HUNTER VALLEY OPERATIONS

2019 Annual Environmental Review

Name of Operations	Hunter Valley Operations
Name of Operator	HV Operations Pty Ltd
Development consent /project approval	DA 450-10-2003 / PA 06_0261
Name of holder of development consent/project approval	HV Operations Pty Ltd
Mining Lease Number	Contained within Table 6 of this report
Name of Mining Lease Holder	Contained within Table 6 of this report
Water Licence Number	Contained within Table 8 of this report
Name of Water Licence Holder	Contained within Table 8 of this report
MOP/RMP Start Date	HVO North – 26 February 2019 HVO South – 25 July 2018
MOP/RMP End Date	HVO North – 30 July 2020 HVO South – 30 July 2023
Annual Review Start Date	01/01/2019
Annual Review End Date	31/12/2019

I, *Tony Galvin*, certify that this audit report is a true and accurate record of the compliance status of Hunter Valley Operations for the period 1st January 2019 to 31st December 2019 and that I am authorised to make this statement on behalf of Hunter Valley Operations.

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 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 the 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	Tony Galvin
Title of Authorised Reporting Officer	General Manager – Hunter Valley Operations
Signature of Authorised Reporting Officer	
Date	31 March 2020

Executive Summary

This Annual Environmental Review (Annual Review) reports on the environmental performance of Hunter Valley Operations (HVO) during the 2019 calendar year and satisfies the requirements of HVO's Development Consents and Mining Leases. The structure of the 2019 Annual Review intends to align with the NSW Government *Post-approval requirements for State significant mining developments – Annual Review GUIDELINE* (October 2015).

HVO extracted 19.19 million tonnes of run-of-mine (ROM) coal during 2019 against an approval ROM extraction rate of 42 million tonnes per annum (mtpa). The Coal Handling Preparation Plants (CHPPs) produced 13.59 million tonnes of saleable coal during 2019.

Noise

There were no noise related non-compliances recorded against HVO's development consent limits. One exceedance of noise criteria was measured at Maison Dieu during May 2019, this exceedance was found to be compliant in accordance with the Noise Management Plan as follow up measurements resulted in noise levels below the relevant criteria.

HVO implemented the revised Noise Management Plan which was approved in February 2019. HVO received and responded to 1456 noise alarms, recording a total of 639 hours of equipment stoppage due to noise management.

To reduce noise output from mobile equipment HVO continued to retrofit sound attenuation packages to the existing haul truck fleet. A further 8 haul trucks were retrofitted, resulting in 94% of the haul truck fleet now being sound attenuated.

Blasting

A total of 221 blast events were initiated at HVO, 140 from HVO South and 81 from HVO North. HVO complied with all blasting related consent and licence criteria with the exception of one blast on 28 May 2019 in the HVO South area which exceeded the Airblast Overpressure criteria at Maison Dieu. This result was independently reviewed by two separate blasting experts which deemed the results to be an anomaly due to a potential influence of a local source and/or wind. The Department of Planning, Infrastructure and Environment (DPIE) issued HVO with a Warning Letter. HVO reviewed the monitoring location and will relocate this monitor to remove any potential influence on the results during 2020.

HVO employs a blast fume management protocol to mitigate generation of post blast fume emissions. Four blasts were ranked as producing Category 3 fume emissions but remained on site, there were not Category 4 or 5 fume events.

An additional non-compliance from 2017 was identified and reported to DPIE. A review of historic blasting data found that HVO had undertaken blasting on a gazetted public holiday (Easter Saturday) without written regulatory approval. HVO has since implemented additional controls to prevent a reoccurrence.

Air Quality

An unprecedented number of days in 2019 were deemed to have been effected by extraordinary events. Air Quality was influenced by a combination of ongoing drought conditions, State wide dust storms, regional dust events and smoke from bushfires which significantly affected the Hunter Valley between October 2019 and December 2019. During this period 58 exceedances of the short term (24 hour) PM_{10} criteria were measured across the HVO monitoring network. Each of these exceedances were reported to DPIE and were noted to have been affected by an extraordinary event and therefore, as per the consent conditions, the criteria was not deemed to be applicable. These events also contributed to exceedances of the long term (annual average) criteria in some instances, however annual averages have been adjusted to exclude these events as per consent conditions. Despite these events, HVO continued to implement operational controls to manage dust emissions in accordance with its Air Quality Management Plan. HVO recorded 7,206 hrs of operational downtime to manage dust in response to real time monitoring alerts and visual inspections. HVO also implemented additional dust management measures including the use of haul road dust suppressant product in HVO West Pit, the use of on bench irrigator to assist with managing dust of blasted material, installation of an additional four monitoring cameras dedicated to dust monitoring and continued upgrade of the CHPP dust suppression system.

Additional exceedances were recorded when extraordinary events were not declared. These include:

- Exceedance of the Total Suspended Particulate (TSP) long term (annual average) impact assessment criteria were recorded at Kilburnie South, Knodlers Lane and Maison Dieu monitoring locations.
- Exceedance of the Long Term (annual average) PM_{10} criteria.at Maison Dieu, Kilburnie South and the Hunter Valley Gliding Club monitoring locations
- Exceedance of the short term (24 hour average) PM_{10} criteria, one at Kilburnie South on 11 September 2019 and one at Jerrys Plains on 13 September 2019.
- Exceedance of the long term (annual average) dust deposition rate at D118, DL30 and Warkworth monitoring locations (however they did not exceed the incremental deposition rate criteria).

Each of these exceedances were investigated by an Air Quality Specialist to determine the level of contribution from HVO activities in accordance with the compliance protocol outlined in the HVO Air Quality Management Plan. The investigation determined that the contributions from HVO (either North, South or Both) in all cases was not the significant cause of the exceedance and therefore considered compliant.

A revised Air Quality and Greenhouse Gas Management Plan was implemented in 2019 which saw a change in monitoring methods used for determining compliance. This change saw the replacement of PM_{10} High Volume Air Samplers (operating every 6 days) with PM_{10} real time TEOM monitors (operating continuously) at Maison Dieu, Knodlers Lane, Warkworth and Wandewoi. HVO also introduced the Jerrys Plains Monitoring location. The change in monitoring methodology significantly increased the number of samples being collected and assessed for compliance compared to previous years.

Following approval of the Air Quality and Greenhouse Gas Management Plan on 6 September 2019, HVO installed $PM_{2.5}$ monitoring at Kilburnie South and Maison Dieu.

Heritage

Under the provisions of both the HVO South and HVO North Aboriginal Cultural Heritage Management Plans (ACHMP), three field based due diligence assessments where undertaken at various locations across HVO and the Mitchelhill Biodiversity Area. Three Aboriginal sites/areas were identified during the assessment at the Mitchelhill Biodiversity Area which were surveyed and pegged, no artefacts or sites were identified during the other assessments.

Stage 2 of the Mitchell Pit salvage program commenced. The salvage program involved teams from Registered Aboriginal Parties (RAPs) resulting in the salvage and mitigation of 284 AHIMS registered Aboriginal heritage sites.

Two compliance inspections were conducted under the provision of the HVO South ACHMP and one inspection was conducted under the HVO North HMP. The inspections found that all sites have been managed in conformance with the ACHMP/HMP requirements. Additional sites were recorded and sites requiring maintenance and upgrades to site barricading and fencing were identified, with upgrade and maintenance work to be implemented in 2020.

Two non-indigenous historic sites, the ‘dog leg fence’ and a remnant ‘timber bridge’ adjacent to the Golden Highway were the subject of a Significance Assessment during 2019. The assessment found that the fence has local historical significance and is of potential State significance for its representativeness and degree of rarity. A program of works will be developed during 2020 for the ongoing management of these sites.

Water

HVO impounded minimal water from surface runoff due to ongoing dry conditions. As a result HVO continued to increase its abstraction of water from the Hunter River (under licence) to supplement its raw water requirements for coal washing and dust suppression. A total of 4,654 ML water was pumped from the River during 2019.

Two water related non-compliances were recorded, both relating to discharge of turbid water to Farrells Creek following rain events on 18 and 30 March 2019. Both incidents were investigated by regulatory authorities. For the incident on 18 March, HVO has entered into an Enforceable Undertaking with the EPA and has also received a Penalty Notice and an Official Caution from the Resource Regulator. For the incident on 30 March HVO received a Warning Letter from DPIE.

HVO undertook a review of the water management network and developed a proposed program to upgrade water containment. The review forms part of a Pollution Reduction Program (PRP) identified in the HVO Environment Protection Licence (EPL) to address the improvements required. Implementation of this program will commence in 2020.

HVO undertook studies during 2019 in accordance with its Pollution Reduction Program relating to Seepage from the North Void Tailings Storage Facility. This included development of a detailed groundwater model and an assessment of potential remedial options. Analysis of groundwater monitoring results has indicated that current management practices are effective in minimising seepage from the Facility.

Rehabilitation and Land Management

Rehabilitation at HVO is undertaken in accordance with commitments made in the various Mining Operations Plans (MOPs) covering the site: Hunter Valley Operations North MOP (includes Newdell CHPP and Hunter Valley Load Point) and Hunter Valley Operations South MOP.

A total of 88.3 ha rehabilitation was undertaken during 2019.

HVO has committed to a detailed work plan in response to rehabilitation monitoring and subsequent engagement with Resources Regulator arising from Section 240 Notices received during 2018 and 2019. The plan is particularly focussed upon native vegetation establishment on historic cover crop areas, and protection of these and existing areas from existing and emergent week threats while vegetation establishes.

On 5 June 2019 Resources Regulator undertook an audit to assess operational performance of HVO South in relation to the management of topsoil and the implementation of management systems and controls to provide for the sustainable management of the mine's topsoil resources.

The audit assessed compliance for the previous 12 months commencing 5 June 2018 with reference to approved Mining Operations Plan, associated management plans and site procedures. The audit included desktop document review, site inspections and interviews with site personnel and identified one non-conformance and made five observations. HVO will finalise a Topsoil Management Plan during 2020 which will formalise revised and updated operational controls to be used to manage the topsoil resources at site.

As part of HVO's Vertebrate Pest Action Plan a number of baiting programmes are carried out on a seasonal basis. These programmes are conducted at a level of frequency designed to disrupt pest species breeding/colonisation cycles and employ a variety of methodologies including baiting, trapping and ground based shooting.

A total of 107 days of weed control work was undertaken on site at HVO during 2019, with approximately 211 ha of land treated, including River Red Gum areas and maintenance of 90 environmental monitoring points.

Biodiversity Management.

Various management activities were undertaken at the Goulburn River Biodiversity area throughout 2019 in accordance with the approved management plan. Activities in weed control, infrastructure inspections, and vertebrate pest management programs.

Independent Environmental Audit

An Independent Environmental Audit (IEA) was undertaken in December 2019. This audit was undertaken against the conditions of both Project Approval PA06-0261 and DA 450-10-2003. The audit identified 28 non-compliances, one was identified as a moderate risk, 15 were administrative in nature and 12 findings were considered to be low risk. The audit report and HVO's response to the auditors' recommendations were submitted to the Department for their consideration on 24 February 2020. At the time of publishing this Annual Review the findings of the audit are still to be finalised with DPIE.

Table of Contents

Figures

Tables

Appendices

Appendix A – 2019 Annual Groundwater Report

Appendix B – HVO S240 Rehabilitation Maintenance Schedule

Appendix C – 2019 Heritage Complaince Inspection Audits

1 Statement of Compliance

Table 1 is a Statement of compliance against the relevant approvals. Table 2 provides a brief summary of the non-compliances against development consents and a reference to where these are addressed within this Annual Review. Table 3 shows the compliance status descriptions relating to Table 2.

Table 1 Statement of Compliance

Were all conditions of the relevant approvals complied with?	
PA 06_02161 (HVO South)	No
DA 450-10-2003 (HVO North)	No

Table 2 Non-compliances

Relevant Approval	Condition Number	Condition Description	Compliance Status	Where addressed in Annual Review
DA450-10-2003	SOC Ref. 22	Annual Visual Assessments 2016-2019	Non-compliant (Administrative)	Section 11.5
PA06_0261	Schedule 3 Condition 23	Missed HVAS sample 25/4/2019	Non-Compliant (low)	Section 11.4.1
PA06_0261	Schedule 3 Condition 7	Overpressure exceedance 28/05/2019	Non-Compliant (low)	Section 11.1.1
PA06_0261	Schedule 3 Condition 10	Blasting Hours 15/04/2017 (Reported 1/07/2019)	Non-Compliant (low)	Section 11.1.2
PA06_0261	Append 4 Condition A4	Tonal Noise Assessments 2016-2019	Non-Compliant (low)	Section 11.3.2
DA450-10-2003	Append 4 Condition A4	Tonal Noise Assessments 2016-2019	Non-Compliant (low)	Section 11.3.2
DA450-10-2003	Schedule 3 Condition 20	Offsite water discharge 18/03/2019	Non-Compliant (medium)	Section 11.2.1
DA450-10-2003	Schedule 3 Condition 20	Offsite water discharge 30/03/2019	Non-Compliant (medium)	Section 11.2.2
PA06_0261	Schedule 3 Condition 22	Dust management 21/08/2019	Non-Compliant (medium)	Section 11.4.2

Table 3 Compliance Status Key for Table 2

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 unlikely 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 unlikely to occur
Administrative Non-compliance	Non-compliant	Only to be applied where the non-compliance does not result in any risk of environmental harm (e.g. submitting a report to government later than required under approval conditions)

2 Introduction

2.1 Document Purpose

This Annual Review is written to satisfy the requirements of the Hunter Valley Operations (HVO) Development Consents and conditions of mining leases for events which occurred during the 2019 calendar year. The Annual Review has been written in accordance with the NSW Government Post-approval requirements for State significant mining developments – Annual Review Guideline (October 2015).

This report is distributed to:

- NSW Department of Planning, Industry and Environment (DPI&E);
- NSW Resource Regulator;
- Natural Resource Access Regulator (NRAR);
- Singleton Council;
- Muswellbrook Shire Council; and
- HVO Community Consultative Committee (CCC).

2.2 Background

HVO is situated in the Upper Hunter Valley between Singleton and Muswellbrook, approximately 24 km northwest of Singleton, and approximately 100 km northwest of Newcastle. The Hunter River geographically divides HVO into HVO North and HVO South; however they are integrated operationally with personnel, equipment and materials utilised as required. This improves operational efficiency, rationalisation of infrastructure and resource utilisation.

HVO is a jointly controlled operation through a Joint Venture between Glencore (49%) and Yancoal (51%).

The regional context and layout of the HVO pits and facilities are shown in Figure 1 and Figure 2 respectively.

.

2.3 Mine Contacts

Key mine contacts are listed in Table 4.

Table 4 Mine Contacts

Contact	Role	Phone	Email
Tony Galvin	General Manager	02 6570 0228	tony.galvin@hvo.com.au
Phillip Price	Operations Manager	02 6570 0086	Philip.price@hvo.com.au
Andrew Speechly	Environment & Community Manager	02 6570 0497	andrew.speechly@hvo.com.au

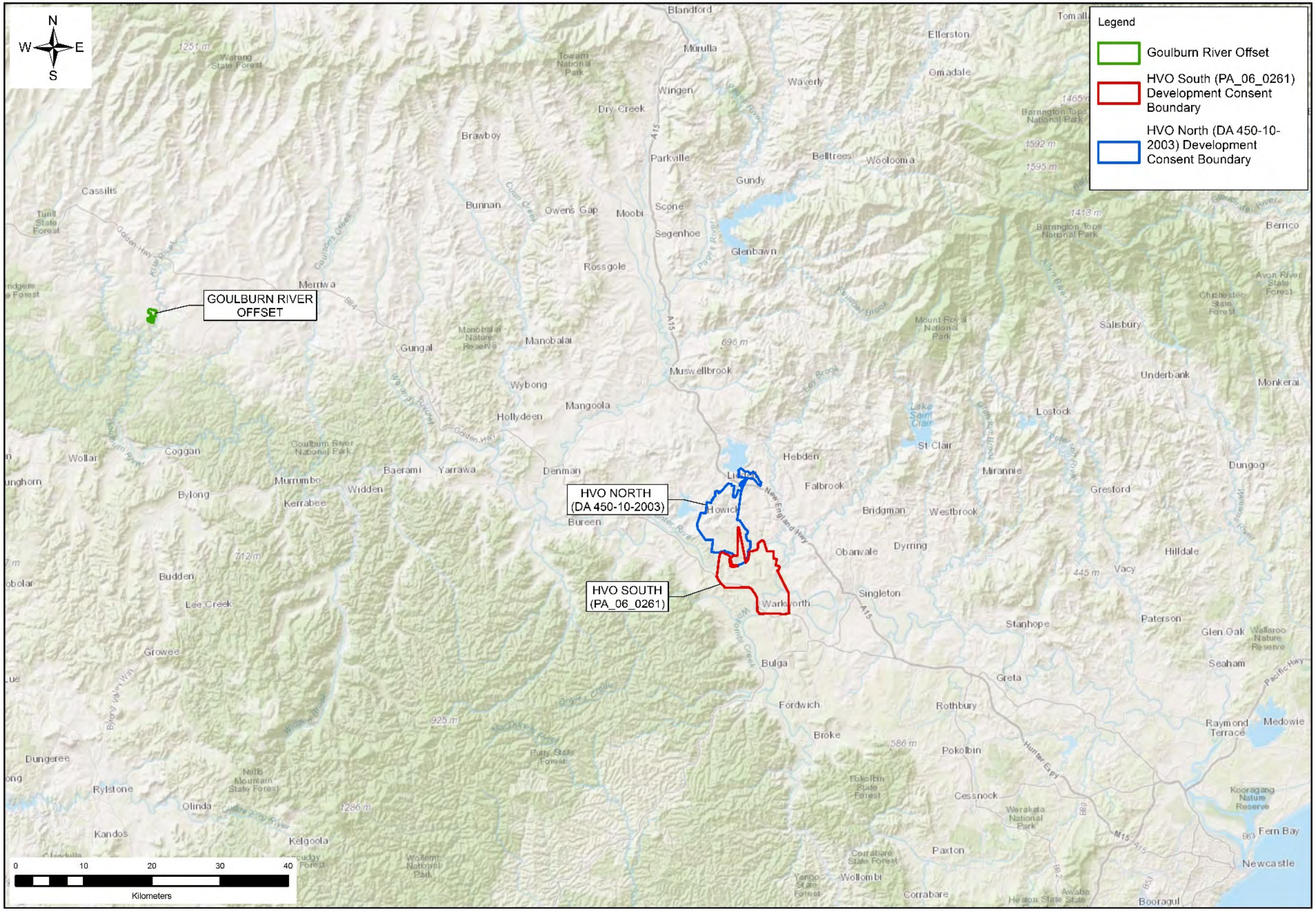


Figure 1 Regional Context

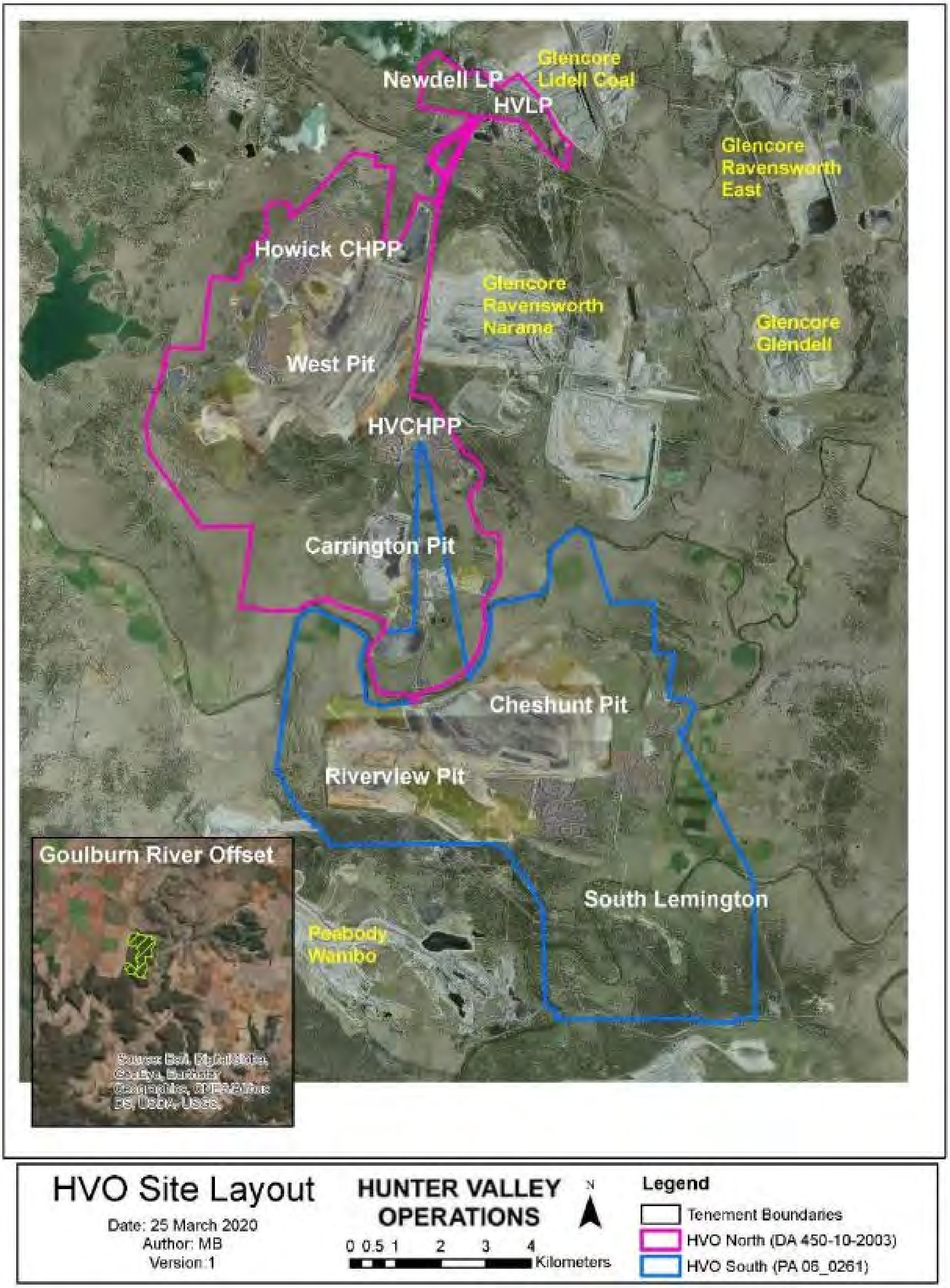


Figure 2 Hunter Valley Operations – Site Layout

3 Approvals

3.1 Approvals, Leases and Licences

3.1.1 Current Approvals

The status of HVO development consents, licenses and relevant approvals are listed in the following tables:

- Table 5: HVO Major Approvals;
- Table 6: Summary of Mining Tenements;
- Table 7: HVO Leases and Permits;
- Table 8: Water Related Approvals; and
- Table 9: Water Access Licence.

Table 5 HVO Major Approvals

Approval Number	Description	Issue Date	Expiry Date
HVO North DA 450-10-2003 MOD 7	HVO West Pit Extension & Minor Modifications (2003); and associated modifications. MOD 7 approved July 2017. Covers West Pit (approved production limit of 12mtpa), Carrington Pit (approved production limit of 10mtpa), HVCHPP (approved processing limit of 20mtpa) and WCHPP (approved processing limit of 6mtpa).	28/07/2017	12/06/2025
HVO South PA 06_0261 MOD 5	Hunter Valley Operations – South Coal Project & associated modifications MOD 5 approved February 2018 The modification covered: - the progression of mining to the base of the Bayswater seam from Cheshunt Pit into Riverview Pit, and to the base of the Vaux seam in South Lemington Pit 2. - increased overburden emplacement height in some areas to 240m AHD and incorporation of micro-relief - extraction rate increase from 16Mpta to 20Mtpa of ROM coal at peak production and increased processing rate from 16Mpta to 20Mtpa of ROM coal across HVO coal preparation plants. The modification also involved changes to the Statement of Commitments.	28/02/2018	24/03/2030
EPBC 2016/7640	Hunter Valley Operations – State approved mining Hunter Valley NSW	10/10/2016	31/12/2030

Table 6 Summary of Mining Tenements

Title	Mining Tenement	Titleholder	Purpose	Grant Date	Expiry Date	Status
AUTH 72	Authorisation	Coal & Allied Pty Ltd and Anotero Pty Ltd	Prospecting	08/03/1977	24/03/2018	Renewal Pending
EL 5291	Exploration Licence	Coal & Allied Pty Ltd and Anotero Pty Ltd	Prospecting	28/04/1997	28/04/2018	Renewal Pending
EL 5292	Exploration Licence	Coal & Allied Pty Ltd and Anotero Pty Ltd	Prospecting	28/04/1997	28/04/2020	Granted
EL 5417	Exploration Licence	Coal & Allied Pty Ltd and Anotero Pty Ltd	Prospecting	23/12/1997	08/05/2018	Renewal Pending
EL 5418	Exploration Licence	Coal & Allied Pty Ltd and Anotero Pty Ltd	Prospecting	23/12/1997	08/05/2017	Renewal Pending
EL 5606	Exploration Licence	Coal & Allied Pty Ltd and Anotero Pty Ltd	Prospecting	11/08/1999	10/08/2019	Renewal Pending
EL 8175	Exploration Licence	Coal & Allied Pty Ltd and Anotero Pty Ltd	Prospecting	23/09/2013	22/09/2018	Renewal Pending
EL 8821	Exploration Licence	Coal & Allied Pty Ltd and Anotero Pty Ltd	Prospecting	13/02/2019	13/02/2025	Granted
(Part) CCL 708	Sub lease	Liddell Tenements Pty Ltd	Prospecting and Mining Coal	17/05/1990	29/12/2023	Granted
CCL 714	Consolidated Coal Lease	Coal & Allied Pty Ltd and Anotero Pty Ltd	Prospecting and Mining Coal	23/05/1990	30/08/2030	Granted
CCL 755	Consolidated Coal Lease	Coal & Allied Pty Ltd and Anotero Pty Ltd	Prospecting and Mining Coal	24/01/1990	05/03/2030	Granted
CL 327	Coal Lease	Coal & Allied Pty Ltd and Anotero Pty Ltd	Prospecting and Mining Coal	06/03/1989	05/03/2031	Granted
CL 359	Coal Lease	Coal & Allied Pty Ltd and Anotero Pty Ltd	Prospecting and Mining Coal	21/05/1990	20/05/2032	Granted
CL 360	Coal Lease	Coal & Allied Pty Ltd and Anotero Pty Ltd	Prospecting and Mining Coal	29/05/1990	28/05/2032	Granted
CL 398	Coal Lease	Coal & Allied Pty Ltd and Anotero Pty Ltd	Prospecting and Mining Coal	04/06/1992	03/06/2034	Granted
CL 584	Coal Lease	Coal & Allied Pty Ltd and Anotero Pty Ltd	Prospecting and Mining Coal	01/01/1982	31/12/2023	Granted
CML 4	Consolidated Mining Lease	Coal & Allied Pty Ltd and Anotero Pty Ltd	Prospecting and Mining Coal	02/03/1993	03/06/2033	Granted

Title	Mining Tenement	Titleholder	Purpose	Grant Date	Expiry Date	Status
ML 1324	Mining Lease	Coal & Allied Pty Ltd and Anotero Pty Ltd	Prospecting and Mining Coal	19/08/1993	19/08/2035	Granted
ML 1337	Mining Lease	Coal & Allied Pty Ltd and Anotero Pty Ltd	Prospecting and Mining Coal	01/02/1994	01/02/2034	Granted
ML 1359	Mining Lease	Coal & Allied Pty Ltd and Anotero Pty Ltd	Prospecting and Mining Coal	01/11/1994	31/10/2015	Renewal Pending
ML 1406	Mining Lease	Coal & Allied Pty Ltd and Anotero Pty Ltd	Prospecting and Mining Coal	27/02/1997	10/02/2027	Granted
ML 1428	Mining Lease	Coal & Allied Pty Ltd and Anotero Pty Ltd	Prospecting and Mining Coal	15/04/1998	14/04/2019	Renewal Pending
ML 1465	Mining Lease	Coal & Allied Pty Ltd and Anotero Pty Ltd	Prospecting and Mining Coal	21/02/2000	20/02/2021	Granted
ML 1474	Mining Lease	Coal & Allied Pty Ltd and Anotero Pty Ltd	Prospecting and Mining Coal	24/11/2000	23/11/2021	Granted
ML 1482	Mining Lease	Coal & Allied Pty Ltd and Anotero Pty Ltd	Prospecting and Mining Coal	19/03/2001	14/04/2019	Renewal Pending
ML 1500	Mining Lease	Coal & Allied Pty Ltd and Anotero Pty Ltd	Prospecting and Mining Coal	21/12/2001	20/12/2022	Granted
ML 1526	Mining Lease	Coal & Allied Pty Ltd and Anotero Pty Ltd	Prospecting and Mining Coal	03/12/2002	02/12/2023	Granted
ML 1560	Mining Lease	Coal & Allied Pty Ltd and Anotero Pty Ltd	Prospecting and Mining Coal	28/01/2005	27/01/2026	Granted
ML 1589	Mining Lease	Coal & Allied Pty Ltd and Anotero Pty Ltd	Prospecting and Mining Coal	02/11/2006	01/11/2027	Granted
ML 1622	Mining Lease	Coal & Allied Pty Ltd and Anotero Pty Ltd	Prospecting and Mining Coal	22/10/2010	10/03/2027	Granted
ML 1634	Mining Lease	Coal & Allied Pty Ltd and Anotero Pty Ltd	Prospecting and Mining Coal	31/07/2009	30/07/2030	Granted
ML 1682	Mining Lease	Coal & Allied Pty Ltd and Anotero Pty Ltd	Prospecting and Mining Coal	16/12/2012	15/12/2033	Granted
ML 1704	Mining Lease	Coal & Allied Pty Ltd and Anotero Pty Ltd	Mining Purposes	05/12/2014	04/12/2035	Granted
ML 1705	Mining Lease	Coal & Allied Pty Ltd and Anotero Pty Ltd	Prospecting and Mining Coal	17/12/2014	16/12/2035	Granted

Title	Mining Tenement	Titleholder	Purpose	Grant Date	Expiry Date	Status
ML 1706	Mining Lease	Coal & Allied Pty Ltd and Anotero Pty Ltd	Mining Purposes	09/12/2014	08/12/2035	Granted
ML 1707	Mining Lease	Coal & Allied Pty Ltd and Anotero Pty Ltd	Prospecting and Mining Coal	09/12/2014	08/12/2035	Granted
ML 1710	Mining Lease	Coal & Allied Pty Ltd and Anotero Pty Ltd	Prospecting and Mining Coal	22/12/2016	10/03/2027	Granted
ML 1732	Mining Lease	Coal & Allied Pty Ltd and Anotero Pty Ltd	Mining Purposes	06/04/2016	05/04/2037	Granted
ML 1734	Mining Lease	Coal & Allied Pty Ltd and Anotero Pty Ltd	Mining Purposes	06/04/2016	05/04/2037	Granted
ML 1748	Mining Lease	Coal & Allied Pty Ltd and Anotero Pty Ltd	Mining Purposes	05/12/2016	04/12/2037	Granted
ML 1753	Mining Lease	Coal & Allied Pty Ltd and Anotero Pty Ltd	Mining Purposes	19/04/2017	18/04/2038	Granted
ALA 52	Assessment Lease Application	Coal & Allied Pty Ltd and Anotero Pty Ltd	Prospecting	Mining Lease Application lodged 10th September 2012		Offer of Grant – Pending Determination
ALA 58	Assessment Lease Application	Coal & Allied Pty Ltd and Anotero Pty Ltd	Prospecting	Mining Lease Application lodged 1st December 2016		Offer of Grant – Pending Determination
ALA 59	Assessment Lease Application	Coal & Allied Pty Ltd and Anotero Pty Ltd	Prospecting	Mining Lease Application lodged 1st December 2016		Offer of Grant – Pending Determination
ELA 5525	Exploration Licence Application	Coal & Allied Pty Ltd and Anotero Pty Ltd	Prospecting	Exploration Licence Application lodged 3rd July 2017		GRANTED EL 8821 (above)
ELA 5526	Exploration Licence Application	Coal & Allied Pty Ltd and Anotero Pty Ltd	Prospecting	Exploration Licence Application lodged 3rd July 2017		
ELA 5527	Exploration Licence Application	Coal & Allied Pty Ltd and Anotero Pty Ltd	Prospecting	Exploration Licence Application lodged 3rd July 2017		
MLA 489	Mining Lease Application	Coal & Allied Pty Ltd and Anotero Pty Ltd	Mining Purposes	Mining Lease Application lodged 10th March 2015		Application Pending
MLA 495	Mining Lease Application	Coal & Allied Pty Ltd and Anotero Pty Ltd	Mining Purposes	Mining Lease Application lodged 12th May 2015		Application Pending
MLA 496	Mining Lease Application	Coal & Allied Pty Ltd and Anotero Pty Ltd	Mining Purposes	Mining Lease Application lodged 12th May 2015		Application Pending
MLA 520	Mining Lease Application	Coal & Allied Pty Ltd and Anotero Pty Ltd	Mining Purposes	Mining Lease Application lodged 23rd December 2015		Application Pending

Title	Mining Tenement	Titleholder	Purpose	Grant Date	Expiry Date	Status
MLA 534	Mining Lease Application	Coal & Allied Pty Ltd and Anotero Pty Ltd	Mining Purposes	Mining Lease Application lodged 28th October 2016		Application Pending
MLA 535	Mining Lease Application	Coal & Allied Pty Ltd and Anotero Pty Ltd	Mining Purposes	Mining Lease Application lodged 28th October 2016		Application Pending
MLA 542	Mining Lease Application	Coal & Allied Pty Ltd and Anotero Pty Ltd	Ancillary Mining Activities (Mining Purposes)	Mining Lease Application lodged 27th July 2017		Application Pending
MLA 543	Mining Lease Application	Coal & Allied Pty Ltd and Anotero Pty Ltd	Ancillary Mining Activities (Mining Purposes)	Mining Lease Application lodged 27th July 2017		Application Pending
MLA 562	Mining Lease Application	Coal & Allied Pty Ltd and Anotero Pty Ltd	Ancillary Mining Activities (Mining Purposes)	Mining Lease Application lodged 21st December 2018		Application Pending

Table 7 HVO Leases and Permits

Type	Licence Number	Description	Authority	Expiry Date
Environment Protection Licence	EPL640	Environment Protection Licence	EPA	N/A
Dangerous Goods/ Explosives	RR12709	Licence to Store	WorkCover	06/07/2022
Radiation Licence	RML5085293	Radiation Management Licence	EPA	14/11/2020
Aboriginal Heritage Permit	C0001890	Care Agreement	OEH	03/06/2036
	C0002193	Aboriginal Heritage impact Permit	OEH	06/12/2026
Road Closure Permit	538338	Road Occupancy Licences– Golden Highway	RMS	30/06/2020
	N/A	Road Closure Approval - Lemington Road	Singleton Council	30/06/2020

Table 8 Water Related Approvals

Licence Number	Type of Licence	Purpose	Legislation	Description	Expiry Date
20BL030566	Bore	Well	Part 5 Water Act 1912	East Open Cut	Perpetuity
20BL141584	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO North – Carrington Work Licence	Perpetuity
20BL166637	Bore	Monitoring Bore	Part 5 Water Act 1912	No Current Bores	Perpetuity
WAL41527	Bore	Excavation - Mining	Water Management Act 2000	HVO North – Carrington Pit	Continuing
20BL168820	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO North – Bores: CGW39, CGW45a, CGW46,CGW47, CGW47a, CGW48, CGW49, P50/38.5, ,CGW56, 4036C, 4035P, 4032P, 4034P, 4033P, 4053P, 4052P, 4051C, 4040P, 4038C, 4037P Destroyed:CGW7,CGW50, CGW57, CGW58, CGW59, CGW60, CGW61, CGW62, CGW63	Perpetuity
20BL169241	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO North – Bores: DM1, HF3, HF7 Destroyed: DM2	Perpetuity
20BL169641	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO North – Bores: CGW5, CGW51A, CGW52, CGW53, CGW54, CGW55A, CGW53A, CGW52A, CGW54A, CGW6, CFW55, CFW57, CFW57A, CFW59, and CFW55R. Destroyed: CGW1, CGW2, CGW3, CGW5, CGW8,CGW9, CGW10, CGW12, CGW13, CGW14, CGW30, CGW33, CGW34, CGW35, CGW36, CGW37, CGW38, CGW40, CGW41, CGW42, CGW43, CGW44, CFW56, CFW56A, CFW58	Perpetuity
20BL170496	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO South – Bores: BZ10 (CHPZ 2A), BZ11 (CHPZ 3A), BZ18 (CHPZ 10A), BZ20 (CHPZ 12A), BZ21 (CHPZ 13D) , BZ21A (CHPZ 13A), BZ20A	Perpetuity

Licence Number	Type of Licence	Purpose	Legislation	Description	Expiry Date
				(CHPZ 12D), BZ11A (CHPZ 3D) Destroyed: AP50/47.5, AQ52, AV50/56.5, AS50/62.5, AR55, Bunc 3, BZ25 (Bunc 12) , BZ23 (Bunc 14), BZ24 (Bunc 13),	
20BL170497	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO South – Bores: BZ15 (CHPZ 7A), BZ16 (CHPZ 8D), BZ17 (CHPZ 9A), BZ19 (CHPZ 11A), BZ16A (CHPZ 8A), Bunc 46D Destroyed: Bunc 39 (Shallow & Deep), Bunc 44D	Perpetuity
20BL170498	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO South – Bores: BZ12 (CHPZ 4A), BZ13 (CHPZ 5A), BZ14, BZ9 (CHPZ 1A), BC1, BC1a, BZ8-1, BZ8-2, BZ8-3, HG1, HG2, HG2a, HG3, S4, S6, BZ22 (CHPZ14D), BZ22A (CHPZ 14A), BZ5-1, BZ5-2 Destroyed: S2, S3, S9, S11	Perpetuity
20BL171423	Bore	Monitoring Bore	Part 5 Water Act 1912	E1.5	Perpetuity
20BL171424	Bore	Monitoring Bore	Part 5 Water Act 1912	Destroyed: GW9711	Perpetuity
20BL171425	Bore	Monitoring Bore	Part 5 Water Act 1912	Bores: GW9701, GW9710	Perpetuity
20BL171426	Bore	Monitoring Bore	Part 5 Water Act 1912	Bores: GW9702 Destroyed: D2(WH236)	Perpetuity
20BL171427	Bore	Monitoring Bore	Part 5 Water Act 1912	Bores: C335, C630 (BFS)	Perpetuity
20BL171428	Bore	Monitoring Bore	Part 5 Water Act 1912	D807	Perpetuity
20BL171429	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO South – Bores: B925 (BFS), C122 (BFS), C122 (WDH)	Perpetuity
20BL171430	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO South – Bores: C613 (BFS), C809 (GM/WDH)	Perpetuity
20BL171431	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO South – Bores: B631 (BFS), B631 (WDH)	Perpetuity
20BL171432	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO South – Bores: C130 (AFSH1), C130 (ALL), C130(BFS), C130 (WDH)	Perpetuity
20BL171433	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO South – Bore B334 (BFS)	Perpetuity

Licence Number	Type of Licence	Purpose	Legislation	Description	Expiry Date
20BL171434	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO South – Bores: C317 (BFS), C317 (WDH)	Perpetuity
20BL171435	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO South – Bores: BZ3-1, BZ3-2, BZ3-3	Perpetuity
20BL171436	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO South – Bores: BZ4A(1), BZ4A(2), BZ4B	Perpetuity
20BL171437	Bore	Monitoring Bore	Part 5 Water Act 1912	Bores: WG1, WG2, WG3	Perpetuity
20BL171439	Bore	Monitoring Bore	Part 5 Water Act 1912	Bores: BRN, E012	Perpetuity
20BL171492	Bore	Monitoring Bore	Part 5 Water Act 1912	Bores: C1(WJ039), GW9704, North, GWAR981	Perpetuity
20BL171681	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO South – Bores: Bunc 45A, Bunc 45D	Perpetuity
20BL171725	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO South – Bores: B425 (WDH), BRS, C621 (BFS), C919 (ALL), D317 (BFS), D317(ALL), D317(WDH) Destroyed: D420, D425, D621, PB02	Perpetuity
20BL171726	Bore	Monitoring Bore	Part 5 Water Act 1912	Bores: SR002, SR003, SR004, SR005, SR006, SR007	Perpetuity
20BL171727	Bore	Monitoring Bore	Part 5 Water Act 1912	SR001	Perpetuity
20BL171728	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO South – Bores: BZ2B, BZ1-1, BZ1-2, BZ1-3, BZ2-1, BZ2-2	Perpetuity
20BL171762	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO South – Bores: C817, D010 (BFS), D214 (BFS), D406 (BFS) (AFS), D510 (BFS), PB01 (ALL), D510 (AFS), D010 (GM), D010 (WDH), D406 (BFS) (AFS), D612 (AFS), D612 (BFS)	Perpetuity
20BL171851	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO North/South – Bores: HV2, PZ1CH200, PZ2CH400, PZ3CH800, 4118P, 4119P	Perpetuity
20BL171852	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO North – PZ4CH1380	Perpetuity
20BL171853	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO North – DM3	Perpetuity
20BL171854	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO North – Bores: DM5, PZ6CH2450	Perpetuity
20BL171855	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO North – PZ5CH1800	Perpetuity
20BL171856	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO North – Bores: HV6, HV3, DM6, HV2 (2),	Perpetuity

Licence Number	Type of Licence	Purpose	Legislation	Description	Expiry Date
				4113P, 4114P. 4116P, 4117P	
20BL171857	Bore	Monitoring Bore	Part 5 Water Act 1912	Bores: HV4, HV4 (2) (GA3), GA3,	Perpetuity
20BL171858	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO North – DM4	Perpetuity
20BL171895	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO West – NPZ4	Perpetuity
20BL171896	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO West – NPZ2	Perpetuity
20BL171897	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO West – Bores: NPZ5, NPZ1	Perpetuity
20BL171898	Bore	Monitoring Bore	Part 5 Water Act 1912	HVO West – NPZ3	Perpetuity
20BL173062	Bore	Monitoring Bore	Part 5 Water Act 1912	RC14	Perpetuity
20BL173065	Bore	Monitoring Bore	Part 5 Water Act 1912	HQ11	Perpetuity
20BL173063	Bore	Monitoring Bore	Part 5 Water Act 1912	RC07, RC08	Perpetuity
20BL173064	Bore	Monitoring Bore	Part 5 Water Act 1912	RC06	Perpetuity
20BL173069	Bore	Monitoring Bore	Part 5 Water Act 1912	RC11	Perpetuity
20CA201247	Works Approval	Pumping Plant	Water Management Act 2000	Associated with WAL965	Perpetuity
20CA212713	Works Approval	Pumping Plant	Water Management Act 2000	Associated with WAL36190	30/05/2025
20FW213280	Flood Work Approval	Levee	Water Management Act 2000	HVO North Carrington Levee 5	21/09/2021
20FW213281 Formerly 20CW802613	Flood Work Approval	Levee	Water Management Act 2000	HVO South – Barry Levee	21/09/2027
20FW213277 Formerly 20CW802603	Flood Work Approval	Block Dam	Water Management Act 2000	HVO South – Hobden Gully Levee	21/09/2027
20FW213278 Formerly 20CW802604	Flood Work Approval	Levee	Water Management Act 2000	HVO North – North Pit Levee 3	21/09/2021
20WA210991 (see WAL 18307) Formerly 20SL050903	Stream Diversion	Stream Diversion	Water Management Act 2000	HVO West – Parnells Creek Dam	09/01/2023

Licence Number	Type of Licence	Purpose	Legislation	Description	Expiry Date
20WA211427 Formerly 20SL061290	Stream Diversion	Cutting (Diversion Drain)	Section 10 Water Act 1912	Pikes Gully Creek Stream Diversion	07/09/2023
20WA210985 (see WAL 18327) 20SL042746	Diversion Works	Industrial	Water Management Act 2000	HV Loading Point Pump Bayswater Creek	08/09/2022
20WA211428 20SL061594	Stream Diversion	Cutting (Diversion Drain)	Water Management Act 2000	HVO North – Carrington Stream Diversion	31/07/2022
20WA201238 (see WAL 962)	Diversion Works	Pumping Plant	Water Management Act 2000	HVCPP River Pump	16/03/2018- Application for renewal pending
20WA201257 (see WAL 970)	Diversion Works	Pumping Plant	Water Management Act 2000	HVO South – LCPP River Pump	Perpetuity
20WA201338 (see WAL 1006)	Diversion Works	Pumping Plant	Water Management Act 2000	HVO South – LCPP River Pump	Perpetuity
20WA201501 (see WAL 1070)	Diversion Works	Pumping Plant	Water Management Act 2000	HVO South – LCPP River Pump	Perpetuity
20WA201685 (see WAL 13387)	Diversion Works	Pumping Plant	Water Management Act 2000	HVO West – "Lake Liddell" Licence	Perpetuity
20FW213274	Flood Work Approval	Levee	Water Management Act 2000	Riverview	26/10/2028

Table 9 Water Access Licences

Licence Number	Description	Water Source	Water Sharing Plan	Water Source – Management Zone	Approved Extraction (ML)	Extraction 2018/19 Water Year (ML)
WAL718[A]	Wambo United Operations	Hunter River	Hunter Regulated River WSP	Zone 2a (Hunter River From Glennies Creek Junction To Wollombi Brook Junction)	300 (HVO take allocation only)	300
WAL867	Comleroi, farming & irrigation	Hunter River	Hunter Regulated River WSP	Zone 2a (Hunter River From Glennies Creek Junction To Wollombi Brook Junction)	486	120[B]
WAL962	HVO North – HVCPP River Pump – Water	Hunter River	Hunter Regulated River WSP	Zone 1b (Hunter River From Goulburn	3,165 (2585 after transfer)	891[C]

Licence Number	Description	Water Source	Water Sharing Plan	Water Source – Management Zone	Approved Extraction (ML)	Extraction 2018/19 Water Year (ML)
	Access Licence			River Junction To Glennies Creek Junction)		
WAL969	HVO South – Former Riverview pump	Hunter River	Hunter Regulated River WSP	Zone 1b (Hunter River From Goulburn River Junction To Glennies Creek Junction)	39	0
WAL970	HVO South – LCPP River Pump – Water Access Licence	Hunter River	Hunter Regulated River WSP	Zone 2a (Hunter River From Glennies Creek Junction To Wollombi Brook Junction)	500 (690 after transfer)	498.5
WAL1006	HVO South – LCPP River Pump – Water Access Licence	Hunter River	Hunter Regulated River WSP	Zone 2a (Hunter River From Glennies Creek Junction To Wollombi Brook Junction)	500 (650 after transfers)	576
WAL1070	HVO South - LCPP River Pump – Water Access Licence	Hunter River	Hunter Regulated River WSP	Zone 2a (Hunter River From Glennies Creek Junction To Wollombi Brook Junction)	500	0
WAL13387	Macquarie Generation Hunter River Pump Station	Hunter River	Hunter Regulated River WSP	Zone 1b (Hunter River From Goulburn River Junction To Glennies Creek Junction)	20	0
WAL 13391	HVO North – Alluvial Rehabilitation Irrigation.	Hunter River	Hunter Regulated River WSP	Zone 1b (Hunter River From Goulburn River Junction To Glennies Creek Junction	420 (1642 after transfers)	1397
WAL18127	Carrington BB1	Hunter River Alluvium	Hunter Unregulated and Alluvial Water Sources WSP	Hunter Regulated River Alluvial Water Source – Upstream Glennies Creek management zone	383	350[D, E]

Licence Number	Description	Water Source	Water Sharing Plan	Water Source – Management Zone	Approved Extraction (ML)	Extraction 2018/19 Water Year (ML)
WAL18158	Ollenberry	Hunter River Alluvium	Hunter Unregulated and Alluvial Water Sources WSP	Hunter Regulated River Alluvial Water Source – Upstream Glennies Creek management zone	65	
WAL18307	HVO West – Parnells Creek Dam (Diversion Works Bywash)	Unregulated River	Hunter Unregulated and Alluvial Water Sources WSP	Jerrys Water Source; Jerrys Management Zone	500	0
WAL18327	HV Loading Point Pump Bayswater Creek (Diversion Works)	Unregulated River	Hunter Unregulated and Alluvial Water Sources WSP	Jerrys Water Source; Jerrys Management Zone	150	0
WAL23889	Greenleek	Wollombi Brook	Hunter Unregulated and Alluvial Water Sources WSP	Lower Wollombi Brook Water Source	144	0
WAL36190	HVO North, old farm bore	Hunter River Alluvium	Hunter Unregulated and Alluvial Water Sources WSP	Hunter Regulated River Alluvial Water Source – Jerrys Management Zone	120	0
WAL39798	Lemington Underground (LUG) Bore	Permian Coal Seams	North Coast Fractured and Porous Rock Groundwater Sources WSP (commenced 1/7/16)	Permian Coal Seams	1,800	1315
WAL40462	HVO Pit Excavations / Alluvial Lands Bores (x4)	Permian Coal Seams	North Coast Fractured and Porous Rock Groundwater Sources WSP (commenced 1/7/16)	Permian Coal Seams	2,400	879[D]
WAL40463					180	
WAL40466					460	
TBA (20BL167860)	HVO North (Carrington Pit)	Permian Coal Seams	North Coast Fractured and Porous Rock	Permian Coal Seams	220	0

Licence Number	Description	Water Source	Water Sharing Plan	Water Source – Management Zone	Approved Extraction (ML)	Extraction 2018/19 Water Year (ML)
			Groundwater Sources WSP (commenced 1/7/16)			
TBA (20BL170000)	HVO North – Pit Excavation	Permian Coal Seams	North Coast Fractured and Porous Rock Groundwater Sources WSP (commenced 1/7/16)	Permian Coal Seams	20	0

Notes:
[A] WAL718 held by Wambo United Operations. HVO transferred allocation to WAL718 and water was extracted by WAL718 works prior to import to HVO via offtake from Wambo pipeline. Reporting considers only extraction by HVO utilising WAL718 and associated works. Extraction by Wambo United Operations not detailed.
[B] Imports to HVO only. Does not include rural use by property licensee.
[C] Comprising 758ML pumping and 133ML passive take/inflow.
[D] Passive take / inflows
[E] Take for 2016/17 water year was 288ML and 2017/18 water year was 350ML (reporting as required by licence).

Trades during reporting period:

Date	Reference	Seller	Buyer	Allocation (ML)
26/9/18	SWC765542	WAL9054	WAL13391	541
26/9/18	SWC765546	WAL946	WAL13391	681
11/10/18	SWC763564	WAL962	WAL718	300
13/11/18	SWC764885	WAL894	WAL970	190
28/5/19	SWC775415	WAL962	WAL13391	130
28/5/19	SWC775416	WAL962	WAL1006	150

3.1.2 Management Plans, Programs and Strategies

Under the development consent approvals, HVO is required to develop and submit a range of environmental management plans for approval prior to implementation. Issued in 2009, and last modified in 2018, the HVO South Coal Project Approval (PA06_0261) required the submission of a number of monitoring programs, strategies and management plans, and similarly or the 2017 modification to the HVO North Consent (DA 450-10-2003)

Numerous updated plans were submitted to DPI&E in 2019. Some plans remain under review and will be submitted to DPI&E in 2020. Approved management plans are made publically available on the HVO website (https://insite.hvo.com.au/).

The status of management plans is shown in Table 10 and Table 11.

Table 10 Management Plans and Mining Operations Plans (MOPs) Required for HVO North

Management Plan	Date Approved
HVO Water Management Plan	16/10/2018
HVO Bushfire Management Plan	23/06/2015
HVO Noise Management Plan	19/02/2019
HVO Blast Management Plan	30/04/2019
HVO Air Quality and Greenhouse Gas Management Plan	06/09/2019
Hunter Valley Operations Environmental Management Strategy	08/01/2019

Management Plan	Date Approved
Rehabilitation Management Plan (addressed in MOP)	26/02/2019
Agricultural Lands Reinstatement Management Plan (addressed in MOP)*	19/02/2016
MOP - HVO North 2019-2021	26/02/2019
HVO River Red Gum Rehabilitation & Restoration Strategy	24/03/2010
HVO North Heritage Management Plan	19/12/2019
HVO Greenhouse and Energy Efficiency Plan (Addressed in HVO Air Quality and Greenhouse Gas Management Plan)	06/09/2019
Fine Reject Management Strategy	07/12/2018

*The Agricultural Lands Reinstatement Management Plan states that the agricultural reinstatement activities and monitoring results will be reported in the HVO Annual Environment Review. However work has not yet commenced hence no monitoring or reporting against the Management Plan specific to the Carrington West Wing project is provided in this report.

Table 11 Management Plans and MOPs Required for HVO South

Management Plan	Date Approved
HVO River Red Gum Rehabilitation & Restoration Strategy	24/03/2010
HVO South Aboriginal Cultural Heritage Management Plan	19/12/2019
HVGC Amenity Management Plan	22/01/2013
HVO Water Management Plan	16/10/2018
HVO South Aboriginal Cultural Heritage Management Plan	19/12/2019
HVO Bushfire Management Plan	23/06/2015
HVO Noise Management Plan	19/02/2019
HVO Blast Management Plan	30/04/2019
HVO Air Quality and Greenhouse Gas Management Plan	06/09/2019
Hunter Valley Operations Environmental Management Strategy	08/01/2019
MOP - HVO South 2019-2021 Incorporates: - Landscape Management Plan - Rehabilitation and Biodiversity Management Plan - Mine Closure Plan - Final Voids Management Plan	26/02/2019
Rehabilitation and Biodiversity Management Plan (Offsets component)	26/06/2017- Goulburn River Biodiversity Area Management Plan
HVO Integrated Biodiversity Management Plan	02/08/2018
HVO Biodiversity Offset Strategy	23/10/2017

4 Operations Summary

4.1 Mining

Areas to be mined are geologically modelled, a mine plan is formed and the relevant mining locations are surveyed prior to mining. Figure 3 illustrates the mining process. HVO have no active underground workings.

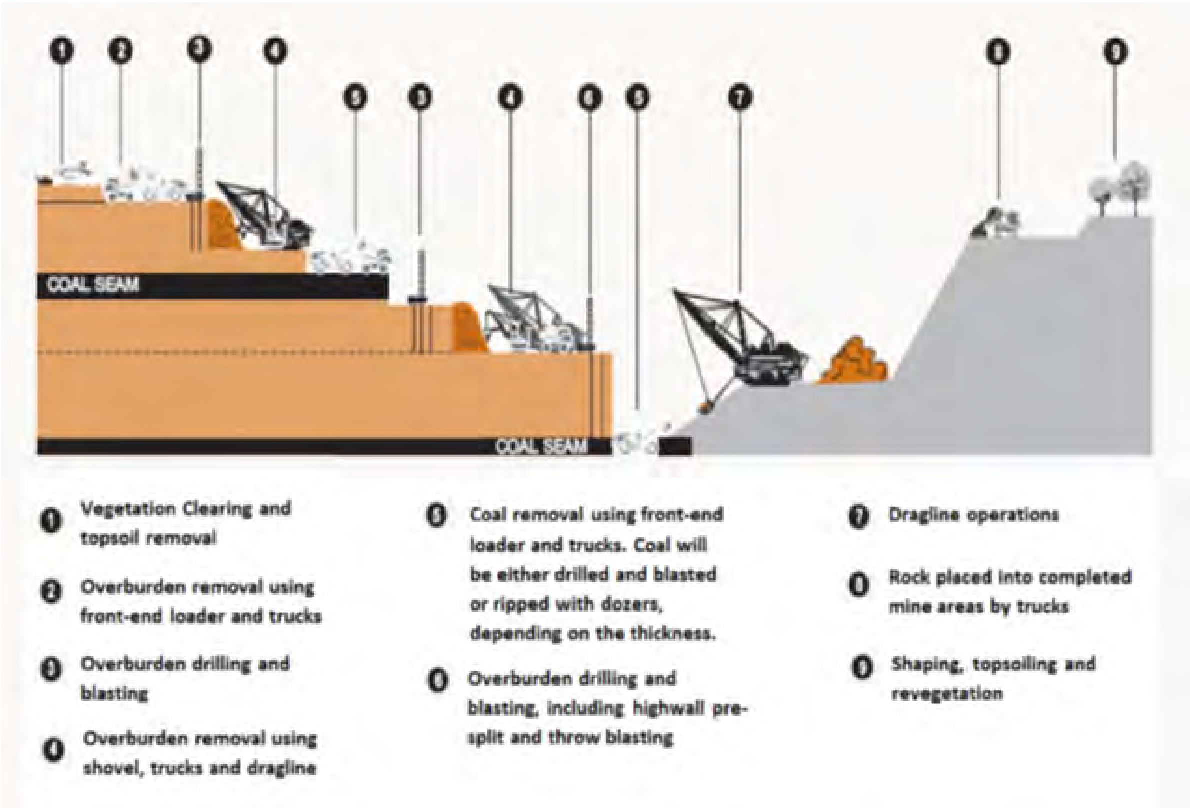


Figure 3 Open Cut Mining Schematic

No changes were made to the mining method during the reporting period. Mining progress deviated slightly from the schedule of the MOPs as a result of normal variations in productivity and utilisation.

The mining equipment fleet employed to carry out mining operations at HVO in 2018 and 2019 is detailed in Table 12 along with the fleet forecast for 2020.

Table 12 HVO Equipment Used 2018-2019

Equipment Type	Number Used in 2018	Number Used in 2019	Forecast Numbers in 2020
Scrapers	2	2	2
Drills	8	8	7
Draglines	2	2	2
Shovels	3	3	3
Excavators	8	8	7
Trucks	81	81	81
Loaders	6	5	5

Equipment Type	Number Used in 2018	Number Used in 2019	Forecast Numbers in 2020
Service Trucks	5	5	6
Track Dozers	29	29	29
Rubber Tyre Dozers	5	5	5
Graders	11	11	10
Water Trucks	10	10	10
Floats	1	1	1
Cable Reeler	1	1	1
Cable Tractors	5	5	5
Total	**177**	**176**	**174**

4.1.1 Mineral Processing

Coal is transported to one of two CHPPs, where it is crushed to size and processed to remove impurities. Processing produces saleable coal, along with coarse and fine reject materials. Coarse rejects are disposed of in pit, and fine rejects are placed in a tailings dam, according to commitments outlined in the MOP. Each CHPP site has storage facilities for processed (saleable) and raw (unprocessed) coal. The capacity of each site is listed in Table 13.

No changes or additions were made to process or facilities during the reporting period.

Table 13 Stockpile Capacities

Location	Raw Stockpile (t)	Saleable Stockpile (t)
Hunter Valley CHPP	176,000	330,000
Howick CHPP	15,000	30,000
Newdell CHPP	0	450,000

Processed, or product coal is transported to one of the two loading points via conveyor belt or road, detailed in Table 14. The coal from HVCHPP is transported to the Hunter Valley Load Point (HVLP) by means of overland conveyor whereas coal from Howick CHPP is typically trucked to Newdell Load Point (NLP) but can receive coal from HVLP via overland conveyor if required. After the coal has reached either HVLP or the NLP, it is transported to the Port of Newcastle by rail.

Table 14 Methods of Coal Transportation

Category of Transport	Quantity (Mt)
Coal transported from the site via trains	13.50
Amount of coal received from Hunter Valley Operations South of the Hunter River	11.00
Amount of coal hauled by road to the Hunter Valley Loading Point	Nil
Coal hauled by road to the Newdell Load Point	2.084
Amount of coal hauled by road from the Newdell Loading Point to the Ravensworth Coal Terminal	Nil
Amount of coal hauled by road from the Hunter Valley Loading Point to the Ravensworth Coal Terminal	Nil

Category of Transport	Quantity (Mt)
Number of coal haulage truck movements generated by the development. (includes -coal hauled to stockpile, coal hauled to bins, coal hauled from stockpile to bins)	247,297 (truck movements)

4.1.2 Production Statistics

Project approvals allow for the extraction of up to 22 million ROM tonnes from operations north of the Hunter River and 20 million ROM tonnes from operations south of the Hunter River. A summary of production and waste at HVO during 2019 in comparison to previous years and approval limits is provided in Table 15.

Product coal includes low-ash, semi-soft and steaming coals.

Table 15 Production Statistics and Correlating Project Approval Limits

	Approved Limit (PA 06_0261 and DA 450-10-2003)	Reporting Period 2018	Reporting Period 2019	Forecast for 2020
Prime Waste (Mbcm)	-	100.4	102.3	102.6
ROM Coal (Mtpa) (mined)	42	18.99	19.19	18.6
- HVO South	*20*	11.9	10.8	11.5
- West Pit	*12*	5.4	8.4	7.07
- Carrington Pit	*10*	1.7	0	0
Coarse Reject (Mt)	-	3.0	2.76	2.98
Fine Reject-Tailings (Mt)	-	1.8	1.7	1.54
Product (Mtpa)	-	13.3	13.59	14.1
ROM Coal Processed	26	17.99	18.05	18.6
- Hunter Valley CHPP	20	15.6	14.9	15.3
- Howick CHPP	6	2.4	3.13	3.3

4.1.3 Summary of Changes

Similar levels of production and equipment were used throughout 2018 to 2019.

Tailings emplacement commenced in the Carrington mining void in 2019.

Mining in the Carrington West Wing location has not yet commenced; at this time mining in this area is not planned to commence during 2020.

4.2 Other Operations

The main sealed entrance road at HVO North that intersects with Lemington Road was not diverted in 2019 as anticipated.

4.3 Forecast Operations for Next Reporting Period

Table 16 outlines the forecast operations for the next reporting period.

Table 16 Production Operations Forecast

Material	Unit	2019	2019 (Actual)	2020 Forecast	2021 Forecast
Stripped Topsoil	M^3	46,435	33,936	520,000	155,800
Rock / Overburden	Mbcm	119.4	116	115.3	124.9
ROM Coal	*Mt*	19.5	19.1Mt	18.6	18.5
Reject Material	*Mt*	4.8	4.5	4.5	4.0
Product	*Mt*	14.1	13.5	14.1	14.3

5 Actions Required From Previous Annual Review

The NSW Resource Regulator (formerly Department of Resources and Geoscience (DRG)) provided feedback on the 2018 Annual Review on 27 September 2019. No further amendment to the 2018 Annual Review was requested.

Following the Department of Planning Industry & Environment's initial feedback on the 2018 Annual Review received by HVO on 14 June 2019, HVO revised the report to provide the additional detail requested. The 2018 Annual Review was resubmitted on 26 July 2019 addressing the Departments feedback. The Department provided final acceptance of the 2019 Annual Review of 16 August 2019 with no further feedback.

Table 17 Actions required following review of the 2018 Annual Review

Action required from previous Annual Review	Requested by	Action taken by HVO	Where discussed in 2019 Annual Review
Please include high resolution maps that adequately show the operations in a regional context, as required by Section 2 of the Department's *Annual Review Guidelines* (for future Annual Environmental Reviews).	DPIE	Figure 1 was added into the 2018 Annual Review. Resolution improved to figure for 2019 Annual Review.	Figure 1
Provide details of the titleholders for each of the Mining Titles. The 2018 Report does not clearly identify the relevant titleholders (for future Annual Environmental Reviews).	RR	No requirement for input into 2018 Annual Review. Addressed in 2019 Annual Review – titleholder column added to Table 6.	Table 6
a. Maps of Operation: i. Figure 1 of the Annual Review includes a map of the operation showing the regional context, and addresses the requirements of Section 2 of the Department's *Annual Review Guideline*. Please amend the figure to improve the resolution of the map so the boundaries can be seen and the labels are legible. ii. Please amend Figure 2 (or provide a further figure) in the Annual Review to show Mining Lease boundaries, as required by Section 2 of the Department's *Annual Review Guideline.*	DPIE	Figures 1 and 2 amended in the 2018 Annual Review. Resolution improved for Figure 1 and 2 for 2019 Annual Review.	Figure 1 and Figure 2
b. Approvals Section 3 of the Annual Review lists HVO major approvals. Please amend this section to include the Mod 5 to PA 06_0261 granted in February 2018, to meet the requirements of the *Annual Review Guidelines* to list all approvals currently and any changes to those approvals that occurred during the reporting period.	DPIE	Amended Table 3 of the 2018 Annual Review. Now Table 5 in 2019 Annual Review.	Table 5
c. Actions required from the previous Annual Review Please amend Section 5 of the Annual Review to include a table that identifies	DPIE	Table 14 was included in the revised 2018 Annual Review. Now Table 17 in 2019 Annual Review.	This table (Table 17)

Action required from previous Annual Review	Requested by	Action taken by HVO	Where discussed in 2019 Annual Review
any actions required as an outcome of the previous Annual Review, including any actions that have been undertaken and when those guides were completed, as required by Section 5 of the Department's *Annual Review Guidelines.*			
d. Environmental Performance Section 6.2 of the Annual Review compares noise data to predictions made in the Environmental Impact Assessment. Please amend Section 6.2 to include "the location of actual mining operations in relation to locations predicted in the EIS" in accordance with the footnote to Table 9 in Schedule 3, Condition 7 of DA 450-10-2003.	DPIE	Amendment to Section 6.2 of the 2018 Annual Review.	Section 6.2
e. Water Management i. Table 7 in Section 3 of the Annual Review describes "actual extraction 2018" for HVO Water Access Licences. Please amend Table 7 to report on the water taken in the previous 'water year' (1 July to 30 June) as required by Section 7 of the Department's *Annual Review Guidelines.* ii. Please amend Section 7 of the Annual Review to include the provision of any "compensatory water' to other users in accordance with Schedule 3 Condition 20B of DA 450-10-2003 and Schedule 3 Condition 26B PA 06_0261, as required by Section 7 of the Department's *Annual Review Guidelines.*	DPIE	Amended Table 7 in the 2018 Annual Review to include actual extraction. Now Table 9 of 2019 Annual Review. Section 7 amended in the 2018 Annual Review. Now Section 7.6 of 2019 Annual Review.	Table 9 Section 7.6
f) Blasting Please amend Section 6.3 of the Annual Review to include a description of performance in relation to blasting hours, operating conditions and frequency in accordance with Schedule 3 Conditions 10, 11 and 12 of PA 06_0261, and Schedule 3 conditions 14 and 14a of DA 450-10-2003.	DPIE	Section 6.3 of the 2018 Annual Review amended.	Section 6.3
g) Rehabilitation i. Figure 92 in Section 8.3 of the Annual Review shows a map of HVO North rehabilitation areas as at 2018. Please amend Section 8.3 of the Annual Review to include an appropriate plan of rehabilitation, as required in section 8 of the Departments *Annual Review Guideline.*	DPIE	Figure 92 amended in the 2018 Annual Review. Now Figure 94 of 2019 Annual Review.	Section 8.3 Rehabilitation Performance

Action required from previous Annual Review	Requested by	Action taken by HVO	Where discussed in 2019 Annual Review
ii. Please amend the Annual review to include an outline of the outcomes of trials, research projects, and other initiatives undertaken during the reporting period to enhance or assure rehabilitation outcomes, as required by section 8 of the Departments *Annual Review Guideline.* iii. Section 8.3 and Section 8.4 of the Annual Review describe rehabilitation programme variations. These sections state that the area of rehabilitation sown in HVO North during the reporting period was 73.5 hectares below the MOP commitment but HVO North net rehabilitation is ahead of the MOP target due to reduced rehabilitation disturbance compared to MOP projections. Please amend the Annual Review to include the reasons for those variations, whether or not DRE was notified, and any actions agreed with DRE to address the variations, as required by Section 8 of the Departments *Annual Review Guideline.*		Section 8.5 added to the 2018 Annual Review. Sections amended in the 2018 Annual Review.	No rehabilitation trials undertaken during 2019 Section 8.4
h) Community complaints register i. A community complaints register in accordance with Schedule 5, Condition 12 of DA 450-10-2003, and Schedule 5, Condition 9 of PA 06_0261 was not able to be found in the community section of HVO's website as required by the Department's Web-based Reporting Guideline. Please amend the HVO website to include a community complaint register. ii. Please amend the second last line in Table 12 of the Annual Review which appears to be a typographical error.	DPIE	Cover letter response to DPIE (2018 Annual Review), website updated to include copy of community complaints register Amended in the 2018 Annual Review.	Website N/A

6 Environmental Performance

6.1 Meteorological Data

The collection of meteorological data is carried out to assist in day to day operational decisions, planning, environmental management and to maintain a historic record. The meteorological (weather) stations record wind speed, wind direction, temperature, humidity, solar radiation and rainfall. HVO operates two real time weather stations; the HVO Corporate Meteorological Station and the Cheshunt Meteorological Station. Daily average data is publically available via the Monthly Environmental Reports published on the HVO Website (insite.hvo.com.au).

6.2 Noise

6.2.1 Noise Management

Mining activities undertaken at HVO are managed to ensure adverse noise impacts are minimised, and to ensure compliance with permissible noise limits at nearby private residences. A combination of both proactive and reactive control mechanisms are employed to ensure effective management of noise as described in the HVO Noise Management Plan.

6.2.2 Sound Attenuation of Heavy Equipment

During 2019, 8 haul trucks were retrofitted with sound attenuation kits to achieve an in service sound power level of 115dB(A). This is in addition to 28 trucks that have previously received Stage 1 noise attenuation, achieving a sound power level of 118 dB(A), 22 trucks attenuated in 2018 and 18 trucks attenuated in 2017 to a level of 115 dB(A), making a total of 76 out of 81 trucks (94%) now sound attenuated.

During 2019, two haul trucks were sound power level tested as part of a research and development project refining the sound attenuation packages being utilised at HVO. HVO also developed a routine sound power level testing schedule which will be implemented during 2020.

In 2020, HVO is scheduled to complete fitment of the final 5 sound attenuation kits haul trucks.

6.2.3 Real Time Noise Management

HVO operates a network of directional real-time noise monitors as a tool to manage noise emissions within compliance limits and to minimise community impact.

During 2019, HVO received and responded to 1456[1] noise alarms, recording a total of 639 hours of equipment stoppage due to noise management.

The real-time system generates alarms when elevated noise is measured, triggering the implementation of reactive controls to reduce noise levels. The location of real time and attended noise monitoring locations as per the approved Noise Management Plan are shown in Figure 4.

[1] Noise alarm triggers are based on internally set noise criteria. Alarms received include noise exceedances from non-mine sources.

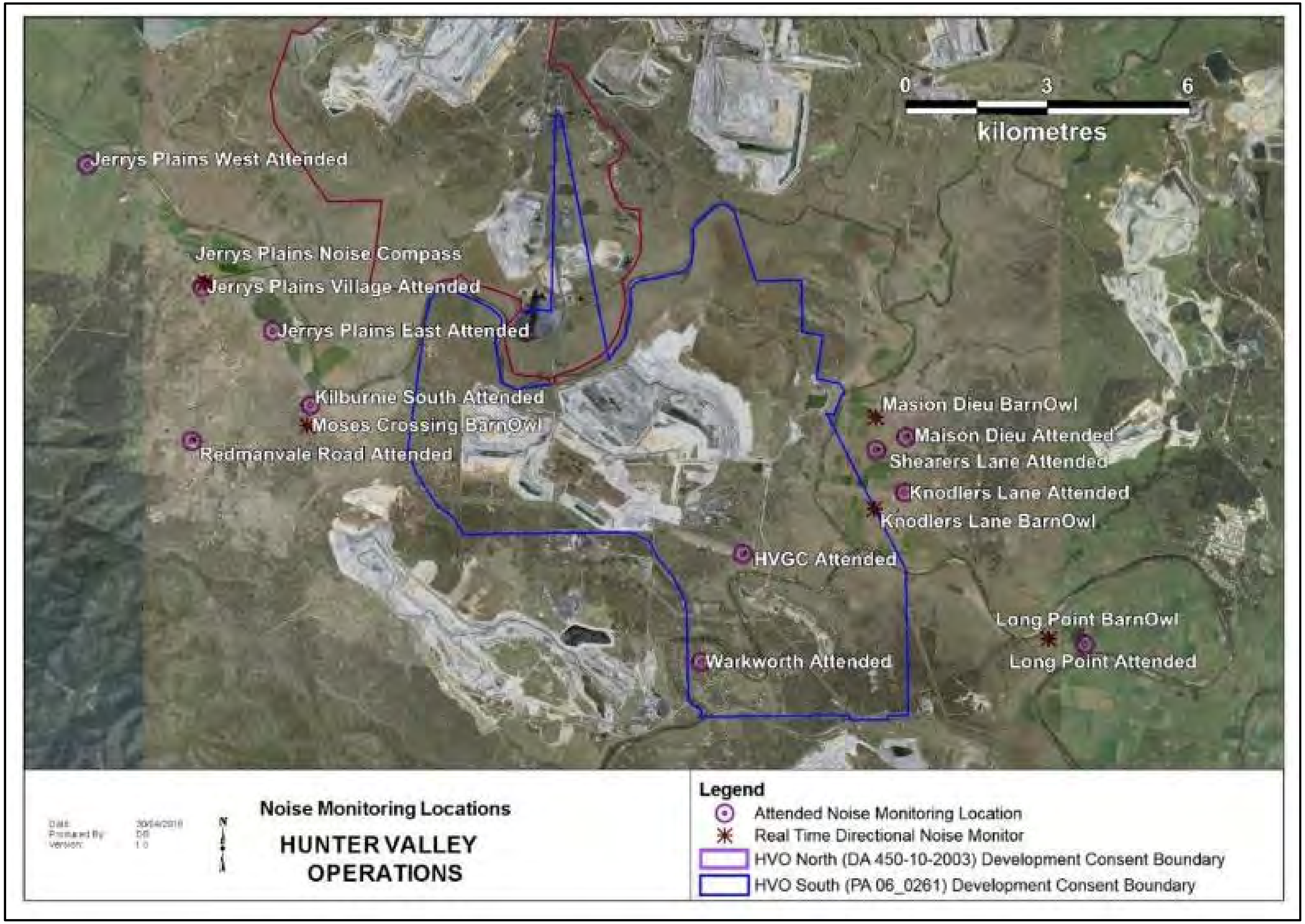


Figure 4 HVO Attended and Real-time Noise Monitoring Locations

An assessment of 2019 real time monitoring compared against attended compliance measurements taken at the same location indicated that the real time monitoring system generally aligned with values recorded during attended noise measurements. Where they didn't align, the majority of real time measurements were higher than attended noise measurements.

Details of this assessment is provided in Table 18.

Table 18 Comparison of Attended and Real Time Noise Monitoring 2019

Monitoring Location	Number of attended noise measurements[1]		Real Time measurements that aligned[2] with attended measurements		Real Time measurements with positive variance > 3dB(A) of attended measurements		Real Time measurements with a negative variance > 3dB(A) of attended measurements	
	South	North	South	North	South	North	South	North
Maison Dieu[3]	14	N/A	7	N/A	3	N/A	0	N/A
Knodlers Lane	12	N/A	11	N/A	1	N/A	0	N/A
Long Point[3]	12	N/A	5	N/A	0	N/A	0	N/A
Kilburnie South[3]	13	16	3	3	9	13	0	0
Jerrys Plains[3]	13	16	0	6	13	9	0	0

Notes:

1. Includes measurements under all meteorological conditions

2. Aligned indicates measurements were within 3dB (A) of each other or measurement results <25dB indicated that source contribution was in audible or not measureable.

3. One or more data points not available for attended and / or real time monitoring events.

6.2.4 Operational Noise Performance

To assess compliance with the relevant Project Approval noise criteria, HVO engages a suitably qualified and experience acoustic consultant to undertake routine compliance monitoring at nearby private residences, in accordance with the HVO Noise Management Plan. Monitoring is undertaken at a frequency of one night per month and an additional one night per quarter as required by the HVO North Approval. The monitoring is undertaken to evaluate and assess noise impacts under a range of meteorological conditions throughout the year.

A total of 101 measurements were taken during 2019. Each measurement involves an assessment of HVO mine noise against the various $L_{Aeq,\ 15minute}$ and $L_{A1,1min}$ noise criteria in place under the HVO North and South Approvals. Full details for all noise assessments completed can be found in the Hunter Valley Operations Monthly Environmental Monitoring Report, published on the HVO website (https://insite.hvo.com.au).

One measurement exceeded the relevant criteria at Maison Dieu on 7 May 2019. As per the compliance protocol detailed in the Noise Management Plan, a follow up measurement was conducted within 75 minutes and again within 7 days. Both follow up measurements resulted in measurements below the criteria and subsequently do not constitute a non-compliance. The results were reported to DPIE during May 2019. Details of the exceedance are presented in Table 19

Table 19 Noise measurements which exceeded noise criteria during 2019

Date/Time	Monitoring Location	Criteria	Criteria (dB)	Measured Noise (dB)	Criteria Exceeded by (dB)
7/05/2019 22:33	Maison Dieu	HVO South $L_{Aeq, 15min}$	39	42	3

Table 20 shows comparisons between the 2019 L_{Aeq} attended noise monitoring results (maximum HVO contribution levels measured under applicable meteorological conditions) and previous years.

Table 20 Comparison of 2019 noise monitoring results against previous years

Year	Number of Measurements	Number of measurements which exceeded allowable noise (under applicable meteorological conditions)	Number of non-compliances
2019	101	1	0
2018	105	3	0
2017	100	1*	0
2016	109	2*	0
2015	107	3*	2

* The now superseded NSW Industrial Noise Policy (INP) allowed for the measured result to be less than or equal to 2 dB above the applicable noise limit without constituting a non-compliance. Note: Where the measured result is greater than 2dB above the applicable noise limit, the site has 75 minutes to reduce noise levels below applicable noise limits before constituting a non-compliance. As of late October 2017, the NSW INP was superseded by the Noise Policy for Industry (NPfI), with the requirements of this policy implemented in late 2017.

Comparisons against the predicted noise levels in the HVO West Pit Extension and Minor Modifications EIS (2003) have been made against the modelled scenario for Year 14 (indicative of activities carried out during 2019) of the development (Table 5.2 of Part J – Hunter Valley Operations West Pit Extension and Minor Modifications Technical Reports Part 3) are shown in Table 21.

Comparison of measured results against the modelled predictions for Year 14 in the HVO West Pit EIS (2003) demonstrates noise levels equal to or lower than predicted at all monitoring locations, with the exception of the Kilburnie South monitoring location which recorded was higher than predicted results by 1dB(A).

Comparisons against the predicted noise levels in the HVO Carrington West Wing EA (2010) have not been made in this years' Annual Review, as this project has not commenced. Mining activity in the Carrington Pit area was limited to a short term mining campaign prior to the proposed deposition of tailings material.

Table 21 Comparison of 2019 monitoring against HVO North (Year 14, West Pit EIS, 2003) - Night Period

Location	Units	EIS Prediction (INP)	2019 (max. measured LAeq 15min under applicable met. conditions)
Knodlers Lane (5)	dB(A)	27	IA
Maison Dieu (6)	dB(A)	26	IA
Shearers Lane (5)	dB(A)	27	IA
Kilburnie South (4)	dB(A)	34	35
Jerrys Plains (13)	dB(A)	N/A	36
Jerrys Plains East (1)	dB(A)	38	35

Comparisons against the predicted noise levels in the HVO South Modification 5 Environmental Assessment have been made against Stage 1 modelling scenario (indicative of activities carried out during

2019), (Table 6.10 of Appendix E– Hunter Valley Operations South Modification 5 Approval Environmental Assessment Report Volume 2).

The comparison (Table 22) indicates that during 2019, noise was lower than predicted levels for all receptors with the exception of Maison Dieu that recorded one exceedance 2dB(A) greater than the EIS Prediction levels. This result was a one off exceedance that did not constitute a non-compliance. .

Table 22 Comparison of 2019 monitoring against HVO South (Stage 1 HVO South Modification 5 EA- 2017)

Location	Units	EIS Prediction (INP)	2019 (max. measured $L_{Aeq\ 15min}$ under applicable met. conditions)
Knodlers Lane (120)	dB(A)	39	39
Maison Dieu (258)	dB(A)	40	42
Shearers Lane (160)	dB(A)	41	35
Kilburnie South (307)	dB(A)	39	37
Jerrys Plains (399)	dB(A)	34	<35
Jerrys Plains East (321)	dB(A)	35	<35

6.3 Blasting

6.3.1 Blasting Management

During 2019, HVO operated a blast monitoring network to assess and evaluate blast vibration and overpressure impacts against the HVO North and HVO South Approval limits. HVO achieved 100% blast data capture for all blast monitors.

Monitors are located at or in close proximity to nearby privately owned residences and function as regulatory compliance monitors as shown in Figure 5 from the Blast Management Plan. These monitors are located at:

- Jerrys Plains Village;
- Warkworth;
- Maison Dieu;
- Moses Crossing; and
- Knodlers Lane

Figure 5 HVO Blast Monitoring Network

6.3.2 Blasting Performance

During the reporting period 221 blast events were initiated at HVO. 140 blasts were fired at HVO South, and 81 at HVO North. HVO complied with all blasting related consent and licence conditions with the exception of one blast on 28 May 2019 in the HVO South area which exceeded the Airblast Overpressure criteria at Maison Dieu. Details on the incident are provided in Section 0. Airblast Overpressure and Ground Vibration results for all blasts fired during the reporting period are displayed in Figure 6 to Figure 10.

There were a total of eight blasts that recorded an overpressure reading greater than 115 dB(L) during the reporting period.

The resulting readings over 115 dB(L) limit have been assessed for comparison against the 5% of the total number of blasts over a 12 month period these results are shown in Table 23.

Table 23 HVO airblast overpressure allowable exceedance summary

Monitoring Location	HVO South Blasts		HVO West / North Blasts	
	Allowable Exceedance over 115 dB(L) of time over 12 months (%)	Percentage of blasts over 115dB(L)	Allowable Exceedance over 115 dB(L) of time over 12 months (%)	Percentage of blasts over 115dB(L)
Moses Crossing	5	0.7	5	0
Jerrys Plains	5	1.4	5	0
Warkworth	5	1.4	5	0
Maison Dieu	5	0.7	5	1.2
Knodlers Lane	5	1.4	5	1.2

There were no exceedances of the 5 mm/s or 10 mm/s ground vibration criteria at any residence on privately-owned land.

During 2019, blasting occurred only between the hours of 7am and 6pm Monday to Saturday. No blasting was carried out on Sundays or Public Holidays. In addition, no more than 3 blasts were fired per day and the maximum number of blasts fired during any week was nine, less than the maximum weekly blasting frequencies as specified in DA 450-10-2003 and PA 06_0261.

No fume events were recorded leaving the site in accordance with protocols detailed in the HVO Blast Management Plan.

During the reporting period, HVO closed Lemington Road on 14 occasions and Golden Highway on 17 occasions with 14 minutes and 15 minutes being the average time that these respective roads were closed.

Coordination of blasting times with neighbouring mines, Ravensworth and Wambo, continued to occur by email notifications.

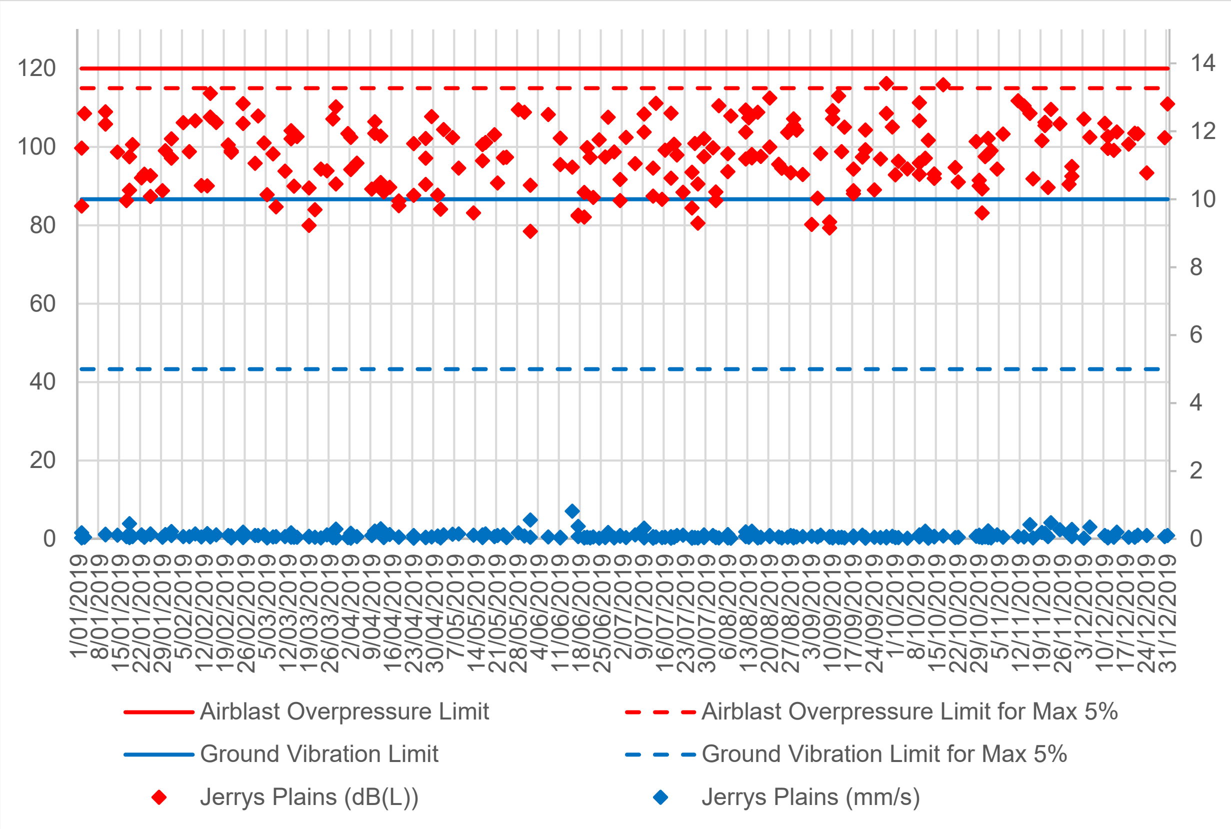


Figure 6: Jerrys Plains Blast Monitoring Results 2019

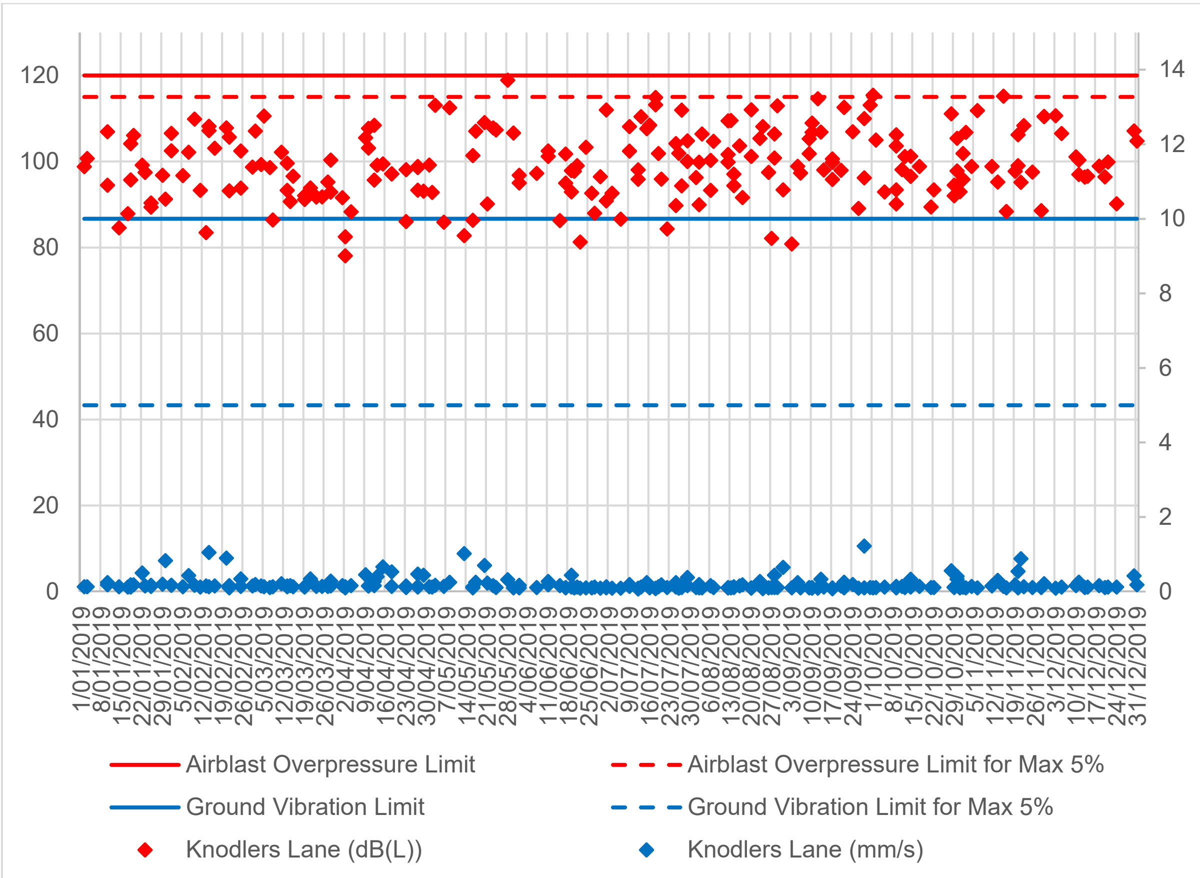


Figure 7: Knodlers Lane Blast Monitoring Results 2019

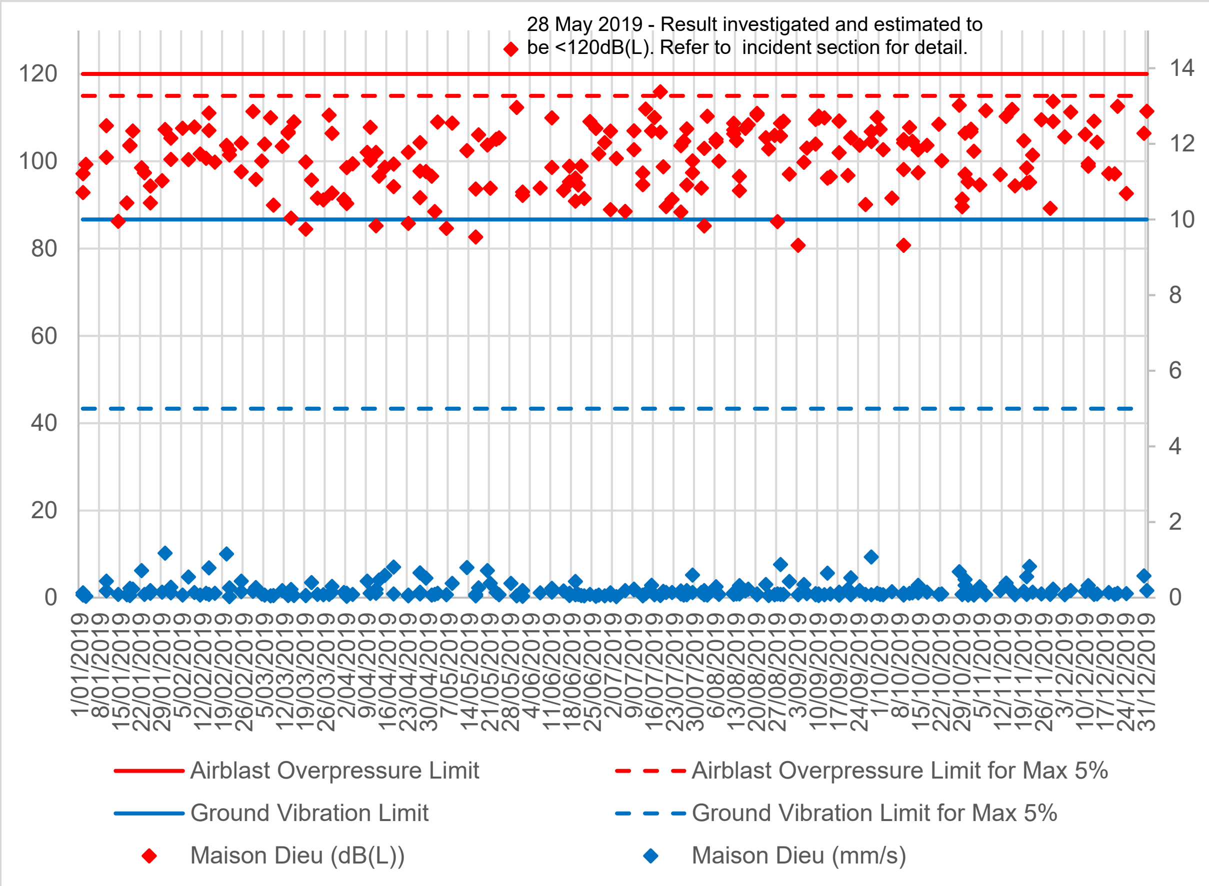


Figure 8: Maison Dieu Blast Monitoring Results 2019

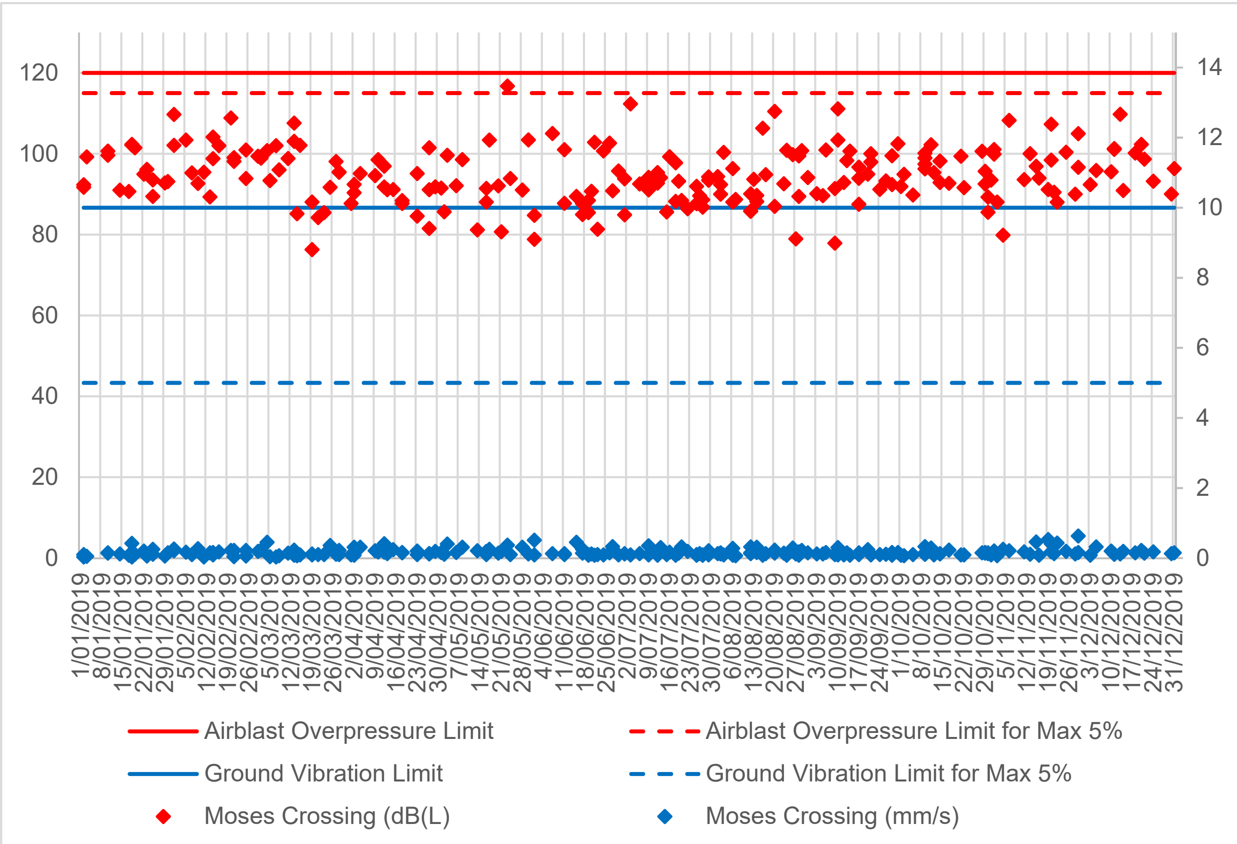


Figure 9: Moses Crossing Blast Monitoring Results 2019

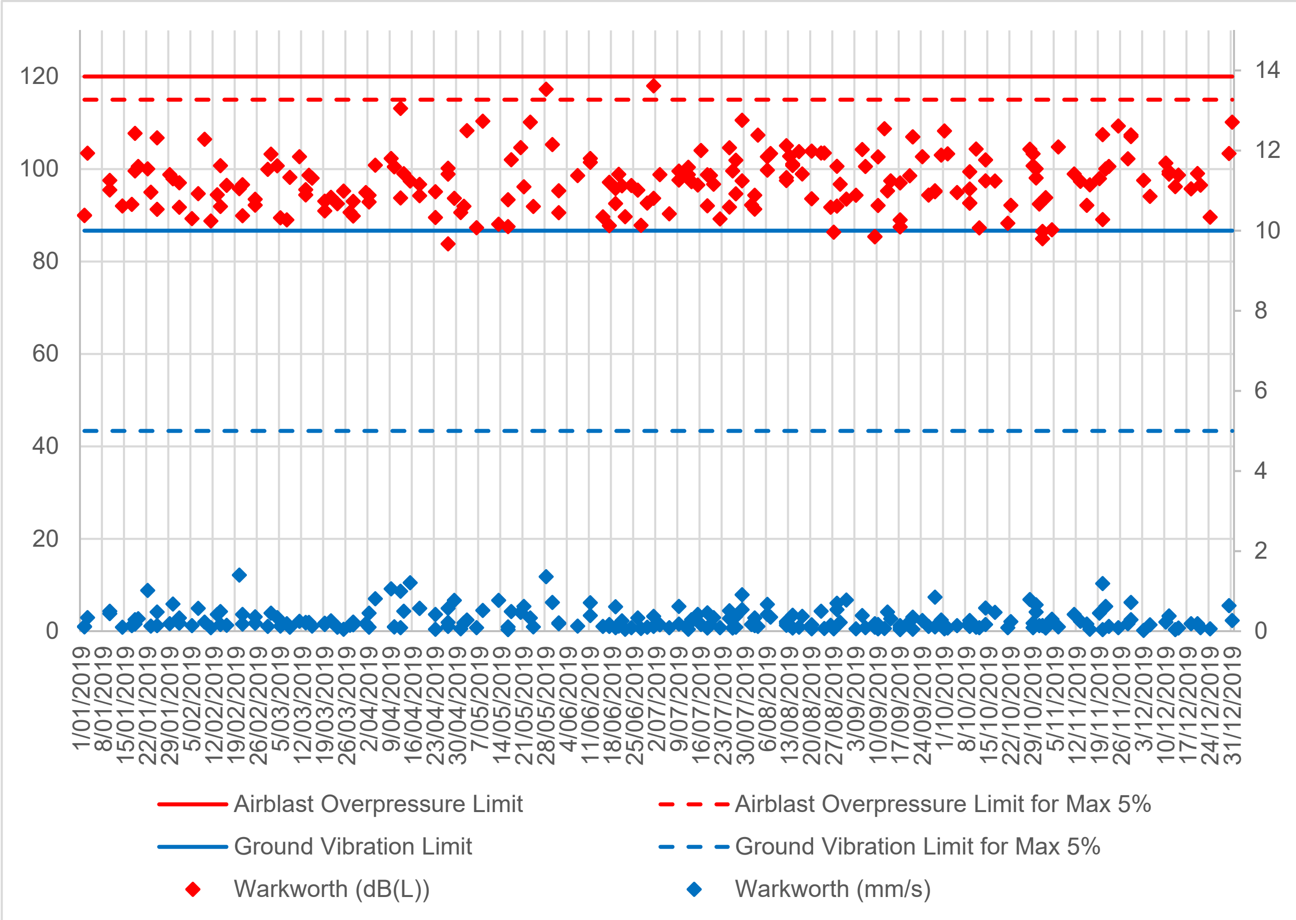


Figure 10: Warkworth Blast Monitoring Results 2019

6.3.3 Blast Fume Management

HVO operates a Post Blast Fume Generation Mitigation and Management Plan. This document outlines the practices to be utilised to reduce the risk of generation of post blast fume, and reduce potential offsite impact from any fume which may be produced. This includes specialised blasting design, appropriate product selection, on-bench water management, implementation of fume management zones and use existing blasting permissions to identify likely path of any fume which may be produced.

All blasts are observed for fume and any fume produced is ranked according to the Australian Explosive Industry & Safety Group (AEISG) Scale.

Fume rankings for shots fired during 2019 and comparison to previous years is provided in Table 24. Four blasts produced fume ranked as category 3 (AEISG scale) but did not leave the mine boundary. No fume ranked as category 4 or 5 occurred during 2019.

Table 24 Visible blast fume rankings according to the AEISG colour scale

AEISG Ranking	2019	2018	2017	2016
0	202	214	272	275
1	39	19	39	49
2	15	16	11	13
3	4	4	2	1
4	0	0	0	0

AEISG Ranking	2019	2018	2017	2016
5	0	0	0	0
Total*	260	253	324	338

* Where a number of individual blasts were fired as a blast event, fume was assessed for each individual blast pattern rather than for the event as a whole.

6.4 Air Quality

6.4.1 Air Quality Management

Air quality management initiatives are implemented at HVO to ensure that:

- Air quality impacts on surrounding residents are minimised;
- All statutory requirements are adhered to; and
- Local community and regulators are kept informed through prompt and effective response to issues and complaints.

Air quality control mechanisms employed at HVO are described in detail in the Hunter Valley Operations Air Quality and Greenhouse Gas Management Plan, publically available via the Hunter Valley Operations Website (https://insite.hvo.com.au).

During 2019, an unprecedented number of days were deemed to have been effected by extraordinary events caused by a combination of continued drought conditions, State wide dust storms, regional dust events and smoke from bushfires which significantly affected the Hunter Valley primarily between October 2019 and January 2020. During this period 58 exceedances of the short term (24 hour) criteria were measured across the HVO monitoring network. Each of these exceedances were reported to DPIE and were noted to have been affected by an extraordinary event and therefore, as per the consent conditions, the criteria was not deemed to be applicable. These events also contributed to exceedances of the long term (annual average) criteria in some instances, however annual averages reported herein have been adjusted to exclude these events. A list of these dates during 2019 that are considered to have been affected by an extraordinary event are provided below:

- January 2019 – 16, 17
- February – 13, 19
- March – 6, 31
- April – 26
- August – 8, 9
- September – 6
- October – 7, 8, 18, 19, 24, 25, 26, 27, 28, 29, 30, 31
- November – 1, 2, 7, 8, 12, 16, 17, 19, 20, 21, 22, 23, 26, 27, 28, 29, 30
- December – 1 to 23, 27 to 31.

Despite difficult conditions, HVO continued to implement operational controls to manage dust emissions in accordance with its Air Quality Management Plan. During 2019, HVO also implemented additional dust management measures including the use of haul road dust suppressant product in HVO West Pit, the use of on bench irrigator to assist with managing dust of blasted material, installation of an additional four monitoring cameras dedicated to dust monitoring and continued upgrade of the CHPP dust suppression system.

6.4.2 Air Quality Performance

6.4.2.1 Real Time Air Quality Management

HVO's real time air quality monitoring stations continuously log information and transmit data to a central database, generating alarms when particulate matter levels exceed internal trigger limits to guide the operational management.

A total of 2527 real time alarms for air quality and meteorological conditions were received and acknowledged during 2019 which is an increase of 1056 alarms from those recorded during 2018. This increase is likely due to the ongoing drought across New South Wales as well as a large number of 'extraordinary event' days, attributed to bushfire smoke from October through to December 2019.

In response, 7206 hours of equipment downtime was recorded due to air quality management. A detailed breakdown of air quality related equipment stoppages (per month, per equipment type) presented in Figure 11.

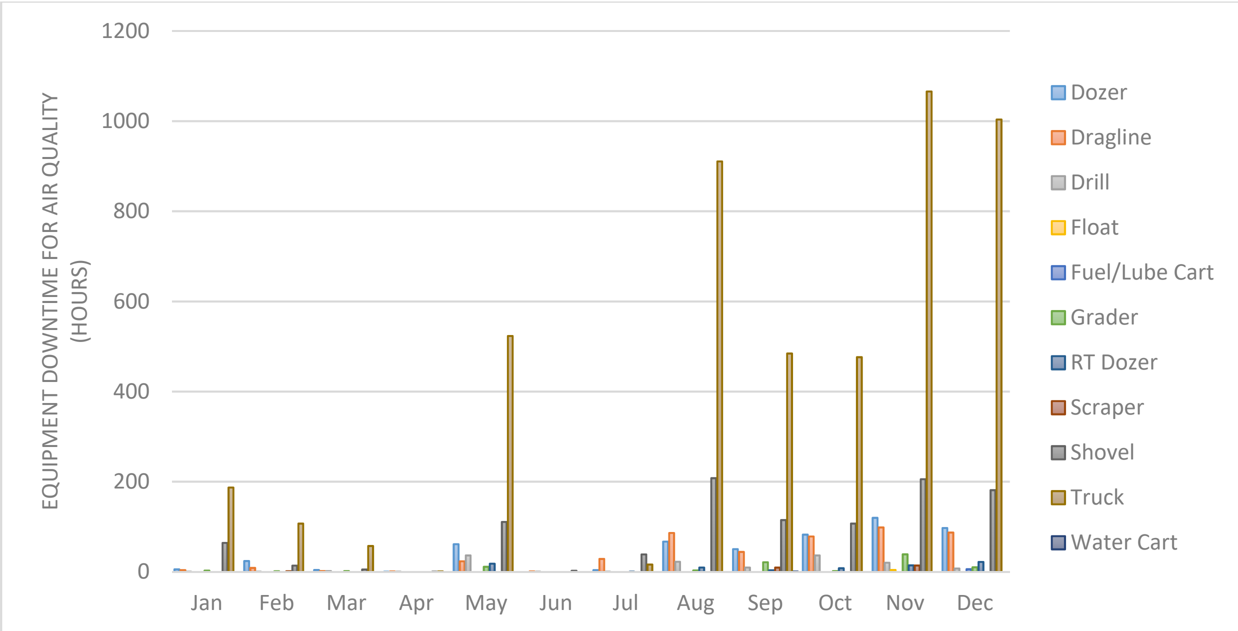


Figure 11: Equipment Downtime Hours for Air Quality Management 2019

Data availability from HVO's real time air quality monitoring stations is presented in Table 25.

Table 25 Real Time PM_{10} Air Quality Monitoring Data Availability 2019

Monitoring Location	2019 Data Availability
Warkworth	99.7%
Knodlers Lane	98.4%
Maison Dieu	99.7%
Howick	99.2%
HC1 Conveyor	98.1%
Wandewoi	96.2%
Golden Highway	98.9%
Jerrys Plains	99.2

Note: Data availability calculated across 2019 is based on availability of a 24 hour average result.

6.4.2.2 Temporary Stabilisation

Aerial Seeding was undertaken in July 2019 by a fixed wing aircraft to provide temporary cover to areas exposed to wind generated dust and erosion at HVO. Waste dumps and exposed areas were selected for seeding if they were not planned to be disturbed within six months. A total area of 405 ha was seeded which included waste dumps ahead of mining disturbance (Figure 12 and Figure 13). All areas were seeded using an exotic pasture and legume mix suitable for autumn sowing. A starter fertiliser was mixed with the seed prior to loading to provide sufficient nutrients for plant growth.

Figure 12: Areas Aerial Seeded in 2019 – HVO North

Figure 13: Areas Aerial Seeded in 2019 – HVO South

6.4.2.3 Air Quality Monitoring

Air quality monitoring at HVO is undertaken in accordance with the HVO Air Quality Monitoring Program. An extensive network of monitoring equipment is utilised to assess performance against the relevant conditions of HVO's approvals. Air quality monitoring locations are shown in Figure 14.

Following approval of the HVO Air Quality and Greenhouse Gas Management Plan on 6 September 2019, HVO installed $PM_{2.5}$ monitoring at Kilburnie South and Maison Dieu within 16 weeks (27 December 2019) of approval of the Plan.

Air quality monitoring data is made publically available through the HVO Monthly Environmental Monitoring Report, which can be viewed on the Hunter Valley Operations Website (https://insite.hvo.com.au).

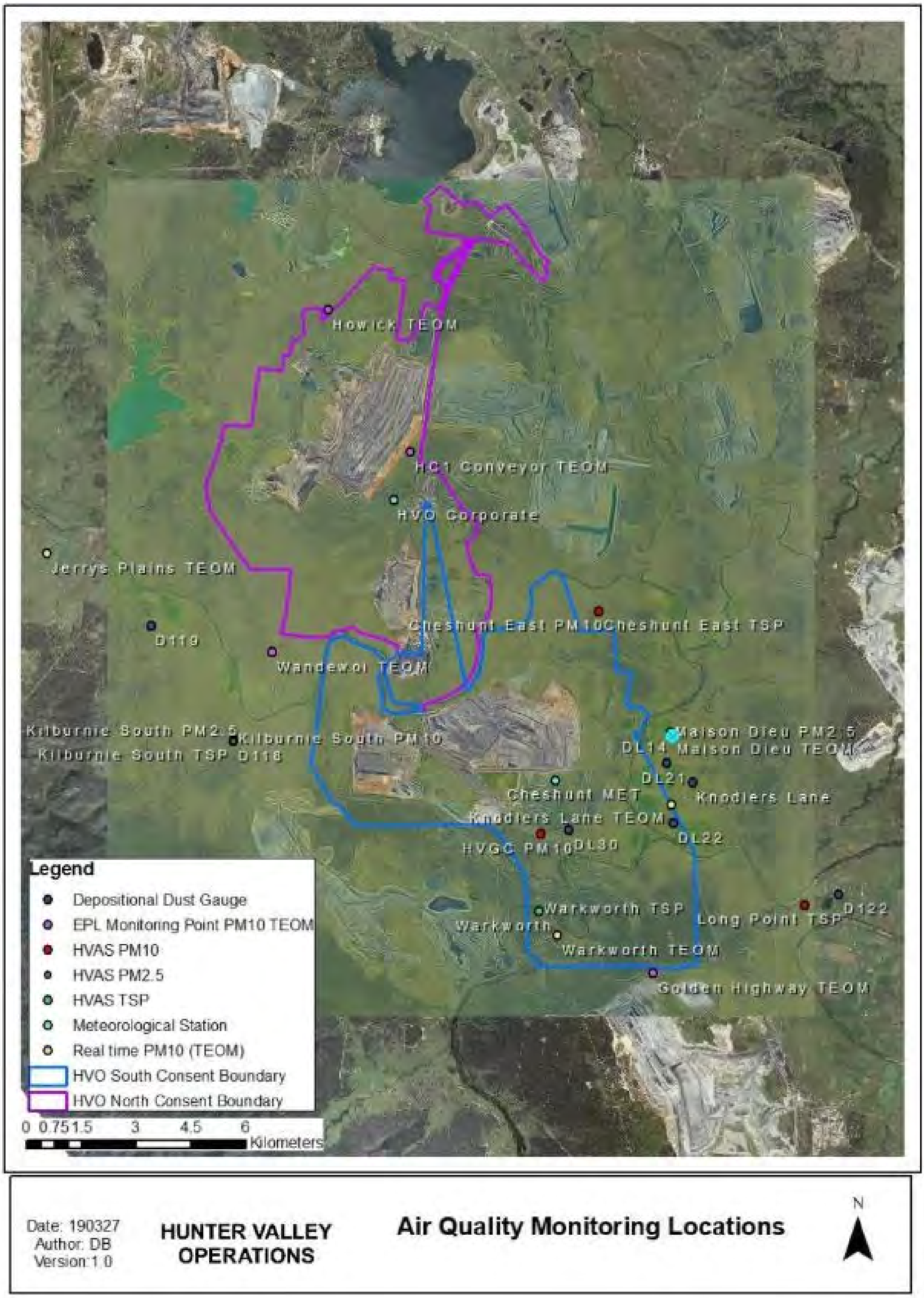


Figure 14: Air Quality Monitoring Locations (as approved 6 September 2019)

6.4.2.4 Deposited Dust

Deposited dust is monitored at nine locations on privately-owned land, in accordance with the HVO Air Quality Monitoring Program. The annual average insoluble matter deposition rates in 2019 compared with the depositional dust impact assessment criterion and previous years' data are shown in Figure 15.

During 2019 monthly dust deposition rates equal to or greater than the long-term impact assessment criteria of 4 g/m2/month were recorded at number of sites. Where field observations denote a sample as contaminated (typically with insects, bird droppings or vegetation), the results are excluded from Annual Average compliance assessment. It should be noted that samples collected between October and December 2019 were affected to some extent by the extraordinary bushfire events however it's not possible to determine the level of impact these events would have had on the samples. It is also consider that depositional dust gauges are less sensitive to smoke particulates than other monitoring methods.

During 2019, three monitoring locations (D118, DL30 and Warkworth) exceeded the annual average insoluble matter deposition rate criteria. All monitoring locations demonstrated compliance with the maximum allowable insoluble solids incremental increase criteria of 2 g/m2/month (Figure 16).

Meteorological conditions and the results of nearby monitors for the sampling period are also considered when determining HVO's level of contribution to any elevated result. Details of excluded results are presented in the relevant HVO Monthly Environmental Monitoring Report.

The three exceedances were assessed to estimate HVO North's maximum contribution to the results. Results of this assessment are provided in Table 26.

Table 26: Dust Deposition Annual Average Assessment

Date	Site	Measured Annual Average Dust Deposition ($g/m^2/month$)	Annual Average Dust Deposition Criteria ($g/m^2/month$)	HVO's contribution to Dust Deposition ($g/m^2/month$)	Discussion
2019	D118	4.8	4	0.4	An external consultant was engaged to investigate the exceedance, which determined that the elevated result was not solely attributable to HVO North. HVO North were not considered to be significant contributor to these exceedances and is therefore compliant.
2019	DL30	4.3	4	1.4	
2019	Warkworth	5.3	4	1.7	

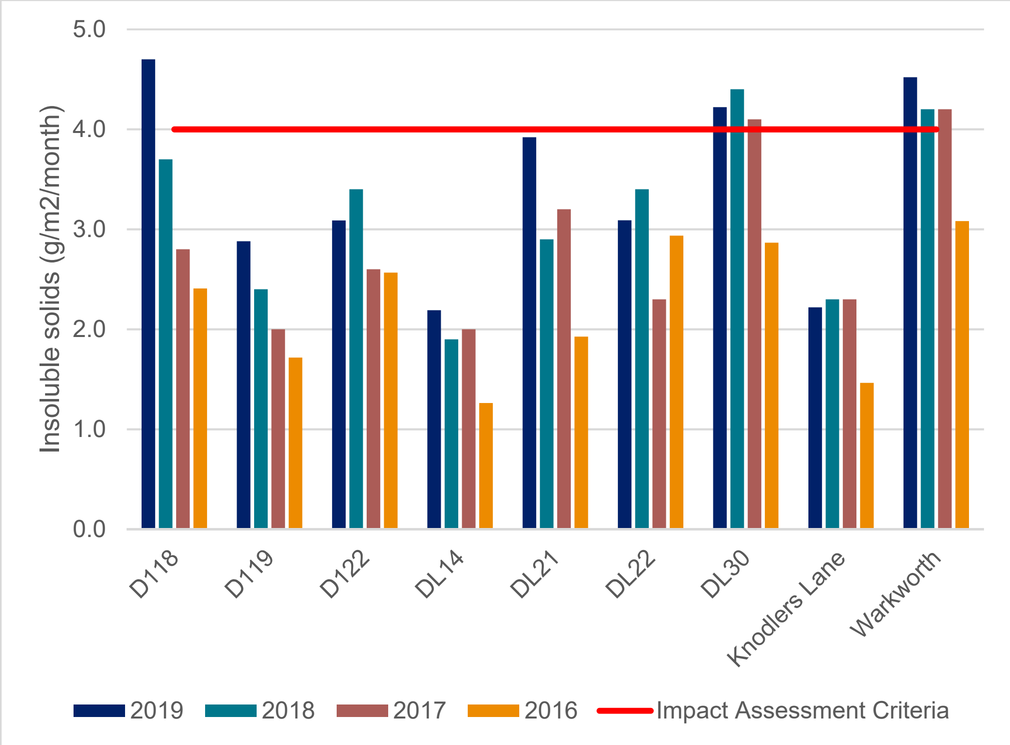


Figure 15: Annual average insoluble matter deposition rates 2016-2019

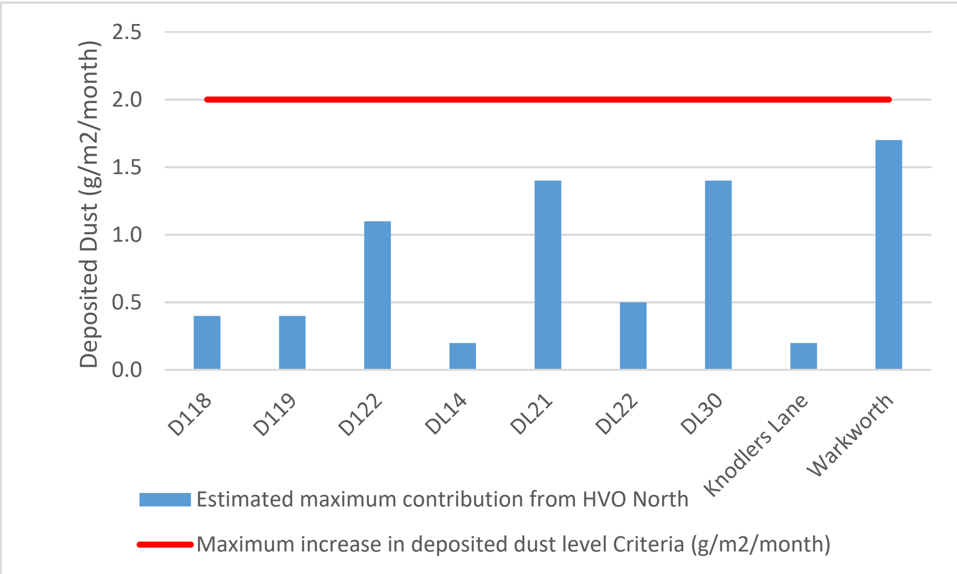


Figure 16: Maximum allowable increase in deposited dust level 2019

6.4.2.5 Total Suspended Particulates (TSP)

Total Suspended Particulates (TSP) are monitored at five locations on privately owned land in accordance with the HVO Air Quality Monitoring Program. In addition, Cheshunt East is located on mine-owned land, however is representative of privately owned property. Historical trends for this location has previously not been reported in annual assessments as it was not previously included formally in the monitoring program until the latest version approved in September 2019.

Annual average TSP concentrations recorded in 2019 compared with the long term impact assessment criterion and previous years' data, are shown in Figure 17. The annual average TSP concentrations recorded in 2019 are reported excluding days deemed to have been affected by extraordinary events (Section 6.4.1). TSP results are consider to be generally consistent with those recorded in previous years.

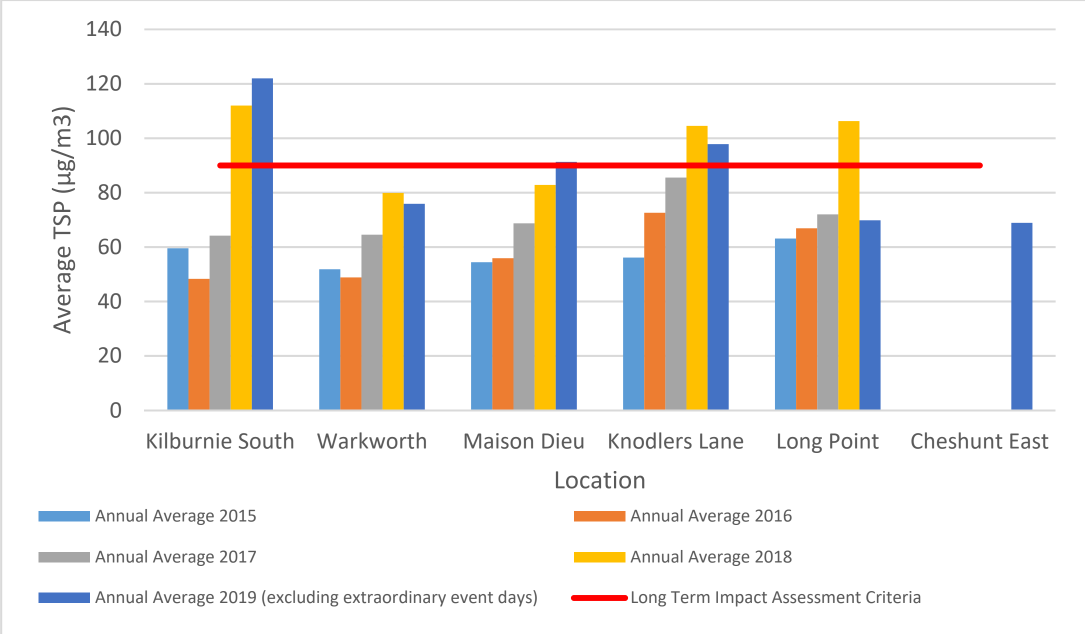


Figure 17: Annual average TSP concentrations 2016 to 2019

During 2019 three monitoring locations exceeded the impact assessment criteria at Kilburnie South, Knodlers Lane and Maison Dieu.

The exceedances were investigated to determine the level of contribution from HVO activities in accordance with the compliance protocol outlined in the HVO Air Quality Management Plan. The estimated contribution was determined following review of results by an air quality consultant which determined that the contributions from HVO (either North, South or Both) in all cases was not deemed to be the significant cause of the exceedances and therefore considered compliant.

A summary of the investigation undertaken for the annual TSP exceedances are provided in Table 27.

Table 27 Annual TSP investigation - 2019

Date	Site	Measured Annual Average TSP level (µg/m³)	Annual Average TSP Criteria (µg/m³)	HVO's contribution to TSP level (µg/m³)	Discussion
2019	Kilburnie South TSP	122	90	40.9 - HVO North 12.9 - HVO South	An air quality specialist was engaged to investigate the exceedance, which determined that the elevated result was not solely attributable to either HVO North or HVO South. HVO North or South were not considered to be significant contributors to this exceedance as they contributed 33% and 11% respectively to the total. With consideration to the HVO being operated as a complex the combined contribution of 44% the contribution is still not considered a significant contributor to the exceedance.
2019	Maison Dieu TSP	91.3	90	18.2 – HVO South Only	An air quality specialist was engaged to investigate the exceedance, which determined that the elevated result was not solely attributable HVO South. HVO South was not considered to be significant

Date	Site	Measured Annual Average TSP level (µg/m³)	Annual Average TSP Criteria (µg/m³)	HVO's contribution to TSP level (µg/m³)	Discussion
					contributors to this exceedance as it contributed only approximately 20% to the exceedance
2019	Knodlers Lane HVAS TSP	97.8	90	22.8 – HVO South Only	An air quality specialist was engaged to investigate the exceedance, which determined that the elevated result was not solely attributable HVO South. HVO South was not considered to be significant contributors to this exceedance as it contributed only approximately 23% to the exceedance

During the reporting period, 3 out of 423 TSP measurements were not able to be collected on the scheduled sampling date (based on a sampling frequency of every six days) due to power failures and technical issues with the monitors.

6.4.2.6 Particulate Matter <10µm (PM_{10})

During 2019, compliance assessment for Particulate Matter <10 µm (PM_{10}) was monitored using HVAS and Real Time TEOM monitors. Prior to the revised Air Quality Management Plan being approved in September 2019, HVAS monitors were utilised as the sole measure of PM_{10} compliance. Post September 2019, TEOM monitors replaced HVAS monitors at Maison Dieu, Knodlers Lane, Warkworth and Wandewoi as the measure of compliance. It should be noted that this increased the number of samples being collected and assessed for compliance compared to previous years.

The Jerrys Plains (DPIE operated) TEOM monitor was also introduced to the monitoring program from September 2019 as such historical trend for this location is not included.

Assessment of annual averages is presented against the full year results recorded against the current approved monitoring program and compliance protocol detailed in the Air Quality and Greenhouse Gas Management Plan.

Cheshunt East is located on mine-owned land, however is representative of privately owned property. Historical trends for this locations have previously not been reported in annual assessments as it was not previously included formally in the monitoring program until the latest version approved in September 2019.

6.4.2.7 Particulate Matter <10µm (PM_{10}) - Short Term (24 hour average) Impact Assessment Criteria

Short Term (24 hour average) PM_{10} concentrations were calculated for both HVAS and TEOM monitors and assessed against the relevant criteria as per the Air Quality and Greenhouse Gas Management Plan. For TEOM monitors, this was undertaken using hourly average data and for HVAS units this was calculated using the 24 hour average concentrations on each of the run days.

Short term (24 hour average) results recorded by HVO's compliance monitoring network during 2019 is presented in Figure 18. Data presented in Figure 18 includes total measured results including contribution from all particulate sources and extraordinary events. Each exceedance was investigated to determine the level of contribution from either HVO North, HVO South or where relevant both. Outcomes of these assessments is provided in Table 28

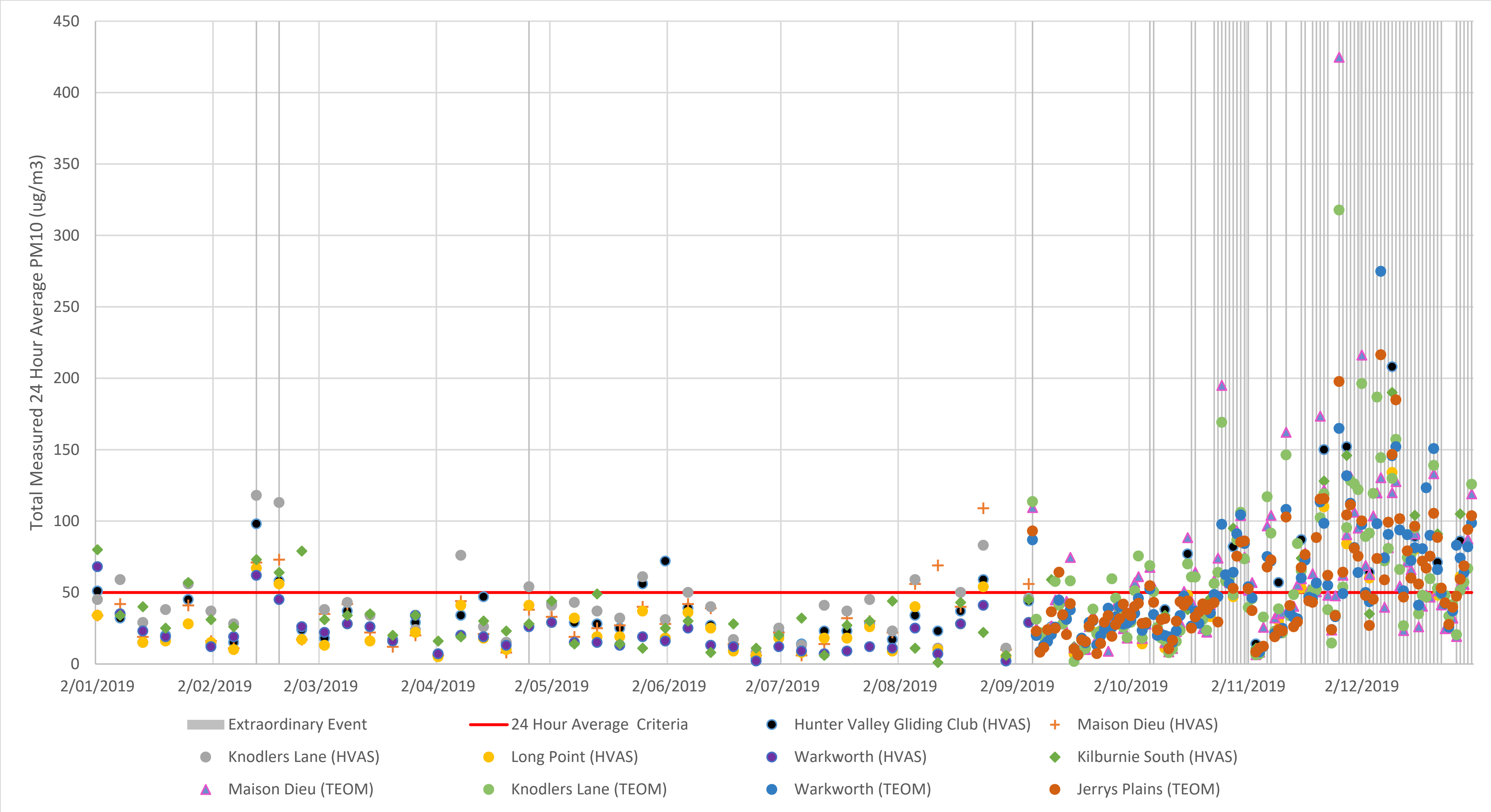


Figure 18: 24 hour average total PM_{10} results- 2019

Table 28 - 24 Hour Elevated TEOMPM10 Investigations

Date	Site	24hr result (µg/m3)	Estimated max. contribution from HVO (µg/m3)	Estimated max. Concentration (%)	Discussion
2/1/2019	Warkworth HVAS	68.0	NA	NA	An investigation found HVO not to be a significant contributor based on prevailing wind conditions.
2/1/2019	Kilburnie South HVAS	80.0	41.0	53.0	An investigation determined that the HVO maximum potential contribution to be in the order of 41.0ug/m3 or 53.0% of the total measured based on prevailing wind conditions and upwind monitoring results. The wind direction was inside the arc of influence for 23% of the 24 hour period.
2/1/2019	Glider Club HVAS	51.0	NA	NA	An investigation found HVO not to be a significant contributor based on prevailing wind conditions.
8/1/2019	Knodlers Lane HVAS	59.0	23.5	39.8	An investigation determined HVO maximum potential contribution to be in the order of 23.5ug/m3 or 39.8% of the total measured based on prevailing wind conditions and upwind monitoring results. The wind direction was inside the arc of influence for 13% of the 24 hour period.
26/1/2019	Kilburnie South HVAS	57.0	14.5	25.4	An investigation determined HVO maximum potential contribution to be in the order of 14.5ug/m3 or 25.4% of the total measured based on prevailing wind conditions and upwind monitoring results. The wind direction was inside the arc of influence for 7% of the 24 hour period.
26/1/2019	Knodlers Lane HVAS	56.0	20.6	43.3	An investigation determined HVO maximum potential contribution to be in the order of 20.6ug/m3 or 43.3% of the total measured based on prevailing wind conditions and upwind monitoring results.
13/02/2019	Cheshunt East HVAS	77.0	49.6	69.7	An investigation determined HVO maximum potential contribution to be in the order of 49.6ug/m3 or 69.7% of the total measured based on prevailing wind conditions and upwind monitoring results. The wind direction was inside the arc of influence for 14% of the 24 hour period. Note that this day is deemed to be affected by an ‘extraordinary’ event.
13/2/2019	Glider Club HVAS	98.0	23.0	19.5	An investigation determined HVO maximum potential contribution to be in the order of 23.0ug/m3 or 19.5% of the total measured based on prevailing wind conditions and upwind monitoring results. The wind direction was inside the arc of influence for 15% of the 24 hour period. Note that this day is deemed to be affected by an ‘extraordinary’ event.

Date	Site	24hr result (µg/m3)	Estimated max. contribution from HVO (µg/m3)	Estimated max. Concentration (%)	Discussion
13/2/2019	Kilburnie South HVAS	73.0	2.5	3.7	An investigation determined HVO maximum potential contribution to be in the order of 2.5ug/m3 or 3.7% of the total measured based on prevailing wind conditions and upwind monitoring results. Note that this day is deemed to be affected by an 'extraordinary' event.
13/2/2019	Maison Dieu HVAS	71.0	NA	NA	An investigation found HVO not to be a significant contributor based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
13/2/2019	Knodlers Lane HVAS	118.0	43.0	36.4	An investigation determined HVO maximum potential contribution to be in the order of 43.0ug/m3 or 36.4% of the total measured based on prevailing wind conditions and upwind monitoring results. The wind direction was inside the arc of influence for 11.8% of the 24 hour period. Note that this day is deemed to be affected by an 'extraordinary' event.
13/2/2019	Long Point HVAS	67.0	NA	NA	An investigation found HVO not to be a significant contributor based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
13/2/2019	Warkworth HVAS	62.0	NA	NA	An investigation found HVO not to be a significant contributor based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
19/02/2019	Cheshunt East HVAS	80.0	24.0	32.9	An investigation determined HVO maximum potential contribution to be in the order of 24.0ug/m3 or 32.9% of the total measured based on prevailing wind conditions and upwind monitoring results. The wind direction was inside the arc of influence for 24% of the 24 hour period. Note that this day is deemed to be affected by an 'extraordinary' event.
19/2/2019	Glider Club HVAS	58.0	2.0	1.8	An investigation determined HVO maximum potential contribution to be in the order of 2ug/m3 or 1.8% of the total measured based on prevailing wind conditions and upwind monitoring results. Note that this day is deemed to be affected by an 'extraordinary' event.
19/2/2019	Kilburnie South HVAS	64.0	NA	NA	An investigation found HVO not to be a significant contributor based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.

Date	Site	24hr result (µg/m3)	Estimated max. contribution from HVO (µg/m3)	Estimated max. Concentration (%)	Discussion
19/2/2019	Knodlers Lane HVAS	113.0	57.0	50.4	An investigation determined HVO maximum potential contribution to be in the order of 57ug/m3 or 50.4% of the total measured based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
19/2/2019	Long Point HVAS	56.0	NA	NA	An investigation found HVO not to be a significant contributor based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
19/2/2019	Maison Dieu HVAS	73.0	17.0	23.3	An investigation determined HVO maximum potential contribution to be in the order of 17ug/m3 or 23.3% of the total measured based on prevailing wind conditions and upwind monitoring results. The wind direction was inside the arc of influence for 23.3% of the 24 hour period. Note that this day is deemed to be affected by an ‘extraordinary’ event.
25/2/2019	Kilburnie South HVAS	79.0	NA	NA	An investigation found HVO not to be a significant contributor based on prevailing wind conditions.
8/4/2019	Knodlers Lane HVAS	76.0	53.5	70.4	An internal investigation determined HVO maximum potential contribution to be in the order of 53.5ug/m3 or 70.4% of the total measured based on prevailing wind conditions and upwind monitoring results. Results considered compliant based on approved management plan (v1.1) at the time.
26/4/2019	Knodlers Lane HVAS	54.0	22.0	70.4	An investigation determined HVO maximum potential contribution to be in the order of 22ug/m3 or 40.7% of the total measured based on prevailing wind conditions and upwind monitoring results. Note that this day is deemed to be affected by an ‘extraordinary’ event.
26/5/2019	Knodlers Lane HVAS	61.0	34.5	57.0	An investigation determined that the HVO maximum potential contribution was estimated to be 34.5ug/m3 or 57.0% of the total measured based on prevailing wind conditions.
26/5/2019	Glider Club HVAS	56.0	41.6	74.0	An investigation determined that the HVO maximum potential contribution was estimated to be 41.6ug/m3 or 74.0% of the total measured based on prevailing wind conditions.
01/06/2019	Gliding Club HVAS	72.0	45.3	63.0	An investigation determined HVO maximum potential contribution to be in the order of 45.3ug/m3 or 63% of the total measured based on prevailing wind conditions and upwind monitoring results.

Date	Site	24hr result (µg/m3)	Estimated max. contribution from HVO (µg/m3)	Estimated max. Concentration (%)	Discussion
6/8/2019	Knodlers Lane HVAS	59.0	41.9	71	An investigation determined HVO maximum potential contribution to be in the order of 41.9.0ug/m3 or 71% of the total measured based on prevailing wind conditions.
6/8/2019	Maison Dieu HVAS	56.0	38.9	69	An investigation determined HVO maximum potential contribution to be in the order of 38.9ug/m3 or 69% of the total measured based on prevailing wind conditions.
24/8/2019	Cheshunt East HVAS	71.0	46.0	42.2	An investigation determined HVO maximum potential contribution to be in the order of 46ug/m3 or 42.2% of the total measured based on prevailing wind conditions.
24/8/2019	Long Point HVAS	54.0	29.0	53.7	An investigation determined HVO maximum potential contribution to be in the order of 29ug/m3 or 53.7% of the total measured based on prevailing wind conditions and upwind monitoring results.
24/8/2019	Gliding Club HVAS	59.0	18.7	31.6	An investigation determined HVO maximum potential contribution to be in the order of 18.7ug/m3 or 31.6% of the total measured based on prevailing wind conditions and upwind monitoring results.
24/8/2019	Maison Dieu HVAS	109.0	<46	<42	An investigation determined HVO maximum potential contribution to be in the order of <46ug/m3 or <42% of the total measured based on prevailing wind conditions.
24/8/2019	Knodlers Lane HVAS	83.0	58.0	69.9	An investigation determined HVO maximum potential contribution to be in the order of 58.0ug/m3 or 69.9% of the total measured based on prevailing wind conditions.
6/9/2019	Jerrys Plains TEOM	93.1	NA – HVO North	NA	An investigation determined HVO North could not have been a significant contributor as wind direction was from HVO for only 9% of the time during the 24 hour period. Note that this day is deemed to be affected by an 'extraordinary' event.
6/9/2019	Jerrys Plains TEOM	93.1	NA – HVO South	NA	An investigation determined HVO South could not have been a significant contributor as wind direction was from HVO for only 2% of the time during the 24 hour period. Note that this day is deemed to be affected by an 'extraordinary' event.
6/9/2019	Knodlers Lane TEOM	113.6	33.8 – HVO South	29	An investigation determined HVO South maximum potential contribution to be in the order of 33.8ug/m3 or 29% of the total measured based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
6/9/2019	Maison Dieu TEOM	109.5	29.7 _ HVO South	27	An investigation determined HVO South maximum potential contribution to be in the order of 29.7ug/m3 or 27% of the total measured based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
6/9/2019	Warkworth TEOM	86.8	7.0 – HVO South	8	An investigation determined HVO South maximum potential contribution to be in the order of 7.0ug/m3 or 8% of the total measured based on prevailing wind conditions.

Date	Site	24hr result (µg/m3)	Estimated max. contribution from HVO (µg/m3)	Estimated max. Concentration (%)	Discussion
					Note that this day is deemed to be affected by an 'extraordinary' event.
11/9/2019	Kilburnie South HVAS	59.0	4.1 – HVO North	2.3	Confirmed results and assessed against compliance protocol to determine if the exceedance was notifiable to the Department. Preliminary notification made internally and to the Department. Engaged air quality consultant to investigate HVO's potential contribution to the exceedance. Investigation determined HVO North Contributed 4.1ug/m3. Department determined that no further action was required, exceedance details to be recorded in the annual review and should be included in the annual average assessment.
11/9/2019	Kilburnie South HVAS	59.0	1.3 – HVO South	7.0	An investigation determined HVO South maximum potential contribution to be in the order of 1.3ug/m3 or 7.0% of the total measured based on prevailing wind conditions.
12/9/2019	Knodlers Lane TEOM	57.7	38.0 – HVO South	65	An investigation determined HVO South maximum potential contribution to be in the order of 19.7ug/m3 or 35% of the total measured based on prevailing wind conditions.
13/9/2019	Jerrys Plains TEOM	64.2	4.3 – HVO North	6	Confirmed results and assessed against compliance protocol to determine if the exceedance was notifiable to the Department. Preliminary notification made internally and to the Department. Commenced investigation into HVO contribution to the exceedance. Investigation determined that HVO North contributed less than 9ug/m3 to the total measured result. Department determined that no further action required with exceedance details to be recorded in the annual review and should be included in the annual average assessment.
13/9/2019	Jerrys Plains TEOM	64.2	NA – HVO South	NA	An investigation determined HVO South could not have been a significant contributor as wind direction was from HVO for 12% of the time during the day.

Date	Site	24hr result (µg/m3)	Estimated max. contribution from HVO (µg/m3)	Estimated max. Concentration (%)	Discussion
16/9/2019	Knodlers Lane	58.1	33.6 – HVO South	57	An investigation determined HVO South maximum potential contribution to be in the order of 33.6ug/m3 or 57% of the total measured based on prevailing wind conditions.
16/9/2019	Maison Dieu TEOM	74.6	7.4 – HVO South	9	An investigation determined HVO South maximum potential contribution to be in the order of 7.4ug/m3 or 9% of the total measured based on prevailing wind conditions.
27/9/2019	Knodlers Lane TEOM	59.5	44.4 – HVO South	74	An investigation determined HVO South maximum potential contribution to be in the order of 44.4ug/m3 or 74% of the total measured based on prevailing wind conditions.
3/10/2019	Maison Dieu TEOM	57.0	0.5 – HVO South	0.0	An investigation determined HVO South maximum potential contribution to be in the order of 0.5ug/m3 based on prevailing wind conditions.
3/10/2019	Knodlers Lane TEOM	51.1	36 – HVO South	70.1	An investigation determined HVO South maximum potential contribution to be in the order of 36.0ug/m3 based on prevailing wind conditions.
4/10/2019	Maison Dieu TEOM	61.1	14.5 – HVO South	23.7	An investigation determined HVO South maximum potential contribution to be in the order of 14.5ug/m3 based on prevailing wind conditions.
4/10/2019	Knodlers Lane TEOM	75.5	30.4 – HVO South	40.2	An investigation determined HVO South maximum potential contribution to be in the order of 30.4ug/m3 based on prevailing wind conditions.
7/10/2019	Jerrys Plains TEOM	64.2	8.4 – HVO South	13.1	An investigation determined HVO South maximum potential contribution to be in the order of 8.4ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
7/10/2019	Jerrys Plain TEOM	54.7	0 – HVO North	0.0	HVO North could not have been a contributor as wind direction was from HVO North for 0% of the day. Note that this day is deemed to be affected by an 'extraordinary' event.
7/10/2019	Maison Dieu TEOM	67.6	21.5 – HVO South	31.8	An investigation determined HVO South maximum potential contribution to be in the order of 21.5ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
7/10/2019	Knodlers Lane TEOM	66.7	43.5 – HVO South	65.2	An investigation determined HVO South maximum potential contribution to be in the order of 43.5ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
7/10/2019	Warkworth TEOM	52.4	39.6 – HVO South	75.6	An investigation determined HVO South maximum potential contribution to be in the order of 39.6ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.

Date	Site	24hr result (µg/m3)	Estimated max. contribution from HVO (µg/m3)	Estimated max. Concentration (%)	Discussion
8/10/2019	Maison Dieu TEOM	53.7	24.8 – HVO South	46.2	An investigation determined HVO South maximum potential contribution to be in the order of 24.8ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
8/10/2019	Knodlers Lane TEOM	50.6	32.5 – HVO South	64.2	An investigation determined HVO South maximum potential contribution to be in the order of 32.5ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
16/10/2019	Maison Dieu TEOM	41.0	24.8 – HVO South	60.5	An investigation determined HVO South maximum potential contribution to be in the order of 24.8ug/m3 based on prevailing wind conditions.
17/10/2019	Gliding Club HVAS	77.0	37.0 – HVO South	48.0	An investigation determined HVO South maximum potential contribution to be in the order of 37.0ug/m3 or 48.0% of the total measured based on prevailing wind conditions and upwind monitoring results.
17/10/2019	Knodlers Lane TEOM	70.0	38.3 – HVO South	54.7	An investigation determined HVO South maximum potential contribution to be in the order of 38.3ug/m3 based on prevailing wind conditions.
17/10/2019	Maison Dieu TEOM	88.4	42.5 – HVO South	48.1	An investigation determined HVO South maximum potential contribution to be in the order of 42.5ug/m3 based on prevailing wind conditions.
18/10/2019	Maison Dieu TEOM	60.8	28.8 – HVO South	47.4	An investigation determined HVO South maximum potential contribution to be in the order of 28.8ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
19/10/2019	Knodlers Lane TEOM	60.8	29.4 – HVO South	48.3	An investigation determined HVO South maximum potential contribution to be in the order of 29.4ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
19/10/2019	Maison Dieu TEOM	64.2	16.1 – HVO South	25.1	An investigation determined HVO South maximum potential contribution to be in the order of 16.1ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
24/10/2019	Maison Dieu TEOM	58.5	16.3 – HVO South	27.9	An investigation determined HVO South maximum potential contribution to be in the order of 16.3ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
24/10/2019	Knodlers Lane TEOM	56.2	16.5 – HVO South	29.4	An investigation determined HVO South maximum potential contribution to be in the order of 16.5ug/m3 based on prevailing wind conditions.

Date	Site	24hr result (µg/m3)	Estimated max. contribution from HVO (µg/m3)	Estimated max. Concentration (%)	Discussion
					Note that this day is deemed to be affected by an 'extraordinary' event.
25/10/2019	Maison Dieu TEOM	74.1	32.1 – HVO South	43.3	An investigation determined HVO South maximum potential contribution to be in the order of 32.1ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
25/10/2019	Knodlers Lane TEOM	64.0	32.4 – HVO South	50.6	An investigation determined HVO South maximum potential contribution to be in the order of 32.4ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
26/10/2019	Knodlers Lane TEOM	169	33.4 – HVO South	20	An investigation determined HVO South maximum potential contribution to be in the order of 33.4ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
26/10/2019	Maison Dieu TEOM	195	33.7 – HVO South	17	An investigation determined HVO South maximum potential contribution to be in the order of 33.7ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
26/10/2019	Warkworth TEOM	97.7	40.4 – HVO South	41.4	An investigation determined HVO South maximum potential contribution to be in the order of 40.4ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
27/10/2019	Knodlers Lane TEOM	58.0	5.5 – HVO South	9.5	An investigation determined HVO South maximum potential contribution to be in the order of 5.5ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
27/10/2019	Maison Dieu TEOM	62.5	12.2 – HVO South	19.5	An investigation determined HVO South maximum potential contribution to be in the order of 12.2ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
27/10/2019	Warkworth TEOM	62.4	11.4 – HVO South	18.3	An investigation determined HVO South maximum potential contribution to be in the order of 11.4ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
28/10/2019	Knodlers Lane TEOM	59.7	2.3 – HVO South	3.9	An investigation determined HVO South maximum potential contribution to be in the order of 2.3ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.

Date	Site	24hr result (µg/m3)	Estimated max. contribution from HVO (µg/m3)	Estimated max. Concentration (%)	Discussion
28/10/2019	Maison Dieu TEOM	57.1	0.6 – HVO South	1.1	An investigation determined HVO South maximum potential contribution to be in the order of 0.6ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
28/10/2019	Warkworth TEOM	56.2	4.8 – HVO South	8.5	An investigation determined HVO South maximum potential contribution to be in the order of 4.8ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
29/10/2019	Glider Club HVAS	82.0	NA – HVO South	NA	An investigation found HVO South not to be a significant contributor based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
29/10/2019	Cheshunt East HVAS	54.0	NA – HVO North	NA	An investigation found HVO North not to be a significant contributor based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
29/10/2019	Kilburnie South HVAS	95.0	NA – HVO North	NA	An investigation determined HVO North not be a significant contributor based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
29/10/2019	Kilburnie South HVAS	95.0	24.0 – HVO South	25.3	An investigation determined HVO South maximum potential contribution to be in the order of 24.0ug/m3 of the total measured based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
29/10/2019	Maison Dieu TEOM	50.3	1.6 – HVO South	3.2	An investigation determined HVO South maximum potential contribution to be in the order of 1.6ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
29/10/2019	Warkworth TEOM	64.0	10.1 – HVO South	15.7	An investigation determined HVO South maximum potential contribution to be in the order of 10.0ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
29/10/2019	Jerrys Plains TEOM	52.8	10.2 – HVO South	19.3	An investigation determined HVO South maximum potential contribution to be in the order of 10.2ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
29/10/2019	Jerrys Plains TEOM	52.8	5.6 – HVO North	10.6	An investigation determined HVO North maximum potential contribution to be in the order of 5.6ug/m3 based on prevailing wind conditions.

Date	Site	24hr result (µg/m3)	Estimated max. contribution from HVO (µg/m3)	Estimated max. Concentration (%)	Discussion
					Note that this day is deemed to be affected by an 'extraordinary' event.
30/10/2019	Knodlers Lane TEOM	86.8	34.3 – HVO South	39.5	An investigation determined HVO South maximum potential contribution to be in the order of 34.3ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
30/10/2019	Maison Dieu TEOM	93.2	23.5 – HVO South	25.2	An investigation determined HVO South maximum potential contribution to be in the order of 23.5ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
30/10/2019	Warkworth TEOM	91.1	24.7 – HVO South	27.1	An investigation determined HVO South maximum potential contribution to be in the order of 24.7ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
30/10/2019	Jerrys Plains TEOM	75.3	5.5– HVO South	7.3	An investigation determined HVO South maximum potential contribution to be in the order of 5.5ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
30/10/2019	Jerrys Plains TEOM	75.3	6.3 – HVO North	8.4	An investigation determined HVO North maximum potential contribution to be in the order of 6.3ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
31/10/2019	Knodlers Lane TEOM	106.1	34.2 – HVO South	32.2	An investigation determined HVO South maximum potential contribution to be in the order of 34.2ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
31/10/2019	Maison Dieu TEOM	103.9	12.9 – HVO South	12.4	An investigation determined HVO South maximum potential contribution to be in the order of 12.9ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
31/10/2019	Warkworth TEOM	104.3	33.5 – HVO South	32.2	An investigation determined HVO South maximum potential contribution to be in the order of 33.5ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
31/10/2019	Jerrys Plains TEOM	85.3	20.2 – HVO South	23.4	An investigation determined HVO South maximum potential contribution to be in the order of 20.2ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.

Date	Site	24hr result (µg/m3)	Estimated max. contribution from HVO (µg/m3)	Estimated max. Concentration (%)	Discussion
31/10/2019	Jerrys Plains TEOM	85.3	7.5 – HVO North	8.8	An investigation determined HVO North maximum potential contribution to be in the order of 7.5ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
1/11/2019	Warkworth TEOM	84.0	8.1 – HVO South	9.6	An investigation determined HVO South maximum potential contribution to be in the order of 8.1ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
1/11/2019	Maison Dieu TEOM	74.8	4.4 – HVO South	5.6	An investigation determined HVO South maximum potential contribution to be in the order of 4.4ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
1/11/2019	Knodlers Lane TEOM	73.5	6.5 – HVO South	8.8	An investigation determined HVO South maximum potential contribution to be in the order of 6.5ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
1/11/2019	Jerrys Plains TEOM	86.0	30.0 – HVO South	34.9	An investigation determined HVO South maximum potential contribution to be in the order of 30.0ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
1/11/2019	Jerrys Plain TEOM	86.0	27.4 – HVO North	21.8	An investigation determined HVO North maximum potential contribution to be in the order of 27.4ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
2/11/2019	Warkworth TEOM	54.0	14.6 – HVO South	27.0	An investigation determined HVO South maximum potential contribution to be in the order of 14.6ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
2/11/2019	Maison Dieu TEOM	51.6	10.1 – HVO South	19.6	An investigation determined HVO South maximum potential contribution to be in the order of 10.1ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
2/11/2019	Jerrys Plains TEOM	52.6	3.5 – HVO South	6.7	An investigation determined HVO South maximum potential contribution to be in the order of 3.5ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
2/11/2019	Jerrys Plains TEOM	52.6	4.6 – HVO North	8.7	An investigation determined HVO North maximum potential contribution to be in the order of 4.6ug/m3 based on prevailing wind conditions.

Date	Site	24hr result (µg/m3)	Estimated max. contribution from HVO (µg/m3)	Estimated max. Concentration (%)	Discussion
					Note that this day is deemed to be affected by an 'extraordinary' event.
3/11/2019	Maison Dieu TEOM	57.0	32.0 – HVO South	56.1	An investigation determined HVO South maximum potential contribution to be in the order of 32.0ug/m3 based on prevailing wind conditions.
7/11/2019	Warkworth TEOM	75.1	3.9 – HVO South	5.2	An investigation determined HVO South maximum potential contribution to be in the order of 3.9ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
7/11/2019	Maison Dieu TEOM	96.7	20.2 – HVO South	20.9	An investigation determined HVO South maximum potential contribution to be in the order of 20.2ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
7/11/2019	Knodlers Lane TEOM	117.0	42.2 – HVO South	36.1	An investigation determined HVO South maximum potential contribution to be in the order of 42.2ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
7/11/2019	Jerrys Plains TEOM	67.8	NA – HVO South	NA	An investigation determined HVO South was not a significant contributor given that wind direction during the 24 hour period was not within the arc of influence. Note that this day is deemed to be affected by an 'extraordinary' event.
7/11/2019	Jerrys Plains TEOM	67.8	NA – HVO North	NA	An investigation determined HVO North was not a significant contributor given that wind direction during the 24 hour period was not within the arc of influence. Note that this day is deemed to be affected by an 'extraordinary' event.
8/11/2019	Warkworth TEOM	72.0	14.3 – HVO South	19.9	An investigation determined HVO South maximum potential contribution to be in the order of 14.3ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
8/11/2019	Maison Dieu TEOM	81.1	8.4 – HVO South	10.4	An investigation determined HVO South maximum potential contribution to be in the order of 8.4ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
8/11/2019	Knodlers Lane TEOM	102.6	29.8 – HVO South	29.0	An investigation determined HVO maximum potential contribution to be in the order of 29.8ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
8/11/2019	Jerrys Plains TEOM	72.8	NA – HVO South	NA	An investigation determined HVO South was not a significant contributor given that wind direction during the 24 hour period was not within the arc of influence.

Date	Site	24hr result (µg/m3)	Estimated max. contribution from HVO (µg/m3)	Estimated max. Concentration (%)	Discussion
					Note that this day is deemed to be affected by an 'extraordinary' event.
8/11/2019	Jerrys Plains TEOM	72.8	NA – HVO North	NA	An investigation determined HVO North was not a significant contributor given that wind direction during the 24 hour period was not within the arc of influence. Note that this day is deemed to be affected by an 'extraordinary' event.
10/11/2019	Gliding Club HVAS	57	34.0 – HVO South	59.6	An investigation determined HVO South maximum potential contribution to be in the order of 34.0ug/m3 or 59.6% of the total measured based on prevailing wind conditions.
12/11/2019	Warkworth TEOM	108.1	14.6 – HVO South	13.5	An investigation determined HVO maximum potential contribution to be in the order of 14.6ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
12/11/2019	Maison Dieu TEOM	162.2	49.4– HVO South	30.5	An investigation determined HVO maximum potential contribution to be in the order of 49.4ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
12/11/2019	Knodlers Lane TEOM	146.3	33.5– HVO South	22.9	An investigation determined HVO maximum potential contribution to be in the order of 33.5ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
12/11/2019	Jerrys Plains TEOM	102.8	0.3– HVO South	2.9	An investigation determined HVO maximum potential contribution to be in the order of 0.3ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
12/11/2019	Jerrys Plains TEOM	102.8	0.1 – HVO North	0.1	An investigation determined HVO maximum potential contribution to be in the order of 0.1ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
15/11/2019	Maison Dieu TEOM	55.5	32.6– HVO South	58.7	An investigation determined HVO maximum potential contribution to be in the order of 32.6ug/m3 based on prevailing wind conditions.
16/11/2019	Cheshunt East HVAS	52.0	NA – HVO North	NA	An investigation found HVO not to be a significant contributor based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.

Date	Site	24hr result (µg/m3)	Estimated max. contribution from HVO (µg/m3)	Estimated max. Concentration (%)	Discussion
16/11/2019	Kilburnie South HVAS	74.0	NA – HVO South	NA	An investigation determined HVO South was not a significant contributor given that wind direction during the 24 hour period was within the arc of influence for 3.5% of the day. Note that this day is deemed to be affected by an 'extraordinary' event.
16/11/2019	Kilburnie South HVAS	74.0	NA – HVO North	NA	An investigation determined HVO North was not a significant contributor given that wind direction during the 24 hour period was within the arc of influence for 5% of the day. Note that this day is deemed to be affected by an 'extraordinary' event.
16/11/2019	Gliding Club HVAS	87.0	34.0 – HVO South	64.2	An investigation determined HVO South maximum potential contribution to be in the order of 34.0ug/m3 or 64.2% of the total measured based on prevailing wind conditions and upwind monitoring results. The wind direction was inside the arc of influence for 19% of the 24 hour period. Note that this day is deemed to be affected by an 'extraordinary' event.
16/11/2019	Long Point HVAS	53.0	NA – HVO South	NA	An investigation found HVO South not to be a significant contributor based on prevailing wind conditions within the arc of influence for 9% of the day. Note that this day is deemed to be affected by an 'extraordinary' event.
16/11/2019	Warkworth TEOM	60.1	8.2 – HVO South	13.6	An investigation determined HVO South maximum potential contribution to be in the order of 8.2ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
16/11/2019	Maison Dieu TEOM	59.7	2.8 – HVO South	4.7	An investigation determined HVO South maximum potential contribution to be in the order of 2.8ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
16/11/2019	Knodlers Lane TEOM	65.2	11.7 – HVO South	17.9	An investigation determined HVO maximum potential contribution to be in the order of 11.7ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
16/11/2019	Jerrys Plains TEOM	67.5	21.0 – HVO South	31.1	An investigation determined HVO South maximum potential contribution to be in the order of 21.0ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
16/11/2019	Jerrys Plains TEOM	67.5	8.9 – HVO North	13.2	An investigation determined HVO North maximum potential contribution to be in the order of 8.9ug/m3 based on prevailing wind conditions.

Date	Site	24hr result (µg/m3)	Estimated max. contribution from HVO (µg/m3)	Estimated max. Concentration (%)	Discussion
					Note that this day is deemed to be affected by an 'extraordinary' event.
17/11/2019	Warkworth TEOM	72.6	24.8 – HVO South	34.1	An investigation determined HVO South maximum potential contribution to be in the order of 24.8ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
17/11/2019	Maison Dieu TEOM	77.7	23.1 – HVO South	29.7	An investigation determined HVO South maximum potential contribution to be in the order of 23.1ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
17/11/2019	Knodlers Lane TEOM	76.5	31.2 – HVO South	40.8	An investigation determined HVO South maximum potential contribution to be in the order of 31.2ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
17/11/2019	Jerrys Plains TEOM	76.5	4.0 – HVO South	5.2	An investigation determined HVO South maximum potential contribution to be in the order of 4.0ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
17/11/2019	Jerrys Plains TEOM	76.5	2.2 – HVO North	2.9	An investigation determined HVO North maximum potential contribution to be in the order of 2.2ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
18/11/2019	Maison Dieu TEOM	51.9	14.9 – HVO South	28.7	An investigation determined HVO South maximum potential contribution to be in the order of 14.9ug/m3 based on prevailing wind conditions.
19/11/2019	Maison Dieu TEOM	63.2	2.8– HVO South	4.4	An investigation determined HVO South maximum potential contribution to be in the order of 2.8ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
19/11/2019	Knodlers Lane TEOM	52.0	21.6– HVO South	41.5	An investigation determined HVO South maximum potential contribution to be in the order of 21.6ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
20/11/2019	Warkworth TEOM	56.6	0 – HVO South	0.0	An investigation determined HVO South was not a significant contributor given that wind direction during the 24 hour period was not within the arc of influence. Note that this day is deemed to be affected by an 'extraordinary' event.
20/11/2019	Maison Dieu TEOM	50.5	0 – HVO South	0.0	An investigation determined HVO South was not a significant contributor given that wind direction during the 24 hour period was not within the arc of influence.

Date	Site	24hr result (µg/m3)	Estimated max. contribution from HVO (µg/m3)	Estimated max. Concentration (%)	Discussion
					Note that this day is deemed to be affected by an 'extraordinary' event.
20/11/2019	Knodlers Lane TEOM	51.9	0 – HVO South	0.0	An investigation determined HVO South was not a significant contributor given that wind direction during the 24 hour period was not within the arc of influence. Note that this day is deemed to be affected by an 'extraordinary' event.
20/11/2019	Jerrys Plains TEOM	88.4	24.2 – HVO South	27.1	An investigation determined HVO South maximum potential contribution to be in the order of 24.2ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
20/11/2019	Jerrys Plains TEOM	88.4	10.0 – HVO North	11.3	An investigation determined HVO North maximum potential contribution to be in the order of 10.0ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
21/11/2019	Warkworth TEOM	113.4	41.0 – HVO South	36.1	An investigation determined HVO South maximum potential contribution to be in the order of 41.0ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
21/11/2019	Maison Dieu TEOM	173.5	12.7 – HVO South	7.3	An investigation determined HVO South maximum potential contribution to be in the order of 12.7ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
21/11/2019	Knodlers Lane TEOM	102.3	31.6 – HVO South	30.9	An investigation determined HVO South maximum potential contribution to be in the order of 31.6ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
21/11/2019	Jerrys Plains TEOM	115.4	5.3 – HVO South	4.6	An investigation determined HVO South maximum potential contribution to be in the order of 5.3ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
21/11/2019	Jerrys Plains TEOM	115.4	7.3 – HVO North	6.3	An investigation determined HVO North maximum potential contribution to be in the order of 7.3ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
22/11/2019	Gliding Club HVAS	150.0	22.0 – HVO South	20.0	An investigation determined HVO South maximum potential contribution to be in the order of 22.0ug/m3 or 20.0% of the total measured based on prevailing wind conditions and upwind monitoring results. The wind direction was inside the arc of influence for 19.9% of the 24 hour period. Note that this day is deemed to be affected by an 'extraordinary' event.

Date	Site	24hr result (µg/m3)	Estimated max. contribution from HVO (µg/m3)	Estimated max. Concentration (%)	Discussion
22/11/2019	Kilburnie South HVAS	128	14.2 – HVO North	11.1	An investigation determined HVO North maximum potential contribution to be in the order of 14.2ug/m3 or 11.1% of the total measured based on prevailing wind conditions. The wind direction was inside the arc of influence for 0.7% of the 24 hour period. Note that this day is deemed to be affected by an 'extraordinary' event.
22/11/2019	Kilburnie South HVAS	128.0	16.0 – HVO South	12.5	An investigation determined HVO maximum potential contribution to be in the order of 16.0ug/m3 or 12.5% of the total measured based on prevailing wind conditions. The wind direction was inside the arc of influence for 4.2% of the 24 hour period. Note that this day is deemed to be affected by an 'extraordinary' event.
22/11/2019	Cheshunt East HVAS	112.0	NA – HVO North	NA	An investigation found HVO North not to be a significant contributor based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
22/11/2019	Long Point HVAS	110.0	NA – HVO South	NA	An investigation found HVO South not to be a significant contributor based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
22/11/2019	Warkworth TEOM	98.4	41.7 – HVO South	42.4	An investigation determined HVO SOuth maximum potential contribution to be in the order of 41.7ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
22/11/2019	Maison Dieu TEOM	121.9	41.8 – HVO South	34.3	An investigation determined HVO South maximum potential contribution to be in the order of 41.8ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
22/11/2019	Knodlers Lane TEOM	119.1	7.2– HVO South	6.0	An investigation determined HVO South maximum potential contribution to be in the order of 7.2ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
22/11/2019	Jerrys Plains TEOM	115.7	3.3– HVO South	2.6	An investigation determined HVO South maximum potential contribution to be in the order of 3.3ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
22/11/2019	Jerrys Plains TEOM	115.7	11.1 – HVO North	9.6	An investigation determined HVO North maximum potential contribution to be in the order of 11.1ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.

Date	Site	24hr result (µg/m3)	Estimated max. contribution from HVO (µg/m3)	Estimated max. Concentration (%)	Discussion
23/11/2019	Warkworth TEOM	55.0	0.3 – HVO South	0.5	An investigation determined HVO South maximum potential contribution to be in the order of 0.3ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
23/11/2019	Jerrys Plains TEOM	61.9	28.7 – HVO South	46.4	An investigation determined HVO South maximum potential contribution to be in the order of 28.7ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
23/11/2019	Jerrys Plains TEOM	61.9	18.9 – HVO North	30.5	An investigation determined HVO North maximum potential contribution to be in the order of 18.9ug/m3 based on prevailing wind conditions. Note that DPIE declared this day to be an ‘extraordinary’ event.
26/11/2019	Warkworth TEOM	164.9	27.9 – HVO South	16.9	An investigation determined HVO South maximum potential contribution to be in the order of 27.9ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
26/11/2019	Maison Dieu TEOM	424.8	25.3 – HVO South	5.9	An investigation determined HVO South maximum potential contribution to be in the order of 25.3ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
26/11/2019	Knodlers Lane TEOM	317.7	48.7 – HVO South	14.9	An investigation determined HVO South maximum potential contribution to be in the order of 48.7ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
26/11/2019	Jerrys Plains TEOM	197.7	0.1 – HVO South	0.0	An investigation determined HVO South maximum potential contribution to be in the order of 0.1ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
26/11/2019	Jerrys Plains TEOM	197.7	NA – HVO North	NA	An investigation determined HVO North was not a significant contributor given that wind direction during the 24 hour period was not within the arc of influence. Note that this day is deemed to be affected by an ‘extraordinary’ event.
27/11/2019	Maison Dieu TEOM	62.1	16.1 – HVO South	25.9	An investigation determined HVO South maximum potential contribution to be in the order of 16.1ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
27/11/2019	Knodlers Lane TEOM	53.8	6.6 – HVO South	12.3	An investigation determined HVO maximum potential contribution to be in the order of 6.6ug/m3 based on prevailing wind conditions.

Date	Site	24hr result (µg/m3)	Estimated max. contribution from HVO (µg/m3)	Estimated max. Concentration (%)	Discussion
					Note that this day is deemed to be affected by an 'extraordinary' event.
27/11/2019	Jerrys Plains TEOM	64.1	8.4 – HVO South	13.1	An investigation determined HVO South maximum potential contribution to be in the order of 8.4ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
27/11/2019	Jerrys Plains TEOM	64.1	5.6 – HVO North	8.7	An investigation determined HVO maximum potential contribution to be in the order of 5.6ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
28/11/2019	Gliding Club HVAS	152.0	68.0 – HVO South	81.0	An investigation determined HVO South maximum potential contribution to be in the order of 68.0ug/m3 or 81.0% of the total measured based on prevailing wind conditions and upwind monitoring results. The wind direction was inside the arc of influence for 15.6% of the 24 hour period. Note that this day is deemed to be affected by an 'extraordinary' event.
28/11/2019	Kilburnie South HVAS	146.0	21.0 – HVO North	14.4	An investigation determined HVO North maximum potential contribution to be in the order of 21.0ug/m3 or 14.4% of the total measured based on prevailing wind conditions. The wind direction was inside the arc of influence for 18.1% of the 24 hour period. Note that this day is deemed to be affected by an 'extraordinary' event.
28/11/2019	Kilburnie South HVAS	146.0	61.0 – HVO South	41.8	An investigation determined HVO South maximum potential contribution to be in the order of 61.0ug/m3 or 41.8% of the total measured based on prevailing wind conditions. The wind direction was inside the arc of influence for 10.4% of the 24 hour period. Note that this day is deemed to be affected by an 'extraordinary' event.
28/11/2019	Cheshunt East HVAS	85.0	1.0 – HVO North	1.2	An investigation determined HVO North maximum potential contribution to be in the order of 1.0ug/m3 or 1.2% of the total measured based on prevailing wind conditions and upwind monitoring results. The wind direction was inside the arc of influence for 6.3% of the 24 hour period. Note that this day is deemed to be affected by an 'extraordinary' event.
28/11/2019	Long Point HVAS	84.0	NA – HVO South	NA	An investigation determined HVO South was not a significant contributor given that wind direction during the 24 hour period was not within the arc of influence. Note that this day is deemed to be affected by an 'extraordinary' event.

Date	Site	24hr result (µg/m3)	Estimated max. contribution from HVO (µg/m3)	Estimated max. Concentration (%)	Discussion
28/11/2019	Warkworth TEOM	133.8	11.3 – HVO South	8.4	An investigation determined HVO South maximum potential contribution to be in the order of 11.3ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
28/11/2019	Maison Dieu TEOM	90.5	11.2 – HVO South	12.4	An investigation determined HVO South maximum potential contribution to be in the order of 11.2ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
28/11/2019	Knodlers Lane TEOM	95.3	17.5 – HVO South	18.4	An investigation determined HVO South maximum potential contribution to be in the order of 17.5ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
28/11/2019	Jerrys Plains TEOM	104.2	6.1- HVO South	5.9	An investigation determined HVO South maximum potential contribution to be in the order of 6.1ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
28/11/2019	Jerrys Plains TEOM	104.2	11.3 – HVO North	10.8	An investigation determined HVO North maximum potential contribution to be in the order of 11.3ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
29/11/2019	Warkworth TEOM	113.3	32.8 – HVO South	28.9	An investigation determined HVO South maximum potential contribution to be in the order of 32.8ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
29/11/2019	Maison Dieu TEOM	128.7	19.9 – HVO South	15.5	An investigation determined HVO South maximum potential contribution to be in the order of 19.9ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
29/11/2019	Knodlers Lane TEOM	128.3	19.4 – HVO South	15.1	An investigation determined HVO South maximum potential contribution to be in the order of 19.4ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
29/11/2019	Jerrys Plains TEOM	109.1	NA – HVO South	NA	An investigation determined HVO South was not a significant contributor given that wind direction during the 24 hour period was not within the arc of influence. Note that this day is deemed to be affected by an 'extraordinary' event.
29/11/2019	Jerrys Plains TEOM	109.1	13.1 – HVO North	12.0	An investigation determined HVO North maximum potential contribution to be in the order of 13.1ug/m3 based on prevailing wind conditions.

Date	Site	24hr result (µg/m3)	Estimated max. contribution from HVO (µg/m3)	Estimated max. Concentration (%)	Discussion
					Note that this day is deemed to be affected by an 'extraordinary' event.
30/11/2019	Warkworth TEOM	82.9	33.5 – HVO South	40.4	An investigation determined HVO South maximum potential contribution to be in the order of 33.5ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
30/11/2019	Maison Dieu TEOM	107.9	34.8 – HVO South	32.3	An investigation determined HVO South maximum potential contribution to be in the order of 34.8ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
30/11/2019	Knodlers Lane TEOM	125.9	30.4 – HVO South	24.1	An investigation determined HVO South maximum potential contribution to be in the order of 30.4 ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
30/11/2019	Jerrys Plains TEOM	84.6	11.4 – HVO South	13.4	An investigation determined HVO South maximum potential contribution to be in the order of 11.4ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
30/11/2019	Jerrys Plains TEOM	84.6	8.1 – HVO North	9.6	An investigation determined HVO North maximum potential contribution to be in the order of 8.1ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
1/12/2019	Knodlers Lane TEOM	112.2	41.3 – HVO South	36.8	An investigation determined HVO maximum potential contribution to be in the order of 41.3 ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
1/12/2019	Maison Dieu TEOM	101.0	30.6 – HVO South	30.3	An investigation determined HVO maximum potential contribution to be in the order of 30.6ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
1/12/2019	Warkworth TEOM	62.9	2.9 – HVO South	4.6	An investigation determined HVO South maximum potential contribution to be in the order of 2.9ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
1/12/2019	Jerrys Plains TEOM	70.8	11.1 – HVO South	15.7	An investigation determined HVO South maximum potential contribution to be in the order of 11.1ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.

Date	Site	24hr result (µg/m3)	Estimated max. contribution from HVO (µg/m3)	Estimated max. Concentration (%)	Discussion
1/12/2019	Jerrys Plains TEOM	70.8	4.2 – HVO North	5.9	An investigation determined HVO North maximum potential contribution to be in the order of 4.2ug/m3 based on prevailing wind conditions Note that this day is deemed to be affected by an 'extraordinary' event.
2/12/2019	Knodlers Lane TEOM	206	117 – HVO South	57.6	An investigation determined HVO maximum potential contribution to be in the order of 117ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
2/12/2019	Maison Dieu TEOM	216	63 – HVO South	29.2	An investigation determined HVO maximum potential contribution to be in the order of 63ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
2/12/2019	Warkworth TEOM	98.7	3.1 – HVO South	3.1	An investigation determined HVO South maximum potential contribution to be in the order of 3.1ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
2/12/2019	Jerrys Plains TEOM	101.2	NA – HVO South	NA	An investigation determined HVO South was not a significant contributor to the exceedance based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
2/12/2019	Jerrys Plains TEOM	101.2	NA – HVO North	NA	An investigation determined HVO North was not a significant contributor to the exceedance based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
3/12/2019	Knodlers Lane TEOM	90.3	46.3 – HVO South	51.2	An investigation determined HVO South maximum potential contribution to be in the order of 46.3ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
3/12/2019	Maison Dieu TEOM	69.0	22.9 – HVO South	33.1	An investigation determined HVO South maximum potential contribution to be in the order of 22.9ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
4/12/2019	Gliding Club HVAS	64.0	29.0 – HVO South	45.3	An investigation determined HVO South maximum potential contribution to be in the order of 29.0ug/m3 or 45.3% of the total measured based on prevailing wind conditions and upwind monitoring results. Note that this day is deemed to be affected by an 'extraordinary' event.

Date	Site	24hr result (µg/m3)	Estimated max. contribution from HVO (µg/m3)	Estimated max. Concentration (%)	Discussion
4/12/2019	Long Point HVAS	60	18.0 – HVO South	30.0	An investigation determined HVO South maximum potential contribution to be in the order of 18.0ug/m3 or 30.0% of the total measured based on prevailing wind conditions and upwind monitoring results. Note that this day is deemed to be affected by an 'extraordinary' event.
4/12/2019	Knodlers Lane TEOM	91.5	43.5 – HVO South	48	An investigation determined HVO maximum potential contribution to be in the order of 43.5 ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
4/12/2019	Maison Dieu TEOM	62.6	4.2 – HVO South	7	An investigation determined HVO South maximum potential contribution to be in the order of 4.2ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
5/12/2019	Knodlers Lane TEOM	119.3	47.1 – HVO South	40	An investigation determined HVO South maximum potential contribution to be in the order of 47.1 ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
5/12/2019	Maison Dieu TEOM	103.6	22.5 – HVO South	22	An investigation determined HVO South maximum potential contribution to be in the order of 22.5ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
6/12/2019	Knodlers Lane TEOM	186.8	45.5 – HVO South	24	An investigation determined HVO South maximum potential contribution to be in the order of 45.5ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
6/12/2019	Maison Dieu TEOM	119.8	13.3 – HVO South	11	An investigation determined HVO South maximum potential contribution to be in the order of 13.3ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
6/12/2019	Warkworth TEOM	102.0	46.6 – HVO South	45.7	An investigation determined HVO South maximum potential contribution to be in the order of 46.6ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
6/12/2019	Jerrys Plains TEOM	75.6	0.9 – HVO South	1.2	An investigation determined HVO South maximum potential contribution to be in the order of 0.9ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.

Date	Site	24hr result (µg/m3)	Estimated max. contribution from HVO (µg/m3)	Estimated max. Concentration (%)	Discussion
6/12/2019	Jerrys Plains TEOM	75.6	NA – HVO North	NA	An investigation determined HVO North was not a significant contributor to the exceedance based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
7/12/2019	Knodlers Lane TEOM	146.0	21.7 – HVO South	14.9	An investigation determined HVO South maximum potential contribution to be in the order of 21.7ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
7/12/2019	Maison Dieu TEOM	130.5	18.1 – HVO South	13.9	An investigation determined HVO South maximum potential contribution to be in the order of 18.1ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
7/12/2019	Warkworth TEOM	243.5	15.7 – HVO South	6.4	An investigation determined HVO South maximum potential contribution to be in the order of 15.7ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
7/12/2019	Jerrys Plains TEOM	207.2	38.8 – HVO South	18.7	An investigation determined HVO South maximum potential contribution to be in the order of 38.8ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
7/12/2019	Jerrys Plains TEOM	216.4	49.3 – HVO North	22.8	An investigation determined HVO North maximum potential contribution to be in the order of 49.3ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
8/12/2019	Knodlers Lane TEOM	72.3	NA – HVO South	NA	An investigation determined HVO South maximum potential contribution to be in the order of 0.0ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
8/12/2019	Warkworth TEOM	75.1	NA – HVO South	NA	An investigation determined HVO South was not a significant contributor to the exceedance based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
8/12/2019	Jerrys Plains TEOM	58.2	14.0 – HVO South	24.1	An investigation determined HVO South maximum potential contribution to be in the order of 14.0ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
8/12/2019	Jerrys Plains TEOM	58.2	48.1 – HVO North	82.6	An investigation determined HVO maximum potential contribution to be in the order of 48.1ug/m3 based on prevailing wind conditions.

Date	Site	24hr result (µg/m3)	Estimated max. contribution from HVO (µg/m3)	Estimated max. Concentration (%)	Discussion
					Note that this day is deemed to be affected by an ‘extraordinary’ event.
9/12/2019	Knodlers Lane TEOM	78.6	11.8 – HVO South	15.0	An investigation determined HVO South maximum potential contribution to be in the order of 11.8ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
9/12/2019	Maison Dieu TEOM	79.3	5.8 – HVO South	7.3	An investigation determined HVO South maximum potential contribution to be in the order of 5.8ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
9/12/2019	Warkworth TEOM	101.7	3.5 – HVO South	3.4	An investigation determined HVO South maximum potential contribution to be in the order of 3.5ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
9/12/2019	Jerrys Plains TEOM	94.4	12.9 – HVO South	13.7	An investigation determined HVO South maximum potential contribution to be in the order of 12.9ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
9/12/2019	Jerrys Plains TEOM	94.4	1.2 – HVO North	1.3	An investigation determined HVO North maximum potential contribution to be in the order of 1.2ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
10/12/2019	Cheshunt East HVAS	117.0	NA – HVO North	NA	An investigation found HVO North not to be a significant contributor based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
10/12/2019	Gliding Club HVAS	208.0	8.0 – HVO South	0.04	An investigation determined HVO South maximum potential contribution to be in the order of 8.0ug/m3 or 0.04% of the total measured based on prevailing wind conditions and upwind monitoring results. Note that this day is deemed to be affected by an ‘extraordinary’ event.
10/12/2019	Kilburnie South HVAS	190	NA – HVO North	NA	An investigation found HVO North not to be a significant contributor based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
10/12/2019	Kilburnie South HVAS	190	NA – HVO South	NA	An investigation found HVO South not to be a significant contributor based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.

Date	Site	24hr result (µg/m3)	Estimated max. contribution from HVO (µg/m3)	Estimated max. Concentration (%)	Discussion
10/12/2019	Long Point HVAS	134	17.0 – HVO South	12.7	An investigation determined HVO South maximum potential contribution to be in the order of 17.0ug/m3 or 12.7% of the total measured based on prevailing wind conditions and upwind monitoring results. Note that this day is deemed to be affected by an ‘extraordinary’ event.
10/12/2019	Knodlers Lane TEOM	134.6	41.1 – HVO South	30.5	An investigation determined HVO South maximum potential contribution to be in the order of 41.1ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
10/12/2019	Maison Dieu TEOM	119.7	35.0 – HVO South	29.2	An investigation determined HVO South maximum potential contribution to be in the order of 35.0ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
10/12/2019	Warkworth TEOM	145.7	44.7 – HVO South	30.1	An investigation determined HVO South maximum potential contribution to be in the order of 44.7ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
10/12/2019	Jerrys Plains TEOM	146.6	20.6 – HVO South	14.1	An investigation determined HVO South maximum potential contribution to be in the order of 20.6ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
10/12/2019	Jerrys Plains TEOM	146.6	16.5 – HVO North	11.3	An investigation determined HVO North maximum potential contribution to be in the order of 16.5ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
11/12/2019	Knodlers Lane TEOM	154.5	NA – HVO South	NA	An investigation found HVO South not to be a significant contributor based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
11/12/2019	Maison Dieu TEOM	129.9	NA – HVO South	NA	An investigation found HVO South not to be a significant contributor based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
11/12/2019	Warkworth TEOM	152.0	NA – HVO South	NA	An investigation found HVO South not to be a significant contributor based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.

Date	Site	24hr result (µg/m3)	Estimated max. contribution from HVO (µg/m3)	Estimated max. Concentration (%)	Discussion
11/12/2019	Jerrys Plains TEOM	184.8	39.4 – HVO South	21.3	An investigation determined HVO South maximum potential contribution to be in the order of 39.4ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
11/12/2019	Jerrys Plains TEOM	184.8	25.6 – HVO North	14.3	An investigation determined HVO maximum potential contribution to be in the order of 25.6ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
12/12/2019	Knodlers Lane TEOM	62.8	NA – HVO South	NA	An investigation found HVO South not to be a significant contributor based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
12/12/2019	Maison Dieu TEOM	50.7	NA – HVO South	NA	An investigation found HVO South not to be a significant contributor based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
12/12/2019	Warkworth TEOM	93.7	NA – HVO South	NA	An investigation found HVO South not to be a significant contributor based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
12/12/2019	Jerrys Plains TEOM	105.7	44.0 – HVO South	41.6	An investigation determined HVO South maximum potential contribution to be in the order of 44.0ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
12/12/2019	Jerrys Plains TEOM	105.7	24.8 – HVO North	23.5	An investigation determined HVO North maximum potential contribution to be in the order of 24.8ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
13/12/2019	Warkworth TEOM	51.1	NA – HVO South	NA	An investigation found HVO South not to be a significant contributor based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
14/12/2019	Knodlers Lane TEOM	76.2	20.9 – HVO South	27.4	An investigation determined HVO South maximum potential contribution to be in the order of 20.9ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
14/12/2019	Maison Dieu TEOM	73.5	20.8 – HVO South	28.2	An investigation determined HVO South maximum potential contribution to be in the order of 20.8ug/m3 based on prevailing wind conditions.

Date	Site	24hr result (µg/m3)	Estimated max. contribution from HVO (µg/m3)	Estimated max. Concentration (%)	Discussion
					Note that this day is deemed to be affected by an 'extraordinary' event.
14/12/2019	Warkworth TEOM	90.5	24.0 – HVO South	26.5	An investigation determined HVO South maximum potential contribution to be in the order of 24.0ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
14/12/2019	Jerrys Plains TEOM	79.0	NA – HVO South	NA	An investigation found HVO South not to be a significant contributor based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
14/12/2019	Jerrys Plains TEOM	81.4	3.6- HVO North	4.4	An investigation determined HVO North maximum potential contribution to be in the order of 3.6ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
15/12/2019	Knodlers Lane TEOM	74.9	24.2 – HVO South	32.3	An investigation determined HVO South maximum potential contribution to be in the order of 24.2ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
15/12/2019	Maison Dieu TEOM	64.3	13.0 – HVO South	20.2	An investigation determined HVO South maximum potential contribution to be in the order of 13.0ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
15/12/2019	Warkworth TEOM	72.4	17.6 – HVO South	24.3	An investigation determined HVO South maximum potential contribution to be in the order of 17.6ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
15/12/2019	Jerrys Plains TEOM	60.0	4.3 – HVO South	7.2	An investigation determined HVO South maximum potential contribution to be in the order of 4.3ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
15/12/2019	Jerrys Plains TEOM	59.8	4.4 – HVO North	7.4	An investigation determined HVO North maximum potential contribution to be in the order of 4.4ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
16/12/2019	Cheshunt East HVAS North	95.0	NA – HVO North	NA	An investigation found HVO North not to be a significant contributor based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.

Date	Site	24hr result (µg/m3)	Estimated max. contribution from HVO (µg/m3)	Estimated max. Concentration (%)	Discussion
16/12/2019	Kilburnie South HVAS	104.0	NA – HVO North	NA	An investigation found HVO North not to be a significant contributor based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
16/12/2019	Kilburnie South HVAS	104.0	NA – HVO South	NA	An investigation found HVO South not to be a significant contributor based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
16/12/2019	Gliding Club HVAS	89.0	9.0 – HVO South	10.1	An investigation determined HVO South maximum potential contribution to be in the order of 89.0ug/m3 or 9.0% of the total measured based on prevailing wind conditions. The wind direction was inside the arc of influence for 24% of the 24 hour period. Note that this day is deemed to be affected by an ‘extraordinary’ event.
16/12/2019	Knodlers Lane TEOM	95.8	5.0 – HVO South	5.2	An investigation determined HVO South maximum potential contribution to be in the order of 5.0ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
16/12/2019	Maison Dieu TEOM	64.3	4.2 – HVO South	6.5	An investigation determined HVO South maximum potential contribution to be in the order of 4.2ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
16/12/2019	Warkworth TEOM	78.6	9.1 – HVO South	11.6	An investigation determined HVO South maximum potential contribution to be in the order of 9.1ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
16/12/2019	Jerrys Plains TEOM	96.3	45.5 – HVO South	47.2	An investigation determined HVO South maximum potential contribution to be in the order of 45.5ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
16/12/2019	Jerrys Plains TEOM	96.4	41.1 – HVO North	42.6	An investigation determined HVO North maximum potential contribution to be in the order of 41.1ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
17/12/2019	Jerrys Plains TEOM	55.8	34.8 – HVO South	62.3	An investigation determined HVO South maximum potential contribution to be in the order of 34.8ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.

Date	Site	24hr result (µg/m3)	Estimated max. contribution from HVO (µg/m3)	Estimated max. Concentration (%)	Discussion
17/12/2019	Jerrys Plains TEOM	56.1	10.3 – HVO North	18.4	An investigation determined HVO North maximum potential contribution to be in the order of 10.3ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
18/12/2019	Warkworth TEOM	80.6	NA – HVO South	NA	An investigation found HVO South not to be a significant contributor based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
18/12/2019	Jerrys Plains TEOM	71.9	17.0 – HVO South	23.6	An investigation determined HVO South maximum potential contribution to be in the order of 17.0ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
18/12/2019	Jerrys Plains TEOM	73.0	13.0 – HVO North	17.8	An investigation determined HVO North maximum potential contribution to be in the order of 13.0ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event..
19/12/2019	Warkworth TEOM	129.0	18.7 – HVO South	25.6	An investigation determined HVO South maximum potential contribution to be in the order of 18.7ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
19/12/2019	Jerrys Plains TEOM	85.8	NA – HVO South	NA	An investigation found HVO South not to be a significant contributor based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
19/12/2019	Jerrys Plains TEOM	85.8	22.5 – HVO North	26.2	An investigation determined HVO North maximum potential contribution to be in the order of 22.5ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
20/12/2019	Knodlers Lane TEOM	59.0	NA – HVO South	NA	An investigation found HVO South not to be a significant contributor based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
20/12/2019	Warkworth TEOM	83.8	NA – HVO South	NA	An investigation found HVO South not to be a significant contributor based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
20/12/2019	Jerrys Plains TEOM	75.5	43.5 – HVO South	57.2	An investigation determined HVO South maximum potential contribution to be in the order of 43.5ug/m3 based on prevailing wind conditions.

Date	Site	24hr result (µg/m3)	Estimated max. contribution from HVO (µg/m3)	Estimated max. Concentration (%)	Discussion
					Note that this day is deemed to be affected by an ‘extraordinary’ event.
20/12/2019	Jerrys Plains TEOM	75.5	13.6 – HVO North	18.0	An investigation determined HVO North maximum potential contribution to be in the order of 13.6ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
21/12/2019	Knodlers Lane TEOM	140.2	31.1 – HVO South	22.1	An investigation determined HVO South maximum potential contribution to be in the order of 31.1ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
21/12/2019	Maison Dieu TEOM	135.0	34.9 – HVO South	25.6	An investigation determined HVO South maximum potential contribution to be in the order of 34.9ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
21/12/2019	Warkworth TEOM	157.4	32.9 – HVO South	20.9	An investigation determined HVO South maximum potential contribution to be in the order of 32.9ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
21/12/2019	Jerrys Plains TEOM	124.3	1.9 – HVO South	1.5	An investigation determined HVO South maximum potential contribution to be in the order of 1.9ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
21/12/2019	Jerrys Plains TEOM	124.3	3.4 – HVO North	2.7	An investigation determined HVO Northmaximum potential contribution to be in the order of 3.4ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.
22/12/2019	Kilburnie South HVAS	91.0	20.0 – HVO North	22.0	An investigation determined HVO North maximum potential contribution to be in the order of 20.0/m3 or 22.0% of the total measured based on prevailing wind conditions. The wind direction was inside the arc of influence for 0% of the 24 hour period. Note that this day is deemed to be affected by an ‘extraordinary’ event.
22/12/2019	Kilburnie South HVAS	91.0	42.0 – HVO South	49.0	An investigation determined HVO South maximum potential contribution to be in the order of 42.0/m3 or 49.0% of the total measured based on prevailing wind conditions. The wind direction was inside the arc of influence for 1.4% of the 24 hour period. Note that this day is deemed to be affected by an ‘extraordinary’ event.
22/12/2019	Gliding Club HVAS	71.0	NA – HVO South	NA	An investigation found HVO South not to be a significant contributor based on prevailing wind conditions. Note that this day is deemed to be affected by an ‘extraordinary’ event.

Date	Site	24hr result (µg/m3)	Estimated max. contribution from HVO (µg/m3)	Estimated max. Concentration (%)	Discussion
22/12/2019	Knodlers Lane TEOM	51.3	NA – HVO South	NA	An investigation found HVO South not to be a significant contributor based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
22/12/2019	Maison Dieu TEOM	50.3	NA – HVO South	NA	An investigation found HVO South not to be a significant contributor based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
22/12/2019	Warkworth TEOM	60.0	NA – HVO South	NA	An investigation found HVO South not to be a significant contributor based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
22/12/2019	Jerrys Plains TEOM	69.8	29.0 – HVO South	41.5	An investigation determined HVO South maximum potential contribution to be in the order of 29.0ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
22/12/2019	Jerrys Plains TEOM	69.8	17.0 – HVO North	24.4	An investigation determined HVO North maximum potential contribution to be in the order of 17.0ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
23/12/2019	Jerrys Plains TEOM	51.6	6.0 – HVO South	11.6	An investigation determined HVO South maximum potential contribution to be in the order of 6.0ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
23/12/2019	Jerrys Plains TEOM	69.8	2.3 – HVO North	3.3	An investigation determined HVO North maximum potential contribution to be in the order of 2.3ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
27/12/2019	Jerrys Plains TEOM	69.4	40.4 – HVO South	58.2	An investigation determined HVO South maximum potential contribution to be in the order of 40.4ug/m3 based on prevailing wind conditions.
27/12/2019	Jerrys Plains TEOM	69.4	14.8 – HVO North	21.3	An investigation determined HVO North maximum potential contribution to be in the order of 14.8ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
28/12/2019	Cheshunt East HVAS	61.0	NA – HVO North	NA	An investigation found HVO North not to be a significant contributor based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.

Date	Site	24hr result (µg/m3)	Estimated max. contribution from HVO (µg/m3)	Estimated max. Concentration (%)	Discussion
28/12/2019	Kilburnie South HVAS North	105.0	NA – HVO North	NA	An investigation found HVO North not to be a significant contributor based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
28/12/2019	Kilburnie South HVAS South	105.0	NA – HVO South	NA	An investigation found HVO South not to be a significant contributor based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
28/12/2019	Gliding Club HVAS	86.0	25.0 – HVO South	29.1	An investigation determined HVO South maximum potential contribution to be in the order of 25.0/m3 or 29.1% of the total measured based on prevailing wind conditions. The wind direction was inside the arc of influence for 20% of the 24 hour period. Note that this day is deemed to be affected by an 'extraordinary' event.
28/12/2019	Long Point HVAS	61.0	NA – HVO South	NA	An investigation found HVO South not to be a significant contributor based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
28/12/2019	Maison Dieu TEOM	56.0	3.7 – HVO South	6.6	An investigation determined HVO South maximum potential contribution to be in the order of 3.7ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
28/12/2019	Warkworth TEOM	98.6	41.2- HVO South	41.8	An investigation determined HVO South maximum potential contribution to be in the order of 41.2ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
28/12/2019	Jerrys Plains TEOM	62.1	10.1 – HVO South	16.3	An investigation determined HVO South maximum potential contribution to be in the order of 10.1ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
28/12/2019	Jerrys Plains TEOM	62.1	26.5 – HVO North	42.7	An investigation determined HVO North maximum potential contribution to be in the order of 26.5ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
29/12/2019	Knodlers Lane TEOM	54.5	2.0 – HVO South	7.3	An investigation determined HVO South maximum potential contribution to be in the order of 2.0ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.

Date	Site	24hr result (µg/m3)	Estimated max. contribution from HVO (µg/m3)	Estimated max. Concentration (%)	Discussion
29/12/2019	Maison Dieu TEOM	57.4	3.4 – HVO South	5.9	An investigation determined HVO South maximum potential contribution to be in the order of 3.4ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
29/12/2019	Warkworth TEOM	64.1	18.8 – HVO South	29.3	An investigation determined HVO South maximum potential contribution to be in the order of 18.8ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
29/12/2019	Jerrys Plains TEOM	70.6	23.4 – HVO South	33.1	An investigation determined HVO South maximum potential contribution to be in the order of 23.4ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
29/12/2019	Jerrys Plains TEOM	70.6	7.1 – HVO North	10.13	An investigation determined HVO North maximum potential contribution to be in the order of 7.1ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
30/12/2019	Knodlers Lane TEOM	66.7	17.6 – HVO South	26.4	An investigation determined HVO South maximum potential contribution to be in the order of 17.6ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
30/12/2019	Maison Dieu TEOM	87.4	27.7 – HVO South	31.7	An investigation determined HVO South maximum potential contribution to be in the order of 27.7ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
30/12/2019	Warkworth TEOM	81.9	13.4 – HVO South	16.4	An investigation determined HVO South maximum potential contribution to be in the order of 13.4ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
30/12/2019	Jerrys Plains TEOM	94.0	11.7 – HVO South	12.4	An investigation determined HVO South maximum potential contribution to be in the order of 11.7ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
30/12/2019	Jerrys Plains TEOM	94.0	15.1 – HVO North	16.1	An investigation determined HVO North maximum potential contribution to be in the order of 15.1ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
31/12/2019	Knodlers Lane TEOM	125.7	30.0 – HVO South	23.9	An investigation determined HVO South maximum potential contribution to be in the order of 30.0ug/m3 based on prevailing wind conditions.

Date	Site	24hr result (µg/m3)	Estimated max. contribution from HVO (µg/m3)	Estimated max. Concentration (%)	Discussion
					Note that this day is deemed to be affected by an 'extraordinary' event.
31/12/2019	Maison Dieu TEOM	119.1	42.2 – HVO South	35.4	An investigation determined HVO South maximum potential contribution to be in the order of 42.2ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
31/12/2019	Warkworth TEOM	98.6	41.2– HVO South	41.8	An investigation determined HVO South maximum potential contribution to be in the order of 41.2ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
31/12/2019	Jerrys Plains TEOM	103.6	3.4– HVO South	3.3	An investigation determined HVO South maximum potential contribution to be in the order of 3.4ug/m3 based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.
31/12/2019	Jerrys Plains TEOM	103.6	NA – HVO North	NA	An investigation found HVO North not to be a significant contributor based on prevailing wind conditions. Note that this day is deemed to be affected by an 'extraordinary' event.

6.4.2.8 Long term PM_{10} impact assessment criteria

Annual average PM_{10} concentrations were calculated for both HVAS and TEOM monitors and assessed against the relevant criteria as per the Air Quality and Greenhouse Gas Management Plan. For TEOM monitors, this was undertaken using hourly average data and for HVAS units this was calculated using the 24 hour average concentrations on each of the run days. Where results were deemed to have been effected by an extraordinary event these results have been excluded from the calculation of the annual average. A comparison of the long term PM_{10} impact assessment criterion and previous years' data, are shown on Figure 19.

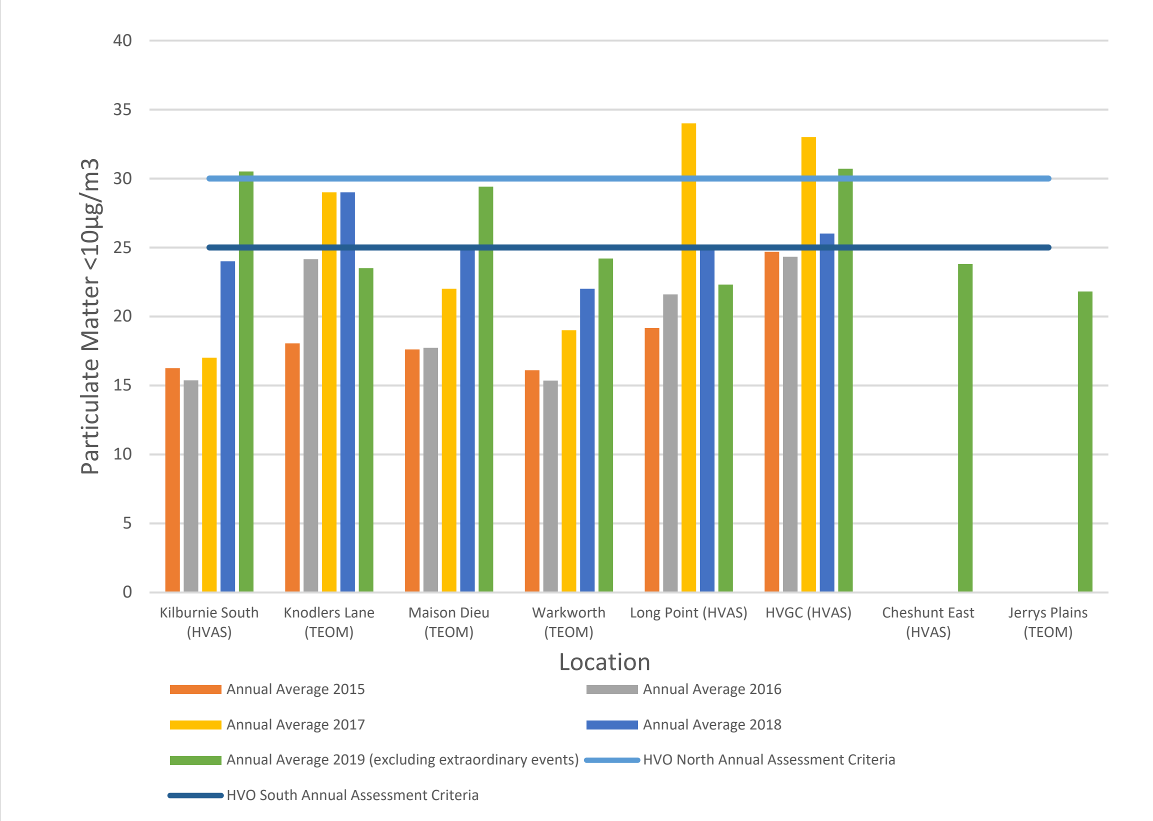


Figure 19: Annual average HVAS PM10 results 2015 to 2019

During 2019, three of the eight monitoring locations exceeded the annual average PM_{10} impact assessment criteria. The results were investigated to determine the level of contribution from HVO activities in accordance with the compliance protocol outlined in the HVO Air Quality Management Plan.

The exceedances were investigated to determine the level of contribution from HVO activities in accordance with the compliance protocol outlined in the HVO Air Quality Management Plan. The estimated contribution was determined following review of results by an air quality consultant which determined that the contributions from HVO (either North, South or Both) in all cases was not deemed to be the significant cause of the exceedance and is therefore considered compliant.

A summary of the investigations undertaken for the annual PM_{10} exceedances are provided in Table 29 .

Table 29 Assessment of Annual Average PM_{10} - 2019

Monitoring Location	Measured PM_{10} Annual Average µg/m³	Annual Average PM_{10} Criteria µg/m³	Maximum Estimated PM_{10} Solely due to HVO µg/m³	Discussion
Kilburnie South (HVAS)	30.5	30 – HVO North 25 – HVO South	2.2 – HVO North 6.7 – HVO South	An air quality specialist was engaged to investigate these exceedances, which determined that the elevated results were not solely attributable to either HVO North or HVO South. HVO North or South were not considered to be significant contributors to this exceedance and HVO considers these exceedances to be compliant.
Maison Dieu (TEOM)t	29.4	25 – HVO South Only	1.4 – HVO South	
Hunter Valley Gliding Club (HVAS)	30.7	25 – HVO South Only	8.8 – HVO South	

6.4.2.9 Particulate Matter <2.5µm ($PM_{2.5}$) – Short Term (24 hour average) Impact Assessment Criteria

Following approval of the HVO Air Quality and Greenhouse Gas Management Plan on 6 September 2019, HVO installed $PM_{2.5}$ monitoring at Kilburnie South and Maison Dieu within 16 weeks (27 December 2019) of approval of the Plan. This resulted in two $PM_{2.5}$ samples being collected at each location during 2019 as such long term (annual average) assessment is not provided. These results are provided in Table 30.

Table 30: Short Term Impact Assessment Criteria – $PM_{2.5}$ Results 2019

Date	Site	Measured 24 hour average $PM_{2.5}$ level (µg/m³)	HVO South 24 hour average $PM_{2.5}$ Incremental Criteria (µg/m³)	Estimated HVO South Incremental contribution to $PM_{2.5}$level (µg/m³)	Discussion
22/12/2019	Kilburnie South	55	25	0	This day was deemed to have been effected by an extraordinary event caused by the influence of Bushfire Smoke. Investigation determined that HVO South was unlikely to have contributed to the exceedance as wind direction on this day was from outside the arc of HVO South's influence for the majority of the day with only short periods of time (approximately 20 minutes) being from within the arc of influence.
22/12/2019	Maison Dieu	30	25	0	This day was deemed to have been effected by an extraordinary event caused by the influence of Bushfire Smoke. Investigation determined that HVO South could not have contributed to the exceedance as wind direction on this day was not within the arc of HVO South's influence for any period of the day.

Date	Site	Measured 24 hour average $PM_{2.5}$ level ($\mu g/m^3$)	HVO South 24 hour average $PM_{2.5}$ Incremental Criteria ($\mu g/m^3$)	Estimated HVO South Incremental contribution to $PM_{2.5}$ level ($\mu g/m^3$)	Discussion
28/12/2019	Kilburnie South	81	25	8.9	This day was deemed to have been effected by an extraordinary event caused by the influence of Bushfire Smoke. Investigation determined the monitor was downwind from HVO South for a portion of the day. Data from real time monitors for the Upper Hunter Air Quality Monitoring Network was used to estimate the percentage of time when monitors were not impacted by bushfire smoke and subsequently estimate a potential contribution.
28/12/2019	Maison Dieu	50	25	0	This day was deemed to have been effected by an extraordinary event caused by the influence of Bushfire Smoke. Investigation determined that HVO South could not have contributed to the exceedance as the monitor was not downwind of HVO South for any significant portion of the day.

Comparison against EA Predictions

Table 31 to Table 33 show a comparison between 2019 air quality data and the Stage 2 predictions made in the HVO South Modification 5 Environmental Assessment 2017 (EA). Comparisons have been made against the predictions listed in the EA for the nearest private residence to each monitoring location.

Annual average PM_{10} measurements in 2019 are generally consistent or slightly above predicted levels for all monitoring locations. Comparison of 2019 maximum 24 hour PM_{10} values against the predicted maximum values returned results generally above the predicted Stage 2 for all monitoring locations. Refer to Table 31 estimates of HVO South contribution to measured exceedances of 24 hour PM_{10} criteria during 2019.

TSP Annual Averages typically exceeded modelled predictions in 2019 at all monitoring locations except Warkworth, it's considered that this is a result of dry conditions that persisted through 2019 and reflects regional air quality trends and ongoing drought conditions not considered in EA predictions.

*Table 31: HVO South PM_{10} annual average results compared against cumulative predictions^*

Site (EA receptor)	Short Term (24hr) criteria		Long Term (annual average) criteria	
	Predicted maximum 24hr PM_{10} due to HVO South alone (µg/m³) Stage 2	2019 maximum 24hr PM_{10} HVO contribution (µg/m³)	Predicted PM_{10} annual averages (µg/m³) Stage 2	2019 PM_{10} annual average (µg/m³)*
Maison Dieu (256)	36	42.5	21	29
Warkworth (90)	95	16.7	46	24
Kilburnie South (307)	31	53**	27	31
Knodlers Lane (117)	59	46.3	28	24
Long Point (137)	36	26	20	22
Hunter Valley Gliding Club***	>50	45	>30	31

^ Cumulative predictions for Stage 2 of the HVO South Mod 5 Environmental Assessment.

* Includes all sources

** Result from February 2019. Result is compliant based on percentage contribution under Management Plan Version 1.1 at the time.

*** The HVGC has entered into an Amenity Management Plan with Hunter Valley Operations.

*Table 32 HVO South TSP annual average results compared against cumulative predictions^*

Site (EA receptor)	Long Term (annual average) TSP criteria	
	Stage 2 prediction (µg/m³)	2019 PM_{10} annual average (µg/m³)*
Maison Dieu (256)	60	91
Warkworth (90)	106	76
Kilburnie South (307)	76	122
Knodlers Lane (117)	75	98
Long Point (137)	61	69

^ Cumulative predictions for Stage 2 of the HVO South Mod 5 Environmental Assessment.

* Includes all sources.

*Table 33: HVO South Depositional Dust annual average results compared against cumulative predictions^*

Site (representative receptor ID)	Units (Insoluble Solids)	Assessment Criteria	Stage 2 EA Predictions Annual Averages	2019 Actual Annual Average*
D118 (Kilburnie Sth) (307)	$g/m^2/month$	4	2.9	4.8
D119 (Jerry's Plains) (421)			2.0	3.2
DL14 (Maison Dieu) (256)			2.0	2.3
DL21 (261)			2.2	3.9
DL22 (118)			2.9	3.0
Knodlers Lane (120)			2.4	2.2
Warkworth (90)			3.4	5.3

^ Cumulative predictions for Stage 2 of the HVO South Mod 5 Environmental Assessment.

* includes all sources

Table 34 and Table 35 detail comparisons between 2019 air quality monitoring results and the modelled predictions from the 2010 HVO North Carrington West Wing Air Quality Impact Assessment. Predictions have been sourced from modelled scenarios of Year One of the Carrington West Wing development. It should be noted that while Approval has been granted for the commencement of that project, works have not yet commenced.

*Table 34 HVO North 2019 PM_{10} annual average results compared against cumulative predictions^*

Site (EA receptor)*	Long Term (annual average) criteria	
	Predicted PM_{10} annual average ($\mu g/m^3$)	2019 PM_{10} annual average ($\mu g/m^3$)**
Maison Dieu (6)	19.1	29
Warkworth (39)	20.8	24
Kilburnie South (4)	19.7	31
Jerrys Plains (13)	16.6	21.8
Cheshunt East (7)	20.8	23.8

^ Cumulative predictions for Year One (CWW) of the HVO North Environmental Assessment.

*no modelled predictions for the Long Point area

** includes all sources

*Table 35 2019 TSP Annual Average results compared against cumulative predictions^*

Site (EA receptor)*	Long Term (annual average) criteria	
	Predicted TSP annual average (µg/m³)	2019 TSP annual average (µg/m³)**
Maison Dieu (6)	44.7	91
Warkworth (39)	46.6	76
Kilburnie South (4)	45.2	122
Cheshunt East (7)	46.5	69

^ Cumulative predictions for Year One (CWW) of the HVO North Environmental Assessment.

*no modelled predictions for the Long Point area

** includes all sources

Comparison of measured PM_{10} and TSP with modelled predictions demonstrates above average values for all monitoring locations. Given that the TSP fraction settles out of suspension faster than PM_{10} (and thus much closer to the operation), it is not reasonable to suggest that nearby private residences are being impacted by mine-generated TSP to a greater degree than by PM_{10}, on the basis of measured data exceeding the predictions. Rather, the data suggests the assumptions in the model relating to extraneous dust sources are under predicting total TSP levels which are experienced at receptors. It is considered that above average results are also attributable to ongoing drought conditions that persisted through 2019 and reflects regional air quality trends.

6.5 Greenhouse Gas and Energy Management

During 2019, HVO continued to comply with Emissions Reporting (EERs) under the National Greenhouse and Energy Reporting (NGERs) Act 2007. As such HVO is required to report its annual greenhouse gas emissions, energy use and energy production. Results of greenhouse gas and energy information from corporations is publically available online at www.cleanenergyregulator.gov.au. A summary of greenhouse gas emissions for HVO compared to the previous reporting year are provided in Table 36.

Total emissions in 2018/2019 reporting year decreased from the previous reporting year. This is largely reflected by reduction in fuel usage emissions

Table 36: Greenhouse Gas Emission summary

HVO Emissions	2017/2018 Reporting Year	2018/2019 Reporting Year
Fuel Usage (Kt CO2e)	354.21	312.24
Fugitive Emissions (Kt CO2e)	261.66	262.67
Industrial Processes (Kt CO2e)	0.03	0.2
Waste emissions by waste disposal (Kt CO2e)	0.05	-
Electricity consumption (Scope 2) (Kt CO2e)	11.49	112.66
Total	727	688

6.6 Waste and Hazardous Materials

6.6.1 Recycling

HVO has continued to have a focus on training and reinforcing the principles of a good waste management across the site including recycling.

In 2019 the percentage of non-mineral waste material generated at HVO and disposed to licensed offsite landfill facilities was 23%. The overall recycling percentage was 77%. These figures are consistent with 2018.

HVO will explore further opportunities to continue to improve recycling rates in 2020.

Details of waste and recyclables removed from demolition activities undertaken during the reporting period are included in Section 8.12.

6.6.2 Sewage Treatment/Disposal

The sewage treatment and disposal facilities at HVO consist of sewage treatment plants which treat, disinfect and re-use the treated effluent on-site. The remaining effluent from some septic systems that can't be treated on site is sent to approved facilities for disposal.

HVO currently has 3 main grouped on-site sewage management systems, these are interconnected from multiple systems forming the 3 main systems. These facilities are located at Howick, HVO North and HVO South.

6.6.3 Hydrocarbons

During 2019, 1085 kL of waste oil was taken offsite to be refined into a base oil for reuse in new oil products. Other hydrocarbons recycled via a licensed waste hydrocarbon disposal company include approximately 36 tonnes of waste grease.

6.6.4 Contaminated Soil

Management of hydrocarbon contaminated soil employs the use of three bioremediation areas that are maintained and operated in accordance with HVO procedures.

Contaminated soil is taken to one of the bioremediation areas and placed in cells based on the time of contamination. To maximise air circulation, contaminated soil is spread out in beds of no more than approximately 300 mm in height and approximately a grader width at the base. The beds are turned by a grader or equivalent on regular intervals in order to provide aeration for beneficial microbial activity.

Soil in the treatment area is sampled and tested as required until total hydrocarbon levels are below relevant guidelines. Soil meeting these criteria is then removed and disposed of in the spoil dump.

6.6.5 Acid Rock Drainage

During 2019, there were no observed issues relating to Acid Rock Drainage. During the reporting period HVO reviewed the acid rock drainage management process and will continue this during 2020.

6.6.6 Waste/Hazardous Materials Non Compliances

There were no externally reportable incidents related to waste or hazard management during the reporting period.

6.6.7 Building Demolition

During 2019, the following waste volumes were removed and disposed of at appropriate facilities during the demolition of rural buildings across HVO:

- 13.0 tonnes of bricks
- 42.4 tonnes of mixed waste
- 3.2 tonnes of asbestos.

6.7 Heritage

6.7.1 Management and Community Consultation

Aboriginal cultural heritage is managed under the provisions of separate Aboriginal Cultural Heritage Management Plans (ACHMP) approved for these development consents. At HVO North, where mining or associated development activities may impact Aboriginal cultural heritage sites, an Aboriginal Heritage Impact Permit (AHIP) must also be sought from the OEH under Part 6 of the National Parks and Wildlife Act 1974 (NPW Act), on the basis of the management requirements established through the ACHMP process. The HVO South ACHMP area was approved as a State Significant Development which excludes the requirement for obtaining AHIPs prior to implementing cultural heritage management measures authorised under the provisions of the ACHMP.

Hunter Valley Operations consults jointly with the Upper Hunter Valley Aboriginal Cultural Heritage Working Group (CHWG) and the Plains Clan of the Wonnarua Peoples (PCWP). The CHWG is comprised of representatives from HVO and Registered Aboriginal Parties (RAPs) from Upper Hunter Valley aboriginal community groups, corporations and individuals. The CHWG met and discussed cultural heritage management matters associated with HVO on the 12 September 2019.

Separate to the ACHMP, the HVO JV is party to an Ancillary Agreement with the Plains Clan of the Wonnarua People (PCWP). This is an Ancillary Agreement to a Deed under section 31(1)(b) of the Native Title Act 1993 (Cth) regarding the grant of Assessment Lease Application 59 and also an agreement for the grant of Mining Lease Application 534. The agreement commenced on the 3rd May 2018.

Aboriginal cultural heritage at HVO is managed; in consultation with the RAPs associated with the CHWG and the PCWP, in accordance with the ACHMPs, development consent conditions, and the Ancillary Agreement to protect, manage and mitigate cultural heritage at HVO. Management measures include:

- Ongoing consultation and involvement of the local Aboriginal community in all matters pertaining to Aboriginal cultural heritage management;
- Compliance with existing ACHMP's and Development Consent conditions;
- A cultural heritage Geographic Information System (GIS) and Cultural Heritage Zone Plan (CHZP) incorporating cultural heritage spatial and spatial data (site location, description, assessments, date recorded, associated reports, management provisions and various other details to assist with the management of sites);
- A Ground Disturbance Permit (GDP) system for the assessment and approval of ground disturbing activities to ensure these activities do not disturb cultural heritage places;
- Limit of Disturbance Boundary (LODB) procedures to demarcate approved disturbance areas and delineate areas not to be disturbed;
- Ongoing cultural heritage site inspections, monitoring and auditing along with regular compliance inspections of development works;
- Protective management measures such as fencing/barricading sites to avoid disturbance, protective buffer zones, cultural heritage off-set areas; and
- Communicating cultural heritage issues and site awareness to personnel via internal electronic and face to face processes.

In consultation with the CHWG and Office of Environment and Heritage (OEH), a Cultural Heritage Storage Facility (CHSF) was established at Hunter Valley Services. The CHSF is a storage shed, with an adjacent sea container, fitted out to allow safe and secure storage of cultural materials, such as stone artefacts. It is a central repository for all materials collected during community collection and salvage activities on all lands related to HVO (including offset properties).

6.7.2 Aboriginal Archaeological and Cultural Heritage Investigations

On the 21st February 2019, a field based due diligence assessment and survey was conducted over the Mitchel Hill Biodiversity Area proposed planting footprint. Three Aboriginal sites/areas were identified and pegged during the assessment and survey.

A second due diligence assessment was conducted along Pikes Gully Road on the 5th September 2019 prior to the installation of road safety signage. No artefacts were identified during the course of this survey.

A third due diligence assessment was conducted at the Wambo Pumps site adjacent to the Hunter River on the 1st October 2019, prior to the proposed installation of a generator and concrete pad. No ACH sites or cultural material objects were found during the archaeological inspection.

On the 17th June 2019 the Stage 2 Mitchell Pit Salvage Program commenced, this included the salvage and mitigation of two hundred and eighty-four (284) AHIMS-registered Aboriginal heritage sites (incorporating 747 discrete locations) which were the subject of a surface collection, with sub-surface investigations conducted at three locations within two of these sites. The work was conducted over a three week period and due to the extent of the works involved three teams of RAP's representing members of the PCWP and the CHWG. This program was authorised and conducted in accordance with the conditions prescribed by Aboriginal Heritage Impact Permit (AHIP) #C0002193 and progresses the salvage work undertaken on the Stage 1 Mitchell Pit Salvage Program that was completed during March/April 2017.

These works were conducted in accordance with the relevant AHIP, the HVO North HMP and the OEH Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales (2010).

6.7.3 Heritage Audits and Incidents

Under the provisions of the HVO South ACHMP, two Compliance Inspections were conducted in 2019 and under the provisions of the HVO North HMP a single Compliance Inspection was conducted during 2019. The purpose of the compliance inspections is to provide the RAPs with:

- The opportunity to visit mine operations and mine areas to inspect operational compliance with ACHMP/HMP provisions and GDP procedures;
- To inspect and monitor the condition and management of sites; and
- To review the effectiveness and performance of the ACHMP/HMP provisions in the management of cultural heritage at the mine.

These compliance inspections were conducted by RAP representatives of the CHWG and RAP representatives of the PCWP with the assistance of a qualified archaeologist and HVO personnel.

The biannual 2019 HVO South compliance inspection was conducted on 3 September 2019 by RAP representatives of the PCWP. A total of 45 aboriginal heritage sites were inspected focusing on areas west of 'South Lemington Pit 1'.The findings and recommendations of these inspections are documented in the Hunter Valley Operations South Aboriginal Heritage Management Plan Compliance Audit Inspection report dated September 2019.

The annual 2019 HVO South and HVO North compliance inspection was conducted over several days between the 29 and 31 of October 2019 by six RAP representatives of the CHWG and a suitably qualified and experienced archaeologist. During the HVO South portion of the compliance inspection a total of 44 aboriginal heritage sites were inspected in the Barellan, Nicholls, Lemington South and Southern areas. During the HVO North portion of the compliance inspection, a total of 15 heritage sites were assessed including the key sites at the Carrington West Wing, Mitchell Pit surrounds and sites in proximity to coal stockpiles Lemington Road and CM CD1. The findings and recommendations of these inspections are documented in the Hunter Valley Operations Aboriginal Heritage Management Plans October 2019 Compliance Audit Inspections report.

The inspections found that all sites have been managed in conformance with the ACHMP/HMP requirements. Additional sites were recorded and sites requiring maintenance and upgrades to site barricading and fencing were identified, with upgrade and maintenance work to be implemented in 2020.

During the reporting period there were 57 GDPs assessed for cultural heritage management considerations at HVO. There were no incidents nor any unauthorised disturbance caused to cultural heritage sites at HVO during 2019.

6.7.4 Historic Heritage – Management and Community Consultation

In 2019, community consultation was conducted at the Hunter Valley Operations Community Consultative Meetings held on the 20th February, 29th May, 21st August and 20th November 2019, no matters were raised pertaining to management of historic (non-Indigenous) heritage located on HVO property at these meetings.

Two non-indigenous historic sites, the 'dog leg fence' and a remnant 'timber bridge' adjacent to the Golden Highway were the subject of a Significance Assessment by an external consultant on 31 October 2019. The assessment found that the fence has local historical significance and is of potential State significance for its representativeness and degree of rarity. The timber bridge was assessed as being of twentieth century construction and not significant at a State or local level. The assessment recommends clearing of vegetation and debris from around the ‘dog leg fence’, archival recording of its features and documentation of its location in Hunter Valley Operations GIS database. Completion of these works will occur in the forthcoming 24 months

7 Water Management

HVO manages surface and ground water according to three main objectives:

- Fresh water usage is minimised;
- Impacts on the environment and HVO neighbours are minimised; and
- Interference to mining production is minimal.

This is achieved by:

- Minimising freshwater use from the Hunter River;
- Preferentially using mine water for coal preparation and dust suppression;
- An emphasis on control of water quality and quantity at the source;
- Segregating waters of different quality where practical;
- Recycling on-site water;
- Ongoing maintenance and review of the system; and
- Disposing of water to the environment in accordance with statutes and regulations.

Plans showing the layout of all water management structures and key pipelines are shown in Figure 20 to Figure 22. The HVO Water Management Plan contains further detail on management practices and is available on HVO website.

Figure 20: West Pit water management infrastructure

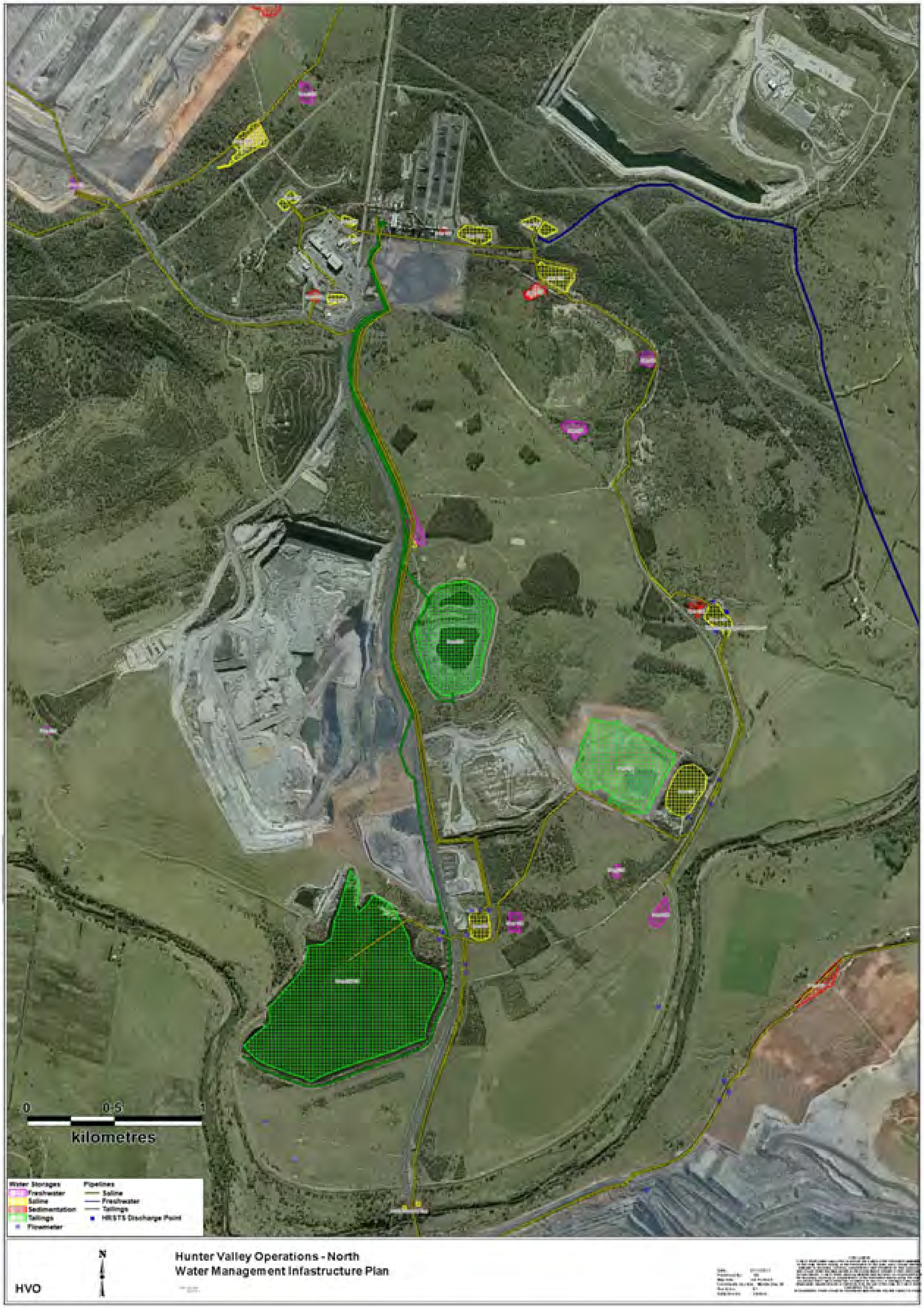


Figure 21: North Pit water management infrastructure

Figure 22: South Pit water management infrastructure

7.1 Water Balance

The 2019 static water balance for HVO is presented in Table 37.

Table 37 2019 HVO Water Balance

Water Stream	Volume (ML)
Inputs	
Fresh Water (potable)	41 (0.4%)
Fresh Water (Hunter River extraction)	4654 (39%)
Groundwater	3348 (28%)
Rainfall Runoff	2996 (25%)
Recycled to CHPP from Tails & Storage (not included in total)	3707
Imported (Liddell/Ravensworth (via Cumnock))	0 (0%)
Water from ROM Coal	910 (7.6%)
Total Inputs	11948
Outputs	
Dust Suppression	2656 (25%)
Evaporation - Mine Water & Tailings Dams	2152 (21%)
Entrained in Process Waste	1996 (19%)
Discharged (HRSTS)	0 (0%)
Vehicle Wash-down	310 (3%)
Sent to Third Party	1367(13%)
Miscellaneous Industrial Use	350 (3%)
Water in Coarse Reject	328 (3%)
Water in Product Coal	1327 (13%)
Total Outputs	10486
Change in Pit Storage	**1462 (increase)**

7.1.1 Water Inputs

A total of 337 mm of rainfall was recorded at HVO in 2019 producing an estimated 2,996 ML of runoff. Water falling on undisturbed clean water catchments is diverted off site into natural systems where possible.

Groundwater inflows to the pits are calculated via numerical groundwater modelling methods. These are given in Table 37.

Groundwater inflows were estimated to have contributed 3348 ML to the site during 2019. 4654 ML of fresh water was pumped from the Hunter River during the reporting period.

7.1.2 Water Outputs

The main outputs were water use for dust suppression (2,656 ML), evaporation from dams (2,152 ML), water entrained in process waste (1,996 ML) and water in product coal (1,327 ML).

HVO participates in the Hunter River Salinity Trading Scheme (HRSTS) allowing it to discharge from licensed discharge points during declared discharge events, associated with increased flow in the Hunter River. HVO maintains three licensed discharge monitoring locations:

Dam 11N, located at HVO North, which discharges to Farrell's Creek

Lake James, located at HVO South, which discharges to the Hunter River; and

Parnell's Dam, located at HVO West, which discharges to Parnell's Creek.

During 2019 Hunter Valley Operations discharged no water under the Hunter River Salinity Trading Scheme and Environment Protection Licence 640.

7.2 Surface Water

Surface water monitoring activities continued in 2019 in accordance with the HVO Water Management Plan and HVO Surface Water Monitoring Program. HVO maintains a network of surface water monitoring sites located on mine site dams, discharge points and surrounding natural watercourses (Figure 23). Water quality monitoring is undertaken to verify the effectiveness of the water management system onsite, and to identify the emergence of potentially adverse effects on surrounding watercourses. A number of mine water dams are monitored routinely to verify the quality of mine water, used in coal processing, dust suppression, and other day to day activities around the mine.

Surface water monitoring data is reviewed on a quarterly basis. The review involves a comparison of measured pH, Electrical Conductivity (EC) and Total Suspended Solids (TSS) results against internal trigger values which have been derived from the historical data set. The response to measured excursions outside the trigger limits is detailed in the HVO Water Management Plan.

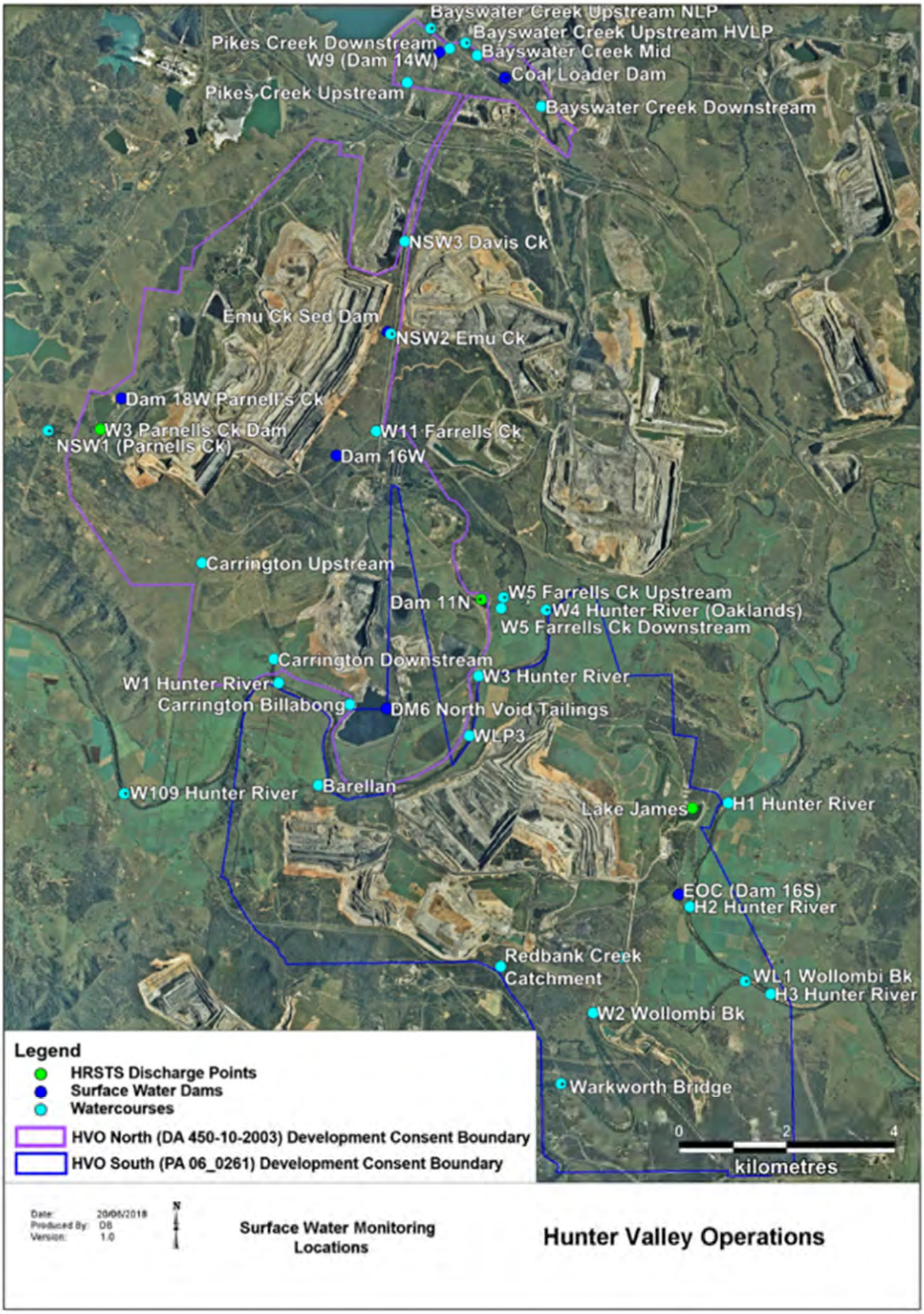


Figure 23: Surface Monitoring Locations

7.2.1 Surface Water Monitoring

Routine surface water monitoring was undertaken in 2019 in accordance with the Surface Water Monitoring Program. All analysis of surface water was carried out in accordance with approved methods by a NATA accredited laboratory.

Water quality is evaluated through the parameters of pH, EC and TSS. Pertinent surface water sites were also sampled for comprehensive analysis annually. Long term water quality trends for the Hunter River, Wollombi Brook, other surrounding tributaries and site dams are presented in this section. The sampling frequency for ephemeral water sites was modified in 2016, from quarterly to a rain-event trigger system, in an effort to ensure samples taken were more representative of typical water quality for those streams (up to eight sampling events per annum can now be taken under the revised sampling protocol).

Dry conditions during the reporting period resulted in fewer rain event sampling events being completed in 2019. All required sampling and analysis was undertaken, except as detailed in Table 38. ANZECC criteria are shown in the figures for comparative purposes.

Table 38 HVO Water Monitoring Data Recovery for 2019 (by exception)

Location	Data Recovery (%)	Comments
Barellan	0%	Site recorded as dry during all 2019 monitoring events.
Bayswater Creek Downstream	50%	Site recorded as dry during 2019 February monitoring event
Bayswater Creek Mid	50%	Site recorded as dry during 2019 February monitoring event
Carrington Billabong	0%	Site recorded as dry during all 2019 monitoring events.
Carrington Upstream	0%	Site recorded as dry during all 2019 monitoring events.
Dam 16W	78%	Site recorded as unsafe access during November monitoring event and dry during December monitoring event
Dam 18W Parnells Ck	89%	Site recorded as having insufficient water during December monitoring event
DM6 North Void Tailings	59%	Site recorded as having insufficient water during July, August, September, October, November and December monitoring events
NSW1 (Parnell's Ck)	0%	Site was dry during 2019 monitoring events
NSW2 Emu Ck	0%	Site was dry during 2019 monitoring events
NSW3 Davis Ck	50%	Site recorded as dry during February monitoring event
Pikes Creek Downstream	50%	Site recorded as dry during March monitoring event
Pikes Creek Upstream	0%	Site recorded as dry during all 2019 monitoring events.
Redbank Creek Catchment	0%	Site recorded as dry 2019 monitoring events
W11 (Farrells Ck Lemington Rd)	50%	Site recorded as dry during February monitoring event

7.2.1.1 Hunter River

The Hunter River was sampled on 47 occasions from eight monitoring locations during 2019. Long term trends for pH, EC and TSS are shown in Figure 24 to Figure 26. Results for water quality were generally consistent with historical trends; EC was seasonally variable and controlled by flow volumes through the catchment. The spike in TSS at multiple locations during the September monitoring event followed rainfall on 18-19 September. Trigger exceedance results are detailed in Table 39.

Table 39 Hunter River Internal Trigger Tracking Results

Location	Date	Trigger Limit	Action Taken In Response
H1	7/03/2019	pH 5th Percentile	First breach of pH 5th Percentile trigger. Watching Brief*
W4	24/06/2019	pH 5th Percentile	First breach of pH 5th Percentile trigger. Watching Brief*.
W109	19/09/2019	TSS	First breach of TSS trigger. Monitoring indicates improved water quality at locations downstream of HVO's potential influence. Results are generally consistent with observations and water quality expected in the Hunter River following rainfall on 18-19 September 2019. No evidence to suggested elevated TSS is associated with mining influence. Maintain watching Brief*.
W1	19/09/2019	TSS	First breach of TSS trigger. Monitoring indicates improved water quality at locations downstream of HVO's potential influence. Results are generally consistent with observations and water quality expected in the Hunter River following rainfall on 18-19 September 2019. No evidence to suggested elevated TSS is associated with mining influence. Maintain watching Brief*
W4	19/09/2019	TSS	First breach of TSS trigger. Monitoring indicates improved water quality at locations downstream of HVO's potential influence. Results are generally consistent with observations and water quality expected in the Hunter River following rainfall on 18-19 September 2019. No evidence to suggested elevated TSS is associated with mining influence. Maintain watching Brief*
W3	19/09/2019	TSS	First breach of TSS trigger. Monitoring indicates improved water quality at locations downstream of HVO's potential influence. Results are generally consistent with observations and water quality expected in the Hunter River following rainfall on 18-19 September 2019. No evidence to suggested elevated TSS is associated with mining influence. Maintain watching Brief*
W4	17/12/2019	pH – 5th percentile	First exceedance. Watching Brief*
W4	17/12/2019	EC – 95th percentile	First exceedance. Watching Brief*
H1	17/12/2019	pH – 5th percentile	First exceedance. Watching Brief*

* = Watching brief established pending outcomes of subsequent monitoring events. No specific actions required.

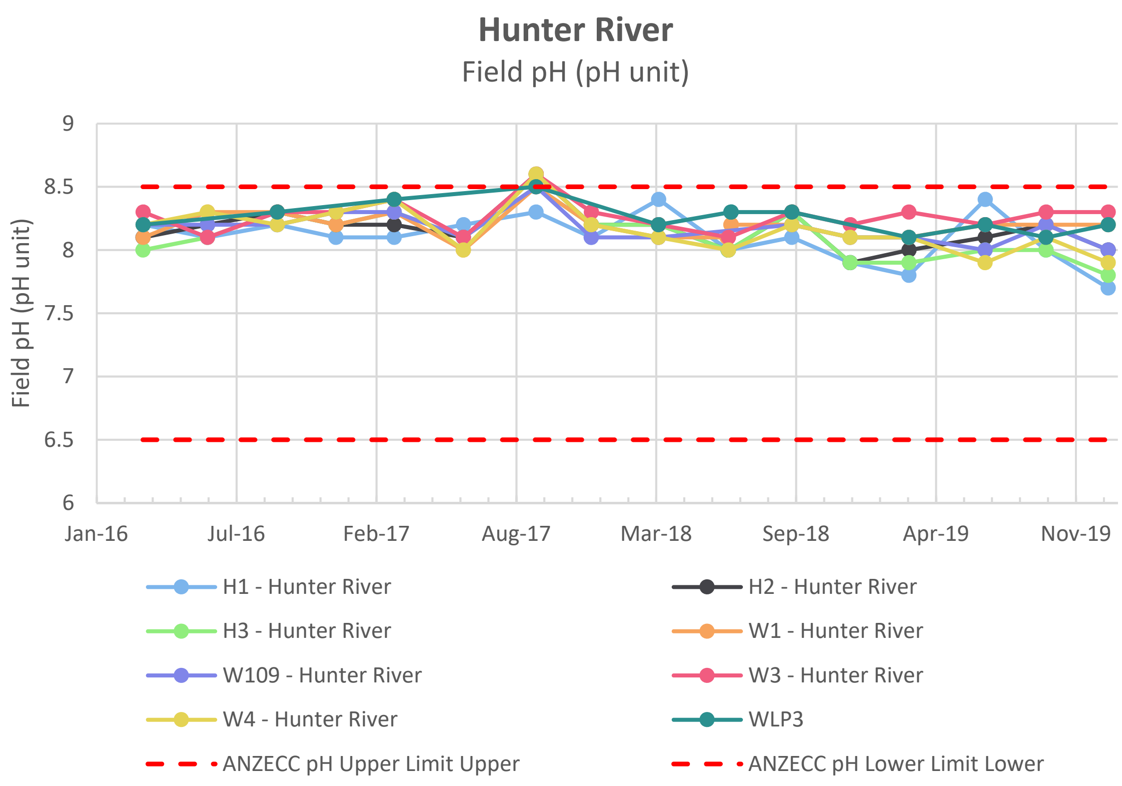


Figure 24: Hunter River pH Trends 2016 - 2019

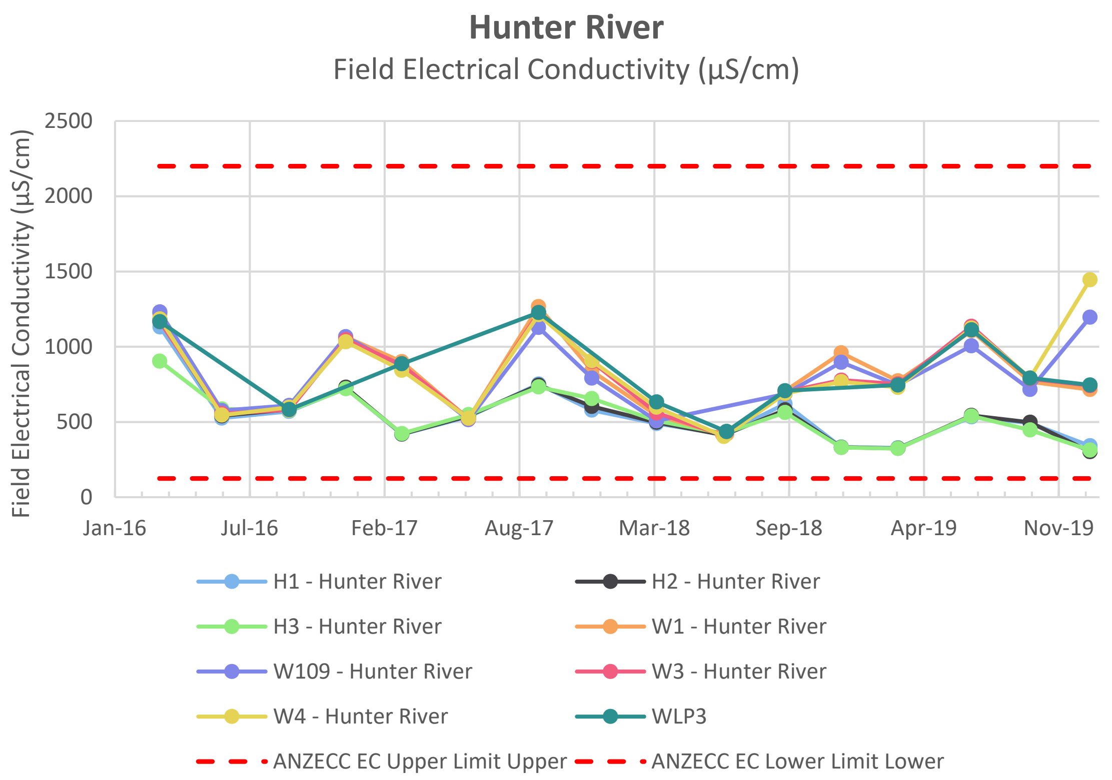


Figure 25: Hunter River EC Trends 2016- 2019

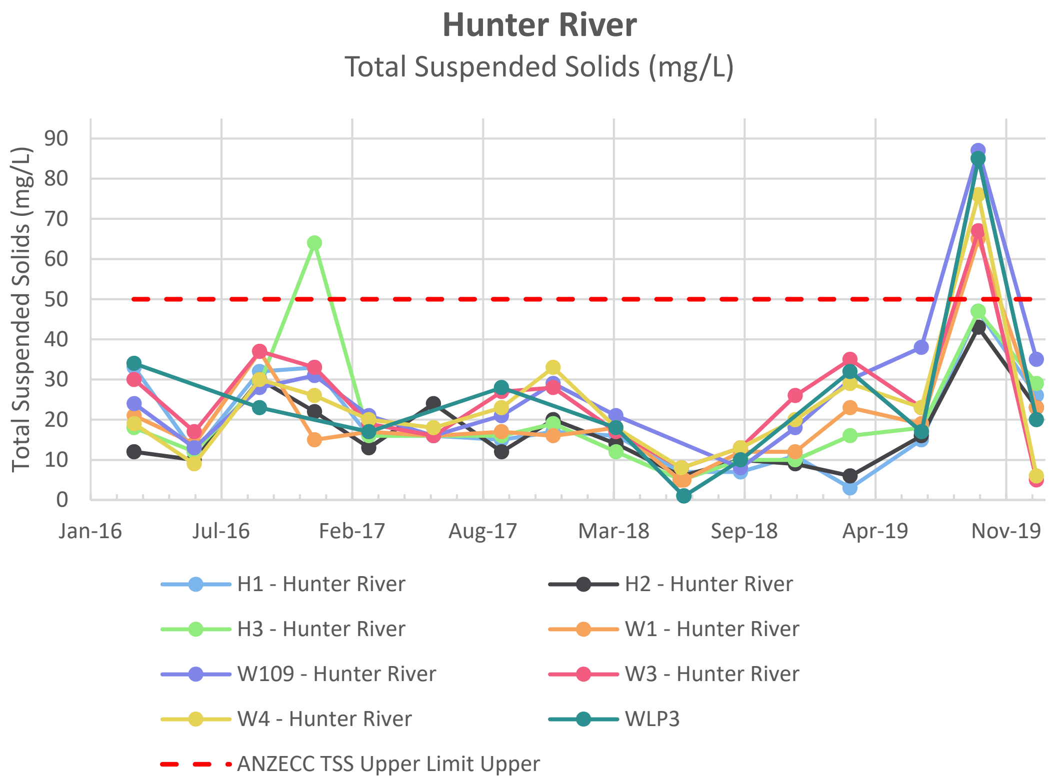


Figure 26: Hunter River TSS Trends 2016 - 2019

7.2.1.2 Wollombi Brook

Wollombi Brook was sampled on 12 occasions from three monitoring locations during 2019. Long term trends for pH, EC and TSS from Wollombi Brook are shown in Figure 27 to Figure 29. Results were generally consistent with historical trends and acceptable ranges. EC was variable and recorded an increasing trend at the W2 location due to drying conditions in the Wollombi Brook. Trigger exceedance investigation results are detailed in Table 40.

Table 40 Wollombi Brook Internal Trigger Exceedance Results

Location	Date	Trigger Limit	Action Taken In Response
W2 - Wollombi Brook	7/03/2019	EC 95th Percentile	Fifth exceedance of EC 95th percentile trigger (2610us/cm). Field observations indicate that sample was taken from a pool of water as there was no flow in the Brook. Downstream monitoring (WL1) indicated a slow flow and lower EC level (515us/cm). Based on this it can be assumed that the sample taken is not representative of flows in the Brook and that there is no impact to suggest mining influence. Maintain watching Brief*.
Warkworth Bridge	7/03/2019	EC 95th Percentile	Sixth exceedance of EC 95th Percentile trigger (1390us/cm). Field observations indicate that sample was taken from a pool of water as there was no flow in the Brook. Downstream monitoring (WL1) indicated a slow flow and lower EC level (515us/cm). Based on this it can be assumed that the sample taken is not representative of flows in the Brook and that there is no impact to suggest mining influence. Maintain watching Brief*.
W2 - Wollombi Brook	24/06/2019	EC 95th Percentile	Sixth exceedance of EC 95th Percentile trigger (2200us/cm). Field observations indicate that sample was taken from a pool of water as there was no flow in the Brook. Downstream monitoring (WL1) indicated a moderate flow and lower EC level (621us/cm). Based on this it can be assumed that the sample taken is not

Location	Date	Trigger Limit	Action Taken In Response
			representative of flows in the Brook and that there is no impact to suggest mining influence. Maintain watching Brief*.
Warkworth Bridge	24/06/2019	EC 95th Percentile	Seventh exceedance of EC 95th Percentile trigger (1515us/cm). Field observations indicate that sample was taken from a pool of water as there was no flow in the Brook. Downstream monitoring (WL1) indicated a moderate flow and lower EC level (621us/cm). Based on this it can be assumed that the sample taken is not representative of flows in the Brook and that there is no impact to suggest mining influence. Maintain watching Brief*.
WL1 – Wollombi Brook	24/06/2019	TSS	First Breach of TSS trigger. Downstream results at monitoring location H3 in the Hunter indicate better water quality than that measured at WL1 indicating that the TSS results may be isolated to a local source to the sampling location and not from a broader impact. Watching Brief*
Warkworth Bridge	19/09/2019	EC 95th Percentile	Continued exceedance of EC 95th Percentile trigger (1581us/cm). Field observations indicate that sample was taken from a pool of water as there was no flow in the Brook. Downstream monitoring (WL1) indicated a slow flow and lower EC level (521us/cm). Based on this it can be assumed that the sample taken is not representative of flows in the Brook and that there is no impact to suggest mining influence. Maintain watching Brief*.
W2 – Wollombi Brook	19/09/2019	EC 95th Percentile	Continued exceedance of EC 95th Percentile trigger (2030us/cm). Field observations indicate that sample was taken from a pool of water as there was no flow in the Brook. Downstream monitoring (WL1) indicated a slow flow and lower EC level (521us/cm). Based on this it can be assumed that the sample taken is not representative of flows in the Brook and that there is no impact to suggest mining influence. Maintain watching Brief*
Warkworth Bridge	17/12/2019	EC 95th Percentile	Ninth exceedance of EC 95th Percentile trigger (1935us/cm). Field observations indicate that sample was taken from a pool of water as there was no flow in the Brook. Downstream monitoring (WL1) indicated still water and lower EC level (442us/cm). Based on this it can be assumed that the sample taken is not representative of flows in the Brook and that there is no impact to suggest mining influence. Maintain watching Brief*
W2 – Wollombi Brook	17/12/2019	EC 95th Percentile	Eighth exceedance of EC 95th Percentile trigger (2500us/cm). Field observations indicate that sample was taken from a pool of water as there was no flow in the Brook. Downstream monitoring (WL1) indicated still water and lower EC level (442us/cm). Based on this it can be assumed that the sample taken is not representative of flows in the Brook and that there is no impact to suggest mining influence. Maintain watching Brief*
WL1 – Wollombi Brook	17/12/2019	TSS	Second Breach of TSS Trigger. Field observations indicate that the water at the sampling site was still and slightly turbid when the sample was taken. Observation at the downstream monitoring location (H3 in the Hunter) indicate the water was flowing slowly and was slightly turbid. Downstream results (29mg/L) showed better water quality than that measured at WL1 indicating that the TSS results may be isolated to a local source to the sampling location and not from a broader impact. Maintain Watching Brief*

* = Watching brief established pending outcomes of subsequent monitoring events. No specific actions required.

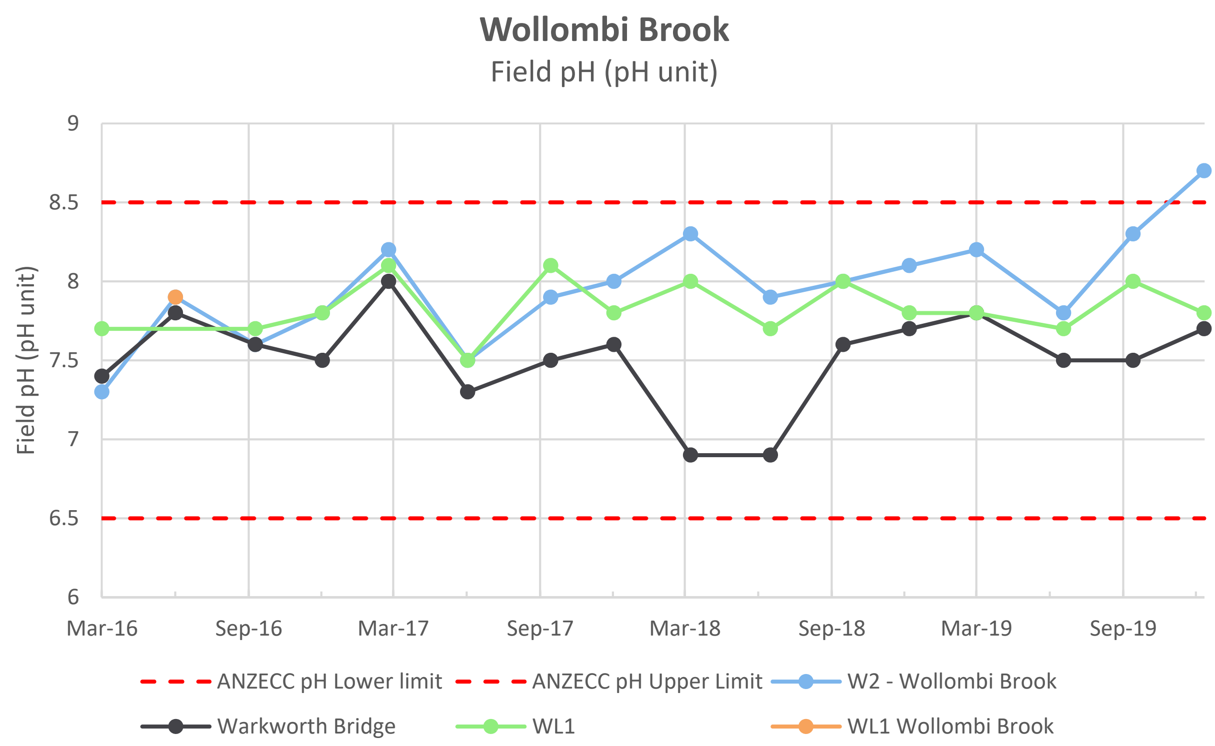


Figure 27: Wollombi Brook pH Trends 2016 – 2019

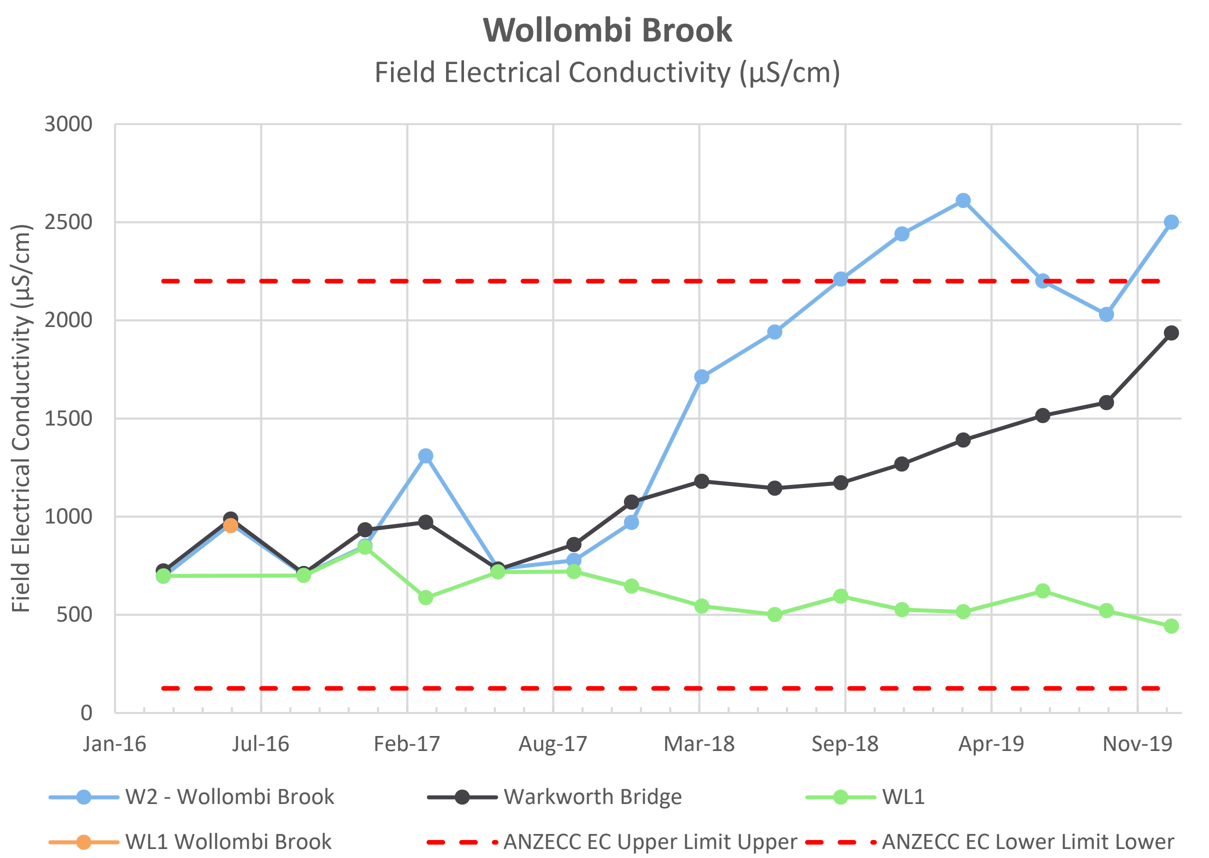


Figure 28: Wollombi Brook EC Trends 2016 – 2019

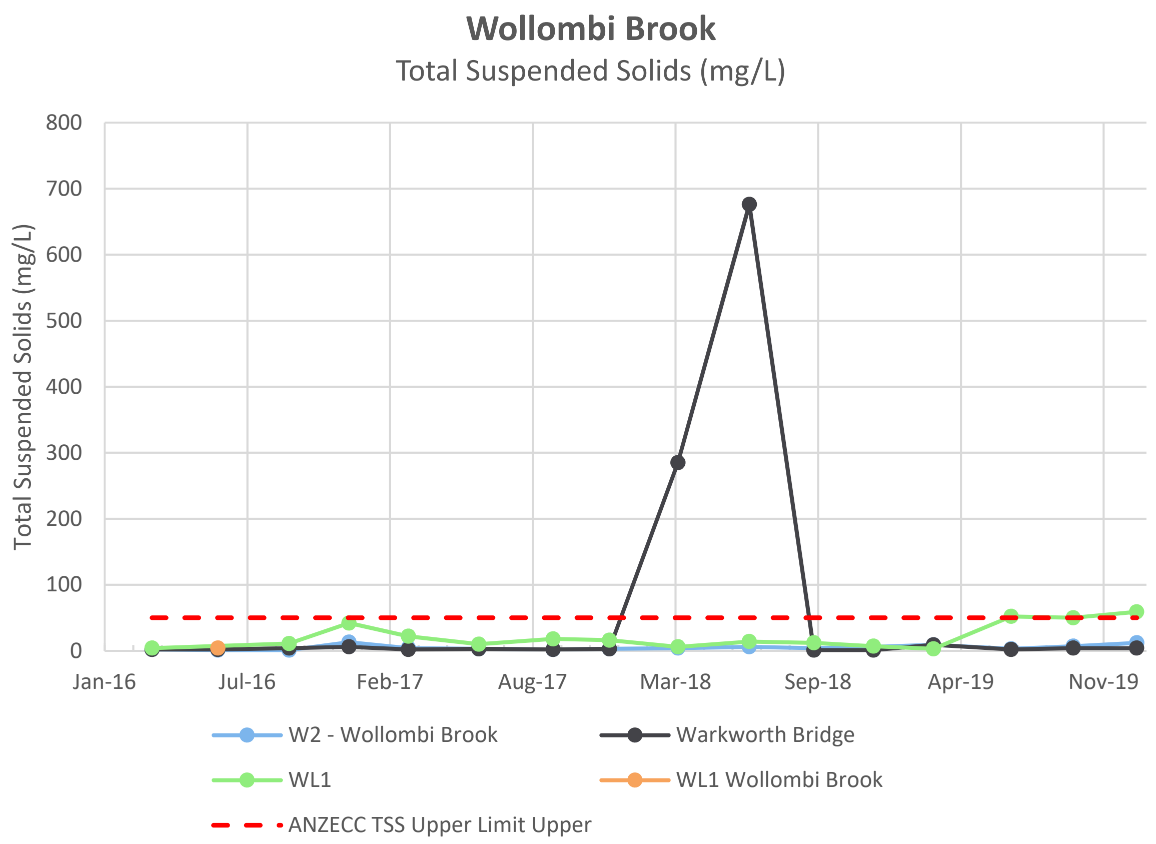


Figure 29: Wollombi Brook TSS Trends 2016 - 2019

7.2.1.3 Other Surrounding Tributaries

Rain event-based monitoring of natural tributaries surrounding HVO continued during 2019.

In accordance with the HVO Water Management Plan, two rain event sampling rounds were triggered during 2019. These occurred following rainfall greater 30mm in a 24 hour period on the days of 11 February and 18 March 2019. Monitoring during these rain event's occurred on the following water courses:

- Comleroi Creek;
- Emu Creek (dry during February rain event);
- Farrells Creek (dry during February rain event);
- Pikes Creek (dry during February and March rain events);
- Redbank Creek (dry during February and March rain events);
- Davis Creek (dry during February rain event);
- Bayswater Creek; and
- Parnells Creek (dry during February and March rain events).

Long term trends for pH, EC and TSS are shown Figure 30 to Figure 32. On occasion, some sampling sites recorded results outside of the internal trigger levels however, results for water quality remained generally within historical trends and acceptable ranges. The surface water monitoring programme will be reviewed in 2020. The ephemeral nature of these monitoring locations is the primary reason for the considerable variation in physical water quality. Trigger tracking results are detailed in Table 41.

Table 41 Other Tributaries Internal Trigger Exceedance Results

Location	Date	Trigger Limit	Action Taken In Response
Bayswater Creek Midstream	18/03/2019	pH -5th Percentile	First exceedance of pH 5th Percentile trigger. Watching Brief
Bayswater Creek Downstream	18/03/2019	pH 5th Percentile	First exceedance of pH 5th Percentile trigger. Watching Brief*
Pikes Creek Downstream	18/03/2019	pH 5th Percentile.	First exceedance of pH 5th Percentile trigger. Watching Brief*
NSW3 Davis Creek	18/03/2019	TSS 50mg/L (ANZECC Guideline)	First exceedance of TSS trigger (67mg/L). Field observations indicate that sample was taken from a pool of water as there was no flow in the creek line. EC (266us/cm) and pH (7.3) results also indicate water quality is not affected by mine water. Maintain watching Brief*.
W11 (Farrells Creek Lemington Road)	18/03/2019	pH 5th Percentile	First exceedance of pH 5th Percentile trigger. Watching Brief*
W5 (Farrells Creek Upstream)	18/03/2019	TSS 50mg/L (ANZECC Guideline)	First exceedance of TSS trigger (450 mg/L). Field observations indicated that there was flow in the creek. Refer to incident section for details.
W5 (Farrells Creek Downstream)	18/03/2019	TSS 50mg/L (ANZECC Guideline)	First exceedance of TSS trigger (177 mg/L). Field Observations indicated that there was flow in the creek. Refer to incident section for details

* = Watching brief established pending outcomes of subsequent monitoring events. No specific actions required.

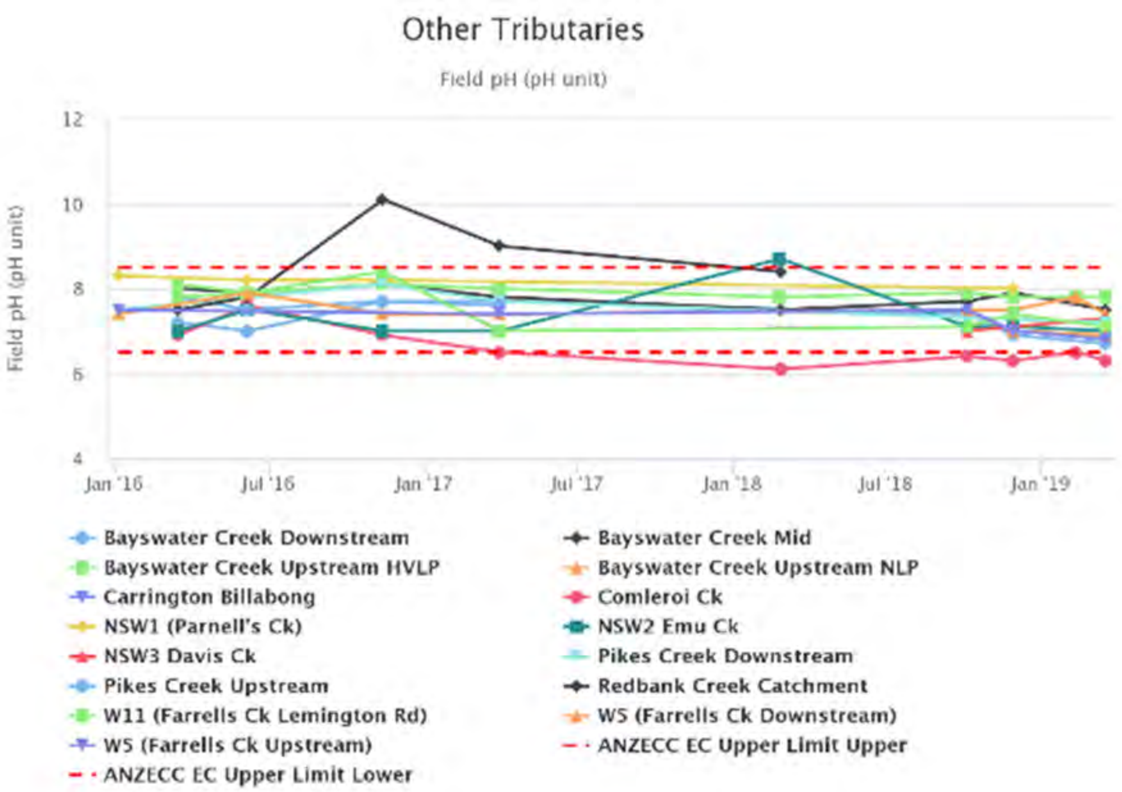


Figure 30: Other Tributaries pH Trends 2016 – 2019

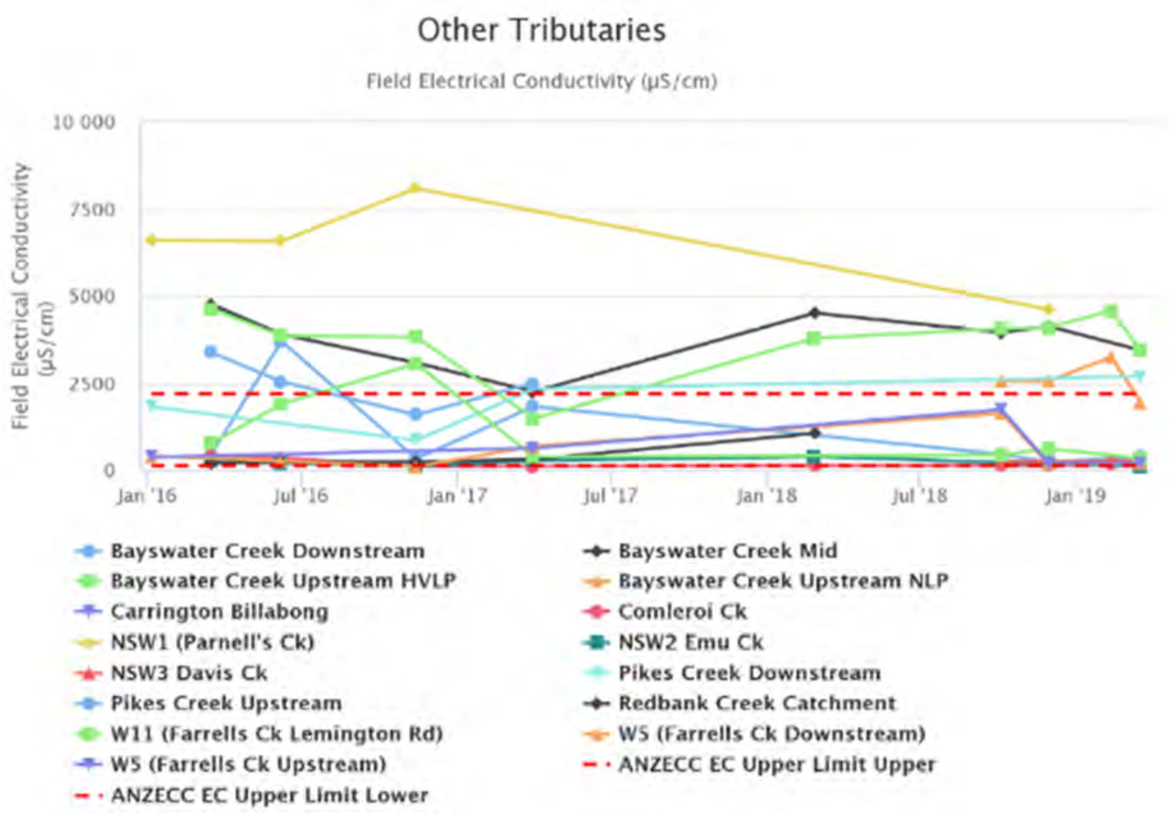


Figure 31: Other Tributaries EC Trends 2016 – 2019

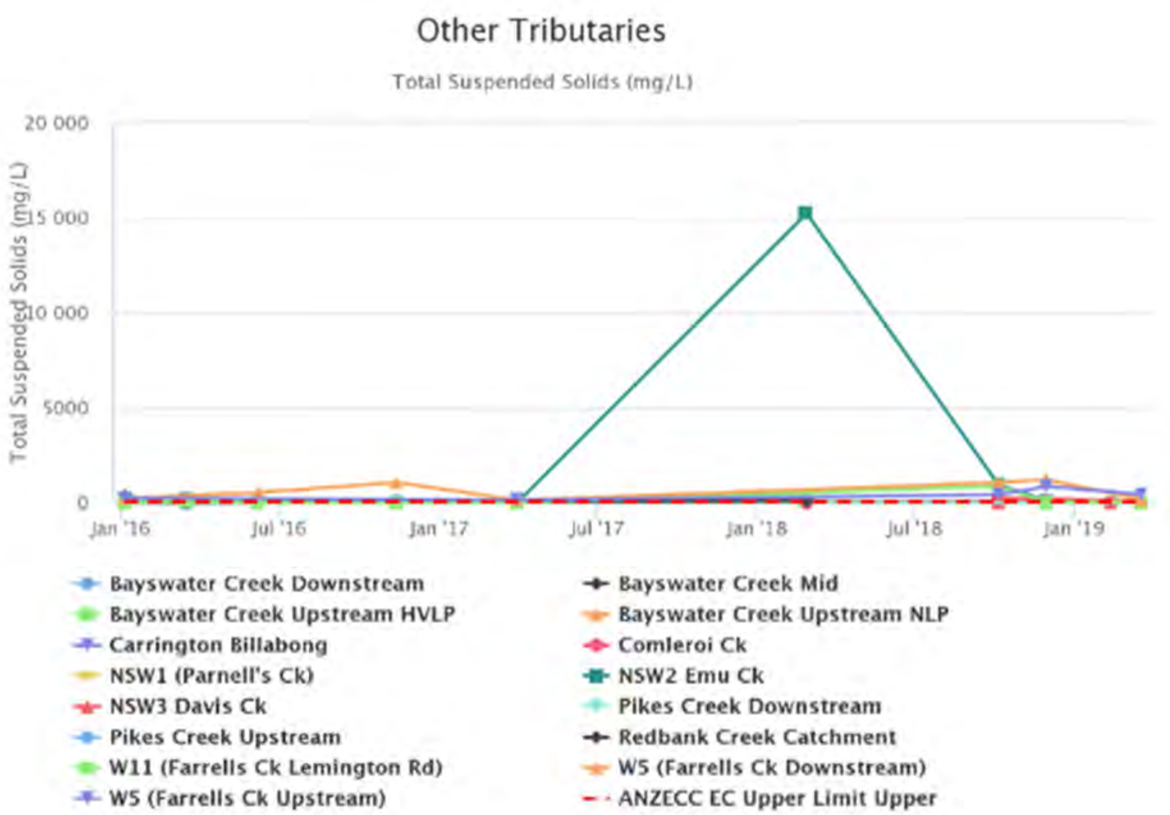


Figure 32: Other Tributaries TSS Trends 2016 – 2019

7.2.1.4 HVO Site Dams

During 2019, 116 samples were collected across 10 onsite dams. Long term trends for pH, EC and TSS are shown in Figure 33 to Figure 35. EC results show a varying trend during the reporting period, as a result of drier weather conditions reducing rainfall runoff inflows to the mine water management system.

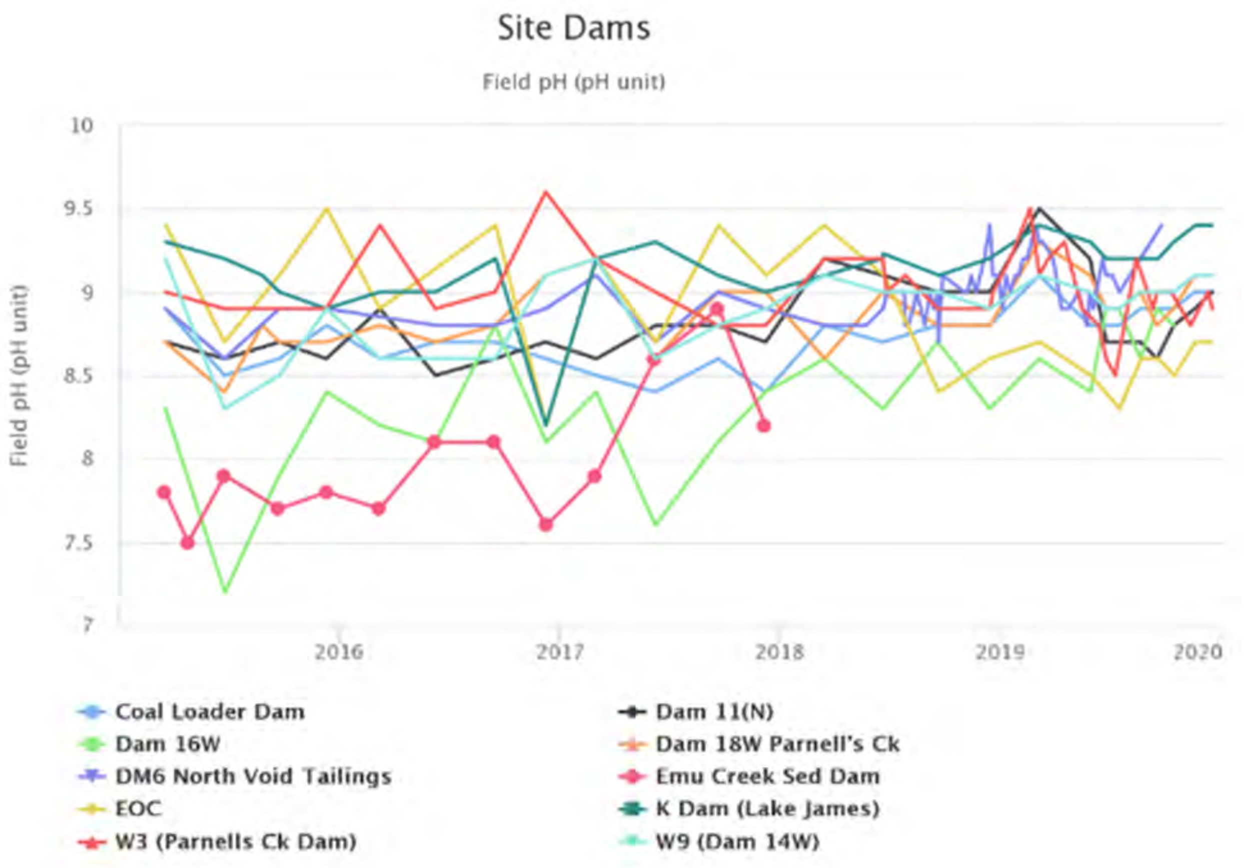


Figure 33: HVO Site Dams pH Trends 2016 – 2019

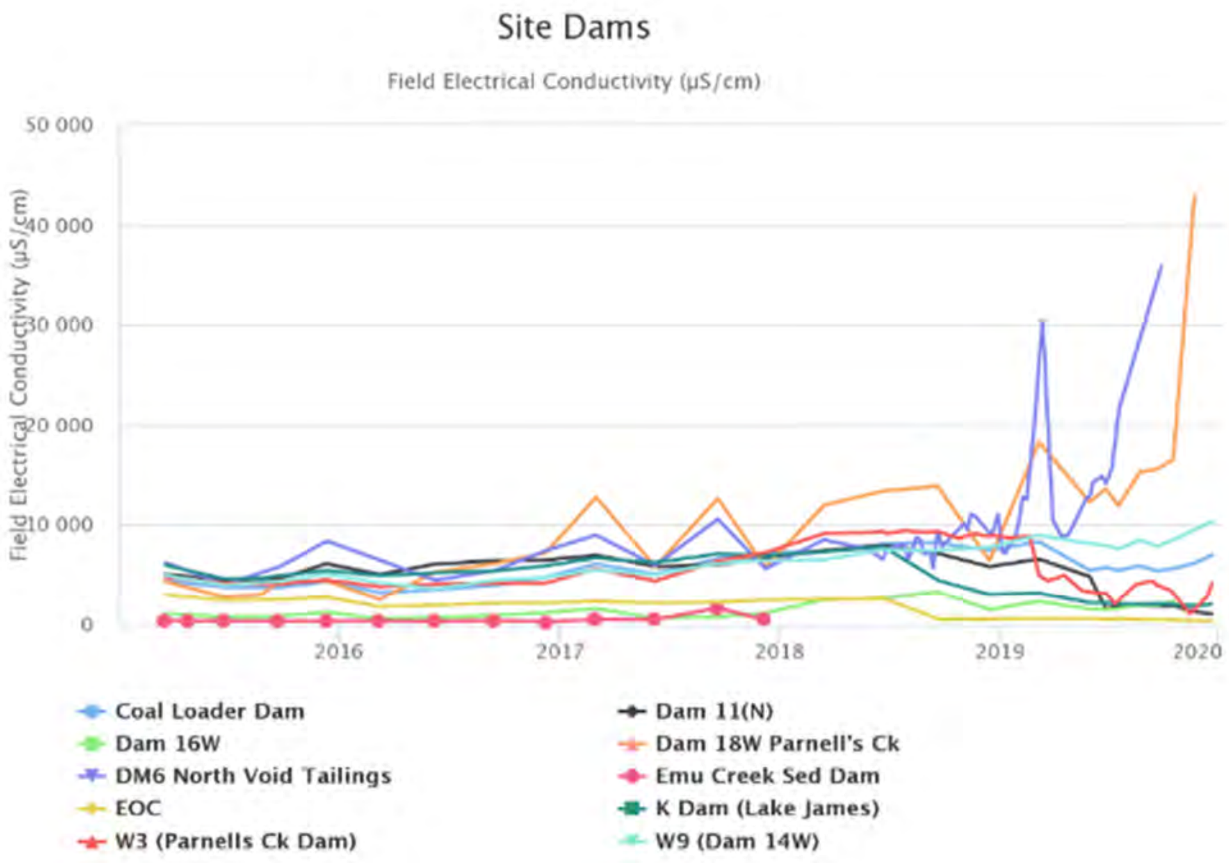


Figure 34: HVO Site Dams EC Trends 2016 – 2019

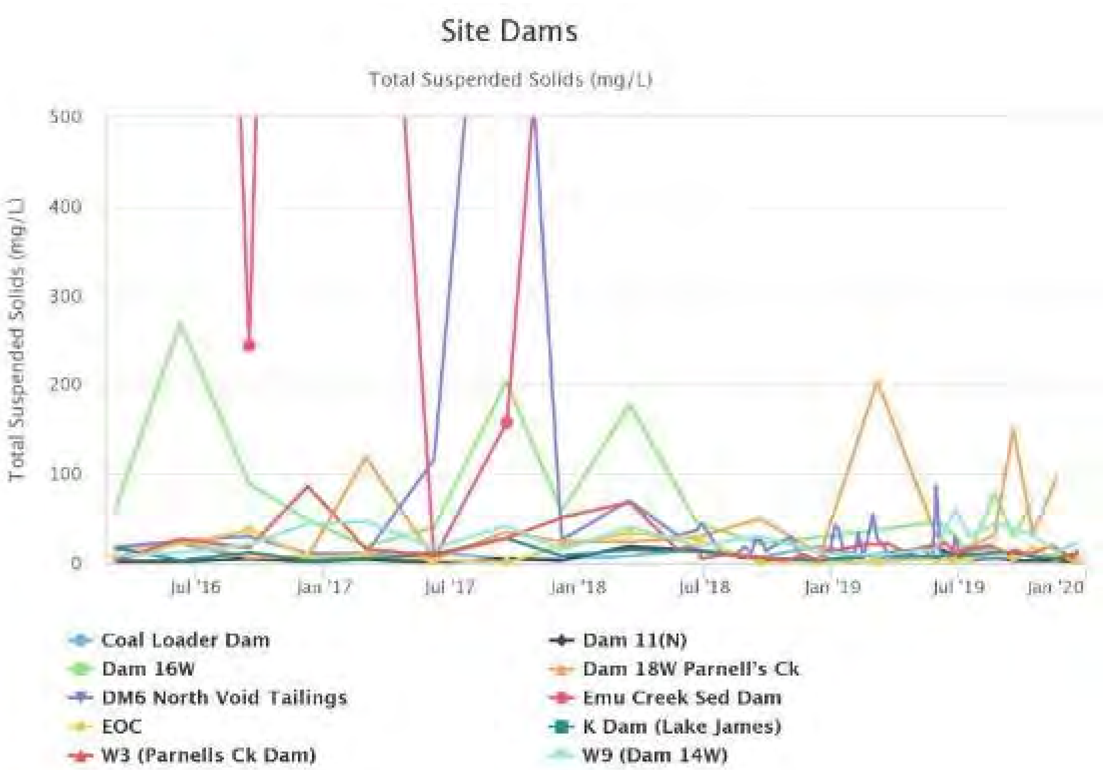


Figure 35: HVO Site Dams TSS Trends 2016 – 2019

7.3 Comparison with EIS Predictions

7.3.1 South Pit EIS Predictions

The South Pit EIS estimated an 'instantaneous' water quality for Electrical Conductivity of 5,700 µS/cm as an upper limit. Instantaneous water quality is a simple estimate obtained by dividing the total salt available by the maximum amount of possible void water. Electrical Conductivity measurements at Lake James averaged 2,187 µS/cm during 2019, in line with predicted EC levels.

The South Pit EIS estimated average runoff water quality from undisturbed catchments to be 400 mg/L for TSS and 615 µS/cm for EC. Comleroi Creek, South of Cheshunt Pit was sampled twice during rain events in 2019 resulting in a TSS of 17 mg/L and EC of 129 µS/cm, demonstrating that runoff water from undisturbed catchments in the HVO South area is of better quality than that which was predicted in the EIS.

7.3.2 Carrington Pit EIS Predictions

The long term mine water quality for Carrington is discussed in the Carrington Mine Environmental Impact Statement (ERM 1999). The EIS estimated an "instantaneous" water quality for Electrical Conductivity of 7,050 µS/cm.

Dewatering from Carrington is a mixture of surface runoff from overburden emplacements, coal mining areas and seepage from the coal seams and alluvium. Water is directed to Dam 9N and into Dam 11N. The average EC and TSS in Dam 11N during 2019 was 2,551 µS/cm and 6 mg/L respectively, and is considered broadly representative of mine water quality for Carrington.

The Carrington EIS states that runoff from undisturbed catchments within the Carrington Pit will be directed around the mine via contour banks or surface drains to discharge where possible into natural creeks. The salinity of the runoff water was predicted to be approximately 615 µS/cm. Runoff from rehabilitated lands was initially predicted to have higher TSS, with levels approaching pre-mining conditions after several years. Carrington Billabong (where such water quality would be measured for this comparison) was reported as dry during the rain event monitoring rounds in 2019 with no samples collected.

7.3.3 West Pit EIS Predictions

The West Pit EIS included the data in Table 42 as representative of water quality in the local catchment area. Emu Creek (NSW2) was sampled once during 2019 as the creek was dry during other sampling rounds. The pH was reported to be 7 pH units during the review period, which is slightly lower than EIS predictions and the Electrical conductivity was 120 µS/cm, indicating fresher than predicted EC results. The pH and EC at Farrells Creek (combined upstream and downstream monitoring sites) averaged 6.9 and 191 µS/cm respectively during the review period, were also slightly lower than EIS predictions. The pH and EC for the sample taken at Davis Creek 7.3 and 266 µS/cm respectively during the review period, slightly lower than EIS predictions. Parnell's Dam (W3) measured an average EC of 4,227 µS/cm in 2019, within the prediction.

Table 42 Representative Water Quality for West Pit

Watercourse	pH (pH Units)	EC (µS/cm)
Davis Creek	7.7 to 8.4	767 to +8,000
Emu Creek	7.5 to 8.8	365 to +1,000
Farrells Creek	7.0 to 9.2	195 to +12,000
Mine Water (Parnell's Dam)	-	2,400 to 6,300

7.4 Performance relating to HRSTS Discharges

HVO participates in the Hunter River Salinity Trading Scheme (HRSTS), allowing it to discharge to the Hunter River via three licensed discharge points, including Dam 11N, Dam 15S (Lake James) and Dam 9W (Parnells Dam). Discharges can only take place subject to the schemes regulations.

As required by the EPL, HVO submitted a discharge report for the 2018/19 financial year. No water was discharged off site during 2019 via the Hunter River Salinity Trading Scheme (HRSTS).

7.5 Groundwater

7.5.1 Groundwater Management

Groundwater monitoring activities were undertaken in 2019 in accordance with the HVO Water Management Plan and Groundwater Monitoring Programme. The monitoring results are used to establish and monitor trends in physical and geochemical parameters of surrounding groundwater potentially influenced by mining.

The groundwater monitoring programme at HVO measures the quality of groundwater against background data, EIS predictions and historical trends. Ground water quality is evaluated through the parameters of pH, EC, and Standing Water Level (SWL) (measured as elevation in metres with respect to the Australian Height Datum, mAHD). On a periodic basis (nominally once per annum) a comprehensive suite of analytes are measured, including major anions, cations and metals. Prior to sampling for comprehensive analysis, bore purging is undertaken to ensure a representative sample is collected.

Groundwater monitoring data is reviewed on a quarterly basis. The review involves a comparison of measured pH and EC results against internal trigger values which have been derived from the historical data set. Trigger limits are calculated as the 95th percentile maximum value (EC and pH) and the 5th percentile minimum value (pH only) from data collected since 2011. Trigger levels have been set on the basis of geographical proximity and target stratigraphy. Bores that record as dry and bores of unknown seam have not been included in calculation of the trigger limits. The response to measured data outside the trigger limits is detailed in the HVO Water Management Plan. Where investigations and subsequent actions have been undertaken following review of monitoring data, these are detailed in this section. Monitoring locations are shown in Figure 36.

The Annual Groundwater Impacts Review and the Triennial Groundwater Model Review conducted during 2019 is provided in Appendix A.

7.5.2 Groundwater Performance

Sampling of ground waters was carried out in accordance with the HVO Groundwater Monitoring Programme. Where laboratory analysis was undertaken, this was performed by a NATA accredited laboratory. Sites with a data capture rate of less than 100 per cent are outlined in Table 43.

Table 43 HVO Groundwater Monitoring Data Recovery for 2019 (by exception)

Location	Data Recovery (%)	Comments
4036C	0%	Insufficient water during 2019 monitoring events.
B425(WDH)	0%	Insufficient water to sample during 2019 monitoring events
BZ1-1	25%	Bore unable to be sampled during February monitoring event due to obstruction, May monitoring event due to insufficient water, and August monitoring event due to obstruction
BZ4A(2)	25%	Insufficient water during May, August and November monitoring events
C919(ALL)	0%	Insufficient water during 2019 monitoring events
CGW45	0%	Bore unable to be sampled during 2019 sampling event due to obstruction
CGW47A	0%	Insufficient water during 2019 monitoring events
CGW51A	92%	Bores unsafe to access during February monitoring events
CHPZ2A	75%	Bore unable to be sampled during May monitoring event due to presence of snake in bore

Location	Data Recovery (%)	Comments
CHPZ8A	0%	Insufficient water during 2019 monitoring events

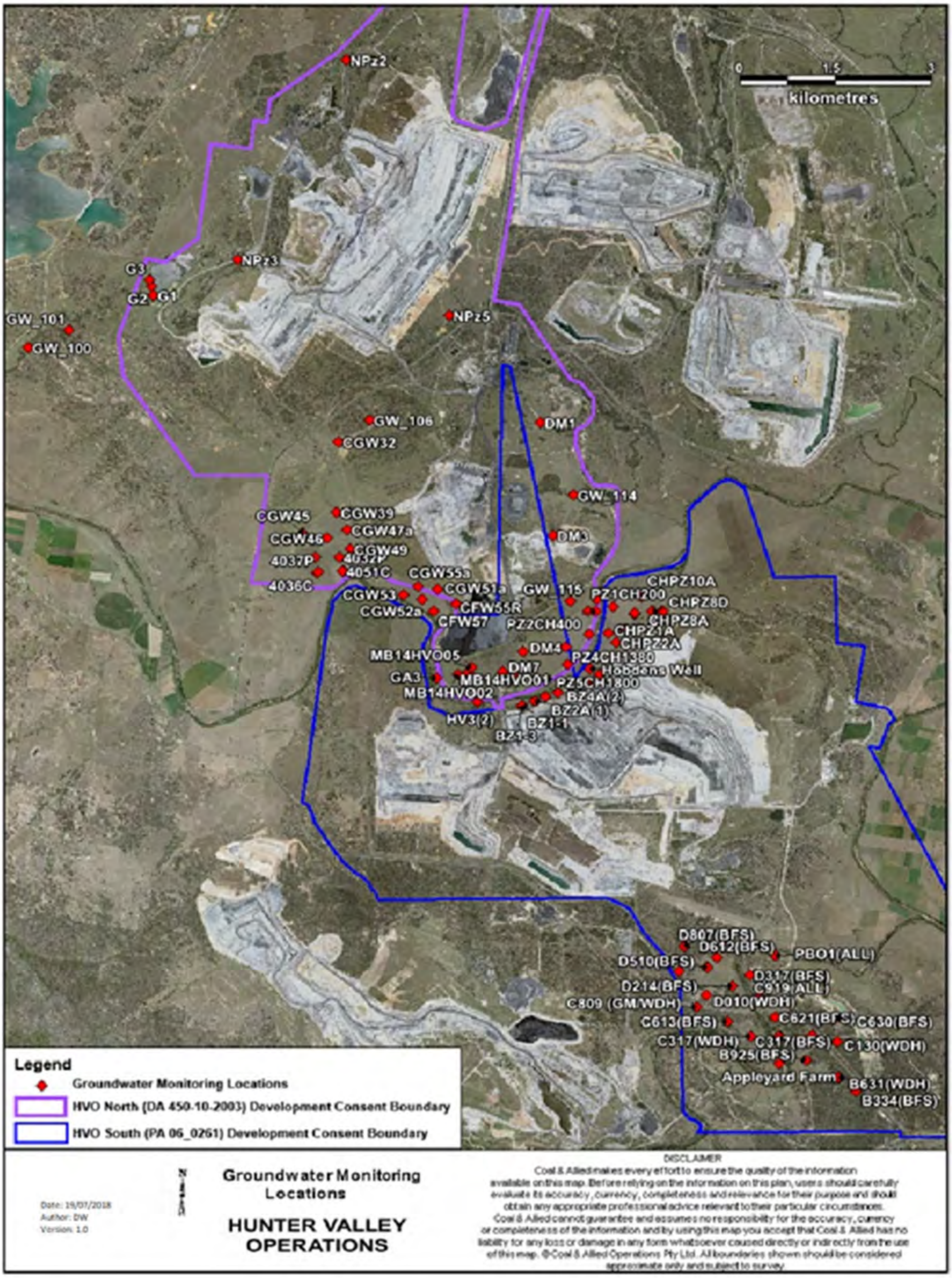


Figure 36: Groundwater Monitoring Network at HVO – 2019

7.5.3 Groundwater Monitoring Summary

The following section presents groundwater monitoring data in relation to the geographic locations and target stratigraphy for groundwater monitoring bores.

Each location is discussed below, and a summary of monitoring data presented. Where monitoring results required further investigation following the recording of three consecutive measurements outside the internal statistical limits, these results are summarised in tables for each location.

7.5.3.1 Carrington Broonie

Carrington Groundwater was sampled on 4 occasions during 2019 from two monitoring locations. The EC, pH and SWL trends for 2016 to 2019 for Carrington Broonie Seam groundwater bores are shown in Figure 37 to Figure 39 respectively. Data was generally consistent with historical ranges with some minor variation noted with pH results. Trigger tracking results are listed in Table 44.

Table 44 HVO Carrington Broonie Groundwater 2019 Monitoring Internal Trigger Tracking

Location	Date	Trigger Limit	Action Taken In Response
CGW53	13/3/2019	pH - 5th percentile	First exceedance. Returned to normal range on next monitoring round.
CGW52	4/12/2019	pH - 5th percentile	First exceedance. Watching Brief established*
CGW53	4/12/2019	pH - 5th percentile	First exceedance. Watching Brief established*

* = Watching brief established pending outcomes of subsequent monitoring events. No specific actions required.

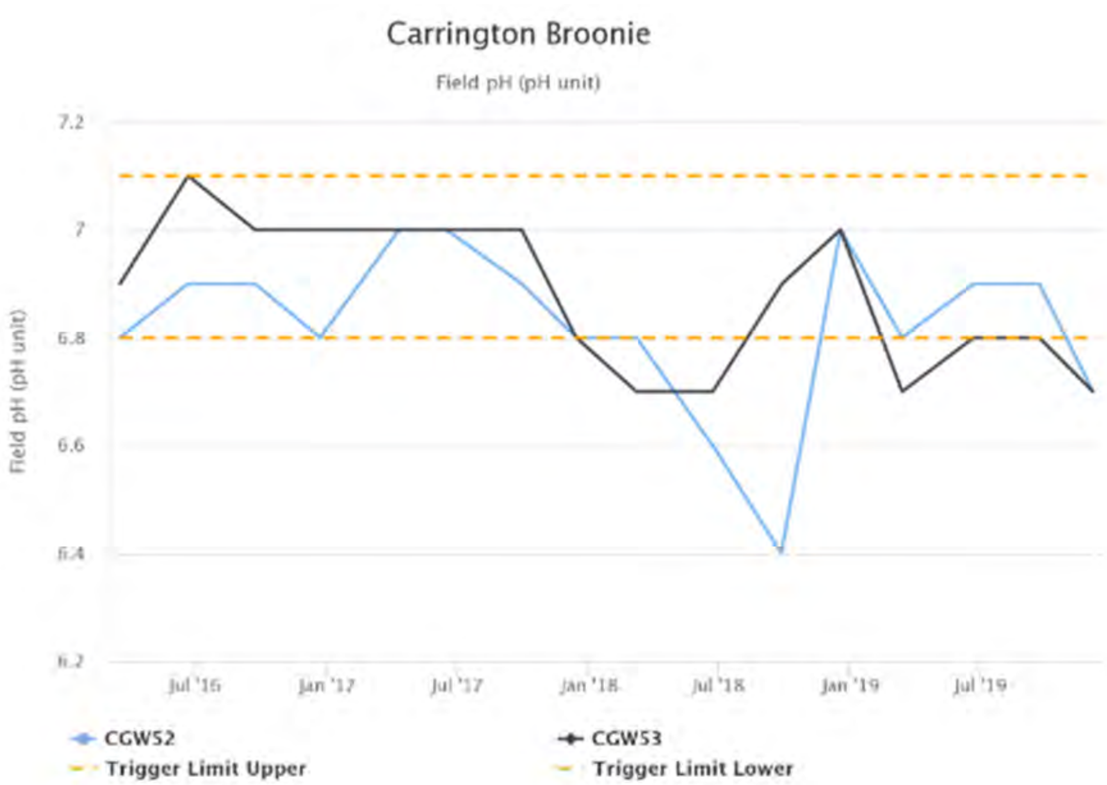


Figure 37: Carrington Broonie Groundwater pH Trends 2016 – 2019

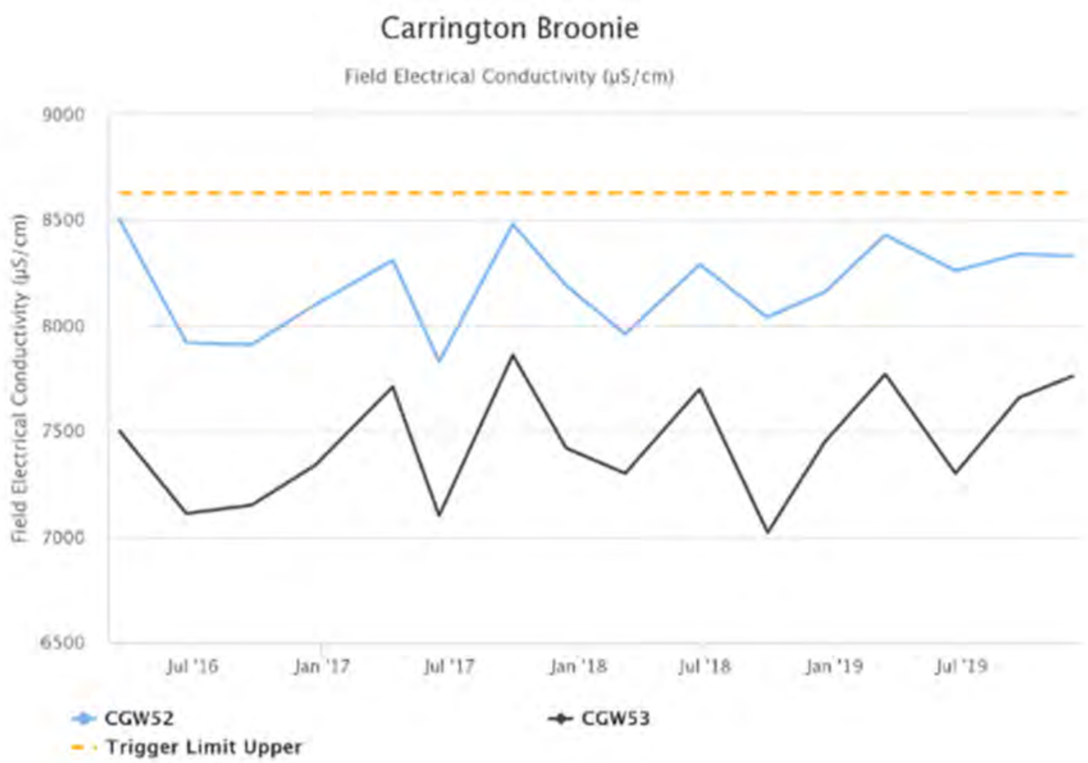


Figure 38: Carrington Broonie Groundwater EC Trends 2016 – 2019

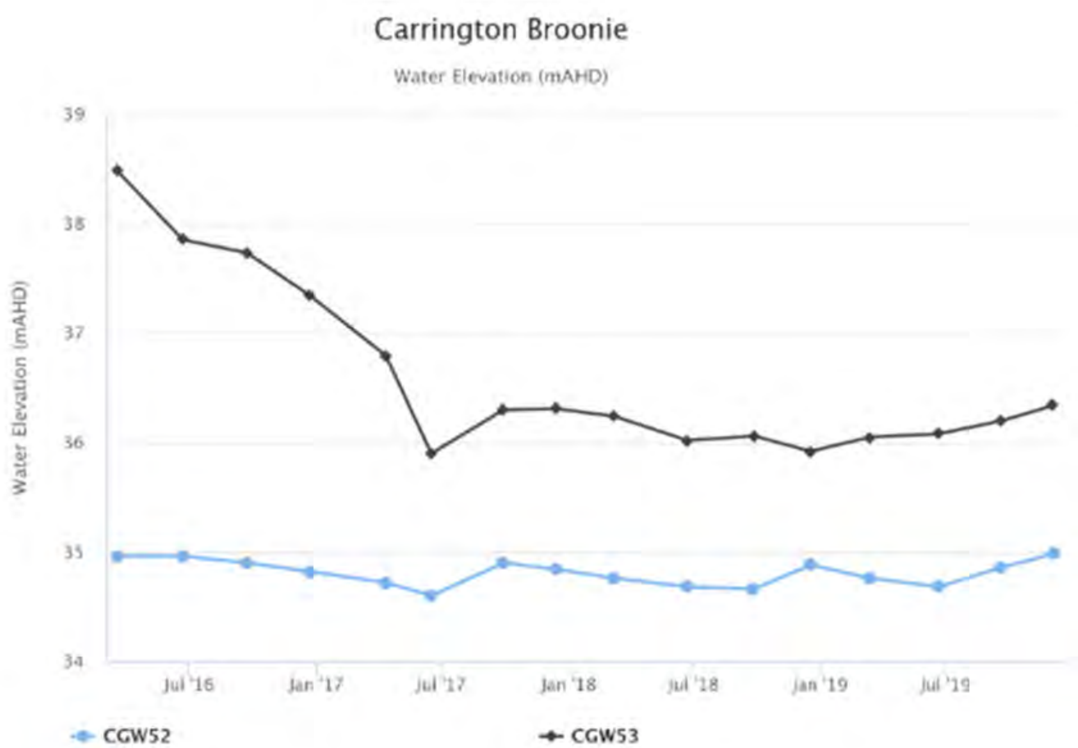


Figure 39: Carrington Broonie Groundwater SWL Trends 2016 – 2019

7.5.3.2 Carrington Alluvium

Groundwater monitoring in the Carrington Alluvium area was undertaken at five sites during 2019, with 91 samples collected during the reporting period. The EC, pH and SWL trends for 2016 to 2019 for Carrington Alluvium groundwater bores are shown in Figure 40 to Figure 42. Trigger exceedance results are listed in

Table 45.

During 2019, HVO continued to work with the NSW Environment Protection Authority (EPA) to address potential impacts of seepage from the North Void Tailings Storage Facility (TSF). This included ceasing deposition of tailings to the TSF and decanting of surface water to allow the tailings to dry and consolidate. Monitoring of the area continues at an increased frequency including data collection from continuous groundwater loggers measuring water level and quality. Electrical conductivity and pH have stabilised and standing water level has declined, this is an indication that current controls are being effective. HVO will continue to work with the EPA during 2020 as part of a Pollution Reduction Programme (PRP) to address the seepage.

Table 45 HVO Carrington Alluvium Groundwater 2019 Monitoring Internal Trigger Tracking

Location	Date	Trigger Limit	Action Taken In Response
CFW55R	3/1/2019 to 12/2/2019	pH - 5th percentile	Investigation in progress as part of North Void Seepage Investigation which is ongoing. Refer to Appendix A.
CFW55R	3/1/2019 to 18/12/2019	EC – 95th percentile	
CGW53A	20/09/2019	Standing Water Level – 5th percentile	First exceedance. Watching brief established*. Returned to normal range on next monitoring round.
CGW55A	4/12/2019	Standing Water Level – 5th percentile	First exceedance. Watching brief established*.
CGW55A	4/12/2019	pH – 95th percentile	First exceedance. Watching brief established*.

* = Watching brief established pending outcomes of subsequent monitoring events. No specific actions required.

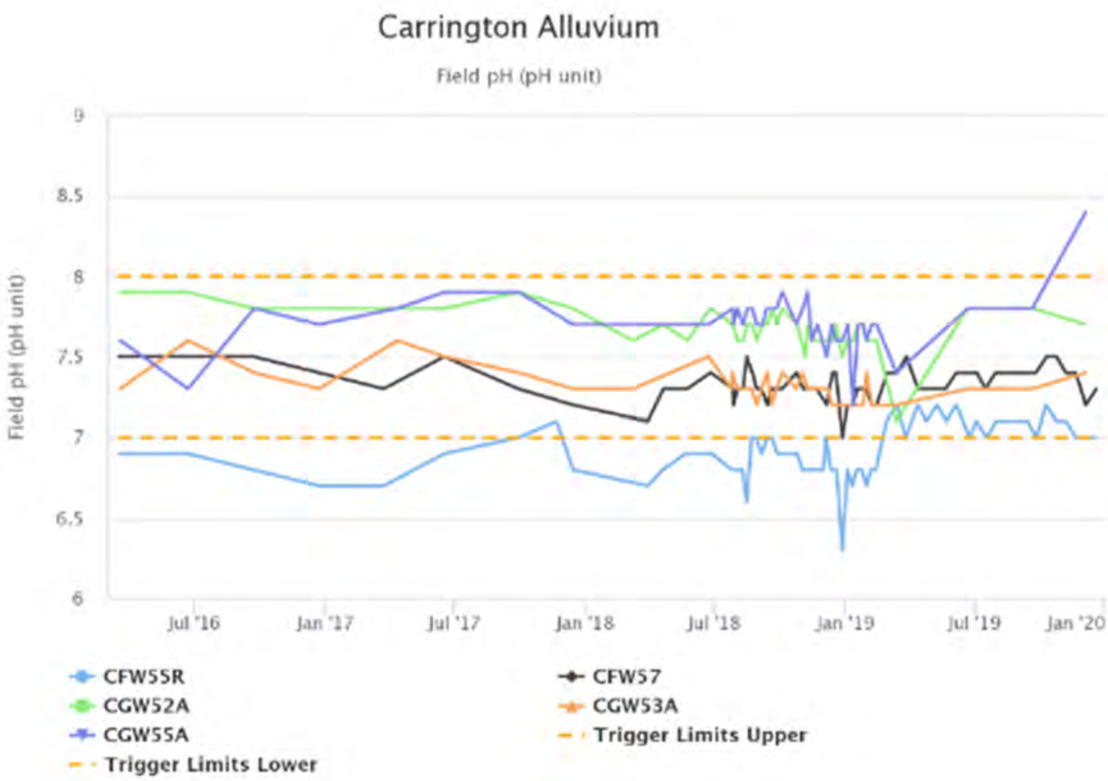


Figure 40: Carrington Alluvium Groundwater pH Trends 2016 – 2019

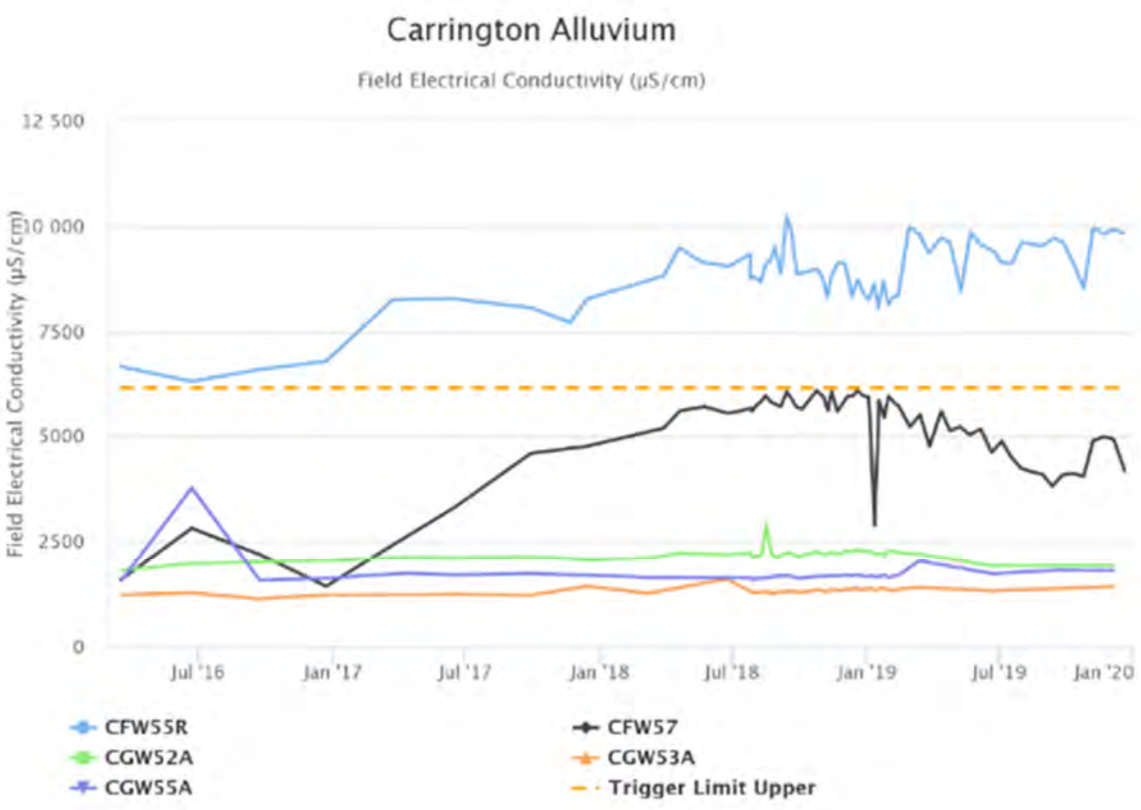


Figure 41: Carrington Alluvium Groundwater EC Trends 2016 – 2019

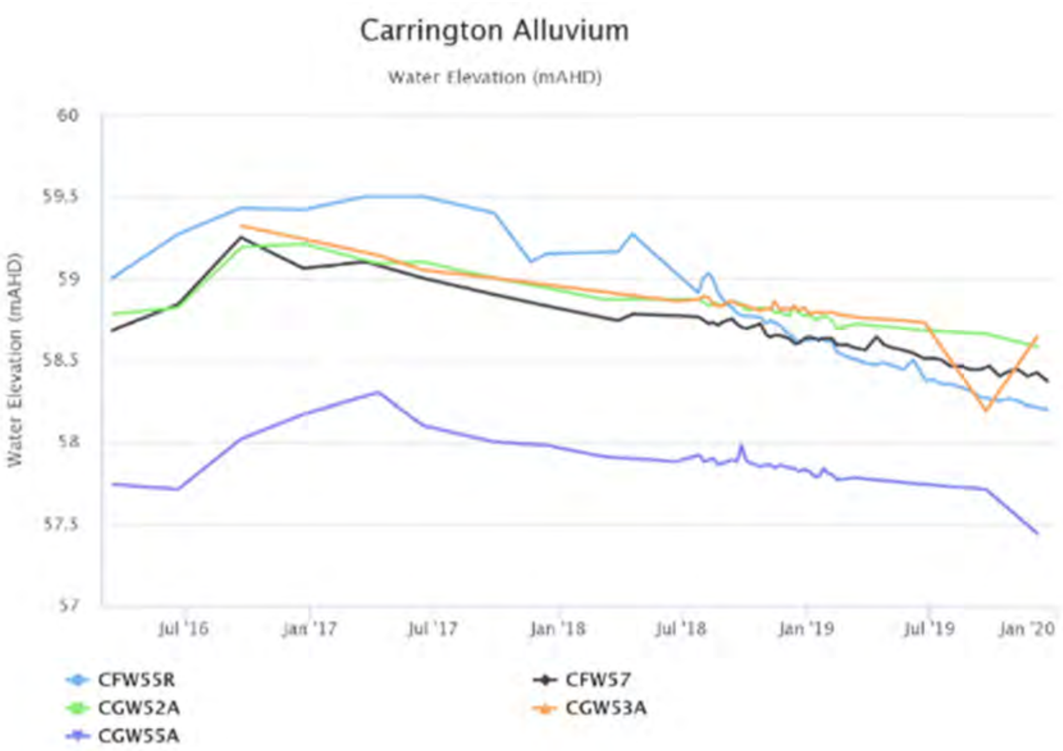


Figure 42: Carrington Alluvium Groundwater SWL Trends 2016 – 2019

7.5.3.3 Carrington Interburden

Groundwater monitoring in the Carrington Interburden was undertaken at two sites during 2019, with 19 samples collected for field analysis during the reporting period.

The EC, pH and SWL trends for 2016 to 2019 for groundwater bores in the Carrington Interburden are shown in Figure 43 to Figure 45 respectively. Results were generally consistent with historical trends.

Bore 4036C contained insufficient water for accurate pH and EC analysis throughout 2019. Bore 4051C was unblocked in late 2018 and sampling recommenced in March 2019 in this bore. Sampling frequency for CGW51A had been increased during early 2019 in response to an ongoing groundwater investigation initiated by exceedances of the pH 95th percentile trigger limit. The pH levels in this bore were below the pH 95th percentile trigger limit during 2019.

There were no exceedances for these monitoring bores during 2019.

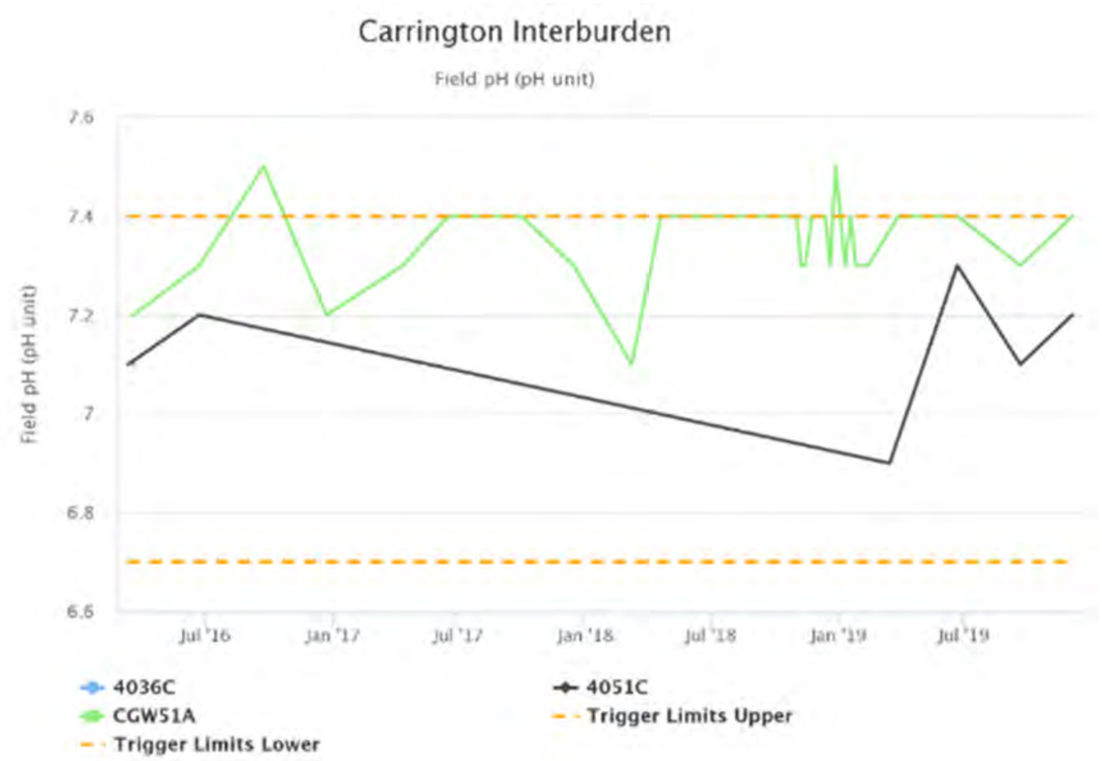


Figure 43: Carrington Interburden Groundwater pH Trends 2016 – 2019

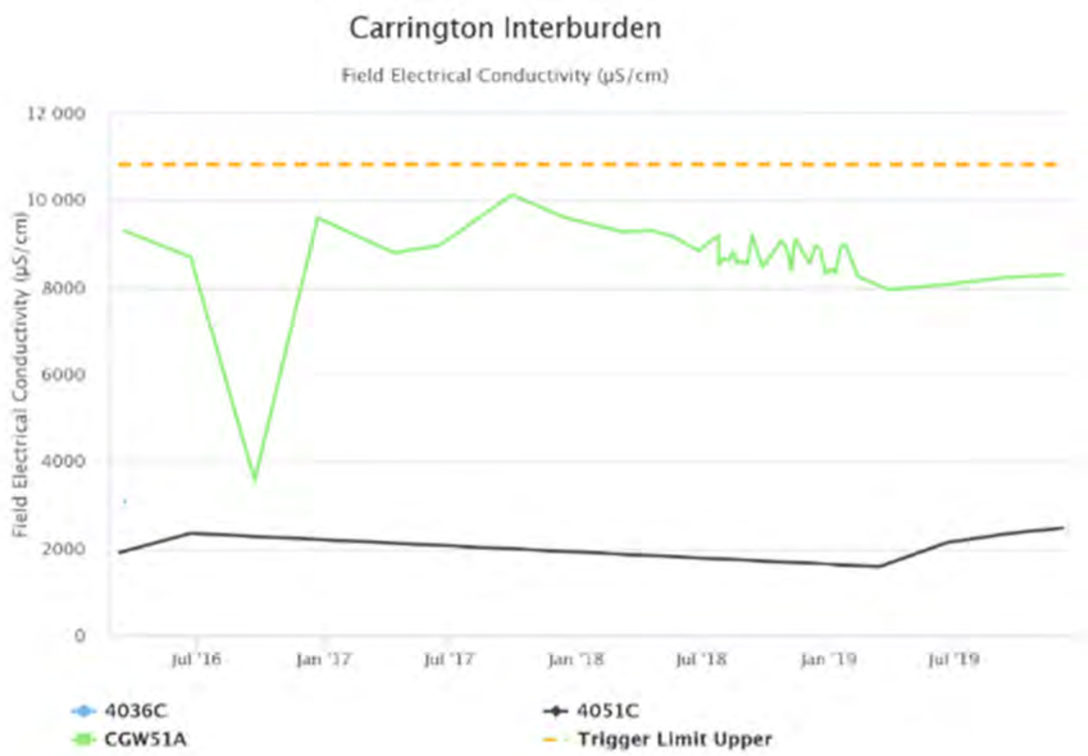


Figure 44: Carrington Interburden Groundwater EC Trends 2016 – 2019

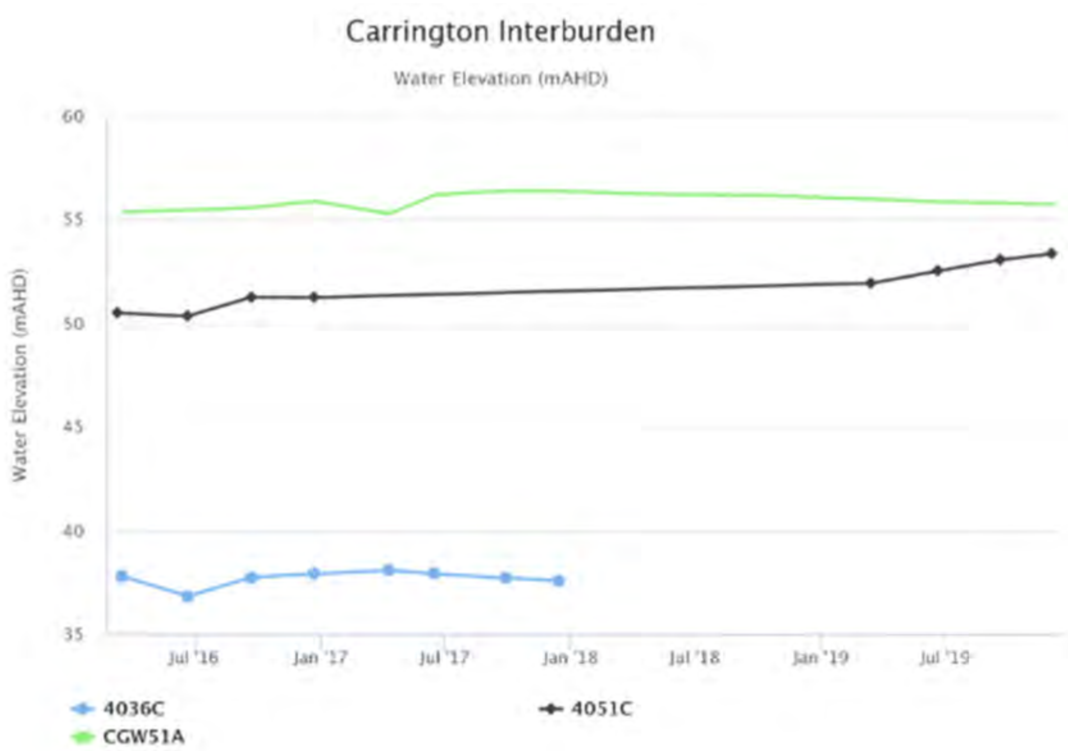


Figure 45: Carrington Interburden Groundwater SWL Trends 2016 – 2019

7.5.3.4 Carrington West Wing Alluvium

Groundwater monitoring in the Carrington West Wing Alluvium was undertaken at five sites in 2019 with 20 samples collected for field analysis during the reporting period. Results are shown in Figure 46 to Figure 48. Results during 2019 were generally consistent with historical trends.

Trigger tracking results are listed in Table 46.

Table 46 HVO Carrington West Wing Alluvium Groundwater 2019 Monitoring Internal Trigger Tracking

Location	Date	Trigger Limit	Action Taken In Response
CGW49	13/3/2019	EC – 95th Percentile	Second exceedance. Maintain watching brief. (Returned to normal range on next sample).
CGW49	20/9/2019	EC – 95th Percentile	First exceedance. Watching brief established*
CGW49	4/12/2019	EC – 95th Percentile	Second exceedance – Maintain watching brief.
4032P	4/12/2019	EC – 95th Percentile	First exceedance - Watching brief established*

* = Watching brief established pending outcomes of subsequent monitoring events. No specific actions required.

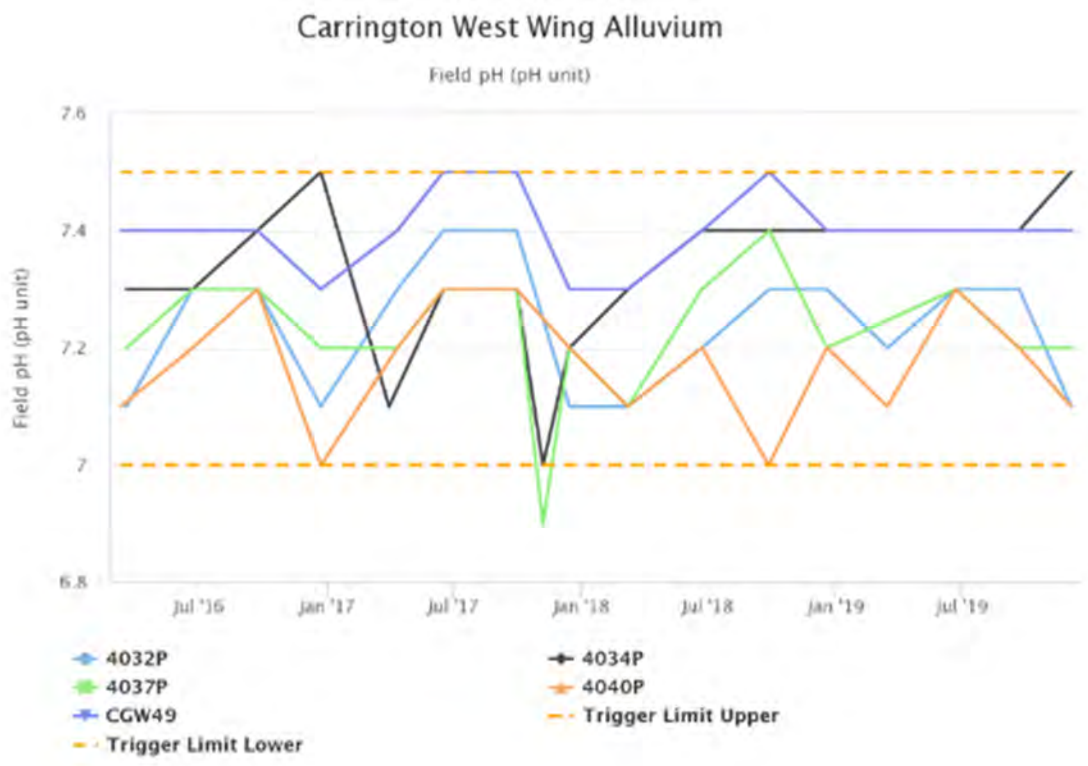


Figure 46: Carrington West Wing Alluvium Groundwater pH Trends 2016 – 2019

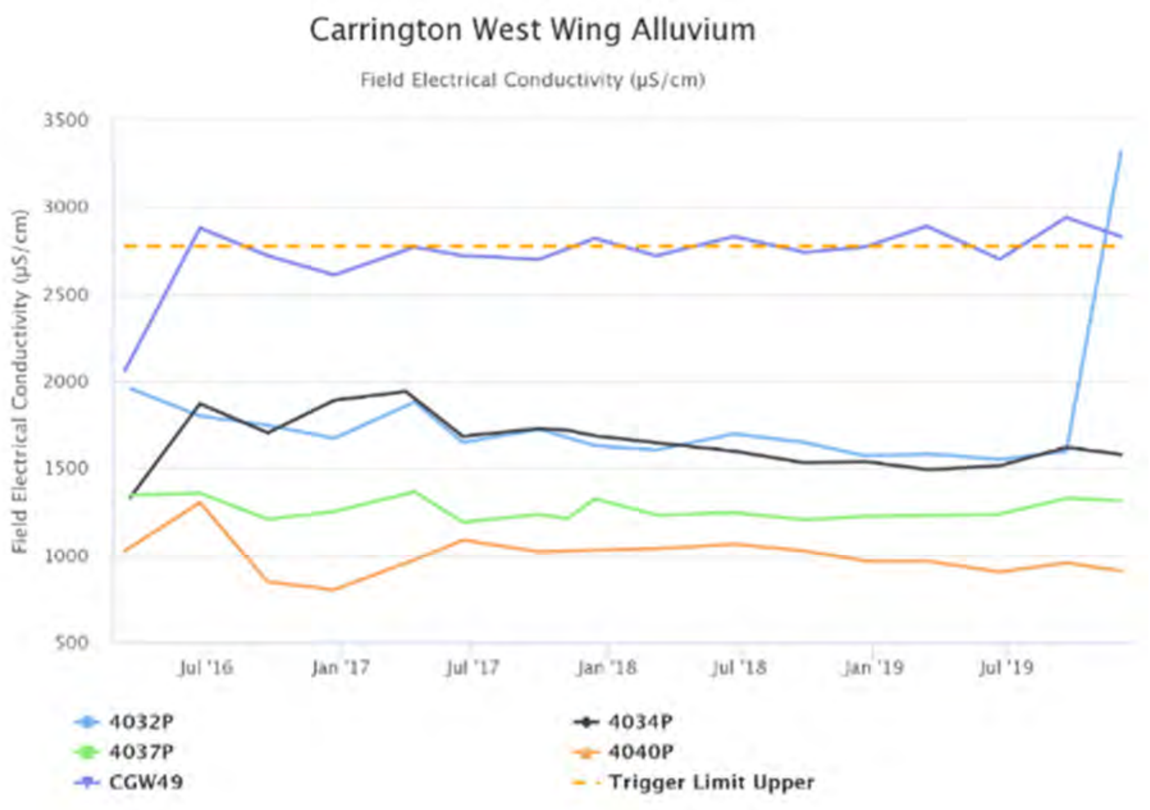


Figure 47: Carrington West Wing Alluvium Groundwater EC Trends 2016 – 2019

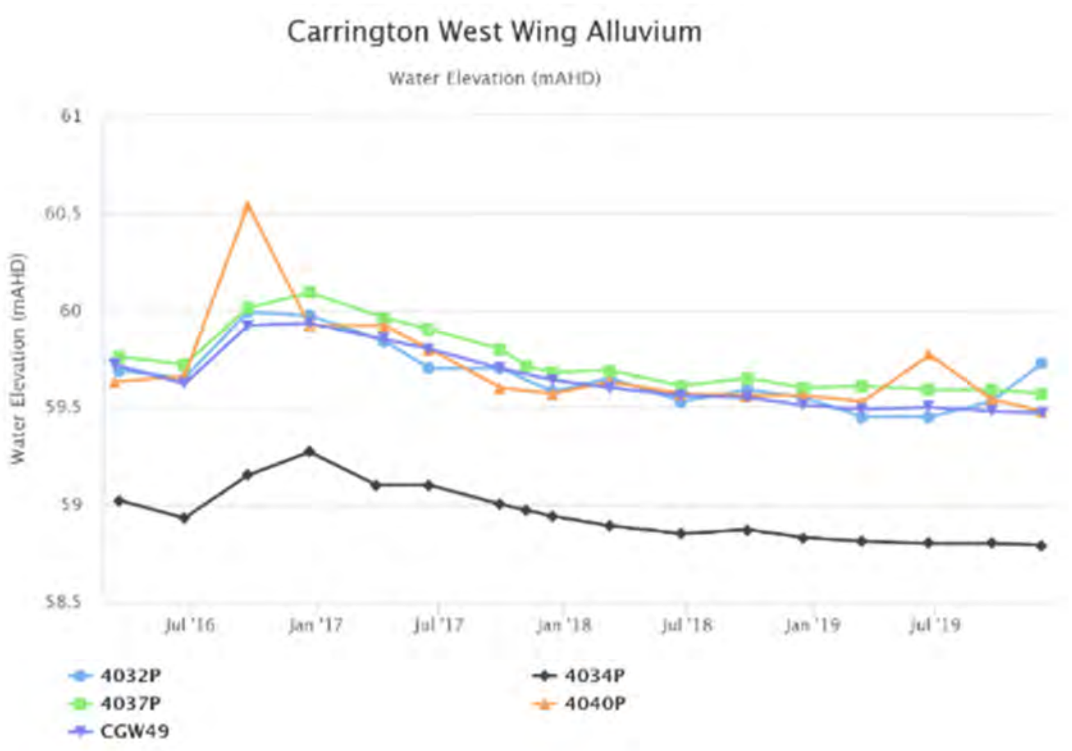


Figure 48: Carrington West Wing Alluvium Groundwater SWL Trends 2016 – 2019

7.5.3.5 Carrington West Wing Flood Plain

Groundwater monitoring in the Carrington West Wing Flood Plain was undertaken at four sites in 2019 with 16 samples collected for field analysis during the reporting period. Results are shown in Figure 49 to Figure 51. Groundwater levels in 2019 were consistent with 2018 levels in all bores. CGW47a was reported as dry during 2019.

There was one trigger exceedance in 2019. Trigger tracking results are listed in Table 47.

Table 47 HVO Carrington West Wing Flood Plain Groundwater 2019 Monitoring Internal Trigger Tracking

Location	Date	Trigger Limit	Action Taken In Response
GW-106	21/06/2019	pH – 5th percentile	First exceedance. Watching brief established*

* = Watching brief established pending outcomes of subsequent monitoring events. No specific actions required.

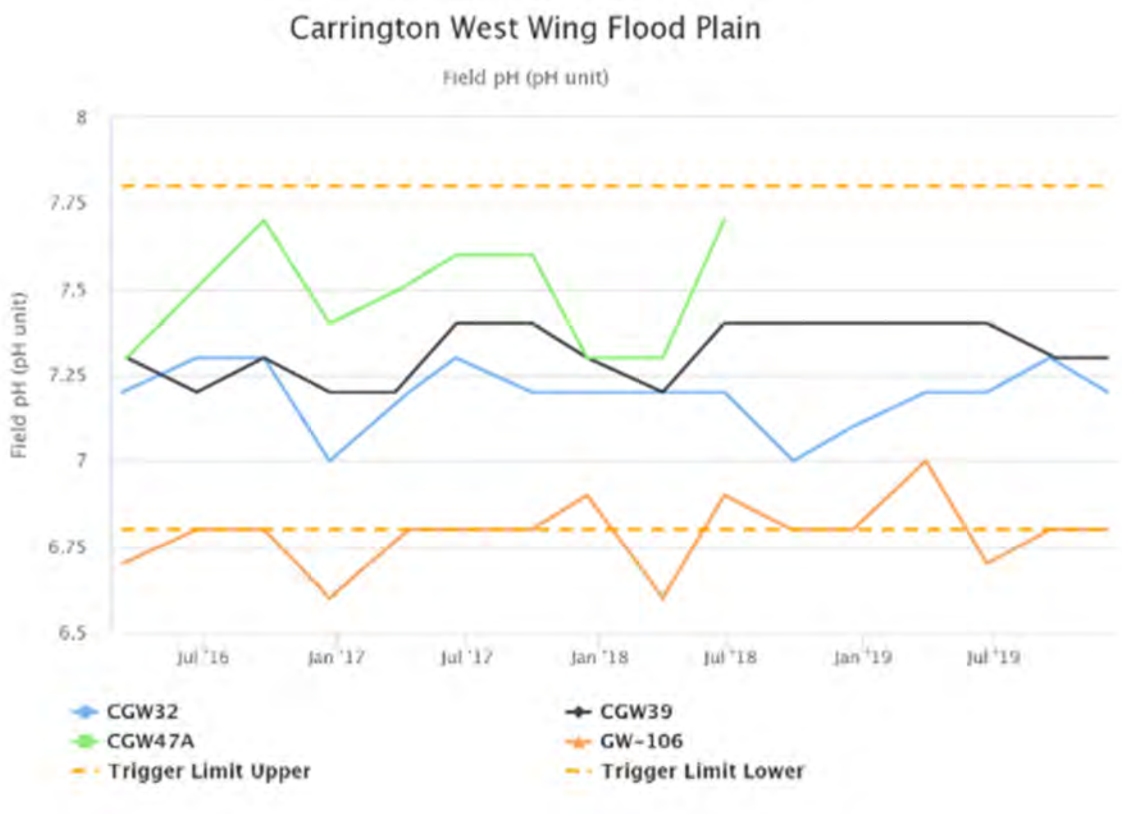


Figure 49: Carrington West Wing Flood Plain Groundwater pH Trends 2016 – 2019

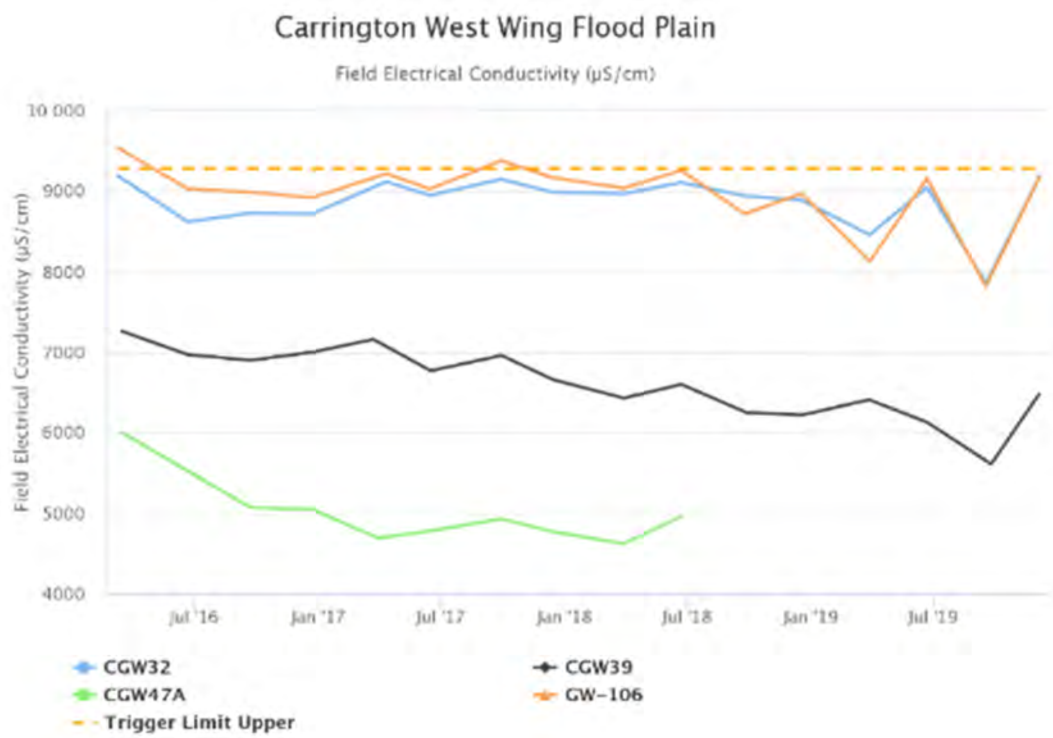


Figure 50: Carrington West Wing Flood Plain Groundwater EC Trends 2016 – 2019

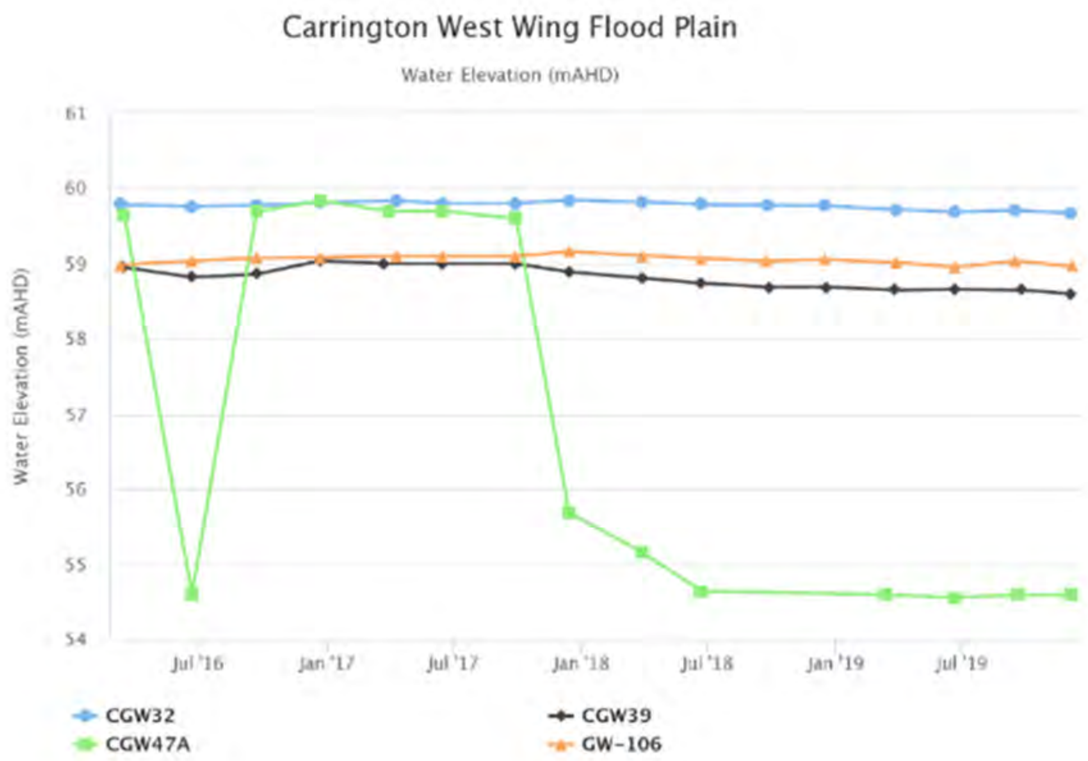


Figure 51: Carrington West Wing Flood Plain Groundwater SWL Trends 2016 – 2019

7.5.3.6 Cheshunt/North Pit Alluvium

Groundwater monitoring in the Cheshunt / North Pit area was undertaken at 17 sites during 2019, with 67 samples collected during routine monitoring. Samples could not be obtained from a number of bores during the reporting period, due to blockages (BZ1-1 and CHP2A) and insufficient water (BZ1-1, CHPZ2A and PZ2CH400). Electrical Conductivity, pH and SWL trends for 2016 to 2019 are shown in Figure 52 to Figure 54. Trigger tracking results are listed in Table 48.

The water level in piezometer PZ2CH400 returned to levels consistent with historical levels during 2019 following a noted increase at the end of 2018.

Table 48 HVO Cheshunt/North Pit Alluvium Groundwater 2019 Monitoring Internal Trigger Exceedances

Location	Date	Trigger Limit	Action Taken In Response
Hobdens Well	22/08/2019	pH - 95th Percentile	First exceedance - Watching brief established*
BZ1-1	14/11/2019	pH - 95th Percentile	First exceedance - Watching brief established*
Hobdens Well	14/11/2019	pH - 95th Percentile	Second exceedance – Maintain watching brief

** Watching Brief established pending outcomes of subsequent monitoring events. No specific actions required.*

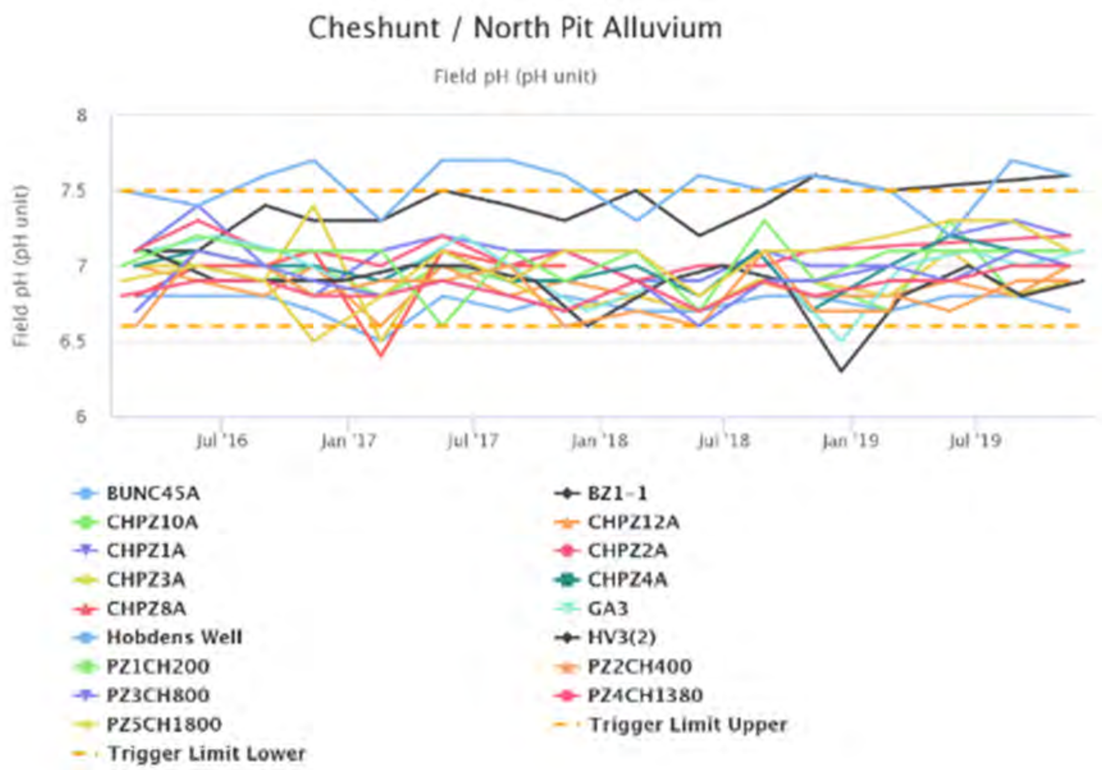


Figure 52: Cheshunt/North Pit Alluvium Groundwater pH Trends 2016 – 2019

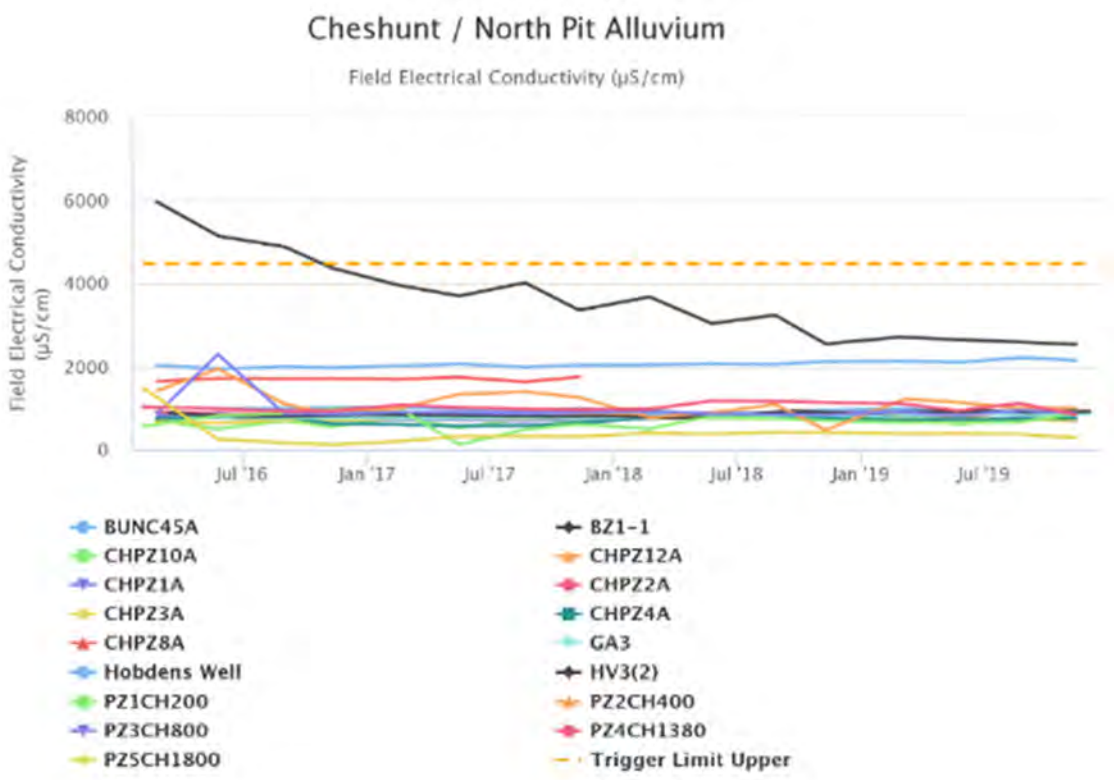


Figure 53: Cheshunt/North Pit Alluvium Groundwater EC Trends 2016 – 2019

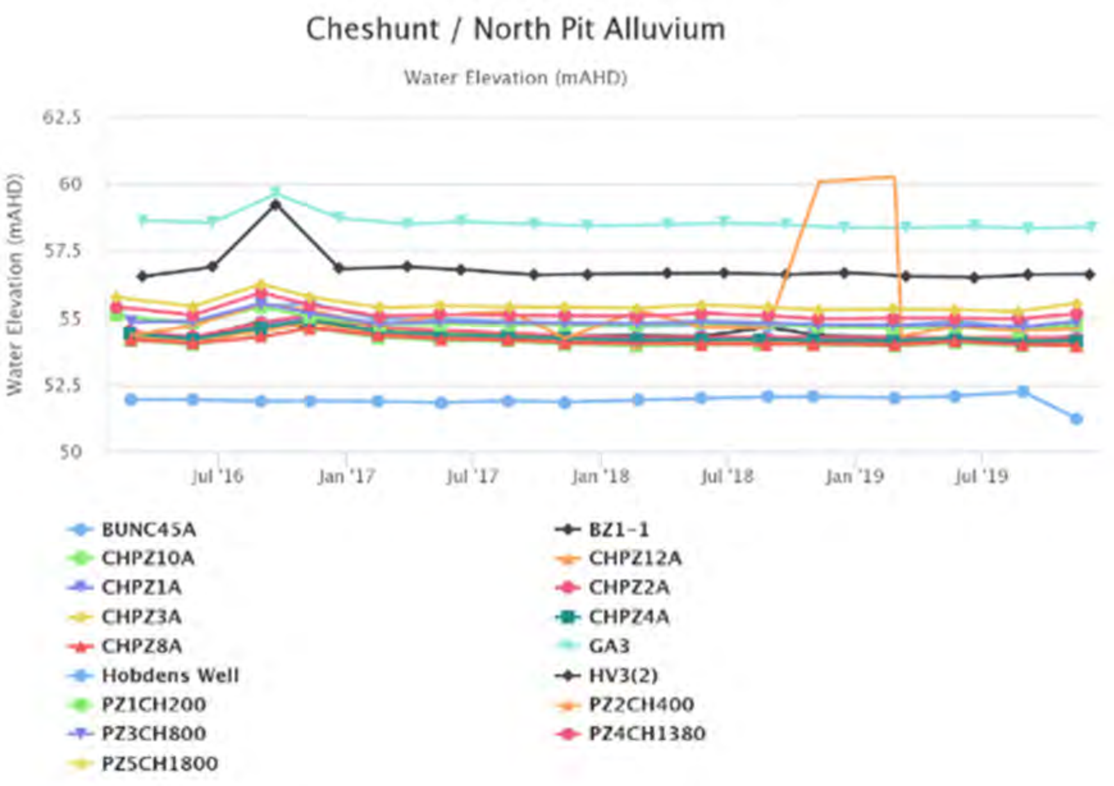


Figure 54: Cheshunt/North Pit Alluvium Groundwater SWL Trends 2016 – 2019

7.5.3.7 Cheshunt Interburden

Groundwater monitoring in the Cheshunt Interburden area was undertaken at three sites during 2019, with 12 samples collected during the reporting period. The EC, pH and SWL trends for 2016 to 2019 are shown in Figure 55 to Figure 57. Trigger tracking results are listed in Table 49.

Table 49 Cheshunt Interburden Groundwater 2019 Monitoring Internal Trigger Tracking

Location	Date	Trigger Limit	Action Taken In Response
BZ3-1	14/11/2019	pH - 95th Percentile	First exceedance - Watching brief established*

* Watching Brief established pending outcomes of subsequent monitoring events. No specific actions required.

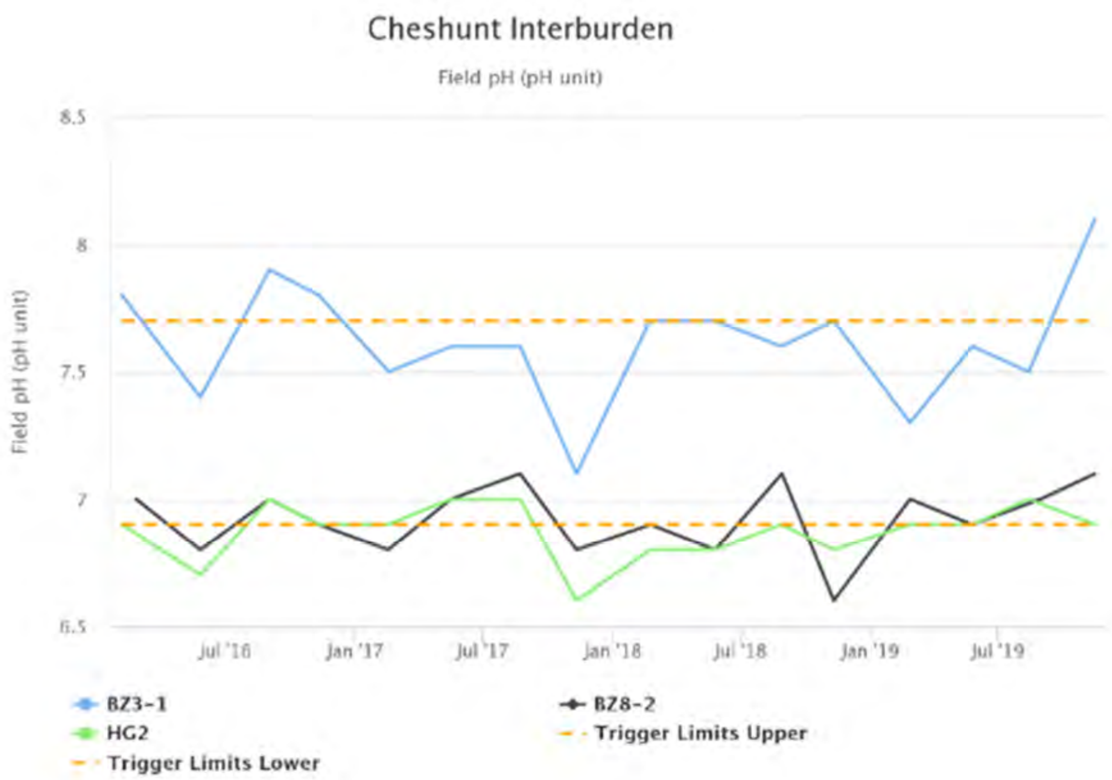


Figure 55: Cheshunt Interburden Groundwater pH Trends 2016 – 2019

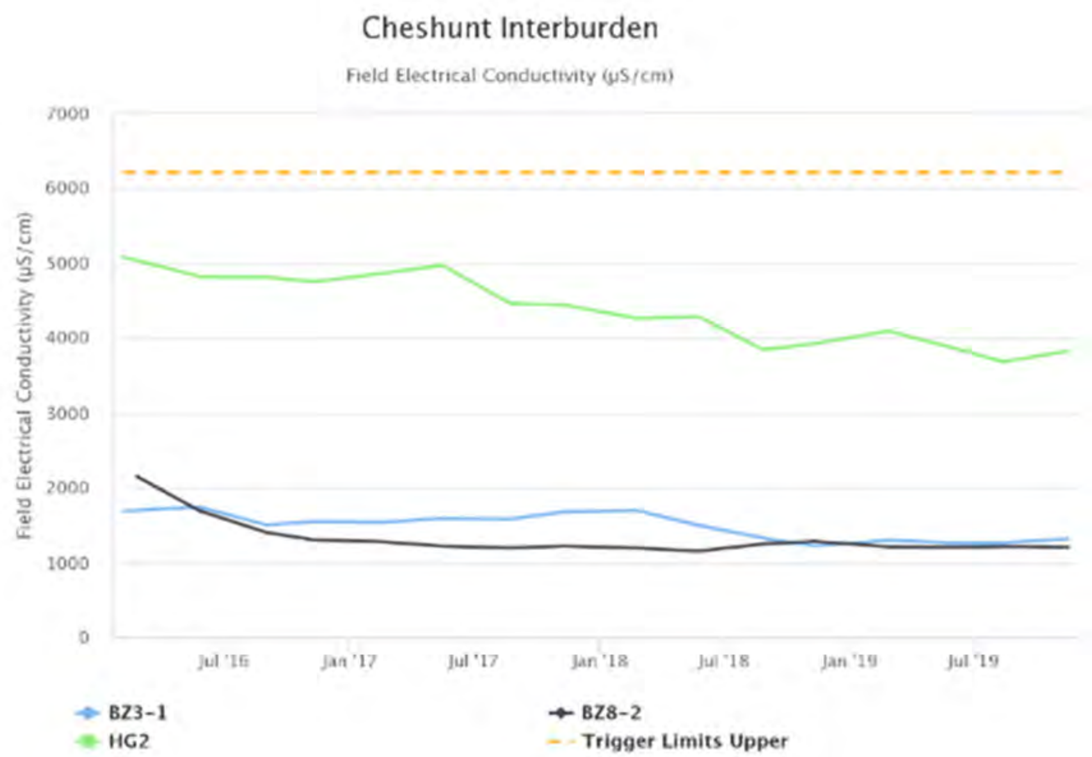


Figure 56: Cheshunt Interburden Groundwater EC Trends 2016 – 2019

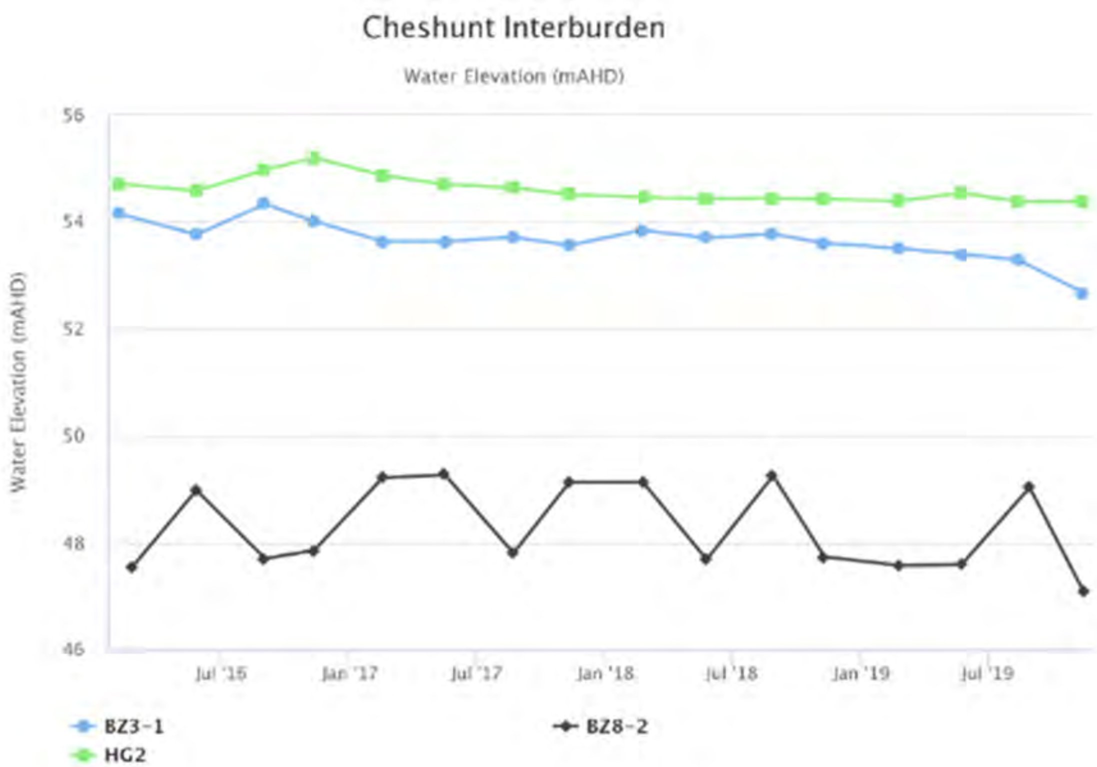


Figure 57: Cheshunt Interburden Groundwater SWL Trends 2016 – 2019

7.5.3.8 Cheshunt Mt Arthur

Groundwater monitoring in the Cheshunt Mt Arthur area was undertaken at nine sites during 2019. A total of 36 samples were collected during the reporting period. The pH, EC and SWL trends for 2016 to 2019 are shown in Figure 58 to Figure 60. Monitoring results were generally consistent with historical trends. Trigger tracking results are listed in Table 50.

Table 50 Cheshunt Mt Arthur Groundwater 2019 Monitoring Internal Trigger Tracking

Location	Date	Trigger Limit	Action Taken In Response
BZ3-3	25/02/2019	pH – 5th Percentile	Second exceedance. Watching brief*
BZ4A(2)	25/02/2019	pH – 5th Percentile	First exceedance - Watching brief established*
CHPZ3D	26/08/2019	pH – 5th Percentile	First exceedance - Watching brief established*
BZ2A(1)	14/11/2019	pH - 5th Percentile	First exceedance - Watching brief established*
BZ3-3	14/11/2019	pH - 5th Percentile	First exceedance - Watching brief established*

* Watching Brief established pending outcomes of subsequent monitoring events. No specific actions required.

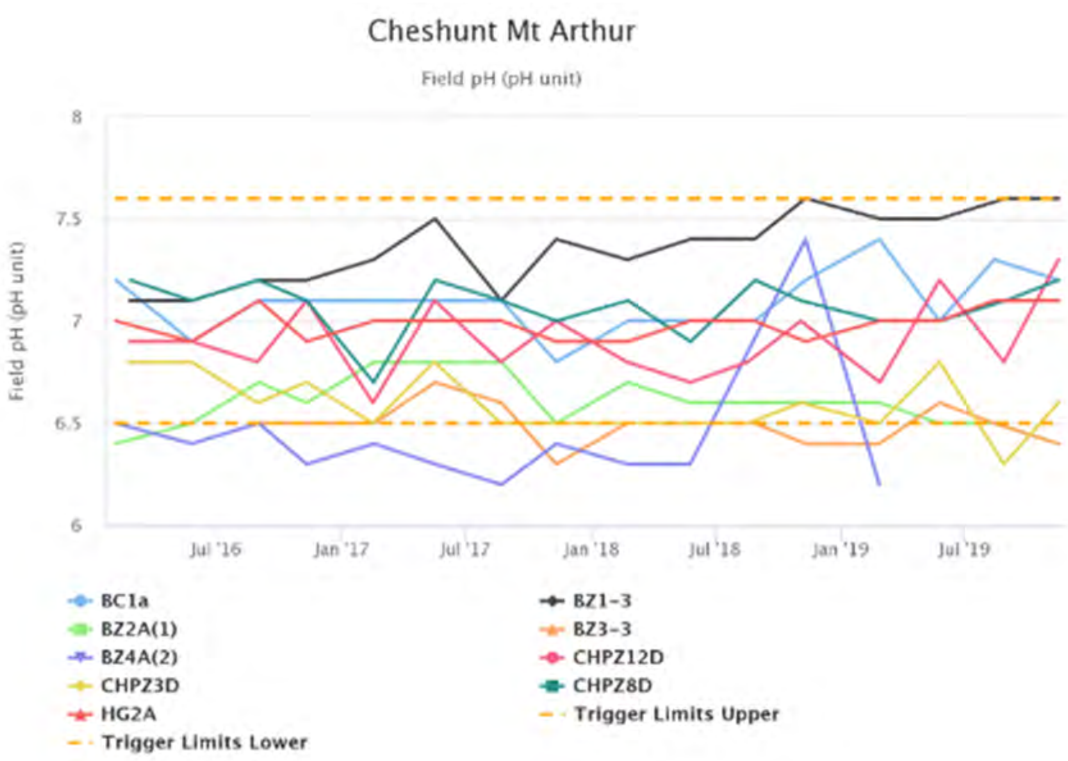


Figure 58: Cheshunt Mt Arthur Groundwater pH Trends 2016 – 2019

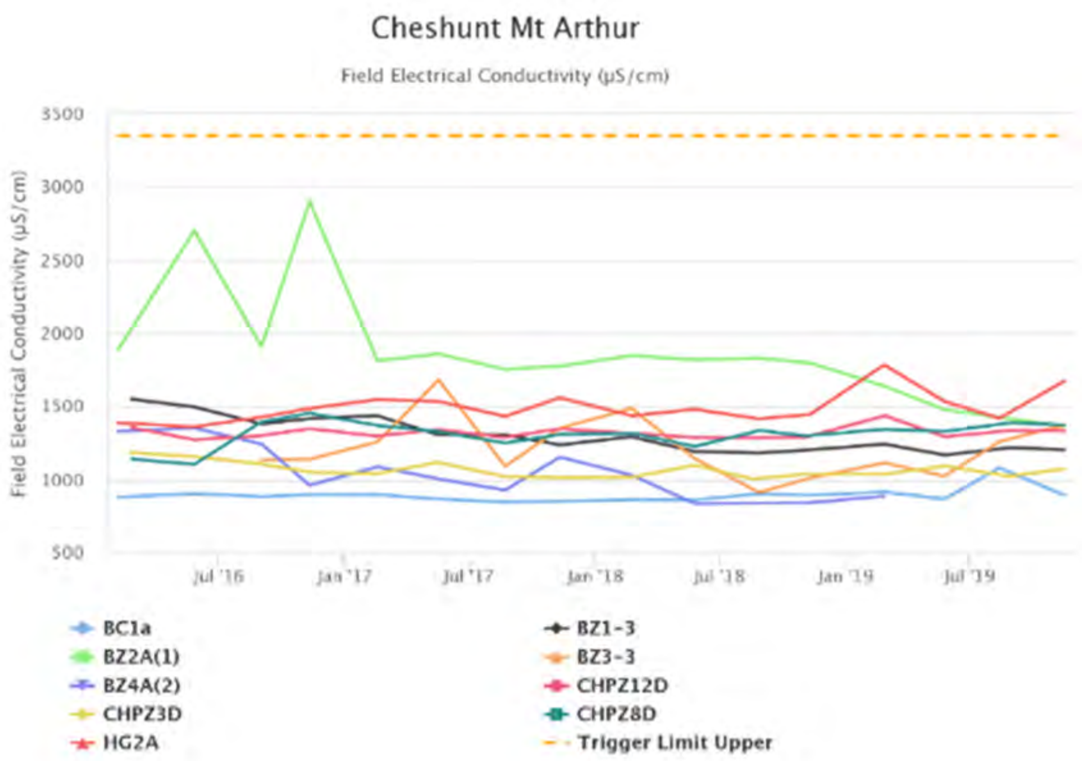


Figure 59: Cheshunt Mt Arthur Groundwater EC Trends 2016 – 2019

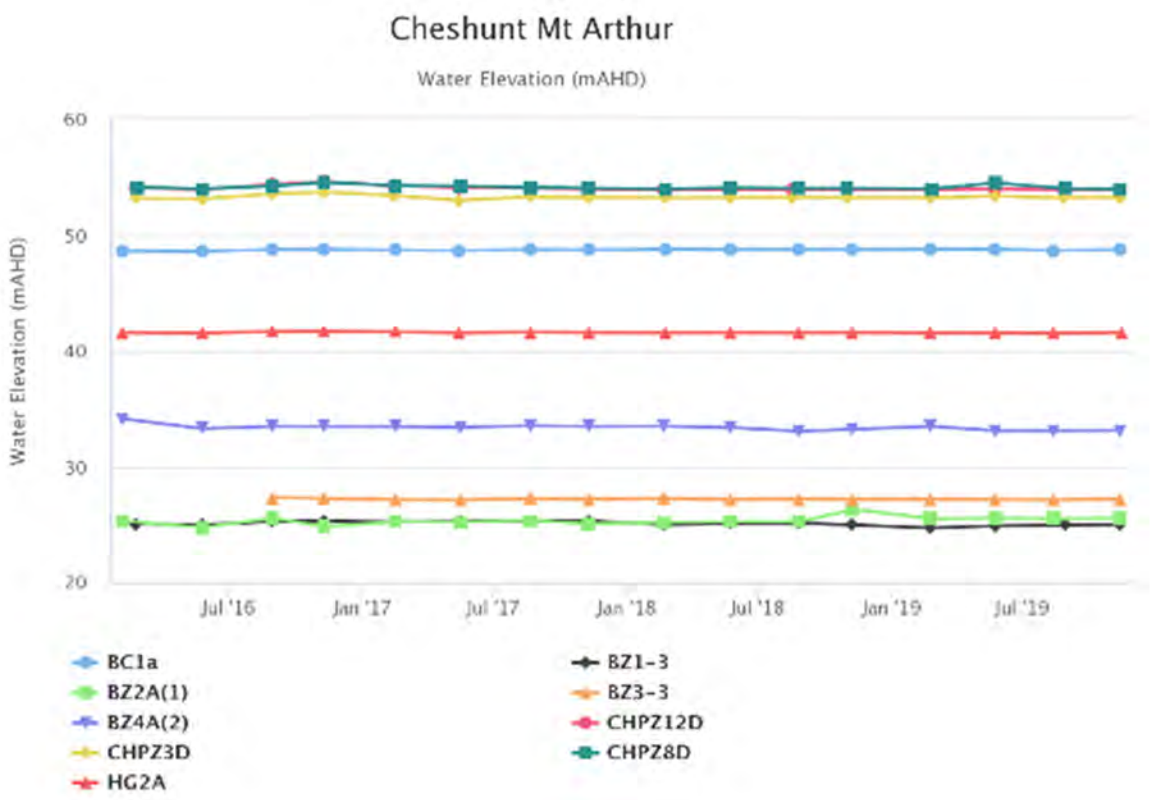


Figure 60: Cheshunt Mt Arthur Groundwater SWL Trends 2016 – 2019

7.5.3.9 Cheshunt Piercefield

Groundwater monitoring in the Cheshunt Piercefield area was undertaken from one site during 2019; a total of four samples were collected. The pH, EC and SWL trends for 2016 to 2019 are shown in Figure 61 to Figure 63.

Water quality results were generally consistent with historical trends. There were no trigger exceedances recorded in 2019.

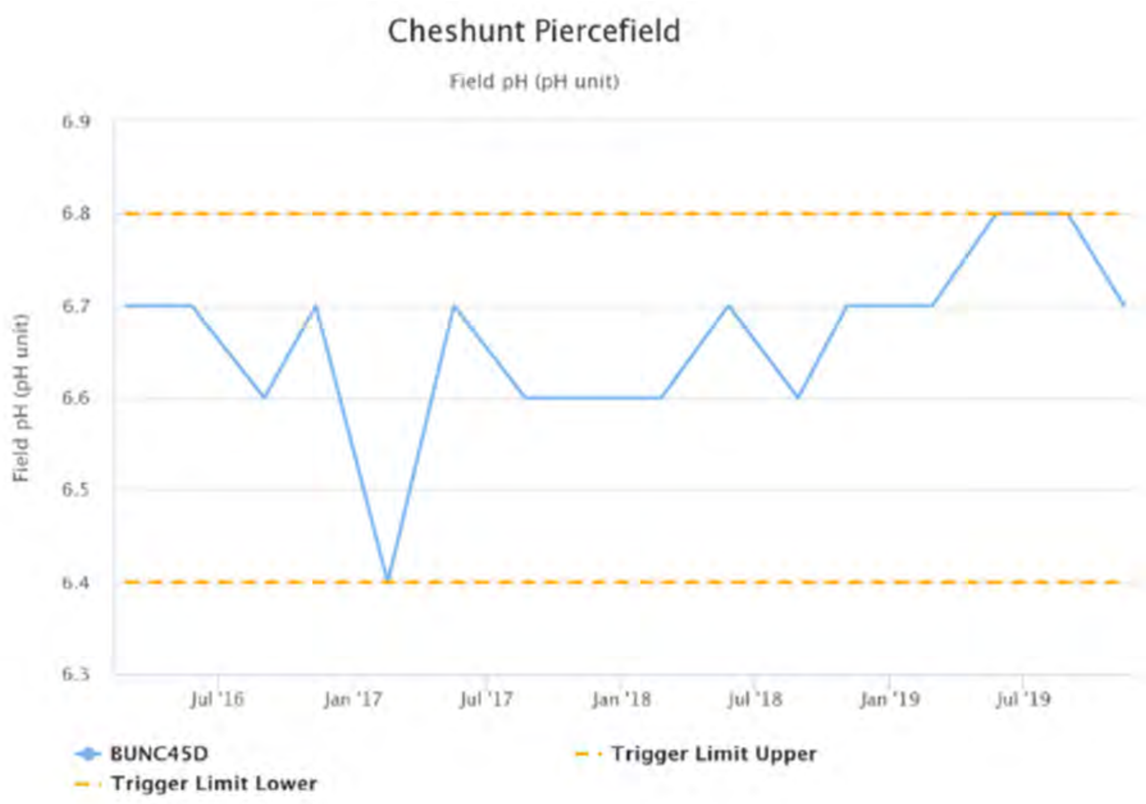


Figure 61: Cheshunt Piercefield Groundwater pH Trends 2016 – 2019

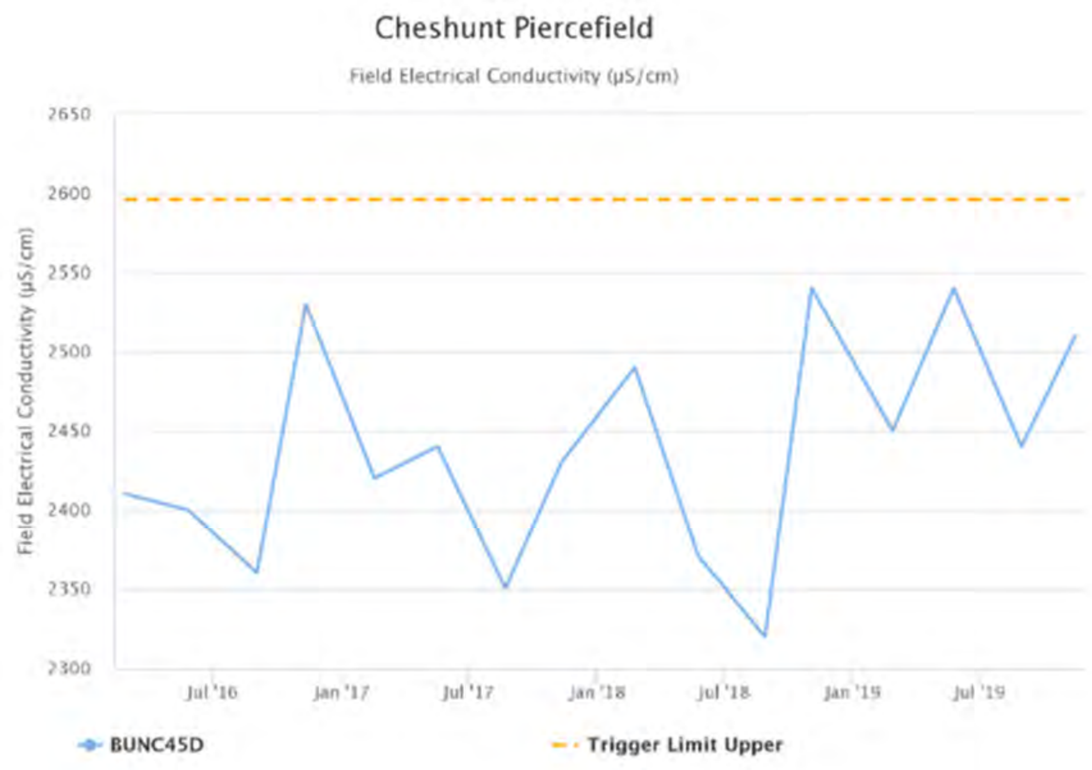


Figure 62: Cheshunt Piercefield Groundwater EC Trends 2016 – 2019

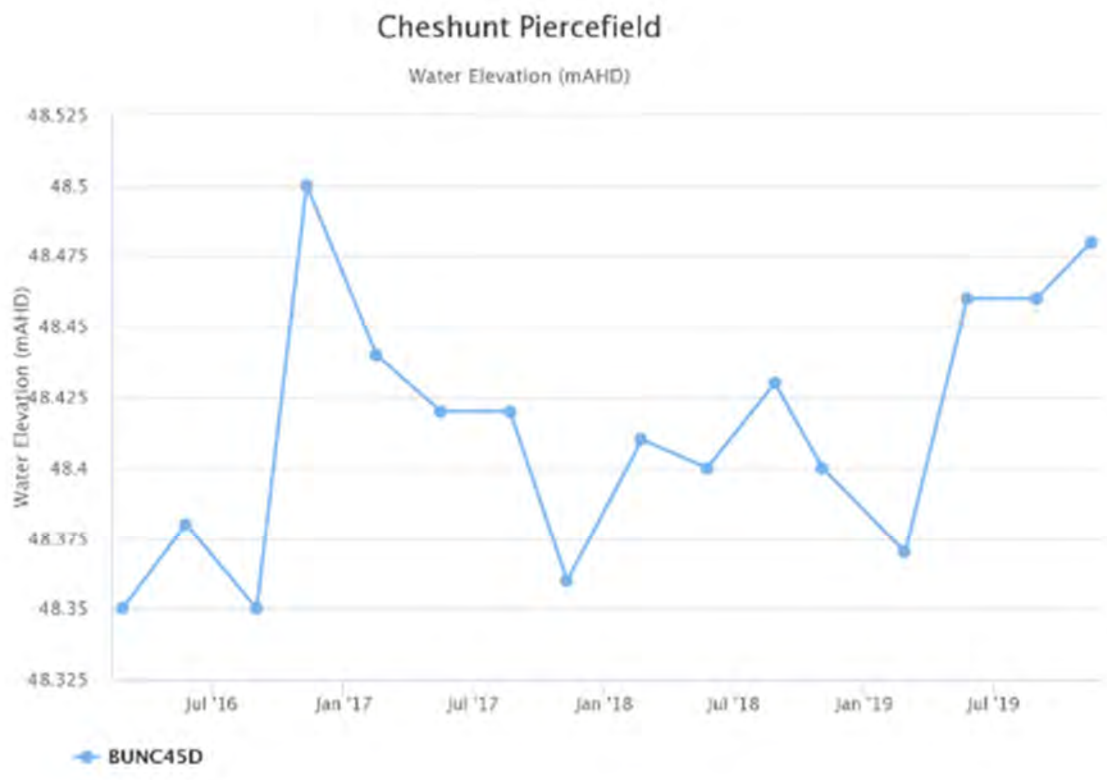


Figure 63: Cheshunt Piercefield Groundwater SWL Trends 2016 – 2019

7.5.3.10 Lemington South Alluvium

Groundwater monitoring in the Lemington South Alluvium area was undertaken at three sites during 2019. A total of 8 samples were collected during the reporting period with water level measured on a monthly basis. Bore C919 (ALL) had insufficient water for sampling during 2019.

The pH, EC and SWL trends for 2016 to 2019 are shown in Figure 64 to Figure 66. Trigger limits are listed in Table 51.

Table 51 Lemington South Alluvium Groundwater 2019 Monitoring Internal Trigger Tracking

Location	Date	Trigger Limit	Action Taken In Response
Appleyard Farm	12/08/2019	pH – 5th percentile	First exceedance. Watching brief established*
PB01(ALL)	26/02/2019	EC – 95th Percentile	Second exceedance. Watching brief*
PB01(ALL)	27/05/2019	EC – 95th Percentile	Third exceedance – investigation commenced. Refer to Appendix A.
PB01(ALL)	12/08/2019	EC – 95th Percentile	Investigation in progress Refer to Appendix A.
PB01(ALL)	8/11/2019	EC – 95th Percentile	Investigation in progress. Refer to Appendix A.

* Watching Brief established pending outcomes of subsequent monitoring events. No specific actions required.

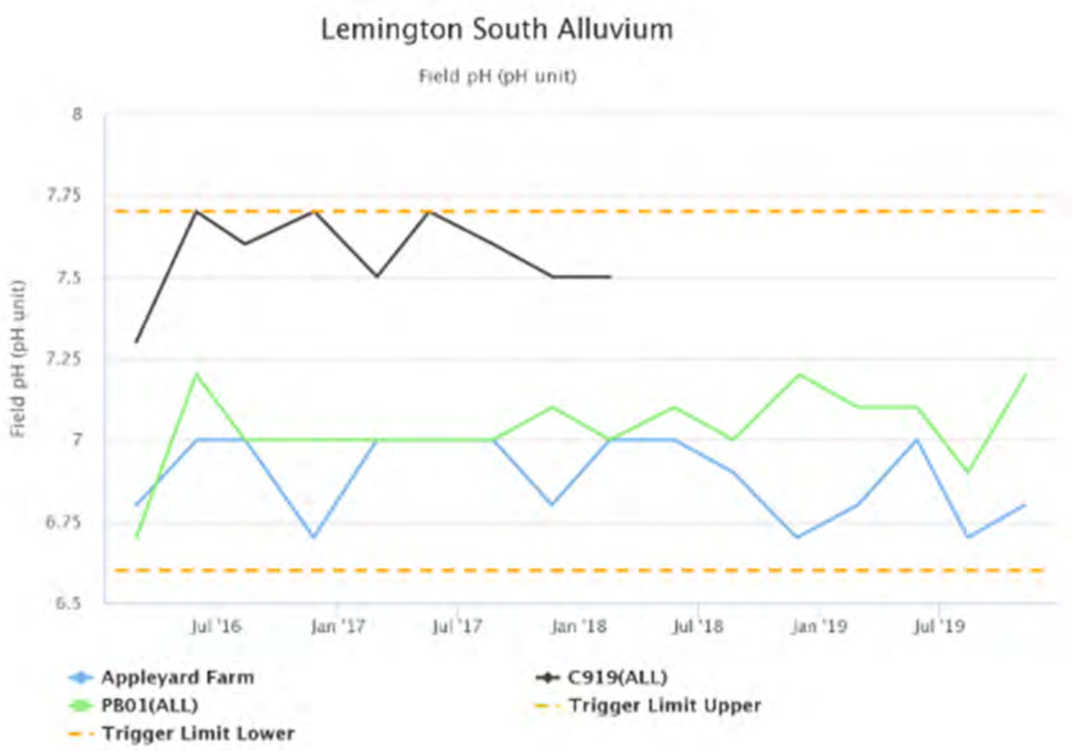


Figure 64: Lemington South Alluvium Groundwater pH Trends 2016 – 2019

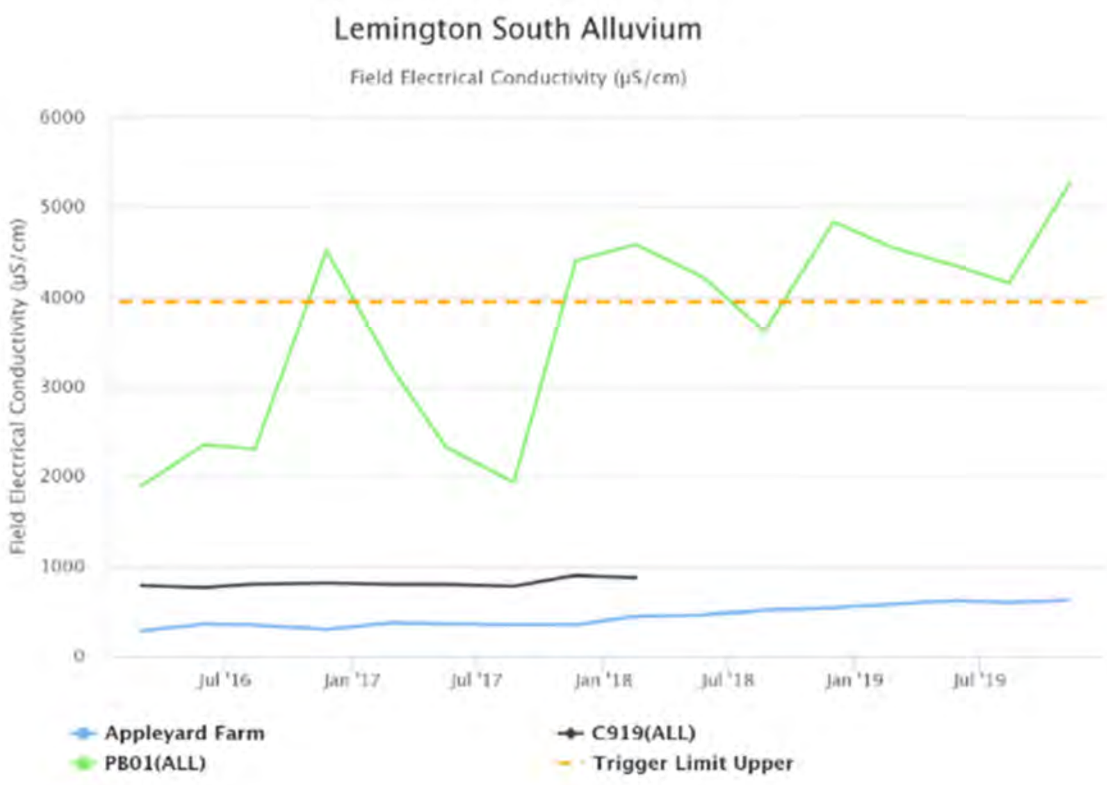


Figure 65: Lemington South Alluvium Groundwater EC Trends 2016 – 2019

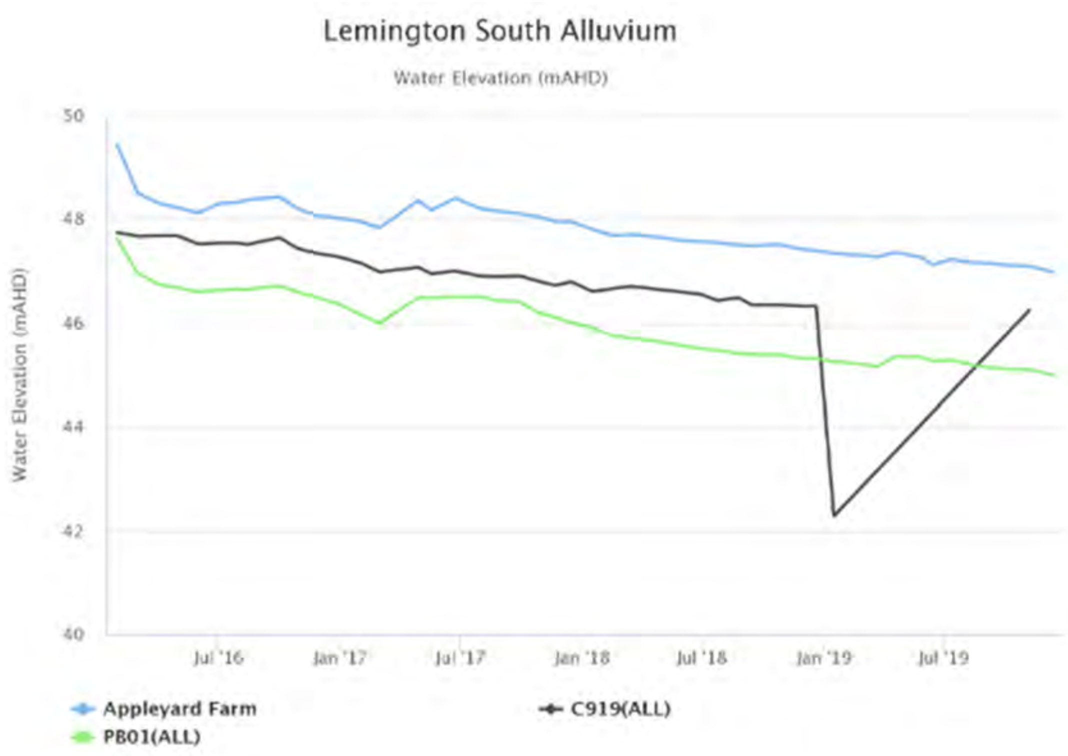


Figure 66: Lemington South Alluvium Groundwater SWL Trends 2016 – 2019

7.5.3.11 Lemington South Arrowfield

Groundwater monitoring in the Lemington South Arrowfield area was undertaken at four sites during 2019. A total of 8 samples were collected during the reporting period. The pH, EC and SWL trends for 2016 to 2019 are shown in Figure 67 to Figure 69. Results were generally consistent with historical trends with the exception of an exceedance of internal EC trigger for D612(AFS) as listed in Table 52.

Table 52 Lemington South Arrowfield Groundwater 2019 Monitoring Internal Trigger Tracking

Location	Date	Trigger Limit	Action Taken In Response
D612(AFS)	8/11/2019	EC – 95th Percentile	First exceedance - Watching brief established*

* Watching Brief established pending outcomes of subsequent monitoring events. No specific actions required.

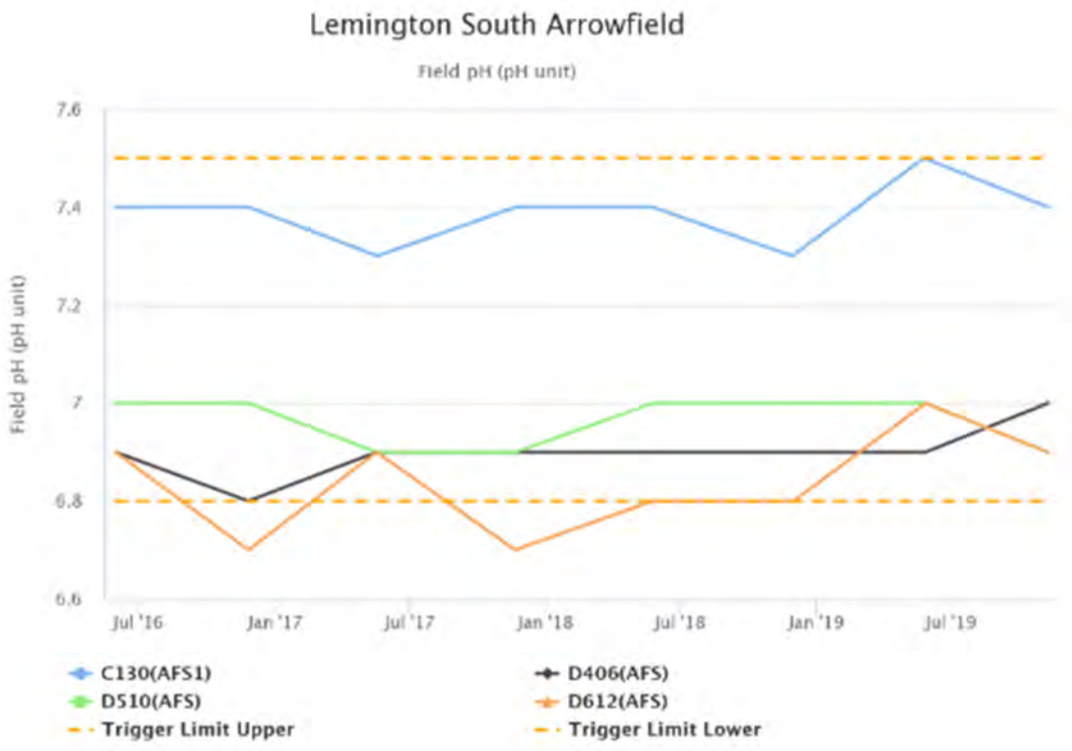


Figure 67: Lemington South Arrowfield Groundwater pH Trends 2016 – 2019

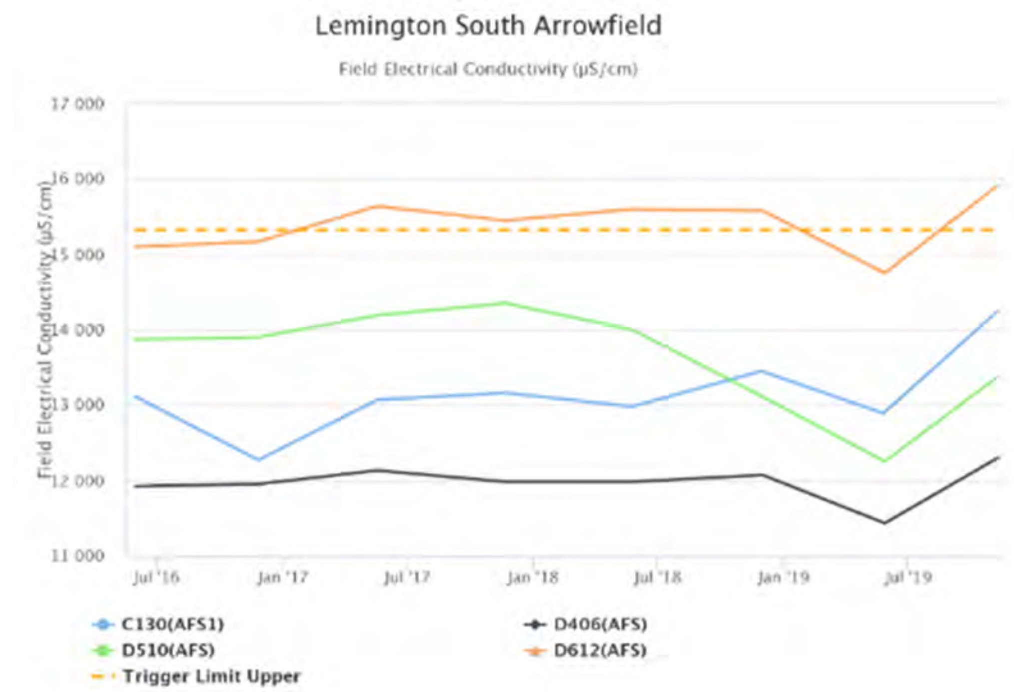


Figure 68: Lemington South Arrowfield Groundwater EC Trends 2016 – 2019

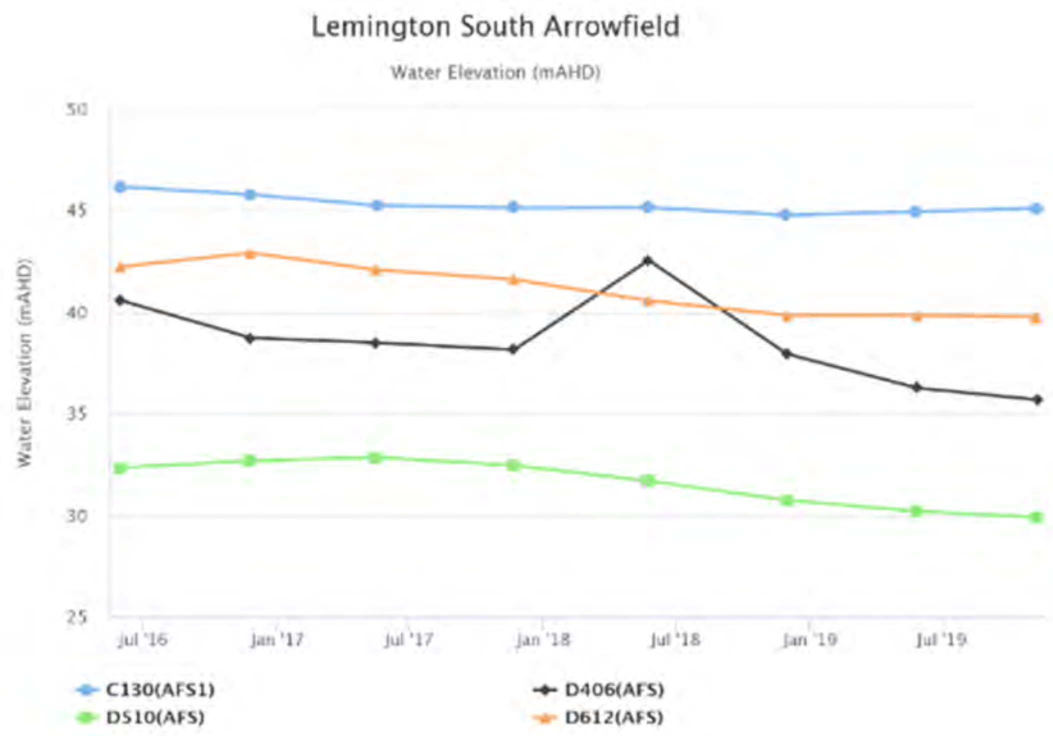


Figure 69: Lemington South Arrowfield Groundwater SWL Trends 2016 – 2019

7.5.3.12 Lemington South Bowfield

Groundwater monitoring in the Lemington South Bowfield area was undertaken at 16 sites during 2019. A total of 52 samples were collected during the reporting period. The pH, EC and SWL trends for 2016 to 2019 are shown in Figure 70 to Figure 72. Results were generally considered to be consistent with historical trends with the exception of B631(BFS) and C630(BFS) which exceeded internal triggers as listed in Table 53. Note that C122 (BFS) has been excluded from the graphs as there was insufficient water for sampling during the reporting period.

Table 53 Lemington South Bowfield Groundwater 2019 Monitoring Internal Trigger Tracking

Location	Date	Trigger Limit	Action Taken In Response
B631(BFS)	27/05/2019	pH – 5th Percentile	Second exceedance. Watching brief *
C630(BFS)	28/05/2019	pH – 95th Percentile	First exceedance. Watching brief established*
B631(BFS)	6/11/2019	pH - 5th Percentile	Third exceedance – investigation commenced. Refer to Appendix A.
B631(BFS)	6/11/2019	EC – 95th Percentile	First exceedance - Watching brief established*
C630(BFS)	8/11/2019	pH - 95th Percentile	First exceedance - Watching brief established*

* Watching Brief established pending outcomes of subsequent monitoring events. No specific actions required.

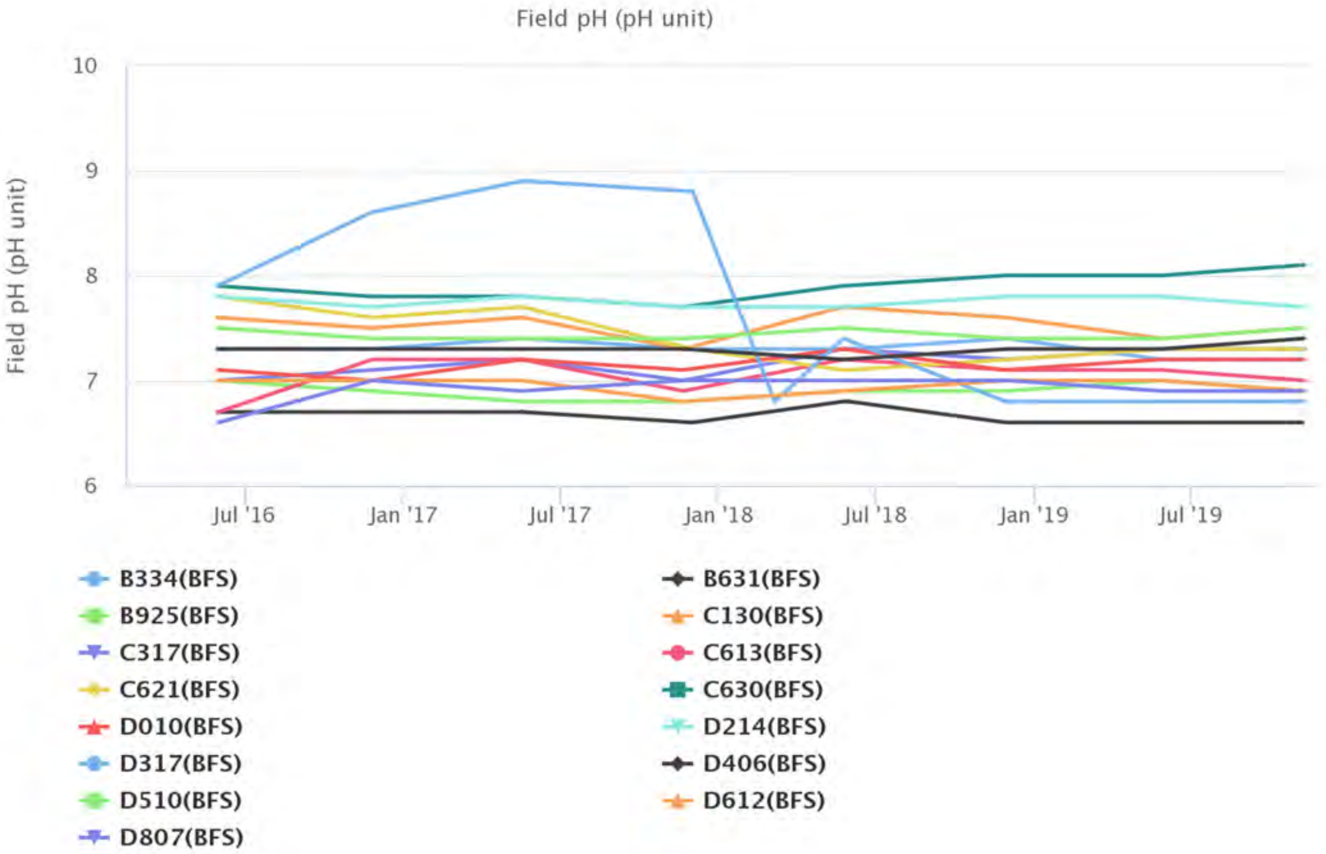


Figure 70: Lemington South Bowfield Groundwater pH Trends 2016 – 2019

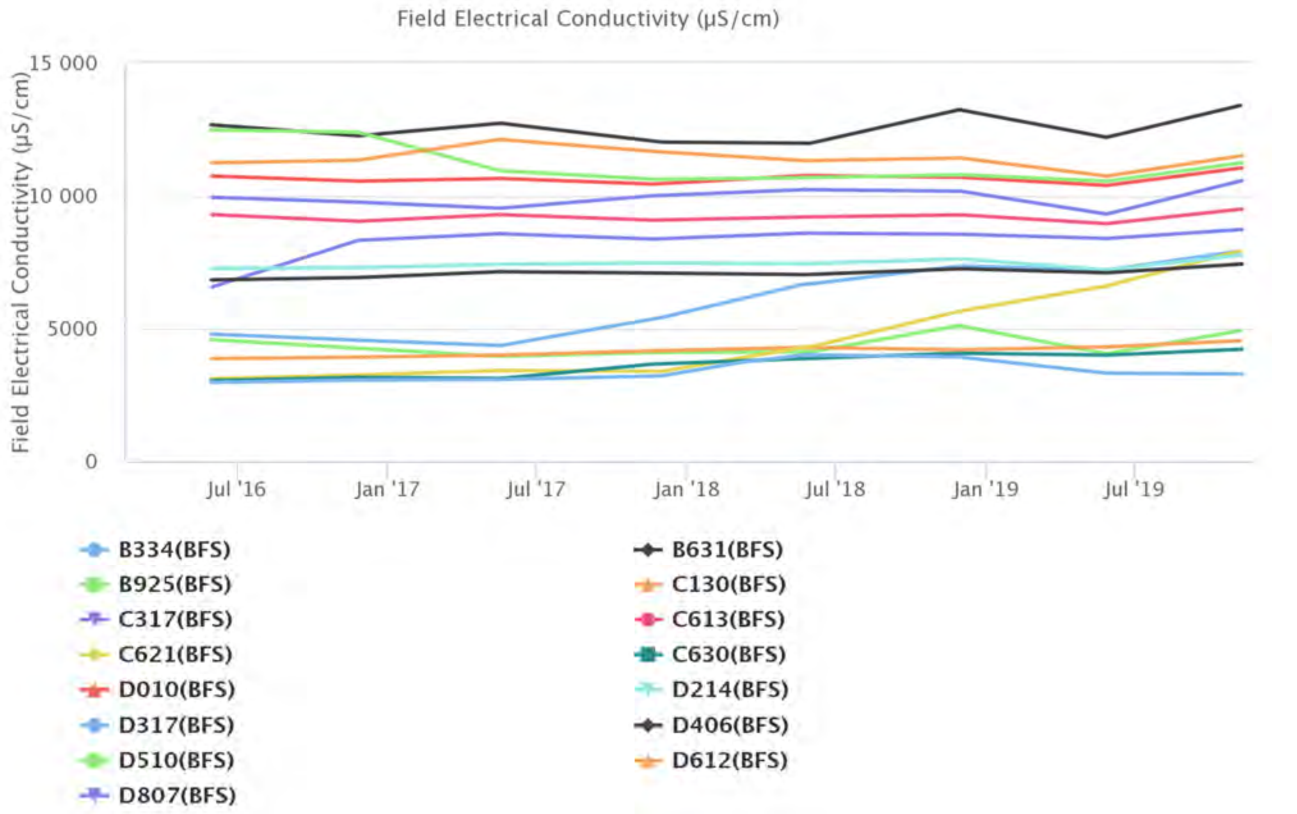


Figure 71: Lemington South Bowfield Groundwater EC Trends 2016 – 2019

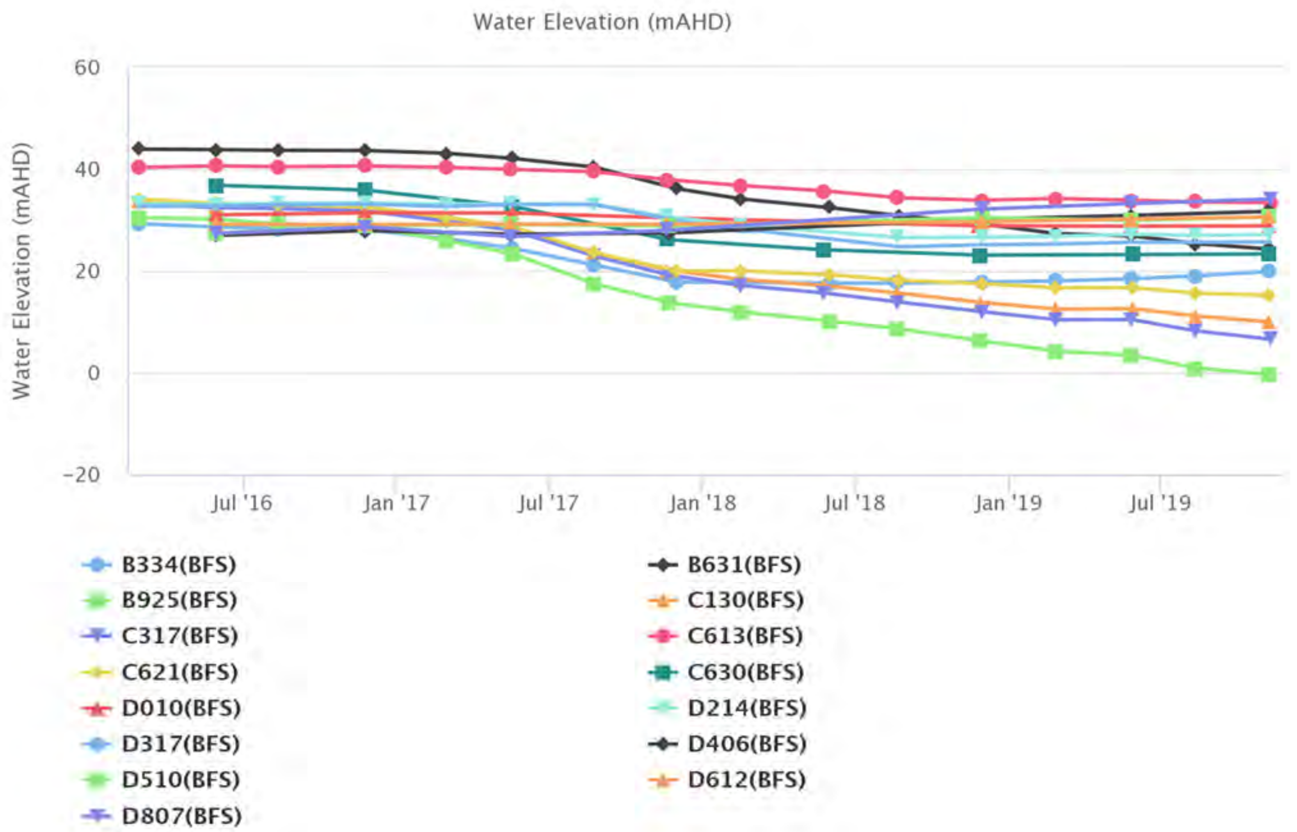


Figure 72: Lemington South Bowfield Groundwater SWL Trends 2016 – 2019

7.5.3.13 Lemington South Interburden

Groundwater monitoring in the Lemington South Interburden area was undertaken at one site during 2019; a total of 12 samples were collected. The pH, EC and SWL trends for 2016 to 2019 are shown in Figure 73 to Figure 75. EC has generally been trending upwards during since 2016. The groundwater level has been gradually declining since 2016. Internal triggers are listed in Table 54.

Table 54 Lemington South Interburden Groundwater 2019 Monitoring Internal Trigger Tracking

Location	Date	Trigger Limit	Action Taken In Response
C130(ALL)	26/02/2019	EC – 95th Percentile	Second exceedance. Watching brief*
C130(ALL)	28/05/2019	EC – 95th Percentile	Third exceedance – investigation commenced. Refer to Appendix A.
C130(ALL)	12/08/2019	EC – 95th Percentile	Investigation in progress. Refer to Appendix A.
C130(ALL)	8/11/2019	EC – 95th Percentile	Investigation in progress. Refer to Appendix A.

* Watching Brief established pending outcomes of subsequent monitoring events. No specific actions required.

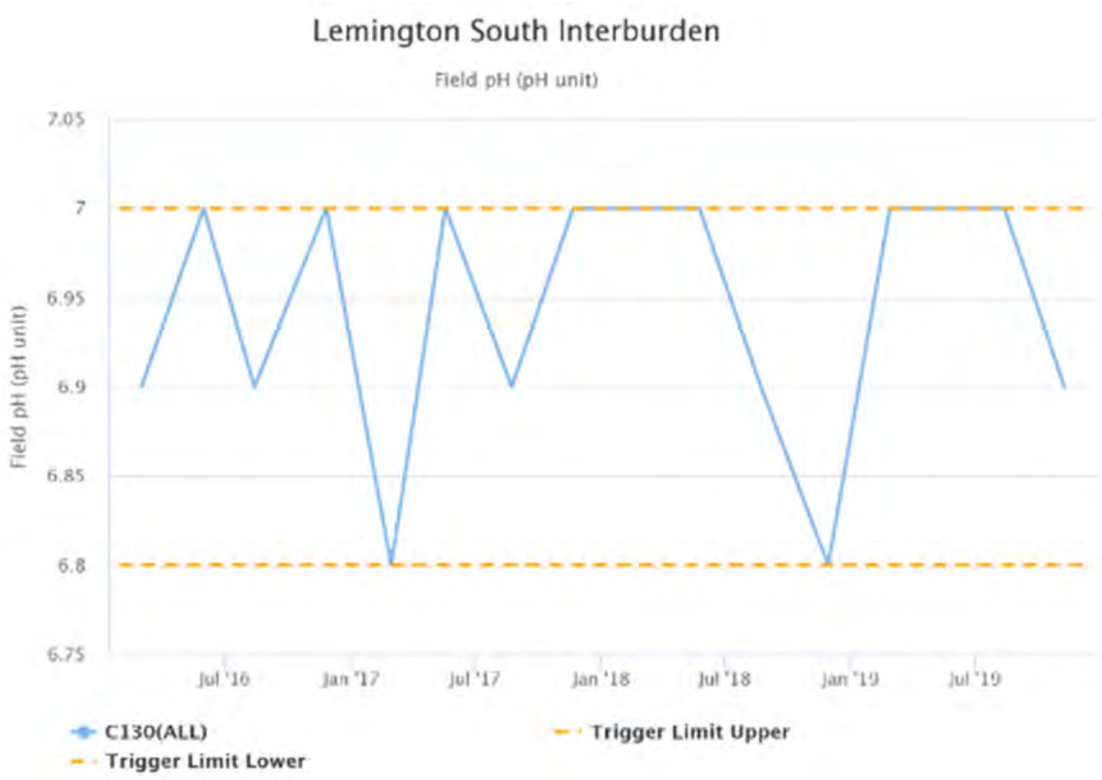


Figure 73: Lemington South Interburden Groundwater pH Trends 2016 – 2019

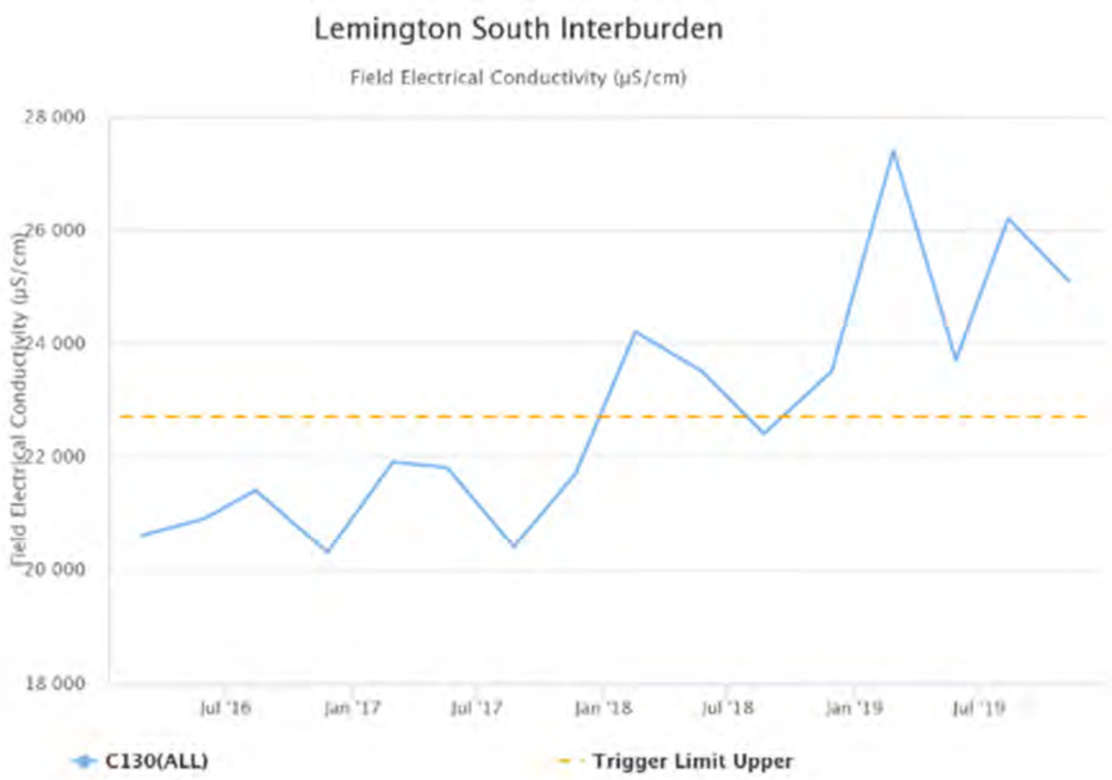


Figure 74: Lemington South Interburden Groundwater EC Trends 2016 – 2019

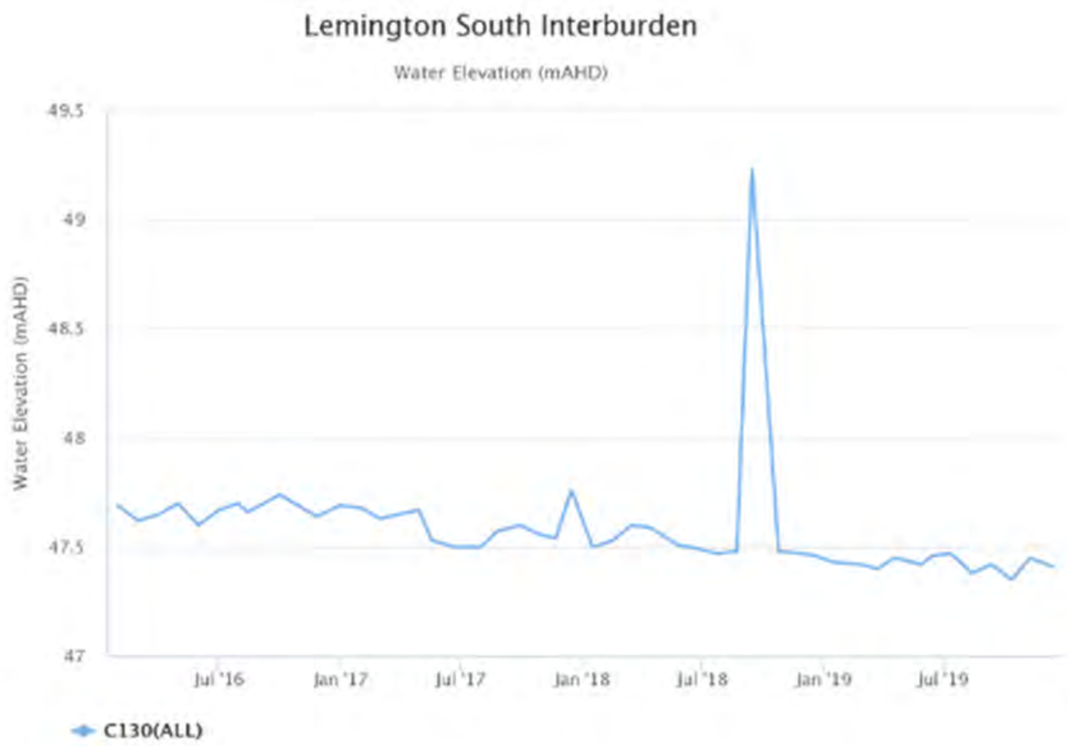


Figure 75: Lemington South Interburden Groundwater SWL Trends 2016 – 2019

7.5.3.14 Lemington South Woodlands Hill

Groundwater monitoring in the Lemington South Interburden area was undertaken at seven sites during 2019; a total of 18 samples were collected. The pH, EC and SWL trends for 2016 to 2019 are shown in Figure 76 to Figure 78. Internal triggers are listed in Table 55.

Table 55 Lemington South Woodlands Hill Groundwater 2019 Monitoring Internal Trigger Tracking

Location	Date	Trigger Limit	Action Taken In Response
C130(WDH)	6/11/2019	EC – 95th Percentile	First exceedance - Watching brief established*

* Watching Brief established pending outcomes of subsequent monitoring events. No specific actions required.

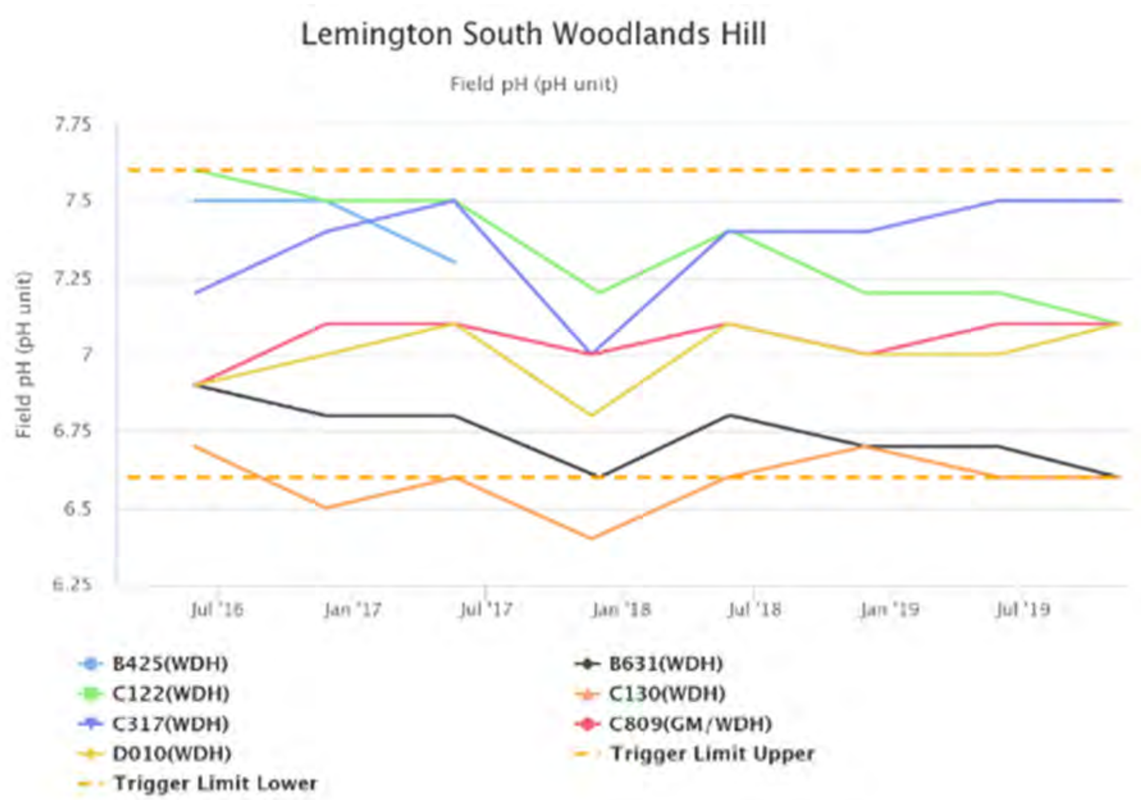


Figure 76: Lemington South Woodlands Hill Groundwater pH Trends 2016 – 2019

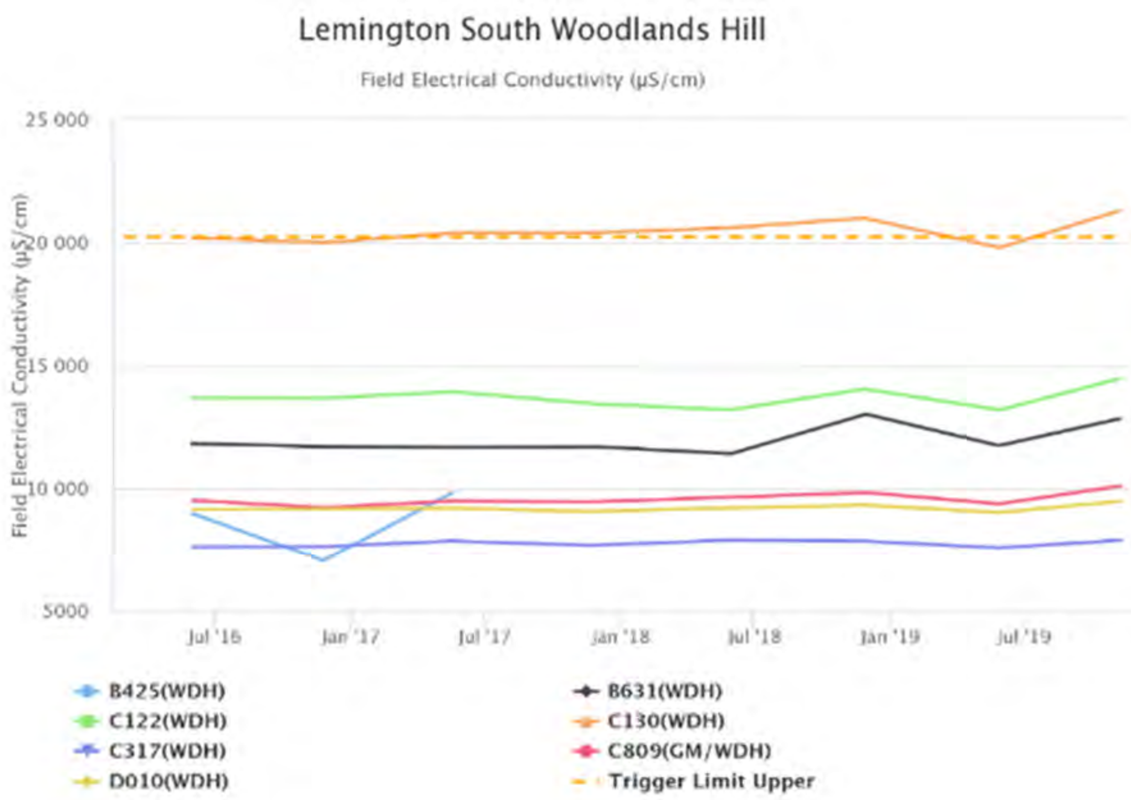


Figure 77: Lemington South Woodlands Hill Groundwater EC Trends 2016 – 2019

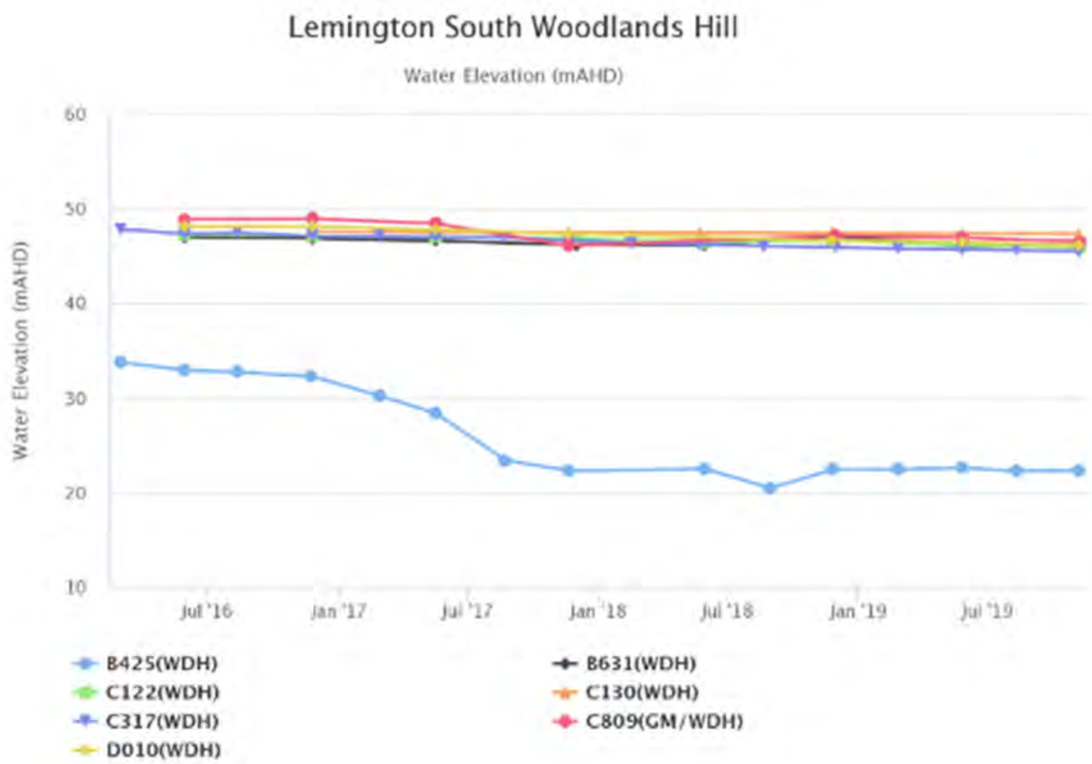


Figure 78: Lemington South Woodlands Hill Groundwater SWL Trends 2016 – 2019

7.5.3.15 Lemington South Glen Munro

Groundwater monitoring in the Lemington South Glen Munro seam was undertaken at one site during 2019; two samples were collected. The pH, EC and SWL trends for 2016 to 2019 are shown in Figure 79 to Figure 81. Internal triggers are listed in Table 56. The groundwater level continued to fall during 2019.

Table 56 Lemington South Glen Munro Groundwater 2019 Monitoring Internal Trigger Tracking

Location	Date	Trigger Limit	Action Taken In Response
D010(GM)	8/11/2019	EC – 95th Percentile	First exceedance. Watching brief.*

* Watching Brief established pending outcomes of subsequent monitoring events. No specific actions required.

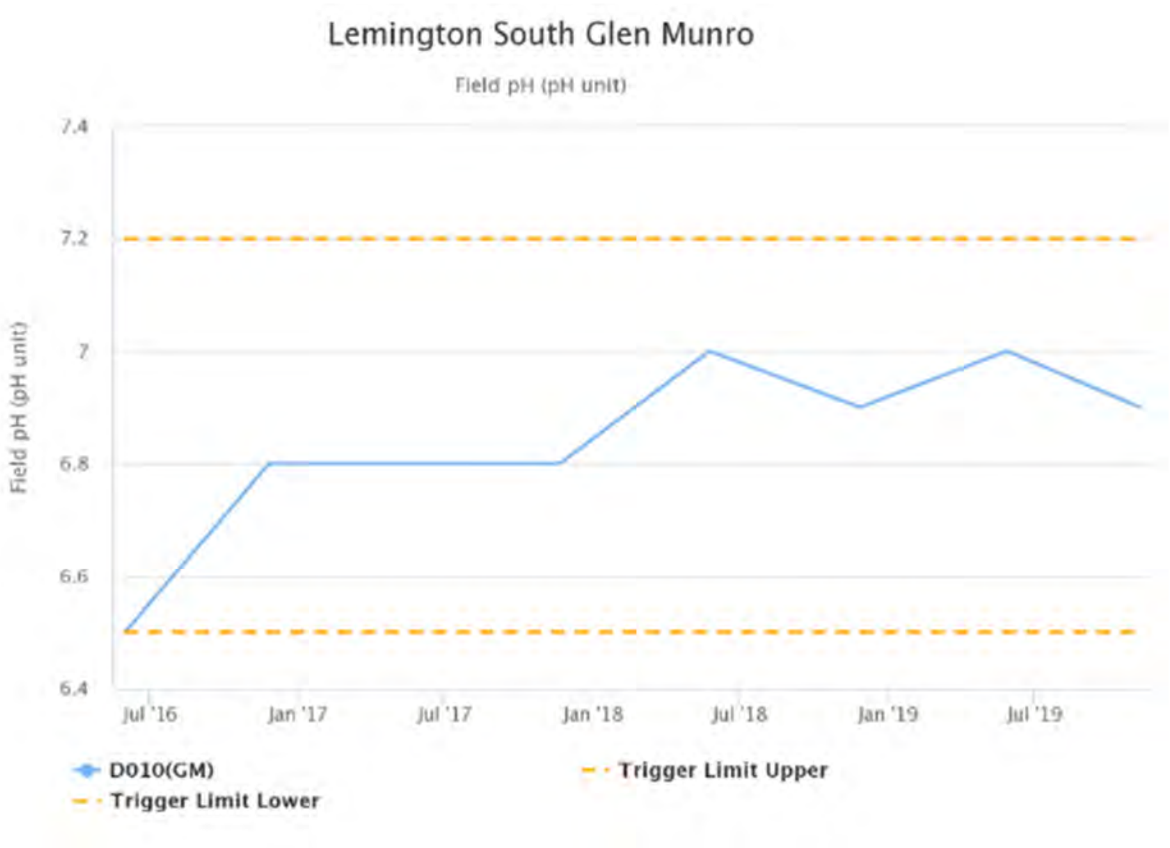


Figure 79: Lemington South Glen Munro Groundwater pH Trends 2016 – 2019

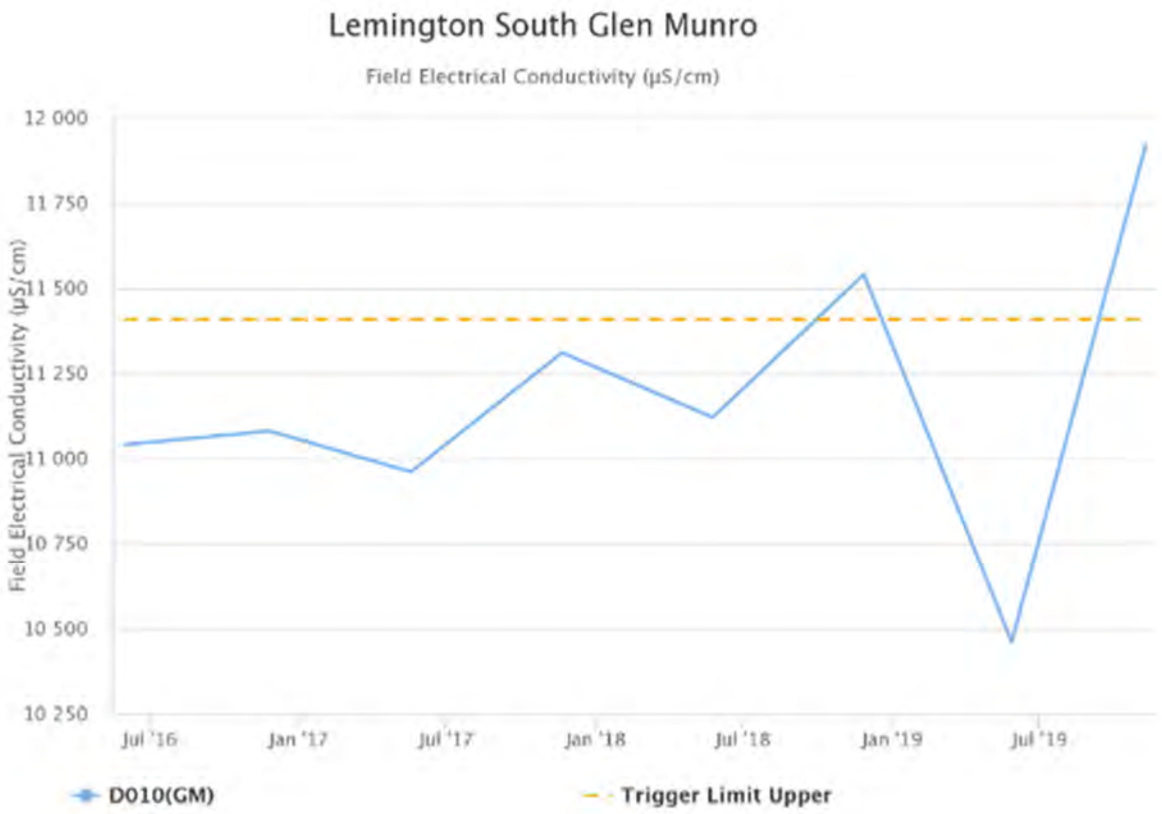


Figure 80: Lemington South Glen Munro Groundwater EC Trends 2016 – 2019

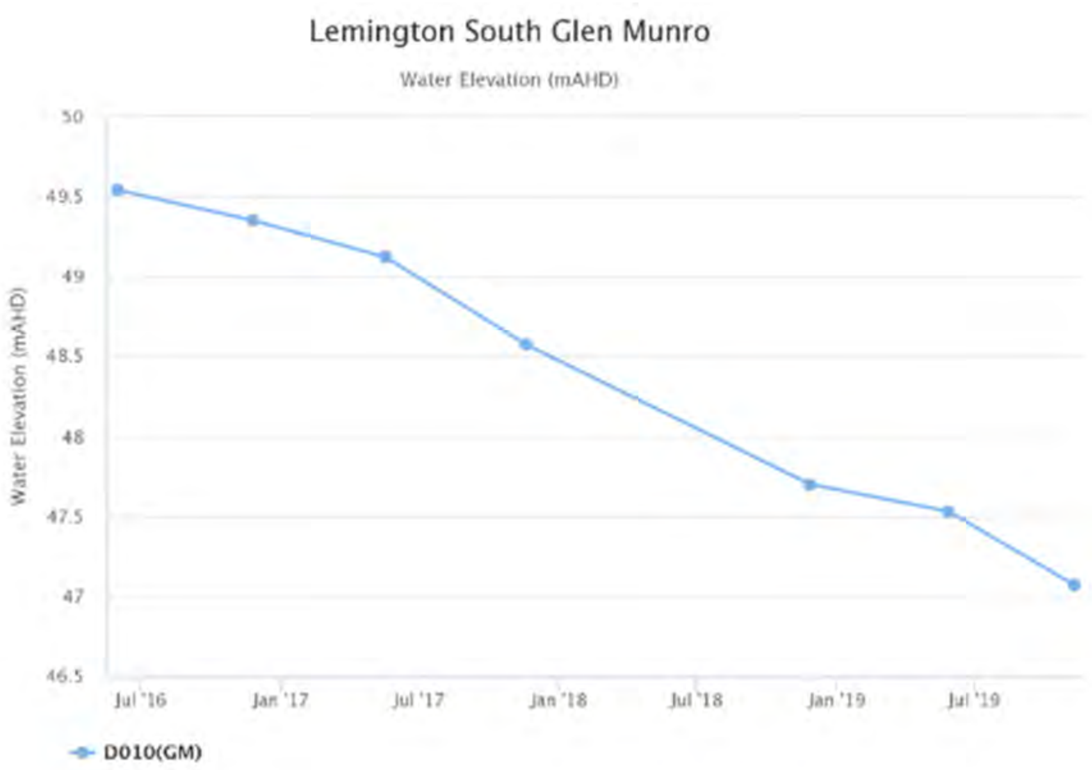


Figure 81: Lemington South Glen Munro Groundwater SWL Trends 2016 – 2019

7.5.3.16 North Pit Spoil

Groundwater monitoring in the North Pit Spoil area was undertaken at 13 sites during 2019. A total of 52 samples were collected during the reporting period. The pH, EC and SWL trends for 2016 to 2019 are shown in Figure 82 to Figure 84. Water quality and levels were generally stable and consistent with historical trends with the exception of exceedances of internal triggers as listed in Table 57. Bore DM7 was dry for the entire reporting period.

Table 57 North Pit Spoil Groundwater 2019 Monitoring Internal Trigger Tracking

Location	Date	Trigger Limit	Action Taken In Response
MB14HVO05	15/03/2019	EC – 95th Percentile	First exceedance. Watching brief established*
MB14HVO05	15/03/2019	pH – 5th Percentile	First exceedance. Watching brief established*
DM3	20/06/2019	pH – 5th Percentile	First exceedance. Watching brief established*
4116P	20/06/2019	EC – 95th Percentile	First exceedance. Watching brief established*
4116P	6/09/2019	EC – 95th Percentile	Second exceedance. Watching Brief*
MB14HVO05	6/09/2019	EC – 95th Percentile	Second exceedance. Watching Brief*
4116P	4/12/2019	EC – 95th Percentile	Third exceedance. Investigation commenced. Refer to Appendix A.

* Watching Brief established pending outcomes of subsequent monitoring events. No specific actions required.

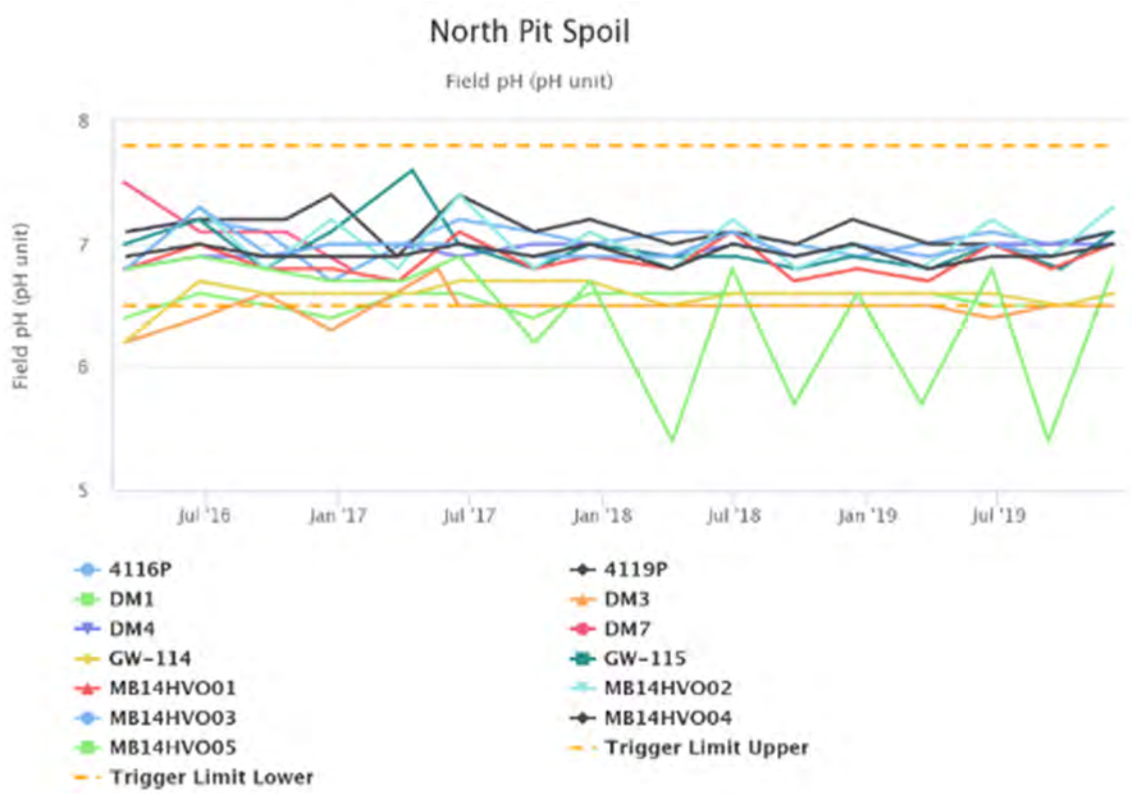


Figure 82: North Pit Spoil Groundwater pH Trends 2016 – 2019

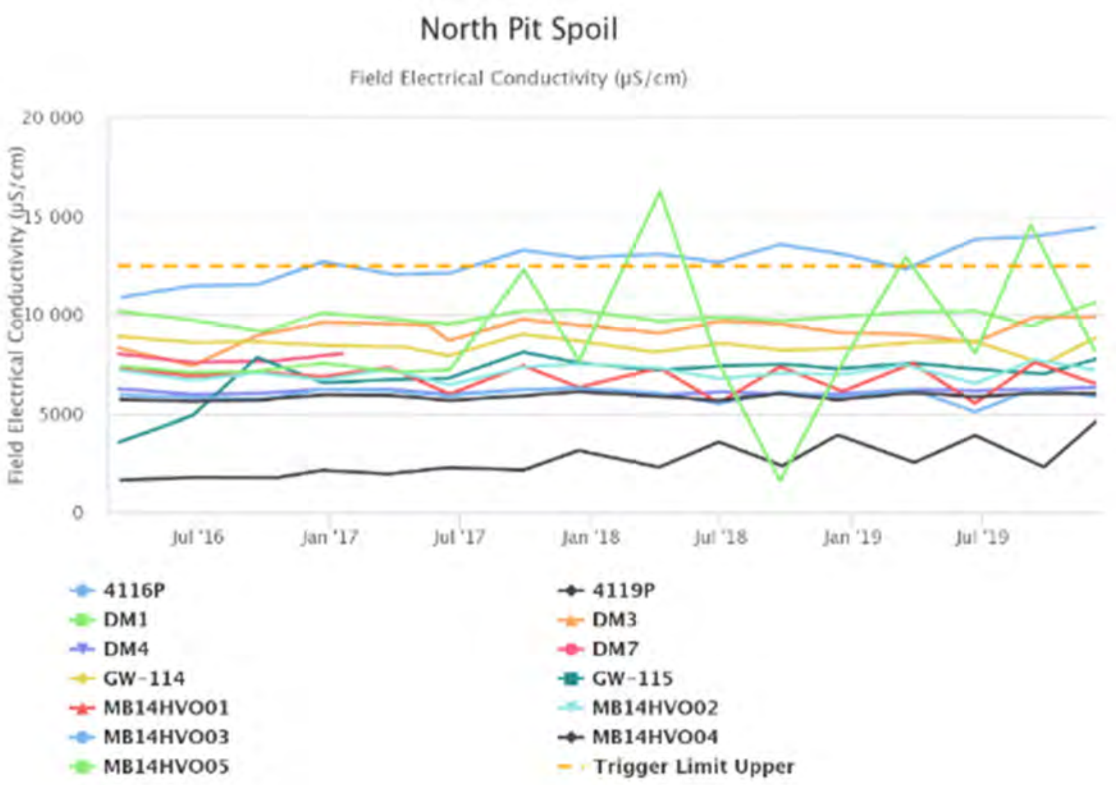


Figure 83: North Pit Spoil Groundwater EC Trends 2016 – 2019

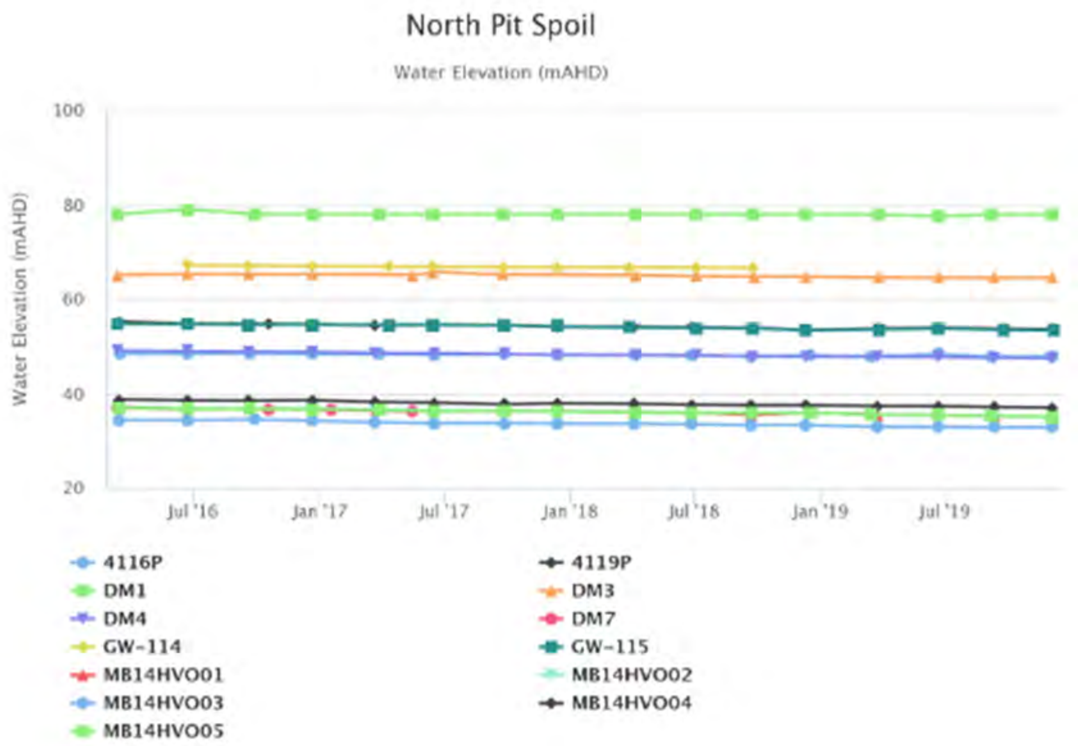


Figure 84: North Pit Spoil Groundwater SWL Trends 2016 – 2019

7.5.3.17 West Pit Alluvium

Groundwater monitoring in the West Pit Alluvium area was undertaken at 5 sites during 2019. A total of 44 samples were collected during the reporting period. Bores G1, G2 and G3 continued to be monitored on a monthly basis during the reporting period. Monitoring frequency of these bores will be reviewed in the next reporting period. Monitoring in bores GW-100 and GW-101 was undertaken quarterly in accordance with the HVO Groundwater Monitoring Programme. GW-101 had insufficient water for sampling in March and June and was dry during the September and December monitoring rounds.

The pH, EC and SWL trends for 2016 to 2019 are shown in Figure 85 to Figure 87. Results were consistent with historical trends. There were no trigger exceedances recorded during the reporting period.

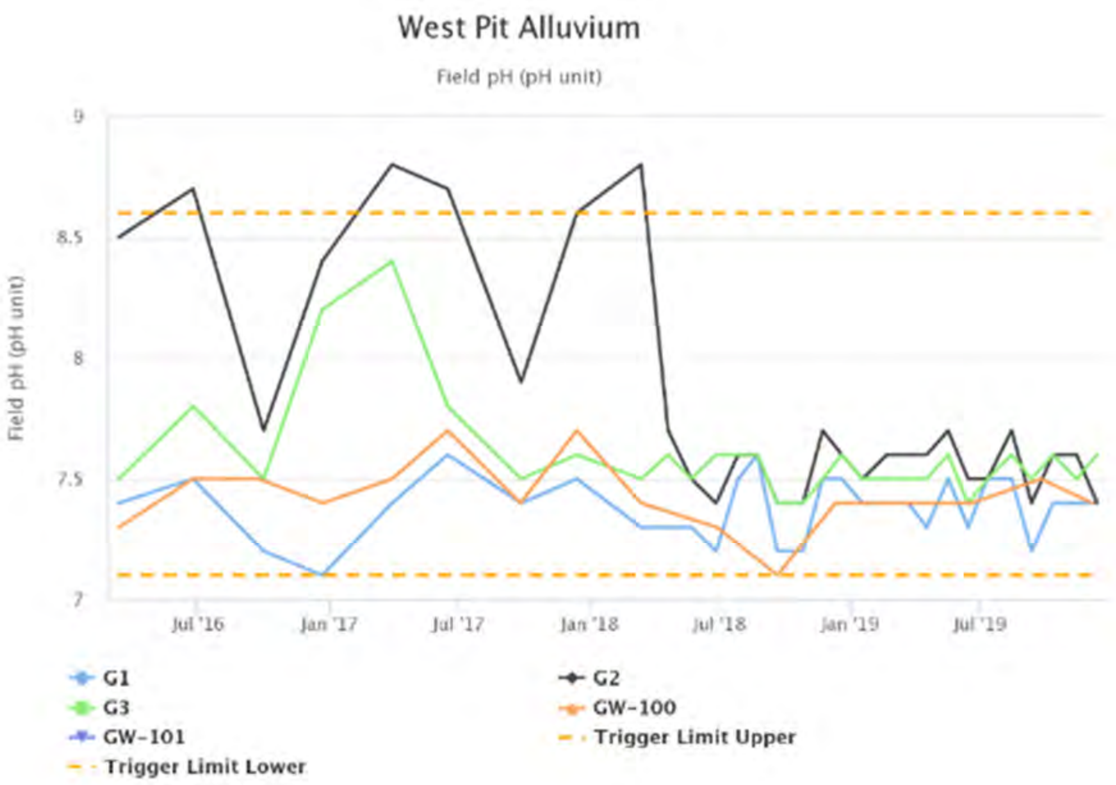


Figure 85: West Pit Alluvium Groundwater pH Trends 2016 – 2019

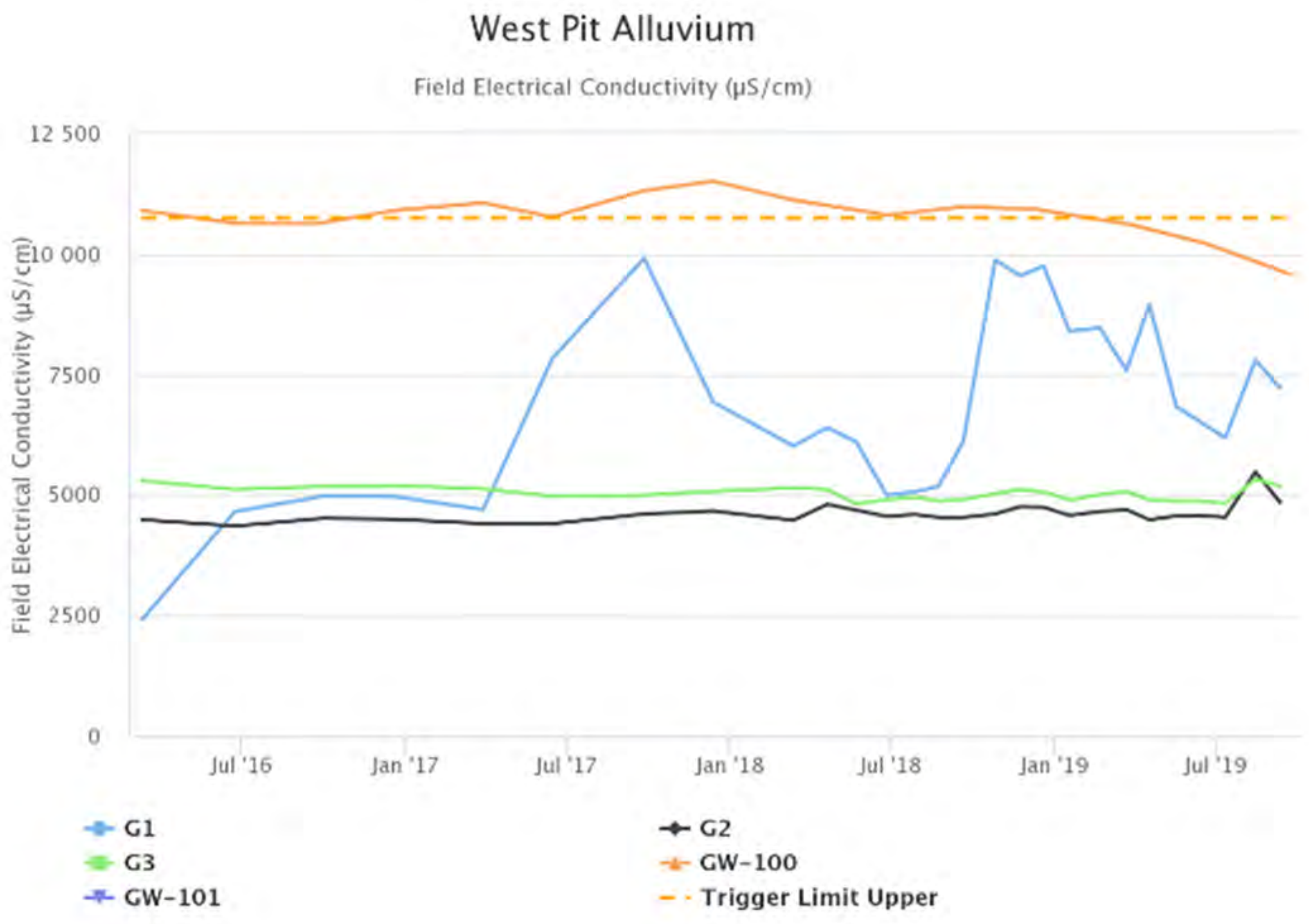


Figure 86: West Pit Alluvium Groundwater EC Trends 2016 – 2019

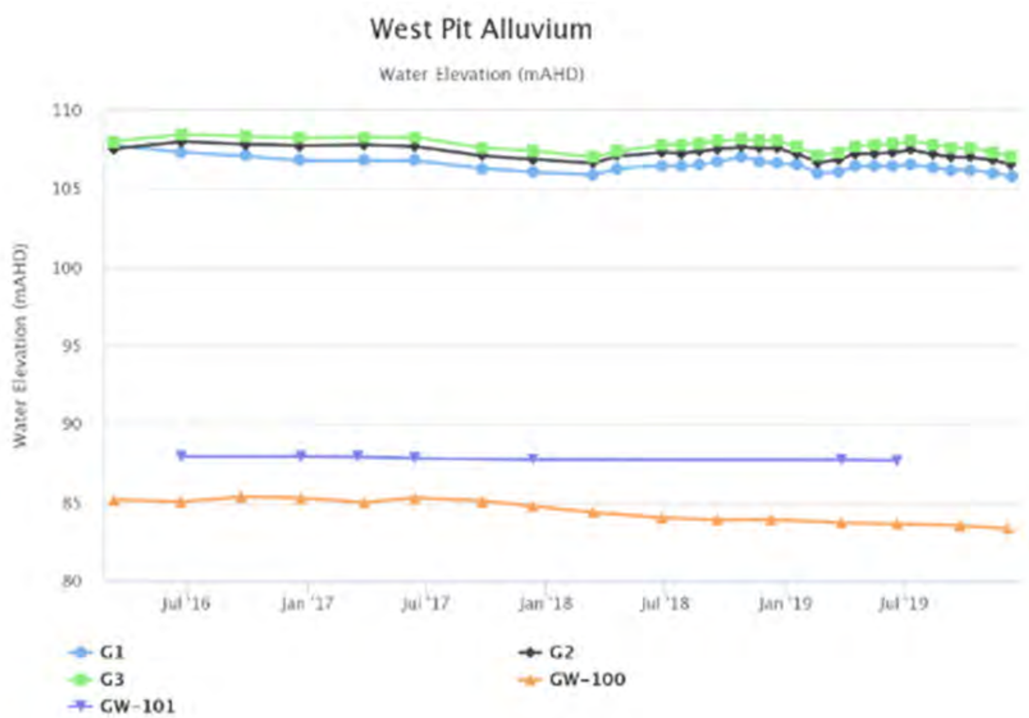


Figure 87: West Pit Alluvium Groundwater SWL Trends 2016 – 2019

7.5.3.18 West Pit Sandstone/Siltstone

Groundwater monitoring in the West Pit Sandstone/ Siltstone area was undertaken at three sites during 2019. A total of 12 samples were collected during the reporting period. The pH, EC and SWL trends for 2016 to 2019 are shown in Figure 88 to Figure 90. Results were generally consistent with historical trends with the exception of internal trigger exceedances listed in Table 58.

Table 58 West Pit Sandstone/Siltstone Groundwater 2019 Monitoring Internal Trigger Tracking

Location	Date	Trigger Limit	Action Taken In Response
NPZ2	27/03/2019	EC – 95th Percentile	First exceedance. Watching brief established. Returned to normal level on next monitoring round.
NPZ2	16/09/2019	EC – 95th Percentile	First exceedance. Watching brief established*
NPZ2	5/12/2019	EC – 95th Percentile	Second exceedance. Watching brief*
NPZ5	5/12/2019	pH - 5th Percentile	First exceedance. Watching brief established*

* Watching Brief established pending outcomes of subsequent monitoring events. No specific actions required.

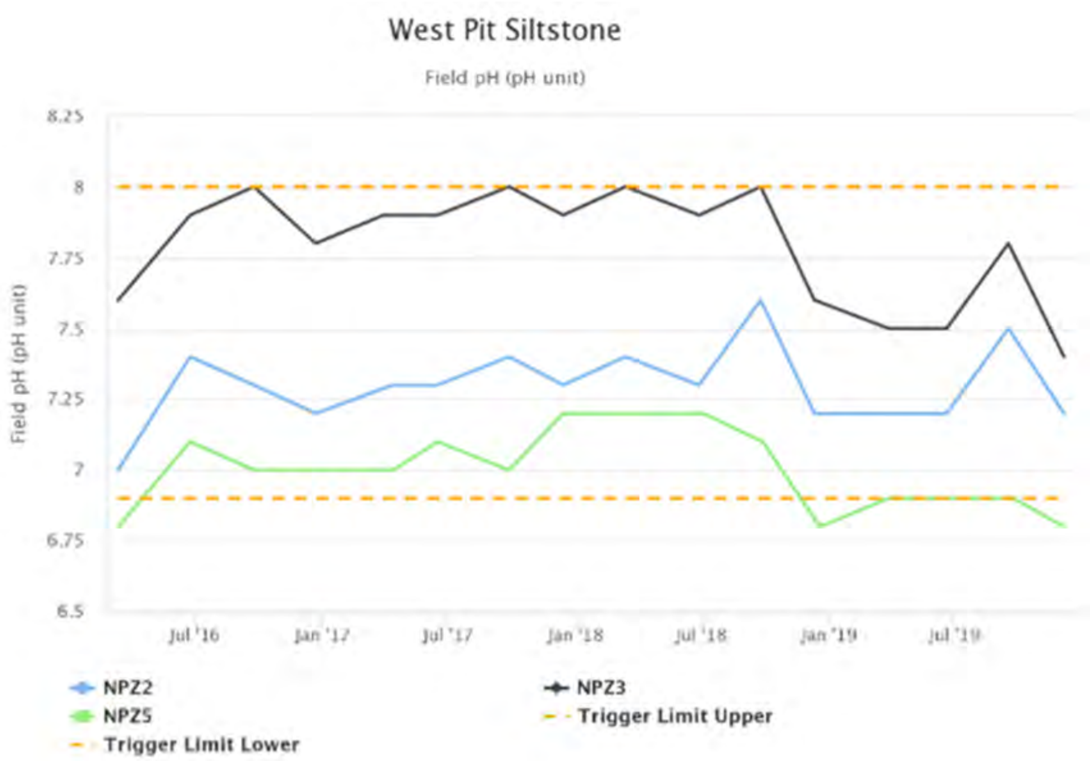


Figure 88: West Pit Sandstone/Siltstone Groundwater pH Trends 2016 – 2019

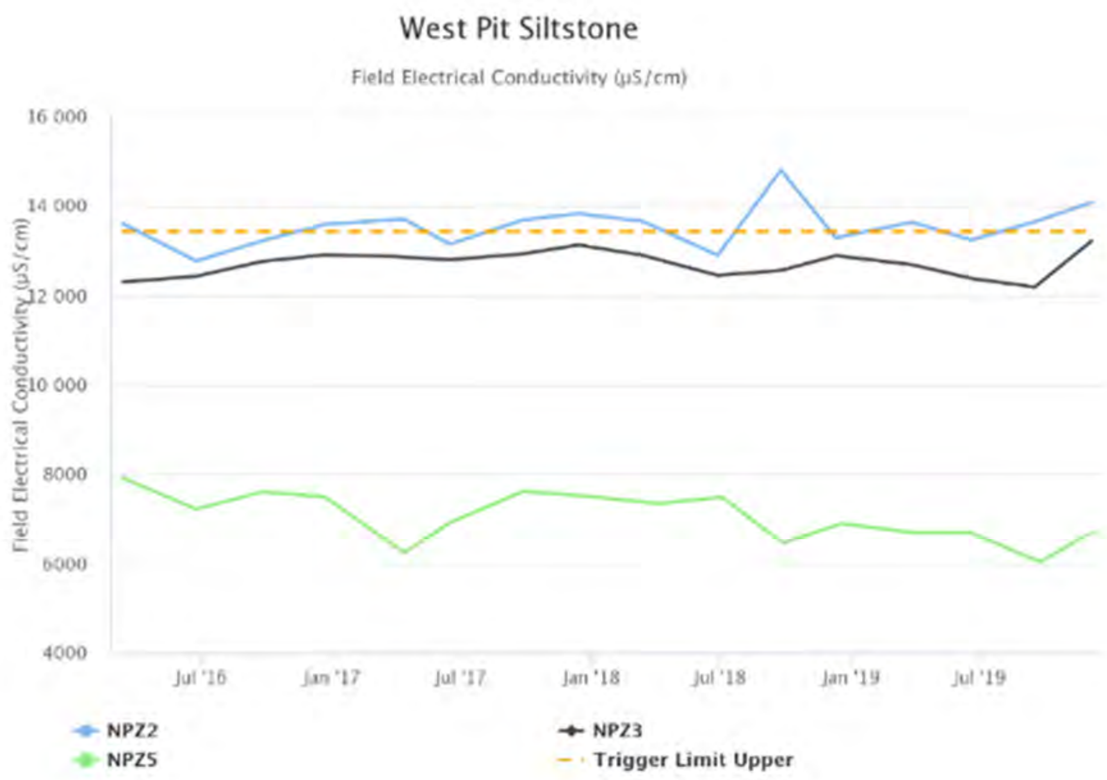


Figure 89: West Pit Sandstone/Siltstone Groundwater EC Trends 2016 – 2019

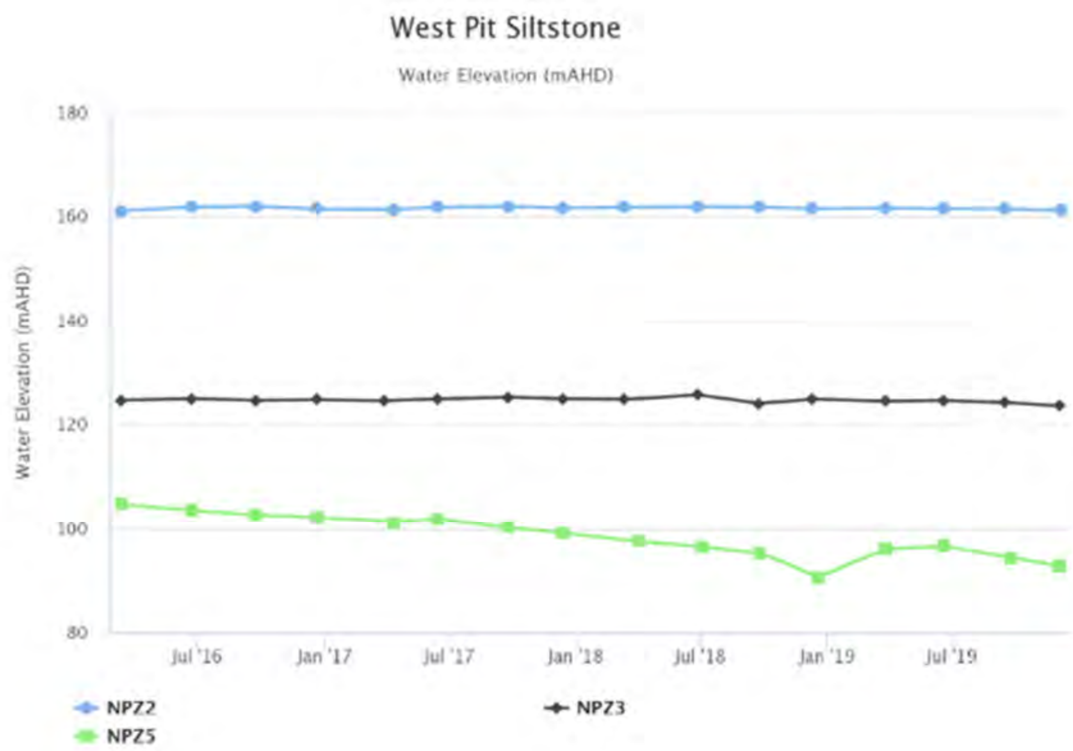


Figure 90: West Pit Sandstone/Siltstone Groundwater SWL Trends 2016 – 2019

7.5.3.19 Carrington West Wing Bayswater

Groundwater monitoring in the Carrington West Wing Bayswater area was undertaken at one site during 2019. A total of 4 samples were collected during the reporting period. The pH, EC and SWL trends for 2016 to 2019 are shown in Figure 91 to Figure 93. There were no trigger exceedances recorded during the reporting period.

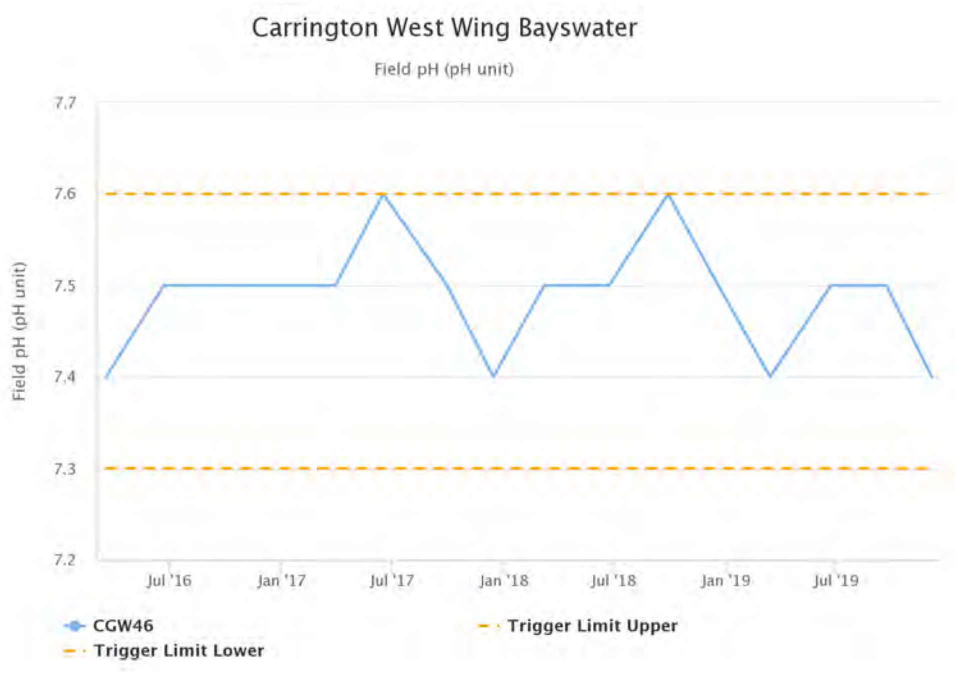


Figure 91 – Carrington West Wing Bayswater Groundwater pH Trends 2016 to 2019

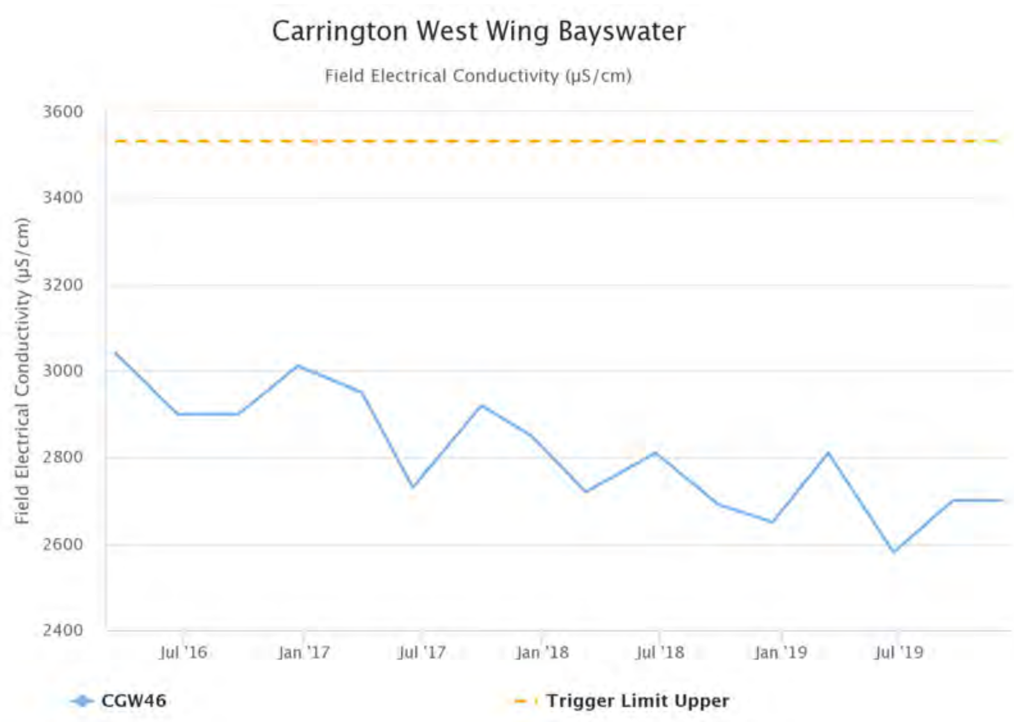


Figure 92 – Carrington West Wing Bayswater Groundwater EC Trends 2016 to 2019

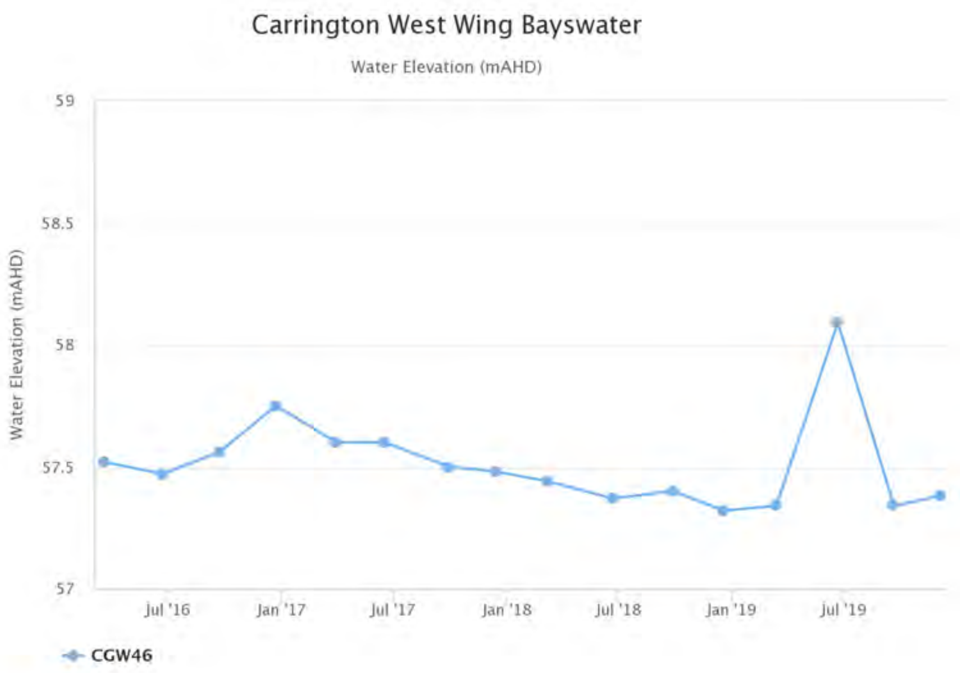


Figure 93 – Carrington West Wing Bayswater Groundwater SWL Trends 2016 to 2019

7.6 Compensatory Water Supply

During 2019 HVO did not provide compensatory water supply or alternate compensation in lieu of compensatory water supply under any new or existing agreements, and circumstances which may trigger a requirement to provide a compensatory water supply were not identified.

8 Rehabilitation and Land Management

8.1 Summary of Rehabilitation

Rehabilitation at HVO is undertaken in accordance with commitments made in the various Mining Operations Plans (MOPs) covering the site: Hunter Valley Operations North MOP (includes Newdell CHPP and Hunter Valley Load Point) and Hunter Valley Operations South MOP.

A summary of the key rehabilitation performance indicators is shown in Table 59.

Table 59 Key Rehabilitation Performance Indicators

Mine Area Type	Previous Reporting Period (Actual) Year 2018 (ha)	This Reporting Period (Actual) Year 2019 (ha)	Next Reporting Period (Forecast) Year 2020 (ha)
A. Total mine footprint[2]	6539	6567.8	6617.2
B. Total Active Disturbance[3]	3599.2	3639.1	3687.0
C. Land being prepared for rehabilitation[4]	212.3*	529.7*	443.7
D. Land under active rehabilitation[5]	2727.5*	2392.5	2486.5
E. Completed rehabilitation[6]	0	0	0

*Increase in land being prepared for rehabilitation is due to reclassification of areas previously reported as under active rehabilitation which require remedial actions prior to being re-sown to final vegetation (i.e. reclassified to Growth Medium Development phase).

[2] **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

[3] **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 stockpiles areas, access tracks and haul road, active mining areas, waste emplacements (active/unshaped/in or out-of-pit), and tailings dams (active/unshaped/uncapped).

[4] **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).

[5] **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 sustainability" (revegetation assessed as showing signs of trending towards relinquishment OR infrastructure development).

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

8.2 Rehabilitation Overview

A summary of rehabilitation completed in 2019 is shown in Table 60.

Table 60 Summary of new rehabilitation completed in 2019

Rehabilitation Site Name	Seed Mix	Area (ha)	Summary
Glider Woodland	HVO Woodland Mix	31.0	Interim landform sown with native seed.
Glider Pasture	HVO Pasture Light Woody Mix	28.7	Final landform sown with final cover.
Riverview North	HVO Woodland Mix	12.6	Interim landform sown with native seed.
West Wilton 210	HVO Pasture Light Woody Mix	8.0	Final landform sown with final cover.
West South 230	HVO Pasture Light Woody Mix	6.0	Final landform sown with final cover.
West Centre 230	HVO Pasture Light Woody Mix	2.0	Final landform sown with final cover.
TOTAL REHABILITATION		**88.3**	

8.2.1 HVON Load Point Rehabilitation

In accordance with HVO North Development Consent approval (DA 450-10-2003) Schedule 3, Condition 31A, 0.14ha has been rehabilitated through the planting of trees and vegetation representative of the Swamp Oak Floodplain Forest community on land that adjoins the existing riparian vegetation along Bayswater Creek.

The area was prepared for planting on 16 August 2019 and planted mid-September 2019. The species planted included *Casuarina glauca, Syzygium smithii, Callistemon salignus and Lomandra longifolia*. These species were planted with tree guards, weed matting, 'Seasol' gel and fertiliser tablets. Ongoing watering and monitoring are occurring.

8.3 Rehabilitation Performance

A total of 88.3 ha rehabilitation was undertaken during 2019. Details of the rehabilitation areas including areas completed during 2019, the extent of mining, surface contours and rehabilitation vegetation types are provided in Figure 94.

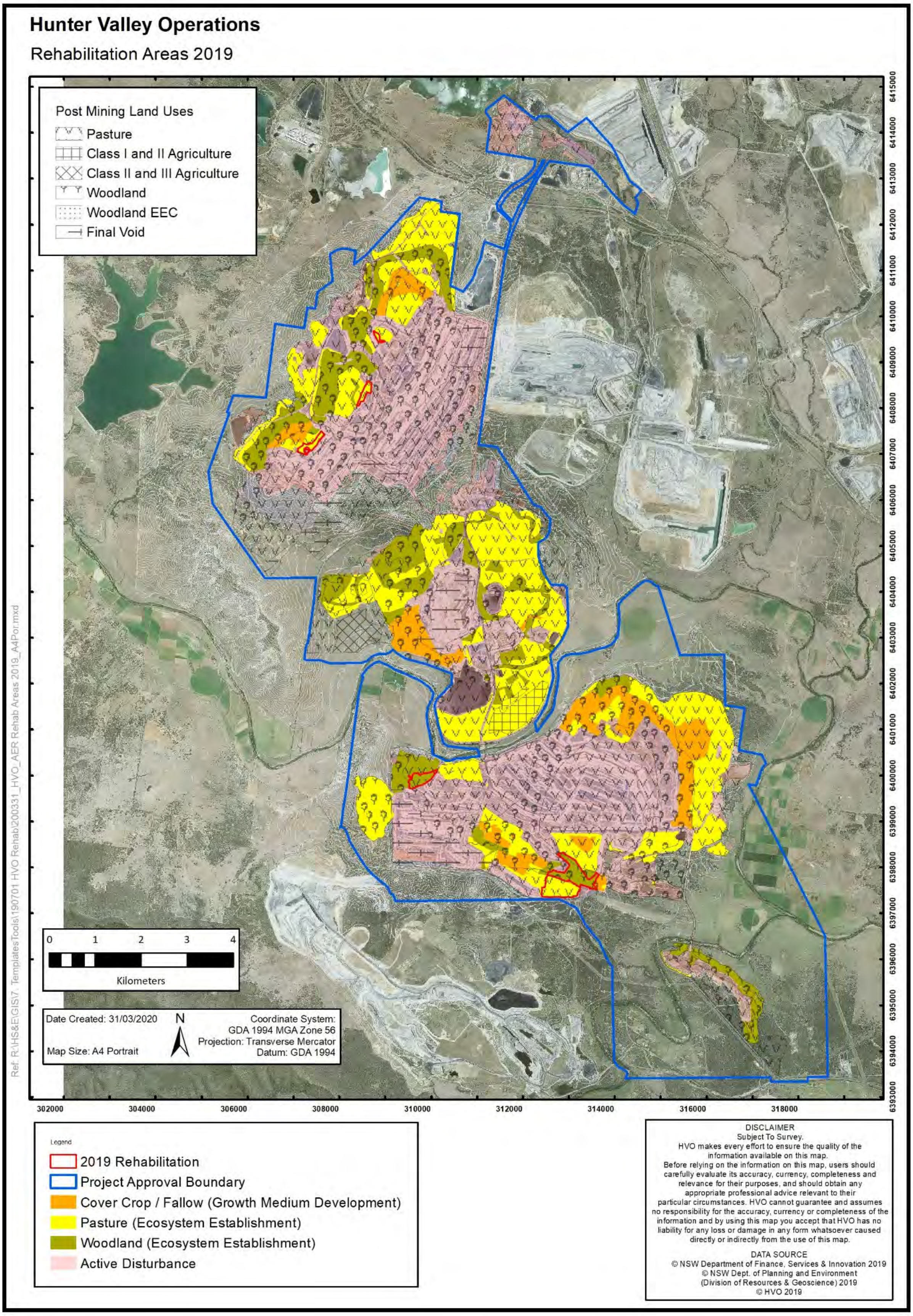


Figure 94: HVO Rehabilitation Areas as at 2019

Table 61 details the amount of rehabilitation and disturbance completed during the reporting period compared with proposed area in the respective MOP's.

Table 61 Summary of rehabilitation and disturbance completed in 2019^

MOP	**2019 Totals (ha)**		**Cumulative Totals During Current MOP Period (ha)***	
	Actual	**Proposed MOP**	**Actual**	**Proposed MOP**
Rehabilitation				
HVO North	16.0	21.4	16.0	21.4
HVO South	72.4	66.4	167.9	151.8
HVO Total	**88.3**	**87.8**	**183.9**	**173.2**
Rehabilitation Disturbance				
HVO North	0	16.6	0	16.6
HVO South	30.1	98.4	30.1	209.1
HVO Total	**30.1**	**115.0**	**30.1**	**225.7**
New Disturbance				
HVO North	4.7	44.6	4.7	44.6
HVO South	0.3	17.4	0.3	41.5
HVO Total	**5.0**	**62.0**	**5.0**	**86.1**
Net Rehabilitation (Rehabilitation minus Rehabilitation Disturbance)				
HVO North	16.0	4.8	16.0	4.8
HVO South	42.3	-32.0	137.8	-57.3
HVO Total	**58.2**	**-27.2**	**153.8**	**-52.5**

Comparison with HVO North MOP 2019 to 2021 (approved 26 February 2019) and HVO South MOP Amendment A 2018 to 2022 (approved 26 February 2018);

*Cumulative North MOP figures for period 2019 only. Cumulative South MOP figures for period 2018-2019.

Following commencement of a new MOP for HVO South in July 2018 the rehabilitation to end of 2019 exceeded the MOP projection for the reporting period by 6 hectares and the projection since MOP commencement by 16.1 hectares. As rehabilitation disturbance projected during the initial period of the MOP has been delayed net rehabilitation since MOP commencement is 195.1 hectares in advance of predictions however this gap will narrow over coming years as planned rehabilitation disturbance occurs.

The area of rehabilitation sown in HVO North during the reporting period was 5.4 hectares below the MOP commitment. As 2019 was the initial year of the MOP the cumulative rehabilitation total across the MOP period was similarly 5.4 hectares below the MOP projection. The reduced rehabilitation at HVO North was offset by the absence of rehabilitation disturbance during the period. In terms of net rehabilitation HVO North is therefore in 11.2 hectares ahead of the MOP projection with net rehabilitation of 16 hectares completed compared with MOP projection of 4.8 hectares.

During 2019 HVO reclassified areas of existing rehabilitation at both HVO North and HVO South from under active rehabilitation to within the growth medium development phase. This was because these areas are under cover-crop vegetation management regimes and remain to be sown to final vegetation covers. Reclassification corrects an historic reporting practice which does not align with contemporary guidelines. These areas are substantively advanced along the establishment continuum however are unable to be reported as active rehabilitation, however exclusion of these areas from reporting tallies would significantly under-represent progress against rehabilitation commitments. Given this, and for completeness, these reclassified areas are and included in progression assessments. Seeding of these areas to final covers is ongoing and the quantum of areas will reduce with time.

A comparison of rehabilitation progression against predictions in the *HVO West Pit Extension and Minor Modifications Environmental Impact Statement (EIS) (October 2003)* and subsequent modifications to the HVO North approval (DA 450-10-2003) indicates that rehabilitation progression is generally consistent with EIS predictions. Planning approval modifications that changed the rate of rehabilitation progression at HVO North include: Carrington East Extension (Modification 2 - 2006); Carrington Out-of-Pit TSF (modification 4 - 2014); and Carrington In-Pit TSF (Modification 6 - 2014). When the modifications listed above are taken into account the EIS projection for rehabilitation area at the end of 2018 was 1766.9 hectares. The EIS projection for average annual rehabilitation between 2018 (Year 14) and 2024 (Year 20) is 26.2 hectares hence projected rehabilitation at the end of 2019 was 1793.1 hectares. Land under active rehabilitation at HVO North at the end of 2019 totalled 1651.6 hectares. A further 168.3 hectares are classified as within growth medium development phase representing a total rehabilitation management footprint at end of 2019 of 1819.9 hectares which is consistent with EIS projections.

As at the end of 2019, rehabilitation progress for HVO South is consistent with the predictions in the HVO South Coal Project Environmental Assessment Report (January 2008), although with similar considerations to HVO North with respect to current rehabilitation phase classifications. EIS rehabilitation progression at the end of 2019 (Stage 1) shows 1047.6 ha of rehabilitation completed. Land under active rehabilitation at the end of 2019 was 740.8 hectares in association with 305.4 hectares in growth medium development phase. Total rehabilitation management footprint at end 2019 is therefore 1046.2 hectares and consistent with progression to the end of Stage 1.

Of further note, during 2019 topsoil stockpiles totalling 72.2 ha located within rehabilitation areas were reclassified from active rehabilitation to active disturbance and these areas removed from rehabilitation tallies. Management of these areas remains as for the surrounding rehabilitation blocks in which they are located and consideration of the 29.0 hectares at HVO North and 43.2 hectares at HVO South further demonstrates rehabilitation progression generally consistent with respective EIS projections.

8.4 Rehabilitation Programme Variations

The 2019 variations to the rehabilitation programme are summarised in Table 62.

Table 62 Variations to the Rehabilitation Programme in 2019

MOP	Has rehabilitation work proceeded generally in accordance with the conditions of an accepted Mining Operations Plan?	Comment
HVO South	No	**New rehab & disturbance** HVO South net rehabilitation (net rehabilitation = rehabilitation minus – rehabilitation disturbance) completed during period 2018 to 2019: Actual = +42.3 ha vs MOP target = -32.0 ha. HVO South net rehabilitation progress 195.1 ha ahead of MOP projection for period 2018 to 2019. HVO South net rehabilitation progress advanced due to HVO delaying disturbing rehabilitation areas at Cheshunt and Riverview. Rehabilitation completion has progressed generally in accordance with MOP. **Historic rehabilitation** Following receipt of Section 240 notice issued 18/7/19 from Resources Regulator HVO reviewed rehabilitation phase classification of all rehabilitation areas. Reclassification approach was supported by Resources Regulator at meeting held 21/8/19. • rehabilitation areas sown to final cover are classified as Ecosystem Establishment phase, • rehabilitation areas awaiting sowing to final cover are classified as Growth Medium Development phase; • topsoil stockpiles located within rehabilitation areas are classified as Active Disturbance. HVO North: 168.3 ha reclassified from active rehabilitation to land being prepared for rehabilitation; 29.0 ha reclassified from active rehabilitation to active disturbance. HVO South: 305.4 ha reclassified from active rehabilitation to land being prepared for rehabilitation; 43.2ha reclassified from active rehabilitation to active disturbance
HVO North	No	

8.5 Rehabilitation Trials

No rehabilitation trials were conducted during 2019.

8.6 Key Issues that may affect Rehabilitation

The key issues that may affect rehabilitation are:

- **Vegetation Establishment** impacts due to competition from problematic weed species, uncontrolled or inappropriate vehicle or livestock impacts, or resulting in low resilience to bushfire impact; and atypical species diversities, structural densities, growth rates, productivity and recruitment levels when compared with analogue sites.

- **Growth Medium Suitability** issues due to soil nutrient and chemical properties impacting vegetation establishment; or establishment of inadequate soil depth during the Growth Medium Establishment phase.
- **Landform Stability** including the stability of water management structures, internal and external batter slopes and final void batters, and settlement and ponding on final landform surfaces of tailings storage facilities;
- **Spontaneous Combustion** occurring from placement of high risk materials on or near the final surface, or from exposed coal seams;
- **Fauna Recolonisation** impacts due to competition and predation by vertebrate pest species; and
- **Ecosystem Function** issues such that key Landscape Function Analysis (LFA) values for stability, infiltration, nutrient cycling or landscape organisation are trending away from analogue site values.

A Trigger Action Response Plan (TARP) is included in the MOPs and identifies the proposed contingency strategies in the event of variations or impacts to rehabilitation outcomes. Weed management continues to be a key issue to manage in order to meet rehabilitation objectives. Management activities to improve rehabilitation performance are described below.

Vegetation Establishment

Over the past decade HVO has utilised cover crops for initial stabilisation of rehabilitation areas and as a tool to combat heavy weed seed loads in site topsoils. Delays in progressing these areas to final cover have led to a backlog of areas requiring ongoing maintenance within the Growth Medium Development phase of rehabilitation. A key current focus of rehabilitation maintenance activities is sowing of these areas to final vegetation covers to allow progression to the Ecosystem Establishment phase. Stand-alone initial cover cropping will no longer be utilised except in case specific circumstances. Following this change HVO will prioritise prompt seeding and establishment of final vegetation covers with inclusion of cover crop components as appropriate to assist with initial stabilisation.

Weed competition

Historic weed infestation of former grazing areas and subsequent weed establishment upon many historic topsoil stockpiles has resulted in a significant weed seed burden in many establishing rehabilitation areas. HVOs response to TARP triggers for weed competition (in association with native stem density i.e. vegetation establishment) are a key element of the current rehabilitation maintenance focus. In addition to improvements in topsoil management practices (see below) there is a strong focus upon managing weed competition during the initial post-sowing establishment window, in addition to prioritised interventions based on routine inspections.

Review of rehabilitation processes

In association with changes in ownership and site management in 2018 HVO has adopted the Glencore Coal Assets Australia rehabilitation process framework. Key additional process elements which are being progressively integrated to site include:

- Development of a comprehensive Annual Rehabilitation and Closure Plan which provides an integrated overview of all rehabilitation and closure related works to be undertaken during the forward period;
- Implementation of an annual walkover inspection of all rehabilitation areas to identify landform stability and vegetation establishment issues, maintenance planning, and budgeting;
- Annual review and inspection of site conformance with annual plans and GCAA rehabilitation processes; and
- Adoption of GCAA spatial data management protocols for rehabilitation.

Topsoil management

Topsoil management processes have been identified as an area for improvement at HVO. During 2018 and in association with the s240 rehabilitation improvement program HVO commenced revision of site topsoil management procedures including characterisation based source separation and discrete stockpiling, topsoil stockpile inspection and maintenance protocols, and topsoil tracking and reconciliation processes. Finalisation of an integrated Topsoil Management Plan to support improvements in site practice and rehabilitation outcomes will be completed during 2020.

Native Vegetation Rehabilitation

Over the previous decade HVO has focussed on re-establishing a diverse native understorey within native vegetation rehabilitation. Experience over this period has shown that weed competition, which includes exotic grasses in the context of native vegetation establishment, is the main limiting factor to the successful establishment of a native understorey. The weed seed source is coming from both historically disturbed areas that are being stripped ahead of mining; and from the cover species on topsoil stockpiles.

HVO continues to refine the approach to minimise the impact of weeds in rehabilitation, including:

- Prioritising the use of topsoils from good quality native vegetation areas on rehabilitation that is being returned to native vegetation;
- Managing new and old topsoil stockpiles to clean up exotic grass/weed cover and establish a cover of native vegetation (see topsoil management, above);
- Development of techniques to use spoils ameliorated with composts (or similar ameliorants) and gypsum as the growth medium for areas being returned to native vegetation. This method avoids the use of “weedy” topsoils and allows native vegetation to become established in the absence of competitive weed species;
- Chemical application techniques to target exotic grasses and weeds in areas that have already been sown with native seed mixes. This includes weed wiping of exotic grasses, post-sowing pre-emergent spraying of areas with high risk weed seed loads; and targeted spot spraying across key development windows.
- Development of native seed production areas to supply local provenance native grasses for use in rehabilitation and topsoil stockpile maintenance.

HVO has committed to a detailed work plan in response to initial TARP triggers arising from rehabilitation monitoring and subsequent engagement with Resources Regulator arising from Section 240 Notices received during 2018 and 2019. The plan is particularly focussed upon native vegetation establishment on historic cover crop areas, and protection of these and existing areas from existing and emergent week threats while vegetation establishes.

8.7 Rehabilitation Monitoring

Performance criteria for each rehabilitation phase have been detailed in the Mining Operations Plan (MOP) for both HVO North and HVO South. These criteria have been developed so that the rehabilitation success can be quantitatively tracked as it progresses through the phases outlined below:

- Stage 1 – Decommissioning
- Stage 2 – Landform Establishment
- Stage 3 – Growing Media Development
- Stage 4 – Ecosystem and Land use Establishment
- Stage 5 – Ecosystem and Land use Sustainability
- Stage 6 – Rehabilitation Complete

The performance criteria are objective target levels or values that can be measured to quantitatively demonstrate the progress and ultimate success of a biophysical process. A monitoring methodology has been developed to measure the performance criteria utilising a combination of tool to assess changes occurring over time.

The target levels or values have been based on monitoring results from reference sites. Continued refinement of the criteria in association with key regulatory stakeholders remains ongoing in association with an adaptive management approach.

The monitoring programme for rehabilitated land returned to native vegetation was commenced during 2015. Further monitoring was conducted in early and mid-2017. A number of results from the 2017 monitoring event initiated TARP triggers in relation to native weed presence and the trajectory of native vegetation establishment. This was reported in the 2017 Annual Environmental Review.

In October 2018 in response to TARP triggers and observations during annual inspections, the DP&E – Resources Regulator issued HVO with notice under Section 240(1)(c) of the Mining Act (1992) (Section 240 Improvement Notice).

As detailed by the TARP triggers, and in accordance with this Section 240 notice, HVO initiated review of 12 areas of concern by suitably qualified specialists using an abridged monitoring methodology so as to understand in more detail current site conditions and trajectory, and support intervention decision making. Details of this monitoring program were presented in the 2018 Annual Environment Review.

Following submission of the review in January 2019, Resources Regulator directed the abridged monitoring methodology be applied to an extended area of rehabilitation undertaken since c.2009 when HVO commenced using widespread sacrificial cover crops during initial rehabilitation establishment. This extended monitoring was undertaken across 25 sites during Autumn 2019. Details of all monitoring undertaken utilising this technique over late 2018 and in 2019 are presented in Table 63 and Figure 95. Maintenance interventions and prioritisations since this time have been informed by this monitoring.

Table 63 Summary of 2019 and 2018 rehabilitation monitoring inspections

Site Name	Trajectory Ranking	Key Issues	Recommendations
HVOWES201101	Stable but needs work to improve	Disturbance through the centre of this site has resulted in weed invasion, particularly exotic grasses but natives in this disturbed area are recruiting from the soil seedbank and/or root stock. In undisturbed areas the canopy layer is too dense and competition is excluding mid and ground layer species.	Control weed threats, open up canopy layer in undisturbed sections and sow test areas with shade tolerant species.
HVOWES201301	Stable but needs work to improve	Exotic grasses are the main threat here. One large patch appears to have lost topsoil and/or have subsoil issues and has a low density of trees and shrubs but a good native ground layer.	Manage exotic grass threat and possibly over-sow natives to increase shrub layer. Investigate soil issues in areas of low shrub density and ameliorate as required.
HVOWES201401	Stable but needs work to improve	The majority of the area is tracking well with excellent shrub layer density and good native ground cover. Canopy species stem density is low and the ground layer has a higher density of Galenia, although this does not appear to be seriously threatening natives. One large zone in this area appears to have soil issues preventing tree and shrub establishment. Rhodes grass and Green panic are present in low density.	Control Galenia and exotic grasses. Investigate soil issues in areas of low shrub density and ameliorate as required.
HVOWES201501	Failing	There is little native cover across this site apart from Saltbush species. Soil issues appear to be limiting native establishment, although it is possible that natives have not germinated due to harsh drought conditions.	Investigate soil issues in areas of low shrub density and ameliorate as required. Reassess site following substantial rain. Re-sowing may be required following further investigation.
HVOWES201502	Stable but needs work to improve	One large zone in this area appears to have soil issues preventing tree and shrub establishment. Native grasses are present in good diversity and density although proper assessment was difficult following drought conditions. The southern third of the site has better shrub establishment and some trees.	Investigate soil issues in areas of low shrub density and ameliorate as required. Reassess site following substantial rain. Over-sowing trees and shrubs may be warranted following further investigation.
HVOWES201602	Tracking towards success	Good diversity and cover in ground and canopy layers. Good canopy species establishment	Control exotic species through this zone but concentrate efforts on neighbouring blocks to reduce threat form invasive weeds.
HVOWES201605	Stable but needs work to improve Failing	This site currently has low weed density but native establishment has been so far limited, probably due to drought conditions. Further assessment is necessary to properly assess but significant rainfall could either stimulate native establishment or result in a serious weed infestation.	Continue monitoring and control exotic grasses and Galenia.
HVOWES201703	Tracking towards success	Good native establishment though low cover, probably due to drought. Galenia is present in significant density, though control efforts have reduced its impact.	Continue weed control and re-assess following rain

Site Name	Trajectory Ranking	Key Issues	Recommendations
HVOWES201704	Failing / Failed	This site was divided into three zones, based on native and weed densities. The Northern and Southern zones have low native diversity and cover and significant weed invasion. The southern zone in particular is invaded with Rhodes grass and Galenia while the northern section is mostly affected by Galenia. The central zone has good native cover, especially grasses, though trees and shrubs are limited.	Control Rhodes Grass across the site and consider resetting northern and southern zones (spray out and re-sow).
HVOCHE201501B	Failed	This site is dominated by Green panic and native establishment has been very poor.	Investigate and ameliorate soil issues. Spray out and re-sow.
HVOCHE201601A	Failed	This site is dominated by Green panic and native establishment has been very poor.	Investigate and ameliorate soil issues. Spray out and re-sow.
HVOCHE201702	Failed / Tracking towards success	This is a varied site, comprised of disturbed remnant woodland with some zones having been completely cleared and rehabbed with imported topsoil. The rehab on imported topsoil has failed, being infested with Galenia and green panic. The remnant woodland has weed issues but natives are re-establishing and with some management the quality of this block will continue to improve overall. Significant weed control and possible over sowing will probably be necessary in the worst-affected zones.	Investigate underlying soil issues. Possible issues could include a combination of subsoil and/or topsoil compaction or contamination or mineral imbalance or nutrient deficiencies. Slash green panic in cleared areas, spot spray Galenia and over-sow cleared areas with colonizing native grasses. Allow natural regeneration from neighbouring zones. Control weeds in remnant woodland zones and encourage natural recruitment.
HVOCHE201801	Failed / Tracking towards success	The southern part of this site is performing extremely well, with excellent native establishment. However, the Northern part (the majority) is completely dominated by green panic and native cover and diversity are extremely low.	Investigate soil issues in areas of low native density and ameliorate as required. Re-sowing of these areas will probably be required following weed control and amelioration.
HVOCHE201802	Stable but needs work to improve	This area has good native grass establishment and some shrubs and canopy species. Native recruitment may continue but native cover is still low. Exotic grasses are present in low densities and should be promptly controlled	Control Rhodes Grass and continue to monitor native establishment.
HVORIV201406	Failing	This site has been almost completely dominated by the native annual saltbush *Salsola australis*. Establishment of other native species has been very limited. *Salsola* is currently mostly senescent but is probably preventing germination of natives by preventing light from reaching the soil surface.	Slash *salsola* stands and re-assess following rainfall.

Site Name	Trajectory Ranking	Key Issues	Recommendations
HVORIV201407	Failing / Failed / Stable	This area has been divided into three zones: South of the power line track has failed due to poor native establishment and a dense infestation of Rhodes and Couch grasses. The flat north of the power line and up to the break in slope has good native grass cover, a low density of native shrubs and a low but significant density of Rhodes grass and green panic. The northern slope has good grass and herb establishment, along with good density of shrubs and canopy species. However, exotic grasses are dominating this area and if not controlled will completely invade the Zone.	Control weed patches in central zone with spot a combination of slashing and spot spraying. Spray out weeds in southern section and resow with native grasses. Slashing program on sloping areas to control high-growing exotic grasses and favour low-growing natives, avoiding Shrubs and trees. Spot spraying as required. Continue to monitor native and weed responses.
HVORIV201601A	Stable but needs work to improve	This site has been almost completely dominated by the native annual saltbush *Salsola australis*. Establishment of other native species has been limited, although cover of other native saltbushes is quite good. *Salsola* is currently mostly senescent but is probably preventing germination of natives by preventing light from reaching the soil surface.	Slash *salsola* stands and re-assess following rainfall. Investigate underlying soil issues and ameliorate as required.
HVORIV201701	Stable but needs work to improve	This site has been almost completely dominated by the native annual saltbush *Salsola australis*. Establishment of other native species has been very limited. *Salsola* is currently mostly senescent but is probably preventing germination of natives by preventing light from reaching the soil surface.	Slash *salsola* stands and re-assess following rainfall. Investigate underlying soil issues and ameliorate as required.
HVORIV201702	Stable but needs work to improve	This site has been almost completely dominated by the native annual saltbush *Salsola australis*. Establishment of other native species has been very limited. *Salsola* is currently mostly senescent but is probably preventing germination of natives by preventing light from reaching the soil surface.	Slash *salsola* stands and re-assess following rainfall. Investigate underlying soil issues and ameliorate as required.
HVORIV201703	Stable but needs work to improve	This site has been almost completely dominated by the native annual saltbush *Salsola australis*. Establishment of other native species has been very limited. *Salsola* is currently mostly senescent but is probably preventing germination of natives by preventing light from reaching the soil surface.	Slash *salsola* stands and re-assess following rainfall. Investigate underlying soil issues and ameliorate as required.
HVORIV201801	Stable but needs work to improve	This site has been almost completely dominated by the native annual saltbush Salsola australis. Establishment of other native species has been very limited. *Salsola* is currently mostly senescent but is probably preventing germination of natives by preventing light from reaching the soil surface.	Slash *salsola* stands and re-assess following rainfall. Investigate underlying soil issues and ameliorate as required.
HVORIV201802	Stable / Tracking towards success	Natives are establishing well on the north western part of this site, and there are initial signs of good native germination on the south eastern part. Exotic grasses and Galenia are present in low densities and should be controlled before they invade bare ground.	Control weeds and continue to monitor native establishment.

Site Name	Trajectory Ranking	Key Issues	Recommendations
HVORIV201803	Stable / Tracking towards success	Natives are establishing well on the northern (lower) part of this site, and there are initial signs of native germination on the southern (higher) part. Exotic grasses and Galenia are present in low densities and should be controlled before they invade bare ground.	Control weeds and continue to monitor native establishment.
HVOCAR200901	Failing	Well established canopy but stem density too high for continued success. Under storey and ground layer have low diversity dominated by threatening weeds (Green Panic) Contour banks and swales without significant native cover and infested with exotic grasses.	Thin Eucalypts using mechanical means or fire. Control Weed threats. Increase shrub layer diversity (fire would stimulate acacia germination) Increase shrub and ground layer diversity with soil disturbance and sowing
HVOLEM201501	Failed / Failing/ Tracking towards success	This is a varied site, comprised of disturbed remnant woodland with some zones having been completely cleared and rehabbed with possibly imported topsoil. The rehab on imported topsoil is variable, some having failed, being infested with couch and green panic. Other areas have good native shrub establishment but with a ground layer dominated by exotic grasses. The remnant woodland has weed issues but natives are re-establishing and with some management the quality of this block will continue to improve overall. Significant weed control and possible over sowing will probably be necessary in the worst-affected zones.	Investigate underlying soil issues. Possible issues could include a combination of subsoil and/or topsoil compaction or contamination or mineral imbalance or nutrient deficiencies. Slash green panic in cleared areas, over-sow cleared areas with colonizing native grasses. Allow natural regeneration from neighbouring zones. Control weeds in remnant woodland zones and encourage natural recruitment.
HVOWES201601 (2018)	Failing	• Soil issues. • Poor plant health and growth. • Threatening weeds present in significant density.	• Repeat monitoring and assessment. • Investigate soil issues and ameliorate as necessary. • Control Galenia (spot spraying). Aerate to prepare a seed bed and stimulate germination of natives. • Seeding options include: • If significant germination/reshooting of natives, consider: • Oversow with native seed mix. • Sow only chenopods, trees and shrubs to enable treatment of grass weeds with selective herbicide, then following 1-2 seasons of weed control sow grasses. • If there is no evidence of improvement in native cover: • Spray out entire block, prepare seedbed and resow either entire suite of natives or staged native sowing such as grasses and herbs only, followed by trees and shrubs as required.

Site Name	Trajectory Ranking	Key Issues	Recommendations
HVOWES201604 (2018)	Stable but needs work to improve	• Stable native vegetation with good grass cover, low shrub and tree diversity and low stem density. • Some threat from weeds.	• Following soil analysis, build on existing native vegetation to increase diversity and cover. • Control weed threats. • Selective seeding, if required.
HVOCAR200902 (2018)	Failing	• Well established canopy but stem density too high for continued success. • Under storey and ground layer have low diversity dominated by threatening weeds (Green Panic). • Contour banks and swales without significant native cover.	• Thin Eucalypts using mechanical means or fire. • Control weed threats. • Increase shrub layer diversity (fire would stimulate Acacia germination). • Increase shrub and ground layer diversity with soil disturbance and sowing.
HVOCHE201201 (2018)	Failing	• Very poor native cover or diversity apart from some saltbushes. • Significant densities of threatening weeds. • Evidence of ongoing soil or subsoil problems – poor plant growth and health. Even normally vigorous weeds show signs of drought stress and nutrition problems when compared to other HVO sites.	• Investigate soil issues and ameliorate as necessary. • Develop and implement a re-establishment plan.
HVOLEM201601 (2018)	Stable but needs work to improve	• Good shrub diversity and density. Ground layer dominated by Couch. Threat from *Acacia saligna* colonising from adjacent vegetation. • Contour banks and swales have low native cover and diversity. • Soil appears to be Warkworth Sands Woodland type so species sown may not have been appropriate to this soil type.	• Manage weed threats. • Investigate initially sown species mix. • Sow ground layer species appropriate for this soil type, if required.
HVORIV201401 (2018)	Stable but needs work to improve	• Good native species diversity but relatively low native groundcover layer (higher percentage of bare ground). • Heavily infested with threatening weeds, especially Rhodes Grass. • Evidence of soil issues in some areas.	• Manage exotic grasses threat to avoid contamination of adjacent areas. This should involve a combination of targeted slashing/brush cutting, blanket spraying of larger areas of exotic grasses and spot spraying of isolated plants. • Following control of exotic grasses increase native ground cover by re-sowing native grasses and Saltbushes.
HVORIV201402 (2018)	Stable but needs work to improve	• Generally good native grass diversity and cover, apart from one area which appears to have a different topsoil type. • Good shrub layer cover and some Eucalypts, although stem density is low. • Threat of invasion and spread of Rhodes Grass and Green Panic.	• Treat threatening weeds. • Augment native ground and shrub layer in areas with lower stem density, if required.

Site Name	Trajectory Ranking	Key Issues	Recommendations
HVORIV201403 (2018)	Stable but needs work to improve	• Good but patchy native diversity and cover in ground layer. • Evidence of soil issues. • Significant weed threats (in particular Rhodes Grass).	• Investigate soil issues and ameliorate as necessary. • Manage weed threats. • Re-sow restricted suite of natives (only sow proven successful species), if required.
HVORIV201404 (2018)	Failing	• Patchy native vegetation cover. • Majority of the site is dominated by threatening weeds. • Soil issues appear to be causing poor native establishment.	• Investigate soil issues and ameliorate as necessary. • Manage any weeds which pose a threat to adjacent rehab areas (Rhodes Grass and Green Panic pose highest risk of quickly invading areas dues to windblown seed). • Consider re-sowing with limited native seed mix (only sow proven successful species).
HVORIV201405 (2018)	Failed	• Evidence of serious soil problems. • Site is almost entirely dominated by annual plants (both native and exotic) suggesting a serious issue with subsoil and/or topsoil.	• Investigate soil issues and ameliorate as necessary. • Spray out and resow with limited native seed mix (only sow proven successful species).
HVORIV201501 (2018)	Tracking towards success but needs work	• Good native cover and diversity in ground layer. • Shrub and canopy layer has low stem density (particularly Eucalypts).	• Manage weed threats. • Selective seeding, if required.
HVORIV201503 (2018)	Tracking towards success but needs work	• Good native cover and diversity across the majority of the site. • Two small zones within the site have lower tree and shrub stem density.	• Manage weed threats. • Selective seeding, if required.

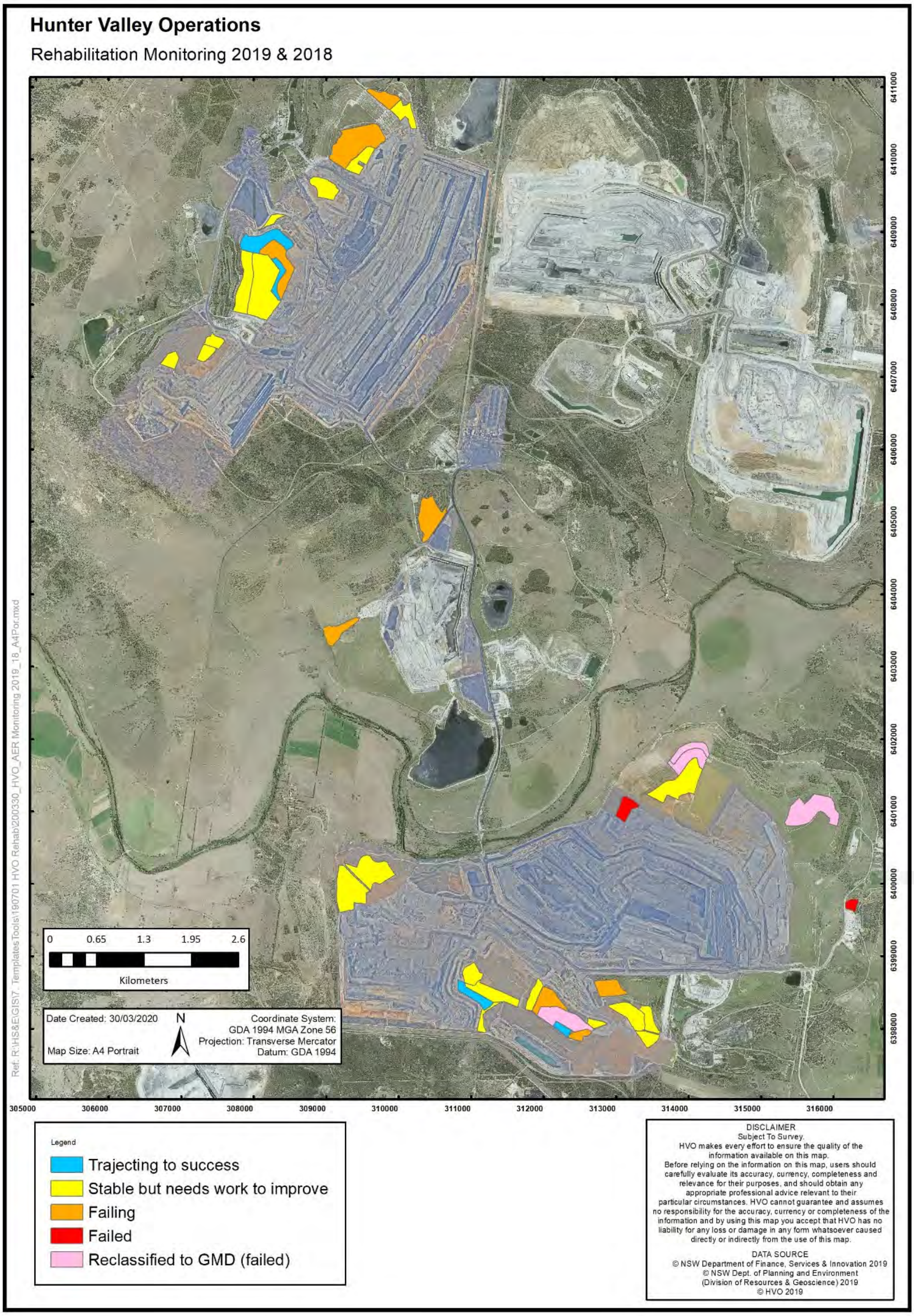


Figure 95: Overview of 2019 and 2018 rehabilitation monitoring inspections

8.8 Overview of Rehabilitation Trajectory

Due to the abridged monitoring methodology used during 2018 and 2019, direct assessment of these results against existing completion criteria is not valid. To assess performance and trajectory inspected sites were placed on a four point scale using quantitative data and qualitative professional judgement and ranked as either:

- Tracking towards success but needs work;
- Stable but needs work to improve
- Failing; or
- Failed.

Where areas of differing qualities occurred across a site the most representative classification for the area was adopted, although with a conservative bias (i.e. generally default to the less favourable classification). Additionally, a number of sites which were classified as failed have been reclassified from the Ecosystem Establishment phase to Growth Medium Development (GMD) phase. Details of these GMD phase areas are included below however as they are now not 'in active rehabilitation' they are excluded from trajectory assessments.

Of the 37 sites inspected during 2019 and 2018, two sites were classified as 'failed' (8.1ha), 10 to be 'failing' (100ha), 21 to be 'stable but needing work' (183.1 ha), and four to be 'tracking towards success' (25.7ha). Notably, the two classified as 'failed' also included sub-areas identified to be 'tracking towards success' (HVOCHE201702, HVOCHE201801) indicating favourable areas which can be built upon during ongoing maintenance.

A further four sites were identified to have 'failed' (49.7ha) and reclassified to GMD phase as described above. Although nominally failed these reclassified sites remain a focus for targeted maintenance in association with the s240 maintenance program and hence are expected to demonstrate improvement when future monitoring occurs following corrective action and resowing.

Based on the monitoring classifications across the period it can be seen that 65-70 percent of the monitored sample are establishing favourably (25 of 37 sites, or 209ha of 317ha) and are on a trajectory for success provided appropriate and timely management interventions continue to occur. As further targeted maintenance interventions are undertaken in association with the s240 maintenance plan this success trajectory may be expected to be more obviously demonstrated across the rehabilitation sites.

Development of SMART (Specific, Measurable, Achievable, Realistic, and Timely) Completion Criteria and identification of suitable representative ecosystems has been occurring during 2019 in association with preparation of a revised and consolidated whole of site Mining Operations Plan. It is expected that a monitoring event utilising these criteria and reference sites will be undertaken during Spring 2020 to provide an up to date understanding of current rehabilitation area trajectories and further inform ongoing adaptive management responses.

8.9 Rehabilitation Maintenance

Management of rehabilitated areas is undertaken proactively to assist in initial establishment and when issues are identified through monitoring, auditing or inspections.

An overview of key rehabilitation maintenance activities is shown in Figure 96 and detailed below.

Section 240 Maintenance Program

In July 2019 the DP&E – Resources Regulator issued HVO with Notice 3259 under Section 240(1)(c) of the Mining Act (1992) (Section 240 Improvement Notice) requiring HVO to outline measures or actions to improve progressive rehabilitation performance across the site. This follows and earlier similar notice received during 2018 which was limited to 12 initial sites of concern. In response to these notices HVO has developed and committed to a rehabilitation maintenance and improvement program across the site as detailed in Appendix B (the s240 Maintenance Plan). This plan integrates and prioritises rehabilitation maintenance activities across the site to progress areas of rehabilitation initially sown to cover crop, manage weed competition, and encourage vegetation establishment. An overview of work from the plan undertaken during 2019 is presented in association with the plan in Appendix B, in addition to being detailed further below.

Broadacre maintenance

Broadacre weed treatment within rehabilitation areas is undertaken using agricultural methods comprising boom sprays, wick wipers and slasher/mulchers. In existing rehabilitation areas boom spraying is primarily used to manage cover crop and fallow areas prior to sowing to final native seed mixes. Pre-emergent application of herbicide is used when appropriate necessary to control emerging weeds in the period between sowing and germination of the desired species. Wick wiping targets rapidly growing exotic grasses and other erect growing weeds in the period following native germination but while desirable species remain below the wiper target zone. Slashing and mulching is used to remove rank pasture grasses and stimulate fresh growth as herbicide target and to truncate seed cycles. During 2019 areas totalling 227 ha were boom sprayed, 76 ha received wick wipe treatment, and 62 ha was slashed or mulched.

Native seed mixes are sown as part of the maintenance program where areas have been sown to an initial cover crop or where areas previously sown to native have not established successfully. During 2019 27 ha of maintenance native seeding was completed, in addition to re-establishment of 131 he of cover crop on areas to provide stabilisation prior to progression to final natives.

Ground based interventions

Hand spraying and manual removal of weeds is undertaken in rehabilitation areas with early stage and establishing native vegetation that would be likely to be damaged or destroyed should broadacre methods be used. During 2019 148 ha of rehabilitation areas at various stages of establishment were treated by ground crews in this manner.

Grazing of Rehabilitation Areas

Grazing of rehabilitation areas is utilised to encourage and maintain pasture diversity, encourage nutrient cycling, and assist in fuel load management. A licence agreement is in place for grazing 666 ha of HVO North rehabilitation area, with temporary fuel load licences across a further 394 ha of rehabilitated land around HVO North and 210 ha around HVO South. Opportunities to integrate grazing to assist rehabilitation progression continue to be assessed.

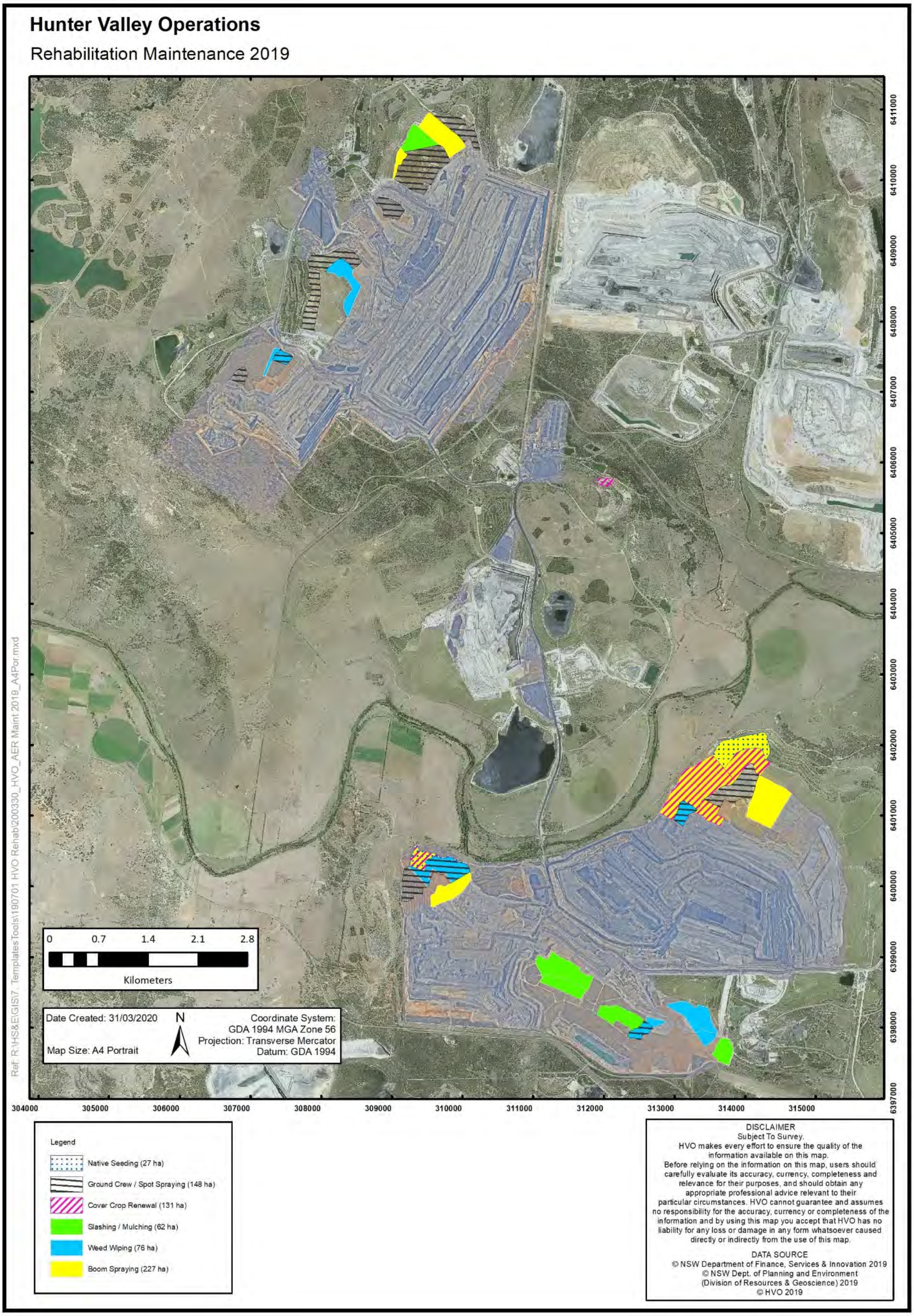


Figure 96: Rehabilitation Maintenance – post-rehabilitation weed control

8.10 Vertebrate Pest Management

As part of HVO's Vertebrate Pest Action Plan a number of baiting programmes are carried out on a seasonal basis. These programmes are conducted at a level of frequency designed to disrupt pest species breeding/colonisation cycles and employ a variety of methodologies including baiting, trapping and ground based shooting

Wild Dog and Fox Baiting Programmes

Three 1080 ground baiting program targeting wild dogs and foxes were implemented across operational and biodiversity areas. These were undertaken during summer, winter and spring. Each program consisted of approximately 35 - 60 bait sites utilising meat baits and ejector baits. Baits were checked over a three week period and replaced each week when taken.

Pig Trapping

Two synchronised 1080 pig trapping programs were conducted by HVO in conjunction with the Singleton Local Land Services (branch) and adjoining corporate landholders in April and September 2019. The programs consisted of 4 trap stations equipped with 'Hog eye cameras'. The trap station at the Wandewoi Biodiversity Area and the Archerfield properties accounted for 20 pigs across the two programs. Pig sightings and numbers are declining and this is attributed partly to the numbers of pigs successfully controlled in previous programs and the benefits of synchronising control activities with neighbours.

In addition there are two pig traps permanently located and maintained at Archerfield Farm. The pigs caught and euthanised in these traps are captured within the shooting summary numbers in Table 64.

Ground Based Shooting

HVO has two shooters attending the site on a regular basis opportunistically controlling feral pest species. Feral species controlled include pigs, wild dogs, foxes, hares /rabbits and cats.

Table 64 summarises the results from the programmes carried out at HVO during 2019 with baiting locations and results for the programmes illustrated in Figure 99 to Figure 102.

Table 64 Summary of Vertebrate Pest Management 2019

Season	1080 Baiting				Trapping		Shooting			
	Total Lethal Baits Laid	Takes by Wild Dog	Takes by Fox	Takes by Feral Pig	Wild Dog	Feral Pig	Feral Pig	Wild Dog	Feral Cat	Hares & Rabbits
Summer	75	39	5					1	1	
Autumn-Winter	124	61	10			1	10			6
Spring	120	66	4			19	7			19
Total	**319**	**166**	**19**			**20**	**17**	**1**	**1**	**25**

Table 65 provides a comparison of results from the last 13 baiting programmes undertaken at HVO. In 2019, as for previous programmes undertaken at HVO, the vast majority of baits showed evidence of being consumed by wild dogs at 93% with foxes taking 6% and 1% being consumed by non-target species.

Results reported indicate the majority of takes by dogs or foxes and photographic evidence taken in previous programs indicate a high populations of wild dogs in the area. It is, however, becoming increasingly apparent as motion sensor camera photographic data is processed, that the non-target species, Australian ravens, are becoming extremely brazen and adept at digging up and extracting meat baits as well as stripping ejector lures, and even on occasions disassembling ejector mechanisms (Figure 97).

Table 65 Comparison of results between baiting programmes at HVO

Baiting Program	No. of Baiting Sites	Baiting Opportunities	Baits taken by Dogs	Dog (%)	Baits taken by Foxes	Fox (%)	Baits taken by other (non-target) species	Other (%)	Total No. of Baits Taken	No. Sites where baits taken at least once	Represented as Percentage (%)	No. sites with baits taken on all occasions	No. sites with no baits taken	No. baits Disturbed Not Taken	No. baits taken alternatively by Dog or Fox	Baiting Efficiency %	Baiting efficiency excluding 'other' %
1506 HVO	40	120	55	98	0	0	1	2	56	31	76	5	9	1	0	47	46
1510 HVO	60	180	71	89	8	10	1	1	80	43	72	10	17	4	5	44	44
1602 HVO	60	120	49	92	3	6	1	2	53	42	70	13	18	0	2	44	43
1606 HVO	60	180	94	96	4	4	0	0	98	54	90	10	6	6	4	54	54
1609 HVO	60	180	83	94	5	6	0	0	88	49	82	11	11	12	3	49	49
1702 HVO	59	117	58	84	10	14.5	1	1.5	69	49	87	20	11	7	5	59	58
1705 HVO	60	120	70	95	4	5	0	0	74	51	85	23	9	3	0	62	62
1709 HVO	60	120	67	96	3	4	0	0	70	48	80	22	12	5	2	58	58
1803 HVO	60	120	69	90	6	8	2	2	77	49	82	31	11	7	0	64	63
1806 HVO	60	120	77	94	5	6	0	0	82	50	83	32	10	8	4	68	68
1809 HVO	61	122	73	87	10	12	1	1	84	50	82	34	11	2	6	69	68
1905 HVO	64	124	61	85	10	14	1	1	72	50	78	22	17	8	8	64	63
1910 HVO	60	120	66		4		1		71	48	80	23	14	8	2	59	58
												Average Baiting Efficiency				59	58

Figure 97: Australian Raven at Ejector Bait Site 44

When assessing bait sites in the field, it is often difficult to ascertain if wild dogs or ravens have taken the meat baits as dogs have been photographed sniffing and investigating bait sites (Figure 98) after an Australian raven has taken the bait; the dog leaving paw prints, digging at and even urinating on the site.

Figure 98: Fox at Ejector Bait Site 44

It is estimated that the number of takes by Australian ravens is increasing, and it is likely they account for at least 10 - 20% or more of meat bait takes. Research shows that Australian native fauna are naturally resistant to 1080 and concentrations in the meat bait need to be substantially higher to adversely affect the animals.

Increasing the number of motion sensor cameras in the field during the baiting process will produce more accurate and realistic bait take results. If future monitoring of program continually reveals increasing take rates of meat baits by ravens, HVO will consider alternatives in baiting techniques to reduce takes by the non-target species.

Vertebrate pest management programmes will continue to be carried out during 2020 to limit feral pest impacts on landholdings and surrounding neighbours.

Figure 99: HVO Vertebrate Pest Management Bait Locations – Summer 2019

Figure 100: HVO North Vertebrate Pest Management Bait Locations – Autumn 2019

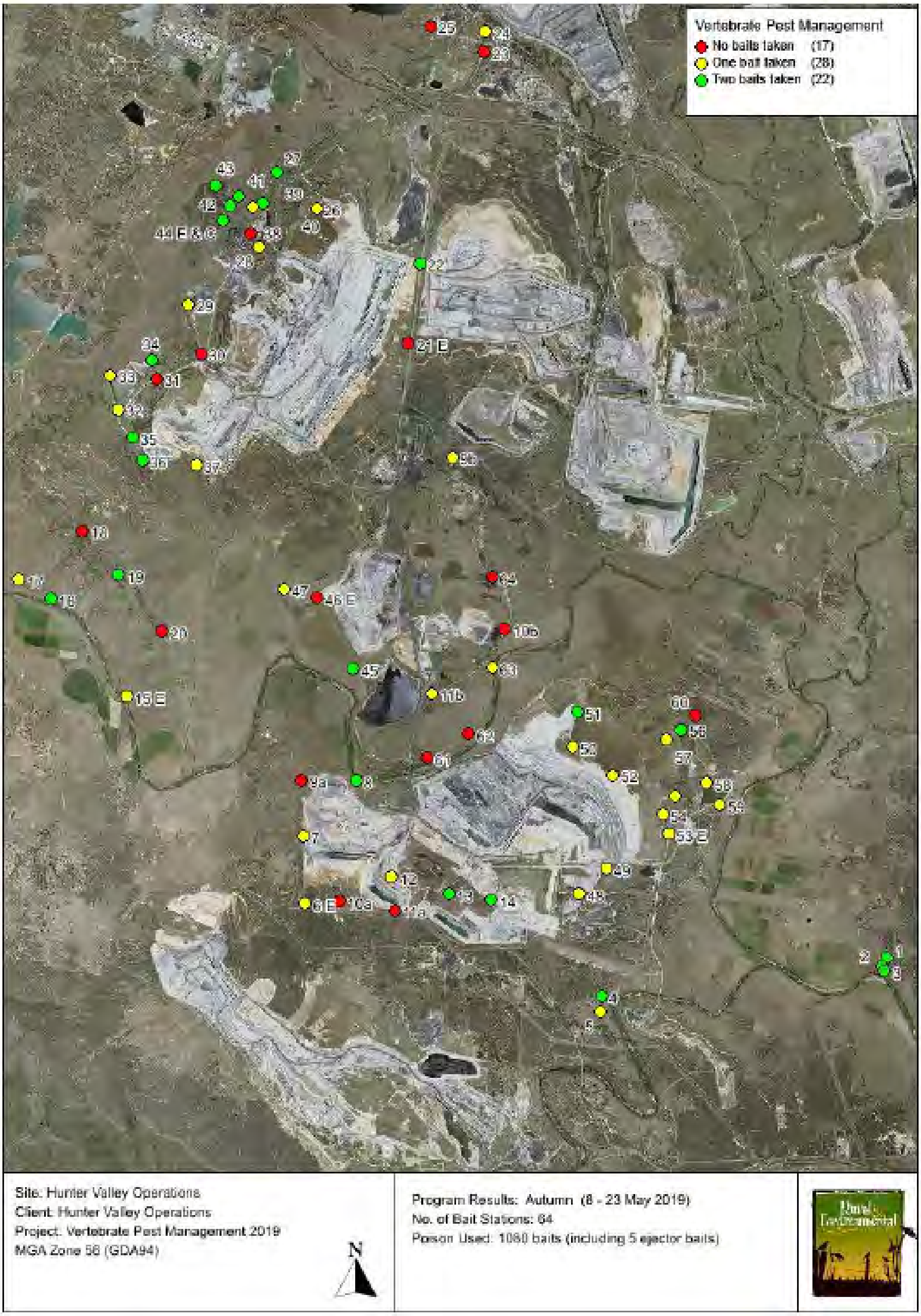


Figure 101: HVO Vertebrate Pest Management Bait Locations – Autumn 2019

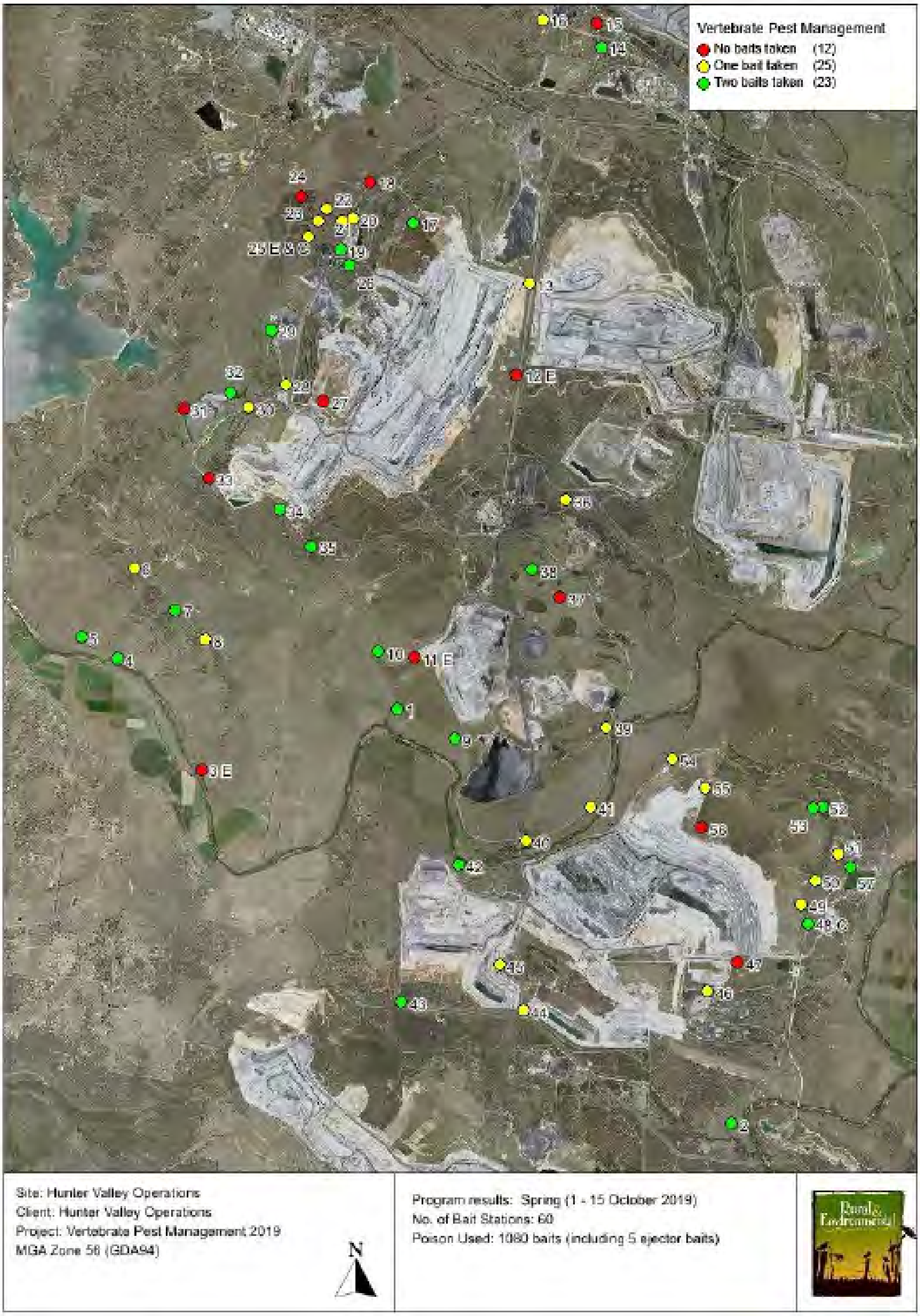


Figure 102: HVO Vertebrate Pest Management Bait Locations – Spring 2019

8.11 Supplementary Weed Treatment

In addition to weed occurrence in rehabilitation areas, weeds identified at HVO occur primarily in areas that have been disturbed such as previous civil works areas, soil stockpiles, water management structure surrounds, and general areas of minor ground disturbance. A total of 107 days of weed control work was undertaken on site at HVO during 2019, with approximately 211 ha of land treated, including River Red Gum areas and maintenance of 90 environmental monitoring points.

The weeds targeted during the 2019 weed management programme were based on the results of the 2018 weed survey. Figure 103 to Figure 105 illustrate the target species and weed treatment areas across HVO.

The dominant weed species that were targeted during 2019 included:

- African boxthorn (*Lycium ferocissimum*)
- African olive (*Olea europea*)
- Balloon vine (*Cardiospermum grandiflorum*)
- Bathurst burr (*Xanthium spinosum*)
- Galenia (*Galenia pubescens*)
- Grasses (*Various spp)*
- Green cestrum (*Cestrum parqui*)
- Mallow (*Malva parviflora*)
- Mustard weed (*Sisymbrium officinale*)
- Narrow leaf cotton bush (*Gomphocarpus fructicosis*)
- Opuntia (Pear) species (Tiger, Prickly and Creeping pear)
- Saligna / Golden wreath wattle (*Acacia saligna*)
- Various thistles: Scotch thistle (*Onopordum acanthium*), saffron thistle(*Carthamus lanatus*) and variegated thistle (*Silybum marianum*)

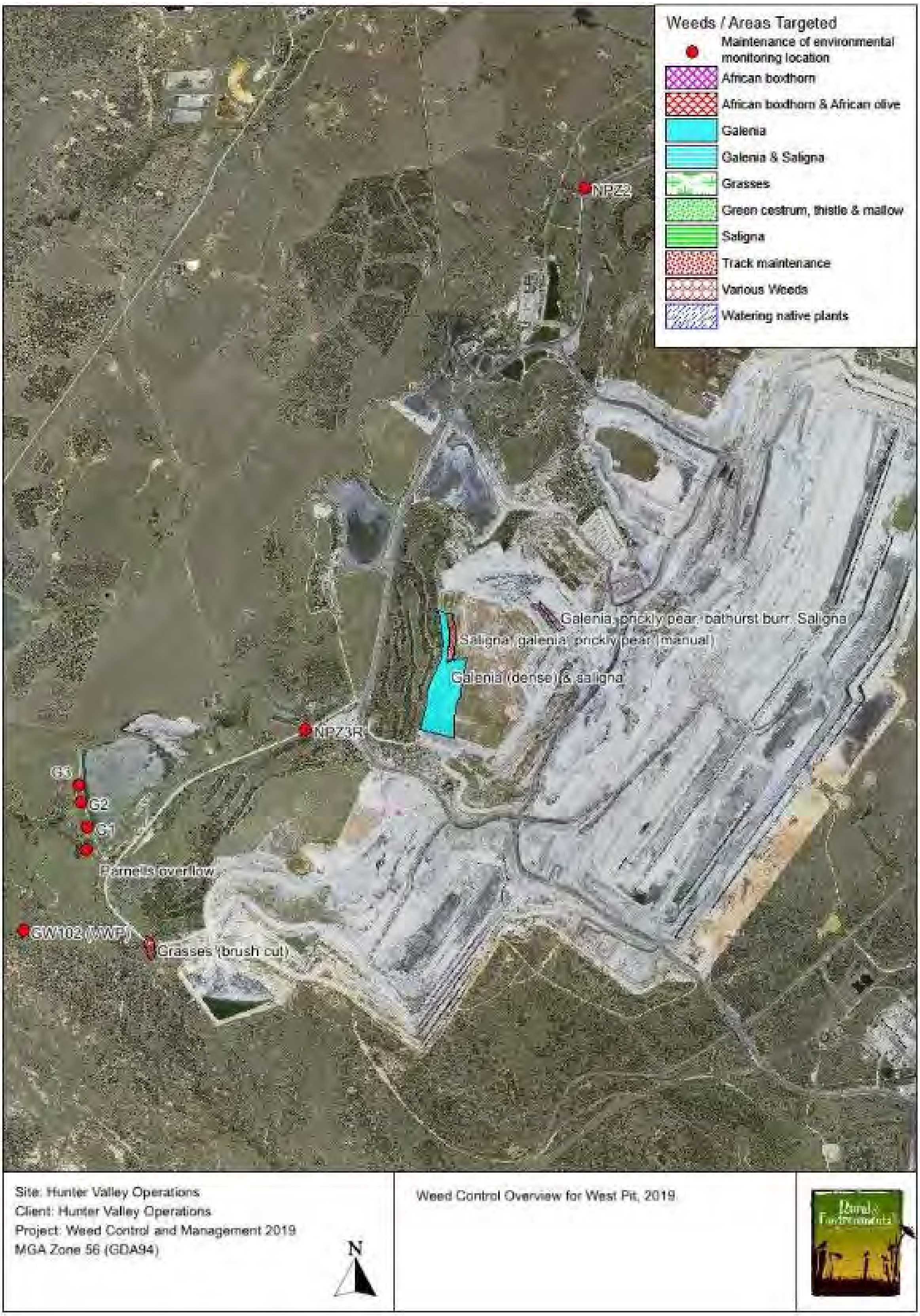


Figure 103: Weed Control Overview for West Pit – 2019

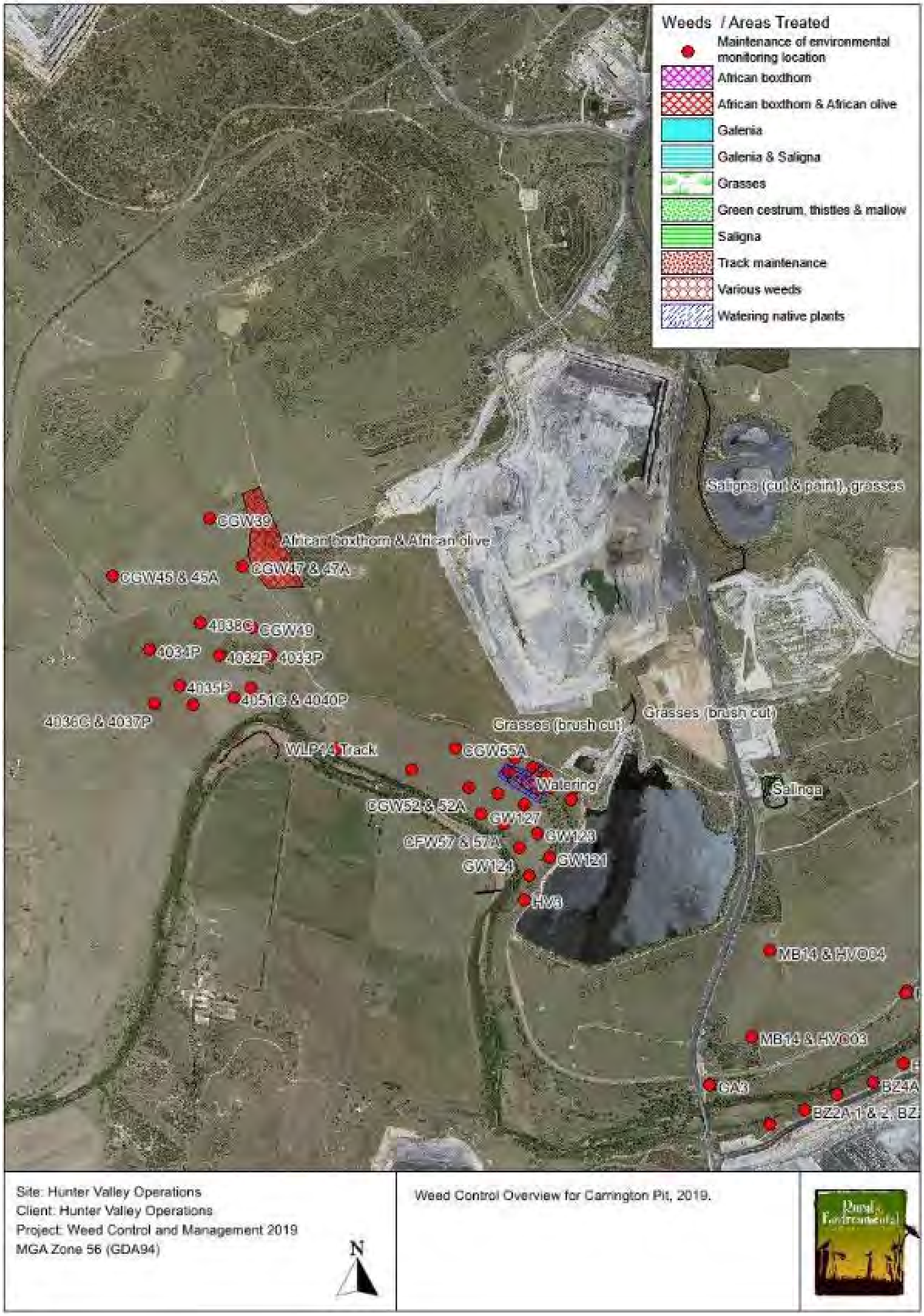


Figure 104: Weed Control Overview for Carrington Pit – 2019

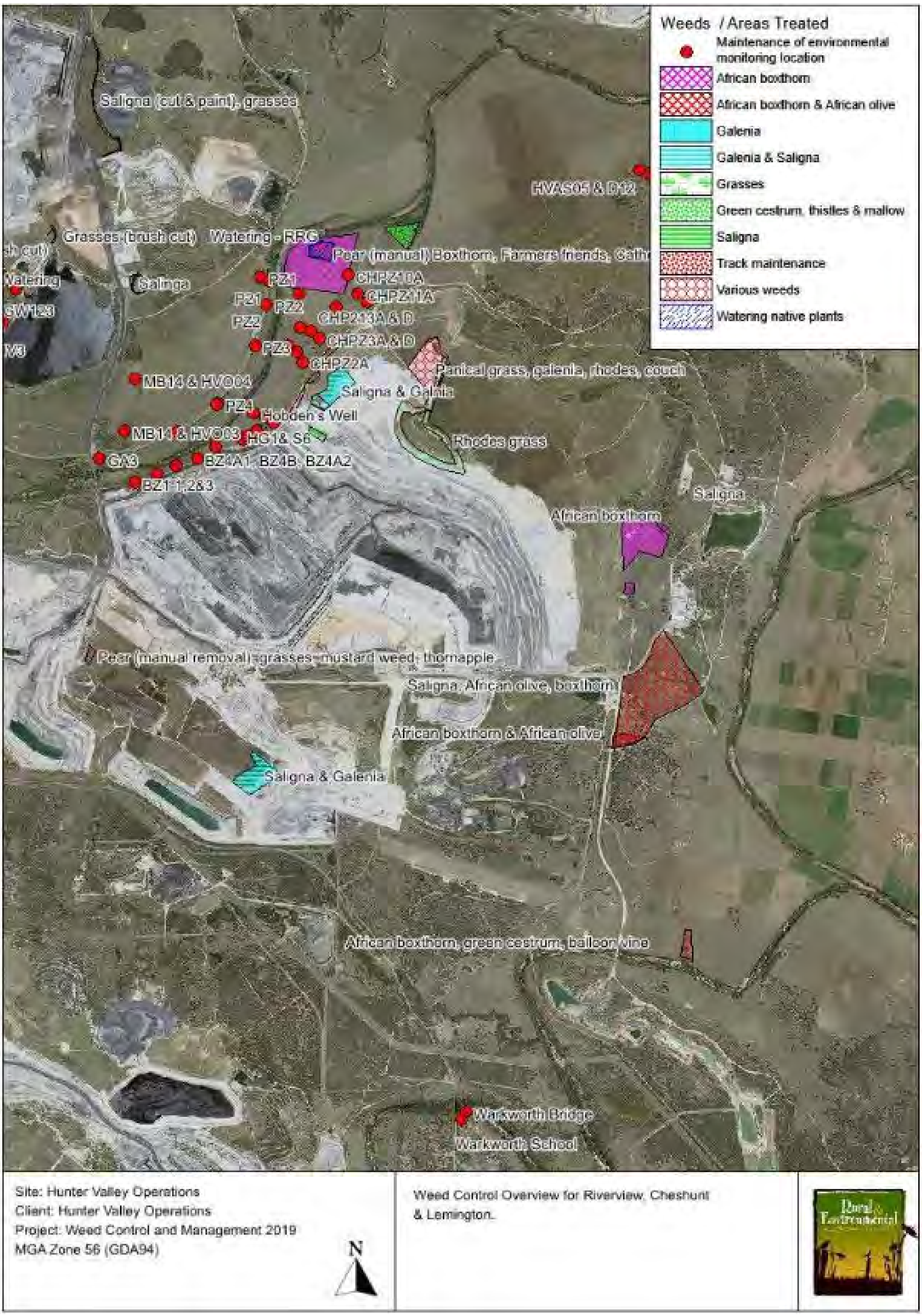


Figure 105: Weed Control Overview for Riverview, Cheshunt and Lemington – 2019

8.12 Renovations

8.12.1 Newdell Coal Handling Preparation Plant (CHPP)

In 2019 HVO completed demolition works at the Newdell CHPP. DPIE were notified of the proposed activities on 18 June 2019. The works involved the demolition and removal of infrastructure (conveyor belts, wash plant, tanks, buildings etc.) as well as the removal of several concrete base slabs and paved/bitumen areas. Works were undertaken in compliance with Australian Standards and Legislation and included the removal of the following infrastructure:

- Newdell Bathhouse;
- Thickener Tank;
- Newdell Office;
- Old laydown area and several tanks;
- Breaker, Reject Line and Bins;
- Plant Feed and Clean Coal Conveyors; and
- Control Room

Asbestos Containing Material (ACM) was found in some sheeting in the eaves and ceiling of the Newdell bathhouse. The following measures were taken in removing the asbestos :

- Hazardous Substances Management Plan prepared by external contractor;
- Demolition contractor held Class A Asbestos Removal License;
- Ongoing air monitoring for airborne asbestos fibre undertaken as required;
- Water down methods undertaken to control risk; and
- ACM bagged and removed appropriately offsite in a timely manner.

No other contamination issues were identified during and subsequent to removal of buildings/waste.

8.12.2 Derelict Rural Buildings

HVO also completed the demolition of two derelict rural buildings located within its rural property portfolio. Works included the decommissioning of septic systems, asbestos removal, the salvage/ recycling of building materials (where feasible) and restoration of vegetation cover. Works were undertaken in compliance with Australian Standards and Legislation.

8.13 Topsoil Management

Topsoil is managed according to the HVO Ground Disturbance Permit system and land management procedures. Table 66 outlines the topsoil used and stockpiled during 2019. There were 88.3 ha of rehabilitation completed during 2019, using soil resources from ahead of mining pre-strip and rehabilitation disturbance activities.

Table 66 Soil Management

Soil Used This Period (m^3)	Soil Prestripped This Period (m^3)	Soil Stockpiled to Date (m^3)	Soil Stockpiled Last Report (m^3)
85,854*	33,936	1,879,745	1,931,663

*excludes rock chutes and rehabilitation water management infrastructures.

Topsoil Audit

On 5 June 2019 Resources Regulator undertook an audit to assess operational performance of HVO South in relation to the management of topsoil and the implementation of management systems and controls to provide for the sustainable management of the mine's topsoil resources.

The audit assessed compliance for the previous 12 months commencing 5 June 2018 with reference to approved Mining Operations Plan, associated management plans and site procedures. The audit included desktop document review, site inspections and interviews with site personnel and identified one non-conformance and made five observations as detailed in Table 67. HVO will finalise a Topsoil Management Plan during 2020 which will formalise revised and updated operational controls to be used to manage the topsoil resources at site.

Full details of the audit are contained in *Compliance Audit Report, Hunter Valley Operations South – Topsoil Management* (COC19/704213) available on the Resources Regulator and HVO Insite websites.

Table 67 HVO Topsoil Audit – findings, recommendations and actions

Ref No.	Finding/Description of Issue	Regulator Recommendation	HVO Action
NC1	The key observation from the audit relating to topsoil stockpiling was that topsoil did not appear to be separately stockpiled based on topsoil quality as indicated in section 2.4.2.4 of the MOP. It is possible for topsoil stripped from a pasture area to be stockpiled with topsoil stripped from a native woodland area that may have implications for vegetation establishment when topsoil is reused. Similarly, there does not appear to be any distinction between stockpiling alluvial topsoil and stockpiling gravelly soils or acid topsoils.	This should be addressed during the development of the topsoil management plan being prepared in response to the Section 240 direction issued in October 2018.	Develop site procedures that support differential stockpiling of site soil resources based upon key soil characteristics, for example, soil source, management history, physical and chemical characterisation, soil classification. [in process]
OB1	Generally, the descriptions in the MOP relating to topsoil management are very brief and quite generic using language such as 'where possible' or 'if required'. Using a risk-based approach to topsoil management, it would be expected that some form of trigger action response plan (TARP) would be available to provide the triggers for 'when' a particular control might be required.	This should be addressed during the development of the topsoil management plan being prepared in response to the Section 240 direction issued in October 2018.	Identify key risks associated with topsoil management and document in Topsoil Management Plan in association with key controls. Where historic commitments are no longer relevant as controls, explicitly identify, and describe any contemporary replacement controls. Develop a TARP to support implementation. [in process]
OB2	One older stockpile (possibly 15+ years old) was observed to be located next to a laydown area for high density polyethylene pipe (HDPE pipe). Although the stockpile was well vegetated and signposted, there was a risk that vehicles could inadvertently impact the stockpile during placement or retrieval of the pipe sections. The location of the laydown area for the HDPE pipe would not appear to be consistent with the location principles for topsoil stockpiles specified in the MOP.	HVO should review the risks associated with the pipe laydown area adjacent to the topsoil stockpile and implement controls as required.	Review poly pipe storage area located opposite Michelle's Fill Point (Dam 17S). Remove/recycle all waste pipe, fittings and miscellaneous items. [complete]
OB3	It was noted that Table 10 of the MOP does identify the erosion potential of each soil type but does not provide any guidance on when erosion and sediment controls are required for topsoil stockpiles.	This should be addressed during the development of the topsoil management plan being prepared in response to the Section 240 direction issued in October 2018.	Develop TARP (or other guidance) to support implementation of erosion and sediment controls around topsoil stockpiles. [in process]
OB4	Although HVO staff advised that topsoil stockpiles were inspected, this process appears to be informal and not documented. Issues with stockpiling identified by the	This should be addressed during the development of the topsoil management plan being prepared in response to the Section 240 direction issued in October 2018.	Develop and implement a topsoil stockpile inspection regime, including supporting documentation.

Ref No.	Finding/Description of Issue	Regulator Recommendation	HVO Action
	auditors may have been identified earlier if a more robust and documented inspection regime was in place.		[complete]
OB5	A maintenance program for the topsoil stockpiles was reported to be implemented. There were no records provided to verify that this program is documented and is consistently implemented. Given that there was no formal inspection program, it was difficult to see how the maintenance program was triggered. If issues are identified during the informal inspections, there does not appear to be a system in place to record those issues, assign actions and verify completion of corrective actions.	Development of a robust inspection and maintenance program for topsoil stockpiles would be beneficial to achieving more successful rehabilitation outcomes.	Develop process for recording maintenance planned and undertaken on topsoil stockpiles. [in process]

8.14 Tailings Management

A Fine Rejects Management Strategy for HVO has been developed in accordance with the planning approval for HVO North (Clause 28A of DA 450-10-2003 Mod 4). A revised strategy was submitted on 28 September 2018 to reflect approval to deposit tailings in Carrington Pit. The strategy outlines tailings management for the time horizon spanned by current approvals.

Key Tailings Management Activities in 2019, include:

- Capping of the Southeast TSF remained ongoing.
- Cessation of tailings deposition into the North Void TSF;
- Construction of the Carrington secondary flocculation plant and commencement of pipe-head flocculation of tailings into the North Void TSF;
- Commencement of tailings deposition to Carrington In-Pit TSF in January 2019 association with pipe-head flocculation;
- Ongoing implementation of the North Void TSF Management Plan to manage and mitigate any potential impacts from an identified seepage pathway.

Table 68 below outlines the current state of Tailings Storage Facilities across HVO that are still active or pending decommissioning.

Table 68 HVO Tailings Storage Facilities

Facility	Status	Decant System
North Void	Inactive	Decant pumps in place, regular pumping.
Dam 6W	Active	Decant pumps in place, regular pumping.
Cumnock Void	Active (not currently depositing)	Decant pump in place, regular pumping when deposition occurring.
Bob's Dump	Inactive	Solar pump in place, pumping as required.
Southeast TSF	Inactive - capping commenced	Solar pump in place, pumping as required.
Central TSF	Inactive	No pumps required due to drying after rainfall (small catchment reporting to TSF).

8.15 River Red Gum Restoration and Rehabilitation

8.15.1 River Red Gum Overview

There are a number of River Red Gum sites (endangered population) across HVO South and North. These are managed under the HVO River Red Gum Restoration and Rehabilitation Strategy (Strategy) which has an implementation plan. In April 2008, the Department of Planning granted HVO conditional approval of the current HVO River Red Gum Strategy subject to preparation of an updated document following its 10 year review.

The sites have been categorised into a high level of management at the Carrington Billabong, intermediate level at the priority sites and low level at the low priority sites. Each has varying levels of monitoring and maintenance requirements as outlined in the Strategy.

In 2019, Umwelt was engaged to update the rehabilitation and restoration strategy. This is being finalised in Q1 2020.

Management activities undertaken within the HVO River Red Gum areas include weed control, vertebrate pest management and ongoing watering and management of the planted tubestock within the Carrington Billabong and high priority areas. Weed and pest management is discussed below. Figures demonstrating the development of the planted areas are presented below (Figure 106 to Figure 109). Additional works are planned for 2020 in these areas which will be reported in the 2020 Annual Review.

Figure 106: Native tube stock planting at Carrington Billabong (photo taken in 2017)

Figure 107: Native tubestock plantings at Carrington Billabong in 2019

Figure 108: Native tubestock plantings at site 51

Figure 109: River red gum plantings at site 51

8.15.1.1 Weeds

Weed management occurred throughout HVO in 2019 and included the Carrington Billabong and areas of lesser priority where the River Red Gums are being protected. While the control efforts concentrated on chemical control methods, manual control of small areas was also undertaken.

In 2019, Rural Environmental Management (REM) were engaged to undertake a weed survey in areas across HVO. The areas surveyed included the River Red Gum areas identified in the Strategy. The findings of the survey were compared to a similar survey undertaken in 2018 and determined that there were 27 weed species identified across HVO in 2019 compared to 38 species in 2018. The significant reduction in weed species numbers can largely be attributed to an extended drought period as well as targeted control of priority weeds and follow up treatment of regrowth.

There were no new weed species observed in this year's survey however it is anticipated that several species which have been drought affected will re-emerge after significant rain events. Vigilant monitoring and follow up treatment is being undertaken to ensure new infestations of priority weeds are kept at bay.

A significant decrease in density and distribution of weed species is evident where concentrated treatment has been carried out, examples include African boxthorn in the Lemington South RRG area. Weed control programs, climatic conditions and general mining operations have been successful in eradicating or preventing heavy reinfestation of several high priority weeds from HVO during 2018 and 2019 that were present in previous surveys but not evident in this year's survey results. This includes Bathurst burr, bitou bush, fireweed, lantana, Noogoora burr, St John's Wort and tree of heaven.

In the 2019 survey, Galenia remains the dominant weed species in the Carrington area with the weed sparsely scattered over a large portion of the site The large infestation in Carrington North now contains sparsely scattered African boxthorn growing amongst it, which has emerged during 2019 (Figure 110). Weed control in this area will continue during 2020.

The Carrington Billabong was treated prior to the 2018 weed survey being carried out and therefore weeds were at a minimum during that survey. Being a low lying area on alluvial soils, weed management is an ongoing issue for the Billabong. Various juvenile weeds have sprouted during 2019 and are scattered throughout the area. The billabong is scheduled for re-treatment during early 2020.

Various weeds were present in the southern Lemington South River Red Gum (RRG) area during the 2018 survey, but have since been treated and the area was reported to be largely clear of weeds for the 2019 survey (Figure 111). Monitoring and treatment of regrowth in this area will be scheduled for early to mid-2020.

Similarly, the African boxthorn infestation in the northern Lemington South RRG has also been treated during 2018 and weeds in the area were negligible for the 2019 survey (Figure 111). Monitoring and follow up treatment of weed regrowth will also be scheduled for early to mid-2020. The new infestation of African boxthorn along the entrance road to South Lemington that has emerged this year is testament to the weed's highly invasive and aggressive nature.

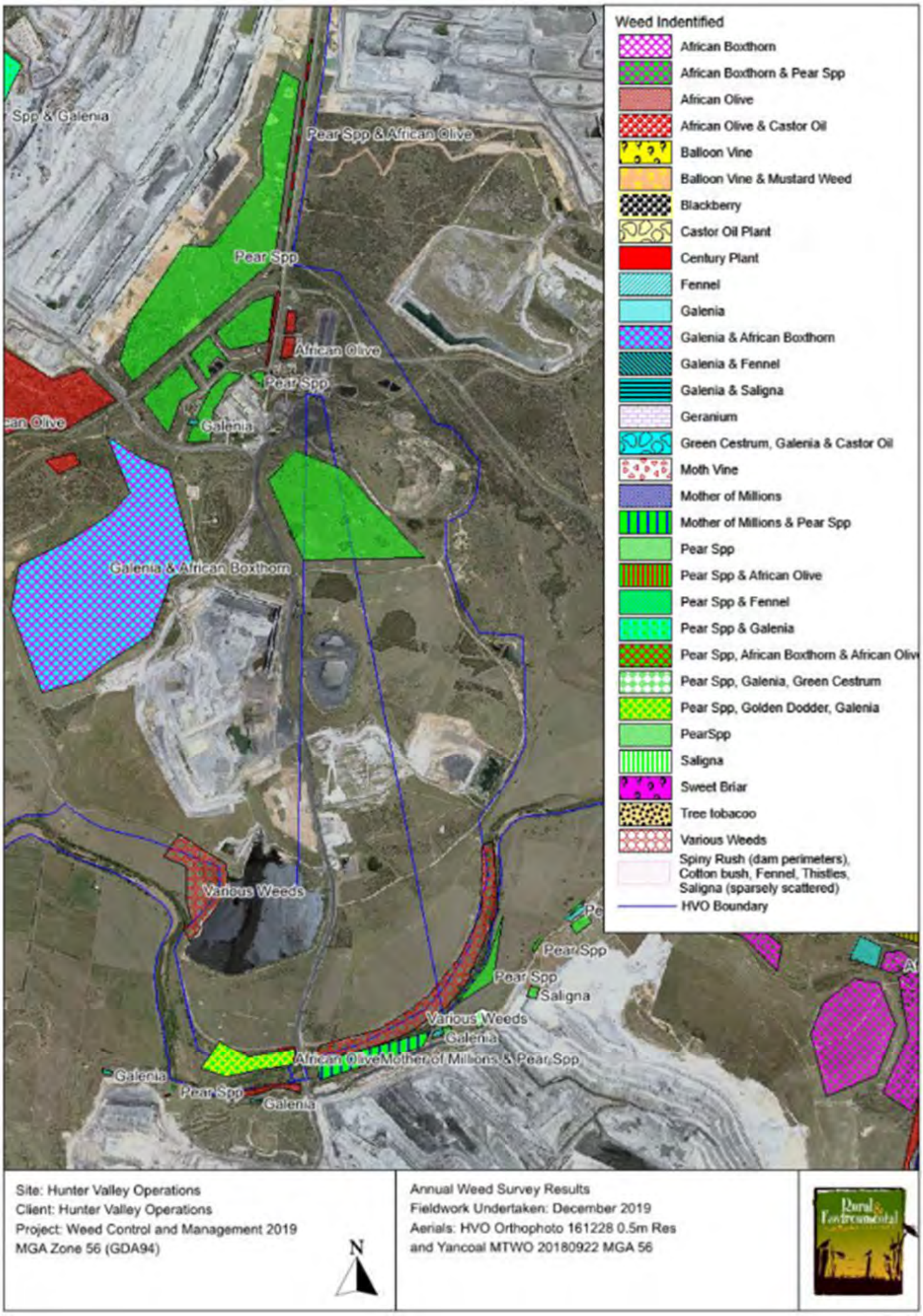


Figure 110: HVO 2019 weed survey results – Carrington

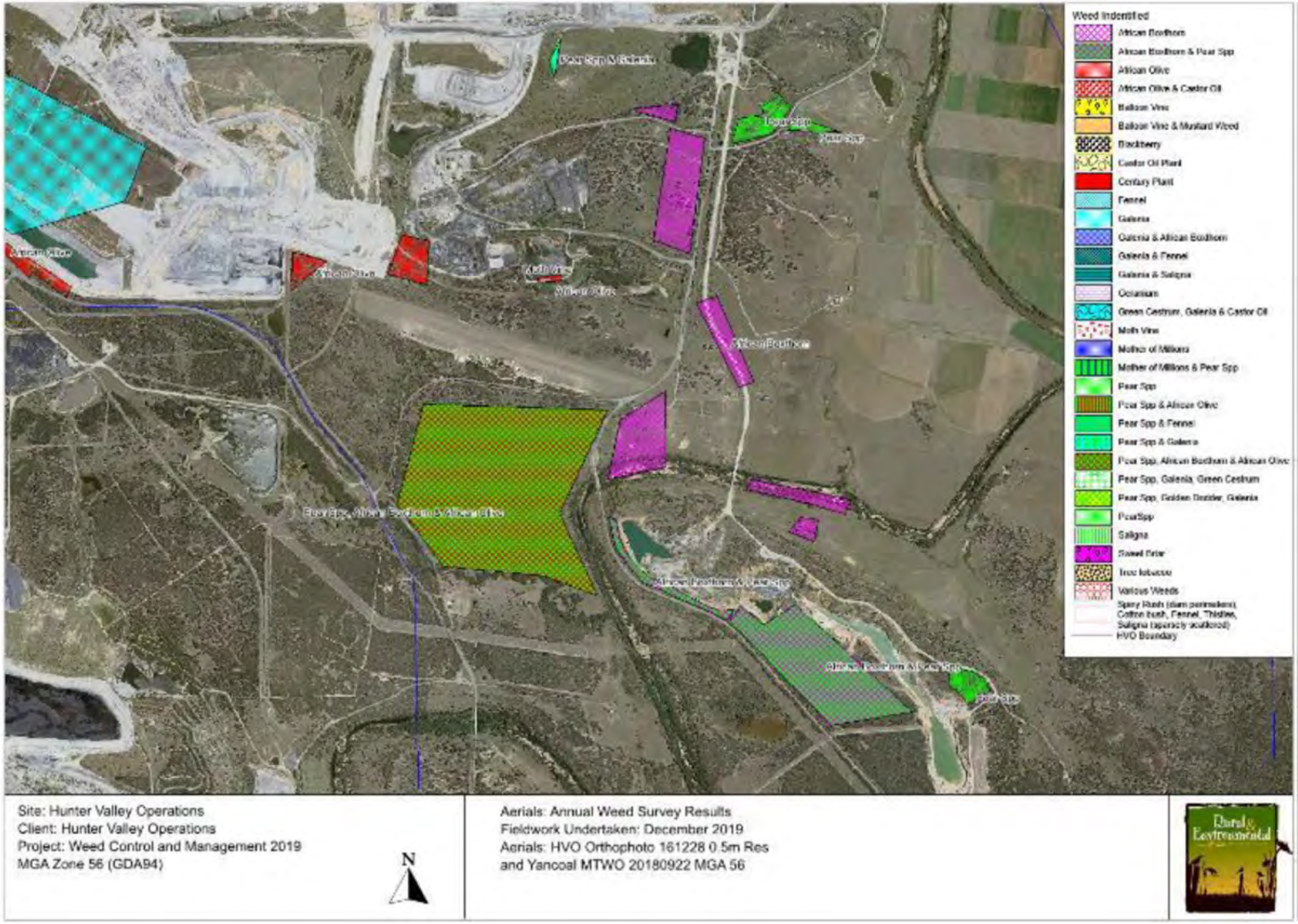


Figure 111: HVO 2019 weed survey results – Lemington

8.15.1.2 Vertebrate Pest Control

Fencing around the Carrington billabong has remained intact and is regularly checked to ensure grazing animals are excluded, or actively discouraged, from the area. Additional areas are scheduled to be assessed and, if required, fenced during 2020. This review of HVO fencing requirements will be reported in the 2020 Annual Review.

As part of HVO's Vertebrate Pest Action Plan, baiting programmes are carried out on a seasonal basis. These programmes are conducted at a level of frequency designed to disrupt pest species breeding/colonisation cycles and employ a variety of methodologies including baiting, trapping and ground based shooting. Further detail on vertebrate pest control undertaken in 2019 is included in Section 8.10.

8.15.1.3 River Red Gum Monitoring

During 2019, monitoring of River Red Gum Management areas included annual weed surveys within the Carrington Billabong and other River Red Gum priority sites. Groundwater monitoring continued in the Carrington Billabong area, these results are presented in the groundwater section of this report.

The River Red Gum Rehabilitation and Restoration Strategy is currently being updated and additional ecological monitoring is scheduled to commence in 2020.

8.16 Biodiversity Offsets

8.16.1 Goulburn River Biodiversity Area Overview

The Hunter Valley Operation Mine's impacts on biodiversity values are offset through the protection and management of Biodiversity Areas (BAs). The BA that relate to HVO PA 06_0261 is the Goulburn River which has an offset area of 140 hectares.

HVO manage a number of other offsets including Wandewoi, Condon View and Mitchelhill, however, these are managed under EPBC approval 2016/7640, are subject to compliance reporting under that approval and are not subject to further discussion in this document.

The Goulburn River BA is located near the town of Merriwa and, when considered in combination with the adjoining offset for the Warkworth Mine, forms an area of protected vegetation extending from the Goulburn River National Park (Figure 112). The Goulburn River BA is managed according to the Goulburn River Management Plan version 2 that is available on the HVO public website (https://insite.hvo.com.au).

Given that the offsets for the Warkworth Mine and HVO are adjacent to each other and that both parties have a common managing partner in Yancoal, HVO and the Warkworth Mine have an agreement that the HVO BA will be managed by the Warkworth Mine on its behalf under a cost recovery agreement. The benefit of this agreement is a reduction in duplication related to the management and monitoring activities that are undertaken by consultants and contractors. As such, while many of the figures presented below will include information relating to the Warkworth Mine, the text will focus on the data and activities originating from the HVO BA.

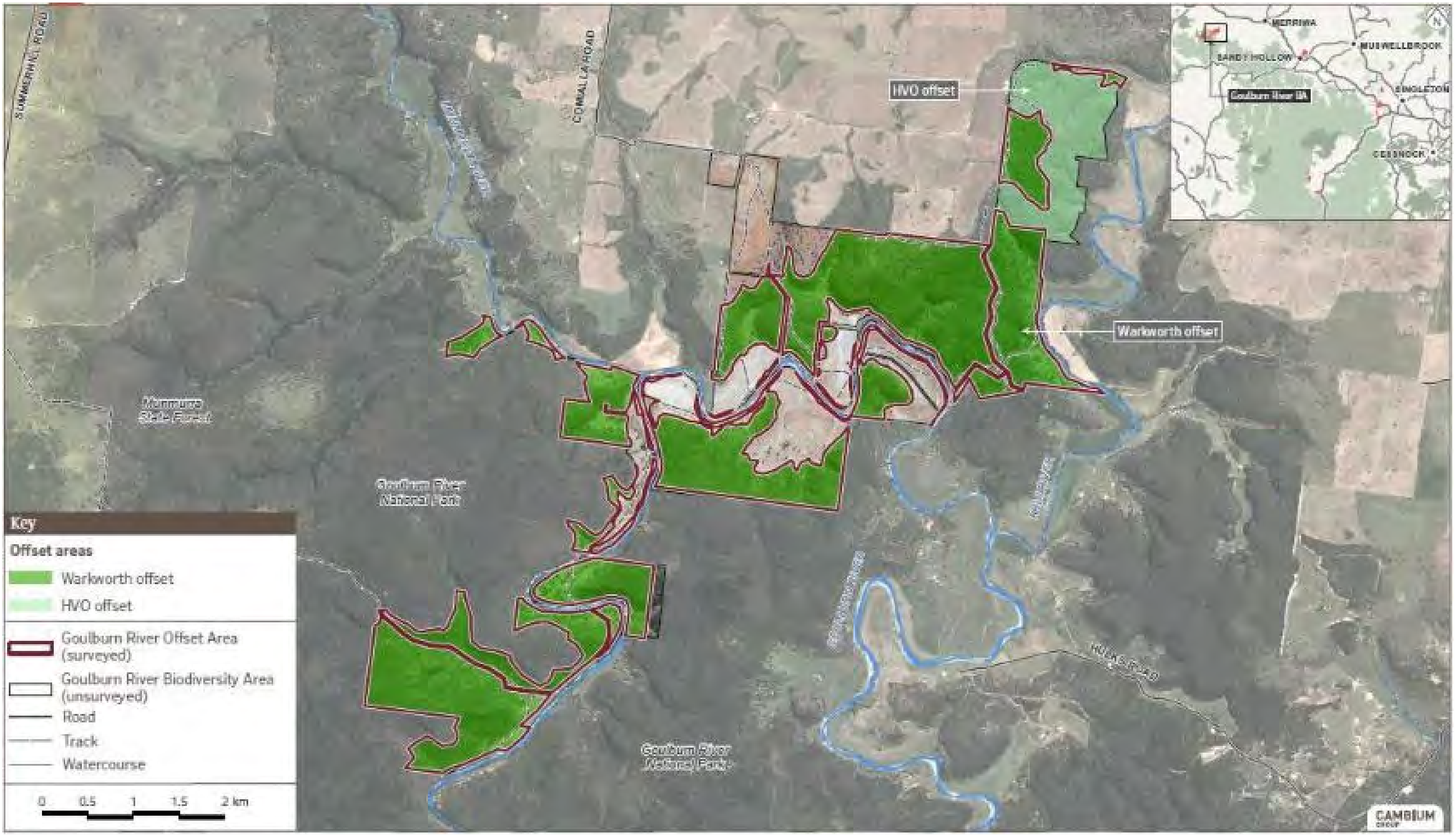


Figure 112: HVO's Goulburn River Offset and adjoining Warkworth Mine offset

8.16.2 Weather Records

Overall, the rainfall recorded at the closest weather station to the Goulburn River BA was significantly down on the average total rainfall (Figure 113). During 2019, the Merriwa region received 237mm which is 40% of the mean average rainfall for the area that has been recorded since 1969. These results were typical of rainfall records across the Hunter Valley during 2019.

As can be seen in Figure 113, the area received a significant rainfall event in March 2019 where the monthly rainfall received was double the monthly mean. The 40% reduction in the annual rainfall received would have been even less if the March average reflected the decline in rainfall received across the rest of the year.

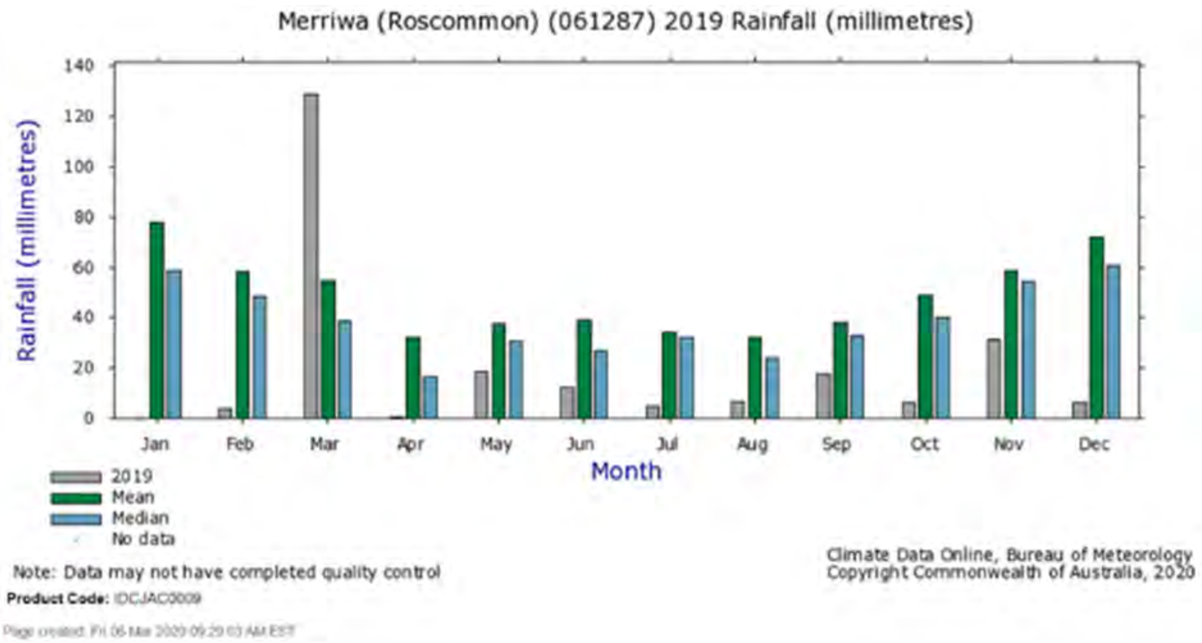


Figure 113: Rainfall records recorded at the Merriwa (Roscommon) gauge - 2019.

8.16.3 Biodiversity Area Management Activities

Various management activities were undertaken at the Goulburn River BA throughout 2019 in accordance with the approved management plan. These activities included weed control, vertebrate pest control and monitoring activities. A summary of the key actions in the BA throughout 2019 is outlined in Table 69 below and discussed further in the text.

Table 69 Biodiversity Area Management Activities 2019

Activity	Description
Weed Control	Weed control activities were conducted at the Goulburn River Biodiversity Area.
Infrastructure Management and Improvement	Monthly property infrastructure inspections were undertaken at the Goulburn River Biodiversity Area in 2019.
Fire Management	Bushfire management consultants LRM were appointed to review the Goulburn River Biodiversity Area, Bushfire Management plan and prepare an updated individual biodiversity Area Bushfire Management Plan in 2019.
Strategic Grazing	Strategic grazing activities did not take place during the 2019 reporting period.

Activity	Description
Vertebrate Pest Management	The 1080 ground baiting programmes were undertaken in autumn and spring at Goulburn River BA targeting wild dogs and foxes. Baits were checked over a two week period and replaced each week when taken. Vertebrate pest management programmes will continue to be implemented during 2020 to limit feral pest impacts on landholdings and surrounding neighbours.

8.16.3.1 Wild Dog and Fox Baiting Programmes

In 2019, vertebrate pest management programmes were undertaken during autumn and spring 2019. Figure 114 and Figure 115 illustrate the baiting location across the HVO and MTW Goulburn River offsets that were covered by the programmes.

The programme targeted wild dogs (*Canis lupus familiaris*) and foxes (*Vulpes vulpes*) and some opportunistic shooting of feral pigs occurred within the MTW section of the BA. As the pig shooting did not occur within the HVO BA, this activity is not discussed further in this report.

The vertebrate pest management programme involved 1080 baiting including ejector baiting stations. The program was run in conjunction with the Local Land Services (LLS) and surrounding landholders.

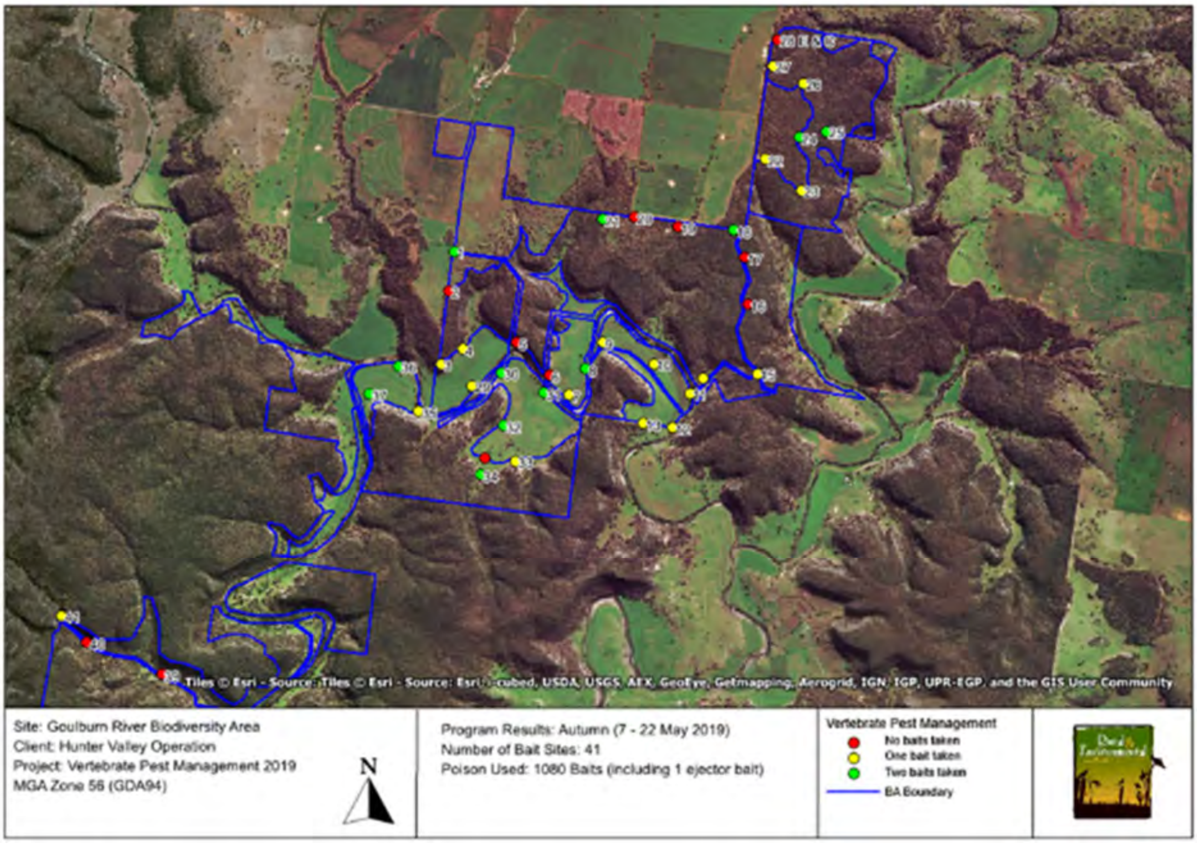


Figure 114: Vertebrate pest baiting results undertaken within the Goulburn River BA - Autumn 2019

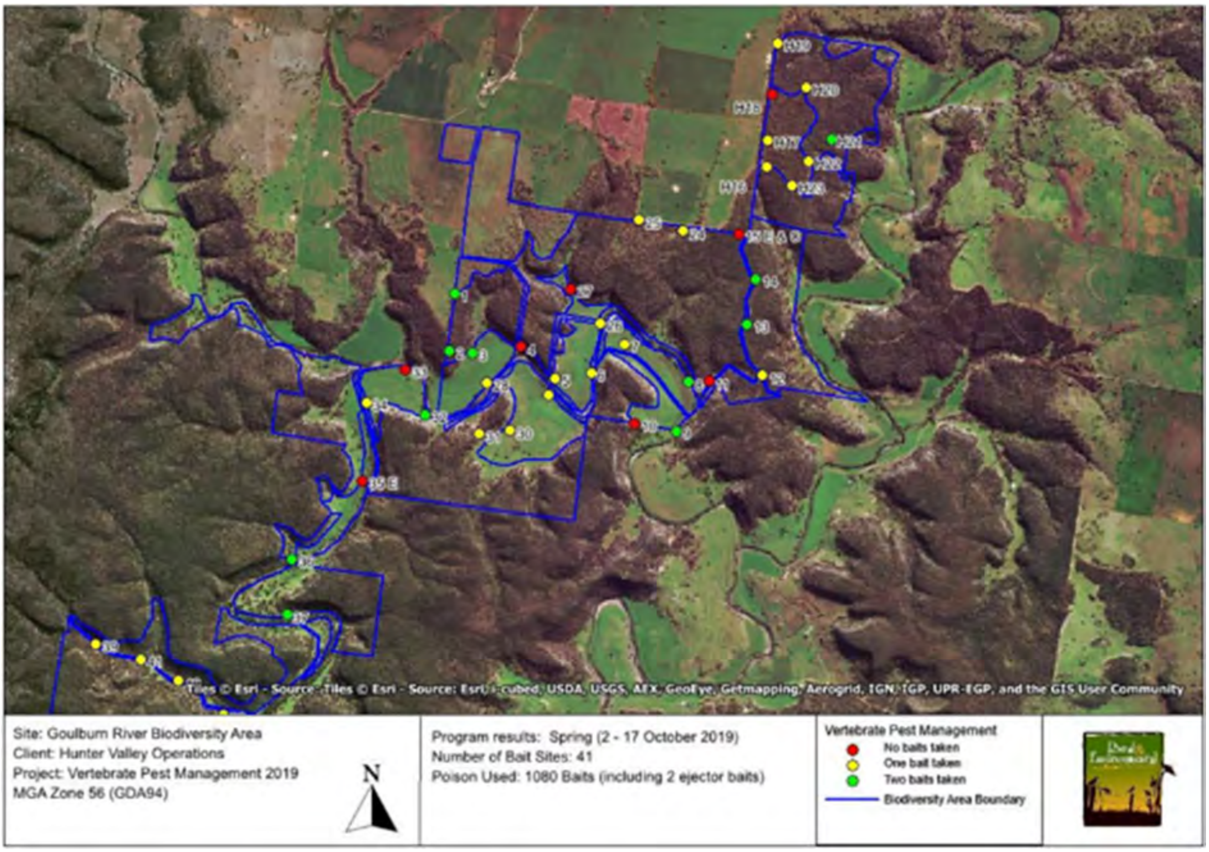


Figure 115: Vertebrate pest baiting results undertaken within the Goulburn River BA - Spring 2019

Table 70 provides a comparison of results for all vertebrate pest management programs for the Goulburn River Biodiversity Area from 2015 to 2019. The discussion below relates to the data in Table 70.

For the 41 bait sites established at Goulburn River BA, baits were taken at least once from 33 (79%) of the bait sites with 44 baits taken overall. Eleven sites had baits taken on both checks and eight sites had no baits taken throughout the program. No sites had baits 'disturbed but not taken (DNT)'. Baits taken at each site are shown in Figure 116.

Track, scat and foraging evidence indicated that 11 (25%) of baits were consumed by dogs of various sizes; nine (20%) were consumed by foxes (12%) and 24 were consumed by non-target species. Results indicate lace monitors (*Varanus various*) took 20 baits and wild pigs (*Sus scrofa*) took four.

Two ejector baits were set up at Ejector Bait Sites 15 and 35. Neither of the ejectors were activated during the program, however the motion sensor camera established at Ejector Bait Site 15 captured images of several vertebrate pest species including a wild dog, hares (*Lepus europaeus*), a feral cat (*Felis catus*) and a wild boar. Native species photographed included several kangaroos (*Macropus* spp), an echidna (*Tachyglossus aculeatus*) and an emu (*Dromaius novaehollandiae*).

The Baiting efficiency calculated in 2019 for Goulburn River BA shows a baiting efficiency of 54% which is consistent with previous programs. The Baiting Efficiency (excluding non-target species) was calculated at 45% for the current programme which is relatively consistent with previous programmes. Evidence of takes by non-target species increased from 12% in the last program to 55% in this program. Takes by foxes at 20% remained consistent with previous programs and takes by wild dogs decreased by over 40% from the last program.

Table 70 Comparison of results - Goulburn River Biodiversity Area.

Baiting Program	No. of Baiting Sites	Baiting Opportunities	Baits taken by Dogs	Dog (%)	Baits taken by Foxes	Fox (%)	Baits taken by other (non-target) species	Other (%)	Total No. of Baits Taken	No. Sites where baits taken at least once	Represented as Percentage (%)	No. sites with baits taken on all occasions	No. sites with no baits taken	No. baits Disturbed Not Taken	No. baits taken alternatively by Dog or Fox	Baiting Efficiency %	Baiting efficiency excluding 'other' %
Jun 2015 GOU	28	84	27	54	17	34	6	12	50	26	96	8	2	2	10	60	52
Oct 2015 GOU	40	120	30	38	31	40	17	22	78	37	92	13	3	0	9	65	51
May 2016 GOU	44	132	36	44	30	37	15	18	81	41	93	11	3	8	5	61	50
Sep 2016 GOU	32	65	15	68	5	23	2	9	22	19	86	0	13	6	1	34	31
Sep 2017 GOU	42	84	19	38	11	22	20	40	50	34	81	16	8	3	3	60	36
Jun 2018 GOU	42	84	39	76	8	16	4	8	51	32	76	19	10	2	3	61	56
Sep 2018 GOU	43	86	21	40	12	23	19	37	52	36	84	18	8	3	1	60	38
May 2019 GOU	41	78	27	64	10	24	5	12	42	30	73	12	11	6	4	54	47
Oct 2019 GOU	41	82	11	25	9	20	24	55	44	33	79	11	8	0	3	54	45

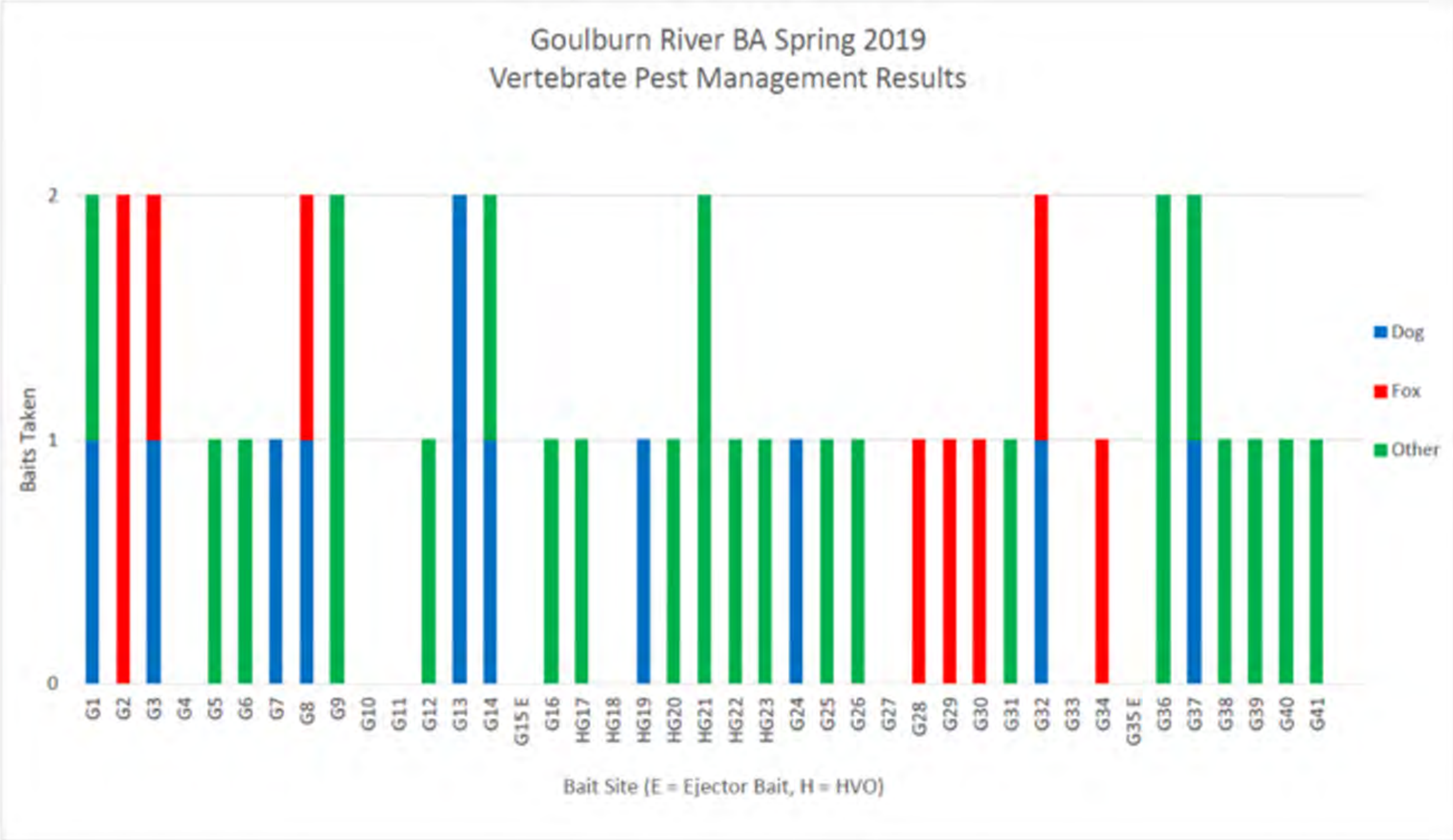


Figure 116: Baits taken from sites established at Goulburn River BA (Sites G1 to G41) - Spring 2019

Note that the sites applicable to the HVO BA are bait sites H16, H19 – H23.

9 Community

9.1 Complaints

HVO provides a 24 hour Community Complaints Hotline (via freecall number 1800 888 733) for community members to comment on concerns relating to its operations. All complaint details are recorded in a database in accordance with Condition M4.2 of Environmental Protection Licence 640 and made available on HVO's website (https://insite.hvo.com.au).

A total of 9 complaints were received by HVO during 2019 (Figure 117). This represents a decrease of 17 community complaints from the previous year (Figure 118). Complaints were received in relation to blasting, air quality and a property accessibility issue. Details of complaints received in 2019 are included in Table 71

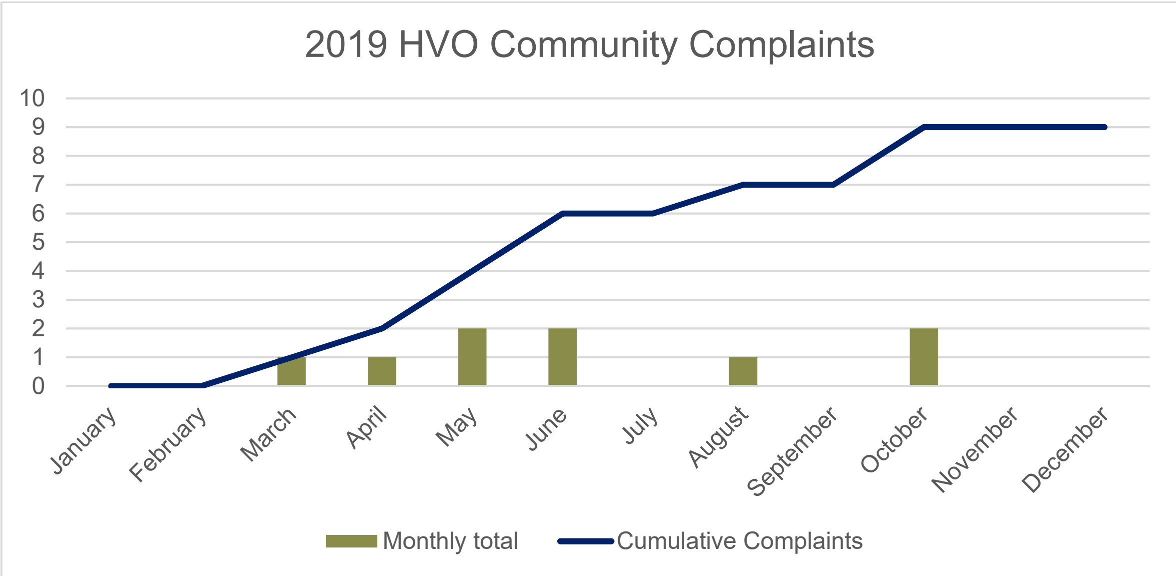


Figure 117 Summary of Community Complaints in 2019

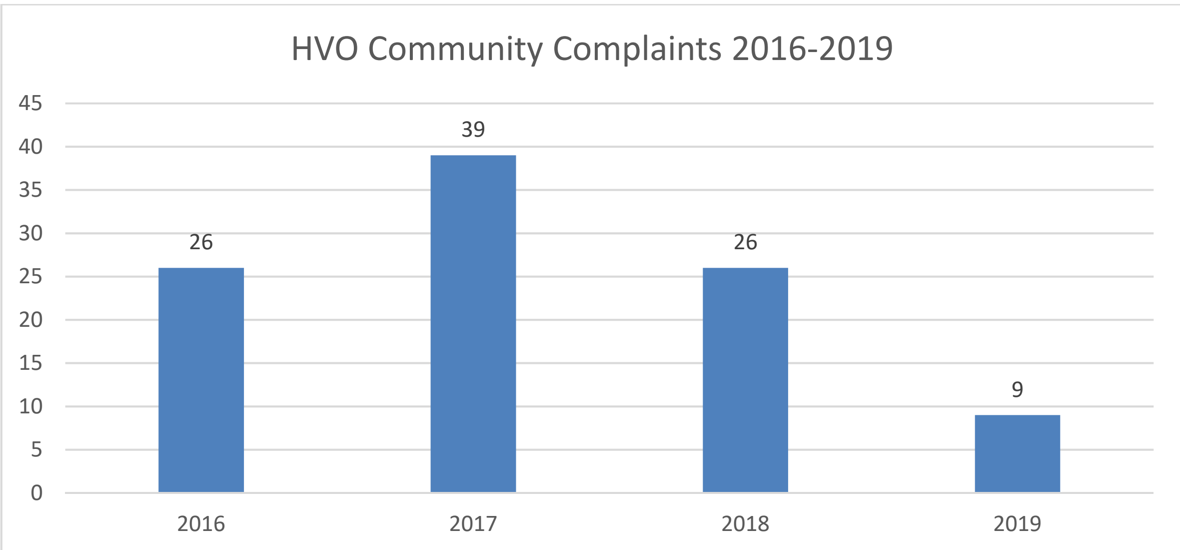


Figure 118 Community Complaints 2016 – 2019

Table 71 Details of Complaints Received in 2019

Date	Type	Description	Follow Up Action
06/03/2019	Air Quality	Complaint reported anonymously to EPA Duty Officer about HVO in relation to dust.	A number of actions were taken by HVO to mitigate dust including working lower in the pit, shutting down various earthmoving equipment and postponing a scheduled blast. Note: 6th of March was affected by regional dust.
29/04/2019	Air Quality	Complainant called HVO in regards to the level of dust recorded on the Upper Hunter Air Quality Monitoring Network (UHAQMN) at the time in Maison Dieu, and was querying what HVO was doing to manage this increased level of dust.	Complainant was called to receive more details of the complaint. Meteorological data was checked to determine the wind direction and found that there was an easterly/ south-easterly wind, blowing dust towards HVO, not in the direction to Maison Dieu. Operational data was then checked and confirmed that there were seven water trucks running and that three dust alarms had activated prior to the complaint. This information was then passed on to the complainant.
27/05/2019	Air Quality	Complainant telephoned neighbouring mine - Mount Thorley Warkworth to complain about high levels of dust on Lemington Road within the vicinity of HVO's West Pit. Complaint was then passed on to the HVO Environment and Community Officer	Complainant was called to obtain further details regarding where the dust was observed. Following this, West Pit was inspected for dust. It was noted that conditions were very windy. There was no visible equipment running and no wind-blown dust visible from the Western side of Pit. A further dust inspection was undertaken on Lemington Road not long after receiving the complaint where no dust was observed coming from West Pit over Lemington Road during this inspection.
27/05/2019	Air Quality	Complaint was received by EPA public complaint hotline regarding dust coming from South Pit, affecting a resident in Long Point Road. Complainant noted extremely dusty conditions on the 26 and 27 of May 2019.	A Environmental alert was received from Knodlers Lane in Maison Dieu at 9.16am, resulting in the OCE being alerted and all load units (except excavator 316 and three trucks deep in the pit) being shut down. In addition, five water trucks were in circulation.
06/06/2019	Blast	Complaint reported anonymously to Department of Planning, Infrastructure and Environment (DPIE) regarding blast odour and fume at HVO.	HVO provided details of blast to DPIE that included time of blast, observations of blast fume, category of blast fume (3B) and photos of blast. No further action was taken (or requested to be taken by DPIE).
26/06/2019	Air Quality	Complainant called the HVO complaints line to complain about the dust being emitted from the mine following a blast in the Riverview Pit. The complainant noted that they reside on a property off the Golden Highway (Jerrys Plains).	Video footage (and met conditions) of the blast indicated a visible dust plume crossed the mine boundary however it was dispersing as it tracked westwards. The video footage was insufficient to track the dust plumes path offsite however, based on wind direction at the time, it is possible the dust plume would have travelled in the general direction of the resident located about 4km from the blast. Based on this, no further action was taken.
12/08/2019	Other	Complaint made by licensee regarding a gate being left unlocked into a Traveling Stock Route (TSR), adjacent to HVO's Riverview pit. The licensee grazes cattle inside the area and was concerned about cattle escaping via the unlocked gate.	HVO Environment and Community Manager contacted the complainant to understand concerns and made assurances that HVO would rectify the situation. HVO fitted a new security lock to the gate (type that requires lock to be closed in order to remove key). In addition a photograph of the closed locked is taken and send to the Environment and Community Manager post

Date	Type	Description	Follow Up Action
			blasting as evidence that the gate has been locked following each blast.
04/10/2019	Air Quality	Complainant called regarding their concern about dust coming from HVO onto their property in Maison Dieu.	The complainant was advised that the Mining Supervisor had conducted a field inspection and reported that four water carts were in circulation. Additionally, two shovels and an excavator at Cheshunt has stopped running and the proposed blast at Riverview had been postponed.
30/10/2019	Blast	Complainant called to advise they could smell a blast fume and observed a dust plume passing across the Maison Dieu river flats	Meteorological conditions were verified to be in line with HVO's blasting permission process. A minor fume was noted following the blast which was ranked as 1A. Dust monitors were checked which identified an isolated spike in dust at time noted by complainant. The complainant was called and was advised that HVO had waited for the most favourable wind conditions and the shot was fired within blasting permissions. The complainant was satisfied with the response and therefore no further action was required.

9.2 Review of Community Engagement

9.2.1 Communication

Three newsletters were sent to HVO's near neighbours during 2019 providing an overview of:

- Operational updates;
- Environmental activities such as aerial seeding activities, feral pest management programme;
- Community initiatives such as near neighbour first aid training, donation and sponsorship programme; and
- Communication tools – InSite website, environmental monitoring public reporting website and the blast notification SMS alert system.

In May and November, HVO hosted community information session's for near neighbours at Maison Dieu and Jerrys Plains aimed at providing community members with an opportunity to speak with HVO representatives about current operations and future plans, The sessions were attended by residents from Maison Dieu and Jerrys Plains as well as members from HVO's Senior Leadership Team.

9.2.2 Consultation and Engagement Activities

A range of consultation and engagement activities were also completed, including:

- Engagement with a number of Maison Dieu residents to discuss the proposed exploration drilling on EL5291;
- HVO hosted site tours from a number of high schools in the Hunter Valley; and
- School engagement - including Singleton High School roundtable interviews and support of Jerrys Plains Primary School pre-school programme.

HVO continued to encourage the community to contact the company in a way that suits the individual community members.

9.2.3 Community Consultative Committee

The HVO CCC meetings were held in February, May, August and November 2019. The HVO CCC meet to discuss operations, projects and mine activities. The Committee is comprised of HVO representatives, community members and other key external stakeholders, including Council. The HVO CCC minutes are available on the HVO website (https://insite.hvo.com.au/document-library/ccc). The community is invited to visit the website(s) to learn more about the HVO CCC.

In 2019 CCC members included:

- Dr Colin Gellatly (Independent chairperson);
- Cr Hollee Jenkins;
- Dr Neville Hodkinson;
- Mrs Janelle Wenham
- Mr David Love;
- Mr Brian Atfield;
- Mrs Di Gee;
- Mr Todd Mills;
- Mr Michael Wellard;
- Mrs Jeanie Hayes;
- Mrs Sarah Purser (minute taker);
- HVO General Manager – Mr Tony Galvin
- HVO Operations Manager – Philip Price
- HVO Environment & Community Manager – Mr Andrew Speechly

9.2.4 Community Grants

HVO supports applications for local donations and sponsorships that have a clear community benefit. In 2019, HVO provided $67,300 to 22 local projects and initiatives, including:

1. Camp Quality – Camp Quality 1000ks 4 kids
2. Singleton Theatrical Society – 2019 Production of Les Miserables
3. Singleton PCYC – Singleton PCYC Open Day
4. Singleton Heights Pre-School Inc – Outdoor Classroom Project
5. Singleton Council- Singleton Community Vehicle Messaging Sign
6. Westpac Rescue Helicopter Service- 2019 Hunter Valley Mining Charity Rugby League Day
7. Singleton Bowling Club Co-operative Limited- Graded Triples Tournament
8. Singleton Pony Club – Portable Horse Yards
9. Singleton Council - Blast
10. Singleton Tri Club – Equipment Upgrade
11. Singleton Council - International Day for People with Disability IDPWD - Bush Dinner Dance
12. Singleton Rugby Club - Field Maintenance Equipment Upgrade
13. Jerrys Plains School of Arts Hall Inc. – New BBQ
14. CWA – Kitchen Upgrade
15. Singleton Australian Football Club – Medical and sports training supplies
16. Australian Stock Horse Society Eastern Branch – Eastern Branch ASHS Championship and Performance Weekend
17. St Catherine’s Catholic College – Chill Out Space
18. Early Links Inclusion Support Service – Little Yogi’s
19. Singleton Girl Guides – Kitchen Improvement/Upgrade
20. Australian Christian College Singleton – Share the Love of Reading
21. Hunter Valley Camp Draft Club – 2019 Hunter Valley Camp Draft
22. Singleton Fire Brigade Social Club – Singleton Lolly Run

HVO also continued its partnership with Jerrys Plains Public School providing funding for their pre-school programme.

10 Independent Audit

An Independent Environmental Audit (IEA) was undertaken in December 2019. This audit was undertaken against the conditions of both Project Approval PA06-0261 (as modified) and DA 450-10-2003 (as modified). The audit also assessed compliance with other licences and approvals including:

- HVO North - EPL 640 and associated Water Access Licences; and
- HVO South – EPL 640 and relevant mining/coal leases including ML1634, ML1465, ML1734, ML1753, ML1682, CL398 and CCL714.

Environmental consultant's Hansen Bailey were engaged and endorsed by DPIE as suitably qualified, independent experts to undertake the audit. The timeframe for the audit was from 1 November 2016 to 1 December 2019. The site inspection component of the audit was undertaken over four days between 2 and 5 December 2019.

The audit report and HVO's response to the auditors' recommendations were submitted to the Department for their consideration on 24 February 2020. At the time of publishing this Annual Review the findings of the audit are still to be finalised with DPIE.

The audit identified 28 non-compliances, one was identified as a moderate risk, 15 were administrative in nature and 12 findings were considered to be low risk. These findings along with the auditor's recommendation and HVO's response to recommendation are summarised in Table 72. Where non-compliances have been identified as relevant to activities that occurred during 2019, these have been identified in the Statement of Compliance in Table 2. The next Independent Environmental Audit is due in 2022.

Table 72: Independent Environmental Audit Findings and Recommendations – 2019

Reference	Audit Finding	Risk Rating	Auditors Recommendation	HVO Response	Timing
HVO South – PA 06_0261 Non-Compliance Recommendations					
Sch 2 Cond 2a	Some non-compliances were identified with the conditions of this approval	Administrative	Work with DPIE to comply with conditions in **Error! Reference source not found.** of the IEA Report where practical.	Actions to address non compliances are committed to via HVO's response to recommendations.	-
Sch 2 Cond 15	Sch 3 Cond 60 no evidence of correspondence with Singleton Council or NSW RFS in relation to consultation on the Bush Fire Management Plan has been provided.	Administrative	Ensure consultation with Singleton Council and RFS over the Bushfire Management Plan as per Schedule 3 Condition 30.	Council and RFS have been consulted on the revised version since the audit and this will be included in the plan once finalised.	30/06/2020
Sch 3 Cond 7	Measured overpressure levels exceeded the 120dbL criterion at two locations (Moses Crossing, Jerrys Plains) on 17 January 2018.	Low	Bridges Acoustic recommends to avoid possible overpressure reflection from the control building and resultant uncertainty regarding overpressure levels, the second Maison Dieu monitor should be considered the primary monitor in this area.	HVO has since received confirmation from DPIE that its relocation approved. HVO is currently seeking approval from the EPA for the relocation as part of the five yearly licence review and will permanently relocate the monitor once approval is received.	TBA – pending EPA response.
Sch 3 Cond 10	One blast on Easter Saturday 2017 (which was officially considered a public holiday in 2017).	Administrative	No recommendation provided		
Sch 3 Cond 19	The measurement on 29/07/17 at the Gliding Club was determined to be non-compliant at 58 µg/m3 (with HVO contribution being 85% against the maximum contribution limit of 75% in accordance with the approved AQMP at the time). Incident was reported to the HVGC and DPIE.	Low	Dust deposition gauges at DL30 and Warkworth; and PM10 monitors at Knodlers Lane and Long Point be reconsidered as to their appropriateness as representative of private receivers (occur outside EA predictions of exceedance of criteria) as they are exceeding annual average results during the IEA period (however stated not due to HVO activities and not reported consistent with approved AQMP). As Knodlers Lane and Long Point monitoring sites occur within exceedance predictions for PM10 in the MOD5 assessment, it is likely that they will exceed on a continuous basis. HVO advises that DG will remain as internal management sites, not compliance as per Table 5 of the AQMP.	The current approved AQMP identifies which DDG are utilised as a measure of compliance, HVO considers this issue to now be addressed in the current AQMP.	Complete

Reference	Audit Finding	Risk Rating	Auditors Recommendation	HVO Response	Timing
			Internal procedures and relevant training be updated for change to AQMP which changes reportable circumstances for PM10 24 hr consistent with the updated AQMP Section 9. HVO advises this is proposed.		
Sch 3 Cond 28	No confirmation that CLWD (now DoI Water) received the 2017 Annual Review.	Administrative	No recommendation provided		
Sch 3 Cond 30 31	No evidence to confirm all River Red Gum sites (as shown in Appendix 8) have addressed management practices listed in the River Red Gum Strategy (2010).	Low	River Red Gum Strategy: • Add confirmation in the Annual Review over what areas of the Goulburn River Biodiversity areas have been addressed (in order to confirm HVO's 140 ha is compliant). • Recommend any revision to the Strategy include consultation with DoI Water and OEH. Recommend holistic review of actions in light of future mining in the immediate area and likely impacts, flooding potential, climate, groundwater and surface water monitoring, and ecological monitoring to determine a realistic way forward in relation to the management of the area which has been inconclusive to date. DPIE should be consulted in relation to findings and way forward to ensure satisfaction secured.	Dot point one – HVO will address this in future Annual Reviews Dot Point two and three – The strategy is currently under review and HVO will include evidence of relevant consultation in next revision.	2020 AEMR – 31/03/2021 30/06/2020
Sch 3 Cond 40	One compliance inspection per year has been completed rather than two as required within the approved ACHMP (2009) for 2018 and 2017.	Administrative	No recommendation provided		
Sch 3 Cond 48	Overburden emplacement area (OEA) in the Glider Pit was approximately 10 m above the Obstacle Limitation Surface without obtaining prior approval from the HVGC. This was reported and OEA reshaped to remediate issue.	Low	No recommendation provided		

Reference	Audit Finding	Risk Rating	Auditors Recommendation	HVO Response	Timing
Sch 3 Cond 53	Northstar advises that whilst a number of the actions undertaken by HVO may have some impact on the annualised GHG emission budget, these have not been presented in context of assessing all reasonable and feasible options.	Low	Northstar recommends that the AQMP Section 7 is updated to identify opportunities for emission reductions (in the reasonable and feasible areas of electricity use, diesel and other fuels, and Land Management. The Annual Review should include a summary of greenhouse gas emissions against commitments in AQMP.	The current AQMP discuss' Greenhouse Gas Management and as such no further modification to the AQMP is considered necessary HVO will recommence reporting in the Annual Review greenhouse gas emission summary information against the AQMP.	2020 AEMR - 31/03/2021
Sch 3 Cond 60	No evidence available of consultation with Singleton Council or the RFS.	Administrative	Obtain correspondence from Council and Rural Fire Service confirming consultation and add to appendix at next review of the Bushfire Management Plan.	Council and RFS have been consulted on the revised version since the audit and this will be included in the plan once finalised.	30/06/2020
Sch 4 Cond 2	Notification of relevant landholders regarding the blasting exceedance - measured overpressure levels exceeded the 120 dBL criterion at two locations (Moses Crossing, Jerrys Plains) on 17 January 2018 (refer to Sch 3 Cond 7) was sent on 27/11/19, however was outside the required 2-week notification timeframe.	Administrative	Update process to notify affected landholders for exceedances of air and blasting.	HVO has developed a post incident (exceedance) checklist which is to ensure that landowners and/or tenants are notified as required.	Complete
Sch 5 Cond 1a	Management plans do not contain all required sections. Refer to Sch 5 Cond 1a for further detail.	Administrative	At the next required revision to relevant management plans (none urgent) ensure all items within Sch 5 Cond 1a are addressed.	HVO does not consider this to be non-compliant in accordance with the footnote of the condition that the Secretary may waive some of the requirements required by the condition if they are unnecessary or unwarranted for particular management plans. HVO considers the Secretary's approval of the plans is Approval of these Waivers. Nonetheless, HVO will review this for adequacy in the next revision of each relevant management plan.	30/06/2020
Sch 5 Cond 4a	No evidence available to confirm reviews of strategies, plans and programs conducted on each occasion listed in this condition. However, all plans have been	Administrative	No recommendation provided		

Reference	Audit Finding	Risk Rating	Auditors Recommendation	HVO Response	Timing
	updated in the audit period except for the following: • HVO South Aboriginal Cultural Heritage Management Plan (May 2009); • Amenity Management Plan-Hunter Valley Gliding Club (October 2012); and River Red Gum Rehabilitation and Restoration Strategy (March 2010).				
App4 A.4	Bridges Acoustics notes the NMP and noise monitoring reports do not assess and correct for (or do not report) tonal noise as required by the NSW Industrial Noise Policy and later Noise Policy for Industry.	Low	Tonal noise should be included in the noise monitoring reports and the NMP on its next revision.	HVO's noise monitoring consultant's monitoring reports indicate that intermittent or tonal features are not typically present in mining operational noise and the assessment is not undertaken on this basis. However, HVO will request this inclusion to noise monitoring reports developed by the noise monitoring consultant.	30/04/2020
SOC Ref 11	No evidence exists that collection and storage of River Red Gum seed from existing stands is occurring.	Low	Collect seed from River Red Gum area or justify why not possible/required in revised BMP.	Seed collection will occur during 2020 if available.	20/12/2020
HVO North - DA 450-10-2003 Non-Compliance Recommendations					
Sch 2 Cond 2a	Some non-compliances were identified with the conditions of this approval.	Administrative	Work with DPIE to comply with non-compliances in **Error! Reference source not found.** of the IEA Report, where practical.	Actions to address non compliances are committed to via HVO's response to recommendations.	-
Sch 2 Cond 15	Sch 3 Cond 61 no evidence of correspondence with Singleton Council or NSW RFS in relation to consultation on the Bushfire Management Plan was available.	Administrative	Ensure consultation with relevant regulators occurs for all management plans, or justify why not required in plan (e.g. administrative changes).	Noted	-
Sch 3 Cond 4	As per PA 06_0261 Sch 3 Cond 53.	Low	As per PA 06_0261 Sch 3 Cond 53.	The current AQMP discuss' Greenhouse Gas Management and as such no further	AEMR 2020 – 31/03/2021

Reference	Audit Finding	Risk Rating	Auditors Recommendation	HVO Response	Timing
				modification to the AQMP is considered necessary HVO will recommence reporting in the Annual Review greenhouse gas emission summary information against the AQMP.	
Sch 3 Cond 7	Exceedance of noise level criteria listed in Table 9. Refer to Appendix E DA 450-10-2003 Sch 3 Cond 7.	Administrative	No recommendation provided		
Sch 3 Cond 20	The following incidents relating to pollution of waters include: • Discharge from leaking pipework on Parnell's Dam to Parnell's Creek on 4 November 2016; and Discharge from the Hunter Valley Load Point Sump to Bayswater Creek on 30 March 2017.	Medium	No recommendation provided		
Sch 5 Cond 4	No evidence available to confirm reviews of strategies, plans and programs conducted on each occasion listed in this condition. However, all plans have been updated in the audit period. Action has since been added to CMO with reminders.	Administrative	No recommendation provided		
App4 A.4	The NMP and noise monitoring reports do not assess and correct for (or do not report) tonal noise as required by the NSW Industrial Noise Policy and later Noise Policy for Industry.	Low	Tonal noise should be included in the noise monitoring reports and the NMP on its next revision.	HVO's noise monitoring consultant's monitoring reports indicate that intermittent or tonal features are not typically present in mining operational noise and the assessment is not undertaken on this basis. However, HVO will request this inclusion to noise monitoring reports developed by the noise monitoring consultant.	30/04/2020

Reference	Audit Finding	Risk Rating	Auditors Recommendation	HVO Response	Timing
SOC Ref 22	Annual visual assessments have not been completed. HVO has since purchased all properties that would have been considered to have been visually impacted by HVO North (particularly the Wandewoi Property on Lemington Road).	Administrative	A written justification should be provided to DPIE for approval that annual visual assessments are no longer required.	As per previous IEA, HVO's response to the recommendations was to review current relevance of completing the assessments in respect to recent property purchases to determine if private receptors would still be impacted visually by HVO north since the 2010 SOC. HVO has since purchased all properties that would have been considered to have been visually impacted by HVO north particularly the Wandewoi Property on Lemington Road. Annual visual assessments are therefore no longer considered relevant. Agree with recommendation to have confirmation from DPIE that these are no longer required.	30/09/2020
EPL 640					
L1.1	The following incidents occurred relating to the pollution of waters: • Turbid water entered Farrells Creek from sediment dam overtop on 4-5/10/18 (See response to DA 450-10-2003 Sch 5 Cond 2); • Turbid water entered Farrells Creek from a rehabilitation area on the 18/3/19 (See response to DA 450-10-2003 Sch 5 Cond 2) • Turbid water entered Farrells Creek from two sediment dams on 30/3/19	Low	No recommendation provided		

Reference	Audit Finding	Risk Rating	Auditors Recommendation	HVO Response	Timing
	(See response to DA 450-10-2003 Sch 5 Cond 2); and Discharge of mine water to Bayswater Creek 11/5/18 (See response to (PA 06_0261 Sch 3 Cond 20).				
L4.1	One blast on Easter Saturday 2017 (which was officially considered a public holiday in 2017) as per PA 06_0261 Sch 3 Cond 10	Administrative	No recommendation provided		
L4.3	Two blasting exceedances on one occasion in 2018 at point 9 &18: Measured overpressure levels exceeded the 120 dBL criterion at two locations (Moses Crossing, Jerrys Plains) on 17 January 2018. (See response to PA 06_0261 Sch 3 Cond 7)	Low	Refer to PA 06_0261 Sch 3 Cond 7.	HVO has since received confirmation from DPIE that its relocation approved. HVO is currently seeking approval from the EPA for the relocation as part of the five yearly licence review and will permanently relocate the monitor once approval is received.	TBA – pending EPA response.
O2.1	Minor discharge of saline water to Parnells Creek due to pinhole leak on 4/11/16. See response to DA 450-10-2003 Sch 3 Cond 20.	Low	No recommendation provided		

11 Incidents and Non-Compliances

There were a total of 7 incidents and non-compliances recorded at HVO, including:

- 18 March – Water
- 30 March – Water
- 25 April – Air Quality
- 28 May– Blasting
- 21 August – Air Quality
- Independent Environmental Audit – Noise and Visual

Details of these incidents and non-compliances are provided below.

In addition, on 1 July 2019 HVO also notified DPIE of an incident that occurred on Easter Saturday 2017, (which was not reported at the time). This non-compliance has not been counted in the 2019 statistics. Details of this incident is included in Section 11.1.2 below.

11.1 Blasting

During 2019 there was one non-compliance related to blasting. A second non-compliance was reported to DPIE on 1 July 2019, relating to a blast that occurred on Easter Saturday 2017.

11.1.1 Air Blast Overpressure Exceedance - 28 May 2019

A blast fired in the HVO South exceeded the air-blast overpressure criteria of 120.0 dB(L). Maximum overpressure recorded at Maison Dieu was 125.69 dB(L). Blasting was undertaken in accordance with internal blasting permissions and the HVO Blast Management Plan. Two independent investigations were undertaken by technical experts, and both assessments identified that an anomaly with the monitor, compared to other monitors within the network, were the cause of the elevated reading.

In response to this investigation, HVO installed an additional blast monitor in the Maison Dieu location, with the addition of a high resolution anemometer, allowing for better assessment of meteorological impacts.

HVO received a Warning Letter on 19 September 2019 from DPIE regarding this incident. DPIE requested that a report comparing the two monitors be provided. A report detailing this comparison was submitted to DPIE on 31 October 2019, which confirmed that there was potential for a local influence near the monitor to be causing elevated overpressure. As such HVO plans to permanently relocate the monitor during 2020 to reduce this influence.

DPIE further requested that the 125.7 dB(L) recording is to be considered in calculating the annual average over 115 dB(L), noting that the likely overpressure was calculated to be more than 115 dB(L) but less than 120 dB(L).

11.1.2 Easter Saturday Blast - 15 April 2017 (reported 1 July 2019)

An incident was reported to DPIE on 1 July 2019 relating to the firing of a blast in HVO's Cheshunt Pit at 9.33am on 15 April 2017 (Easter Saturday), a gazetted public holiday. The incident was identified in 2019 as part of a review of historic blasting data. No complaints were received relating to the blast and the blast monitoring results were below the criteria.

Due to the time elapsed and change in personnel it could not be confirmed why the decision was made to blast on a public holiday. Preventative actions implemented as a result of this non-compliance include:

- HVO blasting permissions page alerts the blast engineer when there is a public holiday;
- Weekly blasting schedules are prepared and issued to an internal and external audience including the E&C team, providing an opportunity to peer review the schedule; and

- The daily blasting checklist has been updated to check for public holidays.

A monthly review and reconciliation of blasting records against monitoring records is also undertaken to ensure compliance with blasting conditions.

11.2 Water

During 2019 there were two incidents related to water as summarised below.

11.2.1 Turbid water discharge - 18 March 2019

HVO received 47.2mm of rainfall over 16, 17 and 18 March 2019. At approximately 14:00 on the 18 March, it was reported to the Environment and Community Coordinator by a sampling contractor that turbid water was identified in Farrell's Creek downstream from HVO. HVO conducted inspections and determined that a source of turbid water from HVO was due to rainfall runoff entraining sediment from an old rehabilitation slope.

HVO undertook the following actions immediately:

Initial works undertaken 18 March 2019:

- A silt curtain was deployed at confluence of Farrells Creek to Hunter River (~ 6pm).
- Undertook water sampling of source and receiving waters (between 6 and 7 pm).
- A containment bund was pushed up at the toe of the rehabilitation slope to reduce further runoff if further rainfall was to occur (prior to 9 pm).

Notifications were made to relevant authorities in accordance with HVO's Pollution Incident Response Management Plan, EPL and Development Consent on 18 March 2019.

Further works undertaken (commencing 19 March 2019) included:

- Construction of new contour lower on slope to help direct water to Dam 1n (19-3-19)
- Rollover bunds installed in vicinity of rehabilitation slope to divert water to Dam 15n (19-3-19)
- Installed coconut fibre logs at the exit of the road culvert and toe of rehabilitation slope for sediment control. (19-3-19)
- Repaired section of bund at toe of rehabilitation slope (19-3-2019)
- Follow up water sampling of source and receiving waters (19-3-2019)
- Re-gravelled roadway (commenced 19 and 20-3-19)
- Re-instated lower contour with new material (19 and 20-3-19)
- Repaired erosion scour on lower slope, re-topsoiled and mulched (20 to 22-3-19)

Investigations into the incident were conducted by the EPA, DPIE and the Resource Regulator. HVO has entered into an Enforceable Undertaking with the EPA and has also received a Penalty Notice and an Official Caution from the Resource Regulator. The Enforceable Undertaking with the EPA includes the following:

- Implement a remediation plan of the failed rehabilitation area;
- Conduct annual inspections of the area;
- Provide $100,000 of funding to the Hunter Local Land Services to undertake a project to improve Travelling Stock Reserves (TSR's) within the Singleton LGA.
- Publically reporting the incident; and
- Payment of EPA's costs.

11.2.2 Turbid water discharge - 30 March 2019

Following 66 mm of rainfall on 30 March 2019, two dams (known as Farm Dam1 and Dam 2n) at HVO North had their capacity exceeded. This resulted in overflow of the dams and flow of turbid water to Farrells Creek. The volume of rainfall had exceeded the designed rainfall event used to construct sediment dams to

Blue Book standard. Runoff water captured from these dams is not mine affected, therefore salinity of the water was low.

Immediate actions undertaken include:

- Pumps were installed prior to the event and these were operated to lower the dam levels
- Sampling undertaken
- Internal and external notifications made

Results from sampling indicated that discharged water had negligible impact on the water quality of the receiving waters.

Investigations into the incident conducted by DPIE resulted in HVO being issued with a Warning Letter for failure to fully implement the Water Management Plan at the time of the incident. HVO has since reviewed inspection process of sediment dams and has implemented additional processes to ensure sufficient dam capacity were required.

11.3 Noise

During 2019 there was one non-compliance relating to noise identified during the Independent Environmental Audit. These are summarised below.

11.3.1 IEA Finding – Tonal Noise Assessments

During the Independent Environmental Audit, it was identified that under HVO North and South Consents (Appendix 4, Condition A4) that HVO was not assessing and reporting on tonal noise as required by the NSW Noise Policy for Industry. HVO's noise monitoring consultant's monitoring reports indicate that intermittent or tonal features are not typically present in mining operational noise and the assessment is not undertaken on this basis. However, HVO has requested this inclusion to noise monitoring reports developed by the noise monitoring consultant.

11.4 Air Quality

During 2019 there were two non-compliances related to air quality. These non-compliances are summarised below.

11.4.1 Missed HVAS Sample - 25 April 2019

On 25 April 2019 HVO was notified by the Hunter Valley Gliding Club that the PM10 High Volume Air Sampler (HVAS) at the site had been damaged by activities occurring at the club, subsequently resulting in the sample not being captured on 26 April 2019 in accordance with the Air Quality Monitoring Program.

Notification of the missed sample was provided to DPIE on 29 April 2019.

HVO consulted with the Gliding Club on possible solutions to prevent future incidents with the HVAS and it was agreed by both parties that improving the visibility of the unit would assist in preventing future issues. As a result high visibility reflective tape was affixed to the unit. No further issues have been reported.

11.4.2 Dust Management Penalty Notice - 21 August 2019

On 21 August 2019 at approximately 14:45, an Authorised Officer from DPIE undertook unannounced surveillance of HVO's activities and allegedly observed operations in HVO South generating visible, off-site air pollution. In the Department's view, at this time, the operations that were taking place in the south-western corner of the Riverview Pit were not being adequately managed to minimise dust generation which travelled off-site, visibly crossing the Golden Highway. This constituted a failure to comply with Schedule 3, Condition 22 of PA06_0261.

DPIE requested information and records relating to HVO's operations and dust management practices at the time of the alleged breach, which HVO subsequently supplied.

On 18 October 2019 HVO received correspondence from DPIE advising that, following an investigation, the Department determined that HVO committed an offence against Section 4.2 of the EP&A Act by carrying out development not in accordance with the conditions of PA 06_0261 by failing to take all reasonable steps to minimise dust emissions and visible off-site air pollution. HVO received a Penalty Infringement Notice (PIN) in the amount of $15,000 for the non-compliance. It should be noted that HVO considers that operations were being managed in accordance with the HVO Air Quality Management Plan at the time of the allegation.

11.5 IEA Finding - Visual Amenity

One non-compliance relating to visual amenity requirements identified during the Independent Environmental Audit. During the Independent Environmental Audit, it was identified that under HVO North Statement of Commitments (SOC Ref. 22) that HVO had not completed the commitment to undertake annual visual assessments during the audit period (2016 to 2019). As per the previous IEA, HVO's response to the recommendations was to review current relevance of completing the assessments in respect to recent property purchases to determine if private receptors would still be impacted visually by HVO north since the 2010 SOC. HVO has since purchased all properties that would have been considered to have been visually impacted by HVO north particularly the Wandewoi Property on Lemington Road. Annual visual assessments are therefore no longer considered relevant. During 202, HVO will seek confirmation on the continuing need to undertake these assessments from DPIE.

12 Activities to be completed in 2020

12.1 Noise

Noise management improvements identified for implementation in 2020 include:

- Sound Power Level testing of various heavy mining equipment ; and
- Review of the HVO Noise Management Plan.

12.2 Blasting

Blasting management improvements identified for implementation in 2020 include:

- Review blast monitoring locations, including relocation of the Maison Dieu Monitor to exclude localised influences on the monitor;
- Review of the HVO Blast Management Plan.

12.3 Air Quality

Air Quality management improvements identified for implementation in 2020 include:

- Review of the HVO Air Quality & Greenhouse Gas Management Plan;
- Aerial seeding of overburden that is temporarily unavailable for rehabilitation; and
- Continue to implement dust management improvements such as dust monitoring camera system and dust management TARP.

12.4 Historic Heritage

Continue to consult with the neighbouring Liddell Coal Operations on any future mining plans that may interact with the Chain of Ponds Inn complex to ensure appropriate protective management measures are implemented where required.

12.5 Water

Improvements to mine water management in 2020 include:

- Implement pipeline and water infrastructure management projects to reduce potential for unauthorised water discharges (EPL 640 Pollution Reduction Program);
- Upgrade of river pumping infrastructure to improve pumping capability and improve pumping system controls;
- Ongoing upgrade of internal water transfer pipelines, pumping infrastructure, and system controls and monitoring; and

12.6 Rehabilitation

During the next reporting period key focus areas for HVO will be:

- Completion of 94ha of new rehabilitation;
- Development of new combined HVO North and South Mine Operations Plan including revised rehabilitation completion criteria and monitoring methodology;
- Continuation of Section 240 rehabilitation maintenance plan including continued progression of historic cover crop / weed management areas to final cover;
- Commence remediation of degraded rehabilitation at the former Eastern TSF at HVO North;
- Further develop opportunities for grazing access to suitable rehabilitation areas.

12.7 Tailing Storage Facility Capping

- Capping activities on Southeast TSF will continue during 2020 to progress rehabilitation of the remaining surface.
- Implementation of management activities for the North Void TSF, focusing on dewatering and capping strategy development;
- Optimisation of pipe-head flocculation systems at Dam 6W and Carrington In-Pit TSF.
- Review the Life of Mine Fine Rejects Management Strategy.

12.8 Stakeholder Engagement

The following stakeholder engagement activities are planned for 2020:

- Implementing two rounds of the HVO Community Fund;
- Developing and distributing two community newsletters;
- Conducting two Community Information sessions (at Jerrys Plains and Maison Dieu) (subject to COVID-19 restrictions); and
- Hosting a UHMD School Site Tour (subject to COVID-19 restrictions)

12.9 Timeline for Implementation of Improvement Projects

A proposed timeline for the improvement projects mentioned in Section 12 is shown below in Figure 119.

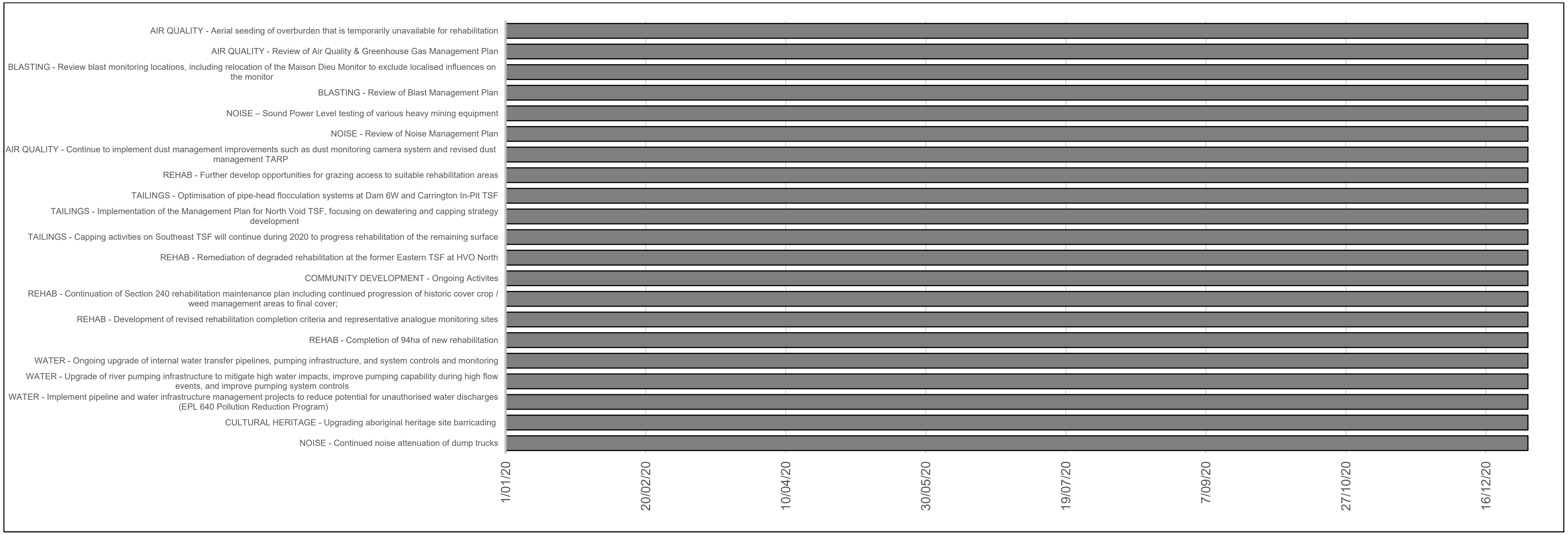


Figure 119: Proposed Timeline for Implementation of 2020 Improvement Project

Appendix A - Annual Groundwater Review 2019

Appendix B - Rehabilitation Maintenance Schedule

Appendix C - Aboriginal Heritage Management Plan Compliance Audit Inspections

HUNTER VALLEY OPERATIONS

2019 Annual Groundwater Review

Prepared for:

HV Operations Pty Ltd
1011 Lemington Road,
Lemington NSW 2330

SLR Ref: 620.12182.00000-R13
Version No: v2.0
March 2020

PREPARED BY

SLR Consulting Australia Pty Ltd
ABN 29 001 584 612
Level 1, The Central Building, UoW Innovation Campus
North Wollongong NSW 2500 Australia

T: +61 404 939 922 F:
E: wollongong@slrconsulting.com www.slrconsulting.com

BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with HV 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
620.12182.00000-R13-v3.0	31 March 2020	Kirsty Cooksey	Claire Stephenson	Claire Stephenson
620.12182.00000-R13-v2.0	26 March 2020	Kirsty Cooksey	Claire Stephenson	Claire Stephenson

CONTENTS

CONTENTS

CONTENTS

DOCUMENT REFERENCES

TABLES

FIGURES

CONTENTS

APPENDICES

1 Introduction

1.1 Overview

The Hunter Valley Operations (HVO) mining complex is located approximately 24 km north-west of Singleton, NSW. As part of compliance with mine approval conditions, routine groundwater monitoring is conducted across HVO, and the data reviewed and analysed on an annual basis. The annual groundwater review is required for:

- HVO North in accordance with Condition 27 of Development Consent (DA 450 10 2003) and individual bore license conditions (20BL173587-89 and 20BL173847).
- HVO South in accordance with Condition 28 of the Project Approval (PA 06 0261 24) and licence conditions for Lemington Underground (LUG) Bore (20BL173392).
- Individual bore license conditions (20BL173587-89, 20BL173847 and 20BL173392).

This report presents the annual groundwater review for HVO, developed in accordance with the approval conditions and requirements outlined within the Water Management Plan (WMP).

1.2 Scope

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

- Site background:
  - Legislative requirements and conditions relevant to groundwater;
  - Mine activities over reporting period;
  - Hydrogeological regime; and
  - Groundwater monitoring network and programme.
- Data review:
  - Review and illustration (i.e. hydrographs) of groundwater level trends;
  - Review and illustration (i.e. hydrographs) of groundwater quality trends;
  - Comparison of water level and quality trends to relevant trigger levels and natural trends (i.e. surface water levels and rainfall); and
  - Assess compliance with mine approval conditions and present a checklist summarising findings.
- Discussion of groundwater impacts and compliance over the reporting period and provision of recommendations (where required).

2 HVO Complex

The following section provides a description of the HVO Complex of relevance to this annual groundwater review. The general site layout is presented in Figure 2-1.

2.1 Mine operations

Table 2-1 presents a summary of mine areas across HVO, approved mining timeframes and activities conducted over 2019. Overall, mining was active at West Pit, Cheshunt Pit, and Riverview Pit over 2019.

Table 2-1 Summary of HVO Activities

Mine Area	Seam Mined To	Approved Life of Mining	2019 Activities
West Pit	Bayswater to Hebden seams	1949 to 2025	Mining active
North Pit	Vaux Seam	1979 to 2003	Inactive – fully rehabilitated
Alluvial Lands	Vaux Seam	1993 to 2003	Inactive – fully rehabilitated
Carrington Pit	Bayswater Seam	2000 to 2021	Inactive – commenced receiving tailings in January 2019
Carrington West Wing	Bayswater Seam	Not commenced	Not commenced
Cheshunt Pit	Vaux & Bayswater seams	2002 to 2030	Mining active – down to the Bayswater Seam
Riverview Pit	Vaux & Bayswater seams	1997 to 2030	Mining active – down to the Vaux Seam
Glider Pit	Vaux Seam	2016 – 2017	Inactive – fully rehabilitated
Lemington South Pit 1	Bowfield Seam Warkworth Seam	1998 to 2006 2019 to 2030	Inactive – rehabilitated with final void/pit lake present. Used for water storage from LUG Bore abstraction

As of the 28th February 2018 the Planning Assessment Commission granted consent for the HVO South Modification 5. These approved operations are reflected in Table 2-1, which includes mining of the Riverview Pit down to the Bayswater seam.

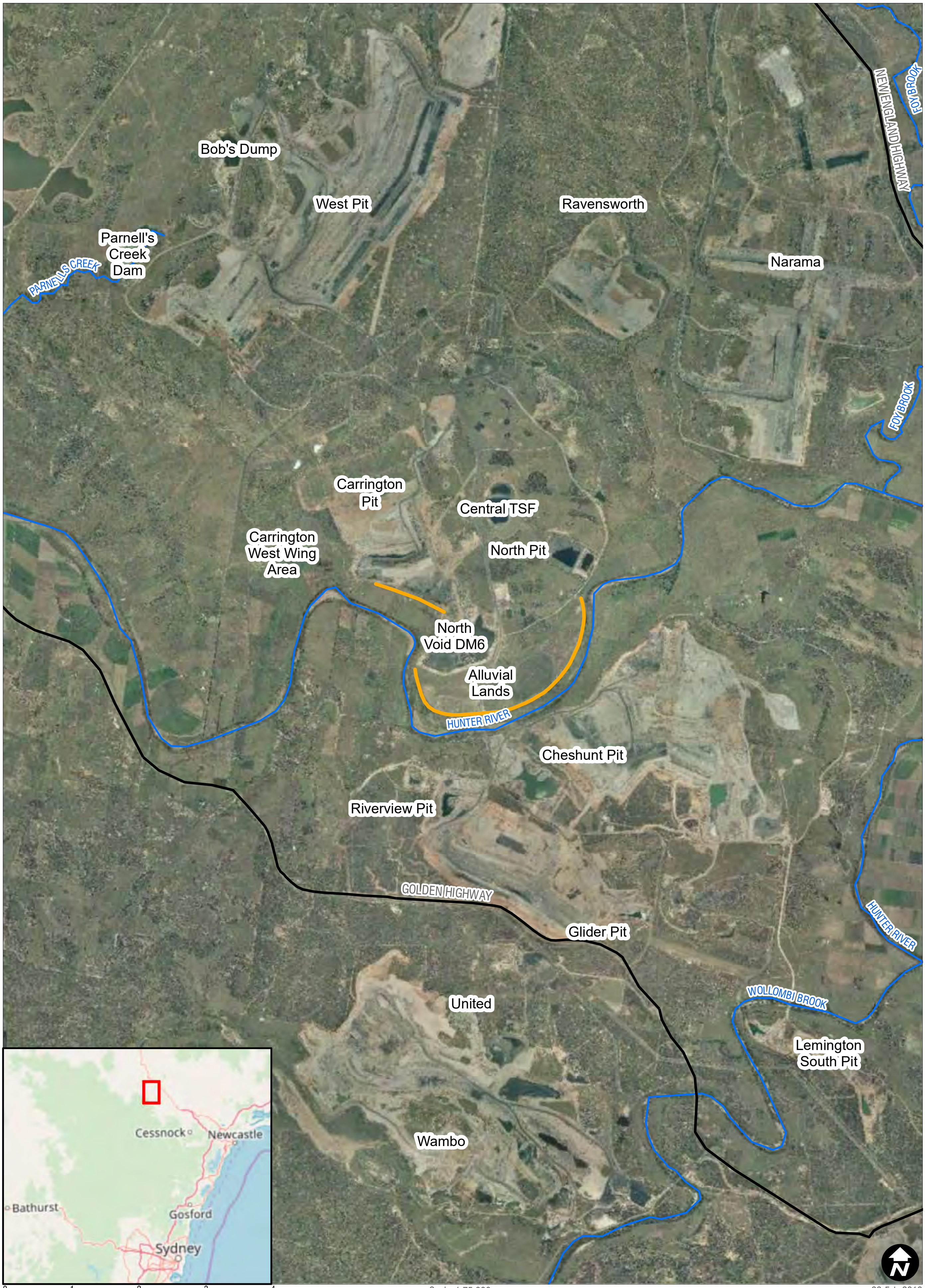
A range of tailings storage facilities (TSF) are present across HVO, as summarised in Table 2-2. The TSF's are managed in accordance with the site Fine Rejects Management Strategy, which includes decant requirements to enable better consolidation of the material.

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

Mine Area	Location	Status
Dam 6W	West Pit	Active over 2019
Bob's Dump (20W)	West Pit	Inactive over 2019
North Void (DM6)	North Pit	Ceased receiving tailings in January 2019, planning for decommissioning and rehabilitation has commenced
Southeast TSF (27N)	North Pit	Inactive – capping commenced 2016
Central TSF (28N)	North Pit	Inactive over 2019
Carrington Out of Pit Fine Reject Emplacement (COOP FRE)	Carrington area – out of pit emplacement.	Approved, not constructed
Carrington In Pit Fine Reject Emplacement (FRE)	Carrington area – in pit emplacement	Void area over 2018, receiving tailings since January 2019

Over 2019 only two areas were actively used for tailings storage, Dam 6W at West Pit and Carrington In Pit Fine Reject Emplacement. North Void ceased receiving tailings in January 2019, planning for decommissioning and rehabilitation has commenced.

Groundwater was also abstracted from the Lemington Underground Bore (LUG) during 2019. LUG Bore is a production bore constructed into the historical Lemington Underground beneath HVO that mined the Mt Arthur Seam of the Whittingham Coal Measures, with this mine having been inactive since 1999. Abstraction from LUG Bore is managed by Yancoal for the Mt Thorley Warkworth (MTW) operations.



H:\Projects-SLR\620-BNE\620-BNE\620.12182 HVO Groundwater Compliance\06 SLR Data\01 GIS\01 ArcGIS\SLR62012182_F02_Locality_001.mxd

0 1 2 3 4 Kilometres

Scale: 1:75,000
GDA 1994 MGA Zone 56

22-Feb-2019

Barrier Walls
Main road
Major watercourses

Sheet Size : A4

SLR
www.slrconsulting.com.au

Hunter Valley Operations
2019 Groundwater Level and Quality Review
Locality Map

Figure 2.1

2.2 Groundwater Impacts

Groundwater impacts associated with the approved operations at HVO have been progressively assessed for each mining area, including:

- Alluvial Lands Project Groundwater Assessment (MMA 1992);
- Carrington Pit Groundwater Assessment (MER 1998);
- West Pit Extension Groundwater Assessment (MER 2003);
- Carrington Pit Extended Groundwater Assessment (MER 2005);
- Carrington West Wing Groundwater Assessment (MER 2010);
- HVO South Groundwater Assessment (ERM 2008);
- HVO North Modification 4 Groundwater Assessment – Carrington Out of Pit Fine Reject Emplacement (AGE 2013b);
- HVO North Modification 6 Groundwater Assessment – Carrington In Pit Fine Reject Emplacement (AGE 2016); and
- HVO South Modification 5 Groundwater Assessment (AGE 2017).

The most recent groundwater assessment that captures operations across HVO North and HVO South was the HVO South Modification 5, which was granted consent by the Planning Assessment Commission on 28th February 2018. The groundwater assessment for Modification 5 was completed by AGE (2017) and included development of a numerical groundwater model to represent groundwater response to approved mine activities and the proposed modification.

AGE (2017) reported on predicted impacts associated with approved operations over 2019 (model Year 4). The approved operations included mining at Cheshunt Pit, Riverview Pit, Glider Pit and West Pit, as well as surrounding non-HVO mining operations (i.e. Ravensworth, Mt Thorley Warkworth etc) and abstraction from the LUG Bore. The model also included approved mining at Carrington West Wing until 2021; however no mining has occurred at Carrington West Wing to date.

The model was calibrated to the end of 2015 and groundwater conditions and groundwater response to approved mining to the end of 2015, as reported by AGE (2017), indicated:

- Groundwater within the hard rock units (i.e. Whittingham Coal Measures) is directly intercepted by approved operations at HVO;
- Groundwater within the confined to semi-confined Permian coal measures became depressurised around the area of active mining. Groundwater drawdown responses were observed around 2 km to 6 km from active mine areas within the Permian coal measures;
- There is no direct interception of groundwater within alluvium for active mine operations at HVO. However, historically the South Lemington Pit 1 footprint did directly intercept alluvium and barrier walls were established at Alluvial Lands and Carrington Pit to separate mine areas from alluvium; and
- With depressurisation of the coal measures, the model predicted a reduction in upward seepage to the alluvium that was referred to as ‘indirect take’.

- These findings largely aligned with historical groundwater assessments conducted for the approved operations across HVO. Groundwater licenses have been obtained for the approved operations, as discussed in Section 2.3. Management and monitoring requirements of potential groundwater related impacts from approved operations are captured within the development consent conditions. Schedule 3, Condition 27 of Development Consent (DA 450 10 2003) for HVO North, last updated January 2017 for Modification 6 and again in July 2017 (no changes to groundwater conditions in July); and
- Schedule 3, Condition 28 of the Project Approval (PA 06 0261 24) for HVO South, last updated October 2012.

These conditions are addressed within the site Water Management Plan (WMP). Further discussion on the monitoring and management requirements is included within Section 2.4.

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 HVO are outlined in Table 2-3.

Table 2-3 HVO Groundwater Licenses

License Number	Description	WSP	Water Source - Management Zone	Approved Extraction (ML)
WAL 40462	HVO Pit Excavations – Alluvial Lands Bores	North Coast Fractured and Porous Rock	Permian Coal Seams	2,400
WAL 40463				180
WAL 40466				460
WAL41527	HVO North – Carrington Pit			700
WAL41533	HVO North Pit Excavation			20
WAL39798	Lemington Underground (LUG) Bore			1,800
WAL18127	Carrington BB1	Hunter Unregulated and Alluvial Water Sources	Hunter Regulated River Alluvial Water Source – Upstream Glennies Creek Management zone	383
WAL18158	Ollenberry			65
WAL18307	HVO West – Parnells Creek Dam (Diversion Works Bywash)		Jerrys Management Zone Jerrys Management Zone	500
WAL18327	HV Loading Point Pump Bayswater Creek (Diversion Works)			150
WAL36190	HVO North, old farm bore			120
WAL23889	Greenleek		Lower Wollombi Brook Water Source	144

License Number	Description	WSP	Water Source - Management Zone	Approved Extraction (ML)
WAL962 (20AL201237)	Surface water access – West Pit area	Hunter Regulated River Water Source	Hunter River (Zone 1b) between Goulburn River junction and Glennies Creek junction.	3,165
WAL970, WAL1006 & WAL1070 (20AL201256, 20AL201337 & 20AL201500)	Surface water access – HVO North and HVO South areas		Hunter River (Zone 2a) between Glennies Creek junction and Wollombi Brook junction.	1,500 (500 each)

2.4 Groundwater Conditions

In accordance with the development consent approval conditions, HVO are required to prepare and implement a Water Management Plan (WMP) to the satisfaction of the Secretary. Table 2-4 presents a summary of the relevant groundwater conditions from the development consent and WMP. The table identifies where the conditions relating to routine groundwater monitoring for 2019 have been addressed.

Table 2-4 Groundwater Conditions within WMP

Approval Condition	Condition	Where Addressed
Sch. 3, Cond. 27(c) (PA 06_0261)	A groundwater monitoring programme that includes:	
	• Additional baseline data of groundwater levels yield and quality in the region, and privately-owned groundwater bores, which could be affected by the project;	See WMP No private bores predicted to be impacted for current approved operations and no monitoring of private bores.
	• Groundwater impact assessment criteria, including trigger levels for investigating any potentially adverse groundwater impacts of the project; and	See Section 4.3 for criteria Section 5 comparison to triggers
	• A programme to monitor: o Groundwater inflows to the open cut mining operations; and	See WMP
	o Impacts of the project on the region's aquifers, any groundwater bores, and surrounding watercourses, and in particular, the Hunter River and Wollombi Brook and adjacent alluvium; and	See Section 5
Sch. 3, Cond. 27(c)	A Groundwater Management Plan, which includes:	

Approval Condition	Condition	Where Addressed
(DA450-10-2003)	• Detailed baseline data on groundwater levels, yield and quality in the region, and privately- owned groundwater bores, that could be affected by the development;	See WMP
	• Groundwater assessment criteria, including trigger levels for investigating any potentially adverse groundwater impacts;	See Section 4.3 for criteria and Section 5 for comparison to triggers
	• A programme to monitor:	
	o Groundwater inflows to the open cut mining operations;	See WMP
	o the impacts of the development on: ▪ The alluvial aquifers, including additional groundwater monitoring bores as required by NOW;	See Section 5.2.1
	▪ The effectiveness of the low permeability barrier;	See Section 5.2.3
	o Base flows to the Hunter River;	Groundwater trends reviewed in Section 5.2
	o Any groundwater bores on privately-owned land that could be affected by the development;	No private bores predicted to be impacted for current approved operations and no monitoring of private bores.
	o Groundwater dependent ecosystems, including the River Red Gum Floodplain Woodland EEC located in the Hunter River alluvium;	See WMP
	o The seepage/leachate from water storages, backfilled voids and the final void;	See Section 5.2.3 – including discussion on groundwater trends within North Pit spoil.
	o The development, including an independent review of the model, every three years and comparison of monitoring results with modelled predictions; and	See Section 5.5
	o A plan to respond to any exceedances of the groundwater assessment criteria.	See Section 6.2
Sch. 3, Cond. 27(c) (DA450-10-2003)	• A programme to validate and recalibrate (if necessary) the groundwater model for the development, including an independent review of the model every 3 years, and comparison of monitoring results with modelled predictions;	See Section 5.5
HVO South Statement of Commitments	In addition to the mitigation measures undertaken at HVO for groundwater management, the following controls specific to the proposal will be implemented:	See Surface Water Review

Approval Condition	Condition	Where Addressed
	• Groundwater Flow To and From Rivers: o development of protocols for monitoring and reporting of NOW stream gauge results to clearly record any reductions in flows that are attributed to mining. This will include monitoring Hunter River flows immediately up gradient and down gradient of the site. In addition, consideration will be given to tying in specific CNA water level recordings with current NOW gauging locations;	
	o monitoring of groundwater elevations within alluvium between the Hunter River and the Cheshunt Pit; and	See Section 5.2.1.3
	o measured groundwater elevations and river flow will be assessed against predictions to determine whether application of additional management measures is required; and	See Section 5.5
	o offset seepage to pits in accordance with regulatory requirements.	See WMP

Additional conditions are in place for the approved Carrington West Wing; however, mining has not commenced here and there are no current plans to commence these operations in the near future.

Groundwater monitoring is conducted in accordance with the Groundwater Monitoring Programme outlined within Appendix A of the WMP. The programme outlines groundwater monitoring frequency, parameters to be tested and groundwater triggers for electrical conductivity (EC) and pH. The WMP was updated in October 2018, including updates to the monitoring network and trigger levels. This annual review is based upon the monitoring and reporting requirements documented within the October 2018 version of the WMP. Further discussion on the groundwater monitoring programme and triggers is included in Section 4.

3 Hydrogeological Setting

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

3.1 Climate, Terrain and Drainage

3.1.1 Climate

The climate of the HVO region can be classed as temperate and is characterised by hot summers and mild dry winters. Rainfall data is available from the Scientific Information for Land Owners (SILO) database of historical climate records for Australia (DSITI, 2015). This service interpolates rainfall and evaporation records from available stations for an area within 100 km of the search coordinates, which was Latitude -32.50/Longitude 151.00. Climatic data was obtained between 01/01/1900 to 01/01/2020. Table 3-1 provides the average monthly rainfall data, as well as the 2019 monthly data from SILO.

A cumulative deviation from mean (CDM) rainfall plot is provided as Figure 3-1 to illustrate long term climate trends in the HVO 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. As shown in Figure 3-1 below, the region has generally experienced below average rainfall from 2016.

Table 3-1 Long Term Average and 2019 Climate Data

Rainfall (mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Average Historical	73.0	71.1	60.3	46.4	38.9	46.1	39.3	34.5	38.5	50.1	60.1	67.0	625.3
2019 Rainfall	58.1	23.0	143.6	1.9	17.6	9.9	10.3	20.8	28.6	5.6	23.5	0.7	343.6

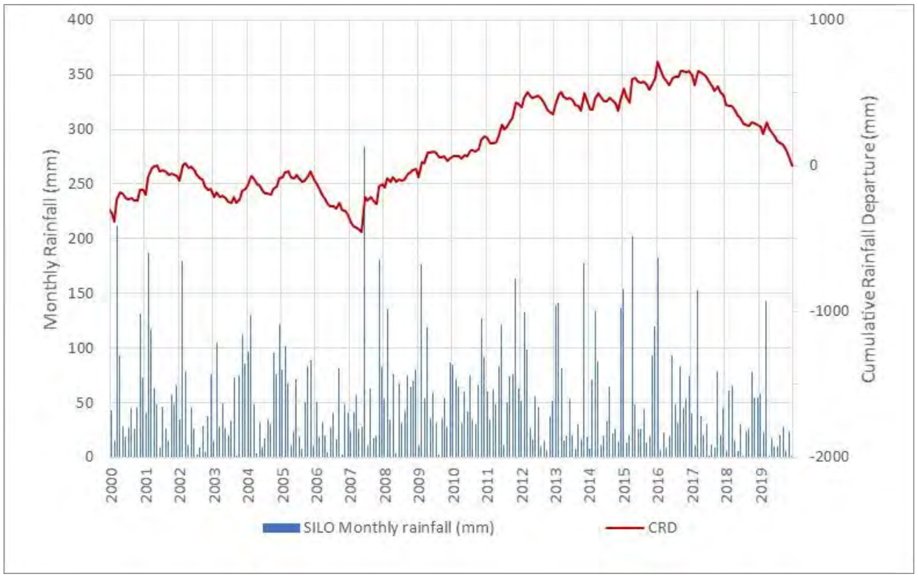


Figure 3-1 Cumulative Rainfall Departure and Monthly Rainfall

3.1.2 Terrain and Drainage

The HVO site terrain and surface drainage is dominated by the easterly flowing Hunter River, which dissects the complex in a general east-west direction. Ground elevations range between 60 m Australian Height Datum (mAHD) along the Hunter River alluvial plains to 180 mAHD in the northern parts of HVO North and in the western parts of HVO South. Minor ephemeral drainage features are also present around HVO North (i.e. Parnells Creek, Farrells Creek and Bayswater Creek) and HVO South (Wollombi Brook), draining into the Hunter River.

Real time stream flow data is monitored along the Hunter River and Wollombi Brook at DPI water gauging stations via the Hunter Integrated Telemetry System (HITS). Time series river water elevations (mean level above zero gauge elevation) is presented in Figure 3-2 for three HITS stations (Hunter River @ Liddell, Hunter River @ U/S Foy Brook and Wollombi Brook @ Warkworth) as well as four locations monitored monthly at HVO along the Hunter River (WL03, WL05, WL10 and WL14).

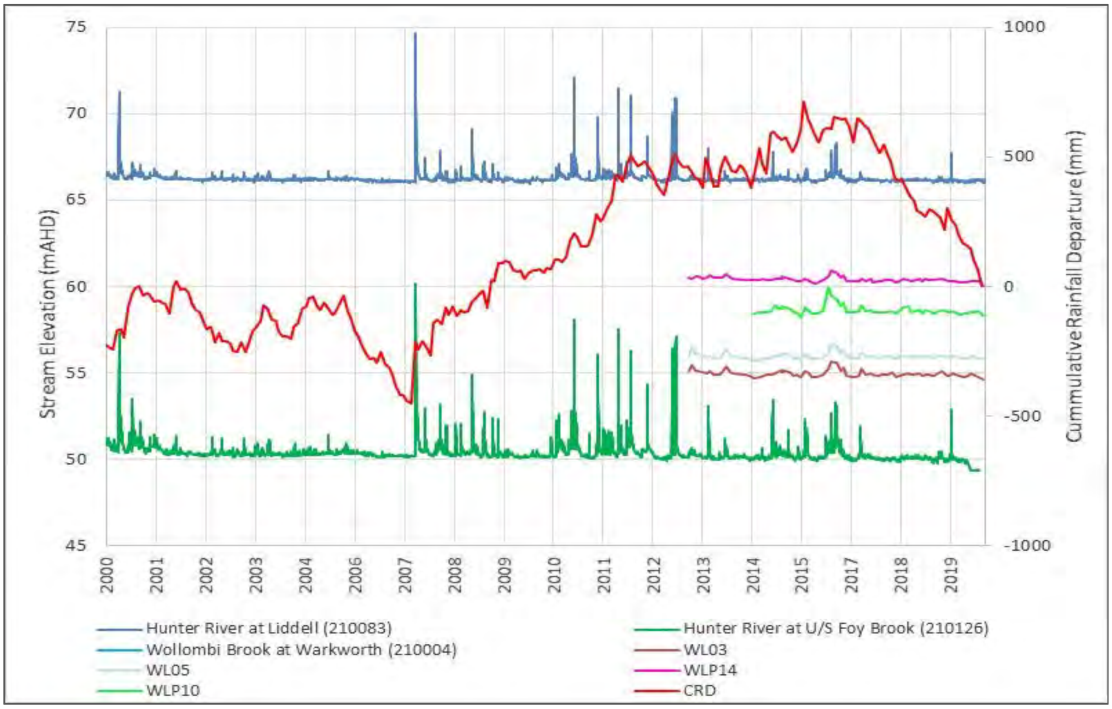


Figure 3-2 Surface Water Levels

As shown in Figure 3-2, over 2019 stream elevations within the Hunter River ranged from 66 mAHD upstream at Liddell, down to 49 mAHD at Foy Brook. Review of stream discharge for the Hunter River at Foybrook (210126) indicates discharge rates peaked during the period March to April 2019 with the highest flow of 12,041 ML/day (1/4/2019) recorded. For the remainder of the year stream discharge remained below 200 ML/day. Over 2019, stream elevations within Wollombi Brook remained fairly static, ranging between 48.52 mAHD and 48.54 mAHD, review of stream discharge shows the Wollombi Brook has not flowed since 2017

3.2 Geology

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

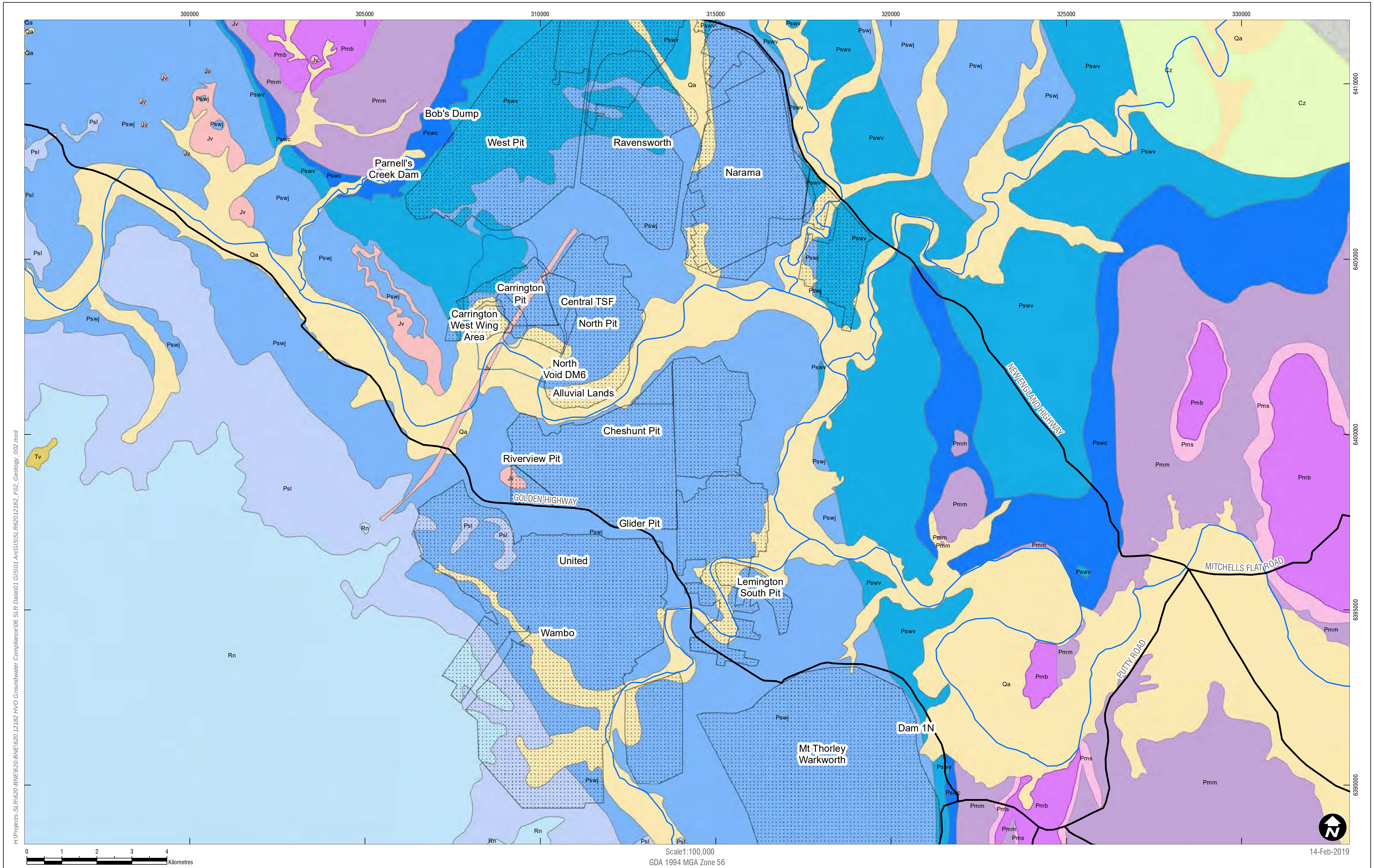
At HVO North the Whittingham Coal Measures are incised by a paleochannel of the Hunter River (Figure 3-3). The properties and extent of the paleochannel were assessed and mapped by MER (2008). The paleochannel comprises heterogeneous distribution of silts, sands and gravels.

Along the Hunter River and Wollombi Brook thin Quaternary alluvial deposits unconformably overlie the Permian strata. The alluvial deposits comprise surficial fine grained sediments (i.e. silts and clays). Along major watercourses (i.e. Hunter River and Wollombi Brook) the surficial sediments overly basal sands and gravels that are between 7 m to 20 m thick.

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

Table 3-2 HVO Generalized Stratigraphy

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



Sheet Size : A3

Mine Areas	Tv - Tertiary Basalt	Pswj - Jerrys Plains Subgroup	Pswc - Saltwater Creek Formation
Palaeochannel (MER)	Jv - Jurassic Volcanics	Pms - Muree Sandstone	Pmm - Mulbring Siltstone
Hunter Coalfields 100k Geology	Rn - Narrabean Group	Pgr _ Rowan Formation	Pmb - Branxton Formation
Qa - Quaternary Alluvium	Psl - Newcastle Coal Measures	Pswv - Archerfield Ss. Vane Subgroup	Cz - Carboniferous tuff and ignimbrite

SLR
www.slrconsultingaustralia.com.au

Hunter Valley Operations
2019 Annual Groundwater Review
Surface Geology

Figure 3-3

3.2.1 Groundwater Units

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

3.2.2 Alluvium

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

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

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

The alluvial aquifer of the Hunter River supports Carrington Billabong, an ephemeral freshwater wetland located south of Carrington Pit that is considered a Groundwater Dependant Ecosystem (GDE). Alluvial groundwater levels around Carrington Billabong have remained relatively stable during active mining at Carrington Pit. This is due to installation of a barrier wall through the unconsolidated alluvial sediments, which separates the Billabong from Carrington Pit. The stable alluvial groundwater levels in this area are also taken to indicate limited hydraulic connection between the nearby paleochannel alluvium and the underlying depressurised coal measures.

3.2.3 Permian Coal Measures

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

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

The coal seams are typically moderately to slightly permeable, whilst the hydraulic conductivity of the interburden material is generally less than coal seams but is more variable, depending on the predominance of fractures in the rock mass. The hydraulic conductivity of the coal seams generally decreases with depth due to the closure of the cleats with increasing stratigraphic pressure.

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

There is no significant usage of groundwater from the Permian coal measures, likely due to the poor quality that generally exceeds ANZECC (2000) water quality guidelines for stock supply, and presence of perennial surface water flows (Hunter River and Wollombi Brook) and the more productive alluvial aquifer.

4 Groundwater Monitoring

4.1 Groundwater Monitoring Program

Groundwater monitoring is conducted at HVO in accordance with the HVO WMP, specifically the Groundwater Management Plan and Groundwater Monitoring Programme. The monitoring results are used to establish and monitor trends in physical and geochemical parameters of surrounding groundwater potentially influenced by mining.

The monitoring programme at HVO measures the Standing Water Level (SWL) in monitoring bores, reported as elevation (mAHD). The data is compared against background data, EIS predictions and historical trends as a means of assessing any HVO related impacts to the quantity of groundwater in the various aquifers.

The monitoring programme at HVO also assesses the quality of groundwater against background data and historical trends. Groundwater quality is evaluated through the parameters of pH and electrical conductivity (EC). On a periodic basis (nominally once per annum) a comprehensive suite of analytes is measured, including major anions, cations and metals. Prior to sampling for comprehensive analysis, bore purging is undertaken to ensure a representative sample is collected.

Groundwater quality monitoring data is reviewed on a quarterly basis. The review involves a comparison of measured pH and EC results against internal trigger values which have been derived from the historical data set. Trigger limits are calculated as the 95th percentile maximum value (EC and pH) and the 5th percentile minimum value (pH only) from data collected since 2011. Trigger levels have been set based on geographical proximity and target stratigraphy.

The groundwater monitoring network at HVO has evolved over time and includes 127 groundwater monitoring points that require routine monitoring in accordance with the 2018 WMP, as well as other historical monitoring locations. The bores are installed into a number of geologic units. As outlined within the WMP, bores are grouped into one of eight Locations, as summarised below:

- West Pit (HVO North)
- North Pit (HVO North – historical mine area fully rehabilitated)
- Carrington (HVO North – historical mine area)
- Carrington West Wing - CWW (HVO North – approved mine area but not yet commenced)
- Cheshunt/North Pit (HVO North and HVO South - bores located between North Pit and Cheshunt Pit)
- Cheshunt (HVO South – south of Hunter River)
- Lemington South – Lemington (HVO South – near Wollombi Brook)
- Southern (HVO South – unmined area east of Lemington South Pit 1)

The details of each of the HVO monitoring bores as well as each bores respective monitoring programme are provided in Appendix A and the location of the bores are presented in Figure 4-1 to Figure 4-3.

The 103 compliance bores have trigger levels set for water quality (EC and pH) and five for water quality and water levels (CFW55R, CFW57, CGW52a, CGW53a and CGW55a). It is noted there are 104 bores listed in the trigger table of the WMP, but no triggers are assigned for one bore (CGW46). It is recommended that triggers be assigned during the next revision of the WMP. An additional ten bores were installed in 2018 to monitor the area to the south of the Carrington Pit/North Void. These bores (GW-120 to GW-129) are yet to be included in the WMP, however, they have been routinely monitored since installation.

As outlined in Appendix A, full laboratory water quality analysis is required to be conducted for 65 bores, either 6-monthly (27 bores) or annually (38 bores). There are also two different laboratory analytical suites used, as follows:

Comprehensive analysis 1

- TDS;
- Major Ions (Ca, Cl, K, Na, SO_4 (or S), CO_3);
- Total Alkalinity, Bicarbonate Alkalinity, Carbonate Alkalinity, Hydroxide Alkalinity; and
- Metals (Al, As, B, Cd, Cu, Hg, Mg, Ni, Pb, Se, and Zn).

Comprehensive analysis 2

- TDS;
- Major ions (Ca, Cl, K, Na, SO_4 (or S), CO_3);
- SiO_2;
- Total Alkalinity, Bicarbonate Alkalinity, Carbonate Alkalinity, Hydroxide Alkalinity;
- Metals (Al, As, B, Be, Cd, Co, Cu, F, Fe, Hg, Mg, Mn, Pb, Rb, Sb, Se, Sr, Zn); and
- Nutrients (Ni, NH3, NO2, NO3 and P).

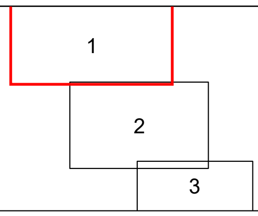
Scale:1:35,000
GDA 1994 MGA Zone 56

24-Mar-2020

\\au.slr.local\Corporate\Projects-SLR\620-BNE\620-BNE\620.12182 HVO Groundwater Compliance\06 SLR Data\01 GIS\01 ArcGIS\mxd\SLR62012182_F01_Groundwater_002.mxd

Sheet Size : A3

SLR global environmental solutions
www.slrconsultingaustralia.com.au



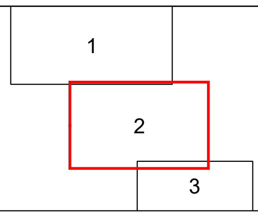
Monitoring point

Hunter Valley Operations
2019 Groundwater Level and Quality Review
Groundwater Monitoring Network – Carrington and North Pit

Figure 4-2

Sheet Size : A3

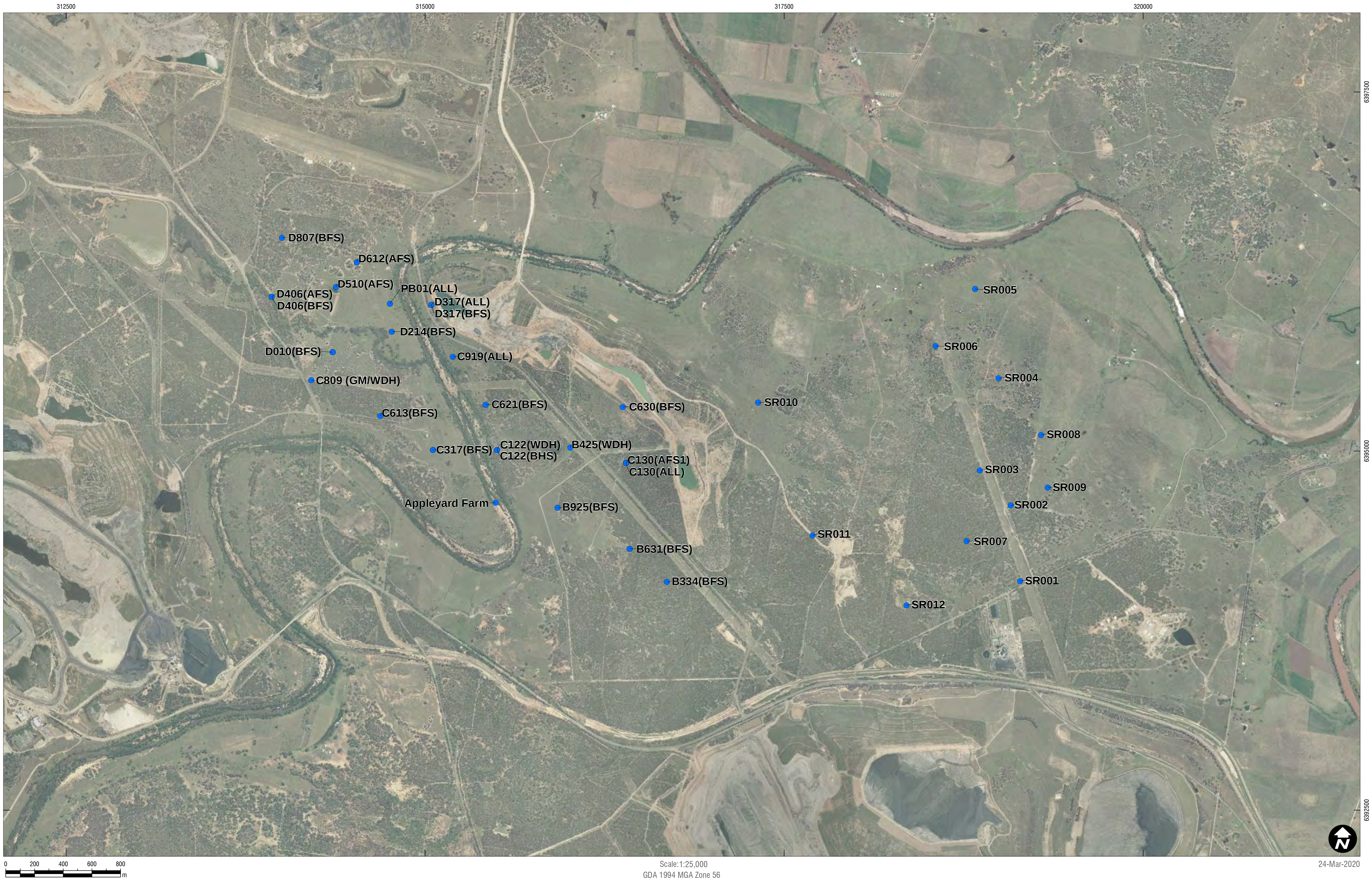
SLR
global environmental solutions
www.slrconsultingaustralia.com.au



● Monitoring point

Hunter Valley Operations
2019 Groundwater Level and Quality Review
Groundwater Monitoring Network – Carrington and North Pit

Figure 4-2

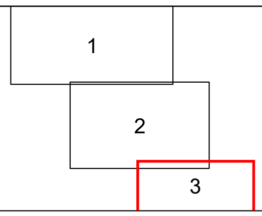


Sheet Size : A3

SLR

global environmental solutions

www.slrconsultingaustralia.com.au



● Monitoring point

Hunter Valley Operations

2019 Groundwater Level and Quality Review

Groundwater Monitoring Network – Carrington and North Pit

Figure 4-2

4.2 Groundwater Monitoring Methodology

HVO engages external contractors AECOM to carry out sampling and analysis. SLR understands that annual sampling is undertaken in accordance with relevant Australian Standards and other regulatory guidelines with representative groundwater quality samples collected. Samples are analysed by laboratories that are National Association of Testing Authorities (NATA) accredited or equivalent for the parameters being analysed.

It was previously identified by SLR (2018) that monthly to quarterly sampling methodology undertaken by the external contractors was not providing representative samples. This resulted in trigger exceedances. This sampling methodology was reviewed by HVO and improvements in sampling technique made to ensure representative samples are collected.

4.3 Groundwater Triggers

The WMP includes groundwater assessment criteria, including trigger levels for investigating any potentially adverse groundwater impacts. These criteria are summarised in Table 4-1.

Table 4-1 Groundwater Impact Assessment Criteria

Criteria	Description
1	The groundwater level does not decline more than 2 m at any privately owned bores and wells identified in the HVO complex EA's (with the exception of a single bore on land owned by the Ravensworth mine (10011459) which is predicted to decline by a maximum of 2.7 m.)
2	Water quality does not lower the beneficial use category of the groundwater source beyond 40 m from the mining pit. This will be identified using groundwater triggers (EC) for individual monitoring bores specified in the Groundwater Monitoring Programme.
3	The alluvial groundwater source within 40 m of the recognised GDE communities does not experience more than a 10% reduction in piezometric levels predicted in the EA's for HVO North and HVO South (allowing for typical climatic variation).

For Criteria 1, assessment of groundwater level trends over 2019 is discussed in Section 5.2. There are no private bores identified within the WMP and no routine monitoring of private landholder bores. However, to ensure no additional impacts are observed than were predicted for current approved operations (including potential for impacts on landholder bores), verification of the model predictions is undertaken in accordance with Condition 27(c) of the Development Consent conditions. Discussion on the model verification is included in Section 5.5.Criteria 2 relates to the trigger levels established for electrical conductivity (EC) based on the 95th percentile of baseline data, and the trigger levels for pH based on the 5th and 95th percentiles, as presented in the WMP and summarized Table 4-2. Groundwater quality readings from the site monitoring bores have been compared to the relevant trigger levels in Section 5.3.

For Criteria 3, it is assumed that direct pumping from surface water is assessed as part of the surface water annual review. Predicted 'indirect' take of water from alluvium and subsequent reductions in baseflow contributions are discussed in Section 5.4. These predictions are derived from the existing regional-scale numerical groundwater model developed by AGE (2017) as part of the HVO South Modification 5.

Table 4-2 Groundwater Quality Triggers by Location

Location	Target Seam/ Stratigraphy	EC (95th) µS/cm	pH (5th)	pH (95th)
Carrington	Alluvium	6,154	7.0	8.0
Carrington	Interburden	10,824	6.7	7.4
Carrington	Broonie	8,628	6.8	7.1
Carrington West Wing	Alluvium	2,775	7.0	7.5
Carrington West Wing	LBL	3,531	7.3	7.6
Cheshunt	Mt Arthur	3,350	6.5	7.6
Cheshunt	Interburden	6,213	6.9	7.7
Cheshunt	Piercefield	2,596	6.4	6.8
Cheshunt / North Pit	Alluvium	4,462	6.6	7.5
Lemington South	Bowfield	12,440	6.7	7.9
Lemington South	Woodlands Hill	20,240	6.6	7.6
Lemington South	Arrowfield	15,324	6.8	7.5
Lemington South	Alluvium	22,700 3,938	6.8 6.6	7.0 7.7
Lemington South	Glen Munro	1,894	6.5	7.2
Lemington South	Interburden	11,408	6.7	7.1
North Pit	Spoil	12,460	6.5	7.8
West Pit	Sandstone / Siltstone	13,428	6.9	8.0

The WMP also includes individual groundwater trigger levels for five bores in the Carrington alluvium. Each individual trigger level and corresponding groundwater level are shown in Table 4-3.

Table 4-3 Carrington Alluvium SWL Trigger Levels

Bore	SWL Trigger (mAHD) (5th Percentile)	SWL Trigger (mAHD) (95th Percentile)
CFW55R	57.06	59.41
CFW57	58.24	59.24
CGW52a	58.23	60.52
CGW53a	58.33	59.19
CGW55a	57.49	58.43

4.4 Trigger Investigations

The 2018 annual groundwater review conducted by SLR (2019) reviewed exceedances for groundwater quality. A range of investigations were conducted at HVO over 2019 to address recommendations for bores with trigger threshold exceedances. A summary of the trigger exceedances are included below, with discussion on findings from investigations where relevant:

- 4116P – bore within spoil at Alluvial Lands constructed to 25.8 m depth. The bore recorded unique EC trends compared to surrounding bores and the trigger exceedances may relate to bore condition. The network review recommended further review of the condition of the bore and removal of the bore from the network. Monitoring was recommended for adjacent bore 4117P that intersects the spoil at the base of Alluvial Lands Pit. However, following investigation during 2019, it was determined that both 4116P and 4117P are blocked. It is recommended that the bores be purged, and if unsuccessful, a replacement bore installed and included in the monitoring network.
- HG2 – bore within weathered overburden overlying the Mt Arthur Seam to the north of Cheshunt Pit. The bore recorded unique pH trends compared to surrounding bores and the trigger exceedances may relate to bore condition but requires further review and monitoring. It was recommended that the condition, construction and geology of bore HG2 be confirmed. It was also recommended that water sampling for HG2 should include analysis of dissolved metals and major ions and data reviewed to better understand the potential cause and for early indication of potential adverse changes in water quality. This was included in the network review and will be captured with revision of the WMP;
- Bores D612(AFS) and C130(WDH) – located near Lemington South Pit intersect the Arrowfield Seam (AFS) and Woodland Hill Seam (WDH). The bores recorded a trend of rising EC with declining groundwater levels. The decline in groundwater levels was found by SLR (2019) to be potentially due to abstraction from the LUG Bore or associated with Lemington Pit final void. Modelling was conducted to predict the influence of various abstraction rates on water availability and impacts to the overlying stratigraphy. These results are discussed in Section 5.2.2.4;
- Bore PB01(ALL) – bore located near Lemington South Pit that intersects the alluvium along Wollombi Brook to 10.2 m depth. The bore recorded a slight decline in groundwater levels and rise in EC; however, SLR (2019) indicated this may relate to there being no reported streamflow along Wollombi Brook since 2017. As discussed in Section 3.1.2 no flows have been recorded along Wollombi Brook since 2017, which results in reduced recharge to the alluvium and subsequently reduced groundwater levels over time;
- D010 (GM) – bore located near Lemington South Pit and intersects the Glen Munro Seam. The bore recorded a groundwater quality trigger exceedance for EC. The trigger exceedance was found to be due to incorrect trigger level of 1,894 µS/cm specified in the WMP that was not representative of historical data. It was recommended that the groundwater trigger level for D010(GM) be updated to reflect historical data and the WMP updated to reflect this. This will be captured with revision of the WMP;
- NPz2 – bore located north-west of West Pit beyond the outcrop of coal seams mined at West Pit and extends to 62.5 m depth into interburden sequences that underlie the coal seams mined at West Pit. The bore recorded a slight rise in EC over time. Review by SLR (2019) found that the trend was consistent with historical levels for the bore. The purpose of the bore was checked as part of a network review by SLR (2019) and it was recommended that NPz2 be removed from the compliance network within the WMP as the location and construction of the bore precludes it from providing an indication of potential impacts. Bore NPz2 has now been removed from the compliance monitoring network;

- BZ1-1 – located north of Cheshunt Pit and is 21.39 m deep. The bore is included in the WMP as being within the alluvium; however as identified in prior annual reviews (AGE, 2013a) the bore likely intersects interburden material. It has been recommended that this bore be updated in the WMP as intersecting interburden. This was included in the network review and will be captured in revision of the WMP;
- CGW46 - intersects the shallow Bayswater Seam (approximately 13 m deep) underlying alluvium on the western limb of the paleochannel near Carrington Pit. The bore has been identified as dry, with field readings showing sustained groundwater levels close to the base of the bore since 2012. However, it is noted that water quality samples have been collected from CGW46 during 2019. A review of the bore construction and condition has been recommended, to confirm whether the water quality samples are representative of the surrounding groundwater; and
- Bore C130(ALL) - located between Lemington South Pit and LUG Bore and intersects interburden. C130(ALL) recorded an EC above 11,480 µS/cm in Q1, Q2, Q3, and Q4 of 2018. The annual review identified that historical readings since 2008 regularly fluctuate between 19,500 µS/cm and 24,200 µS/cm for EC and 6.4 to 7.9 for pH. The trigger levels were therefore not considered representative of historical data and should be revised within the WMP. Irrespective of this, a general trend of rising EC with a decline in water levels has been observed for C130(ALL). This trend is further explored and discussed in Section 5.3.2.4.

In 2017, trigger level exceedances for EC were also identified in Carrington bore CFW55R. Investigations were conducted and identified potential seepage in a localised area from the North Void Tailings Storage Facility (NV TSF) to the paleochannel near the bore. This was reported to the regulatory authority, and ongoing monitoring, management and assessment activities are being undertaken in consultation with the regulatory authority. This is further discussed in Section 5.2.1.2 and Section 5.3.1.2.

Also, during 2017, trigger level exceedances were recorded for pH in bore G2, near West Pit. During the trigger investigation the water level, pH and EC of bores G1, G2 and G3 were also reviewed. Recommendations in the 2018 Annual Review included review of the condition of the bores, installation of loggers, extension of the casing height for bore G3, measure the volume of water pumped from Parnell's Creek Dam and review the construction of the dam. Over 2019, the dam construction was reviewed with nothing new identified. A downhole camera investigation was conducted in bores G1 to G3. The screen interval was confirmed in G1 and G3. Bore G2 appeared to be blocked. Bore repairs, installation of loggers, casing height extension, and dam level monitoring is still to be completed during 2020.

A review of the bore condition and construction was also recommended for PZ2CH400, BC1a, BZ1-3, BZ2A(1), BZ3-3, BZ4A(2) and B425(WDH) in the 2018 Annual Review. These investigations are planned to be undertaken during 2020.

Other works to be completed during 2020, based on recommendations in the 2018 Annual Review, is the review of land use activities around D807(BFS) to understand trends and to purge bore DM4 to remove sediment present.

5 Monitoring Results

5.1 Data Recovery

As per the WMP, groundwater level monitoring and sampling was carried out at 127 monitoring bores. An additional 15 monitoring bores not specified in the WMP were also sampled and measured as part of the site monitoring programme. Sites with a data capture rate of less than 100 per cent are outlined in Table 5-1.

Table 5-1 Groundwater Monitoring Data Recovery – Compliance Bores

Location	Type	Data Recovery	Comments
4036C	SWL, WQ	0%	Bore dry
4037P	WQ	75%	Blocked in Q1
B425(WDH)	WQ	0%	Insufficient water to sample
BZ1-1	SWL	75%	Bore dry in Q2
	WQ	50%	Bore dry in Q2 and blocked in Q3
BZ4A(2)	WQ	25%	Insufficient water to sample in Q2, Q3 and Q4
C122(BFS)	SWL, WQ	0%	Bore dry
C919(ALL)	WQ	0%	Bore dry
CGW45	SWL, WQ	0%	Blocked
CGW47a	WQ	0%	Bore dry
CHPZ2A	SWL	75%	Snake in bore in Q2
	WQ	25%	Bore blocked Q2, Q3 and Q4
CHPZ8A	WQ	0%	Insufficient water to sample
DM7	SWL, WQ	0%	Bore dry
GW-101	SWL	50%	Bore dry Q3 and Q4
	WQ	0%	Insufficient water to sample
GW-107	WQ	0%	Bore dry
GW-108	WQ	0%	Insufficient water to sample

5.2 Water Levels

A summary of the water level results is provided for each of the main water bearing units (alluvium, Permian coal measures and spoil) below. Routine water level readings for 2019 are presented in Appendix B.

5.2.1 Alluvium

Three bores were recorded as dry part way through the year (C919(ALL) in Q2, Q3 and Q4; GW-101 in Q3 and Q4; BZ1-1 in Q2). One bore was recorded as blocked in Q2 (CHPZ2A).

Most alluvial bores recorded a slight decline in groundwater levels over 2019, which corresponds with a declining trend in the CRD (below average rainfall). Where saturated, groundwater within the alluvium occurred between 0.46 m (bore G3) and 23.3 m (bore GW-106) below surface over 2019. Discussion of water level trends is included for each of the mine locations from Section 5.2.1.1 to Section 5.2.1.4.

5.2.1.1 West Pit

Time series groundwater levels for the five alluvial/regolith bores north and north-west of West Pit are presented in Figure 5-1. Over 2019 groundwater elevations within the three bores (G1, G2 and G3) on the south-western side of Parnell's Creek Dam (18W) ranged between 107.12 mAHD and 109.52 mAHD (2.42 m and 0.46 m depth). Groundwater levels decreased slightly over 2019, consistent with rainfall trends.

Bores GW-100 and GW-101 are located along Parnell's Creek, downslope of the dam (18W). Comparison between groundwater levels and screened depths indicates the bores are likely dry and readings may relate to water within the sump at the base of the bore. Review of the bore construction log indicates GW-100 extends to 6 m depth and has screen from 4 m to 6 m within gravels (colluvial deposit). Bore GW-101 extends to 12 m depth and has a screen from 9 m to 12 m depth within clay. Groundwater levels within bore GW-100 show a general decline since 2017 from 4.2 m below top of casing (TOC) to 6.2 mTOC near the base of the bore. This decline in groundwater levels appears to correspond with a general declining trend in CRD since 2017 and is likely related to reduced rainfall recharge. Bore GW-101 has recorded groundwater levels over 12 mTOC and noted as dry or having insufficient water to sample since 2013. This may relate to the construction of the bore screen across low permeability clay.

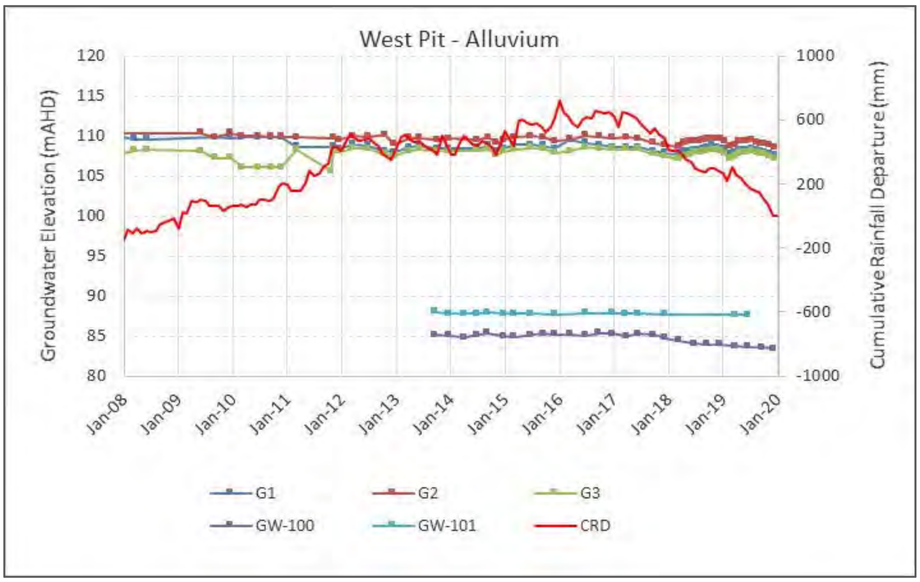


Figure 5-1 Hydrograph of Alluvial Bores – West Pit

5.2.1.2 Carrington West Wing and Carrington

Time series groundwater levels for bores within the alluvium on the western limb of the paleochannel near Carrington and Carrington West Wing are shown in Figure 5-2. Over 2019 groundwater elevations within the four bores (4032P, 4034P, 4037P and 4040P) in this area ranged between 58.79 mAHD and 59.77 mAHD (10.36 m and 12.67 m depth). Groundwater levels declined in three of the bores by 0.02 m up to 0.05 m over 2019, which appears to correlate with climate and stream flow trends. The groundwater level of 4032P increased by 0.28 m over 2019. The cause for this trend is unclear as no other bores recorded this rise and there are no known changes in land use near the bore. The bore is located outside of the mine area on land used for cattle grazing and is located near a small stand of trees. It is recommended that the condition of the bore and local land use be reviewed to determine the cause of the increase.

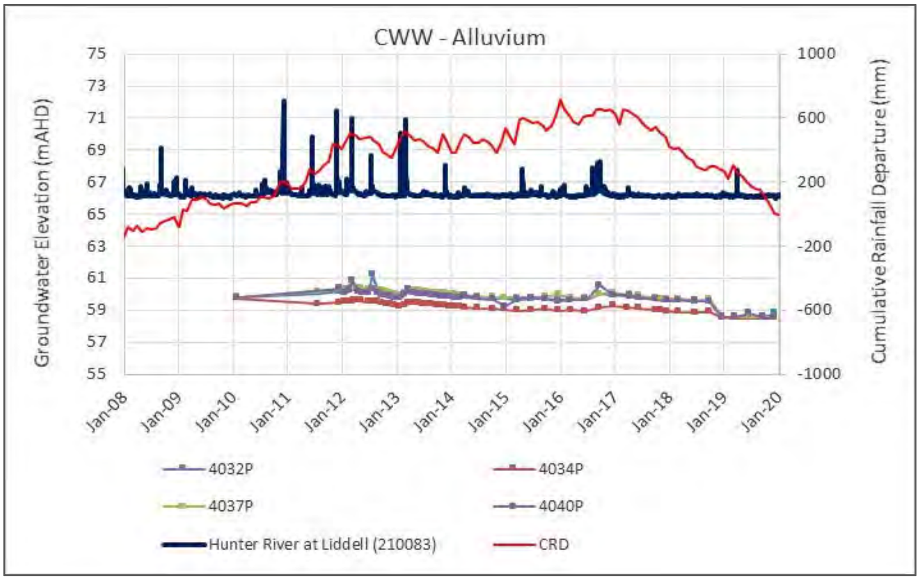


Figure 5-2 Hydrograph of Alluvial Bores – Carrington (Western Limb)

Time series groundwater levels for bores within the floodplain alluvium on the northern end of the paleochannel (CGW32 and GW-106) and the two bores on the western limb of the paleochannel (CGW39 and CGW47a) near Carrington and Carrington West Wing are shown in Figure 5-3. Over 2019 groundwater elevations within the four bores in this area ranged between 54.55 mAHD and 59.88 mAHD (12.18 m and 23.30 m depth). However, bore CGW47a was recorded as dry throughout 2019. Groundwater levels declined by 0.05 m within the bores over 2019, which appears to correlate with climate and stream flow trends and may also relate to localised drawdown towards the Carrington Pit final void.

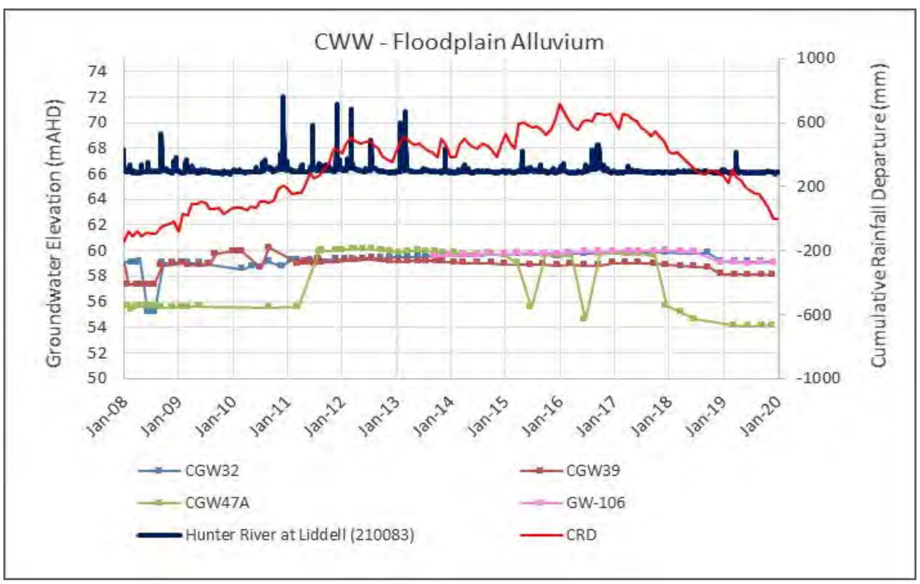


Figure 5-3 Hydrograph of Floodplain Alluvial Bores – Carrington (Western Limb)

Time series groundwater levels for bores within the alluvium on the five bores on the eastern limb of the paleochannel near Carrington and Carrington West Wing are shown in Figure 5-4. The groundwater levels in all five bores, CFW55R, CGW53a, CFW57, CGW55a, and CGW52a, remained relatively stable throughout 2019. Groundwater levels ranged between 57.44 mAHD (13.60 m depth – CGW55a) and 58.63 mAHD (11.65 m depth – CFW55R).

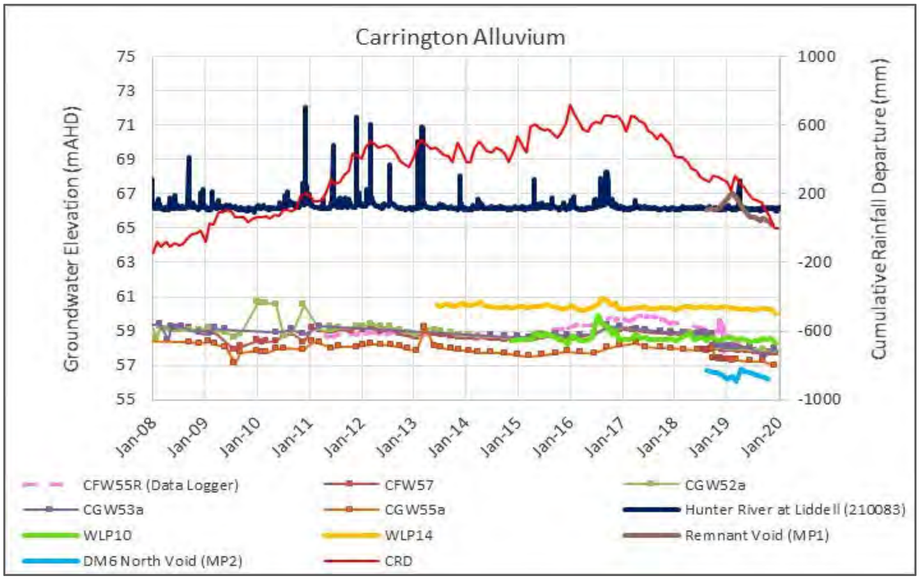


Figure 5-4 Hydrograph of Alluvial Bores – Carrington

Ten additional groundwater monitoring bores (GW-120 to GW-129) were installed in 2018 to the west of the NV TSF; eight bores within the alluvium, one within spoil and one with the Permian coal measures. The bores were installed to delineate the extent of impacts and monitor response to management practices. Groundwater level triggers were assigned to the existing five alluvial bores at Carrington, CFW55R, CFW57, CGW52a, CGW53a and CGW55a. Hydrographs for each of the bores and Hunter River elevations are compared to CRD in Figure 5-5 to Figure 5-9. The graphs show that the five bores stayed within the trigger levels until late 2018. Following this groundwater levels started to decline below the 5th percentile trigger level and have continued to decline in 2019. The decline in groundwater levels indicates a decline in seepage from NV TSF.

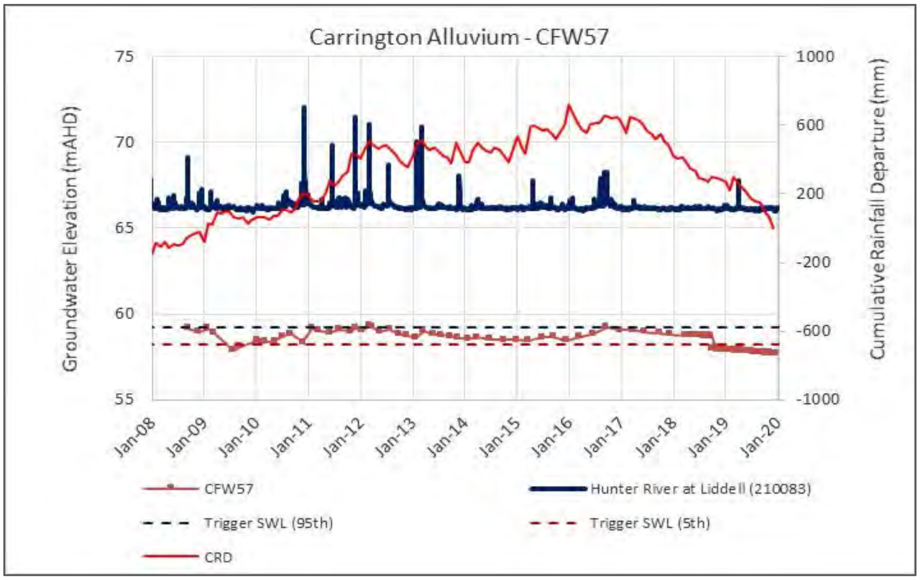


Figure 5-5 Hydrograph of Alluvial Bores – Carrington – CGW57

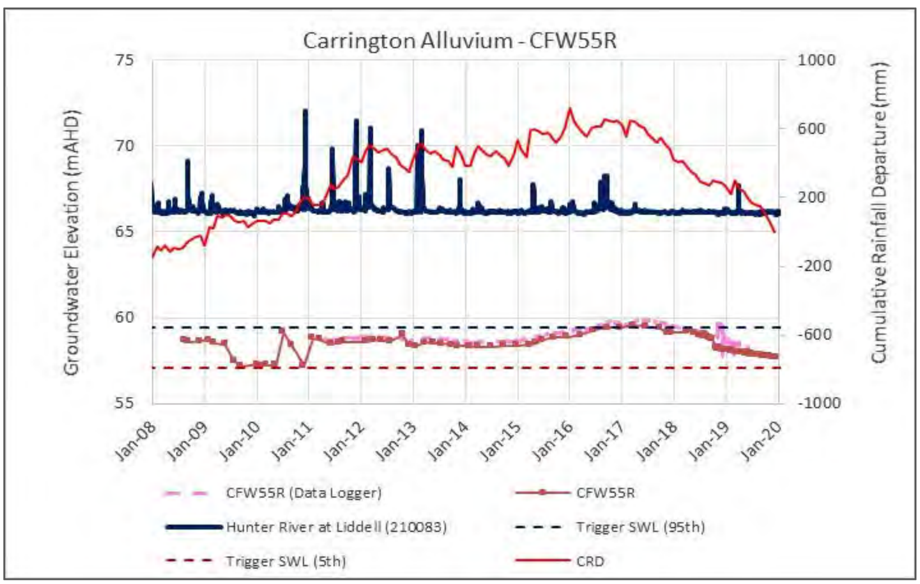


Figure 5-6 Hydrograph of Alluvial Bores – Carrington – CGW55R

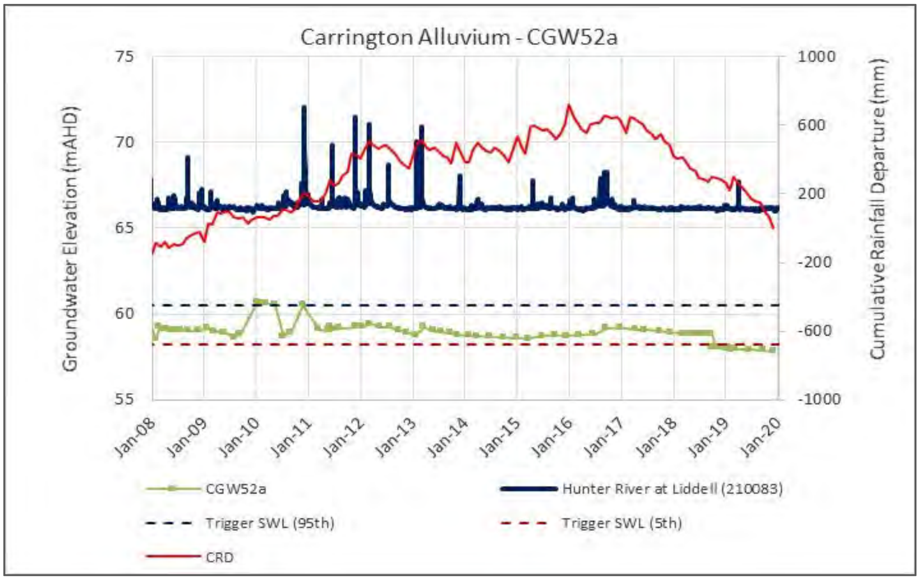


Figure 5-7 Hydrograph of Alluvial Bores – Carrington – CGW52a

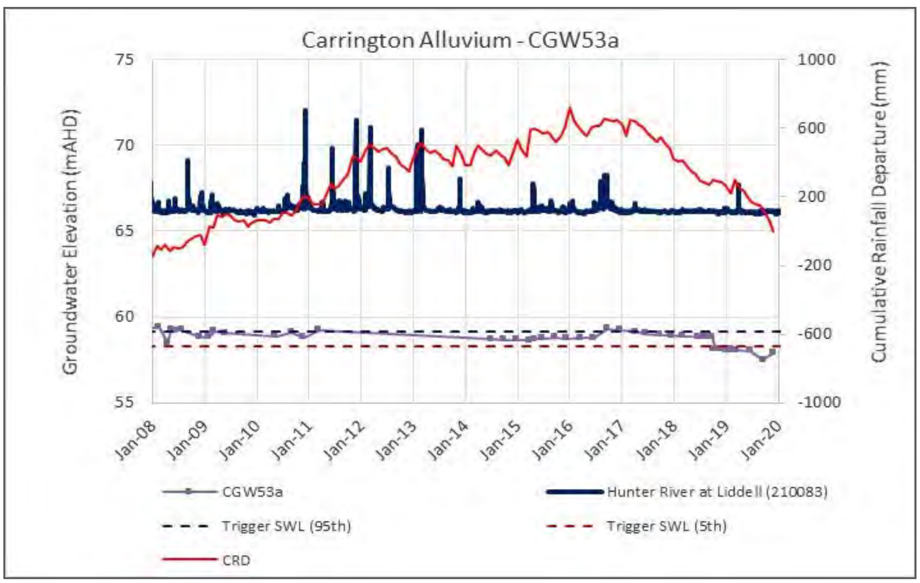


Figure 5-8 Hydrograph of Alluvial Bores – Carrington – CGW53a

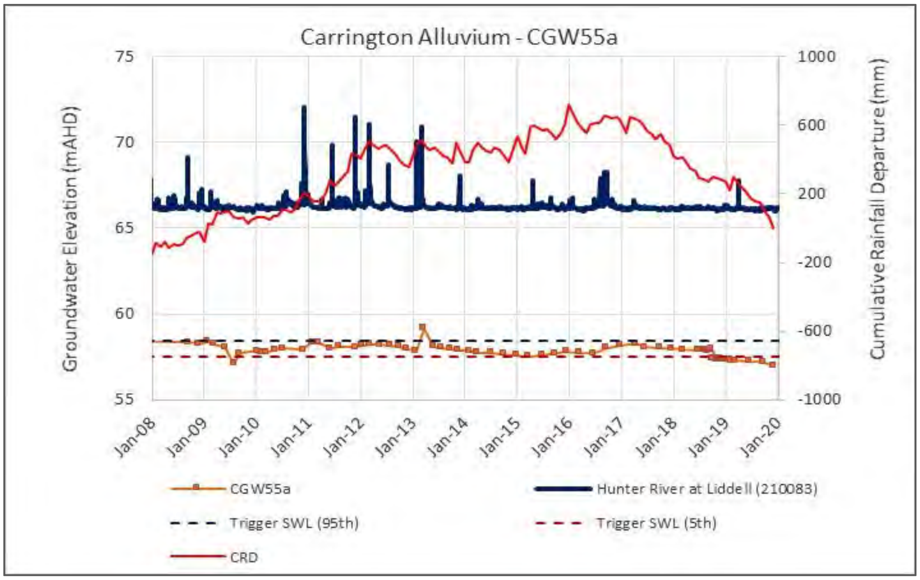


Figure 5-9 Hydrograph of Alluvial Bores – Carrington – CGW55a

Time series groundwater levels for the newly installed bores within the alluvium along the western edge of the North Void and south of Carrington Pit are shown in Figure 5-10. Monitoring began in the eight bores in October 2018. Over 2019 groundwater elevations within the eight alluvium bores in this area ranged between 58.44 mAHD and 58.91 mAHD (10.21 m and 12.30 m depth). Bore GW-121 was recorded as dry throughout 2019. Groundwater levels declined by 0.04 m to 0.12 within the bores over 2019. The purpose of the monitoring is to ensure no additional seepage into the alluvium at this location. The observed decline in groundwater levels over 2019 indicates a decline in seepage and corresponds with a general trend of below average rainfall.

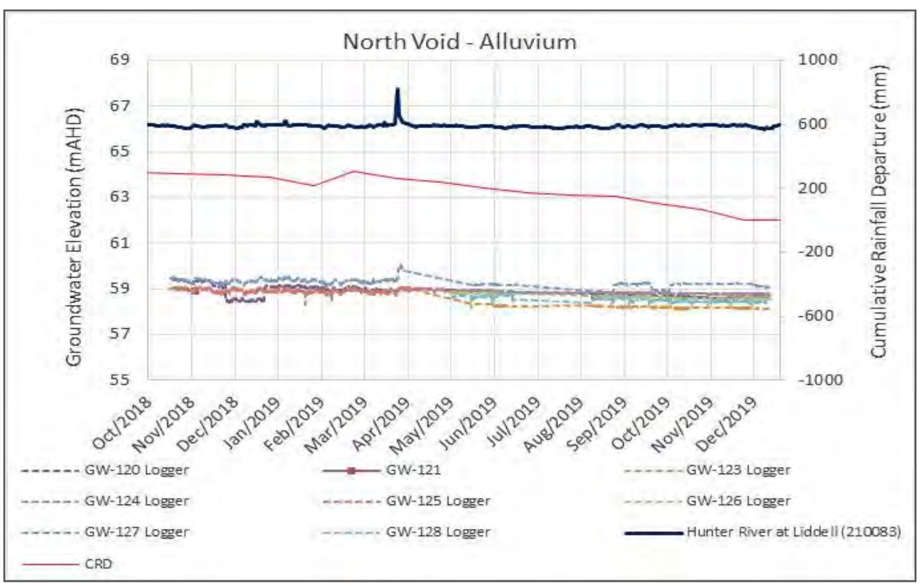


Figure 5-10 Hydrograph of Alluvial Bores – Carrington/North Void

5.2.1.3 Cheshunt Pit/North Pit

Time series groundwater levels for bores within the alluvium north and south of the Hunter River, between North Pit and Cheshunt Pit are shown in Figure 5-11. Two bores (CHPZ8A and BUNC45A) recorded groundwater levels at or below the base of the screen and are believed to be dry. Bore BZ1-1 was recorded as dry in Q2 and bore CHPZ2A was recorded as blocked in Q2. Where the alluvium is saturated, groundwater levels ranged between 53.94 mAHD and 60.27 mAHD (2.36 m and 17.68 m depth). With the exception of PZ2CH400, groundwater levels generally stable and increased slightly by up to 0.24 m within the alluvial bores over 2019.

Bore PZ2CH400 recorded fluctuations of up to 6.87 m between 2018 and 2019, and from March 2019 the bore has recorded a slight rise in groundwater levels of 0.28 m. Groundwater elevations indicate groundwater flow in the Hunter River alluvium follows stream flow, with higher elevations to the west at PZ3CH800 and lowest elevations at bores PZ2CH400 and PZ1CH200.

Over 2019 groundwater levels in PZ2CH400 ranged from 2.36 m (60.27 mAHD) in Q1 to 8.02 m (54.61 mAHD) in Q4, but remained higher than upstream bore PZ3CH800, by 5.24 m by the end of the year. Bore PZ2CH400 is located immediately east of the North Pit barrier wall and around 180 m east of spoil bore 4119P. Bore 4119P recorded spoil water elevations between 53.56 mAHD and 53.85 mAHD over 2019, lower than alluvial levels at bore PZ2CH400. It was recommended that the bore construction and condition be reviewed in the 2018 Annual Review. It is noted that this is planned to be undertaken during 2020.

It is also noted that bore BZ1-1 is included in the WMP as being within the alluvium, however as identified in prior annual reviews (AGE, 2013a) the bore likely intersects interburden material. It is recommended that this bore be updated in the WMP as intersecting interburden.

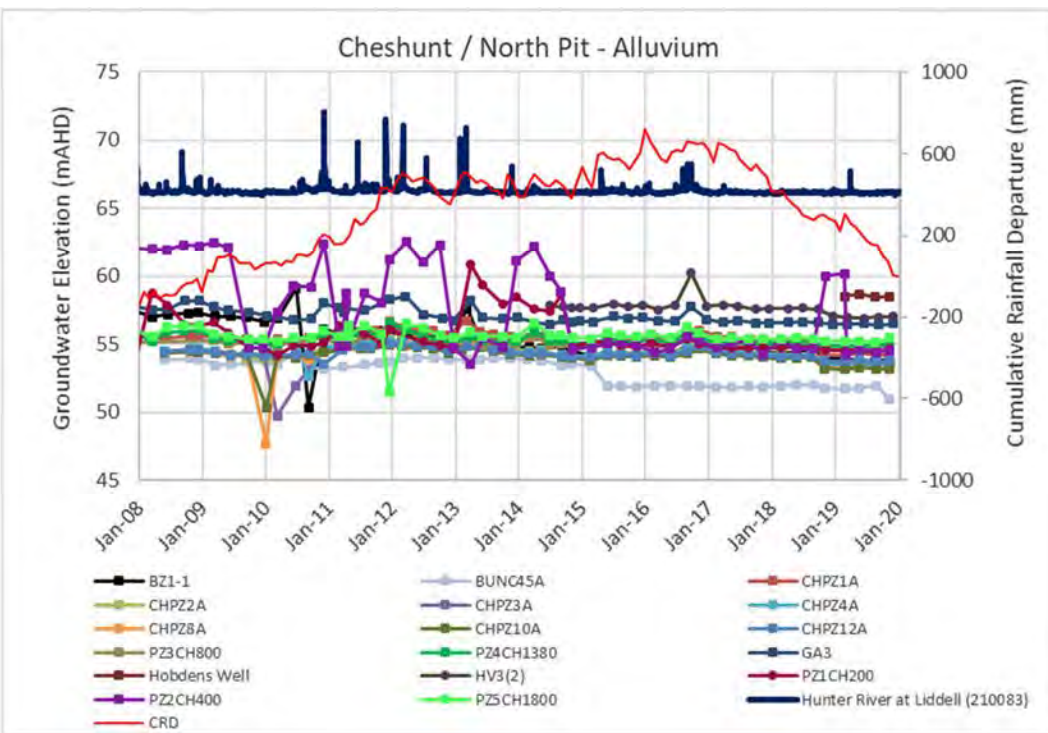


Figure 5-11 Hydrograph of Alluvial Bores – Cheshunt/North Pit

5.2.1.4 Lemington South

Time series groundwater levels for four bores within the alluvium at Lemington South, along the Wollombi Brook, are shown in Figure 5-12. As shown in Figure 5-12, groundwater levels fairly stable throughout 2019 with the a decline in groundwater levels of 0.36 m recorded within Appleyard Farm bore, which is located over 1.2 km upstream of Lemington South Pit and within 50 m of Wollombi Brook. Stream gauge Wollombi Brook at Warkworth is located approximately 350 m upstream of the bore. The groundwater level trends show a close correlation with declining stream flow levels and discharge for Wollombi Brook, with no discharge recorded since 2017.

Bore PB01(ALL) is located approximately 150 m from Wollombi Brook and shows a more muted response to stream flow with a decline in groundwater levels of 0.26 m. Bore C919(ALL) was recorded as dry in Q2, Q3 and Q4 of 2019. Bore D317(ALL) is located adjacent to the Lemington South Pit, approximately 190 m from Wollombi Brook.

Over 2019 groundwater elevations within the alluvial bores Appleyard Farm and PB01(ALL) ranged between 36.48 mAHD and 45.35 mAHD. Groundwater levels remained fairly stable over 2019, but showed a decline of up to 0.36 m in line with stream flow and rainfall.

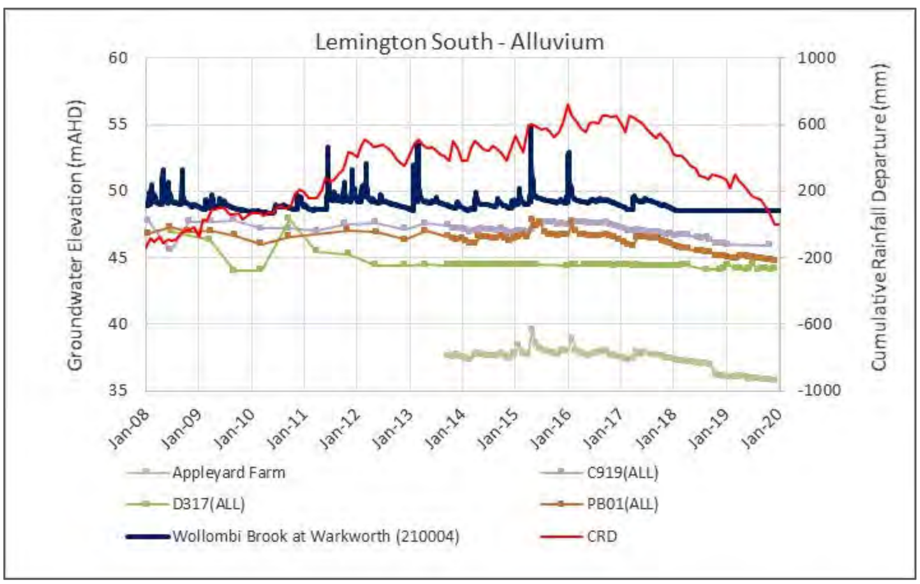


Figure 5-12 Hydrograph of Alluvial Bores – Lemington South

5.2.2 Permian Coal Measures

Over 2019, two bores in the Permian coal measures were recorded as dry (4036C and C122(BFS)), and one bore was reported as blocked (CGW45). There are eight vibrating wire piezometers (VWPs) that monitor the coal seam and interburden sequences of the Permian coal measures in the Carrington mine area (GW-100a, GW-101a, GW-102, GW-103, GW-104, GW-105, GW-109 and GW-110).

Discussion in water level trends within the Permian coal measures is included for each of the mine locations from Section 5.2.2.1 to Section 5.2.2.4.

5.2.2.1 West Pit

Three of the four bores targeting the Permian coal measures at West Pit were monitored over 2019, bores NPz2, NPz3 and NPz5. Bores NPZ4 and NZP5 intersect the Jerrys Plains Subgroup between West Pit and Carrington Pit. NPz4 was monitored up to December 2016 before being decommissioned due to advancement of mining, and NPZ5 is planned to be decommissioned with advancement of mining in 2020. Review of the geology mapped at bore NPZ2 identified that it intersects the Saltwater Creek Formation (Pswc), and bore NPz3 intersects Mulbring Siltstone. The Saltwater Creek Formation underlies the Vane Subgroup mined at West Pit. The Saltwater Creek Formation comprises laminated sequences of siltstone and sandstone, and the underlying Mulbring Siltstone comprises low permeability siltstone and claystone units and is considered to act as a confining unit. Bore NPz3 intersects Mulbring Siltstone (Pmm).

Groundwater elevations for the bores at West Pit are presented in Figure 5-13. Over 2019 groundwater levels within bore NPz2 declined by 0.48 m over 2019, while bore NPz3 groundwater levels declined 0.91 m over 2019. These two bores are located upslope, on the northwest side of West Pit. The cause for the groundwater trends at NPz2 and NPz3 is unclear and would require further information regarding historical land use activities in the region. However, based on available information, the cause for the changes in groundwater levels do not appear to correlate to mine activities conducted at West Pit. As part of a network review it was recommended that NPz2 and NPz3 be removed from the compliance network within the WMP, as the location and construction of the bores precludes them from providing an indication of potential impacts. However, it is recommended these bores remain in the monitoring program to assist with future assessments and assessment of post closure groundwater conditions.

Bore NPz5 is located down-slope (south) of the West Pit highwall and recorded a 3.28 m decline in groundwater levels over 2019. This decline is likely a response to mining at West Pit, and consistent with groundwater drawdown predictions for the approved operations (see Section 2.2). With the removal of bores NPZ4 and NPZ5, ongoing monitoring of groundwater trends in the coal measures can be captured at VWP GW-103 to GW-105.

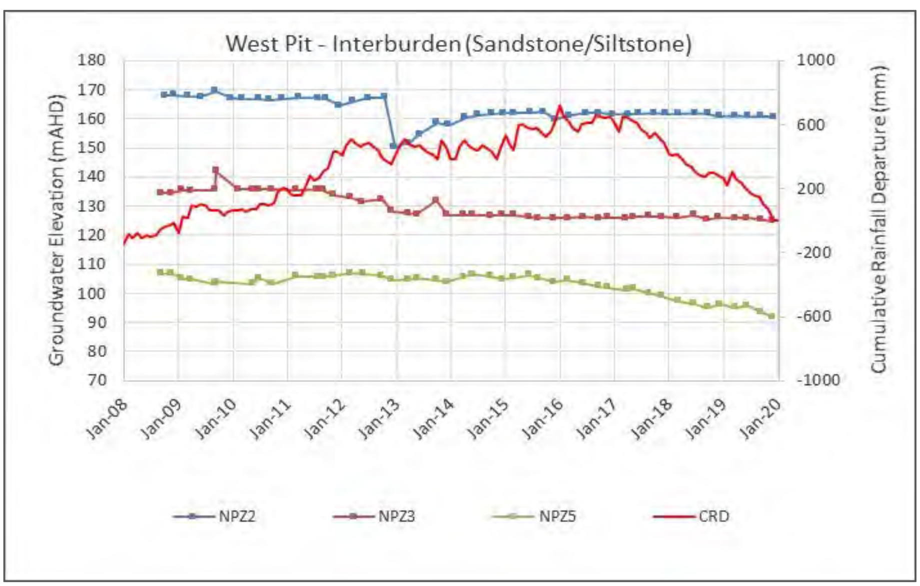


Figure 5-13 Hydrograph of Permian Coal Measures Bores – West Pit Bores

Eight vibrating wire piezometers (VWPs) were installed in the West Pit area (GW-100a, GW-101a, GW-102, GW-103, GW-104, GW-105, GW-109, and GW-110) in 2012, intersecting the Permian coal measures. Bores GW-103, GW-104 and GW-105 are located to the south of West Pit. Bore GW-109 is located to the west of Carrington Pit, and bore GW-110 is located north of Carrington Pit. Groundwater level trends for the VWPs are presented in Figure 5-14. Review of the data identified that some sensors have previously failed, including VWP1 (interburden) in GW-101a and VWP3 (coal seam) in GW-109. The units these sensors monitor are also monitored by nearby bores/VWPs. It is recommended that these sensors be removed from the revised WMP. In addition, calibration details for GW-110 were not available at the time of reporting, therefore data could not be converted and graphed. However, VWP GW-110 is located near the highwall within Carrington Pit void and may be decommissioned. Ongoing monitoring of groundwater level recovery in spoil material near Carrington Pit void can continue to be conducted at bores GW-107 and GW-108.

VWP GW-100a (Barrett Seam and interburden) and VWP GW-102 (interburden) are located to the west of West Pit. GW-100a recorded relatively stable levels, while GW-102 declined over time.

VWP GW-103, VWP GW-104 and VWP GW-105 are located south of West Pit. GW-103 recorded relatively stable levels, while GW-105 shows a gradual decline in levels over time. GW-104 VWP1 (Lower Pikes Gully Seam), VWP2 (interburden material) and VWP3 (in sandstone above the Barrett Seam) all declined over time due to depressurisation from coal mining at West Pit.

VWP GW-109 is located within the west of the Carrington Pit and the sensor within weathered coal (GW-109 VWP1) recorded a slight rise in water levels over 2019, while the deeper sensor within tuffaceous coal (GW-109 VWP2) recorded a relatively stable groundwater levels at a lower elevation. The difference in the two sensors may relate to instrument drift or an additional source of recharge to the shallow stratigraphy. The area generally experienced below average rainfall and no water storage is known of at the site or upgradient of the VWP. Groundwater levels within the spoil in Carrington Pit 1.3 km to the north are also lower at around 24 mAHD (GW-109) and predicted to remain low due to the presence of the Carrington Pit void (AGE, 2016). It is recommended that local site conditions and the condition of the VWP GW-109 be reviewed, and groundwater conditions within the spoil in Carrington Pit continue to be monitored.

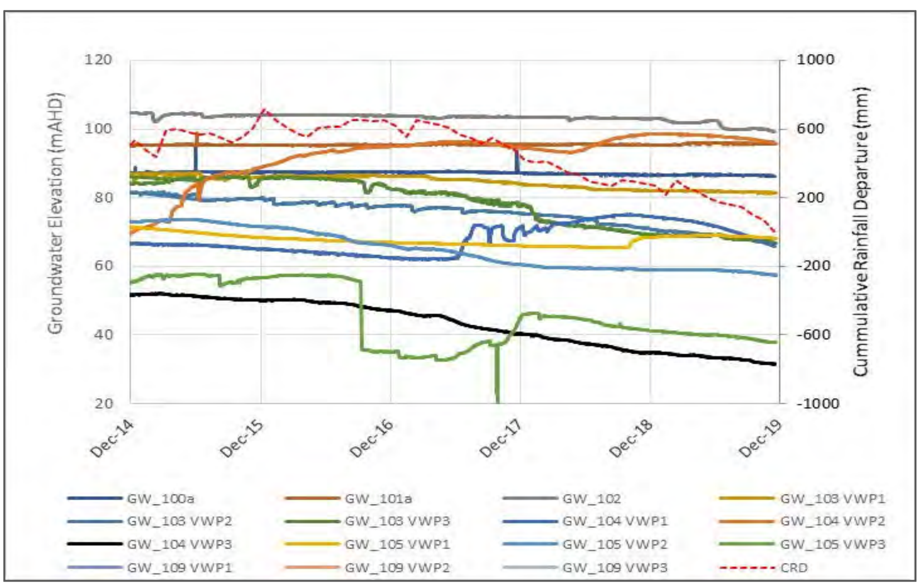


Figure 5-14 Hydrograph of Permian Coal Measures Bores – West Pit VWPs

5.2.2.2 Carrington and Carrington West Wing

The WMP includes seven monitoring bores with screens that intersect the Permian coal measures at Carrington and Carrington West Wing. This includes two bores within the Bayswater Seam (CGW45 and CGW46), two within the Broonie Seam (CGW52, CGW53) and three within the interburden material (4036C, 4051C and CGW51a). One of the bores (CGW45) were reported as blocked in 2019, and one was recorded as dry (4036C). Time series groundwater elevations for the seven bores are presented in Figure 5-15.

Bore CGW46 intersects the shallow Bayswater Seam (approximately 13 m deep) underlying alluvium on the western limb of the paleochannel. Over 2019, groundwater within the bore remained relatively stable, recorded at depths of between 12.19 m and 12.94 m. Groundwater levels within the bore are close to the base of the bore and have remained relatively stable since 2012, which may indicate the bore is dry. Further review of the condition of the bore is recommended. Bore CGW53 recorded fluctuations in groundwater levels throughout the year with an overall 0.29 m decline in groundwater levels. Bores CGW52 and CGW53 both intersect the Broonie Seam and recorded a slight rise in water levels over 2019, which appears to relate to recovery in groundwater conditions with cessation of mining at Carrington Pit.

Review of available bore details indicates bore CGW51a is actually screened within alluvium comprising fine to medium grained gravel and sand immediately overlying coal. As a result, groundwater within the bore is representative of alluvial groundwater and groundwater within the weathered coal measures. Over 2019 the bore recorded a general decline in groundwater levels following climate trends. Due to the construction of the bore, it is recommended that it be decommissioned to minimise potential mixing and groundwater levels within the backfilled Carrington Pit be monitored to ensure the void continues to act as a groundwater sink. It is recommended that a new bore be installed within the spoil material to replace CGW51a.

Bore 4051C is located in the western limb of the paleochannel, screened within interburden. Groundwater levels in bore 4051C increased by 1.42 m over 2019. Nearby, bore 4040P, screened in alluvium, remained stable over 2019. Previous records indicated an obstruction within bore 4051C, it is recommended that the total depth of the bore be checked and a downhole camera survey conducted to verify if 4051C is providing representative groundwater data.

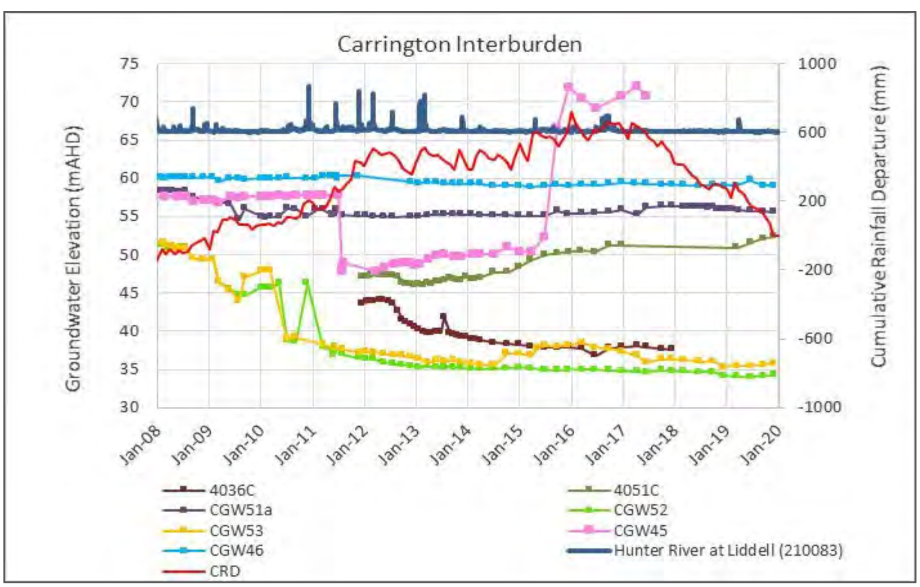


Figure 5-15 Hydrograph of Permian Coal Measures Bores – Carrington

5.2.2.3 Cheshunt Pit

The WMP includes 13 monitoring bores with screen that intersects the Permian coal measures at Cheshunt Pit. This includes nine bores within the Mt Arthur Seam (BC1a, BZ1-3, BZ2A(1), BZ3-3, BZ4A(2), CHPZ3D, CHPZ8D, CHPZ12D, HG2a), one within the Piercefield Seam (BUNC45D) and three within the interburden material (BZ3-1, BZ8-2 and HG2).

Time series groundwater elevations for the bores are presented in Figure 5-16 to Figure 5-18. Sustained groundwater level drawdown in response to the approved mining is visible within two of the bores intersecting the Mt Arthur seam (BZ1-3 and BZ4A(2)). Bores BZ2A(1), BZ3-3, which also intersect the Mt Arthur seam, had stable groundwater level trends over 2019. Bore BC1a also intersects the Mt Arthur Seam and showed drawdown from 2011 to 2014 (48.78 mAHD), followed by a gradual recovery in groundwater levels (49.08 mAHD) in 2017. A decline was recorded in November 2018 of 0.3m (48.78 mAHD). Over 2019 groundwater levels in BC1a remained fairly stable with a groundwater elevation of 48.75 mAHD in Q4. The adjacent Mt Arthur Seam bore HG2a shows relatively stable groundwater elevations of around 41.15 mAHD since 2012. Due to the proximity of BC1a and HG2a it is recommended that the bore construction and condition is reviewed to understand the difference in groundwater elevations between the two bores.

Groundwater levels in bore BZ3-1, which intersects the Cheshunt Interburden, declined 0.83 m over 2019. The remaining Mt Arthur seam bores (CHPZ3D, CHPZ8D and CHPZ12D) and Piercefield seam bore (BUNC45D) are located over 1 km north-east of Cheshunt Pit, north of the rehabilitated Barry's Pit. All four bores show relatively stable groundwater levels over 2019.

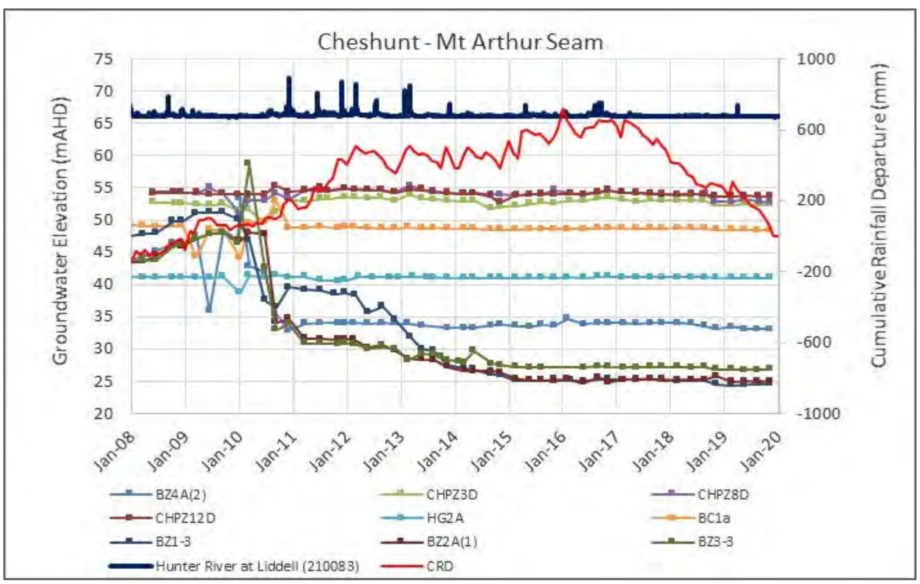


Figure 5-16 Hydrograph of Permian Coal Measures – Cheshunt Mt Arthur Seam

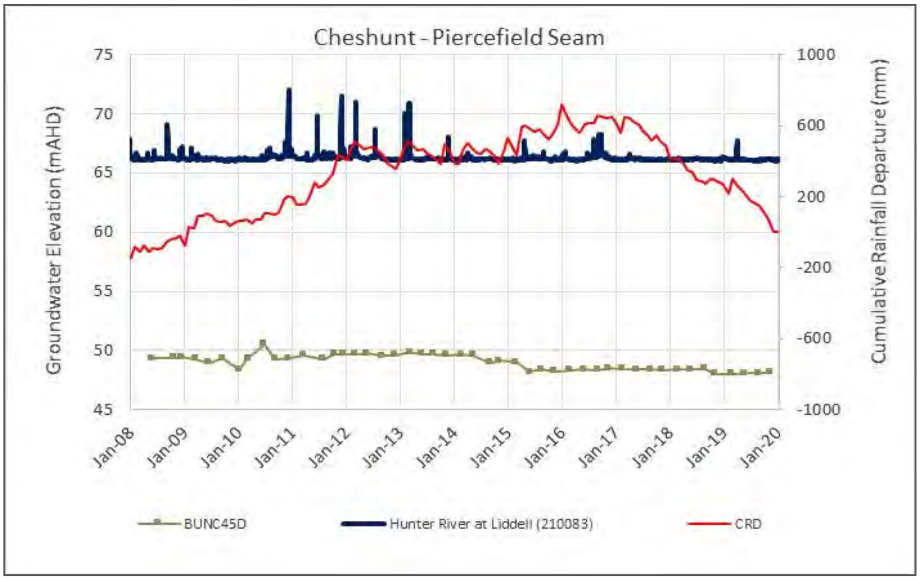


Figure 5-17 Hydrograph of Permian Coal Measures – Cheshunt Piercefield Seam

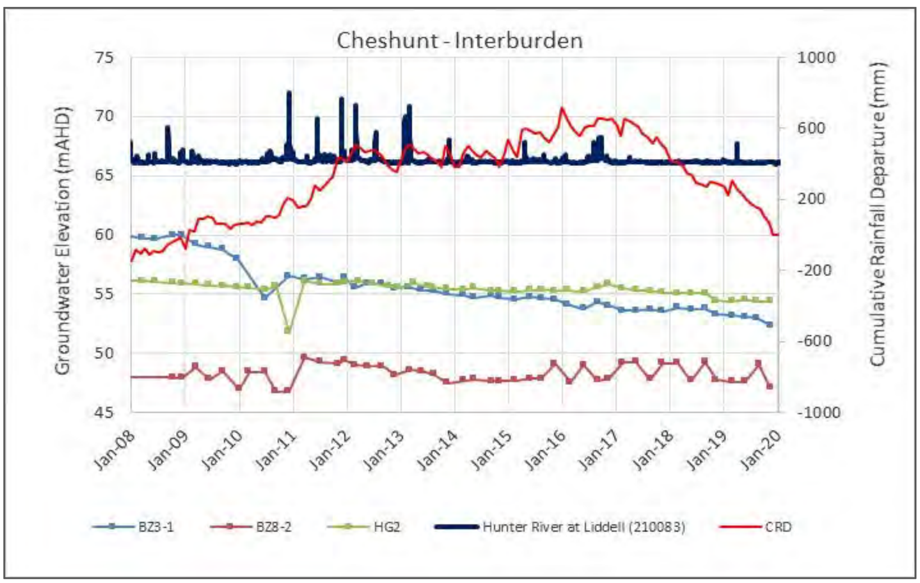


Figure 5-18 Hydrograph of Permian Coal Measures – Cheshunt Interburden

5.2.2.4 Lemington South

The WMP includes 29 monitoring bores with screen that intersects the Permian coal measures at Lemington South. This includes:

- Four bores within the Arrowfield Seam - C130(AFS1), D406(AFS), D510(AFS) and D612(AFS);
- One bore within the shallow interburden material (siltstone/sandstone) - C130(ALL);
- Eight bores within the Glen Munro Seam and/or Woodlands Hill Seam - B425(WDH), B631(WDH), C122(WDH), C130(WDH), C317(WDH), C809(GM/WDH), D010(WDH) and D010(GM); and

- 16 bores within the Bowfield Seam - B334(BFS), B631(BFS), B925(BFS), C122(BFS), C130(BFS), C317(BFS), C613(BFS), C621(BFS), C630(BFS), D010(BFS), D214(BFS), D317(BFS), D406(BFS), D510(BFS), D612(BFS) and D807(BFS).

Time series data for bores targeting the Arrowfield Seam are presented in Figure 5-19. As shown in Figure 5-19, two of the Arrowfield Seam bores recorded declining groundwater levels over 2019, consistent with climate trends. Bores D406(AFS) and D510(AFS) declined by up to 0.58 m during 2019. Bores D612(AFS) and C130(AFS1) remained stable over 2019. Groundwater levels in bores C130(AFS1) and D406(AFS) both remained stable over 2019.

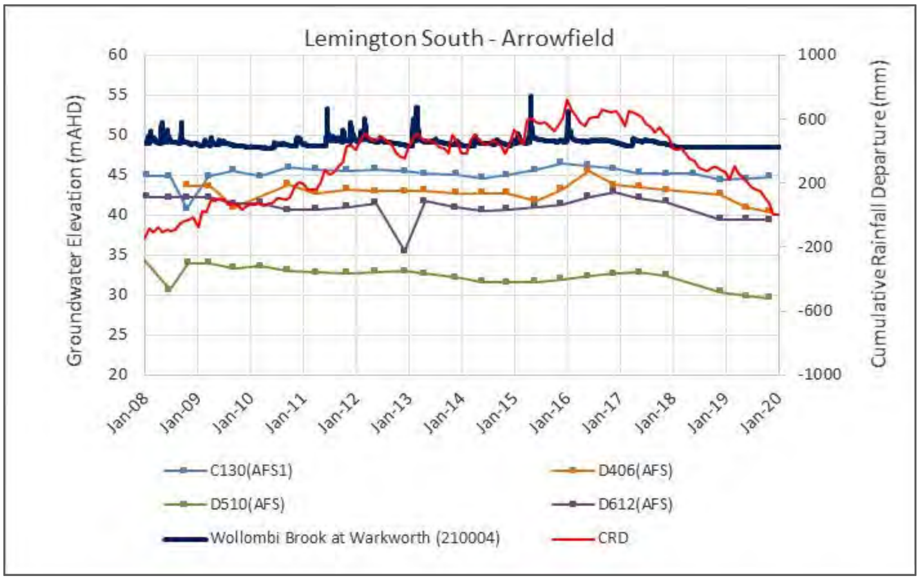


Figure 5-19 Hydrograph of Arrowfield Seam – Lemington South

Time series data for bores targeting the shallow interburden, Woodlands Hill Seam and Glen Munro Seam are presented in Figure 5-20. As shown in Figure 5-20 groundwater elevations for all bores except B425(WDH) ranged between 45.51 mAHD and 47.60 mAHD (8.73 m and 26.21 m depth). Over 2019 the groundwater levels declined between 0.02 m (C130(WDH)) and 0.46 m (D010(GM)). Following the decline of groundwater levels in bore B425(WDH) during 2017, the bore was recorded as dry throughout 2018 and 2019. These elevations and trends correspond more closely with trends observed for the Bowfield Seam bores. Further review of the construction and target lithology of bore B425(WDH) is required. From the network review it was suggested the bore be removed from the monitoring network in favour of ongoing monitoring at nearby bore C130(WDH).

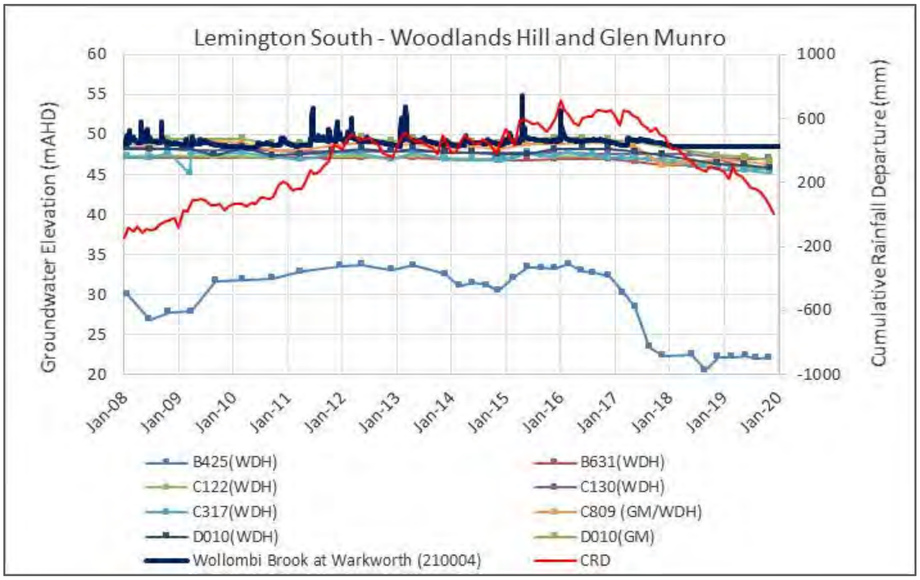


Figure 5-20 Hydrograph of Woodlands Hill Seam and Glen Munro Seam – Lemington South

Time series data for bores targeting the Bowfield Seam are presented in Figure 5-21. As shown in Figure 5-21, groundwater elevations ranged between 6.58 mAHD and 34.22 mAHD (24.66 m and 55.66 m depth). Interpolated groundwater elevation contours for the Bowfield Seam are presented in Figure 5-22, based on December 2019 readings. Groundwater levels in bores C630(BFS), D317(BFS), D214(BFS), D010(BFS) and C613(BFS) have remained relatively stable over 2019. All of the bores are located west of Lemington South pit. In comparison, bore D807(BFS) rose by 0.88 m, D612(BFS) rose by 0.42 m, D406(BFS) rose by 0.79 m and B334(BFS) rose by 1.88 m over 2019. With the exception of B334(BFS), all of the bores are north-west of the Lemington South pit, close to Wollombi Brook. B334(BFS) is located south of Lemington South pit. Increasing water level trend likely relates to water level recovery following the cessation of mining in the nearby Glider Pit.

Bore C631(BFS) declined by 3.02 m, C621(BFS) declined by 1.48 m, C130(BFS) declined by 2.50 m, C317(BFS) declined by 3.82 m and B925(BFS) declined by 4.57 m. The bores are located between 300 m (B925(BFS)) and 1.3 km (C621(BFS)) of the LUG bore. The LUG bore intersects the historical Lemington Underground workings, which mined through the Bowfield Seam. Over the 2019 (calendar year) 1,732.5 ML of water was abstracted from the bore, at an average rate of 4,800 m^3/day. The groundwater level drawdown is therefore likely related to abstraction from the bore. This is shown in Figure 5-22, which illustrates groundwater flow towards LUG Bore to the southwest. This trend is visible in a range of bores intersecting the Permian coal measures in the area.

The observed drawdown is consistent with predicted drawdown in the coal measures with abstraction from LUG Bore, as modelled by SLR (2019b). SLR (2019b) utilised the existing numerical groundwater model developed for HVO Modification 5 to predict the change in groundwater levels and sustainable yield from LUG Bore. The model predicted groundwater level drawdown within the Mt Arthur Seam in response to abstraction from the historical Lemington Underground workings by LUG Bore. The abstraction was predicted to induce depressurisation in the coal measures correlating to the observed decline in groundwater levels for bores intersecting the coal measures near Lemington Underground.

Alluvial bore Appleyard Farm is the closest alluvial bore to the LUG Bore. As discussed in Section 5.2.1.4, groundwater trends within the bore reflect rainfall and stream flow trends. The bore shows no clear impacts related to groundwater abstraction from the historical underground mine beyond climate and streamflow changes. However, the abstraction rate from the LUG bore is higher than previously assessed. It is recommended that numerical modelling be undertaken to assess the impacts of the higher abstraction rate from the LUG bore.

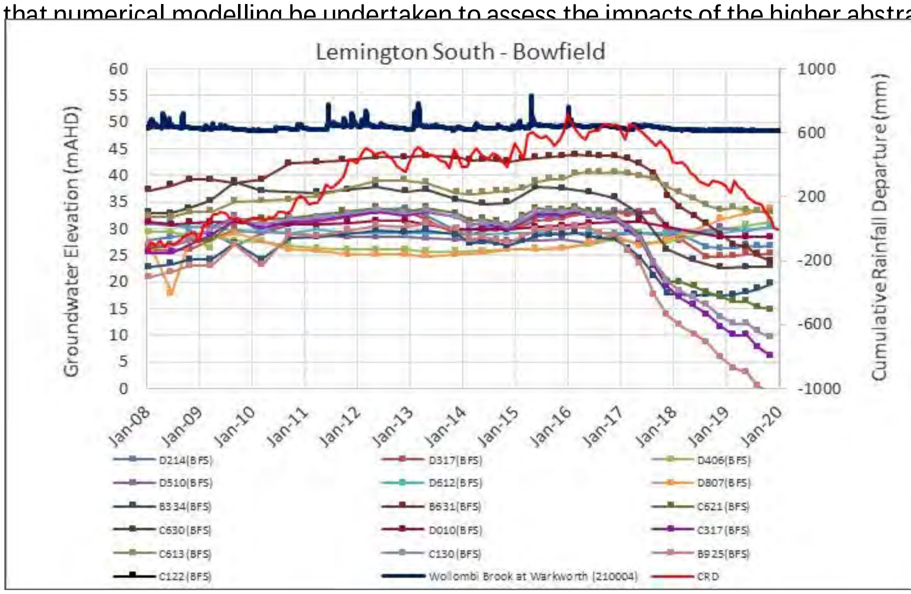
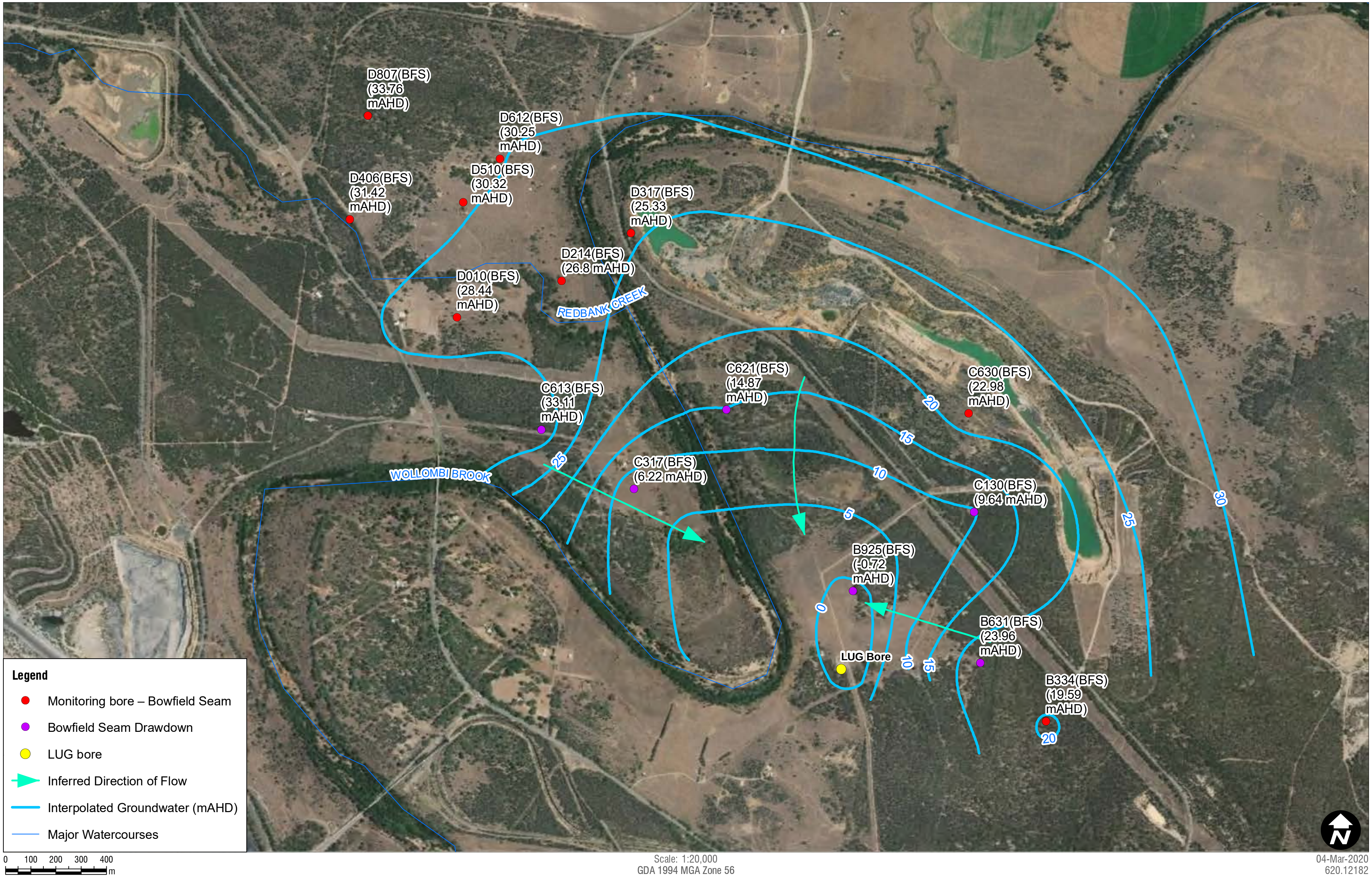


Figure 5-21 Hydrograph of Bowfield Seam – Lemington South



Sheet Size : A4

SLR
www.slrconsulting.com

Hunter Valley Operations
2019 Review
Interpolated LUG Bore Groundwater Drawdown - Bowfield Seam

FIGURE 5-22

\\au.slr.local\Corporate\Projects-SLR\620-BNE\620-BNE\620.12182 HVO Groundwater Compliance\06 SLR Data\01 GIS\01 ArcGIS\mxd\62012182_Interpolated LUG Bore Groundwater Drawdown - Bowfield Seam - 2019 Review_2.mxd

5.2.3 Spoil

The WMP includes 15 monitoring bores that intersect spoil material within North Pit. Bore DM7 which is located within North Pit, was recorded as dry through 2019. A comparison was made in bores GW-114, 4116P, GW-107 and GW-108, which intersect the spoil, between groundwater levels and screened depths and indicates that the bores are likely dry and readings may relate to water within the sump at the base of the bore.

5.2.3.1 North Pit

Time series groundwater levels for the spoil are presented in Figure 5-23. Over 2019 groundwater elevations within the bores ranged between 32.74 mAHD and 77.86 mAHD (10.89 m and 36.68 m depth). Groundwater within the spoil flows from northern-most bore DM1 (77.86 mAHD) in a southerly direction towards the southern-most bore MB14HVO03 (32.74 mAHD). Over the course of 2019 groundwater levels declined by between 0.01 m and 0.82 m, consistent with rainfall trends.

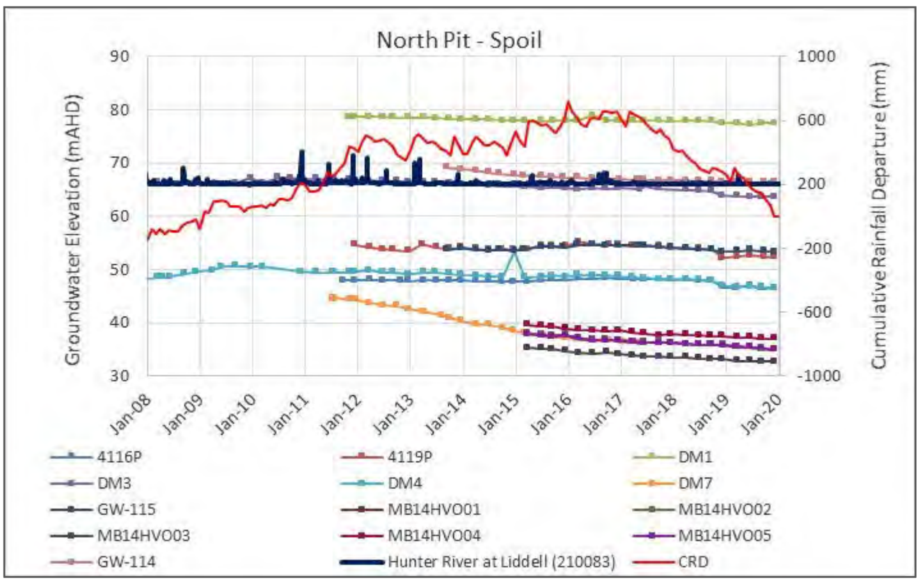


Figure 5-23 Hydrograph of Spoil Bores – North Pit

5.2.3.2 Carrington

Time series groundwater levels for the spoil are presented in Figure 5-24. Over 2019 groundwater elevations within the bores ranged between 23.50 mAHD and 61.54 mAHD (11.49 m and 60.9 m depth). Groundwater within the spoil flows from northern-most bore DM1 (77.86 mAHD) in a southerly direction towards southern-most bore MB14HVO03 (32.74 mAHD). Over the course of 2019 groundwater levels declined by 3.49 m in bore GW-129, while bores GW-107 and GW-108 were essentially dry throughout 2019. It is likely the reduction in groundwater levels in these bores is a result of decanting of water from the North Pit/North Void and influence of the Carrington Pit final void.

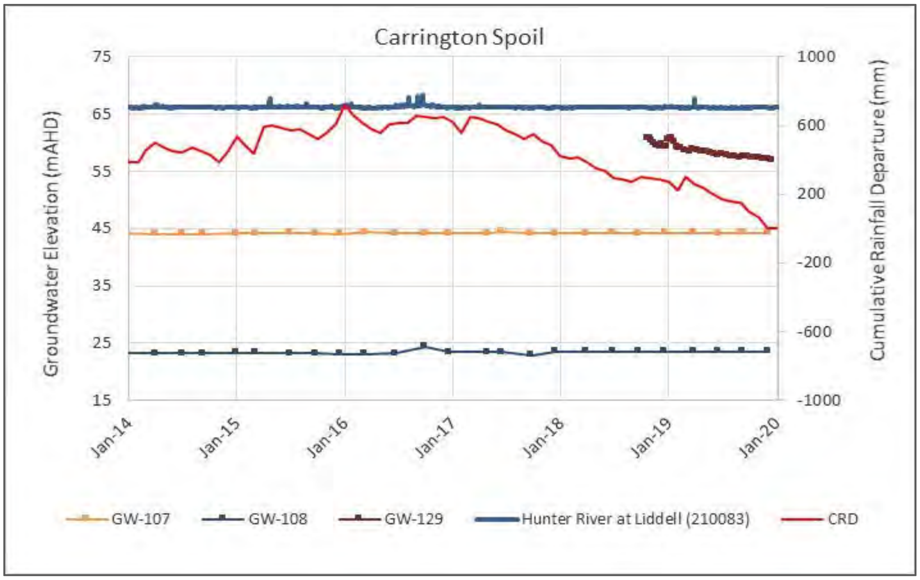


Figure 5-24 Hydrograph of Spoil Bores – Carrington

5.3 Water Quality

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

5.3.1 Alluvium

Routine monitoring of EC and pH was conducted for all alluvial monitoring bores over 2019 on a quarterly basis. An exception to this were bores GW-101, CGW47a, C919(ALL), GW-121 and CHPZ8A, which were recorded as dry over 2019. Bore BZ1-1 was recorded as dry in Q2. In addition, water quality samples were unable to be collected from bores 4037P (Q1), BZ1-1 (Q3) and CHPZ2A (Q1, Q2 and Q3) due to blockages.

Alluvial groundwater quality over 2019 ranges between locations, as discussed below:

- West Pit: EC ranges between 1,830 µS/cm and 10,610 µS/cm and pH ranges between 7.2 and 7.7;
- Carrington and Carrington West Wing area: EC ranges between 901 µS/cm and 9,990 µS/cm and pH ranges between 6.7 and 8.4;
- Between Cheshunt Pit and North Pit: EC ranges between 285 µS/cm and 2,700 µS/cm and pH ranges between 6.7 and 7.7; and
- Lemington South Pit: EC ranges between 568 µS/cm and 5,260 µS/cm and pH ranges between 6.7 and 7.2.

Discussion in water quality trends and triggers is included for each of the mine locations from Section 5.3.1.1 to Section 5.3.1.4.

Full water quality analysis was conducted for the site alluvial bores in accordance with the WMP. Exceptions to this include bores C919(ALL), CGW47a, CHPZ8A, GW-121 and GW-101, which had insufficient water available to sample. Full water quality data is presented in Appendix E and summarised below:

- Total aluminium: variable readings from below laboratory limit of reporting up to 27.2 mg/L (CGW39 and GW-100) over 2019;
- Total arsenic: concentrations generally below the limit of reporting or less than 0.014 mg/L;
- Total cadmium: concentrations generally below the limit of reporting or less than 0.0013 mg/L; and
- Total zinc: concentrations generally below the limit of reporting or less than 0.2 mg/L. Exceptions to this were a reading of 0.414 mg/L for bore GW-128, 0.262 mg/L for bore 4037P and 0.213 mg/L for bore GW-100.

As discussed in Section 5.2.1, groundwater level readings for bores GW-100 and GW-101 indicates they are dry and water quality sampled is likely influenced by sediment in the base of the bore and not considered representative. It is recommended that the total depth of the bore be checked, and the monitoring programme reviewed to ensure only representative groundwater samples are collected.

5.3.1.1 West Pit

Over the 2019 monitoring period, the following triggers for EC and pH were exceeded at the following bores:

- Bore NPz2 exceeded the trigger level for EC of 13,428 µS/cm in Q1, Q3 and Q4, but is within the historical reading range of 12,590 µS/cm to 19,400 µS/cm with no adverse impacts identified; and
- Bore NPz5 recorded pH of under the trigger level of 6.9 in Q4, but is within the historical reading range of 6.8 to 7.9 with no adverse impacts identified.

5.3.1.2 Carrington and Carrington West Wing

Over the 2019 monitoring period, the following triggers for EC and pH were exceeded at the Carrington and Carrington West Wing bores:

- Bore CGW49 recorded EC above 2,775 µS/cm in Q1, Q3 and Q4;
- Bore CFW55R recorded EC above 6,154 µS/cm in Q1, Q2, Q3 and Q4;
- Bore 4032P recorded EC above 2,775 µS/cm in Q4;
- Bore CGW55a recorded pH above 8 in Q4;
- Bore GW-106 recorded pH below 6.8 in Q2; and
- Bore CFW55R recorded pH below 7 in Q1.

Bore CGW49 intersects alluvium within the western limb of the paleochannel. Historical readings show that bore CGW49 has recorded an average EC of 4,692 µS/cm and ranging between 2,060 µS/cm and 8,180 µS/cm. Review of EC readings at CGW49 shows levels fluctuated slightly over 2019 but remained consistent with historical concentrations. The results show no adverse impacts due to mining and highlight that the established trigger levels do not reflect historical trends.

Bore CGW55a is located approximately 875 m west of the North Void Tailings. Historical readings show that bore CGW55a has recorded an average pH of 7.5 and ranging between 6.8 and 8. The pH reading in Q4 of 8.4 is above historical readings and may correlate with the decrease in the groundwater level and bore condition.

Bore 4032P is located west of Carrington Pit and intersects alluvium within the western limb of the paleochannel. Historical readings show that bore 4032P has recorded an average EC of 1,903 µS/cm and ranging between 1,571 µS/cm and 2,325 µS/cm. Review of EC readings at 4032P shows that there is a sudden increase to 3,320 µS/cm in Q4, which coincides with a slight (0.28 m) rise in groundwater levels. The cause for this trend in water level and water quality is unclear as no other bores recorded this rise and there are no known changes in land use near the bore. The comment in the sample notes state the presence of suspended solids, which may have impacted water quality results that may indicate a blockage at the base of the bore or surface inundation (i.e. loose casing) The bore is located outside of the mine area on land used for cattle grazing and is located near a small stand of trees. It is recommended that the construction and condition bore and local land use be reviewed to determine the cause of the increase.

Bore GW-106 intersects a remnant patch of paleochannel alluvium between West Pit and Carrington Pit. Since monitoring commenced at the bore in September 2013, bore GW-106 has recorded an average pH of 6.8 and ranging between 6.6 and 6.9. Review of pH readings are within historical concentrations. The results show no adverse impacts due to mining.

Bore CFW55R recorded EC above the trigger threshold over 2019, and a pH reading below 7 in Q1, but above 7 over the remainder of the year. Bore CFW55R is an alluvial bore located approximately 50 m north of Carrington Billabong, 80 m west of the North Void Tailings. Following on from the 2017 annual groundwater review, work has been conducted to investigate trigger exceedances at the bore. In 2018 this investigation included installation of additional groundwater monitoring bores, hydraulic testing and increased groundwater monitoring. This is in addition to changes in North Void management undertaken from 2018, including installation of a flocculation plant to discharge flocculated tailings to enhance consolidation, cessation of tailings discharge and water management.

Over 2019 EC readings for CFW55R fluctuated and were recorded above the trigger level of 6,154 µS/cm, but remained below historical reading of 10,840 µS/cm (2008) as shown in Figure 5-25. Figure 5-25 shows that bores within the paleochannel alluvium (CFW57, CFW55R and CGW54A) were historically saline but became fresher with progression of mining at Carrington Pit. This is due to direct interception of groundwater within the paleochannel, as well as depressurisation of the coal measures reducing natural upward seepage from the coal measures where they are incised by the paleochannel. Sulphate was also identified as a key analyte to track the extent and movement of impacted water. Over 2019 sulphate concentrations fluctuated between 1,300 mg/L and 2,480 mg/L at CFW55R, with a slight rising trend. In contrast bores CGW54a and CFW57 recorded a general decline in sulphate over 2019, from around 890 mg/L in January down to 623 mg/L at CGW54a and 397 mg/L at CFW57 by December 2019. The sulphate to chloride molar ratio helps to indicate presence sulphate oxidation. Figure 5-26 shows a general reduction in the SO_4/Cl ratio for bores CFW57 and CGW54A and fluctuations for bore CFW55R. These trends correspond with a change in groundwater level and gradients as discussed in Section 5.2.1.2. With the management practices undertaken to minimise seepage from NV TSF, groundwater levels have reduced around CFW55R. This has resulted in a change in alluvial flow directions, with recharge from the Hunter River now creating a gradient of flow from CFW57 towards CFW55R. This has resulted in fluctuations in concentrations of EC and sulphate at CFW55R, but reduction in the extent and degree of impacted water at surrounding bores like CFW57 and CGW54a. A fluctuation at the end of February 2019 is visible in CFW57, CFW55R and CGW54A, that occurred prior to a peak rainfall period and was highest for CFW57. The cause for this fluctuation is unclear, but was not observed in upgradient bores like GW-126, and quickly dissipated with a rapid decline in the following month.

Assessment of trigger exceedances and impacts is ongoing and has been conducted in consultation with the regulatory authority.

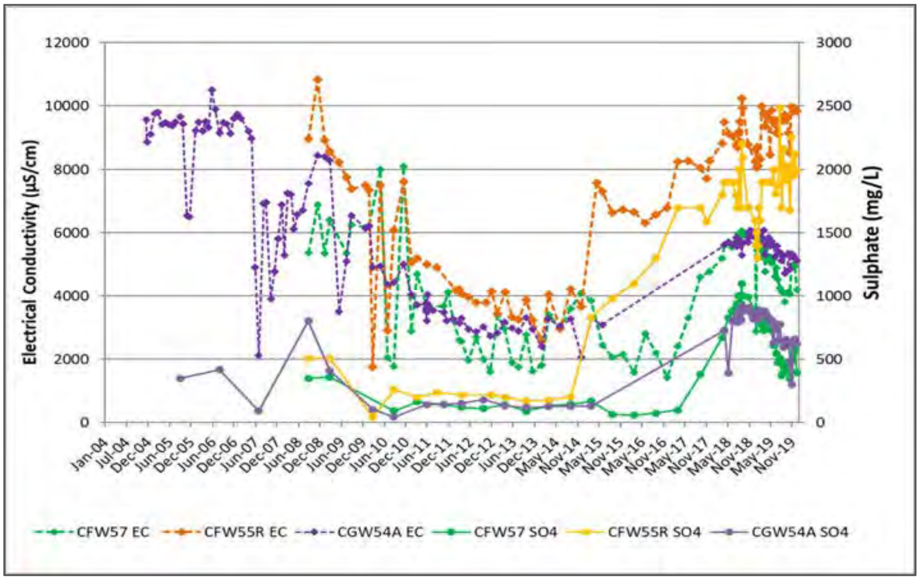


Figure 5-25 EC vs Sulphate

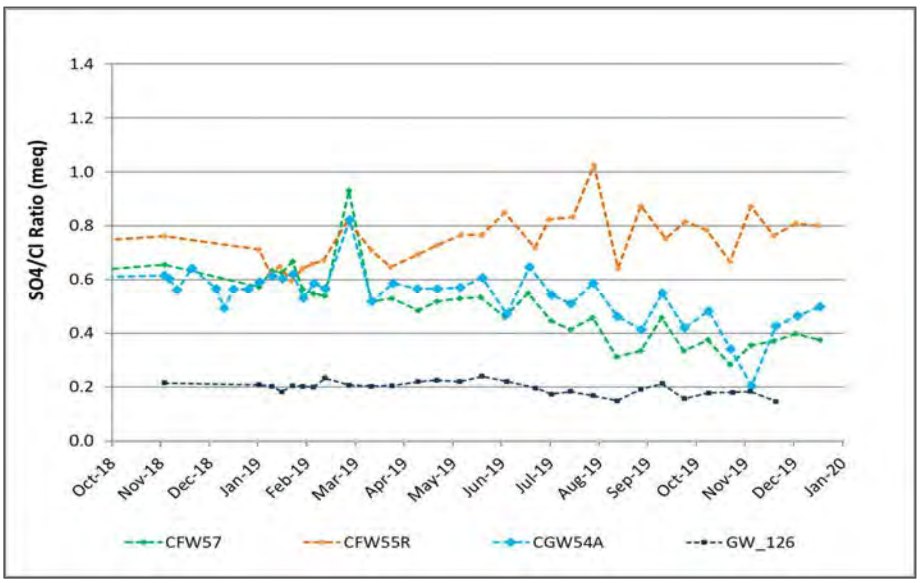


Figure 5-26 Sulphate/Chloride Ratio

5.3.1.3 Cheshunt Pit

During 2019, bore CHPZ8A was essentially dry as groundwater levels were close to bore depth. There was insufficient water to sample. Bore BZ1-1 was recorded as dry in Q2 and blocked in Q3. Bore CHPZ2A was recorded as blocked in Q1, Q2 and Q3.

Over the 2019 monitoring period, the following triggers were exceeded at the Cheshunt Pit bores:

- No bores exceeded triggers for EC;

- Hobden's Well recorded pH of over 7.5 in Q3 and Q4, but is within the historical reading range of 7.2 to 7.8 with no adverse impacts identified; and
- Bore BZ1-1 recorded a pH over 7.5 in Q4, but pH remained within the trigger limits for the remainder of the monitoring period with no adverse impacts identified. As noted earlier, bore BZ1-1 intersects interburden rather than alluvium (AGE, 2013a), therefore this should be updated in the WMP.

5.3.1.4 Lemington South

Over the 2019 monitoring period, the following triggers for EC and pH were exceeded at the Lemington South bores:

- Bore PB01(ALL) recorded EC above 3,938 µS/cm throughout 2019.

Since monitoring commenced at the bore in January 2000, PB01(ALL) has recorded an average EC of 2,758 µS/cm and ranging between 840 µS/cm and 5,260 µS/cm. Review of EC readings at PB01(ALL) show EC levels have historically fluctuated. PB01(ALL) records large fluctuations in EC, however, there appears to be a slight trend of rising EC over time up to 5,260 µS/cm in 2019. This coincides with a slight decline in groundwater levels. Groundwater elevations range between 44.99 mAHD and 47.81 mAHD and trends generally correlate to changes in stream flow along Wollombi Brook. Water level and EC trends for PB01(ALL) are presented in Figure 5-27. The data is compared to trends for Wollombi Brook as recorded at HITS station Wollombi Brook @ Warkworth (Station 210004). Figure 5-27 shows that water levels within bore PB01(ALL) roughly mimic water level trends within the Wollombi Brook. With the cessation of flow along Wollombi Brook since 2017 there has been a decline in groundwater levels in PB01(ALL), to over 9 m below surface.

Bore PB01(ALL) is located on the northern banks of the Wollombi Brook, in an area with no active mining or land clearance. The results indicate the spikes in EC likely relate to the natural decline in recharge to the alluvium. It is also understood that sampling methodology was revised over 2019, therefore the change in results may relate to increased purging of the bore and collection of more representative samples. No adverse impacts due to mining have been identified. It is recommended that the duplicate trigger level for the Lemington South alluvium be removed from the WMP, and one trigger level be applied based on representative data.

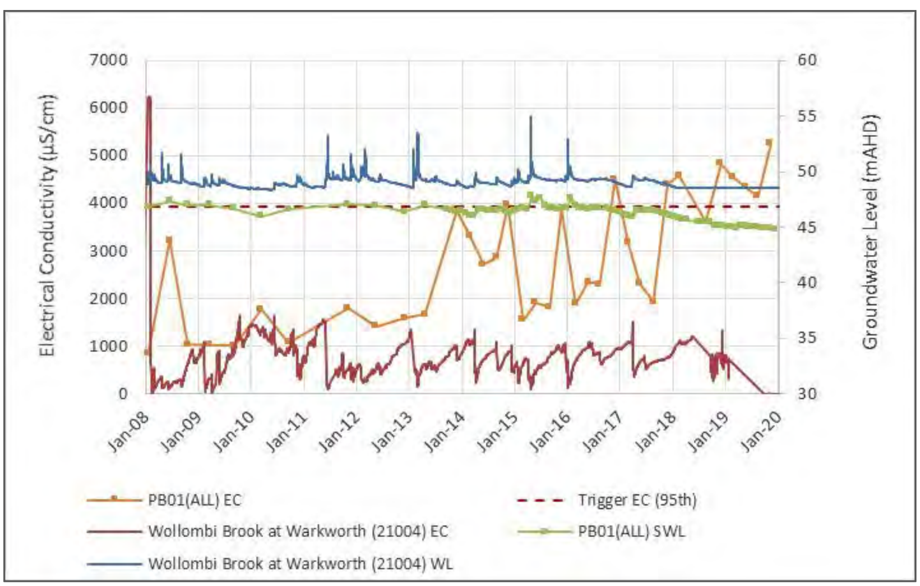


Figure 5-27 Water Level and EC Trends for PB01(ALL) and Wollombi Brook

5.3.2 Permian Coal Measures

Routine monitoring of EC and pH was conducted for all monitoring bores intersecting the Permian coal measures on a quarterly or six-monthly basis over 2019. Exceptions to this were bores 4036C, B425(WDH), C122(BFS) that were dry all year and bore CGW45 that was blocked. Bore BZ4A(2) was dry in Q2, Q3 and Q4.

Over 2019 groundwater quality within the Permian coal measures varied within and between locations, as discussed below:

- West Pit: EC ranges between 6,030 µS/cm and 14,080 µS/cm and pH ranges between 6.8 and 7.8;
- Carrington and Carrington West Wing area: EC ranges between 1,584 µS/cm and 8,960 µS/cm and pH ranges between 6.7 and 7.5;
- Between Cheshunt Pit and North Pit: EC ranges between 868 µS/cm and 8,410 µS/cm and pH ranges between 6. and 8.1; and
- Lemington South Pit: EC ranges between 3,290 µS/cm and 27,400 µS/cm and pH ranges between 6.6 and 8.1.

Discussion in water quality trends and triggers is included for each of the mine locations from Section 5.3.2.1 to Section 5.3.2.4.

In accordance with the WMP full water quality analysis was conducted for the bores targeting the Permian coal measures. Analysis was also conducted for bores not specified within the WMP. Full water quality data is presented in Appendix E and summarised below:

- Total aluminium: variable readings from below laboratory limit of reporting to 8.4 mg/L (CGW46) over 2019;
- Total arsenic: concentrations generally below the limit of reporting or less than 0.051 mg/L;
- Total cadmium: concentrations generally below the limit of reporting or less than 0.0029 mg/L;
- Total lead: concentrations below the limit of reporting or less than 0.131 mg/L;
- Total selenium: concentrations below the limit of reporting or less than 0.028 mg/L; and
- Total zinc: concentrations generally below the limit of reporting or less than 0.31 mg/L.

5.3.2.1 West Pit

Over the 2019 monitoring period, the following triggers were exceeded for the West Pit bores:

- Bore NPz2 recorded EC over the trigger level of 13,428 µS/cm in Q1, Q3 and Q4; and
- Bore NPz5 recorded pH under the trigger level of 6.9 in Q4.

Bore NPz2 is located approximately 4.5 km north-east of Plashett Reservoir and 1 km north-west of the West Pit mine area. The bore intersects interburden material (siltstone/sandstone) of the deeper Permian coal measures; with a screened interval between 57-60 mbgl. Historical EC readings for NPz2 since 2008 show regular fluctuations of between 12,590 µS/cm and 19,400 µS/cm at the site. The 2019 readings of 13,640 µS/cm, 13,650 µS/cm and 14,080 µS/cm are therefore considered consistent with historical concentrations. Based on available information, the cause for the changes in EC at NPz2 do not appear to correlate to mine activities conducted at West Pit. As discussed in Section 5.2.2, it has been recommended that NPz2 be removed from the compliance network as the bore location and construction does not provide information on potential impacts related to site activities. However, this bore should continue to be monitored to assist with other assessments and post closure monitoring.

Bore NPz5 is located approximately 1.4 km east of the West Pit mine area. The bore intersects interburden material (siltstone/sandstone) of the Permian coal measures; with a screened interval between 40-43 mbgl. Historical pH readings for NPz5 since 2008 show regular fluctuations between 6.8 and 7.9 at the site. The 2018 reading of 6.8 and 6.9 is therefore considered consistent with historical concentrations.

5.3.2.2 Carrington and Carrington West Wing

Over the 2019 monitoring period, the following triggers were exceeded for the Carrington and Carrington West Wing bores:

- No bores exceeded triggers for EC;
- Bore CGW52 both recorded a pH under the trigger level of 6.8 in Q4; and
- Bore CGW53 both recorded a pH under the trigger level of 6.8 in Q1 and Q4.

Bore CGW52 and CGW53 are located along the Hunter River. Available bore information indicates CGW52 is constructed with screen from 39.6 m to 42.6 m below surface with 25 mm diameter casing and screened across siltstone and coal (Broonie Seam). Bore CGW53 is constructed with screen from 38.5 m to 41.5 m below surface with 25 mm diameter casing and screened across coal (Broonie Seam). Historical pH readings for the bores since 2005 show regular fluctuations of between 6.4 and 8.6. The 2019 readings ranging from 6.7 to 6.9 are considered consistent with historical concentrations, with no adverse impacts identified.

5.3.2.3 Cheshunt Pit

Over the 2019 monitoring period, the following triggers were exceeded at the Cheshunt Pit bores:

- No bores exceeded triggers for EC;
- Bore BZ2A(1) recorded a pH under the trigger level of 6.5 in Q4 (6.4);
- Bore BZ3-1 recorded pH over the trigger level of 7.7 in Q4 (8.1); interburden
- Bore BZ3-3 recorded pH under the trigger level of 6.5 in Q1 and Q4 (6.4); and
- Bore CHPZ3D recorded pH under the trigger level of 6.5 in Q3 (6.2).

Bores BZ2A(1), BZ3-3 and CHPZ3D intersect the Mt Arthur Seam and are positioned between Cheshunt Pit and the Hunter River. The trigger range for the bores is 6.5 to 7.6, while the range in historical data for the bores is 6 to 8.2. The 2019 readings for the three bores are considered consistent with historical recorded concentrations, with no adverse impacts identified.

Bore BZ3-1 intersects interburden and is positioned between Cheshunt Pit and the Hunter River. The trigger range for the bore is 6.9 to 7.7 and readings of pH above 7.7 have been recorded historically. However, a slight trend of rising pH is visible for the bore, similar to trends for bore BZ1-1 within the overburden, but not observed for the Mt Arthur Seam (BZ3-3). This trend may relate to the condition of the bores and weathering of the overburden material. The rise in pH is not considered to be of concern as it will not result in adverse impacts like mobilisation of metals due to low pH, but the condition of the bore should be reviewed to ensure the quality of data collected.

5.3.2.4 Lemington South

Over the 2019 monitoring period, the following triggers were exceeded at the Lemington South bores:

- Bore B631(BFS) recorded an EC above the trigger level of 12,440 µS/cm in Q4 and a pH below 6.7 in Q2 and Q4;
- Bore C130(ALL) recorded an EC above the trigger level of 11,408 µS/cm in Q1, Q2, Q3, and Q4;
- Bore C130(WDH) recorded an EC above the trigger level of 20,240 µS/cm in Q4;
- Bore C630(BFS) recorded a pH above the trigger level of 7.9 in Q2 and Q4;
- Bore D010(GM) recorded an EC above the trigger level of 1,894 µS/cm in Q2 and Q4; and
- Bore D612(AFS) recorded an EC above the trigger level of 15,324 µS/cm in Q4.

Bore B631(BFS) is located approximately 560 m south-west of Lemington South pit and around 660 m east of the LUG Bore. The bore intersects the Bowfield Seam (BFS). Historical readings for bore B631(BFS) since 2000 show regular fluctuations of EC between 9,250 µS/cm and 15,780 µS/cm and pH of 5.7 to 7.3 for pH. The 2019 readings are therefore considered consistent with historical concentrations. However, it is noted that the slight decline in pH for B631(BFS) may correspond with the decline in groundwater levels within the Bowfield Seam.

Bore C130(ALL) is located between Lemington South pit and the LUG Bore and intersects shallow weathered overburden to 17 m depth. Historical readings since 2000 show regular fluctuations of between 19,500 µS/cm and 24,200 µS/cm for EC and 6.4 to 7.9 for pH. The 2019 readings for pH are considered consistent with historical concentrations; however, three of the 2019 readings for EC are above historical concentrations. The rise in EC corresponds with a general decline in groundwater levels. Review of water quality data also indicates a slight rise in sulphate concentrations over time with the rise in EC Figure 5-28. However, a low SO_4/Cl molar ratio of 0.07 meq was recorded, indicating the trend is likely not a result of sulphide oxidation. The groundwater type for C130(ALL) is Na-Mg-Cl and this has remained the same over the last four years of water quality sampling. It is unclear as to the cause for the EC exceedances and it is recommended that ongoing analysis of major ions be conducted for C130(ALL), and water quality sampling and analysis from the LUG bore and Lemington South Pit be undertaken for comparison to bore water quality data to enable further analysis.

It is also recommended that the water level of Lemington South Pit be monitored to understand the influence of in-pit water storage on the local groundwater regime. It is also noted that the trigger level for the Lemington South interburden was 22,780 µS/cm prior to a change in 2018 to 11,408 µS/cm. It is recommended that the trigger level for the interburden, and therefore C130(ALL), be reviewed.

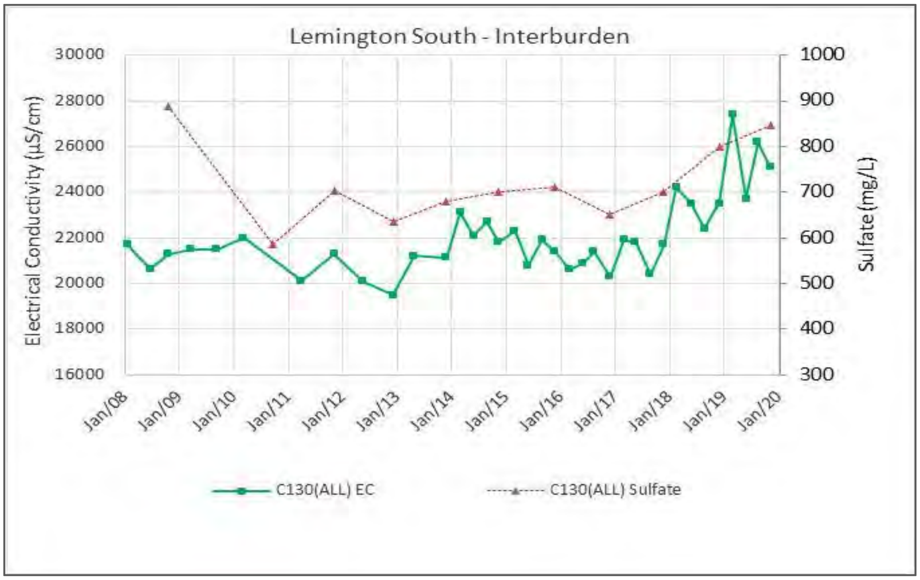


Figure 5-28 C130(ALL) EC vs Sulphate

Bore C130(WDH) is located between Lemington South Pit and LUG Bore and intersects the Woodlands Hill Seam (WDH). Historical readings since 2000 show regular fluctuations of EC between 18,210 µS/cm and 21,000 µS/cm and pH of 6.4 to 7.5 for pH. The 2019 readings for pH are therefore considered consistent with historical concentrations. The 2019 reading for EC of 21,300 µS/cm recorded in Q4 is slightly above historical concentrations.

Bore C630(BFS) is located between Lemington South Pit and LUG Bore and intersects the Bowfield Seam (BFS). Historical readings show regular fluctuations of between 2,660 µS/cm and 4,190 µS/cm for EC and 7.1 to 8.3 for pH. The 2019 readings are therefore considered consistent with historical concentrations.

Bore D612(AFS) is located between Lemington South Pit and LUG Bore and intersects the Arrowfield Seam (AFS). Historical readings show regular fluctuations of between 11,000 µS/cm and 15,890 µS/cm for EC and 6.7 to 7.6 for pH. The EC reading in Q4 of 15,920 µS/cm is slightly above historical concentrations. The rise in EC appears to correlate with a decline in groundwater levels, to over 22 m below surface. No information is available on the construction of D612(AFS), it is recommended that the total depth be measured to see if levels are near the base of the bore and water quality may reflect sediment within the bore.

Bore D010(GM) is located between Lemington South Pit and LUG Bore and intersects the Glen Munro Seam (GM). Historical readings show regular fluctuations of between 9,050 µS/cm and 12,310 µS/cm for EC and 6.5 to 8.1 for pH. The 2019 readings are therefore considered consistent with historical concentrations.

At Lemington there is a continued general trend of rising EC within the bores intersecting the Permian coal measures. The rise in EC for some bores is within the range of historical readings, but a trend is visible. There are no known changes in local land use in the area that could result in introduction of more saline groundwater. The trend of rising EC appears to correlate to the decline in groundwater levels around the LUG Bore that is used to abstract water stored within the Lemington Underground. EC is a measure of the ability of water to conduct an electrical current and relates to the concentration of dissolved ions in the water, which can comprise dissolved salts, alkalis, chlorides, sulphides and carbonate compounds. The change in EC around the LUG Bore likely relates to changes in local recharge processes and geochemistry in response to abstraction. There are no private groundwater users near Lemington that could be impacted by the change in water quality.

5.3.3 Spoil

Routine monitoring of EC and pH was conducted for the spoil monitoring bores over 2019 on a quarterly basis. Exceptions to this were bore DM7, GW-107 and GW-108 which were recorded as dry throughout the year. Over 2019, water within the spoil material at North Pit recorded an EC of between 2,300 µS/cm and 14,540 µS/cm, and a pH of between 5.4 and 7.3. Exceedances for EC was recorded for bores 4116P and MB14HVO05.

Bore 4116P is located at the southern end of North Pit and recorded EC of 13,820, 13,950 and 14,420 µS/cm in Q2, Q3 and Q4, respectively. Historical readings show regular fluctuations of between 10,890 µS/cm and 13,560 µS/cm for EC. The 2019 readings are slightly above the range of historical readings. Review of water quality and water level data for nearby bores indicates this trend is unique to bore 4116P. The groundwater level trends indicate the bore is almost dry and there is potential that historical readings may not have been based on representative groundwater samples. Numerous blockages have been recorded in 4116P since 2015. On review of the bore construction details it appears the groundwater level is below the screened interval and water quality samples are not representative of the groundwater in this area. Monitoring was recommended for adjacent bore 4117P that intersects the spoil at the base of Alluvial Lands Pit in the network review (SLR, 2019). However, bore 4117P has also become blocked, or possibly collapsed. It is also noted that nearby bore 4113P also collapsed in 2018. This coincides with a general reduction in water levels in the spoil over time, and settling of the waste rock material. Ongoing monitoring of the spoil can be maintained at the more recently installed bores MB14HVO01 and MB14HVO02.

Bore MB14HVO05 recorded EC more than the trigger level of 12,460 µS/cm; 12,920 µS/cm in Q1 and 14,540 µS/cm in Q3. In Q1 and Q3 pH was recorded below the trigger level of 6.5; with readings of 5.7 and 5.4 respectively. Bore MB14VHO05 has been monitored since March 2015. EC and pH concentrations have fluctuated significantly over a short period of time. The timing of fluctuations appears to correspond with results for MB14HVO01 and MB14HVO02; however, the degree of the fluctuations is unique to MB14VHO05. This may relate to localised geochemical processes within the spoil material.

In accordance with the WMP full water quality analysis was conducted for the site bores targeting the spoil material, with the exception of dry bores GW-107, GW-108 and DM7. Additional analysis was also conducted for bores not specified within the WMP. Full water quality data is presented in Appendix E and summarised below:

- Total aluminium: variable readings from below laboratory limit of reporting to 14.8 mg/L (MB14HVO05) over 2019;
- Total arsenic: concentrations generally below the limit of reporting or less than 0.269 mg/L;
- Total cadmium: concentrations generally below the limit of reporting or less than 0.0159 mg/L;
- Total lead: concentrations below the limit of reporting or less than 0.034 mg/L;
- Total selenium: concentrations below the limit of reporting or less than 0.005 mg/L, with the exception of MB14HVO05 (0.07 mg/L in Q1 and 0.14 mg/L in Q3); and
- Total zinc: concentrations generally below the limit of reporting or less than 0.365 mg/L, with the exception of MB14HVO05 that recorded zinc concentration of 13 mg/L (Q1) and 14.8 mg/L (Q3) 2019.

5.4 Groundwater Take

Interception of groundwater occurs at site due to a range of activities, including direct interception of groundwater with mining activities and abstraction from water supply bores, and indirect interception via induced inter-formation flows due to depressurisation of the Permian coal measures. Each activity is discussed below, and the estimated groundwater take for the various water sources summarised in Section 5.4.3.

5.4.1 Groundwater Inflows to Mine Operations

A numerical groundwater model was developed for the HVO South Modification 5. The model was calibrated up to December 2015 and replicates mine progression on a quarterly basis to the year 2039. Year 3 model results (predictive model) represent predicted groundwater conditions and take for the 2018 reporting period for inclusion in this report. The AGE (2015) report does not report predicted take for West Pit and includes inflows for Carrington West Wing that did not commence operations in 2018. To account for this, the predicted inflows to West Pit for model Year 3 were extracted from the model and added to the total take from the North Coast Fractured and Porous Rock water source. In addition, the volume of water taken as part of the modelled Carrington West Wing was subtracted from the total take.

5.4.2 Bore Abstraction

Lemington Underground (LUG) bore is an abstraction bore constructed into the abandoned LUG mine void underlying HVO. The bore is licensed to take up to 1,800 ML of water from the North Coast Fractured and Porous Rock aquifer (20BL173392) per water year. The bore is equipped with a flow meter, with total monthly abstraction is documented. Based on the flow volumes recorded, from July 2018 to June 2019 (water year) 1,315 ML of water was abstracted from the LUG bore, which is within the licensed allocation of 1,800 ML/year. From June 2019 to December 2019 990 ML of water was abstracted.

As the bore intersects LUG that mined the Permian coal measures, groundwater levels within bores intersecting the coal measures around the bore have been reviewed to identify the extent of groundwater drawdown. As discussed in Section 5.2.2.4, groundwater levels within the Bowfield Seam of the Permian coal measures around Lemington South have declined by up to 4.57 m (B925(BFS)) to a distance of 1.8 km from LUG Bore. However, only limited drawdown (maximum 0.58 m decline) was recorded for bores within the shallower coal measures surrounding LUG Bore. In addition, no clear impacts related to groundwater abstraction from the historical underground mine were observed for nearby alluvial bore Appleyard Farm.

However, the abstraction rate from the LUG bore is higher than previously assessed. It is recommended that numerical modelling be undertaken to assess the impacts of the higher abstraction rate from the LUG bore on surrounding groundwater levels.

5.4.3 Summary of Groundwater Take For 2019

The predicted take of groundwater from the various groundwater sources associated with HVO is presented in Table 5-2.

Table 5-2 Predicted Groundwater Take for 2019

	Hunter Regulated (ML)	Hunter Unregulated (ML)	North Coast Fractured and Porous Rock (ML)
HVO Mine Operations†	159	358	853

	Hunter Regulated (ML)	Hunter Unregulated (ML)	North Coast Fractured and Porous Rock (ML)
LUG Bore Abstraction	-	-	1,315*
Total	159	358	2,168

Note: † HVO Mine Operation predictions from HVO South Modification 5 include Carrington West Wing that has not commenced, and excludes West Pit

* take over water year (July 2018 to end of June 2019)

As shown in Table 5-2, over the 2019 reporting year the total take under the Hunter Regulated water source was estimated at 159 ML, total take from Hunter Unregulated water source was estimated at 358 ML and around 2,158 ML from the North Coast Fractured and Porous Rock water source.

5.5 Verification of Model Predictions

In accordance with Schedule 4 Condition 27 (c) under DA 450-10-2003 (HVO North) and Schedule 3 Condition 27 (c) under PA 06_0261 (HVO South), the WMP includes requirements to validate and recalibrate (if necessary) the groundwater model for the development. This includes an independent review of the model every 3 years, and comparison of monitoring results with modelled predictions. The latest numerical groundwater model that replicates all approved operations across HVO (north and south) was developed by AGE Consultants as part of HVO South Modification 5 (2017).

The three yearly independent review of the HVO South Modification 5 numerical groundwater model to verify model predictions was undertaken by SLR at the end of 2019 and included in Appendix F. The hydrogeological description, conceptualisation and model design of AGE's 2016 groundwater model were revisited and reviewed. As a part of the review process, the modelled recharge, stream stage heights and mine progression were compared against the actual data for January 2016 to December 2019.

The review of the model files showed minor discrepancies between modelled rainfall and river stage heights between 2016 and present day. The review showed differences between mine progression and the actual measurements in different areas of the model domain. The modelled mined area between January 2016 to December 2019 covers a larger than the actual mine area, which has likely resulted in overpredicted of groundwater drawdowns.

The calibration data base was updated to include latest measurements up to December 2019. The calibration hydrographs were regenerated. The updated calibrated hydrographs indicated that despite the discrepancies, the model calibration is still satisfactory.

The overall match between observed and measured levels in the transient calibration is reasonable. However, in some areas of the model domain (i.e., Carrington West Wing area and Lemington Pit) the match between observed and simulated heads is some of the bores is poor with the model predicting more impact than captured by observed water levels. This is likely due to the discrepancies between the actual mine progression and modelled progression and the model not being able to represent these mining activities adequately.

As an overall conclusion, this reviewer considered the hydrogeological description, the conceptualisation of the groundwater system and the numerical model design and the numerical model calibration are still fit for purpose and additional impacts to what was previously predicted, such as impacts on landholder bores, is considered unlikely. Given the scale of the discrepancies comparing to the regional scale of the model, the reviewer believed updates to the model to remove the discrepancies will result in insignificant changes to the model predictions. However, groundwater models should periodically be evolved, updated and assessed when new data is available. The reviewer believed updating the mine progression in the model to match the actual mine progression is likely to improve the calibration statistics and hydrographs. Therefore, the reviewer recommended the following updates to the groundwater model:

- Update to Recharge Package (RCH): Update to include to the latest rainfall measurement at site;
- Update to River Package (RIV): Update to include to the latest river stage height measurements at gauging stations 210083 and 210004;
- Update to Drain Package (DRN) and Time-Variant Materials (TVM): Update to ensure modelled and actual mine progressions match; and
- Re-calculate transient calibration statistics and assess the calibration performance.

6 Conclusions and Recommendations

6.1 Conclusions

This annual groundwater review covers data collected over 2019 and was completed in compliance with:

- Condition 27 of Development Consent DA 450 10 2003 for HVO North;
- Condition 28 of the Project Approval PA 06 0261 24 for HVO South; and
- Individual bore license conditions (20BL173587-89, 20BL173847 and 20BL173392).

Over 2019 operations across HVO included active mining at West Pit, Cheshunt Pit, and Riverview Pit. Two tailings facilities were used over the year (Dam 6W and North Void DM6) and groundwater was abstracted from LUG Bore.

Review of climate data indicates the region generally experienced below average rainfall over 2019 (343.6 mm). Similar trends are reflected in stream levels for the Hunter River and Wollombi Brook from the HITS stations and site monitoring locations (WL03, WL05, WL10 and WL14).

The groundwater bore network at HVO is extensive, with 137 bores that were installed progressively over the life of the operations, with 104 of these bores within the WMP. Annual sampling is undertaken in accordance with relevant Australian Standards. It was previously identified by SLR (2018) that monthly to quarterly sampling methodology undertaken by the external contractors was not providing representative samples. This resulted in trigger exceedances. This sampling methodology was reviewed by HVO and improvements in sampling technique made to ensure representative samples are collected. Over 2019 monitoring of the groundwater bore network was largely conducted in accordance with the Groundwater Monitoring Programme outlined within the WMP. However, water level and water quality readings were not taken in every quarter for 16 bores due to a range of factors such as dry or blocked bore conditions and access restrictions.

Review of groundwater level trends indicates that where saturated, water within the alluvium were relatively stable to slightly declining over 2019, generally in line with climate and stream flow trends. Groundwater within the Permian coal measures remained relatively stable to slightly declining over 2019.

Review of water quality results and comparison to trigger levels for EC and pH identified several trigger exceedances over 2019. It was identified that several bores exceeded triggers for EC and pH; however, 2019 readings were generally in line with historical trends for these bores. Groundwater quality trends that may indicate potential impacts from mine operations were observed for bore CFW55R, which is located within the alluvium near Carrington Pit and North Void DM6. Investigation into the cause and impact of the change in groundwater quality was conducted and the regulatory authority notified. Management controls were implemented to mitigate further seepage in consultation with the NSW Environmental Protection Authority. Subsequently, a Pollution Reduction Program was developed under Condition 8, U1 of Environmental Protection Licence 640. Monitoring and mitigation are currently ongoing, with the latest monitoring results indicating that the impacts of seepage are being mitigated.

Quantification of groundwater take was undertaken based on reported volumes estimated for approved operations as part of Modification 5 (AGE 2017) and metered abstraction volumes from LUG Bore. Based on this, over the 2019 reporting year the total take under the Hunter Regulated water source was estimated at 159 ML, total take from Hunter Unregulated water source was estimated at 358 ML and around 2,168 ML from the North Coast Fractured and Porous Rock water source. These volumes are within the licensed take for each groundwater source.

6.2 Recommendations

Based on review of the available data for 2019, the following recommendations have been made:

- Bore CGW46 is included in the current WMP, however, there are no trigger levels specified. It is recommended that trigger levels be added in the revised version of the WMP, and the purpose of bores be reviewed and outlined within the WMP.
- Bore BZ1-1 is included in the WMP as being within the alluvium; however, as identified in prior annual reviews the bore likely intersects interburden material. It is recommended that this bore be updated in the WMP as intersecting interburden.
- It is recommended that NPz2 and NPz3 be removed from the compliance network within the WMP, as the location and construction of the bores precludes them from providing an indication of potential impacts. However, these bores should continue to be monitored to assist with other assessments and post closure monitoring.
- Bores NPZ4 and NPZ5 should be removed from the WMP as they have been/will be decommissioned with progression of mining at West Pit. Ongoing monitoring should be conducted at VWP's GW-103 to GW-105.
- Sensor 1 within VWP GW-101a and sensor 3 within VWP GW-109 have failed. It is recommended that these sensors be removed from the WMP as monitoring can be continued by surrounding, close by bores.
- VWP GW-110 is located close to the highwall of Carrington Pit final void and may be decommissioned. It is recommended that this be removed from the WMP and ongoing monitoring be conducted at spoil bores GW-107 and GW-108. Review of spoil water levels around the backfilled southern edge of Carrington Pit is also recommended.
- Review condition of CGW46 and 4051C, including checking the total depth of the bores and downhole camera survey to understand cause for uncharacteristic water trends that may relate to blockages in the bore or the condition of the bore.
- Decommission bore CGW51a as available bore construction and water quality results indicates the bore was drilled through alluvium and into a shallow coal seam and does not provide representative groundwater results from one groundwater unit.
- Check the total depth of bore 4051C.
- Groundwater levels in bores GW-100 and GW-101 indicate they are dry and water quality sampled is likely influenced by sediment in the base of the bore and not considered representative. It is recommended that the total depth of the bore be checked, and the monitoring programme reviewed to ensure only representative groundwater samples are collected.
- No information is available on the construction of D612(AFS), it is recommended that the total depth be measured to see if levels are near the base of the bore and water quality may reflect sediment within the bore.
- Assign one trigger level for EC for bore PB01(ALL) and C130(ALL) in WMP, based on historical data.
- Ongoing water quality analysis for C130(ALL), as well as water quality analysis (i.e. major ions) and water level monitoring for LUG Bore and water stored within Lemington South Pit is recommended. This would also assist in verifying model predictions relating to abstraction from LUG Bore.

- Spoil bores 4116P and 4117P should be removed from the compliance network and ongoing monitoring be conducted at nearby bores MB14HVO01 and MB14HVO02.
- Review condition of bore 4032P and local land use practices to understand cause for recent rise in water levels.
- Further works in relation to bores G1 to G3, including:
    - Based on findings from the downhole camera survey, conduct bore repairs for site monitoring bores and abandon adjacent bores;
    - Install dataloggers into bores G1 to G3 to collect more robust timeseries data;
    - Extend casing height for bore G3 and install a cap that enables pressure release;
- Review the bore condition and construction to investigate the elevated groundwater levels at bore PZ2CH400.
- Review the condition and construction of bores HG2a, BC1a, BZ1-3, BZ2A(1), BZ3-3,BZ4A(2) and B425(WDH) in order to understand the cause for the variability in trends.
- Review local land use activities around D807(BFS) to understand trends.
- Clear out/purge bore DM4 to remove sediment.
- The abstraction rate from the LUG bore is higher than previously assessed. It is recommended that numerical modelling be undertaken to assess the impacts of the higher abstraction rate from the LUG bore on surrounding groundwater levels.

7 References

Australasian Groundwater and Environmental Consultants 2013a, 2012 HVO South Groundwater Impacts Report, prepared for Coal & Allied Operations Pty Ltd, March 2013.

Australasian Groundwater and Environmental Consultants 2013b, HVO North Modification Fine Reject Emplacement Groundwater Assessment, prepared for Coal & Allied Operations Pty Ltd, June 2013.

Australasian Groundwater and Environmental Consultants 2016, HVO North Modification 6 Groundwater Study, prepared for EMM Consulting for Coal & Allied Operations Pty Ltd, November 2016.

Australasian Groundwater and Environmental Consultants 2017, HVO South Modification 5 Groundwater Study, prepared for EMM Consulting for Coal & Allied Operations Pty Ltd, January 2017.

Environmental Resources Management Mitchell McCotter Pty Ltd 1997, Extension of Mining Operations at Ravensworth Mine: Environmental Impact Statement, Volume 1, prepared for Peabody Resources Limited, August 1997.

Environmental Resources Management 2008, Groundwater Assessment, Hunter Valley Operations South Coal Project, Annex J, prepared for Coal & Allied Operations Pty Ltd, January 2008.

Mackie Environmental Research 1998, Hunter Valley South Mining Extension: Groundwater and Surface Water Management Studies, prepared for Rio Tinto Coal, July 1998.

Mackie Environmental Research 2003, West Pit Extension Groundwater Assessment, prepared for Coal & Allied, 2003.

Mackie Environmental Research 2005, Assessment of River Leakage Within the Cheshunt Pit Buffer Zone, prepared for Coal & Allied, April 2005.

Mackie Environmental Research 2010, Carrington West Wing Modification – Groundwater Assessment, prepared for Coal & Allied, in Carrington West Wing Environmental Assessment (EA), Volume 2, Appendix E – Groundwater Study, March 2010.

Mackie Martin & Associates 1992, Hunter Valley Mine Alluvial Floodplain Groundwater Studies, prepared for Coal & Allied, Appendix D – Groundwater Study, August 1992.

SLR Consulting Australia, 2019. 2018 Annual Groundwater Review, prepared for Hunter Valley Operations Pty Ltd, March 2019.

APPENDIX A

Groundwater Monitoring Programme

ID	Location	Easting	Northing	Ground Level (mAHD)	Screened Interval (mbgl)	Geology	Groundwater Monitoring Programme				
							Water Level	EC	pH	Full WQ	Alk/Acidity
4032P	CWW	308609	6402945	69.35	7.4-13.4	Paleochannel alluvium	Q	Q	Q	6M	
4034P	CWW	308239	6402959	71.15	5.6-14.6	Paleochannel alluvium	Q	Q	Q	6M	
4036C	Carrington	308272	6402688	70.7	33.1-34.1	Interburden (Siltstone/Sandstone)	Q	Q	Q		
4037P	CWW	308277	6402702	70.74	8.3-14.3	Paleochannel alluvium	Q	Q	Q	6M	
4040P	CWW	308675	6402724	69.16	5.9-11.9	Paleochannel alluvium	Q	Q	Q		
4051C	Carrington	308664	6402721	68.92	31.8-32.8	Interburden (Siltstone/Sandstone)	Q	Q	Q		
4116P	North Pit	310681	6400978	70.17	20.9-23.5	Spoil	Q	Q	Q	6M	
4119P	North Pit	312501	6402048	63.51	14.9-17.5	Spoil	Q	Q	Q	6M	
Appleyard Farm	Lemington	315491	6394639	43.4	7-10	Alluvium	M	Q	Q	A	
B334(BFS)	Lemington	316684	6394088	73.37	58.5-64.5	Bowfield Seam	Q	6M	6M		
B425(WDH)	Lemington	316010	6395024	57.88	31.5-35.5	Woodlands Hill Seam	Q	6M	6M	A	
B631(BFS)	Lemington	316425	6394319	72.11	78-84	Bowfield Seam	Q	6M	6M		
B631(WDH)	Lemington	316424	6394319	71.98	29.8-32.3	Woodlands Hill Seam	6M	6M	6M		
B925(BFS)	Lemington	315921	6394604	62.45	81-87	Bowfield Seam	Q	6M	6M	A	
BC1a	Cheshunt	312421	6400872	66.08	21.98	Mt Arthur Seam	Q	Q	Q		
BUNC45A	Cheshunt/ North Pit	313667	6402055	72.9	17.3-20.3	Regolith	Q	Q	Q	6M	
BUNC45D	Cheshunt Pit	313677	6402060	73.36	25.9-28.9	Mt Arthur Seam	Q	Q	Q	6M	
BZ1-1	Cheshunt/ North Pit	311472	6400483	71.39	21-24	Interburden	Q	Q	Q	6M	
BZ1-3	Cheshunt	311472	6400483	71.39	53-56	Mt Arthur Seam	Q	Q	Q	6M	
BZ2A(1)	Cheshunt	311671	6400561	71.17	49.1-52.1	Mt Arthur Seam	Q	Q	Q		
BZ3-1	Cheshunt	311840	6400640	69.97	TD 26.5	Interburden	Q	Q	Q		
BZ3-3	Cheshunt	311840	6400640	69.97	41.5-44.5	Mt Arthur Seam	Q	Q	Q		
BZ4A(2)	Cheshunt	312029	6400705	74.4	38-41	Mt Arthur Seam	Q	Q	Q		
BZ8-2	Cheshunt	312685	6401010	67.8	18-21	Interburden	Q	Q	Q	6M	
C122(WDH)	Lemington	315501	6395007	58.44	19.6-22.6	Woodlands Hill Seam	6M	6M	6M		
C122(BFS)	Lemington	315501	6395007	58.2	-	Bowfield Seam	Q	Q	Q		
C130(AFS1)	Lemington	316400	6394916	63.17	42-44	Arrowfield Seam	6M	6M	6M	A	
C130(ALL)	Lemington	316400	6394916	63.04	15-17	Interburden	Q	Q	Q	A	

ID	Location	Easting	Northing	Ground Level (mAHD)	Screened Interval (mbgl)	Geology	Groundwater Monitoring Programme				
							Water Level	EC	pH	Full WQ	Alk/Acidity
C130(BFS)	Lemington	316400	6394916	62.98	55.5-64.5	Bowfield Seam	6M	6M	6M		
C130(WDH)	Lemington	316400	6394916	63.14	19-21.5	Woodlands Hill Seam	6M	6M	6M		
C317(BFS)	Lemington	315054	6395007	60.38	70-76.5	Bowfield Seam	Q	6M	6M		
C317(WDH)	Lemington	315054	6395007	60.12	31-33.5	Woodlands Hill Seam	Q	6M	6M		
C613(BFS)	Lemington	314688	6395243	63.64	77-85	Bowfield Seam	Q	6M	6M		
C621(BFS)	Lemington	315421	6395321	58.37	47-56	Bowfield Seam	Q	6M	6M		
C630(BFS)	Lemington	316378	6395306	68.81	40.3-48.3	Bowfield Seam	6M	6M	6M		
C809 (GM/WDH)	Lemington	314207	6395493	59.13	28-38	Woodlands Hill Seam	6M	6M	6M		
C919(ALL)	Lemington	315192	6395655	57.94	7.5-13.5	Alluvium	M	Q	Q	A	
CFW55R	Carrington	310439	6402180	69.78	9.4-16.4	Paleochannel alluvium	Q	Q	Q	6M	
CFW57	Carrington	310084	6402053	70.05	8.4-15.4	Paleochannel alluvium	Q	Q	Q	6M	
CGW32	CWW	308598	6404872	78.48	14-23	Paleochannel alluvium	Q	Q	Q		
CGW39	CWW	308566	6403694	70.31	5-14	Alluvium	Q	Q	Q	6M	
CGW45	CWW	308042	6403349	71.83	28.6	Bayswater Seam	Q	Q	Q		
CGW46	CWW	308413	6403276	71.95	13.6	Bayswater Seam	Q	Q	Q	6M	
CGW47a	CWW	308731	6403405	70.39	16.47	Broonie Seam	Q	Q	Q	6M	
CGW49	CWW	308778	6403098	69.05	13.3	Bayswater Seam	Q	Q	Q		
CGW51a	Carrington	310149	6402419	70.04	13 - 16	Interburden (Siltstone/Sandstone)	Q	Q	Q		
CGW52	Carrington	309906	6402255	70.7	39.6-42.6	Broonie Seam	Q	Q	Q		
CGW52a	Carrington	309902	6402249	70.61	15 - 18	Alluvium	Q	Q	Q		
CGW53	Carrington	309606	6402333	69.87	38.5-41.5	Broonie Seam	Q	Q	Q		
CGW53a	Carrington	309606	6402333	69.83	11.7 – 14.7	Alluvium	Q	Q	Q		
CGW55a	Carrington	309840	6402457	70.56	12.8 – 15.8	Alluvium	Q	Q	Q		
CHPZ10A	Cheshunt/ North Pit	313334	6402297	62.57	9.5-12.6	Alluvium	Q	Q	Q	6M	
CHPZ12A	Cheshunt/ North Pit	313238	6402013	63.13	9.5-11.5	Alluvium	Q	Q	Q	6M	
CHPZ12D	Cheshunt	313236	6402019	63.26	12-15	Mt Arthur Seam	Q	Q	Q	6M	
CHPZ1A	Cheshunt/ North Pit	312820	6401697	65.9	15-18.7	Alluvium	Q	Q	Q	6M[2]	
CHPZ2A	Cheshunt/ North Pit	312941	6401539	65.14	13.7-16.9	Alluvium	Q	Q	Q	6M	

ID	Location	Easting	Northing	Ground Level (mAHD)	Screened Interval (mbgl)	Geology	Groundwater Monitoring Programme				
							Water Level	EC	pH	Full WQ	Alk/Acidity
CHPZ3A	Cheshunt/ North Pit	313086	6401756	63.18	14.5-11.5	Alluvium	Q	Q	Q	6M	
CHPZ3D	Cheshunt	313094	6401756	62.96	20.5-23.6	Mt Arthur Seam	Q	Q	Q	6M	
CHPZ4A	Cheshunt/ North Pit	312904	6402123	65.45	10.9-14.2	Alluvium	Q	Q	Q	6M	
CHPZ8A	Cheshunt/ North Pit	313503	6402051	60.05	4-6	Alluvium	Q	Q	Q	6M	
CHPZ8D	Cheshunt	313508	6402047	59.89	6-9.5	Mt Arthur Seam	Q	Q	Q	6M	
D010(BFS)	Lemington	314355	6395687	55.94	60-66.5	Bowfield Seam	6M	6M	6M		
D010(GM)	Lemington	314355	6395687	55.95	12.5-17	Glen Munro Seam	6M	6M	6M	A	
D010(WDH)	Lemington	314355	6395687	56	19.5-22.5	Woodlands Hill Seam	6M	6M	6M		
D214(BFS)	Lemington	314768	6395831	56.67	43-52.5	Bowfield Seam	Q	6*M	6*M		
D317(BFS)	Lemington	315043	6396019	59.64	39-44.2	Bowfield Seam	Q	6M	6M		
D406(AFS)	Lemington	313931	6396074	57.41	24-27.5	Arrowfield Seam	6M	6M	6M		
D406(BFS)	Lemington	313931	6396074	57.36	51-57	Bowfield Seam	6M	6M	6M		
D510(AFS)	Lemington	314380	6396141	54.99	25.5-30.5	Arrowfield Seam	6M	6M	6M		
D510(BFS)	Lemington	314380	6396141	54.98	34-38	Bowfield Seam	6M	6M	6M		
D612(AFS)	Lemington	314524	6396314	62.16	24.01	Arrowfield Seam	6M	6M	6M		
D612(BFS)	Lemington	314524	6396314	62.1	29.15	Bowfield Seam	6M	6M	6M		
D807(BFS)	Lemington	314002	6396484	59.94	36-41	Bowfield Seam	6M	6M	6M		
DM1	North Pit	311778	6405164	102.73	29.15	Spoil (Base)	Q	Q	Q	A	Q
DM3	North Pit	311971	6403310	94.14	41.5	Spoil (Base)	Q	Q	Q	A	Q
DM4	North Pit	312222	6401418	64.85	55-	Spoil (Base)	Q	Q	Q	A	Q
DM7	North Pit	311136	6400961	69.26	32-	Spoil	Q	Q	Q	A	Q
G1	West Pit	305694	6407301	110	<10	Alluvium	Q	Q	Q	A	
G2	West Pit	305660	6407451	110.6	3.04	Alluvium	Q	Q	Q	A	
G3	West Pit	305636	6407556	108.6	<10	Alluvium	Q	Q	Q	A	
GA3	Cheshunt/ North Pit	310159	6400876	67.02	12	Coal	Q	Q	Q		
GW-100	West Pit	303729	6406436	89.6	4.4-5	Alluvium	Q	Q	Q	A	
GW_100a (VWP)	Carrington	303722	6406445	89.4	51	Barrett Seam and Interburden	Q*				
GW-101	West Pit	304374	6406728	100.5	9-12	Alluvium	Q	Q	Q	A	

ID	Location	Easting	Northing	Ground Level (mAHD)	Screened Interval (mbgl)	Geology	Groundwater Monitoring Programme				
							Water Level	EC	pH	Full WQ	Alk/Acidity
GW-101a (VWP)	Carrington	304362	6406721	100.5	51	Interburden (Siltstone/Sandstone)	Q*				
GW-102 (VWP)	Carrington	305280	6406668	114.6	60.5	Interburden (Sandstone with minor coal)	Q*				
GW-103 (VWP)	Carrington	306769	6404610	103.2	25.5 64.5 119.5	Coal - undifferentiated and weathered Siltstone and coal Sandstone - mg, fresh	Q*				
GW-104 (VWP)	Carrington	307549	6404657	86.7	59 107 135	Lower Pikes Gully Seam Sandstone IB (near Upper Liddell Seam) Sandstone (above Barret)	Q*				
GW-105 (VWP)	Carrington	308597	6405442	93.1	33 103.5 154	Coal - undifferentiated Coal - tuffaceous Coal	Q*				
GW-106	CWW	309092	6405224	82.3	24-27	Paleochannel alluvium	Q	Q	Q	A	
GW-107	Carrington	308738	6404103	73.5	24.2-27.2	Carrington Spoil	Q	Q	Q	A	
GW-108	Carrington	309695	6403971	84.4	52.5-58.5	Carrington Spoil	Q	Q	Q	A	
GW-109 (VWP)	Carrington	309232	6402706	85.2	31.5 65 89.5	Coal - slightly weathered Coal - tuffaceous Bayswater Seam	Q*				
GW-110 (VWP)	Carrington	310503	6404598	124.6	38 63 93	Sandstone - fresh Sandstone Bayswater Seam	Q*				
GW-114	North Pit	312272	6403981	98.2	27-30	Spoil	Q	Q	Q	A	
GW-115	North Pit	312227	6402216	68.3	22.2-28.2	Spoil	Q	Q	Q	A	
GW-120	Carrington	310463	6402239	69.97	12-15	Alluvium	TBC	TBC	TBC	TBC	
GW-121	Carrington	310332	6401877	68	5-8	Alluvium	TBC	TBC	TBC	TBC	
GW-122	Carrington	310225	6401781	69.06	12-15	Interburden	TBC	TBC	TBC	TBC	
GW-123	Carrington	310259	6402014	68.99	9.9-12.9	Alluvium	TBC	TBC	TBC	TBC	
GW-124	Carrington	310170	6401924	68.9	11.7-14.7	Alluvium	TBC	TBC	TBC	TBC	

ID	Location	Easting	Northing	Ground Level (mAHD)	Screened Interval (mbgl)	Geology	Groundwater Monitoring Programme				
							Water Level	EC	pH	Full WQ	Alk/Acidity
GW-125	Carrington	310118	6402315	68.46	10.4-13.4	Alluvium	TBC	TBC	TBC	TBC	
GW-126	Carrington	310055	6402214	70.29	11.8-14.8	Alluvium	TBC	TBC	TBC	TBC	
GW-127	Carrington	309973	6402109	68.92	11.1-14.1	Alluvium	TBC	TBC	TBC	TBC	
GW-128	Carrington	310314	6402307	69.77	8.7 - 11.7	Alluvium	TBC	TBC	TBC	TBC	
GW-129	Carrington	310553	6402211	72.3	12.3 - 21.3	Spoil	TBC	TBC	TBC	TBC	
HG2	Cheshunt	312469	6400886	67.4	11-17	Interburden	Q	Q	Q		
HG2a	Cheshunt	312469	6400886	66.82	25.8-27.8	Mt Arthur Seam	Q	Q	Q		
Hobdens Well	Cheshunt/ North Pit	312540	6401093	71	13.9	Alluvium	Q	Q	Q	A	
HV3(2)	Cheshunt/ North Pit	310776	6400546	68.06	-	Hunter River Alluvium	Q	Q	Q		
LUG Bore	Lemington	315874	6394295		-		M	Q	Q	A	
NPz2	West Pit	307800	6411340	190.475	57-60	Sandstone/Siltstone	Q	Q	Q	A	
NPz3	West Pit	306305	6409131	148.4	93.3-96.6	Siltstone	Q	Q	Q	A	
NPz5	West Pit	310730	6406550	113.76	40-43	Sandstone/Siltstone	Q	Q	Q	A	
PBO1(ALL)	Lemington	314754	6396026	54.37	9.5-12.5	Alluvium	M	Q	Q	A	
PZ1CH200	Cheshunt/ North Pit	312646	6402256	62.06	>8.9-11.1	Alluvium	Q	Q	Q		
PZ2CH400	Cheshunt/ North Pit	312635	6402051	62.53	>9.9-11.2	Hunter River Alluvium	Q	Q	Q	6M[2]	
PZ3CH800	Cheshunt/ North Pit	312522	6401674	64.16	10.47	Hunter River Alluvium	Q	Q	Q	6M[2]	
PZ4CH1380	Cheshunt/ North Pit	312196	6401176	64.93	14.58	Hunter River Alluvium	Q	Q	Q		
PZ5CH1800	Cheshunt/ North Pit	311852	6400928	66.1	15	Hunter River Alluvium	Q	Q	Q		
SR001	Southern	319146	6394094	58.44	60	Coal	6M	6M	6M		
SR002	Southern	319079	6394620	56.99	38-41	Bayswater Seam	6M	6M	6M		
SR003	Southern	318863	6394864	61.33	64.44	Bayswater Seam	6M	6M	6M		
SR004	Southern	318994	6395506	78.15	40.64	Bayswater Seam	6M	6M	6M		
SR005	Southern	318831	6396128	65.36	27.08	Bayswater Seam	6M	6M	6M		
SR006	Southern	318555	6395732	83.31	92.25	Bayswater Seam	6M	6M	6M		
SR007 (RC_11)	Southern	318772	6394373	60.9	31.5-37.5	Overburden and Vaux Seam coal	6M	6M	6M	A	

ID	Location	Easting	Northing	Ground Level (mAHD)	Screened Interval (mbgl)	Geology	Groundwater Monitoring Programme				
							Water Level	EC	pH	Full WQ	Alk/Acidity
SR008 (RC_7)	Southern	319290	6395111	56.8	24.4-30.4	Siltstone/sandstone below Lemington Seam	6M	6M	6M	A	
SR009 (RC_8)	Southern	319338	6394746	56.1	30.4-36.4	Lemington Seam	6M	6M	6M	A	
SR010 (RC_6)	Southern	317319	6395338	57.5	24.6-30.6	Conglomerate and Warkworth Seam	6M	6M	6M	A	
SR011 (RC_14)	Southern	317699	6394412	88.2	41.4-47.4	Mt Arthur Seam and underburden	6M	6M	6M	A	
SR012(HQ_11)	Southern	316354	6393926	76.2	23.4-29.4	Overburden - conglomerate and sandstone	6M	6M	6M	A	
MB14HVO01	North Pit	310587	6401003	71.3	90	Spoil	Q	Q	Q	A	
MB14HVO02	North Pit	310469	6401001	70.9	90	Spoil	Q	Q	Q	A	
MB14HVO03	North Pit	311387	6400950	67.1	80	Spoil	Q	Q	Q	A	
MB14HVO04	North Pit	311491	6401392	67.1	55	Spoil	Q	Q	Q	A	
MB14HVO05	North Pit	310675	6401127	71.7	85	Spoil	Q	Q	Q	A	

Notes:

(VWP) indicates that the hole is fitted with a grouted vibrating wire piezometer.
Q* - Data downloaded quarterly
RE – Rain Event sampling (≥30mm rainfall in 24hrs, max 2 sampling events per quarter),
M – Monthly,
Q – Quarterly,
6M – Six Monthly
A – Annual
[2] Comprehensive analysis 2

APPENDIX B

Groundwater Level Readings 2019

Alluvium

ID	Location	Easting	Northing	Ground Level (mAHD)	Screened Interval (mbgl)	WMP Geology	SWL (mAHD)			
							Q1	Q2	Q3	Q4
4032P	CWW	308609	6402945	69.35	7.4-13.4	Carrington West Wing_Alluvium	58.51	58.51	58.59	58.79
4034P	CWW	308239	6402959	71.15	5.6-14.6	Carrington West Wing_Alluvium	58.5	58.49	58.49	58.48
4037P	CWW	308277	6402702	70.74	8.3-14.3	Carrington West Wing_Alluvium	58.58	58.56	58.56	58.54
4040P	CWW	308675	6402724	69.16	5.9-11.9	Carrington West Wing_Alluvium	58.56	58.8	58.57	58.51
Appleyard Farm	Lemington	315491	6394639	43.4	7-10	Lemington South_Alluvium	36.04	36.06	35.92	35.8
BUNC45A	Cheshunt/ North Pit	313667	6402055	72.9	17.3-20.3	Cheshunt / North Pit_Alluvium	51.71	51.78	51.93	50.93
BZ1-1	Cheshunt/ North Pit	311472	6400483	71.39	21-24	Cheshunt / North Pit_Alluvium	53.88	Bore Dry	53.71	53.93
C919(ALL)	Lemington	315192	6395655	57.94	?	Lemington South_Alluvium	45.98	Bore Dry	Bore Dry	Bore Dry
CFW55R	Carrington	310439	6402180	69.78	9.4-16.4	Carrington_Alluvium	58.12	57.97	57.88	57.75
CFW57	Carrington	310084	6402053	70.05	8.4-15.4	Carrington_Alluvium	57.94	57.94	57.81	57.7
CGW32	CWW	308598	6404872	78.48	?	Carrington West Wing_Flood Plain	59.14	59.11	59.13	59.09
CGW39	CWW	308566	6403694	70.31	5-14	Carrington West Wing_Flood Plain	58.12	58.13	58.12	58.07
CGW47a	CWW	308731	6403405	70.39	?	Carrington West Wing_Flood Plain	54.15	54.11	54.15	54.15
CGW49	CWW	308778	6403098	69.05	?	Carrington West Wing_Alluvium	58.97	58.98	58.96	58.95
CGW52a	Carrington	309902	6402249	70.61	?	Carrington_Alluvium	58.03	57.93	57.91	57.83
CGW53a	Carrington	309606	6402333	69.83	?	Carrington_Alluvium	58.08	58.03	57.49	57.94
CGW55a	Carrington	309840	6402457	70.56	?	Carrington_Alluvium	57.34	57.26	57.23	56.96
CHPZ10A	Cheshunt/ North Pit	313334	6402297	62.57	9.5-12.6	Cheshunt / North Pit_Alluvium	53.14	53.25	53.16	53.14
CHPZ12A	Cheshunt/ North Pit	313238	6402013	63.13	9.5-11.5	Cheshunt / North Pit_Alluvium	53.76	53.86	53.77	53.74
CHPZ1A	Cheshunt/ North Pit	312820	6401697	65.9	15-18.7	Cheshunt / North Pit_Alluvium	54.2	54.32	54.15	54.19
CHPZ2A	Cheshunt/ North Pit	312941	6401539	65.14	13.7-16.9	Cheshunt / North Pit_Alluvium	53.62	Blocked	53.62	53.61
CHPZ3A	Cheshunt/ North Pit	313086	6401756	63.18	14.5-11.5	Cheshunt / North Pit_Alluvium	53.48	53.59	53.48	53.46
CHPZ4A	Cheshunt/ North Pit	312904	6402123	65.45	10.9-14.2	Cheshunt / North Pit_Alluvium	53.41	53.51	53.39	53.41
CHPZ8A	Cheshunt/ North Pit	313503	6402051	60.05	4-6	Cheshunt / North Pit_Alluvium	53.18	53.32	53.2	53.16
G1	West Pit	305694	6407301	110	?	West Pit_Alluvium	108.37	108.22	108.35	107.99
G2	West Pit	305660	6407451	110.6	?	West Pit_Alluvium	109.26	109.28	109.52	109.06

ID	Location	Easting	Northing	Ground Level (mAHD)	Screened Interval (mbgl)	WMP Geology	SWL (mAHD)			
							Q1	Q2	Q3	Q4
G3	West Pit	305636	6407556	108.6	?	West Pit_Alluvium	107.76	107.83	108.14	107.69
GA3	Cheshunt/ North Pit	310159	6400876	67.02	?	Cheshunt / North Pit_Alluvium	56.46	56.52	56.43	56.49
GW-100	West Pit	303729	6406436	89.6	4.4-5	West Pit_Alluvium	83.74	83.68	83.56	83.39
GW-101	West Pit	304374	6406728	100.5	9-12	West Pit_Alluvium	87.68	87.63	Bore Dry	Bore Dry
GW-106	CWW	309092	6405224	82.3	24-27	Carrington West Wing_Alluvium	59.06	59	59.08	59.01
GW-120	North Void	310463	6402239	69.97	12-15	North Void_Alluvium	58.19	58.02	57.93	57.78
GW-121	North Void	310332	6401877	68	5-8	North Void_Alluvium	Bore Dry	Bore Dry	Bore Dry	Bore Dry
GW-123	North Void	310259	6402014	68.99	10-12.9	North Void_Alluvium	57.91	57.9	57.8	57.67
GW-124	North Void	310170	6401924	68.9	11.7-14.7	North Void_Alluvium	58.18	58.22	58.05	57.94
GW-125	North Void	310118	6402315	68.46	10.4-13.4	North Void_Alluvium	58.24	58.22	58.16	58.04
GW-126	North Void	310055	6402214	70.29	11.8-14.8	North Void_Alluvium	57.92	57.84	57.84	57.72
GW-127	North Void	309973	6402109	68.92	11.1-14.1	North Void_Alluvium	58.19	58.2	58.09	57.98
GW-128	North Void	310314	6402307	69.77	8.7-11.7	North Void_Alluvium	57.83	57.73	57.66	57.52
Hobdens Well	Cheshunt/ North Pit	312540	6401093	71	?	Cheshunt / North Pit_Alluvium	58.5	58.67	58.44	58.5
HV3(2)	Cheshunt/ North Pit	310776	6400546	68.06	?-16.7	Cheshunt / North Pit_Alluvium	56.95	56.9	57	57.02
PB01(ALL)	Lemington	314754	6396026	54.37	9.5-12.5	Lemington South_Alluvium	45.01	45.11	45.04	44.86
PZ1CH200	Cheshunt/ North Pit	312646	6402256	62.06	>8.9-11.1	Cheshunt / North Pit_Alluvium	54.5	54.55	54.42	54.65
PZ2CH400	Cheshunt/ North Pit	312635	6402051	62.53	>9.9-11.2	Cheshunt / North Pit_Alluvium	60.17	54.58	54.41	54.51
PZ3CH800	Cheshunt/ North Pit	312522	6401674	64.16	?	Cheshunt / North Pit_Alluvium	54.74	54.74	54.67	54.86
PZ4CH1380	Cheshunt/ North Pit	312196	6401176	64.93	?	Cheshunt / North Pit_Alluvium	54.89	54.89	54.86	55.06
PZ5CH1800	Cheshunt/ North Pit	311852	6400928	66.1	?	Cheshunt / North Pit_Alluvium	55.21	55.2	55.14	55.45

Permian Coal Measures

ID	Location	Easting	Northing	Ground Level (mAHD)	Screened Interval (mbgl)	WMP Geology	SWL (mAHD)			
							Q1	Q2	Q3	Q4
4036C	Carrington	308272	6402688	70.7	33.1-34.1	Carrington_Interburden	Bore Dry	Bore Dry	Bore Dry	Bore Dry
4051C	Carrington	308664	6402721	68.92	31.8-32.8	Carrington_Interburden	50.96	51.56	52.1	52.38
B334(BFS)	Lemington	316684	6394088	73.37	58.5-?	Lemington South_Bowfield	17.71	18.16	18.73	19.59
B425(WDH)	Lemington	316010	6395024	57.88	?	Lemington South_Woodlands Hill	22.14	22.28	21.98	22.06
B631(BFS)	Lemington	316425	6394319	72.11	78-?	Lemington South_Bowfield	26.98	26.53	25.02	23.96
B631(WDH)	Lemington	316424	6394319	71.98	?	Lemington South_Woodlands Hill	-	45.8	-	45.77
B925(BFS)	Lemington	315921	6394604	62.45	81-?	Lemington South_Bowfield	3.85	3.06	0.52	-0.72
BC1a	Cheshunt	312421	6400872	66.08	?	Cheshunt_Mt Arthur	48.49	48.5	48.42	48.47
BUNC45D	Cheshunt Pit	313677	6402060	73.36	25.9-28.9	Cheshunt_Piercefield	48.01	48.1	48.1	48.12
BZ1-3	Cheshunt	311472	6400483	71.39	?	Cheshunt_Mt Arthur	24.34	24.52	24.57	24.63
BZ2A(1)	Cheshunt	311671	6400561	71.17	?	Cheshunt_Mt Arthur	25	25.04	25	25.04
BZ3-1	Cheshunt	311840	6400640	69.97	?	Cheshunt_Interburden	53.18	53.07	52.97	52.35
BZ3-3	Cheshunt	311840	6400640	69.97	?	Cheshunt_Mt Arthur	26.84	26.82	26.8	26.86
BZ4A(2)	Cheshunt	312029	6400705	74.4	?	Cheshunt_Mt Arthur	33.44	33.06	33.06	33.09
BZ8-2	Cheshunt	312685	6401010	67.8	?	Cheshunt_Interburden	47.58	47.6	49.04	47.09
C122(WDH)	Lemington	315501	6395007	58.44	?	Lemington South_Woodlands Hill	-	45.86	-	45.71
C122(BFS)	Lemington	315501	6395007	58.2	?	Lemington South_Bowfield	Bore Dry	Bore Dry	Bore Dry	Bore Dry
C130(AFS1)	Lemington	316400	6394916	63.17	42-44	Lemington South_Arrowfield	-	44.56	-	44.74
C130(ALL)	Lemington	316400	6394916	63.04	15-17	Lemington South_Interburden	47.05	47.07	47.09	46.97
C130(BFS)	Lemington	316400	6394916	62.98	55.5-64.5	Lemington South_Bowfield	12.14	12.22	10.77	9.64
C130(WDH)	Lemington	316400	6394916	63.14	19-21.5	Lemington South_Woodlands Hill	-	47.01	-	46.99
C317(BFS)	Lemington	315054	6395007	60.38	?	Lemington South_Bowfield	10.04	10.06	7.82	6.22
C317(WDH)	Lemington	315054	6395007	60.12	?	Lemington South_Woodlands Hill	45.55	45.51	45.4	45.3
C613(BFS)	Lemington	314688	6395243	63.64	?	Lemington South_Bowfield	33.91	33.57	33.22	33.11
C621(BFS)	Lemington	315421	6395321	58.37	?	Lemington South_Bowfield	16.35	16.37	15.3	14.87
C630(BFS)	Lemington	316378	6395306	68.81	?	Lemington South_Bowfield	-	22.86	-	22.98
C809 (GM/WDH)	Lemington	314207	6395493	59.13	28-38	Lemington South_Woodlands Hill	-	46.62	-	46.25
CGW45	CWW	308042	6403349	71.83	?	Carrington West Wing_LBL	Blocked	Blocked	Blocked	Blocked
CGW46	CWW	308413	6403276	71.95	?	Carrington West Wing_Bayswater	59.01	59.76	59.01	59.05
CGW51a	Carrington	310149	6402419	70.04	?	Carrington_Interburden	55.89	55.7	55.63	55.57

ID	Location	Easting	Northing	Ground Level (mAHD)	Screened Interval (mbgl)	WMP Geology	SWL (mAHD)			
							Q1	Q2	Q3	Q4
CGW52	Carrington	309906	6402255	70.7	?	Carrington_Broonie	34.06	33.98	34.16	34.28
CGW53	Carrington	309606	6402333	69.87	?	Carrington_Broonie	35.44	35.47	35.59	35.73
CHPZ12D	Cheshunt	313236	6402019	63.26	12-15	Cheshunt_Mt Arthur	53.68	53.75	53.66	53.66
CHPZ3D	Cheshunt	313094	6401756	62.96	20.5-23.6	Cheshunt_Mt Arthur	52.39	52.56	52.39	52.45
CHPZ8D	Cheshunt	313508	6402047	59.89	6-9.5	Cheshunt_Mt Arthur	52.81	53.31	52.82	52.76
D010(BFS)	Lemington	314355	6395687	55.94	60-66.5	Lemington South_Bowfield	-	28.39	-	28.44
D010(GM)	Lemington	314355	6395687	55.95	12.5-17	Lemington South_Glen Munro	-	47.22	-	46.76
D010(WDH)	Lemington	314355	6395687	56	19.5-22.5	Lemington South_Woodlands Hill	-	46.22	-	45.84
D214(BFS)	Lemington	314768	6395831	56.67	43-52.5	Lemington South_Bowfield	26.47	26.86	26.64	26.8
D317(BFS)	Lemington	315043	6396019	59.64	39-44.2	Lemington South_Bowfield	24.94	25.3	25.3	25.33
D406(AFS)	Lemington	313931	6396074	57.41	?	Lemington South_Arrowfield	-	40.95	-	40.37
D406(BFS)	Lemington	313931	6396074	57.36	?	Lemington South_Bowfield	-	30.63	-	31.42
D510(AFS)	Lemington	314380	6396141	54.99	25.5-30.5	Lemington South_Arrowfield	-	29.88	-	29.58
D510(BFS)	Lemington	314380	6396141	54.98	34-38	Lemington South_Bowfield	-	29.62	-	30.32
D612(AFS)	Lemington	314524	6396314	62.16	?	Lemington South_Arrowfield	-	39.46	-	39.38
D612(BFS)	Lemington	314524	6396314	62.1	?	Lemington South_Bowfield	-	29.83	-	30.25
D807(BFS)	Lemington	314002	6396484	59.94	36-41	Lemington South_Bowfield	-	32.88	-	33.76
GW-122	North Void	310225	6401781	69.06	12-15	North Void_Permian	58.28	58.13	57.82	57.82
HG2	Cheshunt	312469	6400886	67.4	11-17	Cheshunt_Interburden	54.39	54.54	54.38	54.38
HG2a	Cheshunt	312469	6400886	66.82	25.8-27.8	Cheshunt_Mt Arthur	41.06	41.06	41.03	41.08
NPz2	West Pit	307800	6411340	190.475	57-60	West Pit_Sandstone/Siltstone	161.055	160.955	160.955	160.575
NPz3	West Pit	306305	6409131	148.4	?	West Pit_Sandstone/Siltstone	125.81	125.96	125.51	124.9
NPz5	West Pit	310730	6406550	113.76	40-43	West Pit_Sandstone/Siltstone	95.21	95.71	93.57	91.93
SR001	Southern	319146	6394094	58.44	?	Southern_Coal	-	47.04	-	46.93
SR002	Southern	319079	6394620	56.99	38-41	Southern_Bayswater Seam	-	42.84	-	42.54
SR003	Southern	318863	6394864	61.33	?	Southern_Bayswater Seam	-	43.16	-	42.8
SR004	Southern	318994	6395506	78.15	?	Southern_Bayswater Seam	-	42.7	-	42.55
SR005	Southern	318831	6396128	65.36	?	Southern_Bayswater Seam	-	42.67	-	42.67
SR006	Southern	318555	6395732	83.31	?	Southern_Bayswater Seam	-	42.57	-	42.46
SR007	Southern	318772	6394373	60.9	31.5-37.5	Southern_Overburden and Vaux Seam coal	25.83	25.75	25.81	25.84
SR008	Southern	319290	6395111	56.8	24.4-30.4	Southern_Siltstone/sandstone below Lemington Seam	47.22	47.19	47.13	47.04

ID	Location	Easting	Northing	Ground Level (mAHD)	Screened Interval (mbgl)	WMP Geology	SWL (mAHD)			
							Q1	Q2	Q3	Q4
SR009	Southern	319338	6394746	56.1	30.4-36.4	Southern_Lemington Seam	49.16	49.16	49.1	49
SR010	Southern	317319	6395338	57.5	24.6-30.6	Southern_Conglomerate and Warkworth Seam	46.61	46.98	47.17	46.92
SR011	Southern	317699	6394412	88.2	41.4-47.4	Southern_Mt Arthur Seam and underburden	53.6	53.47	53.45	53.36
SR012	Southern	316354	6393926	76.2	23.4-29.4	Southern_Overburden - conglomerate and sandstone	49.49	49.25	49.11	49

Spoil

ID	Location	Easting	Northing	Ground Level (mAHD)	Screened Interval (mbgl)	WMP Geology	SWL (mAHD)			
							Q1	Q2	Q3	Q4
4116P	North Pit	310681	6400978	70.17	20.9-23.5	North Pit_Spoil	46.54	47	46.46	46.52
4119P	North Pit	312501	6402048	63.51	14.9-17.5	North Pit_Spoil	52.45	52.62	52.4	52.33
DM1	North Pit	311778	6405164	102.73	?	North Pit_Spoil	77.52	77.19	77.53	77.54
DM3	North Pit	311971	6403310	94.14	50-?	North Pit_Spoil	63.76	63.68	63.66	63.7
DM4	North Pit	312222	6401418	64.85	55-?	North Pit_Spoil	46.86	46.81	46.7	46.61
DM7	North Pit	311136	6400961	69.26	32-?	North Pit_Spoil	Bore Dry	Bore Dry	Bore Dry	Bore Dry
GW-107	Carrington	308738	6404103	73.5	24.2-27.2	Carrington_Spoil	44.29	44.18	44.28	44.3
GW-108	Carrington	309695	6403971	84.4	52.5-58.5	Carrington_Spoil	23.51	23.5	23.52	23.54
GW-114	North Pit	312272	6403981	98.2	27-30	North Pit_Spoil	66.47	66.39	66.36	66.32
GW-115	North Pit	312227	6402216	68.3	22.2-28.2	North Pit_Spoil	53.51	53.68	53.44	53.36
GW-129	Carrington	310553	6402211	72.3	12.3-21.3	Carrington_Spoil	60.47	58.6	57.95	57.36
MB14HVO01	North Pit	310587	6401003	71.3	?	North Pit_Spoil	35.56	35.42	35.14	35
MB14HVO02	North Pit	310469	6401001	70.9	?	North Pit_Spoil	35.48	35.41	35.14	35
MB14HVO03	North Pit	311387	6400950	67.1	?	North Pit_Spoil	32.9	32.85	32.74	32.74
MB14HVO04	North Pit	311491	6401392	67.1	?	North Pit_Spoil	37.35	37.3	37.12	37.04
MB14HVO05	North Pit	310675	6401127	71.7	?	North Pit_Spoil	35.56	35.43	35.32	35.02

APPENDIX C

Groundwater Quality Data 2019

Alluvium

ID	Location	Q1		Q2		Q3		Q4		EC Trigger	pH Trigger (5th Percentile)	pH Trigger (95th Percentile)
		EC	pH	EC	pH	EC	pH	EC	pH			
4032P	CWW	1582	7.2	1551	7.3	1596	7.3	3320	7.1	2775	7	7.5
4034P	CWW	1492	7.4	1514	7.4	1620	7.4	1579	7.5	2775	7	7.5
4037P	CWW	Blocked	Blocked	1236	7.3	1327	7.2	1314	7.2	2775	7	7.5
4040P	CWW	963	7.1	901	7.3	954	7.2	907	7.1	2775	7	7.5
Appleyard Farm	Lemington	568	6.8	608	7	585	6.7	613	6.8	22700 3938	6.8 6.6	7.0 7.7
BUNC45A	Cheshunt/ North Pit	2130	6.7	2100	6.8	2210	6.8	2140	6.7	4462	6.6	7.5
BZ1-1	Cheshunt/ North Pit	2700	7.5	Bore Dry	Bore Dry	Blocked	Blocked	2530	7.6	4462	6.6	7.5
C919(ALL)	Lemington	Bore Dry	Bore Dry	Bore Dry	Bore Dry	Bore Dry	Bore Dry	Bore Dry	Bore Dry	22700 3938	6.8 6.6	7.0 7.7
CFW55R	Carrington	8250	6.8	9720	7.2	9140	7.1	9150	7.2	6154	7	8
CFW57	Carrington	5940	7.2	5600	7.3	4890	7.4	4120	7.5	6154	7	8
CGW32	CWW	8460	7.2	9050	7.2	7860	7.3	9190	7.2	9280	6.8	7.8
CGW39	CWW	6410	7.4	6130	7.4	5610	7.3	6480	7.3	9280	6.8	7.8
CGW47a	CWW	Bore Dry	Bore Dry	Bore Dry	Bore Dry	Bore Dry	Bore Dry	Bore Dry	Bore Dry	9280	6.8	7.8
CGW49	CWW	2890	7.4	2700	7.4	2940	7.4	2830	7.4	2775	7	7.5
CGW52a	Carrington	2290	7.6	1920	7.8	1930	7.8	1925	7.7	6154	7	8
CGW53a	Carrington	1408	7.2	1323	7.3	1382	7.3	1428	7.4	6154	7	8
CGW55a	Carrington	1672	7.7	1733	7.8	1820	7.8	1810	8.4	6154	7	8
CHPZ10A	Cheshunt/ North Pit	779	6.7	604	7.3	777	6.8	712	7	4462	6.6	7.5
CHPZ12A	Cheshunt/ North Pit	841	6.8	795	6.9	901	6.8	898	7	4462	6.6	7.5
CHPZ1A	Cheshunt/ North Pit	738	7	683	7.2	774	7.3	688	7.2	4462	6.6	7.5
CHPZ2A	Cheshunt/ North Pit	Blocked	Blocked	Blocked	Blocked	Blocked	Blocked	888	7.2	4462	6.6	7.5
CHPZ3A	Cheshunt/ North Pit	715	6.8	732	7.1	713	6.8	702	6.9	4462	6.6	7.5
CHPZ4A	Cheshunt/ North Pit	707	7	733	7.2	734	7.1	763	7.1	4462	6.6	7.5
CHPZ8A	Cheshunt/ North Pit	Bore Dry	Bore Dry	Bore Dry	Bore Dry	Bore Dry	Bore Dry	Bore Dry	Bore Dry	4462	6.6	7.5

ID	Location	Q1		Q2		Q3		Q4		EC Trigger	pH Trigger (5th Percentile)	pH Trigger (95th Percentile)
		EC	pH	EC	pH	EC	pH	EC	pH			
G1	West Pit	8400	7.4	8950	7.3	6190	7.5	6250	7.4	10751	7.1	8.6
G2	West Pit	4580	7.5	4490	7.6	4540	7.5	4840	7.6	10751	7.1	8.6
G3	West Pit	4900	7.5	4900	7.5	1830	7.5	5090	7.6	10751	7.1	8.6
GA3	Cheshunt/ North Pit	811	7	868	7.1	836	7	860	7.1	4462	6.6	7.5
GW-100	West Pit	10610	7.4	10220	7.4	9570	7.5	10460	7.4	10751	7.1	8.6
GW-101	West Pit	Bore Dry	Bore Dry	Bore Dry	Bore Dry	Bore Dry	Bore Dry	Bore Dry	Bore Dry	10751	7.1	8.6
GW-106	CWW	8130	7	9160	6.7	7820	6.8	9180	6.8	9280	6.8	7.8
GW-120	North Void	8850	7.2	9530	7.2	8890	7.1	8800	7.3	-	-	-
GW-121	North Void	Bore Dry	Bore Dry	Bore Dry	Bore Dry	Bore Dry	Bore Dry	Bore Dry	Bore Dry	-	-	-
GW-123	North Void	7470	7.2	7270	7.3	7270	7.3	7200	7.3	-	-	-
GW-124	North Void	5170	7.4	5200	7.5	5260	7.4	5260	7.5	-	-	-
GW-125	North Void	4880	7.9	4620	7.8	4880	7.8	4340	7.8	-	-	-
GW-126	North Void	2830	7.5	3200	7.5	2850	7.6	2580	7.6	-	-	-
GW-127	North Void	2310	7.4	2500	7.3	2420	7.3	2270	7.4	-	-	-
GW-128	North Void	4500	7.6	5900	7.5	6310	7.4	7050	7.6	-	-	-
Hobdens Well	Cheshunt/ North Pit	980	7.5	945	7.2	916	7.7	943	7.6	4462	6.6	7.5
HV3(2)	Cheshunt/ North Pit	899	6.8	937	7	888	6.8	922	6.9	4462	6.6	7.5
PB01(ALL)	Lemington	4,540	7.1	4,340	7.1	4,150	6.9	5260	7.2	22700 3938	6.8 6.6	7.0 7.7
PZ1CH200	Cheshunt/ North Pit	653	7.1	643	7.1	660	7.1	859	7.1	4462	6.6	7.5
PZ2CH400	Cheshunt/ North Pit	1160	6.7	1133	6.7	990	6.9	1001	6.9	4462	6.6	7.5
PZ3CH800	Cheshunt/ North Pit	900	7	822	6.9	946	7.1	867	7	4462	6.6	7.5
PZ4CH1380	Cheshunt/ North Pit	1112	6.9	936	6.9	1112	7	846	7	4462	6.6	7.5
PZ5CH1800	Cheshunt/ North Pit	380	7.2	382	7.3	374	7.3	285	7.1	4462	6.6	7.5

Permian Coal Measures

ID	Location	Q1		Q2		Q3		Q4		EC Trigger	pH Trigger (5th Percentile)	pH Trigger (95th Percentile)
		EC	pH	EC	pH	EC	pH	EC	pH			
4036C	Carrington	Bore Dry	Bore Dry	Bore Dry	Bore Dry	Bore Dry	Bore Dry	Bore Dry	Bore Dry	10824	6.7	7.4
4051C	Carrington	1584	6.9	2140	7.3	2350	7.1	2470	7.2	10824	6.7	7.4
B334(BFS)	Lemington	-	-	7200	7.2	-	-	7920	7.2	12440	6.7	7.9
B425(WDH)	Lemington	-	-	Bore Dry	Bore Dry	-	-	Bore Dry	Bore Dry	20240	6.6	7.6
B631(BFS)	Lemington	-	-	12200	6.6	-	-	13400	6.6	12440	6.7	7.9
B631(WDH)	Lemington	-	-	11750	6.7	-	-	12840	6.6	20240	6.6	7.6
B925(BFS)	Lemington	-	-	4050	7	-	-	4920	6.9	12440	6.7	7.9
BC1a	Cheshunt	916	7.4	868	7	1081	7.3	895	7.2	3350	6.5	7.6
BUNC45D	Cheshunt	2450	6.7	2540	6.8	2440	6.8	2510	6.7	2596	6.4	6.8
BZ1-3	Cheshunt	1243	7.5	1169	7.5	1219	7.6	1204	7.6	3350	6.5	7.6
BZ2A(1)	Cheshunt	1640	6.6	1479	6.5	1426	6.5	1366	6.4	3350	6.5	7.6
BZ3-1	Cheshunt	1298	7.3	1266	7.6	1265	7.5	1317	8.1	6213	6.9	7.7
BZ3-3	Cheshunt	1115	6.4	1025	6.6	1260	6.5	1374	6.4	3350	6.5	7.6
BZ4A(2)	Cheshunt	888	6.2	Bore Dry	Bore Dry	Bore Dry	Bore Dry	Bore Dry	Bore Dry	3350	6.5	7.6
BZ8-2	Cheshunt	1212	7	1207	6.9	1217	7	1207	7.1	6213	6.9	7.7
C122(WDH)	Lemington	-	-	13200	7.2	-	-	14470	7.1	20240	6.6	7.6
C122(BFS)	Lemington	Bore Dry	Bore Dry	Bore Dry	Bore Dry	Bore Dry	Bore Dry	Bore Dry	Bore Dry	12440	6.7	7.9
C130(AFS1)	Lemington	-	-	12890	7.5	-	-	14250	7.4	15324	6.8	7.5
C130(ALL)	Lemington	27400	7	23700	7	26200	7	25100	6.9	11408	6.7	7.1
C130(BFS)	Lemington	-	-	4310	7.4	-	-	4540	7.5	12440	6.7	7.9
C130(WDH)	Lemington	-	-	19800	6.6	-	-	21300	6.6	20240	6.6	7.6
C317(BFS)	Lemington	-	-	8390	7.3	-	-	8730	7.3	12440	6.7	7.9
C317(WDH)	Lemington	-	-	7590	7.5	-	-	7900	7.5	20240	6.6	7.6
C613(BFS)	Lemington	-	-	8950	7.1	-	-	9500	7	12440	6.7	7.9
C621(BFS)	Lemington	-	-	6610	7.3	-	-	7930	7.3	12440	6.7	7.9
C630(BFS)	Lemington	-	-	4000	8	-	-	4220	8.1	12440	6.7	7.9
C809 (GM/WDH)	Lemington	-	-	9380	7.1	-	-	10110	7.1	20240	6.6	7.6

Permian Coal Measures

ID	Location	Q1		Q2		Q3		Q4		EC Trigger	pH Trigger (5th Percentile)	pH Trigger (95th Percentile)
		EC	pH	EC	pH	EC	pH	EC	pH			
CGW45	CWW	Blocked	Blocked	Blocked	Blocked	Blocked	Blocked	Blocked	Blocked	3531	7.3	7.6
CGW46	CWW	2810	7.4	2580	7.5	2700	7.5	2700	7.4	Trigger Removed	Trigger Removed	Trigger Removed
CGW51a	Carrington	8430	7.4	8070	7.4	8240	7.3	8290	7.4	10824	6.7	7.4
CGW52	Carrington	8430	6.8	8260	6.9	8340	6.9	8330	6.7	8628	6.8	7.1
CGW53	Carrington	7770	6.7	7300	6.8	7660	6.8	7760	6.7	8628	6.8	7.1
CHPZ12D	Cheshunt	1437	6.7	1294	7.2	1335	6.8	1335	7.3	3350	6.5	7.6
CHPZ3D	Cheshunt	1037	6.5	1093	6.8	1024	6.3	1073	6.6	3350	6.5	7.6
CHPZ8D	Cheshunt	1345	7	1330	7	1389	7.1	1373	7.2	3350	6.5	7.6
D010(BFS)	Lemington	-	-	10390	7.2	-	-	11050	7.2	12440	6.7	7.9
D010(GM)	Lemington	-	-	10460	7	-	-	11920	6.9	1894	6.5	7.2
D010(WDH)	Lemington	-	-	9030	7	-	-	9490	7.1	20240	6.6	7.6
D214(BFS)	Lemington	-	-	7210	7.8	-	-	7770	7.7	12440	6.7	7.9
D317(BFS)	Lemington	-	-	3320	6.8	-	-	3290	6.8	12440	6.7	7.9
D406(AFS)	Lemington	-	-	11430	6.9	-	-	12300	7	15324	6.8	7.5
D406(BFS)	Lemington	-	-	7100	7.3	-	-	7430	7.4	12440	6.7	7.9
D510(AFS)	Lemington	-	-	12250	7	-	-	13380	6.9	15324	6.8	7.5
D510(BFS)	Lemington	-	-	10550	7.4	-	-	11240	7.5	12440	6.7	7.9
D612(AFS)	Lemington	-	-	14750	7	-	-	15920	6.9	15324	6.8	7.5
D612(BFS)	Lemington	-	-	10740	7	-	-	11510	6.9	12440	6.7	7.9
D807(BFS)	Lemington	-	-	9310	6.9	-	-	10570	6.9	12440	6.7	7.9
GW-122	North Void	-	-	7400	7	-	-	5300	7.3	-	-	-
HG2	Cheshunt	4090	6.9	3880	6.9	3680	7	3820	6.9	6213	6.9	7.7
HG2a	Cheshunt	1785	7	1534	7	1420	7.1	1673	7.1	3350	6.5	7.6
LUG Bore	Lemington	8710	7.1	7940	7.1	8460	7.1	8540	7	-	-	-
NPz2	West Pit	13640	7.2	13240	7.2	13650	7.5	14080	7.2	13428	6.9	8
NPz3	West Pit	12690	7.5	12380	7.5	12190	7.8	13220	7.4	13428	6.9	8
NPz5	West Pit	6700	6.9	6690	6.9	6030	6.9	6700	6.8	13428	6.9	8
SR001	Southern	-	-	16500	6.7	-	-	17440	6.7	-	-	-
SR002	Southern	-	-	14840	6.8	-	-	15990	6.9	-	-	-
SR003	Southern	-	-	9830	7	-	-	10180	7	-	-	-

ID	Location	Q1		Q2		Q3		Q4		EC Trigger	pH Trigger (5th Percentile)	pH Trigger (95th Percentile)
		EC	pH	EC	pH	EC	pH	EC	pH			
SR004	Southern	-	-	12140	6.8	-	-	13840	6.8	-	-	-
SR005	Southern	-	-	3270	6.5	-	-	3490	6.5	-	-	-
SR006	Southern	-	-	11120	6.8	-	-	11720	6.9	-	-	-
SR007	Southern	5030	6.6	6350	6.6	5670	6.7	6000	6.6	-	-	-
SR008	Southern	4250	7.4	12390	6.8	5020	7.2	14270	6.8	-	-	-
SR009	Southern	4340	7.8	5790	7.3	5100	7.6	6090	7.3	-	-	-
SR010	Southern	1990	7.6	5760	7	2180	7.5	5940	7	-	-	-
SR011	Southern	13280	6.6	16800	6.6	15030	6.6	16750	6.5	-	-	-
SR012	Southern	12700	6.8	14750	6.8	14450	6.8	14950	6.7	-	-	-

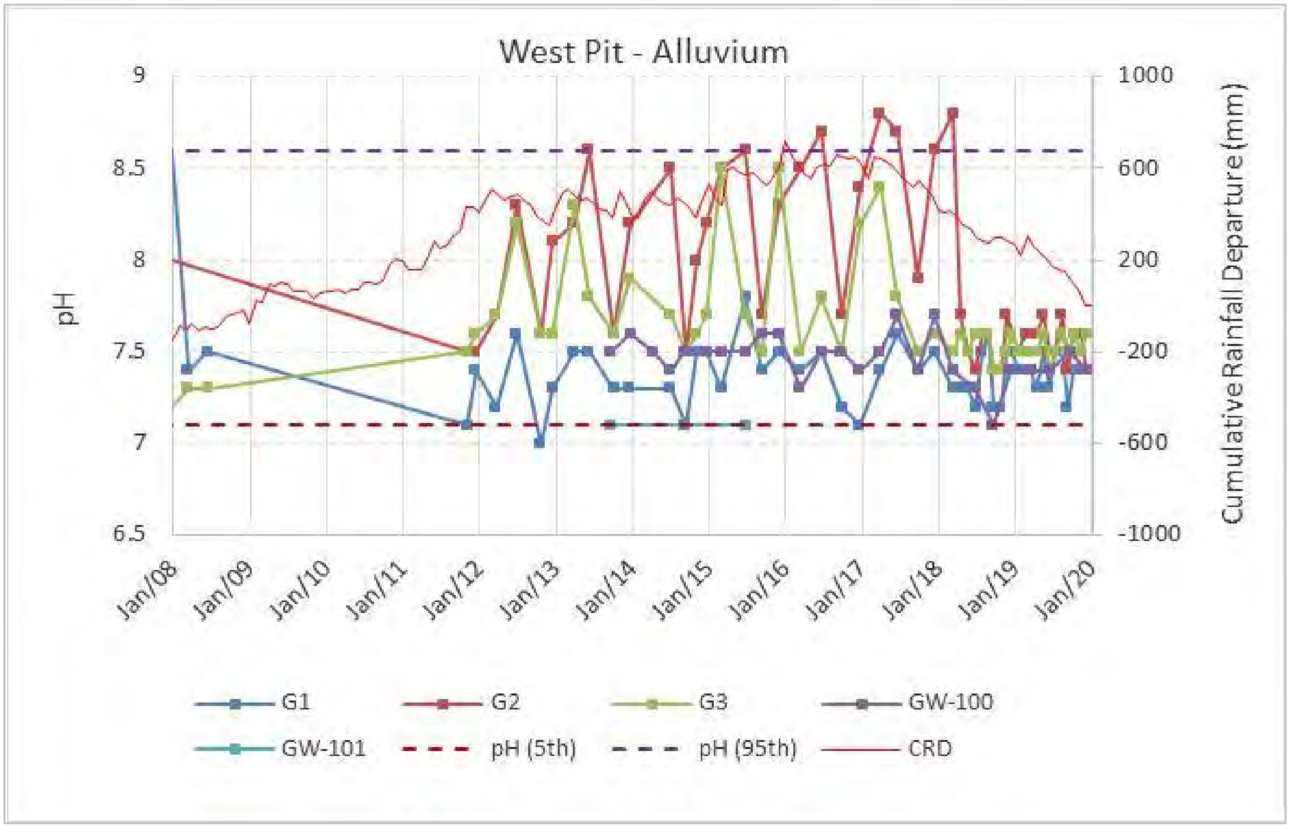
Spoil

ID	Location	Q1		Q2		Q3		Q4		EC Trigger	pH Trigger (5th Percentile)	pH Trigger (95th Percentile)
		EC	pH	EC	pH	EC	pH	EC	pH			
4116P	North Pit	12320	7	13820	7.1	13950	7	14420	7.1	12460	6.5	7.8
4119P	North Pit	2530	7	3910	7	2300	7	4580	7.1	12460	6.5	7.8
DM1	North Pit	10140	6.6	10190	6.5	9420	6.5	10630	6.5	12460	6.5	7.8
DM3	North Pit	8980	6.5	8600	6.4	9860	6.5	9880	6.5	12460	6.5	7.8
DM4	North Pit	6210	6.9	6130	7	6230	7	6300	7	12460	6.5	7.8
DM7	North Pit	Bore Dry	Bore Dry	Bore Dry	Bore Dry	Bore Dry	Bore Dry	Bore Dry	Bore Dry	12460	6.5	7.8
GW-107	Carrington	Bore Dry	Bore Dry	Bore Dry	Bore Dry	Bore Dry	Bore Dry	Bore Dry	Bore Dry	-	-	-
GW-108	Carrington	Bore Dry	Bore Dry	Bore Dry	Bore Dry	Bore Dry	Bore Dry	Bore Dry	Bore Dry	-	-	-
GW-114	North Pit	8600	6.6	8660	6.6	7480	6.5	8840	6.6	12460	6.5	7.8
GW-115	North Pit	7540	6.8	7240	7	6990	6.8	7740	7.1	12460	6.5	7.8
GW-129	Carrington	8580	7.2	8920	7.2	8360	7.1	8000	7.3	-	-	-
MB14HVO01	North Pit	7530	6.7	5500	7	7580	6.8	6510	7	12460	6.5	7.8
MB14HVO02	North Pit	7450	6.8	6510	7.2	7720	6.9	7200	7.3	12460	6.5	7.8
MB14HVO03	North Pit	6190	6.9	5070	7	6260	6.9	5860	7	12460	6.5	7.8
MB14HVO04	North Pit	6040	6.8	5840	6.9	6010	6.9	6000	7	12460	6.5	7.8
MB14HVO05	North Pit	12920	5.7	8040	6.8	14540	5.4	8200	6.8	12460	6.5	7.8

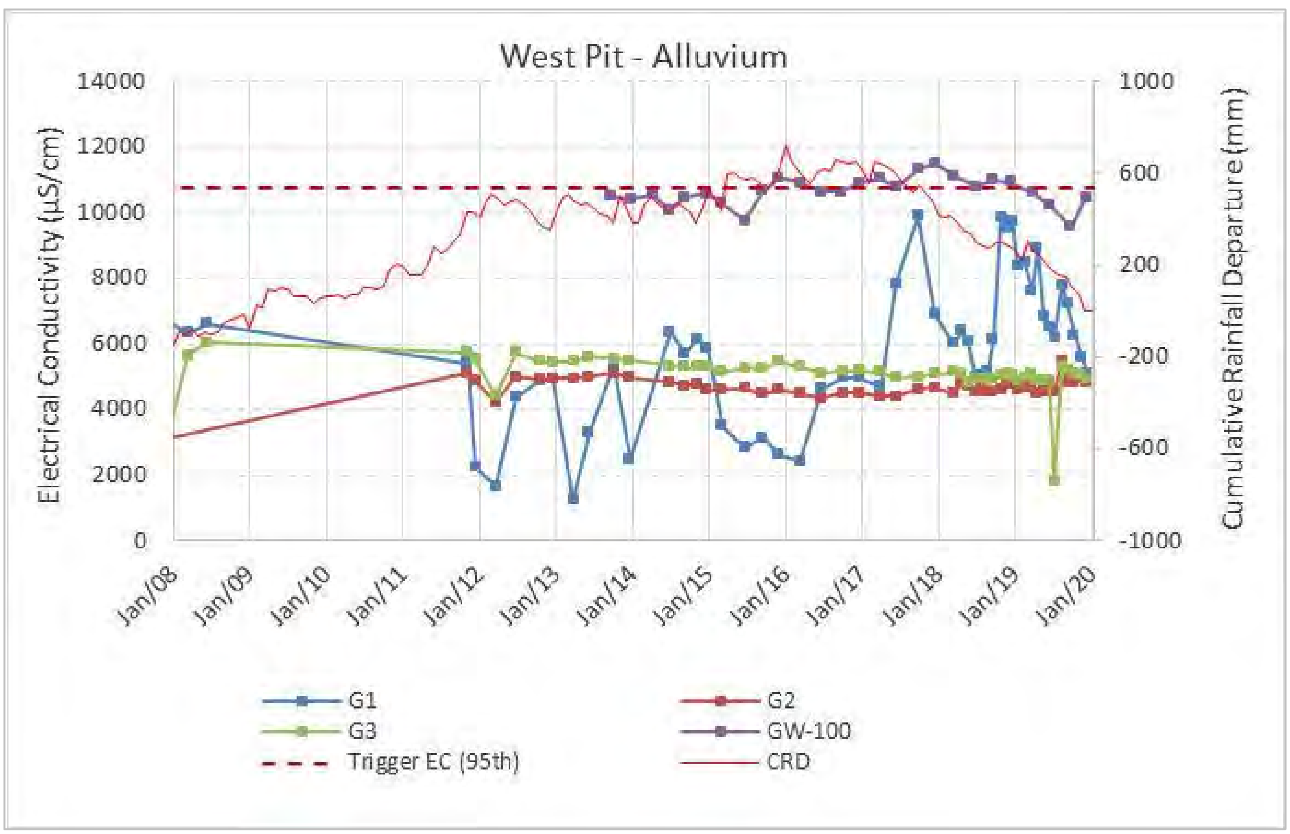
APPENDIX D

Groundwater Quality Graphs – By Location and Geology

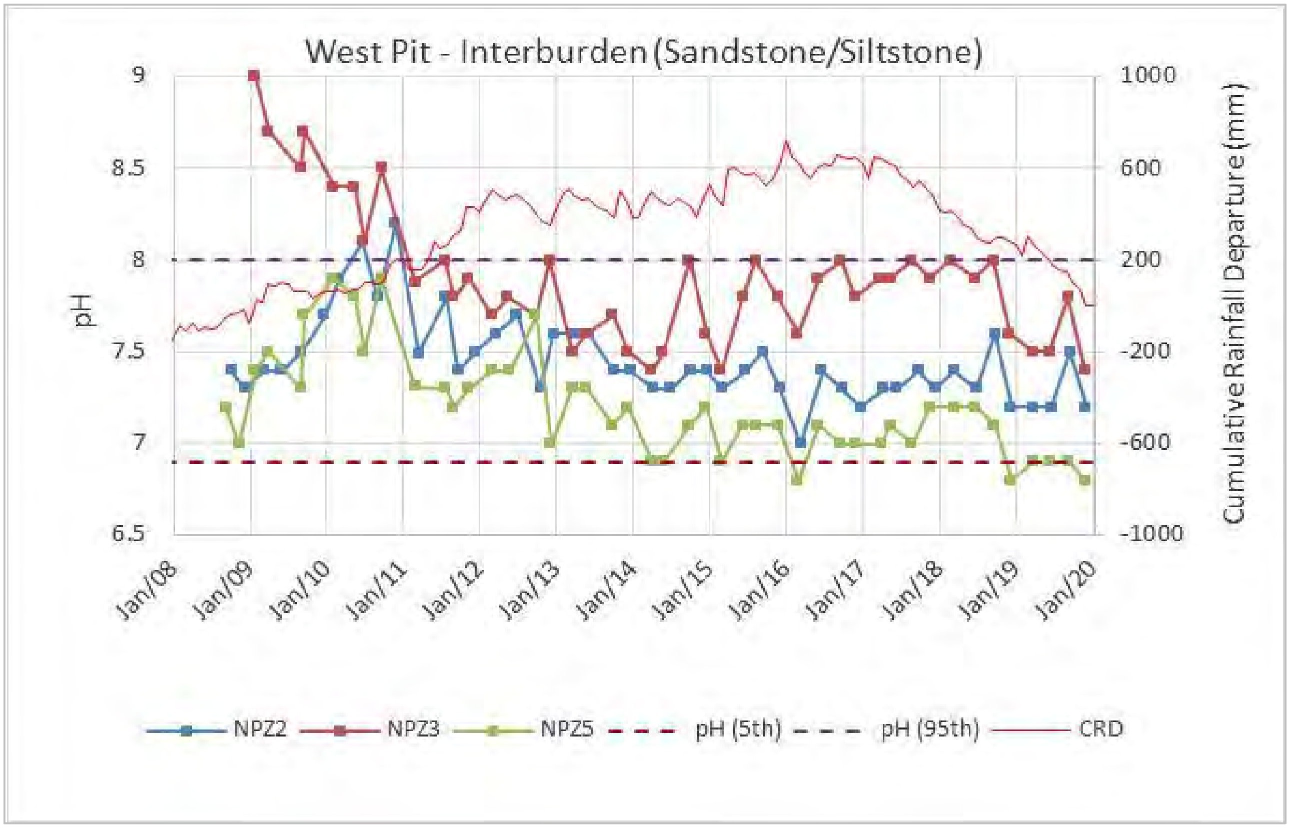
West Pit – Alluvium: pH



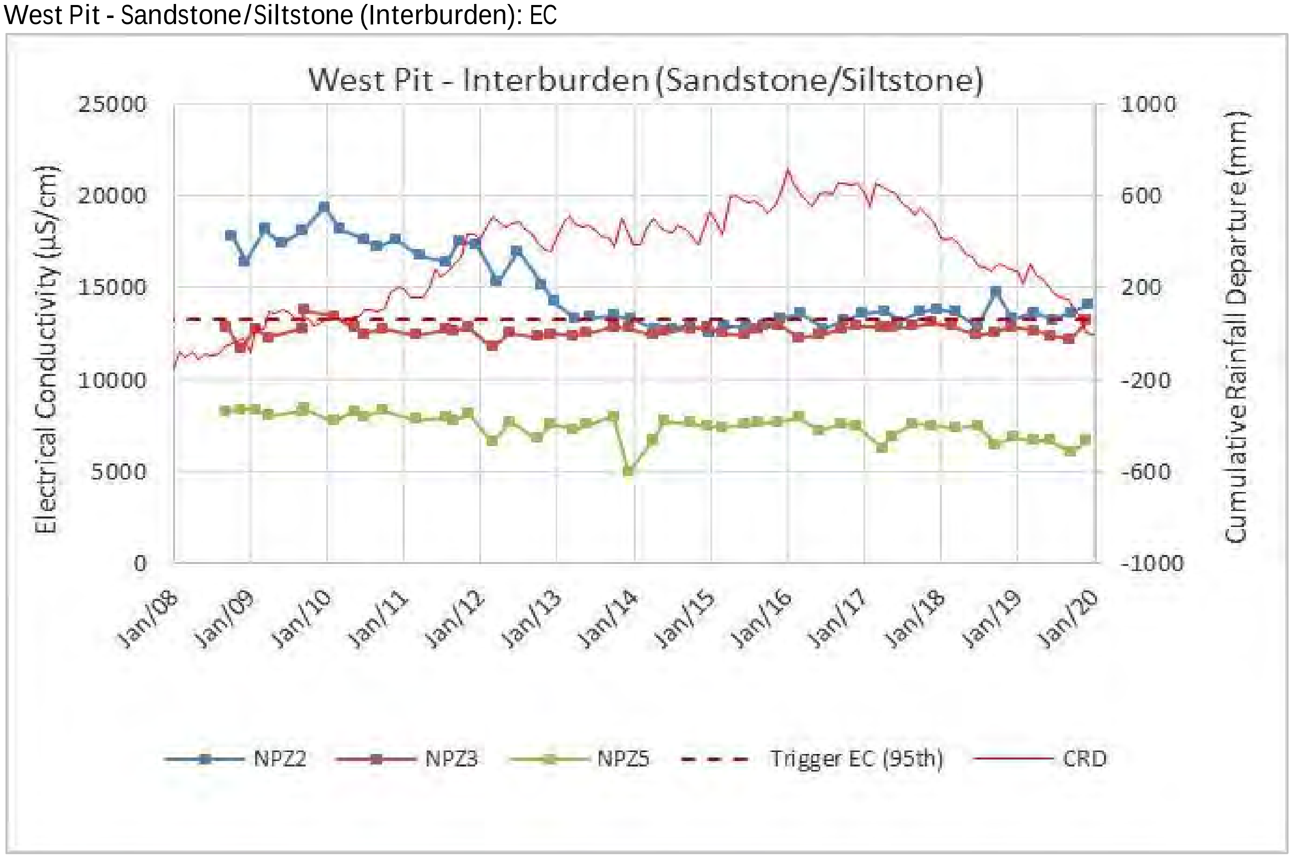
West Pit – Alluvium: EC



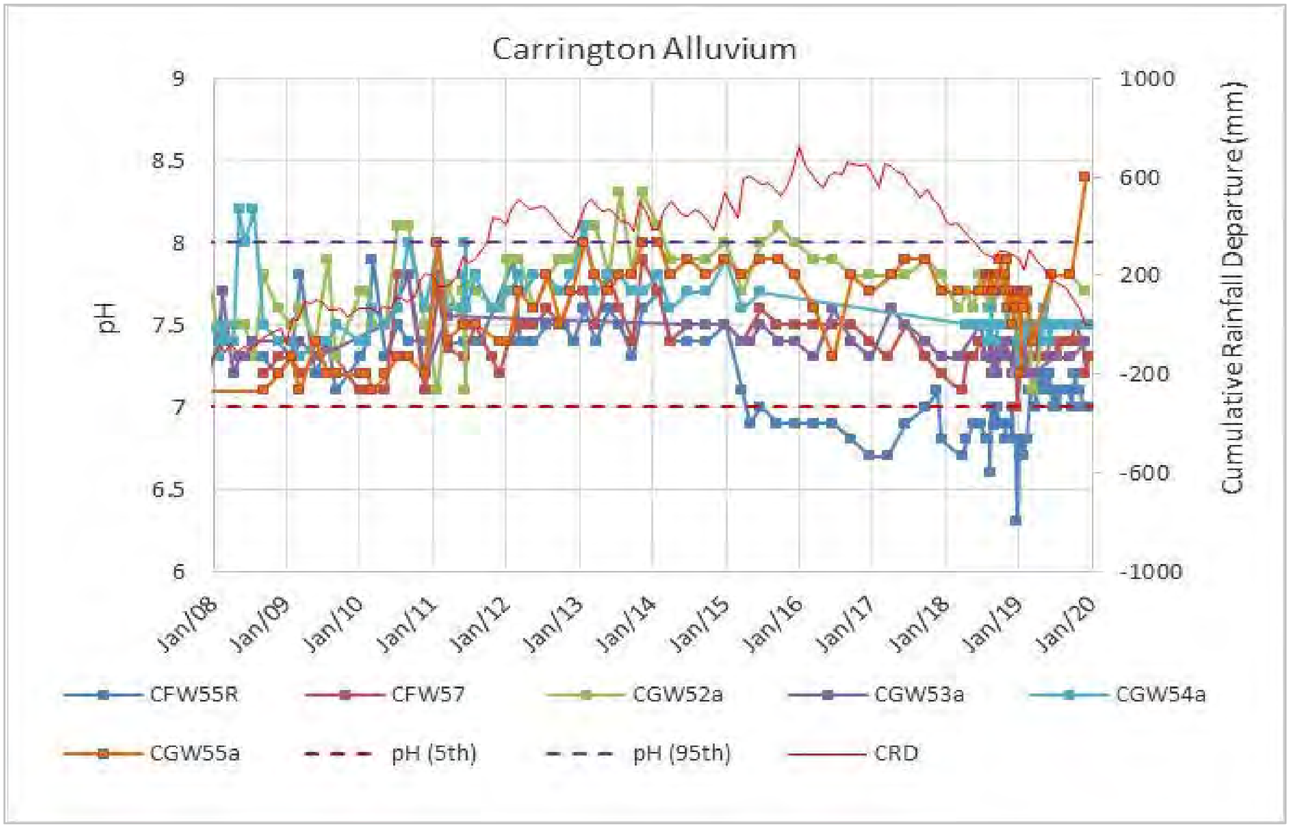
West Pit - Sandstone/Siltstone (Interburden): pH



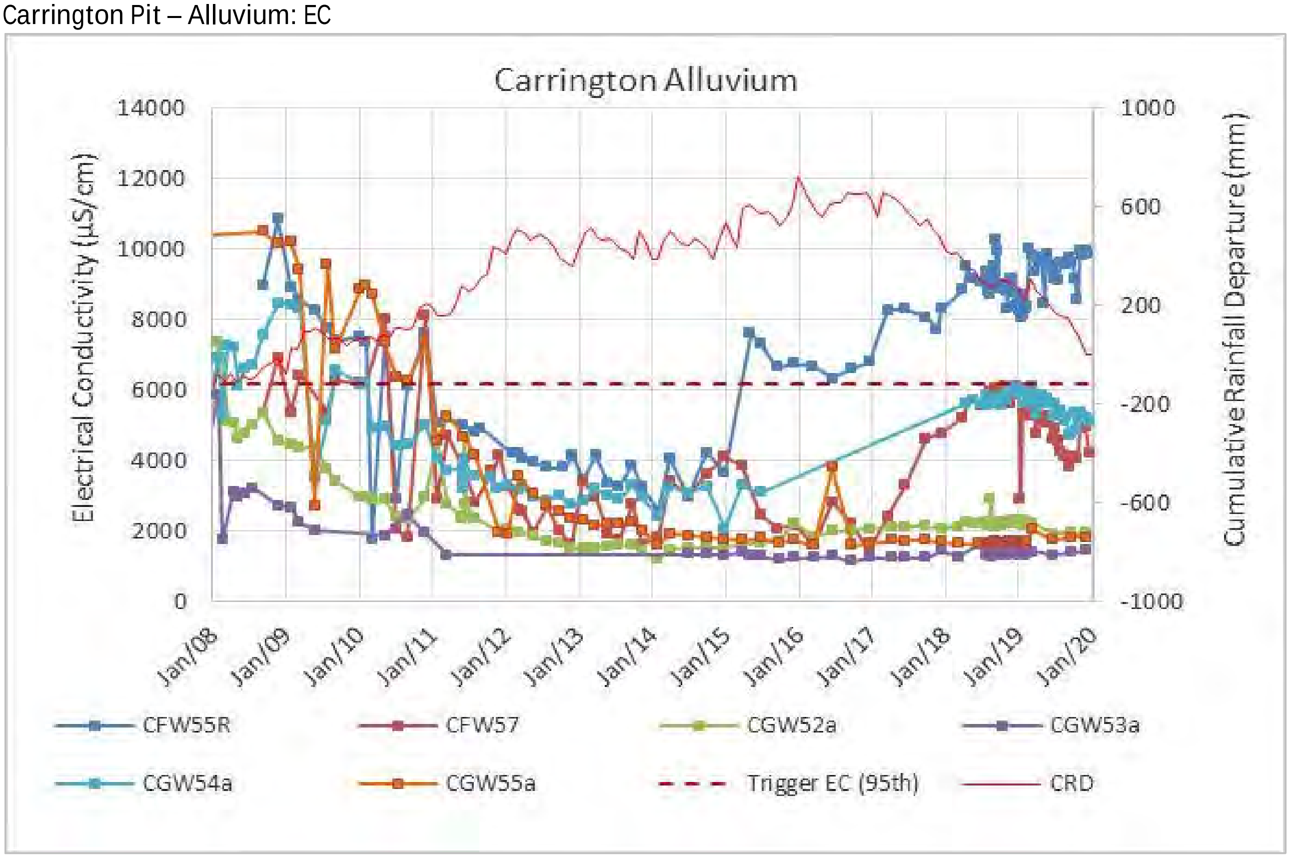
West Pit - Sandstone/Siltstone (Interburden): EC



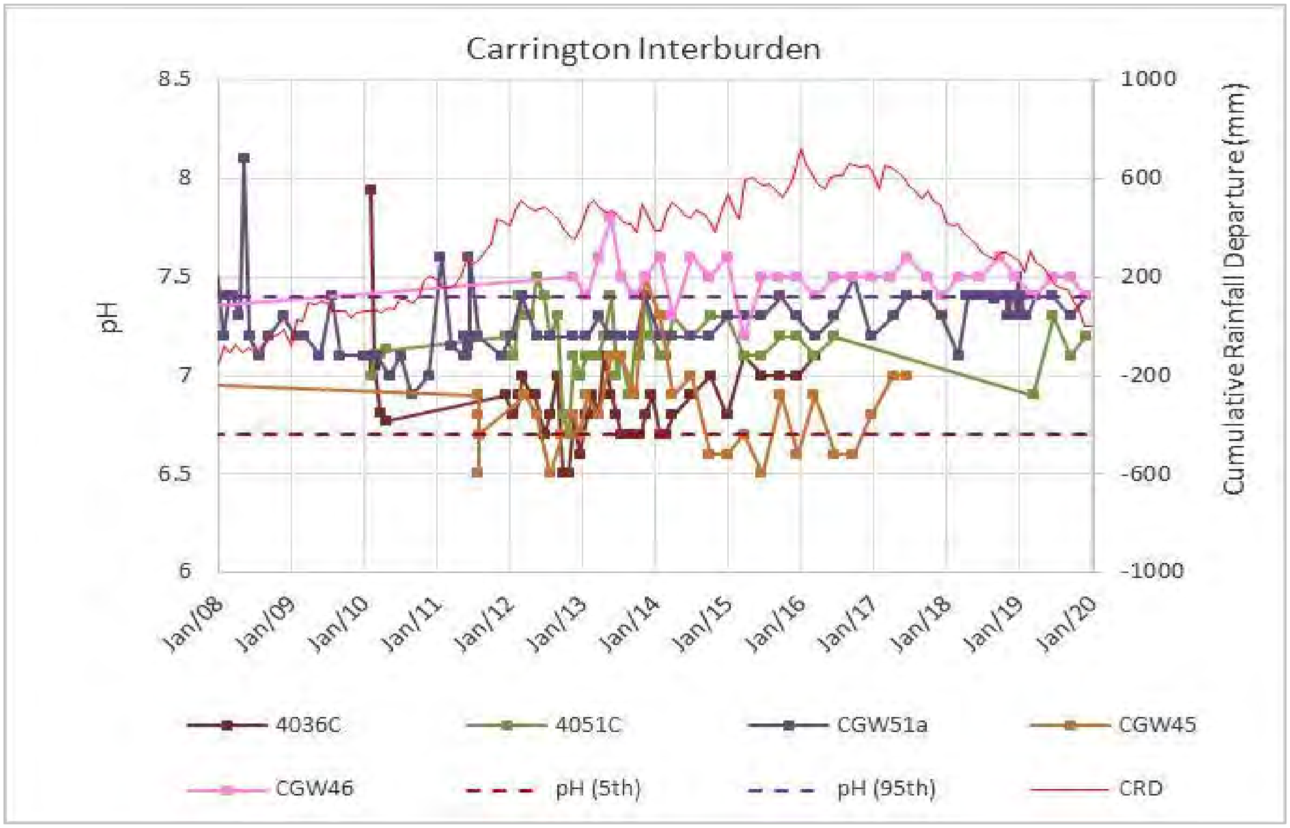
Carrington Pit – Alluvium: pH



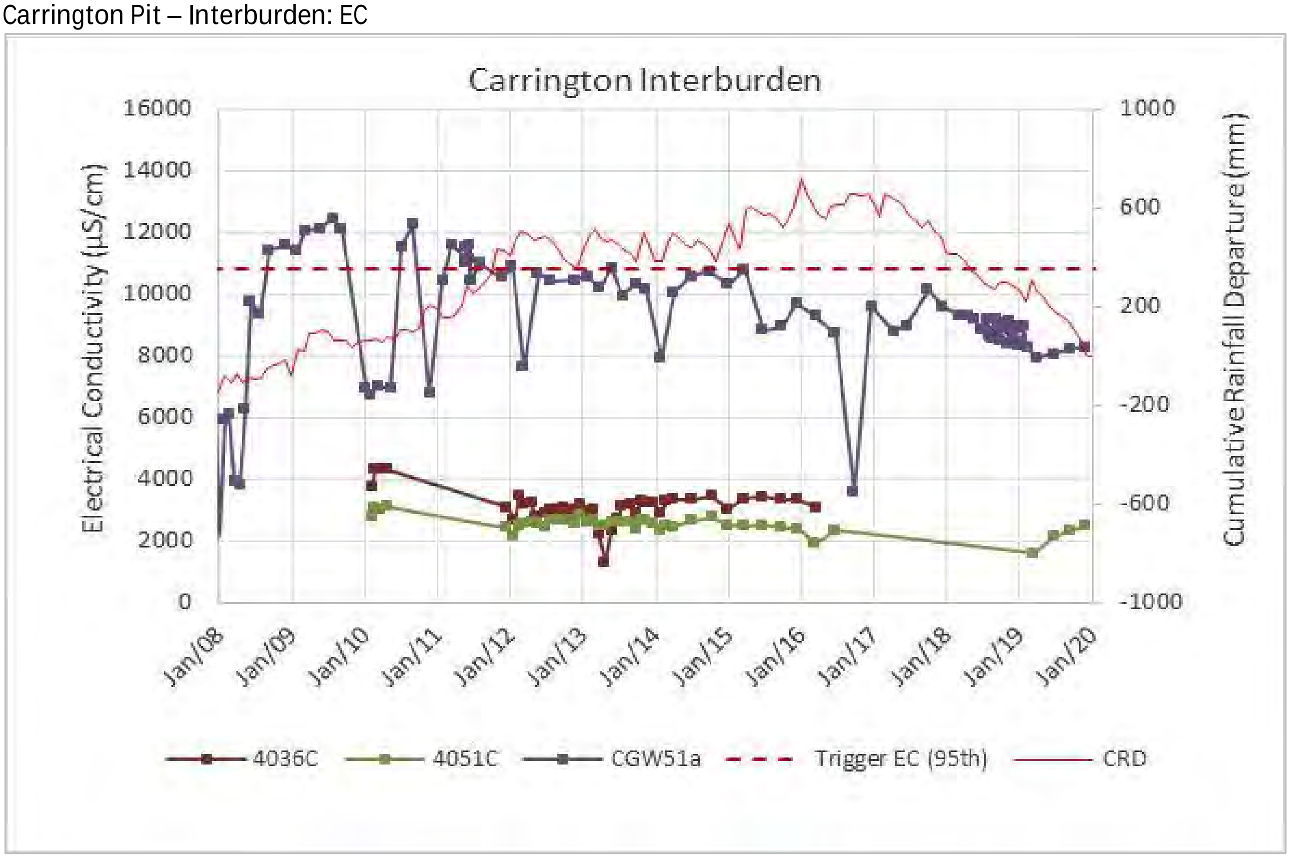
Carrington Pit – Alluvium: EC



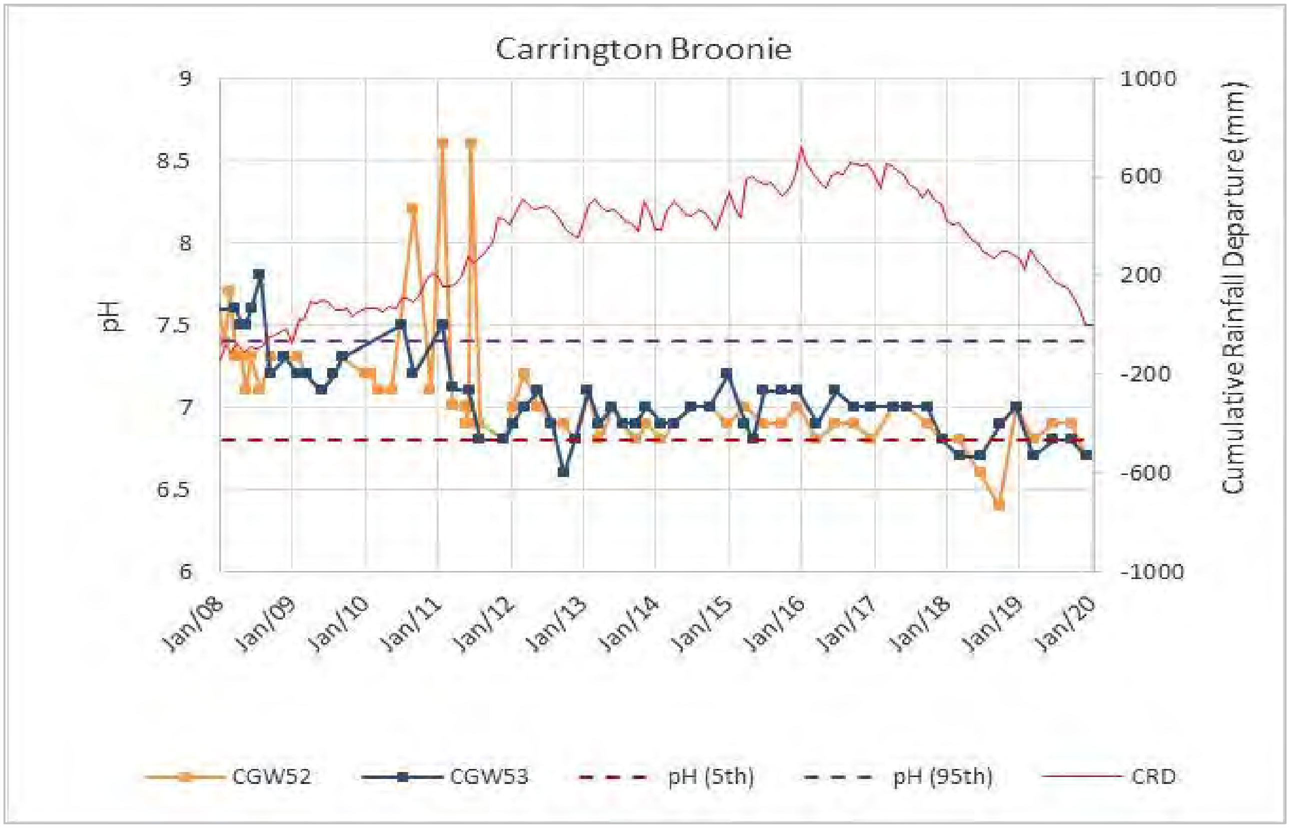
Carrington Pit – Interburden: pH



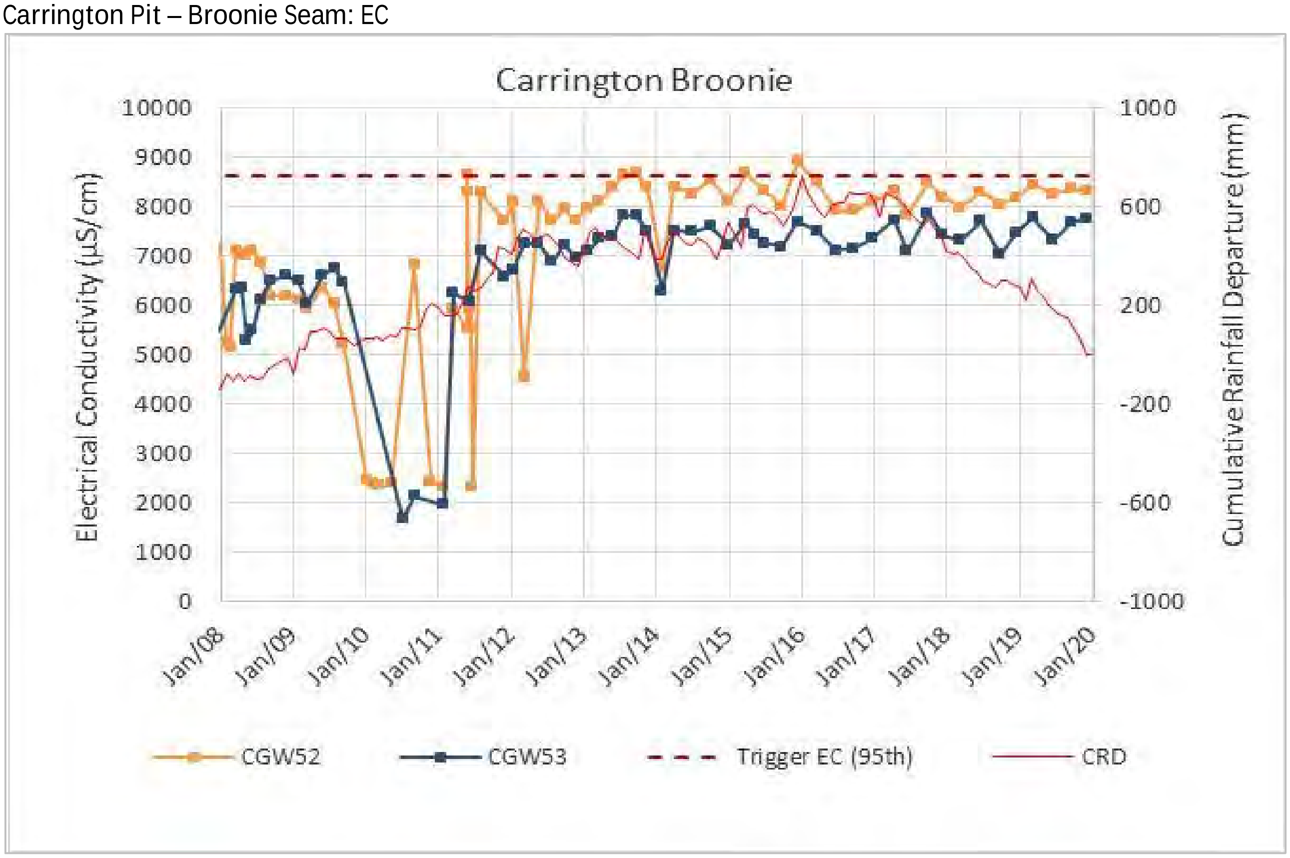
Carrington Pit – Interburden: EC



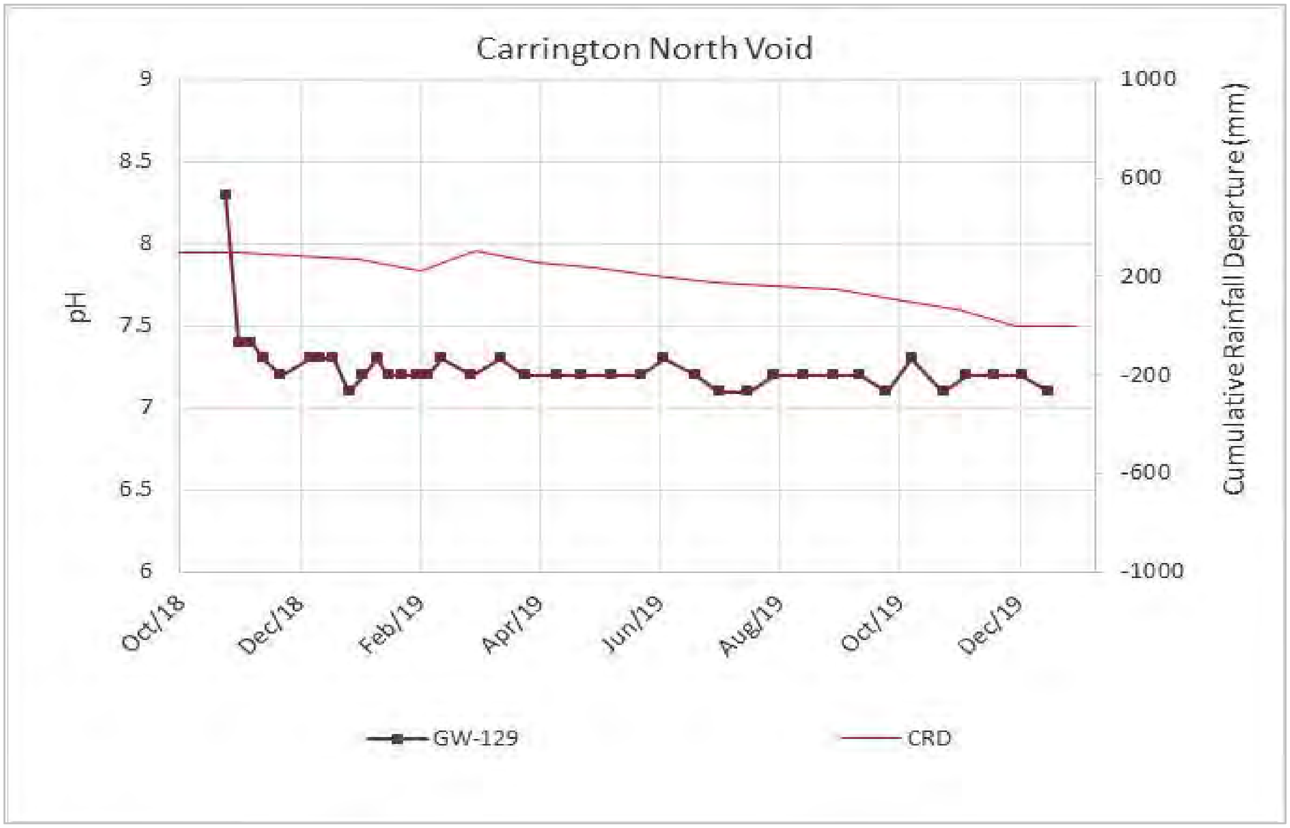
Carrington Pit – Broonie Seam: pH



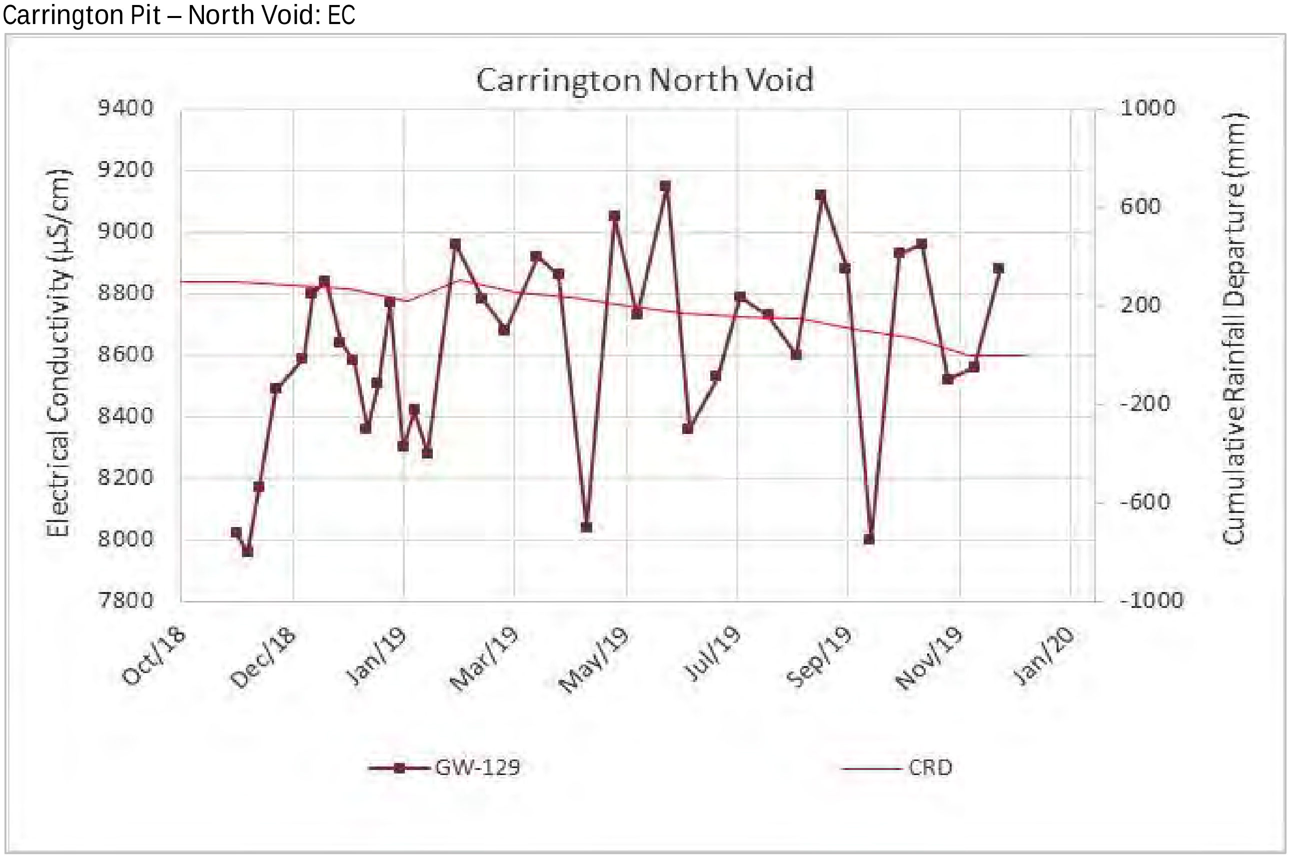
Carrington Pit – Broonie Seam: EC



Carrington Pit – North Void: pH

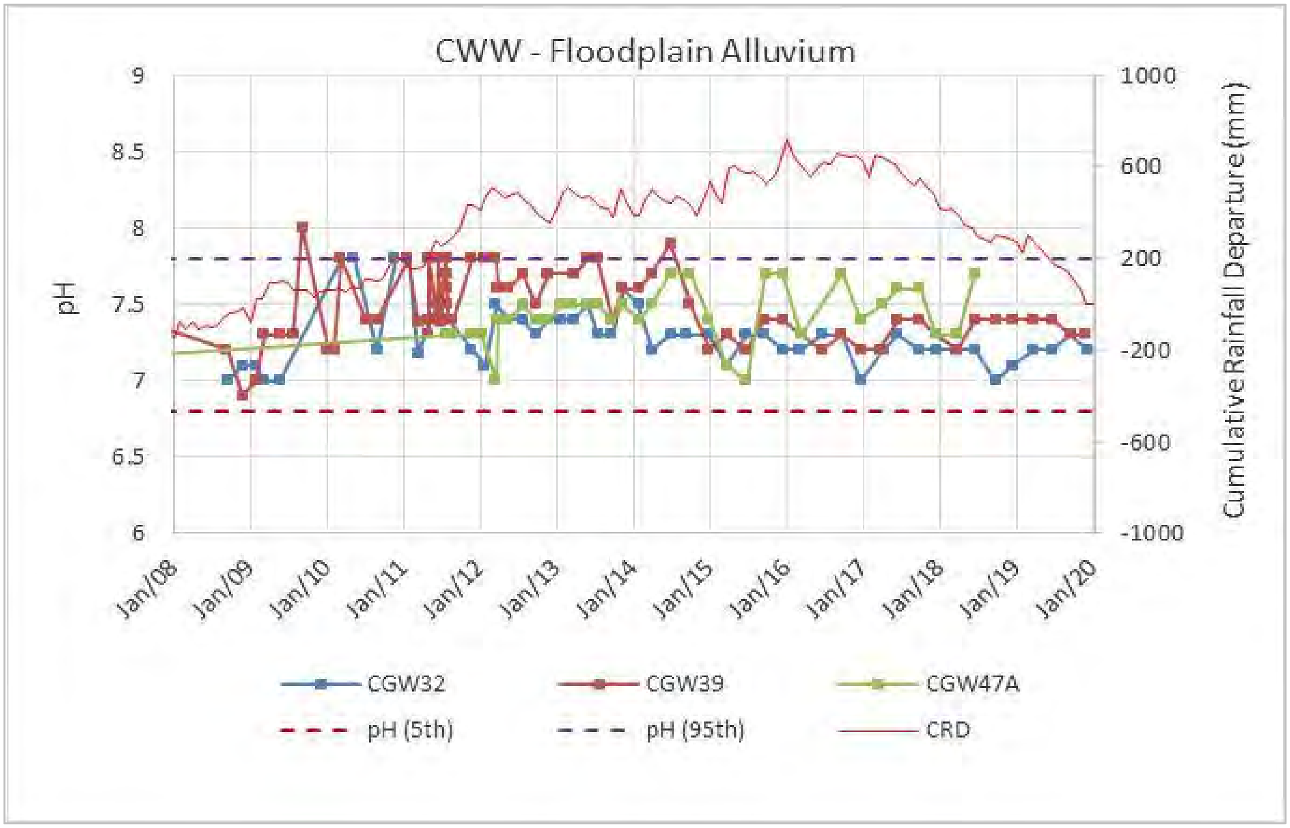


Carrington Pit – North Void: EC

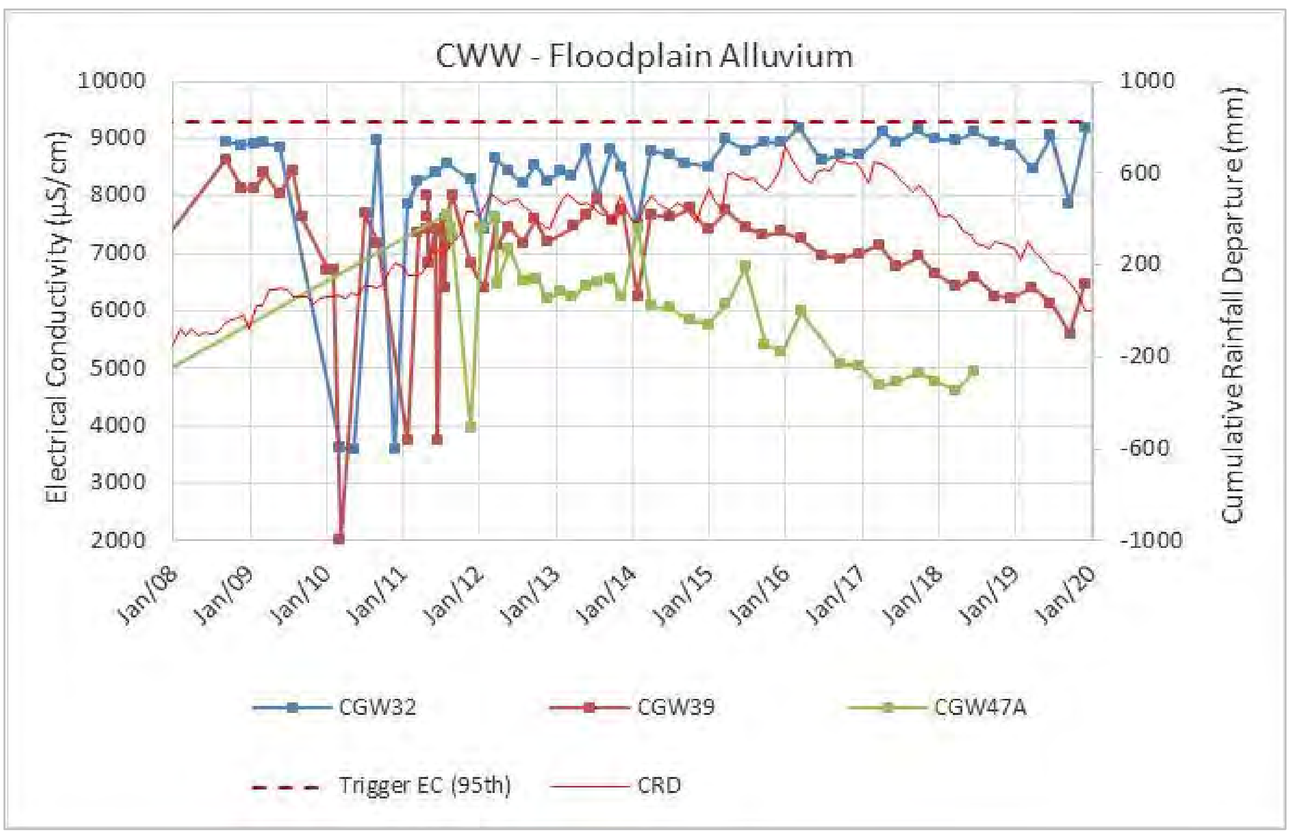


SLR

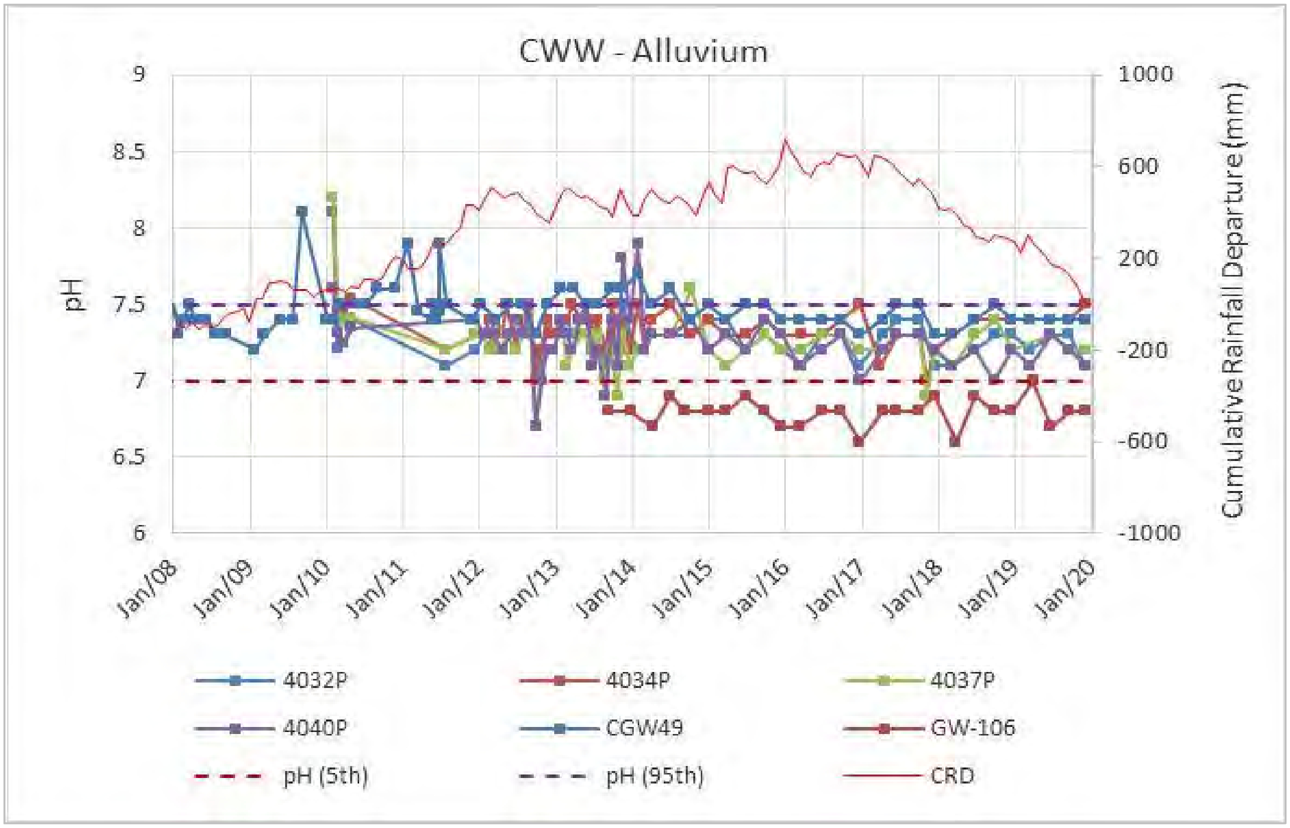
CWW Area - Flood Plain Alluvium: pH



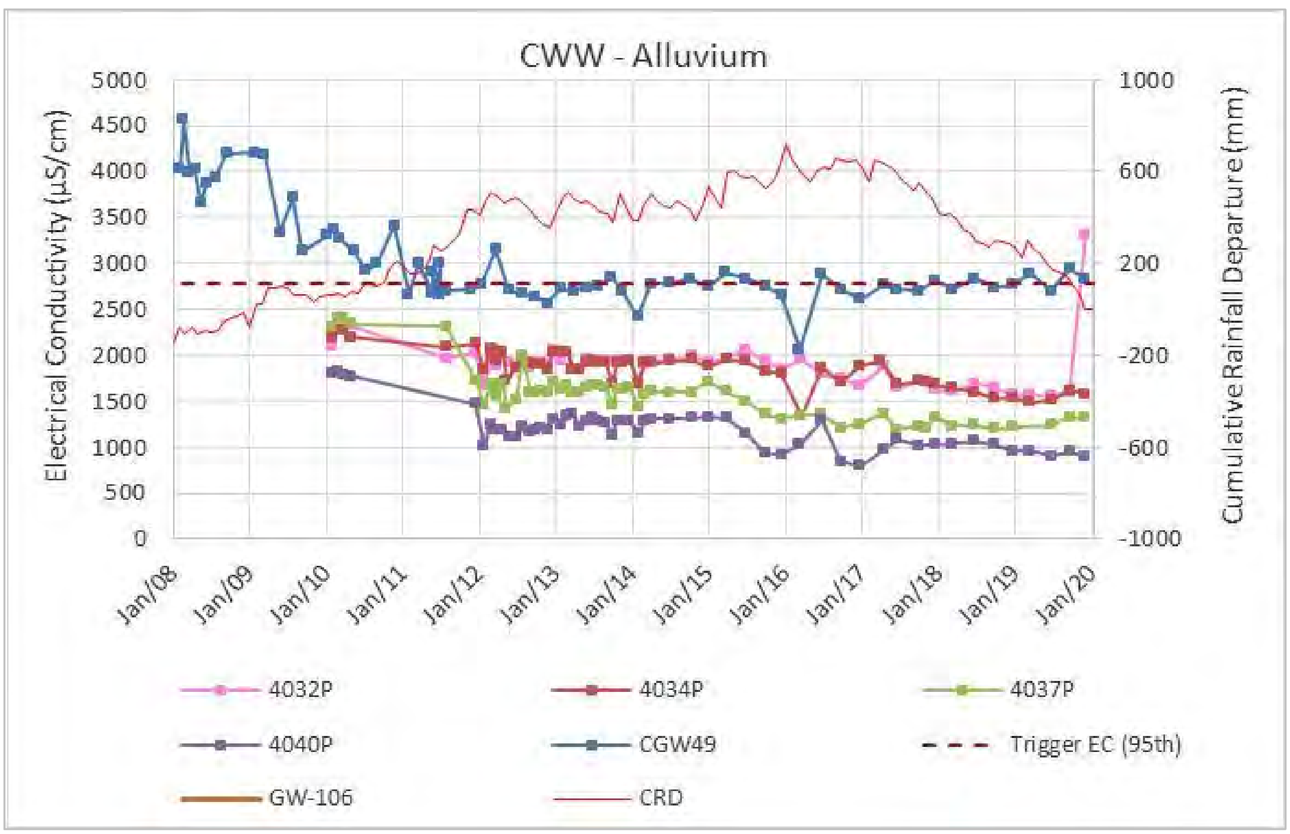
CWW Area - Flood Plain Alluvium: EC



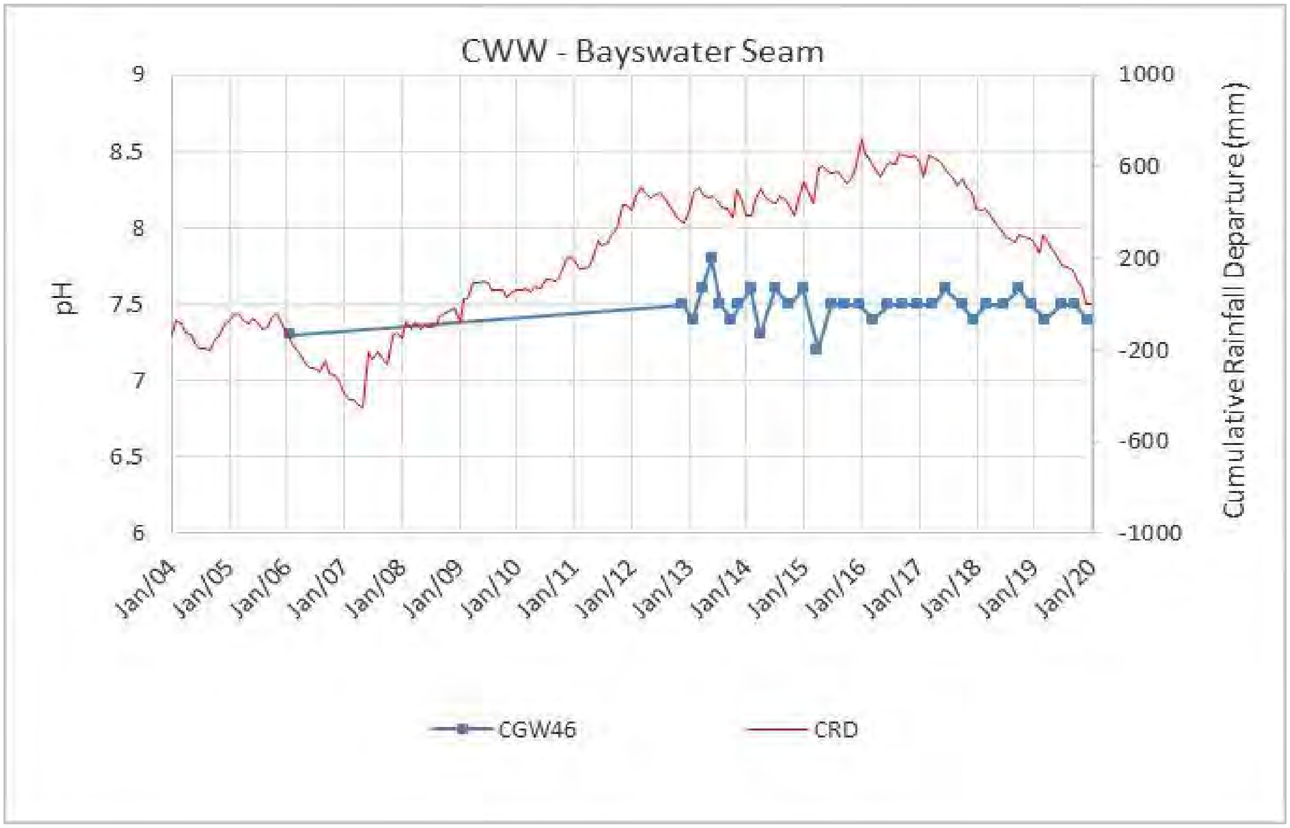
CWW Area – Alluvium: pH



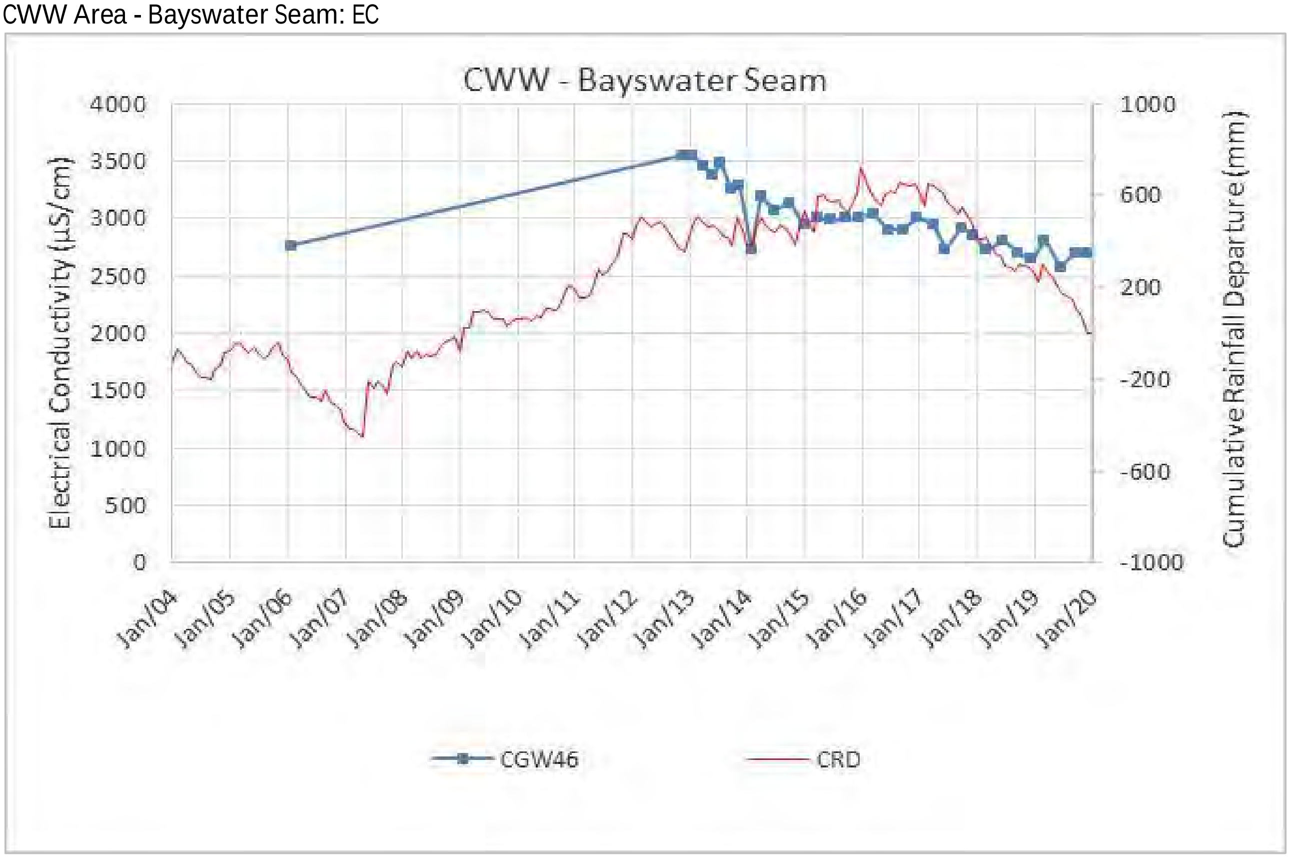
CWW Area – Alluvium: EC



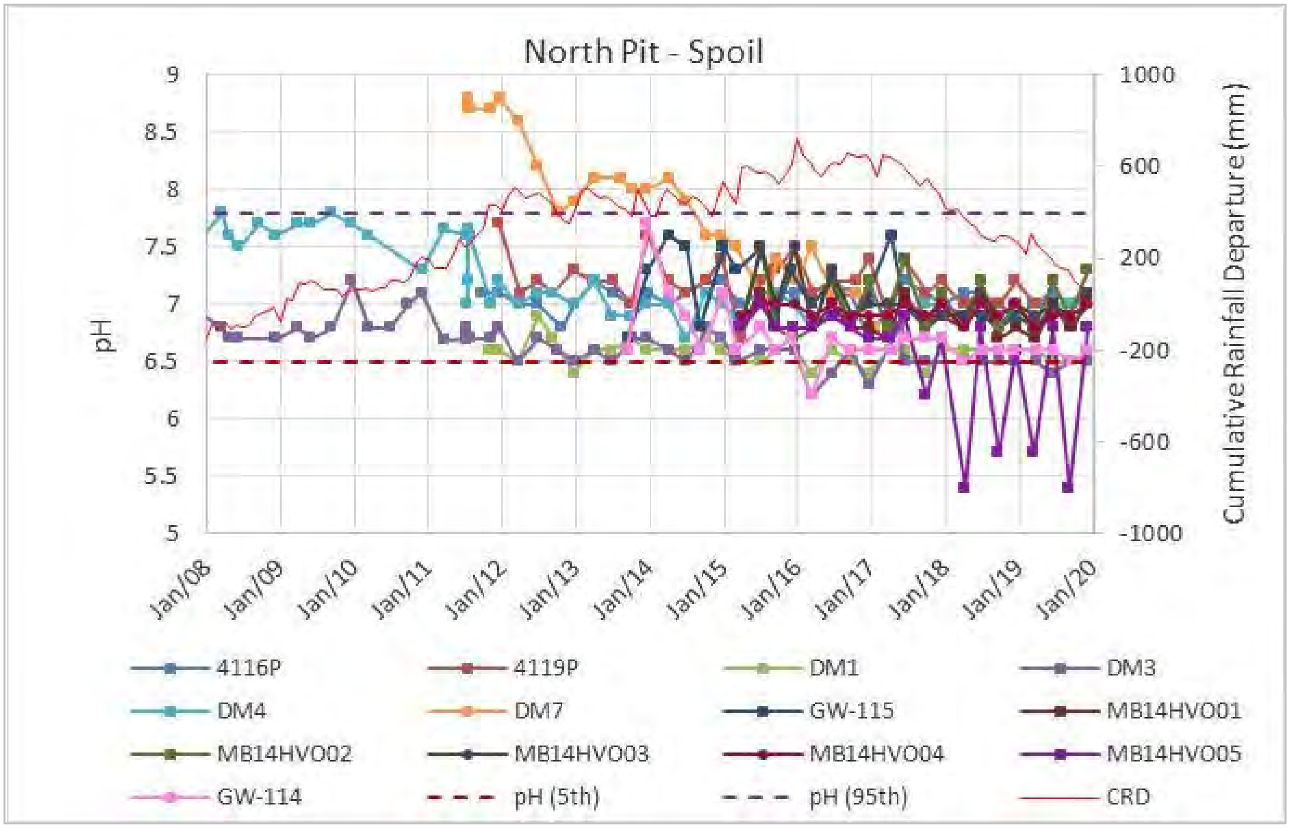
CWW Area - Bayswater Seam: pH



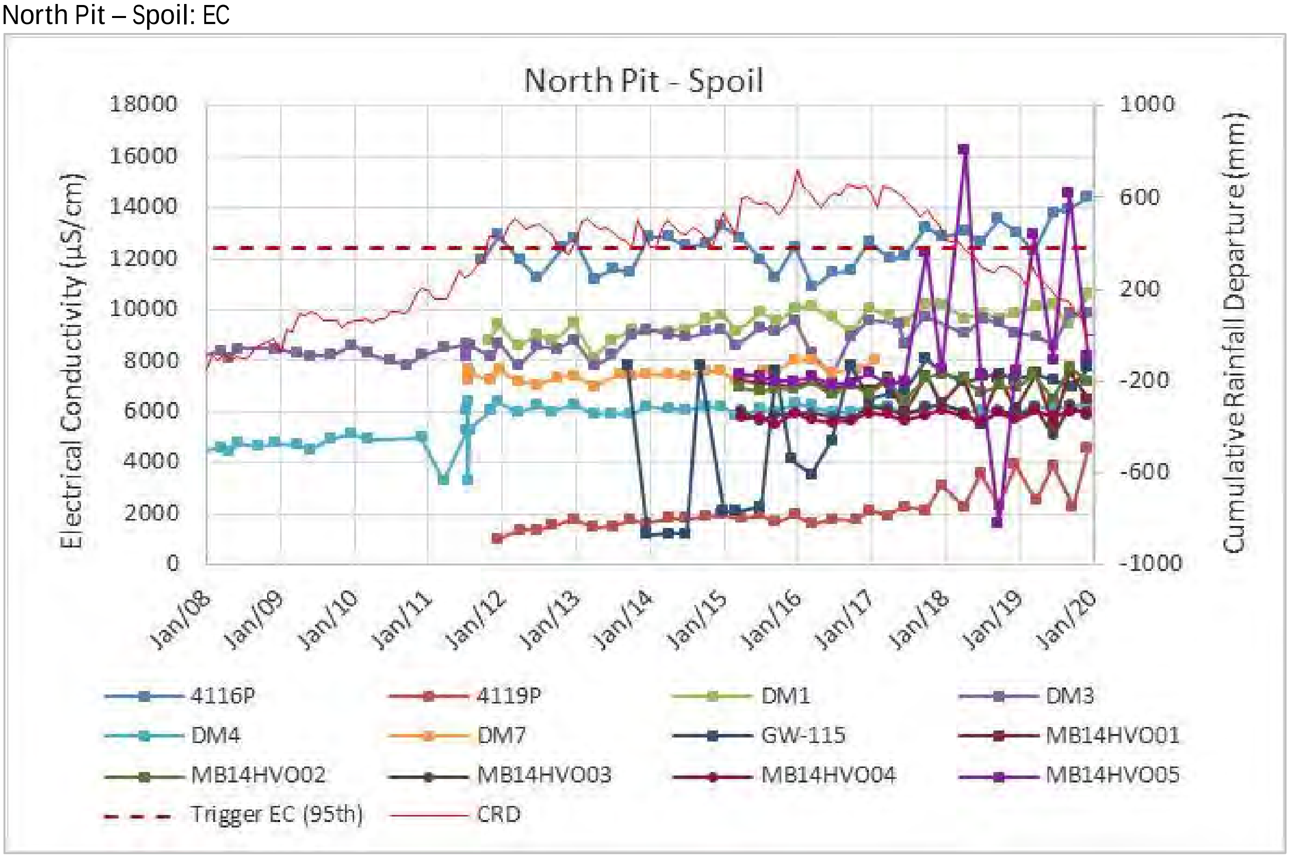
CWW Area - Bayswater Seam: EC



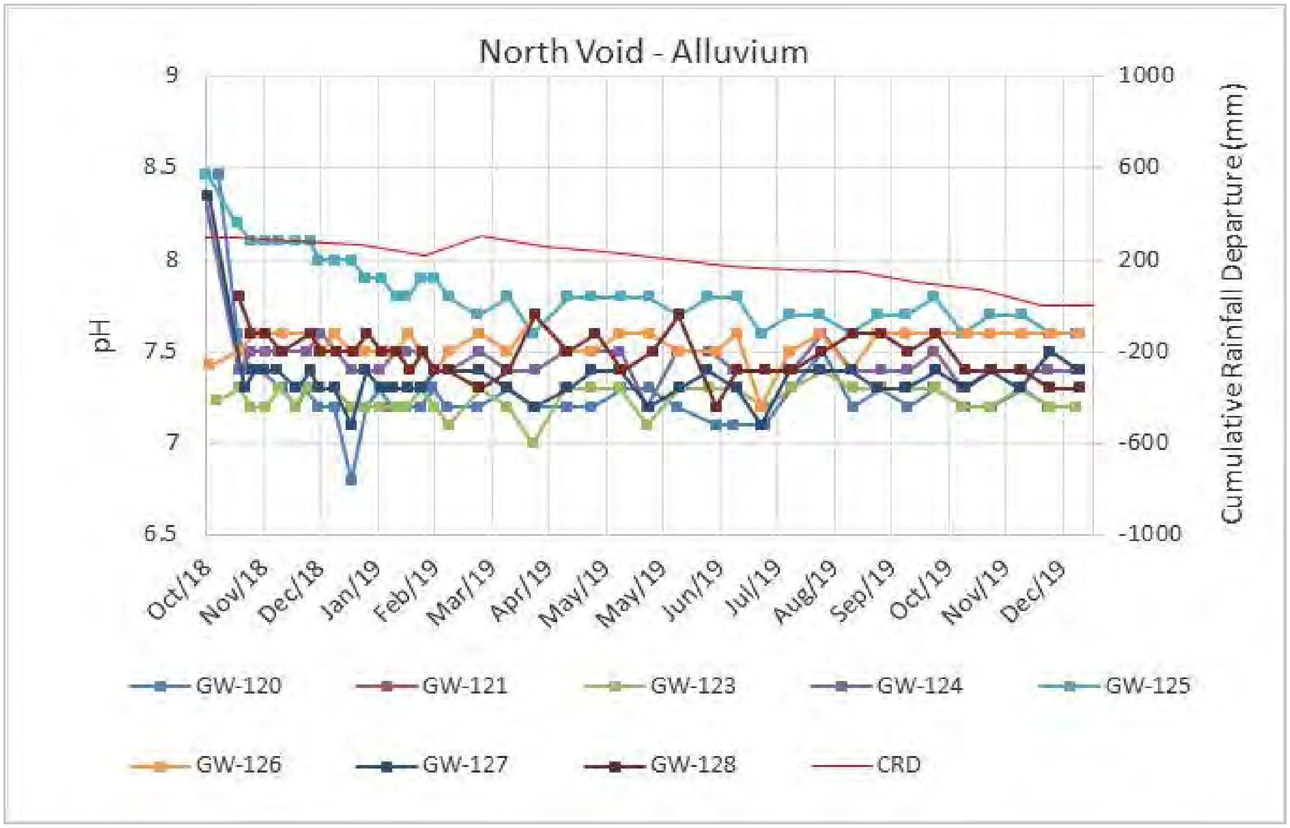
North Pit – Spoil: pH



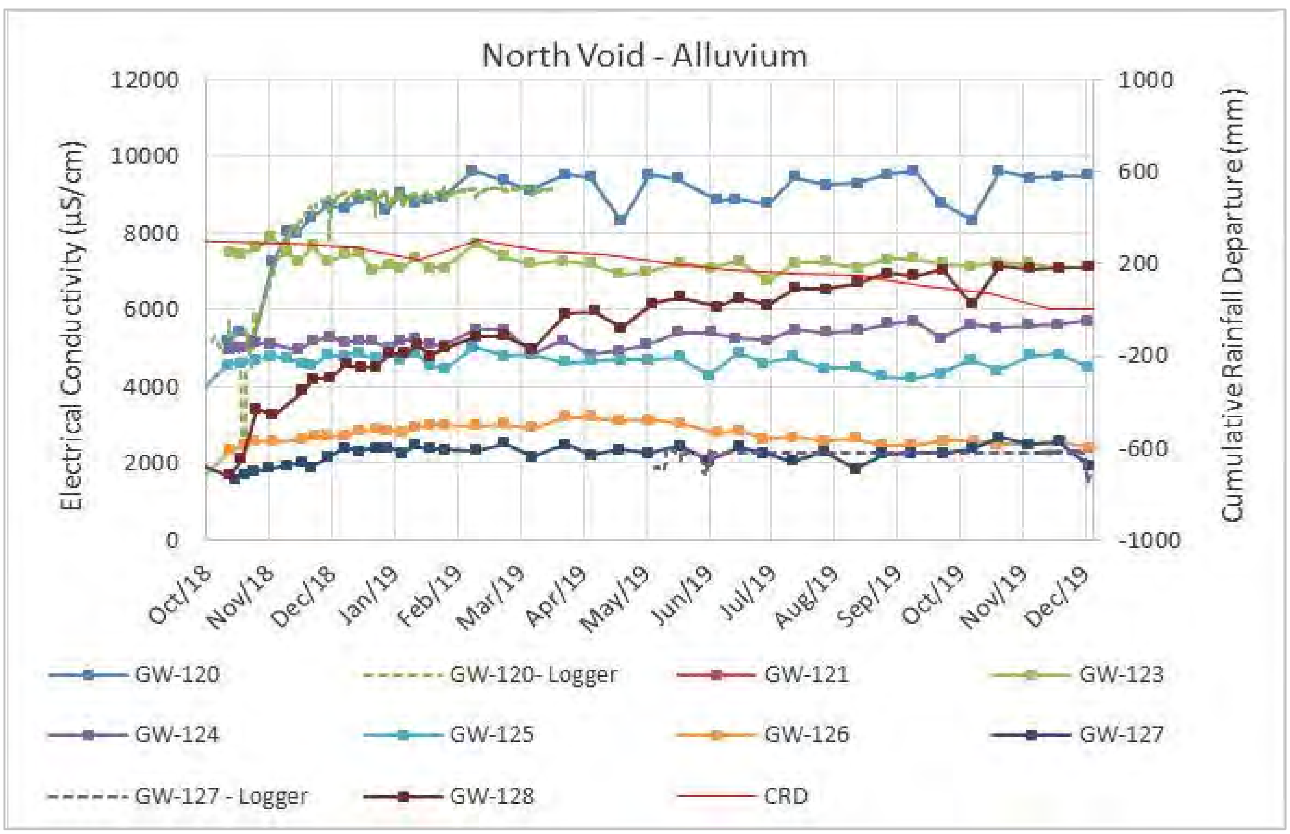
North Pit – Spoil: EC



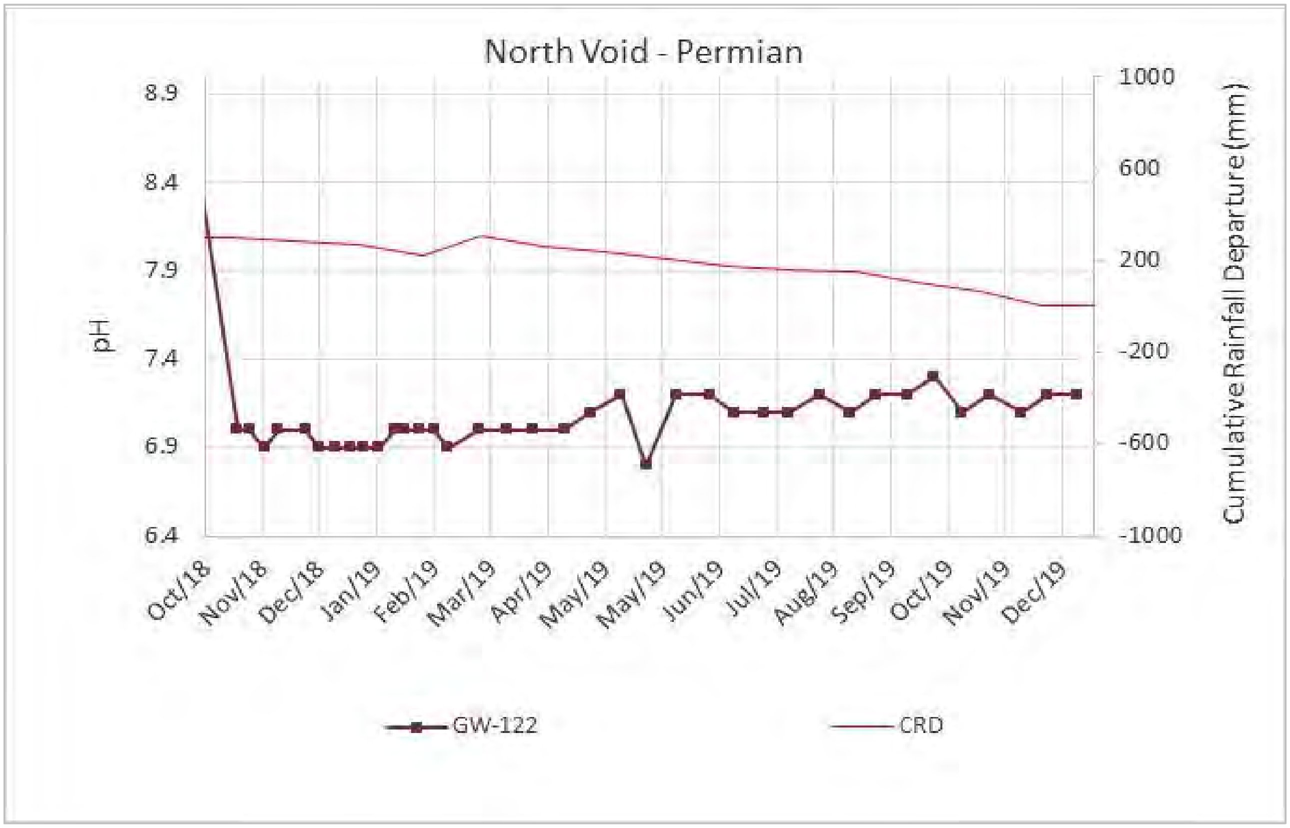
North Void – Alluvium: pH



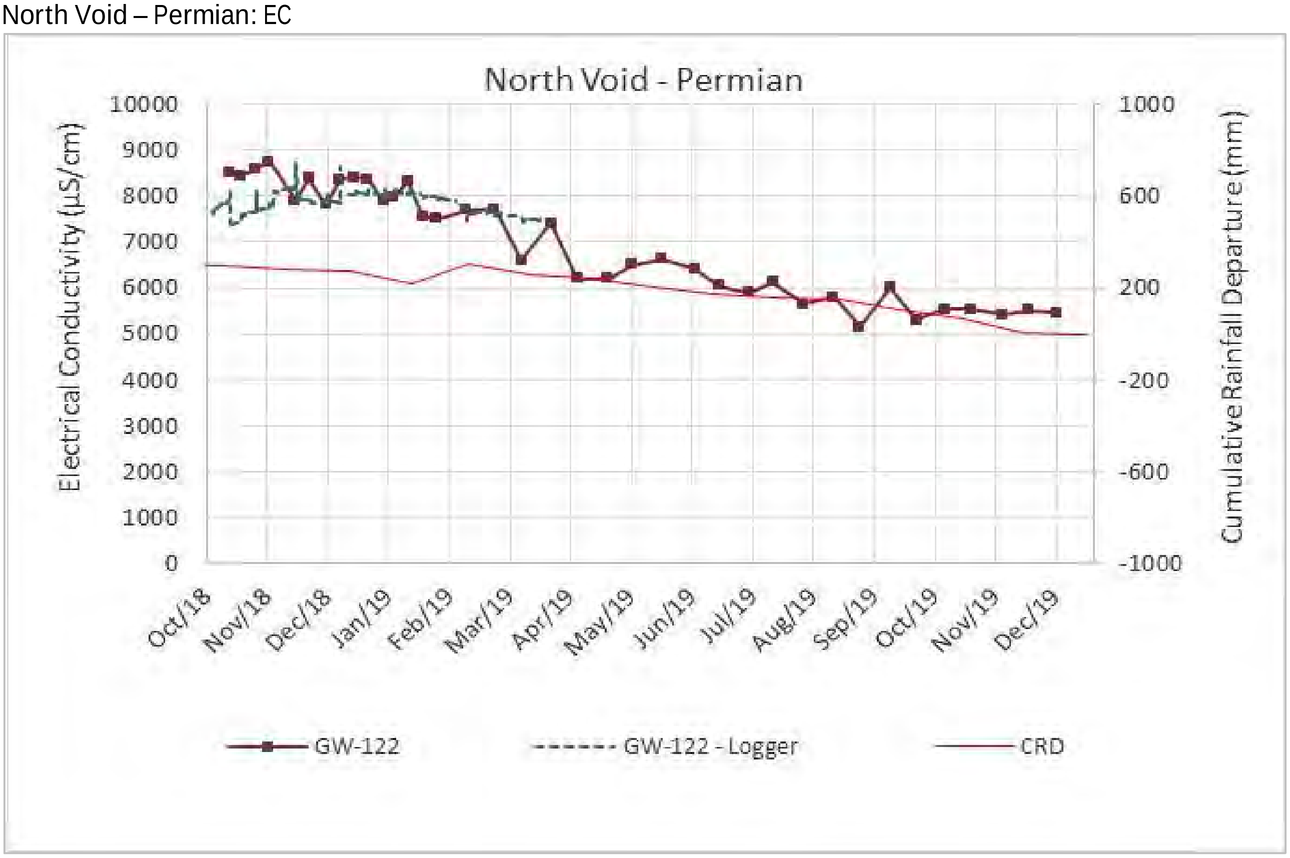
North Void – Alluvium: EC



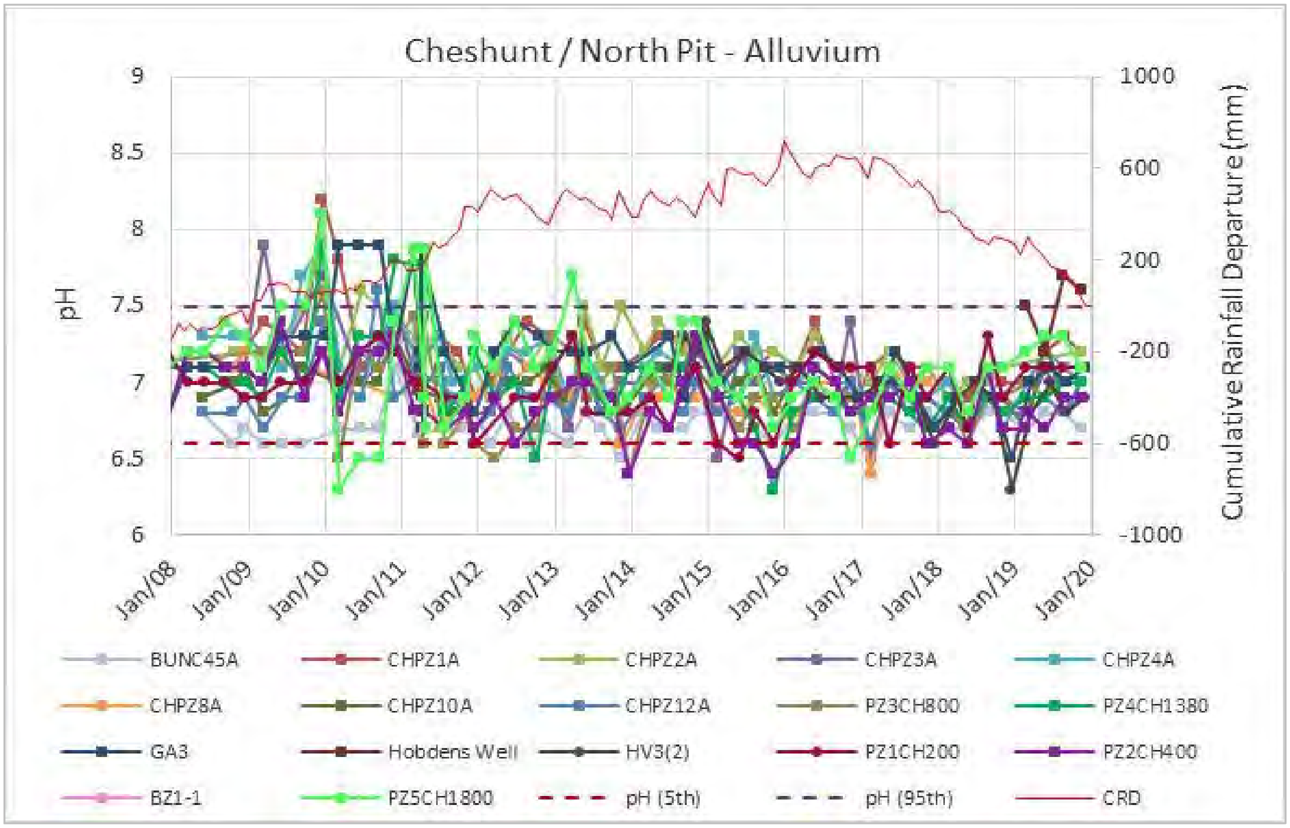
North Void – Permian: pH



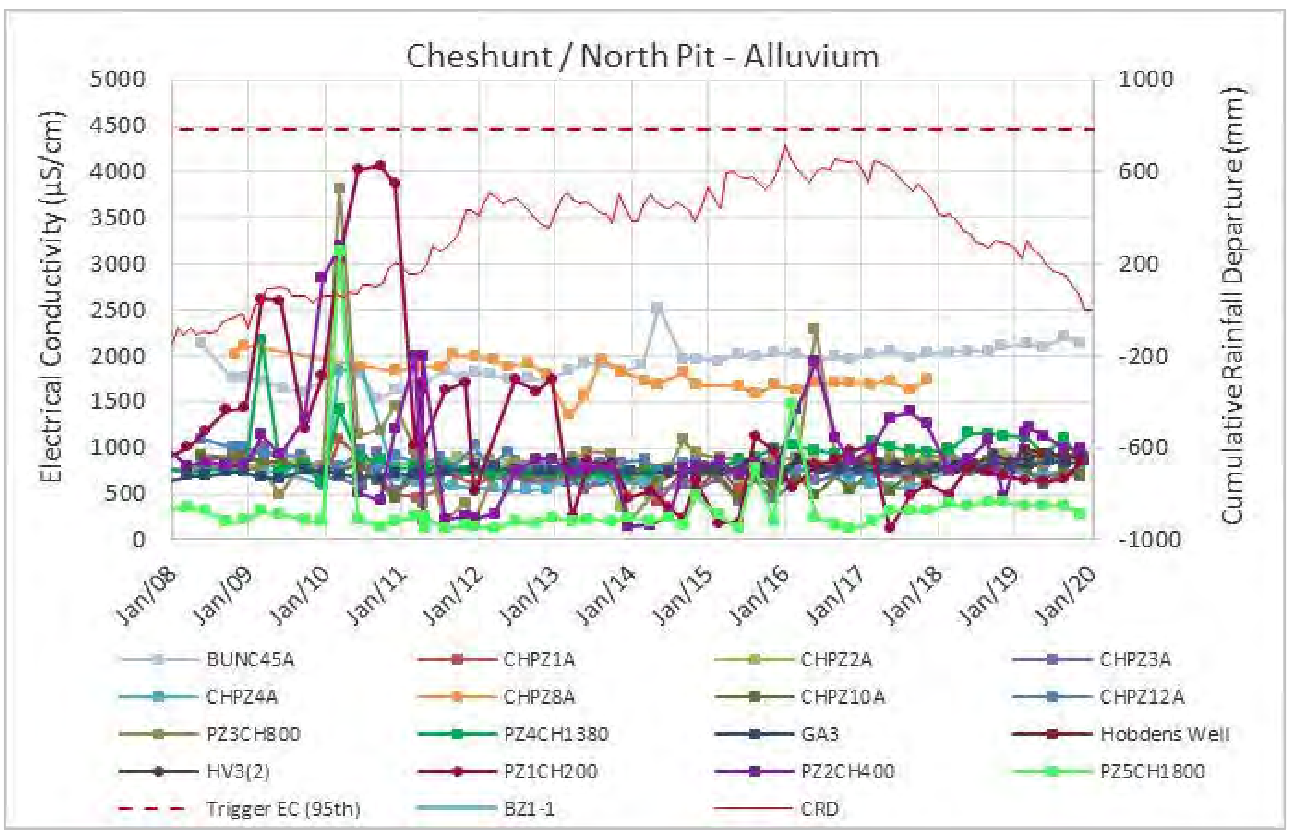
North Void – Permian: EC



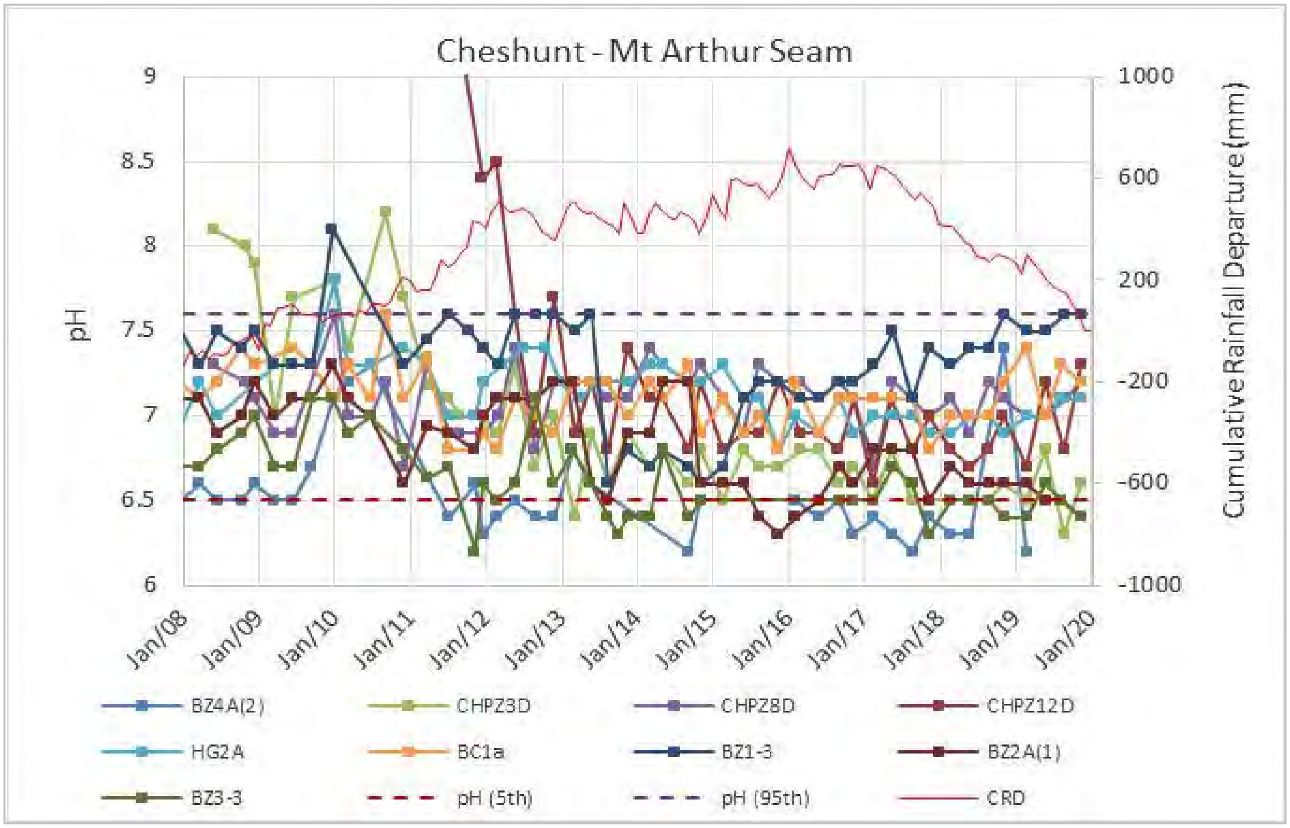
Cheshunt Pit/ North Pit – Alluvium: pH



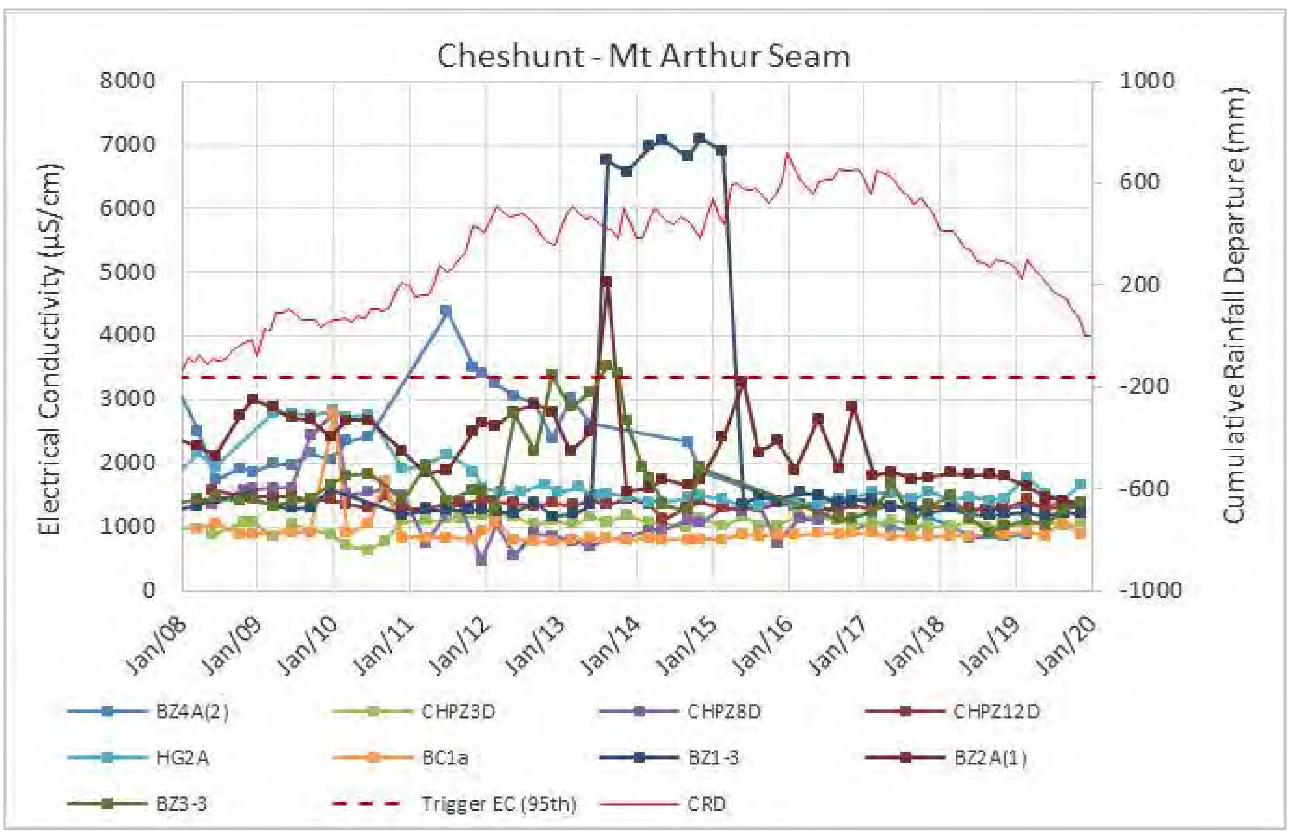
Cheshunt Pit/ North Pit – Alluvium: EC



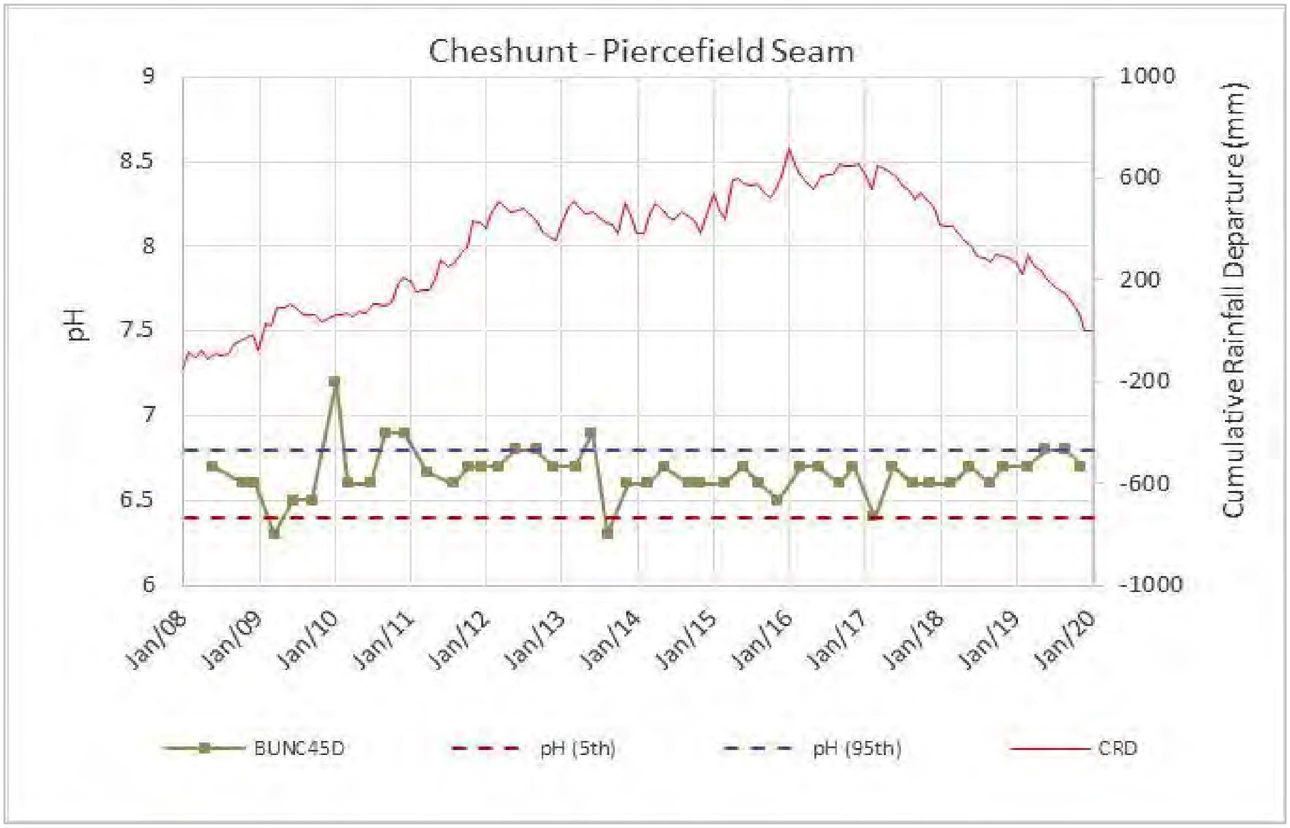
Cheshunt Pit - Mt Arthur Seam: pH



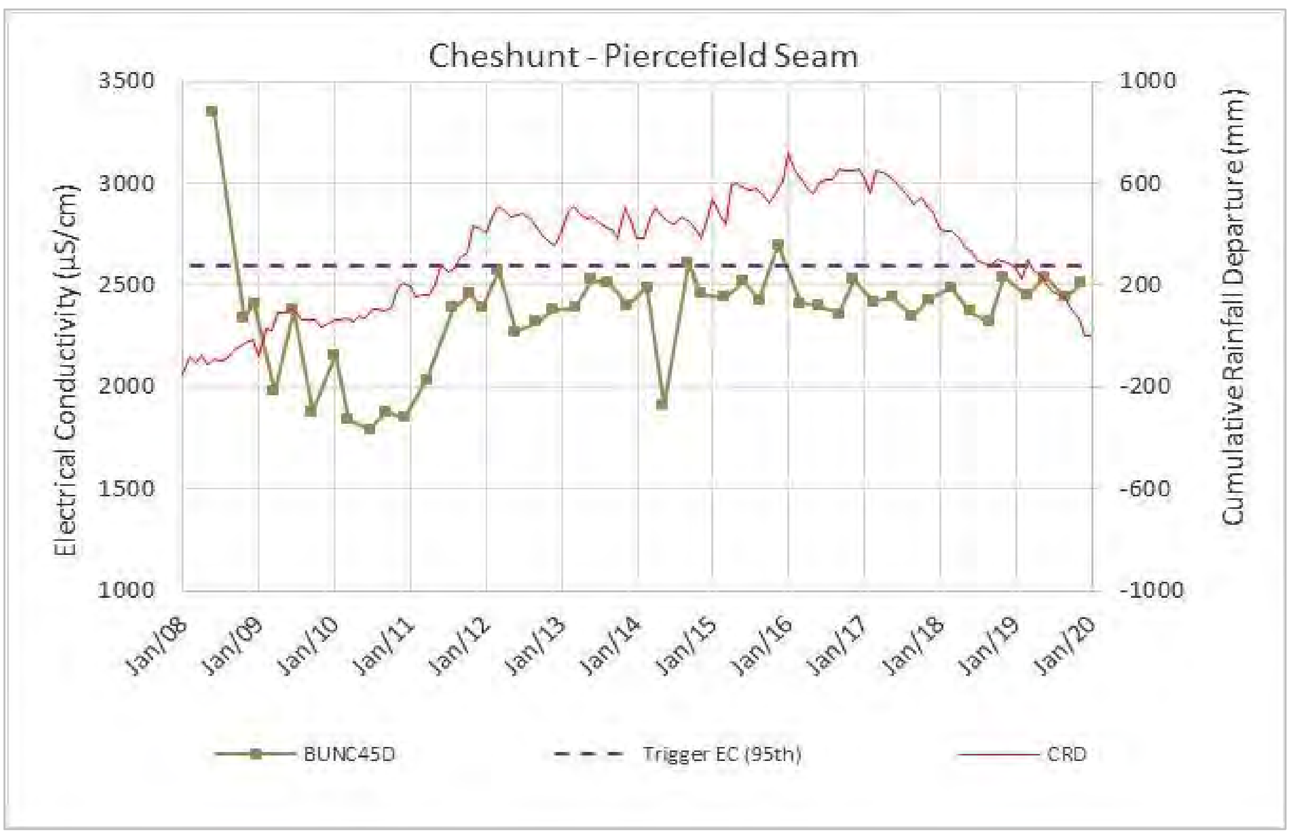
Cheshunt Pit - Mt Arthur Seam: EC



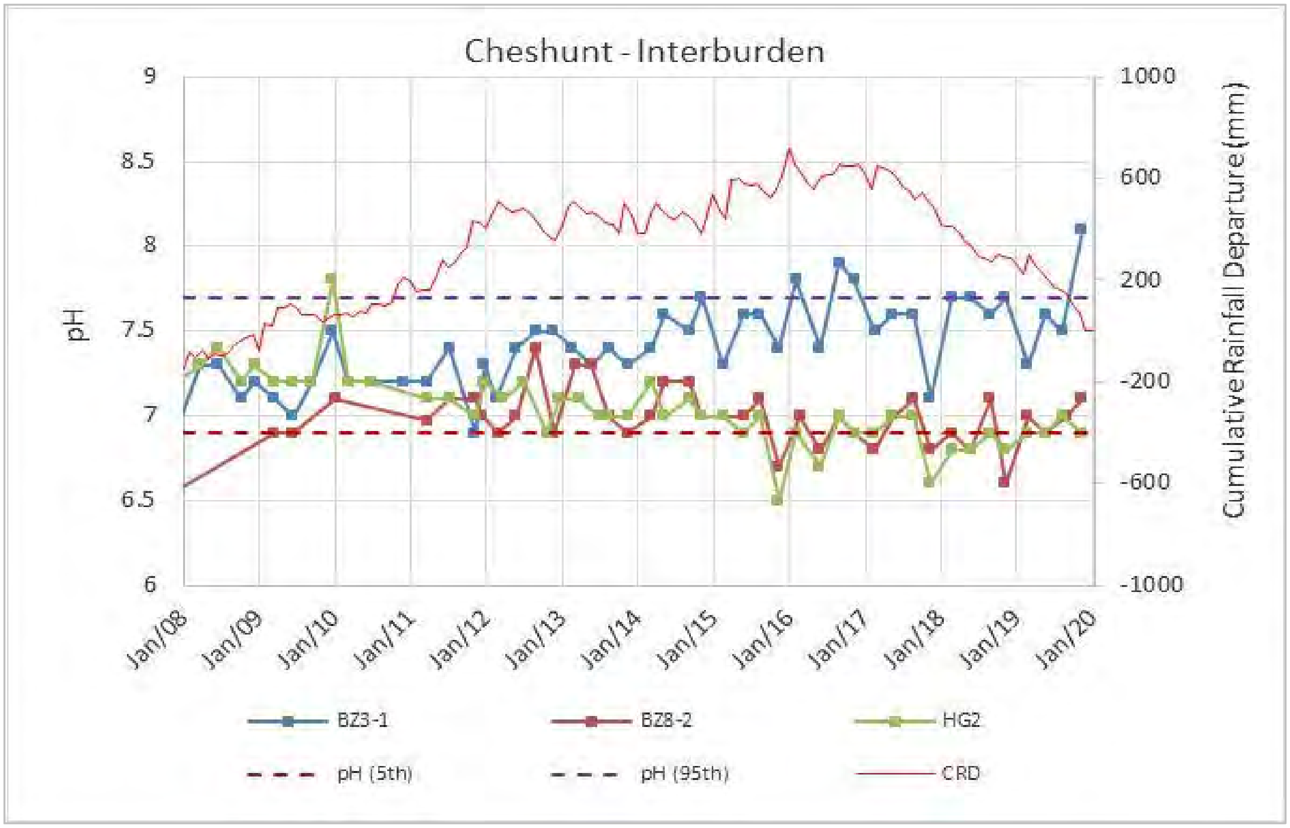
Cheshunt Pit – Piercefield: pH



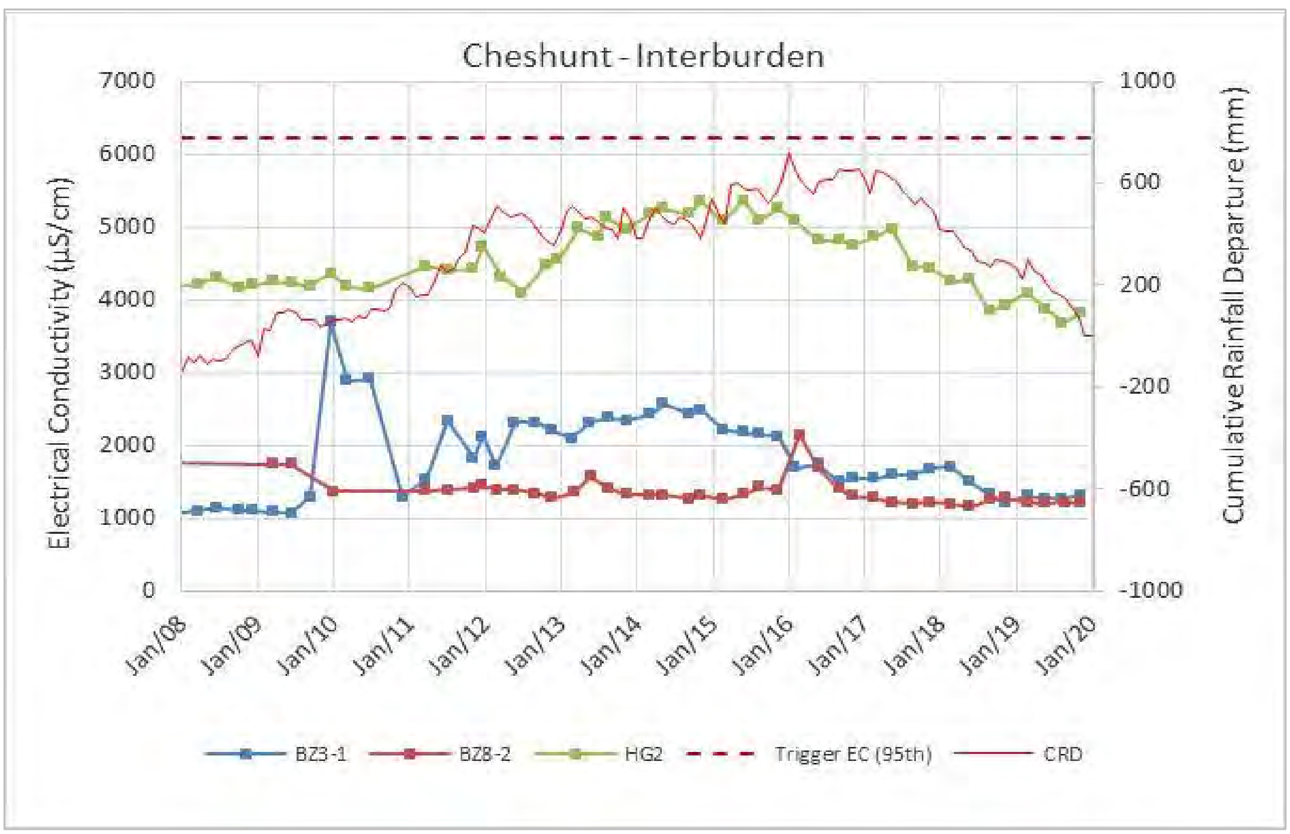
Cheshunt Pit – Piercefield: EC



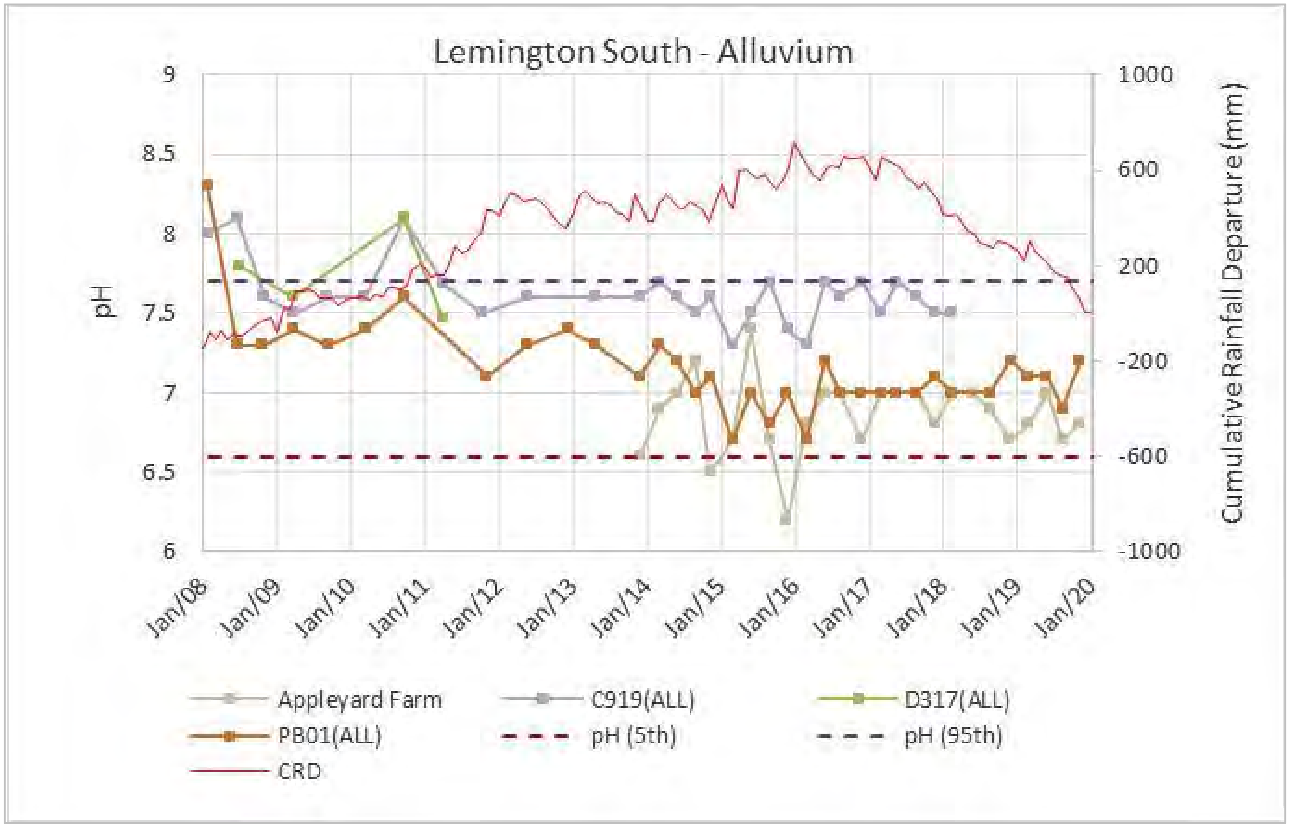
Cheshunt Pit – Interburden: pH



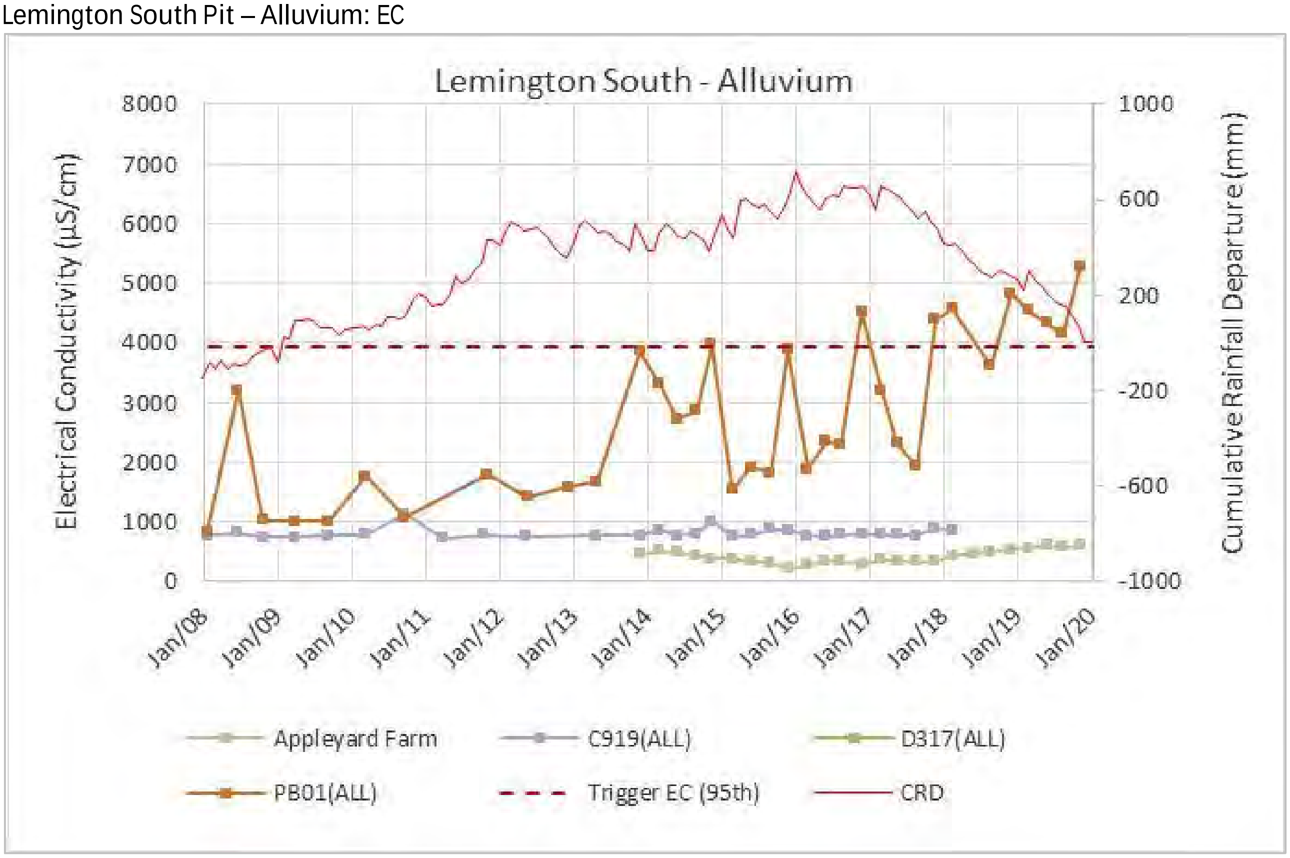
Cheshunt Pit – Interburden: EC



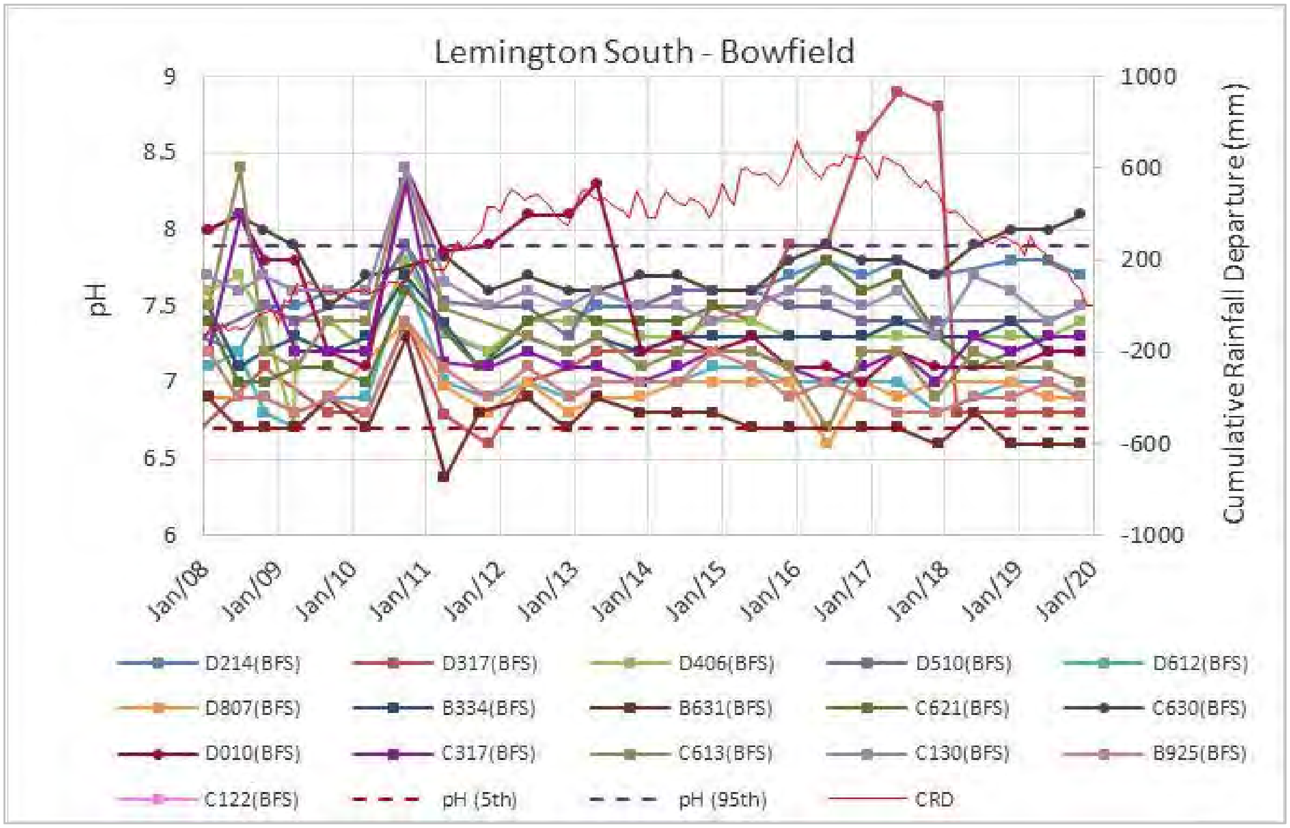
Lemington South Pit – Alluvium: pH



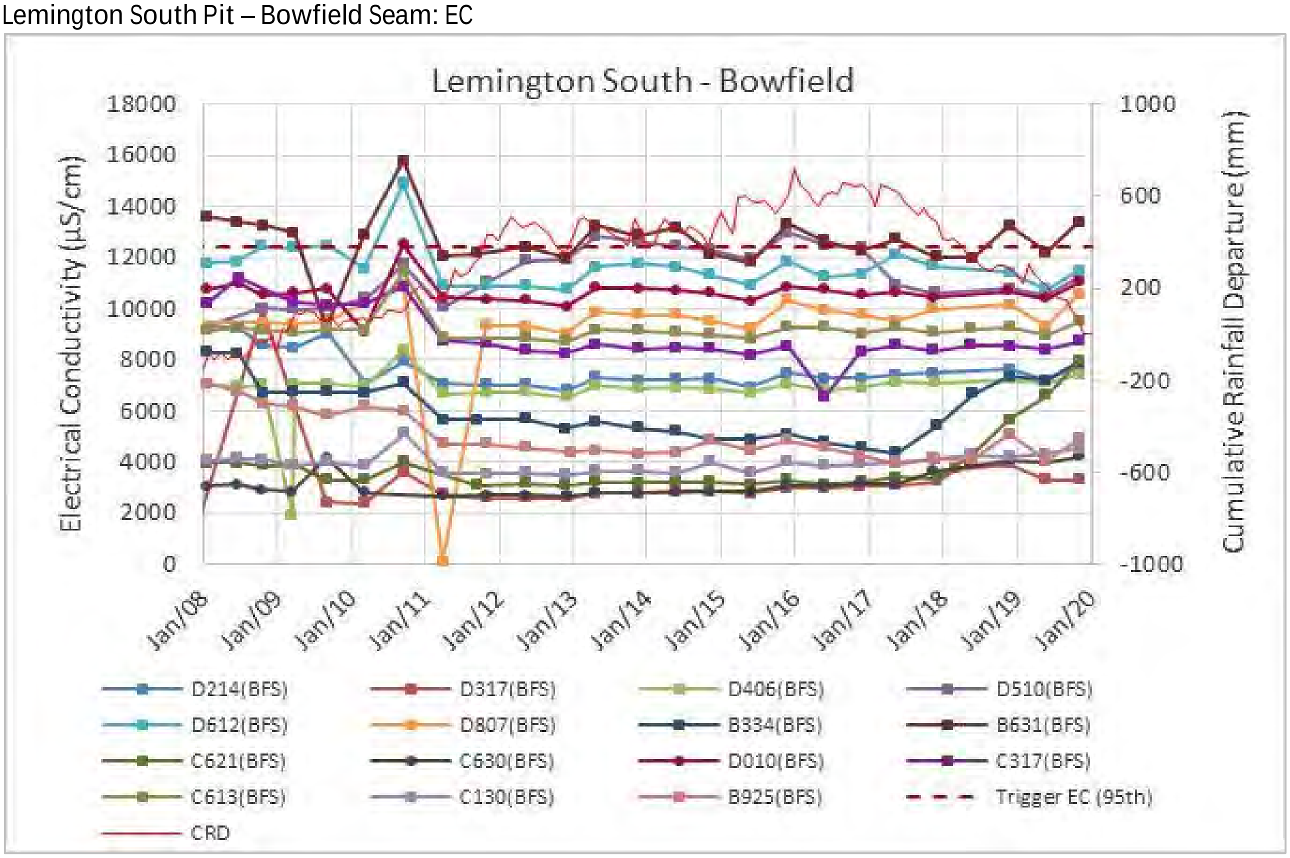
Lemington South Pit – Alluvium: EC



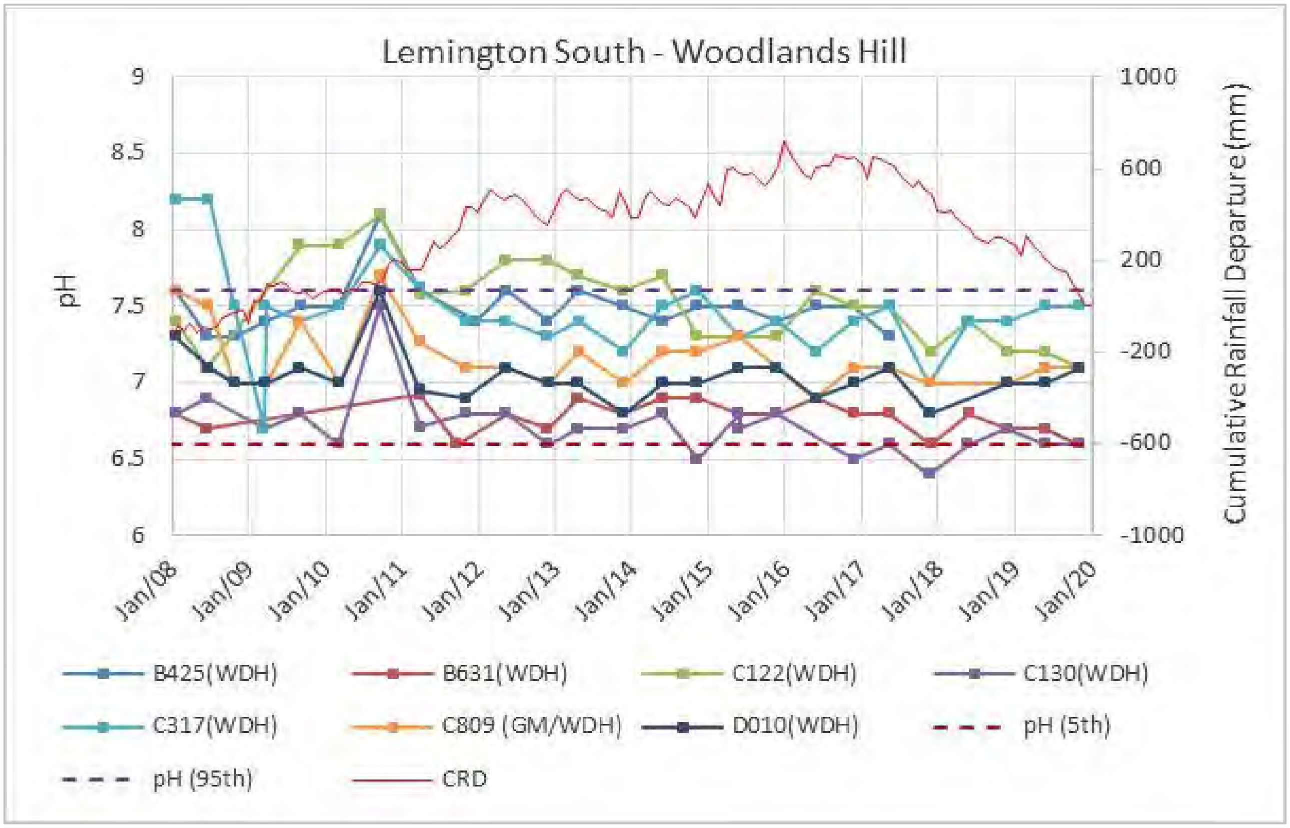
Lemington South Pit – Bowfield Seam: pH



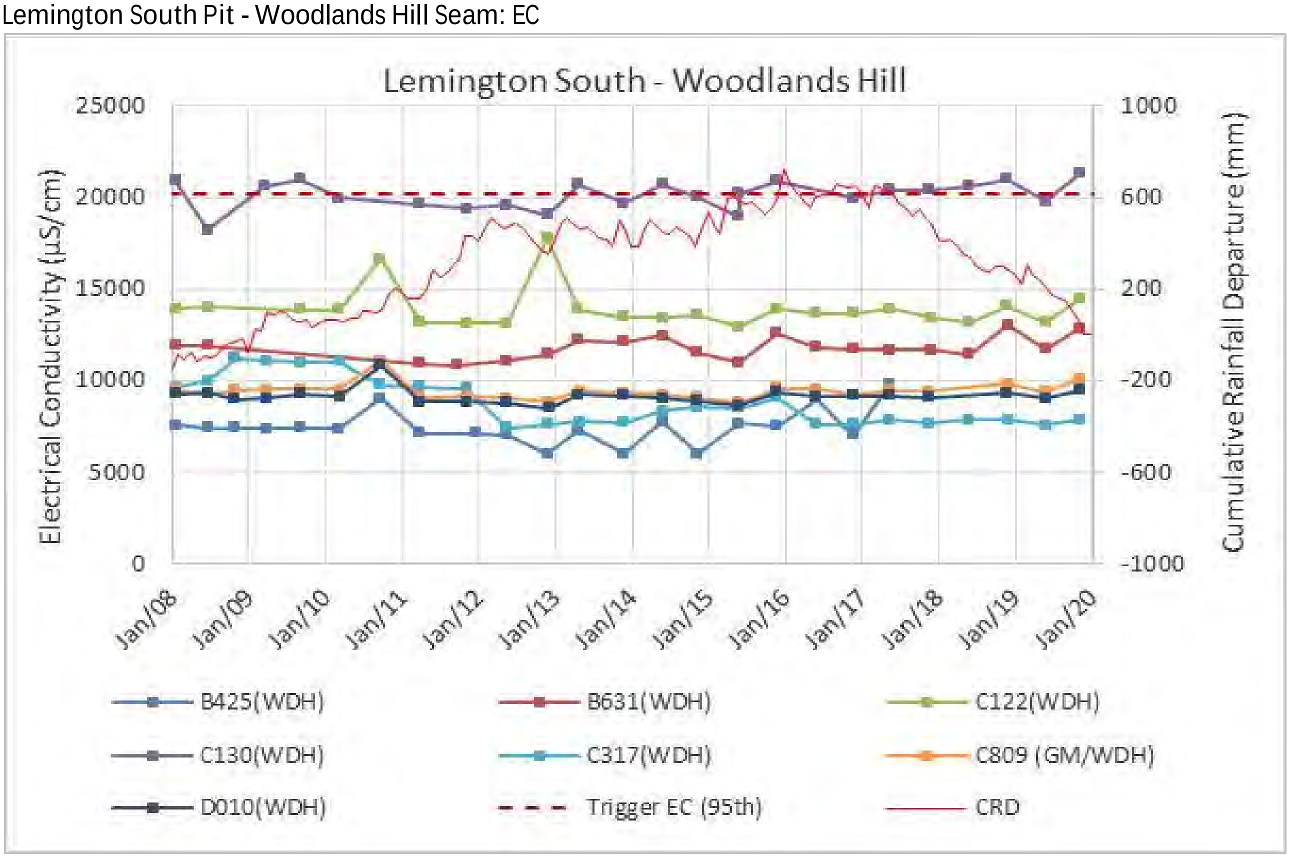
Lemington South Pit – Bowfield Seam: EC



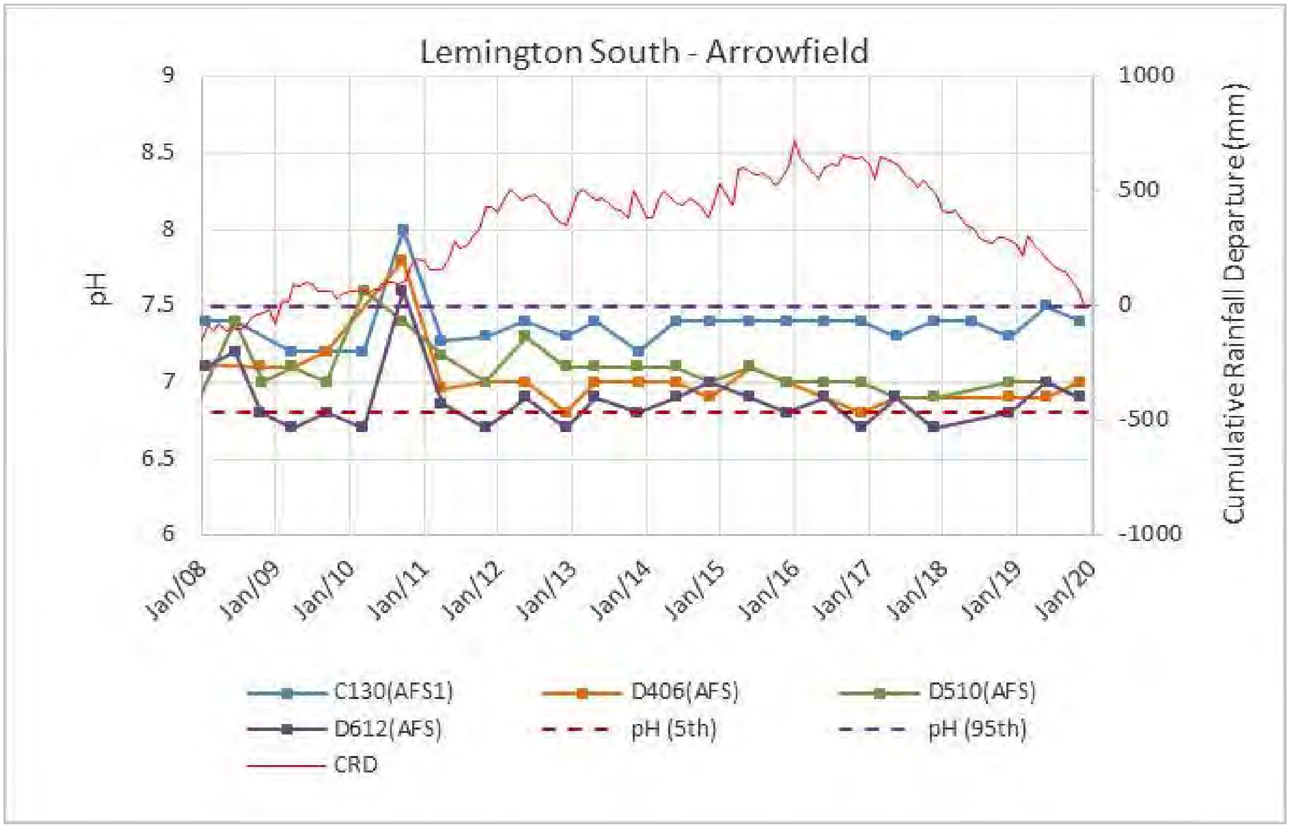
Lemington South Pit - Woodlands Hill Seam: pH



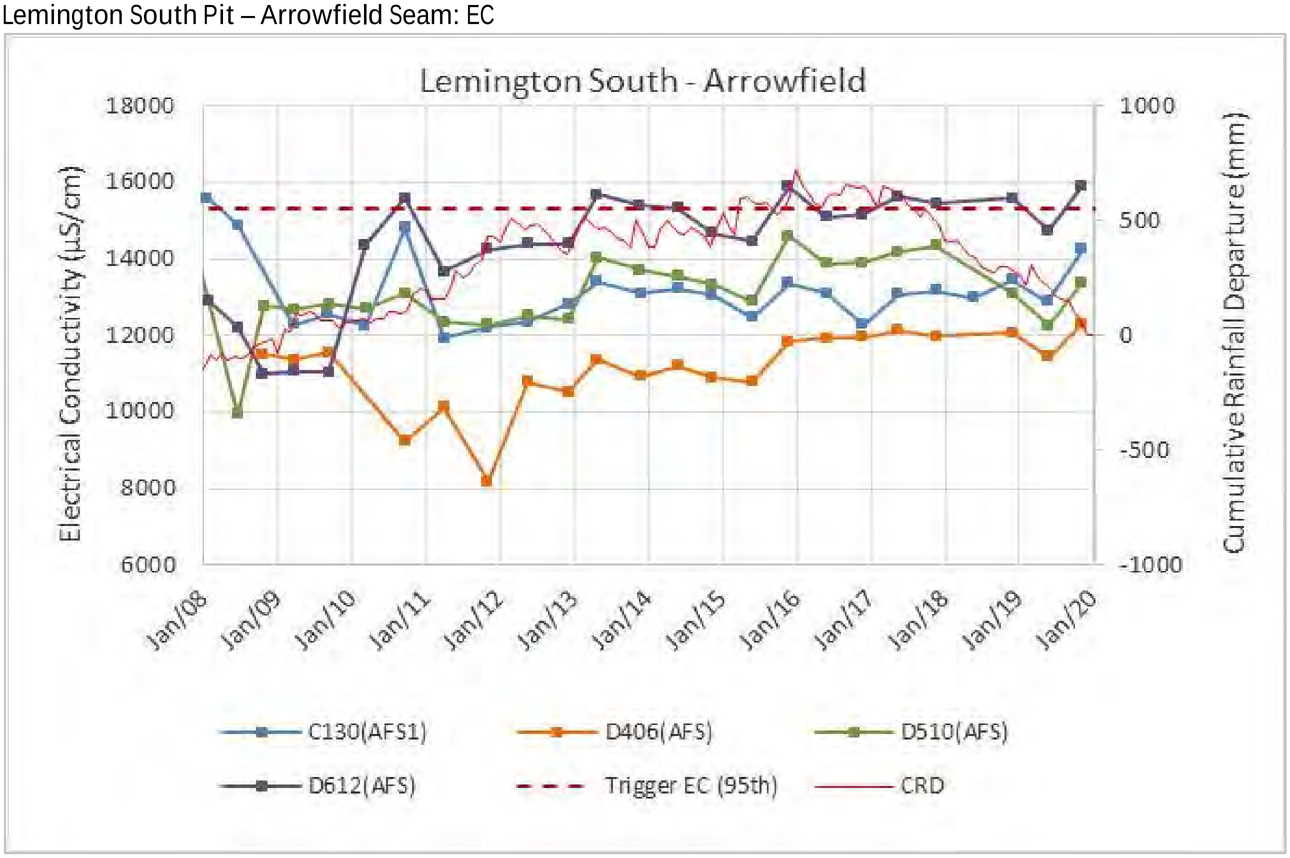
Lemington South Pit - Woodlands Hill Seam: EC



Lemington South Pit – Arrowfield Seam: pH



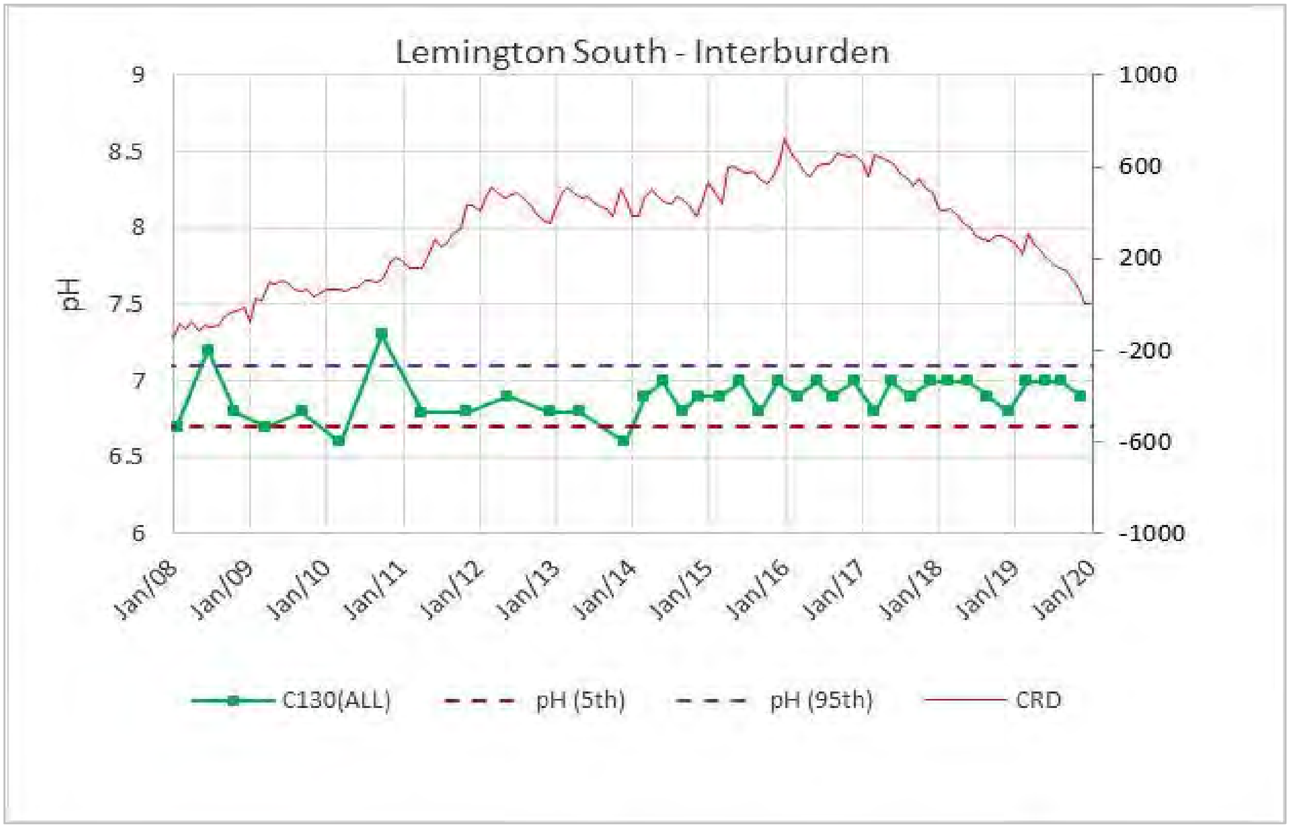
Lemington South Pit – Arrowfield Seam: EC



Lemington South Pit - Glen Munro Seam: pH

Lemington South Pit - Glen Munro Seam: EC

Lemington South Pit – Interburden: pH



Lemington South Pit – Interburden: EC

APPENDIX E

Full Water Quality Data 2019

Station	Date	Geology	Comprehensive Anlysis Event	pH Field	EC Field (uS/cm (25TRef))	TDS - Total (mg/l)	Depth to Stand Pipe (m)	SWL (mAHD)	Al - Total (mg/l)	Alk - Total (mg/l)	As - Total (mg/l)	B (mg/l)	Bicarbonate Alkalinity as CaCO3	Ca - Total (mg/l)	Carbonate Alkalinity as CaCO3	Cd - Total (mg/l)	Cl- (mg/l)	Co - Total (mg/l)	Cu - Total (mg/l)	F (mg/l)	Fe - Filtered (mg/L)	Hg - Total (mg/l)	Hydroxide Alk (mg/l)	K - Total (mg/l)	Mg - Total (mg/l)	Mn - Total (mg/l)	Na - Total (mg/l)	Ni - Total (mg/l)	Pb - Total (mg/l)	Se (mg/l)	SO4 - Total (mg/l)	Zn - Total (mg/l)
4032P	04-12-2019	Alluvium	6M	7.1	3320		-	58.79																								
4032P	15-03-2019	Alluvium	6M	7.2	1,582	1080	10.84	58.51	4.1	500	0.00	0.10	500	54	0	0	202		0.02			<0.00	0	5.0	57		190	0.02	0.00	0.009	61	0.08
4034P	04-12-2019	Alluvium	6M	7.5	1579		12.67	58.48																								
4034P	15-03-2019	Alluvium	6M	7.4	1,492	912	12.65	58.50	2.2	447	0.007	0.086	447	49	0	<0.0001	222		0.029			<0.0001	0	2.9	68		170	0.012	0.002	0.006	59	0.04
4037P	04-12-2019	Alluvium	6M	7.2	1314		12.2	58.54																								
4037P	15-03-2019	Alluvium	6M				12.16	58.58																								
Appleyard Farm	12-12-2019	Alluvium	A				7.6	35.8									0															
Appleyard Farm	06-11-2019	Alluvium	A	6.8	613	250	7.6	35.8	0.47	63	<0.001	<0.05	63	17	<1	<0.0001	141		0.19			0.0001	<1	4	14		65	0.012	0.003	<0.01	12	0.013
Appleyard Farm	16-10-2019	Alluvium	A				7.6	35.8																								
Appleyard Farm	16-10-2019	Alluvium	A				7.6	35.8																								
Appleyard Farm	22-03-2019	Alluvium	A				7.36	36.04																								
Appleyard Farm	26-02-2019	Alluvium	A	6.8	568		7.36	36.04																								
Appleyard Farm	15-01-2019	Alluvium	A				7.36	36.04																								
BUNC45A	14-11-2019	Alluvium	6M	6.7	2140		21.97	50.93																								
BUNC45A	26-02-2019	Alluvium	6M	6.7	2,130	1090	21.19	51.71	2.4	489	<0.001	0.1	489	52	0	<0.0001	352		0.01			<0.0001	0	6.3	36		310	0.005	0.005	<0.001	72	0.043
BZ1-1	14-11-2019	Alluvium	6M	7.6	2530		17.46	53.93																								
BZ1-1	25-02-2019	Alluvium	6M	7.50	2,700		17.51	53.88																								
C919(ALL)	12-12-2019	Alluvium	A																													
C919(ALL)	06-11-2019	Alluvium	A																													
C919(ALL)	11-10-2019	Alluvium	A																													
C919(ALL)	11-10-2019	Alluvium	A																													
C919(ALL)	22-03-2019	Alluvium	A				11.96	45.98																								
C919(ALL)	26-02-2019	Alluvium	A				11.96	45.98																								
CFW55R	18-12-2019	Alluvium	6M	7.0	9830	6600	12.03	57.75		706			706	129	<1		1840						<1	30	280		1830				1990	
CFW55R	04-12-2019	Alluvium	6M	7.0	9920	6340	12.03	57.75	0.73	773	<0.001	0.08	773	123	<1	<0.0001	1940		<0.001			<0.0001	<1	30	259		1660	0.024	<0.001	<0.01	2120	<0.005
CFW55R	20-11-2019	Alluvium	6M	7.0	9810	6230	12.03	57.75		782			782	136	<1		1890						<1	32	294		1950				1950	
CFW55R	06-11-2019	Alluvium	6M	7.1	9960	6540	12.03	57.75	0.32	827	<0.001	0.09	827	121	<1	<0.0001	1910		0.002			<0.0001	<1	30	259		1690	0.020	<0.001	<0.01	2250	<0.005
CFW55R	24-10-2019	Alluvium	6M	7.1	8,520	6180	12.03	57.75		773			773	125	<1		1860						<1	30.0	260		1720				1680	
CFW55R	24-10-2019	Alluvium	6M	7.1	8520	6180	12.03	57.75		773			773	125	<1		1860						<1	30	260		1720				1680	
CFW55R	9-10-2019	Alluvium	6M	7.2	9,150	6460	12.03	57.75	0.36	694	<0.001	0.08	694	125	<1	<0.0001	1860		0.006			<0.0001	<1	30.0	263		1720	0.023	<0.001	<0.01	1970	0.007
CFW55R	09-10-2019	Alluvium	6M	7.2	9150	6460	12.03	57.75	0.36	694	<0.001	0.08	694	125	<1	<0.0001	1860		0.006			<0.0001	<1	30	263		1720	0.023	<0.001	<0.01	1970	0.007
CFW55R	26-03-2019	Alluvium	6M	7.00	9,360	6620	11.66	58.12	0.39	745	<0.00	0.09	745	130	0	<0.00	2169		0.00			<0.00	0	50.0	250		1500	0.01	<0.00	0.005	1900	<0.00
CFW55R	14-03-2019	Alluvium	6M	7.20	9,780	6680	11.66	58.12		742			742	110	0		1980						0	47.0	240		1700				1900	
CFW55R	27-02-2019	Alluvium	6M	7.10	9,990	6450	11.66	58.12	0.29	740	<0.00	0.09	740	120	0	<0.00	1712		0.00			<0.00	0	54.0	240		1700	0.02	<0.00	0.006	1900	<0.00
CFW55R	12-02-2019	Alluvium	6M	6.80	8,340	5760	11.66	58.12		741			741	99	0		1761						0	43.0	210		1600				1600	
CFW55R	5-02-2019	Alluvium	6M	6.80	8,310	5780	11.66	58.12		748			748	96	0		1908						0	41.0	210		1900				1700	
C919(ALL)	15-01-2019	Alluvium	A				11.96	45.98																								
CFW55R	30-01-2019	Alluvium	6M	6.70	8,130	5620	11.66	58.12		742			742	96	0		1614						0	41.0	220		1500				1400	
CFW55R	23-01-2019	Alluvium	6M	6.80	8,690	5510	11.66	58.12		747			747	100	0		1614						0	42.0	210		1500				1300	
CFW55R	16-01-2019	Alluvium	6M	6.80	8,060	4340	11.66	58.12	0.68	770	<0.00	0.11	770	100	0	<0.00	1712		0.00			<0.00	0	43.0	220		1500	0.06	<0.00	<0.001	1500	<0.00
CFW55R	10-01-2019	Alluvium	6M	6.70	8,630	5600	11.66	58.12		762			762	97	0		1663						0	40.0	220		1500				1400	
CFW57	19-12-2019	Alluvium	6M	7.3	4190	2400	12.35	57.7		534			534	76	<1		783						<1	5	103		692				397	
CFW57	04-12-2019	Alluvium	6M	7.2	4940	2730	12.35	57.7	0.16	663	<0.001	0.09	663	94	<1	<0.0001	1070		<0.001			<0.0001	<1	5	137		746	0.032	<0.001	<0.01	573	<0.005
CFW57	20-11-2019	Alluvium	6M	7.4	4990	2470	12.35	57.7		687			687	103	<1		1080						<1	6	156		855				540	

CFW57	06-11-2019	Alluvium	6M	7.4	4900	2750	12.35	57.7	0.52	696	<0.001	0.10	696	86	<1	<0.0001	1020		<0.001			<0.0001	<1	5	124		734	0.007	<0.001	<0.01	488	<0.005
CFW57	24-10-2019	Alluvium	6M	7.5	4,060	2560	12.35	57.7		604			604	73	<1		913						<1	5.0	111		738				348	
CFW57	24-10-2019	Alluvium	6M	7.5	4060	2560	12.35	57.7		604			604	73	<1		913						<1	5	111		738				348	
CFW57	10-10-2019	Alluvium	6M	7.5	4,120	2430	12.35	57.7	0.08	578	<0.001	0.1	578	63	<1	<0.0001	799		<0.001			<0.0001	<1	4.0	97		678	0.009	<0.001	<0.01	404	<0.005
CFW57	10-10-2019	Alluvium	6M	7.5	4120	2430	12.35	57.7	0.08	578	<0.001	0.10	578	63	<1	<0.0001	799		<0.001			<0.0001	<1	4	97		678	0.009	<0.001	<0.01	404	<0.005
CFW57	27-03-2019	Alluvium	6M	7.50	4,770	3410	12.11	57.94	0.07	641	<0.00	0.12	641	110	0	<0.00	1061		<0.00			<0.00	0	7.5	160		810	0.01	<0.00	0.007	760	<0.00
CFW57	14-03-2019	Alluvium	6M	7.40	5,520	3290	12.11	57.94		635			635	93	0		1040						0	6.7	150		870				730	
CFW57	28-02-2019	Alluvium	6M	7.40	5,230	3300	12.11	57.94	0.41	631	<0.00	0.13	631	100	0	<0.00	612		0.00			<0.00	0	8.3	160		850	0.02	<0.00	0.007	770	0.01
CFW57	13-02-2019	Alluvium	6M	7.20	5,720	3440	12.11	57.94		640			640	100	0		1125						0	7.8	160		850				820	
CFW57	6-02-2019	Alluvium	6M	7.20	5,820	3680	12.11	57.94		642			642	100	0		1174						0	7.4	160		1100				870	
CFW55R	3-01-2019	Alluvium	6M	6.80	8,250	5460	11.66	58.12		771			771	88	0		1663						0	29.0	200		1600				1600	
CFW57	30-01-2019	Alluvium	6M	7.30	5,960	3520	12.11	57.94		646			646	110	0		1076						0	7.9	170		910				820	
CFW57	24-01-2019	Alluvium	6M	7.30	5,450	3570	12.11	57.94		642			642	110	0		930						0	7.9	170		820				840	
CFW57	17-01-2019	Alluvium	6M	7.30	5,860	3720	12.11	57.94	0.43	656	<0.00	0.11	656	120	0	<0.00	1027		0.00			<0.00	0	8.0	180		910	0.01	<0.00	0.006	870	<0.00
CFW57	11-01-2019	Alluvium	6M	7.20	2,890	3630	12.11	57.94		648			648	110	0		1027						0	7.6	180		900				880	
CGW39	04-12-2019	Alluvium	6M	7.3	6480		12.24	58.07																								
CGW39	27-03-2019	Alluvium	6M	7.4	6,410	3880	12.19	58.12	3.7	880	0.003	0.1	880	130	0	<0.0001	1567		0.007			<0.0001	0	10.0	200		920	0.007	0.002	0.024	250	0.03
CGW47A	04-12-2019	Alluvium	6M				16.24	54.15																								
CGW47A	13-03-2019	Alluvium	6M				16.24	54.15																								
CHPZ10A	14-11-2019	Alluvium	6M	7.0	712		9.43	53.14																								
CHPZ10A	26-02-2019	Alluvium	6M	6.7	779	452	9.43	53.14	0.43	215	<0.001	0.053	215	52	0	<0.0001	93		0.002			<0.0001	0	1.0	32		40	0.003	<0.001	<0.001	23	0.007
CHPZ12A	14-11-2019	Alluvium	6M	7.0	898		9.39	53.74																								
CHPZ12A	25-02-2019	Alluvium	6M	6.8	841	524	9.37	53.76	0.031	214	<0.001	0.046	214	58	0	<0.0001	98		<0.001			<0.0001	0	0.9	36		43	0.001	<0.001	0.002	37	<0.005
CHPZ1A	14-11-2019	Alluvium	6M*	7.2	688		11.71	54.19																								
CHPZ1A	25-02-2019	Alluvium	6M*	7	738	416	11.7	54.20	0.032	233	<0.001	0.034	233	45	0	<0.0001	73		<0.001	0.2	<0.005	<0.0001	0	2.4	30	0.003	51	0.001	<0.001	<0.001	18	<0.005
CHPZ2A	15-11-2019	Alluvium	6M	7.2	888	463	11.53	53.61	0.02	240	<0.001	<0.05	240	44	<1	<0.0001	132		<0.001			<0.0001	<1	<1	39		81	0.006	<0.001	<0.01	34	<0.005
CHPZ2A	25-02-2019	Alluvium	6M				11.52	53.62																								
CHPZ3A	14-11-2019	Alluvium	6M	6.9	702		9.72	53.46																								
CHPZ3A	25-02-2019	Alluvium	6M	6.8	715	394	9.7	53.48	0.76	188	<0.001	0.041	188	38	0	<0.0001	78		0.013			<0.0001	0	1.0	29		48	0.004	<0.001	<0.001	28	0.013
CHPZ4A	14-11-2019	Alluvium	6M	7.1	763		12.04	53.41																								
CHPZ4A	25-02-2019	Alluvium	6M	7	707	398	12.04	53.41	0.29	209	<0.001	0.032	209	45	0	<0.0001	78		0.001			<0.0001	0	2.0	28		45	0.007	<0.001	<0.001	25	<0.005
CHPZ8A	14-11-2019	Alluvium	6M				6.89	53.16																								
CHPZ8A	26-02-2019	Alluvium	6M				6.87	53.18																								
G1	12-12-2019	Alluvium	A	7.4	5110	3280	2.01	107.99	2.77	631	0.002	0.27	631	88	<1	<0.0001	988		0.008			<0.0001	<1	2	125		952	0.008	0.008	<0.01	664	0.055
G1	13-11-2019	Alluvium	A	7.4	5580	3140	2.01	107.99	0.36	570	0.001	0.26	570	93	<1	<0.0001	964		<0.001			<0.0001	<1	4	115		931	0.006	0.002	<0.01	812	0.037
G1	11-10-2019	Alluvium	A	7.4	6,250	3930	2.01	107.99	0.07	516	<0.001	0.19	516	123	<1	<0.0001	1260		<0.001			<0.0001	<1	3.0	148		1170	0.002	<0.001	<0.01	790	0.018
G1	11-10-2019	Alluvium	A	7.4	6250	3930	2.01	107.99	0.07	516	<0.001	0.19	516	123	<1	<0.0001	1260		<0.001			<0.0001	<1	3	148		1170	0.002	<0.001	<0.01	790	0.018
G1	22-03-2019	Alluvium	A	7.4	7,590	4840	1.63	108.37	0.067	537	0.001	0.25	537	160	0	<0.0001	1591		0.001			<0.0001	0	6.2	160		1300	0.007	<0.001	<0.001	1100	0.031
G1	20-02-2019	Alluvium	A	7.4	8,470	5270	1.63	108.37	0.027	515	0.001	0.23	515	180	0	<0.0001	2006		0.002			<0.0001	0	4.2	170		1500	0.007	<0.001	<0.001	1400	0.043
CFW57	3-01-2019	Alluvium	6M	7.20	5,940	3650	12.11	57.94		648			648	100	0		1150						0	5.9	160		730				890	
G2	12-12-2019	Alluvium	A	7.4	4800	3000	1.54	109.06	0.09	640	<0.001	0.33	640	42	<1	<0.0001	925		<0.001			<0.0001	<1	5	113		927	0.002	<0.001	<0.01	583	<0.005
G2	13-11-2019	Alluvium	A	7.6	4950	2770	1.54	109.06	0.08	675	<0.001	0.35	675	39	<1	<0.0001	875		<0.001			<0.0001	<1	8	101		900	0.001	<0.001	<0.01	638	0.007
G2	11-10-2019	Alluvium	A	7.6	4,840	2730	1.54	109.06	0.06	579	<0.001	0.31	579	46	<1	<0.0001	909		<0.001			<0.0001	<1	6.0	113		963	0.007	<0.001	<0.01	572	<0.005
G2	11-10-2019	Alluvium	A	7.6	4840	2730	1.54	109.06	0.06	579	<0.001	0.31	579	46	<1	<0.0001	909		<0.001			<0.0001	<1	6	113		963	0.007	<0.001	<0.01	572	<0.005
G2	22-03-2019	Alluvium	A	7.6	4,700	2890	1.34	109.26	0.057	668	<0.001	0.39	668	42	0	<0.0001	796		<0.001			<0.0001	0	7.6	97		840	0.002	<0.001	<0.001	590	<0.005
G2	20-02-2019	Alluvium	A	7.6	4,660	2900	1.34	109.26	0.073	669	<0.001	0.35	669	36	0	<0.0001	807		<0.001			<0.0001	0	5.2	97		740	0.002	<0.001	<0.001	600	<0.005
G1	17-01-2019	Alluvium	A	7.4	8,400	5830	1.63	108.37	0.01	498	<0.001	0.16	498	190	0	<0.0001	2055		<0.001			<0.0001	0	7.0	190		1600	0.005	<0.001	<0.001	1400	0.023
G3	12-12-2019	Alluvium	A	7.6	4940	3120	0.91	107.69	0.01	722	<0.001	0.3	722	36	<1	<0.0001	907		<0.001			<0.0001	<1	3	90		1020	0.002	<0.001	<0.01	587	<0.005
G3	13-11-2019	Alluvium	A	7.5	5040	2820	0.91	107.69	<0.01	757	<0.001	0.30	757	36	<1	<0.0001	833		<0.001			<0.0001	<1	4	78		992	<0.001	<0.001	<0.01	650	0.009
G3	11-10-2019	Alluvium	A	7.6	5,090	2900	0.91	107.69	<0.01	632	<0.001	0.24	632	38	<1	<0.0001	909		<0.001			<0.0001	<1	3.0	88		1060	0.003	<0.001	<0.01	588	<0.005
G3	11-10-2019	Alluvium	A	7.6	5090	2900	0.91	107.69	<0.01	632	<0.001	0.24	632	38	<1	<0.0001	909		<0.001			<0.0001	<1	3	88		1060	0.003	<0.001	<0.01	588	<0.005
G3	22-03-2019	Alluvium	A	7.5	5,080	3070	0.84	107.76	0.012	717	<0.001	0.37	717	37	0	<0.0001	868		<0.001			<0.0001	0	4.5	80		960	0.002	<0.001	<0.001	620	0.012
G3	20-02-2019	Alluvium	A	7.5	5,010	3070	0.84	107.76	0.012	716	<0.001	0.36	716	33	0	<0.0001	930		<0.001			<0.0001	0	2.4	80		850	0.002	<0.001	<0.001	640	<0.005
G2	17-01-2019	Alluvium	A	7.5	4,580	2730	1.34	109.26	0.036	680	<0.001	0.33	680	44	0	<0.0001	807		<0.001			<0.0001	0	7.4	98		800	0.004	<0.001	<0.001	580	<0.005

GW-100	05-12-2019	Alluvium	A	7.4	10460		6.21	83.39																								
GW-100	27-03-2019	Alluvium	A	7.4	10,610		5.86	83.74																								
GW-101	05-12-2019	Alluvium	A																													
GW-101	27-03-2019	Alluvium	A				12.82	87.68																								
GW-106	05-12-2019	Alluvium	A	6.8	9180		23.29	59.01																								
GW-106	28-03-2019	Alluvium	A	7.0	8,130		23.24	59.06																								
GW-114	05-12-2019	Alluvium	A	6.6	8840		31.88	66.32																								
GW-114	27-03-2019	Alluvium	A	6.6	8,600		31.73	66.47																								
PB01(ALL)	12-12-2019	Alluvium	A				9.51	44.86																								
PB01(ALL)	08-11-2019	Alluvium	A	7.2	5260	4270	9.51	44.86	3.58	415	0.006	0.12	415	90	<1	0.0013	1430		0.028			<0.0001	<1	19	162		666	0.012	0.051	<0.01	136	0.078
PB01(ALL)	11-10-2019	Alluvium	A				9.51	44.86																								
PB01(ALL)	11-10-2019	Alluvium	A				9.51	44.86																								
PB01(ALL)	22-03-2019	Alluvium	A				9.36	45.01																								
PB01(ALL)	26-02-2019	Alluvium	A	7.1	4,540		9.36	45.01																								
G3	17-01-2019	Alluvium	A	7.5	4,900	3140	0.84	107.76	0.013	712	<0.001	0.31	712	35	0	<0.0001	832		<0.001			<0.0001	0	4.2	80		940	0.002	<0.001	<0.001	620	<0.005
PZ2CH400	14-11-2019	Alluvium	6M*	6.9	1001		8.02	54.51																								
PZ2CH400	7-03-2019	Alluvium	6M*	6.8	1,219	504	2.36	60.17	11	396	0.004	0.038	396	59	0	0.0001	118		0.049	0.13	0.61	<0.0001	0	18.0	20	0.73	51	0.027	0.012	0.004	1	0.13
PZ2CH400	25-02-2019	Alluvium	6M*	6.7	1,160		2.36	60.17																								
PZ3CH800	14-11-2019	Alluvium	6M*	7.0	867		9.3	54.86																								
PZ3CH800	25-02-2019	Alluvium	6M*	7	900	514	9.42	54.74	0.44	300	<0.001	0.04	300	67	0	<0.0001	88		0.009	0.17	0.01	<0.0001	0	3.2	38	0.11	44	0.004	0.002	<0.001	36	0.02
PB01(ALL)	15-01-2019	Alluvium	A				9.36	45.01																								
Hobdens Well	14-11-2019	Cheshunt / North Pit_Alluvium	A	7.6	943																											
Hobdens Well	25-02-2019	Cheshunt / North Pit_Alluvium	A	7.5	980																											
C130(AFS1)	08-11-2019	Arrowfield	A	7.4	14250	7890	18.43	44.74	0.41	804	0.002	0.15	804	195	<1	0.0002	4740		0.028			0.0001	<1	29	169		2890	0.069	0.006	<0.01	9	0.027
CGW46	04-12-2019	Bayswater	6M	7.4	2700		12.9	59.05																								
CGW46	13-03-2019	Bayswater	6M	7.4	2,810	1600	12.94	59.01	8.4	669	0.003	0.13	669	46	0	0.0001	472		0.031			<0.0001	0	7.8	71		390	0.017	0.008	0.028	98	0.31
B925(BFS)	06-11-2019	Bowfield	A	6.9	4920	2800	63.17	-0.72	1.13	1190	<0.001	0.11	1190	12	<1	0.0002	893		0.038			0.0001	<1	14	11		925	0.006	0.004	<0.01	<1	0.075
B925(BFS)	26-02-2019	Bowfield	A				58.6	3.85																								
SR012	28-11-2019	Conglomerate/Sandstone	A	6.7	14950	8300	27.2	49	0.21	1100	<0.001	<0.05	1100	260	<1	<0.0001	4950		0.002			<0.0001	<1	44	596		2560	0.019	<0.001	<0.01	697	0.020
SR012	28-03-2019	Conglomerate/Sandstone	A	6.8	12,700		26.71	49.49																								
SR010	28-11-2019	Conglomerate/Warkworth Seam	A	7.0	5940	3000	10.58	46.92	<0.01	638	<0.001	<0.05	638	97	<1	<0.0001	1550		<0.001			<0.0001	<1	14	158		1020	<0.001	<0.001	<0.01	257	<0.005
SR010	28-03-2019	Conglomerate/Warkworth Seam	A	7.6	1,990		10.89	46.61																								
D010(GM)	08-11-2019	Glen Munro	A	6.9	11920	6930	9.19	46.76	0.74	1190	0.001	0.11	1190	160	<1	<0.0001	3600		0.004			<0.0001	<1	34	404		2100	0.004	0.002	<0.01	348	0.010
SR009	28-11-2019	Lemington Seam	A	7.3	6090	3060	7.1	49	<0.01	849	<0.001	0.07	849	32	<1	<0.0001	1550		<0.001			<0.0001	<1	8	57		1310	<0.001	<0.001	<0.01	72	<0.005
SR009	28-03-2019	Lemington Seam	A	7.8	4,340		6.94	49.16																								
BZ1-3	14-11-2019	Mt Arthur	6M	7.6	1204		46.76	24.63																								
BZ1-3	25-02-2019	Mt Arthur	6M	7.5	1,243	683	47.05	24.34	2.5	377	<0.001	0.09	377	12	0	<0.0001	108		0.009			<0.0001	0	10.0	22		200	0.011	0.004	<0.001	39	0.12
CHPZ12D	14-11-2019	Mt Arthur	6M	7.3	1335		9.6	53.66																								
CHPZ12D	26-02-2019	Mt Arthur	6M	6.7	1,437	733	9.58	53.68	0.34	515	<0.001	0.12	515	18	0	<0.0001	103		0.007			<0.0001	0	9.1	12		230	0.005	0.001	<0.001	3	0.015
CHPZ3D	14-11-2019	Mt Arthur	6M	6.6	1073		10.51	52.45																								
CHPZ3D	25-02-2019	Mt Arthur	6M	6.5	1,037	588	10.57	52.39	0.023	428	<0.001	0.13	428	15	0	<0.0001	88		0.001			<0.0001	0	6.1	10		190	0.002	<0.001	<0.001	2	0.007
CHPZ8D	14-11-2019	Mt Arthur	6M	7.2	1373		7.13	52.76																								
CHPZ8D	26-02-2019	Mt Arthur	6M	7	1,345	766	7.08	52.81	1.8	545	0.002	0.07	545	120	0	<0.0001	112		0.008			<0.0001	0	3.1	64		40	0.003	0.003	<0.001	16	0.018
LUG Bore	06-11-2019	Mt Arthur	A	7.0	8540	4520			<0.01	2350	0.051	0.17	2350	26	<1	<0.0001	1490		<0.001			<0.0001	<1	31	28		1600	<0.001	<0.001	<0.01	<1	0.014
LUG Bore	26-02-2019	Mt Arthur	A	7.1	8,710																											
SR011	28-11-2019	Mt Arthur Seam/Underburden	A	6.5	16750	10300	34.84	53.36	<0.01	834	<0.001	0.06	834	455	<1	<0.0001	5830		<0.001			<0.0001	<1	36	657		2570	<0.001	<0.001	<0.01	722	<0.005
SR011	28-03-2019	Mt Arthur Seam/Underburden	A	6.6	13,280		34.6	53.60																								
SR007	28-11-2019	Overburden/Vaux Seam coal	A	6.6	6000	3070	35.06	25.84	0.55	729	0.006	<0.05	729	166	<1	<0.0001	1580		0.009			<0.0001	<1	15	313		673	0.095	0.002	<0.01	232	0.028
SR007	28-03-2019	Overburden/Vaux Seam coal	A	6.6	5,030		35.07	25.83																								
BUNC45D	14-11-2019	Piercefield	6M	6.7	2510		25.24	48.12																								
BUNC45D	26-02-2019	Piercefield	6M	6.7	2,450	1330	25.35	48.01	0.33	776	<0.001	0.16	776	71	0	<0.0001	352		0.001			<0.0001	0	12.0	50		340	0.001	<0.001	<0.001	3	0.012
B425(WDH)	06-11-2019	Woodlands Hill	A				35.82	22.06																								
B425(WDH)	26-02-2019	Woodlands Hill	A				35.74	22.14																								
C130(ALL)	15-01-2019	Interburden	A				15.99	47.05																								

BZ8-2	14-11-2019	Interburden	6M	7.1	1207		20.71	47.09																								
BZ8-2	25-02-2019	Interburden	6M	7	1,212	661	20.22	47.58	0.31	313	<0.001	0.064	313	31	0	<0.0001	137		<0.001			<0.0001	0	5.9	46		140	<0.001	<0.001	<0.001	47	0.006
C130(ALL)	12-12-2019	Interburden	A				16.07	46.97																								
C130(ALL)	08-11-2019	Interburden	A	6.9	25100	14100	16.07	46.97	4.5	1150	0.004	<0.05	1150	241	<1	0.0029	8480		0.039			0.0002	<1	69	722		3790	0.013	0.131	<0.01	846	0.099
C130(ALL)	11-10-2019	Interburden	A				16.07	46.97																								
C130(ALL)	11-10-2019	Interburden	A				16.07	46.97																								
C130(ALL)	22-03-2019	Interburden	A				15.99	47.05																								
C130(ALL)	26-02-2019	Interburden	A	7	27,400		15.99	47.05																								
NPZ2	05-12-2019	Sandstone/Siltstone	A	7.2	14080		29.9	160.575																								
NPZ2	27-03-2019	Sandstone/Siltstone	A	7.2	13,640		29.42	161.06																								
NPZ3	05-12-2019	Sandstone/Siltstone	A	7.4	13220		23.5	124.9																								
NPZ3	27-03-2019	Sandstone/Siltstone	A	7.5	12,690		22.59	125.81																								
NPZ5	05-12-2019	Sandstone/Siltstone	A	6.8	6700		21.83	91.93																								
NPZ5	27-03-2019	Sandstone/Siltstone	A	6.9	6,700		18.55	95.21																								
SR008	28-11-2019	Sandstone/Siltstone	A	6.8	14270	7580	9.76	47.04	0.01	1020	<0.001	0.05	1020	127	<1	<0.0001	4740		<0.001			<0.0001	<1	20	307		2850	<0.001	<0.001	<0.01	378	<0.005
SR008	28-03-2019	Sandstone/Siltstone	A	7.4	4,250		9.58	47.22																								
GW-107	05-12-2019	Spoil	A				29.2	44.3																								
GW-107	27-03-2019	Spoil	A				29.21	44.29																								
GW-108	05-12-2019	Spoil	A				60.86	23.54																								
GW-108	27-03-2019	Spoil	A				60.89	23.51																								
4116P	04-12-2019	Spoil	6M	7.1	14420		23.65	46.52																								
4116P	15-03-2019	Spoil	6M	7.00	12,320	8140	23.63	46.54	10.00	765	0.01	0.19	765	160	0	0.00	4240		0.04			<0.00	0	58.0	540		1900	0.08	0.01	0.005	900	0.19
4119P	05-12-2019	Spoil	6M	7.1	4580		11.18	52.33																								
4119P	27-03-2019	Spoil	6M	7	2,530	1760	11.06	52.45	0.012	614	0.079	0.1	614	100	0	<0.0001	289		<0.001			<0.0001	0	19.0	73		330	0.013	<0.001	<0.001	330	0.008
DM1	05-12-2019	Spoil	A	6.5	10630		25.19	77.54		888			888		<1								<1									
DM1	27-03-2019	Spoil	A	6.6	10,140		25.21	77.52		871			871		0								0									
DM3	05-12-2019	Spoil	A	6.5	9880		30.44	63.7		868			868		<1								<1									
DM3	27-03-2019	Spoil	A	6.5	8,980		30.38	63.76		768			768		0								0									
DM4	05-12-2019	Spoil	A	7	6300		18.24	46.61		959			959		<1								<1									
DM4	25-03-2019	Spoil	A	6.9	6,210		17.99	46.86		911			911		0								0									
DM7	04-12-2019	Spoil	A																													
DM7	15-03-2019	Spoil	A																													
GW-115	05-12-2019	Spoil	A	7.1	7740		14.94	53.36																								
GW-115	27-03-2019	Spoil	A	6.8	7,540		14.79	53.51																								
MB14HVO01	04-12-2019	Spoil	A	7	6510		36.3	35																								
MB14HVO01	25-03-2019	Spoil	A	6.7	7,530	4850	35.74	35.56	<0.005	795	0.064	0.15	795	200	0	<0.0001	1422		<0.001			<0.0001	0	39.0	220		1100	0.054	<0.001	<0.001	1300	0.011
MB14HVO02	04-12-2019	Spoil	A	7.3	7200		35.9	35																								
MB14HVO02	14-03-2019	Spoil	A	6.8	7,450	4840	35.42	35.48	0.01	773	0.18	0.19	773	190	0	<0.0001	1520		0.005			<0.0001	0	40.0	230		1100	0.058	<0.001	<0.001	1100	0.02
MB14HVO03	05-12-2019	Spoil	A	7	5860		34.36	32.74																								
MB14HVO03	25-03-2019	Spoil	A	6.9	6,190	4070	34.2	32.90	<0.005	829	0.13	0.14	829	180	0	<0.0001	1085		<0.001			<0.0001	0	36.0	190		900	0.003	<0.001	<0.001	1000	0.007
MB14HVO04	05-12-2019	Spoil	A	7	6000		30.06	37.04																								
MB14HVO04	25-03-2019	Spoil	A	6.8	6,040	3740	29.75	37.35	0.9	744	0.15	0.13	744	270	0	<0.0001	1012		0.003			<0.0001	0	33.0	220		770	0.082	0.001	<0.001	1200	0.034
MB14HVO05	04-12-2019	Spoil	A	6.8	8200		36.68	35.02																								
MB14HVO05	15-03-2019	Spoil	A	5.7	12,920	17200	36.14	35.56	11	47	0.11	0.4	47	290	0	0.0097	2600		0.027			<0.0001	0	110.0	820		1600	0.86	0.029	0.14	8400	13

APPENDIX F

HVO Triennial Groundwater Model Review

Memorandum

To:	Andrew Speechly	**At:**	Hunter Valley Operations Pty Ltd
From:	Arash Mohajeri	**At:**	SLR Consulting Australia Pty Ltd
Date:	13 February 2020	**Ref:**	620.12182.50000-M01-v2.0.docx
Subject:	HVO Triennial Groundwater Model Review		

1 Introduction

The Hunter Valley Operations (HVO) mining complex is located approximately 20 km north-west of Singleton, NSW. As listed below, it is outlined within the consent conditions and HVO Water Management Plan (WMP) that an independent review of the numerical groundwater model is required on a three-yearly basis:

- Schedule 3, Condition 27(c) of Development Consent 450-10-2003- a program to validate and recalibrate (if necessary) the groundwater model for the development, including an independent review of the model every 3 years, and comparison of monitoring results with modelled predictions;
- Schedule 3, Condition 27 of Project Approval 06_0261- a program to periodically update and validate the water balance and groundwater model for the project and compare monitoring results with modelled predictions, unless otherwise agreed by the Secretary.

The latest numerical groundwater model that replicates all approved operations across HVO (north and south) was developed by AGE Consultants as part of HVO South Modification 5 submitted in 2017. This memo presents the three yearly independent review of the HVO South Modification 5 numerical groundwater model.

2 Scope

The scope of this peer review includes the following items:

- Comparison between modelled and actual mine progression at HVO;
- Comparison between modelled and actual recharge;
- Comparison between modelled and actual streamflow;
- Review of predicted changes in groundwater levels for the Project scenario (with HVO South Mod 5), with comparison of model outputs to observed data (i.e. modelled and observed groundwater levels).

The following activities informed this audit:

- Australasian Groundwater and Environmental Consultants 2016 for Hunter Valley Operations South – Modification 5- Environmental Assessment, Appendix G, Groundwater Study–January 2017. 143 pages;
- HVO South Modification 5 groundwater model files provided by AGE;

- Mine progressions files provided by Hunter Valley Operations.

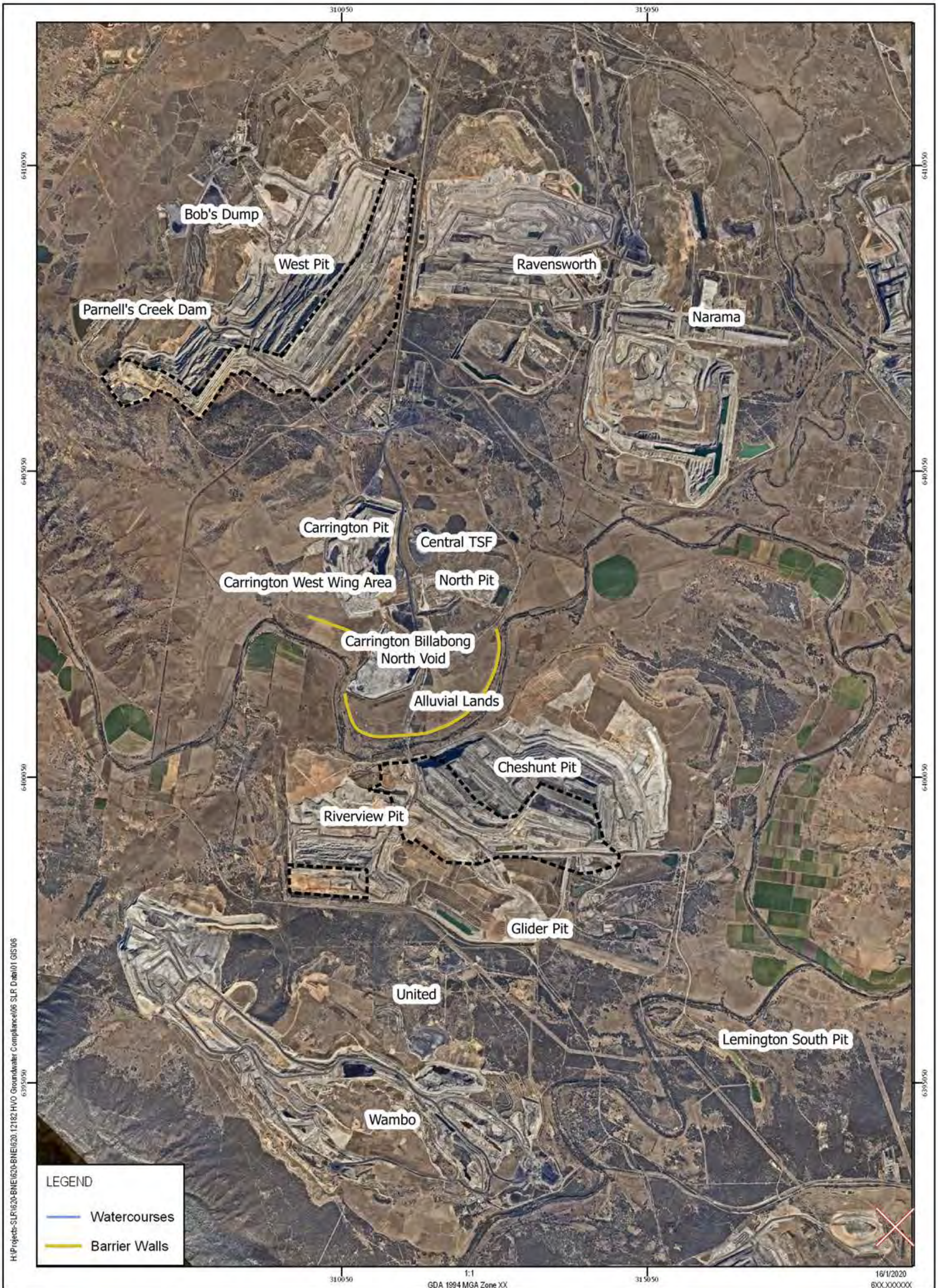
3 HVO Complex

This section provides a brief description of the HVO Complex of relevance to these three yearly independent groundwater model reviews.

Table 1 presents a summary of mine areas across HVO, approved mining timeframes and activities conducted including January 2016 to December 2019 period. Overall, mining was active at West Pit, Cheshunt Pit, and Riverview Pit over the review period, with rehabilitation of Glider Pit commencing in 2017.

Table 1 Summary of HVO Activities

Mine Area	Seam Mined To	Approved Life of Mining	Activities
West Pit	Bayswater to Hebden seams	1949 to 2025	Mining active
North Pit	Vaux Seam	1979 to 2003	Inactive – fully rehabilitated
Alluvial Lands	Vaux Seam	1993 to 2003	Inactive – fully rehabilitated
Carrington Pit	Bayswater Seam	2000 to 2021	Inactive – not rehabilitated (open pit)
Carrington West Wing	Bayswater Seam	Not commenced	Not commenced
Cheshunt Pit	Vaux & Bayswater seams	2002 to 2030	Mining active – down to the Bayswater Seam
Riverview Pit	Vaux & Bayswater seams	1997 to 2030	Mining active – down to the Vaux Seam
Glider Pit	Vaux Seam	2016 – 2017	Mining completed in 2017 and fully backfilled.
Lemington South Pit 1	Bowfield Seam Warkworth Seam	1998 to 2006 2019 to 2030	Inactive – rehabilitated with final void/pit lake present. Used for water storage from LUG Bore abstraction



Sheet Size: A4

0 2 4 6 m

SLR

www.slrconsultingaustralia.com.au PH: 61 7 3858 4800

Hunter Valley Operations - Locality Map

FIGURE 1

4 HVO Groundwater Model Summary

The HVO South numerical groundwater model replicates all approved operations across HVO (north and south) and was developed by AGE Consultants in 2016 as part of HVO South Modification 5 Impact Assessment (AGE 2017).

The model was built around the conceptual groundwater model summarised in Section 5.6 of AGE (2017). Development of the model was based on previous HVO groundwater models, with updates using data from HVO geological model as well as publicly available data (i.e. geological maps and groundwater studies for the surrounding region). The model extends north to include the HVO North and Ravensworth operations, and to the east and south to include the full lateral extent of the Wittingham Coal Measures.

The model uses MODFLOW-USG model code and comprises a total of 1,103,832 cells. The extent of the model was set up relatively large to capture all active mine operations surrounding the proposed modification. The surrounding mines simulated in the model domain are HVO North, Ravensworth, Cumnock, Ashton, United, Wambo and MTW.

The groundwater model calibration replicates steady state (1970 to 2003) and transient groundwater levels (2003 to 2015). The calibration model captured historical mining that occurred at HVO South as well as at surrounding mines that intersected the Wittingham Coal Measures. The transient calibration achieved a 3.61 per cent scaled root mean square (SRMS) error, which is within acceptable limits (i.e., 10 per cent), recommended by the Australian groundwater modelling guidelines (Barnett et al 2012). Therefore, the model calibration was considered valid.

The model simulated the currently approved mine plan at HVO South. The model represented mining using the drain (DRN) package. During the predictive run, drain cells were used to simulate the effect of the proposed mine and other mines in the area. A high drain conductance of 100 m^2/day was applied to the drain cells and the drain elevation was set the base of the modelled layer. The model represented the growth of spoil piles by progressively changing the hydraulic conductivities and storage properties of cells behind the active open cut mining area. No recharge was applied to the spoil emplacement areas immediately after drain cells were removed to represent the gradual rewetting of the unsaturated spoil over time (AGE 2017).

The HVO predictive model runs from 1/12/2015 (Year 1) to 1/12/2039 (Year 24). Quarterly stress periods were used so that the model could capture seasonal variability in recharge and streams. Long term average quarterly rainfall and river stage heights were used in the predictive model (AGE 2017).

The groundwater model was peer reviewed by Dr Frans Kalf. The peer review assessed the adequacy of both the hydrogeological data and the numerical model for predicting the impact from Modification 5. The peer review concluded that the hydrogeological description, conceptualisation, model design, simulations and reporting were conducted in a professional manner and described in detail. The review stated that no fatal flaws were found in the description or modelling work (AGE 2017).

The groundwater assessment also went through State and Commonwealth approval pathways and were found to have adequately addressed requirements for modelling groundwater impacts, with approval granted in 2018.

5 HVO Model Against the Current Conditions

This section presents comparison between the model inputs and results against observations over the review period.

5.1 Modelled and Actual Recharge

Figure 2 compares the actual rainfall at HVO against the rainfall simulated in the model. As discussed in the previous section rainfall long-term quarterly averages were used in the predictive model (1/12/2015 onwards). The figure shows discrepancies between the actual and modelled rainfall, with observed rainfall generally lower than modelled.

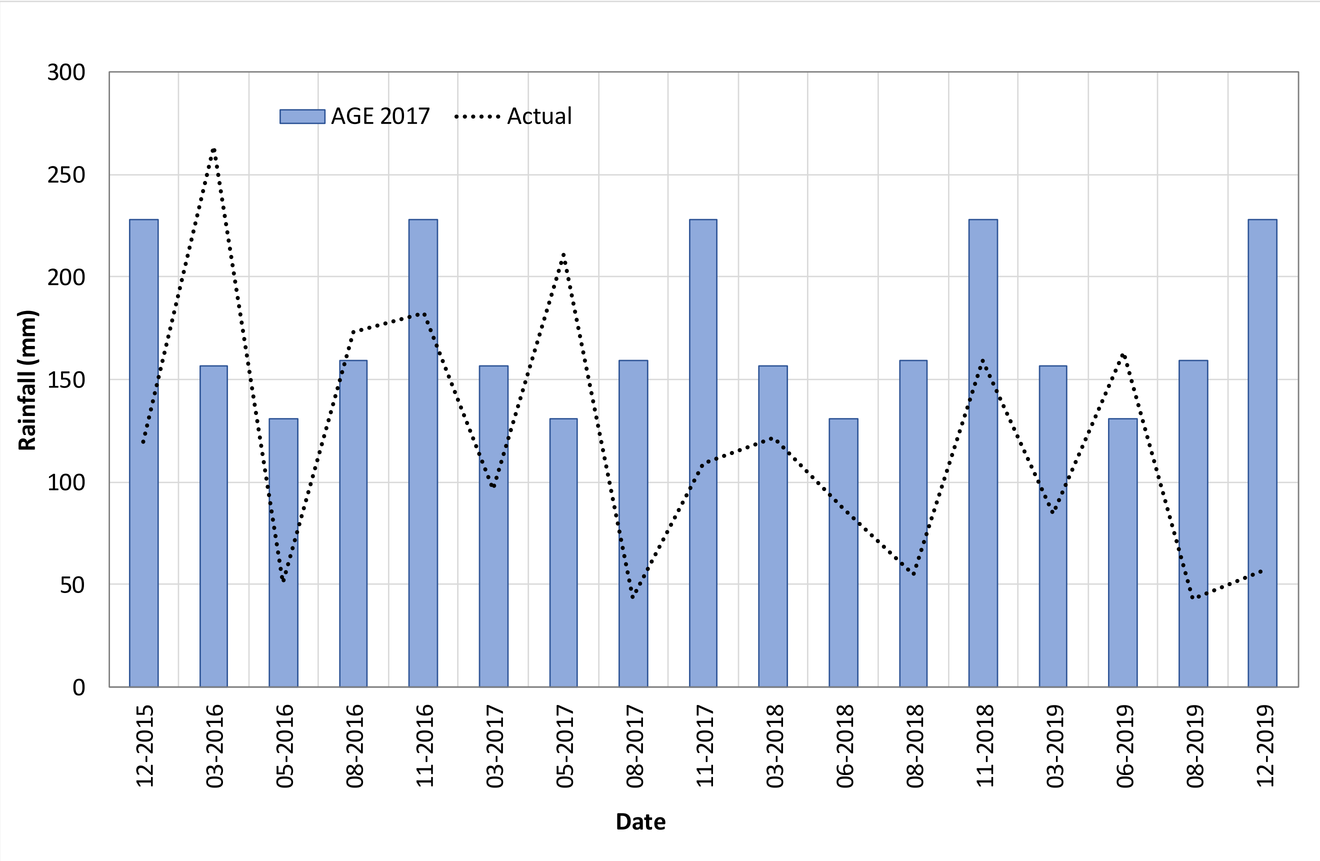


Figure 2: Modelled Rainfall against Actual Rainfall (2016-2019)

5.2 Modelled and Actual Stage Height

AGE (2017) suggests that the stream stage height in the HVO South Modification 5 model was based on interpolated gauge levels from NOW stream gauges (NSW DPI, 2014). A linear interpolation was used to the river stage heights recorded from these gauges. The interpolated stage heights were then applied to the model river cells, per stress period. As the groundwater model report has not given any details on why and how the interpolation was applied to river stage heights, it is not possible for the reviewer to comment on whether the methodology used was appropriate. Therefore, the modelled and actual river stage elevations were compared at the location of two gauging stations, Wollombi Brook at Warkworth (ID 210004) and Hunter River at Liddell (ID 210083)

Figure 3 shows a comparison between the modelled stage height and recorded stage height at Wollombi Brook at Warkworth and Hunter River at Liddell. As it is shown in the figure, the modelled stage elevations for Hunter River show negligible difference to the recorded stage elevations. The figure shows there is approximately 1 m difference between the modelled and actual stage elevations for Wollombi Brook. This difference is likely due the methodology used to calculate the stage elevations or the resolution of the regional model. Flow along the Wollombi Brook has also ceased since 2017, while the groundwater model assumed continued flow along Wollombi Brook. This creates greater recharge to the alluvium in the model compared to actual.

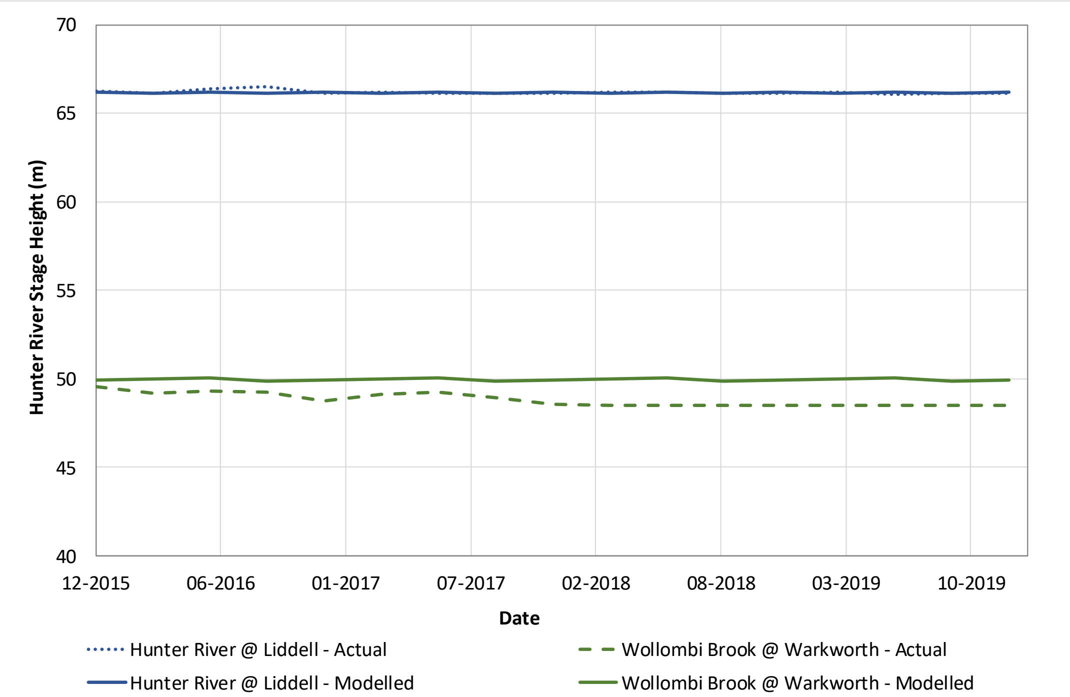
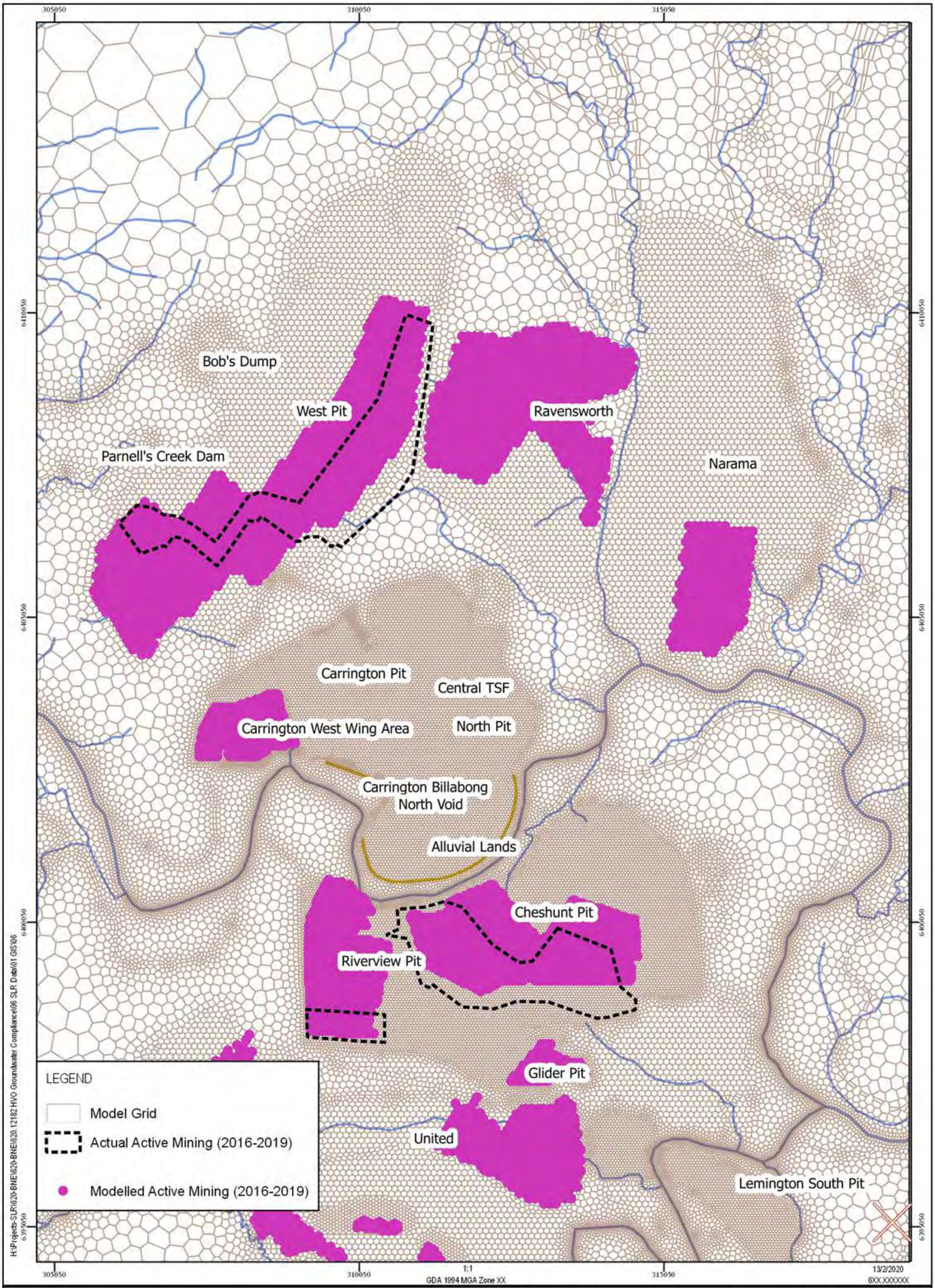


Figure 3: Modelled against Actual Stage Elevation for Hunter River @ Liddell and Wollombi Brook @ Warkworth

5.3 Modelled and Actual Stage Mine Progression

Figure 4 compares the modelled mine progression to the actual mine progression from January 2016 to December 2019. As shown in the figures, there are mismatches between the actual and modelled mine progression in several areas of the model. The modelled active mining between January 2016 and December 2019 covers a larger area comparing to the actual mine progression and it also has different shapes.



Sheet Size: A4

0 2 4 6 m

SLR

www.slrconsultingaustralia.com.au PH: 61 7 3858 4800

Actual Mine Progression against Modelled Mine Progression

FIGURE 4

5.4 Calibration Hydrographs

The calibration data set was updated with the latest recorded water levels at HVO bores. However, re-calculation of the calibration statistics was not possible as the reviewer did not have access to the calibration files and the weights applied to the calibration points. Therefore, the model calibration was assessed by comparing the updated hydrographs to the hydrographs in AGE (2017).

Appendix A shows the regenerated hydrographs for the calibration bores listed in the AGE (2017). Overall, the model has been able to replicate the response of groundwater levels to the mining activities and seasonality from 2016 to the present day. The hydrographs for HVO bores show a general over prediction in water level drawdowns most likely due to the modelled mine progression covering a bigger area in comparison to the actual mine progression as discussed in **Section 5.3.** Some of the hydrographs show poor match between simulated and observed water levels, indicating that calibration in those areas could be further improved.

The hydrographs of the alluvial bores around Lamington, such as Appleyard Farm bore, show that the model is still underpredicting the starting groundwater levels in alluvium, and is not able to match the declining trends in water levels over recent years (**Figure 5**). The declining trends in the bore is likely due to Wollombi Brook being dry from 2017. As discussed in **Section 5.2,** the groundwater model assumed streamflow exists in Wollombi Brook between 2016 and December 2019.

In most of the bores within the Hunter River alluvium, the model continues to replicate response to climate seasonality reasonably well. An exception to this is bores CGW39 and 4034P, which both have groundwater level drawdown predicted, as shown in **Figure 6** and **Figure 7**. Both bores are located within the footprint of the approved Carrington West Wing, which is included in the model as being actively mined while mining has not actually commenced.

The Permian bores located to the south of West Pit and Carrington West Wing area also show an overall over-prediction of water level drawdowns. These is shown in **Figure 8** where the simulated water level in bore CGW46 is declining due to mining while the observed water levels is stable. Mismatches as such in the model appear to be to discrepancies between the modelled mine progression and actual mine progression, discussed in **Section 5.3**.

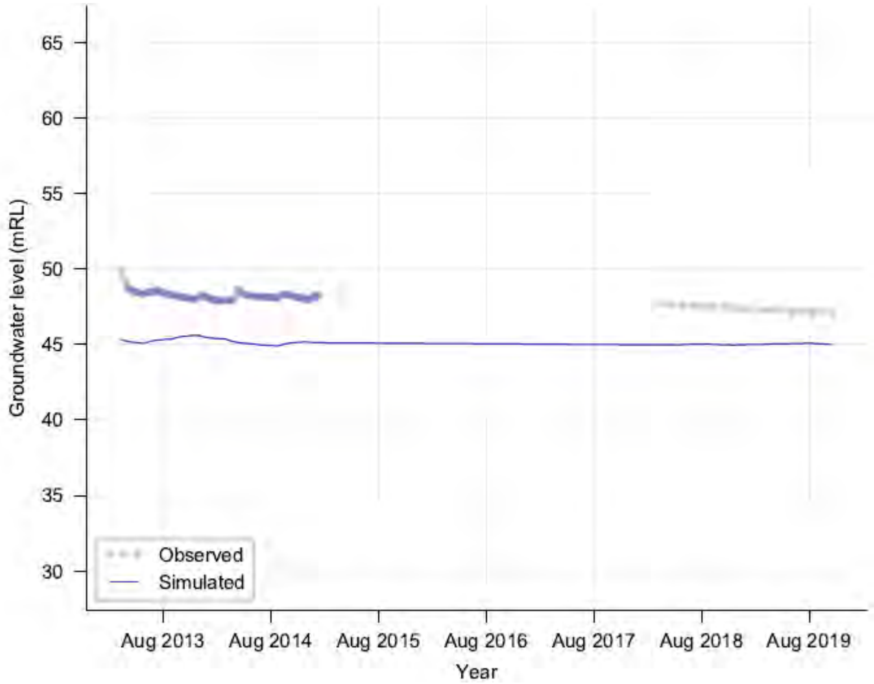


Figure 5: Calibration Hydrograph for Appleyard Farm Bore – Wollombi Brook Alluvium

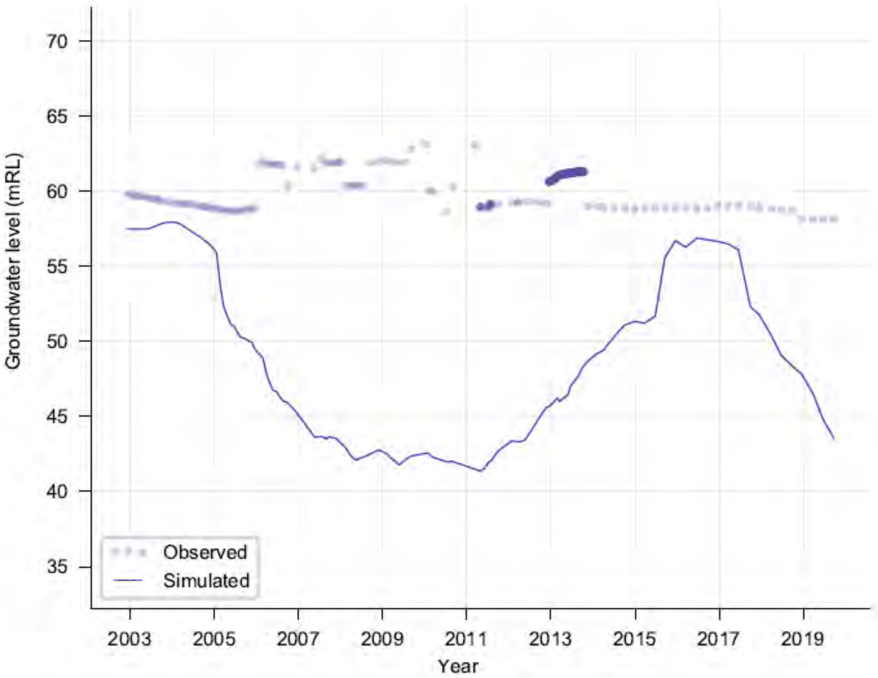


Figure 6: Calibration Hydrograph for Bore CGW39

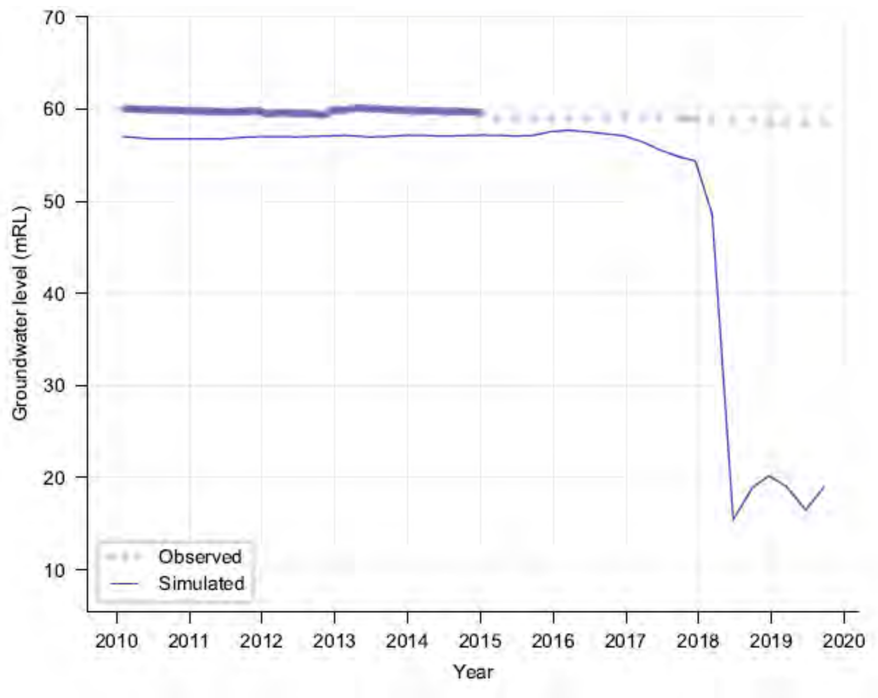


Figure 7: Calibration Hydrograph for Bore 4034P

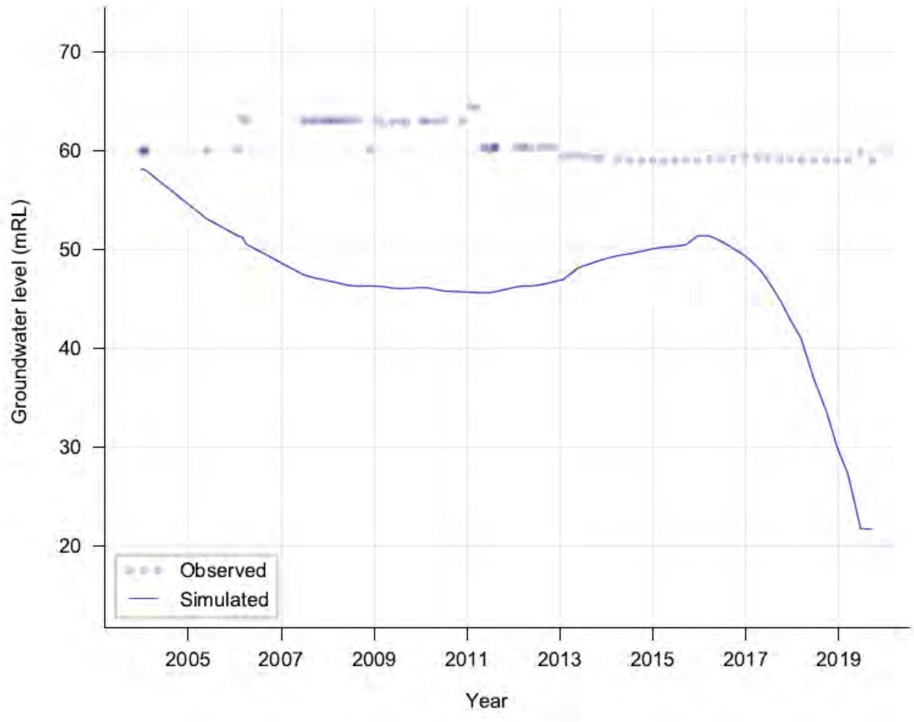


Figure 8: Calibration Hydrograph for Bore CGW46

6 Conclusions and Recommendations

The hydrogeological description, conceptualisation and model design of AGE's 2016 groundwater model were revisited and reviewed. As a part of the review process, the modelled recharge, stream stage heights and mine progression were compared against the actual data for 2016 to present time.

The review of the model files showed minor discrepancies between modelled rainfall and river stage heights between 2016 and present day. The review showed differences between mine progression and the actual measurements in different areas of the model domain. The modelled mined area between January 2016 to December 2019 covers a larger than the actual mine area which has likely resulted in overpredicted of groundwater drawdowns.

To calibration data base was updated to include latest measurements up to December 2019. The calibration hydrographs were regenerated. The reviewer was not able to re-calculate the calibration statistics based on the updated calibration data base. Therefore, the model calibration was assessed by comparing the updated hydrographs to the original hydrographs reported in AGE (2017). The updated calibrated hydrographs indicated that despite the discrepancies, the model calibration is still satisfactory.

The overall match between observed and measured levels in the transient calibration is reasonable. However, in some areas of the model domain (i.e., Carrington West Wing area and Lemington Pit) the match between observed and simulated heads is some of the bores is poor with the model predicting more impact than captured by observed water levels. This is likely due to the discrepancies between the actual mine progression and modelled progression and the model not being able to represent these mining activities adequately.

As an overall conclusion, this reviewer considers the hydrogeological description, the conceptualisation of the groundwater system and the numerical model design and the numerical model calibration are still fit for purpose. Given the scale of the discrepancies comparing to the regional scale of the model, the reviewer believes updates to the model to remove the discrepancies will result in insignificant changes to the model predictions. However, groundwater models should periodically be evolved, updated and assessed when new data is available. The reviewer believes updating the mine progression in the model to match the actual mine progression is likely to improve the calibration statistics and hydrographs. Therefore, the reviewer recommends the following updates to the groundwater model:

- Update to Recharge Package (RCH): Update to include to the latest rainfall measurement at site;
- Update to River Package (RIV): Update to include to the latest river stage height measurements at gauging stations 210083 and 210004;
- Update to Drain Package (DRN) and Time-Variant Materials (TVM): Update to ensure modelled and actual mine progressions match; and
- Re-calculate transient calibration statistics and assess the calibration performance.

Yours sincerely

Dr. Arash Mohajeri
Associate Groundwater Modeller

Checked/ Authorised by: IE

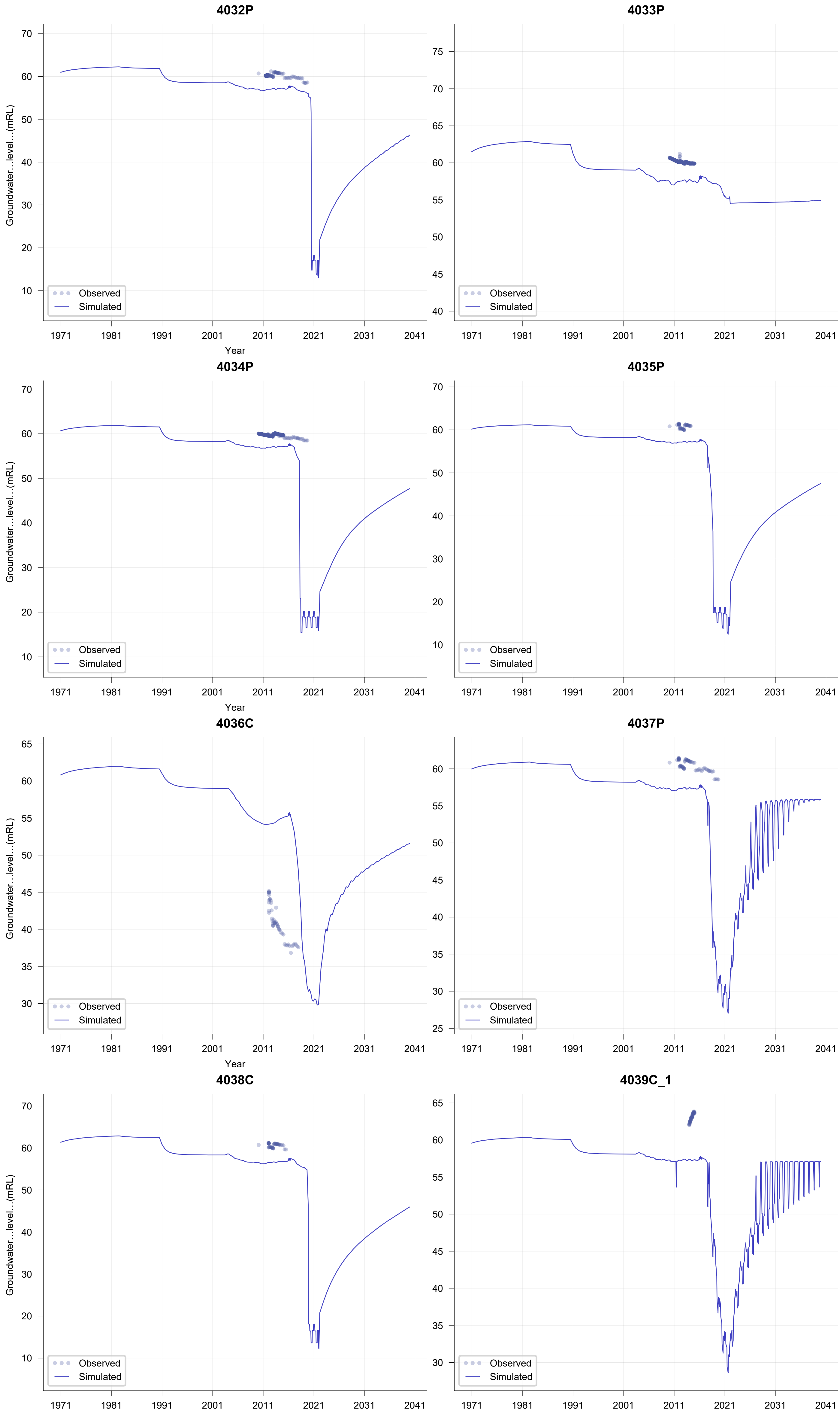
7 References

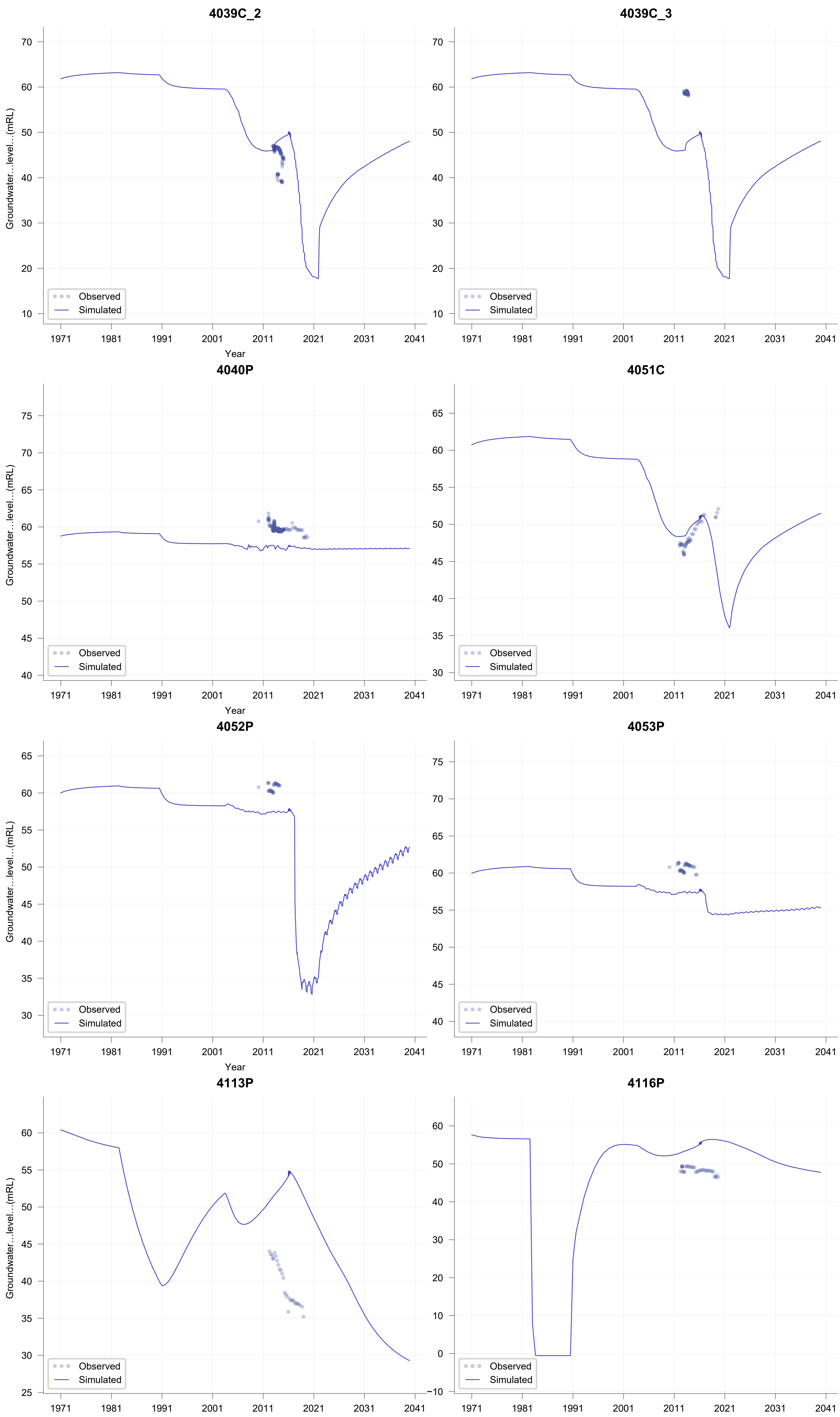
Australasian Groundwater and Environmental Consultants 2016 for Hunter Valley Operations South – Modification 5- Environmental Assessment, Appendix G, Groundwater Study–January 2017.

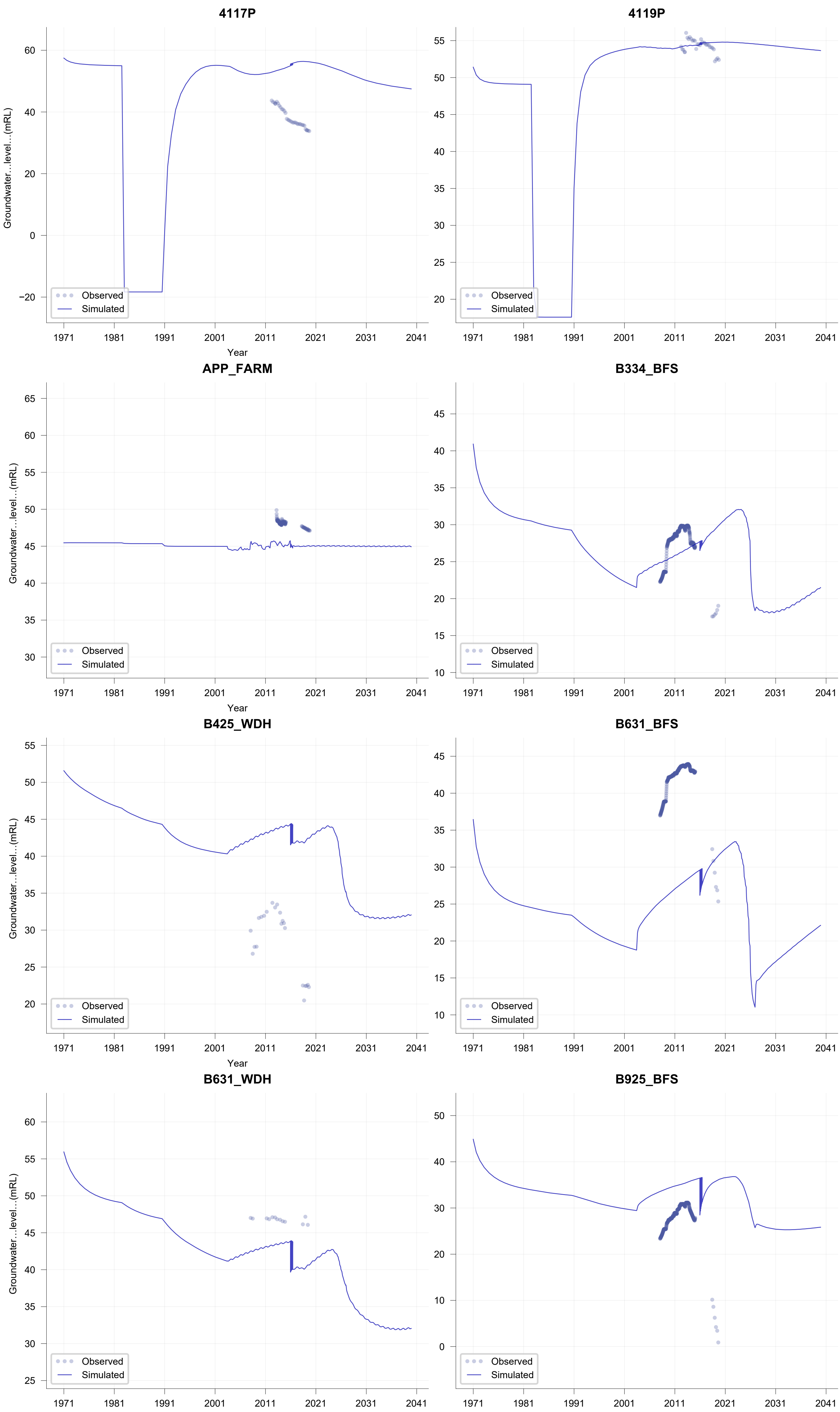
MDBC (2001), Groundwater Flow Modelling Guideline, Murray-Darlin Basin Commission, URL: https://www.mdba.gov.au/sites/default/files/archived/mdbc-GW-reports/2175_GW_flow_modelling_guideline.pdf

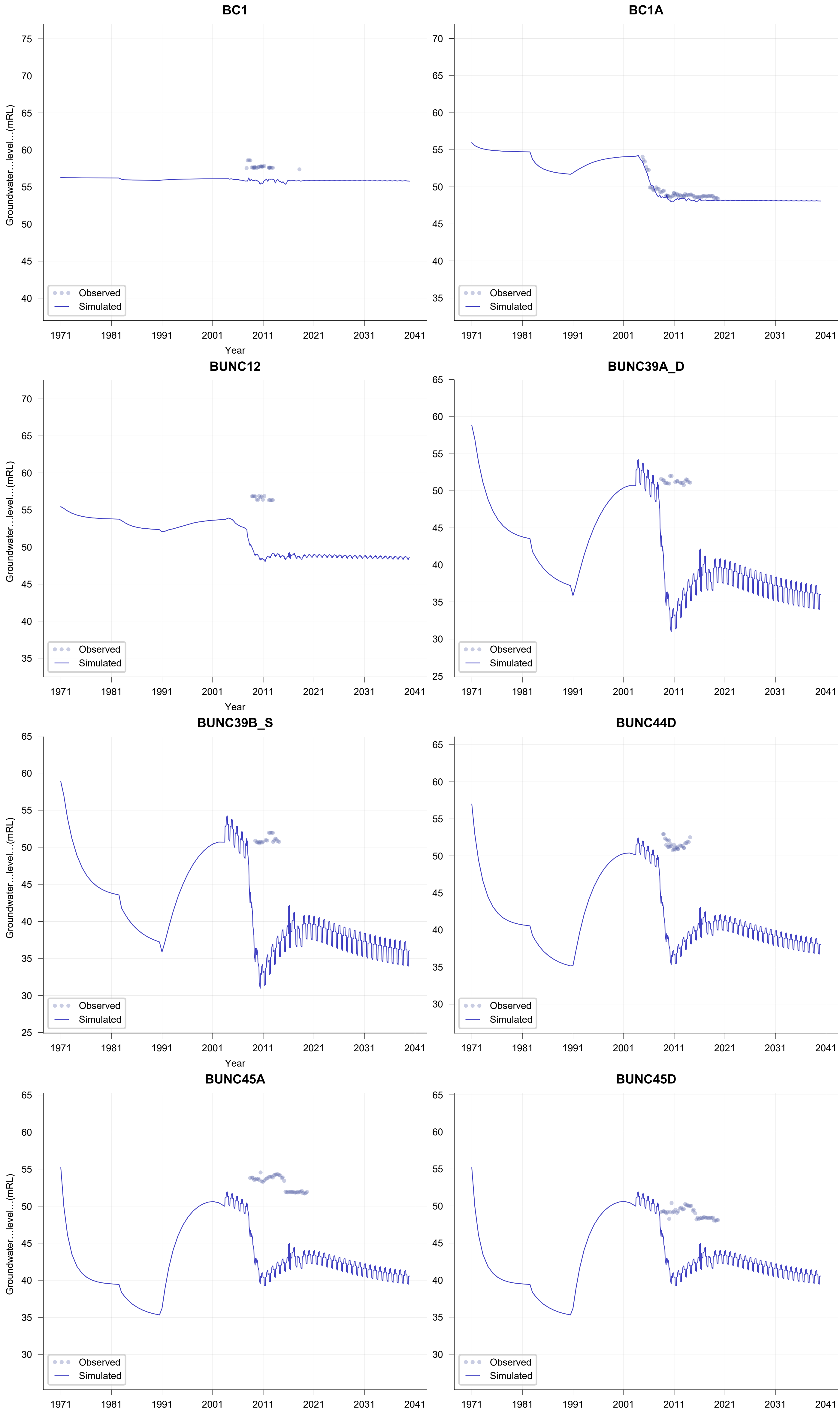
APPENDIX A

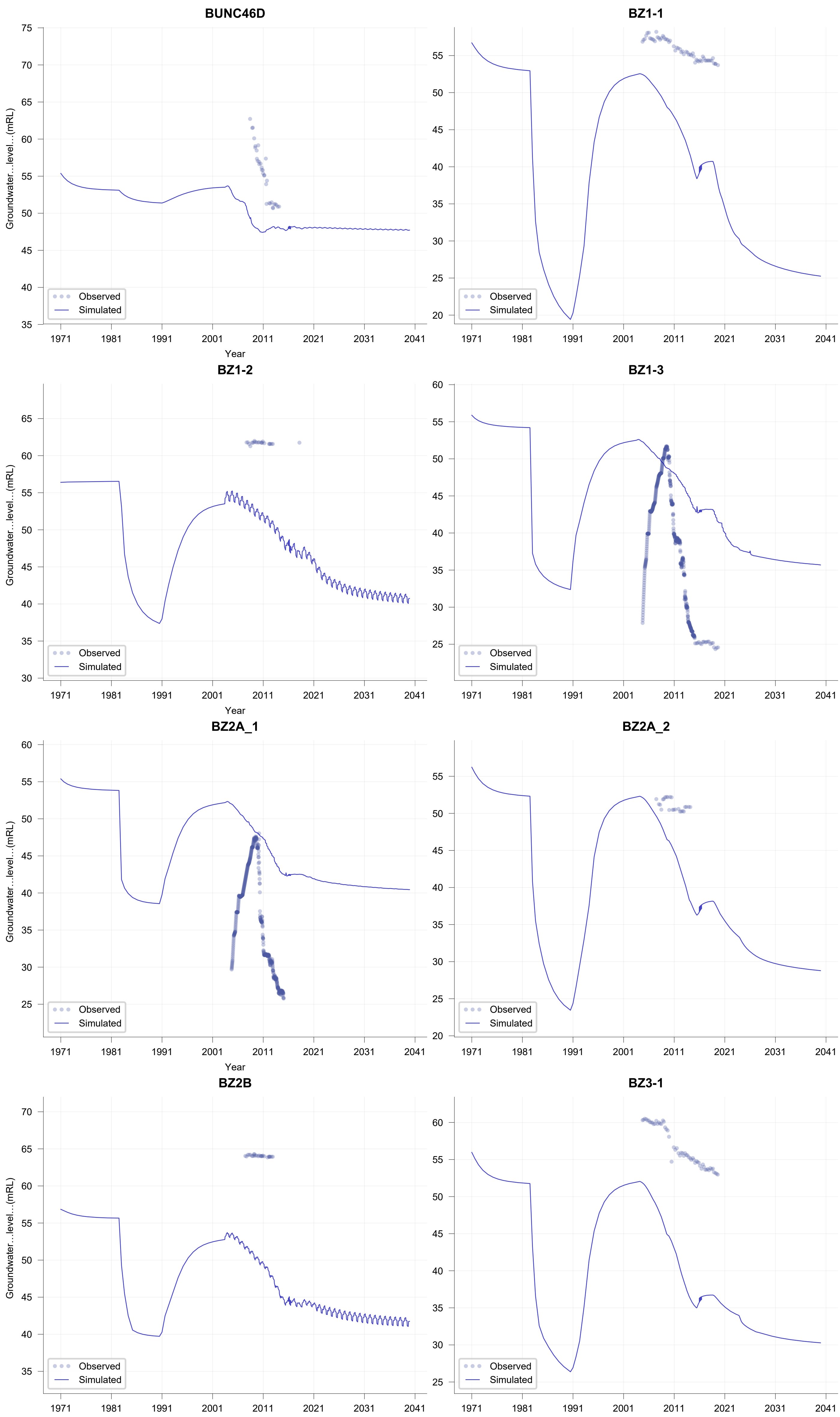
Calibration Hydrographs

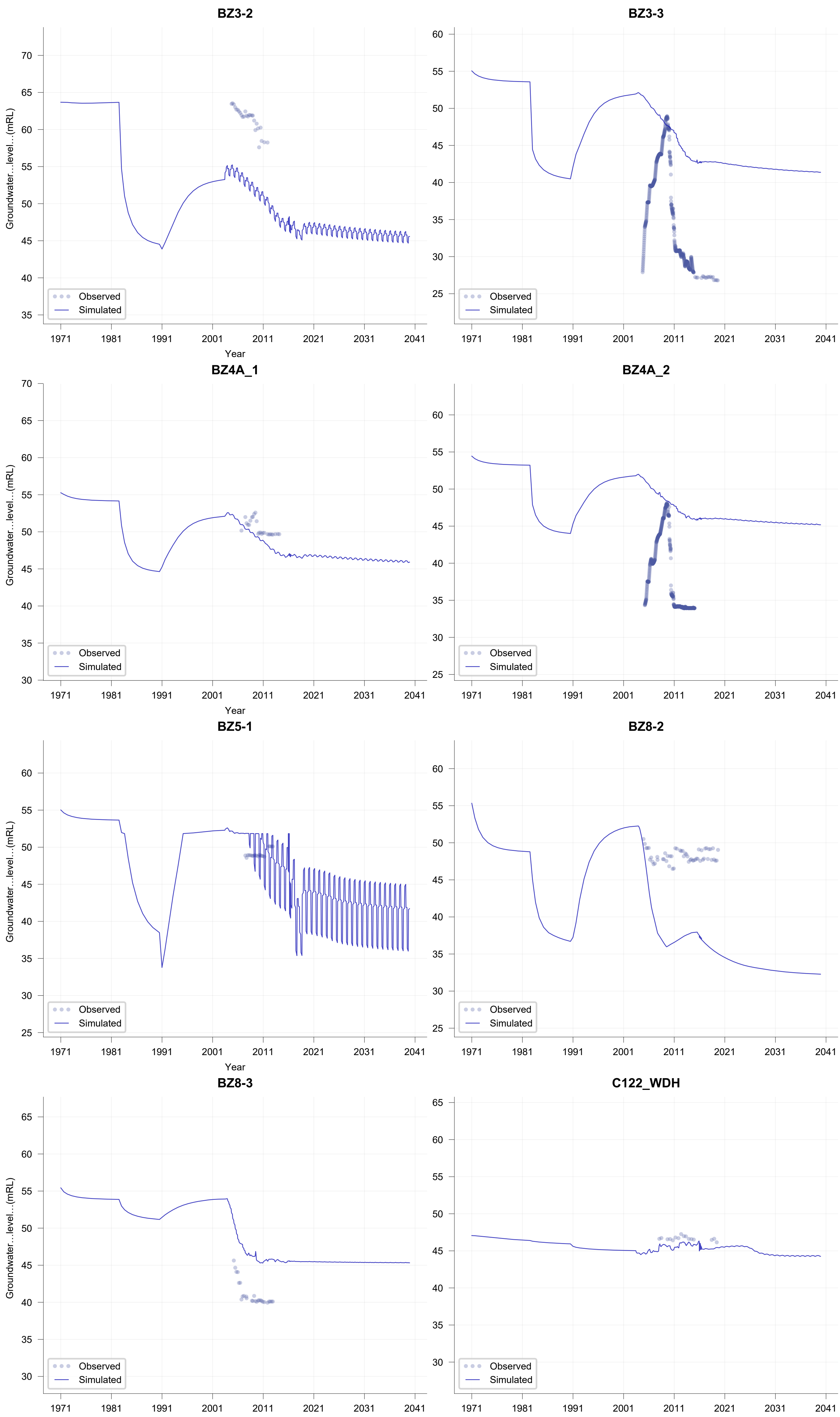

4032P
4033P
4034P
4035P
4036C
4037P
4038C
4039C_1
Groundwater...level...(mRL)
Year
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041

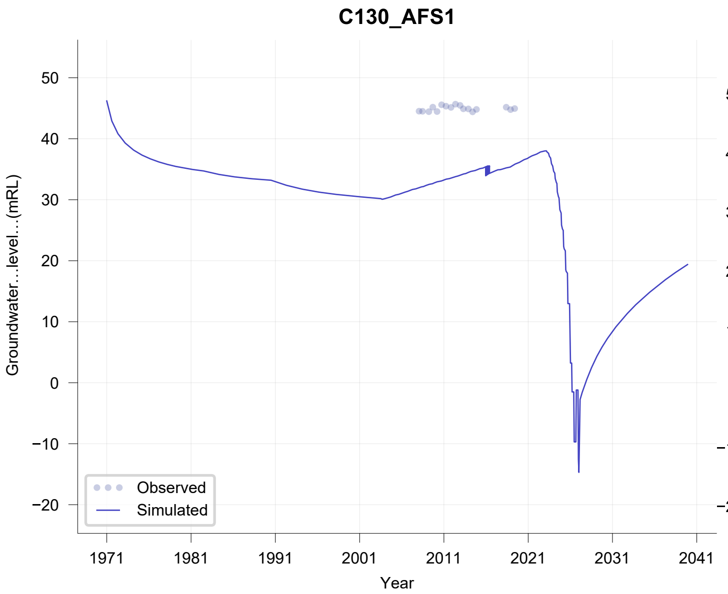

4039C_2
4039C_3
4040P
4051C
4052P
4053P
4113P
4116P
Groundwater...level...(mRL)
Year
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041

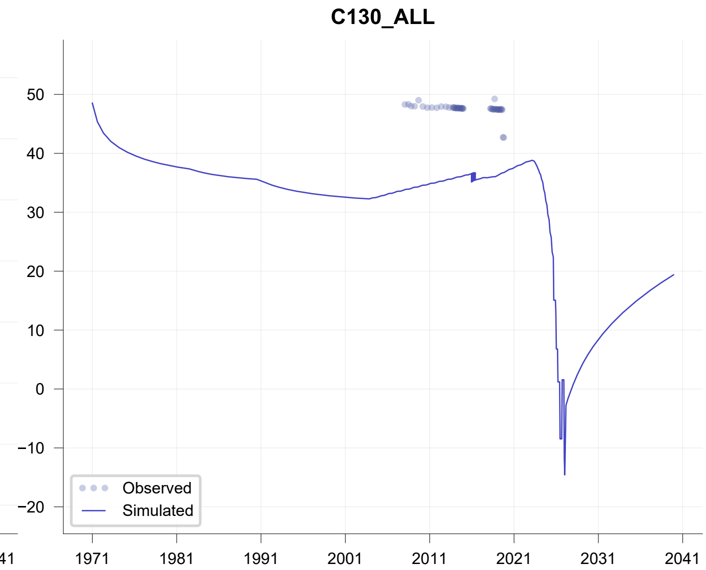

4117P
4119P
APP_FARM
B334_BFS
B425_WDH
B631_BFS
B631_WDH
B925_BFS
Groundwater...level...(mRL)
Year
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041

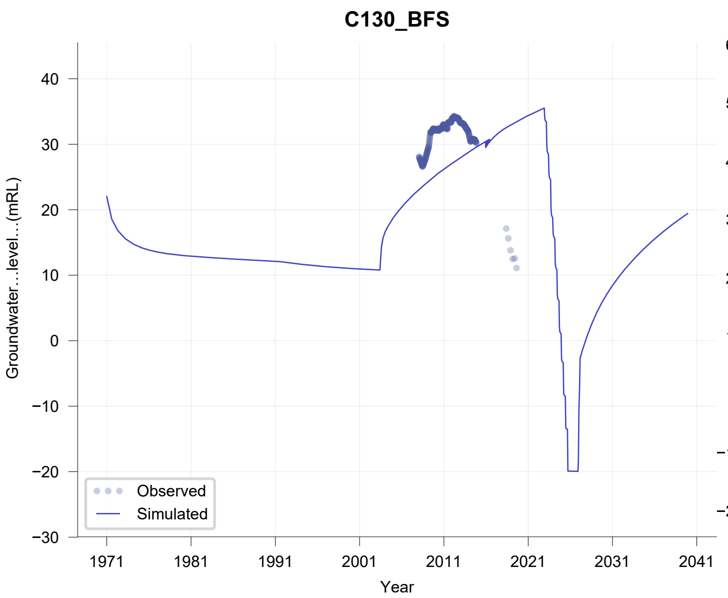

BC1
BC1A
BUNC12
BUNC39A_D
BUNC39B_S
BUNC44D
BUNC45A
BUNC45D
Groundwater...level...(mRL)
Year
1971
1981
1991
2001
2011
2021
2031
2041
Observed
Simulated

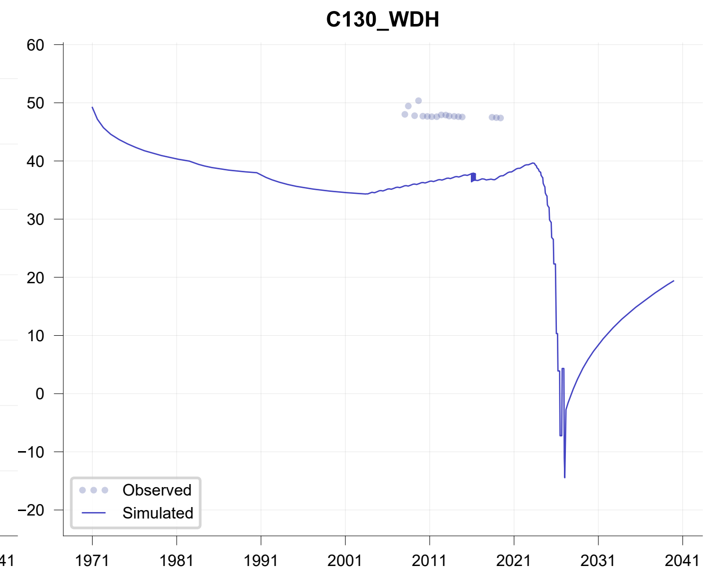

BUNC46D
BZ1-1
BZ1-2
BZ1-3
BZ2A_1
BZ2A_2
BZ2B
BZ3-1
Groundwater...level...(mRL)
Year
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041

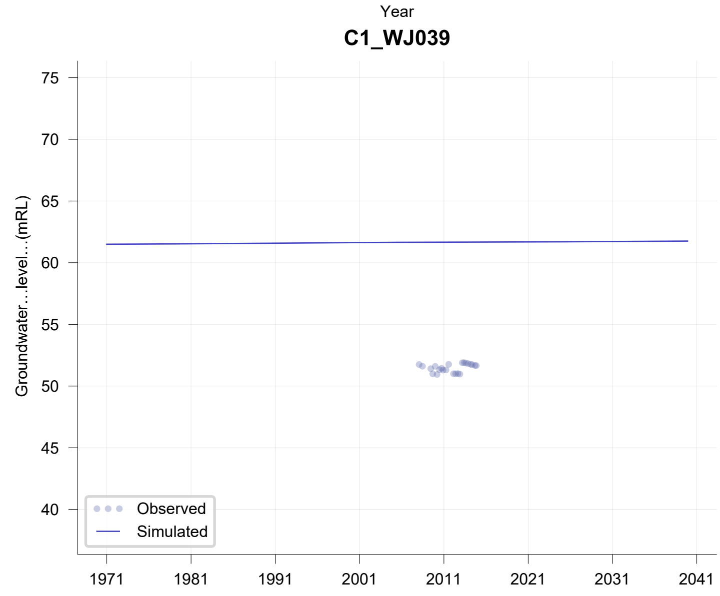

BZ3-2
BZ3-3
BZ4A_1
BZ4A_2
BZ5-1
BZ8-2
BZ8-3
C122_WDH
Groundwater...level...(mRL)
Year
Observed
Simulated
1971 1981 1991 2001 2011 2021 2031 2041

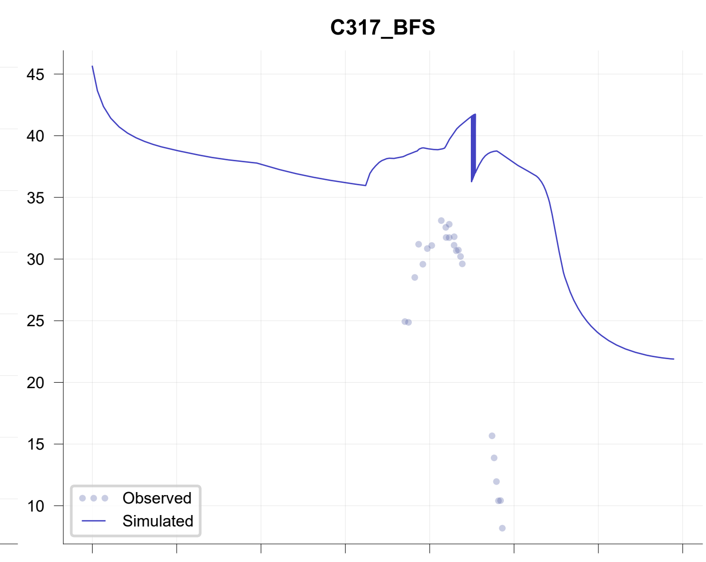

C130_AFS1
Groundwater...level...(mRL)
Year
Observed
Simulated

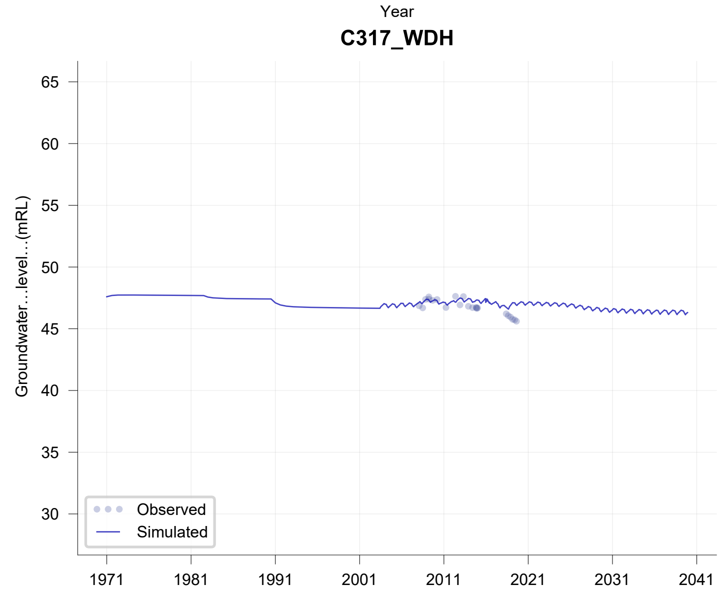

C130_ALL
Observed
Simulated

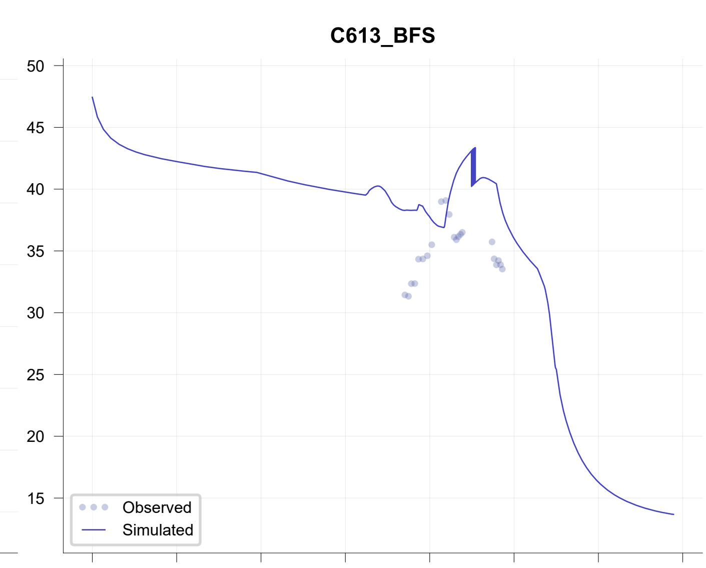

C130_BFS
Groundwater...level...(mRL)
Year
Observed
Simulated

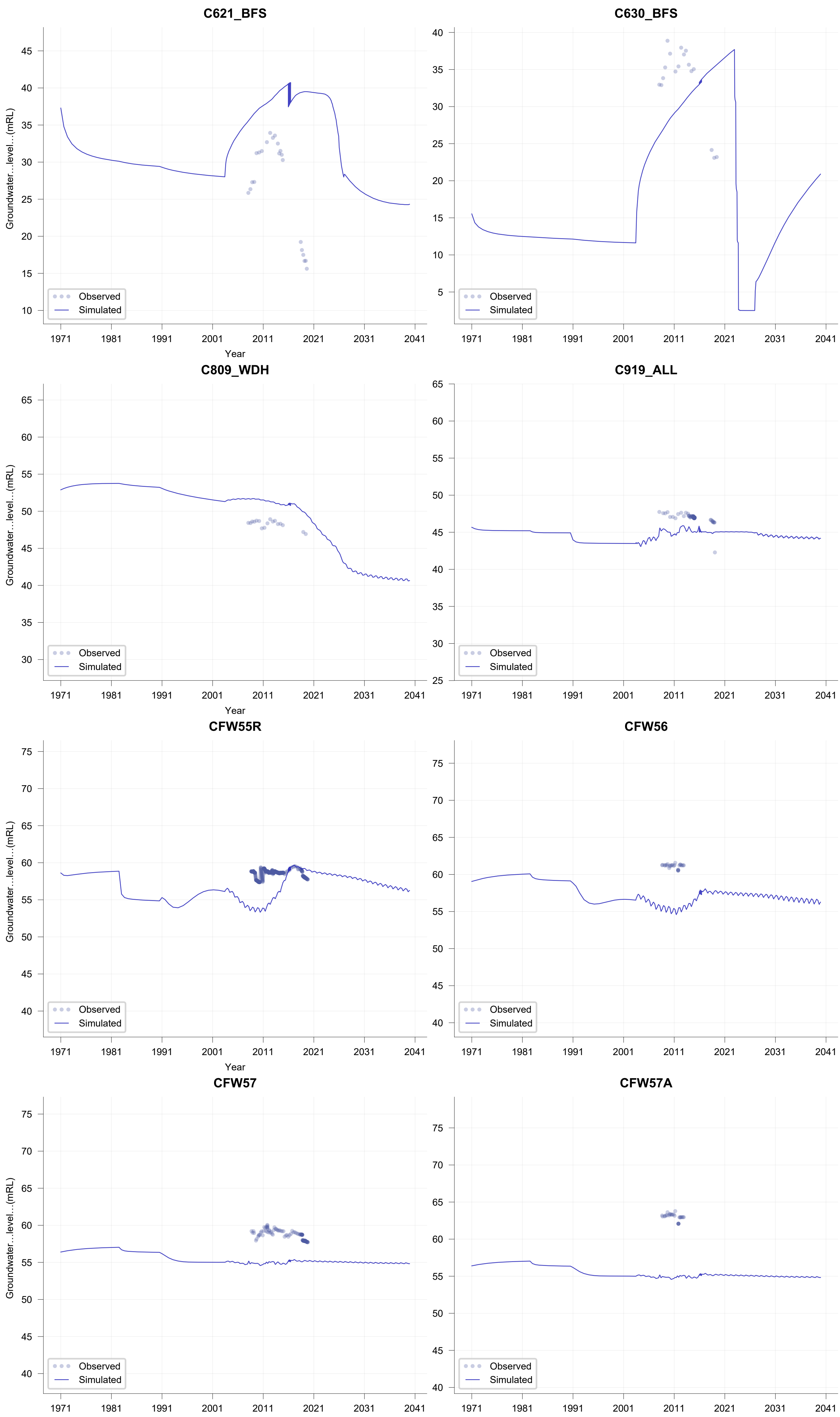

C130_WDH
Observed
Simulated


C1_WJ039
Groundwater...level...(mRL)
Year
Observed
Simulated

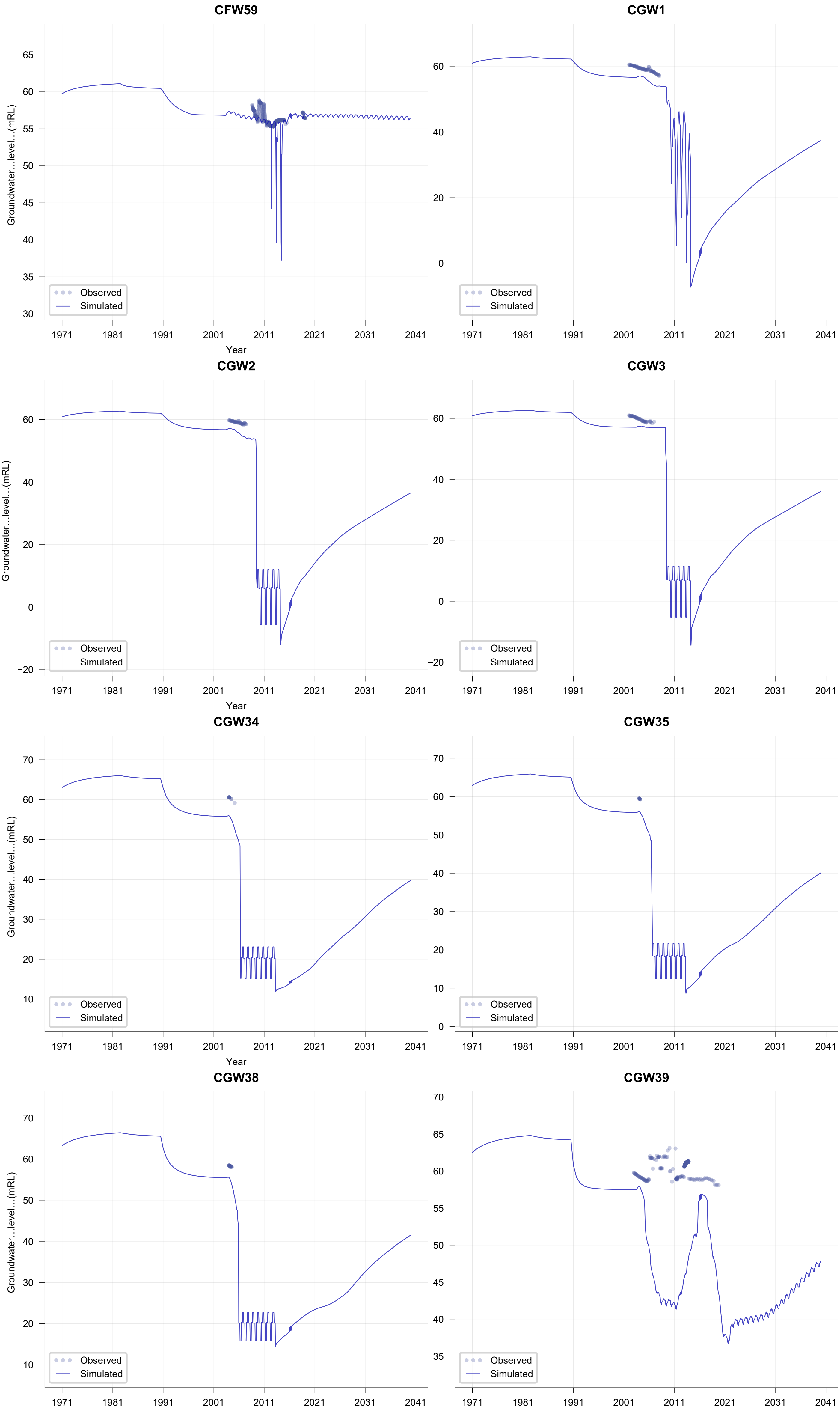

C317_BFS
Observed
Simulated

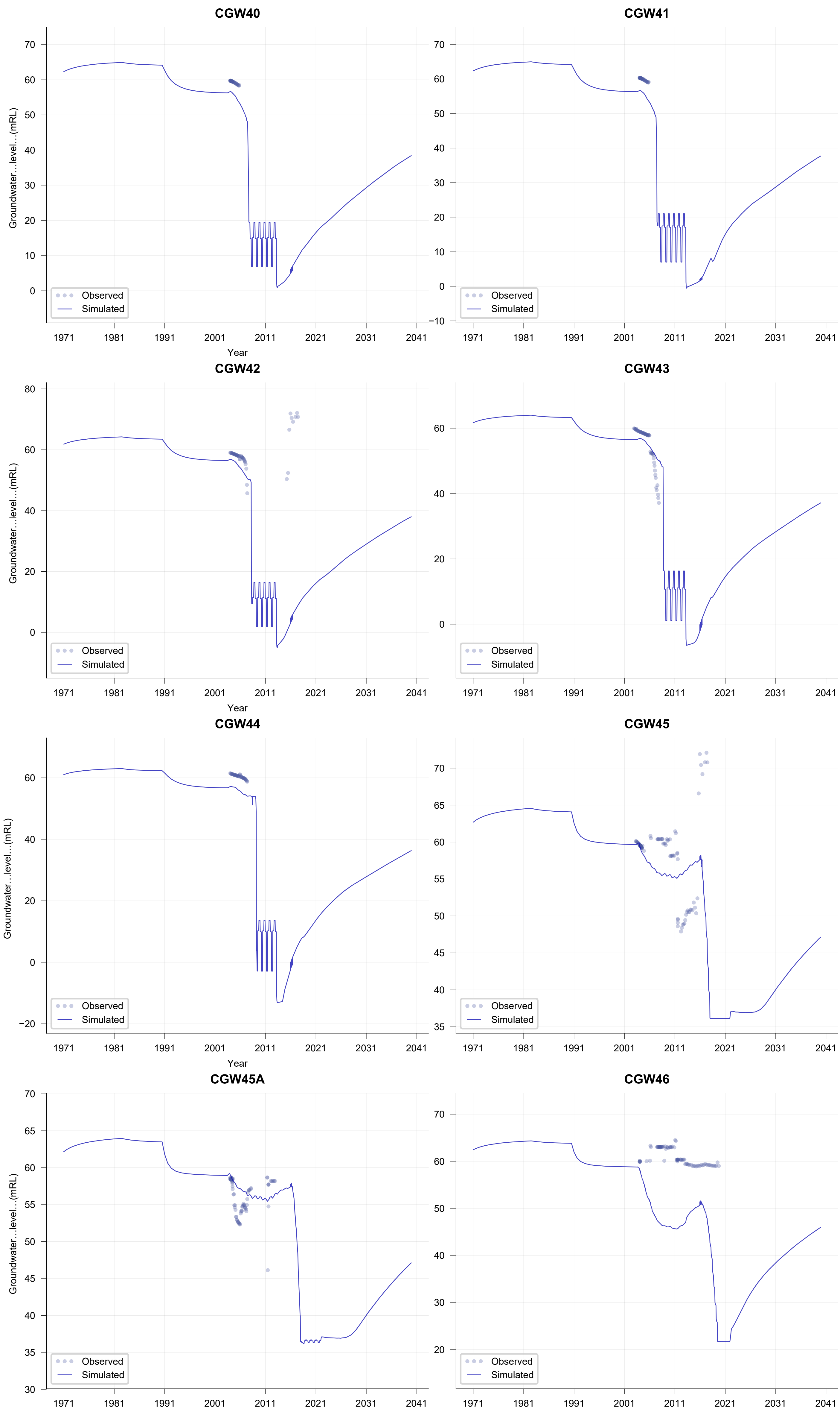

C317_WDH
Groundwater...level...(mRL)
Year
Observed
Simulated

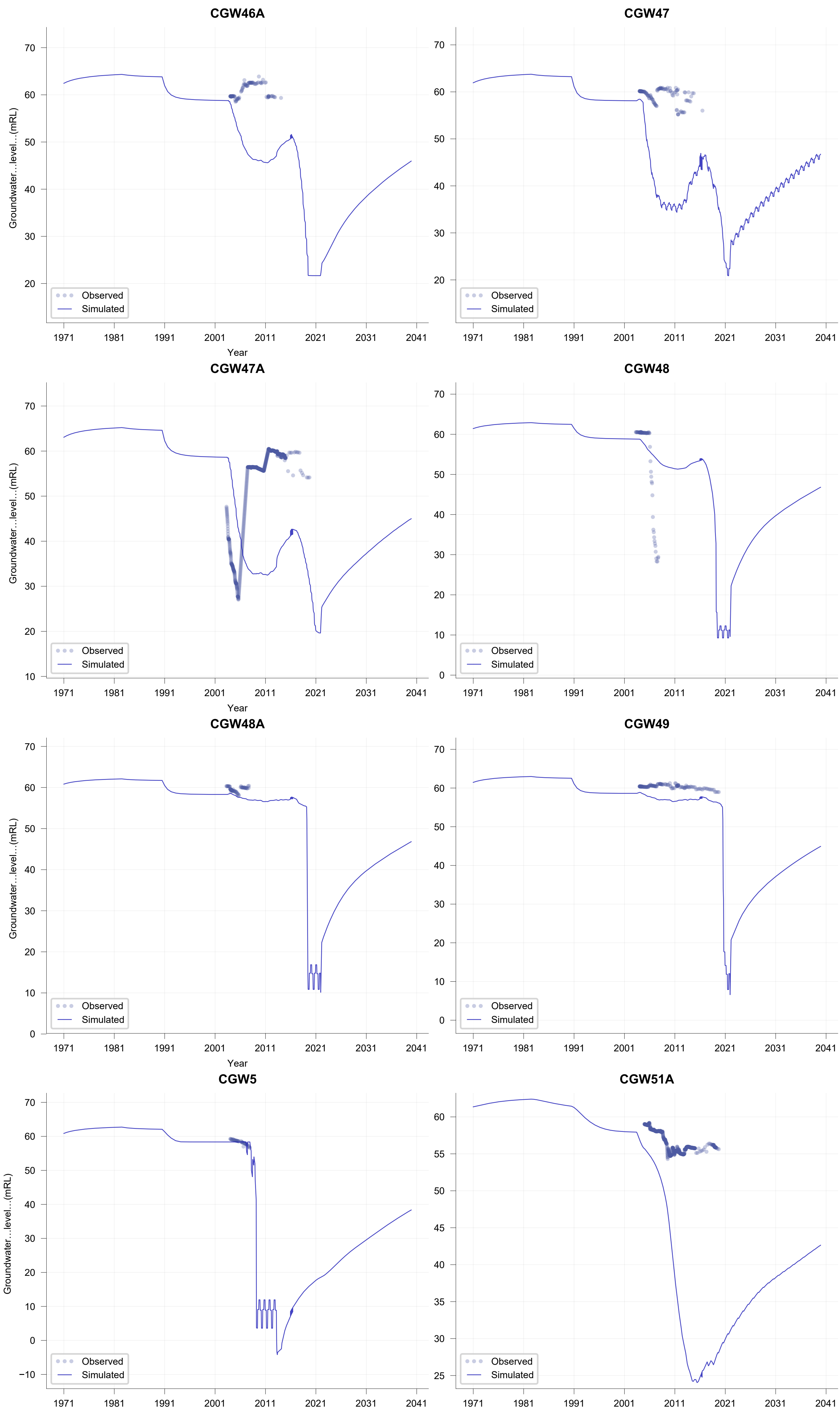

C613_BFS
Observed
Simulated

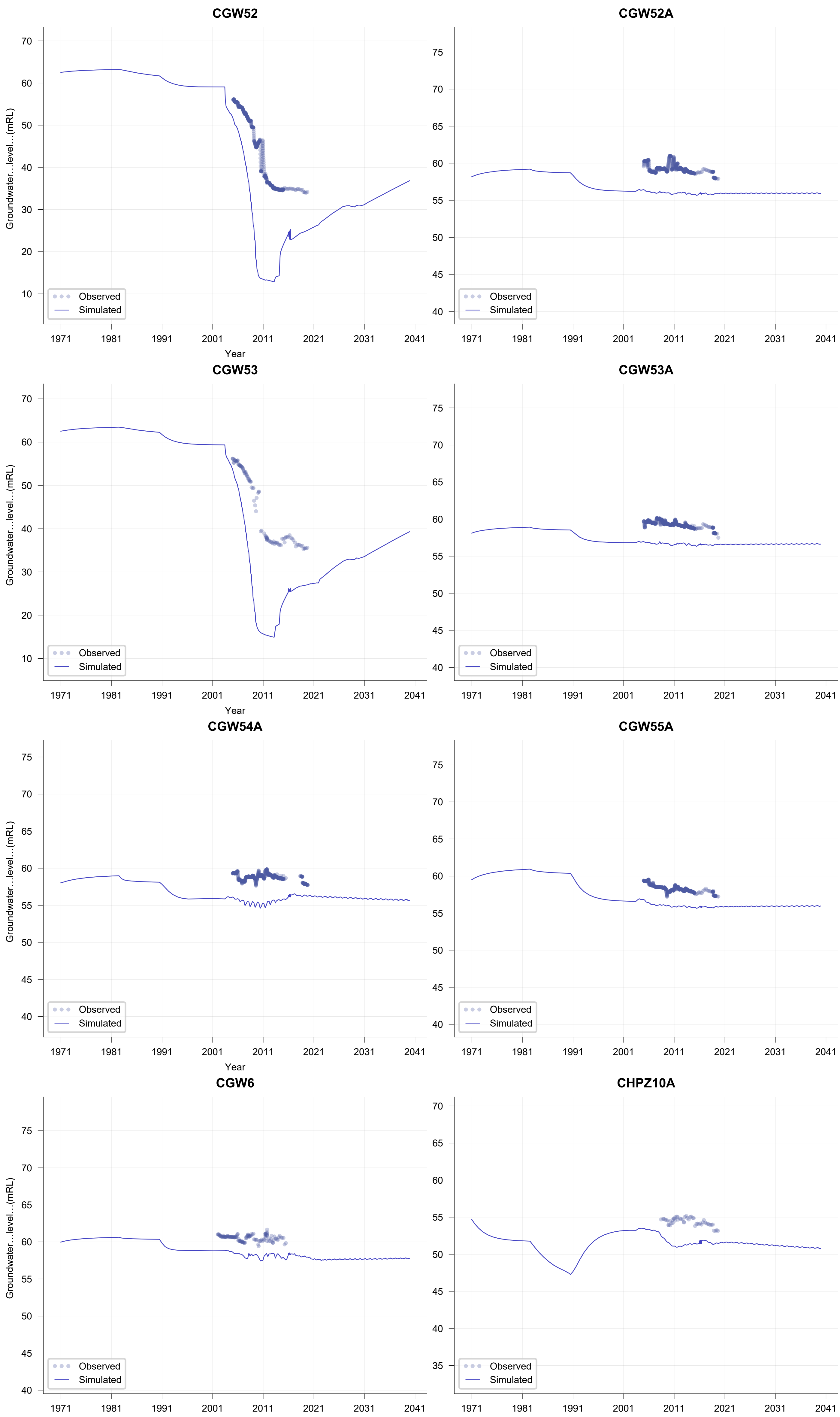


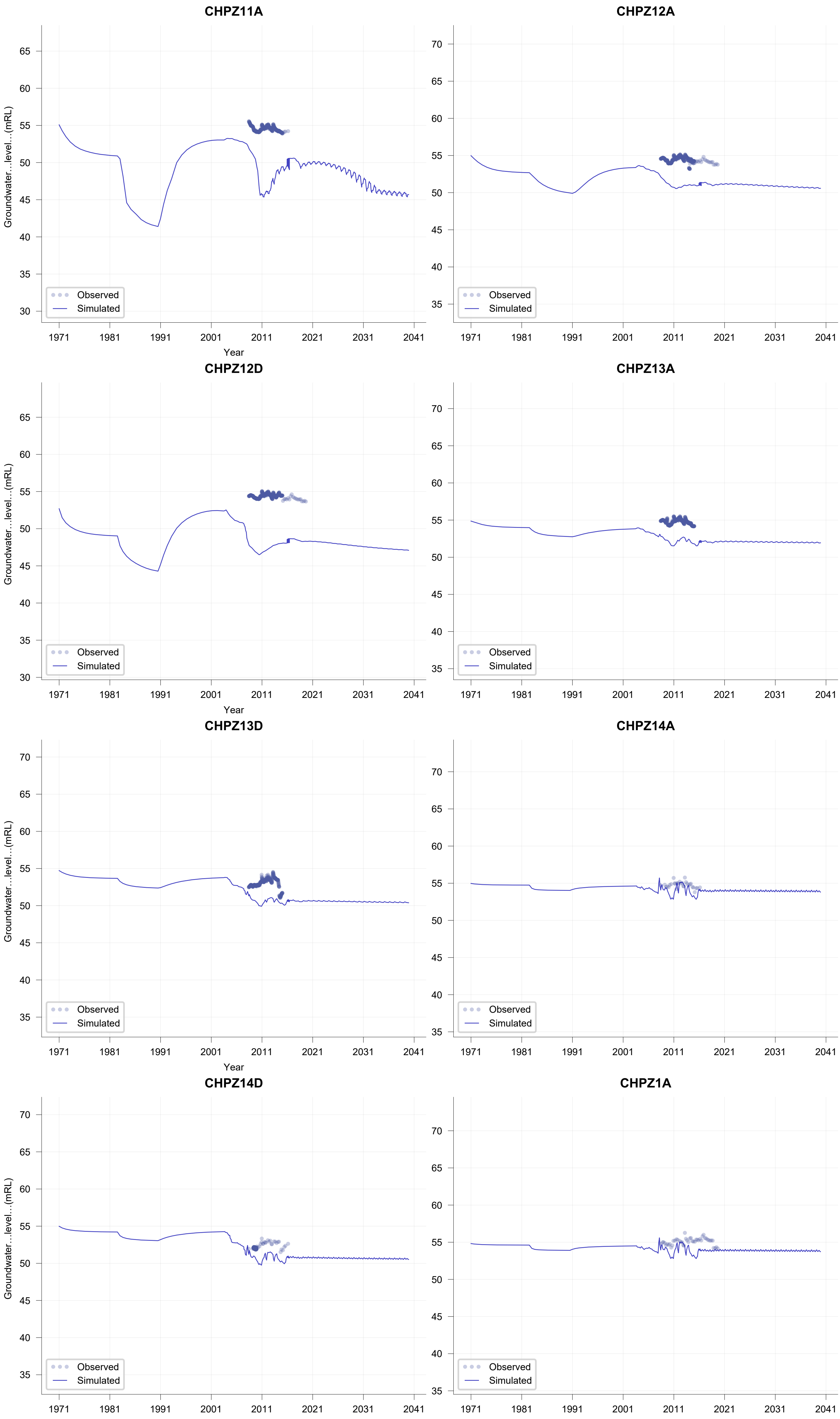
C621_BFS
C630_BFS
C809_WDH
C919_ALL
CFW55R
CFW56
CFW57
CFW57A
Groundwater...level...(mRL)
Year
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041

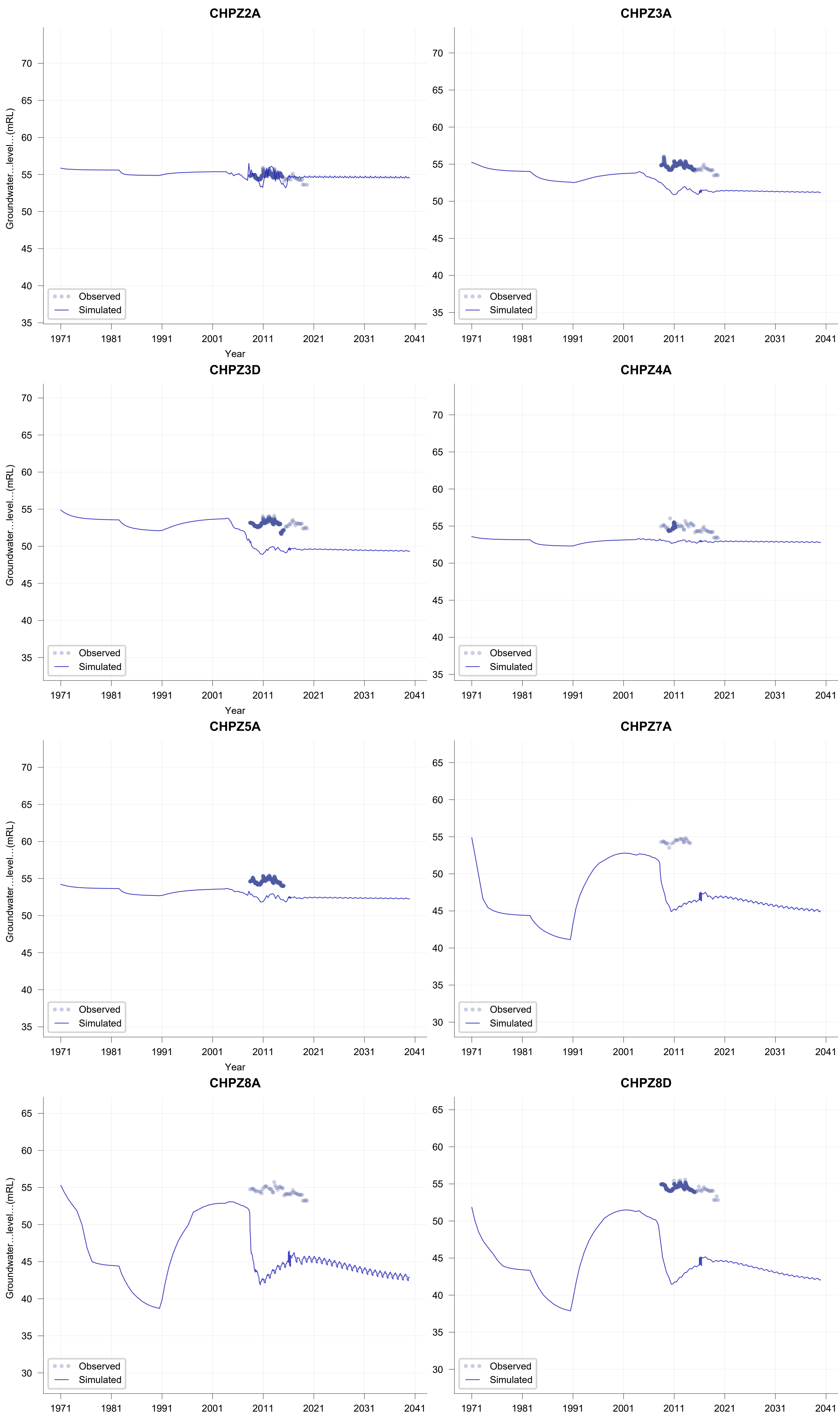

CFW59
CGW1
CGW2
CGW3
CGW34
CGW35
CGW38
CGW39
Groundwater...level...(mRL)
Year
1971
1981
1991
2001
2011
2021
2031
2041
Observed
Simulated

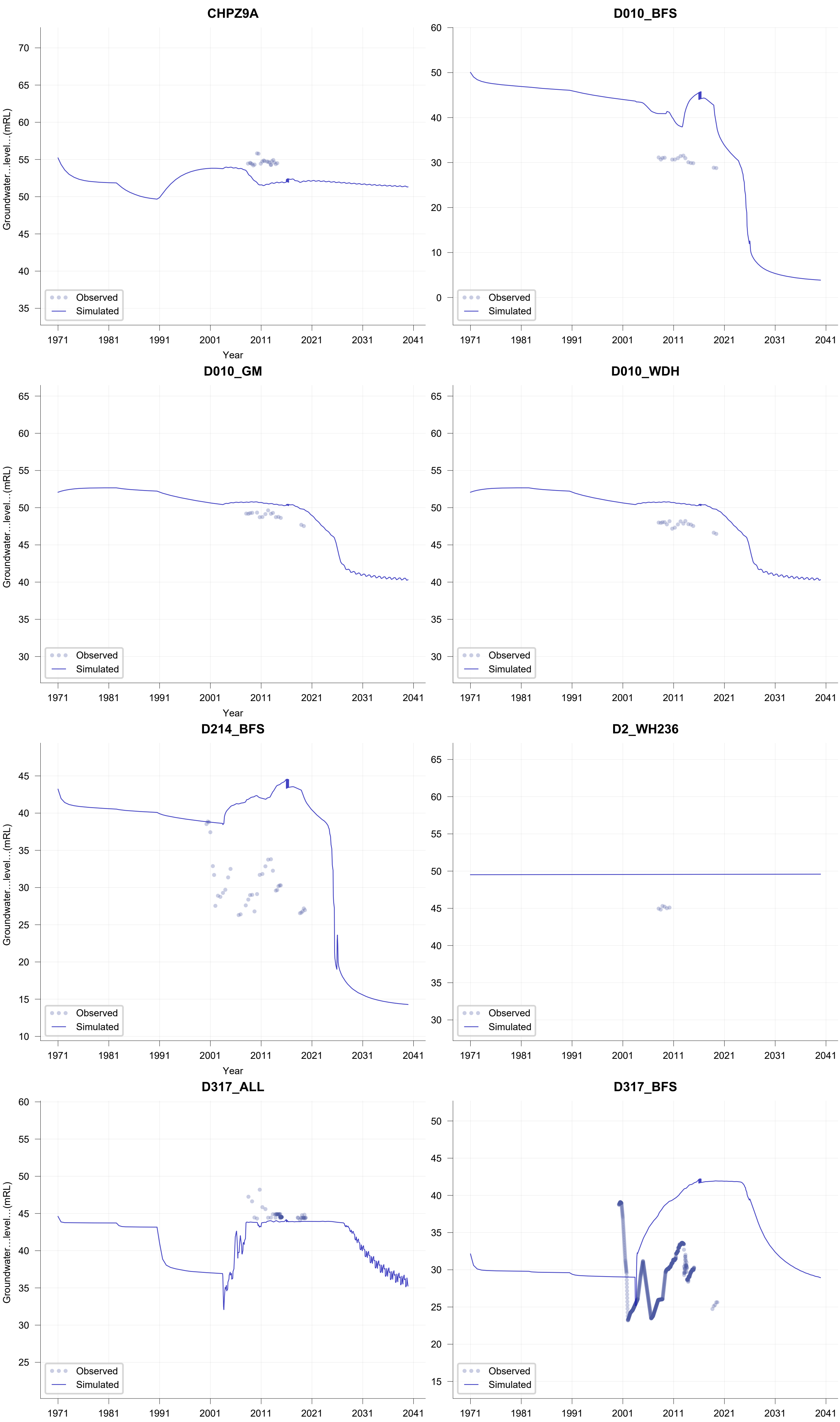

CGW40
CGW41
CGW42
CGW43
CGW44
CGW45
CGW45A
CGW46
Groundwater...level...(mRL)
Year
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041


CGW46A
CGW47
CGW47A
CGW48
CGW48A
CGW49
CGW5
CGW51A
Groundwater...level...(mRL)
Year
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041

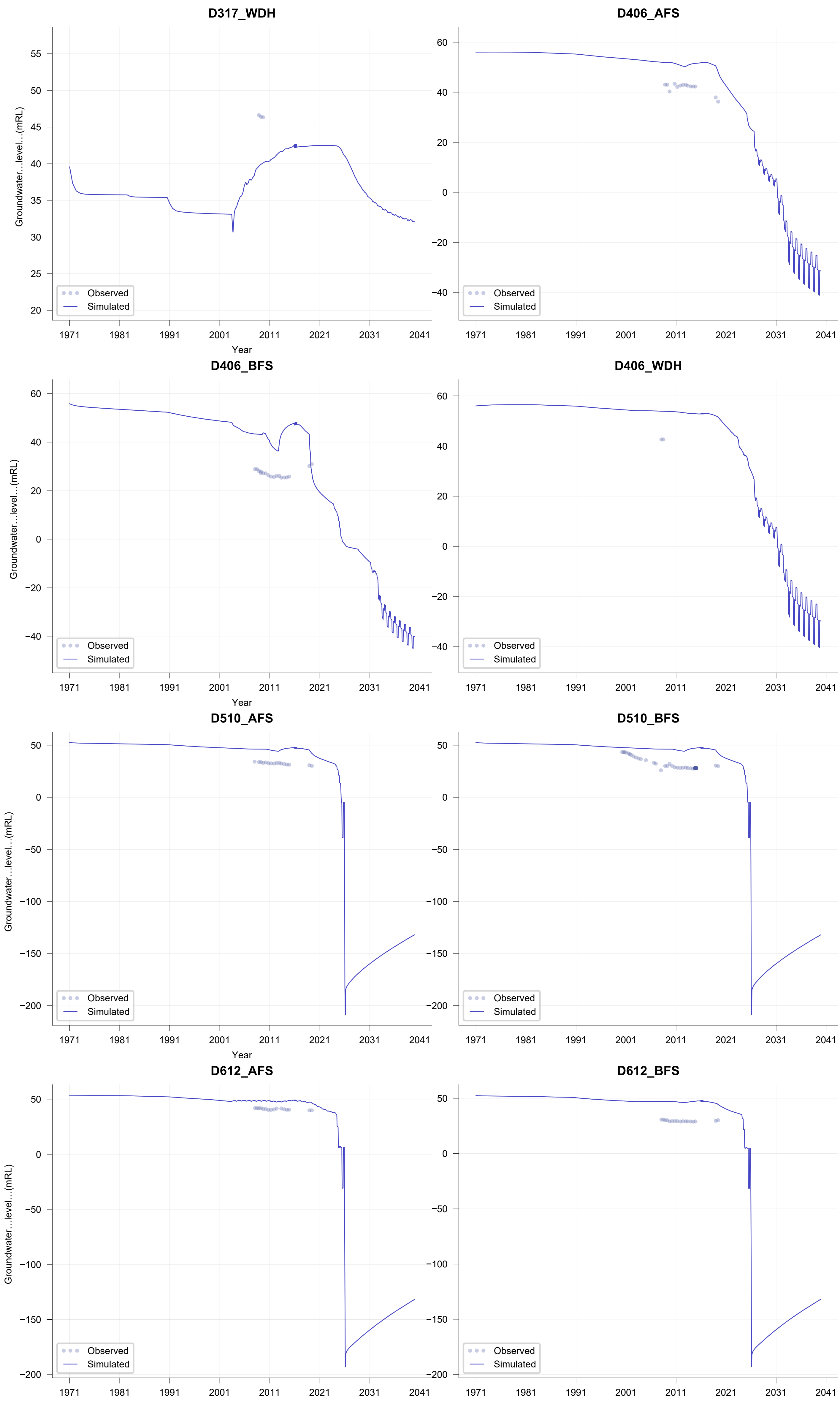

CGW52
Groundwater...level...(mRL)
Observed
Simulated
Year
CGW52A
Observed
Simulated
CGW53
Groundwater...level...(mRL)
Observed
Simulated
Year
CGW53A
Observed
Simulated
CGW54A
Groundwater...level...(mRL)
Observed
Simulated
Year
CGW55A
Observed
Simulated
CGW6
Groundwater...level...(mRL)
Observed
Simulated
Year
CHPZ10A
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041

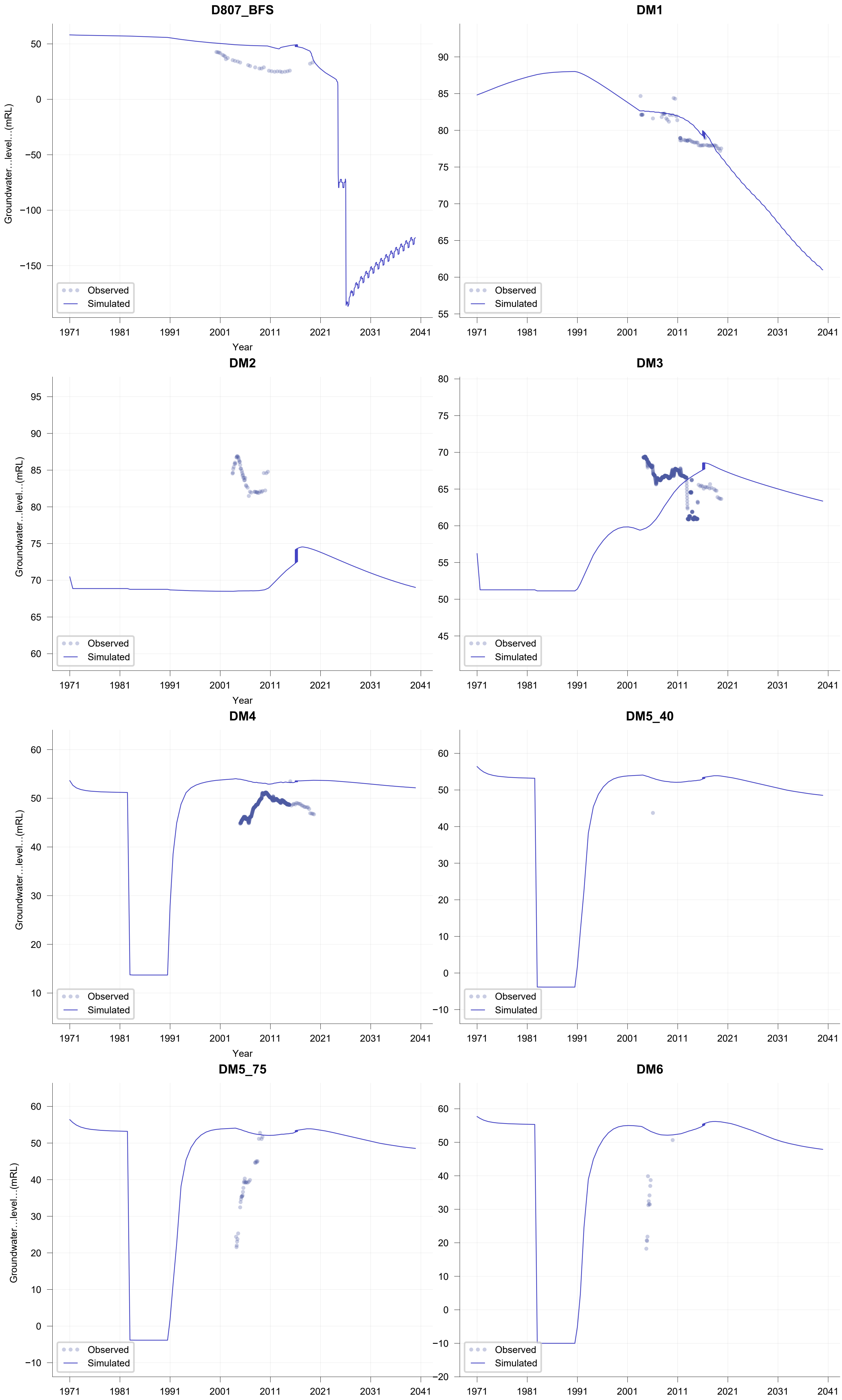

CHPZ11A
CHPZ12A
CHPZ12D
CHPZ13A
CHPZ13D
CHPZ14A
CHPZ14D
CHPZ1A
Groundwater...level...(mRL)
Year
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041
30
35
40
45
50
55
60
65
70


CHPZ2A
CHPZ3A
CHPZ3D
CHPZ4A
CHPZ5A
CHPZ7A
CHPZ8A
CHPZ8D
Groundwater...level...(mRL)
Year
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041

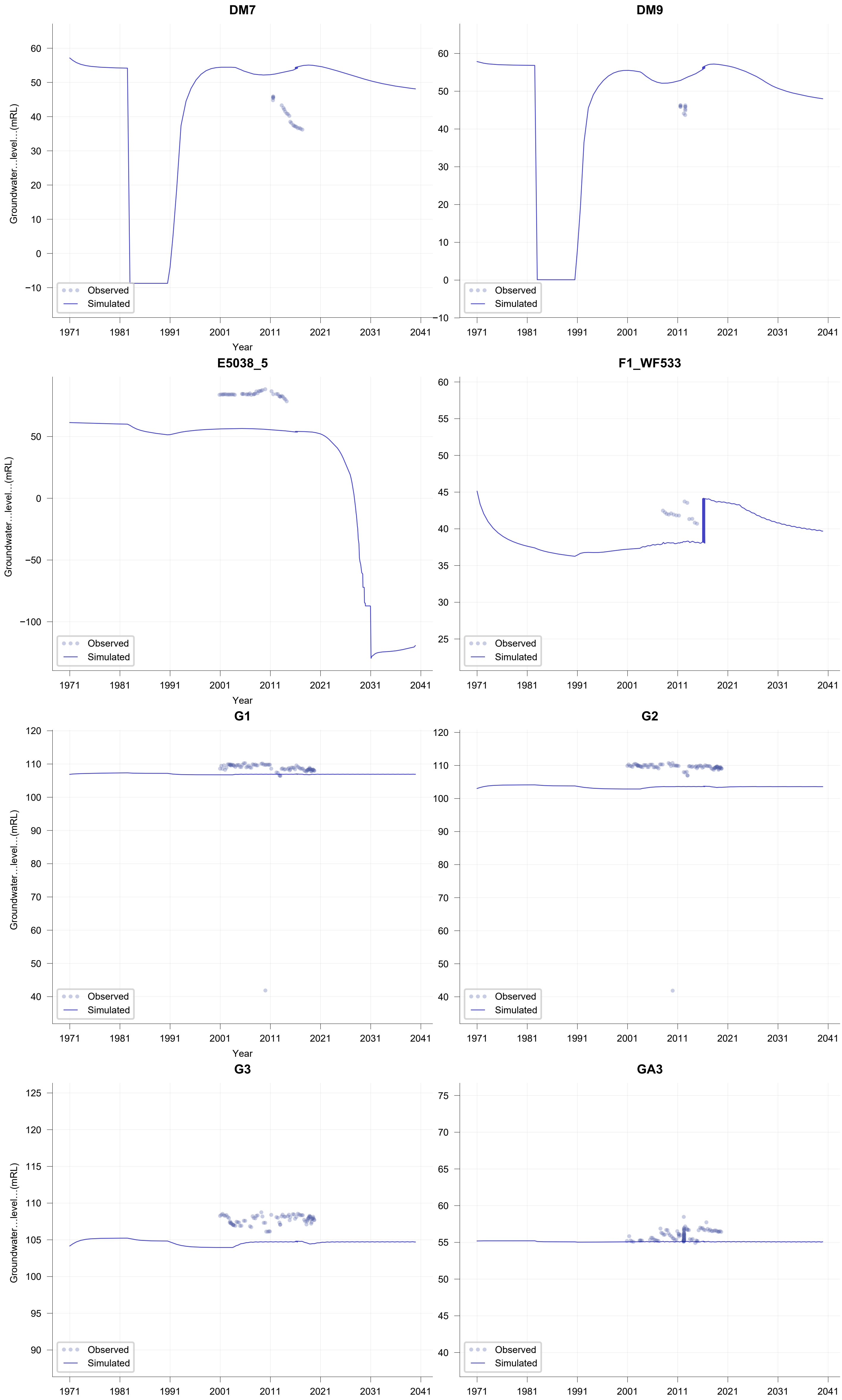


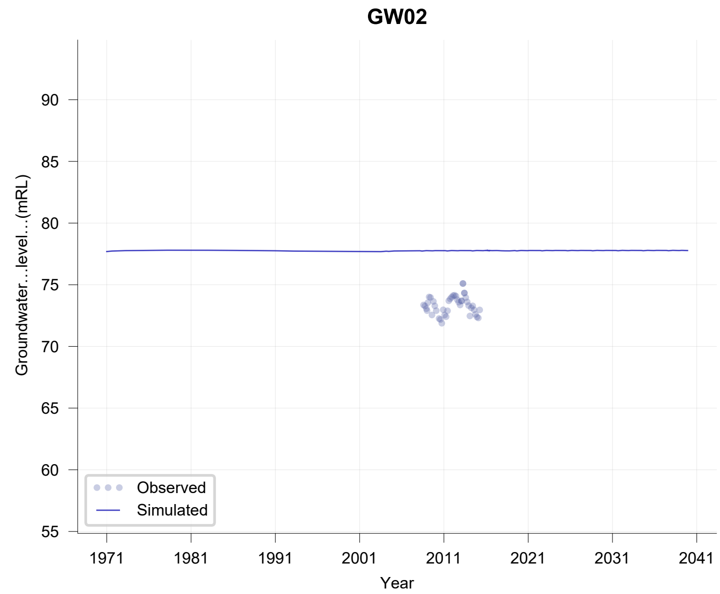
CHPZ9A
D010_BFS
D010_GM
D010_WDH
D214_BFS
D2_WH236
D317_ALL
D317_BFS
Groundwater...level...(mRL)
Year
Observed
Simulated

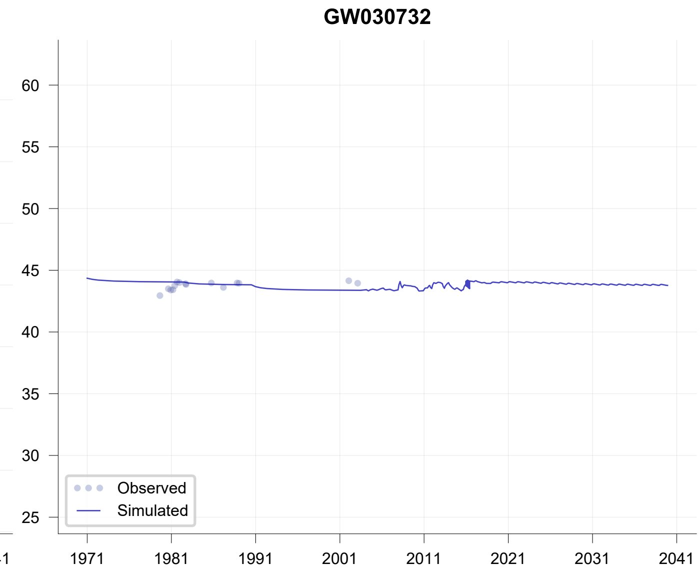

D317_WDH
D406_AFS
D406_BFS
D406_WDH
D510_AFS
D510_BFS
D612_AFS
D612_BFS
Groundwater...level...(mRL)
Year
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041

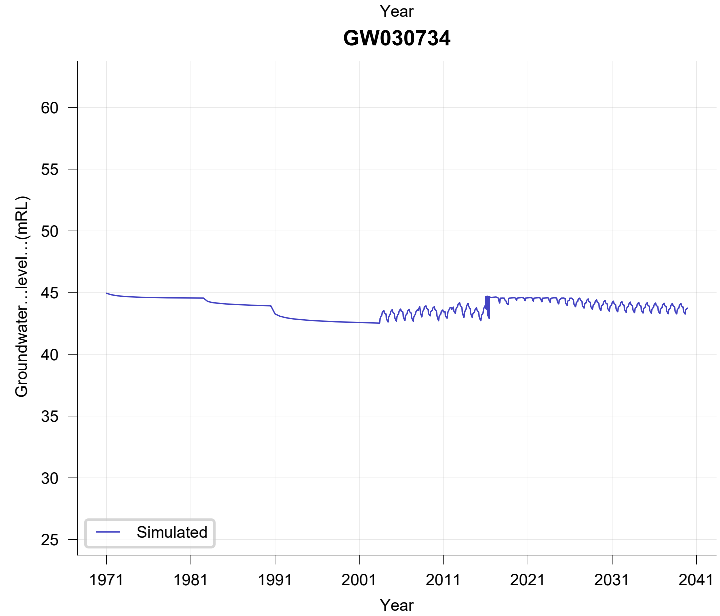


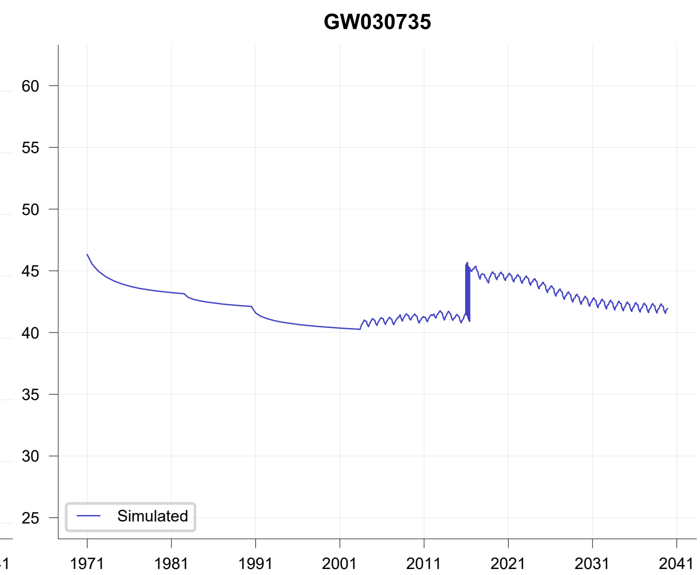
D807_BFS
DM1
DM2
DM3
DM4
DM5_40
DM5_75
DM6
Groundwater...level...(mRL)
Year
1971
1981
1991
2001
2011
2021
2031
2041
Observed
Simulated

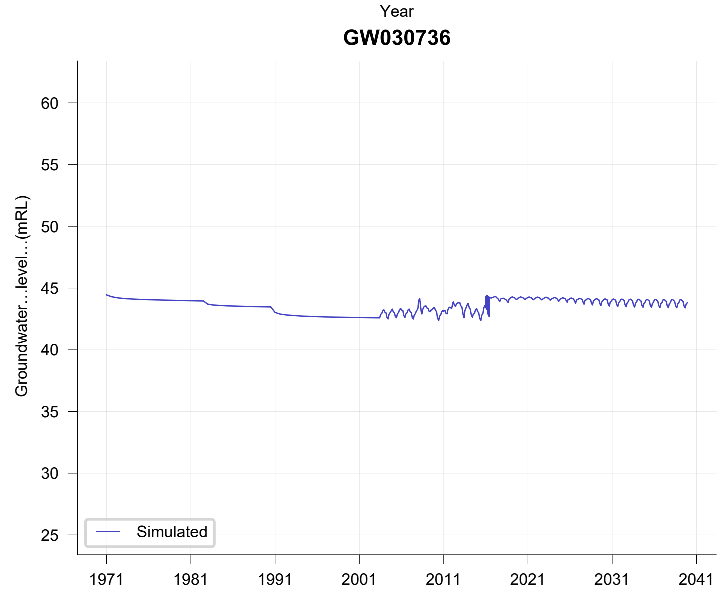

DM7
DM9
E5038_5
F1_WF533
G1
G2
G3
GA3
Groundwater...level...(mRL)
Year
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041

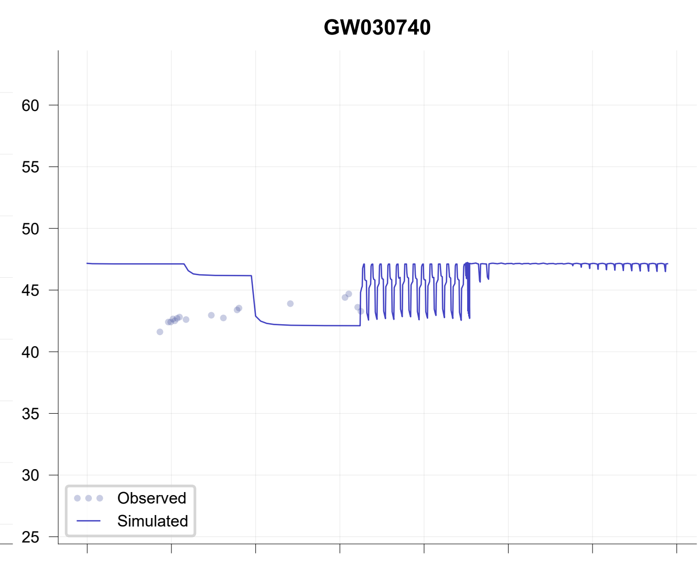

GW02
Groundwater...level...(mRL)
Year
Observed
Simulated

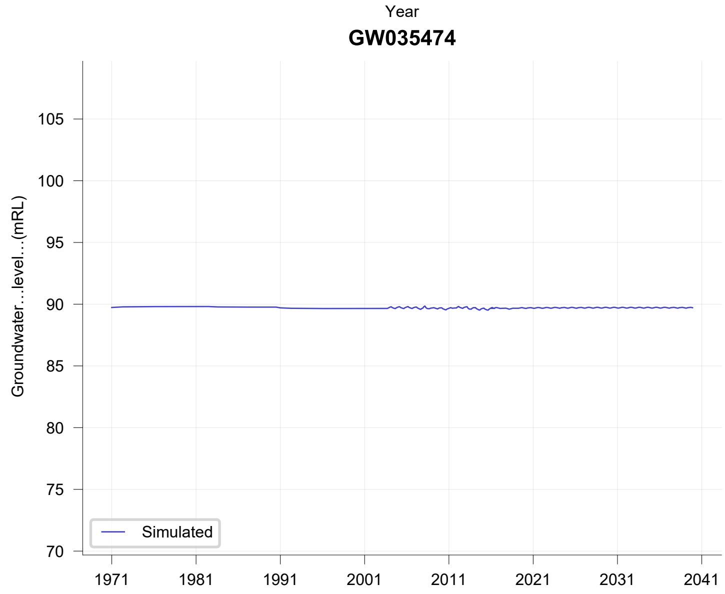

GW030732
Observed
Simulated

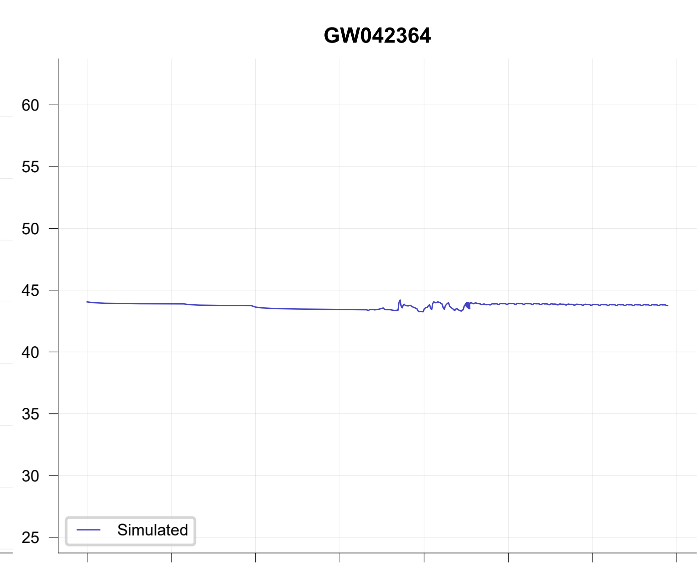

GW030734
Groundwater...level...(mRL)
Year
Simulated

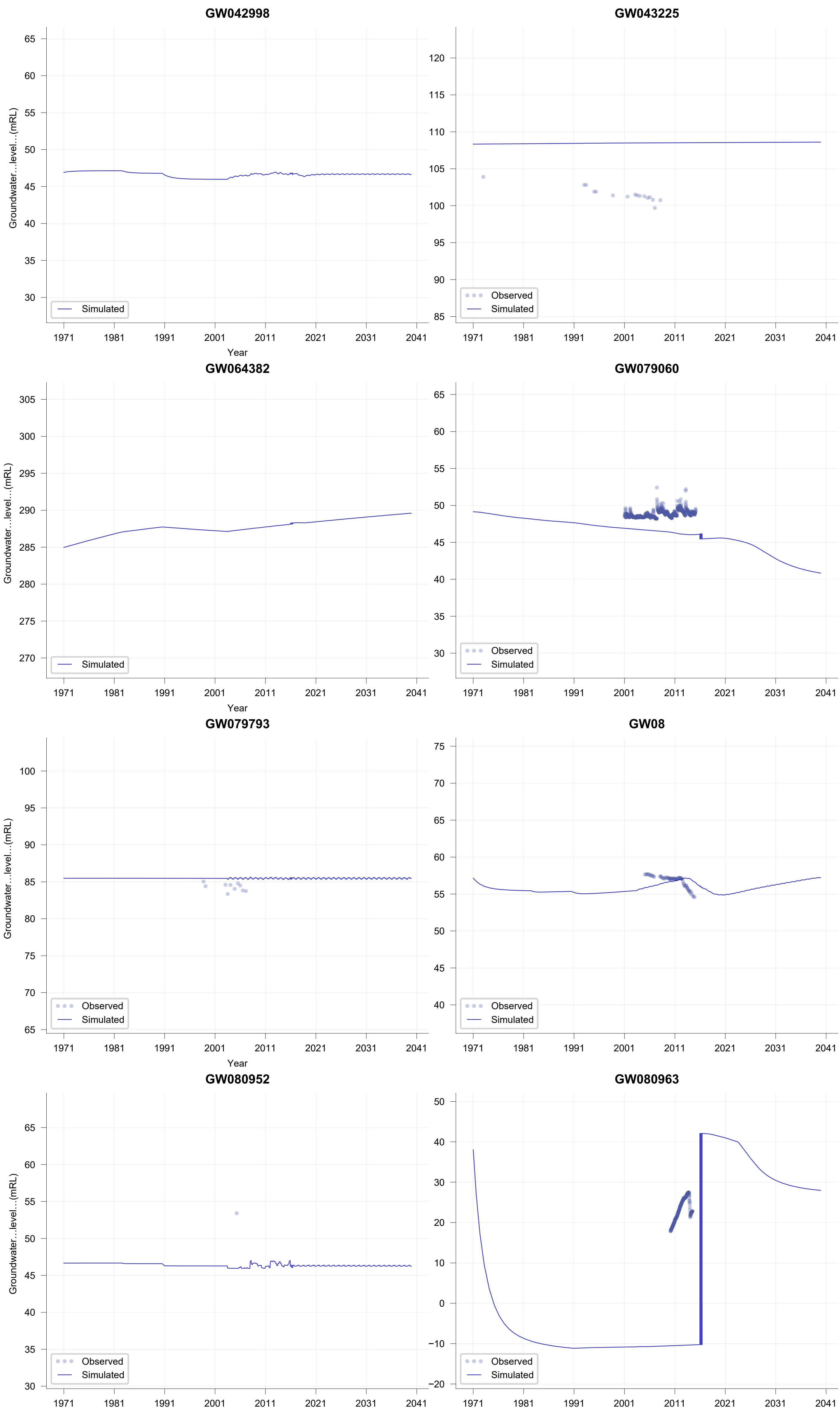

GW030735
Simulated

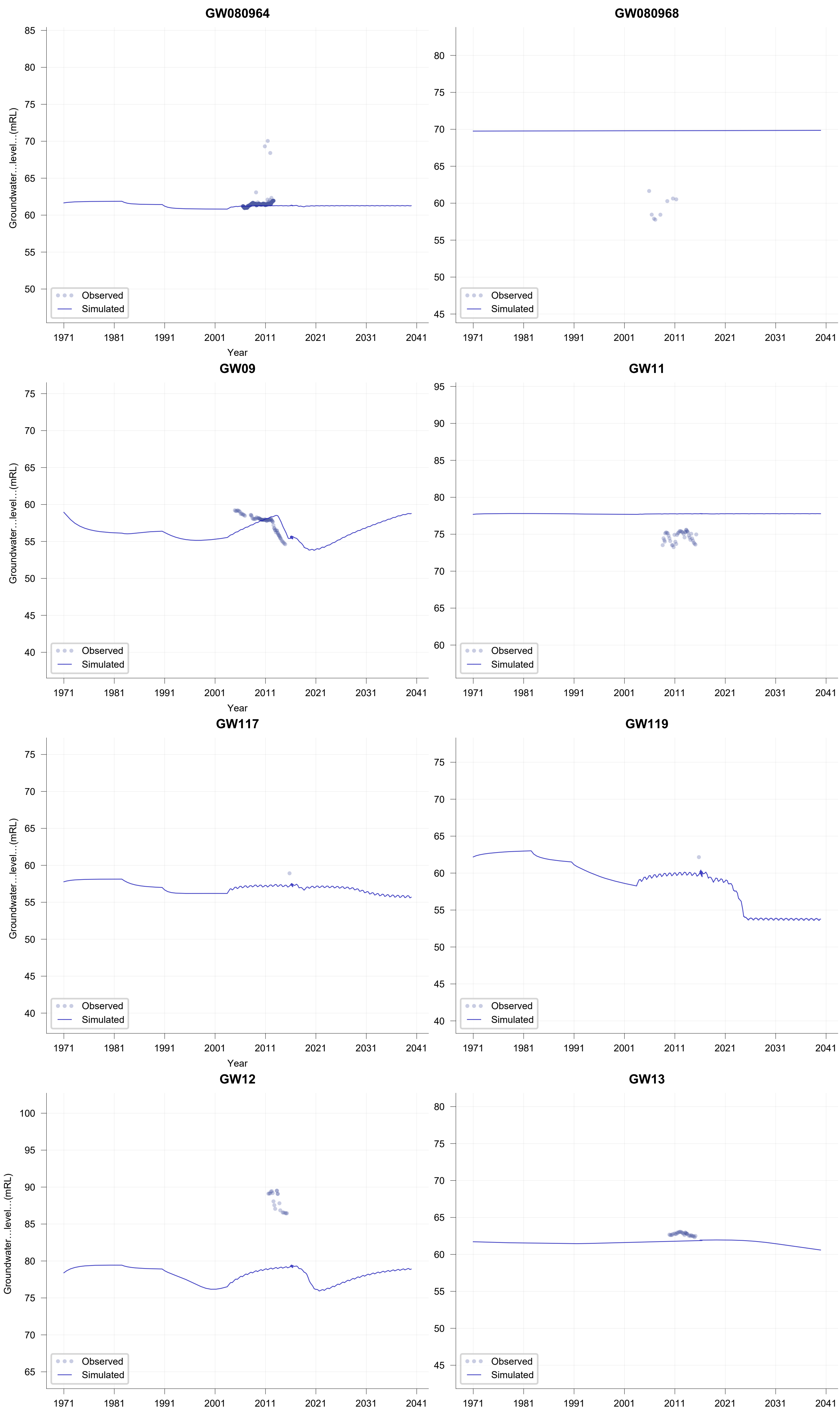

GW030736
Groundwater...level...(mRL)
Year
Simulated

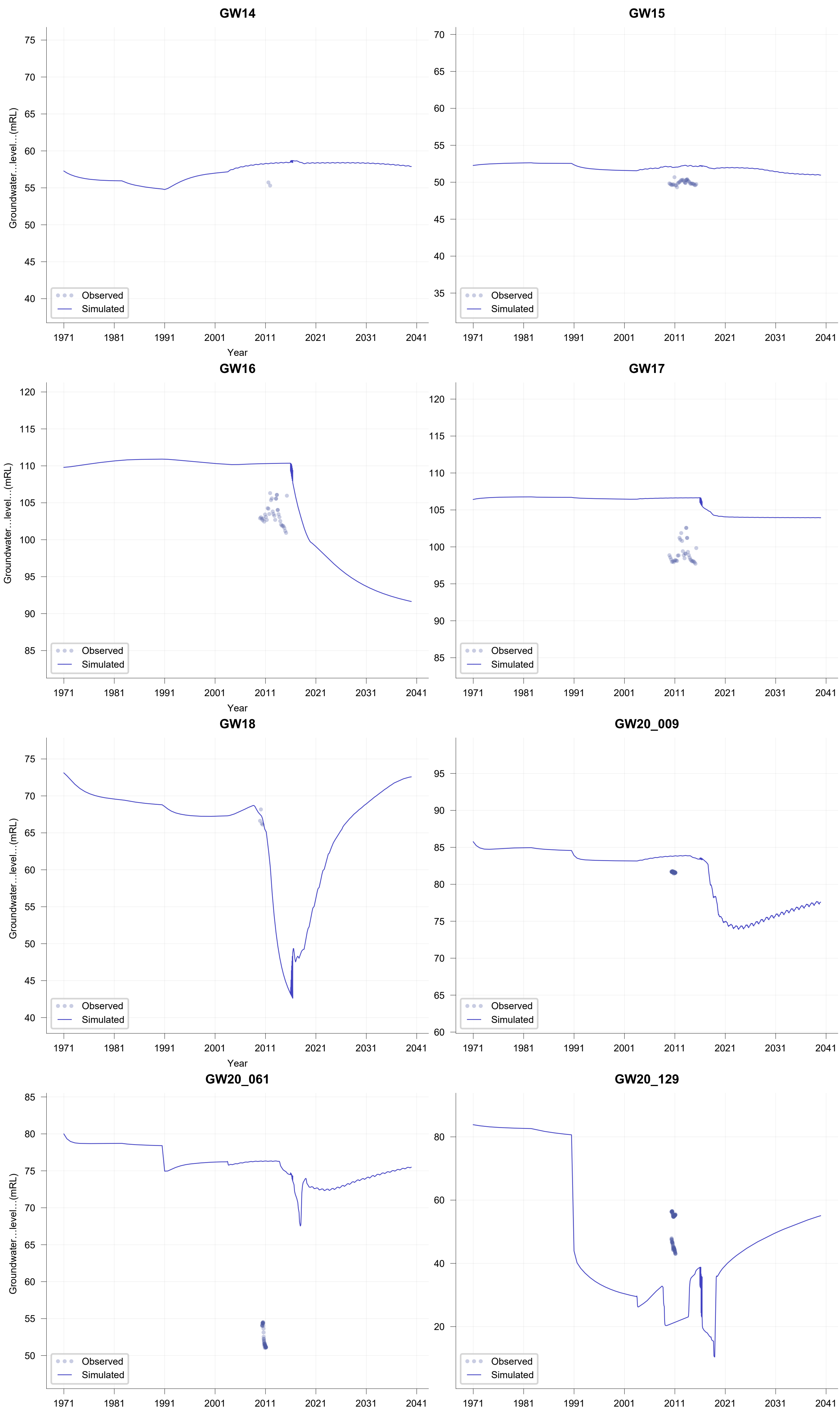

GW030740
Observed
Simulated

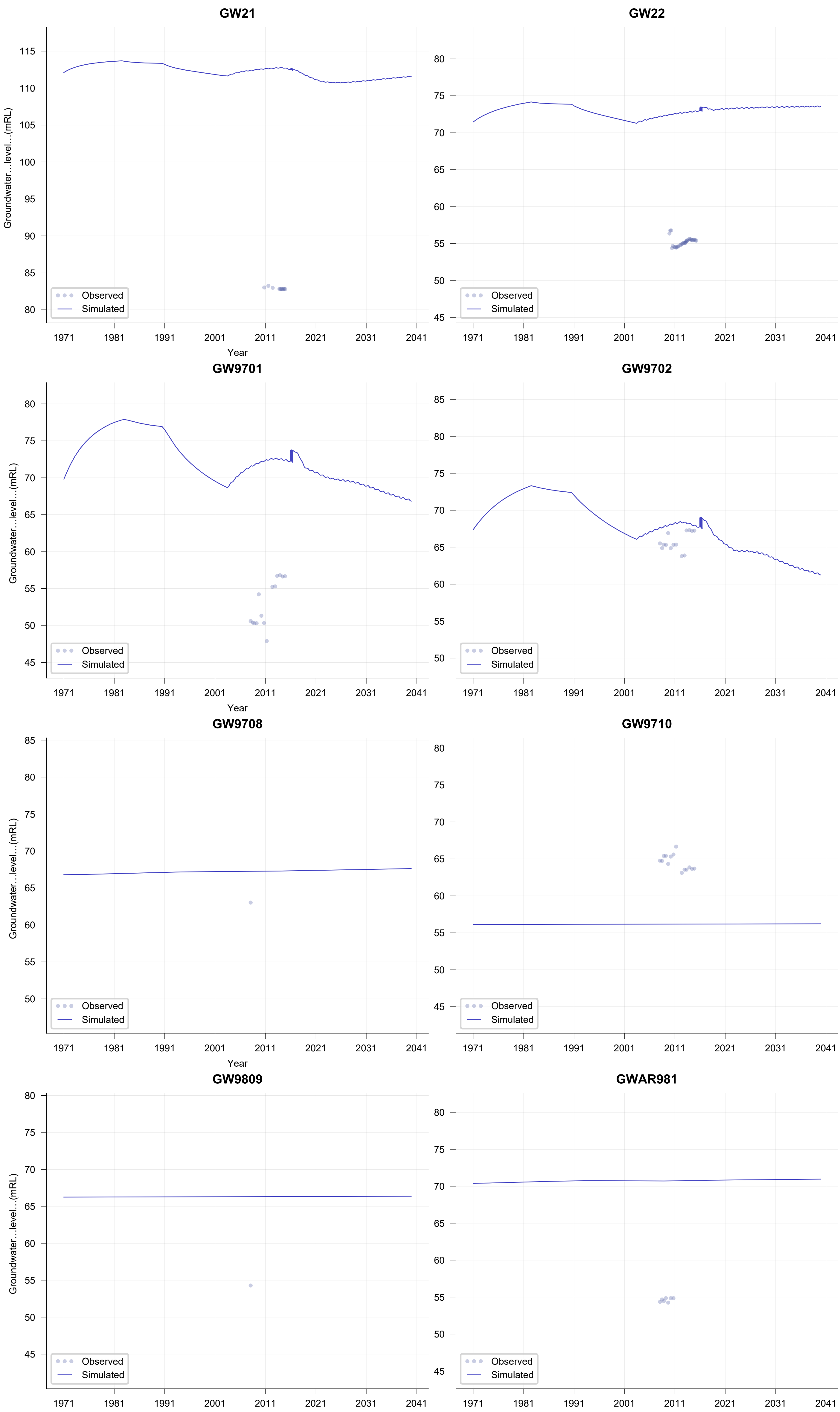

GW035474
Groundwater...level...(mRL)
Year
Simulated

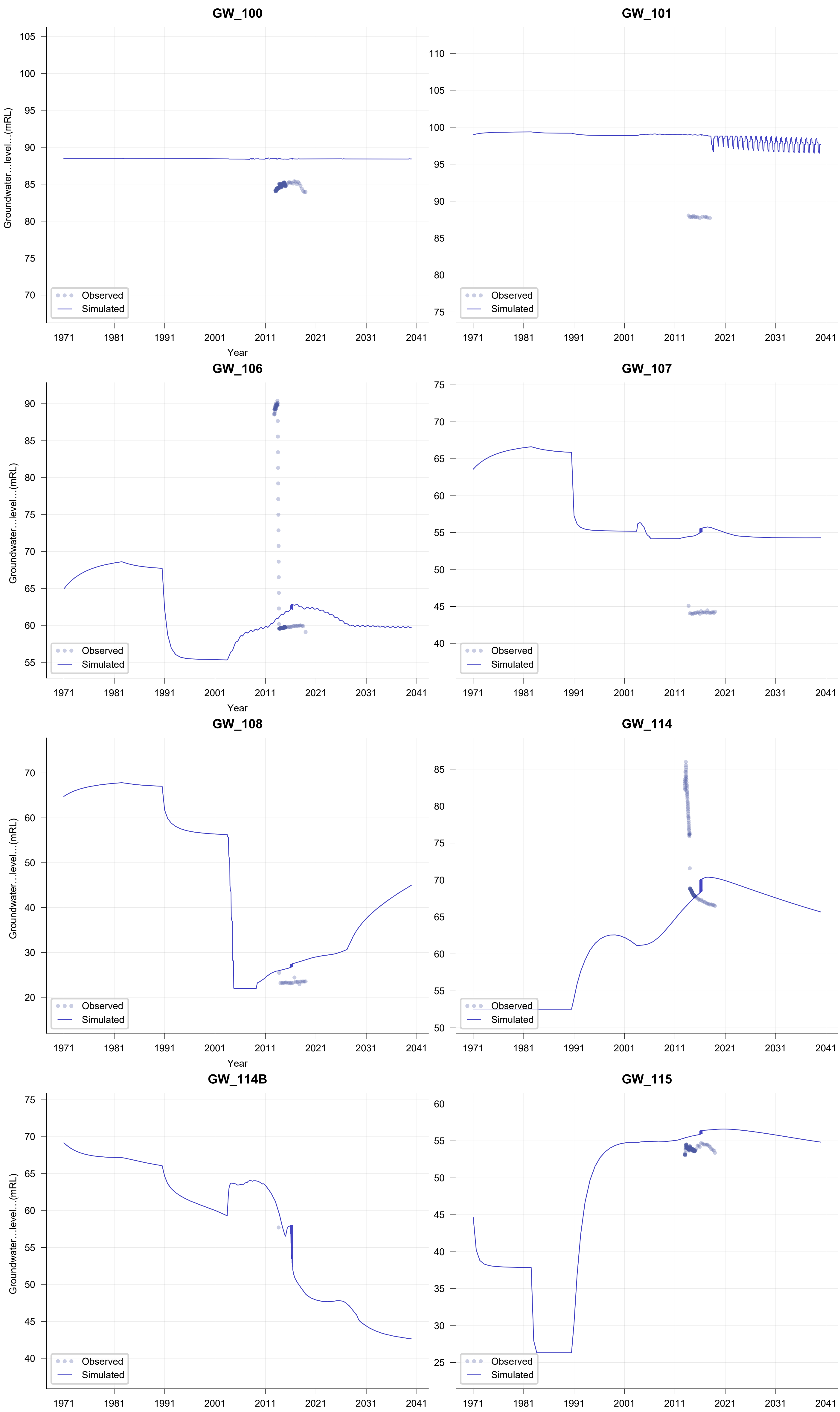

GW042364
Simulated


GW042998
GW043225
GW064382
GW079060
GW079793
GW08
GW080952
GW080963
Groundwater...level...(mRL)
Year
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041

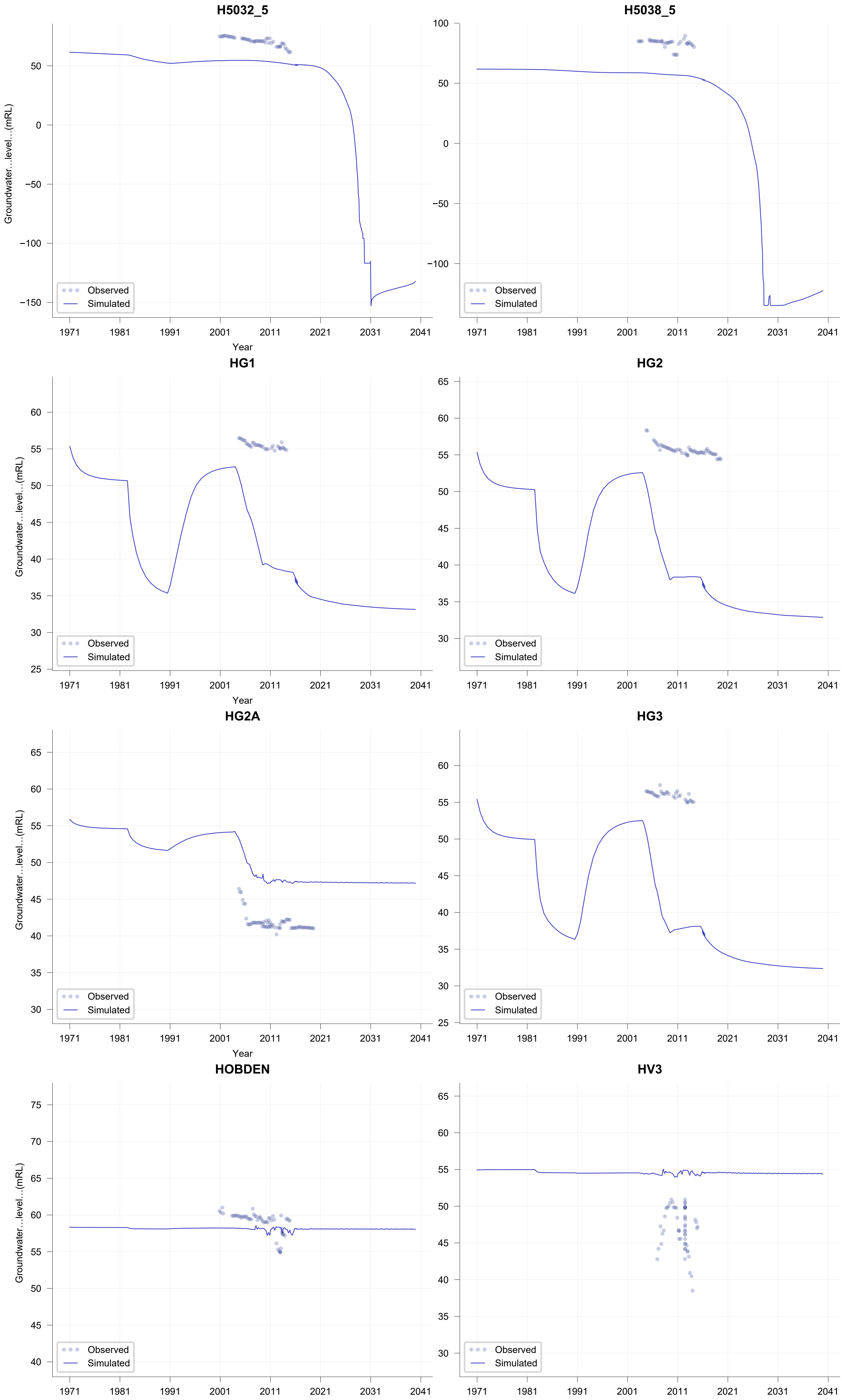

GW080964
GW080968
GW09
GW11
GW117
GW119
GW12
GW13
Groundwater...level...(mRL)
Year
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041

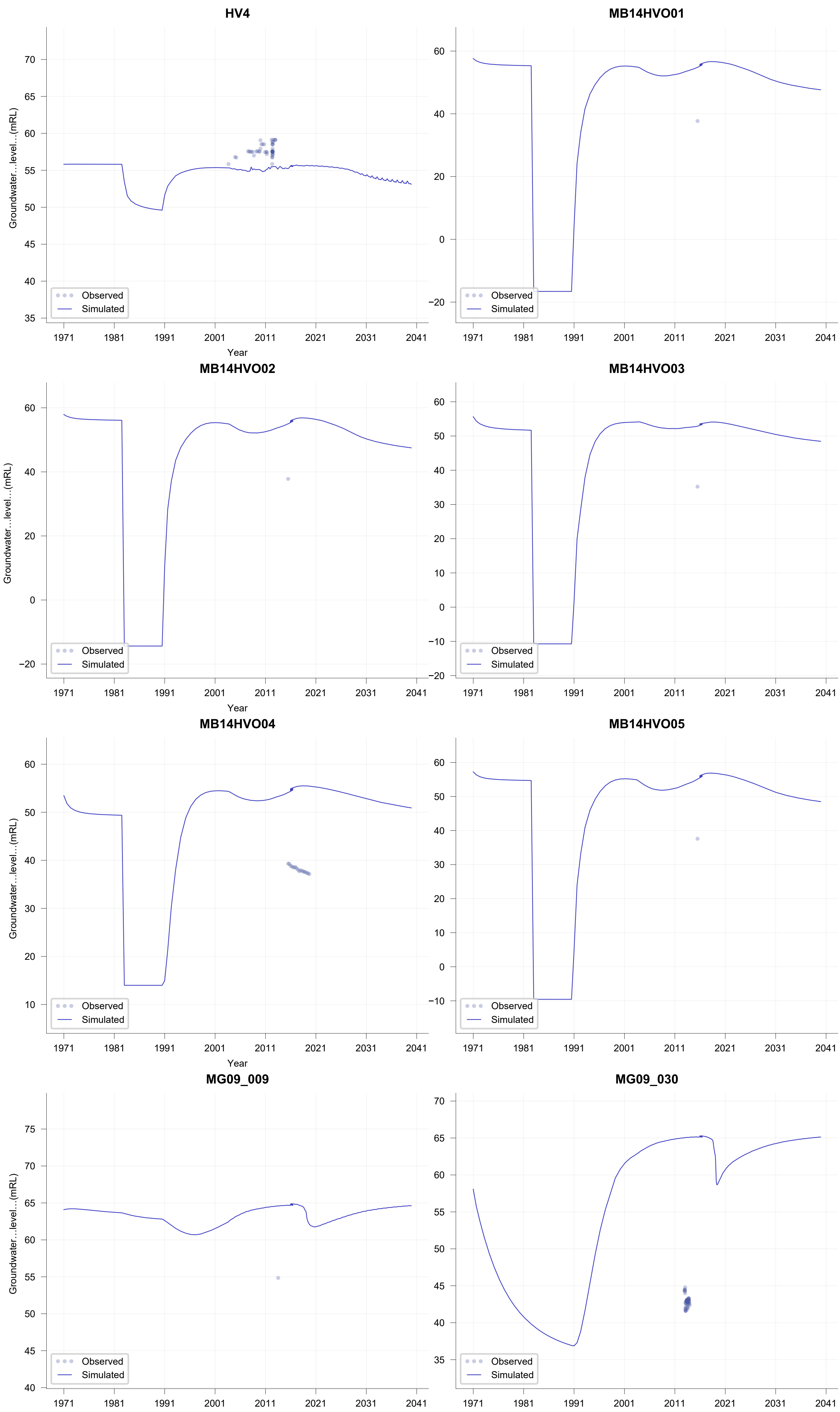

GW14
GW15
GW16
GW17
GW18
GW20_009
GW20_061
GW20_129
Groundwater...level...(mRL)
Year
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041

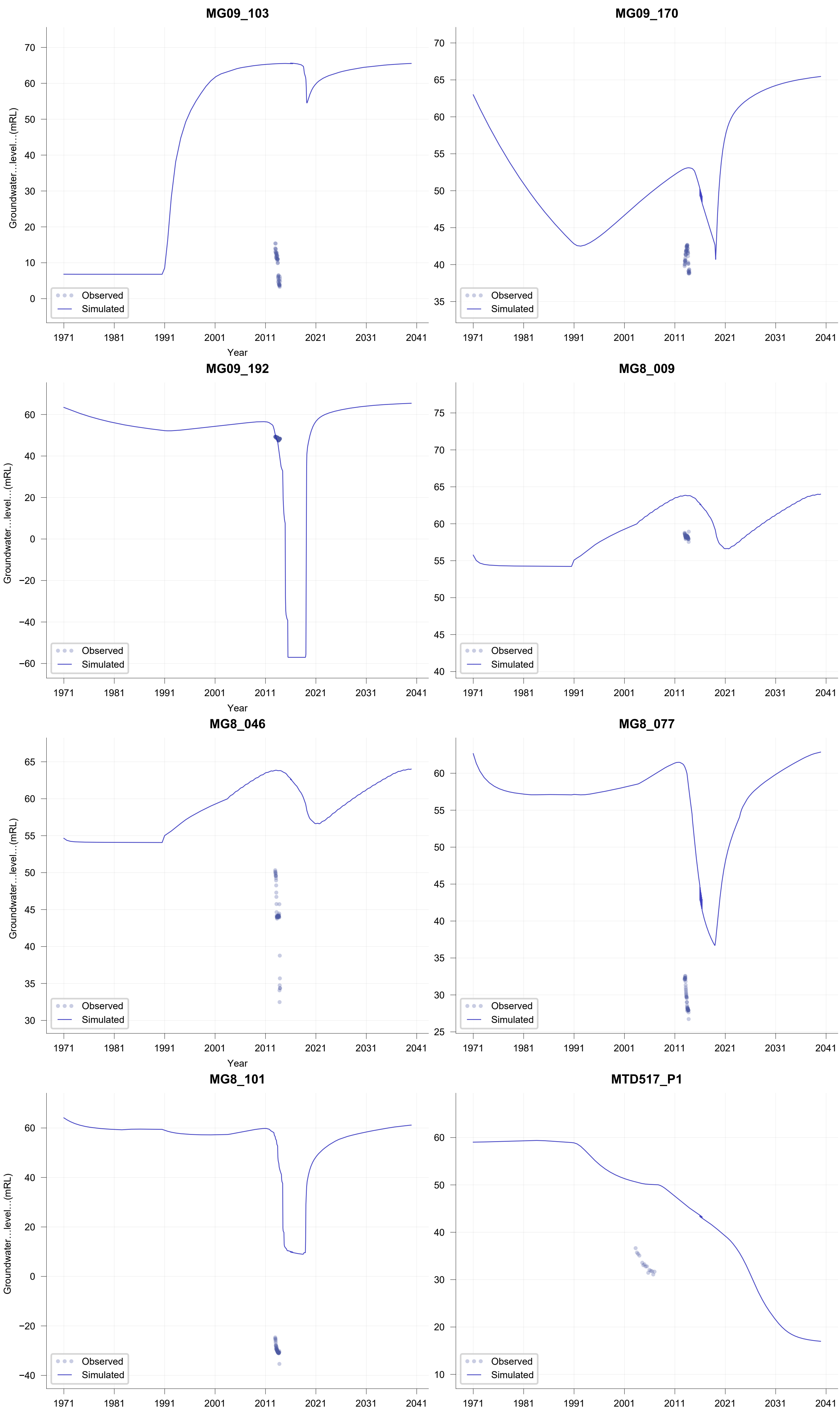

GW21
GW22
GW9701
GW9702
GW9708
GW9710
GW9809
GWAR981
Groundwater...level...(mRL)
Year
1971 1981 1991 2001 2011 2021 2031 2041
Observed
Simulated

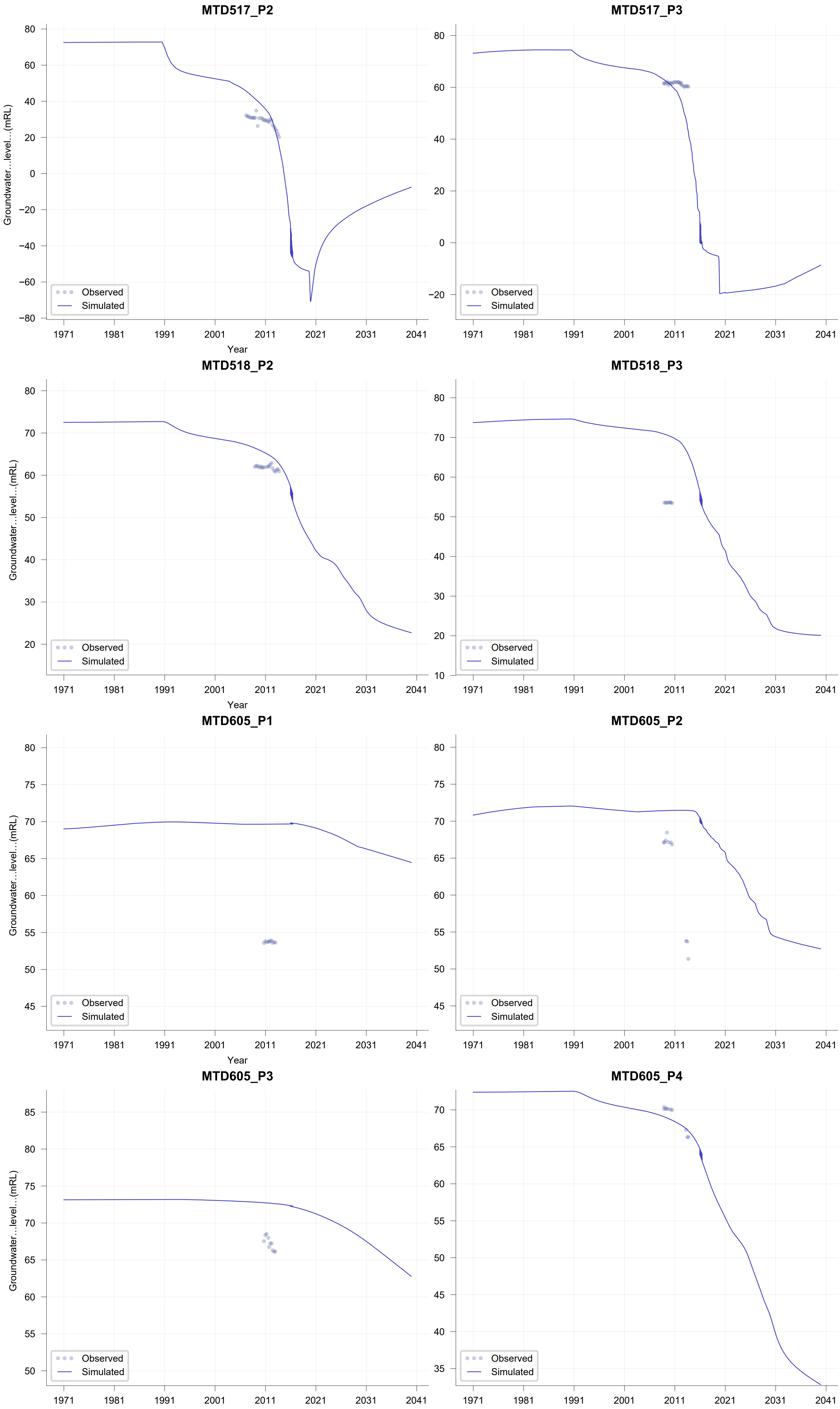


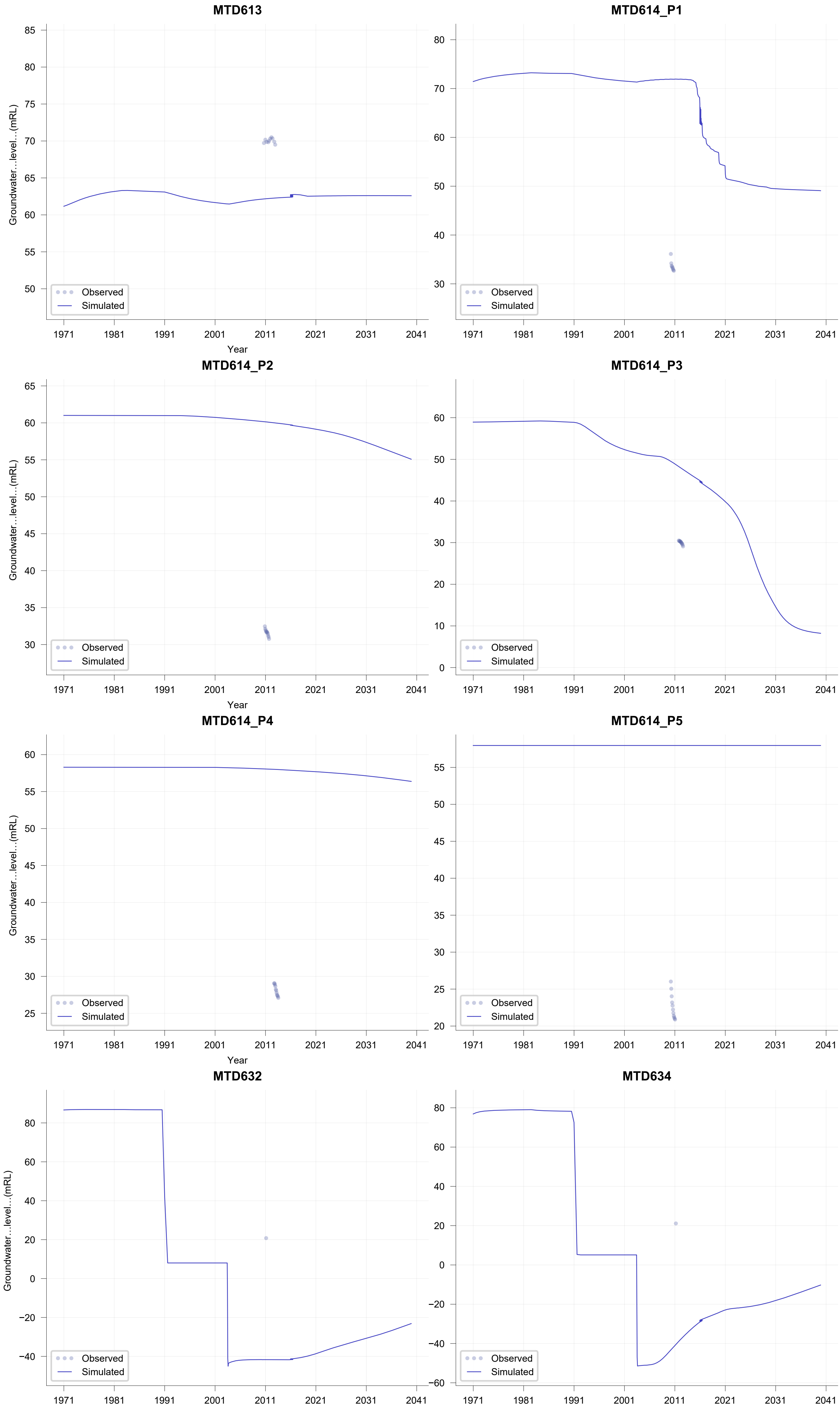
GW_100
GW_101
GW_106
GW_107
GW_108
GW_114
GW_114B
GW_115
Groundwater...level...(mRL)
Year
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041

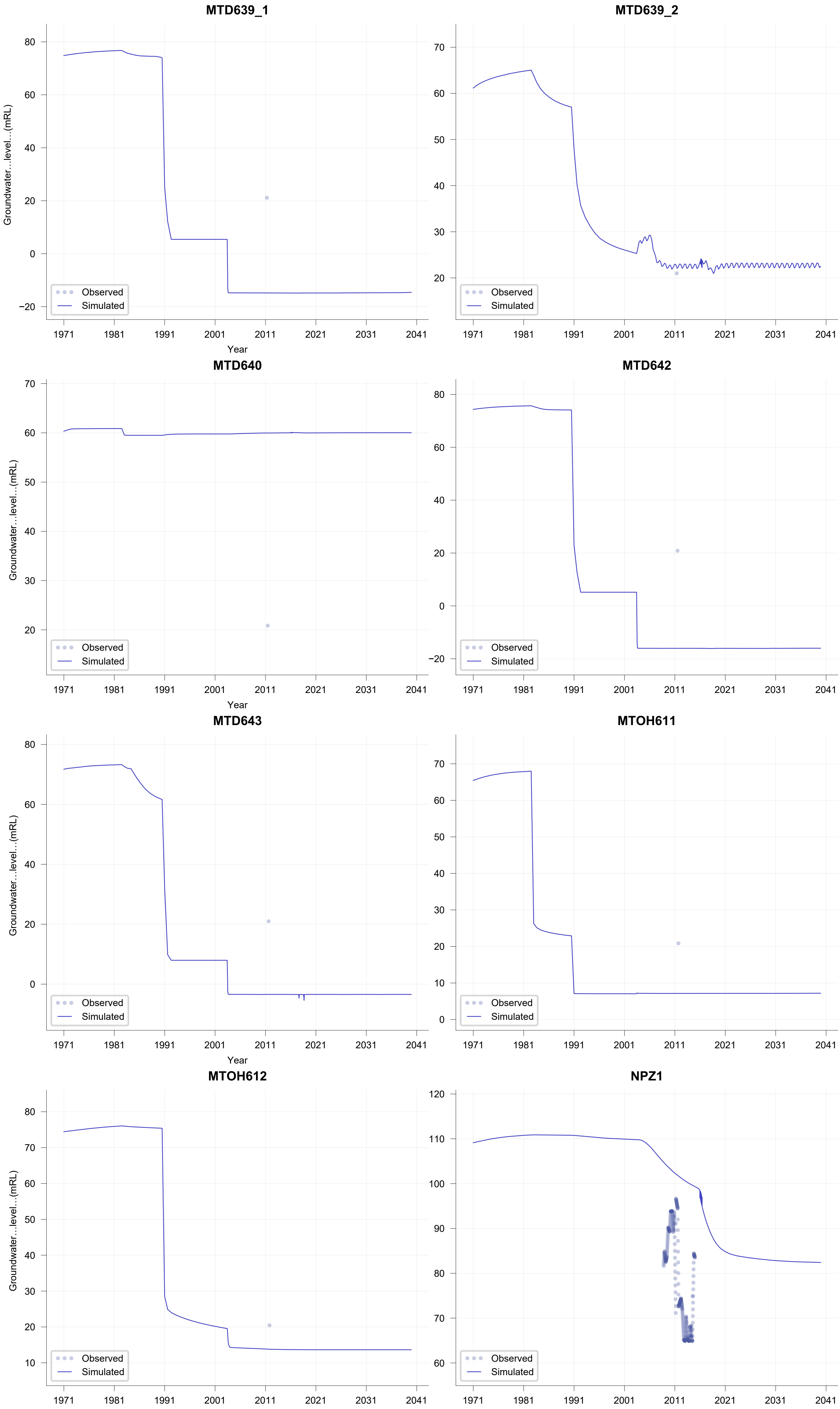

H5032_5
H5038_5
HG1
HG2
HG2A
HG3
HOBDEN
HV3
Groundwater...level...(mRL)
Year
Observed
Simulated

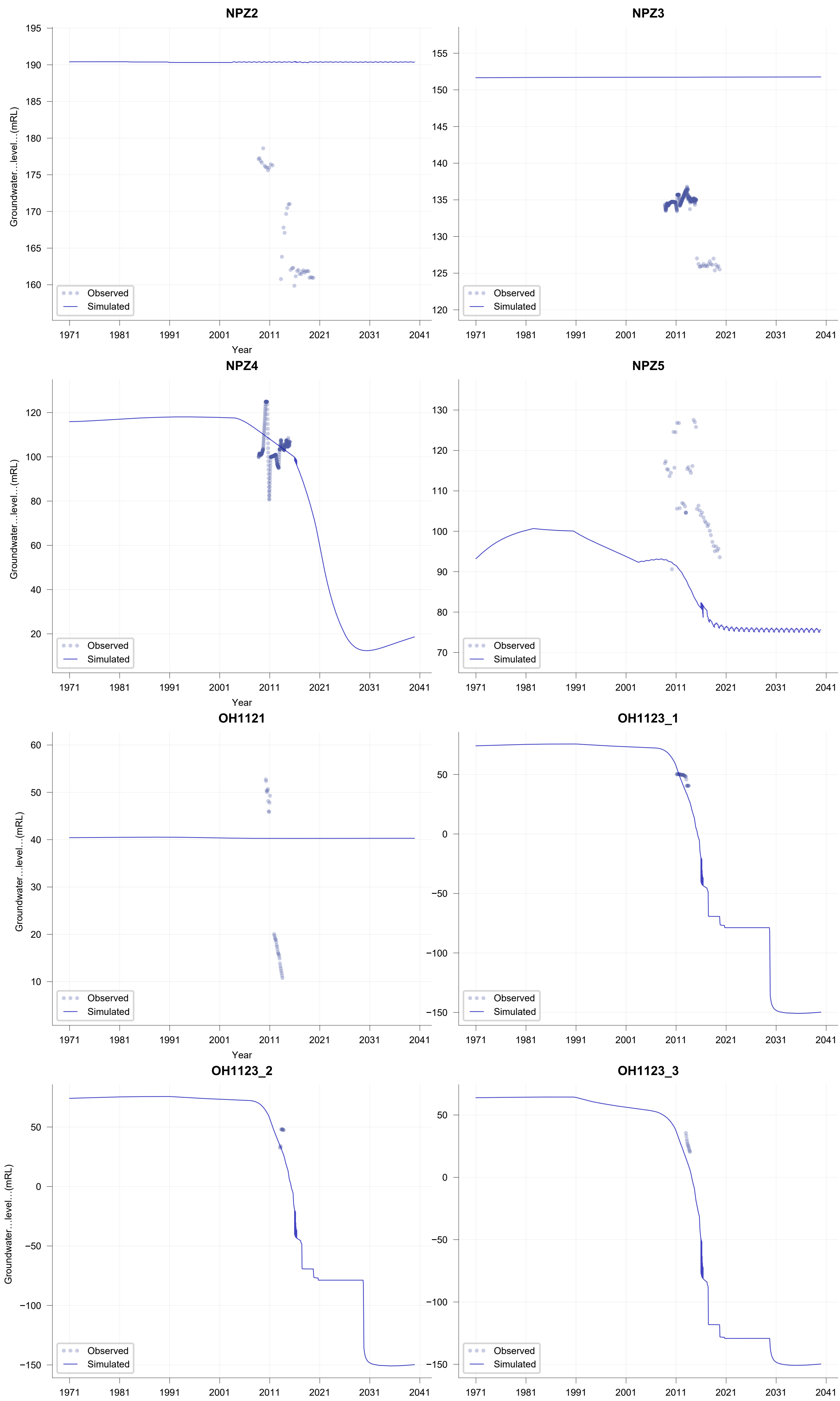

HV4
MB14HVO01
MB14HVO02
MB14HVO03
MB14HVO04
MB14HVO05
MG09_009
MG09_030
Groundwater...level...(mRL)
Year
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041

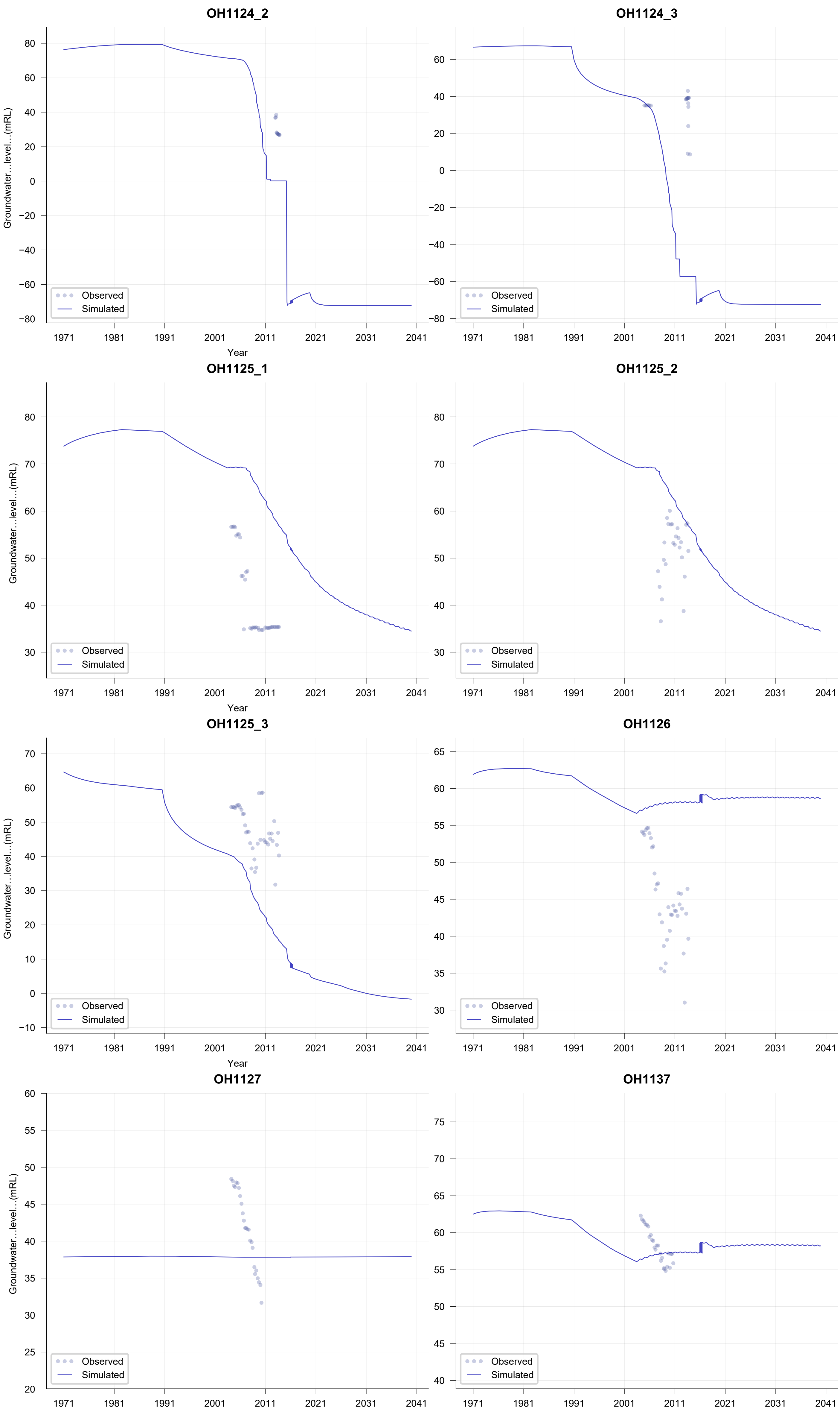

MG09_103
Groundwater...level...(mRL)
Year
Observed
Simulated
MG09_170
Observed
Simulated
MG09_192
Groundwater...level...(mRL)
Year
Observed
Simulated
MG8_009
Observed
Simulated
MG8_046
Groundwater...level...(mRL)
Year
Observed
Simulated
MG8_077
Observed
Simulated
MG8_101
Groundwater...level...(mRL)
Year
Observed
Simulated
MTD517_P1
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041

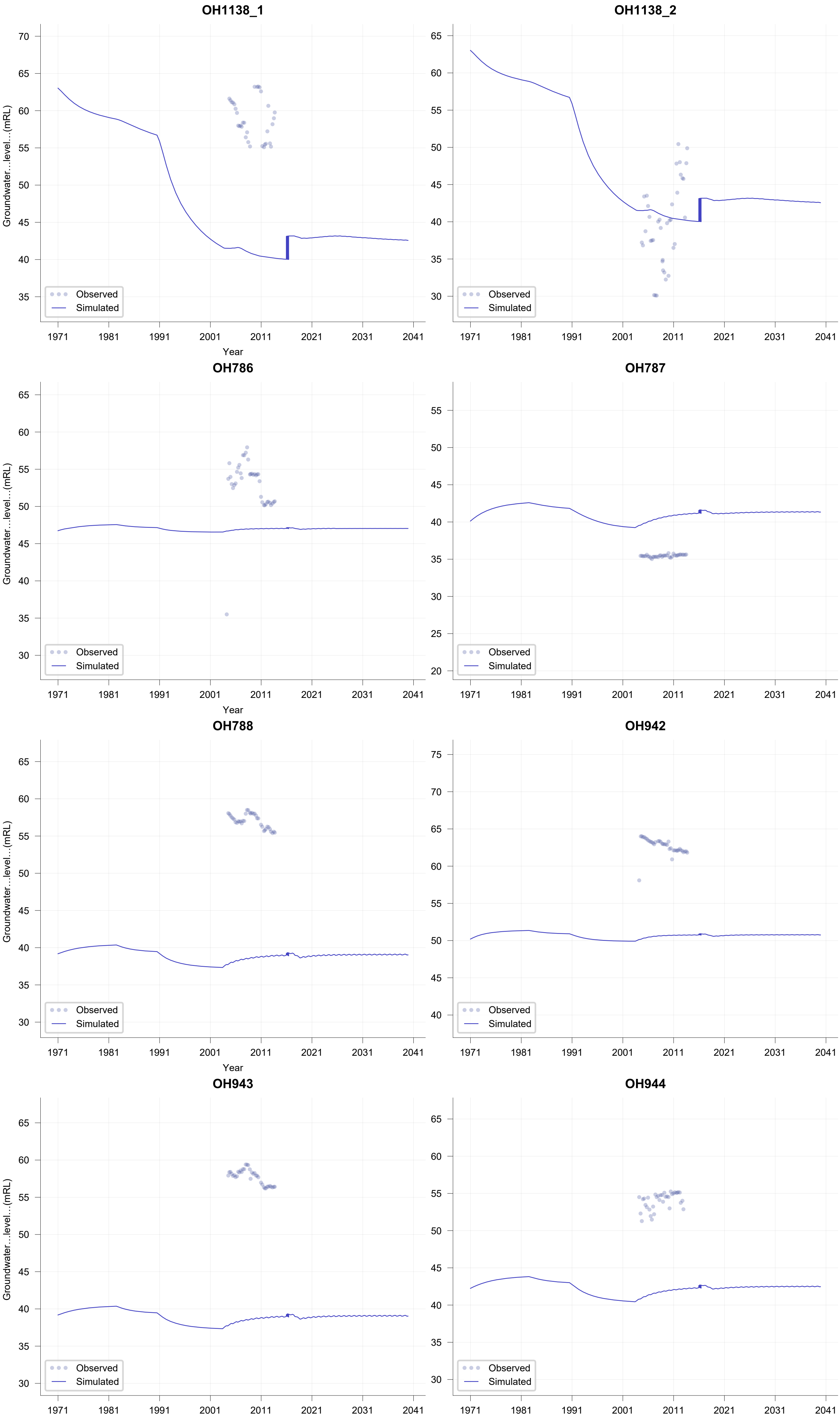

MTD517_P2
MTD517_P3
MTD518_P2
MTD518_P3
MTD605_P1
MTD605_P2
MTD605_P3
MTD605_P4
Groundwater...level...(mRL)
Year
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041

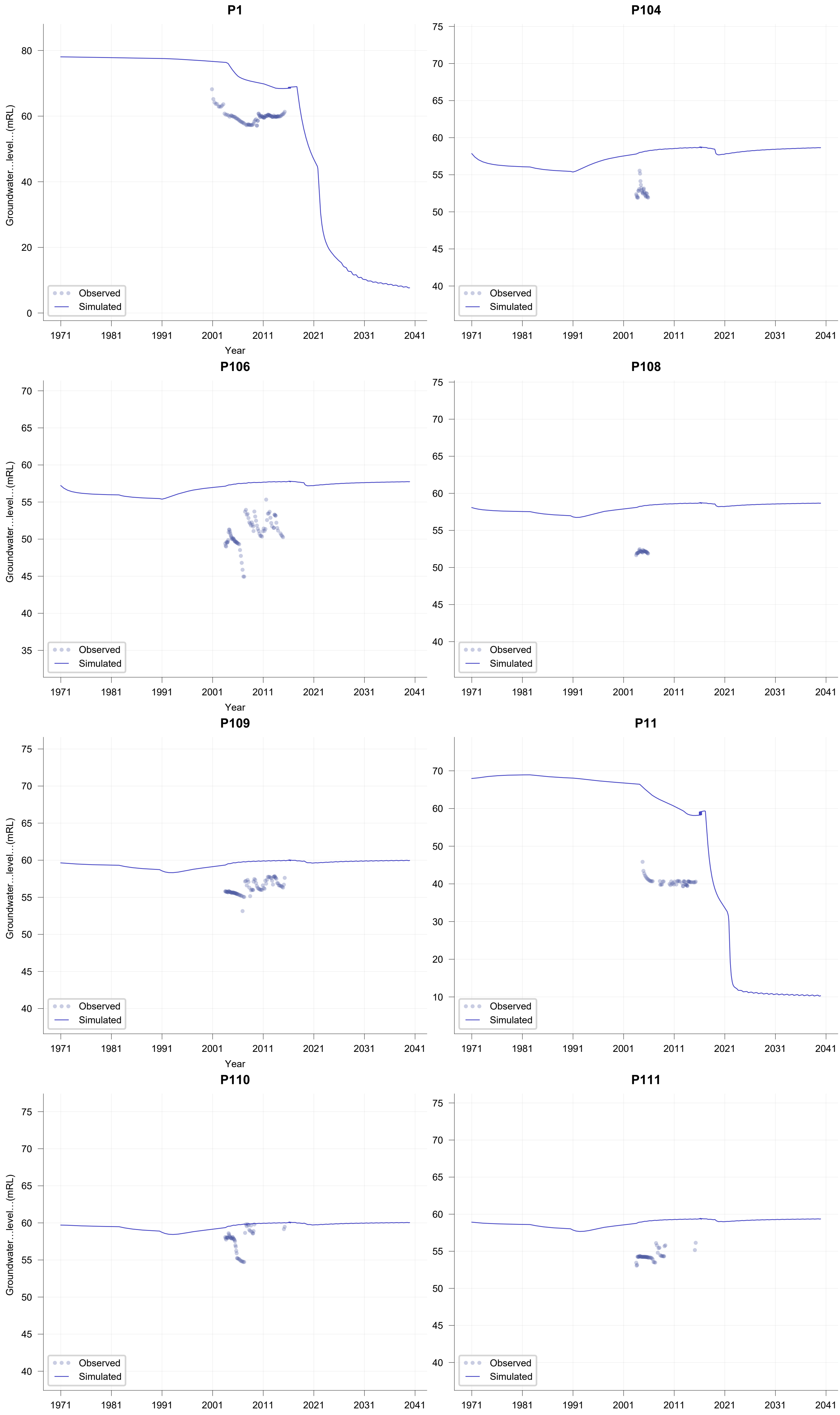

MTD613
Groundwater...level...(mRL)
85
80
75
70
65
60
55
50
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041
Year
MTD614_P1
80
70
60
50
40
30
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041
MTD614_P2
Groundwater...level...(mRL)
65
60
55
50
45
40
35
30
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041
Year
MTD614_P3
60
50
40
30
20
10
0
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041
MTD614_P4
Groundwater...level...(mRL)
60
55
50
45
40
35
30
25
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041
Year
MTD614_P5
55
50
45
40
35
30
25
20
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041
MTD632
Groundwater...level...(mRL)
80
60
40
20
0
−20
−40
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041
Year
MTD634
80
60
40
20
0
-20
-40
-60
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041

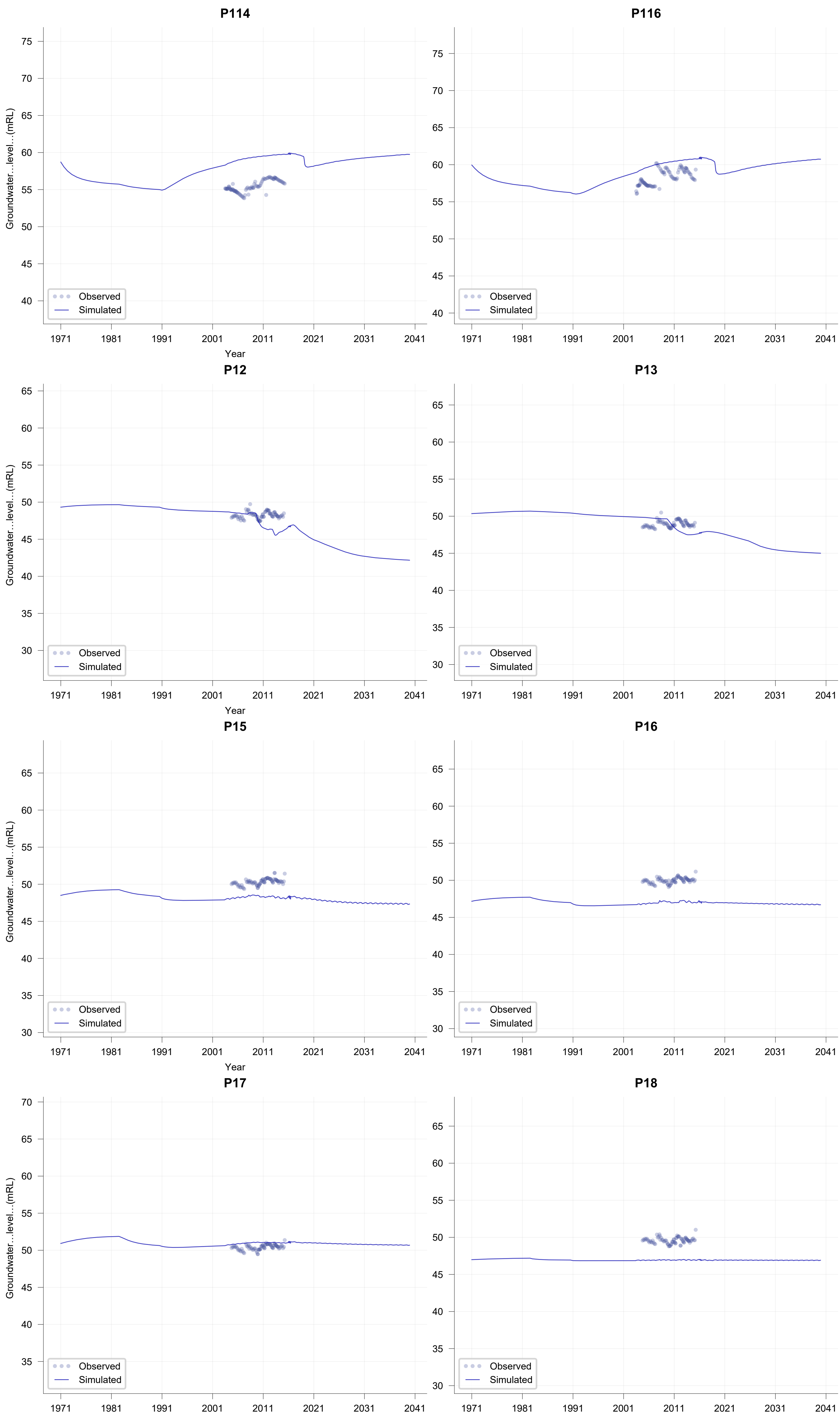

MTD639_1
MTD639_2
MTD640
MTD642
MTD643
MTOH611
MTOH612
NPZ1
Groundwater...level...(mRL)
Year
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041

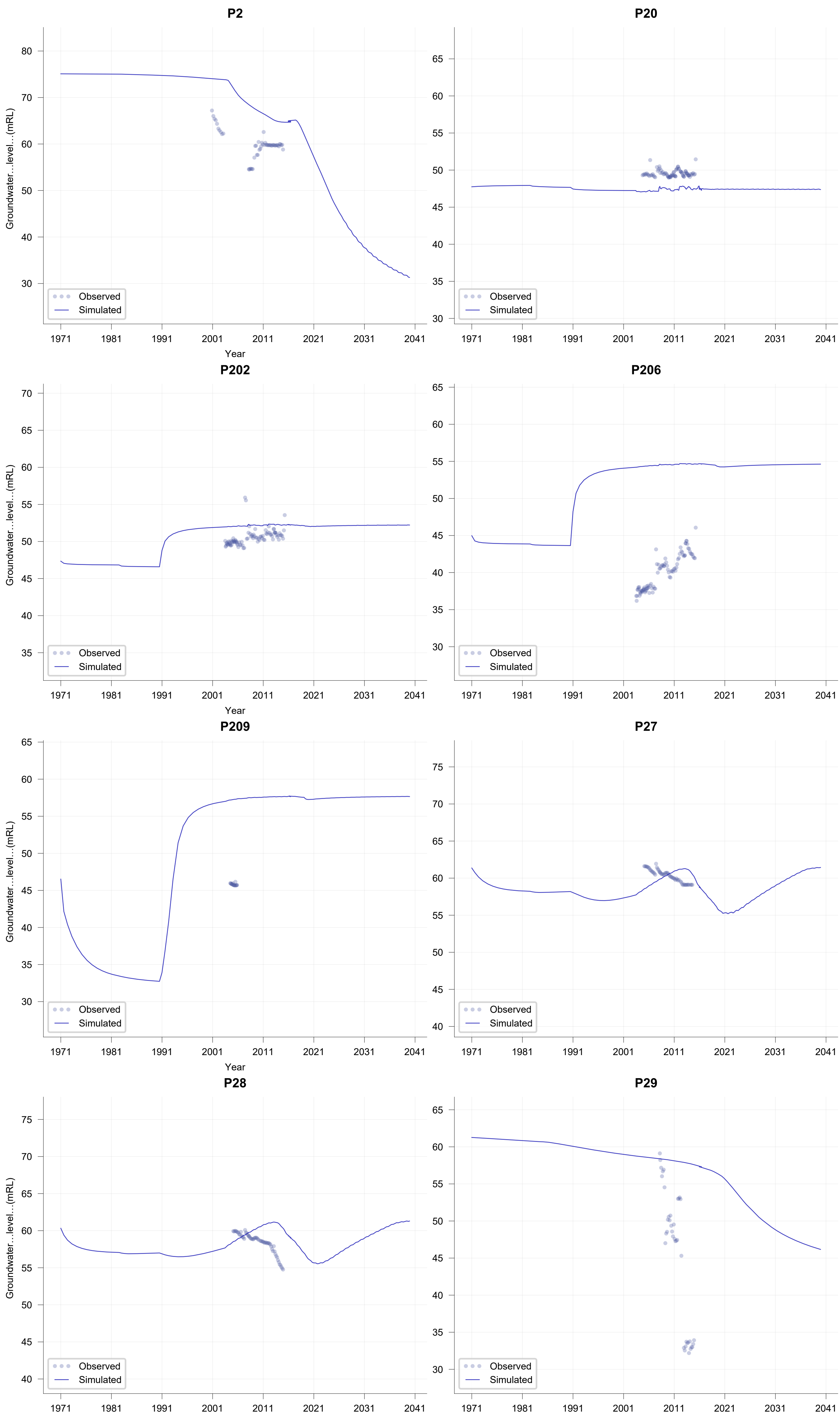

NPZ2
NPZ3
NPZ4
NPZ5
OH1121
OH1123_1
OH1123_2
OH1123_3
Groundwater...level...(mRL)
Year
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041

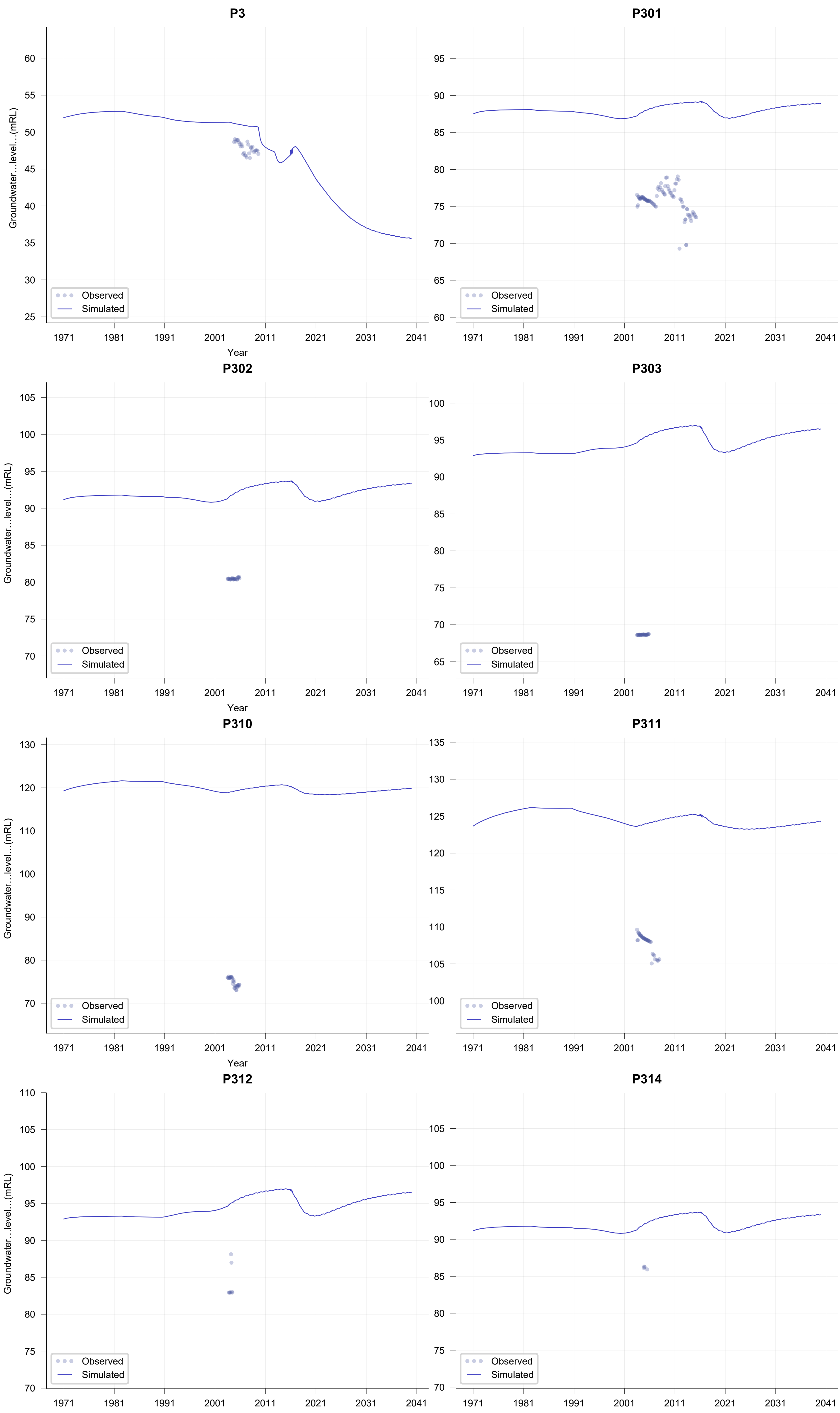

OH1124_2
OH1124_3
OH1125_1
OH1125_2
OH1125_3
OH1126
OH1127
OH1137
Groundwater...level...(mRL)
Year
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041

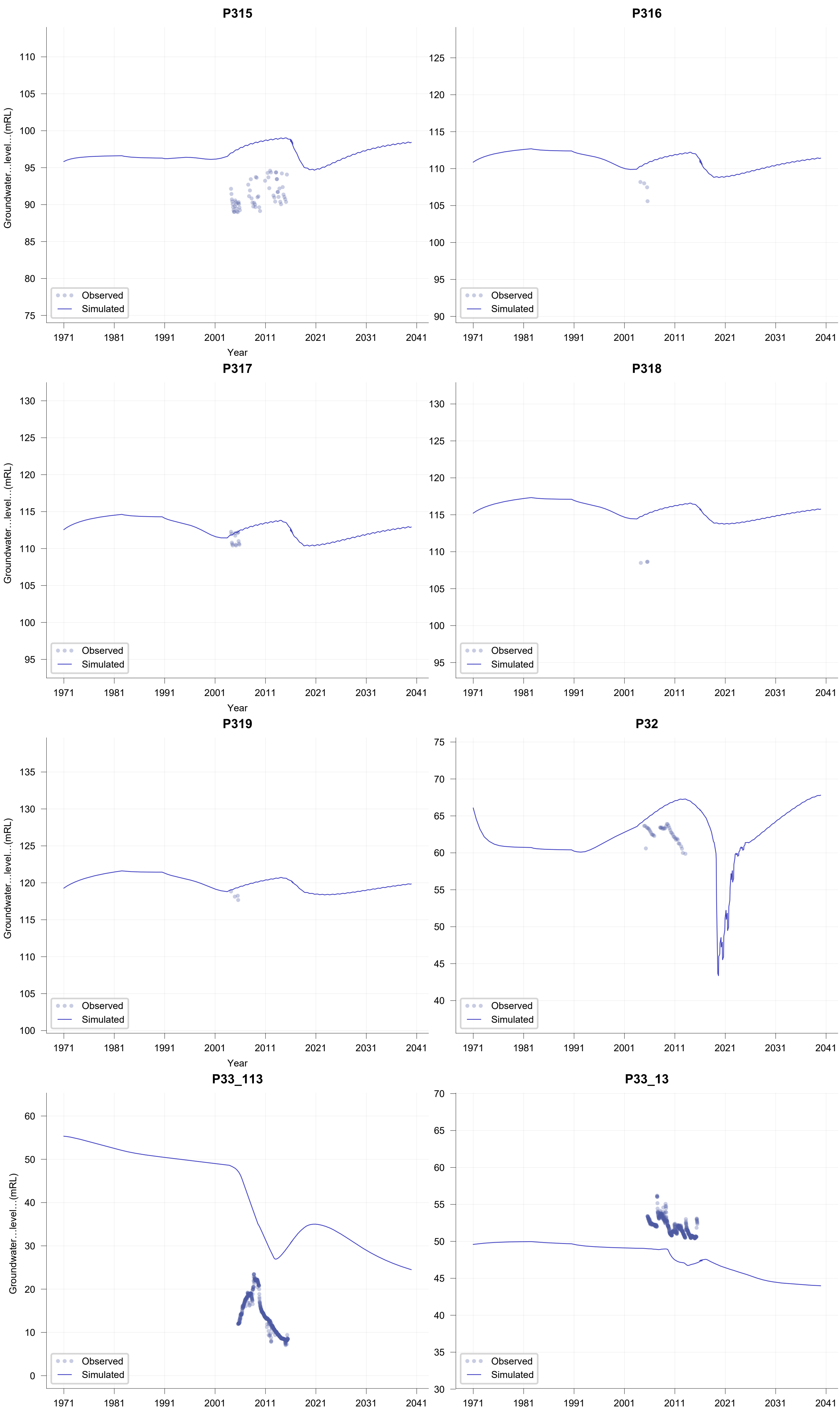

OH1138_1
OH1138_2
OH786
OH787
OH788
OH942
OH943
OH944
Groundwater...level...(mRL)
Year
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041

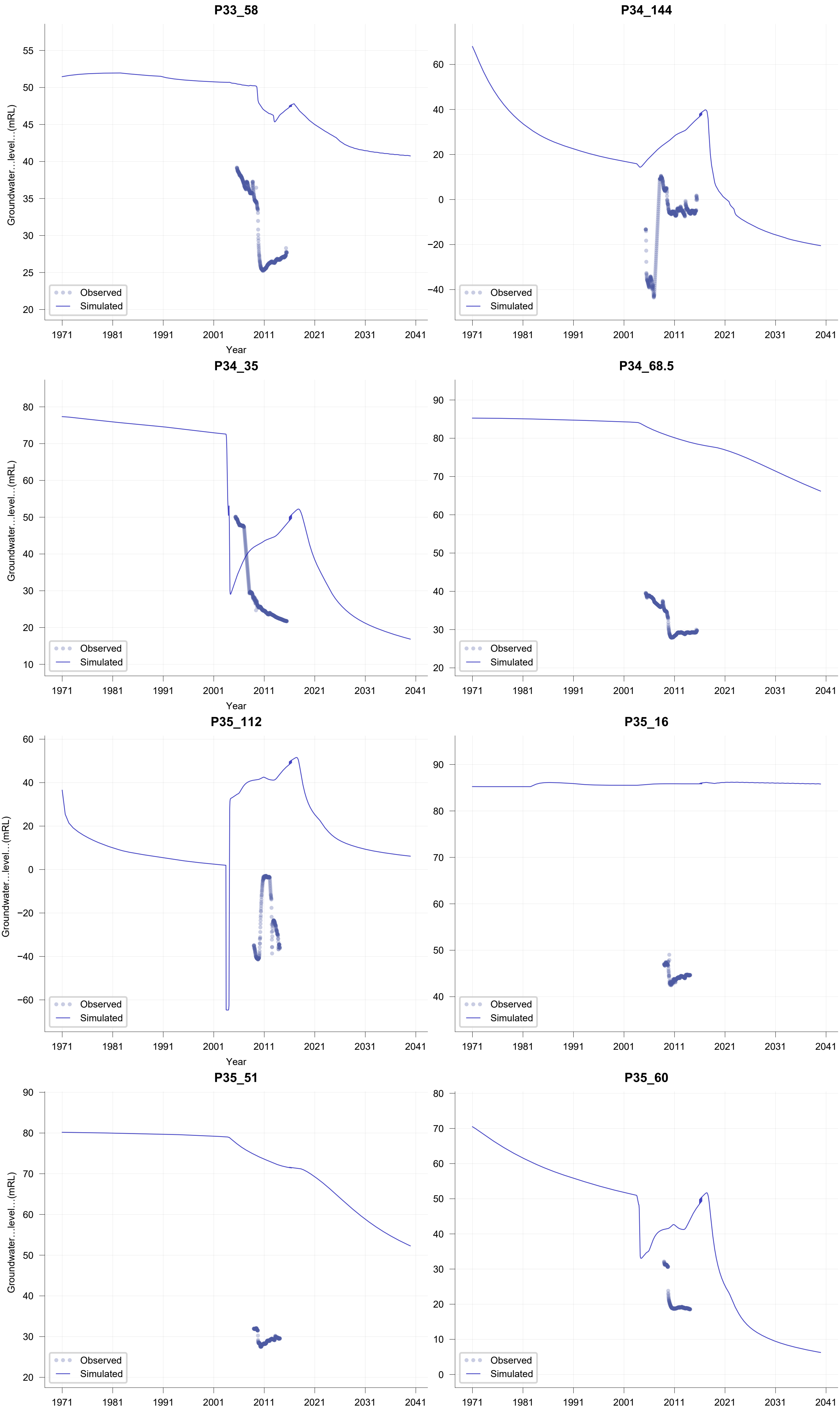

P1
P104
P106
P108
P109
P11
P110
P111
Groundwater...level...(mRL)
Year
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041

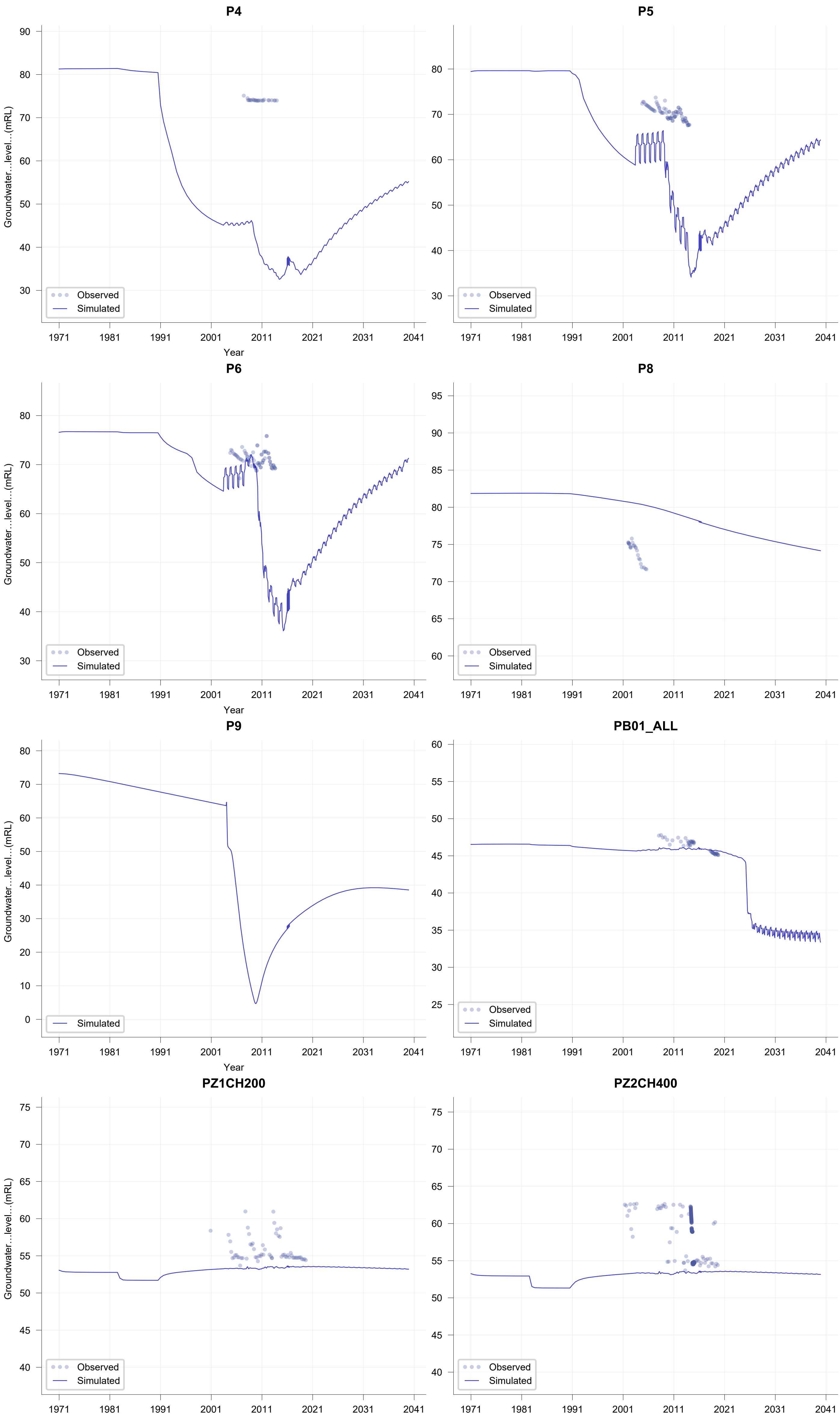

P114
P116
P12
P13
P15
P16
P17
P18
Groundwater...level...(mRL)
Year
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041


P2
P20
P202
P206
P209
P27
P28
P29
Groundwater...level...(mRL)
Year
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041

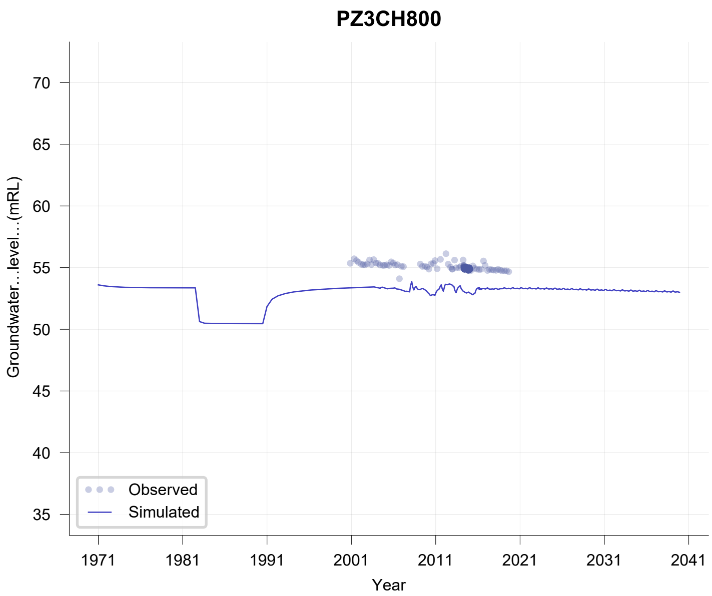

P3
P301
P302
P303
P310
P311
P312
P314
Groundwater...level...(mRL)
Year
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041

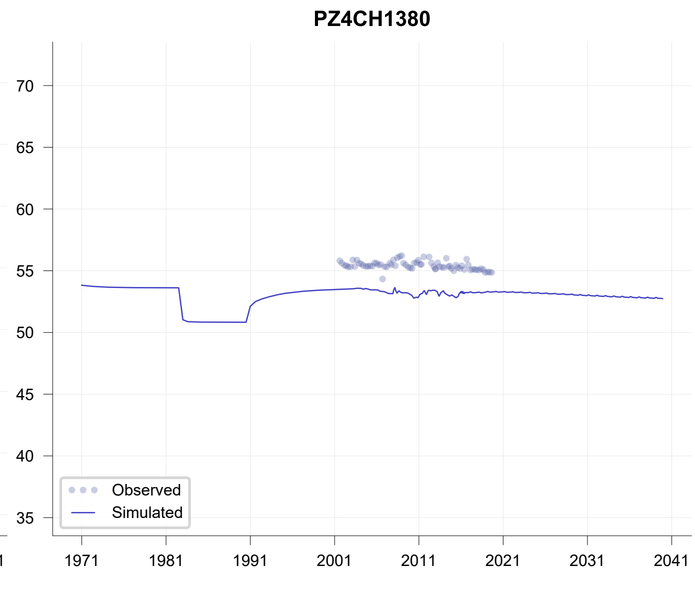

P315
P316
P317
P318
P319
P32
P33_113
P33_13
Groundwater...level...(mRL)
Year
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041

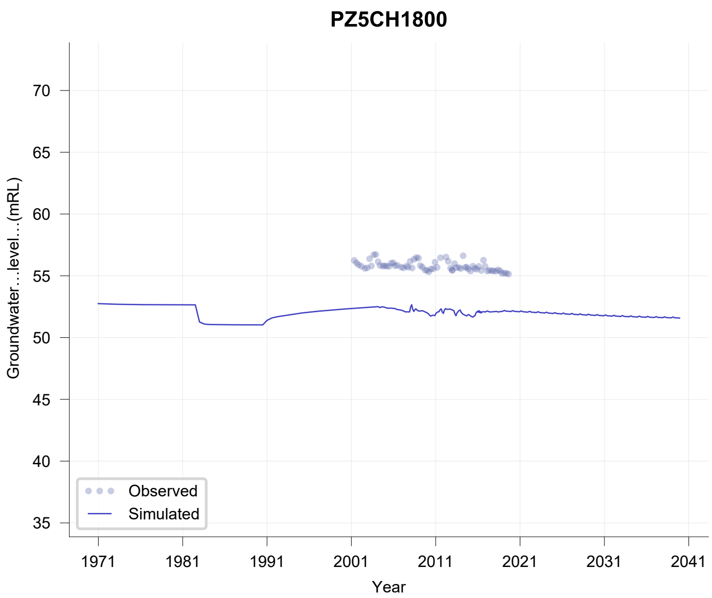

P33_58
P34_144
P34_35
P34_68.5
P35_112
P35_16
P35_51
P35_60
Groundwater...level...(mRL)
Year
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041

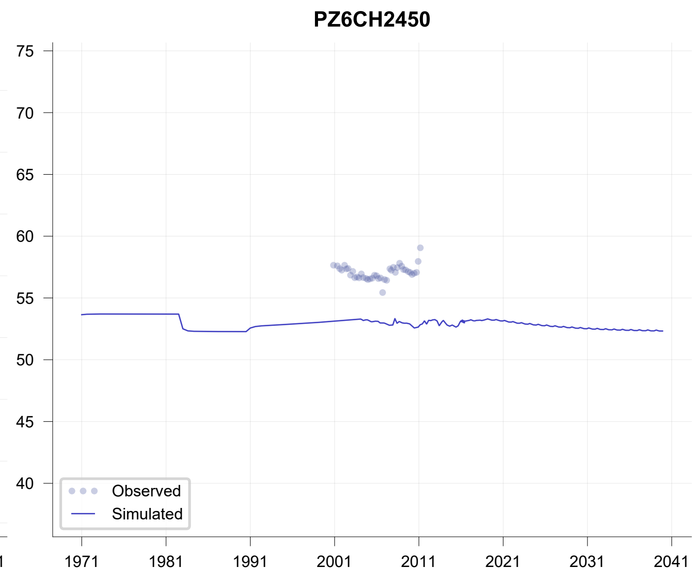


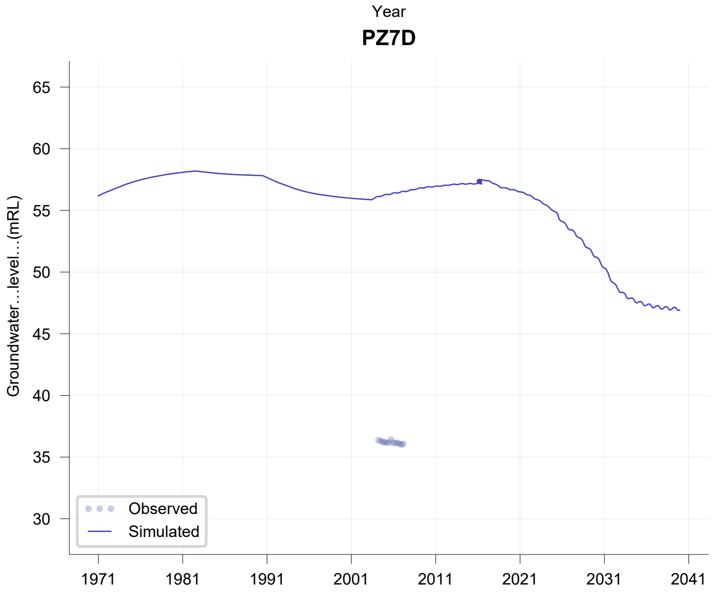
P4
Groundwater...level...(mRL)
Year
Observed
Simulated
P5
Observed
Simulated
P6
Groundwater...level...(mRL)
Year
Observed
Simulated
P8
Observed
Simulated
P9
Groundwater...level...(mRL)
Year
Simulated
PB01_ALL
Observed
Simulated
PZ1CH200
Groundwater...level...(mRL)
Year
Observed
Simulated
PZ2CH400
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041

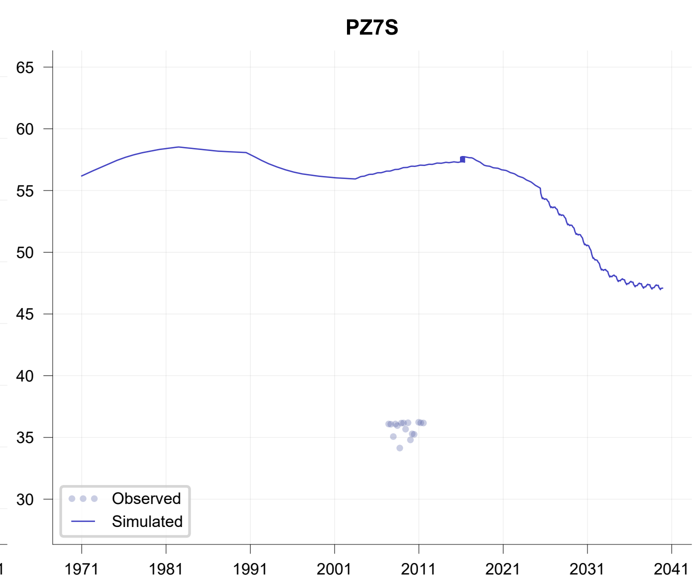

PZ3CH800
Groundwater...level...(mRL)
70
65
60
55
50
45
40
35
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041
Year

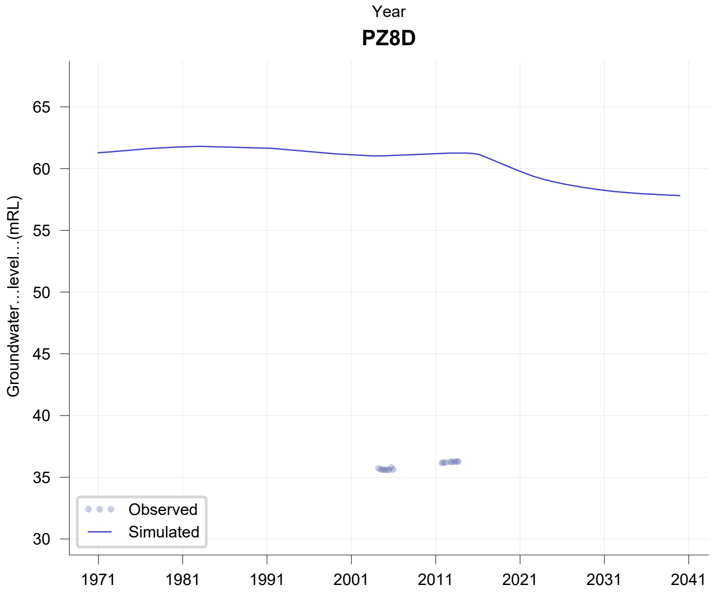

PZ4CH1380
70
65
60
55
50
45
40
35
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041

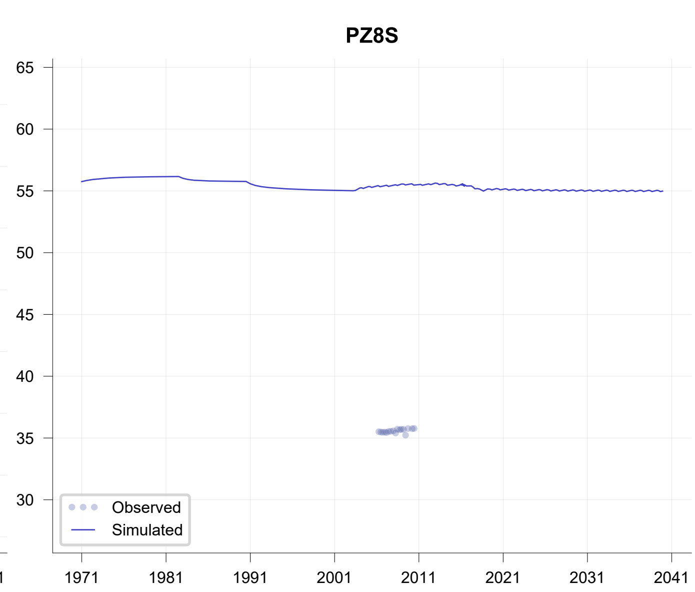

PZ5CH1800
Groundwater...level...(mRL)
70
65
60
55
50
45
40
35
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041
Year

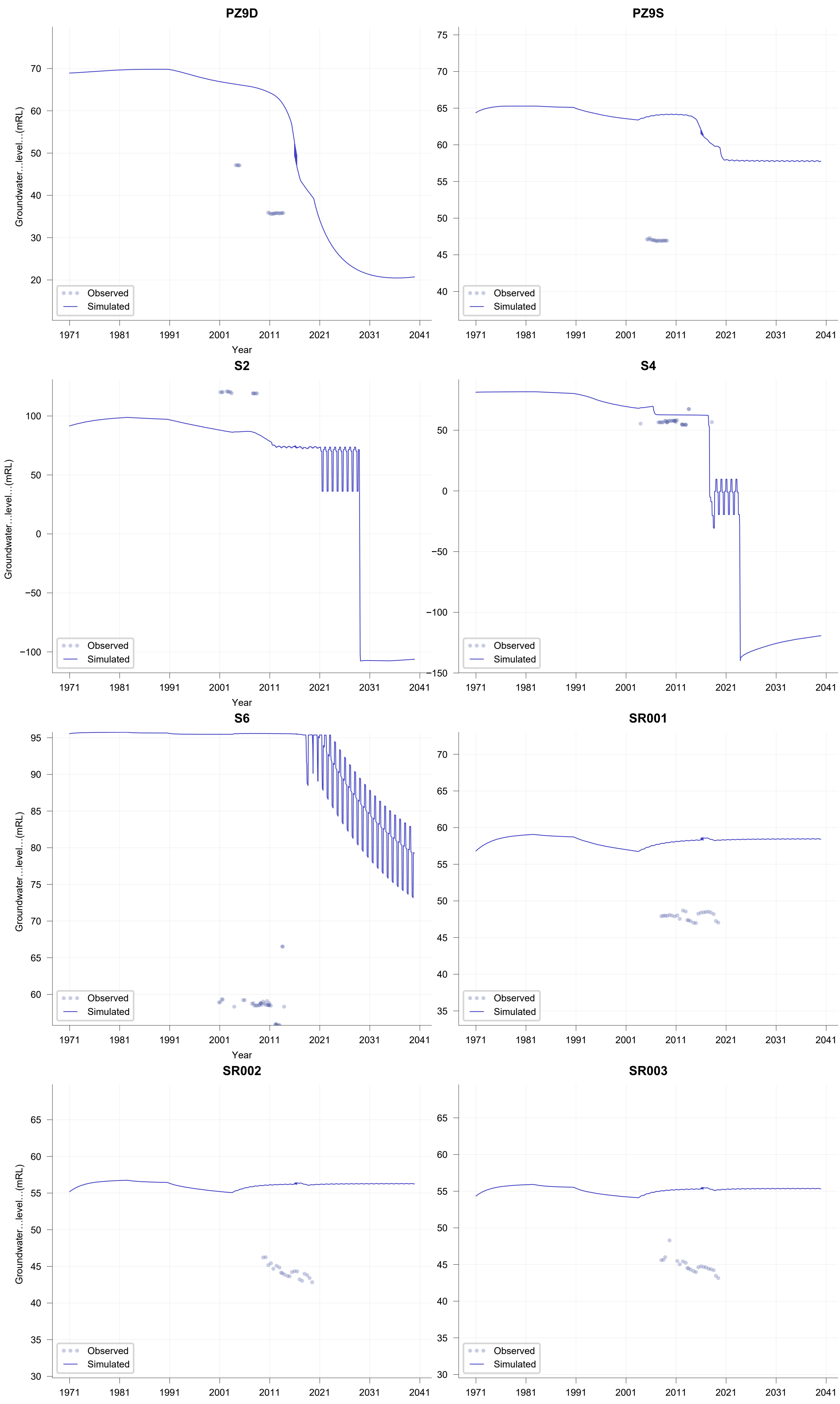

PZ6CH2450
75
70
65
60
55
50
45
40
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041

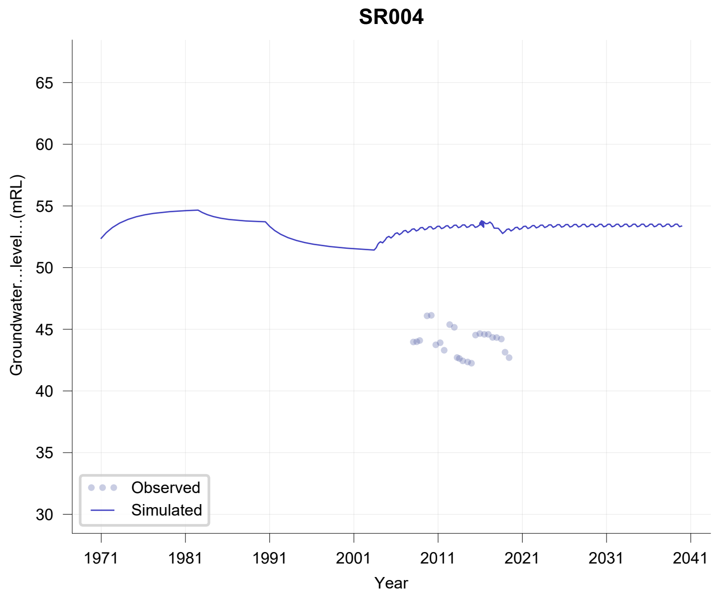

PZ7D
Groundwater...level...(mRL)
65
60
55
50
45
40
35
30
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041
Year

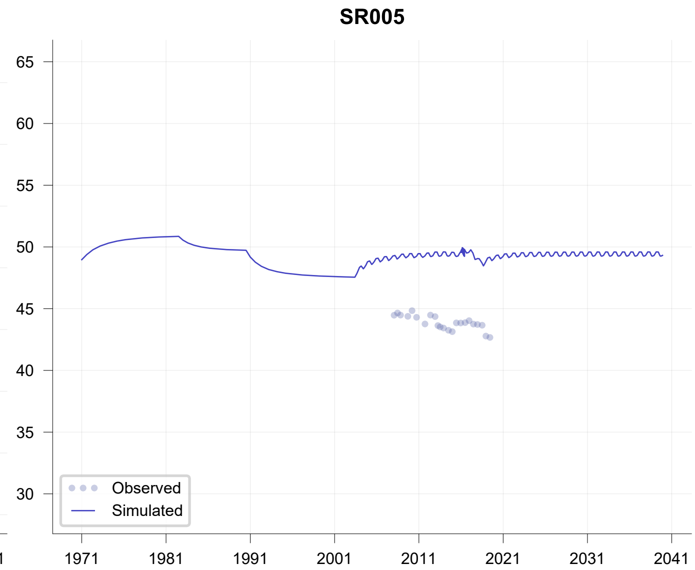

PZ7S
65
60
55
50
45
40
35
30
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041

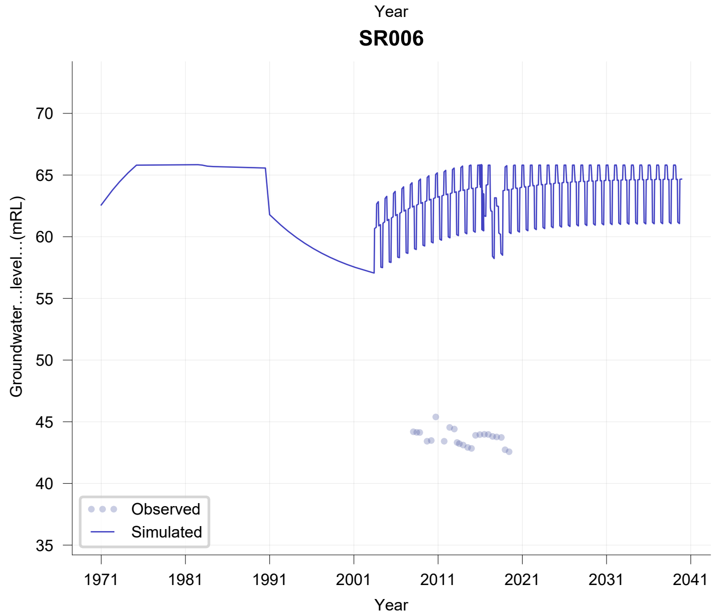

PZ8D
Groundwater...level...(mRL)
65
60
55
50
45
40
35
30
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041
Year

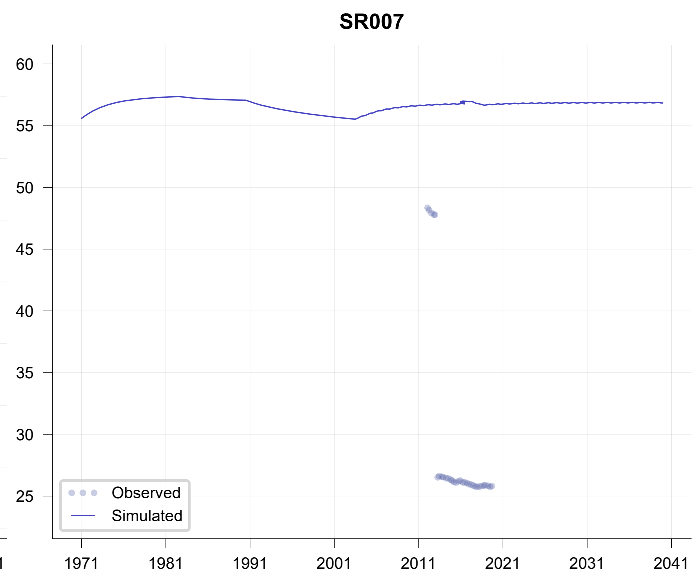

PZ8S
65
60
55
50
45
40
35
30
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041

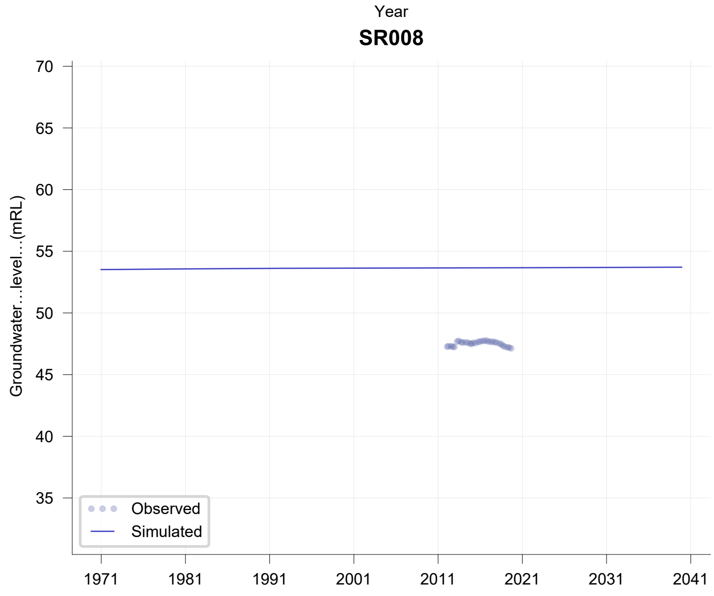

PZ9D
PZ9S
S2
S4
S6
SR001
SR002
SR003
Groundwater...level...(mRL)
Year
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041

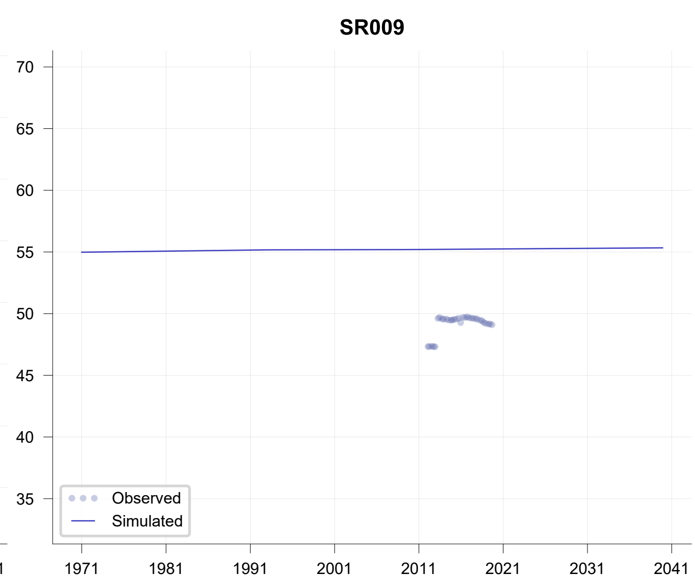

SR004
Groundwater...level...(mRL)
Year
Observed
Simulated

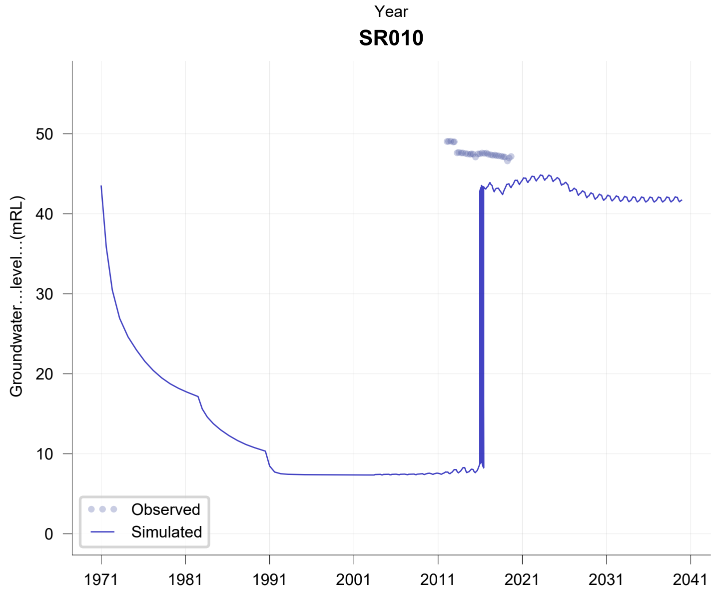

SR005
Observed
Simulated

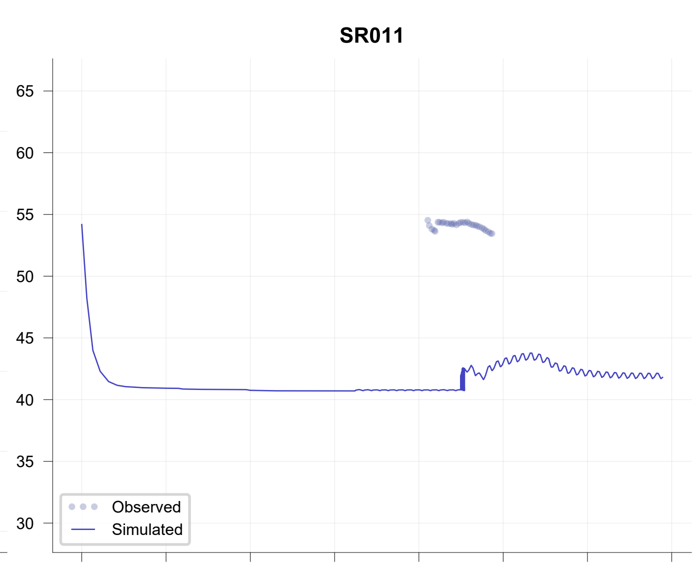

SR006
Groundwater...level...(mRL)
Year
Observed
Simulated

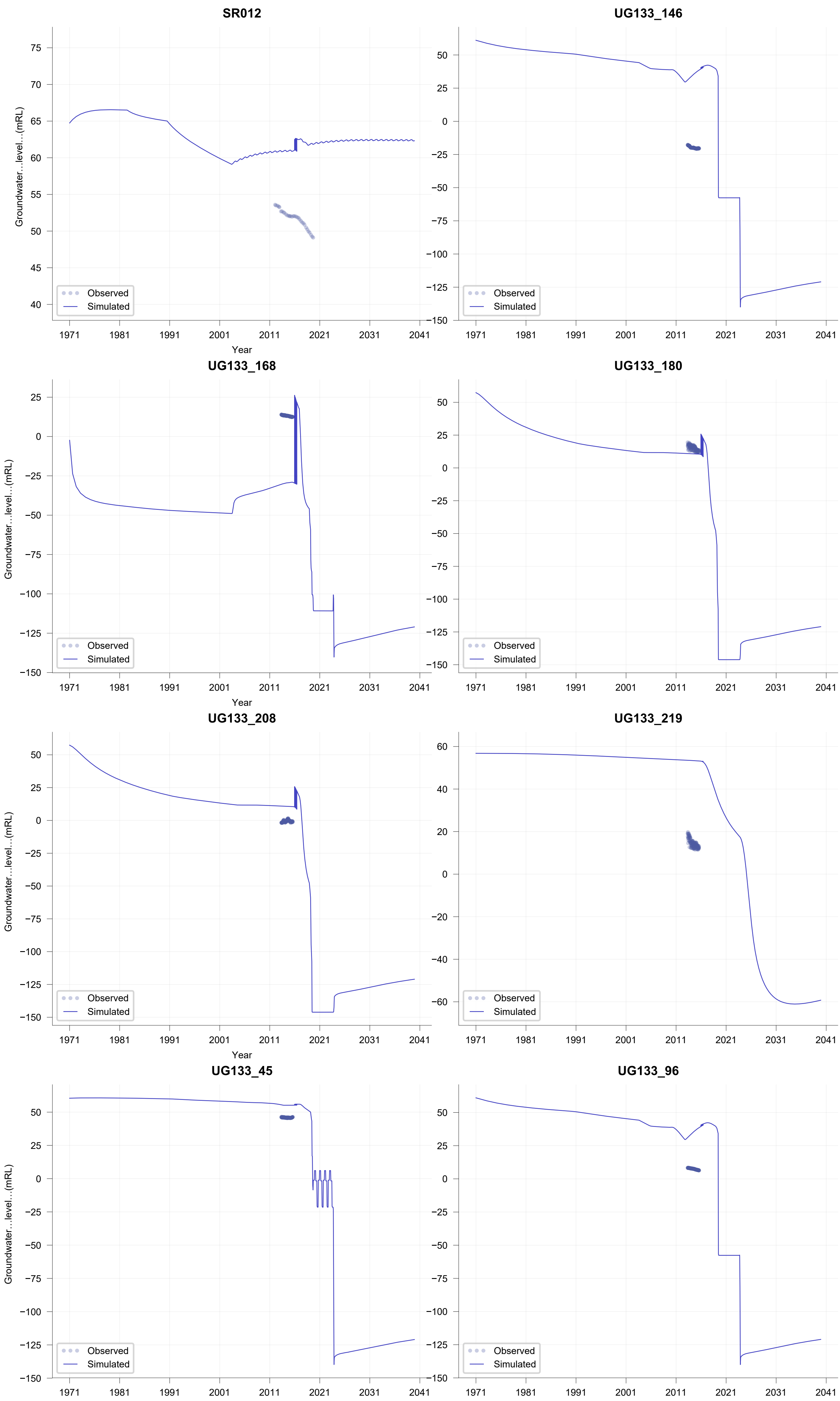

SR007
Observed
Simulated

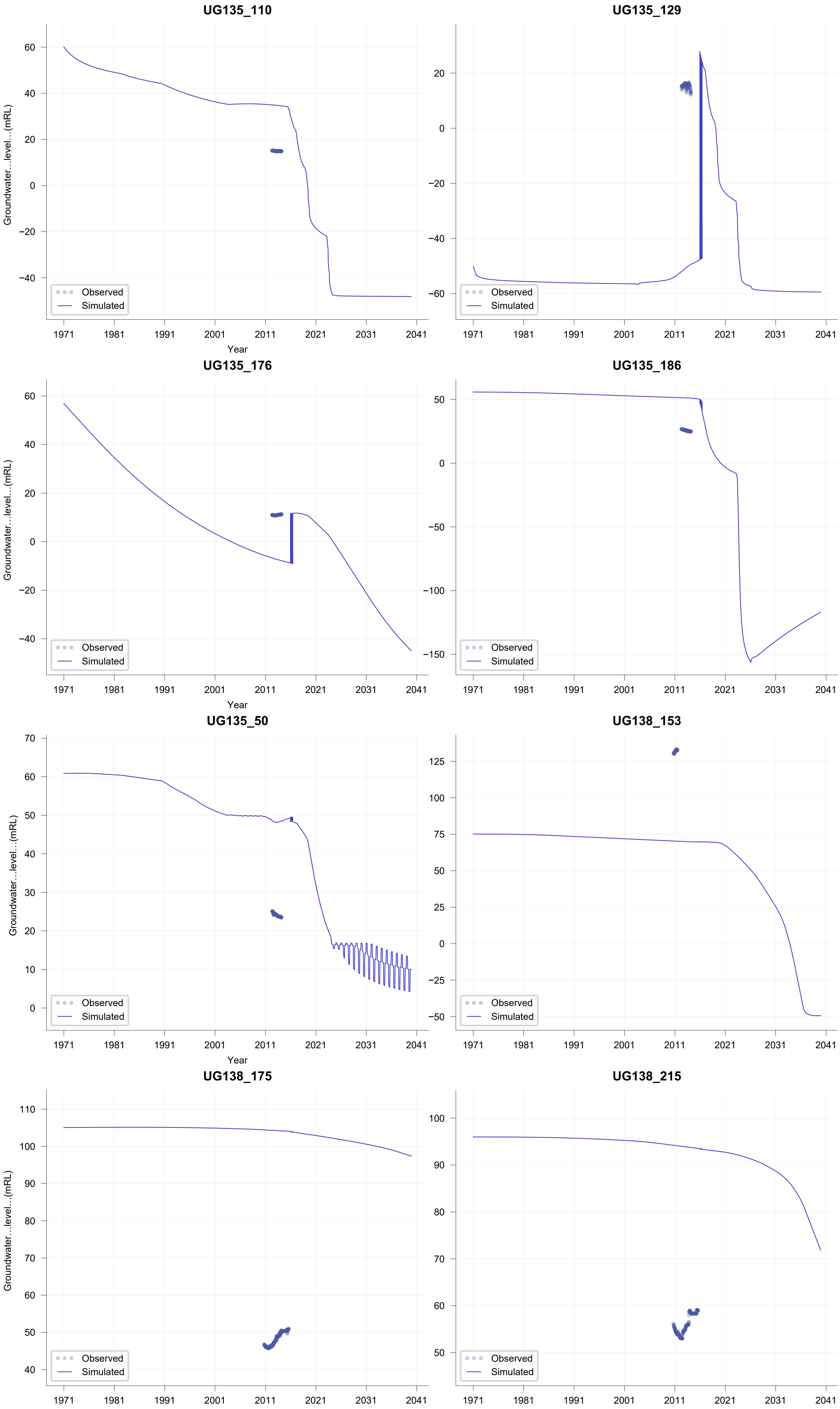

SR008
Groundwater...level...(mRL)
Year
Observed
Simulated


SR009
Observed
Simulated

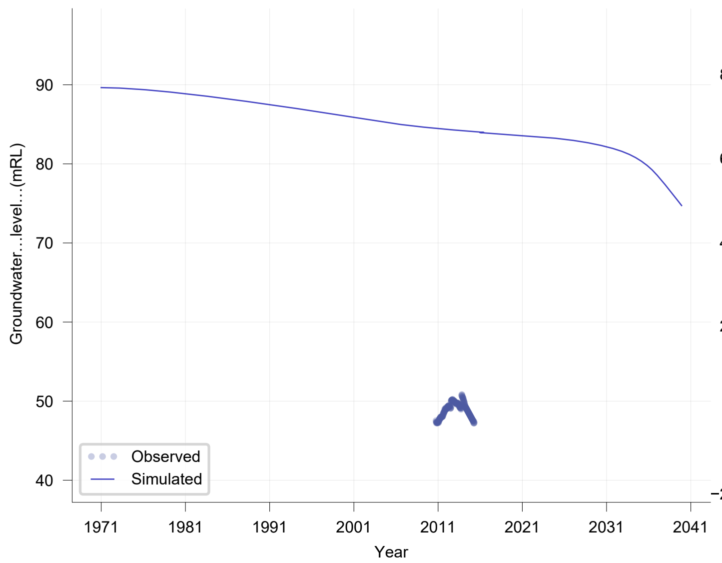

SR010
Groundwater...level...(mRL)
Year
Observed
Simulated


SR011
Observed
Simulated

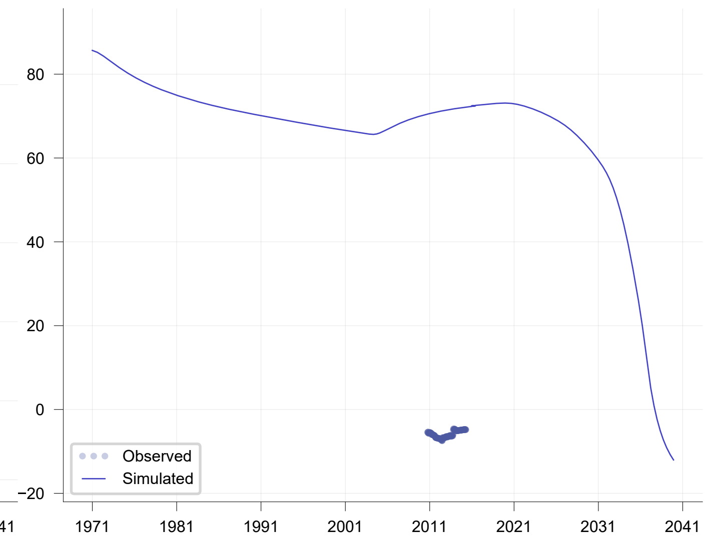

SR012
UG133_146
UG133_168
UG133_180
UG133_208
UG133_219
UG133_45
UG133_96
Groundwater...level...(mRL)
Year
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041


UG135_110
UG135_129
UG135_176
UG135_186
UG135_50
UG138_153
UG138_175
UG138_215
Groundwater...level...(mRL)
Year
1971 1981 1991 2001 2011 2021 2031 2041
Observed
Simulated

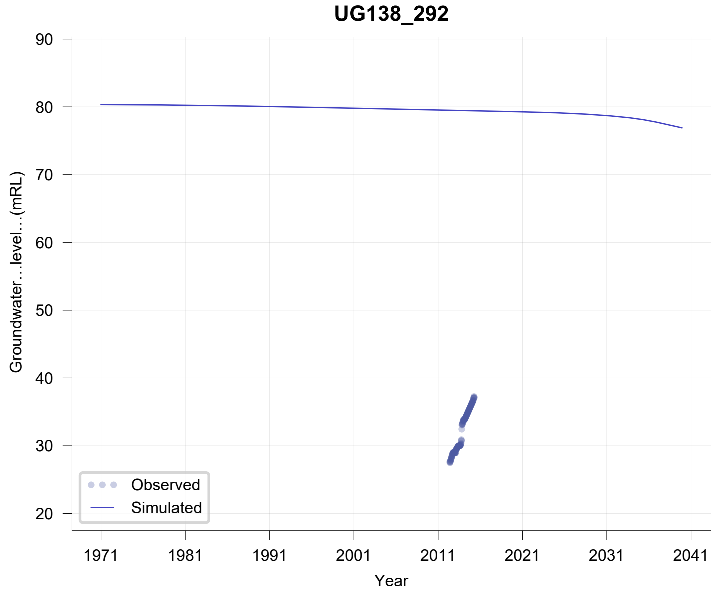
UG138_245



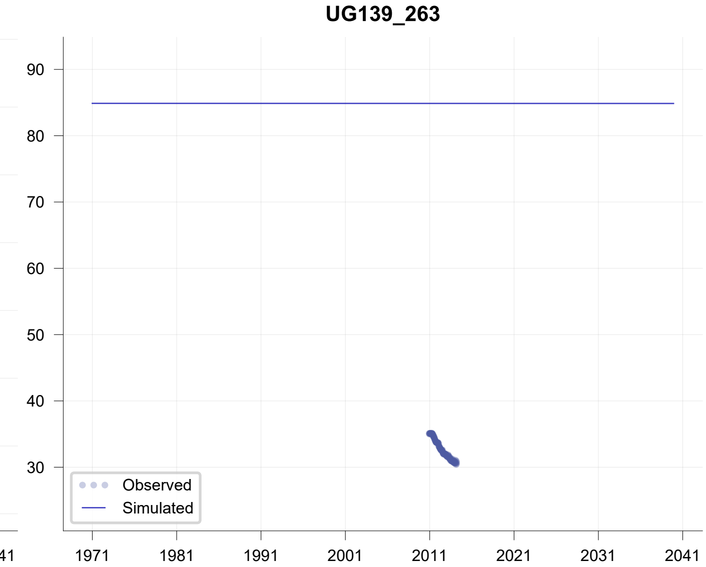
UG138_250



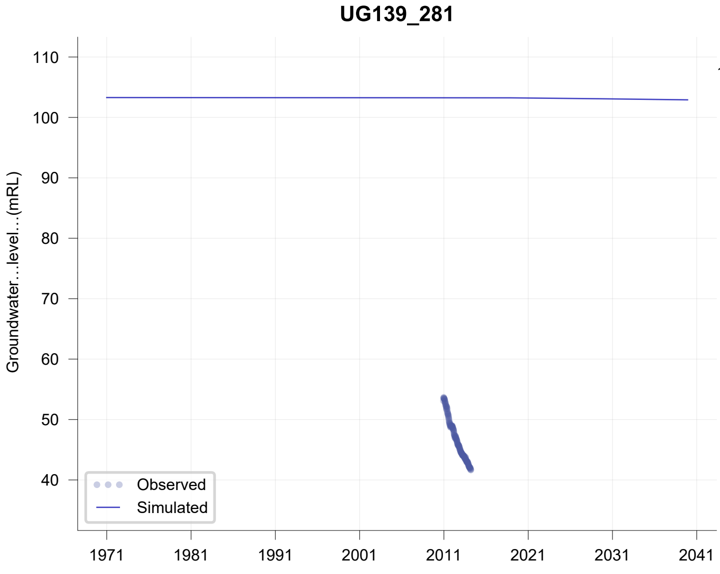
UG138_292



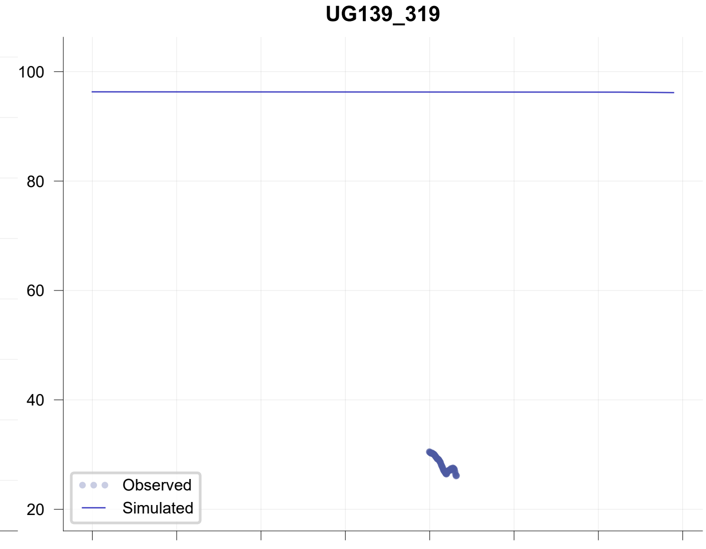
UG139_263



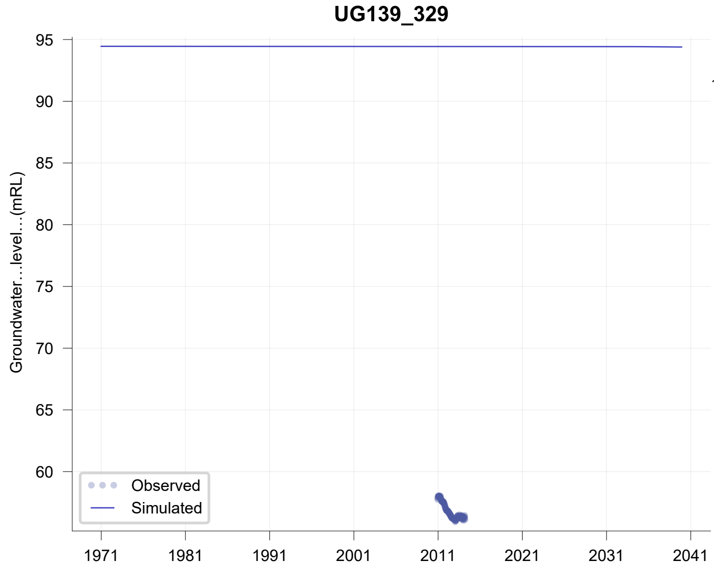
UG139_281



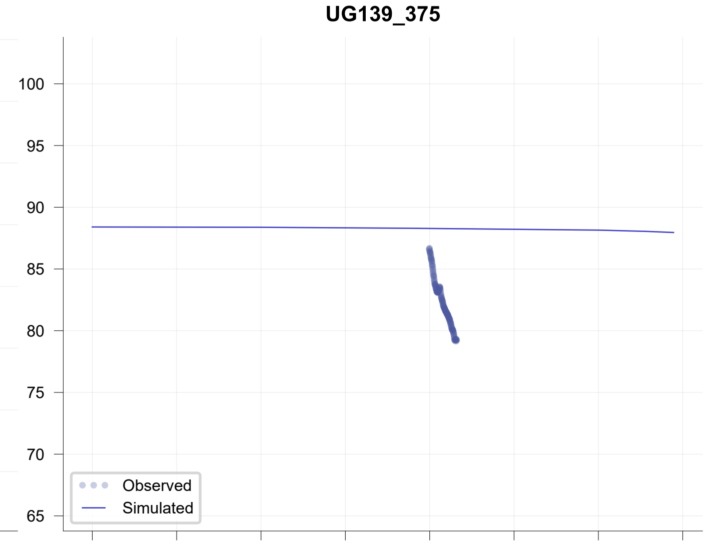
UG139_319

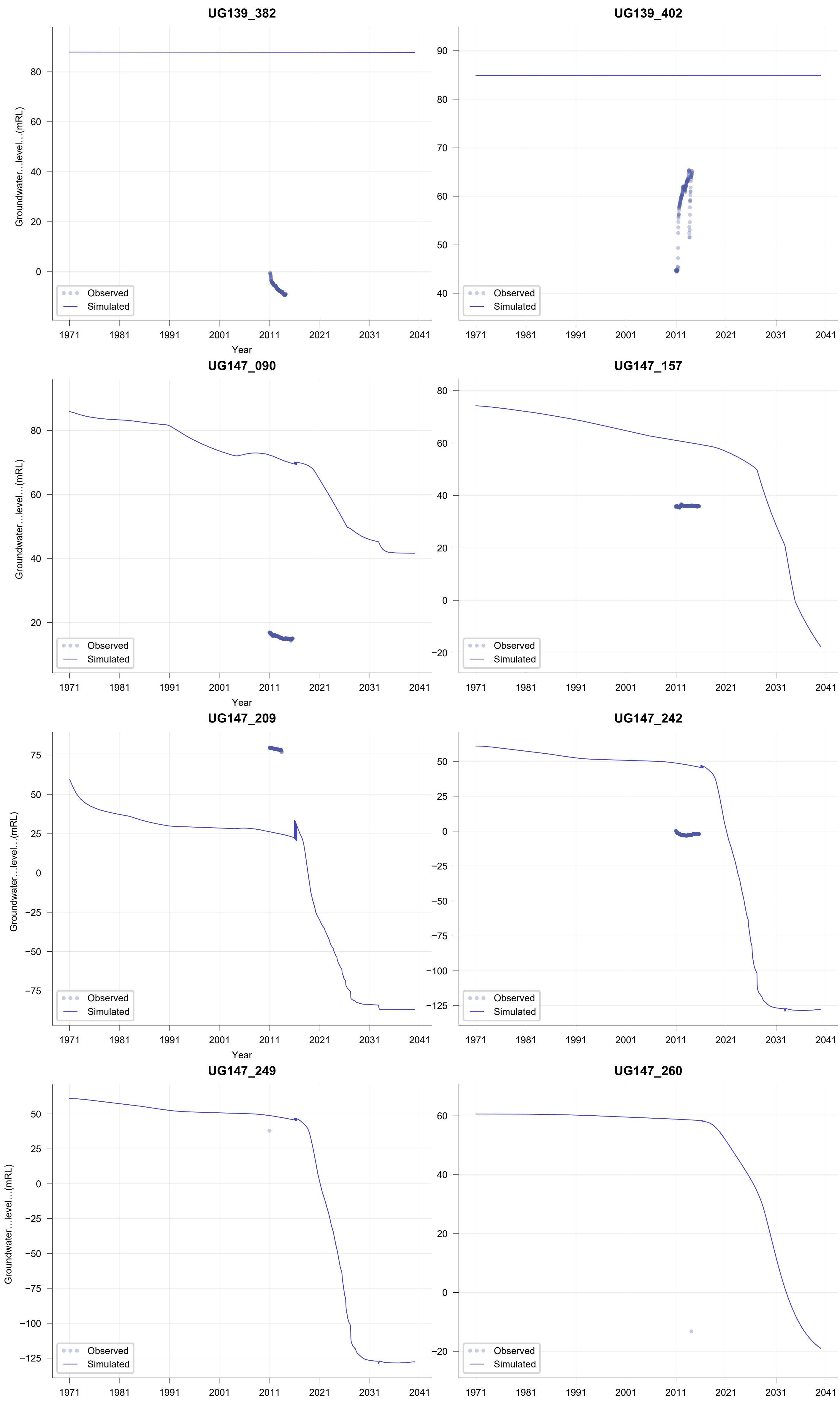


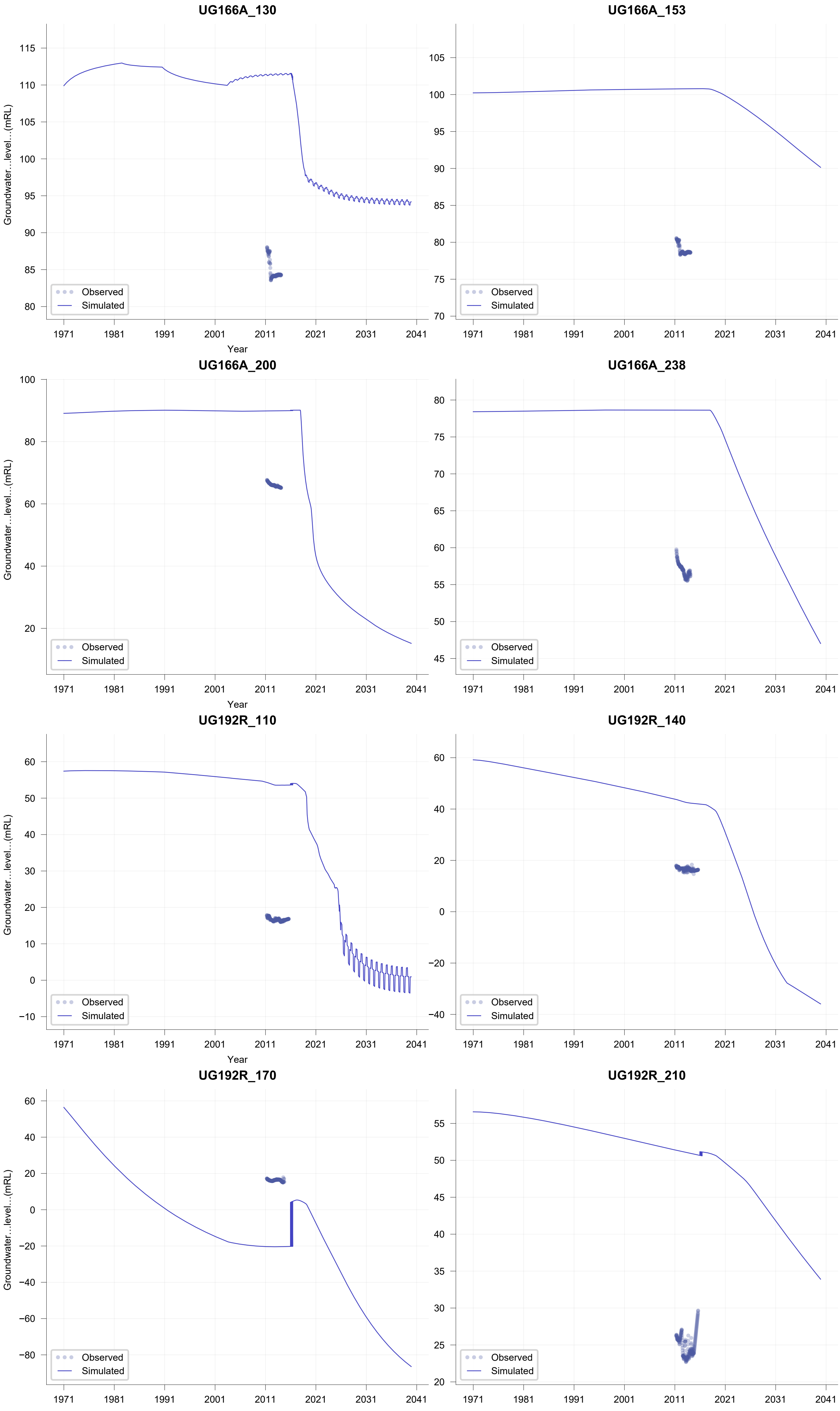
UG139_329

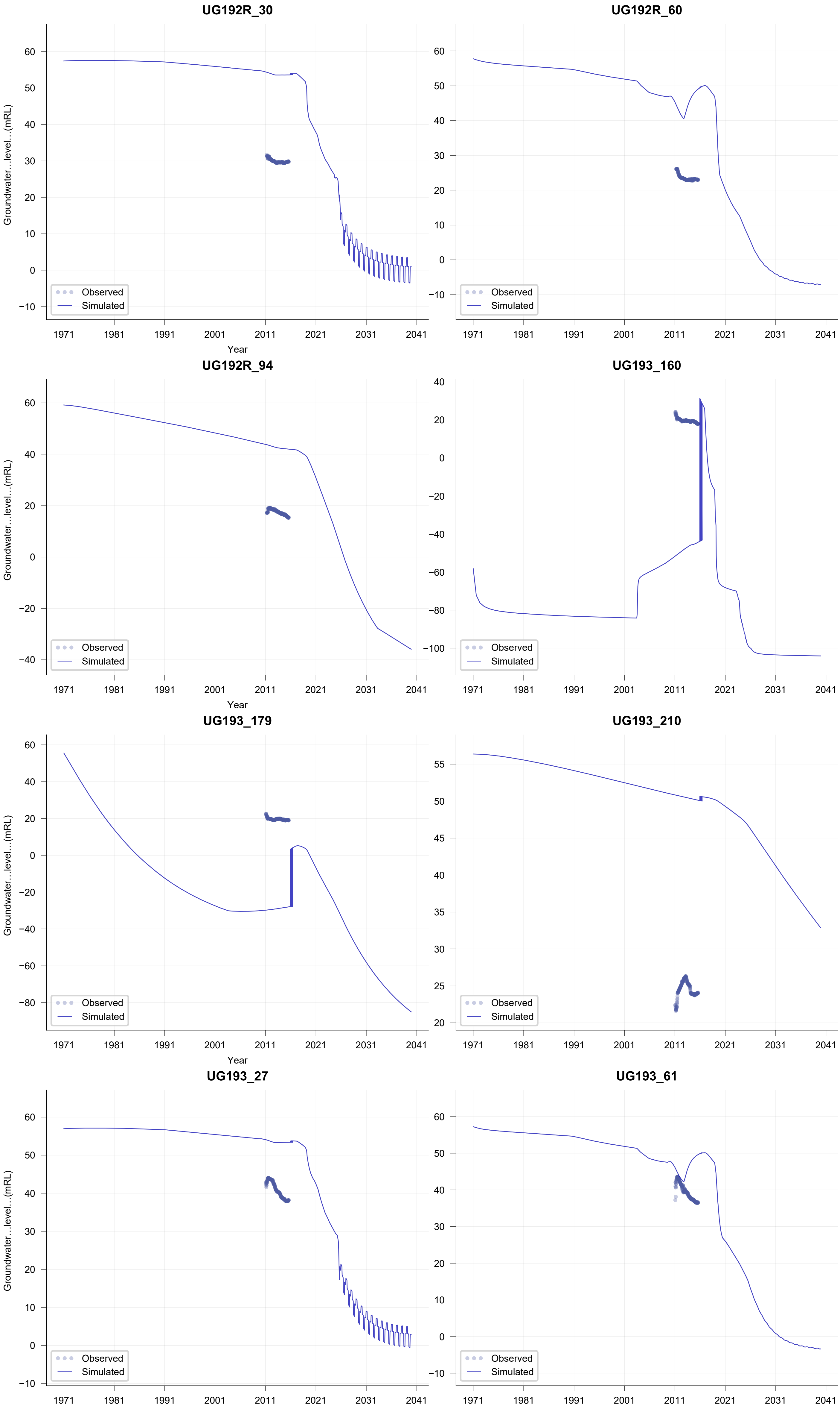


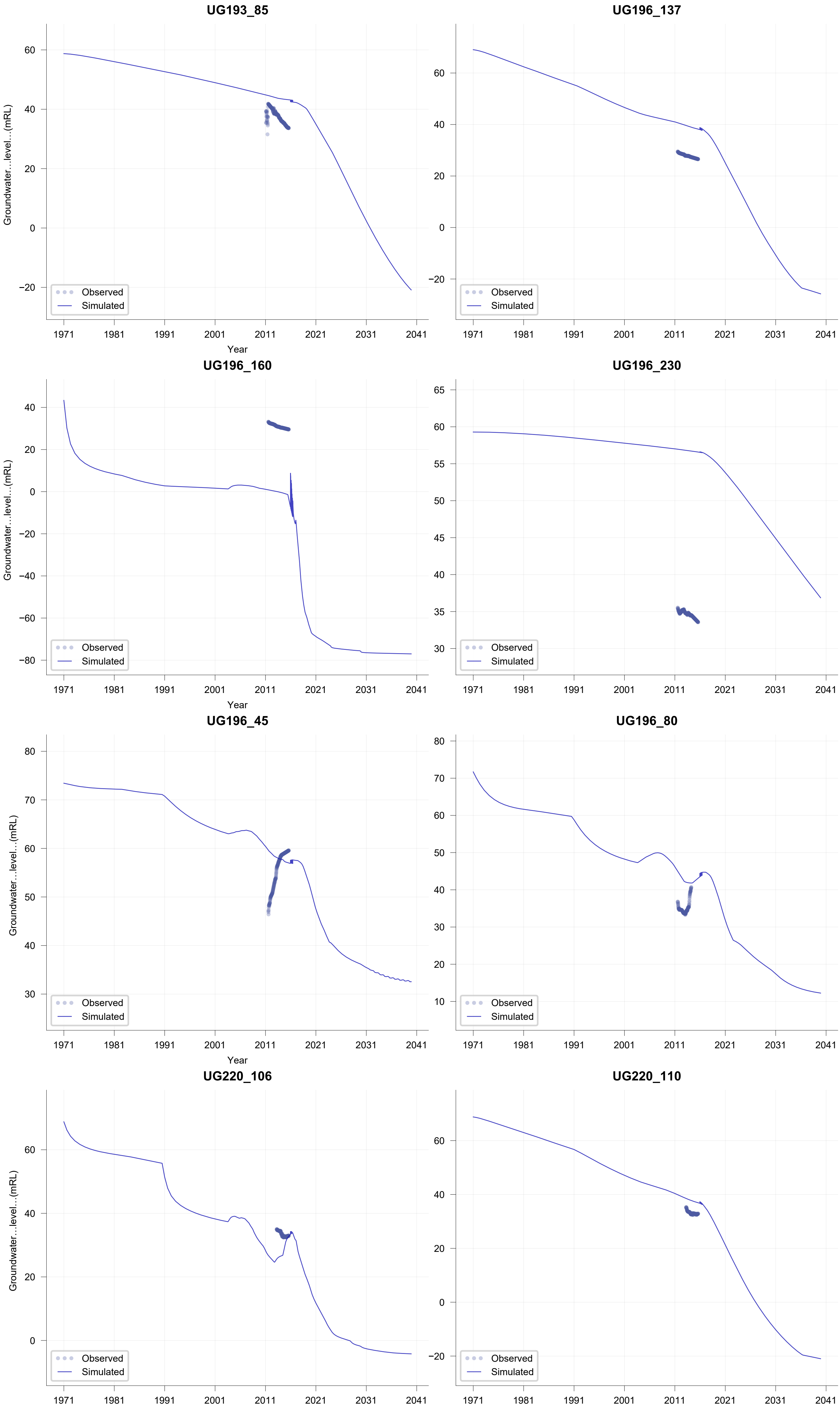
UG139_375

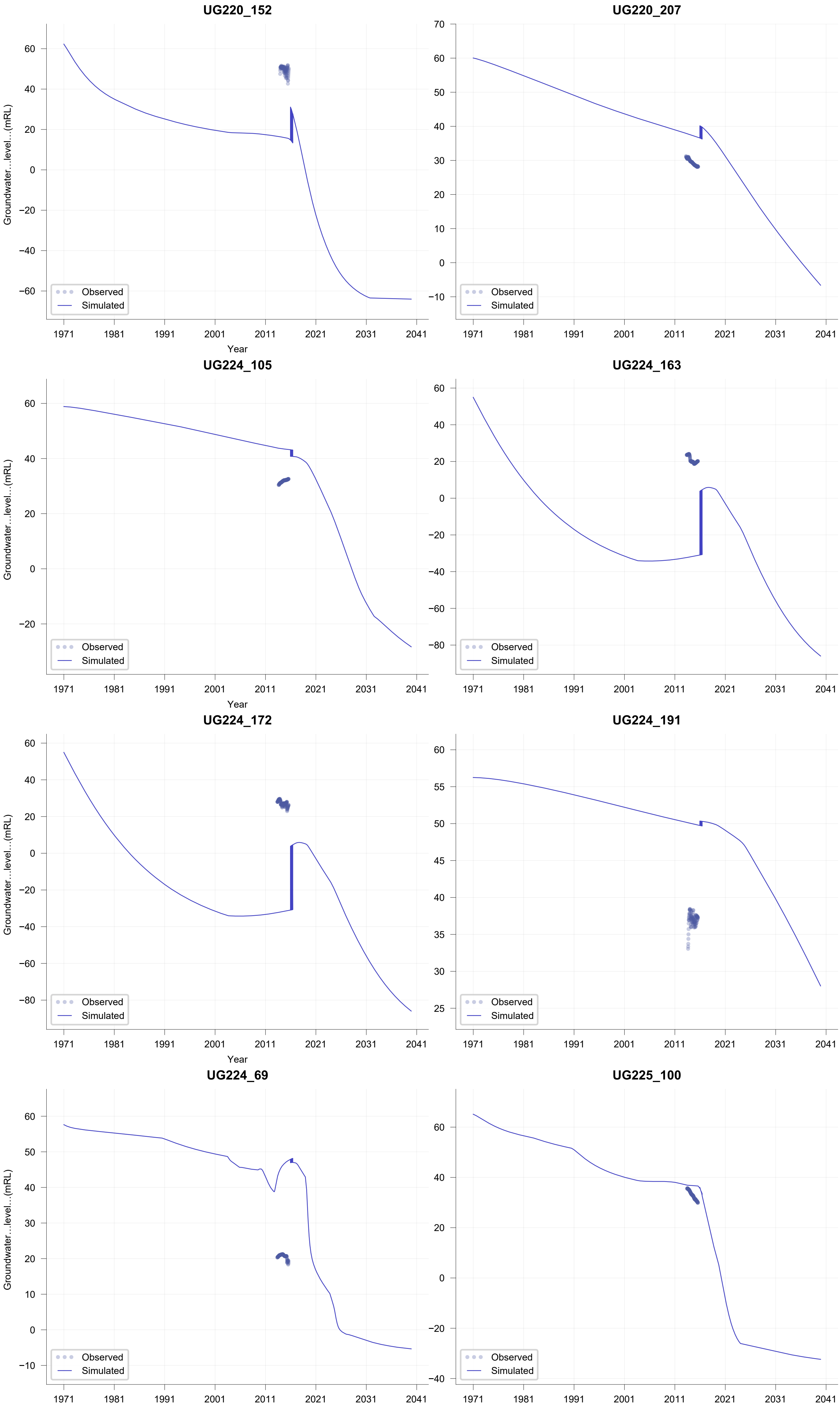


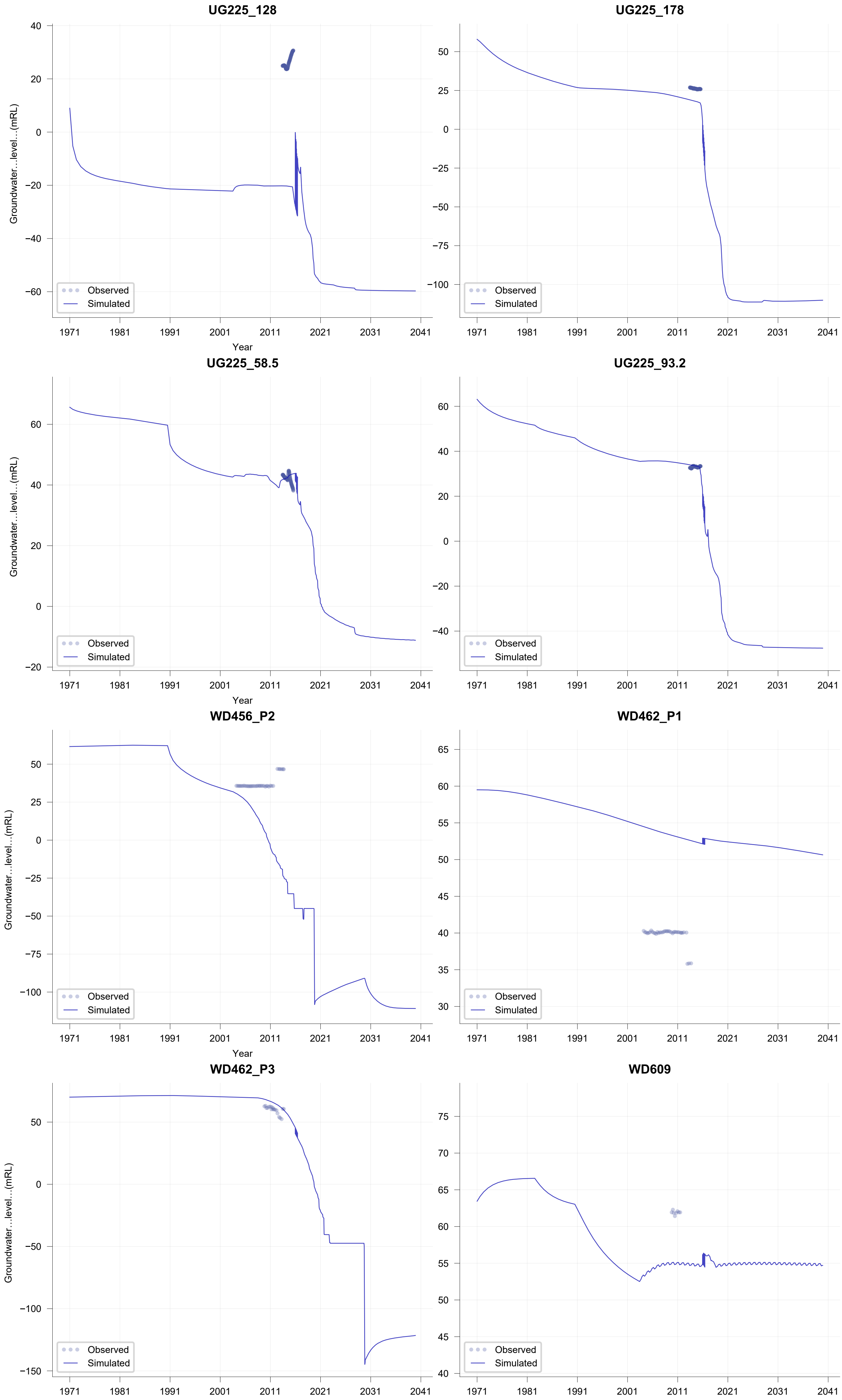

UG139_382
UG139_402
UG147_090
UG147_157
UG147_209
UG147_242
UG147_249
UG147_260
Groundwater...level...(mRL)
Year
Observed
Simulated
1971 1981 1991 2001 2011 2021 2031 2041

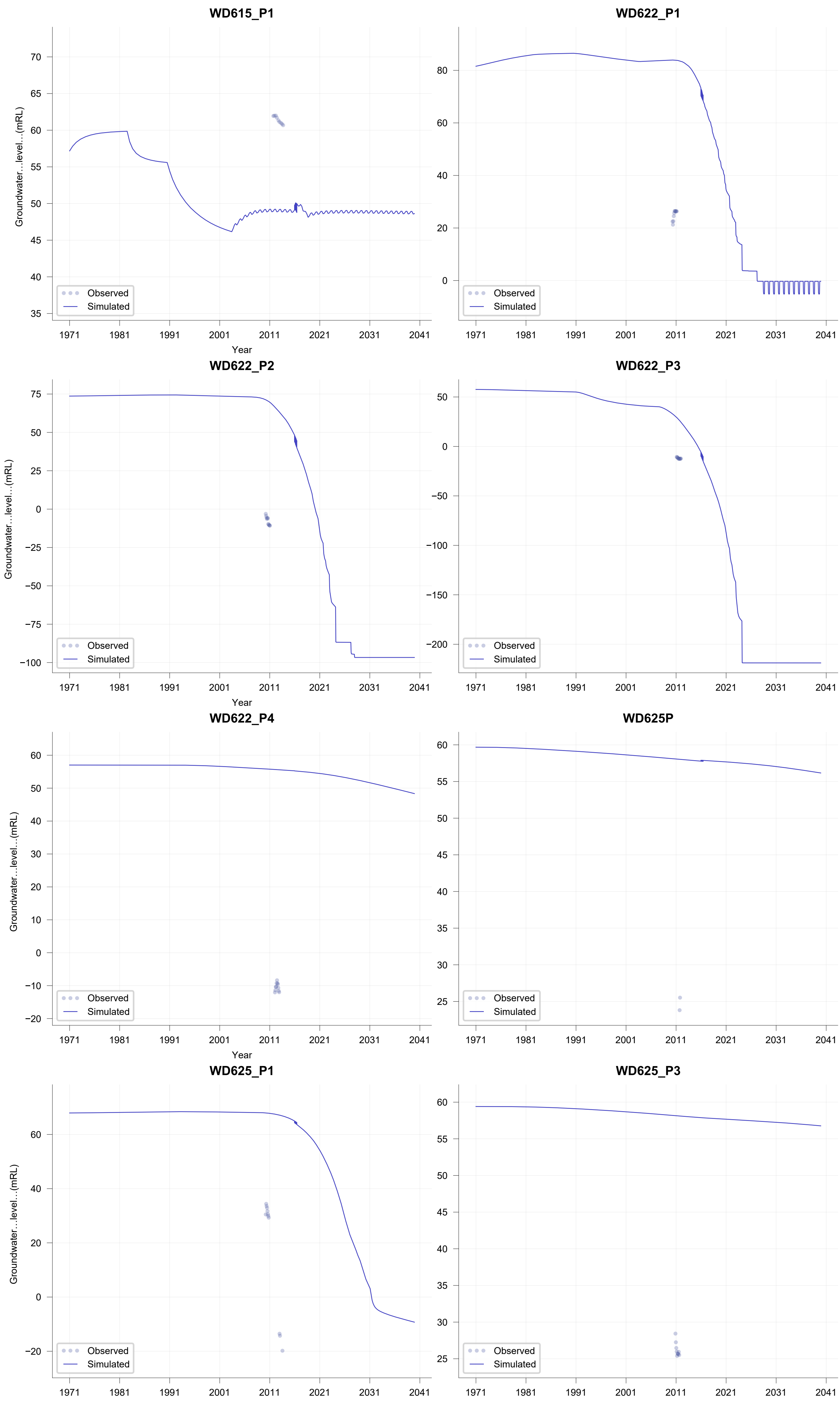

UG166A_130
UG166A_153
UG166A_200
UG166A_238
UG192R_110
UG192R_140
UG192R_170
UG192R_210
Groundwater...level...(mRL)
Year
1971
1981
1991
2001
2011
2021
2031
2041
Observed
Simulated

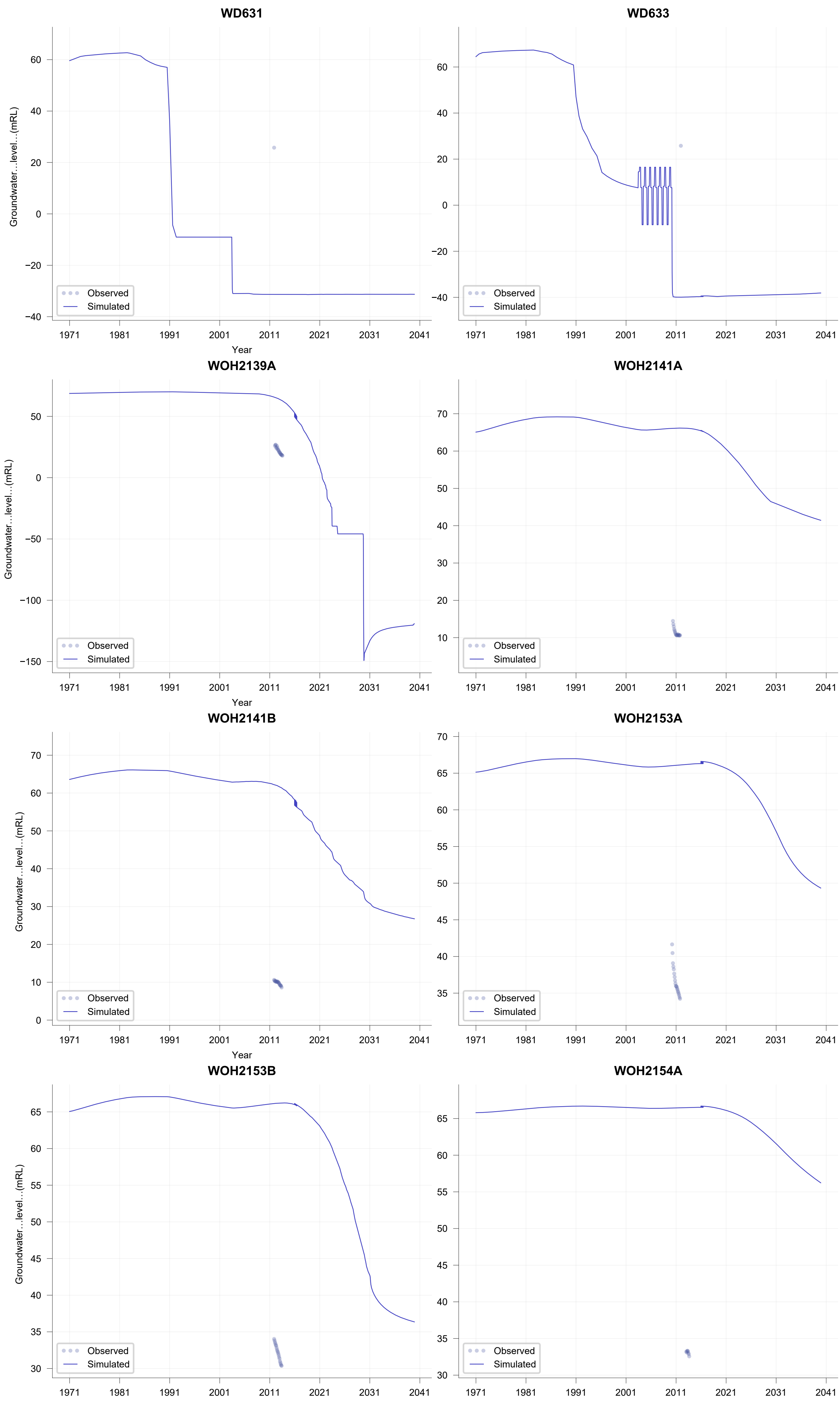

UG192R_30
UG192R_60
UG192R_94
UG193_160
UG193_179
UG193_210
UG193_27
UG193_61
Groundwater...level...(mRL)
Year
Observed
Simulated
1971 1981 1991 2001 2011 2021 2031 2041

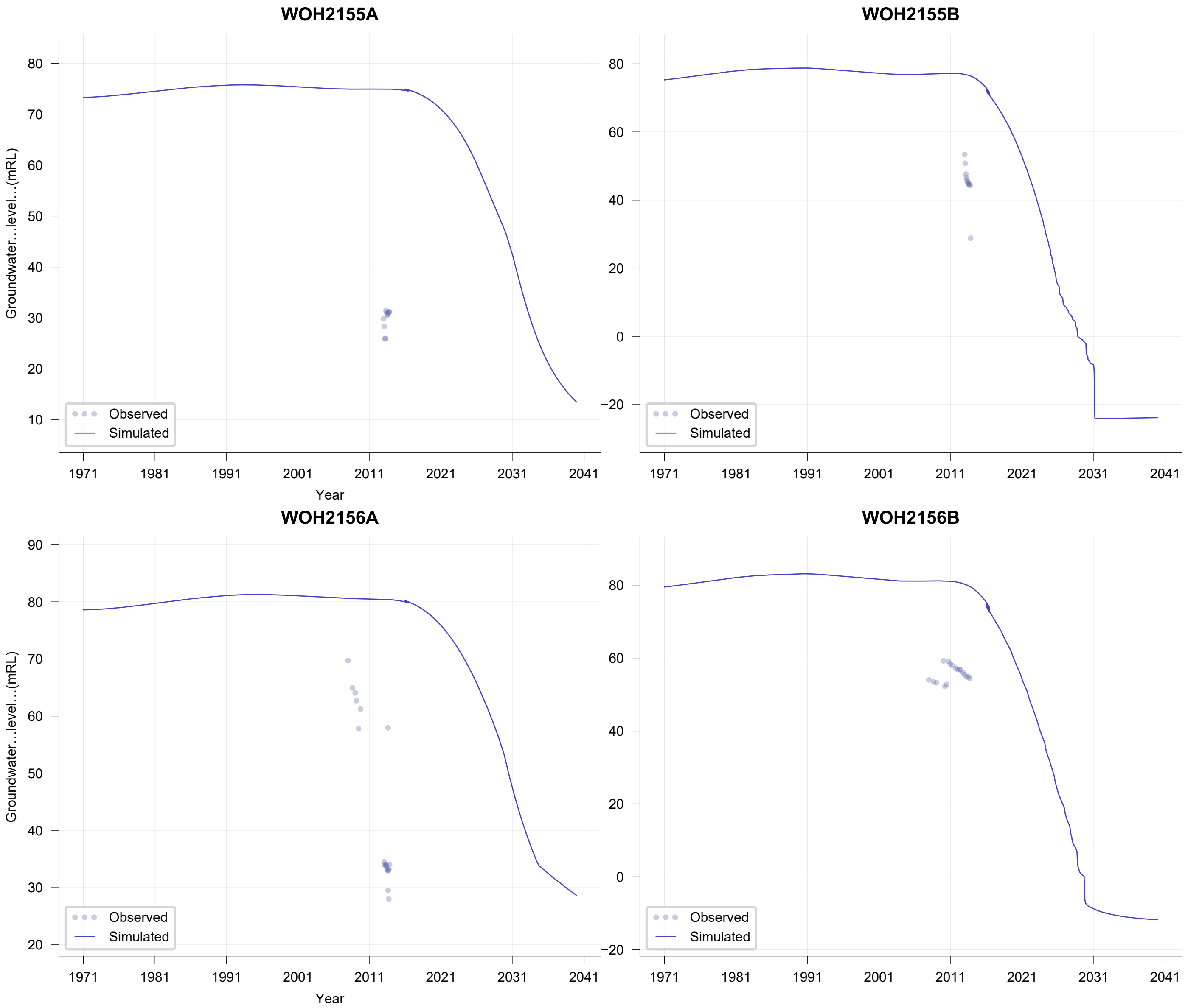

UG193_85
UG196_137
UG196_160
UG196_230
UG196_45
UG196_80
UG220_106
UG220_110
Groundwater...level...(mRL)
Year
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041


UG220_152
UG220_207
UG224_105
UG224_163
UG224_172
UG224_191
UG224_69
UG225_100
Groundwater...level...(mRL)
Year
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041


UG225_128
UG225_178
UG225_58.5
UG225_93.2
WD456_P2
WD462_P1
WD462_P3
WD609
Groundwater...level...(mRL)
Year
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041


WD615_P1
WD622_P1
WD622_P2
WD622_P3
WD622_P4
WD625P
WD625_P1
WD625_P3
Groundwater...level...(mRL)
Year
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041


WD631
WD633
WOH2139A
WOH2141A
WOH2141B
WOH2153A
WOH2153B
WOH2154A
Groundwater...level...(mRL)
Year
1971
1981
1991
2001
2011
2021
2031
2041
Observed
Simulated


WOH2155A
WOH2155B
WOH2156A
WOH2156B
Groundwater...level...(mRL)
Year
Observed
Simulated
1971
1981
1991
2001
2011
2021
2031
2041

ASIA PACIFIC OFFICES

BRISBANE
Level 2, 15 Astor Terrace
Spring Hill QLD 4000
Australia
T: +61 7 3858 4800
F: +61 7 3858 4801

CANBERRA
GPO 410
Canberra ACT 2600
Australia
T: +61 2 6287 0800
F: +61 2 9427 8200

DARWIN
5 Foelsche Street
Darwin NT 0800
Australia
T: +61 8 8998 0100
F: +61 2 9427 8200

MACKAY
21 River Street
Mackay QLD 4740
Australia
T: +61 7 3181 3300

MELBOURNE
Suite 2, 2 Domville Avenue
Hawthorn VIC 3122
Australia
T: +61 3 9249 9400
F: +61 3 9249 9499

NEWCASTLE
10 Kings Road
New Lambton NSW 2305
Australia
T: +61 2 4037 3200
F: +61 2 4037 3201

PERTH
Ground Floor, 503 Murray Street
Perth WA 6000
Australia
T: +61 8 9422 5900
F: +61 8 9422 5901

ROCKHAMPTON
rockhampton@slrconsulting.com
M: +61 407 810 417

SYDNEY
2 Lincoln Street
Lane Cove NSW 2066
Australia
T: +61 2 9427 8100
F: +61 2 9427 8200

TAMWORTH
PO Box 11034
Tamworth NSW 2340
Australia
M: +61 408 474 248
F: +61 2 9427 8200

TOWNSVILLE
Level 1, 514 Sturt Street
Townsville QLD 4810
Australia
T: +61 7 4722 8000
F: +61 7 4722 8001

AUCKLAND
68 Beach Road
Auckland 1010
New Zealand
T: +64 27 441 7849

NELSON
5 Duncan Street
Port Nelson 7010
New Zealand
T: +64 274 898 628

NEW PLYMOUTH
Level 2, 10 Devon Street East
New Plymouth 4310
New Zealand
T: +64 0800 757 695

HVO s240 Rehab Maintenance Schedule 2019-2020 - West Pit - [31 DECEMBER 2019 UPDATE]

Location	Maintenance	Relative Priority	2019 Q1	2019 Q2	2019 Q3	2019 Q4	2020 Q1	2020 Q2	2020 Q3	2020 Q4	s240 Issue
HVOWES201101 [WS190 above Dam 6W, 2.2ha]		**5**									
Priorities	Weed control										
1. weed control	Selective seeding (if req)										19Q2
2. manage for re-disturbance											
HVOWES201301 [West Wilton, 3.7ha]		**4**									
Priorities	Weed control			✓							
1. weed control	Selective seeding (if req)										19Q2
HVOWES201401 [West Centre 230, 8ha]		**2**									
Priorities	Weed control					✓					
1. weed control	Soil investigation					✓					19Q2
2. understanding growth medium	Soil amelioration (if req)										
	Selective seeding (if req)										
HVOWES201501 [West North 230 Flat, 26.2ha]		**3**									
Priorities	Routine inspection (watching brief)				✓	✓					
1. weed control	Weed control										19Q2
2. monitor trajectory	Re-monitor (if req)										
HVOWES201502 [West South 230 Flat, 29.2ha]		**2**									
Priorities	Weed control										
1. weed control	Selective seeding (if req)										19Q2
HVOWES201601 [West North 190, 6.2ha]		**1**									
Priorities	Re-monitoring, Soil investigation		✓								
1. additional monitoring	Soil amelioration (if req)										Veg, Weeds
2. weed control	Weed control / spray out				✓	✓					
3. understanding growth medium	Seeding										
HVOWES201602 [West South 230 Flat, 4ha]		**5**									
Priorities	Weed control										
1. weed control	Selective seeding (if req)										19Q2
	3										
HVOWES201603 [West North 230 Flat, 6.7ha]		**3**									
Priorities	Soil investigation		✓								
1. weed control	Weed control				✓						19Q2
	Selective seeding (if req)										
HVOWES201604 [Wilton 210, 3.7ha]		**3**									
Priorities	Weed control			✓							
1. weed control	Selective seeding (if req)										Weeds
2. understanding growth medium											
3. increase diversity											
HVOWES201605 [West South 230 - Nth Slope, 14.2ha]		**2**									
Priorities	Routine inspection (watching brief)				✓						
1. weed control	Weed control										19Q2
2. monitor trajectory (natives sown 2018)											
HVOWES201701 [West North 190, 6.6ha]		**1**									
Priorities	Weed control			✓	✓	✓					
1. weed control	Scope contour repair										19Q2
2. monitor trajectory	Contour repair										
HVOWES201702 [West Wilton 210 - Nth Amphitheatre, 3.6ha]		**2**									
Priorities	Weed control		✓								
1. weed control	Soil investigation		✓								19Q2
2. understanding growth medium / degraded area issues	Develop intervention plan										
3. intervention plan development for degraded portion	Plan execution										
HVOWES201703 [West South 230 - Nth Slope, 13.1ha]		**4**									
Priorities	Weed control										
1. Weed control	Selective seeding (if req)										19Q2
HVOWES201704 [West South 230 Flat, 13ha]		**2**									
Priorities	Weed control										
1. weed control	Soil investigation					✓					19Q2
2. understanding growth medium	Develop intervention plan										
3. intervention plan development	Plan execution										

Notes:

Work to occur across the periods shown, however may not occur in all periods shown.

Relative priorities balance addressing at-risk areas with maintaining areas demonstrating favourable trajectories.

2020 work plans are indicative only. Final 2020 plans to be informed by observations and trajectory at 2019 monitoring events, and will be detailed in annual reporting.

Changes to work plans may occur due to weather events and climatic influences. Where work components are not undertaken details will be provided in annual reporting.

Legend - Rehab Trajectory (after CPS monitoring)

Blue	Tracking towards success but needs work
Yellow	Stable but need work to improve
Orange	Failing
Red	Failed
Pink	Not monitored

Legend - planned work

Dark grey	Primary task timing
Light grey	Secondary timing (contingency / follow-up as needed)

Legend - s240 Issue

Veg, Weeds	2018 TARP Monitoring event & event trigger(s)
19Q2	2019 Additional sites monitoring event
GMD Rollback	Failed block - phase reversion to Growth Med. Dev.

Version 4.0; 31/12/19

HVO s240 Rehab Maintenance Schedule 2019-2020 - Riverview Pit - [31 DECEMBER 2019 UPDATE]

Location	Maintenance	Relative Priority	2019 Q1	2019 Q2	2019 Q3	2019 Q4	2020 Q1	2020 Q2	2020 Q3	2020 Q4	s240 Issue
HVORIV201401 [Riverview 145, 5.8ha]		3									
Priorities	Weed control										Weeds
1. weed control	Selective seeding (if req)										
HVORIV201402 [Riverview 145, 10ha]		3									
Priorities	Weed control										Weeds
1. weed control	Selective seeding (if req)										
HVORIV201403 [Riverview 145/155, 4.8ha]		1									
Priorities	Soil investigation		✓								Veg, Weeds
1. weed control	Soil amelioration (if req)										
2. soil amelioration	Weed control										
3. manage for re-disturbance	Selective seeding (if req)										
HVORIV201404 [Riverview 155, 8.4ha]		1									
Priorities	Soil investigation		✓								Veg
1. weed control	Weed control / spray out										
2. soil amelioration	Soil amelioration										
3. manage for re-disturbance	Seeding										
HVORIV201405 [Riverview 155, 14.3ha]		1									
Priorities	Soil investigation		✓								Veg / GMD Rollback
1. weed control	Weed control / spray out				✓						
2. manage for re-disturbance	Soil amelioration										
	Seeding										
HVORIV201406 [Riverview East Amphitheatre & adjacent 155, 5.1ha]		4									
Priorities	Weed control			✓							19Q2
1. weed control	Soil investigation					✓					
2. monitor trajectory	Selective seeding (if req)										
3. manage for re-disturbance											
HVORIV201407 [Riverview 125, 7.8ha]		4									
Priorities	Weed control										19Q2
1. weed control											
2. manage for re-disturbance											
HVORIV201501 [Riverview 155, 2.4ha]		3									
Priorities	Weed control										Weeds
1. weed control	Selective seeding (if req)										
HVORIV201503 [Riverview 145, 6.2ha]		3									
Priorities	Weed control										Weeds
1. weed control	Selective seeding (if req)										
HVORIV201601A [Riverview Western Amphitheatre, 3ha]		3									
Priorities	Weed control			✓							19Q2
1. weed control											
2. monitor trajectory											
3. manage for re-disturbance											
HVORIV201701 [Riverview Glider 125 Flat, 10ha]		3									
Priorities	Weed control		✓								19Q2
1. weed control											
2. monitor trajectory (natives sown 2018)											
HVORIV201702 [Riverview Glider 110 North Batter, 4.4ha]		3									
Priorities	Weed control		✓								19Q2
1. weed control											
2. monitor trajectory (natives sown 2018)											
HVORIV201703 [Riverview Glider 110 South Batter, 5.4ha]		2									
Priorities	Weed control		✓								19Q2
1. weed control											
2. monitor trajectory (natives sown 2018)											
HVORIV201801 [Riverview 155, 2.2ha]		3									
Priorities	Weed control		✓								19Q2
1. weed control											
2. monitor trajectory											
HVORIV201802 [RivNorth West Batter, 18.8ha]		2									
Priorities	Weed control			✓							19Q2
1. weed control											
2. monitor trajectory											
HVORIV201803 [RivNorth North Batter, 16.3ha]		2									
Priorities	Weed control		✓								19Q2
1. weed control											
2. monitor trajectory											
Riverview North Hayshed block [7.2ha]		1									
Priorities	Weed control										-
1. weed control											
2. monitor trajectory (sown over to native 19Q2, not yet monitored)											

Notes:
Work to occur across the periods shown, however may not occur in all periods shown.
Relative priorities balance addressing at-risk areas with maintaining areas demonstrating favourable trajectories.
2020 work plans are indicative only. Final 2020 plans to be informed by observations and trajectory at 2019 monitoring events, and will be detailed in annual reporting.
Changes to work plans may occur due to weather events and climatic influences. Where work components are not undertaken details will be provided in annual reporting.
Maintenance in Riverview reflects that majority of blocks are temporary rehabilitation of interim landform and will be progressively re-disturbed with mine advance.

Legend - Rehab Trajectory (after CPS monitoring)
- Tracking towards success but needs work
- Stable but need work to improve
- Failing
- Failed
- Not monitored

Legend - planned work
- Primary task timing
- Secondary timing (contingency / follow-up as needed)

Legend - s240 Issue
- Veg, Weeds: 2018 TARP Monitoring event & event trigger(s)
- 19Q2: 2019 Additional sites monitoring event
- GMD Rollback: Failed block - phase reversion to Growth Med. Dev.

Version 4.0; 31/12/19

HVO s240 Rehab Maintenance Schedule 2019-2020 - Carrington, Cheshunt & Lemington Pits - [31 DECEMBER 2019 UPDATE]

Location	Maintenance	Relative Priority	2019 Q1	2019 Q2	2019 Q3	2019 Q4	2020 Q1	2020 Q2	2020 Q3	2020 Q4	s240 Issue
HVOCAR200901 [Carrington, 14.2ha]		**5**									
Priorities	Stem thinning										
1. open canopy	Weed control										19Q2
2. weed control	Selective seeding										
3. drainage review	Drainage review										
HVOCAR200902 [Carrington, 7.7ha]		**5**									
Priorities	Stem thinning										
1. open canopy	Weed control										Weeds
2. weed control	Selective seeding										
3. increase diversity											
HVOCHE201201 [Cheshunt Rim, 20.8ha]		**4**									
Priorities	Investigate soil issues		✓								
1. understanding growth medium	Develop re-establishment plan										Veg / GMD Rollback
2. addressing growth medium constraints	Plan execution										
3. plan development											
HVOCHE201501A [Barrys Lower East Slope, 19.6ha]		**1**									
Priorities	Weed control										
1. weed control											-
2. monitor trajectory (sown to native 19Q2, not yet monitored)											
HVOCHE201501B / HVOCHE201601A [Barrys Upper East Slope, 16.1ha]		**1**									
Priorities	Weed control / spray out		✓								
1. halt exotic establishment & competition	Re-establish cover crop			✓							GMD Rollback
2. re-establish cover crop	Investigate soil issues		✓			✓					
3. understand growth medium	Develop re-establishment plan										
HVOCHE201702 [Fmr Drill Parkup, 2.2ha]		**4**									
Priorities	Weed control										
1. weed control	Selective seeding (if req)										19Q2
2. increase ground cover /surface stability											
HVOCHE201801 [Barrys Slope, 4.9ha; east portion of 2018 block]		**1**									
Priorities	Weed control			✓	✓	✓					
1. weed control	Routine inspection										19Q2
2. monitor trajectory											
HVOCHE201801 [Barrys Slope, 1ha; west portion of 2018 block]		**2**									
Priorities	Weed control			✓							
1. weed control											19Q2
HVOCHE201802 [Barrys 230 Flat, 19.5ha]		**4**									
Priorities	Weed control		✓								
1. weed control											19Q2
2. manage for potential re-use of surface layer (temp spoil/compost rehab)											
HVOLEM201501 [Lemington South, 13.4ha]		**4**									
Priorities	Weed control										
1. weed control	Soil investigation					✓					19Q2
2. understanding growth medium	Soil amelioration (if req)										
	Selective seeding (if req)										
HVOLEM201601 [Lemington South, 5ha]		**4**									
Priorities	Weed control										
1. weed control	Soil investigation					✓					Weeds
	Soil amelioration (if req)										
	Selective seeding (if req)										

Notes:

Work to occur across the periods shown, however may not occur in all periods shown.

Relative priorities balance addressing at-risk areas with maintaining areas demonstrating favourable trajectories.

2020 work plans are indicative only. Final 2020 plans to be informed by observations and trajectory at 2019 monitoring events, and will be detailed in annual reporting.

Changes to work plans may occur due to weather events and climatic influences. Where work components are not undertaken details will be provided in annual reporting.

Maintenance of HVOCHE201802 reflects that the block is temporary rehab of an interim landform and will be subsequently re-disturbed by overburden emplacement.

Legend - Rehab Trajectory (after CPS monitoring)

Blue	Tracking towards success but needs work
Yellow	Stable but need work to improve
Orange	Failing
Red	Failed
Pink	Not monitored

Legend - planned work

Dark grey	Primary task timing
Light grey	Secondary timing (contingency / follow-up as needed)

Legend - s240 Issue

Veg, Weeds	2018 TARP Monitoring event & event trigger(s)
19Q2	2019 Additional sites monitoring event
GMD Rollback	Failed block - phase reversion to Growth Med. Dev.

Version 4.0; 31/12/19

HVO s240 Rehab Maintenance Schedule - Growth Medium Development Progression [31 DECEMBER 2019 UPDATE]

Location	Maintenance	Relative Priority	2019	2020	2021	2022	2023+	s240 Issue
West North 230 2014 Flat [14.1ha]		1						
Priorities	Slashing, spraying		✓					
1. weed control - break seed cycle, prevent exotic re-establishment	Drainage improvement							GMD
2. establish pioneer native species	Seeding							Phase
3. weed control - manage competition								
West North 230 East Batter [18.3ha]		1						
Priorities	Sink hole repairs							
1. repair sinkholes	Slashing, spraying							GMD
2. weed control - break seed cycle, prevent exotic re-establishment	Develop intervention plan							Phase
3. improve growth medium	Plan execution							
Riverview Glider RL80 [7.6ha]		1						
Priorities	Enlarge sediment dam for increased catchment		✓					
1. enlarge sediment dam	Slashing / spraying		✓					GMD
2. weed control - break seed cycle, prevent exotic re-establishment	Pre-sowing herbicide application (if needed)							Phase
3. establish pioneer native species	Sow final vegetation							
Cheshunt Barrys Amphitheatre [5.9ha]		1						
Priorities	Pre-sowing herbicide application / spot-spray							
1. establish pioneer native species (slope stability)	Sow native pioneers (grasses)							GMD
2. weed control	Increase native diversity / sow final vegetation							Phase
3. progression to final vegetation								
Cheshunt Barrys Upper West Slope [17ha]		1						
Priorities	Re-establish / maintain cover crop		✓					
1. weed control / sowing preparation	Pre-sowing herbicide application / spot-spray		✓					GMD
2. sow to final cover	Sow final vegetation							Phase
3. weed control / monitor trajectory								
West Wilton 210 2014 Flat [9.6ha]		2						
Priorities	Slashing, spot spraying		✓					
1. weed control - exotic grasses	Sow native pioneers							GMD
2. augment existing native grasses / establish pioneer native species	Increase native diversity							Phase
Cheshunt Barrys Lower West Slope (east) [chute to amphitheatre, 12.1ha]		2						
Priorities	Weed control		✓					
1. weed control	Soil investigation							GMD
2. understanding growth medium	Soil amelioration (if required)							Phase
3. intervention plan development	Sow final vegetation							
Cheshunt Barrys Lower West Slope (west) [west of amphitheatre, 5.7ha]		2						
Priorities	Pre-sowing herbicide application / spot-spray		✓					
1. weed control / sowing preparation	Sow final vegetation							GMD
2. sow to final cover								Phase
3. weed control / monitor trajectory								
Cheshunt Rim [north, central & south; 87.6ha]		2						
Priorities	Develop intervention plan							
1. intervention plan development (livestock grazing based)	Install grazing infrastructure							GMD
2. grazing introduction	Plan execution							Phase
3. sequenced progression to final vegetation								
Cheshunt Barrys RL155 2018 Topsoil [7.8ha]		2						
Priorities	Re-establish cover crop		✓					
1. weed control - prevent establishment	Residual herbicide application							GMD
2. establish pioneer native species	Sow native pioneers (grasses)							Phase
3. manage for re-disturbance (over-dumping)	Sow native pioneers (trees & shrubs)							
Cheshunt Barrys RL155 2013 Topsoil [27.9ha]		2						
Priorities	Residual herbicide application							
1. weed control	Slashing / ongoing spraying							GMD
2. manage for re-disturbance (over-dumping)	Sow native pioneers (grasses)							Phase
Cheshunt Polo Green [52.4ha]		3						
Priorities	Develop intervention plan							
1. intervention plan development (livestock grazing based)	Install grazing infrastructure							GMD
2. grazing introduction	Plan execution							Phase
3. sequenced progression to final vegetation								
West North 230 North Batter [22.8ha]		3						
Priorities	Monitor landform & drainage stability		✓					
1. monitor landform stability	Develop intervention plan							GMD
2. intervention plan development	Plan execution							Phase
West Wilton 210 2013 North Batter [13ha]		3						
Priorities	Monitor landform & drainage stability							
1. monitor landform stability	Develop intervention plan							GMD
2. intervention plan development	Plan execution							Phase
Carrington Western OEA [88.6ha]		3						
Priorities	Develop intervention plan							
1. intervention plan development (livestock grazing based)	Install grazing infrastructure							GMD
2. grazing introduction	Plan execution							Phase
3. sequenced progression to final vegetation								
South East TSF [23.6ha]		3						
Priorities	Hold on ground works proposed during capping							
1. recommence capping (in process)	Review medium term landform and drainage plans							GMD
2. review rehab strategy following cap establishment								Phase
Riverview Void [Western Amphitheatre, Void Slope; 34.2]		3						
Priorities	Pre-sowing herbicide application (if needed)							
1. weed control / sowing preparation	Ground preparation							GMD
2. establish pioneer native species	Aerial seed (drone / light aircraft)							Phase
3. manage for re-disturbance								
Riverview 125 Pasture / CHE2 AOM [12.9ha]		3						
Priorities	Slashing / spraying		✓					
1. weed control								GMD
2. manage for re-disturbance (mine advance)								Phase
Riverview 145 Pasture / CHE1 AOM [30.2ha]		3						
Priorities	Slashing / spraying		✓					
1. weed control								GMD
2. manage for re-disturbance (mine advance)								Phase

Notes:
Work anticipated to occur across the periods shown, however may not occur in all periods shown.
Changes to work plans may occur due to weather events, climatic influences, and operational interactions. Where work components are not undertaken details will be provided in annual reporting.

Legend		Legend - planned work	
	Area in Growth Medium Development phase		Primary task timing
			Secondary timing (contingency / follow-up as needed)

Version 4.0; 31/12/19

HVO s240 Rehab Maintenance Schedule - Other Maintenance [31 DECEMBER 2019 UPDATE]

Location	Planning & Maintenance	Relative Priority	2019	2020	2021	2022	2023+	s240 Issue
North Rehab / Former East TSF / Dam 5N catchment		1						
<u>Context / background</u>	Routine inspection of initial stabilisation works		✓					
* Integrated drainage is degarded. Turbid water has flowed off site.	Expert development of detailed intervention plan		✓					Other Maint.
* Vegetation development appears constrained in places.	Plan implementation							
West South drainage chute		2						
<u>Context / background</u>	Confirm reporting catchment and design adequacy							
* initial migration of rock in drainage chute	Repair / upgrade drainage chute							Other Maint.
* timely repair may prevent major failure								
Cheshunt Rim drainage		2						
<u>Context / background</u>	Detailed drainage design for future layout							
* Catchment modifying with development of upper level dumps.	Construct / upgrade / repair drainage incl. chute							Other Maint.
* Existing central chute failed.								
* Clarification of future needs required prior to repair / replacement.								
West South historic rehab		2						
<u>Context / background</u>	Review area drainage							
* Integrated drainage throughout catchment is degraded.	Develop detailed, sequenced improvement plan(s)							Other Maint.
* Complex cycling occurring (e.g. fruiting fungi) in association with presence of undesirable species. Targeted corrective actions required.								
Historic rehabilitation areas (generally)		4						
<u>Context / background</u>	Conduct verification inspections							
* Walkover identified minor issues in various historic catchments	Identify issues of elevated rehab progression risk							Other Maint.
* Risk ranking / prioritisation required to support decision making & resource allocation	Develop maintenance task scopes and priorities							

Notes:

Initial tasks identified from GCAA Annual Rehab Walkover. Other sources may include: Monthly Inspections, discussions and informal reports.

Work anticipated to occur across the periods shown, however may not occur in all periods shown.

Changes to work plans may occur due to weather events, climatic influences, and operational interactions. Where work components are not undertaken details will be provided in annual reporting.

Outcomes of plan development tasks to be reported at annual reporting and be reflected in subsequent annual work plans.

Legend

Other / general rehab maintenance

Legend - planned work

Primary task timing

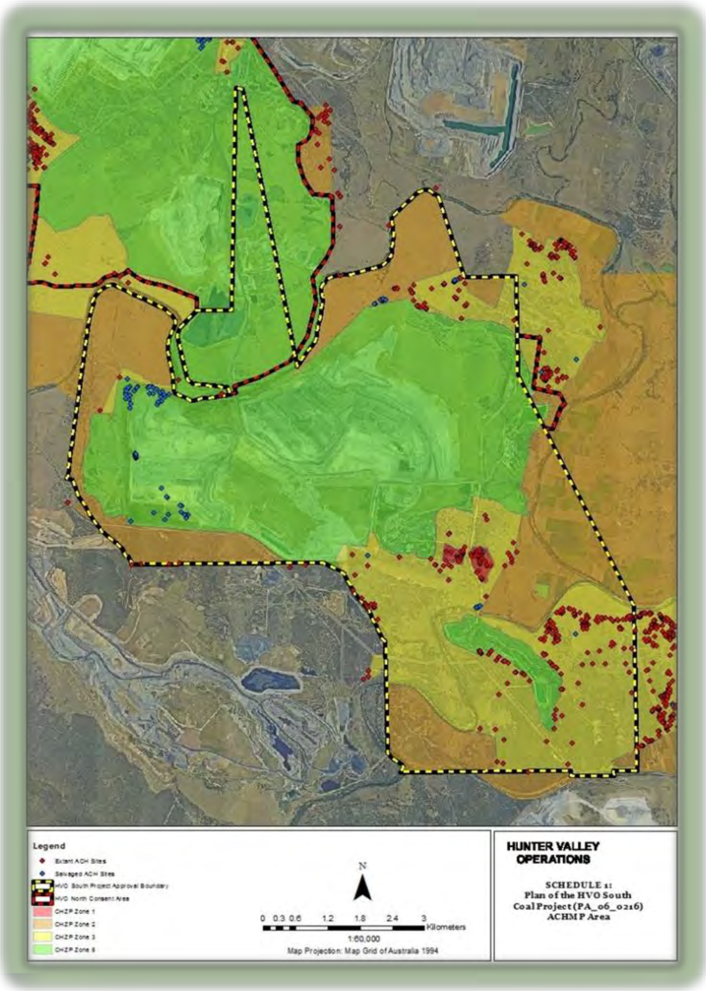
Secondary timing (contingency / follow-up as needed)

Version 4.0; 31/12/19

Hunter Valley Operations South Aboriginal Heritage Management Plan Compliance Audit Inspection

Report prepared for

Hunter Valley Operations



September 2019

Joel Deacon

ARROW HERITAGE SOLUTIONS

1910_HVO_South_September_2019_AHMP_Compliance_Audit_Report

Arrow Heritage Solutions Pty Ltd, ABN: 44 626 545 515

Introduction

The Hunter Valley Operations Joint Venture manages the Hunter Valley Operations (HVO) mining complex and associated Biodiversity Areas located in the Hunter Valley. The development of HVO mining operations has occurred through a process of expansion and acquisition and as a result there are two separate development approvals that apply to the operation. The mining & processing activities at HVO are geographically divided by the Hunter River, with movements of coal, overburden, equipment, materials and personnel between two operational areas - HVO North (DA_450-10-2003) and HVO South (PA_06_0261).

The HVO South consent contains a condition requiring the development of an Aboriginal Heritage Management Plan (AHMP), which has been developed (in consultation with the Aboriginal community through the HVO Cultural Heritage Working Group [CHWG]) and approved. Within this AHMP provision is made to conduct biannual AHMP compliance inspections with members of the Aboriginal community throughout the life of operations. The purpose of the compliance inspections is to afford the Aboriginal stakeholders and HVO:

- the opportunity to visit mine operations and mine areas to inspect the operational compliance with AHMP provisions and Ground Disturbance Permit procedures;
- to inspect and monitor the condition and management of various sites; and
- to review the effectiveness and performance of AHMP provisions in the management of cultural heritage at the mine.

The aim is to conduct these compliance inspections at least twice annually. Due to the number of cultural heritage sites within the AHMP area & the time foreseen to inspect all sites, it is not feasible to inspect every site during the same field trip. Therefore, a regular, rolling program of compliance inspections has been implemented that will visit all sites at each location periodically each & every year. A record will be kept of each compliance inspection against each cultural heritage site, so that it can be ensured that each site is inspected regularly.

Proposed Activity and Project Brief

The HVO South compliance inspection involved the following elements:

- An AHMP compliance inspection report pro-forma will be completed for the nominated inspection areas and Aboriginal cultural heritage sites visited;
- Photographs of the inspected Aboriginal cultural heritage sites will also be taken; and
- The pro-forma will note the outcomes of the inspections including evidence of compliance and non-compliance with AHMP provisions, recommendations on modifications and improvements to management provisions, recommendations on corrective actions, and other comments associated with AHMP provisions.

Timing & Personnel

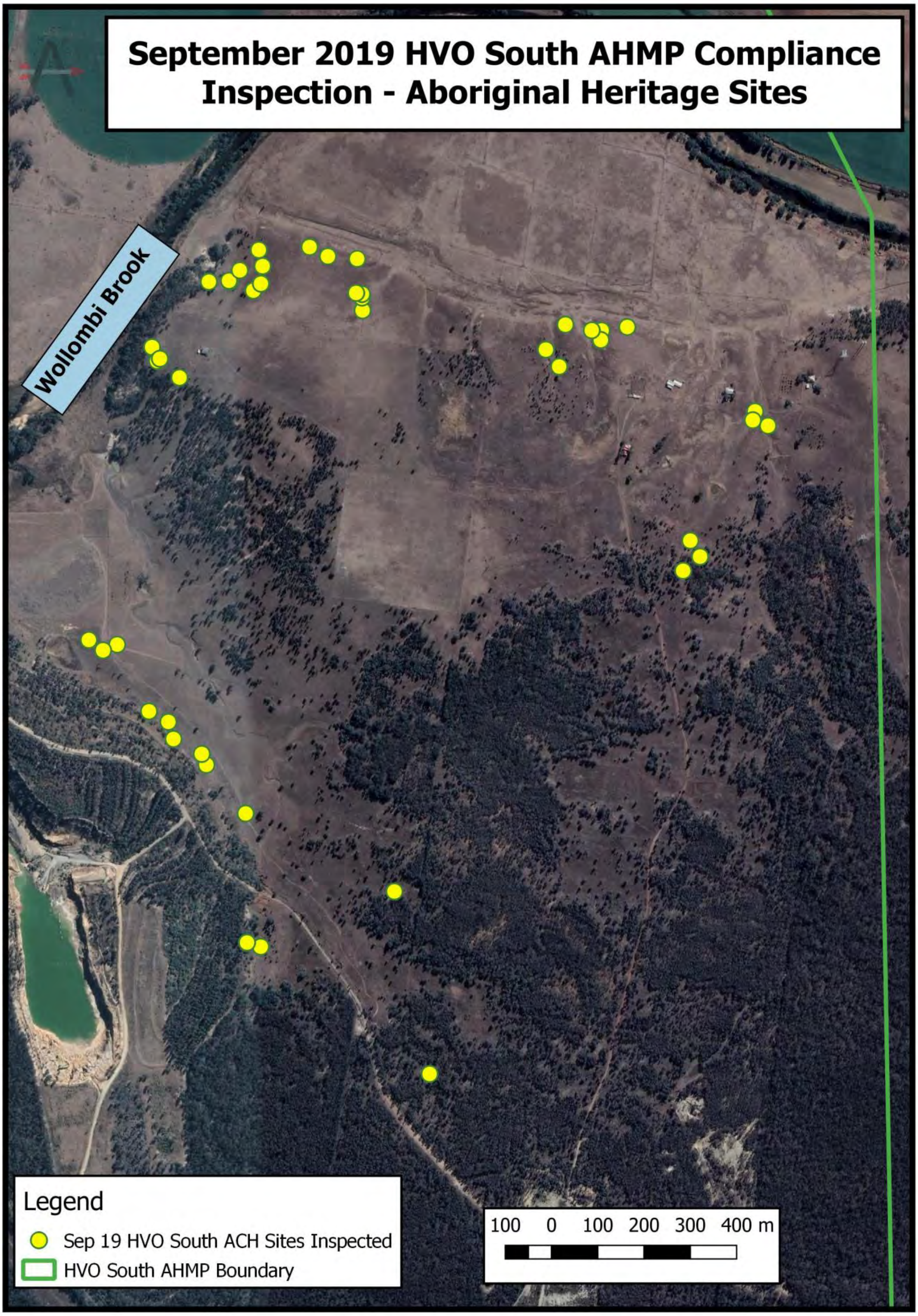
The HVO South AHMP compliance inspection was conducted on Tuesday 3 September, 2019. The personnel involved in these inspections were:

- Joel Deacon – Technical Advisor, Arrow Heritage Solutions;
- Peter Bowman – Environment and Community Officer, HVO;
- Danny Franks – Cultural Heritage Field Officer (CHFO), Plains Clans of the Wonnarua People (PCWP);
- Mary Franks – CHFO, PCWP; and
- Rhonda Ward – CHFO, Ungooroo Community and Cultural Services.

Arrow Heritage Solutions were engaged as independent heritage consultants to conduct the AHMP compliance inspection, and Joel Deacon acted as technical advisor and author of this report. HVO's Environment & Community Officer Peter Bowman arranged the compliance inspection program and escorted the field team. Representatives of the HVO Registered Aboriginal Parties (RAPs) participated in the compliance inspection.

HVO South AHMP Compliance Inspection

A total of 45 Aboriginal heritage sites were inspected in the HVO Southern area (see Map below). Although not active mining zones, these areas were selected for inspection as they are located in areas that are frequently accessed for a variety of activities associated with water and environmental management, as well as being currently leased for pastoral enterprises.



September 2019 HVO South AHMP Compliance Inspection - Aboriginal Heritage Sites
Wollombi Brook
Legend
Sep 19 HVO South ACH Sites Inspected
HVO South AHMP Boundary
100 0 100 200 300 400 m

Results

The following table summarises the results of the September 2019 HVO South compliance inspection and summarises the information recorded on the individual pro-forma inspection sheets. Using a mobile mapper pre-loaded with the GIS co-ordinates for each Aboriginal heritage site, the field team travelled to each location and attempted to re-locate each site. Sometimes this was not possible due to poor ground surface visibility (GSV), a result which in itself was not overly significant as long as it was determined that the vicinity had not been inadvertently disturbed. The presence and condition of barricading or fencing was noted, as well as the presence and nature of various potential site disturbing factors (e.g erosion, animal, human). General observations of each site were made if necessary, and, based on information provided for all of the above factors, management recommendations were discussed and agreed by the field team for each site.

Site Name	Date Inspected	Site re-identified?	Site intact?	Site fenced/ barricaded?	Fencing/ barricading intact?	Natural erosion	Livestock damage	Human disturbance	Animal disturbance	Pests & weeds	General observations	Management recommendations
HVO-1198	3/9/2019	Yes	Yes	No	N/A	No	No	No	No	No	-	Nil
HVO-1199	3/9/2019	Yes	No	No	N/A	Yes	No	No	No	No	Located on/in active flow line – only one artefact relocated	Salvage site
HVO-1200	3/9/2019	Yes	Yes	No	N/A	No	No	No	No	No	-	Nil
HVO-1201	3/9/2019	Yes	Yes	No	N/A	No	No	No	No	No	-	Nil
HVO-1202	3/9/2019	Yes	Yes	No	N/A	No	No	No	No	No	-	Nil
HVO-1203	3/9/2019	Yes	Yes	No	N/A	No	No	No	No	No	-	Nil
HVO-1204	3/9/2019	Yes	Yes	No	N/A	No	No	No	No	No	-	Nil
HVO-1205	3/9/2019	No	Yes	No	N/A	No	No	No	No	No	-	Include in next audit
HVO-1206	3/9/2019	Yes	Yes	No	N/A	No	No	No	No	No	-	Nil
HVO-1207	3/9/2019	Yes	Yes	No	N/A	No	No	No	No	No	-	Nil
HVO-1208	3/9/2019	Yes	Yes	Yes	Yes	No	No	No	No	No	Older hard fencing	Some fence wires require mending
HVO-1209	3/9/2019	Yes	Yes	No	N/A	No	Yes	No	No	No	Stock congregate around gate near site	Nil
HVO-1252	3/9/2019	No	Yes	No	N/A	No	No	No	No	No	-	Include in next audit
HVO-1253	3/9/2019	Yes	Yes	No	N/A	No	No	No	No	No	-	Nil
HVO-1254	3/9/2019	Yes	Yes	No	N/A	No	No	No	No	No	-	Nil
HVO-1255	3/9/2019	Yes	Yes	No	N/A	No	No	No	No	No	-	Nil
HVO-1256	3/9/2019	Yes	Yes	No	N/A	No	No	No	No	No	-	Nil
HVO-1257	3/9/2019	Yes	Yes	No	N/A	No	Yes	No	No	No	Located on cattle pad	Nil
HVO-1258	3/9/2019	Yes	Yes	No	N/A	No	Yes	No	No	No	Located on cattle pad	Nil
HVO-1259	3/9/2019	Yes	Yes	No	N/A	No	No	No	No	No	-	Nil
HVO-1260	3/9/2019	Yes	Yes	No	N/A	No	No	No	No	No	-	Nil
HVO-1261	3/9/2019	Yes	Yes	No	N/A	Yes	No	No	No	No	Some erosion present	Nil
HVO-1262	3/9/2019	Yes	Yes	No	N/A	Slight	No	No	No	No	Slight erosion	Nil
HVO-1263	3/9/2019	Yes	Yes	No	N/A	No	No	No	No	No	-	Nil
HVO-1264	3/9/2019	Yes	Yes	No	N/A	No	No	No	No	No	-	Nil
HVO-1265	3/9/2019	Yes	Yes	No	N/A	Severe	No	No	No	No	Severe erosion but regenerating	Nil
HVO-1266	3/9/2019	Yes	Yes	No	N/A	No	No	No	No	No	Axe not found	Nil
HVO-1267	3/9/2019	Yes	Yes	No	N/A	Slight	No	No	No	No	-	Nil
HVO-1273	3/9/2019	No	Yes	No	N/A	No	No	No	No	No	-	Include in next audit
HVO-1274	3/9/2019	Yes	Yes	No	N/A	No	No	No	No	No	-	Nil
HVO-1276	3/9/2019	Yes	Yes	No	N/A	Yes	No	No	No	No	-	Nil
HVO-1277	3/9/2019	Yes	Yes	No	N/A	Severe	No	No	No	Boxthorn	Evidence of successful weed eradication in area	Continue weed eradication program
HVO-1278	3/9/2019	No	Yes	No	N/A	Slight	No	No	No	No	-	Include in next audit
HVO-1279	3/9/2019	Yes	Yes	No	N/A	Severe	No	No	No	No	Quartz flake not found but several others	Nil
HVO-1280	3/9/2019	Yes	Yes	No	N/A	Slight	No	No	No	No	-	Nil
HVO-1281	3/9/2019	No	Yes	No	N/A	No	No	No	No	No	-	Include in next audit
HVO-1282	3/9/2019	No	Yes	No	N/A	No	No	No	No	No	-	Include in next audit
HVO-1283	3/9/2019	Yes	Yes	No	N/A	No	No	No	No	No	-	Nil
HVO-1290	3/9/2019	Yes	Yes	No	N/A	No	No	No	No	No	-	Nil
HVO-1291	3/9/2019	Yes	Yes	No	N/A	Severe	No	No	No	No	-	Nil

HVO-1292	3/9/2019	Yes	Yes	No	N/A	No	No	No	No	Ant nest	-	Nil
HVO-1307	3/9/2019	Yes	Yes	No	N/A	No	No	No	No	Ant nest	-	Nil
HVO-1308	3/9/2019	Yes	Yes	No	N/A	No	No	No	No	No	-	Nil
HVO-1309	3/9/2019	Yes	Yes	No	N/A	Slight	No	No	No	No	-	Nil
HVO-1694	3/9/2019	Yes	Yes	No	N/A	No	No	No	No	No	-	Nil

Results of September 2019 HVO South Aboriginal Sites Compliance Inspection

Aboriginal Site Management Recommendations

The compliance inspection of the selected HVO South sites showed that most were in good condition and able to be relocated. No management recommendations were provided by the field team for the majority of inspected sites. Recommendations were provided for nine of the Aboriginal heritage sites visited, which are described below.

Repair fencing wires

Sites: HVO-1208

HVO-1208 has been fenced with wooden posts and stock-proof wire. This fencing is generally in good repair, however, some broken wires require mending to maintain the fence's integrity, particularly as it is high traffic area for stock

Broken fence wires at HVO-1208

Include in next audit

Sites: HVO-1205, 1252, 1273, 1278, 1281, 1282

Due to poor GSV at some locations as a result of sheet-wash erosion, heavy leaf litter or ground covering vegetation, some Aboriginal heritage sites were unable to be relocated. As the surrounding area was noted as being undisturbed, it is not suggested that the sites have been damaged, rather it is recommended that further attempts are made to relocate these sites during the next scheduled AHMP compliance audit inspection.

Continue weed eradication program

Sites: HVO-1277

Boxthorn was identified at this site, however, it is clear that a successful boxthorn eradication program is underway in the vicinity. Although the presence of this species is not specifically detrimental to Aboriginal heritage sites, its presence is noted so that this area can remain included in HVO's regular weed eradication program. If this area is to be treated, then access for any poisoning or plant removal must be on foot, with no unnecessary ground disturbance to be conducted.

Remnant and poisoned boxthorn at HVO-1277

Suggest salvage next program

Sites: HVO-1199

Upon inspection, only one artefact was re-located from HVO-1199, which was originally recorded as containing 12 stone artefacts. The area has been significantly affected by erosion and sheet wash, with the banks of the drainage channel that runs through the site clearly eroding. As there is a moderate risk that artefacts from HVO-1199 are being damaged and moved from this site location, HVO-1199 should be salvaged as soon as is practicable to prevent any further possible damage. An AHIP is not required to implement this measure, as the salvage of this site, with Aboriginal community participation, is authorised under the HVO South AHMP.

Eroded drainage channel at HVO-1199

Hunter Valley Operations Aboriginal Heritage Management Plans October 2019 Compliance Audit Inspections

Report prepared for

Hunter Valley Operations

November 2019

Joel Deacon

ARROW HERITAGE SOLUTIONS

Introduction

The Hunter Valley Operations Joint Venture (HVOJV) manages the Hunter Valley Operations (HVO) mining complex and associated Biodiversity Areas located in the Hunter Valley. The HVOJV provides management services that include accountability for Aboriginal cultural heritage management & community consultation.

The development of HVO mining operations has occurred through a process of expansion and acquisition and as a result there are two separate development approvals that apply to the operation. The mining & processing activities at HVO are geographically divided by the Hunter River, with movements of coal, overburden, equipment, materials and personnel between two operational areas - HVO North (DA_450-10-2003) and HVO South (PA_06_0261).

Each consent contains a condition requiring the development of an Aboriginal Heritage Management Plan (AHMP). Such plans have been developed (in consultation with the Aboriginal community through the HVO Cultural Heritage Working Group [CHWG]) and approved for each operational area. Within each of these plans provision is made to conduct annual AHMP compliance inspections (biannual for HVO South) with members of the Aboriginal community throughout the life of operations. The purpose of the compliance inspections is to afford the Aboriginal stakeholders and the HVOJV:

- the opportunity to visit mine operations and mine areas to inspect the operational compliance with AHMP provisions and Ground Disturbance Permit procedures;
- to inspect and monitor the condition and management of various sites; and
- to review the effectiveness and performance of AHMP provisions in the management of cultural heritage at the mine.

Due to the number of cultural heritage sites within the AHMP areas & the time foreseen to inspect all sites, it is not feasible to inspect every site during the same field trip. Therefore, a regular, rolling program of compliance inspections has been implemented that will visit all sites at each location periodically each & every year. A record will be kept of each compliance inspection against each cultural heritage site, so that it can be ensured that each site is inspected regularly.

Proposed Activity and Project Brief

The compliance inspections involved the following elements:

- An AHMP compliance inspection report pro-forma will be completed for the nominated inspection areas and Aboriginal cultural heritage sites visited;
- Photographs of the inspected Aboriginal cultural heritage sites will also be taken;
- The pro-forma will note the outcomes of the inspections including evidence of compliance and non-compliance with AHMP provisions, recommendations on modifications and improvements to management provisions, recommendations on corrective actions, and other comments associated with AHMP provisions;
- Specific site condition monitoring inspection of site CM-CD1, as per Schedule 15 of the HVO North HMP.

Timing & Personnel

The HVO October 2019 AHMP compliance inspection program was conducted between 29-31 October 2019. The personnel involved in these inspections were:

Name	**Organisation**	**Tue 29 Oct**	**Wed 30 Oct**	**Thu 31 Oct**
Joel Deacon	Arrow Heritage Solutions	X	X	X
Peter Bowman	HVO	X	X	X
Margaret Matthews	Aboriginal Native Title Consultants	X	X	X
John Matthews	Aboriginal Native Title Consultants	X	X	X
Colleen Stair	Hunter Valley Aboriginal Corporation	X	X	X
Brian Horton	Hunter Valley Aboriginal Corporation	X	X	X
Aleira French	Aleira French Trading	X	X	
Wayne French	Aleira French Trading			X

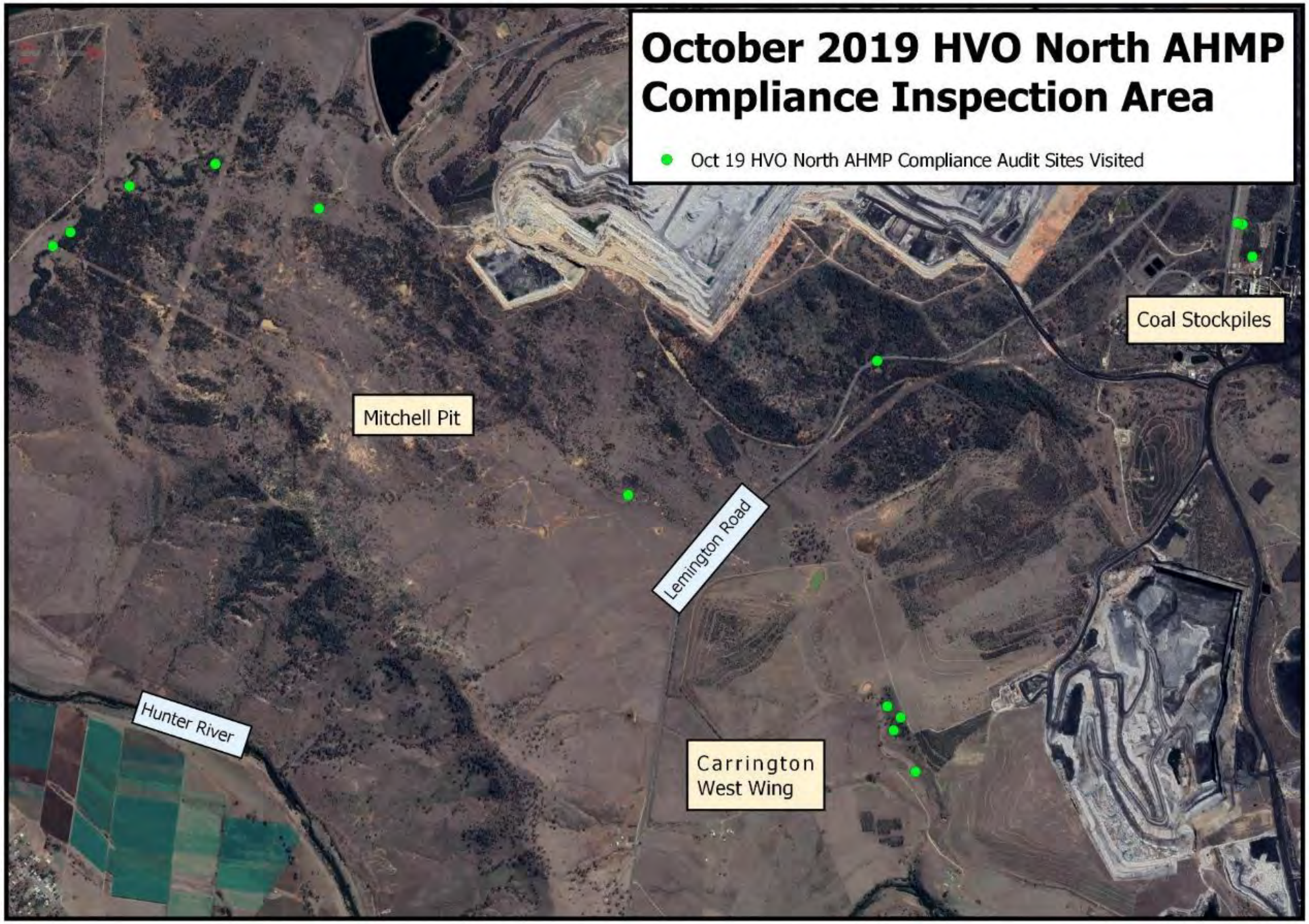
Arrow Heritage Solutions were engaged as independent heritage consultants to conduct the AHMP compliance inspections, and Joel Deacon acted as technical advisor and author of this report. HVO's Environment & Community Officer Peter Bowman arranged the compliance inspection programs and escorted the field team.

HVO North AHMP Compliance Inspection

A total of 15 Aboriginal heritage sites were inspected either side of Lemington Road at HVO North in the Carrington West Wing and Mitchell Pit surrounds, as well as the coal stockpiles area (see Map 1). Although not active mining zones, these areas were selected for inspection for a variety of reasons. Some of the sites are located adjacent to mining pits or active infrastructure areas, while others were visited to obtain further information regarding their extent, contents and condition as the information contained in the HVO sites database was lacking in some regard.

Results

The following table details the results of the HVO North compliance inspection and summarises the information recorded on the individual pro-forma inspection sheets. Using a mobile mapper pre-loaded with the GIS co-ordinates for each Aboriginal heritage site, the field team travelled to each locale and attempted to re-identify each site. Sometimes this was not possible due to poor ground surface visibility (GSV), a result which in itself was not overly significant as long as it was determined that the vicinity had not been inadvertently disturbed. Another factor affecting site re-identification was the age of the original recording and the lack of data recorded. The presence and condition of barricading or fencing was noted, as well as the presence and nature of various potential site disturbing factors (e.g erosion, animal, human). General observations of each site were made if necessary, and, based on information provided for all of the above factors, management recommendations were discussed and agreed by the field team for each site.



Map 1: Location of Aboriginal heritage sites inspected during the October 2019 HVO North AHMP compliance inspection program

Site Name	Date Inspected	Site re-identified?	Site intact?	Site fenced/ barricaded?	Fencing/ barricading intact?	Natural erosion	Livestock damage	Human disturbance	Animal disturbance	Pests & weeds	General observations	Management recommendations
C5	29/10/19	No	Yes	Yes	No	Yes	No	No	No	No	-	mend barricading
CM-1	30/10/19	No	Yes	No	No	No	No	Road/gate	No	No	-	May have been previously salvaged – check AHIMS data when received
CM-2*	30/10/19	Yes	Yes	Yes	Yes	No	No	No	No	No	Within CM-CD1 fence	nil
CM-3*	30/10/19	Yes	Yes	Yes	Yes	No	No	No	No	No	Within CM-CD1 fence	nil
CM-CD1*	30/10/19	Yes	Yes	Yes	Yes	No	No	No	rabbits	No	-	nil
HC-25	29/10/19	Yes	Yes	No	No	No	No	on dam wall and roadside	No	No	One artefact falls within road reserve	Amend HVO sites database to refine position
HVO-1127	29/10/19	No	Yes	Yes	Yes	No	No	No	No	No	-	nil
HVO-1128	29/10/19	Yes	Yes	Yes	Yes	No	No	On conveyor corridor	No	No		Update and reduce barricading, remove rubbish
HVO-1129	29/10/19	No	Yes	Yes	Yes	No	No	No	No	No	New hard fence	
HVO-215	29/10/19	Yes	No	No	No	Yes	Yes	No	No	No	Dubious hearth, site area is deteriorating	Seek AHIP to excavate area and confirm if hearth or not
HVO-930	29/10/19	Yes	Yes	No	No	No	No	No	No	termites	Field RAPs dubious about cultural origin	Install heritage site signage near track on approaches to site. Engage scarred tree expert to assess this tree (and other HVO trees) and potentially deregister
Ponds Creek (37-2-0190)	29/10/19	Yes	Yes	No	No	Yes	No	Under powerline	No	No	Fencing not practical as within power easement	Amend HVO sites database to refine position; install signage on track at both ends of site.
Ponds Creek/ Parnells Creek (37-2-0035)	29/10/19	No	Yes	No	No	No	No	No	No	No	Old recording and heavy vegetation	Request site card and report to refine search area
Ponds Creek/ Parnells Creek (37-2-0036)	29/10/19	Yes	Yes	No	No	No	No	No	No	No	-	Amend HVO sites database to refine position
T/L3/ Plashette (37-2-0562)	29/10/19	Yes	Yes	No	No	Severe creek erosion	No	Major powerline	No	No	Fencing not practical as within power easement	Amend HVO sites database to refine position; install signage on track at both ends of site.

Table 1: Results of the October 2019 HVO North Aboriginal Sites Compliance Inspection

- See specific section below for CM-CD1 inspection.

Aboriginal Site Management Recommendations

Management recommendations were provided for many of the Aboriginal heritage sites visited. At some sites, more than one management action was recommended. The nature of these recommendations are described below.

Update barricade, wire and/or signage

Sites: C5, HVO-1128, HVO-930

C5 and HVO-1128 have been fenced or barricaded in the past and are located in areas that are subject to moderate levels of mining activity or grazing. It is recommended that the barricading, fencing and signage at these sites be repaired or re-instated to prevent inadvertent disturbance. At HVO-930, it would be beneficial to install heritage site signage adjacent to the tracks on the approach to the site.

It should be noted that the new and upgraded barricading specification being trialled and installed at several ACH sites across HVO was received positively by the RAPs in attendance and should be considered as a favourable option when upgraded site protection is warranted.

Suggest salvage next program

Sites: HVO-215

HVO-215 is a deteriorating hearth that should be salvaged as soon as is practical, however, it is located outside of the current Mitchell Pit AHIP area. This site was visited during the last audit inspection also, with HVO keen to have as many RAPs as possible familiar with the site prior to any CHWG discussions on its salvage, which would require a new AHIP.

Request and assess further site information

Sites: CM1, Ponds Creek/ Parnells Creek (37-2-0035)

These sites were unable to be re-identified during the audit inspection, and prior to any further attempts at re-identification it would be beneficial to obtain and assess any site information held at HVO or within AHIMS. CM1 is located in a former Section 90 Consent to Destroy area, however it is not clear whether this site was in fact salvaged. An assessment of the latest available AHIMS data as well the relevant salvage report for the area may assist. The other site, AHIMS 37-2-0035, was also unable to be re-identified. This site was recorded several decades ago and minimal information is held by HVO regarding its nature or size. Examination of the AHIMS site card and any survey reports would assist in focussing any further re-identification attempts.

Update HVO Aboriginal sites databases

Sites: HC-25, Ponds Creek (37-2-0190), Ponds Creek/ Parnells Creek (37-2-0036), T/L3/ Plashette (37-2-0562)

Prior to the October 2019 audit inspection of these sites, the locational and archaeological information held by HVO on them was minimal and/or incomplete. During this audit further information was obtained that should be updated within the "HVO_sites_current" and "HVO_site_extents" GIS databases to keep them current.

Remove rubbish from site vicinity

Sites: HVO-1128

Although not impacting the artefacts located at HVO-1128, there are several items of scrap metal rubbish within the currently barricaded site extent associated with the adjacent conveyor. These items should be removed when the barricading at this site is upgraded.

Consider engaging a scarred tree expert to assess HVO-930

Sites: HVO-930

Although HVO-930 has been registered within both the HVO Aboriginal sites and the AHIMS databases as a culturally scarred tree, several members of the field team questioned this appraisal and contended that it should be deregistered as a valid site. Although not an unprecedented action for such sites in NSW, HVO may wish to consider engaging, with the CHWG's concurrence, a scarred tree expert to provide a specialist and final assessment prior to the scarred tree removal process commencing. Consideration of all currently registered scarred trees at HVO may be prudent if this course of action is undertaken.

Scarred tree HVO-930

Install signage at site perimeter

Sites: Ponds Creek (37-2-0190), T/L3/ Plashette (37-2-0562)

Both these sites were re-identified underneath power-lines within easements accessed by power companies. In both situations it is not feasible to erect fencing or barricading under the power-lines. As an alternative to alert power company staff, signage should be erected next to the tracks on all approaches to the sites stating that Aboriginal cultural material is located throughout the area and that vehicles should remain on formed tracks. Direct notification to the power companies could also be made.

Site TL/3/Plashette is located on exposures throughout both sides of Parnells Creek in between two power pylons

CM-CD1

The HVO North HMP (Schedule 15) contains a specific Plan of Management for Aboriginal site CM-CD1 (AHIMS ID 37-2-1877) that includes a description of measures that would be implemented to protect, monitor and manage potential impacts on the site by HVO North's mining operations and associated activities. As shown in Map 2, CM-CD1 includes an area c.450m long and up to 25m in width and is located immediately to the west of HVO Carrington Pit and c.900m north of the Hunter River.


Map 2 Aboriginal heritage site CM-CD1 showing protective buffers
HVO_CMCD1Extent
HVO_CMCD1Buffer20m_2013
HVO_CMCD1BufferDisturbanceExclusion
CMCD1_FENCING
former alignment
new fenceline
50
0
50
100
150
200 m

As part of the brief for the HVO North AHMP compliance inspection audit, the consultant was also required to audit the current condition of CM-CD1 with reference to the management measures outlined in Schedule 15 of the HVO AHMP. It should be positively noted that actions identified in the December 2018 compliance audit have been addressed and the maintenance of the current robust management processes will be the ongoing focus of compliance audits at CM-CD1:

1. A disturbance exclusion buffer area will be maintained around Aboriginal cultural heritage site 37-2-1877 (CM-CD1) of not less than 20m from the boundary of the recorded extent of the CM-CD1 site and incorporating the Older Stratum.
   During the October 2019 inspection of CM-CD1 no ground disturbance was noted within the disturbance exclusion buffer area (as depicted on the map above and the co-ordinates in 2. below). Comparison of photographs between the current and the previous (December 2018) audit inspections shows a reduction in rubbish and stock impact.

2. The CM-CD1 disturbance exclusion buffer area will be aligned within the following coordinates (MGA 94):
   i. North-East corner at E308805 and N6403833
   ii. North-West corner at E308696 and N6403791
   iii. South-West corner at E308861 and N6403341
   iv. South-East corner at E308996 and N6403355

   See Point 1.

3. The CM-CD1 disturbance exclusion buffer area is to be zoned as a Zone 1 Restricted Access Area within the HVO North CHZS. All development disturbance activities are to be excluded from within the buffer area.
   The CM-CD1 disturbance exclusion area is now zoned as Zone 1 in the HVO North CHZS.

4. The CM-CD1 disturbance exclusion buffer area will be delineated with stock-proof fencing and appropriate signage denoting that the area is a Restricted Access Area and no ground disturbance is authorised within the buffer area except where such ground disturbance is authorised under the provisions of this Plan of Management. Ground disturbance, such as for archaeological investigations, may require a consent under relevant legislation.
   The entirety of CM-CD1, including a substantial buffer, has been delineated with stock-proof fencing and adequate Cultural Heritage Site signage is visible on the fence.

5. Access within the CM-CD1 disturbance exclusion buffer area will be limited to authorised personnel and visitors only either on foot (e.g. for monitoring inspections) or in light vehicles (e.g. for pest, weed and fire management) for the purposes of implementing the management provisions approved under this Plan of Management.
   No evidence was noted to suggest the contrary has occurred.

6. An annual site condition monitoring inspection will be conducted by HVO personnel with representatives of the CHWG and the results of the inspection reported as an element of the HVO North DA 450-10-2003 Annual Environmental Management Report. The results of the inspection will also be reported to Aboriginal community stakeholders through the CHWG and/or other relevant Aboriginal community consultation forum.

This report documents the 2019 annual site condition monitoring inspection.

7. A series of condition and disturbance monitoring photo points will be established within the CM-CD1 disturbance exclusion buffer area and condition monitoring images taken during the course of the annual monitoring inspection. **Five unpegged photographic monitoring points were established, and photographs taken of CM-CD1. These points were located in the north-west, north-east, south-west and south-east of the site, as well as the centre. These photographs and their locational information are contained in Appendix A of this report.**

8. HVO will determine the nature and risks of potential impacts of blasting activities upon site CM-CD1 as an element of the HVO North blast management plan. Consistent with the results of the risk assessment process used to inform the development of the HVO North blast management plan, HVO will implement appropriate management measures to protect site CM-CD1 from any adverse impact that may be caused by blasting in a manner consistent with the provisions of this Plan of Management. In accordance with Schedule 4 of Condition 40 of the Approval, regular visual monitoring will be undertaken to confirm that impacts have not been caused by blasting vibration or from flyrock impacts.
No evidence of any blasting-related disturbance or flyrock impacts were noted during the site inspection. Indeed, blasting activity in the Carrington Pit ceased on the 17th October 2018 and mining and blasting activity was been focused on the eastern side of the Carrington Pit in the years leading up to the cessation of blasting.

9. As mining, and related blasting activities, approach the CM-CD1 disturbance exclusion buffer area, regular visual monitoring to confirm that impacts have not been caused by blasting vibration will be conducted by HVO personnel. Damage to CM-CD1 caused by flyrock is considered a very low risk, however, if it is evident, through regular monitoring, that this risk profile may increase in the future, protective management measures will be considered.
See above Point 8.

10. A variety of land management activities will be required to maintain the cultural and environmental values of the CM-CD1 disturbance exclusion buffer area. Land management activities approved under this HMP are as follows.
    i. Hand or light vehicle spraying of weeds.
    ii. Brush cutting by hand to control weeds and vegetation.
    iii. Prescribed burning and fire protection management.
    iv. Maintenance of fencing including replacement of posts as required.

    No evidence was noted of any adverse impacts to CM-CD1 by any of the land management practices listed above, with no evidence of site disturbance arising from the erection of the new fencing.

Recommendations

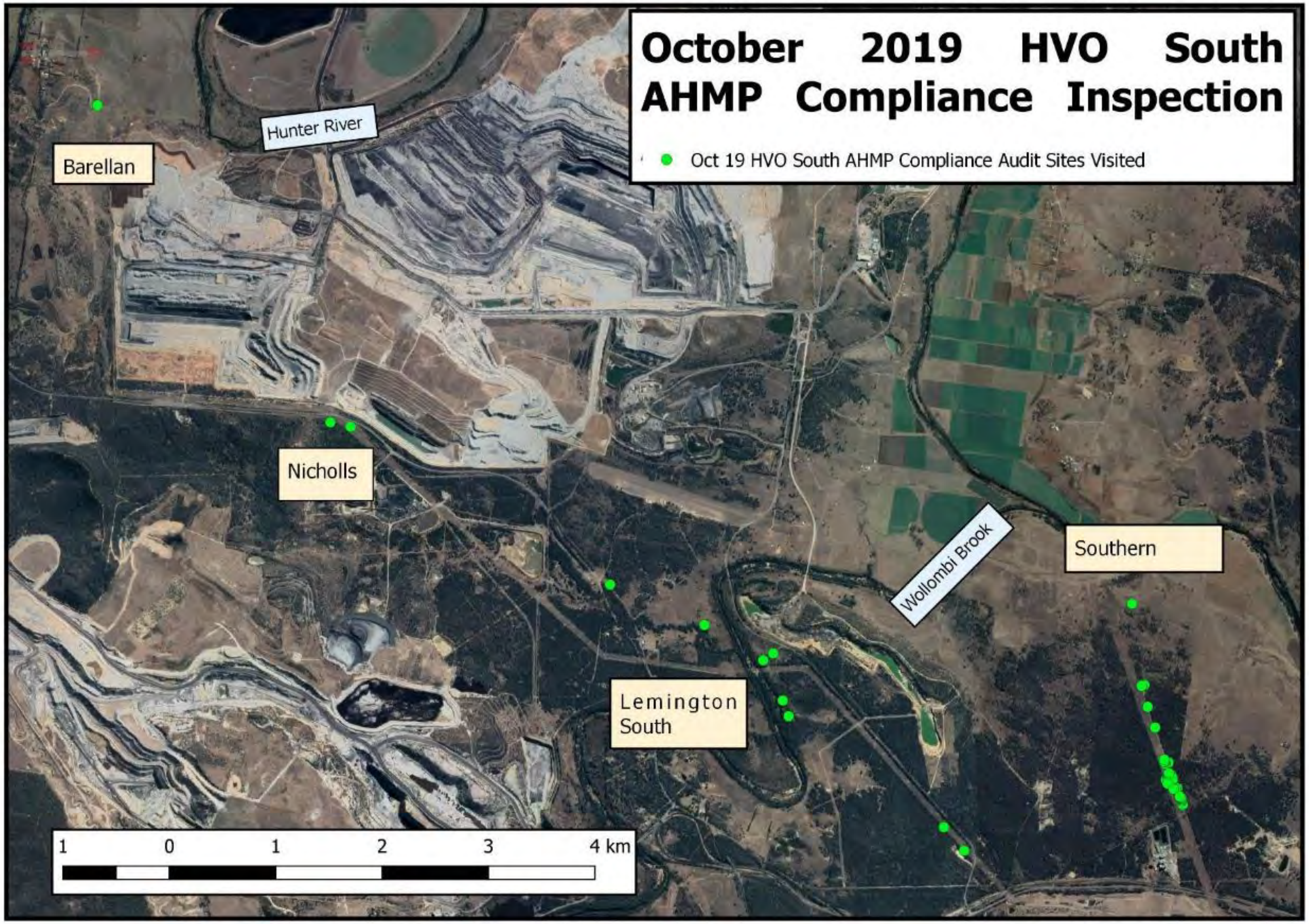
CM-CD1 is being managed well, with no evident impacts to the site's cultural heritage values. All recommended actions from the December 2018 compliance inspection have been implemented. No further management actions are recommended as part of this compliance inspection.

HVO South AHMP Compliance Inspection

A total of 44 Aboriginal heritage sites were inspected in the Barellan, Nicholls, Lemington South and Southern areas at HVO South (see Map 3). Although not active mining zones, these areas were selected for inspection as they are located in areas that are frequently accessed for a variety of activities associated with water and environmental management, and by third party users.

Results

The following table summarises the results of the HVO South compliance inspection and summarises the information recorded on the individual pro-forma inspection sheets. Using a mobile mapper pre-loaded with the GIS co-ordinates for each Aboriginal heritage site, the field team travelled to each location and attempted to re-identify each site. Sometimes this was not possible due to poor ground surface visibility (GSV), a result which in itself was not overly significant as long as it was determined that the vicinity had not been inadvertently disturbed. The presence and condition of barricading or fencing was noted, as well as the presence and nature of various potential site disturbing factors (e.g erosion, animal, human). General observations of each site were made if necessary, and, based on information provided for all of the above factors, management recommendations were discussed and agreed by the field team for each site.



Map 3: Location of Aboriginal heritage sites inspected during the HVO South AHMP compliance inspection program

Site Name	Date Inspected	Site re-identified	Site intact?	Site fenced/ barricaded?	Fencing/ barricading intact?	Natural erosion	Livestock damage	Human disturbance	Animal disturbance	Pests & weeds	General observations	Management recommendations
37-6-3613	31/10/2019	Yes	Yes	Yes	Yes	No	No	No	No	No	-	Nil
Heatherlea	30/10/2019	No	Yes	No	No	No	No	No	No	No	Very old recording	Request site card and report to refine search area
HVO-130	30/10/2019	Yes	Yes	Yes	Yes	No	No	No	No	ant nest	-	Nil
HVO-983	31/10/2019	Yes	Yes	No	No	No	No	No	No	No	Artefacts identified at salvaged locale	Collect during next salvage program
HVO-985	31/10/2019	No	Yes	Yes	No	No	No	Track construction	No	No	Heavy ground cover	Recommend for salvage
Grenleek Powerline Sites: HVO 1404-11; 1450-5; 1460-5; 1469-75	30/10/2019	Yes	Yes	Yes	No	Yes	No	Beside track	No	No	Many sites close together	Specific barricading/fencing program for clustered sites along powerline easement. Consultation with Transgrid/Ausgrid is recommended to devise the best strategy for managing this shared area.
HVO-1421	30/10/2019	Yes	Yes	Yes	No	No	No	Beside track	No	No	-	Fix barricading
HVO-1422	30/10/2019	Yes	Yes	Yes	No	No	No	Beside track	No	No	-	Fix barricading
HVO-1425	30/10/2019	No	Yes	Yes	No	No	No	Beside track	No	No	-	Fix barricading
HVS-29	31/10/2019	No	Yes	Yes	No	No	No	Under powerlines	No	No	-	Fix barricading
ISF 1	31/10/2019	No	Yes	No	No	Yes	No	No	No	No	Old recording	Request site card and report to refine search area
NW 1	30/10/2019	No	Yes	No	No	No	No	No	No	No	Old recording	Request site card and report to refine search area
United IF1	31/10/2019	No	Yes	Yes	Yes	No	No	Stockpiles	No	No	-	Request site card and report to refine search area
WB5	30/10/2019	No	Yes	No	No	Yes	No	Dam construction	No	No	Old recording	Request site card and report to refine search area
WB 15	31/10/2019	Yes	Yes	No	No	No	No	No	No	No	Site outside of fenced area	Amend HVO sites database to refine position
WB 21A	30/10/2019	No	Yes	Yes	Yes	No	No	No	No	No	-	Repair fence from tree fall
WB 21B	30/10/2019	Yes	Yes	Yes	Yes	No	No	No	Wombats	No	Artefact on central wombat mound	Nil
Wollombi Brook Trench	30/10/2019	No	Yes	No	No	No	No	Trench alongside track	No	No		Request site card and report to refine search area

Table 2: Results of HVO South Aboriginal Sites Compliance Inspection

Aboriginal Site Management Recommendations

Management recommendations were provided for many of the Aboriginal heritage sites visited. At some sites, more than one management action was recommended. The nature of these recommendations are described below.

Mend barricading and signage

Sites: HVO-1421, HVO-1422, HVO-1425, HVS-29, WB 21A

WB 21A has been hard fenced with pockets and wire, and is generally in good repair. However, a tree has fallen across a small section of fence that should be removed and the wires re-tensioned. The remaining sites sites have been barricaded in the past and are located in areas subject to regular activity – i.e. under power-lines. It is recommended that the barricading, fencing and signage at these sites be repaired or re-instated to prevent inadvertent disturbance while third parties are accessing the powerline easement.

It should be noted that the new and upgraded barricading specification being trialled and installed at several ACH sites across HVO was received positively by the RAPs in attendance and should be considered as a favourable option when upgraded site protection is warranted.

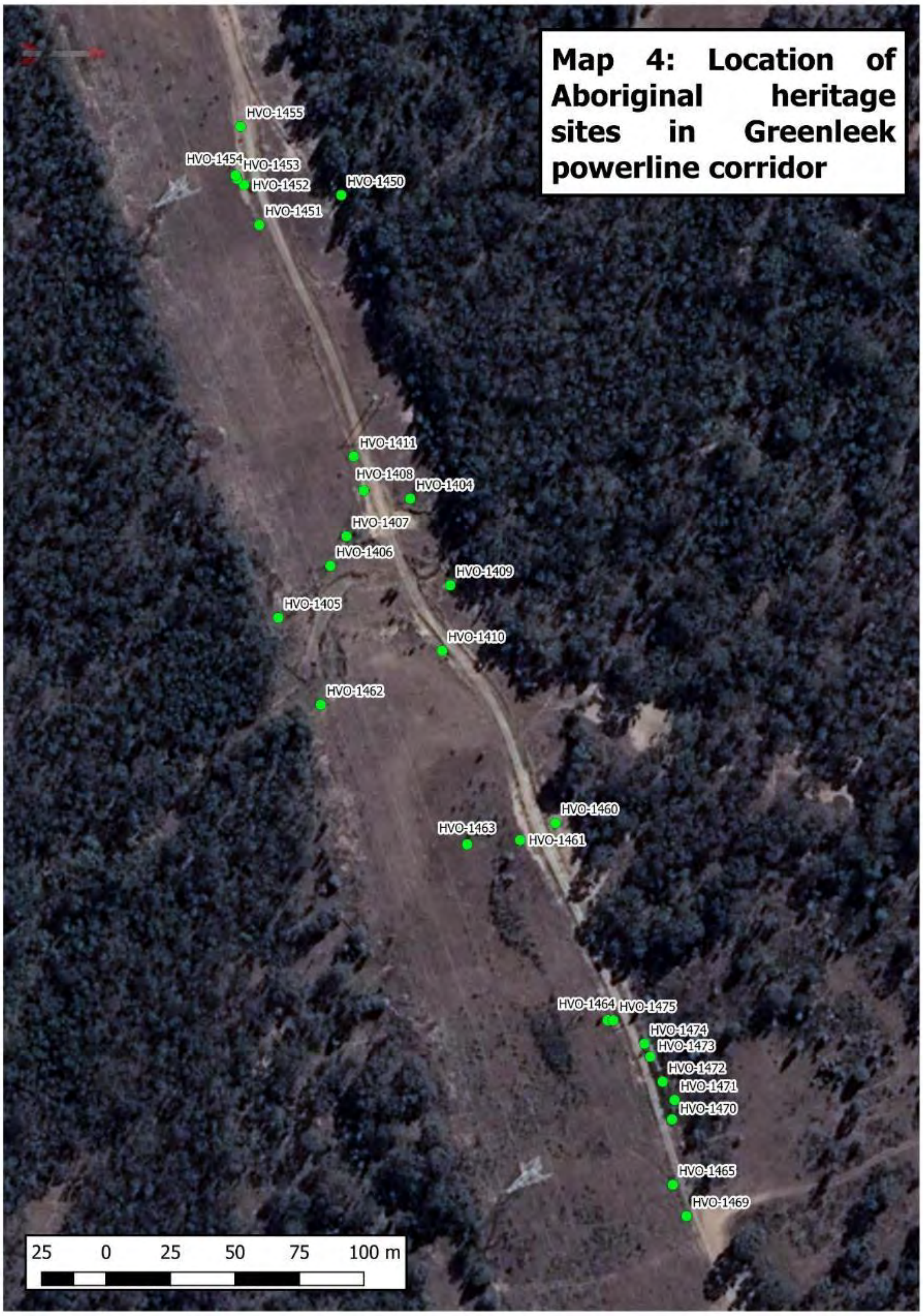
An example of dilapidated barricading at HVS-29

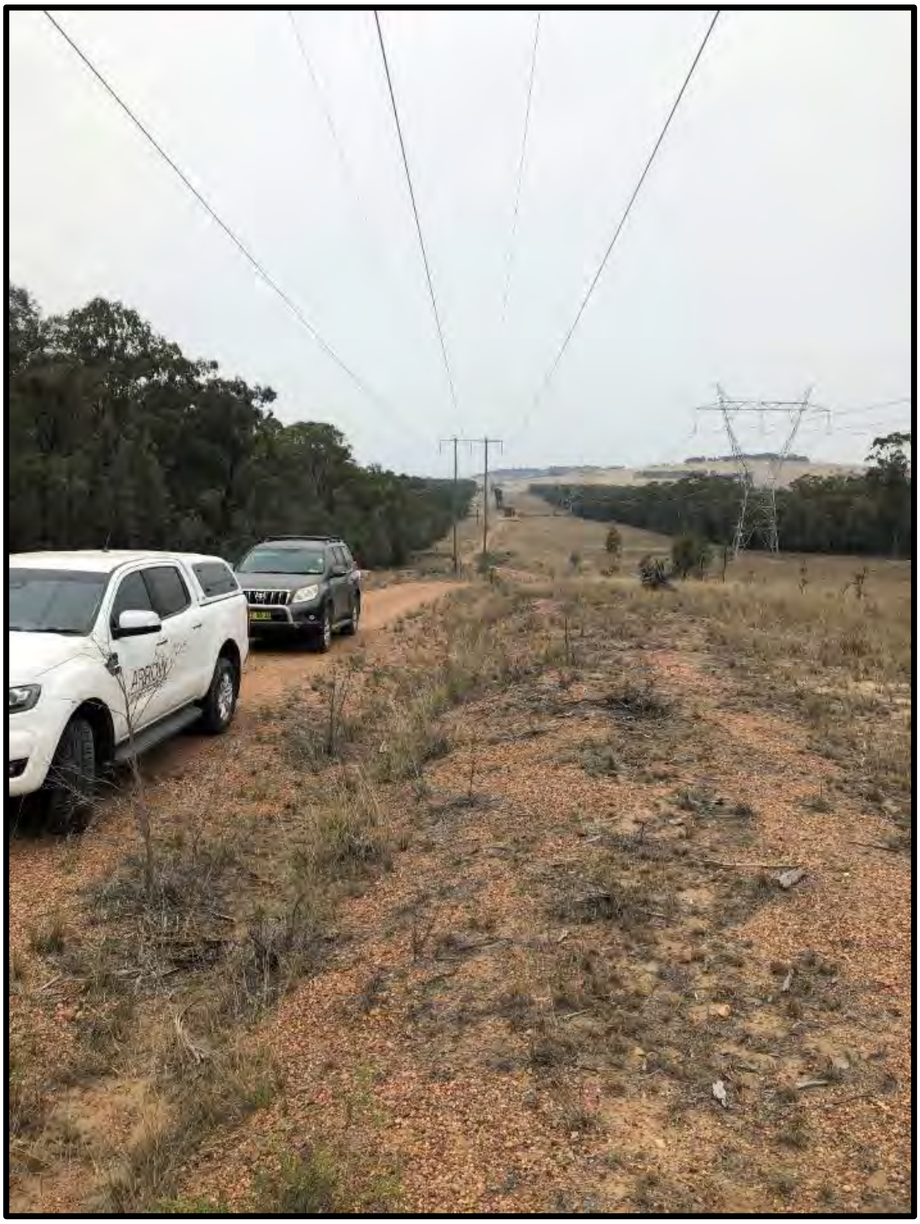
Fencing along both sides of track – Greenleek Powerline

Sites: HVO-1404-11, 1450-5, 1460-5, 1469-75

These sites were originally recorded as small, discrete locations of artefacts either side of a powerline easement track, and have been barricaded separately or in small clusters. Upon inspection during this program, artefacts were noted as occurring throughout exposures and outside of the dilapidated barricaded areas. Although not located on the track itself, their close proximity does constrain access in some parts, particularly at the creek crossing. It is recommended that the fencing be altered so that it is installed along both sides of the track in those locations where sites are present to protect them from inadvertent vehicle disturbance – in effect, restricting vehicle movement off the track and onto areas containing artefacts.

Alternatively, consideration may be given to grading a new track to the west within the powerline easement, which has been comprehensively surveyed for Aboriginal heritage sites. Regardless of which management action is decided, consultation with Transgrid/Ausgrid is recommended to devise the best strategy for managing this shared area.





View south along Greenleek powerline corridor across sites shown in Map 4

Request and assess further site information

Sites: Heatherlea, ISF 1, NW 1, United IF1, WB 5, Wollombi Brook Trench

These sites were unable to be re-identified during the audit inspection, and prior to any further attempts at re-identification it would be beneficial to obtain and assess any site information held at HVO or within AHIMS. Some sites are located in former Section 90 Consent to Destroy areas, however it is not clear whether they were in fact salvaged. An assessment of the latest available AHIMS data as well the relevant salvage report for the area may assist.

Suggest salvage next program

Sites: HVO-983, HVO-985

HVO-985 consists of a single flake on the edge of a track covered by a thick ground covering of galenia. This site has been unable to be re-identified during previous audits and, due to the risk of further disturbance arising from track use it is recommended that this site be salvaged. Also, two mudstone flakes were noted at nearby HVO-983 – a site that had been previously salvaged. For completeness, these artefacts should also be salvaged at the same time. An AHIP is not required to implement this measure, as the salvage of these sites, with Aboriginal community participation, is authorised under the HVO South AHMP.

Location of HVO-985

Update HVO Aboriginal sites databases

Sites: WB 15

Prior to the October 2019 audit inspection of this site, the locational and archaeological information held by HVO was minimal and/or incomplete, but did suggest artefactual material was located outside of the current fenced area. During this audit a flake of mudstone was located close to the fenced area. This information should be updated within the "HVO_sites_current" and "HVO_site_extents" GIS databases to keep them current.

Recommendations and Actions Arising from Previous Audits

During the December 2018 compliance audit at HVO North and South, and the September 2019 additional audit at HVO South, management recommendations were provided for many of the Aboriginal heritage sites visited. The table below outlines the management actions completed with reference to these recommendations.

Recommendation	ACH sites involved	Actions completed
Dec 18: Reinstate barricading, wire &/or signage if activity increases	CM19, CM32, HVO-69, HVO-76, HVO-77, HVO-123, HVO-127, HVO-129, HVO-1792, HVO-1793	Several sites have been rebarricaded or fenced where activity levels have required (see photographs below).
Dec 18: Re-audit in 2019	CM19, CM32, HVO-69, HVO-70, HVO-74, HVO-112, HVO-122, HVO-126, HVO-127, HVO-215, HVO-296, HVO-313, HVO-793, HVO-905, HVO-945, WB-20	Due to the large number of sites at HVO and the short passage of time since last audited, the re-audit of these sites will take place at a later date.
Dec 18: Cattle proof fence along both banks of gully	CM55	Complete, see photograph below.
Dec 18: Discuss options to protect with HVO	HVO-1121, HVO-1122, HVO-1124	HVO-1121 and 1122 have been hard fenced with HVO-1124 to be managed in situ.
Dec 18: Remove stock until sites salvaged	All Mitchell Pit sites	Stock was removed prior to the completion of the Mitchell Pit salvage program in July 2019.
Dec 18: Cattle proof fence around tree	HVO-1123	Complete
Dec 18: Remove weeds	CM55, HVO-127, HVO-1793, HVO-223	HVO have a comprehensive ongoing weed control program.
Dec 18: Suggest salvage next program	HVO-75, HVO-215	HVO-75 yet to be salvaged, HVO-215 requires AHIP and further consultation.
Dec 18: Barricading along both sides of track	HVO-71, HVO-72	Complete.
Dec 18: Remove historic farm litter and debris	CM-CD1	Complete.
Dec 18: Edit the HVO North CHZS to reflect the CM-CD1 disturbance exclusion area as Zone 1	CM-CD1	Complete.
Dec 18: Alter the CM-CD1 northern fence alignment to encompass the northern tip of disturbance exclusion area	CM-CD1	Complete.
Dec 18: Alter the CM-CD1 western fence alignment, which is dilapidated in segments	CM-CD1	Complete.

Recommendation	ACH sites involved	Actions completed
Dec 18: Install new Cultural Heritage Site signage around the CM-CD1 fenced area	CM-CD1	Complete.
Dec 18: Peg the photographic point locations so that the same points can be used from year to year	CM-CD1	Co-ordinates are logged but pegging yet to be installed.
Dec 18: Ensure that the HVO North Blast Management Plan contains sufficient information to ensure no adverse blasting impacts affect CM-CD1	CM-CD1	Complete.
Sep 19: Repair fencing wires	HVO-1208	Complete.
Sep 19: Include in next audit	HVO-1205, HVO-1252, HVO-1273, HVO-1278, HVO-1281, HVO-1282	Due to the large number of sites at HVO and the short passage of time since last audited, the re-audit of these sites will take place at a later date.
Sep 19: Continue weed eradication program	HVO-1277	HVO have a comprehensive ongoing weed control program.
Sep 19: Suggest salvage next program	HVO-1199	Yet to be salvaged.

Photographs below show examples of new fencing, received positively by the RAPs, installed at HVO sites as per previous audit recommendations, (top: CM55, middle: HVO-1792, bottom: HVO-127)


RANGER


HERITAGE SITE
KEEP OUT

Recommendations from October 2019 and Previous Audits

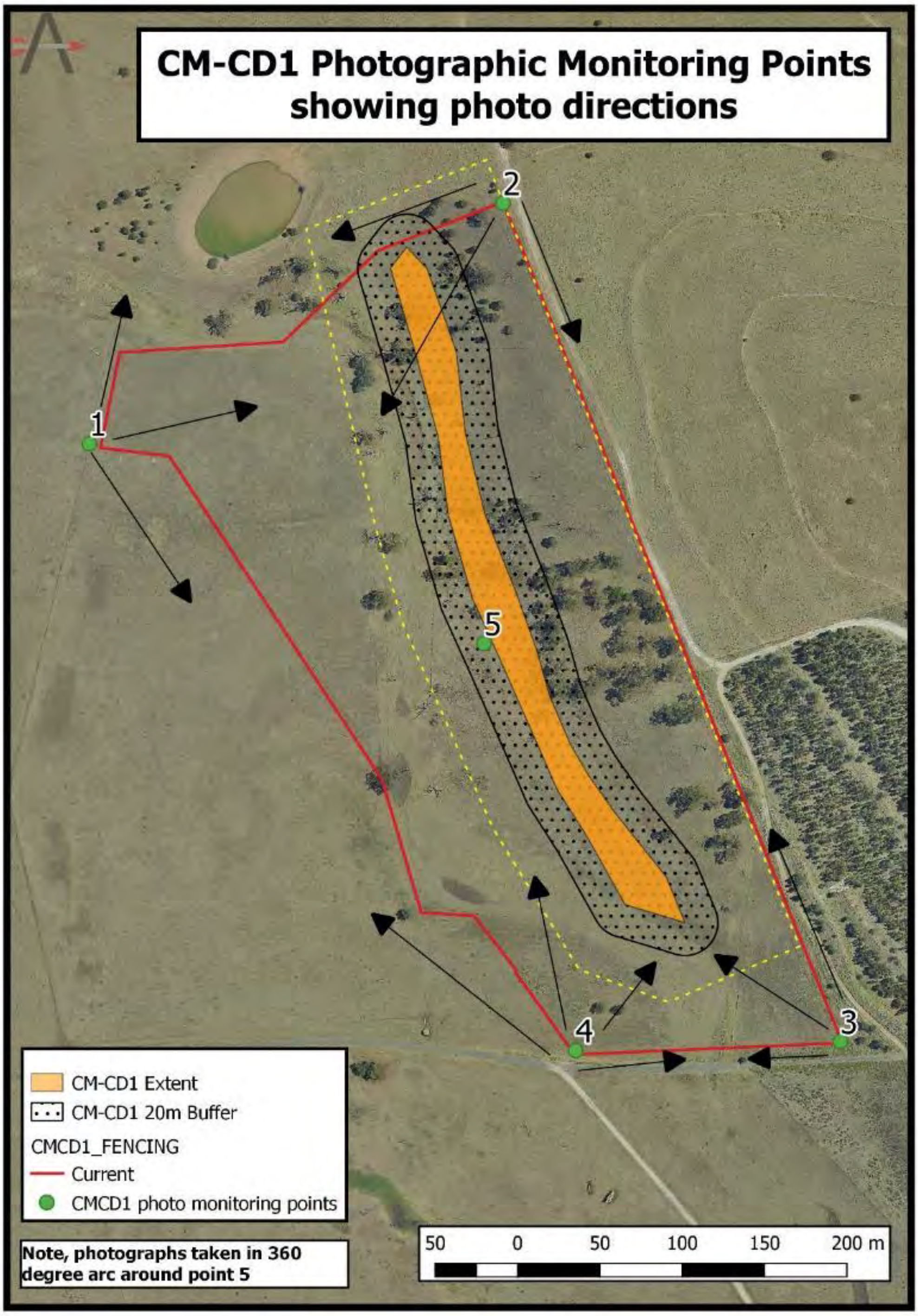
The following ACH management recommendations are provided as a result of the October 2019 AHMPs Compliance Audit, as well as including those recommendations outstanding from earlier audits.

1. **Pending increased nearby activity, update barricading, wire and/or signage at ACH sites C5, HVO-1128 HVO-1421, HVO-1422, HVO-1425, HVS-29 and WB 21A;**
2. **Discuss salvage of hearth HVO-215 with CHWG in context of wider AHIP program at Mitchell Pit south;**
3. **Request and assess further AHIMS site information for ACH sites CM1, Ponds Creek/ Parnells Creek (37-2-0035), Heatherlea, ISF 1, NW 1, United IF1, WB 5 and Wollombi Brook Trench;**
4. **Update HVO Aboriginal sites databases with additional information for ACH sites HC-25, Ponds Creek (37-2-0190), Ponds Creek/ Parnells Creek (37-2-0036), T/L3/ Plashette (37-2-0562) and WB 15;**
5. **Remove rubbish from vicinity of ACH site HVO-1128;**
6. **Consider engaging a scarred tree expert to re-assess ACH site HVO-930, and potentially include all scarred trees on HVO leases and lands;**
7. **Install ACH signage at perimeter of sites HVO-930, Ponds Creek (37-2-0190) and T/L3/ Plashette (37-2-0562);**
8. **Fencing around ACH sites along both sides of the Greenleek Powerline access track, or develop new access route to avoid potential impacts to ACH sites. Consultation with Transgrid/Ausgrid is recommended to devise the best strategy for managing this shared area;**
9. **After discussions of these recommendations with the CHWG, implement a salvage program including ACH sites HVO-75, HVO-983, HVO-985 and HVO-1199; and**
10. **Peg CM-CD1 annual photographic location points.**

APPENDIX A – CM-CD1 PHOTO MONITORING RESULTS

Photo Point #	Location at CM-CD1	Easting	Northing
1	North-west	308614	6403653
2	North-east	308814	6403807
3	South-east	309022	6403297
4	South-west	308860	6403290
5	Centre	308809	6403513

Co-ordinates (GDA94, z56) for CM-CD1 photo monitoring points



Location of CM-CD1 photo monitoring points

CM-CD1 Monitoring Point 1 photographs

CMCD-1 photo monitoring point 1, view east.


CMCD-1 photo monitoring point 1, view south-east.

CMCD-1 photo monitoring point 1, view south.

CMCD-1 photo monitoring point 1, view north.

CM-CD1 Monitoring Point 2 photographs

CMCD-1 photo monitoring point 2, view south-west.


CMCD-1 photo monitoring point 2, view south-south-west.

CMCD-1 photo monitoring point 1, view south.

CMCD-1 photo monitoring point 1, view west.


CMCD-1 photo monitoring point 1, view west-south-west.

CM-CD1 Monitoring Point 3 photographs

CMCD-1 photo monitoring point 3, view west.


CMCD-1 photo monitoring point 3, view north.


CMCD-1 photo monitoring point 1, view north-west.

CM-CD1 Monitoring Point 4 photographs

CMCD-1 photo monitoring point 4, view east.

CMCD-1 photo monitoring point 4, view north-east.

CMCD-1 photo monitoring point 4, view north-north-east.

CMCD-1 photo monitoring point 4, view north.

CMCD-1 photo monitoring point 1, view north-west.

CM-CD1 Monitoring Point 5 photographs

CMCD-1 photo monitoring point 5, view north.

CMCD-1 photo monitoring point 5, view north-west.

CMCD-1 photo monitoring point 5, view west.

CMCD-1 photo monitoring point 5, view south-west.

CMCD-1 photo monitoring point 5, view south.

CMCD-1 photo monitoring point 5, view south-south-east.

CMCD-1 photo monitoring point 5, view south-east.

CMCD-1 photo monitoring point 5, view east.

CMCD-1 photo monitoring point 5, view east-north-east.

CMCD-1 photo monitoring point 5, view north-east.

Mr Tony Galvin
General Manager – Hunter Valley Operations
HV Operations Pty Ltd
PO Box 315
SINGLETON NSW 2330

Ref: DA450-10-2003-PA-19
MP06_0261-PA-13

Via Email ONLY: environmentandcommunity@hvo.com.au

03/06/2020

Dear Mr Galvin

Hunter Valley Operations - DA 450-10-2003 (North) & MP 06_0261 (South)
Annual Review 2019

Reference is made to the Annual Review for the period 1 January 2019 to 31 December 2019, submitted to the Department of Planning, Industry and Environment (the Department) as required under Schedule 5, Condition 9 of DA 450-10-2003 (HVO North) and Schedule 5, Condition 4, of Project Approval MP 06_0261 (HVO South) (the approvals, as modified).

The Department has reviewed the Annual Review and considers it to satisfy the reporting requirements of the approval and the Department's *Annual Review Guideline* (October 2015).

The Department notes the following:

- Section 7.5 – Groundwater: exceedances of groundwater quality trigger values are reported across various monitoring locations to have occurred during the reporting period. The Department has reviewed Appendix A – 2019 Annual Groundwater Review and supports the recommendations made in Section 6.2 to better understand the current impact on groundwater quality within the monitoring network.

The Department notes that the Annual Review was submitted via the Major Projects portal under DA 450-10-2003 and MP 06_0261. For future submissions, please only submit reports under one approval (the most recent) and submit a cover letter outlining the submission to the others. This will assist in undertaking timely reviews of required reporting documents.

As required by Schedule 5, Condition 12 of DA 450-10-2003 and Schedule 5, Condition 9 of MP 06_0261 of the approvals, please make publicly available a copy of the Annual Review on the company website

Please note that the Department's acceptance of this Annual Review is not endorsement of the compliance status of the project. Non-compliances identified in the Annual Review will be assessed in accordance with the Department's Compliance Policy. Further correspondence may be sent in relation to non-compliances.

Should you need to discuss the above, please contact James Epstein, Senior Compliance Officer, on (02) 6575 3419 or email to compliance@planning.nsw.gov.au

Yours sincerely

HWatters

Heidi Watters
Team Leader Northern
Compliance
As nominee of the Secretary