December 2020 HVAS01 failed to run for the full 24-hour periods. HVAS01 was investigated by HVO's environmental contractors, and the likely cause was determined to be a localised power outage, upon inspection HVAS01 was operating as required.

On 4 December 2020 it was noted that HVAS02 failed to run for a full 24-hour period, upon inspection it was noted that the residual current device for the unit has been tripped. The unit was resent and continue to run without issue.

10.2.3 Effluent Quality

Effluent Quality Monitoring – Missed Quarterly Sewage Sample

As per Condition M2.2 of EPL3141, United Wambo is required to monitor effluent quality by collecting quarterly samples of faecal coliforms and pH. During Quarter 1 of 2020 United Wambo failed to collect a quarterly sample as the sewage treatment plant did not have a sampling location installed.

Following Quarter 1 of 2020 a sampling point was installed and United Wambo continued to collect quarterly samples as required by the EPL.

11 ACTIVITIES TO BE COMPLETED IN NEXT REPORTING PERIOD

Table 11-1 outlines the key proposed activities during 2021.

Table 11-1 Proposed Actions for 2021

Proposed Action	Timeline	2020 Comments
Construction and Demolition	2021	Completion of the MIA construction.
	2021	Capping works will commence (all tailings associated with the United Wambo open cut operations will be managed by Wambo).
	March/ April 2021	Removal of the 330kV powerlines.
Approvals	2021	Surrender of DA-410-11-2002-i in accordance with Condition A16 of SSD 7142.
	2021	Independent Environmental Audit completed in accordance with Condition E12 of SSD 7142.
	2021	Develop and submit Biodiversity Stewardship Agreement applications for the retirement of biodiversity credit as required by Condition B55 of SSD7142.
Blasting	2021	Develop plan and commence Blast Fume Monitoring Trial.
Rehabilitation	2021	9.9 hectares of rehabilitation will be undertaken.
		Environmental monitoring, land management and rehabilitation maintenance.
		Targeted weed control in areas identified during monitoring.

12 REFERENCES

ATC Williams (2017) *Conceptual Closure Strategy, Tailings Dam No.1 & No.2, Glencore United Collieries Pty Ltd, Ref: 110006.08-R01, Revision 1*

GHD (2017) *Stage 1 Preliminary Contamination Investigation, United Collieries Pty Ltd, Warkworth NSW 2330*

Glencore (2014) *Compensatory Habitat Management Plan.*

Glencore (2019) United Wambo Air Quality and Greenhouse Gas Management Plan.

Glencore (2019a) United Wambo Historic Heritage Management Plan.

Glencore (2019b) United Wambo Noise Management Plan.

Glencore (2020) *United Wambo Aboriginal Cultural Heritage Management Plan.*

Glencore (2020a) *United Wambo Biodiversity Management Plan.*

Glencore (2020b) *United Wambo Erosion and Sediment Control Plan.*

Glencore (2020c) *United Wambo Groundwater Management Plan*

Glencore (2020d) *United Wambo Water Management Plan.*

Glencore (2020e) United Wambo Joint Venture Blast Management Plan

HLA Envirosciences Pty Ltd (2002). *United Extension Environmental Impact Statement.*

SLR Consulting (2016) *Mining Operations Plan United Collieries – 1 January 2017 – 4 June 2019.*

SLR Consulting *(2019) Mining Operations Plan United Collieries – 1 January 2017 – 12 July 2020.*

Umwelt (2016) *United Wambo Open Cut Coal Mine Project – Heritage Impact Statement.*

Umwelt (2021) *United Wambo Groundwater Dependent Ecosystem Study*.

Umwelt (2019) *United Collieries 2019 Ecological Monitoring Report.*

Umwelt (2016a) *United Wambo Open Cut Coal Mine Project – Environmental Impact Statement*

Umwelt (2017) *United Wambo Open Cut Coal Project – Response to Submissions Part*

Umwelt (2017a) *United Wambo Open Cut Coal Project – Response to Submissions Part B*

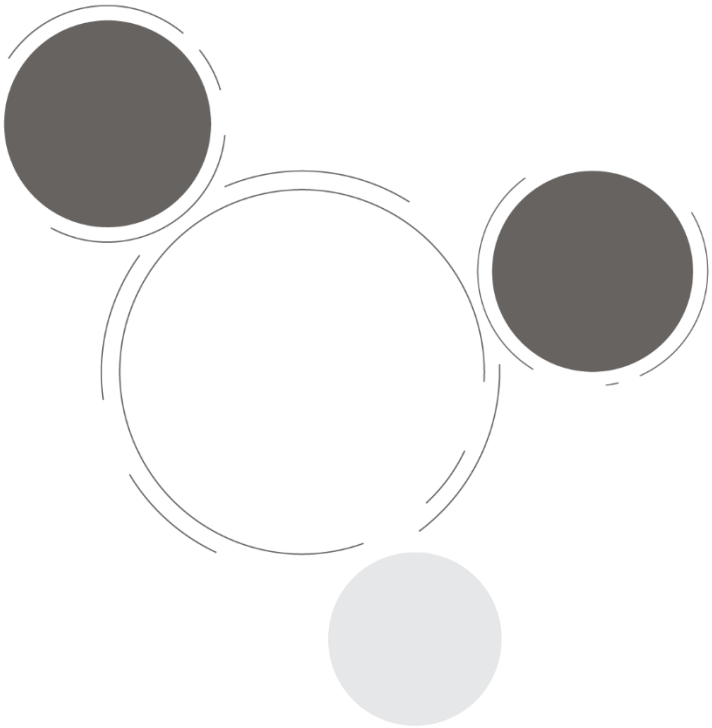
Umwelt (2018a) United Wambo Open Cut Coal Project – Response to Independent Planning Commission Recommendations

Umwelt (2003) *DA – 410 – 11 – 2002 – i Modification 1. Statement of Environmental Effects – Proposed Extension of Longwall Mining.*

APPENDIX 1 – EPBC 2015 – 7600 Compliance Report

UNITED WAMBO
JOINT VENTURE

GLENCORE



EPBC 2015/7600 Annual Compliance Report 2020

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1. Purpose

This report was prepared to satisfy the requirements of Condition 10 of the United and Wambo Open Cut Coal Mine Project *Environment Protection and Biodiversity Conservation Act 1999 (Cth)* (EPBC Act) Approval 2015/7600 (**EPBC 2015/7600**). Condition 10 of EPBC 2015/7600 states:

> *10. The approval holder must prepare a compliance report addressing compliance with each of the conditions of this approval, including implementation of any management plans and strategies from the State development consent that are referred to in this approval, for each 12 month period following the date of commencement of the action, or otherwise in accordance with an annual date that has been agreed to in writing by the Minister. The approval holder must:*
>
> *a. publish each compliance report on a website within 60 business days following the relevant 12 month period,*
>
> *b. notify the Department by email that a compliance report has been published on the website and provide the website's link for the compliance report within five business days of the date of publication,*
>
> *c. keep all compliance reports publicly available on the website until this approval expires,*
>
> *d. exclude or redact sensitive ecological data from compliance reports published on the website, and*
>
> *e. where any sensitive ecological data has been excluded from the version published, submit the full compliance report to the Department within 5 business days of publication.*

2. Notification of Commencement and Reporting Period

Notification was made to the former Department of Environment and Energy on 10 January 2020 that the United Wambo Open Cut Coal Mine Project commenced on 6 January 2020.

Condition	Requirement	Compliance Finding
1	The approval holder must comply with State development consent conditions B39, B40, B46, B49, B51, B52, B53 and B54.	All conditions listed have been complied with during 2020.
2	Within the area shown at Annexure 1, the approval holder must not clear more than: a. 203.7 hectares of Regent Honeyeater (Anthochaera phrygia) habitat, b. 203. 7 hectares1 of Swift Parrot (Lathamus discolor) habitat, c. 352.9 hectares of Spotted-tail quo II (Dasyurus maculatus maculatus) habitat, d. 246.8 hectares of the Central Hunter Valley Eucalypt Forest and Woodland ecological community.	As of 31 December 2020, the area of clearance for each MNES listed is as follows: a. 88.1 hectares of Regent Honeyeater (Anthochaera phrygia) habitat, b. 88.1 hectares1 of Swift Parrot (Lathamus discolor) habitat, c. 213.9 hectares of Spotted-tail quo II (Dasyurus maculatus maculatus) habitat, d. 121.5 hectares of the Central Hunter Valley Eucalypt Forest and Woodland ecological community.
3	The approval holder must comply with the State development consent conditions B55, B56, B57, B58, B59, B60, B61, B62, B69, B71, B72 and B73.	All Conditions listed have been complied with. An extension was granted by DPIE on 22 October 2020 for Condition B56 for the retirement of the Stage 1 offsets. The condition was extended for an additional 12 months to 6 January 2022.
3a	To compensate for the loss of the listed threatened species and ecological community habitat identified at condition 2, the approval holder must submit the Biodiversity Offset Strategy plan (specified at condition B71(e) of the State development consent) to the Minister for approval. i. The approval holder must not commence Phase 1A until the Biodiversity Offset Strategy plan has been approved by the Minister. ii. The approval holder must implement the Biodiversity Offset Strategy plan as approved by the Minister.	The Biodiversity Offset Strategy is contained within the United Wambo Biodiversity Management Plan and was approved by the Minister on 19 December 2019. The Biodiversity Offset Strategy has been implemented as approved. As per Condition 3, the requirement to retire the credits has been extended to 6 January 2022.

Condition	Requirement	Compliance Finding
4	The approval holder must comply with the State development consent conditions B97, B98, B100, B101, B102, B103, B104 and B105.	All Conditions listed have been complied with.
5	The approval holder must notify the Department in writing of the date of commencement of the action within 10 business days after the date of commencement of the action.	The United Wambo Open Cut Coal Mine Project commenced on 6 January 2020. The Department was notified in writing on 10 January 2020.
6	If the commencement of the action does not occur within 5 years from the date of this approval, then the approval holder must not commence the action without the prior written agreement of the Minister.	Not applicable
7	The approval holder must maintain accurate and complete compliance records.	All records required by this approval are held by United Wambo JV.
8	If the Department makes a request in writing, the approval holder must provide electronic copies of compliance records to the Department within the timeframe specified in the request.	No request has been received

Condition	Requirement	Compliance Finding
9	The approval holder must: a. Submit the Biodiversity Offset Strategy plan at condition 3a electronically to the Department for approval by the Minister, b. publish the Biodiversity Offset Strategy plan on the website within 20 business days of the date the Biodiversity Offset Strategy plan is approved by the Minister or of the date a revised Biodiversity Offset Strategy plan is submitted to the Minister or the Department, unless otherwise agreed to in writing by the Minister, c. exclude or redact sensitive ecological data from the Biodiversity Offset Strategy plan published on the website or provided to a member of the public, and d. keep the Biodiversity Offset Strategy plan published on the website until the end date of this approval.	All requirements of Condition 9 have been met: a. See condition 3a above b. The United Wambo Biodiveristy Management Plan has published on the United Wambo website within 20 business days of approval. c. No sensitive ecological data is contained within the Biodiversity Offset Strategy d. The United Wambo Biodiveristy Management Plan is published on the United Wambo website (*https://www.glencore.com.au/operations-and-projects/coal/current-operations/united-wambo-open-cut*)

Condition	Requirement	Compliance Finding
10	The approval holder must prepare a compliance report addressing compliance with each of the conditions of this approval, including implementation of any management plans and strategies from the State development consent that are referred to in this approval, for each 12 month period following the date of commencement of the action, or otherwise in accordance with an annual date that has been agreed to in writing by the Minister. The approval holder must: a. publish each compliance report on a website within 60 business days following the relevant 12 month period, b. notify the Department by email that a compliance report has been published on the website and provide the website's link for the compliance report within five business days of the date of publication, c. keep all compliance reports publicly available on the website until this approval expires, d. exclude or redact sensitive ecological data from compliance reports published on the website, and e. where any sensitive ecological data has been excluded from the version published, submit the full compliance report to the Department within 5 business days of publication.	This report is the first compliance report prepared for this approval. It will be published on the website and the Department will be notified as required.

Condition	Requirement	Compliance Finding
11	The approval holder must notify the Department in writing of any: incident, or non-compliance with the conditions, or non-compliance with the commitments made in plans. The notification must be given as soon as practicable, and no later than two business days after becoming aware of the incident or non-compliance. The notification must specify: a. any condition which is in breach, b. a short description of the incident and/or non-compliance, and c. the location (including co-ordinates), date, and time of the incident and/or non-compliance. In the event the exact information cannot be provided, provide the best information available.	No incidents or non-compliances occurred during 2020.
12	The approval holder must provide to the Department the details of any incident or non-compliance with the conditions or commitments made in plans as soon as practicable and no later than 10 business days after becoming aware of the incident or non-compliance, specifying: a. any corrective action or investigation which the approval holder has already taken or intends to take in the immediate future, b. the potential impacts of the incident or non-compliance, and c. the method and timing of any remedial action that will be undertaken by the approval holder.	No incidents or non-compliances occurred during 2020.
13	The approval holder must ensure that independent audits of compliance with the conditions are conducted as requested in writing by the Minister.	No request has been received

Condition	Requirement	Compliance Finding
14	For each independent audit, the approval holder must: a. provide the name and qualifications of the independent auditor and the draft audit criteria to the Department, b. only commence the independent audit once the audit criteria have been approved in writing by the Department, and a. submit an audit report to the Department within the timeframe specified in the approved audit criteria.	No request has been received
15	The approval holder must publish the audit report on the website within 10 business days of receiving the Department's approval of the audit report and keep the audit report published on the website until the end date of this approval.	No request has been received
16	The approval holder must comply with the State development consent condition A9.	Condition A9 allows for mining up until 31 August 2042.
17	Within 30 days after the completion of the action, the approval holder must notify the Department in writing and provide completion data.	The action has not been completed.
18	The approval holder must notify the Department in writing of any proposed change to the State development consent conditions referred to in these conditions within 10 business days of formally proposing a change or becoming aware of any proposed change.	No changes to the State development consent conditions occurred during 2020. An extension of Condition B56 was granted as discussed above.
19	The approval holder must notify the Department in writing of any change to the conditions of the State development consent referred to in these conditions, within 10 business days of a change to conditions being finalised.	No changes to the State development consent conditions occurred during 2020. An extension of Condition B56 was granted as discussed above.

Condition	Requirement	Compliance Finding
20	The approval holder may, at any time, apply to the Minister for a variation to an action management plan approved by the Minister under condition 3.a, or as subsequently revised in accordance with these conditions, by submitting an application in accordance with the requirements of section 143A of the EPBC Act. If the Minister approves a revised action management plan (RAMP) then, from the date specified, the approval holder must implement the RAMP in place of the previous action management plan.	Not applicable
21	The approval holder may choose to revise an action management plan approved by the Minister under condition 3.a, or as subsequently revised in accordance with these conditions, without submitting it for approval under section 143A of the EPBC Act, if the taking of the action in accordance with the RAMP would not be likely to have a new or increased impact.	Not applicable

Condition	Requirement	Compliance Finding
22	If the approval holder makes the choice under condition 21 to revise an action management plan without submitting it for approval, the approval holder must: a. notify the Department in writing that the approved action management plan has been revised and provide the Department with: i. an electronic copy of the RAMP, ii. an electronic copy of the RAMP marked up with track changes to show the differences between the approved action management plan and the RAMP, iii. an explanation of the differences between the approved action management plan and the RAMP, iv. the reasons the approval holder considers that taking the action in accordance with the RAMP would not be likely to have a new or increased impact, and v. written notice of the date on which the approval holder will implement the RAMP (RAMP implementation date), being at least 20 business days after the date of providing notice of the revision of the action management plan, or a date agreed to in writing with the Department. b. subject to condition 24, implement the RAMP from the RAMP implementation date.	Not applicable
23	The approval holder may revoke their choice to implement a RAMP under condition 21 at any time by giving written notice to the Department. If the approval holder revokes the choice under condition 21, the approval holder must implement the action management plan in force immediately prior to the revision undertaken under condition 21.	Not applicable

Condition	Requirement	Compliance Finding
24	If the Minister gives a notice to the approval holder that the Minister is satisfied that the taking of the action in accordance with the RAMP would be likely to have a new or increased impact, then: a. condition 21 does not apply, or ceases to apply, in relation to the RAMP; and b. the approval holder must implement the action management plan specified by the Minister in the notice.	Not applicable
25	At the time of giving the notice under condition 24, the Minister may also notify that for a specified period of time, condition 21 does not apply for one or more specified action management plans.	Not applicable

APPENDIX 2 – ADDITIONAL ENVIRONMENTAL MONITORING RESULTS

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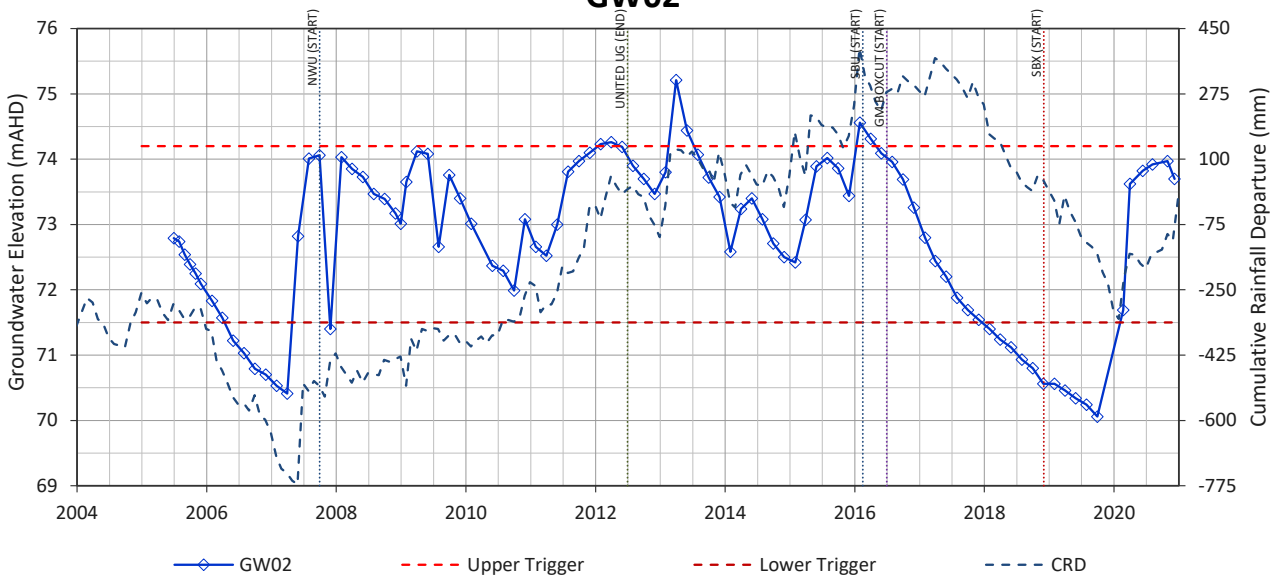
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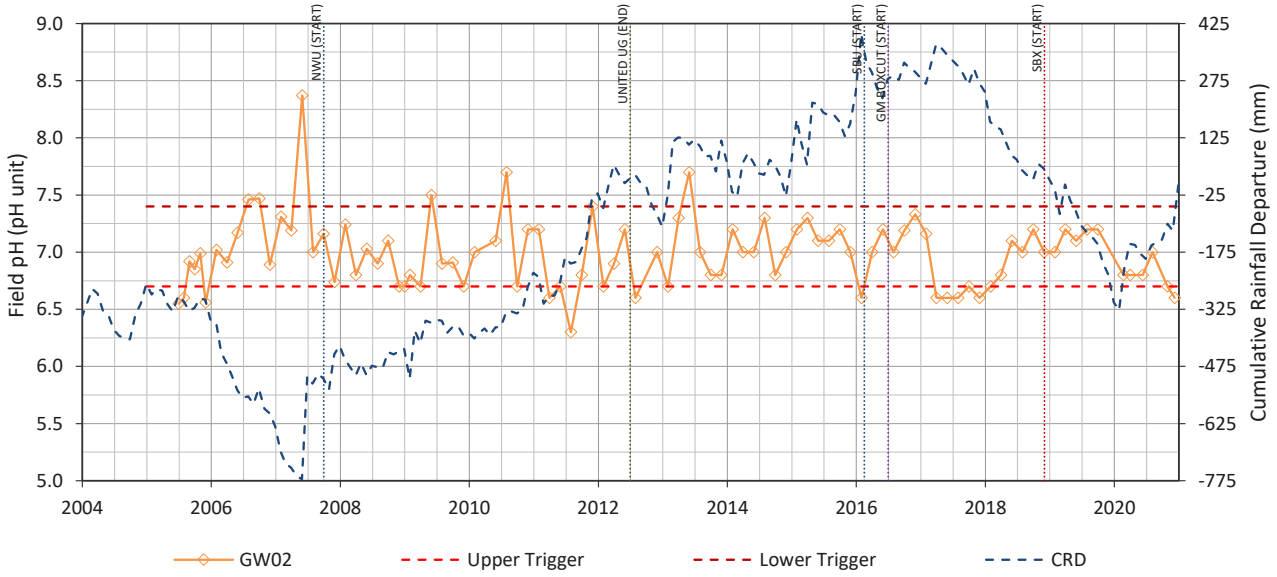
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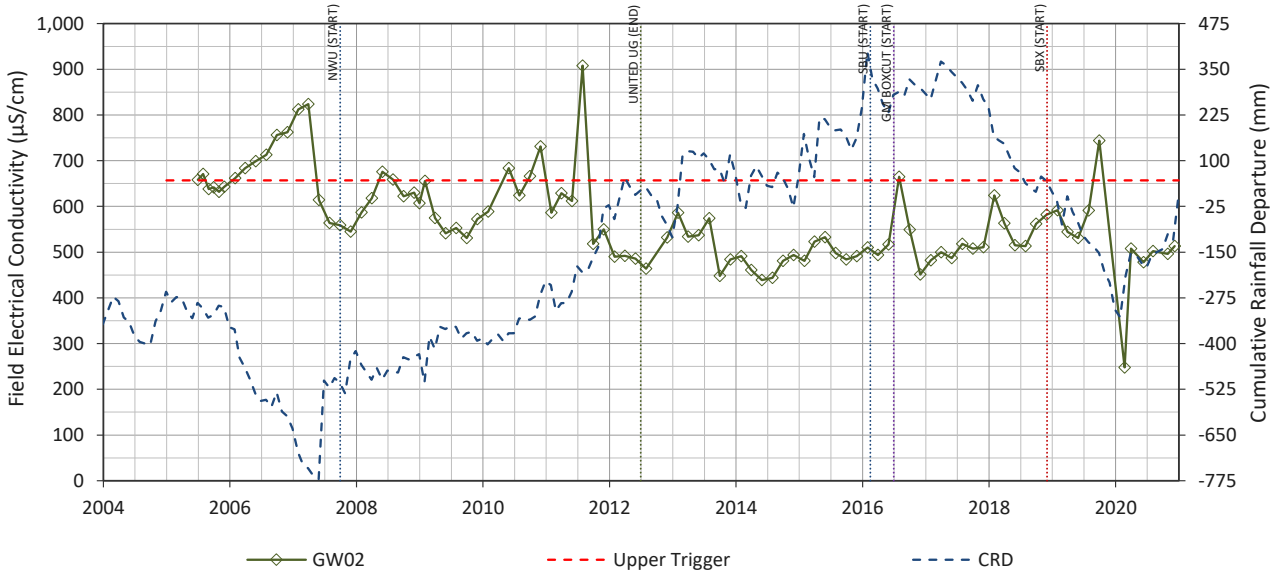
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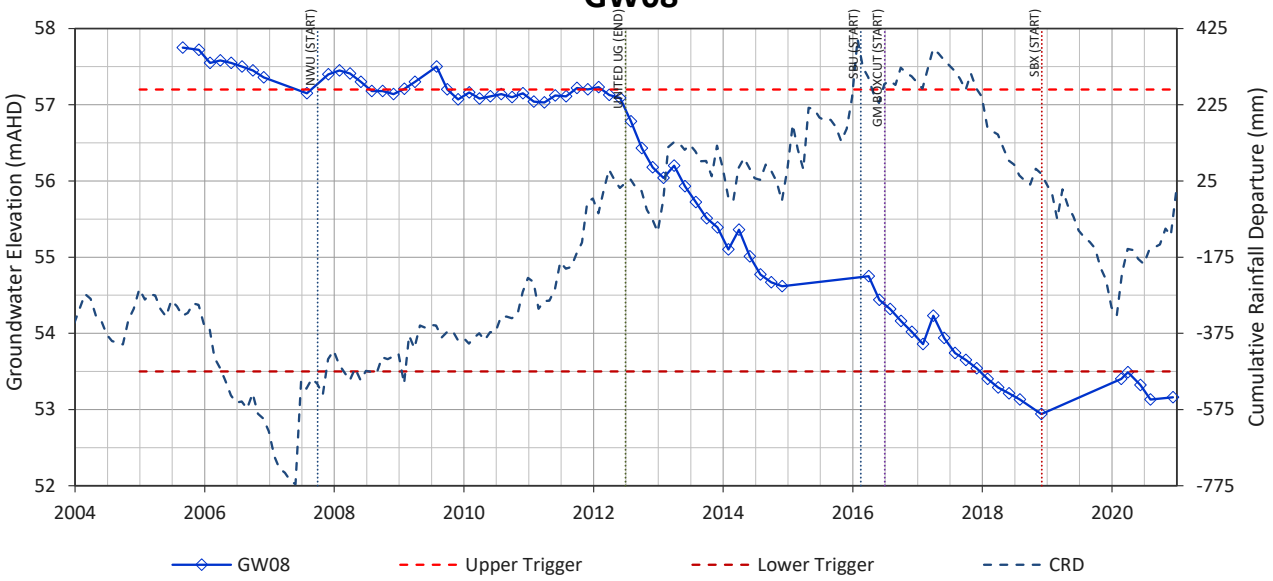
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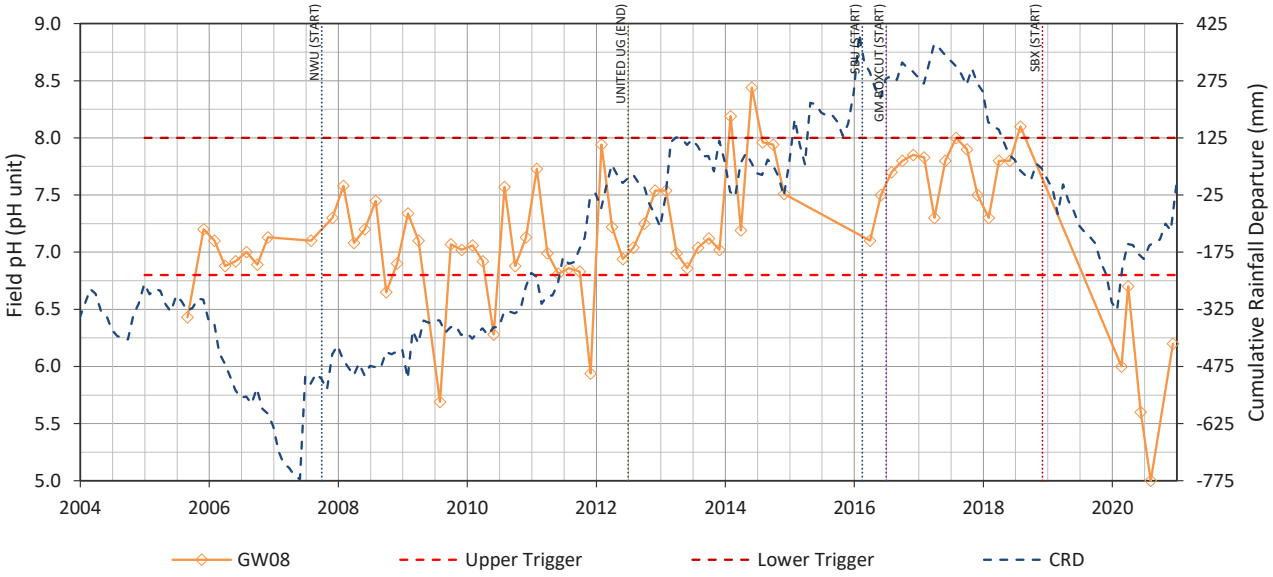
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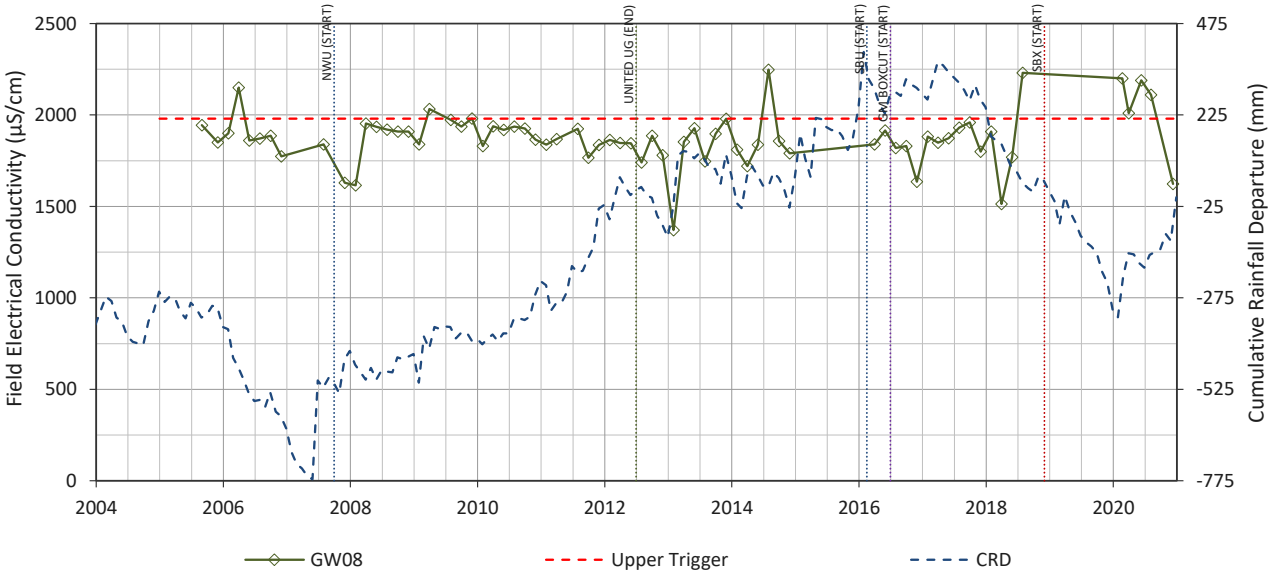
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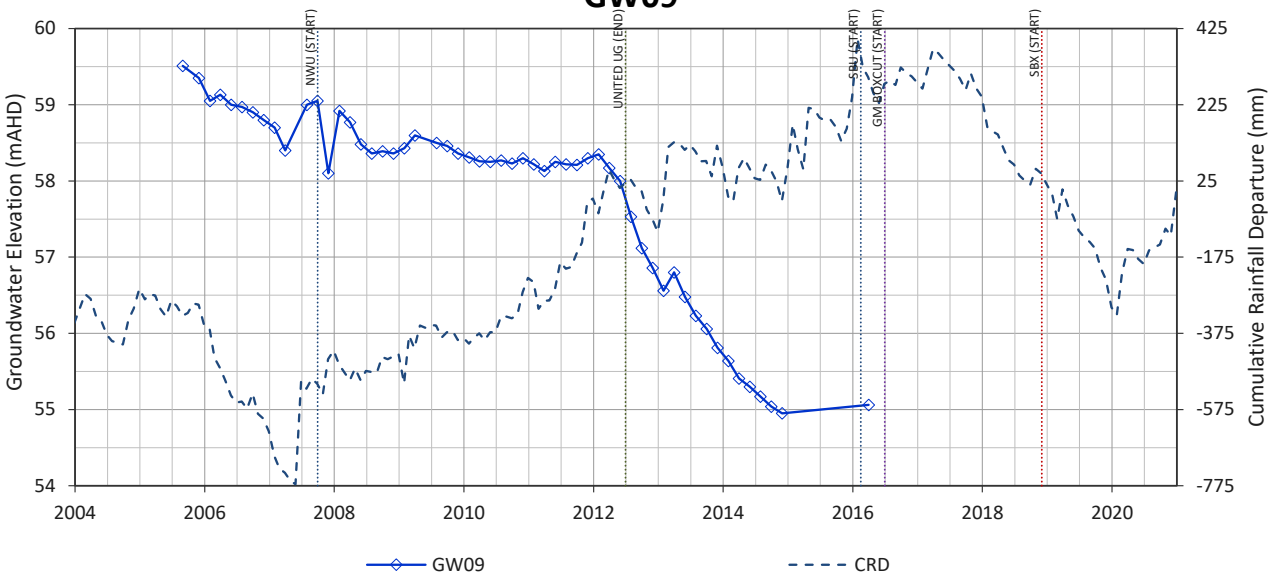
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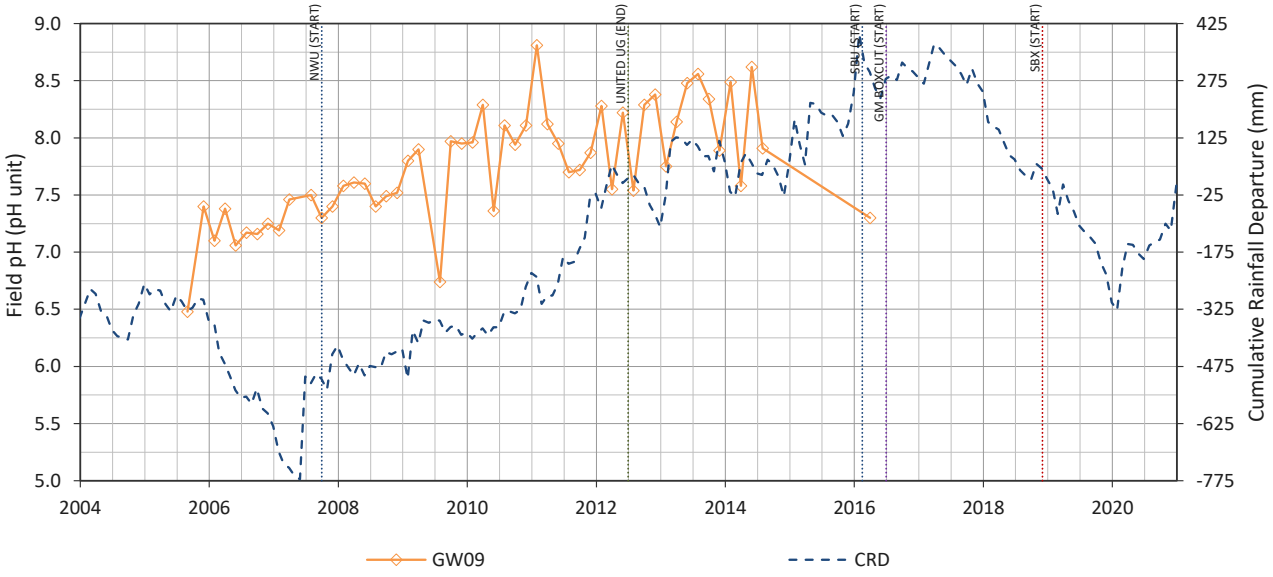
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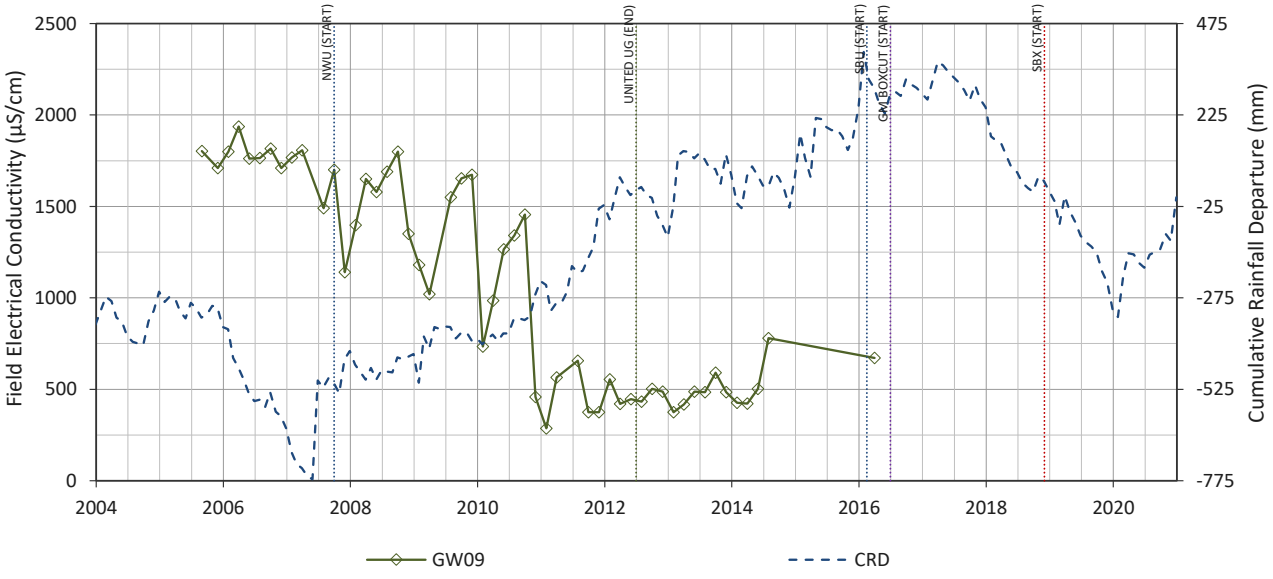
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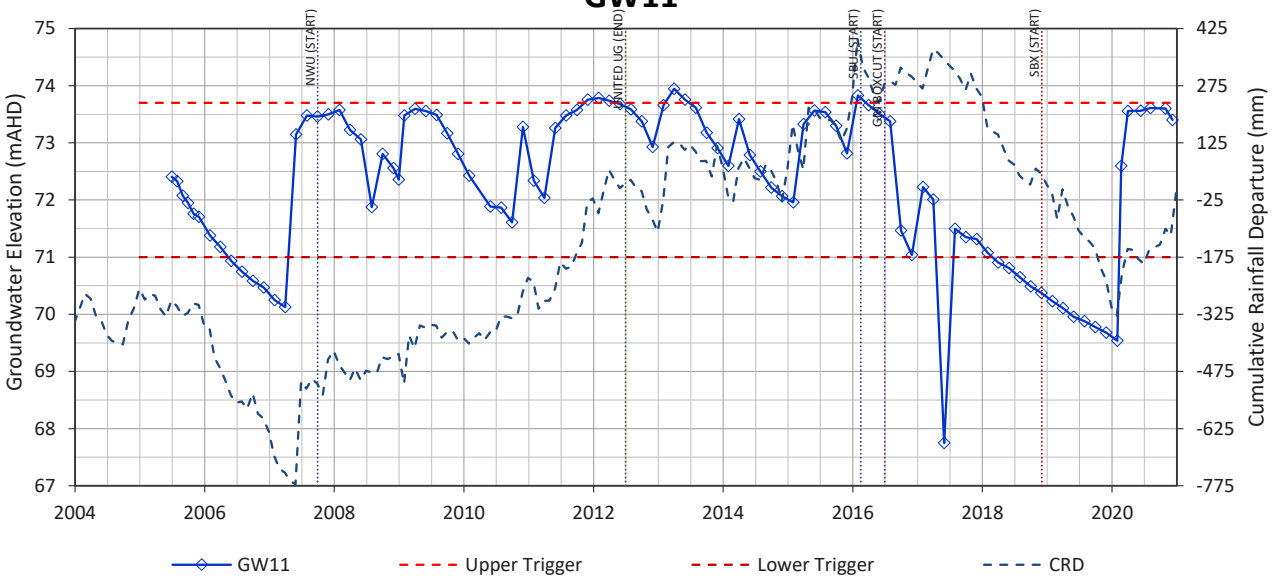
GW09
CRD

GW11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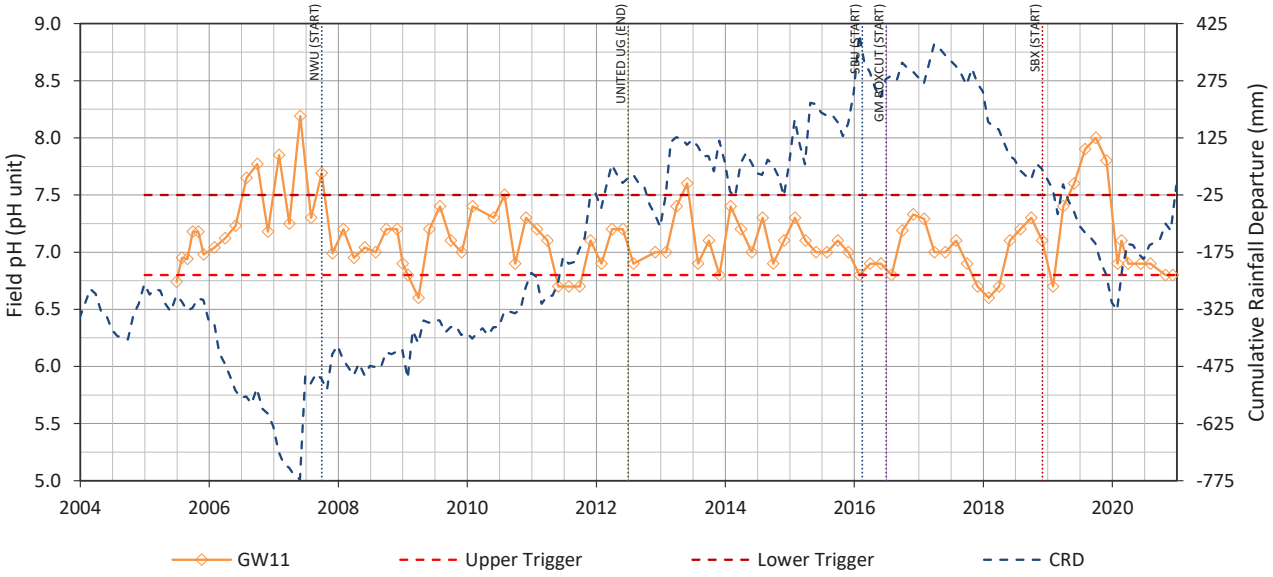
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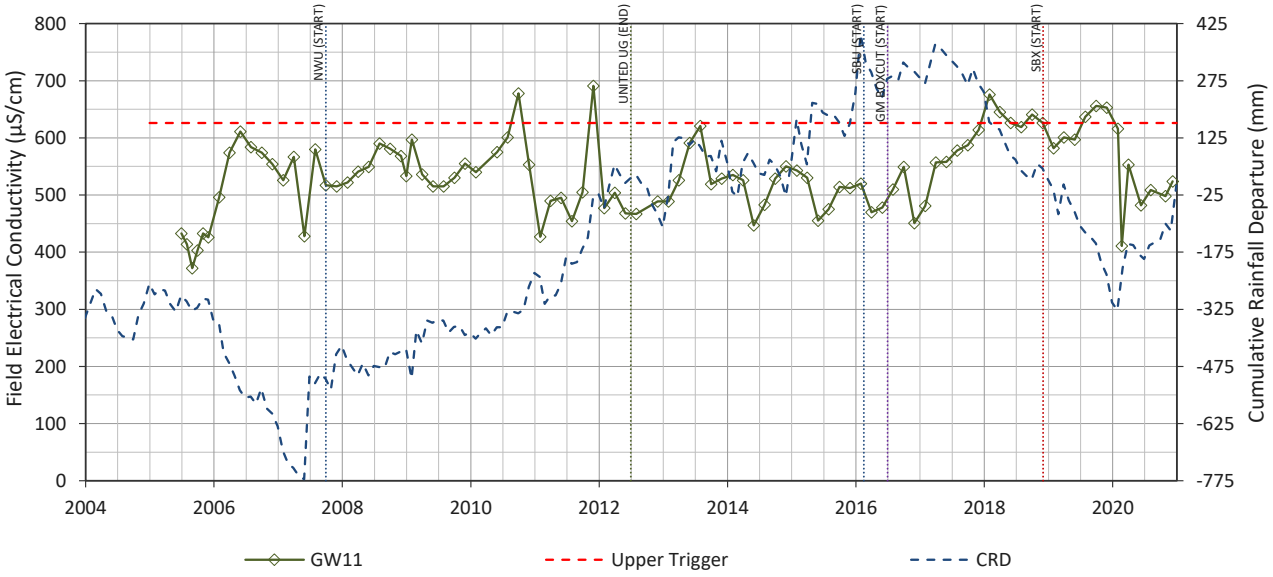
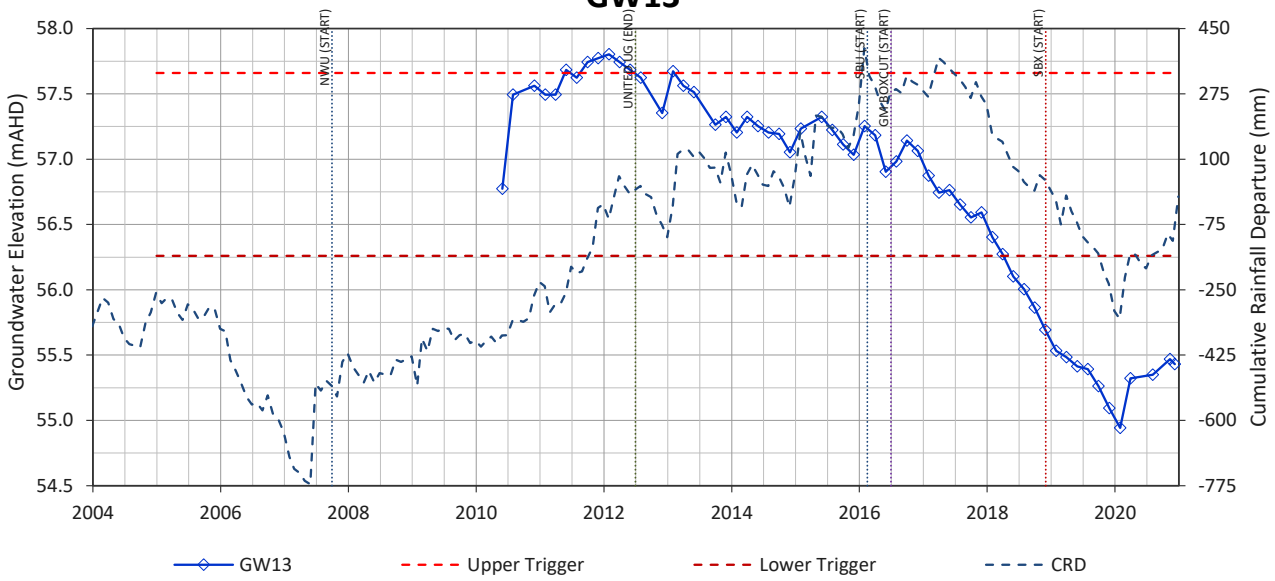
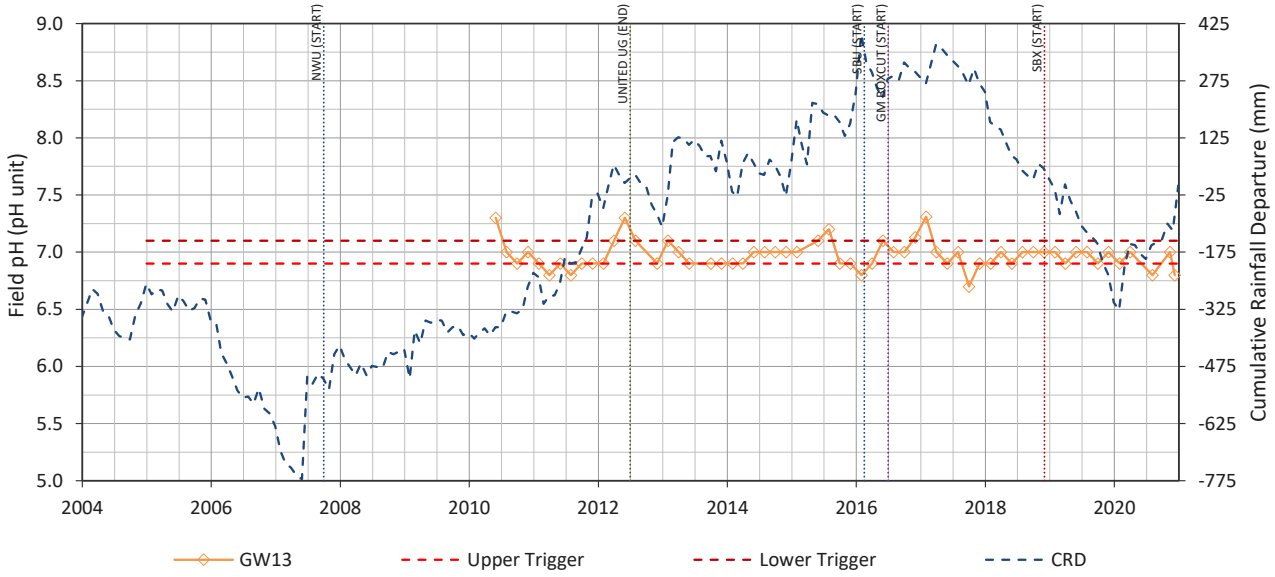
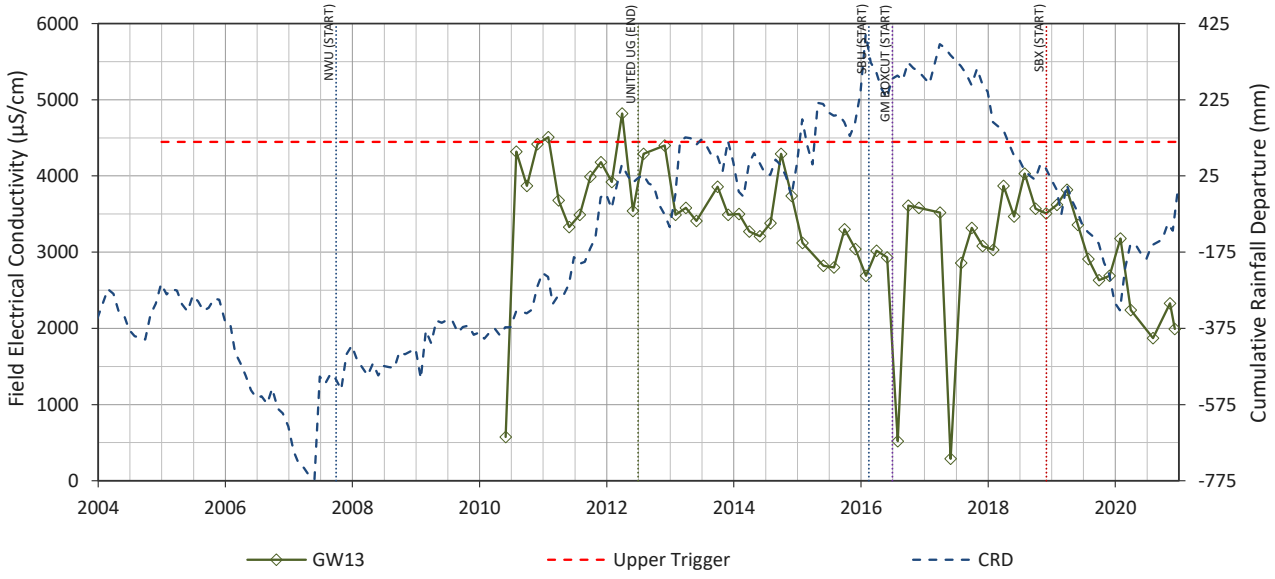
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM & OXCUT (START)
SBX (START)
GW11
Upper Trigger
Lower Trigger
CRD

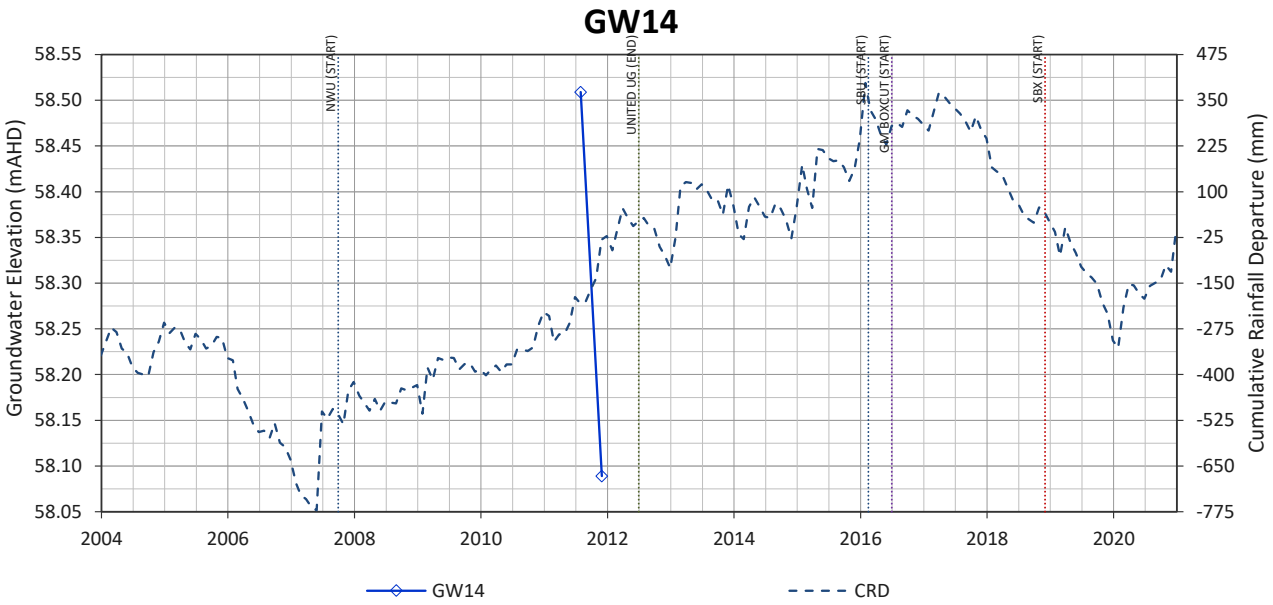

Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM & OXCUT (START)
SBX (START)
GW11
Upper Trigger
CRD

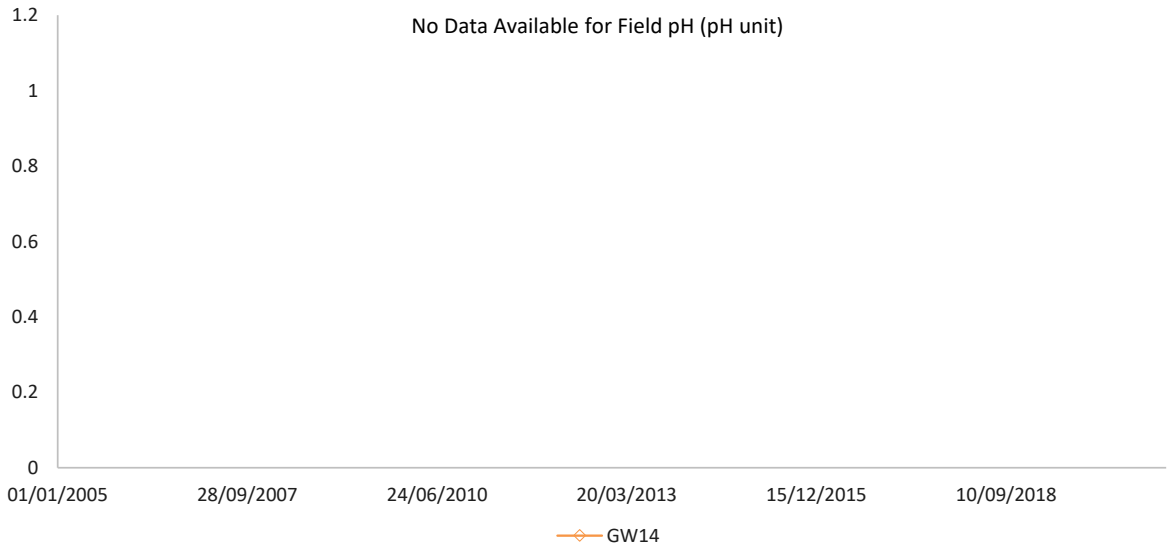
GW13

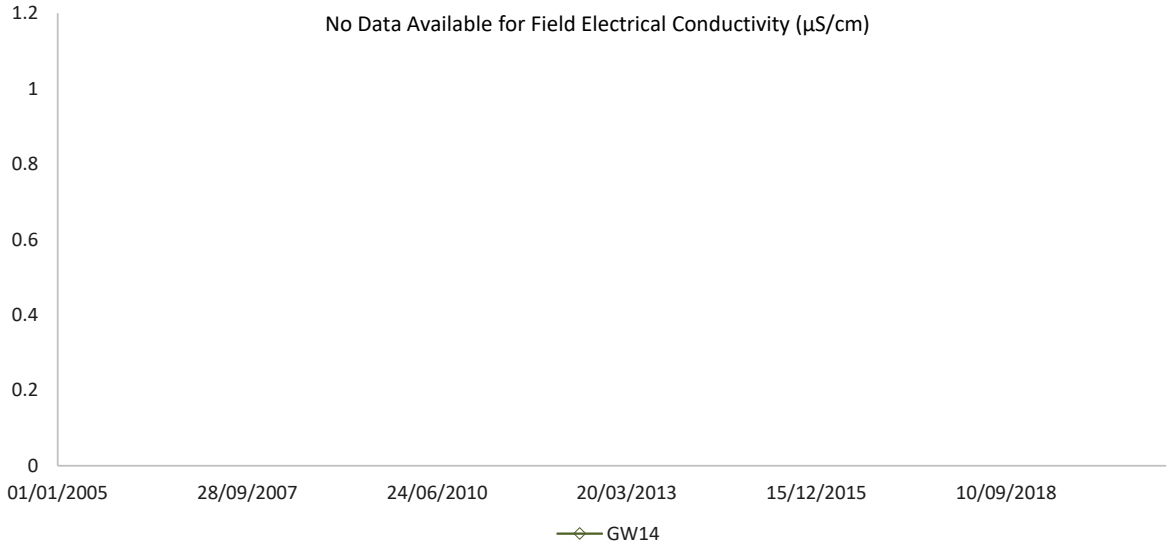

Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
GW13
Upper Trigger
Lower Trigger
CRD


Field pH (pH unit)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
GW13
Upper Trigger
Lower Trigger
CRD

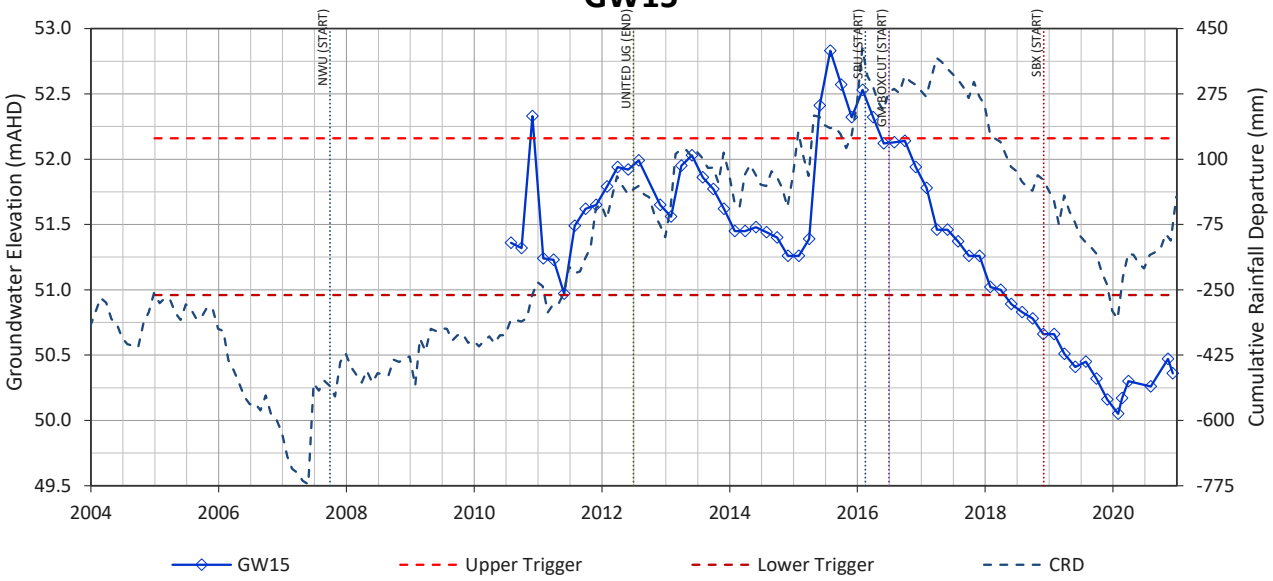

Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
GW13
Upper Trigger
CRD

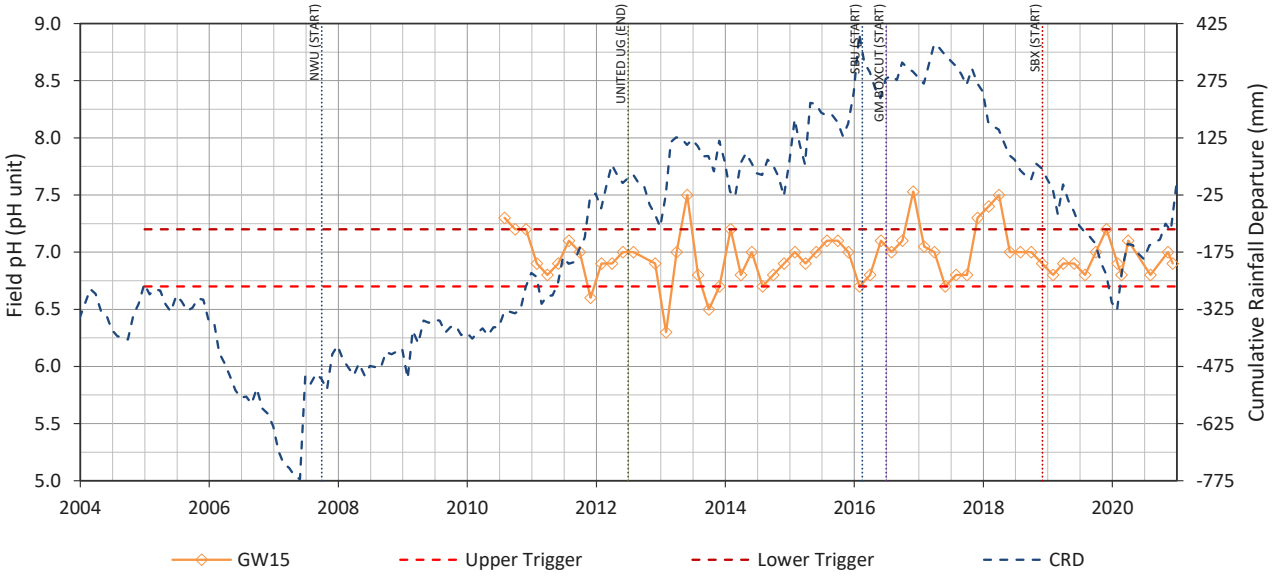

GW14
Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
58.55
58.50
58.45
58.40
58.35
58.30
58.25
58.20
58.15
58.10
58.05
475
350
225
100
-25
-150
-275
-400
-525
-650
-775
2004
2006
2008
2010
2012
2014
2016
2018
2020
NWU (START)
UNITED UG (END)
SBU (START)
GW BOXCUT (START)
SBX (START)
GW14
CRD

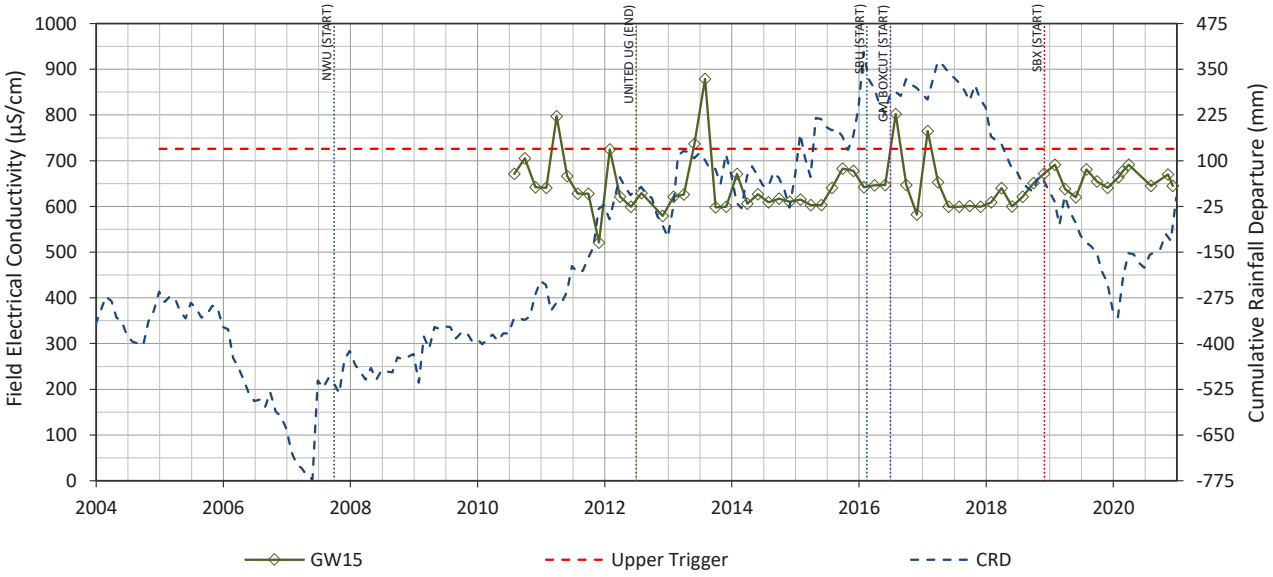

No Data Available for Field pH (pH unit)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
GW14


No Data Available for Field Electrical Conductivity (µS/cm)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/2005
28/09/2007
24/06/2010
20/03/2013
15/12/2015
10/09/2018
GW14

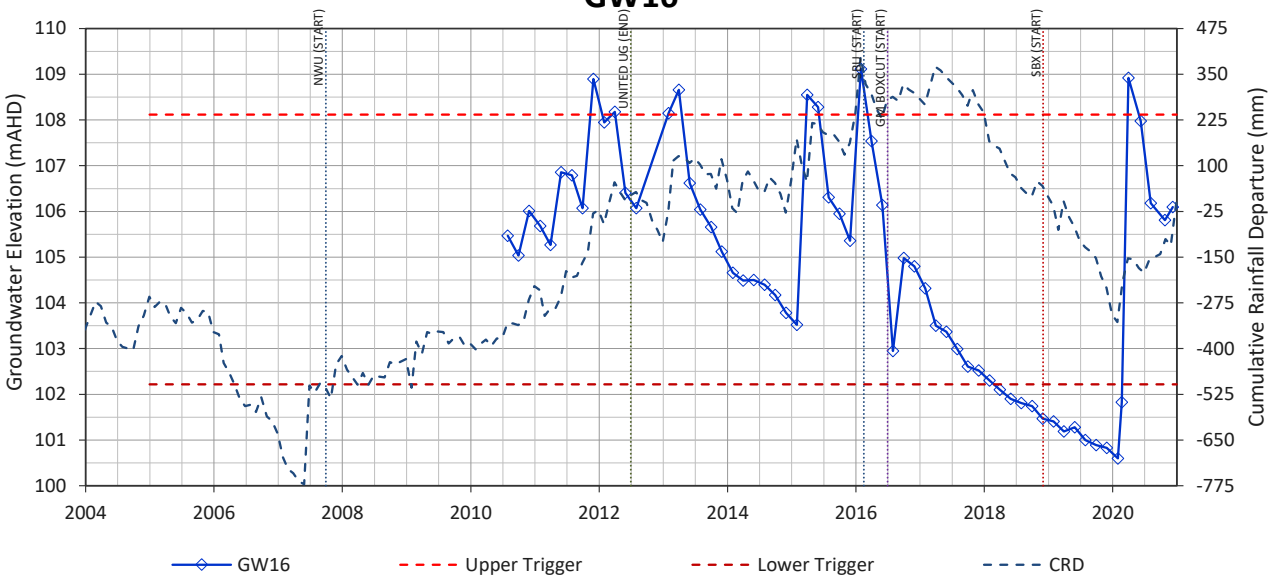
GW15

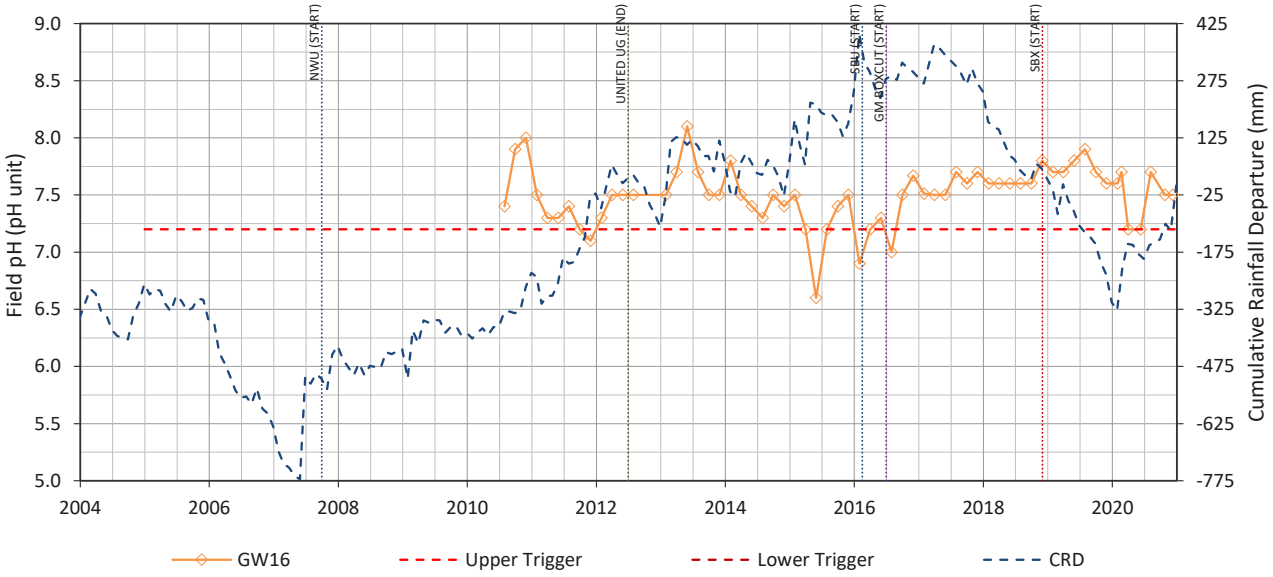

Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM4 BOXCUT (START)
SBX (START)
GW15
Upper Trigger
Lower Trigger
CRD

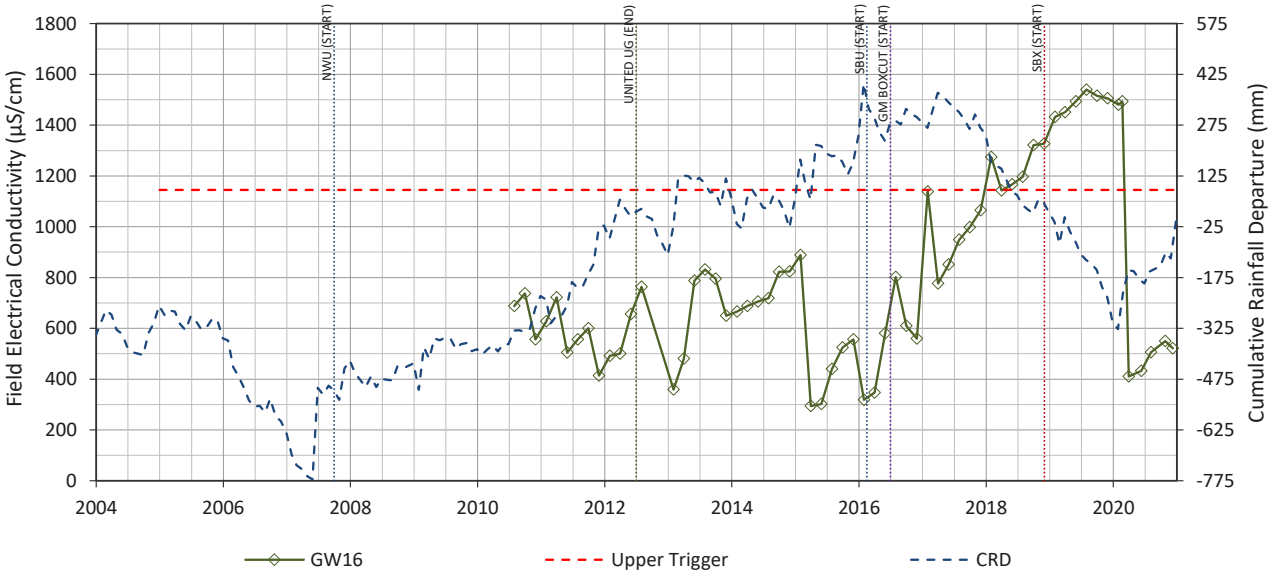

Field pH (pH unit)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM4 BOXCUT (START)
SBX (START)
GW15
Upper Trigger
Lower Trigger
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM4 BOXCUT (START)
SBX (START)
GW15
Upper Trigger
CRD

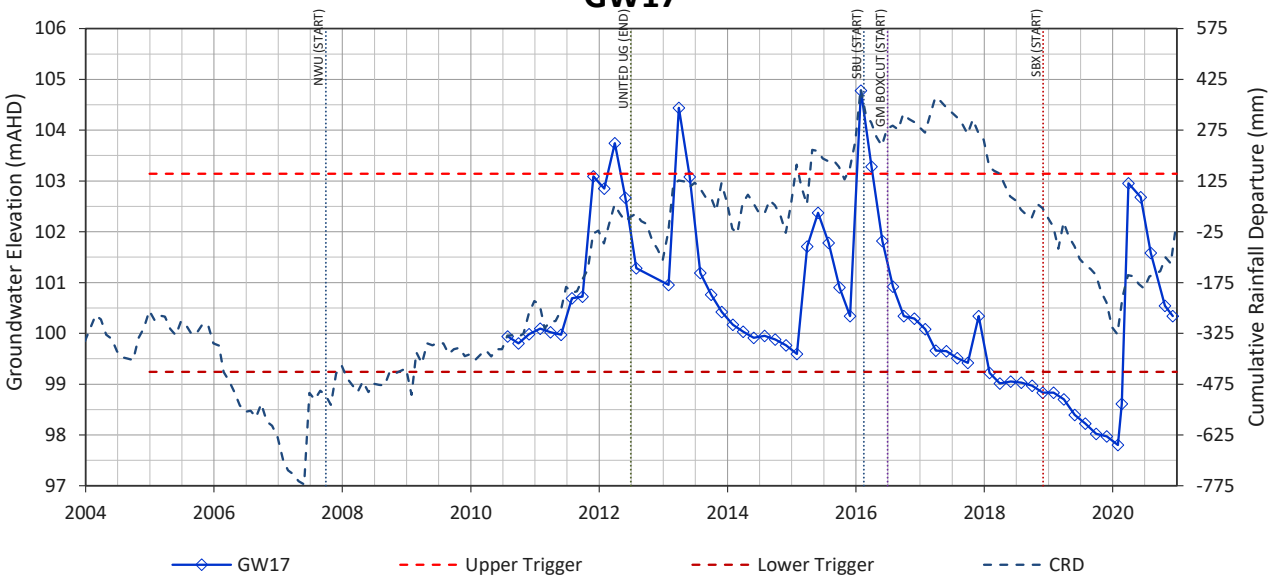
GW16

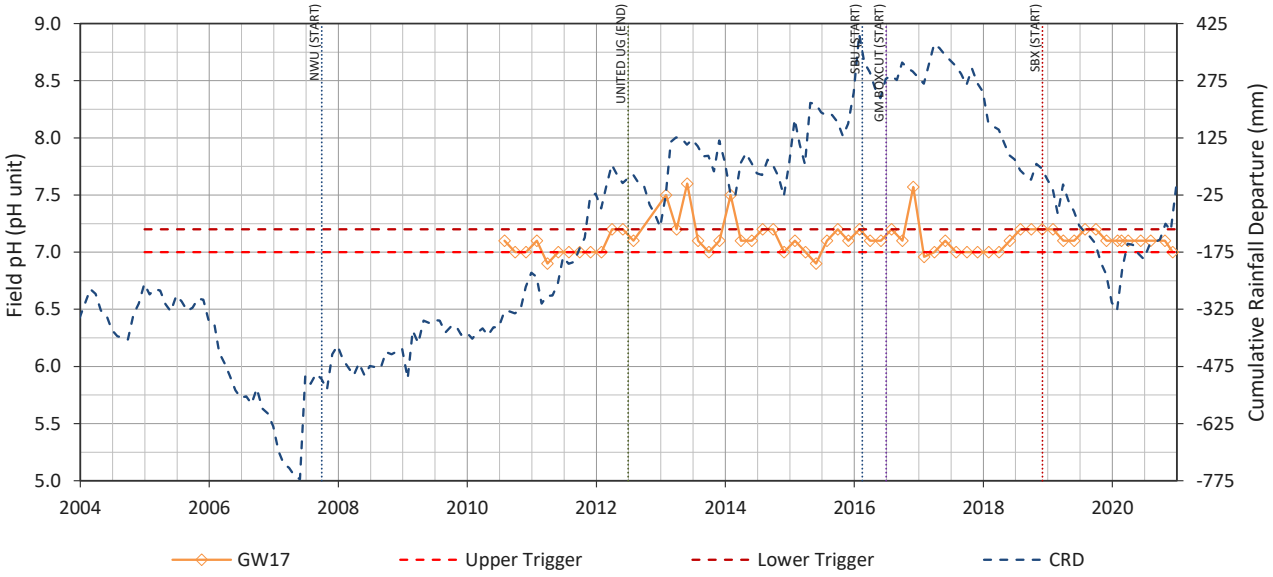

Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
GW16
Upper Trigger
Lower Trigger
CRD

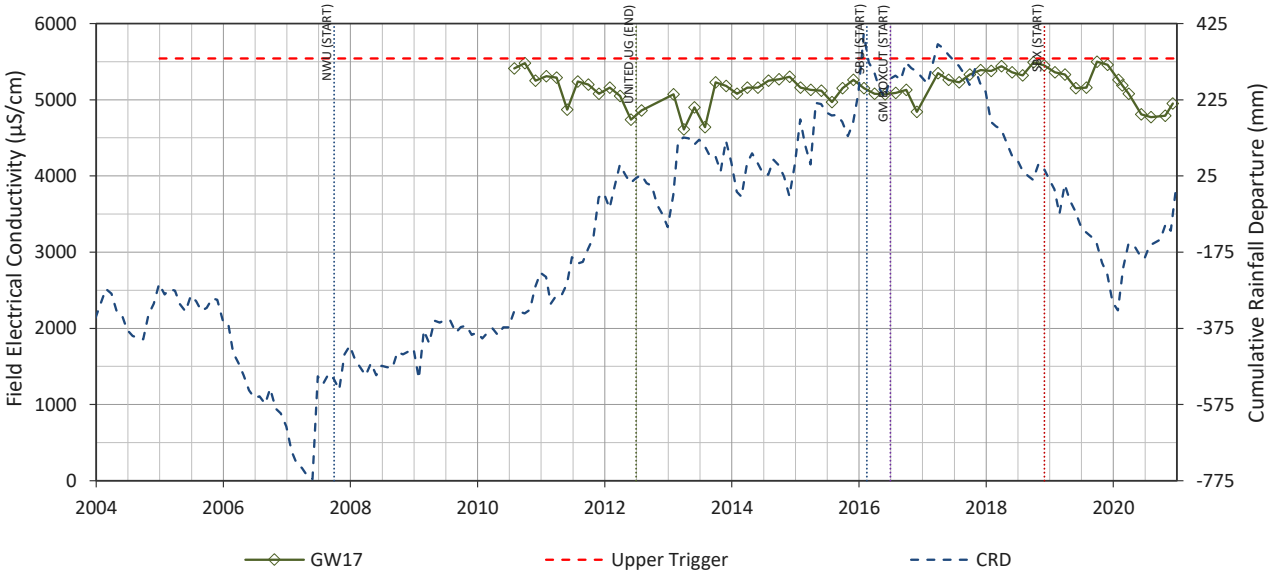

Field pH (pH unit)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
GW16
Upper Trigger
Lower Trigger
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
GW16
Upper Trigger
CRD

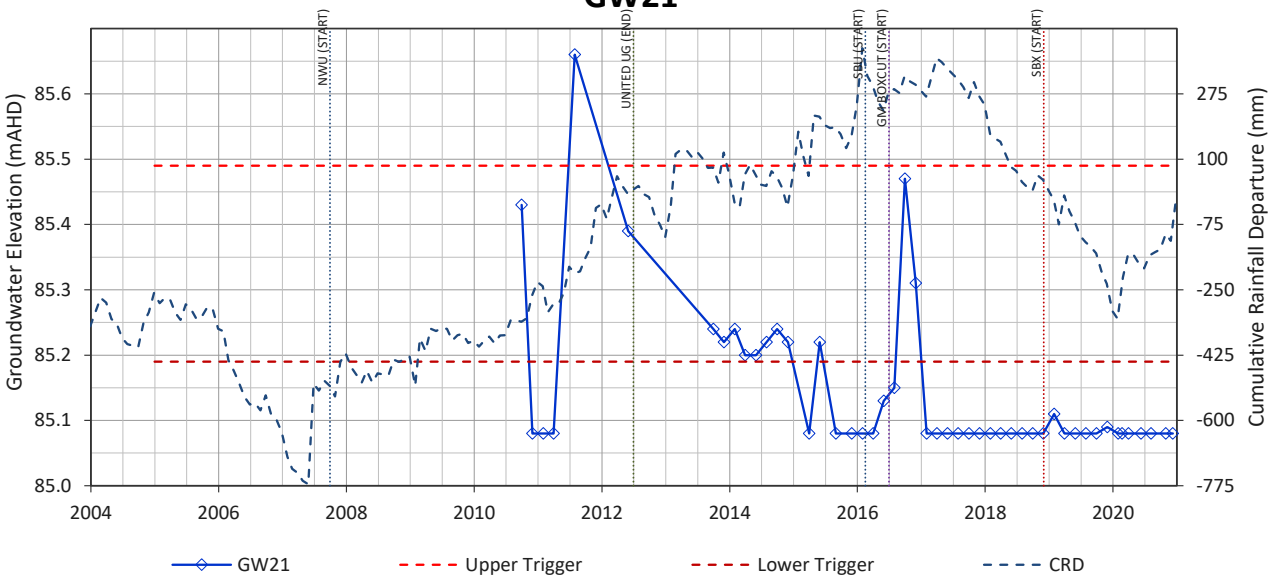
GW17

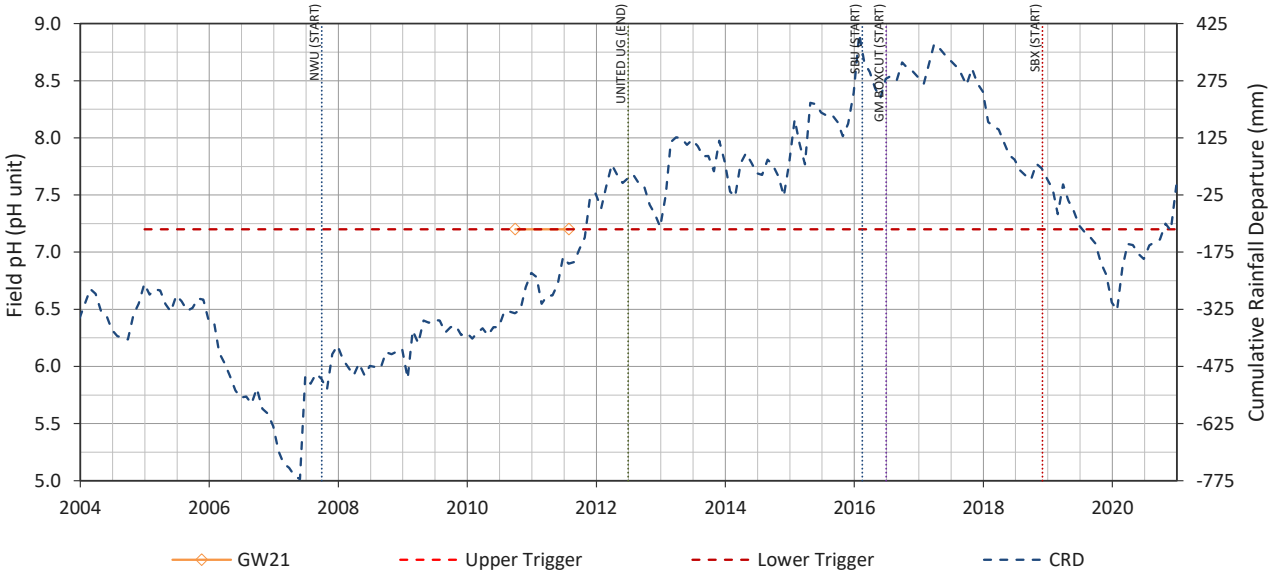

Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
GW17
Upper Trigger
Lower Trigger
CRD

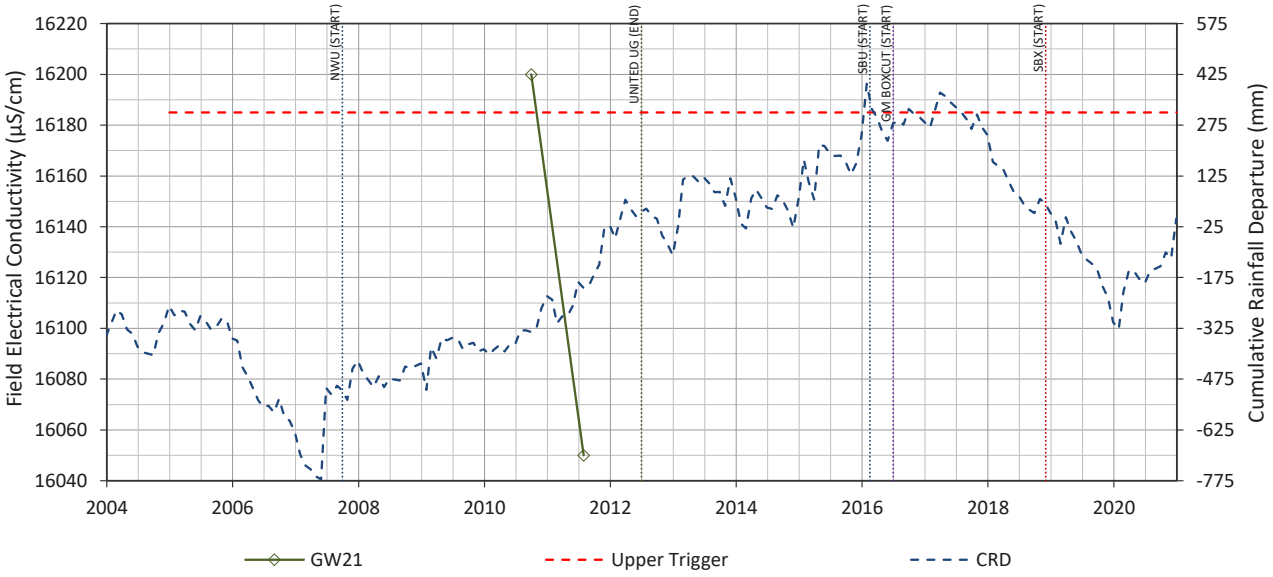

Field pH (pH unit)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
GW17
Upper Trigger
Lower Trigger
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
GW17
Upper Trigger
CRD

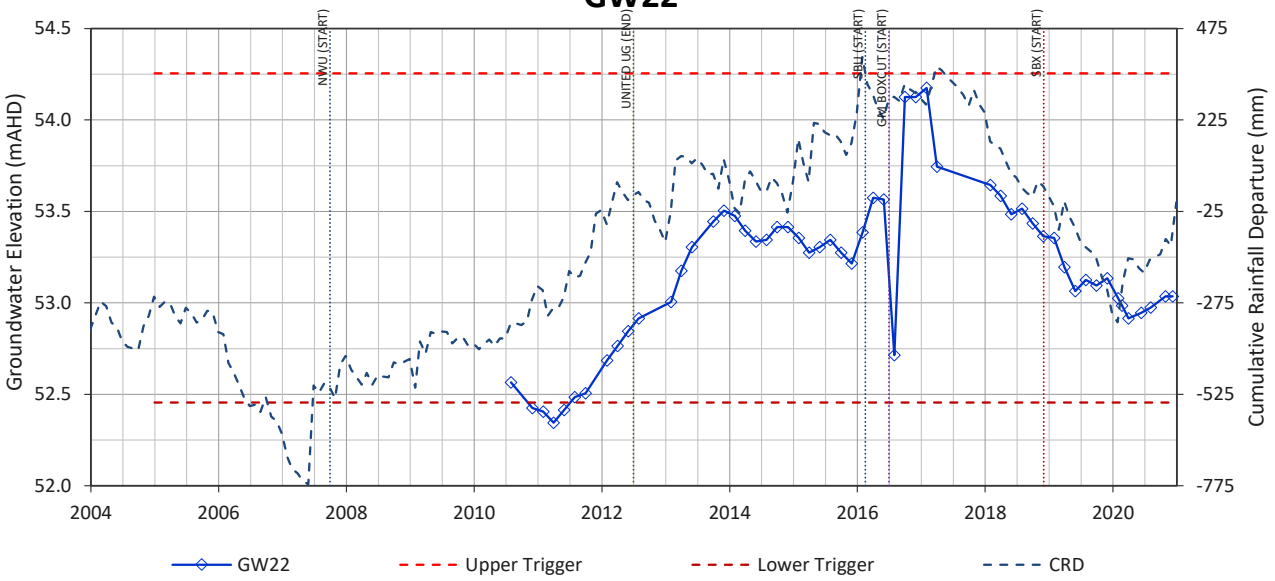
GW21

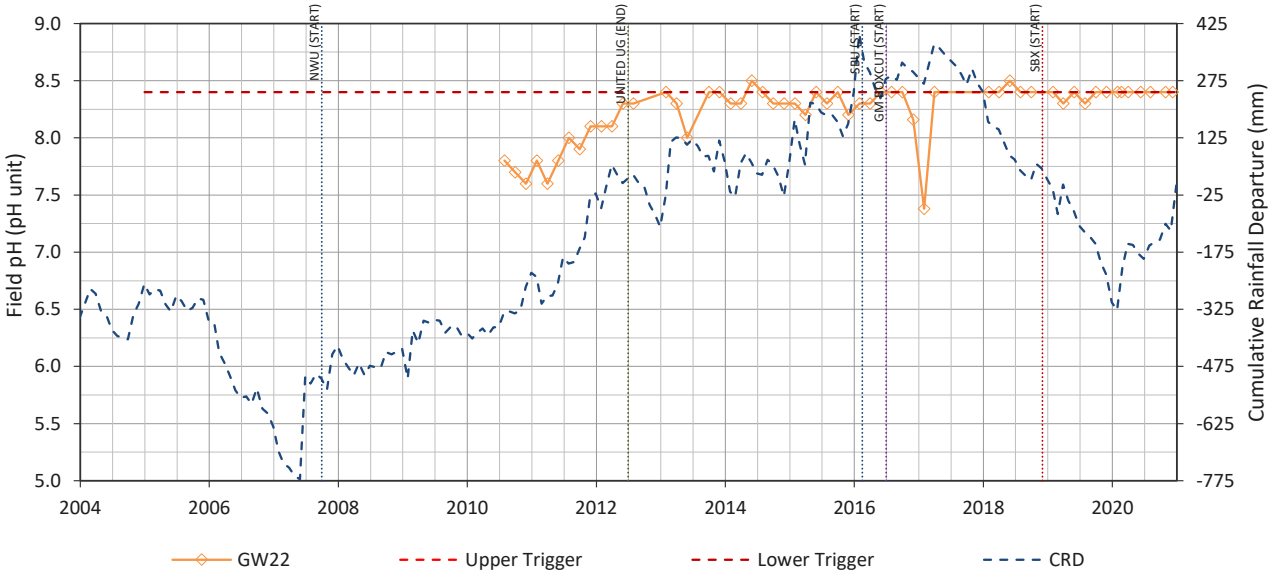

NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
85.6
85.5
85.4
85.3
85.2
85.1
85.0
275
100
-75
-250
-425
-600
-775
2004
2006
2008
2010
2012
2014
2016
2018
2020
GW21
Upper Trigger
Lower Trigger
CRD

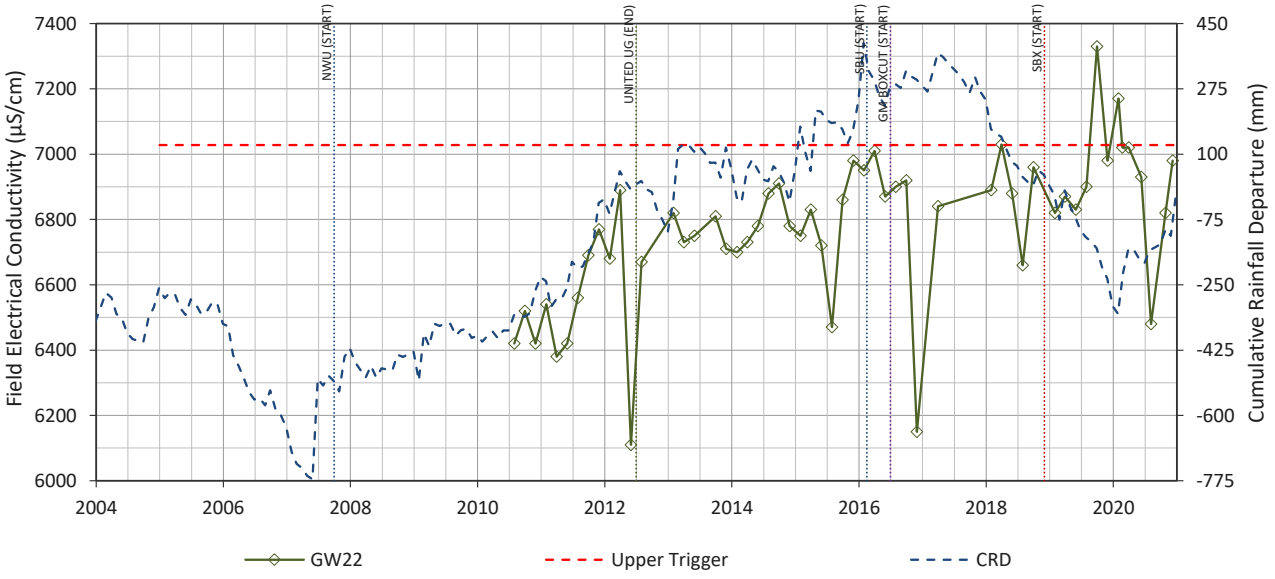

NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
2004
2006
2008
2010
2012
2014
2016
2018
2020
GW21
Upper Trigger
Lower Trigger
CRD


NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
16220
16200
16180
16160
16140
16120
16100
16080
16060
16040
575
425
275
125
-25
-175
-325
-475
-625
-775
2004
2006
2008
2010
2012
2014
2016
2018
2020
GW21
Upper Trigger
CRD

GW22


Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
GW22
Upper Trigger
Lower Trigger
CRD

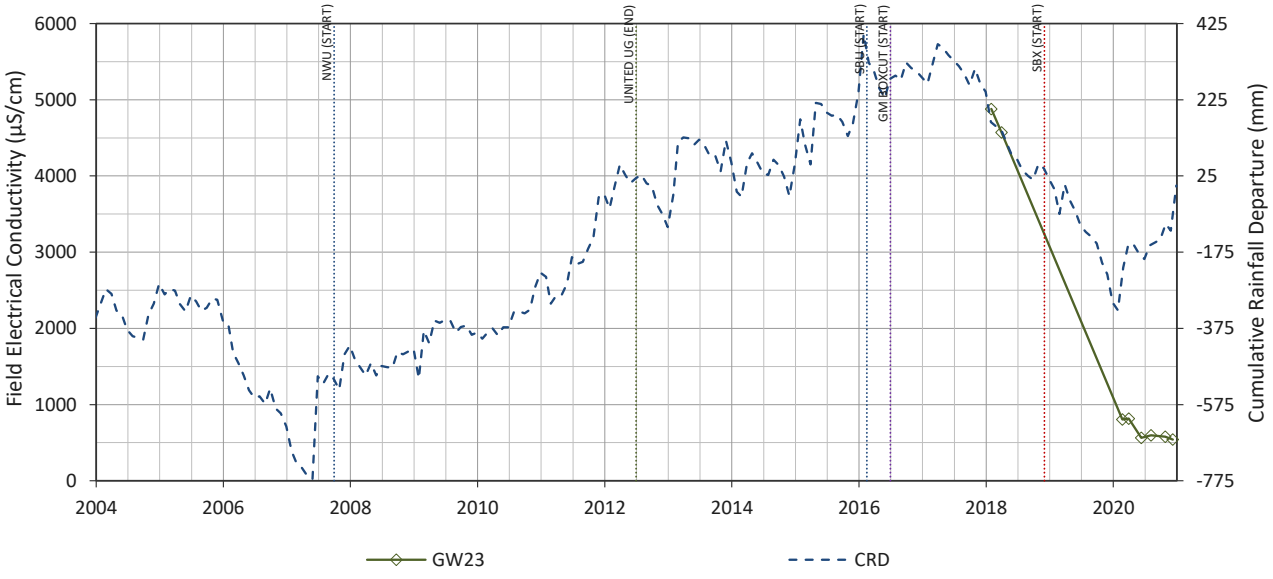

Field pH (pH unit)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
GW22
Upper Trigger
Lower Trigger
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
GW22
Upper Trigger
CRD

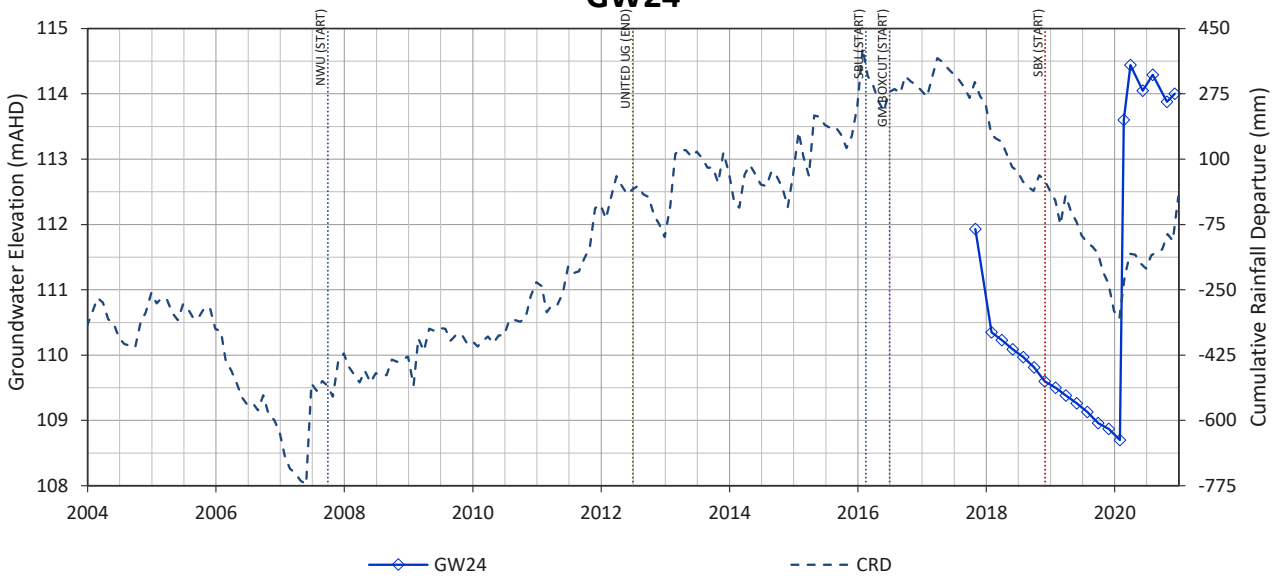
GW23

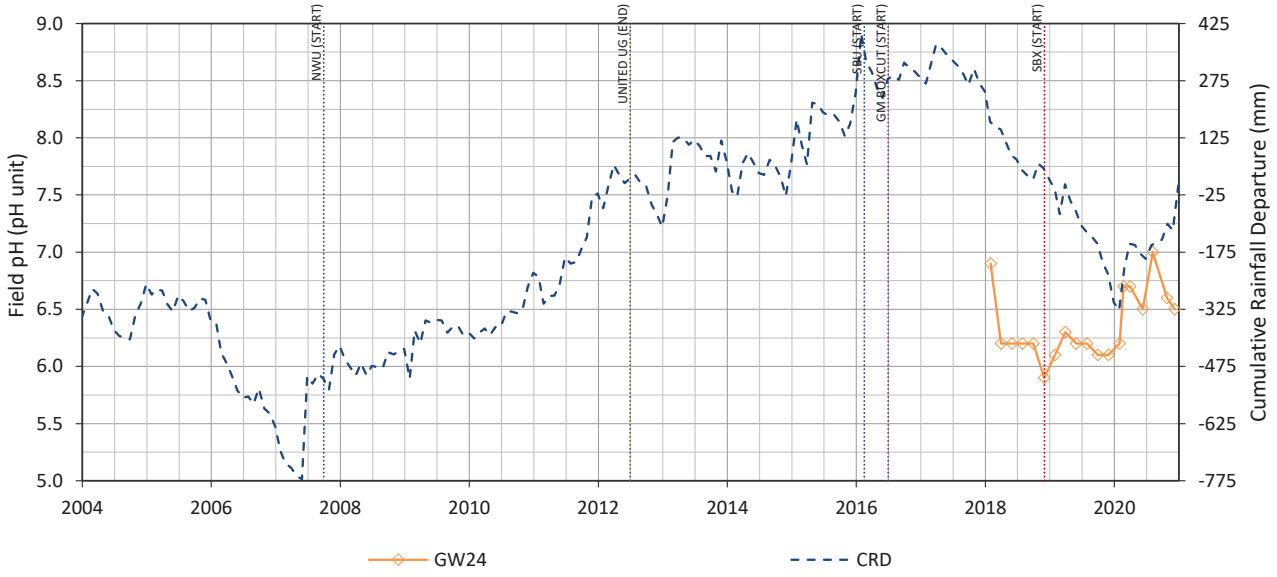

Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM4D XCUT (START)
SBX (START)
GW23
CRD

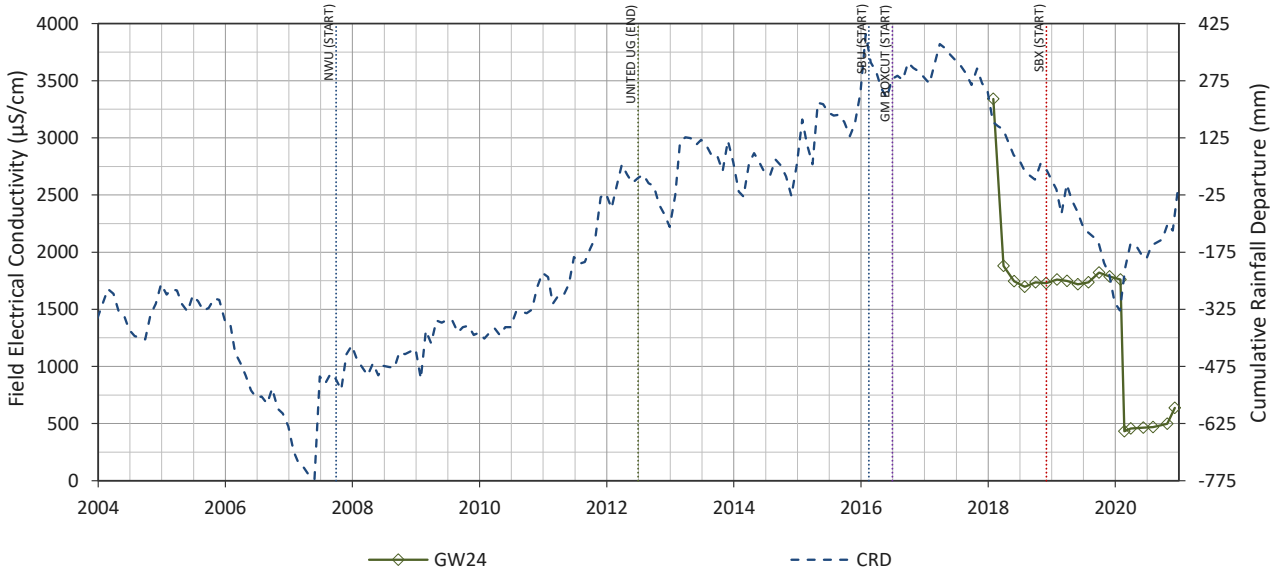

Field pH (pH unit)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM4D XCUT (START)
SBX (START)
GW23
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM4D XCUT (START)
SBX (START)
GW23
CRD

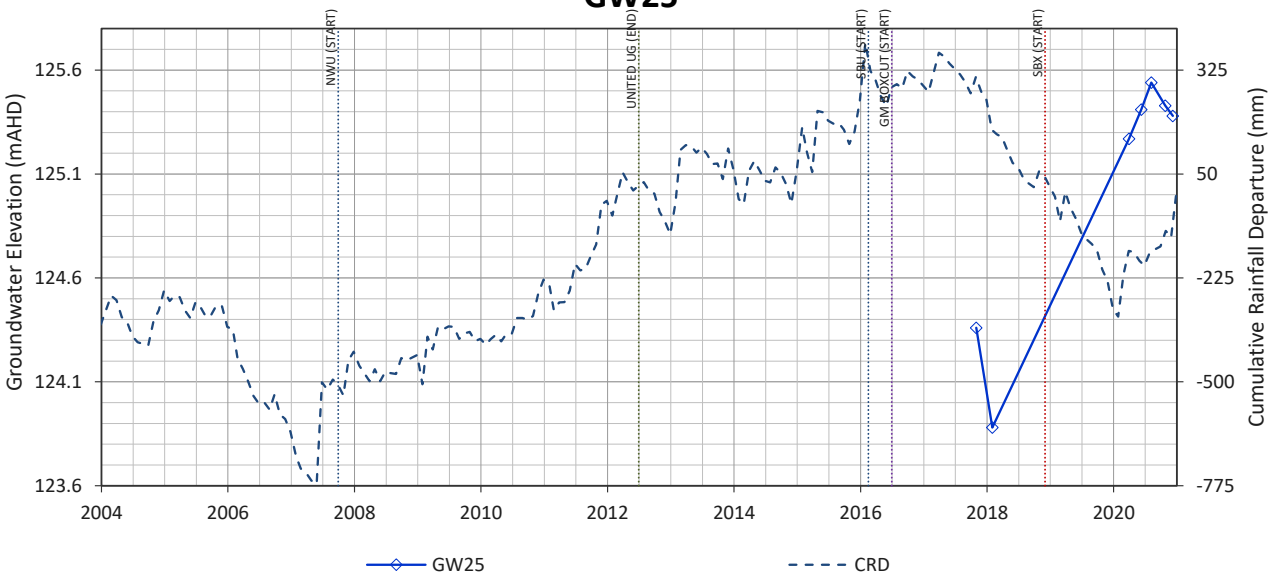
GW24


Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
GW24
CRD

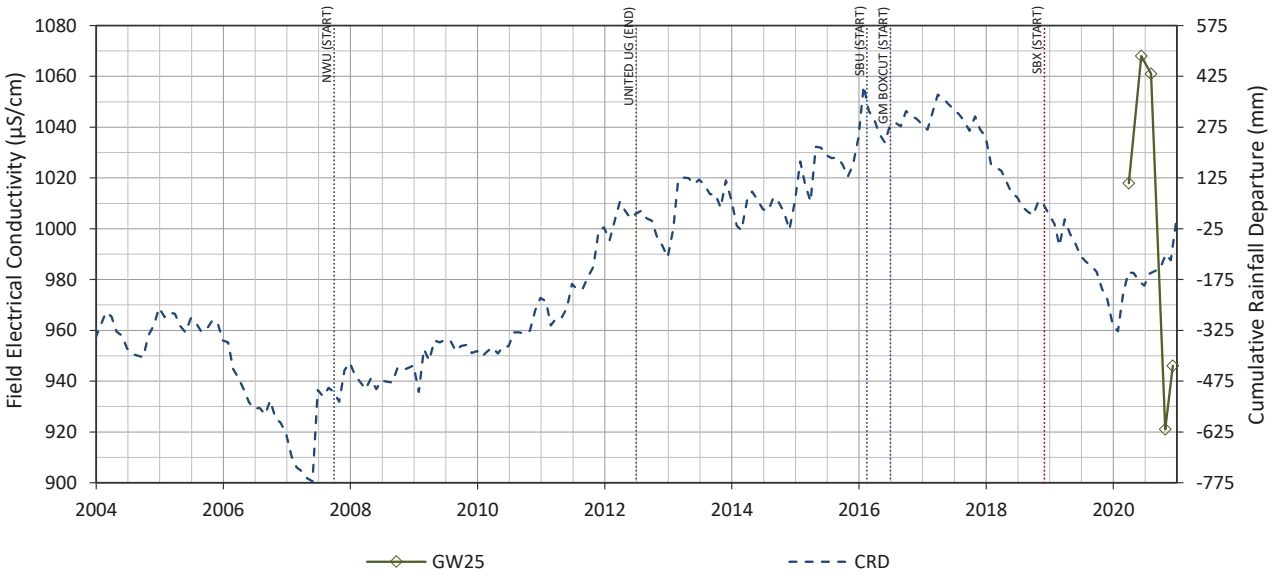

Field pH (pH unit)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
GW24
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
GW24
CRD

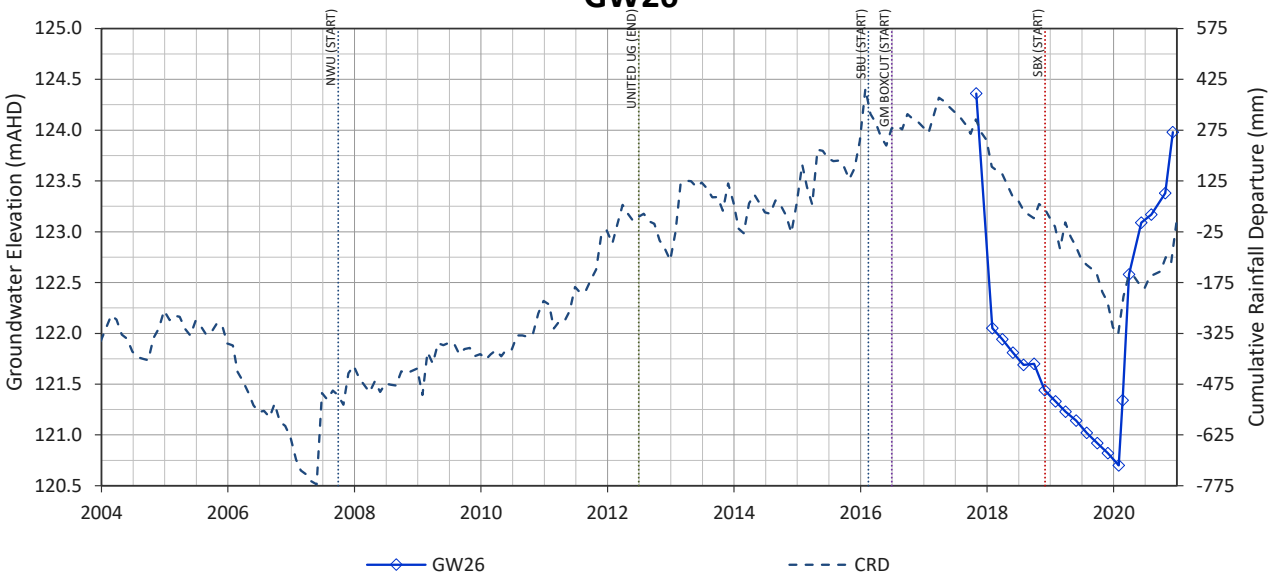
GW25

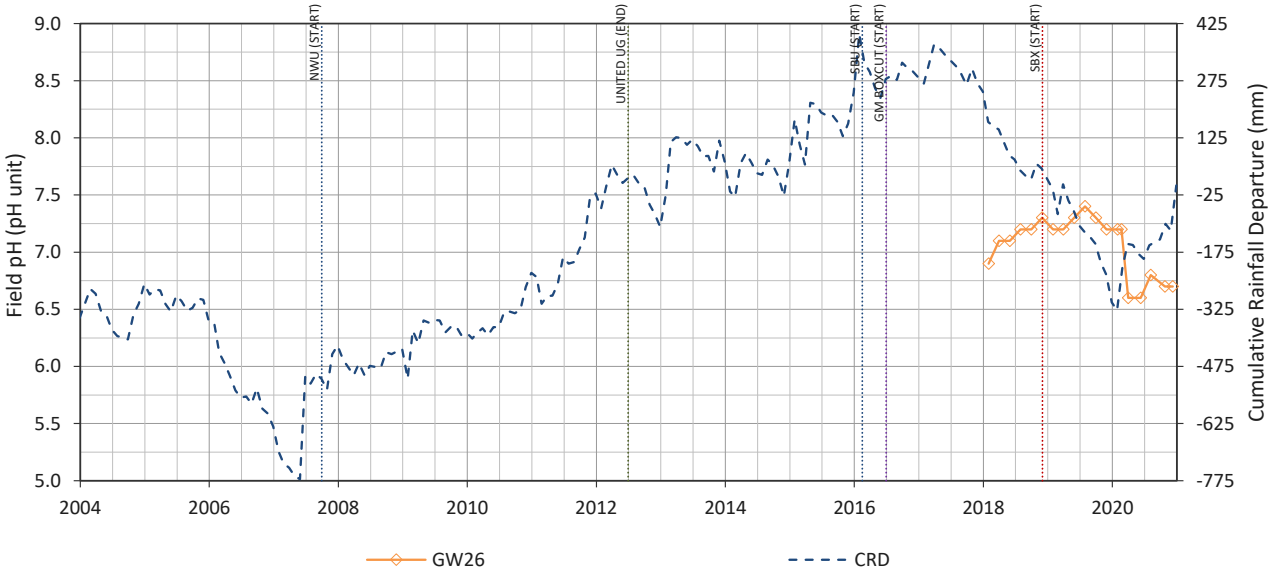

NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
125.6
125.1
124.6
124.1
123.6
325
50
-225
-500
-775
2004
2006
2008
2010
2012
2014
2016
2018
2020
GW25
CRD

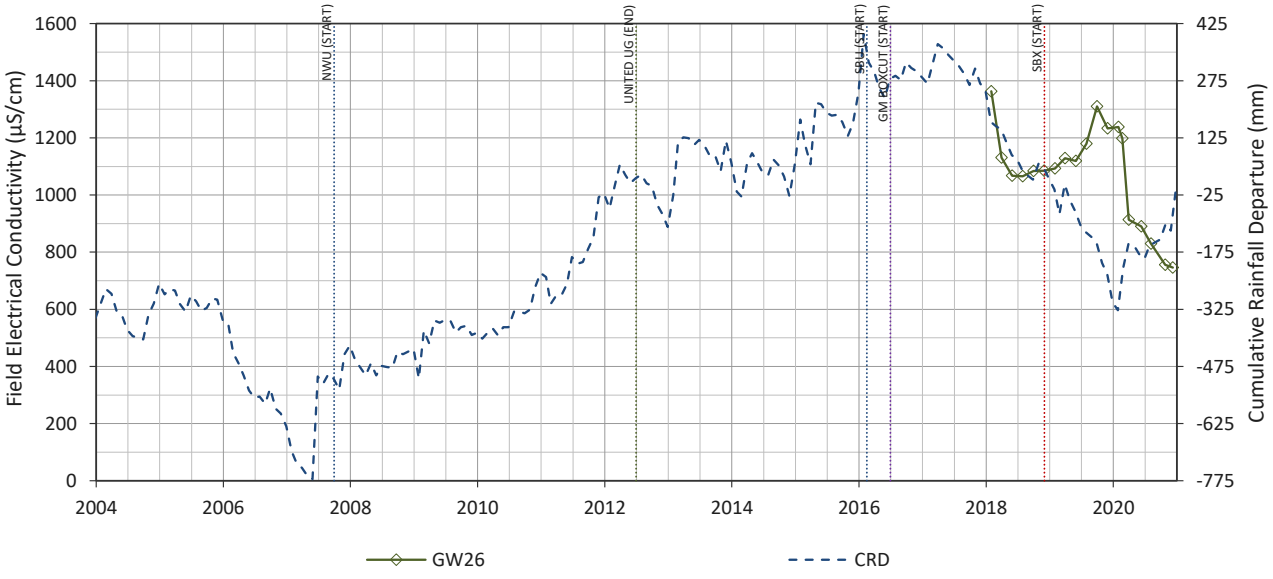

NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
Field pH (pH unit)
Cumulative Rainfall Departure (mm)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
425
275
125
-25
-175
-325
-475
-625
-775
2004
2006
2008
2010
2012
2014
2016
2018
2020
GW25
CRD


NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
1080
1060
1040
1020
1000
980
960
940
920
900
575
425
275
125
-25
-175
-325
-475
-625
-775
2004
2006
2008
2010
2012
2014
2016
2018
2020
GW25
CRD

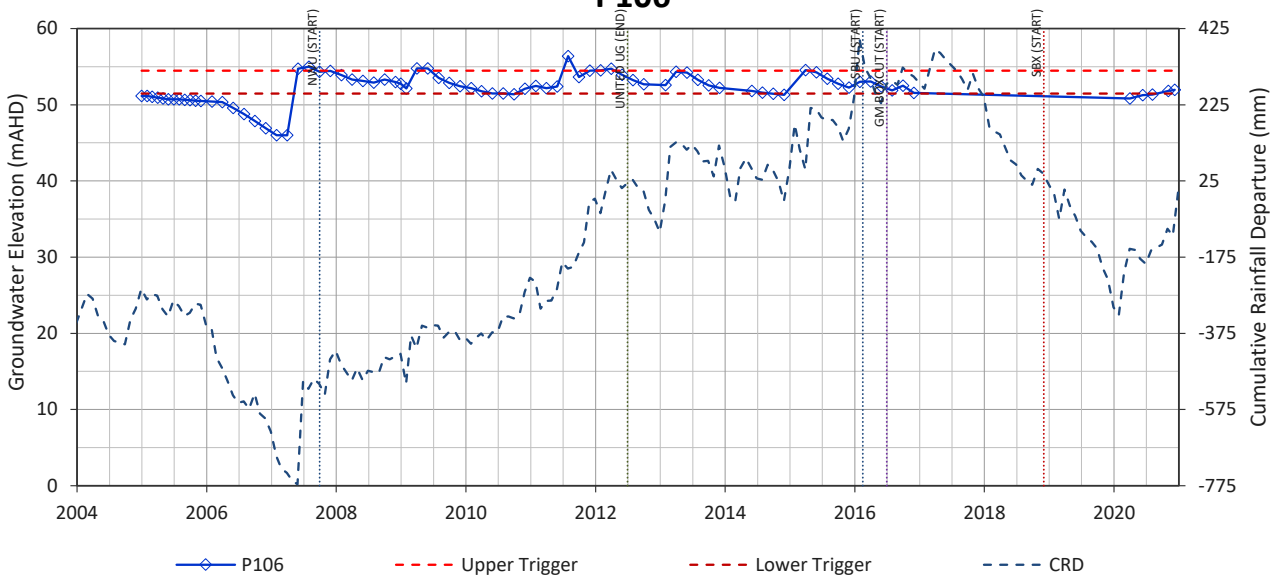
GW26

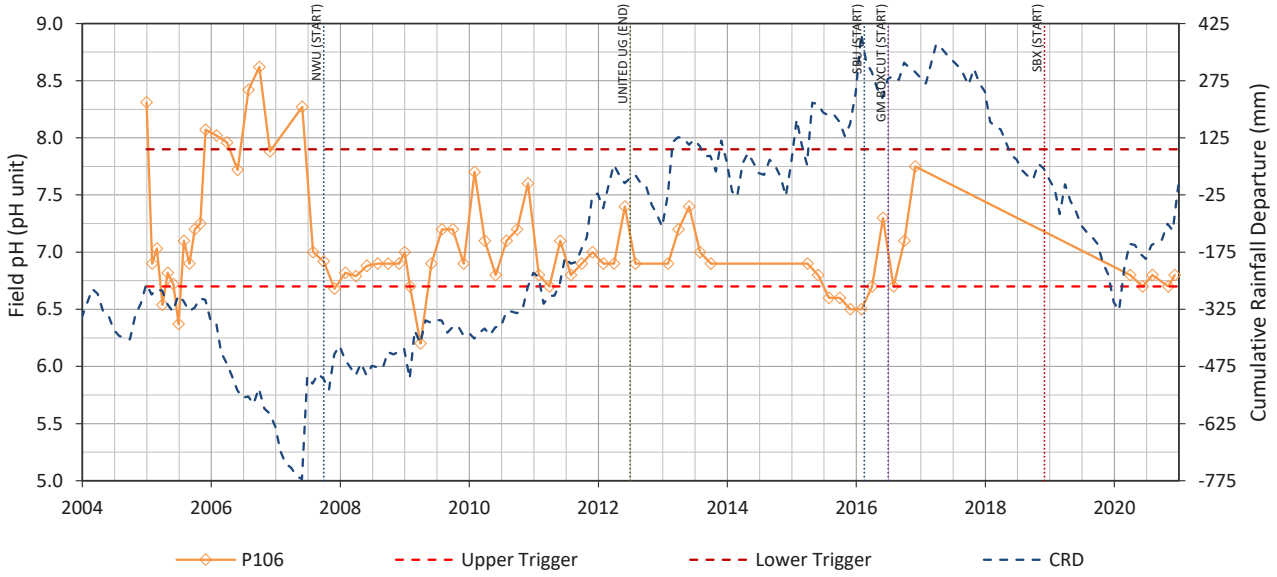

Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
GW26
CRD

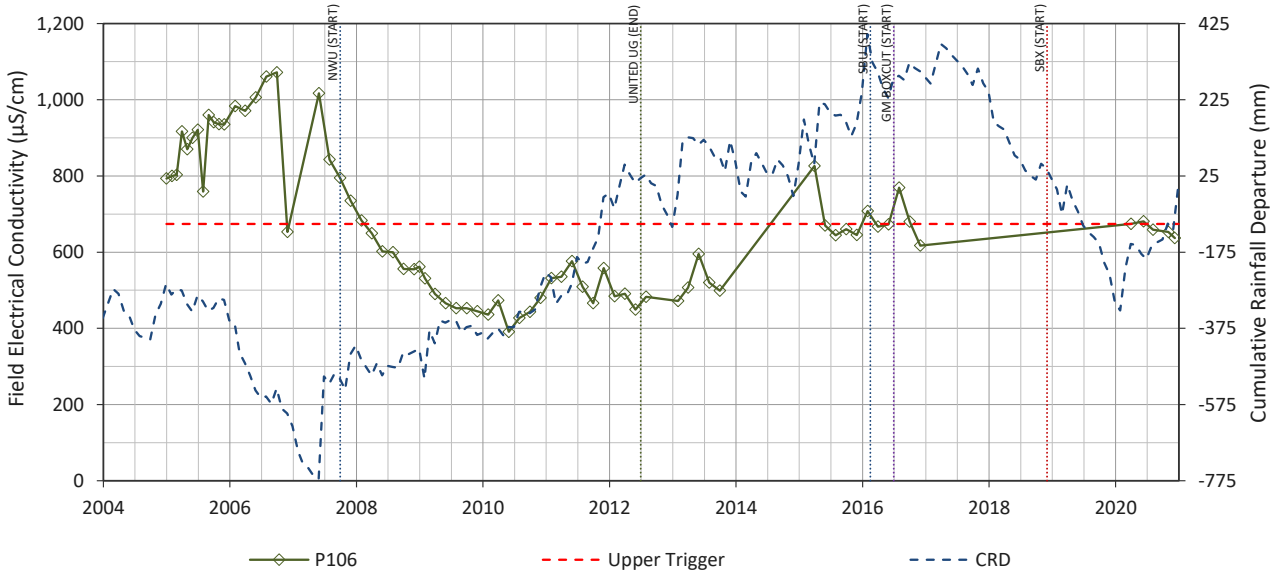

Field pH (pH unit)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
GW26
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
GW26
CRD

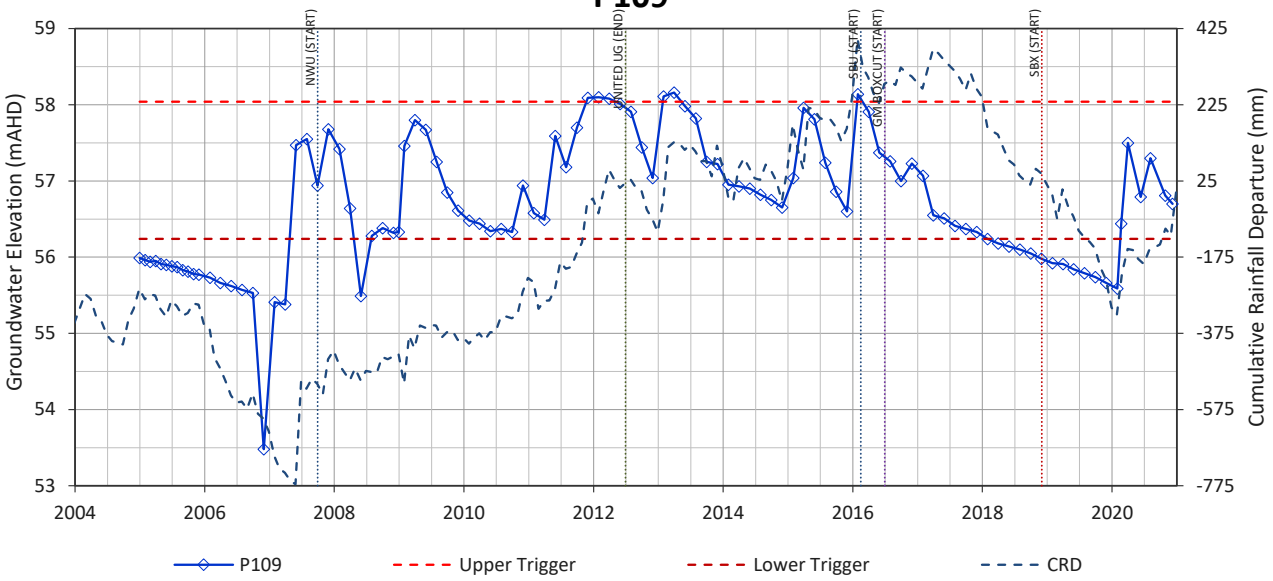
P106

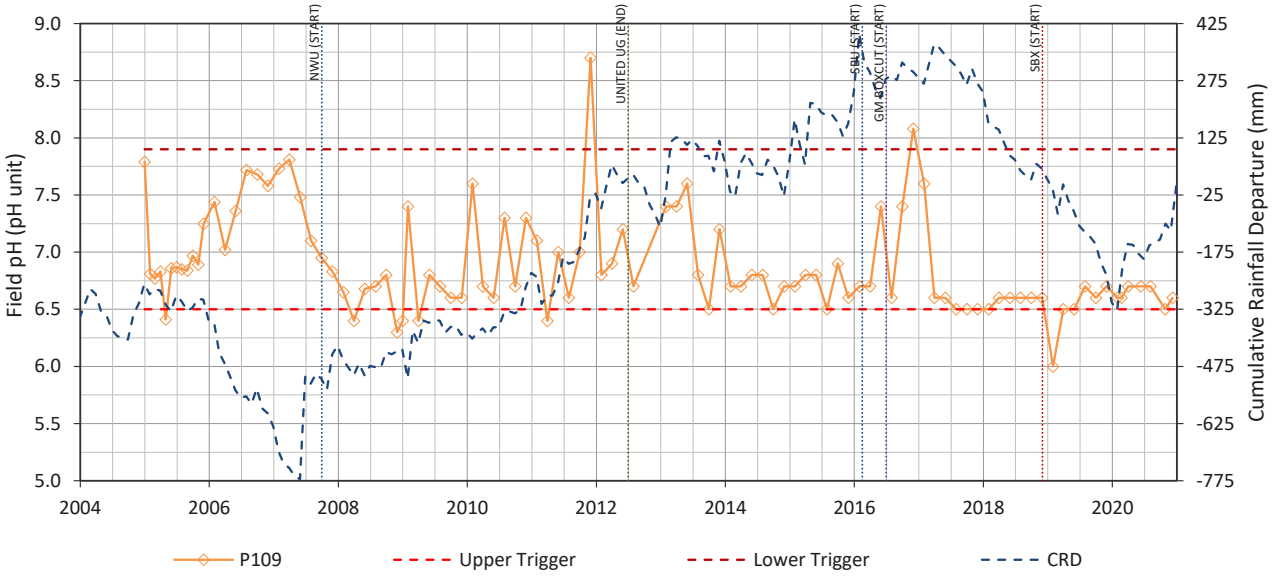

Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM & OXCUT (START)
SBX (START)
P106
Upper Trigger
Lower Trigger
CRD

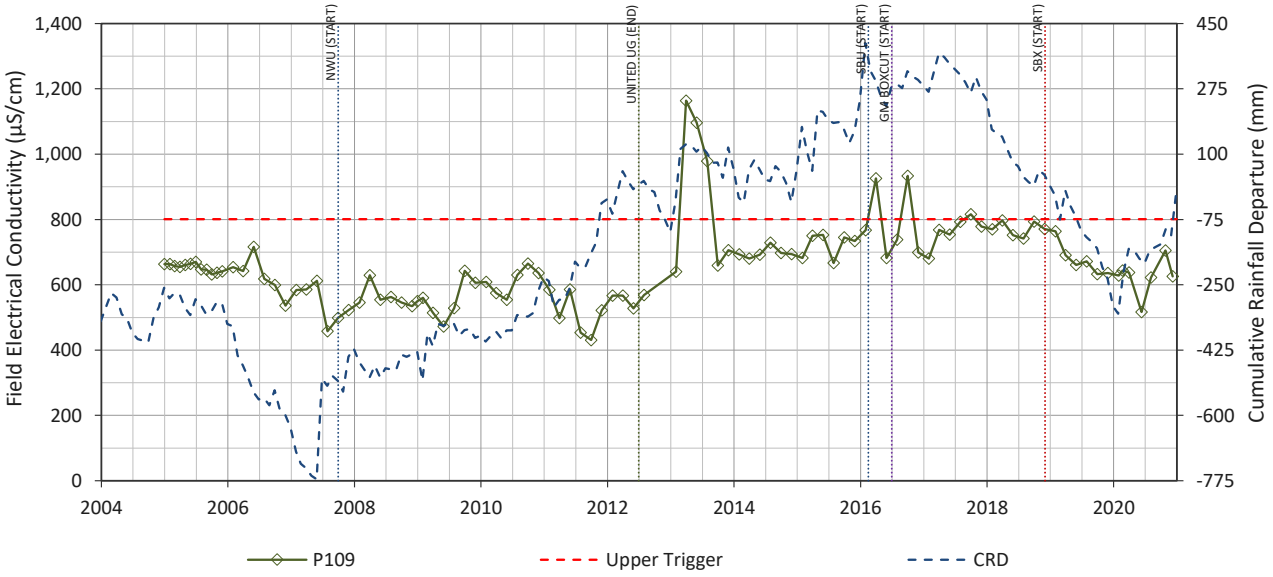

Field pH (pH unit)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM & OXCUT (START)
SBX (START)
P106
Upper Trigger
Lower Trigger
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM & OXCUT (START)
SBX (START)
P106
Upper Trigger
CRD

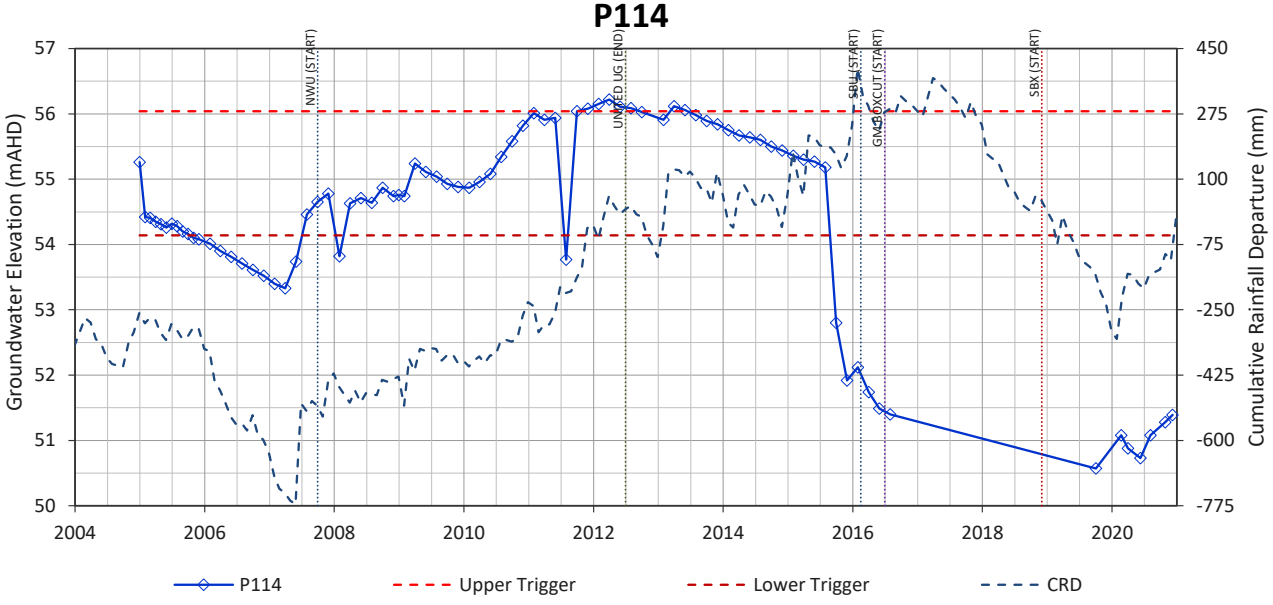
P109

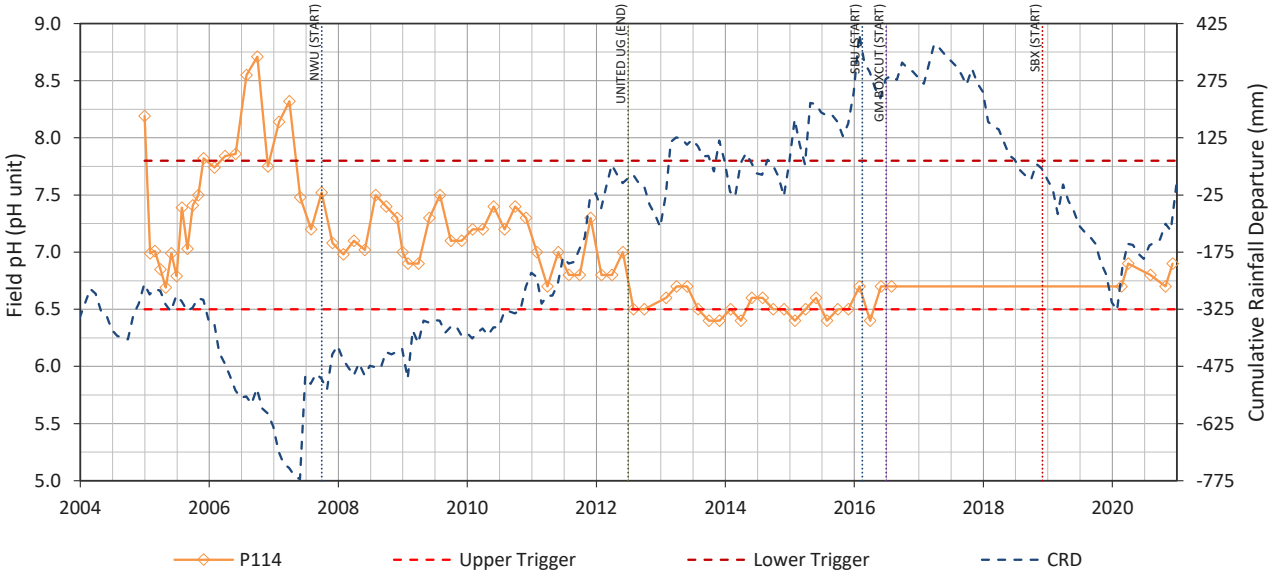

Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
P109
Upper Trigger
Lower Trigger
CRD

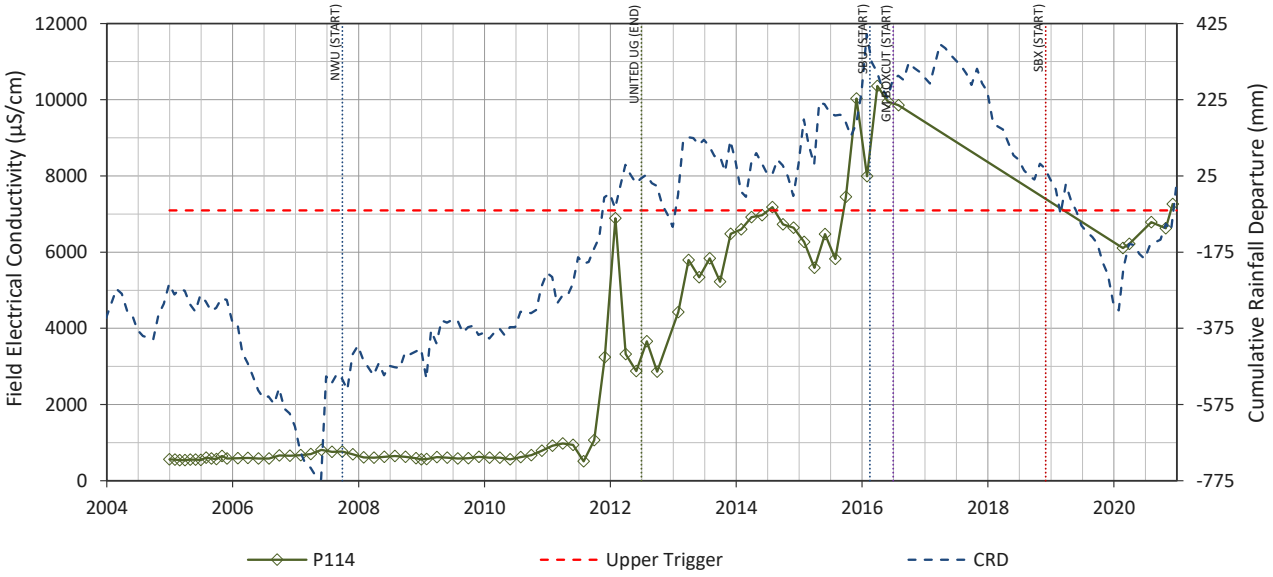

Field pH (pH unit)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
P109
Upper Trigger
Lower Trigger
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
P109
Upper Trigger
CRD

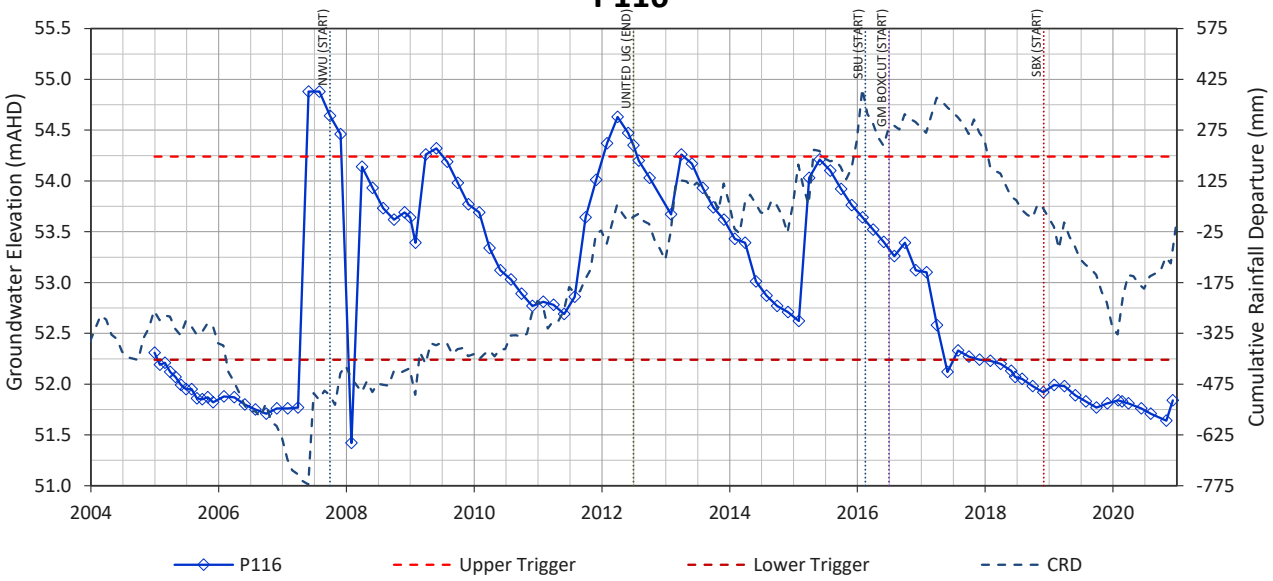
P114

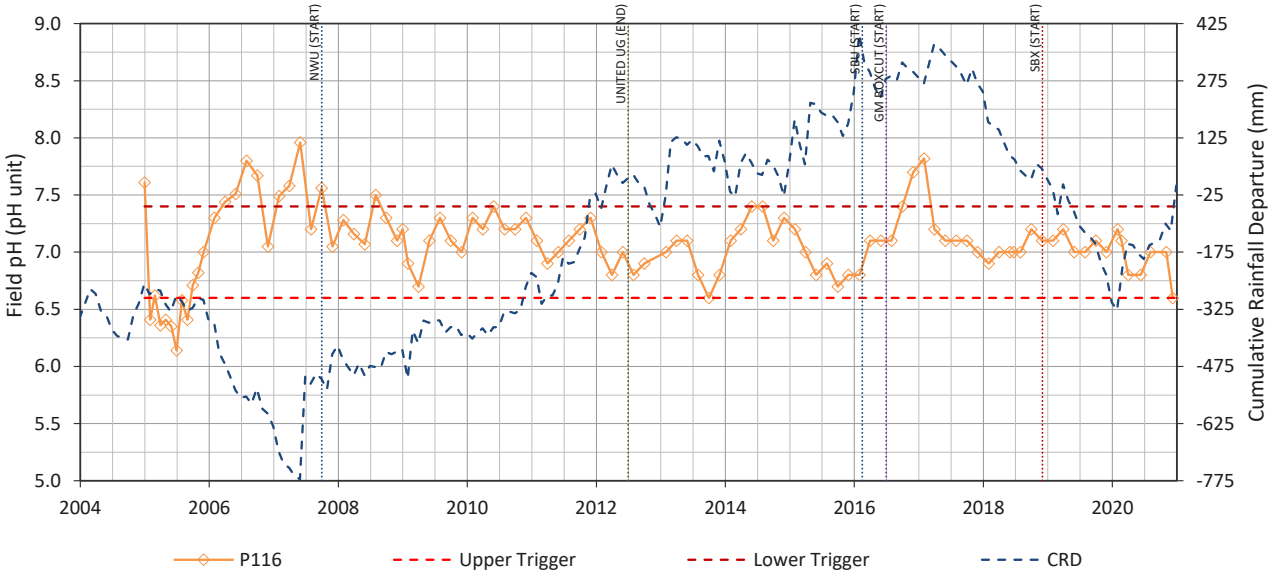

Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM4 OXCUT (START)
SBX (START)
P114
Upper Trigger
Lower Trigger
CRD

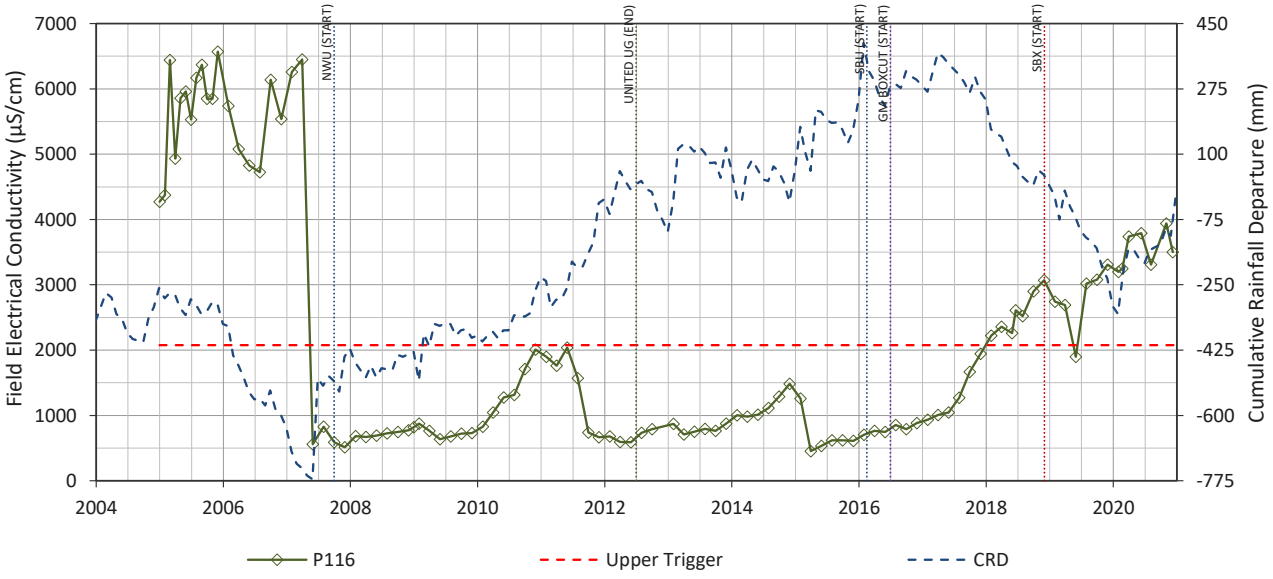

Field pH (pH unit)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM4 OXCUT (START)
SBX (START)
P114
Upper Trigger
Lower Trigger
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM4 OXCUT (START)
SBX (START)
P114
Upper Trigger
CRD

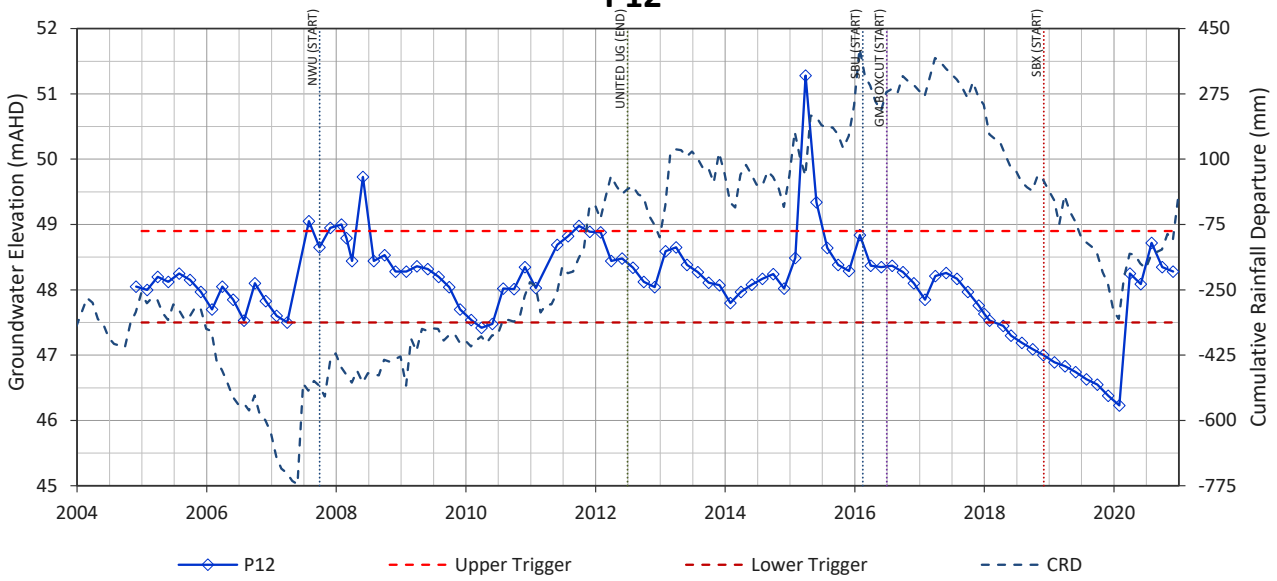
P116

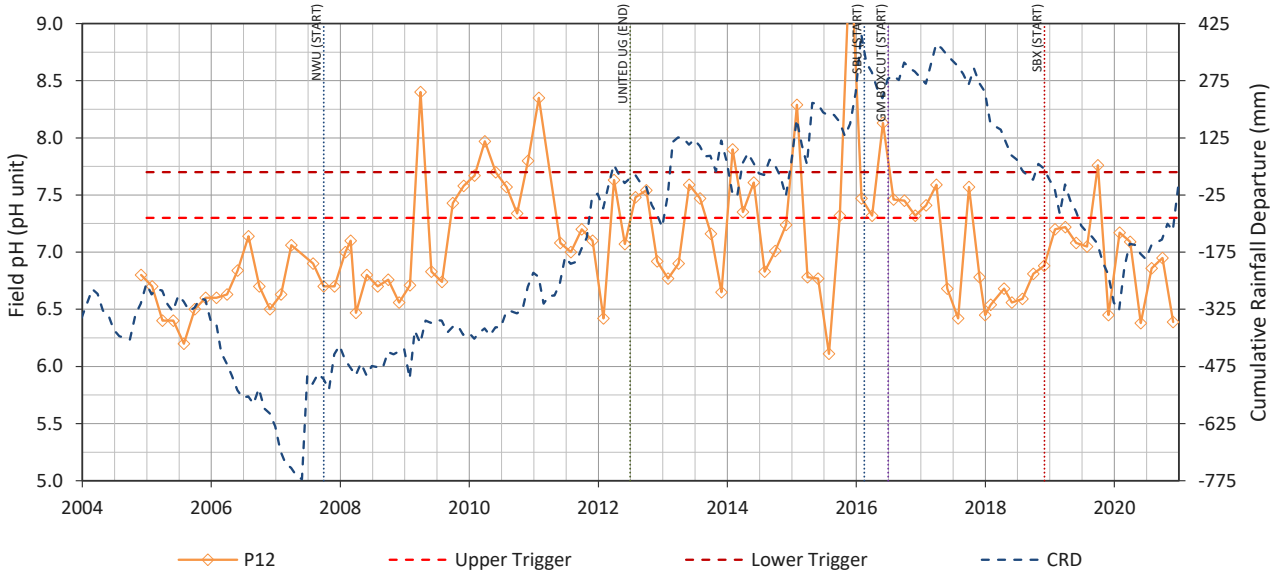

Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
P116
Upper Trigger
Lower Trigger
CRD

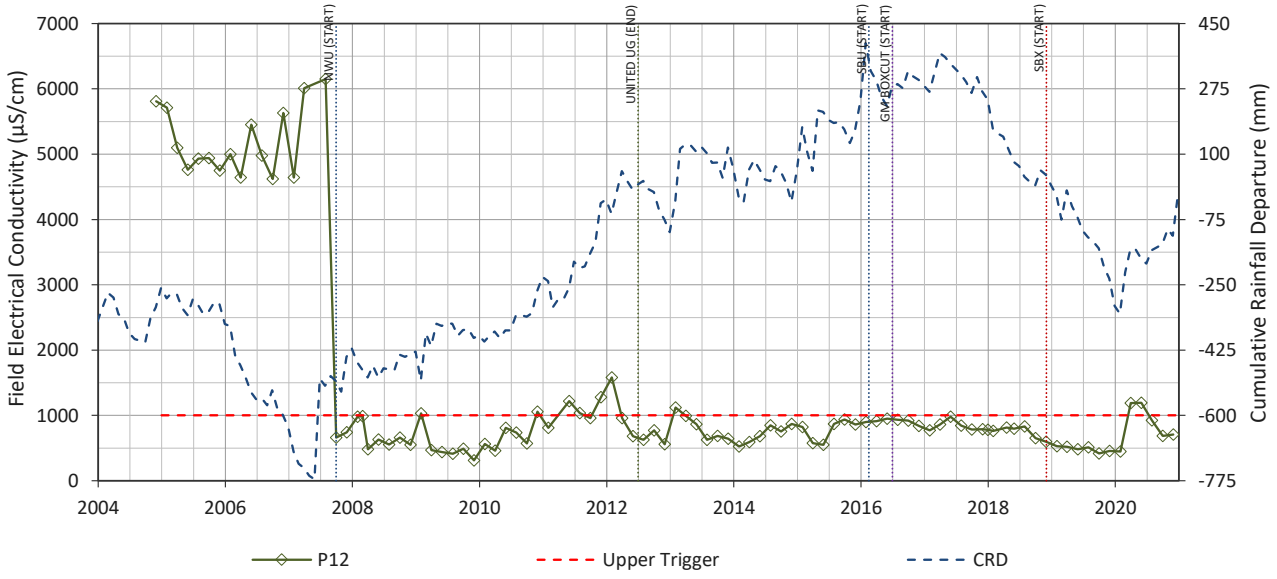

Field pH (pH unit)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
P116
Upper Trigger
Lower Trigger
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
P116
Upper Trigger
CRD

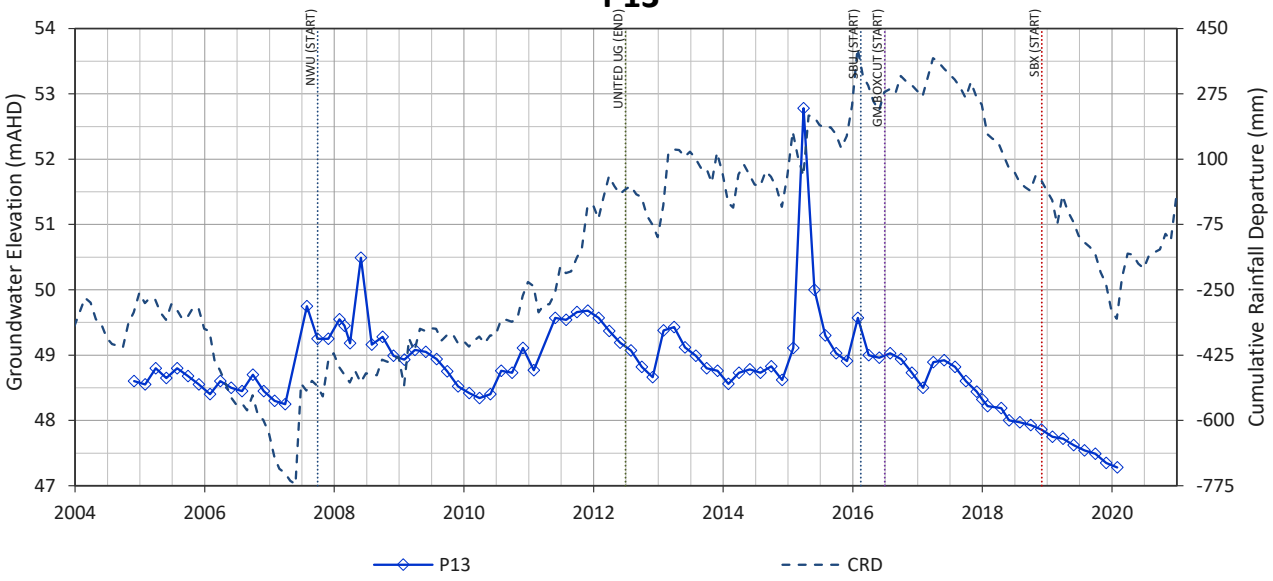
P12

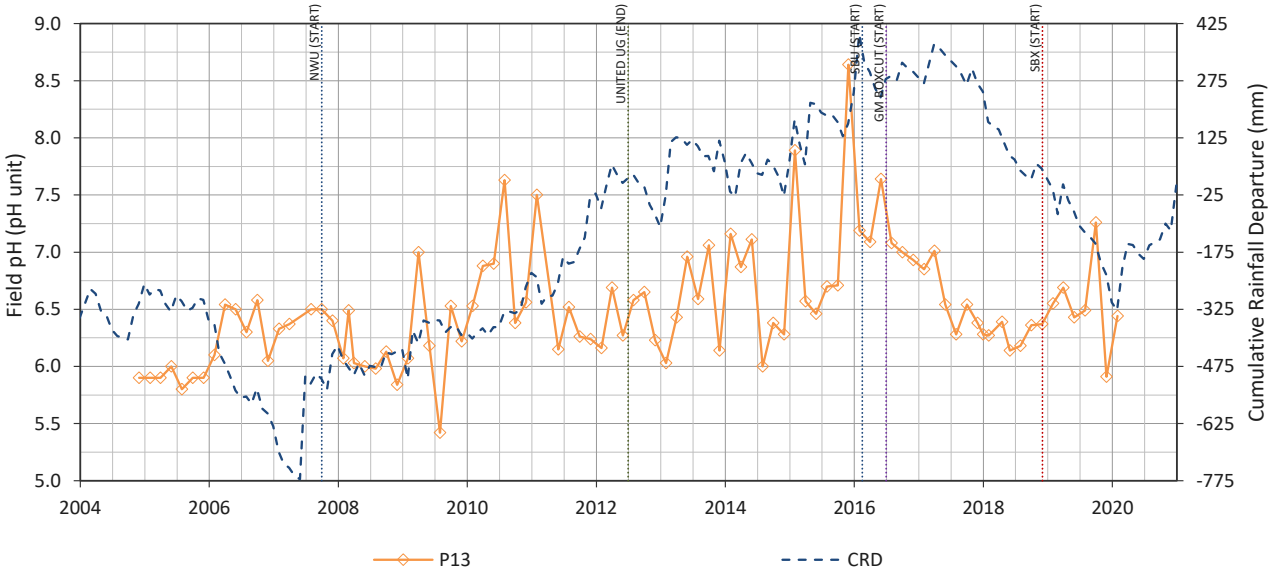

Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM4 BOXCUT (START)
SBX (START)
P12
Upper Trigger
Lower Trigger
CRD

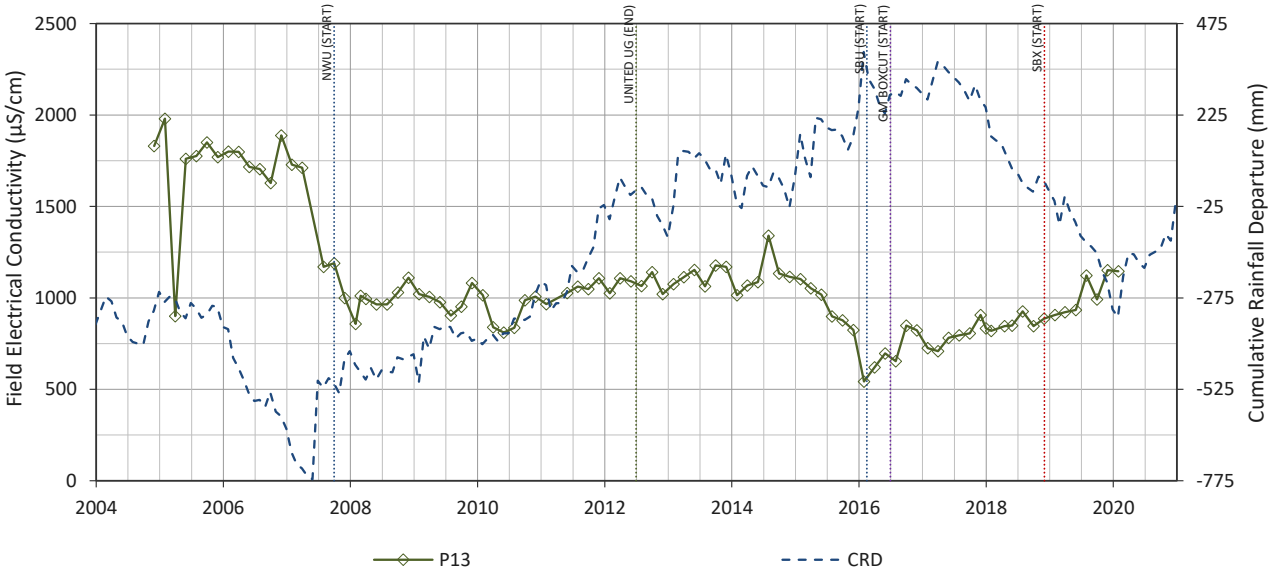

Field pH (pH unit)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM4 BOXCUT (START)
SBX (START)
P12
Upper Trigger
Lower Trigger
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM4 BOXCUT (START)
SBX (START)
P12
Upper Trigger
CRD

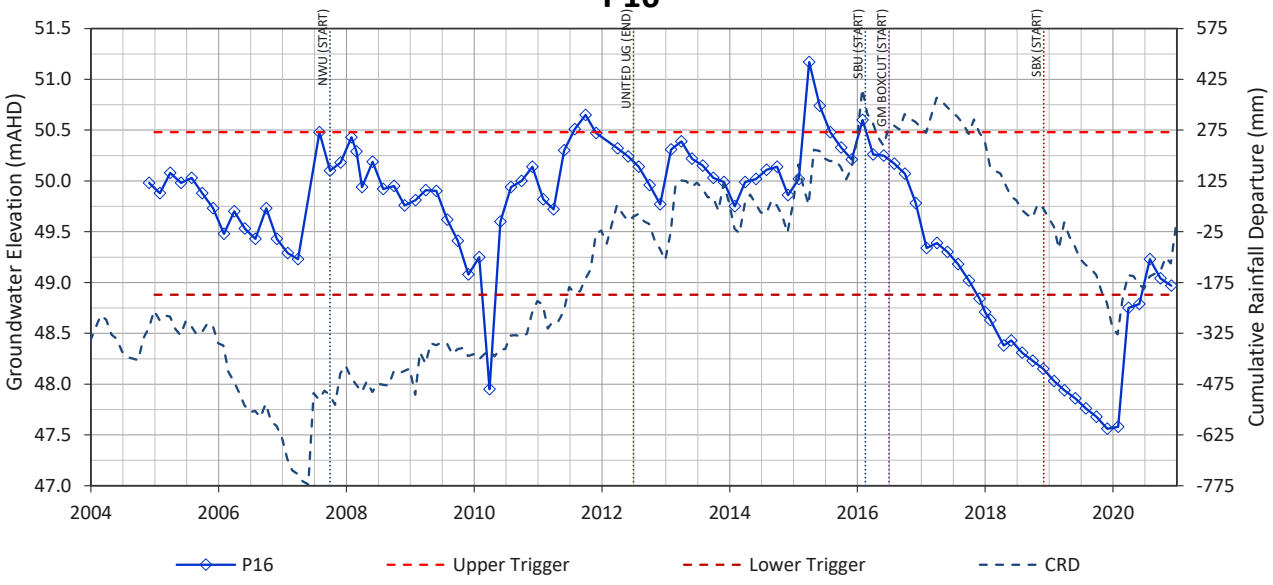
P13

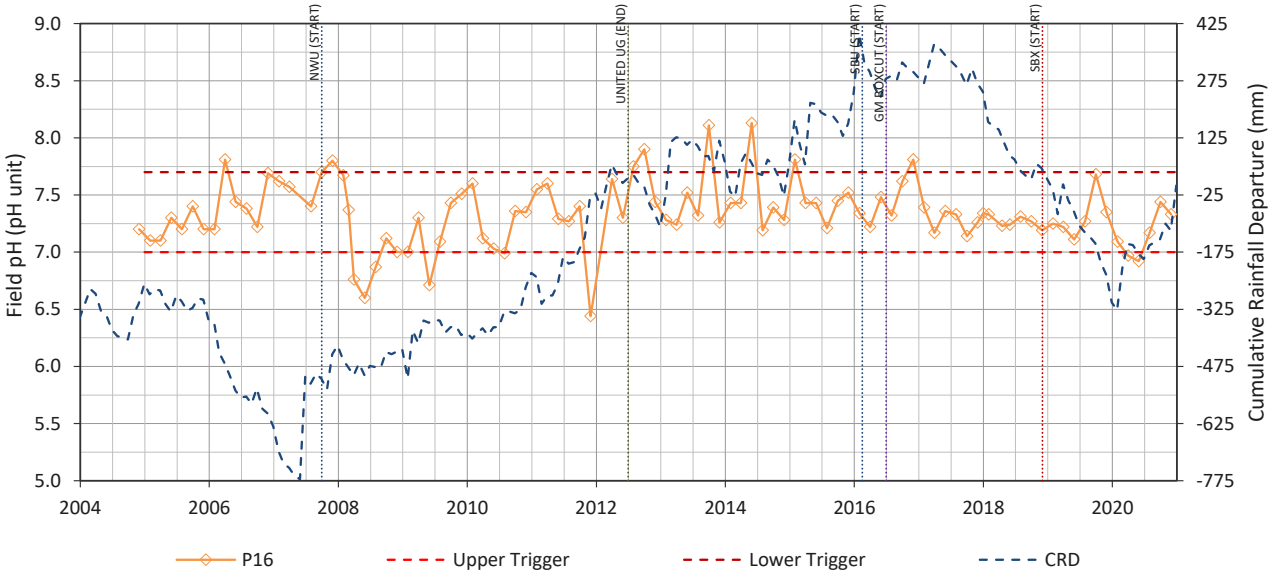

Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBH (START)
GM4 BOXCUT (START)
SBX (START)
P13
CRD

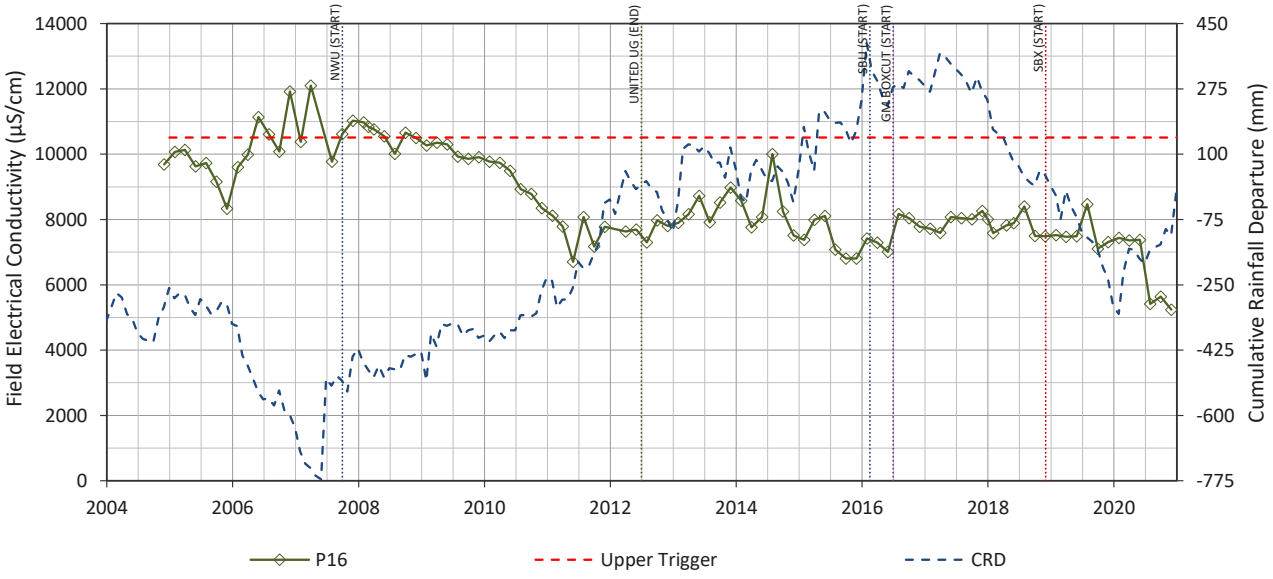

Field pH (pH unit)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBH (START)
GM4 BOXCUT (START)
SBX (START)
P13
CRD

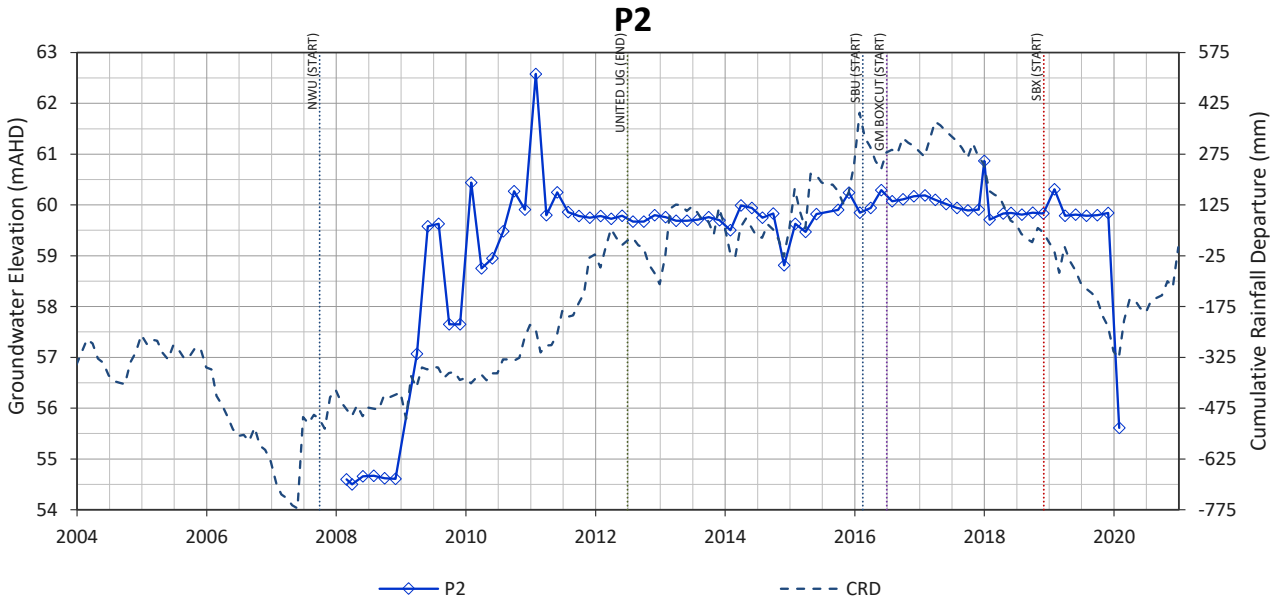

Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBH (START)
GM4 BOXCUT (START)
SBX (START)
P13
CRD

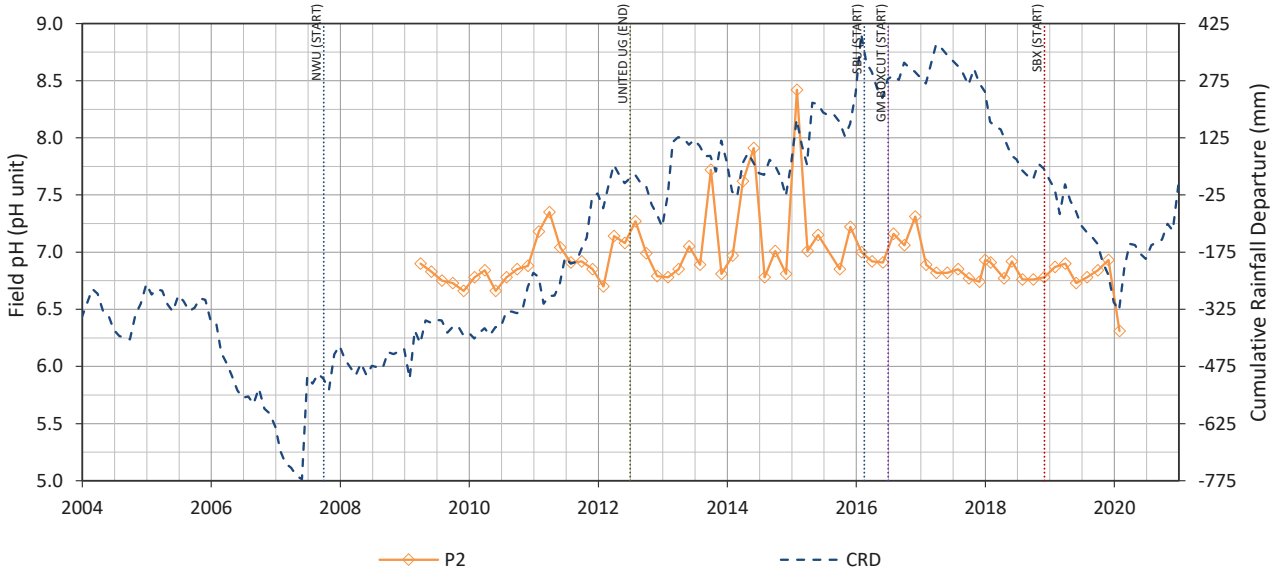
P16

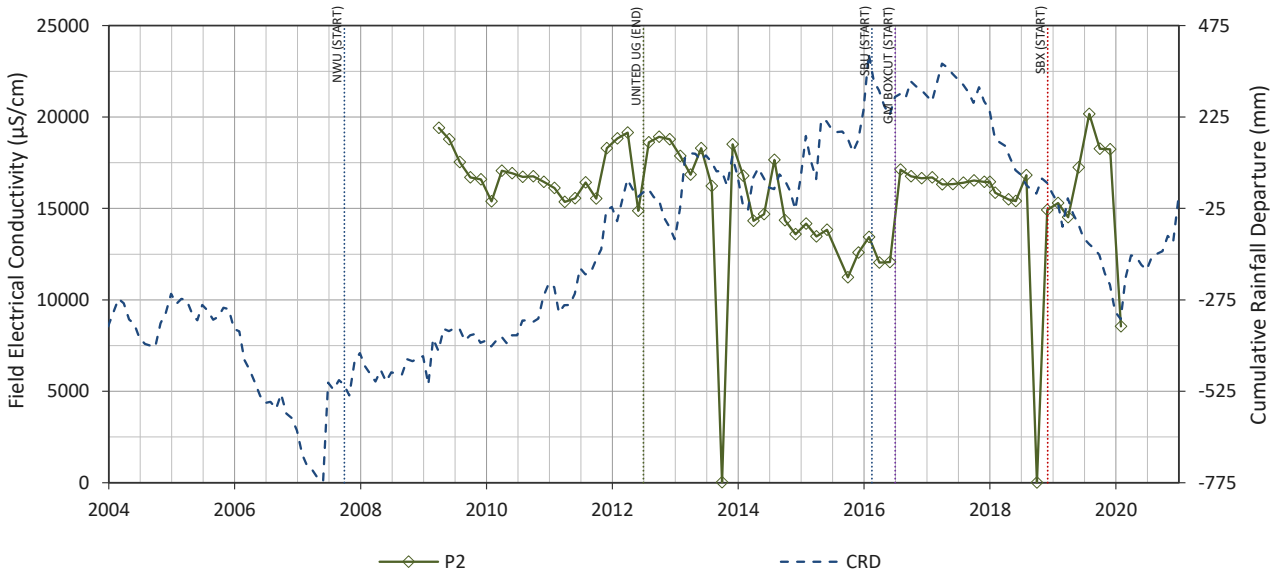

Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
P16
Upper Trigger
Lower Trigger
CRD


Field pH (pH unit)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
P16
Upper Trigger
Lower Trigger
CRD

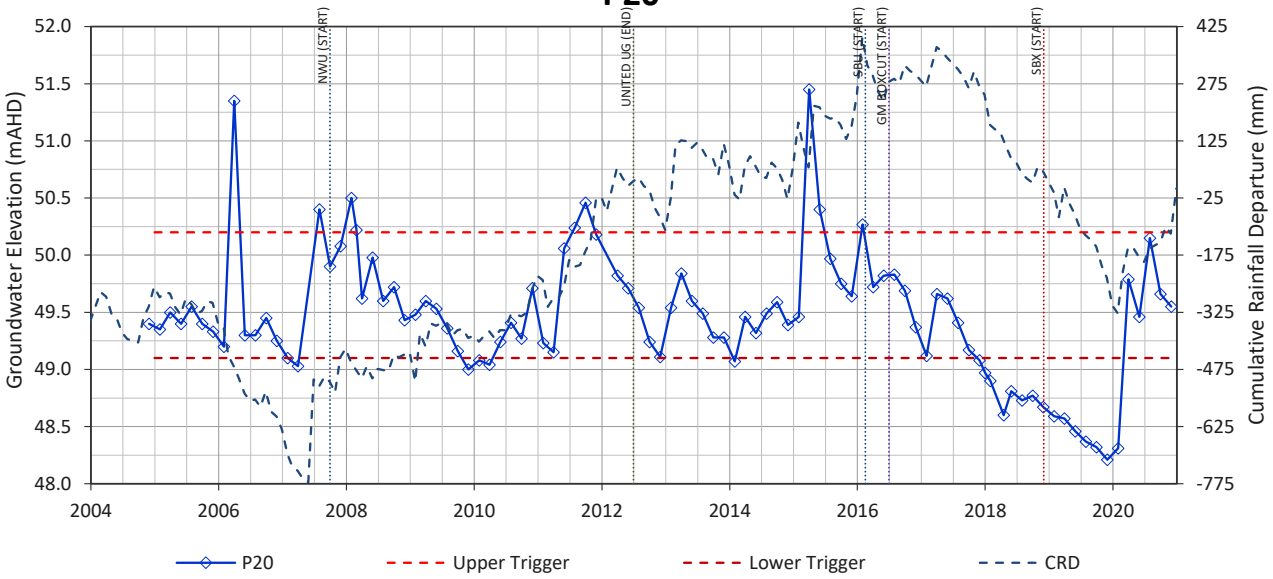

Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
P16
Upper Trigger
CRD

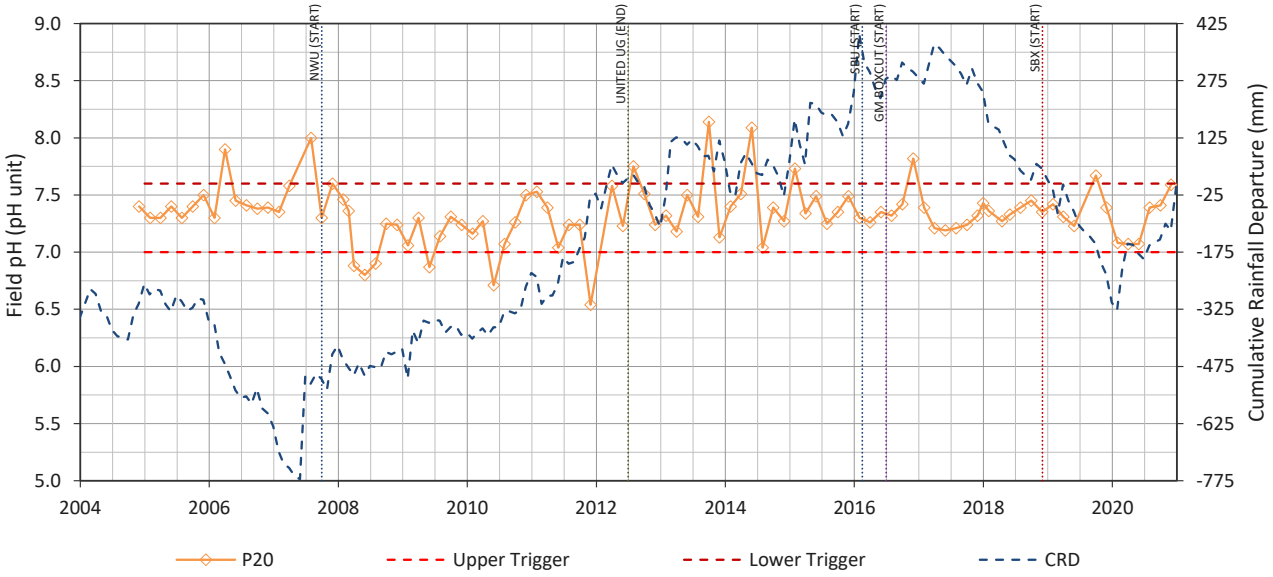

P2
Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
P2
CRD

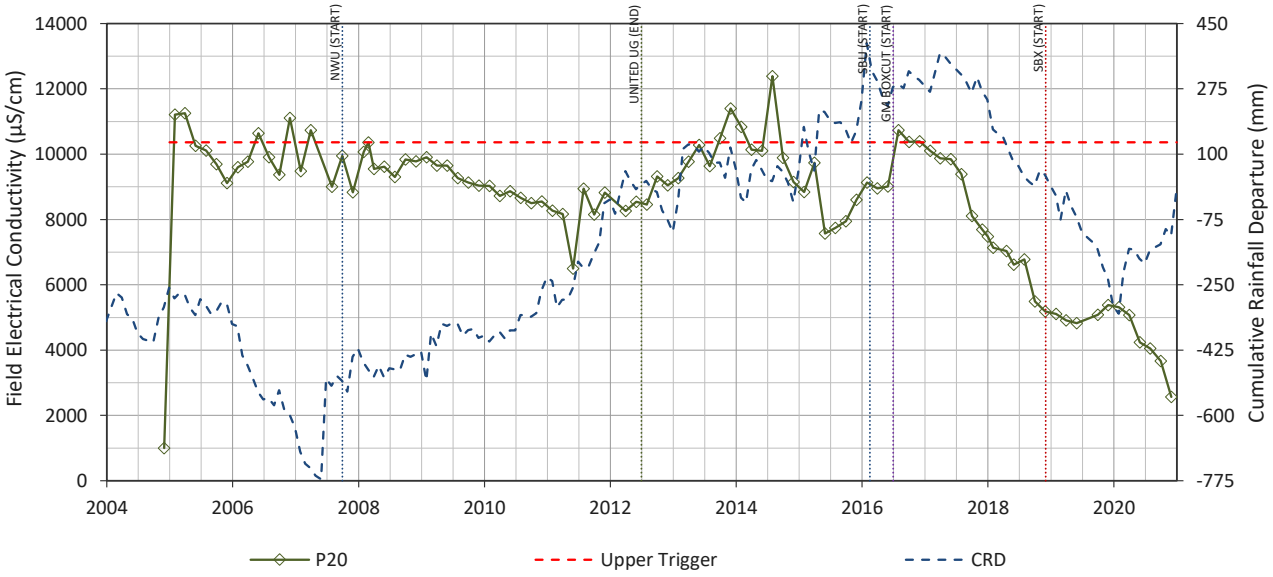

Field pH (pH unit)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
P2
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
P2
CRD

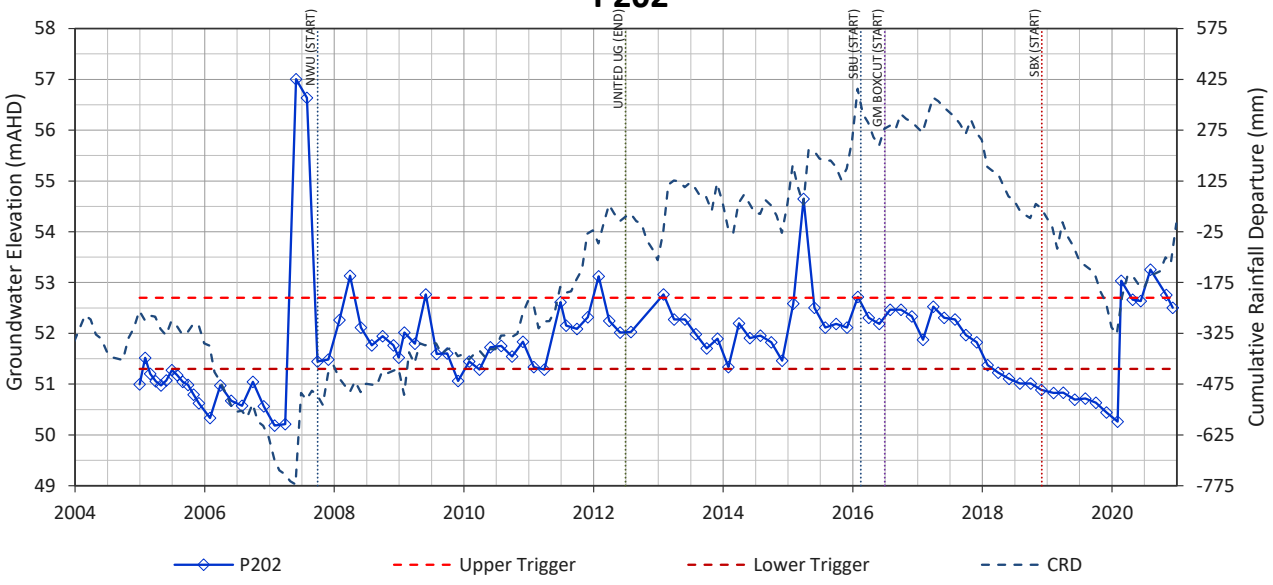
P20

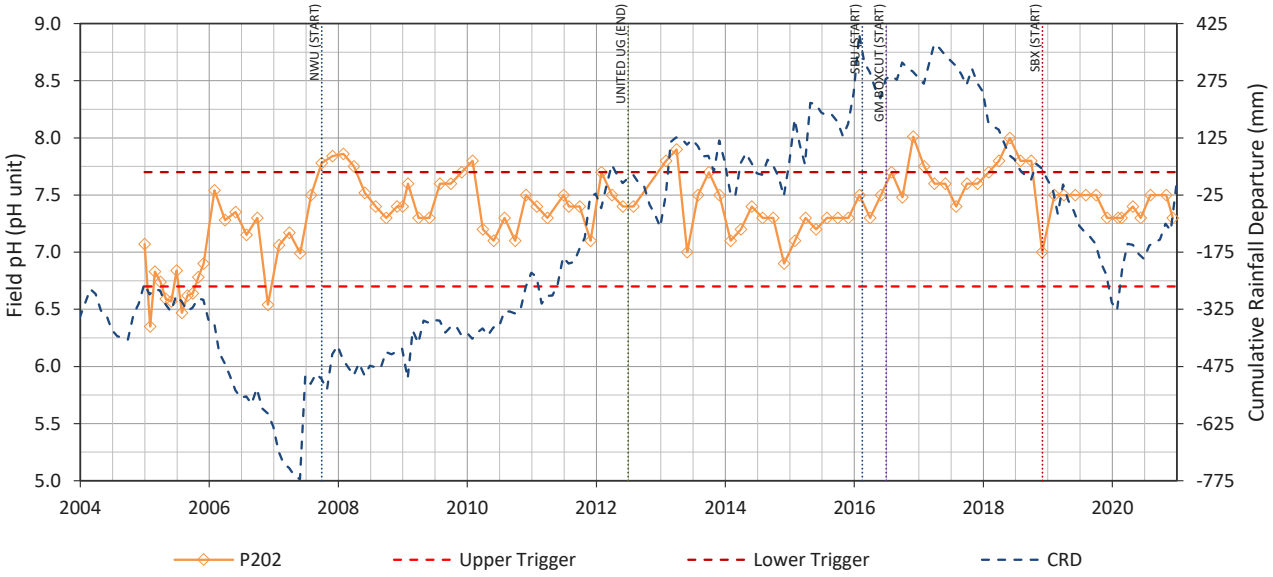

Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
P20
Upper Trigger
Lower Trigger
CRD

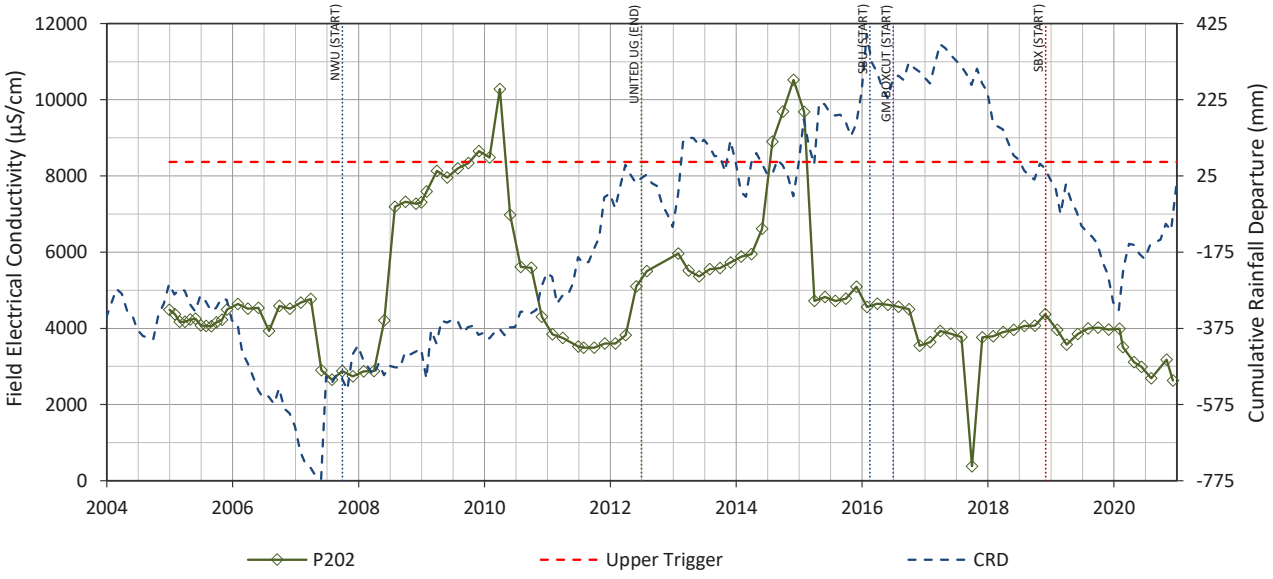

Field pH (pH unit)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
P20
Upper Trigger
Lower Trigger
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
P20
Upper Trigger
CRD

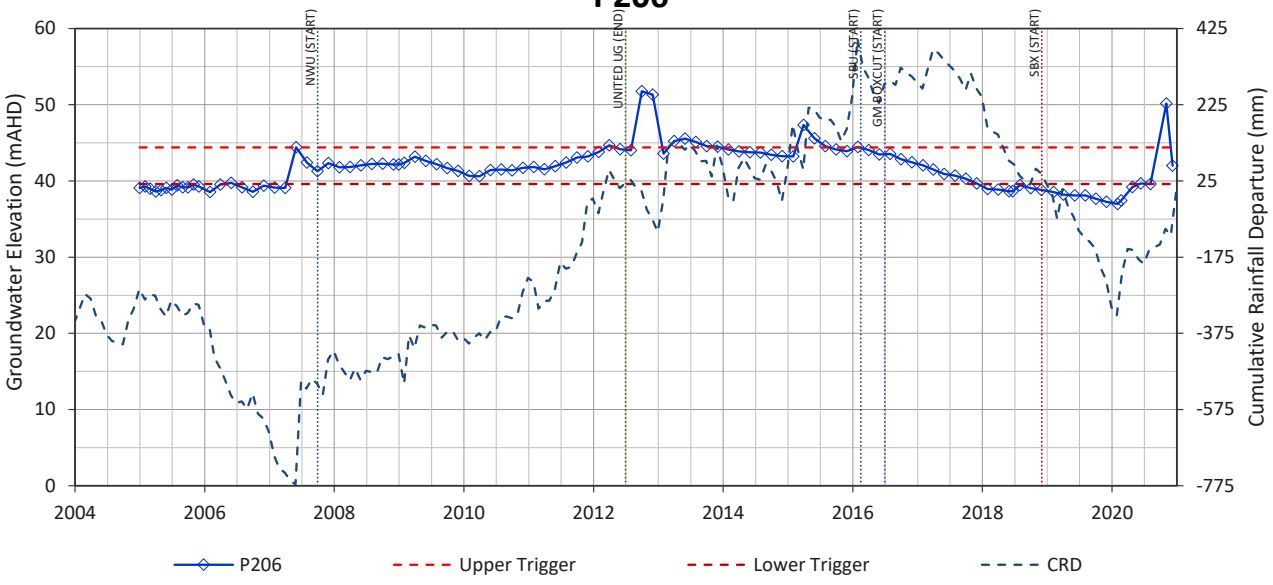
P202

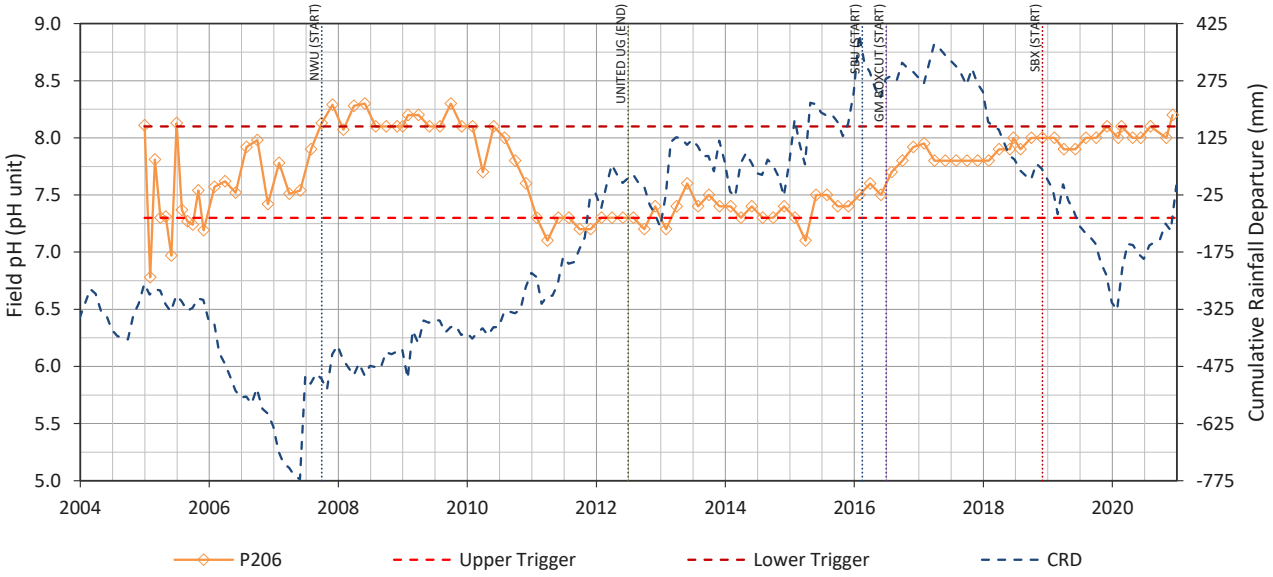

Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
P202
Upper Trigger
Lower Trigger
CRD

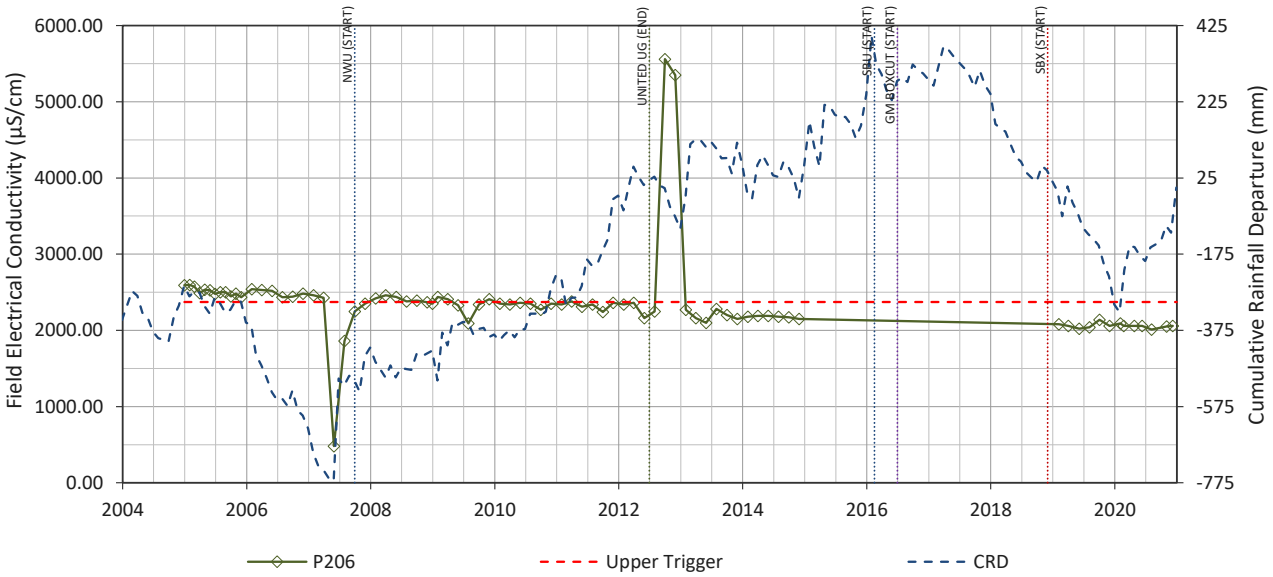

Field pH (pH unit)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
P202
Upper Trigger
Lower Trigger
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
P202
Upper Trigger
CRD

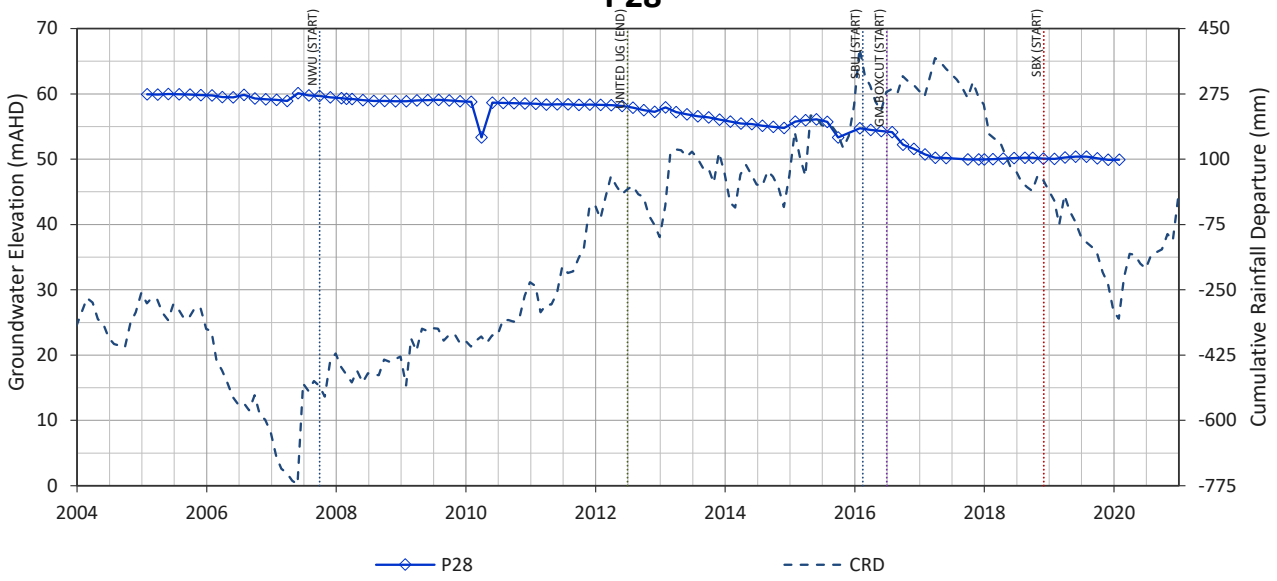
P206

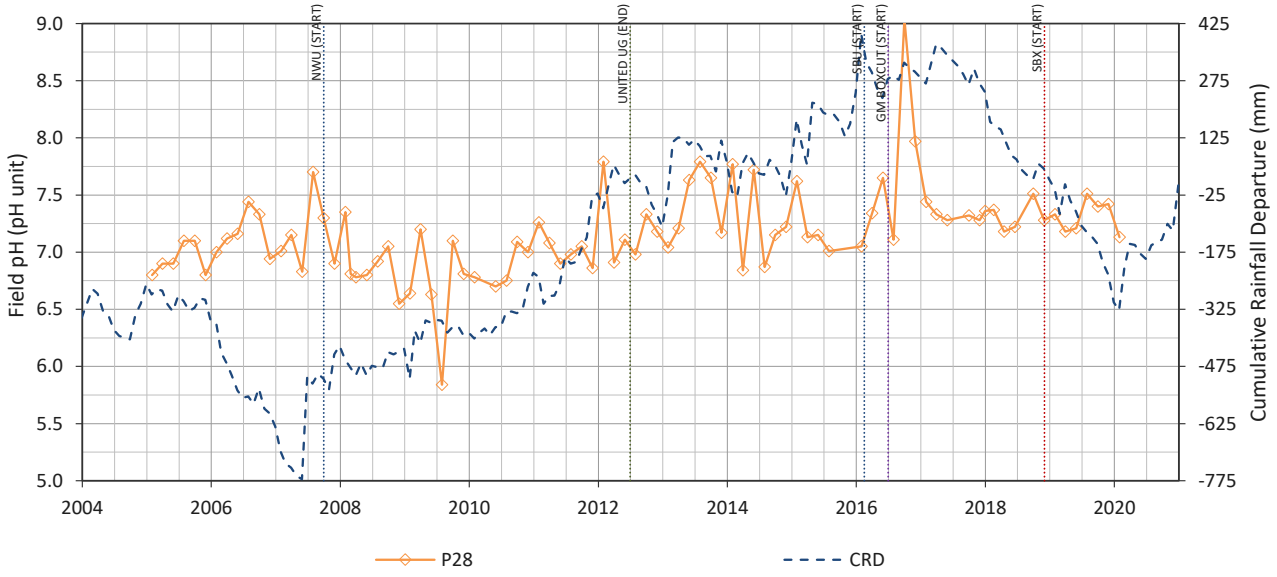

Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM & OXCUT (START)
SBX (START)
P206
Upper Trigger
Lower Trigger
CRD

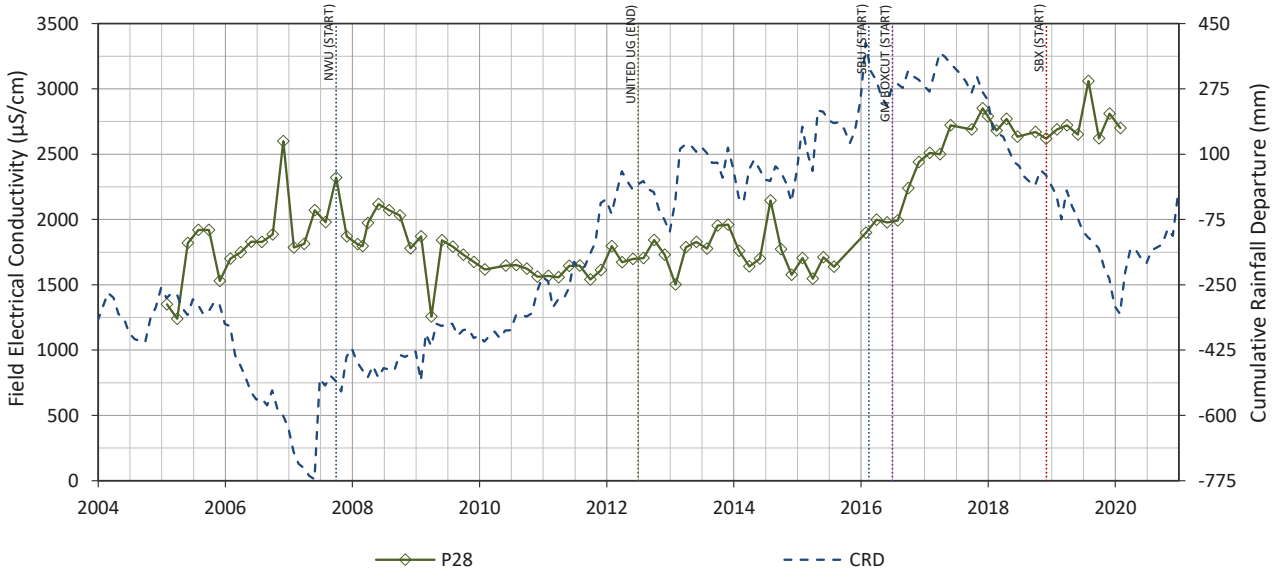

Field pH (pH unit)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM & OXCUT (START)
SBX (START)
P206
Upper Trigger
Lower Trigger
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM & OXCUT (START)
SBX (START)
P206
Upper Trigger
CRD

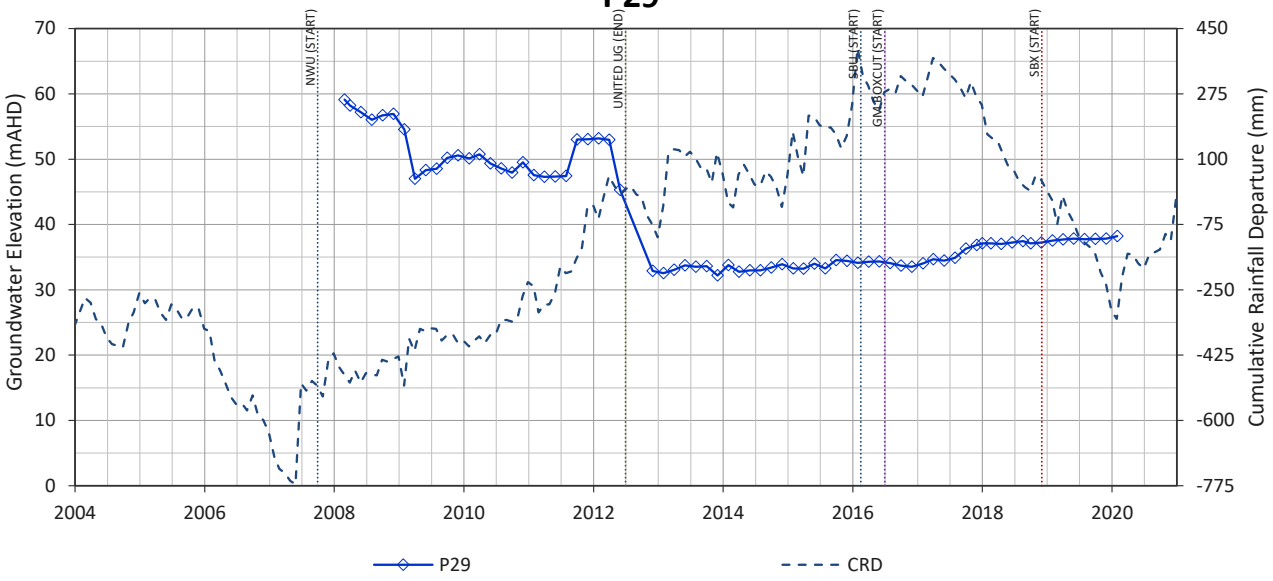
P28

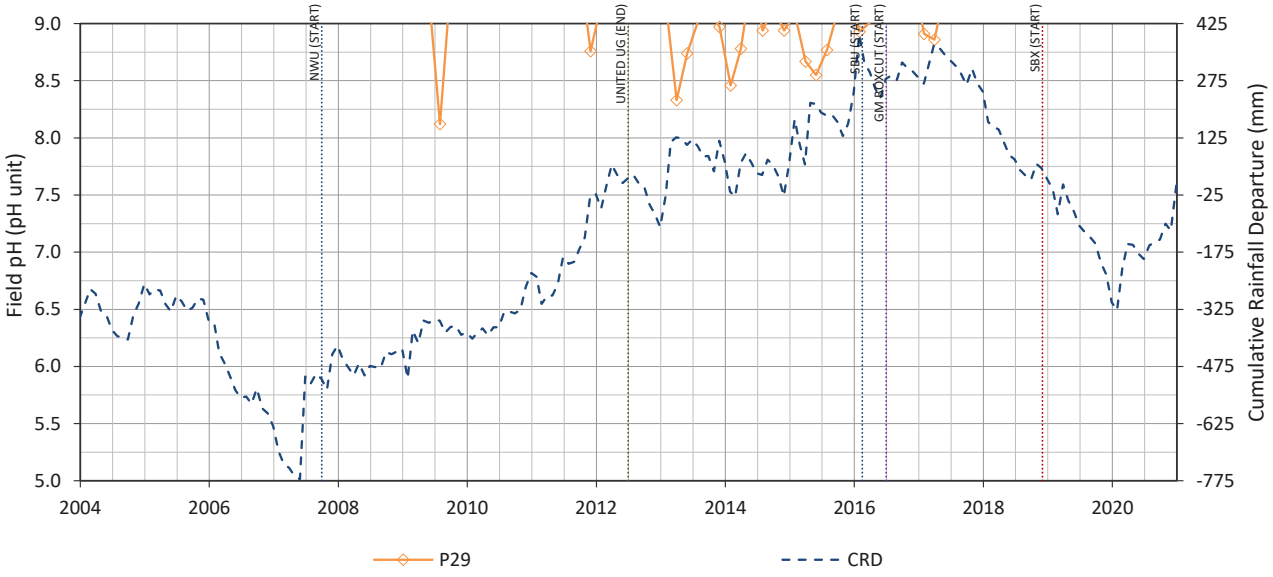

Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
P28
CRD

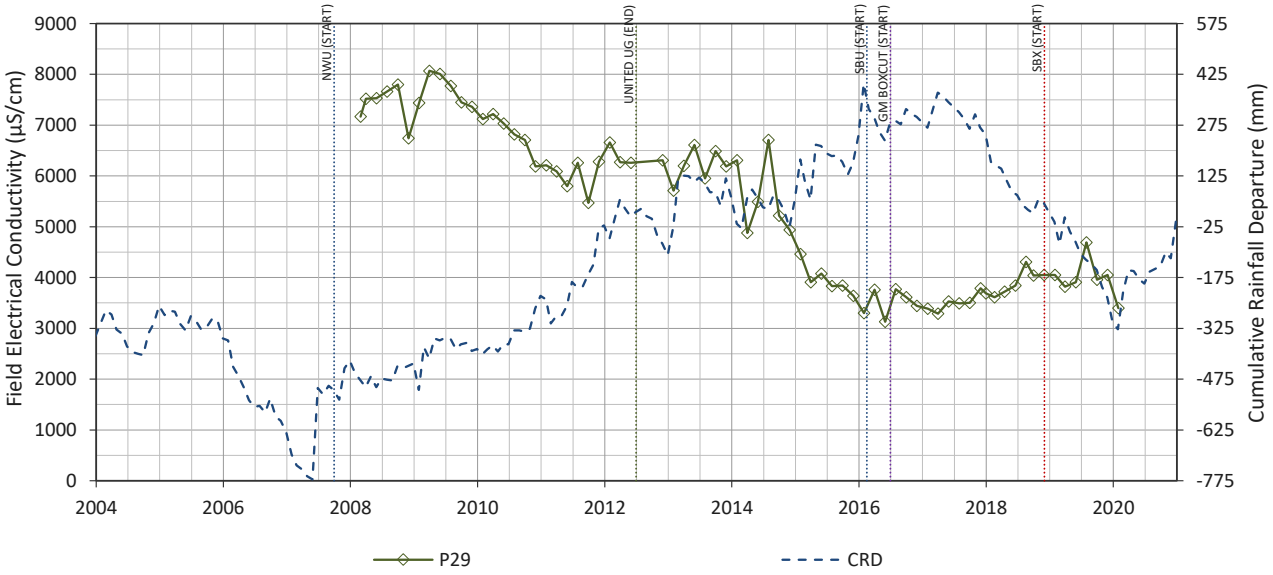

Field pH (pH unit)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
P28
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
P28
CRD

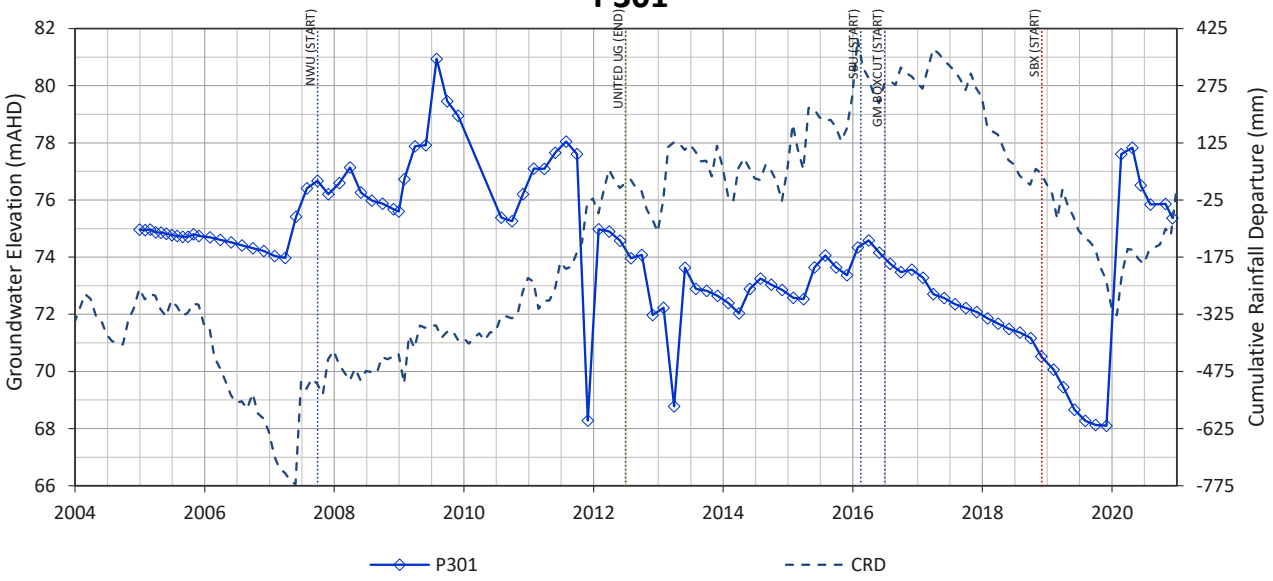
P29

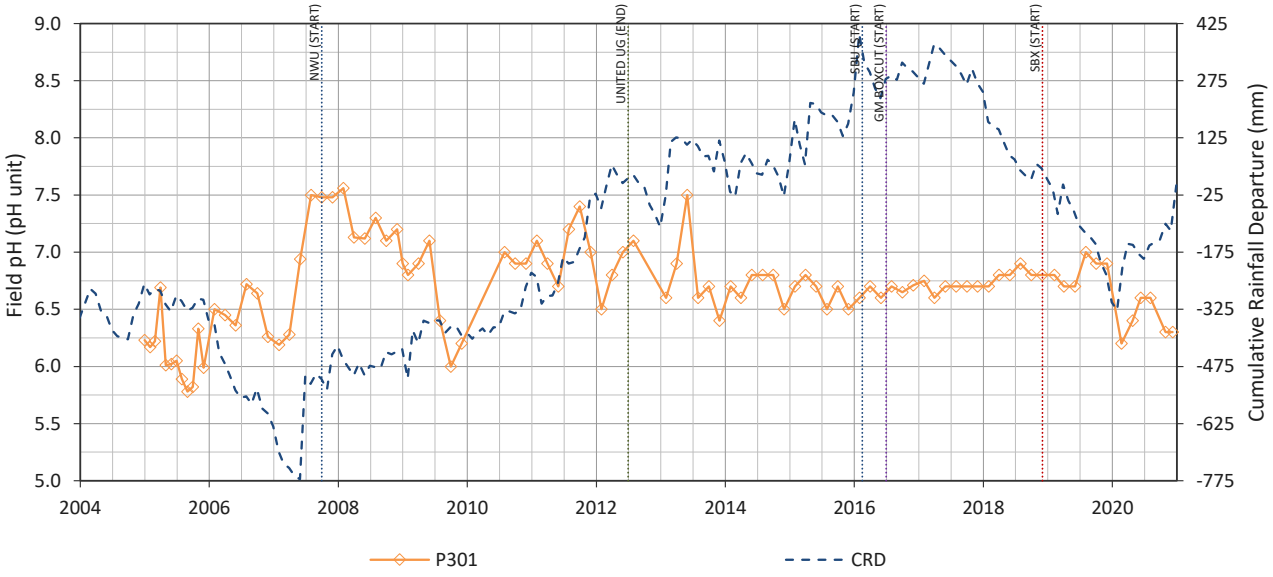

Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
P29
CRD

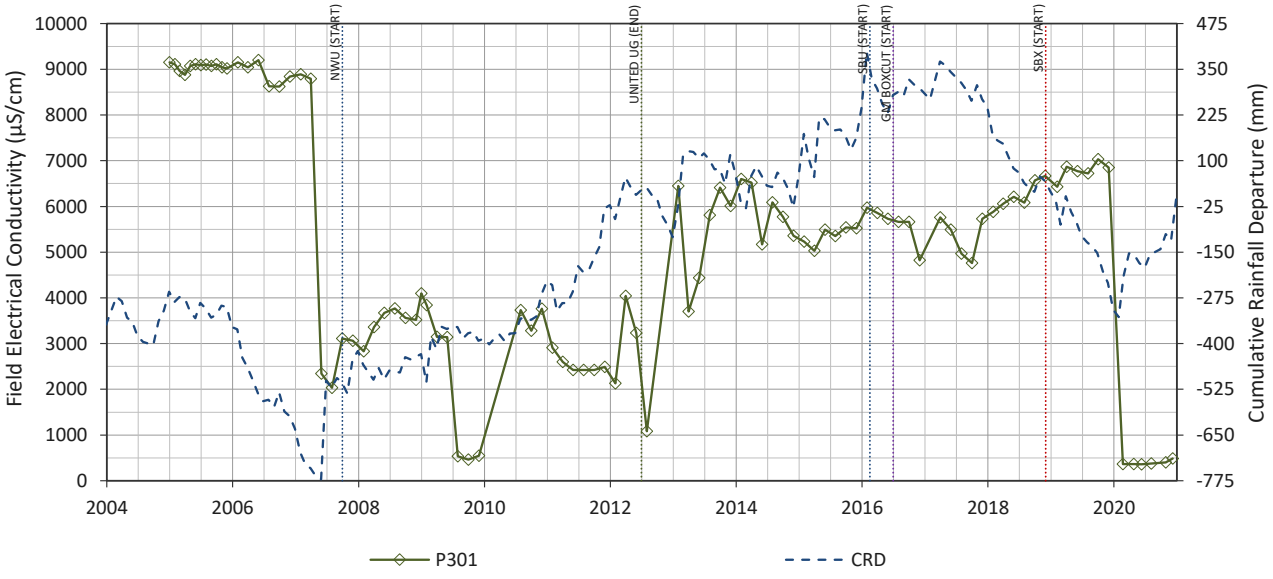

Field pH (pH unit)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
P29
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
P29
CRD

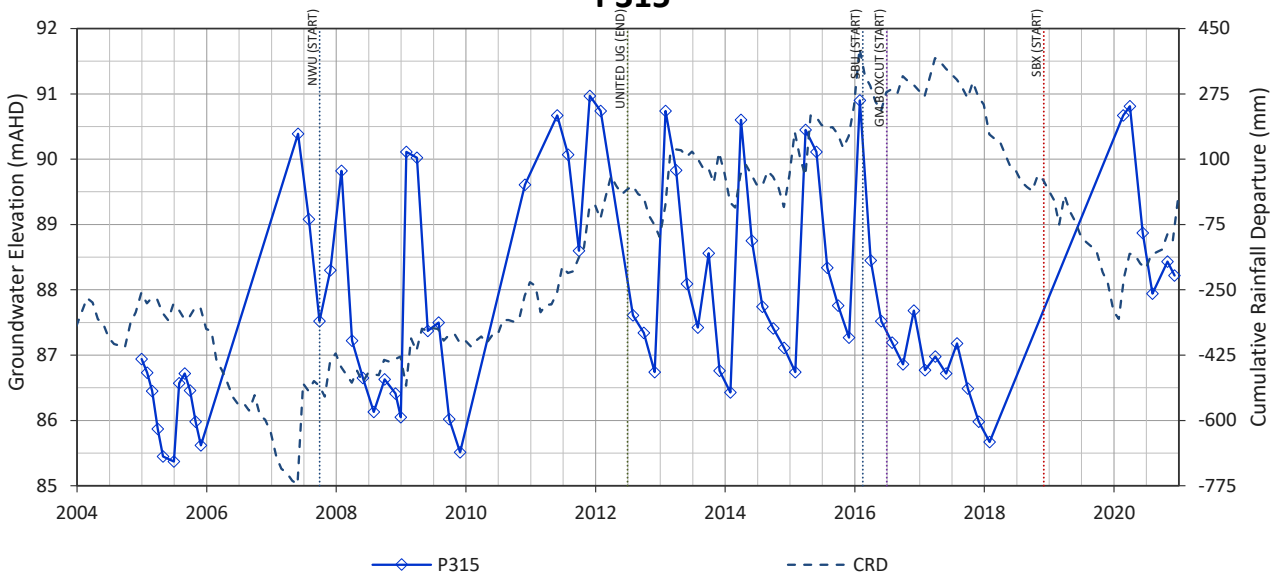
P301


Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM4 BOXCUT (START)
SBX (START)
P301
CRD


Field pH (pH unit)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM4 BOXCUT (START)
SBX (START)
P301
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM4 BOXCUT (START)
SBX (START)
P301
CRD

P315


Groundwater Elevation (mAHD)
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GM BOXCUT (START)
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P315
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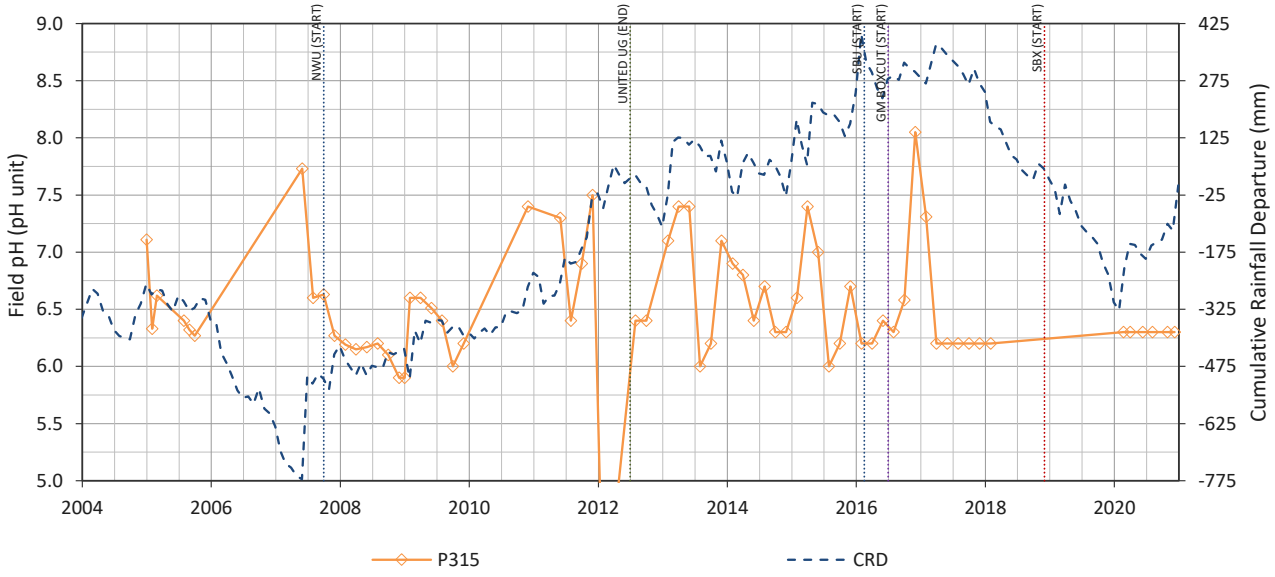
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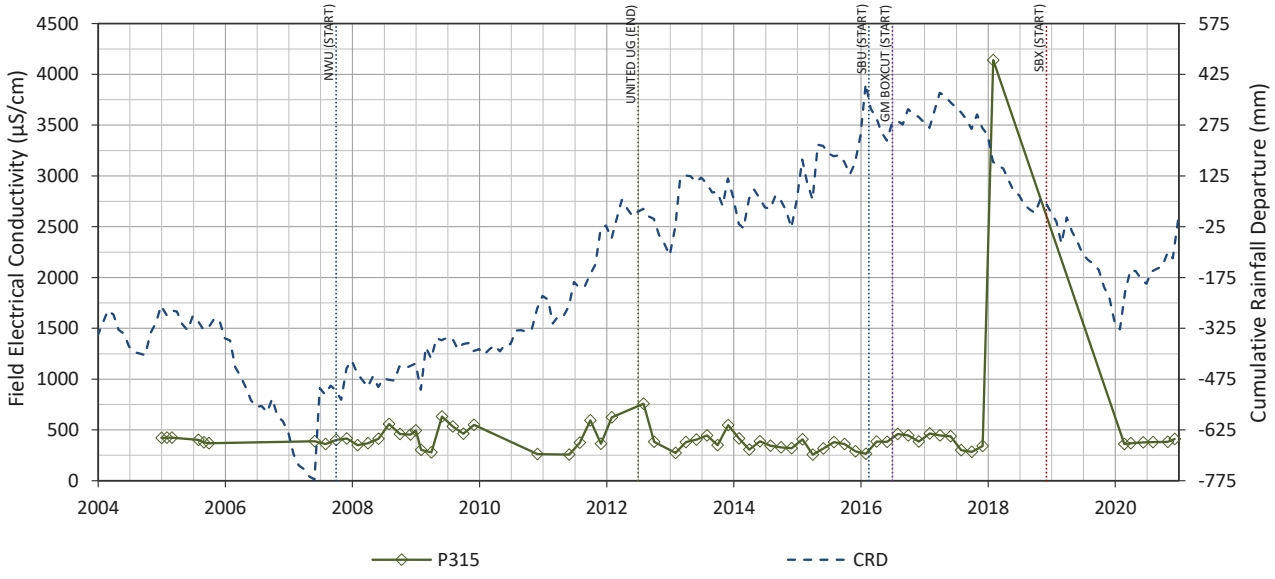
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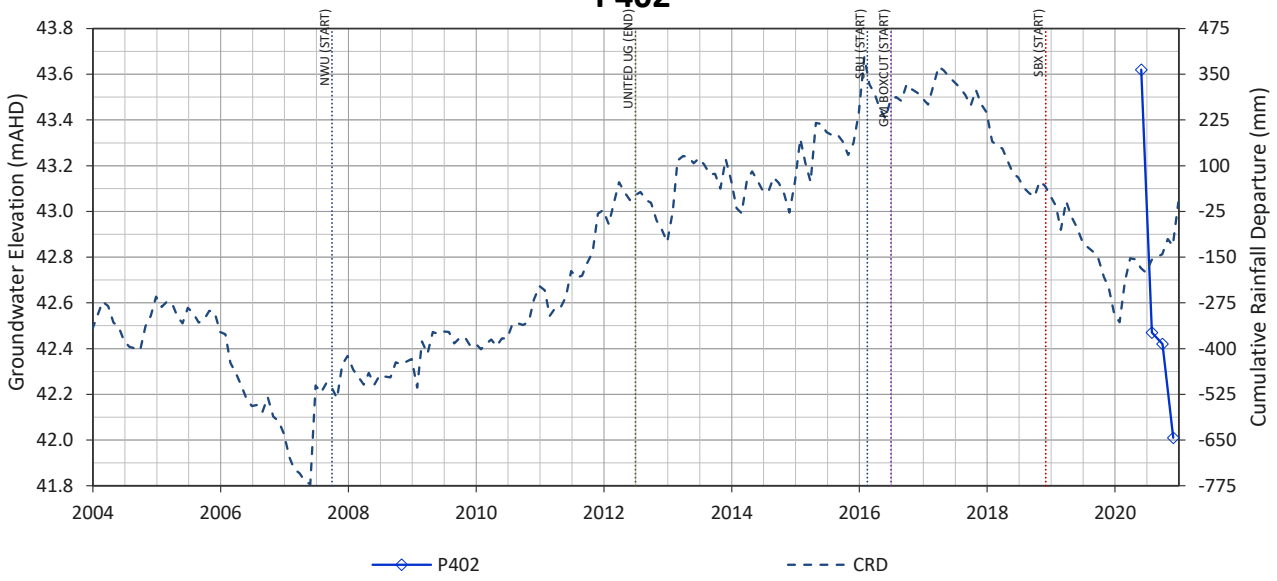
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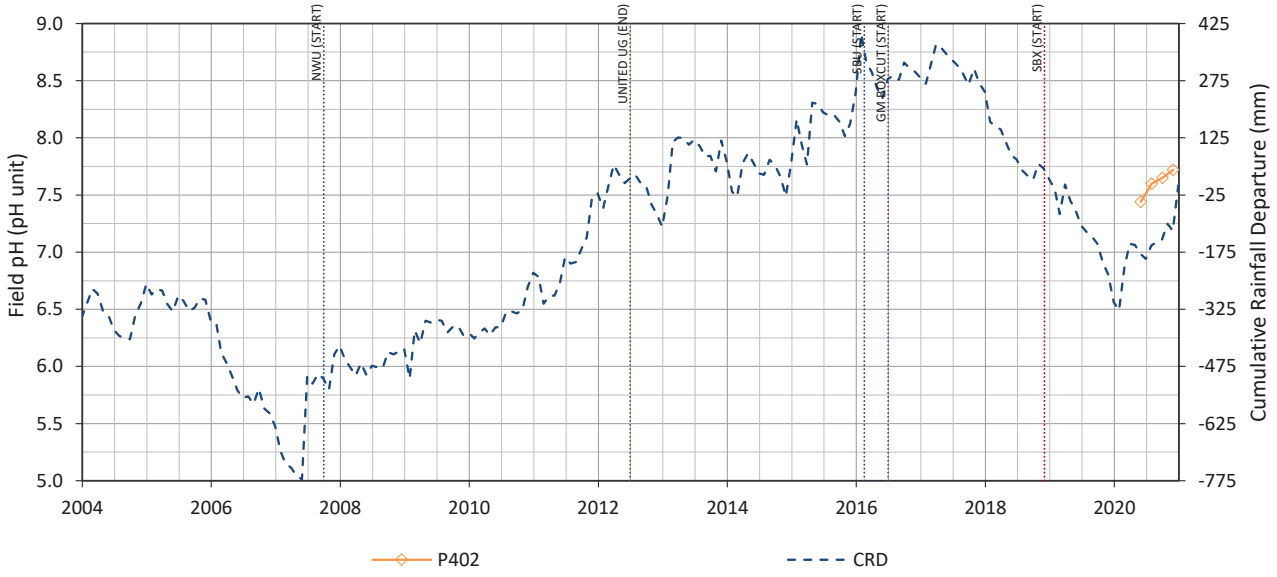
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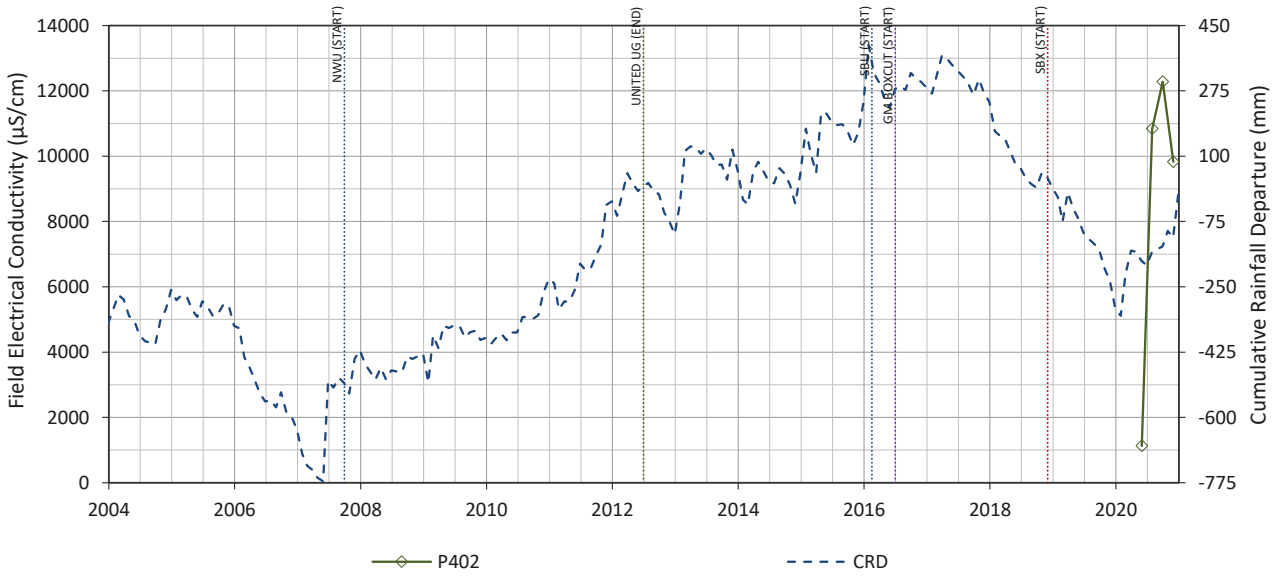
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Cumulative Rainfall Departure (mm)
NWU (START)
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SBX (START)
P402
CRD

APPENDIX 3 – Groundwater Review

UNITED WAMBO JOINT VENTURE OPEN CUT COAL MINE

Annual Groundwater Review 2020

Prepared for:

United Wambo OC Operations Pty Ltd
Hunter Regional MC

SLR Ref: 660.30030.00100-R01
Version No: -v0.3
March 2021

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BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with United Wambo OC Operations Pty Ltd (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
660.30030.00100-R01-v0.3	9 March 2021	Stephen Lee and Manfred Thienenkamp	Sharon Hulbert	
660.30030.00100-R01-v0.9-UWJV Annual Review 2020 20210325	25 March	Sharon Hulbert / Adam Skorulis	Angus McFarlane	
660.30030.00100-R01-v1.0-UWJV Annual Review 2020 20210326	26 March	Sharon Hulbert / Adam Skorulis	Sean Pigott	
660.30030.00100-R01-v2.0-UWJV Annual Review 2020 20210330	30 March	Sharon Hulbert	Angus McFarlane	Angus McFarlane

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1 Introduction

1.1 Overview

United Wambo is an open cut coal mine which commenced operations in 2020, operated by the United Wambo Joint Venture (UWJV). The 50:50 joint venture comprises United Collieries (Glencore and CFMMEU) and Wambo Coal (Peabody). United Wambo is located approximately 16 km west of Singleton, NSW.

The UWJV Groundwater Management Plan (GMP) was developed to ensure negligible impacts to groundwater users (both consumptive and environmental) and to ensure the underlying and adjacent groundwater resources are not degraded. Routine groundwater monitoring is undertaken to comply with mine approval conditions and reporting dictated by the GWMP as per Table 1.

Table 1 GWP Reporting Requirements

Schedule	Requirements	Recipient
Monthly	Review of the groundwater monitoring results and associated trends in groundwater quality against performance criteria.	United Wambo E&C Department
Annually	Review of groundwater monitoring results (including all water level, water quality and mine water seepage data). Comparison of groundwater data trends with those of previous years highlighting any results that are inconsistent with trends in baseline data. Comparison of groundwater data against specified trigger levels.	Government agencies (DPIE, DPIE Water, EPA) and the Community Consultative Committee

This document forms the Annual Review developed in accordance with the Conditions of Consent and requirements outlined within the GMP (GWMP; UWJV, 2020) and will be distributed to DPIE, DPIE Water, EPA and the Community Consultive Committee.

1.2 Scope

This annual review is for the period January 2020 through to December 2020, inclusive. The scope of works are detailed as follows;

- Review of site background, including (but not limited to):
  - Legislative requirements and conditions relevant to groundwater (Section 2);
  - Mine activities over the reporting period (at site and surrounding operations) (Section 2);
  - Hydrogeological regime (Section 3);
  - Groundwater monitoring network and program (Section 4).
- Data review:

- Review of groundwater monitoring results (including all water level, water quality and mine water seepage data) from the monitored infrastructure outlined in Section 5.4.1 of the GWMP (Section 5).
- Review and produce hydrographs for relevant groundwater monitoring bores/ VWPs and conduct a cause-and-effect analysis to determine whether trends are due to climatic changes or mining-related activities. This includes a comparison of monitored groundwater levels to model predictions (Section 5 and Appendix B).
- Hydrographs displaying groundwater quality trends, including physio-chemical parameters (pH, EC, TDS), major ions, metals and alkalinity (Appendix B).
- Assess groundwater data for compliance with the groundwater level and water quality triggers and natural trends (i.e. surface water levels and rainfall) (Section 5.7).
- Comparison of groundwater level and quality trends with previous years, highlighting any results which are inconsistent with trends in baseline data (Section 5).
- Review of Stygofauna monitoring requirements for compliance (Section 8)
- Review of GDE monitoring requirements for compliance (Section 9)

- Discuss groundwater impacts and compliance over the reporting period and provide recommendations (if required) for the existing monitoring network (Section 11).

2 United Wambo Joint Venture Mine Complex

The following section provides a description of the mine operations, groundwater impacts, groundwater licensing and Conditions of Consent related to groundwater at United Wambo. The general site layout is presented in Figure 1

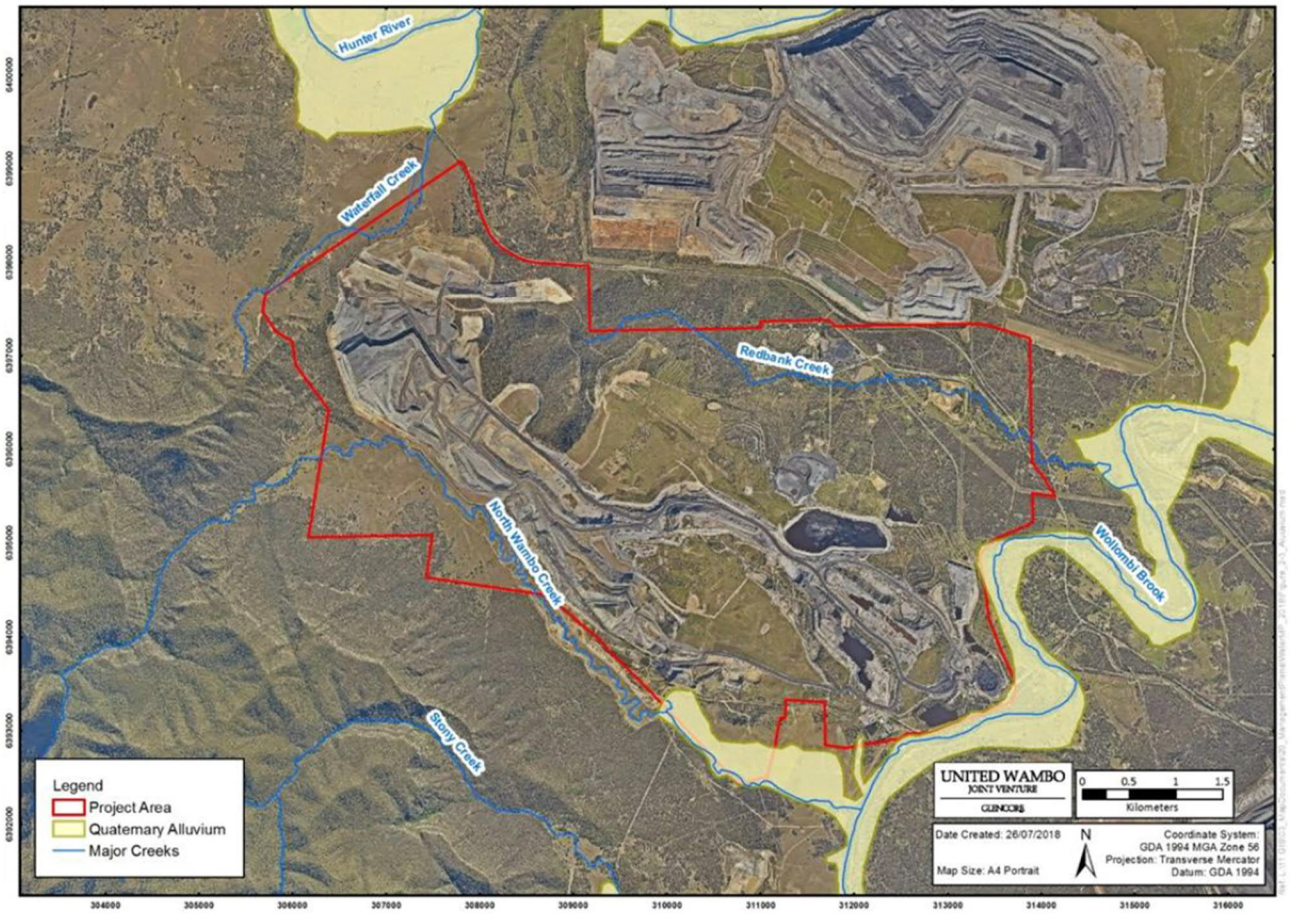


Figure 1 General Location Plan (from UWJV GWMP)

2.1 Mine operations

The UWJV open-cut mine commenced operation in January 2020. The mine integrates existing open-cut operations at the Wambo coal mine with a new open-cut mine at the adjacent United coal mine. The new combined open-cut mine is forecast to produce 10 million tonnes of thermal and metallurgical coal annually until projected closure in 2042.

Previous open-cut mining operations occurred at the United coal mine between 1989 and 1992 while underground operations commenced in 1992 through until the mine was placed under 'care and maintenance' in 2010. Course rejects and fine tailings were deposited in the United reject emplacement area which consisted of Tailings Dam 1 (TD1) and Tailings Dam 2 (TD2).

The current operations at the Wambo Mine Complex commenced in 2004 and comprises both open-cut and underground operations. The underground operations at Wambo include the North Wambo, the South Bates, the Arrowfield, and the Bowfield underground mines. The North Wambo operations have been completed while South Bates is still operational. Operations at the other two sites are yet to commence. The Wambo Mine Complex has three main in-pit reject emplacement areas (Homestead, Hunter and Main Homestead). United Wambo does not include the Wambo underground operations to the south of the joint venture tenement area.

Mining and coal handling at United Wambo involves conventional open-cut mining methods involving truck and excavator/shovel operations. The run-of-the-mine (ROM) coal will be transported to the existing coal handling and preparation plant (CHPP) at the site. The existing coal handling infrastructure comprises conveyors, stockpiles, and train loading facilities. Upgrades will be carried out for overburden emplacement and storage areas, and a 2 km section of the Golden Highway will be realigned, as part of United Wambo ongoing operations. Table 2 presents a summary of the historical and future mining activities at Wambo and United Wambo.

Table 2 Summary of Mine Activities at Wambo and United

Coal Seams	Original Wambo		Original United		UWJV Open cut
	Open cut	Underground	Open cut	Underground	
Whybrow	1969-2020	1969-2018			
Redbank Creek					
Wambo		1969-2018	1989-1992		
Whynot					2020-2039
Blakefield					
Glen Munro					
Woodlands Hill		2019-2029			
Arrowfield		2017-2032		1992-2010	
Warkworth					
Mt Arthur					
Piercefield					
Vaux					
Broonie					
Bayswater					

2.2 Groundwater Impacts

Potential groundwater impacts associated with the approved operations at United Wambo have been assessed via the groundwater impact assessment (AGE, 2016) incorporated into the EIS (Umwelt, 2016).

The potential impacts to groundwater due to proposed mining activities at United Wambo include (UWJV, 2019) are:

- Groundwater interception by mining within the project area;
- Drawdown in groundwater level in the adjacent alluvium and coal measures;
- Changes in alluvial water resources availability;
- Changes to surface water flow;
- Impacts on supplies from private bores;
- Drawdown at potential GDEs;
- Impacts on stygofauna; and
- Cumulative groundwater level drawdown.

The key findings of the impact assessment study (AGE 2016) included:

- Future drawdown within the Quaternary alluvium from the joint operation could extend for up to 3 km north of the Wambo open-cut and 2 km east of the United open-cut.
- Depressurisation of the Wambo Seam was predicted to extend up to 2.5 km from the proposed extraction area. While depressurisation of the Arrowfield Seam was predicted to extend up to 3.5 km from the edge of the proposed extraction area.
- The magnitude of depressurisation in all modelled coal seams is generally less than 10 m, extending approximately 1.5 km from the edge of the pits. Depressurisation in the Vaux Seam is expected to be less extensive to the southwest due to the lower permeability of the coal seam within the model.
- The extent of predicted drawdown in all coal seams due to United Wambo is generally within the extent of drawdown already approved for existing mines surrounding the project to the north, east and south. Increased predicted drawdown in excess of already approved drawdown is mainly restricted to the west of United Wambo, extending up to 2 km from the already approved drawdown extents from other mines.
- Flow from the Permian strata to the alluvium along Wollombi Brook was modelled to decline by up to 175 ML/year. It was commented that while a reduction of up to 40 ML/year may reduce water levels in the alluvium it would also potentially result in an improvement of water quality within the alluvium.
- Leakage from the Hunter River alluvium to the underlying Permian coal measures was modelled to increase by an additional 58ML/year.
- Due to cumulative impacts from combined approved mining, it was predicted that the net baseflow from alluvium to Wollombi Brook will reduce from 1,450 ML/year to 1,000 ML/year and from 3,500ML/year to 2,800ML/year from alluvium to the Hunter River.
- Predicted impact to private water bores will be limited to areas within the project area, with no impact predicted on residual agricultural areas up to 4 km from the mine.

- Identification of two red gum areas within the zone of cumulative groundwater drawdown that are predicted to be subject to groundwater drawdown impacts that are at least, in part, attributable to the project. The two areas have been identified as GDE1 and GDE2. At GDE2 ~1 m of groundwater level decline was predicted due to the cumulative impacts of mining. This drawdown is relatively limited in area and impacts upon only a small portion of possible Hunter Valley River Oak Forest and possibly a small number of river red gum trees. At GDE1 the decline was predicted to be more significant as the alluvium could become largely unsaturated, affecting the potentially groundwater-dependent riparian vegetation.
- Although stygofauna were found to be present in alluvium, the risk of impacting the subterranean ecosystem was considered as low. No adverse impacts on stygofauna were predicted.
- The numerical groundwater model assessed the cumulative drawdown from surrounding mines including approved and proposed operations at Wambo, HVO South, HVO North, Ravensworth and MTW

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 United Wambo are outlined in Table 3 and have a combined total entitlement of 2,317 ML/year.

Under the Joint Venture, the proponents hold 1306ML/year for the Hunter Regulated Water Sharing Plan (WSP) (Hunter River), 370ML/year for the Hunter Unregulated WSP and 1947ML/year under the North Coast Fractured and Porous Rock WSP (formerly Water Act 1912).

Table 3 United Wambo Groundwater Entitlement and Licenses

Licence Number	Holder	Entitlement [1]	Tenure Type
Groundwater: Lower Wollombi Brook Water Source[2]			
WAL23897	Wambo	70 unit shares	Perpetuity
WAL18549	United	100 unit shares	Perpetuity
WAL18445	United	200 unit shares	Perpetuity
Groundwater: Sydney Basin -North Coast Porous Rock Water Source[3]			
WAL42373	Wambo	1549 unit shares	Perpetuity
WAL41532	Wambo	98 unit shares	Perpetuity
WAL41510	United	300 unit shares	Perpetuity

Note: WAL = water access licence, ML/year = megalitres per year.

[1] one unit share is equivalent to 1 ML/year unless reductions are in place via an annual available water determination

[2] water source under the Hunter Unregulated and Alluvial Water Sources WSP 2009

[3] water source under the North Coast Fractured and Porous Rock Groundwater Sources WSP 2016

2.4 Groundwater Conditions

In accordance with the development consent approval requirements of SSD 7142 and various groundwater licences, UWJV are required to prepare and implement a Groundwater Monitoring Program (GWMP). Table 4 presents a summary of the relevant groundwater conditions from the development consent and GWMP.

Table 4 SSD 7142 Requirements for the GWMP

Condition	Condition Details*	GWMP Section
B52 e	(v) The Water Management Plan must include a Groundwater Management Plan, which is consistent with Groundwater Monitoring and Modelling Plans – Introduction for prospective mining and petroleum activities (DPI Water, 2014) and the National Water Quality Management Strategy (DoEE, 2015) and includes:	Section 2.1.2.4
	• Detailed baseline data of groundwater levels, yield and quality for groundwater resources potentially impacted by the development, including groundwater supply for other water users and groundwater dependent ecosystems;	Section 3.4 Section 3.4
	• A detailed description of the groundwater management system;	Section 3.3

Condition	Condition Details*	GWMP Section
	Groundwater performance criteria, including trigger levels for identifying and investigating any potentially adverse groundwater impacts associated with the development, on:	Section 5.3
	• regional and local aquifers (alluvial and hardrock);	Section 5.3, Table 5-4
	• groundwater supply for other water users such as privately-owned licensed groundwater bores;	Section 4.2.7
	• groundwater dependent ecosystems; and	Section 4.2.8
	• Aquatic habitat and stygofauna	Section 4.2.9
	A program to monitor and evaluate:	
	• compliance with the relevant performance measures listed in Table 4 (see Table 2-3), and the performance criteria established above;	Section 5.1
	• water loss/seepage from water storages into the groundwater system;	Section 5.1.3
	• groundwater inflows, outflows and storage volumes to inform the Site Water Balance;	Section 5.1
	• any hydraulic connectivity between the alluvial and hardrock aquifers;	Section 5.1
	• Impacts on groundwater supply for other water users;	Section 5.1.4
	• impacts on groundwater dependent ecosystems; and	Section 5.1.2.4
	• the effectiveness of the groundwater management systems;	Section 7.1
	Reporting procedures for the results of the monitoring program;	Section 7.6
	A plan to respond to any exceedances of the groundwater performance criteria, and repair, mitigate, compensate and/or offset any adverse groundwater impacts of the development; and	Section 7.6 Section 7.7 Appendix B
	A program to periodically validate the groundwater model for the development, including an independent review of the model every 3 years, and comparison of monitoring results with modelled predictions.	Section 7.9

Groundwater monitoring at Wambo is conducted in accordance with the Wambo GWMP as outlined within the United Wambo GWMP, whereas monitoring at United is undertaken in accordance with the United Environmental Monitoring Program. The program outlines groundwater monitoring frequency, parameters to be tested and groundwater triggers for electrical conductivity (EC) and pH. Further discussion on the groundwater monitoring program and triggers is provided in Section 4.

3 Hydrogeological Setting

For context, a brief summary of the hydrogeological setting for UWJV is provided here, including climate, terrain, drainage, geology, and groundwater bearing units.

3.1 Climate, Terrain and Drainage

3.1.1 Climate

The temperate climate of the Wambo region is characterised by hot summers and mild dry winters. Locally, daily rainfall has been recorded at Bulga, South Wambo (Bureau of Meteorology (BOM) Station: 0611191) since January 1959. Table 5 provides the long-term average monthly rainfall data, as well as the 2020 monthly data from the Bulga, South Wambo station.

Table 5 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	86.1	67.7	45.9	39.9	43.9	30.6	34.3	38.6	55	61.5	73.5	662.2
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*

Seven months in 2020 experienced above long-term average rainfall, with total annual rainfall for the year also above long-term average. Particularly high rainfall events are apparent in February and December 2020 (although these are not uncharacteristic for this climate).

The Bulga Station data was also used to generate a cumulative rainfall deficit (CRD) plot, also known as a Rainfall Residual Mass Curve (RMC), as seen in Figure 2. A CRD plot is provided as a comparative tool to illustrate long term climate trends and their influence on groundwater in the UWJV area. The CRD graphically shows trends in recorded rainfall compared to long-term averages 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.

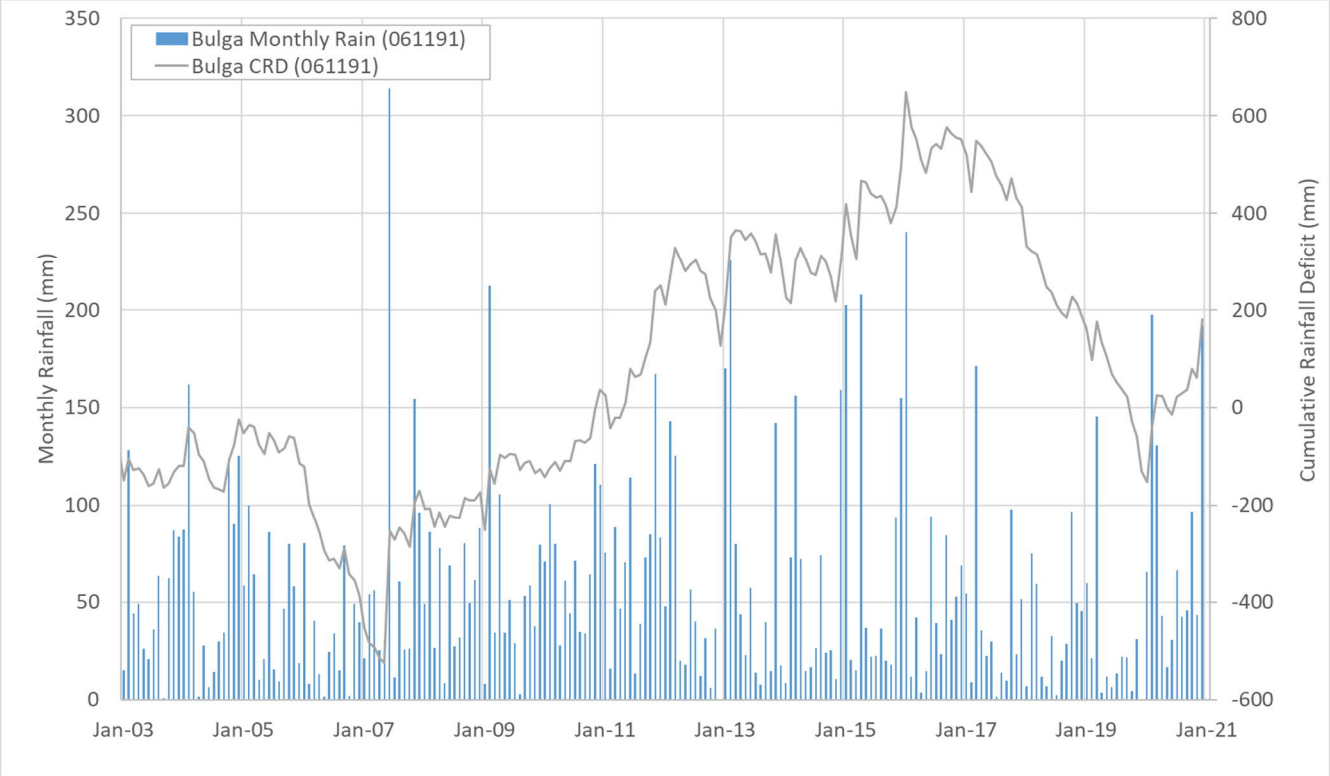


Figure 2 Cumulative Rainfall Deficit

The CRD performs an additional service: if rainfall recharge is a significant source of groundwater, the temporal variability in recorded groundwater levels can be expected to mimic the pattern of this curve. That is, natural fluctuations in the groundwater table result from temporal changes in rainfall recharge to groundwater systems. Typically, changes in groundwater elevation reflect the deviation between the long-term monthly (or yearly) average rainfall, and the actual rainfall, illustrated by the rainfall CRD.

To provide a long-term uninterrupted data set, SILO Grid Point Data (Latitude -32.55, Longitude 150.95) was utilised to assess long-term rainfall trends. This dataset is interpolated from quality checked observational timeseries data collected at nearby stations by the Bureau of Meteorology.

SILO data also provides pan evaporation and calculated plant evapotranspiration (using the Penman-Monteith formulation) (see Figure 3). The bimodal plot indicates higher rainfall, evaporation, and evapotranspiration during the summer months. During the mid-year winter months evaporation and evapotranspiration is lowest.

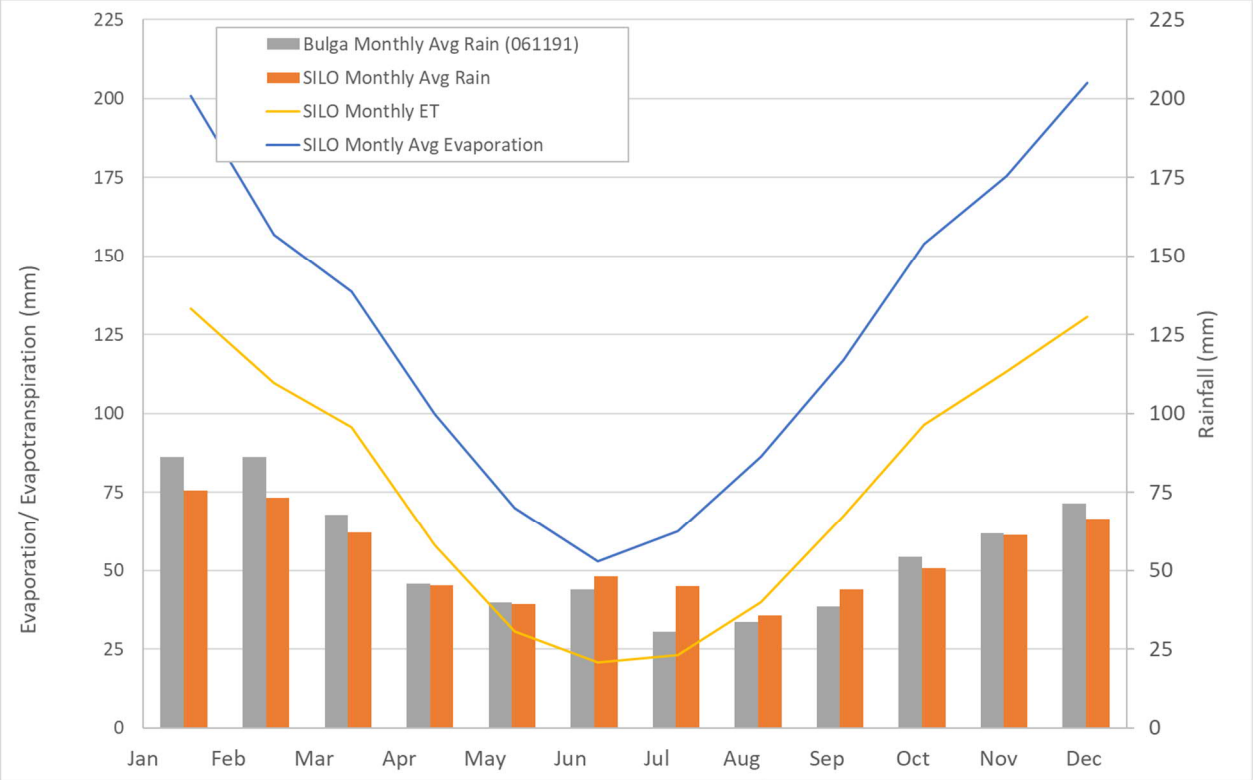


Figure 3 Monthly climate statistics from SILO and Bulga (061191)

3.1.2 Terrain and Drainage

Regionally, the terrain is characterised by the steep and incised range, namely the Wollemi National Park escarpment, to the west (650 mAHD), generally grading towards the flat alluvial lands associated with the adjacent water course. The project area is gently undulating, with elevations ranging between 60 mAHD in the east and 215 mAHD in the west.

The project area is drained by Wollombi Brook and its minor tributary systems. Wollombi Brook flows north to north-easterly before reporting to the Hunter River approximately 4km to the east of the project area. The minor tributary systems are typically ephemeral in nature, relying on rainfall for flow events. Identified tributaries of Wollombi Brook within the project area include;

- North Wambo Creek, traversing from the west to the south east of the project area
- Redbank Creek flowing in an easterly direction
- Stony Creek traverses in a south-easterly direction

Stream flow analysis was undertaken as part of the EIS (AGE, 2016) to assess the contribution of baseflow in Wollombi Creek with results showing flow is largely a function of rainfall. It is estimated that groundwater contributes up to 70 ML/day to the flows in the Wollombi Brook. Although both the Wollombi Brook and Hunter River are predominantly gaining environments (receiving groundwater) there are also areas where the river recharges the underlying alluvium (losing environment).

Due to historical farming and mining, the majority of the project area is cleared of vegetation, excluding Wollemi National Park to the west. Land use within the project area is dominated by coal mining, whilst locally outside the Project is typically agricultural.

3.2 Geology

Regionally, the predominant geological feature is the Sydney Basin, formed via igneous rifting and crustal thinning resulting in the deposition of Permian and Triassic aged sedimentary sequences. Within the UWJV Project area Permian sediments form the Wittingham Coal Measures of the Hunter Coalfields. The coal measures generally plunge in a west to south-westerly direction and outcrop to the east of the Project area near the Hunter River.

The Wittingham Coal Measures comprise the economic coal seams interspersed with overburden and interburden consisting of sandstone, siltstone, tuffaceous mudstone and conglomerate. Quaternary alluvial deposits unconformably top the Permian sediments. These deposits consist of silt, sand and gravel in the alluvial floodplain of the Wollombi Brook. To the east of the Wollombi Brook is a sequence of aeolian sands, known as the Warkworth Sands Formation, that form a thin capping on the underlying Permian bedrock Additionally, the Triassic Narrabeen Group also unconformably overlie the Permian sediments. The Narrabeen Group, which formed from uplift during the Triassic, comprises fluviatile deposits that form the ridges and a high plateau within the Wollemi National Park, west of the Project Area. Surficial weathering, typically present as a thin heterogeneous layer of unconsolidated material overlying fresh bedrock occurs across the project area. Table 6 provides a summary of the regional stratigraphy.

Table 6 Regional Generalised 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 overlying surficial alluvium along major watercourses (i.e. Hunter River and Wollambi Brook).
	Silicified weathering profile (Czas)		Silcrete
	Alluvial terraces (Cza)		Silt, sand and gravel
Jurassic	Volcanics (Jv)		Flows, sills and dykes
Triassic	Narrabeen Group (Rn)		Sandstone, interbedded sandstone and siltstone, claystone (localised at Wollemi National Park)
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.

Locally, the predominant stratigraphic units that occur within the Project area and nearby surround, include:

- Quaternary sediments
  - Localised presence along North Wambo Creek, 4-7 metres thick comprised of clays, sandy silts, with localised occurrence of medium grained sand.
  - Along Wollombi Brook and the Hunter River flood plans – commonly comprises two distinct depositional units, the surficial alluvium and productive basal alluvium. Typically constrained to within 400 metres of the creeks and is between 7 – 19 metres thick.
- Triassic Narrabeen Group
  - Comprises quartz-lithic to quartzose sandstone, conglomerate, mudstone and siltstone with rare coal. Does not occur within the project area but 500 metres west
- Permian Newcastle Coal Measures
  - Formally known as the Wollombi Coal Measures, present in the south-west of the Project area. Generally less than 15 metres thick and deeply weathered comprised of tuffaceous claystone, tuff, siltstone, sandstone, conglomerate, and minor coal. Coal within the Newcastle Coal Measures generally contains stone and is not considered of economic quality within the region
- Permian Wittingham Coal Measures.
  - comprise coal seams interbedded with siltstone, sandstone and shale (known as the interburden) and up to 450m thick at the Project Area.

3.2.1 Groundwater Units

The main groundwater bearing unit occurring near the Project Area is the Quaternary alluvium, with less productive aquifers occurring within coal seams of the Wittingham Coal Measures. The Triassic Narrabeen Group, present to the south-west of the Project Area, also contains thick sequences of groundwater bearing sandstones, but these are not directly connected with the Project Area.

3.2.1.1 Alluvium

Groundwater within the Wollombi Brook alluvium reflects topography flowing in a north to north-easterly direction towards the Hunter River, which flows in an easterly direction.

The Quaternary alluvium is an unconfined groundwater system that is recharged by rainfall infiltration, streamflow and upward leakage from the underlying stratigraphy, particularly along Wollombi Brook.

3.2.1.2 Wittingham Coal Measures

The Wittingham Coal Measures outcrop approximately 8km to the north and east of the Project area where recharge via rainfall infiltration occurs. The coal seams also subcrop in localised zones along the Hunter River and Wollombi Brook, where they are recharged by the overlying alluvium. Recharge also occurs via leakage from the overlying Triassic Narrabeen Group. The coal measures form unconfined groundwater systems at outcrop, becoming confined as they dip towards the south-west

The direction of groundwater flow for the Wittingham Coal Measures is influenced by the local geomorphology and structural geology, as well as the long history of mining within the region. The laminated fabric of the interbedded sandstone/siltstone/mudstone strata suggests that vertical hydraulic conductivities are significantly lower than horizontal hydraulic conductivities. Due to the laminar nature of the coal measures, groundwater flow generally occurs within or along the boundaries between stratigraphic layers. The coal seams are generally more brittle and therefore more densely fractured than the overburden and interburden strata, which causes the higher permeability. Within the coal seams, groundwater flows predominantly through cleat fractures, although there is some evidence of structure-related fracturing and this may play an important role in groundwater flow paths.

4 Groundwater Monitoring

4.1 Groundwater Monitoring Program

Groundwater monitoring is conducted at United Wambo in accordance with the GWMP and the United Wambo Open Cut and Wambo Water Monitoring Program (WMP) (Peabody, 2020). The purpose of groundwater monitoring at UWJV is to monitor groundwater quality and levels to detect potential impacts on surrounding groundwater users, consumptive or environmental, and assess the performance of the mine against the performance indicators to ensure that relevant legislative and policy requirements are met.

The UWJV groundwater monitoring network defined in the GWMP is comprised of 27 bores and 11 vibrating wire piezometers (VWPs) with a total of 55 sensors installed at VWP arrays.

An update to this network is provided in the WMP which categorises bores as 1) part of the combined network (monitored for both Wambo and UWJV), including 30 bores and 7 VWPs (with 35 sensors), 2) part of the UWJV network only, including a further 9 bores (5 currently installed) and 16 VWPs (with 56 sensors), or 3) part of the Wambo only network. A summary of the bore network details is provided in Appendix A, with the spatial distribution shown on Figure 4. The network has been established to ensure that a long-term monitoring capability exists, that monitors all key groundwater units and with adequate spatial and vertical depth coverage across the site. Groundwater monitoring has been undertaken bi-monthly for groundwater levels (reported as a groundwater elevation in metres above Australian Height Datum (mAHD) and basic water quality (pH and EC). UWJV also undertake comprehensive annual groundwater quality monitoring of 12 analytes including:

- pH
- EC
- Total dissolved solids (TDS)
- Sodium
- Potassium
- Calcium
- Magnesium
- Chloride
- Nitrate
- Sulfate
- Hardness
- Bicarbonate

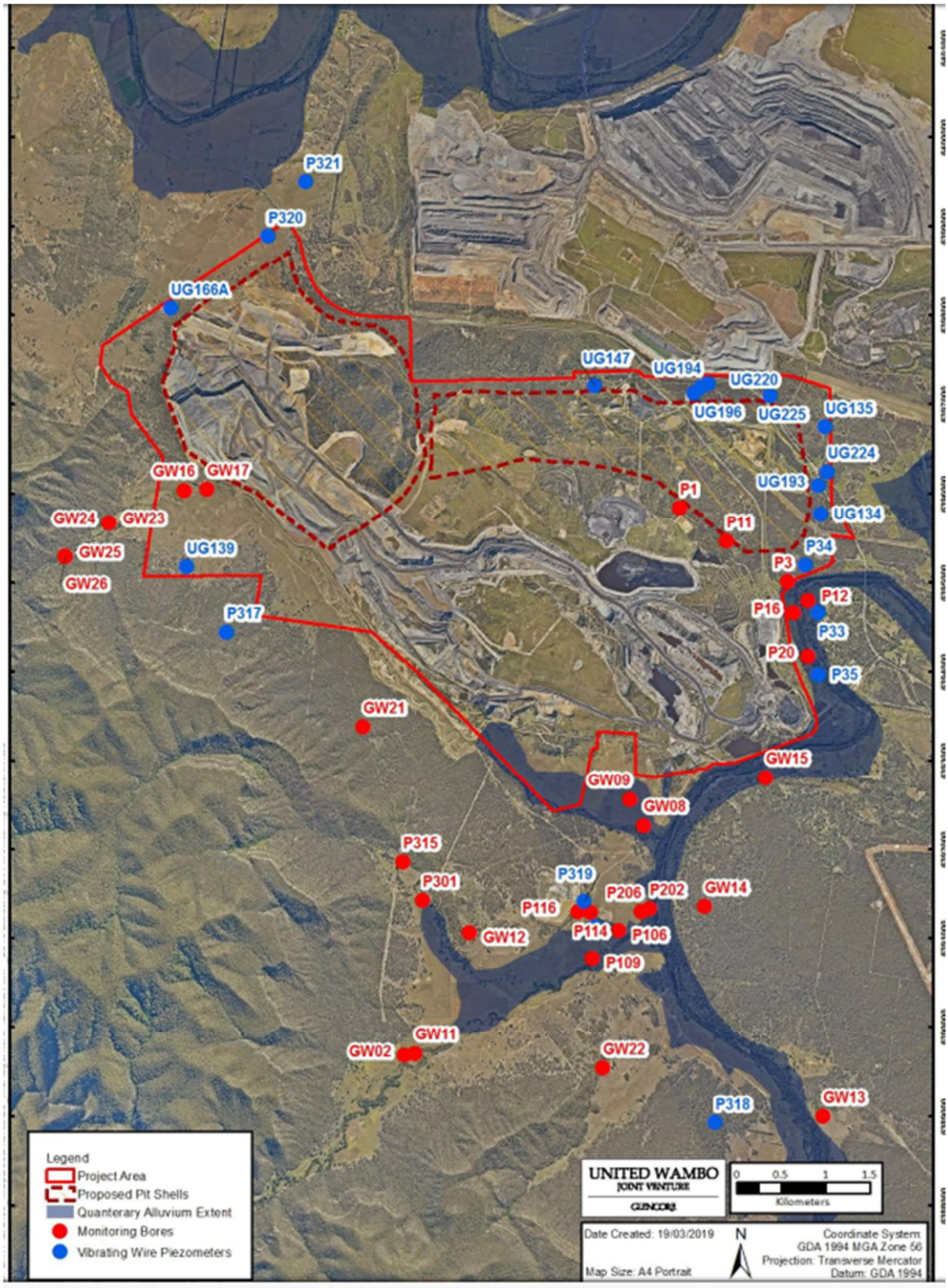


Figure 4 UWJV Monitoring Network

4.2 Groundwater Monitoring Methodology

Groundwater monitoring is undertaken in accordance with the United Wambo procedures for environmental monitoring and evaluation outlined in the United Wambo Environmental Management Strategy. The methodology for monitoring groundwater for the project includes:

- Assessment of groundwater level (manual measurement and datalogger download prior to purging/sampling);
- Sampling of groundwater (sampling after purging, or low-flow sampling); and
- Implementation of a quality control plan including appropriate chain-of-custody for laboratory analysis and provision of appropriate documentation.

Groundwater monitoring will be overseen by personnel with appropriate qualifications and experience, with field sampling undertaken by trained personnel using appropriate personal protective equipment (PPE) and approved sampling procedures.

Additional detail on groundwater monitoring at United Wambo is provided in the Section 8 of the GWMP.

4.3 Groundwater Triggers

Trigger levels are used to initiate investigations into the groundwater levels or groundwater quality at UWJV. The trigger levels, as specified by the United Wambo Groundwater Monitoring Program (UWJV, 2019), are based on statistical analysis of pre-mining baseline monitoring data. It should be noted that the 10th percentile pH triggers specified in Table 5-3 of UWJV (2019) are incorrect and likely to have been duplicated from Table 5-2. It is recommended that this table be amended to reflect the correct triggers. The correct triggers are shown in Table 7 and have been used in this annual review assessment.

For groundwater levels, a response is triggered when depth to groundwater increases above the 90th percentile (and not related to seasonal variability) over three consecutive bi-monthly observations. It is noted that the groundwater trigger action response plan (TARP) mentions the trigger to be “over three consecutive months” (UWJV, 2019 – Appendix B). This should be amended to “over three consecutive bi-monthly observations” (a 6 month period).

Triggers for EC and pH occur when three consecutive bi-monthly observations (a 6-month period) exceed the specified trigger level (90th percentile).
Trigger exceedances and analysis for the 2020 monitoring period are presented in Section 5.7

Table 7 Groundwater Level and Groundwater Quality Trigger Levels (UWJV, 2019)

Bore	Targeted Unit	Groundwater Level (mAHD)		Groundwater Quality		
		Maximum (10th percentile depth)	Minimum (90th percentile depth)	EC (µS/cm)	pH Minimum	pH Maximum
Alluvial monitoring bores						
GW02	Wambo Creek Alluvium	74.2	71.5	657	5.7	7.3
GW08[2]	North Wambo Creek Alluvium	57.2	53.5	1980	3.3	7.9
GW09[2]	North Wambo Creek Alluvium	Dry since 2016	Dry since 2016	Dry since 2016	Dry since 2016	Dry since 2016
GW11	Wambo Creek Alluvium	73.7	71	626	4	7.4
GW13	Wollombi Brook Alluvium	57.66	56.26	4447	4.9	7.1
GW15	Wollombi Brook (east) Alluvium	52.16	50.96	726	10.2	7.3
GW16[3]	North Wambo Creek Alluvium	108.118	101.218	1145	5	7.7
GW17[3]	North Wambo Creek Alluvium	103.142	98.242	5542	8.2	7.2
P12	Wollombi Brook (east) Alluvium	48.9	47.5	1002	6.3	7.7
P16	Wollombi Brook (west) Alluvium	50.48	48.88	10510	7	7.7
P20	Wollombi Brook (west) Alluvium	50.2	49.1	10364	7.2	7.6
P106	Wambo Creek Alluvium	54.47	51.47	674	6.6	7.4
P109	Wambo Creek Alluvium	58.04	56.24	801	4.4	7.4
P114	Wambo Creek Alluvium	56.04	54.14	7096	5.4	7.4
P116	Wambo Creek Alluvium	54.24	52.24	2076	4.8	7.4
Offsite bedrock monitoring bores						
GW21	Overburden	85.49	85.19	ND	ND	ND
GW22	Overburden	54.255	52.455	7028	8.1	8.4
P11	Overburden	41.4	39.8	ND	6.7	7.5
P202	Overburden	52.7	51.3	8368	6.7	7.7
P206	Overburden	44.4	39.6	2372	7.3	8.1
P404[4]	Overburden	ND	ND	ND	ND	ND
P405[4]	Overburden	ND	ND	ND	ND	ND

[2]WCPL has installed replacement bores for GW08 and GW09. Trigger levels will be established for these bores based on modelled groundwater levels and will replace the GW08 and GW09 in this table.
[3]GW16 and GW17 are located upstream of the North Wambo Creek Diversion and in close proximity to the approved open cut. There are no groundwater users located in the vicinity of North Wambo Creek upstream of the North Wambo Creek Diversion. Therefore, a trigger level for these two bores is not considered warranted. Monitoring data will be reviewed annually at these bores.
[4] ND – No historical data

4.4 Groundwater Performance Criteria

The groundwater performance criteria for alluvial and bedrock aquifers are provided in Table 8.

Table 8 Groundwater Performance Measures (Table 5-4 of UWJV, 2019)

Aspect	Performance Measures	Performance Indicator/Trigger	Response
Alluvial aquifers	Negligible change in groundwater level (compared to predicted impacts[1])	90th percentile (and not related to seasonal variability) over three consecutive months.	TARP – Groundwater Level
	Negligible change in groundwater quality	Groundwater quality concentrations outside of adopted trigger values (GWMP Table 7-3) for at least one parameter for more than three consecutive months.	TARP – Groundwater Quality
Bedrock aquifers	Negligible change in groundwater level (compared to predicted impacts[1])	90th percentile (and not related to seasonal variability) over three consecutive months. No trigger adopted for monitoring sites within the project area.	TARP – Groundwater Level
	Negligible change in groundwater quality	pH of 6.5 to 8.5 EC < 17,500 µS/cm	TARP – Groundwater Quality
Groundwater inflows to mining pits	Groundwater inflows to mining pits consistent with groundwater model predictions and all take is covered by relevant licences	Groundwater inflows to mining pits is >10% higher than predicted for three consecutive months, without logical reason (i.e. changes to mine plan or wetter than average climate conditions).	TARP – Groundwater Inflows
Seepage/leachate	Negligible seepage/leachate from water storages	Visual inspections of water storages (as per the United Wambo Erosion and Sediment Control Plan Checklists) shows the seepage zones, and reporting water balance indicates seepage is greater than negligible (i.e. >5% of inflows to water storage)	The water storage integrity will be reviewed by a specialist. Other actions as per Unforeseen Impacts Protocol (Section 7.10)
	All seepage/leachate from emplacement areas is captured in water management system	Visual inspections (as per the United Wambo Erosion and Sediment Control Plan Checklists) indicates seepage areas and confirms location of drainage pathways outside of water management system	Seepage/leachate area to be investigated, including water quality, source of seepage. Works to be undertaken to determine any potential downstream impacts and to ensure seepage is ceased or diverted to water management system. Other actions as Unforeseen Impacts Protocol (Section 9.10)

Aspect	Performance Measures	Performance Indicator/Trigger	Response
	Negligible impacts of seepage/leachate impacts from backfilled voids on regional groundwater quality	No increasing trends in water quality parameters in monitoring bores downdip of backfilled voids. An increasing trend would be indicated by three consecutive water quality readings showing continual increases in analyte concentrations.	Other actions as per Unforeseen Impacts Protocol (Section 9.10)
	Seepage/leachate impacts from final voids are consistent with predictions in relevant environmental impact statements for the two approved final voids (United and Wambo Open Cuts)	Measures to be developed as part of United Wambo Closure Plan (at least 5 years prior to completion mining)	To be completed as part of United Wambo Closure Plan

[1] Predicted impacts as determined in the numerical groundwater model (AGE, 2016)

5 Monitoring Results

A summary of the water level results and basic quality parameters (EC and pH) is provided for each of the main water bearing units below. Hydrographs, EC timeseries plots and pH timeseries plots for each key site are shown in Appendix B.

5.1 Alluvium

Alluvium bores at United Wambo are present along South Wambo Creek, Wollombi Brook and Stony Creek. During the 2020 monitoring year groundwater levels in most of the alluvium bores increased due to a recovery from previous drought conditions. As previously discussed, the Quaternary alluvium is an unconfined groundwater system that is recharged by rainfall infiltration. Annual rainfall in 2020 was approximately 46% above long-term average annual rainfall.

Salinity responses were variable, with some bores showing a decline in salinity commensurate to increased groundwater levels via rainfall recharge. Groundwater pH changes were minimal, overall measuring values in line with previous measurements.

Potential losses from North Wambo Creek through the alluvium into the mine pits is a focus of the monitoring program. The alluvium is thin, very clayey and dry along the full length of North Wambo Creek until close to the confluence with Wollombi Brook. Currently, there is no groundwater inflow into the mine pits but monitoring of bores along North Wambo Creek will continue, together with visual inspection of the mine pit face.

5.1.1 North Wambo Creek Alluvium

United Wambo monitors the North Wambo Creek alluvium at multiple groundwater monitoring bores. Four bores (GW16m GW17, GW23 and GW25) are located close to the Wollemi National Park (NP) escarpment. Monitoring groundwater level in the alluvium downstream of the North Wambo Creek diversion are bores GW08.2, GW09.2, GW10.2 and GW10.2a. These bores were installed in 2020 within the unconsolidated strata and serve as replacement sites for historical monitoring wells GW08 and GW09

Groundwater developments in these bores through 2020 are described in Table 9.

Since 2017, several additional bores have been installed in the North Wambo Creek alluvium and are currently monitored by Wambo. Consideration of these monitoring results is recommended for future reviews of groundwater behaviour in the North Wambo Creek alluvium.

Table 9 Bores screening the North Wambo Creek alluvium

Bore	SWL	pH	EC
GW08	No data	No data	No data
GW09	No data	No data	No data
GW10.2	No data	No data	No data
GW16	Recovered by about 8.5m from low point in early 2020, then showing steady decline. Now within range of previous years	Fairly stable since 2017. No significant change during 2020	Decreased from ~ 1,500 µS/cm to ~ 500 µS/cm in early 2020 commensurate with water level increase. Now within range of previous years

Bore	SWL	pH	EC
GW17*	Recovered by about 5m from low point in early 2020, then showing steady decline. Now within range of previous years	Very stable pH, no significant changes in 2020	Slight decrease in EC commensurate with water level increase
GW24	Continued groundwater level rise in early 2020, followed downward trend from mid-2020	Variable pH however downward trending from mid-2020	Declining EC of time showing signs of stabilising (rate of decline subsiding significantly)
GW26	Continued groundwater level rise in early 2020, followed downward trend from mid-2020	Steady pH for first 6 months of 2020, followed by downward trend from mid-2020	Variable EC (between 920 and 1070 µS/cm) which may be within natural fluctuations, however no long-term records to confirm

*GW17 identified as screening North Wambo Creek Alluvium in GWMP and Regolith in WMP (Peabody 2020). Given the variable nature of the hydrograph this bore has been assumed to screen the Alluvium (at least partially)

Most of the monitoring bores installed in the upstream reaches of the North Wambo Creek alluvium from 2017 to early 2020 were recorded as being dry. This has been attributed to a lack of rainfall and flow in North Wambo Creek associated with the NSW drought. In 2020, above average rainfall conditions resulted in several flow events occurring in North Wambo Creek and subsequent saturation of the adjacent alluvium.

Sites such as GW24 and GW26, located close to the Wollemi National Park (NP) escarpment, were observed to respond strongly to the first rainfall and flow event in February 2020, with observed water level increases of >4 m. Subsequent rainfall and flow events result in similar responses at these sites (April and July 2020). Observations outside the periods of rainfall and flow are seen to decline rapidly, with observations declining by up to 1 m in a month.

Observations at North Wambo Creek alluvial sites during 2020 indicate the importance of flow in North Wambo Creek as a recharge mechanism for the aquifer, with sites close to or within the creek channel receiving vertical leakage through the sandy creek bed. The delayed response and lower levels of saturation in sites further downstream and further from the channel may be related to the underlying weathered Permian strata recharging following the 2017-2020 drought, before recovery is seen in the overlying alluvium. The delayed response may also relate to the larger storage volume within the aquifer as the alluvial plain broadens downstream of the Wollemi NP escarpment, requiring larger volumes of water to cause the same increase in observed groundwater level.

Observations at GW08 in 2020 showed some minor response to rainfall in 2020 (0.5 m) but remained near-dry, GW09 also remained dry in 2020 and has been dry since early 2017. GW08.2 and GW09.2 were dry for the two observations taken in October and December 2020. Reduced catchment area for this section of the North Wambo Creek alluvium caused by open cut operations, impacts from nearby underground mining operations, and the performance of the North Wambo Creek Diversion may all be contributing the lack of recovery observed within this section of the North Wambo Creek alluvium.

EC within the North Wambo Creek Alluvium, upstream of the North Wambo Creek diversion is generally fresh with observations <1000 µS/cm. Observations within GW08, downstream of the diversion were around 2000 µS/cm, consistent with historical observations.

5.1.2 Wambo Creek Alluvium

Groundwater associated with the Wambo Creek alluvium is monitored upstream at GW02 and GW11, as well as in closer proximity to the mine footprint area at P106. A summary of the 2020 groundwater data is provided in Table 10.

Table 10 Bores screening the Wambo Creek alluvium

Bore	SWL	pH	EC
GW02	2.4m increase, but within range of previous years	Decreased by 0.5 pH, but within range of previous years	Remained similar to previous years
GW11	4m increase, but within range of previous years	Decreased by 0.5 pH, but within range of previous years	lower than previous year but within range of previous years
P106#	About 2m increase, but within range of previous years	Within range of previous years	Slightly declining throughout the year but within range of previous years
P109#	Approximate 1.5m increase, but within range of previous years	Very similar to previous year	Similar to previous year but with some more marked variation

bores for replacement. P106 is noted as obstructed, and P109 is screening multiple aquifers

Groundwater monitoring within the Wambo Creek alluvium upstream of mining operations (GW02 and GW11) has shown a sharp rise in water levels (up to 4m) following a period of above average rainfall in 2020. This event follows a period of below average rainfall between 2017 and early 2020, known as the NSW drought, which resulted in a gradual decline of groundwater levels (of approximately 3m to 4m) at these locations. Water levels within the Wambo Creek alluvium have shown a strong correlation between water level fluctuations and the rainfall trends since monitoring began in 2005, with no apparent evidence of mining impact. Evidence of landholder pumping from both of these bores was noticed in early 2020 and it is recommended that the pumps be removed, or a dedicated replacement monitoring bore be installed to mitigate any apparent impacts that may be due to pumping.

P106 is closer to mining operations, located 250 m from NWU longwall 10A, which commenced extraction in July 2015. An obstruction has been identified in P106, and a replacement bore is recommended to allow for ongoing assessment of water level trends in the Wambo creek alluvium. It is noted that P109 is also due to be replaced as it is screened across both alluvial and Permian strata (Groundsearch, 1998), not conforming to the standards set out in the *Minimum Construction Requirements For Water Bores In Australia* (NUDLC, 2020). The P109 replacement bore is recommended to be a paired site, with a standpipe in the alluvium, and another in the in the underlying weathered Permian (Peabody, 2020). This site would be an appropriate replacement for both P109 and P106 in the Wambo Creek alluvium.

Groundwater within the Wambo Creek alluvium is generally fresh (<1,000µS/cm) with minor fluctuations observed in response to climatic trends.

5.1.3 Wollombi Brook Alluvium

There are six bores screened in the Wollombi Brook alluvium immediately to the east and south east of the UWJV project area. Groundwater developments in these bores through 2020 are shown in Table 11.

Table 11 Bores screening the Wollombi Brook alluvium

Bore	SWL	pH	EC
GW15	Water level showing recovering from previous low at the start of this year.	Within range of previous years	Within range of previous years
P12	Water level recovered from previous low for most of 2020. Within range of previous years	Within the lower range of previous years	Very similar to previous years
P13*	Only one data point for 2020	Only one data point for 2020	Only one data point for 2020
P16	Water level recovering from previous low	pH temporarily lower but within previous range	Slight decrease in EC parallel with water level increase
P20	Water level recovering from previous low. Now within range of previous years	Fairly stable. No significant change during 2020	Continued steady decrease of EC since mid-2016

* No data since early 2020

The shallow groundwater on the western bank of Wollombi Brook is measured at P16, P20. Both sites are observed to respond to rainfall recharge events and surface water levels within Wollombi Brook. Decline in groundwater levels is observed at these sites in response to the 2017 to early 2020 NSW drought, with declines ranging from approximately 2 to 3 m. Due to their proximity to mining activities, some of the groundwater level decline at P16 (in the range of 1 m) and less significantly at P20 was attributed to excavation at the South Wambo Boxcut.

The rainfall events in early 2020 have recharged the shallow aquifer monitored by P16 and P20 with a 2m increase observed in water levels. in. Groundwater levels at P20 have rebounded to a similar level as observed before the NSW drought (re-established baseline conditions). At P16, recharge to groundwater is muted, not seeing a return to pre-drought levels, indicating impacts from nearby mining activities are impacting groundwater levels.

To the east of Wollombi Creek GW15, P12 and P13 monitor groundwater in the alluvium. Again, response to rainfall recharge with recovering water levels is observed. P12 recovered to pre-drought baseline levels, however GW15 had a muted response, with a groundwater level rise of only 0.5 metres, less than previously observed responses to above average rainfall years (i.e. 2011 and 2015, 1 metre and 1.5 metres respectively). Due to its location on the opposite bank of Wollombi Brook to mining operations, a UWJV mining impact is unlikely at this location. It is possible that the approaching Warkworth Open Cut may be responsible for some decline in groundwater levels during the NSW drought, and for limiting the response of groundwater level to rainfall recharge throughout 2020. However, the monitoring record does not include observations from before the millennium drought (2001-2007), making it difficult to determine whether 2020 observations are normal for this location. Fluctuations are typically subdued for alluvial sediments (other site recordings show fluctuations of up to 10 metres), so this site may reflect a tighter less responsive composition. P13 only has one monitoring record for 2020 as it was removed from the GMP. It is recommended that P13 should be reinstated to the monitoring program.

East of Wollombi Brook, alluvial groundwater is fresh, ranging between 500 µS/cm to 1,00 µS/cm at GW15 and P12. Sites on the western bank, where aquifer material has a higher clay content, have groundwater that is brackish to saline (between 8,000 µS/cm and 10,000 µS/cm) suggesting, some contribution of Permian groundwater to the aquifer, or from nearby shallow weathered Permian material. During the NSW drought, groundwater at P20 freshens (EC decline from 10,000 µS/cm to 5,000 µS/cm), while EC at P16 declines from 8,000 µS/cm to 6000 µS/cm. This observation suggests the regional drawdown induced by mining may have reduced the upwelling of Permian groundwater, increasing the proportion of fresher surface water from Wollombi Brook that mixes with groundwater locally at P20 and somewhat less significantly 500 m downstream at P16. Additionally, increased rainfall recharge directly to the aquifer and resultant mixing will reduce groundwater salinity. Throughout 2020, groundwater in the vicinity of P20 and P16 has freshened to around 2,500 µS/cm and 5,500 µS/cm respectively.

Groundwater pH adjacent to Wollombi Brook has a similar pH to alluvial groundwater in the North Wambo Creek being near neutral to slightly acidic (pH from 6.5 to 7.5). In 2020, pH is stable with no significant changes due to wetter conditions.

Construction of P407 is proposed in UWJV GMP for the United Wambo Open Cut Only Program. This recommendation is upheld to strengthen the existing network.

5.1.4 Stony Creek Alluvium/Colluvium

The Stony Creek alluvium, to the south west of UWJV is monitored by GW12, P301 and P315. P315 and P301 are located between 60m and 70m from Stony Creek, whilst GW12 is located further downstream and 300m east of the Creek. GW12 was removed from the network due to the screen construction being across alluvial and Permian strata (Peabody, 2020). Groundwater developments in P301 and P315 through 2020 are summarised in Table 12.

Table 12 Bores screening the Stony Creek alluvium/colluvium

Bore	SWL	pH	EC
P315	3m decrease since the start of the year but within range of previous years	Very stable, since 2018. No change during 2020	Very stable, since 2013. No change during 2020
P301	10m increase from previous year in early 2020, then steady decline, but within range of previous years	Decreased by 1.5 pH, but within range of previous years	Decreased from 7000 µS/cm to 500 µS/cm at start of 2020 (same timing as large water level rise) then very slight increase over year.

There is a strong relationship between the trends in rainfall and groundwater levels at P315 and P301, with large fluctuations in groundwater levels during periods of above average rainfall suggesting a combination of both direct rainfall recharge and leakage of surface water from Stony Creek to the underlying alluvial/ colluvial aquifer. This is supported by the significant reduction in groundwater salinity in P301 from 7,000 µS/cm to 500 µS/cm as a result of dilution through increased fresh recharge to the aquifer. P315 reports stable low EC readings of approximately 500 µS/cm.

Short-term fluctuations across 2020 reflect climatic conditions again indicating a strong correlation between rainfall trends and groundwater level.

5.2 Regolith/ Shallow Weathered Sandstone

5.3 Wollombi Brook

Groundwater level and quality associated with shallow weathered strata present below the Wollombi Brook alluvial/unconsolidated material is monitored at GW13 and GW14. GW13 is located 380m west of Wollombi Brook. A summary of the 2020 observations is provided in Table 13.

Table 13 Bores screening the regolith beneath Wollombi Brook Alluvium

Bore	SWL	pH	EC
GW13	3m decrease since the start of the year but within range of previous years	Very stable, since 2018. No change during 2020	Very stable, since 2013. No change during 2020
GW14	Bore dry	Bore dry	Bore dry

At GW13, groundwater level trends are somewhat similar those observed at GW15 in the shallower strata, although the magnitude of groundwater level change in response to climate or streamflow is less. The site has seen steady groundwater decline since approximately 2016. Groundwater response to the above average rainfall in 2020 is relatively minor, (an approximate 0.5m water level rise) which could be influenced by the advancing Warkworth Open Cut.

EC levels in groundwater sampled have slowly declined in GW13 from 2019 levels during 2020, from 3,180µS/cm in February 2020 to 1,870µS/cm in August 2020, with a small increase in EC levels at the end of 2020 to 1,993µS/cm in December 2020. Changes in EC in this bore correlate well with the above average rainfall conditions in 2020, but the longer-term decline may relate to a reduced component of more saline Permian groundwater associated with regional depressurisation.

pH in groundwater samples collected from GW13 remains stable with levels staying at similar levels during 2020 as to those in 2019, fluctuating around a neutral pH (7.0).

GW14 has been dry since December 2011.

5.4 Wambo Creek

Bore associated with the weathered sandstone underlying the Wambo Creek Alluvium are P114, P116 and P109.

P114 and P116, included in the GWMP but not in the WMP, are screened across both the alluvial sediments and regolith which does not satisfy the *Minimum Construction Requirements For Water Bores In Australia* (NUDLC, 2020). Work is underway to decommission the sites screened across multiple aquifers and replace them with sites only screened in one aquifer. It is recommended that these bores be removed from the trigger assessment and replaced with P316 (a nested site monitoring the alluvials, weathered Permian and Permian). No measurement data is available for P316 to date.

P109 is also screened across multiple aquifers and proposed for replacement. The P109 replacement bore is recommended to be a paired site, with a standpipe in the alluvium, and another in the in the underlying weathered Permian (Peabody, 2020). This site would be an appropriate replacement for both P109 and P106 in the Wambo Creek alluvium.

5.5 North Wambo Creek

Bore associated with the weathered regolith underlying the North Wambo Creek Alluvium are GW23, GW25, GW17, and GW10.2.

Downstream of the North Wambo Creek Diversion this unit is monitored at GW10.2 which has no recorded data to date. A summary of the groundwater observations throughout 2020 are provided in Table 14.

Table 14 Bores screening the regolith beneath the North Wambo alluvium

Bore	SWL	pH	EC
GW23	Bore showed steady decline until early 2020 with significant recovery	variable	Stable EC until 2020 when significant decrease followed by extremely slow rise established
GW25	Bore showed steady decline until early 2020 with significant recovery	Variable but overall decrease	Significant decline in early 2020, followed by continued by less rapid decline
GW17	Rapid groundwater level increase for first half of 2020, followed by steady decline. Within standard record fluctuations.	Stable	Decline in salinity, particularly in second half of 2020
GW10.2	Bore dry	Bore dry	Bore dry

Groundwater level observations within these sites show response to the climatic conditions. GW17displays a variable hydrograph although showing consistent decline since approximately 2016. Through 2020 a rapid rise in water levels occurred at this site commensurate with the above average annual rainfall experience.

The response to rainfall recharge and leakage from North Wambo Creek is evident at GW23 and GW25. The alluvial bores at these sites have shown more rapid responses to rainfall and periods where dry indicating a greater connection to climatic conditions and North Wambo Creek. The regolith bores show a slightly subdued response indicative of less connectivity resulting from some disconnect via the overlying alluvium and the lithological nature of the regolith.

EC is variable across these monitoring sites (from <1000 µS/cm to 4000 µS/cm) and was generally observed to decline in 2020. Indicating the influence of downward leakage of fresher water from overlying unconsolidated strata.

pH in groundwater samples collected from these sites are near-neutral (6.5-7.5) with slightly basic pH observed at GW16 (~7.5). pH observations at these locations are generally stable with no clear departure from normal trends.

5.6 Permian Coal Measures

A series of bores are screened in the Permian Coal Measures, the geological unit encompassing the target coal seams mined at UWJV.

5.6.1 Overburden/Interburden

There are seven bores installed to monitor the overburden/interburden of the Whybrow Coal Seam, with a summary of the 2020 monitoring results provided in Table 15.

Table 15 Bores screening the overburden/interburden of the Whybrow Coal Seam

Bore	SWL	pH	EC
GW21	Bore Dry	No Data	No data
GW22	Steady groundwater decline in 2017 ceased in 2020 with slight recovery occurring	Very stable no change in 2020	Variable, increase since mid-2020, but within long-term range
P202	3m increase in early 2020, but within range of previous years	Fairly stable. No significant change during 2020	EC decline in 2020 with some minor fluctuation in the later part of the year
P206	About 5m increase in 2020, but within range of previous years	Slight increase through 2020 but within range of previous years	Stable, consistent very slow long-term decline
P28	Only one data point for 2020	Only one data point for 2020	Only one data point for 2020
P29	Only one data point for 2020	Only one data point for 2020	Only one data point for 2020

[1] Record incomplete for 2020

At GW22, upstream to mine operations, groundwater levels associated with the Whybrow Seam interburden show a good correlation to rainfall recharge events. During the NSW drought, water levels declined by 1m before slightly responding by less than 0.5m to the wetter climatic conditions observed in early 2020. EC in this bore is shown to historically fluctuate but has an overall increasing trend. 2020 EC levels in groundwater sampled started off at approximately 7,000µS/cm before falling to 6,600µS/cm mid-year, and then climbing back to 7,000µS/cm in December 2020. pH is stable, though slightly basic at 8.2. The groundwater response at GW22 from the above average rainfall conditions in 2020 at suggests vertical connectivity between the Wollombi Brook alluvium/unconsolidated aquifer and the underlying Permian aquifer

P206 was previously impacted by historical Homestead-Wollemi underground mining, with current observations ~15 m lower than those in the late 1990's. From 2015 to early 2020, groundwater level declined at P206 by about ~10 m and did not respond to above average rainfall in 2016/17, indicating a NWU mining impact that was likely enhanced by below average rainfall from 2017-2020. Both sites continue to respond to the long-term rainfall trend, and quality observations (EC and pH) do not show trends in 2020 outside of normal historical ranges. A similar decline but of a smaller magnitude (~2 m) was observed at P202 from 2015 to 2020. Both P202 and P206 recovered in response to the above average rainfall from February 2020 to levels consistent or above those observed in other wet periods.

P28 and P29 have not been monitored beyond the first event in 2020 as they were removed from the GMP. It is recommended that these bores are reinstated to the ongoing monitoring regime.

Two bores are identified as screening the interburden of the Blakefield Seam, being P1 and P2, with their 2020 levels described in Table 16.

Table 16 Bores screening the overburden/interburden of the Blakefield Coal Seam

Bore	SWL	pH	EC
P1	Only one data point for 2020	Only one data point for 2020	Only one data point for 2020
P2	Only one data point for 2020	Only one data point for 2020	Only one data point for 2020

P1 and P2 have not been monitored beyond the first event in 2020 as they were removed due to progression of mining.

5.6.2 Coal Seams

One bore screens the Arrowhead Seam of the Permian Coal Measures and is described in Table 17.

Table 17 Bore screening the Arrowfield Seam

Bore	SWL	pH	EC
P402	Steady decline of 1.6 metres over 2020	Steady increase in pH	Initial significant increase of (2,000 µS/cm to 12,000 µS/cm), followed by slight decline

No long-term record exists for this bore so analysis can only be done on the 2020 data. A decrease in water groundwater level occurred over 2020, likely indicative of mining activity and commensurate drawdown. Groundwater pH showed a steady increase, with EC showing an early increase then decline late in 2020.

5.7 Trigger Exceedances

The triggers for UWJV monitoring bores have been specified in Section 4.3 of this report.

For groundwater levels, a response is triggered when depth to groundwater increases above the 90th percentile (and not related to seasonal variability) over three consecutive bi-monthly observations. Triggers for EC and pH occur when three consecutive bi-monthly observations (a 6-month period) exceed the specified trigger level (90th percentile).

Monitoring locations where three consecutive bi-monthly exceedances of the triggers have been observed are shown in Table 18.

Table 18 Exceedances of trigger limits for groundwater in 2020 highlighted

		Groundwater Level (mAHD)		Groundwater Quality		
		Maximum (10th percentile depth)	Minimum (90th percentile depth)	EC (µS/cm)	pH Minimum	pH Maximum
Alluvial monitoring bores						
GW02	Wambo Creek Alluvium	74.2	71.5	657	5.7	7.3

		Groundwater Level (mAHD)		Groundwater Quality		
GW08[2]	North Wambo Creek Alluvium	57.2	53.5	1980	3.3	7.9
GW09[2]	North Wambo Creek Alluvium	Dry since 2016	Dry since 2016	Dry since 2016	Dry since 2016	Dry since 2016
GW11	Wambo Creek Alluvium	73.7	71	626	4	7.4
GW13	Regolith/Shallow Weathered Sandstone Wollombi Brook	57.66	56.26	4447	4.9	7.1
GW15	Wollombi Brook (east) Alluvium	52.16	50.96	726	10.2	7.3
GW16[3]	North Wambo Creek Alluvium	108.118	101.218	1145	5	7.7
GW17[3]	North Wambo Creek Alluvium	103.142	98.242	5542	8.2	7.2
P12	Wollombi Brook (east) Alluvium	48.9	47.5	1002	6.3	7.7
P16	Wollombi Brook (west) Alluvium	50.48	48.88	10510	7	7.7
P20	Wollombi Brook (west) Alluvium	50.2	49.1	10364	7.2	7.6
P106	Wambo Creek Alluvium	54.47	51.47	674	6.6	7.4
P109	Wambo Creek Alluvium	58.04	56.24	801	4.4	7.4
P114	Wambo Creek Alluvium	56.04	54.14	7096	5.4	7.4
P116	Regolith/Shallow Weathered Sandstone Wombo Creek	54.24	52.24	2076	4.8	7.4
Offsite bedrock monitoring bores						
GW21	Overburden	85.49	85.19	ND	ND	ND
GW22	Overburden	54.255	52.455	7028	8.1	8.4
P11	Overburden	41.4	39.8	ND	6.7	7.5
P202	Overburden	52.7	51.3	8368	6.7	7.7
P206	Overburden	44.4	39.6	2372	7.3	8.1
P404[4]	Overburden	ND	ND	ND	ND	ND
P405[4]	Overburden	ND	ND	ND	ND	ND

N/A = Not applicable

ND = insufficient baseline data to develop meaningful trigger level

*Minimum depth-to-water is equivalent to maximum groundwater level (mAHD)

**Maximum depth-to-water is equivalent to minimum groundwater level (mAHD)

*** P206 also known as P203 – triggers defined in GWMP (Peabody, 2018)

5.7.1 Groundwater Level Trigger Exceedances

Throughout 2020 seven bores recorded groundwater level trigger exceedances.

5.7.1.1 GW13

GW13 is screened in the regolith beneath the Wollombi Brook alluvium. The groundwater levels at this site have been in steady decline since late 2011, however levels have seen recovery in 2020. This bore has been below the trigger level since 2013. The subdued reaction to the above average rainfall in 2020 and the steady decline may indicate influence of the advancing Warkworth Open Cut.

5.7.1.2 GW15

GW15 is located 275 m east of the channel of Wollombi Brook and 1.5 km west of the advancing Warkworth Open Cut. During 2020, all groundwater level observations at bore GW15 were below the 90th percentile trigger level. A slight recovery is observed during 2020, though groundwater recovery responses are limited in comparison to other bores.

As concluded in HydroSimulations (2019) and SLR (2020), the start of the decline in observed groundwater levels at GW15 corresponded to trends observed in the rainfall residual mass and the water levels within Wollombi Brook, both indicating declining levels since March 2016. However, when considering observations during 2020, a relatively wet year, the small magnitude of response to increased stream flow and rainfall recharge is not consistent with previous observations. Due to GW15's location on the opposite side of Wollombi Brook to WCPL, it is considered unlikely that WCPL mining activity is impacting GW15. Due to monitoring record at GW15 not including the millennium drought, it is possible that the response is normal following a long period of below average rainfall. However, it is also possible that the approaching Warkworth Open Cut may be responsible for some decline in groundwater levels at GW15.

The following further investigation is recommended:

- Confirmation of the validity of data collected at GW15 and to check if the bore is obstructed or compromised.
- This should include consideration of groundwater level collected in the Wollombi Brook/ Warkworth Sands alluvium at other nearby mine sites, the Wollombi Brook water elevation, P16 and P20 groundwater level observations, and South Wambo Boxcut floor elevation and fill level.
- Confirmation of the nature of the material (alluvial or weathered sandstone) intersected by GW15.

5.7.1.3 P16

The Wollombi Brook Alluvium is monitored by P16. Bore P16 is located approximately 4.5 km from LW11, adjacent to Wollombi Brook and downstream of underground mining at WCPL. P16 is less than 200 m from the excavation that occurred for the South Wambo Boxcut, now known as Glen Munro Pit, which was completed in July 2017. Bore P16 was constructed as part of an assessment to identify whether the alluvial aquifer located to the east of Wollombi Brook extended to the west of the channel, overlying the United Underground longwalls (GeoTerra, 2003). The study found that colluvial and silty alluvial material ranging in thickness from 1.9 m to 11.5 m existed at sites to the west of Wollombi Brook, but that this material is not part of the Wollombi Brook Alluvial Aquifer. The colluvial and silty alluvial material in bore P16 was 11 m thick.

Previous rainfall and stream level trends from 2015 to 2020 indicate decreased recharge, with the lowest groundwater level on record at P16 occurring in late 2019 (approximately 1.4 m below the minimum observation recorded from 2005 to 2015). While some of the decline in groundwater level at P16 could be attributed to the low rainfall conditions as part of the 2017 to early 2020 NSW drought, excavation at Glen Munro Pit appears to have caused additional drawdown in the order of 1.2 m. Groundwater levels have increased during 2020, to 1.5m higher than late-2019 levels, however groundwater levels are still lower than the 90th percentile water level from the baseline period, likely indicating an ongoing mining impact on this bore.

The amount of drawdown in P16 is consistent with the groundwater assessment for the South Wambo Boxcut by HydroSimulations (2016) which predicted a small amount of additional drawdown in Permian strata at P16 due to the excavation of the boxcut, on top of broader regional depressurisation from mining activity such as NWU, United Underground and the United Wambo Joint Venture.

Bore P16 was only below the minimum trigger level for the initial six months of 2020 at which point its recovery surpassed the minimum trigger level into the acceptable water level range.

5.7.1.4 P114 and P116

Monitoring bores P114 and P116 have been below the water trigger level since mid-2015 and mid-2017 respectively. These bores, although included in the GWMP, have been removed from the WMP. As discussed, they are screened across both the alluvial sediments and regolith which does not satisfy the *Minimum Construction Requirements For Water Bores In Australia* (NUDLC, 2020).

5.7.1.5 GW21

Bore GW21 has been consistently dry for 2017. The quality of this bore should be reviewed to ensure it is still suitable for inclusion in the monitoring regime. The bore condition is currently not known and a representative hydrograph cannot be constructed without data.

5.7.1.6 P206

P206 is screened in the Permian Coal measures and as discussed above, was previously impacted by historical Homestead-Wollemi underground mining. Current observations show water levels approximately 15 m lower than those in the late 1990's. Given the expected disturbed nature of Permian Coal Measures the institution of trigger levels may prompt additional investigative works that do not add value. Alterations to the groundwater system are to be expected whilst mining this unit and have been understood through modelling. Rather than trigger levels, comparison to expected outcomes of the modelling may be a more productive way to monitor the impacts on the Permian Coal Measures.

5.7.2 EC Trigger Exceedances

Bore P116, screened in the Wambo Creek Alluvium, recorded groundwater EC above the trigger level for the entire of 2020. The groundwater at this site has been experiencing long term relatively steady increase in EC, and excluding one data point in mid-2019 has been consistently above the trigger level since 2018.

5.7.3 pH Trigger Exceedances

Bore P12, screened in the Wollombi Brook Alluvium, recorded pH levels below the minimum trigger level for majority of 2020, except for one data point at which it exceeded the upper trigger level. The groundwater at this site has shown significant variation over time and the 2020 pH measurements are not outside the long-term variation experienced. Groundwater has been below the lower trigger level since 2013 and between 2008 – 2013.

5.8 Reporting against Groundwater Performance

The 2020 groundwater monitoring is to be compared against the Groundwater Performance Measures (UWJV, 2020), as presented in Table 19.

Table 19 Groundwater performance measures and response

Aspect	Performance Measures	Performance Indicator/Trigger	Response	Overall Compliance
Alluvial aquifers	Negligible change in groundwater level (compared to predicted impacts[1])	90th percentile (and not related to seasonal variability) over three consecutive months.	TARP – Groundwater Level	Trigger levels breached in several bores, see discussion and recommendations
	Negligible change in groundwater quality	Groundwater quality concentrations outside of adopted trigger values (Table 7-3) for at least one parameter for more than three consecutive months.	TARP – Groundwater Quality	Trigger exceeded in one bore, further investigation to be undertaken
Bedrock aquifers	Negligible change in groundwater level (compared to predicted impacts[1])	90th percentile (and not related to seasonal variability) over three consecutive months. No trigger adopted for monitoring sites within the project area.	TARP – Groundwater Level	Compliance achieved – no triggers breached in bedrock
	Negligible change in groundwater quality	pH of 6.5 to 8.5 EC < 17,500 µS/cm	TARP – Groundwater Quality	Water level trigger breached, pending further discussion regarding suitability of trigger.
Groundwater inflows to mining pits	Groundwater inflows to mining pits consistent with groundwater model predictions and all take is covered by relevant licences	Groundwater inflows to mining pits is >10% higher than predicted for three consecutive months, without logical reason (i.e. changes to mine plan or wetter than average climate conditions).	TARP – Groundwater Inflows	Not pertinent to this annual reporting

Aspect	Performance Measures	Performance Indicator/Trigger	Response	Overall Compliance
Seepage/leachate	Negligible seepage/leachate from water storages	Visual inspections of water storages (as per the United Wambo Erosion and Sediment Control Plan Checklists) shows seepage zones, and reporting water balance indicates seepage is greater than negligible (i.e. >5% of inflows to water storage)	The water storage integrity will be reviewed by a specialist. Other actions as per Unforeseen Impacts Protocol (Section 7.10)	Not pertinent to this annual reporting
	All seepage/leachate from emplacement areas is captured in water management system	Visual inspections (as per the United Wambo Erosion and Sediment Control Plan Checklists) indicates seepage areas and confirms location of drainage pathways outside of water management system	Seepage/leachate area to be investigated, including water quality, source of seepage. Works to be undertaken to determine any potential downstream impacts and to ensure seepage is ceased or diverted to water management system. Other actions as Unforeseen Impacts Protocol (Section 9.10)	Not pertinent to this annual reporting
	Negligible impacts of seepage/leachate impacts from backfilled voids on regional groundwater quality	No increasing trends in water quality parameters in monitoring bores downdip of backfilled voids. An increasing trend would be indicated by three consecutive water quality readings showing continual increases in analyte concentrations.	Other actions as per Unforeseen Impacts Protocol (Section 9.10)	Not pertinent to this annual reporting

Aspect	Performance Measures	Performance Indicator/Trigger	Response	Overall Compliance
	Seepage/leachate impacts from final voids are consistent with predictions in relevant environmental impact statements for the two approved final voids (United and Wambo Open Cuts)	Measures to be development as part of United Wambo Closure Plan (at least 5 years prior to completion mining)	TBA as part of United Wambo Closure Plan	Not pertinent to this annual reporting

5.9 Vibrating Wire Piezometer Data Review

Detailed assessment of the observed groundwater level trends of VWP data have not been undertaken or presented in this report but will be included in future reporting once additional data is collected to confirm the findings of the data quality assessment. The preliminary data quality assessment has been provided in Appendix C.

6 Verification of Model Predictions

Predictive groundwater modelling was completed in 2015, assuming commencement of mining activities in 2017. The climatic conditions applied with mining progression and subsequent predicted water levels are all outdated given the delayed actual mining commencement date in 2020.

The groundwater model is currently undergoing an update to provide more robust and realistic data around predicted water levels, using updated climatic data and mining progression (i.e. year 1 of mining will match 2020 climatic conditions, not 2017 as originally modelled). Consequently, it is not warranted to review water levels this year against outdated model predictions. This analysis will be completed in the future when model predictions are updated to reflect current mining practices.

7 Water Licencing Requirements

United Wambo has a combined total entitlement of up to 370 ML/year assuming full allocation under the Hunter Unregulated and Alluvial WSP (Lower Wollombi Water Source), and up to 1,306 ML/year high security surface water under the Hunter Regulated WSP (Hunter River). In addition, entitlements held by United Wambo for water take from the Permian groundwater system under the North Coast Fractured and Porous Rock WSP, are 1947 ML/year.

Water entitlements and peak project take volumes from groundwater sources based on modelling results from the UWJV EIS (AGE, 2016), are shown in Table 20.

Table 20 United Wambo Groundwater Entitlement and Licenses

Licence Number	Holder	Entitlement [1]	Project Water Take (ML/year) [4]
Groundwater: Lower Wollombi Brook Water Source[2]			
WAL23897	Wambo	70 unit shares	40
WAL18549	United	100 unit shares	
WAL18445	United	200 unit shares	
Groundwater: Porous Rock Water Source[3]			
WAL42373	Wambo	1549 unit shares	633
WAL41532	Wambo	98 unit shares	
WAL41510	United	300 unit shares	

Note: WAL = water access licence, ML/year = megalitres per year.

[1] one unit share is equivalent to 1 ML/year unless reductions are in place via an annual available water determination

[2] water source under the Hunter Unregulated and Alluvial Water Sources water sharing plan (WSP) 2009

[3] water source under the North Coast Fractured and Porous Rock Groundwater Sources WSP 2016

[4] predicted peak annual project water take over life of mine based on AGE (2016) groundwater modelling

Excavation of the United Open Cut starter pit began in May 2020, with groundwater take from rock sources (Permian coal measures) likely to be consistent with or less than take estimates from mining year two, up to approximately 40 ML (Figure 5). This has been inferred by comparing the mine progression simulated in the EIS groundwater assessment (AGE, 2016) and the actual disturbance footprint at the end of 2020. This take is under the maximum predicted take of 633 ML/yr that was predicted to occur in year seven of the project and within the entitlement volumes of the Sydney Basin – North Coast Porous Rock Water Source water licences.

Figure 5 Groundwater predicted to be intercepted from Permian coal measures (Source: AGE (2016) Figure 7-1)

Alluvial take due to excavation of the United Wambo operations has also been inferred for year two of mining operations as predicted in the EIS (AGE, 2016). Figure 6 indicates no additional take from Wollombi Brook Alluvium is predicted at this stage of operations and is therefore less than the maximum predicted take of 40 ML/yr and within the entitlement volumes of the Lower Wollombi Brook Water Source water licences.

It should be noted that the 'Approved Mining' scenarios in both Figure 5 and Figure 6 include impacts from the approved South Wambo Project, that has not yet commenced longwall mining operations. Approved take estimates from rock and alluvial sources are likely to be large overestimates. A contemporary groundwater model is scheduled for finalisation in mid-2021 that has been updated to include actual climatic and operational inputs since the completion of the modelling contributing the UWJV EIS (AGE, 2016). The model also includes updates in areas such as the North Wambo Creek alluvium, where conceptual understanding of the groundwater system has improved. Once finalised, a review of licence estimates will be undertaken and the GMP updated where necessary, submitted to DPIE and reported against in future annual reviews.

Figure 6 Predicted net change in flow from Permian to Wollombi Brook alluvium due to mining

Stygofauna Monitoring

To fulfil the monitoring requirements as per the GWMP UWJV committed to monitoring stygofauna in the alluvial aquifers within (or near to subject to bore suitability) the predicted drawdown areas every three years.

An assessment of the presence and potential impacts on stygofauna communities within the aquifers surrounding the project area was undertaken for the EIS in 2015 (Umwelt 2016b). The assessment showed that stygofauna exists in small isolated populations within the shallow alluvial aquifers in the area surrounding the project, including those associated with Wollombi Brook and North Wambo Creek.

A second survey was in 2016 and was undertaken on additional bores in the Hunter River and Wollombi Brook Alluvium. Most recently, the third stygofauna survey was conducted in 2019 to initially identify and then monitor the presence of stygofauna within the predicted area of drawdown. Table 21 outlines the bores that were sampled in the 2019 survey event.

Table 21 Stygofauna sampling event 2019

Bore ID	Sample Collected	Catchment	Comment
GW08	No	North Wambo Creek	Bore dry, no sample
GW16	Yes	North Wambo Creek	
P116	Yes	Wollombi Brook / Stony Creek	
P12	Yes	Wollombi Brook / Stony Creek	
P16	Yes	Wollombi Brook / Stony Creek	
P408	Yes	Hunter River	
P409	Yes	Hunter River	
P410	Yes	Hunter River	

The stygofauna survey and assessment recorded an absence in subterranean fauna on this occasion within the shallow alluvials in the Study Area. A risk assessment for the current ecological conditions and the risk from current and proposed development indicated that the ecological values of the aquifers and the stygofauna community are low.

To mitigate any potential risks, if groundwater monitoring indicates that impacts are greater than predicted within the shallow alluvial aquifers surrounding the Project Area, more regular monitoring for stygofauna will be triggered. Of the seven bores sampled during the 2019 event, four are trigger bores for the UWJV. Of these four bores, two did breach lower trigger levels for the groundwater level (P116 and P16).

9 GDE Monitoring

As required by Condition B51 of SSD 7142, United Wambo must, within 12 months of commencement under SSD 7142, undertake a Groundwater Dependent Ecosystem Study. This study must:

a. be prepared by suitably qualified and experienced person/s;

b. be developed in consultation with DPIE Water;

c. assess the hydrological and hydrogeological settings of the site;

d. be integrated with the similar studies being undertaken by nearby mines (where practicable);

e. further characterise groundwater dependent ecosystems (vegetation and communities) potentially impacted by the development, including the Central Hunter Swamp Oak Forest EEC (GDE1), Hunter Valley River Oak Forest (GDE2) and individual River Red Gums (GDE1 and GDE2) identified along the riparian buffers of Redbank Creek and Wollombi Brook;

f. detail the reliance of groundwater dependent ecosystems on surface and groundwater resources;

g. identify the potential risks to groundwater dependent ecosystems from the development and the Wambo Mining Complex, and other nearby mines (where practicable); and

h. use the results of this study to develop performance criteria to achieve the performance measures in SSD 7142 and inform the GWMP.

The required Groundwater Dependant Ecosystem Study was completed in January 2021 (Umwelt, 2021), with key findings relevant to this review provided below:

- The water table at GDE1 was inferred as being >10 m below surface, indicating that vegetation in the downstream reaches of Redbank Creek is unlikely to be reliant on the broader groundwater system, but may access saturate shallow clays and localised perched aquifers along the creek line that are recharged during flood events.
- The Lemington South Pit 1 final void may be limiting any upward leakage of Permian groundwater into the alluvium near GDE1.
- Limited groundwater monitoring sites target the alluvium near GDE1. The GDE Study (Umwelt, 2021) recommends the installation of an additional shallow bore near Redbank Creek to characterise the potential shallow water table within the alluvium or underlying weathered sandstone in the area.
- The water table at GDE2 is measured from 4 to 9 m below surface and is likely shallow enough to enable uptake by larger vegetation and trees.
- Bores currently managed by United Wambo or Wambo exist adjacent to GDE2 (P12, P15, P16, P401. P402 and BH1).

The GDE Study (Umwelt, 2021) has provided a framework for monitoring and analysis of groundwater level and quality data near GDE1 and GDE2 that will enable assessment against the following performance measures specific to GDEs and groundwater (Table 22)

Table 22 Groundwater Performance Measures – GDE (Umwelt, 2021)

Aspect	Performance Measure	Performance Indicator/ Trigger	Response
Aluvial Aquifers	Negligible change in groundwater level (compared to predicted impacts)	90th percentile (and not related to seasonal variability) over three consecutive months	TARP – Groundwater Level

Aspect	Performance Measure	Performance Indicator/ Trigger	Response
	Negligible change in groundwater quality that could impact on GDE health	90th percentile for EC 10th to 90th percentile for pH 90th percentile for sulfate For at least one parameter for more than three consecutive months	TARP – Groundwater Quality

Note: TARP – Trigger Action Response Plan – as outlined within the approved groundwater management plan

10 Conclusions

The 2020 groundwater monitoring program successfully collected a suite of data to inform the ongoing management of groundwater for the UWJV Project site. To conclude, a summary of the key findings are presented below:

- 2020 experienced significantly above average annual rainfall resulting in flow events occurring in ephemeral watercourses, which combined with increased direct rainfall recharge saw broad-scale recovery of groundwater levels
- A number of bores have been identified as failing to satisfy the *Minimum Construction Requirements For Water Bores In Australia* (NUDLC, 2020) as result of screening multiple aquifer and these have been flagged for replacement
- A series of new bores have been installed to supplement the existing network and replace bores previously reported as unsuitable
- The data quality assessment undertaken for UWJV VWPs will enable their ongoing inclusion in groundwater assessment work. Identifying arrays with failed/ poor quality sites will improve sampling efficiency
- Trigger level assessments identified seven bores breaching the minimum groundwater level trigger, and one bore each breaching trigger levels for both pH and EC.
- groundwater take from groundwater units (alluvial and Permian coal measures) likely to be consistent with or less than modelled take estimates from mining year two

11 Recommendations

A series of recommendations has been provided to promote the best practice for fulfilling the requirements of the GWMP and WMP, including;

- Series of bores identified as requiring decommissioning and replacing;
  - P106 noted as obstructed
  - P109, P114 and P116 are screened across multiple aquifers
- Investigate condition of groundwater bores:
  - GW15 – review bore condition and validity of data, confirm screened geology
  - GW14 and GW21 – long-term dry bore, review condition

  - GW17 – review lithology to confirm screened geology
- Finalise review of VWP data for presentation and analysis
- It is noted that the groundwater trigger action response plan (TARP) mentions the trigger to be "over three consecutive months" (UWJV, 2019 – Appendix B). This should be amended to "over three consecutive bi-monthly observations" (a 6 month period)
- P13, P28 and P29 only have one monitoring record for 2020 and should be reinstated to the monitoring program
- Groundwater bores GW23, GW24, GW25 and GW26 have some confusion around their identification and should be reviewed to confirm data referring to correct bore
- It is noted that the 10th percentile pH triggers specified in Table 5-3 of UWJV (2019) are incorrect and likely to have been duplicated from Table 5-2. It is recommended that this table be amended to reflect the correct triggers. The correct triggers are shown in Table 7 and have been used in this annual review assessment.
- Review and analysis of all groundwater quality data (including major ions, metals and alkalinity)
- Review of groundwater levels against updated model results when model outputs finalised
- Review of trigger levels for bores screened in the Permian Coal measures as may be more suitable to use model outputs to inform risks
- Further investigation into quality trigger breaches (EC and pH) to identify potential cause – review additional hydrochemistry available (full suite of parameters), review trigger levels to ensure suitable for each bore given long-term periods below triggers
- Review of bores exceeding groundwater level triggers against model outputs when finalised and against any comparable VWP data to confirm validity of record and inform investigation
- A more detailed investigation into the potential requirement for additional stygofauna monitoring given the breach of trigger levels in two of the sampled bores.

12 References

AGE (2016) *United Wambo Open-Cut Coal Mine Project Groundwater Impact Assessment*. Australasian Groundwater and Environmental Consultants, Pty Ltd

DPIE Water (2014) *Groundwater Monitoring and Modelling Plans – Introduction for prospective mining and petroleum activities*

GeoTerra 2003, *Wollombi Brook Alluvial Aquifer Assessment*, prepared for United Colliers Pty Ltd, August 2003

HydroSimulations (2019) *Wambo Knowledge to inform GDE Study* Report HS2018/5 for Wambo Coal Pty Ltd. April 2018

Peabody (2018) *Wambo Coal Groundwater Monitoring Program*. Document No. WA-ENV-MNP-509.1 April 2018

SLR (2020) *Hunter Valley Operations 2019 Annual Groundwater Review*, in Hunter Valley Operations 2019 Annual Environmental Review, Appendix A.

SLR (2020) *Wambo 2019 Annual Review – Groundwater* Report 665.10008.00006-R01-v2.0 for Wambo Coal Pty Ltd. 31 March 2020

Umwelt (2016) *United Wambo Open Cut Coal Mine Project – Environmental Impact Statement*

APPENDIX A

Monitoring Network

Lookup ID	Monitoring Program	Responsible for Monitoring	Type	Status	Easting	Northing	Ground elevation (mAHD)	Bore depth (mbGL)	Screen/ Sensor from (mbGL)	Screen to (mbGL)	Lithology
GW02	Combined	Wambo	Well	EX	309109	6389680	82.5	11.2			Upper South Wambo Creek Alluvium
GW08.2	Combined	Wambo	MB	EX	311869	6392326		3	2.0	3	North Wambo Creek Alluvium
GW09.2	Combined	Wambo	MB	EX	311743	6392326		7.4	4.5	7.4	North Wambo Creek Alluvium
GW10.2	Combined	Wambo	MB	EX	311872	6392264		3	2	3	
GW10.2a	Combined	Wambo	MB	EX	311872	6392264		25	22	25	
GW11	Combined	Wambo	Well	EX	309228	6389699	76.335	9.6			Upper South Wambo Creek Alluvium
GW13	Combined	United Wambo	MB	EX	313810	6388990	61.839	15	6.0	15.0	Regolith
GW15	Combined	Wambo	MB	EX	313164	6392807	61.895	17.4	13.8	17.4	Wollombi Bk alluvium
GW16	Combined	Wambo	MB	EX	306641	6396034	112.445	12.15	6.2	12.2	Alluvium, Regolith
GW17	Combined	Wambo	MB	EX	306895	6396048	110.685	14	11.0	14.0	Regolith
GW21	Combined	Wambo	MB	EX	308647	6393378	121.824	36	24.0	36.0	Whybrow Coal Interburden
GW22	Combined	Wambo	MB	EX	311335	6389535	88.403	54	42.0	54.0	Whybrow Coal Interburden
GW23	Combined	Wambo	MB	EX	305791	6395668	118.8	13.2	11.7	13.2	North Wambo Creek – Consolidated Bedrock
GW25	Combined	Wambo	MB	EX	305299	6395288	129.4	13.2	11.7	13.2	North Wambo Creek – Consolidated Bedrock
P1	Combined	United Wambo	MB	EX	312199	6395840	86.0	37	31.0	37.0	Interburden - Blakefield - unnamed C

Lookup ID	Monitoring Program	Responsible for Monitoring	Type	Status	Easting	Northing	Ground elevation (mAHD)	Bore depth (mbGL)	Screen/ Sensor from (mbGL)	Screen to (mbGL)	Lithology
P2	Combined	United Wambo	MB	EX	312403	6395552	85		24	30	Interburden - Blakefield Seam
P106 (repair/ replace)	Combined	Wambo	MB	Blocked	311518	6391084	61.07	11	5.0	11.0	Alluvium
P109 (replacement)	Combined	Wambo	MB	Proposed	311215	6390768	62.44				Alluvium
P109 (replacement)	Combined	Wambo	MB	Proposed	311215	6390768	62.44				Permian
P11	Combined	United Wambo	MB	EX	312728	6395462	71.8	31	19.0	28.0	Interburden Blakefield - unnamed D
P316(a,b,c)	Combined	Wambo	MB	EX	311255	6391087		7	4.0	7.0	North Wambo Creek alluvium
								13	10.0	13.0	Weathered Permian
								26	23.0	26.0	Permian
P16	Combined	Wambo	MB	EX	313480	6394655	57.48	11.5	5.0	10.5	West Wollombi Brook Colluvium
P20	Combined	Wambo	MB	EX	313639	6394166	57.4	10.6	6.0	9.2	West Wollombi Brook Colluvium
P28	Combined	United Wambo	MB	EX	311396	6392632	63.1	-	-	-	Whybrow Coal Overburden
P29	Combined	United Wambo	MB	EX	311820	6392560	60.8	-	-	-	Whybrow Coal Overburden
P202	Combined	Wambo	MB	EX	311854	6391262	60.265	20	14.0	20.0	Overburden Whybrow
P301	Combined	Wambo	MB	EX	309360	6391466	88.18	20.4		20.4	Alluvium, shallow overburden
P315	Combined	Wambo	MB	EX	309084	6391856	94.74	9.5		9.5	Stoney Creek Alluvium/Regolith
P317	Combined	Wambo	VWP	Unknown	307115	6394439	155.41	248.5	35		Regolith
									100		Overburden
									174		Whybrow Seam
									213		Wambo Rider Seam

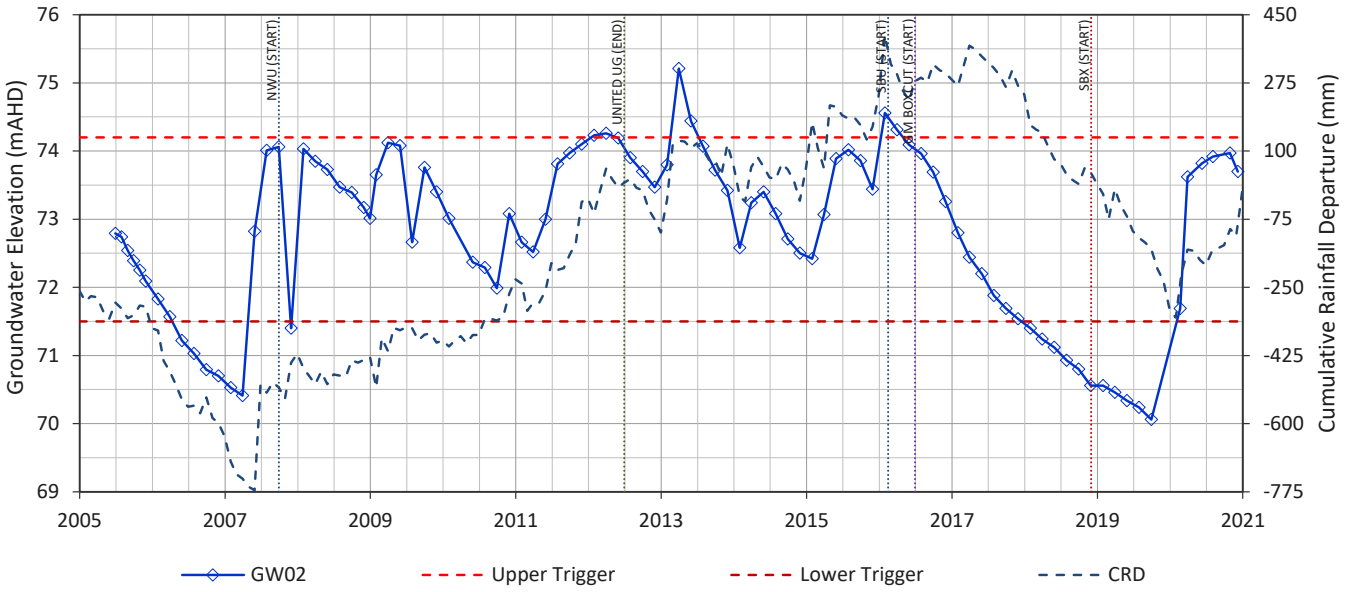
Lookup ID	Monitoring Program	Responsible for Monitoring	Type	Status	Easting	Northing	Ground elevation (mAHD)	Bore depth (mbGL)	Screen/ Sensor from (mbGL)	Screen to (mbGL)	Lithology
									248.5		Wambo Seam
P318	Combined	Wambo	VWP	Unknown	312599	6388922	71.05	357	11		Regolith
									150.79		Whybrow Seam
									205.25		Wambo Seam
									314.25		Woodlands HIll
									357		Arrowfield Seam
P319	Combined	Wambo	VWP	Unknown	311125	6391412	64.4	265.3	11		Regolith
									74.9		Whybrow Seam
									161.3		Wambo Seam
									265.3		Interburden Sandstone
P320	Combined	Wambo	VWP	Unknown	307573	6398890	85.86	344	92		Warkwort
									191		Vaux
									217.5		Baywater
									263		Pike Gully
									305		Lower Arties
									344		Middle Barrett
P321	Combined	Wambo	VWP	Unknown	307573	6398890	110.39	187.8	31.8		Arrowfield
									72.1		Warkworth
									161.15		Vaux
									187.82		Bayswater
UG139	Combined	United Wambo	VWP	EX	306665.45	6395172.7	128.9	402.0	263.0		Unnamed D
									281.0		Unnamed E
									319.0		interburden Glen Munro - Unnamed E
									329.0		Glen Munro
									375.0		interburden Arrowfield - Glen Munro
									382.0		Arrowfield

Lookup ID	Monitoring Program	Responsible for Monitoring	Type	Status	Easting	Northing	Ground elevation (mAHD)	Bore depth (mbGL)	Screen/ Sensor from (mbGL)	Screen to (mbGL)	Lithology
									402.0		interburden Warkworth - Bowfield
UG166A	Combined	United Wambo	VWP	EX	306488.43	6398076	141.5	260.0	130.0		Unnamed D
									153.0		Unnamed E
									183.0		Blakefield
									200.0		Glen Munro
									238.0		Arrowfield
									254.0		Bowfield
									260.0		Bowfield
									190		Wambo Seam
									336.5		Arrowfield Seam

APPENDIX B

Monitoring Results (hydrographs, EC and pH plots)

GW02


Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
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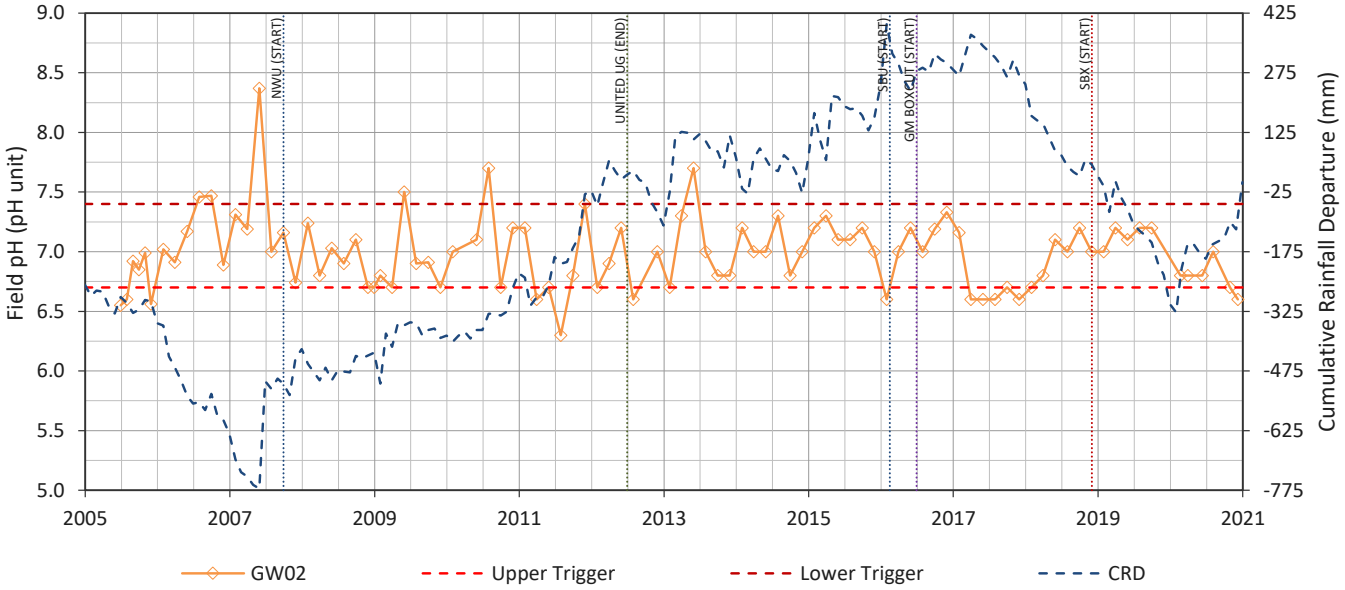
SBU (START)
GM BOXCUT (START)
SBX (START)
GW02
Upper Trigger
Lower Trigger
CRD


Field pH (pH unit)
Cumulative Rainfall Departure (mm)
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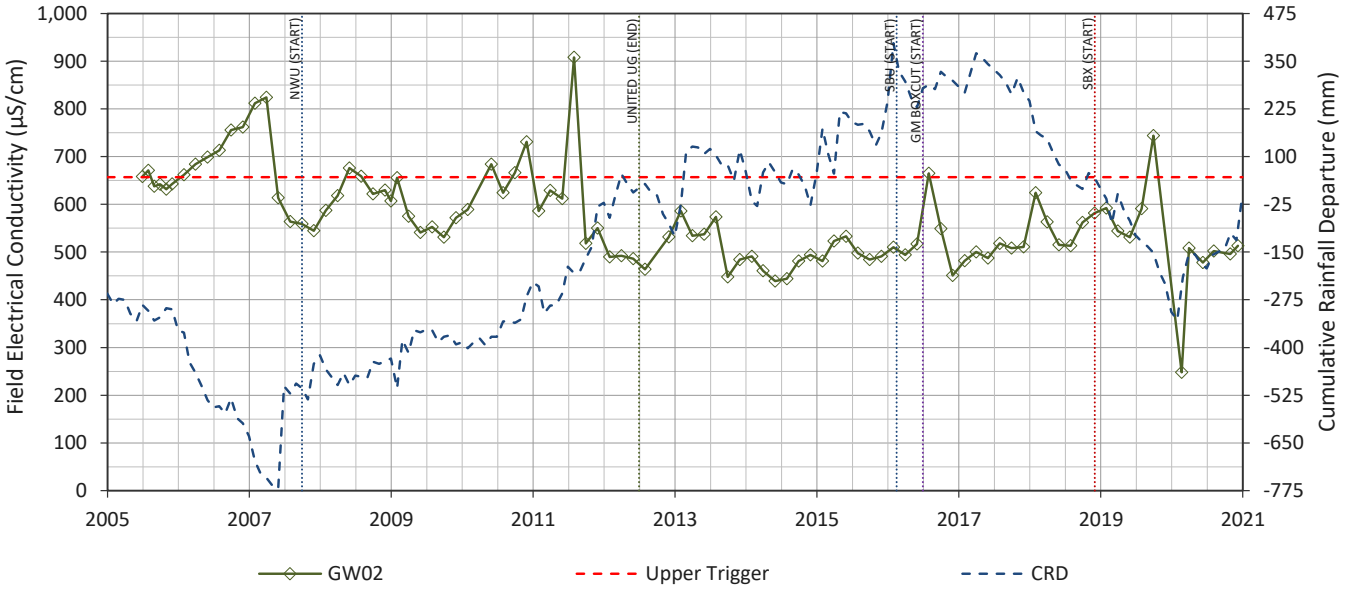
SBU (START)
GM BOXCUT (START)
SBX (START)
GW02
Upper Trigger
Lower Trigger
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
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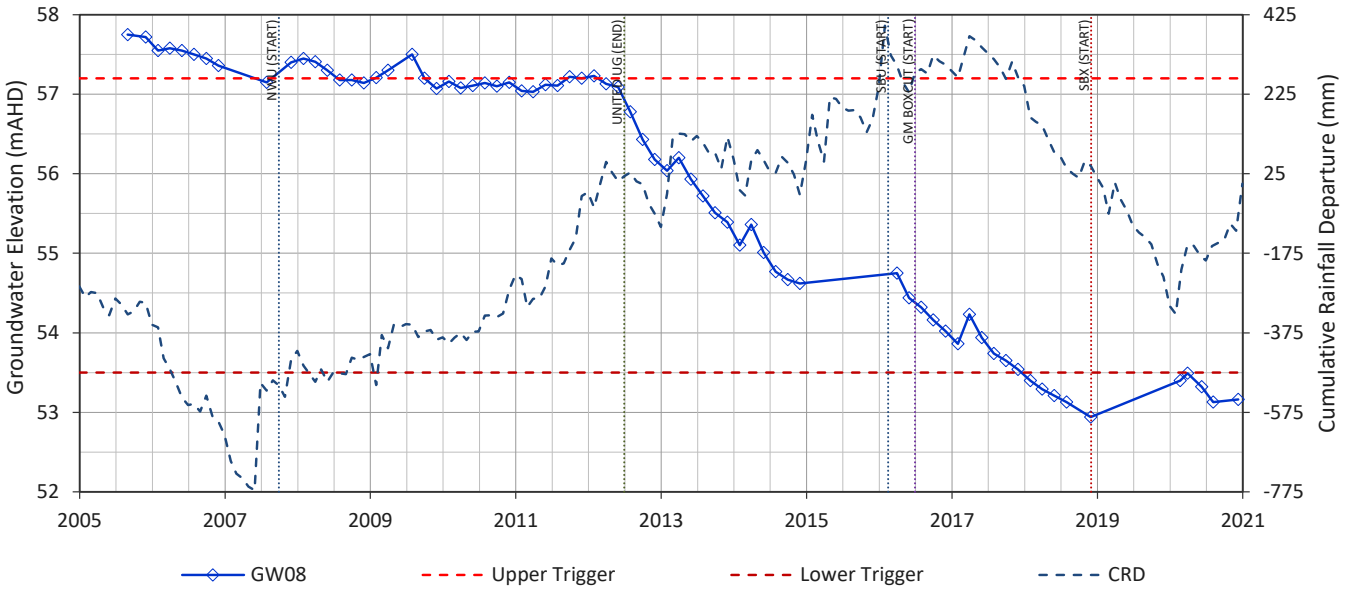
SBU (START)
GM BOXCUT (START)
SBX (START)
GW02
Upper Trigger
CRD

GW08


Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
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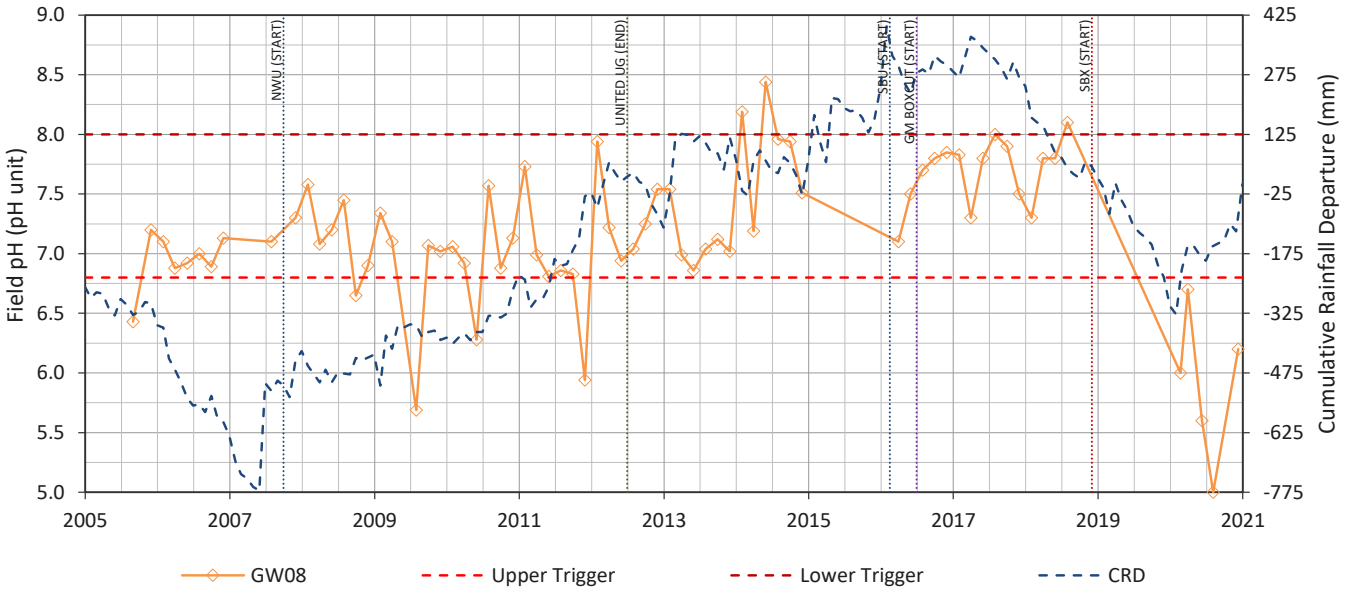
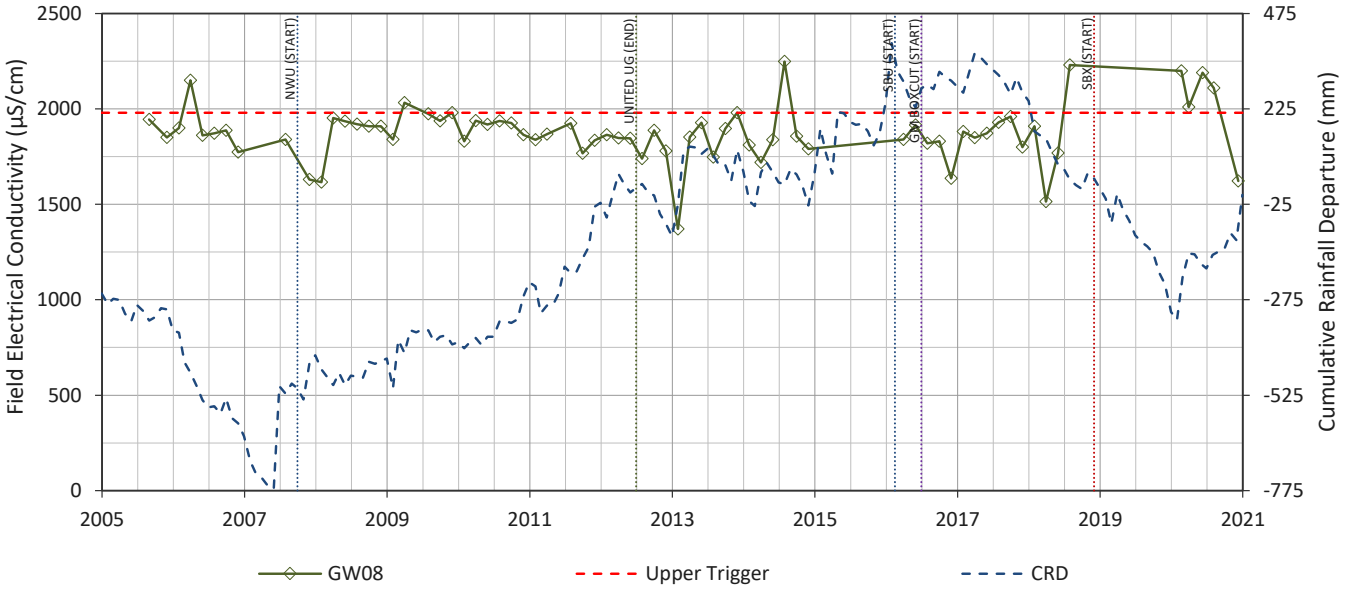
UNITED UG (END)
SBU (START)
GM BOX CUT (START)
SBX (START)
GW08
Upper Trigger
Lower Trigger
CRD


Field pH (pH unit)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOX CUT (START)
SBX (START)
GW08
Upper Trigger
Lower Trigger
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
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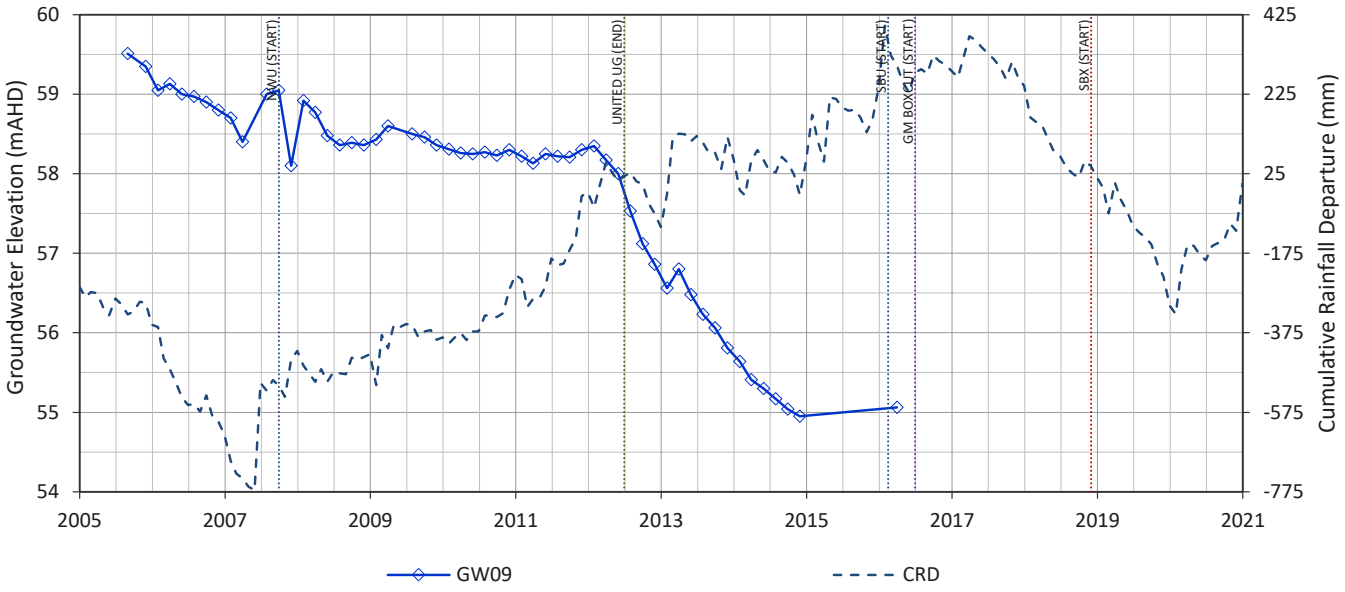
UNITED UG (END)
SBU (START)
GM BOX CUT (START)
SBX (START)
GW08
Upper Trigger
CRD

GW09


Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
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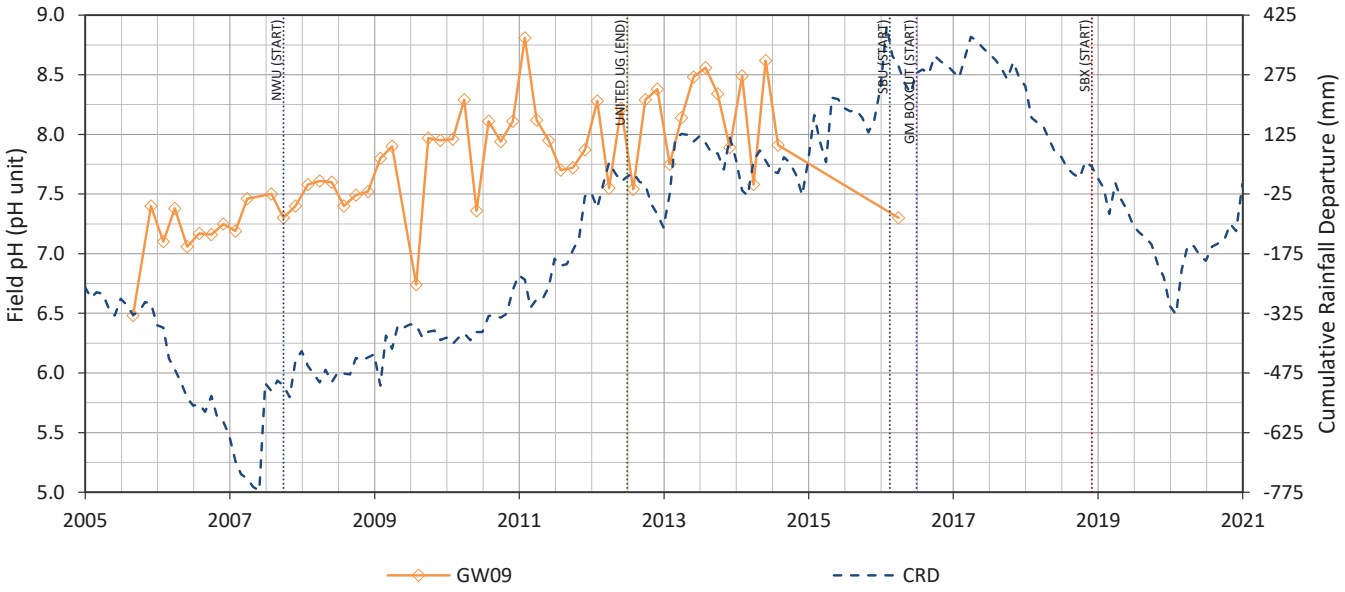
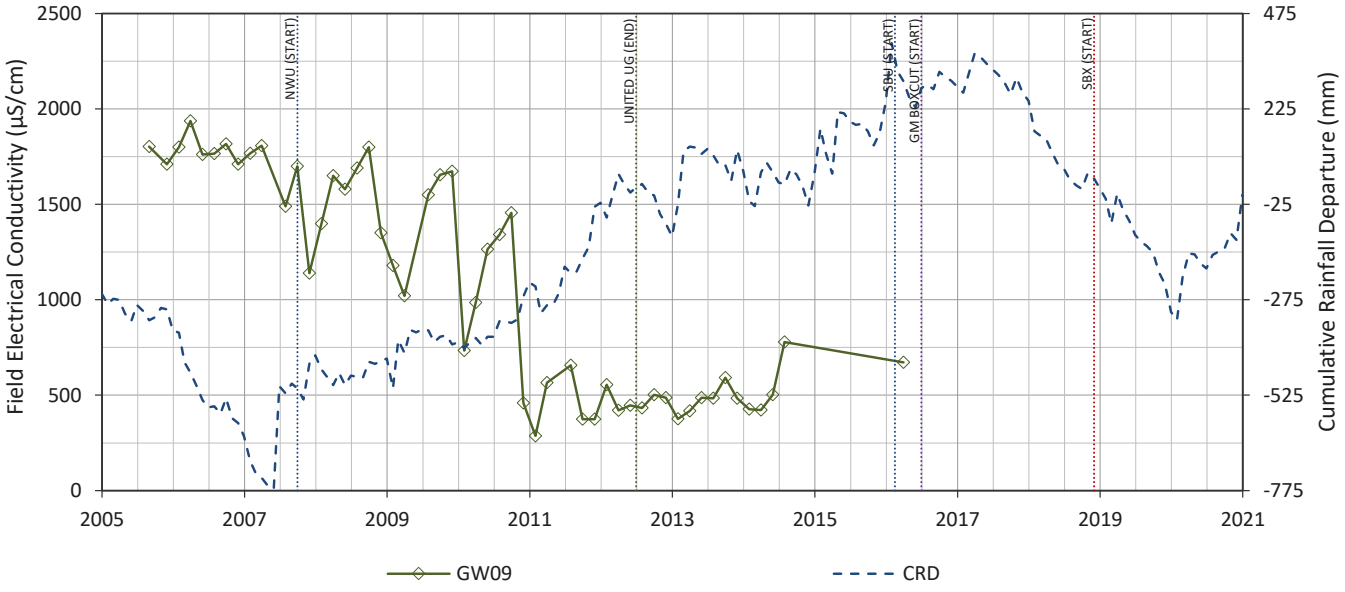
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
GW09
CRD


Field pH (pH unit)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
GW09
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
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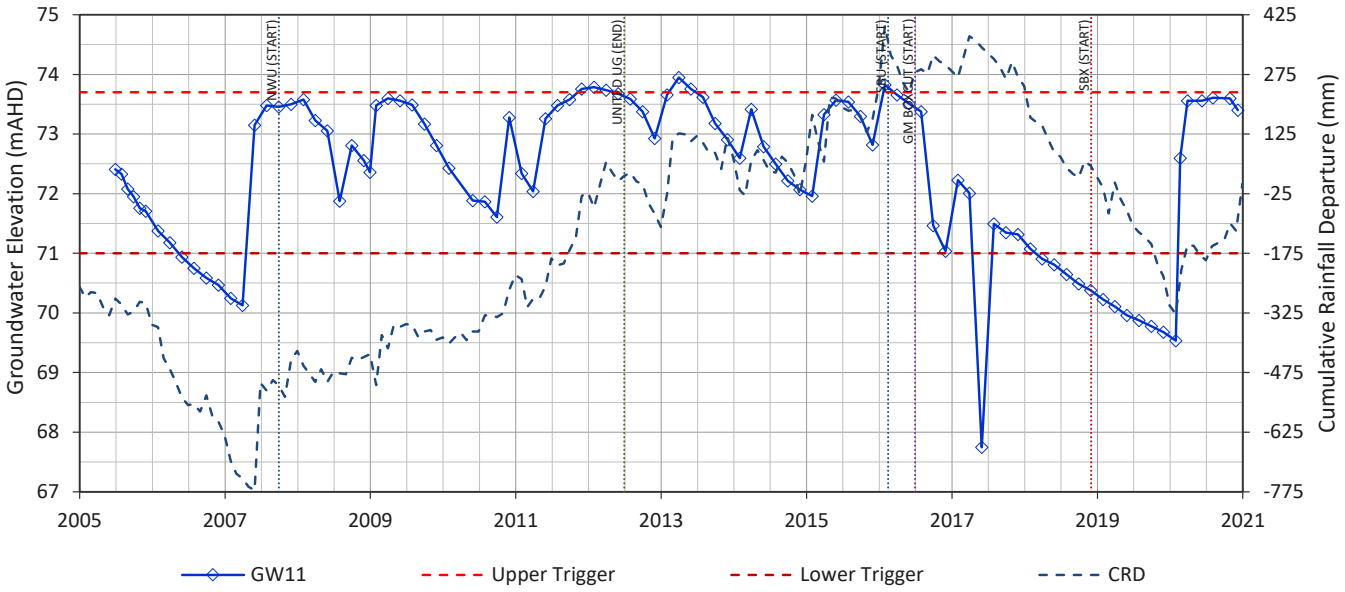
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
GW09
CRD

GW11


Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
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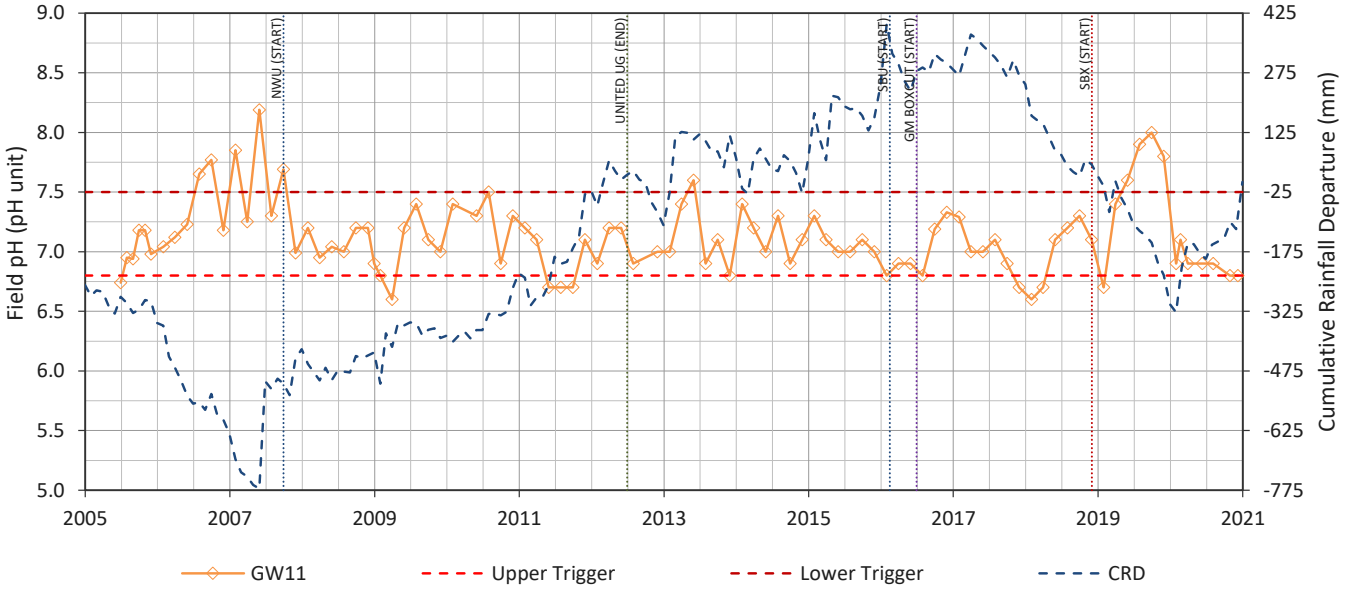
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
GW11
Upper Trigger
Lower Trigger
CRD


Field pH (pH unit)
Cumulative Rainfall Departure (mm)
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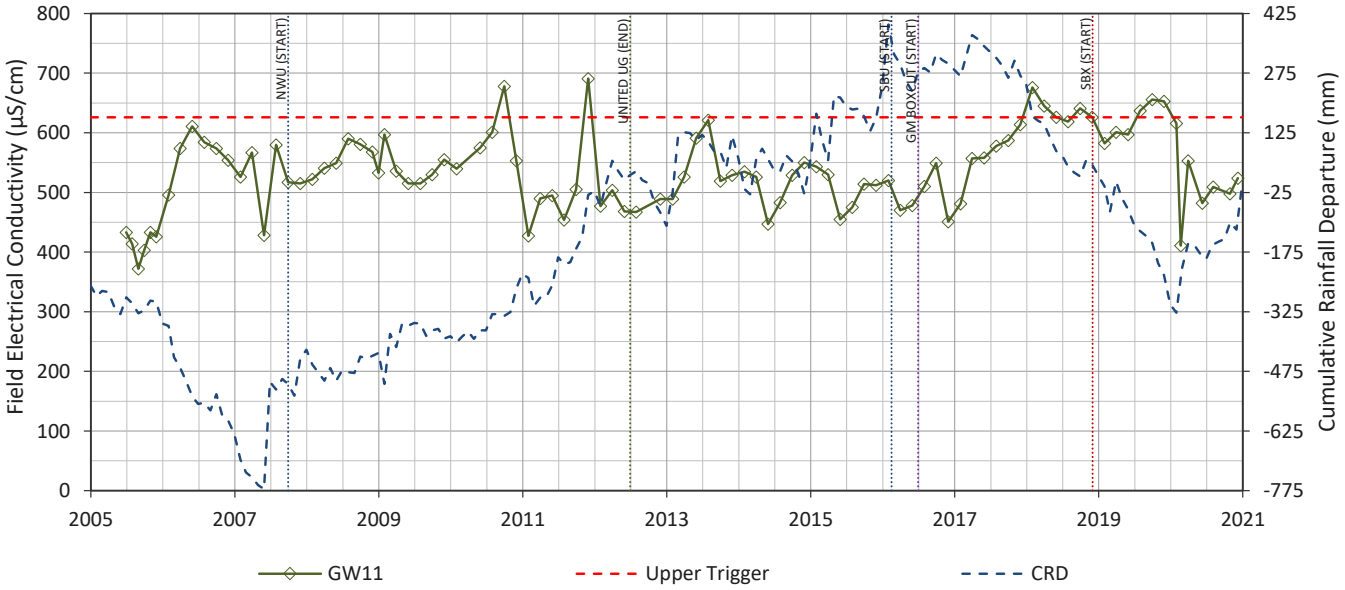
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
GW11
Upper Trigger
Lower Trigger
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
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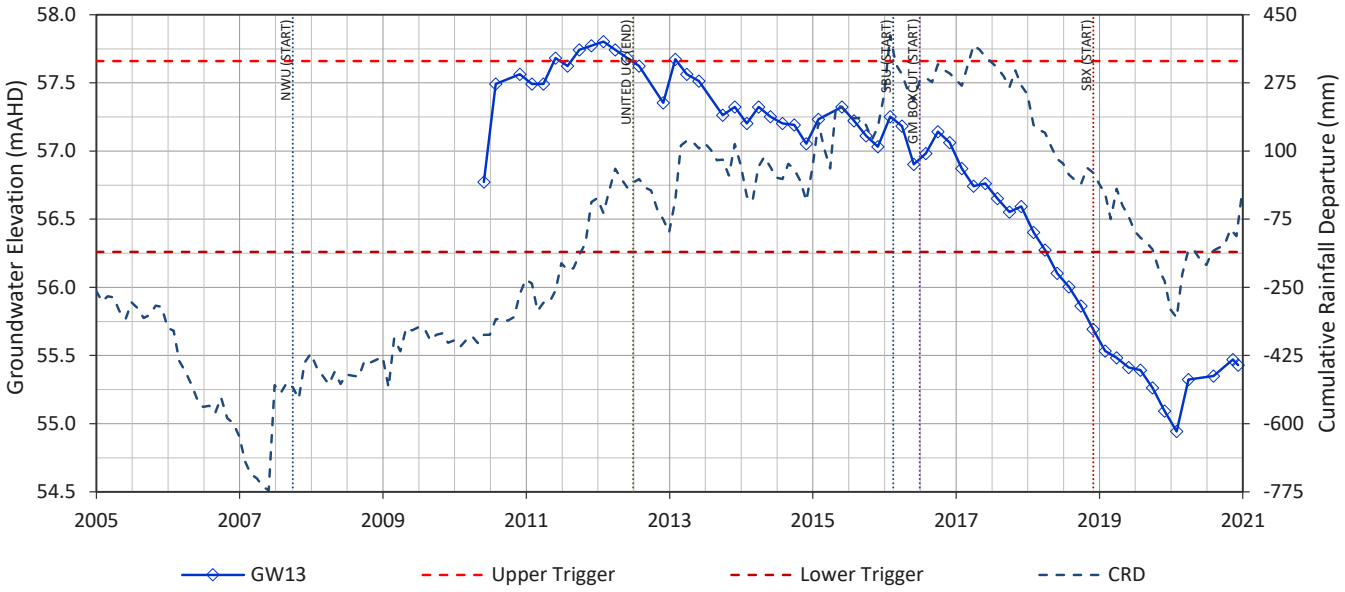
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
GW11
Upper Trigger
CRD

GW13


Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
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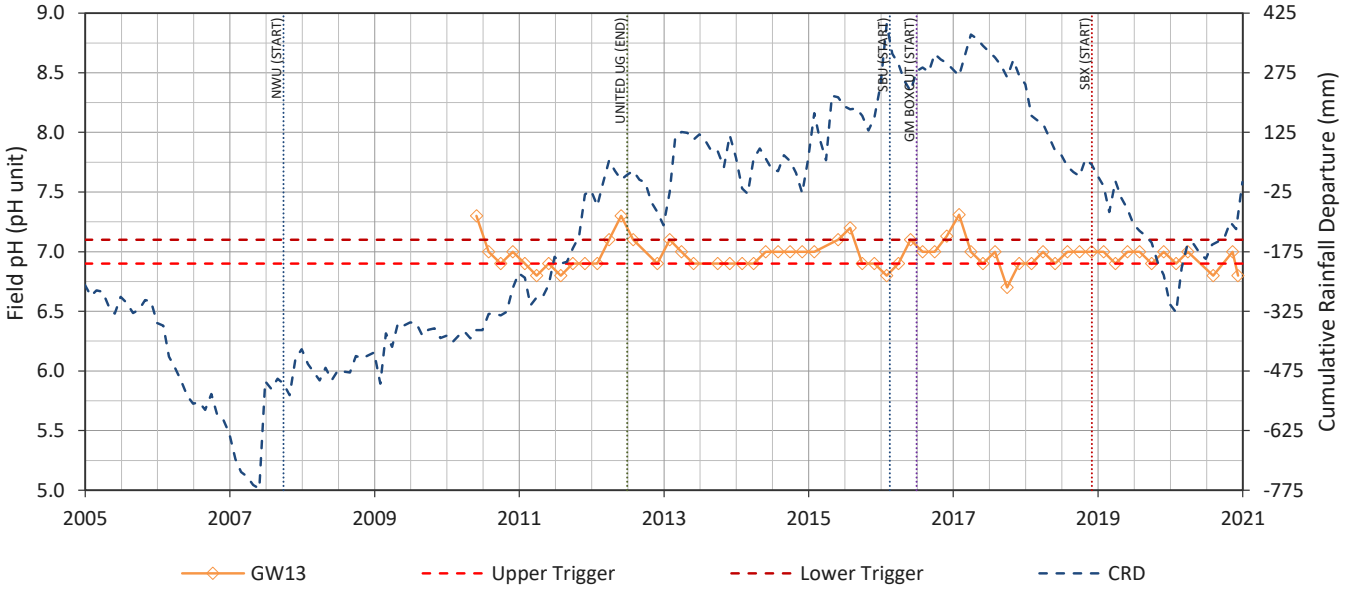
UNITED UG (END)
SBU (START)
GM BOX CUT (START)
SBX (START)
GW13
Upper Trigger
Lower Trigger
CRD


Field pH (pH unit)
Cumulative Rainfall Departure (mm)
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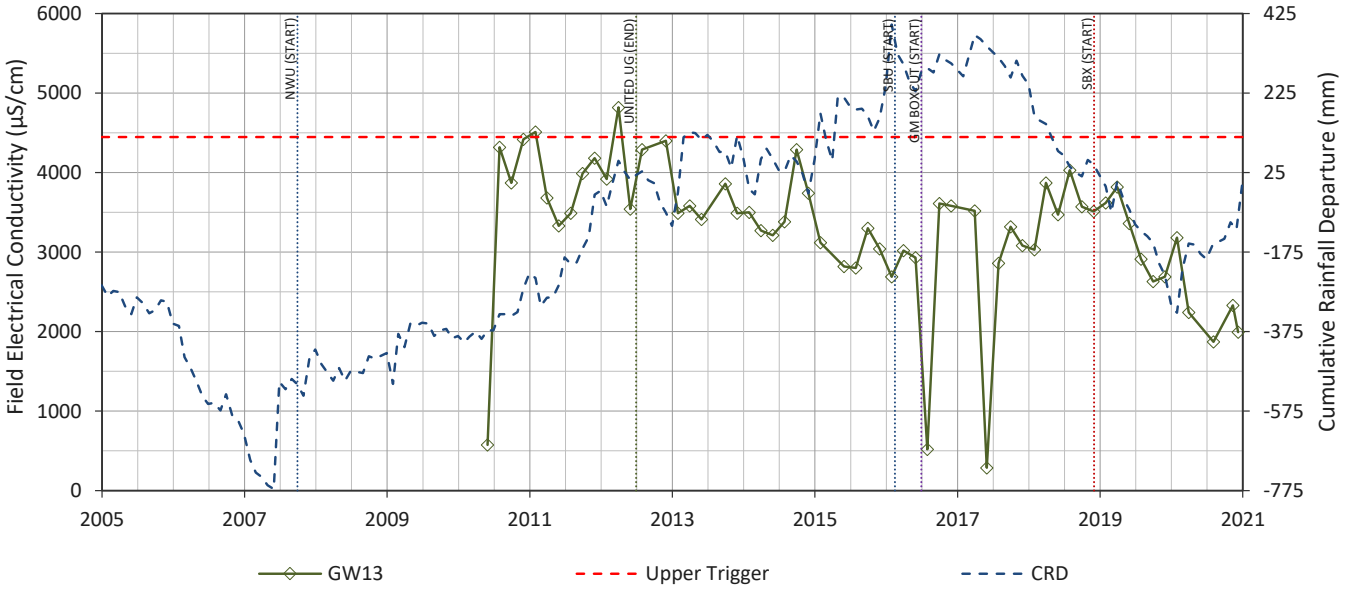
UNITED UG (END)
SBU (START)
GM BOX CUT (START)
SBX (START)
GW13
Upper Trigger
Lower Trigger
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
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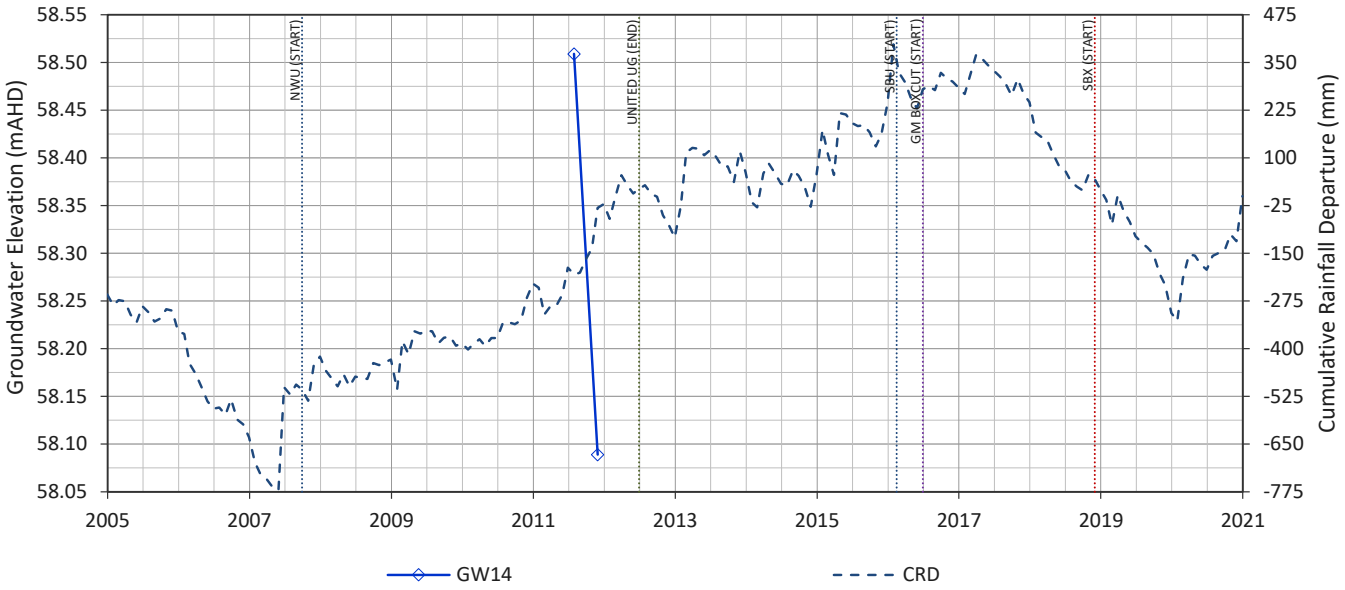
UNITED UG (END)
SBU (START)
GM BOX CUT (START)
SBX (START)
GW13
Upper Trigger
CRD

GW14



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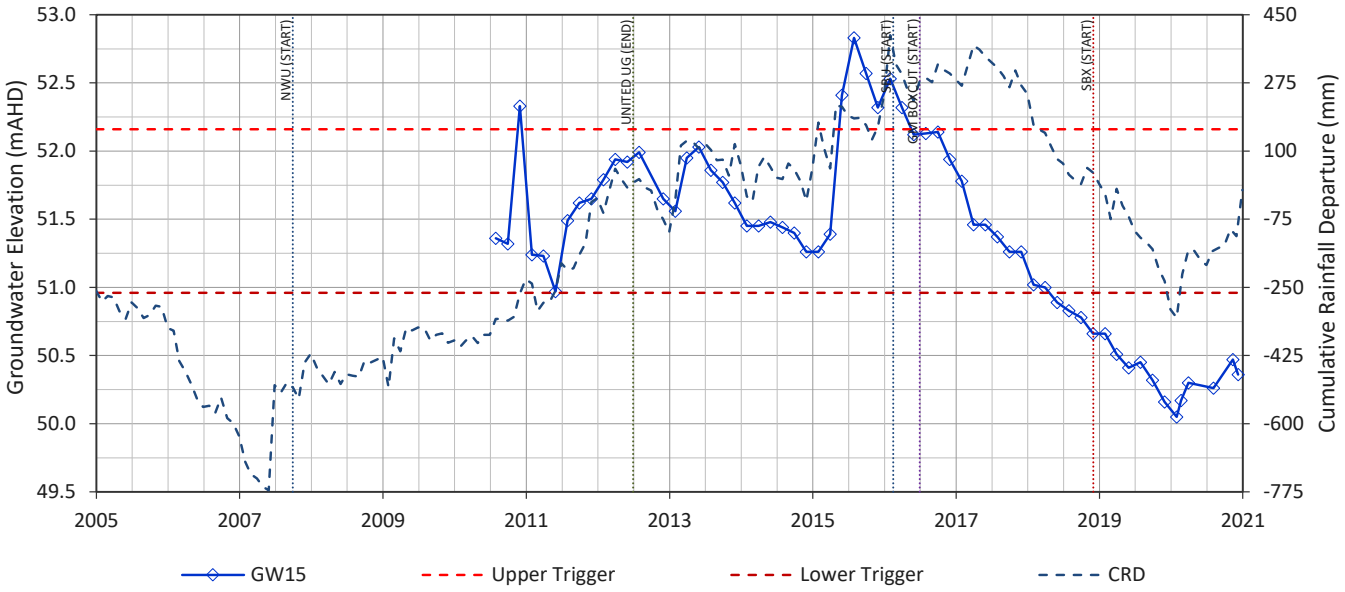
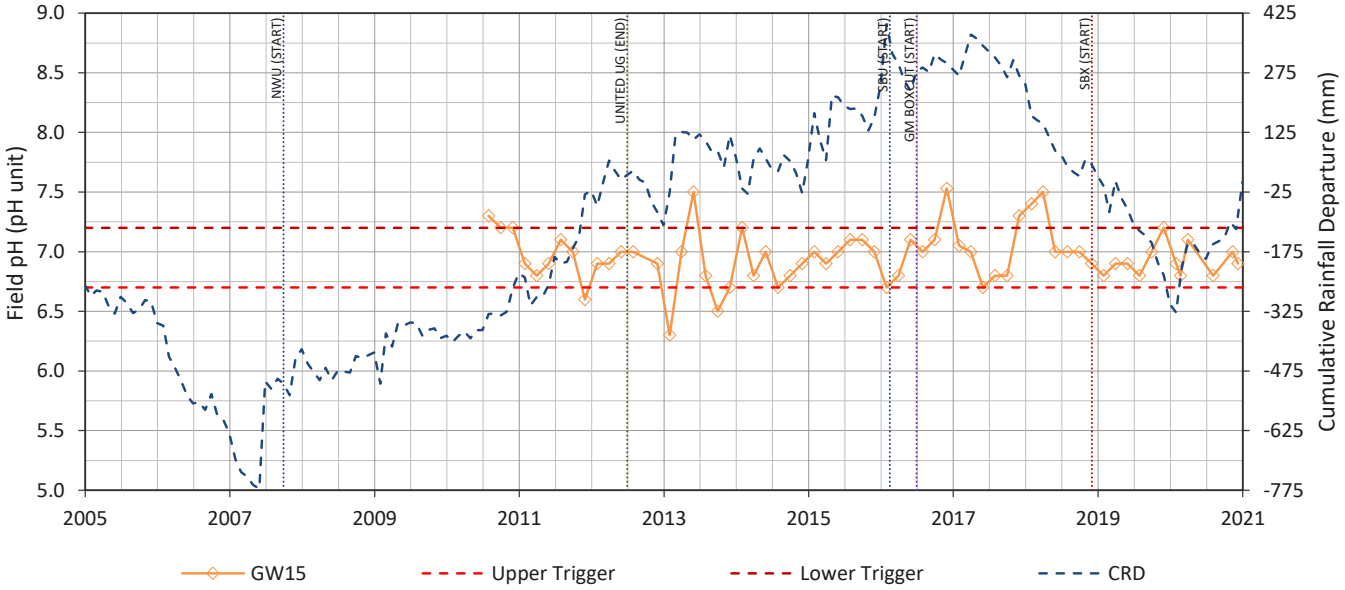
No Data Available for Field Electrical Conductivity (µS/cm)

GW15


Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOX CUT (START)
SBX (START)
GW15
Upper Trigger
Lower Trigger
CRD


Field pH (pH unit)
Cumulative Rainfall Departure (mm)
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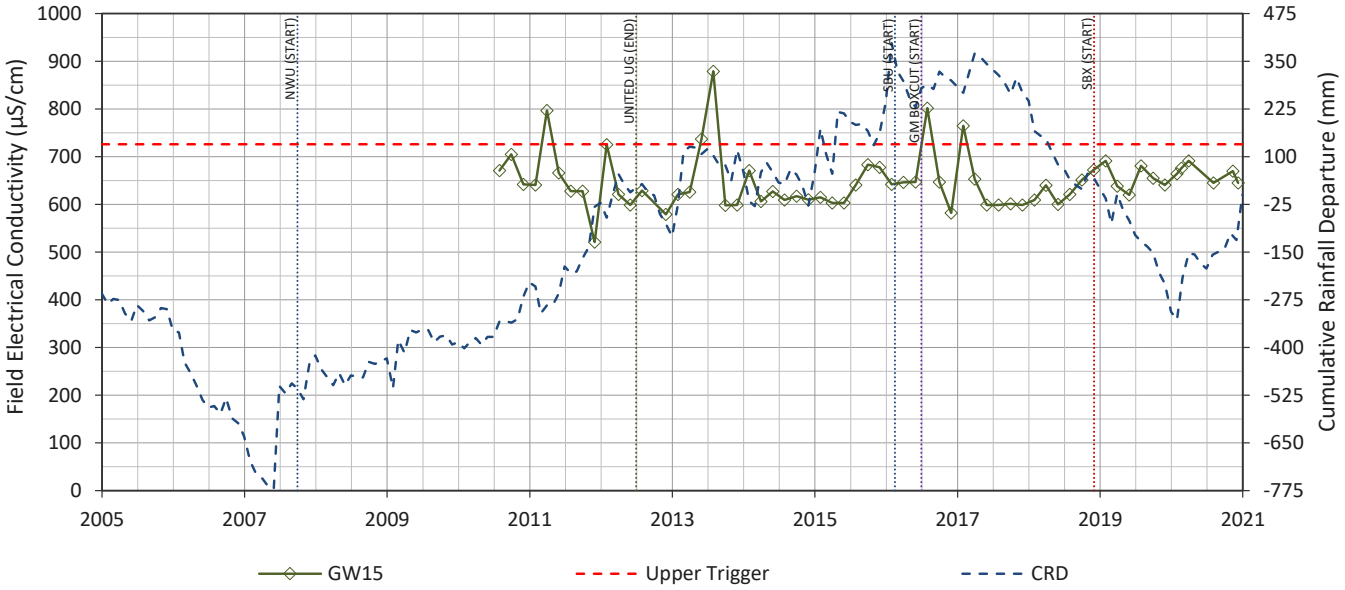
SBX (START)
GW15
Upper Trigger
Lower Trigger
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
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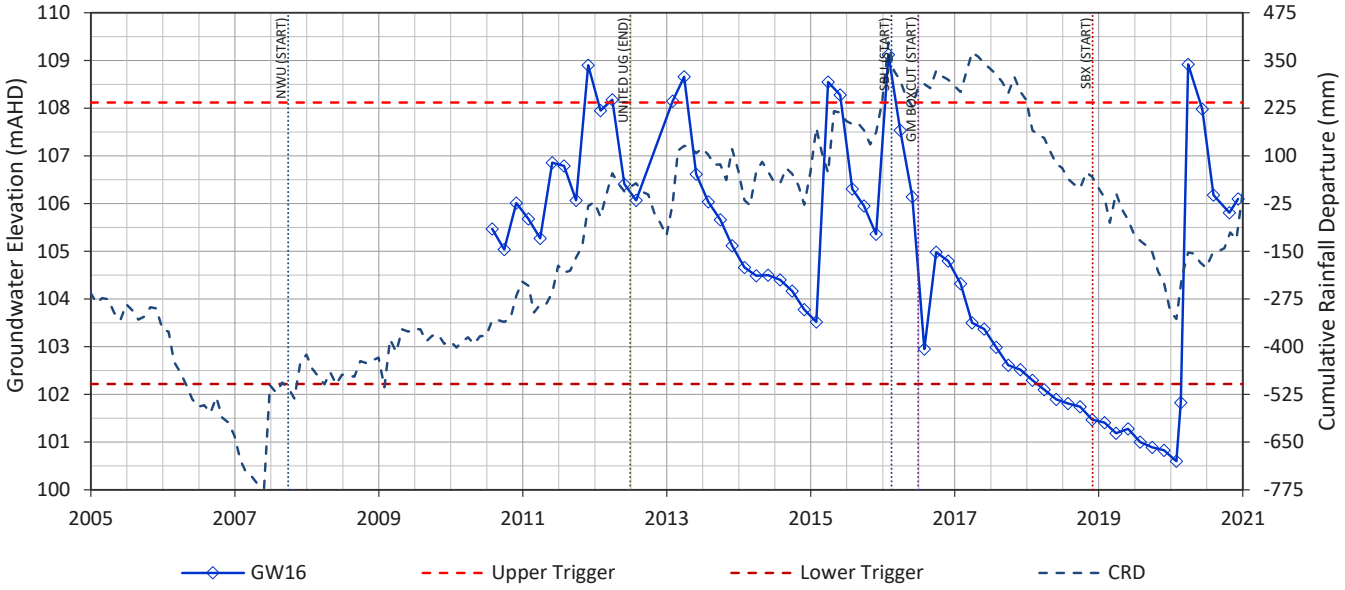
SBU (START)
GM BOX CUT (START)
SBX (START)
GW15
Upper Trigger
CRD

GW16


Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
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UNITED UG (END)
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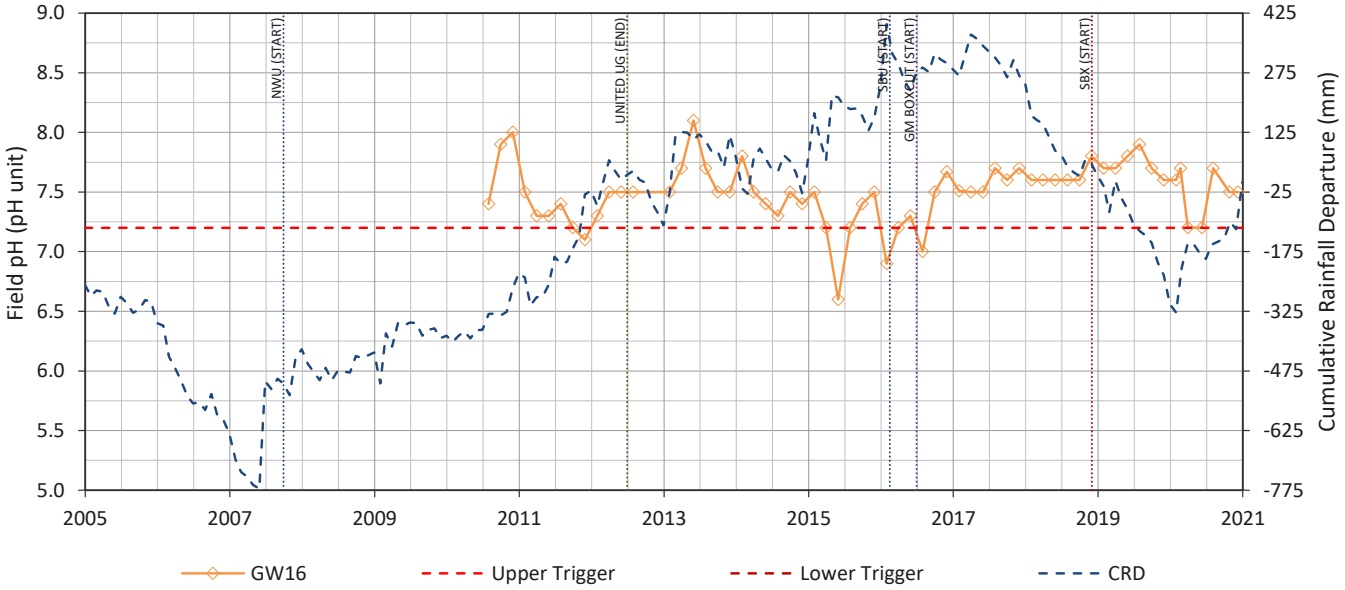
SBX (START)
GW16
Upper Trigger
Lower Trigger
CRD


Field pH (pH unit)
Cumulative Rainfall Departure (mm)
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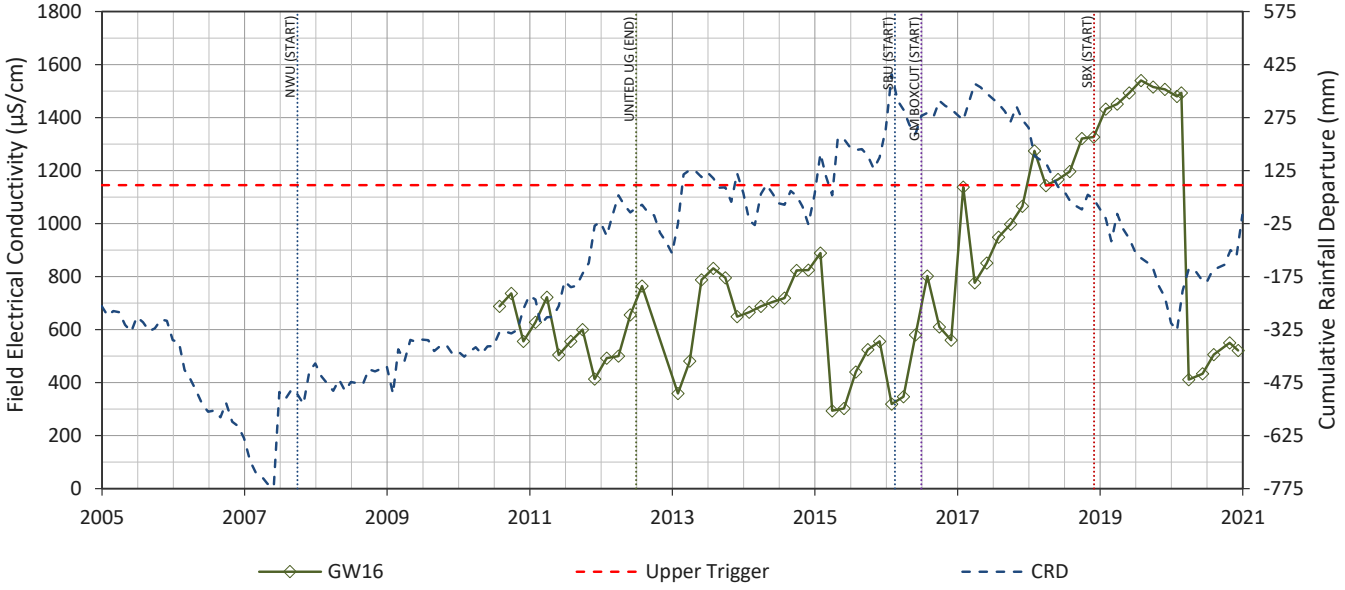
SBU (START)
GM BOXCUT (START)
SBX (START)
GW16
Upper Trigger
Lower Trigger
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
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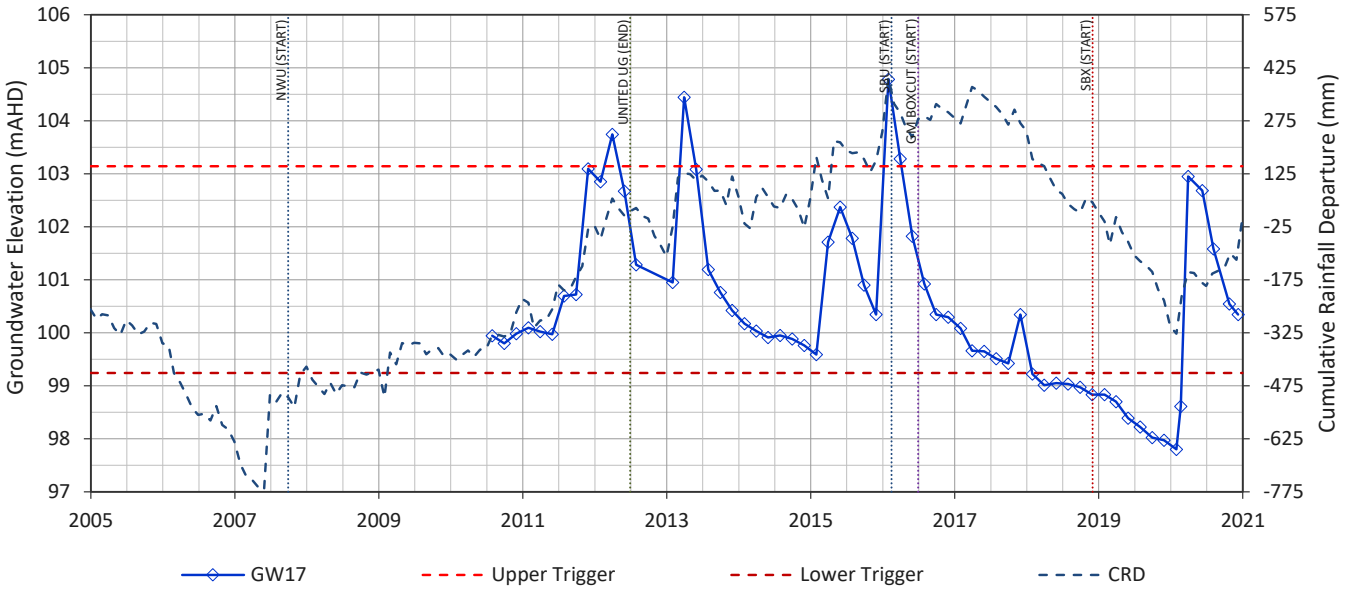
GM BOXCUT (START)
SBX (START)
GW16
Upper Trigger
CRD

GW17


Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
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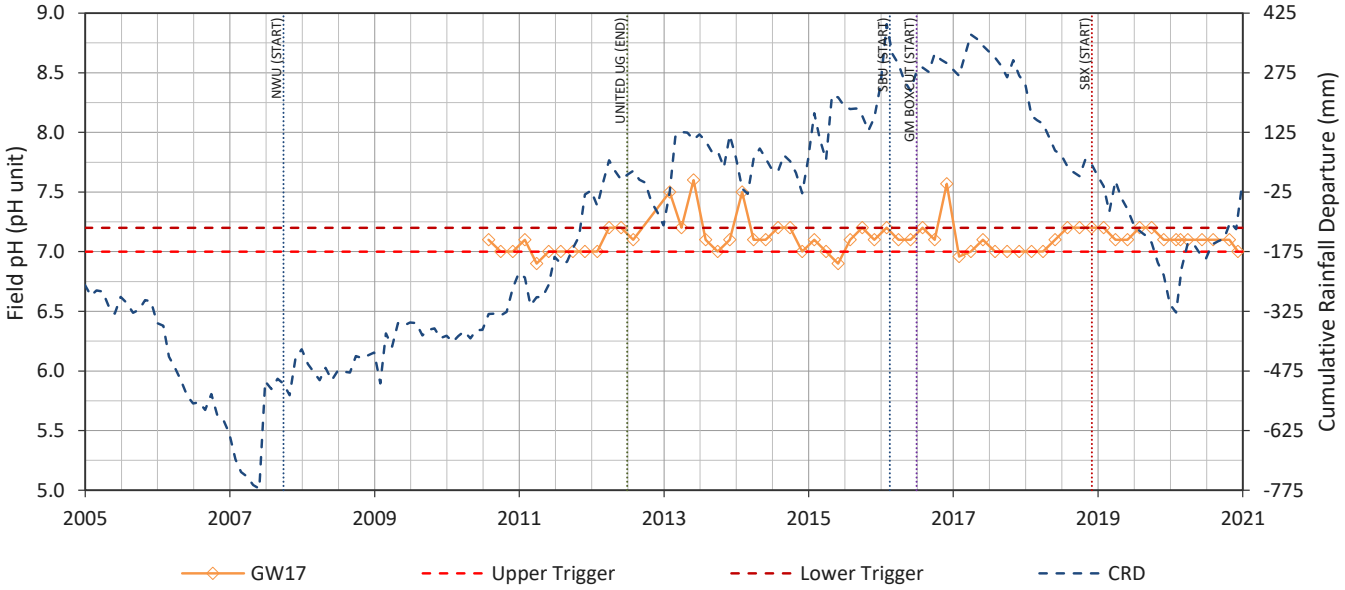
SBU (START)
GM BOXCUT (START)
SBX (START)
GW17
Upper Trigger
Lower Trigger
CRD


Field pH (pH unit)
Cumulative Rainfall Departure (mm)
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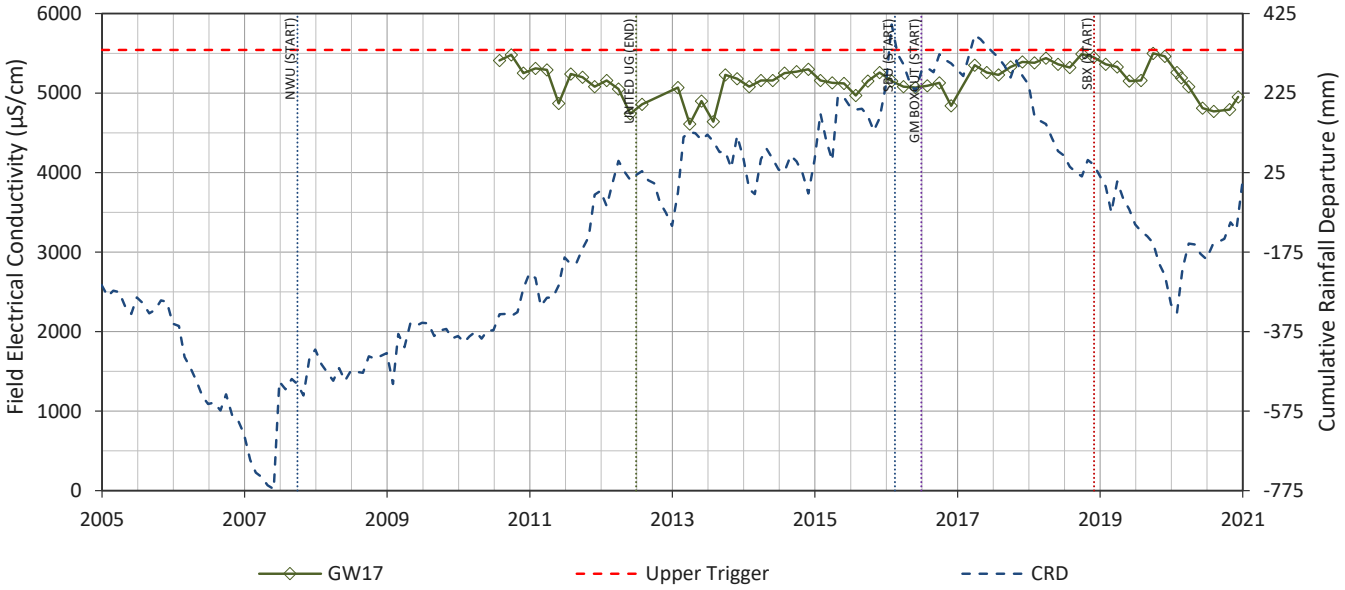
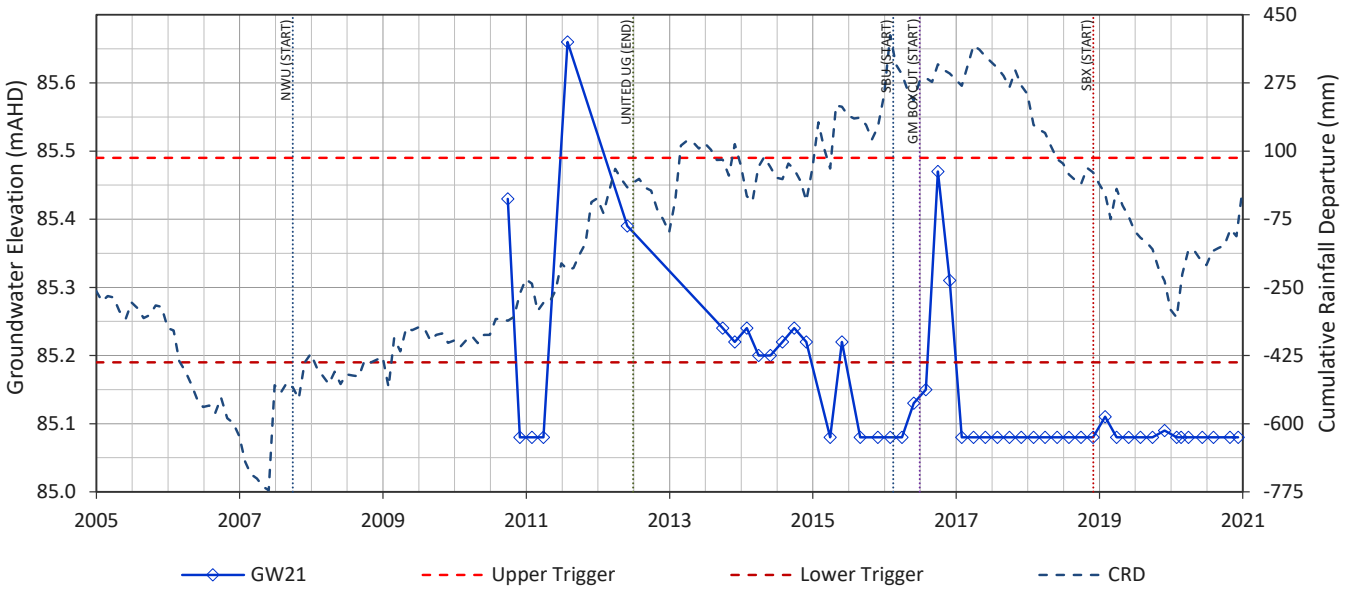
SBX (START)
GW17
Upper Trigger
Lower Trigger
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
GW17
Upper Trigger
CRD

GW21


Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
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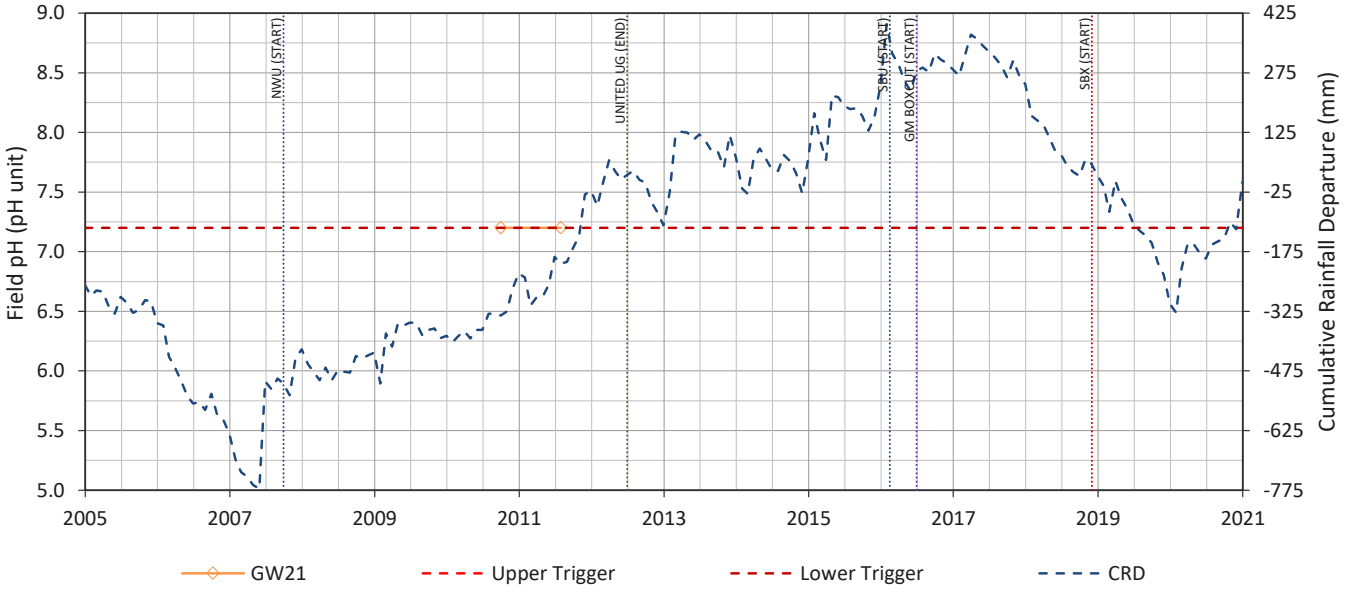
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
GW21
Upper Trigger
Lower Trigger
CRD


Field pH (pH unit)
Cumulative Rainfall Departure (mm)
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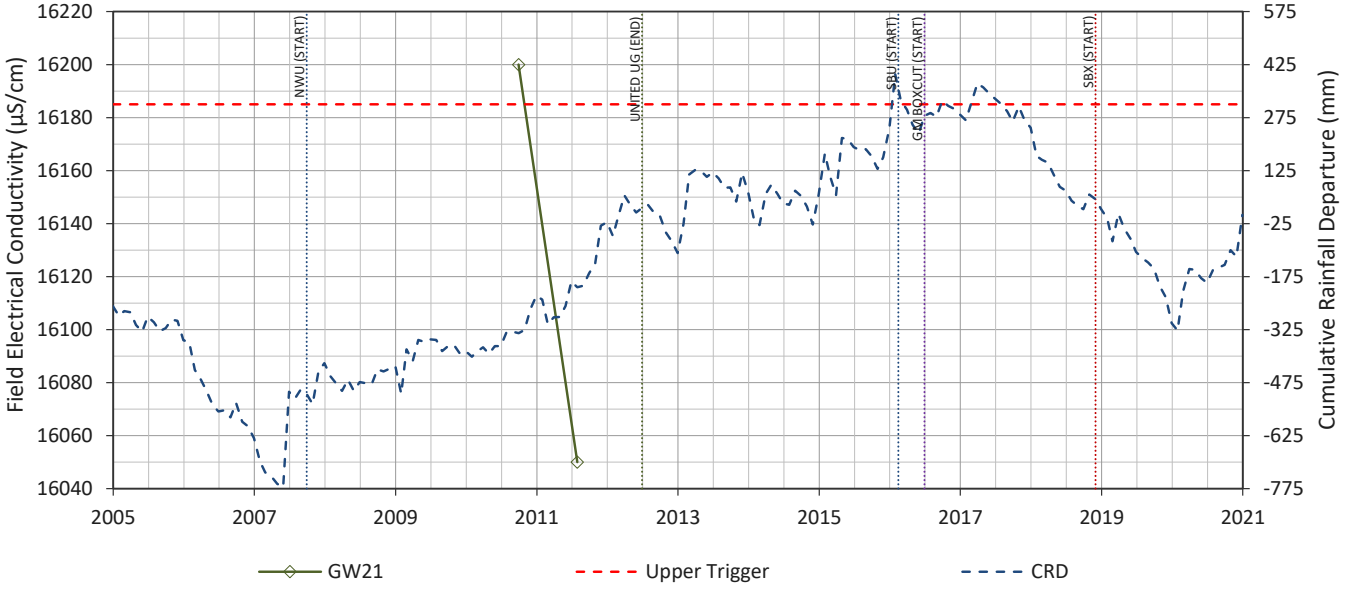
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
GW21
Upper Trigger
Lower Trigger
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
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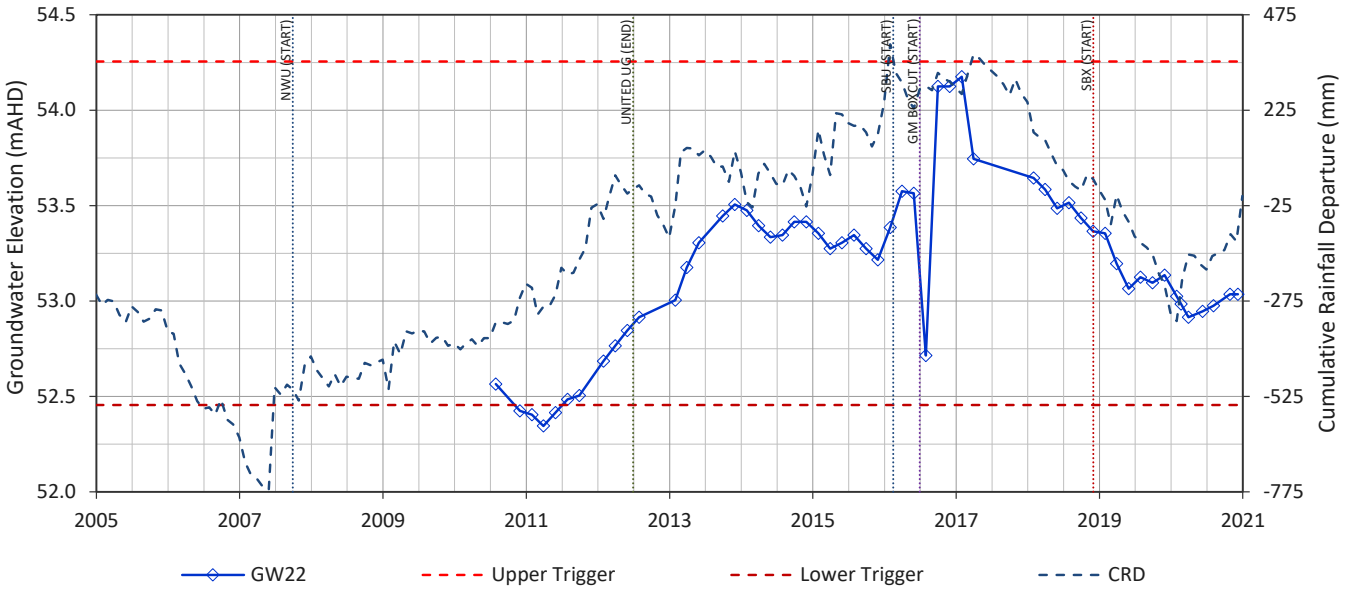
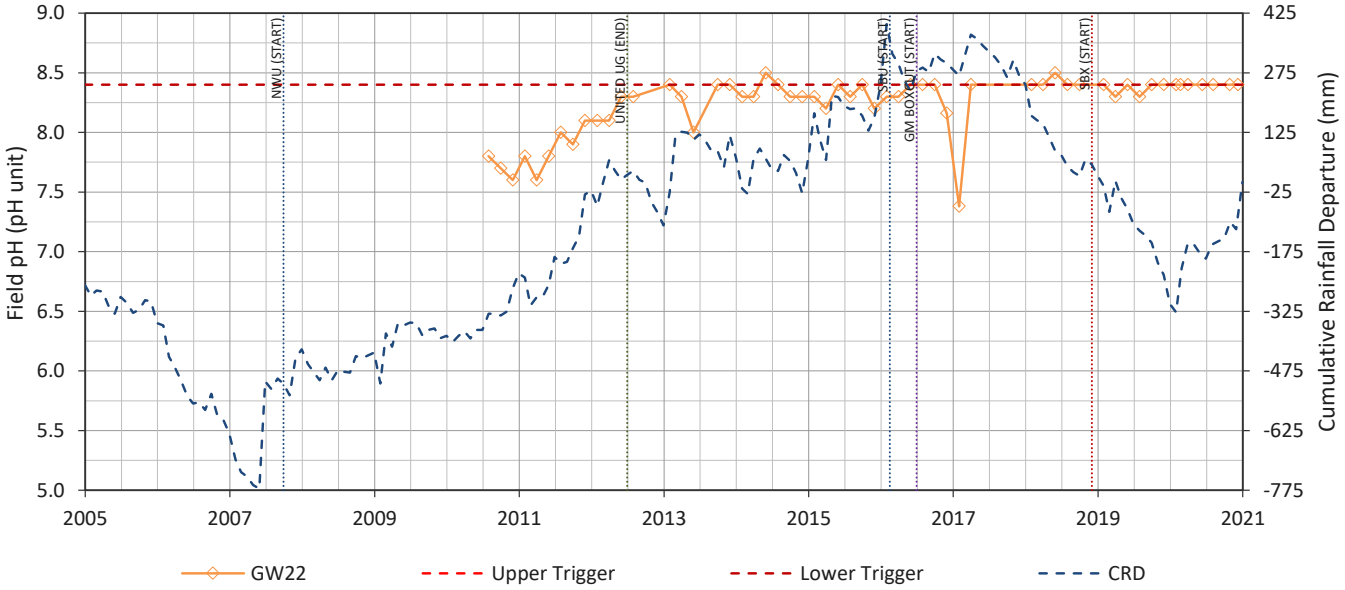
SBU (START)
GM BOXCUT (START)
SBX (START)
GW21
Upper Trigger
CRD

GW22


Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOX CUT (START)
SBX (START)
GW22
Upper Trigger
Lower Trigger
CRD


Field pH (pH unit)
Cumulative Rainfall Departure (mm)
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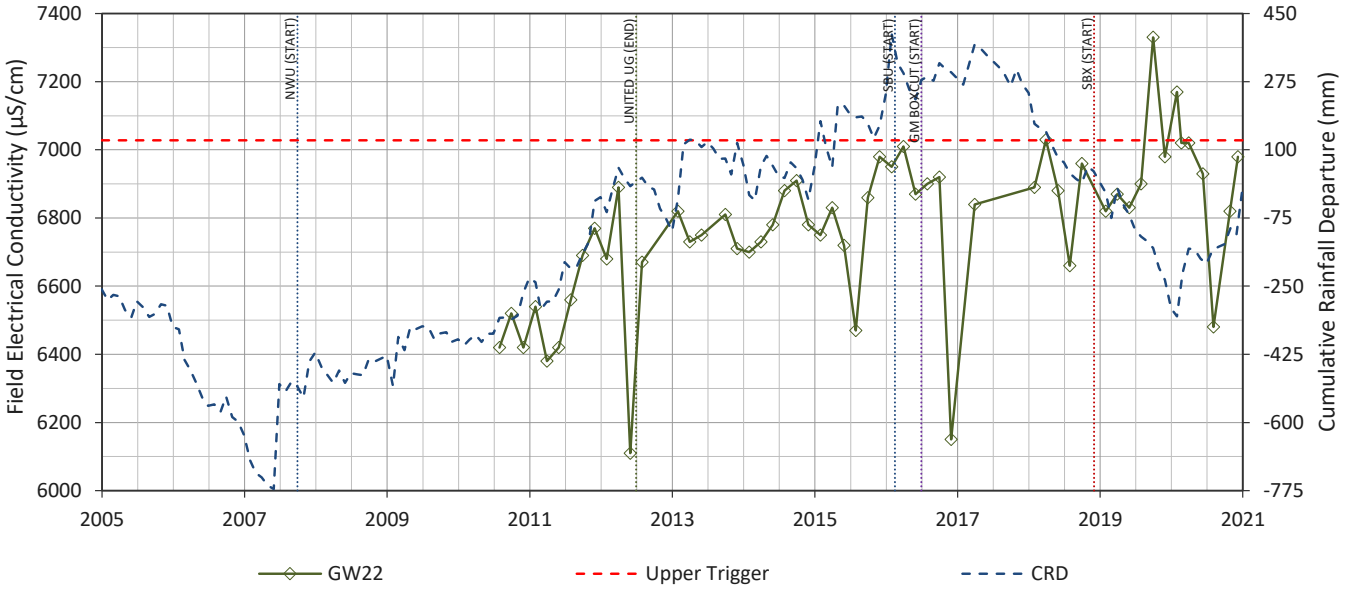
UNITED UG (END)
SBU (START)
GM BOX CUT (START)
SBX (START)
GW22
Upper Trigger
Lower Trigger
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
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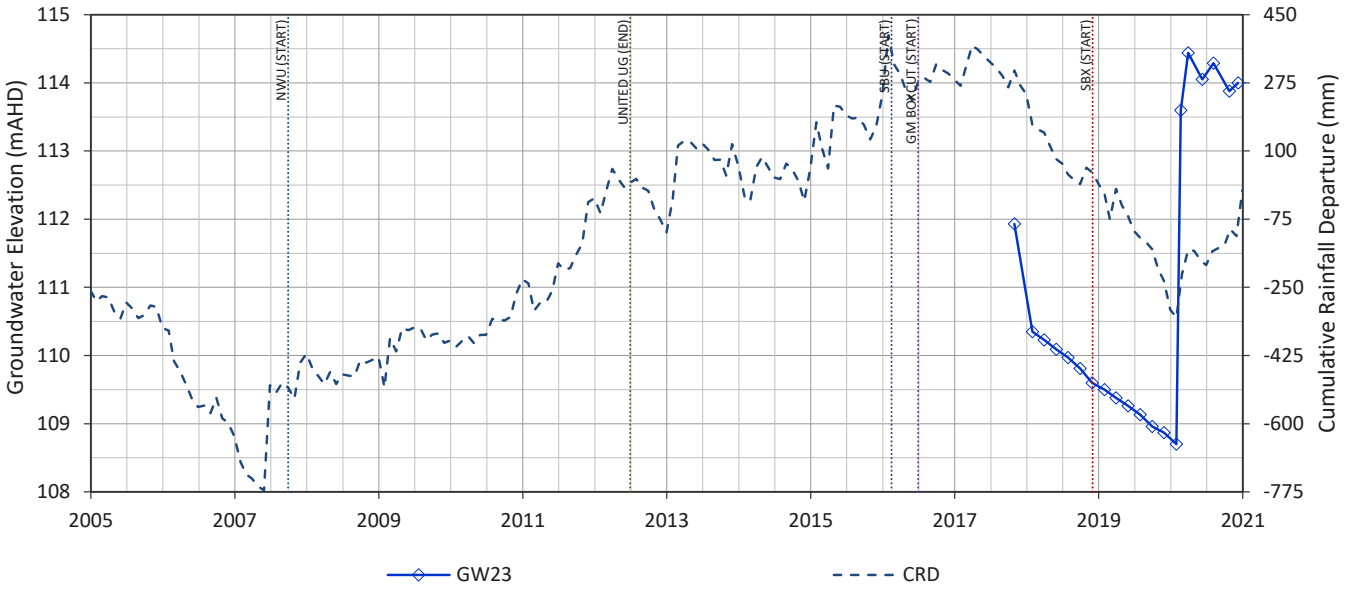
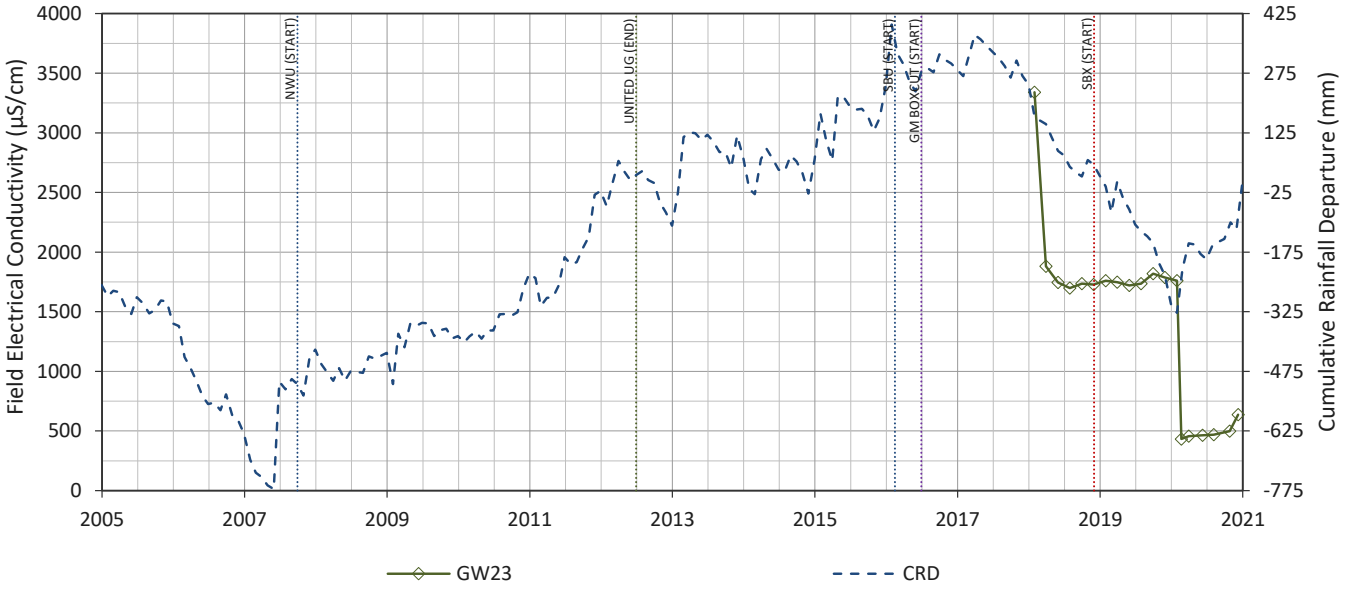
UNITED UG (END)
SBU (START)
GM BOX CUT (START)
SBX (START)
GW22
Upper Trigger
CRD

GW23


Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
GW23
CRD

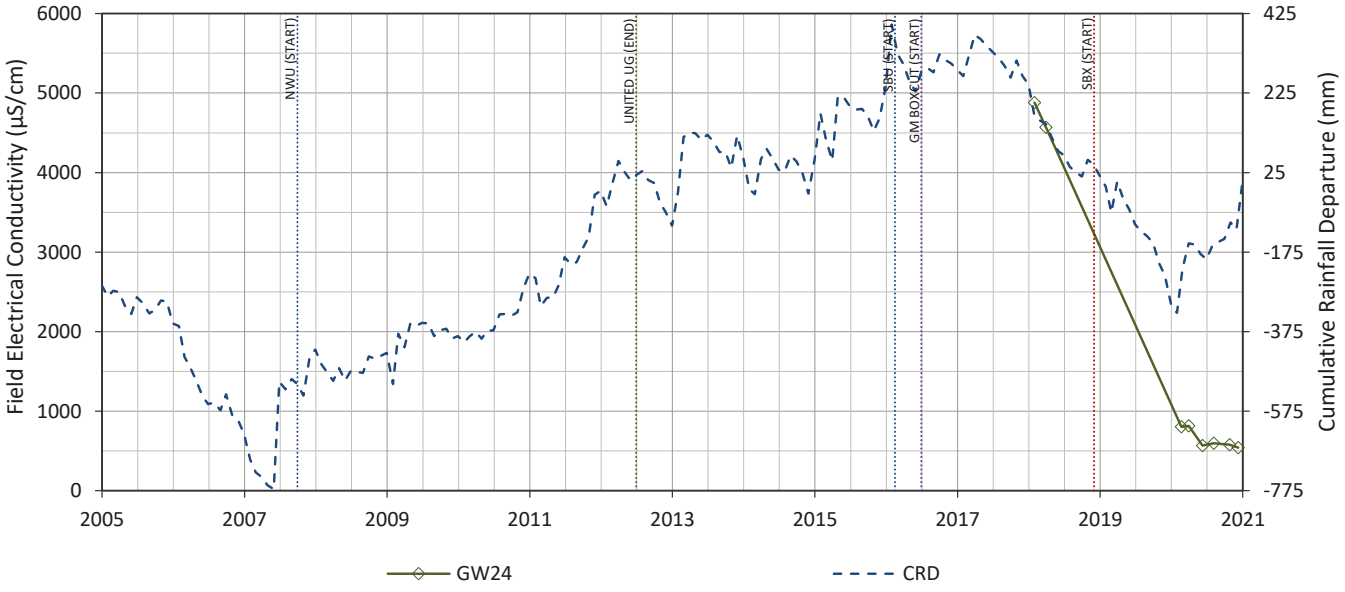

Field pH (pH unit)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
GW23
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
GW23
CRD

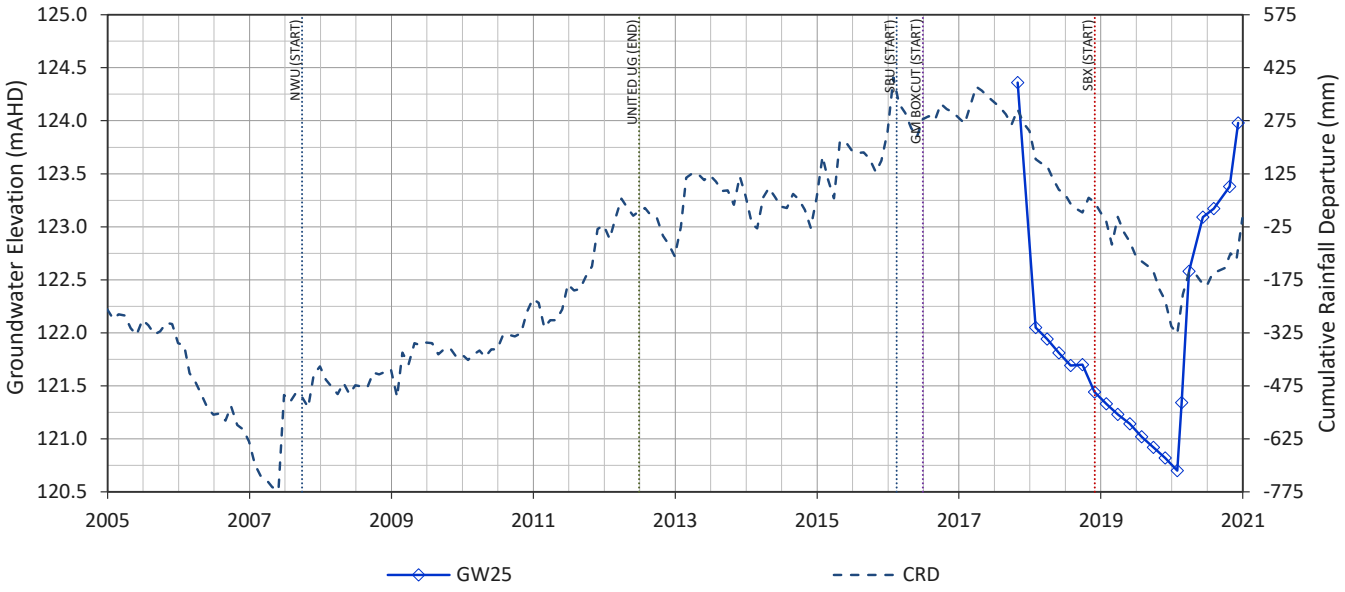
GW24


Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOX CUT (START)
SBX (START)
GW24
CRD

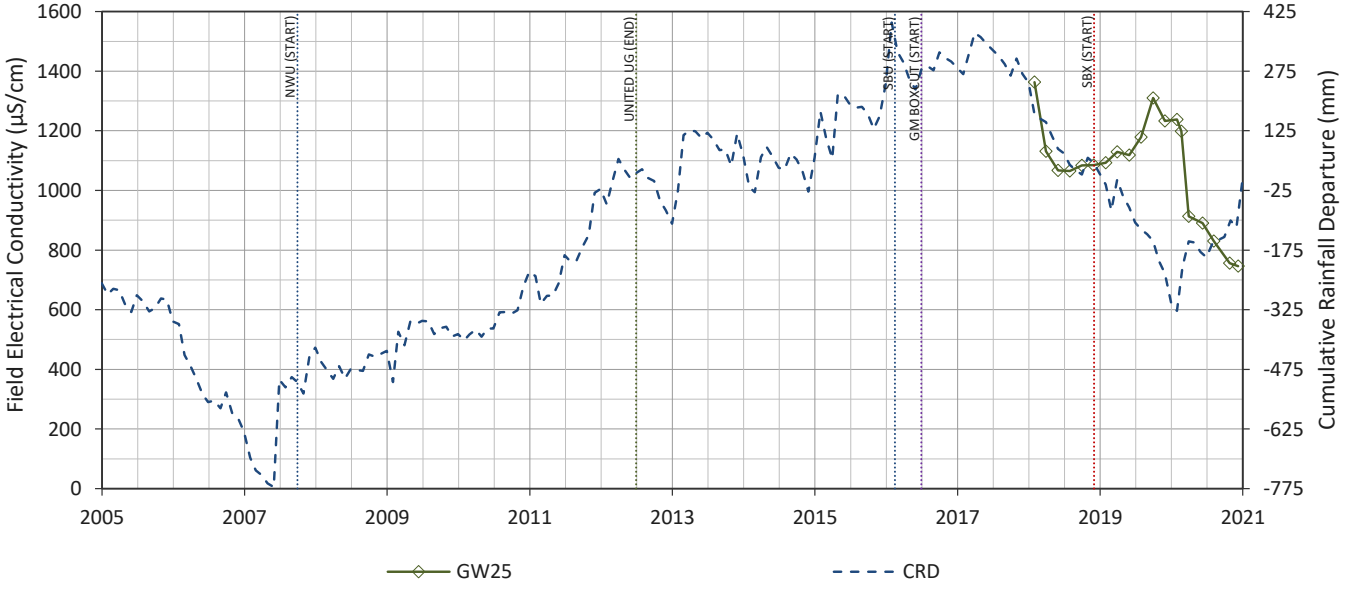

Field pH (pH unit)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOX CUT (START)
SBX (START)
GW24
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOX CUT (START)
SBX (START)
GW24
CRD

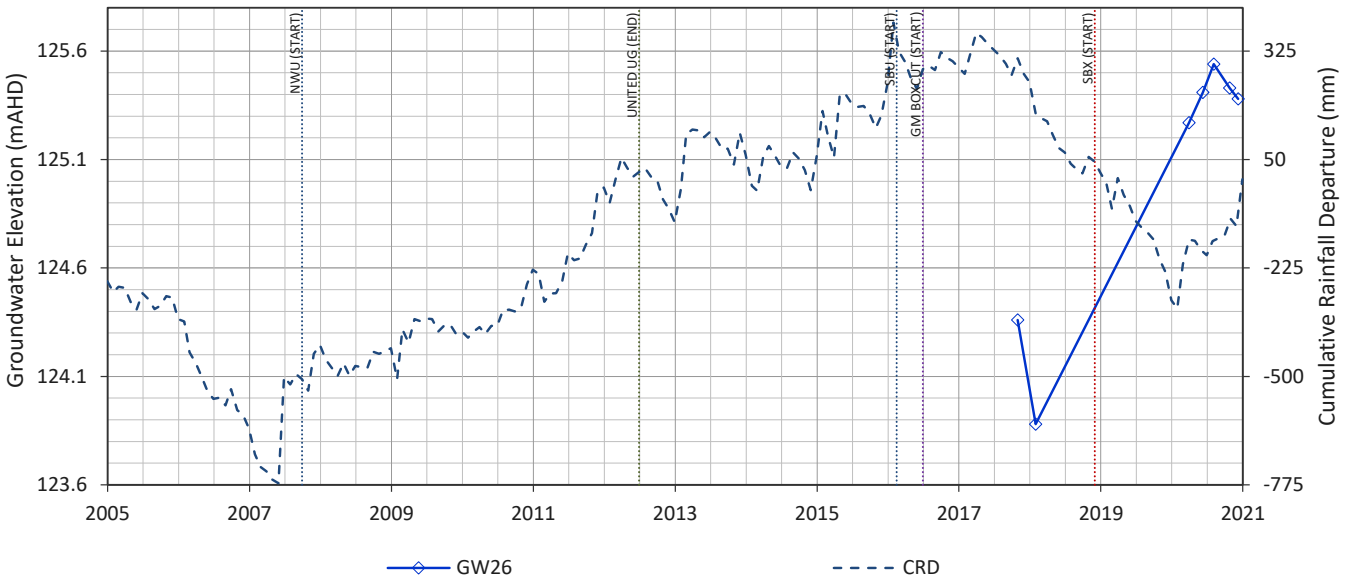
GW25


Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
GW25
CRD

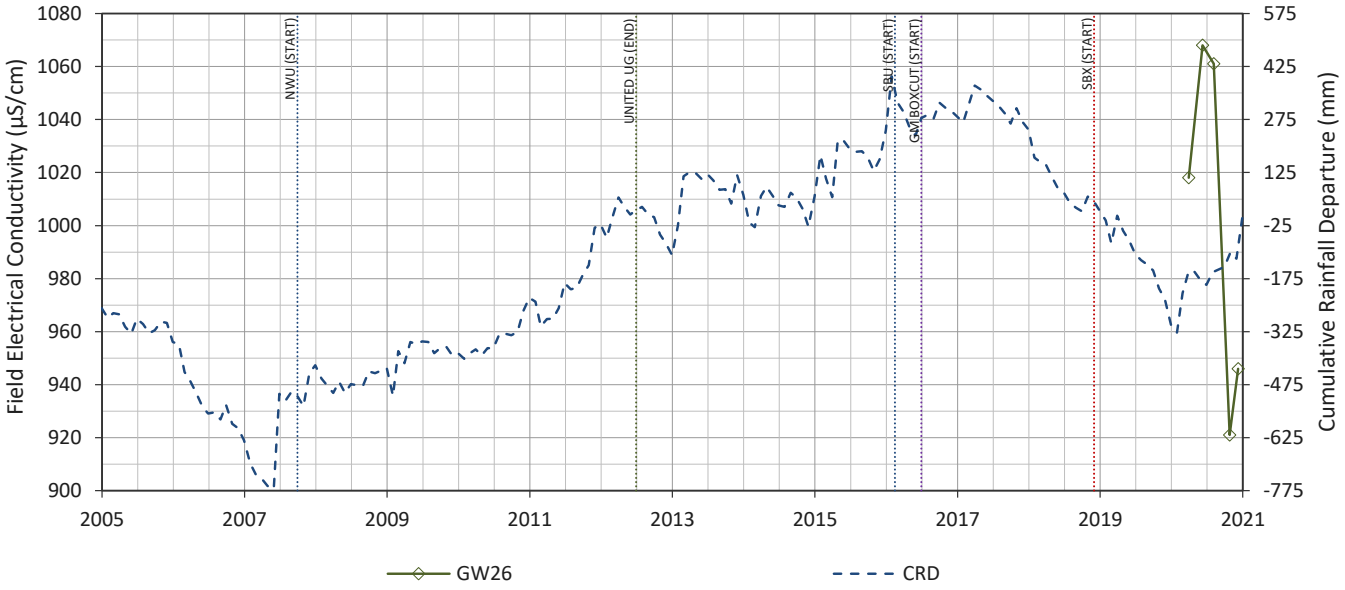

Field pH (pH unit)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
GW25
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
GW25
CRD

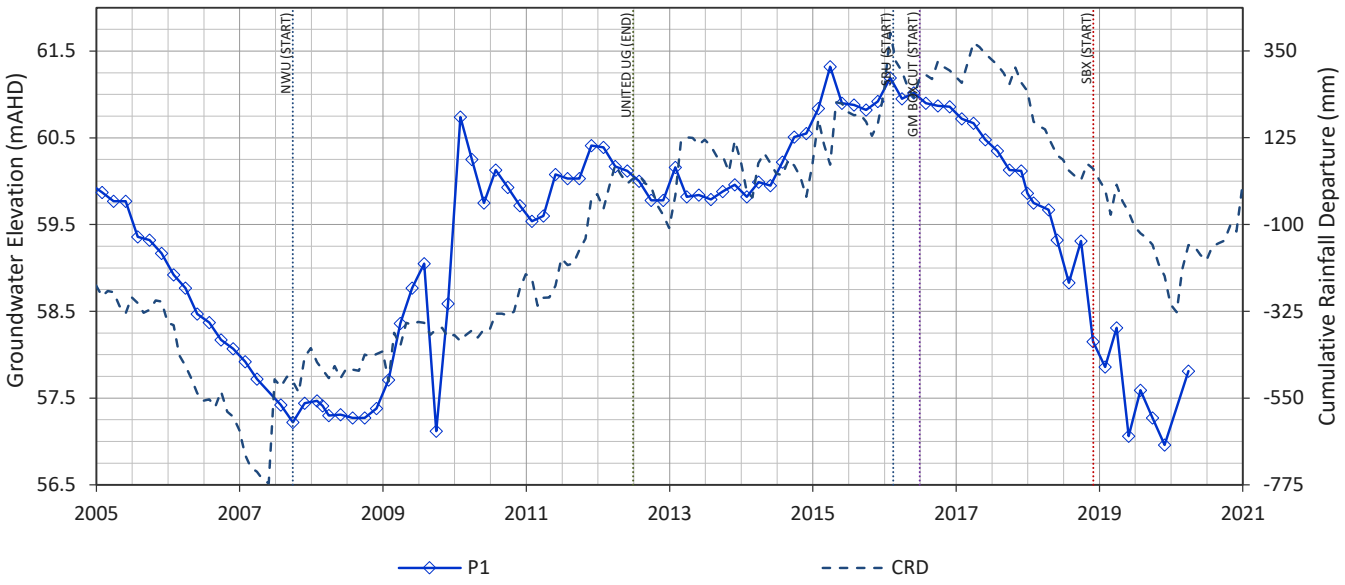
GW26

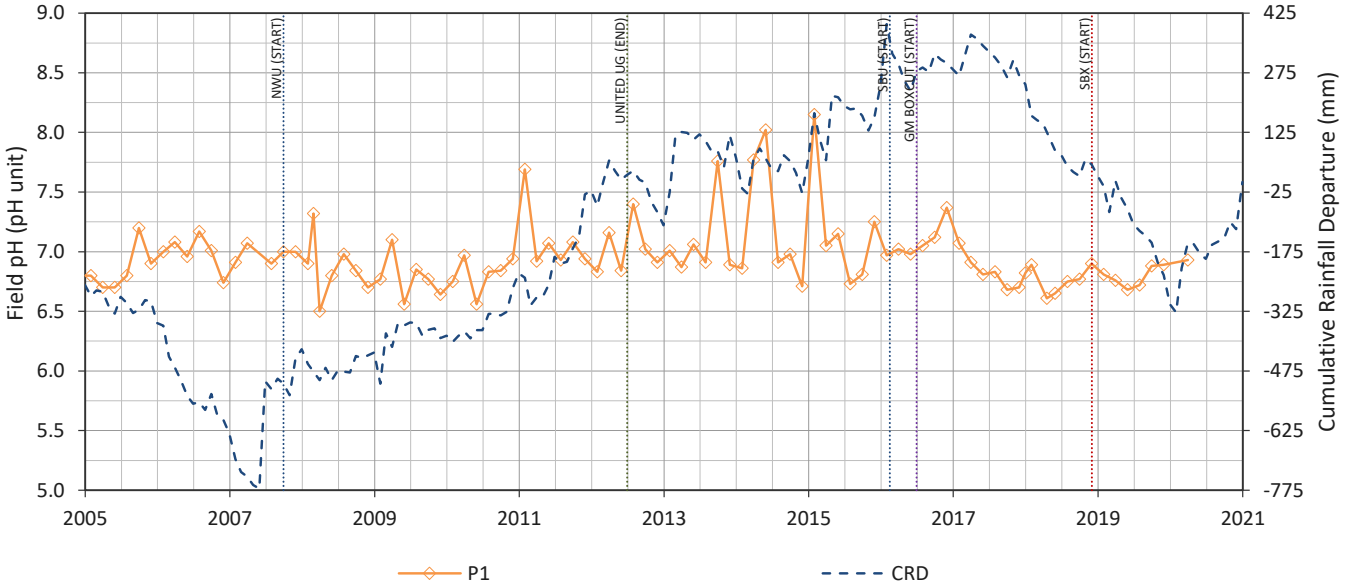

Groundwater Elevation (mAHD)
125.6
125.1
124.6
124.1
123.6
Cumulative Rainfall Departure (mm)
325
50
-225
-500
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
GW26
CRD

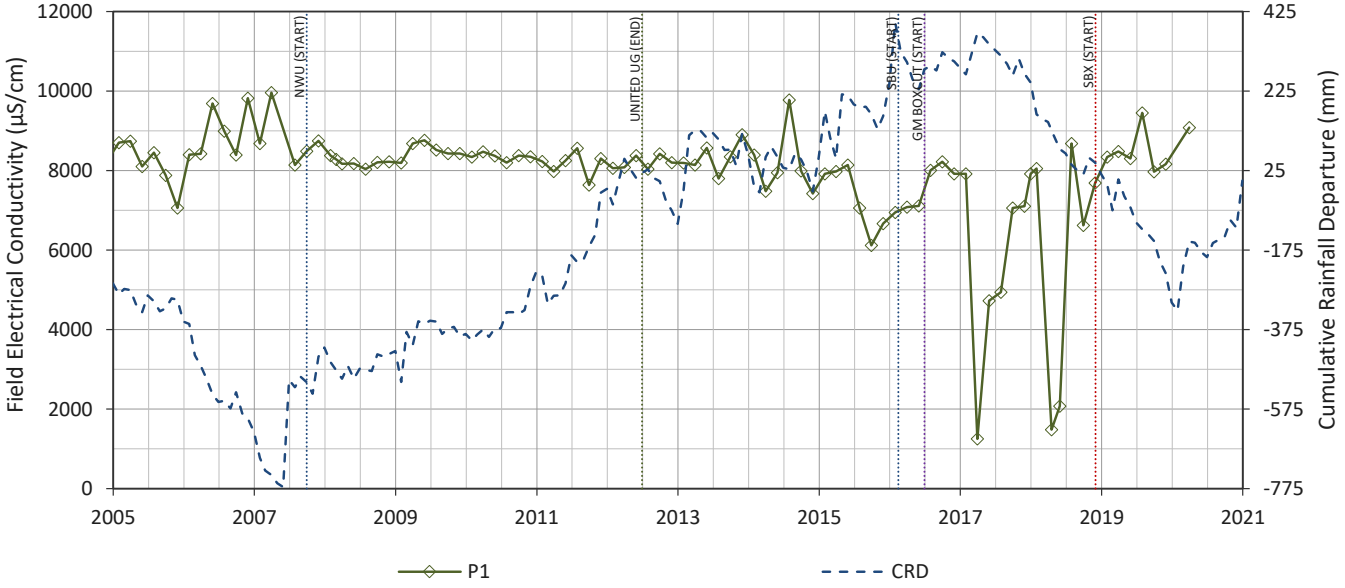

Field pH (pH unit)
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
Cumulative Rainfall Departure (mm)
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
GW26
CRD


Field Electrical Conductivity (µS/cm)
1080
1060
1040
1020
1000
980
960
940
920
900
Cumulative Rainfall Departure (mm)
575
425
275
125
-25
-175
-325
-475
-625
-775
2005
2007
2009
2011
2013
2015
2017
2019
2021
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
GW26
CRD

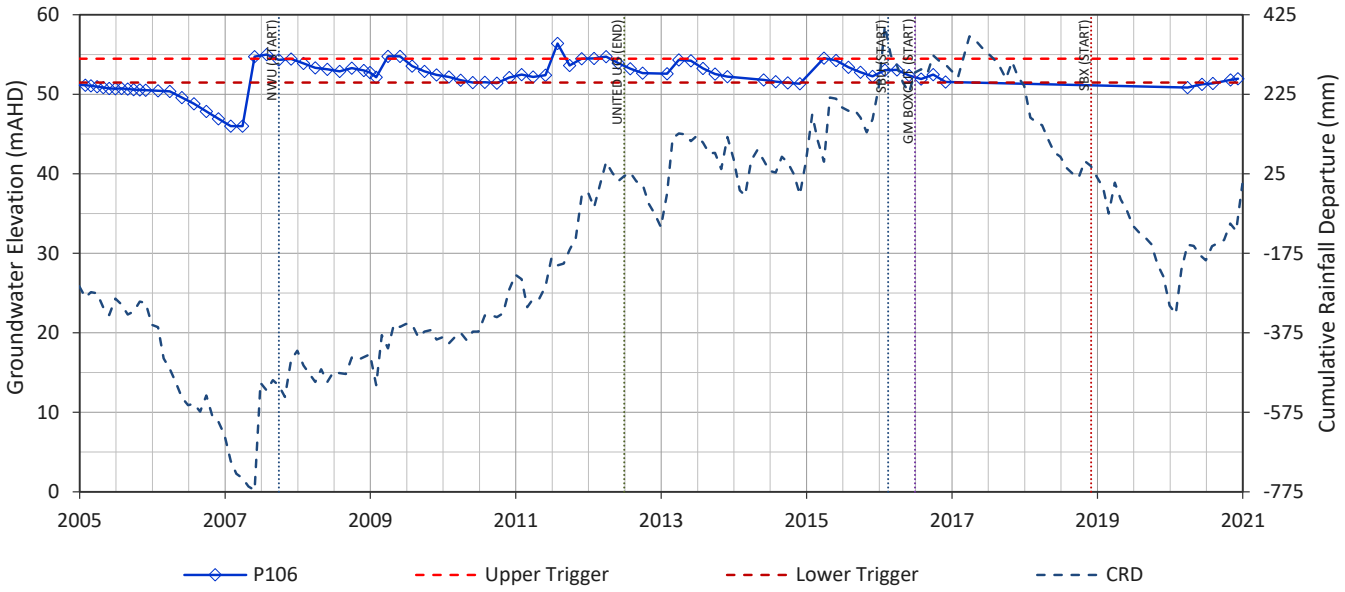
P1

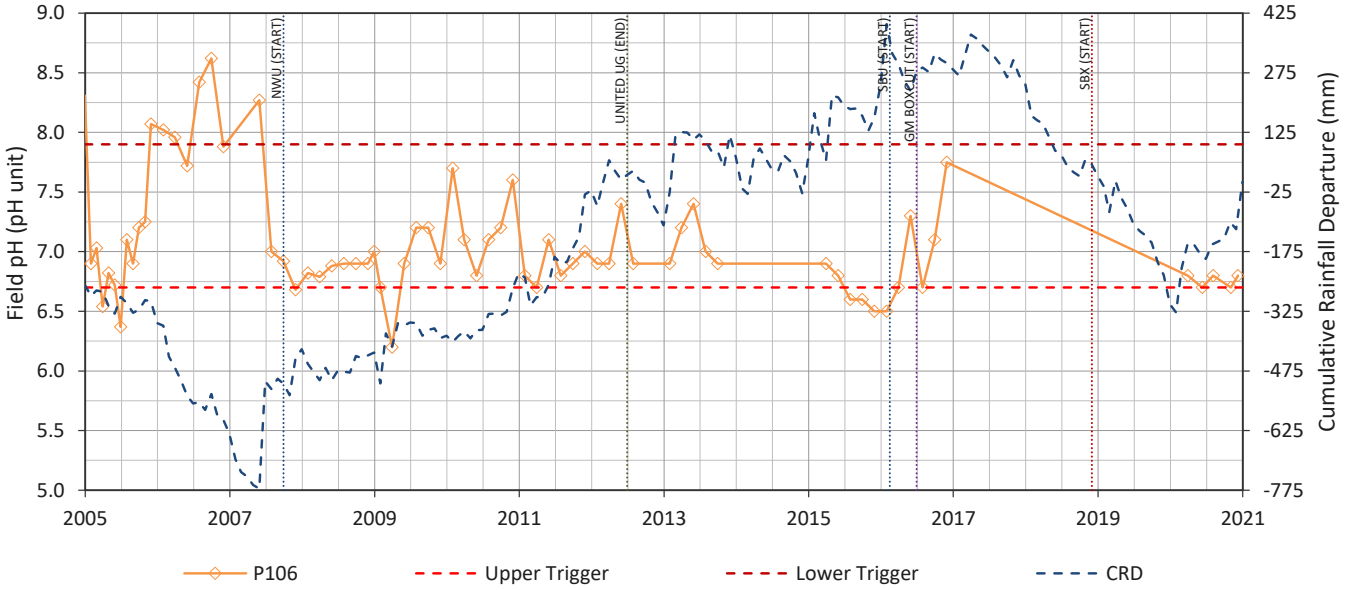

Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOX CUT (START)
SBX (START)
P1
CRD

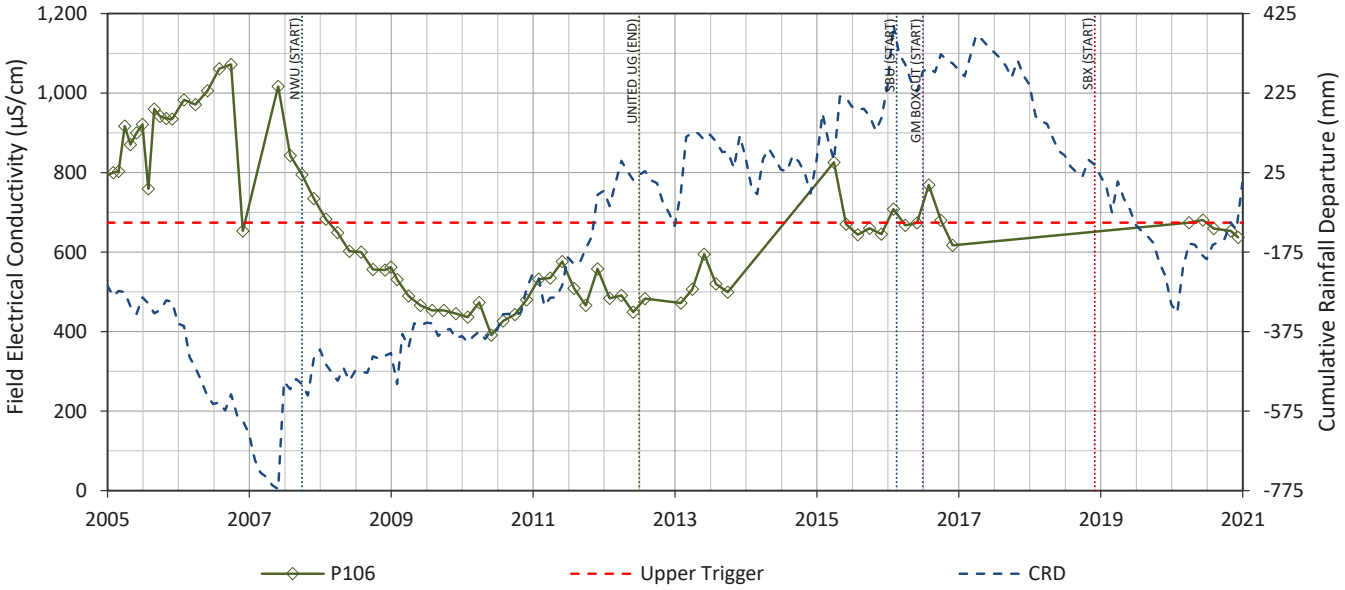

Field pH (pH unit)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOX CUT (START)
SBX (START)
P1
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOX CUT (START)
SBX (START)
P1
CRD

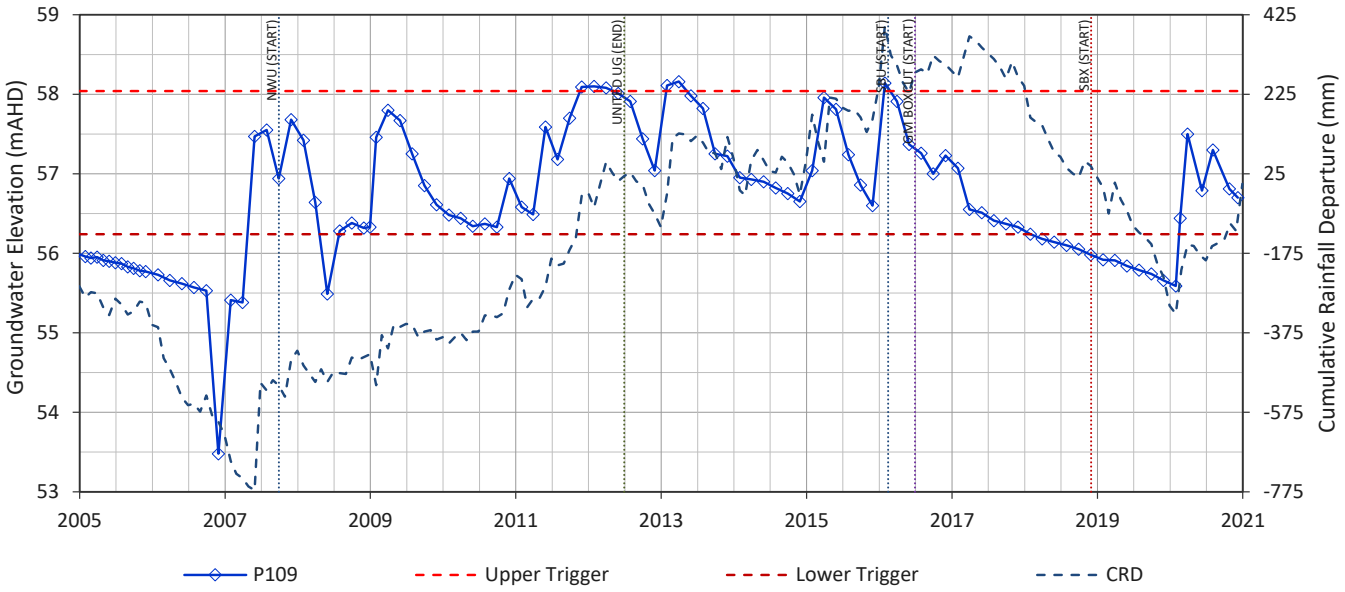
P106

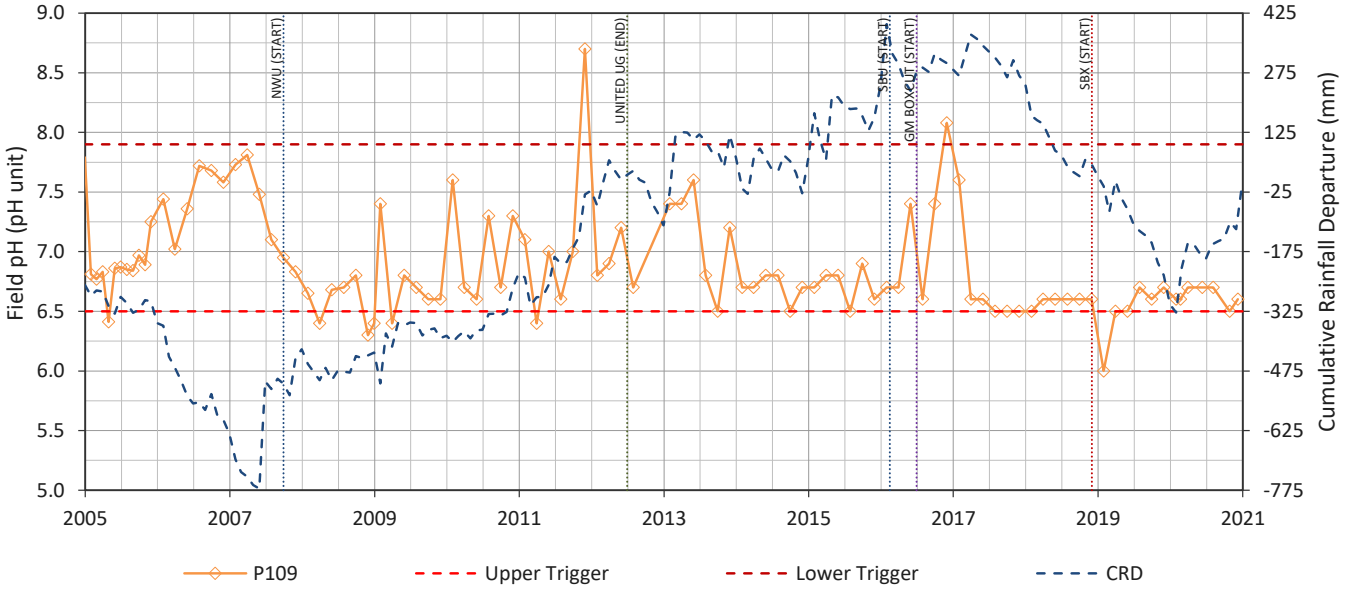

Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBH (START)
GM BOXCUT (START)
SBX (START)
P106
Upper Trigger
Lower Trigger
CRD

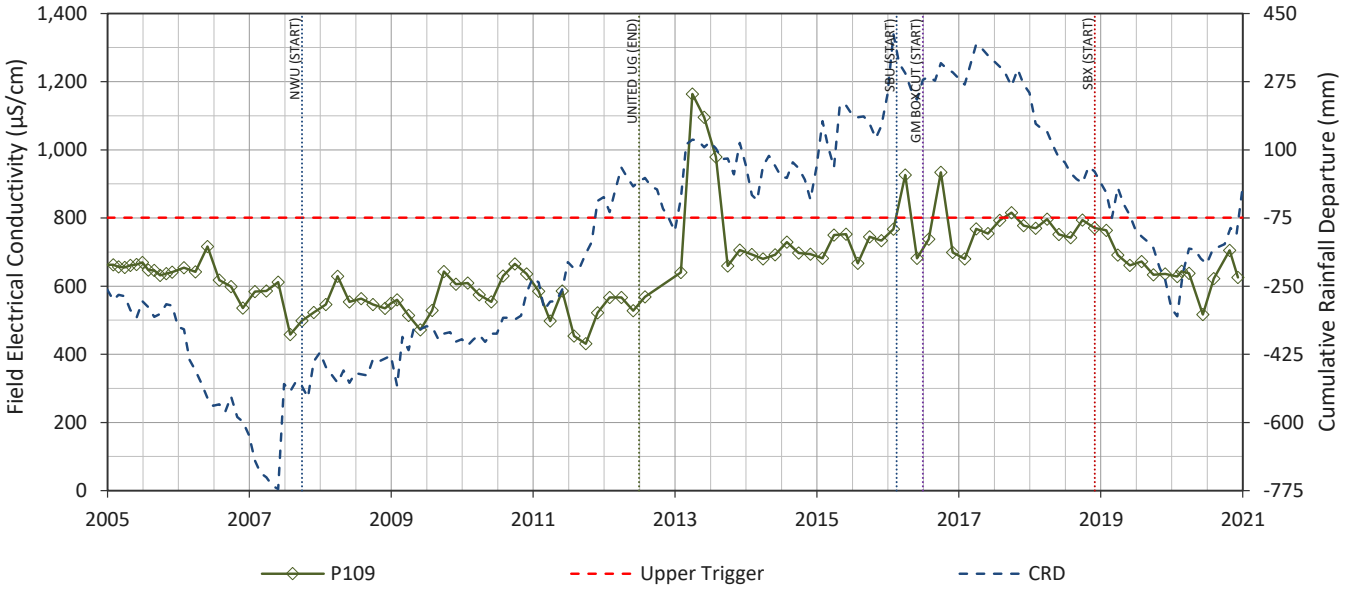

Field pH (pH unit)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBH (START)
GM BOXCUT (START)
SBX (START)
P106
Upper Trigger
Lower Trigger
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBH (START)
GM BOXCUT (START)
SBX (START)
P106
Upper Trigger
CRD

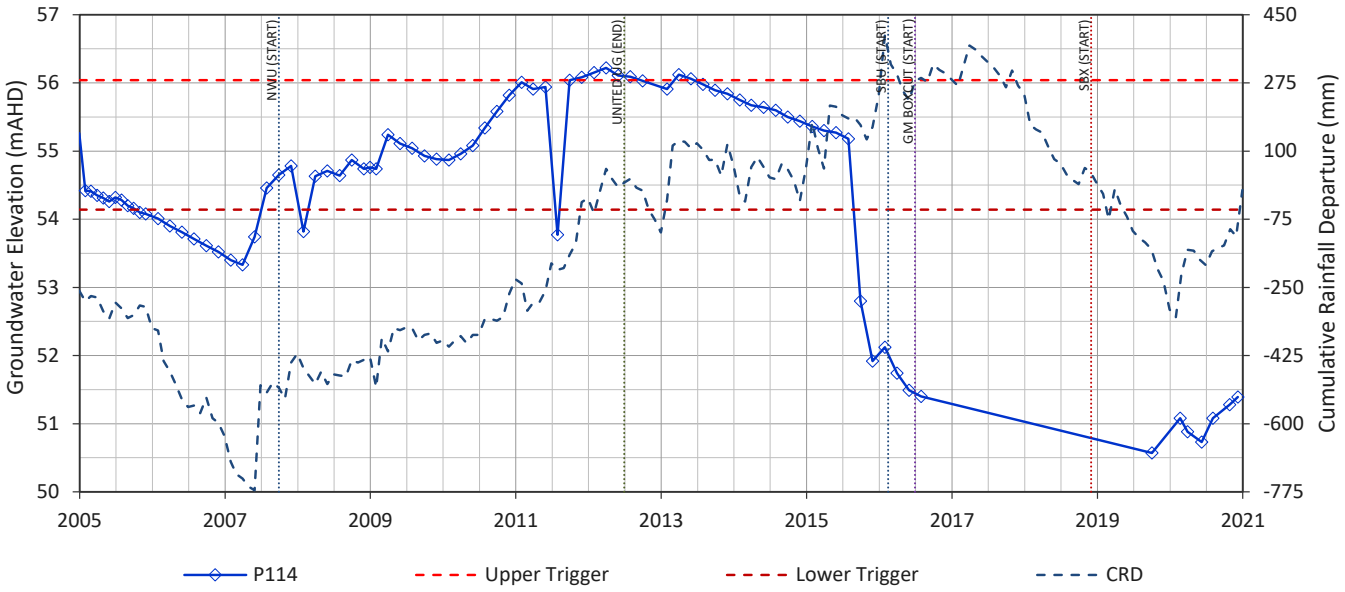
P109

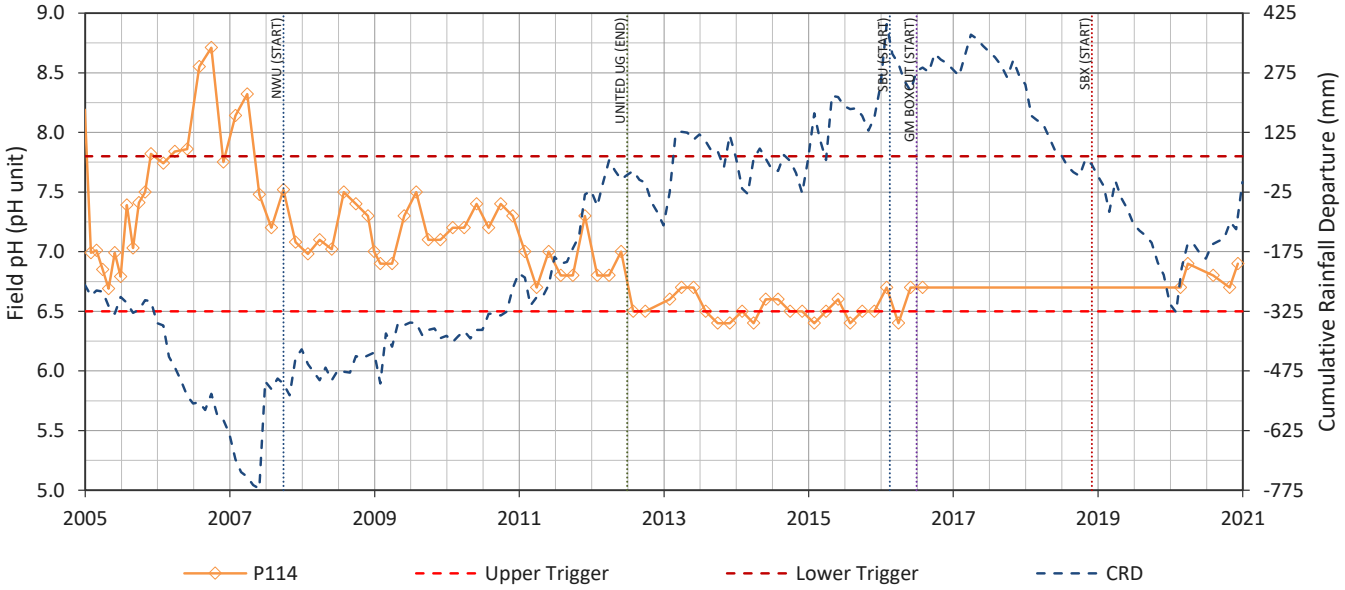

Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOX CUT (START)
SBX (START)
P109
Upper Trigger
Lower Trigger
CRD

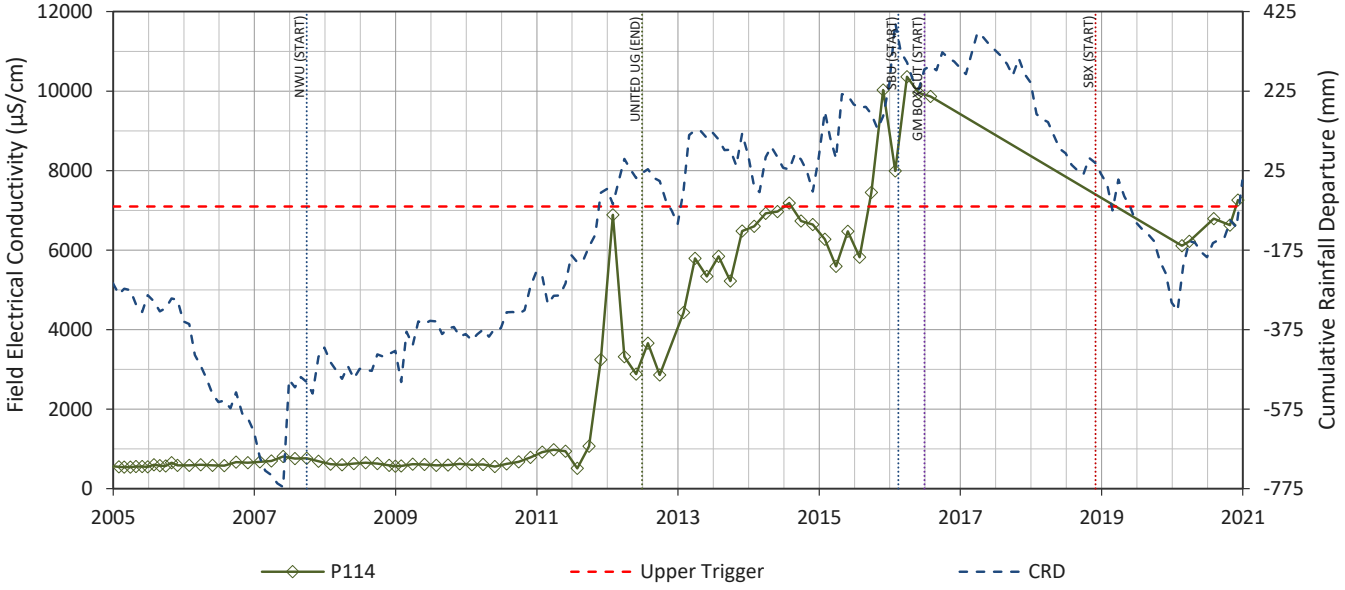

Field pH (pH unit)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOX CUT (START)
SBX (START)
P109
Upper Trigger
Lower Trigger
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOX CUT (START)
SBX (START)
P109
Upper Trigger
CRD

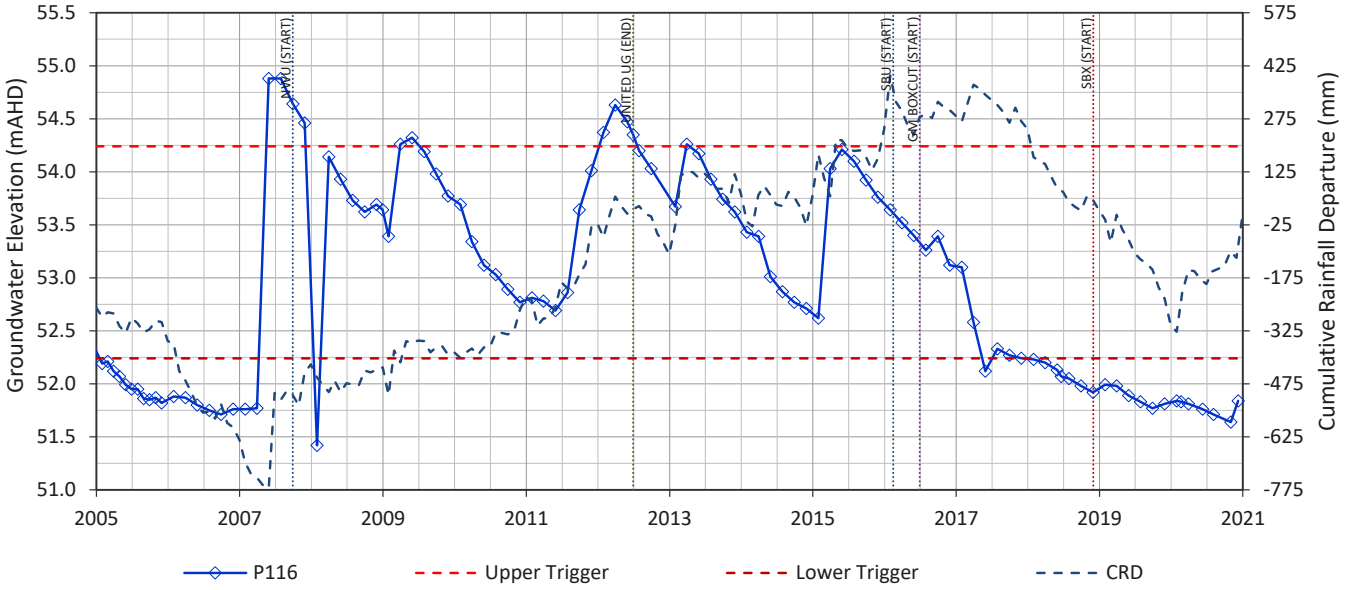
P114

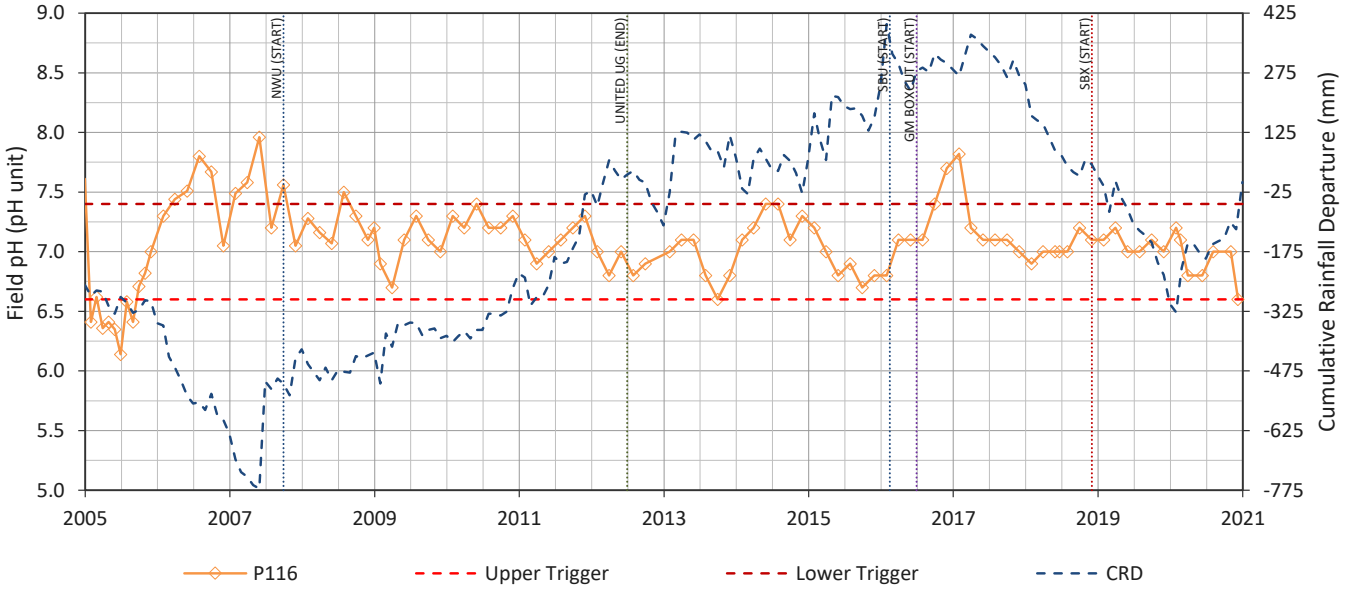

Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOX CUT (START)
SBX (START)
P114
Upper Trigger
Lower Trigger
CRD

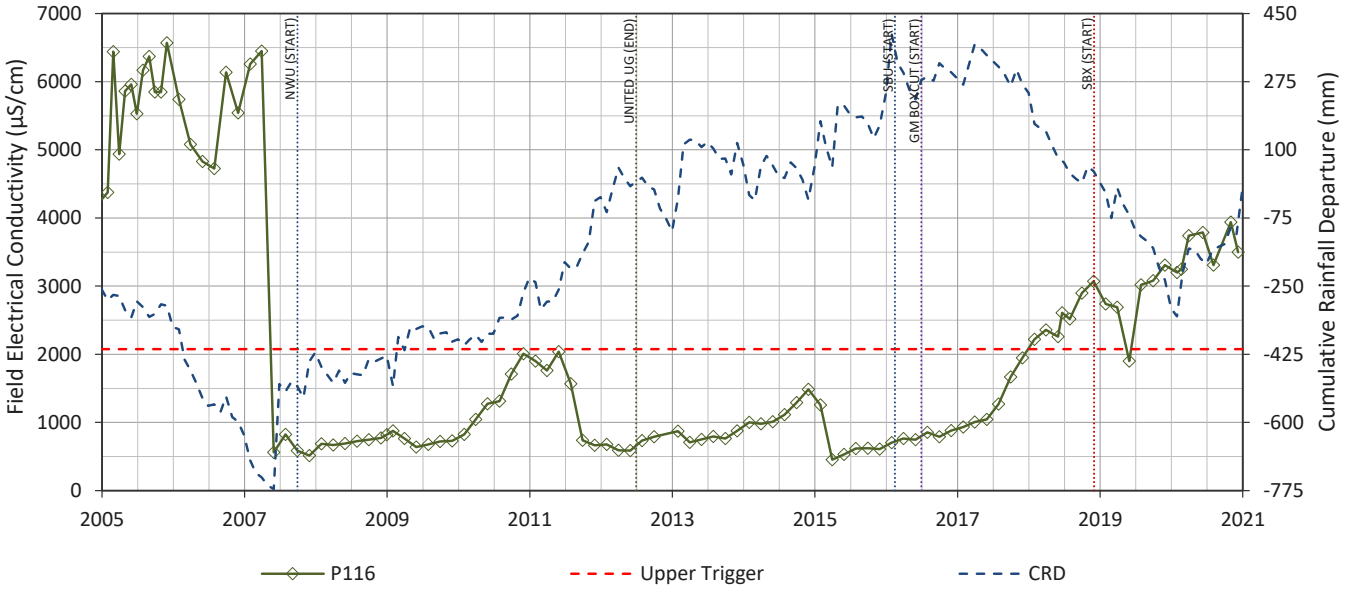

Field pH (pH unit)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOX CUT (START)
SBX (START)
P114
Upper Trigger
Lower Trigger
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOX CUT (START)
SBX (START)
P114
Upper Trigger
CRD

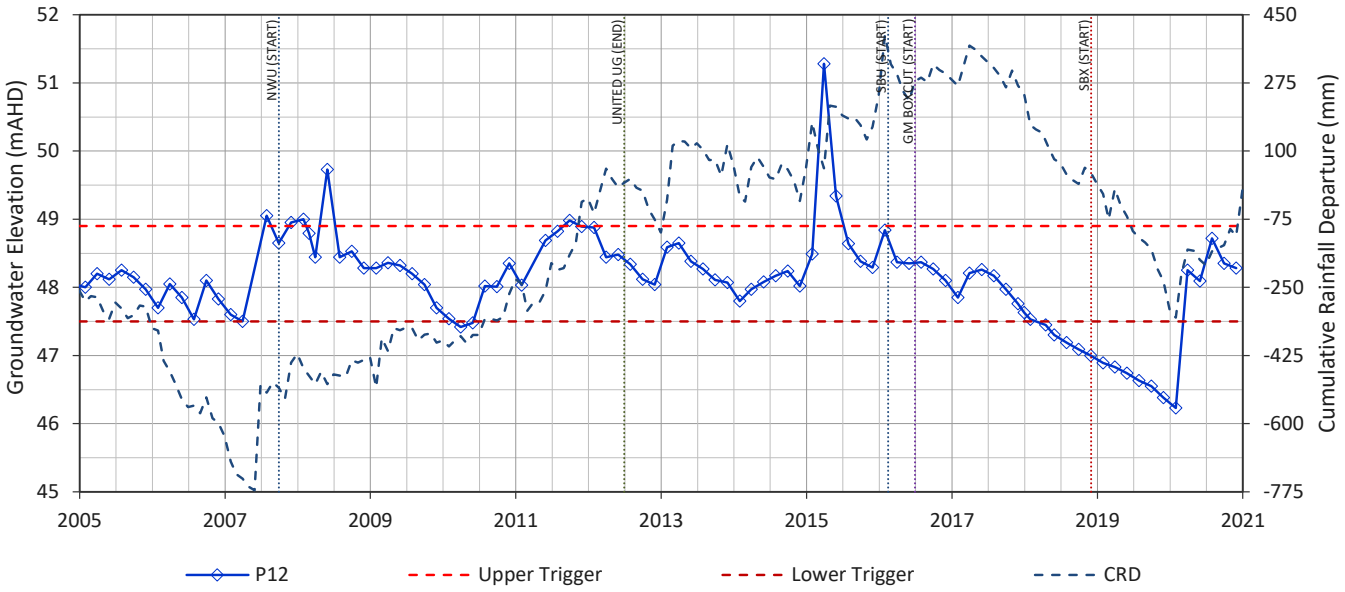
P116

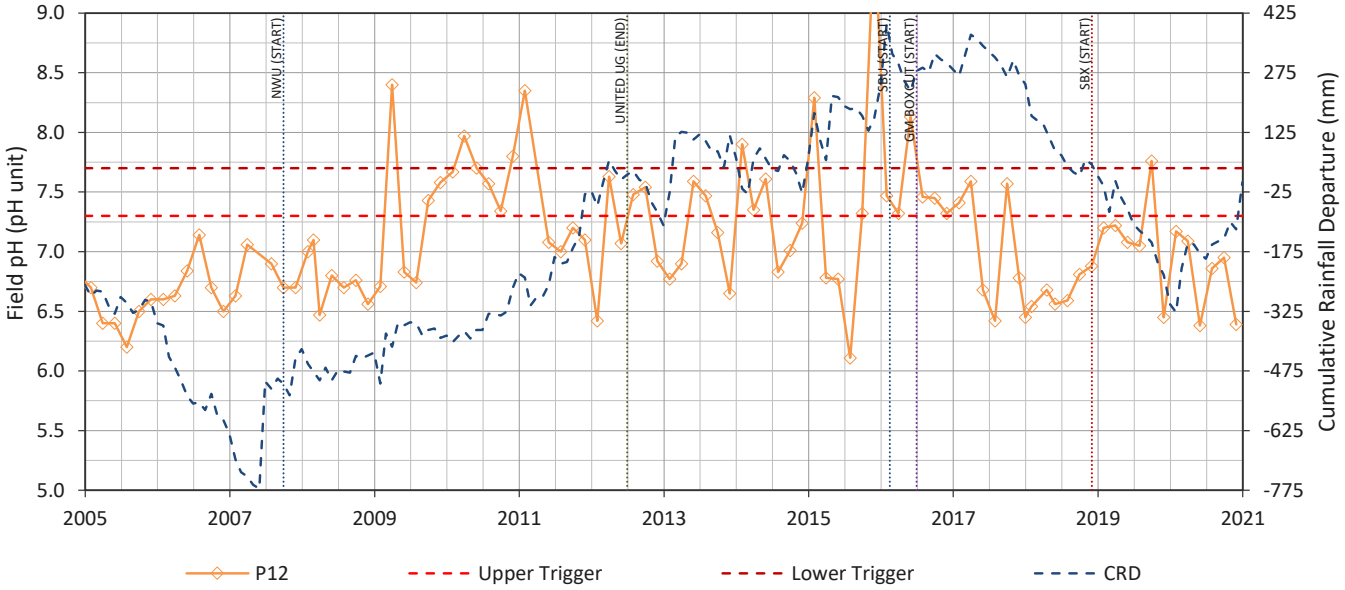

Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
P116
Upper Trigger
Lower Trigger
CRD

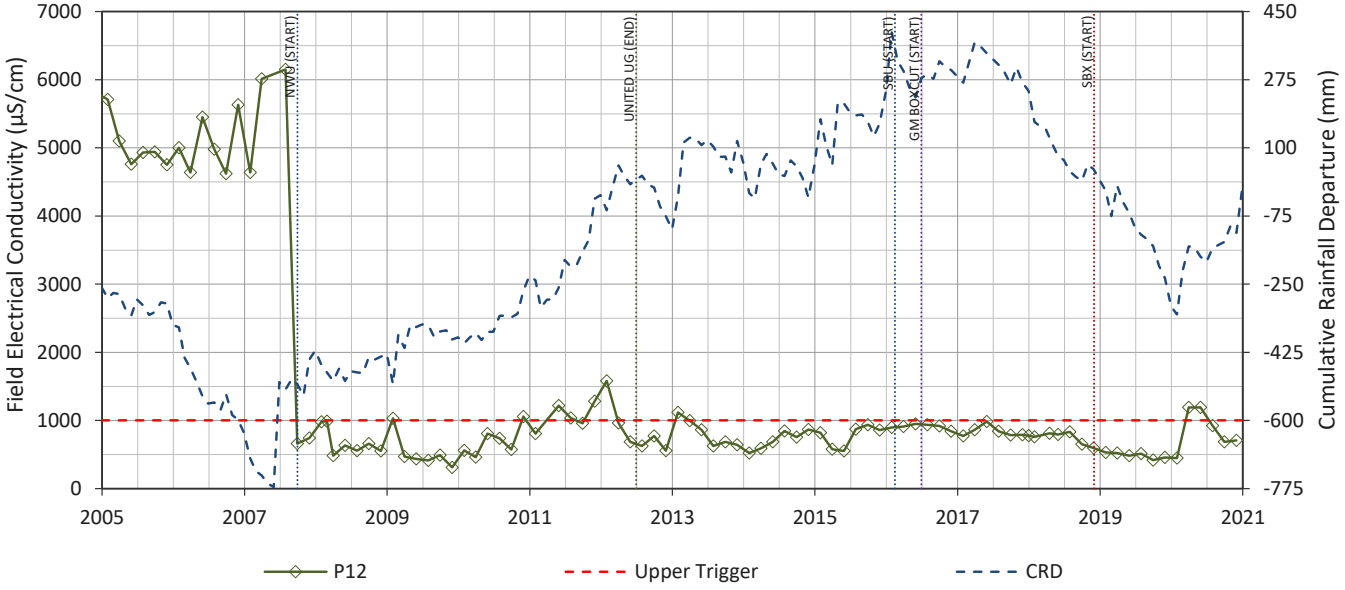

Field pH (pH unit)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
P116
Upper Trigger
Lower Trigger
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
P116
Upper Trigger
CRD

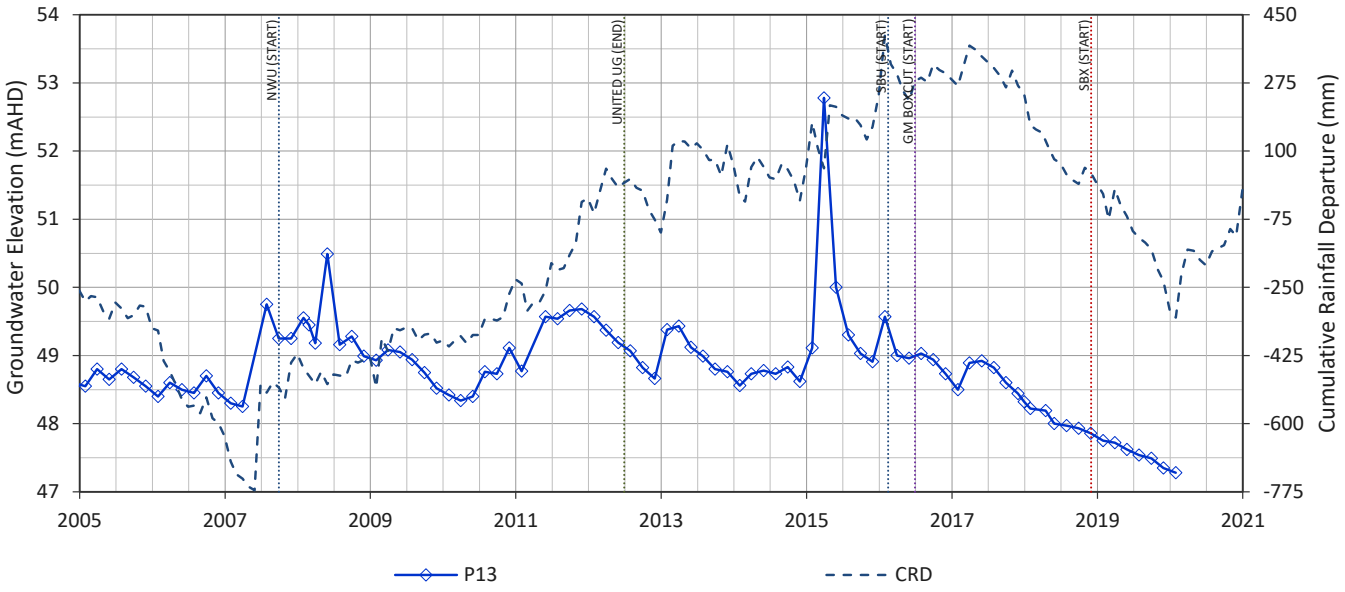
P12

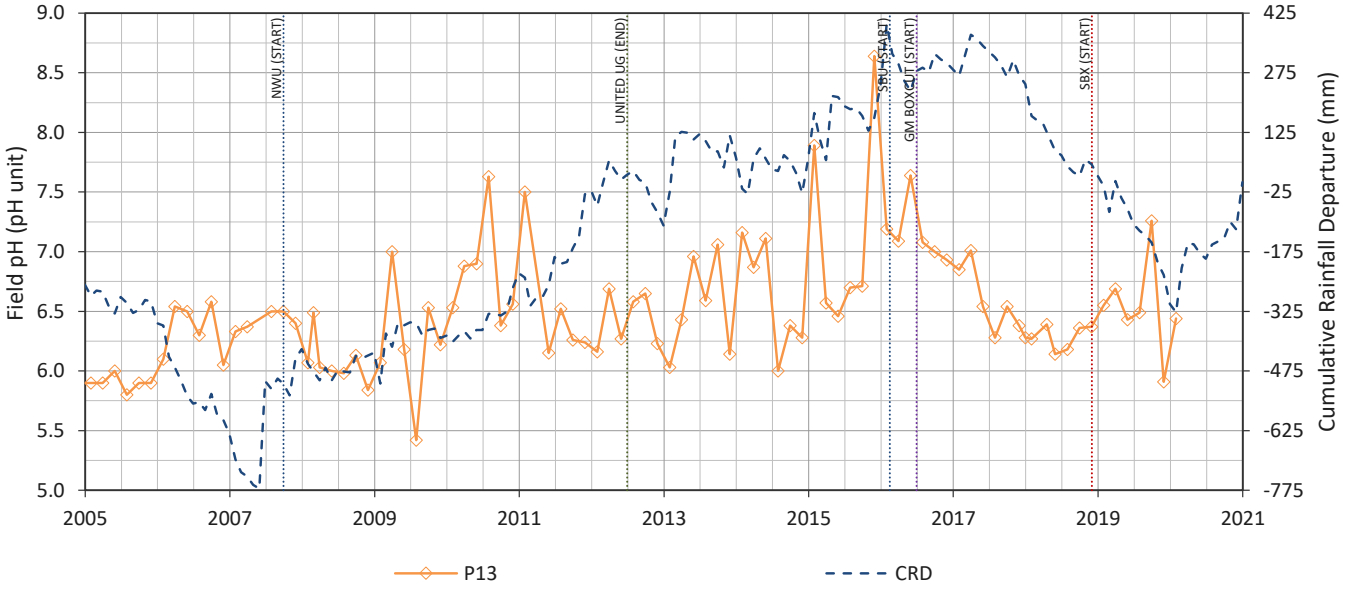

Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOX CUT (START)
SBX (START)
P12
Upper Trigger
Lower Trigger
CRD

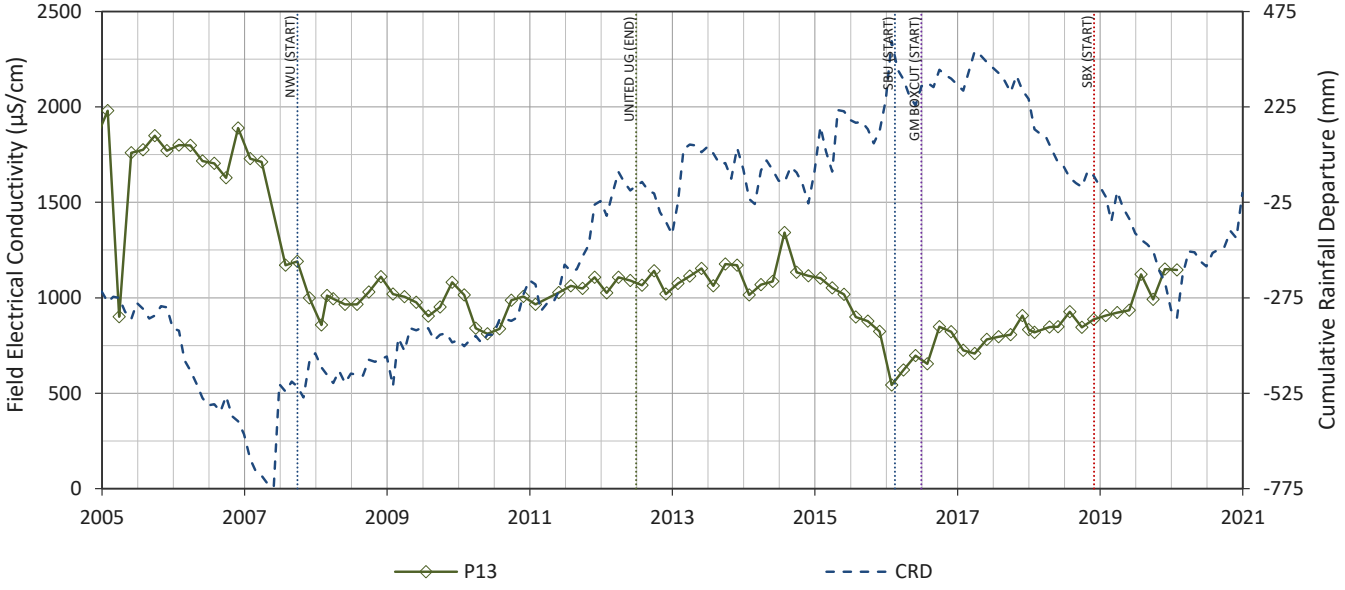

Field pH (pH unit)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOX CUT (START)
SBX (START)
P12
Upper Trigger
Lower Trigger
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOX CUT (START)
SBX (START)
P12
Upper Trigger
CRD

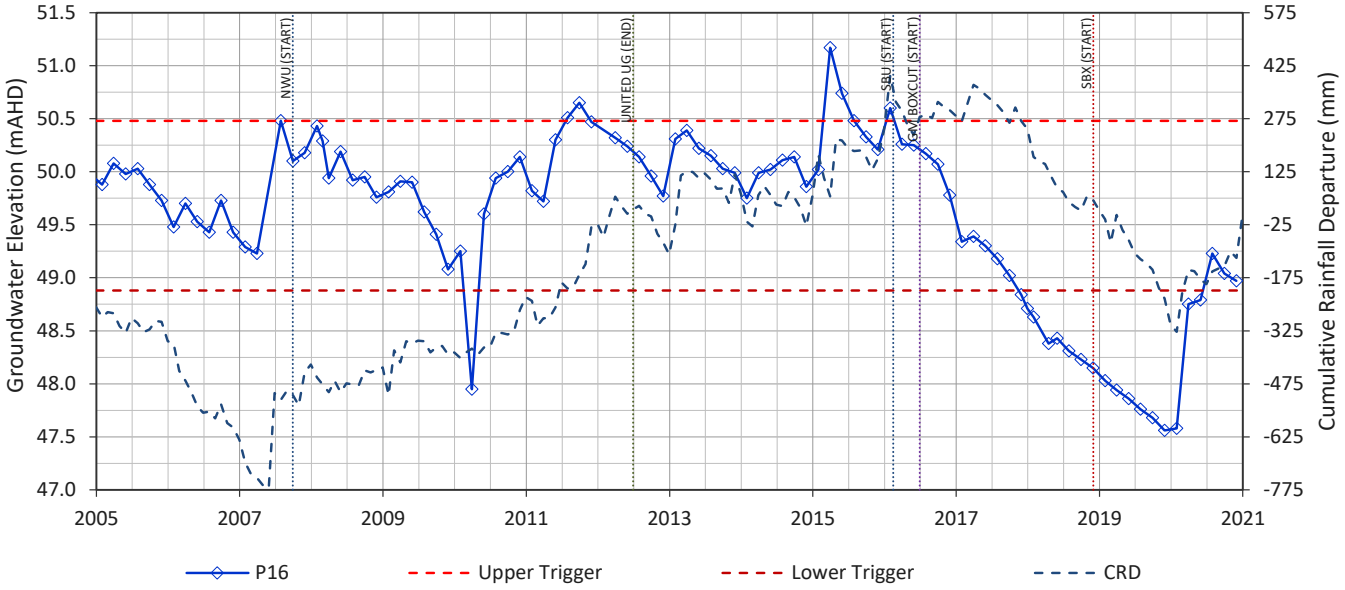
P13

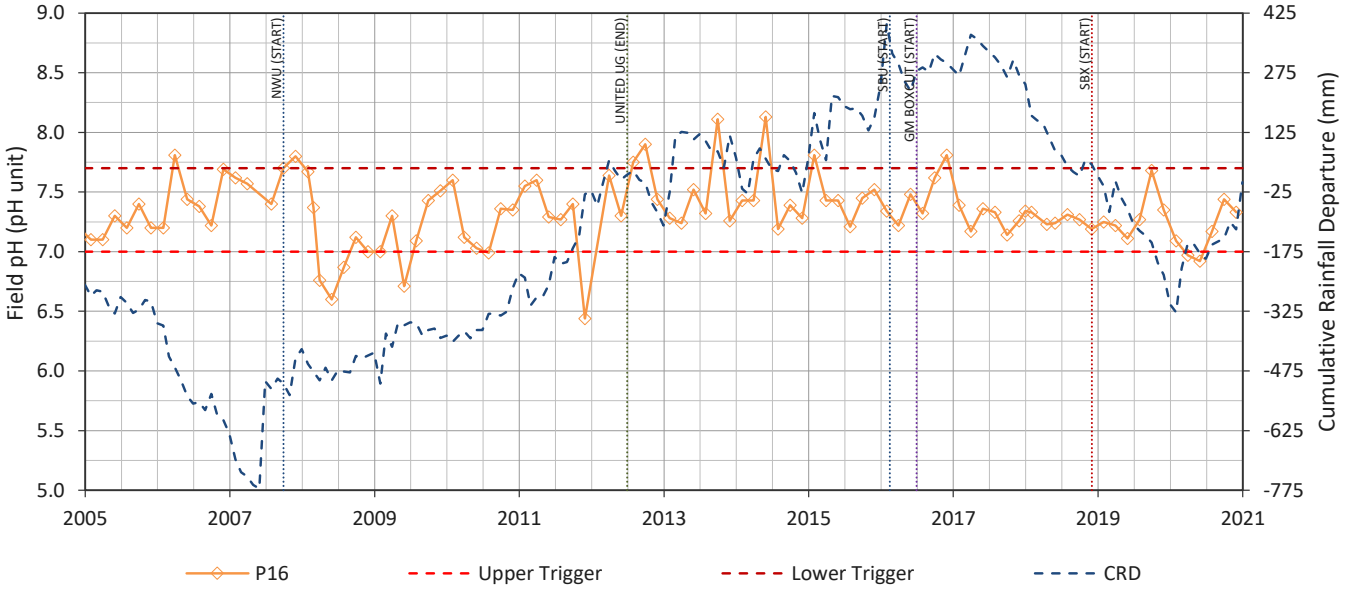

Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOX CUT (START)
SBX (START)
P13
CRD

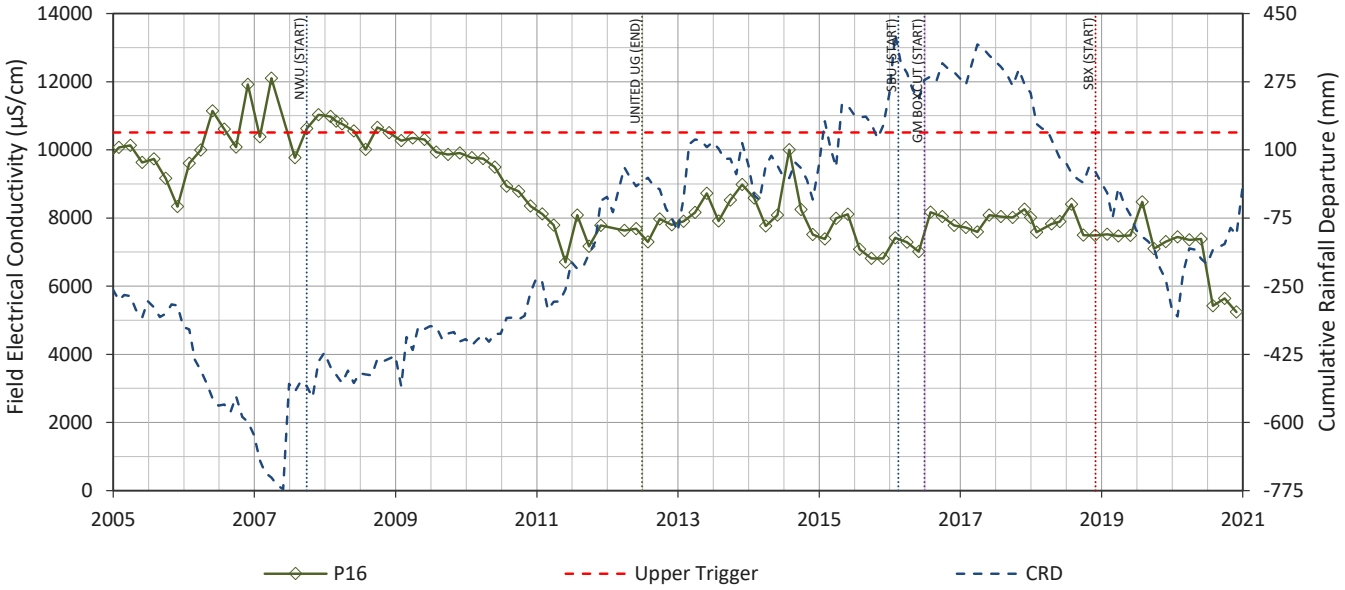

Field pH (pH unit)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOX CUT (START)
SBX (START)
P13
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOX CUT (START)
SBX (START)
P13
CRD

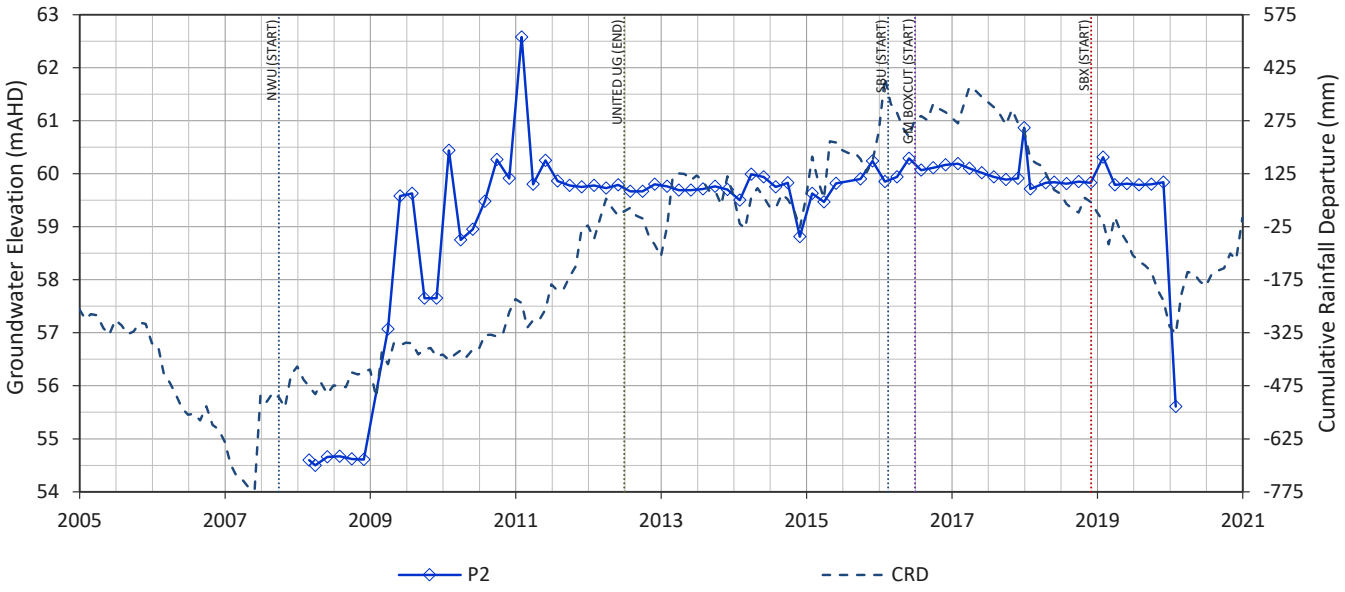
P16

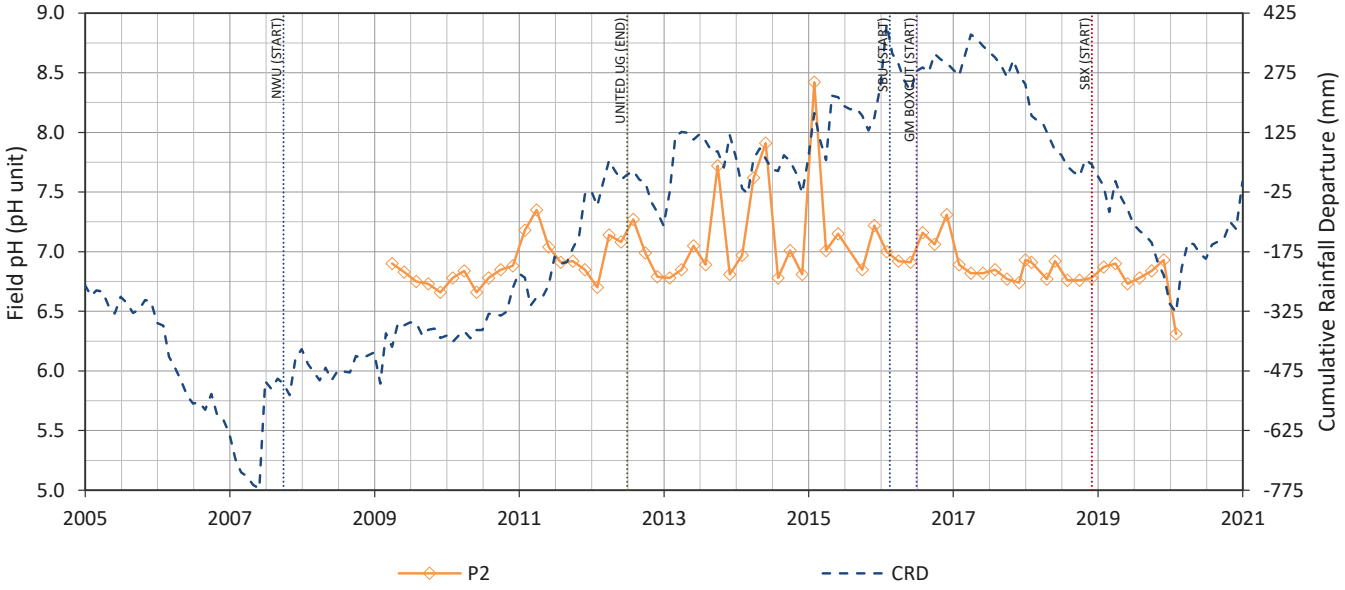

Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
P16
Upper Trigger
Lower Trigger
CRD

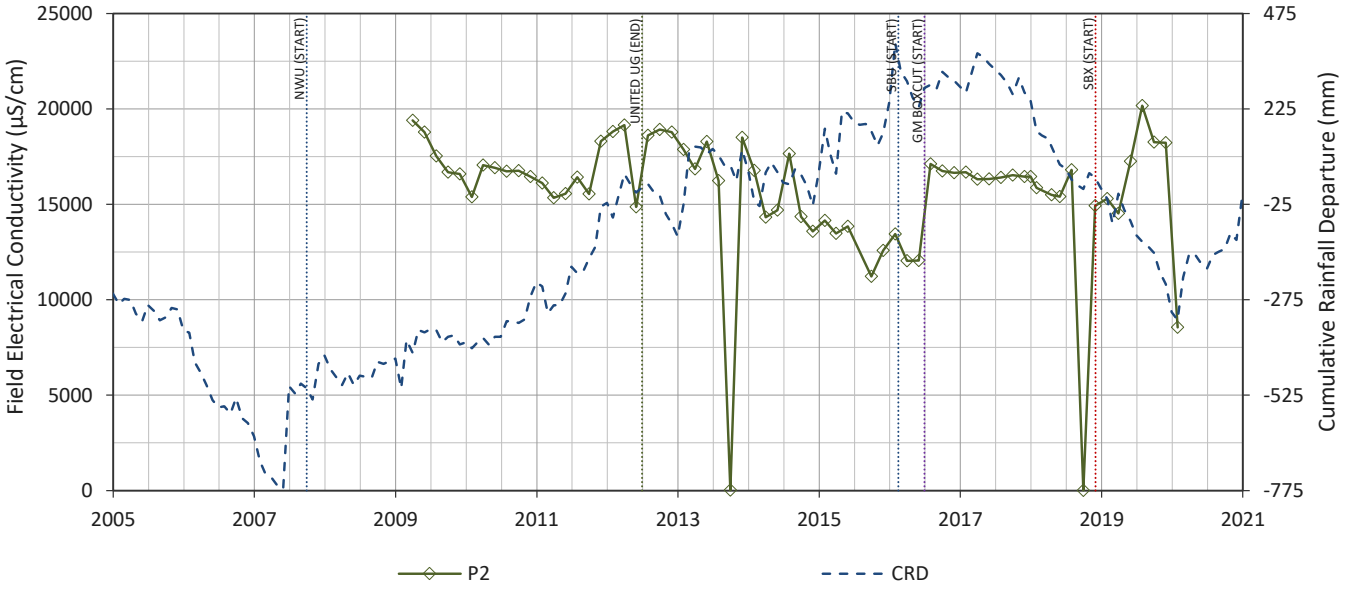

Field pH (pH unit)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
P16
Upper Trigger
Lower Trigger
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
P16
Upper Trigger
CRD

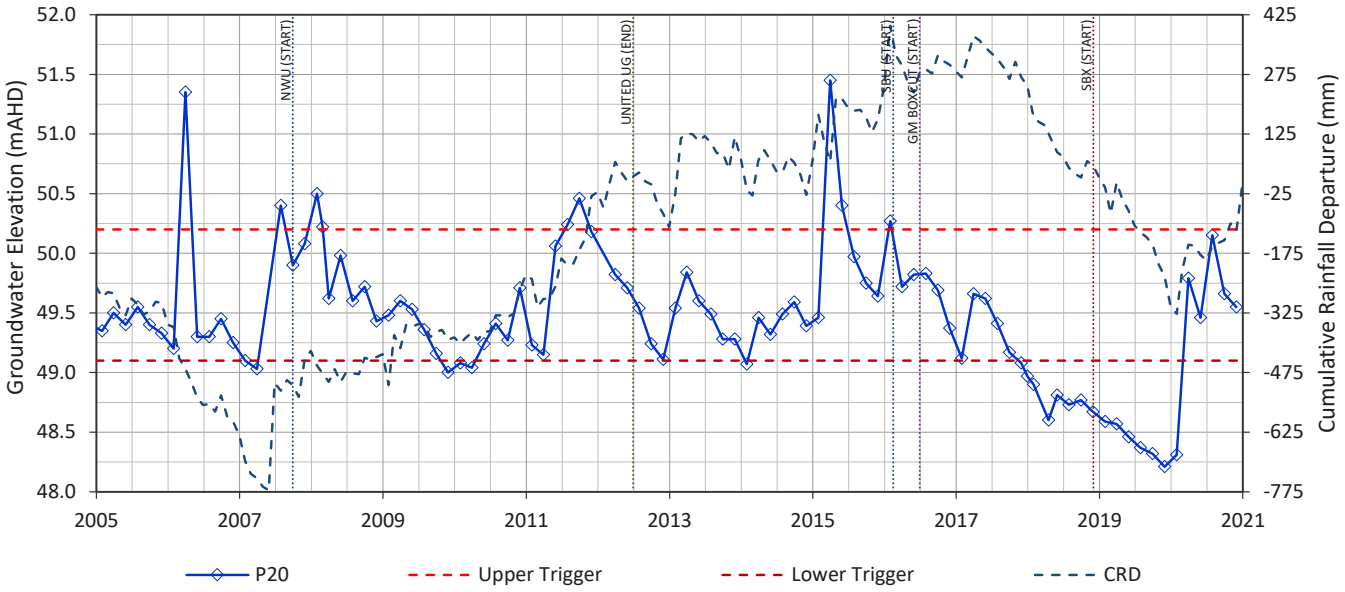
P2

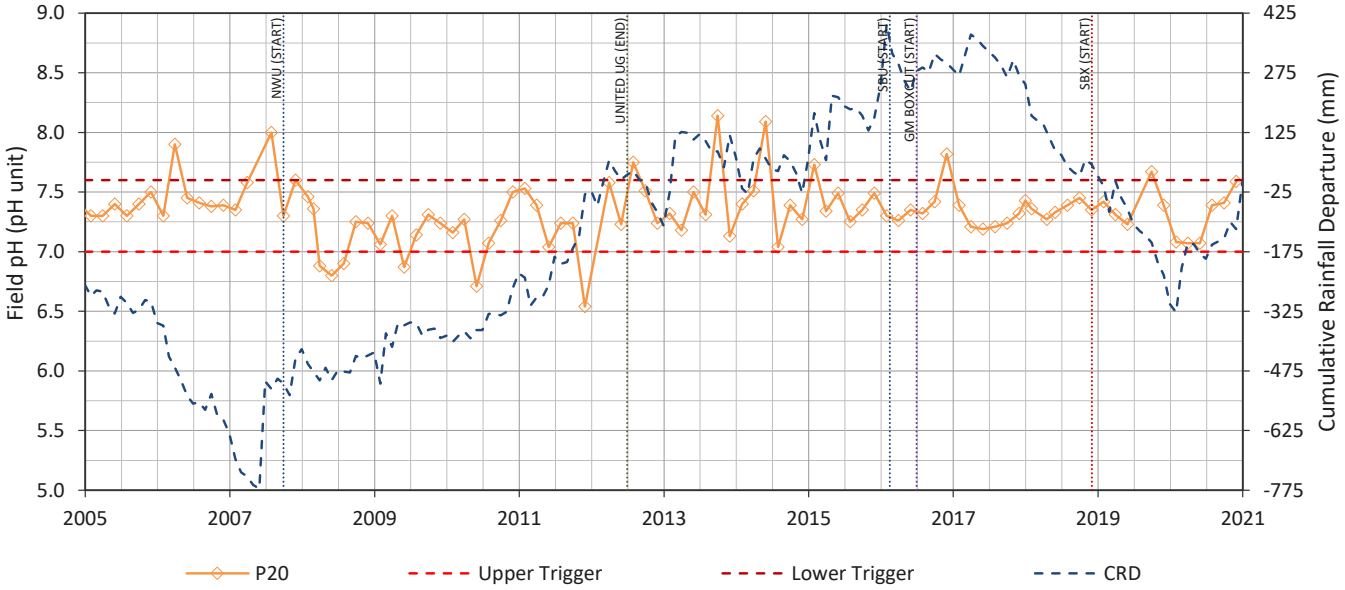

Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
P2
CRD

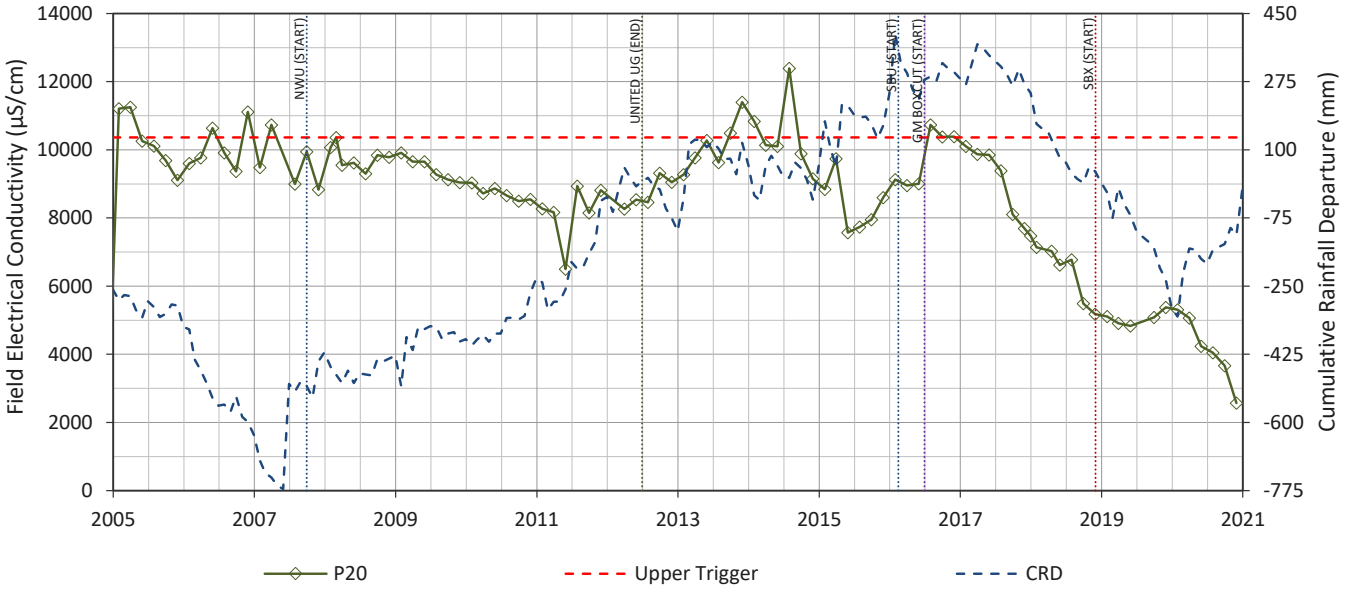

Field pH (pH unit)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
P2
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
P2
CRD

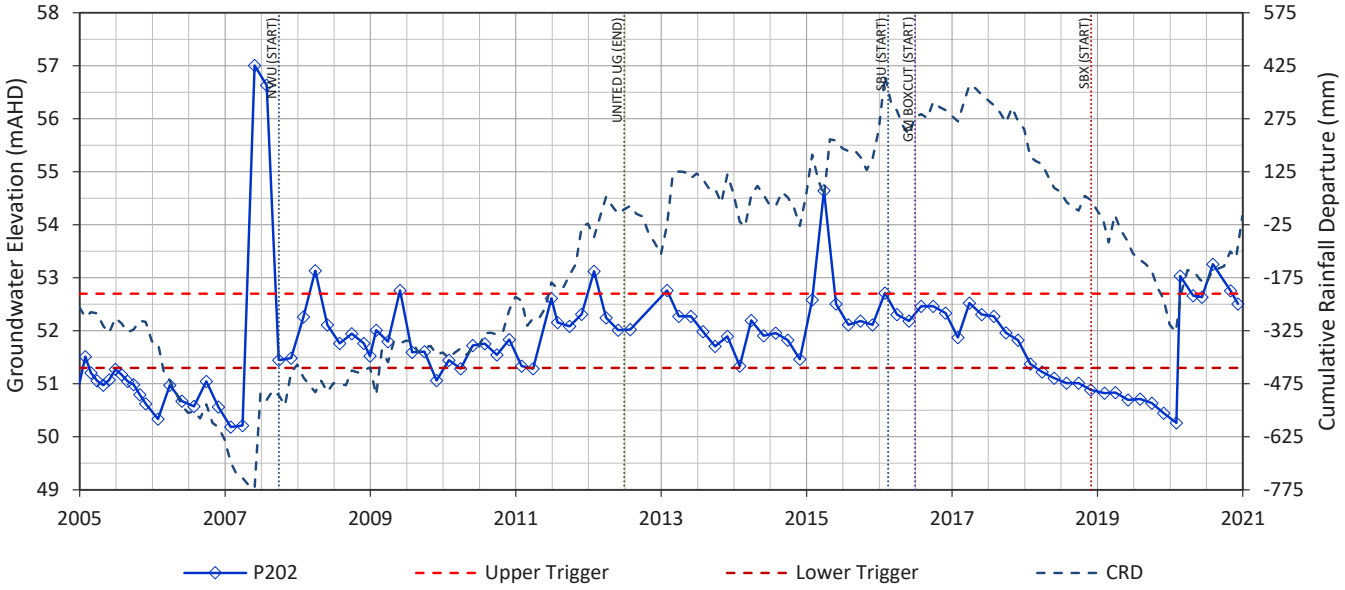
P20


Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOX CUT (START)
SBX (START)
P20
Upper Trigger
Lower Trigger
CRD


Field pH (pH unit)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOX CUT (START)
SBX (START)
P20
Upper Trigger
Lower Trigger
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOX CUT (START)
SBX (START)
P20
Upper Trigger
CRD

P202


Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
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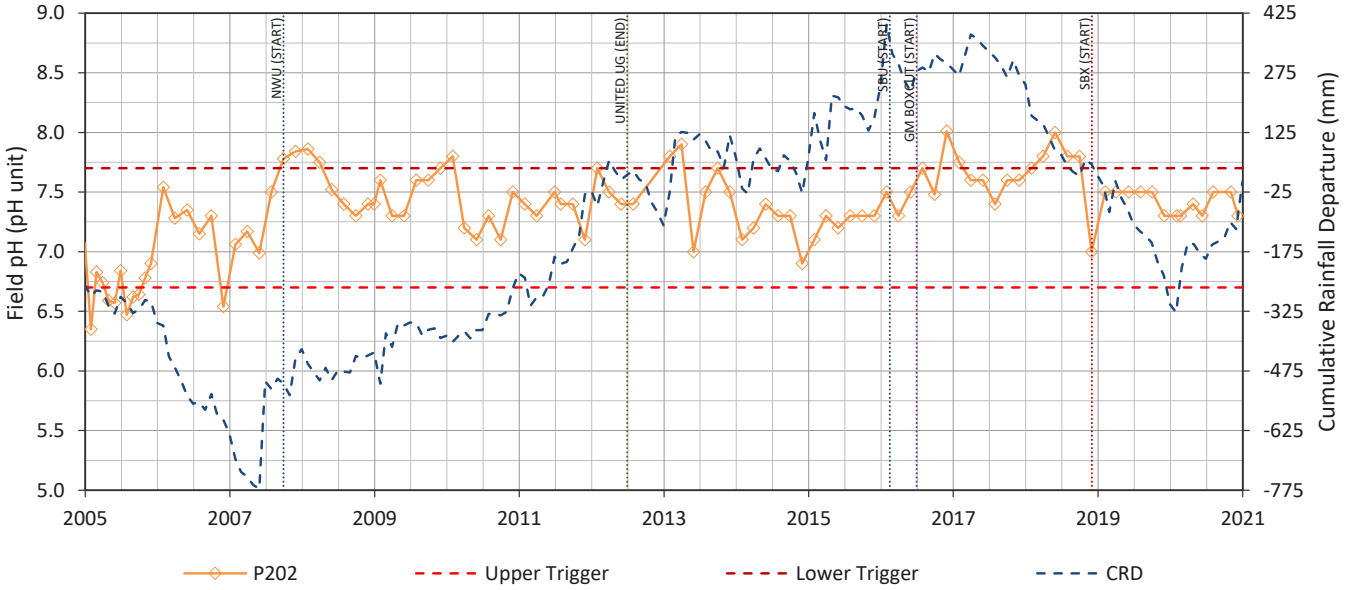
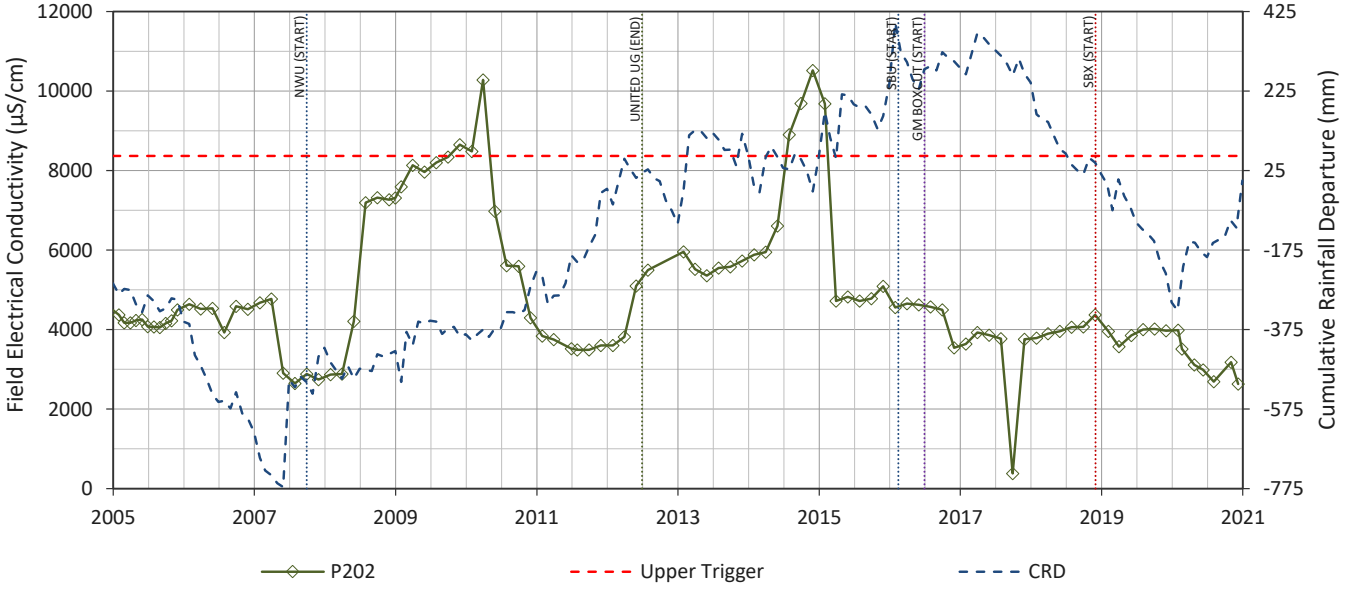
SBU (START)
GM BOXCUT (START)
SBX (START)
P202
Upper Trigger
Lower Trigger
CRD


Field pH (pH unit)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
P202
Upper Trigger
Lower Trigger
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
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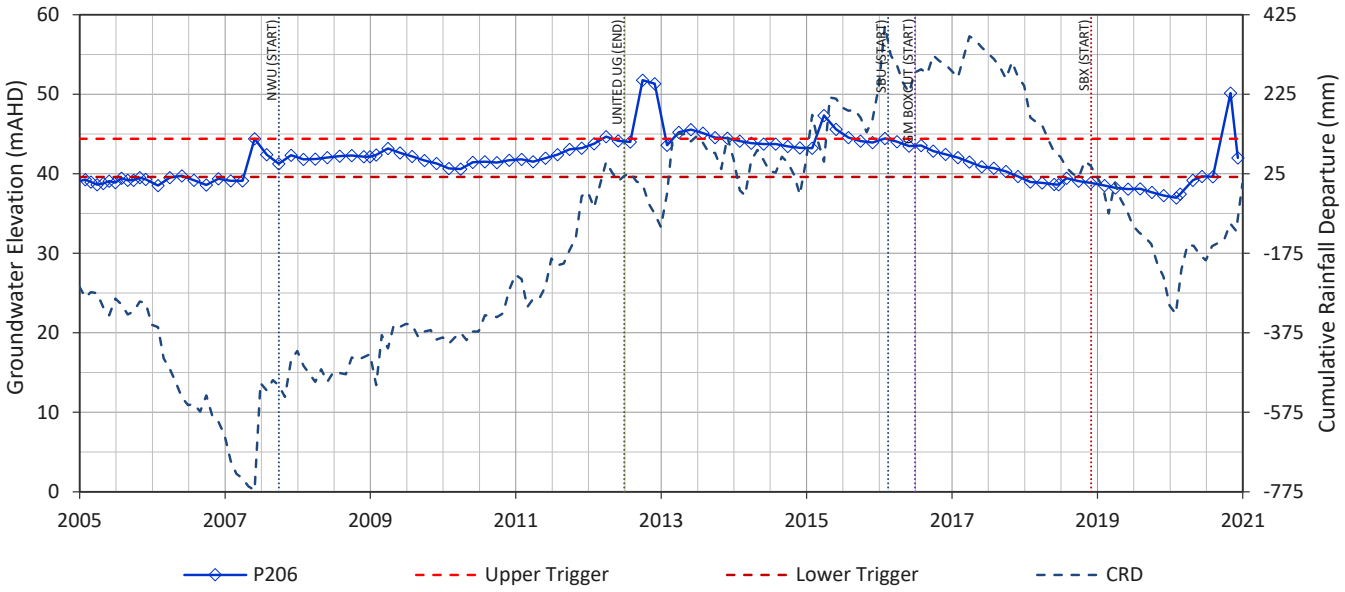
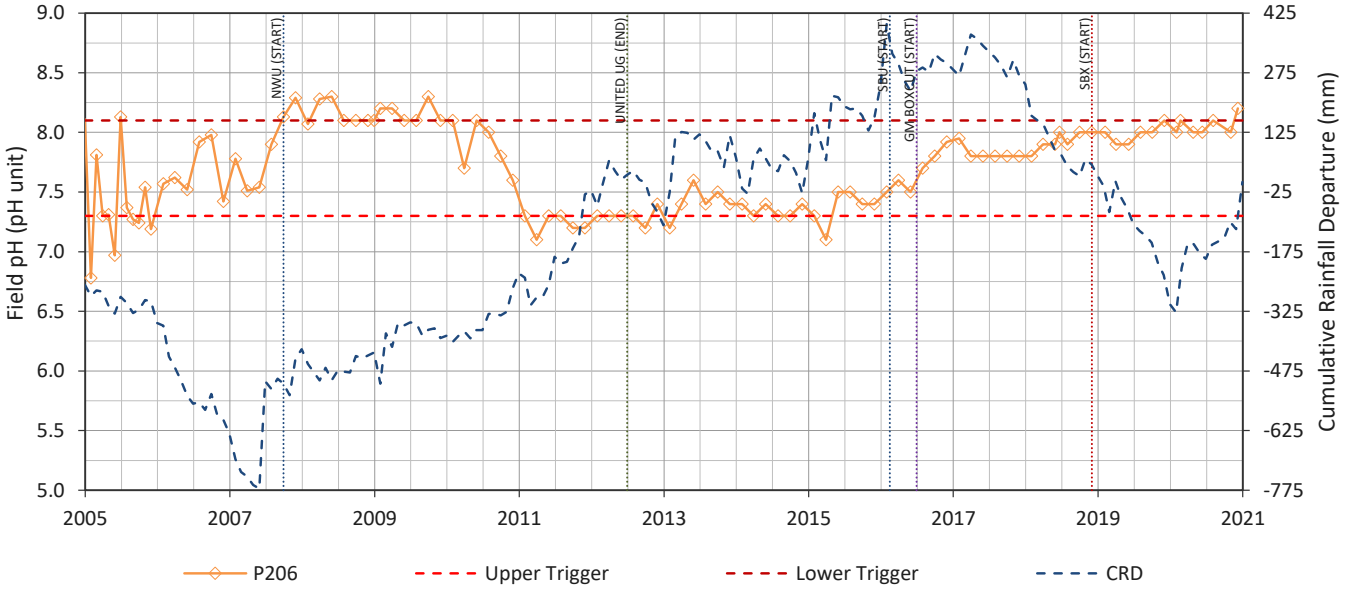
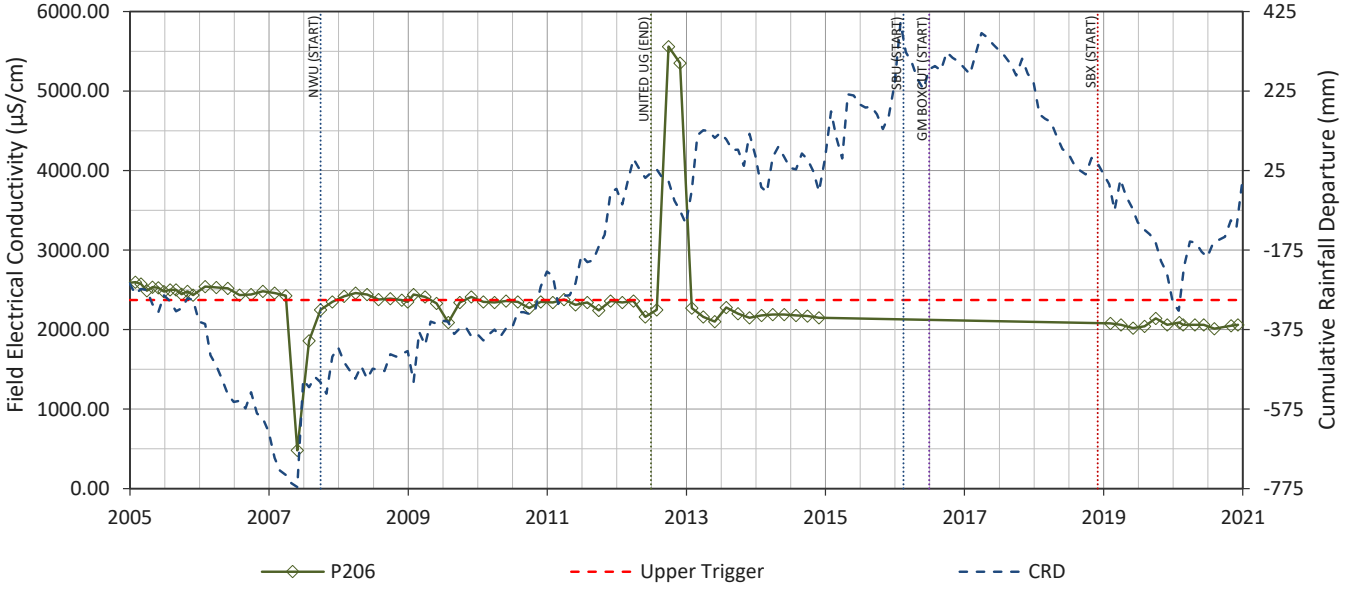
SBU (START)
GM BOXCUT (START)
SBX (START)
P202
Upper Trigger
CRD

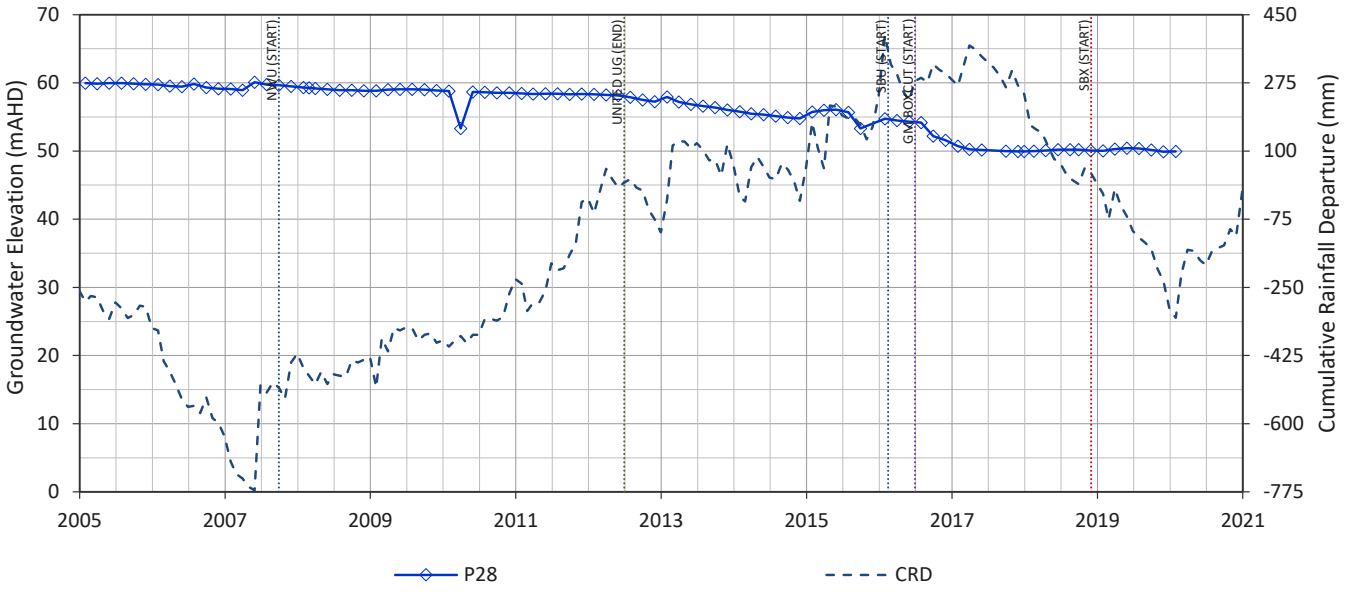
P206


Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOX CUT (START)
SBX (START)
P206
Upper Trigger
Lower Trigger
CRD


Field pH (pH unit)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOX CUT (START)
SBX (START)
P206
Upper Trigger
Lower Trigger
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOX CUT (START)
SBX (START)
P206
Upper Trigger
CRD

P28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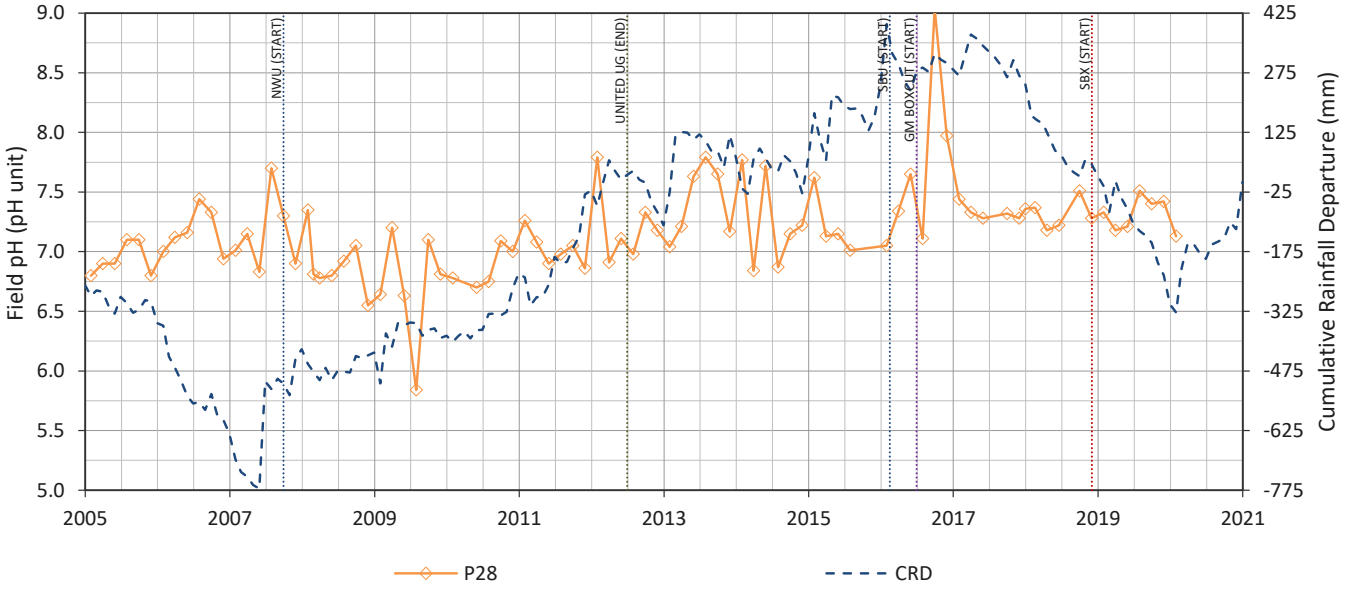
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
P28
CRD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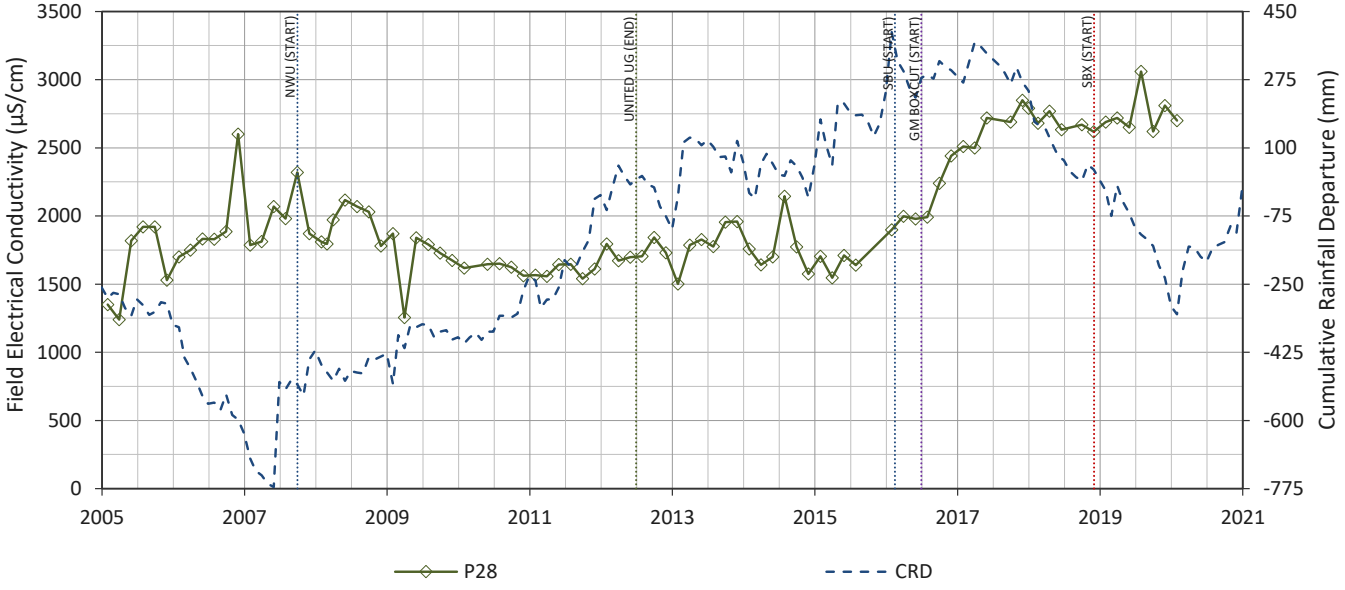
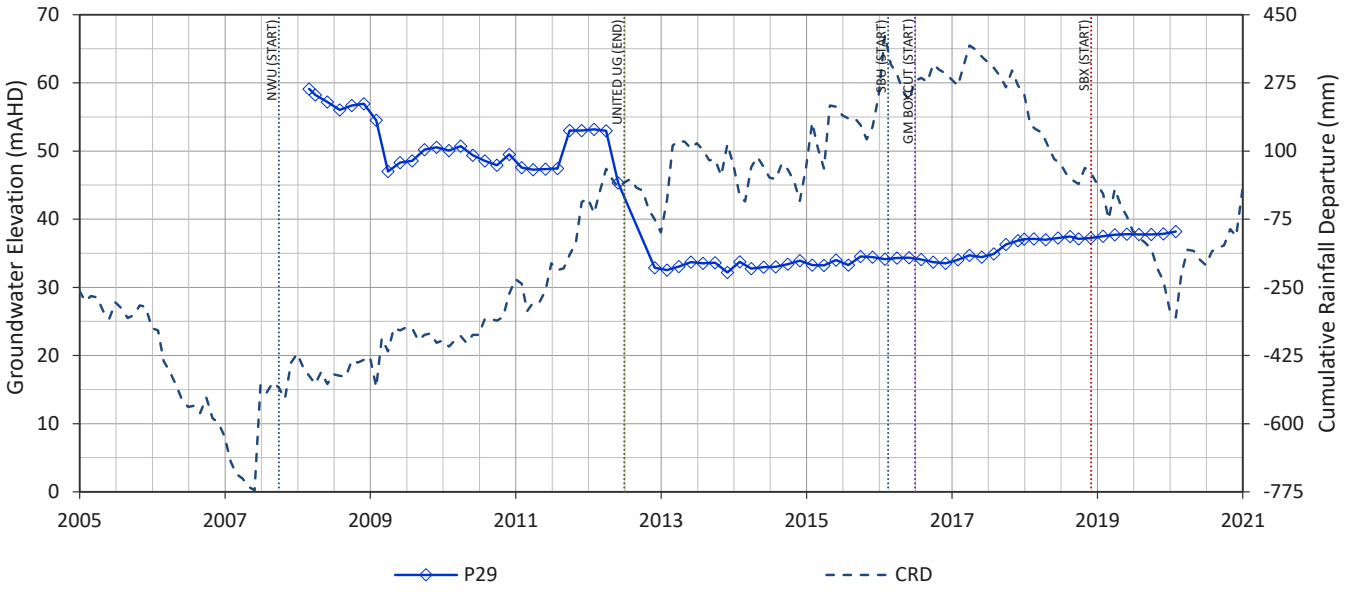
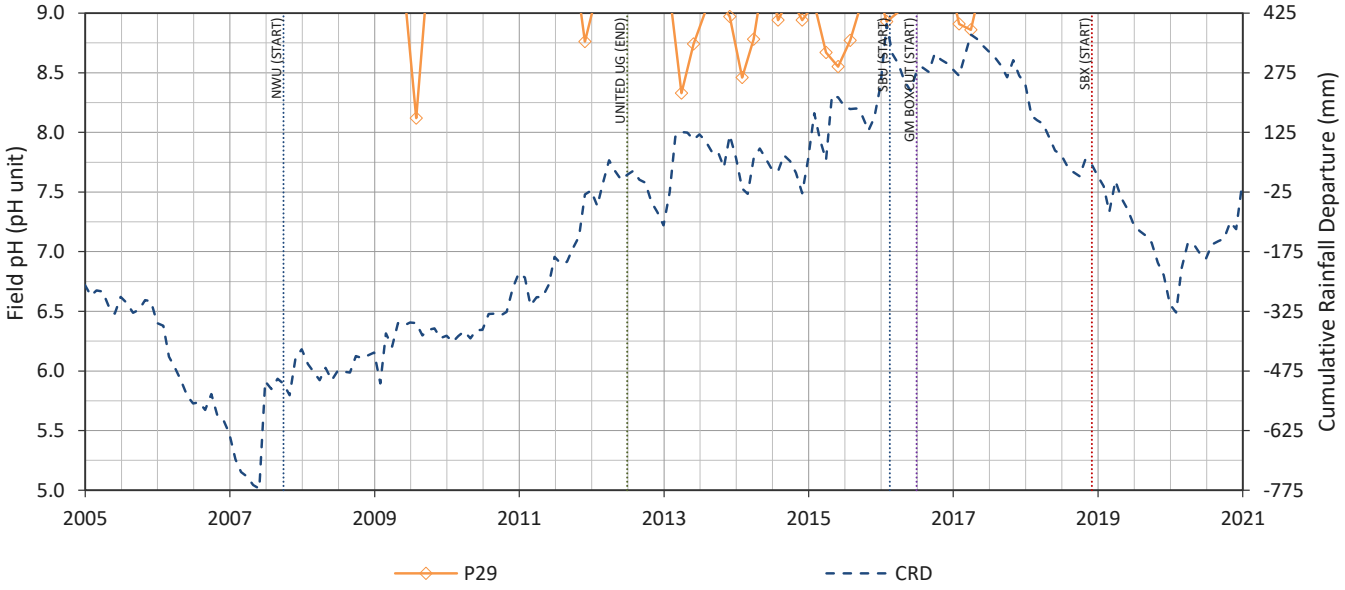
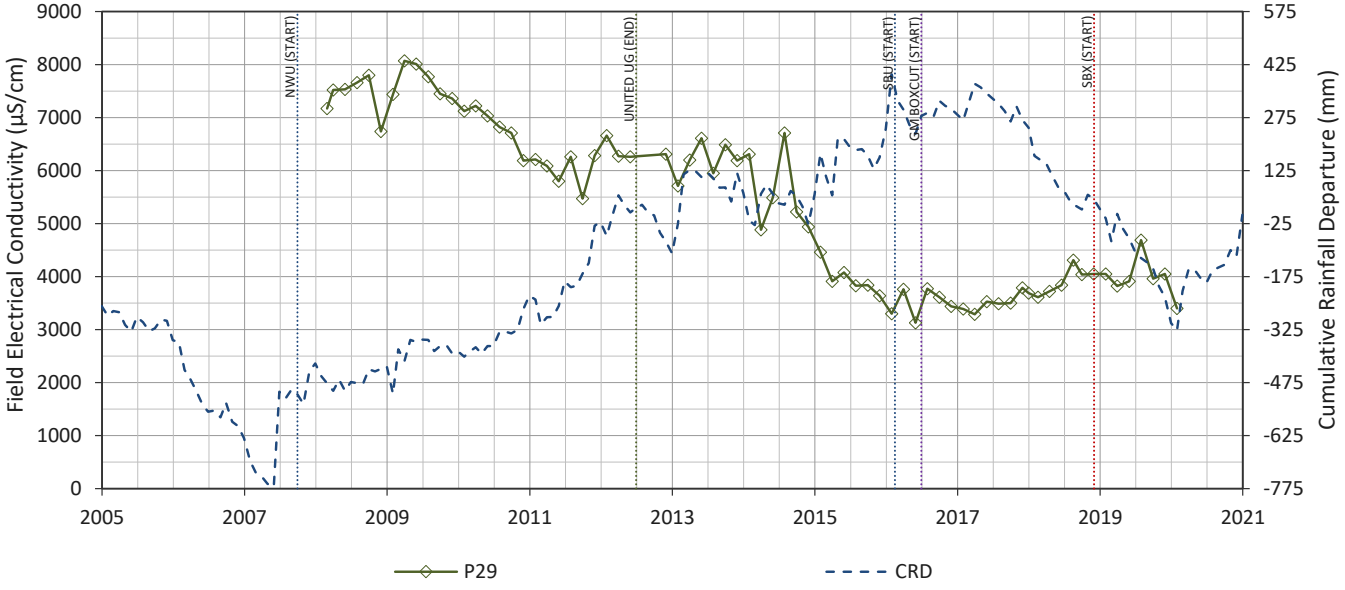
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
P28
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
P28
CRD

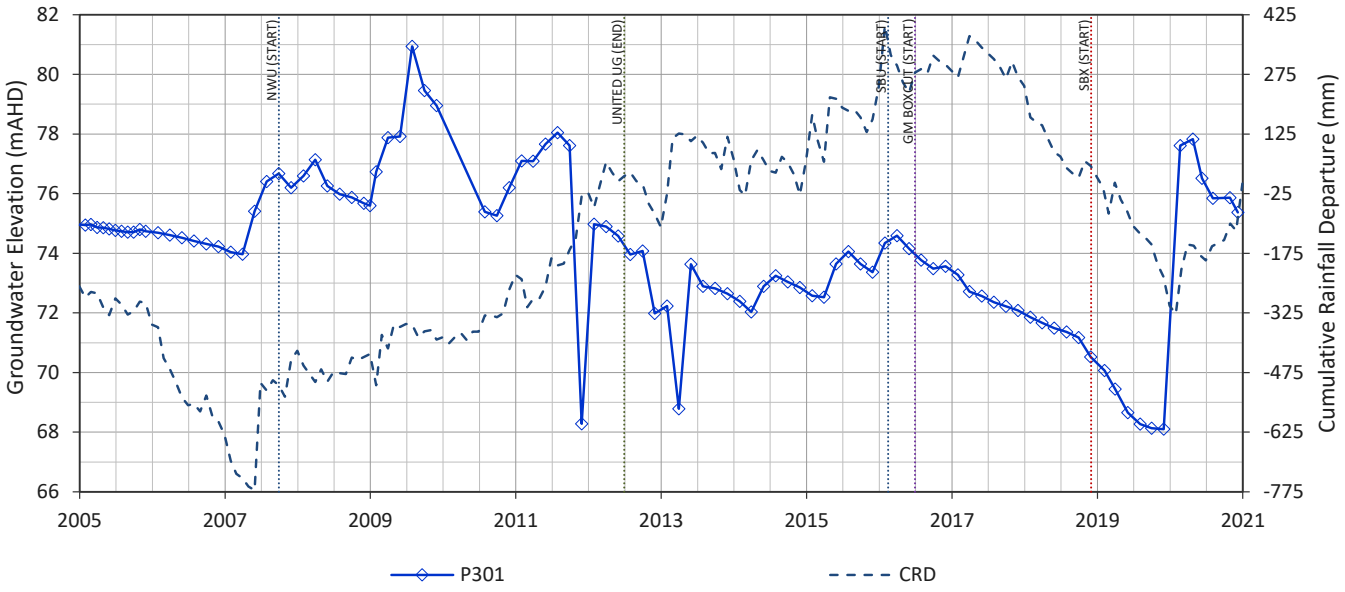
P29

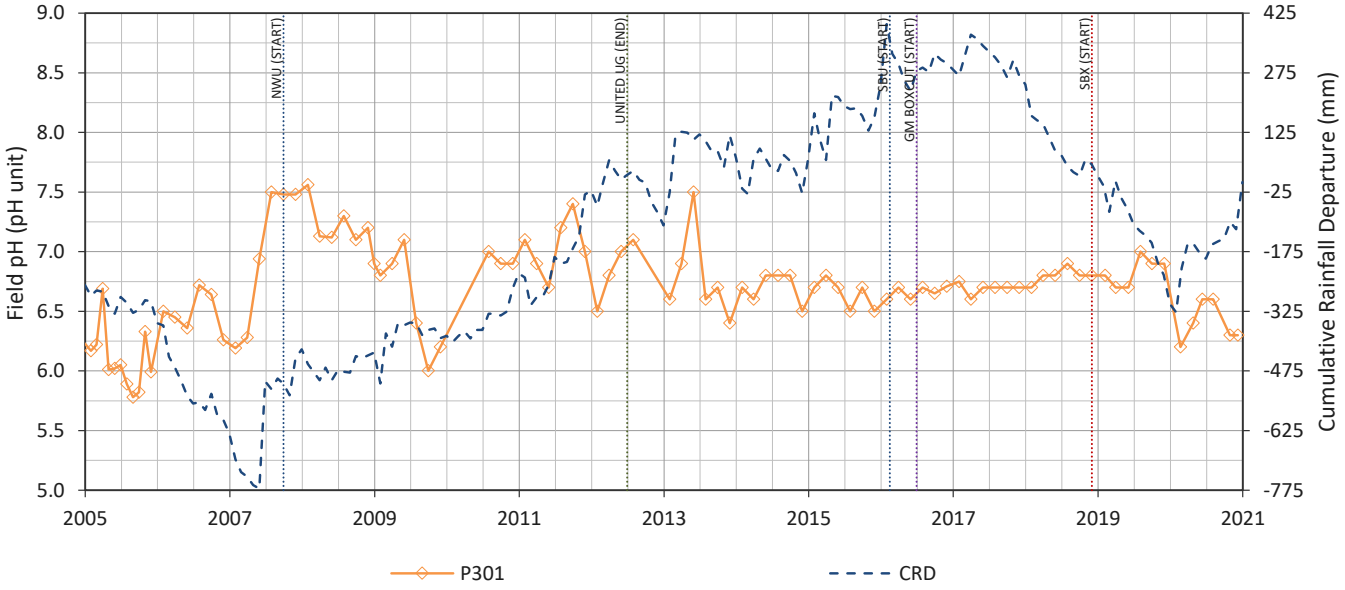

Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
P29
CRD


Field pH (pH unit)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
P29
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
P29
CRD

P301


Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOX CUT (START)
SBX (START)
P301
CRD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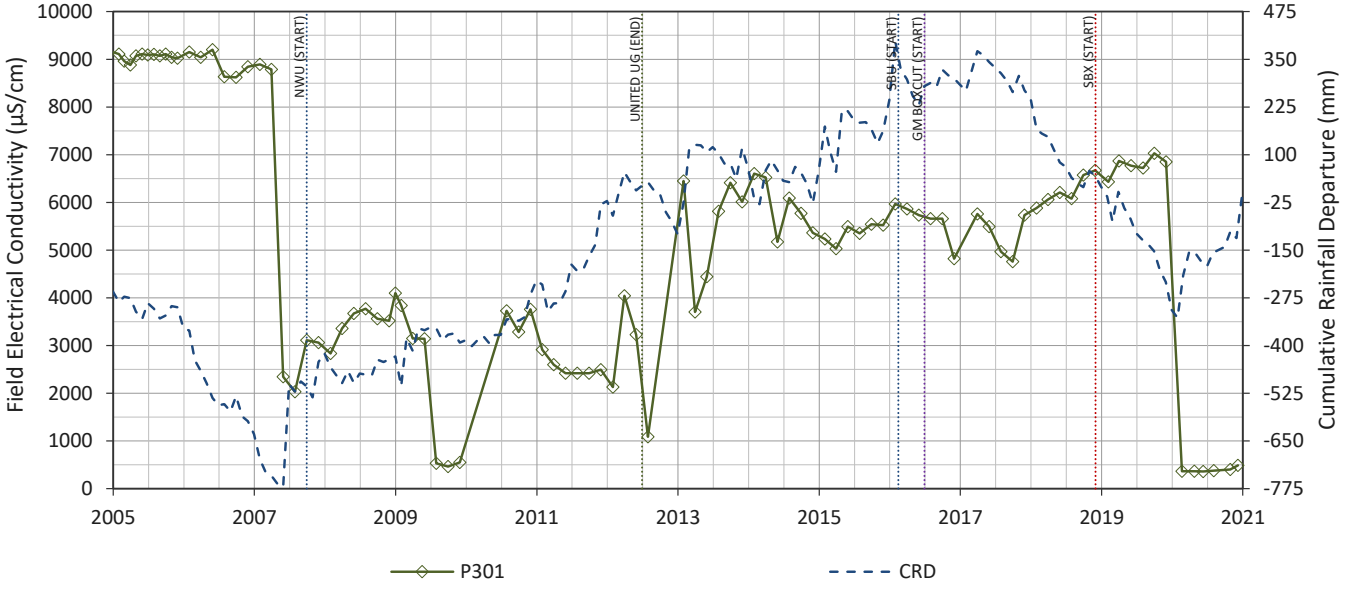
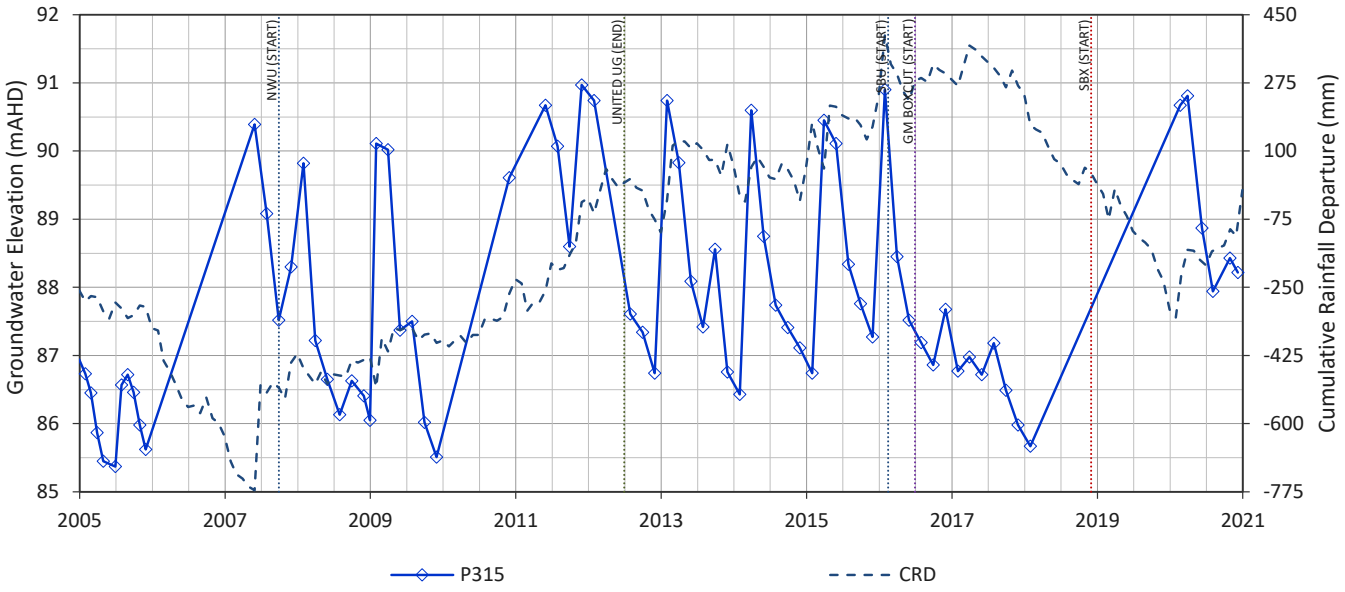
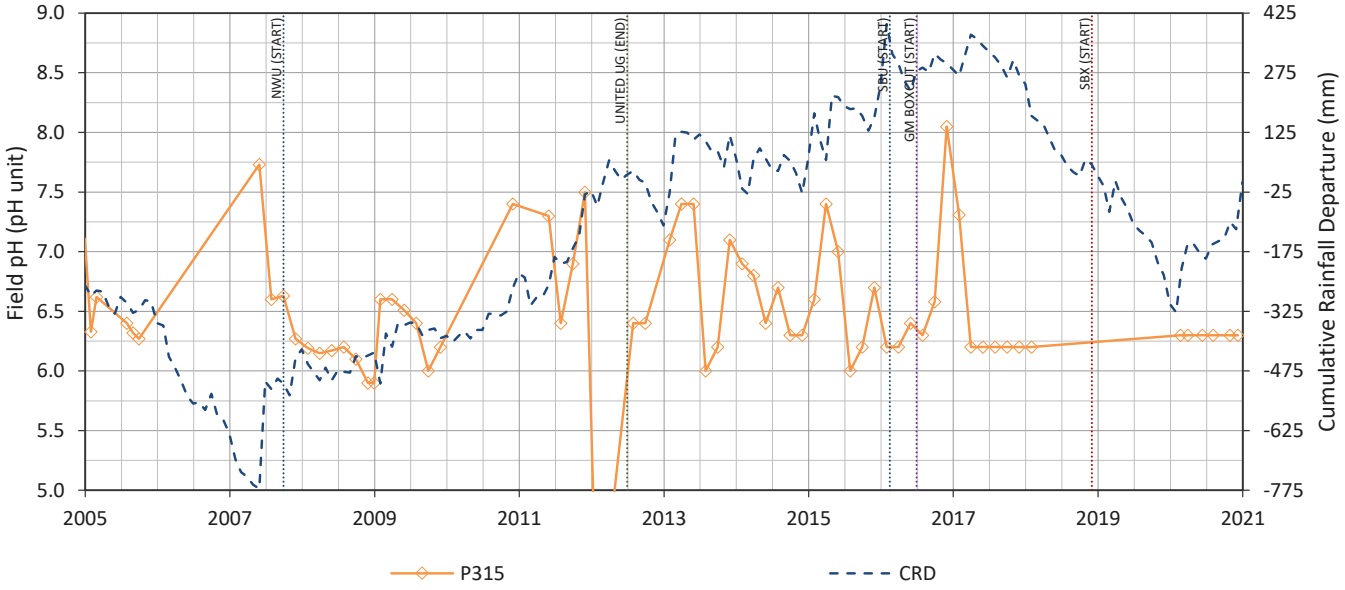
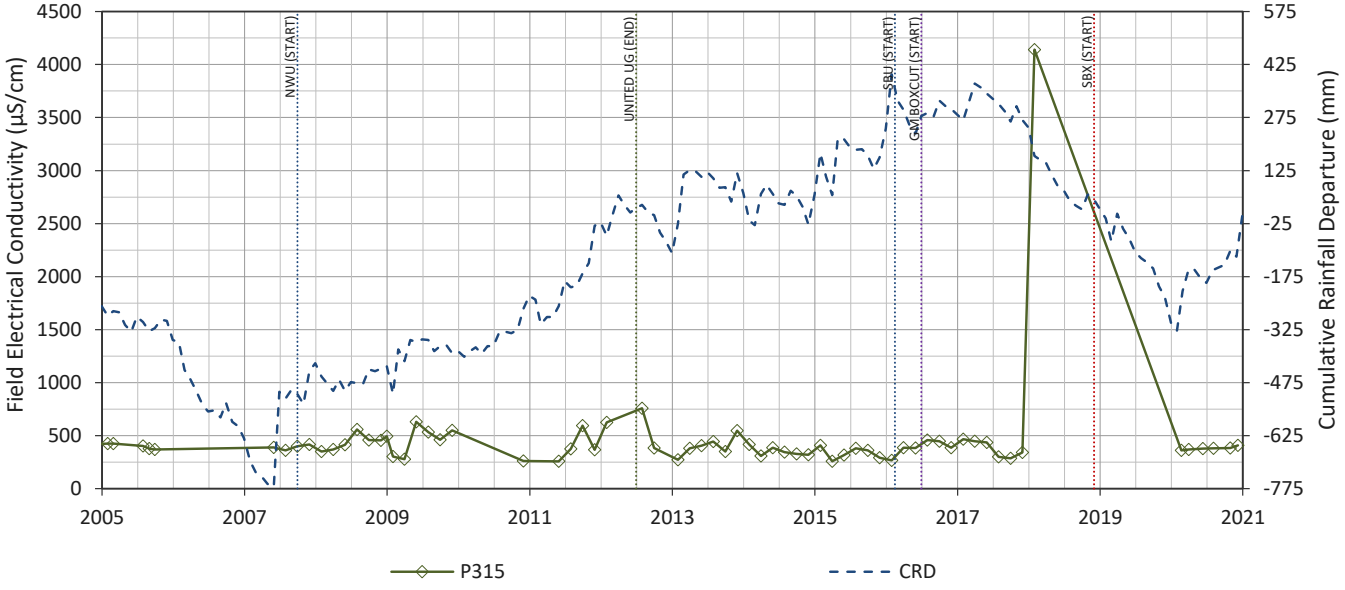
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOX CUT (START)
SBX (START)
P301
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOX CUT (START)
SBX (START)
P301
CRD

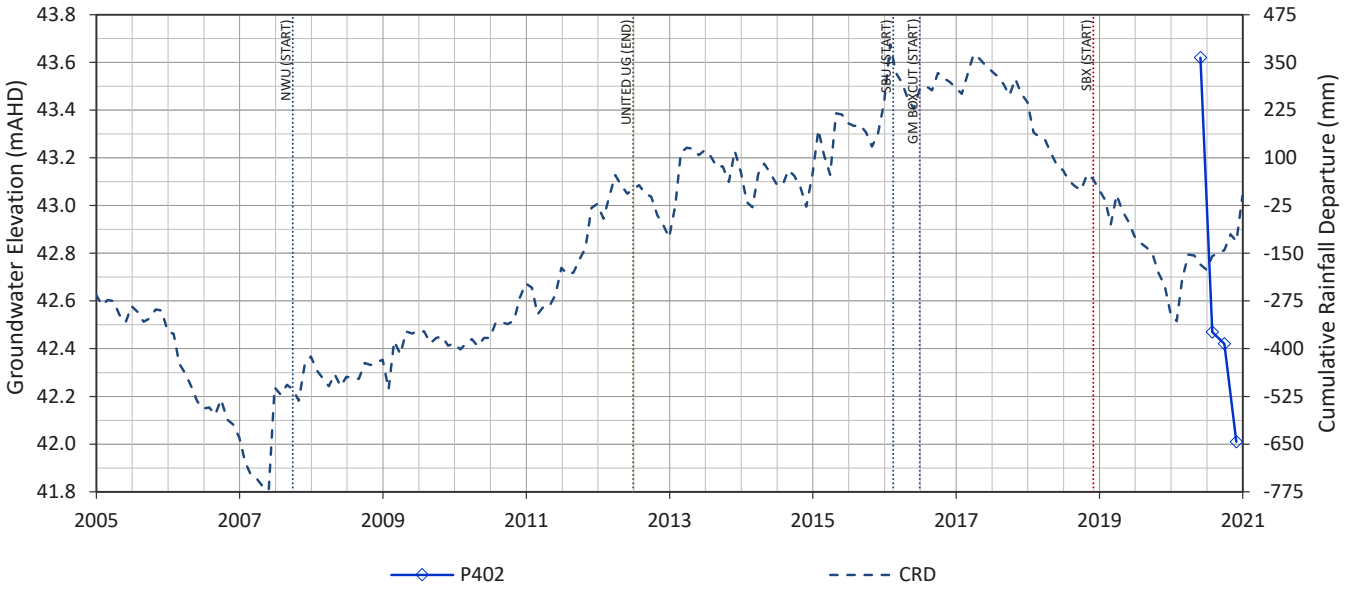
P315


Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
P315
CRD

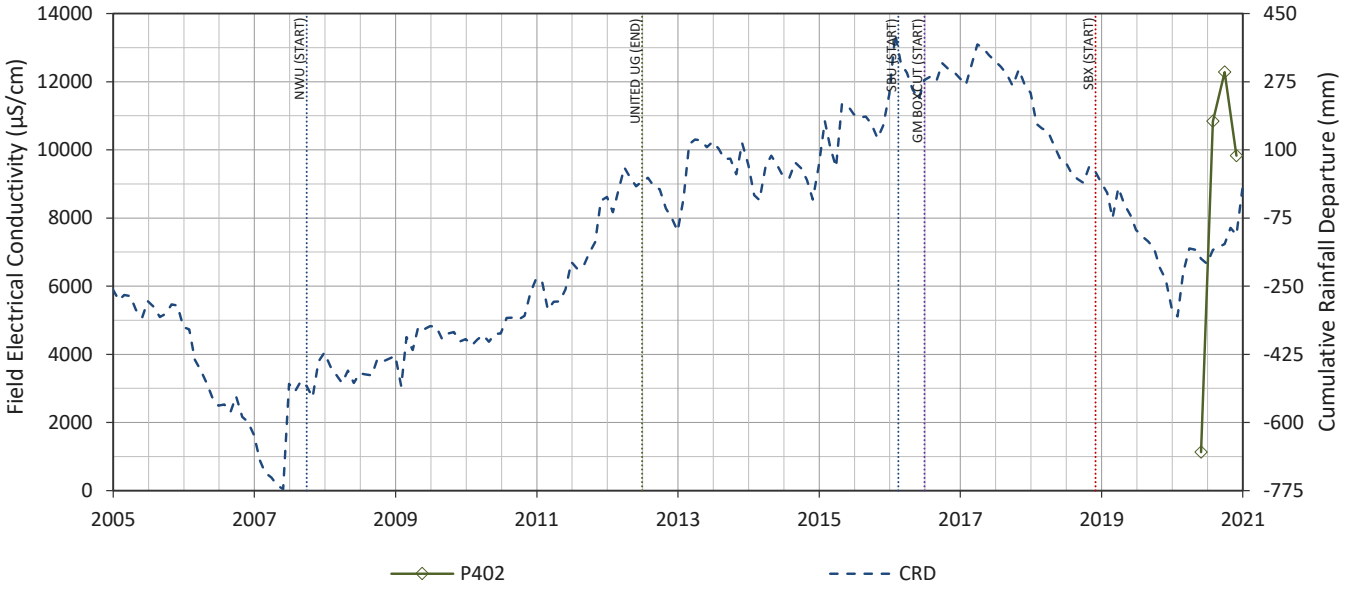

Field pH (pH unit)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
P315
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOXCUT (START)
SBX (START)
P315
CRD

P402


Groundwater Elevation (mAHD)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOX CUT (START)
SBX (START)
P402
CRD


Field pH (pH unit)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOX CUT (START)
SBX (START)
P402
CRD


Field Electrical Conductivity (µS/cm)
Cumulative Rainfall Departure (mm)
NWU (START)
UNITED UG (END)
SBU (START)
GM BOX CUT (START)
SBX (START)
P402
CRD

APPENDIX C

VWP Preliminary Data Quality Assessment

Bore ID	Easting	Northing	ground elevation (mAHD)	Sensor Depth (mBGL)	Sensor Elevation	Targeted unit	Sensor Quality Assessment	Latest download date
P33	313757	6394659	55.932	113	-57.068	Arrowfield Seam	Ok	July 2019
				58	-2.068	Blakefield Seam	Ok	
				46.5	9.432	Unnamed Seam E	Ok	
				19	36.932	Unnamed Seam D	Ok	
				13	42.932	Unnamed Seam C	Ok	
P34	313757	6393961	57.001	35	22.001	Glen Munro Seam	Sensor dry/ near-dry sine 2013	March 2019
				68.5	-11.499	Blakefield Seam	Ok	
				144	-86.999	Bowfield Seam	Ok	
P35	313611	6395196	59.887	112	-52.113	Arrowfield Seam	Poor data early, now ok.	July 2019
				60	-0.113	Blakefiled Seam	Ok	
				51	8.887	Blakefield Seam	Ok	
				19	40.887	Interburden	Sensor dry/ near-dry sine 2009	
				16	43.887	Interburden	Sensor dry/ near-dry sine 2009	
UG133	313297	6396177	62.566	45	17.566	Overburden	Unstable sensor	March 2019
				96	-33.434	Woodlands Hill Seam	ok	
				146	-83.434	Warkworth Seam	Unstable sensor to March 2013	
				168	-105.434	Mt Arthur Seam	ok	
				180	-117.434	Piercefield Seam	ok	
				208	-145.434	Vaux Seam	ok	
				219	-156.434	Under Vaux Seam	ok	
UG134	313782	6395767	61.32	45		Interburden	N/A	No data available
				116		Interburden	N/A	
				175		Warkworth Seam	N/A	
				190		Mt Arthur Seam	N/A	
				198		Piercefield Seam	N/A	

Bore ID	Easting	Northing	ground elevation (mAHD)	Sensor Depth (mBGL)	Sensor Elevation	Targeted unit	Sensor Quality Assessment	Latest download date
				215		Vaux Seam	N/A	
UG135	313831	6396748	65.31	50	15.31	Interburden	Poor quality data at all sites between August 2017 and June 2018 Recent download Ok	July 2019
				110	-44.69	Warkworth Seam		
				129	-63.69	Mt Arthur Seam		
				146	-80.69	Piercefield Seam		
				176	-110.69	Vaux Seam		
				186	-120.69	Broonie Seam		
UG136	313282	6397308	72.9	21	51.9	Glen Munro	Sensor dry all obs	July 2019
				55	17.9	Woodlands Hill	ok	
				101	-28.1	Warkworth	ok	
				133	-60.1	Mt Arthur	ok	
				167	-94.1	Piercefield	ok	
				178	-105.1	Vaux	ok	
				193	-120.1	Broonies Seams	ok	
UG138	306665	6395173	144.977	153	-8.023	Unnamed D Seam	Frequency data downloaded to March 2018 but no water level conversion since March 2016. Check installation report and calibration statistics.	March 2018
				175	-30.023	Unnamed E Seam		
				202	-57.023	Blakefield Seam		
				215	-70.023	Glen Munro Seam		
				245	-100.023	Woodlands Hill Seam		
				250	-105.023	Bowfields Seam		
				292	-147.023	Warkworth Seam		
UG139	306532	6396957	128.91	263	-134.09	Unnamed D Seam	Successful downloads to early 2020.. Review of temperature sensor data recommended to validate calculated groundwater levels.	February 2020
				281	-152.09	Unnamed E Seam		
				319	-190.09	Interburden		
				329	-200.09	Glen Munro Seam		

Bore ID	Easting	Northing	ground elevation (mAHD)	Sensor Depth (mBGL)	Sensor Elevation	Targeted unit	Sensor Quality Assessment	Latest download date
				375	-246.09	Interburden		
				382	-253.09	Arrowfield Seam		
				402	-273.09	Interburden		
UG143	311245	6397207	134.361				N/A	No data avialable
UG147	306488	6398076	108	73.5	34.5		Near dry but Ok, responds to rainfall trend	July 2019
				90.5	17.5	Glen Munro Seam	Sensor dry, all obserations	
				157	-49	Interburden	Ok Sensors reading okay, check calibration statistics to verify quality of calculated water level.	
				209	-101	Mt Arthur Seam		
				242	-134	Piercefield Seam?		
				249	-141	Vaux Seam?		
				260	-152	Broonie Seam?	no data	
UG166A	313683	6396084	141.45	130	11.45	Unnamed D Seam	Sensors Ok to 2014, only 1 data point in 2018 consistent with earlier observations. Recommend download and data verification.	May 2018
				153	-11.55	Unnamed E Seam		
				183	-41.55	Blakefield Seam		
				200	-58.55	Glen Munro Seam		
				238	-96.55	Arrowfield Seam		
				254	-112.55	Bowfield Seam		
				260	-118.55	Bowfield Seam		
UG192R	313757	6396090	58.85	210	-151.15	Siltstone/Sandstone	ok	March 2019
				170	-111.15	Sandstone	Sensor fail mid-2014	
				140	-81.15	Sand/Conglomerate	ok	
				110	-51.15	Conglomerate	ok	
				94	-35.15	Shear Zone	ok	
				60	-1.15	Sandstone	ok	

Bore ID	Easting	Northing	ground elevation (mAHD)	Sensor Depth (mBGL)	Sensor Elevation	Targeted unit	Sensor Quality Assessment	Latest download date
				30	28.85	Sandstone	Near dry	
UG193	312436	6397191	58.21	210	-151.79	Broonie Seam	Check 2016 data (8 March -21 September 2016) 210 m (Broonie Seam) sensor appears to have failed January 2018.	March 2019
			58.21	179.5	-121.29	Piercefield Seam		
			58.21	160	-101.79	Warkworth Seam		
			58.21	85	-26.79	Bowfield Seam		
			58.21	61	-2.79	Arrowfield Seam		
			58.21	27	31.21	Glen Munro Seam		
UG194	312364	6397122	81.66	220	-138.34	Vaux Seam	Sensor failed December 2015	June 2018
				190	-108.34	Interburden	Sensor failed January 2015	
				150	-68.34	Interburden	ok	
				100	-18.34	Blakefield Seam	Sensor failed July 2017	
				60	21.66	Interburden	ok	
				20	61.66	Blakefield Seam	Near dry – poor data from early 2017	
UG196	313009	6396950	81.1	230	-148.9	Broownie Seam	ok	July 2019
				160	-78.9	Mt Arthur Seam	ok	
				137	-55.9	Interburden	ok	
				110	-28.9	Interburden	ok	
				80	1.1	Arrowfield Seam	Poor data 2014-17 now appears Ok	
				45	36.1	Glen Munro Seam	ok	
UG200	313009	6396950	70.66	210	-139.34	Unknown	Ok	May 2019
				180	-109.34	BRI Coal	Possible sensor failure January 2016	
				150	-79.34	Carbonaceous Claystone	Ok	
				120	-49.34	Sandstone	Ok	
				90	-19.34	Sandstone	Ok	

Bore ID	Easting	Northing	ground elevation (mAHD)	Sensor Depth (mBGL)	Sensor Elevation	Targeted unit	Sensor Quality Assessment	Latest download date
				60	10.66	WHC Coal	Ok	
				30	40.66	Siltstone	Ok	
UG201	313087	6397025	68.78	190	-121.22	Sandstone	Ok	March 2019
				165	-96.22	Carbonaceous Siltstone	Ok	
				120	-51.22	Siltstone	Ok	
				95	-26.22	Siltstone	Ok	
				65	3.78	Coal WHC	Ok	
				24	44.78	Siltstone	Ok	
				16	52.78	Siltstone	Ok	
UG220	312522	6397233	81.98	207	-125.02	Vaux Seam	Sensor failed late 2016	June 2019
				152	-70.02	Mt Arthur Seam	Sensor failed late 2016	
				136	-54.02	Warkworth Seam	Ok	
				110	-28.02	Interburden	Sensor failed late 2016	
				106	-24.02	Interburden	Sensor failed late 2016	
				77	4.98	Arrowfield Seam	Ok	
				52.5	29.48	Overburden	Ok	
UG224	313860	6396243	58.83	197	-138.17	Vaux Seam	Possible poor-quality data from late 2015	May 2018
				172	-113.17	Interburden	Ok	
				163	-104.17	Piercefield Seam	Ok	
				105	-46.17		Ok	
				69	-10.17		Ok	
				25	33.83		Possible sensor failure May 2017	
UG225	313214	6397095	68.9	178	-109.1	Vaux Seam	Sensors Ok - Check data September 2016 to 2017	June 2019
				128	-59.1	Mt Arthur Seam		

Bore ID	Easting	Northing	ground elevation (mAHD)	Sensor Depth (mBGL)	Sensor Elevation	Targeted unit	Sensor Quality Assessment	Latest download date
				100	-31.1	Interburden		
				93.2	-24.3	Bowfield		
				58.5	10.4	Arrowfield		
				23	45.9	Overburden	Near dry but responsive to rainfall	

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APPENDIX 4 – REHABILITATION FIGURE (MOP Plan)

306000
308000
310000
312000
314000
6398000
6396000
6394000
M.G.A.
ML 1572
ML 1594
CL 374
CL 397
CCL 775
CCL 743
ML 1402
EL 8456
A
A'
B
B'
0 200 400 600 800 1000
metres

LEGEND:

- Project Approval Area
- Area of Disturbance
- Phase 1 RMP Boundary
- Phase 2 RMP Boundary
- Tenements
- Section Locations
- United Underground

PRIMARY DOMAINS

- Infrastructure
- Reject and Tailings Emplacement
- Topsoil Stockpiles
- Water Management
- Overburden Emplacement
- Active Mining
- Access and Haul Roads
- Proposed Powerline corridors
- Future Mining
- New Rehabilitation
- Offset Area

SECONDARY DOMAINS

- Rehabilitation Area - United Ecosystem and Landuse Establishment

Note: Aerial Photo NearMap May 2020

GLENCORE
United Wambo Joint Venture
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Unless stated otherwise:
- All dimensions are in metres
- Coordinates shown are MGA Zone 56
- Levels are in metres on AHD.

UNITED WAMBO JOINT VENTURE
REHABILITATION MANAGEMENT PLAN
REHABILITATION AT COMMENCEMENT - PLAN 4

DRAFT

SCALE : 1:8250 @ A0	DRAWN : LF
DATE : 17/08/2020	CHECKED :
DWG No. : PLAN 4	

APPENDIX 5 – DPIE Feedback

DPIE Requirement	How and where items have been addressed
1. Schedule 2, Condition E11(c) requires the Annual Review to report on the progress of implementing reasonable and feasible diesel emissions reduction measures for the Project. The Annual Review must be updated to report on progress of all measures identified within Section 11.4 of the Air Quality and Greenhouse Gas Management Plan.	Table 6-12 added into Section 6.4.2.
2. Condition E11(d)(i) of SSD-7142 requires a comprehensive review of relevant statutory requirements, limits or performance measures/criteria. The Annual Review must be updated to report:	
a. a comparison of monitoring results against Environmental Protection Licence (EPL) limits for waste, noise, or blasting.	Noise is compared to EPL limits in 6.2.3.1, Blasting is compared to limits in 6.3.1 and 6.3.2. There are no waste limits in EPL3141
b. Compliance with water performance measures in Condition B49 of SSD-7142.	Have added in Section 6.8.5 to address this
c. Monitoring locations are not adequately shown on Figure 9 within Section 6. The labelling for some monitoring locations has not been displayed.	Figure split into two to allow for all labels to be clearly shown.
3. Condition E11(d)(ii) of SSD-7142 requires the Annual Review to report on the requirements of any plan or program required under this consent. The Annual Review must be updated to report on:	
a. Fuel consumption and any re-calculation and assessment of any change in PM2.5 emissions from baseline (Section 11.5 of the Air Quality and Greenhouse Gas Management Plan)	Clarification has been added to Section 6.4.7
b. Section 15.1.1 of the Blast Management Plan states that reporting of compliance with SSD-7142 and EPL 3141 conditions and any required modifications to the blast monitoring. The Annual Review must report on all monitoring locations in SSD-7142 and the EPL.	Updated Table 6-11 in Section 6.3 to summarise all results
c. Section 12.5 of the Blast Management Plan states that progress on the fume monitoring trial will be reported in the Annual Review.	Section 6.3.5 added to reflect work commencing in 2021
d. The water monitoring section does not clearly report on the requirements of the Surface Water Management Plan. The water monitoring section is not clearly written and must be updated, including addressing the following points:	
i. the purpose of the surface water quality monitoring program is not clearly described, particularly given the site does not have licenced discharge points.	Context added to Section 6.8.1

ii. Section 6.8.3 describes surface water criteria, however Table 37 does not indicate if the criteria are for maximum values, as indicated later in Section 6.8.4.2.	Footnote added to explain the criteria which is a maximum value.
iii. Provide a clear description why surface water quality criteria only apply at 4 sites when monitoring is reported at 25 sites.	Wording added. While sampling occurs at additional points onsite, those listed in Table 6-27 are the only offsite locations monitored and are therefore reflective of environmental impacts. All other locations are onsite dams used for early indications of changes and are not reflective of environmental impacts.
iv. The purpose of monitoring site water dams is not reported in Section 6.8.4.2.	The following text was added to the relevant section: Note analysis of monitoring data occurs for the offsite locations listed in Table 6-27 (WB04, NWC03, RC01 and WFC01). Data from all other monitoring locations including storage dams and pits is used for operational purposes and is reported internally and is therefore not analysed in this document.
v. The description of water quality monitoring comparison to criteria in Section 6.8.4.2 appears to be comparing average values to maximum criteria and must be clarified.	The analysis of data is comparing the against the ranges in criteria. The average result has only been used on occasion as a gauge of where most results fell. Note a minor tweak to the analysis of RC01 was completed to make it flow better with the way NWC03 was worded.
vi. Section 6.8.4.2 does not describe how many samples were collected during the reporting year.	Surface water sample count has been added to Table 6-32.
b. Watercourse Stability Monitoring as identified in Section 11.1.2 of the Surface Water Management Plan.	Added Section 6.8.4.3 to discuss the monitoring undertaken in 2020.
4. Schedule 2, Condition B40 of SSD-7142 requires a report on water extracted from the site each year (direct and indirect) in the Annual Review, including water taken under each water licence. Section 6.8.7 Table 48 incorrectly reports the site water balance in compliance with Condition B40.	Updated Water Balance section to clarify that the volumes are annual averages from the balance model update. Added in Table 6-40 to show water take as required by Condition B40
5. Condition B91 of SSD-7142 requires the Annual Review to monitor and report on the effectiveness of the waste minimisation and management measures. The Annual Review must be updated in compliance with Condition B91.	Waste management measures added into Section 6.7.2
6. Section 6.7.1 reports on the demolition of the CHPP and associated infrastructure. In accordance with the Departments *Annual Review Guideline* (2015), the Annual Review must describe any renovation or removal of buildings.	Renovation and removal of buildings is described in Section 4.2. A reference has been made to Section 4.2 within Section 6.7.1.

7. Section 9 reports that the Independent Environmental Audit (IEA) was conducted during the reporting period. In accordance with the *Departments Annual Review Guideline* (2015), the Annual Review must outline the key audit outcomes, discuss progress made in implementing the action plan and identify when the next Independent Audit is scheduled.	Wording added to explain the audit findings were not available until the 24 March a few days prior to the Annual Review being submitted. The Audit findings will be included in the 2021 Annual Review.
a. Further the IEA report identified the blast non-compliance associated with the transmission towers as a moderate risk. Section 10.1 reports the incident as a low risk. The discrepancy must be clarified.	Section 10.1 updated
b. The Annual Review does not report on other incidents and non-compliances (e.g. HVAS monitoring failures) identified during the IEA.	Section 1 and 10.2 updated
6. In accordance with the Departments *Annual Review Guideline* (2015), the Annual Review must identify any action resulting from a condition of a relevant approval that will be triggered in the next reporting period.	Additional actions added into Table 11-1
7. Section 6.9.9 reports on Groundwater Dependent Ecosystem monitoring recommends installation of an additional shallow bore near Redbank Creek. Please confirm in the Annual Review if this monitoring bore will be implemented as a proposed action or if not, describe why.	Added commitment to investigate location and approvals for recommended bore
8. A number of minor typographical errors have been identified:	
a. Table 6 incorrectly identifies that Condition E11(a) is addressed in Section 7 only. Operations summary is also provided in Section 4.	Addressed
b. Table 6 incorrectly identifies that Condition E11(b) is addressed in Section 7.	Addressed
c. Section 6.3.2 includes a typo – “Error reference source not found”.	Addressed
d. Section 6.9.1 is used for three section headings, and needs to be corrected where the section should be 6.9.10 and 6.9.11.	Addressed