CENTENNIAL

CENTENNIAL COAL
SPRINGVALE COLLIERY
ANNUAL REVIEW
January 2020 to December 2020

March 2021

Annual Review Title Block

Name of Operation	Springvale Colliery
Name of Operator	Springvale Coal Pty Limited
Development Consent/ Project Approval #	SSD 5594
Name of holder of development consent / project approval	Centennial Springvale Pty Limited
Mining Lease #	ML1303, ML 1323, ML 1326, part ML 1424, ML 1537, ML 1588, ML 1670, ML 1727, MLA 445, MLA 497, CL 377, MPL 314, EL 6974, AUTH 460
Name of Holder of Mining Lease	Centennial Springvale Pty Ltd Boulder Mining Pty Ltd
Water License #	10WA118719 (WAL 36383) 10BL603519 (WAL 36383) 10BL602017 (WAL 36443) 10BL601863 (WAL 36446)
Name of Holder of Water License	Centennial Springvale Pty Ltd
MOP/RMP Start Date	June 2018
MOP/RMP End Date	May 2025
Annual Review Start Date	1 January 2020
Annual Review End Date	31 December 2020

I, Michael Clark **, certify that this audit report is a true and accurate record of the compliance status of Springvale Colliery for the period 01/01/2020 to 31/12/2020 and that I am authorized to make this statement on behalf of Springvale Colliery.**

Note:

a) *The Annual Review is an 'environmental audit' for the purposes of s122B(2) of the Environmental Planning and Assessment Act 1979. Section 122E provides that a person must not include false or misleading information (or provide information for inclusion) in an audit report produced to the Minister in connection with an environmental audit if the person knows that the information is false or misleading in a material respect. The maximum penalty is, in the case of a corporation, $1 million and for an individual, $250,000.*

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

Name of Authorised Reporting Officer	**MICHAEL CLARK**
Title of Authorised Reporting Officer	Director
Signature of Authorised Reporting Officer	M. Clark
Date	16-03-21

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1. STATEMENT OF COMPLIANCE

Table 1 provides a statement of compliance with the relevant approvals during the reporting period.

Table 1: Statement of Compliance

Were all conditions of the relevant approval(s) complied with?	
SSD 5594	No
EPBC 2011/5949	Yes
EPBC2013/6881	Yes
SMP LW 411-418 (04/1673)	Yes
ML 1303	Yes
ML 1323	Yes
ML 1326	Yes
ML 1424 (part)	Yes
ML 1537	Yes
ML 1588	Yes
ML 1670	Yes
ML1727	Yes
CL 377	Yes
MPL 314	Yes
EL 6974	Yes
AUTH 460	Yes
EPL 3607	Yes
WAL 36383	No
WAL 36443	Yes
WAL 36446	Yes

Table 2 provides a list of conditions that were not complied with during the reporting period.

Table 2: Non-Compliances

Relevant Approval	Condition #	Condition summary	Compliance Summary	Comments	Section Addressed in Annual review
SSD 5594	S4 C12	Design, install and maintain mine water storage infrastructure to unsure no unlicensed or uncontrolled discharge of mine water off-site	Potential for low environmental consequence	Ventilation Facility Pipeline Incident- Potential Non-compliance	Section 11- Table 90
WAL 36383	2	Share Component	Administrative Non-Compliance	Over extraction of share component	Section 11- Table 91

Note: Compliance Status Key for Table 3

Risk Level	Colour Code	Description
High	Non-complaint	Non-compliance with potential for significant environmental consequences, regardless of the likelihood of occurrence
Medium	Non-complaint	Non-compliance with: • Potential for serious environmental consequences, but is unlikely to occur; or • Potential for moderate environmental consequences, but is likely to occur
Low	Non-complaint	Non-compliance with: • Potential for moderate environmental consequences, but is unlikely to occur; or • Potential for low environmental consequences, but is likely to occur
Administrative	Non-complaint	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

Springvale Mine is an existing underground coal mine producing high quality thermal coal which is supplied to both domestic and international markets. It is located 15 kilometres to the northwest of the regional city of Lithgow and 120 kilometres west-northwest of Sydney in New South Wales (NSW). This is shown in Figure 1.

Underground coal mining commenced at Springvale Mine in 1995 following the granting of Springvale Mine's development consent (DA 11/92) on the 27th of July 1992, pursuant to Section 101 under Part 4 of the NSW Environmental Planning and Assessment Act, 1979 (EP&A Act). Springvale Coal Pty Limited is the operator of Springvale Mine.

On the 21st of September 2015 SSD 5594 was approved by the Department of Planning and Environment. Modifications 1 and 2 to SSD 5594 were subsequently approved in 2017 by the Planning Assessment Commission (PAC), under delegation from the Minister. The approval of SSD 5594 (including Mods 1 and 2) allows Springvale to continue underground coal mining operations within the Lithgow Seam at rates up to 5.5 Mtpa until 31 December 2028, with subsequent rehabilitation and closure works. In summary the project includes:

- Continued longwall mining operations to extract up to 5.5 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal from the Lithgow Seam;
- Continued operation of the mine's pit top area, support facilities and utilities;
- Extension and continued use of the Springvale Delta Water Transfer Scheme, bore dewatering facilities and ventilation infrastructure;
- Continued processing (sizing and screening) of ROM coal at the pit top area;
- Continued stockpiling of ROM coal (200,000 tonnes (t) capacity);
- Continued transportation of processed coal by overland conveyor to Centennial's Western Coal Services site (WCSS) for further processing or to the Mt Piper Power Station;
- Continued transportation of processed coal by road haulage to other local domestic customers (limited to 50,000 tpa); and
- Rehabilitation of the pit top area and Newnes Plateau surface infrastructure sites.

A summary of the development consent and mining lease boundary is shown in Figure 1 and Figure 2.

The main components of Springvale Mine's operations are an underground longwall mine, accessed via the Springvale pit top, and supporting surface infrastructure within the pit top area and on Newnes Plateau within the Newnes State Forest. The Newnes Plateau infrastructure areas are accessed by light vehicles via State Mine Gully Road located in north Lithgow, and Old Bells Line of Road though Clarence for light and heavy vehicles Newnes Plateau and Pit Top disturbance Areas are shown in Figure 4 and Figure 5 respectively.

The Environmental Planning and Assessment Amendment (Sydney Drinking Water Catchment) Act 2017 No 47 which was passed by the NSW Parliament in October 2017 validated SSD 5594 (and the modifications) following earlier court proceedings challenging the development consent.

The contact details for Springvale personnel responsible for environment management and community relations, along with details for community complaints and enquiries have been provided in Table 3.

Table 3: Environmental Management Contact Details

Contact	Position	Contact Details
Primary Contacts		
Dennis Wallace	Mine Manager	T: (02) 6350 1613
		F: (02) 6355 1502
		E: dennis.wallace@centennialcoal.com.au
Natalie Gardiner	Environment and Community Co-ordinator	T: (02) 6350 1672
		F: (02) 6355 1502
		E: natalie.gardiner@centennialcoal.com.au
Community Enquiries/Complaints		
Springvale Enquiries and Community Complaints		T: (02) 6350 1640

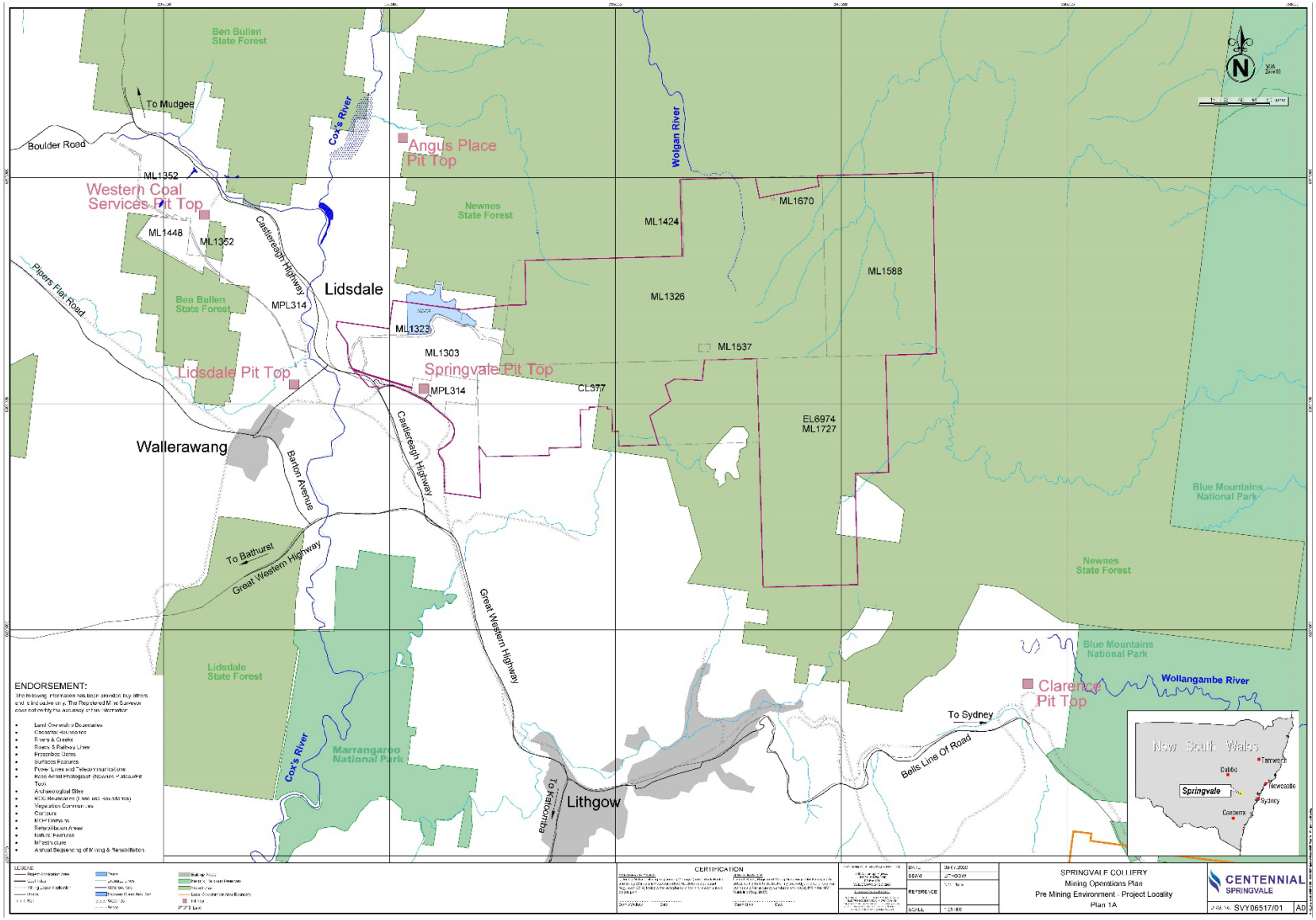


Figure 1: Development Consent Boundary

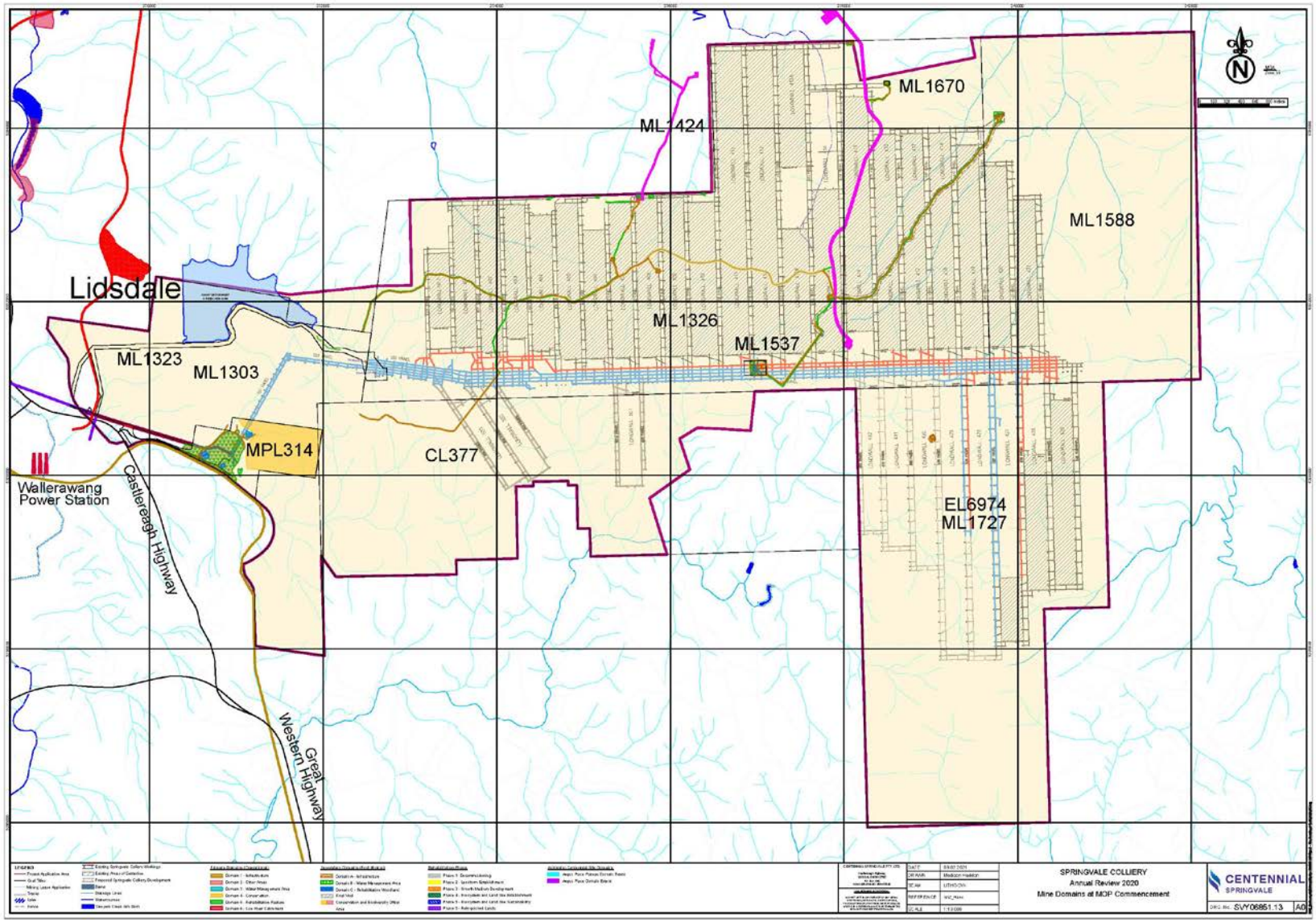


Figure 2: Mining Lease Boundaries

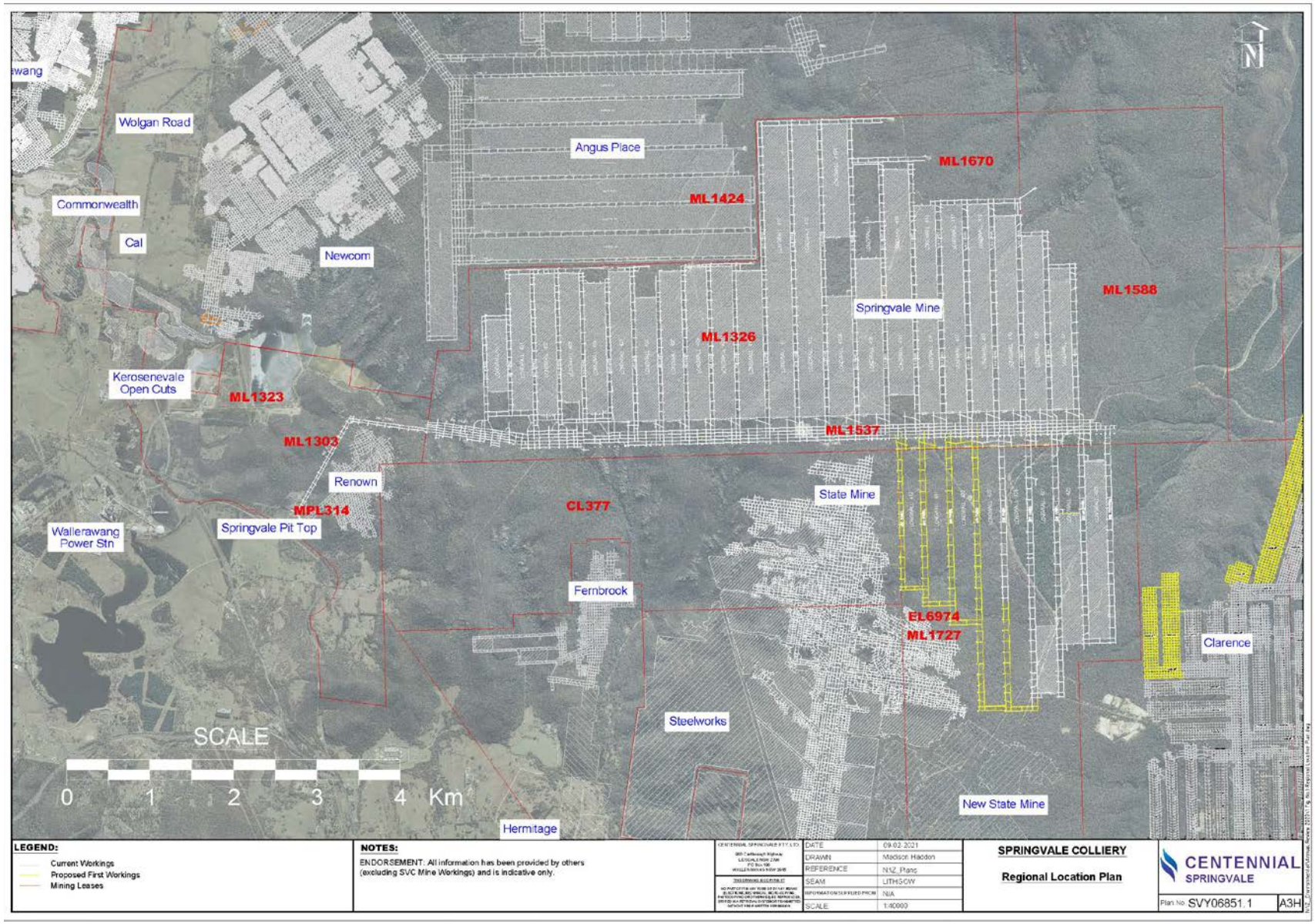


Figure 3: Regional Location

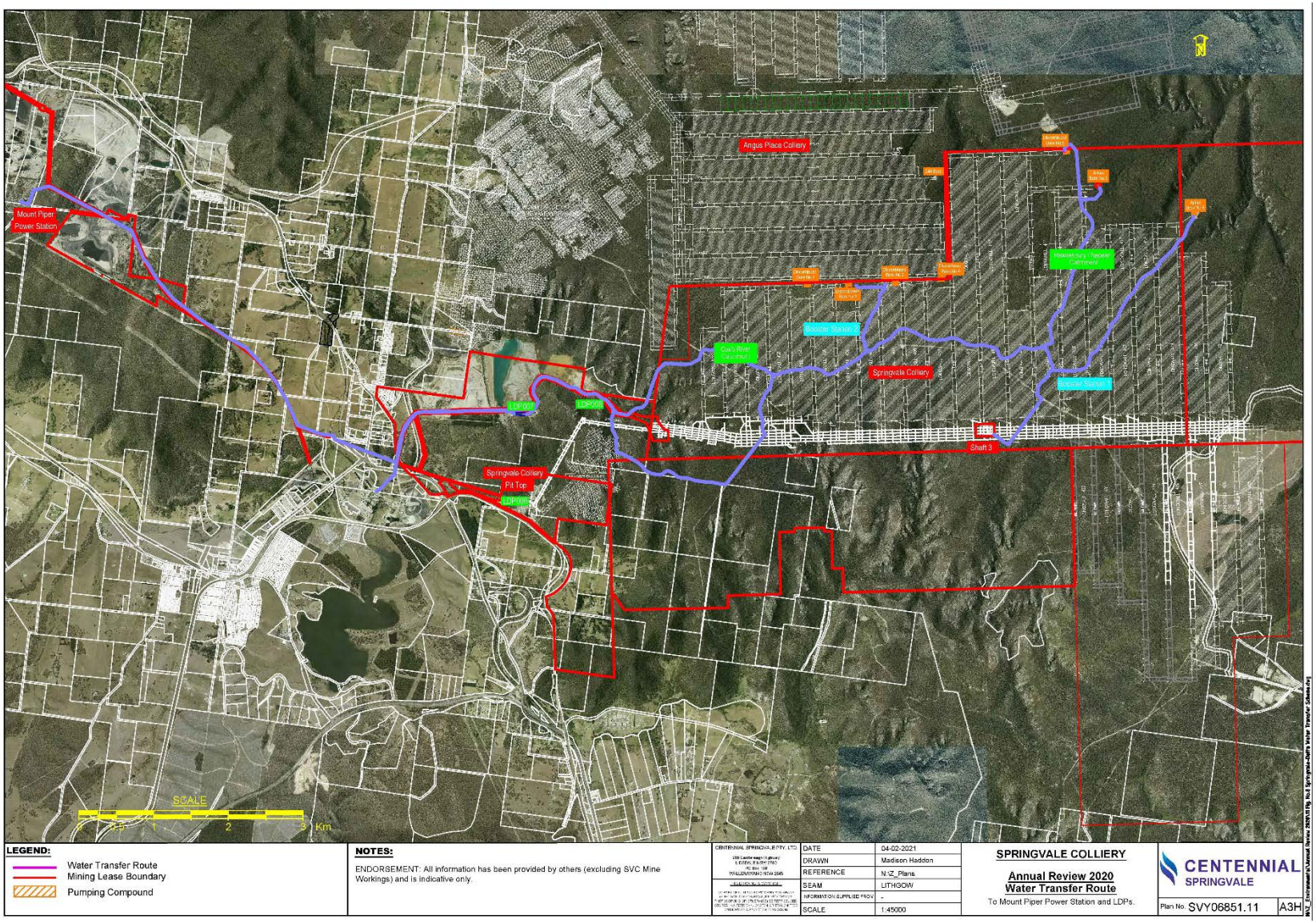


Figure 4: Newnes Plateau Operational Disturbance

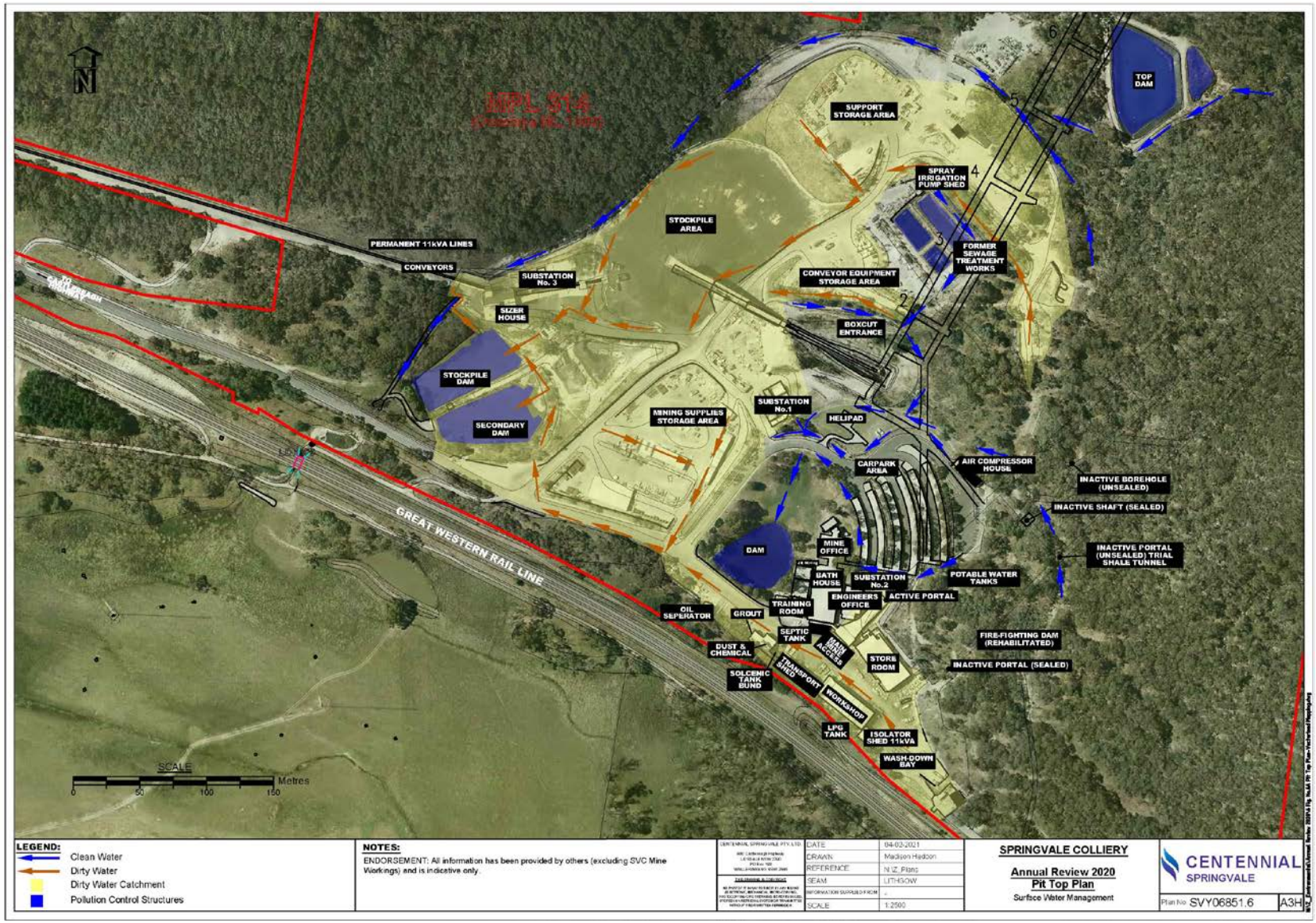


Figure 5: Springvale Pit Top Operational Disturbance

3. APPROVALS

Section 3 details the environmental approvals held by Springvale under the EP&A Act, Mining Act, POEO Act, NPW Act, Water Act, Water Management Act, Radiation Act, and any changes made to these approvals during the reporting period.

3.1. Development Consents and EPBC Approvals

Development Consent SSD 5594 was granted to Springvale on the 21st of September 2015. This consent supersedes the former Development Consent DA 11/92.

In accordance with Schedule 2, Condition 10 of SSD 5594, DA 11/92 was required to be surrendered by the 21st of September 2016. A legislative amendment has been proposed by the Department to manage the difficulties with the surrender of consents across multiple landholdings. The current extension to the surrender of consents is until 19 September 2021. All development and activities at Springvale from the 21st of September 2016 will be undertaken in accordance with SSD 5594 and DA 11/92 will not be relied upon to undertake development or activities beyond those encompassed by SSD 5594.

During the reporting period Springvale surrendered DA461/02 which was associated with the Ventilation Shaft No3 site as required under Schedule 2 Condition 10 of SSD5594. This was accepted by Lithgow City Council on 12 November 2020.

In addition to SSD5594, Springvale operates in accordance with two federal approvals under the EPBC Act granted by the Department of Energy and Environment (former Department of Environment, former Department of Sustainability, Environment, Water, Population and Communities). Approval EPBC 2011/5949 was granted on the 14th of March 2012 and allows Springvale to extract coal from Longwalls 415 – 417. A second approval (EPBC 2013/6881) was issued on the 15th of October 2015 to allow secondary extraction associated with the Springvale Mine Extension Project SSD 5594.

Additional detail pertaining to the Springvale Development Consents and EPBC Approvals has been provided in Table 4.

Table 4: Development Consents and EPBC Approvals

Approval	Details	Date of Issue	Expiry
SSD 5594	Springvale Mine Extension Project	21 September 2015	31 December 2028
EPBC 2011/5949	Mining of Longwalls 415 – 417.	14 March 2012	19 March 2032
EPBC 2013/6881	Mining associated with the Springvale Mine Extension Project.	15 October 2015	8 October 2035

Two Modifications to SSD 5594 were submitted to DPE in 2016 and approved in 2017. Details of these are outlined in Table 5 below.

Table 5: SSD 5594 Modification Details and Status

Modification No.	Details of Modification	Date of Application /Exhibition Period	Status
Mod 1	• Increase of the approved workforce (including contractors) from 310 full time equivalent (FTE) to 450; • Increase in ROM coal production from the approved 4.5 Mtpa to 5.5 Mtpa; and	23/07/2016 / 02/08/2016 – 23/08/2016	Approved 19 April 2017

Modification No.	Details of Modification	Date of Application /Exhibition Period	Status
	• Increase in the existing stockpile capacity at the Springvale pit top from 85,000 tonnes to 200,000 tonnes capacity and an increase in the coal stockpile footprint by 0.3ha northeast of the stockpile area.		
Mod 2	• To remove the requirement to *Meet limits for salinity of 700 (50th percentile), 900 (90th percentile) and 1000 (100th percentile) uS/cm by 30 June 2017;* and • To defer to 30 June 2019 the requirement to *Eliminate acute and chronic toxicity from LDP009 discharges to aquatic species by 30 June 2017, with acute toxicity defined as >10% effect relative to the control group and chronic toxicity defined as >20% effect relative to the control group.*	22/12/2016 / 24/01/2017 – 28/02/2017	Approved 19 June 2017

During the reporting period Springvale prepared a pre modification application for the inclusion of AIHMS site 45-1-2805 and AIHMS 45-1-2796. This Modification to SSD 5594 (Mod 3) will be pursued in 2021.

Voluntary Undertaking – Sunnyside Swamp Rehabilitation

In the 2017 Annual Review, Springvale reported an incident in relation to an unauthorised disturbance to Sunnyside Swamp. On the 15th of February 2018, Springvale Coal entered a voluntary undertaking with DPE to implement rehabilitation at Sunnyside Swamp (at the site and area adjacent to the disturbance) and carry out ongoing monitoring and reporting in relation to the rehabilitation.

A summary of the compliance status against the conditions of the voluntary undertaking is presented detailed in Table 6 below.

Table 6: Voluntary Undertaking Actions and Completion Notes

Voluntary Undertaking Action Requirement	Action Completion Note
(a) Implement rehabilitation of Sunnyside Swamp using treatments as detailed in the Sunnyside Swamp Powerline Crossing Clearing Impacts Report and Rehabilitation Work Plan dated 9 February 2018.	Milestones of Work Plan form (b) and (c) Action Requirements outlined below. Springvale Coal has complied with the requirements of the Work Plan during the reporting period.
(b) Achieve the following milestones contingent on receiving the relevant regulatory approvals:	
• Finalise exclusion barrier locations with Forestry NSW by 23rd February 2018;	• Inspections undertaken with Forestry NSW week of the 19th of February 2018. Identification of exclusion barriers to swamp agreed upon to block access. Plan of barrier locations and supporting feedback from Forestry NSW provided to DPE on the 23rd of February 2018.

Voluntary Undertaking Action Requirement	Action Completion Note
• Submit *the work plan to the Office of Environment and Heritage (OEH) in association* with the Threatened Species Licence Application pursuant to Part 2 of the Biodiversity Conservation Act 2016 (NSW) by 17 March 2018;	• Rehabilitation Work Plan and Threatened Species Licence application submitted to OEH on the 16th of March 2018. • The threatened species licence was approved on 9 April 2018 #C0003546
• Complete installation of exclusion barriers by 30 March 2018;	• Exclusion barriers installed and locked on the 29th of March 2018. 'No access' signs placed on the gates.
• Commission the work plan with The Bush Doctor by 17 April 2018;	• The Bush Doctor engaged for rehabilitation work plan on the 23rd of March 2018. • Threatened Species Licence #C0003546 issued to Springvale Coal on the 9th of April 2018 (subject to updated Hygiene Protocol submission).
• Complete the rehabilitation of Sunnyside Swamp by 17 May 2018.	• *Rehabilitation Activities Report (under Threatened Species Licence #C0003546)* provided by The Bush Doctor to Springvale Coal on the 14th of May 2018, outlining rehabilitation undertaken. Rehabilitation of Sunnyside Swamp completed in early-mid May.
(c) Complete inspections as per the timeline below: 1. Conduct six monthly inspections in November 2018.	Six monthly inspections carried out on the 12th of November 2018. Report provided to DPE and OEH.
2. Conduct six monthly inspections in May 2019 and complete a review of maintenance requirements.	Six Monthly Inspections carried out on the 17th of May 2019. Report provided to DPE and OEH.
3. Implement maintenance identified in the review in (2) as required in June 2019	Maintenance works completed 14th June 2019.
4. Provide a brief annual report on rehabilitation progress to EOH and the Department in July 2019	Report provided to DPE and OEH on the 17th of July 2019.
5. Conduct six monthly inspection in November 2019	Six monthly inspections carried out on the 11th of November 2019. Report provided to DPE and OEH
6. Conduct six monthly inspection in May 2020 and complete a review of maintenance requirements	Six monthly inspections carried out on the 15th of May 2020 which included a review of maintenance requirements
7. Provide final report to OEH and the Department on final rehabilitation outcomes of the work plan in July 2020	Report provided to DPE and OEH on the 13th of July 2020
8. Review the implementation and success of the work plan with OEH and the Department and	The report provided to the Department and subsequent correspondence with Centennial Rehabilitation specialist meet the requirements of this condition.

Voluntary Undertaking Action Requirement	Action Completion Note
9. Seek agreement from OEH and the Department that successful stabilisation has been achieved and remediation activities can cease	OEH provided DPIE agreement that no further action was required on the 5th of August 2020. DPIE subsequently provided notification to Centennial on the 7th of August 2020 that no further actions are required in relation to the stabilisation and remediation of Sunnyside Swamp

3.2. Authorisations

The Springvale holding includes Mining Lease (ML) 1303, ML 1323, ML 1326, part ML 1424, ML 1537, ML 1588, ML 1670, ML 1727 one Coal Lease (CL) (CL 377) and one Mining Purposes Lease (MPL) (MPL 314). Springvale also undertakes exploration activities in accordance with Exploration Licence (EL) 6974 and Authorisation (AUTH) 460. On the 22nd of October 2012 and 28th of May 2015, Centennial Springvale Pty Limited submitted Mining Lease Application (MLA) 445 and MLA 497, respectively. MLA 445 is associated with the Bore 8 dewatering facility (and the associated infrastructure corridor) and MLA 497 is associated with Licenced Discharge Point (LDP) 009. ML 1727 was obtained in 2016 and is associated with the proposed longwall panels 424 – 432. Additional details relating to these mining tenements have been provided in Table 7.

Table 7: Mining Tenements

Lease	Grant Date	Expiry Date
ML 1303	15 December 1992	15 December 2034
ML 1323#	3 August 1993	3 August 2035
ML 1326	28 September 1993	18 August 2024
ML 1424 (part)	18 August 2003	18 August 2024
ML 1537	15 June 2003	15 June 2024
ML 1588	19 June 2006	19 June 2027
ML 1670	17 February 2012	17 February 2033
ML 1727	4 February 2016	4 February 2037
MLA 445^	-	-
MLA 497^	-	-
CL 377	24 February 1992	9 March 2025
MPL 314	3 August 1993	3 August 2035
EL 6974	11 December 2007	13 December 2017*
AUTH 460	7 July 1992	6 June 2020

^ MLA 445, and MLA 497 were submitted 22 October 2012 and 28 May 2015, respectively. Both applications are still being processed.
* EL6974 renewal lodged 3 November 2017. Renewal Pending.
# ML 1323 part cancellation was submitted to the department 10th May 2016 to update the mining lease boundary. Approval took effect 2nd December 2020. The part cancellation is outside the consent boundary for SSD5594 .

3.3. SMP Longwalls 411 - 418

In May 2005, Springvale submitted a Subsidence Management Plan (SMP) Application to the NSW Department of Primary Industries (now DRE) seeking approval for first workings and secondary extraction within Longwalls 411 – 418. SMP Approval was issued on the 7th of March 2006 (Reference Number 04/1673). Subsequent SMP variations were submitted and approved between 2008 and 2014 allowing various changes to the mining layout within Longwalls 413 – 418. Underground mining in Longwalls 411 to 418 has now been completed (extraction of Longwall 418 was completed on the 27th of May 2016). Monitoring will continue to be undertaken post-mining in accordance with the approved Longwalls 411 to 418 SMP.

Additional details pertaining to the SMP Approvals and SMP Variations at Springvale have been provided in Table 8.

Table 8: SMP Approvals and Variations

SMP	Issue Date	Description	Purpose of Refinement
Initial SMP Approval 04/1673	2006	SMP for Longwalls 411-418	Mining lease requirement for approved SMP prior to mining and in accordance with the approved dimensions of DA 11/92. Void widths of 315 m and longwalls lengths in excess of 3,750 m.
Section 138 Approval (*Coal Mine Regulation Act 1982*)	January 2006	-	Approval to extract Longwalls 411 and 412 within the Lithgow Seam.
SMP Variation	November 2008	Reduction in Length of Longwalls 414-418	Longwalls 414 to 418 shortened by 471 m to the south to avoid a geological syncline running through the northern extent of these longwall blocks. Also as a result of this mine design modification, sensitive surface features have been avoided, including hanging swamps and pagodas to the north of Longwalls 416 to 418.
SMP Variation 08/8497	February 2009	Longwall 413 step around and reduction of Longwall 414	Step around of Longwall 413 was approved to avoid existing geological constraints. Longwall 414 shortened by approximately 700 m to the south due to anticipated geological conditions which could potentially lead to dangerous roof control issues and difficult mining conditions within the northern portion of Longwall 414.
SMP Variation 08/8497	August 2009	Changes to Longwall 413 block dimensions	Variation to the take-off face position in Longwall 413.
Clause 88 Approval	October 2009	-	Variation approval to extract Longwall 414 within the Lithgow Seam.
SMP Variation 08/8497	2010	Reduction in length of Longwall 414	Based on monitoring results and feedback from stakeholder consultation, Longwall 414 was shortened by in excess of 1,186 m. Dimensions were modified to avoid significant business interruption and production discontinuity. Another outcome of the shortening of Longwall 414 was the avoidance of Sunnyside Swamp.
SMP Variation 08/8497	2011	Changes in Mine Plan dimensions of Longwalls 416 and 417	Change of mine plan to reduce void width of Longwalls 416 and 417 from 315 m to 261 m and increase of chain pillar width from 45 m to 58 m. The new dimensions were to improve underground stability and minimise the risk of environmental impact to surface features.

SMP	Issue Date	Description	Purpose of Refinement
SMP Variation 08/8497	2012	SMP Variation Longwall 415	Change in mine plan to reduce the length of Longwall 415 due to geological conditions.
SMP Variation 11/3964	2012	SMP Variation Longwall 416	Longwall 416 was shortened based upon identification of lithology change, which posed a risk to mine safety, coal quality and production rates. Also as a result of this mine design modification, sensitive surface features have been avoided, including hanging swamps to the north of Longwall 416.
SMP Variation OUT 12/27914 OUT13/37387 OUT14/33055	2013/2014	SMP Variation Longwalls 411-418	Reduction of Longwall 416 Length to current Bore 8 drive age. Subsequent approvals under same variation for Longwalls 417 and 418
SMP Variation OUT13/2174	2013	SMP Variation Longwalls 411-418	Change in mine plan dimensions for Longwalls 411–418. Increase of pillar length to 130 m.
SMP Variation OUT13/1178	2013	Extension in time SMP Approval	Variation to extend relevant SMP approvals until 28 September 2014.
SMP Variation OUT13/21877	2013	SMP Variation Longwalls 411-418	Adjust Longwall 418 void dimensions to be consistent with Longwalls 416-417.
SMP Variation OUT14/9977	2014	SMP Variation Longwalls 411-418	Increase Longwall cutting height up to 3.5 m outside Newnes Plateau Shrub Swamp Buffer Zones (as defined by SEWPaC EPBC approval)
SMP Variation OUT 14/15149	2014	SMP Variation Longwalls 411-418	Extension of time to 30 September 2015.
SMP Variation OUT15/26505	2015	SMP Variation Longwalls 411-418	Extension of time to 30 September 2016.

Extraction of Longwall 418 was completed on the 30th of May 2016. Springvale's ongoing mining activities are now undertaken in accordance with approved extraction plans as required under Schedule 3 Condition 10.

Consultation regarding the monitoring program for longwall 411-418 was undertaken during the reporting period. A revised monitoring program will be further discussed with Resource Regulator in 2021 parallel to the 428-432 Extraction Plan which considers the adoption of a consolidated study area for longwall 415-432.

3.4. Extraction Plans

Extraction Plans prepared by Springvale have been developed in accordance with the requirements of:

- SSD 5594, Schedule 3, Conditions 1, 2, 3, 4, 5, 6, 7, and 10;
- EPBC 2013/6881 Conditions 2, 4, 5, 7, 9, 12; and
- Department of Planning and Environment and NSW Trade and Investment Guidelines for the Preparation of Extraction Plans.

Previous Extraction Plans approved under the consent include:

- Longwall 419
- Longwall 420-422
- Longwall 424-427

During the reporting period Springvale only undertook secondary extraction of coal from Longwall 426 and 427. The Longwall 424-427 Extraction Plan was approved on 27th of July 2018. Monitoring of subsidence related impacts has been undertaken in accordance with the requirements of the Longwall 424 - 427 Extraction Plan.

This Annual Review encompasses the Six-Monthly Environmental Monitoring Report requirement of the Longwall 424 - 427 Extraction Plan, which states that the reports will be submitted by 30th of September (covering January to June) and by the 31st of March in the form of an Annual Review.

3.4.1. Longwalls 428 – 432

During the reporting period Springvale commenced development of the Longwall 428-432 extraction plan in consultation with the independent Monitoring Panel and DPIE. The management and monitoring programs required under the consent were provided in December 2020 for consultation to relevant stakeholders. The Swamp, Biodiversity and Water management Plans have been prepared to align the monitoring practices of previously approved documents into a document which will address the monitoring requirements for Longwall 415-432.

This extraction plan will be a key focus in 2021.

3.5. Licences

Environment Protection Licence

Springvale currently operates under Environmental Protection Licence (EPL) 3607, issued under the *Protection of the Environment Operations Act 1997* (POEO Act). EPL 3607 was varied on 8th May 2019, the variation separated the Western Coal Services premises (EPL 21229) from the Springvale site. The variation therefore amended the premises boundary and removed conditions that apply to Western Coal Services. The variation also updated the licence conditions in line with the current approval and approved environmental management plan for the premises.

Water Licences

Springvale currently holds three groundwater extraction licences and four works approvals as outlined in Table 10**.** Additionally Springvale holds licences for groundwater monitoring bores under the Water Act.

Dangerous Goods Licence

Springvale possesses Dangerous Goods Licence (NDG027897 2014 acknowledgement number) for the storage and handling of hazardous chemicals on the premises. The Springvale licenses are summarised in Table 9.

Table 9: Licences

Licence	Works Approval	Date of Issue	Expiry
EPL 3607	-	17 May 2000	Renewed Annually
Groundwater Licence - WAL 36383	10WA118719	5 August 2013	Perpetuity
Groundwater Licence - WAL 36443	10WA118754	25 February 2010	Perpetuity
Groundwater Licence - WAL 36446	10WA118752 10WA118754	4 September 2007	Perpetuity
Dangerous Goods Licence	-	16 February 2012	Perpetuity

3.6. Other Approvals

Occupation Permit

The Newnes State Forest is located above the majority of the Springvale underground workings. Springvale has established a Level 3 Occupation Permit with the Forestry Corporation of NSW (FCNSW) to operate under the forest and to build infrastructure and other surface facilities. The permit allows for infrastructure construction and ongoing maintenance on the surface to support below ground operations, including ventilation, dewatering and electricity supply infrastructure. Level 2 Occupation permits will be discussed with the FCNSW with regards to short term duration activities such as exploration drilling. Details of the Occupation Permit have been provided in Table 10.

Section 95 Certificate/Threatened Species Licence

Springvale currently holds two Section 95 Certificates and nine Threatened Species Licenses as issued by OEH. The approvals allow for the installation of monitoring equipment (subsidence and groundwater monitoring) within Shrub Swamps on the Newnes Plateau, for the hand removal of weeds within Newnes Plateau Shrub Swamp, to undertake remediation works in East Wolgan Swamp which is a Newnes Plateau Shrub Swamp, and to undertake remedial work within Sunnyside Swamp, also a Newnes Plateau Shrub Swamp. Newnes Plateau Shrub Swamps are listed as an Endangered Ecological Community (EEC) under the Threatened Species Conservation Act 1995 (TSC Act). Previous certificates have been granted for geotechnical and geophysical investigations in addition to the installation of monitoring equipment.

Details on the certificates and licenses are provided in Table 10.

Table 10: Occupation Permit and Section 95 Certificates/Threatened Species Licences

Licence	Date of Issue	Expiry	Details
Level 3 Occupation Permit – Infrastructure	1 February 2018	1 February 2023*	Approval from FCNSW allowing to operate and build surface infrastructure/facilities on the surface within the Newnes State Forest to support below ground operations.
Section 95 Certificate Document No C0000077	25 November 2013	30 June 2024	Approval from OEH to allow geotechnical/geophysical investigations and the installation of monitoring equipment within EEC.
Threatened Species Licence Document No C0006077 (formerly Section 95 Certificate Document No C0001276)	7 September 2015	31 December 2028	Approval from OEH to allow the hand removal of weeds from within East Wolgan Swamp and Narrow Swamp.

Section 95 Certificate Document No C0002065	1 August 2016	31 August 2021	Approval from OEH to allow installation and operation of eight augured boreholes at five locations within Newnes Plateau Shrub Swamp.
Threatened Species Licence Document No C0006026 (formerly Section 95 Certificate Document No C0002931)	8 August 2017	31 December 2028	The installation and monitoring of a total of 14 monitoring stations along four subsidence monitoring lines within Newnes Plateau Shrub Swamps.
Threatened Species License (formerly Section 95 Certificate) Document No C0003184	6 December 2017	6 December 2022	Approval from OEH to install and operated surface water piezometers and soil moisture probes in Newnes Plateau Shrub Swamp.
Threatened Species Licence Document No C0003546	9 April 2018	9 April 2023	Approval from OEH to remediate Sunnyside Swamp.
Threatened Species Licence Document No C0003839	12 July 2018	12 July 2028	Approval from OEH for the implementation of the Centennial Coal Coxs River Catchment Improvement and Land Management Plan, Springvale Mine (March 2018) (CILMP)
Threatened Species Licence Document No C0003684	26 June 2018 (Variation 16 August 2019)	31 December 2028	Approval from OEH to install and operate seven subsidence monitoring lines on the Newnes Plateau.
Threatened Species Licence Document No C0004842	21 May 2019	31 December 2028	Approval from OEH for the installation and operation of piezometers and soil moisture tension probes in Newnes Plateau Shrub Swamp.
Threatened Species Licence Document No C0005809	5 May 2020	5 May 2021	Approval for BCD for the establishment of three drill pads and associated access tracks on the Newnes plateau (SIS drilling)
Threatened Species Licence Document No C0005809	1 September 2020	31 December 2028	Approval for BCD for the installation and operation of a shallow piezometer and soil moisture probe in Marrangaroo Swamp (MS3)

During the reporting period obtained approval to extend the expiry of previously approved s95 certificates for the hand removal of weed in east Wolgan swamp (now C0006077) and subsidence line monitoring within Gang Gang East and Gang Gang South West swamps (now C0006026).

Additionally, during the reporting period Springvale obtained two Threatened species licenses for the establishment of drill and access pads for the 2020 drilling program and the establishment of additional groundwater monitoring in Marrangaroo Swamp.

Two applications are currently under assessment by BCD for the installation of groundwater monitoring equipment in Lost City Swamp, and subsidence line installation and monitoring for Longwall 428-432.

3.7. Annual Review Requirements

The Annual Review has been developed to satisfy the reporting requirements of the approvals listed in Table 11.

Table 11: Annual Review Requirements

Approval	Condition No	Requirement	Where addressed in Annual Review
Development Consent SSD 5594	Schedule 6 Condition 12	By the end of March each year, or as otherwise agreed by the Secretary, the Applicant shall review the environmental performance of the development to the satisfaction of the Secretary. This review must:	Noted
		(a) describe the development (including any rehabilitation) that was carried out in the past calendar year, and the development that is proposed to be carried out over the current calendar year;	Section 8
		(b) include a comprehensive review of the monitoring results and complaints records of the development over the past calendar year, which includes a comparison of these results against the: i. relevant statutory requirements, limits or performance measures/criteria; ii. requirements of any plan or program required under this consent; iii. monitoring results of previous years; and iv. relevant predictions in the EIS;	Section 6 & 7
		(c) identify any non-compliance over the past calendar year, and describe what actions were (or are being) taken to ensure compliance;	Section 11
		(d) identify any trends in the monitoring data over the life of the development;	Section 6 & 7
		(e) identify any discrepancies between the predicted and actual impacts of the development, and analyse the potential cause of any significant discrepancies; and	Section 6 & 7
		(f) describe what measures will be implemented over the current calendar year to improve the environmental performance of the development.	Section 6 & 7
CL 377 ML1326 ML1424 ML1537 ML 1588	Condition 3	ANNUAL ENVIRONMENTAL MANAGEMENT REPORT (AEMR) 1) Within 12 months of the commencement of mining operations and thereafter annually or, at such other times as may be allowed by the Director-General, the lease holder must lodge an Annual Environmental Management Report (AEMR) with the Director-General.	Noted
		2) The AEMR must be prepared in accordance with the Director-General's guidelines current at the time of reporting and contain a review and forecast of performance for the preceding and ensuing twelve months in terms of a) the accepted Mining Operations Plan; b) development consent requirements and conditions;	Section 6 & 7

Approval	Condition No	Requirement	Where addressed in Annual Review
		c) Environment Protection Authority and Department of Land and Water Conservation licences and approvals; d) any other statutory environmental requirements; e) details of any variations to environmental approvals applicable to the lease area. and f) where relevant, progress towards final rehabilitation objectives.	
		3) After considering an AEMR the Director-General may, by notice in writing, direct the lease holder to undertake operations, remedial actions or supplementary studies in the manner and within the period specified in the notice to ensure that operations on the lease area are conducted in accordance with sound mining and environmental practice.	Noted
		4) The lease holder shall, as and when directed by the Minister, co-operate with the Director-General to conduct and facilitate review of the AEMR involving other government agencies.	Noted
ML1303 ML1323 ML1727 MPL 314	Condition 3 (f)	The lease holder must prepare a Rehabilitation Report to the satisfaction of the Minister. The report must: (i) Provided a detailed review of the progress of rehabilitation against the performance measures and criteria established in the approved MOP. (ii) Be submitted annually on the grant anniversary date (or at such other times as agreed by the Minister); and (iii) Be prepared in accordance with any relevant annual reporting guidelines published on the Department's website.	Section 8
ML 1670	Condition 4	(a) The lease holder must lodge Environment Management Reports (EMR) with the Director-General annually or at dates otherwise directed by the Director-general. (b) The EMR must: i) Report against non-compliance with the MOP; ii) Report on progress in respect of rehabilitation completion criteria; iii) Report on the extent of compliance with regulatory requirements; and iv) Have regard to any relevant guidelines adopted by the Director-General.	Section 8
LW419 Extraction Plan	Section 6.1.3	Annual Review The Annual Review is completed in accordance with the post-approval	Section 6 & 7

Approval	Condition No	Requirement	Where addressed in Annual Review
LW420-422 Extraction Plan LW424-427 Extraction Plan	Section 7.1.3 Section 7.1.2	requirements for State significant mining developments Annual Review Guidelines (2015) as required by the Department of Planning and Environment, incorporating the reporting requirements of the Department of Resources and Energy. The Annual Review will include information on operational activities, environmental performance and non-conformances and complaints received. This report is made available on the Centennial Coal website.	

4. OPERATIONS SUMMARY

Springvale has approval for the extraction of up to 5.5 million tonnes per annum (Mtpa) of ROM coal from the Lithgow Seam underlying the Project Application Area. Coal processing and distribution is managed at the Springvale Coal Services site in accordance with the Western Coal Services Project (State Significant Development 12_5579). The exception for this is the transport of up to 50,000 tonnes per annum of coal from the Springvale pit top to local domestic customers by road haulage. Springvale's production summary is presented in Table 12.

Table 12: Production Summary

Material	Approved Limit (and source)	Previous Reporting Period (Actual)	This Reporting Period (Actual)	Next Reporting Period (Forecast)
Waste Rock/ Overburden	NIL	Not Applicable	Not Applicable	Not Applicable
ROM Coal	5.5 million tonnes per calendar yr. (Source: SSD5594 S2 C6)	2.217442 Mt	2.939530 Mt	2.967822Mt
Coarse reject	NIL	Not Applicable	Not Applicable	Not Applicable
Fine reject (Tailings)	NIL	Not Applicable	Not Applicable	Not Applicable
Saleable product	NIL	Not Applicable	Not Applicable	Not Applicable

There are no inconsistences between approved limits and actual production.

4.1. Other Operations

All operational management of coal processing and transport facilities is undertaken by the Western Coal Services Project (State Significant Development 12_5579), except for the transport of up to 50,000 tonnes per annum of coal from the Springvale pit top to local domestic customers by road haulage which is authorised by SSD 5594.

Springvale's operational summary is presented in Table 13. Operations relating to the Western Coal Services Project are reported in the Western Coal Services Annual Review.

Table 13: Operations Summary

	Approved Limit (and source)	Previous Reporting Period (Actual)	This Reporting Period (Actual)	Comment (if applicable)
Hours of operation	24 hours a day, 7 days a week (Source: SSD5594 S2 C7)	24 hours a day, 7 days a week	24 hours a day, 7 days a week	No change
Transport (rail)	NIL	Not Applicable	Not Applicable	Not Applicable
Transport (road)	50,000 tonnes of ROM Coal per calendar year (Source: SSD 5594 S2 C8)	580t	0t	Within approved limits

4.2. Exploration

Springvale is currently undertaking one exploration project. The project aims to confirm the coal seam barrier between the proposed Springvale Mine workings and old flooded State Mine workings. The Project Area is located within Mining Lease ML1727 (Springvale Colliery) and the Exploration Licence area EL6974

During 2020 two boreholes were completed and have been appropriately sealed in accordance with approvals. Exploration is planned to continue in 2021 at two SIS exploration sites on the Newnes Plateau. Full rehabilitation has not been undertaken at SVSIS01 and SVSIS02 as the sites are required to be used for storage and a second borehole in 2021. The rehabilitation timing has been discussed and agreed with the landowner (FCNSW)

Table 14 summarises exploration boreholes completed during the reporting period.

Table 14: Exploration boreholes completed

Borehole	Total Depth (m)	Drilled	Easting	Northing	Elevation (m)	Hole Purpose	Rehabilitation Status
SVSIS01 (Drill pad reference SIS19S1)	1480.05	Aug 2020 – Sep 202	238877	6298930	1109	Exploration	Cemented
SVSIS02 (Drill pad reference SIS19S2)	1611.40	Sep 2020	239214	6297972	1162	Exploration	Cemented

Figure 6 shows the location of the completed boreholes and Figure 7 shows the locations of the proposed boreholes for 2021.

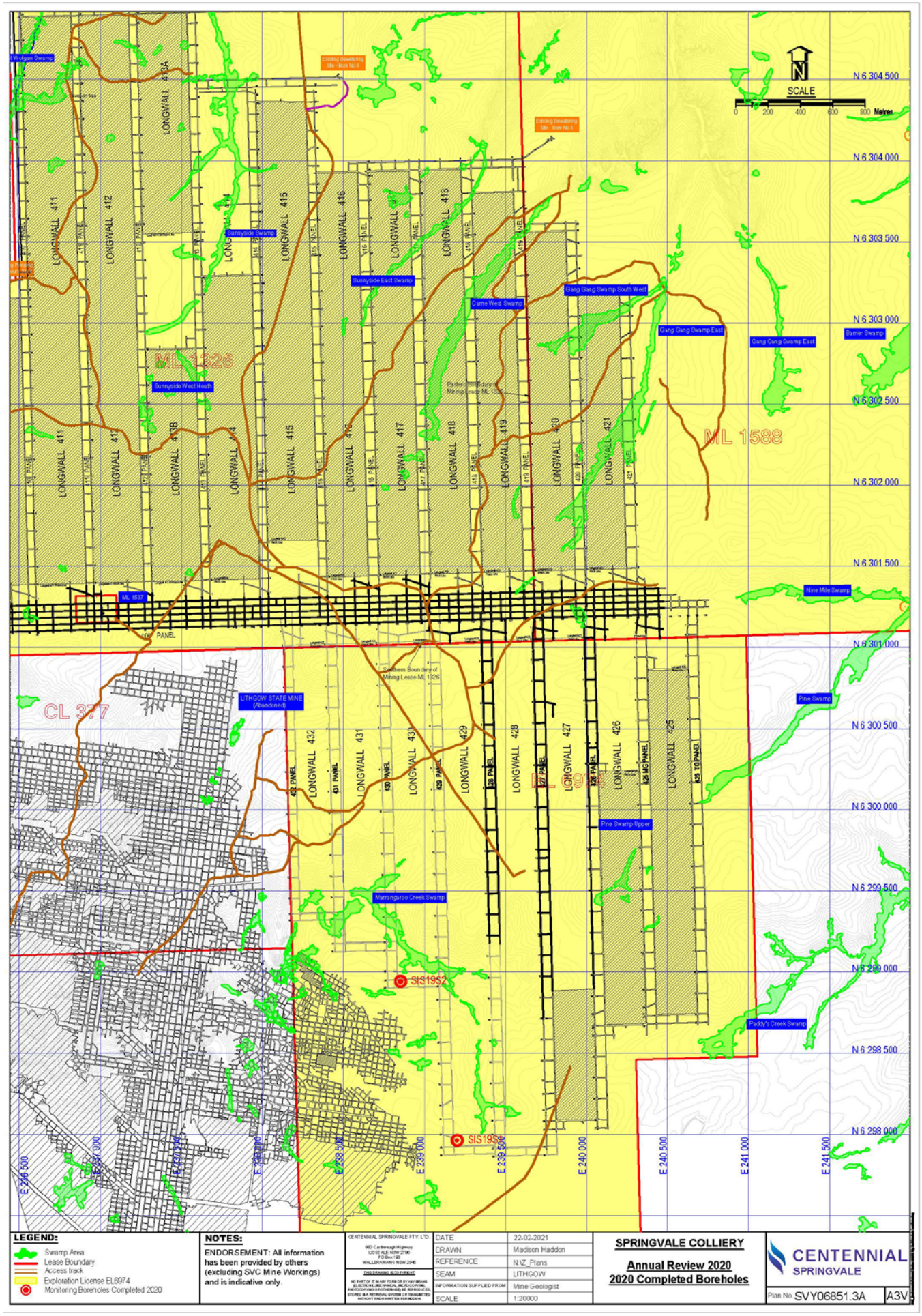


Figure 6: Completed Borehole Locations 2020

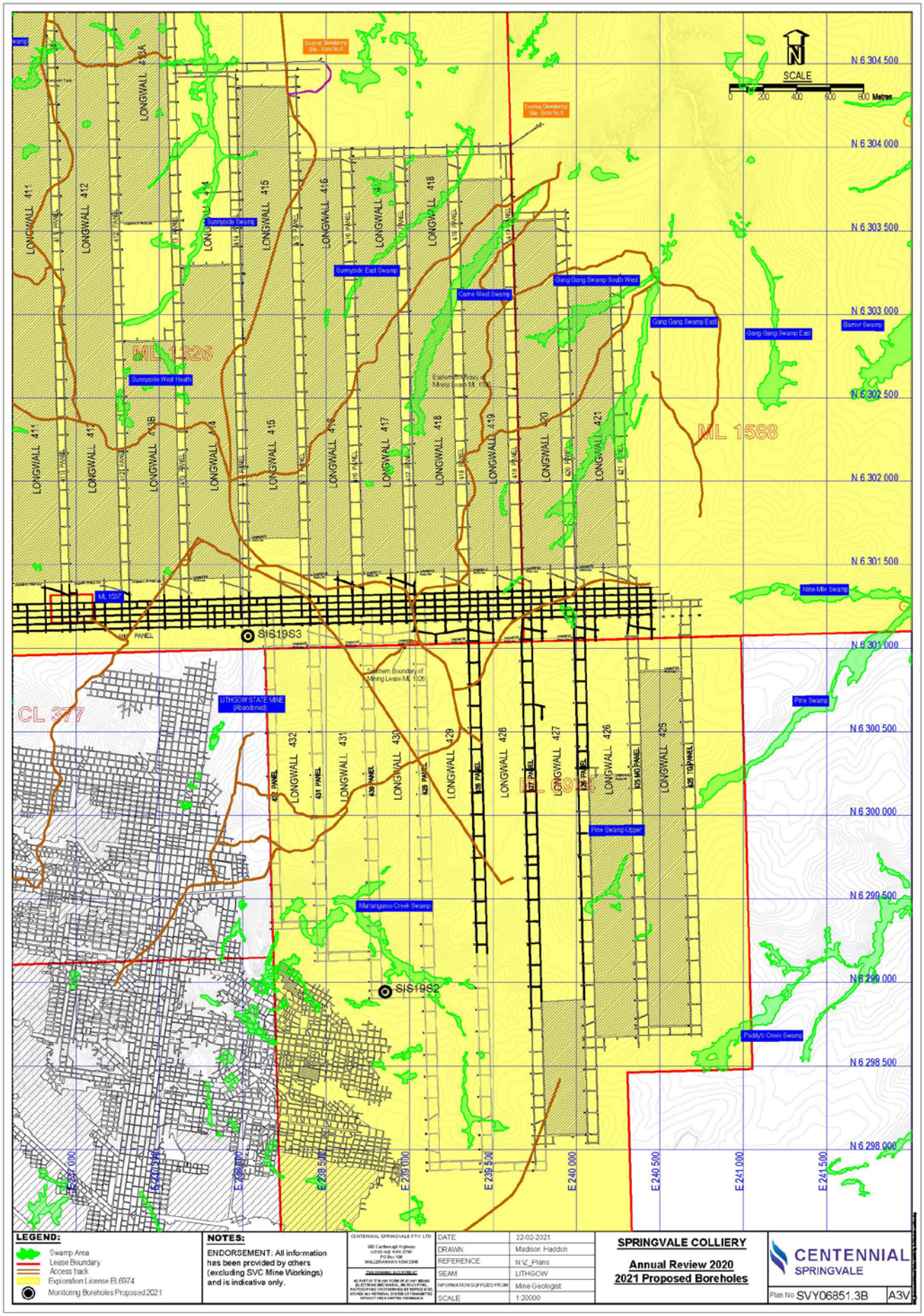


Figure 7: Proposed Borehole Locations for 2021

5. ACTIONS REQUIRED FROM PREVIOUS ANNUAL REVIEW

Table 15 outlines actions required from the previous Annual Review.

Table 15: Actions from previous Annual Review

Action Required	Requested By	Action Taken	Where addressed in Annual Review
Request for the inclusion of the key findings from the 2019 independent environmental audit, including progress made in implementing the action plan from the audit.	DPIE	A section including the key findings and action plan from the 2019 independent environmental audit has been included within this Annual review	Section 10
Reminder regarding the publication of the annual review on the website	DPIE	The 2019 Annual Review is available on the website. (https://data.centennialcoal.com.au/domino/centennialcoal/cc205.nsf/File.xsp?documentId=D9664642EE318EEECA2583CB0072F934)	Not Applicable

5.1. Site Inspection

Site inspections have been undertaken by EPA for the incidents discussed in Section 11. DPIE and the IMP have undertaken site inspection during the reporting period as part of the consultation process for the Extraction Plan.

6. ENVIRONMENTAL PERFORMANCE

Sections 6 and 7 provided results and analysis of environmental performance during the reporting period.

As discussed in Section 6.14 the Gospers Mountain Bushfire impacted access to the Newnes Plateau from December 2019. Throughout December 2019 the Gosper Fire burned a significant portion of the Newnes Plateau and access to the Newnes Forest was not permitted by Rural Fire Service. Springvale worked actively work with Forestry Corporation of NSW to provide a safe method of managing the new hazards created by the bushfire (e.g. dangerous trees) to ensure safety of any person requiring access to the plateau for Springvale Colliery. Access to the plateau did not resume until March 2020.

For the above stated reason, all monitoring sites could not be accessed by contractors for the full length of the reporting period for safety reasons and some monitoring equipment required replacement in 2020. Where possible Springvale did re-schedule monitoring works to ensure collection of monitoring data. Programs are established by Springvale to ensure monitoring plans and programs are implemented in accordance with consent requirements under normal safe operational conditions.

6.1. Air Quality

Potential dust sources from the Springvale Colliery operations include unsealed or dirty traffic areas, coal stockpiles, ventilation fans, and coal being conveyed.

The Springvale Colliery pit top is situated against the Newnes State Forest and therefore is largely enclosed by native forest. Coal delivered to the ROM stockpile is wet with moisture levels ranging from 10-12% which acts to reduce particulate emissions. Other measures which are routinely employed at the Springvale Colliery to reduce emissions of particulate matter are the implementation of speed limits on internal roads, the enclosure of coal crushing and screening processes and material transfer by conveyor as well as the use of water carts on open areas of site. In addition, paved and bitumen covered pit top areas are swept with a street sweeper as required to minimise dust loading and a water cart is used on unsealed site roads.

In December 2010 Springvale installed and commissioned two High Volume Air Samplers (HVAS) to measure Total Suspended Particles (TSP) and PM10. The units are located on an adjoining property on Springvale Lane. The system operates automatically, for a 24 hour period, every 6 days, in accordance with Australian Standards. Monitoring of TSP and PM10 is required under Schedule 4, Condition 5 of SSD 5594.

There is no recent history of fugitive dust complaints from adjoining residents nor has there been any regulatory notices issued requiring surface dust suppression. The Springvale Environmental Management System provides a platform for the maintenance and operation of dust control measures.

6.1.1. Dust Monitoring

Depositional Dust

Air quality monitoring has been undertaken during the reporting period in accordance with SSD 5594 and EPL 3607 requirements. The compliance results obtained during the reporting period were below the cumulative SSD 5594 criteria limit of 4g/m2/month.

Elevated results in December 2019 and January 2020 are observable due to Gospers Mountain fire that was burning throughout November and December. As per note D of Schedule 4 Condition 5, the criteria excludes extraordinary events such as such fires.

All other results obtained were below the criteria levels specified in SSD 5594.

Table 16 presents a summary of dust results obtained during the reporting period. Figure 8 shows the mean result of both the dust gauges.

Air quality results are also presented graphically in Appendix 1.

Table 16: 2020 Monthly Dust Gauge Results

Sample Exposure Start Date	Sample Exposure End Date	DG1	DG2
06/12/2019	08/01/2020	2.5	5.3
08/01/2020	07/02/2020	7.5	7.3
07/02/2020	06/03/2020	1.9	0.4
06/03/2020	06/04/2020	0.8	0.2
06/04/2020	07/05/2020	0.7	0.4
07/05/2020	04/06/2020	0.4	0.1
04/06/2020	02/07/2020	0.7	0.5
02/07/2020	03/08/2020	0.6	0.3
03/08/2020	01/09/2020	0.7	0.5
01/09/2020	01/10/2020	0.8	1.2
01/10/2020	02/11/2020	1.1	0.8
02/11/2020	01/12/2020	1.1	0.9
01/12/2020	29/12/2020	1.0	0.8

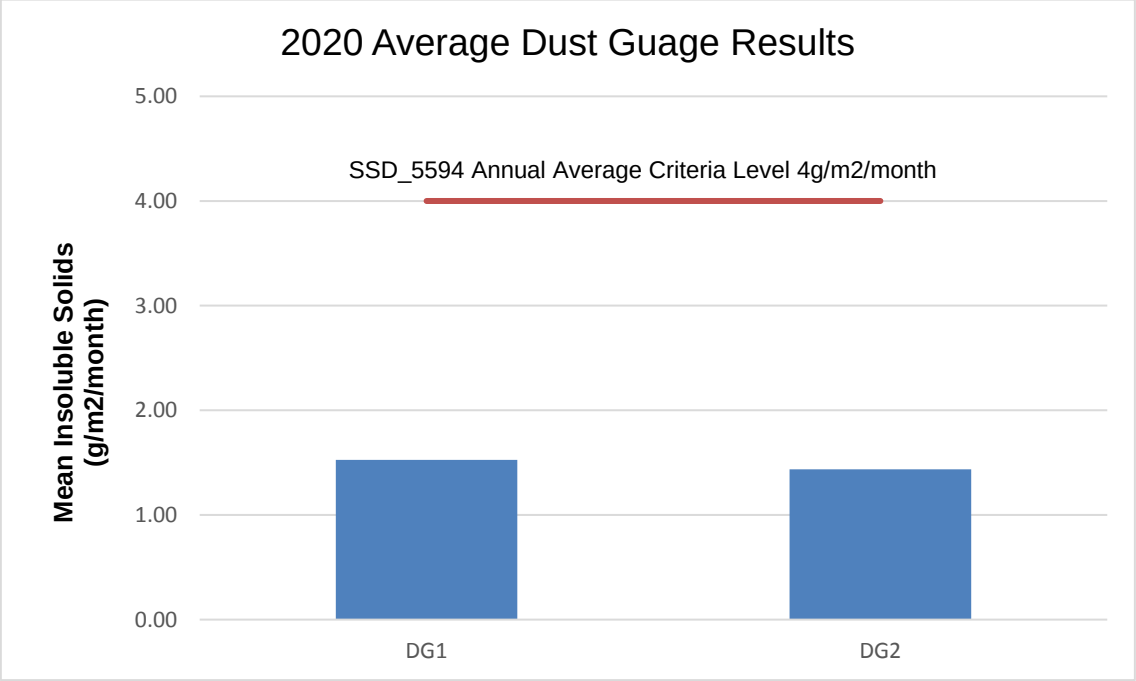


Figure 8: 2020 Average Dust Gauge Deposits

A comparison of the 2015 - 2020 average dust monitoring results is presented in Table 17.

Table 17: Annual Average Dust Monitoring Results

Springvale Dust Gauge	2015	2016	2017	2018	2019	2020
DG1	1.53	1.53	1.27	1.86	1.49	1.53
DG2	0.68	0.29	0.71	1.04	1.55	1.44
AVERAGE	1.11	0.91	0.99	1.45	1.52	1.48

When compared against historic dust trends, results are considered generally consistent with previous years. This indicates the relatively short term effect of the Gosper bushfire on regional air quality results.

Total Suspended Particulates (TSP) and Particulate Matter (PM10)

The HVAS monitoring system was commissioned in late 2010. Monitoring of TSP and PM10 is required under Schedule 4, Condition 5 of SSD 5594. A comparison of the 2015 - 2020 average results is displayed in Table 18. Results are consistent with historical results. Figure 9 shows the 2020 TSP and PM10 results against criteria limits in the 2019 Annual Review. Extra ordinary events were excluded as permissible under note D in the consent.

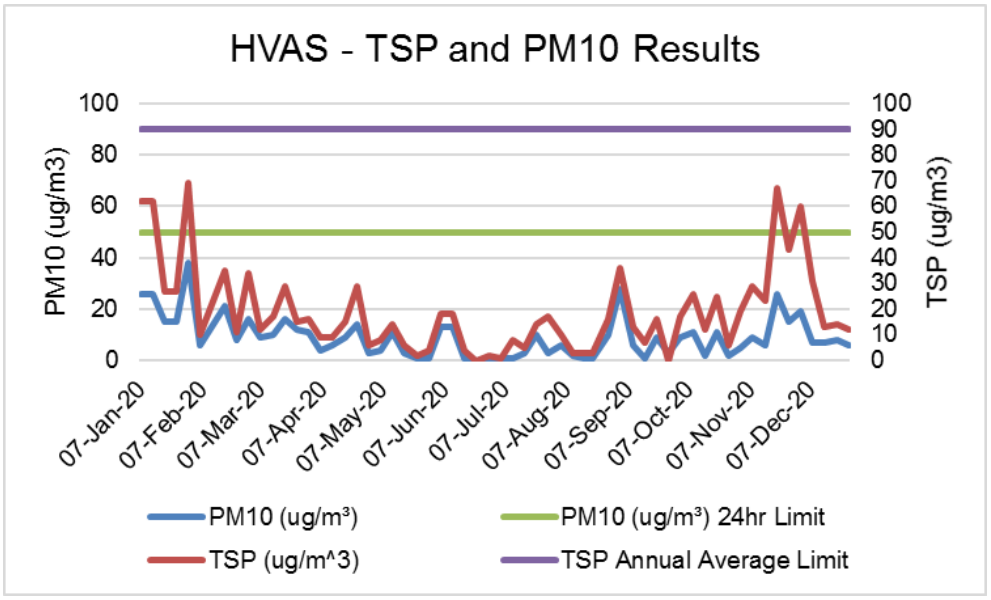
Table 18: HVAS Average Results

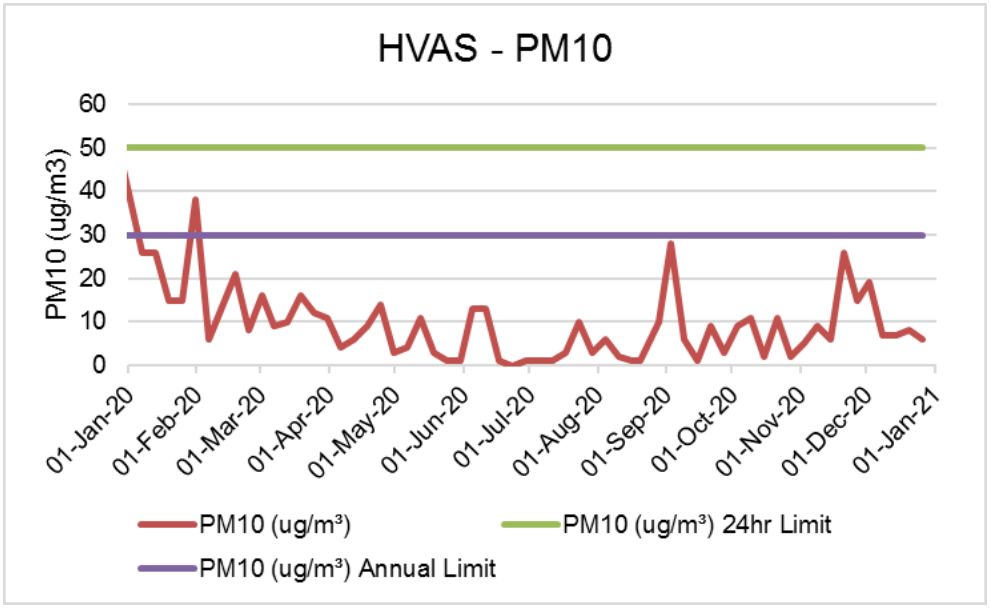
AVERAGE	TSP Annual Average (µg/m3)	TSP Annual Average Limit	PM10 Annual Average (µg/m3)	PM10 Annual Average Limit
2015	14	90	8	30
2016	19	90	9	30
2017	17	90	8	30
2018	20	90	10	30
*2019 (including bushfire period)	55*	90	35*	30
2019 (excluding bushfire period)	24.18	90	11.41	30
2020	20	90	9	30

*As per note D of Schedule 4 Condition 5, the criteria exclude extraordinary events such as such fires. Data from 20 November 2019 to the end of the reporting period has therefore been excluded due to the Gosper Fire.

In 2020, the maximum PM10 result was 38 µg/m^3 which is below the 24h criteria of 50 µg/m^3. The maximum TSP result was 69 µg/m^3 which is below the annual average limit of 90 µg/m^3. As the levels remained below the consent criteria data has not been excluded at the start of 2020 when the bushfire was still burning.

2020 results are consistent with results obtained between 2015 and 2019.





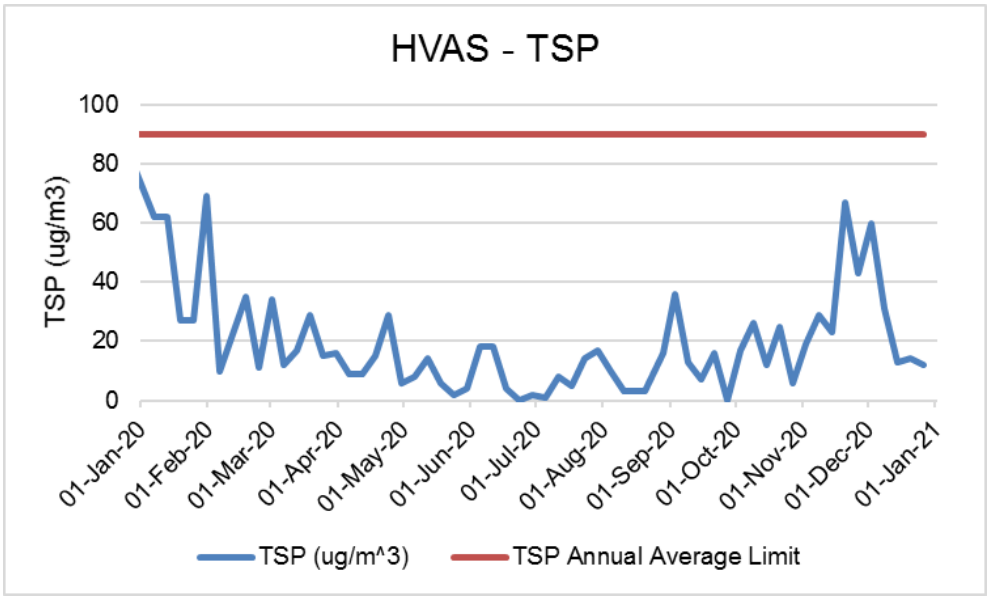


Figure 9: 2019 HVAS (TSP and PM10) Results

6.2. Biodiversity

A comprehensive biodiversity monitoring program has been prepared which covers the LW411-418 SMP Area and Extraction Plan Areas in accordance with relevant conditions of the SMP Approval, EPBC2011/5949 and EPBC2013/6881.

Monitoring and management of biodiversity impacts has been undertaken in accordance with these monitoring methodologies and relevant monitoring programs.

Monitoring is undertaken under two methodologies. Relevant to LW411-418 SMP Area is the Erskine & Fletcher monitoring methodology, and relevant to the Extraction Plans is the Brownstein methodology. Flora triggers have been previously reported at Sunnyside Swamp, Sunnyside East Swamp, Carne West, Lower and East Gang Gang swamp.

The following provides a summary of flora triggers detected under relevant Trigger Action Response Plans (TARPs) during the reporting period. As part of the response process, an Initial Notification is sent out to relevant regulators and a subsequent Trigger Investigative Report is completed and supplied to these same regulators. A trigger does not necessarily infer that an impact has occurred, but rather that further investigation is required. Springvale will continue to review the TARP actions in relation to these triggers, conducting further investigative work as required.

6.2.1. LW411-418 SMP Area

Details of trigger levels for flora are set out in Table 19. Each trigger has a defined level of change and a defined timescale in which this change is to be observed to determine whether an impact has occurred. No new triggers were observed during the reporting period. A summary of the results obtained in the reporting period is presented in the following table.

Table 19: LW411-418 SMP Area Flora Trigger

Performance Indicator	Parameter Measured	Trigger Level*	Summer 2019/20	Autumn 2020	Winter 2020	Spring 2020
Change in species assemblage	Change in diversity of native species	A change in the number of species of greater than 30 % for a given site within a three-year period.	Not completed due to bushfire	Four impact sites (WC01, WC02, WC04 and SSE01) showed a repeat trigger for species richness. One Impact site triggered for the first time (WC03). One reference site was also below the trigger level (TRI01).	Four impact sites (WC01, WC02, WC03 and SSE01) showed a repeat trigger for species richness. Two reference sites were above the upper trigger level (TRI02, BS01).	A recurring lower trigger exceedance for species richness was recorded at impact sites WC02 and WC03. Recurring upper trigger exceedances were observed at reference sites TRI02 and BS01.
	Recruitment of eucalypt species	An increase in eucalypts in an impact site compared to reference sites of more than three individual plants within a one year period.	Not completed due to bushfire	No impact sites showed an increase in eucalypt recruitment beyond the trigger level.	One impact site showed an increase in eucalypt recruitment beyond the trigger level for the first time (WC02).	Three impact sites triggered in spring 2020. WC02 recorded a recurring trigger from the previous survey, and WC01 and WC04 recorded new trigger exceedances.
Change in condition	Condition of key species	A decline in condition score at an impact site of more than 1.5 compared to the average condition score at un-impacted sites within a one year period.	Not completed due to bushfire	Four impact sites showed a recurring and worsening decline in condition beyond the trigger level for both *Baumea rubiginosa*	Four impact sites maintained a recurring and worsening decline in condition beyond the trigger level for *Gleichenia dicarpa* (WC01, WC02, WC03	A recurring trigger level decrease in condition for *Gleichenia dicarpa* was observed in WC01, WC02, WC03 and WC04. A

Performance Indicator	Parameter Measured	Trigger Level*	Summer 2019/20	Autumn 2020	Winter 2020	Spring 2020
				and *Gleichenia dicarpa* (WC01, WC02, WC03 and WC04).	and WC04) and *Baumea rubiginosa* (WC01, WC02 and WC04).	recurring trigger level decrease in condition for *Baumea rubiginosa* was observed in WC01, WC02 and WC04.
	Non-live ground cover	An increase of bare ground of more than 100m^2 in a site within a three-year period.	Not completed due to bushfire	One impact site showed a repeat of a previous trigger for non-live ground cover (WC04). Four impact sites recorded new trigger level exceedances (WC01, WC02, WC03 and SSE01).	Five impact sites maintained a previous trigger for non-live ground cover (WC01, WC02, WC03, WC04 and SSE01).	Five impact sites maintained a recurring exceedance of trigger level for non-live ground cover (WC01, WC02, WC03, WC04 and SSE01).
	Non-native weeds	An increase in non-native weed species of more than 4 in a monitoring site (each having a cover of greater than 5%) compared to the average number in reference sites within a one year period.	Not completed due to bushfire	No impact sites showed an increase in weed species beyond the trigger level.	No impact sites showed an increase in weed species beyond the trigger level.	No sites showed an increase in weed species beyond the trigger level.

*Taken from THPSS MMP 415-417 and THPSS MMP 418. Data collection method used consistent with Erskine and Fletcher (2011).

6.2.2. Extraction Plan Area

Springvale undertake monitoring requirements in accordance with three different extraction plans. Details of trigger levels for flora are set out in Table 20-Table 22. Each trigger has a defined level of change and a defined timescale in which this change is to be observed to determine whether an impact has occurred. The current Extraction Plan Area is LW 424-427.

During the reporting period there were no new flora triggers reported.

Table 20: LW419 Triggers under Brownstein methodology

Performance Indicators	**Trigger Level (Brownstein et al 2014)**	**Measure**	Summer 2019/20	Autumn 2020	Winter 2020	Spring 2020
Shrub Swamps						
Negligible change to the shallow groundwater regime when compared with control swamps	A 10% increase of dry habitat or a 10% increase in damp habitat as a proportion of total vegetation cover	Proportion of terrestrial dry or terrestrial damp species of the total vegetation cover	NA*	NA*	NA*	• West Carne • East Gang Gang • West GangGang • Sunnyside East • Twin Gully • Barrier
Negligible erosion of the surface of the swamp	Signs of ponding or scouring	Observed and reported signs of ponding/scouring	-	-	-	-

Performance Indicators	**Trigger Level (Brownstein et al 2014)**	**Measure**	Summer 2019/20	Autumn 2020	Winter 2020	Spring 2020
Negligible change in the size of the swamp	A reduction of more than 20%	Increase in non-live (Mean Area (SAVI<0.12) in ha;	• West Carne • East Gang Gang • West Gang Gang • East Sunnyside • Firetail • Tristar • Twin Gully	• West Carne • East Gang Gang • West Gang Gang • East Sunnyside • Tristar • Twin Gully	• West Carne • East Gang Gang • West Gang Gang • East Sunnyside • Tristar • Twin Gully	• West Carne • East Gang Gang • West Gang Gang • East Sunnyside • Tristar • Twin Gully
Negligible change in the ecosystem functionality of the swamp	A floristic change that can be correlated with a hydrological change.	Change in non-veg cover per quadrat;	NA*	NA*	NA*	• West Carne • East Gang Gang • West Gang Gang • Sunnyside East • Barrier • Firetail • Tristar • Twin Gully
		Proportion of live green cover;	NA*	NA*	NA*	• West Carne • East Gang Gang • West Gang Gang • Sunnyside East • Barrier • Firetail • Tristar • Twin Gully

Performance Indicators	**Trigger Level (Brownstein et al 2014)**	**Measure**	Summer 2019/20	Autumn 2020	Winter 2020	Spring 2020
		Eucalypt Recruitment	NA*	NA*	NA*	• West Carne • East Gang Gang • West Gang Gang • Sunnyside East • Barrier • Firetail • Tristar • Twin Gully
Negligible change to the composition or distribution of species within the swamp	If any other performance indicator is exceeded and can be correlated with a change in hydrology	Proportion of amphibious plant species of the total vegetation cover	NA*	NA*	NA*	• West Carne • East Gang Gang • West Gang Gang • Sunnyside East
		Proportion of terrestrial dry species of the total vegetation cover;	NA*	NA*	NA*	• West Carne • East Gang Gang • West Gang Gang • Sunnyside East • Twin Gully
		Proportion of Terrestrial Damp Species of the total vegetation cover	NA*	NA*	NA*	• Barrier
Negligible change to the structural integrity of the bedrock base or any controlling rockbar/s of the swamp	No significant fracturing, where fracturing is identified visually if the structural damage is exposed.	Observed and reported signs of fracturing	-	-	-	-

Performance Indicators	**Trigger Level (Brownstein et al 2014)**	**Measure**	Summer 2019/20	Autumn 2020	Winter 2020	Spring 2020
Hanging Swamp						
Negligible change in the size of the swamp	A reduction of more than 20%	Increase in non-live (Mean Area (SAVI<0.12) in ha;	• East Sunnyside HS • Gang Gang HS • West Carne HS	• East Sunnyside HS • Gang Gang HS • West Carne HS	• East Sunnyside HS • Gang Gang HS • West Carne HS • Twin Gully HS	• East Sunnyside HS • Gang Gang HS • West Carne HS
Negligible change in the ecosystem functionality of the swamp	A floristic change that can be correlated with a hydrological change.	Change in non-veg cover per quadrat	NA*	NA*	NA*	• East Sunnyside 1 • East Sunnyside 2 • East Sunnyside 3 • Firetail HS • Twin Gully HS
		Proportion of live green cover;	NA*	NA*	NA*	• East Sunnyside 1 • East Sunnyside 2 • East Sunnyside 3 • Firetail HS • Twin Gully HS
		Eucalypt Recruitment	NA*	NA*	NA*	• East Sunnyside 1 • East Sunnyside 2 • East Sunnyside 3 • Firetail HS • Twin Gully HS
Negligible change to the composition	If any other performance	Proportion of amphibious plant	NA*	NA*	NA*	• East Sunnyside 3

Performance Indicators	**Trigger Level (Brownstein et al 2014)**	**Measure**	Summer 2019/20	Autumn 2020	Winter 2020	Spring 2020
or distribution of species within the swamp	indicator is exceeded and can be correlated with a change in hydrology	species of the total vegetation cover				
		Proportion of terrestrial dry species of the total vegetation cover;	NA*	NA*	NA*	• East Sunnyside 3 • Firetail Hanging
		Proportion of Terrestrial Damp Species of the Total Vegetation Cover	NA*	NA*	NA*	-

Table 21: LW420-422 Triggers under Brownstein methodology

Performance Indicators	Trigger Level (Brownstein et al 2014)	Measure	Summer 2019/20	Autumn 2020	Winter 2020	Spring 2020
Shrub Swamps						
Negligible change to the shallow groundwater regime when compared with control swamps	A 10% increase of dry habitat or a 10% increase in damp habitat as a proportion of total vegetation cover	Increase in proportion of vegetation classified as terrestrial dry (Tdr) or terrestrial damp (Tda).	NA*	NA*	NA*	
Negligible erosion of the surface of the swamp	Signs of ponding or scouring	Observed signs of ponding/scouring	-	-	-	-
Negligible change in the size of the swamp	A reduction of more than 20%	Increase in non-live (Mean Area (SAVI<0.12) in ha;	• Nine Mile	• Twin Gully • Nine Mile	• Firetail • Tristar • Twin Gully • Nine Mile	• Tristar • Twin Gully
Negligible change in the ecosystem functionality of the swamp	A floristic change that can be correlated with a hydrological change.	Change in non-veg cover per quadrat;	NA*	NA*	NA*	• Barrier • Best • Firetail • Tristar • Twin Gully • Nine Mile
		Proportion of live green cover;	NA*	NA*	NA*	• Barrier • Best • Firetail • Tristar • Twin Gully • Nine Mile

Performance Indicators	Trigger Level (Brownstein et al 2014)	Measure	Summer 2019/20	Autumn 2020	Winter 2020	Spring 2020
		Eucalypt Recruitment	NA*	NA*	NA*	• Barrier • Best • Firetail • Tristar • Twin Gully • Nine Mile
Negligible change to the composition or distribution of species within the swamp	If any other performance indicator is exceeded and can be correlated with a change in hydrology	Proportion of amphibious plant species of the total vegetation cover	NA*	NA*	NA*	• Barrier
		Proportion of terrestrial dry species of the total vegetation cover;	NA*	NA*	NA*	-
		Proportion of Terrestrial Damp Species of the Total Vegetation Cover	NA*	NA*	NA*	• Barrier • Tristar
Negligible change to the structural integrity of the bedrock base or any controlling rockbar/s of the swamp	No significant fracturing, where fracturing is identified visually if the structural damage is exposed.	Observed and reported signs of fracturing	-	-	-	-
Hanging Swamp						
Negligible change in the size of the swamp	A reduction of more than 20%	Increase in non-live (Mean Area (SAVI<0.12) in ha;	• Twin Gully HS	• Twin Gully HS	• Twin Gully HS	-
Negligible change in the ecosystem functionality of the swamp	A floristic change that can be correlated with a hydrological change.	Change in non-veg cover per quadrat;	NA*	NA*	NA*	• Firetail Hanging • Twin Gully Hanging
		Proportion of live green cover;	NA*	NA*	NA*	• Firetail Hanging • Twin Gully Hanging

Performance Indicators	Trigger Level (Brownstein et al 2014)	Measure	Summer 2019/20	Autumn 2020	Winter 2020	Spring 2020
		Eucalypt Recruitment	NA*	NA*	NA*	• Firetail Hanging • Twin Gully Hanging
Negligible change to the composition or distribution of species within the swamp	If any other performance indicator is exceeded and can be correlated with a change in hydrology	Proportion of amphibious plant species of the total vegetation cover	NA*	NA*	NA*	-
		Proportion of terrestrial dry species of the total vegetation cover;	NA*	NA*	NA*	-
		Proportion of Terrestrial Damp Species of the Total Vegetation Cover	NA*	NA*	NA*	-

* Not applicable for Seasonal Remote Sensing analysis. See Annual (Spring) Monitoring

Table 22: LW424-427 Triggers under Brownstein methodology

Performance Indicator	Trigger Level	Measure	Summer 2019/20	Autumn 2020	Winter 2020	Spring 2020
Negligible change to the shallow groundwater regime when compared with control swamps	Groundwater levels remain within 95th percentile of pre-mining groundwater depth for more than 7 consecutive days.	Groundwater depth in any piezometer exceeds the 95th percentile pre-mining groundwater depth for more than 7 consecutive days	**	**	**	**
		A statistically significant reduction in the abundance of native wetland species in an impacted swamp when compared to control swamps.	NA*	NA*	NA*	• Barrier • Twin Gullys • Firetail HS • Twin Gullys HS • Pine • Marrangaroo
		30% increase in frequency of eucalypt and/or pine seedlings (≤1m in height)	NA*	NA*	NA*	• Barrier • Best • Firetail • Tristar • Twin Gully • Firetail HS • Twin Gully HS • Pine • Marrangaroo • Paddys Creek • Pine HS

Performance Indicator	Trigger Level	Measure	Summer 2019/20	Autumn 2020	Winter 2020	Spring 2020
Negligible erosion of the surface of the swamp	Evidence of natural recruitment comprising characteristic swamp plant species within patches of nonvegetative cover. Characteristic swamp species are defined as terrestrial damp habitat (Tda) or amphibious (A) species[3]	20% increase in the extent of non-vegetated area (excluding areas covered by standing water)	• Marangaroo • Paddys Creek • Pine • Pine HS • Twin Gully	• Marangaroo • Paddys Creek • Pine • Pine HS • Twin Gully • Twin Gullys HS	• Marangaroo • Paddys Creek • Pine • Pine HS • Firetail • Tristar • Twin Gullys • Twin Gullys HS	• Marangaroo • Paddys Creek • Pine • Pine Hanging
		A single patch of non-vegetative cover greater than 400 m^2 doubles in size compared to baseline data				• Barrier • Best • Firetail • Tristar • Twin Gully • Firetail HS • Twin Gully HS • Pine • Marrangaroo • Paddys Creek

Performance Indicator	Trigger Level	Measure	Summer 2019/20	Autumn 2020	Winter 2020	Spring 2020
Negligible change in the size of the swamp	Swamp boundaries remain within the variation observed throughout the baseline monitoring period. The live green vegetated area within a swamp boundary remains within the variation observed throughout the baseline monitoring period for the corresponding season.	Significant contraction in swamp boundary when compared to baseline conditions and variance observed in control swamps and/ or Significant loss in photosynthetic activity at a swamp scale compared with baseline conditions	• Marangaroo • Paddys Creek • Pine • Pine HS • Twin Gully	• Marangaroo • Paddys Creek • Pine • Pine HS • Twin Gully • Twin Gullys HS	• Marangaroo • Paddys Creek • Pine • Pine HS • Firetail • Tristar • Twin Gullys • Twin Gullys HS	• Marangaroo • Paddys Creek • Pine • Pine Hanging
Negligible change in the ecosystem functionality of the swamp	The population size and/ or spatial occurrence of key swamp obligate species[6] remains stable at the swamp scale	A statistically significant reduction in population size and/ or spatial occurrence of a key swamp obligate species in an impacted swamp relative to control swamps.				
	The population size and/ or spatial occurrence of key swamp obligate species[6] remains stable at the swamp scale	30% increase in frequency of eucalypt and/or pine seedlings (≤1m in height)	NA*	NA*	NA*	• Barrier • Best • Firetail • Tristar • Twin Gully • Firetail HS • Twin Gully HS • Pine • Marrangaroo • Paddys Creek • Pine HS

Performance Indicator	Trigger Level	Measure	Summer 2019/20	Autumn 2020	Winter 2020	Spring 2020
		Statistically significant increase in terrestrial dry habitat (Tdr) vegetation as a proportion of total vegetation cover in an impacted swamp relative to control swamps.	NA*	NA*	NA*	
Negligible change to the composition or distribution of species within the swamp	The proportion of amphibious (A) vegetation remains within the variability measured during the baseline period	Statistically significant[1] decrease in amphibious (A) species cover as a proportion of total vegetation cover in an impacted swamp relative to control swamps	NA*	NA*	NA*	• Barrier • Twin Gullys • Firetail HS • Twin Gullys HS • Pine Marrangaroo
	The proportion of terrestrial damp habitat (Tda) vegetation remains within the variability measures during the baseline period	Statisticallysignificant[1] change (increase or decrease) in Tda vegetation as a proportion of total vegetation in an impacted swamp relative to control swamps	NA*	NA*	NA*	• Barrier • Tristar • Twin Gullys HS
	The proportion of terrestrial dry habitat (Tdr) vegetation remains within the variability measured during the baseline period	Statistically significant increase in terrestrial dry habitat (Tdr) vegetation as a proportion of total vegetation in an impacted swamp relative to control swamps	NA*	NA*	NA*	-
	No increase in exotic vegetation cover	A statistically significant increase exotic vegetation as a proportion of total vegetation cover for an impact swamp compared to control swamp	NA*	NA*	NA*	• Firetail • Tristar • Twin Gully • Pine • Marrangaroo • Paddys Creek

Performance Indicator	Trigger Level	Measure	Summer 2019/20	Autumn 2020	Winter 2020	Spring 2020
	No increased establishment of eucalypt and/or pine seedlings (≤1m in height)	30% increase in frequency of eucalypt and/or pine seedlings (≤1m in height)	NA*	NA*	NA*	• Barrier • Best • Firetail • Tristar • Twin Gully • Firetail HS • Twin Gully HS • Pine • Marrangaroo • Paddys Creek • Pine HS
Negligible change to the structural integrity of the bedrock base or any controlling rockbar/s of the swamp	Measured subsidence does not exceed predictions. No visual cracking or peat slumping that was not present prior to mining	Measured subsidence in excess of predictions (>125% of predicted levels) Visual cracking >50mm in width and 10m in length (not present prior to mining) Peat slumping >0.5m depth and >20m^2 relative to adjacent swamp surface (not present prior to mining)	-	-	-	-

* Not applicable for Seasonal Remote Sensing analysis. See Annual (Spring) Monitoring ** See Groundwater Results

6.3. Aquatic Ecology

Aquatic Monitoring is undertaken to address the requirements of the Upper Coxs River Action and Monitoring Plan and the Extraction Plan- Biodiversity Management Plan. Macroinvertebrate samples were collected by during autumn 2020 and spring 2020 to meet these requirements. Water quality and sediment quality analysis were also undertaken.

Table 23: Macroinvertebrate monitoring

Site	Description	Site Type
Coxs River		
CR0	Upstream	Background
CR1	Upstream	Background
CR3	Located downstream of Wangcol Creek and upstream of Sawyers Swamp Creek confluence.	Upstream
CR4	Located at the Maddox Lane road crossing	Impact
CR5	Located at the Main Street road crossing	Impact
CR6	Coxs River directly downstream of Lake Wallace, on the downstream side of Rocky Waterhole Drive.	Recovery
Sawyers Swamp Creek		
SSCup	Upstream reference site in Sawyers Swamp Creek, located upstream of Sawyers Swamp Creek Ash Dam.	Background
DP9dn	Within offline drainage channel receiving runoff from Sawyers Swamp Creek.	Impact
Springvale Creek		
MC2	Located on Marrangaroo Creek. Replacement background site for SCup.	Background
SCdn	Located at the railway crossing 200 m upstream of the Castlereagh Highway.	Impact

The following macroinvertebrate metrics were calculated:

- **Taxa richness**: the number of different families/groups collected in a sample. This metric provides a measure of macroinvertebrate community diversity.
- **EPT richness**: the number of taxa belonging to the Ephemeroptera, Plecoptera and Trichoptera families. These groups of macroinvertebrates have been found to be particularly sensitive to changes in their environment and, therefore, can be used to assess impacts due to chemical and physical changes
- **SIGNAL-2 Biotic Index**: pollution sensitivity of the macroinvertebrates collected in a sample, expressed as an average1 = greatest pollution tolerance, 10 = greatest pollution sensitivity.

Summary of results:

Licensed discharges from Springvale's LDP007 (previously LDP009) ceased during 2019. As such, any differences in macroinvertebrate community health between Sawyers Swamp Creek sites are not attributable to LDP007 discharges.

Taxa richness at sites in Sawyers Swamp Creek, SSCup and DP9dn, was generally low compared to that observed in other systems, with results at DP9dn in autumn 2020 particularly low spring 2020, taxa richness results were more comparable between background site SSCup and impact site DP9dn. EPT richness displayed more seasonal than site-based differences, with the lowest EPT richness results at both the background and impact sites in autumn 2020. Higher EPT richness

results were observed at both sites in spring 2020, including the presence of Plecoptera that were not observed in autumn. No Ephemeroptera were collected at either site in 2020. SIGNAL-2 results were also lower at both sites in autumn, and results were higher at background site SSCup than impact site DP9dn during both seasons.

In 2020, macroinvertebrate community health in the Coxs River downstream of the Sawyers Swamp Creek confluence (at CR4) was similar to or better than that of the upstream site CR3, with comparable results for taxa richness, EPT richness and SIGNAL-2 in autumn and generally higher results at CR4 in spring. These results indicate that there has not been a notable negative impact on macroinvertebrate communities in the Coxs River due to the influence of Sawyers Swamp Creek in 2020, despite the elevated metals observed.

Background site MC2 (previously referred to as MC1) was sampled for the first time in spring 2019, as a replacement site for SCup. Results from previous monitoring events found that SCup is occasionally influenced by the LDP6 discharge as a result of the pumping of water from downstream of the discharge to the farm dam, and as such, it was not considered a suitable background site.

Despite low taxa richness at MC2 in autumn, EPT richness was high, with results much higher than those observed at SCdn, and both replicates containing equal to or more EPT taxa than the long-term SCup/MC2 median. In spring, EPT richness was higher at SCdn than MC2. Plecoptera were not observed at SCdn in autumn but were collected in all other samples in 2020. SIGNAL-2 scores were higher at MC2 than SCdn during both sampling events, though all results at both sites were similar to or higher than the long-term SCup/MC2 median.

Water quality results indicated that the ionic composition of water was very different at SCdn compared to the dilute water observed at MC2. Concentrations of several dissolved metals were observed in concentrations that may cause biological effects on aquatic organisms, including dissolved aluminium, which was similarly high at both sites, dissolved cobalt which was elevated at MC2 only, and dissolved arsenic and nickel, which were elevated at SCdn only.

In 2020, the macroinvertebrate community health in the Coxs River downstream of the Springvale Creek confluence (at CR6), was in a poorer condition than the site immediately upstream of the Springvale Creek confluence (at CR5), with lower levels of all metrics at CR6. Given the generally improved water and sediment quality observed at CR6, these differences in the macroinvertebrate community are likely due to the scouring influence at CR6 caused by the Lake Wallace impoundment and spillway immediately upstream of CR6. At recovery site CR7, taxa richness, EPT richness and SIGNAL-2 was generally consistent with or higher than the long-term CR5 median in both autumn and spring 2020.

Aquatic ecology monitoring was conducted in waterways on the Newnes Plateau which are situated above Springvale Longwalls 420-422 (Carne Creek sites) or 424-427 (Bungleboori, Paddys and Marrangaroo Creeks), where impacts due to subsidence or fracturing are considered possible. Macroinvertebrate samples were collected by GHD during spring 2020 (11/11/2020, 12/11/2020 and 23/11/2020) at the sites. Water and sediment quality were tested in conjunction with macroinvertebrate monitoring.

Table 24: Macroinvertebrate Monitoring on the Newnes Plateau

Site	Catchment area	Description
BCN2	Bungleboori Creek (Nine Mile Creek)	Located on the northern unnamed drainage to Bungleboori Creek tributary that drains Pine Swamp.
MC1	Marrangarro Creek	Located in upper Marrangaroo Creek.

PC1	Paddys Creek	Located midway along Paddys Creek below two swamps.
CC1	Carne Creek	Located downstream of Sunnyside East Swamp.
CC2	Carne Creek	Located at the downstream end of Carne West Swamp.
CC3	Carne Creek	Located at the downstream end of Gang Gang swamp, below the confluence of two swamp flow channels.
CC4	Carne Creek	Located at the downstream end of a hanging swamp adjacent to Barrier Swamp.
CC5 / CCXdn	Carne Creek	Located below confluence of upper catchment tributaries draining CC1 and CC2-CC3.

Summary of results:

In spring 2020, CC2 contained insufficient water for the collection of macroinvertebrate samples, though water and sediment samples were able to be collected. CC3 was dry and was not able to be sampled for macroinvertebrates, water or sediment. There was only sufficient edge habitat at PC1 for one macroinvertebrate sample to be collected.

Taxa richness results were similar at all sites sampled on Carne Creek but were lowest at CC1. All results at Carne Creek sites were well below historical median results. Taxa richness results at BCN2 in spring 2020 were slightly higher than at Carne Creek sites, in one of two replicates, and were slightly below the historical median result for the site. Taxa richness results at MC1 displayed variability between replicates, with Replicate 1 containing six fewer taxa than were collected in Replicate 2, though both results were below the historical median. Taxa richness was at PC1 was 23, which is eight more taxa than the next highest result (BCN2/MC1) and higher than the historical median.

EPT richness results were highest at CC1, with six taxa observed in Replicate 1. Despite low total taxa richness in Replicate 1 at MC1, both samples collected at this site contained the same number of EPT taxa, which was equal to the median result of five. Five EPT taxa were also recorded in at least one of the two samples at CC5 and PC1, and while this was close to the PC1 median of 6, it was much lower than CC5 median of nine. EPT richness results were lowest at BCN2, particularly in Replicate 2 which contained only one EPT taxon, and both results were below the historical median. At CC4, the four EPT taxa collected in one of the replicates was two taxa less than the median. BCN2 and CC4 exhibited the greatest between sample variability.

SIGNAL-2 results were high at Carne Creek sites and MC1 in spring 2020, with these results all similar to the historical median results. SIGNAL-2 results at BCN2 in spring 2020 were very low, with results indicating a dominance of tolerant taxa at this site that was not observed historically, based on the high median result. The SIGNAL-2 result at PC1 in spring 2020 was also lower than the historical result, and below the scores observed at the Carne Creek sites and MC1.

Overall, the macroinvertebrate results indicated that the best community health was at PC1, with very high diversity relative to other sites. Macroinvertebrate community health was similar between the Carne Creek sites and MC1. The macroinvertebrate community at BCN2 was dominated by tolerant taxa, relative to the other swamp sites. The aquatic habitat at BCN2 was very different to that observed at all other sites in spring 2020. This site was primarily a wide, deep, marshy pool with a silty substrate, containing macrophytes and submerged grasses. No flow was evident, resulting in a lower dissolved oxygen saturation than at all other sites. In contrast, Carne Creek sites, MC1 and PC1 were all narrow channels with shallow, flowing water, and a rocky or sandy

substrate. Given the similar water and sediment quality observed at all sites in spring 2020, these habitat differences at BCN2 likely explain the poorer macroinvertebrate community health at this site.

The swamp sites were badly affected by the Gospers Mountain bushfire, with fire damage to vegetation and nearby infrastructure still present during sampling in spring 2020. Without more recent macroinvertebrate data from these sites it is difficult to distinguish the influence of the bushfires from the recent drought. However, either of these factors could explain the depressed macroinvertebrate community health observed at Carne Creek sites and BCN2, as evidenced by departures in macroinvertebrate metrics from the historical median.

Regeneration of vegetation was evident at all sites by spring 2020, including epicormic growth on eucalypts and regrowth of groundcover vegetation including ferns and shrubs. Sampling in 2021 will allow for a further the determination of any recovery in the macroinvertebrate communities that is due to vegetation regeneration and associated improvements in water quality.

6.4. Weed Management

Major weed threats include Blackberry, Spear Thistle, Sweet Briar, St. Johns Wart, Patterson's Curse, Field Mustard, and Fireweed. A comprehensive weed management strategy was developed in November 2020 to accurately map and target the weeds present on site. Weeds are targeted during the autumn and spring seasons and within the monthly surface maintenance program. The weed control program mainly focuses on controlling weeds on the Pit Top.

During the reporting period, weed eradication campaigns were conducted at the Pit-top and across Newnes Plateau infrastructure sites.

6.5. Erosion and Sediment Control

There are minimal exposed earthen areas at Springvale and most activities at the pit top are undertaken on relatively flat areas. In addition, high activity areas are sealed (e.g. car park areas). Internal unsealed roads are maintained to prevent dust, primarily through dust suppression sprays and water carts. Sediment fences are installed where required to filter sediment from drainage / seepage. Sediment is controlled by a series of dams and water treatment facilities at the Springvale pit top and at Newnes Plateau infrastructure sites. Water discharged from Licensed Discharge Points are monitored for suspended solids.

Erosion and sediment control work conducted during the reporting period included:

- Maintenance and improvement of pit top sediment fencing;
- Installation of sediment and erosion control in the areas cleared for fire breaks in December 2019 during the Gospers Mountain bushfires;
- Clean out of pit top clean water drain, including gabion wall sediment and vegetation matter build up; and
- Maintenance and improvement of sediment and erosion control at the Ventilation Fan Site and all other Newnes Plateau infrastructure sites.

6.6. Feral Animals

There were no issues of concern regarding feral animal control at the pit top or Newnes Plateau sites during the reporting period.

6.7. Heritage

6.7.1. Aboriginal Heritage

In 2016 Centennial Coal prepared a Western Region Aboriginal Cultural Heritage Management Plan in consultation with relevant stakeholders. This document aims to provide Centennial and Springvale with a consistent approach to consultation with local Aboriginal communities regarding Aboriginal cultural heritage identification as well as identify consistent minimum standards and processes for aboriginal cultural heritage identification, monitoring and management across Centennial's western operations. The plan was approved by the DPE and was in effect during the reporting period.

In accordance with the Heritage Management Plan LW424-427 (prepared under Schedule 3, Condition 10h of SSD5594) inspections and reports have been completed as listed in Table 25.

Table 25: Aboriginal Heritage Inspections

Site	Inspections Undertaken	Findings During Reporting Period
#45-1-0005 Artefact Scatter	Phase 1 (baseline) – 21 January 2019 Phase 2 – 30 June 2020	Phase 1 – No artefacts identified Phase 2 – Visibility was good following the recent bushfires. However, as with the Phase 1 inspection, this site could not be identified.
#45-1-2805 Grinding Groves	Phase 1 (baseline) – 21 January 2019 Phase 2 – 30 June 2020	Phase 1 – Identified during #45-1-0002 inspection. Several small grinding groves and a water hole identified on a sandstone outcropping. Phase 2 – The inspection identified several grooves in similar condition to the Phase 1 inspection, with a likelihood of more below the thick vegetation which is covering most of the sandstone outcropping. The site
#45-1-0002 Grinding Groves	Phase 1 (baseline) – 21 January 2019 Phase 2 – 30 June 2020	Phase 1 - Leaf litter and soil was covering much of the depressions on the sandstone platform. Multiple grooves were identified. Phase 2 – Between the Phase 1 and Phase 2 inspections, there was a significant increase in litter, such as discarded tents and other rubbish from recreational activities. Vehicle tracks also covered much of the site. There was scrapping on the sandstone where vehicles have entered the site and evidence of campfires were also observed. No cracking or mining related impacts were identified.

EIS (1992) Predictions \ Recommendations

The archaeological survey undertaken as part of the EIS predicts that the shelters above the area proposed for Longwall mining are not at risk from subsidence. It was recommended that shelter sites be included in any subsidence monitoring programs as a check on their stability.

During the reporting period, no noticeable damage to Aboriginal Heritage sites was observed, nor damage caused by subsidence. These findings are representative of those predicted within the EIS.

6.7.2. Natural and European Heritage

In 2016 Centennial Coal prepared a Western Region Historic Heritage Management Plan. The plan was approved by the DPE and was in effect during the reporting period.

Newnes State Forest occupies the area above the Springvale underground coal leases. The area is currently managed by Forests NSW who regularly carries out logging activities of both its pine

plantations and native forests. In addition to logging activities, tracks are maintained by Forests NSW which attracts a large number of 4WD and trail bike riders. The area is also very popular for campers and bushwalkers. In 2006, the Newnes State Forest was gazetted as a hunting area for Bow Hunters.

Previously, an historical heritage assessment was completed including a review of relevant Commonwealth, State and local historic heritage registers. The review of relevant registers included the National Heritage List, Commonwealth Heritage List, State Heritage Register, State Government Agency Heritage and Conservation Register and the Lithgow City Local Environmental Plan. No historic heritage items and/or National Heritage Places have been identified within the Springvale Colliery holding.

One site occurred within the LW420-422 Extraction Plan Area, A European scarred tree (Springvale Tree) was initially recorded as an Aboriginal scarred tree and registered on the Aboriginal Heritage Management System (AHIMS) as site number 45-1-2788. Subsequent assessment of the tree revealed it to be of European origin and is currently registered as 'not a site' on the AHIMS database. The site is now being managed in accordance with the Historic Heritage Management Plan.

One site occurs within the LW424-427 Extraction Plan Area, locally listed as I245, the Wolgan Valley Railway (Newnes to Zig Zag).

Table 26 details the inspection timing and findings during the reporting period.

Table 26: European Heritage Inspections

Site	Inspections Undertaken	Findings During Reporting Period
#45-1-2788 European Scar Tree	Phase 1 (baseline) – 24 November 2017 Phase 2 (post undermining) – 28 February 2018 Phase 3 (secondary post undermining inspection) – 17 September 2018	Phase 1 - Found the scarred tree in good condition with no damage to trunk or branches identified. Phase 2 – No changes to the tree and the surrounding area were identified. Phase 3 – No adverse effects to tree identified.
Wolgan Valley Railway (Newnes to Zig Zag) I245	Phase 1 (baseline) – 17 July 2018 Phase 2 (post mining) – Not Triggered	Phase 1 – No heritage items identified and no damage to the railway route was identified.

6.8. Meteorological Monitoring

Springvale mine is required to operate a meteorological station on-site in accordance with EPL 3607. The meteorological station conforms to AS3580.14. A summary of meteorological data collected from Springvale Colliery during 2018 is presented in Table 27.

Table 27: Site Weather Data

Month	Total Rainfall (mm)	Minimum Temperature (ºC) @ 2m	Maximum Temperature (ºC) @ 2m
Jan-20	41	9.81	38.63
Feb-20	134	5.11	38.25
Mar-20	80.6	5.2	30.39
Apr-20	97.6	-0.46	23.93
May-20	47.8	-4.89	19.6
Jun-20	32.8	-5.05	15.85
Jul-20	87.4	-5.54	14.45
Aug-20	100.8	-5.31	18.8
Sep-20	52.4	-2.21	22.55
Oct-20	58.4	0.11	24.49
Nov-20	92.6	3.22	31.62
Dec-20	91.2	2.88	34.18

The minimum temperature recorded on-site during the reporting period was -5.54°C in July and the maximum temperature recorded was 38.63°C in January.

Annual temperature and rainfall are presented in Figure 10, with 2019 rainfall data also presented for comparative purposes. Total annual rainfall increased by 486mm from 431mm in 2019 to 917mm in 2020.

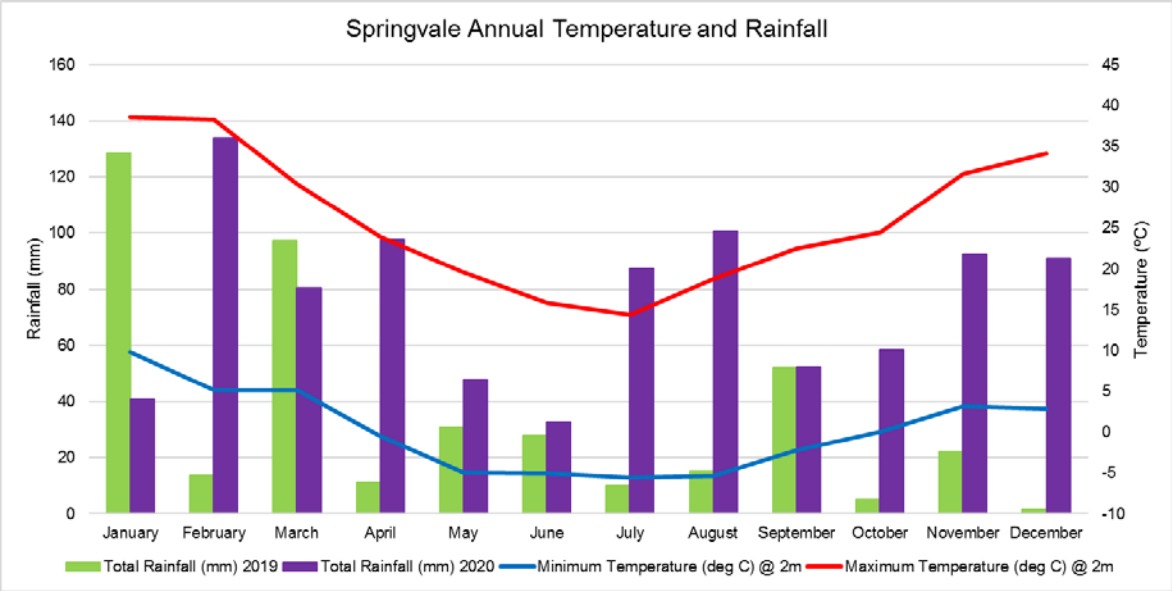


Figure 10: Annual Temperature and Rainfall

An annual wind velocity and direction wind rose is presented in Figure 11. Both parameters are generally consistent with 2019 averages, with the predominant wind speed and wind direction during the reporting period 1.8 m/sec and east north east respectively.

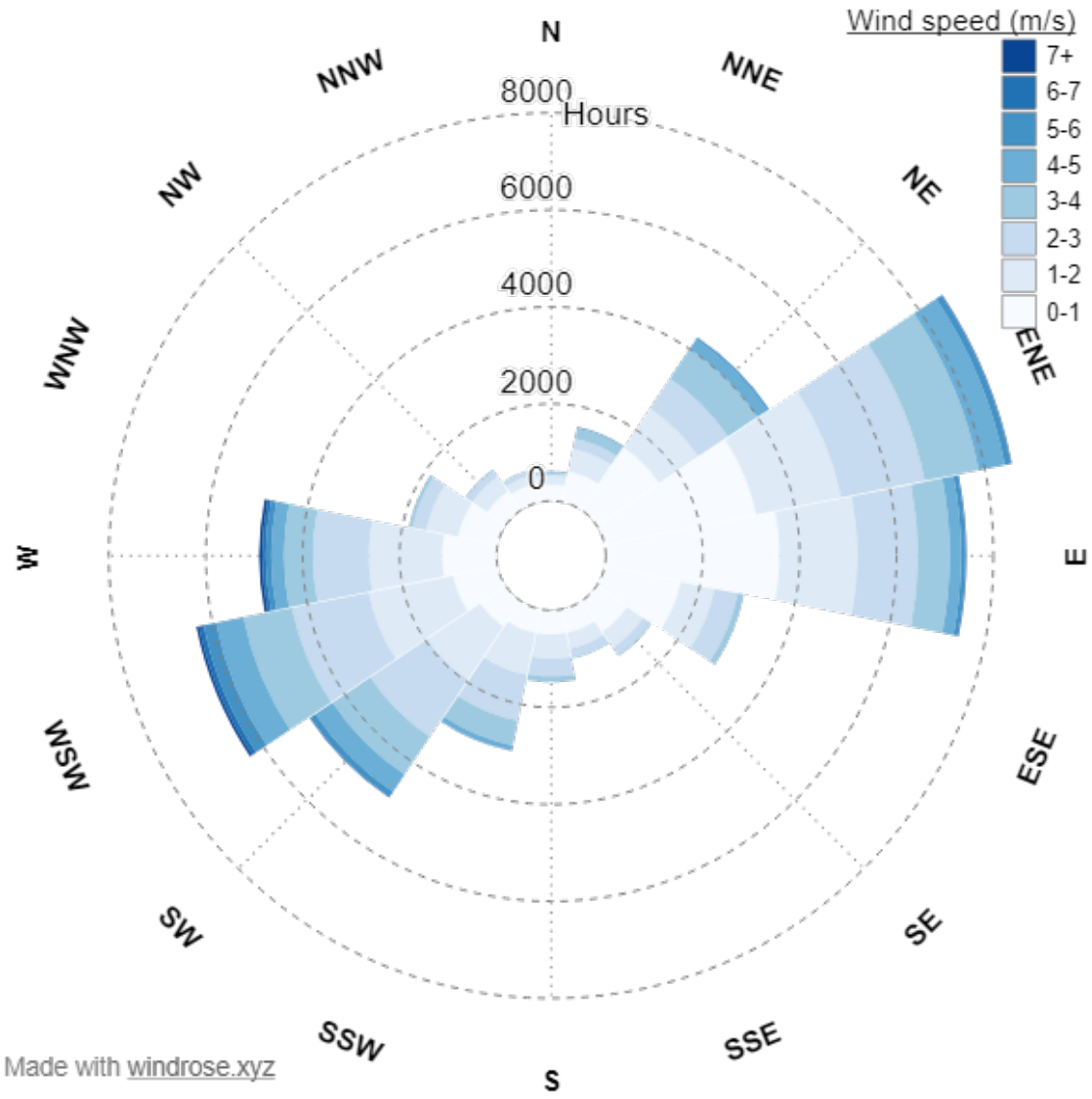


Figure 11: Annual Wind Rose

6.9. Noise

Operator attended noise monitoring was conducted at five locations during the reporting period in accordance with requirements under SSD 5594 and EPL 3607.

Table 28 below compares the results of the operator attended noise monitoring with relevant noise goals.

Compliance with the noise criteria goals was achieved at all noise monitoring locations during all monitoring periods.

Results are shown graphically in Appendix 4, with results from 2015 onwards included for trend analysis. 2020 results are consistent with previous years with no significant trends identified.

Table 28: Noise Monitoring Results Summary 2020

Location	Q1	Q2	Q3	Q4	Criteria Limit
Day (LAeq (15 minute) dBA)					
S1 (EPL ID No. 3)	~36	<37	<30	Inaudible	44
S2 (EPL ID No. 4)	~36	<36	<30	Inaudible	32
S3	Inaudible	Inaudible	Inaudible	Inaudible	35
S4 (EPL ID No. 5)	Inaudible	Inaudible	32	Inaudible	35
S5	Inaudible	Inaudible	<30	Inaudible	35
Evening (LAeq (15 minute) dBA)					
S1	41	41	<30	<36	44
S2	40	40	33	36	43
S3	Inaudible	Inaudible	Inaudible	Inaudible	35
S4	<27	<33	<30	<33	35
S5	<30	<30	<30	I<30	35
Night (LAeq (15 minute) dBA)					
S1	39	41	35	41	42
S2	44*	44*	37	44*	43
S3	Inaudible	Inaudible	Inaudible	Inaudible	35
S4	~28	<28	<30	<30	35
S5	<33	<30	31	<30	35
Night (LA1 (1 minute) dBA)					
S1	49	51	43	48	52

Location	Q1	Q2	Q3	Q4	Criteria Limit
S2	54*	48	46	54*	53
S3	Inaudible	Inaudible	Inaudible	Inaudible	60
S4	<30	<33	34	<35	45
S5	38	<30	38	33	45

* Within 2dB tolerance as per Section 11.1.3 of the NSW Industrial Noise Policy (INP). A development will be deemed to be in non-compliance with a noise consent or licence if the monitored noise level is more than 2dB above the statutory noise limit specified in the consent or licence condition.

6.9.1. Low Frequency Noise

This section has been included in the 2020 Annual Review as recommended in the 2019 Independent Audit.

Background
In 2013 and 2014, a series of complaints were received by Centennial Coal and the Environment Protection Authority (EPA) from two separate residents (Skelly Road Residence in the vicinity of Springvale Mine; Donald Road Residence in the vicinity of Clarence Colliery), in regard to a low frequency noise issue, potentially emanating from the Springvale Mine, Angus Place Colliery or Clarence Colliery operations. The following paragraphs provide reference of investigation outcomes.

The Acoustics Group 2015
Following the receipt of the complaints, consultation with the potentially impacted residents commenced. Concurrently, a series of low frequency noise investigations was initiated by both Centennial Coal and the EPA in order to determine the source of the potential issue. Centennial Coal's investigations were carried out over a number of months and included a series of attended and unattended noise monitoring. Centennial Coal's investigations were initially undertaken by SLR Consulting before The Acoustic Group, a specialist low frequency noise consultant, was engaged for further investigations.

The assessment report prepared by The Acoustic Group (April 2015) included a significant volume of attended and unattended noise monitoring data (including 1/3 octave and narrow band analyses). These results were also supported by contextual data including resident logbooks and limited on/off testing of various items of plant within the Centennial Coal operations. The Acoustic Group recommended that a series of on - off testing of the fan at the Springvale Mine's Vent Shaft 3 Facility, and running the fan at various speeds, should be undertaken. The Acoustic Group report was provided to both the Skelly Road Residence and Donald Road Residence.

Global Acoustics 2015
A peer review of the Acoustic Group report was undertaken by Global Acoustics in 2015.

EMM 2016
In October 2015 EMM was engaged to undertake the recommended on – off testing of the fans at Springvale's Vent Shaft 3 Facility when the opportunity arose with the stand down of the Springvale Mine's workforce in August/October 2015, and the facility could be switched off.

The EMM report concluded the following for the two potentially affected residences.

Skelly Road Residence

Low frequency noise measured inside the dwelling was not at a level likely to cause disturbance according to the DEFRA criteria.
With reference to the Broner criteria, ambient external noise levels were below the recommended criterion for the duration of the monitoring program (i.e. below 65 dB(C) at all times).
Springvale Mine's Vent Shaft 3 fan may be a minor contributor to ambient noise levels inside the dwelling at 131 Hz however was measured to be at a level significantly below the average threshold of hearing.
Springvale Mine's Vent Shaft 3 fan is not a contributor to ambient noise levels at the dwelling (inside or out) at frequencies up to 12 Hz i.e. at the operating speed of the fan.

Donald Road Residence
Low frequency noise measured inside the dwelling was not at a level likely to cause disturbance according to the DEFRA criteria.
With reference to the Broner criteria, ambient external noise levels were below the recommended criterion for the duration of the monitoring program (i.e. below 65 dB(C) at all times).
Springvale Vent Shaft 3 fan is not a contributor to ambient noise levels at the dwelling (inside or out) at frequencies up to 12 Hz i.e. at the operating speed of the fan or any other frequency.

Both residents were notified of the outcome of the investigations by EMM in January 2016. A copy of the EMM report the raw data collected during the investigation were provided to the residents in February 2016, to allow them to undertake their own testing and verification. Centennial was subsequently contacted by the Skelly Road Residence requesting additional technical information relating to the vent shaft fan and the testing methodology. The additional information was provided to both the residents by Centennial.

Advitech 2017
Further Investigations of Low Frequency Noise sources was undertaken in 2017 by Advitech. Further Low Frequency Noise Investigations to identify potential mitigation opportunities is ongoing.

6.10. Mine Subsidence

During the 2020 reporting period, coal was extracted from longwall (LW) 426 and 427. LW426 commenced on the 10th November 2019 and was completed on the 3rd August 2020 with a total chainage of 1564.9m (finish chainage 825.1m). LW427 commenced on the 28th September 2020 and the retreat chainage at 31st December 2019 was 2174.0m (796.7m extracted).

No anomalous surface movements were detected during the reporting period that warranted investigation.

The following tables summarise the results for the subsidence lines surveyed during the reporting period against the relevant trigger values.

During the reporting period, MCS Line was surveyed on the 14th of February. Table 29 outlines the max result recorded against the trigger value. No triggers were detected.

Table 29: MCS Line Subsidence Results

	Subsidence		Tilt		Strain	
	(m)		(mm/meter)		(mm/meter)	
	Max Result	Trigger value	Max Result	Trigger value	Max Result	Trigger value
LW426	-0.007	-0.5	-0.5	-4.5	-0.05	-0.08

During the reporting period, AA Line was surveyed on the 27th of February and the 29th of June. Table 30 outlines the max result recorded against the trigger value. No triggers were detected.

Table 30: AA Line Subsidence Results

	Subsidence		Tilt		Strain	
	(m)		(mm/meter)		(mm/meter)	
	Max Result	Trigger value	Max Result	Trigger value	Max Result	Trigger value
LW426	-0.527	-1.15	-11.3	-7	7.8	9

During the reporting period, Z Line was surveyed on the 10th of July and the 7th of September. Table 31 outlines the max result recorded against the trigger value. No triggers were detected.

Table 31: Z Line Subsidence Results

	Subsidence		Tilt		Strain	
	(m)		(mm/meter)		(mm/meter)	
	Max Result	Trigger value	Max Result	Trigger value	Max Result	Trigger value
LW426	-0.357	-1.15	-5.5	-7	-7	-7

During the reporting period, Zx Line was surveyed on the 15th of July and 8th of September. Table 32 outlines the max result recorded against the trigger value. No triggers were detected.

Table 32: Zx Line Subsidence Results

	Subsidence		Tilt		Strain	
	(m)		(mm/meter)		(mm/meter)	
	Max Result	Trigger value	Max Result	Trigger value	Max Result	Trigger value
LW426	-0.039	-1.15	-1.5	-7	1.9	-7

During the reporting period, NMS Line was surveyed on the 29th of July. Table 33 outlines the max result recorded against the trigger value. No triggers were detected.

Table 33: NMS Line Subsidence Results

	Subsidence		Tilt		Strain	
	(m)		(mm/meter)		(mm/meter)	
	Max Result	Trigger value	Max Result	Trigger value	Max Result	Trigger value
LW426	-0.001	-0.020	-0.1	-0.5	-0.9	-1

During the reporting period, PCS Line was surveyed on the 30TH of July. Table 34 outlines the max result recorded against the trigger value. No triggers were detected.

Table 34: PCS Line Subsidence Results

	Subsidence		Tilt		Strain	
	(m)		(mm/meter)		(mm/meter)	
	Max Result	Trigger value	Max Result	Trigger value	Max Result	Trigger value
LW426	-0.122	-0.150	-0.8	-3	-0.7	-5

During the reporting period, PS Line was surveyed on the 29th of July. Table 35 outlines the max result recorded against the trigger value. No triggers were detected.

Table 35: PS Line Subsidence Results

	Subsidence		Tilt		Strain	
	(m)		(mm/meter)		(mm/meter)	
	Max Result	Trigger value	Max Result	Trigger value	Max Result	Trigger value
LW426	-0.000	-0.020	-0.2	-7	-0.6	-1.4

During the reporting period, GGSW Line was surveyed on the 18th of August. Table 36 outlines the max result recorded against the trigger value. No triggers were detected.

Table 36: GGSW Line Subsidence Results

	Subsidence		Tilt		Strain	
	(m)		(mm/meter)		(mm/meter)	
	Max Result	Trigger value	Max Result	Trigger value	Max Result	Trigger value
LW421	-0.763	-1.25	-3.7	-9	-2.2	-9

During the reporting period, GGE Line was surveyed on the 18th of August. Table 37 outlines the max result recorded against the trigger value. No triggers were detected.

Table 37: GGE Line Subsidence Results

	Subsidence		Tilt		Strain	
	(m)		(mm/meter)		(mm/meter)	
	Max Result	Trigger value	Max Result	Trigger value	Max Result	Trigger value
LW421	-0.687	-1.15	-7	-9	-3.5	-9

During the reporting period, GG Line was surveyed on the 13th of August. Table 38 outlines the max result recorded against the trigger value. No triggers were detected.

Table 38: GG Line Subsidence Results

	Subsidence		Tilt		Strain	
	(m)		(mm/meter)		(mm/meter)	
	Max Result	Trigger value	Max Result	Trigger value	Max Result	Trigger value
LW421	-0.070	-1.25	-0.5	-9	-1.5	-9

During the reporting period, X Line was surveyed on the 1st of June and the 8th of October. Table 39 outlines the max result recorded against the trigger value. No triggers were detected.

Table 39: X Line Subsidence Results

	Subsidence		Tilt		Strain	
	(m)		(mm/meter)		(mm/meter)	
	Max Result	Trigger value	Max Result	Trigger value	Max Result	Trigger value
LW421	-0.614	-1.15	-6	-9	-3.7	-9

During the reporting period, B Line was surveyed on the 2nd of June and the 17th of November. Table 40 outlines the max result recorded against the trigger value. No triggers were detected.

Table 40: B Line Subsidence Results

	Subsidence		Tilt		Strain	
	(m)		(mm/meter)		(mm/meter)	
	Max Result	Trigger value	Max Result	Trigger value	Max Result	Trigger value
LW421	-0.993	-1.15	-6	-9	-11	-9

During the reporting period, BB Line was surveyed on the 18th of May and the 3rd of November. Table 41 outlines the max result recorded against the trigger value. No triggers were detected.

Table 41: BB Line Subsidence Results

	Subsidence		Tilt		Strain	
	(m)		(mm/meter)		(mm/meter)	
	Max Result	Trigger value	Max Result	Trigger value	Max Result	Trigger value
LW421	-0.622	-1.15	-4.2	-9	-2.0	-9

EIS Predictions \ Recommendations

As part of the Extraction Plan process, a subsidence review is conducted. This section compares to the EIS predications (Section 8.4 EIS) only and individual extraction plans shall be referred to for additional information.

The maximum total subsidence, after the completion of all the proposed longwalls is 1650 mm which represents approximately 52% of the 3.2 m maximum extraction height. The predicted total tilt is 25 mm/m (i.e. 2.5%), which represents a change in grade of 1 in 40. The maximum predicted total curvatures are 0.60 km-1 hogging and 0.60 km-1 sagging, which represent minimum radii of curvature of 1.7 kilometres and 1.7 kilometres, respectively. Non-conventional subsidence has been predicted, in brackets, for subsidence above lineaments.

Table 42: Maximum predicated Total Conventional Subsidence

Longwall	Subsidence (mm)	Tilt (mm/m)	Hogging Curvature (km-1)	Sagging Curvature (km-1)
LW416 to LW423	1,200 (1,450)	10	0.15	0.20
LW424 to LW432	1,350 (1,650)	13	0.20	0.35
LW501	1,350	25	0.60	0.60
LW502 and LW503	1,650	25	0.60	0.60

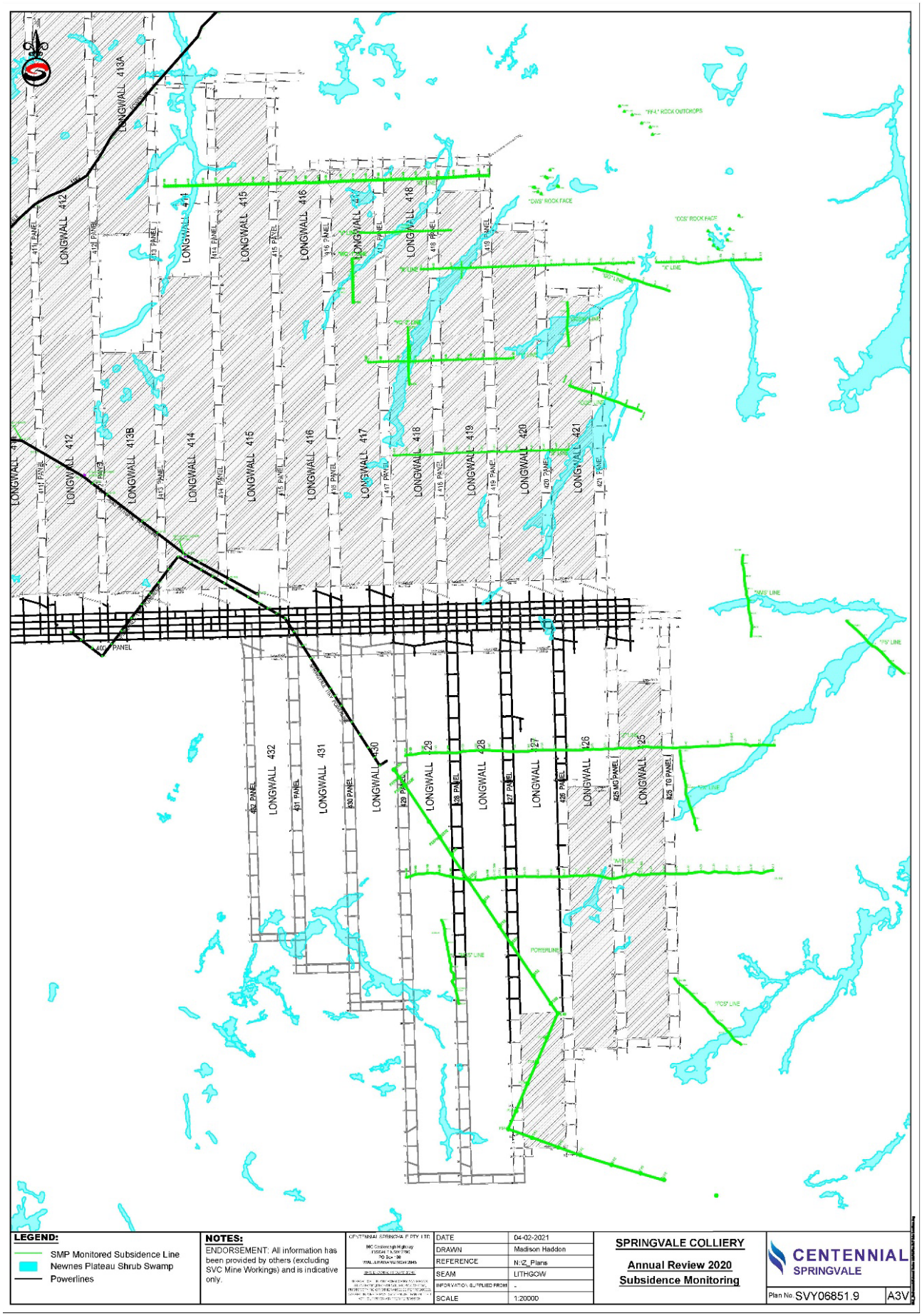


Figure 12: Subsidence Monitoring Locations

6.11. Waste

The major waste streams from the mine include water, packaging material including plastic, paper and cardboard, wood, waste oil, oil filters, oil drums, scrap metal, hoses, bottles (plastic and glass), sewage effluent, as well as general putrescible rubbish.

General waste is disposed of to landfill by licensed waste contractors. Recyclable materials, for example, plastic, paper and cardboard products, are recycled whenever possible at the site. Oil drums and filters are recycled with other waste metals and are removed from site by a metal recycling company. Waste oil collected in the workshop is stored in an underground collection sump before being removed off site by a licensed contractor for recycling.

Paper, plastic and cardboard are recycled both from bulk packaging from the store and site offices, either at the pit top or other infrastructure areas are transferred to a recycling facility.

Non-production waste is managed in accordance with the EIS and existing Mining Operations Plan, with all potentially hazardous material stored and/or bunded appropriately in accordance with relevant standards. Where possible, all quantities of waste or recyclable material are quantified and recorded for benchmarking and continuous improvement purposes as well as reporting in accordance with the National Greenhouse and Energy Reporting Scheme.

During the reporting period a recycling rate of 24.98% (Total offsite waste tonnes / Recycled waste) was achieved. This rate compares to 28.35% and 22.45% in 2019 and 2018 respectively.

Springvale continued the implementation of the waste program and has noted improvements including:

- Increased scrap steel recovery;
- Improved oil drum handling and disposal;
- Improved waste segregation through sorting of general waste bins on-site; and
- Increased equipment recovery for site, reducing general waste.

Waste sorting will continue in 2021 with the objective of continuing to improve on waste segregation, hydrocarbon (oil/chemical drum) management and recycling.

A summary of the waste removed and recycled is presented in Figure 13 and Figure 14.

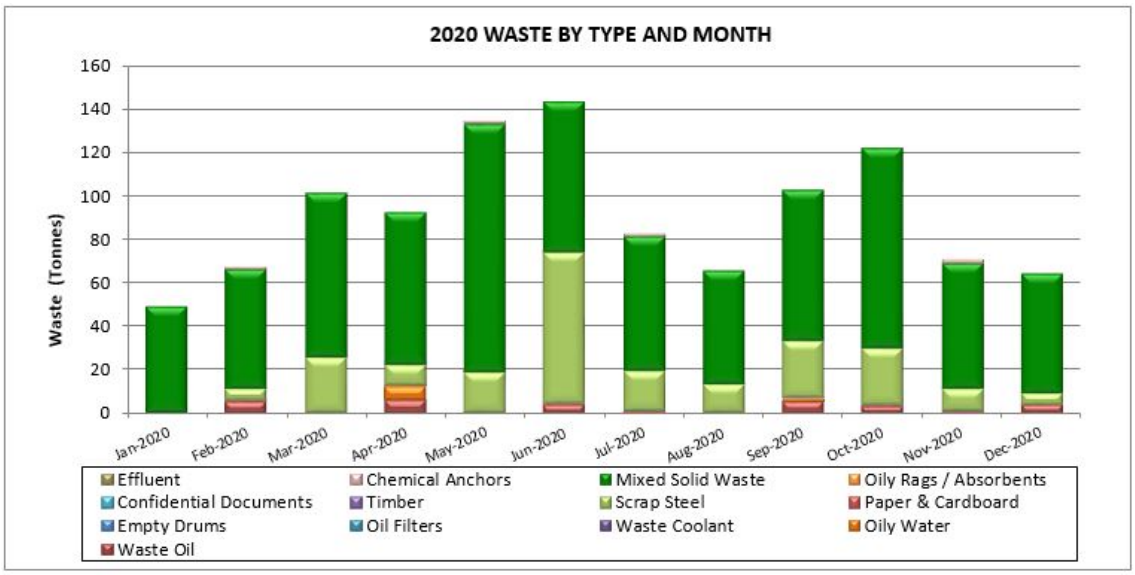


Figure 13: 2020 Waste Management Summary

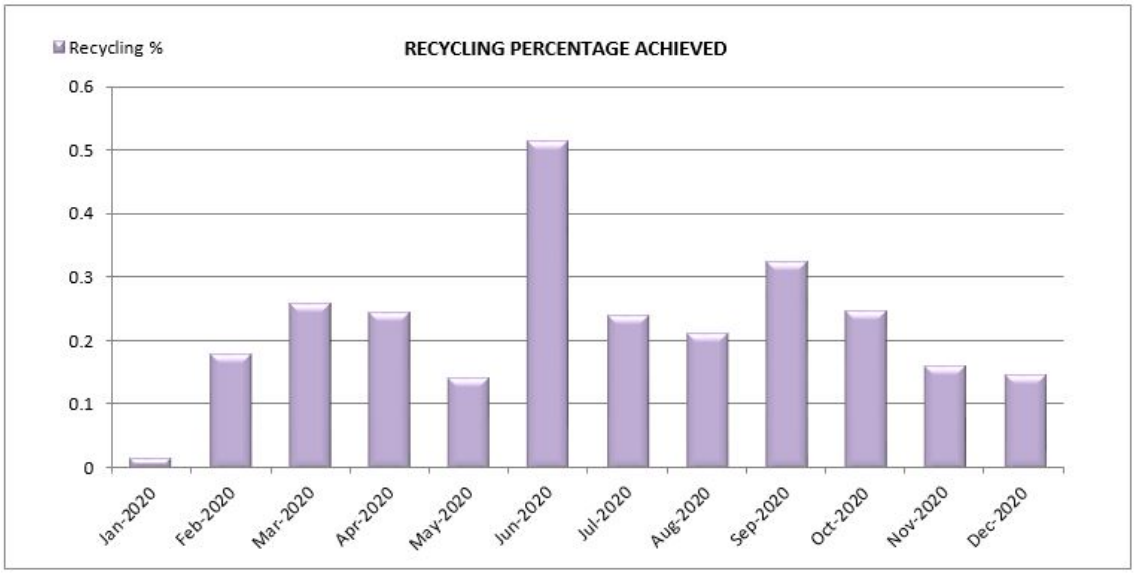


Figure 14: 2020 Recycling Summary

In June 2020 a large chain from underground was recycled scrap steel which is evident in the waste management trends. Mixed Solid waste is higher in September/October 2020 due to longwall relocations activities

6.12. Hydrocarbon Contamination

Fuels and oils are stored in purpose-built facilities with appropriate bunding and firefighting provisions. Diesel is stored in above ground bunded tanks from where it is transferred to diesel pods for underground use or direct to machinery. A licenced contractor is engaged to remove and recycle and/or dispose of used oil and grease products at licensed facilities.

6.13. Spontaneous Combustion

The Lithgow coal seam has a low propensity for spontaneous combustion with no spontaneous combustion issues in relation to in-situ or for processed Lithgow seam coal. The highest risk of spontaneous combustion in relation to Lithgow seam coal appears to be during stockpiling for periods greater than approximately 1 year. Springvale coal is generally stockpiled for less than 1 year. There have been no incidences of spontaneous combustion in the life of Springvale mine.

EIS (1992) Predictions \ Recommendations

As predicted within the EIS, no occurrences of spontaneous combustion were observed during the reporting period.

6.14. Bushfire

The majority of the land within the Springvale holding has been identified as Bushfire Prone Land. Fire history data from the Forestry Corporation of NSW indicates that the majority of bushfires in the area spread from the north and east of Springvale Mine due to the direction of dominant winds throughout the bushfire season. A number of fire trails exist across the Newnes Plateau, namely Sunnyside Ridge Road, Campbells Track and Maiyingu Marragu Trail. These act as containment lines mitigating a degree of bushfire risk to Springvale Mine's infrastructure.

In 2013 the State Mine fire burnt through more than 46,000 hectares. The bushfire caused power outage and minor damage to mine infrastructure located on the Newnes Plateau. Several flora monitoring plots on the Springvale lease were affected by the bushfire.

In both 2019 and 2020, The Gospers Mountain Bushfire affected the Lithgow, Hawkesbury and Central Coast regions. The Gospers Mountain bushfire started on 26 October 2019 and was not contained until 13 January 2020. The fire burnt approximately 512,000ha.

The fire threatened the pit top on the 16 December 2019 and forced the evacuation of the mine and cessation of mining operations underground at the site. The Newnes State Forest was closed during this period and impacted monitoring activities from October 2019 until March 2020. Contractors were not permitted to access the Newnes Plateau due to the increased danger of falling trees and branches. An extensive program to clear access tracks to monitoring locations was undertaken during March and April 2020. Springvale worked closely with FCNSW and the NSW Rural Fire Service during the disastrous event.

A large proportion of monitoring equipment installed in the swamps, and surrounding areas, for ground water and surface water monitoring were damaged during the fires and required complete replacement. This resulted in the development of an interim monitoring program. The replacement project was completed in by October 2020 and the regular monitoring program was able to be resumed.

The extent and impact of the bushfire is exemplified in the following figures.

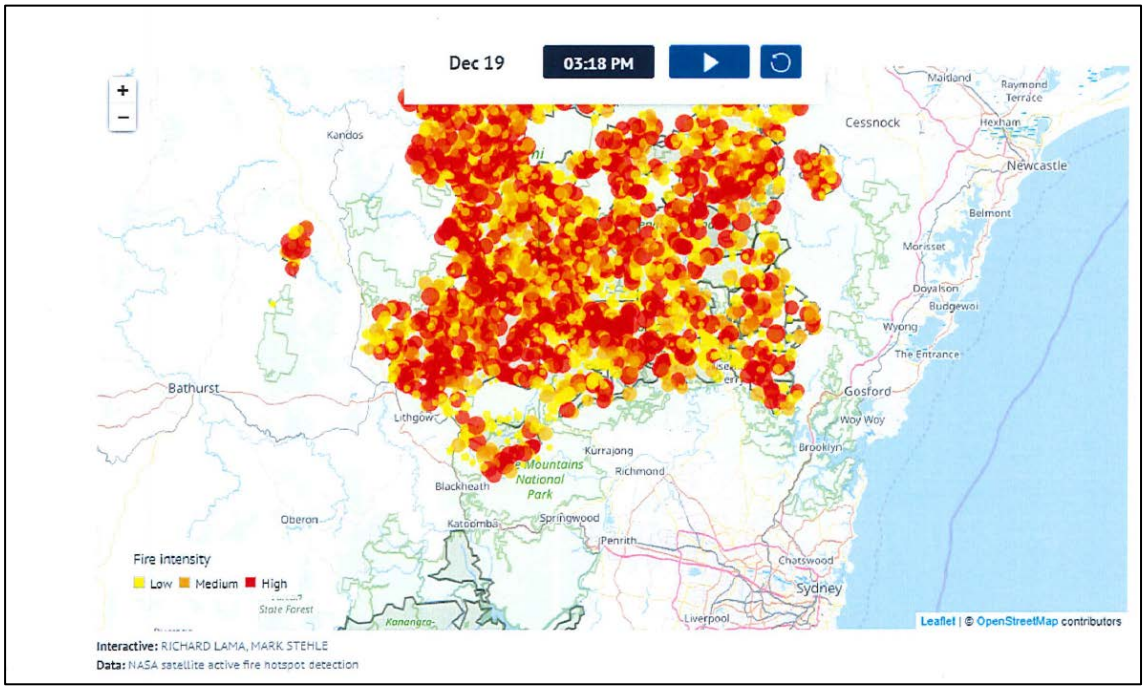


Figure 15: Gosper Fire Bushfire extent

Figure 16: Visual representation of air quality

EIS (1992) Predictions \ Recommendations

The EIS details the requirement for firefighting services to access water at the Pit Top and Washery in the event of a bushfire. Current bushfire controls include the Springvale-Delta Transfer Scheme, which pumps up to 30ML per day from Springvale Coal and Angus Place Colliery to the Water Treatment Facility (SSD 7592). Along the pipeline's length, fire hydrant points have been installed for use by fire services.

6.15. Water Management

The following table presents water take for Springvale 2019/2020 financial year. It is important to note that Table 43 reports on the water reporting year, which is from the 1st of July to the 30th of June, not the calendar year.

Table 43: Water Take

WAL Number	Works Approvals	Water Sharing Plan, source and management zone (as applicable)	Entitlement (ML)	Passive take/flows (ML)	Active pumping (ML)	TOTAL (ML)
WAL 36383	10WA118719 – Bore 6 and 8	Sydney Basin Richmond Groundwater Source	5,958+1000 traded from WAL36479 Total 6958	N/A	6816	6816
WAL36449	10WA118719– Bore 6 and 8		2523		1458	1458
WAL 36446	10WA118752 – 24C/T to 8ML Dam	Sydney Basin Coxs River Groundwater Source	3,300	N/A	1243	1243
WAL 36443	10WA118754 – 85 C/T Pump Station		585	N/A	174.2	174.2

Note: Volume is reported in annual megalitres (ML)

From the information presented in Table 43, it is acknowledged that WAL 36383 exceeded its normal volume of 5958 ML in the water year 2019/2020, with approximately 858 ML extracted in excess of the allocation limit. The exceedance of the WAL occurred due to operational requirements to dewater the majority of underground water via Bore 6 and 8 (accounted from within the Richmond Groundwater Source) rather than being able to utilise the FBT dewatering system (accounted from within the Coxs River Groundwater Source).

The over extraction was forecast by the Springvale Mine and subsequently, points of extraction at Angus Place were reduced to account for the over extraction. However, additional allocation was still required. The required additional allocation was traded from unused proportion from Clarence Colliery and was approximately 1000 ML. This combined sharing of the WALs across the three operations enabled a compliant water account for the year.

It is important to note that this process of water accounting across the operations does not equate to an over extraction of water from the Springvale Mine operations but an acknowledgement of limitations present within the water licensing of adjacent cascading water sources that can only be accounted through metered works. Strategies to combat this scenario are being developed in consultation with specialist consultants and the regulator.

The total allocation from a combined Clarence Colliery, Angus Place Colliery and Springvale Mine from the Sydney Basin Richmond Groundwater Source, for the primary dewatering works, Bore 6 and 8, was 8274 ML/year.

6.16. Surface Water Monitoring

Surface water monitoring is undertaken in accordance with EPL 3607. Results of the monitoring are reported on an annual basis to the EPA via the EPA Annual Return. The following tables provide a summary of results obtained during the reporting period.

6.16.1. Water Quality – Licensed Discharge Points

Water quality results for LDP006 (formally LDP001) are presented in Table 44. LDP007 (formally LDP009) is no longer operational as of July 2019.

LDP water quality results are also presented graphically in Appendix 2.

Table 44: LDP006 Quality

Pollutant	Unit of measure	Lowest sample value	Mean of sample	Highest sample value	Limit
Conductivity	microsiemens per centimetre (µS/cm)	551	905.16	1063	NA
Filterable iron	milligrams per litre mg/L)	<0.05	0.035	0.260	NA
Filterable manganese	milligrams per litre (mg/L)	<0.001	0.0184	0.3530	NA
Oil and Grease	milligrams per litre (mg/L)	<5	<5	<5	10
pH	pH	6.60	7.94	8.80	6.5-9.0
Total suspended solids	milligrams per litre (mg/L)	<5	5.3	16.0	30
Turbidity	Nephelometric turbidity units	2.70	12.26	33.0	50

EC ranged from 551µS/cm to 1063µS/cm with an average of 905.16µS/cm during the reporting period. This is consistent with last years average of 982.4µS/cm.

Filterable iron ranged from <0.05mg/L to 0.260mg/L with an average of 0.035mg/L. This is higher than the previous year average of 0.014mg/L.

Filterable manganese ranged from <0.001mg/L to 0.3530mg/L with an average of 0.0184mg/L. This is higher than the previous year average of 0.0069mg/L.

Oil and grease results were consistently below the respective detection limits (<5mg/L) during the reporting period.

pH ranged between 6.6 to 8.8 with an average of 7.94. An acid dosing system was in place during the reporting period, which utilizes real time technology to adjust to varying flows and pH levels continued to operate effectively during the reporting period.

TSS ranged from <5mg/L to 16mg/L with an average of 5.3mg/L. This is higher than the previous year average of 4.8mg/L.

The Springvale Water Treatment Project (SWTP) is operational with discharge ceased at LDP007 on the 30th June 2019.

6.16.2. Surface Water Flows – Newnes Plateau

Surface Water Flows and Levels

Surface water flows are monitored at multiple locations. The following six locations have been selected in accordance with Longwall 424- 427 SMP:

- Marrangaroo Swamp;
- Paddys Creek Swamp;
- Nine Mile Swamp;
- Pine / Nine Mile Swamp Confluence;
- Gang Gang South West Swamp; and
- Gang Gang Swamp Confluence.

Table 45: Surface Flow 2020

Flow Site	Min (kl/day)	Median (kl/day)	Max (kl/day)
Marrangaroo Swamp	77	363	1347
Paddys Creek	120	224	1978
9 Mile Swamp	Too low	Too low	Too low
Pine/9 Mile Swamp Confluence	Too low	Too low	Too low
Gang Gang South West	Too low	Too low	Too low
Carne (West) Swamp	Too low	Too low	Too low
Sunnyside Upstream Junction	155	361	1563
Sunnyside Swamp Upstream	Too low	Too low	Too low
Sunnyside Swamp Downstream	112	889.5	1667
Tristar	95	518	2851
Twin Gully	354	432	717
Marrangaroo Creek	Dry	Dry	Dry

Marrangaroo Swamp

Marrangaroo Swamp is considered a potential impact site to be undermined by future longwalls. As this point in time it is still considered unimpacted. flows are consistent and generally below 1000 kl/day.

Paddys Creek Swamp

Flows at Paddys Creek are generally consistent and below 500kL/day.

Nine Mile Swamp

Nine mile swamp has been an impact site since 2018. The flow rate at Nine mile swamp is highly variable with flows to low to measure since 2018.

Pine / Nine Mile Confluence

Flows have not been able to be measured since 2019 due to low water depths.

Gang Gang South West Swamp

Gang Gang South West is an impact site that has been predominately dry since 2018. There were only 2 samples taken in 2020.

Carne West Pool

Carne West was destroyed by the 2019/2020 bushfires. The swamp was also monitored at Carne West Pool (CWP) for the pooled water depth but was damaged by the bushfires in 2020 and decommissioned.

Carne West Swamp

Carne Swamp is an impact site that has been predominately dry since 2017. It is part of Carne West Swamp. In 2020 Carne West was frequently dry.

Sunnyside Swamp

Sunnyside swamp flows flows were observed to taper off in 2018 becoming predominately too low to measure. The recently observed flows in the reporting period were recorded during a time of above average rainfalls.

Tristar Swamp

Tristar Flows are generally consistent at Tristar with the majority of flows below 400kl/day. Flow measurements became intermitted from mid 2019 onwards due to declining rains.

Twin Gully Swamp

Flows at Twin gully have been historically consistent until 2019 when flows were often too low to measure or pooled up. Flows during the reporting period were often too low to measure.

Marrangaroo Creek Upstream

Flows at Marrangaroo Creek have not been able to be consistently recorded since 2017 due the flows being too low to monitor.

6.16.3. Water Quality – Newnes Plateau

Surface water quality parameters of pH, Electrical Conductivity (EC), Manganese (Mn) and Iron (Fe) are monitored at the following locations, selected in accordance with the SMP LW425-427:

- Nine Mile Swamp;
- Pine / Nine Mile Swamp Confluence; and
- Paddys Creek Swamp; and
- Marrangaroo Swamp.

The Sunnyside Swamp and Upper Wolgan River sites are monitored for electrical conductivity (EC), pH, manganese and iron. The Carne West Swamp and Sunnyside East Swamp sites are monitored for electrical conductivity (EC), pH and iron. The monitoring results are presented below.

Monitoring Results

Nine Mile Swamp

A summary of the water quality statistics for Nine Mile Swamp are provided in Table 46.

Table 46: Nine Mile Swamp Water Quality Statistics (Apr 2020 – Dec 2020)

Site	Analyte	Min	Max	Mean
Nine Mile Swamp	pH	4.1	5.2	6.7
	EC (uS/cm)	16	43	87
	Fe (mg/L)	0.05	0.5	0.7
	Mn (mg/L)	0.013	0.0255	0.056
	TSS (mg/L)	5	6.5	1915

Pine / Nine Mile Swamp Confluence

A summary of the water quality statistics for Pine / Nine Mile Swamp Confluence are provided in Table 47.

Table 47: Pine/Nine Mile Swamp Water Quality Statistics (Apr 2020 – Dec 2020)

Site	Analyte	Min	Max	Mean
Pine/Nine Mile Swamp	pH	3.9	5.25	6.7
	EC (uS/cm)	25	42.5	79
	Fe (mg/L)	0.16	0.335	0.83
	Mn (mg/L)	0.014	0.029	0.063
	TSS (mg/L)	5	5	98

Paddys Creek Swamp

A summary of the water quality statistics for Paddys Creek Swamp are provide in Table 48.

Table 48: Paddy's Creek Swamp Water Quality Statistics (Apr 2020 – Dec 2020)

Site	Analyte	Min	Max	Mean
Paddy's Creek Swamp	pH	3.9	4.9	6.8
	EC (uS/cm)	36	48	115
	Fe (mg/L)	0.05	0.225	0.48
	Mn (mg/L)	0.022	0.036	0.053
	TSS (mg/L)	5	5	22

Marrangaroo Swamp

A summary of the water quality statistics for Marrangaroo Swamp are provide in Table 49.

Table 49: Marrangaroo Swamp Water Quality Statistics (Apr 2020 – Dec 2020)

Site	Analyte	Min	Max	Mean
Marrangaroo Swamp	pH	4.4	5.55	6.9
	EC (uS/cm)	26	41	209
	Fe (mg/L)	0.14	0.685	1.5
	Mn (mg/L)	0.015	0.029	0.054
	TSS (mg/L)	5	5	28

East Wolgan River

A summary of the water quality statistics for Wolgan River are provided in Table 50.

Table 50: Wolgan River - 2020 Water Quality Statistics

Site	Analyte	Min	Max	Mean
East Wolgan D/S Junction	pH	4.4	5.45	6.9
	EC (uS/cm)	28	47	248
	Fe (mg/L)	0.07	0.145	0.61
	Mn (mg/L)	0.003	0.009	0.019
	TSS (mg/L)	5	5	106
Sunnyside U/S Junction	pH	4.3	5.55	7
	EC (uS/cm)	31	45	68
	Fe (mg/L)	0.07	0.165	0.66
	Mn (mg/L)	0.003	0.01	0.019
	TSS (mg/L)	5	5	26

Sunnyside Swamp

A summary of the water quality statistics for Sunnyside Swamp are provided in Table 51.

Table 51: Sunnyside Swamp - 2020 Water Quality Statistics

Site	Analyte	Min	Max	Mean
Sunnyside Swamp D/S	pH	4.5	5.45	6.6
	EC (uS/cm)	29	46	65
	Fe (mg/L)	0.05	0.095	0.91
	Mn (mg/L)	0.001	0.003	0.031
	TSS (mg/L)	5	5	24
Sunnyside Swamp U/S	pH	5	5.5	6.6
	EC (uS/cm)	31	55	123
	Fe (mg/L)	0.05	0.145	1.29
	Mn (mg/L)	0.001	0.0075	0.05
	TSS (mg/L)	5	8.5	337

Sunnyside East Swamp

A summary of the water quality statistics for Sunnyside East Swamp are provide in Table 52. There is little historical data for this location as monitoring for Sunnyside East Swamp began in March 2016. 16 samples were collected during the reporting period.

Table 52: Sunnyside East Swamp - 2019 Water Quality Statistics

Site	Analyte	Min	Max	Mean
Sunnyside East	pH	3.7	4.7	5.2
	EC (uS/cm)	37	64	103
	Fe (mg/L)	0.05	0.05	0.5
	Mn (mg/L)	0.012	0.0345	0.207
	TSS (mg/L)	5	5	26

6.16.4. Water Volume

Water volume for the reporting period was monitored through flowmeters located at discharge points LDP006, LDP007 and LDP008. Daily discharge volumes are measured against EPL 3607 volume limits and reported on monthly in the EPL 3607 Environmental Monitoring Report published on the Springvale website. Annual discharge volumes are outlined in Table 53. Discharged volume was within EPL 3607 limits during the reporting period.

Table 53: Water Volume

Licensed Discharge Point	Annual Total (kilolitres)
LDP006 (formally LDP001)	267507.93
LDP007 (formally LDP009)	No discharge
LDP008 (formally LDP010)	No discharge

6.17. Water Balance

During the reporting period both the Water Management Plan and Upper Coxs River Management Plan were reviewed and revised to reflect the cessation of discharge at LDP007 (formally LDP009) in 2019.

Additionally, there is a compliance commitment stated in Appendix 3: Statement of commitments of SSD 5594, which involves the update of the groundwater model every 6-months and to provide a summary of changes to the model in the Annual Review. During the reporting period the hydrogeo model was redeveloped with groundwater predications

The latest observations in groundwater elevations and mine dewatering rates have been integrated into the existing calibration dataset and have been used to validate the model performance. The comparison of new observations with modelled groundwater elevations at the selected swamps in the vicinity of Springvale Mine is consistent. In addition, it is demonstrated that the model remains reasonably consistent in its prediction of the mine dewatering rate.

6.18. Groundwater Monitoring

6.18.1. Groundwater Monitoring Strategy

As part of the environmental management plans for Springvale Colliery, an intensive monitoring programme has been implemented on the Newnes Plateau to detect any impacts from underground mining on the groundwater regime, and in particular the Newnes Plateau Shrub Swamps (NPSS). The greater monitoring programme incorporates NPSS and groundwater monitoring locations above both Springvale Colliery and the adjacent Angus Place Colliery. The monitoring locations within the Springvale mining lease boundary include the following main aspects:

- Groundwater levels are monitored in 12 swamps, with a total of 37 swamp piezometers. Additional monitoring is also undertake within two swamps off-lease (Best and Firetail Swamps), with four swamp piezometers across these two swamps.
- The groundwater levels in the aquifer systems of the Burralow Formation and Banks Wall Sandstone are measured in 18 piezometers that have been installed on the ridges between the swamps.
- Shallow groundwater levels adjacent to swamps are measured in 10 piezometers which have been at the downgradient end of all impact and reference swamps.
- Hydrogeological conditions in the shallow and deep groundwater systems above the working seam are monitored by 16 Vibrating Wire Piezometer installations (VWP).
- Deep groundwater levels are monitored at three stygofauna piezometers.
- Groundwater quality data is collected, when available, from 10 swamp piezometers across 5 swamps.
- Surface water flows in swamps are measured at Junction Swamp (v-notch weir), Sunnyside Swamp (pool depth) and Carne West Swamp (pool depth).
- Surface water quality data is collected, when available, at 10 surface water sites.
- Soil moisture levels are monitored at various depths at 28 sites across 12 swamps.
- Rainfall data is collected at the Newnes Plateau Prison Farm rain gauge and at the Bureau of Meteorology rain gauge at Maddox Lane, Lithgow (BoM Station No. 063132).

Data are recorded at various frequencies as follows:

- At swamp and aquifer piezometers data is recorded daily.
- Surface water level data in pools and weirs is recorded daily.
- VWP data is recorded daily or twice daily.
- Manual measurements at swamp perched and ridge piezometers are undertaken monthly.
- Barometric data is recorded daily for correction of swamp, perched and ridge piezometer water levels.
- Swamp flow rate and water quality data are recorded fortnightly.
- Soil moisture data is recorded daily.

6.18.2. Swamp Water Level Monitoring

The following section summarises the key observations at swamp piezometers during the monitoring period.

Sunnyside West Swamp

There is one piezometer installed in Sunnyside West Swamp, the details of which are shown in Table 54.

Table 54: Sunnyside West Swamp Piezometer Information

Piezometer	Mined Status	Monitoring Commencement
SW1	LW413B and LW414	26/07/2007

SW1 experienced heavy rainfall events in the beginning of the year and water levels increased as result. Water levels receded below the monitoring well in the latter half of the year, coinciding with a decline in the CRD curve. SW1 experienced heavy rainfall events in the beginning of the year in February 2020 that recharged swamp water levels. Through the remainder of the year SW1 has remained waterlogged with the peaks and troughs of the hydrograph corresponding to movements of the CRD.

No mining related impact is visible for the reporting period.

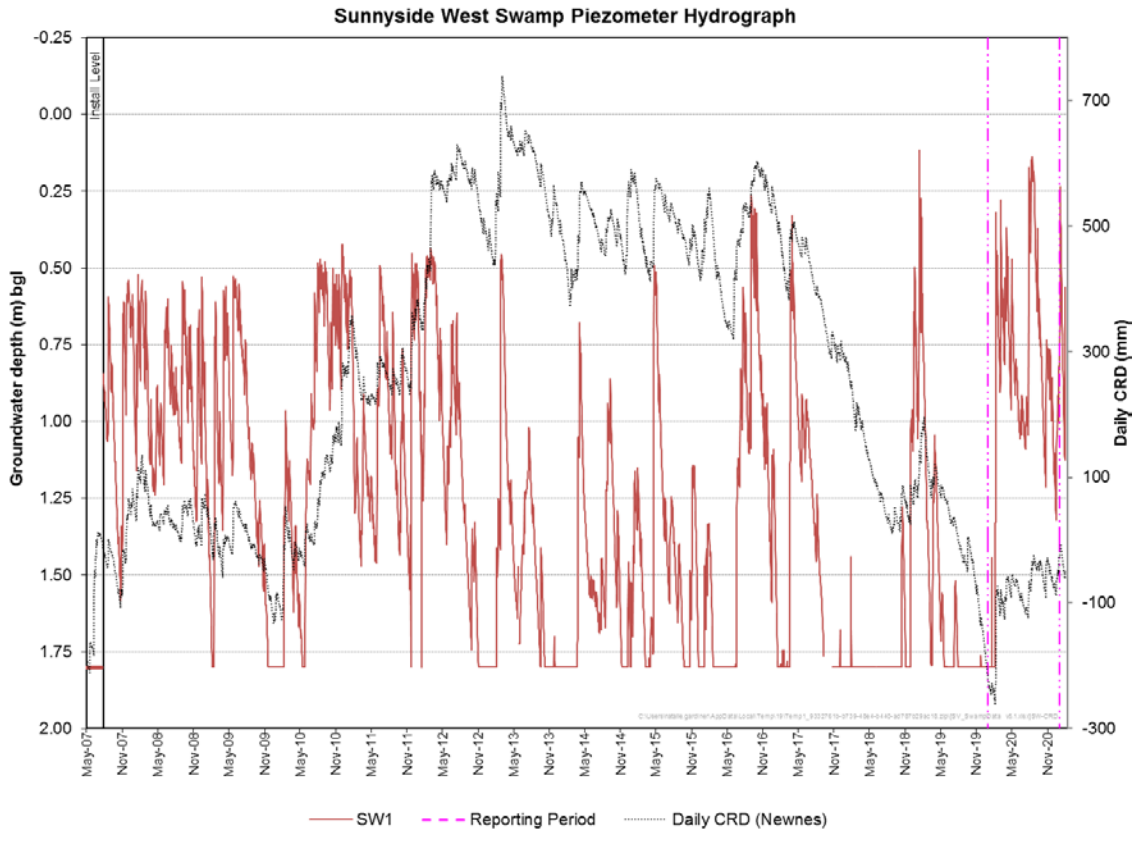


Figure 17: Sunnyside West Swamp Hydrograph

Sunnyside Swamp

There are five piezometers installed in Sunnyside Swamp, the details of which are shown in Table 55. Sunnyside Swamp has not been directly undermined as LW413 and LW414 were stepped around the swamp.

Table 55: Sunnyside Swamp Piezometer Information

Piezometer	Mined Status	Monitoring Commencement
SS1	Not Undermined	12/05/2005
SS2	Not Undermined	12/05/2005
SS3	Not Undermined	12/03/2010
SS4	Not Undermined	12/03/2010
SS5	Not Undermined	12/03/2010

Towards the end of the drought in late 2019, water levels at SS1 SS2 and SS3 were dry, and SS4 and SS5 were in decline. Following the rains in February 2020, all piezometers recorded an increase in water levels. SS1 and SS2 remained water logged for the remainder of the year with fluctuations corresponding the CRD. SS3 water levels receded after the February rainfall event and displayed large peaks with water levels often dropping to close to the base of the piezometer. SS4 and SS5 located near the lower end of the swamp remained generally stable after the large rainfall event in February 2020.

No mining related impact is visible for the reporting period.

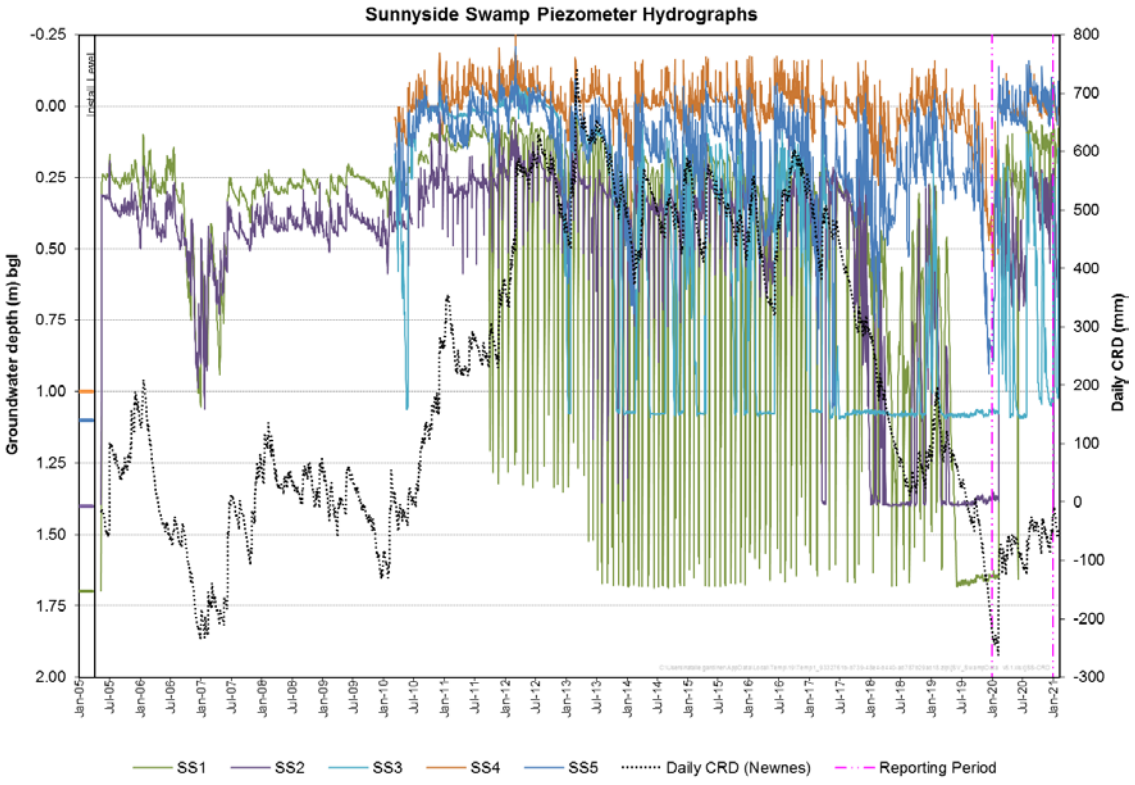


Figure 18: Sunnyside Swamp Hydrograph

Sunnyside East Swamp

Three piezometers are installed into Sunnyside East Swamp as shown in Table 56.

Table 56: Sunnyside East Swamp Piezometer Information

Piezometer	Mined Status	Monitoring Commencement
SSE1	LW417	12/03/2010
SSE2	LW417	12/03/2010
SSE3	LW418	12/03/2010

Site SSE1 was damaged in the Gospers Mountain bushfire in 2020 and the site was decommissioned in February 2020. Water levels at SSE2 and SSE3 generally remained below the base of the piezometer in 2020. A brief increase in water level was recorded in February 2020 at SSE3 associated with the heavy rainfalls. The small fluctuations in water levels are from trapped water in the cap at the end of the borehole and atmospheric fluctuation.

Figure 19 displays the Sunnyside East Swamp hydrograph.

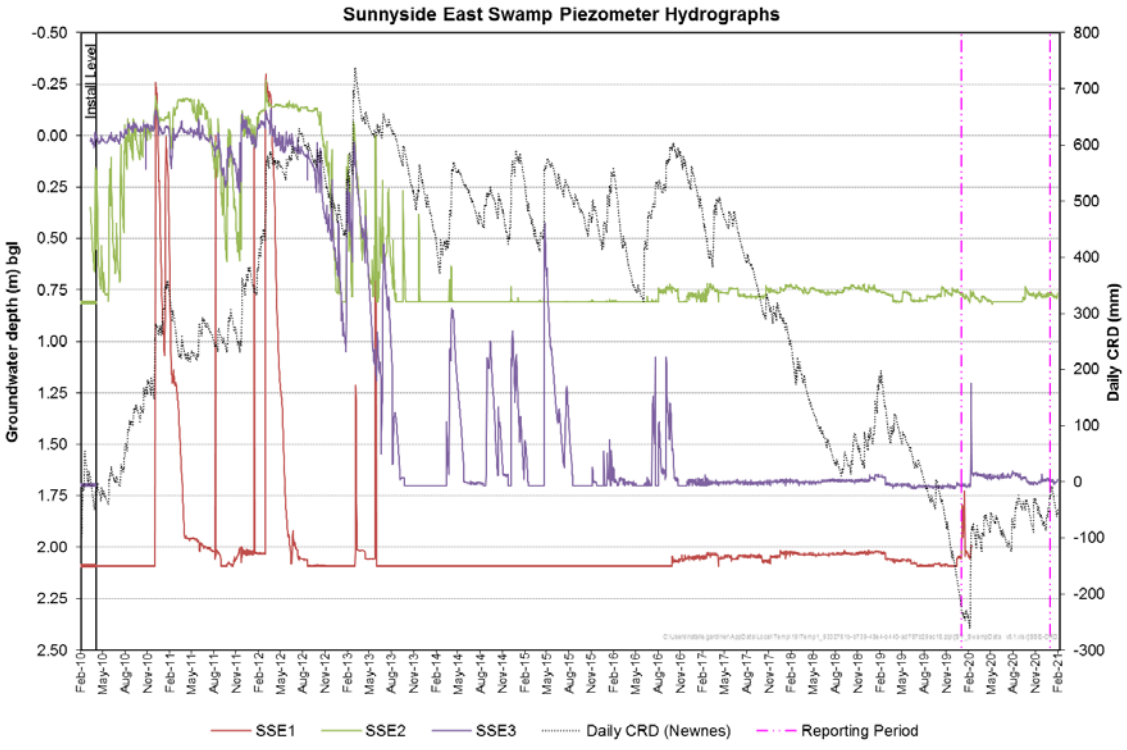


Figure 19: Sunnyside East Swamp Hydrograph

Short term groundwater levels triggers have been reported at this swamp outside the reporting period.

Carne West Swamp

There were previously four piezometers installed into Carne West Swamp as shown in Table 57.

Table 57: Carne West Piezometer Information

Piezometer	Mined status	Monitoring Commencement
CW1	Undermined LW419	12/05/2005
CW2	Undermined LW419	12/05/2005
CW3	Adjacent LW417	14/10/2011
CW4	Adjacent LW417	14/10/2011

Piezometers at CW1 and CW2 were damaged by the Gospers Mountain bushfires in early 2020 and were subsequently reinstated. Water levels at CW1, CW2, CW3 and CW4 primarily remained below the base of the piezometer during the reporting period. A temporary water level increase was recorded at CW2 in February 2020.

Figure 20 displays the Carne West Swamp hydrograph.

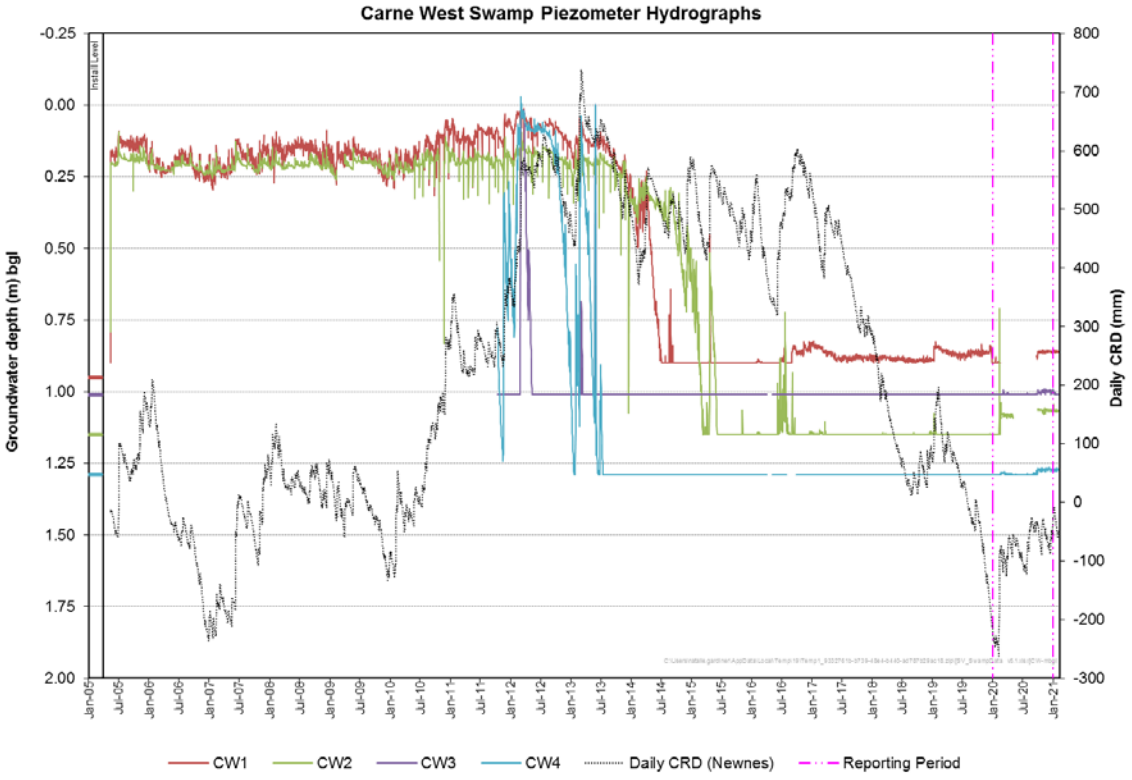


Figure 20: Carne West Swamp Hydrograph

Short term groundwater level triggers have been reported at this swamp outside the reporting period.

Junction Swamp

There are three piezometers installed at Junction Swamp as shown in Table 58.

Table 58: Junction Swamp Piezometer Information

Piezometer	Mined status	Monitoring Commencement
JS1	Undermined LW408	10/05/2002
JS2	Undermined LW408	10/05/2002
JS3	Undermined LW408	10/05/2002

JS1 to JS3 are installed into the weathered bedrock (Burralow Formation) up gradient of Junction Swamp.

In 2020, large increases in water levels were recorded in February and in July/August during a period of above average rainfall. The temporary peak in water level at JS1 in February was most likely due to infiltration of surface water as the top of the bore is at ground level and is not an actual groundwater response.

Figure 21 displays the Junction Swamp hydrograph.

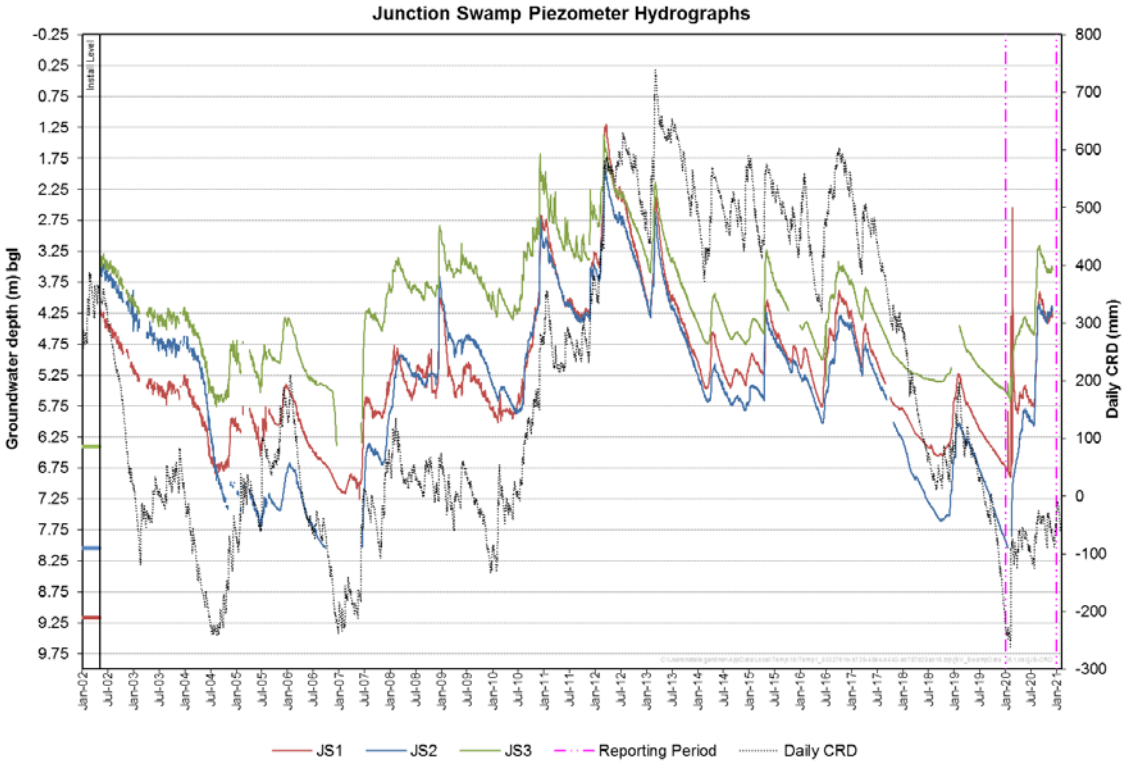


Figure 21: Junction Swamp Hydrograph

Carne Central Swamp

There is one piezometer installed in Carne Central Swamp as shown in Table 59.

Table 59: Carne Central Swamp Piezometer Information

Piezometer	Mined status	Monitoring Commencement
CC1	Not Undermined	14/10/2011
CC2	Not undermined	19/04/2018

In 2020, with the above average rainfall conditions since February 2020, waterlogged conditions were once again observed at the swamp. However, the declining trend suggest that the above average rainfalls have not recharged groundwater sufficiently for the return to pre-drought conditions. The two peaks in water levels in February and august are linked to the period of sustained above average rainfalls.

Figure 22 displays the Central Carne Swamp hydrograph.

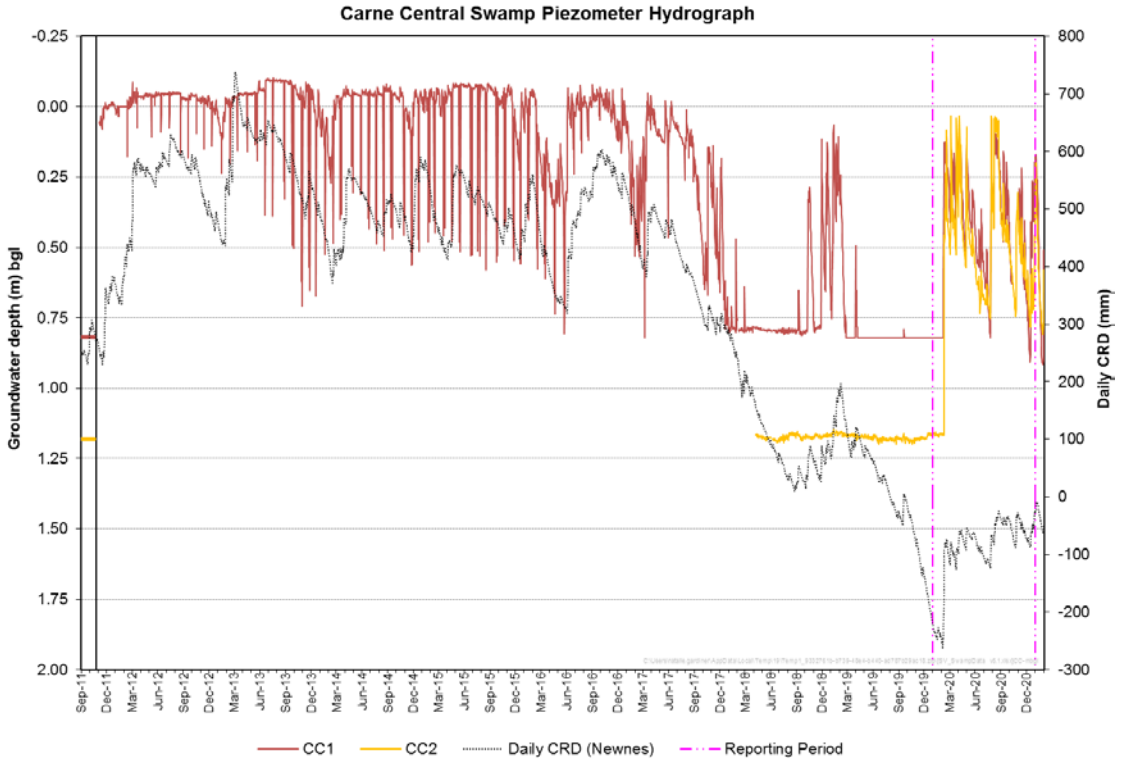


Figure 22: Carne Central Swamp Hydrograph

Gang Gang West Swamp

There are six piezometers in Gang Gang West Swamp, as shown on Table 60. Two of these (GW1 and GW2) were in place before the 2016 monitoring period and an additional four piezometers (SPR1602, SPR 1603, GW3 and GW4) were installed in August and October 2016.

Table 60: Gang Gang West Piezometer Information

Piezometer	Mined status	Monitoring Commencement
GW1	LW420	14/10/2011
GW2	LW420	14/10/2011
GW3	Not undermined	01/10/2016
GW4	LW420	01/10/2016

Piezometer GW2 was damaged in the Gospers Mountain bushfire of 2020 and was decommissioned. Gang Gang West has been primarily dry since it was undermined. In February and August 2020, a rainfall response was observed at GW1, GW3 and GW4 with the most pronounced response recorded at GW4. Aside from these two periods, Gang Gang West was predominately dry.

Figure 23 displays the Gang Gang West Swamp hydrograph.

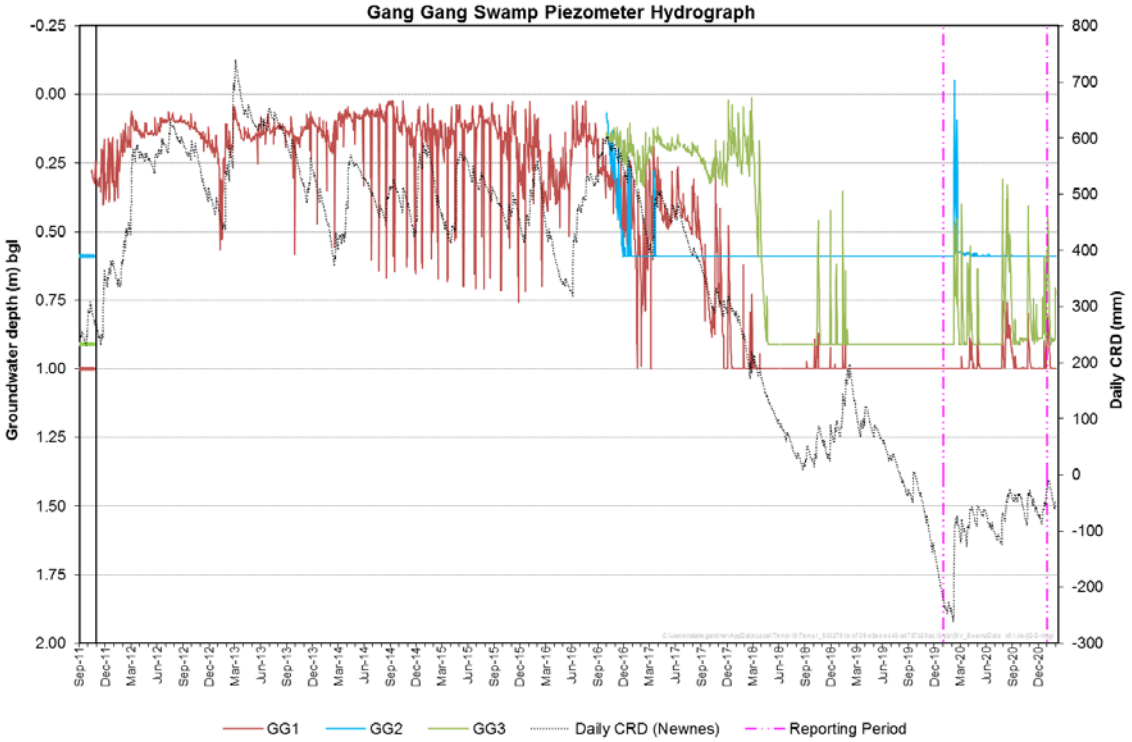


Figure 23: Gang Gang West Swamp Hydrograph

Short term groundwater level triggers have been reported at this swamp outside the reporting period.

Gang Gang Swamp

There are three piezometers installed in Gang Gang Swamp, as shown in Table 61.

Table 61: Gang Gang Swamp Piezometer Information

Piezometer	Mined status	Monitoring Commencement
GG1	LW420	14/10/2011
GG2	LW420	01/10/2016
GG3	LW420	01/10/2016

In 2020, Gang Gang Swamp remained mostly dry with some peaks in water levels during periods of above average rainfall. GG2 recorded a single peaked response in February 2020. GG3, located further downgradient, recorded multiple peaks and was slower to drain. GG1 displayed a similar response as GG3 but with lesser magnitude as it is located further upgradient.

Figure 24 displays the Gang Gang Swamp hydrograph.

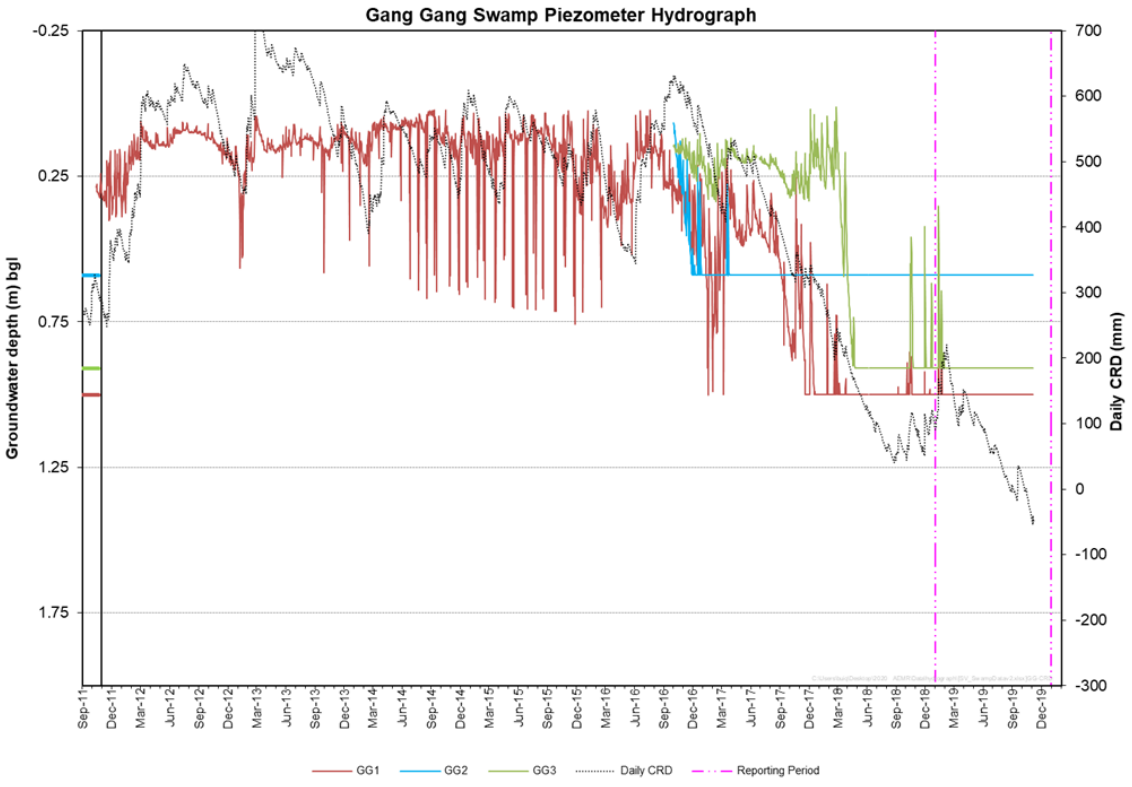


Figure 24: Gang Gang Swamp Hydrograph

Short term groundwater level triggers have been reported at this swamp outside the reporting period.

Pine and Nine Mile Swamp

There are five piezometers installed in Nile Mile Swamp (previously known as Bungleboori Swamp), as shown in Table 62.

Table 62: Nine Mile Swamp Piezometer Information

Piezometer	Mined status	Monitoring Commencement
BS1	Not undermined	14/10/2011
BS2	LW425	04/11/2011
BS2	LW425	04/11/2011
PSS (BS4)	LW425	13/07/2018
NMSS (BS5)	Not undermined	13/07/2018

Pine

In the beginning of 2020, all the swamp piezometers went dry. Following the above average rainfall in February, water levels in the downstream sections at BS3 and BS4 returned to pre-mining conditions and have since remained relatively stable in line with historical observations. However, in the upper reaches at BS2, the response to the rain was short-lived. This suggests an altered hydrology in the upper reaches with the primary contribution now from rainfall rather than groundwater.

Nine Mile

In the beginning of 2020, BS1 was dry and BS5 was at its lowest levels. Following the heavy rainfall in February 2020, water levels downstream at BS5 were recharged to historic levels and have remained relatively stable. In the upstream section at BS1, it appears the swamp has not recovered. The large increase and decline in water levels in February and August suggest a reduction of the stable groundwater flow contribution. Similarly to Pine swamp, it appears the hydrology in the upper reaches of the swamps have been altered.

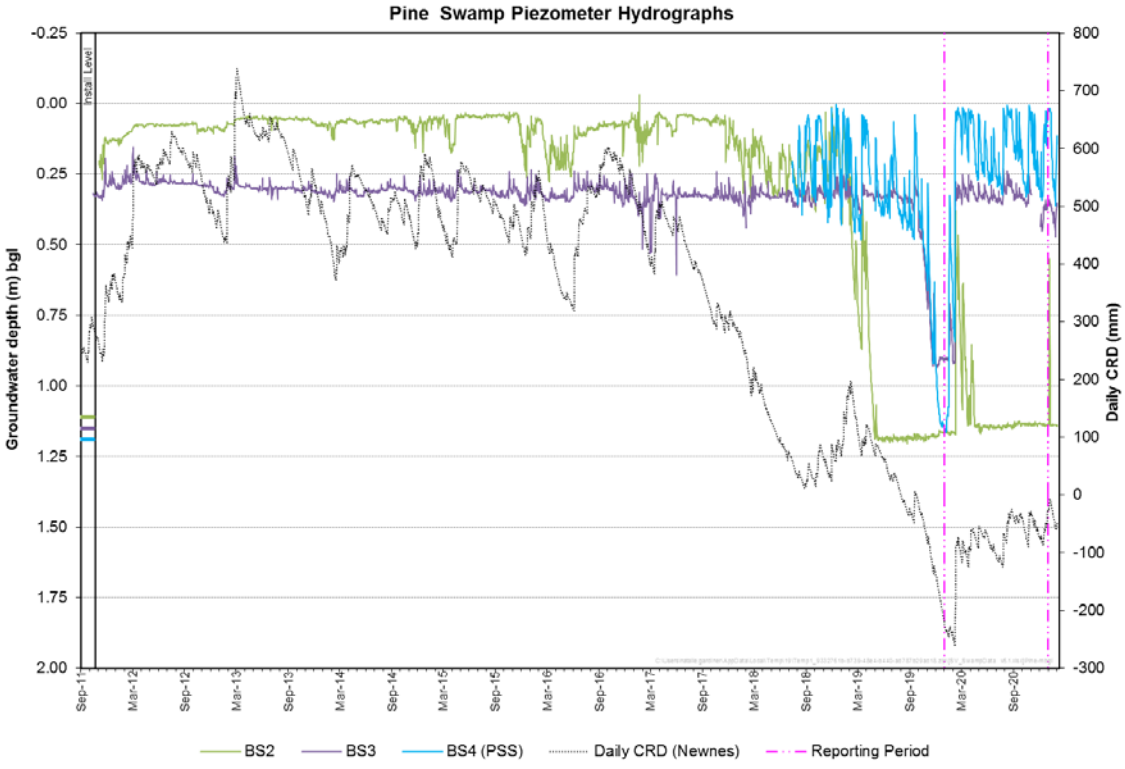


Figure 25: Pine Swamp Hydrograph

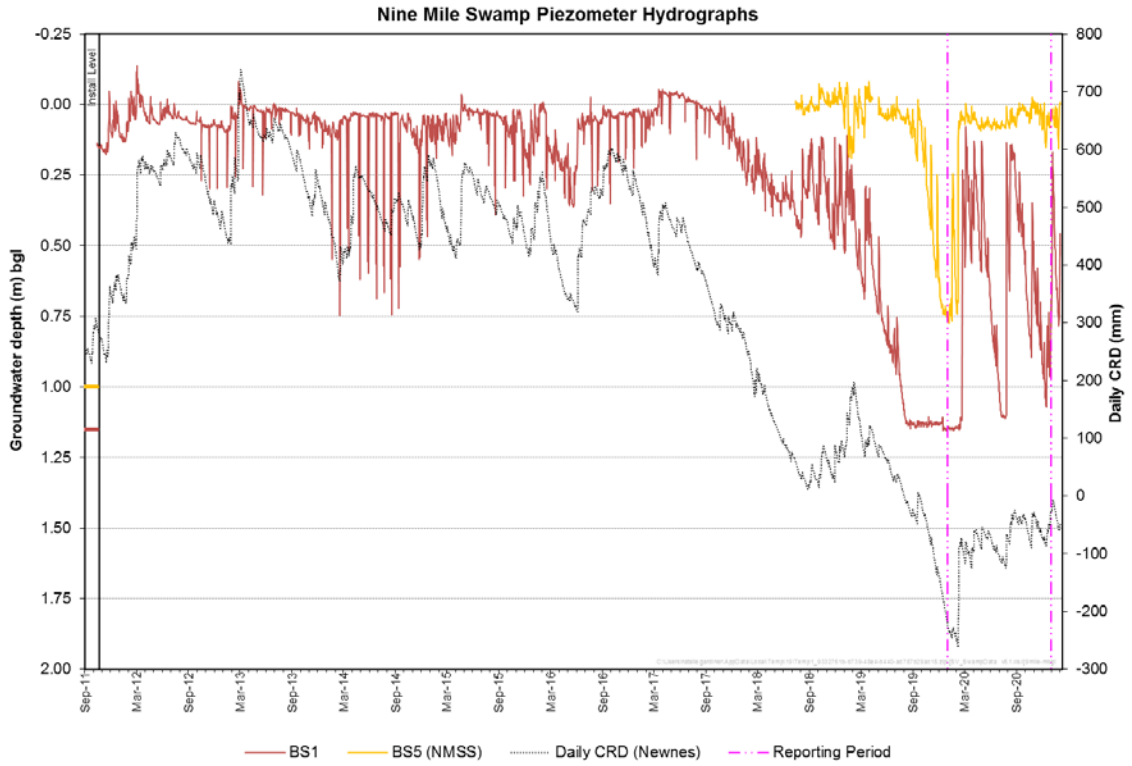


Figure 26: Pine and Nine Mile Swamp Hydrograph

Short term groundwater level triggers have been reported at these swamps in the reporting period. Further detail is presented in Section 6.19.

Marrangaroo Swamp

There are two piezometers installed in Marrangaroo Swamp, as shown in Table 63.

Table 63: Marrangaroo Swamp Piezometer Information

Piezometer	Mined status	Monitoring Commencement
MS1	Not undermined	04/11/2011
MS2	Not undermined	10/04/2018

In 2020, water levels at Marrangaroo Swamp were fluctuating with rainfall events corresponding to the CRD curve. There were two large increases in February and August associated with a period of above average rainfalls. Between February and August, water levels were observed to slowly decline in line with the CRD curve.

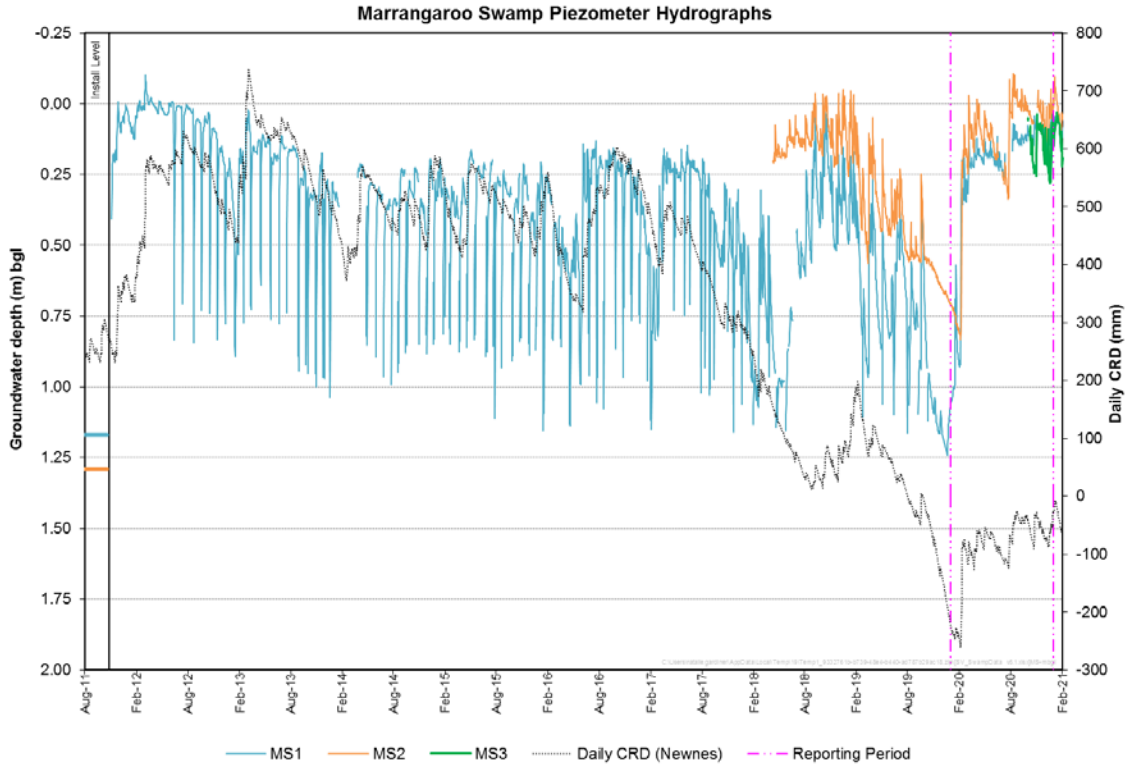


Figure 27: Marrangaroo Swamp Hydrograph

Barrier Swamp

There are three piezometers installed in Barrier Swamp, as shown in Table 64.

Table 64: Barrier Swamp Piezometer Information

Piezometer	Mined status	Monitoring Commencement
BA1	Not undermined	11/04/2018
BA2	Not undermined	09/04/2018
BA3	Not undermined	09/04/2018

In 2020, BA1, BA2 and BA3 showed stable water levels following an increase from the rainfalls in February 2020. The piezometers each responded to CRD in relative agreement, with downgradient piezometers BA2 and BA3 showing larger variation in water levels.

Figure 28 displays the Barrier Swamp Hydrograph.

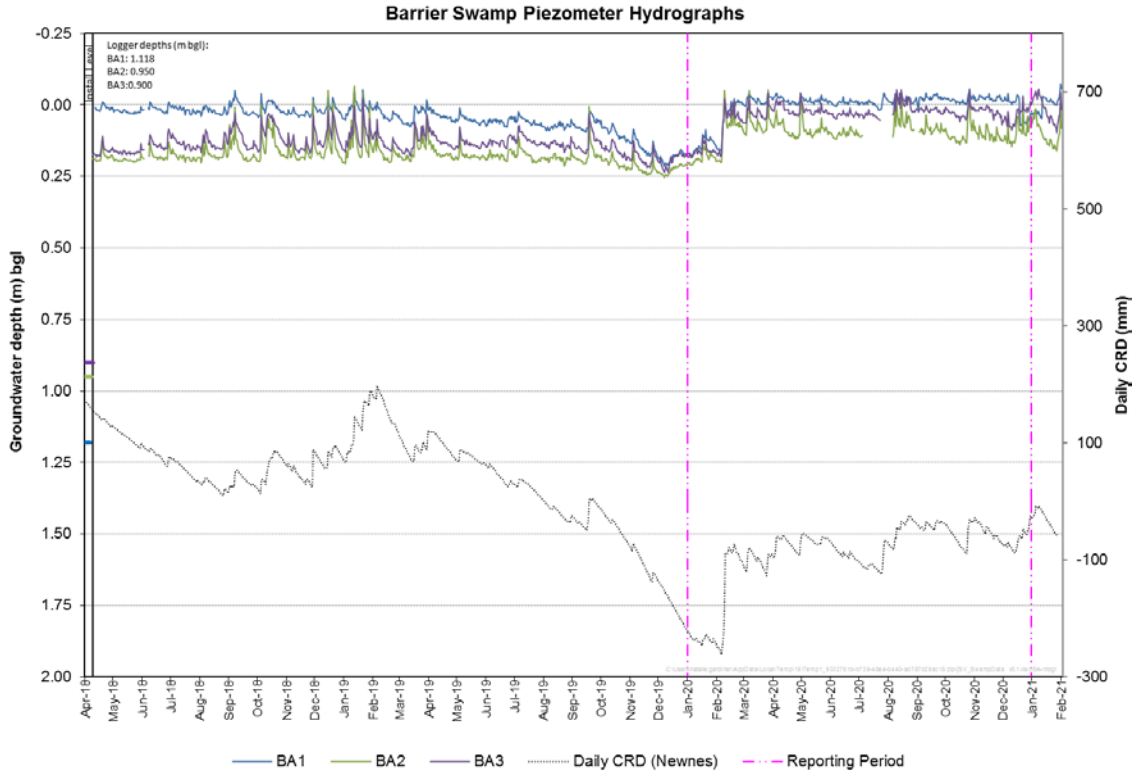


Figure 28: Barrier Swamp Hydrograph

Best Swamp

There are two piezometers installed in Best Swamp, as shown in Table 65.

Table 65: Best Swamp Piezometer Information

Piezometer	Mined status	Monitoring Commencement
BE1	Not undermined	12/04/2018
BE2	Not undermined	12/04/2018

The declining trend continued into 2020 until the rainfall in February 2020 recharged the swamp. The water level has remained relatively stable since. No mining related impacts are visible in the monitoring data.

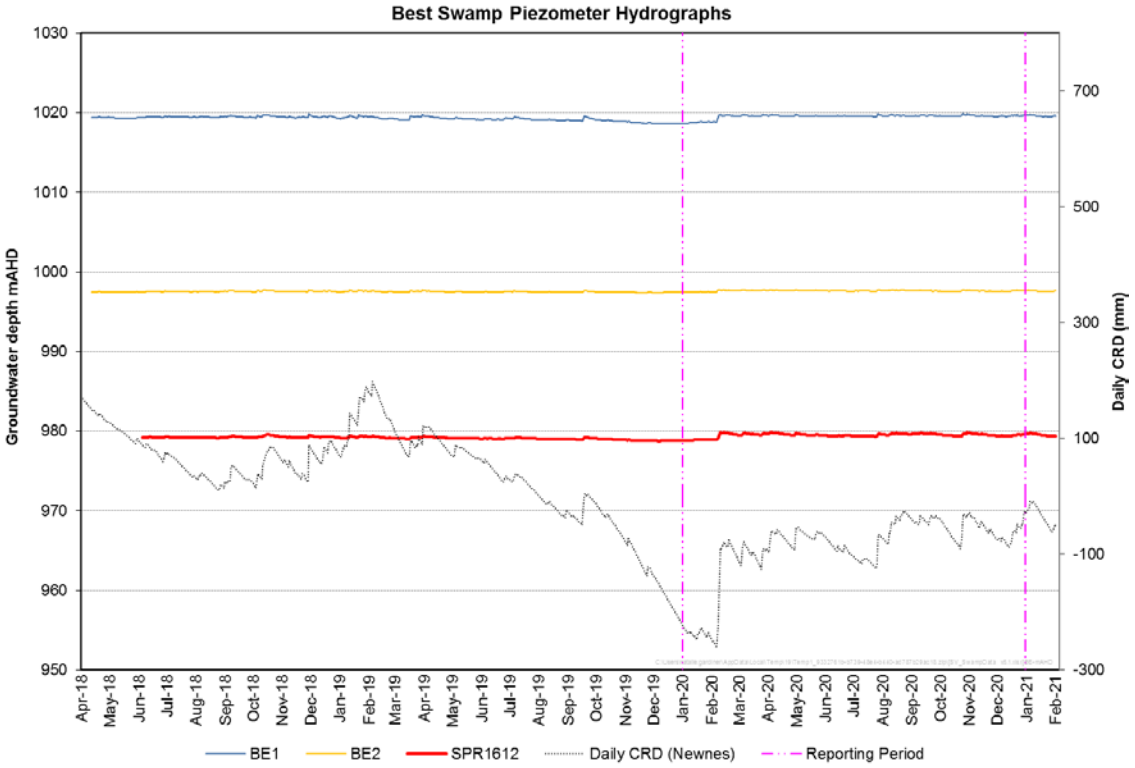


Figure 29: Best Swamp Hydrograph

Paddy's Creek Swamp

There are three piezometers installed in Paddy's Creek Swamp, as shown in Table 66.

Table 66: Paddy's Creek Swamp Piezometer Information

Piezometer	Mined status	Monitoring Commencement
PC1	LW425 (2019)	10/04/2018
PC2	LW425 (2019)	10/04/2018

In February 2020, the heavy rainfalls recharged swamp water levels where they have since remained stable.

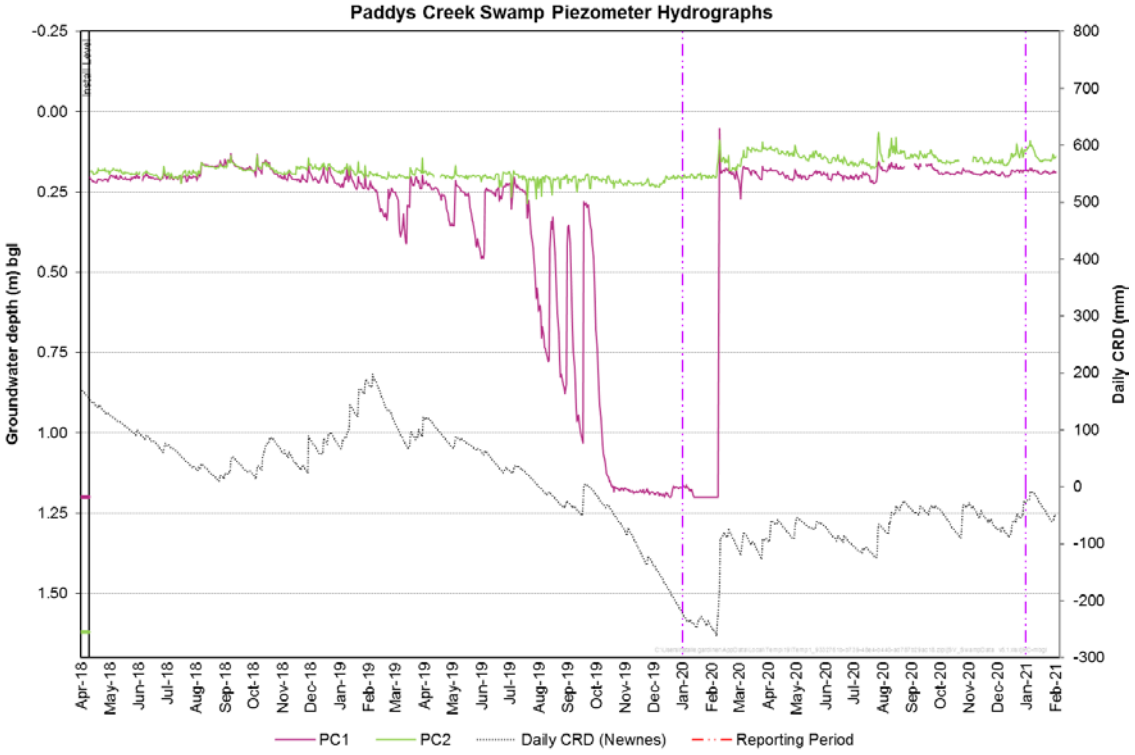


Figure 30: Paddy's Creek Swamp Hydrograph

Short term groundwater level triggers have been reported at this swamp in the reporting period. Further detail is presented in Section 6.19

Fire Tail Swamp

There are two piezometers installed in Firetail Swamp, as shown in Table 67.

Table 67: Firetail Swamp Piezometer Information

Piezometer	Mined status	Monitoring Commencement
FS1	Not undermined	12/04/2018
FS2	Not undermined	12/04/2018

In 2020, large increases in water levels were observed from January to February associated with the heavy rainfall following drought conditions. Following this the general water level trend has remained relatively stable with fluctuations corresponding to rainfall. Both monitoring wells display similar magnitude of responses to rainfall events.

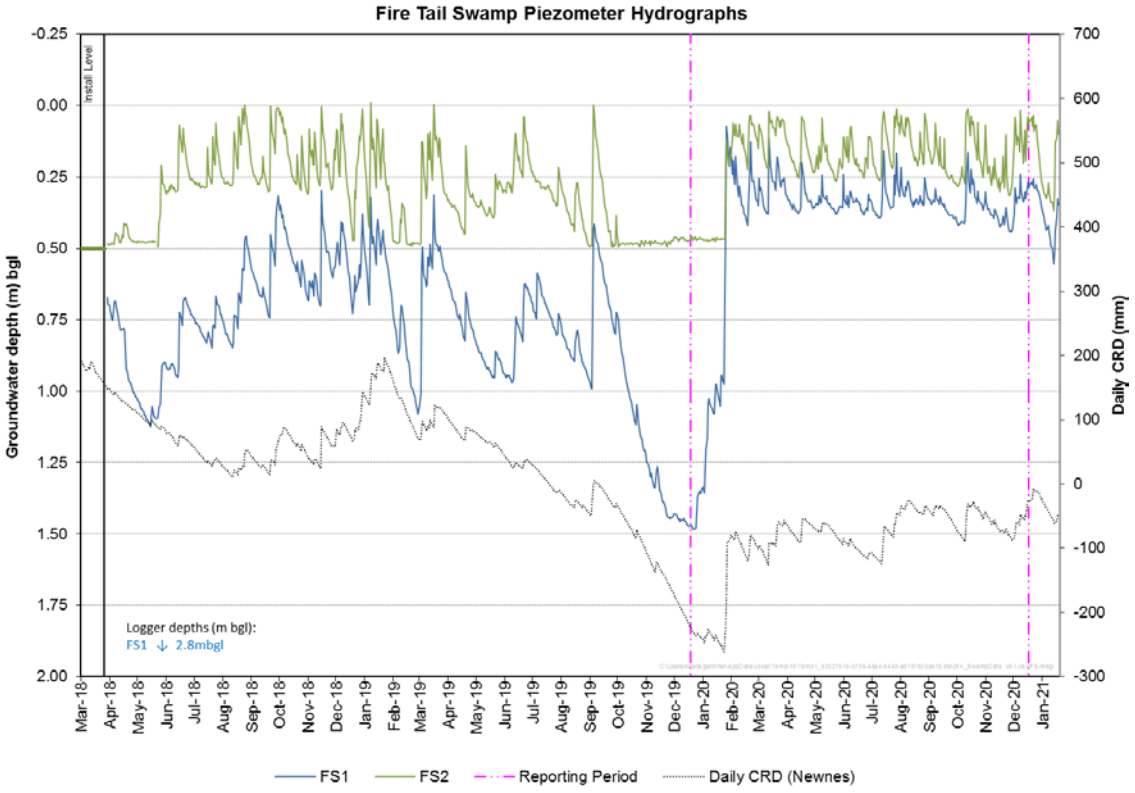


Figure 31: Fire Tail Swamp Hydrograph

Twin Gully Swamp

There are three piezometers installed in Twin Gully Swamp, as shown in Table 68.

Table 68: Twin Gully Swamp Piezometer Information

Piezometer	Mined status	Monitoring Commencement
TG1	Not undermined	14/04/2011
TG2	Not undermined	11/04/2018

In 2020, water levels continued to show a close correspondence with CRD and showed a large increase in February in response to the heavy rainfall following drought conditions, TG1, located further upgradient, displayed a more stable water compared to TG2.

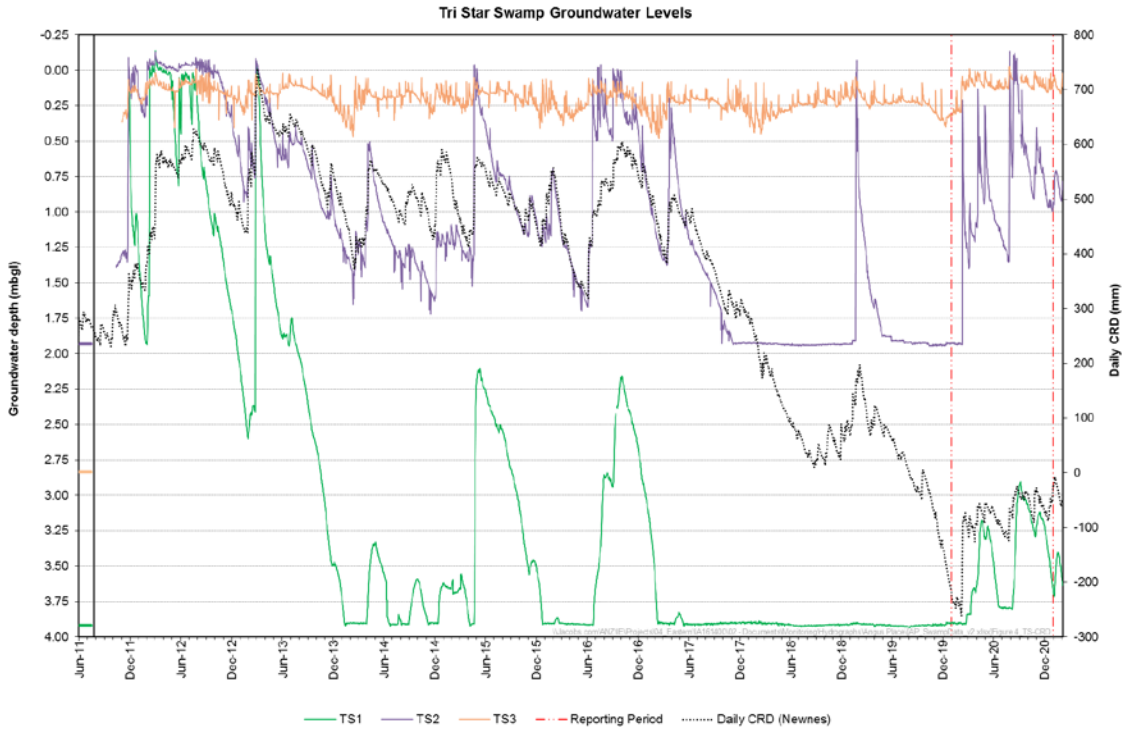


Figure 32: Twin Gully Swamp Hydrograph

Tristar Swamp

There are three piezometers installed in Tristar Swamp, as shown in Table 69.

Table 69: Tristar Swamp Piezometer Information

Piezometer	Mined status	Monitoring Commencement
TS1	Not undermined	14/10/2016
TS2	Not undermined	04/10/2016
TS3	Not undermined	01/11/2016

The swamp at TS1 is rainfall dependent with water levels only observed during periods of prolonged above average rainfalls. The swamp regularly becomes dry in periods of declining rainfall as observed in CRD curve in 2013 and from 2016 onwards. In 2020, the rainfalls in February and August filled the swamp before slowly draining.

The swamp at TS2 is strongly influenced by the prevailing rainfall conditions closely following the CRD curve. Compared to TS1, the swamp at TS2 retains water for a longer period. The water levels fell below the base of the borehole in mid-2017, but it is likely the water table was still present in the swamp profile. The borehole screened section did not reach the targeted depth at the base of the swamp due to caving during construction. Since the rains in February 2020, the swamp at TS2 has returned to waterlogged conditions.

The swamp at TS3 is waterlogged with evidence of a strong groundwater contribution. Water levels remained stable through the drought from 2016 and rainfall events do not significantly influence water levels compared to the other two branches. The above average rainfalls in February 2020 raised the average standing water level height where it has remained stable since.

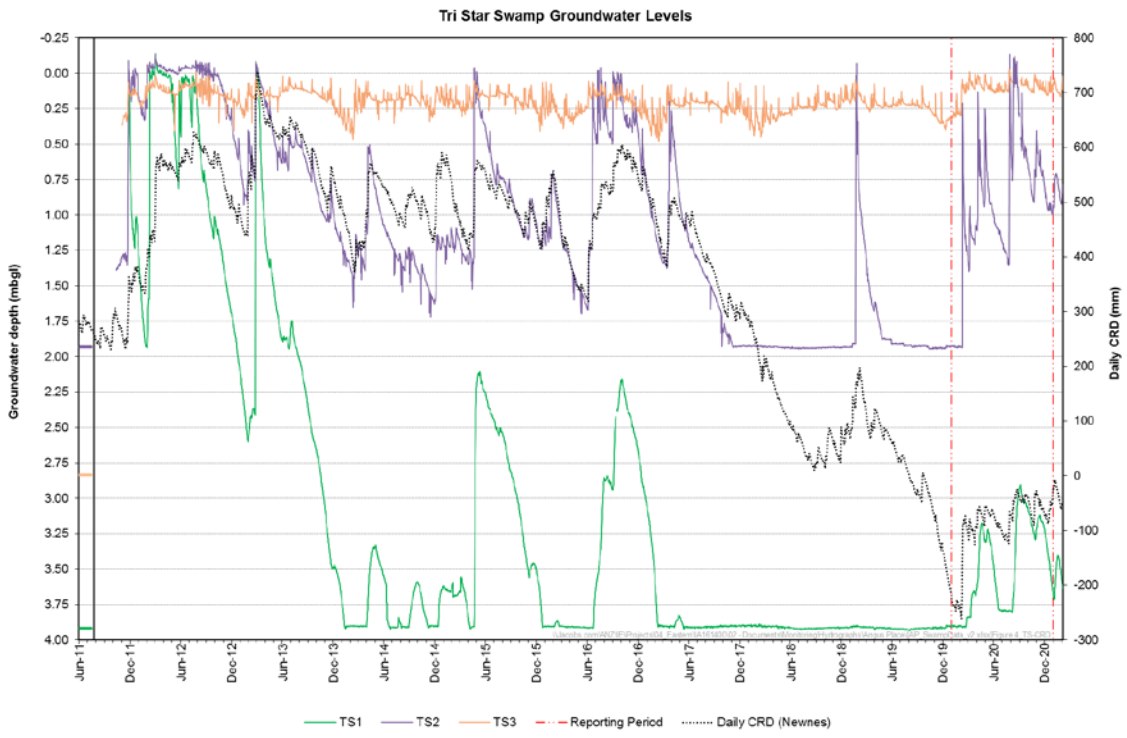


Figure 33: Tristar Swamp Hydrograph

Swamp Water Level Interpretation

Swamps that were previously undermined were predominately dry with some temporary responses to the above average rainfall particularly in February 2020. These swamps include Wolgan East, Sunnyside East, Carne West, Gang Gang and Gang Gang West

In the 2019 reporting period, Pine, Nine Mile and Paddys Creek Swamps recorded some abnormal declines that fell below the trigger threshold. After the rains in February 2020, Paddys Creek Swamp recharged and water levels returned to their historical levels and have remained stable. At Pine and Nine Mile swamp, water levels have recovered in the downstream sections.

In 2020, when LW427 was extracted Marrangaroo Swamp was with the 600m trigger investigation area. No mining related impacts were visible. The declines in the groundwater levels can be linked to the prevailing rainfall conditions.

6.18.3. Shallow Aquifer Piezometer Monitoring

Since 2018, an additional seven shallow aquifer piezometers were installed. Details of the shallow aquifer piezometers are shown in Table 70. The installation of the additional shallow aquifer piezometers was a condition of approval for the LW425-427 SMP, designed to target the aquifers in the weathered bedrock profile beneath the swamps to further understand the relationship between swamp water levels and the shallow aquifers underlying the swamps.

Table 70: Shallow Aquifer Piezometers

Bore ID	Monitoring Date	Associated Swamp
SPR1601	31/08/2016	Carne West
SPR1602	31/08/2016	Gang Gang West
SPR1603	31/08/2016	Gang Gang
SPR1604	06/06/2018	Carne Central
SPR1605	03/05/2018	Pine/Nine Mile
SPR1606	03/05/2018	Paddy’s Creek
SPR1607	06/06/2018	Marrangaroo
SPR1608	07/06/2018	Barrier
SPR1611	06/06/2018	Fire Tail
SPR1612	06/06/2018	Best

SPR1601, located near the downstream end of Carne West Swamp, approximately 230m north of LW420, showed water level responses closely linked to the CRD. The historic water level response appears abnormal due to the rapidly rising water levels following rainfalls in a manner that is significantly exaggerated compared to other shallow piezometers and it is possible rainwater is infiltrating this borehole from the surface through unnatural pathways. In 2020, following the rainfalls in February water levels have increased and have remained stable. In the reporting period, the overall water level increased approximately 5.9m.

SPR1602 and SPR1603, located near the confluence of Gang Gang and Gang Gang West swamps approximately 230m west of LW421, displayed water level increases resulting from the February 2020 rainfalls. It is noted that both the sites recorded a temporary peak and decline associated with the February rainfalls. The significant water level increase was delayed by one month when compared to the other shallow aquifer piezometers. In the reporting period, the overall water level increased approximately 4.0m and 5.8m at SPR1602 and SPR1603, respectively.

SPR1604 recorded a gradual increasing trend that is a subdued reflection of the CRD curve. The water level increase resulting from the February 2020 rainfall was delayed by approximately one month. In the reporting period, the overall water level increased approximately 1.8m.

A stepped water level increase was observed at SPR1605, SPR1606, SPR1607, SPR1611, and SPR1612 (0.6m, 1.5m, 1.4m,1.0m, 0.8m respectively over the reporting period). Following this increase, water levels have remained relatively stable with movements corresponding to the CRD curve.

SPR1608 recorded a water level above ground level with a stable increasing trend and no significant fluctuations. In the reporting period, the overall water level increased approximately 0.4m.

No mining related impact is visible for the reporting period.

Figure 34 displays the shallow aquifer piezometer hydrograph.

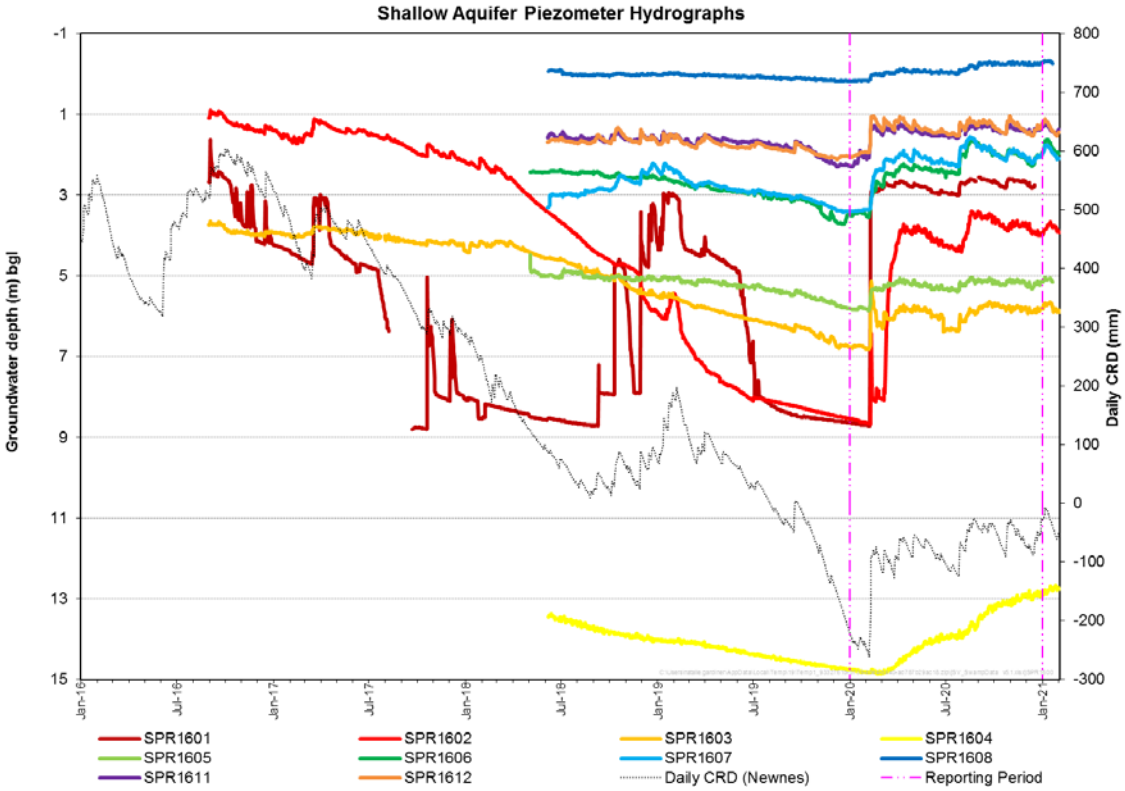


Figure 34: Shallow Aquifer Piezometer Hydrograph

6.18.4. Groundwater Monitoring

Standpipe Piezometers

Ridge piezometers have been established within the Springvale mining lease to monitor the groundwater level in the perched and shallow aquifers of the Burralow Formation and Banks Wall Sandstone at Springvale. One piezometer (AP5PR) located within the Angus Place mining lease has also been included as a reference point. The standpipe piezometers are equipped with water level pressure transducers (with the exception of Bore RSE) and data loggers.

The standpipe piezometers are equipped with water level pressure transducers (with the exception of Bore RSE) and data loggers

The standpipe piezometers are summarised in Table 71.

Table 71: Standpipe Piezometer Locations

Monitoring Point	Easting	Northing	Monitoring Date	Hole Depth	Comment/ Change of Reporting Period
AP5PR	236529	6308528	28/07/2010	94.00	Reference well Increased 0.52m
AP1105	238865	6305671	3/11/2011	37.21	Reference well Declined 0.55m
RSE	236840	6304191	20/12/2005	50.00	Dry since 4/10/2017
RSS	238072	6303500	01/12/2005	43.90	Slightly declining 0.94m
SPR1101	238484	6302635	14/11/2011	47.40	Dry since December 2013 Investigation found that casing sheared at 42 mbgl
SPR1104	239746	6303184	4/11/2011	47.00	Dry since July 2017
SPR1106	239980	6304227	15/12/2011	86.20	Declined 4.92m
SPR1107	239739	6301305	4/11/2011	55.60	Large fluctuations Increased 4.59m
SPR1108	241045	6303314	4/11/2011	76.10	Declined 1.04m
SPR1109	239186	6302160	14/12/2011	60.10	Increased 0.13m
SPR1110	238699	6302330	14/12/2011	65.80	Dry since November2014
SPR1111	240404	6303692	14/12/2011	60.90	Declined 1.02m
SPR1112	240852	6302995	15/12/2011	50.00	Declined 0.71m
SPR1113	240625	6302995	13/02/2012	60.60	Declined 0.72m
SPR1210	239677	6300052	31/05/2013	131.20	Declined 0.68m
SPR1211	239677	6300052	31/05/2013	133.80	Dry since 30/12/2019
SPR1301	239275	6299271	26/05/2014	86.70	Declined 0.40m
SPR1401	238453	6303547	21/11/2014	46.55	Replacement bore for SPR1101 Declined 0.53m
SPR1402	238163	6303489	6/01/2015	92.90	Vandalised No recorded data since 2/2/2016
SPR1403	239133	6303287	5/08/2015	51.10	Damaged in the Gospers Mountain fires
SPR1806	239628	6297962	6/12/2018	55.50	Declined 1.90m
SPR1807	239628	6299681	5/07/2019	72.85	Declined 1.96m
SPR1808	239495	6298643	3/07/2019	39.30	Declined 11.13m

Standpipe piezometer hydrographs are presented in Figure 34.

The trends of ridge piezometers close to the extraction area can be summarised as follows:

- SPR1211, directly over LW426. Site was impacted by LW425 in August 2018 and saw rapid water levels declines of approximately 8m in 2 months. The declining trend continued at a lesser rate of decline until November 2019 when it was impacted again by extraction at LW426. Water levels rapidly declined below the base of the logger, falling by 8m in a period of one month from 62mbgl to 70mbgl. When the site was manually dipped in February 2020, the water level was greater than 100mbgl and the below ground casing was observed to be damaged by subsidence. Water levels are not currently captured by the logger and there are no plans to redeploy the logger at a greater depth due to the risk of the logger getting stuck in the damaged casing.
- SPR1806 is above LW429 and approximately 650m west of LW427. Water levels have maintained a slowly declining trend since installation. No further mining impacts were apparent in 2020.
- SPR1807 is above LW428 and 200m west of LW427 and was installed in July 2019. Water levels have been close to the bottom of the standpipe since installation, less than 2m above the base and steadily declining. The water within the bore has been observed to be very muddy. A small stepped decline of less than 1m was observed in the month of May 2020 with the bore becoming dry. This coincides with when LW426 was closest to SPR1807. That said, it is difficult to determine if this is a legitimate mining response as the baseline period is short and it is uncertain if the water is remnant of the drilling fluid. In Mid-June 2020, water was observed in the bore again, an increase of 0.6m in one day. Then in August 2020, the water level dropped 0.5m and became dry. This increase and decrease is likely due to the interactions between rainfall and the mud at the base of the well causing inaccurate readings.
- SPR1808 was installed in July 2019 and is above LW428 and 300m west of LW427 . A small decline of approximately 1.5m was observed between late November and early December 2019, coinciding with when LW426 was closest to SPR1808. Following this period, the water levels showed a slow decline. In October to December 2020, SPR1808 recorded a large decline of approximately 10.2m over a period of 2 months coinciding with LW427 encroaching within the 600m TIA. The water level is currently showing signs of stabilising suggesting the cause may be due to bed separation or fracture dilation and not vertical drainage into the lower layers.
- SPR1108 is located next to the main shaft way, 400m south of LW420 and close the northern end of LW427. Abnormal groundwater levels were observed from March 2019 onwards. Water levels began to show a greater rate of decline, mirroring the movements of the CRD curve but with an approximately four month delay. Mining did not occur in close to SPR1108 when it began to show abnormal movements and there were no observable impacts when mining at LW420 occurred. Observations suggest the changes are likely to be a response to the climate. In September 2020. Water levels at SPR1108 began to increase most likely from the recharge event from the beginning of 2020.
- SPR1210 is above LW428 and 100m west of LW427. At the end of 2020, mining at LW427 was more than 2km away from SPR1210. In 2020, a continuation of stable water levels close to the bottom of the standpipe were observed.
- SPR1301 is located above LW429 and approximately 500m west of LW427. At the end of 2020, mining at LW427 was approximately 700m away from SPR1301. A continuation of stable water levels were observed with no mining impacts visible.

Ridge piezometers outside the extraction area that displayed notable trends during the reporting are:

- AP5PR and AP1105, both reference sites in the Angus place lease show stable water levels with minor movements.
- SPR1106, ~700m north of LW420 and over 4km away from the current longwall, observed a continuation of groundwater level decline that began back in 2012. Water levels decreased approximately 4.9m during the reporting period.
- SPR1107, overlying LW420, displayed abnormal fluctuations water level increases up to 5m and are sustained over 2-3 days. Manual measures over different months can show large variations around these fluctuation events. It is hypothesised this is a real response caused by rainwater infiltrating through unnatural pathways as the water level spikes align with rainfall data. SPR1107 is located above a fractured zone above LW420 that has been previously mined out. It is plausible the subsidence has damaged the integrity of the bore construction, or created unnatural pathways through the fracture ground increasing the amount of subsurface flows to the bore.
- SPR1403 was damaged by the Gospers Mountains bushfire and has been out of action for the reporting period.
- The remaining bores showed a continuation of previous trends.

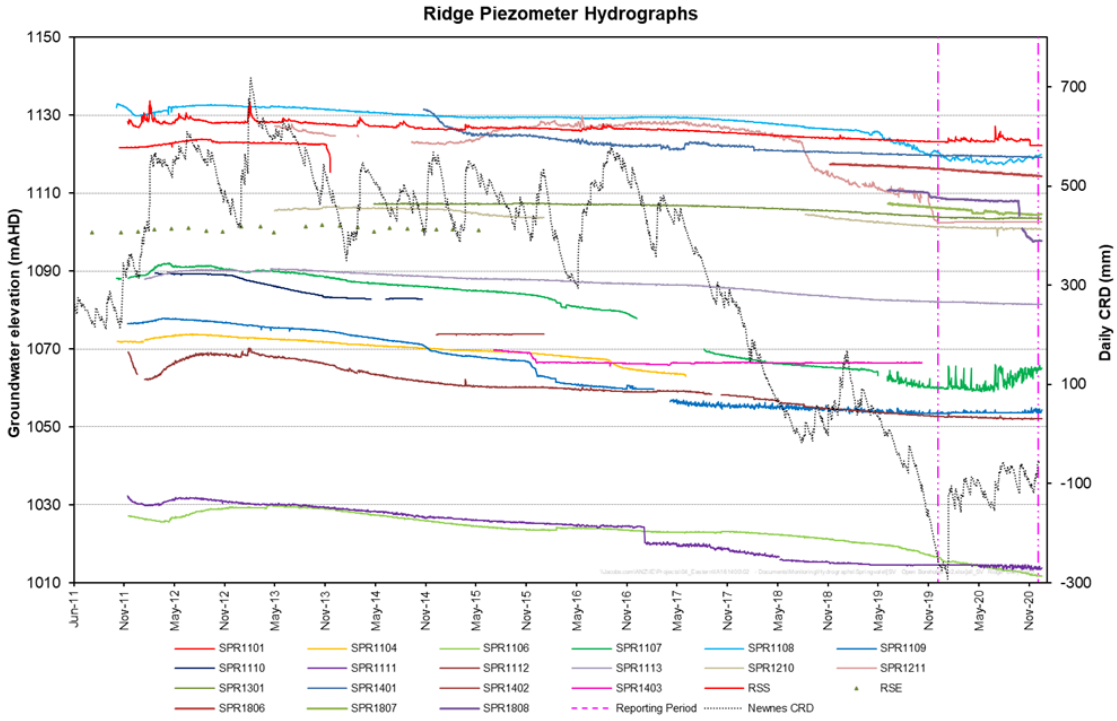


Figure 35: Ridge Piezometer Hydrograph

Short term groundwater level triggers have been reported at SPR1108, SPR1111, SPR1104, SPR1107, SPR1113, SPR1211, SPR38 and SPR1302.

Vibrating Wire Piezometers

Multi-level vibrating wire piezometers (VWPs) have been installed in boreholes across the mining lease area to monitor pore pressures in the shallow and deep aquifer systems. Most of the VWPs are located in the centre of the current workings at Springvale Colliery, in the area that is being currently mined, or will be mined in the future.

For the analysis and interpretation of groundwater levels in this report, only VWP monitoring points within the proximity of active longwalls during the reporting period have been analysed, as shown in Table 72.

Table 72: Vibrating Wire Piezometer Locations

Monitoring Point	Easting	Northing	Monitoring Frequency	Monitoring Commence Date	No. of Functioning Piezometers	VWP Setting Depth (mbgl)*
SPR37	239074	6300367	Twice Daily	13/02/2006	6 out of 8	110, 135, 165, 187, 260, 320, 350, 405
SPR38	240061	6298330	Twice Daily	29/12/2005	5 out of 8	80, 100, 135, 190, 230, 300, 355, 370
SPR1208	240949.5	6301650	Twice Daily	04/11/2012	8 out of 8	89.7, 129.7, 225.7, 303.2, 329.7, 379.7, 410.7, 420.7
SPR1210	239694.1	6300050.7	Daily	25/09/2012	7 out of 7	76, 160, 224.5, 308.6, 326.6, 376.8, 388.5
SPR1302DP	239700.3	6297795.5	Daily	13/12/2013	5 out of 5	200, 270, 310, 370, 390
SPR1804	240460.5	6299638	Daily	21/07/2018	3 out of 6	37.8, 69.5, 118.7, 218.2, 291.2, 345.3

SPR37

SPR37 is located approximately 700m west of LW427 and monitors the piezometric pressures across eight formations. Sensor#2 and #3 lost communications in 2011 and 2017 respectively. Sensor #1 and #6 show abnormal pressure spikes that is typical of a sensor nearing the end of its lifespan. The increased rate of decline at Sensor #1 and #4 in 2019 is inferred to be a depressurisation response to either LW425 or the LW426/427 development drives.

In 2020, another minor response was also observed at Sensor #1 and #4 towards the end of LW426. It is unclear if the response was due to mining at LW426 as the extraction stopped short before the one of the major lineaments was undermined. The remaining sensors show a continuation of stable to slightly declining trends

SPR38

SPR38 is located above LW427 side panel. The piezometric pressures are monitored in eight formations.

It was noted that sensors #6 to #8 are in hydraulic connection and displayed similar piezometric pressures. A large stepped decline was observed in sensors #6 to #8 in April 2019, which resulted

in the sensor #6 to become unsaturated. This coincides with development of the side panels for LW427 passing very close to SPR38. Sensor #5 appeared to be unsaturated since its installation.

In October 2020, when extraction at LW427 was approximately 50m from SPR38, a depressurisation response was observed across all sensors and communication to the lowest three sensors were lost. A preliminary trigger investigation was conducted and concluded depressurisation was most likely due to fracture dilations and bed separation caused by subsidence. At the end of the reporting period, the upper sensors from #1 to #4 are recording low pressure heads and it is unclear if they are still saturated. Sensor #1 is recording negative pore pressures with large fluctuations. It is likely the sensor is unsaturated and the fluctuations are due to rainfall infiltration.

SPR1210

SPR1210 is located above LW428 and is approximately 100 m west of LW427. Piezometric pressures were monitored at seven depths at SPR1210.

Communication has been lost with sensors due to software malfunction throughout the history of SPR1210. A large stepped decline was observed in Sensors #1 and #2 in January 2019, which coincides with LW425 approaching approximately 750 m away. Sensors #3 and #4 show a drop of smaller magnitude during the same time.

In July 2020, depressurisation was observed in the lowest two Sensors #1 and #2. The timing coincided with when LW426 was at a distance approximately 400m directly east of SPR1210. The Sensors #3 to #6 show a minor decline in pressure heads that align with the change in Sensors #1 and #2. This is likely associated with strata dilation, rather than vertical cracking. The upper most sensor (#7) does not appear to have been impacted by the depressurisation event.

SPR1302

SPR1302 is located approximately 300m south west of LW427. Piezometric pressures are monitored at five depths.

The SPR1302 hydrograph has historically displayed stable trends. The deepest Sensors #1 and #2, displayed a sudden drop in piezometric pressure in April and July 2019. The depressurisation observed could be due to the development of headings in the surrounding area as LW425 was over 1.3km away from SPR1302.

In 2020, from April to August, the lowest Sensors #1 and #2 displayed some erratic movements. The cause is unclear as mining at LW426 was more than 2km from SPR1302. In October 2020, depressurisation of the top three sensors was observed when LW427 was at its closest to SPR1302 at a distance less than 300m away. A trigger investigation was conducted and found the depressurisation was stabilising that suggests a re-equilibration with subsided formations and not deep drainage.

6.18.5. Groundwater Quality Monitoring

Key parameters for the swamp groundwater quality program are pH, Electrical conductivity and Filtered iron. They are monitored at the following locations..

- Nine Mile Swamp – BS1 and BS5 (NMSS)
- Pine Swamp – BS2, BS3 and BS4 (PSS)
- Paddys Creek Swamp – PC1 and PC2
- Marrangaroo Swamp – MS1 and MS2
- Gang Gang East Swamp – GG1
- Carne West – CW1 and CW2
- Carne Central-CC1 and CC2
- Sunnyside East – SSE3

Time series data for reference location Twin Gully Swamp (TG1) is included for comparison purposes.

Pine and Nine Mile Swamp

A summary of the water quality statistics for Nine Mile Swamp is provided in Table 73.

Table 73: Pine and Nine Mile Swamp water quality statistics (Jan 2020 – Dec 2020)

Site	Analyte	Min	Median	Max
BS1	pH	4.8	5.1	5.2
	EC (uS/cm)	44	67	71
	Fe (mng/L)	0.05	0.095	0.7
BS2	pH	Dry	Dry	Dry
	EC (uS/cm)	Dry	Dry	Dry
	Fe (mng/L)	Dry	Dry	Dry
BS3	pH	3.5	4.7	5.3
	EC (uS/cm)	36	56	80
	Fe (mg/L)	0.05	0.18	2.17
NMSS	pH	2.9	5	5.3
	EC (uS/cm)	26	42	48
	Fe (mg/L)	0.12	1.065	2.76
PSS	pH	4.4	4.7	5.6
	EC (uS/cm)	39	51	66
	Fe (mg/L)	0.05	0.05	2.07

Paddys Creek

A summary of the water quality statistics for Paddys Creek Swamp is provided in the table below.

Table 74: Paddy Creek Swamp water quality statistics (Jan 2020 – Dec 2020)

Site	Analyte	Min	Median	Max
PC1	pH	4	4.35	5.4
	EC (uS/cm)	36	56.5	81
	Fe (mg/L)	0.05	0.105	0.41
PC2	pH	4.3	4.4	4.9
	EC (uS/cm)	33	41	52
	Fe (mg/L)	0.05	0.05	0.24

Marrangaroo Swamp

A summary of the water quality statistics for Marrangaroo Swamp is provided in the table below.

Table 75: Marrangaroo Swamp water quality statistics (Jan 2020 – Dec 2020)

Site	Analyte	Min	Median	Max
MS1	pH	4	5	5.2
	EC (uS/cm)	26	46	710
	Fe (mg/L)	0.05	0.2	1.66
MS2	pH	4.4	5	6
	EC (uS/cm)	32	49	91
	Fe (mg/L)	0.05	0.44	0.74

Gang Gang East Swamp

It was not possible to collect water samples at GG1 for analyses over the reporting period as the piezometer was either dry or the water level too low to sample.

Carne West Swamp

It was not possible to collect water samples at CW1 or CW2 for analysis over the reporting period as the piezometer was either dry or the water level too low to sample.

Carne Central Swamp

A summary of the water quality statistics for Carne Central Swamp is provided in the table below.

Table 76: Carne Central Swamp water quality statistics (Jan 2020 – Dec 2020)

Site	Analyte	Min	Median	Max
CC1	pH	Dry	Dry	Dry
	EC (uS/cm)	Dry	Dry	Dry
	Fe (mg/L)	Dry	Dry	Dry
CC2	pH	4.3	4.3	4.3
	EC (uS/cm)	92	92	92
	Fe (mg/L)	0.05	0.05	0.05

Sunnyside East Swamp

A summary of the water quality statistics for Sunnyside East Swamp is provided in the table below.

Table 77: Sunnyside East Swamp water quality statistics (Jan 2020 – Dec 2020)

Site	Analyte	Min	Median	Max
SSE1	pH	Dry	Dry	Dry
	EC (uS/cm)	Dry	Dry	Dry
	Fe (mg/L)	Dry	Dry	Dry
SSE2	pH	Dry	Dry	Dry
	EC (uS/cm)	Dry	Dry	Dry
	Fe (mg/L)	Dry	Dry	Dry
SSE3	pH	5	-	-
	EC (uS/cm)	22	-	-
	Fe (mg/L)	0.09	-	-

Twin Gully Swamp

A summary of the water quality statistics for Twin Gully Swamp is provided in Table 78.

Table 78: Twin Gully Swamp water quality statistics (Jan 2020 – Dec 2020)

Site	Analyte	Min	Median	Max
TG1	pH	3.8	5.56	5.6
	EC (uS/cm)	30	101.25	117
	Fe (mg/L)	0.1	3.179	4.03

6.18.6. Soil Moisture Monitoring

Soil moisture probes were installed to provide a means to continue monitoring swamp conditions if swamp water levels decline. An additional twenty-four soil moisture probes across various swamps were installed between July and October 2018. The soil moisture systems were damaged in the 2020 Gospers Mountain bushfire and were subsequently reinstated in September 2020.

A results summary is presented in Table 79.

Table 79: Soil moisture probe monitoring results summary

Soil Moisture ID	Comments
BA1SM	10 cm sensor out of the ground. 20cm sensor increasing with rainfall Other sensors displayed stable trends.
BA2SM	10 and 20 cm sensors slowly declining and fluctuating with rainfall All sensors displayed stable trends.
BA3SM	10 cm sensor responded to rainfall events. Other sensors displayed stable trends.
BE1SM	Sensors shallower than 50cm displayed fluctuations corresponding to rainfall Large fluctuations observed at the 40 and 50cm sensor which is close to the standing water level Other sensors displayed stable trends near saturation.
BE2SM	Sensors shallower than 60cm fluctuate with rainfall events. Large fluctuations observed at the 40 to 60cm sensor which is close to the standing water level
BS1SM	Shallower sensors up to 60cm displayed declining trends and responded to rainfall events Deeper sensors displayed a slowly increasing trend
BS2SM	All sensors displayed movements corresponding the prevailing rainfall conditions The most pronounced fluctuation was observed at the 10cm sensor.
BS3SM	All sensors recorded an increasing trend. 10 cm to 30 cm sensors responded strongly to rainfall events
CC1SM	10 to 40 cm sensor showed a strong response to rainfall events. The 50 to 80cm sensors were generally stable except for the temporary decline in October and December
CC2SM	Relatively stable trends at all sensors Large fluctuations at 50 and 60cm sensors corresponding to the swamp water level increases.
CW1SM	Relatively stable trends at all sensors. Large fluctuations at 40cm sensor
CW4SM	Relatively stable trends at most sensors. Large fluctuations at 10 and 20cm sensors
FT1SM	30 to 60 cm responded to rainfall events. Other sensors displayed stable trends to slightly increasing trends.
FT2SM	10 cm to 30 cm sensors fluctuated with rainfall events. 40cm sensors displayed an increasing trends.
GG2SM	10cm sensor fluctuated with rainfall. Remaining sensors are stable with moisture content decreasing closer to the surface

Soil Moisture ID	Comments
GG3SM	Large fluctuations were observed at the two deepest sensors at 110 and 120cm where water is observed Other sensors remained relatively stable with minor responses to rainfall events
GW1SM	Sensors at 40 cm fluctuated with rainfall. Sensor at 10cm and 20cm were above ground. Other sensors had a slowly declining trend and recorded minor increases with rainfall events.
GW3SM	Soil moisture is low around this site generally below 20%. Soil moisture fluctuated with rainfall events with the deeper sensors displaying more pronounced movements
MS1SM	10 cm sensors responded to the prevailing rainfall events. Other sensors displayed increasing trends.
MS2SM	30 cm sensors fluctuated with rainfall events. Other sensors displayed stable trends
MS3SM	10cm to 40cm sensors fluctuated with rainfall and water levels. Remaining sensors displayed stable water levels.
NMSS	40 to 60cm sensors fluctuated accordingly to the standing water level Remaining sensors show stable trends.
PC1SM	10 cm ,20 cm and 30cm sensors were above ground Remaining sensors were stable.
PC2SM	10 cm sensor displayed fluctuations corresponding to rainfall. Other sensors displayed stable trends with minor movements corresponding to rainfall events
PSSSM	Sensors 20cm to 50 cm fluctuate with rainfall events and water levels. Sensor at 10cm was above ground Remaining sensors show stable trends
TG1SM	10 cm and 40 cm sensors responded to rainfall events. Other sensors displayed stable trends.
TG2SM	10 cm and 20 cm sensors responded to rainfall events. Other sensors displayed stable trends. 10 cm probe fluctuated around and below field capacity. The remaining probes fluctuated between field capacity and saturation.
TS2SM	Overall stable trend at 10 to 30cm sensors with rainfall fluctuations Declining trend from 40 to 80cm sensors Slightly increasing trend from sensors 90cm to 120 cm.
TS3SM	10 cm and 20 cm sensors fluctuated with rainfall events. Other sensors displayed stable trends with the exception of the 70cm sensor. It is likely the 70cm sensor does not have good contact with the soil.

6.19. Surface Water and Groundwater Triggers

During the reporting period, two monitoring sites were triggered under relevant TARPs. As part of the response process, an Initial Notification is sent out to relevant regulators and a subsequent Trigger Investigative Report is completed and supplied to these same regulators. A trigger does not necessarily infer that an impact has occurred, but rather that further investigation is required. Springvale will continue to review the TARP actions in relation to these triggers, conducting further investigative work as required. Table 80 outlines further details regarding the triggers.

Table 80: Surface Water and Groundwater Trigger Details

Monitoring Site	Trigger Document	Notification / Investigative Reporting Dates	Trigger Report Findings
BS3, BS4 and BS5	Swamp Monitoring Program for longwall 424-427 EPBC 2013/6881 Condition 17	Initial Notification – 2/10/2019 Trigger Investigation Report- 5/03/2020	Notification of an exceedance at groundwater monitoring location BS3, BS4 (PSS) and BS5(NMSS) was received by Springvale from Jacobs on the 26 November 2019. Notification of the trigger was then provided to the Department of Environment and the Department of Planning and Environment on the 26 November 2019. An extension to the submission of the 8-week reported has been granted by DEE and DPIE due to the access constraints experienced as a result of the Gosper Fire which impacted the Springvale operation from December 2019. This was approved by both Departments to 6 March 2020. Pine Swamp piezometers BS3, BS4 and BS5 displayed accelerated water declines into the post mining period. Prior to the exceedance, water levels at the Pine Swamp piezometers were generally stable under permanently waterlogged conditions. The Gosper Mountain bushfire that burnt through the plateau in 2019/2020 will be a confounding factor in future assessments as it is likely that swamp hydrology and interaction with rainfall and runoff will have changed. Compounded with the recent rainfalls in January and February 2020 that increased water levels to pre-mining levels, the effects of mining influences, or absence of effects, will become more apparent with on-going monitoring.
BMWS	Biodiversity and Swamp Monitoring Program 419, 420-422 and 424-427 EPBC 2013/6881 Condition 13	Initial Notification and Report- 7/09/2020	Notification of a trigger was reported in Carne West, Gang-Gang East and Gang Gang West due to a decline in capture rates of the BMWS. The notification was provided on 7 September 2020. The 2019/2020 Annual report was provided to the Department on 7 September 2020 which includes natural impacts of such as bushfire.

Monitoring Site	Trigger Document	Notification / Investigative Reporting Dates	Trigger Report Findings
			Monitoring during the 2020-21 is required to confirm whether reduced captures in predicted impact swamps is a true trend, and not an artefact of the limited sampling effort (which was hampered by the fire). If this is the case, then reliable skink capture data, to be collected during 2020-21, will also allow for a more statistically rigorous test of environmental drivers that may explain lower capture rates in predicted impact swamps (such as surface rugosity or extent of peat remaining).
SPR38 and SPR1302	Water Management Plan 424-427 EPBC 2013/6881 Condition 3		Notification of a trigger at groundwater monitoring location SPR38 and SPR1302 was received by Springvale from Jacobs on 27 November 2020. Notification of the trigger was then provided to the Department of Environment and the Agriculture, Water and Energy on 27 November 2020. The Investigation Report will be submitted in 2021 which is within 8 weeks of notification of the trigger. Further details will therefore be included in the 2021 Annual Review

7. BIODIVERSITY MANAGEMENT

7.1. Coxs River Land Management Plan

The Catchment Improvement and Land Management Plan (CILMP) is intended to guide water quality and catchment improvement measures associated with the approval SSD 5594 Modification 2. Implementation of the CILMP aims assist compliance with the performance measures required under Schedule 4, Condition 12 of SSD 5594.

The CILMP project site comprises two broad management areas (Riparian Management Area and Land Management Area across three discrete component sites (that occur along the upper Coxs River. A 10 Year work schedule is currently being undertaken by a bush regeneration specialist. Sites are presented in Figure 36.

Table 81: Management Activities

	Management Works	Status	Year Complete
CILMP North	Fence Installation	Fencing for cattle exclusion from site completed.	2020
	Cattle crossing stabilisation and bank stabilisation and flows control	To be completed 2021	
	Environmental and noxious weed control	Ongoing. Post fire weed germination prolific. Seed production has been halted on priority weeds.	2020
	Revegetation: shrub/canopy mid-upper banks	Scheduled Autumn 2021	
	Revegetation: instream/bank stabilisation	Instream erosion control planned 2021.	
	Revegetation: Revegetation watering and maintenance	Commencing Autumn 2021	
	Mountain Hollow Grassy Fen re-wetting	Instream erosion control planned 2021.	
CILMP Central	Environmental and noxious weed control	Ongoing. Post fire weed germination prolific.	2020
	Revegetation: shrub/canopy mid-upper banks	To be completed	
	Revegetation: Revegetation Watering and Maintenance	Commencing Autumn 2021	
CILMP South	Fence Installation	Completed	
	Environmental and Noxious Weed Control	Ongoing. At maintenance stage. Seed production has been halted on priority weeds.	2020
	Bank Stabilisation and Flow Controls	To continue in 2021	
	Revegetation: shrub/canopy mid-upper banks	Planned Autumn 2021	
	Revegetation: In-stream/bank stabilisation	Planned Autumn 2021	
	Revegetation: Revegetation watering and maintenance	Commencing Autumn 2021	

Monitoring Activities

Site inspections including photo monitoring have been undertaken as required.

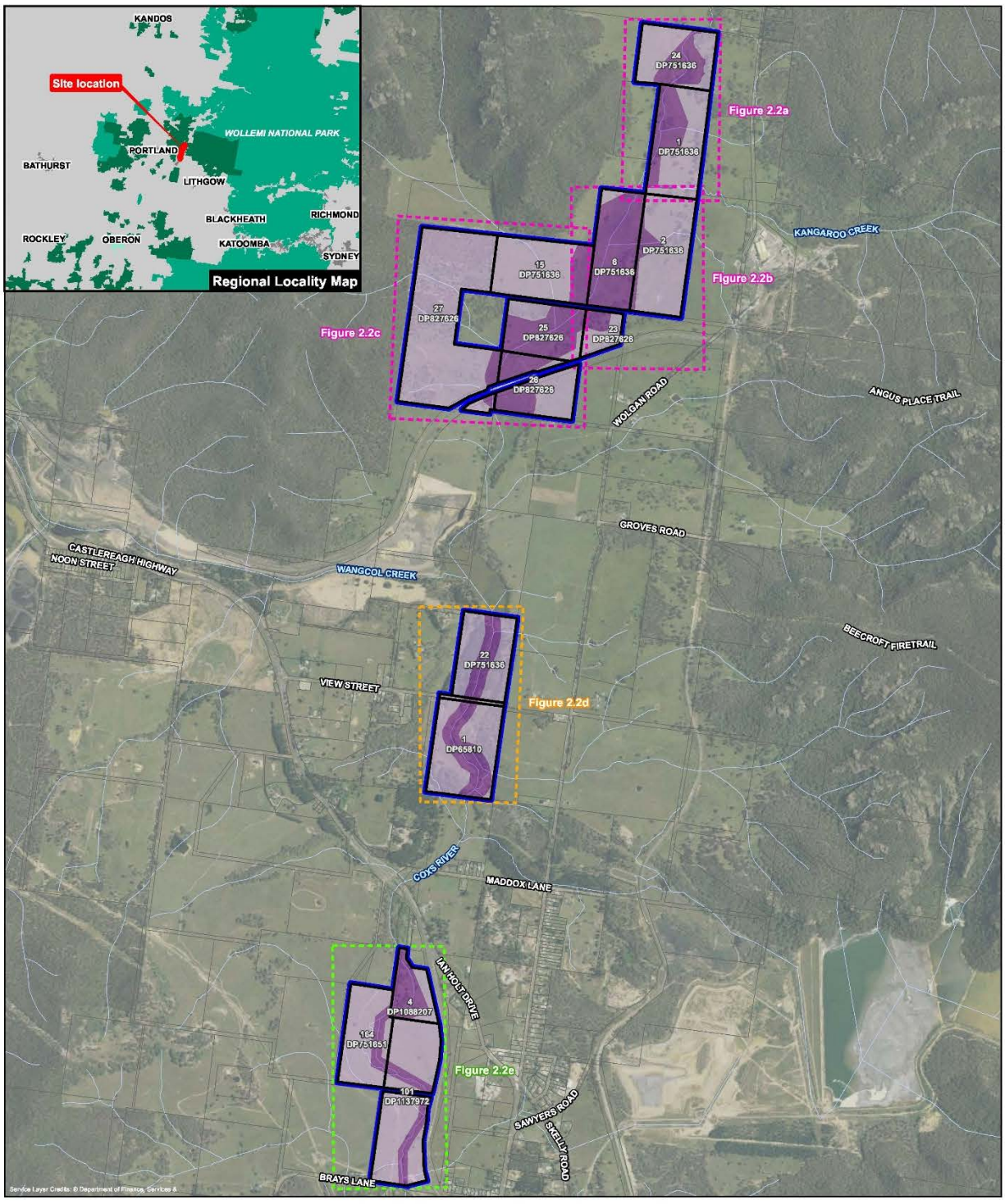


Figure 36: Coxs River Land Improvement Sites

7.2. Biodiversity Offset Strategy

The Western Region Biodiversity Offset Strategy (WRBOS) was approved by the NSW Department of Planning, Industry and Environment (DPIE) on 23 April 2019. The WRBOS satisfied conditions of consent for Angus Place Colliery, Clarence Colliery, Springvale Mine and Western Coal Services site. Figure 37 shows the Biodiversity Offsets for the Western Region.

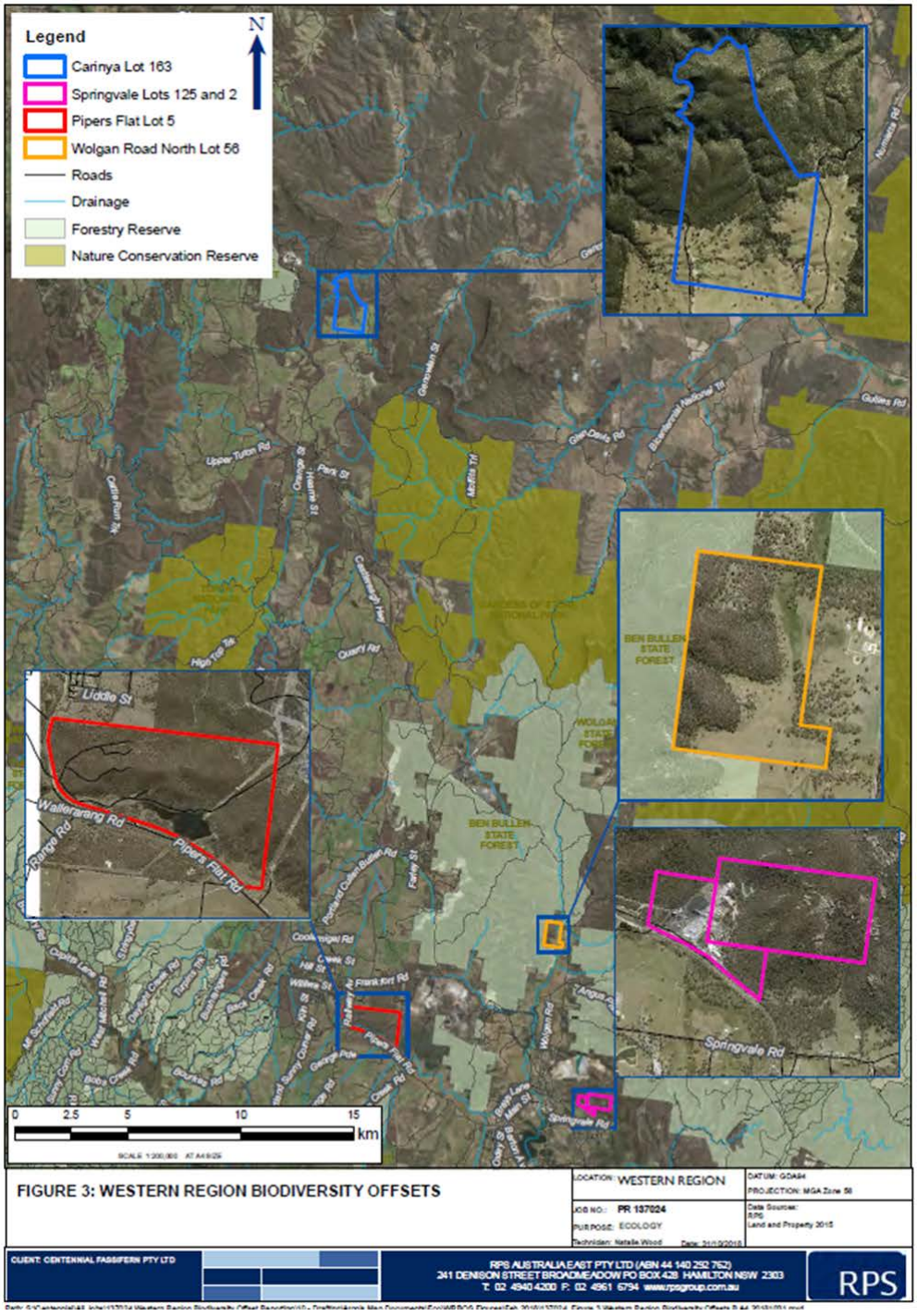


Figure 37: Western Region Biodiversity Offsets

The following table highlights the key management actions undertaken during the reporting period for Offset sites associated with Springvale.

Table 82: Management Activities

Management Action	Description of works	Applicable Site
Management of Grazing	During the reporting period the following actions have been taken to prevent stock grazing on the BSA site: -Southern fence completed between Coxs River Land Improvement area and the Wolgan Road North lot 56 Biobank site. -Fence was repaired on the northern boundary following Gosper bushfire fire damage.	Wolgan Road Lot 56
Weed control	Weed control activities were undertaken on all sites	Springvale Lot 125 Wolgan Road Lot 56 Piper flat Lot 5
Management of Fire	Bushfire Management Plans were developed for the 3 sites	Springvale Lot 125 Wolgan Road Lot 56 Piper flat Lot 5
Management of Human Disturbance	Signage (and gates where required) installed.	Springvale Lot 125 Wolgan Road Lot 56 Piper flat Lot 5
Vertebrate Pest management	A feral cat trapping program was conducted on site in November 2020.	Springvale Lot 125
	A rabbit and feral cat trapping program was carried out during November 2020.	Wolgan Road Lot 56
	A cat trapping program was completed in November 2020.	Piper flat Lot 5

During the reporting period Springvale completed an inspection of the three Biodiversity Offset sites associated with the Springvale project was undertaken with BCD on 16 December 2020. Annual Reports were supplied to BCD on 16 November 2020.

8. REHABILITATION

8.1. Rehabilitation in 2020

Springvale has adopted a progressive approach to rehabilitation which reduces and mitigates potential environmental impacts. Facilities no longer required (e.g. exploration sites, ventilation or dewatering facilities) are rehabilitated soon after decommissioning, to return disturbed land to the original landform. Rehabilitation performance is tracked with periodic inspections, rehabilitation monitoring and maintenance as necessary (e.g. based upon evidence of endemic regrowth, weeds and soil disturbance).

Due to the underground nature of mining operations at Springvale, surface disturbance and the need for progressive rehabilitation is relatively minor compared to that required at an open cut mining operation. Progressive rehabilitation at Springvale has mainly been associated with infrastructure corridors following the trenching of services. No major rehabilitation of the pit top and Newnes Plateau infrastructure is anticipated until site closure.

During the reporting period, minor disturbance activities were undertaken. As discussed in section 4.2 two exploration drill sites were prepared during the reporting period. The remaining SIS is likely to be completed in 2021. As the sites are required for the remaining hole no rehabilitation activities were completed during the reporting period. These activities are outlined in Table 83.

Table 83: Disturbance and Rehabilitation during the Reporting Period

Disturbance	Rehabilitation
1.7ha (SIS drilling)	-

The status of disturbance and rehabilitation for Springvale (SSD-5594) and the SWTP (SSD-7592) as at the end of 2020 is presented in Table 84 and Figure 38. It has been forecast that the 3 drill sites will be rehabilitated at the completion of the SIS drill program in 2021.

Table 84: Rehabilitation Status

Mine Area Type	Approval	Previous Reporting Period (Actual)	This Reporting Period (Actual)	Next Reporting Period (Forecast)
		Year 2019 (ha)*	Year 2020 (ha)	Year 2021 (ha)
A. Total mine footprint[1]	Springvale	41.7	43.4	44.2
	SWTP	7.7	7.7	7.7
B. Total active disturbance[2]	Springvale	34.6	36.3	37.1
	SWTP	5.8	5.8	5.8
C. Land being prepared for rehabilitation[3]	Springvale	-		-
	SWTP	-		-
D. Land under active rehabilitation[4]	Springvale	7.1	7.1	8.5
	SWTP	1.9	1.9	1.9
E. Completed rehabilitation[5]	Springvale	-		-
	SWTP	-		-

[1] **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 the DRE MOP/RMP Guidelines). Please note that subsidence remediation areas are excluded.

[2] **Total Active Disturbance:** includes all areas requiring rehabilitation

[3] **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)

[4] **Land under active rehabilitation:** includes areas under rehabilitation and being managed to achieve relinquishment – includes 'ecosystem and land use establishment' and 'ecosystem and land use sustainability (as defined under the DRE MOP/RMP Guidelines)

[5] **Completed rehabilitation**: requires formal sign off from DRE that the area has successfully net the rehabilitation land use objectives or completion criteria

*Springvale and SWTP GIS data for 2019 was refined to address previous inconsistencies. Areas for 2018 have not been updated for Springvale as the snapshot of disturbance was based upon end of 2019. SWTP disturbance and rehabilitation for 2018 has been captured based upon data and timing of completed activities.

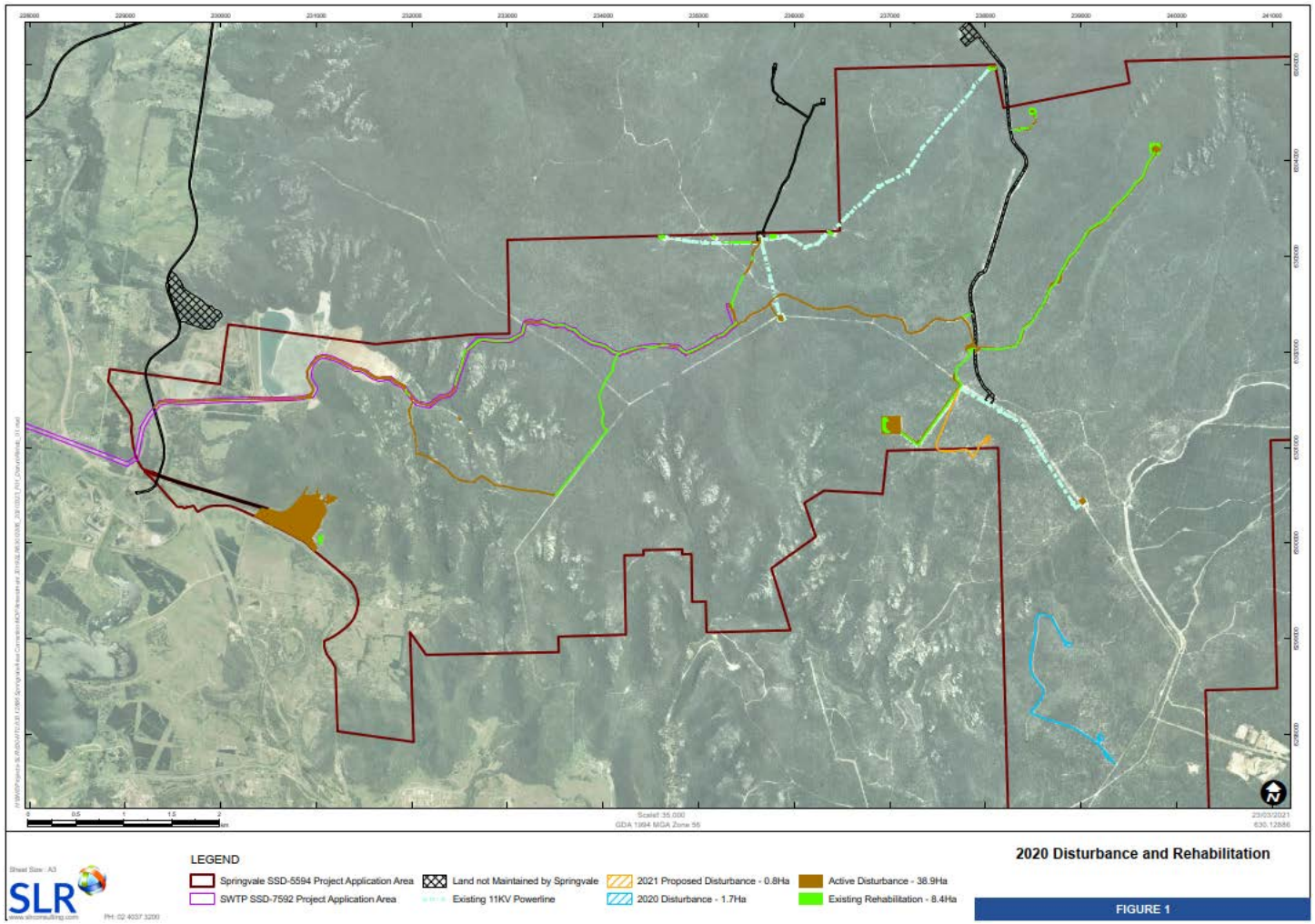


Figure 38: Disturbance and Rehabilitation as at 31 December 2020

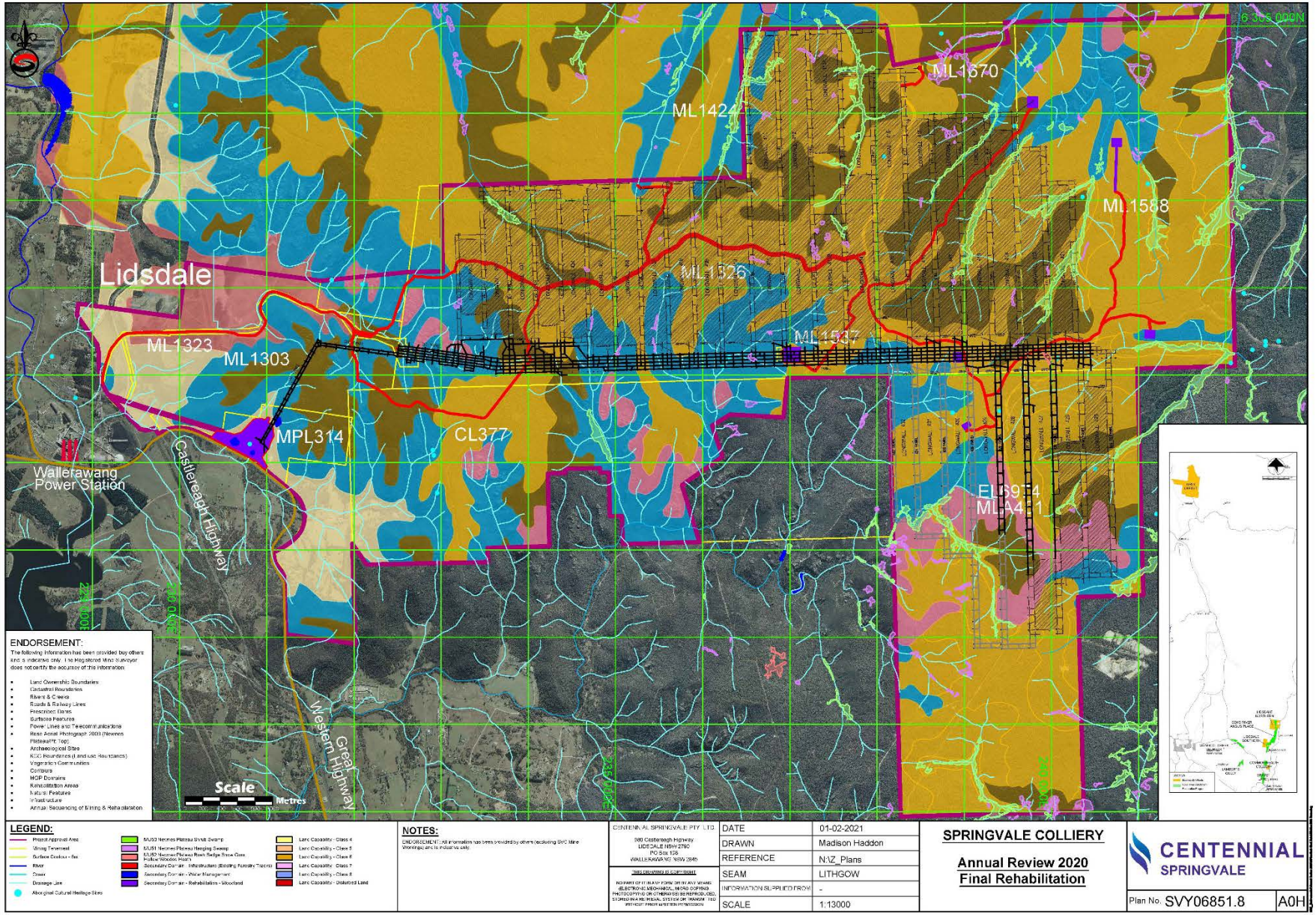


Figure 39: Final Rehabilitation

8.2. Rehabilitation Monitoring

The Rehabilitation sites associates with Springvale Rehabilitation monitoring are presented in the following table.

Table 85: Rehabilitation monitoring Sites

Site	Description
SPR 1	Rehabilitation site previously used as a dam. The Old Fire Dam has since been infilled with soil and or seeded with native vegetation;
SPR 2	Rehabilitation site on the Newnes Plateau is associated with the infrastructure corridor to the Bore 8 Dewatering Facility;
SPR 3	Rehabilitation site on the Newnes Plateau at the previous Bore 2 Dewatering Facility;
SPR 4	Control site for the Pit Top located upslope from SPR 1;
SPR 5	Control site on the Newnes Plateau;
SPR 6	Rehabilitation site located on Newnes Plateau at the previous Bore 1 Dewatering Borehole;
SPR 7	Rehabilitation site located on Newnes Plateau at the previous Bore 3 Dewatering Borehole;
SPR 8	Rehabilitation site located on Newnes Plateau at previous Bore 4 Dewatering Borehole; and
SPR 9	Control site located on Newnes Plateau

1.1.1. 2019 Rehabilitation results

Rehabilitation monitoring undertaken in Autumn 2020 and to the annual rehabilitation monitoring requirements for 2019. April 2020 due to the occurrence of bush fires throughout the Newnes Plateau during late 2019.

1.1.2. 2020 Rehabilitation results

Land Function Analysis

Resource retention capacity (Landscape Organisation Index) for rehabilitation sites remains similar to previous results and within the range of the medium term (4-year) average for control sites. After being heavily impacted by the server bushfires in 2019 the control sites SPR 4 and SPR 5, positioned at the Pit Top and on the Newnes Plateau respectively, show significant increase in resource retention capacity. The likely reason behind these increases is the biological response to the above mean rainfall that fell in the region during 2020 contributing ground cover and shrub growth since the 2019 survey. Notably, signs of fire damage within rehabilitation were less than in control sites, which are positioned within forest edges and in turn, post fire response is far less distinct.

Soil stability has remained stable at most of the rehabilitation sites, which is attributable to the presence of dense shrub and ground-cover layers (including Acacia spp. and Cassinia spp.). By contrast, a considerable amount of shrub cover was evidently burnt during the recent bush fires and this has caused large declines in soil stability at some sites. A dense shrub cover can significantly reduce erosion potential and hence improve overall soil stability. It is expected that post-bushfire regeneration (observed in its early stages during our assessment) will lead to a recovery of native shrub and groundcover and hence an increase in stability indices across control sites towards pre-bushfire values.

Soil water infiltration and retention capacity remains relatively stable amongst rehabilitation sites; however no site is currently within the four-year average of the control sites after SPR8's value decreased during 2020. However, it is expected that the continuation of vegetation growth within rehabilitation sites will contribute to soil mixing and the addition of greater volumes of organic

material to the soils, thus increasing water infiltration capacity over time. Infiltration indices remains similar to previous results at control sites, indicating that recovery from the 2019 bushfires is still in progress. It is likely that infiltration rates will improve as the sites recover further.

Soil nutrient cycling has remained relatively stable across rehabilitation sites with only minor increases and decreases across monitoring sites since the last survey. None of the rehabilitation sites currently has nutrient cycling scores that are comparable to the four-year average for control sites; however, this will likely improve as rehabilitation progresses. The two younger sites, SPR6 (four years old) and SPR7 (five years old) showed the most significant increase of the rehabilitation sites and evidence of progression towards comparable control site mean scores. By comparison, the control sites showed signs of recovery from the 2019 bushfires with all controls sites recoding increases.

Vegetation

The current monitoring results indicate that native plant species diversity has increased across all monitoring sites since the last monitoring event. These results reflect observations during the current survey that ground cover has increased and plant species that were absent in the previous two surveys, have germinated and grown over the 2020 monitoring period in response to higher rainfall across the region.

Results for native overstorey cover were mixed, with some sites remaining the same, some increasing and some decreasing. Canopy cover at some sites was reduced or removed during the high-intensity bushfires in 2019, with signs of crown fire damage noted across most monitoring sites. The only exception were the slight increases in canopy cover observed at rehabilitation sites SPR 1 and SPR 3, both which are 10-year old rehabilitation sites, not impacted by the recent fires and are beginning to see the maturing of some canopy species.

Native midstorey cover remained stable across most monitoring sites, with some small decreases at some sites and no change at other sites. Whilst there were signs of a number of shrub species beginning to recover, the bushfires have effectively removed the midstorey across many of the control sites, and some of the rehabilitation sites. The exceptions are those rehabilitation sites that have avoided fire damage but have experienced a decline in midstorey cover as canopy species begin to mature.

Native grass cover increased across most sites across the Pit Top Area and Newnes Plateau. SPR3 was the only site within the survey to experience any decrease in did native grass cover. Native shrub cover increased across most sites, with the exception of SPR2 (Newnes Plateau). Scores for native groundcover ‘other’ species (i.e. forbs, ferns, rushes and sedges) increased across all rehabilitation and control survey sites.

No severe infestations of weed (or exotic) species were observed. Exotic groundcover within rehabilitation sites overall remains at low levels, but has increased marginally since the previous survey. Many weed species are regarded as being particularly successful early-successional species and may quickly re-establish and dominate ecosystems recently impacted by fire. Future weed monitoring is vital to ensure exotics are appropriately managed post-fire.

Fauna Species and habitat

The presence of fauna species across the rehabilitation areas is a positive indication that rehabilitation sites are progressing towards a healthy self-sustaining ecosystem. The higher fauna species diversity observed during the current survey could be indicative of post-fire recovery within and surrounding the rehabilitation sites. Considering that vast tracts of bushland that constitutes foraging habitat and nesting habitat for woodland and forest birds was lost to the fires, it is expected that bird diversity and activity will be lower across the region.

As the surrounding bushland continues to recover post-fire, an improvement in diverse habitat features including structural complexity and food resources will increase faunal diversity to levels not dissimilar to pre-fire values**.**

MOP performance Criteria Assessment

A summary of the performance of rehabilitation monitoring sites against the relevant MOP completion criteria is presented in Table 85. The criteria have been converted into a range of ecological targets or 'ecosystem measures', as well as against data recorded in respective control sites. Rehabilitation sites meeting or exceeding the range values of the control sites have been identified with a green shaded box and have therefore already met the criteria.

The results summarised in Table 86 show that the rehabilitation sites have met the majority of their completion criteria (with the exception of some rehabilitation objectives that relate to 'Ecosystem health, structure and composition).

Table 86: Status of Rehabilitation against MOP performance criteria

Rehabilitation Phase (MOP)	Rehabilitation objectives	Performance indicator	Completion Criteria	Sub criteria	Ecosystem measure	Unit of measure	SPR 1	SPR 2	SPR 3	SPR 4	SPR 5	SPR 6	SPR 7	SPR 8	SPR 9
							Rehab	Rehab	Rehab	**Control**	**Control**	Rehab	Rehab	Rehab	**Control**
Phase 1: De-commissioning Development	All sites are in natural state with no hazardous or contaminated materials remaining.	Absence of hazardous material (including carbonaceous materials)	All hazardous materials and contaminated materials removed	N/A	Physical inspection of sites	y/n	Yes	Yes	Yes	N/A Control Site	N/A Control Site	Yes	Yes	Yes	N/A Control Site
Phase 2: Landform Establishment	Landforms are stable and non-polluting	Erosion control	No active erosion present	N/A	Inspection for areas of active erosion. Landscape Function Analysis – Rill assessment (if required)	m^2	None	None	None	N/A Control Site	N/A Control Site	None	None	None	N/A Control Site
			Erosion control structures have been installed.	N/A	Inspection for control structures	y/n	Yes	Yes	Yes	N/A Control Site	N/A Control Site	Yes	Yes	Yes	N/A Control Site
		Suitable gradient	Slope (<14°)	N/A	Gradient assessment of sites	Degrees	12°	5°	4°	11°	4°	2°	5°	10°	1°
		Stable landform	Final landform is consistent with surrounding landforms	N/A	Inspection of site and surroundings	y/n	Yes	Yes	Yes	N/A Control Site	N/A Control Site	Yes	Yes	Yes	N/A Control Site

Rehabilitation Phase (MOP)	Rehabilitation objectives	Performance indicator	Completion Criteria	Sub criteria	Ecosystem measure	Unit of measure	SPR 1	SPR 2	SPR 3	SPR 4	SPR 5	SPR 6	SPR 7	SPR 8	SPR 9
	Drainage structures are performing as designed	Surface water drainage	Landform is stable and contour banks and diversion drains into appropriate areas	N/A	Inspection of site and surroundings	y/n	Yes	Yes	Yes	N/A Control Site	N/A Control Site	Yes	Yes	Yes	N/A Control Site
Phase 3: Growth Medium	Land and Soil Capability Class 5	Suitable topsoil present and no stockpiles	Suitable growth medium available – no stockpiles present	N/A	Inspection of site and topsoil	y/n	Yes	Yes	Yes	N/A Control Site	N/A Control Site	Yes	Yes	Yes	N/A Control Site
Phase 4: Ecosystem Establishment	Ecosystem health, structure & composition satisfying completion criteria	Species Selection	A mixture of native trees, shrubs and grasses representative of regionally occurring woodland is present.	The diversity of shrubs and juvenile trees is comparable to that of the control sites	BioBanking Native plant species richness (total)	Total species Pit Top Sites representing **PCT 728**	30			32					
						Total species Newnes Plateau Sites representing **PCT 1789**		31	34		39	33	28	39	24
			<15 % weeds present in monitoring sites.	Exotic plant cover is comparable to that of the control sites	Exotic plant cover	%	2%	0%	0%	2%	0%	0%	0%	0%	0%

Rehabilitation Phase (MOP)	Rehabilitation objectives	Performance indicator	Completion Criteria	Sub criteria	Ecosystem measure	Unit of measure	SPR 1	SPR 2	SPR 3	SPR 4	SPR 5	SPR 6	SPR 7	SPR 8	SPR 9
	Ecosystem health, structure & composition satisfying completion criteria	Sustainability / Nutrient Cycling	Landform is ecologically functional and performing as designed.	Ability of the site to retain resources is comparable to that of the control sites	LFA Landscape Organisation index	0-1	0.88	0.74	0.88	0.73	0.73	0.61	0.77	0.77	0.84
				Infiltration is comparable with control sites	LFA Infiltration index	%	39.94	41.05	35.67	36	34.56	35.02	37.53	55.68	37.97
				Nutrient cycling is comparable with control sites	LFA Nutrient Cycling index	%	30.50	30.51	28.42	25.63	28.23	31.01	29.64	29.93	27.83
			Flora species reproducing. Evidence of second generation.	Succession of plants comparable with control sites	N/A	y/n	Yes	Yes	Yes	N/A Control Site	N/A Control Site	Yes	Yes	Yes	N/A Control Site
		Stable landform	Landform is stable and functioning as intended	Indication of the sites stability and that it is comparable to that of the control sites	LFA Stability index	%	59.48	54.8	58.84	57.39	54.84	62.68	60.65	57.4	56.33
				Native over-storey cover is comparable to that of the control sites	Native over-storey cover (%) (Biobanking)	%	4	5	5	11	11	1	3	0	17

Rehabilitation Phase (MOP)	Rehabilitation objectives	Performance indicator	Completion Criteria	Sub criteria	Ecosystem measure	Unit of measure	SPR 1	SPR 2	SPR 3	SPR 4	SPR 5	SPR 6	SPR 7	SPR 8	SPR 9
		Development of Woodland Habitat, Vegetation health, Vegetation structure		Native mid-storey cover is comparable to that of the control sites	Native mid-storey cover (%) (Biobanking)	%		0	1	0	0	6	7	2	1
				Groundcover of native grasses is comparable to that of the control sites	Native groundcover (grasses) (Biobanking)	%	52	12	10	16	24	14	26	14	36
				Groundcover of native shrubs is comparable with remnant vegetation	Native groundcover (shrubs) (%) (Biobanking)	%	18	0	38	29	18	30	54	10	4
	Ecosystem health, structure & composition satisfying completion criteria			Native groundcover 'other' is comparable to that of the control sites	Native groundcover (other) (%) (Biobanking)	%	14	30	56	51	28	18	16	38	10
				Regeneration of over-storey species is comparable to that of the control sites	Over-storey regeneration (Biobanking)	0-1	1	1	1	1	1	1	1	1	1

Rehabilitation Phase (MOP)	Rehabilitation objectives	Performance indicator	Completion Criteria	Sub criteria	Ecosystem measure	Unit of measure	SPR 1	SPR 2	SPR 3	SPR 4	SPR 5	SPR 6	SPR 7	SPR 8	SPR 9
				Abundance of hollow logs is comparable to that of the control sites	Total length of fallen logs (Biobanking)	m	40	40	49	11	21	16	67	75	61
		Functional Indicators	Presence of vertebrate and invertebrate species from broad range of groups.	Vertebrate and invertebrate species comparable with control sites and surrounding environment.	Inspection of sites and surrounding environment.	y/n	Yes	Yes	Yes	N/A Control Site	N/A Control Site	Yes	Yes	Yes	N/A Control Site
		Habitat	Typical food and water sources required by vertebrates & invertebrates are present.	Food and water sources available or comparable to control sites.	Inspection of sites.	y/n	Yes	Yes	Yes	N/A Control Site	N/A Control Site	Yes	Yes	Yes	N/A Control Site
		Land Use	Rehabilitated sites can meet designated land uses without further management inputs.	Regeneration and ecosystem development occurring naturally	Inspection of sites and analysis of LFA and biobanking results.	y/n	Yes	Yes	Yes	N/A Control Site	N/A Control Site	Yes	Yes	Yes	N/A Control Site
			Less than 20 % bare ground.	N/A	biobanking results	%	4	28	6	16	10	26	16	22	0

Rehabilitation Phase (MOP)	Rehabilitation objectives	Performance indicator	Completion Criteria	Sub criteria	Ecosystem measure	Unit of measure	SPR 1	SPR 2	SPR 3	SPR 4	SPR 5	SPR 6	SPR 7	SPR 8	SPR 9
			Total woody species richness differs 10 – 20 % from control sites	N/A	biobanking results	y/n	Yes	Yes	Yes	N/A Control Site	N/A Control Site	Yes	Yes	Yes	N/A Control Site

8.3. Agreed Post-Rehabilitation Land Use

Following the cessation of mining operations at Springvale, the pit top and all rehabilitated areas on the Newnes Plateau will be rehabilitated to woodland commensurate with the adjacent remnant vegetation. The *Springvale Mine Extension Project Decommissioning and Rehabilitation Strategy* (SLR 2014) prepared as a component of the EIS commits to the final land use for these areas becoming 'environmental protection works' which is consistent with the surrounding land use of forestry within the Newnes State Forest. Additionally the final land use aligns with the current Lithgow Local Environmental Plan (LEP) 1994, the Draft Lithgow LEP 2013 and the Lithgow Draft Land Use Strategy 2010 – 2030.

8.4. Rehabilitation Maintenance

8.4.1. East Wolgan Swamp

East Wolgan Swamp was impacted over a period of years by a combination of regulator approved mine water discharge and potential subsidence effects.

The East Wolgan Swamp major slump and the piping area were rehabilitated in accordance with the s95 Certificate issued by OEH with major works completed through 2014 by The Bush Doctor swamp rehabilitation specialist. A joint inspection with OEH, Bush Doctor and Centennial was undertaken on the 10th of December 2014 as per the s95 Certificate. Work continued with final brush-matting activities in January 2015. Since that time reporting requirements have been adhered to and weed control activities by The Bush Doctor have been undertaken.

60 month monitoring was undertaken during the reporting period in February 2020. The summer bushfire had a dramatic impact on the swamp, consuming all green plant material and much of the organic cover across the surface of East Wolgan Swamp including jute rolls, jute matting and brush matting. There was still a reasonable degree of soil stability as litter cover, including burnt organic material, exceeded 50%. There was a very low level of living plant cover (ca. 1%) in February, with many plants just starting to resprout. The total number of native plant species recorded opportunistically at this time was ten, including two species of eucalypt whose seeds had germinated. Germination of weed species into the open ground resulting from the bushfire can be expected.

Centennial will continue to discuss the rehabilitation project with OEH.

8.5. Renovation/Removal of Buildings

No permanent buildings were renovated or removed during the reporting period.

8.6. Rehabilitation Sign Off from DRG

No rehabilitation areas received formal sign-off from DRG that they were completed to a standard suitable for lease relinquishment during the reporting period.

8.7. Variations in Activities from the MOP

The MOP amendment submission in 2020 was approved 29th September 2020. The primary purpose of the MOP amendment has to address an error with the rehabilitation calculations as discussed with the NSW Resource Regulator. Additional rehabilitation works that will be undertaken within the Coxs River Catchment Improvement and Land Management Area were also captured. The varied end position of southern longwalls due to geological and geotechnical conditions was also captured.

8.8. Key Issues Affecting Successful Rehabilitation

The MOP identifies a number of issues that have the potential to affect rehabilitation at Springvale. These included:

- Greater than anticipated subsidence impacts;
- Erosion and sedimentation;
- Poor topsoil quality;
- Subsidence impacts on steep slopes; and
- Pest species presence.

Maintenance work was conducted at Newnes Plateau sites and pit-top throughout the reporting period. No major issues were encountered during the reporting period.

8.9. Next Reporting Period

Rehabilitation at Springvale will continue to be undertaken progressively and will involve partial rehabilitation of the following disturbed areas after completion of construction on Newnes Plateau.

In 2021 Springvale will primarily focus on land improvement works associated with the Coxs River Catchment Improvement and Land Management Plan and Biodiversity Offset sites

In 2021 changes to the ERMP will be triggered by the upcoming LW428-432 extraction plan approval that is forecast to occur in quarter 3 2021. Subsequent MOP amendments will then occur in consultation with the resource regulator as discussed 17th December 2020.

9. COMMUNITY

9.1. Community Engagement

9.1.1. Community Consultative Committee

A Community Consultative Committee (CCC) has been established to monitor the operations and provide a forum whereby the community can communicate with the mine operators and be kept up to date with the progress of the mine.

In 2012 the established Angus Place CCC was combined to also include Springvale. Furthermore in October 2014 the CCC was also expanded to include Western Coal Services.

The combined Angus Place, Springvale and Western Coal Services CCC aims to facilitate a single channel of communication regarding current operations in the area.

The committee is composed of:

- An independent chairperson;
- Four representatives from Centennial Coal, including the Environment and Community Officer;
- One representative from Council; and
- At least three representatives from the local community.

Due to COVID-19, the Committee was required to modify its meeting processes. Three meetings were hosted instead of the preferred four. Meetings were held on the following dates:

- 8 April 2020
- 19 August 2020
- 18 November 2020

Minutes from the meeting are available on the Centennial Coal website.

In July 2020 a new independent chairperson commenced. The appointment was undertaken in consultation with the Department of Planning, Industry and Environment (DPIE) and in line with the Department's CCC Guidelines processes and procedures.

The Western Region Consultative Committee meets on a regular basis to find the best solution(s) to the following challenges:

- Respecting the local and regional environment;
- Minimising adverse impacts of mine operations on people, homes, and businesses;
- Supporting the economic, social and cultural life of the area; and
- Maintaining profitable and efficient mine operations that meet regulatory requirements.

Meetings will continue to be held during 2021.

9.1.2. Community Enhancement

As required under Schedule 2, Condition 15 of SSD 5594, Centennial shall pay a community contribution to Lithgow City Council (LCC) of $0.03 per saleable tonne of coal produced from Springvale, Angus and Airly mines, capped at $200,000. The contribution is due by the 31st of March each year commencing on the 31st of March 2016.

For operations undertaken during 2020, the Springvale community contribution has been calculated to be $76,130. Payment will be made to LCC in accordance with SSD 5594. This annual community contribution will be allocated for long term community activities and projects.

9.2. Community Complaints

There were no community complaints received during the reporting period. One community phone call was received during August 2020; however, the resident was located on the Central Coast and the enquiry was not related to Springvale. The resident was referred to the EPA by the Group Manager for Stakeholder Engagement.

Trends in community complaints are documented in Table 87.

Table 87: Community Complaint Trends

	2015	2016	2017	2018	2019	2020
Number	1	1	4	1	1	0
Category	Traffic	Noise	Noise	Other	Noise	N/A

10. INDEPENDENT AUDIT

Independent Audit's are required three-yearly under SSD 5594 Schedule 6 Condition 13. An Independent Audit was conducted by MCW Environmental in 2019 with the final audit report submitted to DPE in November 2019.

This report is available on the website in accordance with consent requirements.

The next Independent Audit will be commissioned prior 19 June 2022.

An update of actions from the audit report are summarised below in Table 88.

Table 88: Independent Audit Actions and Progress

Audit Reference	Action	Status	Summary
OFI-2019-002	Ensure documents made available on the website are kept up to date and that redundant and/or draft versions are removed.	Complete	Compliance database action amended to identify changes in documents required to be available on the website.
OFI-2019-003	Update the noise management procedure (SV-STD-2172) to include process for identifying when weather forecasts anticipate meteorological conditions where noise limits do not apply and associated mitigation measures to be implemented during these conditions.	Complete	Springvale is currently trialling a real time weather alarm system for CHP activity management. The Site procedure has been updated to reflect this change.
OFI-2019-004	Centennial Springvale to monitor noise levels from dozer activities once full production levels are reached, and address issues if they arise.	Complete	Noise monitoring investigation undertaken quarterly. No non-compliances recorded.
OFI-2019-005	Implement recommendations from Advitech Low Frequency Noise report 2017, relevant to SSD5594.	Complete	There are no outstanding Low Frequency Noise issued for Springvale to address which are relevant to SSD5594.

Audit Reference	Action	Status	Summary
OFI-2019-006	Report on progress and outcomes of the Low Frequency Noise Investigations in the Annual Review	Complete	LFN outcomes reported on in 2020 annual review.
OFI-2019-007	Include site specific detail in the WRAQGHGMP in relation to the GHG reduction strategies in place to deliver the 25% reduction target.	Ongoing	GHG reductions are part of a companywide project.
OFI-2019-008	Implement a system to track onsite reductions in emissions to demonstrate compliance with the 25% reduction.	Ongoing	GHG reductions are part of a companywide project
OFI-2019-009	Centennial Springvale to continue to communicate with DPE regarding progressing the approval of the Upper Coxs River Action and Monitoring Plan	Complete	DPIE approval received 07/05/2020.
OFI-2019-010	Centennial Springvale to continue to communicate with DPIE regarding progressing the approval of the Water Management Plan.	Complete	DPIE approval received 19/02/2021.
OFI-2019-011	Centennial Springvale to continue to communicate with DPIE regarding progressing the approval of the Biodiversity Management Plan.	Ongoing	A revised Biodiversity Management Play was resubmitted 3 September 2019. Centennial will continue to consult with DPIE to for approval of the biodiversity management plan.
OFI-2019-012	Centennial Springvale to further consider their responsibilities in respect to the maintenance of the access road to Sunnyside Swamp and consult with FCNSW as to what their expectations are to rehabilitation.	Ongoing	Springvale has continued to work collaboratively with FCNSW on road maintenance activities. Ensuring that the surface of the roads are free draining whilst maintaining appropriate erosion controls. Formed roads and fire trials are priority.
OFI-2019-013	Centennial Springvale to ensure that the conditions of the MOP approval are included in the next MOP amendment.	Complete	The MOP approval conditions are included in section 1.2.5 of the MOP. The MOP was approved 29/09/2020.
OFI-2019-014	Centennial Springvale to communicate with DPIE regarding progressing the approval of the Environmental Management Strategy.	Complete	The latest version Environmental Management Strategy was approved on 14/4/2020.
OFI-2019-015(a)	Update the periodic review schedule for the	Complete	All management plans to be reviewed within 3 months of

Audit Reference	Action	Status	Summary
	management plans to ensure compliance with SSD5594 CoA S6-6.		the submission of the annual review and immediately following an incident.
OFI-2019-015(b)	If low community member attendance occurs in future meetings, it is suggested that additional members of the community are invited to participate in the CCC.	Complete	Discussion point included in CCC 20/11/19 meeting regarding current community membership level and suggestion that additional members are invited to participate in the CCC if triggered. Attendance will continue to be monitored.
OFI-2019-016	Ensure all incidents and non-compliances are included in the annual review for the respective reporting period.	Complete	All incidences and non-compliances are reported in Annual Reviews.
OFI-2019-017	Ensure documents are made available on the website are kept up to date and that redundant and/or draft versions are removed.	Complete	Compliance database action created for yearly audit of website documents.
OFI-2019-018	Springvale are encouraged to identify opportunities to continually improve the management of coal residues on site and to improve general housekeeping standards across the pit top.	Ongoing	Housekeeping initiatives developed since the audit include signage, maintenance procedures, stock movement monitoring process (spray paint). Housekeeping practices will continue to be managed.
OFI-2019-019	Continue to investigate and implement measures to reduce dust generation from tacking dirt around the pit top areas.	Complete	The Dust levels at Springvale are <2g/month. Springvale utilise a water truck and road sweeping as required.
OFI-2019-020(a)	There is an opportunity to review the naming of the dams within the Springvale pit top to ensure consistency across EPL documentation. During the next EPL variation update the dam referred to in this condition to reflect P1.3.	Complete	The naming of the dams has been addressed in the most recent Water management plan approved 19/02/2021.
OFI-2019-020(b)	It is noted that the sediment dam in this condition is referred to as Dam 3 in EPL p1.3 and “primary and secondary dams” in the water management plan.	Noted.	
OFI-2019-021	Centennial Springvale to review and update the water management plan and associated schematics to include the sediment dam located at LDP006 and to correctly represent	Complete	The schematics have been updated in the Water management plan approved 19/02/2021.

Audit Reference	Action	Status	Summary
	drainage from the Fire Dam to the correct off site discharge point.		
OFI-2019-022	Centennial Springvale to investigate opportunities other than the website to publicise the community information hotline.	Complete	Letterbox drop leaflet was prepared and distributed on 02/03/2020 to residents of Springvale Lane detailing the community complaint/enquiry hotline number for Springvale.
OFI-2019-023	Centennial Springvale to develop an incident checklist as part of the PIRMP that includes the initial phone call and follow up notification requirements of EPL3607.	Complete	Section 6.2 of PIRMP details actions required relating to the notification requirements to EPA as per EPL3607.
OFI-2019-024	Centennial Springvale to further investigate operations within the Warragamba Outer Catchment Area to confirm compliance with this condition.	Complete	Springvale was obtained specialist advice in regards to the Warragamba Outer Catchment Area to confirm compliance with this condition.
OFI-2019-026	Upload a copy of the Extraction Plan LW424-427 Powerline Management Plan to the Centennial website.	Complete	Uploaded to the website.
REC-2019-001	Consult with Lithgow City Council regarding the surrender of DA 461/02 in accordance with Section 104A of the EP&A Act.	Complete	LCC approved the surrender of DA 461/02 on 12 November 2020
REC-2019-002	Put processes in place to ensure payments to LCC are made prior to the required 31 March annually.	Complete	Compliance database action modified to allow payment completion of voluntary payment as per consent by 31 March annually.
REC-2019-003	That DPIE seek clarification from the IMP on their assessment of compliance with the performance measures defined in Condition S3-1.	Noted.	
REC-2019-004	A compliance section that includes assessment and reporting of compliance with the performance measures in condition S3-1 should be included in the relevant reports developed for the 6 monthly extraction plan reports and annual reviews. This should include an assessment of the performance measures for	Complete	As outlined in Volume 1 of the Extraction Plan, to establish compliance with the performance measures as outlined in Condition 3-1 , Springvale has developed a monitoring program and associated TARPs. The TARPS specified in each component extraction plan management plan are incorporated into a master TARP. Section 4 of the 6

Audit Reference	Action	Status	Summary
	potential impacts to waster resources due to reduced water levels in swamps		monthly Extraction Plan Report reports on TARP triggers in the current extraction plan area with a detailed summary incorporated in section 6 of the document. TARP exceedances are similarly documented in the Annual Review.
REC-2019-005	That monitoring reports include the latest research and understanding regarding subsidence/mining impacts on swamps, particularly where the reports are pubic documents.	Complete	Annual review and six-monthly extraction plan report environmental performance section includes reference triggers reported during the reporting period.
REC-2019-006	That Centennial Springvale, DPIE and relevant agencies continue to develop suitable offset/strategies to address impacts that have occurred in swamps.	Ongoing	Centennial will continue to work with DPIE and other agencies.
REC-2019-007	That Centennial Springvale complete and submit a revised Swamp offset package for determining offset liabilities.	Ongoing	Centennial will continue to work with DPIE and other agencies.
REC-2019-008	Ensure consultation section of the component management plans (generally section 10) reflects the consultation undertaken for that plan and with the agencies identified in SSD5594.	Complete	Consultation is undertaken with relevant stakeholders during management plan preparation.
REC-2019-011	Ensure that the sediment and erosion control structures at Centennial Springvale sites on Newnes Plateau are compliant with all aspects of the Managing Urban Stormwater: Soils and Construction.	Complete	Sediment and erosion controls are inspected and maintained as required.
REC-2019-012	Investigate the opportunity to construct a clean water diversion at Bore 8.	Complete	The construction of the Bore 8 erosion and sediment controls reviewed against the approved Bore 8 project management plan.
REC-2019-013	Update the EMS to include a register of any strategies, plans and programs approved under the conditions of SSD5594.	Complete	Summary table included in the EMS outlining the approval status of plans under SSD5594. The latest version Environmental

Audit Reference	Action	Status	Summary
			Management Strategy was approved on 14/4/2020.
REC-2019-014	Update EMS to include clear plan depicting all monitoring required to be carried out under the conditions of this consent.	Complete	Monitoring locations are clearly presented in the latest version Environmental Management Strategy was approved on 14/4/2020
REC-2019-015	Ensure notification and submission of the written reports are provided to the DPIE and other relevant agencies within the required timeframe.	Complete	The PIRMP includes notification to DPIE (and other relevant agencies) on incident relating to an exceedance of performance measures or material harm.
REC-2019-016	Ensure that March 2019 noise monitoring results received from SLR in April 2019 are reported in the next monthly environmental report.	Complete	March 2019 noise monitoring reported in March 2019 Monthly EPL Monitoring report.
REC-2019-017	Put process in place to ensure that monitoring occurs within the required timeframe.	Complete	Expectations of ALS regarding failure to monitor as per the agreed scope of work discussed and agreed upon.
REC-2019-018	Put process in place to ensure that the Annual Exploration Report is provided to the Resources Regulator within the required time frame.	Complete	Compliance database action created to ensure timely submission.
REC-2019-019	Review UCRAMP following updates to the Springvale Water Management Plan to ensure consistency between these documents.	Complete	The water management plan was reviewed with consideration to the UCRAMP. UCRAMP was approved 7/05/2020.

11. INCIDENTS AND NON-COMPLIANCES DURING THE REPORTING PERIOD

There were two incidents reported to DPIE and EPA during the reporting period. The third incident is an administrative non-compliance in regards to water licencing.

Table 89: Bore Substation Transformer Incident

Nature of the incident/non-compliance	Structural failure of a 66/11kv transformer and the subsequent release of oil to the transformer sump and the immediate environment surrounding the bore substation on Newnes Plateau.
Date of incident/ non-compliance (if known; if not known state not known)	13/01/2020
The location of the incident/ non-compliance (include a figure if appropriate), if known	The bore substation site located on the Newnes Plateau. (235852E, 6302487N)
Detail the cause of the incident/non-compliance	The release of transformer oil into the bund containing the transformer and release of transformer oil into the area surrounding the site was caused by a failure of a metering transformer which is believed to have then lead to a major failure of a 66/11kV 5MVA transformer.
Detail action that has been, or will be, taken to mitigate any adverse effects of the incident/ non-compliance	On the 14/1/2020 fire fighting immediately commenced to control and contain the transformer. The sump capacity was actively managed throughout the incident to ensure containment of transformer oil and fire fighting materials by a licenced waste contractor. Inspections and samples have been taken to determine the extent of contamination outside the bore substation area and develop a remediation action plan to ensure that materials (soil and ballast) contaminated with the transformer oil will be remediated and disposed of lawfully.
Detail action that has been, or will be, taken to prevent recurrence of the incident/ non-compliance	The engineering investigation resulted in the following actions which are being implemented: • Review of the Springvale EECP (Electrical Engineering Control Plan) to determine whether a specific, standalone, Electrical Engineering Standard is required for above ground HV installations to set out the mine operator's minimum requirements for High Voltage installation. • Review of the Springvale EECP to determine whether a specific *High Voltage Customer Safety Plan* is required for each above ground High Voltage point of supply, in accordance with *NSW Service and Installation Rules,* and incorporating a bight line of delineation between assets owned and maintained by the supply authority and those of the mining company. • Review of the Springvale EECP to determine whether specific provisions should be made to set out requirements for a High Voltage Testing and Maintenance regime. • Review of the Springvale EECP to determine whether specific requirements should be incorporated for remote monitoring and local fault logging for High Voltage Installations. • Review existing High Voltage installations against accepted practice as set out in SA/NZ *HB 119:2019 Handbook Mines and quarries electrical protection and AS 2067:2016 Substation and high voltage installations exceeding 1kV a.c.*

Table 90: Ventilation Facility Incident

Nature of the incident/non-compliance	The event relates to a spilt in the fire line at the Springvale Ventilation Facility Site and the subsequent release of mine water through established sediment and erosion control structures on the Newnes Plateau
Date of incident/ non-compliance (if known; if not known state not known)	Monitoring of the water system indicates that the pipe split at approximately 17:00 on 7 November 2020. The incident was identified by a Springvale Colliery contractor (JR Engineering) at 9:44am on 9 November 2020.
The location of the incident/ non-compliance (include a figure if appropriate), if known	Newnes Plateau- Springvale No 3 Ventilation Shaft
Detail the cause of the incident/non-compliance	A failure of a polyethylene pipeline which resulted in the discharge of mine water from the site into a dry drainage line downstream.
Detail action that has been, or will be, taken to mitigate any adverse effects of the incident/ non-compliance	The following actions were undertaken immediately -Pipe immediately isolated to prevent further erosion of the surrounding area. -locally available resources (rocks, logs) were utilised to dissipate concentrated flows -A contracting company was organised to attend site for the installation of additional erosion and sediment controls, and the placement of the emergency flocculation blocks in the flow path to reduce suspended solid loading in the receiving environment. -bulk water sample to allow the dose rate of flocculant to be calculated for the main ventilation dam and co-ordinated the treatment of this dam.
Detail action that has been, or will be, taken to prevent recurrence of the incident/ non-compliance	Springvale engineers will co-ordinate the installation of burst pipe protection to the fire line take off point.

Table 91: WAL 36383 Exceedance

Nature of the incident/non-compliance	WAL 36383 Exceedance of water extraction for the 2019/2020 water year.
Date of incident/ non-compliance (if known; if not known state not known)	30/06/2020
The location of the incident/ non-compliance (include a figure if appropriate), if known	NA
Detail the cause of the incident/non compliance	WAL 36383 was exceeded in the water year 2019/2020 with approximately 858 ML extracted in excess of the limit. This exceedance was done whilst an application was being processed by WaterNSW and ongoing consultation with the Natural Resource Access Regulator was being undertaken. The application was seeking the sharing of WAL allocations between Clarence Colliery, Angus Place Colliery and Springvale Mine to in effect increase the total extraction allocation accessible by the two operations. The over extraction was forecast by Springvale Mine and subsequently, points of extraction at Angus Place were reduced to account for the over extraction. This meant that between the three operations extractions within the Sydney Basin Richmond Groundwater Source did not exceed the total entitlement available across the two operations.

	The total extraction from Clarence Colliery, Angus Place Colliery and Springvale Mine from the Sydney Basin Richmond Groundwater Source is 8274 ML/year. Attempts have been made to address this forecast exceedance through administrative modifications to WALs initiated in 2018. There remains a pending licence application with WaterNSW to share the extraction works of Springvale across multiple WALs (covering both Angus Place Colliery and Springvale Mine). In the absence of a determination the operation of the dewatering infrastructure will function such that extraction activities from the primary dewatering locations are less than the combined water allocation across the two operations. The application with WaterNSW was pursed for determination in 2020 however it is expected to be determined in 2021.
Detail action that has been, or will be, taken to mitigate any adverse effects of the incident/ non-compliance	Follow up with Natural Resource Access Regulator.
Detail action that has been, or will be, taken to prevent recurrence of the incident/ non-compliance	Seek approval for combining of Springvale and Angus Place works approval to WAL 36383, to enable Sydney Basin Richmond Groundwater Source entitlement to be shared across Springvale and Angus Place.

Table 92: Summary of Reportable Incidents and Regulatory Actions

Compliance Type	Agency(ies)	Number	Response
Incidents	EPA, DPIE	2	Ventilation Facility Water Leak (Table 90) and Bore Substation Transformer Incident (Table 85)
Caution Notices	NIL		
Warning Letters	NIL		
Penalty Notices	NIL		
Prosecutions	NIL		

Note: This table includes actions taken by DPE, DRG, Resources Regulator and the EPA during the reporting period.

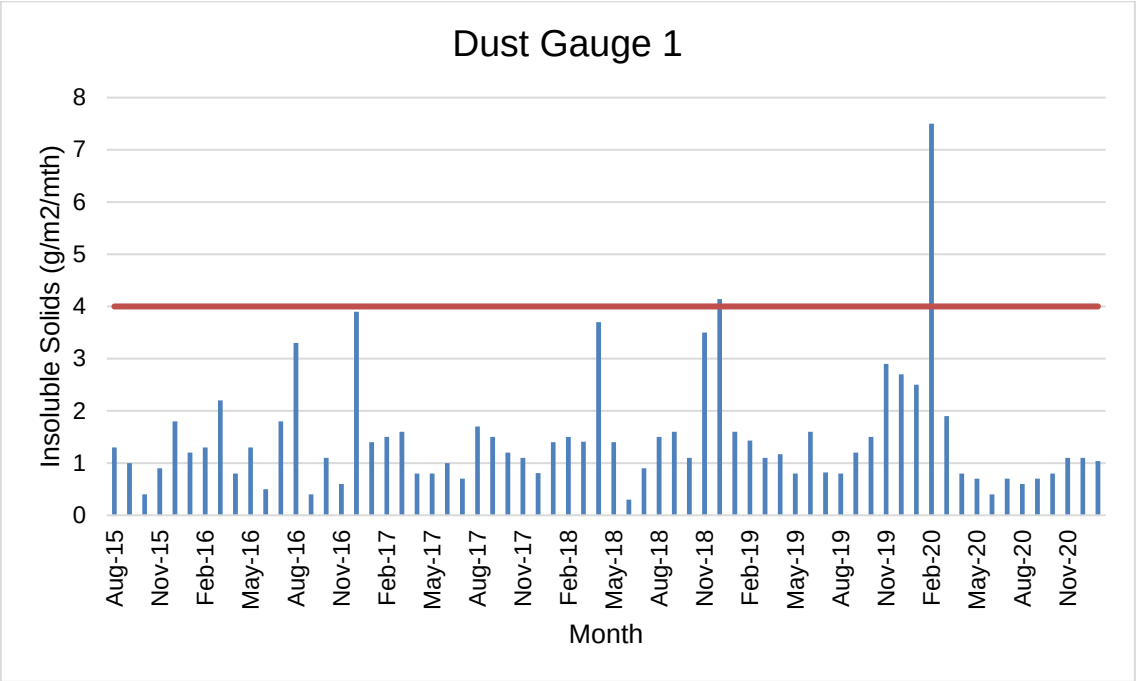
12. ACTIVITES TO BE COMPLETED IN THE NEXT REPORTING PERIOD

The following activities (and associated timings) are planned to be undertaken by Springvale in 2020:

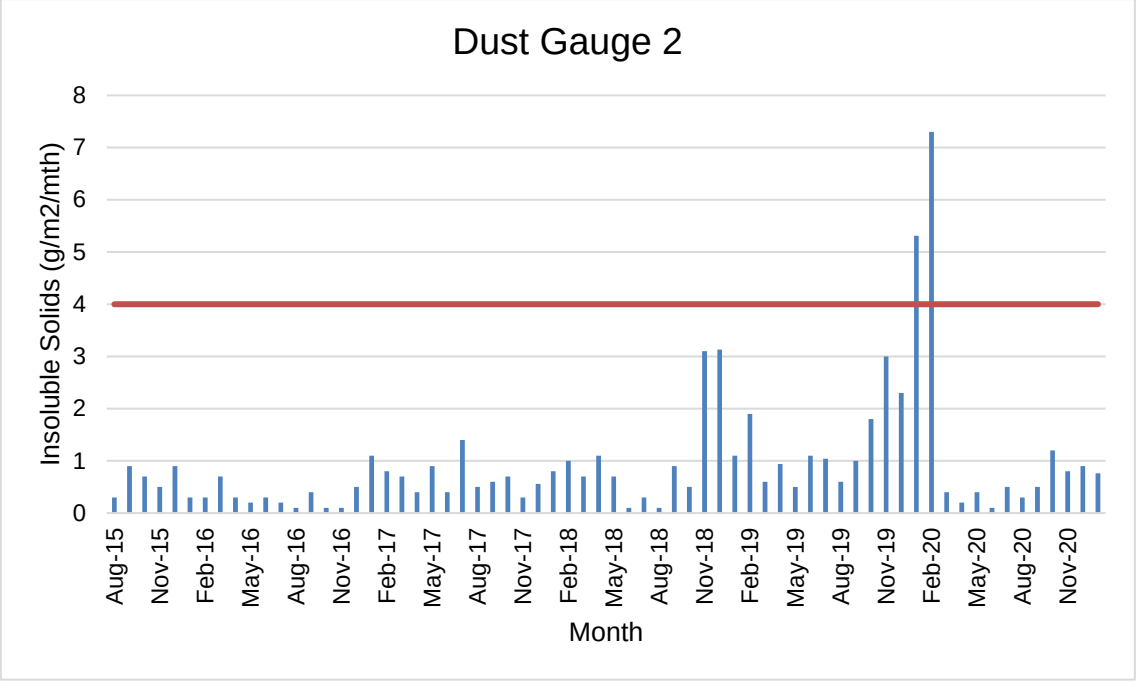
- Completion of the extraction of Longwall 427.
- Extraction Plan approval for 428-432 and implementation of requirements
- Installation of additional monitoring equipment (piezometers, soil moisture probes, subsidence lines)
- Commencement of Longwall 428.
- Conduct Approved Exploration Activities (SIS Drilling).
- MOP amendment preparation
- Undertake Land management works at Coxs river and biodiversity offset sites

APPENDIX 1 – AIR QUALITY MONITORING RESULTS

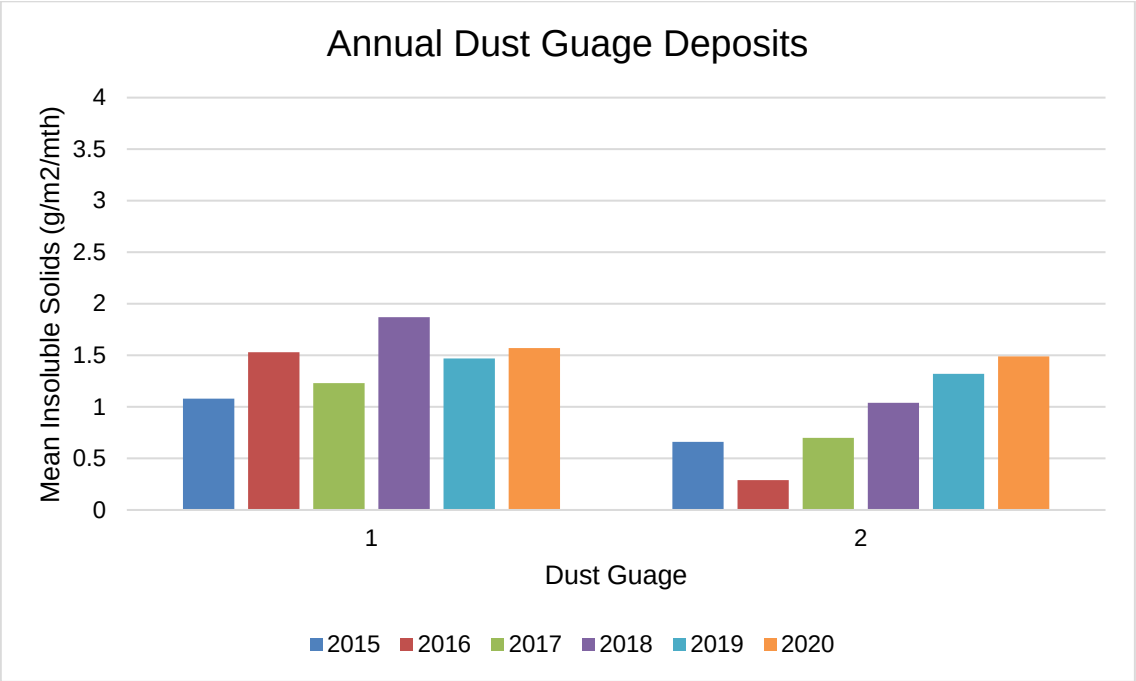
Dust Gauge 1 Results – 2015-2020



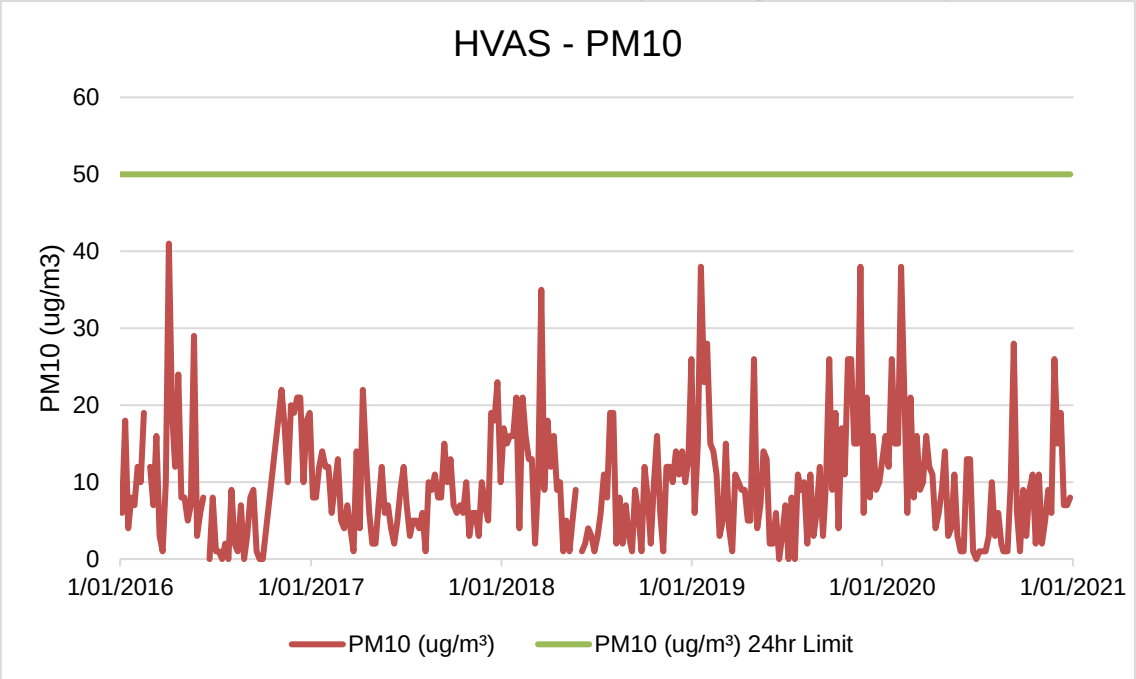
Dust Gauge 2 Results – 2015-2020



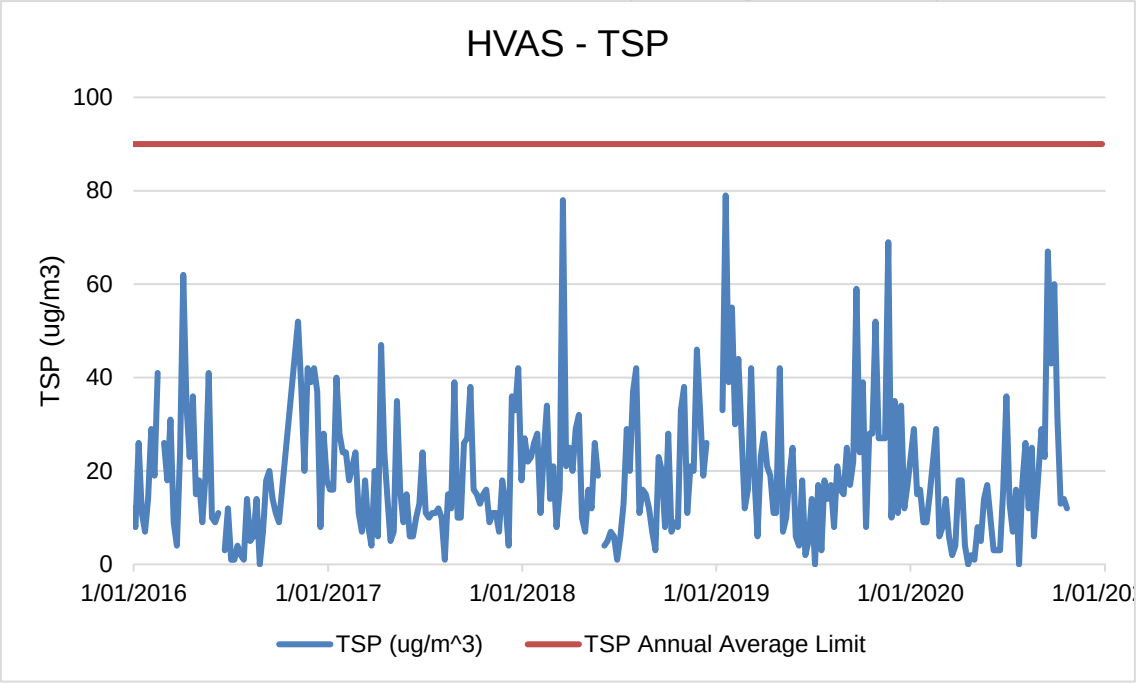
Annual Mean Dust Gauge Result Comparison - 2015 to 2020



HVAS Results PM10 2015 – 2020 (excluding bushfire data)

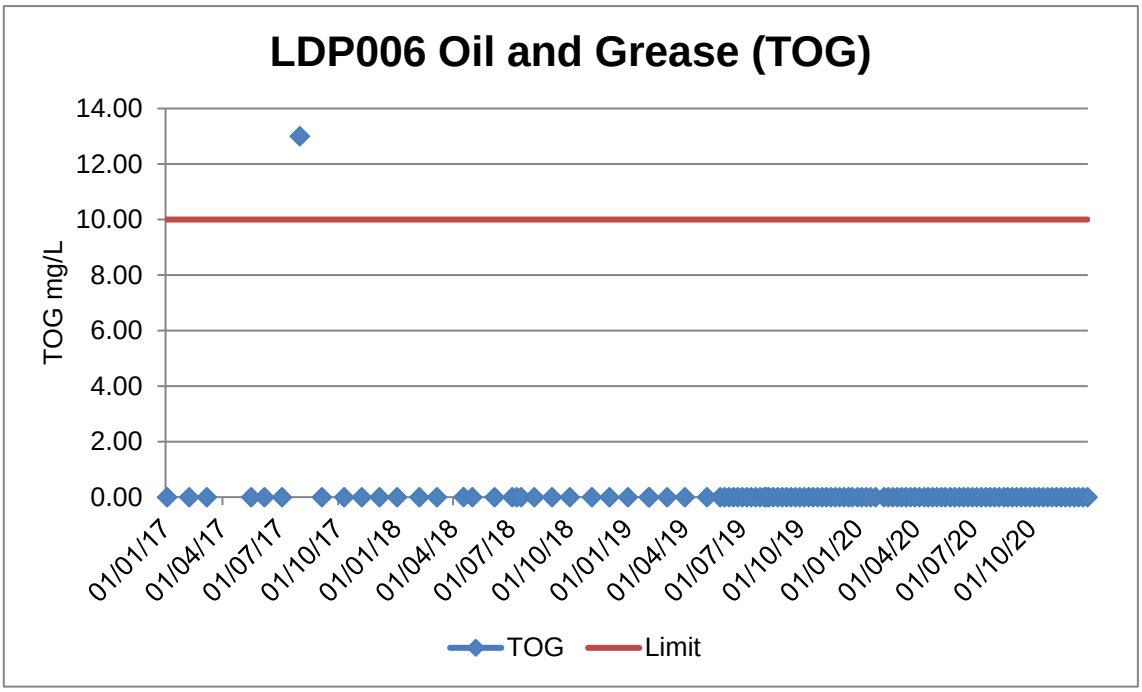


HVAS Results TSP 2015 – 2020 (excluding bushfire data)

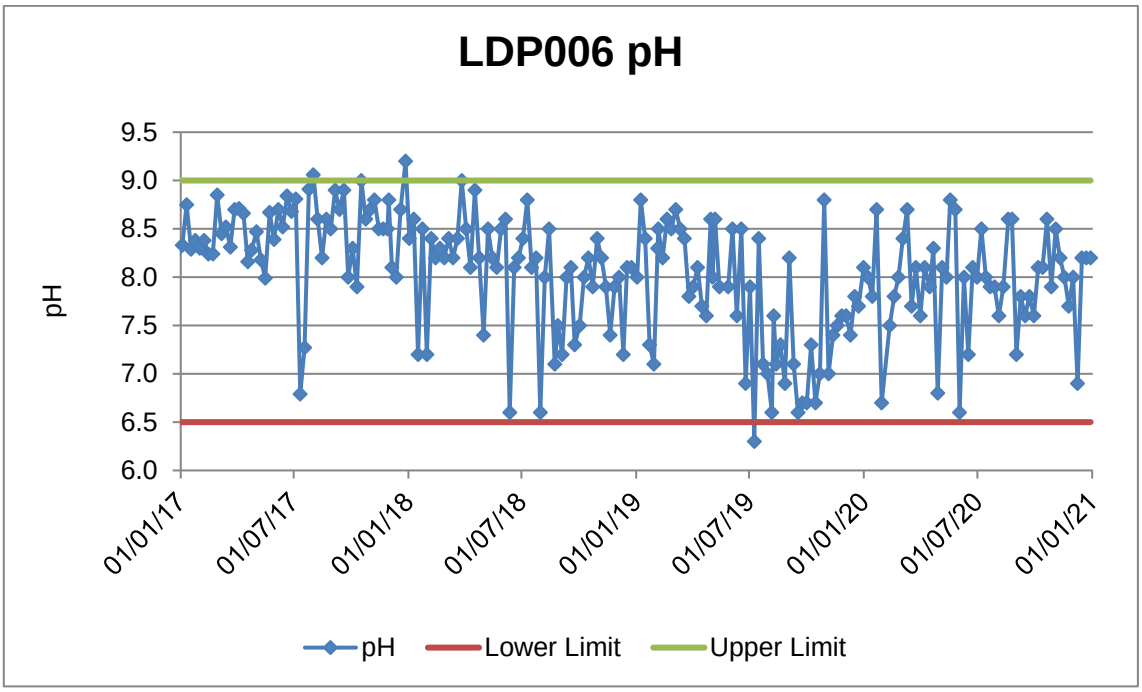


APPENDIX 2 – LDP WATER QUALITY MONITORING RESULTS

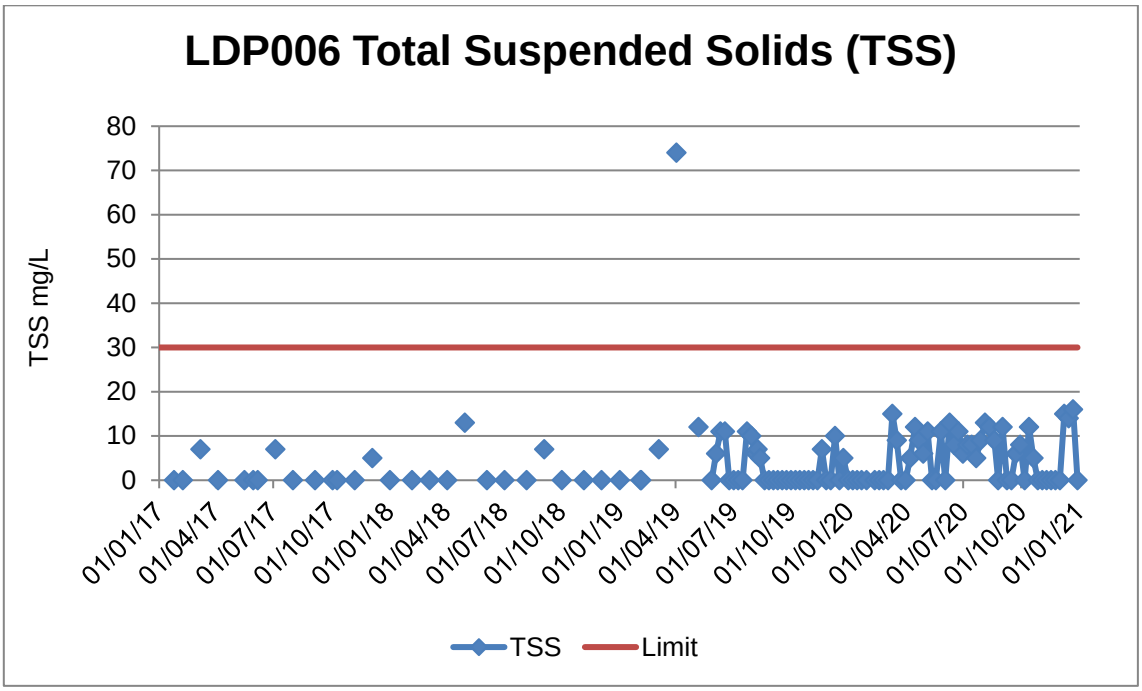
LDP006 Oil and Grease 2017 - 2021



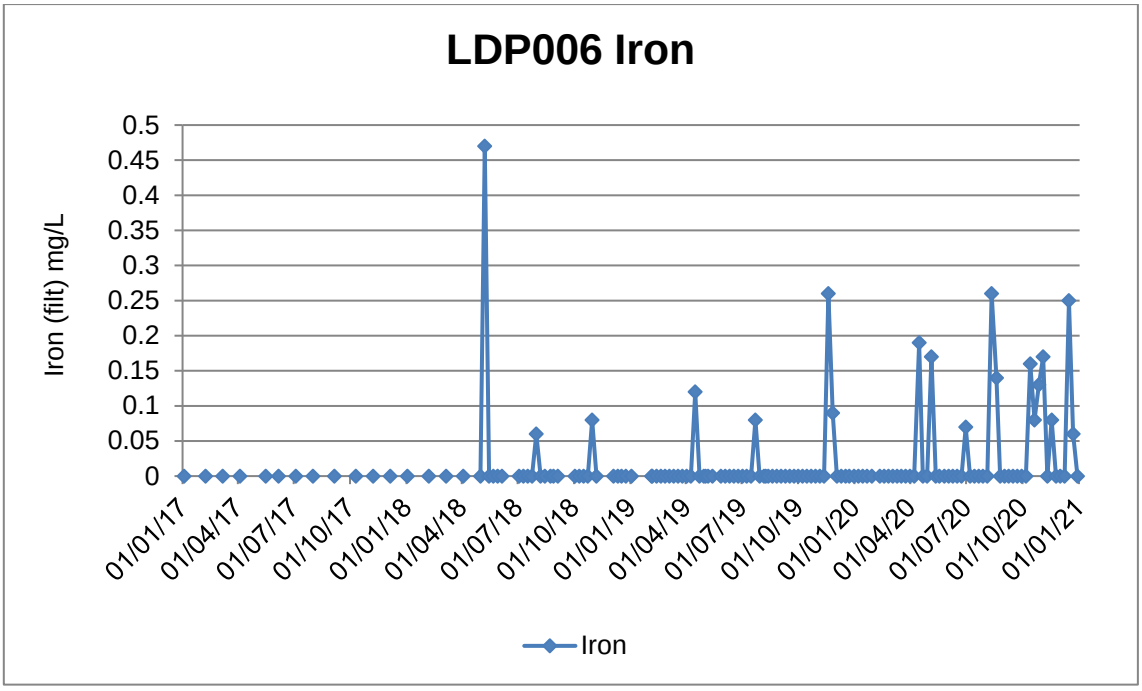
LDP006 pH 2017 - 2021



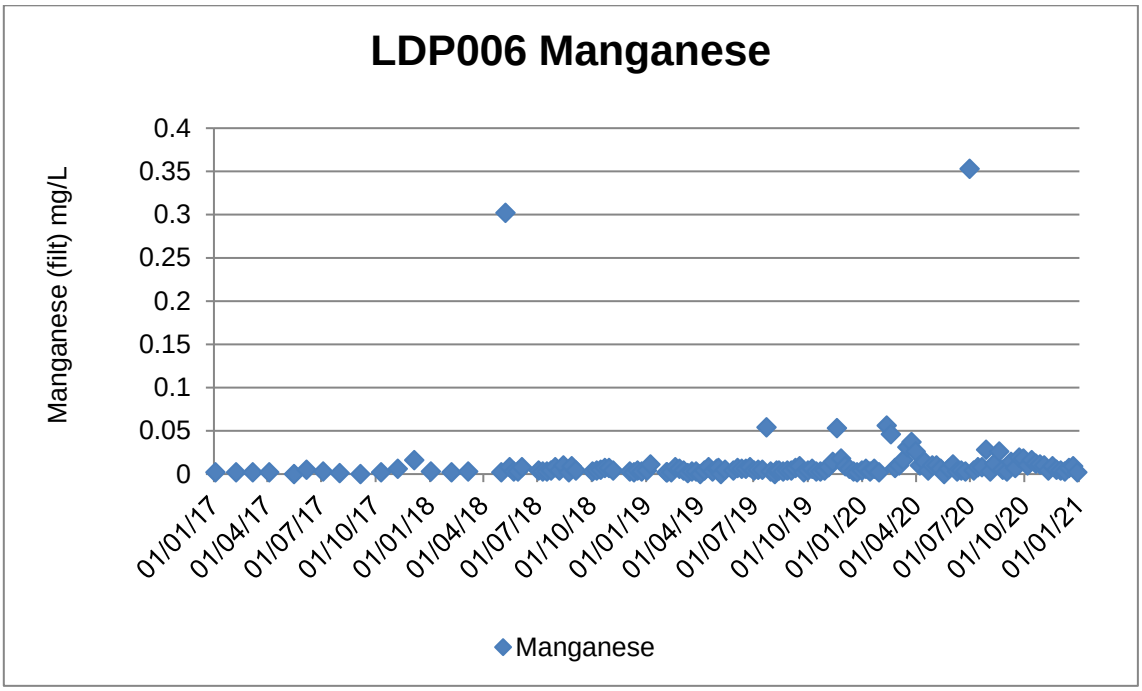
LDP006 Total Suspended Solids 2017 - 2021



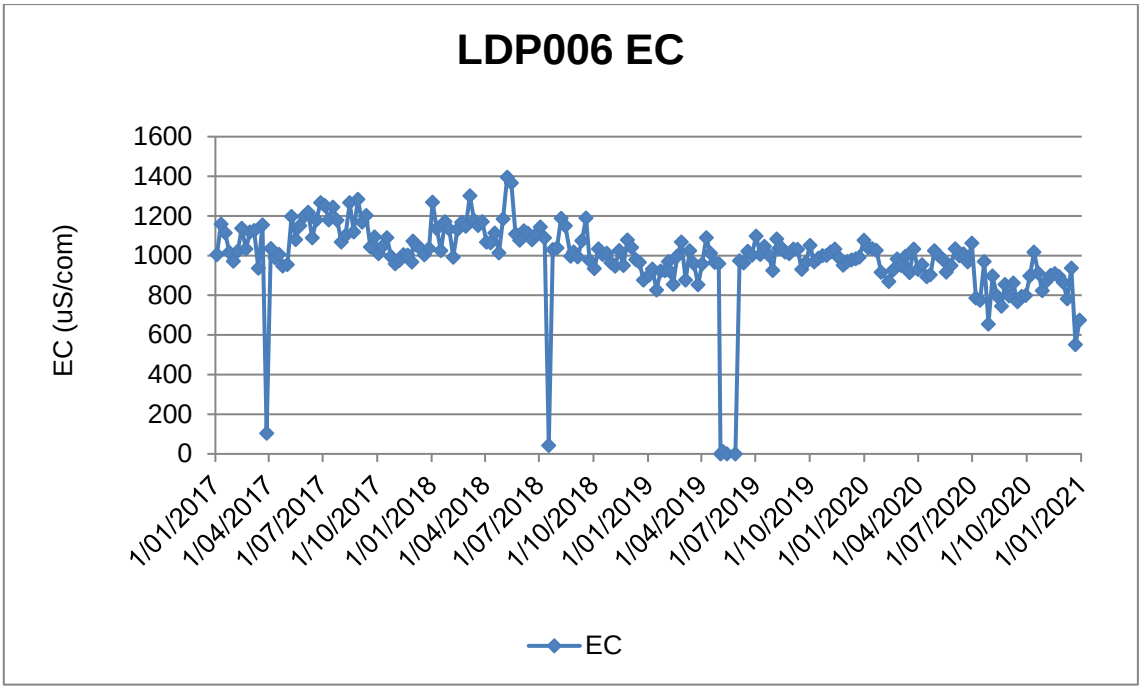
LDP006 Iron 2017 – 2021



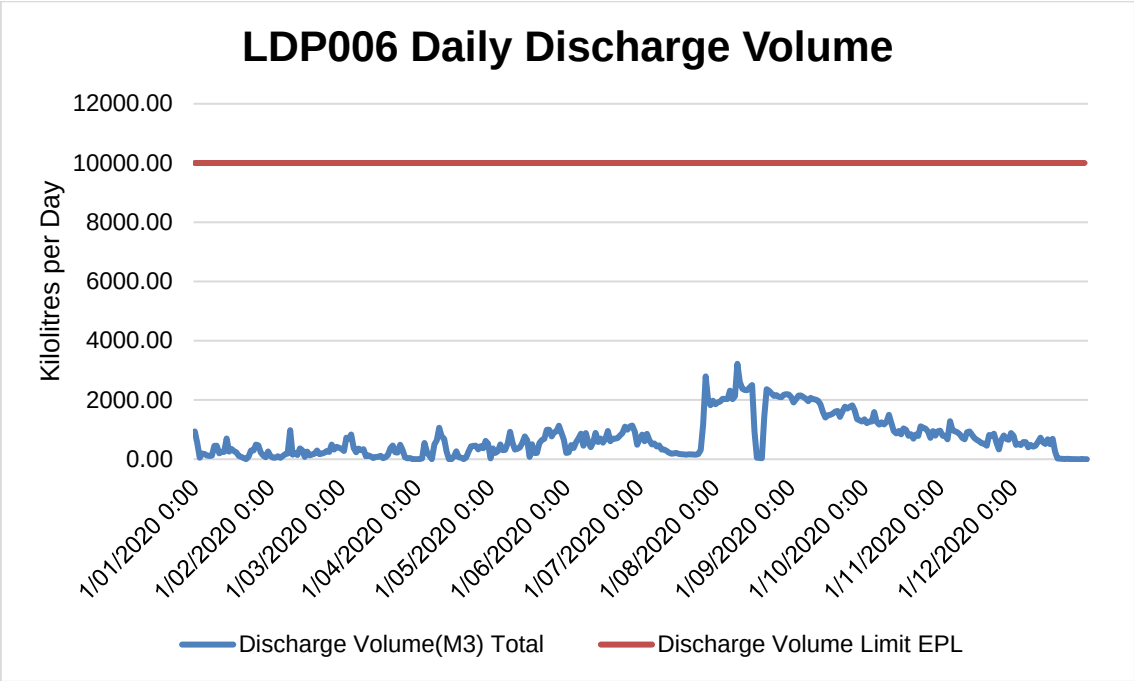
LDP006 Manganese 2017 - 2021



LDP006 Electrical Conductivity 2017 – 2021



LDP006 Discharge Volume 2020



APPENDIX 3 – GROUNDWATER AND SURFACE WATER ANNUAL REPORT

Centennial Coal Groundwater Monitoring

2020 Springvale Colliery AEMR

187 | a

26 February 2021

Springvale Colliery

IA161502

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Centennial Coal Groundwater Monitoring

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Executive Summary

Reporting Period

This review covers the twelve-month period from January 2020 to December 2020 ('the reporting period'). During the reporting period, Longwall 426 (LW426) and LW427 were mined.

Site Conceptual Hydrogeology

The series of aquifers and aquitards at Springvale form three basic groundwater systems:

- A perched groundwater system within the Burralow Formation, upon which the occurrence of shrub and hanging swamps tend to coincide.
- A shallow regional groundwater system within the Bankswall Sandstone, above the Mount York Claystone, ranging from unconfined to semi-confined.
- A significant aquitard, known as the Mount York Claystone separates the shallow and deep groundwater systems. The Mount York Claystone is a sequence of claystone and shale horizons that persist across the Newnes Plateau, averaging a thickness of 22m.
- A deep groundwater system, below the Mount York Claystone, which includes the Lithgow coal seam.

Rainfall

Overall rainfall for 2020 was above average during the reporting period on the Newnes Plateau with 1123mm recorded compared to a long term average of 924.5mm. 2020 rainfall represents an easing of the drought conditions that began in 2017. The high rainfall in February 2020 saw an increase in swamp water levels across most of the plateau.

Swamp Monitoring

Monitored swamps generally followed historic trends and water level fluctuations were closely related to fluctuations in the cumulative rainfall departure (CRD) during the reporting period. Monitoring wells in Pine and Nine Mile Swamp which previously showed declines coinciding with longwall extraction appeared to make a recovery in the lower reaches of the swamp. Water levels at Marrangaroo Swamp, the swamp closest to the active longwall, showed no mining impacts.

Regional Shallow Aquifer Monitoring

Groundwater levels in ridge standpipe bores were stable, showing subdued and delayed responses to climatic variability, most noticeably in regards to Cumulative Rainfall Departure (CRD) that has been declining since April 2017 till early 2020. SPR1211 and SPR1808 has shown a water level decline in response to the mining during the reporting period.

Deep Aquifer Monitoring

A comprehensive array of multi-level Vibrating Wire Piezometers (VWP) monitor deep groundwater levels throughout the site. The installations are designed to measure pore pressure response and the propagation of depressurisation, mainly within the lower sequence (Deep Groundwater system) including the coal measures, and to assess the effectiveness of the Mount York Claystone to act as an aquitard and constrain the upward propagation of depressurisation effects. During the reporting period, VWP's have generally shown a stable or slightly declining trend. Piezometers located in close proximity of active longwall extraction (SPR38, SPR1210 and SPR1302) showed declines in pore pressure.

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Surface Water Monitoring

Surface water quality and flow monitoring generally showed observation following historic trends during the reporting period. It was noted a few sites recorded elevated levels of some analytes particularly EC. This is most likely attributed to the altered ground conditions and runoff composition caused the Gospers Mountain bushfire.

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1. Introduction

1.1 Scope

As part of the environmental management for Springvale Colliery, an intensive monitoring programme has been implemented on the Newnes Plateau to detect impacts from underground mining on the groundwater regime, and in particular the Newnes Plateau Shrub Swamps (NPSS). The greater monitoring programme incorporates NPSS and groundwater monitoring locations above both Springvale Colliery and the adjacent Angus Place Colliery. The groundwater and surface water monitoring locations within the Springvale mine area (Figure A1 and Figure A2) include the following main aspects:

- Groundwater levels are monitored in 12 swamps, with a total of 46 swamp piezometers. Additional monitoring is also undertaken within two swamps off-lease (Best and Firetail Swamps), with four swamp piezometers across these two swamps.
- The groundwater levels in the aquifer systems of the Burralow Formation and Banks Wall Sandstone are measured in 18 piezometers that have been installed on the ridges between the swamps.
- Shallow groundwater levels adjacent to swamps are measured in 10 piezometers, which have been installed at the downgradient end of the majority of impact and reference swamps.
- Hydrogeological conditions in the shallow and deep groundwater systems above the working seam are monitored by 16 Vibrating Wire Piezometer installations (VWP).
- Deep groundwater levels are monitored at three stygofauna piezometers.
- Groundwater quality data is collected, when available, from 10 swamp piezometers across 5 swamps.
- Surface water flows in swamps were historically been measured at Junction Swamp (v-notch weir), Sunnyside Swamp (pool depth) and Carne West Swamp (pool depth). These locations have since been damaged by the Gospers Mountain bushfire.
- Surface water quality data is collected, when available, at 10 surface water sites.
- Soil moisture content and soil moisture profiles are monitored at 29 sites across 13 swamps.
- Rainfall data is collected at the Newnes Plateau Prison Farm rain gauge and at the Bureau of Meteorology rain gauge at Maddox Lane, Lithgow (BoM Station No. 063132).

Data are recorded at various frequencies as follows:

- At swamp and aquifer piezometers data is recorded daily.
- Surface water level data in pools and weirs is recorded daily.
- VWP data is recorded daily or twice daily.
- Manual measurements at swamp, perched and ridge piezometers are undertaken monthly.
- Barometric data is recorded daily for correction of swamp, perched and ridge piezometer water levels.
- Swamp flow rate and water quality data are recorded fortnightly.
- Soil moisture data is recorded daily.

This report discusses data for the period January 2020 to December 2020 (the reporting period). The latest downloaded data is presented, including data from previous reporting periods, to aid in the identification of longer-term trends. The report highlights any anomalies and/or mining-induced impacts observed during the reporting period for swamps, ridge piezometers and VWP. Any observed impacts that exceed trigger levels set out in the NPSS Management Plan are identified in order to implement the appropriate management solutions.

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1.2 Mining

During the reporting period, Longwall 426 (LW426) and Longwall 427 (LW427) were mined. LW426 commenced extraction on 11/11/2019 and finished on the 31/07/2020. LW427 commenced extraction on 28/09/2020 and at the end of 2020 approximately 700m had been extracted (Figure A.3).

The start and finish dates of historical mining at Springvale are tabulated below:

Table 1.1: Historic Longwall Dates

Longwall	Start	Finish
No 1	March 1995	Jan 1996
401	March/ April 1996	Jan/ Feb 1997
402	Feb/ Mar 1997	Nov/ Dec 1997
403	Jan/ Feb 1998	Nov/ Dec 1998
404	Jan/ Feb 1999	Feb/ Mar 2000
405	10/04/2000	26/03/2001
406	27/05/2001	23/01/2002
407	28/03/2002	9/01/2003
408	20/02/2003	18/12/2003
409	18/02/2004	10/12/2004
410	9/02/2005	19/01/2006
411	10/03/2006	26/10/2007
412	14/12/2007	22/06/2009
413A	7/08/2009	1/04/2010
413B	20/05/2010	29/12/2010
414	11/02/2011	21/11/2011
415	15/03/2012	17/09/2013
416	24/09/2013	19/08/2014
417	11/10/2014	4/07/2015
418	22/10/2015	30/05/2016
419	2/08/2016	18/03/2017
420	29/04/2017	9/11/2017
421	23/12/2017	15/06/2018
425	2/08/2018	16/08/2019
426	11/11/2019	31/07/2020
427	28/09/2020	-

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1.3 Criteria/ triggers

Performance triggers and measures are used to identify when observed variance exceeds the natural range, acting as an early warning sign for potential mining impacts; however, these conclusions can only be drawn through detailed investigation. This report will focus on the short term changes to identify any potential impacts for the period January 2020 to December 2020.

The performance indicators for monitoring sites pertain to their respective management plan, that is, either the SMP (Section 7) or the WMP (Section 8). A brief summary of the performance measures relevant to this report are summarised in Table 1.2.

Table 1.2: Trigger Summary

Swamp Management Plan performance trigger	
Swamp water levels	if the measured water levels are at less than the baseline 95th percentile for more than seven days
Ridge standpipes	if the seven-day moving average water levels are less than the 5th percentile for more than 1 month
Swamp groundwater water quality	if the values for **pH, EC and dissolved iron** exceed the baseline 80th percentile by two standard deviations for more than two months
Ridge standpipe water quality	if the following parameter measurements/ values are exceeded: - pH <2.73 or >7.87 - EC >100 µS/ cm - Fe > 1mg/ L
Swamp surface water quality	if the values for **pH, EC, iron, manganese, and TSS** exceed the baseline 80th percentile by two standard deviations for more than two months
Water Management Plan performance trigger	
Surface water quality	if the following parameter measurements/ values are exceeded: - TSS: 20 mg/ L - pH: 5.5 and 7.5 - EC: 30 µS/ cm.

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2. Existing Environment

2.1 Hydrogeology

The groundwater regime underlying the Springvale mining lease boundary can be grouped together to form three basic groundwater systems as follows:

- a perched groundwater system.
- a shallow regional groundwater system, ranging from unconfined to semi-confined.
- a deep confined groundwater system which includes the Lithgow coal seam.

The aquifer units identified above are each separated by strata of lower permeability, which behave as aquitards.

2.1.1 Perched Groundwater System – Burralow Formation

These systems comprise multiple, discontinuous, perched aquifer systems that are hydraulically independent of the underlying regional groundwater system. The perched groundwater is generally near surface geological horizons where the Burralow Formation is present. The perched system is recharged by excess rainfall and the presence of fine grained or less permeable claystone and siltstone horizons prevent infiltration to the shallow groundwater system. Six low permeability plies (designated YS1 to YS6) have been observed across the Springvale Mining lease.

The perched groundwater system produces seeps and discharge points at outcrop areas that are fundamental to the existence of hanging and shrub swamp systems. At the base of the perched groundwater system, a regionally continuous aquitard unit (YS6) separates the perched groundwater system from the underlying shallow groundwater system.

2.1.2 Shallow Groundwater System – Banks Wall Sandstone

This groundwater system is a regional system located in the Banks Wall Sandstone of the Narrabeen Group and extends to a depth of up to 200 m below ground surface.

Groundwater flow in this water bearing sequence is predominantly horizontal through more permeable structural defects and along bedding planes. Some vertical flow is likely to occur within the shallow groundwater system, such as the infiltration of rainfall in the upper part of the aquifer where it is exposed in gullies and by minor vertical leakage from the perched groundwater system.

Bish (1999) identified that the general flow direction in the shallow groundwater system is towards the northeast, which is consistent with the general formation dip direction. Recharge potentially occurs in areas of outcrop/sub-crop to the west and southwest of the study area. Discharge is inferred to occur to the northeast, where the geological unit outcrop in the scarp of the plateau.

At the base of the shallow groundwater system is the Mount York Claystone (MYC) horizon. This horizon comprises a sequence of shale and claystones that form a low permeability aquitard that greatly attenuates vertical connectivity between the Banks Wall Sandstone and the underlying deep groundwater system.

2.1.3 Deep Groundwater System

The deep groundwater system is located within the strata underlying the MYC and includes the Illawarra Coal Measures in the lower portion of the groundwater system, overlain by the Caley Formation and Burra Moko Head Sandstone in the upper portion. The deep groundwater system is approximately 200 m thick, the upper boundary of which is typically found at a depth greater than 200 m below ground surface. Most of the coal measures overlying the Lithgow seam in this groundwater system have low permeability characteristics. There are a small number of aquifer units in the system that have a slightly higher permeability and represent the water bearing zones.

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The few water-bearing zones that occur at depth in this groundwater system are typically fractured rock aquifers (with groundwater flow exploiting the secondary porosity, fracture-plane conduits). These include jointed or cleated coal seams and other localised jointed or fractured lithologies, often adjacent to faults.

2.2 Swamp Classification

For past assessments, the swamps in the monitoring programme have been divided into two basic types based on an interpretation of the dominant source of water within the swamp. This interpretation was undertaken based on the monitoring results available at the time. The two basic types identified are:

- Type A: swamp water derived predominantly from rainfall infiltration (periodically waterlogged swamps)
- Type C: swamp water derived predominantly from groundwater discharge as well as rainfall contribution (permanently waterlogged swamps).

It has become apparent through ongoing monitoring that a rigid classification of swamps is not always entirely appropriate. Swamps within the study area have shown to transition between both rainfall and groundwater dependant within the same swamp. The point of transition will vary depending on the prevailing climatic conditions (in particular CRD) and its geological setting. Different swamps, and different areas of the same swamp, can display varying lag times between predominantly wet or dry conditions and a corresponding fluctuation in water levels. This can be further compounded if a swamp is hydraulically connected with multiple perched aquifers along its length.

Extensive baseline data collected over the past years has shown that following a prolonged period of prevailing dry conditions (below average rainfall), numerous swamps that had previously been classified as Type C, are now displaying a tendency towards Type A characteristics.

This observation has prompted a move away from applying the swamp classification until a more definitive analysis of long-term trends can be undertaken.

2.3 Rainfall Data

Daily rainfall is measured at the ALS Environmental Newnes Plateau Prison Farm Rain Gauge and at the Bureau of Meteorology rain gauge at Maddox Lane, Lidsdale (BoM Station No. 063132). Two weather stations were used in analysis because local weather patterns in Lithgow can vary due to the variable nature of the landscape. Rainfall data is summarised in Table 2.1 and shown on Figure 2.1. Figure 2.2 shows the cumulative rainfall departure (CRD) which is a tool to evaluate the correlation of rainfall with groundwater levels. It uses a running difference between daily rainfall and average rainfall.

Recent observations and long-term averages at these locations have been compared because the Newnes Plateau rainfall period is relatively short for calculating representative long-term conditions. The Newnes Plateau rainfall gauging period commenced in August 1998 compared to Lidsdale weather station which commenced recording rainfall in 1959. It is noted there are rainfall differences between the two sites as the landscape of Newnes Plateau can create localized rainfall patterns.

In the years before 2020, rainfall at Newnes Plateau can be described as:

- Steady average rainfall from 2012 to 2015
- Declining below average rainfall between 2015 to 2017
- Severe below average rainfall and drought conditions from 2017 to 2019

Recorded rainfall at the Newnes Prison farm gauge has been observed to be greater than the Maddox lane rain gauge at Lidsdale across most months. From around 2016 to the end of 2019 drought conditions were prevalent throughout most of NSW. A return to normal rainfall in 2020 saw drought conditions ease. Significantly above average rainfall fell in February 2020 (262.6mm) which recharge in swamp water levels across the plateau.

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Overall annual rainfall was above average. There were a few months where rainfall was below average, in January, June and November.

Table 2.1: Monthly Rainfall

Month	2020 Rainfall (mm) and difference		Long Term Average Rainfall* (mm)	
	Newnes Plateau	Lidsdale	Newnes Plateau	Lidsdale
Jan	61.8 (-25.9)	46.8	87.7	85.8
Feb	262.6 (144.4)	131.6	118.2	79.5
Mar	124.6 (17.4)	115.0	107.2	66.6
Apr	87.2 (27)	93.6	60.2	42.4
May	41.2 (-1.2)	47.8	42.4	47.9
Jun	39.4 (-36.2)	39	75.6	49.3
Jul	85.4 (33.5)	77.8	51.9	64
Aug	89.4 (33.9)	103.8	55.5	62.4
Sept	53.2 (-0.9)	57	54.1	53.0
Oct	84.8 (6.6)	68.6	78.2	67.1
Nov	60 (-44.2)	76.4	104.2	72.4
Dec	133.2 (43.9)	125	89.3	73.9
Total	1123 (198.6)	982.4	924.5	764.3

*Lithgow average for all years since 1959; Newnes average for all years since 1998.

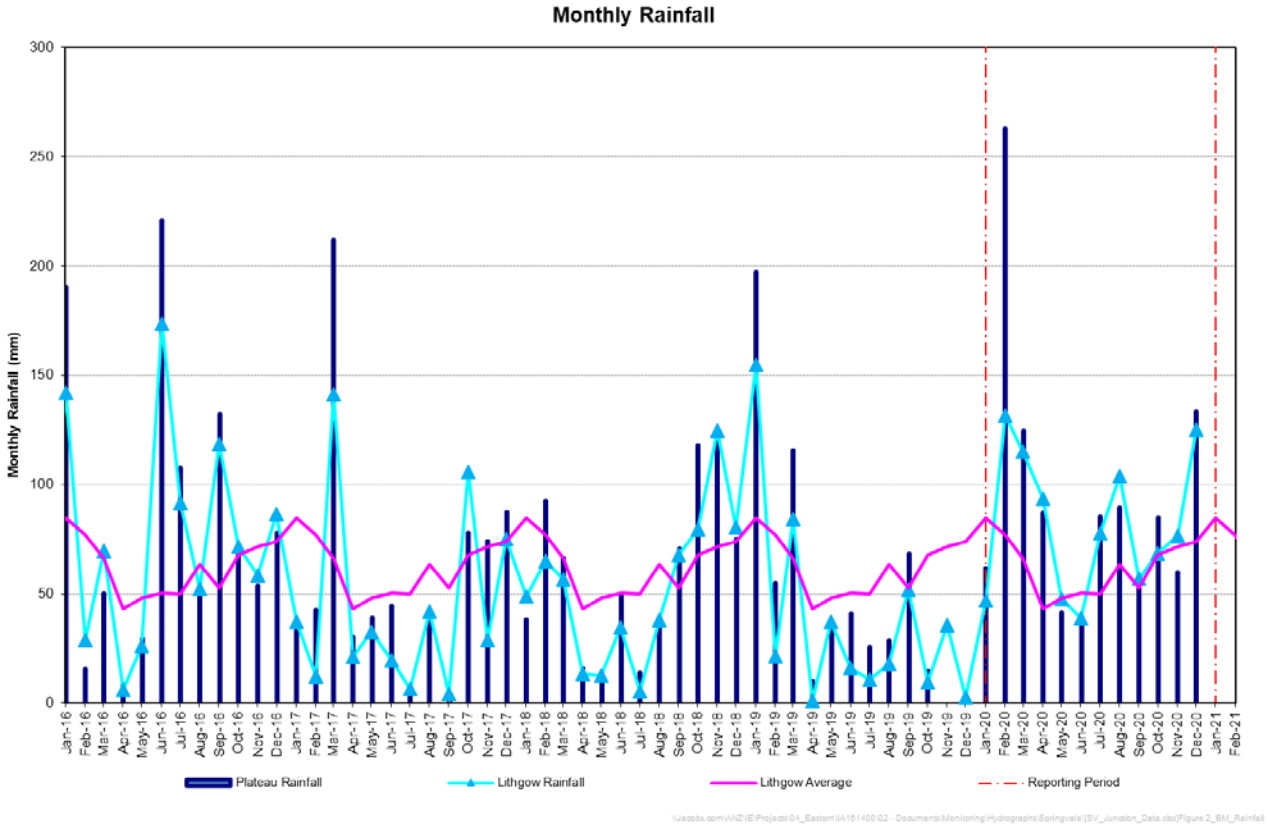

Figure 2.1: Monthly Rainfall (Lithgow and Newnes Plateau) 2016 to 2020.

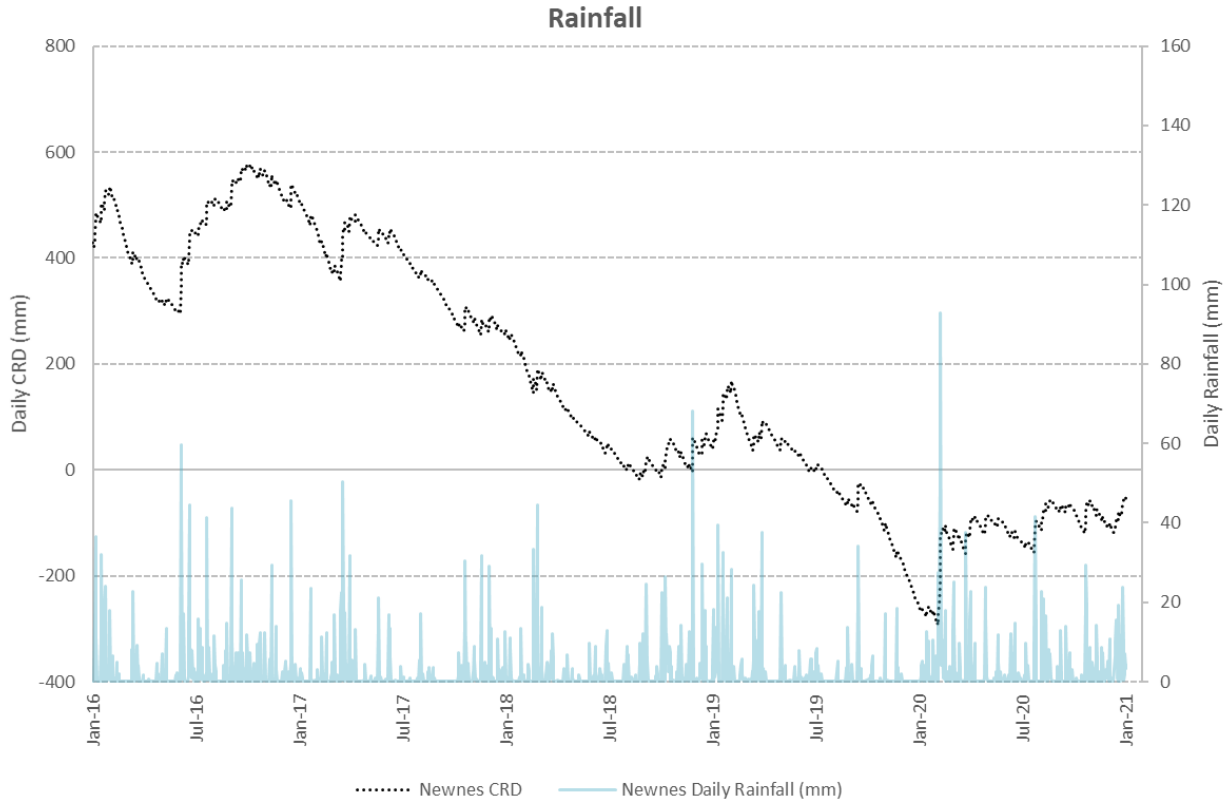

Figure 2.2: CRD of Newnes Plateau

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3. Swamp Water Level Monitoring

Swamp monitoring hydrographs are shown below in each respective section, and the locations of all monitoring bores are shown on Figure A.1 in Appendix A. Five of these swamps (Twin Gully, Tri Star, Fire Tail, Barrier and Best Swamps) are considered reference swamps and included for understanding of regional trends in swamps. It is noted that some swamp hydrographs show cyclic drawdown responses that are the result of routine water quality sampling.

The following sections summarise the key observations at swamp piezometer during the monitoring period. The relevant longwalls and their active mining periods are tabulated along with the commencement of water level records in the respective swamp. An interpretation summary can be found in Section 3.3.

3.1 Reference Swamps

3.1.1 Barrier Swamp

There are three piezometers installed in Barrier Swamp and the shallow aquifer is monitored downstream at SPR1608. Groundwater at Barrier swamp is primarily fed by the outcropping of the YS4 ply which runs parallel to the length of the swamp. The swamp terminates downstream intersecting with the YS5, YS5a and YS6 plies.

Data from the borelogs was used to characterise the swamp profile. The average depth of the swamp is approximately 1m with a weathered sandstone bedrock. The surface peat layer is typically 0.3 m to 0.6 m thick, under which lies a clayey sand or sand that transitions into a weather sandstone.

The mined status is detailed in **Table 3.1.** Hydrographs for BA1 to BA3 are shown below.

Table 3.1: Barrier Swamp Piezometer Information

Piezometer	Mined Status	Monitoring Commencement	Easting (GDA94z56)	Northing (GDA94z56)
BA1	Not undermined	11/04/2018	242024	6302814
BA2	Not undermined	9/04/2018	242099	6303297
BA3	Not undermined	9/04/2018	242070	6303923

Barrier Swamp is a reference swamp located off the extraction area. It is a waterlogged swamp that exhibits stable water levels with a large groundwater base flow contribution. Water levels at the three piezometers reflect the general trends of the CRD curve and respond to rainfall events in relative agreement, with downgradient piezometers BA2 and BA3 showing larger variation in water levels.

In 2020, BA1, BA2 and BA3 showed stable water levels following an increase from the rainfalls in February 2020. The piezometers each responded to CRD in relative agreement, with downgradient piezometers BA2 and BA3 showing larger variation in water levels.

No mining related impacts are visible in the monitoring data.

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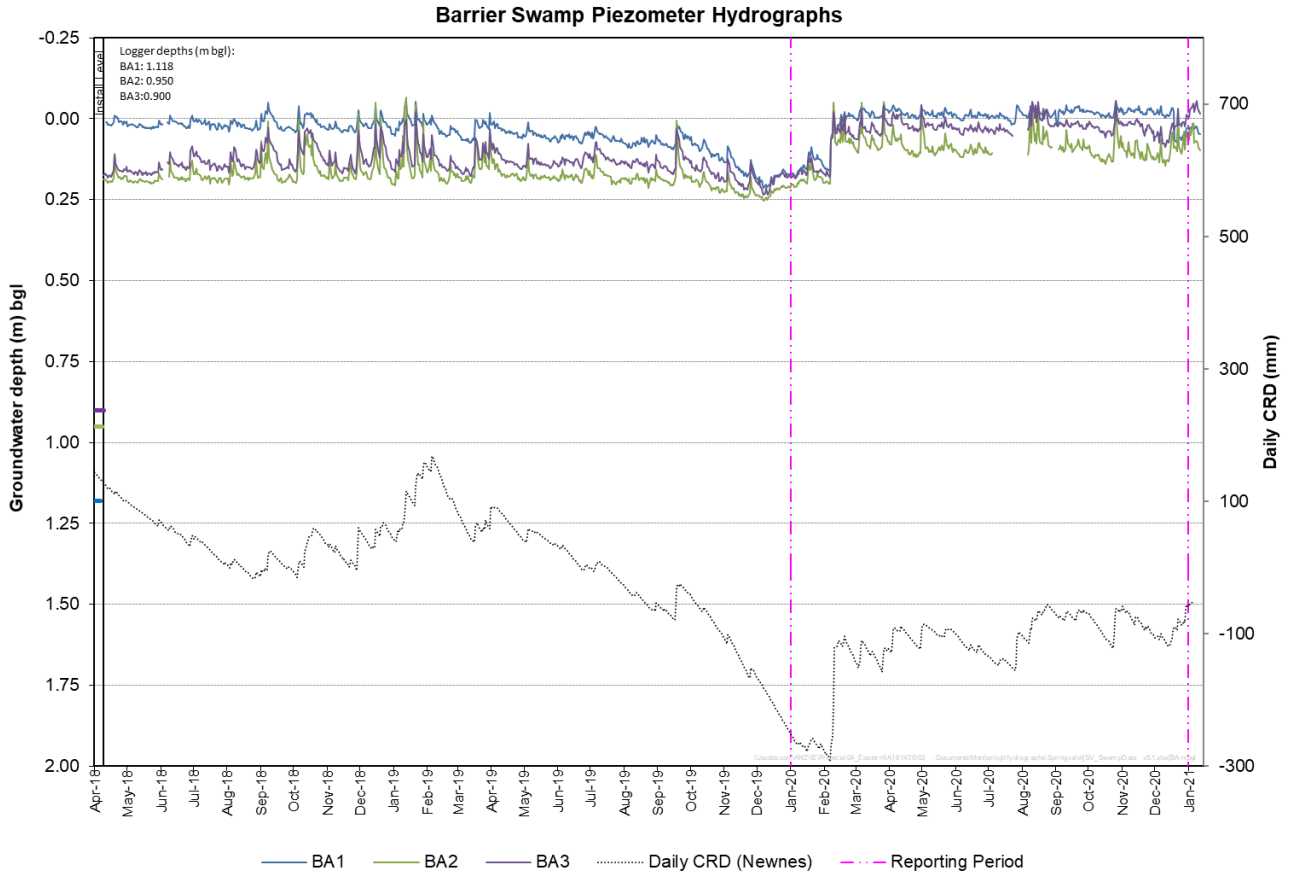

Figure 3.1: Barrier Swamp Hydrograph

3.1.2 Best Swamp

Best Swamp is a reference swamp located off the extraction area. It is a waterlogged swamp with water levels strongly correlated to the CRD curve particularly at BE1 located upstream. The declining water levels since installation to January 2020 reflect the drought conditions and reduction in groundwater recharge since 2016. The correspondence of the peaks of the hydrograph and the CRD suggest rainfall has a strong influence on short term water levels at Best Swamp.

There are two piezometers installed in Best Swamp (BE1 and BE2) and the shallow bedrock aquifer is monitored by SPR1612. Borelogs were used to characterise the swamp profile. The swamp thickness is approximately 1.5 m and lies above a weathered sandstone bedrock. The profile thickness is varied, with the peat layer in the upstream section at BE1 approximately 0.7 m thick and at BE2 it is 0.3 m thick. At BE1, beneath the peat, is a thin (0.2m) layer of clayey sand that transitions into a 0.5 m thick weathered sandstone soil that terminates on bedrock. At BE2, above the bedrock is a 0.6m thick weathered sandstone soil, then a 0.4 m layer of clayey sand with bands of clay, then a 0.2 m later of sand with a peat surface.

The mined status is detailed in Table 3.2.. Hydrographs for BE1 and BE2 are shown below.

Table 3.2: Best Swamp Piezometer Information

Piezometer	Mined Status	Monitoring Commencement	Easting (GDA94z56)	Northing (GDA94z56)
BE1	Not undermined	12/04/2018	245818	6307614
BE2	Not undermined	12/04/2018	246565	6308274

The declining trend continued into 2020 until the rainfall in February 2020 recharged the swamp. The water level has remained relatively stable since. No mining related impacts are visible in the monitoring data.

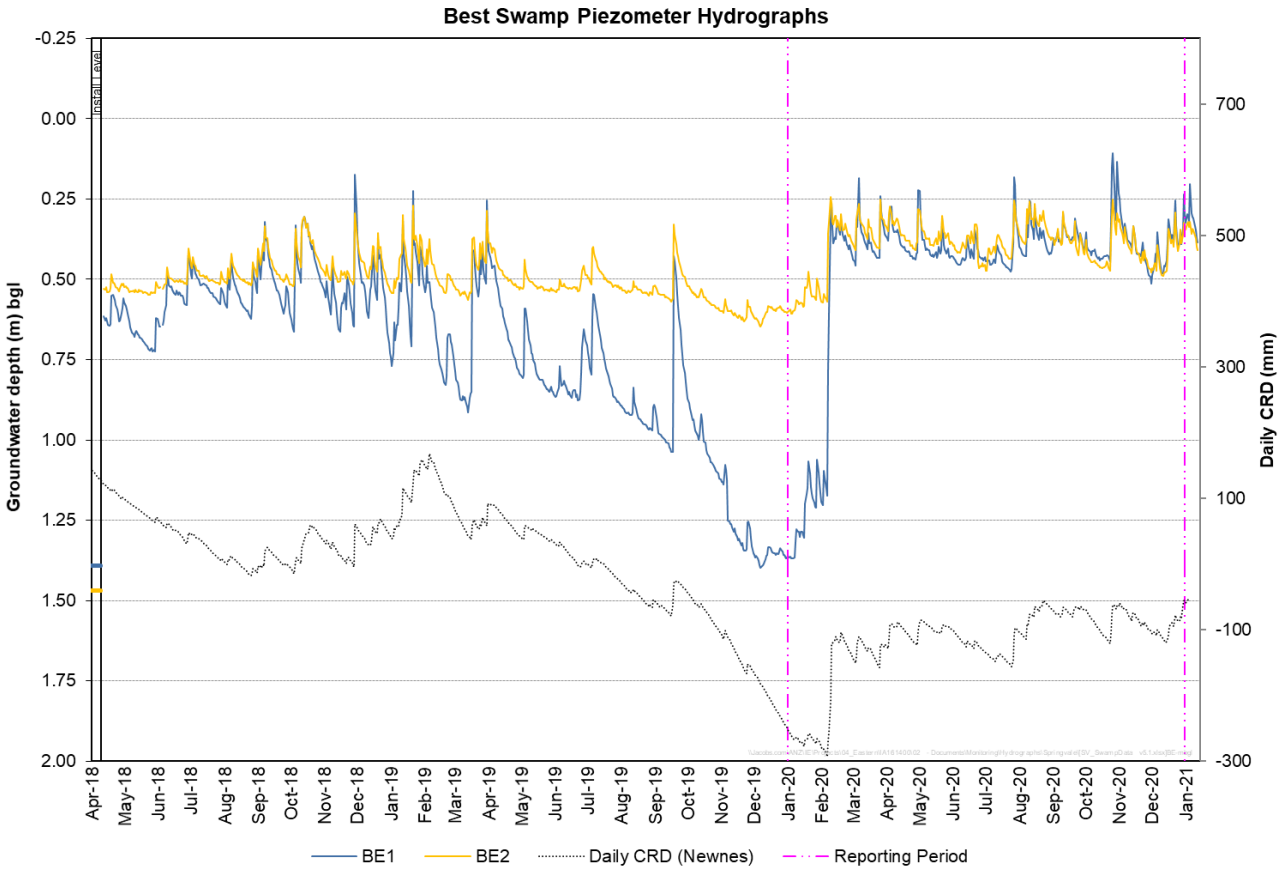

Figure 3.2: Best Swamp Hydrograph

3.1.3 Carne Central Swamp

There are two piezometers (CC1 and CC2) installed in Carne Central Swamp, which is defined as a reference swamp. The shallow aquifer is monitored by SPR1604. The swamp is fed by outcropping of the YS4 ply in the upstream section near CC1 and YS5 ply near CC2. Further downstream Carne Central hanging swamp is supported outcropping of the YS5, YS5a and YS6 plies near the cliff edge.

Bore log data was used to characterise the swamp profile. The upstream section at CC1 has a 0.2m of root mat followed by a 0.2m of sandy clay, then by a 0.5m later of clayey sands and terminates on weathered sandstone bedrock at 0.95m. The downstream section at CC2 is characterised by a 0.3m surface peat layer followed by a 0.3m clayey sand layer followed by a 0.2m sandy clay layer that transitions into a weathered sandstone profile (0.4m thick) and terminates on bedrock. The clay layers within the swamp profile are likely related to the outcropping plies.

Mined status is detailed in Table 3.3.. The hydrographs for CC1 and CC2 are presented below.

Table 3.3: Carne Central Swamp Piezometer Information

Piezometer	Mined Status	Monitoring Commencement	Easting (GDA94z56)	Northing (GDA94z56)
CC1	Not Undermined	14/10/2011	241175	6302695
CC2	Not undermined	19/04/2018	241131	6303290

Carne Central swamp is a reference swamp with water levels strongly correlating to the CRD curve. The sharp drawdowns observed in the hydrograph are sampling spikes caused by bore purging. The declining water levels from 2016 to 2018 and the dryness from 2018 to 2020 at CC1 reflect the drought conditions experienced on the plateau. Although CC2 is located downgradient, water levels did not readily respond to rainfall in mid 2018 because it is situated on the edge of the swamp. During this time, Carne Central Swamp has transitioned from a permanently waterlogged swamp into a periodically waterlogged swamp

In 2020, with the above average rainfall conditions since February 2020, waterlogged conditions were once again observed at the swamp. However, the declining trend suggest that the above average rainfalls have not recharged groundwater sufficiently for the return to pre-drought conditions. The two peaks in water levels in February and august are linked to the period of sustained above average rainfalls.

No mining related impacts are visible in the monitoring data.

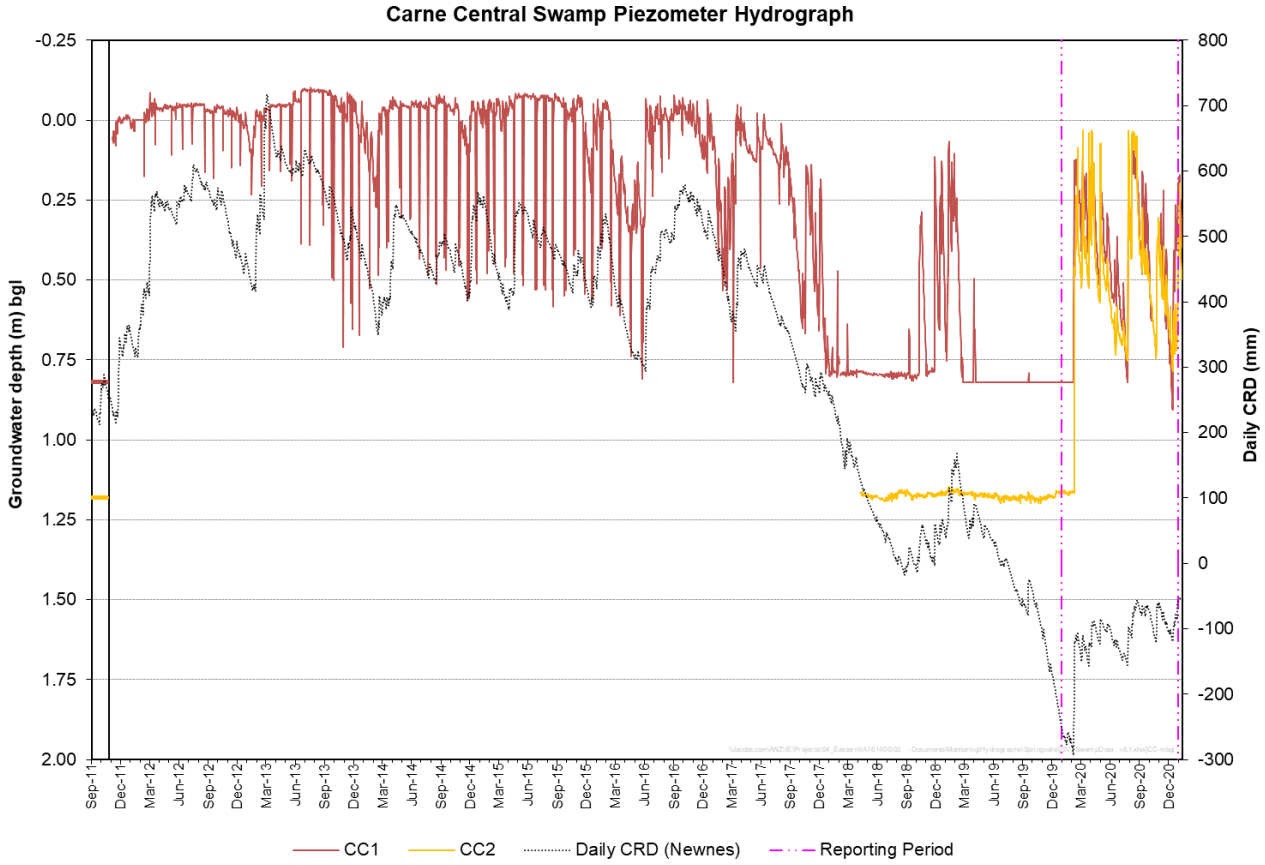

Figure 3.3: Carne Central Swamp Hydrograph

3.1.4 Fire Tail Swamp

There are two piezometers (FS1 and FS2) installed in Fire Tail Swamp and the shallow aquifer is monitored by SPR1611. The swamp is characterised from the bore log data. The profile between FS1 and FS2 is different due to the siting of FS2 which is located on the very edge of the swamp. The profile at FS1 is relatively deep at 2.9m with a 0.4m surface peat layer, followed by a 2.5m layer of clayey sands with two 0.2m bands of clay between 1m and 1.5m depth, and terminating on bedrock. The profile at FS2 is relatively shallow at 0.5m deep with a 0.3m surface peat layer followed by a think 0.1m sandy layer that transitions into the weathered sandstone bedrock.

The mined status is detailed in Table 3.4.. Hydrographs for FS2 and FS2 are shown below.

Table 3.4: Fire Trail Swamp Piezometer Information

Piezometer	Mined Status	Monitoring Commencement	Easting (GDA94z56)	Northing (GDA94z56)
FS1	Not undermined	12/04/2018	246893	6306485
FS2	Not undermined	12/04/2018	247489	6307074

Firetail Swamp is located off the extraction area. Both swamp piezometers show fluctuations corresponding the CRD curve with more pronounced variations at FS1 which has a greater depth profile. Towards the end of the drought in late2019, FS1 showed a strong decline and FS2 was dry.

In 2020, large increases in water levels were observed from January to February associated with the heavy rainfall following drought conditions. Following this the general water level trend has remained relatively stable with fluctuations corresponding to rainfall. Both monitoring wells display similar magnitude of responses to rainfall events.

No mining related impacts are visible in the monitoring data.

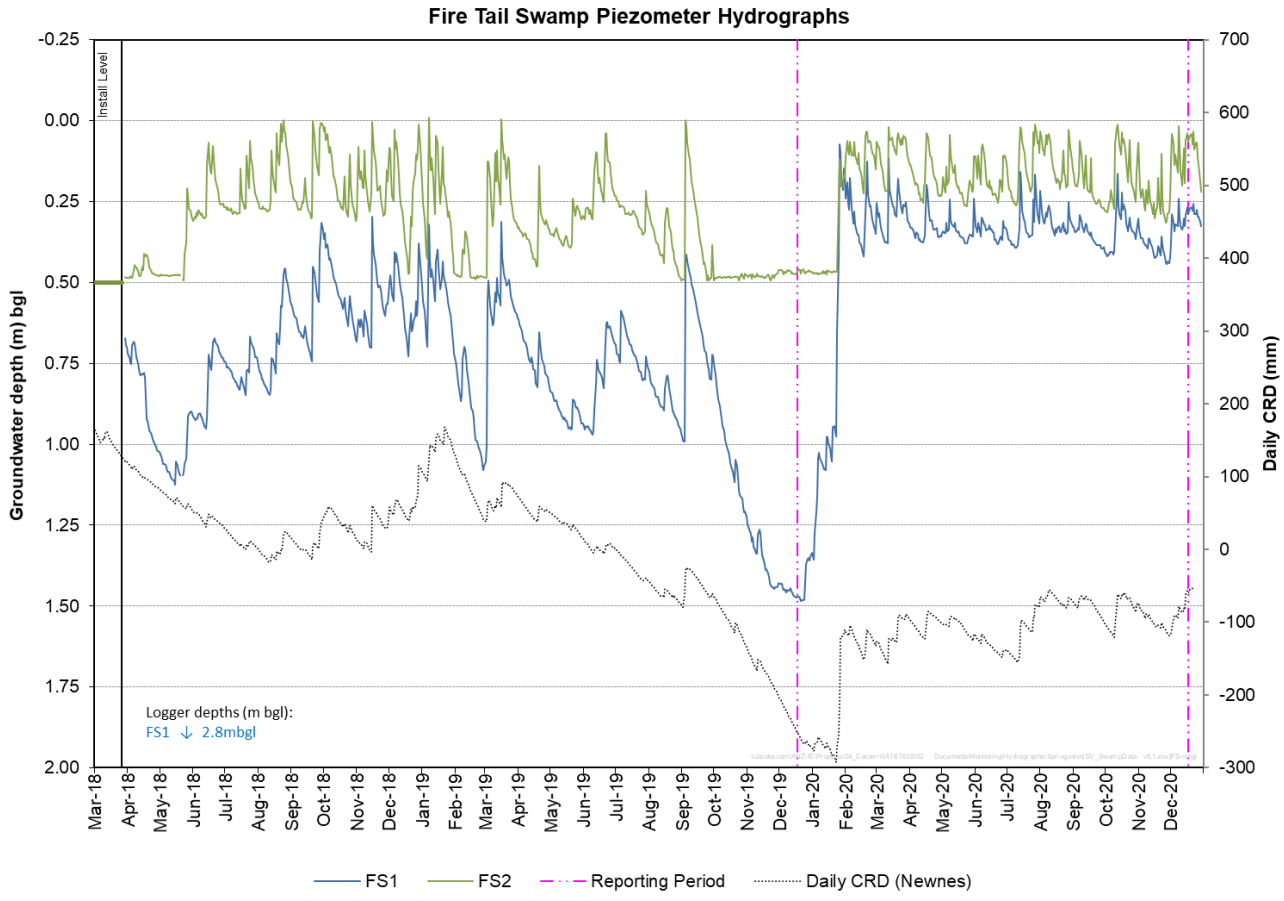

Figure 3.4: Firetail Swamp Hydrograph

3.1.5 Twin Gully Swamp

There are two piezometers (TG1 and TG2) installed in Twin Gully Swamp. Twin Gully lies predominantly over AQ4 (Banks Wall sandstone) and commences between the YS5 and YS6 plies where hanging swamps are observed. On the southern side of the swamp, a hanging swamp outcrops from the YS6 ply where there is a permanent pool of water.

Twin Gully Swamp is highly channelized with free-flowing surface water. The swamp is characterised by a surface peat layer above a sandy/ weathered sandstone profile. TG1 is located on the edge of the swamp and there is only a think root mat layer, whereas at TG2, which is located within the swamp, there is a 0.3m peat layer. The depth of the swamp varies from 0.9m to greater than 1.1m. It is noted the total depth from the bore log of TG1 is not representative as drilling was terminated prior to refusal on bedrock due to collapse of the borehole.

Mined status is detailed in Table 3.5.. The hydrographs for TG1 and TG2 are shown below.

Table 3.5: Twin Gully Swamp Piezometer Information

Piezometer	Mined Status	Monitoring Commencement	Easting (GDA94z56)	Northing (GDA94z56)
TG1	Not Undermined	14/ 10/ 2011	236436	6308767
TG2	Not undermined	11/ 04/ 2018	236043	6308932

Twin Gully Swamp is a reference swamp located on Angus Place. Water levels are correlated to the CRD curve and the trends between TG1 and TG2 are very similar. Long term water level trends at Twin Gully are relatively stable and fluctuate around a stable mean. It suggests there is a large groundwater baseflow contribution to the swamp that maintains its waterlogged conditions.

In 2020, water levels continued to show a close correspondence with CRD and showed a large increase in February in response to the heavy rainfall following drought conditions, TG1, located further upgradient, displayed a more stable water compared to TG2.

No mining related impacts are visible in the monitoring data.

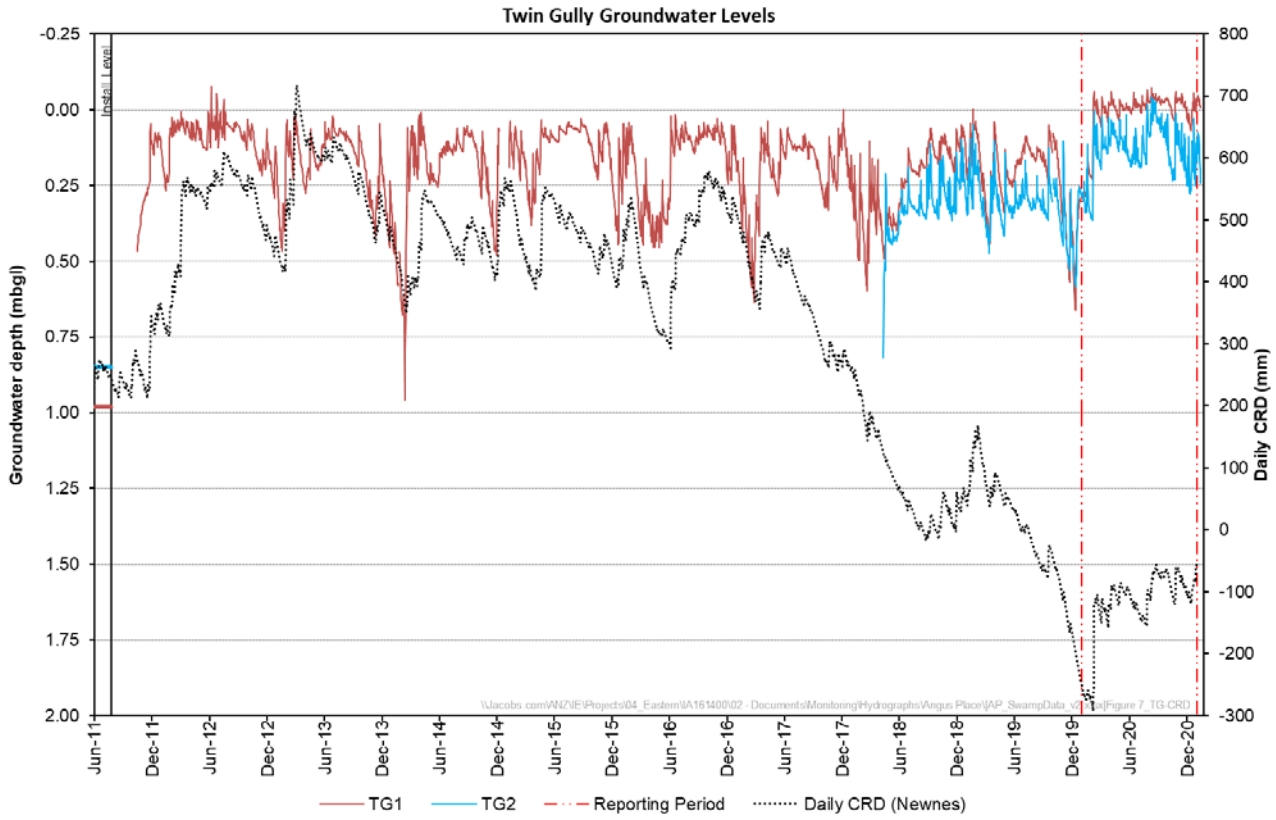

Figure 3.5: Twin Gully Swamp Hydrograph

3.1.6 Tristar Swamp

Water levels are monitored in three piezometers (TS1, TS2 and TS3) at Tristar Swamp. The swamp consists of two arms that converge in the main swamp valley. The swamp lies above AQ4 and AQ5 with the upper reaches of the swamp commencing below YS5. Tristar Swamp likely receives seepage from YS5, and YS6 plies. Two substantial hanging swamps coincide with the location of YS5 above the upper reaches of the two arms of the swamp. A large proportion of the swamp is situated within the Banks Wall Sandstone formation which is apparent in the sandy profile of the swamp below the confluence.

The swamp is characterised by a peaty/ highly organic surface soil layer that ranges from 0.3m to 1.1m, and a sandy profile that extends to the weathered sandstone bedrock. The valley walls are steep, and the swamp is highly channelised with free-flowing surface water observed down gradient at TS3. The swamp profile is very deep compared to other swamp on the plateau with the bedrock encountered 3.95m below ground level at TS1 and hole termination beyond 2m due to collapse at TS2.

Mined status is detailed in Table 3.6 The hydrographs for TS1 to TS3 are shown below.

No mining related impacts are visible in the monitoring data.

Table 3.6: Tristar Swamp Piezometer Information

Piezometer	Mined Status	Monitoring Commencement	Easting (GDA94z56)	Northing (GDA94z56)
TS1	Not Undermined	14/10/2016	237555	6307286
TS2	Not Undermined	04/10/2016	237446	6306779
TS3	Not Undermined	01/11/2016	236897	6307163

Tristar Swamp is a reference swamp located in Angus Place. The swamp consists of three branches that each have different hydrology, and each monitored with a swamp piezometer.

The swamp at TS1 is rainfall dependent with water levels only observed during periods of prolonged above average rainfalls. The swamp regularly becomes dry in periods of declining rainfall as observed in CRD curve in 2013 and from 2016 onwards. In 2020, the rainfalls in February and August filled the swamp before slowly draining.

The swamp at TS2 is strongly influenced by the prevailing rainfall conditions closely following the CRD curve. Compared to TS1, the swamp at TS2 retains water for a longer period. The water levels fell below the base of the borehole in mid-2017, but it is likely the water table was still present in the swamp profile. The borehole screened section did not reach the targeted depth at the base of the swamp due to caving during construction. Since the rains in February 2020, the swamp at TS2 has returned to waterlogged conditions.

The swamp at TS3 is waterlogged with evidence of a strong groundwater contribution. Water levels remained stable through the drought from 2016 and rainfall events do not significantly influence water levels compared to the other two branches. The above average rainfalls in February 2020 raised the average standing water level height where it has remained stable since.

No mining related impacts are visible in the monitoring data.

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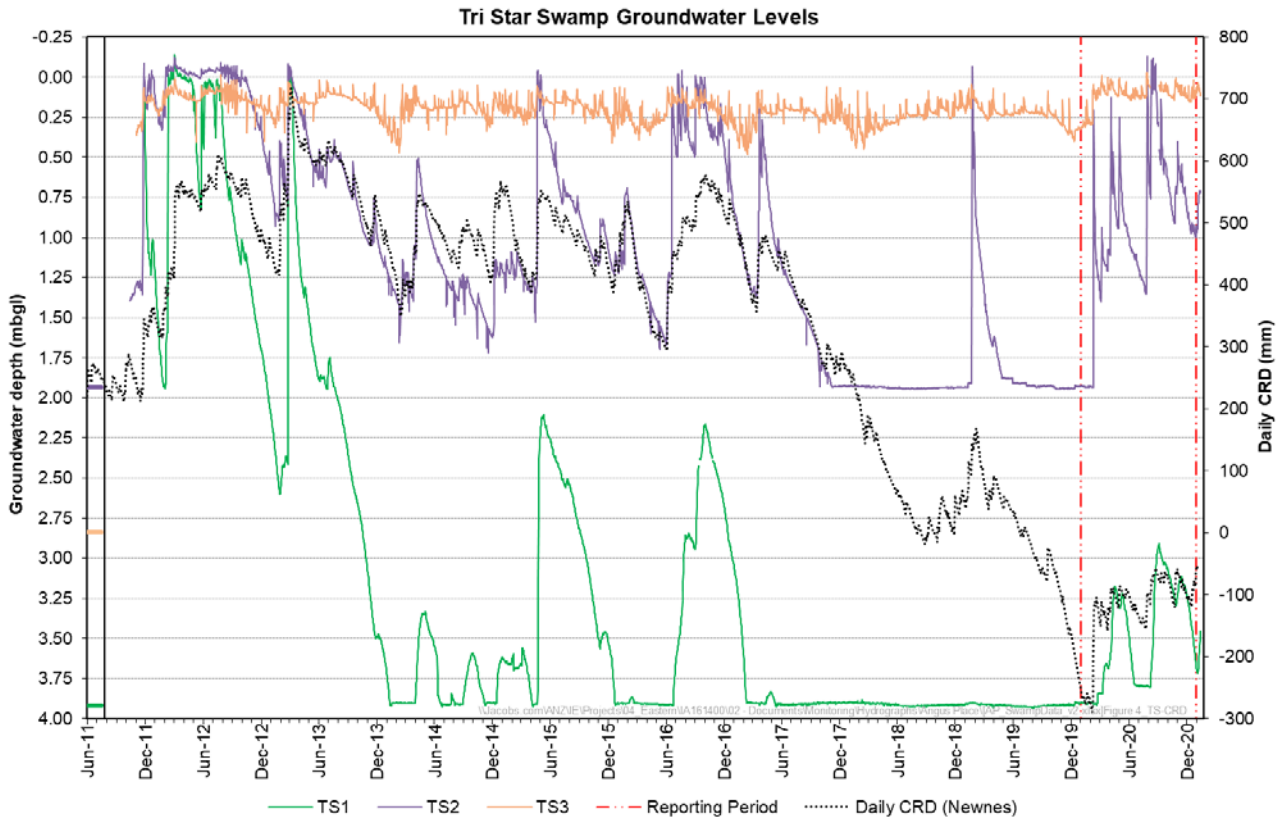

Figure 3.6: Tristar Swamp Hydrograph

3.2 Impact Swamps

3.2.1 Carne West Swamp

There are four piezometers installed (CW1 – CW4) in Carne West Swamp and the shallow aquifer is monitored by bore SPR1601. Carne West Swamp overlies AQ5 and AQ6 of the Burralow Formation. The hanging swamp upstream of Carne West coincides with the outcropping of the YS2 ply and the swamp terminates downstream of YS5. Carne West likely receives groundwater input from above the YS3 and YS4 plies, and to a lesser extent YS5 plies. CW1 and CW2 are installed in AQ4 beneath the YS4 ply. CW3 and CW4 are installed in AQ6, above and below the YS3 ply respectively. SPR1601 is installed in the lower Burralow Formation beneath the YS5 ply. The swamp alignment also coincides with the regional Deanes Creek lineament structural zone.

Data from the four swamp bore logs were used to characterise the swamp. There is a 0.4m – 0.8m peat top layer, and below that a layer of sand/ gravelly sand that transitions into the weathered bedrock. At CW3 there is a clay presence that is likely related to the YS3 ply. The depth of the swamp varies from 1 – 1.5m.

Mined status is detailed in Table 3.7. Hydrographs for CW1 to CW4 are shown below.

Table 3.7: Carne West Piezometer Information

Piezometer	Mined Status	Monitoring Commencement	Easting (GDA94z56)	Northing (GDA94z56)
CW1	LW419 (2016-2017)	12/05/2005	239350	6303195
CW2	LW419 (2016-2017)	12/05/2005	239379	6303249

CW3	LW418 (2015-2016)	14/10/2011	238982	6302173
CW4	LW417 / 418 (2014-2016)	14/10/2011	239075	6302375

Piezometers at CW1 and CW2 were damaged by the Gospers Mountain bushfires in early 2020 and were subsequently reinstated. Water levels at CW1, CW2, CW3 and CW4 primarily remained below the base of the piezometer during the reporting period. A temporary water level increase was recorded at CW2 in February 2020.

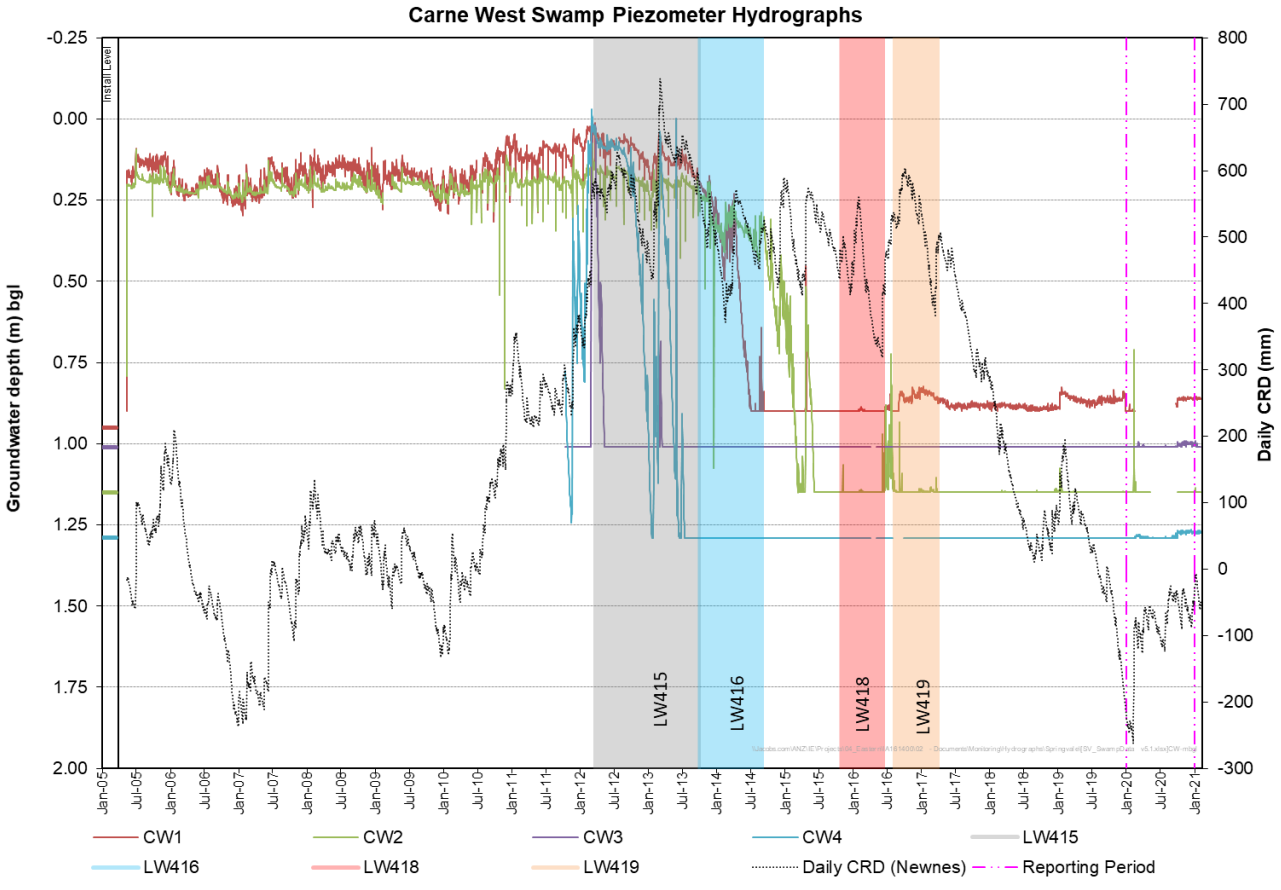

Figure 3.7: Carne West Swamp Hydrograph

3.2.2 Gang Gang West Swamp

There are four piezometers (GW1 – GW4) in Gang Gang West Swamp and at shallow aquifer monitoring bore SPR1602. The upper reach of the swamp starts just above the YS4 ply and the swamp terminates on the YS5 ply Gang Gang West likely receives seepage contribution from above each ply. A lineament is mapped along the length of the swamp and is connected to the Deanes Creek lineament.

Data from GW1 and GW2 borelogs and the GW3 soil analysis were used to characterize the swamp profile. The swamp profile is thinner than at Gang Gang swamp with a thickness of the order of 0.6 to 0.7m. The top layer comprises of a highly organic sandy clay/peat about 0.3m thick. Below this is a layer of sand that transitions into the weathered sandstone bedrock.

Mined status is detailed in Table 3.8. Hydrographs for GW1 to GW4 are shown below.

Table 3.8: Gang Gang West Swamp Piezometer Information

Piezometer	Mined Status	Monitoring Commencement	Easting (GDA94z56)	Northing (GDA94z56)
GW1	LW420 (2017)	14/10/2011	239820	6302891
GW2	LW420 (2017)	14/10/2011	240258	6303093
GW3	Not Undermined	01/10/2016	240397	6303190
GW4	LW420 (2017)	02/10/2016	239906	6302926

The first impacts were observed in the upper reaches at GW1 in August 2014 at the end of LW416 as it intersected the Deanes Creek lineament. The subsequent longwalls saw increasing changes to the swamp water levels as the swamp was observed to have a decreasing groundwater baseflow contribution. By the time the swamp was directly undermined by LW420 it was already dry.

The groundwater level trigger has already been investigated and the evidence suggested mining impacts were a probable cause.

Piezometer GW2 was damaged in the Gospers Mountain bushfire of 2020 and was decommissioned. Gang Gang West has been primarily dry since it was undermined. In February and August 2020, a rainfall response was observed at GW1, GW3 and GW4 with the most pronounced response recorded at GW4. Aside from these two periods, Gang Gang West was predominately dry.

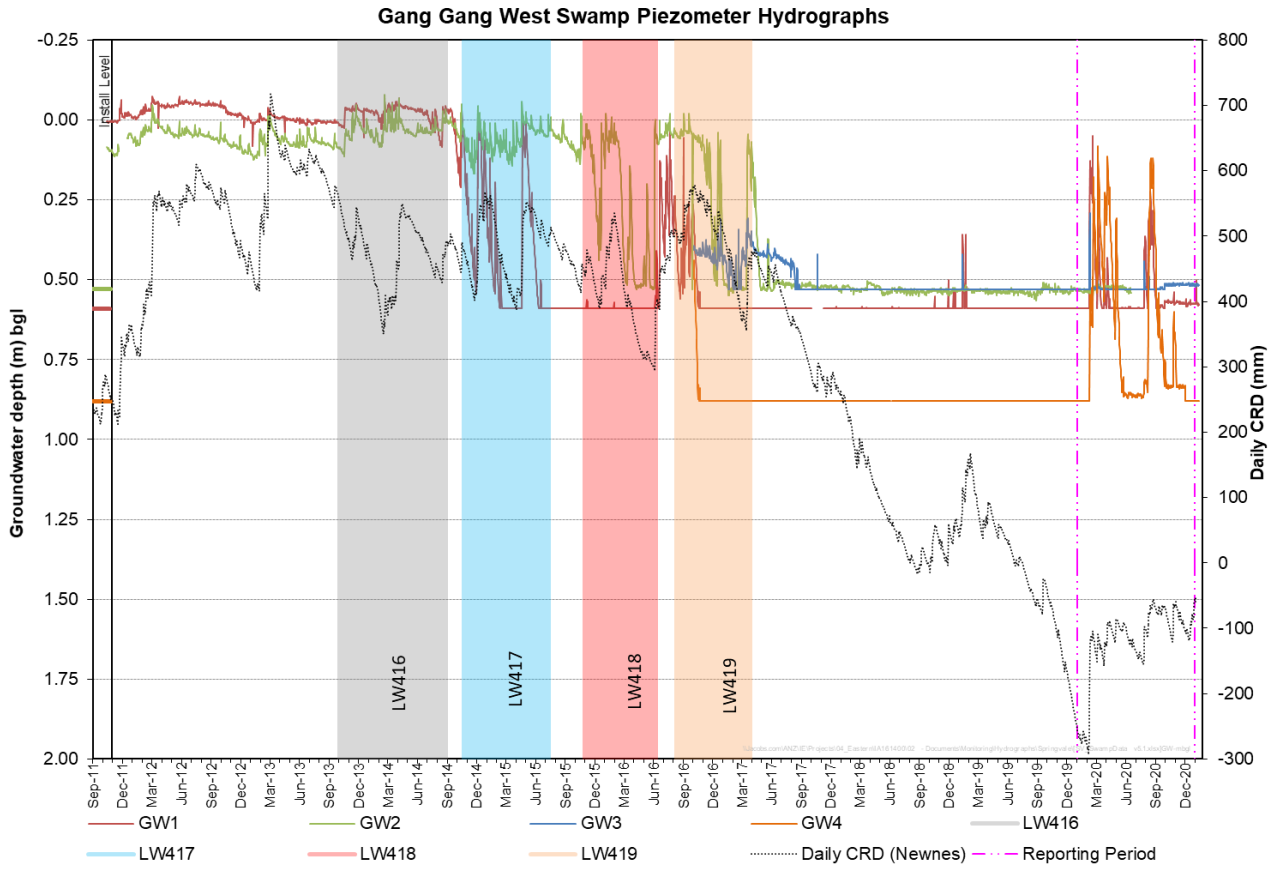

Figure 3.8: Gang Gang West Swamp Hydrograph

3.2.3 Gang Gang Swamp

There are three piezometers (GG1 – GG3) installed in Gang Gang Swamp and a shallow perched aquifer bore SPR1603. The swamp overlies AQ5 and AQ6. Gang Gang swamp initiates below YS1, and likely receives groundwater seepage from above the YS2 to YS5 plies. A lineament is mapped across the length of the swamp.

Data from GG1 borelog and the soil analysis from GG2 and GG3 was used to characterise the swamp profile. The swamp profile is characterised by a thin shallow organic peat/clay layer less than 0.3m; over a sandy gravelly layer above a weathered sandstone bedrock. In some areas, e.g. at GG2, a very fine sand/clay layer approximately 20cm thick is observed at the interface between the bedrock and the swamp. The average thickness of the swamp sediments is approximately 1m.

Mined status is detailed in Table 3.9. Hydrographs for GG1 to GG3 are shown below.

Table 3.9: Gang Gang Swamp Piezometer Information

Piezometer	Mined Status	Monitoring Commencement	Easting (GDA94z56)	Northing (GDA94z56)
GG1	LW420 (2017)	14/10/2011	240283	6302299
GG2	LW420 (2017)	01/10/2016	239937	6301850
GG3	LW420 (2017)	01/10/2016	240449	6303084

Water level declines were first observed at GG1 in August 2016 during the extraction of LW419. GG2 and GG3 were installed October 2016 and only capture the respective declines. In August 2017, GG1 displayed a rapid decline in water levels as mining at LW420 advanced closer. Downgradient at GG3, water levels remained elevated until February 2018 until LW421 passed through the swamp lineament. Gang Gang Swamp remained predominately dry after April 2018 with brief responses to prolonged periods of above average rainfalls.

The groundwater level trigger has already been investigated and the evidence suggested mining impacts were a probable cause.

In 2020, Gang Gang Swamp remained mostly dry with some peaks in water levels during periods of above average rainfall. GG2 recorded a single peaked response in February 2020. GG3, located further downgradient, recorded multiple peaks and was slower to drain. GG1 displayed a similar response as GG3 but with lesser magnitude as it is located further upgradient.

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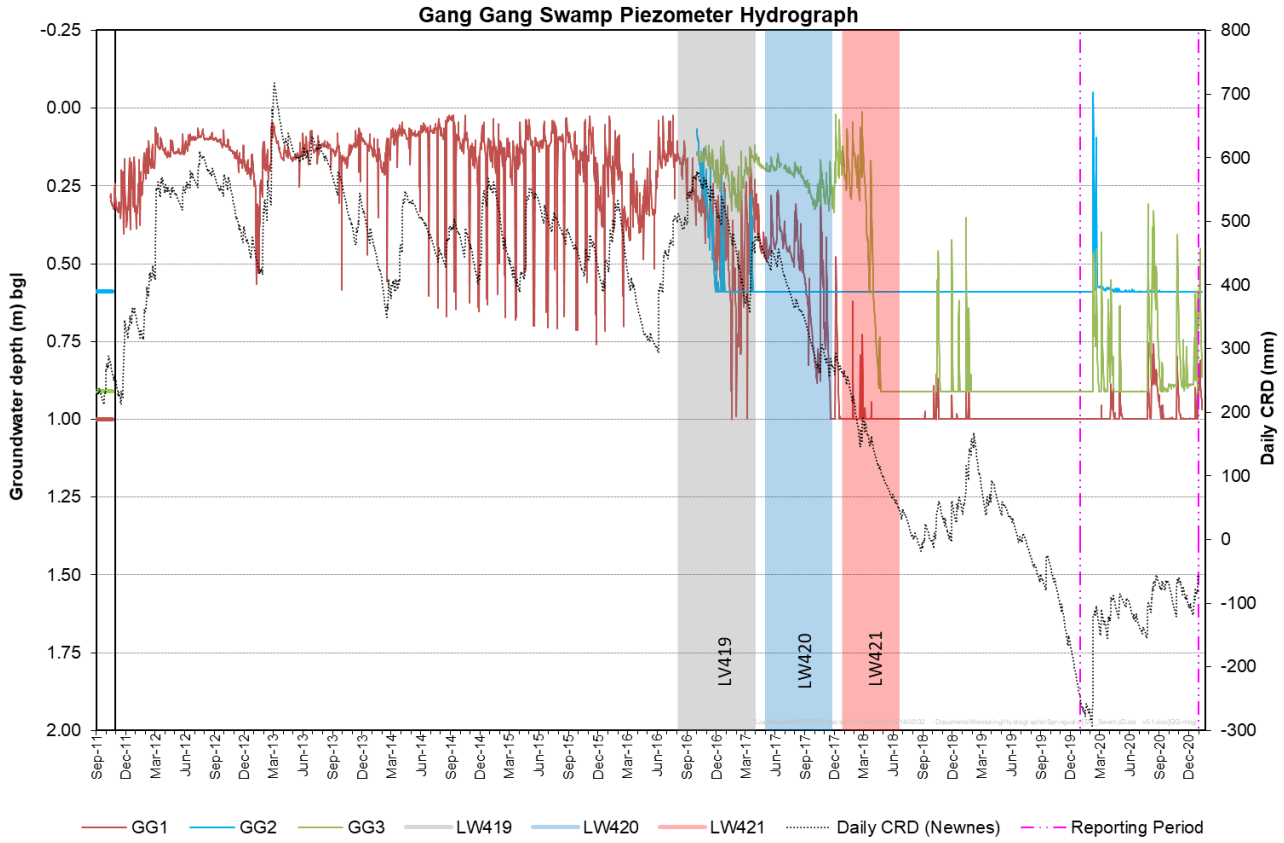

Figure 3.9: Gang Gang Swamp Hydrograph

3.2.4 Pine Swamp

There are three piezometers (BS2, BS3, BS4) installed in Pine Swamp and one shallow perched aquifer piezometer SPR1605. The upstream end of Pine Swamp commences at the YS3 subcrop, with the confluence with Nine Mile Swamp occurring at the YS4 subcrop. The swamp likely receives groundwater seepage contribution from above the YS3 ply with some contribution at the downstream end from above the YS4 ply. A smaller upstream section of swamp, disconnected from the main Pine Swamp, commences at YS2. A mapped lineament coincides with the strike of the swamp.

The swamp profile is varied and total thickness ranges from 0.8m to 1.2m. The top layer consists of a clayey sand/sand with high organics approximately 0.8m to 1m thick, at BS4 a thin 0.2m peat layer is present above this layer. There is a thin sand interface approximately 0.2m thick above the weathered sandstone bedrock but at BS4 this interface is slightly thicker at 0.4m. At BS4 where the YS4 ply outcropping runs parallel to the swamp, a clay band is observed beneath the peat layer.

The mined status is detailed in Table 3.10. Hydrographs for BS1 to BS5 are shown below.

Table 3.10: Pine and Nine Mile Swamps Piezometer Information

Piezometer	Mined Status	Monitoring Commencement	Easting (GDA94z56)	Northing (GDA94z56)
BS2 (Pine)	LW425 (2018-2019)	04/11/2011	240813	6300172
BS3 (Pine)	LW425 (2018-2019)	04/11/2011	241980	6301243

PSS (BS4) (Pine confluence)	LW425 (2018-2019)	13/07/2018	241959	6301202

Pine Swamp has been a historically waterlogged swamp with stable water level trends that suggest a significant component of groundwater contribution. In February 2019, when LW425 passed directly under the swamp, close to BS2, water levels in the upper reaches rapidly declined and BS2 became dry three months later in May 2019. Downgradient at BS3 and BS4, water levels began to show indications of decline in mid-2019 and commencing rapid decline in October 2019. This decline is approximately eight months after the longwall directly undermined Pine Swamp upgradient of the monitoring location, but coincides with the longwall approaching Nine Mile Swamp and drawing level with BS3/ BS4 at a distance of approximately 1.3 km.

In the beginning of 2020, all the swamp piezometers went dry. Following the above average rainfall in February, water levels in the downstream sections at BS3 and BS4 returned to pre-mining conditions and have since remained relatively stable in line with historical observations. However, in the upper reaches at BS2, the response to the rain was short-lived . This suggests an altered hydrology in the upper reaches with the primary contribution now from rainfall rather than groundwater.

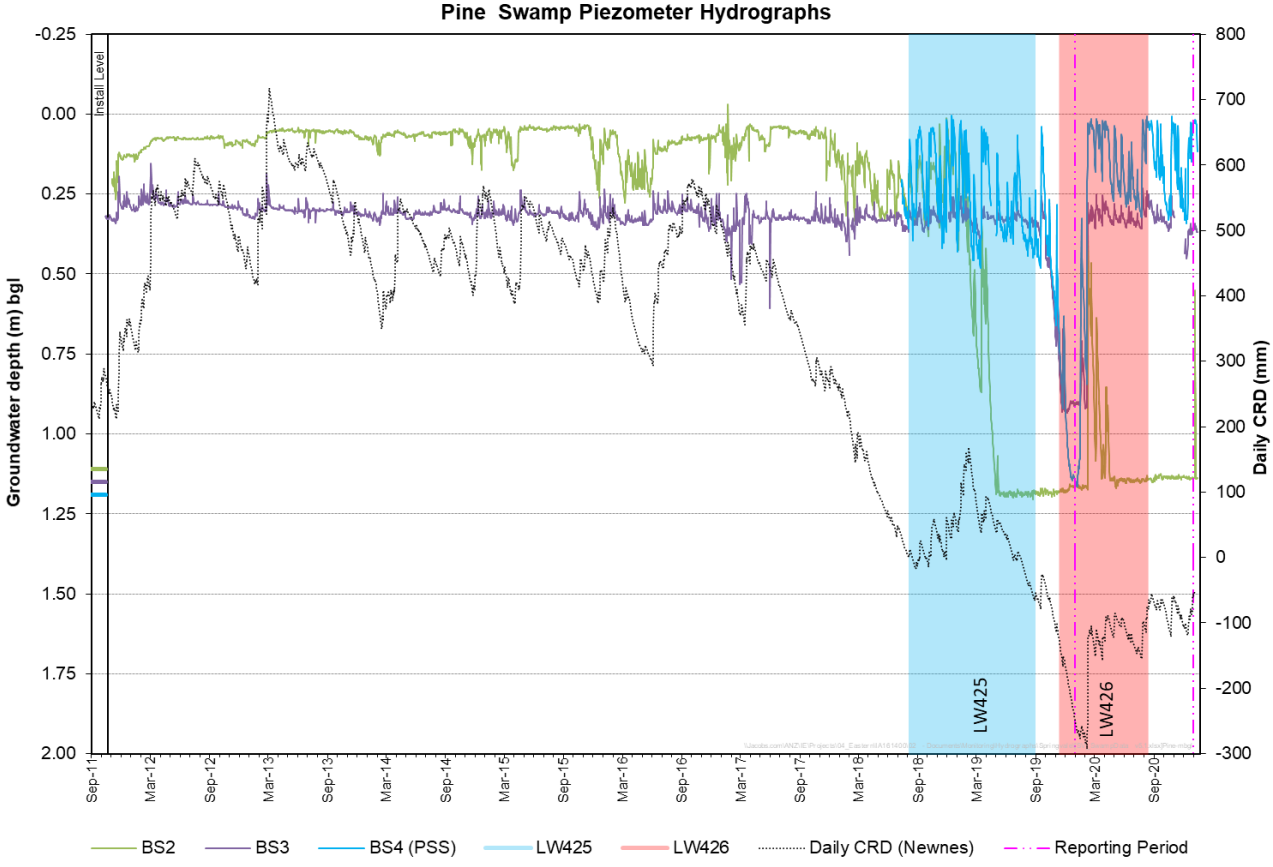

Figure 3.10: Pine Swamp Hydrograph

3.2.5 Nine Mile Swamp

There are two piezometers (BS1 and BS5) installed in Nine Mile Swamp and one shallow perched aquifer piezometer SPR1605. The YS3 ply runs parallel to the length of the swamp and the confluence with Pine Swamp occurs around the YS4 outcrop. Pine Swamp likely receives groundwater seepages from above the YS3 ply. There is a major NNE-SSW fault zone in this area that intersects with both LW425, LW426 and Pine and Nine Mile Swamps.

The swamp profile is varied. In the upstream section, the bore log at BS1 does not penetrate the full depth of the swamp due to refusal on caving at 1.1m. This top layer consists of a highly organic clay. In the downstream section at BS5 there is a 0.4m peat top layer that transitions into a peaty clay layer (0.3m thick) and below that is a 0.3m thick layer or gravelly sand that terminates in the weather sandstone bedrock with a total depth of 1m.

The mined status is detailed in Table 3.10. Hydrographs for BS1 to BS5 are shown below.

Table 3.11: Pine and Nine Mile Swamps Piezometer Information

Piezometer	Mined Status	Monitoring Commencement	Easting (GDA94z56)	Northing (GDA94z56)
BS1 (Nine Mile)	Not Undermined	14/10/2011	241053	6301325
NMSS (BS5) (Nine Mile confluence)	Not Undermined	13/07/2018	241913	6301328

Nine Mile swamp is a historically waterlogged swamp with relatively stable water levels. The drawdowns are sampling effects from bore purging. From mid-2017 water levels at BS1 began declined in response to the drought that commenced in 2016. The water level decline at BS1 was accelerated during the extraction of LW425 (800m from BS1) and in February 2019 when the longwall passed through the Pine Swamp lineament water levels downstream at BS5 were temporarily impacted. Towards the end of extraction of LW425, when the mining face was approximately 600m away from Nine Mile Swamp, BS1 went dry and BS5 was observed to decline rapidly.

In the beginning of 2020, BS1 was dry and BS5 was at its lowest levels. Following the heavy rainfall in February 2020, water levels downstream at BS5 were recharged to historic levels and have remained relavitely stable. In the upstream section at BS1, it appears the swamp has not recovered. The large increase and decline in water levels in February and August suggest a reduction of the stable groundwater flow contribution. Similarly to Pine swamp, it appears the hydrology in the upper reaches of the swamps have been altered.

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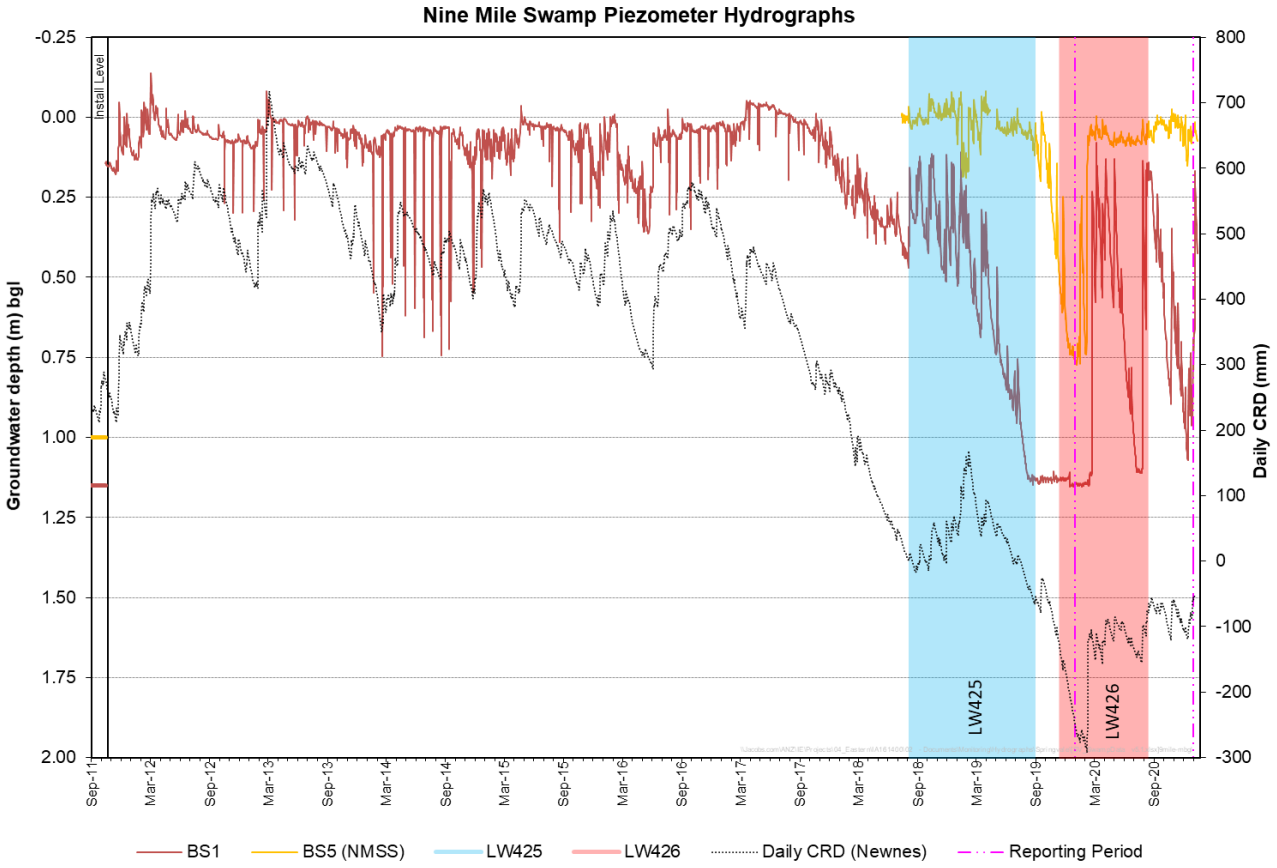

Figure 3.11: Nine Mile Swamp Hydrograph

3.2.6 Marrangaroo Swamp

There are three piezometers (MS1 – MS3) installed in Marrangaroo Swamp and one shallow piezometer SPR1607. The upper reaches of Marrangaroo Swamp at MS2 and MS3 initiate below the YS2 plies, and the swamp extends over AQ6, AQ5 and AQ4. Marrangaroo Swamp likely receives seepage from above the YS3 and YS6 plies with the YS4 to YS6 plies intersection with the swamp being pronounced in the lower segment. There is a distinct clay band that is present in the three bore logs.

The bore logs indicate the swamp depth is approximately 1.3m to 1.5m at MS1 and MS2, and greater than 2.4m at MS3. A 0.2-0.3m peat layer is present in the upper segment (MS2 and MS3) of the swamp. The swamp has a sandy profile above a sandstone bedrock with a clayey layer in the order of 0.3m to 0.6m thick depending on the location within the swamp.

The mined status is detailed in Table 3.12 Hydrographs for MS1, MS2 and MS3 are shown below.

Table 3.12: Marrangaroo Swamp Piezometer Information

Piezometer	Mined Status	Monitoring Commencement	Easting (GDA94z56)	Northing (GDA94z56)
MS1	Not undermined	4/11/2011	238861	6299170
MS2	Not undermined	10/04/2018	239046	6299049

MS3	Within 500m of LW427	30/09/2020	239359	6298208

Marrangaroo Swamp is a waterlogged swamp and historical records show a strong correlation between water levels and the CRD. The drawdowns in the hydrographs are sampling spikes caused by bore purging. The three swamp piezometers display similar water level fluctuations with MS1 located further downgradient having a greater magnitude of fluctuations. The upper reaches of the swamp at MS3 were within the 600m TIA at the commencement of LW427 in September 2020; however, no unusual water level movements have been observed. The declines in water levels during this period can be linked to the declining CRD.

In 2020, water levels at Marrangaroo Swamp were fluctuating with rainfall events corresponding to the CRD curve. There were two large increases in February and August associated with a period of above average rainfalls. Between February and August, water levels were observed to slowly decline in line with the CRD curve.

No mining related impact is visible for the reporting period.

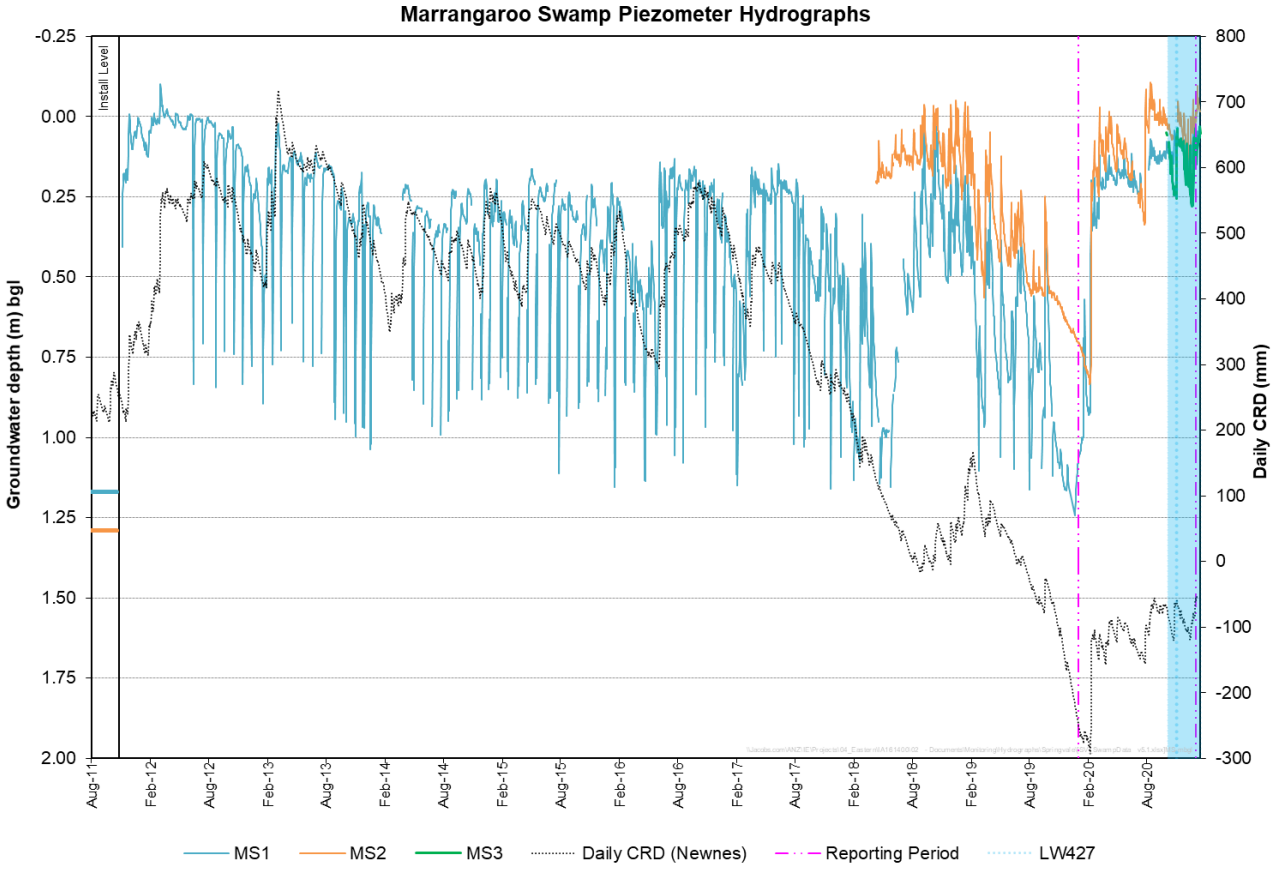

Figure 3.12: Marrangaroo Swamp Hydrograph

3.2.7 Paddy's Creek Swamp

There are two piezometers (PC1 and PC2) installed in Paddy's Creek Swamp and a shallow aquifer piezometer SPR1606. The upper sections of the swamp begin at the outcropping of the YS4 ply, and the swamp extends over the YS5, YS5a and YS6 plies. The swamp likely receives seepages from above the YS4 to YS6 plies with some valley wall seepages as well.

The bore log at PC1 shows there is a 0.3m peat layer, and below that is a 0.3m sand layer that transitions into a clayey sand layer which is 0.6m thick. The depth here is 1.2m and terminates on bedrock. Upstream at PC2, the

borelog shows a similar profile with a 0.3m peat layer above a thicker layer of sand (1m thick) and below that a 0.1m sandy clay layer above the bedrock. The total depth here is 1.6m.

The mined status is detailed in Table 3.13. Hydrographs for PC1 and PC2 are shown below.

Table 3.13: Paddy's Creek Swamp Piezometer Information

Piezometer	Mined Status	Monitoring Commencement	Easting (GDA94z56)	Northing (GDA94z56)
PC1	LW425 (2019)	10/04/2018	241204	6298832
PC2	LW425 (2019)	10/04/2018	240913	6298663

Paddy's Creek is not directly over an extraction area; however, it was within 600 m of LW425. LW425 commenced extraction with in 600m in August 2018. Water levels downstream at PC1 began to decline in late 2018 despite an increasing rainfall. There is not enough baseline data to draw any conclusions, but it is noted LW425 was within 600m of the swamp during this period. There is an increased water level decline at PC1 from April 2019 before it became dry. It is unclear if the changed rate of decline is a delayed impact from the drought which began in mid-2016 or a mining impact.

In February 2020, the heavy rainfalls recharged swamp water levels where they have since remained stable.

No mining related impact is visible for the reporting period.

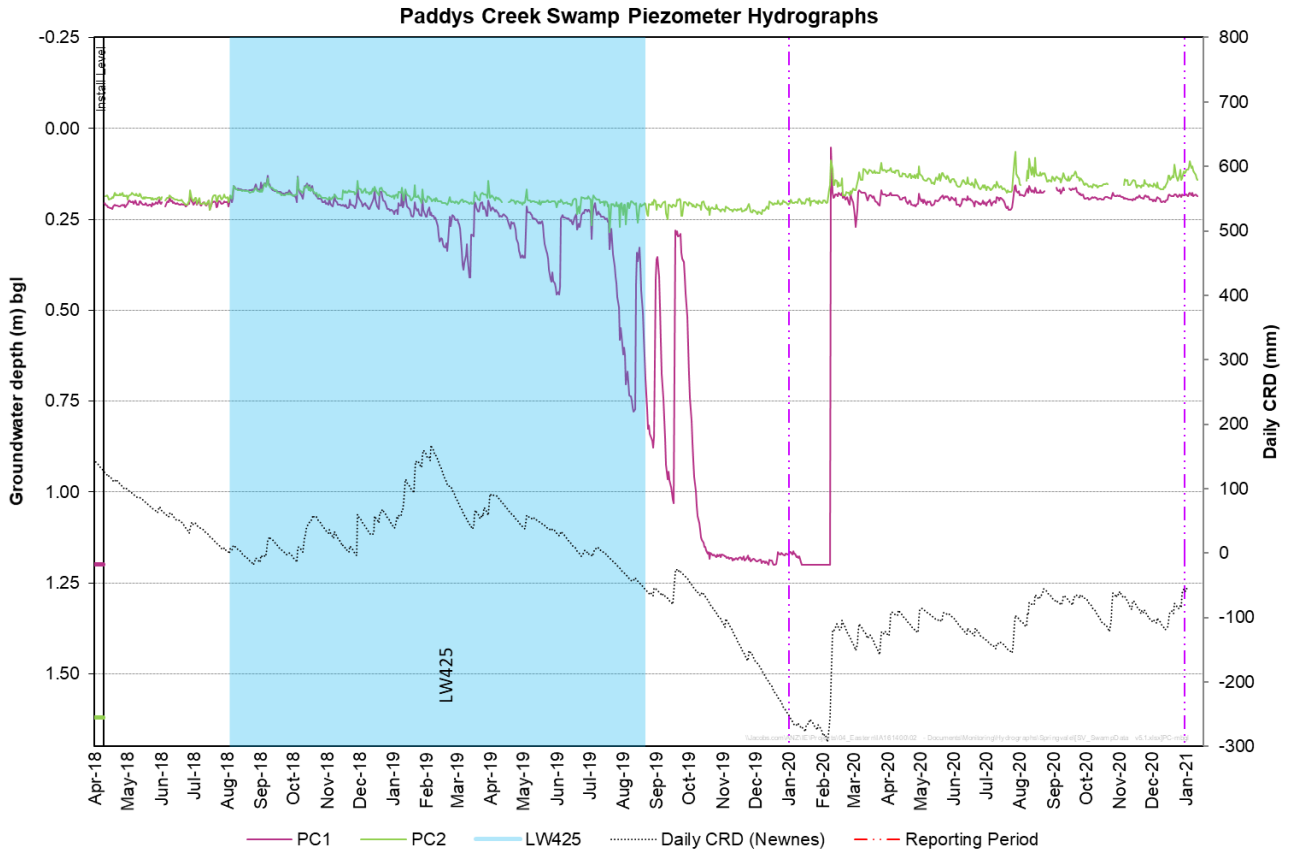

Figure 3.13: Paddys Creek Swamp Hydrograph

3.2.8 Sunnyside Swamp

There are five piezometers (SS1 – SS5) installed in Sunnyside Swamp. Sunnyside Swamp generally commences below YS2, however the western branch (containing SS3) commences between YS1 and YS2. The swamp likely receives seepage contribution from above the YS2 to YS4 plies. The Sunnyside Swamp valley is considered to be structurally controlled and associated with a series of faults of relatively short strike length (Centennial, 2016)

Mined status is detailed in Table 3.14

Hydrographs for SS1 to SS5 are shown below.

Sunnyside Swamp has not been directly undermined as LW413 and LW414, which commenced in August 2009 and February 2011 respectively, was stepped around to avoid undermining. However, the extraction sites were within 250 m of the piezometers and bordering the swamp in certain areas. Additionally, the swamp has lineaments passing through that intersect LW413 and LW414. The water level draw downs on the hydrograph are sampling spikes caused by bore purging

Table 3.14: Sunnyside Swamp Piezometer Information

Piezometer	Mined Status	Monitoring Commencement	Easting (GDA94z56)	Northing (GDA94z56)
SS1	Not Undermined	12/05/2005	237770	6303520
SS2	Not Undermined	12/05/2005	237780	6303573
SS3	Not Undermined	12/03/2010	237844	6303844
SS4	Not Undermined	12/03/2010	237791	6304398
SS5	Not Undermined	12/03/2010	237787	6304631

Sunnyside swamp has been a historically waterlogged swamp with water level movements following the CRD. Towards the end of the drought in late 2019, water levels at SS1 SS2 and SS3 were dry, and SS4 and SS5 was in decline. Following the rains in February 2020, all piezometers recorded an increase in water levels. SS1 and SS2 remained water logged for the remainder of the year with fluctuations corresponding the CRD. SS3 water levels receded after the February rainfall event and displayed large peaks with water levels often dropping to close to the base of the piezometer. SS4 and SS5 located near the lower end of the swamp remained generally stable after the large rainfall event in February 2020.

No mining related impact is visible for the reporting period.

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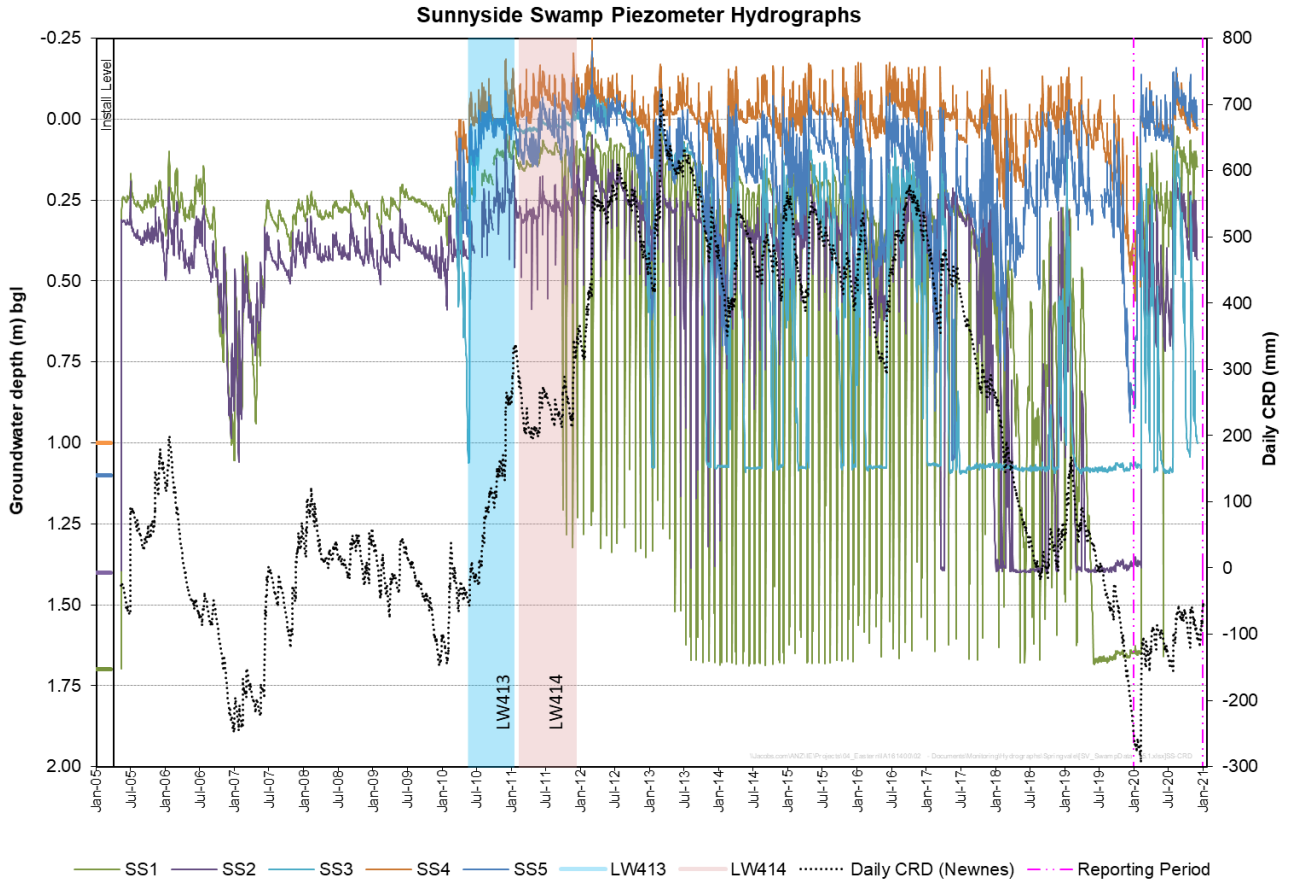

Figure 3.14: Sunnyside Swamp Hydrograph

3.2.9 Sunnyside East Swamp

There are three piezometers (SSE1 – SSE3) installed in Sunnyside East Swamp. Sunnyside East Swamp is located predominantly over AQ5 with the upper reach of the swamp commencing just above YS4 and the lower end terminating before YS5. Groundwater seepage is likely from the YS4 ply where it outcrops above the edges of the swamp. The swamp alignment coincides with a significant lineament that trends parallel with the Deans Creek Lineament Zone. Sunnyside East Swamp is considerably smaller and narrower than neighbouring Carne West Swamp.

Sunnyside East Swamp profile is relatively deep compared to other swamps on the plateau with logs suggesting depths of approximately 1.8m to 2.3m. The swamp profile is characterised by a surface layer of peat with depths of 0.2m to 0.4m, below that a clayey sand layer with thicknesses of 1.0m to 1.5m, below that a think interface approximately 0.2m to 0.4m between the swamp and the underlying bedrock. This interface is a sandy gravel in the upgradient section and a silty clay in the downgradient section. It is noted that SSE2 which monitors the middle section may not provide a full representation of the swamp as the installation reached refusal on tree roots and did not go all the way to the bedrock.

Mined status is shown in Table 3.15.. Hydrographs for SSE1 to SSE3 are shown below.

Table 3.15: Sunnyside East Swamp Information

Piezometer	Mined Status	Monitoring Commencement	Easting	Northing
SSE1	LW417 (2014-2015)	12/03/2010	238663	6303152
SSE2	LW417 (2014-2015)	12/03/2010	238825	6303351
SSE3	LW418 (2015-2016)	12/03/2010	239075	6303566

Sunnyside swamp water level impacts were first observed towards the end of LW414 when it intersected with the lineament underlying the swamp. Water levels made a subsequent recovery but when the lineament was undermined by LW415 more significant impacts were observed and the swamp became dry. The swamp was dry by the time LW417 and LW418 directly undermined the swamp.

Site SSE1 was damaged in the Gospers Mountain bushfire in 2020 and the site was decommissioned in February 2020. Water levels at SSE2 and SSE3 generally remained below the base of the piezometer in 2020. A brief increase in water level was recorded in February 2020 at SSE3 associated with the heavy rainfalls. The small fluctuations in water levels are from trapped water in the cap at the end of the borehole and atmospheric fluctuation.

No mining related impact is visible for the reporting period.

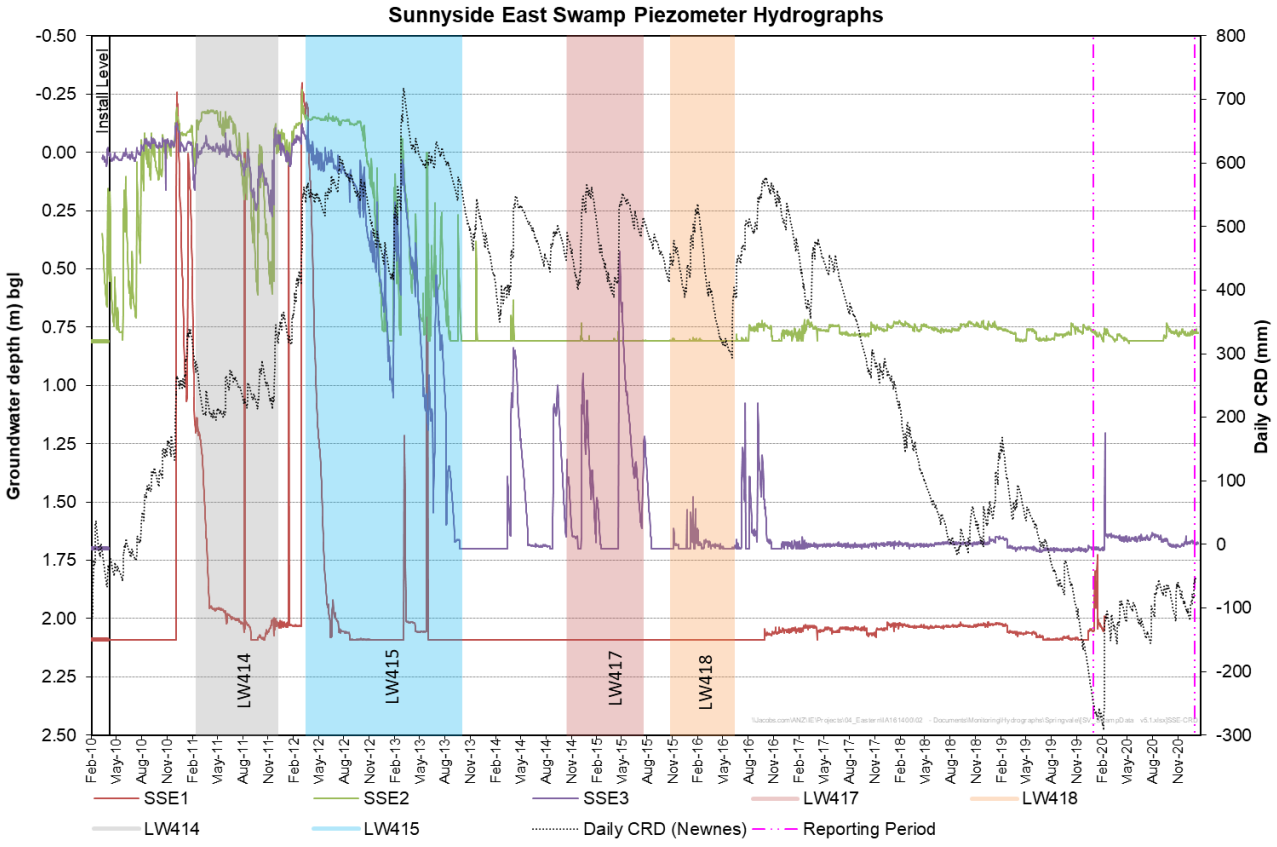

Figure 3.15: Sunnyside East Swamp Hydrograph

3.2.10 Sunnyside West Swamp

One monitoring well was installed in Sunnyside West Swamp (SW1). The swamp is located south west, upgradient of Sunnyside Swamp. Sunnyside West swamp is a shrub swamp lying on a local high point with no visible surface water.

The bore log shows there is a 0.4m peat layer above a 1.1m clayey sand layer, and below that a 0.5m silty clay and terminates at 2m on siltstone. The groundwater here is likely from the perched aquifer/ sub surface flow from above the lower permeability clay/ claystone YS1 ply.

Mined status is detailed in Table 3.16. The hydrograph for SW1 is shown below.

Table 3.16: Sunnyside West Swamp Piezometer Information

Piezometer	Mined Status	Monitoring Commencement	Easting (GDA94z56)	Northing (GDA94z56)
SW1	LW412 (2007-2009)	26/07/2007	237230	6302421

Sunnyside West Swamp was undermined by LW412 which commenced in December 2007. It is difficult to assess the pre-mining hydrogeological conditions of the swamp as the baseline period is short. Water levels are highly variable and correlate to periods of above average rainfalls. it often becomes dry during periods of low rainfall

SW1 experience heavy rainfall events in the beginning of the year in February 2020 that recharged swamp water levels. Through the remainder of the year SW1 has remained waterlogged with the peaks and troughs of the hydrograph corresponding to movements of the CRD.

No mining related impact is visible for the reporting period.

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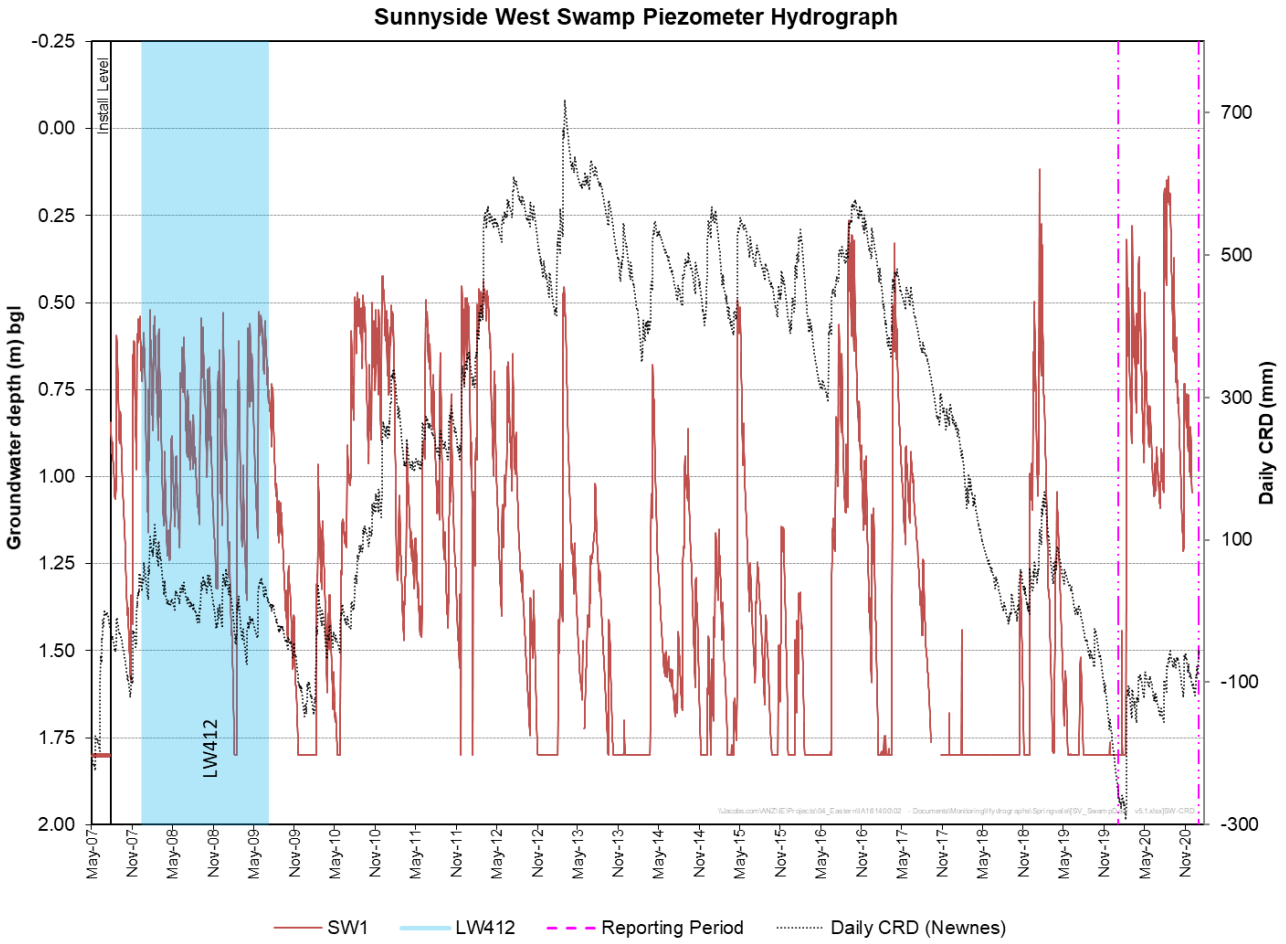

Figure 3.16 Sunnyside West Swamp Hydrograph

3.2.11 Junction Swamp

There are three piezometers (JS1 – JS3) installed at Junction Swamp. Mined status is detailed in Table 3.17. Hydrographs for JS1 to JS3 are shown in below.

Table 3.17: Junction Swamp Piezometer Information

Piezometer	Mined Status	Monitoring Commencement	Easting (GDA94z56)	Northing (GDA94z56)
JS1	LW408 (2003)	10/05/2002	235774	6302686
JS2	LW408 (2003)	10/05/2002	235800	6302753
JS3	LW408 (2003)	10/05/2002	235857	6302737

JS1 to JS3 are installed into the weathered bedrock (Burralow Formation) up gradient of Junction Swamp. The profile consists of a thin topsoil with a clayey sand layer than transitions into the sandstone bedrock. At JS1, a layer of shale is present at the base of the borehole.

Water levels at JS1 to JS3 corresponded closely with CRD. except for the period when LW408 was extracted from February 2003 to December 2003. During this period water levels were out on sync with the CRD and remained stable to slightly declining despite the increasing CRD.

In 2020, large increases in water levels were recorded in February and in July/ August during a period of above average rainfall. The temporary peak in water level at JS1 in February was most likely due to infiltration of surface water as the top of the bore is at ground level and is not an actual groundwater response.

No mining related impact is visible for the reporting period.

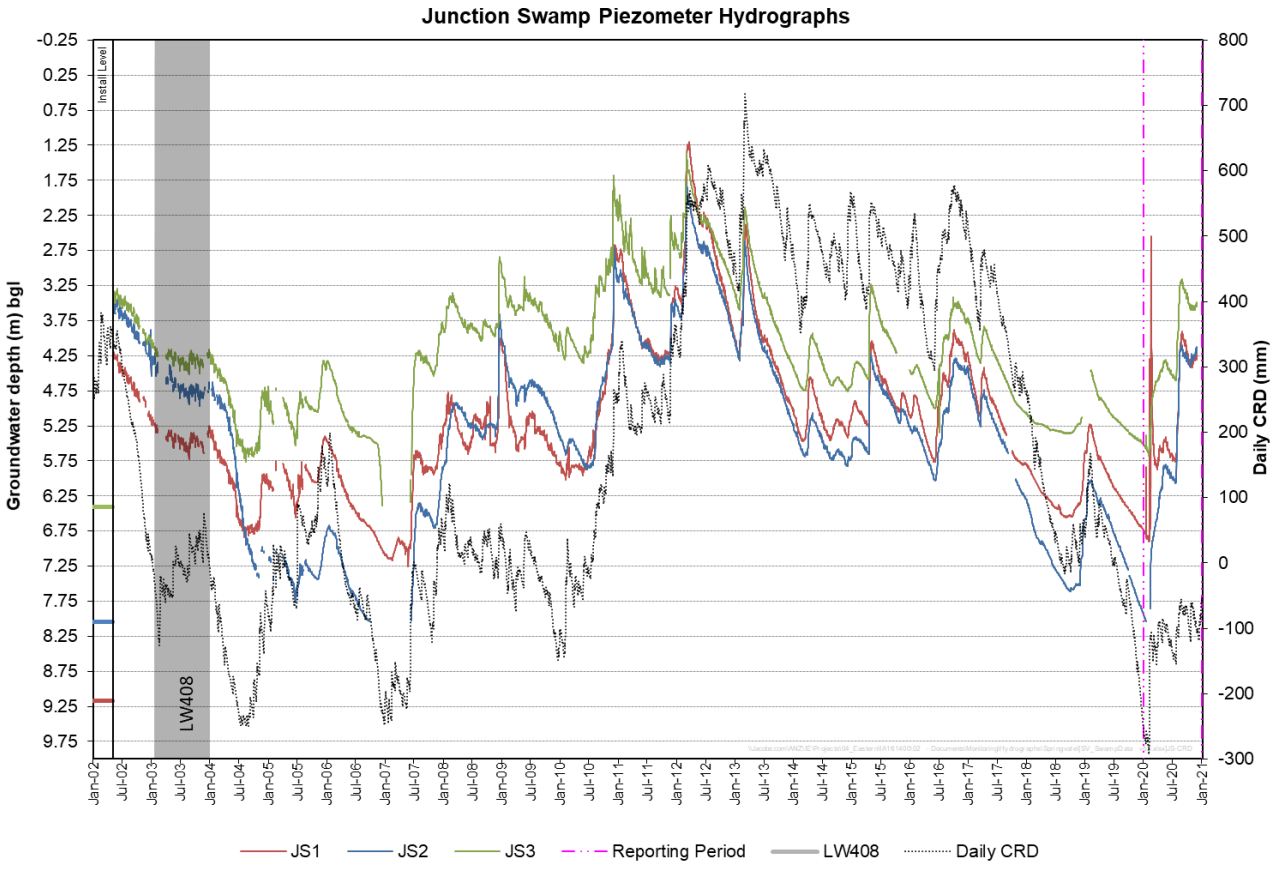

Figure 3.17: Junction Swamp Hydrograph

3.2.12 East Wolgan Swamp

East Wolgan swamp is monitored by two swamp piezometers (WE1 and WE2) located in the upper half of the swamp. The swamp likely receives seepages from the outcropping of the YS4 ply that runs along the length of the swamp.

The bore logs show the depth of the swamp at WE1 is 2.8m with a 0.5m surface peat layer, followed by a 0.8m sand layer, followed by a1.5m clayey sand layer and terminating on sandstone bedrock. At WE2, a 1m thick peat layer is present, followed by a 0.3m clayey sand layer and terminates on sunstone bedrock.

The mined status is detailed in Table 3.18. The hydrographs for WE1 and WE2 are shown below.

Table 3.18: East Wolgan Swamp Piezometer Information

Piezometer	Mined Status	Monitoring Commencement	Easting (GDA94z56)	Northing (GDA94z56)
WE1	Undermined by LW960, AOD of LW411 (2006/2007)	14/05/2005	236387	6304057
WE2	Undermined by LW960, AOD of LW411 (2006/2007)	14/05/2005	236419	6304178

Wolgan East Swamp was within the Angle of Draw of Springvale Longwall 411 in July 2006 and undermined by Angus Place Longwall 960 in August and September 2011. It was also used as an emergency licenced discharge point (LDP004) for Springvale from 2005 to 2009.

Water levels in East Wolgan are believed to be rainfall dependent with little groundwater influence. The elevated water levels on the hydrograph apparent during 2005, 2006, 2008 and early 2009 are due to the upstream discharge from LDP004. It is difficult to characterise the swamp's natural water level behaviour prior to 2005 because the swamp was subject to mine water discharge at the time of installation and was soon passed by LW411.

The swamp has remained predominately dry with temporary water level increases during periods of intense rainfall. In 2020 particularly around the months of February and August, the above average rainfalls resulted in temporary water level increases at WE2, while WE1 remained predominately dry.

No mining related impact is visible for the reporting period.

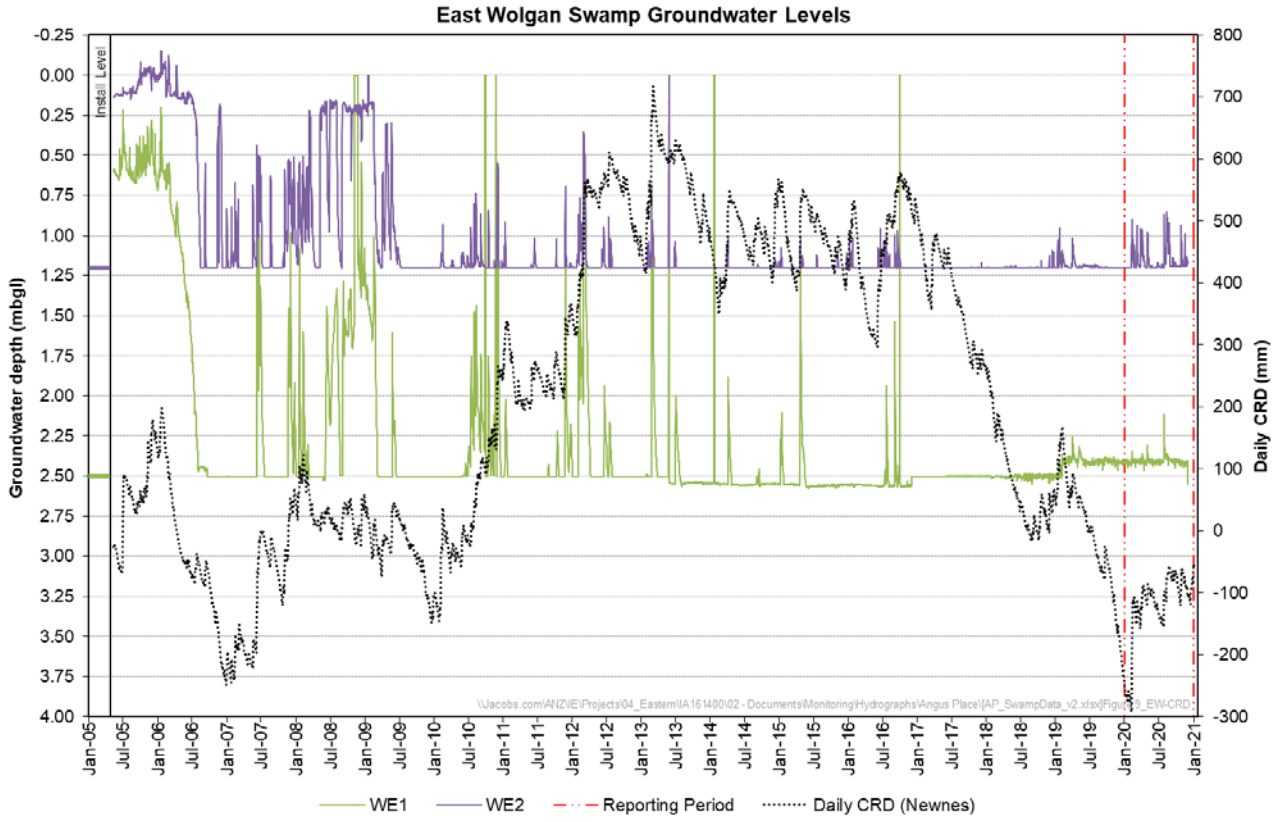

Figure 3.18: East Wolgan Swamp Hydrograph

3.3 Swamp Water Level Interpretation

Many swamp piezometers that have demonstrated stable water levels since installation have undergone significant groundwater level declines from 2017 to 2020, which is inferred to be due to a prolonged rainfall deficit that occurred since October 2016. By the beginning of 2020, some of these swamps have recorded one of their lowest levels since installation. This is most apparent at Carne Central (CC1), Marrangaroo Swamp (all piezometers), Junction Swamp (JS2), Sunnyside Swamp (all piezometers). Since the rainfall in February 2020, the majority of these piezometers have shown signs of recovery.

Swamps that were previously undermined were predominately dry with some temporary responses to the above average rainfall particularly in February 2020. These swamps include Wolgan East, Sunnyside East, Carne West, Gang Gang and Gang Gang West

In the 2019 reporting period, Pine, Nine Mile and Paddys Creek Swamps recorded some abnormal declines that fell below the trigger threshold. After the rains in February 2020, Paddys Creek Swamp recharged and water levels returned to their historical levels and have remained stable. At Pine and Nine Mile swamp, water levels have recovered in the downstream sections but the upstream sections at BS1 and BS2 have not shown signs of a long-term recovery.

In 2020, when LW427 was extracted Marrangaroo swamp was with the 600m trigger investigation area. No mining related impacts were visible. The declines in the groundwater levels can be linked to the prevailing rainfall conditions.

3.4 Shallow Aquifer Piezometer Monitoring

Since 2018, an additional seven shallow aquifer piezometers were installed. Details and locations of the shallow aquifer piezometers are shown in Figure A.1 and Table 3.19. The paired hydrographs for shallow aquifer piezometer and their respective swamps is shown in Appendix H. Due to mAHD scaling in the paired hydrograph is difficult to identify trends. The installation of the additional shallow aquifer piezometers was a condition of approval for the LW425-427 SMP, designed to target the aquifers in the weathered bedrock profile beneath the swamps to further understand the relationship between swamp water levels and the shallow aquifers underlying the swamps. There are no performance measures associated with shallow aquifer piezometers.

Table 3.19: Shallow Aquifer Piezometers

Bore ID	Easting (GDA94z56)	Northing (GDA94z56)	Ground elevation (mAHD)	Monitoring Date	Associated Swamp
SPR1601	239808	6303789	1070.21	31/08/2016	Carne West
SPR1602	240414	6303186	1085.35	31/08/2016	Gang Gang West
SPR1603	240491	6303177	1069.45	31/08/2016	Gang Gang
SPR1604	241231	6303296	1062.25	06/06/2018	Carne Central
SPR1605	241965	6301250	1066.20	03/05/2018	Pine/Nine Mile
SPR1606	241416	6299066	1066.79	03/05/2018	Paddys Creek
SPR1607	238751	6299241	1091.66	06/06/2018	Marrangaroo

Bore ID	Easting (GDA94z56)	Northing (GDA94z56)	Ground elevation (mAHD)	Monitoring Date	Associated Swamp
SPR1608	241991	6304157	1034.48	07/06/2018	Barrier
SPR1611	247843	6307206	960.01	06/06/2018	Fire Tail
SPR1612	246637	6308319	980.87	06/06/2018	Best

3.4.1 Shallow Aquifer Groundwater Level Interpretation

The hydrographs of the Shallow Aquifer Piezometers are presented in Figure 3.19. Following the February 2020 rainfalls, all shallow piezometers recorded a water level response, some more than pronounced than others.

SPR1601, located near the downstream end of Carne West Swamp, approximately 230m north of LW420, showed water level responses closely linked to the CRD. The historic water level response appears abnormal due to the rapidly rising water levels following rainfalls in a manner that is significantly exaggerated compared to other shallow piezometers and it is possible rainwater is infiltrating this borehole from the surface through unnatural pathways. In 2020, following the rainfalls in February water levels have increased and have remained stable. In the reporting period, the overall water level increased approximately 5.9m.

SPR1602 and SPR1603, located near the confluence of Gang Gang and Gang Gang West swamps approximately 230m west of LW421, displayed water level increases resulting from the February 2020 rainfalls. It is noted that both the sites recorded a temporary peak and decline associated with the February rainfalls. The significant water level increase was delayed by one month when compared to the other shallow aquifer piezometers. In the reporting period, the overall water level increased approximately 4.0m and 5.8m at SPR1602 and SPR1603, respectively.

SPR1604 recorded a gradual increasing trend that is a subdued reflection of the CRD curve. The water level increase resulting from the February 2020 rainfall was delayed by approximately one month. In the reporting period, the overall water level increased approximately 1.8m.

A stepped water level increase was observed at SPR1605, SPR1606, SPR1607, SPR1611, and SPR1612 (0.6m, 1.5m, 1.4m,1.0m, 0.8m respectively over the reporting period). Following this increase, water levels have remained relatively stable with movements corresponding to the CRD curve.

SPR1608 recorded a water level above ground level with a stable increasing trend and no significant fluctuations. In the reporting period, the overall water level increased approximately 0.4m.

No mining related impact is visible for the reporting period.

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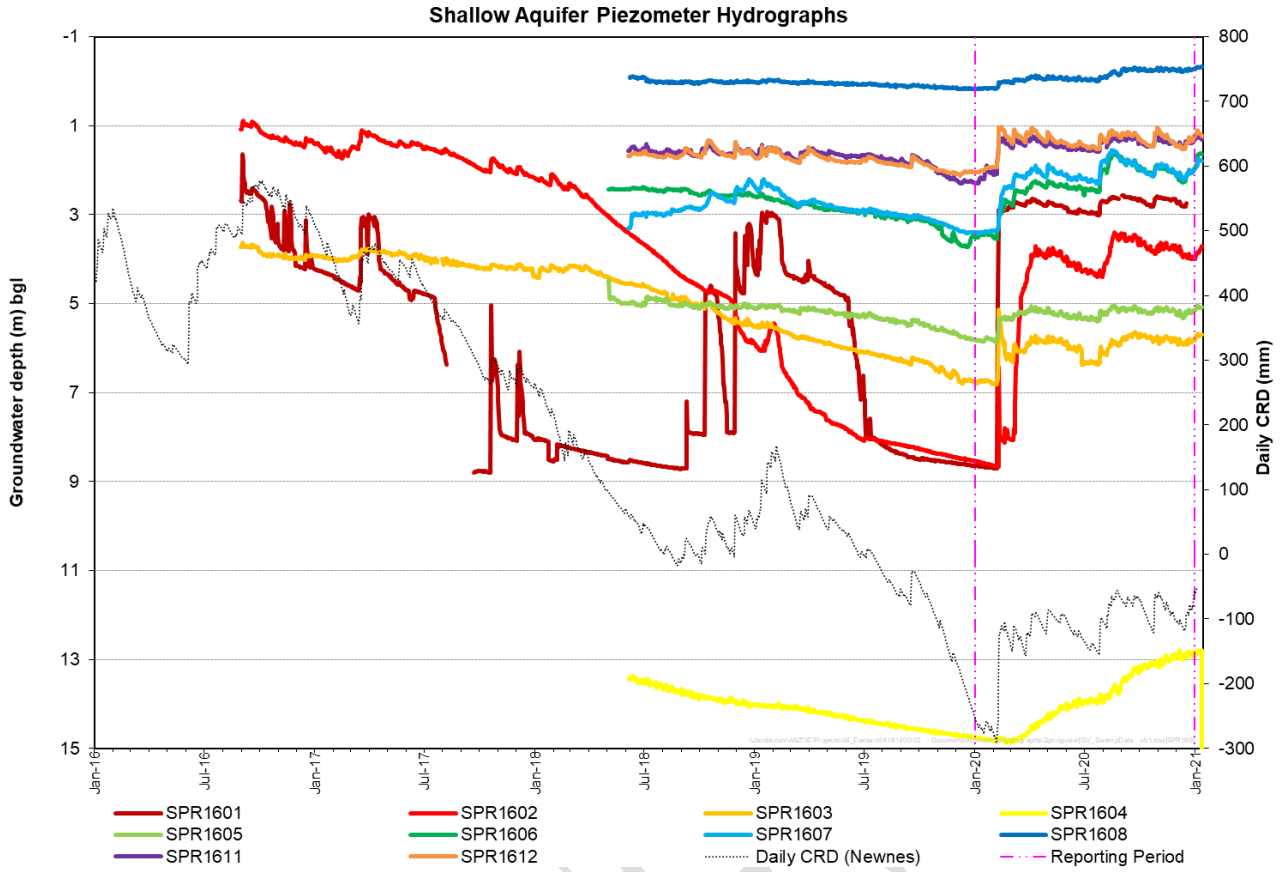

Figure 3.19: SPR1600 series Hydrograph

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4. Groundwater Monitoring

4.1 Standpipe Piezometers

The ridge piezometers, as shown on Figure A.1, have been established within the Springvale mining lease to monitor the groundwater level in the perched and shallow aquifers of the Burralow Formation and Banks Wall Sandstone at Springvale. Two piezometers (AP5PR and AP1105) located within the Angus Place mining lease have also been included as reference points. The standpipe piezometers are equipped with water level pressure transducers (with the exception of Bore RSE) and data loggers. The standpipe piezometers are summarised in Table 4.2.

Table 4.1: Standpipe Monitoring well details

Monitoring Point	Easting (GDA94z56)	Northing (GDA94z56)	Monitoring Date	Hole Depth (mbgl)	Comments/ Change over reporting period
AP5PR	236529	6308528	28/07/2010	94.00	▪ Reference well ▪ Increased 0.52m
AP1105	238865	6305671	3/11/2011	37.21	▪ Reference well ▪ Declined 0.55m
RSE	236840	6304191	20/12/2005	50.00	▪ Dry since 4/10/2017
RSS	238072	6303500	01/12/2005	43.90	▪ Slightly declining 0.94m
SPR1101	238484	6302635	14/11/2011	47.40	▪ Dry since December 2013 ▪ Investigation found that casing sheared at 42 mbgl
SPR1104	239746	6303184	4/11/2011	47.00	▪ Dry since July 2017
SPR1106	239980	6304227	15/12/2011	86.20	▪ Declined 4.92m
SPR1107	239739	6301305	4/11/2011	55.60	▪ Large fluctuations ▪ Increased 4.59m
SPR1108	241045	6303314	4/11/2011	76.10	▪ Declined 1.04m
SPR1109	239186	6302160	14/12/2011	60.10	▪ Increased 0.13m
SPR1110	238699	6302330	14/12/2011	65.80	▪ Dry since November2014
SPR1111	240404	6303692	14/12/2011	60.90	▪ Declined 1.02m
SPR1112	240852	6302995	15/12/2011	50.00	▪ Declined 0.71m
SPR1113	240625	6302995	13/02/2012	60.60	▪ Declined 0.72m
SPR1210	239677	6300052	31/05/2013	131.20	▪ Declined 0.68m
SPR1211	239677	6300052	31/05/2013	133.80	▪ Dry since 30/12/2019
SPR1301	239275	6299271	26/05/2014	86.70	▪ Declined 0.40m

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Monitoring Point	Easting (GDA94z56)	Northing (GDA94z56)	Monitoring Date	Hole Depth (mbgl)	Comments/ Change over reporting period
SPR1401	238453	6303547	21/11/2014	46.55	▪ Replacement bore for SPR1101 ▪ Declined 0.53m
SPR1402	238163	6303489	6/01/2015	92.90	▪ Vandalised ▪ No recorded data since 2/2/2016
SPR1403	239133	6303287	5/08/2015	51.10	▪ Damaged in the Gospers Mountain fires
SPR1806	239628	6297962	6/12/2018	55.50	▪ Declined 1.90m
SPR1807	239628	6299681	5/07/2019	72.85	▪ Declined 1.96m
SPR1808	239495	6298643	3/07/2019	39.30	▪ Declined 11.13m

Ridge piezometers that were undermined ,or that are within proximity of an active longwall, have displayed groundwater trends associated with undermining (stepped drops due to bed separation and parting, fracture dilation and sudden increase in storage capacity) or equilibrium drawdown (steady groundwater declines as aquifers fill increased storage space created from subsidence).

Table 4.2: Standpipe Monitoring well details

The standpipe piezometer hydrographs are presented in Figure 4.1. The trends of ridge piezometers close to the extraction area can be summarised as follows:

- SPR1211, directly over LW426. Site was impacted by LW425 in August 2018 and saw rapid water levels declines of approximately 8m in 2 months. The declining trend continued at a lesser rate of decline until November 2019 when it was impacted again by extraction at LW426. Water levels rapidly declined below the base of the logger, falling by 8m in a period of one month from 62mbgl to 70mbgl. When the site was manually dipped in February 2020, the water level was greater than 100mbgl and the below ground casing was observed to be damaged by subsidence. Water levels are not currently captured by the logger and there are no plans to redeploy the logger at a greater depth due to the risk of the logger getting stuck in the damaged casing.
- SPR1806 is above LW429 and approximately 650m west of LW427. Water levels have maintained a slowly declining trend since installation. No further mining impacts were apparent in 2020.
- SPR1807 is above LW428 and 200m west of LW427 and was installed in July 2019. Water levels have been close to the bottom of the standpipe since installation, less than 2m above the base and steadily declining. The water within the bore has been observed to be very muddy. A small stepped decline of less than 1m was observed in the month of May 2020 with the bore becoming dry. This coincides with when LW426 was closest to SPR1807. That said, it is difficult to determine if this is a legitimate mining response as the baseline period is short and it is uncertain if the water is remnant of the drilling fluid. In Mid-June 2020, water was observed in the bore again, an increase of 0.6m in one day. Then in August 2020, the water level dropped 0.5m and became dry. This increase and decrease is likely due to the interactions between rainfall and the mud at the base of the well causing inaccurate readings.
- SPR1808 was installed in July 2019 and is above LW428 and 300m west of LW427 . A small decline of approximately 1.5m was observed between late November and early December 2019, coinciding with when LW426 was closest to SPR1808. Following this period, the water levels showed a slow decline. In October to December 2020, SPR1808 recorded a large decline of approximately 10.2m over a period of 2 months

coinciding with LW427 encroaching within the 600m TIA. The water level is currently showing signs of stabilising suggesting the cause may be due to bed separation or fracture dilation and not vertical drainage into the lower layers.

- SPR1108 is located next to the main shaft way, 400m south of LW420 and close the northern end of LW427. Abnormal groundwater levels were observed from March 2019 onwards. Water levels began to show a greater rate of decline, mirroring the movements of the CRD curve but with an approximately four month delay. Mining did not occur in close to SPR1108 when it began to show abnormal movements and there were no observable impacts when mining at LW420 occurred. Observations suggest the changes are likely to be a response to the climate. In September 2020. Water levels at SPR1108 began to increase most likely from the recharge event from the beginning of 2020.
- SPR1210 is above LW428 and 100m west of LW427. At the end of 2020, mining at LW427 was more than 2km away from SPR1210. In 2020, a continuation of stable water levels close to the bottom of the standpipe were observed.
- SPR1301 is located above LW429 and approximately 500m west of LW427. At the end of 2020, mining at LW427 was approximately 700m away from SPR1301. A continuation of stable water levels were observed with no mining impacts visible.

Ridge piezometers outside the extraction area that displayed notable trends during the reporting are:

- AP5PR and AP1105, both reference sites in the Angus place lease show stable water levels with minor movements.
- SPR1106, ~700m north of LW420 and over 4km away from the current longwall, observed a continuation of groundwater level decline that began back in 2012. Water levels decreased approximately 4.9m during the reporting period.
- SPR1107, overlying LW420, displayed abnormal fluctuations water level increases up to 5m and are sustained over 2-3 days. Manual measures over different months can show large variations around these fluctuation events. It is hypothesised this is a real response caused by rainwater infiltrating through unnatural pathways as the water level spikes align with rainfall data. SPR1107 is located above a fractured zone above LW420 that has been previously mined out. It is plausible the subsidence has damaged the integrity of the bore construction, or created unnatural pathways through the fracture ground increasing the amount of subsurface flows to the bore.
- SPR1403 was damaged by the Gospers Mountains bushfire and has been out of action for the reporting period.
- The remaining bores showed a continuation of previous trends.

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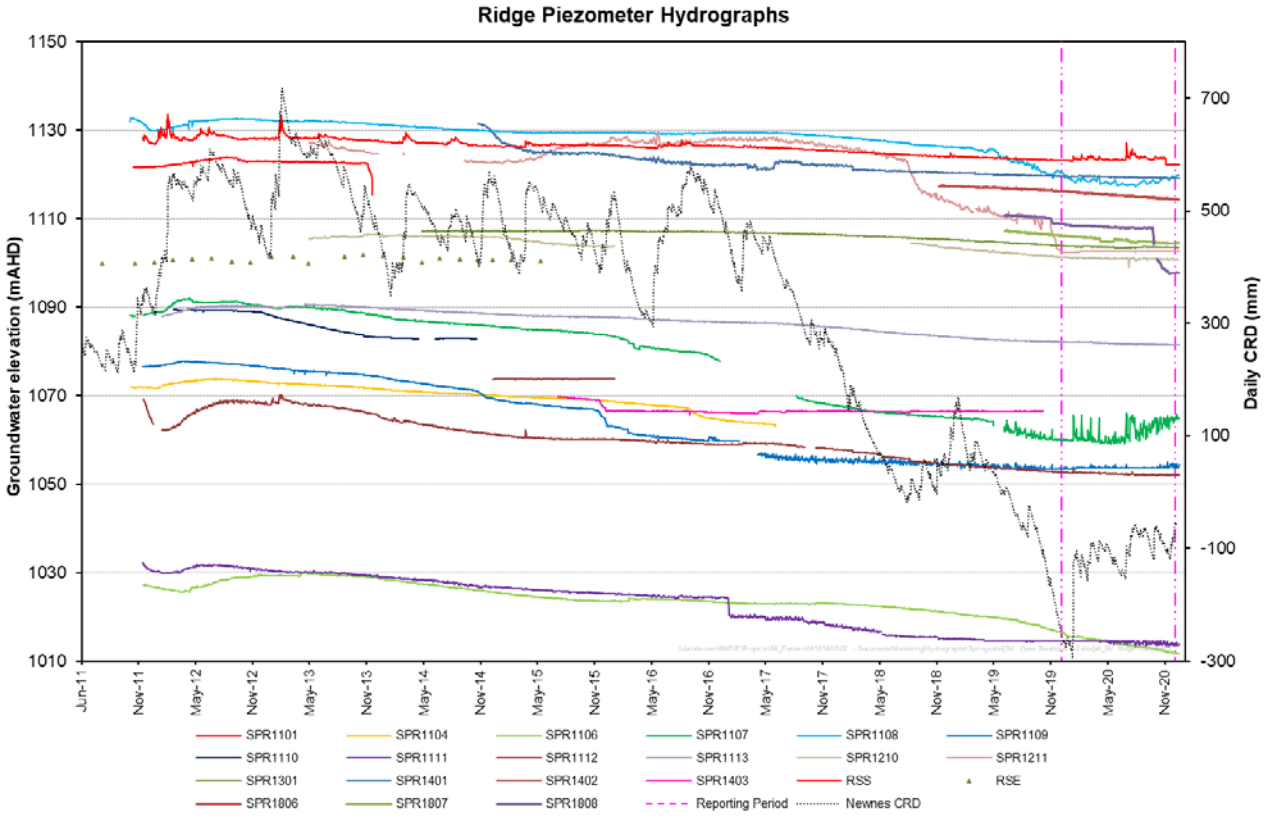

Figure 4.1: Ridge Piezometer Hydrograph

4.2 Vibrating Wire Piezometers

Multi-level vibrating wire piezometers (VWPs) have been installed in boreholes across the mining area to monitor pore pressures in the shallow and deep aquifer systems described in Section 2.1. Most of the VWPs are in the vicinity of the current workings at Springvale Colliery. The locations of the VWP monitoring points are shown on Table 4.3.

The VWP hydrographs are presented in the following sections. For the interpretation of groundwater levels in this report, only VWP monitoring points within the proximity of active longwalls during the reporting period have been analysed and are presented in Table 4.3. Remaining VWP monitoring points are presented in Appendix D.

There are no performance measures linked to the VWPs. They are used as additional monitoring points to inform management measures and to gain a greater understanding of the hydrogeological conditions.

Table 4.3: VWP Monitoring Details adjacent to LW421 and LW425

Monitoring Location	Easting (GDA94z56)	Northing (GDA94z56)	Monitoring Frequency	Monitoring Commence Date	No. of Functioning Piezometers	VWP Settling Depth (mbgl)*
SPR37	239074	6300367	Twice Daily	13/02/2006	6 out of 8	110, 135, 165, 187, 260, **320, 350**, 405
SPR38	240061	6298330	Twice Daily	29/12/2005	5 out of 8	80, 100, 135, 190,

Monitoring Location	Easting (GDA94z56)	Northing (GDA94z56)	Monitoring Frequency	Monitoring Commence Date	No. of Functioning Piezometers	VWP Settling Depth (mbgl)*
						230, **300, 355, 370**
SPR1210	239694.1	6300050.7	Daily	25/09/2012	7 out of 7	76, 160, 224.5, 308.6, 326.6, 376.8, 388.5
SPR1302DP	239700.3	6297795.5	Daily	13/12/2013	5 out of 5	200, 270, 310, 370, 390
AP10PR	237246	6306781	Daily	7/05/2010	8 of 9	343, 327, 300, ***270***, 248, 205, 150, 103, 60

Note - * Bold indicates the sensors which are no longer functioning or have been disconnected.

SPR37

SPR37 is located approximately 700m west of LW427 and monitors the piezometric pressures across eight formations (Figure 4.2: SPR37 Hydrograph). Sensor#2 and #3 lost communications in 2011 and 2017 respectively. Sensor #1 and #6 show abnormal pressure spikes that is typical of a sensor nearing the end of its lifespan. The increased rate of decline at Sensor #1 and #4 in 2019 is inferred to be a depressurisation response to either LW425 or the LW426/427 development drives.

In 2020, another minor response was also observed at Sensor #1 and #4 towards the end of LW426. It is unclear if the response was due to mining at LW426 as the extraction stopped short before the one of the major lineaments was undermined. The remaining sensors show a continuation of stable to slightly declining trends.

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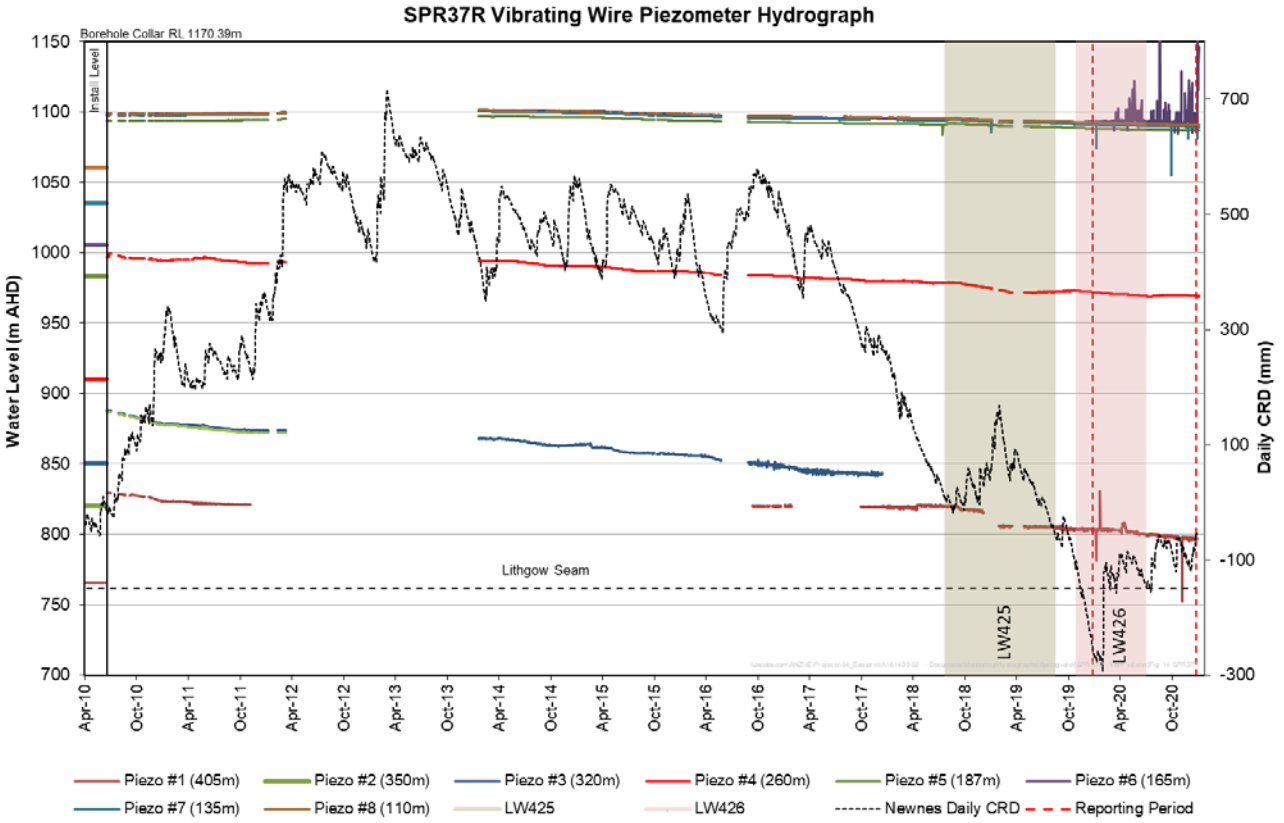

Figure 4.2: SPR37 Hydrograph

SPR38

SPR38 is located above LW427 side panel. The piezometric pressures are monitored in eight formations (Figure 4.3: SPR38 Hydrograph).

It was noted that sensors #6 to #8 are in hydraulic connection and displayed similar piezometric pressures. A large stepped decline was observed in sensors #6 to #8 in April 2019, which resulted in the sensor #6 to become unsaturated. This coincides with development of the side panels for LW427 passing very close to SPR38. Sensor #5 appeared to be unsaturated since its installation.

In October 2020, when extraction at LW427 was approximately 50m from SPR38, a depressurisation response was observed across all sensors and communication to the lowest three sensors were lost. A preliminary trigger investigation was conducted and concluded depressurisation was most likely due to fracture dilations and bed separation caused by subsidence. At the end of the reporting period, the upper sensors from #1 to #4 are recording low pressure heads and it is unclear if they are still saturated. Sensor #1 is recording negative pore pressures with large fluctuations. It is likely the sensor is unsaturated and the fluctuations are due to rainfall infiltration.

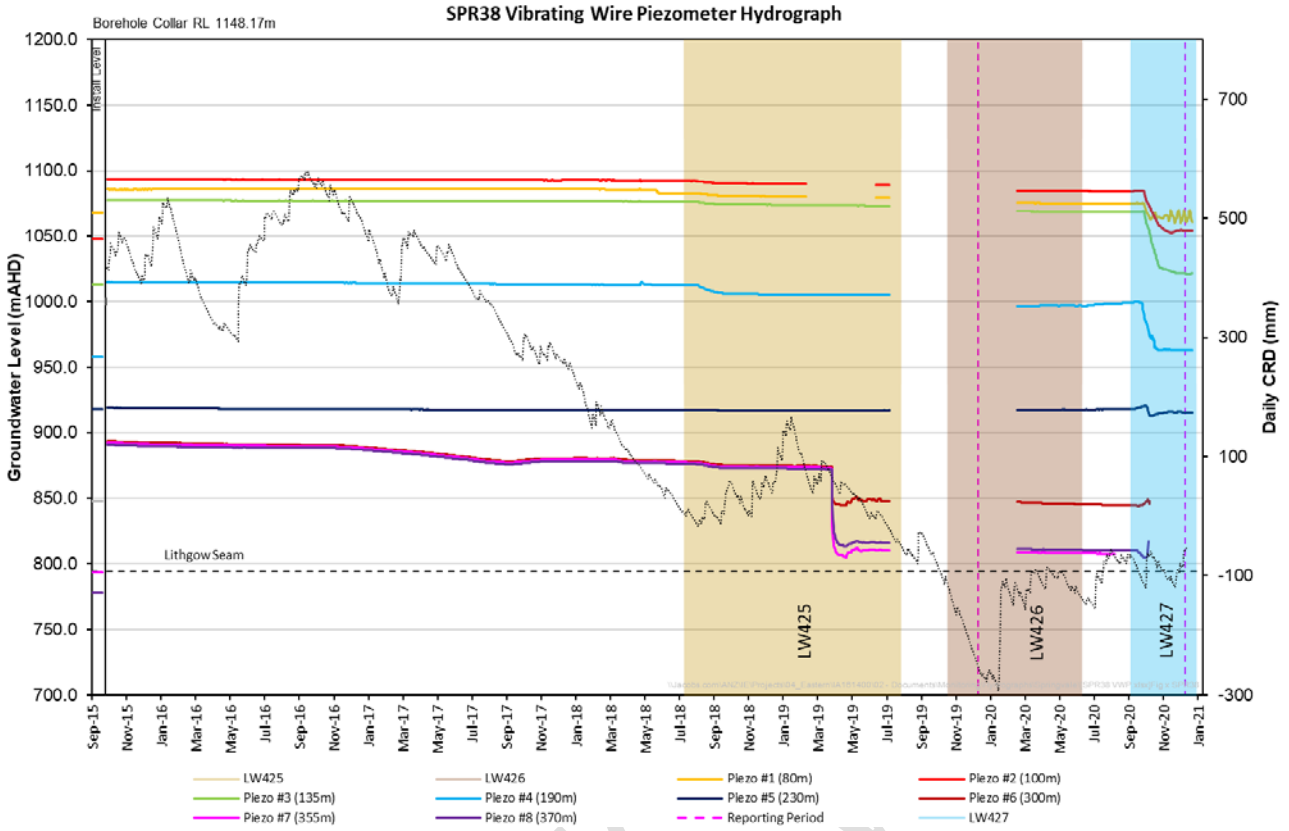

Figure 4.3: SPR38 Hydrograph

SPR1210

SPR1210 is located above LW428 and is approximately 100 m west of LW427. Piezometric pressures were monitored at seven depths at SPR1210 (Figure 4.4).

Communication has been lost with sensors due to software malfunction throughout the history of SPR1210. A large stepped decline was observed in Sensors #1 and #2 in January 2019, which coincides with LW425 approaching approximately 750 m away. Sensors #3 and #4 show a drop of smaller magnitude during the same time.

In July 2020, depressurisation was observed in the lowest two Sensors #1 and #2. The timing coincided with when LW426 was at a distance approximately 400m directly east of SPR1210. The Sensors #3 to #6 show a minor decline in pressure heads that align with the change in Sensors #1 and #2. This is likely associated with strata dilation, rather than vertical cracking. The upper most sensor (#7) does not appear to have been impacted by the depressurisation event.

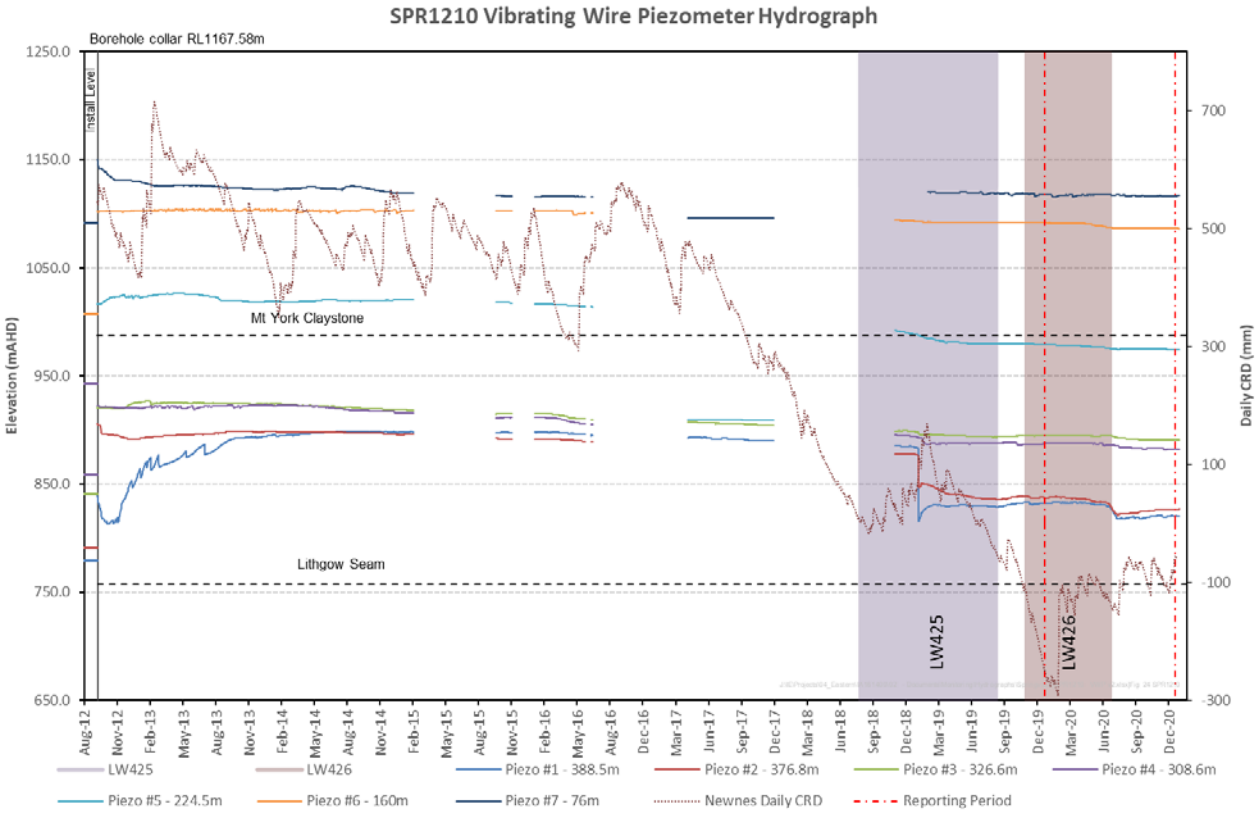

Figure 4.4: SPR1210 Hydrograph

SPR1302

SPR1302 is located approximately 300m south west of LW427. Piezometric pressures are monitored at five depths (Figure 4.5).

The SPR1302 hydrograph has historically displayed stable trends. The deepest Sensors #1 and #2, displayed a sudden drop in piezometric pressure in April and July 2019. The depressurisation observed could be due to the development of headings in the surrounding area as LW425 was over 1.3km away from SPR1302.

In 2020, from April to August, the lowest Sensors #1 and #2 displayed some erratic movements. The cause is unclear as mining at LW426 was more than 2km from SPR1302. In October 2020, depressurisation of the top three sensors was observed when LW427 was at its closest to SPR1302 at a distance less than 300m away. A trigger investigation was conducted and found the depressurisation was stabilising that suggests a re-equilibration with subsided formations and not deep drainage.

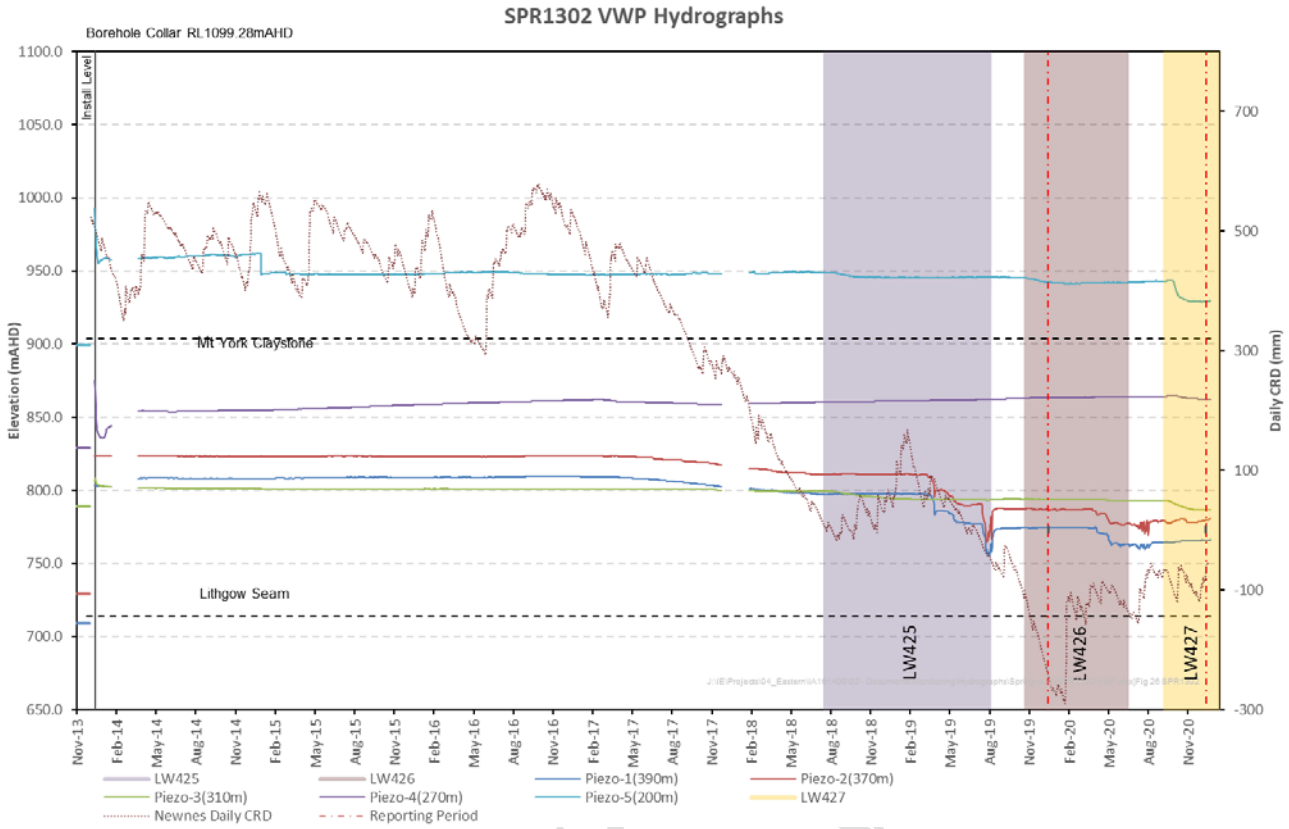

Figure 4.5: SPR1302 Hydrograph

AP10PR

AP10PR is a reference VWP array, located north within the Angus Place lease on the ridge adjacent Tri Star Swamp. Piezometric heads are monitored at nine depths. Sensor #3 displays some erroneous fluctuations in pressure. Sensor #4 displayed some erratic fluctuations typical of a sensor nearing the end of its lifespan and became unresponsive in February 2020. The two deepest sensors #1 and #2 displayed a minor stepped decline around July 2020. The cause is unclear as AP10PR is far from active mining and sudden groundwater changes in deep systems are not climatically driven. The remaining sensors display stable trends with no evidence of mining impacts during the reporting period.

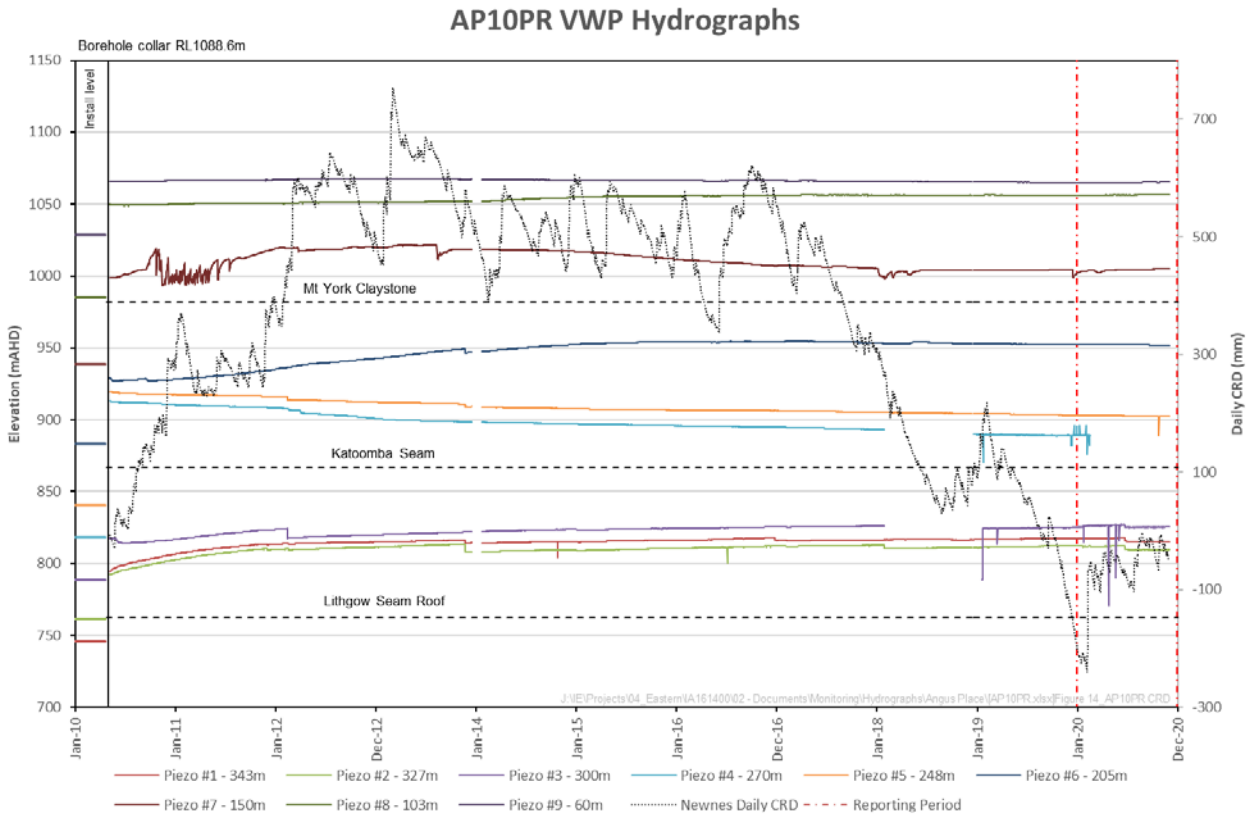

Figure 4.6: AP10PR Hydrograph

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5. Soil Moisture Monitoring

Soil moisture probes were installed to provide a means to continue monitoring swamp conditions if swamp water levels decline. An additional twenty-four soil moisture probes across various swamps were installed between July and October 2018. The soil moisture systems were damaged in the 2020 Gospers Mountain bushfire and were subsequently reinstated in September 2020. Soil moisture time-series data is presented in Appendix F; and their locations are shown on Figure A.1.

5.1.1 Soil Moisture Probes

As part of the conditions of the LW420-LW422 Swamp Management Plan (SMP) for Springvale Colliery, additional twenty-four soil moisture probes were installed between 6 and 18 July and on the 3 October 2018. Details of the installed probes are presented in Table H.1 in Appendix H.

5.1.2 Monitoring Results

Soil moisture is predominantly influenced by rainfall infiltration, evapotranspiration, and infiltration to the water table. Generally, most shallow sensors demonstrated responses to rainfall events. The monitoring results are summarised in Table 5.1 and Appendix F.

Table 5.1: Soil moisture probe monitoring results summary

Soil Moisture ID (Figure No.)	Comments
BA1SM	• 10 cm sensor out of the ground. • 20cm sensor increasing with rainfall • Other sensors displayed stable trends.
BA2SM	• 10 and 20 cm sensors slowly declining and fluctuating with rainfall • All sensors displayed stable trends.
BA3SM	• 10 cm *sensor* responded to rainfall events. • Other sensors displayed stable trends.
BE1SM	• Sensors shallower than 50cm displayed fluctuations corresponding to rainfall • Large fluctuations observed at the 40 and 50cm sensor which is close to the standing water level • Other sensors displayed stable trends near saturation.
BE2SM	• Sensors shallower than 60cm fluctuate with rainfall events. • Large fluctuations observed at the 40 to 60cm sensor which is close to the standing water level
BS1SM	• Shallower sensors up to 60cm displayed declining trends and responded to rainfall events. • Deeper sensors displayed a slowly increasing trend
BS2SM	• All sensors displayed movements corresponding the prevailing rainfall conditions • The most pronounced fluctuation was observed at the 10cm sensor. .
BS3SM	• All sensors recorded an increasing trend. • 10 cm to 30 cm sensors responded strongly to rainfall events..
CC1SM	• 10 to 40 cm sensor showed a strong response to rainfall events.

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Soil Moisture ID (Figure No.)	Comments
	• The 50 to 80cm sensors were generally stable except for the temporary decline in October and December
CC2SM	• Relatively stable trends at all sensors • Large fluctuations at 50 and 60cm sensors corresponding to the swamp water level increases.
CW1SM	• Relatively stable trends at all sensors. • Large fluctuations at 40cm sensor
CW4SM	• Relatively stable trends at most sensors. • Large fluctuations at 10 and 20cm sensors
FS1SM	• 30 to 60 cm responded to rainfall events. • Other sensors displayed stable trends to slightly increasing trends.
FS2SM	• 10 cm to 30 cm sensors fluctuated with rainfall events. • 40cm sensors displayed an increasing trends.
GG2SM	• 10cm sensor fluctuated with rainfall. • Remaining sensors are stable with moisture content decreasing closer to the surface
GG3SM	• Large fluctuations were observed at the two deepest sensors at 110 and 120cm where water is observed • Other sensors remained relatively stable with minor responses to rainfall events.
GW1SM	• Sensors at 40 cm fluctuated with rainfall. • Sensor at 10cm and 20cm were above ground. • Other sensors had a slowly declining trend and recorded minor increases with rainfall events.
GW3SM	• Soil moisture is low around this site generally below 20%. • Soil moisture fluctuated with rainfall events with the deeper sensors displaying more pronounced movements
MS1SM	• 10 cm sensors responded to the prevailing rainfall events. • Other sensors displayed increasing trends.
MS2SM	• 30 cm sensors fluctuated with rainfall events. • Other sensors displayed stable trends.
MS3SM	• 10cm to 40cm sesnors fluctuated with rainfall and water levels. • Remaining sensors displayed stable water levels.
NMSS	• 40 to 60cm sensors fluctuated accordingly to the standing water level • Remaining sensors show stable trends.
PC1SM	• 10 cm ,20 cm and 30cm sensors were above ground • Remaining sensors were stable.
PC2SM	• 10 cm sensor displayed fluctuations corresponding to rainfall. • Other sensors displayed stable trends with minor movements corresponding to rainfall events

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Soil Moisture ID (Figure No.)	Comments
PSSSM	• Sensors 20cm to 50 cm fluctuate with rainfall events and water levels. • Sensor at 10cm was above ground • Remaining sensors show stable trends.
TG1SM	• 10 cm and 40 cm sensors responded to rainfall events. • Other sensors displayed stable trends.
TG2SM	• 10 cm and 20 cm sensors responded to rainfall events. • Other sensors displayed stable trends. • 10 cm probe fluctuated around and below field capacity. • The remaining probes fluctuated between field capacity and saturation.
TS2SM	• Overall stable trend at 10 to 30cm sensors with rainfall fluctuations • Declining trend from 40 to 80cm sensors • Slightly increasing trend from sensors 90cm to 120 cm.
TS3SM	• 10 cm and 20 cm sensors fluctuated with rainfall events. • Other sensors displayed stable trends with the exception of the 70cm sensor. It is likely the 70cm sensor does not have good contact with the soil.

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6. Swamp Groundwater Quality Monitoring

Groundwater quality triggers for swamps are dynamic and are developed using data collected during the pre-mining period. Investigation performance triggers are outlined in the Swamp Management Plan. Short term investigation triggers changes are defined as greater than the pre-mining 80th percentile by two standard deviations for more than two months. Long term triggers are defined as the post mining 50th percentile being greater than the pre-mining 80th percentile. The focus of this report will be on the short-term triggers to identify potential impacts.

A suite of quality parameters is monitored including field parameters (pH, temperature, EC, Eh, dissolved oxygen, TDS), major ions and trace ions but the focus will be on the key parameters that will be used to identify potential mining impacts. Swamp water quality on the plateau is characterised by low EC, low concentrations of dissolved metals and generally acidic conditions. The averaged key water quality parameters are tabulated for the reporting period for each swamp. The graphs of long-term water quality trends can be found in Appendix E.

Due to the bushfire conditions there was limited access to these sites in 2020. The first monitoring round conducted post bushfire was in June 2020.

The key parameters for the swamp groundwater quality monitoring program are:

- pH
- Electrical Conductivity (EC)
- Filtered Iron

Groundwater quality is monitored across the plateau at the locations shown in Appendix A on Figure A.1

6.1 Reference Swamps

Reference swamp sites are sites that are regarded to be outside of the area of influence of mining related groundwater and surface water impacts. The graphs of the main analytes show the general trends. The beginning of the reporting period is marked by the dotted line at January 2020. At reference sites, the whole dataset is considered to be baseline data and baseline cut off is at the most recent monitoring round.

There are no triggers at reference sites.

6.1.1 Barrier Swamp

6.1.1.1 Statistics

Barrier swamp is a reference swamp and the trigger values are still dynamic. Table 14 of SMP LW424-LW427 outlines the dynamic trigger values. In this instance, the summary statistics of all recorded data would be more appropriate (refer Table 6.1).

Limited data was collected during the reporting due to the bushfire restricting access in early 2020. Most recent values are not compared against triggers as the swamp is a reference swamp. That said, a single instance of elevated EC was observed at BA2. The spike was also accompanied by elevated Aluminium. The elevated levels of Iron at BA2 was accompanied by a corresponding increase in other metal cations and it is unclear what could have caused this.

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Table 6.1: Barrier Swamp - Groundwater quality summary statistics

ID	Historic date ranges	Analyte	Historic data statistics				Dynamic long term trigger &	Dynamic short term trigger &	Reporting period statistics			Comments
			Data point count	Min	Mean	Max			Min	Median	Max	
BA1	18/03/2018 – present											
		pH	14	4.3	4.91	6.1	4.6-5.1	3.5-6.1	4.6	5.78	6	Reference site - No trigger
		EC (µS/cm)	14	40	48.3	104	54	68	30	92.4	104	Reference site - No trigger
		Fe (mg/L)	13	0.08	0.231	0.67	0.264	0.608	0.12	0.194	0.2	Reference site - No trigger
BA2	18/03/2018 – present											
		pH	17	5.1	5.7	6.4	5.4-6.1	4.5-7.0	5.4	6	6	Reference site - No trigger
		EC (µS/cm)	17	48	212.3	1350	182	309	120	940.15	1350	Reference site - No trigger
		Fe (mg/L)	16	0.1	1.57	11.6	1.308	2.582	0.78	8.546	11.6	Reference site - No trigger
BA3	18/03/2018 – present											
		pH	11	5.1	5.6	6.2	5.3-5.9	4.6-6.6	5.3	5.985	6	Reference site - No trigger
		EC (µS/cm)	12	45	223	1486	110	158	97	1223.6	1486	Reference site - No trigger
		Fe (mg/L)	10	0.05*	0.294	1.22	0.396	1.155	0.05*	0.1	0.1	Reference site - No trigger

Notes: * value at detection limit (Limit of Reporting - LOR)
positive delta value equals a recent value that is greater than the historic mean, and vice versa for negative delta values.
% no monitoring data available post 19/10/2019, due to lack of access caused to bushfire/ dry conditions
@ where values are below limit of reporting, a value of half the measurement has been assumed.
& investigation trigger performance indicators based on Table 33 of the SMP LW424-LW427. The long- and short-term triggers are based on the 80th data percentile and the 80th percentile plus two standard deviations, respectively

6.1.1.2 Quality Trends

SMP states that groundwater results will be compared to performance for the parameters EC, pH and Iron. The trends for these analytes are shown below.

Barrier Swamp is still an unimpacted swamp and the variability in parameters reflect natural fluctuations. There are no clear trends in either pH, EC or Iron concentrations (refer Figure 6.1 to Figure 6.3) and the values for this reporting period are generally within historic ranges expect for the single instance of spiked concentrations.

Graphs for all other parameter trends are included in **Appendix E**. Trends of note are:

- Single spike in concentrations in 2020 of: Zinc, Chlorine, Aluminium, Chromium, Copper, Hardness, Potassium, Calcium, Lead, Arsenic, Cadmium, Selenium, Mercury. It is possible the sample was contaminated during the sampling round.

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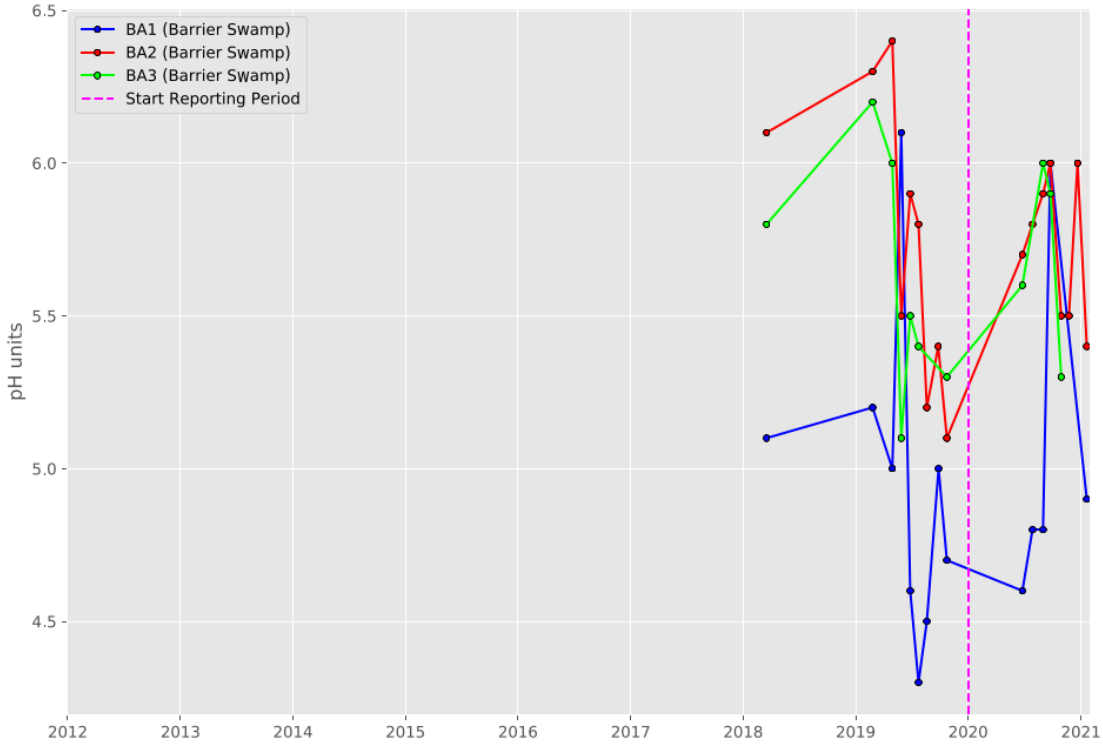
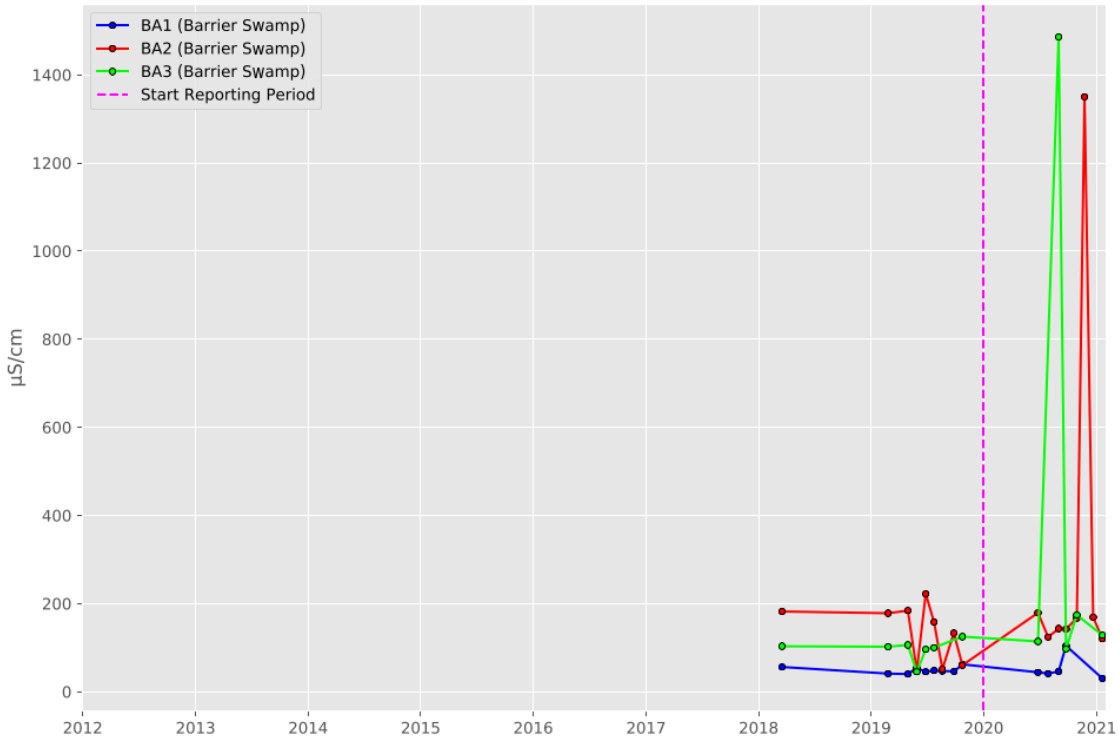


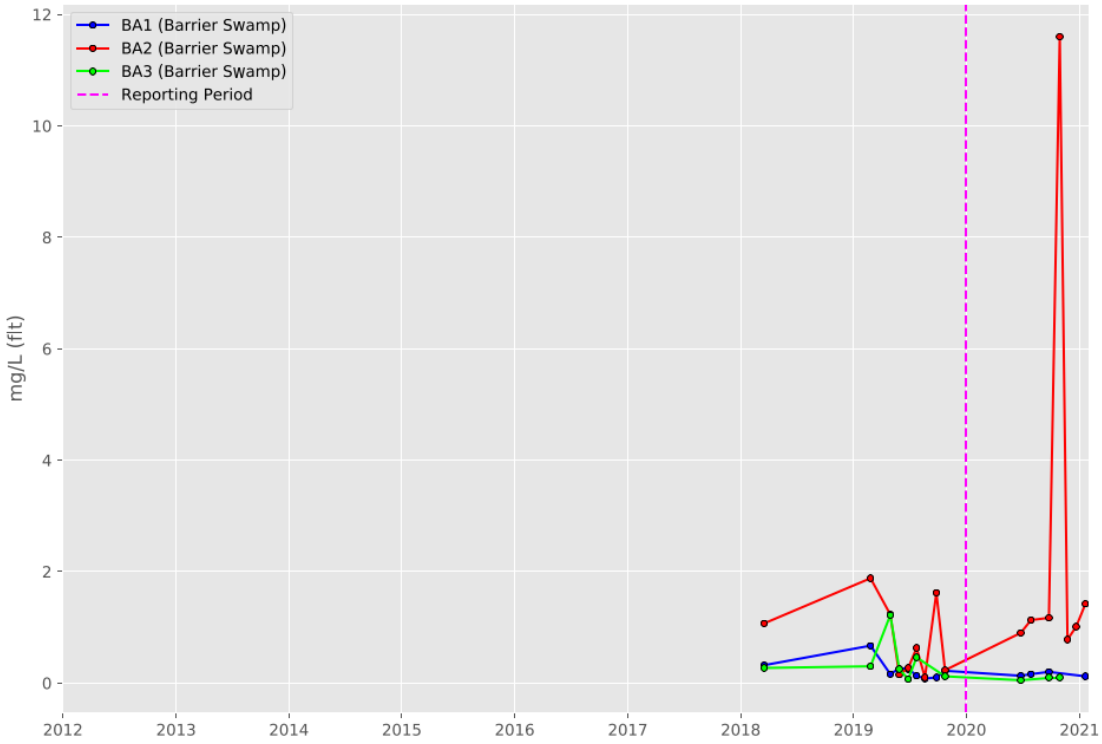
NB – Trigger not applicable to reference sites

Figure 6.1: Barrier Swamp - pH



NB – Trigger not applicable to reference sites

Figure 6.2: Barrier Swamp - EC



NB – Trigger not applicable to reference sites

Figure 6.3: Barrier Swamp - Iron

6.1.2 Best Swamp

6.1.2.1 Statistics

Best Swamp is a reference swamp and the trigger values are still dynamic. Table 14 of SMP LW424-LW427 outlines the dynamic trigger values. In this instance the summary statistics of all recorded data would be more appropriate (refer

Table 6.2)

Limited data was collected during the reporting due to the bushfire restricting access in early 2020. Most recent value are not compared against triggers as the swamp is a reference swamp. Elevated levels of EC and pH were recorded at BE2 but returned to normal levels the following month. There is a declining trend in Iron concentrations at BE1 .

Table 6.2: Best Swamp - Groundwater quality summary statistics

ID	Historic date ranges	Analyte	Historic data statistics				Dynamic long term trigger &	Dynamic short term trigger &	Reporting period statistics			Comments
			Data point count	Min	Mean	Max			Min	Median	Max	
BE1	18/03/2018 – present											
		pH	16	3.4	4.76	6	4.3-5.5	2.7-7.0	4.3	4.97	5	Reference site - No trigger
		EC (µS/cm)	17	39	53.7	131	58	81	40	106.5	131	Reference site - No trigger

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ID	Historic date ranges	Analyte	Historic data statistics				Dynamic long term trigger &	Dynamic short term trigger &	Reporting period statistics			Comments
			Data point count	Min	Mean	Max			Min	Median	Max	
		Fe (mg/L)	15	0.05	0.258	0.63	0.394	0.749	0.05	0.446	0.47	Reference site - No trigger
BE2	18/03/2018 – present											
		pH	15	4	4.80	7	4.5-4.9	3.9-5.6	4	6.23	7	Reference site - No trigger
		EC (µS/cm)	15	27	47.4	131	48	57	27	100.2	131	Reference site - No trigger
		Fe (mg/L)	14	0.05	0.108	0.37	0.224	0.452	0.05	0.087	0.09	Reference site - No trigger

Notes: * value at detection limit (Limit of Reporting - LOR)
positive delta value equals a recent value that is greater than the historic mean, and vice versa for negative delta values.
% no monitoring data available post 19/10/2019, due to lack of access caused to bushfire/ dry conditions
@ where values are below limit of reporting, a value of half the measurement has been assumed.
& investigation trigger performance indicators based on Table 33 of the SMP LW424-LW427. The long- and short-term triggers are based on the 80th data percentile and the 80th percentile plus two standard deviations, respectively

6.1.2.2 Quality Trend

SMP states that groundwater results will be compared to performance for the parameters EC, pH and Iron. The trends for these analytes are shown below.

Best Swamp is still an unimpacted swamp and the variability in parameters reflect natural fluctuations. There are no clear trends in either pH, EC or Iron concentrations (refer Figure 6.4 to Figure 6.6) and the values for this reporting period are generally within historic ranges.

Graphs for all other parameter trends are included in **Appendix E**. Trends of note are:

- Alkalinity – a spiked increases in 2019 and 2020
- Aluminium – general decline since mid-2019
- Copper – Spikes in copper concentrations are common.
- Zinc – general decline since 2019

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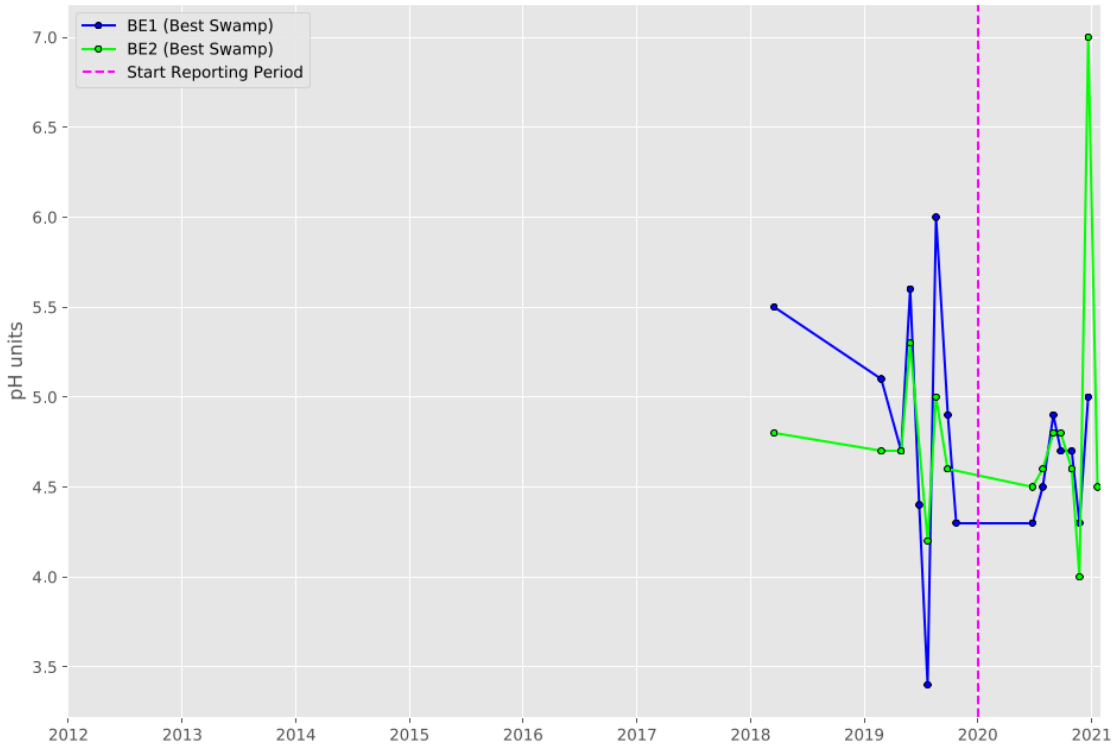
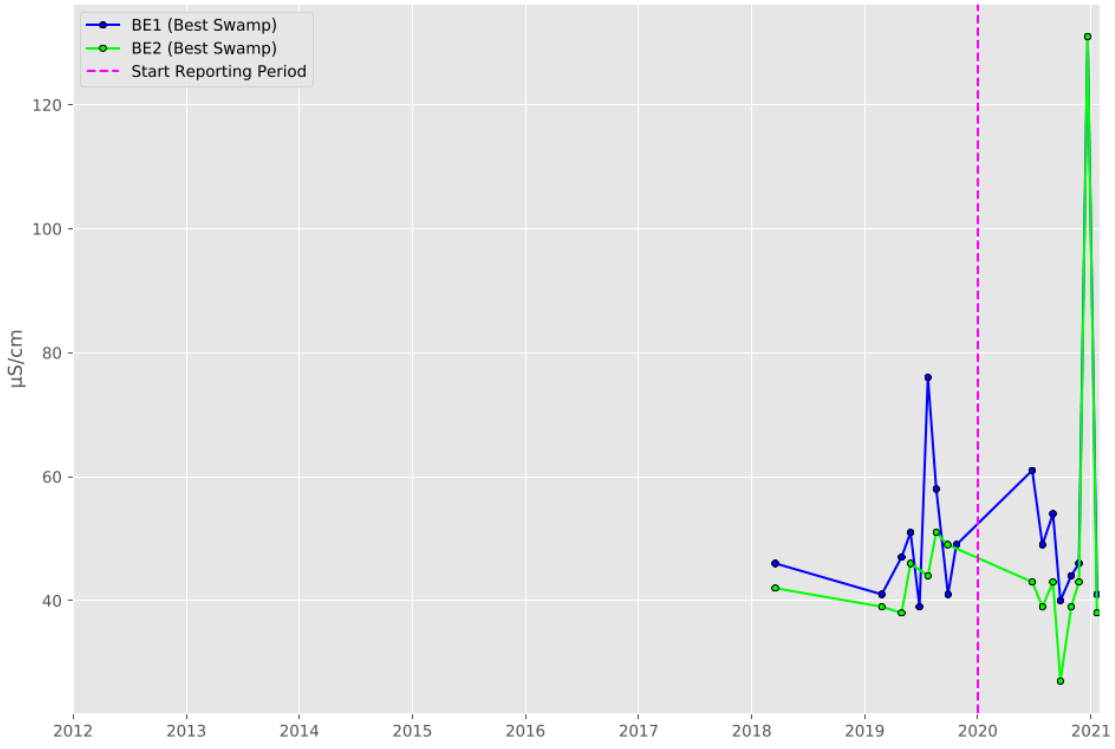


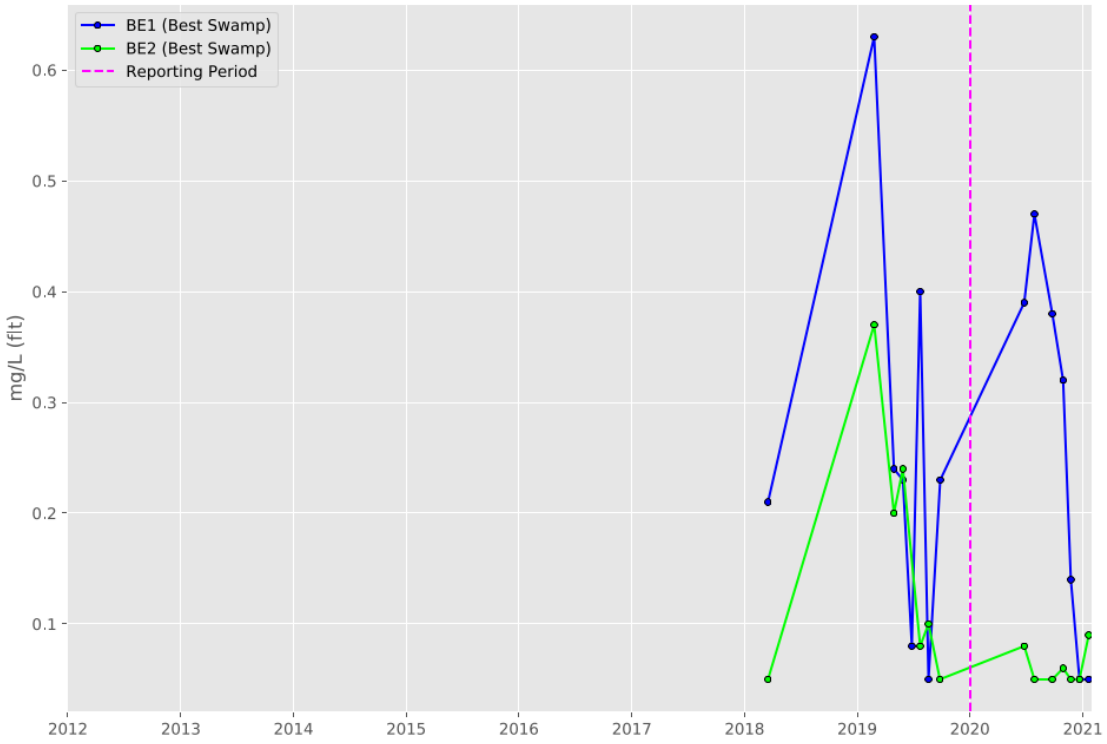
NB – Trigger not applicable to reference sites

Figure 6.4: Best Swamp - pH



NB – Trigger not applicable to reference sites

Figure 6.5: Best Swamp - EC



NB – Trigger not applicable to reference sites

Figure 6.6: Best Swamp - Iron

6.1.3 Carne Central Swamp

CC1 was not able to be sampled during the reporting period as it was dry

6.1.3.1 Statistics

Carne Central swamp is still in the pre-mining phase and the trigger value are still dynamic. Table 14 of SMP LW424-LW427 outlines the dynamic trigger values. In this instance the summary statistics of all recorded data would be more appropriate (refer

Table 6.3).

Only one sample was collected at CC2 during the reporting period due to the bushfires restricting access in early 2020 and the site was dry.

Table 6.3: Carne Central Swamp - Groundwater quality Summary Statistics

ID	Historic date ranges[%]	Analyte	Historic data statistics				Dynamic Long term trigger [&]	Dynamic Short term trigger [&]	Reporting period statistics			Comments
			Data point count	Min	Mean	Max			Min	Median	Max	
CC1	**12/06/2012 – present**											
		pH	72	5.3	6.24	7.41	6.0-6.5	5.3-7.2	Dry	Dry	Dry	Reference site - No trigger
		EC (µS/cm)	61	8.3	102	173	143	261	Dry	Dry	Dry	Reference site - No trigger
		Fe (mg/L)	68	0.05	7.37	31.5	3	7	Dry	Dry	Dry	Reference site - No trigger
CC2	08/07/2019 – present										-	-
		pH	2	4.3	4.95	5.6	NA - Insufficient data to establish triggers		4.3	4.3	4.3	Reference site - No trigger
		EC (µS/cm)	2	52	72	92			92	92	92	Reference site - No trigger
		Fe (mg/L)	2	0.05	0.11	0.17			0.05	0.05	0.05	Reference site - No trigger

Notes: * value at detection limit (Limit of Reporting - LOR)
positive delta value equals a recent value that is greater than the historic mean, and vice versa for negative delta values.
% no monitoring data available post 19/10/2019, due to lack of access caused to bushfire/ dry conditions
@ where values are below limit of reporting, a value of half the measurement has been assumed.
& investigation trigger performance indicators based on Table 33 of the SMP LW424-LW427. The long- and short-term triggers are based on the 80th data percentile and the 80th percentile plus two standard deviations, respectively

6.1.3.2 Quality Trend

SMP states that groundwater results will be compared to performance for the parameters EC, pH and Iron. The trends for these analytes are shown below.

Carne Central Swamp is still an unimpacted swamp and the variability in parameters reflect natural fluctuations. There is no clear trend in EC values, but the average EC value has been declining since early-2016. pH has also shown to be declining (since 2015). Both the declining EC and pH are most likely related to the declining average rainfall experienced at the site between 2015 and 2019. Limited samples have been collected at Carne Central since 2019 due to dry conditions.

There is no clear seasonal trend for Iron, but the highest concentrations are observed after 2016, during a period of declining rainfalls when water levels at Carne Central were in decline.

Graphs for all other parameter trends are included in **Appendix E**. Trends of note are:

- Alkalinity – declining since 2015
- Calcium – declining trend since 2015
- Copper – declining trend since 2013 with decreasing variability.

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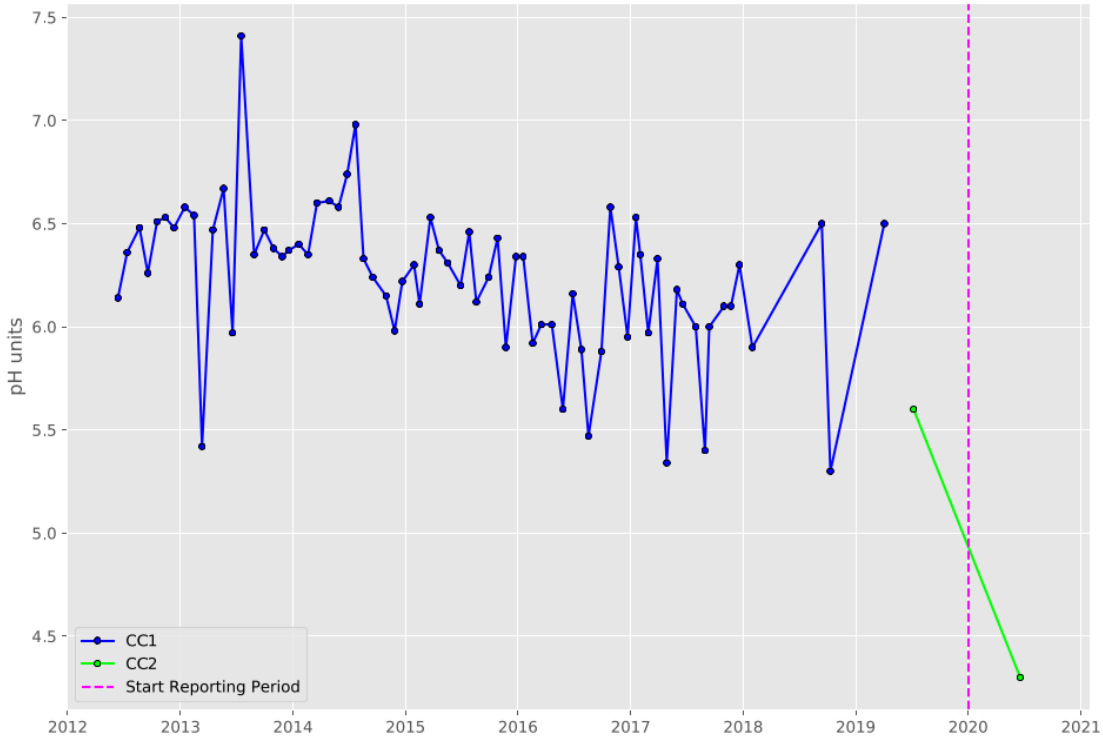
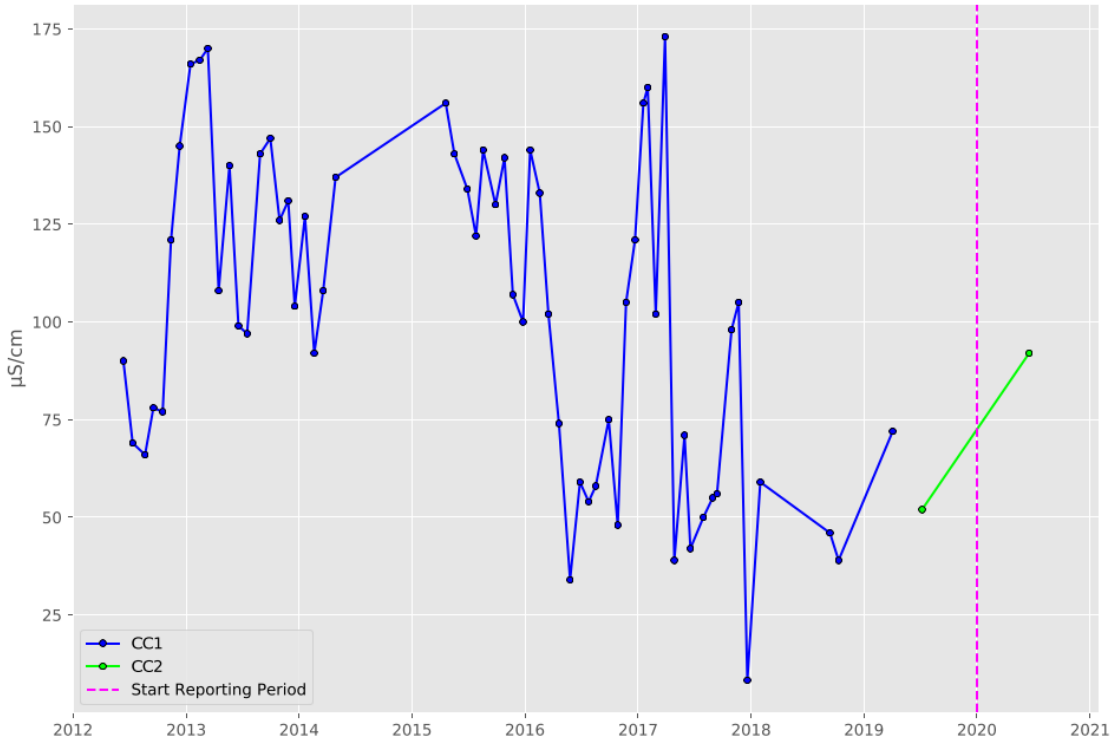
- Zinc – declining trend since mid-2014

These declining values are all likely related to the declining below average rainfall conditions between 2015 and 2019.



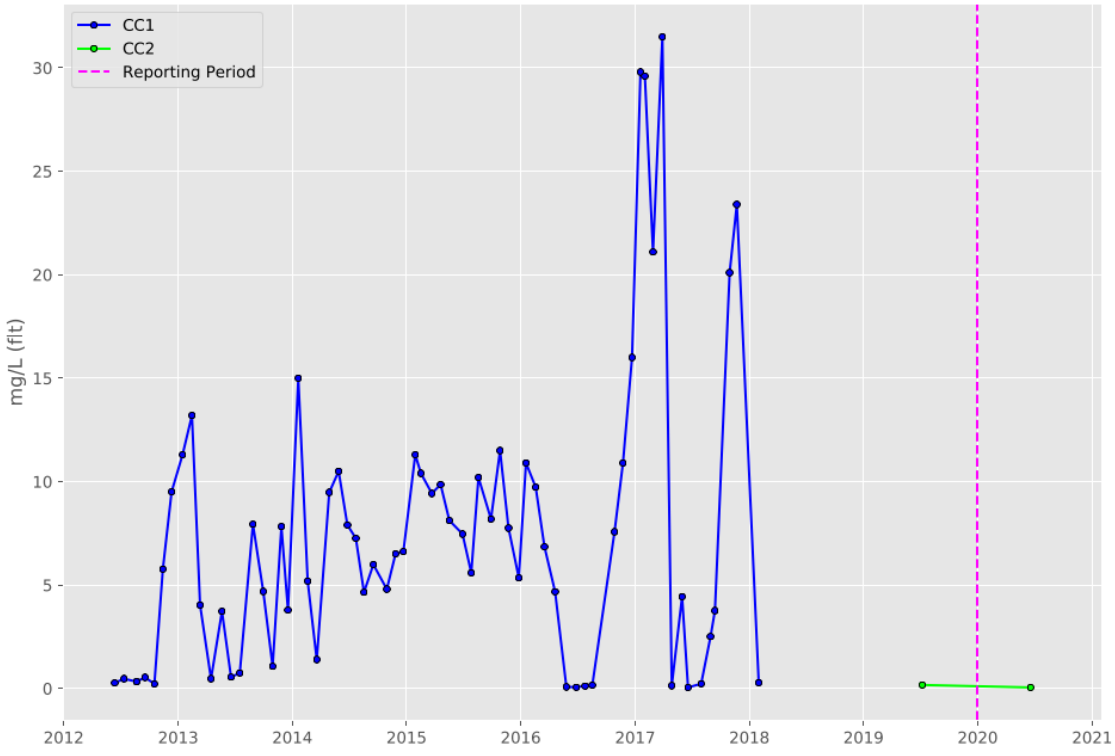
NB – Trigger not applicable to reference sites

Figure 6.7: Carne Central Swamp - pH



NB – Trigger not applicable to reference sites

Figure 6.8: Carne Central Swamp - EC



NB – Trigger not applicable to reference sites

Figure 6.9: Carne Central Swamp - Iron

6.1.4 Firetail Swamp

6.1.4.1 Statistics

Firetail Swamp is a reference swamp and the trigger values are still dynamic. Table 14 of SMP LW424-LW427 outlines the dynamic trigger values. In this instance the summary statistics of all recorded data would be more appropriate (refer Table 6.4)

Limited data was collected during the reporting due to the bushfire restricting access in early 2020. Only one sample was taken at FT2 as the bore was dry. Most recent value are not compared against triggers as the swamp is a reference swamp.

Table 6.4: Firetail Swamp = Groundwater quality summary statistics

ID	Historic date ranges	Analyte	Historic data statistics				Dynamic long term trigger &	Dynamic short term trigger &	Reporting period statistics			Comments
			Data point count	Min	Mean	Max			Min	Median	Max	
FT1	18/03/2018 - present											
		pH	14	4.2	4.88	6	4.6-5.2	3.5-6.3	4.5	5.3	5.3	Reference site - No trigger

ID	Historic date ranges	Analyte	Historic data statistics				Dynamic long term trigger &	Dynamic short term trigger &	Reporting period statistics			Comments
			Data point count	Min	Mean	Max			Min	Median	Max	
		EC (µS/cm)	14	41	50.7	86	51	72	42	83	86	Reference site - No trigger
		Fe (mg/L)	13	0.05	0.158	0.71	0.114	0.197	0.05	0.642	0.71	Reference site - No trigger
FT2	18/03/2018 - present											
		pH	4	4.3	4.75	5.3	4.5-5.0	3.6-5.8	4.3	4.3	4.3	Reference site - No trigger
		EC (µS/cm)	4	40	49	65	54	77	43	43	43	Reference site - No trigger
		Fe (mg/L)	4	0.05	0.198	0.37	0.34	0.683	0.37	0.37	0.37	Reference site - No trigger

Notes: * value at detection limit (Limit of Reporting - LOR)
positive delta value equals a recent value that is greater than the historic mean, and vice versa for negative delta values.
% no monitoring data available post 19/10/2019, due to lack of access caused to bushfire/ dry conditions
@ where values are below limit of reporting, a value of half the measurement has been assumed.
& investigation trigger performance indicators based on Table 33 of the SMP LW424-LW427. The long- and short-term triggers are based on the 80th data percentile and the 80th percentile plus two standard deviations, respectively

6.1.4.2 Quality Trend

SMP states that groundwater results will be compared to performance for the parameters EC, pH and Iron. The trends for these analytes are shown below.

Firetail Swamp is still an unimpacted swamp and the variability in parameters reflect natural fluctuations. pH shows minor fluctuations but is generally stable around a narrow band. EC shows some fluctuations that is likely linked to the rainfall conditions. Iron concentrations at FT1 showed a large spike in October most likely linked with rainfall events.

Graphs for all other parameter trends are included in **Appendix E**. Trends of note are:

- Alkalinity- Increasing since mid 2019 and peaked in October 2020
- Aluminium – generally declining since mid 2019 at FT1
- Zinc – generally declining concentrations since 2018
- Metal cations – a single peak in October 2020.

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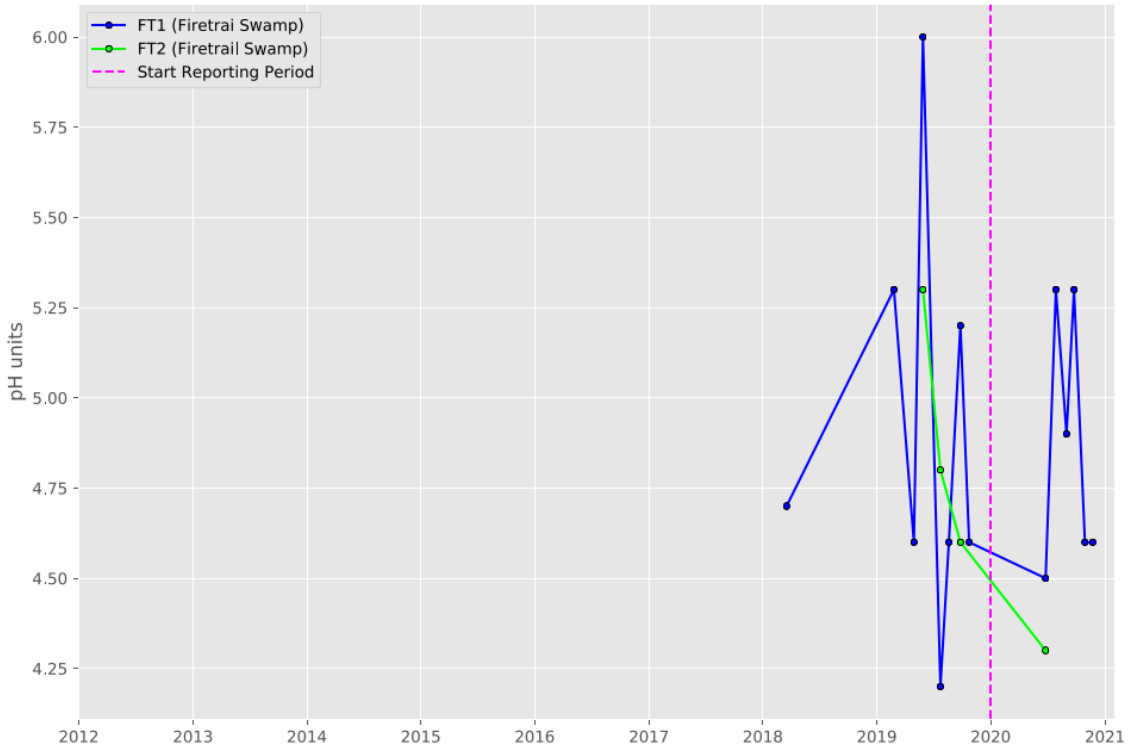
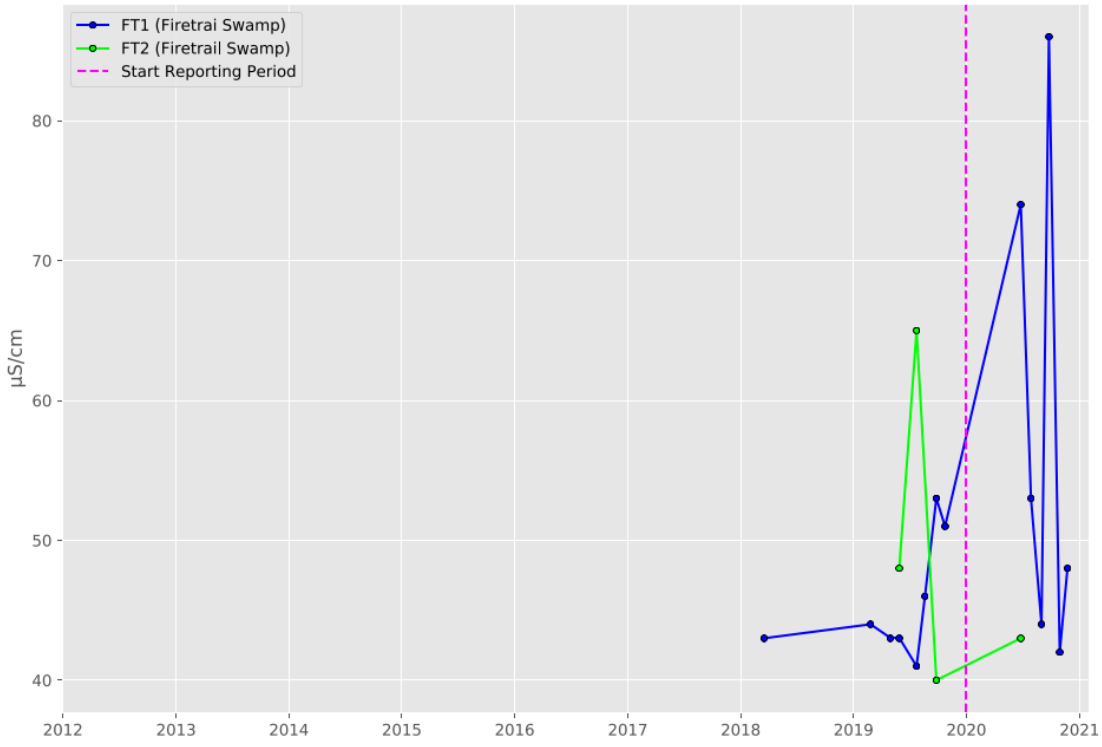


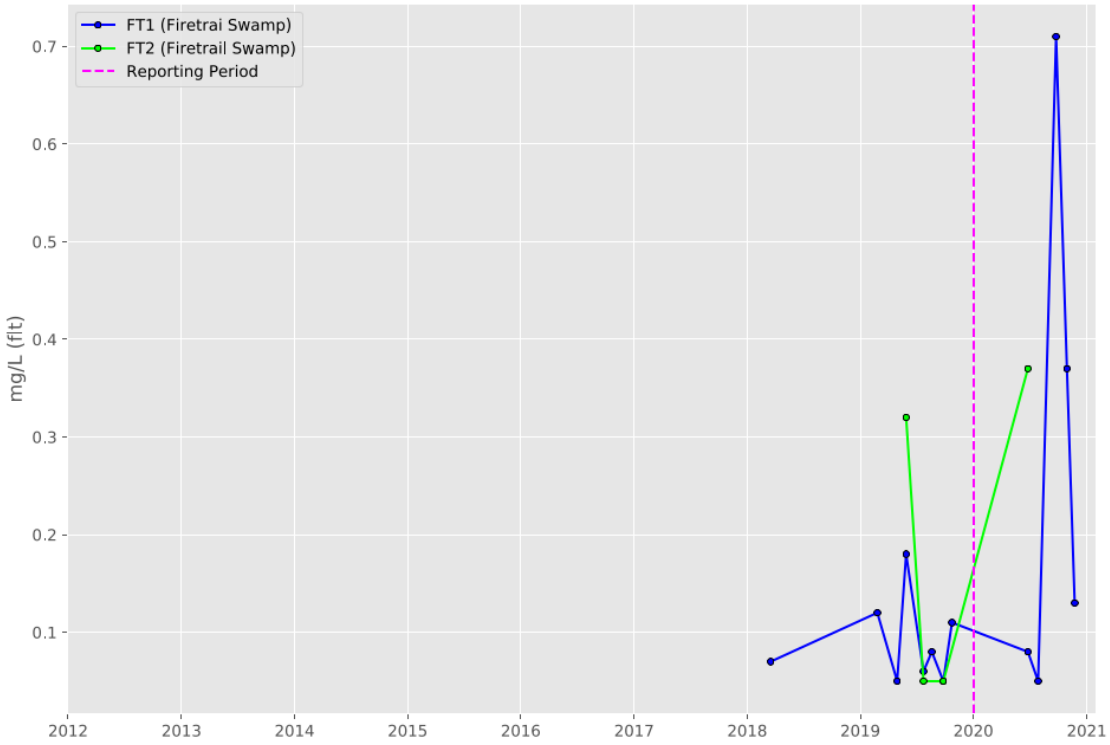
NB – Trigger not applicable to reference sites

Figure 6.10: Firetail Swamp - pH



NB – Trigger not applicable to reference sites

Figure 6.11: Firetail Swamp - EC



NB – Trigger not applicable to reference sites

Figure 6.12: Firetail Swamp - Iron

6.1.5 Tristar Swamp

6.1.5.1 Statistics

Tristar Swamp is a reference swamp and the trigger values are still dynamic and as such is considered to be outside of the area of precited groundwater impact. Table 14 of SMP LW424-LW427 outlines the dynamic trigger values. In this instance the summary statistics of all recorded data would be more appropriate (refer Table 6.5)

Limited data was collected during the reporting due to the bushfire restricting access in early 2020. There were no samples collected at TS1 as it was dry. Most recent value are not compared against triggers as the swamp is a reference swamp.

Table 6.5: Tristar Swamp - Groundwater quality summary statistics

ID	Historic date ranges	Analyte	Historic data statistics				Dynamic long term trigger &	Dynamic short term trigger &	Reporting period statistics			Comments
			Data point count	Min	Mean	Max			Min	Median	Max	
TS1	12/06/2014 – present											
		pH	19	2.28	5.25	7.37	5.1-5.5	3.3-7.3	Dry	Dry	Dry	Reference site - No trigger
		EC (µS/cm)	16	0	27.15	37	32	49	Dry	Dry	Dry	Reference site - No trigger

ID	Historic date ranges	Analyte	Historic data statistics				Dynamic long term trigger &	Dynamic short term trigger &	Reporting period statistics			Comments
			Data point count	Min	Mean	Max			Min	Median	Max	
		Fe (mg/L)	19	0.05	0.094	0.75	0.054	0.374	Dry	Dry	Dry	Reference site - No trigger
TS2	16/10/2012 – present											
		pH	70	4.1	5.97	7.88	5.6-6.4	4.5-7.6	4.1	4.1	4.1	Reference site - No trigger
		EC (µS/cm)	60	20	57.105	134	80	135	48	48	48	Reference site - No trigger
		Fe (mg/L)	68	0.05	0.233	6.26	0.248	1.772	0.19	0.19	0.19	Reference site - No trigger
TS3	17/10/2012 - present											
		pH	90	3.55	5.38	8.2	5.0-5.7	3.7-7.1	3.9	5.43	5.5	Reference site - No trigger
		EC (µS/cm)	80	17	47.4	135	54	91	47	80.75	86	Reference site - No trigger
		Fe (mg/L)	88	0.05	2.576	12	4.34	9.631	0.17	7.975	8.22	Reference site - No trigger

Notes: * value at detection limit (Limit of Reporting - LOR)
positive delta value equals a recent value that is greater than the historic mean, and vice versa for negative delta values.
% no monitoring data available post 19/10/2019, due to lack of access caused to bushfire/ dry conditions
@ where values are below limit of reporting, a value of half the measurement has been assumed.
& investigation trigger performance indicators based on Table 33 of the SMP LW424-LW427. The long- and short-term triggers are based on the 80th data percentile and the 80th percentile plus two standard deviations, respectively

6.1.5.2 Quality Trend

SMP states that groundwater results will be compared to performance for the parameters EC, pH and Iron. The trends for these analytes are shown below.

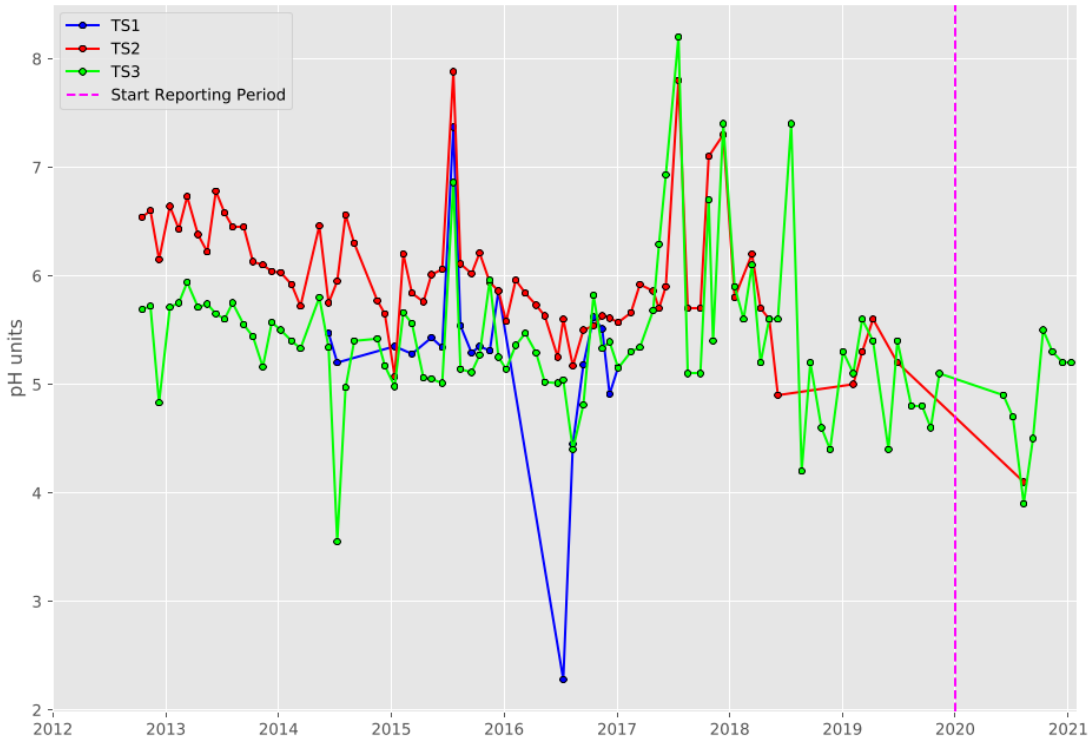
Tristar Swamp is still an unimpacted swamp and the variability in parameters reflect natural fluctuations. pH and was observed to be generally stable, with some short periods of elevated values. EC displayed a peak in concentrations around October 2020 most likely linked to rainfall conditions. Iron concentrations are observed to be stable at TS1 and TS2, whereas concentrations follow a seasonal trend with peaks around the summer months at TS3.

No mining related impact is visible for the reporting period.

Graphs for all other parameter trends are included in **Appendix E**. Trends of note are:

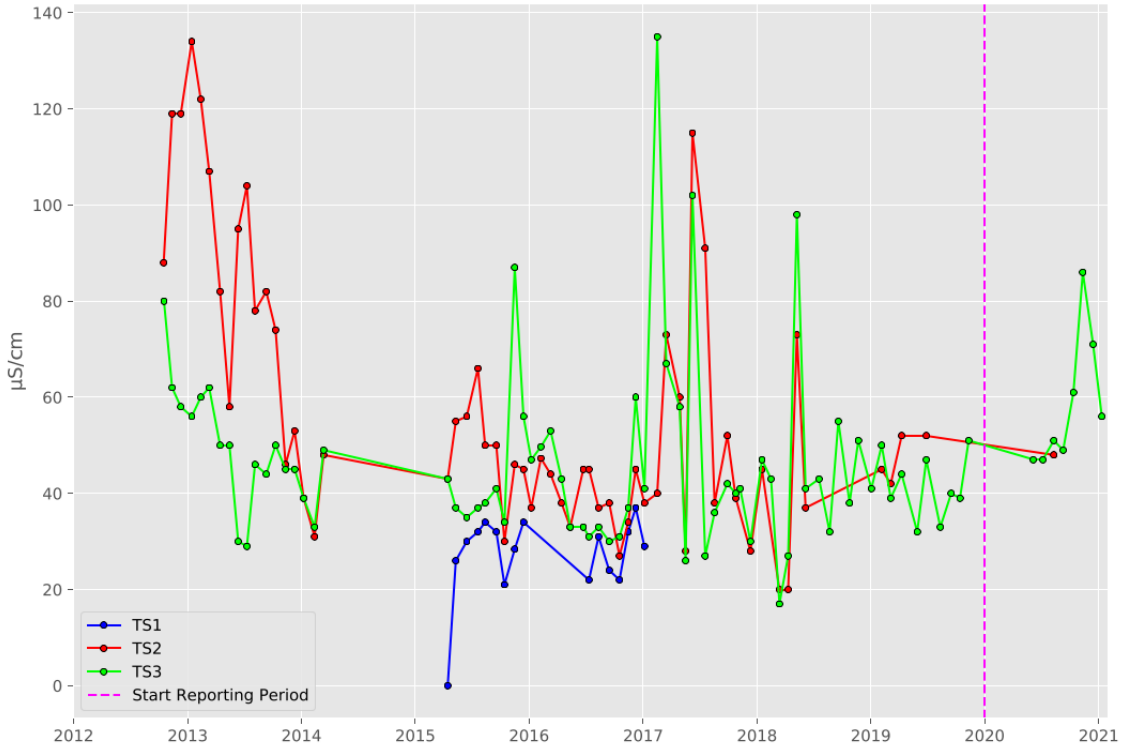
- Aluminium – Distinct peaks at TS2 while other sites remained relatively stable
- Alkalinity- generally declining trend at TS2 since monitoring commenced in 2013.
- Calcium - generally declining trend at TS2 since monitoring commenced in 2013.
- Metal cations – there was a temporary peak in October 2020

SPRINGVALE



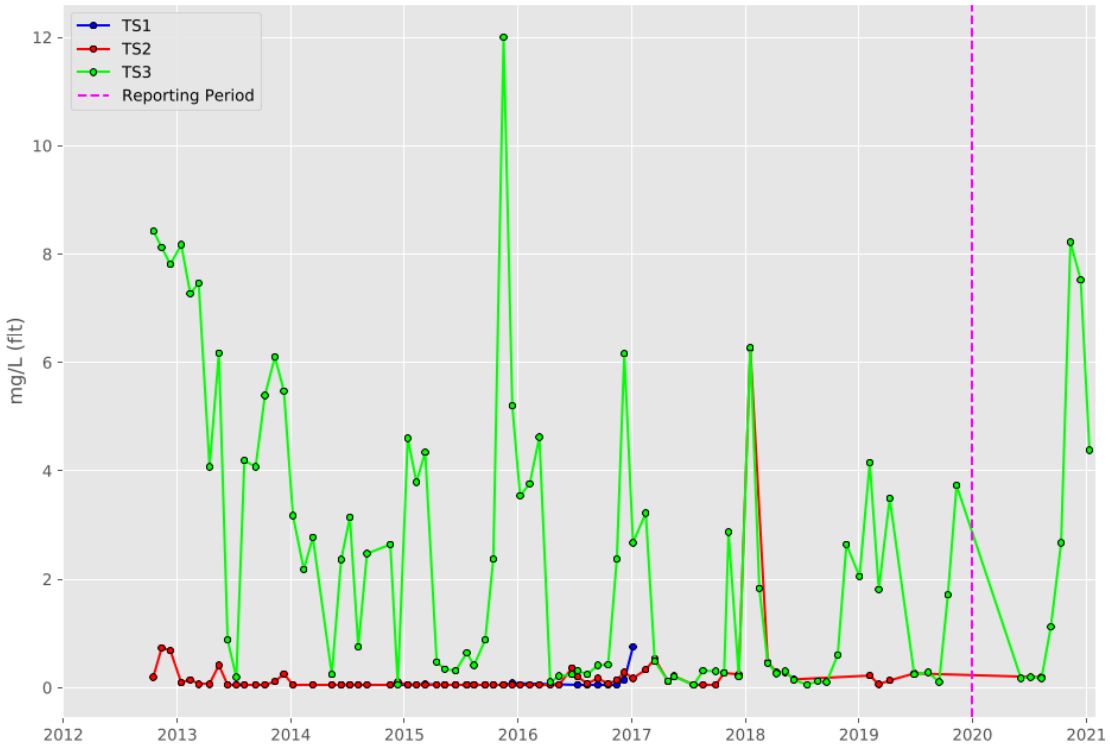
NB – Trigger not applicable to reference sites

Figure 6.13: Tristar Swamp - pH



NB – Trigger not applicable to reference sites

Figure 6.14: Tristar Swamp - EC



NB – Trigger not applicable to reference sites

Figure 6.15: Tristar Swamp - Iron

6.1.6 Twin Gully Swamp

6.1.6.1 Statistics

Twin Gully Swamp is a reference swamp and the trigger values are still dynamic. Table 14 of SMP LW424-LW427 outlines the dynamic trigger values. In this instance the summary statistics of all recorded data would be more appropriate (refer Table 6.6)

Limited data was collected during the reporting due to the bushfire restricting access in early 2020. Most recent values are not compared against triggers as the swamp is a reference swamp.

Table 6.6: Twin Gully Swamp - Groundwater quality summary statistics

ID	Historic date ranges	Analyte	Historic data statistics				Dynamic long term trigger &	Dynamic short term trigger &	Reporting period statistics			Comments
			Data point count	Min	Mean	Max			Min	Median	Max	
TG1	15/10/2012 – present											
		pH	87	3.8	5.46	8.56	5.0-5.8	3.6-7.3	3.8	5.56	5.6	Reference site - No trigger
		EC (µS/cm)	79	25	46.5	164	52	90	30	101.25	117	Reference site - No trigger
		Fe (mg/L)	84	0.05	0.504	4.03	0.498	1.931	0.1	3.179	4.03	Reference site - No trigger

ID	Historic date ranges	Analyte	Historic data statistics				Dynamic long term trigger &	Dynamic short term trigger &	Reporting period statistics			Comments
			Data point count	Min	Mean	Max			Min	Median	Max	
TG2	19/11/2018 - present											
		pH	8	4.5	5.15	6	4.8-5.5	3.7-6.6	4.6	5.65	5.7	Reference site - No trigger
		EC (µS/cm)	8	30	56.5	105	82.6	139	30	73.1	77	Reference site - No trigger
		Fe (mg/L)	8	0.05	0.54	1.86	0.428	1.225	0.05	1.698	1.86	Reference site - No trigger

Notes: * value at detection limit (Limit of Reporting - LOR)
positive delta value equals a recent value that is greater than the historic mean, and vice versa for negative delta values.
% no monitoring data available post 19/10/2019, due to lack of access caused to bushfire/ dry conditions
@ where values are below limit of reporting, a value of half the measurement has been assumed.
& investigation trigger performance indicators based on Table 33 of the SMP LW424-LW427. The long- and short-term triggers are based on the 80th data percentile and the 80th percentile plus two standard deviations, respectively

6.1.6.2 Quality Trend

SMP states that groundwater results will be compared to performance for the parameters EC, pH and Iron. The trends for these analytes are shown below.

Tristar Swamp is still an unimpacted swamp and the variability in parameters reflect natural fluctuations. Greater fluctuations in pH were observed since 2017 which coincide with an increasingly dry period and varied rainfall pattern. EC has shown a generally stable trend with some fluctuations. Iron shows a seasonal trend with peaks around the summer months. There is a period of stability between 2014 and 2016, which coincides with a relatively stable and high rainfall climate.

Graphs for all other parameter trends are included in **Appendix E**. Trends of note are:

- Chloride – slight increasing trend since 2018
- Nitrogen – increased variability in Kjeidahl Nitrogen and total Nitrogen since 2017 and 2020 respectively.

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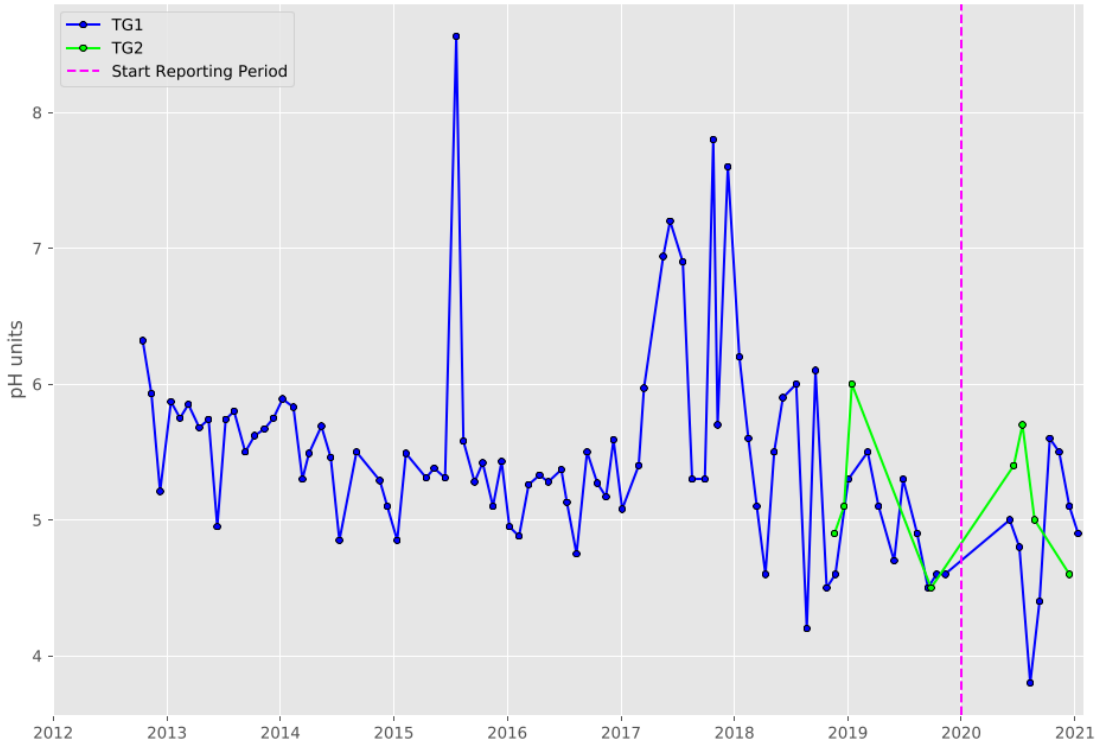
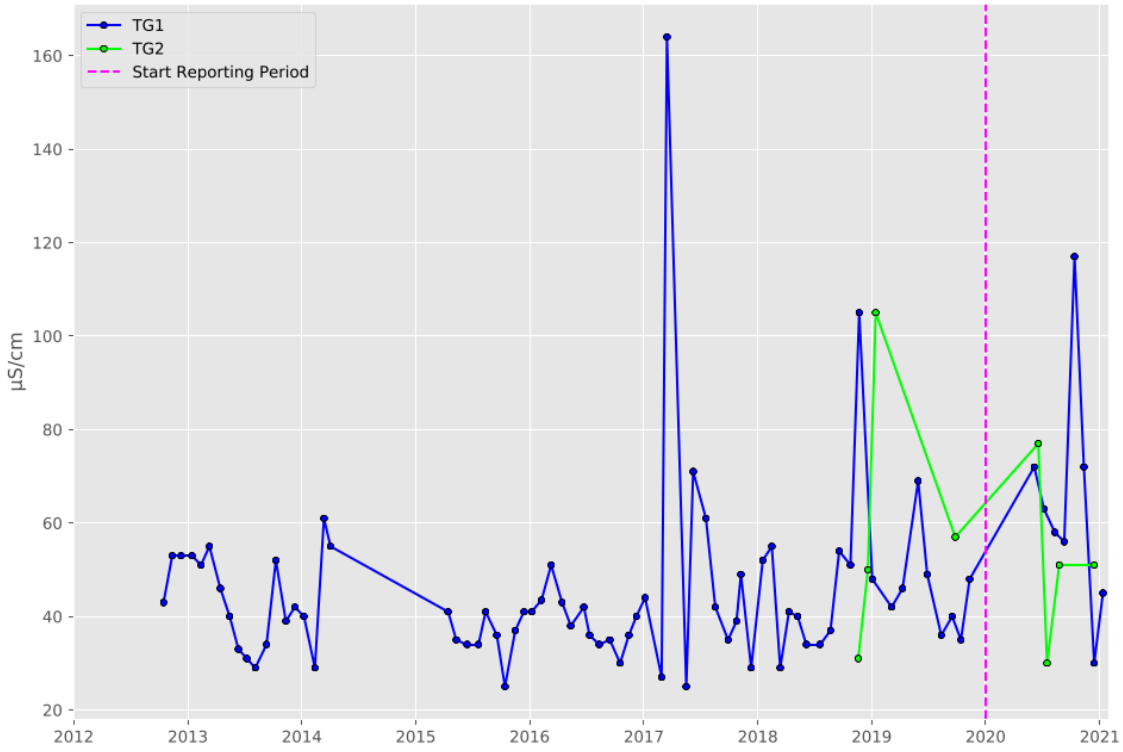


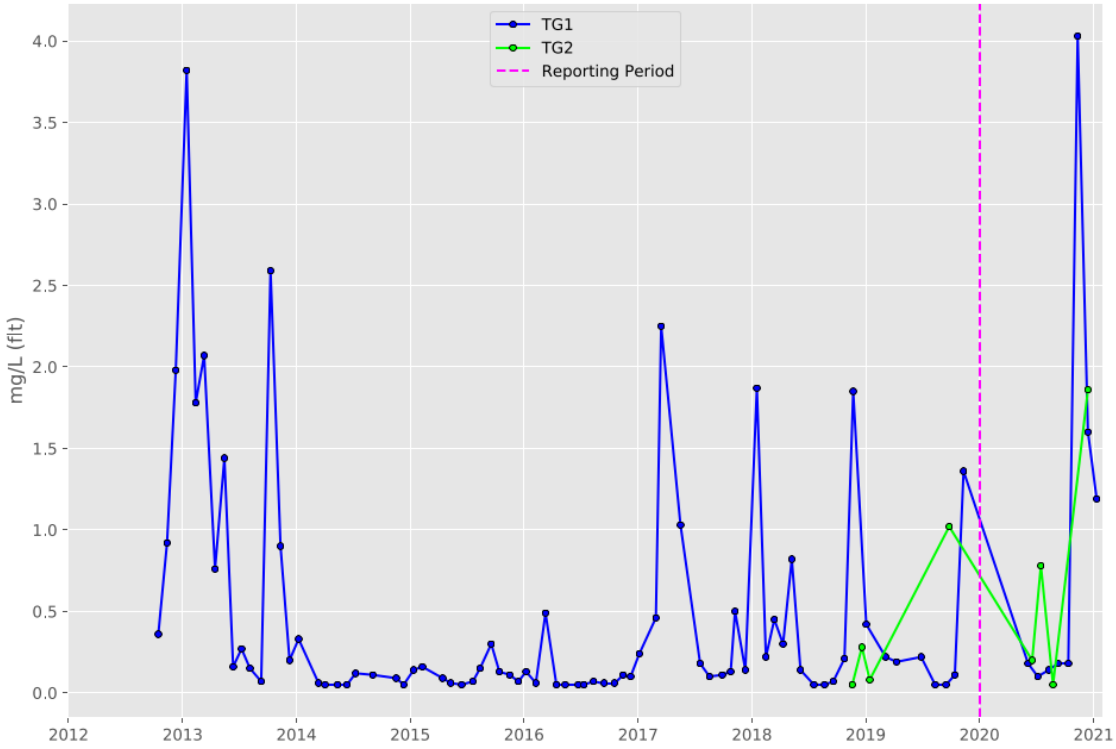
NB – Trigger not applicable to reference sites

Figure 6.16: Twin Gully - pH



NB – Trigger not applicable to reference sites

Figure 6.17: Twin Gully - EC



NB – Trigger not applicable to reference sites

Figure 6.18: Twin Gully - Iron

6.2 Impact Swamps

Impact swamp sites are sites that are regarded to have been, or may be, impacted by mining activities. The graphs of the main analytes show the general trends. The beginning of the reporting period is marked by the dotted line at January 2020. The pre-mining dataset is the baseline data and baseline cut off is defined when the site encroaches within the Trigger Investigation Area[1] (TIA) or a significant lineament has been undermined.

6.2.1 Pine Swamp

There were no observable water quality impacts attributed to mining.

6.2.1.1 Statistics

Table 6.7 summarises the baseline trigger levels and statistics for the measured values. Data for this reporting period is limited due to the lack of access to site due to the bushfire damage. The most recent values were within historic ranges and generally toward the lower limits of the ranges.

Table 6.7: Pine Swamp - Groundwater quality summary statistics

ID	Historic date ranges	Analyte	Pre-mining data statistics				Long term trigger &	Short term trigger &	Reporting period statistics			Comments
			Data point count	Min	Mean	Max			Min	Median	Max	
BS2	15/10/2012 – 21/01/2019											
		pH	74	4.6	5.6	7.8	4.4 – 6.8	5.3 – 5.9	Dry	Dry	Dry	No sample

[1] The TIA is the area within 600m of an active longwall, and where the longwall intersects a lineament, a 2km distance from the longwall.

ID	Historic date ranges	Analyte	Pre-mining data statistics				Long term trigger &	Short term trigger &	Reporting period statistics			Comments
			Data point count	Min	Mean	Max			Min	Median	Max	
		EC (µS/cm)	64	31	50	224	66.2	34.6	Dry	Dry	Dry	No sample
		Fe (mg/L)	74	0.05	0.92	4.93	2.33	0.07	Dry	Dry	Dry	No sample
BS3	15/10/2012 – 21/01/2019											
		pH	74	4.32	5.21	8.51	3.5-6.7	4.8-5.4	3.5	4.7	5.3	Within Limits
		EC (µS/cm)	64	32	58.9	250	120.1	63.2	36	56	80	Within Limits
		Fe (mg/L)	73	0.05	1.122	5.38	5.319	2.218	0.05	0.18	2.17	Within Limits
BS4 (PSS)	18/02/2018 – 14/01/2019						NA - Insufficient data to establish triggers					
		pH	4	5.4	6	6.6			4.4	4.7	5.6	NA
		EC (µS/cm)	4	80	106	133			39	51	66	NA
		Fe (mg/L)	4	0.06	1.645	5.94			0.05	0.05	2.07	NA

Notes: * value at detection limit (Limit of Reporting - LOR)
positive delta value equals a recent value that is greater than the historic mean, and vice versa for negative delta values.
% no monitoring data available post 19/10/2019, due to lack of access caused to bushfire/ dry conditions
@ where values are below limit of reporting, a value of half the measurement has been assumed.
& investigation trigger performance indicators based on Table 33 of the SMP LW424-LW427. The long- and short-term triggers are based on the 80th data percentile and the 80th percentile plus two standard deviations, respectively

6.2.1.2 Quality Trend

SMP states that groundwater results will be compared to performance for the parameters EC, pH and Iron. The trends for these analytes are shown on the figures below.

Pine Swamp was impacted by LW425 in January 2019. The pH trend has been declining since 2015, and measurements increased and peaked in early 2019, coinciding with the mining of LW425. pH values for the reporting period are toward the lower end of historic ranges. EC was observed to spike during 2019 and the cause is uncertain. It is possible the EC recording may be erroneous or the equipment is not recording accurately as there is a magnitude difference. In the reporting period there is slight elevation in EC at BS3 but it returned to below the trigger the following month. Iron concentrations are observed to follow a seasonal pattern with peaks around the wetter months of the year. A peak in iron values occurs in late 2020.

No mining related impact is visible for the reporting period.

Graphs for all other parameter trends are included in **Appendix E**. Trends of note are:

- Zinc – a lower average concentration from 2015, likely due to the declining rainfall over 2015 to 2019.
- Sulfate – lower average concentrations from mid-2017, likely due to the declining rainfall over 2015 to 2019.
- Calcium – higher levels at PSS due to recent construction and use of bentonite clays.
- Aluminium – temporary spike in elevation in 2020

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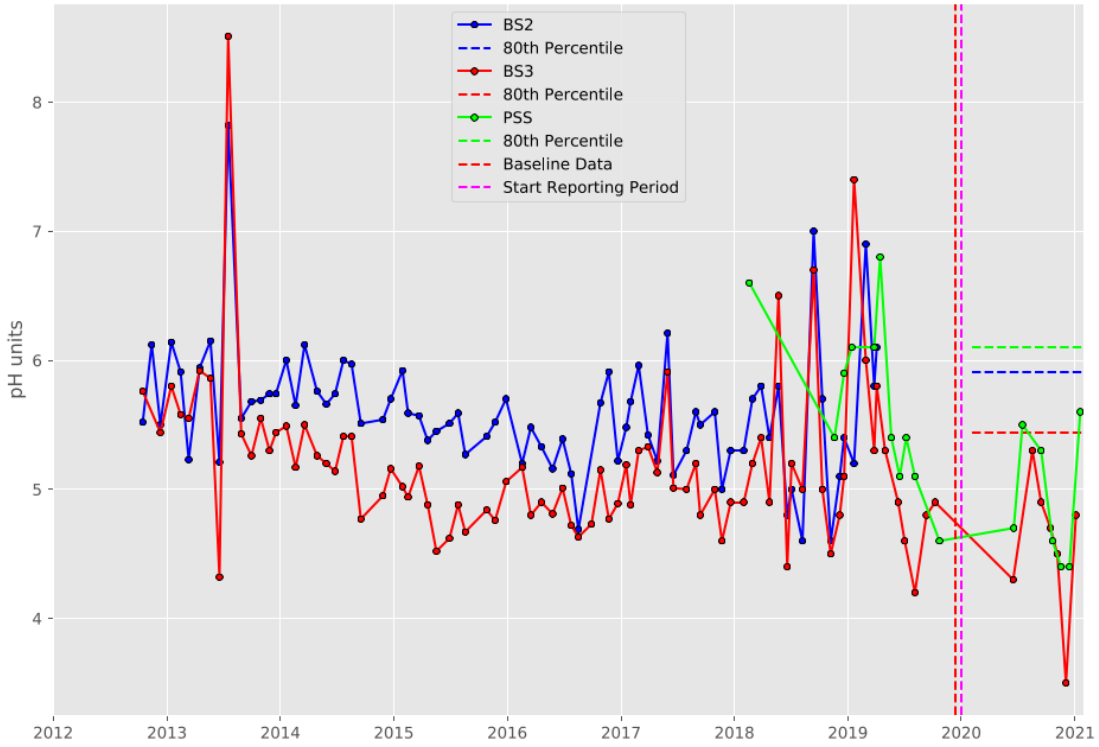

Figure 6.19: Pine Swamp - pH

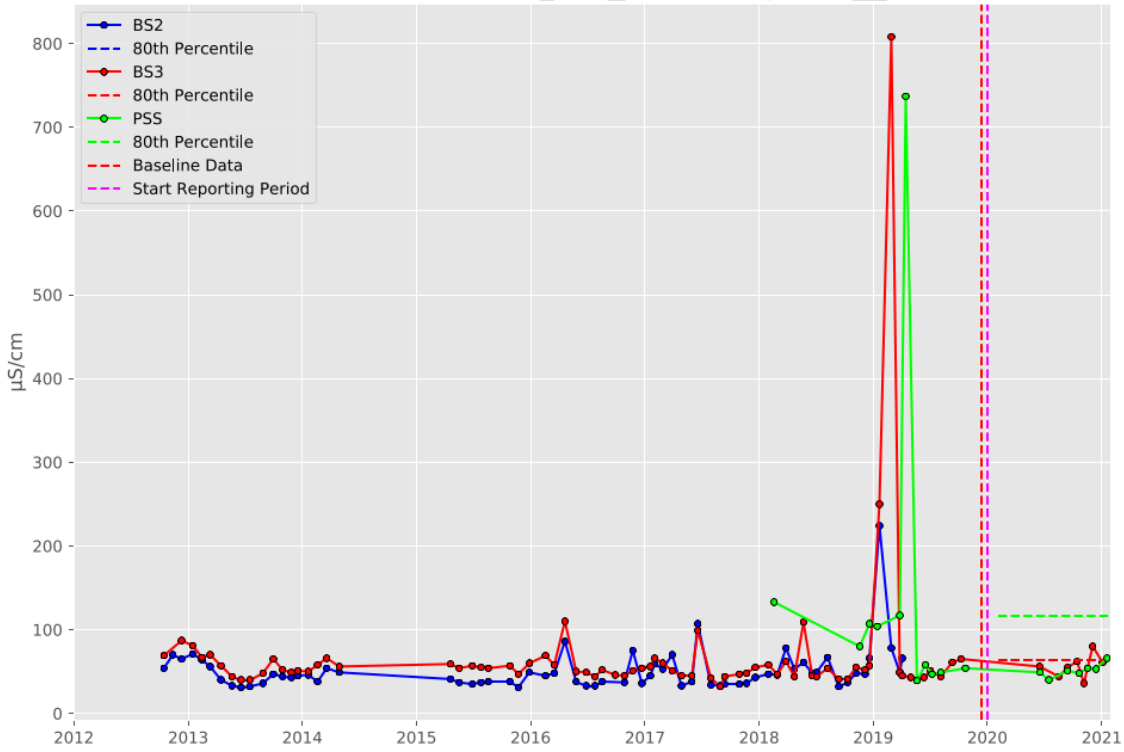

Figure 6.20: Pine Swamp - EC

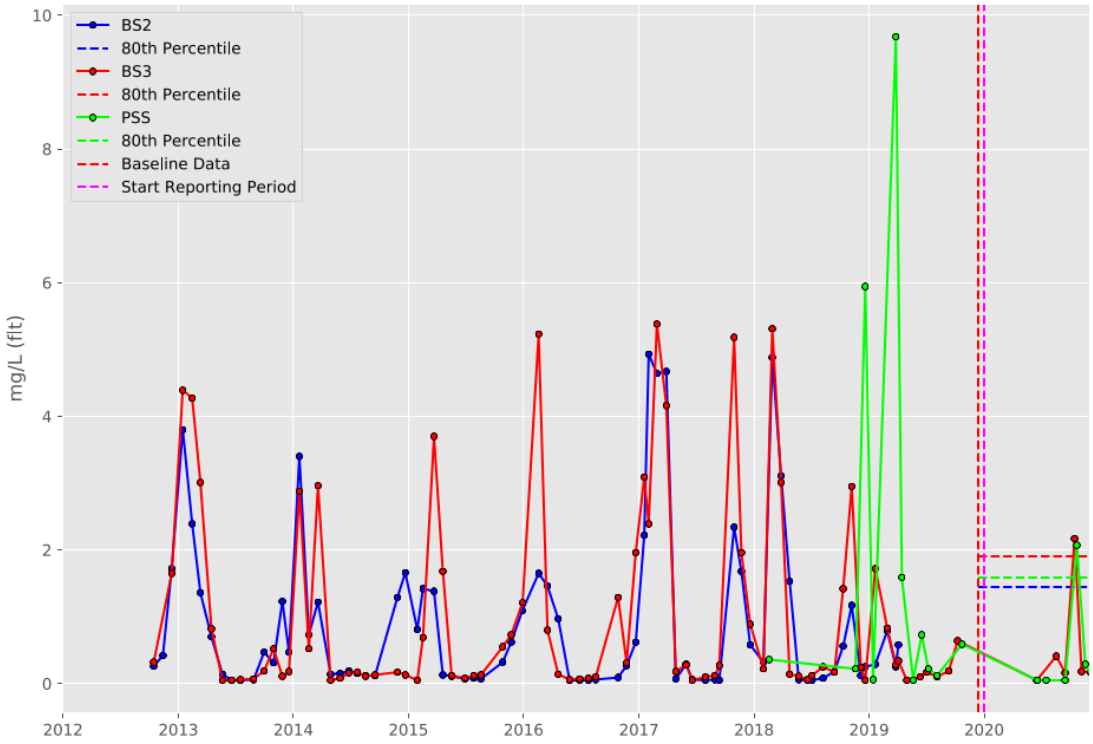

Figure 6.21: Pine Swamp - Iron

6.2.2 Nine Mile Swamp

There were no observable water quality impacts attributed to mining

6.2.2.1 Statistics

Table 6.8 summarises the baseline trigger levels and statistics for the measured values. A lot of data points are missing due to the bushfire restricting access. The most recent values were all within historic ranges

Table 6.8: Nine Mile Swamp - Groundwater quality summary statistics

ID	Historic date ranges	Analyte	Pre-mining data statistics				Long term trigger &	Short term trigger &	Reporting period statistics			Comments
			Data point count	Min	Mean	Max			Min	Median	Max	
BS1	15/10/2012 – 21/01/2019											
		pH	75	4.2	5.5	9.0	3.9-6.9	5.2-5.8	4.8	5.1	5.2	Within Limits
		EC (µS/cm)	65	27	50	279	122	56	44	67	71	Within Limits
		Fe (mg/L)	30	0.02	0.78	1.00	1.829	1	0.05	0.095	0.7	Within Limits
BS5 (NMSS)	15/10/2012 – 21/01/2019											
		pH	4	5.4	5.9	6.3	Insufficient baseline date to develop a trigger		2.9	5	5.3	NA
		EC (µS/cm)	4	52.0	62.8	93.0			26	42	48	NA
		Fe (mg/L)	4	0.0	0.0	0.1			0.12	1.065	2.76	NA

Notes: * value at detection limit (Limit of Reporting - LOR)
positive delta value equals a recent value that is greater than the historic mean, and vice versa for negative delta values.
% no monitoring data available post 19/10/2019, due to lack of access caused to bushfire/ dry conditions
@ where values are below limit of reporting, a value of half the measurement has been assumed.
& investigation trigger performance indicators based on Table 33 of the SMP LW424-LW427. The long- and short-term triggers are based on the 80th data percentile and the 80th percentile **plus** two standard deviations, respectively

6.2.2.2 Quality Trend

SMP states that groundwater results will be compared to performance for the parameters EC, pH and Iron. The trends for these analytes are shown in the figures below.

Nine Mile Swamp was impacted by LW425 in January 2019. The pH trend has been declining since 2015, and measurements spiked in early 2019, coinciding with the mining of LW425. pH values for the reporting period are toward the lower end of historic ranges. EC is observed to spike in 2019 and the cause is uncertain. It is possible the EC recording may be erroneous, or the equipment is not recording accurately as there is almost a magnitude of difference. In the reporting period EC is within trigger limits. Iron concentrations are observed to follow a seasonal pattern with peaks around the wetter months of the year.

No mining related impact is visible for the reporting period.

Graphs for all other parameter trends are included in **Appendix E**. Trends of note are:

- Zinc – a lower average concentration from 2015, likely due to the declining rainfall over 2015 to 2019.
- Sulfate – lower average concentrations from mid-2017, likely due to the declining rainfall over 2015 to 2019.
- Calcium – higher levels at MNSS due to recent construction and use of bentonite clays.
- Nitrate – spike in nitrate in late 2020 as BS1, likely due to the drying out of the site.
- Redox – declining trend at BS5 since 2019

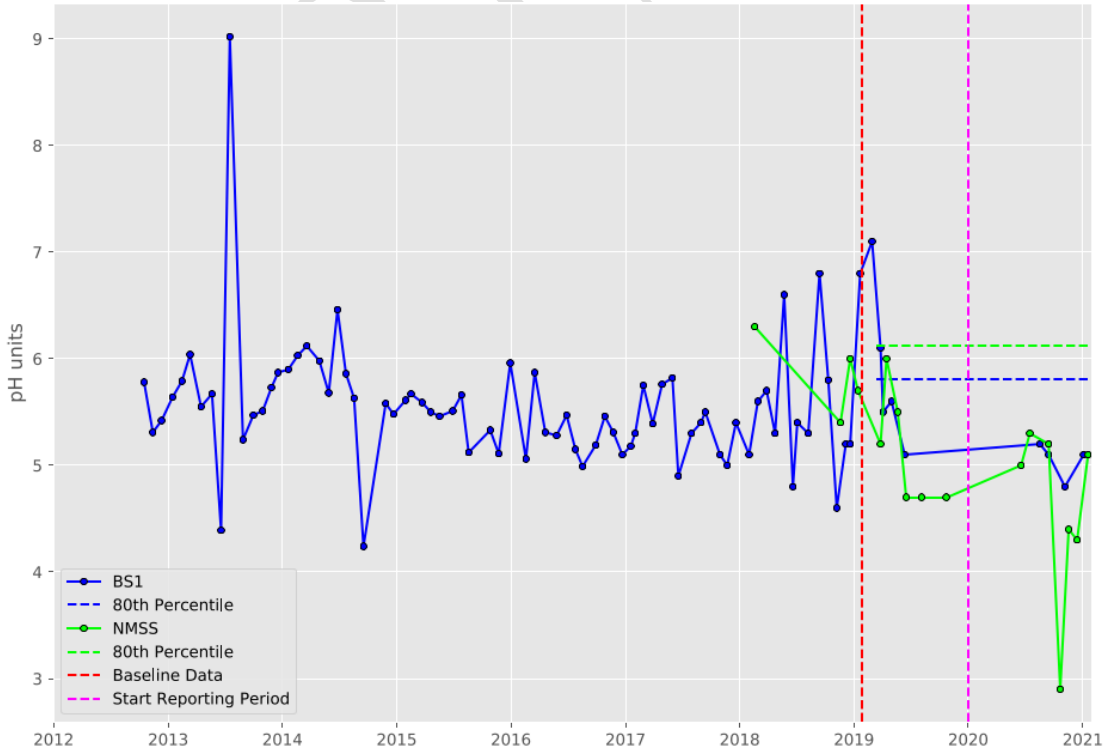

Figure 6.22: Nine Mile Swamp - pH

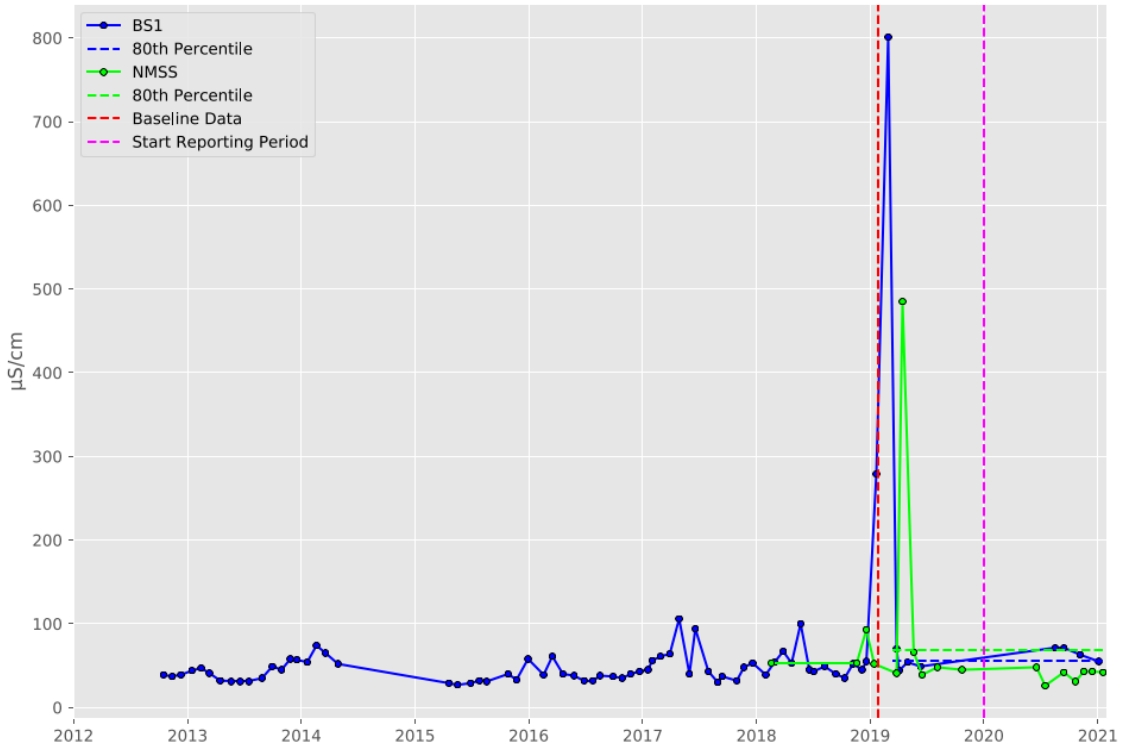

Figure 6.23: Nine Mile Swamp - EC

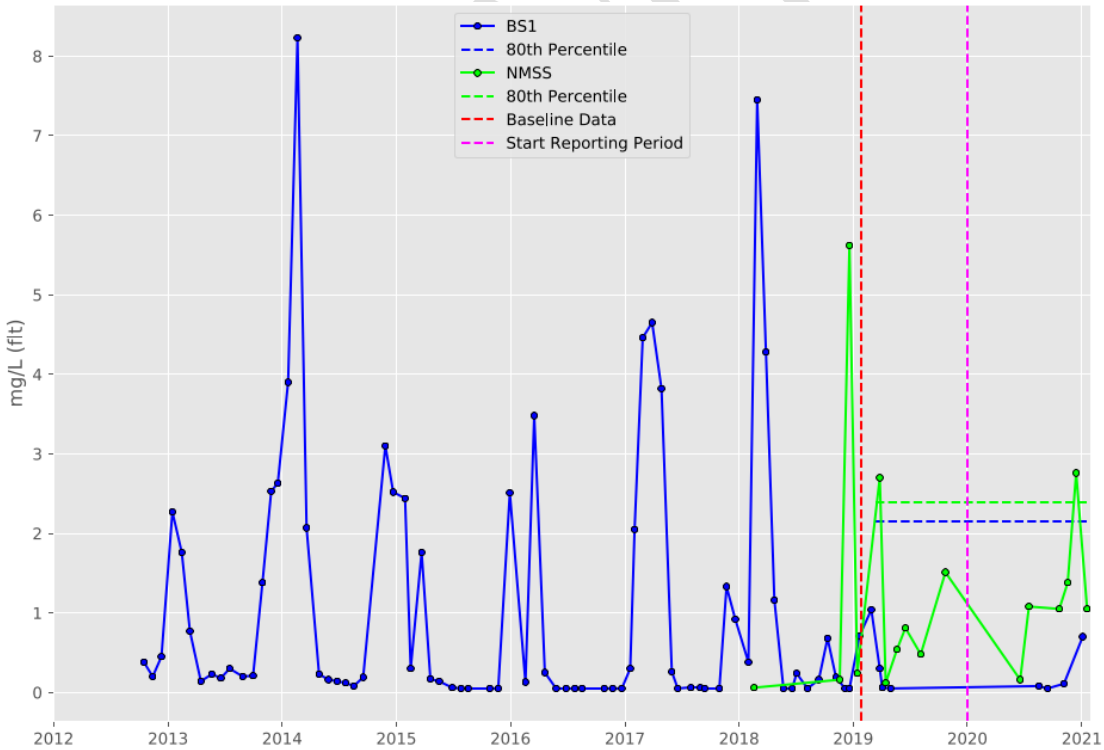

Figure 6.24: Nine Mile Swamp - Iron

6.2.3 Carne West Swamp

No water samples were collected at CW1 and CW2 over the reporting period as the piezometers were dry. The bores have been predominately dry since 2015.

6.2.3.1 Statistics

Table 6.9 summarises the water quality triggers and statistics. The swamp has been predominately dry since 2014 and there is limited post mining data. No data was collected during the reporting period due to the bushfires restricting access in early 2020 and the bores being dry.

Table 6.9: Carne West - Groundwater quality summary statistics

ID	Historic date ranges	Analyte	Pre-mining data statistics				Long term trigger &	Short term trigger &	Reporting period statistics			Comments
			Data point count	Min	Mean	Max			Min	Median	Max	
CW1	22/02/2011 – 30/09/2013											
		pH	32	3.95	5.14	8.77	3.2-6.7	4.8-5.2	Dry	Dry	Dry	N/A%
		EC (µS/cm)	32	15	23.03	82	46.54	24	Dry	Dry	Dry	N/A%
		Fe (mg/L)	33	0.05*	0.147	0.56	0.483	0.236	Dry	Dry	Dry	N/A%
CW2	22/02/2011 – 30/09/2013											
		pH	32	4.15	5.29	8.28	3.7-6.8	5.0-5.5	Dry	Dry	Dry	N/A%
		EC (µS/cm)	32	12	20.19	44	33.30	22	Dry	Dry	Dry	N/A%
		Fe (mg/L)	33	0.05*	0.108	0.62	0.358	0.102	Dry	Dry	Dry	N/A%

Notes: * value at detection limit (Limit of Reporting - LOR)
positive delta value equals a recent value that is greater than the historic mean, and vice versa for negative delta values.
% no monitoring data available post 19/10/2019, due to lack of access caused to bushfire/ dry conditions
@ where values are below limit of reporting, a value of half the measurement has been assumed.
& investigation trigger performance indicators based on Table 33 of the SMP LW424-LW427. The long- and short-term triggers are based on the 80th data percentile and the 80th percentile plus two standard deviations, respectively

6.2.3.2 Quality Trend

SMP states that groundwater results will be compared to performance for the parameters EC, pH and Iron. The trends for these analytes are shown on figures below.

Carne West is an impacted swamp that has been predominately dry since 2015, with few samples collected after 2015.

Graphs for all other parameter trends are included in **Appendix E**.

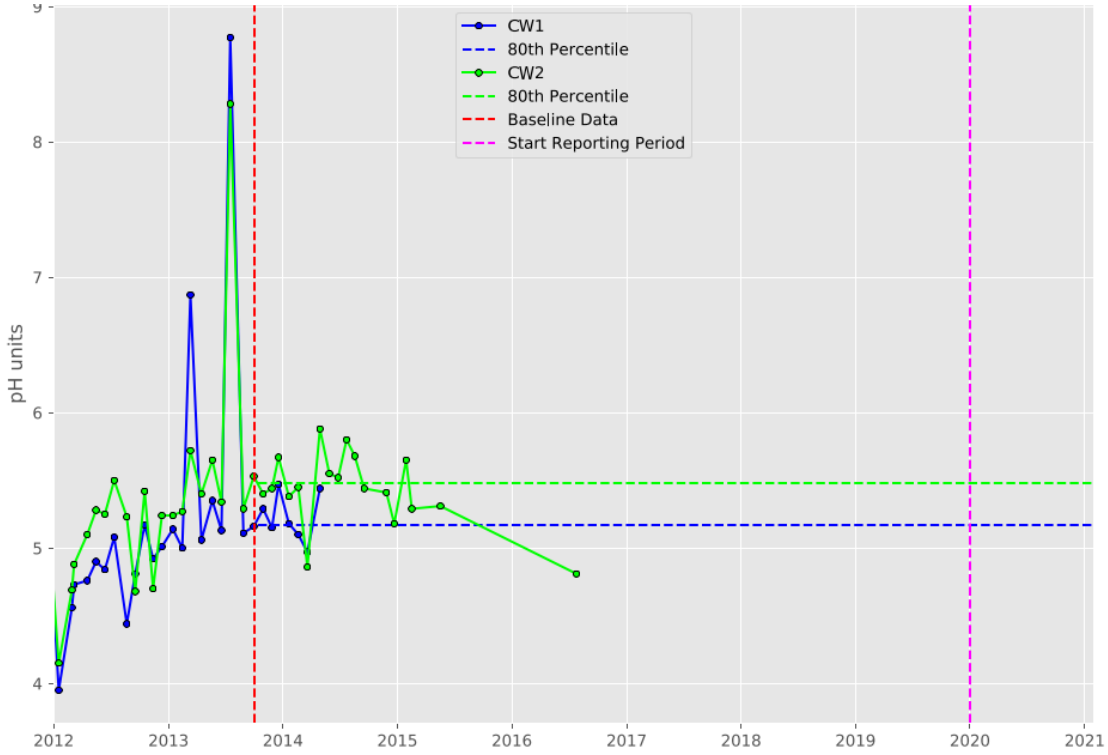

Figure 6.25: Carne West Swamp- pH

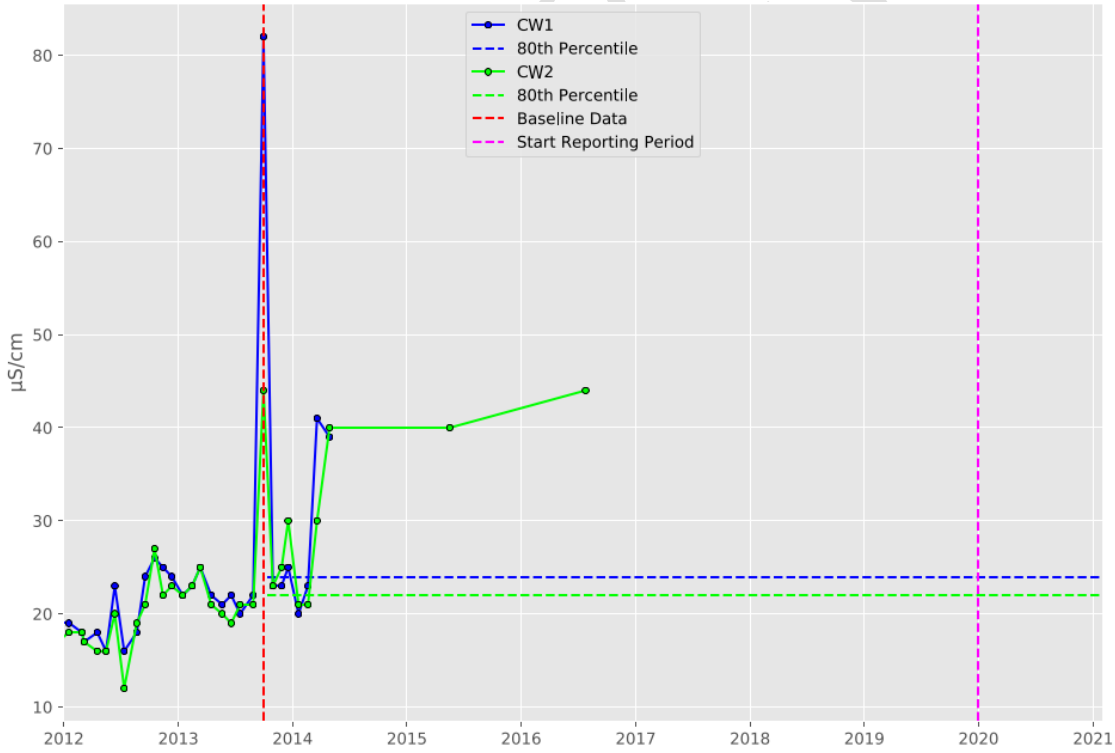

Figure 6.26: Carne West Swamp - EC

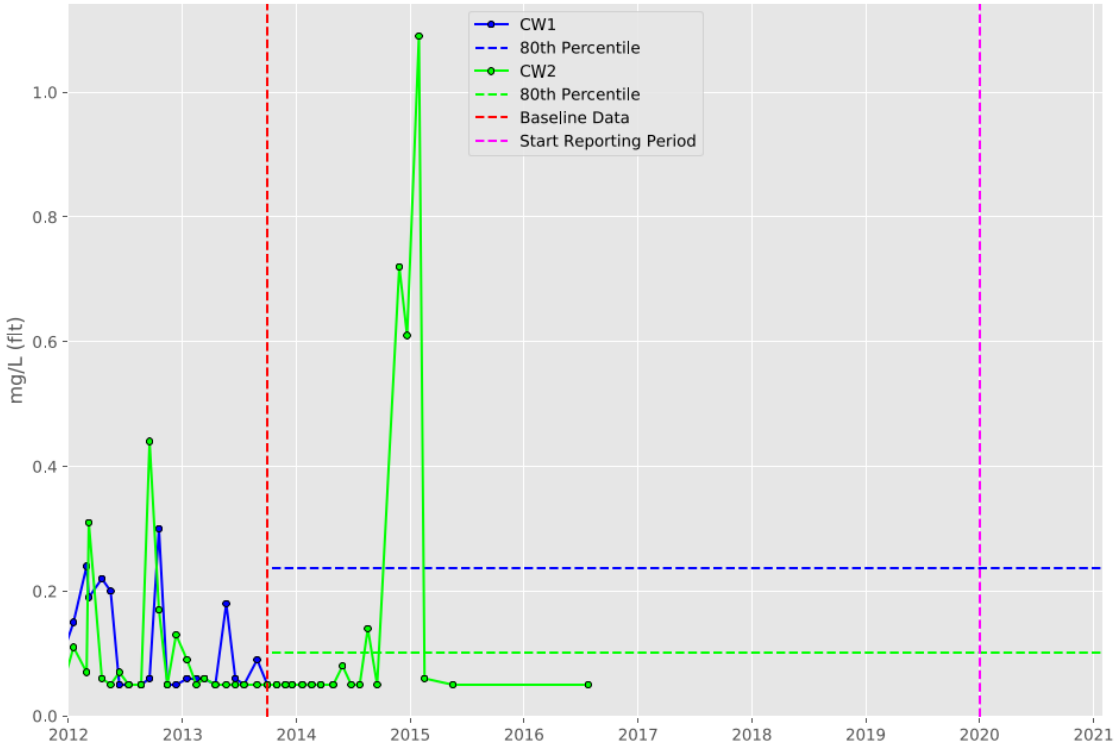

Figure 6.27: Carne West Swamp - Iron

6.2.4 Gang Gang Swamp

Gang Gang swamp is an impact swamp and no samples have been collected since January 2018 when the swamp became dry.

6.2.4.1 Statistics

Table 6.10 summarises the water quality triggers and statistics. The swamp has been predominately dry since 2018 and there is limited post mining data. No data was collected during the reporting period due to the bushfires restricting access in early 2020 and the swamp being dry.

Table 6.10: Gang Gang Swamp - Groundwater quality summary statistics

ID	Historic date ranges	Analyte	Pre-mining data statistics				Long term trigger &	Short term trigger &	Reporting period statistics			Comments
			Data point count	Min	Mean	Max			Min	Median	Max	
GG1	16/10/2012 – 28/04/2017											
		pH	54	4.56	5.33	8.12	5.0-5.6	4.0-6.5	Dry	Dry	Dry	NA
		EC (µS/cm)	43	31	44.8	142	51	87	Dry	Dry	Dry	NA
		Fe (mg/L)	53	0.05*	1.258	7.01	2.142	5.379	Dry	Dry	Dry	NA

Notes: * value at detection limit (Limit of Reporting - LOR)
positive delta value equals a recent value that is greater than the historic mean, and vice versa for negative delta values.
% no monitoring data available post 19/10/2019, due to lack of access caused to bushfire/ dry conditions
@ where values are below limit of reporting, a value of half the measurement has been assumed.
& investigation trigger performance indicators based on Table 33 of the SMP LW424-LW427. The long- and short-term triggers are based on the 80th data percentile and the 80th percentile plus two standard deviations, respectively

6.2.4.2 Quality Trend

SMP states that groundwater results will be compared to performance for the parameters EC, pH and Iron. The trends for these analytes are shown on figures below.

Gang Gang Swamp is an impacted swamp that has been predominately dry since 2018, with few samples collected into the post mining period. No data was available for the reporting period.

Graphs for all other parameter trends are included in **Appendix E**.

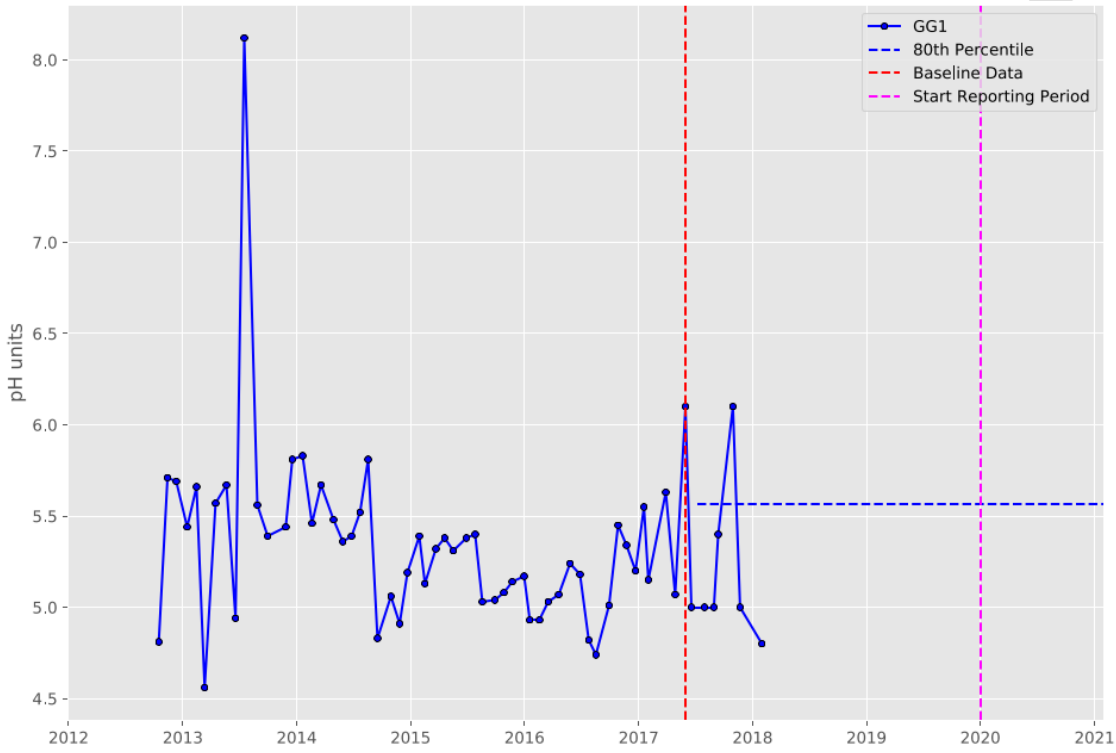

Figure 6.28: Gang Gang Swamp - pH

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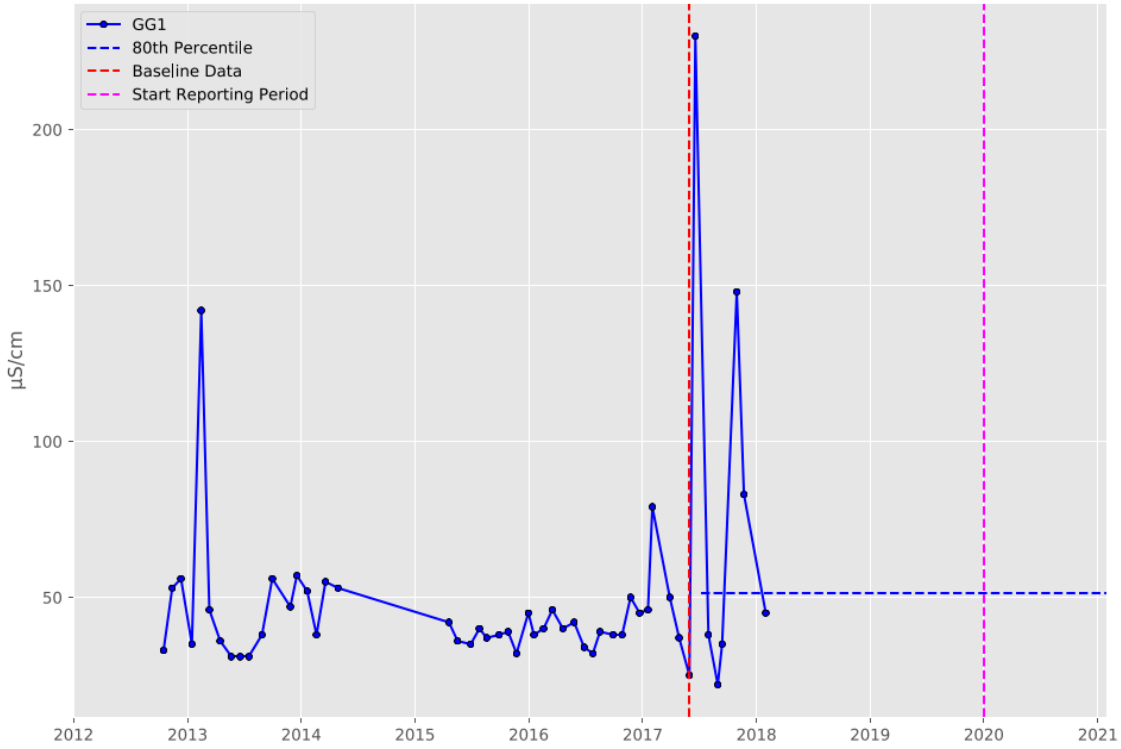

Figure 6.29: Gang Gang Swamp - EC

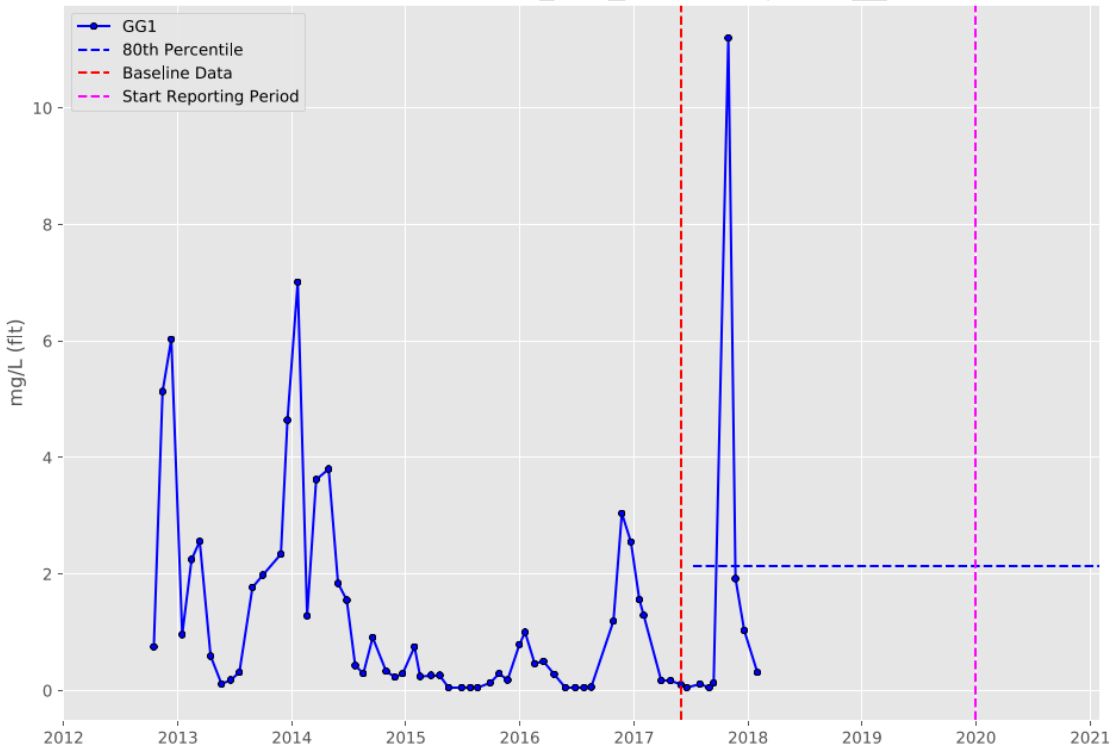

Figure 6.30: Gang Gang Swamp - Iron

6.2.5 Gang Gang West Swamp

Gang Gang West swamp is an impact swamp and no samples have been collected at GW1 since September 2016 and at GW2 since March 2017, as the swamp became dry.

6.2.5.1 Statistics

The swamp has been predominately dry since 2017 and there is limited post mining data. No data was collected during the reporting period due to the swamp being dry.GW2 was destroyed in the 2020 bushfires and was decommissioned.

Table 6.11: Gang Gang West - Groundwater quality summary statistics

ID	Historic date ranges	Analyte	Pre-mining data statistics				Long term trigger &	Short term trigger &	Reporting period statistics			Comments
			Data point count	Min	Mean	Max			Min	Median	Max	
GW1	13/11/2012 – 28/09/2016											
		pH	26	4.74	6.14	7.84	5.9-6.5	4.7-7.7	Dry	Dry	Dry	N/A%
		EC (µS/cm)	20	38	54.25	86	61	90	Dry	Dry	Dry	N/A%
		Fe (mg/L)	24	0.05*	0.349	1.88	0.42	1.264	Dry	Dry	Dry	N/A%
GW2	13/11/2012 – 29/03/2017											
		pH	45	1.5	5.82	7.73	5.4-6.2	4.1-7.4	NA%	NA%	NA%	N/A%
		EC (µS/cm)	36	27	5.82	7.73	6.2	7.4	NA%	NA%	NA%	N/A%
		Fe (mg/L)	43	0.06	3.142	9.5	5.048	10.000	NA%	NA%	NA%	N/A%

Notes: *value at detection limit (Limit of Reporting - LOR)
positive delta value equals a recent value that is greater than the historic mean, and vice versa for negative delta values.
% no monitoring data available post 19/10/2019, due to lack of access caused to bushfire/ dry conditions
@ where values are below limit of reporting, a value of half the measurement has been assumed.
& investigation trigger performance indicators based on Table 33 of the SMP LW424-LW427. The long- and short-term triggers are based on the 80th data percentile and the 80th percentile plus two standard deviations, respectively

SPRINGVALE

6.2.5.2 Quality Trend

SMP states that groundwater results will be compared to performance for the parameters EC, pH and Iron. The trends for these analytes are shown on figures below.

Gang Gang West Swamp is an impacted swamp that has been predominately dry since 2017, with no samples collected into the post mining and reporting period. The sample in October 2020 at GW2 is erroneous as the site was destroyed and decommissioned after the bushfire.

Graphs for all other parameter trends are included in **Appendix E**.

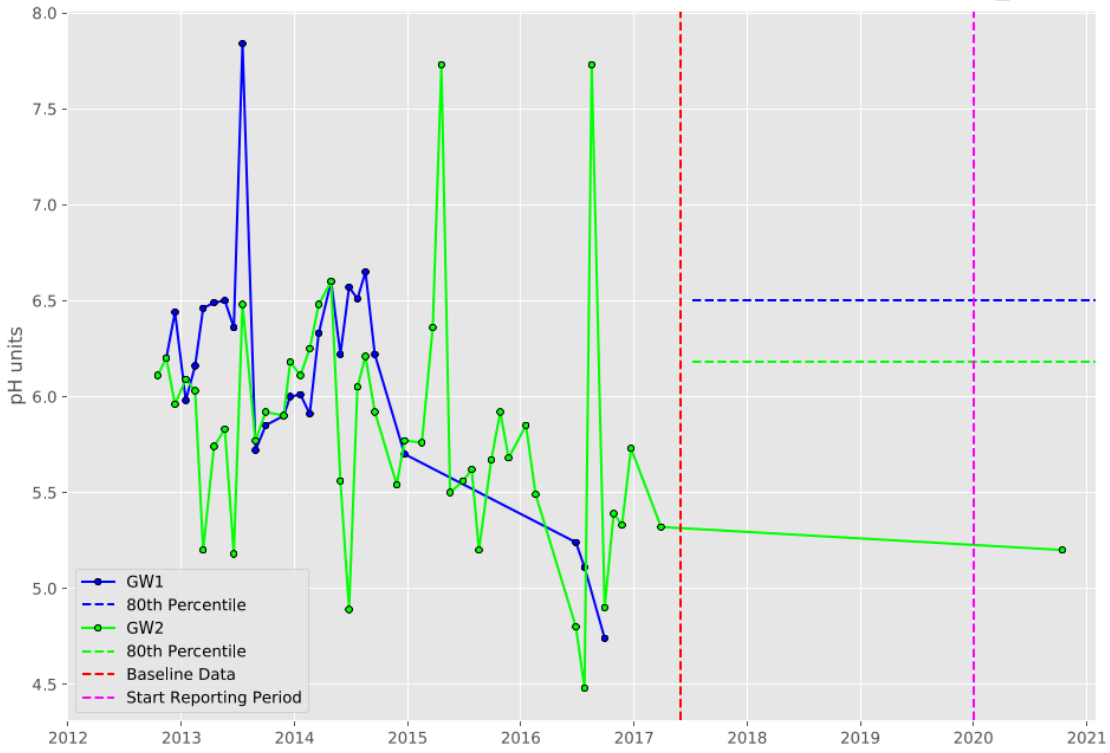

Figure 6.31: Gang Gang West Swamp - pH

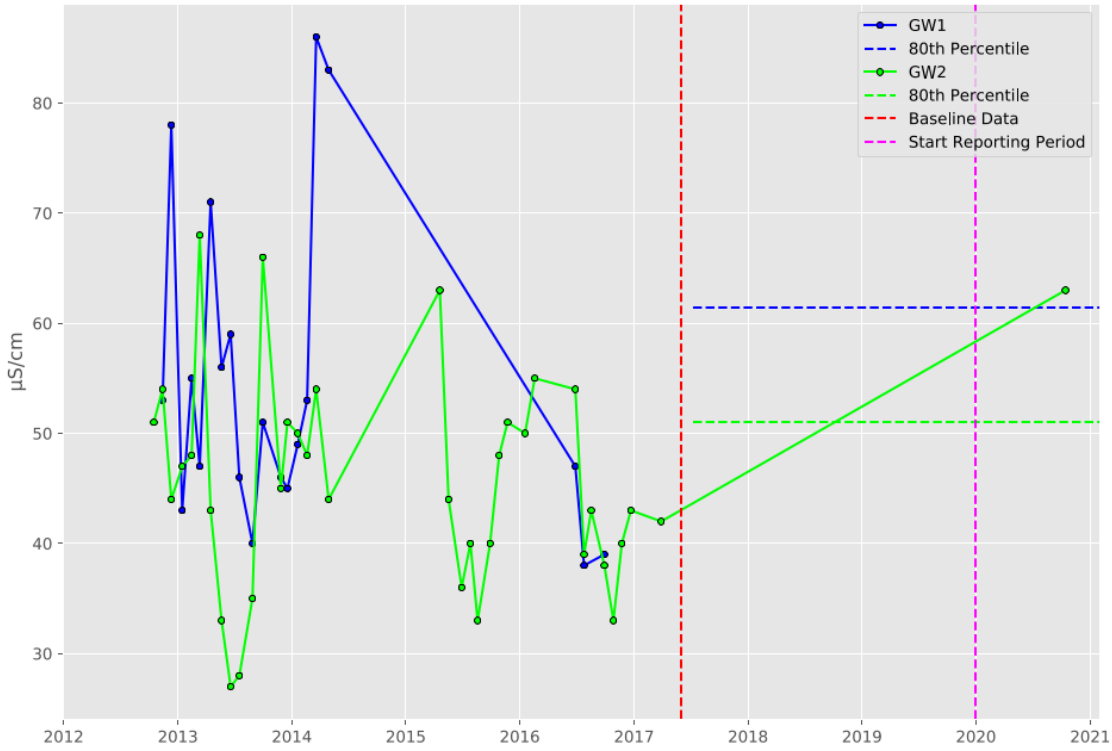

Figure 6.32: Gang Gang West Swamp - EC

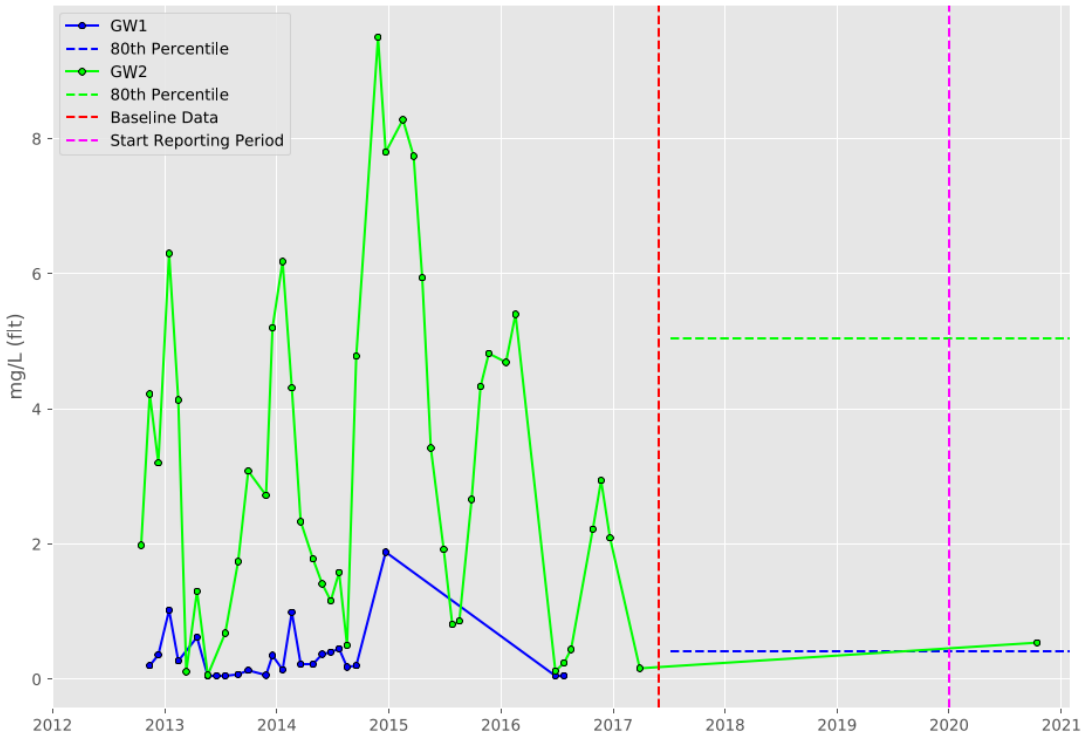

Figure 6.33: Gang Gang West Swamp - Iron

6.2.6 Marrangaroo Swamp

Marrangaroo is classified as a future impact site. The lower segment of Marrangaroo swamp at MS1 and MS2 where it is sampled were outside the 600m TIA during the reporting period. There were limited samples at Marrangaroo swamp taken during the start of 2020 due to the bushfire and road closures restricting access.

6.2.6.1 Statistics

Marrangaroo Swamp is still in the pre-mining phase and therefore the quality trigger values are still dynamic. Table 14 of SMP LW424-LW427 outlines the dynamic trigger values (refer Table 6.12). Groundwater quality at Marrangaroo Swamp is generally very fresh, slightly acidic and low concentrations of dissolved metals.

Table 6.12: Marrangaroo Swamp - Groundwater quality summary statistics

ID	Historic date ranges	Analyte	Pre-mining data statistics				Dynamic long term trigger &	Dynamic short term trigger &	Reporting period statistics			Comments
			Data point count	Min	Mean	Max			Min	Median	Max	
MS1	04/11/2011 – present											
		pH	95	4	5.68	7.52	5.3-6.1	4.3-7.1	4	5	5.2	Pre-mining stage
		EC (µS/cm)	84	26	83.3	1310	68.8	372.8	26	46	710	Single sample of elevated EC
		Fe (mg/L)	95	0.05	3.072	17.1	1.0	2.02	0.05	0.2	1.66	Pre-mining stage
MS2	10/04/2018 – present											
		pH	11	4.4	5.28	6	5.1-5.9	3.9-7.0	4.4	5	6	Pre-mining stage
		EC (µS/cm)	12	32	110	708	94.4	591.7	32	49	91	Pre-mining stage
		Fe (mg/L)	11	0.05	0.403	1	0.05	0.094	0.05	0.44	0.74	Pre-mining stage

Notes: * value at detection limit (Limit of Reporting - LOR)
positive delta value equals a recent value that is greater than the historic mean, and vice versa for negative delta values.
% no monitoring data available post 19/10/2019, due to lack of access caused to bushfire/ dry conditions
@ where values are below limit of reporting, a value of half the measurement has been assumed.
& investigation trigger performance indicators based on Table 33 of the SMP LW424-LW427. The long- and short-term triggers are based on the 80th data percentile and the 80th percentile plus two standard deviations, respectively

SPRINGVALE

6.2.6.2 Quality Trend

SMP states that groundwater results will be assessed against triggers and performance for the parameters EC, pH and Iron. The trends for these analytes are shown below.

Marrangaroo Swamp is currently unimpacted and the variability in parameters reflect natural fluctuations. pH has been trending downwards. In December 2020 the pH at MS1 (4 pH Units) briefly fell below the 80th percentile before returning to normal levels. The first sample at MS1 for 2020 recorded an elevated EC reading before falling back to historical levels. Iron concentrations show a seasonal trend, however the peak was not observed in 2020 due to limited sampling. As the peak in analytes were not sustained, no triggers were breached.

Graphs for all other parameter trends are included in **Appendix E**. Trend of note are:

- Nitrogen – is recording more fluctuations in 2020
- Metal cations – some metal analytes recorded a single peak in concentrations during reporting period.

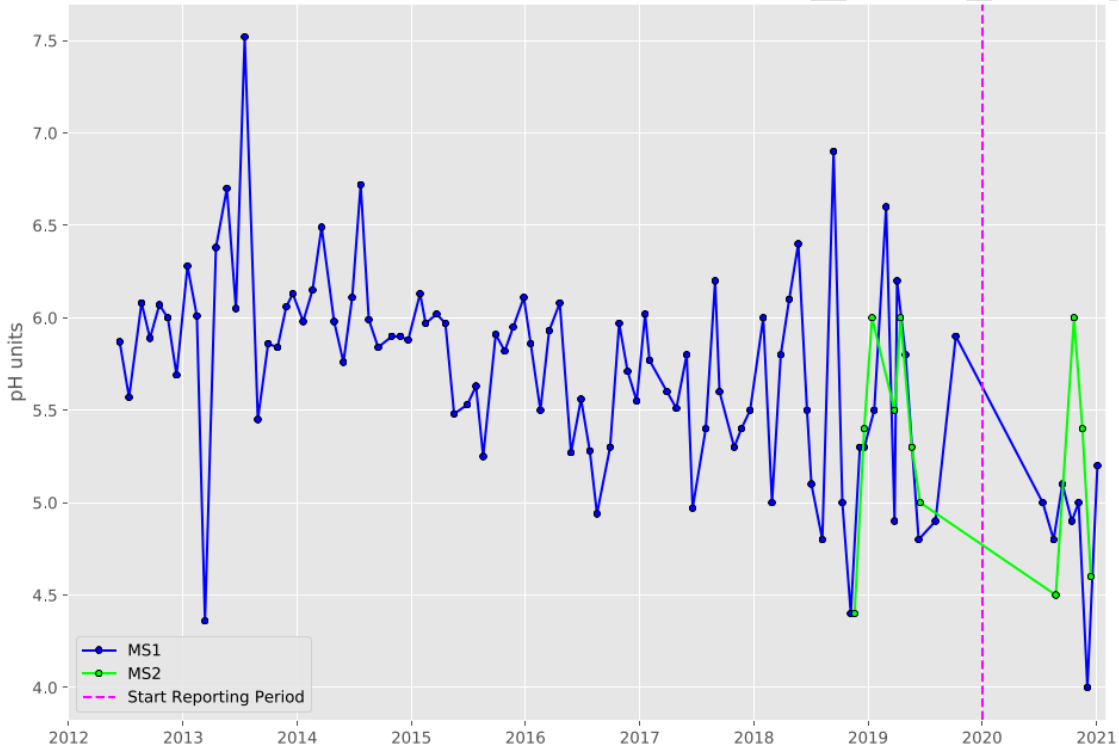

Figure 6.34: Marrangaroo Swamp - pH

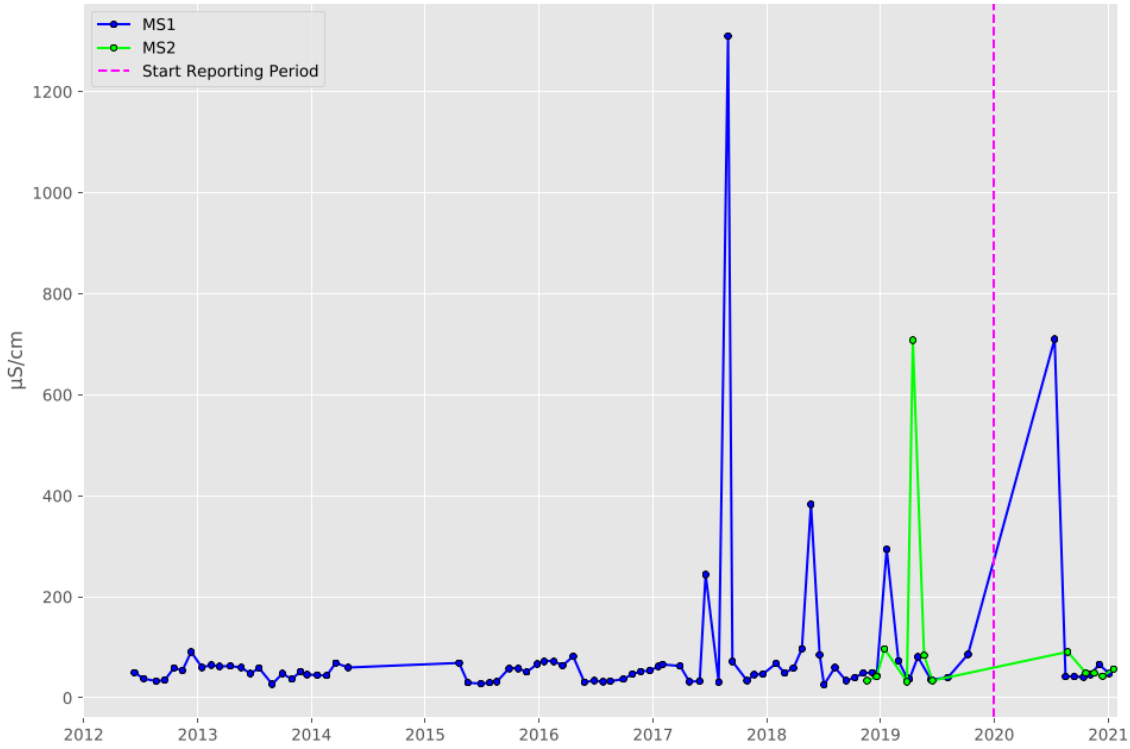

Figure 6.35: Marrangaroo Swamp - EC

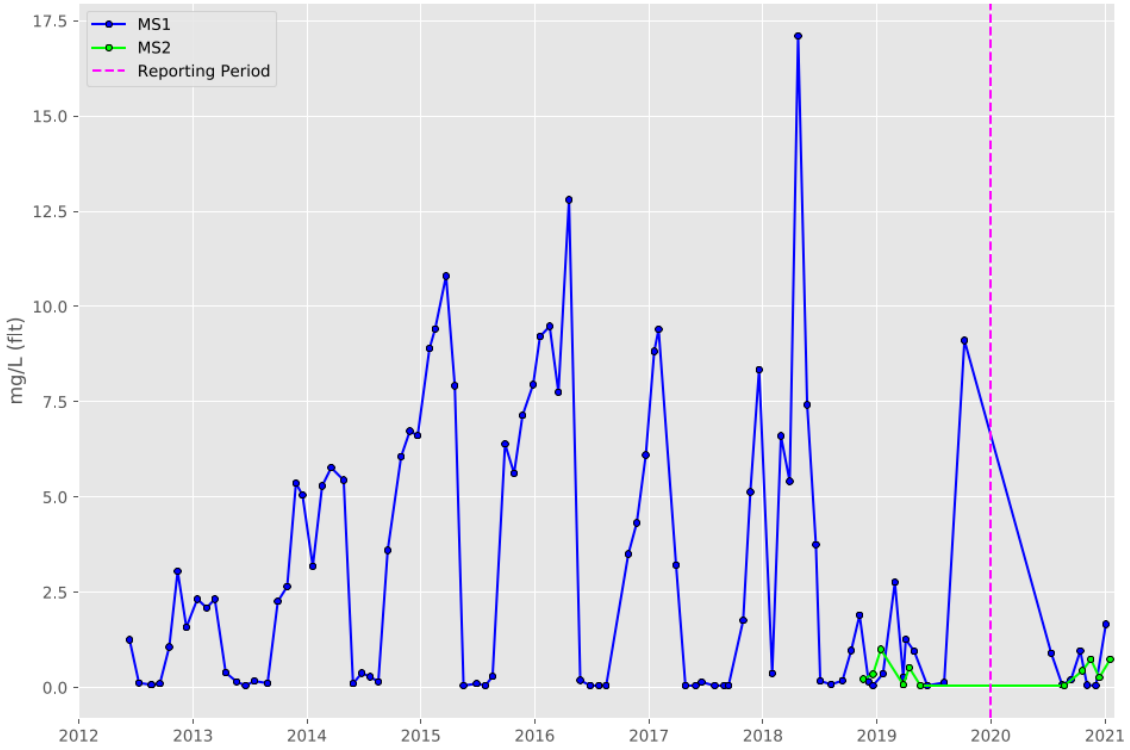

Figure 6.36: Marrangaroo Swamp - Iron

6.2.7 Paddys Creek Swamp

Paddys Creek is an impact swamp that was within the TIA of LW425 from August 2018.

6.2.7.1 Statistics

Table 6.13 outlines the groundwater statistics. There is insufficient baseline data to develop representative triggers, and therefore only general comments can be made.

Table 6.13: Paddys Creek Swamp - Groundwater quality summary statistics

ID	Historic date ranges	Analyte	Pre-mining data statistics				Long term trigger &	Short term trigger &	Reporting period statistics			Comments
			Data point count	Min	Mean	Max			Min	Median	Max	
PC1	18/02/2018 Insufficient pre-mining data											
		pH	1	7.3	N/A	N/A	Insufficient baseline data		4	4.35	5.4	No baseline
		EC (µS/cm)	1	107	N/A	N/A			36	56.5	81	No baseline
		Fe (mg/L)	1	3.41	N/A	N/A			0.05*	0.105	0.41	No baseline
PC2	18/02/2018 Insufficient pre-mining data											
		pH	1	7.1	N/A	N/A	Insufficient baseline data		4.3	4.4	4.9	No baseline
		EC (µS/cm)	1	112	N/A	N/A			33	41	52	No baseline
		Fe (mg/L)	1	4.24	N/A	N/A			0.05*	0.05*	0.24	No baseline

Notes: * value at detection limit (Limit of Reporting - LOR)
positive delta value equals a recent value that is greater than the historic mean, and vice versa for negative delta values.
% no monitoring data available post 19/10/2019, due to lack of access caused to bushfire/ dry conditions
@ where values are below limit of reporting, a value of half the measurement has been assumed.
& investigation trigger performance indicators based on Table 33 of the SMP LW424-LW427. The long- and short-term triggers are based on the 80th data percentile and the 80th percentile plus two standard deviations, respectively

SPRINGVALE

6.2.7.2 Quality Trend

SMP states that groundwater results will be assessed against triggers and performance for the parameters EC, pH and Iron. The trends for these analytes are shown below.

PC1 and PC2 piezometers were constructed in early 2018. pH levels have been declining since monitoring began and is currently at around 4.0-5.4 pH. It is possible the higher initial readings contained residues of the basic sodium bentonite clays used during construction. There was limited measurements in the reporting period, however, it appears the pH is becoming more stable. EC is relatively stable with lower concentrations from mid-2019 and the measurement taken during the reporting period was within historic ranges. Iron concentrations have declined significantly shortly after installation. The iron concentrations have been relatively stable since late 2018.

Graphs for all other parameter trends are included in **Appendix E**. Trends of note are:

- Alkalinity – declining from 2019
- Manganese – peaked in mid-2019 coinciding with declining water levels at PC1.
- Sodium – major constituent of sodium bentonite clays, has been declining. This suggests it took a few months of purging to reduce residues from construction.

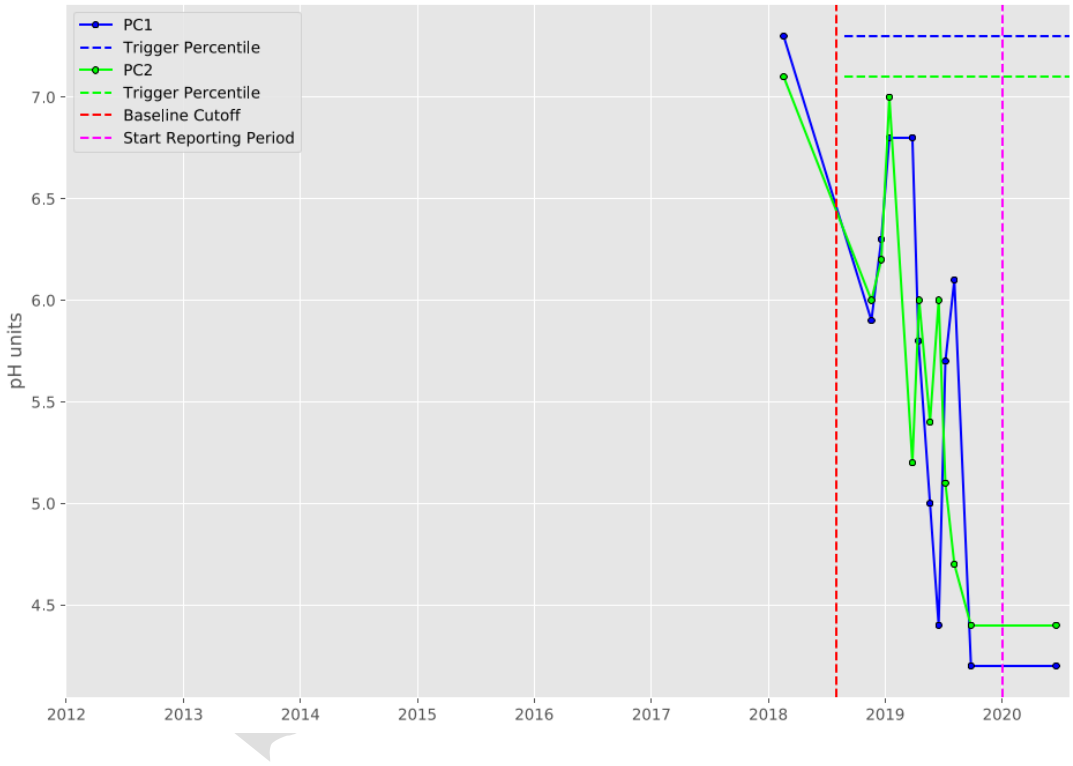

Figure 6.37: Paddys Creek - pH

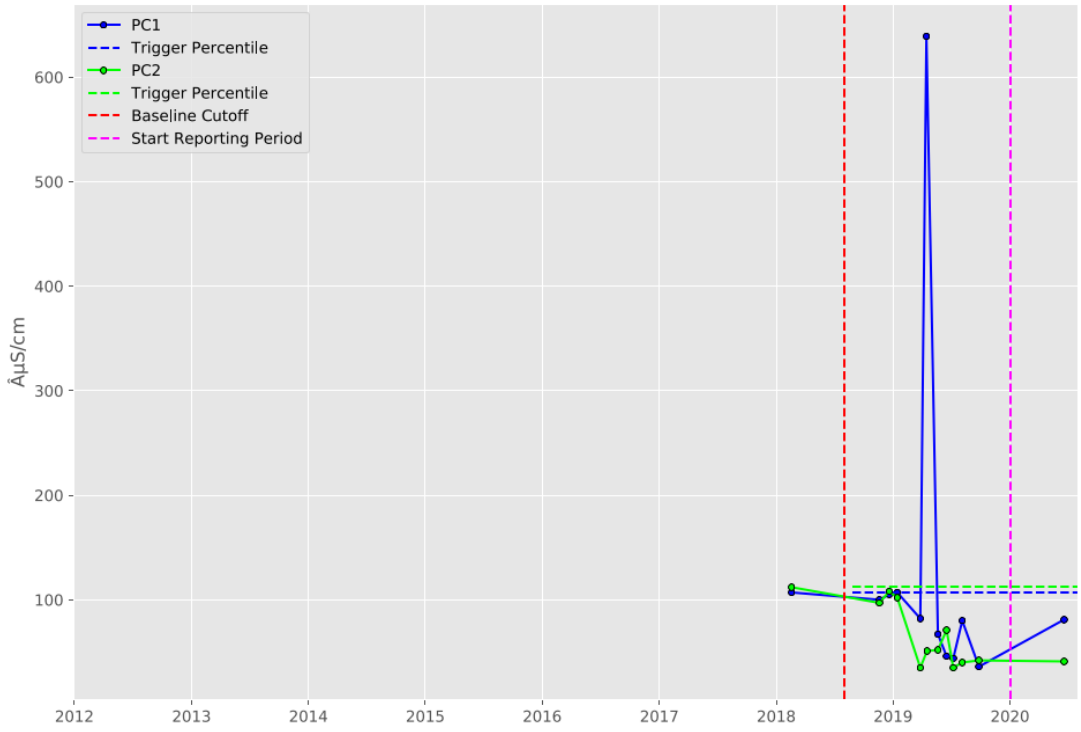

Figure 6.38: Paddys Creek - EC

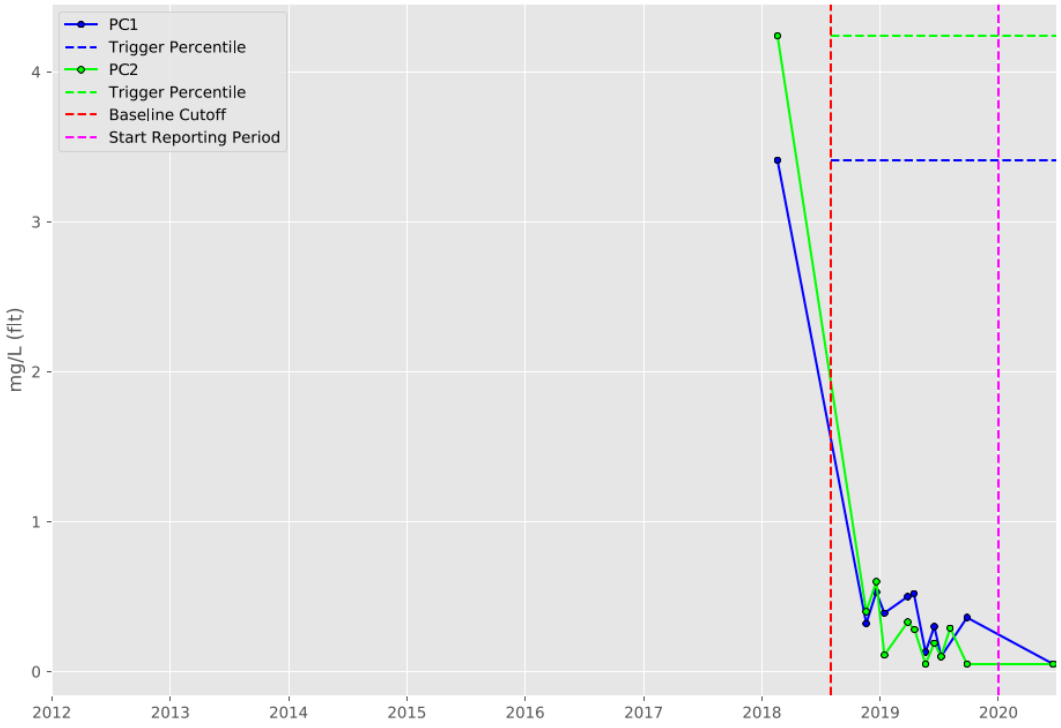

Figure 6.39: Paddys Creek - Iron

6.2.8 Sunnyside Swamp

6.2.8.1 Statistics

Sunnyside Swamp is an impact swamp overlying LW413-LW414, where mining occurred prior to the TIA areas being established. Also, water quality sampling occurred after mining began in LW413-LW414 and there is no retroactive baseline data. As such, there are no triggers defined. Table 6.14 outlines the groundwater statistics.

Table 6.14: Sunnyside Swamp - Groundwater quality summary statistics

ID	Historic date ranges	Analyte	Pre-mining data statistics				Long term trigger &	Short term trigger &	Reporting period statistics			Comments
			Data point count	Min	Mean	Max			Min	Median	Max	
SS1	Pre-mining precedes first data point											
		pH	0	No baseline			No baseline defined		3.8	4.8	5.1	No baseline
		EC (µS/cm)	0	No baseline					23	121	1150	Single elevated EC
		Fe (mg/L)	0	No baseline					0.05*	0.19	4.57	No baseline
SS3	Pre-mining precedes first data point											
		pH	0	No baseline			No baseline defined		4	4.95	5.5	No baseline
		EC (µS/cm)	0	No baseline					30	79	106	No baseline
		Fe (mg/L)	0	No baseline					0.05*	0.13	0.55	No baseline
SS4	Pre-mining precedes first data point											
		pH	0	No baseline			No baseline defined		3.1	5.1	5.1	No baseline
		EC (µS/cm)	0	No baseline					22	48	48	No baseline
		Fe (mg/L)	0	No baseline					0.05*	0.12	0.12	No baseline
SS5	Pre-mining precedes first data point											
		pH	0	No baseline			No baseline defined		3.6	5.05	5.5	No baseline
		EC (µS/cm)	0	No baseline					17	45.5	82	No baseline
		Fe (mg/L)	0	No baseline					0.05*	0.135	7.13	No baseline

Notes: * value at detection limit (Limit of Reporting - LOR)
positive delta value equals a recent value that is greater than the historic mean, and vice versa for negative delta values.
% no monitoring data available post 19/10/2019, due to lack of access caused to bushfire/ dry conditions
@ where values are below limit of reporting, a value of half the measurement has been assumed.
& investigation trigger performance indicators based on Table 33 of the SMP LW424-LW427. The long- and short-term triggers are based on the 80th data percentile and the 80th percentile plus two standard deviations, respectively

SPRINGVALE

6.2.8.2 Quality Trend

SMP states that groundwater results will be assessed against triggers and performance for the parameters EC, pH and Iron. In this case there are no triggers to be assessed against and the data will be qualitatively assessed. The trends for these analytes are shown below.

The pH at Sunnyside Swamp piezometers have remained within a general ranges between 4.5 to 6.5 pH. That said, the pH trend changes from mid 2017 was slowly decreasing, which is likely due to the declining water levels at the swamp and decline in average rainfalls during this period. The pH measurements for the reporting period has shown the pH is relatively stable. The EC has remained generally stable, the large peak at SS1 is likely an error. EC values for the reporting period have been within historic ranges. Iron concentrations follow a seasonal trend with peaks around the wetter summer months. The recent values are reflective of this trend.

Graphs for all other parameter trends are included in **Appendix E**. Trends of note are:

- Alkalinity- higher concentrations upstream at SS1 and SS3. Alkalinity declined in mid-2017 at SS1 and SS3 but stable downstream at SS4 and SS5 where there is regular water.
- Copper – higher concentrations upstream at SS1 and SS3, and follows a seasonal trend with peaks in the winter months
- Sodium – higher concentrations upstream at SS1 and SS3
- Sulfate – concentration spikes more common since 2017 at upstream locations SS1 and SS3.
- Zinc – Large sustained peak in 2014 gradually declining. Another small peak around 2019. It is likely linked to the prevailing rainfall conditions.

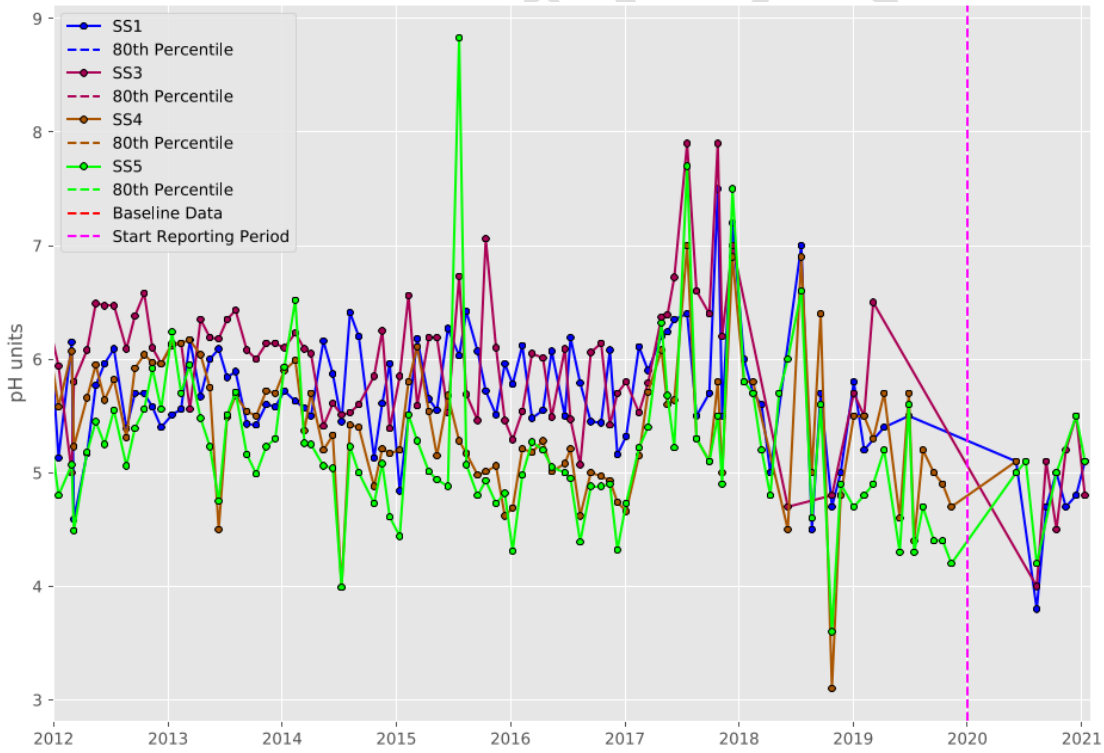

Figure 6.40: Sunnyside Swamp - pH

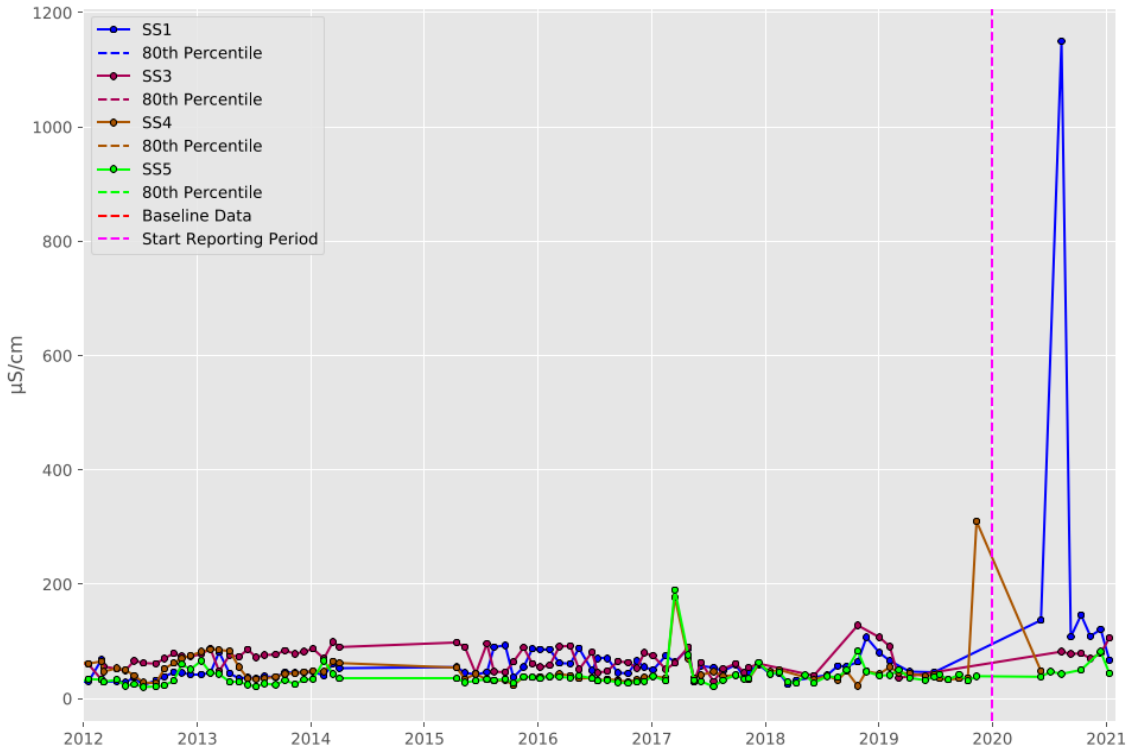

Figure 6.41: Sunnyside Swamp - EC

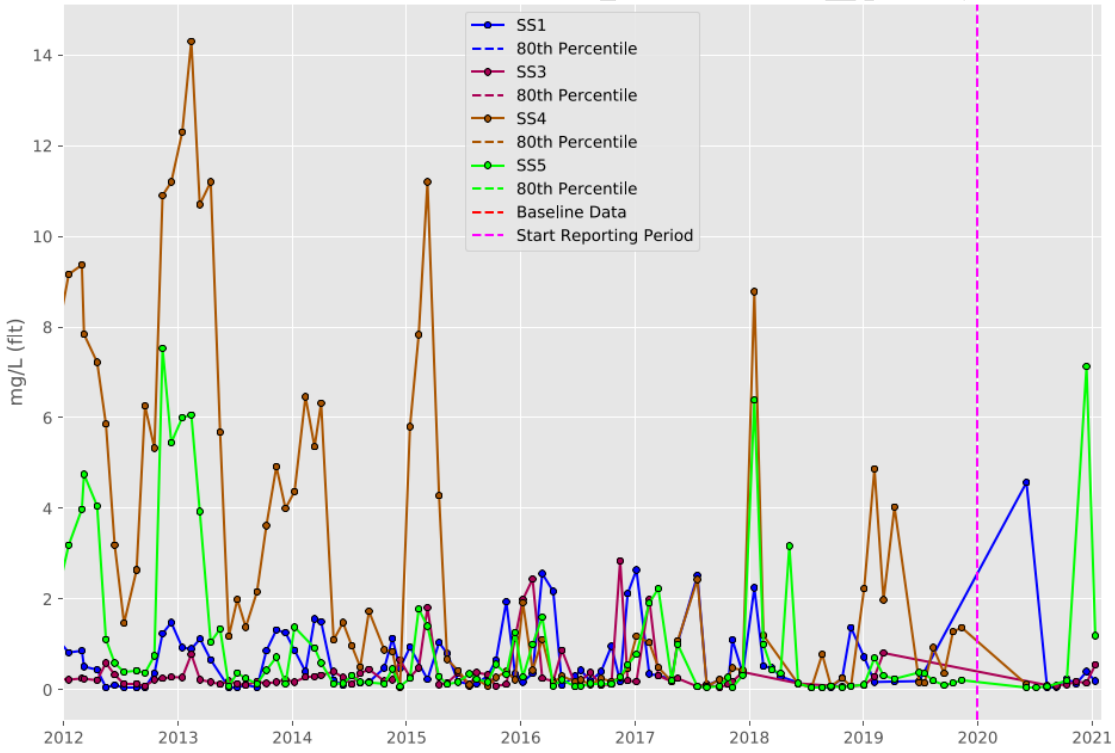

Figure 6.42: Sunnyside Swamp - Iron

6.2.9 Sunnyside East Swamp

Sunnyside East Swamp is an impact swamp that overlies LW416-LW418. No samples have been collected since 2017.

6.2.9.1 Statistics

Table 6.15 outlines the summary statistics. Sunnyside swamp has been predominately dry since mid 2013. Beyond that there are a few interspersed records of data at SSE3, usually following a period of rain. Only one sample was taken at SSE3 in 2020.

Table 6.15: Sunnyside East Swamp - Groundwater quality summary statistics

ID	Historic date ranges	Analyte	Pre-mining data statistics				Long term trigger &	Short term trigger &	Reporting period statistics			Comments
			Data point count	Min	Mean	Max			Min	Median	Max	
SSE1	11/03/2013 only 1 data point											
		pH	1	4.81			Insufficient baseline data		Dry	Dry	Dry	No baseline
		EC (µS/cm)	1	36					Dry	Dry	Dry	No baseline
		Fe (mg/L)	0	NA					Dry	Dry	Dry	No baseline
SSE2	12/06/2012 – 6/08/2013											
		pH	13	5.05	5.42	5.92	5.2-5.6	4.8-6.0	Dry	Dry	Dry	NA
		EC (µS/cm)	13	32	42	70	45	65	Dry	Dry	Dry	NA
		Fe (mg/L)	10	0.08	0.929	3.17	1.00	2.77	Dry	Dry	Dry	NA
SSE3	22/02/2011 – 9/07/2013											
		pH	30	5.18	5.69	6.34	5.4-6.0	4.7-6.7	5	-	-	NA
		EC (µS/cm)	30	20	45	102	53	94	22	-	-	NA
		Fe (mg/L)	30	0.18	4.334	14.4	7.502	15.9	0.09	-	-	NA

Notes: * value at detection limit (Limit of Reporting - LOR)
positive delta value equals a recent value that is greater than the historic mean, and vice versa for negative delta values.
% no monitoring data available post 19/10/2019, due to lack of access caused to bushfire/ dry conditions
@ where values are below limit of reporting, a value of half the measurement has been assumed.
& investigation trigger performance indicators based on Table 33 of the SMP LW424-LW427. The long- and short-term triggers are based on the 80th data percentile and the 80th percentile plus two standard deviations, respectively

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6.2.9.2 Quality Trend

SMP states that groundwater results will be assessed against triggers and performance for the parameters EC, pH and Iron. The trends for these analytes are shown below.

Only one sample was collected at SSE3 for the reporting period.

Graphs for all other parameter trends are included in **Appendix E**.

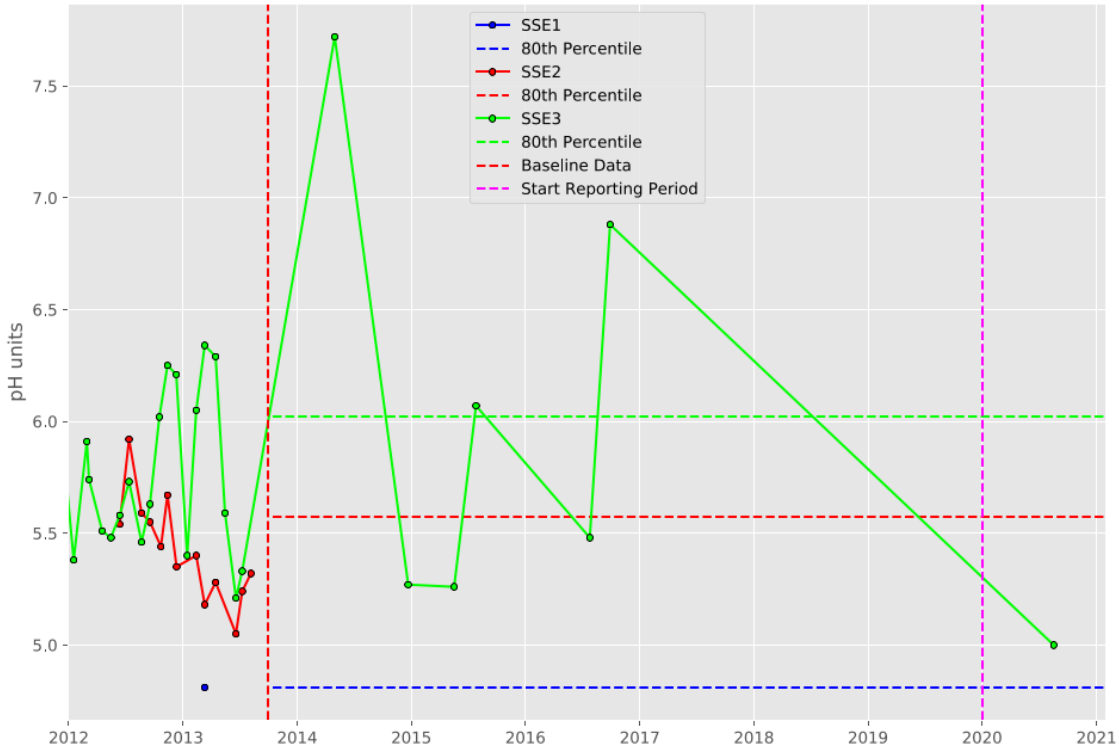

Figure 6.43: Sunnyside East Swamp - pH

SPRI

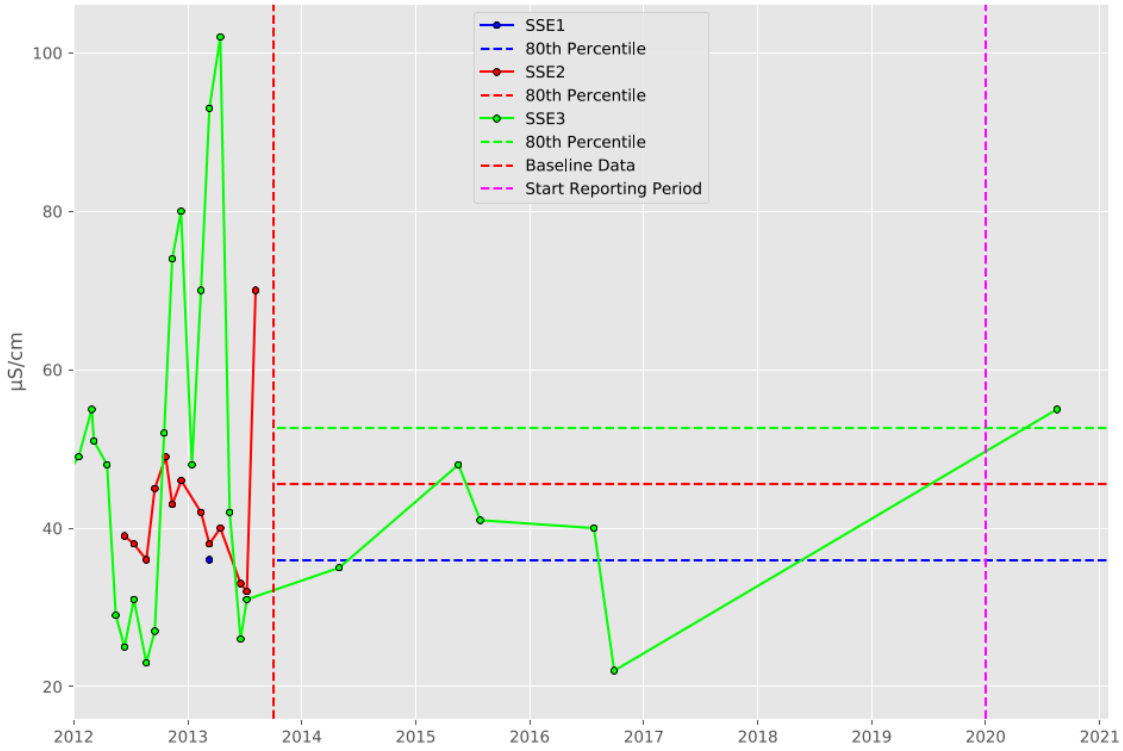

Figure 6.44: Sunnyside East Swamp - EC

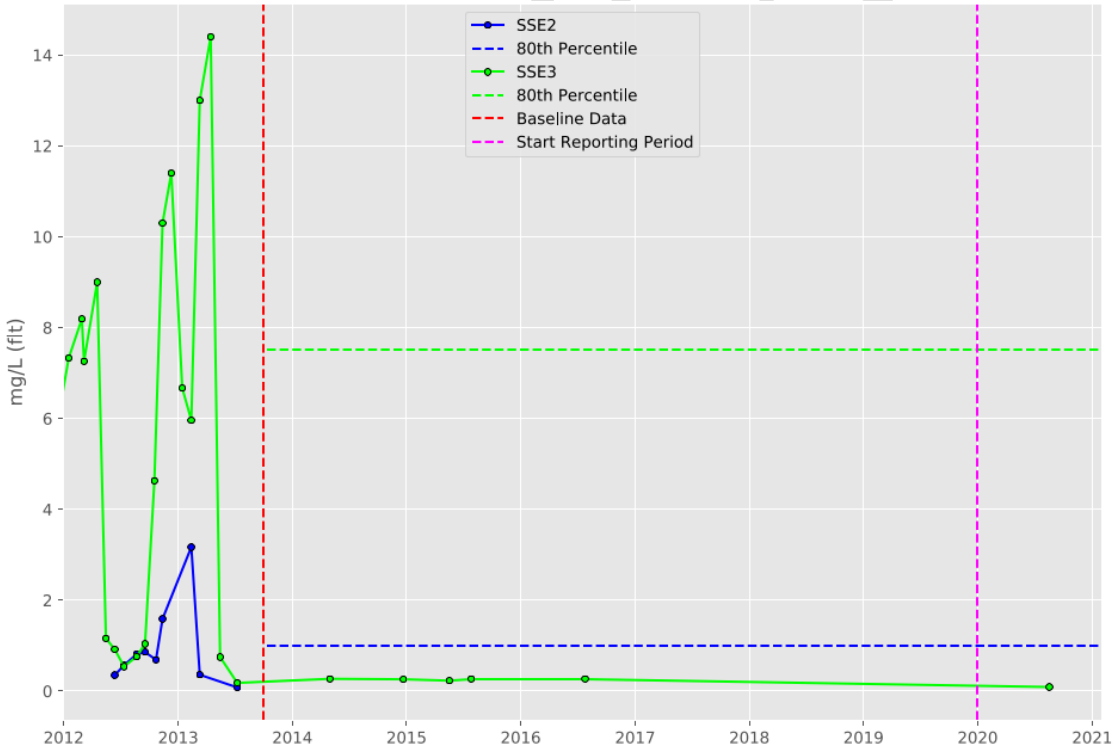

Figure 6.45: Sunnyside East Swamp - Iron

7. Ridge Piezometer Groundwater Quality

The regional groundwater quality in the Banks Wall sandstone and the Burralow Formation units are sampled quarterly from the ridge piezometers throughout the plateau. There is limited groundwater quality data from the deeper Mount York Claystone, Burra-Moko Head Sandstone and the Caley Formation units, but routine sampling from dewatering infrastructure can provide indicative water quality of mine inflows.

A suite of quality parameters are monitored including field parameters (pH, temperature, EC, Eh, dissolved oxygen, TDS), major ions and trace ions but the focus will be on the key parameters that will be used to identify potential mining impacts. Table 33 of the SMP LW424 – LW427 outlines the performance indicators for ridge piezometers, which are summarised in Table 1.2.

There was no access to the plateau in March 2020 for the quarterly sampling round.

The key performance parameters are outline in Table 1.2, with additional focus on the following parameters:

- pH
- EC
- Iron
- TDS
- Sodium (Na)
- Potassium (K)
- Calcium (Ca)
- Magnesium (Mg)
- Chloride (Cl)
- Sulfate (SO4)
- Bicarbonate (HCO3)

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7.1 Ridge piezometers

Ridge piezometer water quality is characterised as slightly acidic with low EC and low concentrations of anions and cations. In general, sodium chloride is the dominant constituent. The other anions and cations are generally below detectable limits. In recent samples there has been an increasing trend in alkalinity, the cause in unknown but it may be linked to the declining water levels and rainfalls since 2016.

The majority of the ridge piezometer water quality were within performance limits and the few sites where it was exceeded are discussed below. Key results for the ridge piezometers within the Springvale Water Management Plan for LW424 - 427 are shown below in Table 7.1 for the reporting period. Exceedances are shown in **red** text. Sampling was not conducted in the March monitoring round due to bushfires restricting access. Graphs can be found in Appendix E.

At reference sites AP1204 and AP1105, a spike in EC concentration was recorded of 110µS/cm and 351µS/cm, respectively. In AP1204, elevated levels of aluminium and manganese accompanied by a low pH was observed, it is unclear why the EC was high, but it is plausible the more acidic conditions would have increased the mobility of metal cations. Sampling at AP1105 is still relatively recent and further monitoring will confirm if this is an intermittent trend.

At impact site, SPR1108, a peak elevated pH level of 9.19 was observed in the reporting period. This sample also recorded an increase in alkalinity. No abnormalities were observed in other analytes. During this time, it is noted that water levels at SPR1108 have been declining since March 2019, and this may have played a role in the altered water chemistry. A trigger report for water level has been completed at this site in 2017.

At impact site SPR1112, a peak of elevated EC level of 213 was recorded in the reporting period. This sample also recorded an erroneously high redox potential and total dissolved solids. It is possible the EC concentration is erroneous as further monitoring confirmed it returned to normal levels.

At site SPR1301, there is evidence of grout contamination as indicated by the high pH 11.27, and relatively high calcium and chromium concentrations that are characteristic of cement. The water quality at this site is not representative of the groundwater here.

Table 7.1: Ridge piezometer groundwater quality summary

ID	Historic date ranges	Analyte	Historical data statistics				Reporting period statistics		
			Data point count	Min	Mean	Max	Min	Median	Max
AP9PR	17/03/2016 - present								
		pH	24	4.27	5.60	6.75	5.2	5.34	5.83
		EC (µS/cm)	24	20.6	27	34	30.8	33	33
		Fe (mg/L)	25	0.05*	0.0768	0.7	0.05	0.05	0.05
		TDS (mg/L)	29	16	39	145	16	20.04	39
		Na (mg/L)	26	1	2.42	3	2	3	3
		K (mg/L)	26	1*	1*	1*	1	1	1
		Ca (mg/L)	26	1-	1.307	3	2	2	2
		Mg (mg/L)	25	1*	1*	1*	1	1	1
		Cl (mg/L)	26	1*	3.26	4	3	4	4
		SO4 (mg/L)	26	1*	1.03	2	1	1	1

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ID	Historic date ranges	Analyte	Historical data statistics				Reporting period statistics		
			Data point count	Min	Mean	Max	Min	Median	Max
		HCO3 (mg/L)	26	1*	4.57	12	7	11	12
AP8PR	17/03/2016 - present								
		pH	23	4.08	5.27	6.29	4.5	4.82	5.48
		EC (µS/cm)	23	34.5	45.7	72	43.6	47	47
		Fe (mg/L)	24	0.05*	0.0558	0.16	0.05	0.05	0.05
		TDS (mg/L)	28	12	45.5	100	28.32	32	58
		Na (mg/L)	25	5	6.36	8	5	6	6
		K (mg/L)	25	1*	1*	1*	1	1	1
		Ca (mg/L)	25	1*	1*	1*	1	1	1
		Mg (mg/L)	24	1*	1*	1*	1	1	1
		Cl (mg/L)	25	7	9.32	11	9	9	10
		SO4 (mg/L)	25	1*	1.16	5	1	1	1
		HCO3 (mg/L)	25	1	3.12	7	4	4	7
AP5PR	17/03/2016 - present								
		pH	25	4.11	5.52	6.49	4.6	5.27	5.47
		EC (µS/cm)	25	18	26.5	37.9	27	29	33.8
		Fe (mg/L)	26	0.05*	0.058	0.21	0.05	0.05	0.05
		TDS (mg/L)	30	4	28.9	76	12	21.97	37
		Na (mg/L)	27	2	2.6	3	2	3	3
		K (mg/L)	27	1*	1*	1*	1	1	1
		Ca (mg/L)	27	1*	1*	1*	1	1	1
		Mg (mg/L)	26	1*	1*	1*	1	1	1
		Cl (mg/L)	27	1*	1.96	13	4	4	5
		SO4 (mg/L)	27	1*	1.7	13	1	1	1
		HCO3 (mg/L)	27	1*	1.9	6	2	4	6
AP4PR	17/03/2016 - present								
		pH	24	4.24	5.33	6.81	4.6	4.73	5.65
		EC (µS/cm)	24	23.5	30.9	60	30.9	33	57
		Fe (mg/L)	25	0.05*	0.05*	0.05*	0.05	0.05	0.05
		TDS (mg/L)	29	9	37	110	12	20.89	38
		Na (mg/L)	26	2	3.69	4	3	4	4
		K (mg/L)	26	1*	1*	1*	1	1	1
		Ca (mg/L)	26	1*	1*	1*	1	1	1
		Mg (mg/L)	25	1*	1*	1*	1	1	1
		Cl (mg/L)	26	4	5.3	6	6	6	7
		SO4 (mg/L)	26	1*	1.03	2	1	1	1

SPRINGVALE

ID	Historic date ranges	Analyte	Historical data statistics				Reporting period statistics		
			Data point count	Min	Mean	Max	Min	Median	Max
		HCO3 (mg/L)	26	1*	1.5	5	3	5	5
AP1204	17/03/2016 - present								
		pH	23	3.81	5.43	6.57	3.81	4.5	5.14
		EC (µS/cm)	23	26	52	110.7	44	45	110.7
		Fe (mg/L)	25	0.05*	0.08	0.45	0.05	0.05	0.05
		TDS (mg/L)	27	10	36.15	74.94	22	36	74.94
		Na (mg/L)	26	4	4.6	6	4	5	6
		K (mg/L)	26	1*	1*	1*	1	1	1
		Ca (mg/L)	26	1*	1*	1*	1	1	1
		Mg (mg/L)	25	1*	1*	1*	1	1	1
		Cl (mg/L)	26	6	8.3	11	9	9	10
		SO4 (mg/L)	26	1	1.03	2	1	1	1
		HCO3 (mg/L)	26	1	1.115	2	1	2	2
AP1105	4/12/2018 - present								
		pH	3	4.74	5.04	5.36	5.36	5.36	5.36
		EC (µS/cm)	3	26.7	135.9	351	351	351	351
		Fe (mg/L)	3	0.05*	0.093	0.18	0.05	0.05	0.05
		TDS	5	19.57	53.078	174	22.82	24.41	26
		Na (mg/L)	3	4	4.3	5	5	5	5
		K (mg/L)	3	1*	1*	1*	1	1	1
		Ca (mg/L)	3	1*	1*	1*	1	1	1
		Mg (mg/L)	3	1*	1*	1*	1	1	1
		Cl (mg/L)	3	6	6.3	7	6	6	6
		SO4 (mg/L)	3	1	1*	1*			
		HCO3 (mg/L)	3	1*	2	4	4	4	4
SPR1113	17/03/2016 - present								
		pH	25	4	5.28	7.55	4.7	6.38	7.55
		EC (µS/cm)	25	17.6	23.28	34	23	29	35
		Fe (mg/L)	26*	0.05*	0.05*	0.05*	0.05	0.05	0.05
		TDS (mg/L)	30	11	31	110	14.07	16	37
		Na (mg/L)	27	1*	2.3	4	2	2	3
		K (mg/L)	27	1	1.03	2	1	1	1
		Ca (mg/L)	27	1*	1*	1*	1	1	1
		Mg (mg/L)	26	1*	1*	1*	1	1	1
		Cl (mg/L)	27	1*	3	4	3	4	4
		SO4 (mg/L)	27	1	1.11	4	1	1	1

SPRINGVALE

ID	Historic date ranges	Analyte	Historical data statistics				Reporting period statistics		
			Data point count	Min	Mean	Max	Min	Median	Max
		HCO3 (mg/L)	27	1*	1.15	4	2	2	4
SPR1401	17/03/2016 - present								
		pH	25	4.44	5.30	6.39	5	5.2	6.38
		EC (µS/cm)	25	15.6	21.56	34.1	27	32	34
		Fe (mg/L)	26	0.05*	0.084	0.51	0.05	0.05	0.13
		TDS(mg/L)	30	5	31	141	15.77	22.07	110
		Na (mg/L)	27	2	2.7	5	2	3	4
		K (mg/L)	27	1*	1*	1*	1	1	1
		Ca (mg/L)	27	1*	1*	1*	1	1	1
		Mg (mg/L)	26	1*	1*	1*	1	1	1
		Cl (mg/L)	27	1	2.51	3	3	3	4
		SO4 (mg/L)	27	1	1.11	3	1	1	1
		HCO3 (mg/L)	27	1	1.89	6	4	5	6
SPR1109	17/03/2016 - 30/11/2016								
		pH	7	4.56	5.20	5.89	No sample	No sample	No sample
		EC (µS/cm)	7	22.4	26.48	32	No sample	No sample	No sample
		Fe (mg/L)	9	0.05*	0.05*	0.05*	No sample	No sample	No sample
		TDS (mg/L)	12	4	43	95	No sample	No sample	No sample
		Na (mg/L)	10	2	3.1	4	No sample	No sample	No sample
		K (mg/L)	10	1*	1*	1*	No sample	No sample	No sample
		Ca (mg/L)	10	1*	1*	1*	No sample	No sample	No sample
		Mg (mg/L)	9	1*	1*	1*	No sample	No sample	No sample
		Cl (mg/L)	10	5	5.3	6	No sample	No sample	No sample
		SO4 (mg/L)	10	1*	1.1	2	No sample	No sample	No sample
		HCO3 (mg/L)	10	1*	1*	1*	No sample	No sample	No sample
SPR1106	17/03/2016 - present								
		pH	25	4.15	5.03	5.94	4.85	5.4	6.4
		EC (µS/cm)	25	20	26.7	33.4	27.5	30	35
		Fe (mg/L)	26	0.05*	0.051	0.1	0.05	0.05	0.05
		TDS (mg/L)	30	10	33	76	16.4	24	38
		Na (mg/L)	27	2	3.37	5	3	4	4
		K (mg/L)	27	1*	1*	1*	1	1	1
		Ca (mg/L)	27	1*	1*	1*	1	1	1
		Mg (mg/L)	26	1*	1*	1*	1	1	1
		Cl (mg/L)	27	2	4.18	5	4	5	5
		SO4 (mg/L)	27	1*	1.03	2	1	1	1

SPRINGVALE

ID	Historic date ranges	Analyte	Historical data statistics				Reporting period statistics		
			Data point count	Min	Mean	Max	Min	Median	Max
		HCO3 (mg/L)	27	1*	1.48	9	3	4	6
SPR1104	17/03/2016 – 29/05/2017								
		pH	13	3.4	5.22	6.19	Dry	Dry	Dry
		EC (µS/cm)	13	15	20.2	23	Dry	Dry	Dry
		Fe (mg/L)	15	0.05*	0.05*	0.05*	Dry	Dry	Dry
		TDS (mg/L)	17	5	35	75	Dry	Dry	Dry
		Na (mg/L)	16	2	3	4	Dry	Dry	Dry
		K (mg/L)	16	1*	1*	1*	Dry	Dry	Dry
		Ca (mg/L)	16	1*	1*	1*	Dry	Dry	Dry
		Mg (mg/L)	15	1*	1*	1*	Dry	Dry	Dry
		Cl (mg/L)	16	2	3.4	4	Dry	Dry	Dry
		SO4 (mg/L)	16	1	1.06	2	Dry	Dry	Dry
		HCO3 (mg/L)	16	1*	1.125	3	Dry	Dry	Dry
SPR1111	17/03/2016 - present								
		pH	25	4.03	5.48	9.21	6.14	6.55	6.97
		EC (µS/cm)	25	15.4	21	29	16	19.5	23
		Fe (mg/L)	26	0.05*	0.051	0.07	0.05	0.05	0.05
		TDS (mg/L)	29	8	28	70	10	10.43	39
		Na (mg/L)	27	2	2.8	4	2	2.5	3
		K (mg/L)	27	1*	1*	1*	1	1	1
		Ca (mg/L)	27	1*	1*	1*	1	1	1
		Mg (mg/L)	26	1*	1*	1*	1	1	1
		Cl (mg/L)	26	1*	2.8	4	3	3.5	4
		SO4 (mg/L)	26	1*	1.03	4	1	1	1
		HCO3 (mg/L)	27	1*	2.07	7	4	5.5	7
SPR1107	17/03/2016 – 28/05/2019								
		pH	23	3.47	5.14	6.61	Low WL	Low WL	Low WL
		EC (µS/cm)	23	19.3	39.5	268	Low WL	Low WL	Low WL
		Fe (mg/L)	24	0.05*	0.051	0.07	Low WL	Low WL	Low WL
		TDS (mg/L)	26	10	27	58	Low WL	Low WL	Low WL
		Na (mg/L)	24	2	3.16	4	Low WL	Low WL	Low WL
		K (mg/L)	24	1*	1*	1*	Low WL	Low WL	Low WL
		Ca (mg/L)	24	1*	1*	1*	Low WL	Low WL	Low WL
		Mg (mg/L)	24	1*	1*	1*	Low WL	Low WL	Low WL
		Cl (mg/L)	24	4	5.125	6	Low WL	Low WL	Low WL
		SO4 (mg/L)	24	1	1.04	2	Low WL	Low WL	Low WL

SPRINGVALE

ID	Historic date ranges	Analyte	Historical data statistics				Reporting period statistics		
			Data point count	Min	Mean	Max	Min	Median	Max
		HCO3 (mg/L)	24	1*	1*	1*	Low WL	Low WL	Low WL
SPR1108	17/03/2016 - present								
		pH	25	3.57	5.39	9.19	4.6	7.85	9.19
		EC (µS/cm)	25	21	31.9	370	31	35.1	370
		Fe (mg/L)	26	0.05*	0.05*	0.05*	0.05	0.05	0.05
		TDS (mg/L)	29	10	28.89	70	22	25	40
		Na (mg/L)	26	2	2.3	3	2	3	3
		K (mg/L)	26	1*	1*	1*	1	1	1
		Ca (mg/L)	26	1*	1*	1*	1	1	1
		Mg (mg/L)	26	1*	1*	1*	1	1	1
		Cl (mg/L)	26	2	3.96	7	4	5	5
		SO4 (mg/L)	26	1*	1.03	2	1	1	1
		HCO3 (mg/L)	26	1*	1.19	6	2	5	6
SPR1112	17/03/2016 - present								
		pH	25	4.05	5.13	6.41	5.9	6.41	6.66
		EC (µS/cm)	25	17	31	213	24	28	213
		Fe (mg/L)	26	0.05*	0.05*	0.05*	0.05	0.05	0.05
		TDS (mg/l)	29	10	74.67	1381	13.91	31	1381
		Na (mg/L)	26	2	2.96	4	2	3	4
		K (mg/L)	26	1*	1*	1*	1	1	1
		Ca (mg/L)	26	1*	1*	1*	1	1	1
		Mg (mg/L)	26	1*	1*	1*	1	1	1
		Cl (mg/L)	26	2	3.65	4	3	4	4
		SO4 (mg/L)	26	1*	1.03	2	1	1	1
		HCO3 (mg/L)	26	1*	1.35	4	2	3	4
SPR1210	5/03/2019 – 28/05/2019								
		pH	2	6.1	7.2	8.3	Low WL	Low WL	Low WL
		EC (µS/cm)	2	31.3	217.65	404	Low WL	Low WL	Low WL
		Fe (mg/L)	1	0.05*	0.05*	0.05*	Low WL	Low WL	Low WL
		TDS (mg/L)	3	18	33.55	62	Low WL	Low WL	Low WL
		Na (mg/L)	1	4	4	4	Low WL	Low WL	Low WL
		K (mg/L)	1	1*	1*	1*	Low WL	Low WL	Low WL
		Ca (mg/L)	1	1*	1*	1*	Low WL	Low WL	Low WL
		Mg (mg/L)	1	1*	1*	1*	Low WL	Low WL	Low WL
		Cl (mg/L)	1	3	3	3	Low WL	Low WL	Low WL
		SO4 (mg/L)	1	1*	1*	1*	Low WL	Low WL	Low WL

SPRINGVALE

ID	Historic date ranges	Analyte	Historical data statistics				Reporting period statistics		
			Data point count	Min	Mean	Max	Min	Median	Max
		HCO3 (mg/L)	1	3	3	3	Low WL	Low WL	Low WL
SPR1211	4/12/2018 – 12/09/2019								
		pH	4	4.52	5.58	7.54	Dry	Dry	Dry
		EC (µS/cm)	4	37	44.25	58.4	Dry	Dry	Dry
		Fe (mg/L)	3	0.05*	0.086	0.16	Dry	Dry	Dry
		TDS (mg/L)	6	10	27.71	58	Dry	Dry	Dry
		Na (mg/L)	3	3	3	3	Dry	Dry	Dry
		K (mg/L)	3	1*	1*	1*	Dry	Dry	Dry
		Ca (mg/L)	3	1*	1*	1*	Dry	Dry	Dry
		Mg (mg/L)	3	1*	1*	1*	Dry	Dry	Dry
		Cl (mg/L)	3	6	6.67	7	Dry	Dry	Dry
		SO4 (mg/L)	3	1*	1*	1*	Dry	Dry	Dry
		HCO3 (mg/L)	1	1*	1*	1*	Dry	Dry	Dry
SPR1301	4/12/2018 - present								
		pH	5	11	11.4	11.61	8.82	9.4	11.27
		EC (µS/cm)	5	325.8	680.16	993.7	122	154	325.8
		Fe (mg/L)	4	0.05*	0.0625	0.1	0.05	0.05	0.05
		TDS (mg/L)	8	94	297.94	647.23	77	94	211.72
		Na (mg/L)	4	3	5.25	10	3	3	4
		K (mg/L)	4	1*	1*	1*	1	1	1
		Ca (mg/L)	4	19	5.25	81	19	20	26
		Mg (mg/L)	4	1*	1*	1*	1	1	1
		Cl (mg/L)	4	4	4	4	4	4	5
		SO4 (mg/L)	4	1	2.5	4	1	1	1
		HCO3 (mg/L)	4	1*	2	5	5	46	72
RSS	17/03/2016 - present								
		pH	25	3.87	5.07	6.07	4.8	5.3	5.99
		EC (µS/cm)	25	24	34	60	54.1	67.37	84
		Fe (mg/L)	26	0.05*	0.05*	0.05*	0.05	0.05	0.05
		TDS (mg/L)	30	10	40.53	100	35.14	40.35	44
		Na (mg/L)	27	3	4.77	11	8	9	11
		K (mg/L)	27	1*	1*	1*	1	1.33	2
		Ca (mg/L)	27	1*	1*	1*	1	1	1
		Mg (mg/L)	26	1*	1*	1*	1	1	1
		Cl (mg/L)	26	3	6.9	17	14	15.3	17
		SO4 (mg/L)	26	1	1.07	3	1	1	1

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ID	Historic date ranges	Analyte	Historical data statistics				Reporting period statistics		
			Data point count	Min	Mean	Max	Min	Median	Max
		HCO3 (mg/L)	26	1	2.2	5	5	5.67	6

7.2 Bore 6 and Bore 8

Bore 6 and Bore 8 are dewatering wells that provides indicative water quality of mine inflows, but it was also be influenced by underground activities and introduced water. pH is relatively stable and is neutral to slightly alkaline. EC concentrations are stable and are higher than the ridge piezometers. This is because water influx from the coal seam is saline. Iron concentrations generally remain below 1mg/L but greater variance has been observed since 2018.

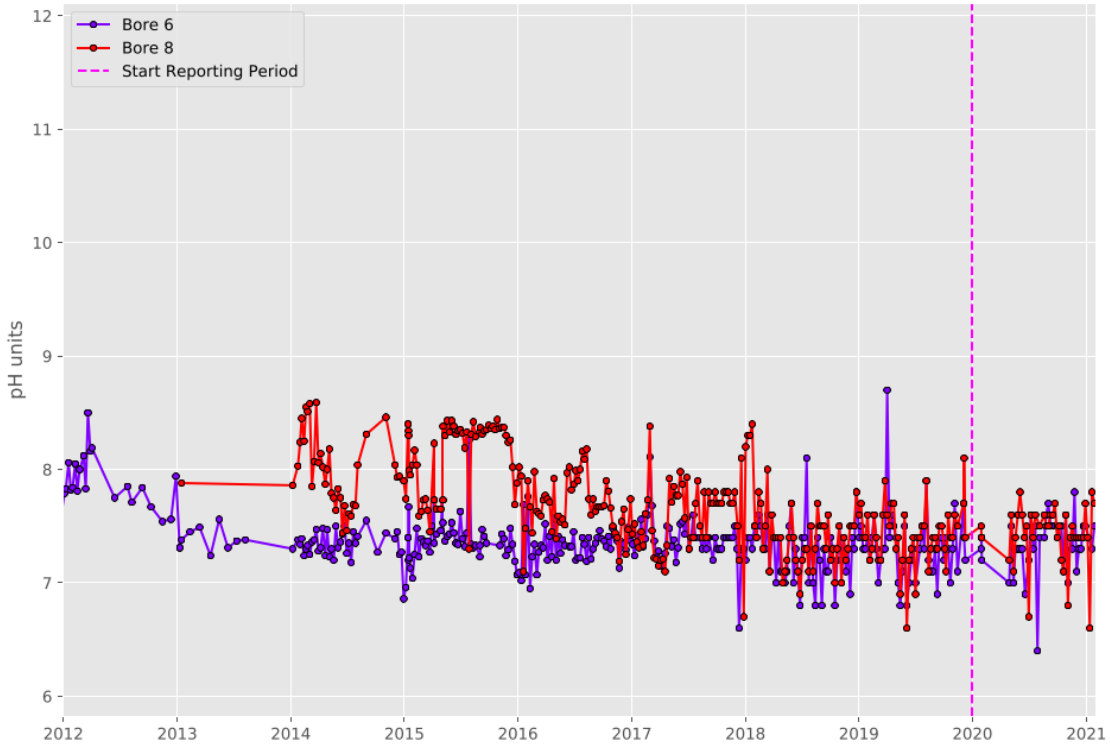

Figure 7.1: Bore 6 and 8 - pH

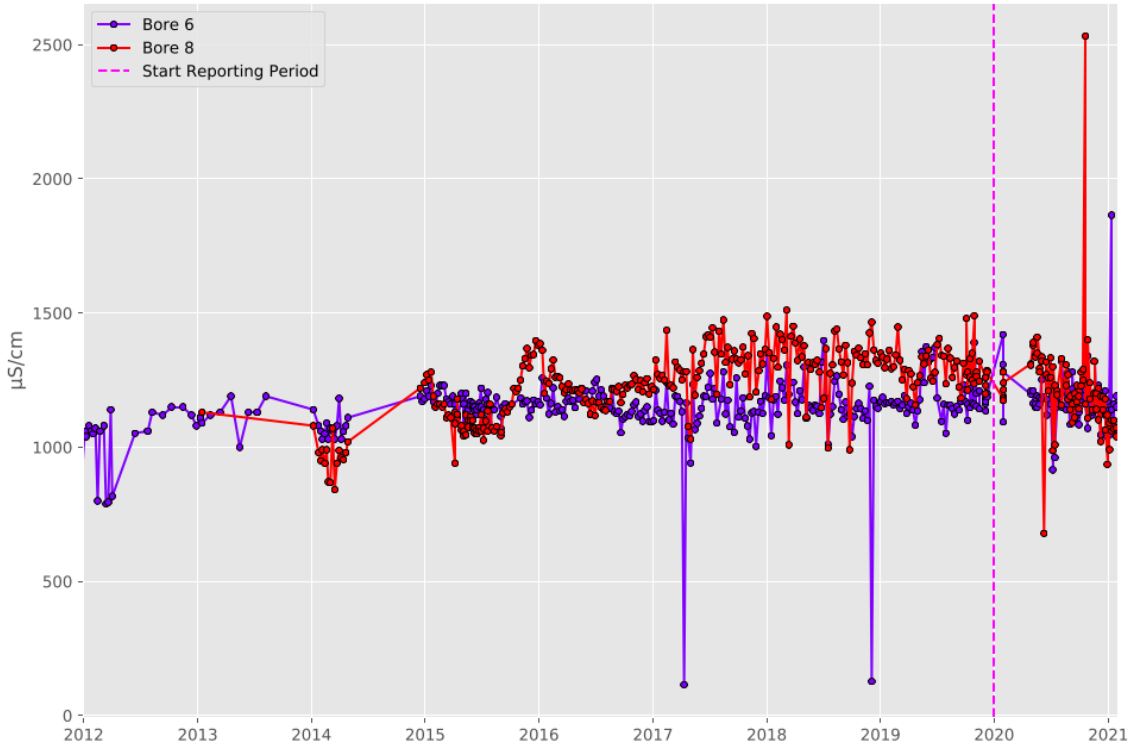

Figure 7.2: Bore 6 and 8 - EC

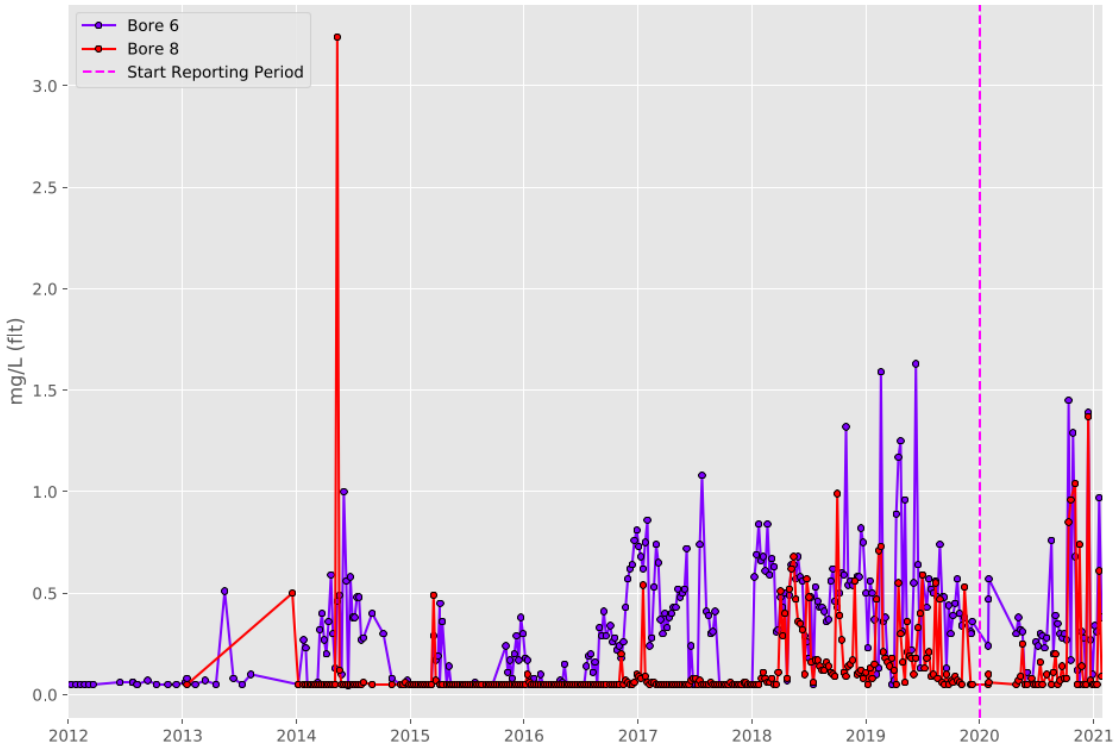

Figure 7.3: Bore 6 and 8 - Iron

A summary of results for the reporting period for the Dewatering Bores are shown in Table 7.2. Graphs can be found in Appendix E. In general, the water quality is characterised by neutral to slightly basic pH with low levels of metals and a high EC. A singular EC spike was observed at both Bore 6 and 8 during the reporting period. It should be noted that the water quality results are also influenced by underground activities and introduced water.

Table 7.2 Dewatering Bore Water Quality Summary

ID	Historic date ranges	Analyte	Historical data statistics				Reporting period statistics		
			Data point count	Min	Mean	Max	Min	Mean	Max
Bore 6	4/09/2009 - present	pH	469	6.11	7.45	11.82	6.4	7.34	7.8
		EC (µS/cm)	483	115	1113	1398	916	1180	1865
		Fe (mg/L)	344	0.044	0.2789	1.63	0.05	0.385	1.45
Bore 8	15/01/2013 - present	pH	308	6.6	7.72	8.59	6.6	7.42	7.8
		EC (µS/cm)	322	842	1225	1511	679	1213	2532
		Fe (mg/L)	303	0.05*	0.121	3.24	0.05	0.211	1.37

SPRINGVALE

8. Surface Water Monitoring – SMP

Surface water quality and flows at Springvale are monitored under the SMP and WMP. Surface water quality parameters monitored at these sites are field parameters (pH, Temp, EC, eH, DO, Turbidity, Flow), major ions, trace ions and nutrients. That said, the performance indicators are different between the SMP and WMP sites and this report will classify those sites under their respective management plan.

Table 33 of the SMP LW424-427 outlines the performance measures against the 80th percentile reference dataset. If any of the EC, pH, Fe, Mn and TSS is greater than the 80th percentile at reference site for more than two months, the trigger is breached.

The key performance parameters are:

- pH
- EC
- Filtered Iron
- Filtered Manganese
- TSS

The locations of the surface water monitoring points are shown on Appendix A and the data is presented in Appendix G.

8.1 Reference Sites

Reference swamp sites are sites that are regarded to be unimpacted by mining activities. The graphs of the main analytes show the general trends. The beginning of the reporting period is marked by the dotted line at January 2020. At reference sites, the whole dataset is considered to be baseline data and baseline cut off is at the most recent monitoring round. There are no triggers at reference sites.

8.1.1 Barrier Swamp

8.1.1.1 Statistics

Barrier Swamp is a reference site and as such there are no performance triggers for this site. Table 8.1 outlines the surface water summary.

Table 8.1: Barrier Swamp - Surface Water quality summary statistics

ID	Historic date ranges	Analyte	Historic data statistics				Trigger (80th percentile +2SD)	Reporting period statistics			Comments
			Data point count	Min	Mean	Max		Min	Median	Max	
Barrier Swamp	27/09/2016 - present										
		pH	69	3.4	5.3	9.1	2.9-7.6	4.1	5.15	7.1	Reference site - No trigger
		EC (µS/cm)	69	22	37.2	106	71	30	41.5	77	Reference site - No trigger
		Fe (mg/L)	40	0.08	0.304	0.71	0.78	0.17	0.33	0.66	Reference site - No trigger

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ID	Historic date ranges	Analyte	Historic data statistics				Trigger (80th percentile +2SD)	Reporting period statistics			Comments
			Data point count	Min	Mean	Max		Min	Median	Max	
		Mn (mg/l)	40	0.0004	0.013	0.216	0.076	0.011	0.014	0.022	Reference site - No trigger
		TSS (mg/L)	40	5	10.1	55	32	5	13	33	Reference site - No trigger
		DO (mg/L)	52	5.1	10.45	109	37.9	5.8	8	15.1	Reference site - No trigger
		Flow (kl/day)	54	43	1086	10627	4761	35	492	3090	Reference site - No trigger

Notes: * value at detection limit (Limit of Reporting - LOR)
positive delta value equals a recent value that is greater than the historic mean, and vice versa for negative delta values.
% no monitoring data available post 19/10/2019, due to lack of access caused to bushfire/ dry conditions
@ where values are below limit of reporting, a value of half the measurement has been assumed.
& investigation trigger performance indicators based on Table 33 of the SMP LW424-LW427. The long- and short-term triggers are based on the 80th data percentile and the 80th percentile plus two standard deviations, respectively

8.1.1.2 Quality Trend

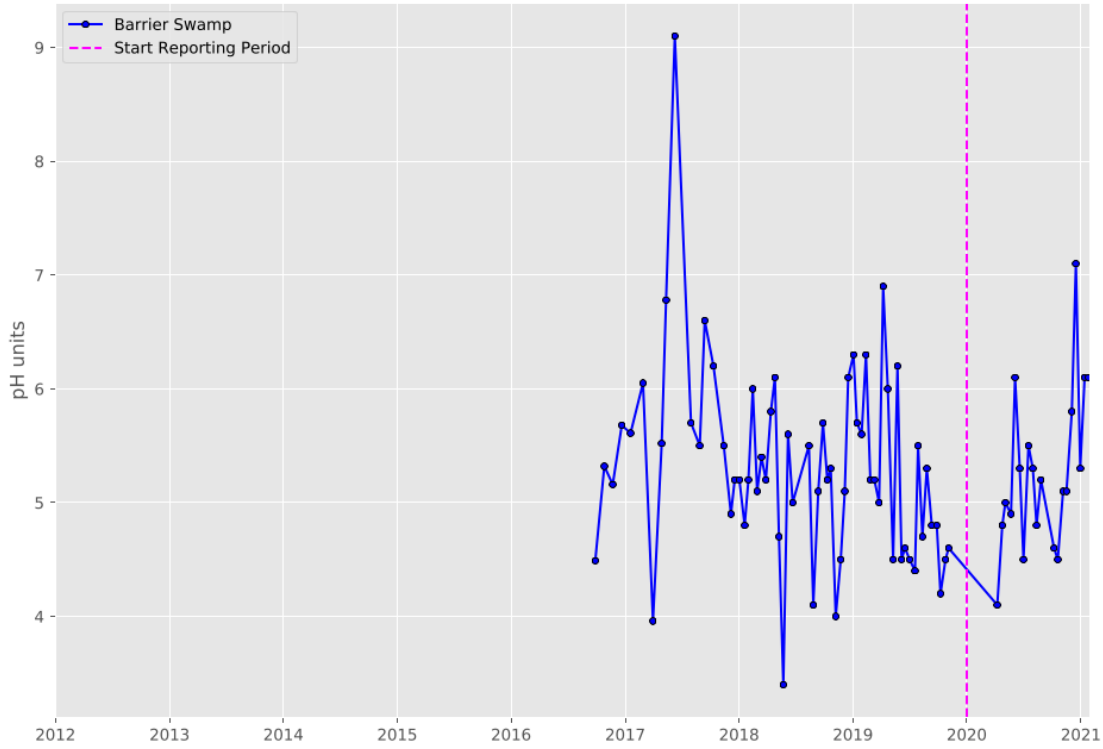
SMP states that surface water results will be assessed against performance triggers for the parameters pH, EC, Iron, Manganese and TSS. Performance triggers are not applicable to reference sites. The trends for these analytes are shown below.

pH at Barrier swamp is observed to be to relatively stable, ranging from neutral to slightly acidic. The peak in EC during 2018 coincides with a period of prolonged declining rainfalls, the recent EC concentrations have been relatively stable. Iron shows a seasonal trend with peaks around the summer months. Manganese is generally stable and the higher concentrations in 2020 are likely related to the bushfire runoff. There are no apparent trends in TSS but recent observations show an increasing TSS.

Graphs for all other parameter trends are included in **Appendix G**. Trends of note are:

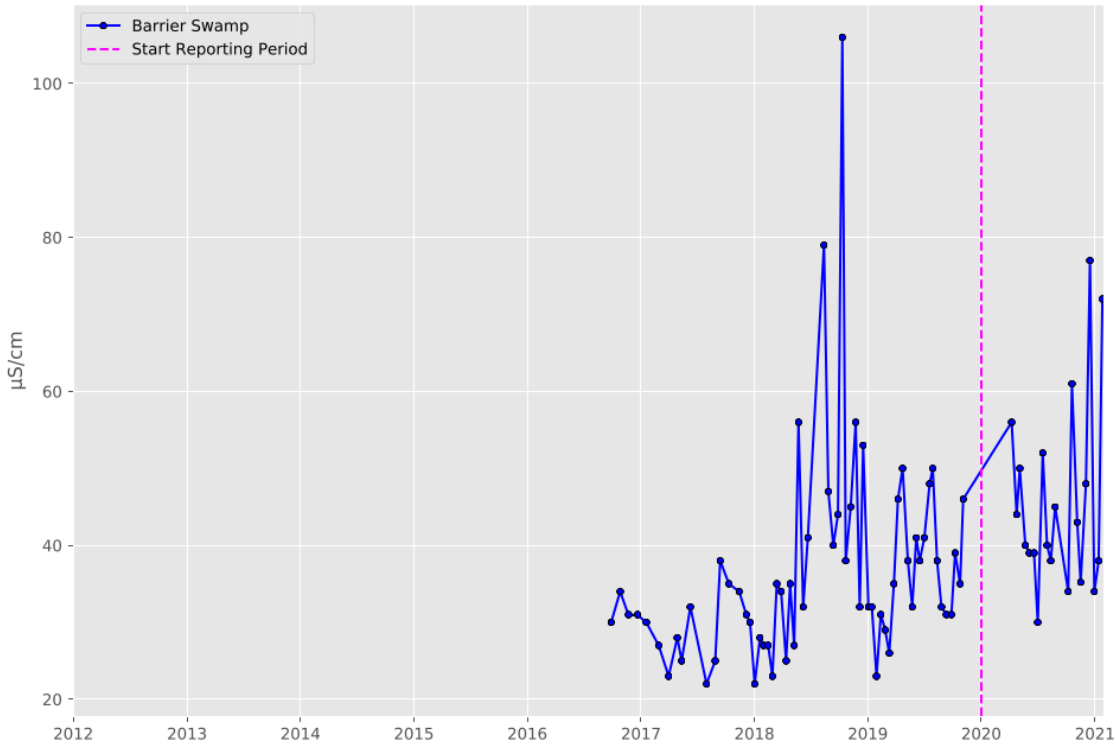
- Alkalinity – highly variable fluctuations.
- Aluminium- seasonal trend with peaks around the summer months
- Nitrogen – increasing trend in 2020
- Flow rate – generally stable flows below 200kL/day with few points of high flow

SPRINGVALE



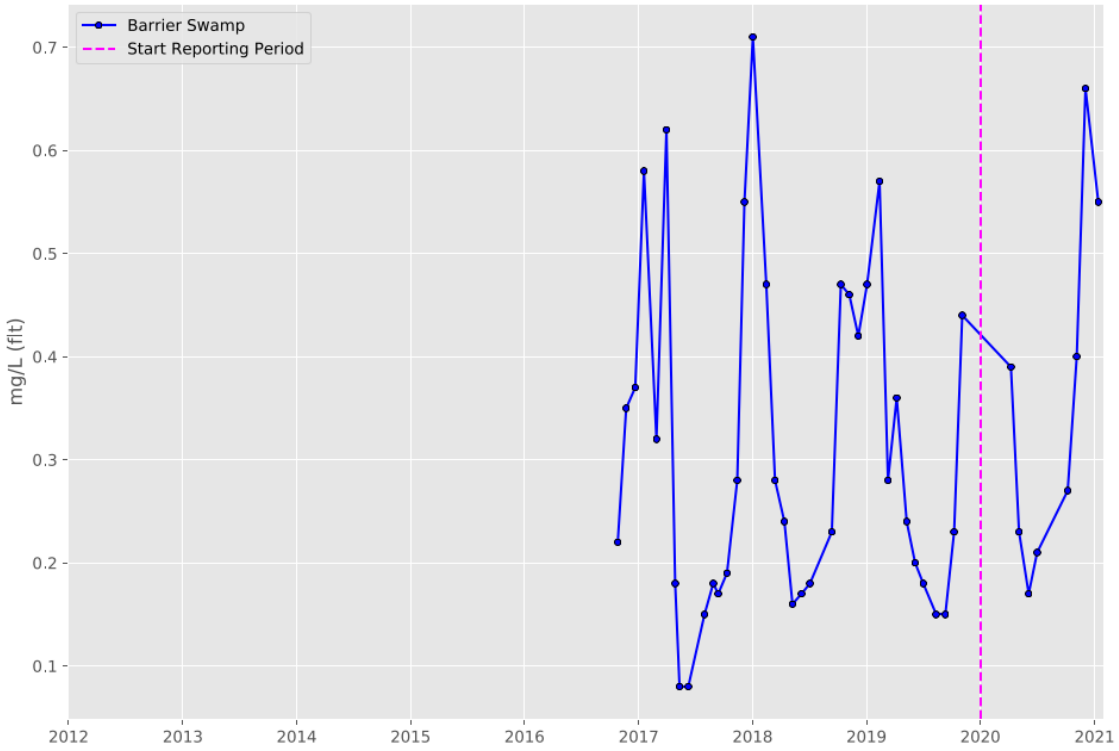
NB – Trigger not applicable to reference sites

Figure 8.1: Barrier Swamp - pH



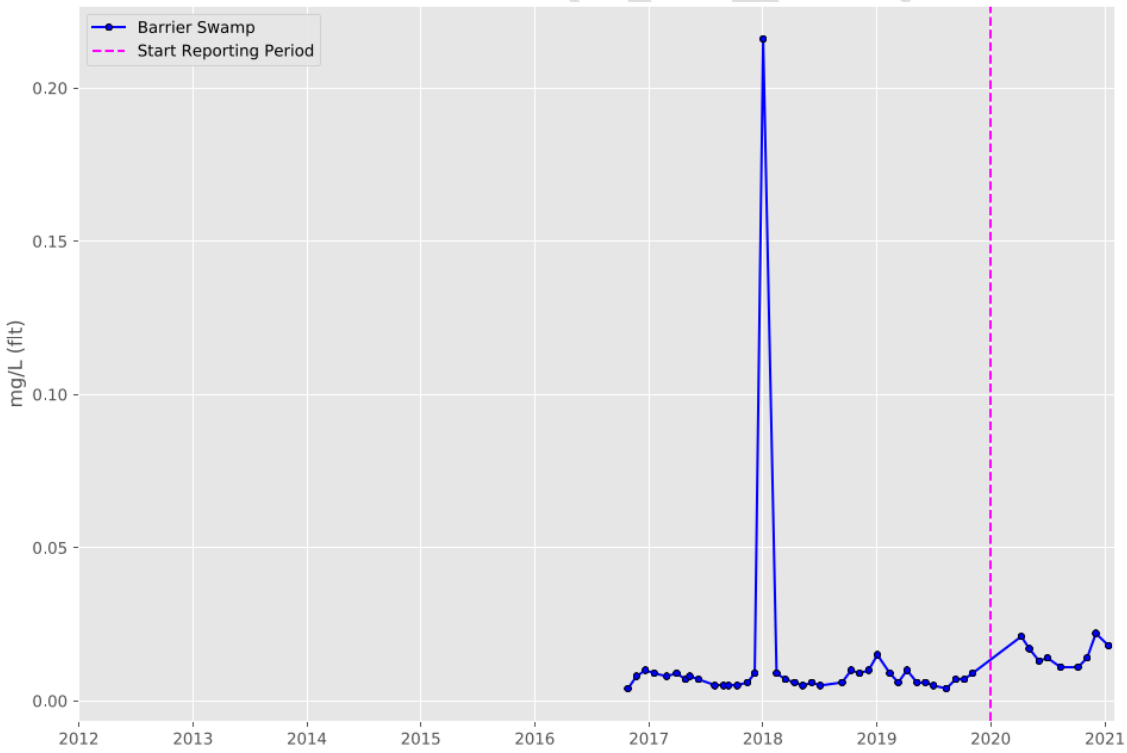
NB – Trigger not applicable to reference sites

Figure 8.2: Barrier Swamp - EC



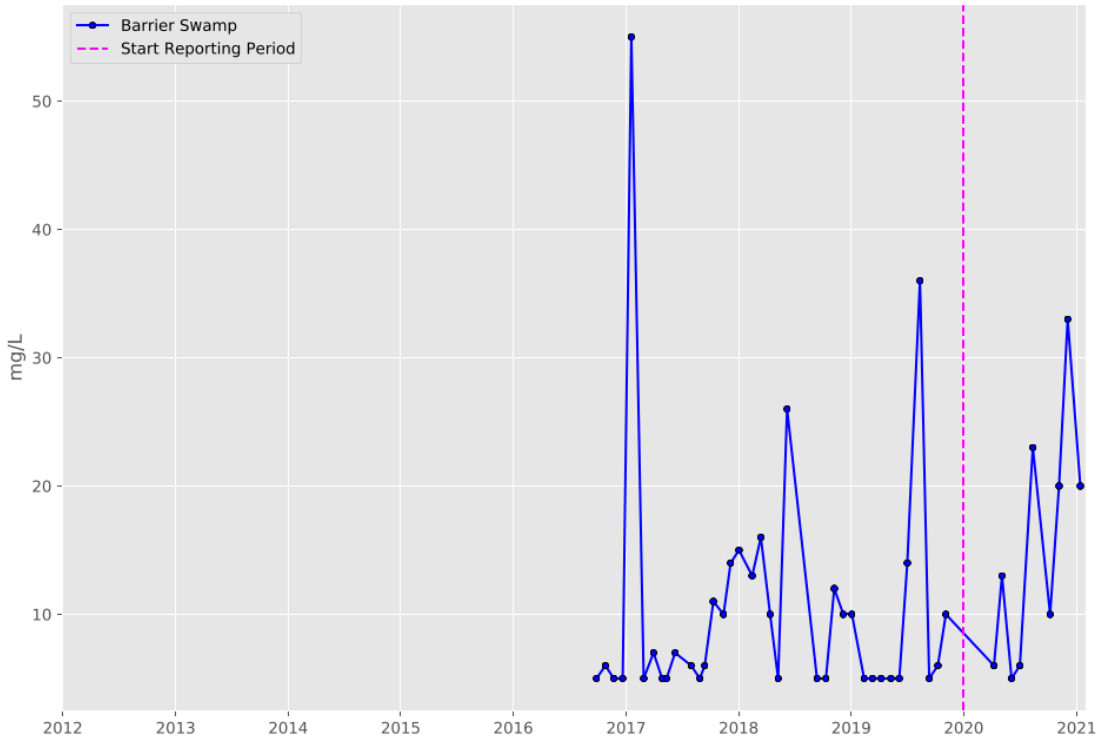
NB – Trigger not applicable to reference sites

Figure 8.3: Barrier Swamp - Iron



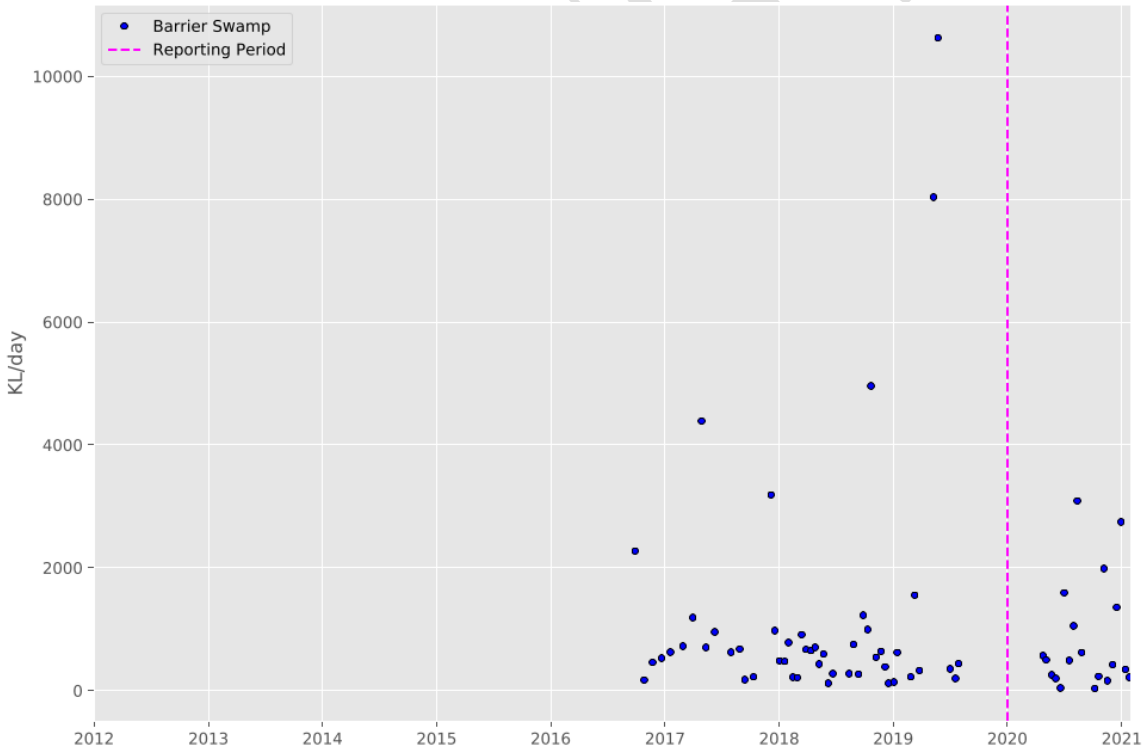
NB – Trigger not applicable to reference sites

Figure 8.4: Barrier Swamp - Manganese



NB – Trigger not applicable to reference sites

Figure 8.5: Barrier Swamp - TSS



NB – Trigger not applicable to reference sites

Figure 8.6: Barrier Swamp - Flow

8.1.2 Best Creek

8.1.2.1 Statistics

Best Creek is a reference site and as such there are no performance triggers for this site. Table 8.2 outlines the surface water summary.

Table 8.2: Best Creek - Surface water summary statistics

ID	Historic date ranges	Analyte	Historic data statistics				80th percentile trigger +2SD &	Reporting period statistics			Comments
			Data point count	Min	Mean	Max		Min	Median	Max	
Best Creek	24/11/2017 - present										
		pH	56	3.8	5.19	8.8	2.8-7.6	3.8	4.9	7.7	Reference site - No trigger
		EC (µS/cm)	56	23	39.8	84	71	30	44.5	70	Reference site - No trigger
		Fe (mg/L)	27	0.05*	0.143	0.45	0.36	0.05	0.115	0.35	Reference site - No trigger
		Mn (mg/l)	27	0.004	0.010	0.018	0.020	0.01	0.018	0.064	Reference site - No trigger
		TSS (mg/L)	26	4	14.2	87	50	5	5	16	Reference site - No trigger
		DO (mg/L)	54	3.6	9.2	65	25.1	4.8	8	13.2	Reference site - No trigger
		Flow (kl/day)	43	8	522	2462	1694	457	1455.5	13409	Reference site - No trigger

Notes: * value at detection limit (Limit of Reporting - LOR)
positive delta value equals a recent value that is greater than the historic mean, and vice versa for negative delta values.
% no monitoring data available post 19/10/2019, due to lack of access caused to bushfire/ dry conditions
@ where values are below limit of reporting, a value of half the measurement has been assumed.
& investigation trigger performance indicators based on Table 33 of the SMP LW424-LW427. The long- and short-term triggers are based on the 80th data percentile and the 80th percentile plus two standard deviations, respectively

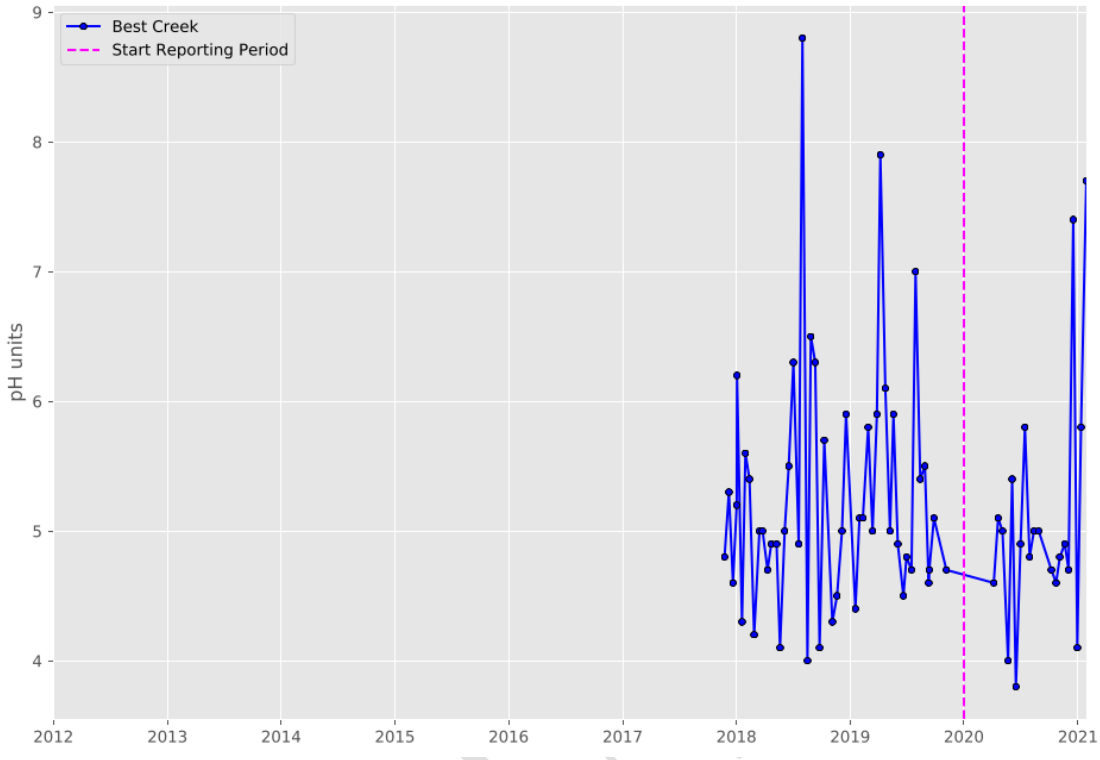
8.1.2.2 Quality Trend

SMP states that surface water results will be assessed against performance triggers for the parameters pH, EC, Iron, Manganese and TSS. Performance triggers are not applicable to reference sites. The trends for these analytes are shown below.

pH at Best Creek is generally stable around slightly acidic conditions, however there are short lived peaks in pH levels but is likely within natural variability. The average EC concentration of 2020 is higher than historic trends but is within historical limits. Iron follows season trends with peaks in the summer months. Manganese concentrations are highly variable with a lagged correspondence to peaks in Iron. TSS has shown fluctuations in the past but TSS is generally below detectable limits.

Graphs for all other parameter trends are included in **Appendix E**. Trends of note are:

- Alkalinity – commonly spikes and is high likely reflecting natural variability
- Aluminium – apparent peaks around summer months
- Flow rate – generally stable below 1000kl/day. Most recent flows in 2020 are higher than average due to recent rainfall conditions.
- Nutrients – highly variable concentrations (Nitrogen, Phosphorous)
- Redox potential – declining trend from mid 2020



NB – Trigger not applicable to reference sites

Figure 8.7: Best Creek - pH

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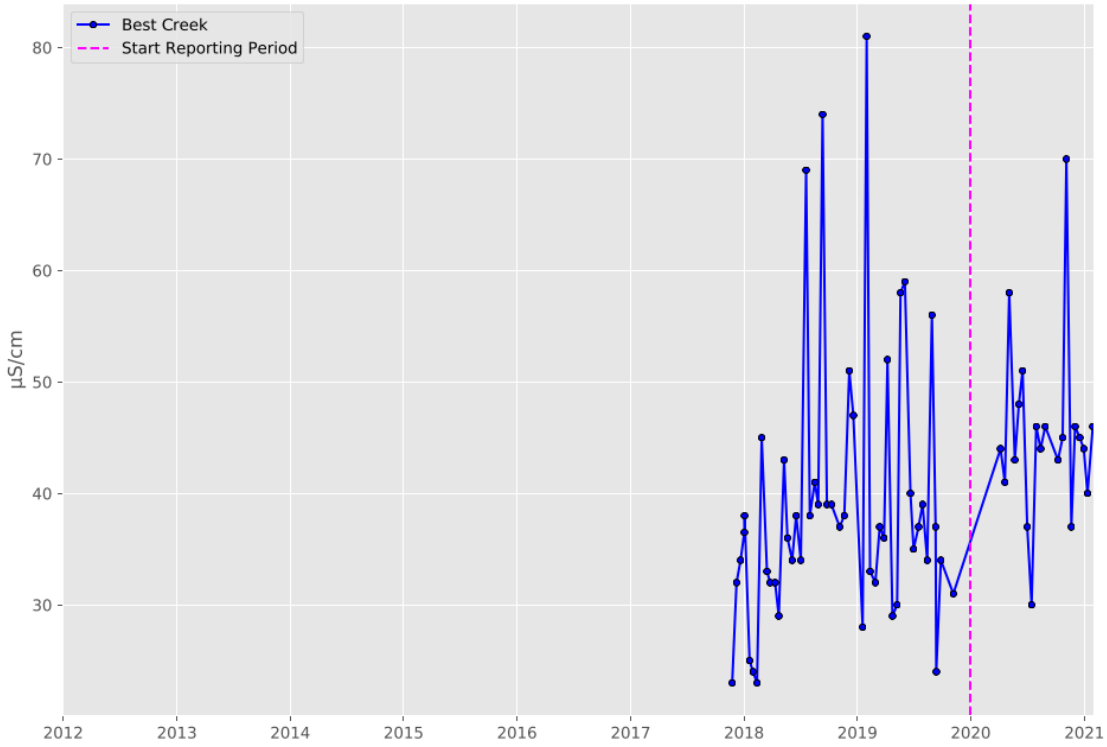
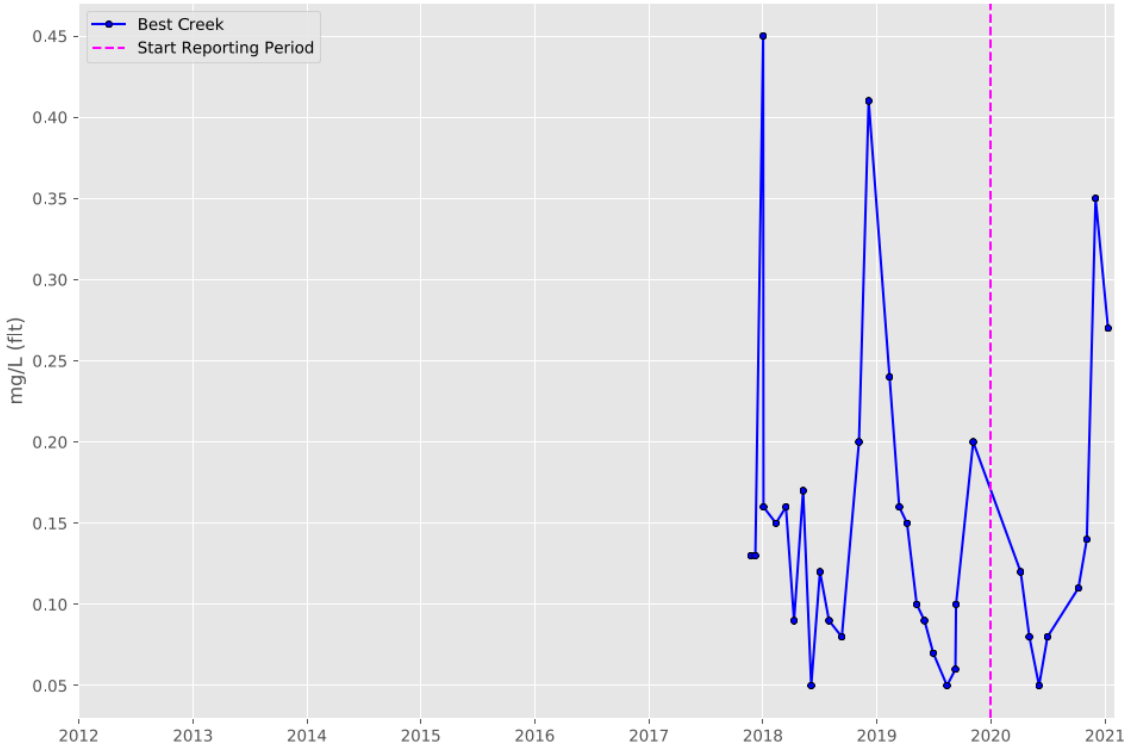


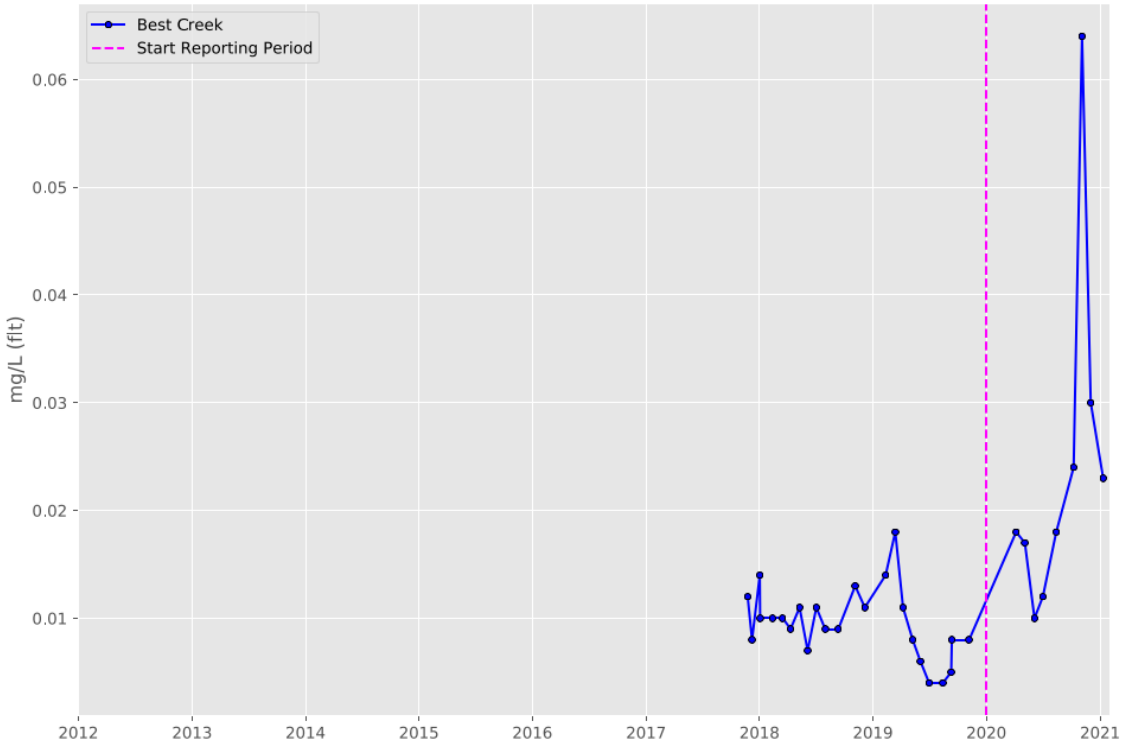
NB – Trigger not applicable to reference sites

Figure 8.8: Best Creek - EC



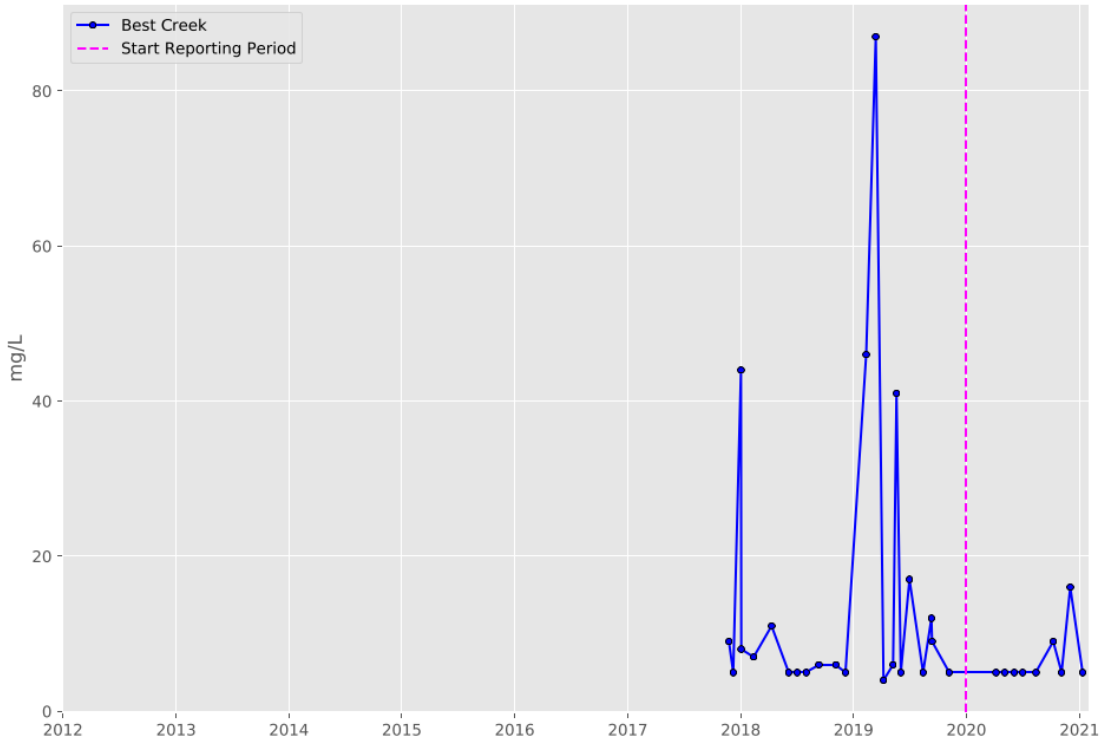
NB – Trigger not applicable to reference sites

Figure 8.9: Best Creek - Iron



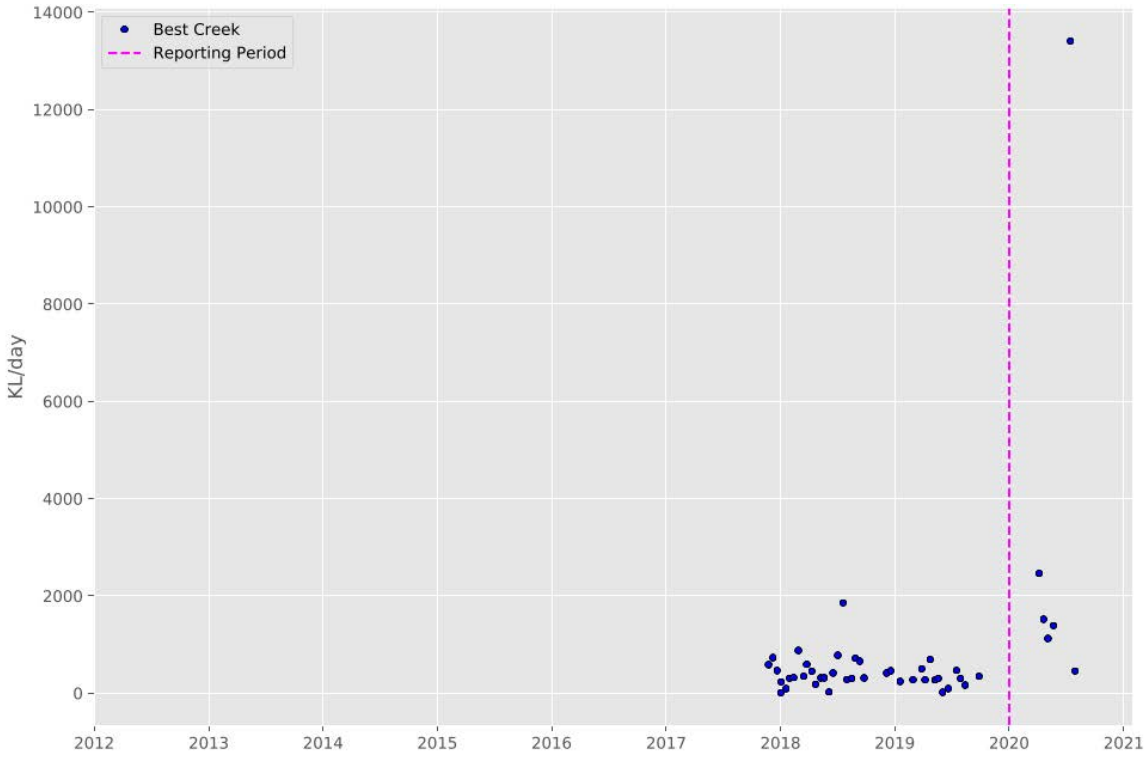
NB – Trigger not applicable to reference sites

Figure 8.10: Best Creek - Manganese



NB – Trigger not applicable to reference sites

Figure 8.11: Best Creek - TSS



NB – Trigger not applicable to reference sites

Figure 8.12: Best Creek - Flow

8.1.3 Carne Central Swamp

Carne Central Swamp is periodically dry or too low to sample.

8.1.3.1 Statistics

Carne Central Swamp is a reference site and as such there are no performance triggers for this site. Table 8.3 outlines the surface water summary.

SPRINGVALE

Table 8.3: Carne Central Swamp - Surface water quality summary statistics

ID	Historic date ranges	Analyte	Historic data statistics				80th percentile trigger +2SD &	Reporting period statistics			Comments
			Data point count	Min	Mean	Max		Min	Median	Max	
Carne Central Swamp	27/09/2016 - present										
		pH	21	4	5.66	8.22	2.5-9.1	3.7	4.4	5.6	Reference site - No trigger
		EC (µS/cm)	21	23	49	142	141	89	107.5	223	Reference site - No trigger
		Fe (mg/L)	11	0.05*	0.128	0.48	0.44	0.05	0.05	0.05	Reference site - No trigger
		Mn (mg/l)	11	0.002	0.0118	0.048	0.035	0.031	0.046	0.048	Reference site - No trigger
		TSS (mg/L)	12	4	5.4	10	8.0	5	5	5	Reference site - No trigger
		DO (mg/L)	12	4	7.2	9.9	12.96	5.4	9	11.9	Reference site - No trigger
		Flow (kl/day)	6	43	400	1028	1181	Too low	Too low	Too low	Reference site - No trigger

Notes: * value at detection limit (Limit of Reporting - LOR)
positive delta value equals a recent value that is greater than the historic mean, and vice versa for negative delta values.
% no monitoring data available post 19/10/2019, due to lack of access caused to bushfire/ dry conditions
@ where values are below limit of reporting, a value of half the measurement has been assumed.
& investigation trigger performance indicators based on Table 33 of the SMP LW424-LW427. The long- and short-term triggers are based on the 80th data percentile and the 80th percentile plus two standard deviations, respectively

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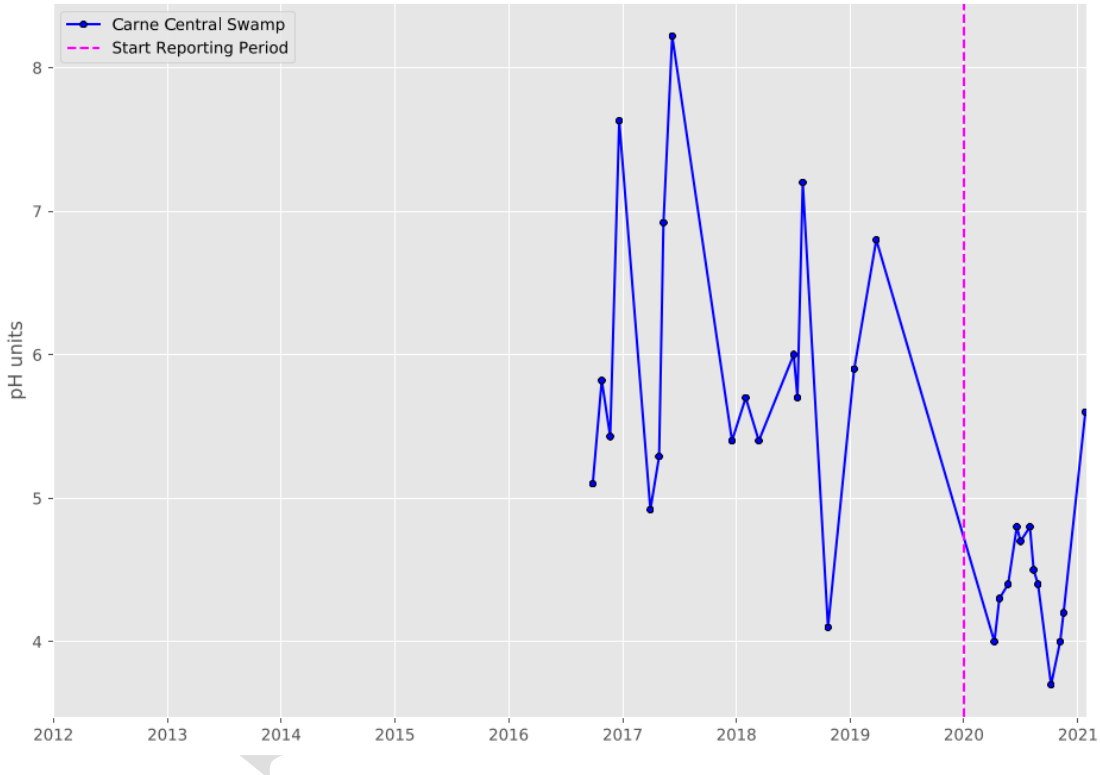
8.1.3.2 Quality Trend

SMP states that surface water results will be assessed against performance triggers for the parameters pH, EC, Iron, Manganese and TSS. Performance triggers are not applicable to reference sites. The trends for these analytes are shown below.

Carne Central Swamp often becomes dry and this influences water quality parameters. pH levels at Carne Central Swamp are observed fluctuate, this is most likely due to the changing hydrological conditions of the swamp and reflect natural variability. The pH level for 2020 is observed to be on the lower end of the historical range. EC is observed to be high after the bushfire period and is likely due to the ash in the runoff post bushfire. The variance in Iron, Manganese and TSS are influenced by the hydrology of the swamp which affects the conditions for cations mobility and erosion. There does not seem to be a clear seasonal trend for Iron and Managese.

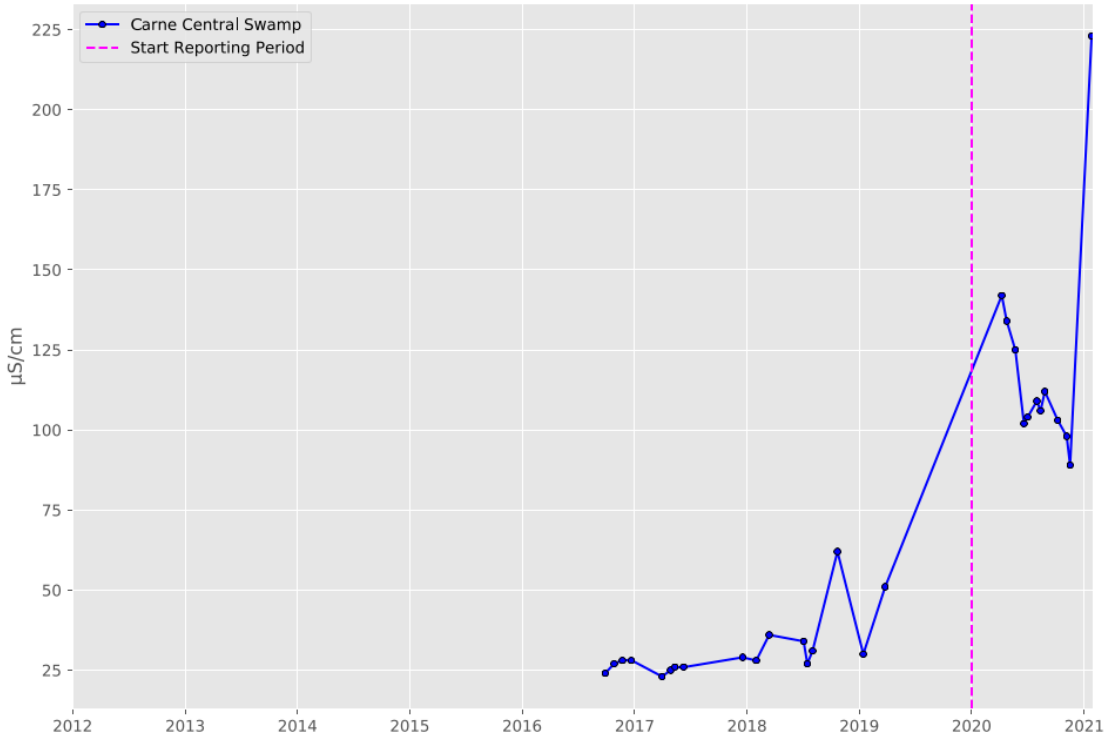
Graphs for all other parameter trends are included in **Appendix E**. Trends of note are:

- Cations – elevated levels of some cations eg aluminium, zinc, sodium. This is most likely due to run off from the ash post bushfire
- Flow rate – Flows are intermittent and highly dependent on localised rainfalls. No flows were recorded in 2020.
- Nutrients- elevated levels of nitrogen nutrients most likely from ash runoff.



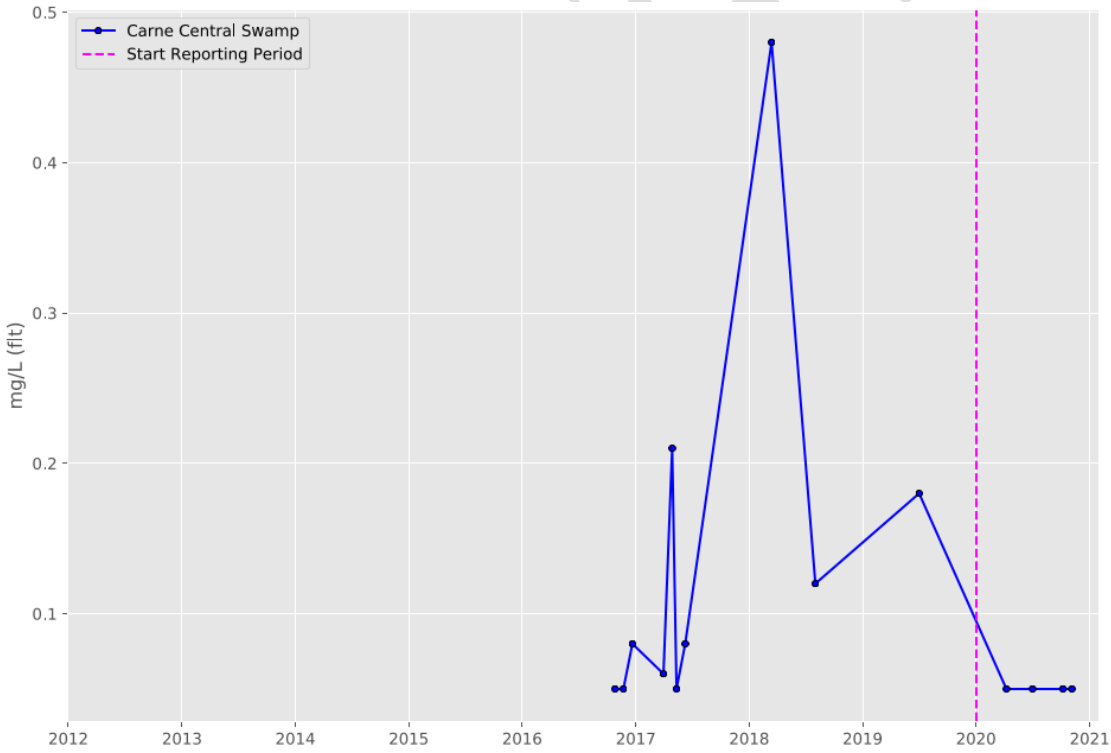
NB – Trigger not applicable to reference sites

Figure 8.13: Carne Central Swamp - pH



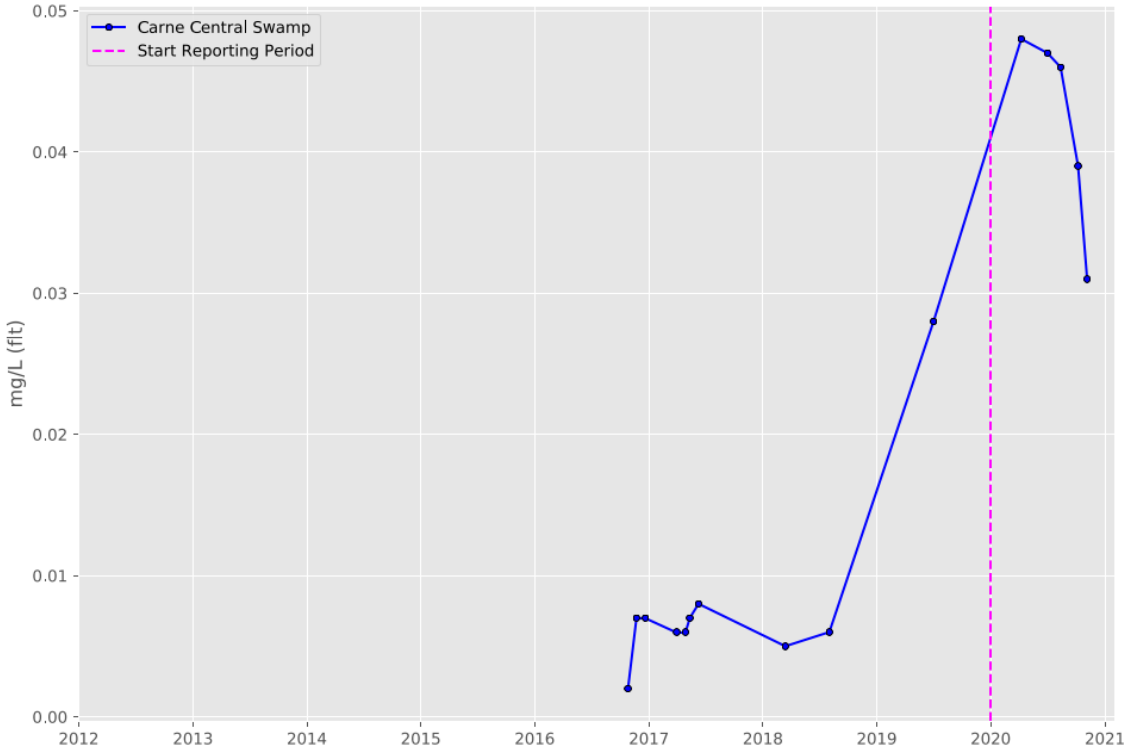
NB – Trigger not applicable to reference sites

Figure 8.14: Carne Central Swamp - EC



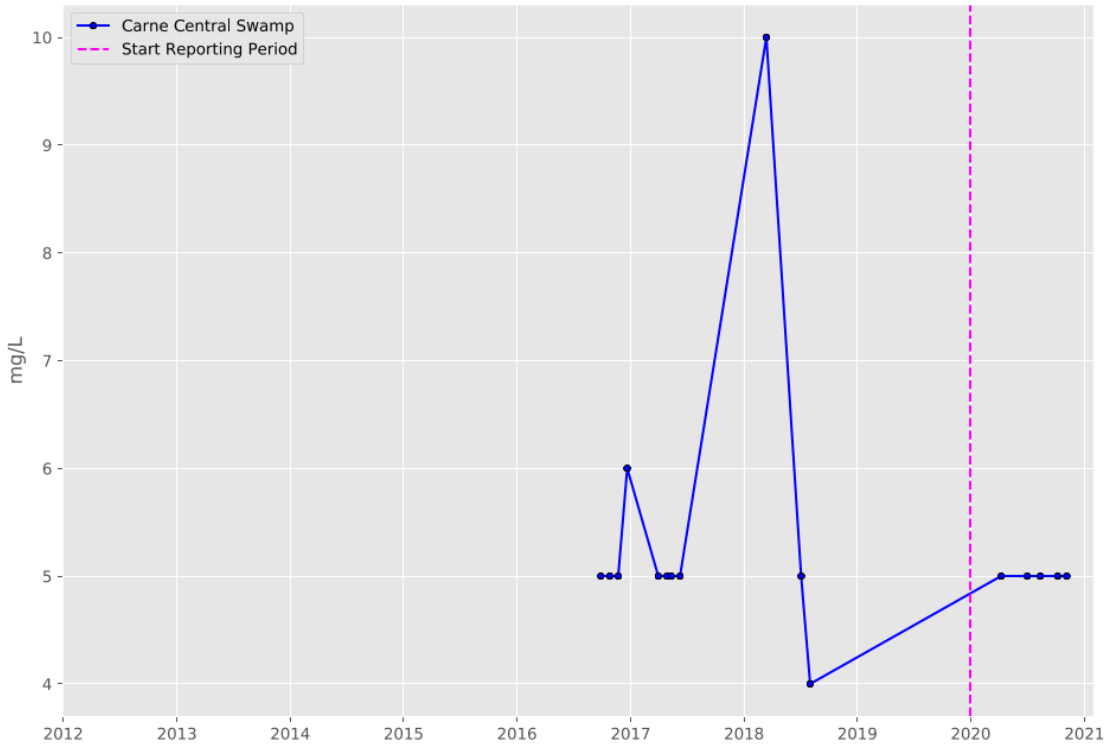
NB – Trigger not applicable to reference sites

Figure 8.15: Carne Central Swamp - Iron



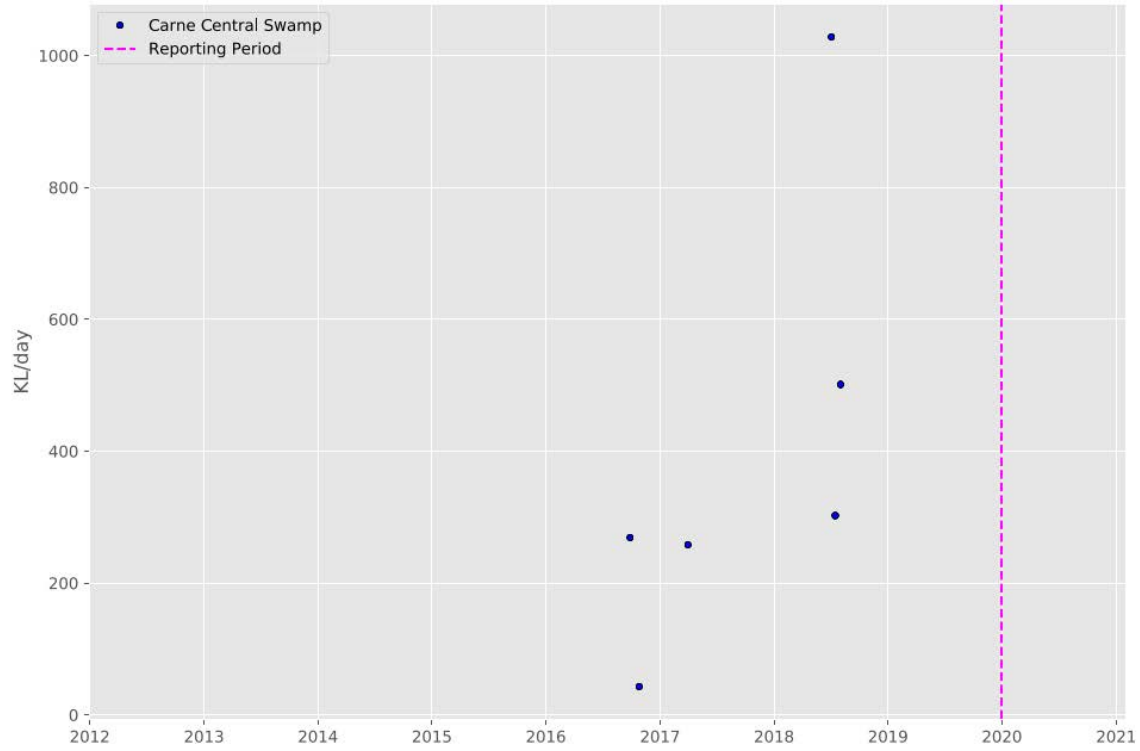
NB – Trigger not applicable to reference sites

Figure 8.16: Carne Central Swamp - Manganese



NB – Trigger not applicable to reference sites

Figure 8.17: Carne Central Swamp - TSS



NB – Trigger not applicable to reference sites

Figure 8.18: Carne Central Swamp - Flow

8.1.4 Firetail

8.1.4.1 Statistics

Firetail is a reference site and as such there are no performance triggers for this site. Table 8.4 outlines the surface water summary.

Table 8.4: Firetail - Surface water quality summary statistics

ID	Historic date ranges	Analyte	Historic data statistics				80th percentile trigger +2SD &	Reporting period statistics			Comments
			Data point count	Min	Mean	Max		Min	Median	Max	
Firetail	24/11/2017 – present										
		pH	48	4.1	5.24	9	2.7-7.9	4.1	4.9	7.6	Reference site - No trigger
		EC (µS/cm)	48	28	42.4	77	67	39	52.5	69	Reference site - No trigger
		Fe (mg/L)	22	0.05*	0.204	1.36	0.87	0.05	0.06	0.12	Reference site - No trigger

ID	Historic date ranges	Analyte	Historic data statistics				80th percentile trigger +2SD &	Reporting period statistics			Comments
			Data point count	Min	Mean	Max		Min	Median	Max	
		Mn (mg/l)	22	0.003	0.0115	0.058	0.038	0.008	0.012	0.016	Reference site - No trigger
		TSS (mg/L)	21	5	27	223	134	5	5	8	Reference site - No trigger
		DO (mg/L)	47	3.6	8.04	19	14.2	5.6	8	12.1	Reference site - No trigger
		Flow (kl/day)	14	8.6	325	881	1062	86	526	1175	Reference site - No trigger

Notes: * value at detection limit (Limit of Reporting - LOR)
positive delta value equals a recent value that is greater than the historic mean, and vice versa for negative delta values.
% no monitoring data available post 19/10/2019, due to lack of access caused to bushfire/ dry conditions
@ where values are below limit of reporting, a value of half the measurement has been assumed.
& investigation trigger performance indicators based on Table 33 of the SMP LW424-LW427. The long- and short-term triggers are based on the 80th data percentile and the 80th percentile plus two standard deviations, respectively

8.1.4.2 Quality Trend

SMP states that surface water results will be assessed against performance triggers for the parameters pH, EC, Iron, Manganese and TSS. Performance triggers are not applicable to reference sites. The trends for these analytes are shown below.

pH at Firetail is highly variable where occurrences of high pH is not uncommon. pH measurements during early 2020 were at the lower end of the historic range, which is most likely due to the elevated rainfall of early 2020. EC is observed be relatively stable around a higher average concentration in 2020 compared to historical observations, most likely due to runoff from the bushfire. Iron concentrations follow a seasonal trend with peaks observed around the summer months. Manganese follows similar trends but the fluctuations are less pronounced. However, these seasonal trends were not recorded in early 2020 due to restricted access. TSS is highly variable and is heavily influenced by disturbances in the sediment and runoff and erosion. In 2020, TSS was generally below detectable limits.

Graphs for all other parameter trends are included in **Appendix E**. Trends of note are:

- Cations – a small increase in reporting period likely from ash in the runoff
- Flow rate – Flows are relatively consistent below 400kL/day. The increase in flow volume and variability during the reporting period is due to the above rainfalls in recent months.
- Sulfate – a declining trend is observable from mid 2019.
- Sodium - an increase in reporting period likely from ash in the runoff

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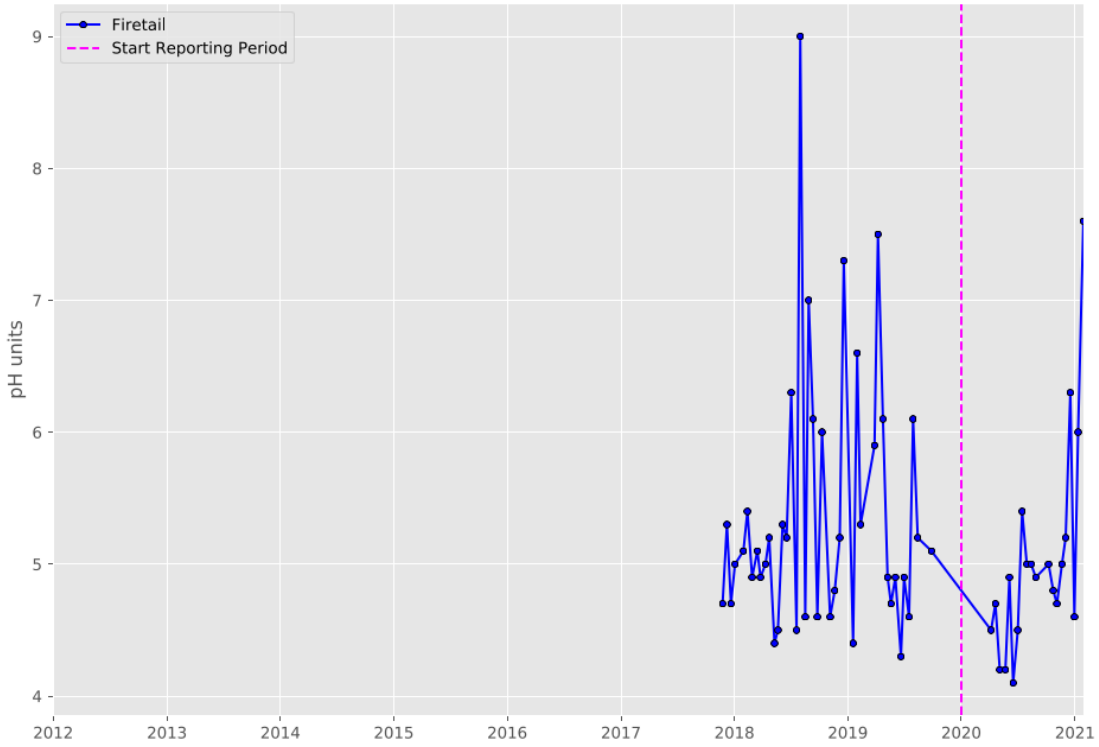
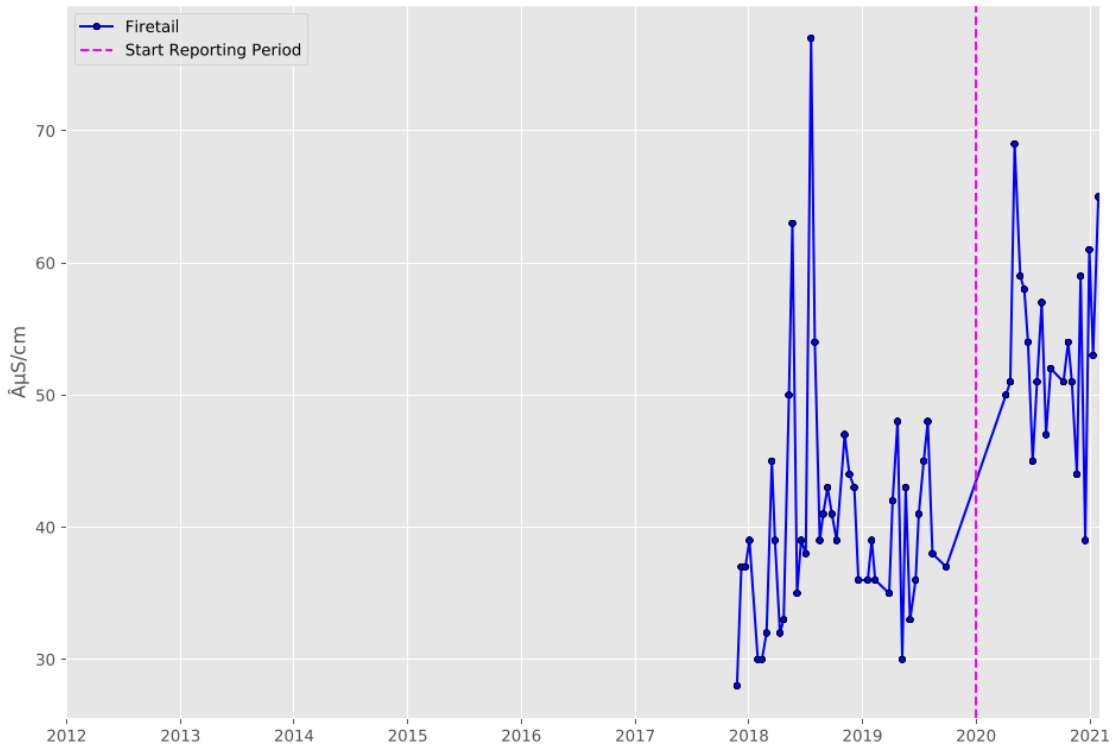


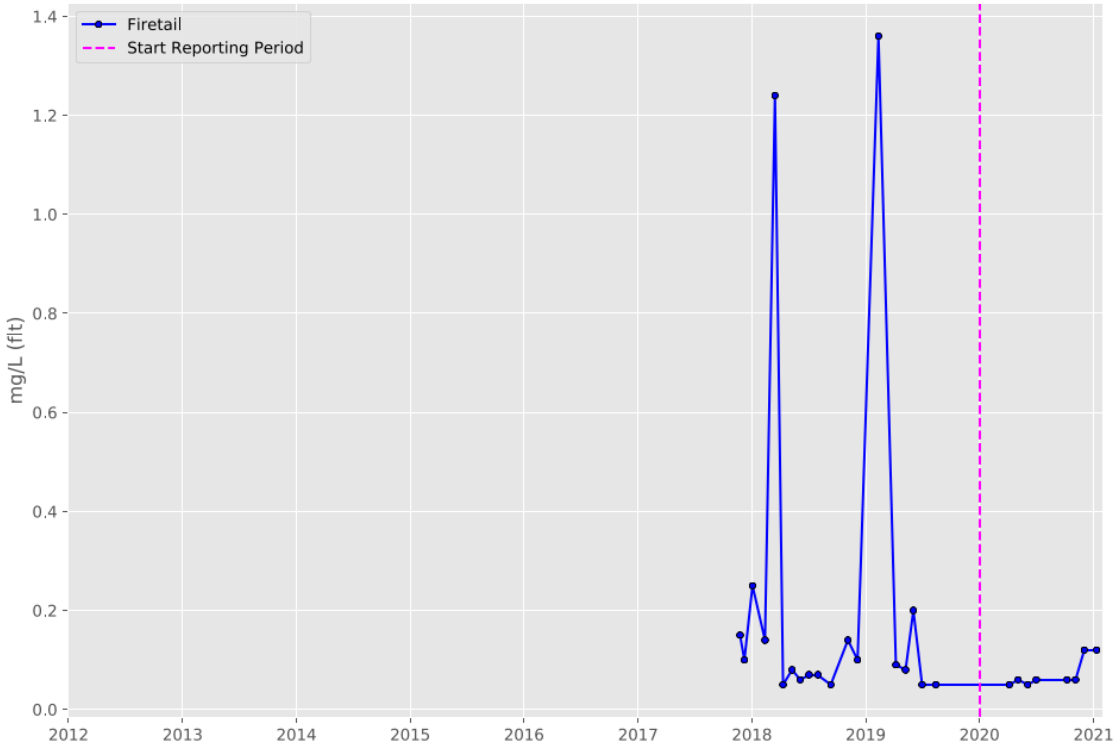
NB – Trigger not applicable to reference sites

Figure 8.19: Firetail - pH



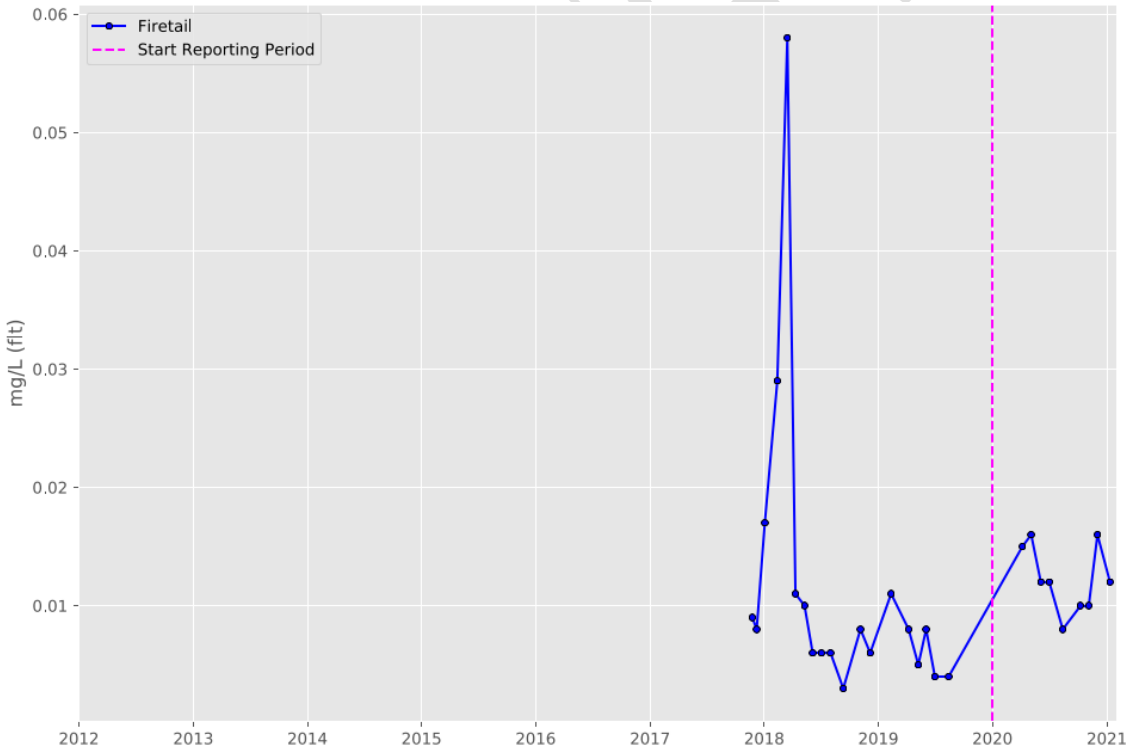
NB – Trigger not applicable to reference sites

Figure 8.20: Firetail - EC



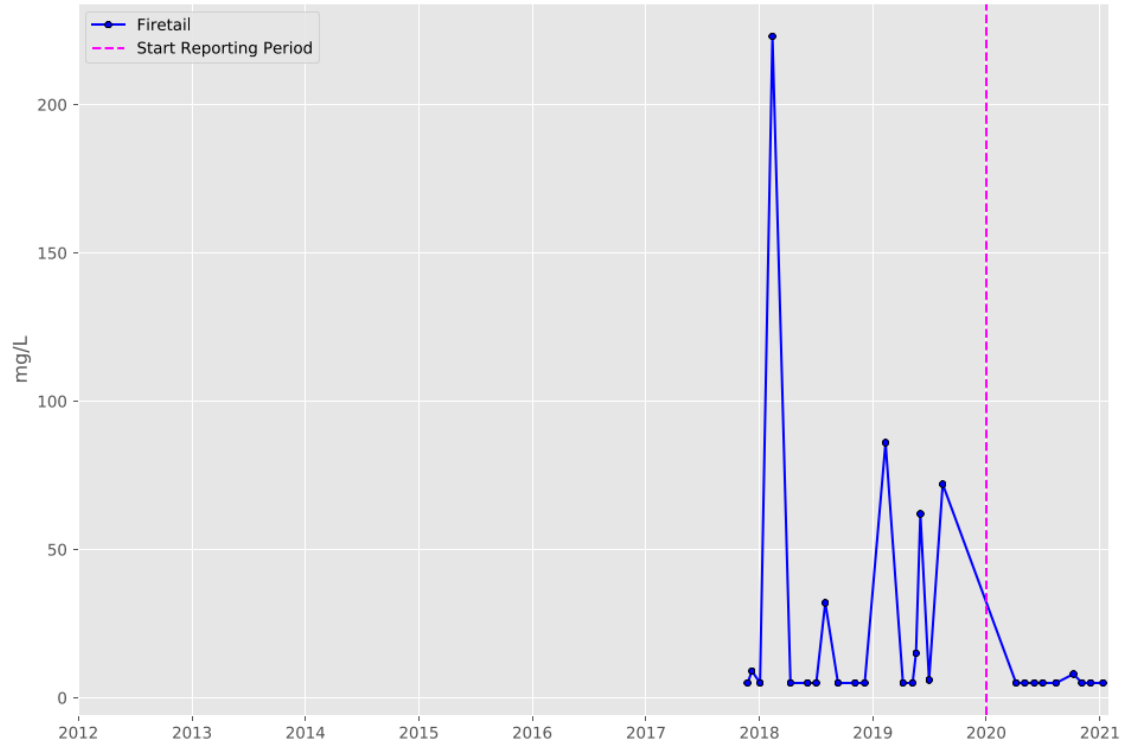
NB – Trigger not applicable to reference sites

Figure 8.21: Firetail - Iron



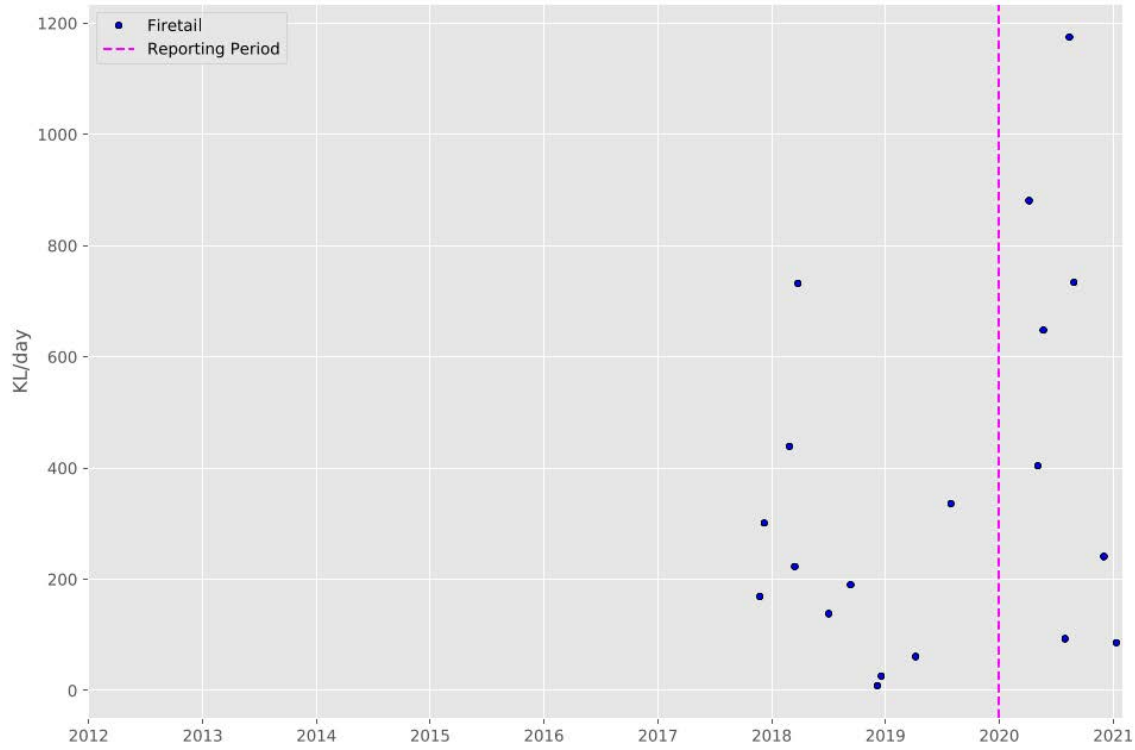
NB – Trigger not applicable to reference sites

Figure 8.22: Firetail - Manganese



NB – Trigger not applicable to reference sites

Figure 8.23: Firetail - TSS



NB – Trigger not applicable to reference sites

Figure 8.24: Firetail - Flow

8.2 Impact Sites

Impact swamp sites are sites that are regarded to have been or will be potentially impacted by mining activities. The graphs of the main analytes show the general trends. The beginning of the reporting period is marked by the dotted line at January 2020. The pre-mining dataset is the baseline data and baseline cut off is defined when the site encroaches within the TIA or a significant lineament under a swamp has been undermined.

8.2.1 Carne Swamp

Carne Swamp is an impact site. It is part of Carne West Swamp.

8.2.1.1 Statistics

Carne Swamp is an impact site that has been predominately dry since 2017.Table 8.5 outlines the surface water summary.

Table 8.5: Carne Swamp - Surface Water quality summary statistics

ID	Historic date ranges	Analyte	Pre-mining data statistics				80th percentile trigger +2SD&	Reporting period statistics			Comments
			Data point count	Min	Mean	Max		Min	Median	Max	
Carne Swamp	5/01/2005 – 25/09/2013										
		pH	263	3.79	5.66	8.2	4.2-7.1	4.1	4.6	5.3	Within limits
		EC (µS/cm)	263	13	23	150	52	68	104	130	Elevated
		Fe (mg/L)	263	0.026	0.298	0.95	0.70	0.05	0.05	0.19	Within limits
		Mn (mg/l)	275	0	0.06	1	0.447	0.104	0.246	0.386	Elevated
		TSS (mg/L)	16	2	8	16	18	5	9	64	Elevated
		DO (mg/L)	13	7.92	9.6	13.31	13.4	4.6	8.6	13.9	Low DO
		Flow (kl/day)	142	58	865	8638	3437	Too low	Too low	Too low	Generally dry

Notes: * value at detection limit (Limit of Reporting - LOR)
positive delta value equals a recent value that is greater than the historic mean, and vice versa for negative delta values.
% no monitoring data available post 19/10/2019, due to lack of access caused to bushfire/ dry conditions
@ where values are below limit of reporting, a value of half the measurement has been assumed.
& investigation trigger performance indicators based on Table 33 of the SMP LW424-LW427. The long- and short-term triggers are based on the 80th data percentile and the 80th percentile plus two standard deviations, respectively

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8.2.1.2 Quality Trend

SMP states that surface water results will be assessed against performance triggers for the parameters pH, EC, Iron, Manganese and TSS. The trends for these analytes are shown below.

Carne Swamp has been predominately dry since 2017 with sparse data points. In 2020, Carne Swamp frequently became dry. Carne West Swamp has already been triggered under the groundwater level triggers and monitoring is ongoing. Historically, pH has shown a generally increasing trend to 2016. The pH is 2020 has been predominately on the lower range. EC was historically stable during the time when the site was waterlogged. In 2020 EC concentrations recorded sustained elevated levels most likely due to reduced flow rates and flushing of the system. The EC is dependent on rainfall and the recent drought and bushfires have likely caused the elevated EC values. That said the elevated measurements are in line with some of the reference swamp sites, which also show elevated EC. Iron has a historical seasonal trend with peaks around the summer months, but the trend was not observed since the swamp became dry. Manganese concentrations are generally stable, however there is a recent increase in concentrations. This is likely a natural phenomenon where the recent rainfalls have caused water level to increase and create reducing conditions that increases the mobility of manganese ions. TSS is historically low with few spikes recorded in 2020.

Graphs for all other parameter trends are included in **Appendix G**. Trends of note are:

- Flow rate – declining trend becoming too low to measure by 2015
- Sodium – elevated levels in 2020 after a long dry period
- Sulfate – elevated levels in 2020
- Zinc – elevated levels in 2020

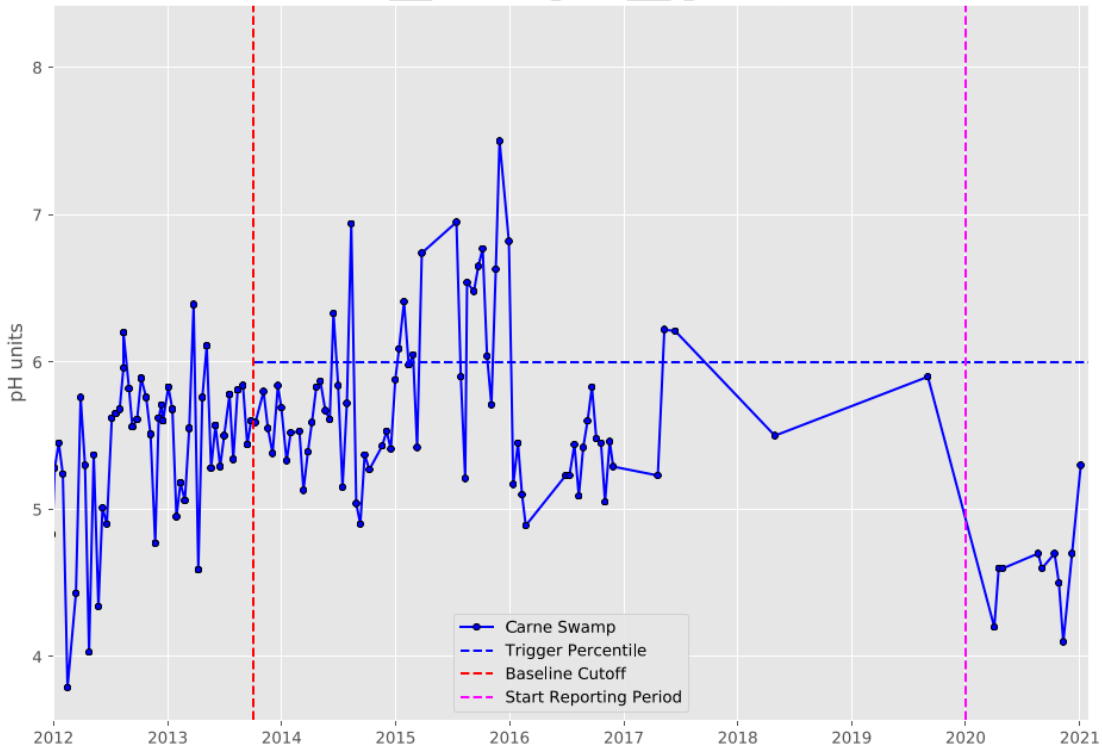

Figure 8.25: Carne Swamp - pH

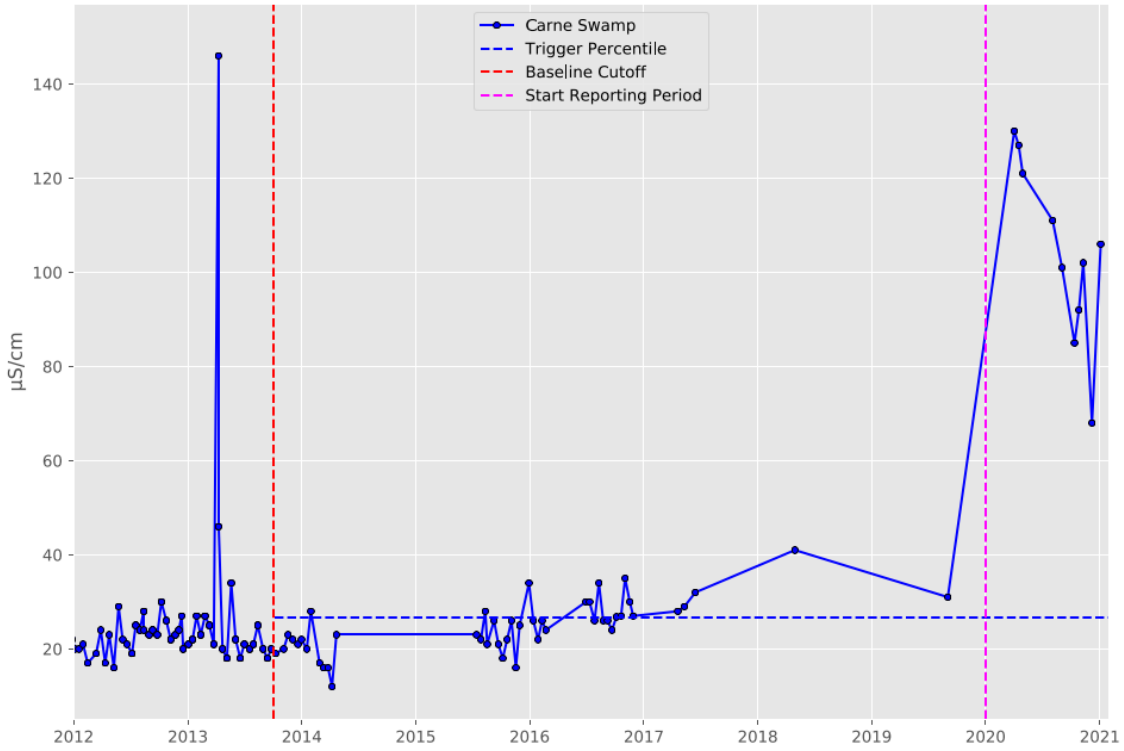

Figure 8.26: Carne Swamp - EC

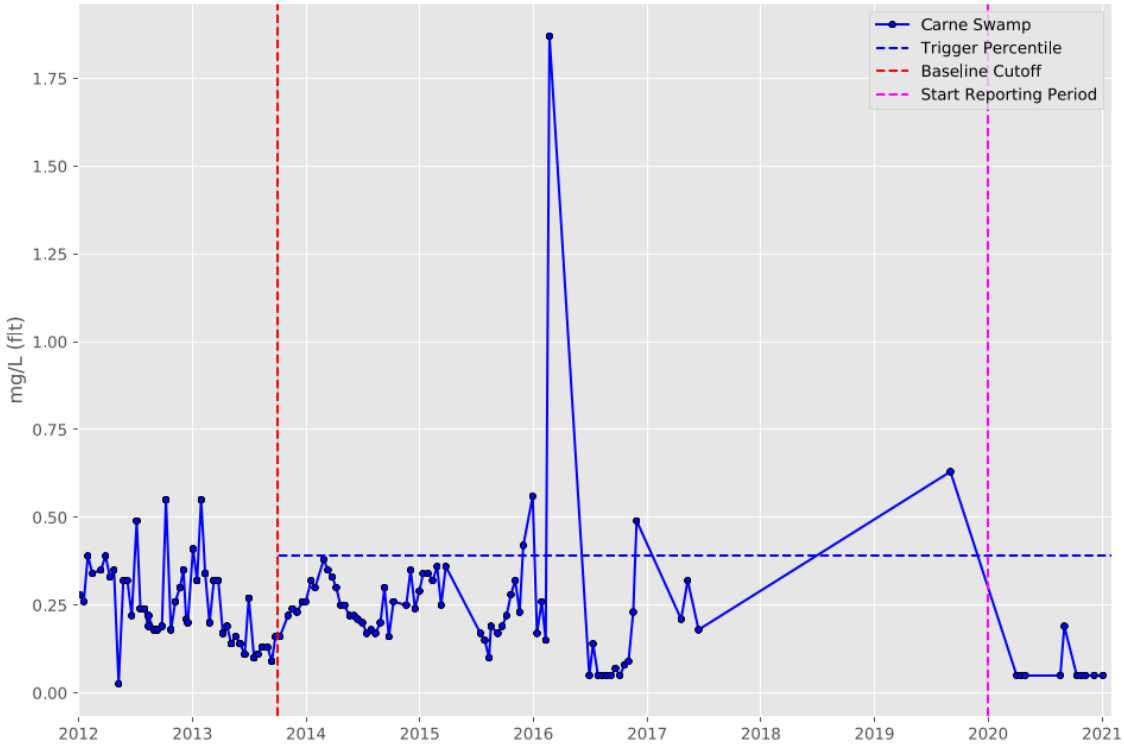

Figure 8.27: Carne Swamp - Iron

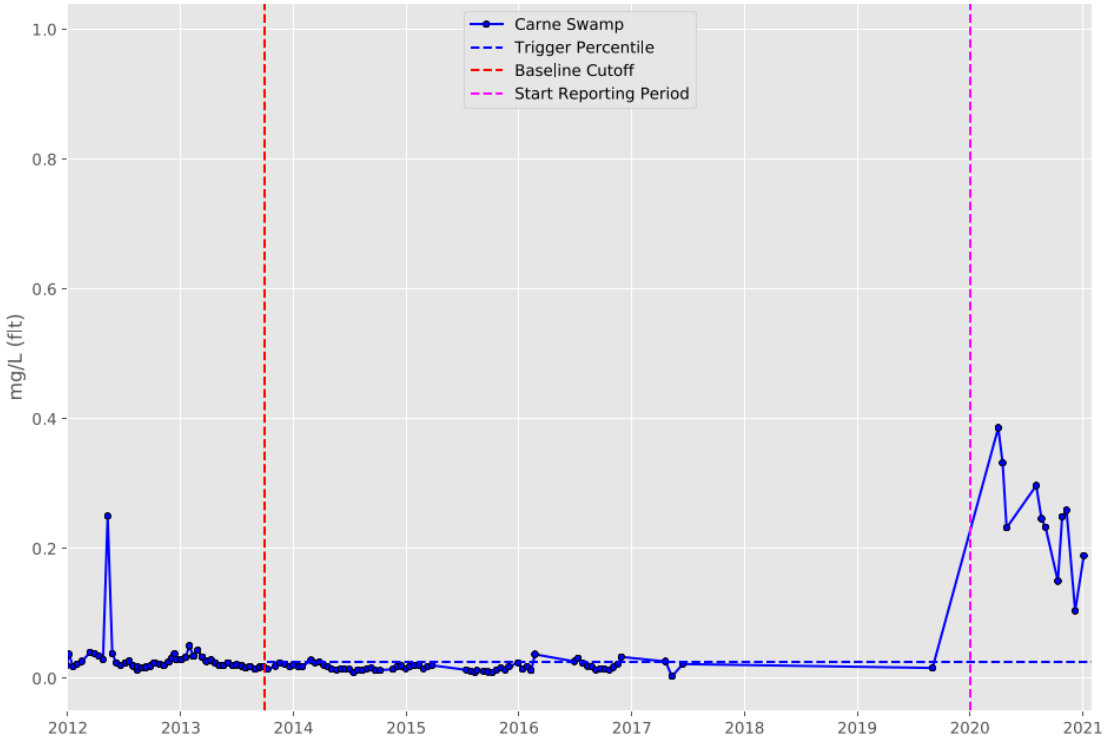

Figure 8.28: Carne Swamp - Manganese

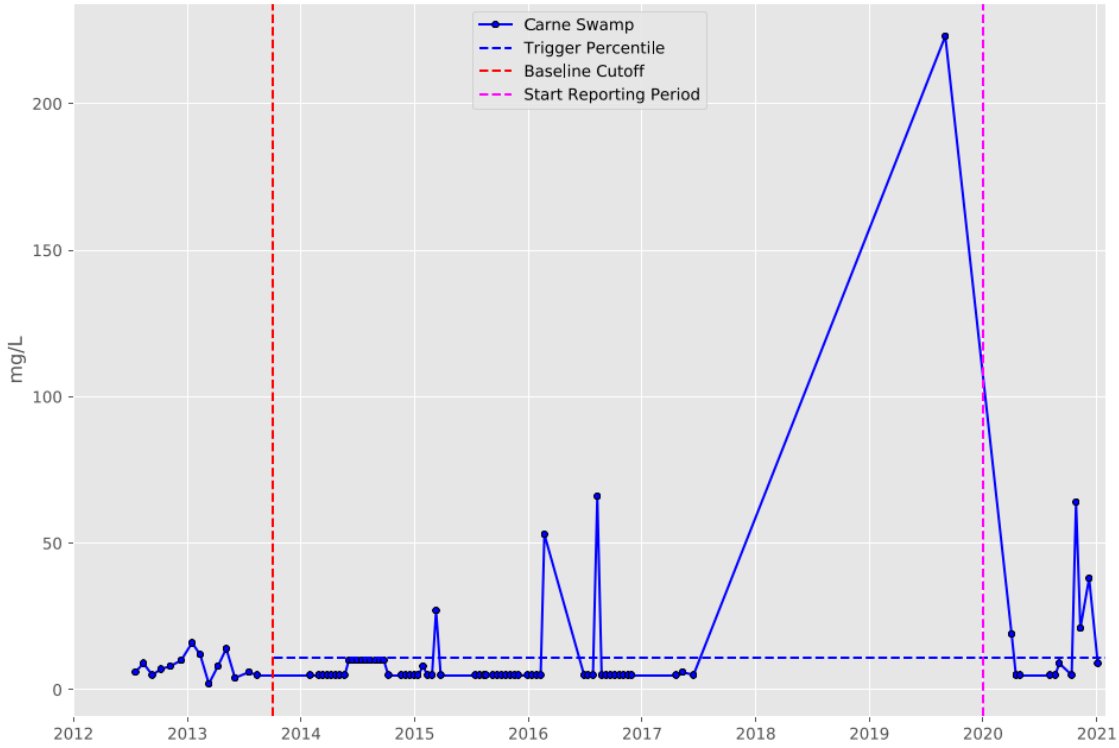

Figure 8.29: Carne Swamp - TSS

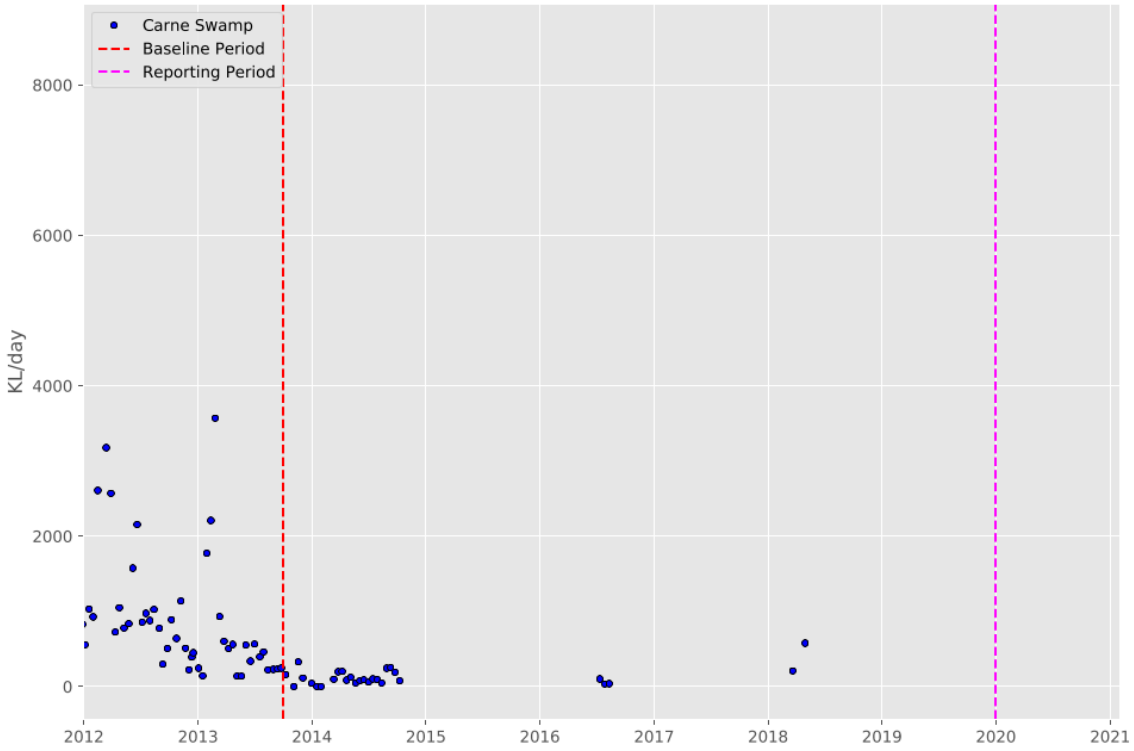

Figure 8.30: Carne Swamp - Flow

8.2.2 Gang Gang South West

Gang Gang South West was predominately dry during the reporting period and limited samples were taken.

8.2.2.1 Statistics

Gang Gang South West is an impact site that has been predominately dry since 2018. There were only 2 samples taken in 2020. Table 8.6 outlines the surface water summary.

Table 8.6: Gang Gang South West - Surface water quality summary statistics

ID	Historic date ranges	Analyte	Pre-mining data statistics				80th percentile trigger +2SD &	Reporting period statistics			Comments
			Data point count	Min	Mean	Max		Min	Median	Max	
Gang Gang South West	27/09/2016 – 15/05/2017										
		pH	8	4.52	6.12	7.69	2.9-9.8	3.2	3.3	3.4	Low pH
		EC (µS/cm)	8	23	27	34	40.6	155	201.5	248	Elevated EC
		Fe (mg/L)	7	0.07	0.232	0.42	0.56	0.18	0.18	0.18	Within limits
		Mn (mg/l)	7	0.008	0.0274	0.092	0.083	0.089	0.0945	0.1	Elevated Mn
		TSS (mg/L)	8	5	23	60	74	5	114	223	Single exceedance
		DO (mg/L)	0	NA	NA	NA	NA	7.9	10.15	12.4	Within limits

ID	Historic date ranges	Analyte	Pre-mining data statistics				80th percentile trigger +2SD &	Reporting period statistics			Comments
			Data point count	Min	Mean	Max		Min	Median	Max	
		Flow (kl/day)	3	32	51	65	96	Too low	Too low	Too low	Too low

Notes: * value at detection limit (Limit of Reporting – LOR)
positive delta value equals a recent value that is greater than the historic mean, and vice versa for negative delta values.
% no monitoring data available post 19/10/2019, due to lack of access caused to bushfire/ dry conditions
@ where values are below limit of reporting, a value of half the measurement has been assumed.
& investigation trigger performance indicators based on Table 33 of the SMP LW424-LW427. The long- and short-term triggers are based on the 80th data percentile and the 80th percentile plus two standard deviations, respectively

8.2.2.2 Quality Trend

SMP states that surface water results will be assessed against performance triggers for the parameters pH, EC, Iron, Manganese and TSS. The trends for these analytes are shown below.

Gang Gang South West has been generally dry since 2018 and there is limited data in 2020 with only two samples. The swamp has previously been triggered under the groundwater level performance measures and is currently monitored for recovery. It is difficult to note any recent trends as the data gap between points is greater than two years. pH was on the lower range. The high EC recorded in the last data point is most likely due to ash in the runoff post bushfire, similar to reference swamp sites. The peak in iron and manganese in the post mining period is likely due to declining water levels in the swamp. The increase in TSS is likely due to changing hydrological conditions of the swamp as water levels declined.

Graphs for all other parameter trends are included in **Appendix G**. Trends of note are:

- Flow rate – there is limited flow data. Flows were only observed in the Pre-mining period during a time of average rainfalls.

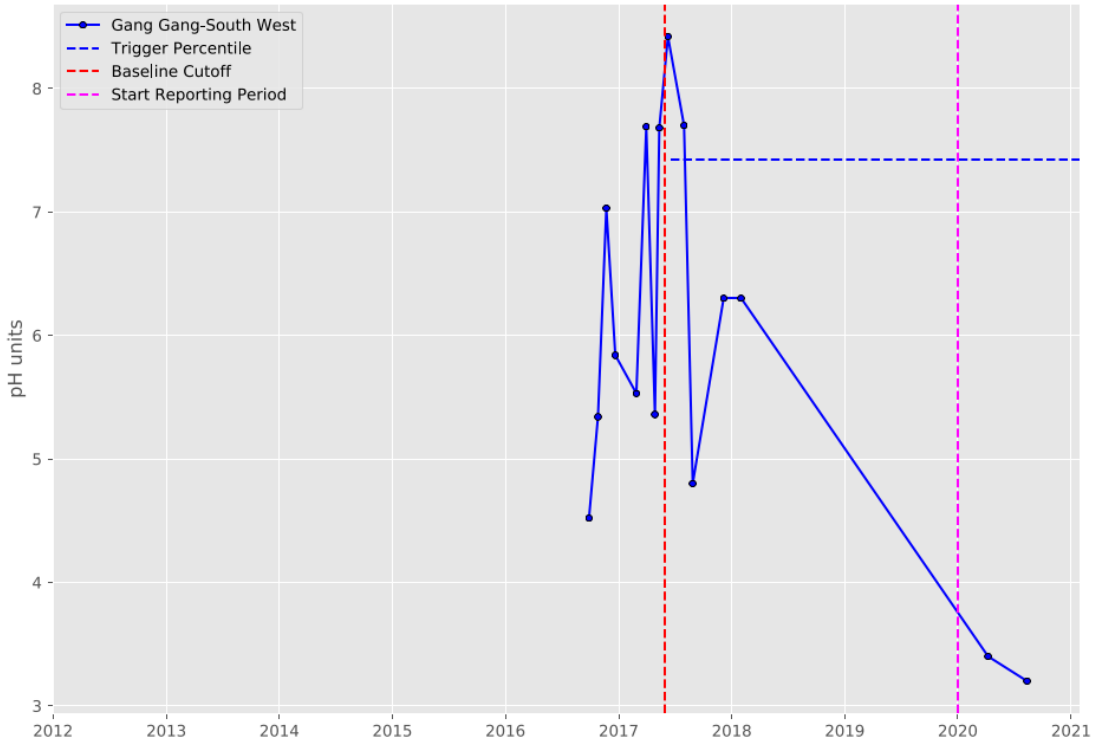

Figure 8.31: Gang Gang South West - pH

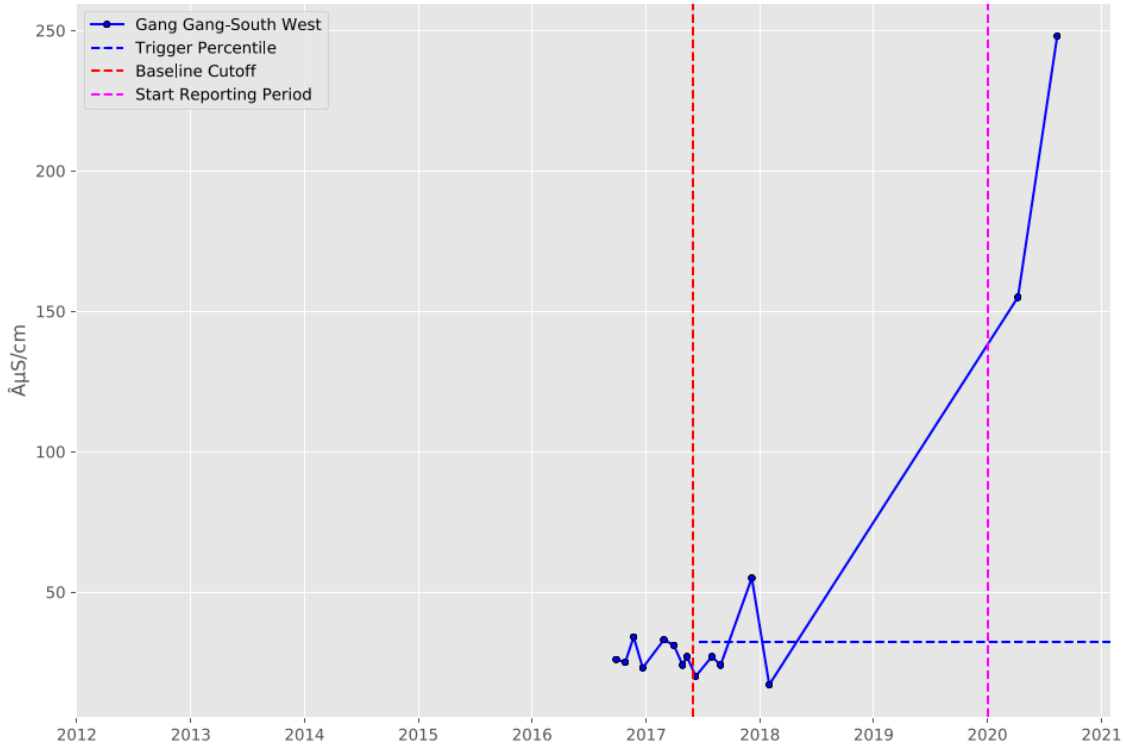

Figure 8.32: Gang Gang South West - EC

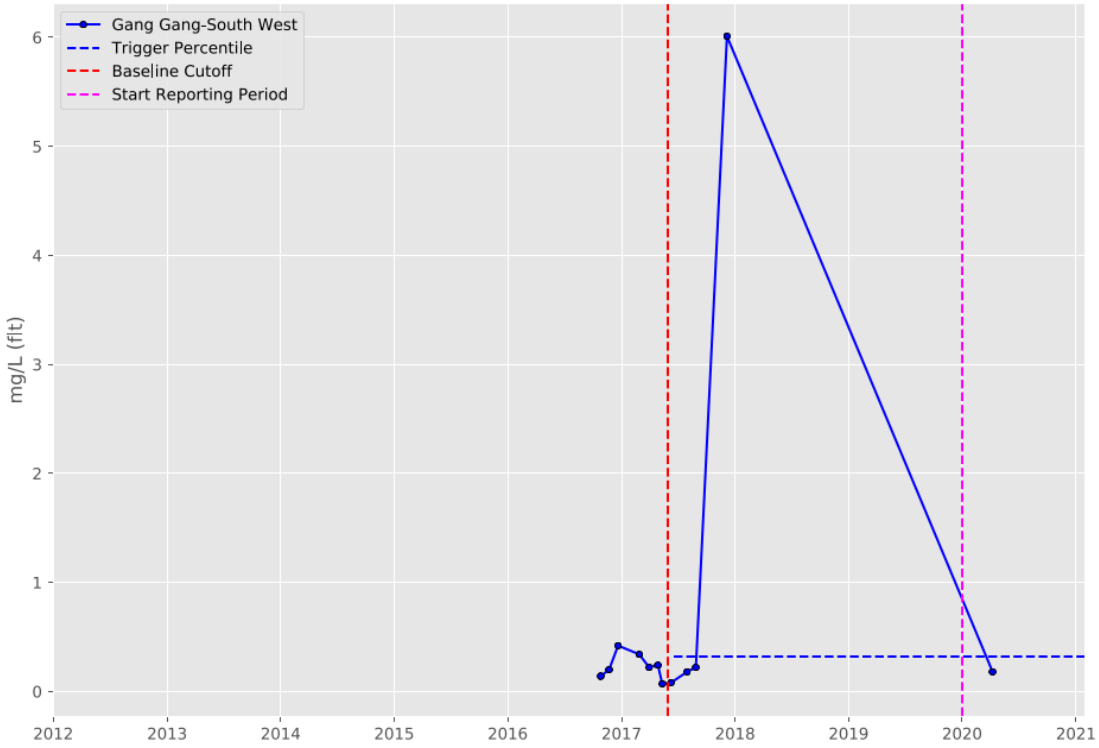

Figure 8.33: Gang Gang South West - Iron

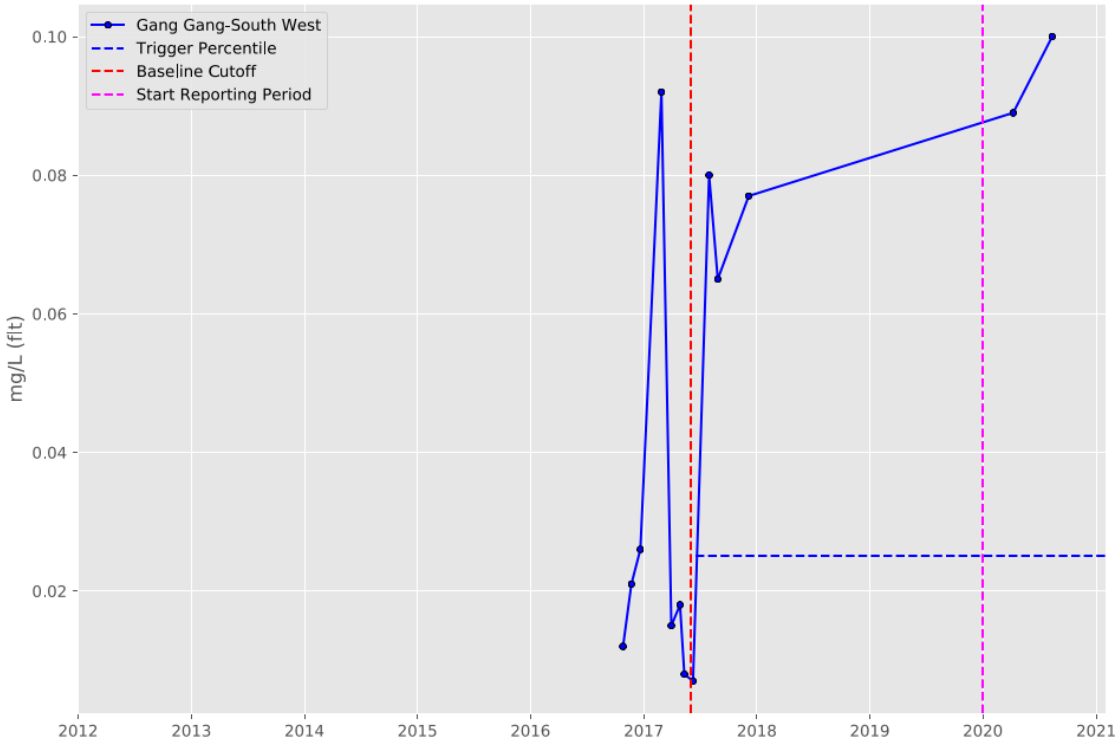

Figure 8.34: Gang Gang South West - Manganese

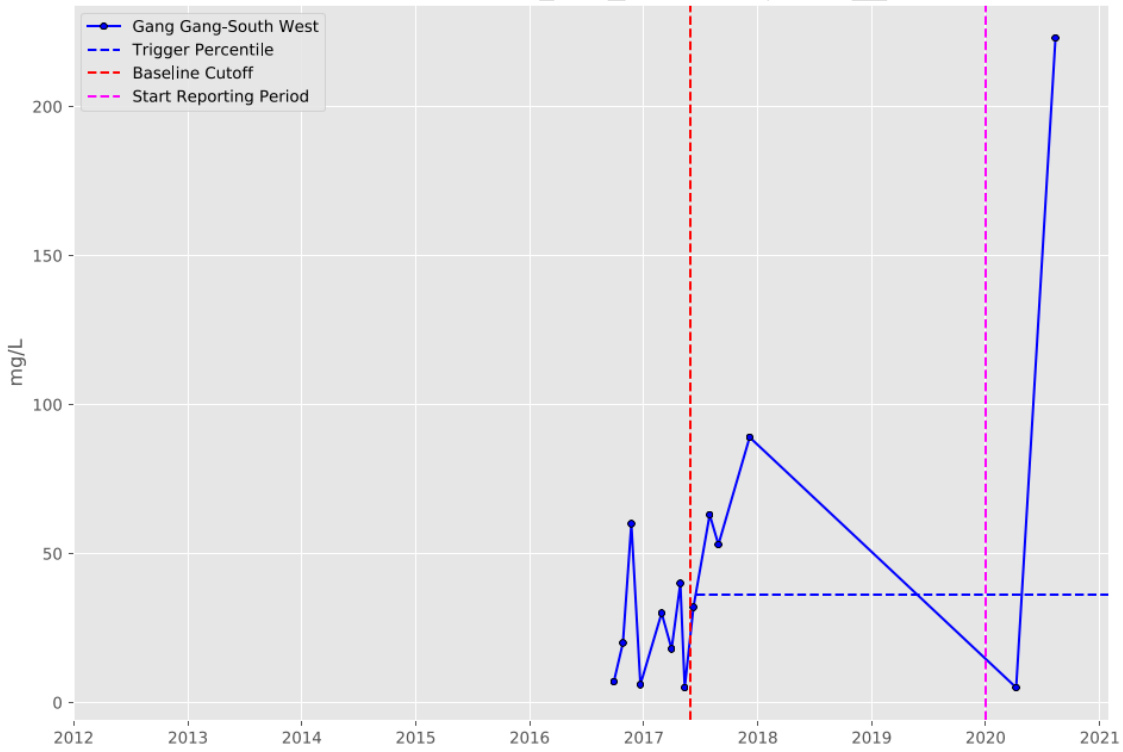

Figure 8.35: Gang Gang South West - TSS

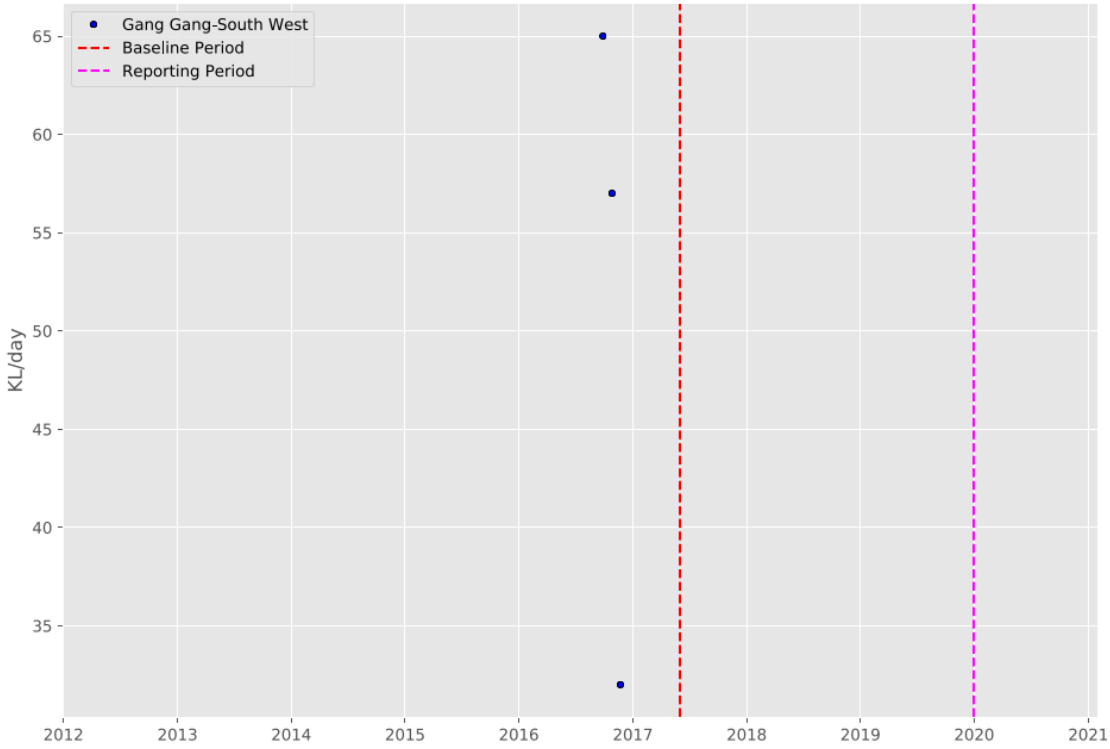

Figure 8.36: Gang Gang South West - Flow

8.2.3 Gang Gang East

Gang Gang East was predominately dry during the reporting period with only two samples taken.

8.2.3.1 Statistics

Gang Gang East is an impact site that has been predominately dry since mid-2018. Table 8.7 outlines the surface water summary.

Table 8.7: Gang Gang East - Surface Water quality summary statistics

ID	Historic date ranges	Analyte	Pre-mining data statistics				80th percentile trigger +2SD &	Reporting period statistics			Comments
			Data point count	Min	Mean	Max		Min	Median	Max	
Gang Gang East	27/09/2016 – 12/05/2017										
		pH	9	5	5.96	7.89	3.6-7.9	4.5	4.55	4.6	Low pH
		EC (µS/cm)	9	20	24	28	33	99	126	153	High EC
		Fe (mg/L)	8	0.06	0.152	0.24	0.29	0.11	0.11	0.11	Within limits
		Mn (mg/l)	8	0.008	0.012	0.015	0.0184	0.187	0.187	0.187	High Mn
		TSS (mg/L)	9	5	6.3	8	10.8	18	18	18	High TSS
		DO (mg/L)	0	NA	NA	NA	NA	7.1	7.65	8.2	NA

ID	Historic date ranges	Analyte	Pre-mining data statistics				80th percentile trigger +2SD &	Reporting period statistics			Comments
			Data point count	Min	Mean	Max		Min	Median	Max	
		Flow (kl/ day)	9	175	358	526	700	Too low	Too low	Too low	Generally dry

Notes: * value at detection limit (Limit of Reporting - LOR)
positive delta value equals a recent value that is greater than the historic mean, and vice versa for negative delta values.
% no monitoring data available post 19/ 10/ 2019, due to lack of access caused to bushfire/ dry conditions
@ where values are below limit of reporting, a value of half the measurement has been assumed.
& investigation trigger performance indicators based on Table 33 of the SMP LW424-LW427. The long- and short-term triggers are based on the 80th data percentile and the 80th percentile plus two standard deviations, respectively

8.2.3.2 Quality Trend

SMP states that surface water results will be assessed against performance triggers for the parameters pH, EC, Iron, Manganese and TSS. The trends for these analytes are shown below.

Gang Gang East has been generally dry since mid-2018 and there is limited data. The swamp has previously been triggered under the groundwater level performance measures. It is difficult to assess the single event during the reporting period as period between the previous data point is approximately two years. The pH is low most likely due to the low alkalinity and build up of humic acids. The elevated EC and is likely due to ash in the runoff post bushfire. The high manganese is a magnitude greater than the average, the cause of this is unknown but it is likely due to the changed hydrological conditions of the swamp post bushfire. Elevated TSS is likely from the erosion and ash in the runoff post bushfire.

Graphs for all other parameter trends are included in **Appendix G**. Trends of note are:

- Anions and Cations – elevated levels likely due to bushfire impacts. Includes metals such as calcium, sodium, zinc, phosphorus, nickel, and copper
- Flow – Flows have generally declined since monitoring began, becoming too low to measure by 2018. The decrease in flow is attributed to a combination of the drought conditions and mining impacts.

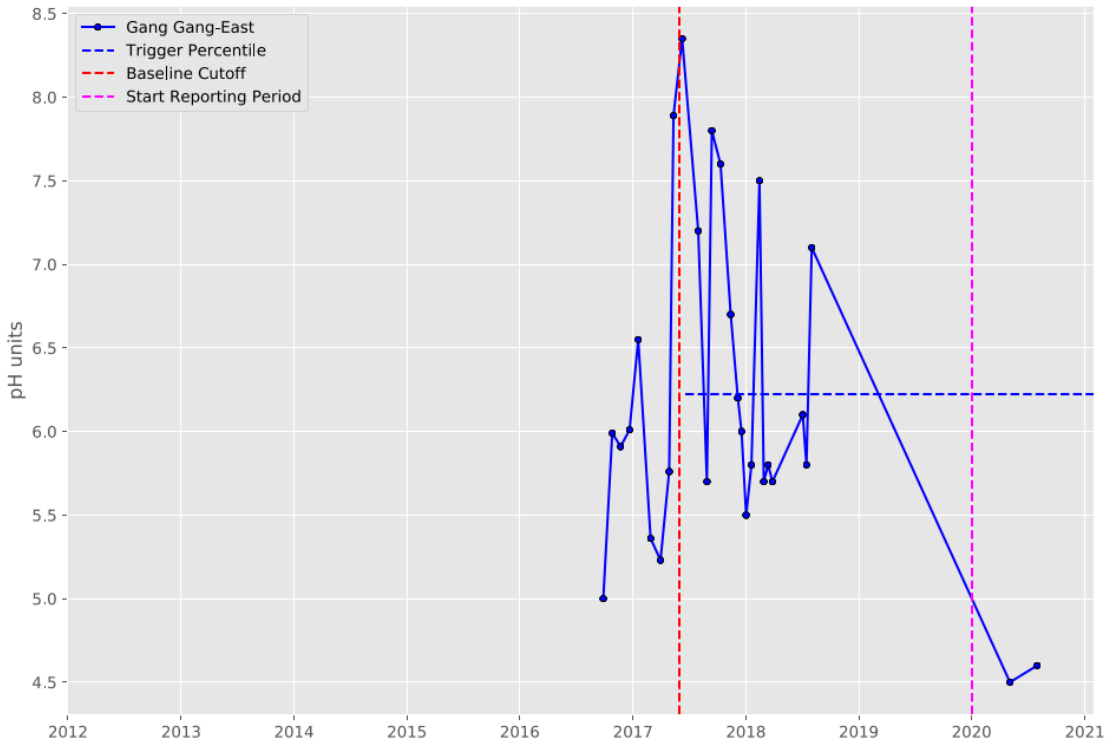

Figure 8.37: Gang Gang East - pH

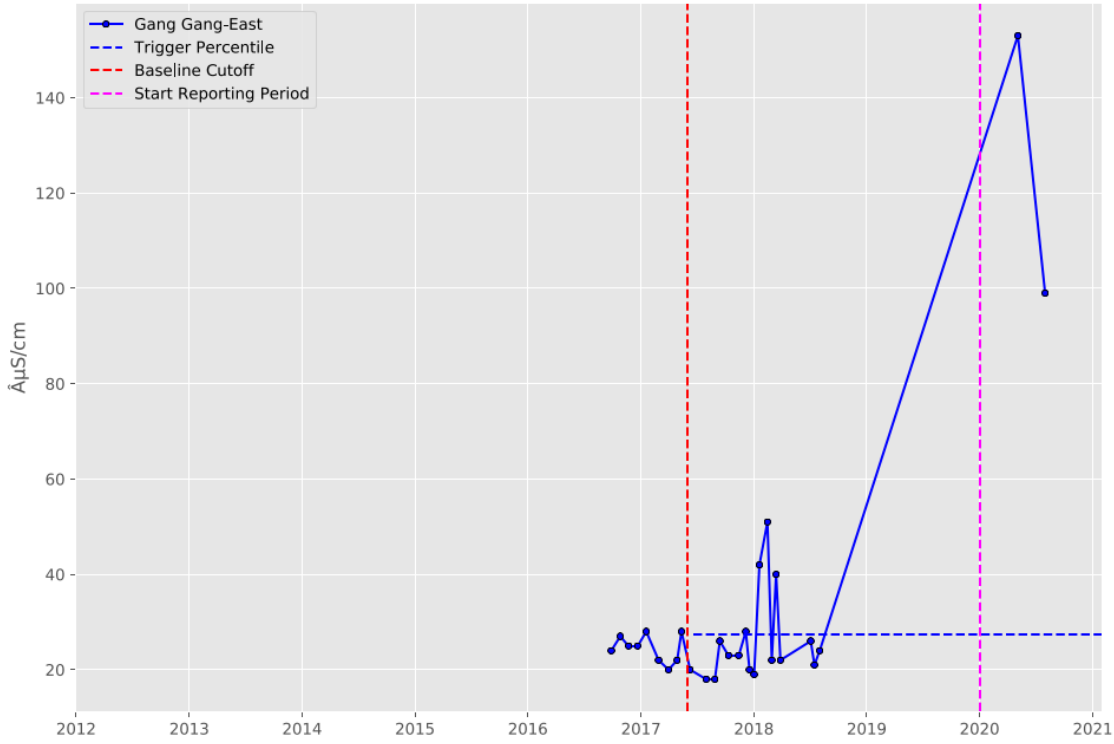

Figure 8.38: Gang Gang East - EC

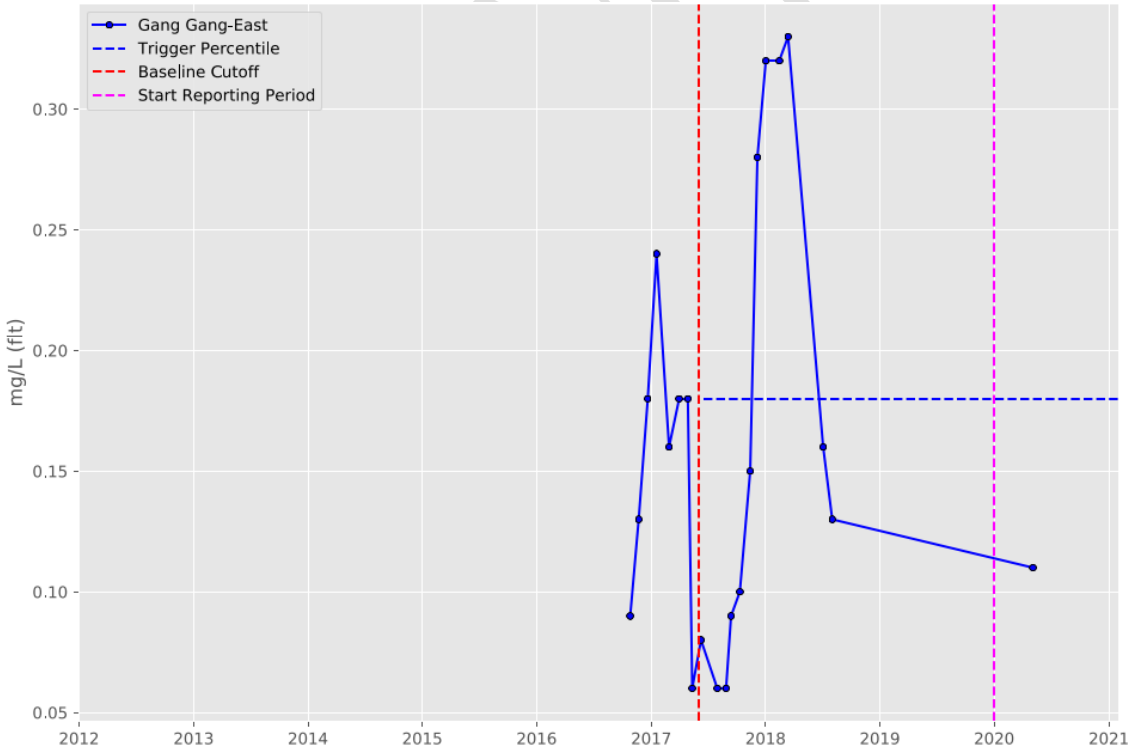

Figure 8.39: Gang Gang East - Iron

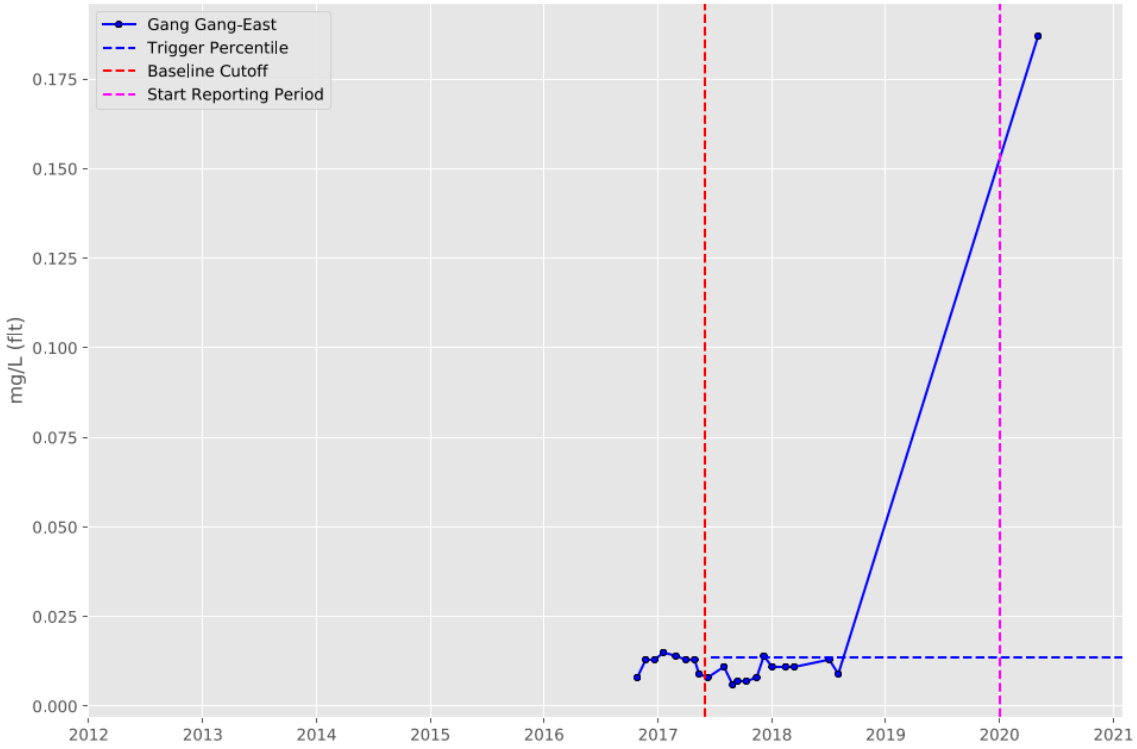

Figure 8.40: Gang Gang East - Manganese

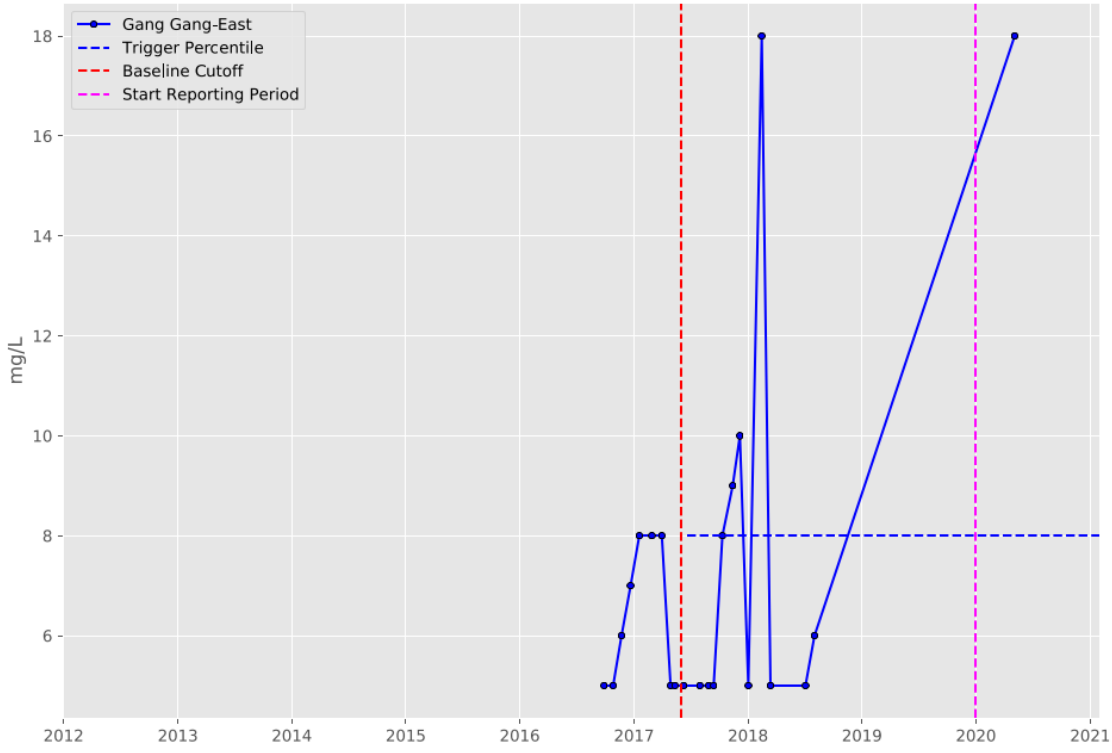

Figure 8.41: Gang Gang East - TSS

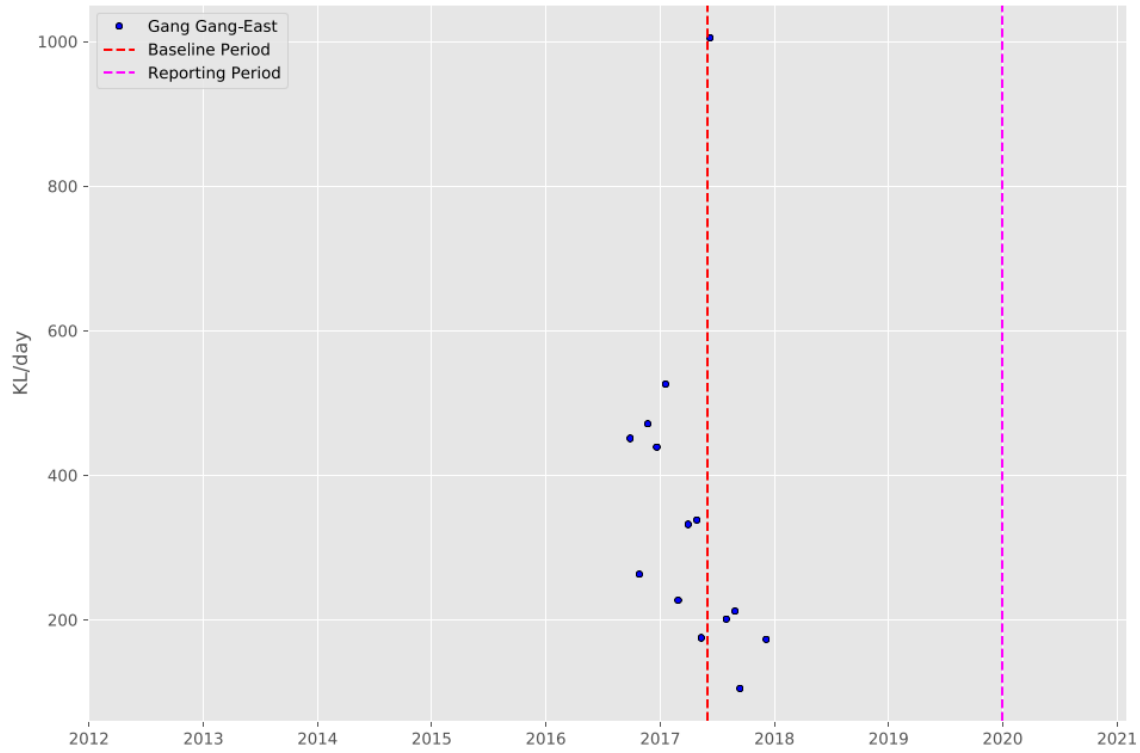

Figure 8.42: Gang Gang East - Flow

8.2.4 Marrangaroo Swamp

Marrangaroo Swamp is considered a potential impact site to be undermined by future longwalls. As this point in time it is still considered unimpacted.

8.2.4.1 Statistics

Marrangaroo swamp is still in its pre-mining phase and there are no performance triggers attached to this site yet. Table 8.8 presents the surface water summary.

Table 8.8: Marrangaroo Swamp - Surface water quality summary statistics

ID	Historic date ranges	Analyte	Historic data statistics				80th percentile trigger +2SD &	Reporting period statistics			Comments
			Data point count	Min	Mean	Max		Min	Median	Max	
Marrangaroo Swamp	24/11/2017 - present										
		pH	53	4	5.3	7.4	3.0-7.5	4.4	5.55	6.9	No trigger – not yet undermined
		EC (µS/cm)	53	17	32	235	98	26	41	209	No trigger – not yet undermined
		Fe (mg/L)	25	0.09	0.297	1.5	0.91	0.14	0.685	1.5	No trigger – not yet undermined
		Mn (mg/l)	25	0.004	0.0106	0.043	0.030	0.015	0.029	0.054	No trigger – not yet undermined

ID	Historic date ranges	Analyte	Historic data statistics				80th percentile trigger +2SD &	Reporting period statistics			Comments
			Data point count	Min	Mean	Max		Min	Median	Max	
		TSS (mg/L)	25	5	21.1	267	115	5	5	28	No trigger – not yet undermined
		DO (mg/L)	51	5.4	10.64	84	33	5.7	8.65	14.7	No trigger – not yet undermined
		Flow (kl/day)	33	69	831	5011.2	3193	77	363	1347	No trigger – not yet undermined

Notes: * value at detection limit (Limit of Reporting - LOR)
positive delta value equals a recent value that is greater than the historic mean, and vice versa for negative delta values.
% no monitoring data available post 19/10/2019, due to lack of access caused to bushfire/ dry conditions
@ where values are below limit of reporting, a value of half the measurement has been assumed.
& investigation trigger performance indicators based on Table 33 of the SMP LW424-LW427. The long- and short-term triggers are based on the 80th data percentile and the 80th percentile plus two standard deviations, respectively

8.2.4.2 Quality Trend

SMP states that surface water results will be assessed against performance triggers for the parameters pH, EC, Iron, Manganese and TSS. Marrangaroo Swamp is still in its pre mining phase and triggers are not applicable to the site. The trends for these analytes are shown below.

pH at Marrangaroo Swamp is slightly acidic and fluctuates around a relatively stable mean. EC is generally very stable; however, there are greater fluctuations in 2020. There is a small peaks in EC during the reporting period are most likely from the ash from the bushfire. The peak in iron and manganese is likely due to a combination of altered hydrological conditions and a release of nutrients post bushfire. TSS is generally stable and the historical spikes are likely to due to natural disturbances.

Graphs for all other parameter trends are included in **Appendix G**. Trends of note are:

- Flow rate – flows are consistent and generally below 1000 kl/day.
- Redox potential – a lower average is observed post bushfire
- Temperature – higher summer temperatures in 2020 likely due to loss of vegetative cover in the bushfire

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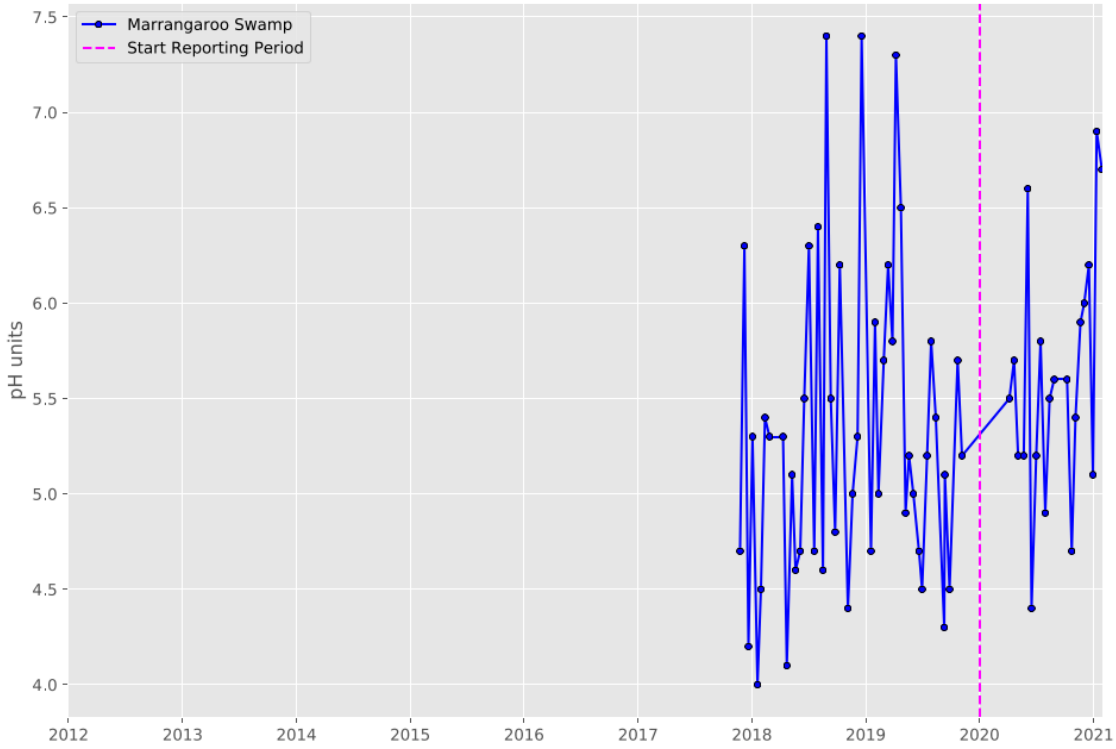

Figure 8.43: Marrangaroo Swamp - pH

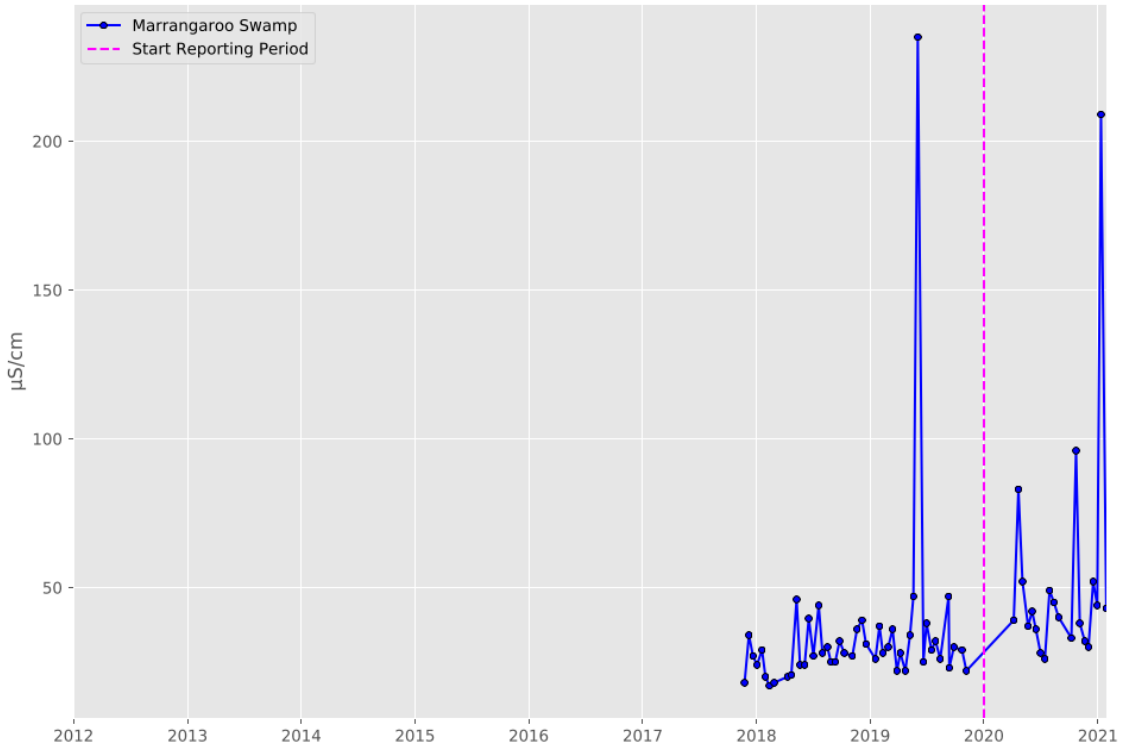

Figure 8.44: Marrangaroo Swamp - EC

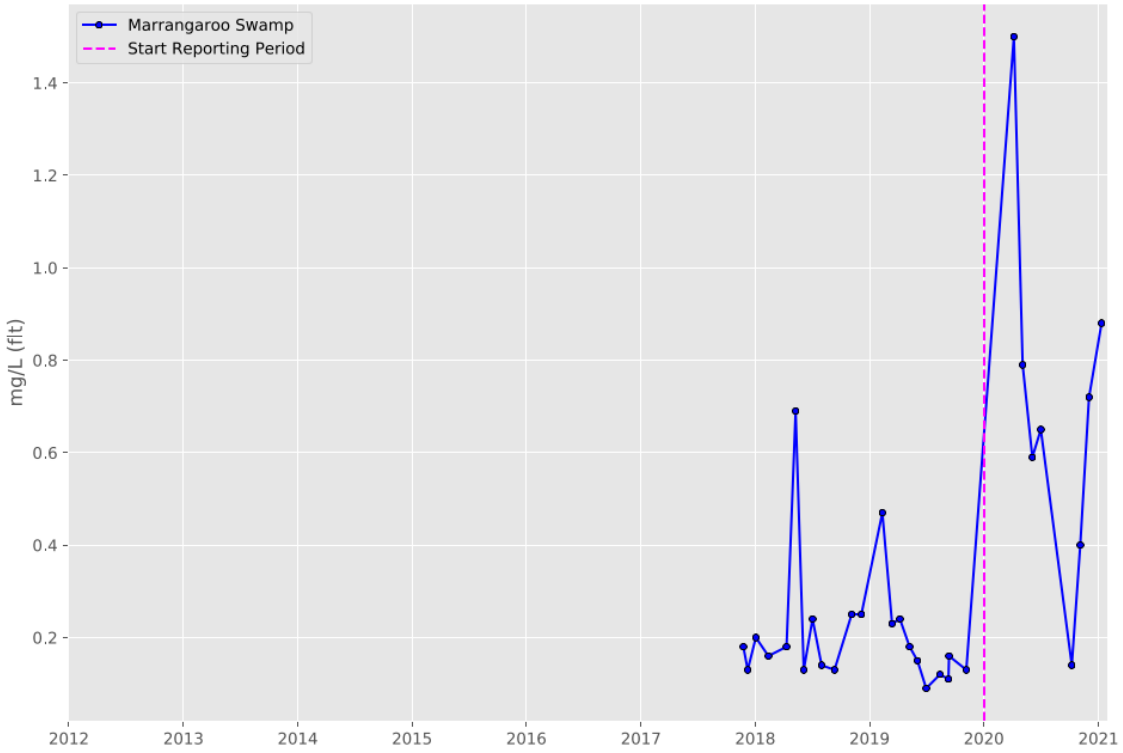

Figure 8.45: Marrangaroo Swamp - Iron

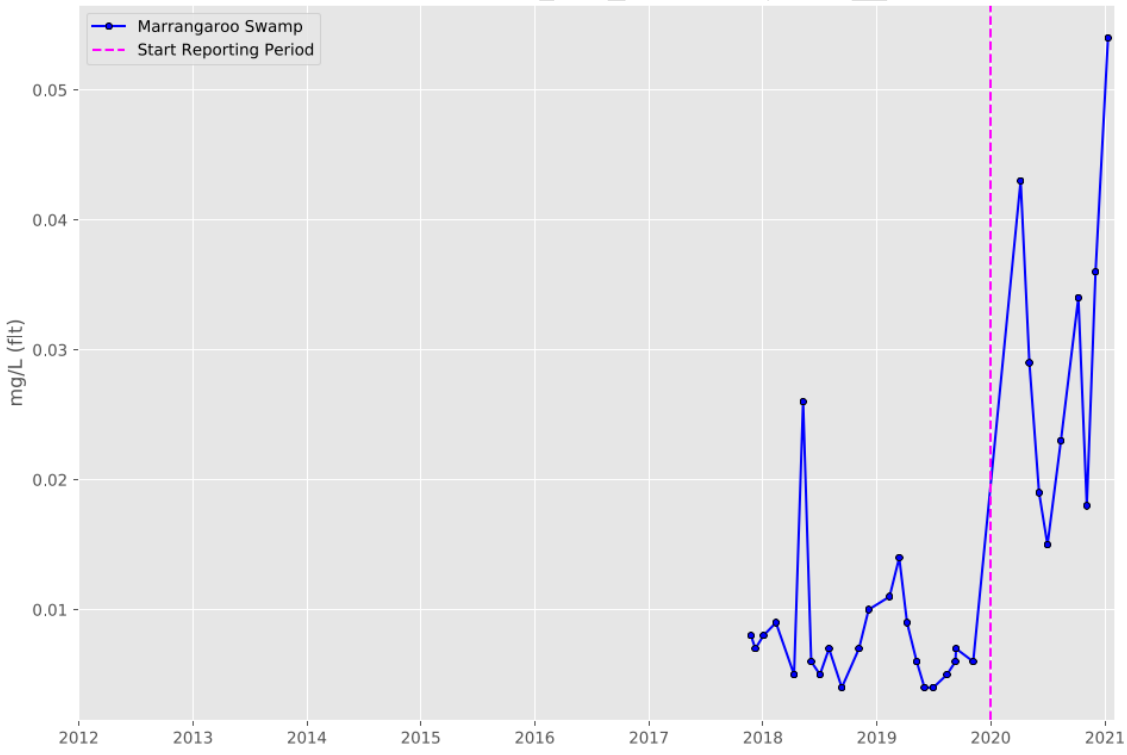

Figure 8.46: Marrangaroo Swamp - Manganese

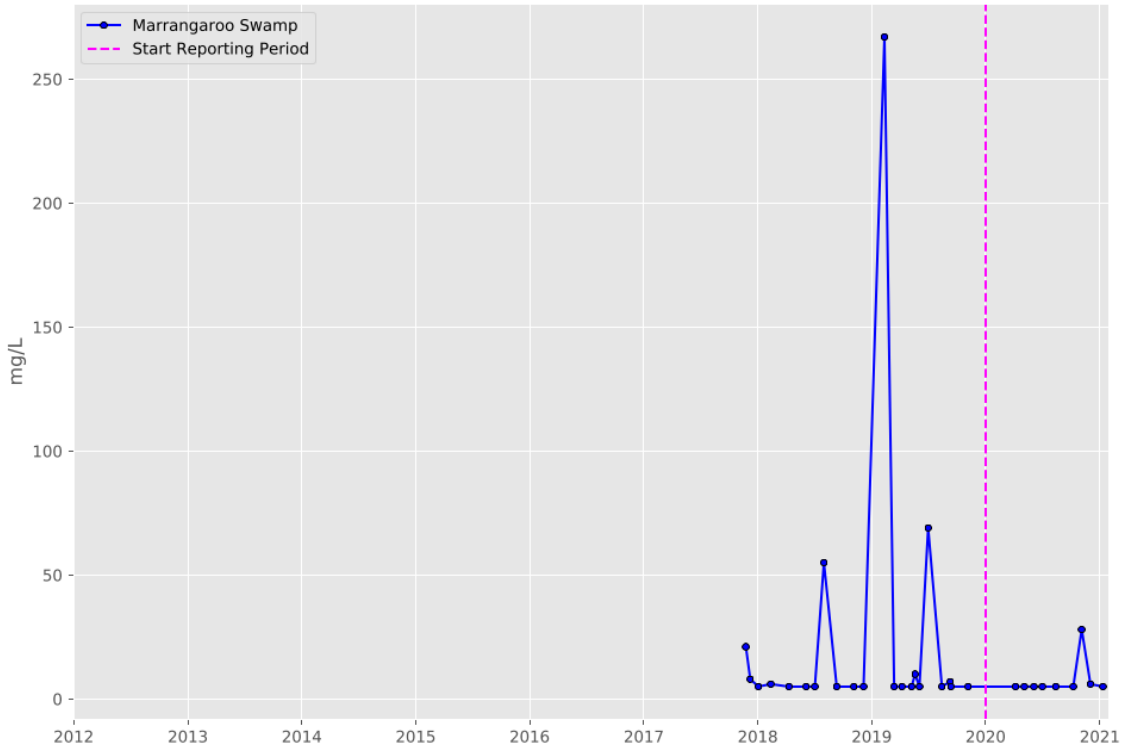

Figure 8.47: Marrangaroo Swamp - TSS

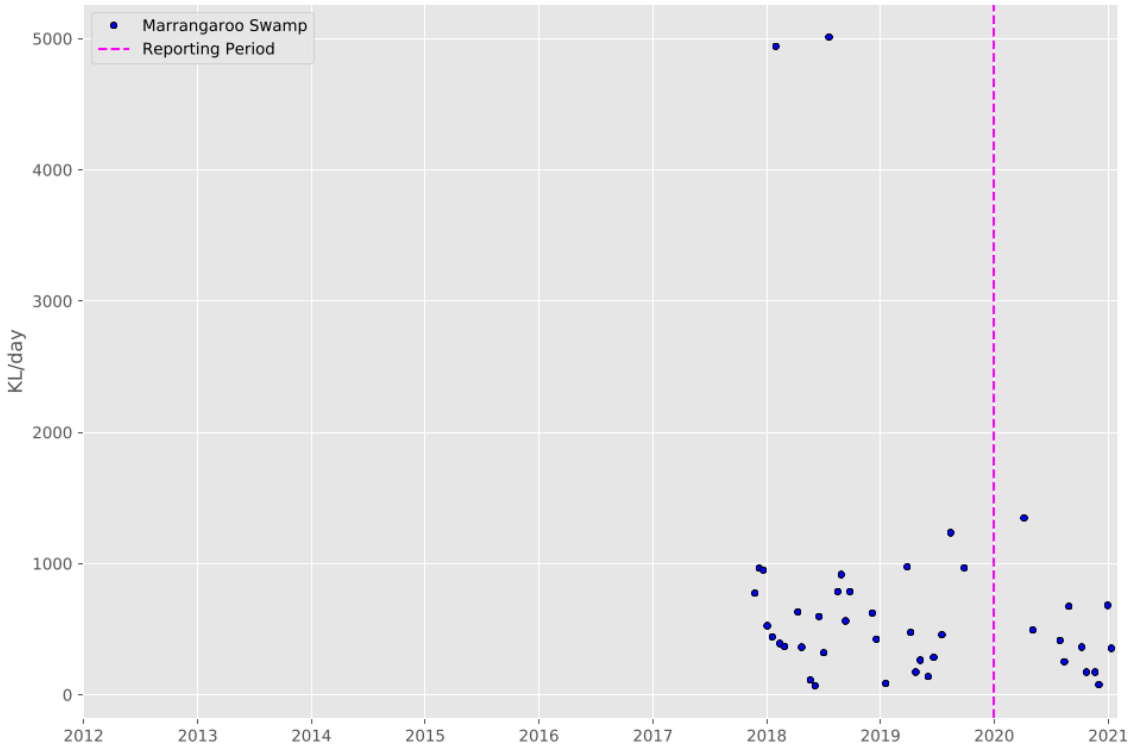

Figure 8.48: Marrangaroo Swamp - Flows

8.2.5 Nine Mile Swamp

Nine Mile swamp was impacted by LW425 in 2018/2019.

8.2.5.1 Statistics

Table 8.9 presents the surface water summary.

Table 8.9: Nine Mile Swamp - Surface water quality summary statistics

ID	Historic date ranges	Analyte	Pre-mining data statistics				80th percentile trigger +2SD&	Reporting period			Comments
			Data point count	Min	Mean	Max		Min	Median	Max	
9 Mile Swamp	27/11/2017 – 14/01/2019										
		pH	30	3.7	5.26	6.9	3.1-7.6	4.1	5.2	6.7	Within limits
		EC (µS/cm)	30	26	38.6	58	56	16	43	87	Within limits
		Fe (mg/L)	15	0.13	0.43	2.29	1.51	0.05	0.5	0.7	Within limits
		Mn (mg/l)	15	0.006	0.029	0.069	0.070	0.013	0.0255	0.056	Within limits
		TSS (mg/L)	15	5	13	80	50	5	6.5	1915	Within limits
		DO (mg/L)	28	3.3	7.1	9.5	11.8	3.8	6.9	12.3	Within limits
		Flow (kl/day)	5	125	312	599	799	Too low	Too low	Too low	Too low

Notes: * value at detection limit (Limit of Reporting - LOR)
positive delta value equals a recent value that is greater than the historic mean, and vice versa for negative delta values.
% no monitoring data available post 19/10/2019, due to lack of access caused to bushfire/ dry conditions
@ where values are below limit of reporting, a value of half the measurement has been assumed.
& investigation trigger performance indicators based on Table 33 of the SMP LW424-LW427. The long- and short-term triggers are based on the 80th data percentile and the 80th percentile plus two standard deviations, respectively

8.2.5.2 Quality Trend

SMP states that surface water results will be assessed against performance triggers for the parameters pH, EC, Iron, Manganese and TSS. The trends for these analytes are shown below.

Nine Mile Swamp has previously triggered under the groundwater level performance measures and there is ongoing monitoring for recovery. pH fluctuates around a generally stable mean. EC levels have shown less stability into the post mining period most likely due to the changed hydrological regime. Furthermore, in 2020 it is likely the ash in the runoff post bushfire would have affected water quality. Iron and manganese show a weak seasonal trend with peaks around the summer months. It is possible the stirred-up sediment during sampling would have elevated concentrations in TSS.

Graphs for all other parameter trends are included in **Appendix G**. Trends of note are:

- Flow rate – Flow is highly variable with flows too low to measure since 2018.
- Metals – i.e. Copper, Nickel, Zinc recorded elevated concentrations most likely from bushfire impacts
- Anions - Fluoride, Sulfate concentrations were elevated.

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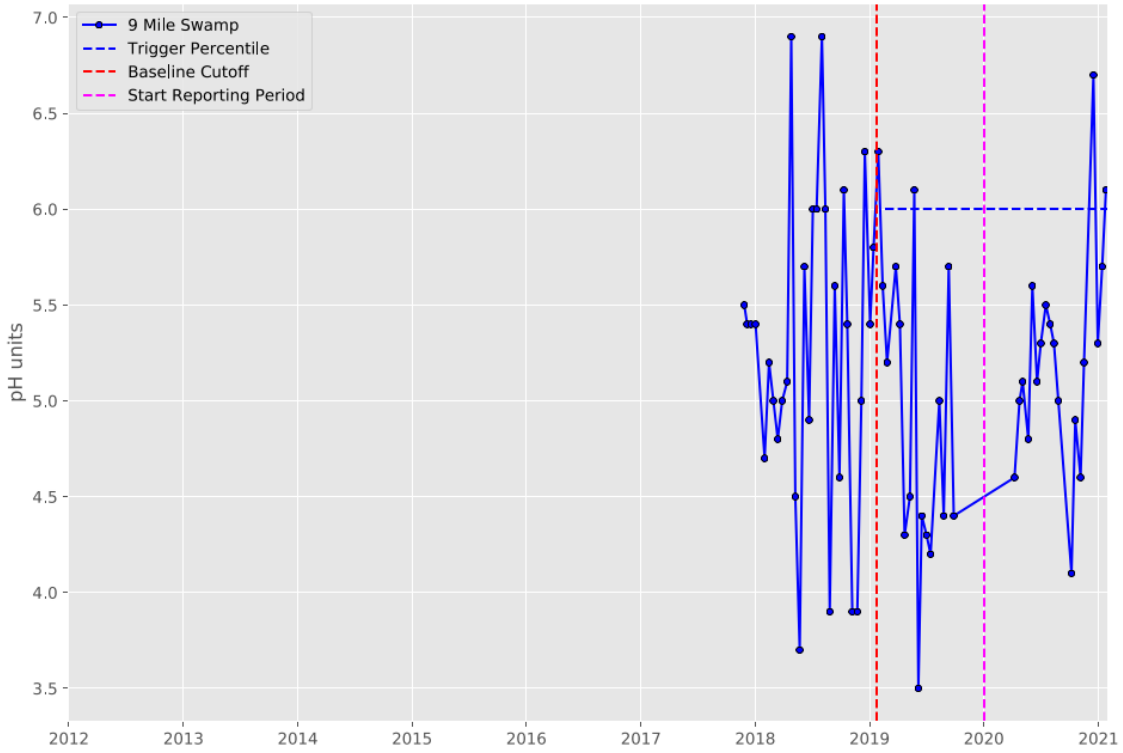

Figure 8.49: Nine Mile Swamp - pH

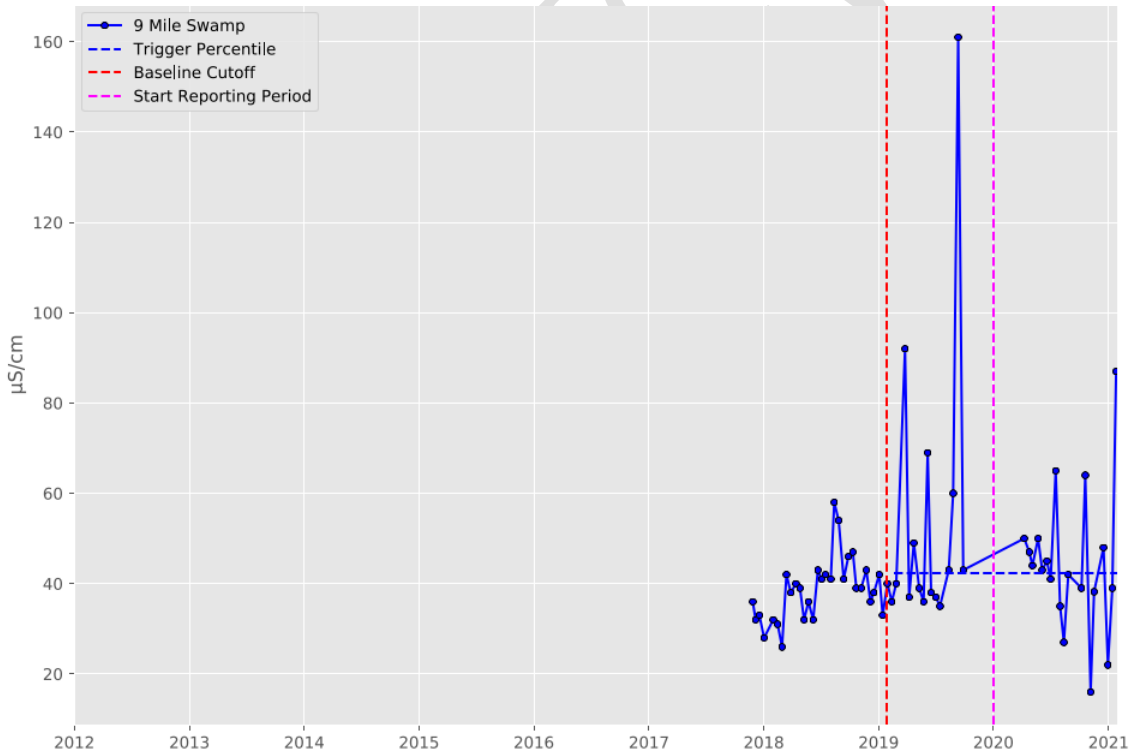

Figure 8.50: Nine Mile Swamp - EC

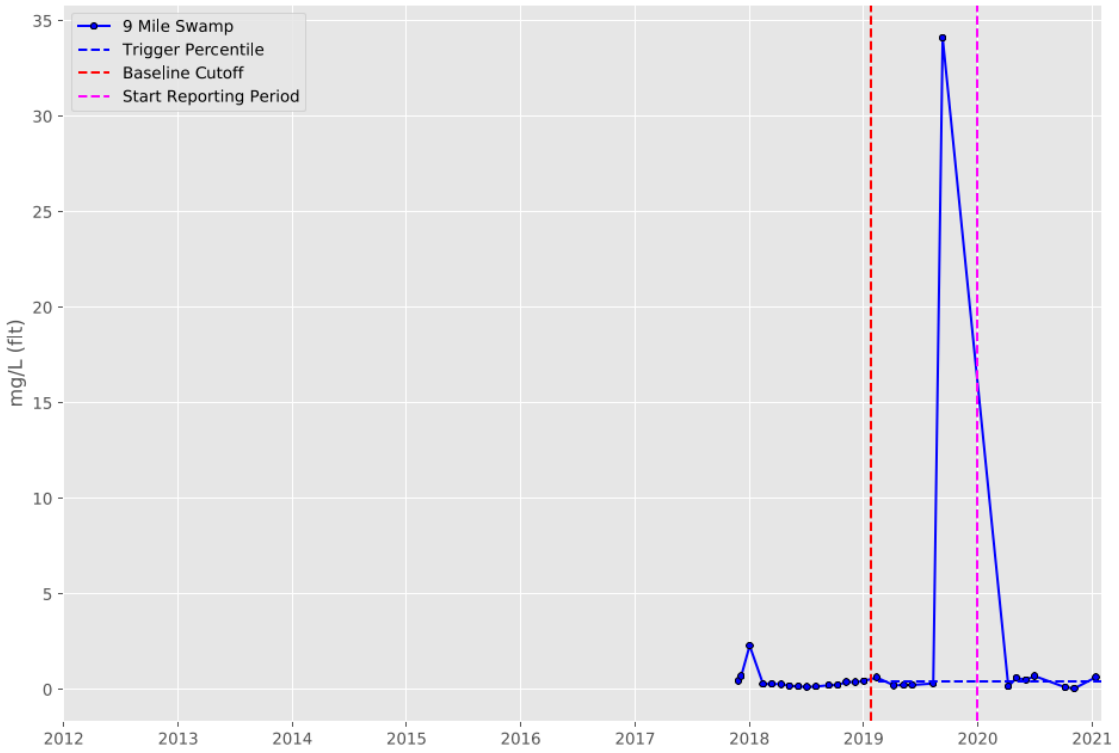

Figure 8.51: Nine Mile Swamp - Iron

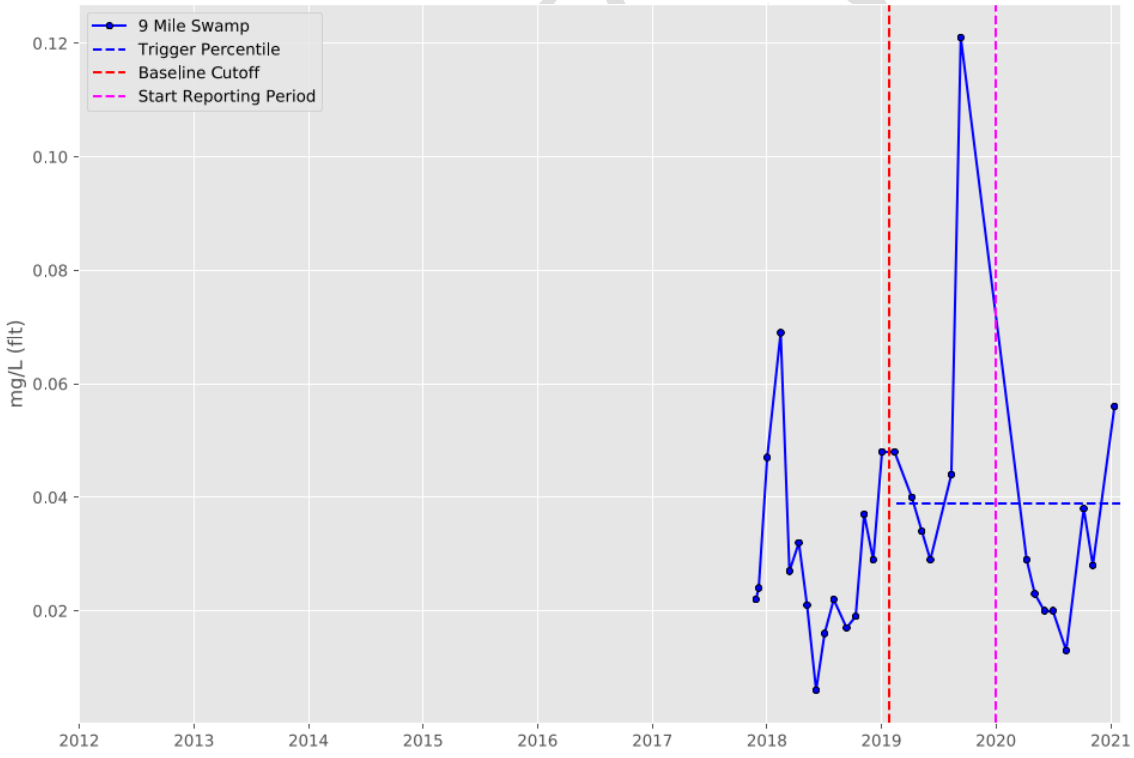

Figure 8.52: Nine Mile Swamp - Manganese

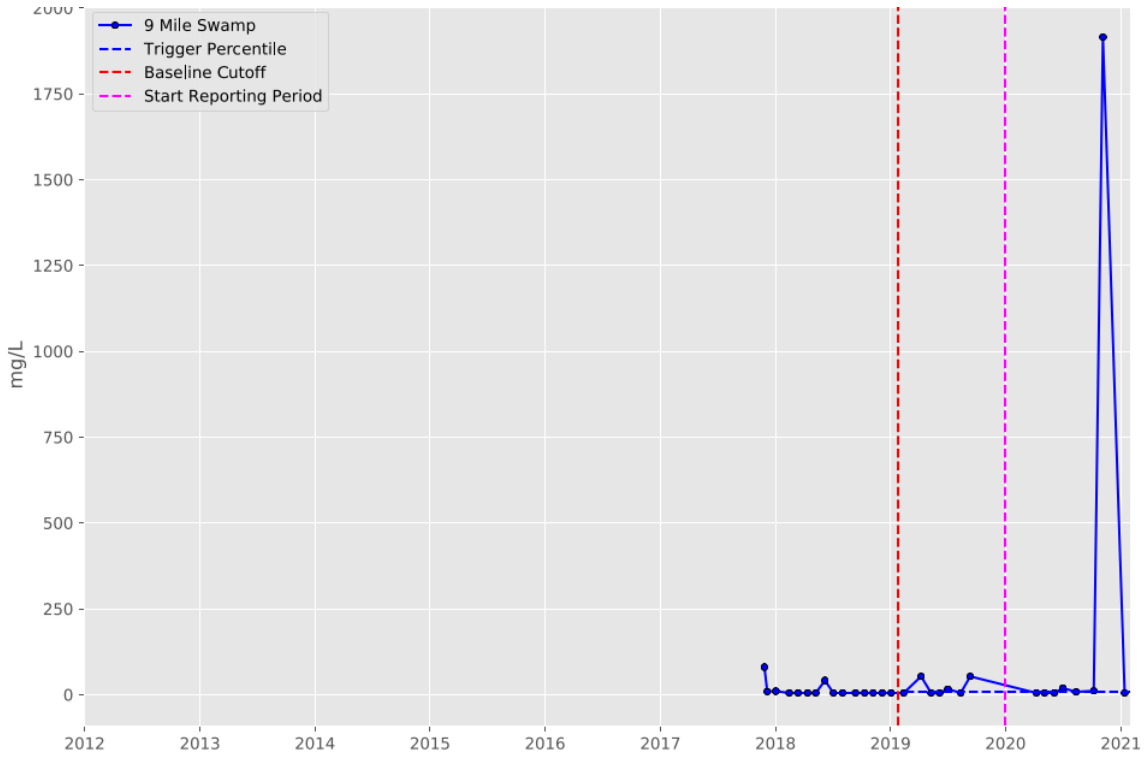

Figure 8.53: Nine Mile Swamp - TSS

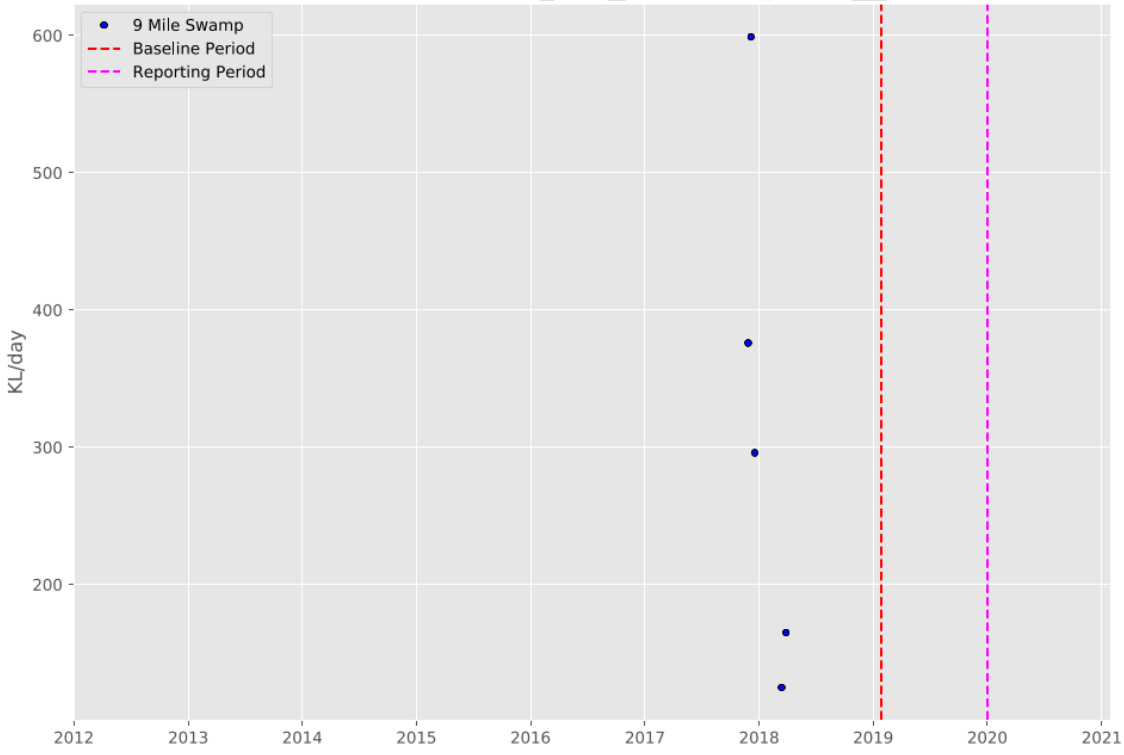

Figure 8.54: Nine Mile Swamp - Flow

8.2.6 Sunnyside Swamp

Longwall mining was stepped around Sunnyside Swamp and the swamp was not directly undermined; that said, it is still considered an impact site. There were limited impacts observed in groundwater levels. TIA triggers were not developed at the time of monitoring at Sunnyside sites. As a result, there are no triggers associated with this

site. Therefore, retrospective 80th percentiles will be applied to these sites to gain a better understanding of natural variability and change.

8.2.6.1 Statistics

Table 8.10 summarises the surface water results.

Table 8.10: Sunnyside Swamp - Surface water quality summary statistics

ID	Historic date ranges	Analyte	Pre-mining data statistics				80th percentile trigger &	Reporting period statistics			Comments
			Data point count	Min	Mean	Max		Min	Median	Max	
Sunnyside Upstream Junction	31/03/2006 – 22/08/2009										
		pH	76	6.4	7.1	8.0	5.9-8.4	4.3	5.55	7	No triggers
		EC (µS/cm)	76	26	47	390	136	31	45	68	No triggers
		Fe (mg/L)	76	0.18	0.747	1.76	1.82	0.07	0.165	0.66	No triggers
		Mn (mg/l)	76	0	0.004	0.03	0.016	0.003	0.01	0.019	No triggers
		TSS (mg/L)	-	-	-	-	-	5	5	26	No triggers
		DO (mg/L)	-	-	-	-	-	6.1	8.8	11.3	No triggers
		Flow (kl/day)	36	257	1031	8977	3869	155	361	1563	No triggers
Sunnyside Swamp Upstream	24/05/2005 – 19/08/2009										
		pH	87	6.6	7.04	8.4	5.7-8.4	5	5.5	6.6	No triggers
		EC (µS/cm)	87	42	162	885	548	31	55	123	No triggers
		Fe (mg/L)	87	0	1.595	7.7	4.42	0.05	0.145	1.29	No triggers
		Mn (mg/l)	87	0	0.0078	0.1	0.034	0.001	0.0075	0.05	No triggers
		TSS (mg/L)	-	-	-	-	-	5	8.5	337	No triggers
		DO (mg/L)	-	-	-	-	-	5.2	6.95	9.4	No triggers
		Flow (kl/day)	37	11	282	3365	1404	Too low	Too low	Too low	No triggers
Sunnyside Swamp Downstream	24/05/2005 – 19/08/2009										
		pH	104	5.6	7.16	8.4	5.8-8.5	4.5	5.45	6.6	No triggers
		EC (µS/cm)	104	37	118	840	447	29	46	65	No triggers

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ID	Historic date ranges	Analyte	Pre-mining data statistics				80th percentile trigger &	Reporting period statistics			Comments
			Data point count	Min	Mean	Max		Min	Median	Max	
		Fe (mg/L)	102	0	1.273	5	3.27	0.05	0.095	0.91	No triggers
		Mn (mg/l)	102	0	0.031	2.5	0.504	0.001	0.003	0.031	No triggers
		TSS (mg/L)	-	-	-	-	-	5	5	24	No triggers
		DO (mg/L)	-	-	-	-	-	4.8	6.8	10.4	No triggers
		Flow (kl/day)	37	20	505	4252	2244	112	889.5	1667	No triggers

Notes: * value at detection limit (Limit of Reporting - LOR)
positive delta value equals a recent value that is greater than the historic mean, and vice versa for negative delta values.
% no monitoring data available post 19/10/2019, due to lack of access caused to bushfire/ dry conditions
@ where values are below limit of reporting, a value of half the measurement has been assumed.
& investigation trigger performance indicators based on Table 33 of the SMP LW424-LW427. The long- and short-term triggers are based on the 80th data percentile and the 80th percentile plus two standard deviations, respectively

8.2.6.2 Quality Trend

SMP states that surface results will be assessed against performance triggers for the parameters pH, EC, Iron, Manganese and TSS. The trends for these analytes are shown below. No triggers are defined for Sunnyside as guidelines for the TIA were developed after monitoring began.

pH has been observed to be on an increasing trend in 2020, which coincides with the returning rains. It is likely changed rainfall patterns have affected water quality parameters. The large spike in EC is most likely erroneous or an instrumental error. Iron and manganese are generally stable, the large spikes are likely errors. TSS is usually stable, the high readings at Sunnyside upstream was likely taken in pooled water that had been disturbed.

No performance criteria have been triggered.

Graphs for all other parameter trends are included in **Appendix G**. Trends of note are:

- Flows – flows were observed to taper off in 2018 becoming predominately too low to measure. The recently observed flows in the reporting period were recorded during a time of above average rainfalls.
- Sulfate – an increase was observed post bushfire, likely from the release of organics during combustion

SPRINGVALE

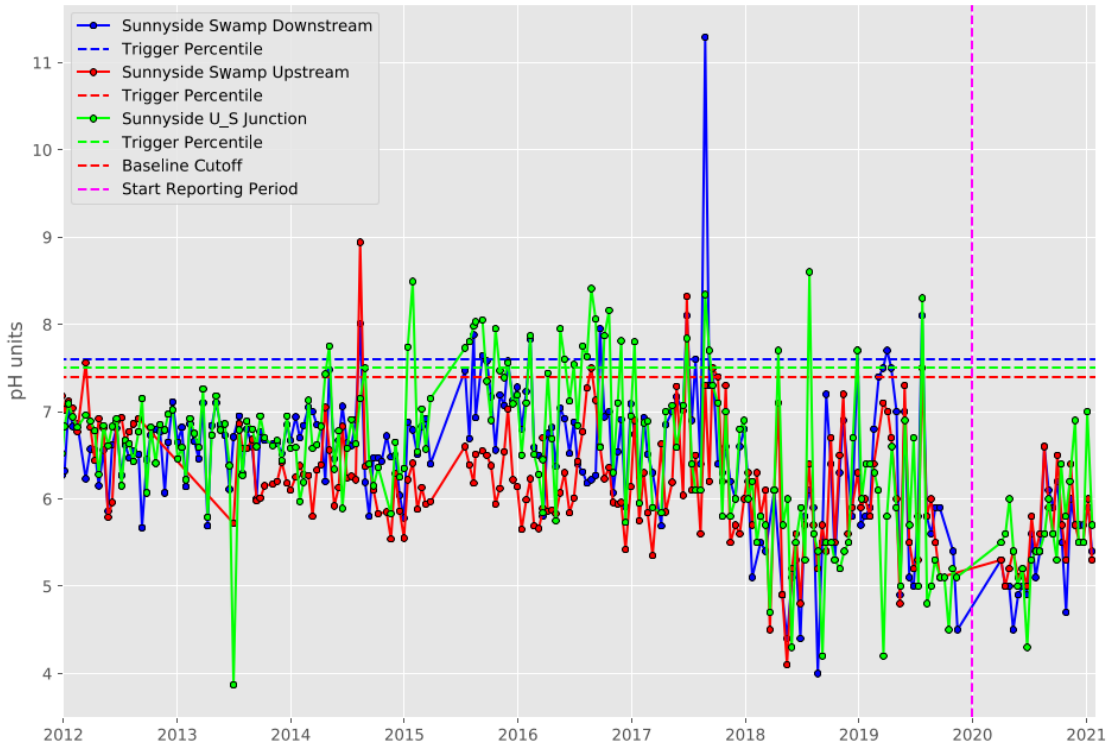

Figure 8.55: Sunnyside - pH

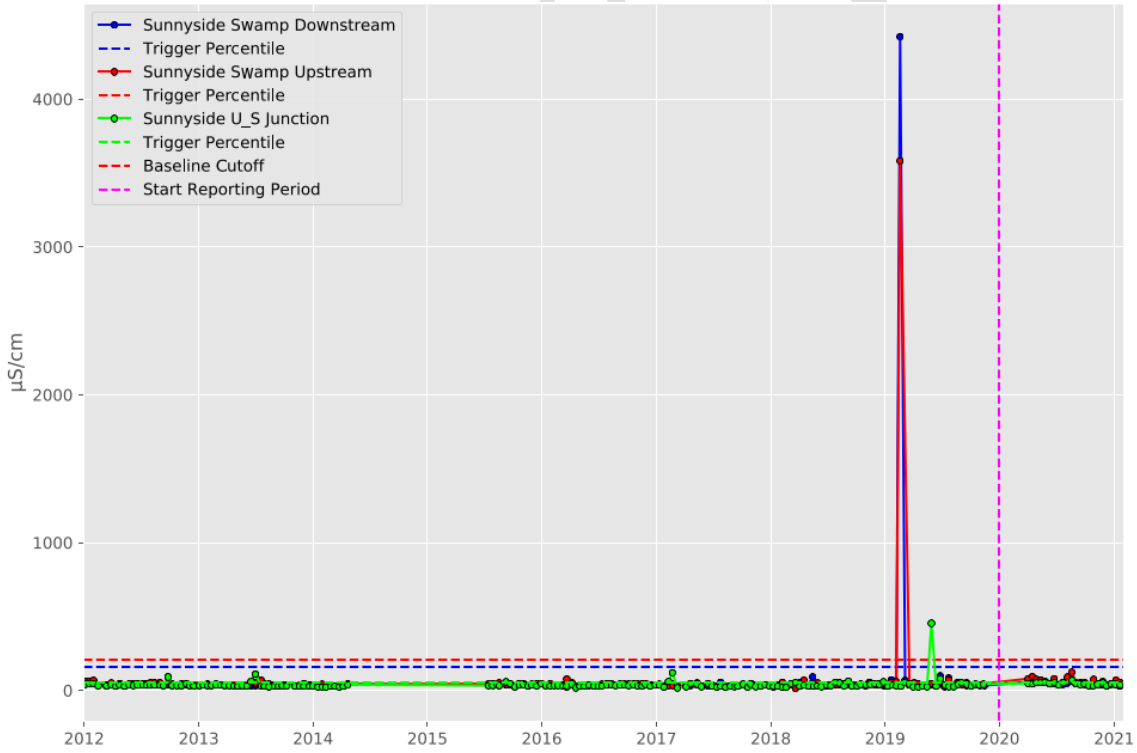

Figure 8.56: Sunnyside - EC

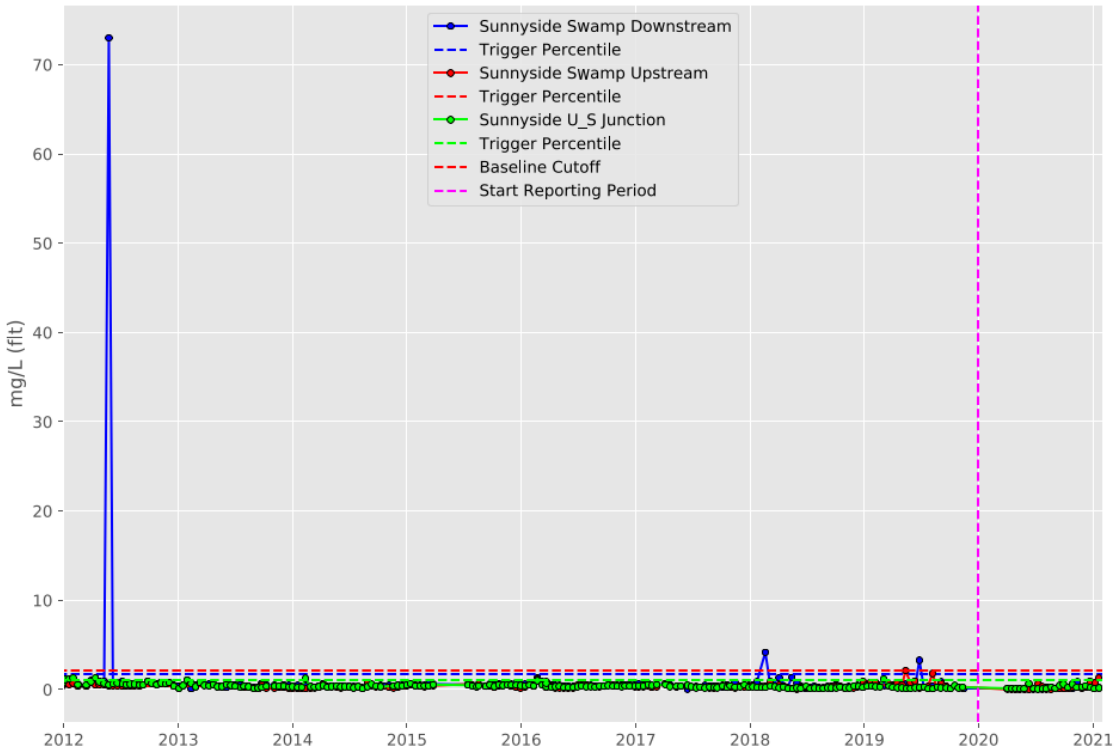

Figure 8.57: Sunnyside - Iron

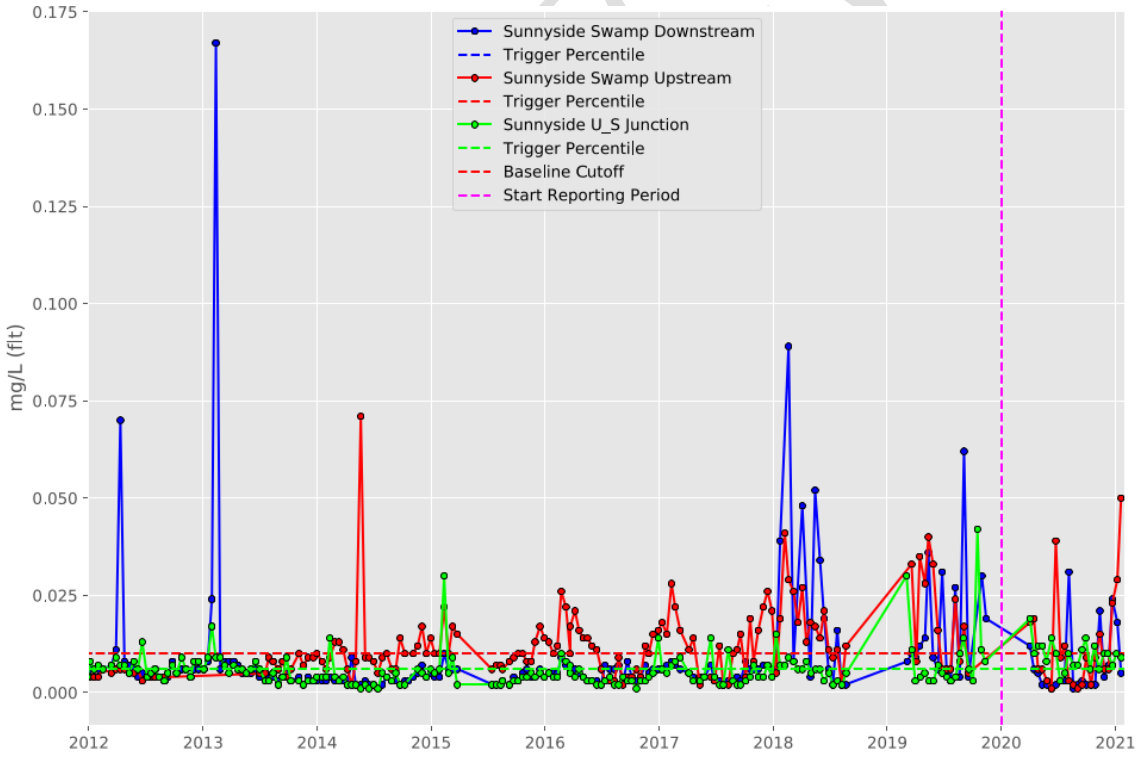

Figure 8.58: Sunnyside - Manganese

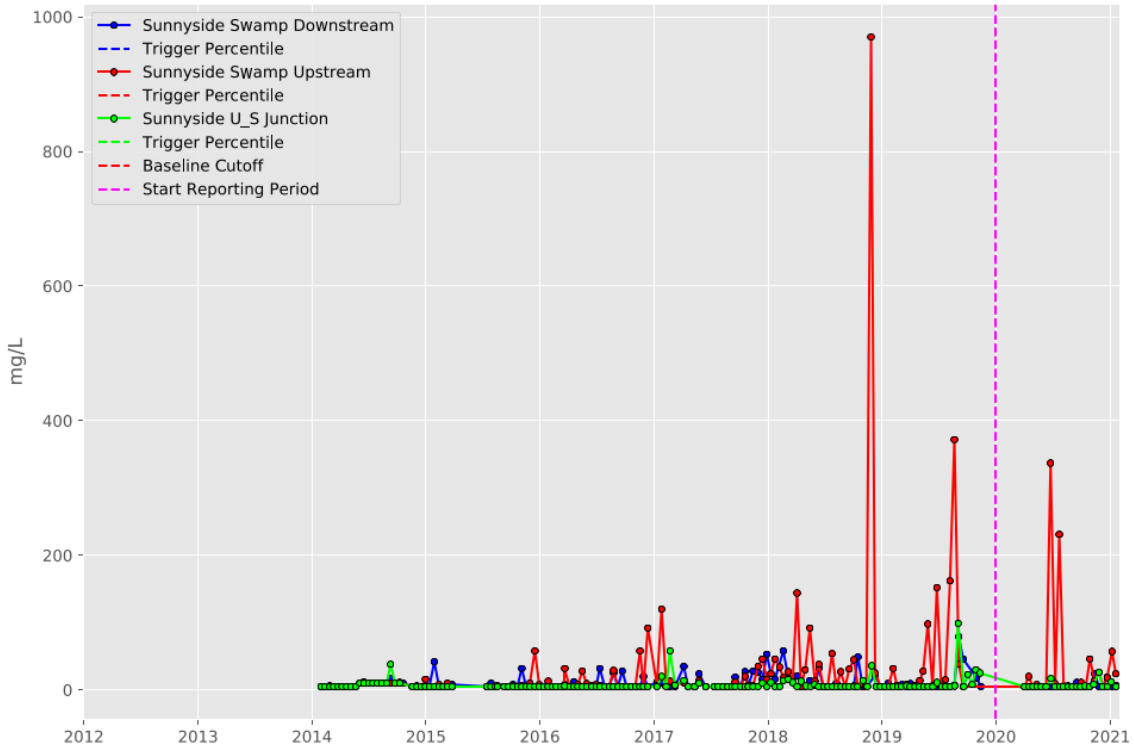

Figure 8.59: Sunnyside - TSS

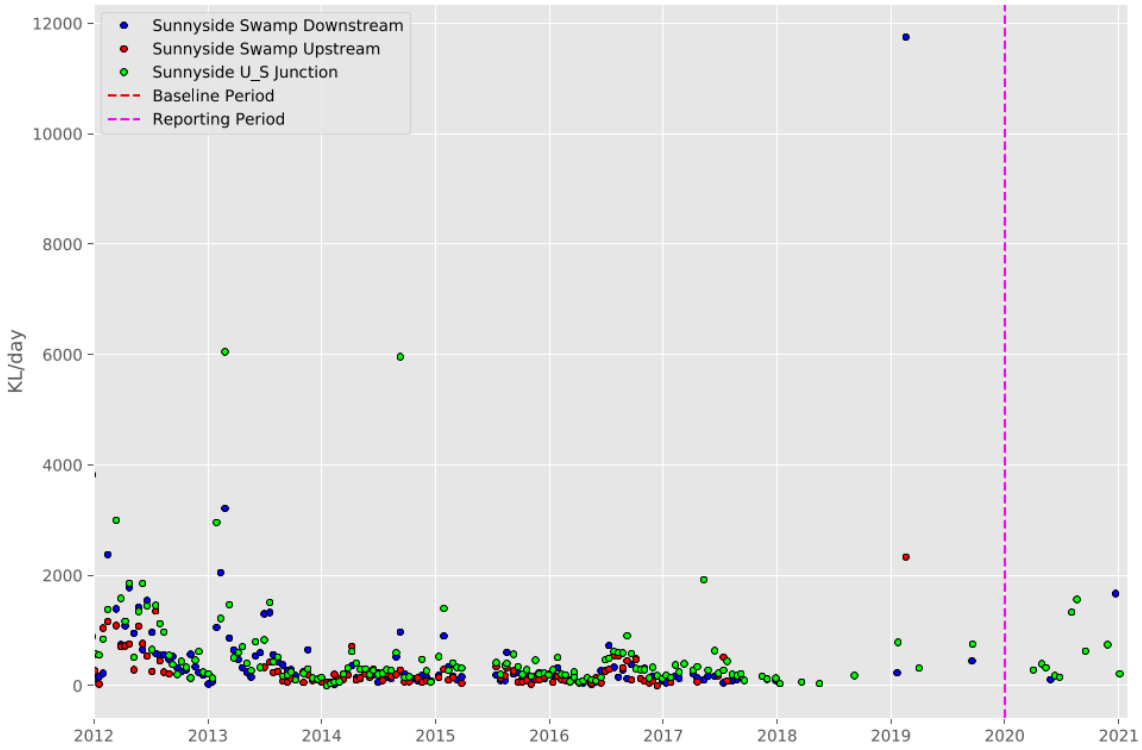

Figure 8.60: Sunnyside - Flow

8.2.7 Sunnyside East Swamp – SS3 D/S

TIA triggers were not developed at the time of monitoring at Sunnyside East sites. As a result, there are no triggers associated with this site. That said, retrospective 80th percentiles will be applied to these sites to gain a better understanding of natural variability.

SS3 DS has been dry since 2015.

8.2.7.1 Statistics

Table 8.11 presents the surface water quality summary.

Table 8.11: SS3 DS - Surface water quality summary statistics

ID	Historic date ranges	Analyte	Pre-mining data statistics				80th percentile trigger +2SD &	Reporting period statistics			Comments
			Data point count	Min	Mean	Max		Min	Median	Max	
SS3 D/S (Sunnyside East 3 downstream)	10/06/2010 – 25/09/2013										
		pH	128	4.18	5.72	7.37	4.5-7.0	Dry	Dry	Dry	Dry
		EC (µS/cm)	128	14	35	334	127	Dry	Dry	Dry	Dry
		Fe (mg/L)	127	0.06	0.217	0.64	0.46	Dry	Dry	Dry	Dry
		Mn (mg/l)	138	0.009	0.096	1	0.563	Dry	Dry	Dry	Dry
		TSS (mg/L)	13	1	24	82	89	Dry	Dry	Dry	Dry
		DO (mg/L)	12	7.42	9.24	15.07	14.0	Dry	Dry	Dry	Dry
		Flow (kl/day)	-	-	-	-	-	Dry	Dry	Dry	Dry

Notes: * value at detection limit (Limit of Reporting - LOR)
positive delta value equals a recent value that is greater than the historic mean, and vice versa for negative delta values.
% no monitoring data available post 19/10/2019, due to lack of access caused to bushfire/ dry conditions
@ where values are below limit of reporting, a value of half the measurement has been assumed.
& investigation trigger performance indicators based on Table 33 of the SMP LW424-LW427. The long- and short-term triggers are based on the 80th data percentile and the 80th percentile plus two standard deviations, respectively

8.2.7.2 Quality Trend

SMP states that surface results will be assessed against performance triggers for the parameters pH, EC, Iron, Manganese and TSS. No triggers are defined for Sunnyside East as guidelines for the TIA were developed after monitoring began. The trends for these analytes are shown below.

SS3 DS (Sunnyside East 3 downstream) has been dry since 2015. No measurements were recorded for the reporting period. Flows are not recorded at SS3 DS

Graphs for all other parameter trends are included in **Appendix G**.

SPRINGVALE

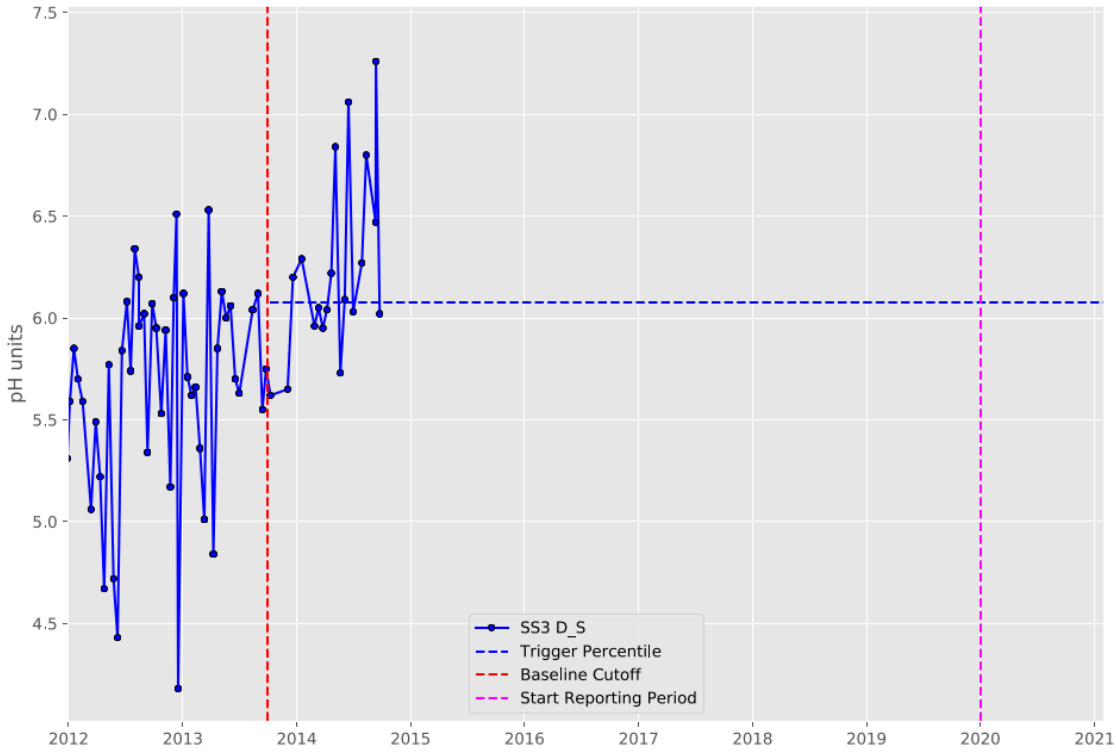

Figure 8.61: SS3 DS - pH

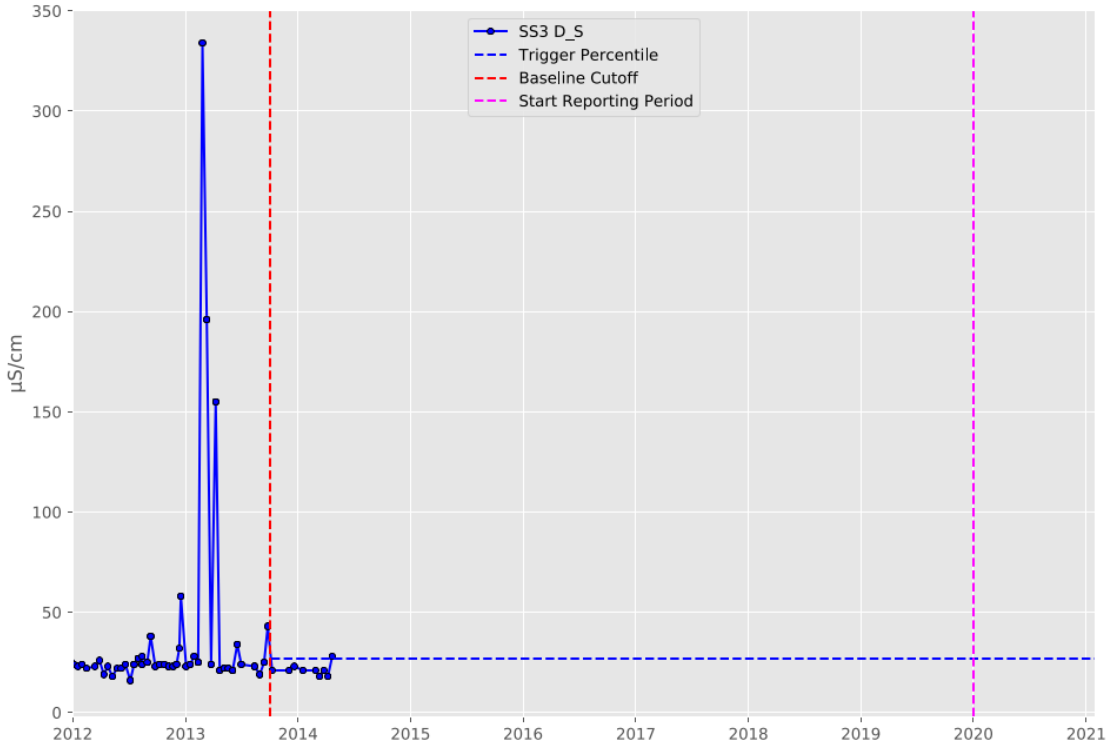

Figure 8.62: SS3 DS - EC

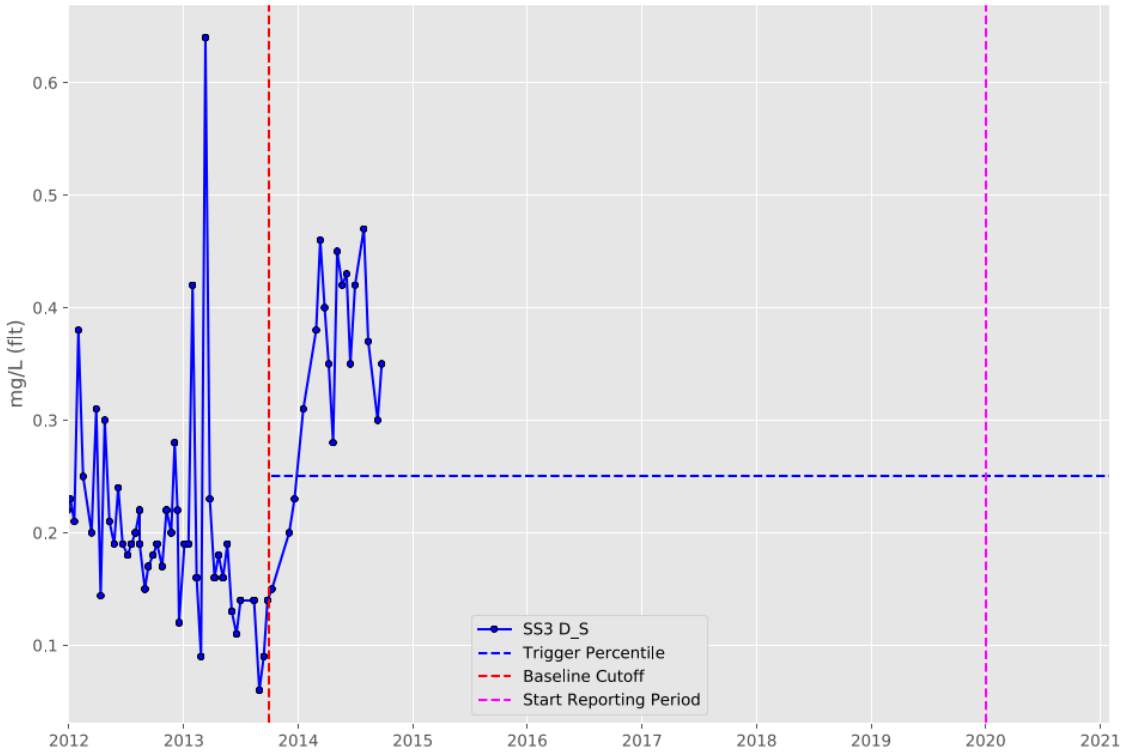

Figure 8.63: SS3 DS - Iron

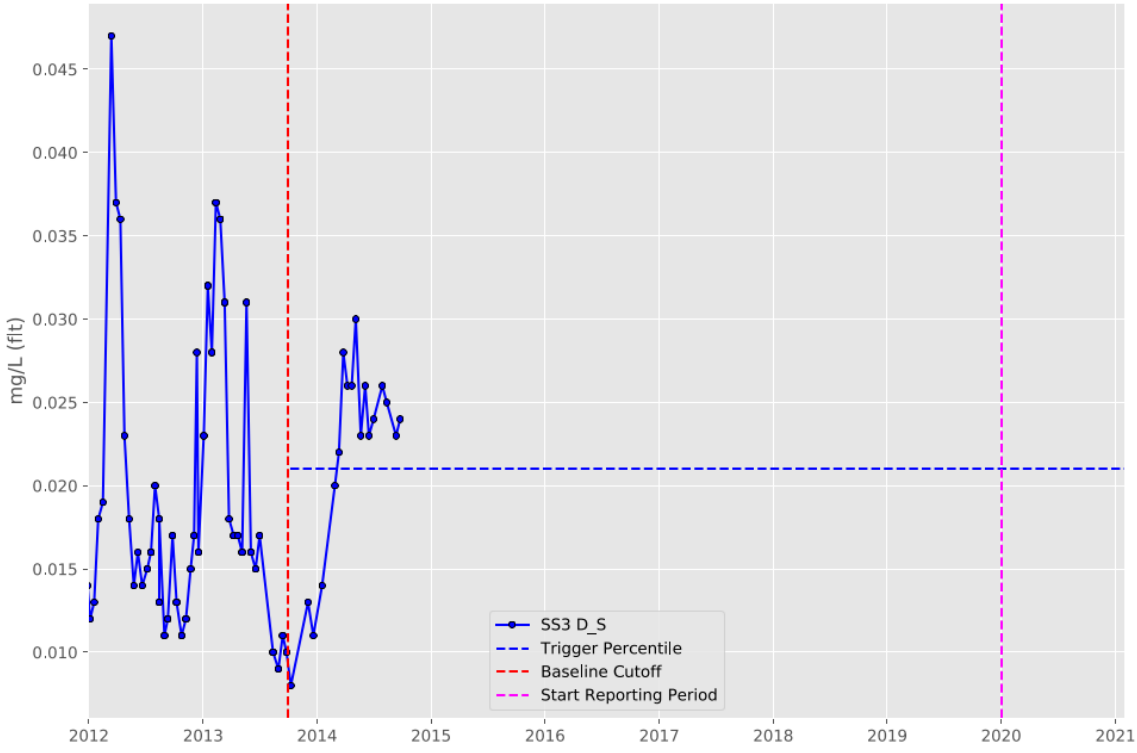

Figure 8.64: SS3 DS - Manganese

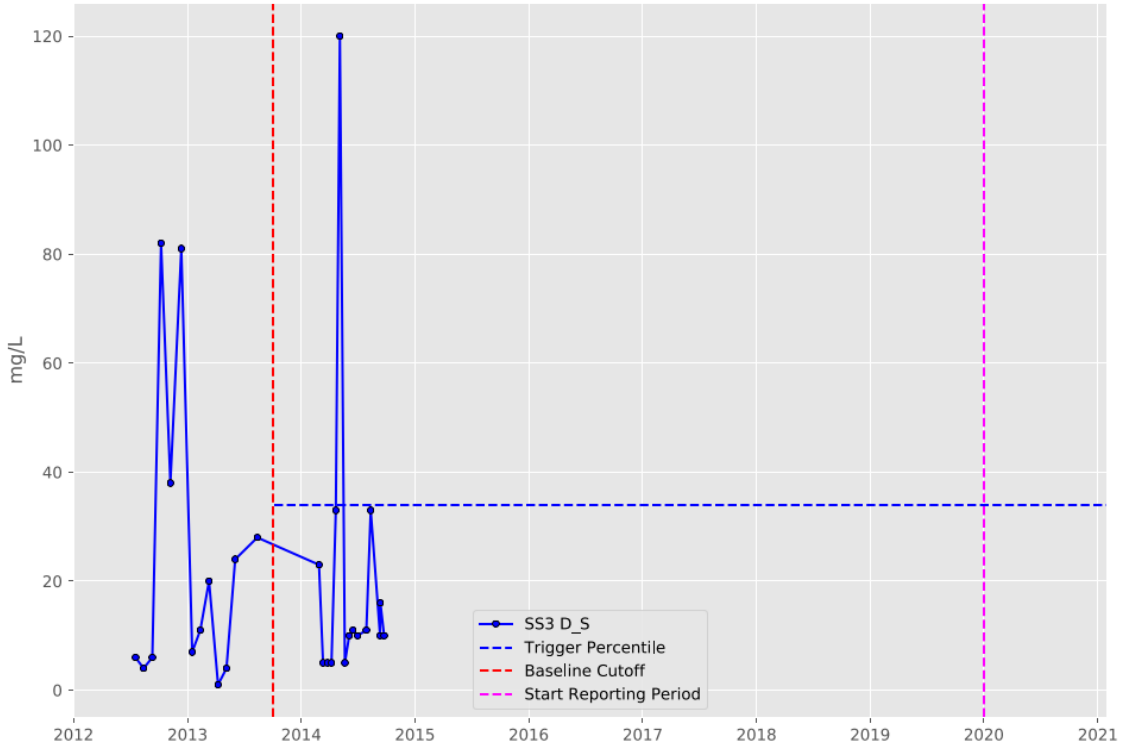

Figure 8.65: SS3 DS - TSS

8.2.8 East Wolgan

TIA triggers were not developed at the time of monitoring at East Wolgan sites. As a result, there are no triggers associated with this site. That said, retrospective 80th percentiles will be applied to these sites to gain a better understanding of natural variability.

East Wolgan has historically been discharge point and historical flows water quality are primarily influenced by these discharges.

8.2.8.1 Statistics

Table 8.12 presents the surface water quality summary.

Table 8.12: East Wolgan - Surface water quality summary statistics

ID	Historic date ranges	Analyte	Pre-mining data statistics				80th percentile trigger &	Reporting period statistics			Comments
			Data point count	Min	Mean	Max		Min	Median	Max	
East Wolgan Upstream	8/04/2005 – 11/04/2006										
		pH	25	7.1	8.64	8.9	7.8-9.7	Dry	Dry	Dry	Dry
		EC (µS/cm)	25	680	905	1055	1098	Dry	Dry	Dry	Dry
		Fe (mg/L)	25	0.1	0.437	1.3	1.25	Dry	Dry	Dry	Dry
		Mn (mg/l)	25	0	0.012	0.12	0.0689	Dry	Dry	Dry	Dry

ID	Historic date ranges	Analyte	Pre-mining data statistics				80th percentile trigger &	Reporting period statistics			Comments
			Data point count	Min	Mean	Max		Min	Median	Max	
		TSS (mg/L)	-	-	-	-	-	Dry	Dry	Dry	Dry
		DO (mg/L)	-	-	-	-	-	Dry	Dry	Dry	Dry
		Flow (kl/day)	-	-	-	-	-	Dry	Dry	Dry	Dry
East Wolgan Downstream	8/04/2005 – 24/04/2006										
		pH	28	6.4	8.2	8.7	6.9-9.7	Dry	Dry	Dry	Dry
		EC (µS/cm)	28	126	591	900	832	Dry	Dry	Dry	Dry
		Fe (mg/L)	27	0.11	0.464	1.2	0.626	Dry	Dry	Dry	Dry
		Mn (mg/l)	27	0	0.0029	0.02	0.01	Dry	Dry	Dry	Dry
		TSS (mg/L)						Dry	Dry	Dry	Dry
		DO (mg/L)						Dry	Dry	Dry	Dry
		Flow (kl/day)						Dry	Dry	Dry	Dry
East Wolgan Downstream Junction	8/04/2005 – 21/06/2006										
		pH	8	6.5	7.18	8.3	5.7-8.4	4.4	5.45	6.9	No trigger
		EC (µS/cm)	8	40	104	330	298	28	47	248	No trigger
		Fe (mg/L)	8	0.17	0.398	0.91	1.05	0.07	0.145	0.61	No trigger
		Mn (mg/l)	8	0	0.0005	0.004	0.003	0.003	0.009	0.019	No trigger
		TSS (mg/L)	-	-	-	-	-	5	5	106	No trigger
		DO (mg/L)	-	-	-	-	-	5.7	8.55	12.4	No trigger
		Flow (kl/day)	-	-	-	-	-	229	565.5	1071	No trigger

Notes: * value at detection limit (Limit of Reporting - LOR)
positive delta value equals a recent value that is greater than the historic mean, and vice versa for negative delta values.
% no monitoring data available post 19/10/2019, due to lack of access caused to bushfire/ dry conditions
@ where values are below limit of reporting, a value of half the measurement has been assumed.
& investigation trigger performance indicators based on Table 33 of the SMP LW424-LW427. The long- and short-term triggers are based on the 80th data percentile and the 80th percentile plus two standard deviations, respectively

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8.2.8.2 Quality Trend

SMP states that surface water results will be assessed against performance triggers for the parameters pH, EC, Iron, Manganese and TSS. No triggers are applicable to East Wolgan as it does not have a baseline. Historical flows at East Wolgan are from discharge points and do not represent natural conditions. The trends for these analytes are shown below.

Flows at East Wolgan Upstream and Downstream stopped in 2009 when discharge stopped. The water quality at East Wolgan is heavily influenced by historical discharge. Further downstream at East Wolgan Downstream junction the influence of discharge is diluted but the evidence is still present with elevated levels of EC, Iron and Manganese compared to other swamps.

Graphs for all other parameter trends are included in **Appendix G**.

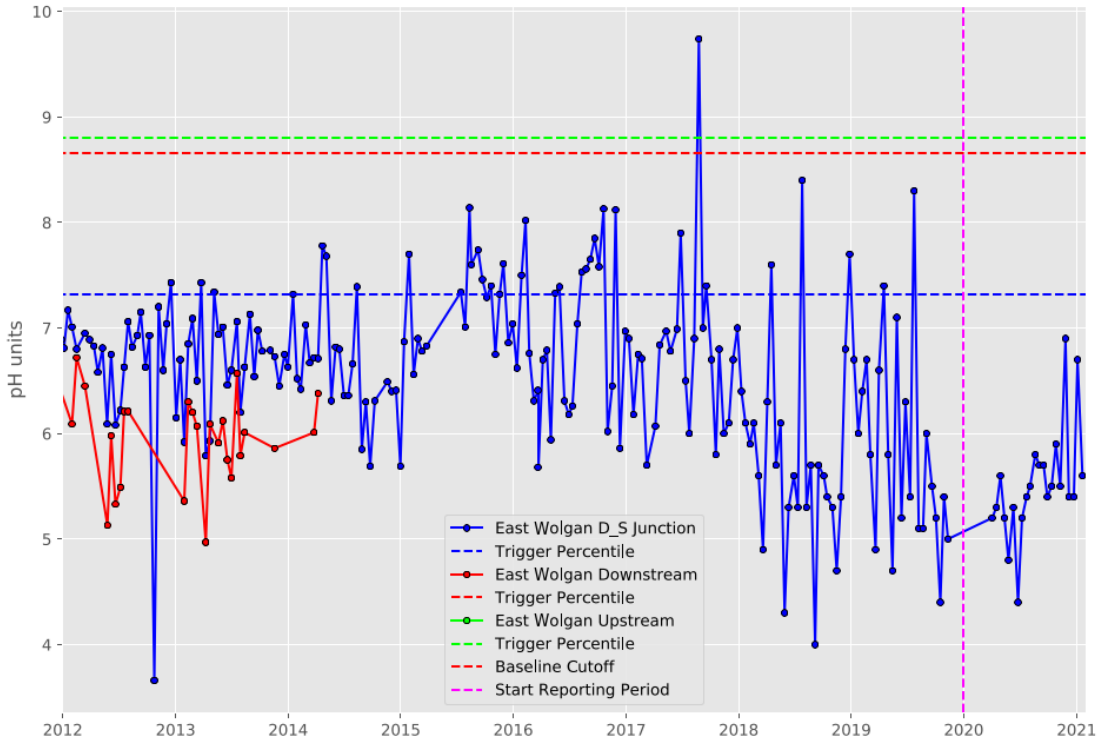

Figure 8.66: East Wolgan - pH

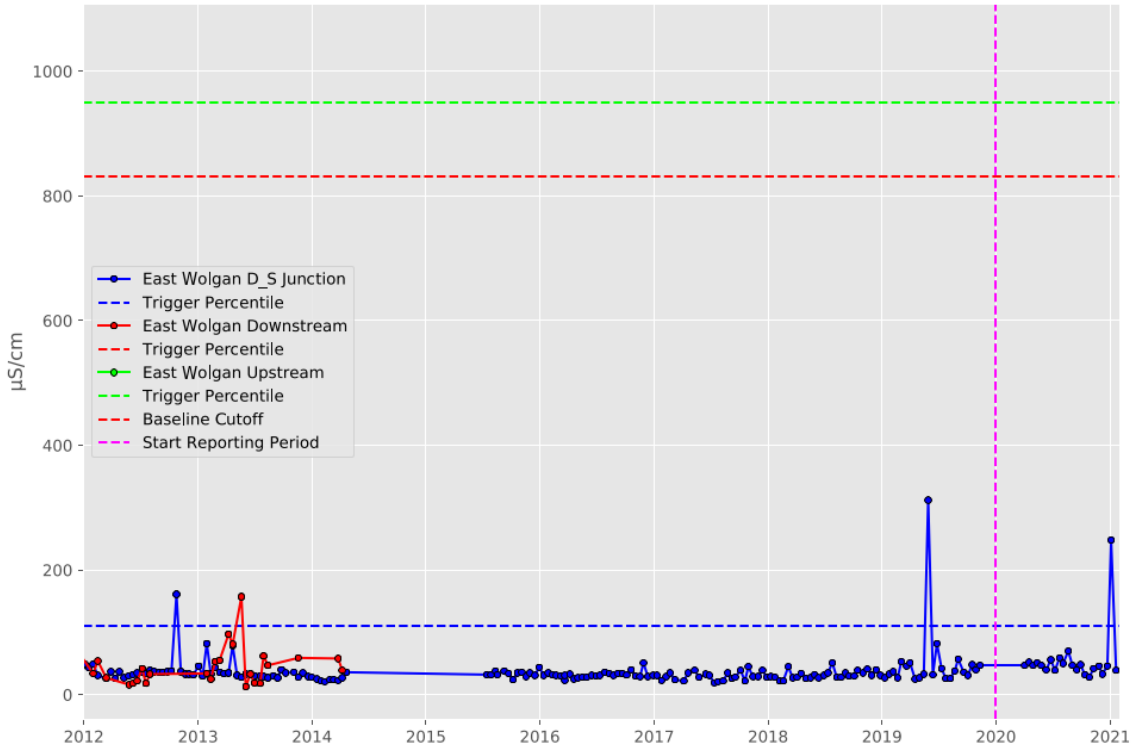

Figure 8.67: East Wolgan - EC

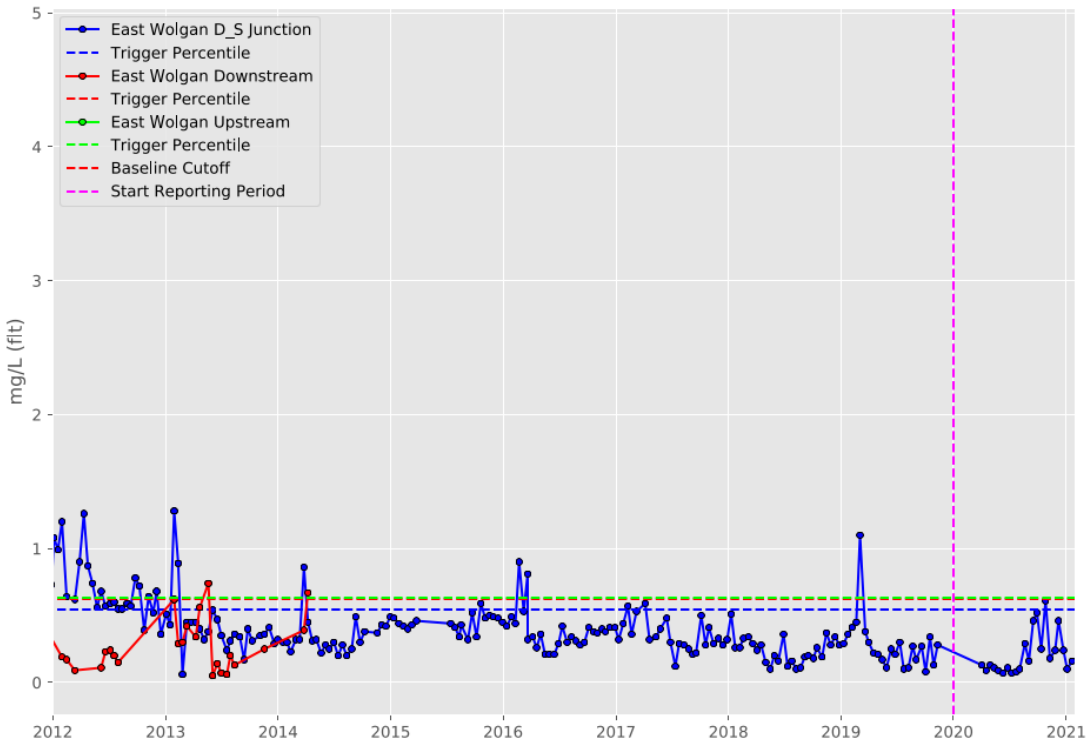

Figure 8.68: East Wolgan - Iron

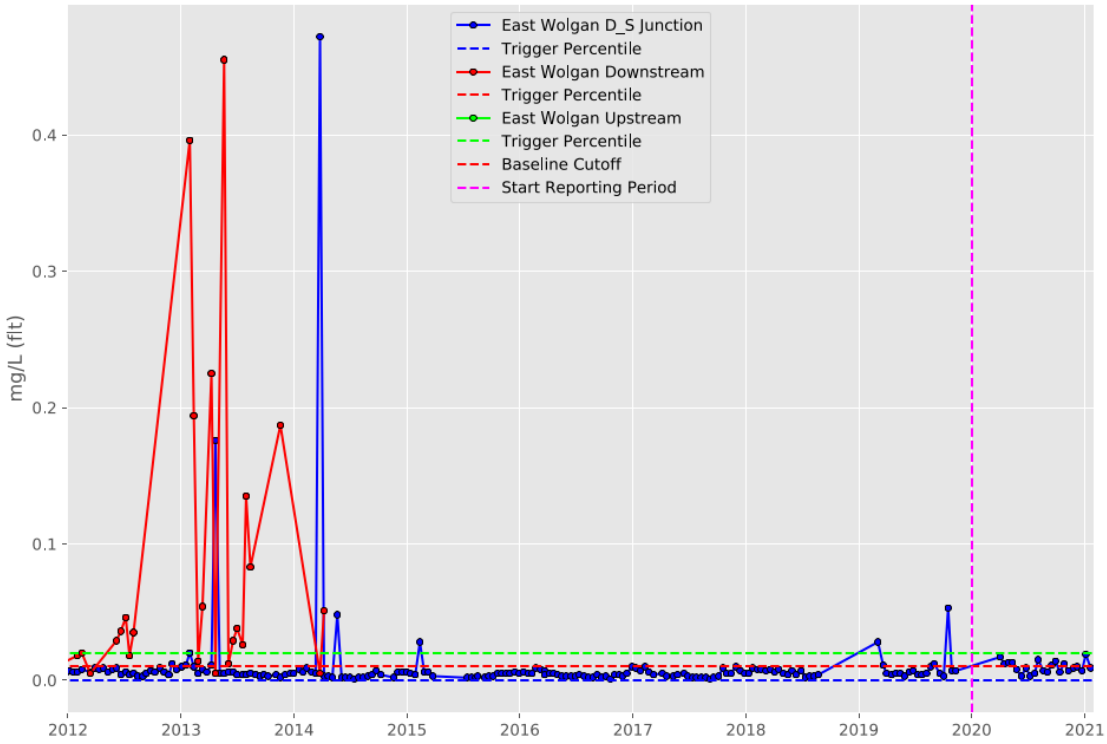

Figure 8.69: East Wolgan - Manganese

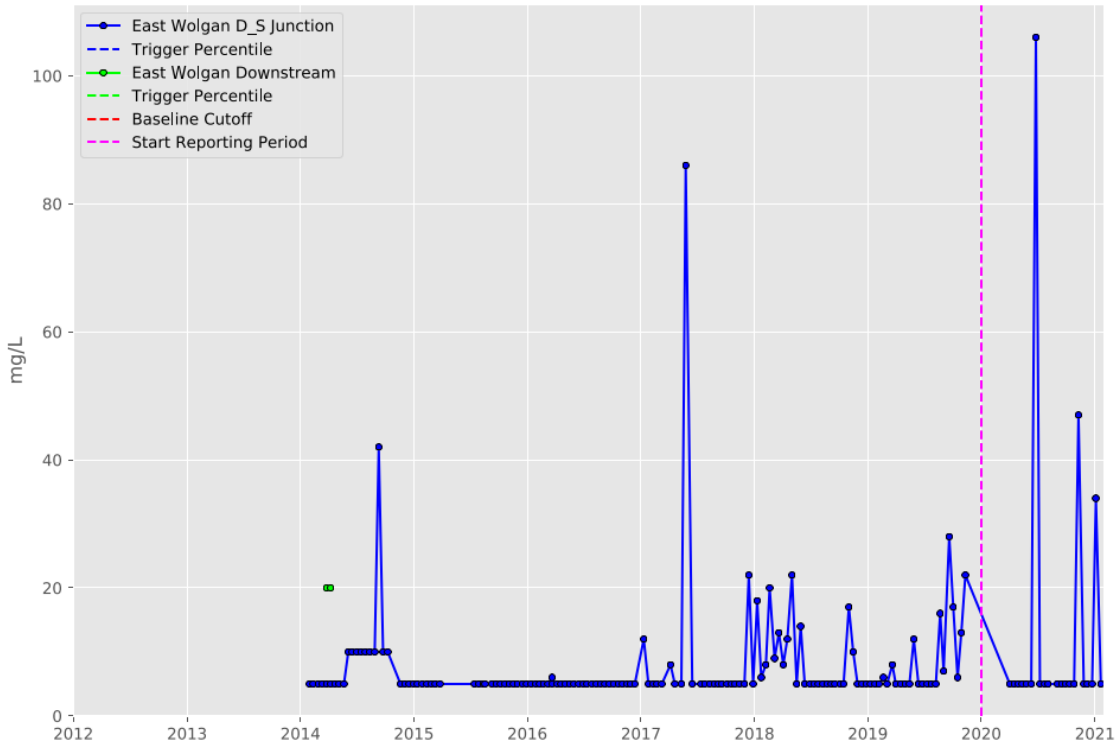

Figure 8.70: East Wolgan - TSS

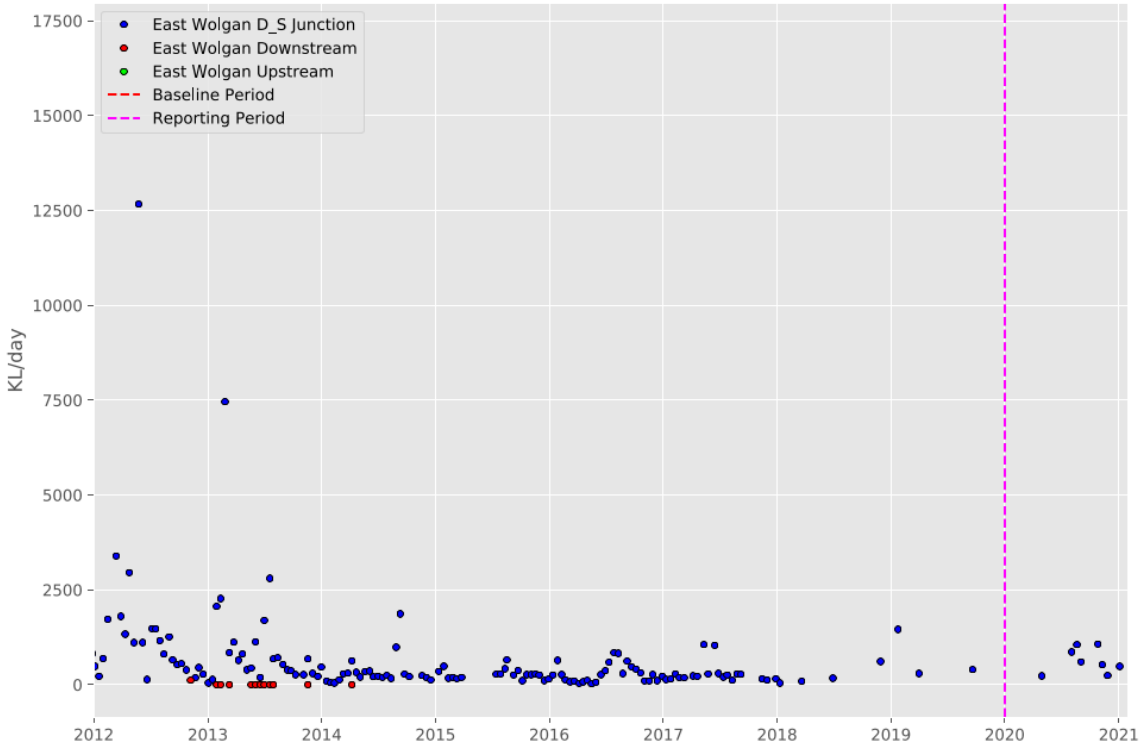

Figure 8.71: East Wolgan - Flows

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9. Surface Water Quality – WMP

Surface water quality and flows at Springvale are monitored under the Swamp Management Plans and Water Management Plans. Surface water quality parameters monitored at these sites are field parameters (pH, Temp, EC, eH, DO, Turbidity, Flow), major ions, trace ions and nutrients. That said, the performance indicators are different between the SMP and WMP sites and this report will classify those sites under their respective management plans

Table 13 and Table 14 of the WMP LW424-427 outlines the performance measures against the 80th percentile reference dataset. If the TSS, pH and EC is greater than the 80th percentile at reference site for more than three consecutive monitoring events, the trigger is breached. When there are insufficient data points and whether the trigger is met is defined by default trigger values summarised in Table 1.2.

The locations of the surface water monitoring points are shown on Appendix A and the data is presented in Appendix G.

9.1 Reference Sites

Reference swamp sites are sites that are regarded to be unimpacted by mining activities. The graphs of the main analytes show the general trends. The beginning of the reporting period is marked by the dotted line at January 2020. At reference sites, the whole dataset is considered to be baseline data and baseline cut off is at the most recent monitoring round. There are no triggers at reference sites.

9.1.1 Carne Central

Carne Central monitoring site is in the western tributaries of Carne Creek

9.1.1.1 Statistics

Table 9.1 presents the surface water summary.

Table 9.1: Carne Central - Surface water quality summary statistics

ID	Historic date ranges	Analyte	Historic data statistics				80th percentile trigger &	Reporting period			Comments
			Data point count	Min	Mean	Max		Min	Median	Max	
Carne Central	21/03/2016 - present										
		pH	47	4.1	5.63	7.4	4.7-6.4	3.9	4.6	4.9	Reference site - No trigger
		EC (µS/cm)	47	19	80.1	1260	49.4	23	118	1260	High EC Reference site - No trigger
		Fe (mg/L)	18	0.05*	0.206	1.82	0.186	0.05	0.05	0.05	Reference site - No trigger
		Mn (mg/l)	18	0.002	0.0143	0.055	0.172	0.021	0.046	0.051	Reference site - No trigger
		TSS (mg/L)	17	3	21.3	210	10.8	5	5	5	Reference site - No trigger

SPRINGVALE

ID	Historic date ranges	Analyte	Historic data statistics				80th percentile trigger &	Reporting period			Comments
			Data point count	Min	Mean	Max		Min	Median	Max	
		DO (mg/L)	46	2.7	8.1	12.7	10.07	5.5	8.2	12.7	Reference site - No trigger
		Flow (kl/day)	10	47	139.5	365	192	-	-	-	Reference site - No trigger

Notes: * value at detection limit (Limit of Reporting - LOR)
positive delta value equals a recent value that is greater than the historic mean, and vice versa for negative delta values.
% no monitoring data available post 19/10/2019, due to lack of access caused to bushfire/ dry conditions
@ where values are below limit of reporting, a value of half the measurement has been assumed.
& investigation trigger performance indicators based on Table 33 of the SMP LW424-LW427. The long- and short-term triggers are based on the 80th data percentile and the 80th percentile plus two standard deviations, respectively

9.1.1.2 Quality Trend

WMP states that surface water results will be assessed against performance triggers for the parameters pH, EC, and TSS. Performance triggers are not applicable to reference sites. The trends for these analytes are shown below.

Since mid 2017 sampling at Carne Central has been intermittent due to dry conditions. pH at Carne Central is generally acidic, the pH during the reporting period is towards the lower range of historical limits. EC concentrations are trending upwards since mid 2017 with EC during the reporting period significantly higher from the ash in the runoff post bushfire. The spike in EC May 2020 is likely erroneous as the TDS, anion and cation ion concentrations did not show a significant increase. TSS is generally stable with the odd temporary increase. DO remained above 6 mg/L. Flows have not been continuously recorded since 2017 with depths often too low to sample or has pooled water. This is most likely a direct influence from the declining rainfalls since 2016.

No mining related groundwater impacts are visible for the reporting period.

Graphs for all other parameter trends are included in **Appendix G**. Trends of note are:

- Alkalinity – observed to increase post bushfire
- Nitrogen nutrients – elevated levels of nitrates during reporting period.

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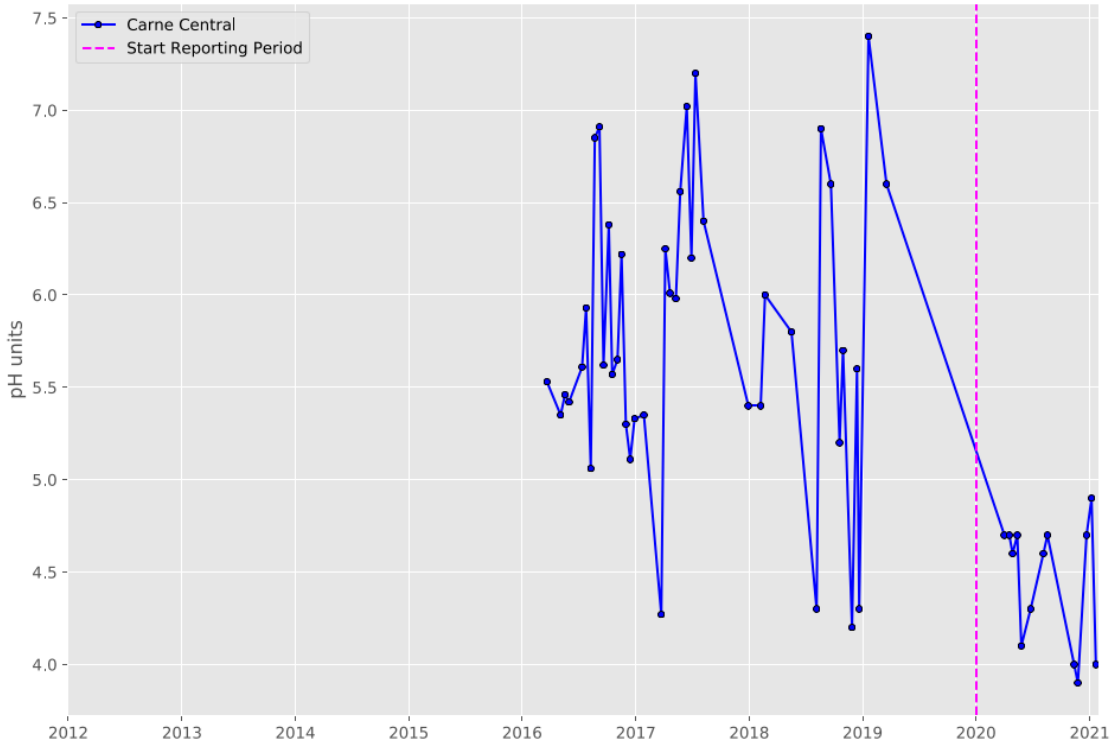
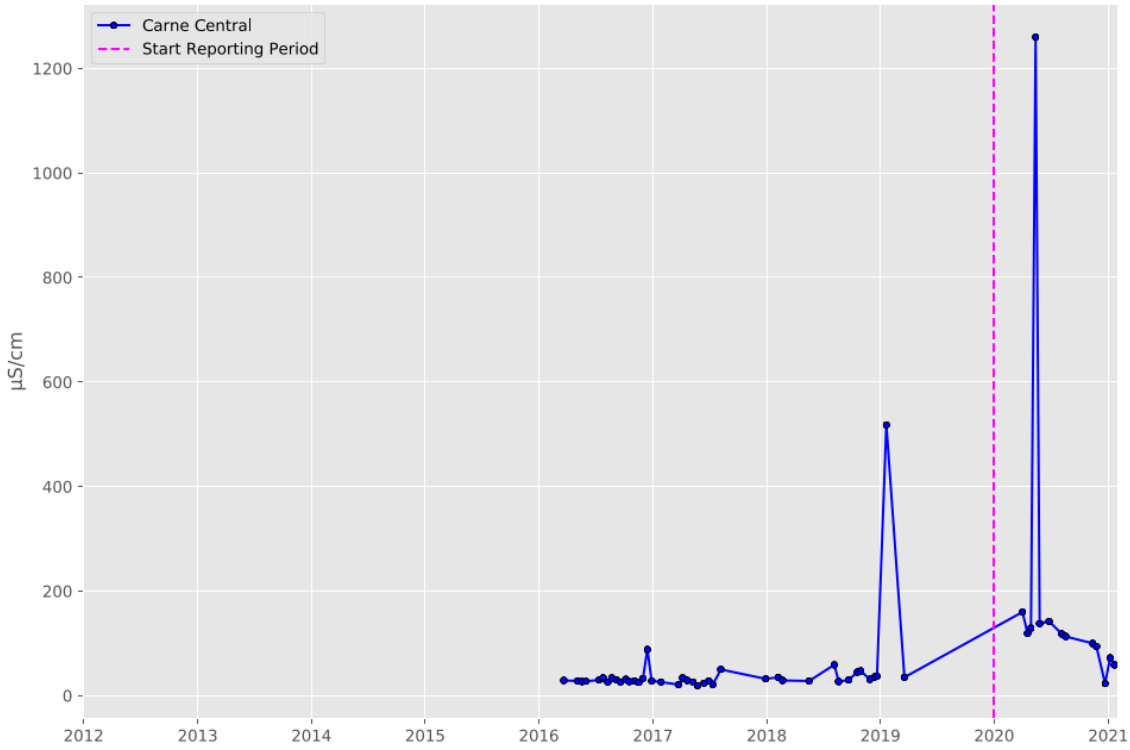


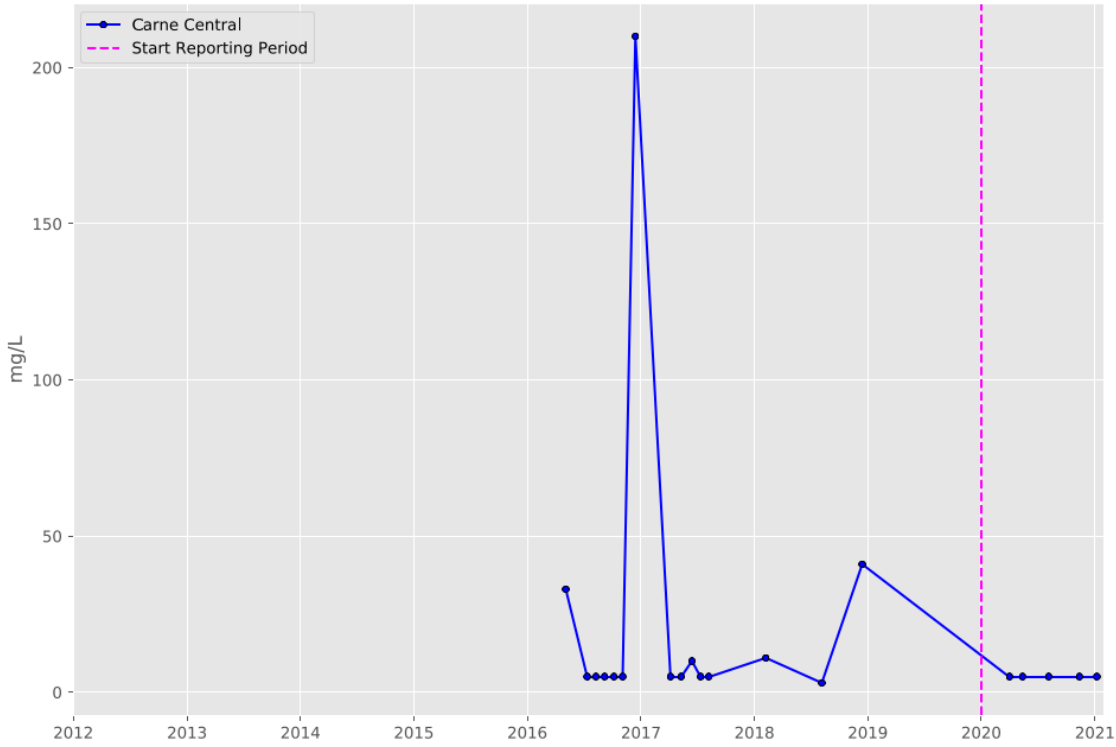
NB – Trigger not applicable to reference sites

Figure 9.1: Carne Central - pH



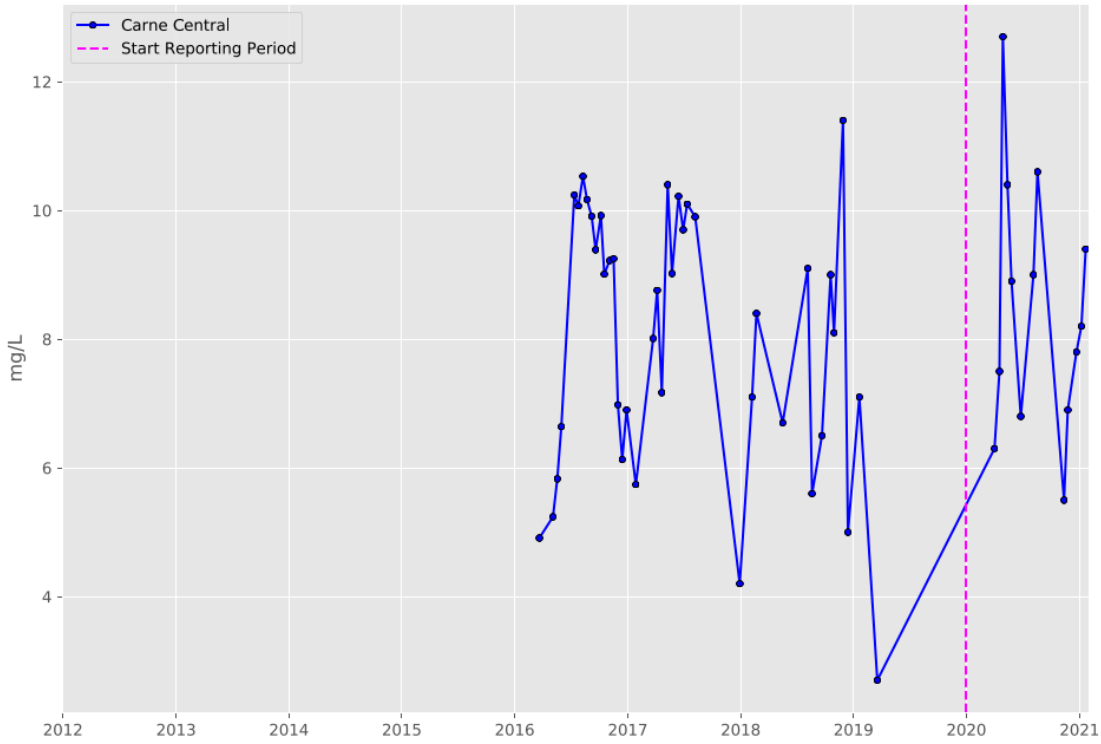
NB – Trigger not applicable to reference sites

Figure 9.2: Carne Central - EC



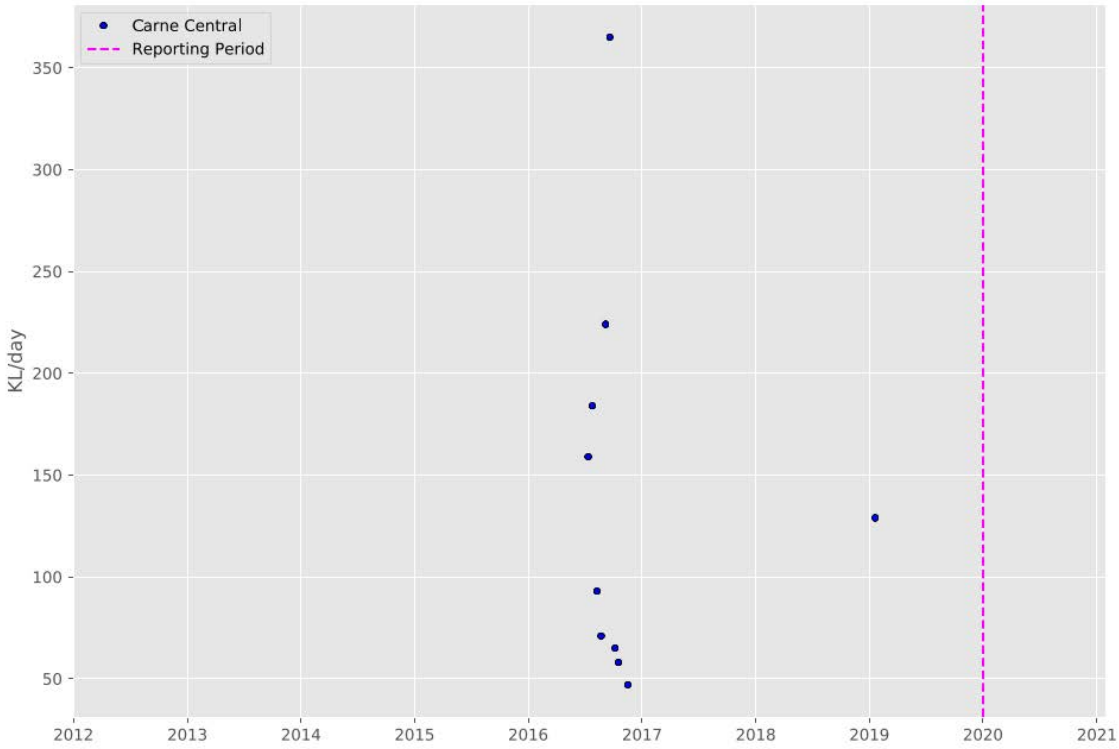
NB – Trigger not applicable to reference sites

Figure 9.3: Carne Central - TSS



NB – Trigger not applicable to reference sites

Figure 9.4: Carne Central - DO



NB – Trigger not applicable to reference sites

Figure 9.5: Carne Central - Flow

9.1.2 Tri Star

Tristar is part of the Wolgan river tributary.

9.1.2.1 Statistics

Table 9.2 presents the surface water summary statistics

Table 9.2: Tristar - Surface water quality summary statistics

ID	Historic date ranges	Analyte	Historic data statistics				80th percentile trigger &	Reporting period statistics			Comments
			Data point count	Min	Mean	Max		Min	Median	Max	
Tristar (Springvale Site)	2/11/2016 - present										
		pH	67	3.6	5.9	8.3	5.0-6.9	4	5.2	7.3	Reference site - No trigger
		EC (µS/cm)	67	17	76	2641	41	26	39	70	Reference site - No trigger
		Fe (mg/L)	30	0.11	0.308	1.13	0.38	0.26	0.365	0.58	Reference site - No trigger
		Mn (mg/l)	30	0.007	0.0119	0.036	0.014	0.012	0.015	0.036	Reference site - No trigger

ID	Historic date ranges	Analyte	Historic data statistics				80th percentile trigger &	Reporting period statistics			Comments
			Data point count	Min	Mean	Max		Min	Median	Max	
		TSS (mg/L)	30	5	9.83	69	9.6	5	14	69	Reference site - No trigger
		DO (mg/L)	65	4.9	9.08	15.3	10.4	5.8	7.8	11.7	Reference site - No trigger
		Flow (kl/day)	43	60	677	10627	567	95	518	2851	Reference site - No trigger

Notes: * value at detection limit (Limit of Reporting - LOR)
positive delta value equals a recent value that is greater than the historic mean, and vice versa for negative delta values.
% no monitoring data available post 19/10/2019, due to lack of access caused to bushfire/ dry conditions
@ where values are below limit of reporting, a value of half the measurement has been assumed.
& investigation trigger performance indicators based on Table 33 of the SMP LW424-LW427. The long- and short-term triggers are based on the 80th data percentile and the 80th percentile plus two standard deviations, respectively

9.1.2.2 Quality Trend

WMP states that surface water results will be assessed against performance triggers for the parameters pH, EC, and TSS. Performance triggers are not applicable to reference sites. The trends for these analytes are shown below.

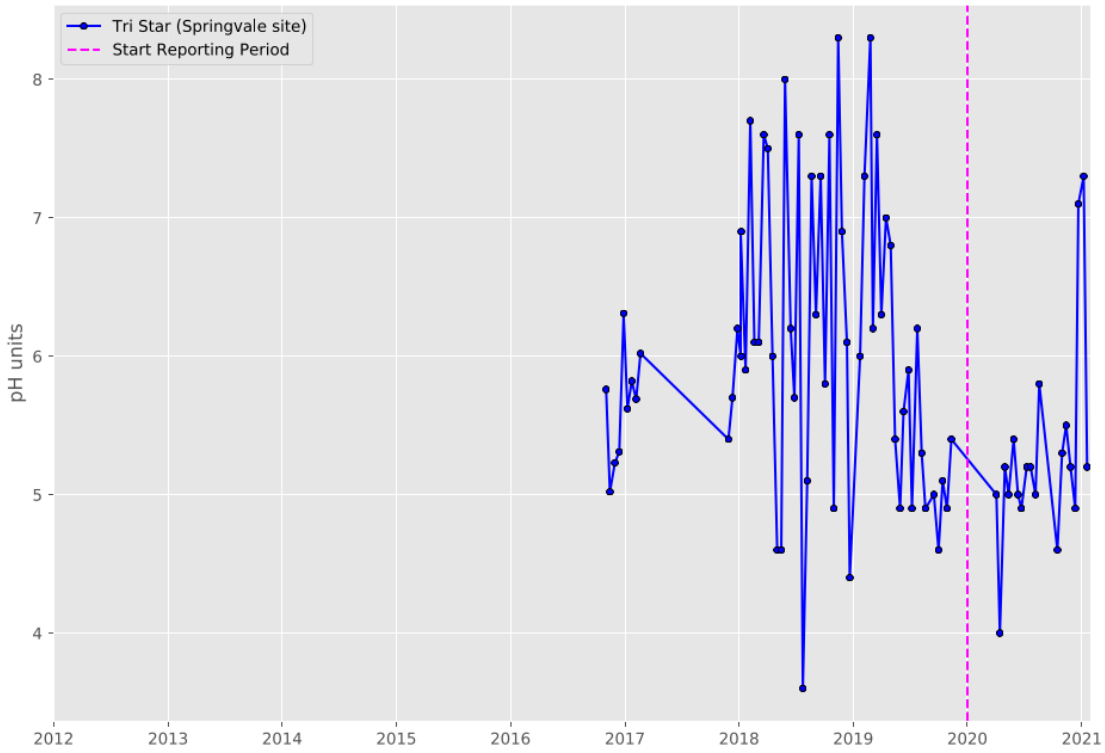
pH at Tristar is highly variable and the measurements during the reporting period are on the lower range of the data. EC is stable, the high reading in 2017 is likely erroneous. The peak in TSS in the early reporting period is most likely due to ash in the runoff post bushfire. DO is relative stable around a mean of 7.8mg/l. Flows are generally consistent at Tristar with the majority of flows below 400kl/day. Flow measurements became intermitted from mid 2019 onwards due to declining rains.

No mining related groundwater impacts are visible for the reporting period.

Graphs for all other parameter trends are included in **Appendix G**. Trends of note are:

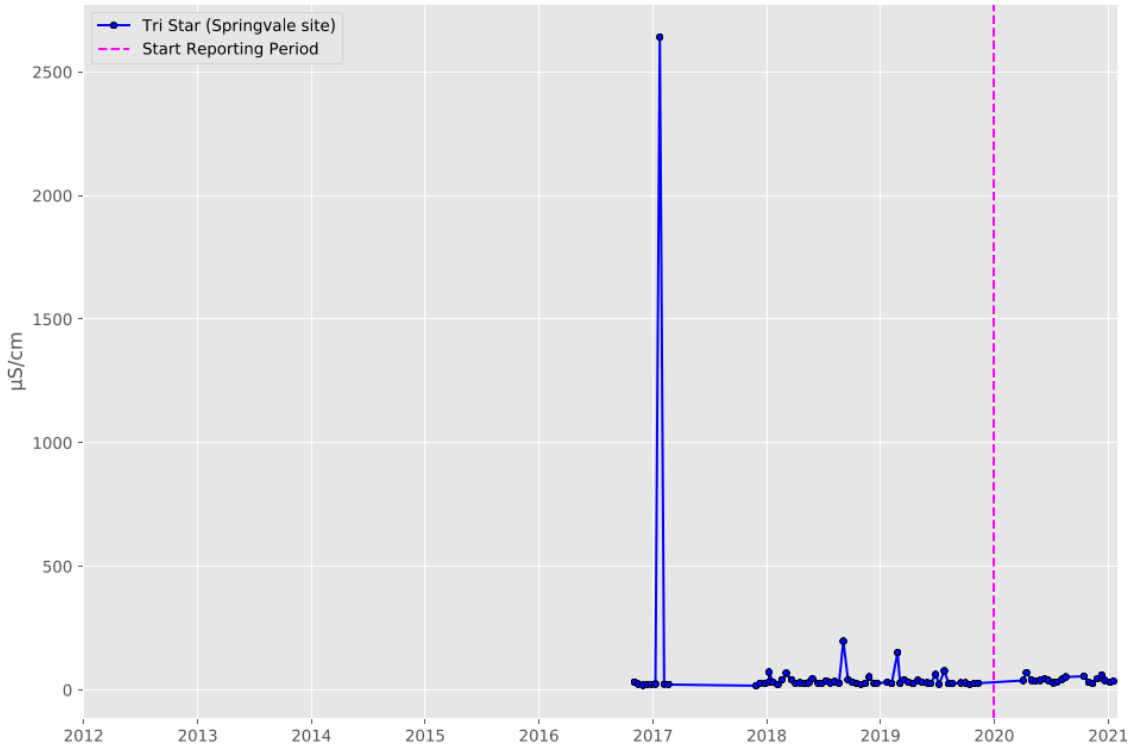
- Anions – increasing trend in reporting period most likely from ash in runoff
- Iron – seasonal trend with peaks in the summer months
- Manganese – the peak in the reporting period most likely from the bushfire impacts

SPRINGVALE



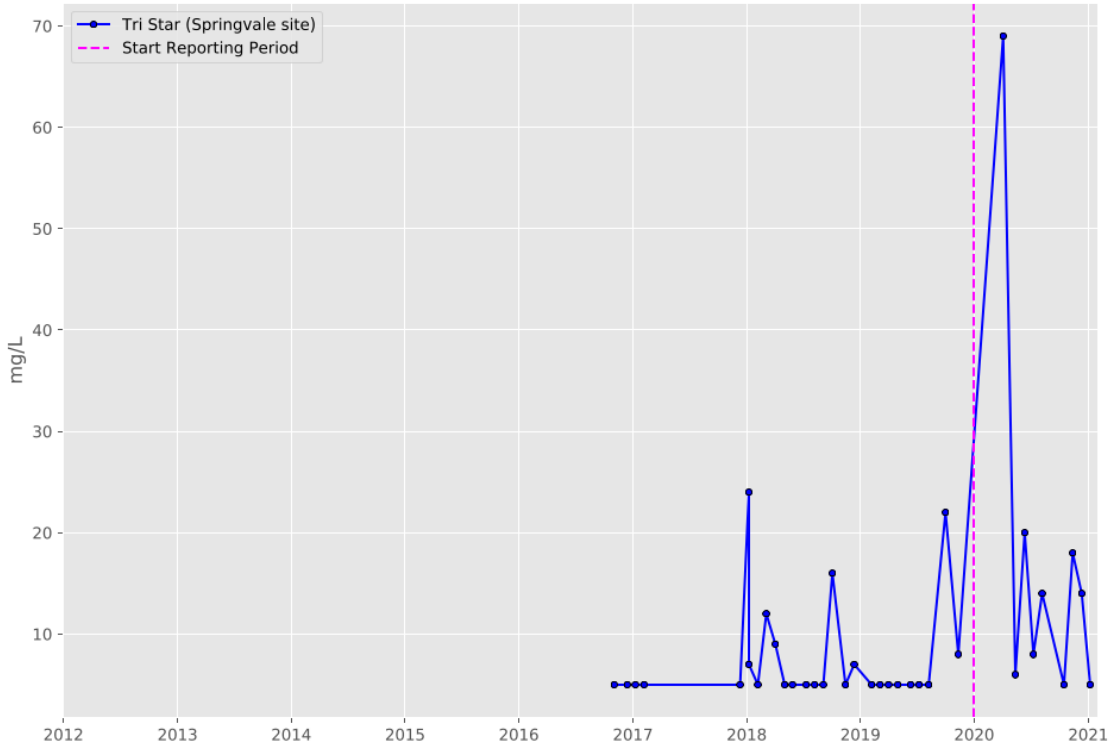
NB – Trigger not applicable to reference sites

Figure 9.6: Tristar - pH



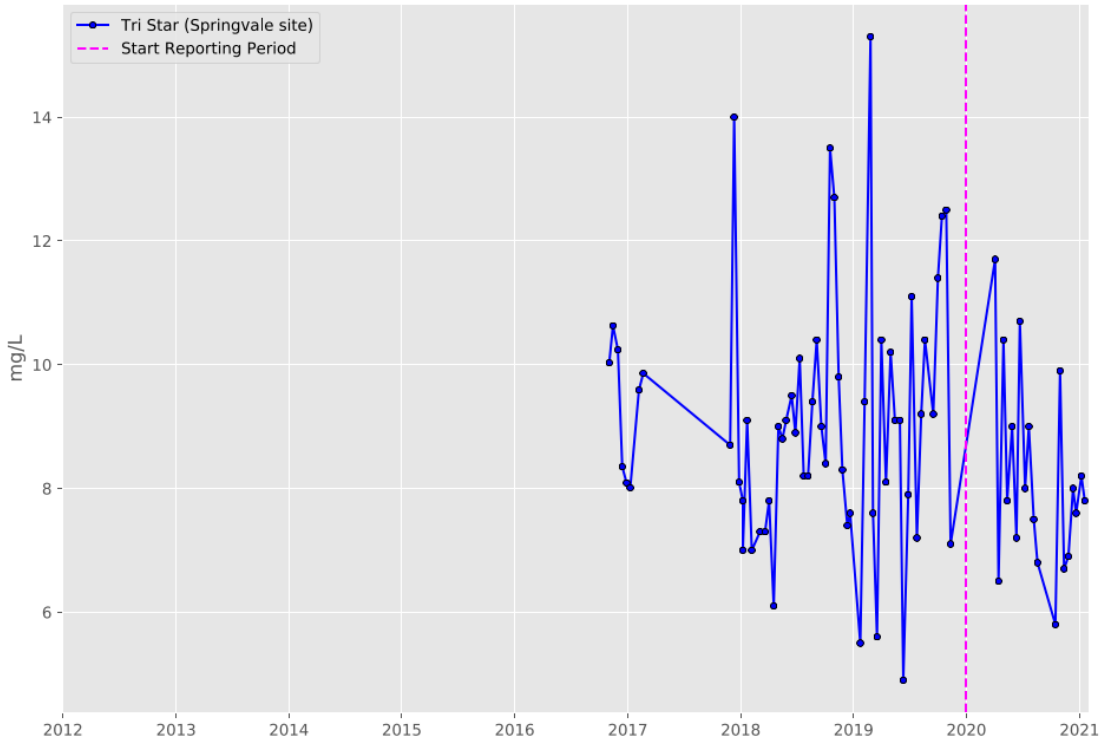
NB – Trigger not applicable to reference sites

Figure 9.7: Tristar - EC



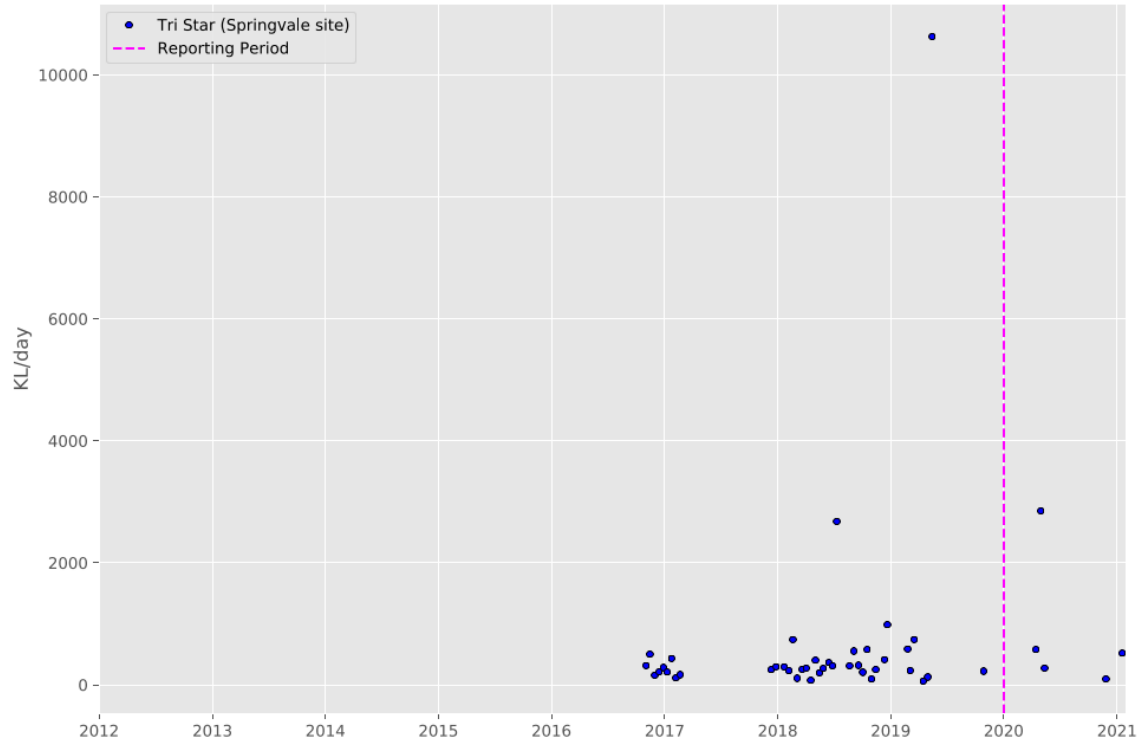
NB – Trigger not applicable to reference sites

Figure 9.8: Tristar - TSS



NB – Trigger not applicable to reference sites

Figure 9.9: Tristar - DO



NB – Trigger not applicable to reference sites

Figure 9.10: Tristar - Flows

9.1.3 Twin Gully

Twin Gully is part of the Wolgan River tributary.

9.1.3.1 Statistics

Table 9.3 presents the surface water summary statistics.

Table 9.3: Twin Gully - Surface water quality summary statistics

ID	Historic date ranges	Analyte	Historic data statistics				80th percentile trigger &	Reporting period statistics			Comments
			Data point count	Min	Mean	Max		Min	Median	Max	
Twin Gully (Springvale Site)	2/11/2016										
		pH	66	2.8	5.7	8.4	4.8-6.7	4.5	5.1	6.9	Reference site - No trigger
		EC (µS/cm)	66	15	41.7	339	43	29	41	131	Reference site - No trigger
		Fe (mg/L)	31	0.12	0.33	1.09	0.41	0.14	0.395	0.78	Reference site - No trigger
		Mn (mg/l)	31	0.003	0.009	0.033	0.014	0.002	0.013	0.025	Reference site - No trigger

ID	Historic date ranges	Analyte	Historic data statistics				80th percentile trigger &	Reporting period statistics			Comments
			Data point count	Min	Mean	Max		Min	Median	Max	
		TSS (mg/L)	31	5	13.4	46	25	5	6	25	Reference site - No trigger
		DO (mg/L)	65	4.8	8.4	13.8	9.6	3.6	7.5	12	Reference site - No trigger
		Flow (kl/day)	29	14	235	1408	219	354	432	717	Reference site - No trigger

Notes: * value at detection limit (Limit of Reporting - LOR)
positive delta value equals a recent value that is greater than the historic mean, and vice versa for negative delta values.
% no monitoring data available post 19/10/2019, due to lack of access caused to bushfire/ dry conditions
@ where values are below limit of reporting, a value of half the measurement has been assumed.
& investigation trigger performance indicators based on Table 33 of the SMP LW424-LW427. The long- and short-term triggers are based on the 80th data percentile and the 80th percentile plus two standard deviations, respectively

9.1.3.2 Quality Trend

WMP states that surface water results will be assessed against performance triggers for the parameters pH, EC, and TSS. Performance triggers are not applicable to reference sites. The trends for these analytes are shown below.

pH at Twin gully is slightly acidic and was relatively stable during the reporting period. EC is generally low with minor fluctuation. EC concentrations showed a temporary peak during the reporting period most likely attributed to natural fluctuation. TSS is affected by numerous factors and has historically shown large fluctuations. DO in the reporting period is within historical bounds except for one sample in mid 2020 which fell below 4mg/L. Flows at Twin gully have been historically consistent until 2019 when flows were often too low to measure or pooled up. Flows during the reporting period were often too low to measure.

No mining related groundwater impacts are visible for the reporting period.

Graphs for all other parameter trends are included in **Appendix G**. Trends of note are:

- Aluminium – seasonal trend with peaks around January. Elevated levels were recorded in the most recent data in June
- Iron – seasonal trend with peaks in the summer months.
- Zinc – increasing trend in 2020
- Cations – increased concentrations past bushfire.

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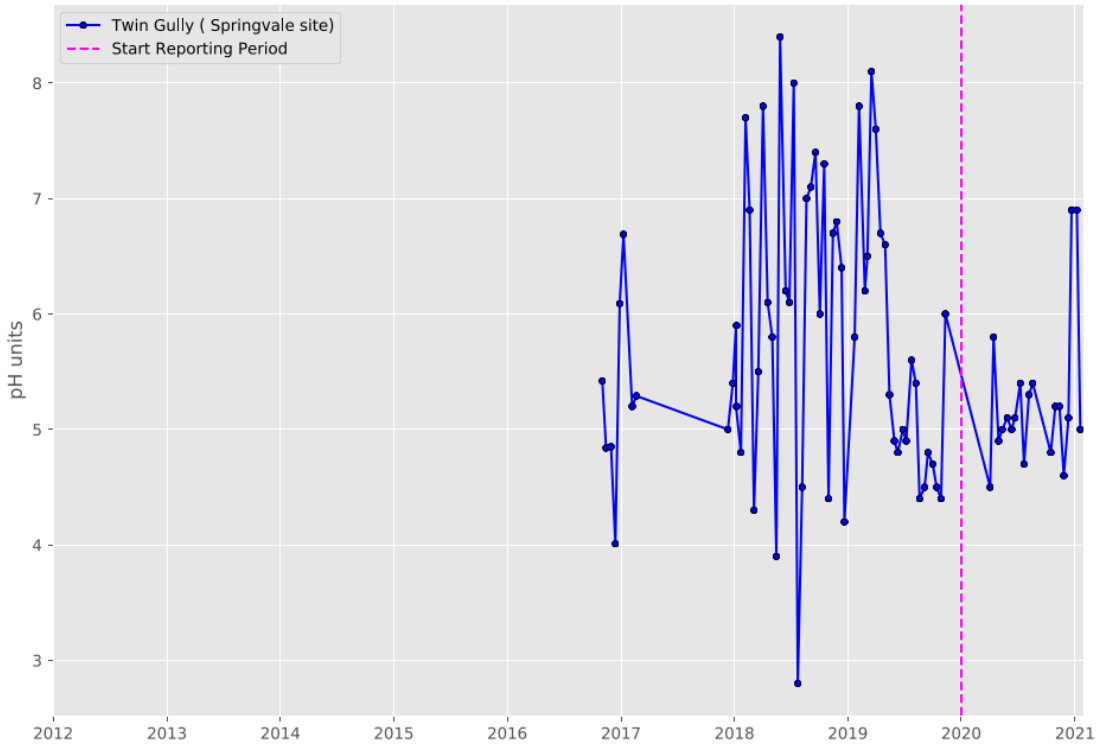
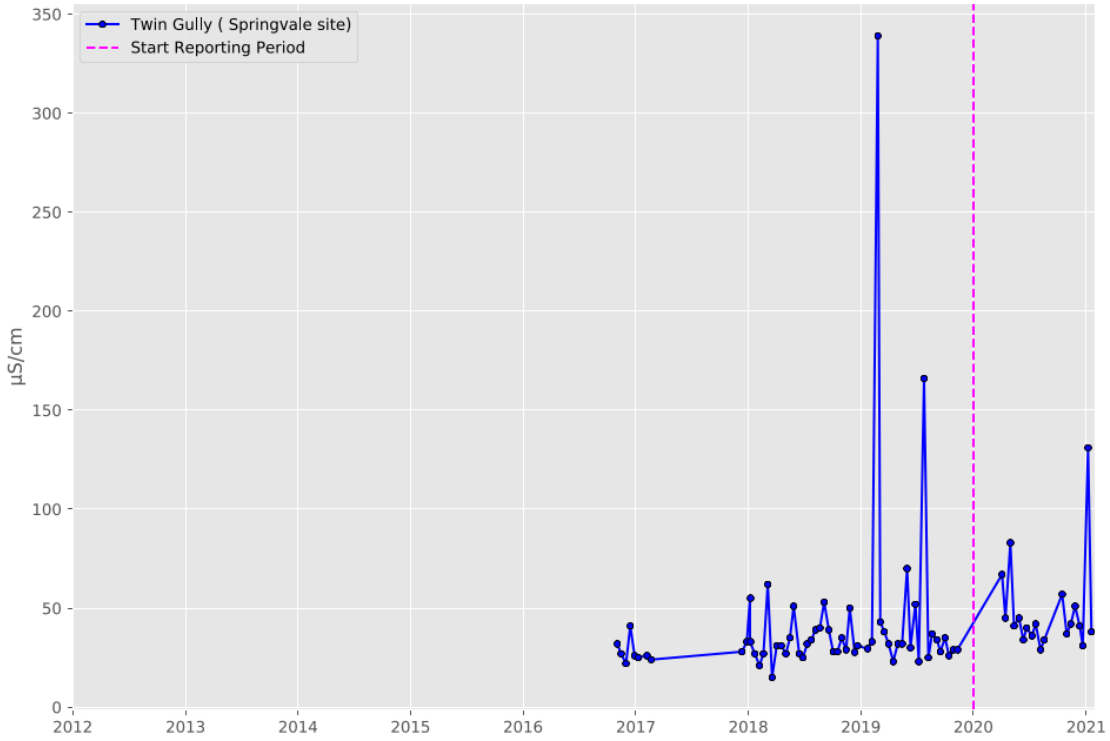


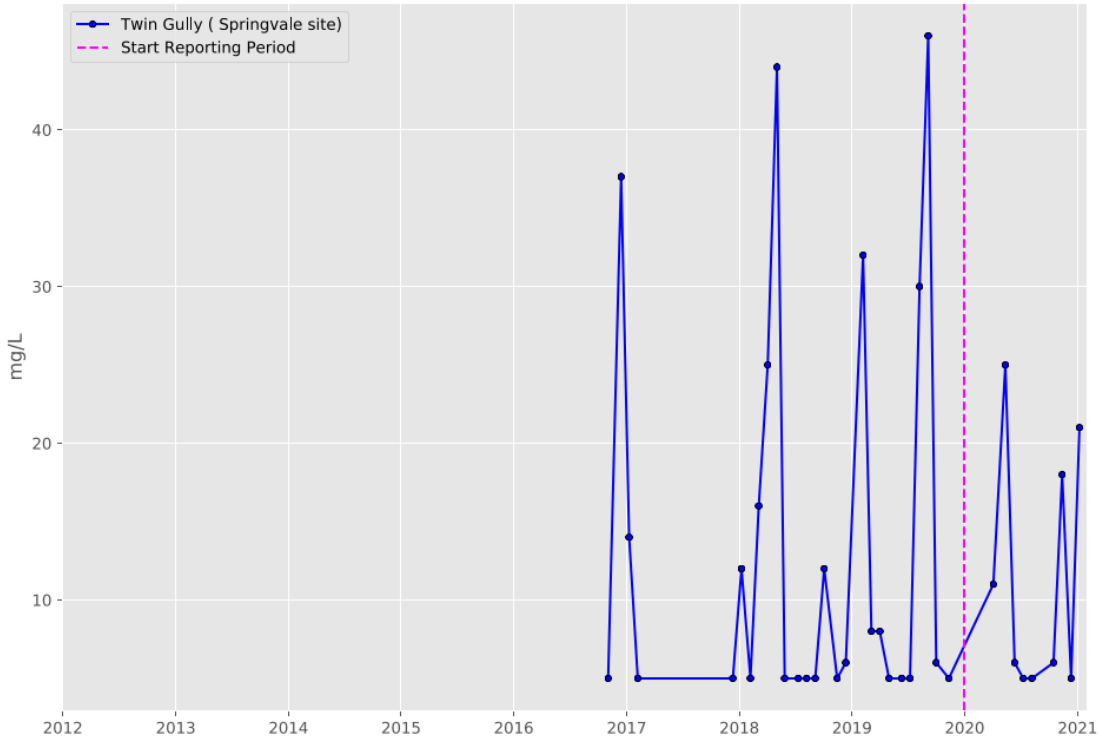
NB – Trigger not applicable to reference sites

Figure 9.11: Twin Gully - pH



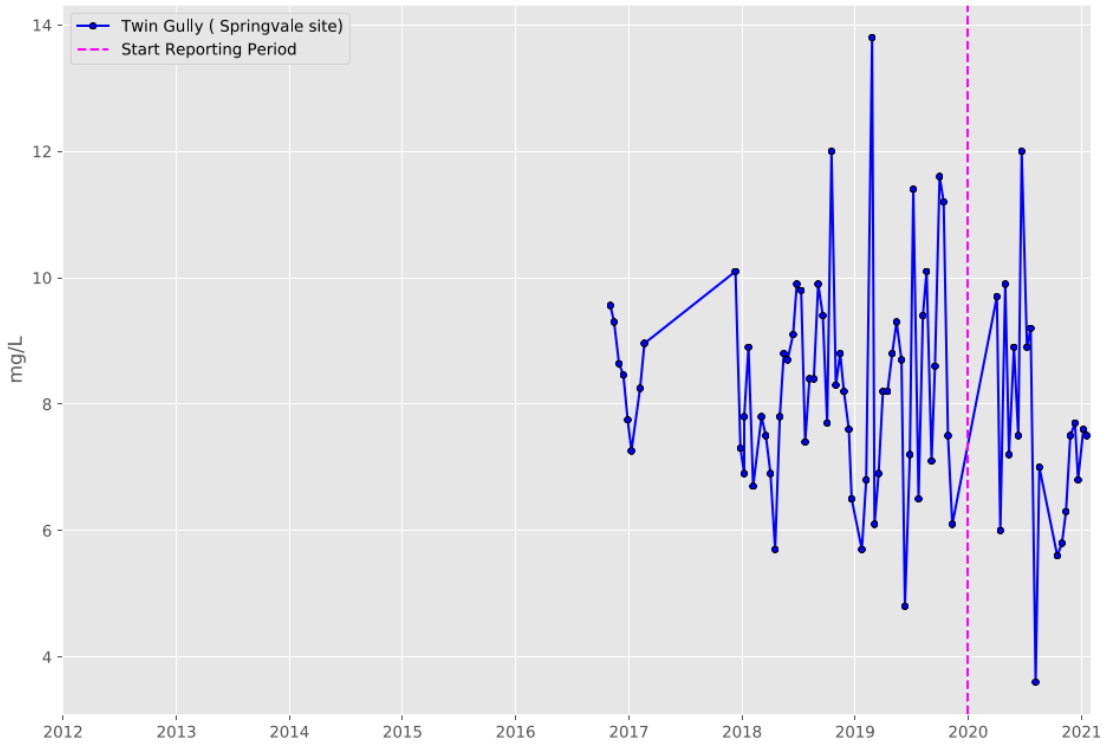
NB – Trigger not applicable to reference sites

Figure 9.12: Twin Gully - EC



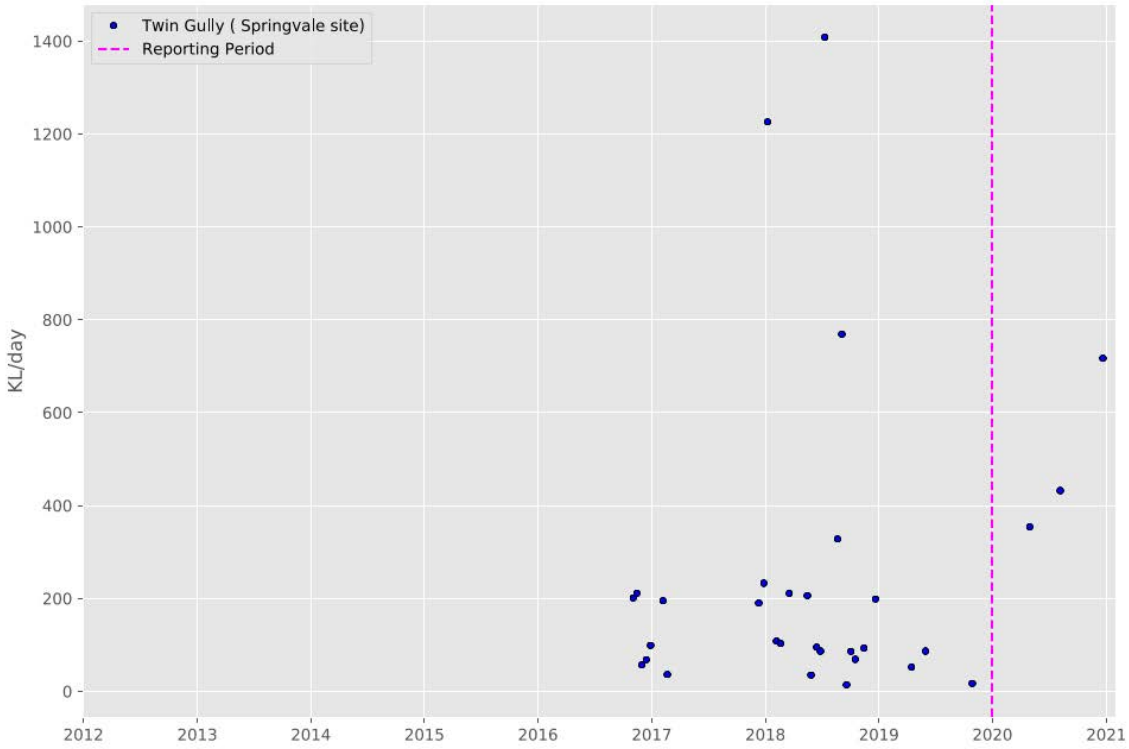
NB – Trigger not applicable to reference sites

Figure 9.13: Twin Gully - TSS



NB – Trigger not applicable to reference sites

Figure 9.14: Twin Gully - DO



NB – Trigger not applicable to reference sites

Figure 9.15: Twin Gully - Flow

9.1.4 Wolgan River

9.1.4.1 Statistics

Table 9.4 outlines the surface water summary statistics.

Table 9.4: Wolgan River - Surface water quality summary statistics

ID	Historic date ranges	Analyte	Pre-mining data statistics				80th percentile	Reporting period statistics			Comments
			Data point count	Min	Mean	Max		Min	Median	Max	
Wolgan River Downstream	4/01/2002 – present										
		pH	862	4.4	7.1	8.83	6.5-8.0	4.5	6.05	6.6	Reference site - No trigger
		EC (µS/cm)	837	6.45	206.82	5890	478	40	56.5	102	Reference site - No trigger
		Fe (mg/L)	439	0	0.498	3.59	0.65	0.05	0.255	0.51	Reference site - No trigger
		Mn (mg/l)	469	0	0.222	38	0.013	0.002	0.0255	0.184	Reference site - No trigger
		TSS (mg/L)	295	0	4.29	63	5	5	5	14	Reference site - No trigger

ID	Historic date ranges	Analyte	Pre-mining data statistics				80th percentile	Reporting period statistics			Comments
			Data point count	Min	Mean	Max		Min	Median	Max	
		DO (mg/L)	182	0.04	8.48	64	9.658	6.1	8.15	11.3	Reference site - No trigger
		Flow (kl/day)	298	0	3485	90547	5040	395	2702.5	13392	Reference site - No trigger
Wolgan River (Wolgan Valley)	30/04/2018 - present										
		pH	48	4.8	6.15	7.8	5.6-6.7	3.6	6.35	7.2	Reference site - No trigger
		EC (µS/cm)	48	31	222	5241	128.6	64	163	1648	Reference site - No trigger
		Fe (mg/L)	48	0.09	0.232	0.65	0.326	0.05	0.17	0.55	Reference site - No trigger
		Mn (mg/l)	48	0.004	5.404	38	7	0.017	0.133	0.207	Reference site - No trigger
		TSS (mg/L)	48	5	11.93	158	5	5	5	356	Reference site - No trigger
		DO (mg/L)	48	5.2	8.6	13.5	10	6	8.25	15.1	Reference site - No trigger
		Flow (kl/day)	40	104	9438	56450	11605	3430	21262.5	56450	Reference site - No trigger

Notes: * value at detection limit (Limit of Reporting - LOR)
positive delta value equals a recent value that is greater than the historic mean, and vice versa for negative delta values.
% no monitoring data available post 19/10/2019, due to lack of access caused to bushfire/ dry conditions
@ where values are below limit of reporting, a value of half the measurement has been assumed.
& investigation trigger performance indicators based on Table 33 of the SMP LW424-LW427. The long- and short-term triggers are based on the 80th data percentile and the 80th percentile plus two standard deviations, respectively

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9.1.4.2 Quality Trend

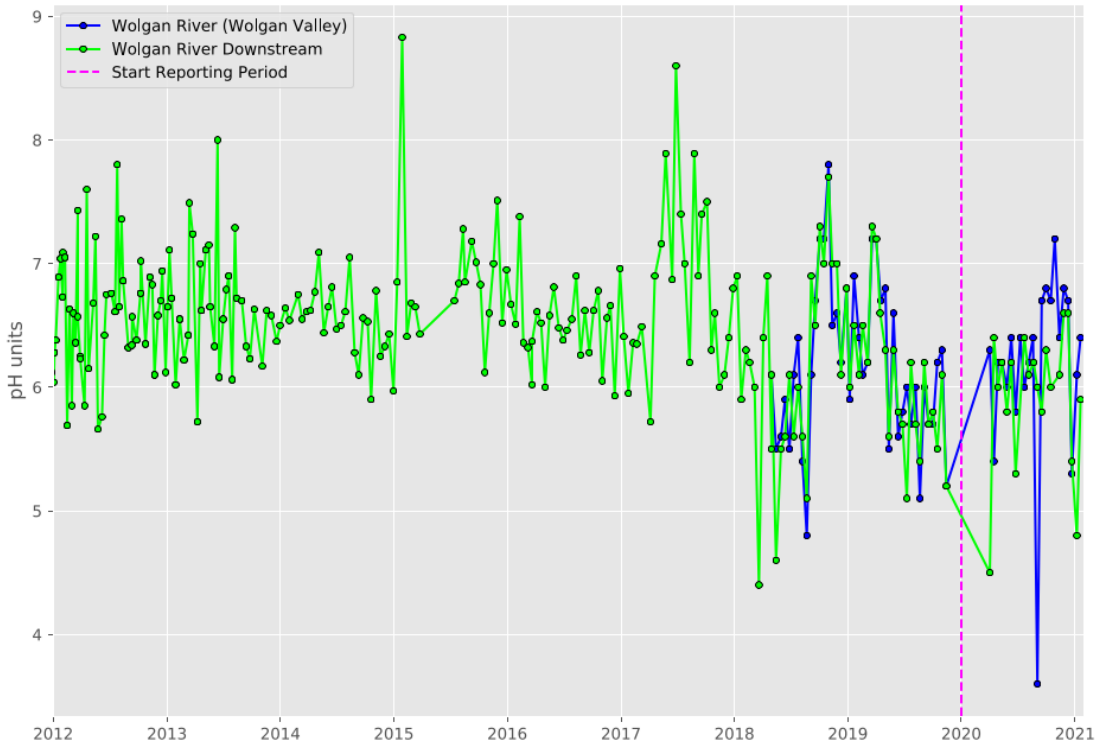
WMP states that surface water results will be assessed against performance triggers for the parameters pH, EC, and TSS. Performance triggers are not applicable to reference sites. The trends for these analytes are shown below.

pH at Wolgan River in 2020 are within historical bounds but towards the lower range. The average EC observed at Wolgan river is higher than that observed at its tributaries. The elevated EC measurements in 2019 are most likely erroneous as there was no corresponding increase in TDS. There is an increasing EC trend at Wolgan Valley most likely from the runoff post bushfire. TSS has remained low below detectable limits with the occasional spike through the reporting period. DO has a seasonal trend with highest concentrations observed in the winter months. Flows at Wolgan river are continuous but are highly variable.

No mining related groundwater impacts are visible for the reporting period.

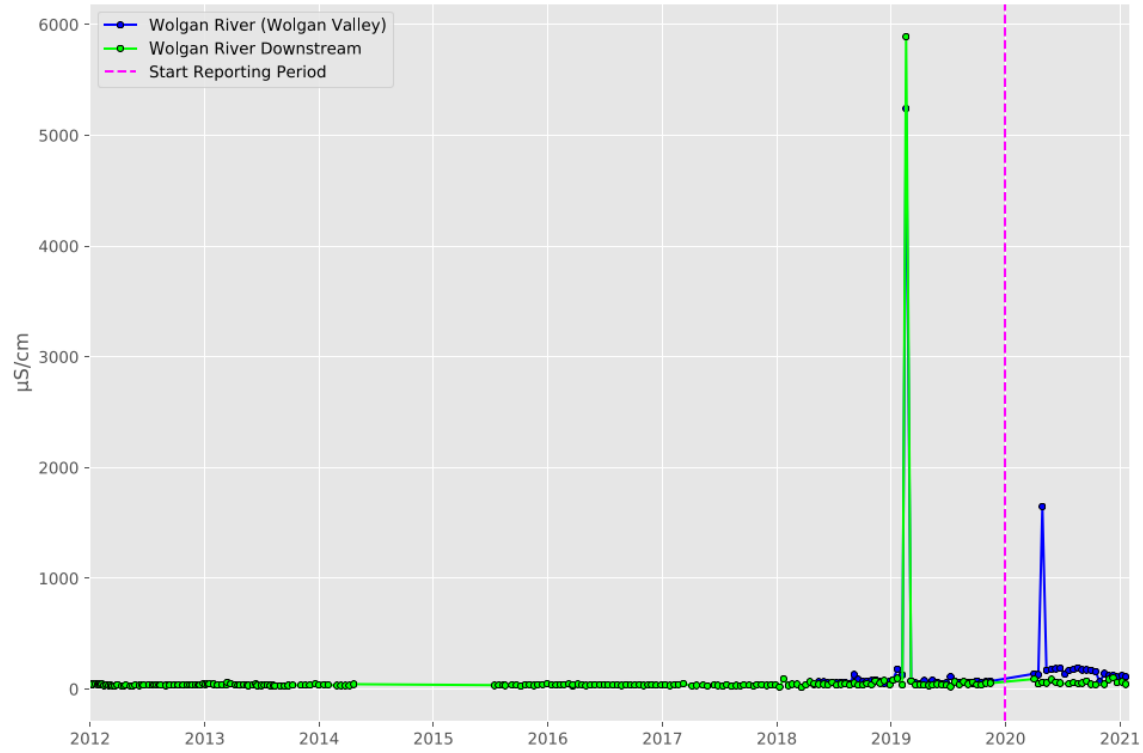
Graphs for all other parameter trends are included in **Appendix G**. Trends of note are:

- Anions and cations – increase in the reporting period following the bushfires
- Iron – seasonal trend with peaks around the summer months
- Manganese – increased concentrations in the reporting period following the bushfires
- Nutrients – nitrogen concentrations are decreasing following an increase post bushfire
- Sulfate – increasing trend in the reporting period



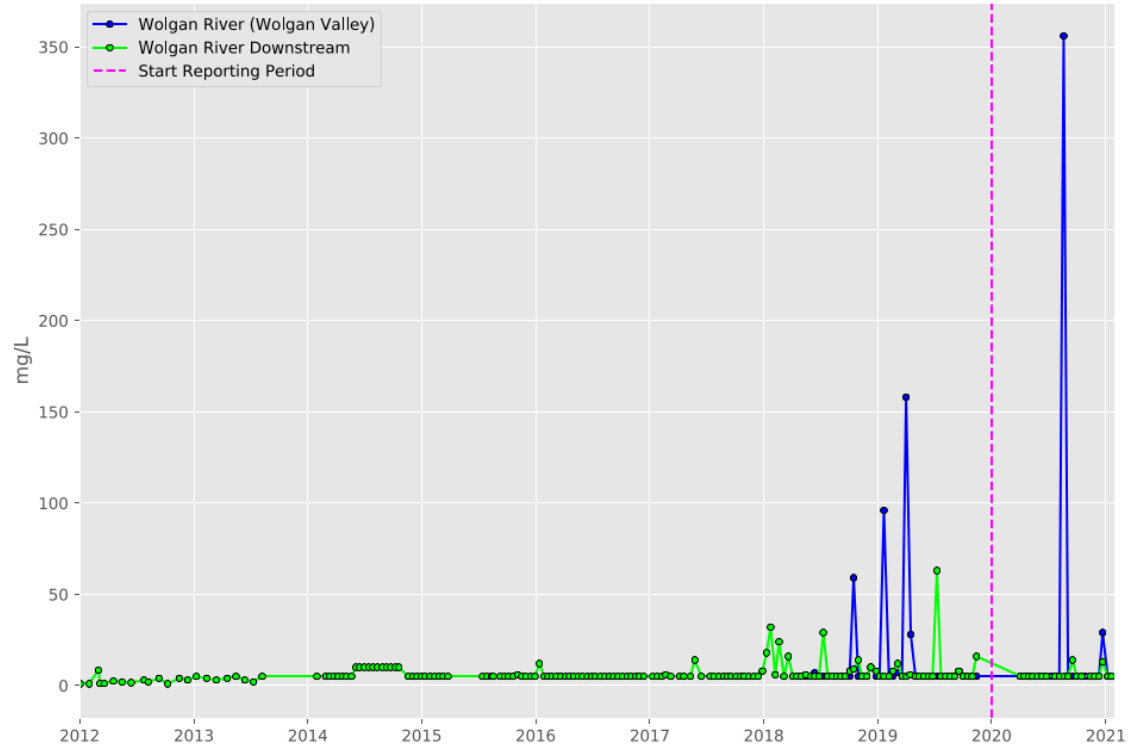
NB – Trigger not applicable to reference sites

Figure 9.16: Wolgan River - pH



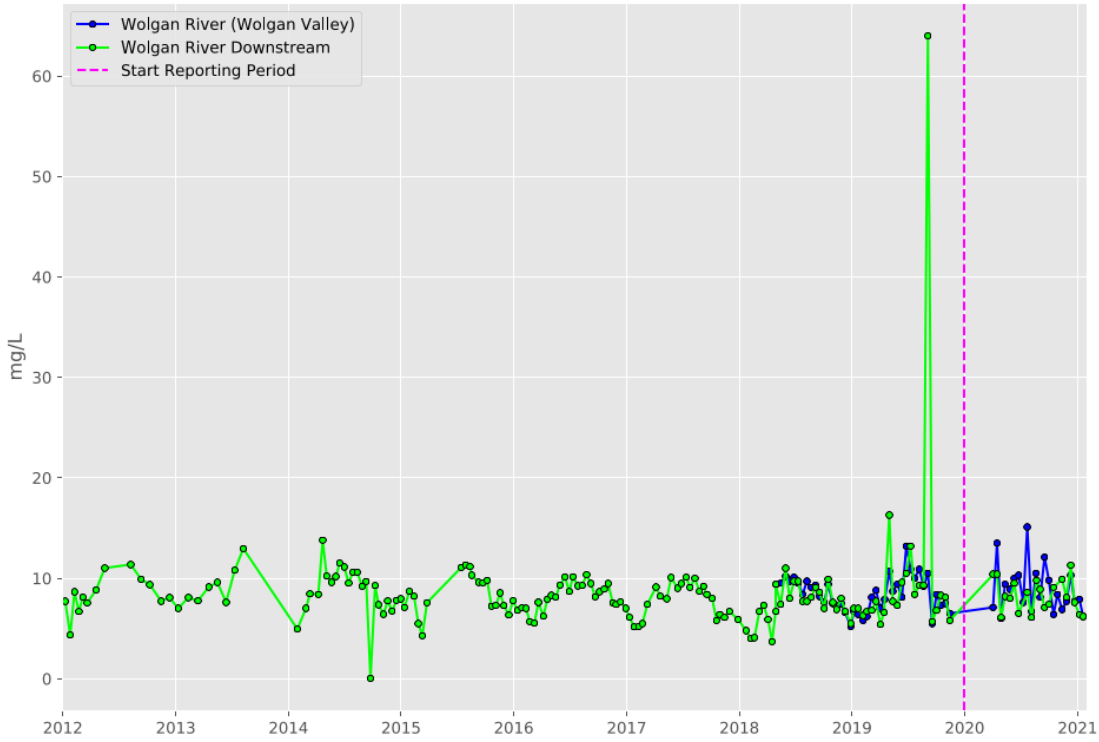
NB – Trigger not applicable to reference sites

Figure 9.17: Wolgan River - EC



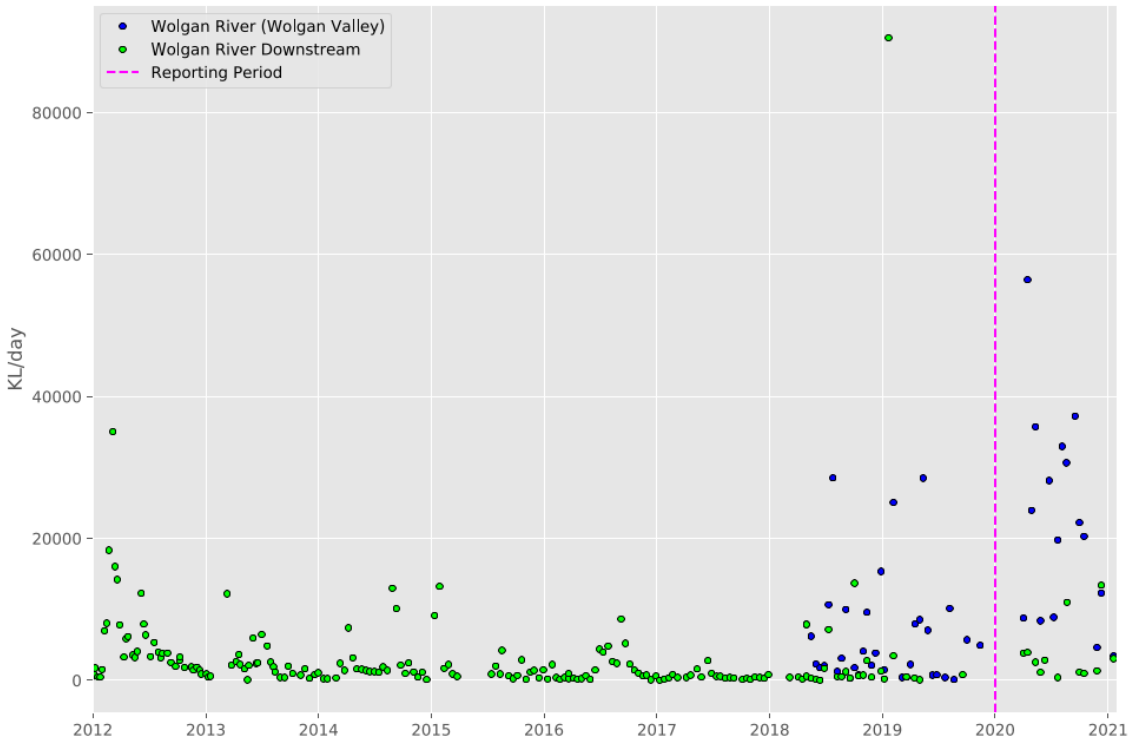
NB – Trigger not applicable to reference sites

Figure 9.18: Wolgan River - TSS



NB – Trigger not applicable to reference sites

Figure 9.19: Wolgan River - DO



NB – Trigger not applicable to reference sites

Figure 9.20: Wolgan River - Flow

9.2 Impact sites

Impact swamp sites are sites that are regarded to have been or will be potentially impacted by mining activities. The graphs of the main analytes show the general trends. The beginning of the reporting period is marked by the dotted line at January 2020. The pre-mining dataset is the baseline data and baseline cut off is defined when the site encroaches within the TIA or a significant lineament under a swamp has been undermined.

9.2.1 Carne West

Carne West was destroyed by the 2019/2020 bushfires. The swamp was also monitored at Carne West Pool (CWP) for the pooled water depth but was damaged by the bushfires in 2020 and decommissioned.

9.2.1.1 Statistics

Carne West is an impact site that has intermitted data since 2017, with the site being predominately dry. Table 9.5 presents the surface water summary statistics.

Table 9.5: Carne West - Surface water quality summary statistics

ID	Historic date ranges	Analyte	Pre-mining data statistics				80th percentile trigger &	Reporting period statistics			Comments
			Data point count	Min	Mean	Max		Min	Median	Max	
Carne West	Pre-mining period Oct 2013. Monitoring began in July 2016										
		pH	No pre-mining baseline					3.1	4.45	5.6	
		EC (µS/cm)						61	96	1091	Single peak
		Fe (mg/L)						0.05	0.05	0.05	
		Mn (mg/l)						0.17	0.211	0.233	
		TSS (mg/L)						5	5	5	
		DO (mg/L)						4.7	7.15	10.2	
		Flow (kl/day)						Too low	Too low	Too low	Too low

Notes: * value at detection limit (Limit of Reporting - LOR)
positive delta value equals a recent value that is greater than the historic mean, and vice versa for negative delta values.
% no monitoring data available post 19/10/2019, due to lack of access caused to bushfire/ dry conditions
@ where values are below limit of reporting, a value of half the measurement has been assumed.
& investigation trigger performance indicators based on Table 33 of the SMP LW424-LW427. The long- and short-term triggers are based on the 80th data percentile and the 80th percentile plus two standard deviations, respectively

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9.2.1.2 Quality Trend

WMP states that surface water results will be assessed against performance triggers for the parameters pH, EC, and TSS. Performance triggers are not applicable at Carne West as there is limited baseline data. The trends for these analytes are shown below.

Trends at Carne West are difficult to characterise as data has been intermittent since 2017. The samples during the reporting period were obtained following a period of above average rainfalls and the water quality is likely affected by the runoff post bushfire. pH is observed to have a slightly declining trend. The large increase in EC in May 2020 is likely erroneous as there is not a significant corresponding increase in the TDS. DO is highly variable but generally remains above 6mg/L. Flows have not been measured since 2017.

No mining related impacts are apparent.

Graphs for all other parameter trends are included in **Appendix G**. Trends of note are:

- Cations and anions – an increase in concentrations following the bushfire including compounds such as chloride, manganese, nickel, nitrate, sodium, sulfate, and zinc.

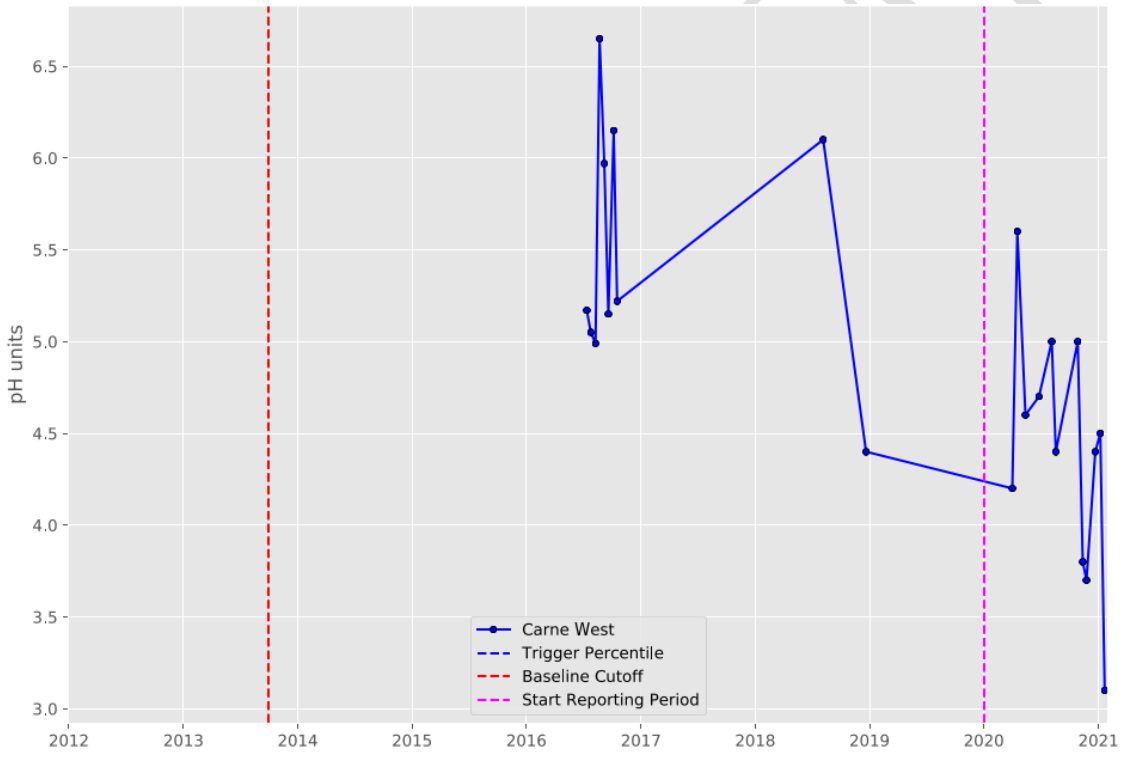

Figure 9.21: Carne West - pH

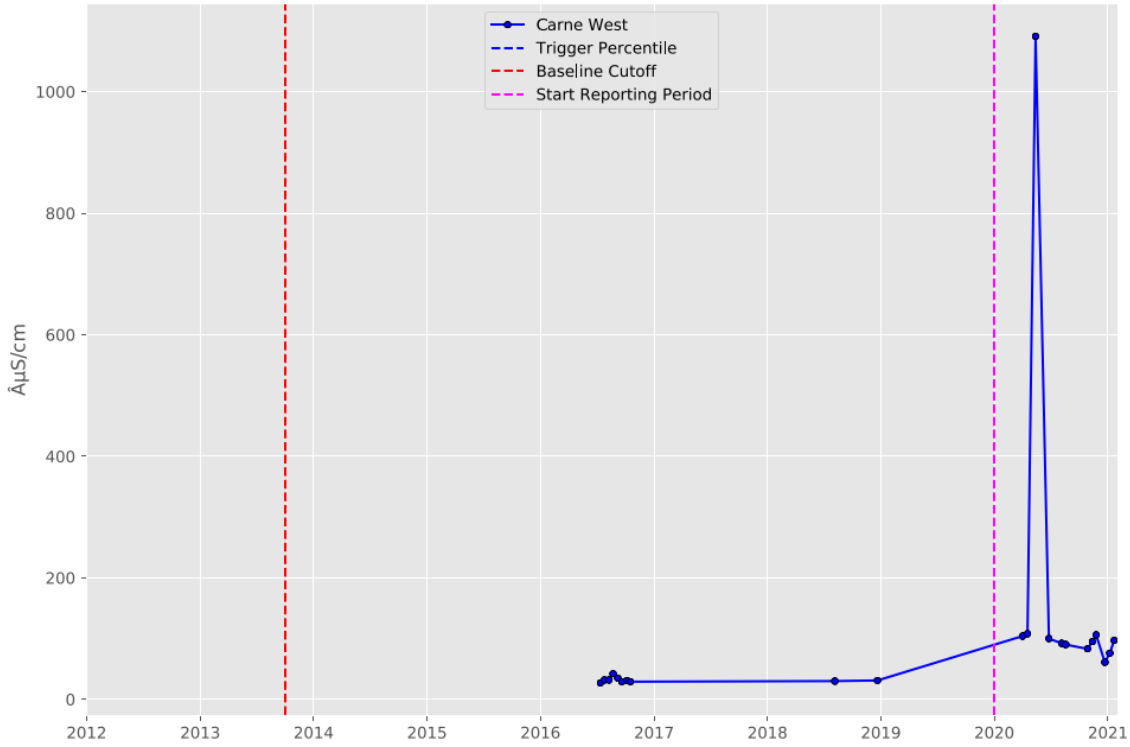

Figure 9.22: Carne West - EC

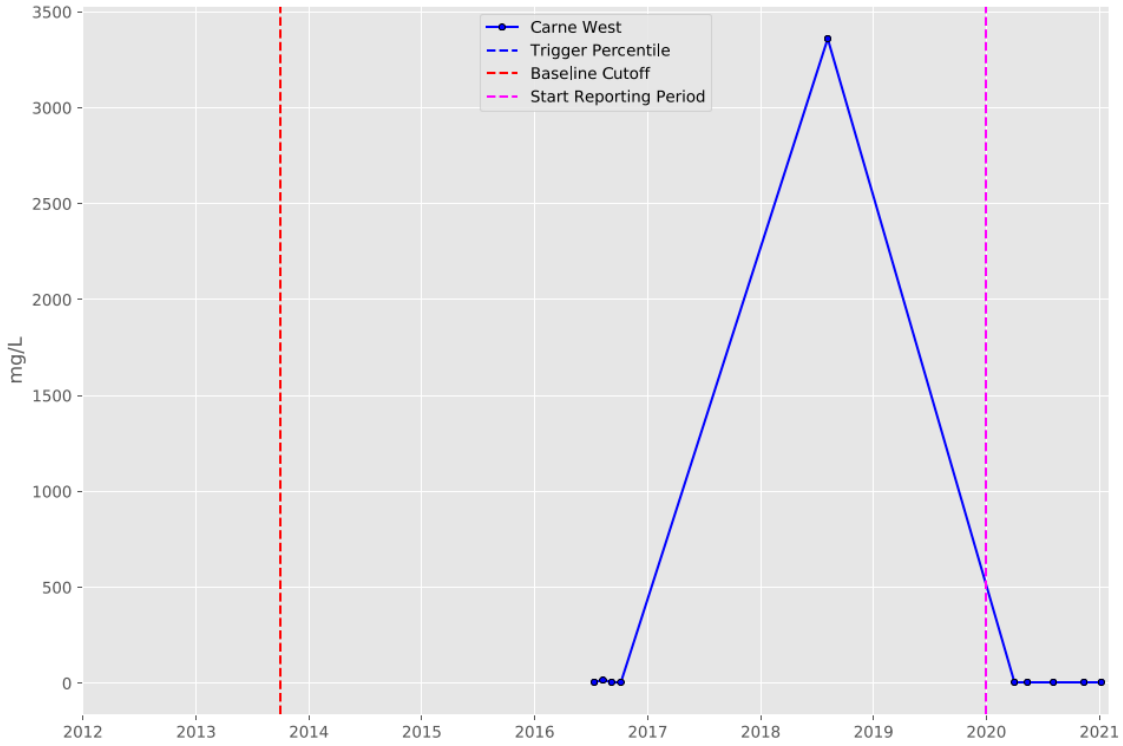

Figure 9.23: Carne West - TSS

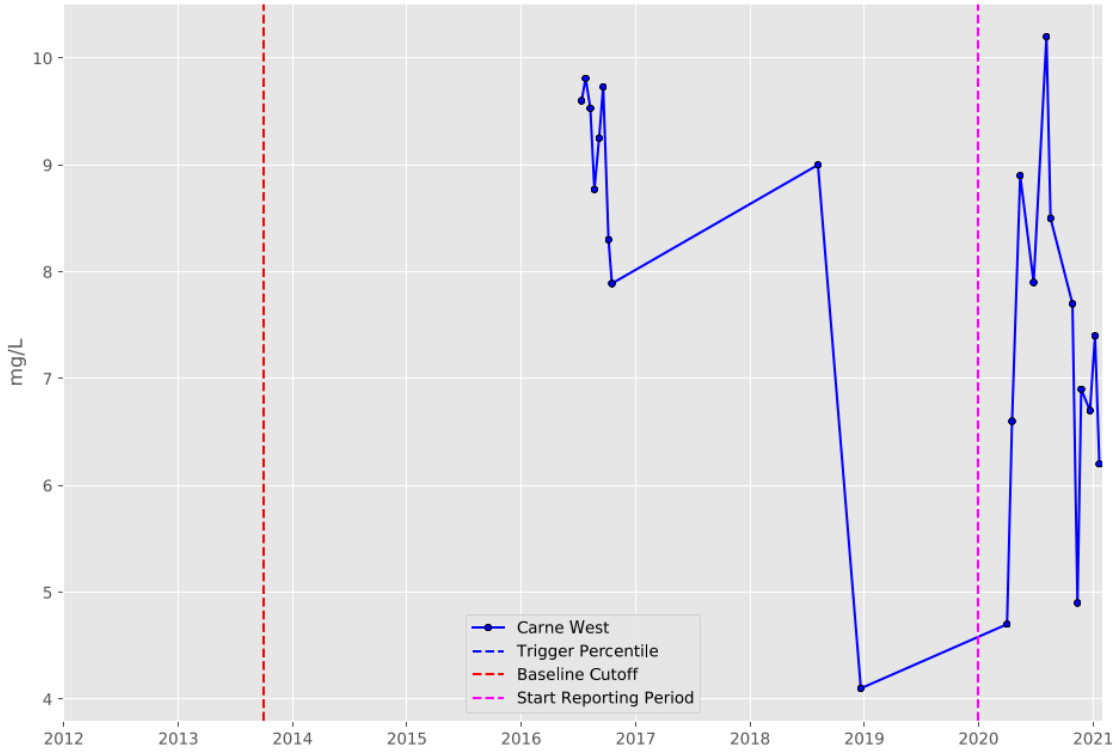

Figure 9.24: Carne West - DO

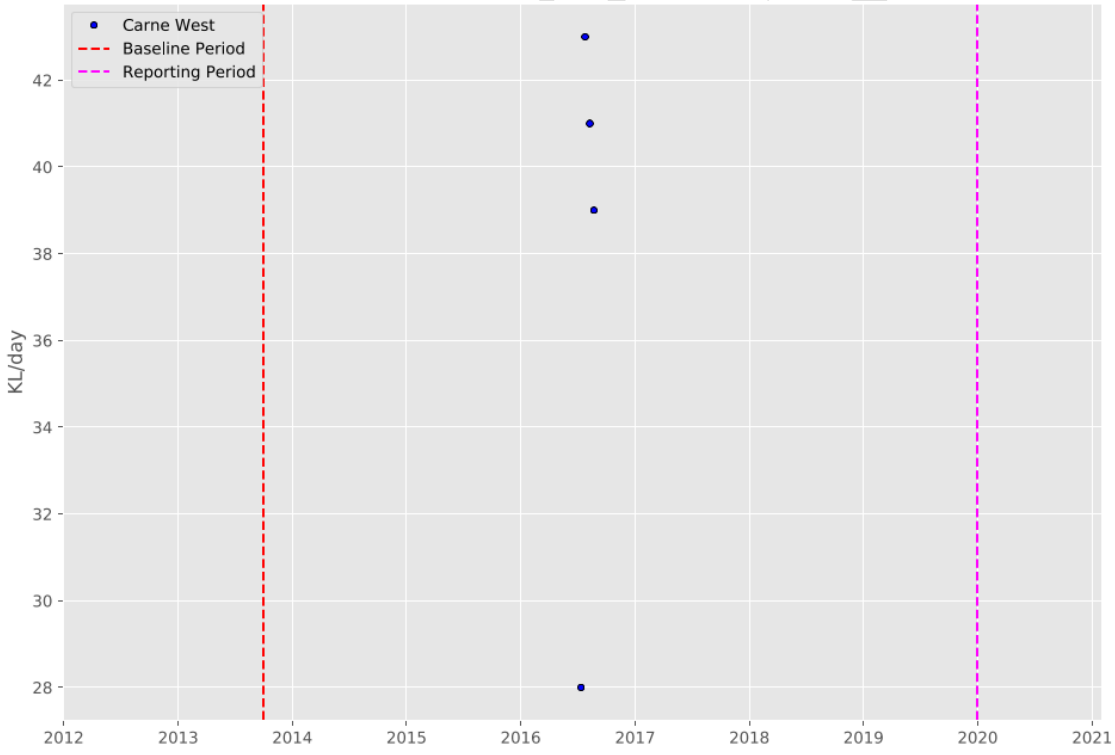

Figure 9.25: Carne West - Flow

9.2.2 Gang Gang

Gang Gang is a tributary of Carne Creek. Gang Gang is an impact site that has been predominately dry since 2019. Only two samples were recorded in 2020 and only field parameters were recorded.

9.2.2.1 Statistics

Table 9.6 presents the surface water summary.

Table 9.6: Gang Gang - Surface water summary statistics

ID	Historic date ranges	Analyte	Pre-mining data statistics				80th percentile trigger &	Reporting period statistics			Comments
			Data point count	Min	Mean	Max		Min	Median	Max	
Gang Gang	21/03/2016 – 24/05/2017										
		pH	27	1.18	5.78	8.56	5.4-6.4	4.6	4.7	4.8	Mostly dry
		EC (µS/cm)	27	17	28	63	29	41	48.5	56	Mostly dry
		Fe (mg/L)	13	0.12	0.21	0.54	0.244	-	-	-	Mostly dry
		Mn (mg/l)	13	0.008	0.012	0.019	0.016	-	-	-	Mostly dry
		TSS (mg/L)	11	5	8.8	24	9	-	-	-	Mostly dry
		DO (mg/L)	27	7.75	9.4	11.2	10.21	7.1	9.8	12.5	Mostly dry
		Flow (kl/day)	26	162	424	1013	609	Mostly dry	Mostly dry	Mostly dry	Mostly dry

Notes: * value at detection limit (Limit of Reporting - LOR)
positive delta value equals a recent value that is greater than the historic mean, and vice versa for negative delta values.
% no monitoring data available post 19/10/2019, due to lack of access caused to bushfire/ dry conditions
@ where values are below limit of reporting, a value of half the measurement has been assumed.
& investigation trigger performance indicators based on Table 33 of the SMP LW424-LW427. The long- and short-term triggers are based on the 80th data percentile and the 80th percentile plus two standard deviations, respectively

9.2.2.2 Quality Trend

WMP states that surface water results will be assessed against performance triggers for the parameters pH, EC, and TSS. The trends for these analytes are shown below.

Gang Gang as not been sampled since 2019, due to dry conditions, and limited data was available for the reporting period. Only field parameters (pH, EC and DO) were recorded.

Historically pH and EC are observed to be relatively stable. The outliers are most likely erroneous. The EC post bushfire is higher due to runoff. TSS is highly variable and dependent on many natural factors such as erosion, rainfall and disturbances to the streambed. DO is observed to decline as the water at Gang Gang begins to stagnate. Gang Gang has not seen significant flows since May 2018 with flows often too low to gauge or no flow at all. This coincides with the decline of water at swamp piezometers at GG1 to GG3 following the mining of LW420 and LW421.

Graphs for all other parameter trends are included in **Appendix G**. Trends of note are:

- Aluminium – spiked increase prior to the last recorded sample.
- Iron – seasonal trend with peaks in the summer months.

- Manganese – spiked increase in the last recorded sample
- Nutrients – spiked increase in Nitrogenous compounds prior the last recorded sample

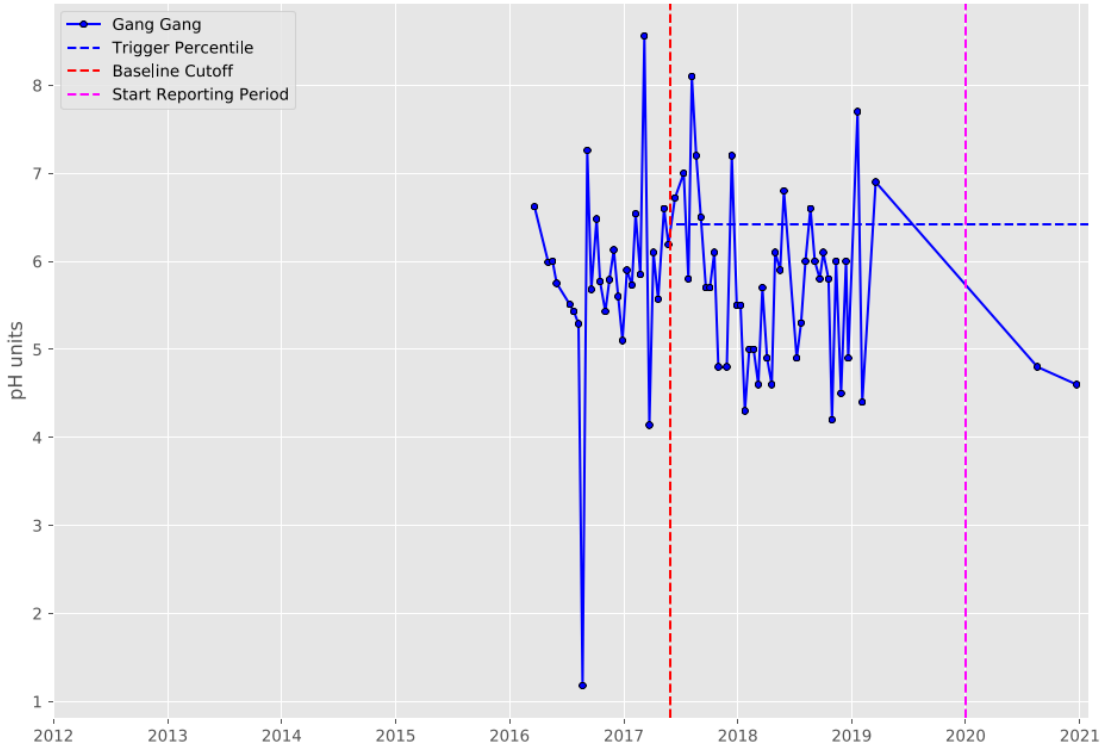

Figure 9.26: Gang Gang - pH

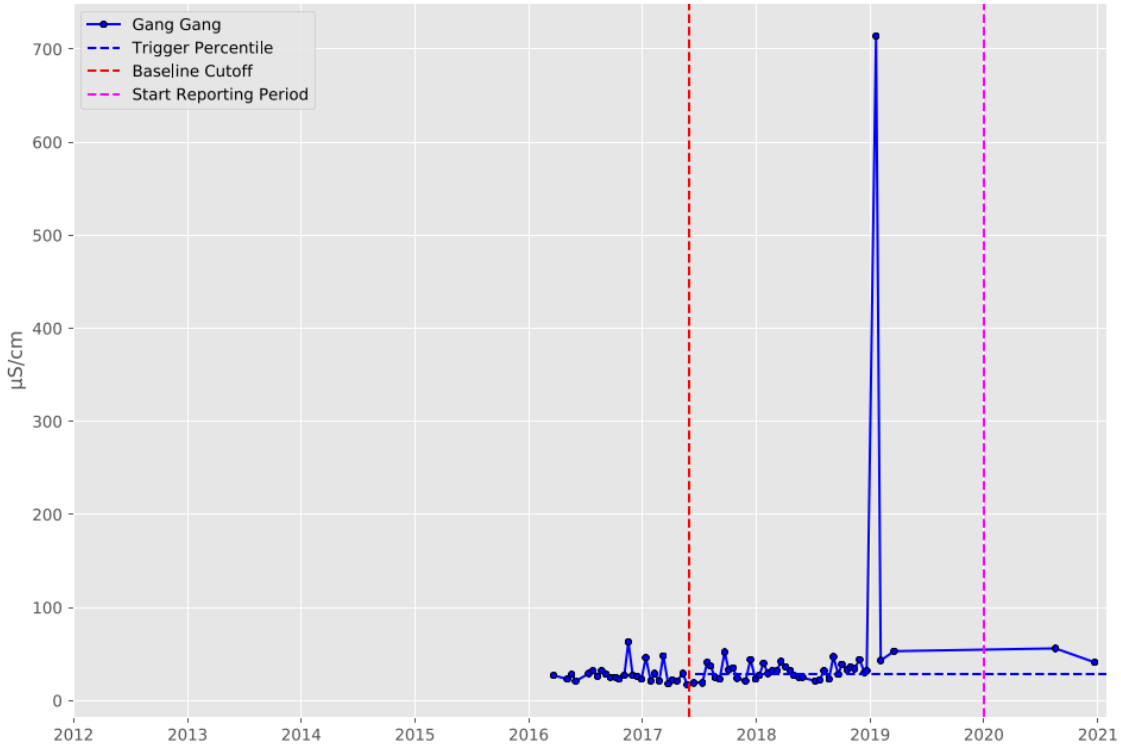

Figure 9.27: Gang Gang - EC

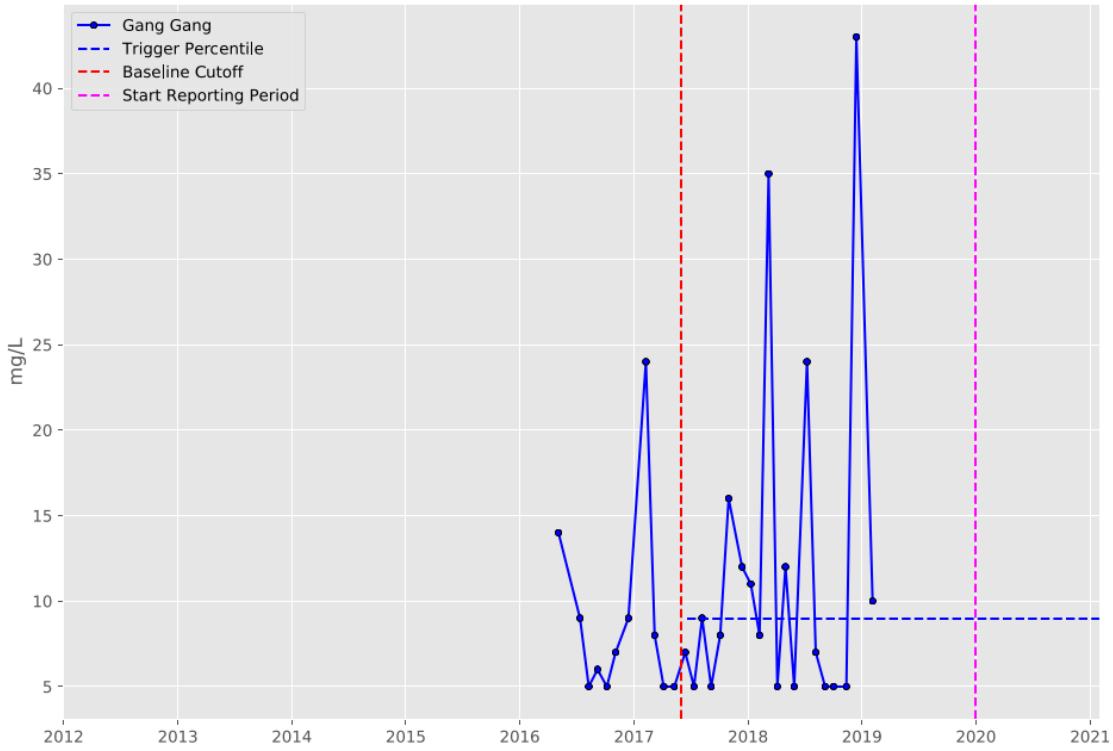

Figure 9.28: Gang Gang - TSS

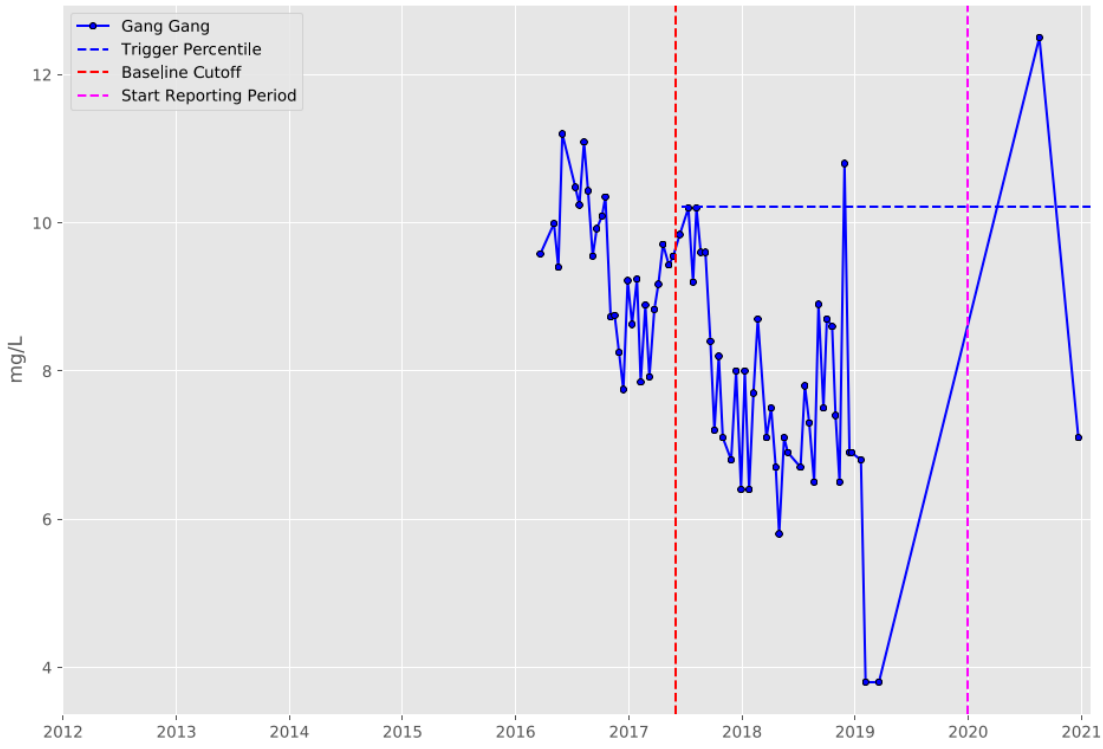

Figure 9.29: Gang Gang - DO

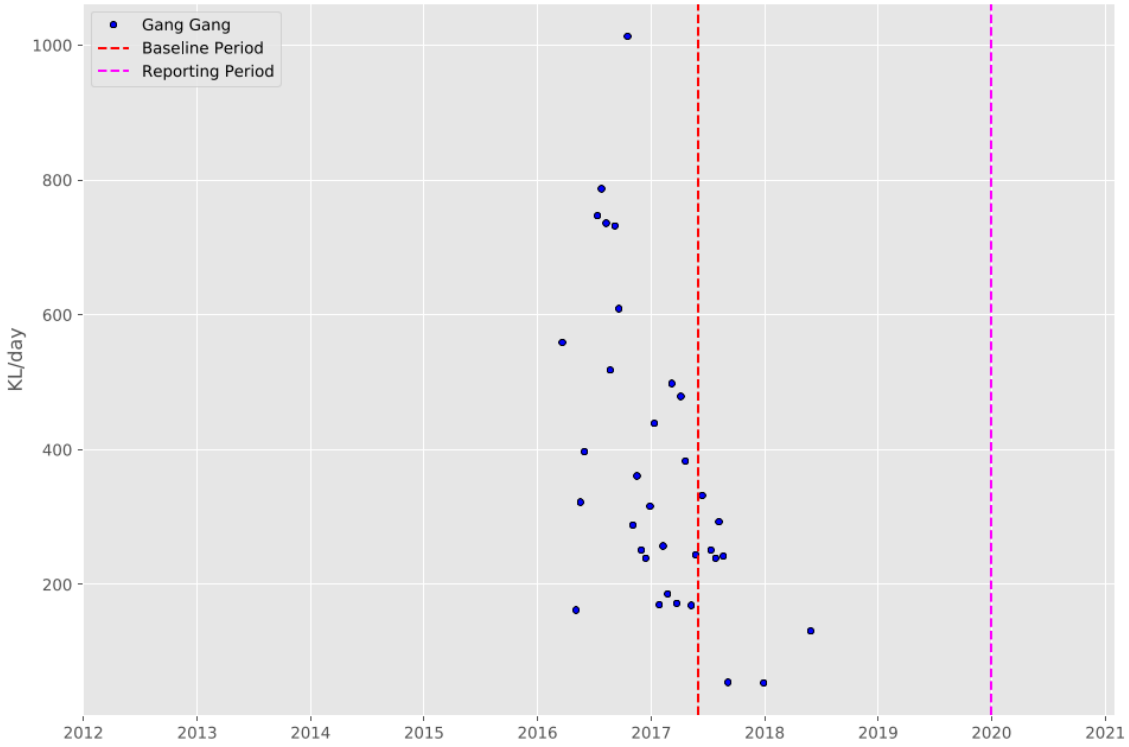

Figure 9.30: Gang Gang - Flow

9.2.3 Marrangaroo Creek

Marrangaroo creek is a potential impact site and is still in its pre-mining phase.

9.2.3.1 Statistics

Table 9.7 presents the surface water summary statistics.

Table 9.7: Marrangaroo Creek - Surface water qualiity summary statistics

ID	Historic date ranges	Analyte	Historic data statistics				80th percentile trigger &	Reporting period statistics			Comments
			Data point count	Min	Mean	Max		Min	Median	Max	
Marrangaroo Creek	30/01/2014 - present										
		pH	129	3.92	5.63	8.85	6.32	Dry	Dry	Dry	Pre-mining – no triggers
		EC (µS/cm)	105	7	54.5	2438	38.4	Dry	Dry	Dry	Pre-mining – no triggers
		Fe (mg/L)	129	0.05*	0.220	4.38	0.134	Dry	Dry	Dry	Pre-mining – no triggers
		Mn (mg/l)	133	0.001*	0.127	1	0.014	Dry	Dry	Dry	Pre-mining – no triggers

ID	Historic date ranges	Analyte	Historic data statistics				80th percentile trigger &	Reporting period statistics			Comments
			Data point count	Min	Mean	Max		Min	Median	Max	
		TSS (mg/L)	128	5	11.5	95	11.6	Dry	Dry	Dry	Pre-mining – no triggers
		DO (mg/L)	126	2.8	8.	11.59	9.58	Dry	Dry	Dry	Pre-mining – no triggers
		Flow (kl/day)	44	0	102.25	1269	121.6	Dry	Dry	Dry	Pre-mining – no triggers

Notes: * value at detection limit (Limit of Reporting - LOR)
positive delta value equals a recent value that is greater than the historic mean, and vice versa for negative delta values.
% no monitoring data available post 19/10/2019, due to lack of access caused to bushfire/ dry conditions
@ where values are below limit of reporting, a value of half the measurement has been assumed.
& investigation trigger performance indicators based on Table 33 of the SMP LW424-LW427. The long- and short-term triggers are based on the 80th data percentile and the 80th percentile plus two standard deviations, respectively

9.2.3.2 Quality Trend

WMP states that surface water results will be assessed against performance triggers for the parameters pH, EC, and TSS. Marrangaroo Creek is still in the pre-mining baseline stage and triggers are not applicable to the site. The trends for these analytes are shown below.

No samples were able to be collected during the reporting period due to dry conditions at the site.

pH at Marrangaroo Creek is observed to fluctuate with a large range. There has been an overall slightly declining pH trend since mid 2017. The single elevated EC value in 2017 is most likely erroneous due the magnitude of difference. TSS is highly variable and is likely due to natural factors that could disturb the streambed and surrounding soils. DO concentrations follow a generally stable trend. Flows at Marrangaroo Creek have not been able to be consistently recorded since 2017 due the flows being too low to monitor.

Graphs for all other parameter trends are included in **Appendix G**. Trends of note are:

- Aluminium – average concentrations have been lower since 2016 and is most likely related to the drought that developed around this period.
- Iron – there is no defined seasonal trends in iron but higher and more variable concentrations have been observed since 2017 coinciding with the decline in flow rates.

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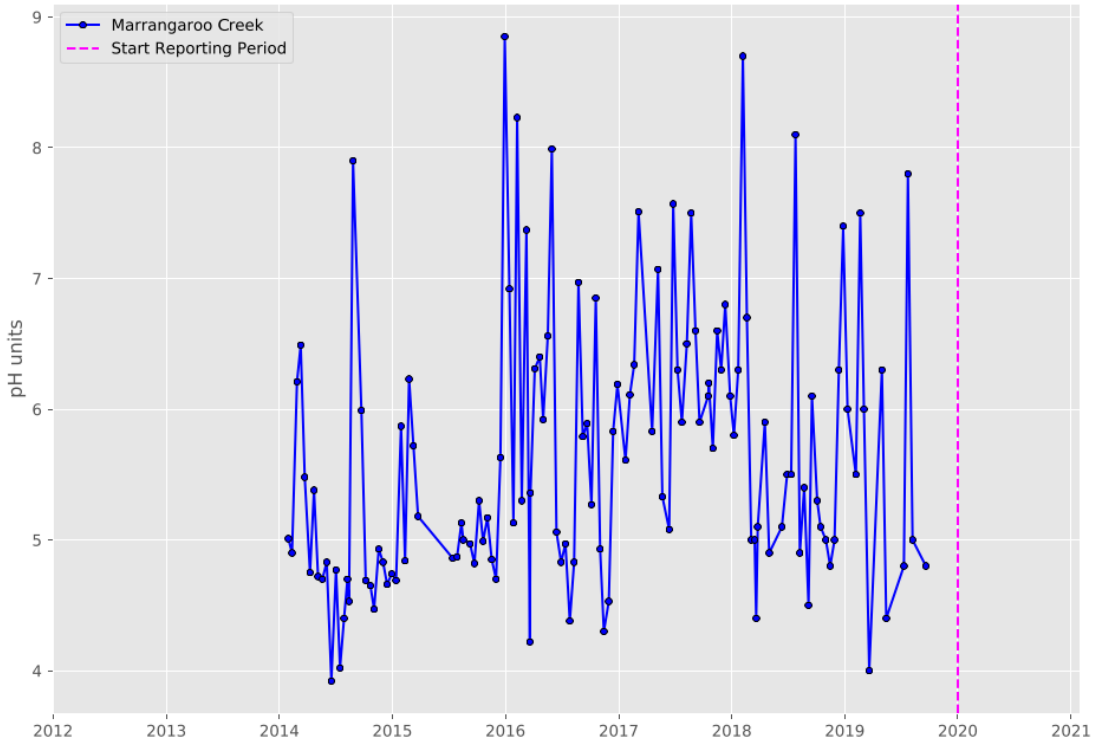

Figure 9.31: Marrangaroo Creek - pH

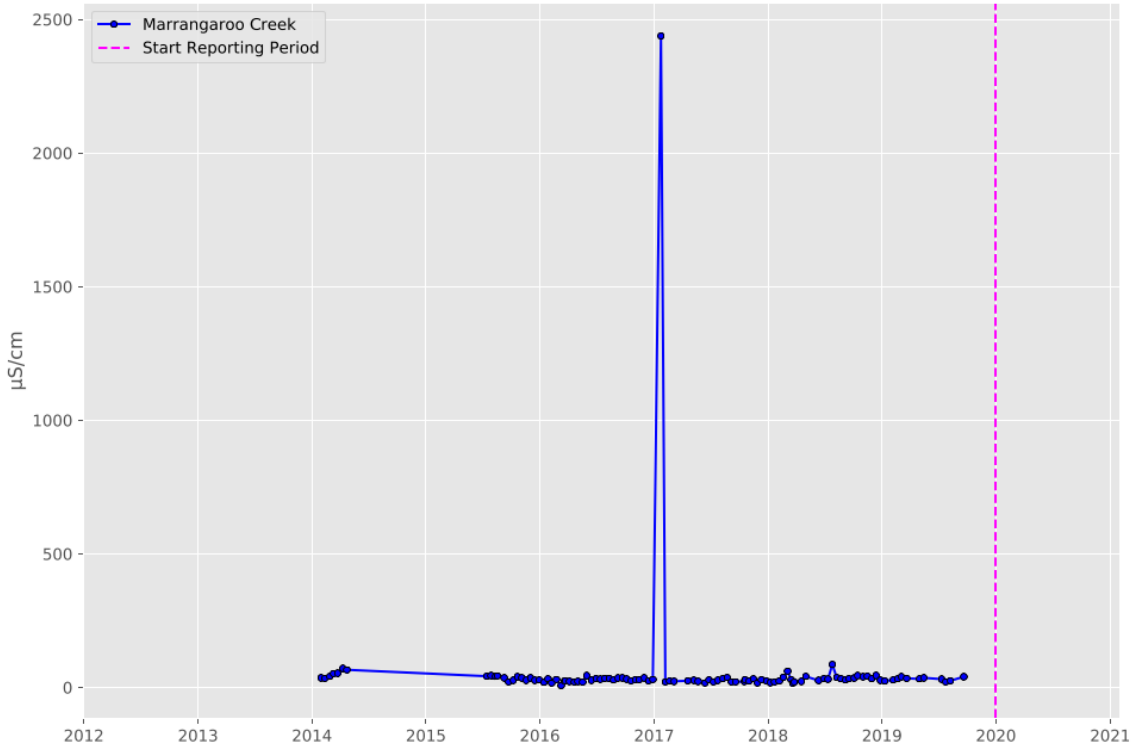

Figure 9.32: Marrangaroo Creek - EC

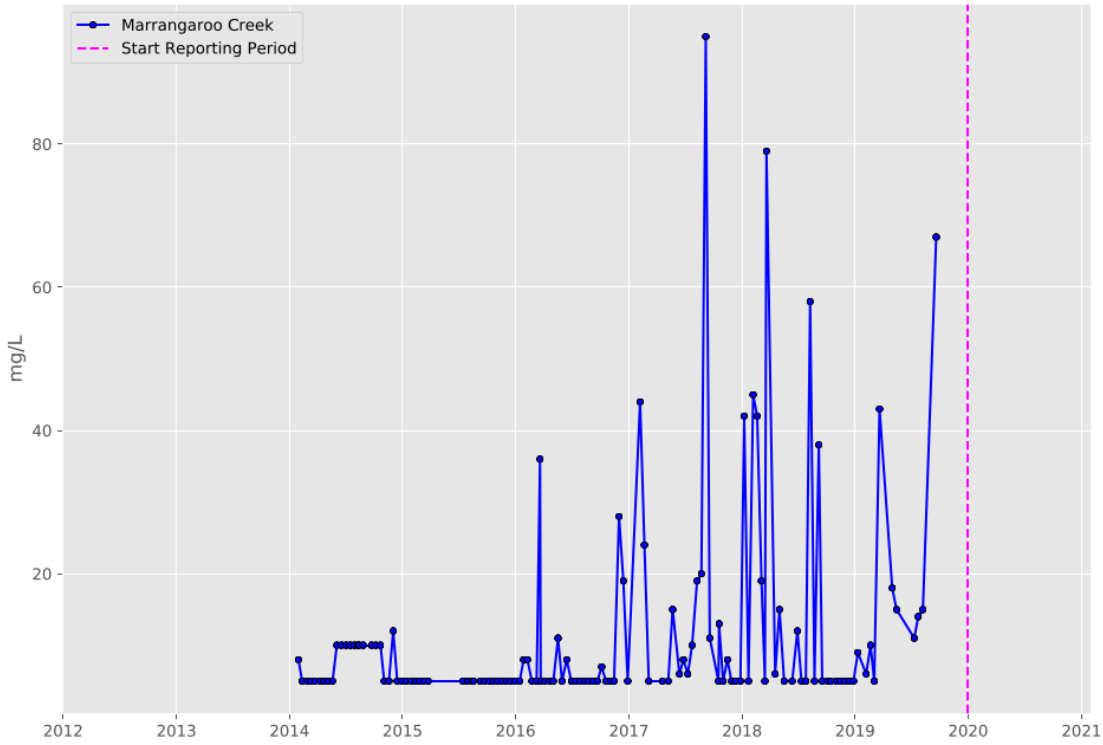

Figure 9.33: Marrangaroo Creek - TSS

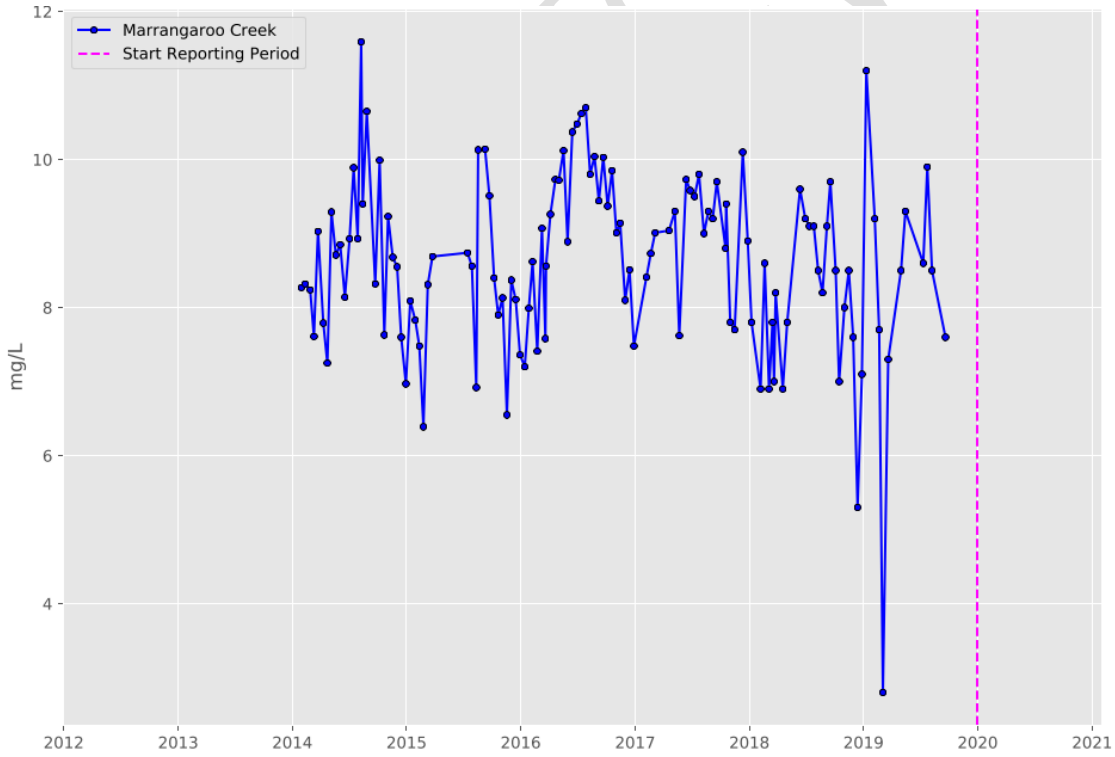

Figure 9.34: Marrangaroo Creek - DO

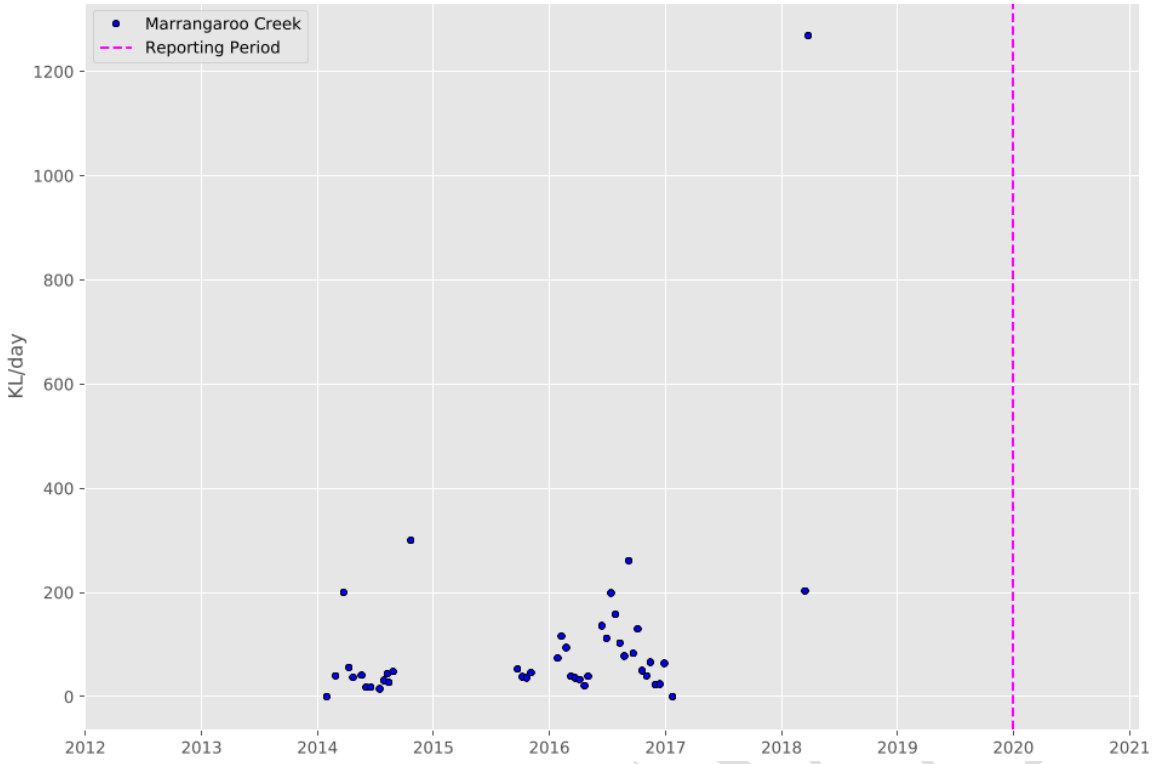

Figure 9.35: Marrangaroo Creek - Flow

9.2.4 Paddys Creek

Paddys Creek is an impact site that has previously triggered under LW425 from August 2018 and is being monitored for recovery.

9.2.4.1 Statistics

Table 9.8 presents the surface water summary statistics.

Table 9.8: Paddys Creek - Surface water quality summary statistics

ID	Historic date ranges	Analyte	Pre-mining data statistics				80th percentile trigger &	Reporting period statistics			Comments
			Data point count	Min	Mean	Max		Min	Median	Max	
Paddys Creek	24/11/2017 – 1/08/2018										
		pH	20	4.1	6.12	25	4.8-5.6	3.9	4.9	6.8	Low pH
		EC (µS/cm)	20	19	27.6	40	33.1	36	48	115	Elevated
		Fe (mg/L)	11	0.15	0.252	0.45	0.34	0.05	0.225	0.48	
		Mn (mg/l)	11	0.009	0.0138	0.022	0.017	0.022	0.036	0.053	Elevated
		TSS (mg/L)	10	5	8.9	41	5.6	5	5	22	
		DO (mg/L)	18	5.1	7.81	9.9	8.44	5.5	7.85	14	

ID	Historic date ranges	Analyte	Pre-mining data statistics				80th percentile trigger &	Reporting period statistics			Comments
			Data point count	Min	Mean	Max		Min	Median	Max	
		Flow (kl/day)	20	25	453	1581	664	120	224	1978	

Notes: * value at detection limit (Limit of Reporting - LOR)
positive delta value equals a recent value that is greater than the historic mean, and vice versa for negative delta values.
% no monitoring data available post 19/10/2019, due to lack of access caused to bushfire/ dry conditions
@ where values are below limit of reporting, a value of half the measurement has been assumed.
& investigation trigger performance indicators based on Table 33 of the SMP LW424-LW427. The long- and short-term triggers are based on the 80th data percentile and the 80th percentile plus two standard deviations, respectively

9.2.4.2 Quality Trend

WMP states that surface water results will be assessed against performance triggers for the parameters pH, EC, and TSS. The trends for these analytes are shown below.

Paddys Creek has previously triggered under the groundwater performance measures. The water quality at Paddys Creek is generally stable. The outliers in the historical data are likely erroneous. There is an increase in pH towards the end of the reporting period. EC values are elevated in the reporting period and is likely attributed to the post bushfire runoff. These values above the trigger were sustained and trigger the response protocol. Paddys Creek has already been triggered under the groundwater level triggers and does not need a separate investigation

Flows at Paddys Creek are generally consistent and below 500kL/day. DO was also found to peak above the 80th percentile; however, DO is not an impact assessment parameter.

Graphs for all other parameter trends are included in **Appendix G**. Trends of note are:

- Chloride – elevated levels in the reporting period
- Iron – seasonal trend with peaks around the summer months
- Manganese – increasing trend since the post mining period.
- Nutrients – declining nitrogen concentrations from a peak following the bushfire.
- Sulfate – elevated concentrations in the reporting period post bushfire.

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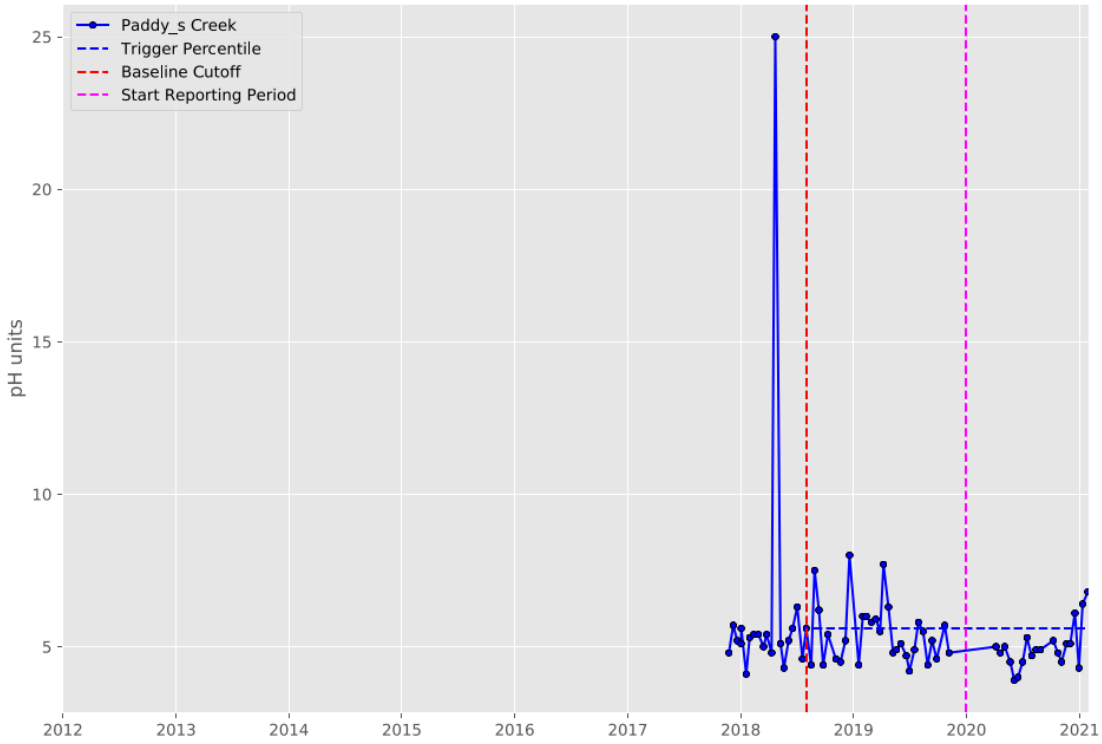

Figure 9.36: Paddys Creek - pH

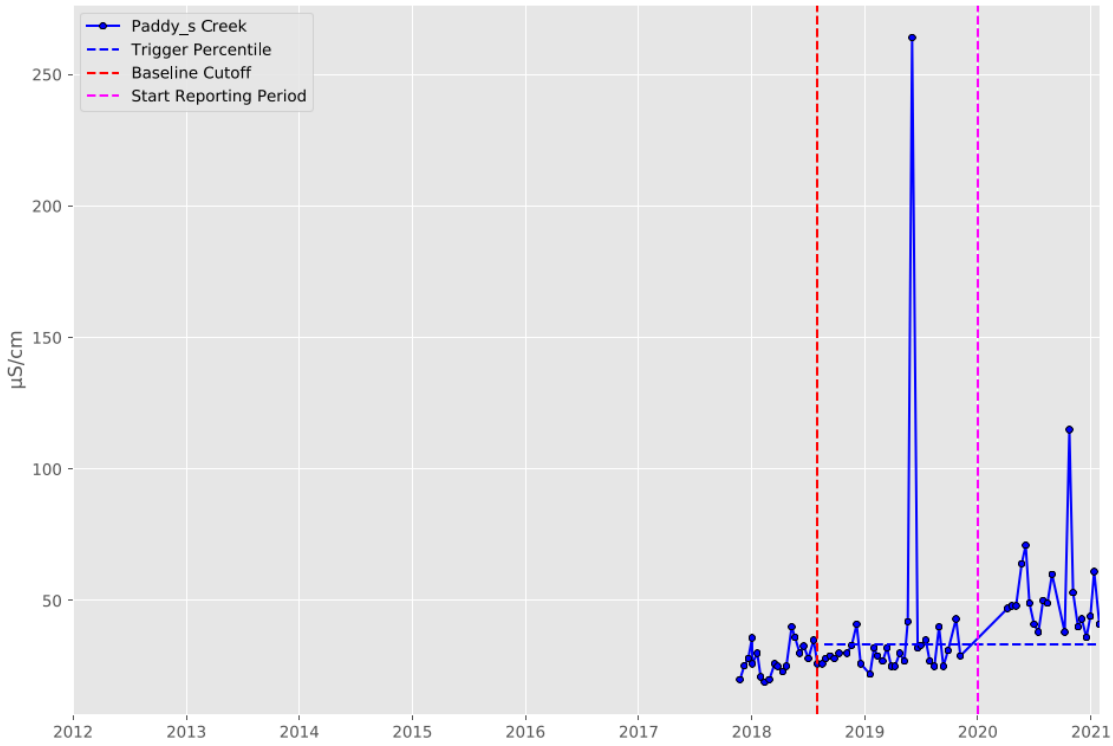

Figure 9.37: Paddys Creek - EC

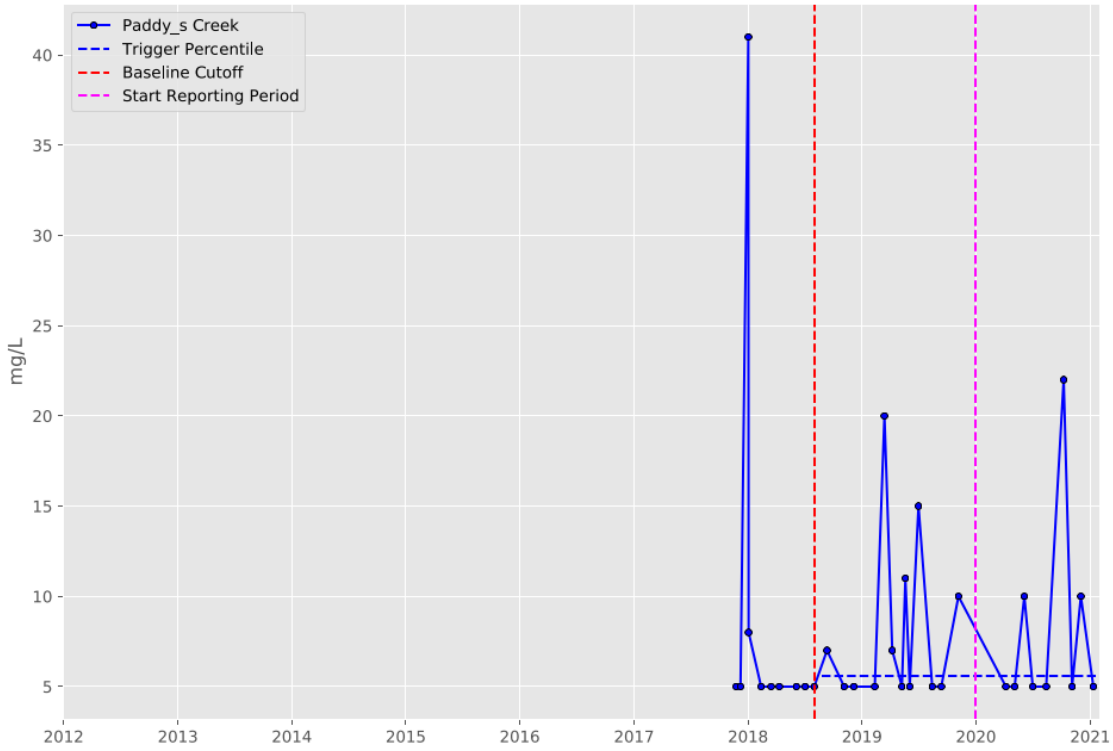

Figure 9.38: Paddys Creek - TSS

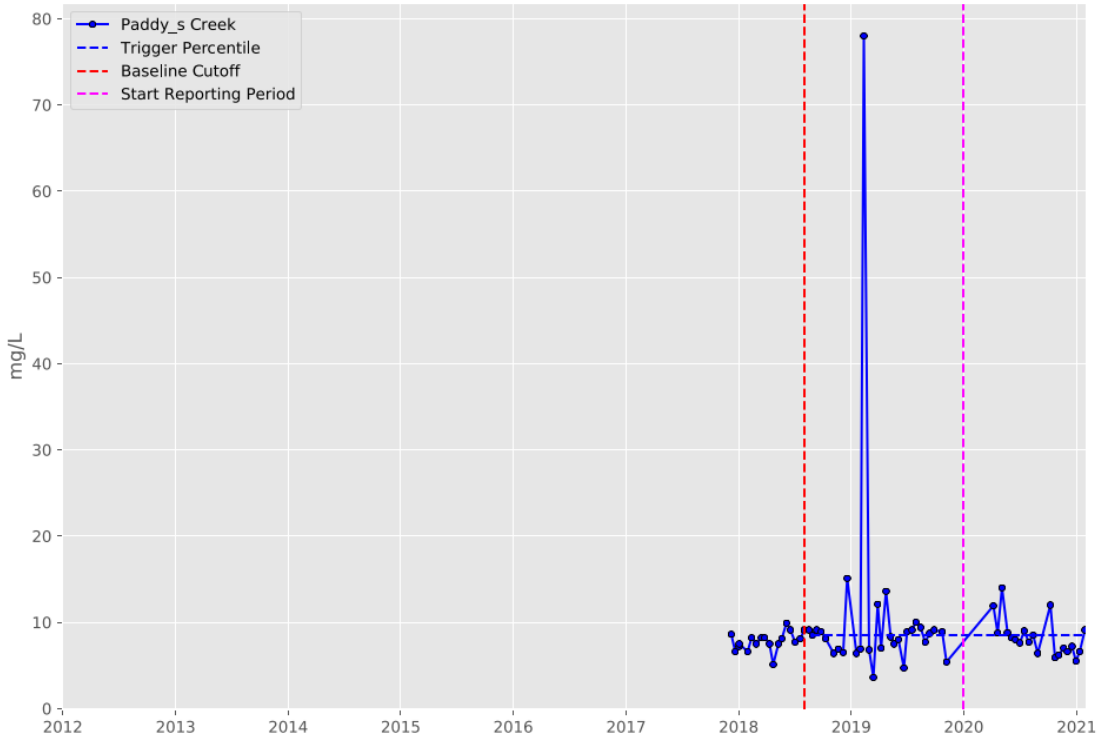

Figure 9.39: Paddys Creek - DO

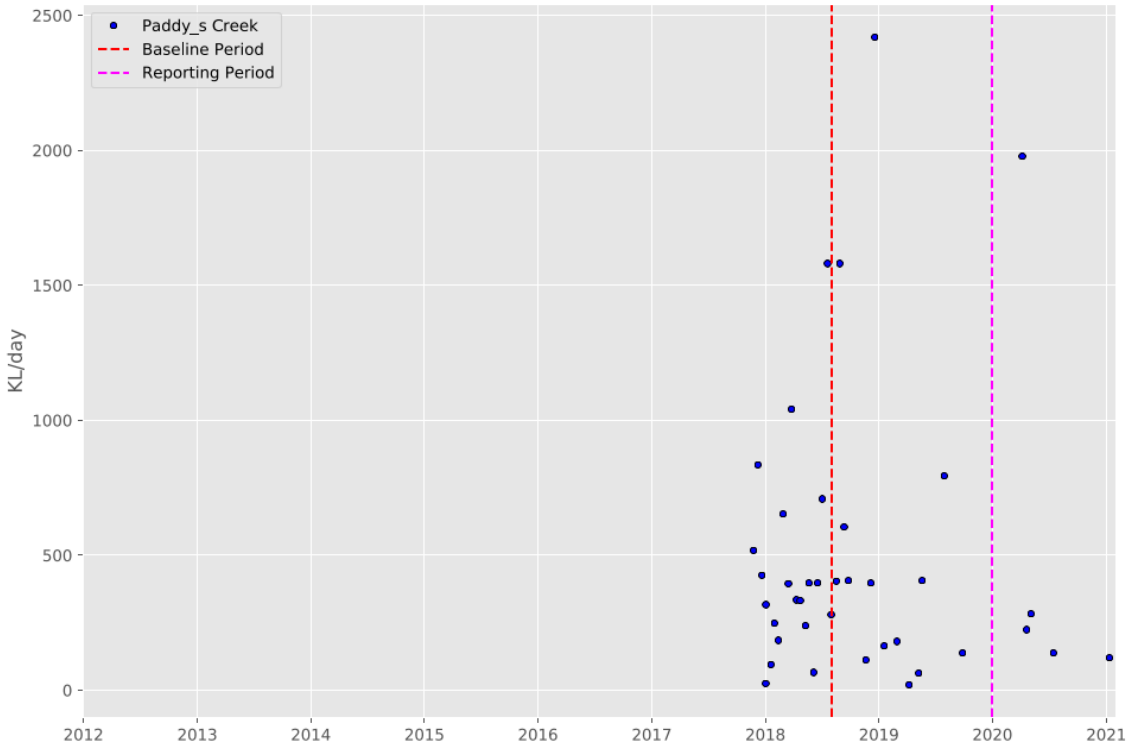

Figure 9.40: Paddys Creek - Flow

9.2.5 Pine/9 Mile Swamp

Pine/9 Mile Swamp is located at the downstream confluence of Pine Swamp and Nine Mile Swamp. The swamp has previously been triggered under the groundwater level performance triggers.

9.2.5.1 Statistics

Table 9.9 presents the surface water summary statistics

Table 9.9: Pine/9 Mile Swamp - surface water quality summary statistics

ID	Historic date ranges	Analyte	Pre-mining data statistics				80th percentile trigger &	Reporting period statistics			Comments
			Data point count	Min	Mean	Max		Min	Median	Max	
Pine/9 Mile Swamp	27/11/2017 – 14/01/2019										
		pH	31	3.8	5.36	7.3	4.9-5.9	3.9	5.25	6.7	Single elevated pH
		EC (µS/cm)	31	27	41.6	129	42	25	42.5	79	Slightly elevated
		Fe (mg/L)	15	0.16	0.415	0.98	0.484	0.16	0.335	0.83	-
		Mn (mg/l)	15	0.006	0.0312	0.071	0.038	0.014	0.029	0.063	-
		TSS (mg/L)	15	5	12.6	68	18.2	5	5	98	Single elevated TSS

ID	Historic date ranges	Analyte	Pre-mining data statistics				80th percentile trigger &	Reporting period statistics			Comments
			Data point count	Min	Mean	Max		Min	Median	Max	
		DO (mg/L)	28	4.1	7.5	9.4	8.9	4.4	7.55	12.7	-
		Flow (kl/day)	15	99	456	1340	566	Too low	Too low	Too low	-

Notes: * value at detection limit (Limit of Reporting - LOR)
positive delta value equals a recent value that is greater than the historic mean, and vice versa for negative delta values.
% no monitoring data available post 19/10/2019, due to lack of access caused to bushfire/ dry conditions
@ where values are below limit of reporting, a value of half the measurement has been assumed.
& investigation trigger performance indicators based on Table 33 of the SMP LW424-LW427. The long- and short-term triggers are based on the 80th data percentile and the 80th percentile plus two standard deviations, respectively

9.2.5.2 Quality Trend

WMP states that surface water results will be assessed against performance triggers for the parameters pH, EC, and TSS. The trends for these analytes are shown below.

Water quality at Pine/9 Mile Swamp is generally stable and the outliers are likely erroneous. pH is generally slightly more acidic in the reporting period but is still within historical ranges. The average EC values in the reporting period are slightly higher than the trigger percentile but are attributable to the post bushfire runoff. The impact protocol is not triggered in this case as the exceedances was not sustained for over a two month period.

TSS is generally below detectable limits. DO is fluctuates around a stable mean. Flows have not been able to be measured since 2019 due to low water depths and limited access in the bushfire period.

Graphs for all other parameter trends are included in **Appendix G**. Trends of note are:

- Copper – single elevated concentration in the reporting period
- Fluoride – single elevated concentration in the reporting period.
- Iron – generally stable concentrations. Peak in 2019 coinciding with summer and reduced flows.
- Manganese – seasonal trend with peaks around the summer months
- Nickel – single elevated concentration in the reporting period
- TDS – declining trend since monitoring began in 2018
- Zinc – single elevated concentration in the reporting period

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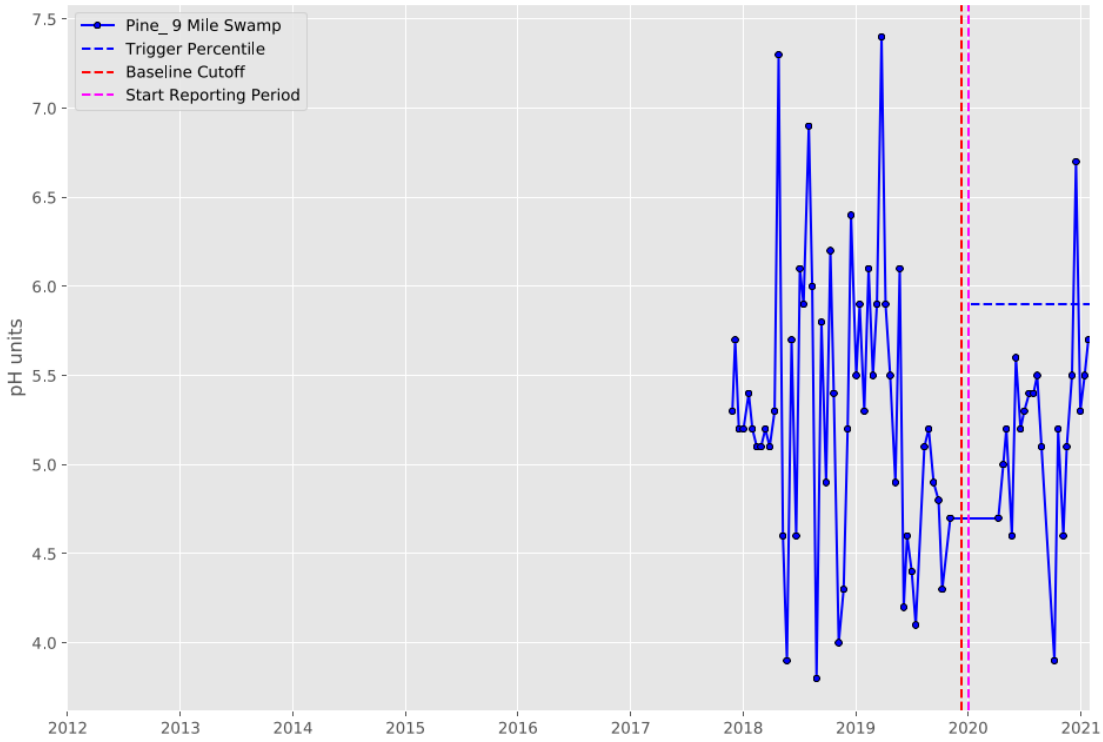

Figure 9.41: Pine/ 9 Mile Swamp - pH

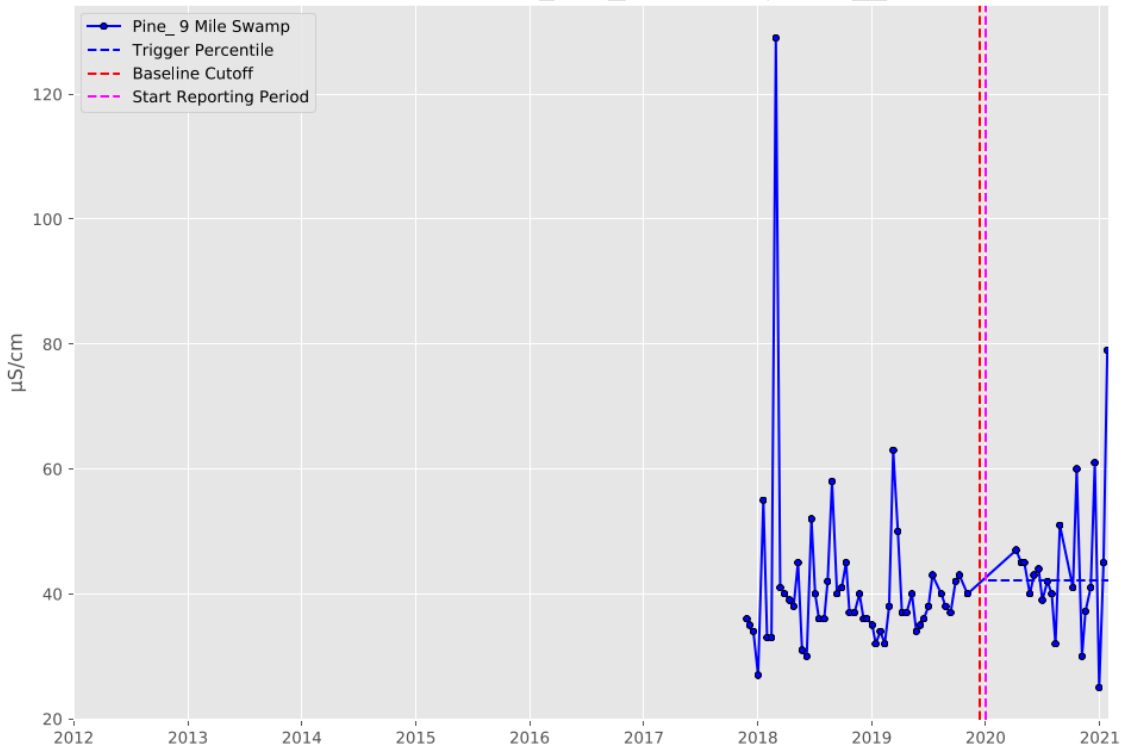

Figure 9.42: Pine/ 9 Mile Swamp - EC

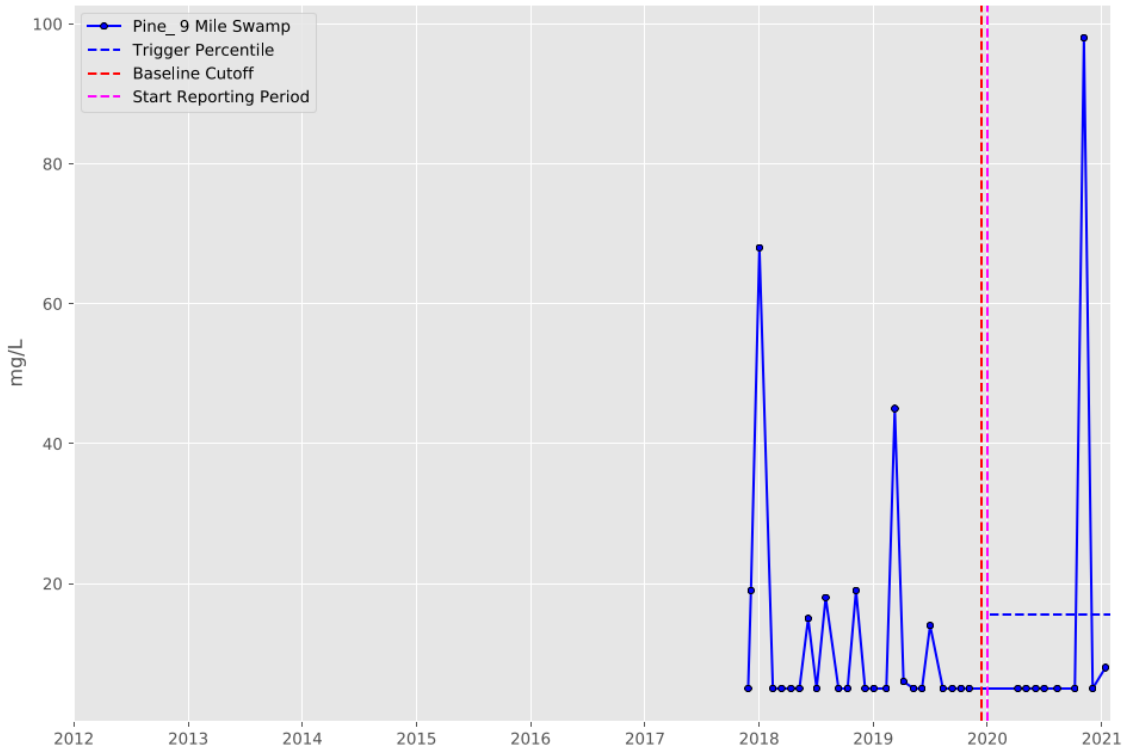

Figure 9.43: Pine/ 9 Mile Swamp - TSS

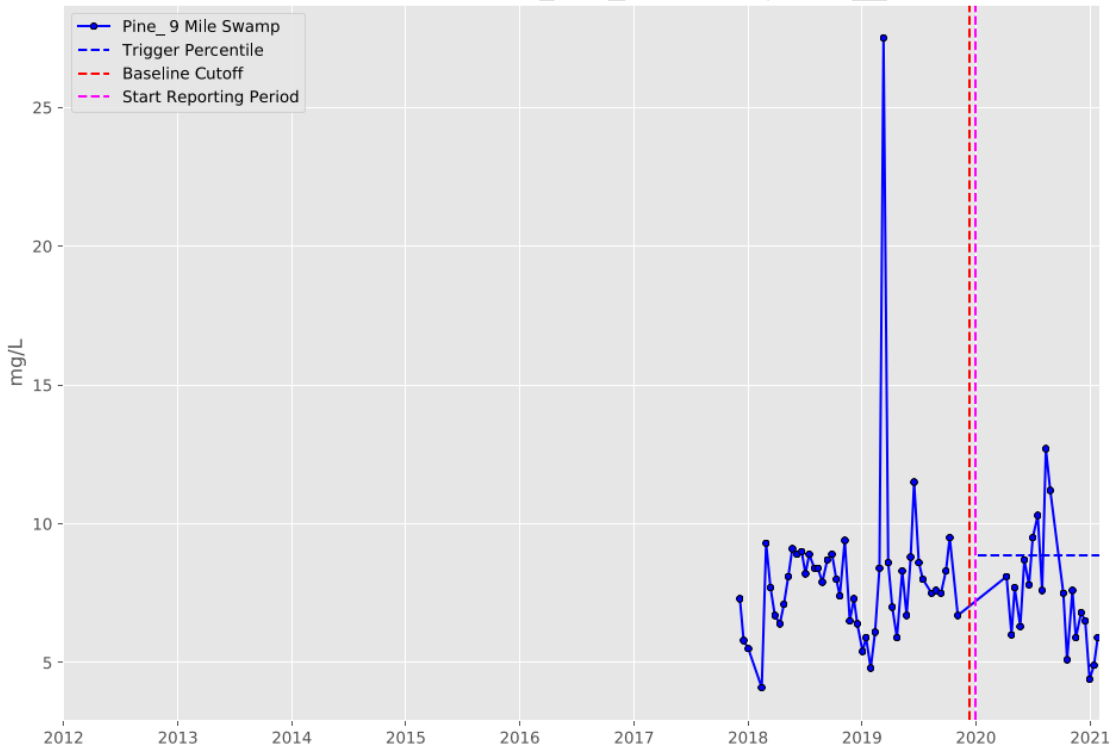

Figure 9.44: Pine/ 9 Mile Swamp - DO

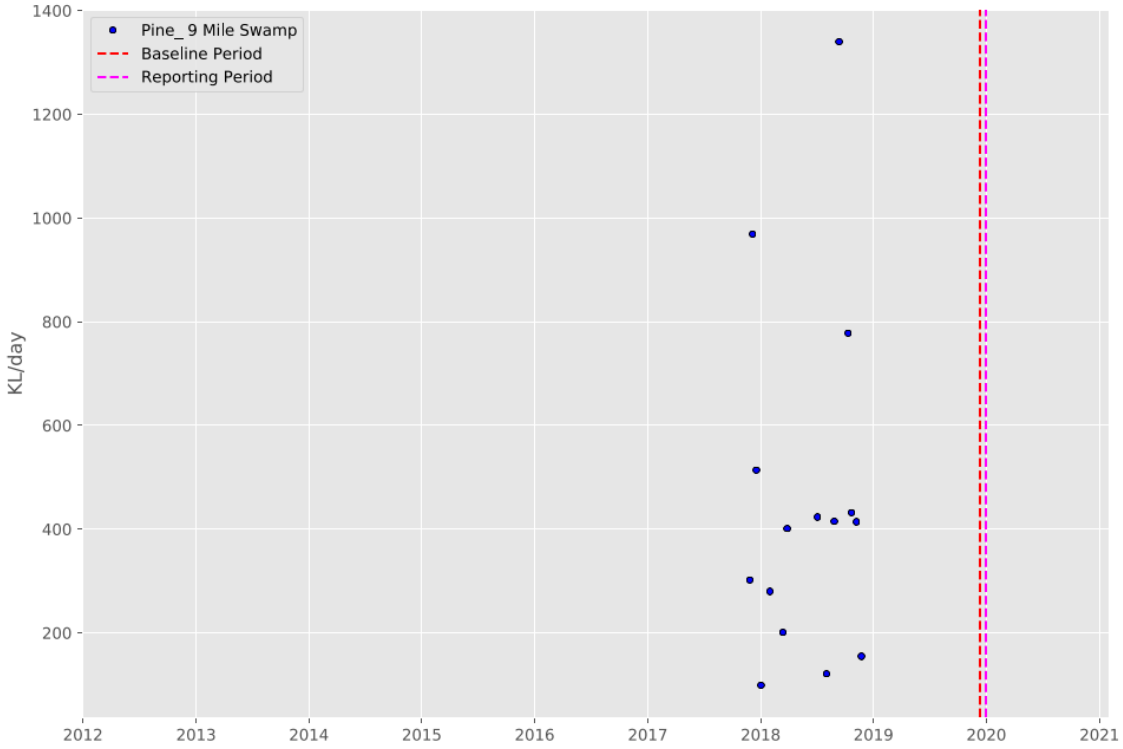

Figure 9.45: Pine/ 9 Mile Swamp - Flow

9.2.6 Sunnyside East

Sunnyside East is a tributary of Carne Creek.

9.2.6.1 Statistics

Table 9.10 presents the surface water summary statistics.

Table 9.10: Sunnyside East - Surface water quality summary statistics

ID	Historic date ranges	Analyte	Pre-mining data statistics				80th percentile trigger &	Reporting period statistics			Comments
			Data point count	Min	Mean	Max		Min	Median	Max	
Sunnyside East	Pre-mining Oct 2013. Monitoring began Mar 2016										
		pH	No pre-mining baseline					3.7	4.7	5.2	No baseline
		EC (µS/cm)						37	64	103	No baseline
		Fe (mg/L)						0.05	0.05	0.5	No baseline
		Mn (mg/l)						0.012	0.0345	0.207	No baseline
		TSS (mg/L)						5	5	26	No baseline
		DO (mg/L)						4.8	7.6	19.5	No baseline

ID	Historic date ranges	Analyte	Pre-mining data statistics				80th percentile trigger &	Reporting period statistics			Comments
			Data point count	Min	Mean	Max		Min	Median	Max	
		Flow (kl/day)						Too low	Too low	Too low	No baseline

Notes: * value at detection limit (Limit of Reporting - LOR)
positive delta value equals a recent value that is greater than the historic mean, and vice versa for negative delta values.
% no monitoring data available post 19/10/2019, due to lack of access caused to bushfire/ dry conditions
@ where values are below limit of reporting, a value of half the measurement has been assumed.
& investigation trigger performance indicators based on Table 33 of the SMP LW424-LW427. The long- and short-term triggers are based on the 80th data percentile and the 80th percentile plus two standard deviations, respectively

9.2.6.2 Quality Trend

WMP states that surface water results will be assessed against performance triggers for the parameters pH, EC, and TSS. There is no baseline data for Sunnyside East as triggers were not defined during the commencement of the its monitoring program. The trends for these analytes are shown below.

The bushfire has likely impacted on some water quality parameters at Sunnyside East. The average pH observed in the reporting period is more acidic compared to the pre-bushfire conditions, but within historic ranges. The EC is within historic ranges, albeit elevated post bushfire, and it most likely related to the bushfire ash runoff. TSS and DO displayed normal fluctuations, but the single high DO concentration in the reporting period is erroneous. Flows at Sunnyside Easy have not been consistently measured since 2017 due to drought and low flow conditions.

Graphs for all other parameter trends are included in **Appendix G**. Trends of note are:

- Anions and cations – elevated concentrations are observed in the reporting period most likely impacted by the runoff from the bushfire
- Boron – single elevated concentration in the reporting period.
- Chromium - single elevated concentration in the reporting period.
- Fluoride - single elevated concentration in the reporting period.
- Hardness as CaCO3 - elevated concentrations in the reporting period.
- Iron – seasonal trend with peaks in the summer months
- Manganese – generally increasing trend since 2018
- Nitrate - elevated concentrations in the reporting period.
- Sulfate - elevated concentrations in the reporting period.
- Turbidity – seasonal trend with peaks around the wetter summer months

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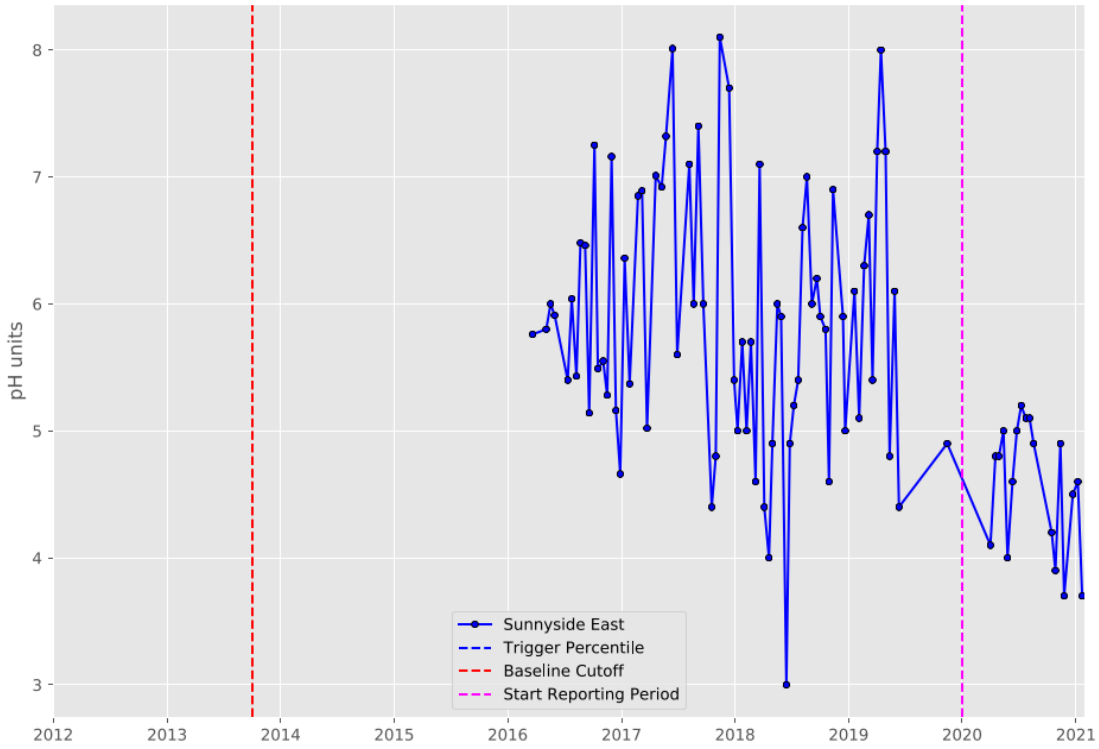

Figure 9.46: Sunnyside East - pH

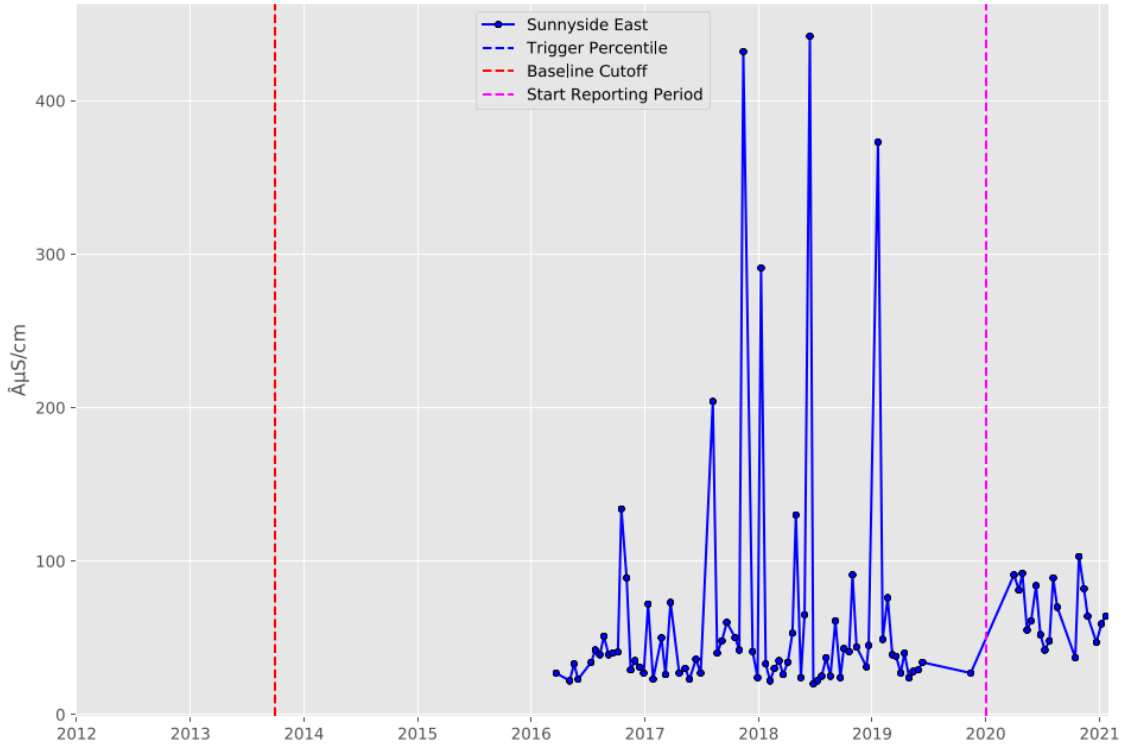

Figure 9.47: Sunnyside East - EC

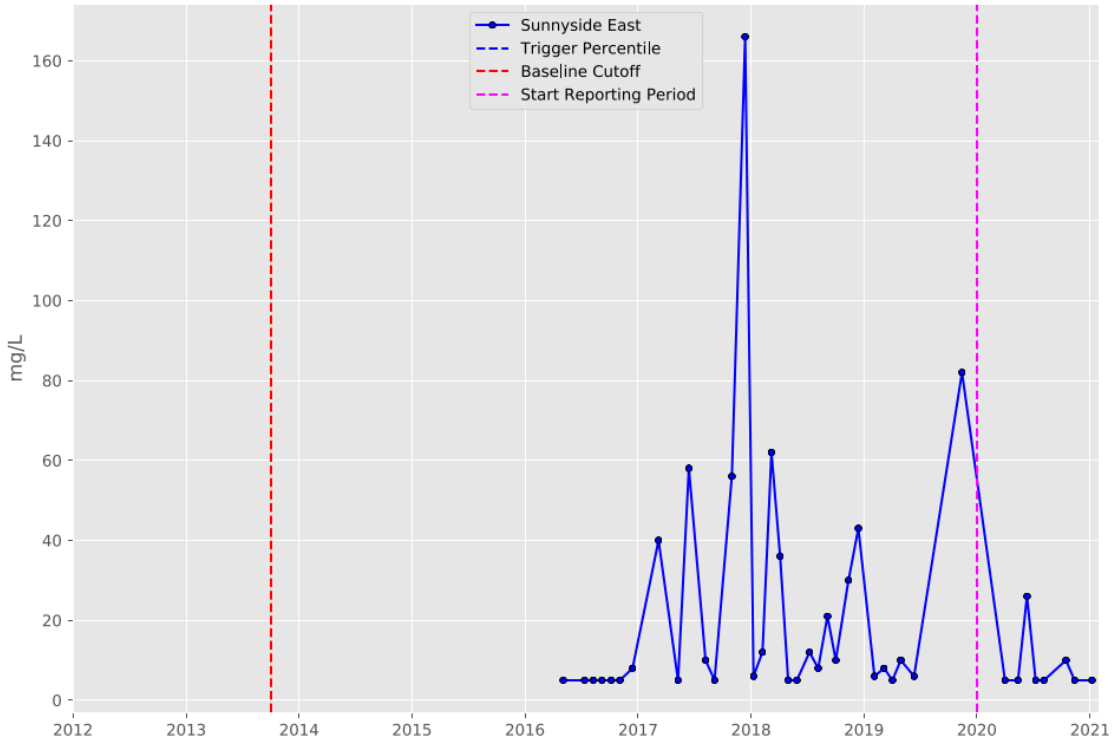

Figure 9.48: Sunnyside East - TSS

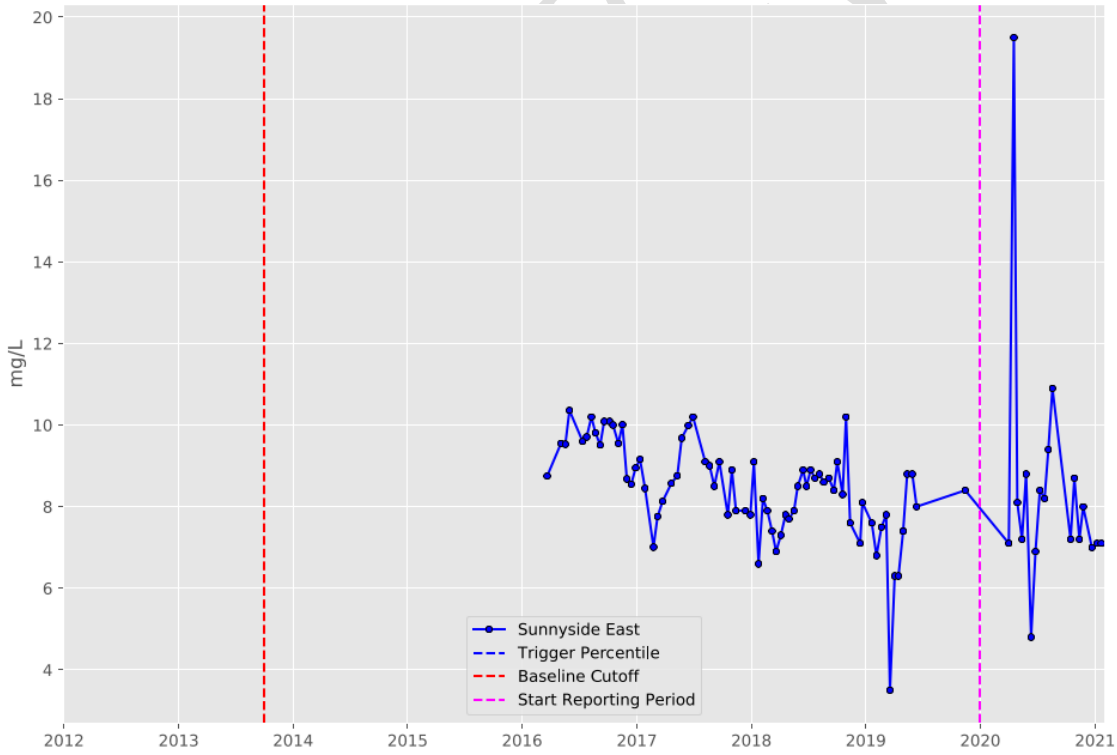

Figure 9.49: Sunnyside East - DO

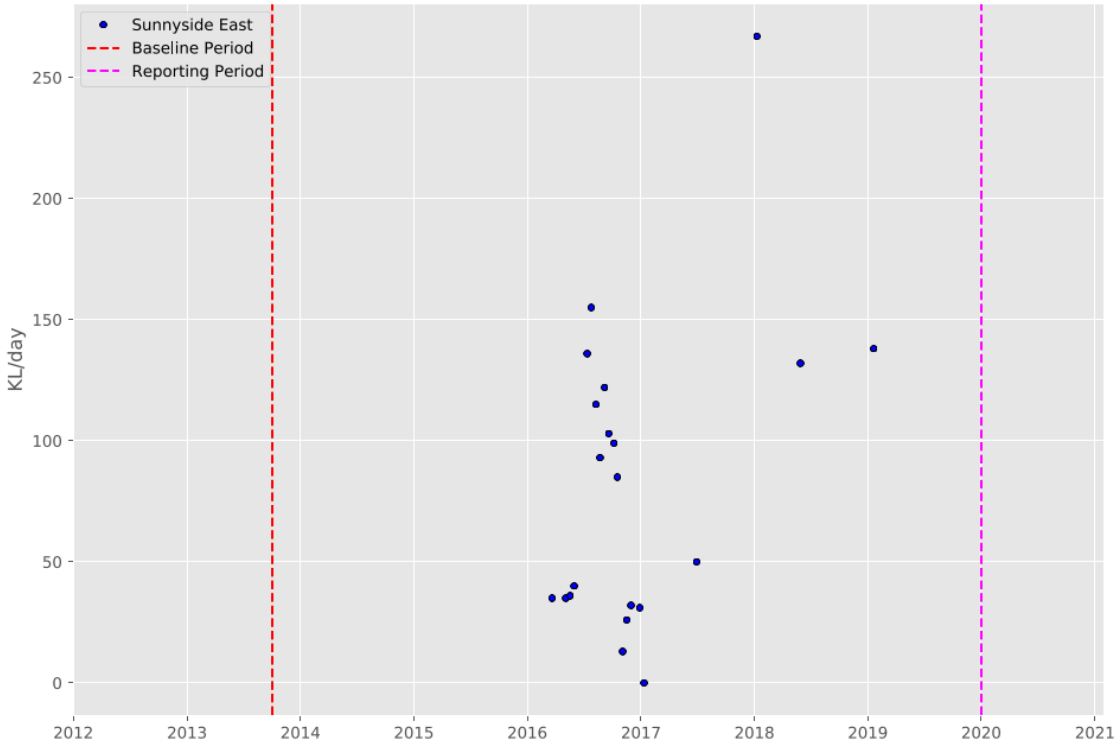

Figure 9.50: Sunnyside East - Flow

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10. Springvale Surface Water Licensed Discharge Points

Springvale currently operates under Environmental Protection License (EPL) 3607 issued by the Environmental Protection Agency (EPA). Springvale collected chemical samples from LDP006 (Point 6). The results from LDP006 are presented in Appendix C.

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11. Modelling Updates

The Development consent of SSD9954 states in Appendix 3 that groundwater models will be updated every 6 months and reviewed in the annual review.

A revised groundwater model has been built in MODFLOW by JBS&G. The model replaces the COSFLOW groundwater model built by CSIRO and used for the Springvale Extension Project EIS. The model was not available for review but has been developed in consultation with the Springvale Independent Monitoring Panel and is considered to be current.

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12. Trigger Action Response Plan

The TARP for the groundwater and surface water monitoring program is provided in Appendix A. The aquifer and swamp groundwater level data were evaluated and compared with trigger levels indicated in the TARP. The review summary is as follows:

Swamp groundwater levels

- Condition Amber remains for swamp piezometers in Carne West, Sunnyside East, Gang Gang and Gang Gang West. The water level declines observed at Carne West, Sunnyside East, Gang Gang and Gang Gang West are inconsistent with their pre-mining water levels with the swamps now rainfall dependent. Centennial reports have found evidence of interactions between the mining subsidence and the lineaments and significant faults that underlie these swamps.
- Condition Amber has recently been assigned to Pine swamp and Nine Mile Swamp, and it is being monitored for further potential changes. The decline in water levels coincided with the undermining of the swamp lineaments by LW425. The recent data has shown a recovery in the lower reaches of the swamps.

Aquifer groundwater levels

- Condition Amber remains for the groundwater level declines at SPR1107, SPR1108, SPR1109 and SPR1111, which are inconsistent with pre-mining groundwater level trends and at other ridge reference and impact piezometers that have not been influenced by mining.
- Condition Amber has been assigned to SPR1211, which has seen abnormal water level declines after the passing of LW425.
- Condition Amber has been assigned to SPR1808 which has seen a decline in water levels with the passing of LW427. The water level declines has been showing signs of stabilising.

Surface water quality

- Surface water quality data for the reporting period was not continuous due to the bushfires restricting access in early 2020. For the locations where data was available, it was common to observe elevated values. These are most likely due to the changed hydrogeological and chemical conditions of the surroundings due to the Gospers Mountain Bushfire in 2019/2020, and associated run-off.

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13. Conclusions and Recommendations

Above average rainfall conditions during the reporting period has caused groundwater level increases across many swamps. Levels have reached close to, or above, pre-drought conditions. That said, those swamps that have previously become dry due to mining impacts (ie Sunnyside East, Carne West, Gang Gang West, and Gang Gang) remained predominately dry and only showed a brief response the rainfall events. The lower reaches at Pine and Nine Mile swamps have shown recovery, with water levels remaining stable at pre-mining levels. Whereas, the hydrology at the upper reaches of Pine and Nine Mile appears to have changed in the post mining period. Water levels at Marrangaroo swamp, the swamp closest to the active longwall, has shown no observable mining impacts.

Ridge piezometers that have not been significantly impacted by mining appear to be reflecting a subdued and delayed response to the CRD and have remained relatively stable in the reporting period. The ridge piezometer SPR1211 has shown depressurisation responses to LW425 and LW426. The ridge piezometer SPR1808 has shown a water level response suggestive of bed separation or fracture dilation from subsidence at LW427.

All VWP piezometers outside the active mining area generally show stable or slightly declining trends similar to historic trends. SPR38 displayed a depressurisation response in all sensors as LW427 passed, and communication was lost with the lower three sensors. SPR1210 observed a decline in pressure in the deepest two sensors towards the middle of the reporting period, when LW426 was approaching; however, the declining piezometric pressure did propagate above the Mount York Claystone, but the impact was subdued compared to the lower sensors. SPR1302 recorded depressurisation of the top three sensors when LW427 was at its closest position to the VWP array. The depressurisation response at these VWPs suggest a localised re-equilibration with subsided formations and is not deep drainage.

Swamp groundwater quality was restricted early in the reporting period due to access issues. Hence, an assessment of trends could not be undertaken. Where data was available reference sites remained within historical limits, and most of the impact sites were predominately dry and only limited samples were taken. The sampled impacts sites did not show any indications of further mining impacts

Ridge groundwater quality was generally within limits. There were some exceedances in both reference and impact sites with the most common being EC. It is plausible that this is a one-off exceedance or an impact of the bushfire. Further monitoring will be required to confirm. SPR1301 continues to show signs of grout contamination.

Surface water quality for both SMP and WMP sites were both sampled from April 2020. Elevated parameters were observed in both reference and impacts sites with the most common parameter being EC. The EC triggers were exceeded for longer than two months in Paddys Creek and Carne Swamp. It is noted similar increases in EC were observed at reference sites. The bushfire has most likely altered the hydrogeological and chemical conditions of the surroundings which would have impacted on the surface water quality. This is predominantly due to the increase erosion and run off caused by the reduced plant and ground cover. These swamps have previously been triggered and investigated under the groundwater level performance trigger and a separate investigation is not required.

The soil moisture monitoring network was destroyed by the fire and the probes were reinstated in September 2020. There is limited data for the reporting period, but observations show moisture levels are closely linked to water levels and rainfall events.

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14. References

Centennial Coal. (2013). *The Geology of the Shrub Swamps within the Angus Place/ Springvale Collieries*.

Centennial Coal. (2019). *CENTENNIAL COAL SPRINGVALE COLLIERY ANNUAL REVIEW January 2018 to December 2018.*

Jacobs. (2018). *Review of Soil Moisture Monitoring data.*

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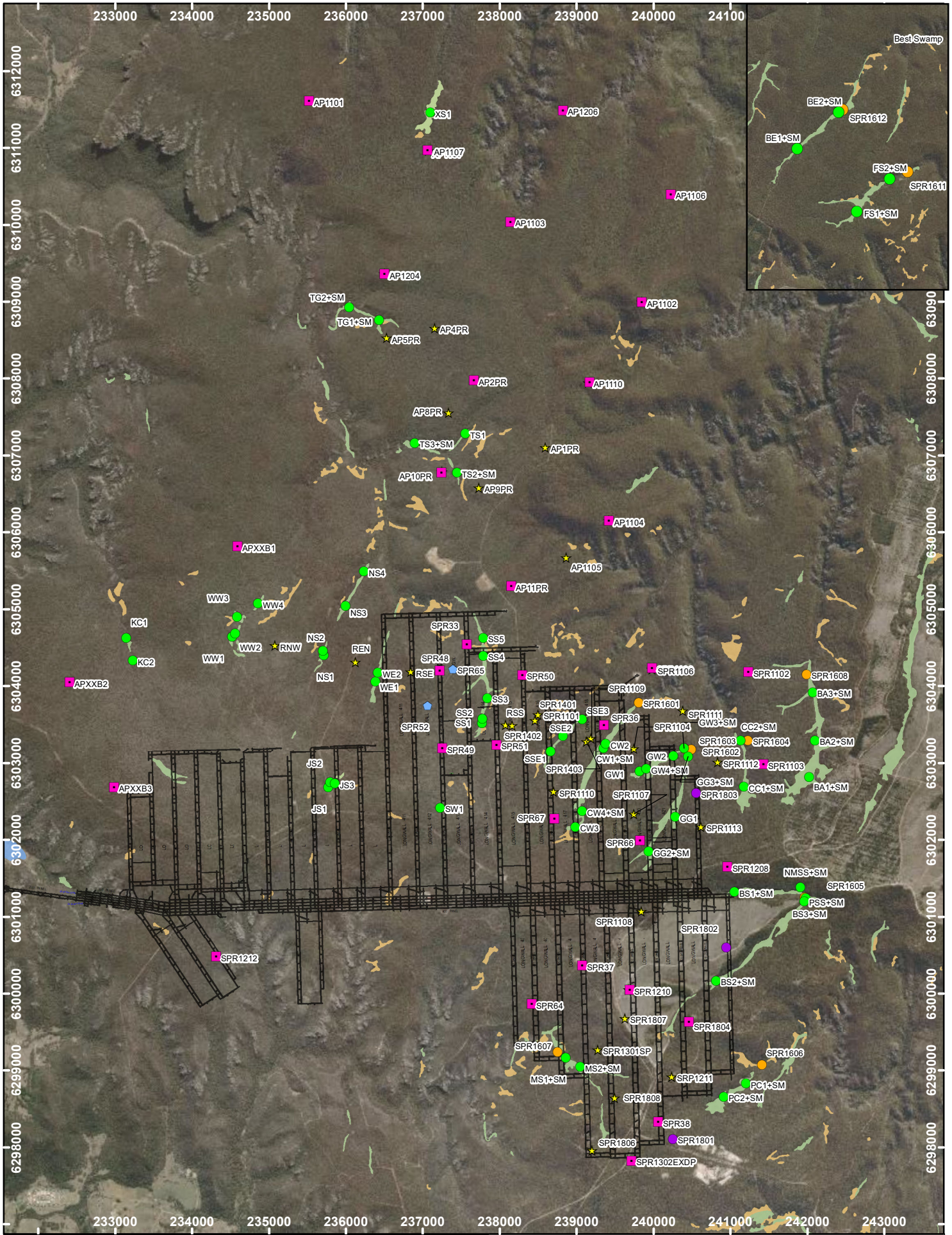
Appendix A. Figures

SPRINGVALE



LEGEND:

Groundwater monitoring locations

- Swamp
- Ridge
- Shallow Aquifer
- VWP
- Stygo
- Exto

Shrub Swamp

Hanging Swamp

Springvale Workings

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

DRAWN: QB	DATE: 22/07/2020
PLAN No: IA161500/159/Figure1.1	
PLAN PREPARED BY: JACOBS	
SCALE: 1:63,000	A4 Sheet 1 of 1

SPRINGVALE MINE

TITLE:

JACOBS
AEMR:
Groundwater Monitoring Locations
Newnes Plateau

Springvale Coal
SPRINGVALE MINE
Castlereagh HWY
Lidsdale NSW 2790
PO Box 198
Wallerawang NSW 2845
Phone: 02-63501600
Fax: 02-63551052

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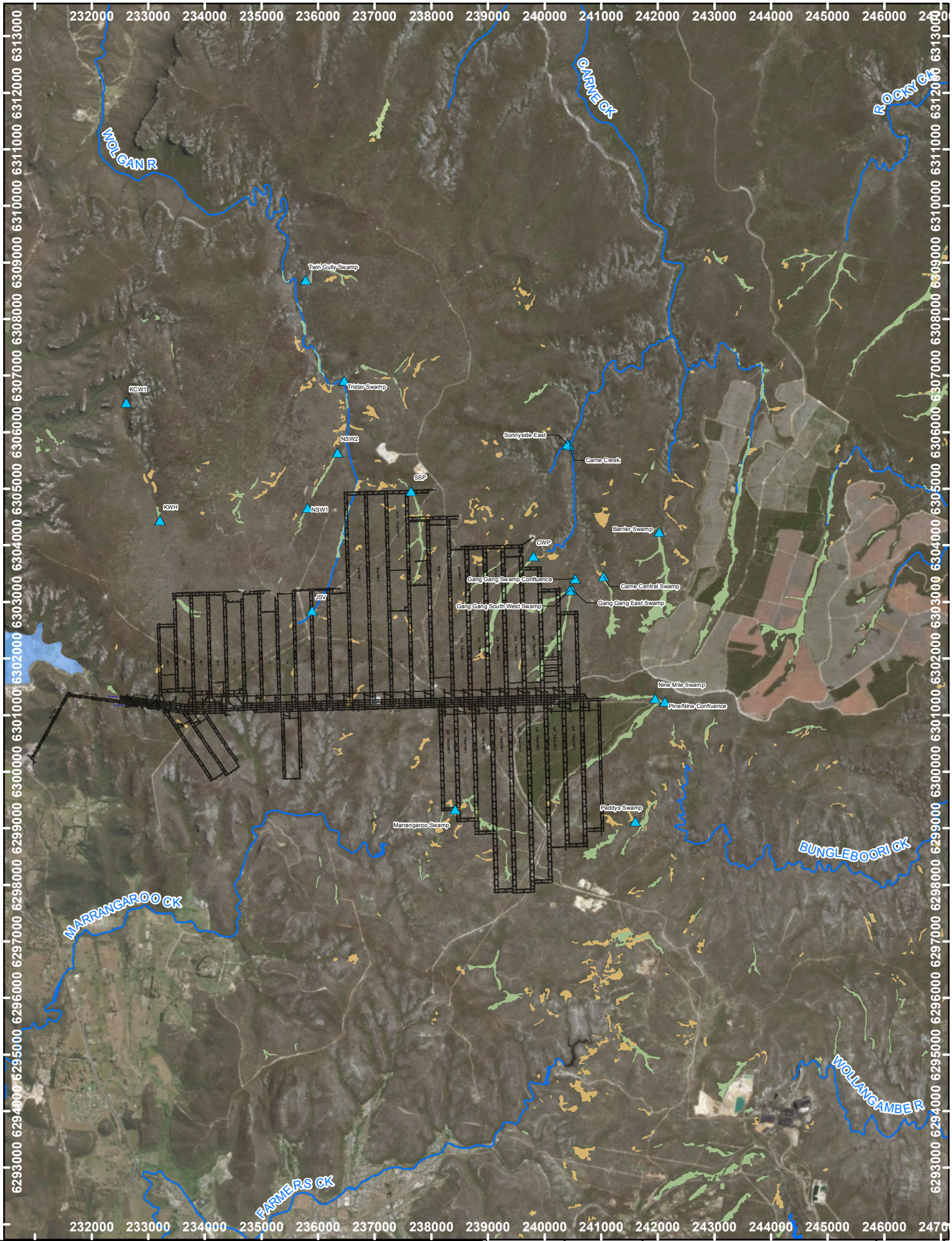


LEGEND:

Surface water monitoring locations

Shrub Swamp

Hanging Swamp

Springvale Workings

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

DRAWN: JY	DATE: 20/02/2019
PLAN No: IA161500/081/Figure2	
PLAN PREPARED BY: JACOBS	
SCALE: 1:86,000	A4 Sheet 1 of 1

SPRINGVALE MINE

TITLE:

Figure A2

JACOBS

AEMR:

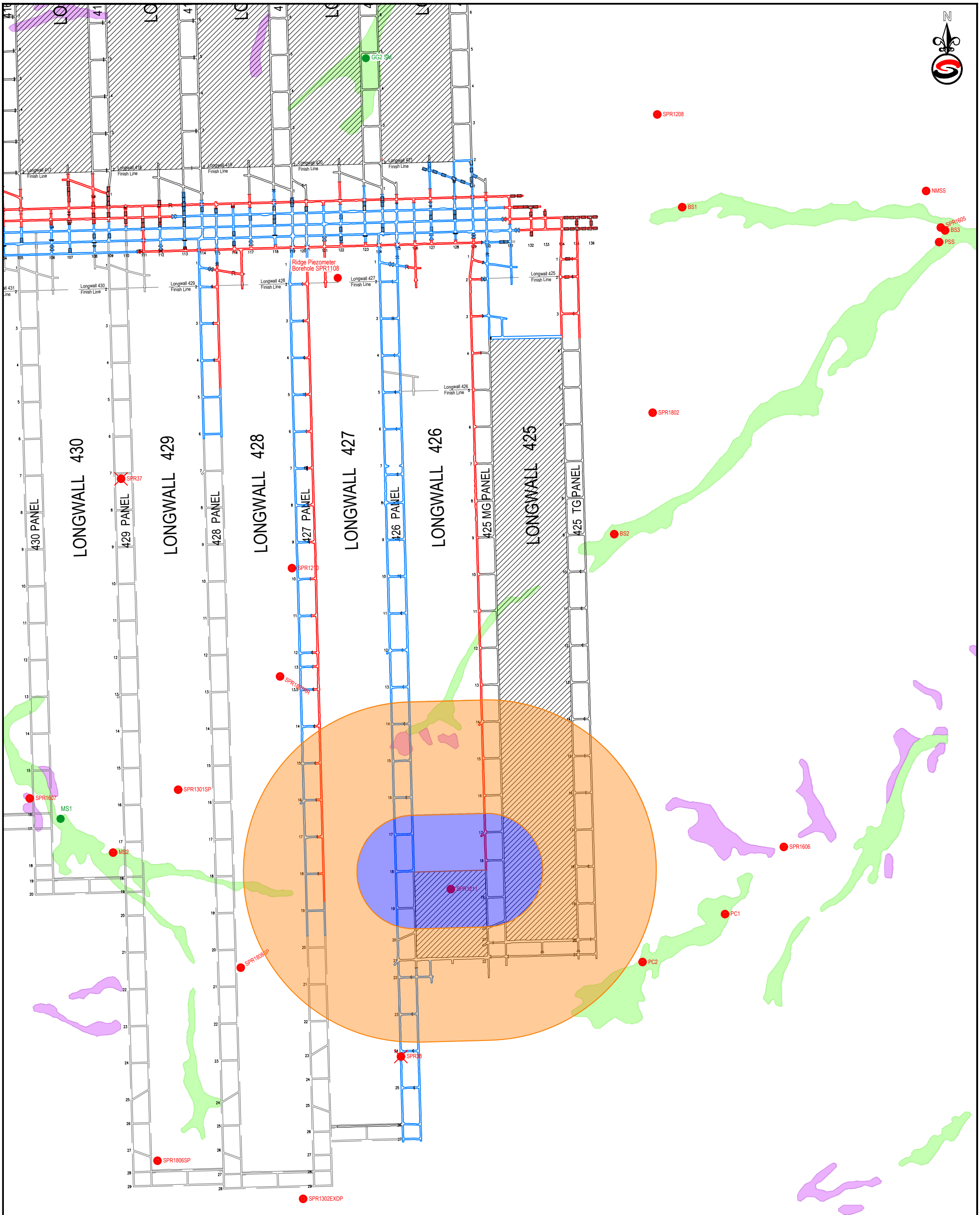
Surface Water Monitoring Locations

Newnes Plateau

Springvale Coal

SPRINGVALE MINE
Castlereagh HWY
Lidsdale NSW 2790
PO Box 198
Wallerawang NSW 2845
Phone: 02-63501600
Fax: 02-63551052

GIS MAP file : J:\IE\Projects\04_Eastern\IA161500\02 Documents\GIS\081_AEMR_2018\081_Fig 2 sw monitoring locations.mxd



LEGEND:

- 600m Faceline Buffer Monitoring Trigger Zone
- 200m Faceline Buffer Monitoring Trigger Zone

NOTES:

DRAWN: Madison Haddon	DATE: 3 January 2020
PLAN No: SVY06189	COMPUTER PATH: N:\Z_Plans
INFORMATION SUPPLIED BY: Peter Corbett/Survey Department	
SCALE: Not To Scale	A3V Sheet 1 of 1

SPRINGVALE MINE

TITLE:

LW426 Extraction Plan

Groundwater and Soil Moisture Monitoring Weekly Operational Trigger Plan

Charted to: 02-01-2020

SpringvaleCoal

SPRINGVALE MINE
Castlereagh HWY
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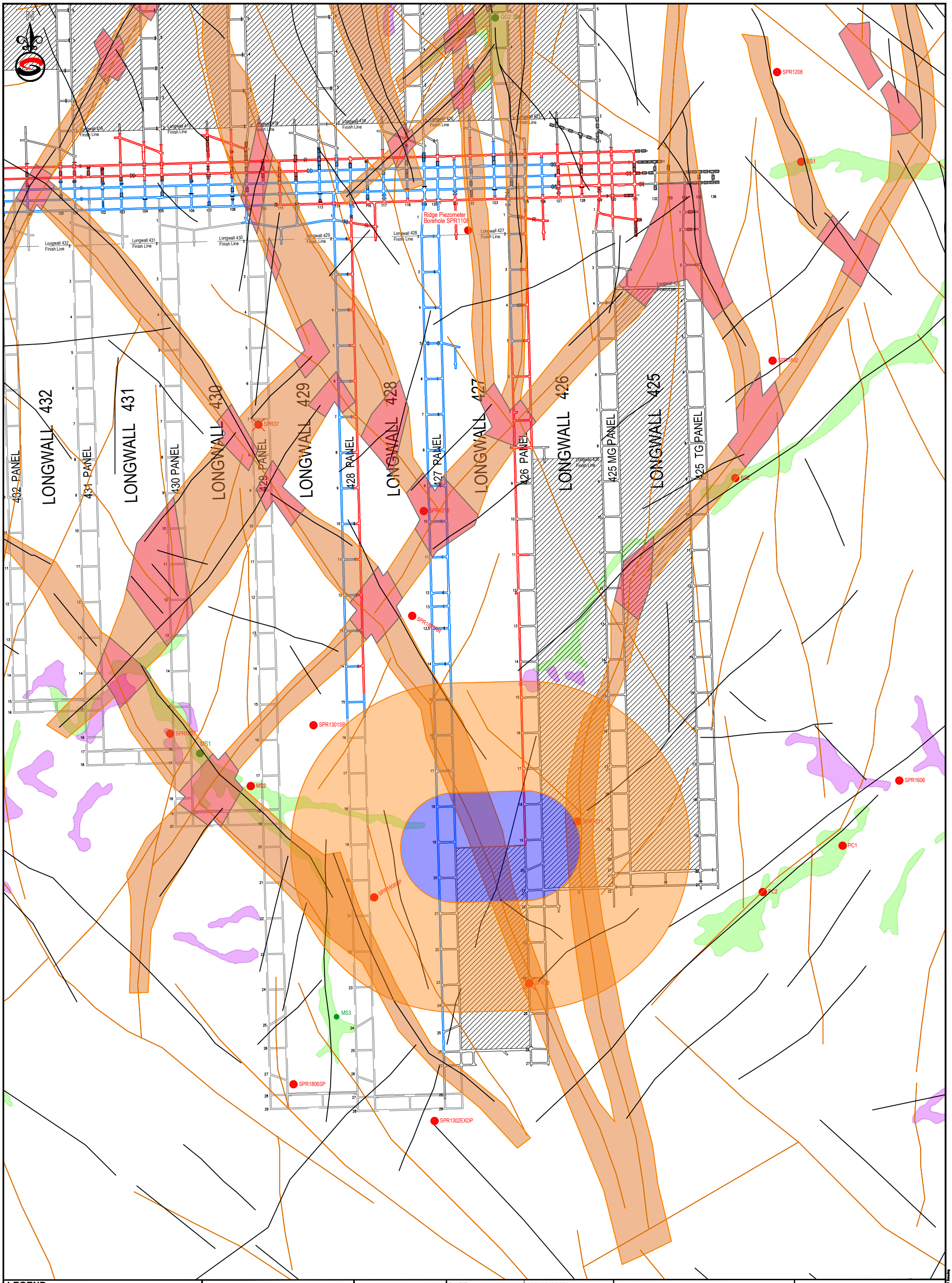
N:\Z_Workings\Weekly Plan\LW426 GW Monitoring Buffer Zone.dwg



LEGEND:

- 600m Faceline Buffer Monitoring Trigger Zone
- 200m Faceline Buffer Monitoring Trigger Zone

NOTES:

SRK 2017 Model Used.

CENTENNIAL SPRINGVALE PTY. LTD.

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DATE	18-12-2020
DRAWN	Madison Haddon
REFERENCE	N:\Z_Plans
SEAM	LITHGOW
INFORMATION SUPPLIED FROM	Peter Corbett, Survey Department
SCALE	NOT TO SCALE

SPRINGVALE COLLIERY

LW426 Extraction Plan
Groundwater & Soil Moisture Monitoring- Weekly Trigger Plan

Charted To: 17-12-2020

CENTENNIAL SPRINGVALE

Plan No. SVY06801.1 | A3V

Appendix B. Trigger Action Response Plan

SPRINGVALE

Table 33 – Summary of Monitoring Against Performance Indicators and Measures

Performance Measure	Monitoring			Data Analysis to Assess Against Performance	Performance Indicator	Performance Indicator Investigation Triggers and Cease Work Triggers	Management Measures
	Sites	Parameters	Frequency				
Subsidence							
No anomalous subsidence in shrub swamps	**Impact Swamps**	· Subsidence · Tilt · Strain · Angle of draw	Pre and post mining i.e. at least 300m prior to and after the line for each longwall	Comparison of measured subsidence against predicted subsidence	Exceedance of anomalous subsidence levels	<u>Investigation Triggers</u> Anomalous subsidence trigger level will be exceeded if: · Subsidence >1.15 metre (>20mm Nine Mile Swamp, Paddy's Creek Swamp and Marrangaroo Creek Swamp) · Tilt > 7.5 mm/m (>0.5mm/m Nine Mile Swamp, Paddy's Creek Swamp and Marrangaroo Creek Swamp) · Hogging Curvature >0.11km^{-1} (>0.01mm/m Nine Mile Swamp, Paddy's Creek Swamp and Marrangaroo Creek Swamp) · Sagging Curvature >0.14km^{-1} (>0.01mm/m Nine Mile Swamp, Paddy's Creek Swamp and Marrangaroo Creek Swamp) <u>Cease Work Triggers</u> In combination with groundwater level cease work triggers, the subsidence cease work trigger is: · Observed subsidence exceeds predicted subsidence by greater than 25%	If the maximum vertical subsidence exceeds the maximum predicted vertical subsidence; but there has been no unpredicted irregular development of subsidence. · No response required. Continue monitoring program. · Investigate exceedance and review the subsidence prediction model at the completion of the longwall. If survey monitoring within the Extraction Plan Area identifies that: significant unpredicted and/or higher-than-predicted subsidence and/or abnormalities (greater than 15%) in the development of subsidence. · Notify the Secretary of DP&E, DRG and relevant stakeholders of exceedance of subsidence predictions. · Investigate exceedance and review the subsidence prediction model. · Identify and implement remedial actions in consultation with relevant stakeholders, if necessary.

Performance Measure	Monitoring			Data Analysis to Assess Against Performance	Performance Indicator	Performance Indicator Investigation Triggers and Cease Work Triggers	Management Measures
	Sites	Parameters	Frequency				
Groundwater Level							
Identify any lowering of water levels or increased interactions between surface and swamp water levels	**Impact and reference swamp piezometers and shallow perched aquifer piezometers**	Swamp water level & perched aquifer groundwater level. Impact and reference shallow perched aquifer piezometers for comparison only.	Data recorded daily at all sites. Telemetered/manual data collection will be carried out weekly at selected swamp piezometers within the TIA. Monthly data collection will be carried out at all impact and reference swamp piezometers as well as and shallow perched aquifer monitoring piezometers across Springvale.	· Water level and groundwater level data analysed as mbgl. · Statistical analysis using 7-day floating average –including 50th, 80th and 95th percentile pre-mining groundwater depths for comparison with post mining data. · Reference sites used to check for climatic variation. · Shallow perched aquifer piezometers used as a reference for swamp piezometers.	**Primary** · Any significant change in water level relative to pre-mining groundwater level behaviour. **Secondary** · Any significant change in water level not related to recent meteorological conditions · Any significant change in water level relative to water level behaviour at reference sites during the same period.	<u>Investigation Triggers</u> Performance indicators will be considered to have been exceeded if statistically significant changes are indicated by the data such as: · For short-term change – if any measured parameter > baseline 95th percentile for more than seven (7) days. · For long-term change – if the post-mining 50th percentile groundwater depth for any piezometer >80th percentile pre-mining level. <u>Cease Work Triggers</u> In combination with subsidence cease work trigger, the swamp water level cease work triggers are: · For short-term change in a swamp – if any measured parameter > baseline 99th percentile for more than one (1) month, which cannot be explained by baseline data, weather patterns or observed behaviour at control sites.	If the primary performance indicator has been exceeded suitable management measures and/or corrective actions will be implemented within 2 months: · Compare with data and statistical analyses from swamp reference sites and impact and reference shallow perched aquifer piezometers. · Check for other swamp health indicators (flora). · Check for anomalous subsidence. · Check for corresponding declines in adjacent perched and shallow aquifer piezometers. If subsidence or flora performance indicators are also exceeded, then follow appropriate management measure for that performance measure. If secondary performance indicator is exceeded: · Notify the Secretary of DP&E and relevant stakeholders of exceedance of subsidence predictions. · Investigate exceedance and review the subsidence prediction model. · Identify and implement remedial actions in consultation with relevant stakeholders, if necessary.

Performance Measure	Monitoring			Data Analysis to Assess Against Performance	Performance Indicator	Performance Indicator Investigation Triggers and Cease Work Triggers	Management Measures
	Sites	Parameters	Frequency				
Identify any lowering of groundwater levels or increased interactions between surface and groundwater in shrub swamps	**Impact and reference ridge piezometers**	Groundwater level	Data recorded daily at all sites. Monthly data collection will be carried out at all Springvale impact and reference ridge piezometers	· Groundwater level data will be analysed as mAHD. · Statistical analysis using 7-day floating average –including median, 5th, 20th, 80th and 95th percentile pre-mining groundwater depths for comparison with post-mining data · Reference sites used to check for climate related fluctuations	**Primary** · Any significant change in groundwater level relative to pre-mining groundwater level behaviour. **Secondary** · Any significant change in groundwater level not related to recent meteorological conditions · Any significant change in groundwater level relative to groundwater level behaviour at reference sites during the same period.	<u>Investigation Triggers</u> Performance indicators are exceeded if statistically significant changes are indicated by the data such as: · For short-term change – if the seven day moving average is greater than the pre-mining 5th percentile for one (1) month. · For long-term change – if the post-mining 50th percentile groundwater depth for any piezometer >20th percentile pre-mining level. An assessment will be made against the performance measure. <u>Cease Work Triggers</u> In combination with subsidence and swamp piezometer cease work triggers, the groundwater level cease work trigger is: For short-term change in a swamp – if any measured parameter > baseline 99th percentile for more than one (1) month, which cannot be explained by baseline data, weather patterns or observed behaviour at control sites.	If the primary performance indicator has been exceeded suitable management measures and/or corrective actions will be implemented within 2 months: · Compare with data and statistical analyses from reference sites for any differences · Check for swamp "health" indicators (swamp water levels, flora). · Check for anomalous subsidence. · Check for corresponding declines in adjacent perched and shallow aquifer piezometers and VWP. If subsidence, swamp water level, or flora performance indicators are also exceeded then follow appropriate management measure for that performance measure. If secondary performance indicator is exceeded: · Notify the Secretary of DP&E and relevant stakeholders of exceedance of subsidence predictions. · Investigate exceedance and review the subsidence prediction model. Identify and implement remedial actions in consultation with relevant stakeholders, if necessary

Performance Measure	Monitoring			Data Analysis to Assess Against Performance	Performance Indicator	Performance Indicator Investigation Triggers and Cease Work Triggers	Management Measures
	Sites	Parameters	Frequency				
Groundwater Quality							
Change in swamp piezometer and shallow perched aquifer water quality	**Impact and reference swamp piezometers and shallow perched aquifer piezometers**	Field (pH, Temp, EC, Eh, DO) Physical (pH, TDS), Major Ions, Trace Ions	Swamp piezometer water quality sampled monthly	· Samples will be analysed by a NATA accredited laboratory. · Initially, only the indicative parameters EC, pH, Fe will be assessed for any change. · Statistical analysis – the pre-mining mean, standard deviation, 80th and 95th percentile level, and post-mining 50th percentile level will be determined for each indicative parameter in impact and reference sites	**Primary** · Any significant change in analyte concentrations relative to pre-mining water quality. **Secondary** · Any significant change in analyte concentrations not related to recent meteorological conditions. · Any significant change in analyte concentrations relative to water quality behaviour at reference sites.	<u>Investigation Triggers</u> Performance indicators will be considered to have been exceeded if statistically significant changes are indicated by the data such as: · For short-term change – if any measured parameter > baseline 80th percentile by two standard deviations for more than two months. · For long-term change – if the post-mining 50th percentile level for any analyte exceeds the 80th percentile pre-mining level.	If the primary performance indicator has been exceeded suitable management measures and/or corrective actions will be implemented including. Within 2 months: · Compare with reference sites for any differences. · Check for trigger level exceedance of secondary performance indicators. · Carry out an investigation to determine the cause of the water quality change.

Performance Measure	Monitoring			Data Analysis to Assess Against Performance	Performance Indicator	Performance Indicator Investigation Triggers and Cease Work Triggers	Management Measures
	Sites	Parameters	Frequency				
Change in groundwater water quality	**Impact and reference ridge piezometers**	Field (pH, Temp, EC, Eh, DO) Physical (pH, TDS), Major Ions, Trace Ions	Quarterly	· Samples will be analysed by a NATA accredited laboratory. · Initially, only the indicative parameters EC, pH, Fe will be assessed for any change. · Statistical analysis – the pre-mining mean, standard deviation, 80th and 95th percentile level, and post-mining 50th percentile level will be determined for each indicative parameter in impact and reference sites.	· Exceedance of Trigger value (pH <2.73 or >7.87; EC > 100 µS/cm; Fe >1mg/L)	Investigation Trigger Performance indicators will be considered to have been exceeded if data exceeds the nominated numerical values.	If the primary performance indicator has been exceeded suitable management measures and/or corrective actions will be implemented including. Within 2 months: · Compare data with historical, including reference sites · Carry out investigation to determine cause of water quality change
Surface Water Quality							
Change in surface water quality	**Impact and reference swamps**	Field (pH, Temp, EC, Eh, DO, NTU, Flow) Physical (pH, TDS, TSS), Major Ions, Trace Ions	Fortnightly – pH, Temp, EC, Eh, DO, NTU, Flow Monthly – pH, Temp, EC, Eh, DO, NTU, Flow, TDS, TSS, Major Ions, Trace Ions	· Samples will be analysed by a NATA accredited laboratory. · The indicative parameters EC, pH, Fe, Mn and TSS will be assessed for any change. · Statistical analysis – the pre-mining mean, standard deviation, 80th percentile level and post-mining 50th percentile level will be determined for each indicative parameter.	**Primary** · Any significant change in analyte concentrations relative to pre-mining. **Secondary** · Any significant change in analyte concentrations not related to recent meteorological conditions. · Any significant change in analyte concentrations relative to water quality behaviour at reference sites.	Investigation Triggers Performance indicators will be considered to have been exceeded if statistically significant changes are indicated by the data such as: **Surface Water Quality** · For short-term change - if any measured parameter > baseline 80th percentile by two standard deviations for more than two months. For long-term change – if the post-mining 50th percentile level for any analyte exceeds the 80th percentile pre-mining level.	Management measures and/or corrective actions will be implemented if the primary performance indicator has been exceeded. Within 2 months: · Check for trigger level exceedance of secondary performance indicators. · Check for anthropogenic or other natural causes of the anomalous data. · Carry out an investigation to determine cause of water quality change.

Chart 1: Trigger Action Response Plan – Overview

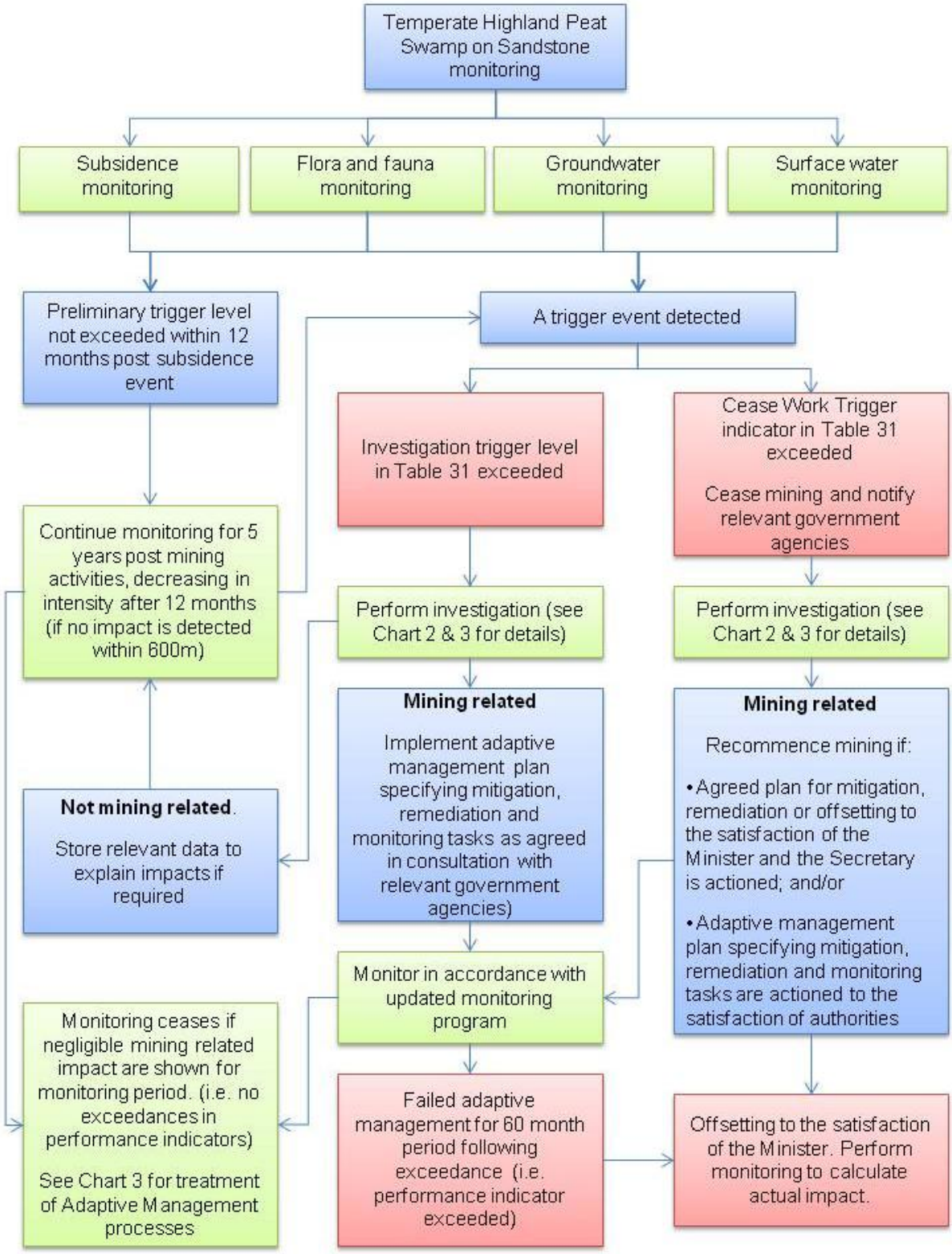


Chart 2: Trigger Action Response Plan – Management Measures

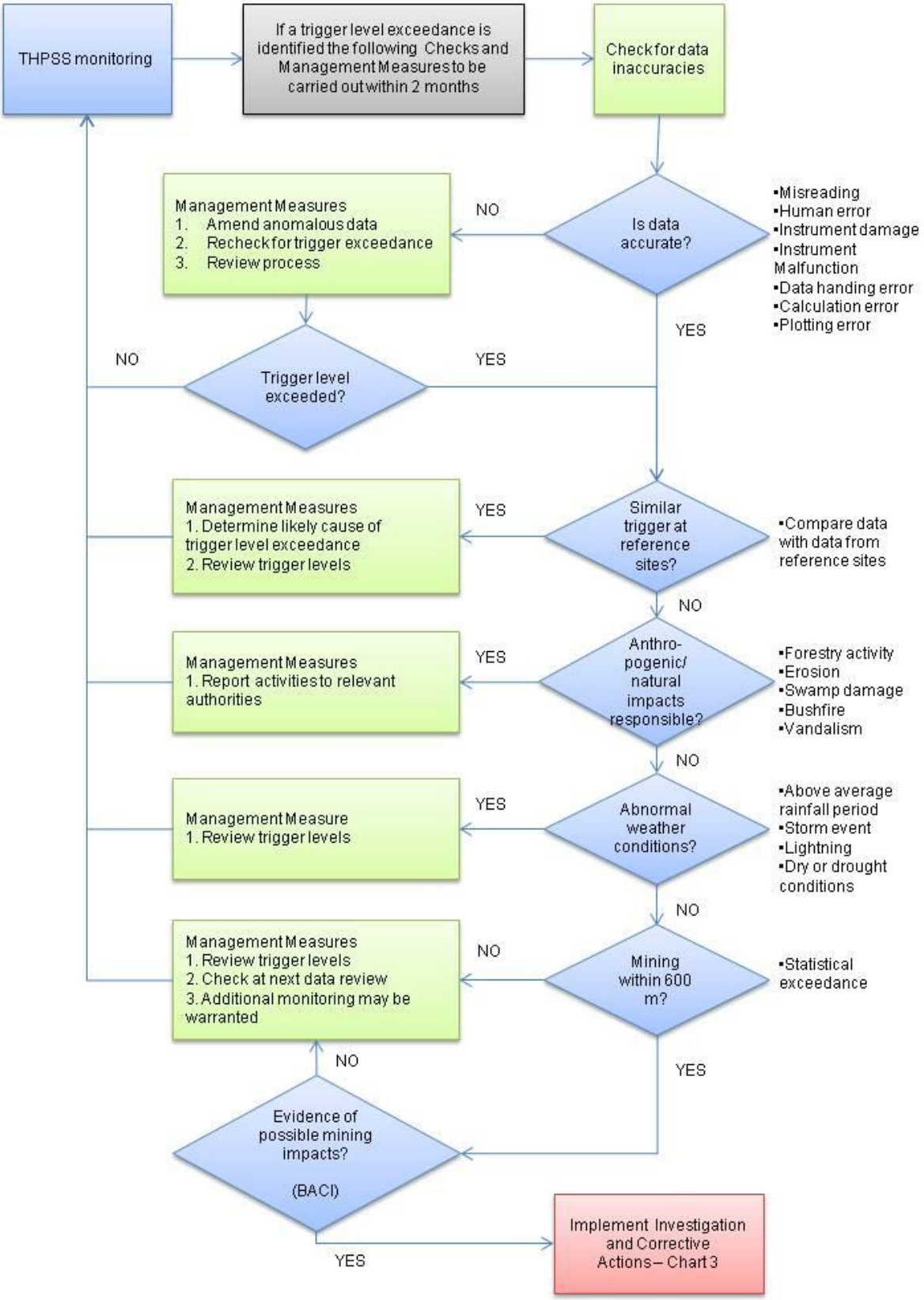
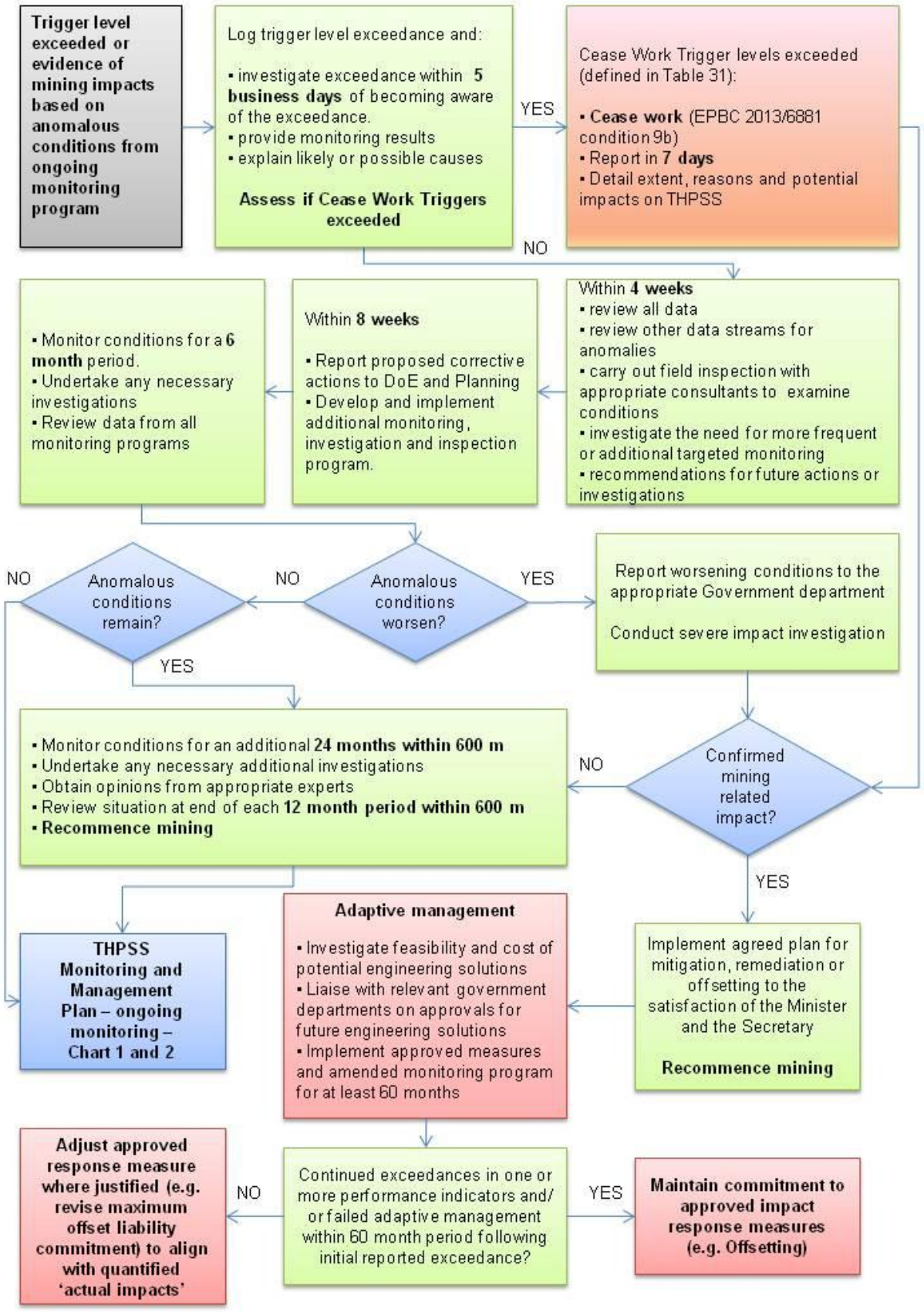


Chart 3: Trigger Action Response Plan – Corrective Actions



Appendix C. LDP006 Chemistry

SPRINGVALE

ID	Date	Chlorine (Free)	Electrical Conductivity (EC)	Aluminium (Filtered)	Arsenic (Filtered)	Boron (Filtered)	Copper (Filtered)	Fluoride	Iron (Filtered)	Manganese (Filtered)	Nickel (Filtered)	Oil and Grease	TSS	Turbidity	Zinc (Filtered)
		mg/L	µS/cm	mg/L	µg/L	µg/L	µg/L	mg/L	mg/L	µg/L	µg/L	mg/L	mg/L	NTU	µg/L
LDP006	7/01/2020	<0.02	1040	0.04	<1	<50	<1	0.5	<0.05	6	<1	<5	<5	5.1	<5
LDP006	11/01/2020	-	-	-	-	-	-	-	-	-	-	-	12	45	-
LDP006	14/01/2020	<0.02	1035	0.03	<1	<50	2	0.4	<0.05	3	1	<5	<5	3.9	11
LDP006	21/01/2020	<0.02	1027	0.06	<1	<50	<1	0.5	<0.05	6	1	<5	<5	8.2	<5
LDP006	28/01/2020	<0.02	916	0.03	<1	<50	<1	0.4	<0.05	2	1	<5	<5	6.7	<5
LDP006	11/02/2020	<0.02	869	0.1	<1	<50	2	0.4	<0.05	56	1	<5	<5	5.9	8
LDP006	18/02/2020	<0.02	927	0.11	<1	<50	<1	0.4	<0.05	46	2	<5	<5	4.8	<5
LDP006	25/02/2020	<0.02	983	0.02	<1	<50	<1	0.6	<0.05	7	<1	<5	15	5.3	<5
LDP006	3/03/2020	<0.02	950	0.06	<1	<50	<1	0.4	<0.05	10	<1	<5	<5	8.6	<5
LDP006	10/03/2020	<0.02	997	0.05	<1	<50	<1	0.4	<0.05	16	2	<5	15	20	<5
LDP006	17/03/2020	<0.02	915	0.08	<1	<50	<1	0.4	<0.05	31	1	<5	9	2.8	<5
LDP006	24/03/2020	<0.02	1033	0.02	<1	<50	<1	0.4	<0.05	37	1	<5	<5	2.7	9
LDP006	31/03/2020	<0.02	931	0.06	1	<50	<1	0.5	<0.05	26	1	<5	<5	5.2	<5
LDP006	7/04/2020	<0.02	942 - 954	0.06	<1	<50	<1	0.3	<0.05	10	1	<5	5	8.2	6
LDP006	15/04/2020	0.03	894	0.41	<1	<50	2	0.4	0.19	14	2	<5	12	30	10
LDP006	21/04/2020	<0.02	903	0.04	<1	<50	1	0.5	<0.05	4	1	<5	9	15.6	<5
LDP006	28/04/2020	<0.02	1025	0.04	<1	<50	2	0.4	<0.05	10	2	<5	6	17	8
LDP006	5/05/2020	0.03	1002	0.86	<1	<50	<1	0.4	0.17	10	2	<5	11	23	7
LDP006	12/05/2020	<0.02	953 - 982	0.03	<1	<50	<1	0.3	<0.05	6	2	<5	<5	11	16
LDP006	18/05/2020	<0.02	917	<0.01	<1	<50	<1	0.3	<0.05	<1	<1	<5	<5	20	<5

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LDP006	26/05/2020	<0.02	950	0.04	<1	<50	<1	0.4	<0.05	6	2	<5	11	14	5
LDP006	2/06/2020	<0.02	1035	0.03	<1	<50	<1	0.4	<0.05	11	1	<5	<5	7.4	<5
LDP006	9/06/2020	<0.02	999	0.03	<1	<50	<1	0.4	<0.05	3	<1	<5	13	12	<5
LDP006	16/06/2020	<0.02	1009	0.05	<1	<50	<1	0.4	<0.05	4	2	<5	8	6.7	<5
LDP006	23/06/2020	<0.02	969	0.05	<1	<50	13	0.4	<0.05	3	2	<5	11	9.3	12
LDP006	30/06/2020	<0.02	1063	0.02	<1	130	<1	0.4	0.07	353	29	<5	6	9.9	25
LDP006	7/07/2020	<0.02	786	0.02	<1	<50	<1	0.4	<0.05	4	2	<5	8	13.1	<5
LDP006	14/07/2020	<0.02	775	0.04	<1	<50	<1	0.4	<0.05	8	<1	<5	8	16	6
LDP006	21/07/2020	<0.02	970	0.04	<1	<50	<1	0.4	<0.05	8	1	<5	5	7.5	<5
LDP006	28/07/2020	<0.02	651 - 655	0.15	<1	<50	<1	0.3	<0.05	28	2	<5	9	17	7
LDP006	4/08/2020	<0.02	898	0.03	<1	<50	<1	0.4	<0.05	3	2	<5	13	19	<5
LDP006	11/08/2020	<0.02	798	1.95	<1	<50	<1	0.3	0.26	12	<1	<5	12	21	8
LDP006	19/08/2020	<0.02	745	0.68	<1	<50	1	0.3	0.14	26	2	<5	9	24	13
LDP006	25/08/2020	<0.02	855	0.07	<1	<50	<1	0.4	<0.05	5	2	<5	<5	12	<5
LDP006	1/09/2020	<0.02	797	0.06	<1	<50	<1	0.3	<0.05	3	<1	<5	12	15.1	<5
LDP006	8/09/2020	<0.02	862	0.03	<1	<50	1	0.4	<0.05	14	2	<5	<5	9.5	6
LDP006	15/09/2020	<0.02	768	0.05	<1	<50	1	0.3	<0.05	7	2	<5	<5	9.3	6
LDP006	22/09/2020	0.02	794 - 806	0.07	<1	<50	<1	0.3	<0.05	19	1	<5	6	20	5
LDP006	29/09/2020	<0.02	799	0.05	2	50	<1	0.4	<0.05	18	2	<5	8	18	<5
LDP006	6/10/2020	<0.02	-	0.04	<1	<50	<1	0.3	<0.05	10	2	<5	<5	13	<5
LDP006	13/10/2020	<0.02	1018	0.5	<1	50	<1	0.4	0.16	16	2	<5	12	8	<5
LDP006	20/10/2020	-	913	0.39	<1	<50	<1	0.4	0.08	12	2	<5	5	5.2	<5
LDP006	27/10/2020	<0.02	823	0.45	<1	<50	<1	0.3	0.13	11	-	<5	<5	8.3	5
LDP006	3/11/2020	<0.02	872	0.56	<1	<50	<1	0.4	0.17	10	1	<5	<5	11	6
LDP006	10/11/2020	<0.02	901	0.03	<1	<50	16	0.3	<0.05	4	1	<5	<5	7.4	10
LDP006	17/11/2020	<0.02	910	0.27	<1	<50	<1	0.4	0.08	9	1	<5	<5	8.6	<5
LDP006	24/11/2020	<0.02	895	0.02	<1	<50	<1	0.3	<0.05	5	1	<5	<5	6.4	<5
LDP006	1/12/2020	<0.02	866	0.02	<1	90	<1	0.4	<0.05	4	1	<5	<5	16	<5
LDP006	8/12/2020	<0.02	782 - 927	0.01	<1	<50	<1	0.3	<0.05	3	1	<5	15	23	<5

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LDP006	15/12/2020	<0.02	937	0.42	<1	<50	<1	0.4	0.25	7	1	<5	14	30	10
LDP006	22/12/2020	0.17	551	0.1	<1	60	1	0.3	0.06	9	1	<5	16	33	<5
LDP006	29/12/2020	<0.02	675 - 677	0.06	<1	<50	<1	0.3	<0.05	2	1	<5	33	40	<5

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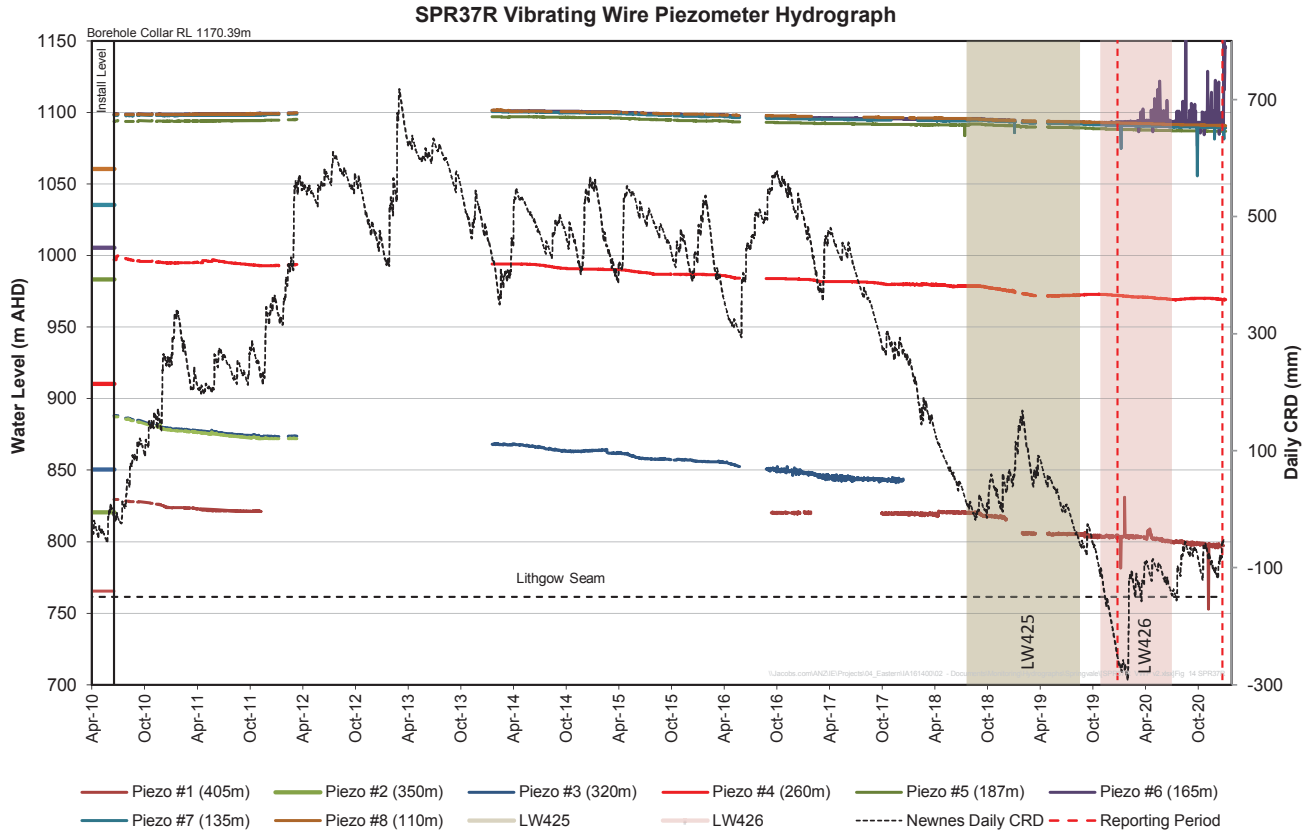
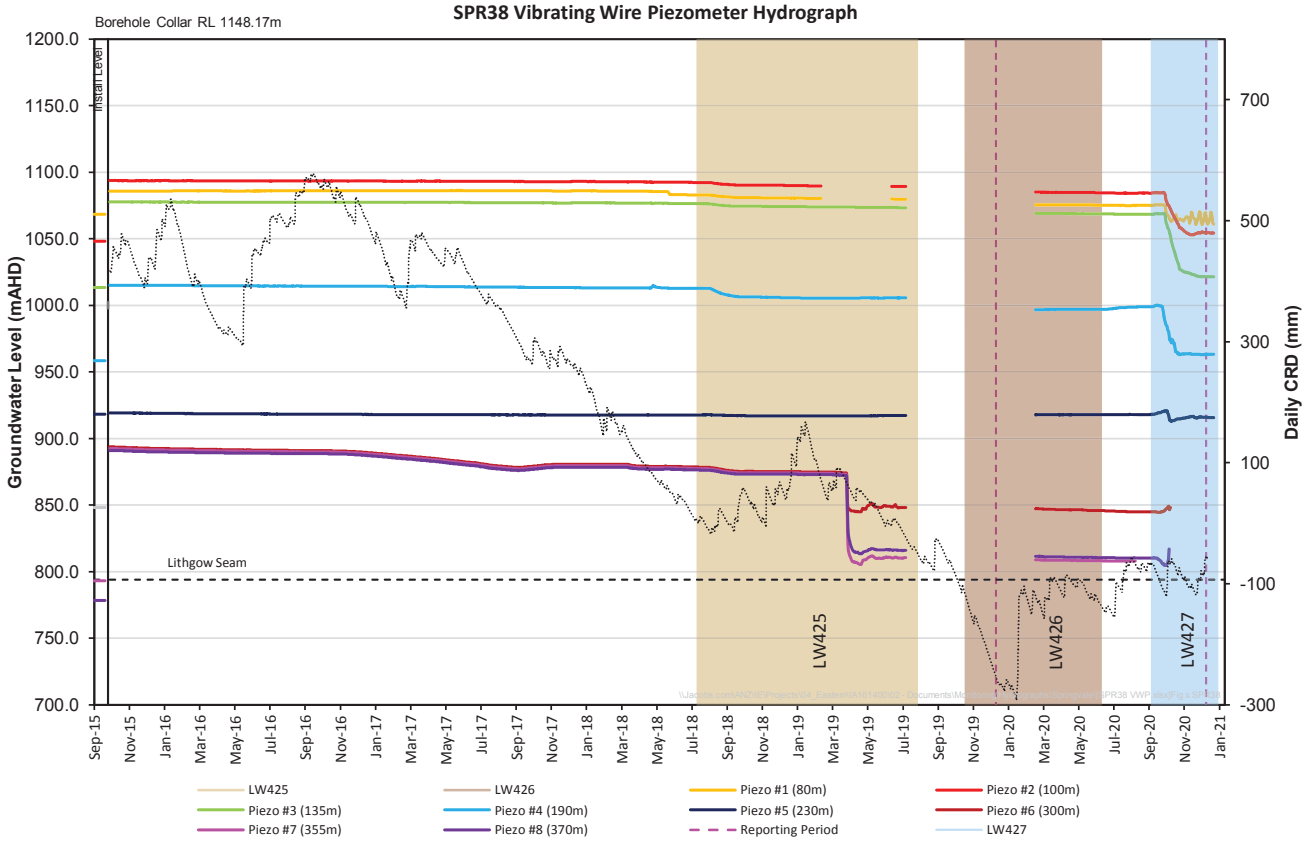
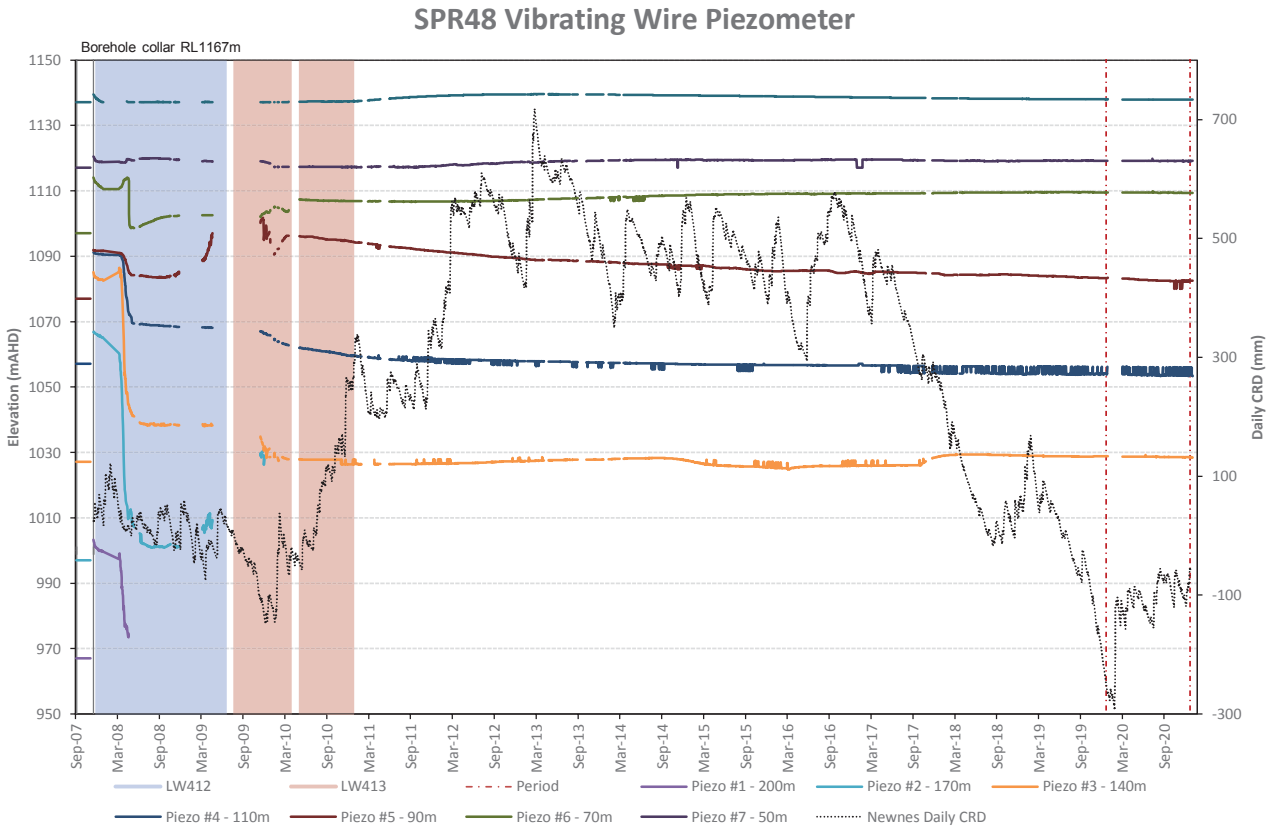
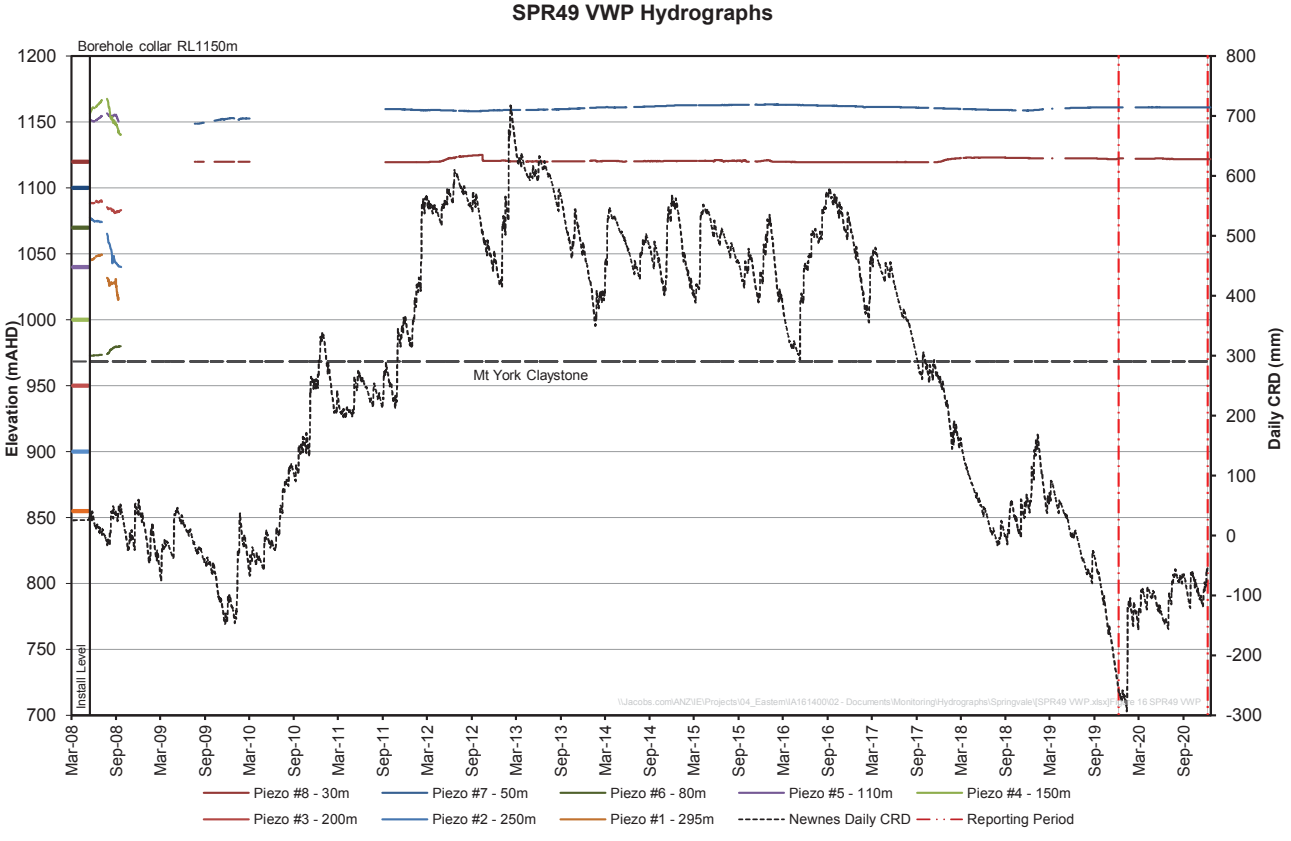
Appendix D. VWP Results

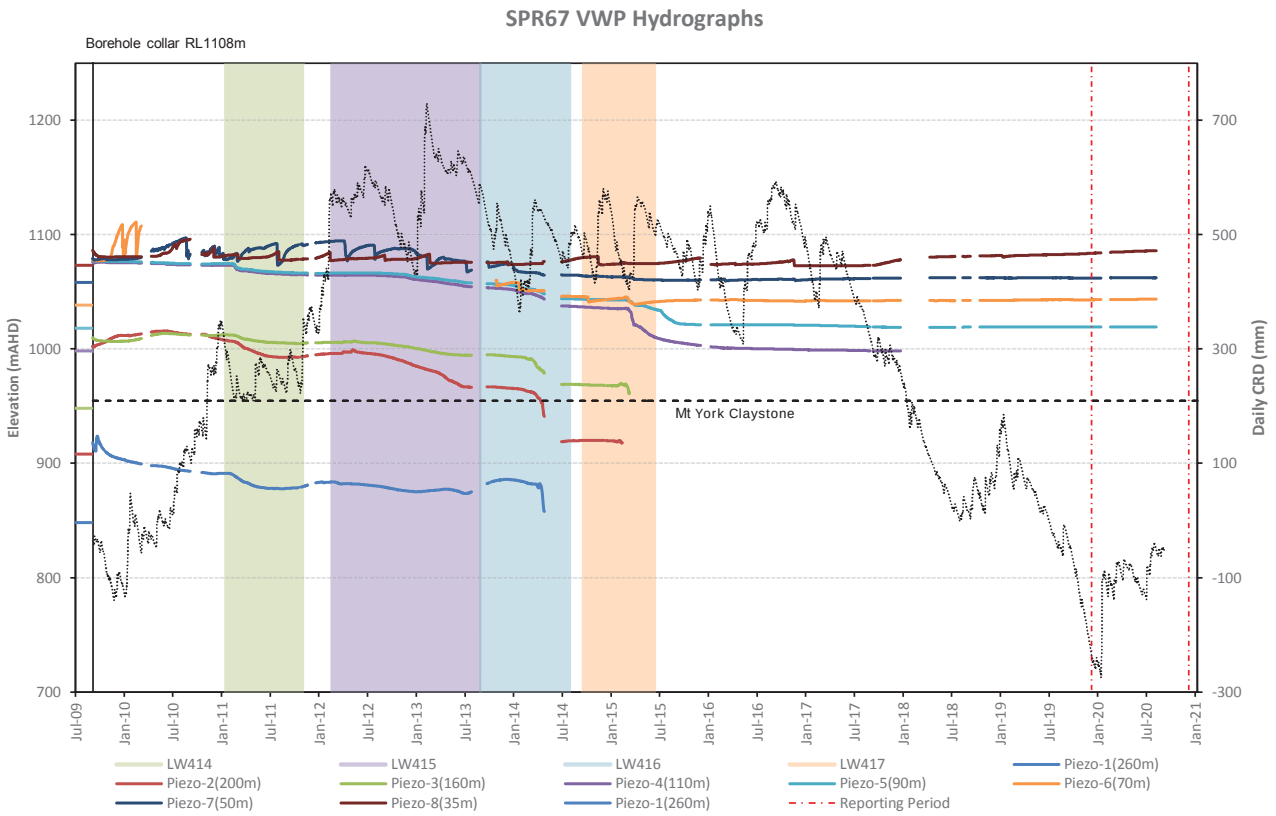
SPRINGVALE

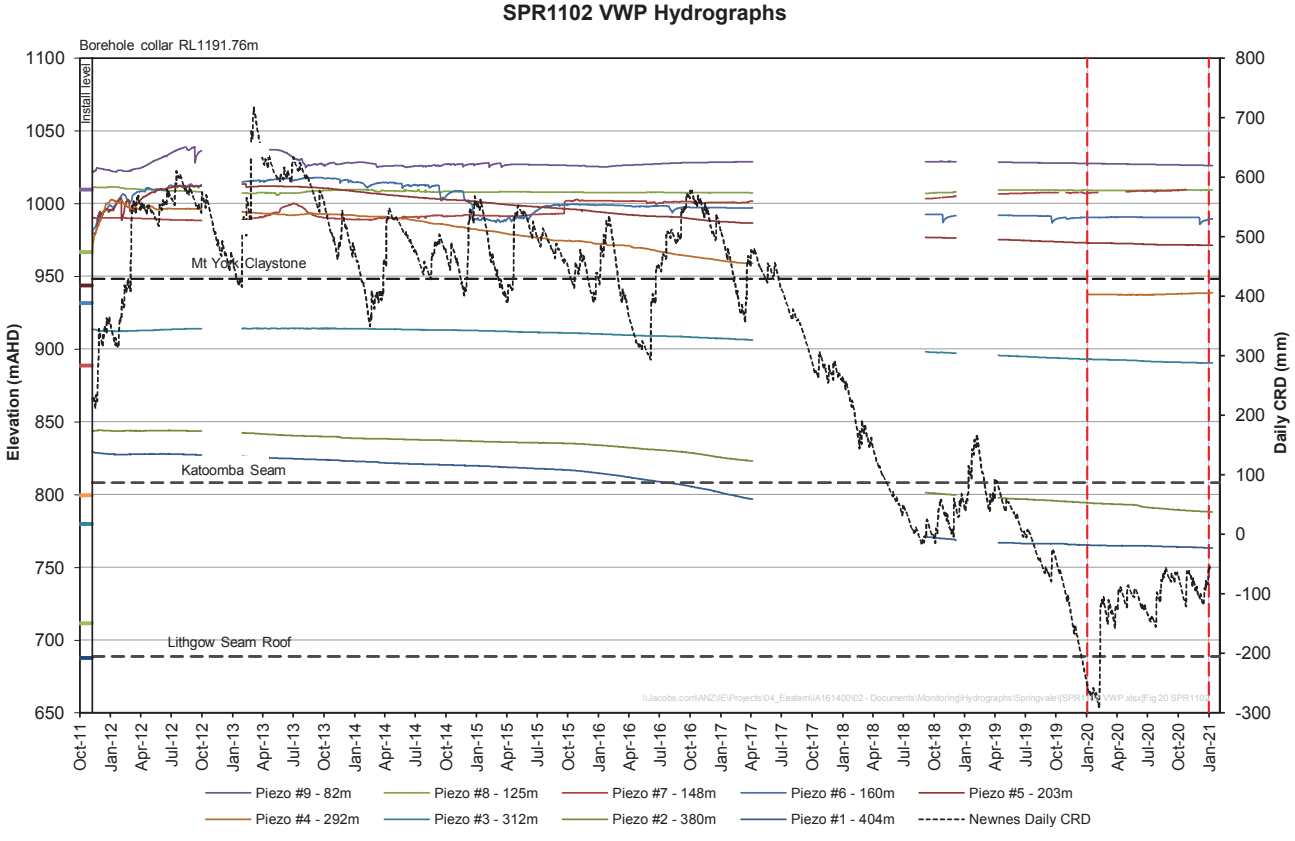

SPR37R Vibrating Wire Piezometer Hydrograph
Borehole Collar RL 1170.39m
Install Level
Water Level (m AHD)
Daily CRD (mm)
Lithgow Seam
LW425
LW426
Piezo #1 (405m)
Piezo #2 (350m)
Piezo #3 (320m)
Piezo #4 (260m)
Piezo #5 (187m)
Piezo #6 (165m)
Piezo #7 (135m)
Piezo #8 (110m)
LW425
LW426
Newnes Daily CRD
Reporting Period

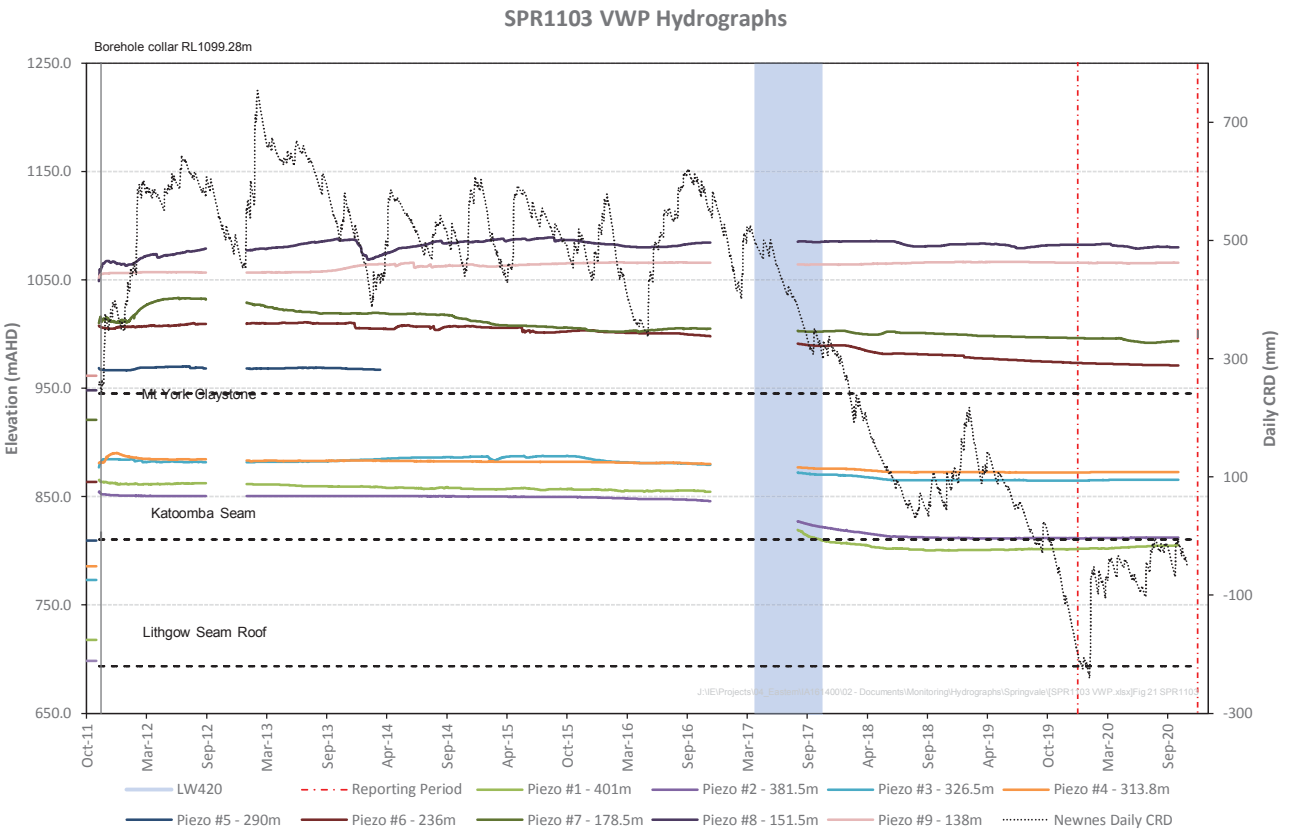

SPR38 Vibrating Wire Piezometer Hydrograph
Borehole Collar RL 1148.17m
Install Level
Groundwater Level (mAHD)
Daily CRD (mm)
Lithgow Seam
LW425
LW426
LW427
LW425
LW426
Piezo #1 (80m)
Piezo #2 (100m)
Piezo #3 (135m)
Piezo #4 (190m)
Piezo #5 (230m)
Piezo #6 (300m)
Piezo #7 (355m)
Piezo #8 (370m)
Reporting Period
LW427

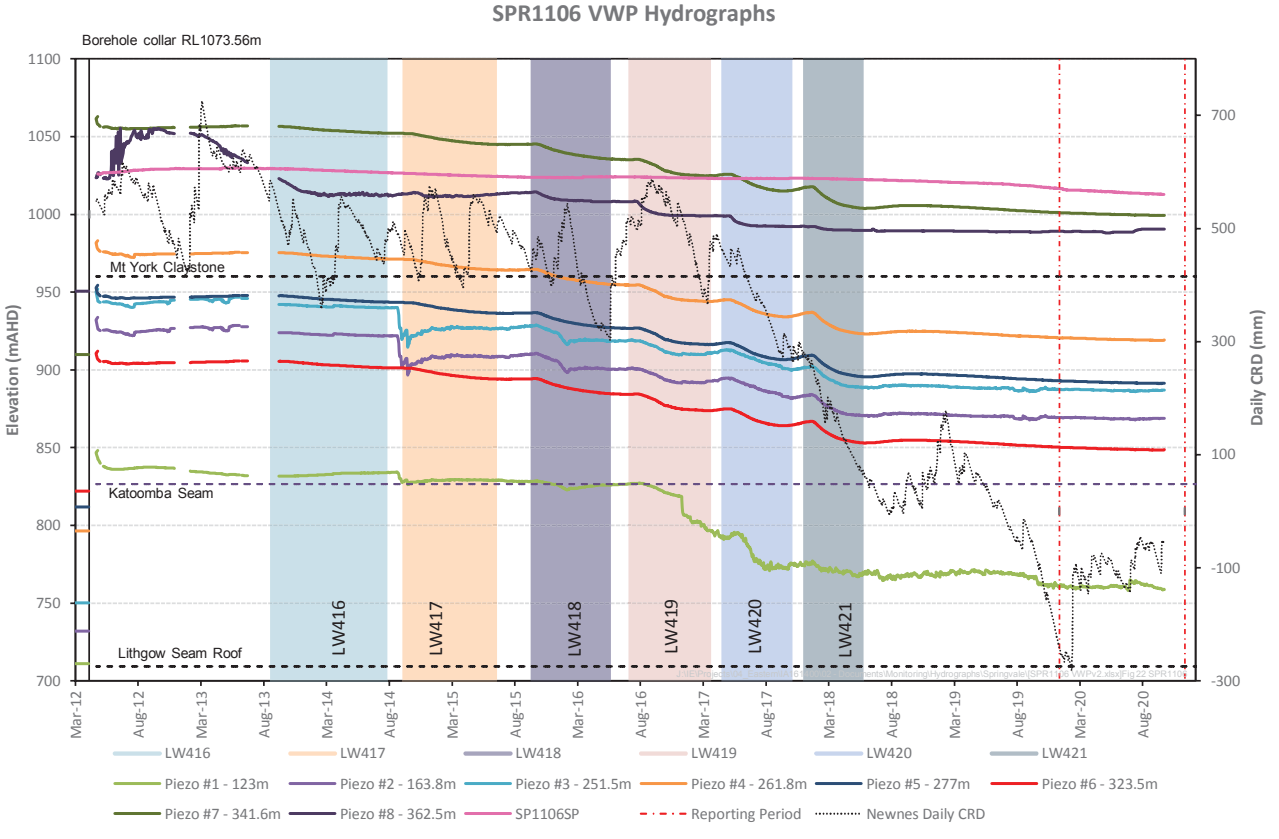

SPR48 Vibrating Wire Piezometer
Borehole collar RL1167m
Elevation (mAHD)
Daily CRD (mm)
LW412
LW413
Period
Piezo #1 - 200m
Piezo #2 - 170m
Piezo #3 - 140m
Piezo #4 - 110m
Piezo #5 - 90m
Piezo #6 - 70m
Piezo #7 - 50m
Newnes Daily CRD

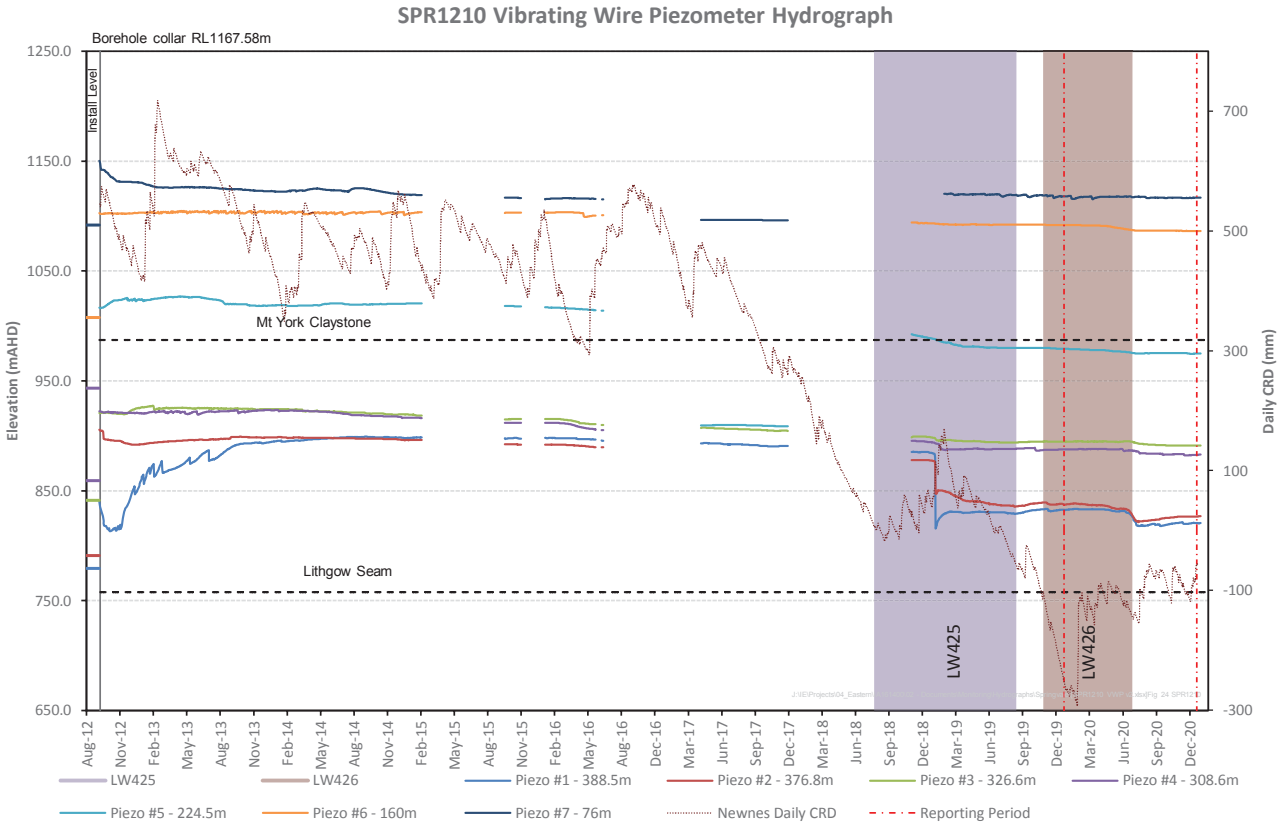

SPR49 VWP Hydrographs
Borehole collar RL1150m
Elevation (mAHD)
Daily CRD (mm)
Mt York Claystone
Install Level
Piezo #8 - 30m
Piezo #7 - 50m
Piezo #6 - 80m
Piezo #5 - 110m
Piezo #4 - 150m
Piezo #3 - 200m
Piezo #2 - 250m
Piezo #1 - 295m
Newnes Daily CRD
Reporting Period

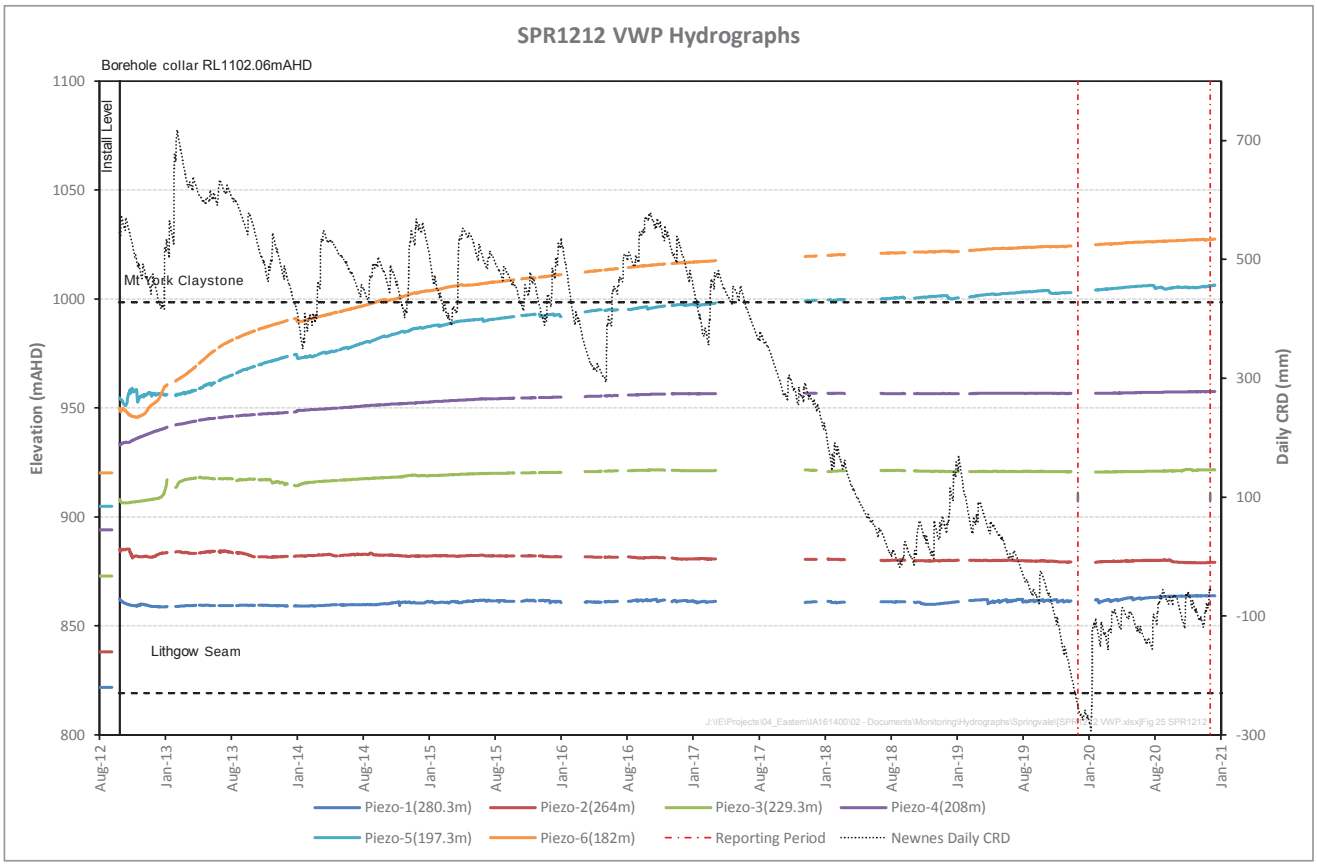

SPR67 VWP Hydrographs
Borehole collar RL1108m
Elevation (mAHD)
Daily CRD (mm)
Mt York Claystone
LW414
LW415
LW416
LW417
Piezo-1(260m)
Piezo-2(200m)
Piezo-3(160m)
Piezo-4(110m)
Piezo-5(90m)
Piezo-6(70m)
Piezo-7(50m)
Piezo-8(35m)
Piezo-1(260m)
Reporting Period

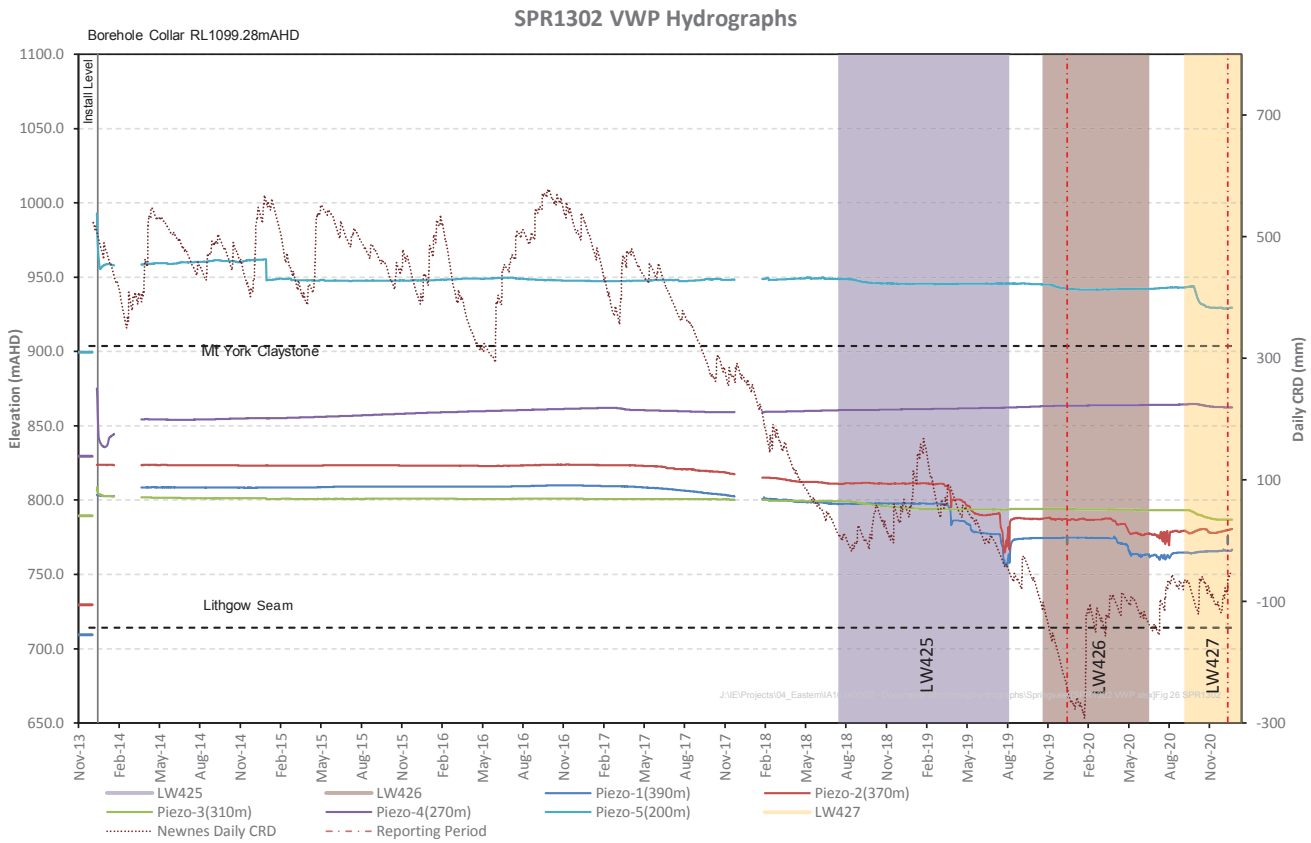

SPR1102 VWP Hydrographs
Borehole collar RL1191.76m
Install level
Elevation (mAHD)
Daily CRD (mm)
Mt York Claystone
Katoomba Seam
Lithgow Seam Roof
Piezo #9 - 82m
Piezo #8 - 125m
Piezo #7 - 148m
Piezo #6 - 160m
Piezo #5 - 203m
Piezo #4 - 292m
Piezo #3 - 312m
Piezo #2 - 380m
Piezo #1 - 404m
Newnes Daily CRD


SPR1103 VWP Hydrographs
Borehole collar RL1099.28m
Elevation (mAHD)
Daily CRD (mm)
Mt York Claystone
Katoomba Seam
Lithgow Seam Roof
LW420
Reporting Period
Piezo #1 - 401m
Piezo #2 - 381.5m
Piezo #3 - 326.5m
Piezo #4 - 313.8m
Piezo #5 - 290m
Piezo #6 - 236m
Piezo #7 - 178.5m
Piezo #8 - 151.5m
Piezo #9 - 138m
Newnes Daily CRD


SPR1106 VWP Hydrographs
Borehole collar RL1073.56m
Elevation (mAHD)
Daily CRD (mm)
Mt York Claystone
Katoomba Seam
Lithgow Seam Roof
LW416
LW417
LW418
LW419
LW420
LW421
Piezo #1 - 123m
Piezo #2 - 163.8m
Piezo #3 - 251.5m
Piezo #4 - 261.8m
Piezo #5 - 277m
Piezo #6 - 323.5m
Piezo #7 - 341.6m
Piezo #8 - 362.5m
SP1106SP
Reporting Period
Newnes Daily CRD


SPR1210 Vibrating Wire Piezometer Hydrograph
Borehole collar RL1167.58m
Install Level
Mt York Claystone
Lithgow Seam
LW425
LW426
Elevation (mAHD)
Daily CRD (mm)
1250.0
1150.0
1050.0
950.0
850.0
750.0
650.0
700
500
300
100
-100
-300
Aug-12
Nov-12
Feb-13
May-13
Aug-13
Nov-13
Feb-14
May-14
Aug-14
Nov-14
Feb-15
May-15
Aug-15
Nov-15
Feb-16
May-16
Aug-16
Dec-16
Mar-17
Jun-17
Sep-17
Dec-17
Mar-18
Jun-18
Sep-18
Dec-18
Mar-19
Jun-19
Sep-19
Dec-19
Mar-20
Jun-20
Sep-20
Dec-20
LW425
LW426
Piezo #1 - 388.5m
Piezo #2 - 376.8m
Piezo #3 - 326.6m
Piezo #4 - 308.6m
Piezo #5 - 224.5m
Piezo #6 - 160m
Piezo #7 - 76m
Newnes Daily CRD
Reporting Period

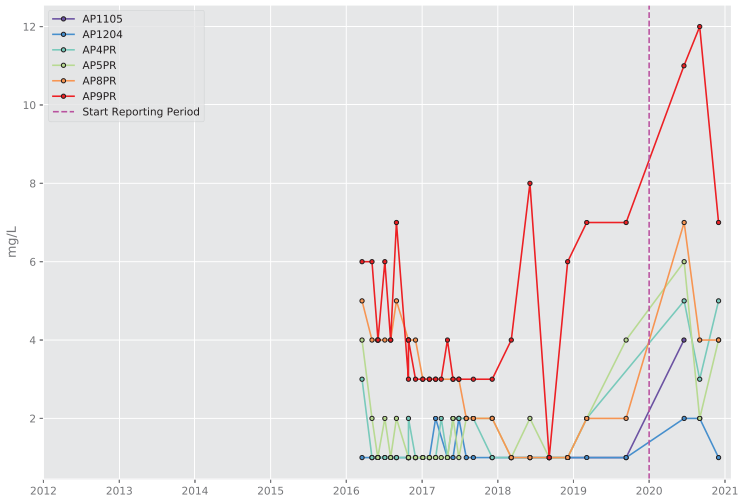

SPR1212 VWP Hydrographs
Borehole collar RL1102.06mAHD
Install Level
Mt York Claystone
Lithgow Seam
Elevation (mAHD)
Daily CRD (mm)
1100
1050
1000
950
900
850
800
700
500
300
100
-100
-300
Aug-12
Jan-13
Aug-13
Jan-14
Aug-14
Jan-15
Aug-15
Jan-16
Aug-16
Jan-17
Aug-17
Jan-18
Aug-18
Jan-19
Aug-19
Jan-20
Aug-20
Jan-21
Piezo-1(280.3m)
Piezo-2(264m)
Piezo-3(229.3m)
Piezo-4(208m)
Piezo-5(197.3m)
Piezo-6(182m)
Reporting Period
Newnes Daily CRD


SPR1302 VWP Hydrographs
Borehole Collar RL1099.28mAHD
Install Level
Mt York Claystone
Lithgow Seam
LW425
LW426
LW427
Elevation (mAHD)
Daily CRD (mm)
1100.0
1050.0
1000.0
950.0
900.0
850.0
800.0
750.0
700.0
650.0
700
500
300
100
-100
-300
Nov-13
Feb-14
May-14
Aug-14
Nov-14
Feb-15
May-15
Aug-15
Nov-15
Feb-16
May-16
Aug-16
Nov-16
Feb-17
May-17
Aug-17
Nov-17
Feb-18
May-18
Aug-18
Nov-18
Feb-19
May-19
Aug-19
Nov-19
Feb-20
May-20
Aug-20
Nov-20
LW425
LW426
Piezo-1(390m)
Piezo-2(370m)
Piezo-3(310m)
Piezo-4(270m)
Piezo-5(200m)
LW427
Newnes Daily CRD
Reporting Period

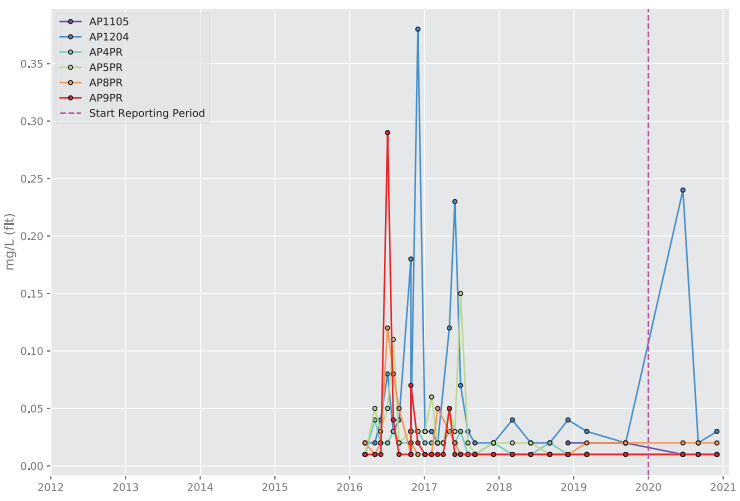
Appendix E. Groundwater Water Quality – Swamp piezometer and Ridge piezometer and Dewatering bores

SPRINGVALE

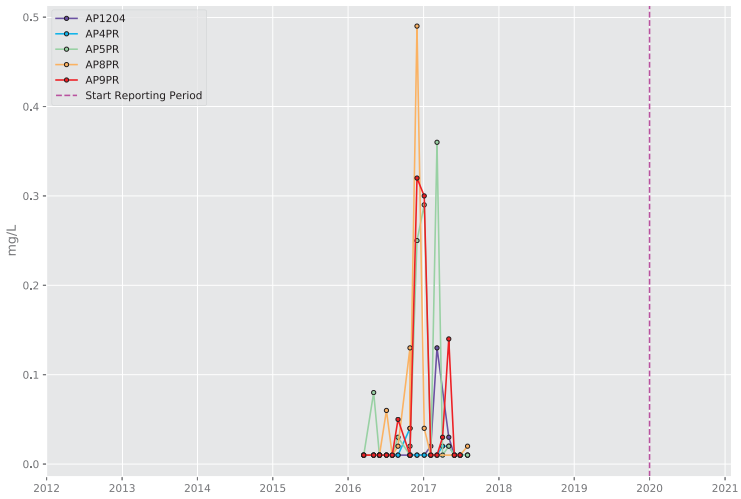
Alkalinity (total) as CaCO3



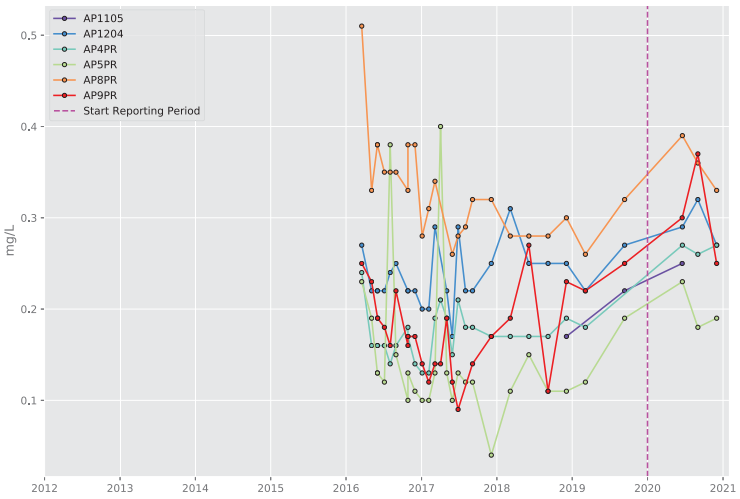
Aluminium



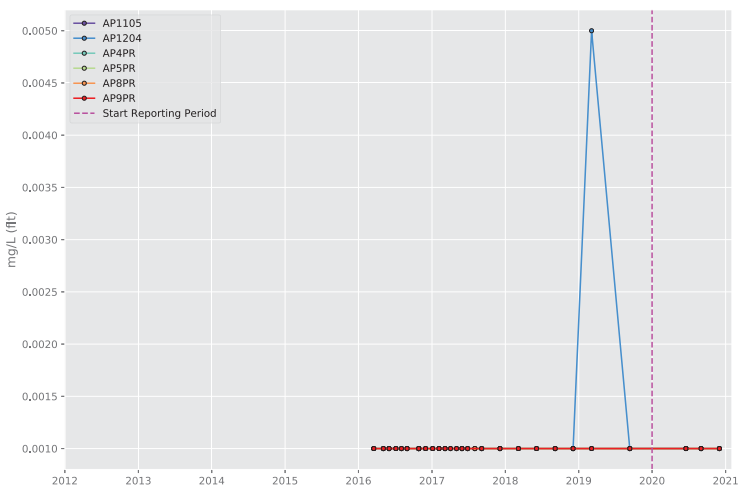
Ammonia as N



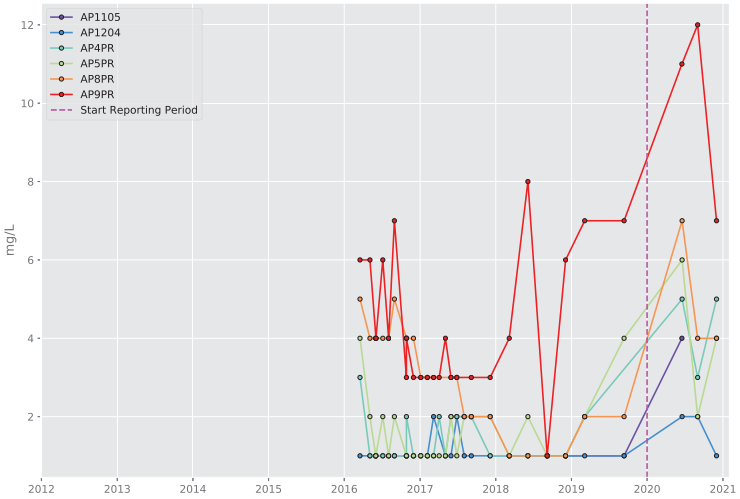
Anions Total



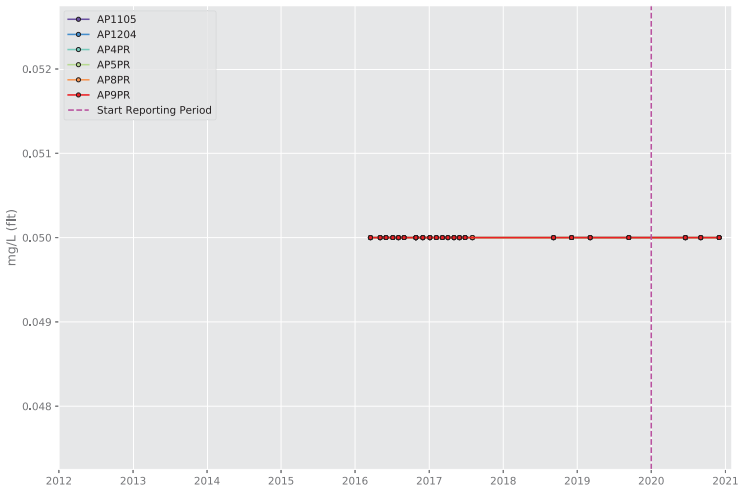
Arsenic



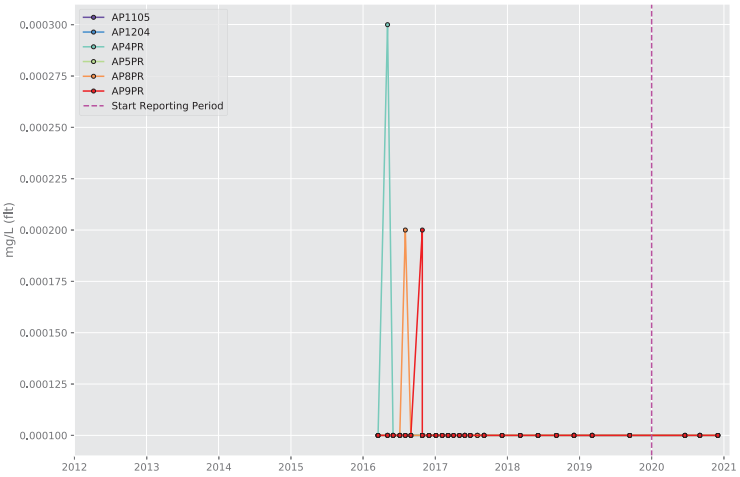
Bicarbonate Alkalinity as CaCO3



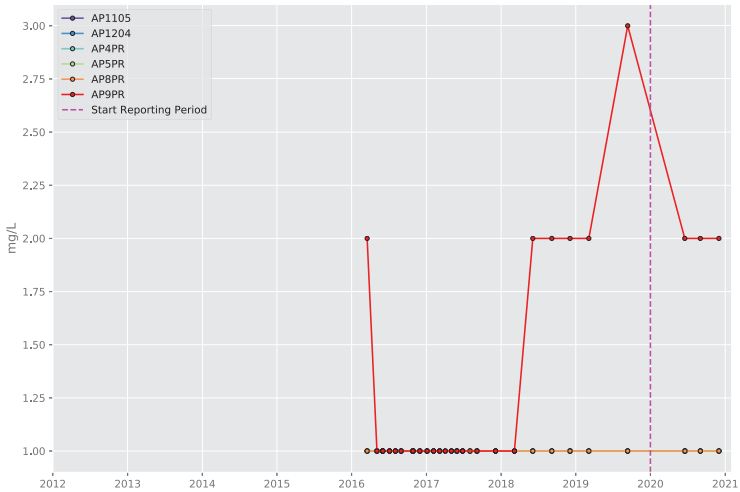
Boron



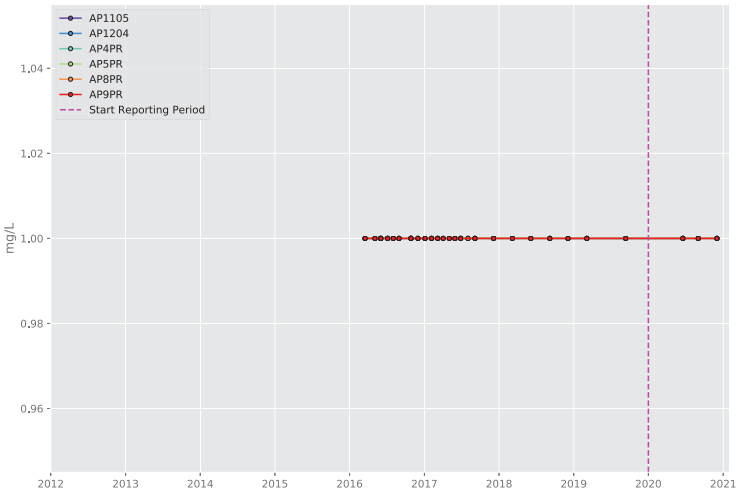
Cadmium



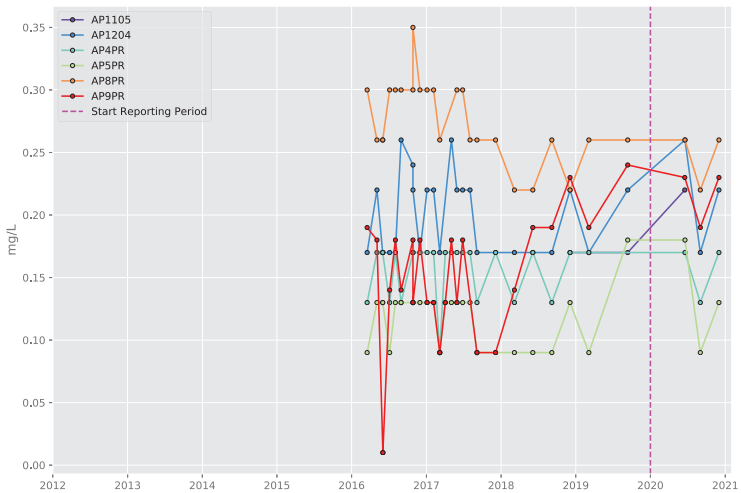
Calcium



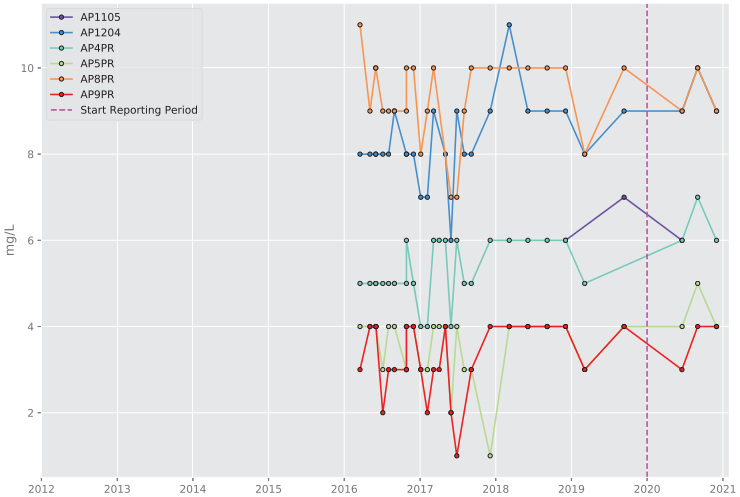
Carbonate



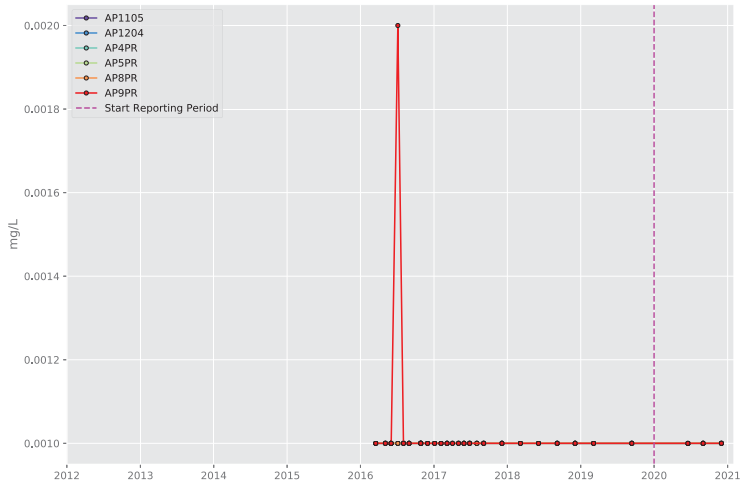
Cations Total



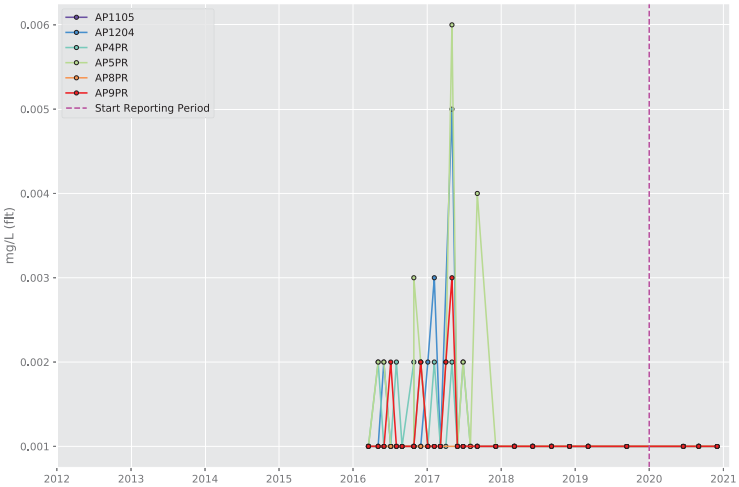
Chloride



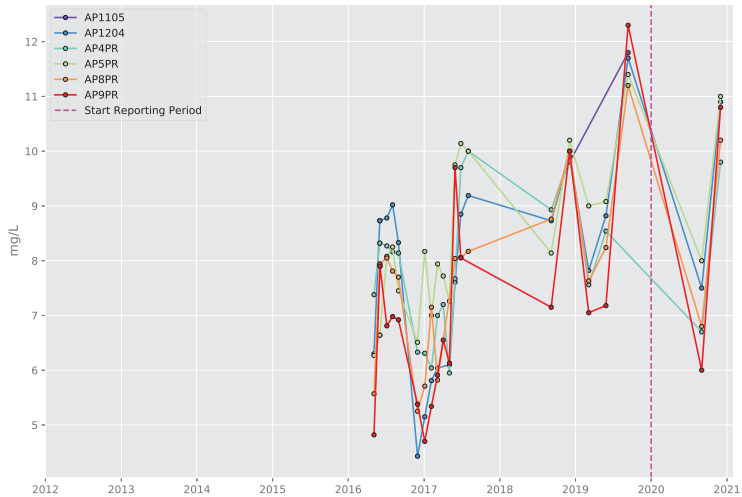
Chromium (soluble)



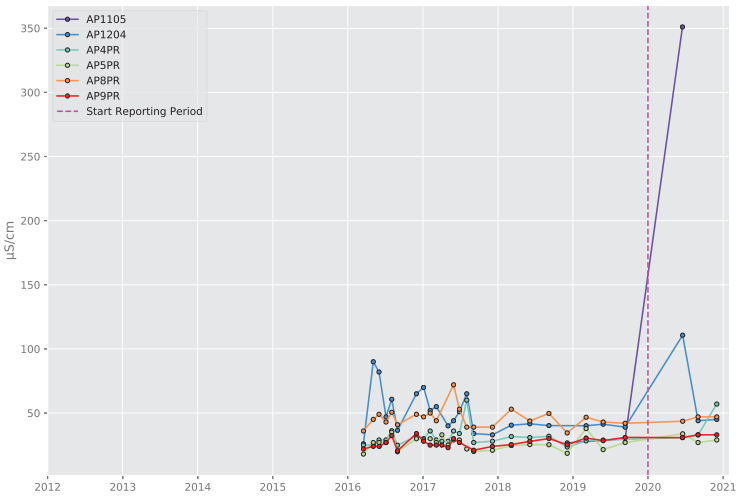
Copper



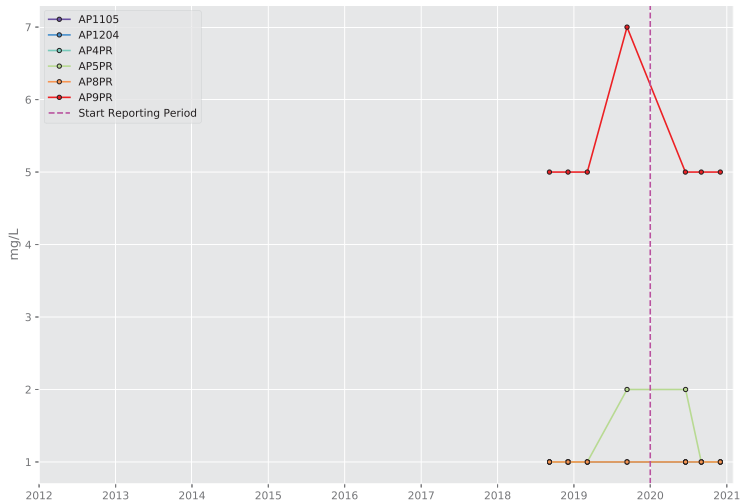
DO (Field)



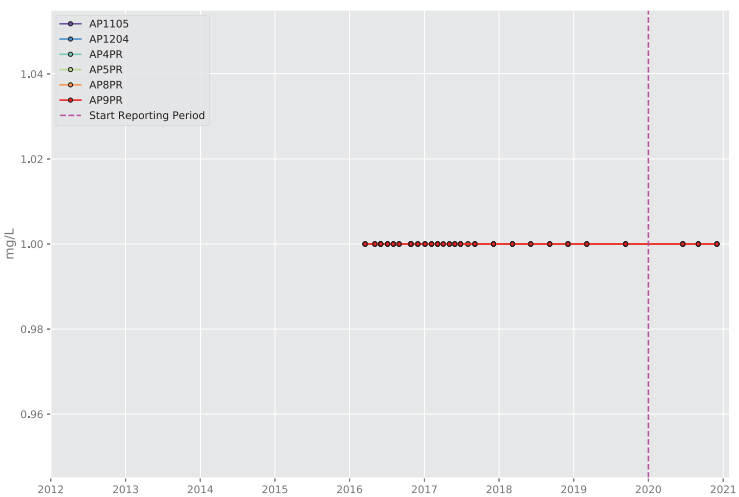
Electrical Conductivity (EC)



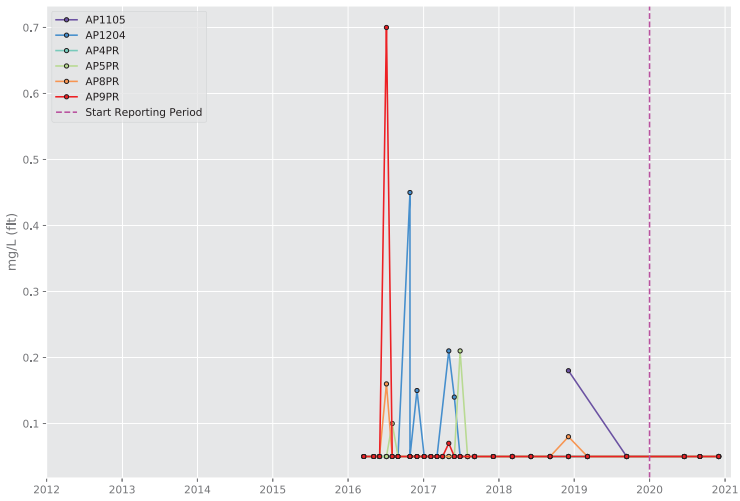
Hardness as CaCO3



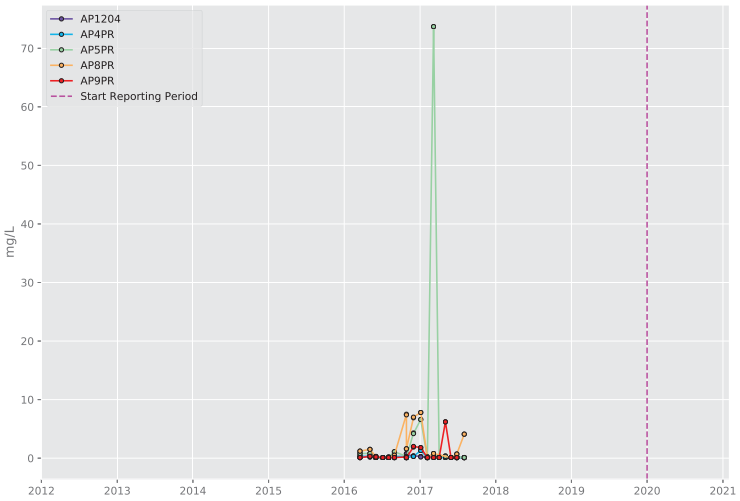
Hydroxide as CaCO3



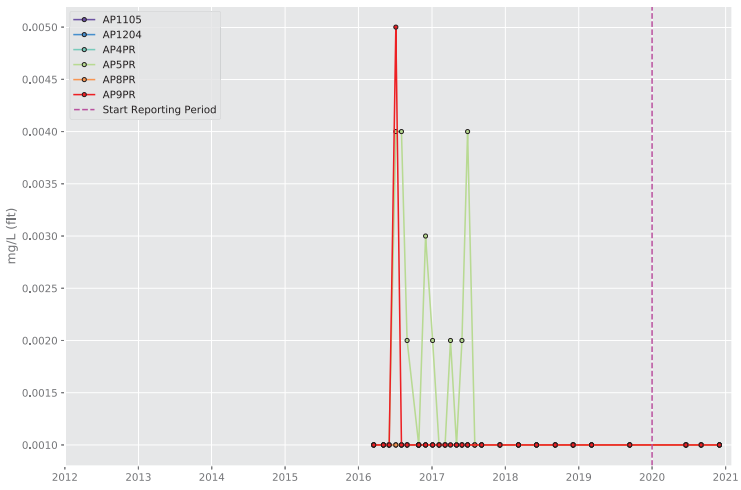
Iron



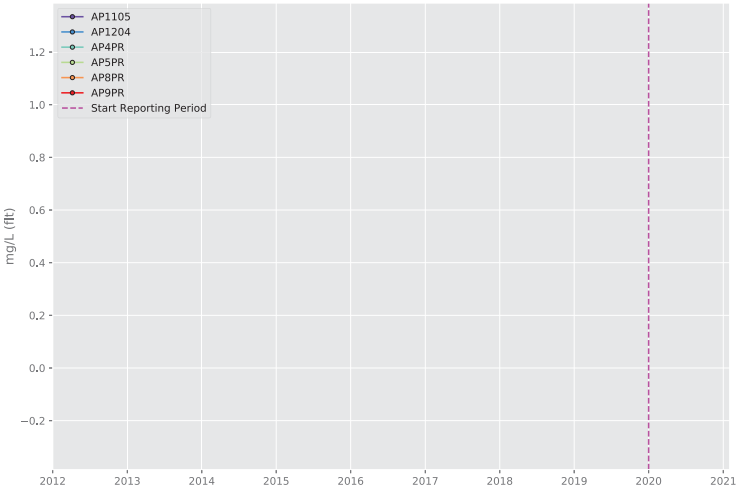
Kjeldahl Nitrogen Total



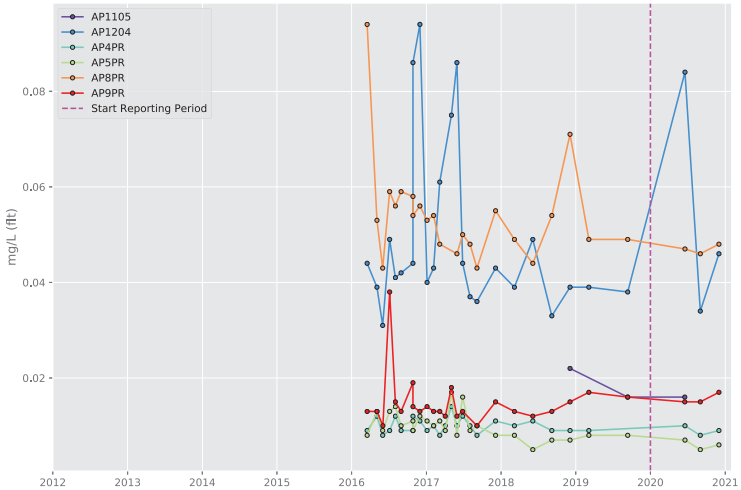
Lead



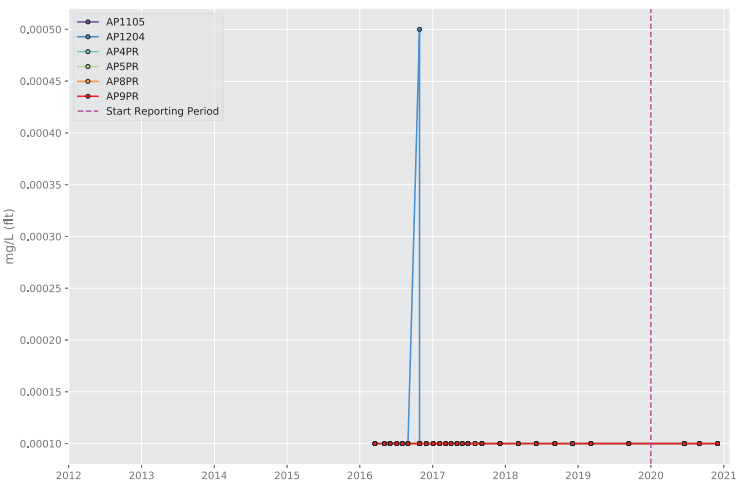
Magnesium



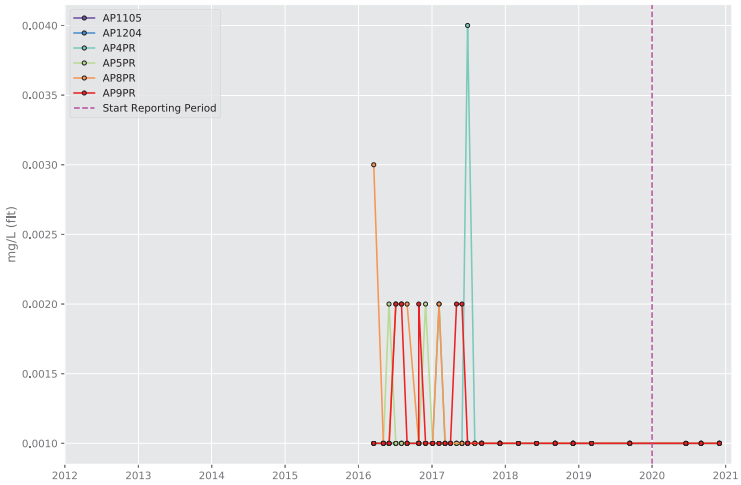
Manganese



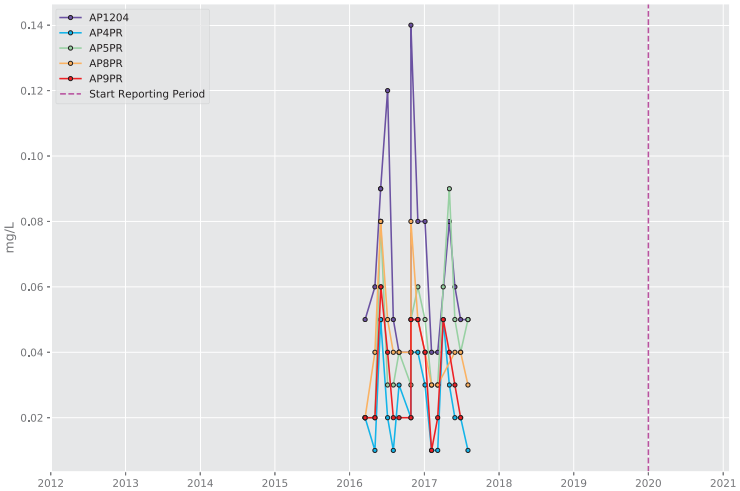
Mercury



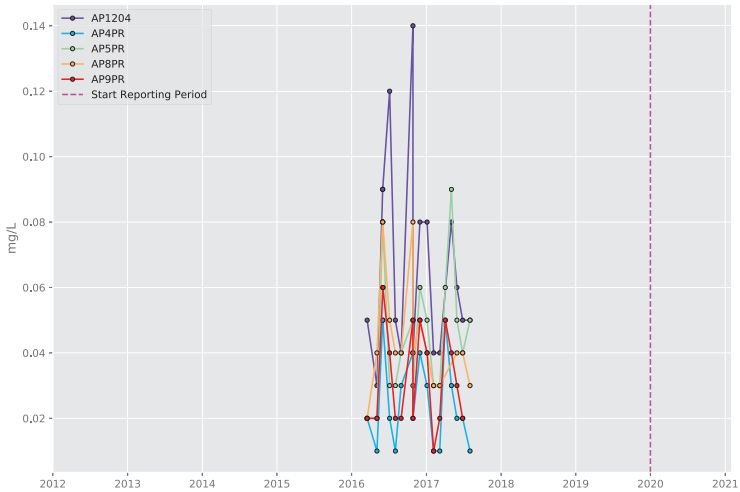
Nickel



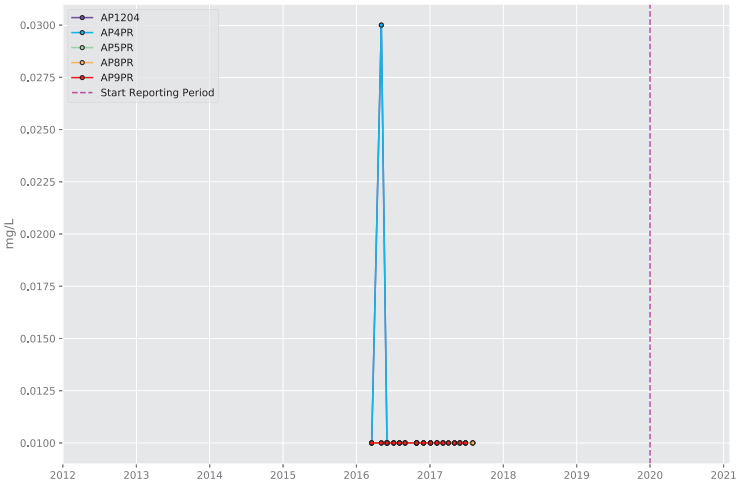
Nitrate & Nitrite (as N)



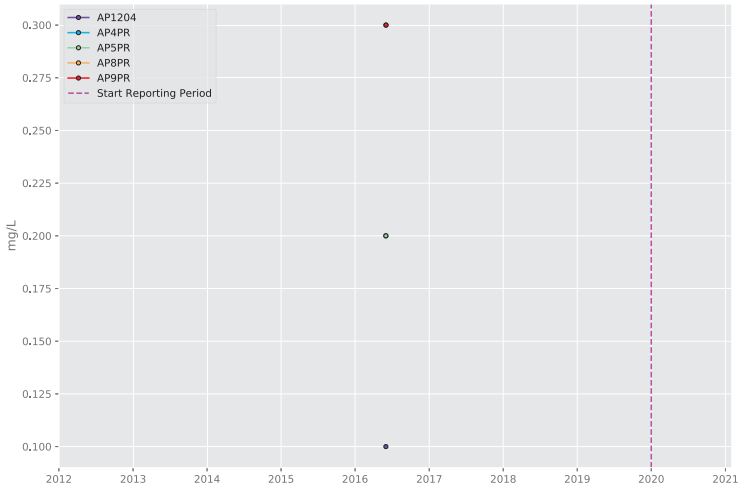
Nitrate (as N)



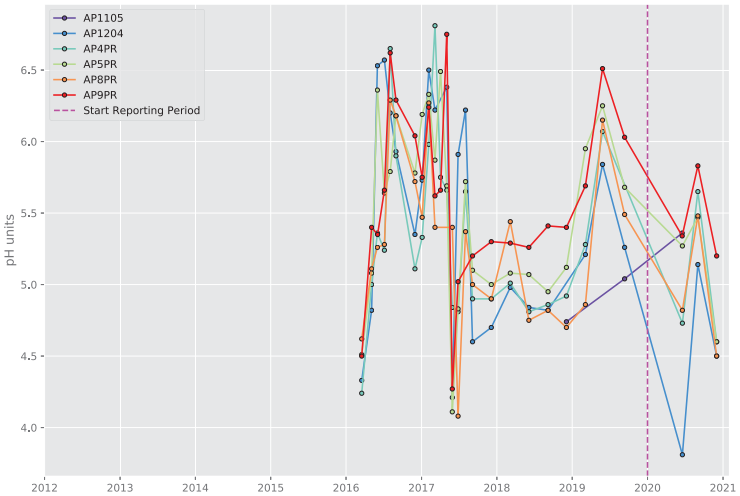
Nitrite (as N)



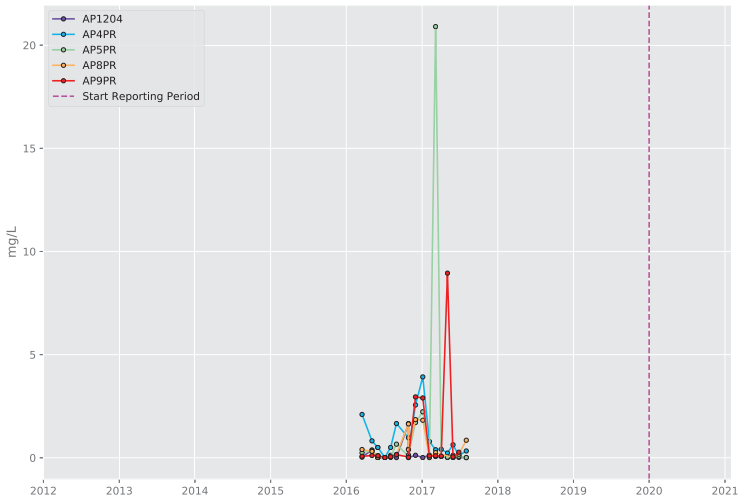
Nitrogen (Total)



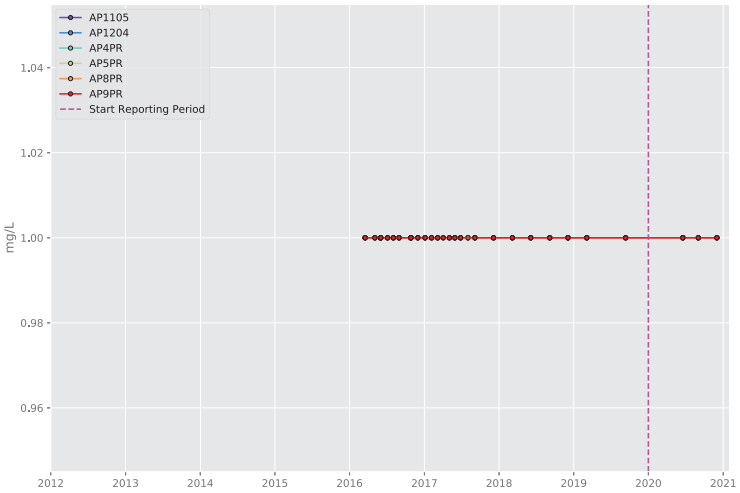
pH_0



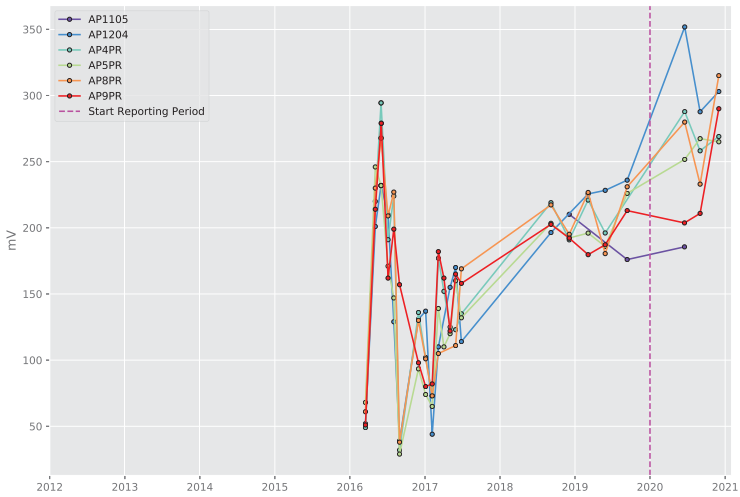
Phosphorus



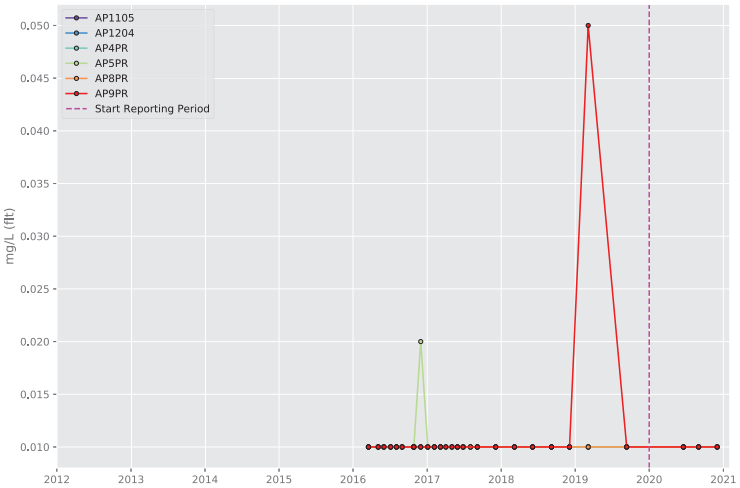
Potassium



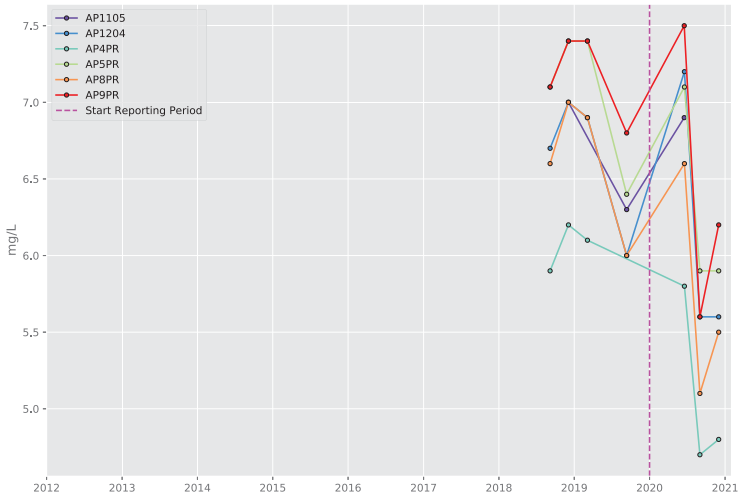
Redox Potential



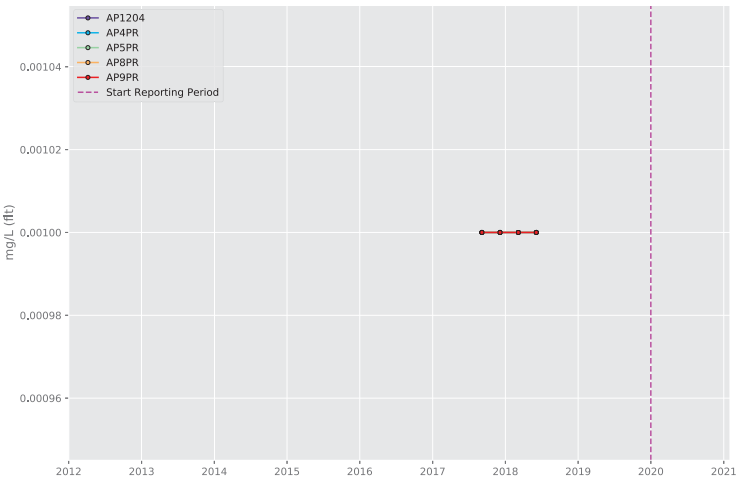
Selenium



Silicon as SiO2



Silver



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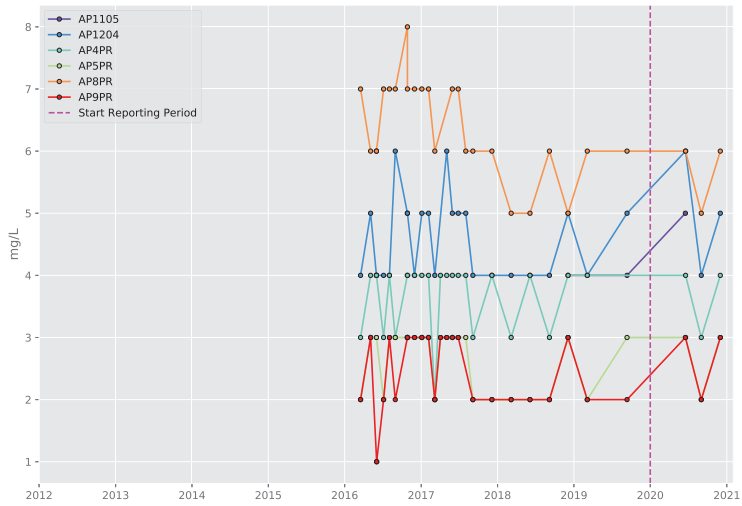
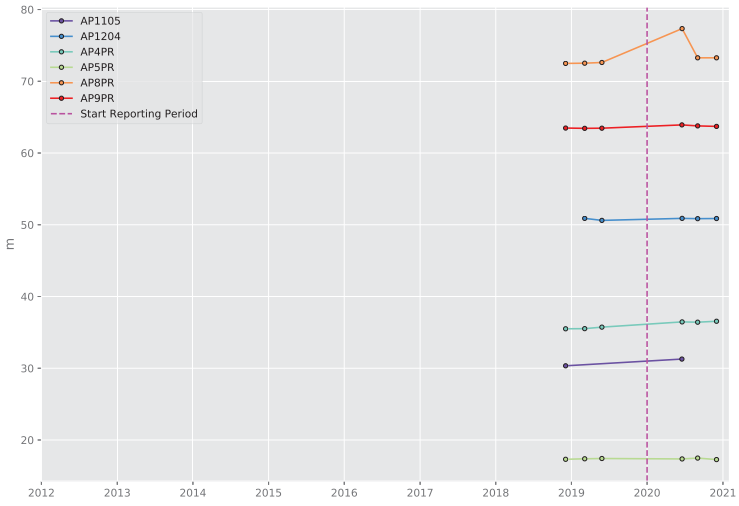
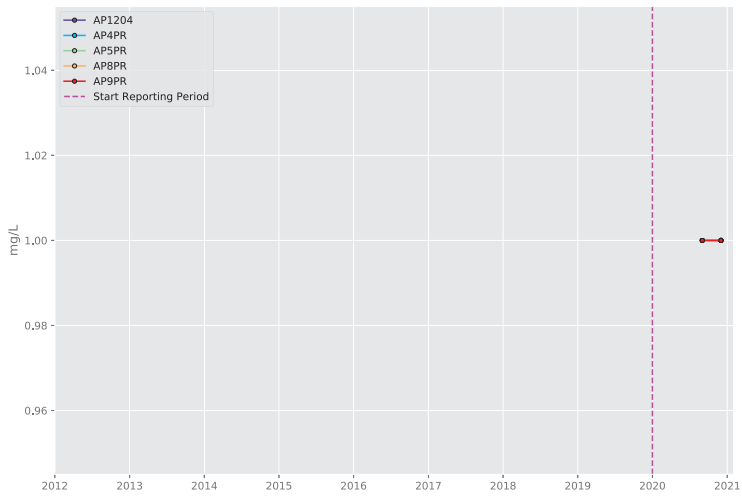


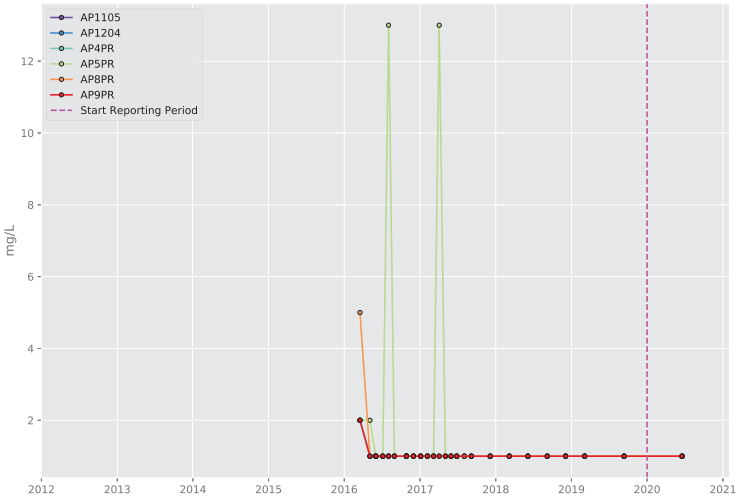
Standing water level



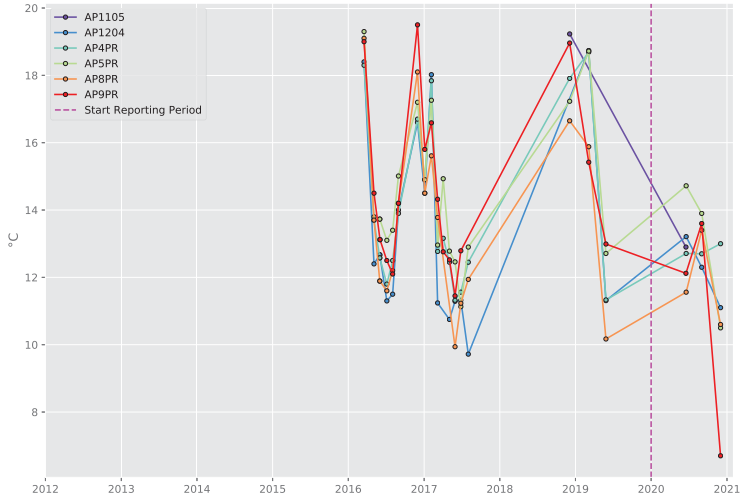
Sulfate as SO4 - Turbidimetric



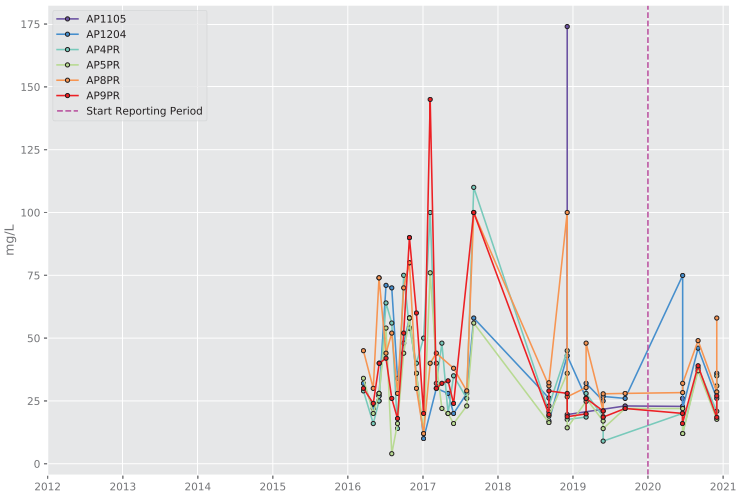
Sulphate



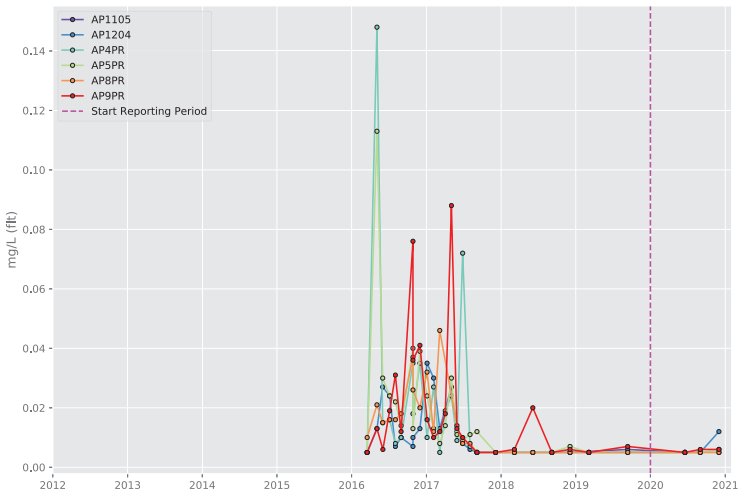
Temp



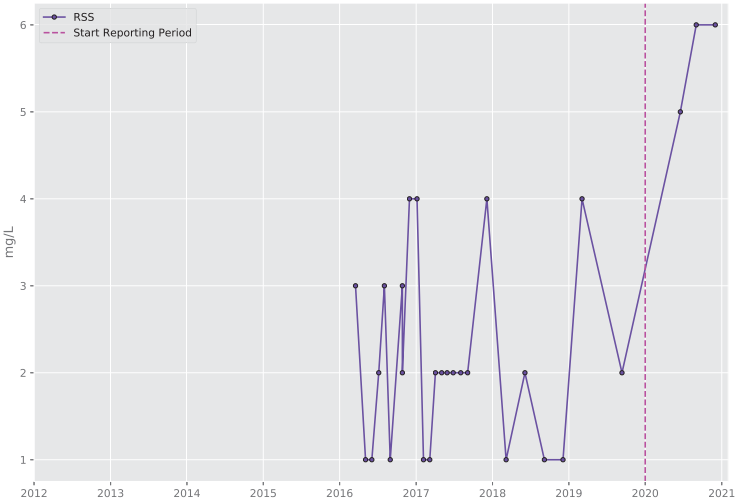
Total Dissolved Solids



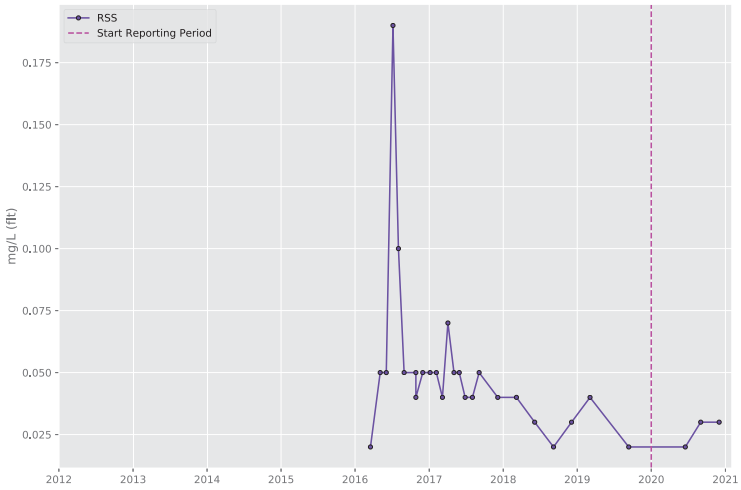
Zinc



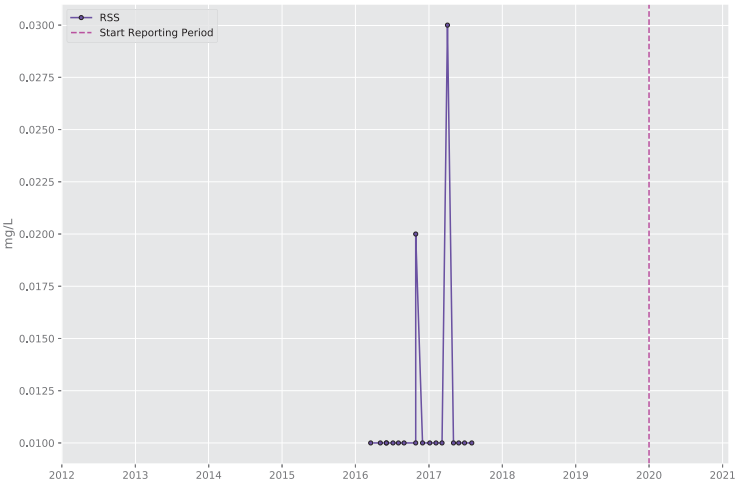
Alkalinity (total) as CaCO3



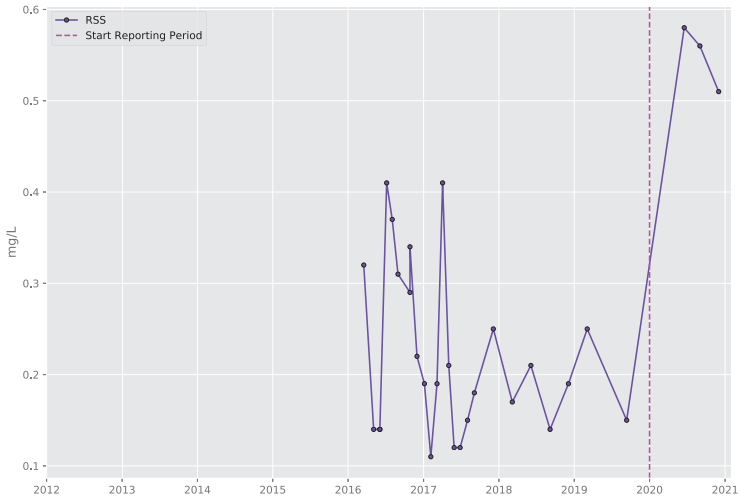
Aluminium



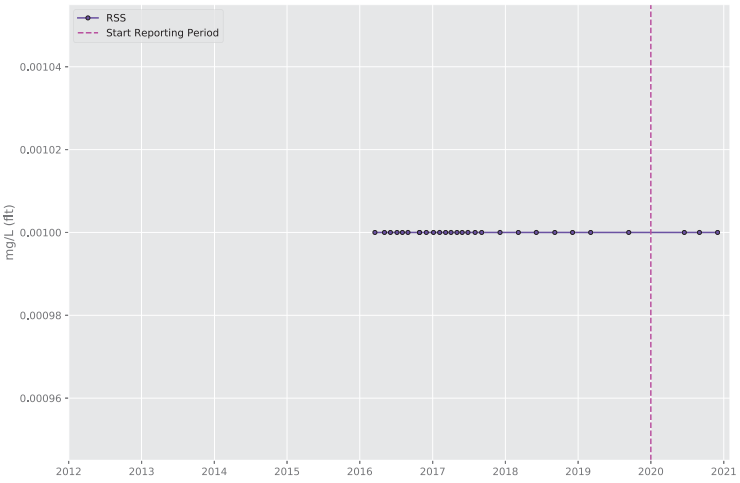
Ammonia as N



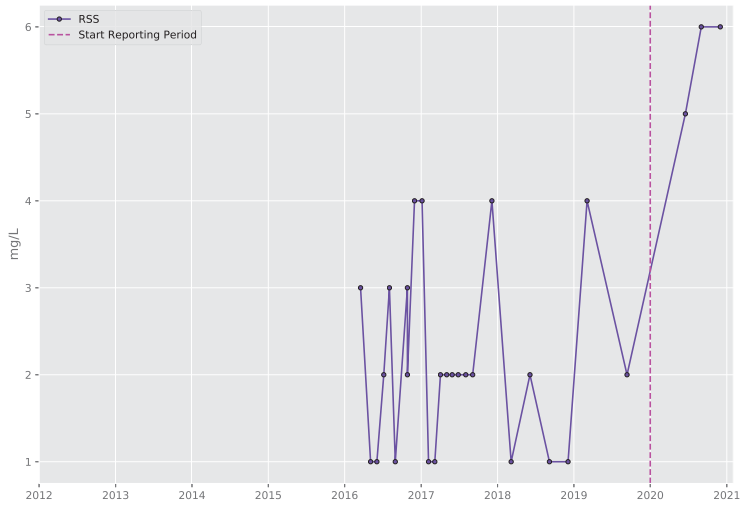
Anions Total



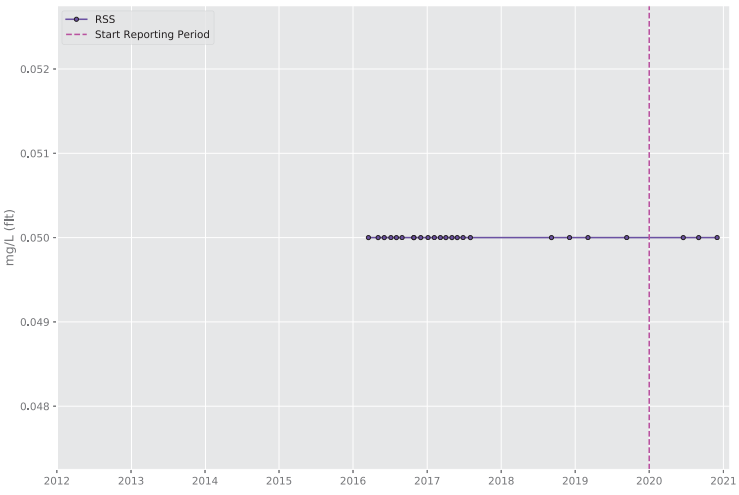
Arsenic



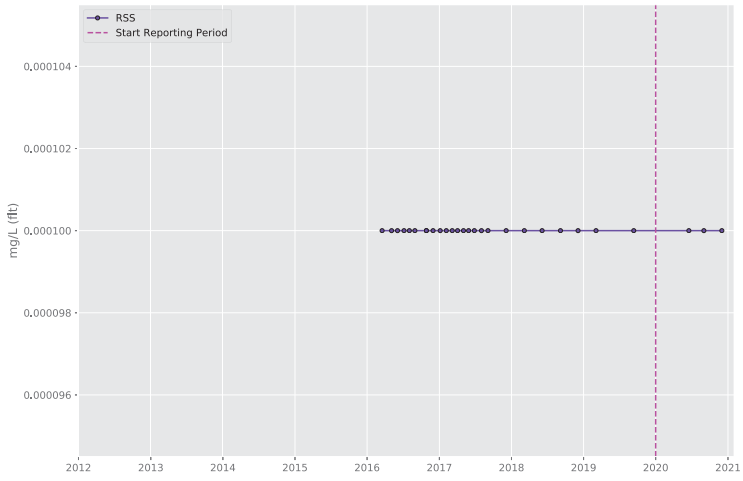
Bicarbonate Alkalinity as CaCO3



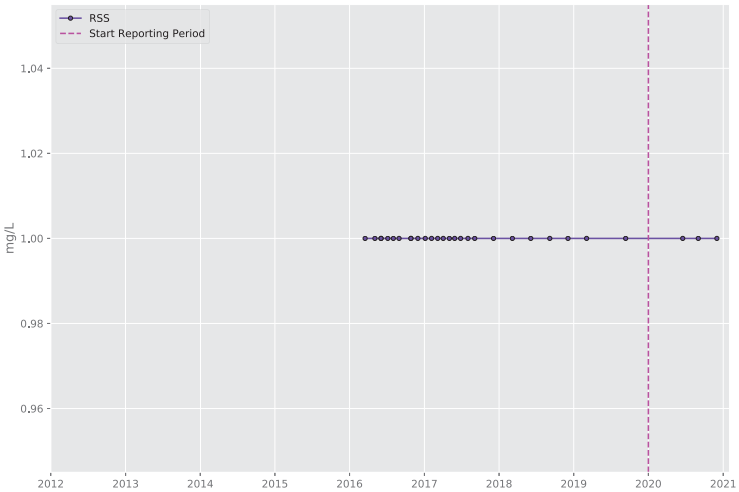
Boron



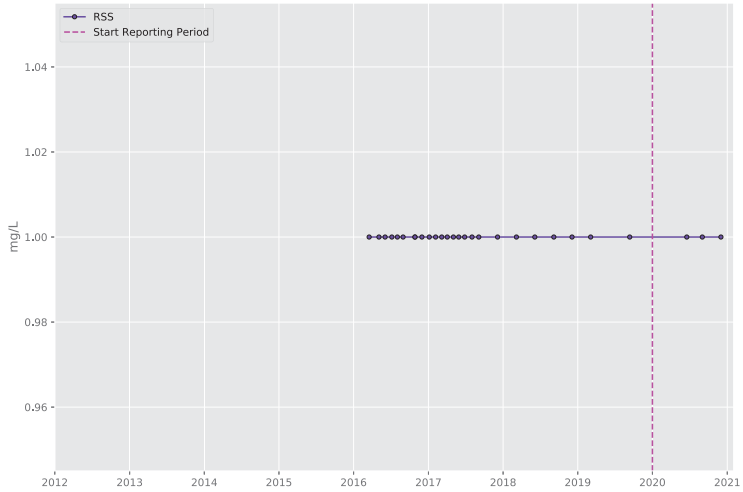
Cadmium



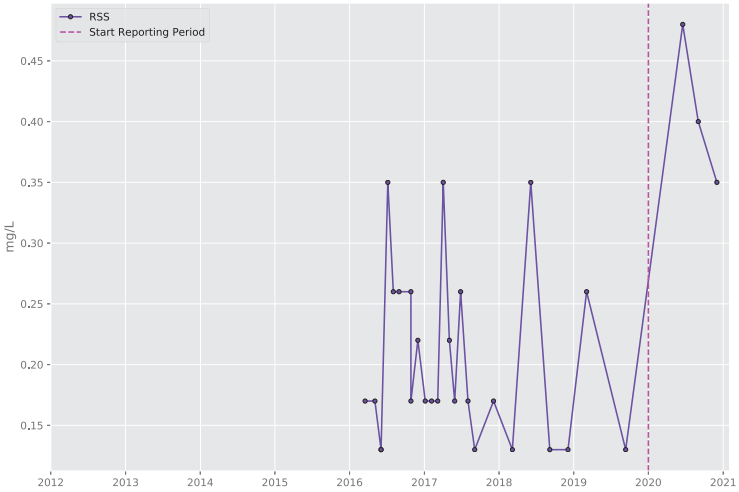
Calcium



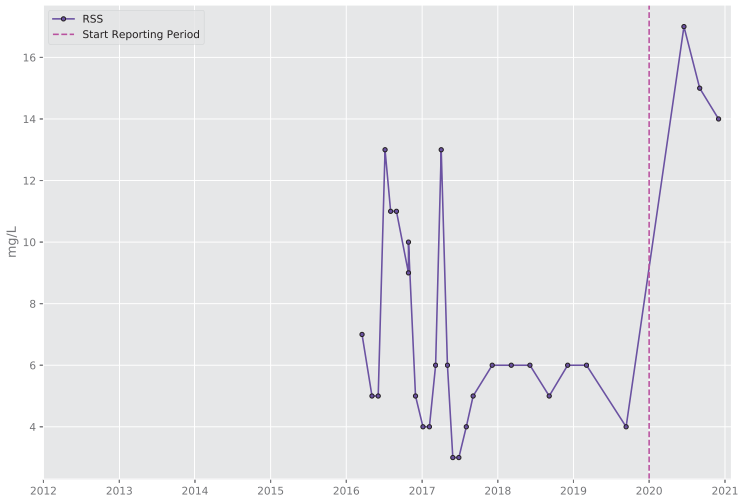
Carbonate



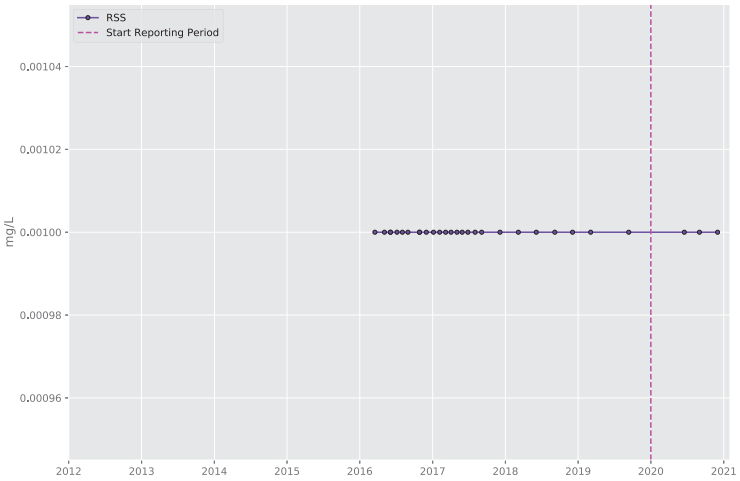
Cations Total



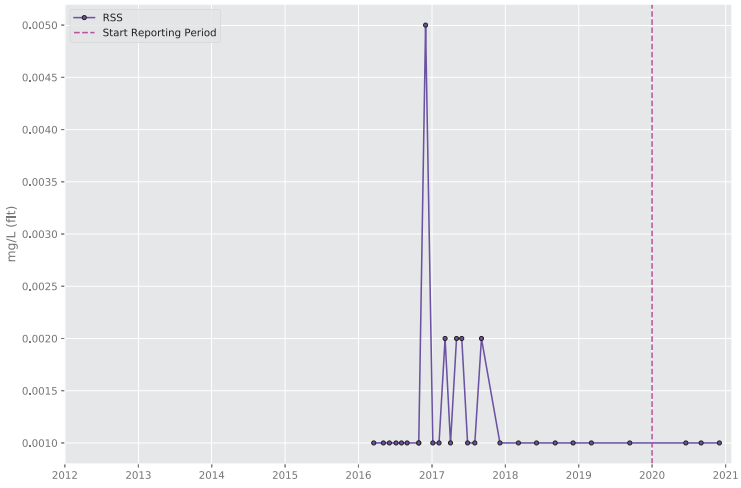
Chloride



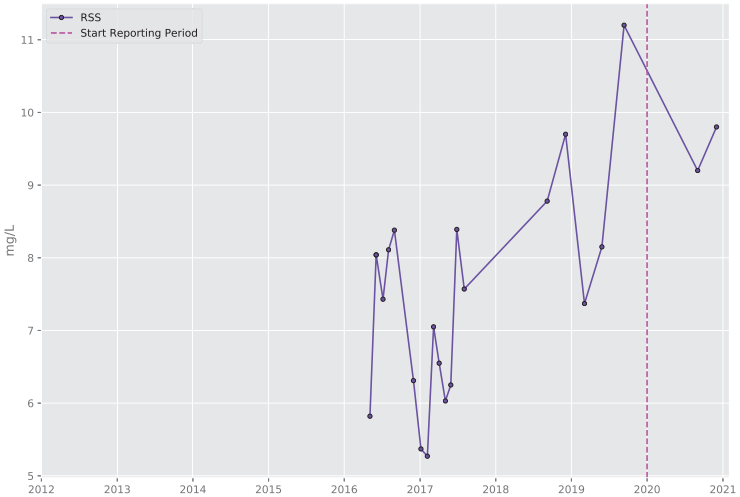
Chromium (soluble)



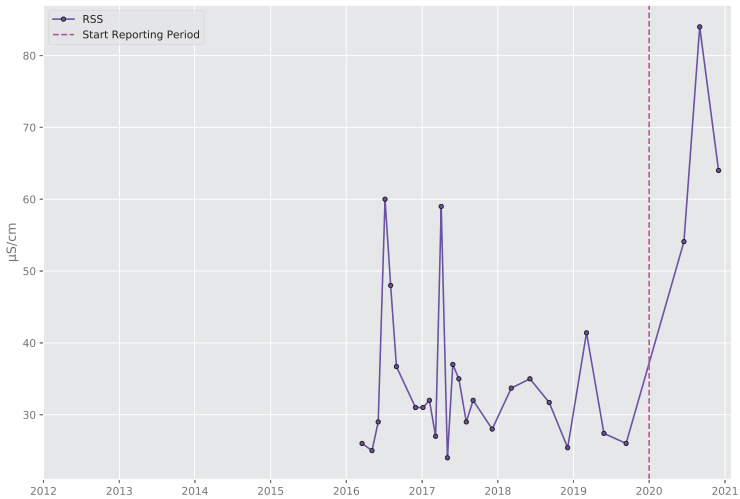
Copper



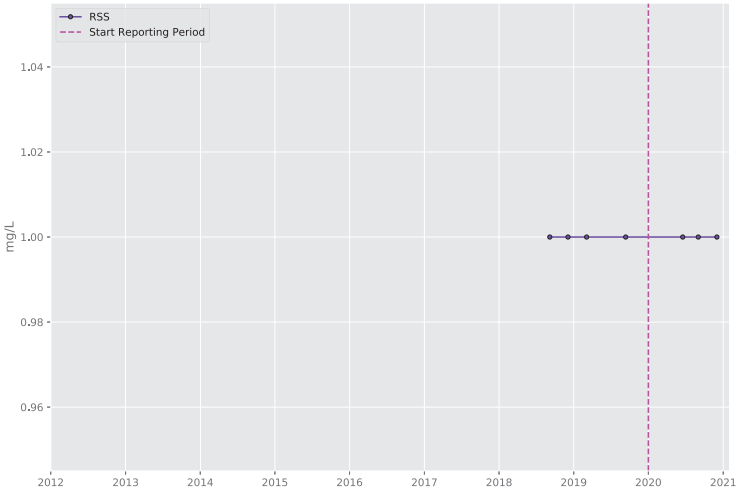
DO (Field)



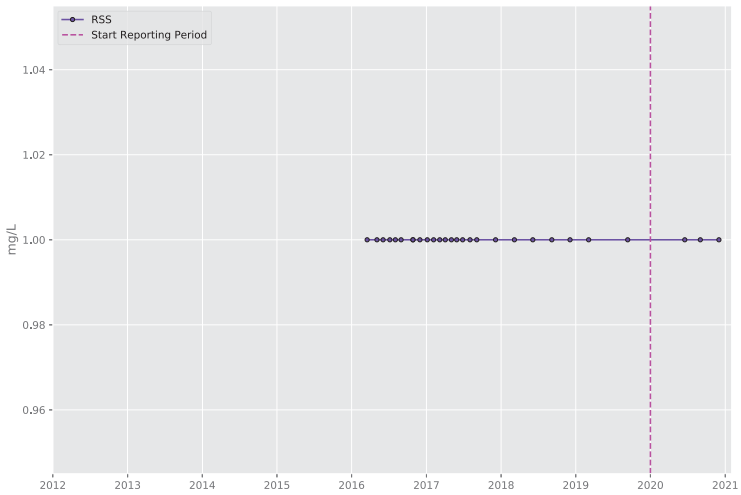
Electrical Conductivity (EC)



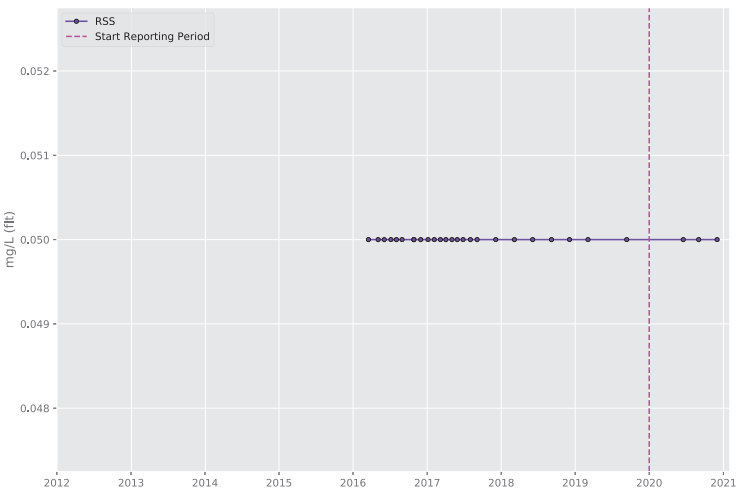
Hardness as CaCO3



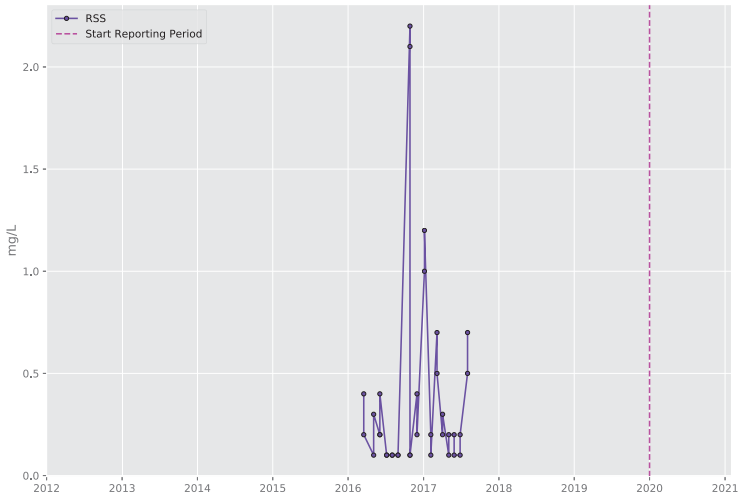
Hydroxide as CaCO3



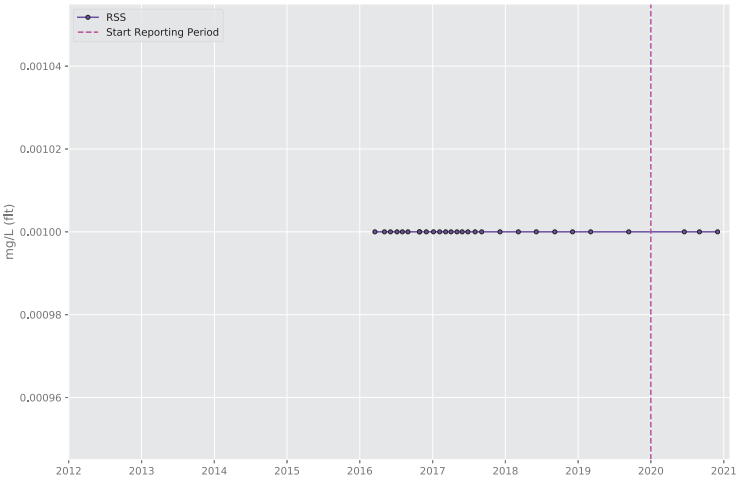
Iron



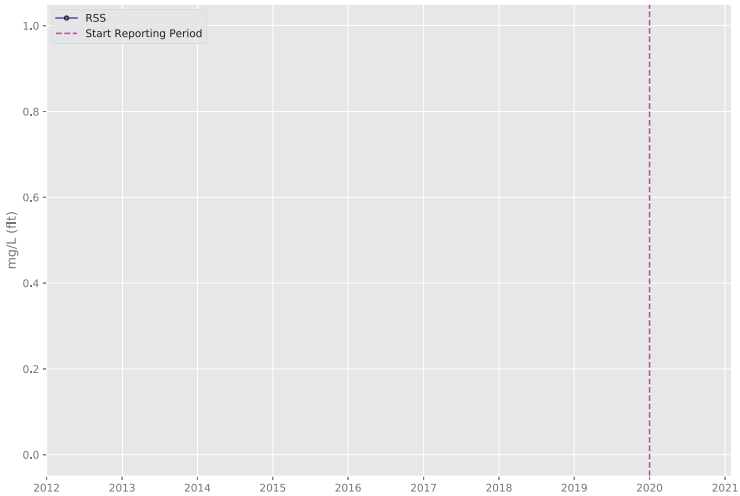
Kjeldahl Nitrogen Total



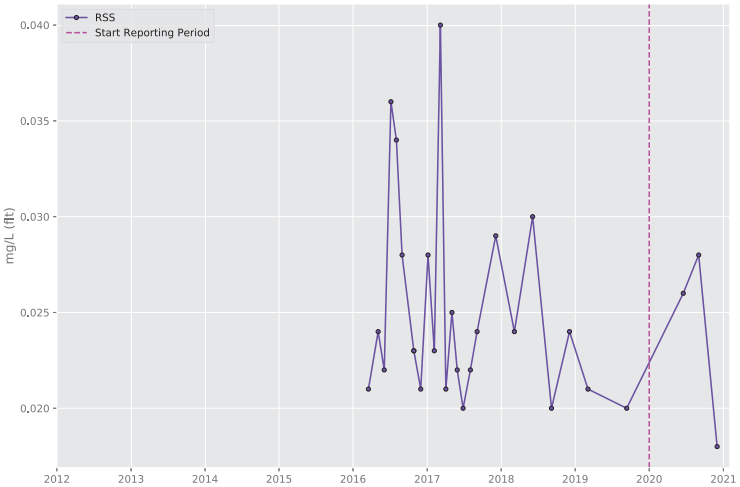
Lead



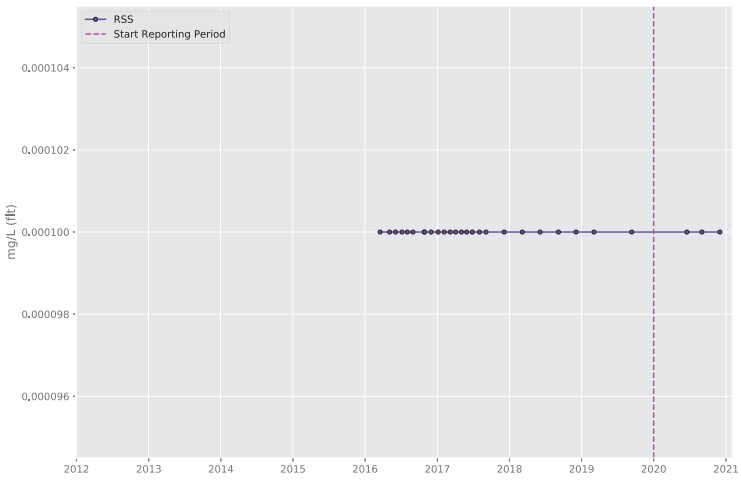
Magnesium



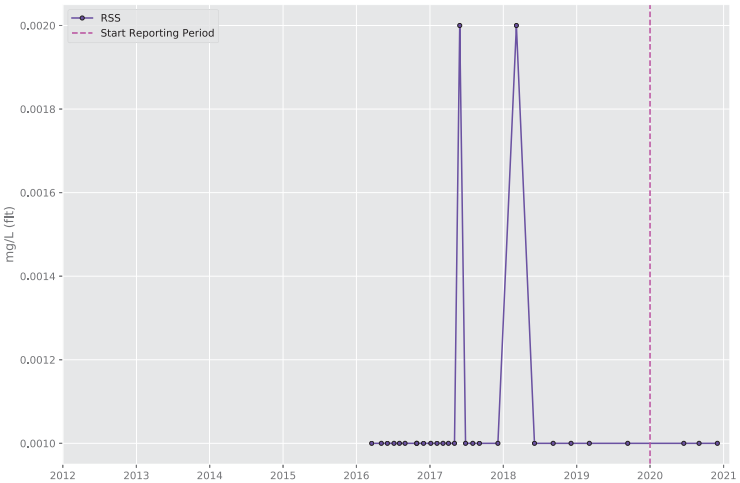
Manganese



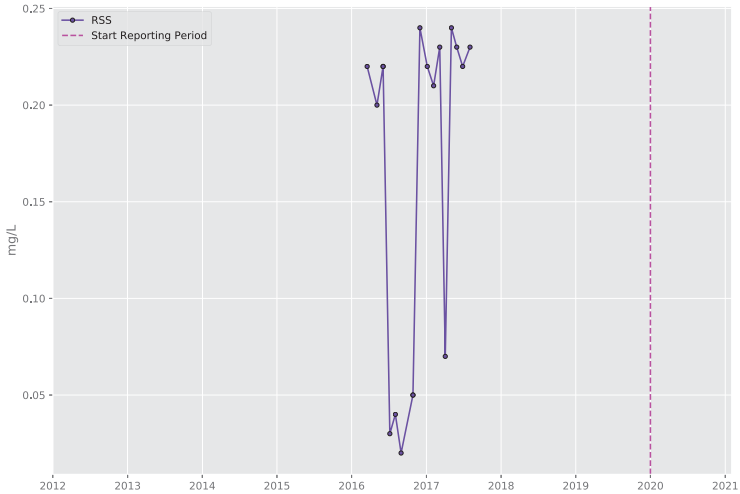
Mercury



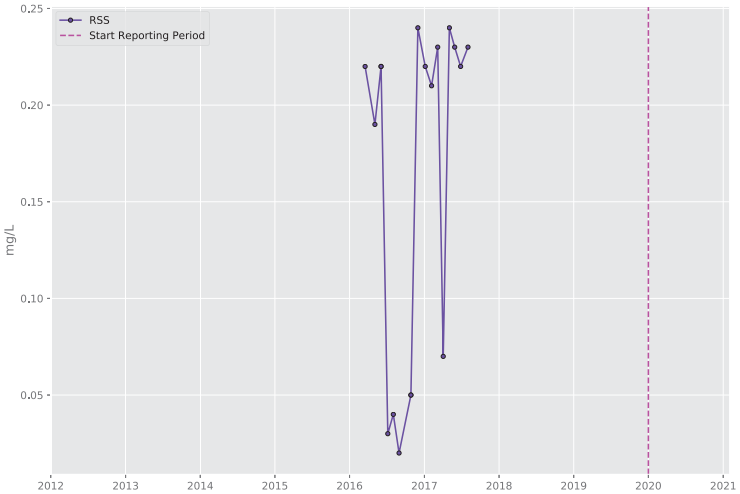
Nickel



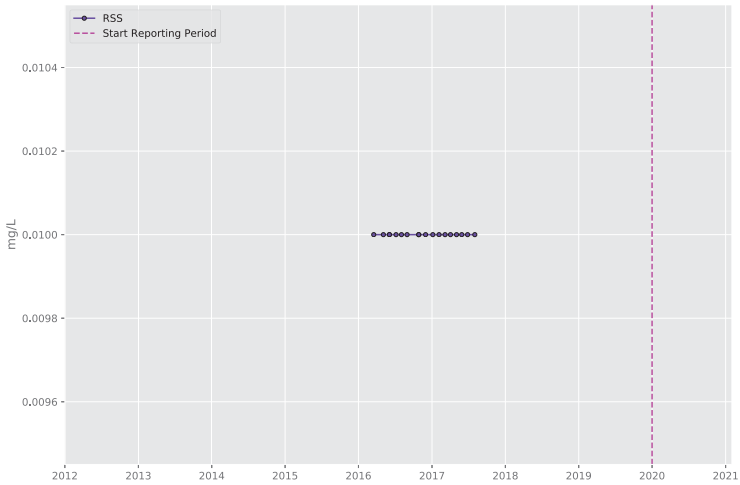
Nitrate & Nitrite (as N)



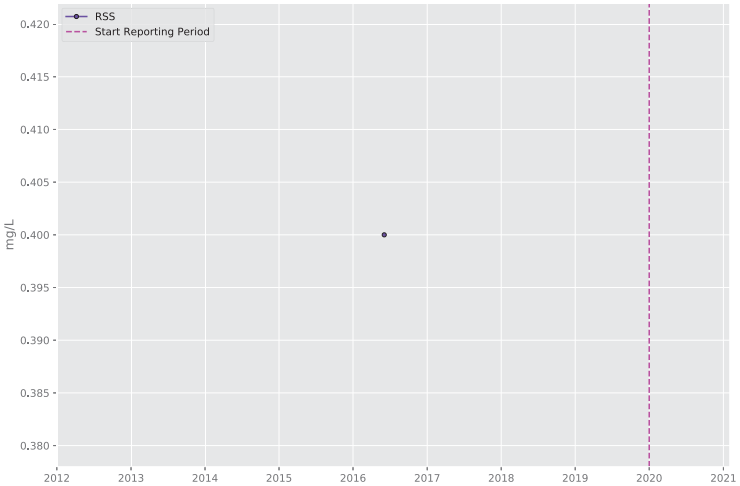
Nitrate (as N)



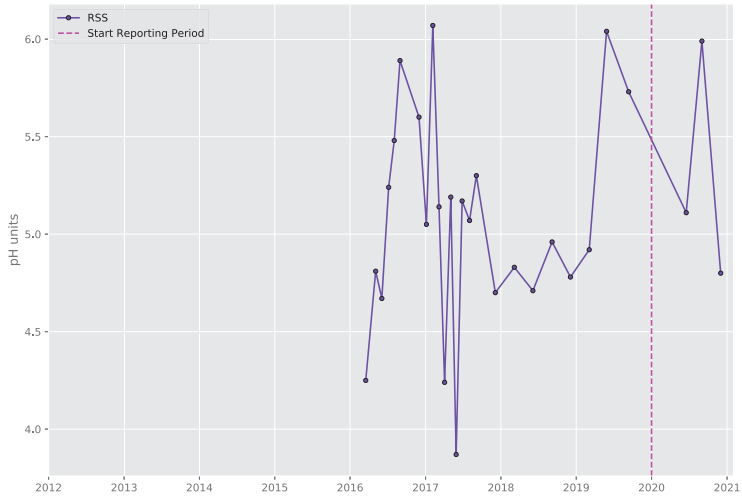
Nitrite (as N)



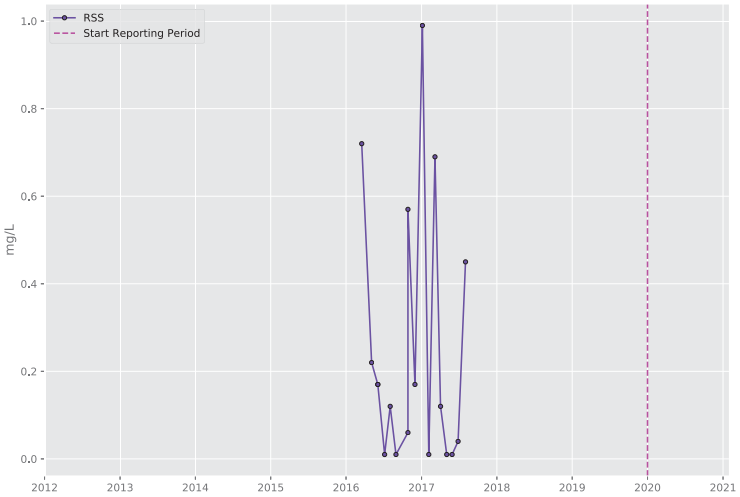
Nitrogen (Total)



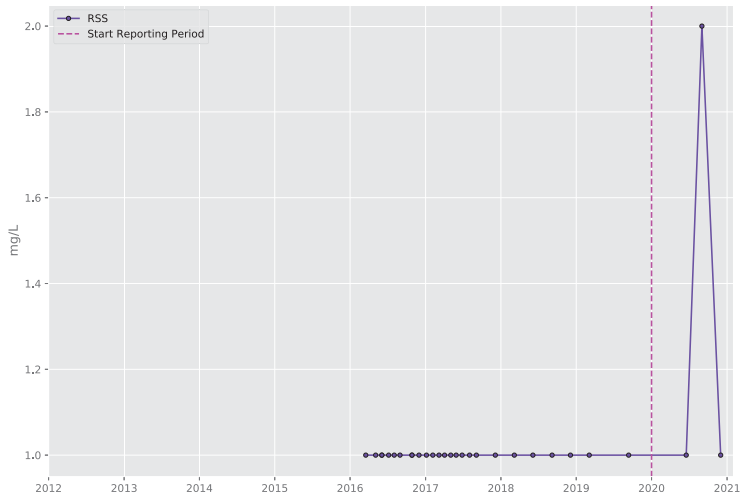
pH_0



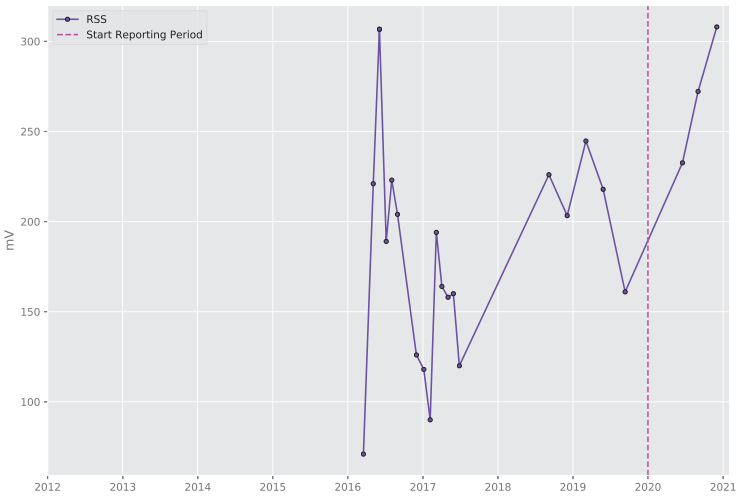
Phosphorus



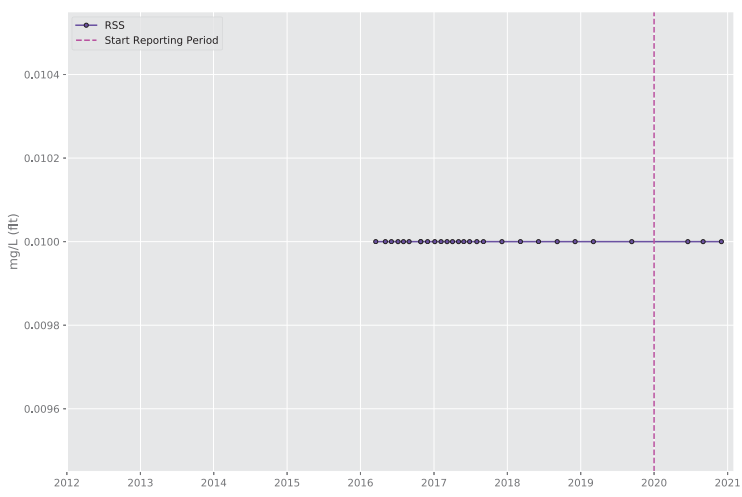
Potassium



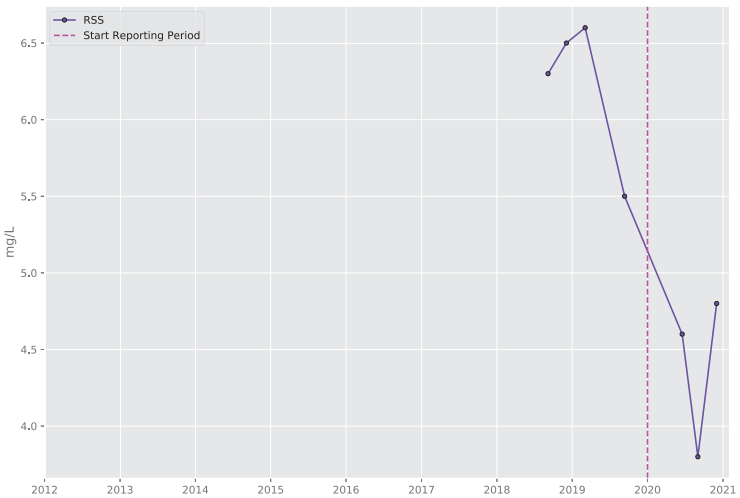
Redox Potential



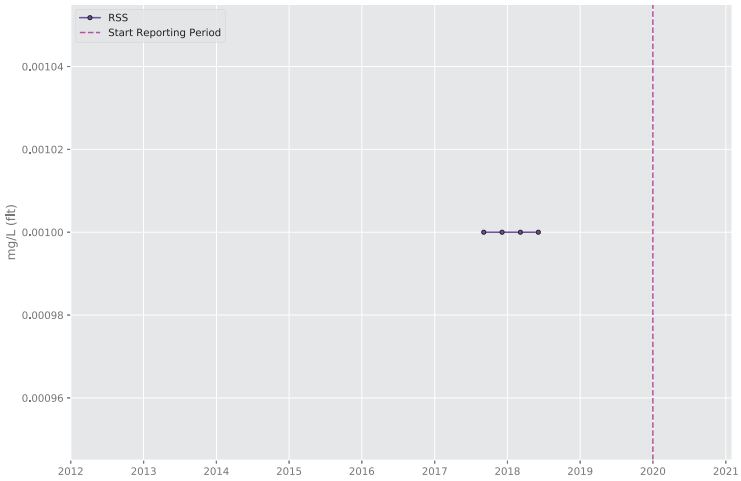
Selenium



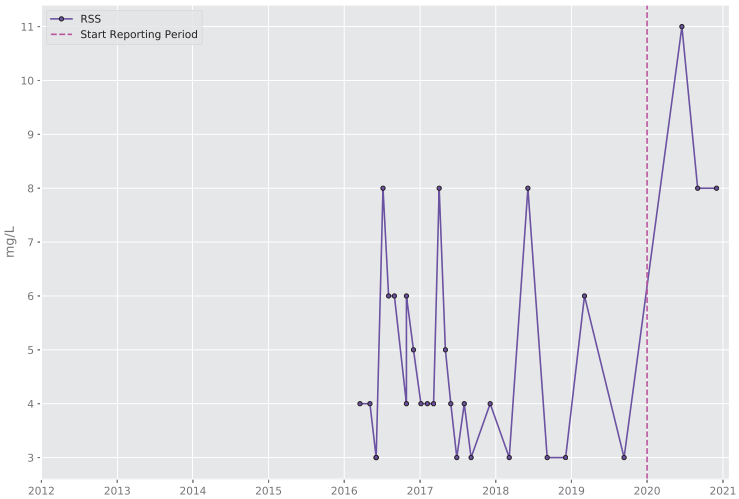
Silicon as SiO2



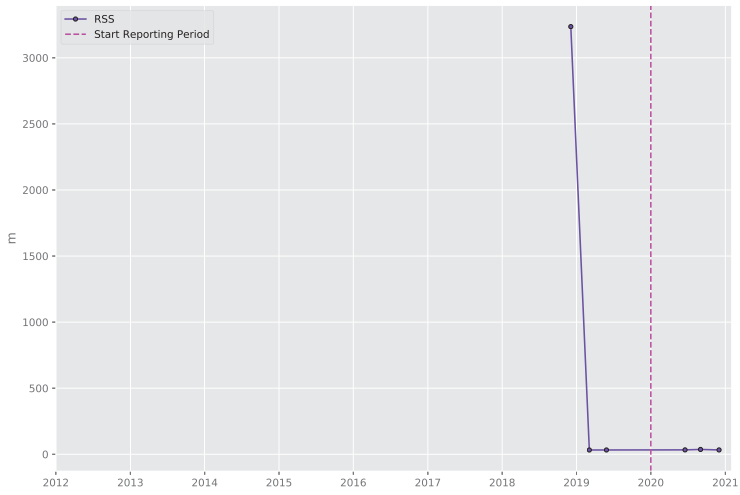
Silver



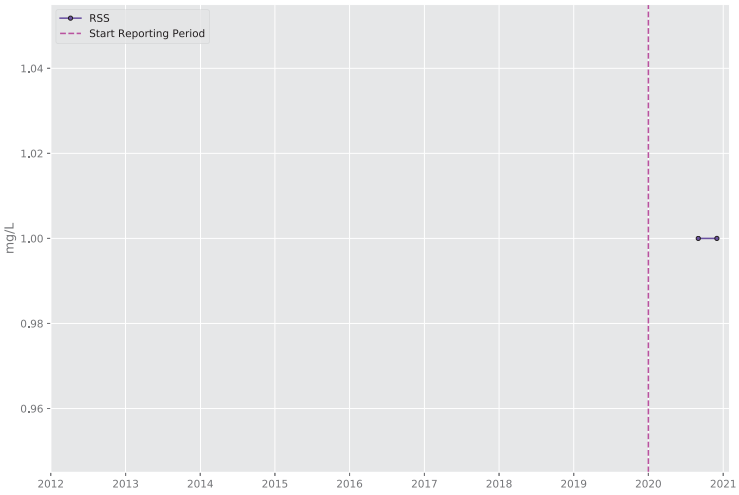
Sodium



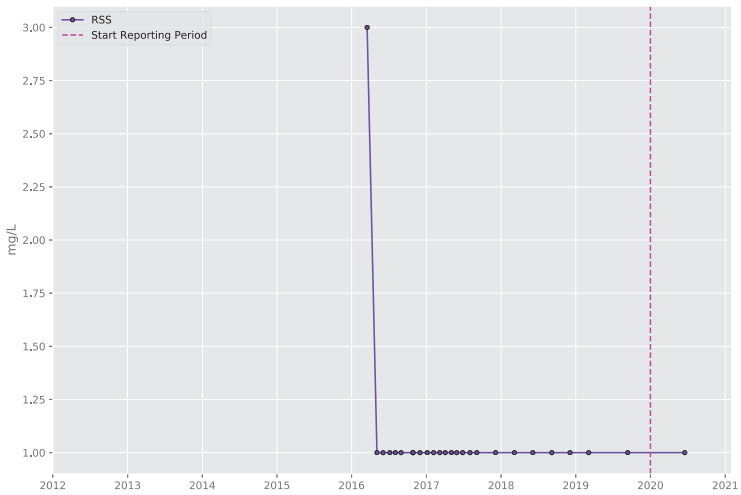
Standing water level



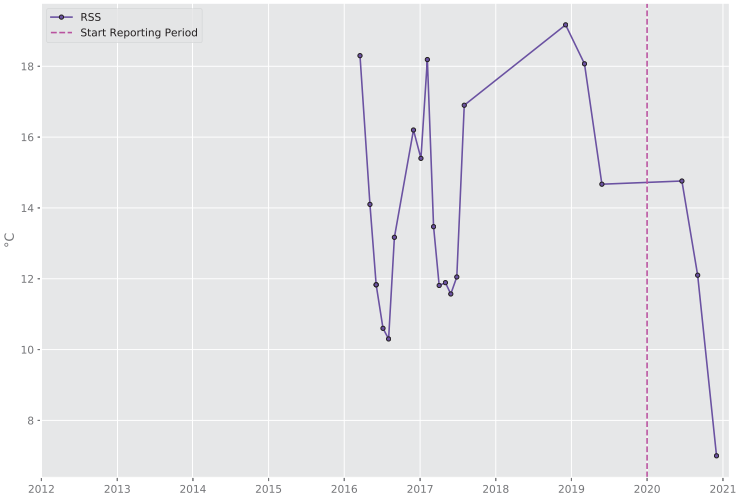
Sulfate as SO4 - Turbidimetric



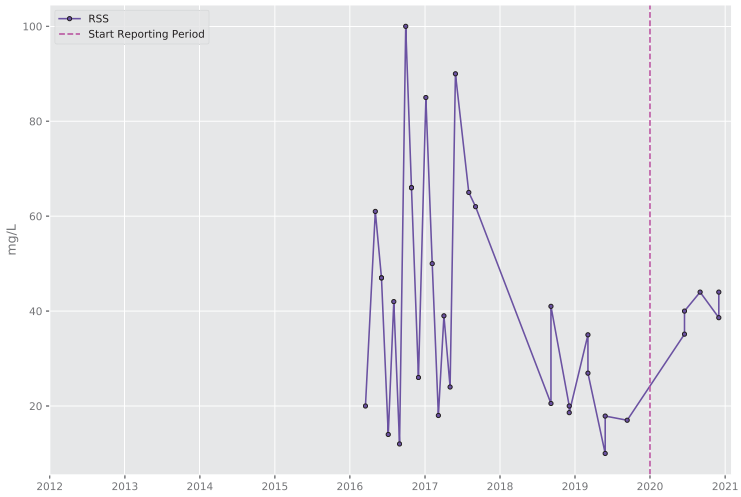
Sulphate



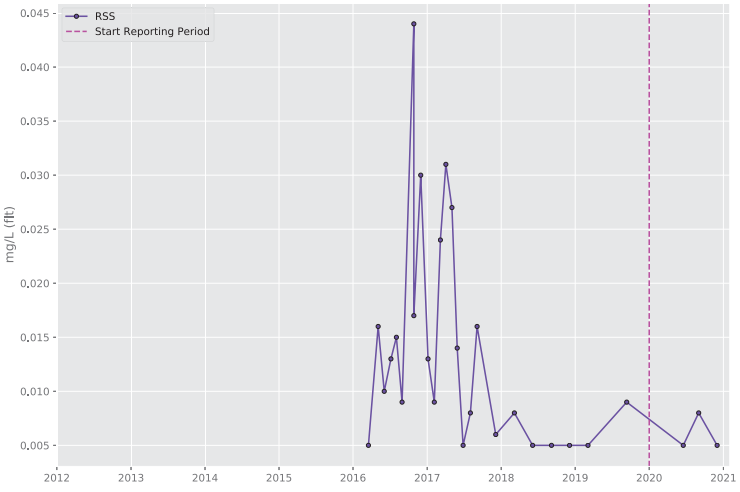
Temp



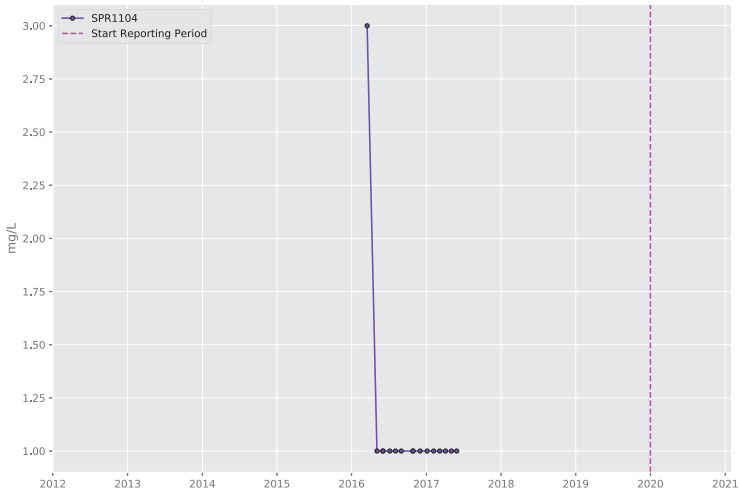
Total Dissolved Solids



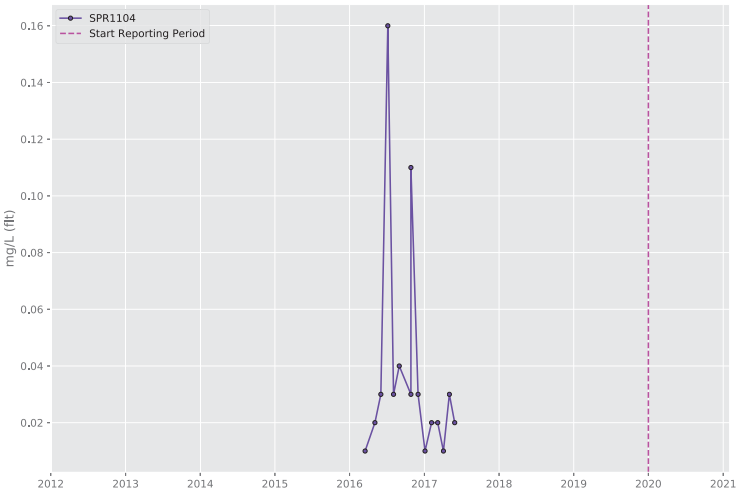
Zinc



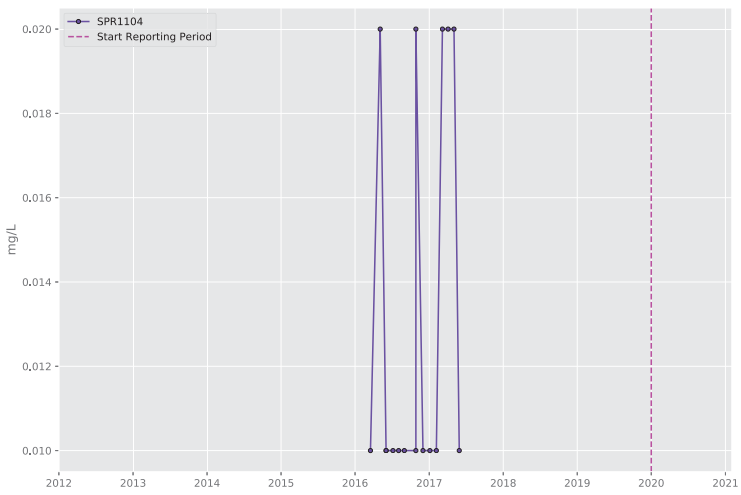
Alkalinity (total) as CaCO3



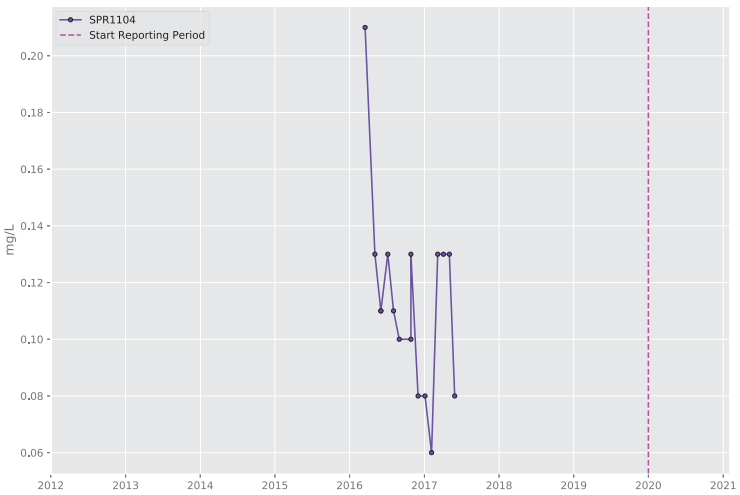
Aluminium



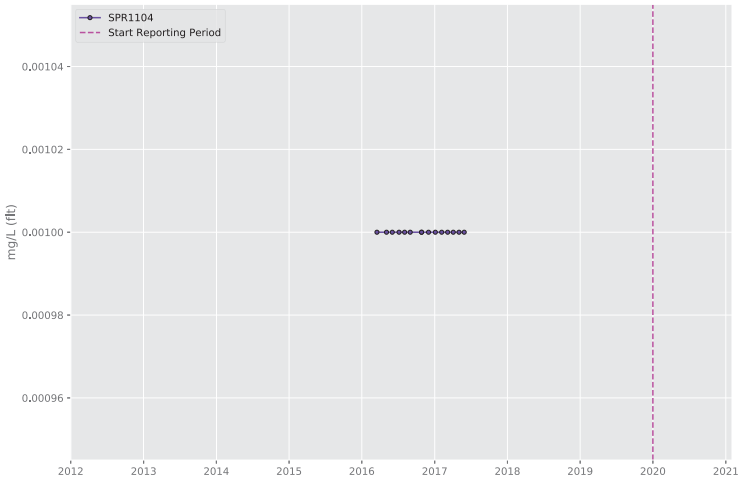
Ammonia as N



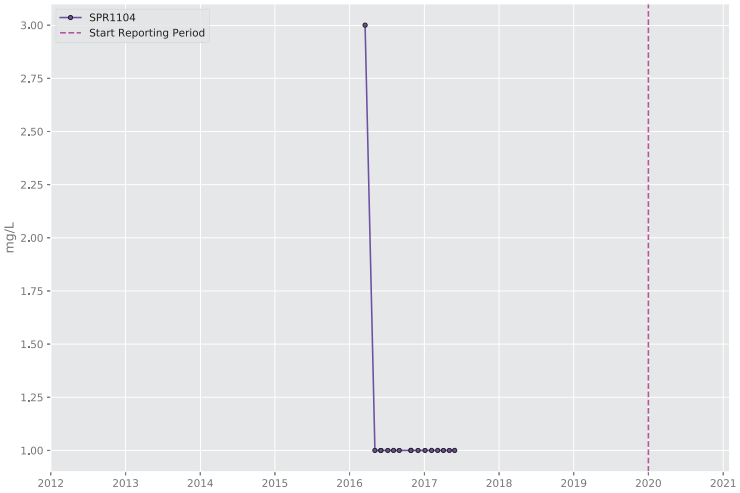
Anions Total



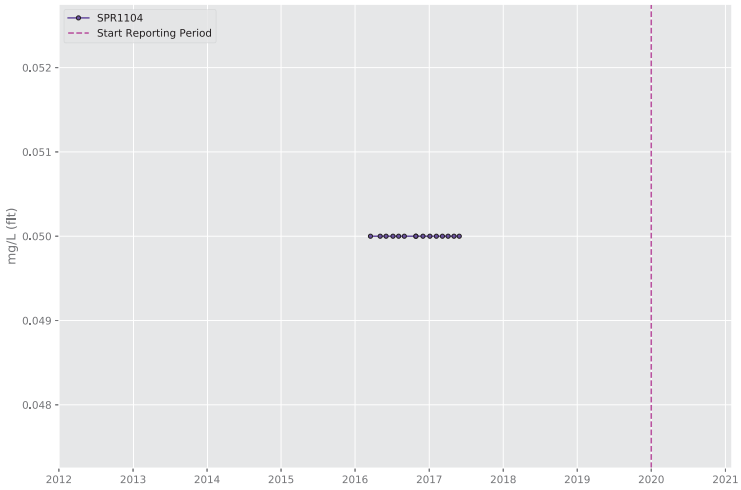
Arsenic



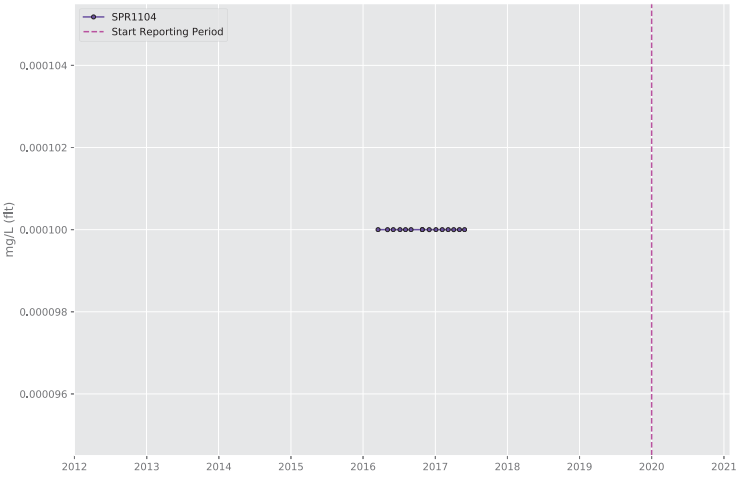
Bicarbonate Alkalinity as CaCO3



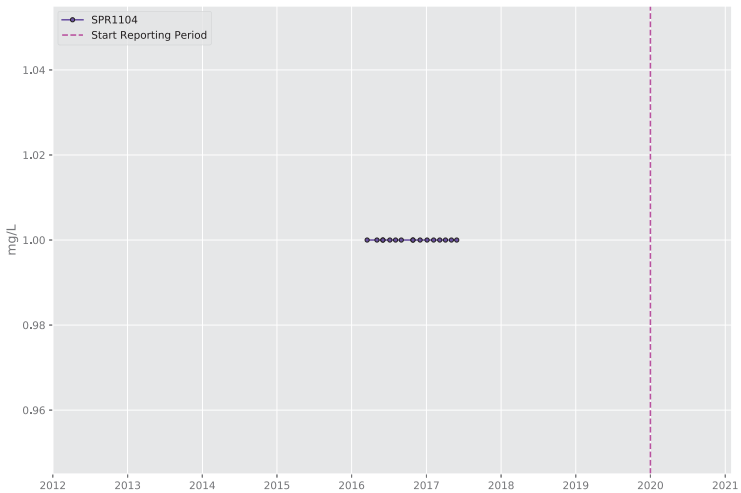
Boron



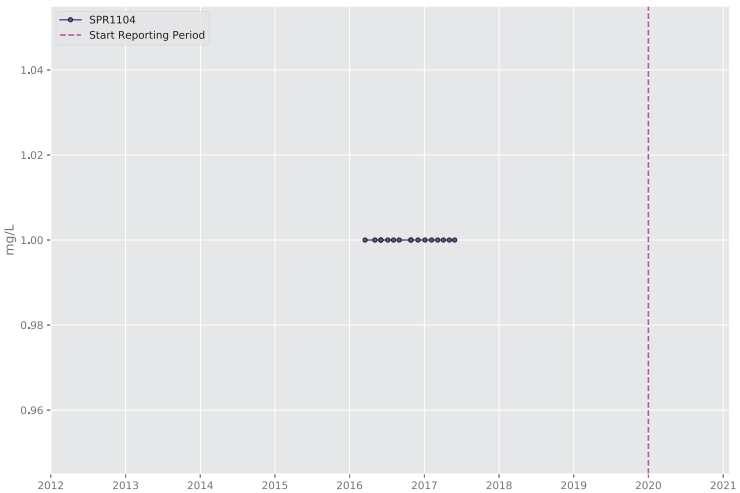
Cadmium



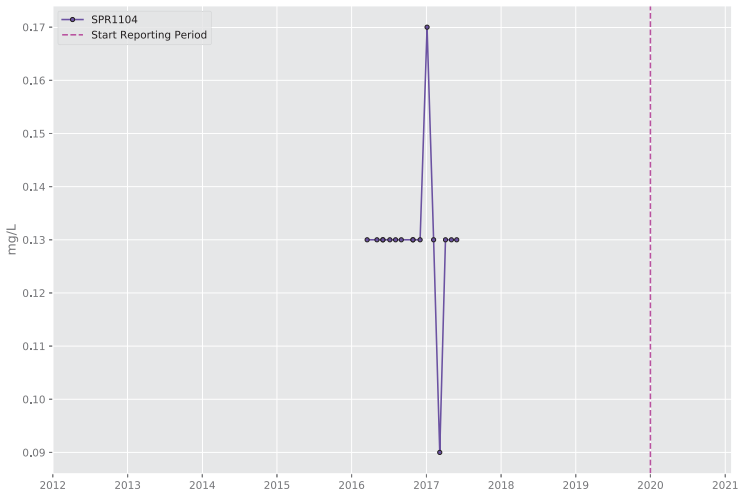
Calcium



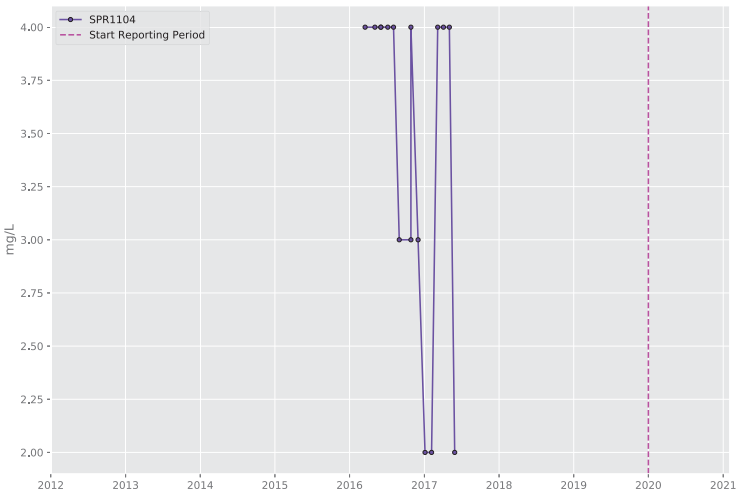
Carbonate



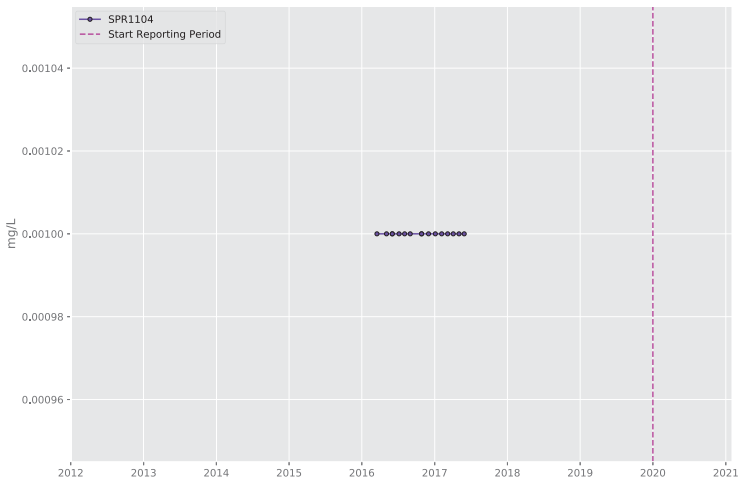
Cations Total



Chloride



Chromium (soluble)



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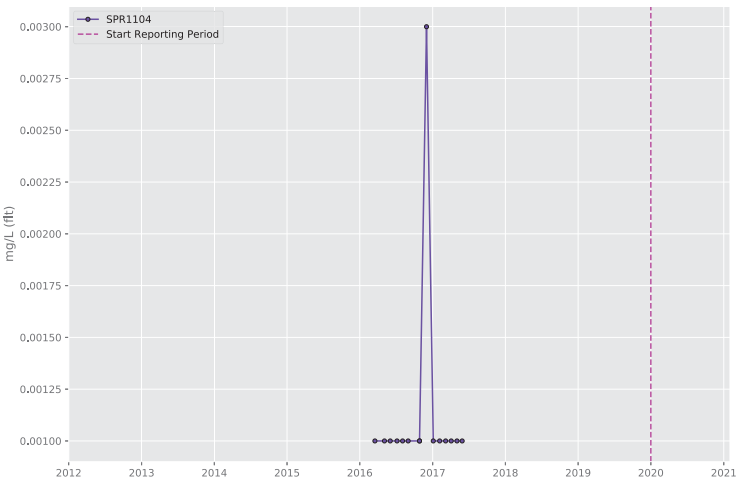
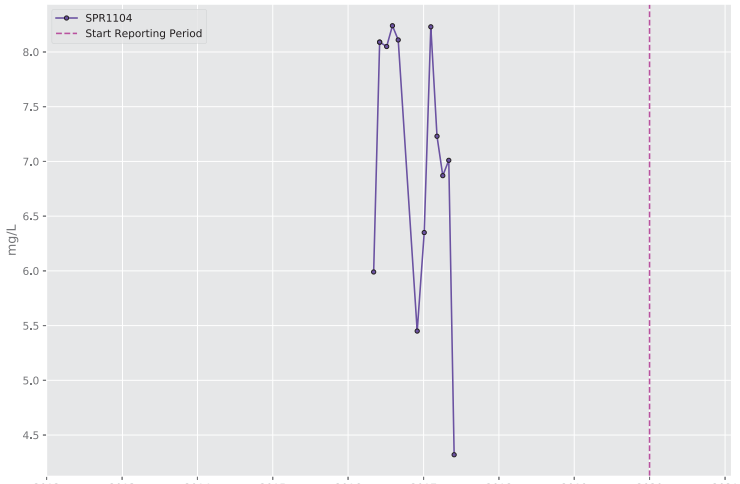
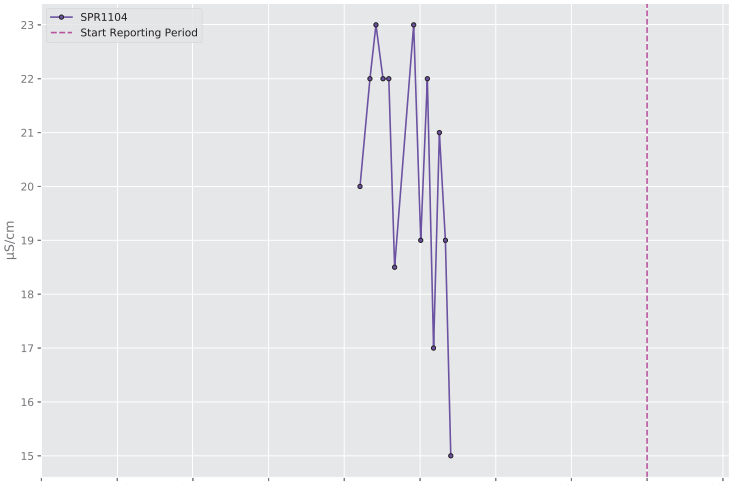


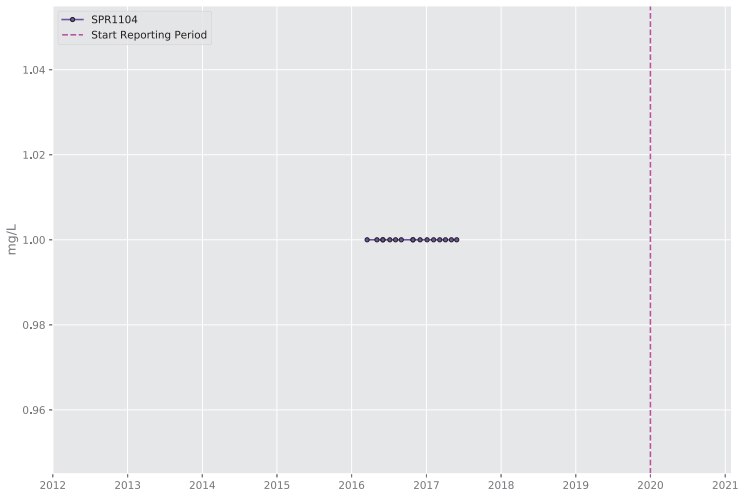
DO (Field)



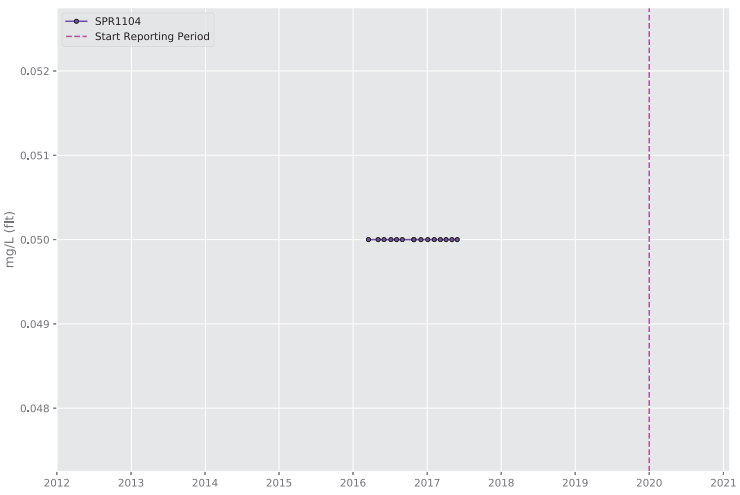
Electrical Conductivity (EC)



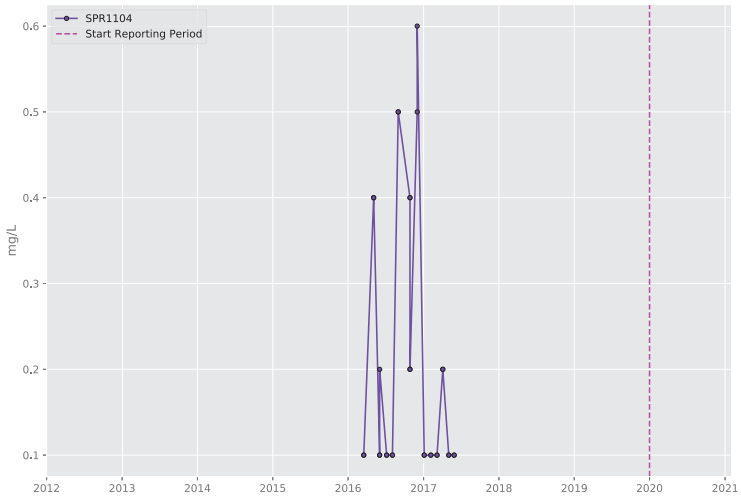
Hydroxide as CaCO3



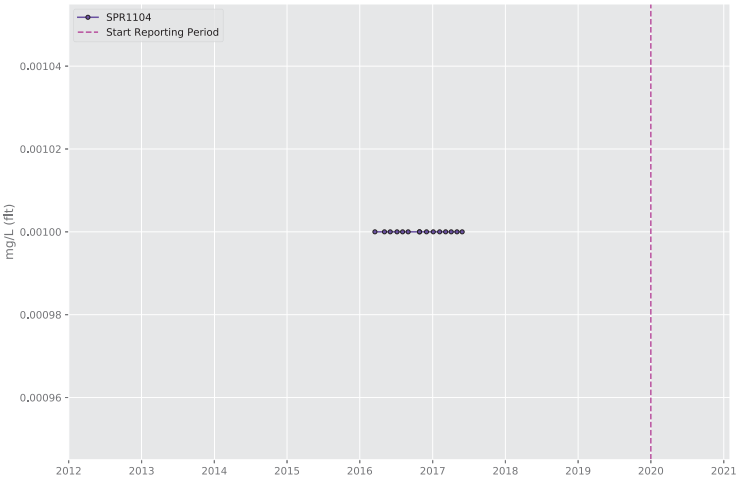
Iron



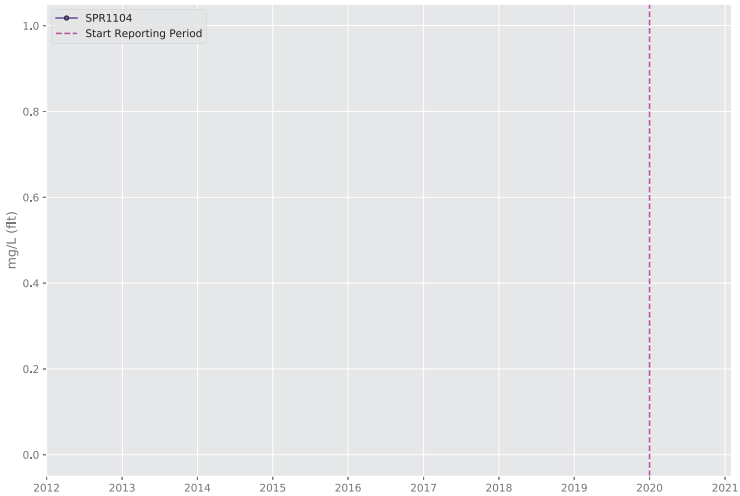
Kjeldahl Nitrogen Total



Lead



Magnesium



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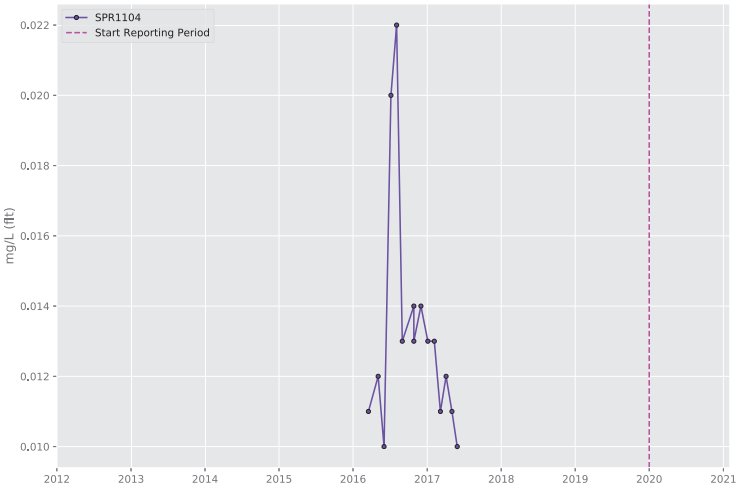
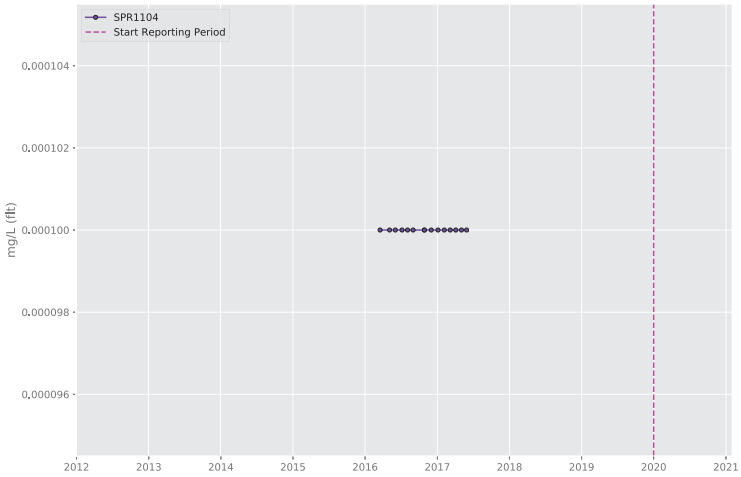
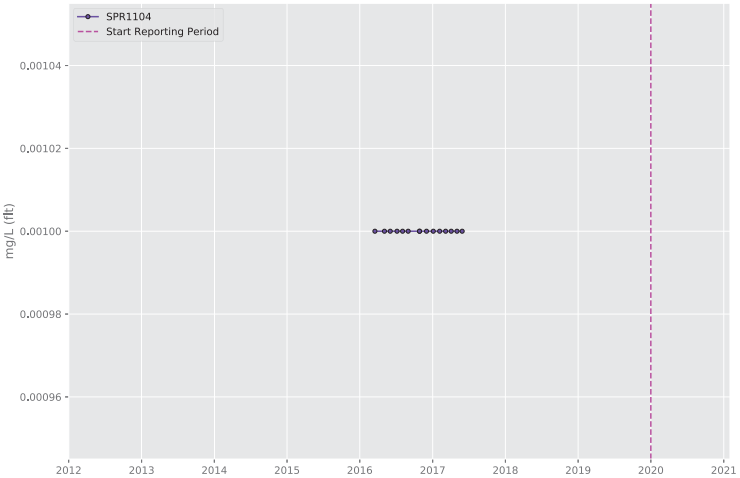


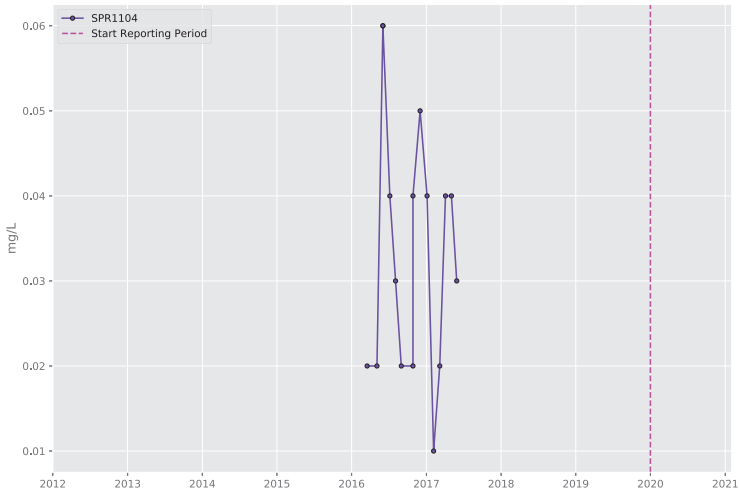
Mercury



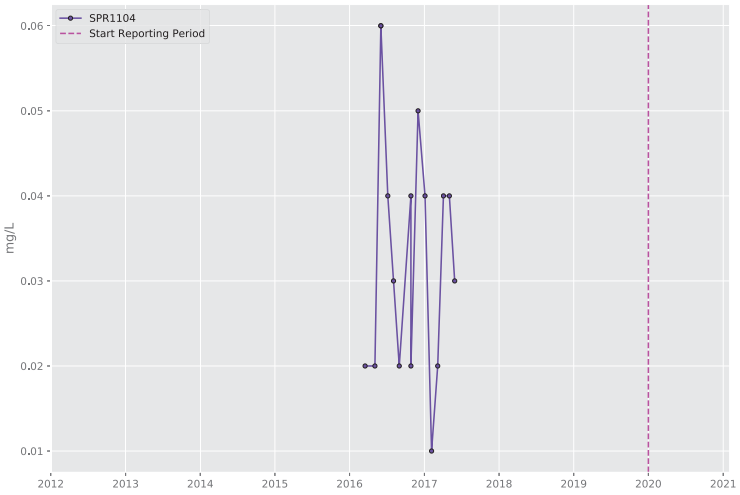
Nickel



Nitrate & Nitrite (as N)



Nitrate (as N)



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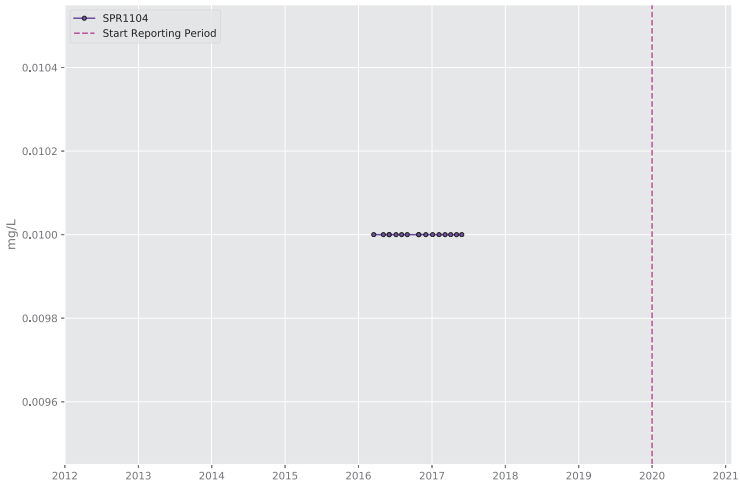
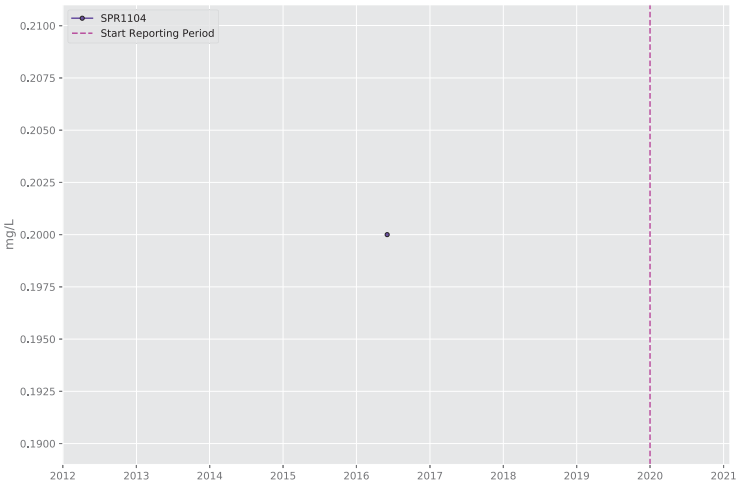
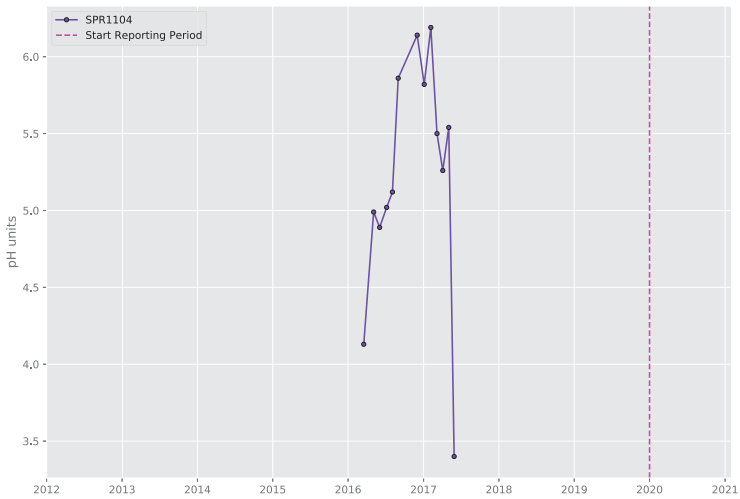


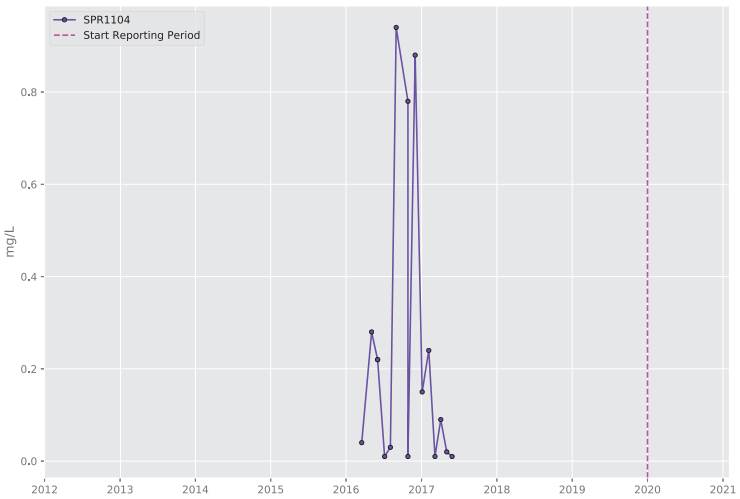
Nitrogen (Total)



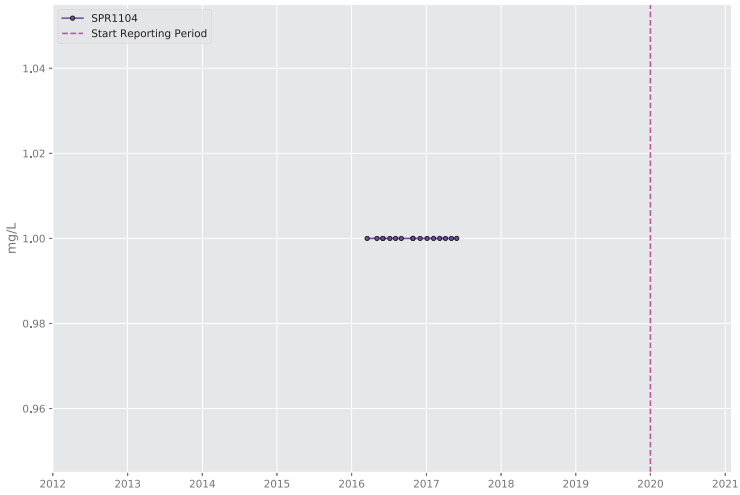
pH_0



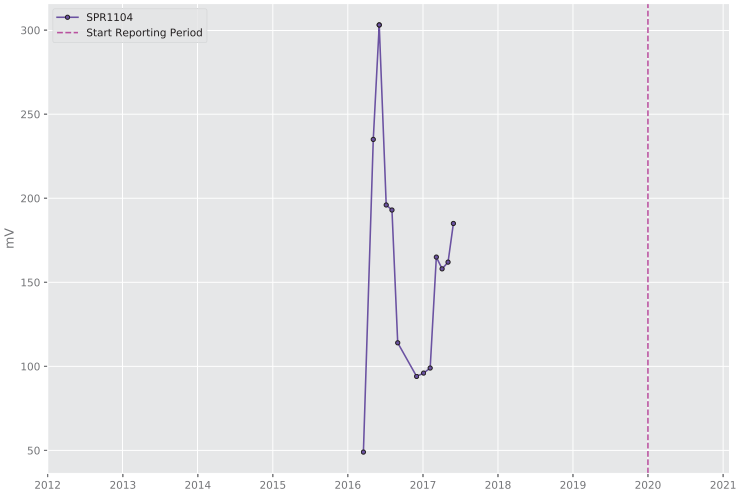
Phosphorus



Potassium



Redox Potential



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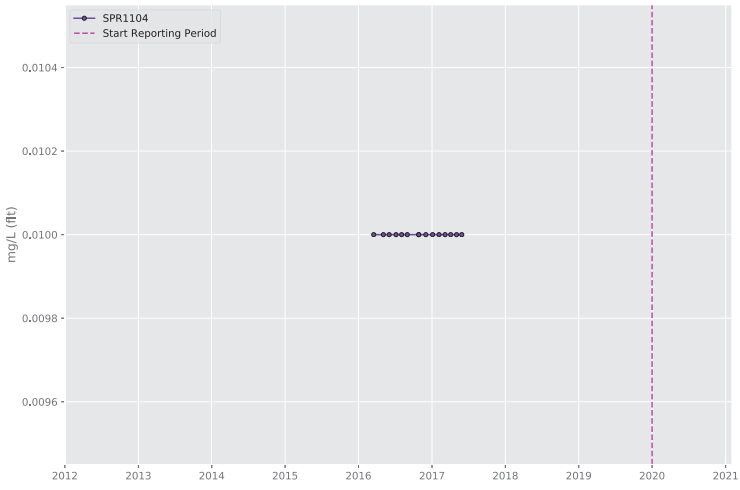

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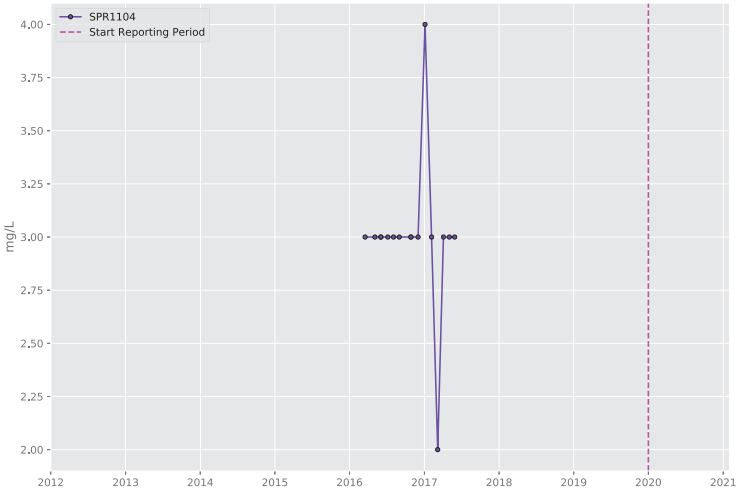
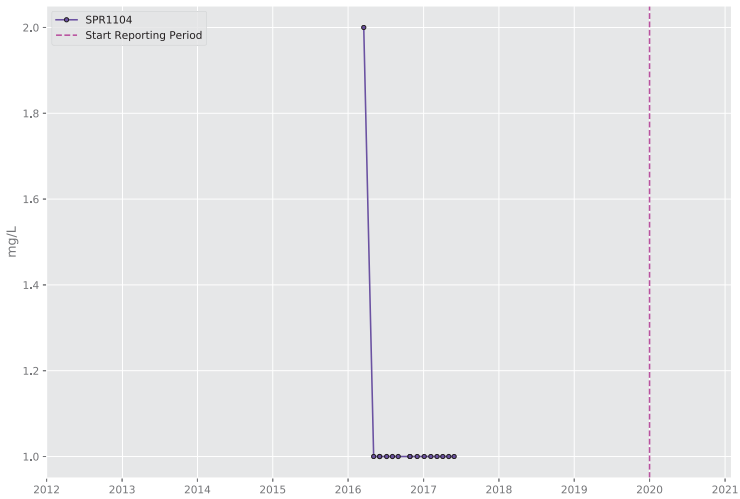
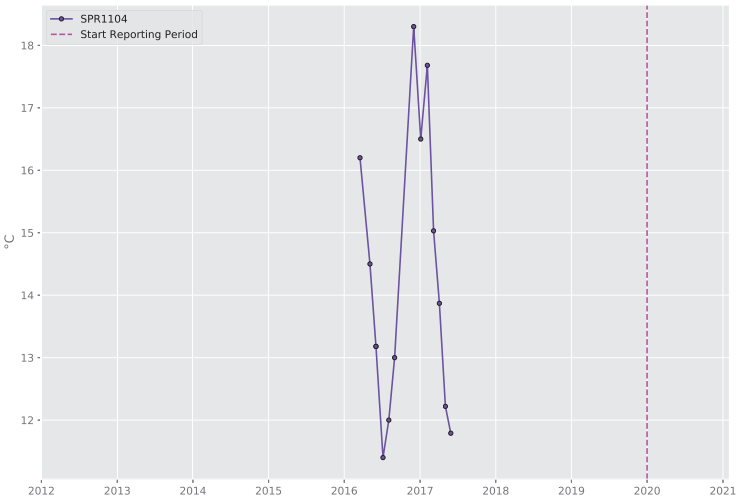


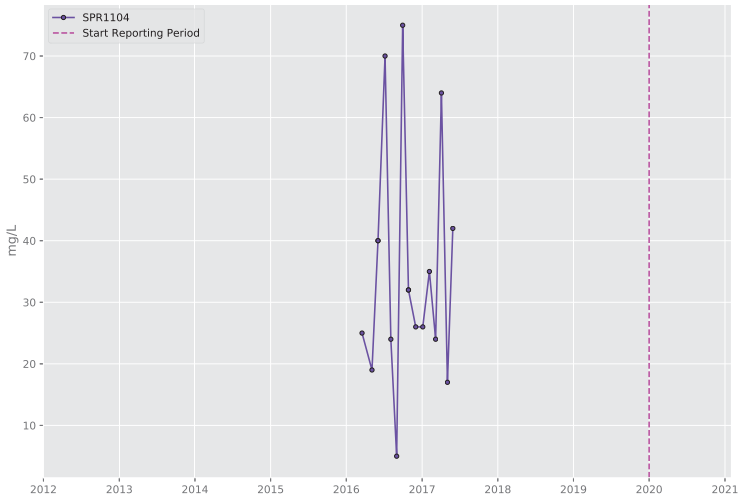
Sulphate



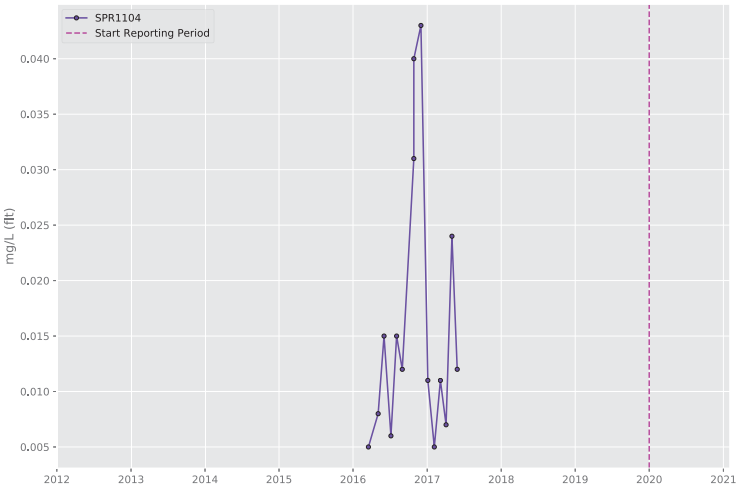
Temp



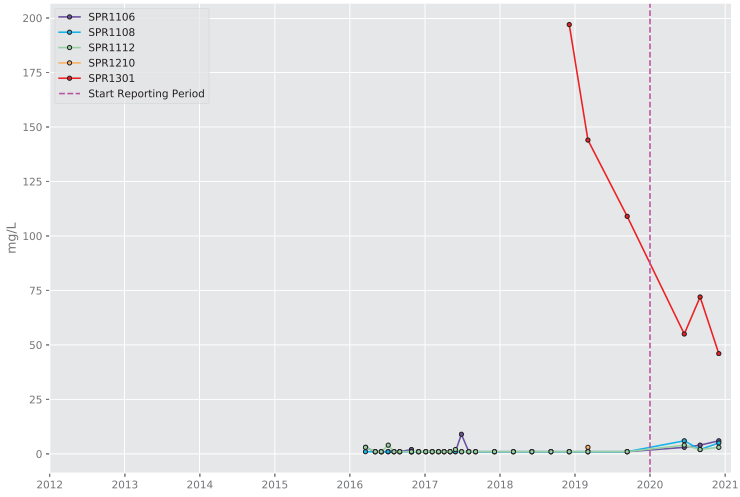
Total Dissolved Solids



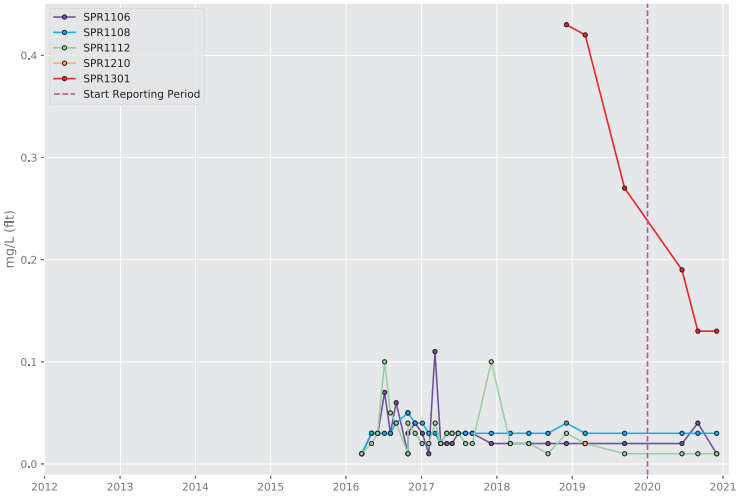
Zinc



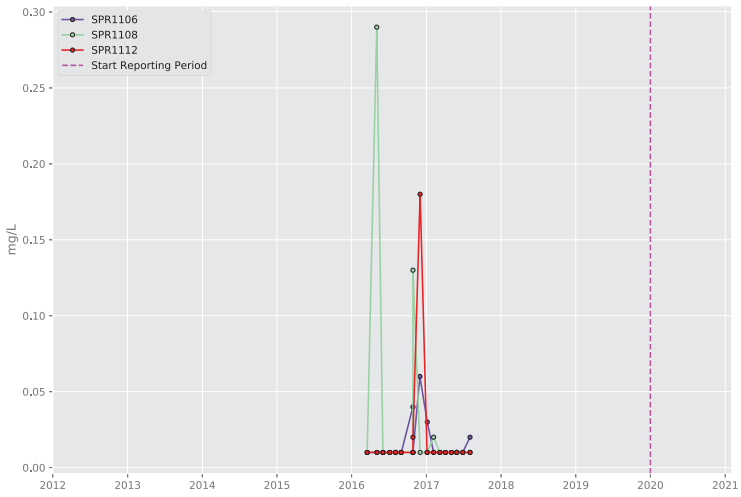
Alkalinity (total) as CaCO3



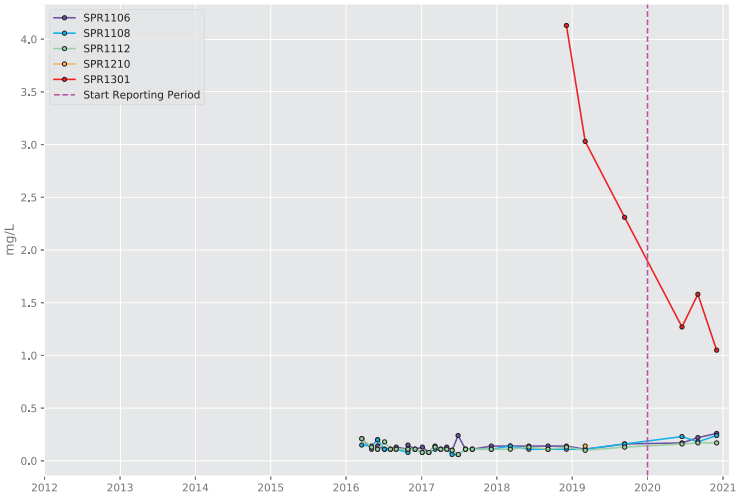
Aluminium



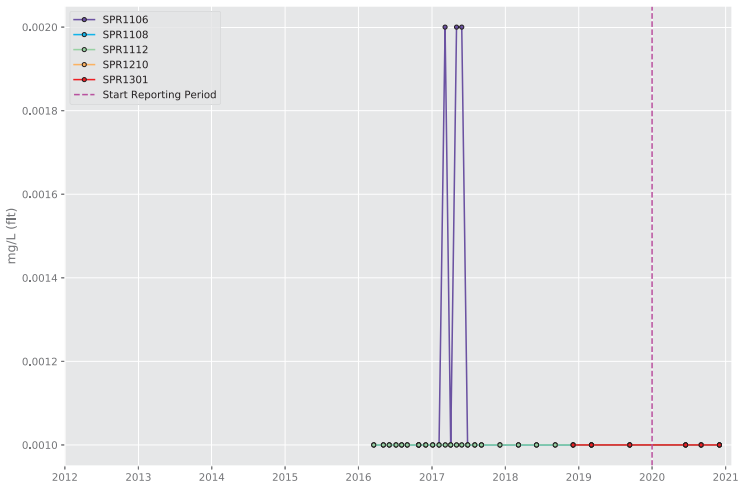
Ammonia as N



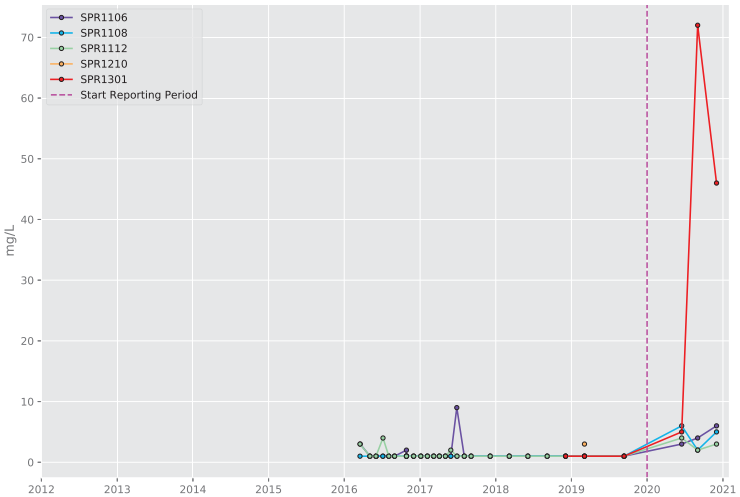
Anions Total



Arsenic



Bicarbonate Alkalinity as CaCO3



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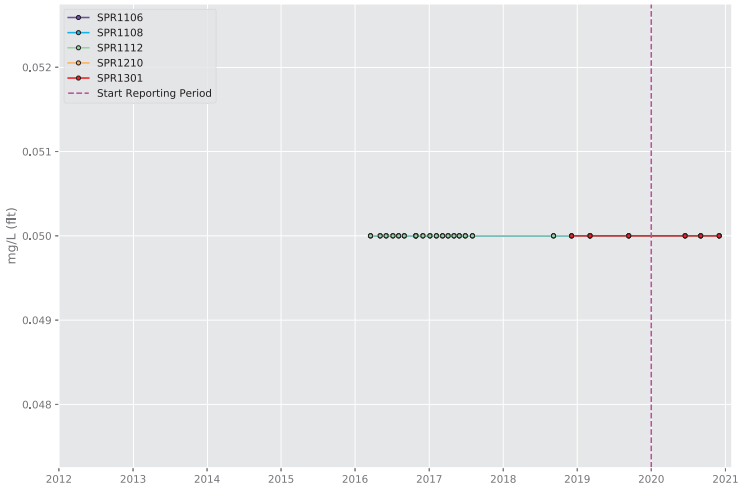
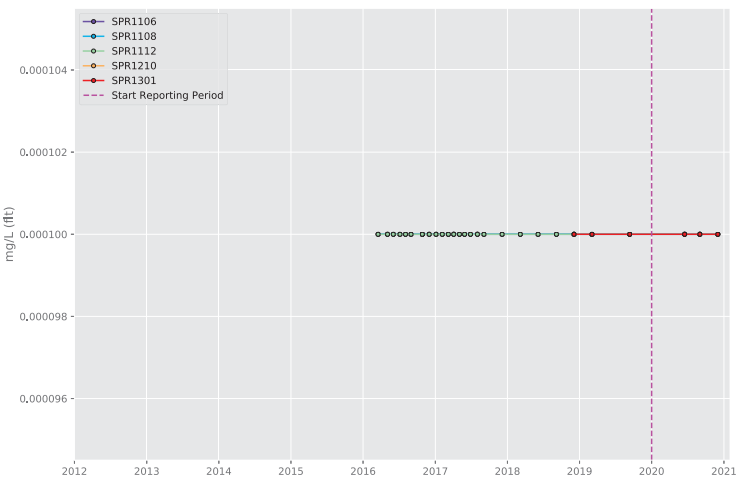
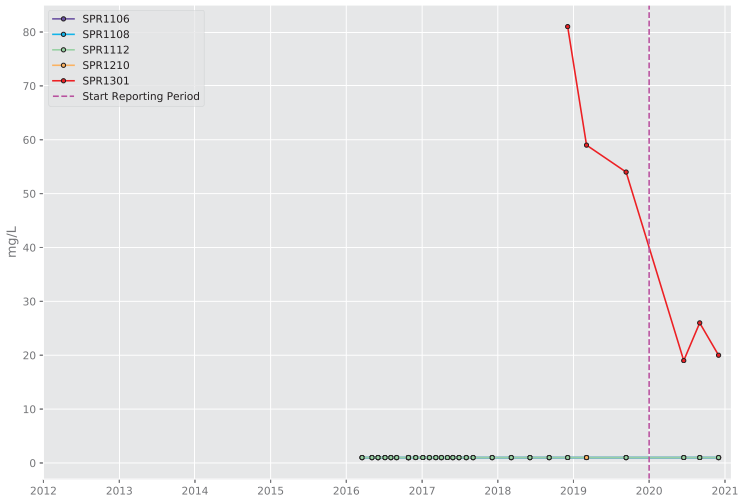


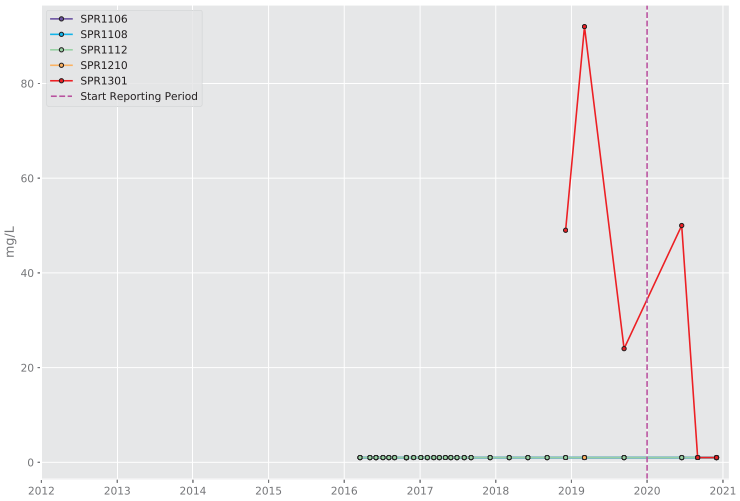
Cadmium



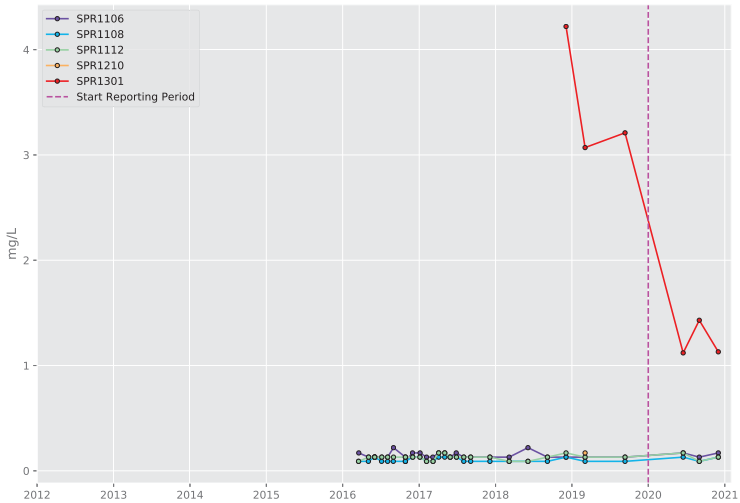
Calcium



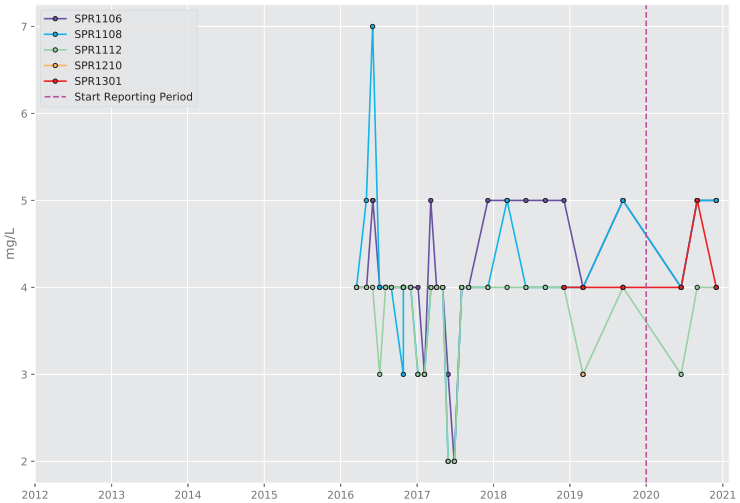
Carbonate



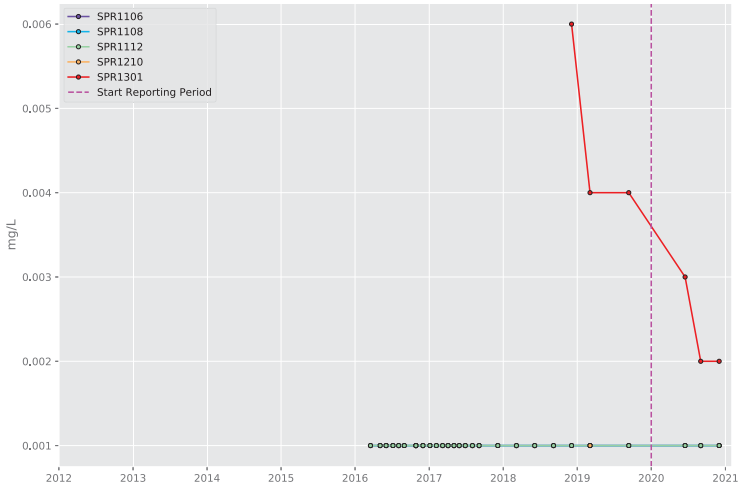
Cations Total



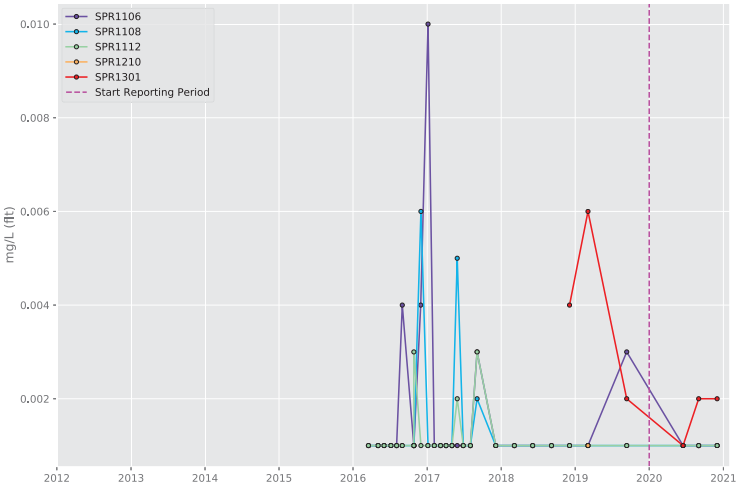
Chloride



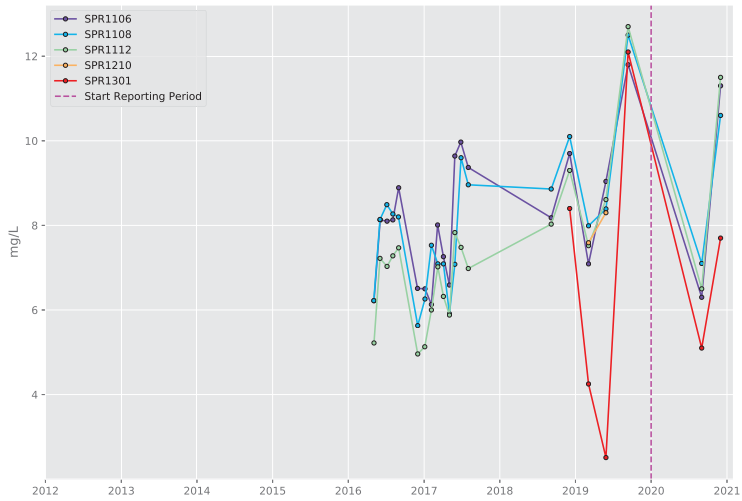
Chromium (soluble)



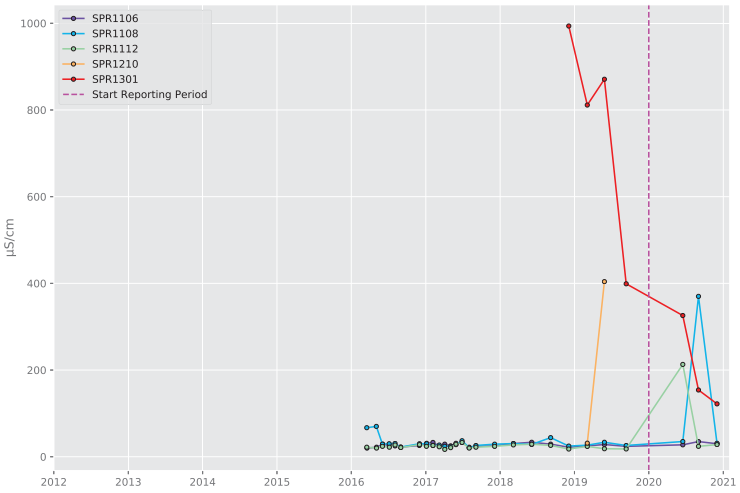
Copper



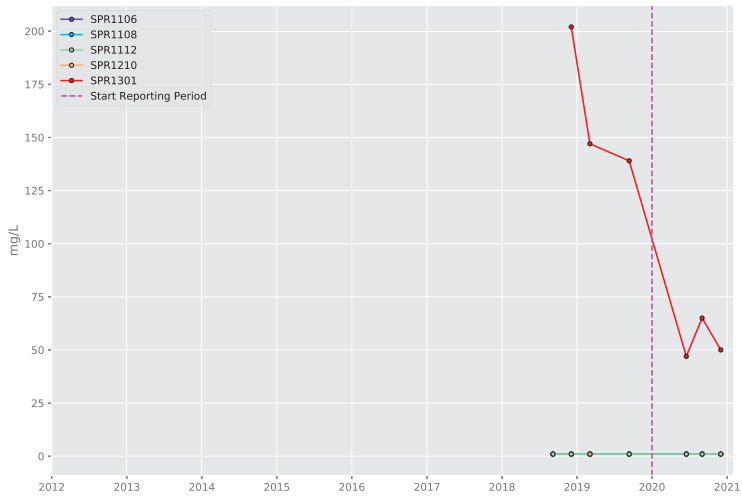
DO (Field)



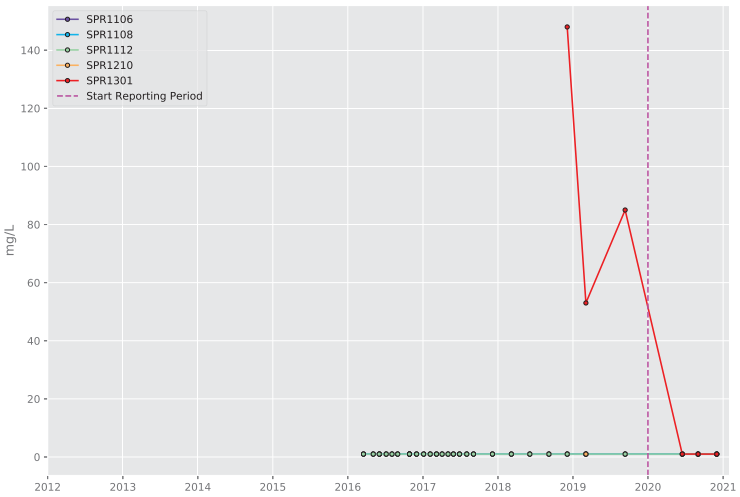
Electrical Conductivity (EC)



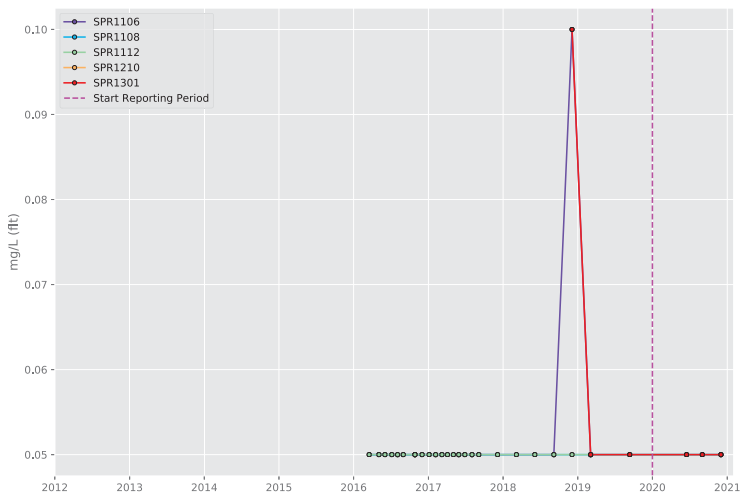
Hardness as CaCO3



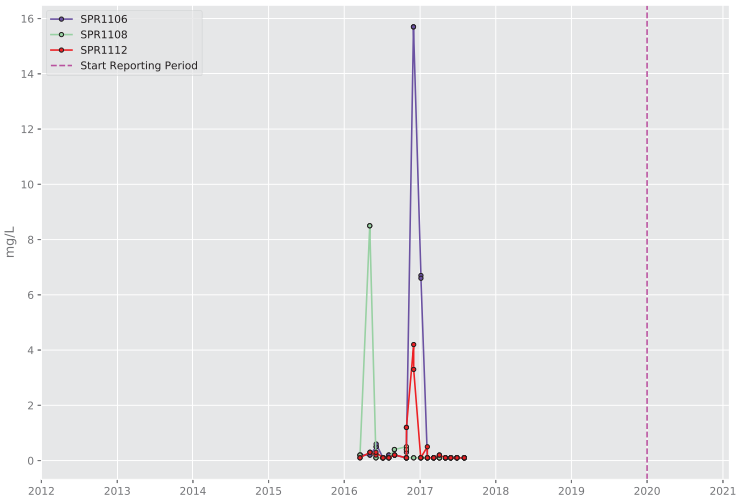
Hydroxide as CaCO3



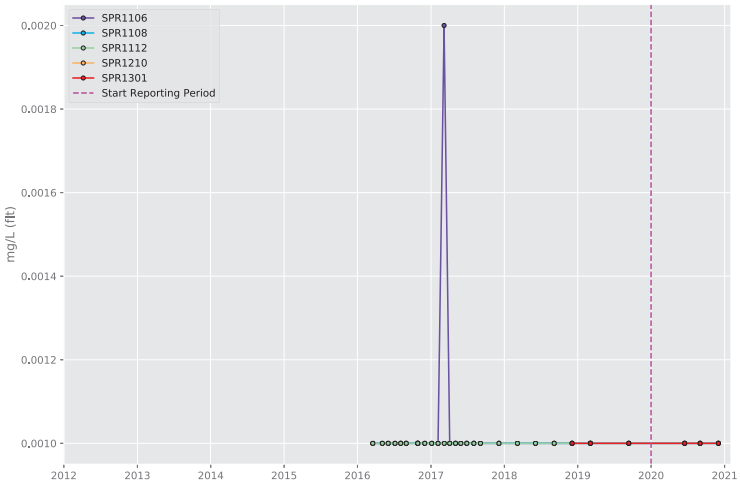
Iron



Kjeldahl Nitrogen Total



Lead



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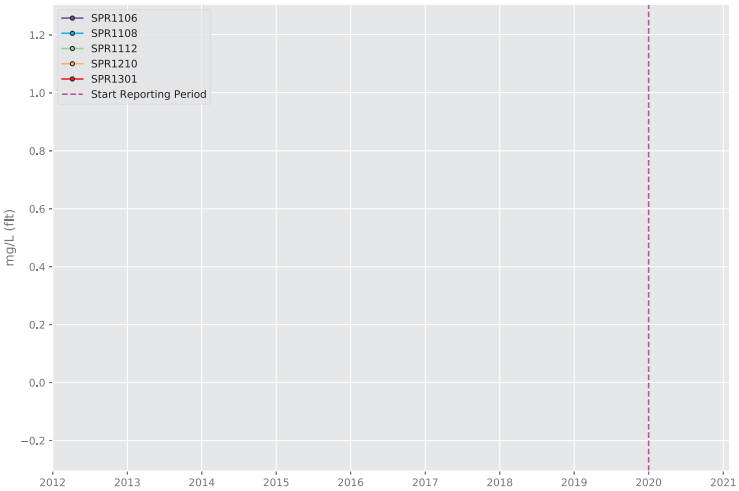

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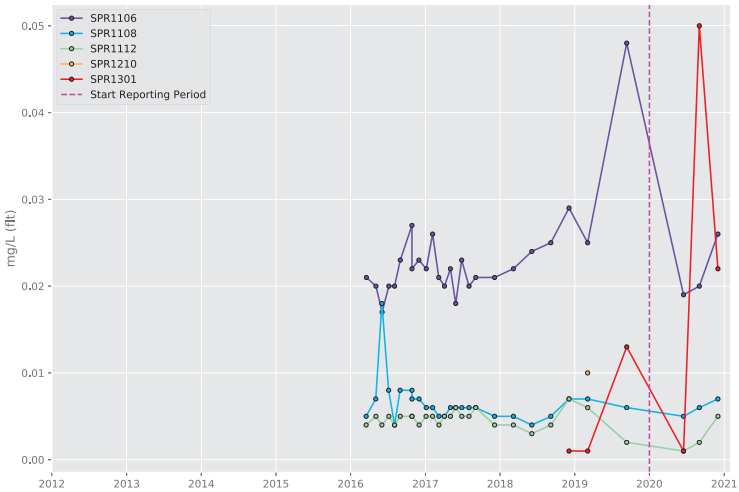

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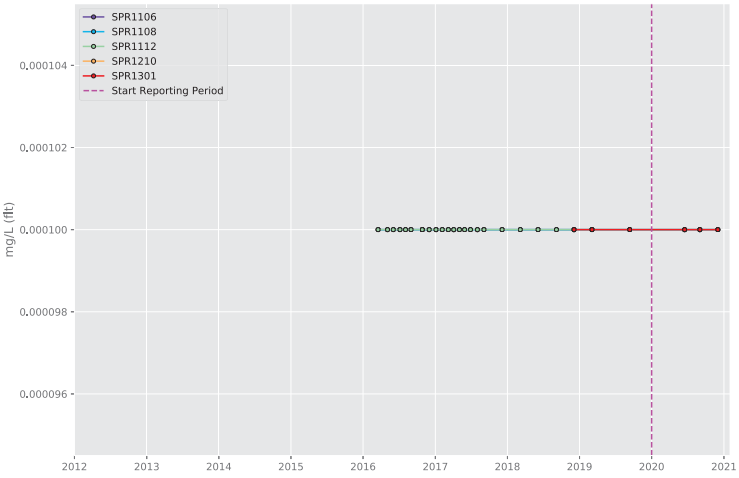

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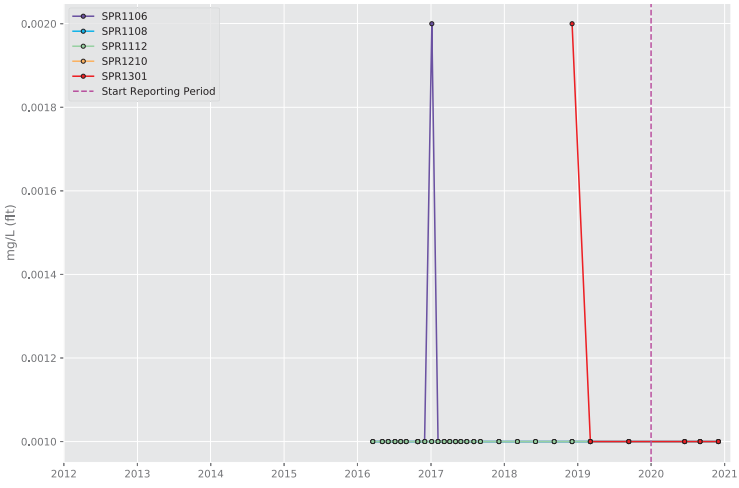
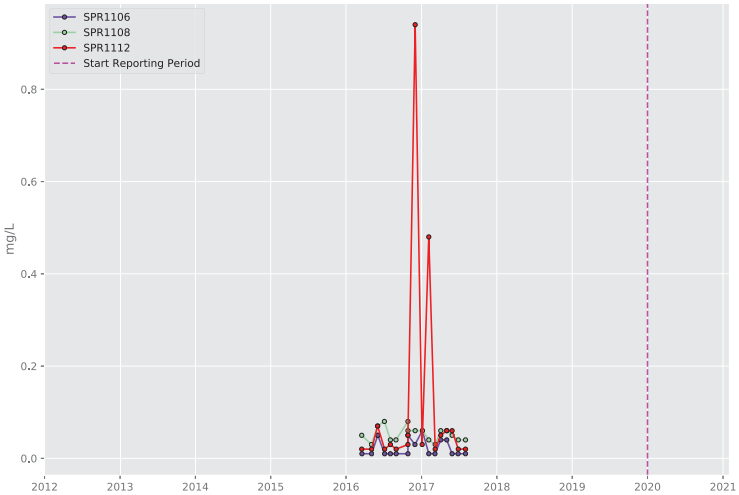
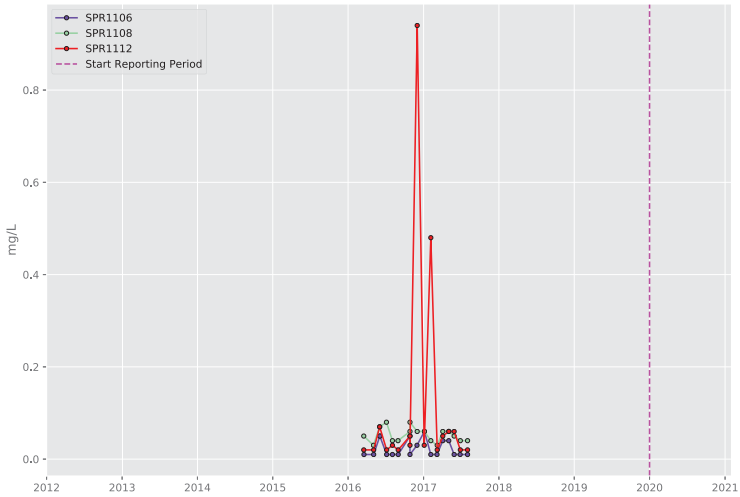


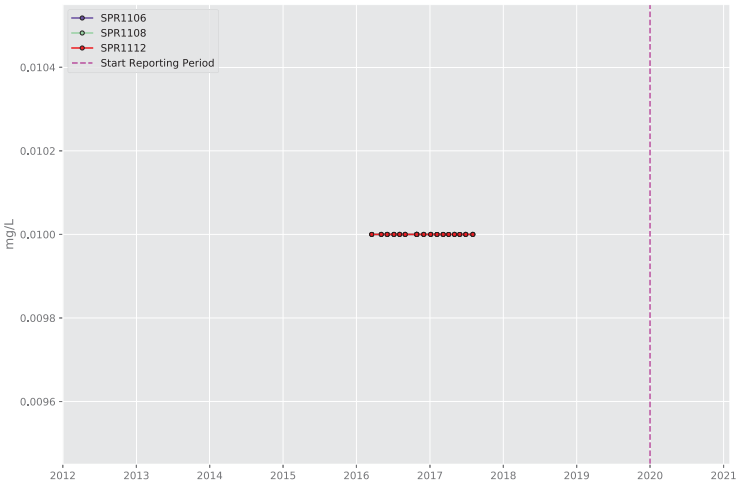
Nitrate & Nitrite (as N)



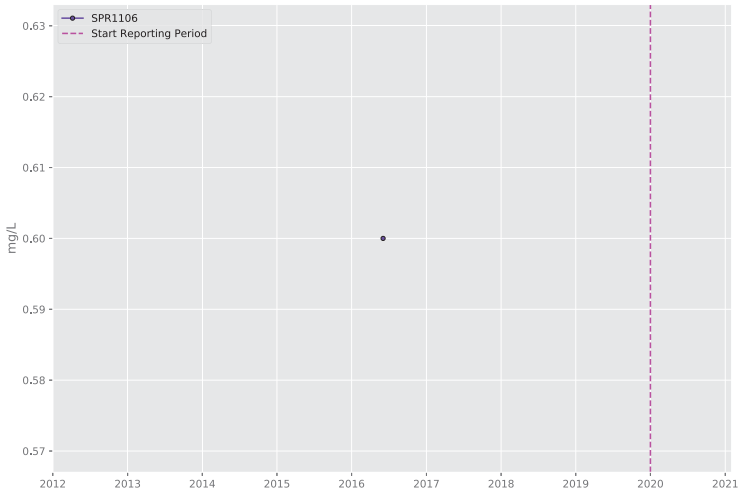
Nitrate (as N)



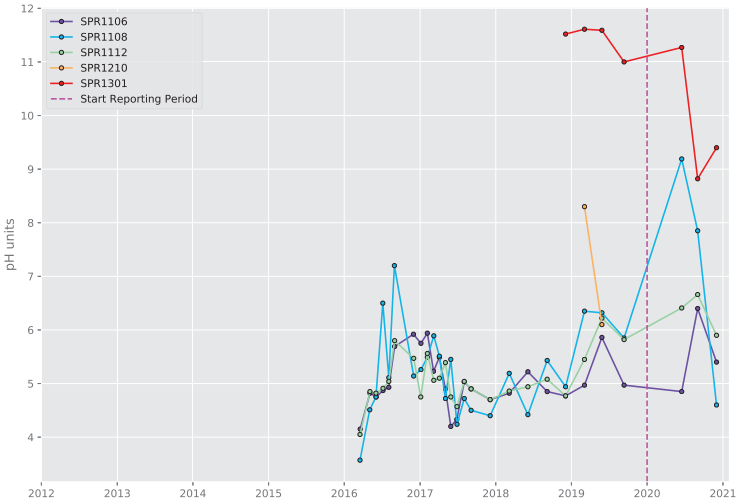
Nitrite (as N)



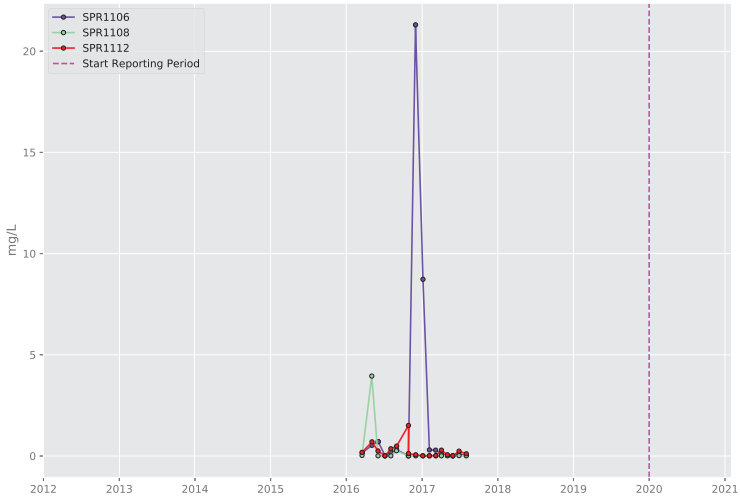
Nitrogen (Total)



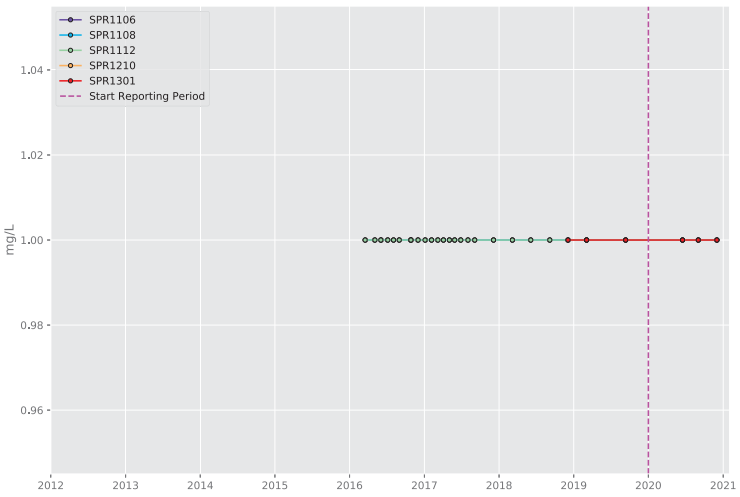
pH_0



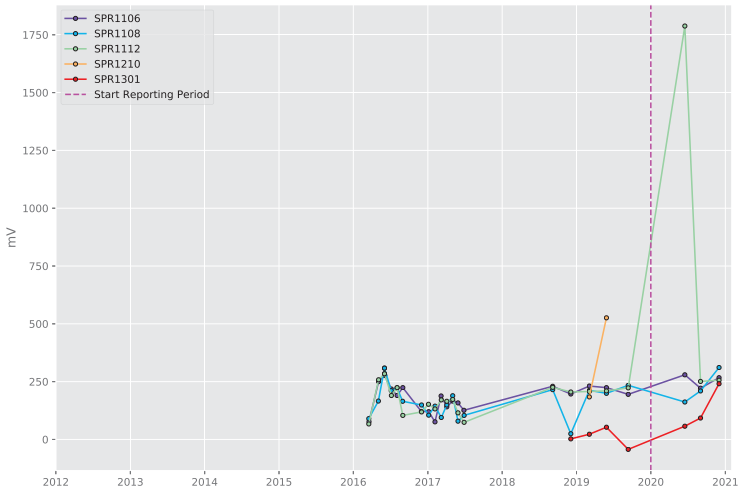
Phosphorus



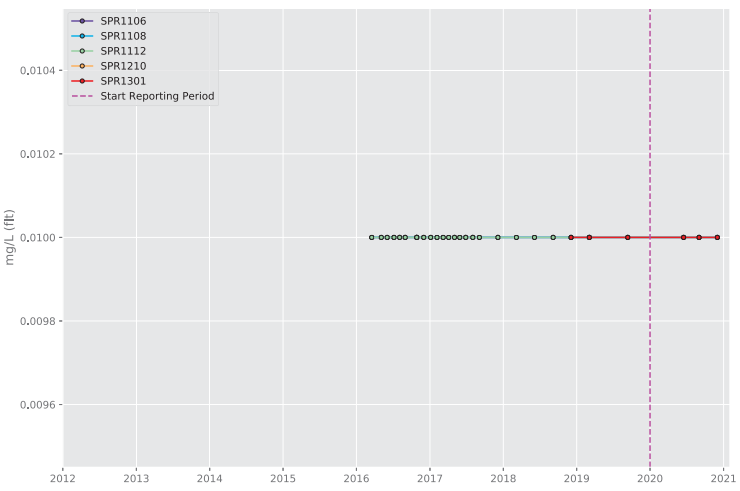
Potassium



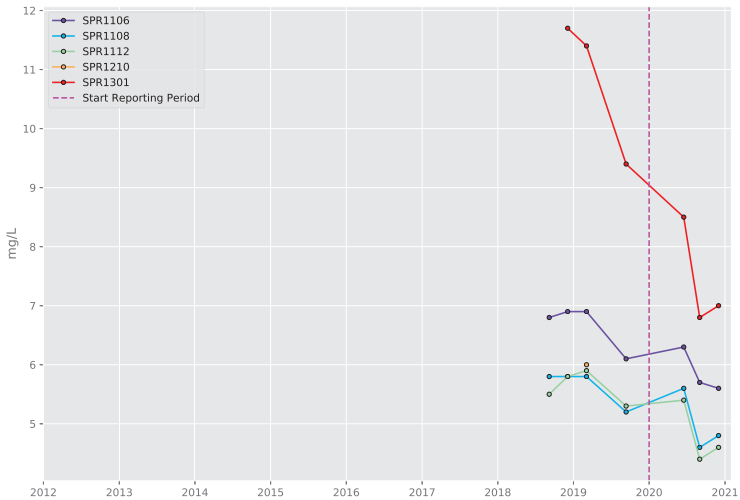
Redox Potential



Selenium



Silicon as SiO2



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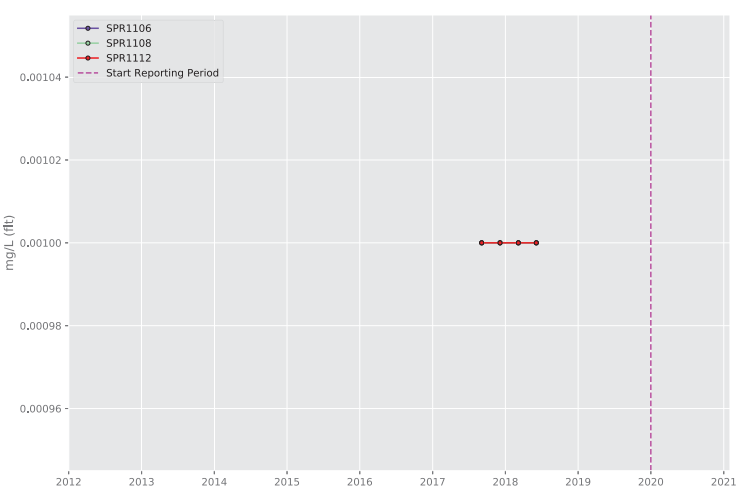
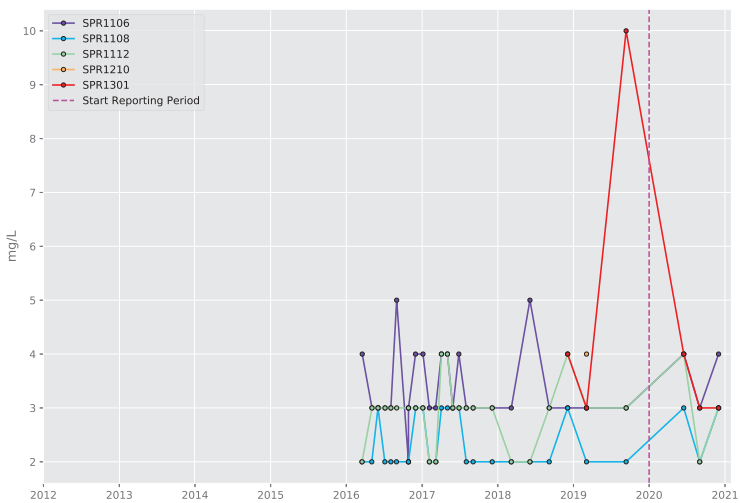
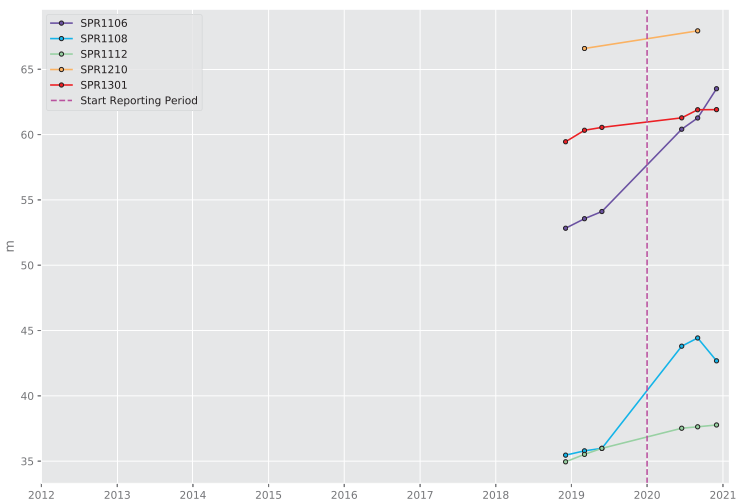


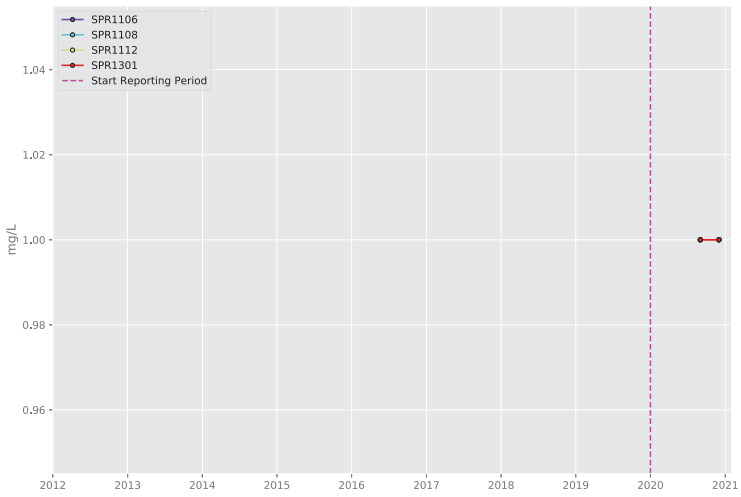
Sodium



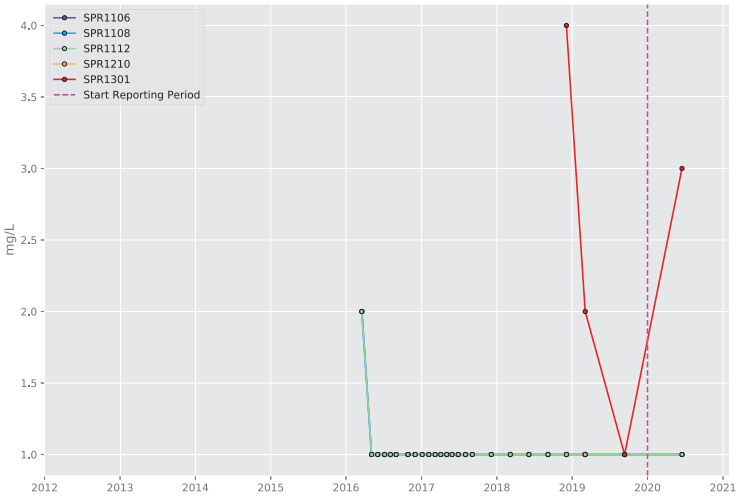
Standing water level



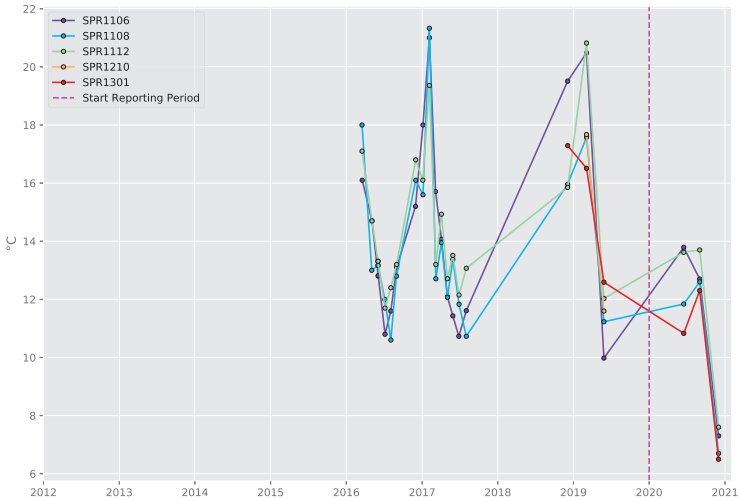
Sulfate as SO4 - Turbidimetric



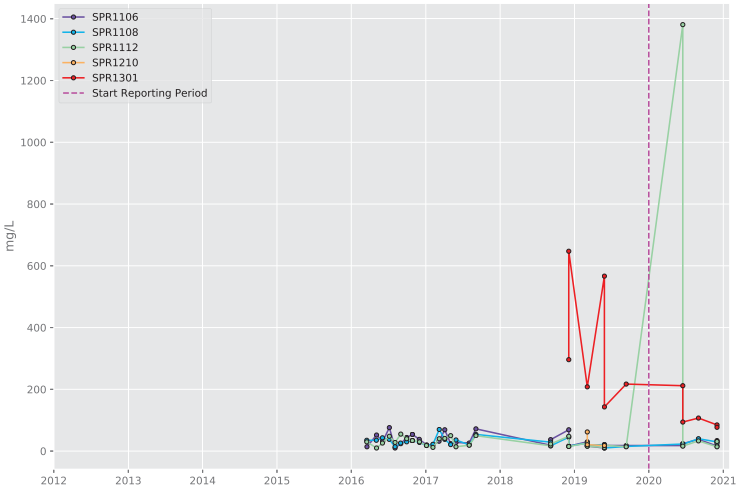
Sulphate



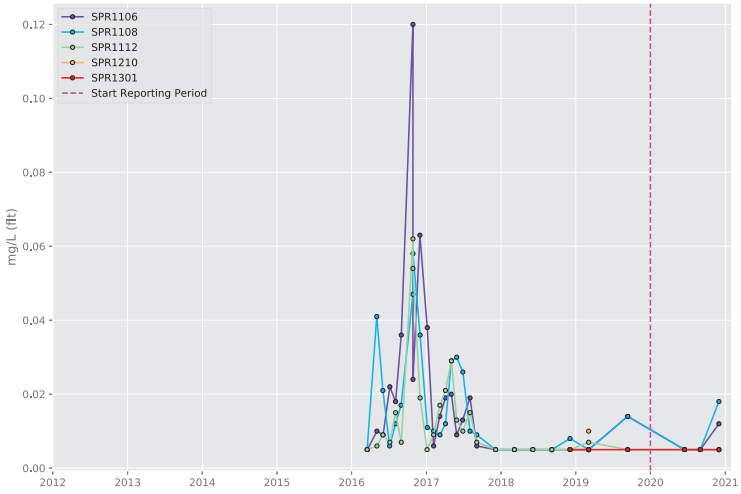
Temp



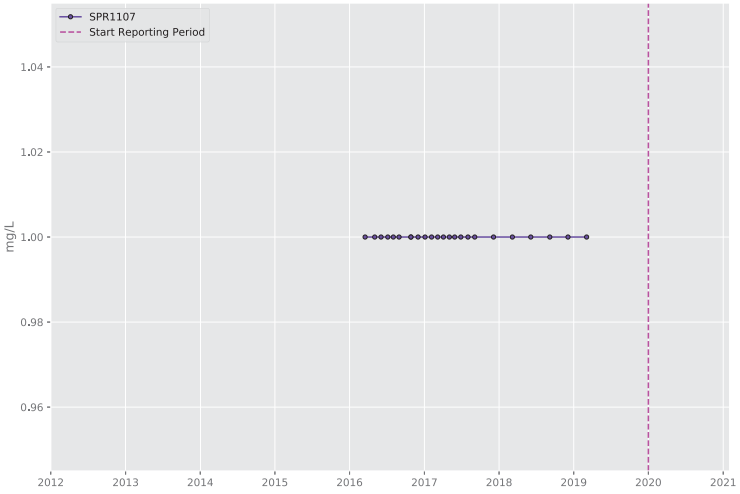
Total Dissolved Solids



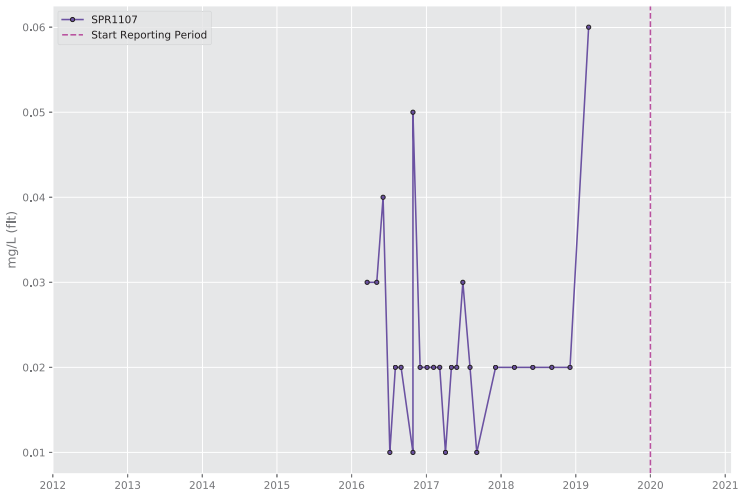
Zinc



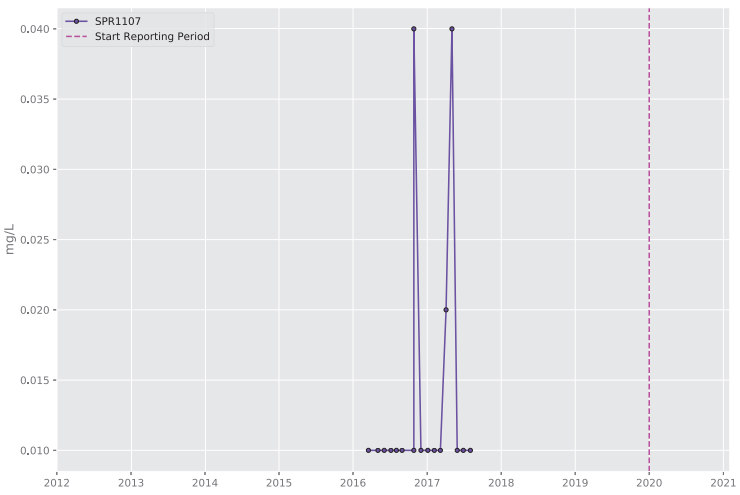
Alkalinity (total) as CaCO3



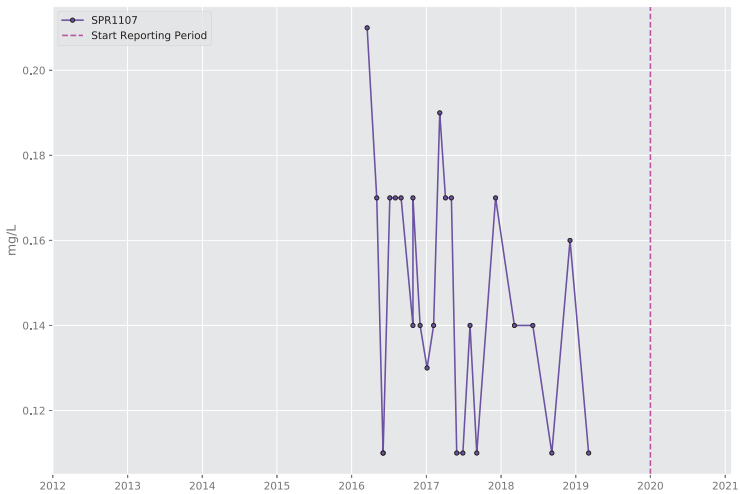
Aluminium



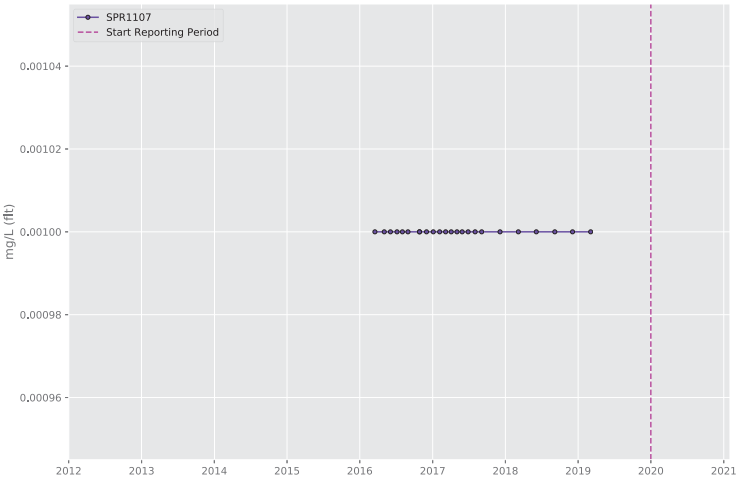
Ammonia as N



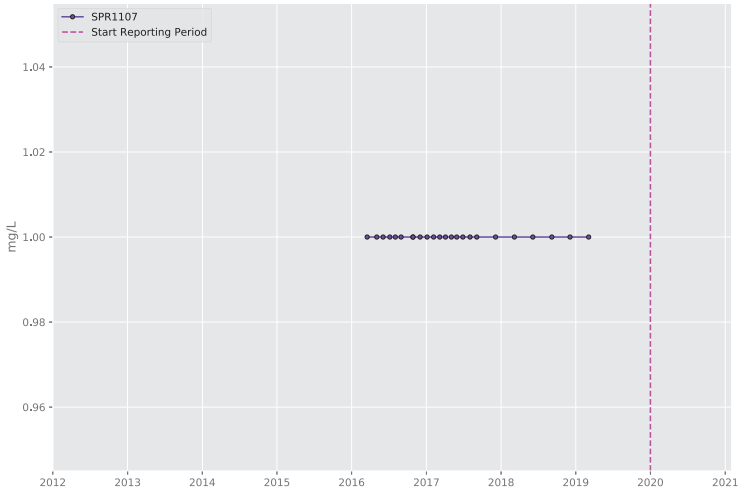
Anions Total



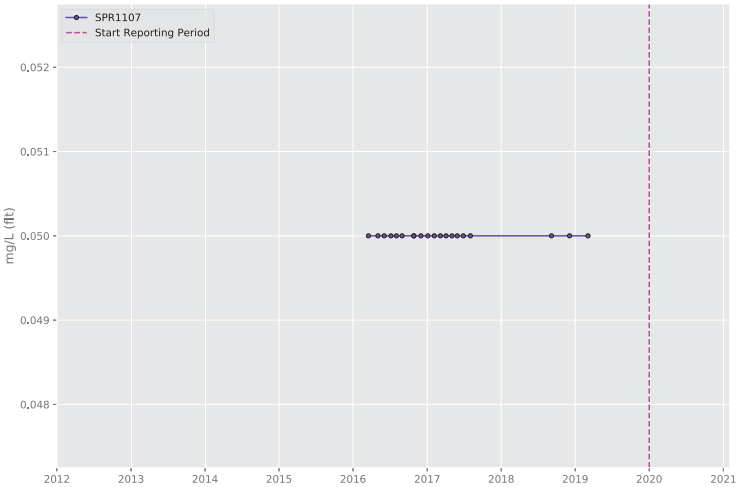
Arsenic



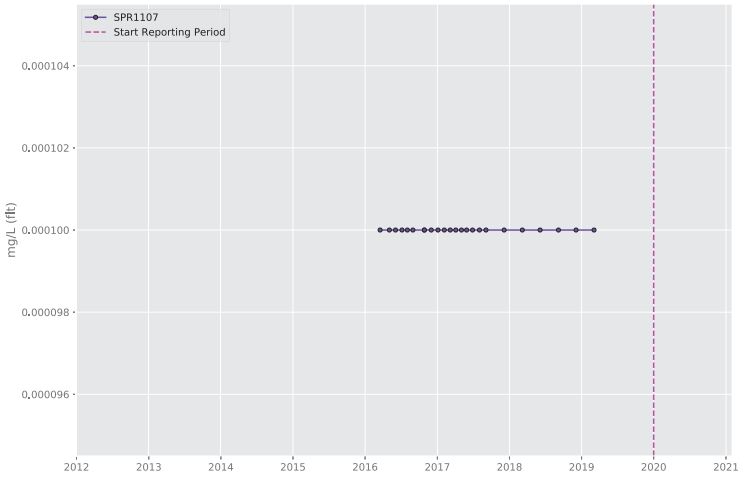
Bicarbonate Alkalinity as CaCO3



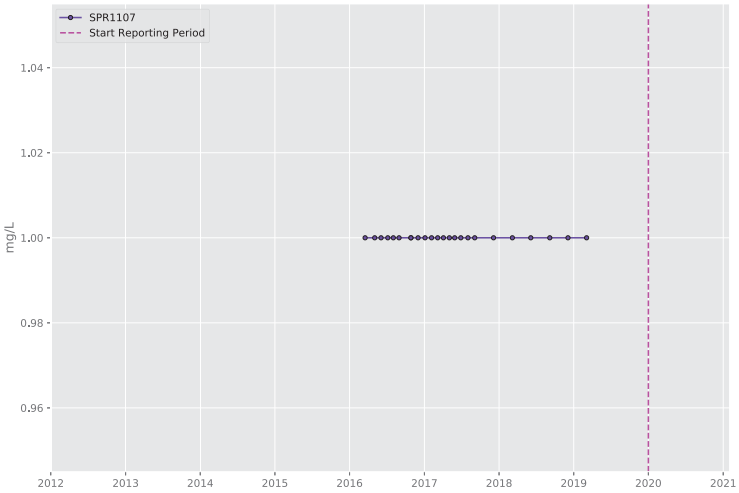
Boron



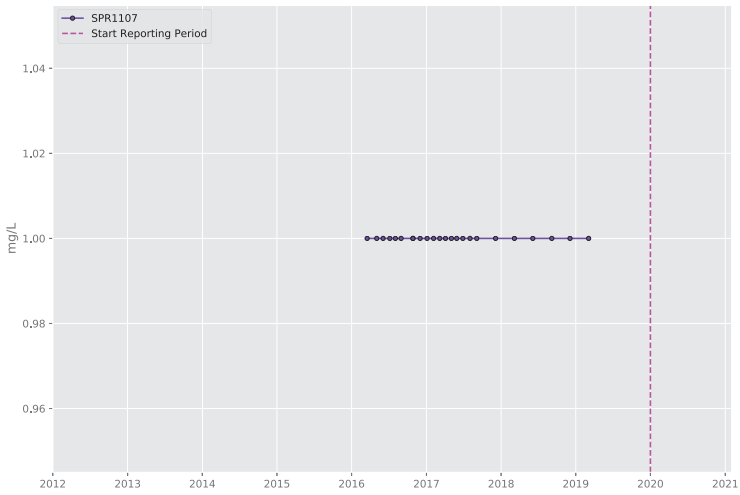
Cadmium



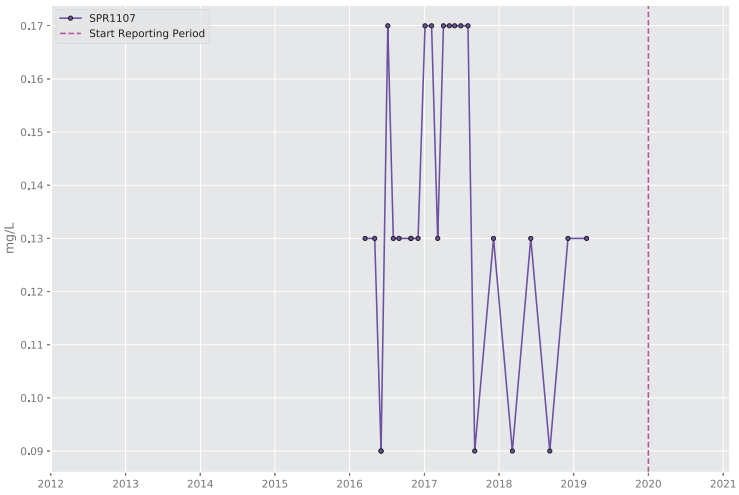
Calcium



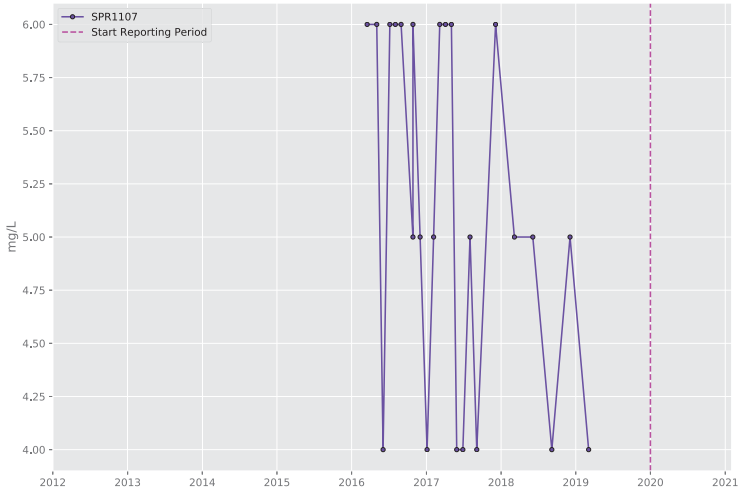
Carbonate



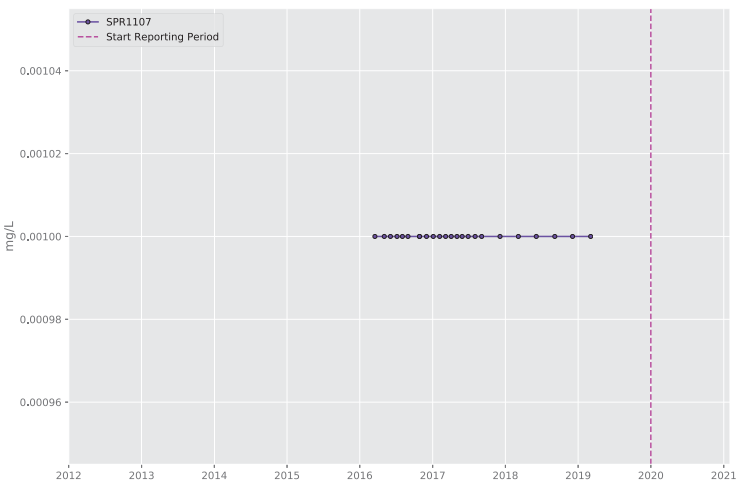
Cations Total



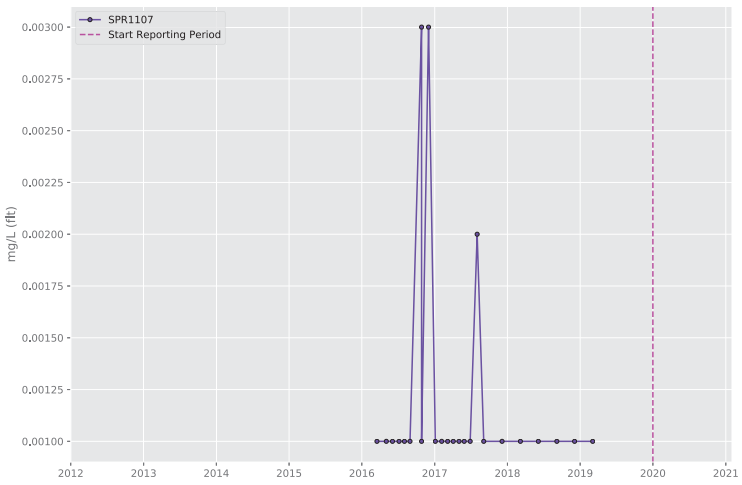
Chloride



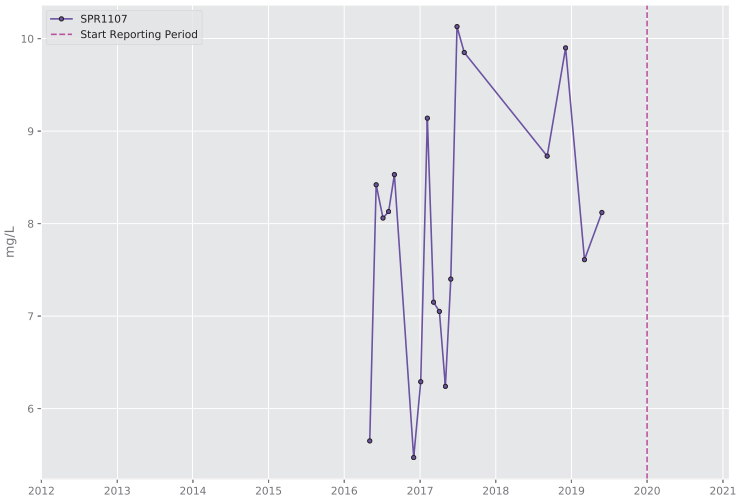
Chromium (soluble)



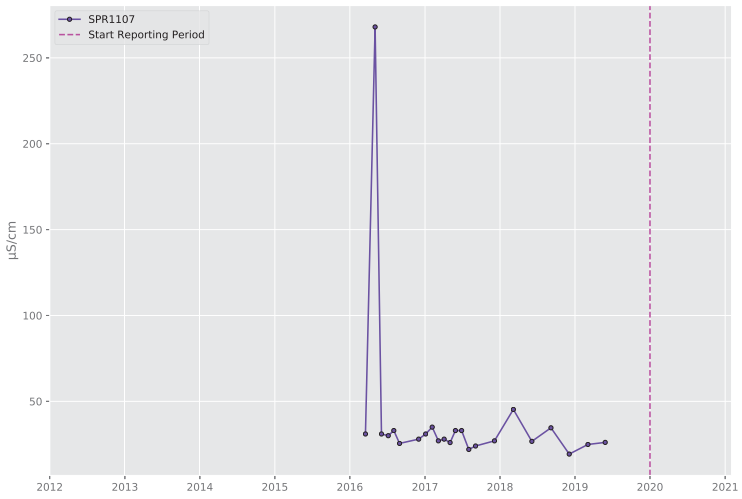
Copper



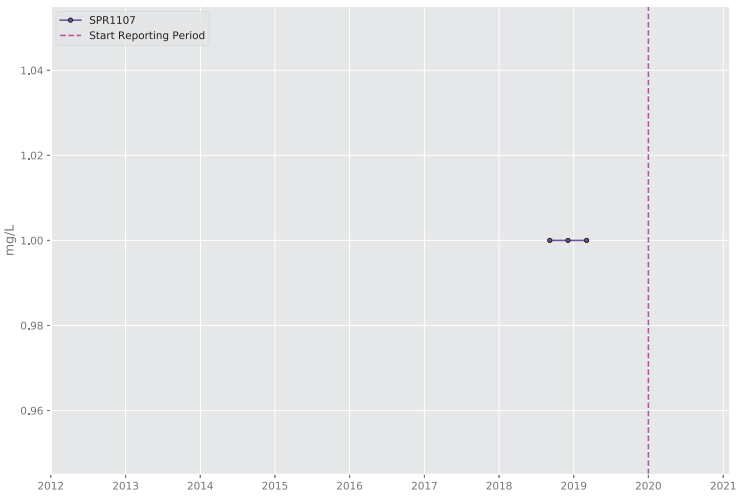
DO (Field)



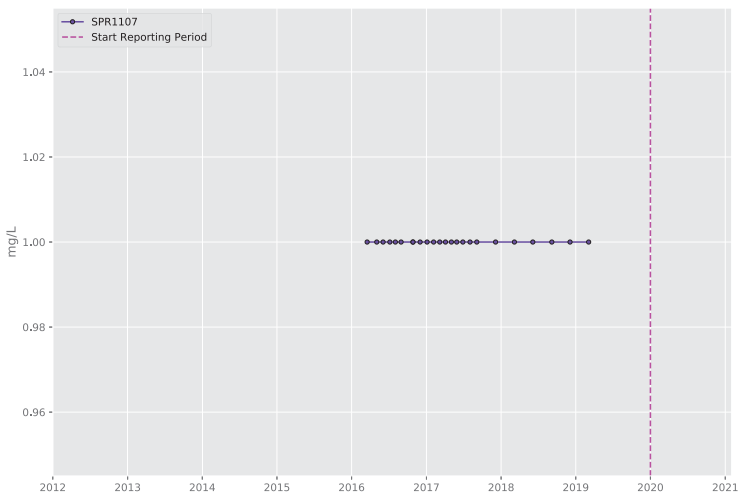
Electrical Conductivity (EC)



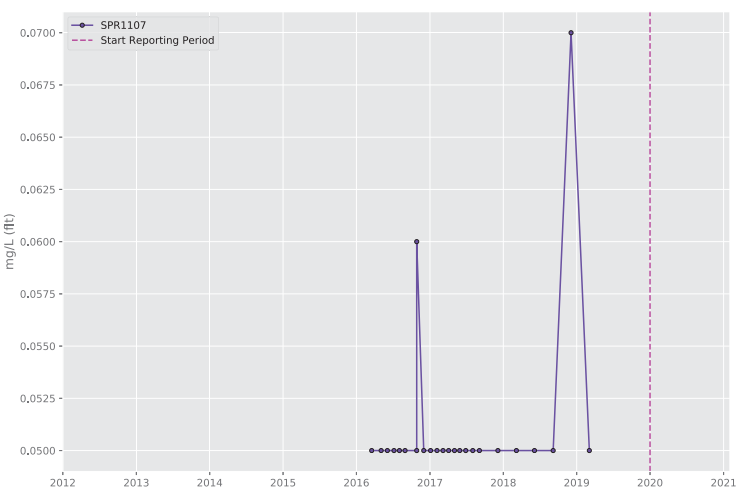
Hardness as CaCO3



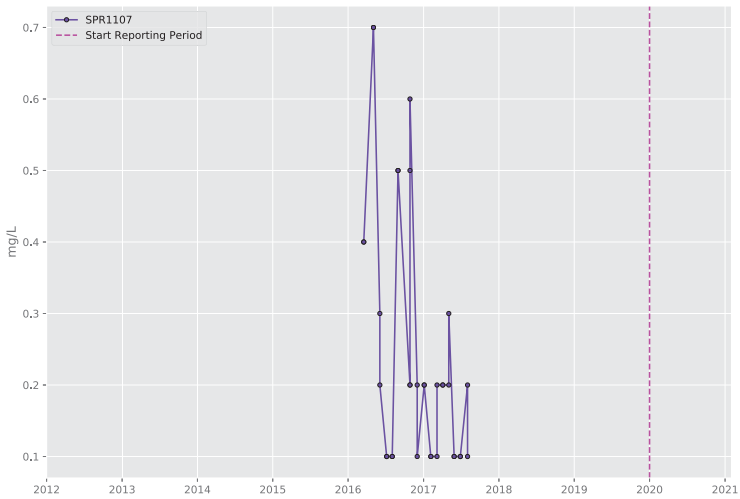
Hydroxide as CaCO3



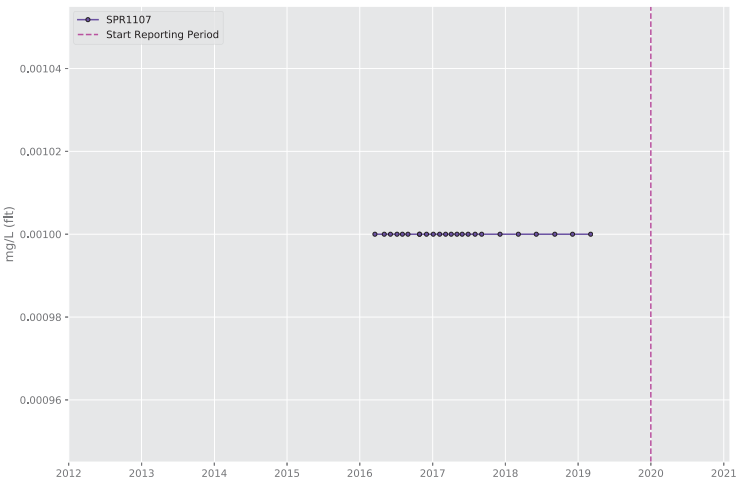
Iron



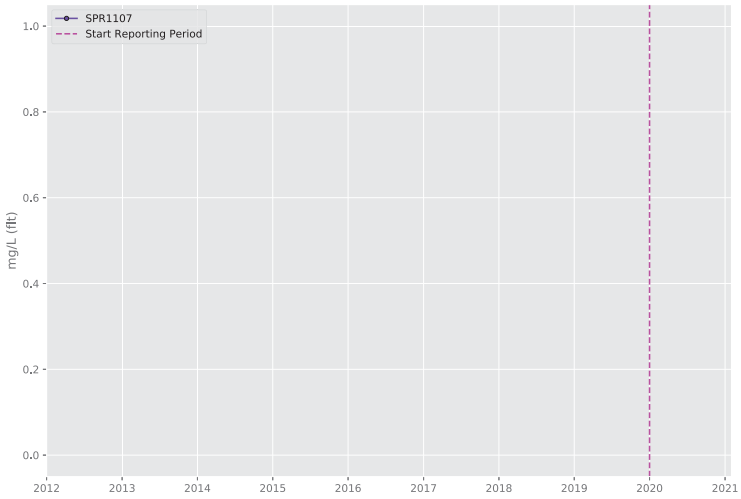
Kjeldahl Nitrogen Total



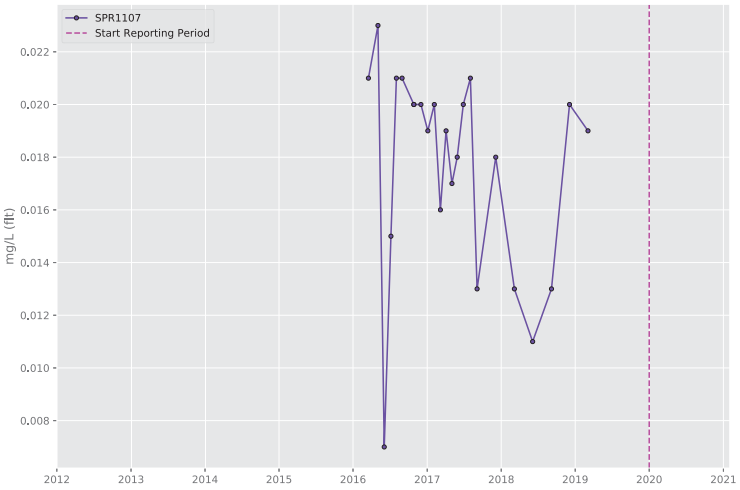
Lead



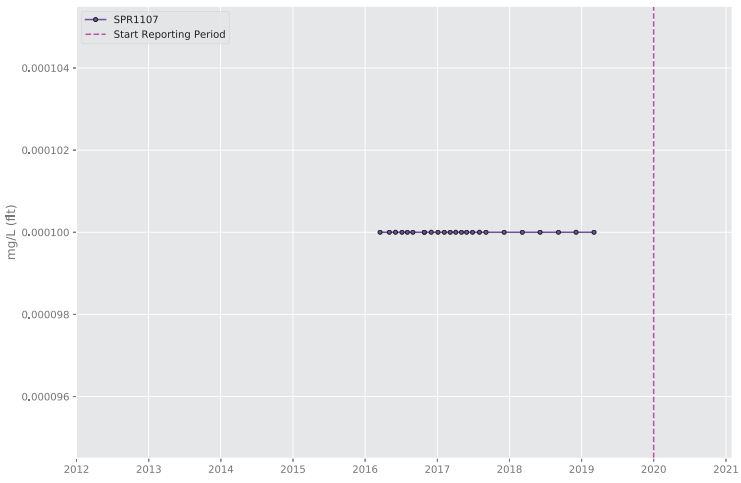
Magnesium



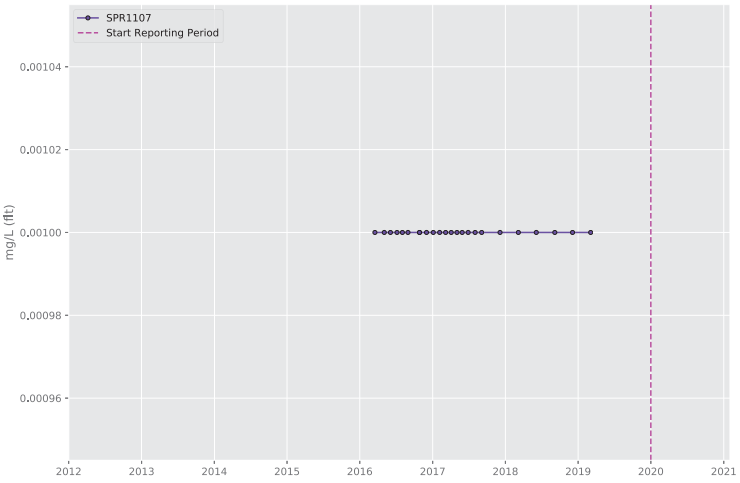
Manganese



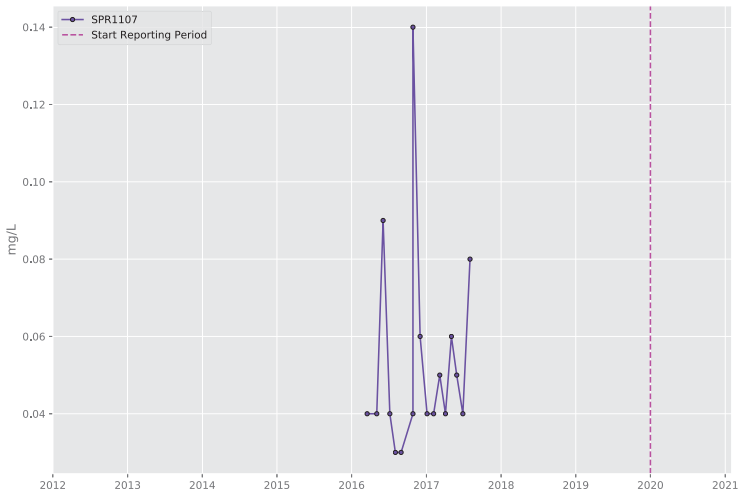
Mercury



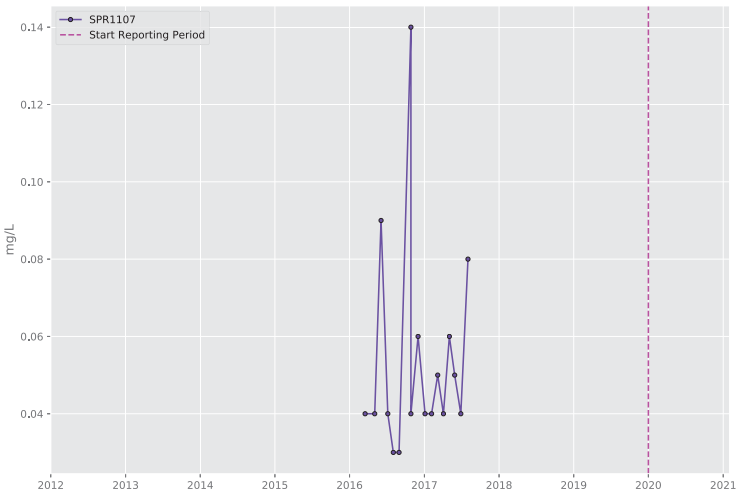
Nickel



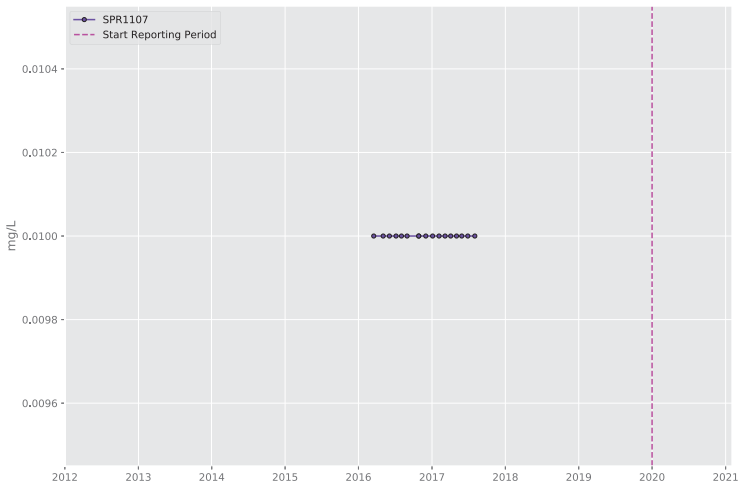
Nitrate & Nitrite (as N)



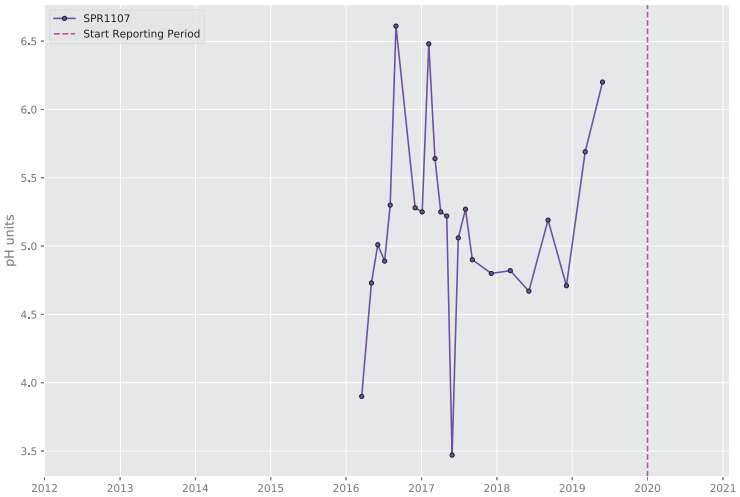
Nitrate (as N)



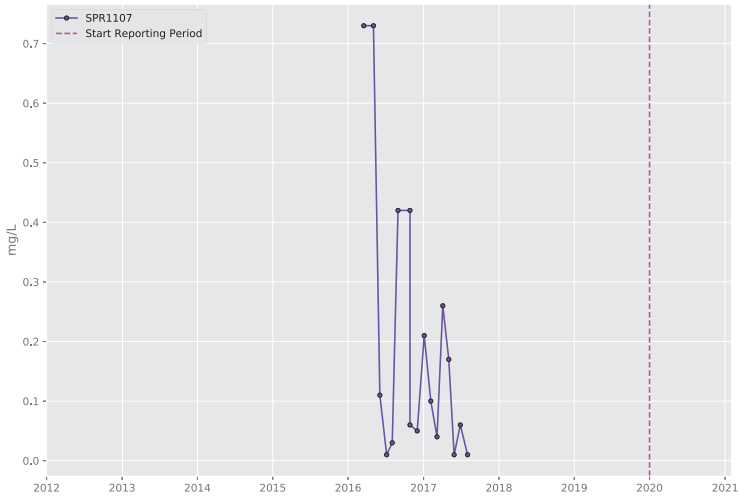
Nitrite (as N)



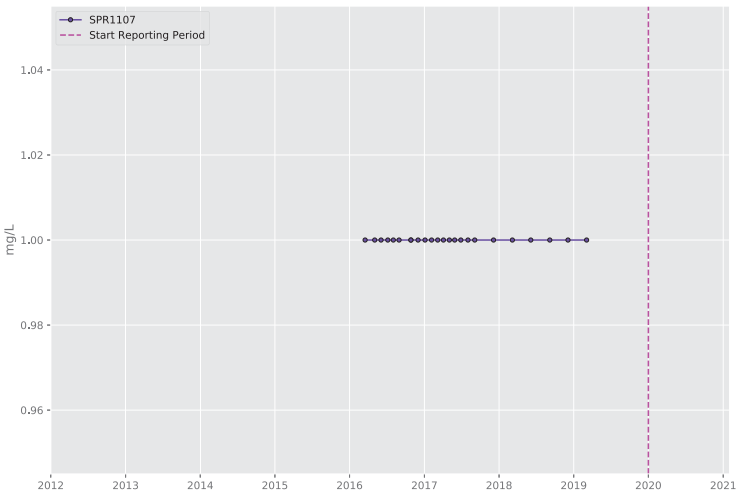
pH_0



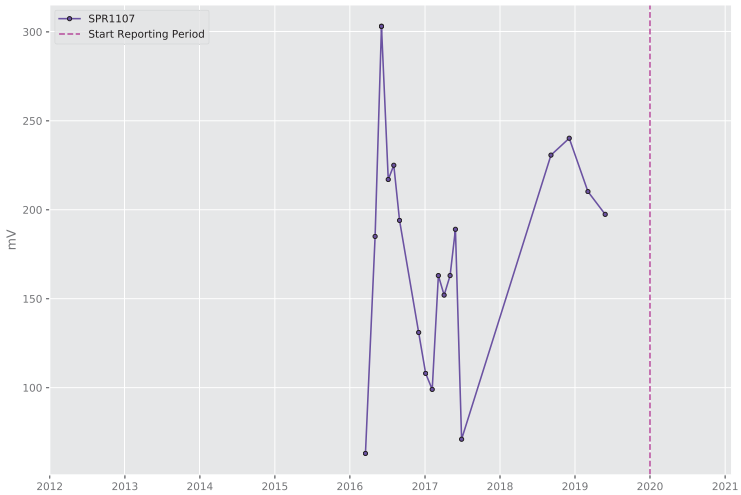
Phosphorus



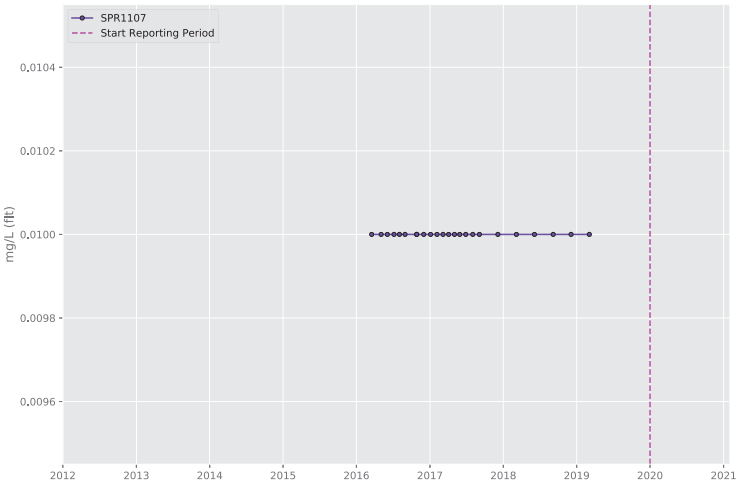
Potassium



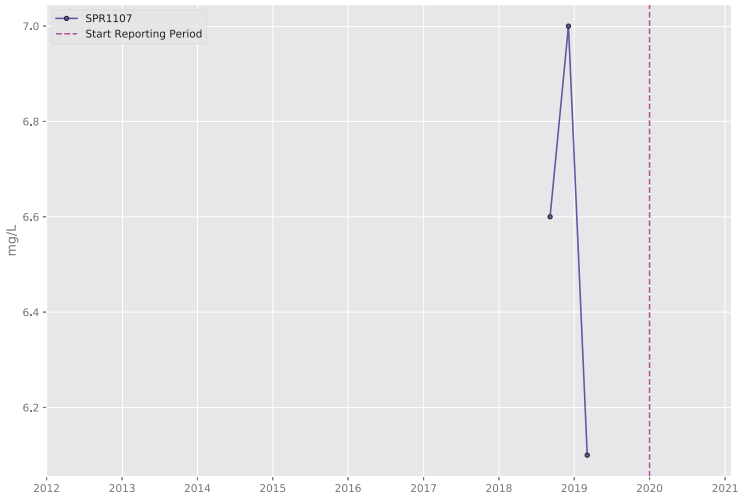
Redox Potential



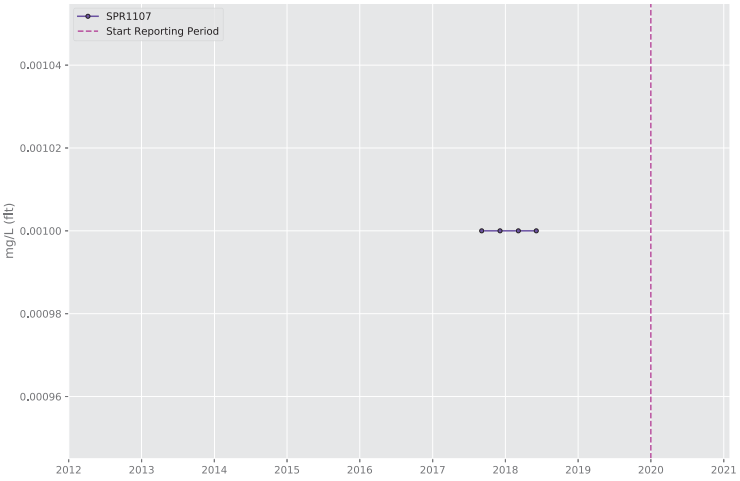
Selenium



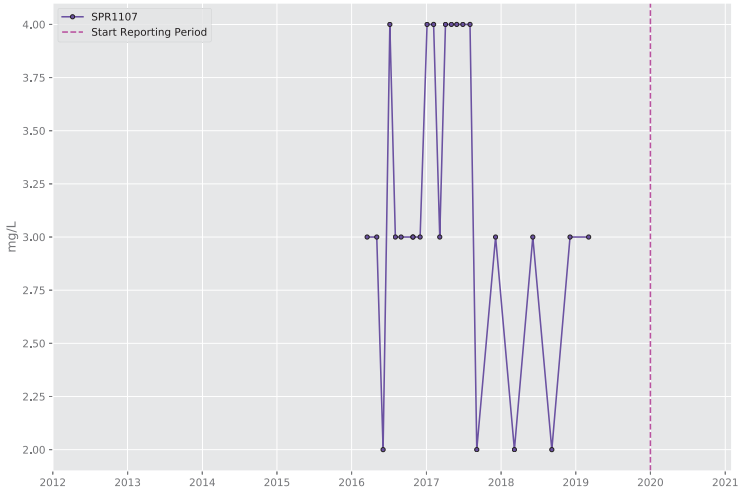
Silicon as SiO2



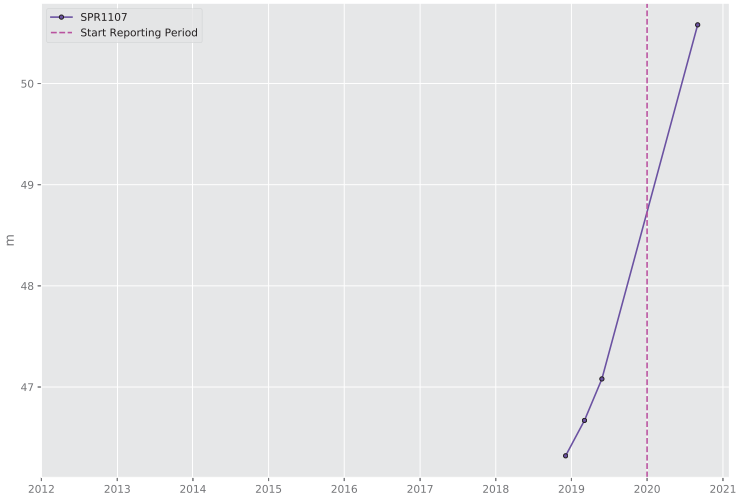
Silver



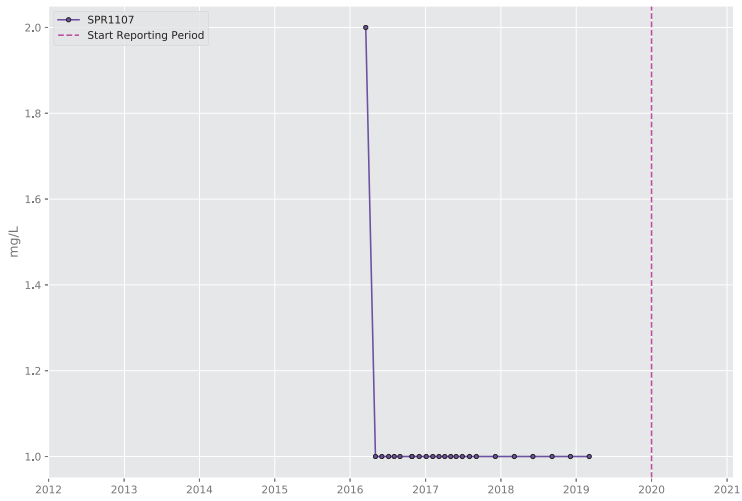
Sodium



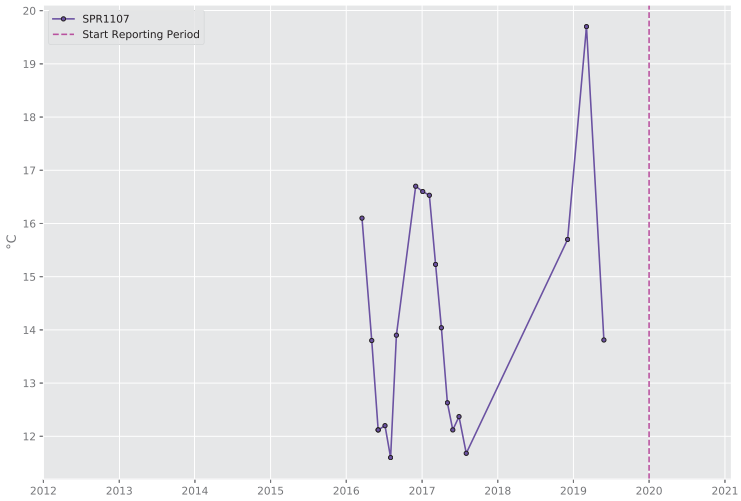
Standing water level



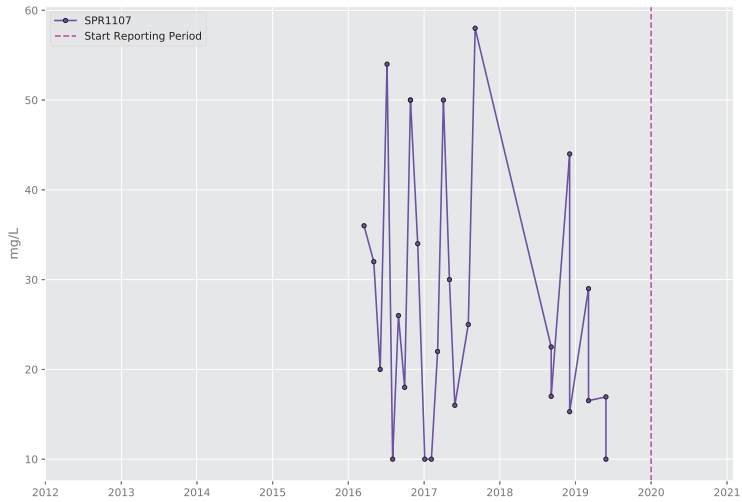
Sulphate



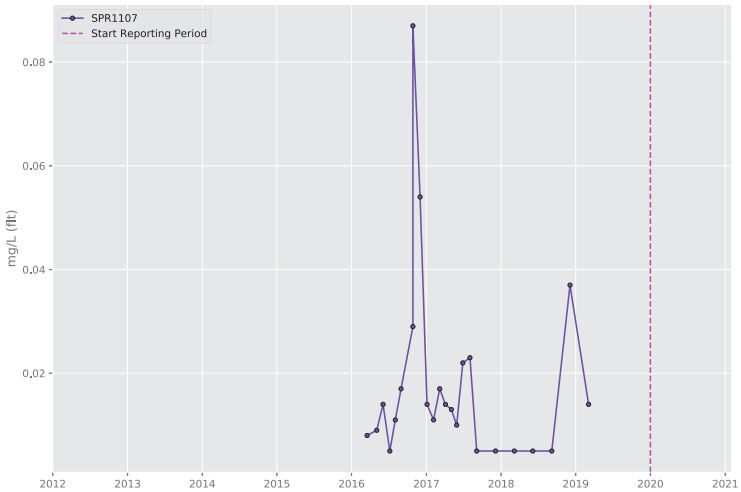
Temp



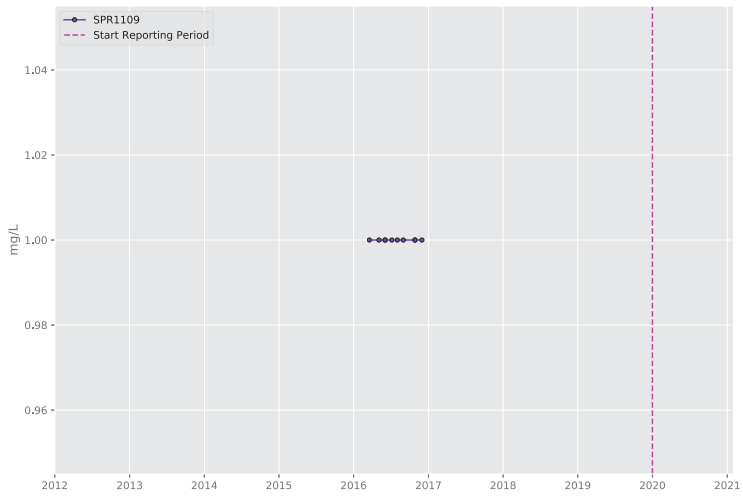
Total Dissolved Solids



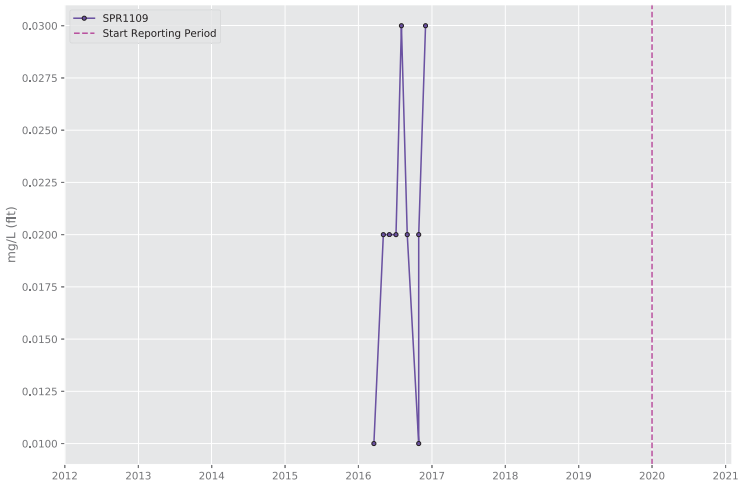
Zinc



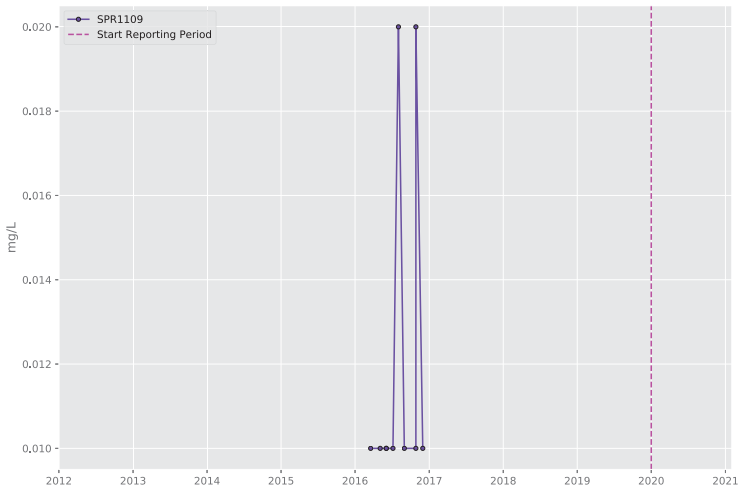
Alkalinity (total) as CaCO3



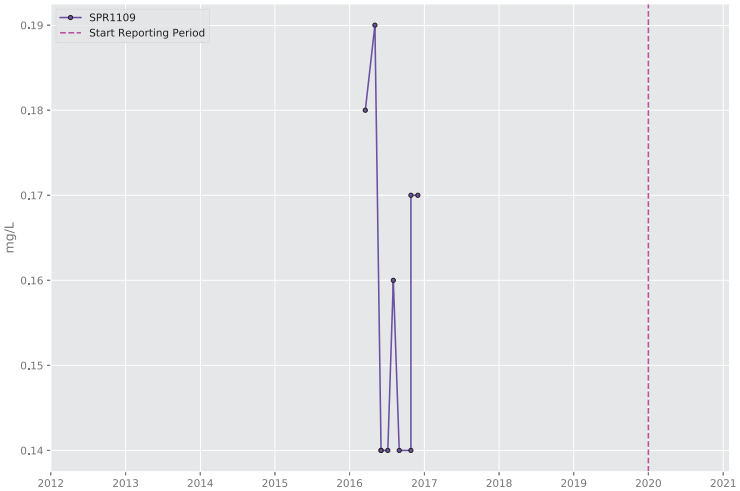
Aluminium



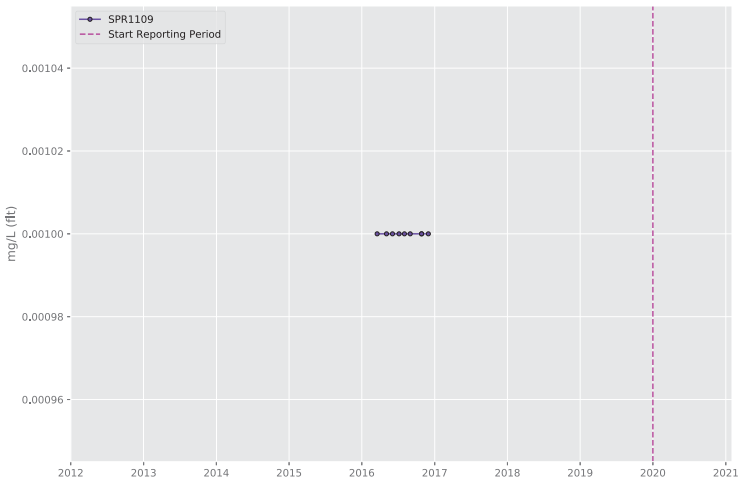
Ammonia as N



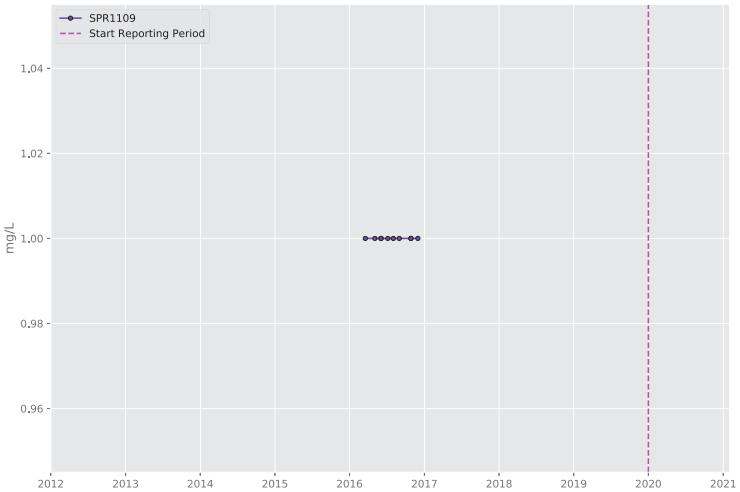
Anions Total



Arsenic



Bicarbonate Alkalinity as CaCO3



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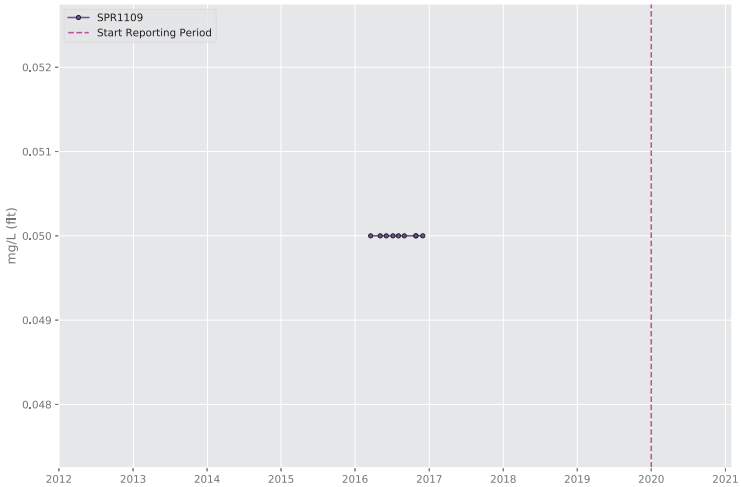
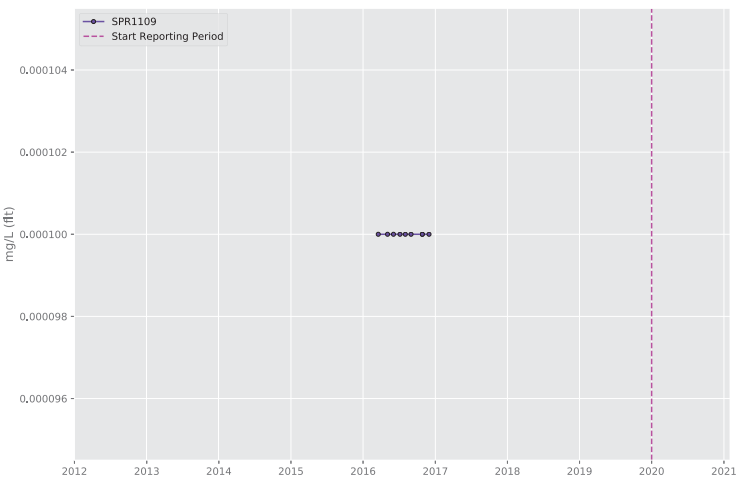
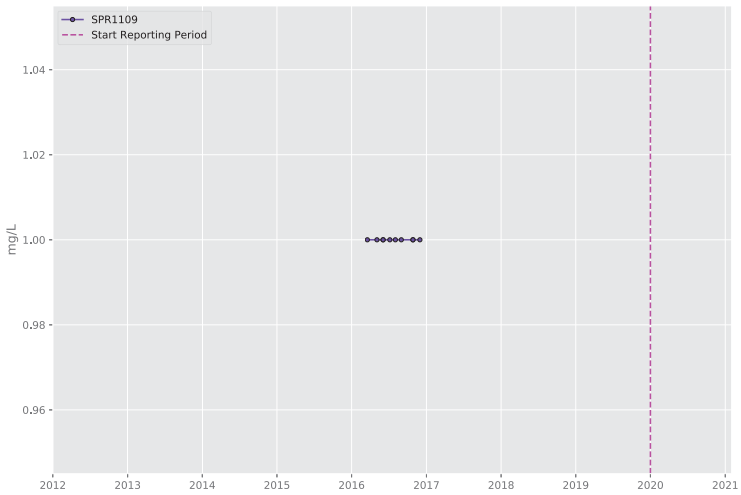


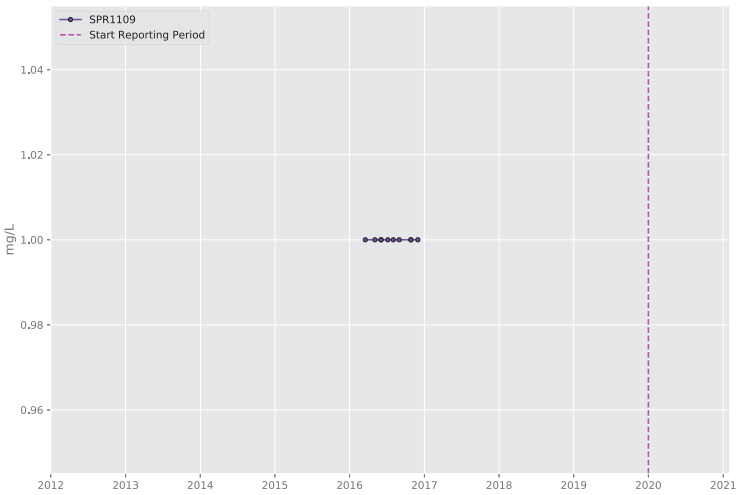
Cadmium



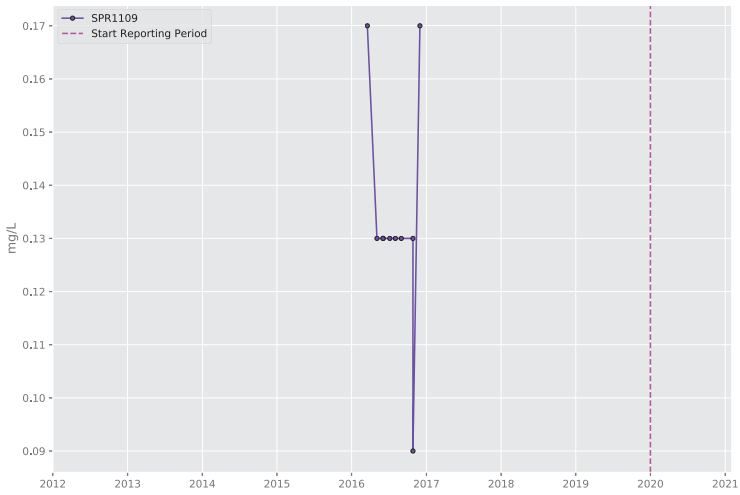
Calcium



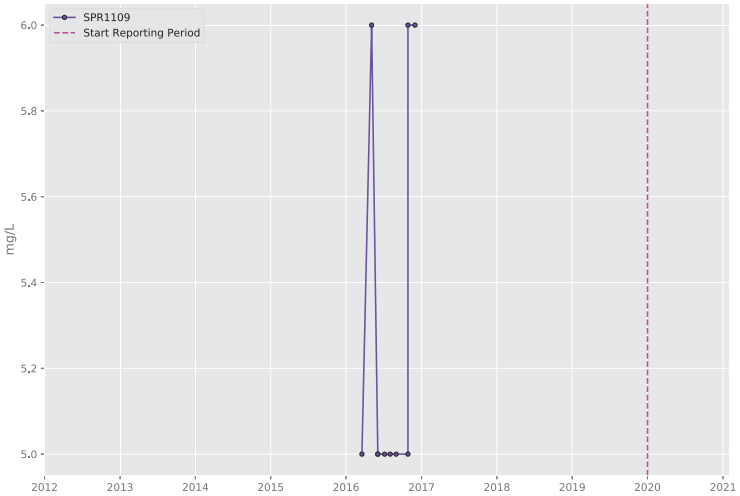
Carbonate



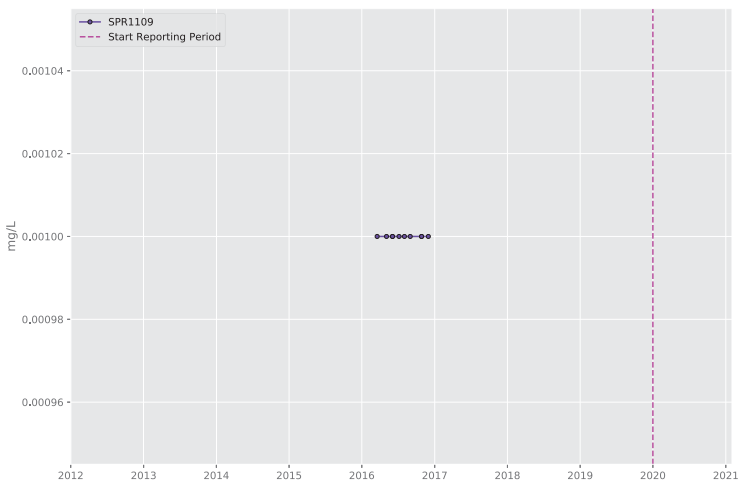
Cations Total



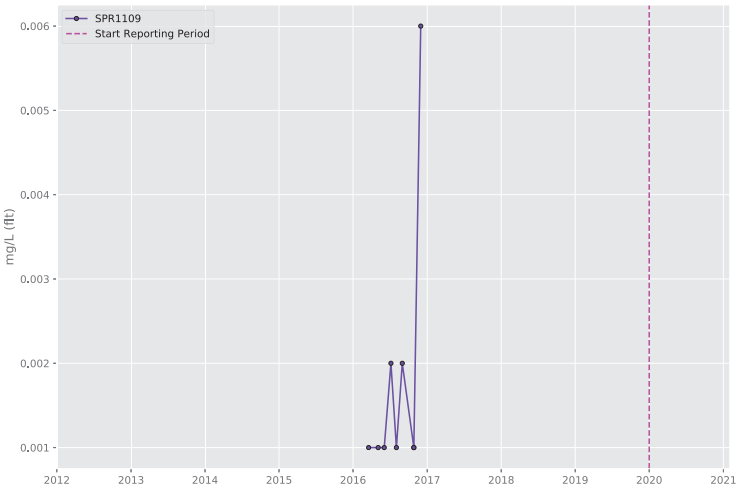
Chloride



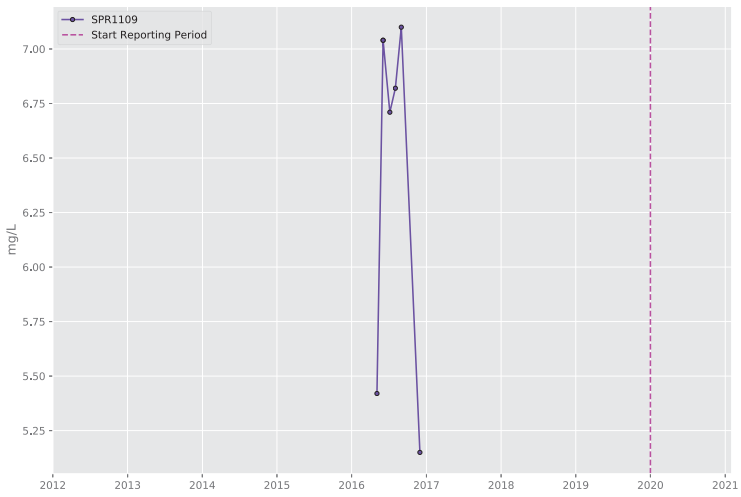
Chromium (soluble)



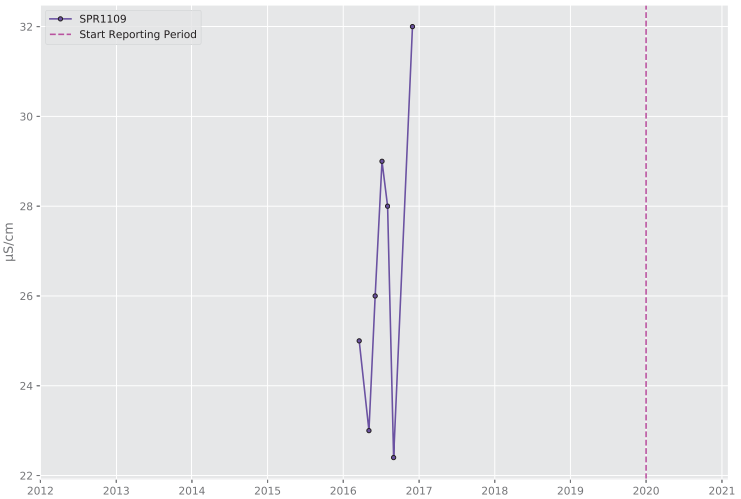
Copper



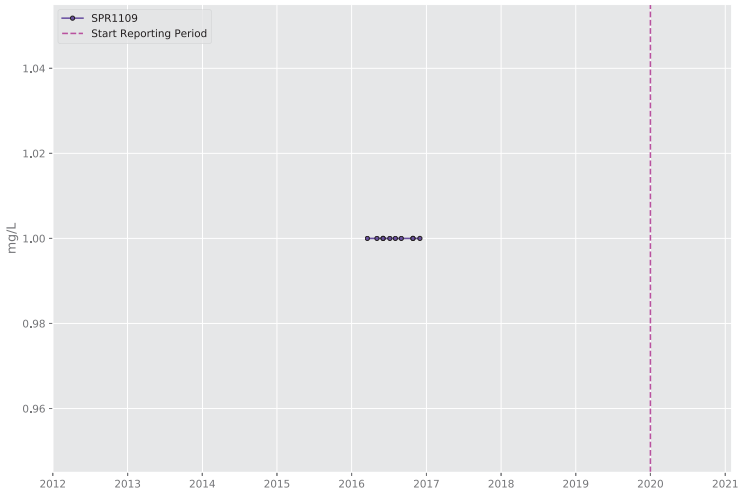
DO (Field)



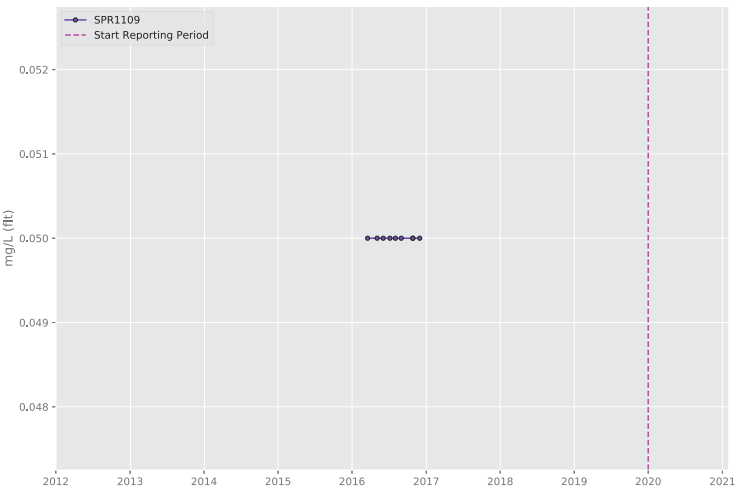
Electrical Conductivity (EC)



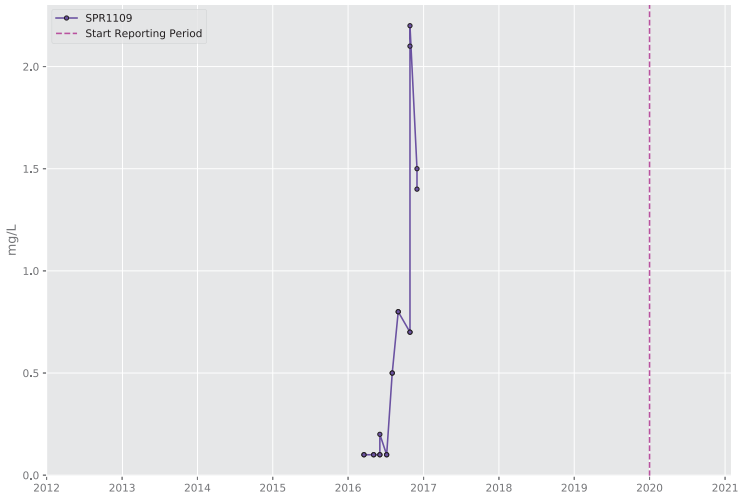
Hydroxide as CaCO3



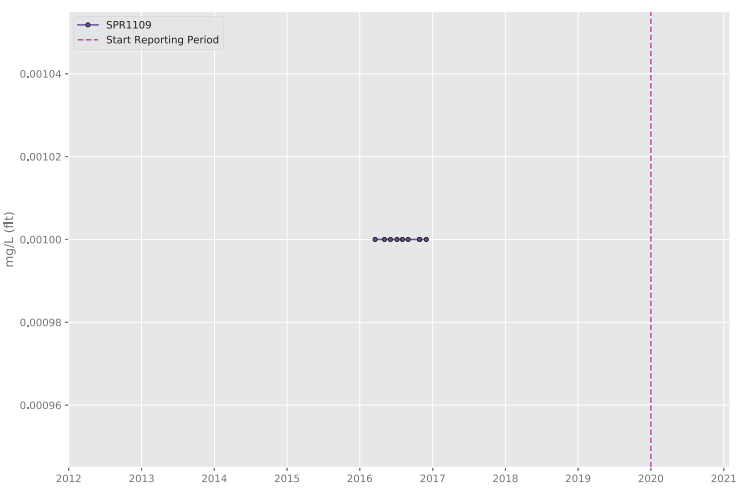
Iron



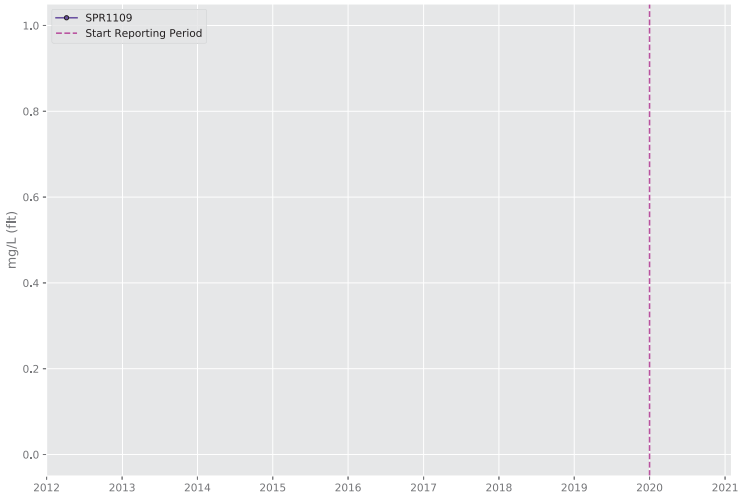
Kjeldahl Nitrogen Total



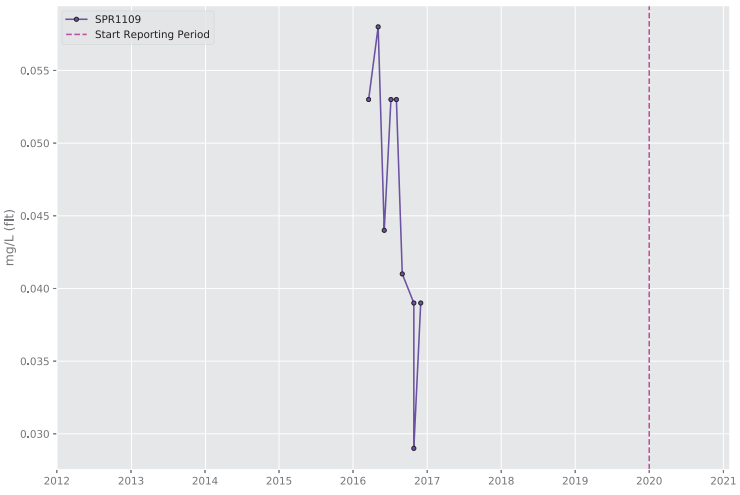
Lead



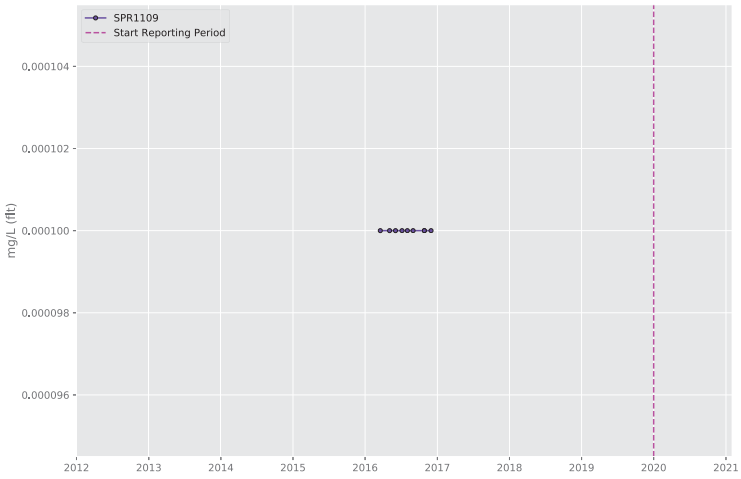
Magnesium



Manganese



Mercury



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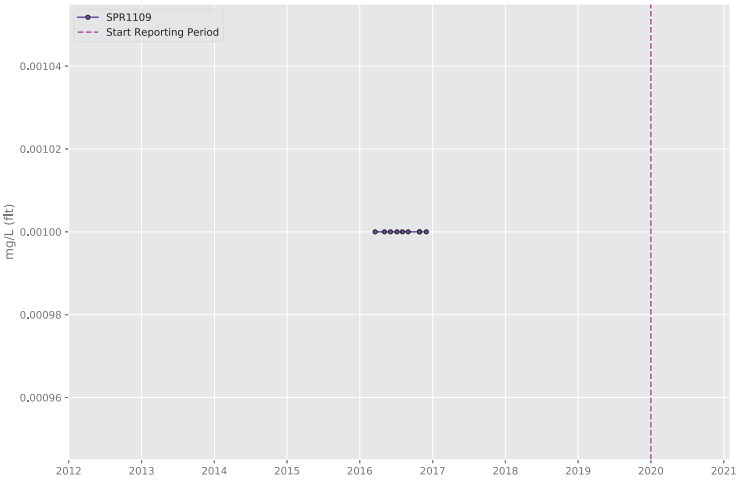
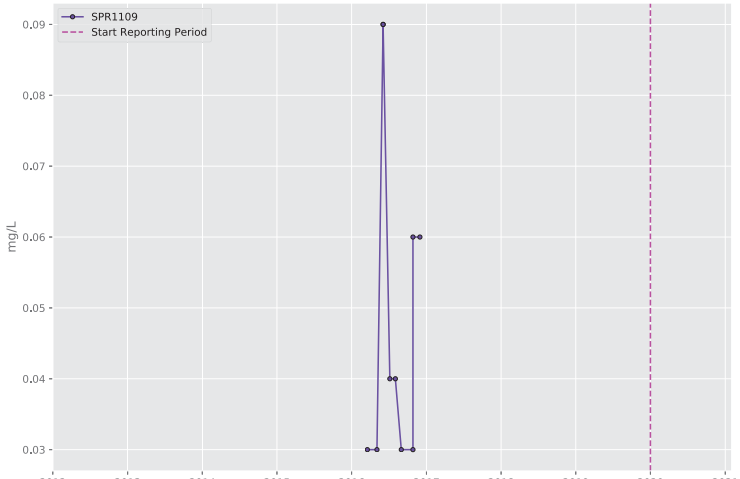
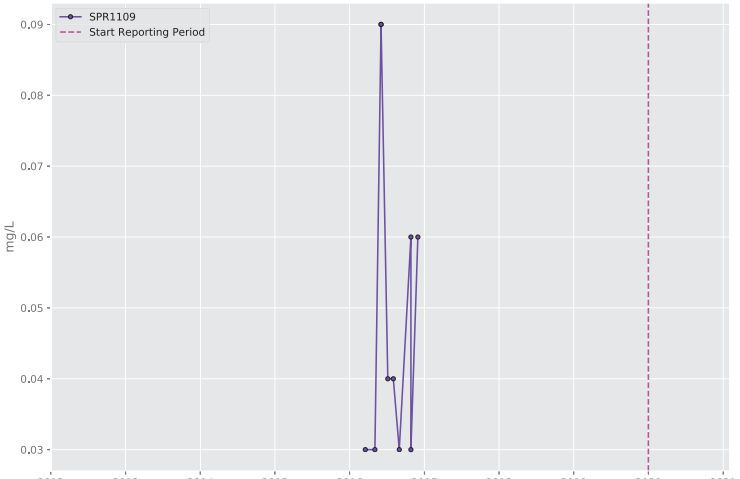


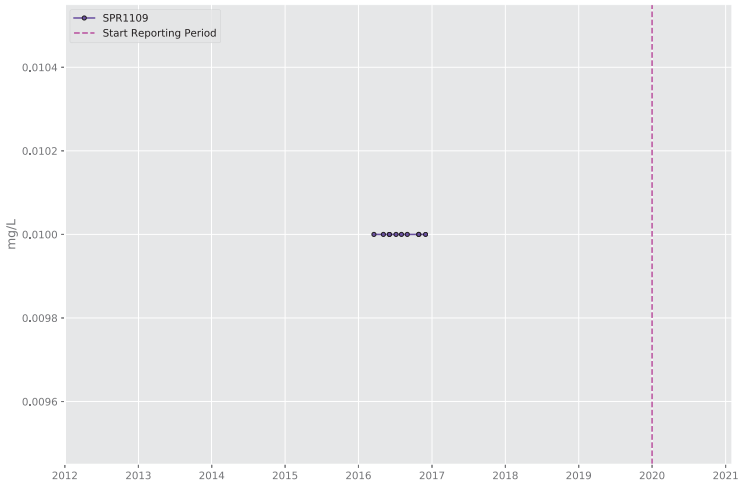
Nitrate & Nitrite (as N)



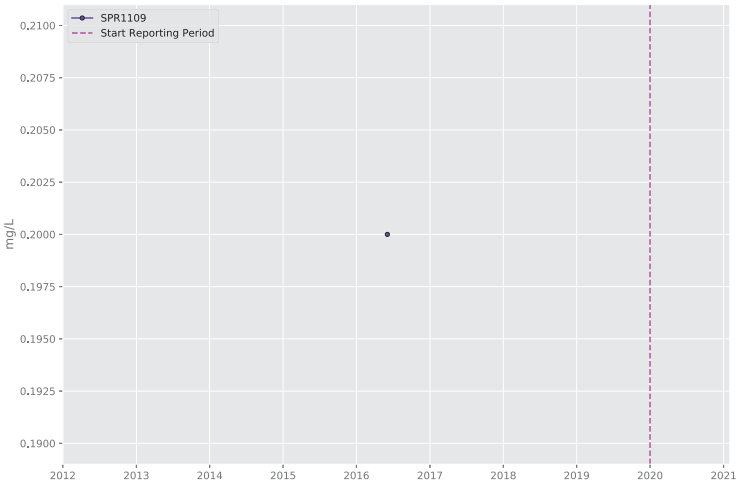
Nitrate (as N)



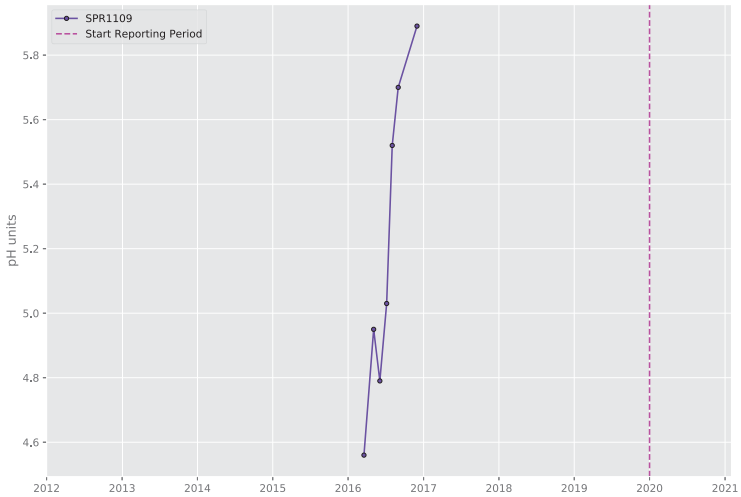
Nitrite (as N)



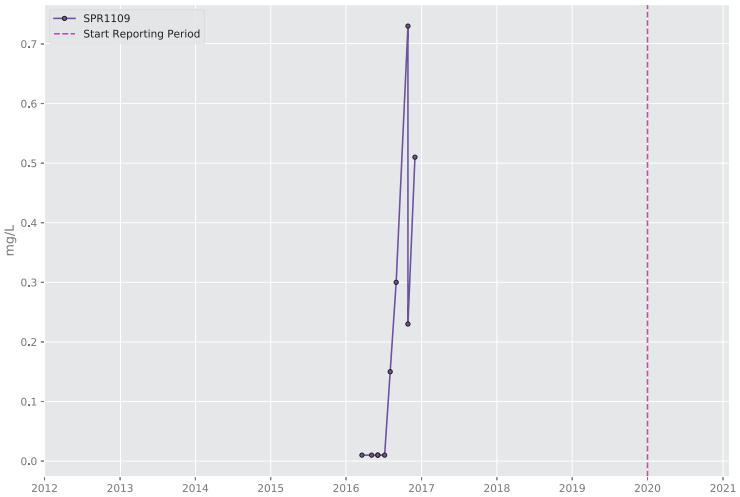
Nitrogen (Total)



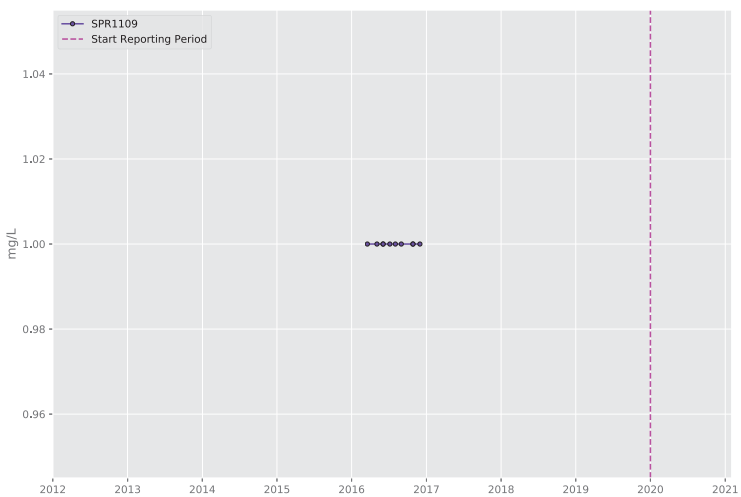
pH_0



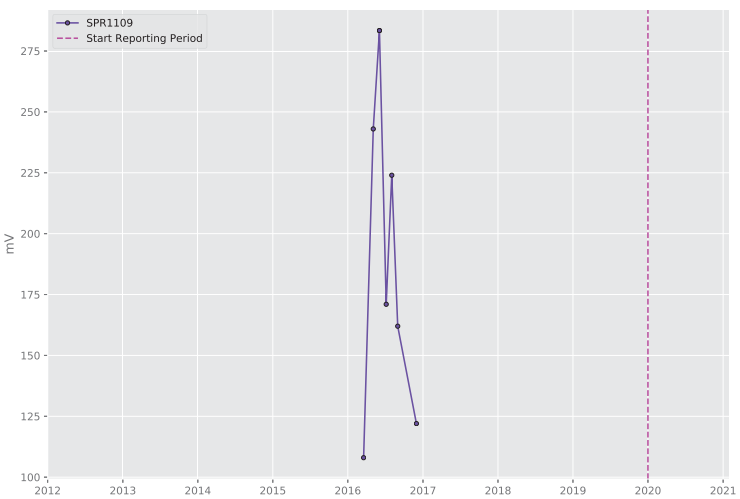
Phosphorus



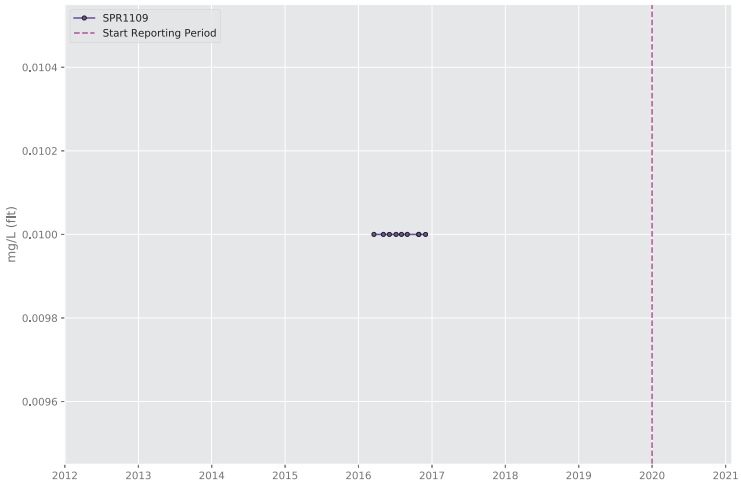
Potassium



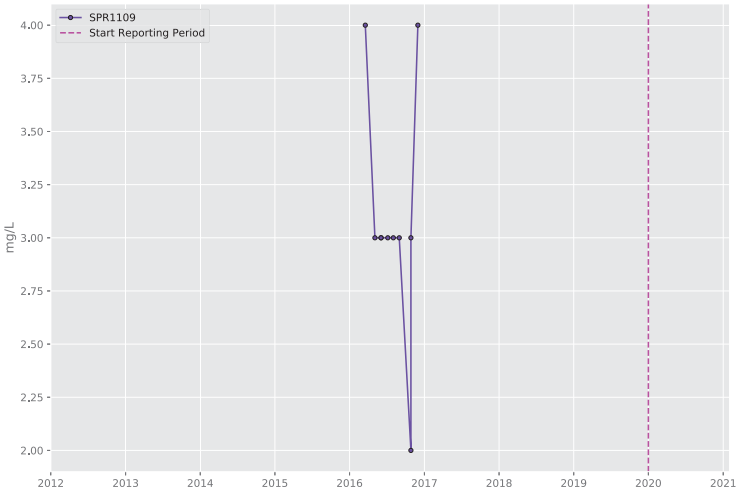
Redox Potential



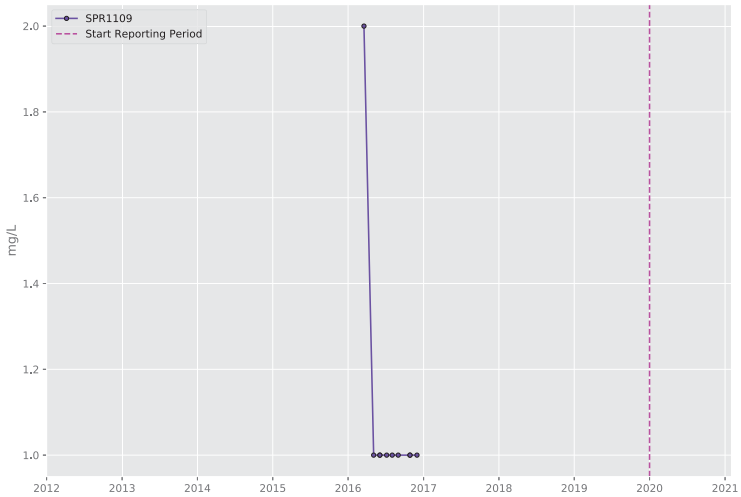
Selenium



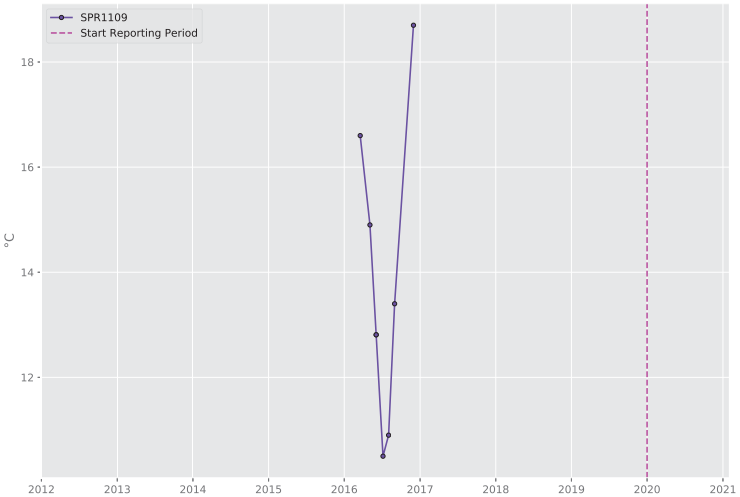
Sodium



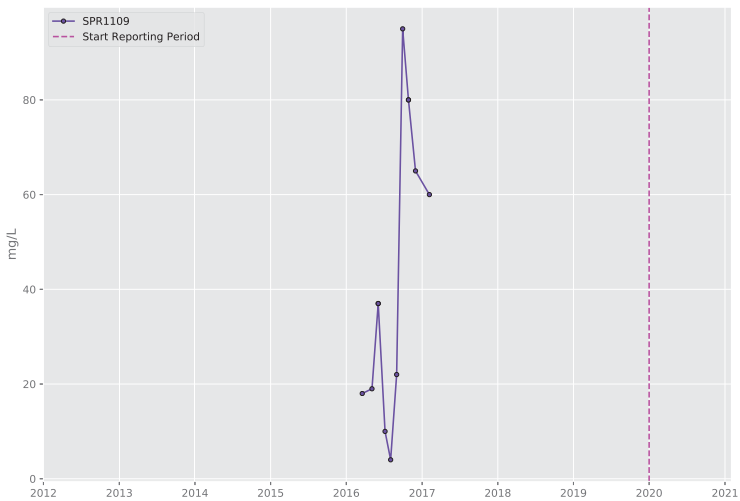
Sulphate



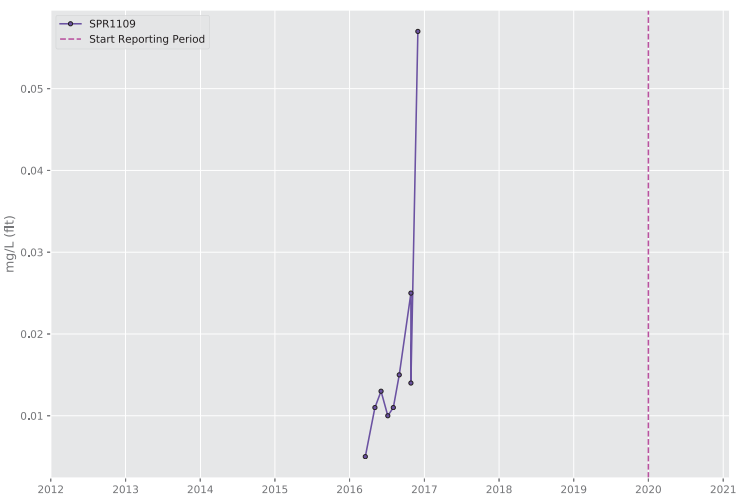
Temp



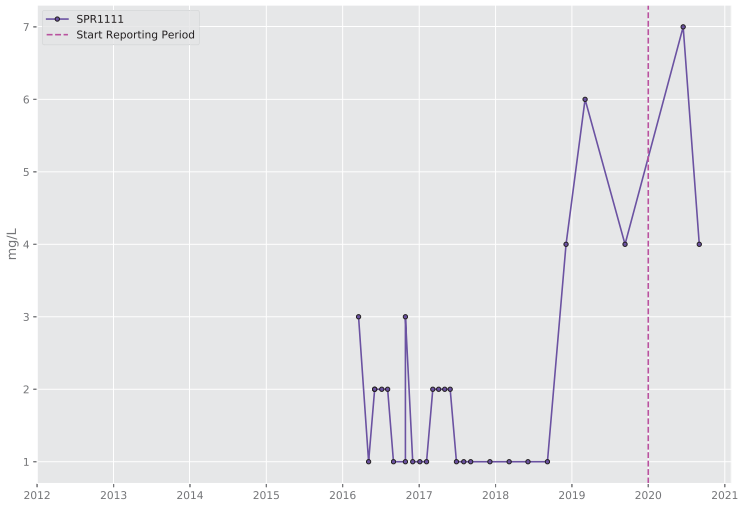
Total Dissolved Solids



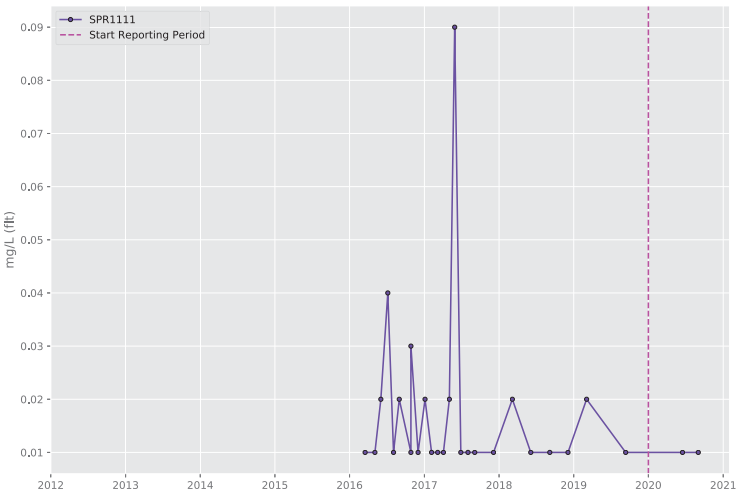
Zinc



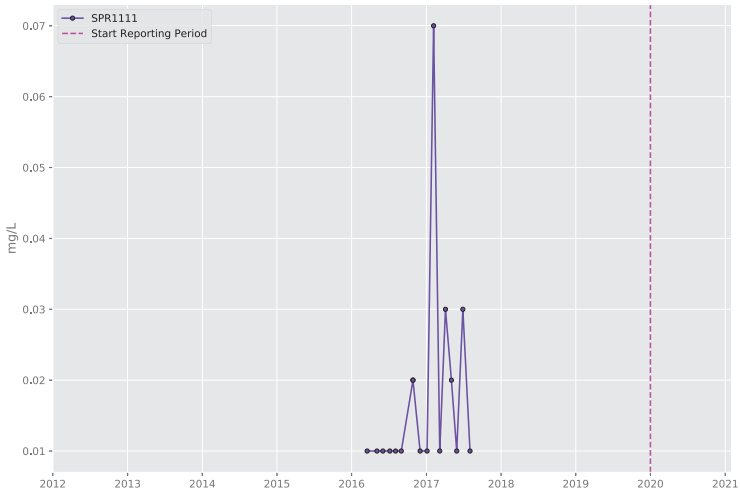
Alkalinity (total) as CaCO3



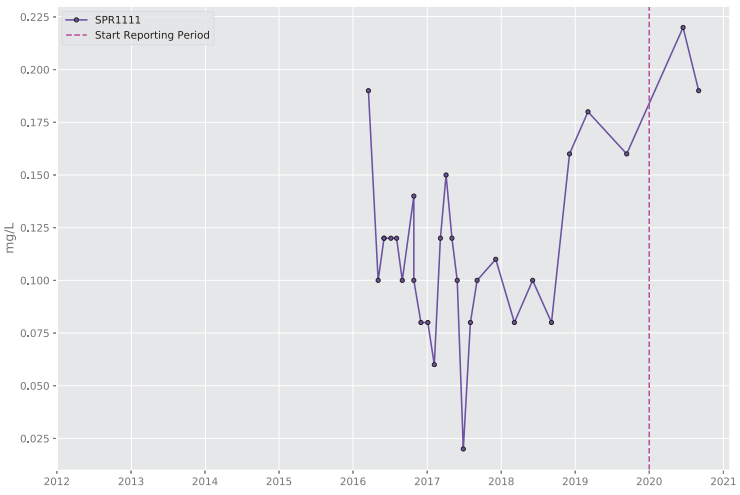
Aluminium



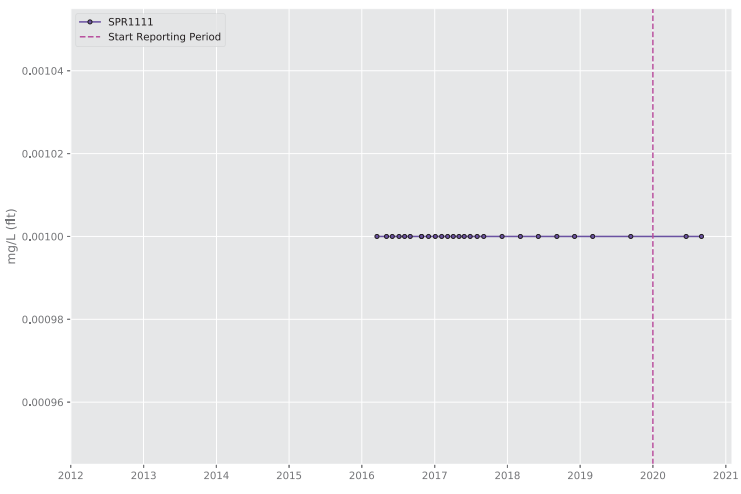
Ammonia as N



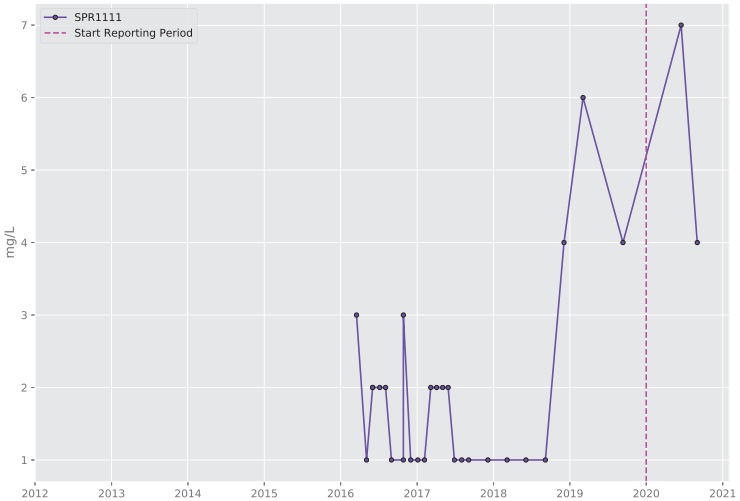
Anions Total



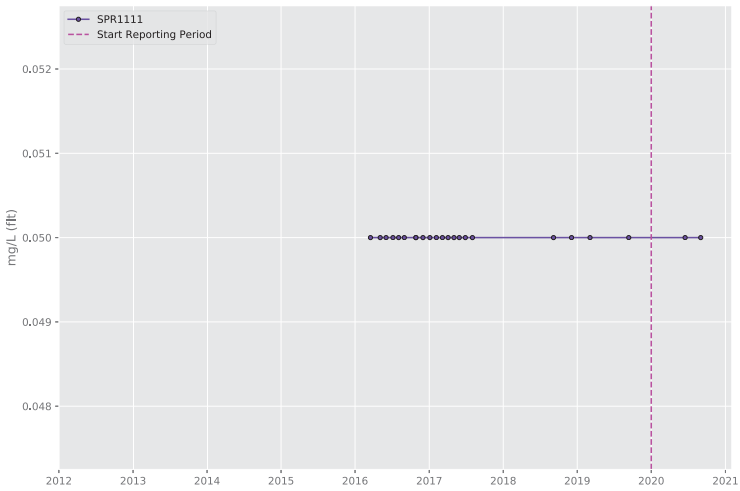
Arsenic



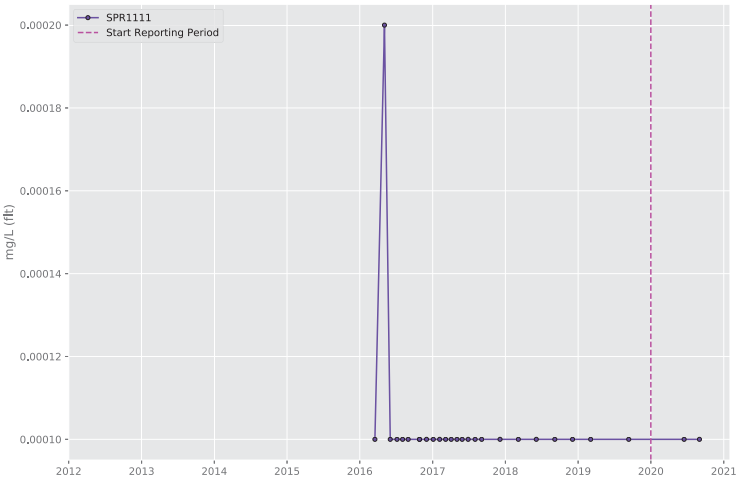
Bicarbonate Alkalinity as CaCO3



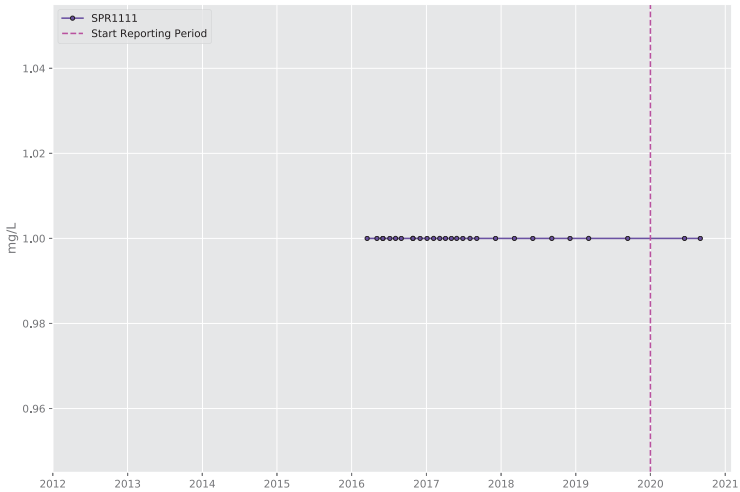
Boron



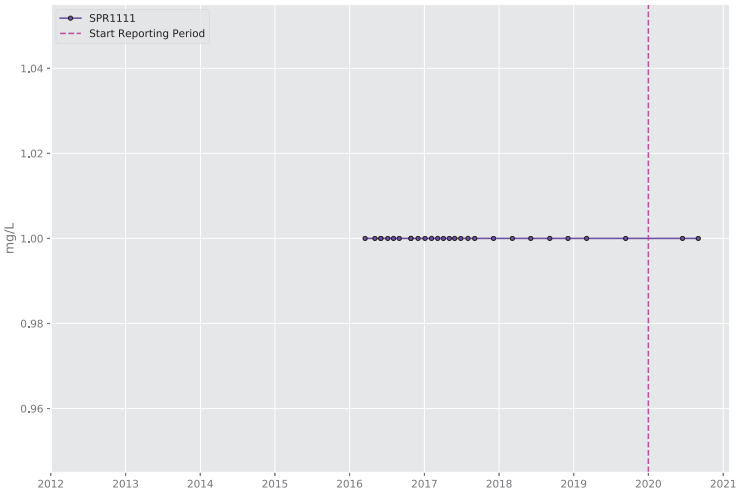
Cadmium



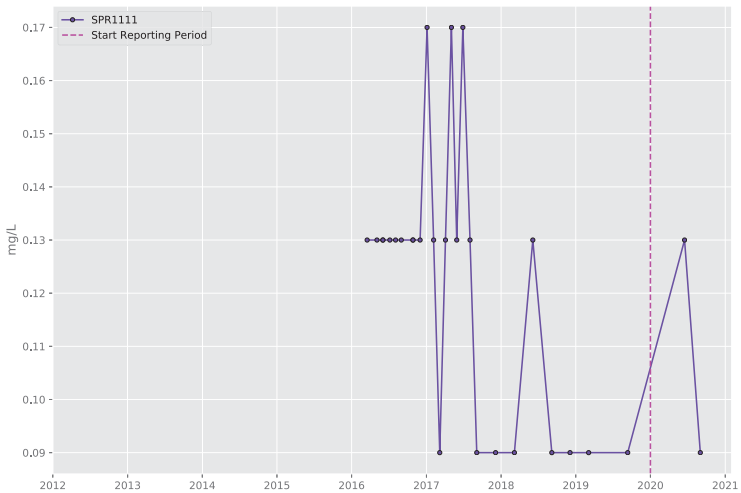
Calcium



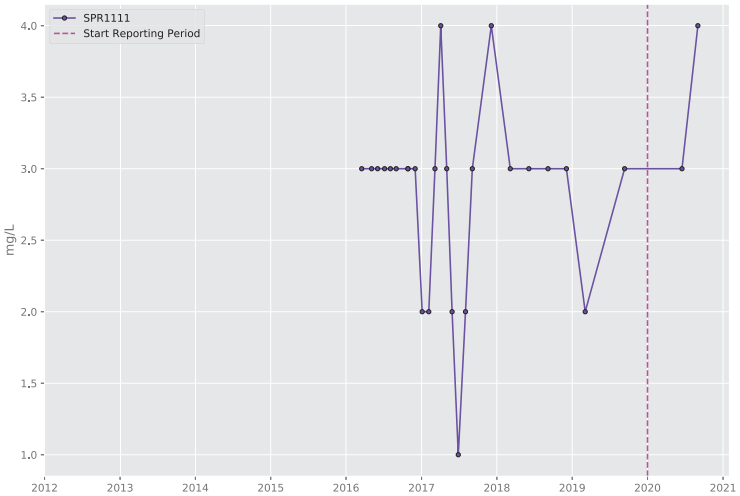
Carbonate



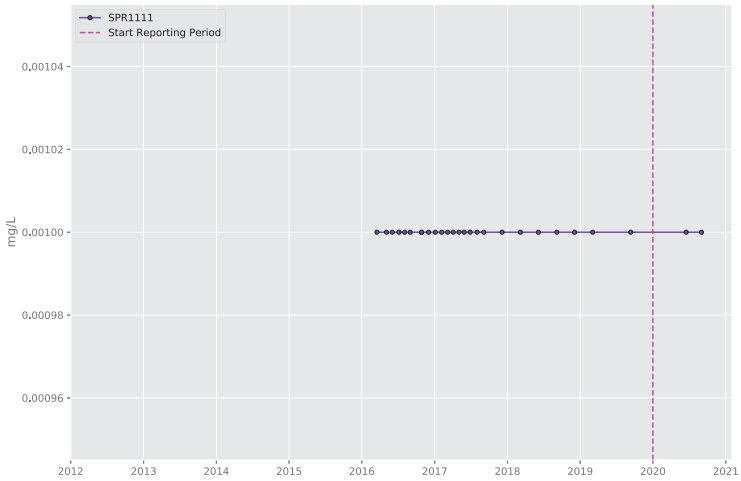
Cations Total



Chloride



Chromium (soluble)



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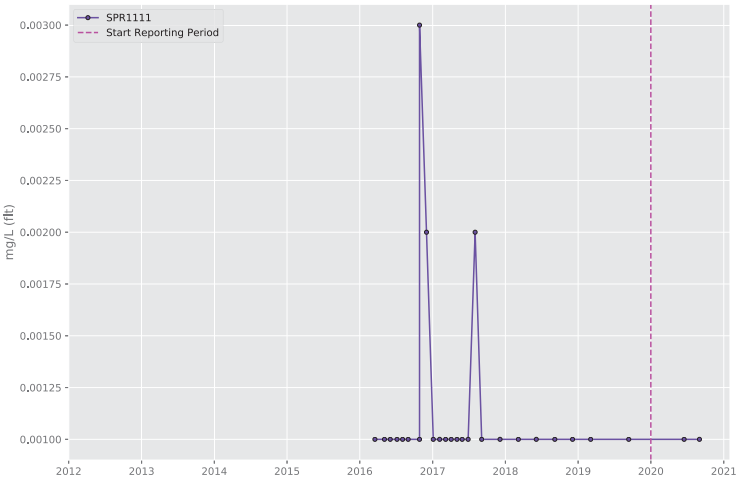
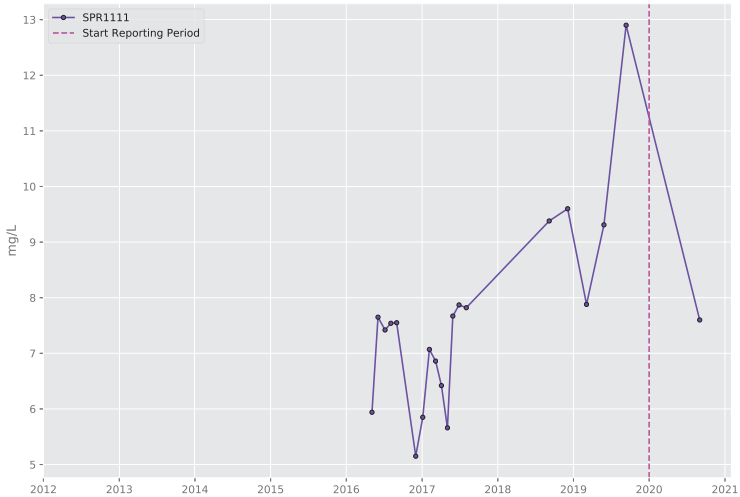
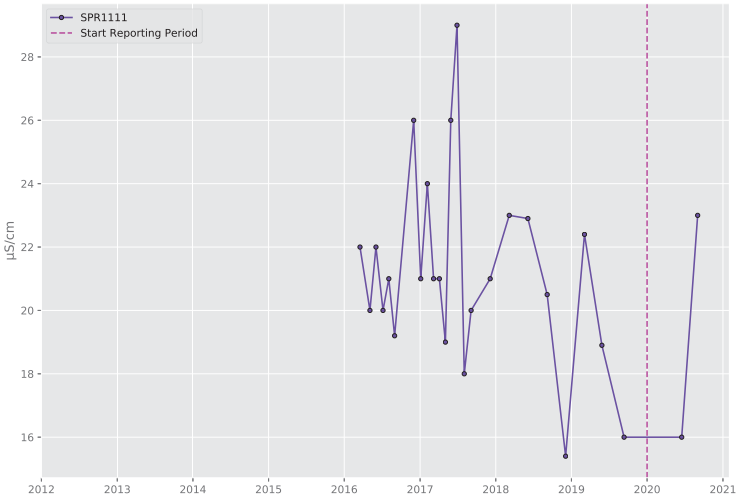


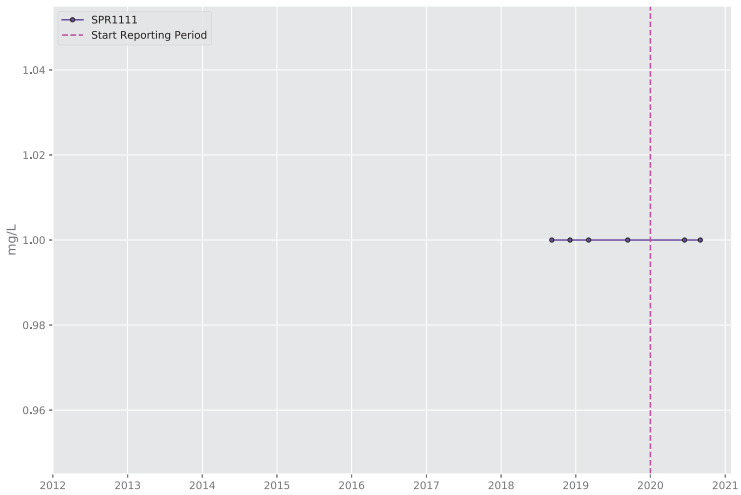
DO (Field)



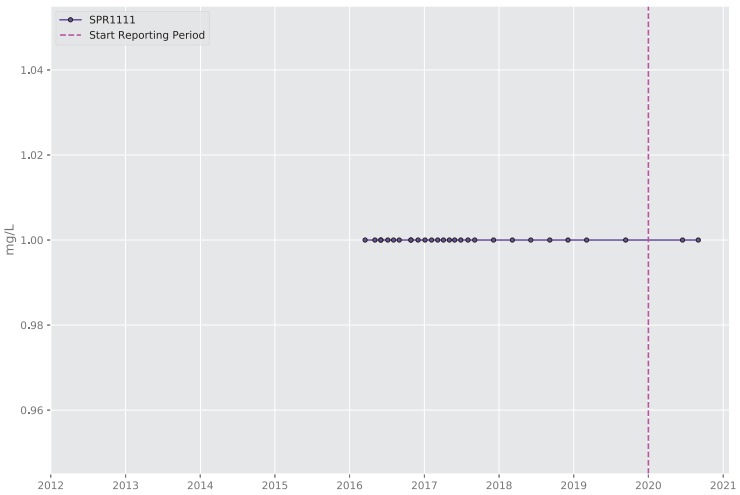
Electrical Conductivity (EC)



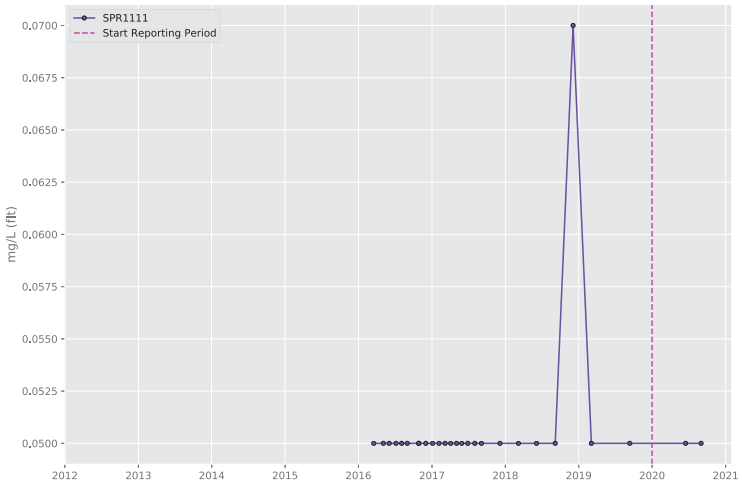
Hardness as CaCO3



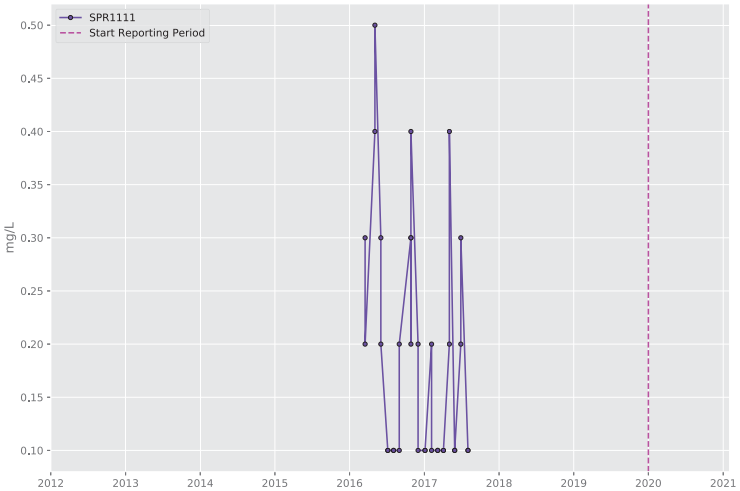
Hydroxide as CaCO3



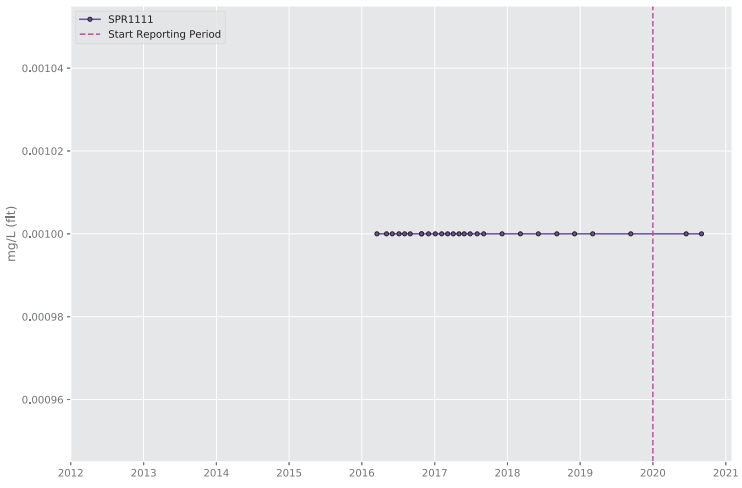
Iron



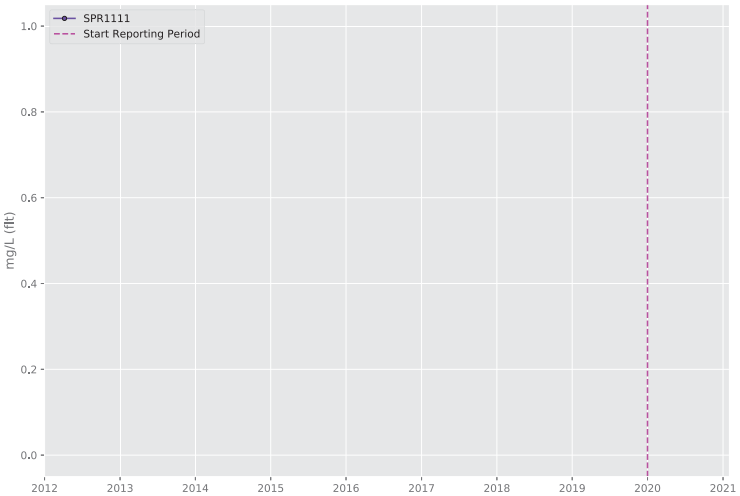
Kjeldahl Nitrogen Total



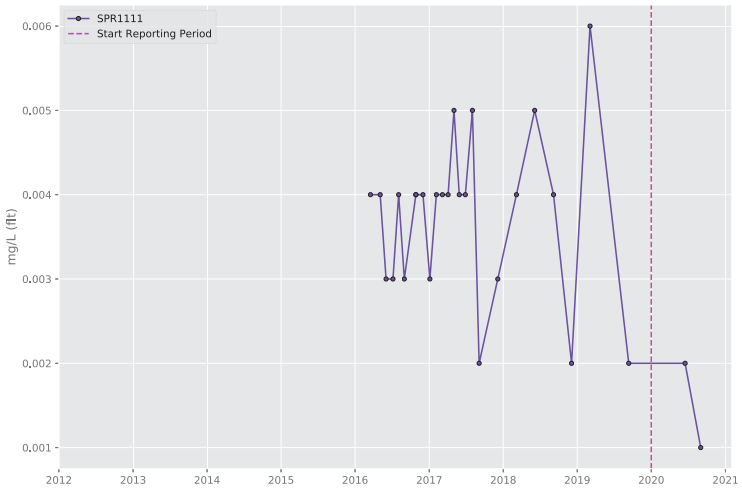
Lead



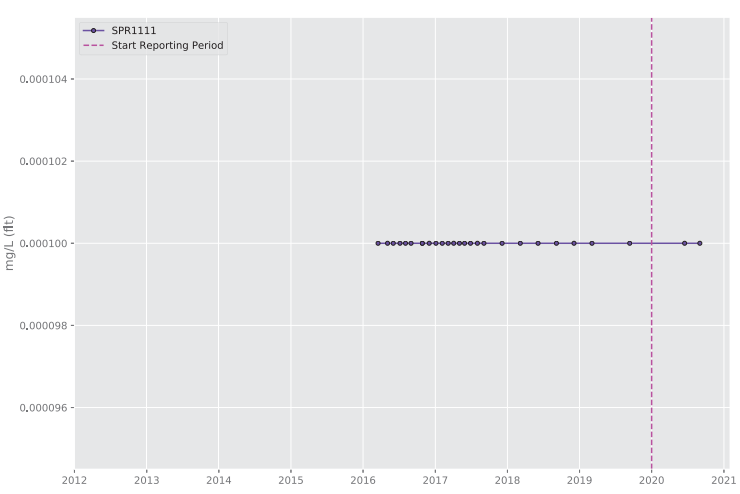
Magnesium



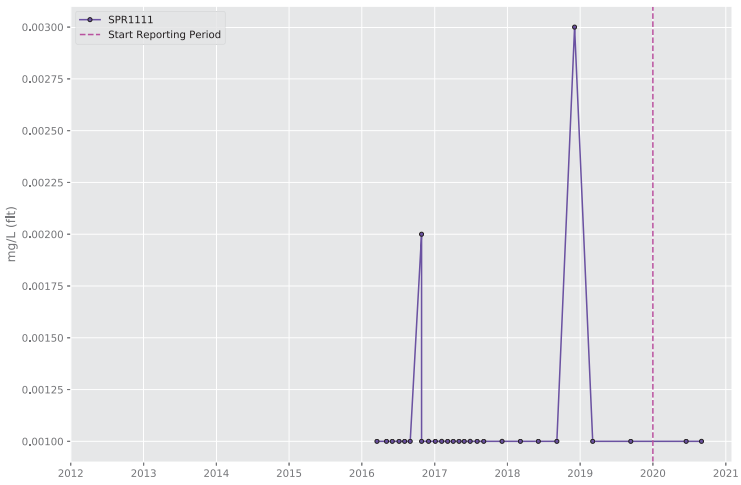
Manganese



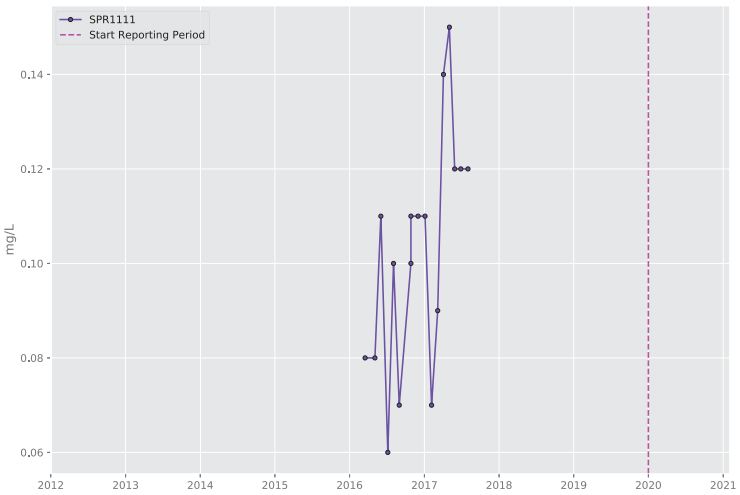
Mercury



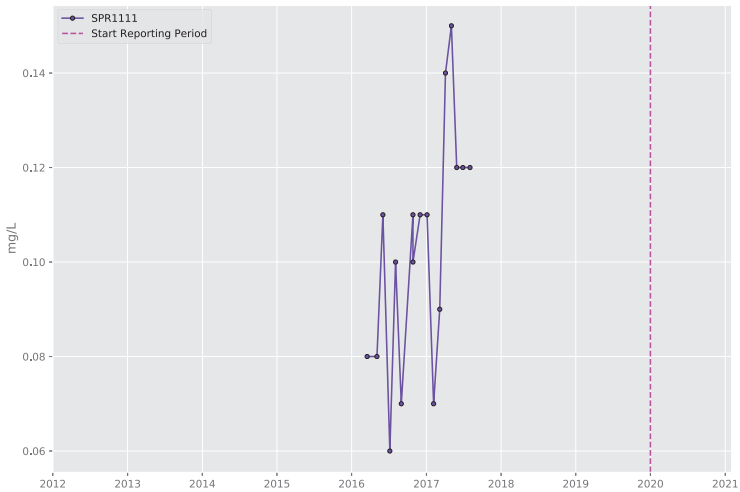
Nickel



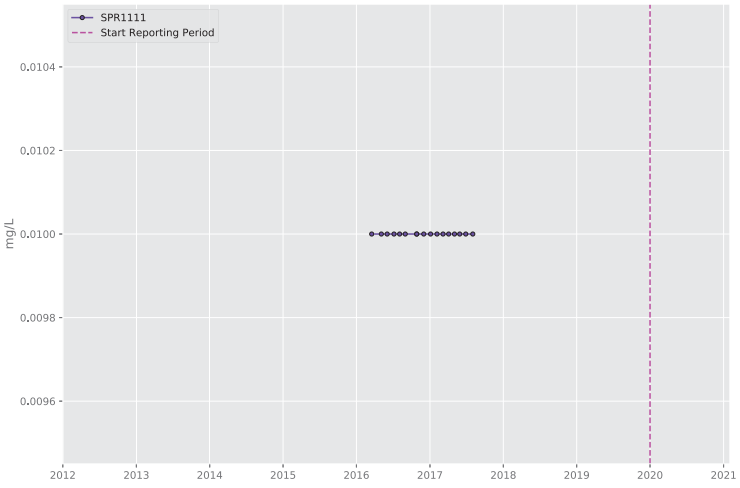
Nitrate & Nitrite (as N)



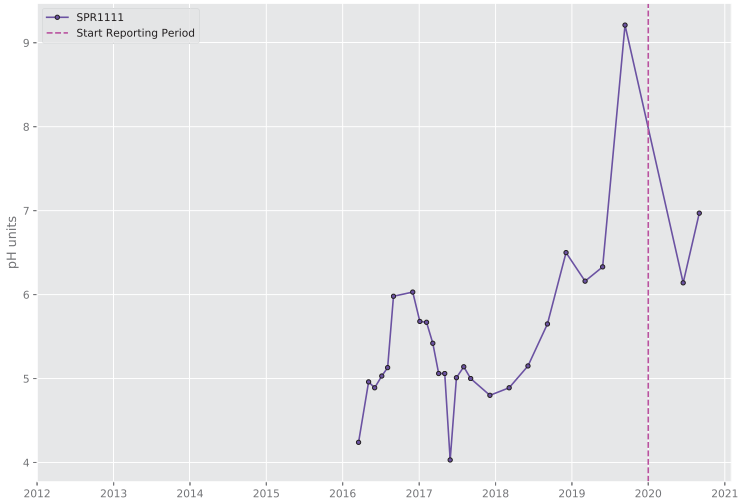
Nitrate (as N)



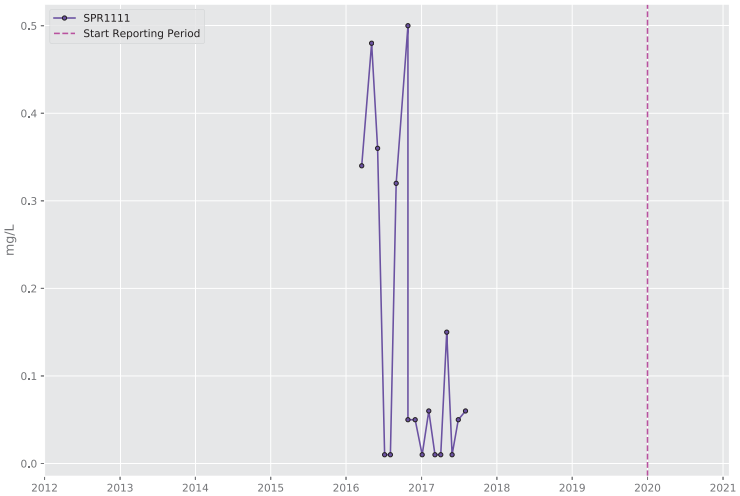
Nitrite (as N)



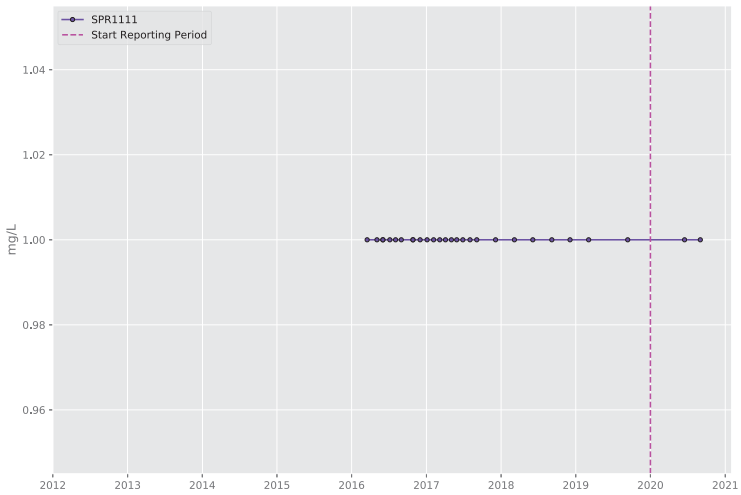
pH_0



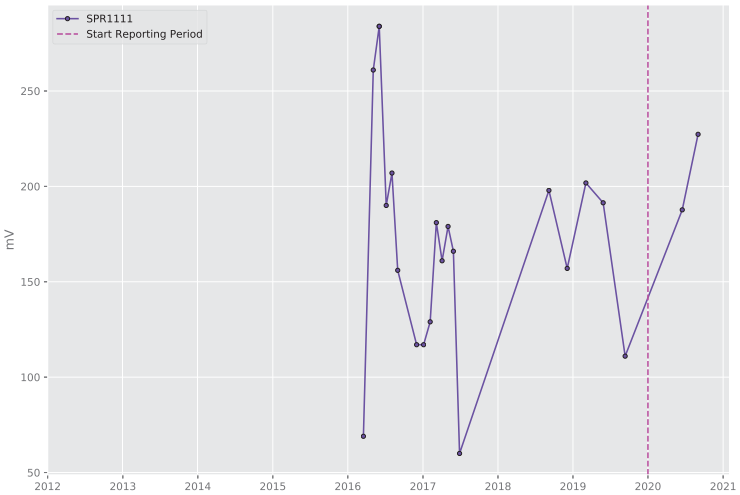
Phosphorus



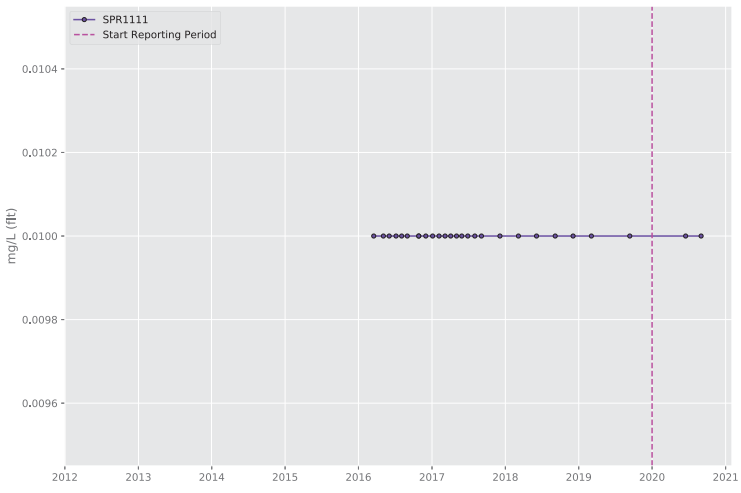
Potassium



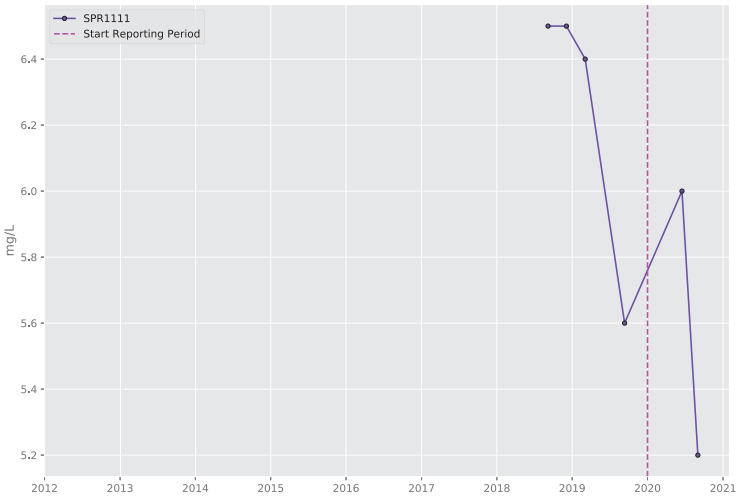
Redox Potential



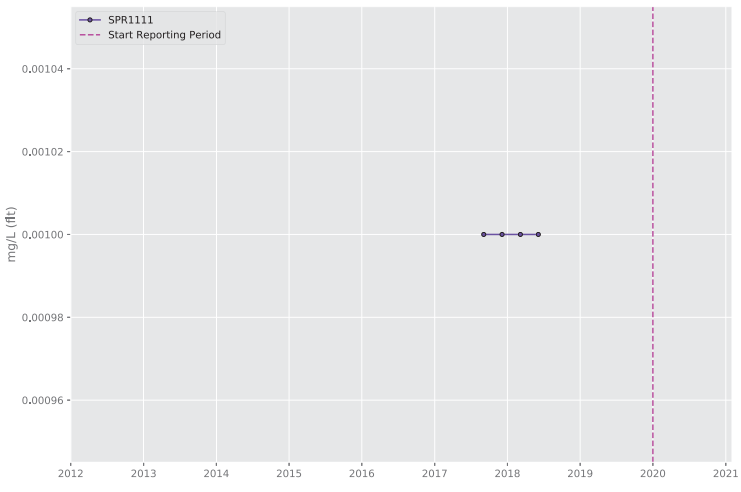
Selenium



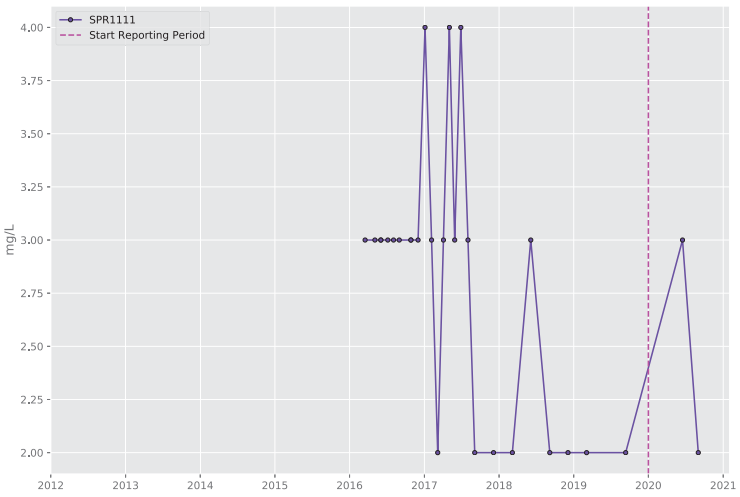
Silicon as SiO2



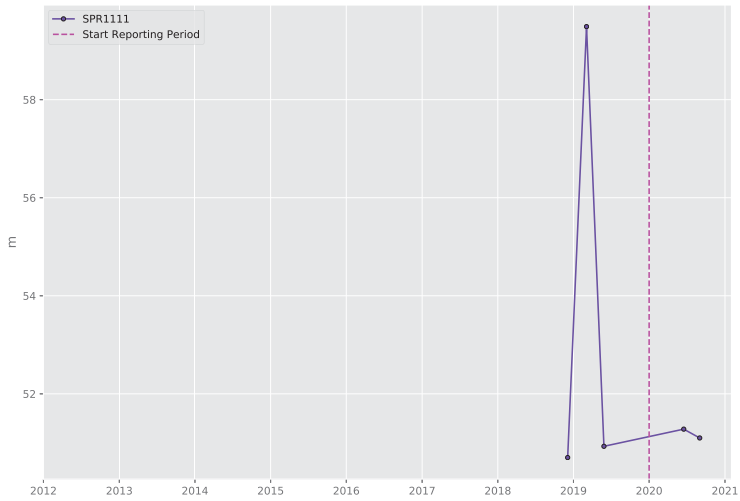
Silver



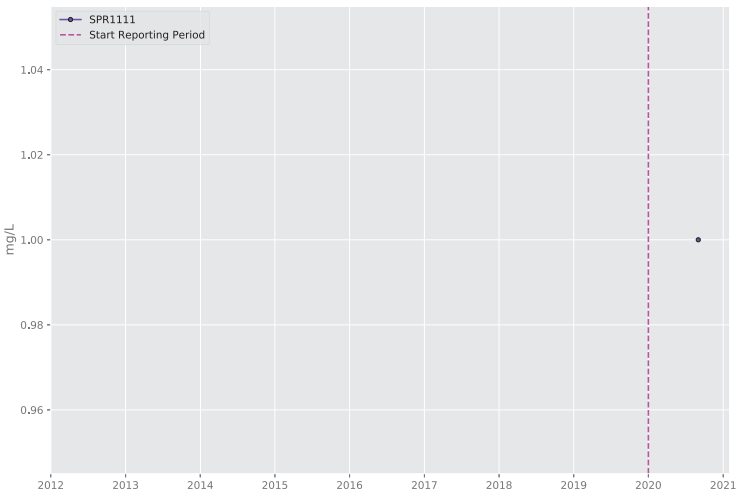
Sodium



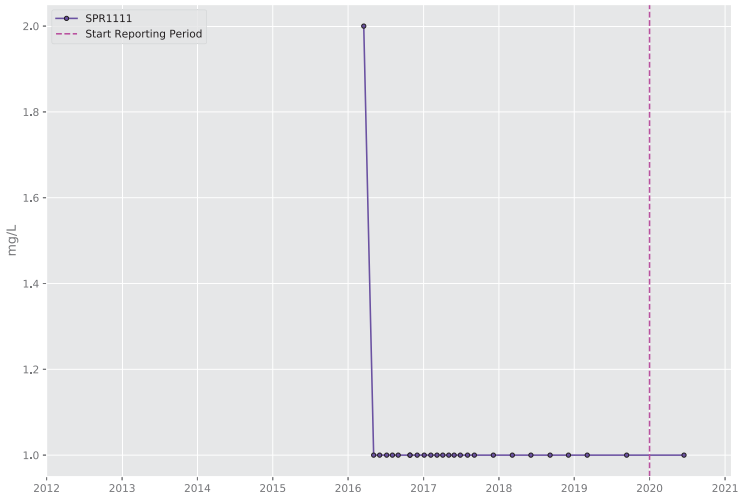
Standing water level



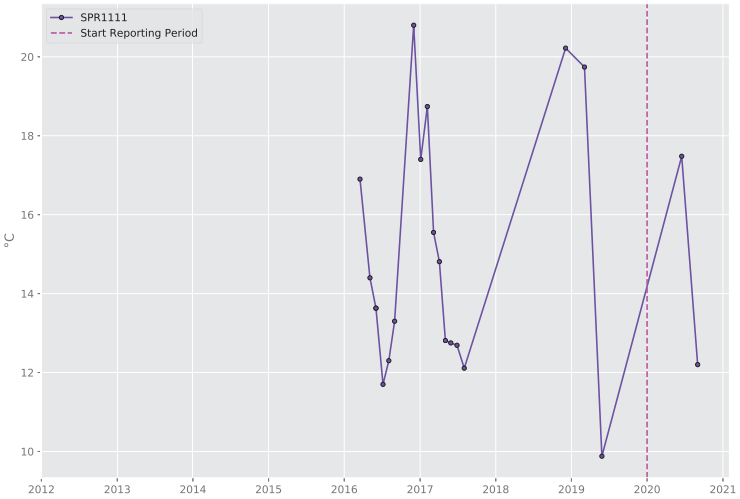
Sulfate as SO4 - Turbidimetric



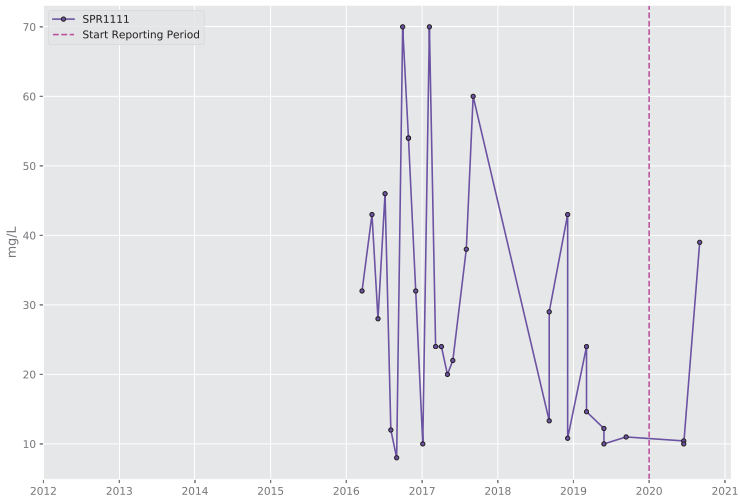
Sulphate



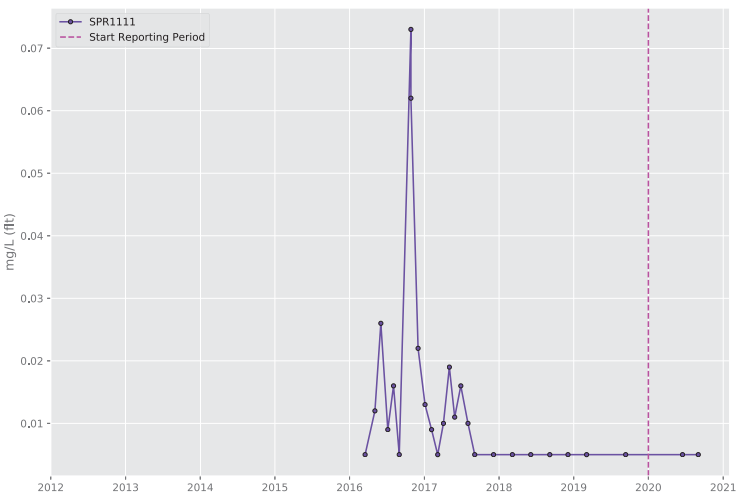
Temp



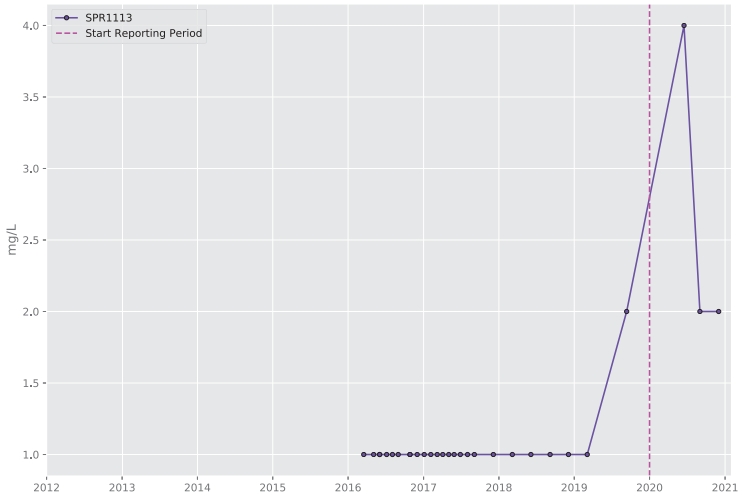
Total Dissolved Solids



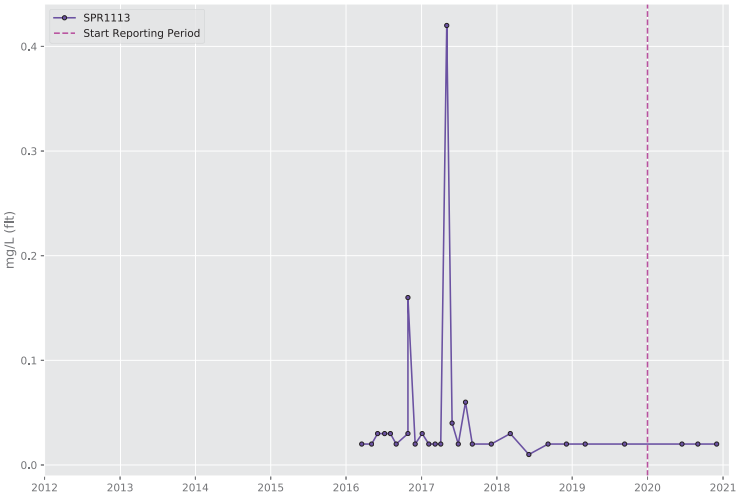
Zinc



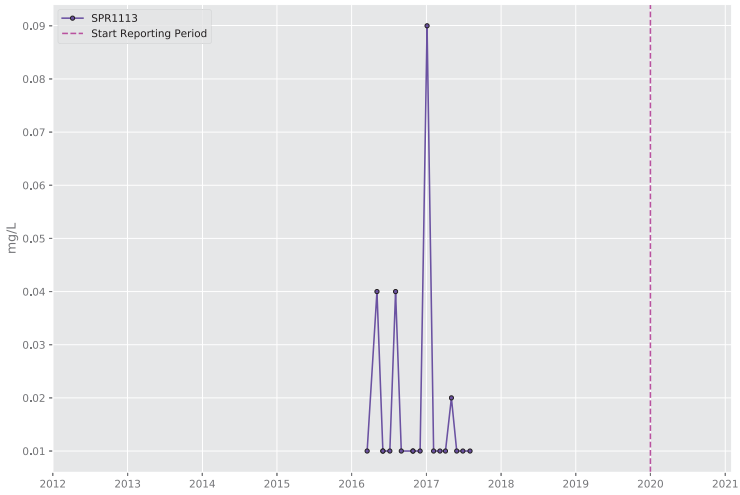
Alkalinity (total) as CaCO3



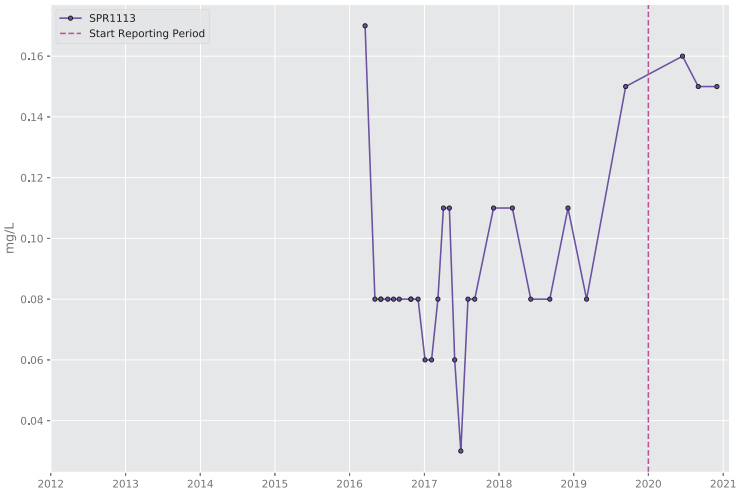
Aluminium



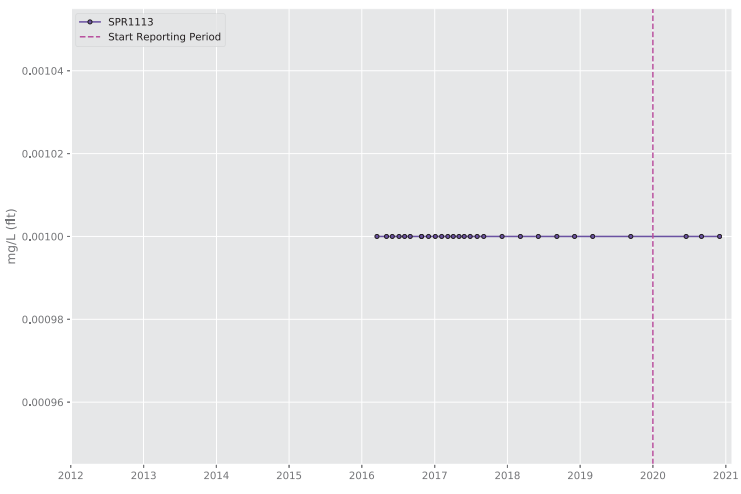
Ammonia as N



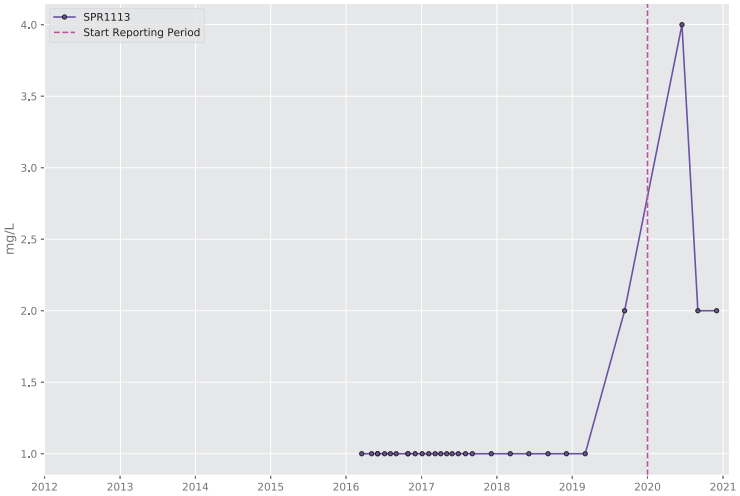
Anions Total



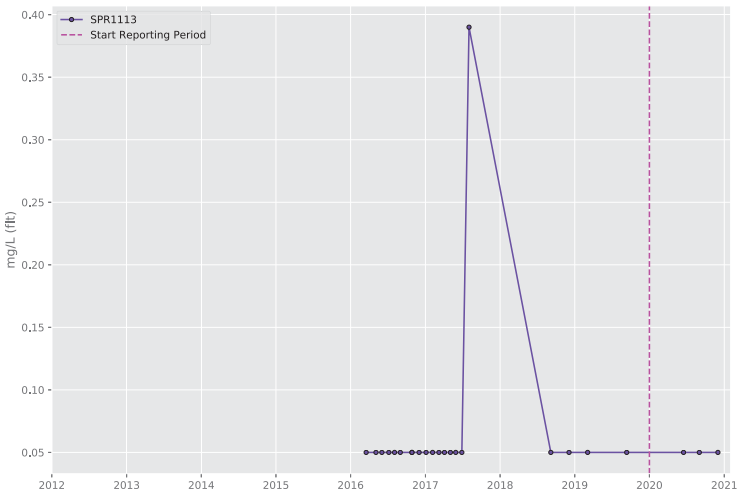
Arsenic



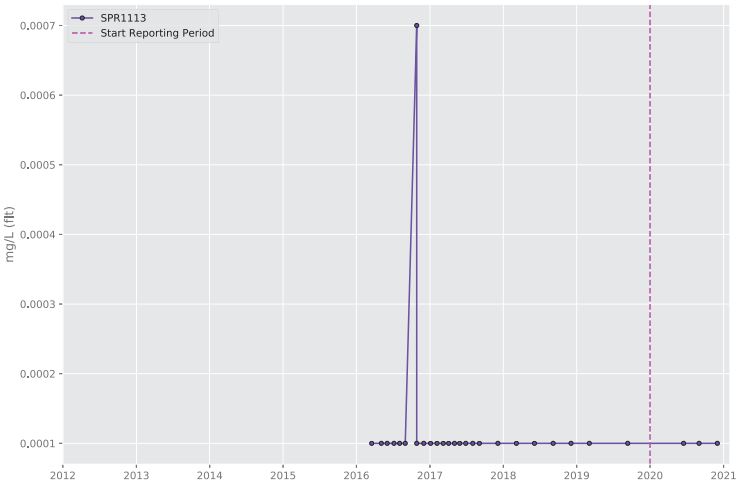
Bicarbonate Alkalinity as CaCO3



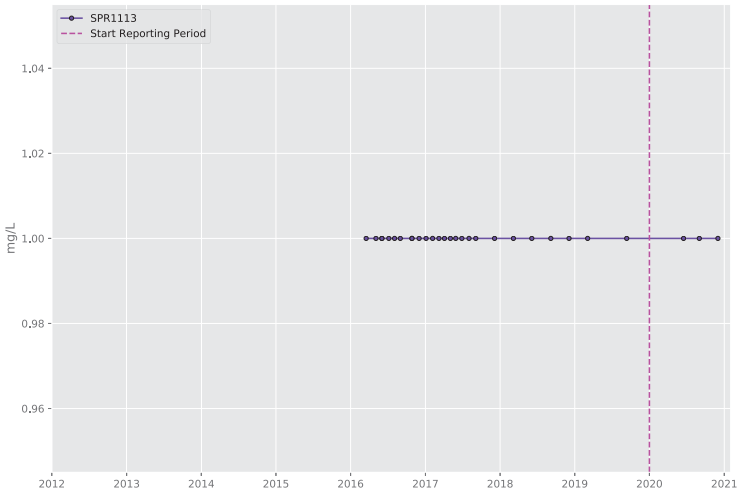
Boron



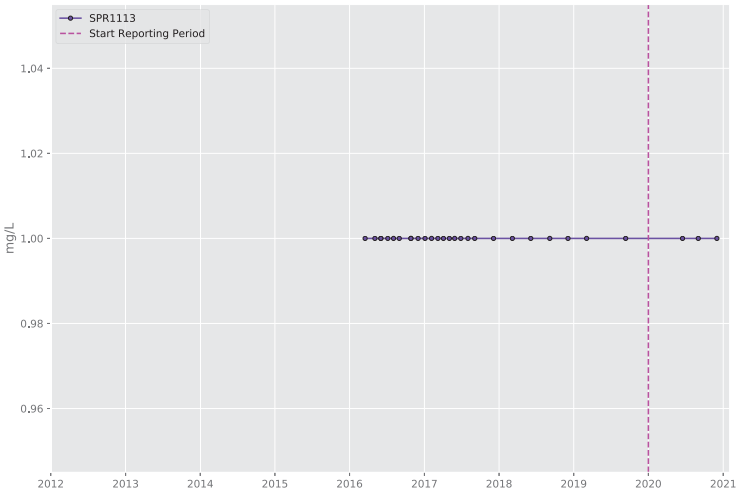
Cadmium



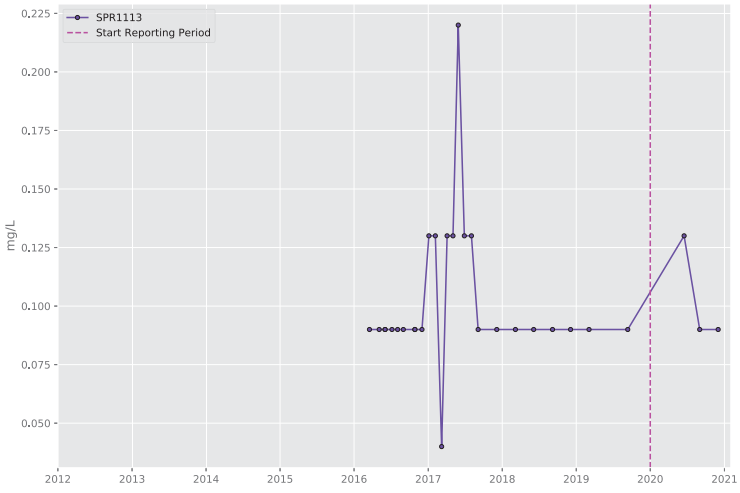
Calcium



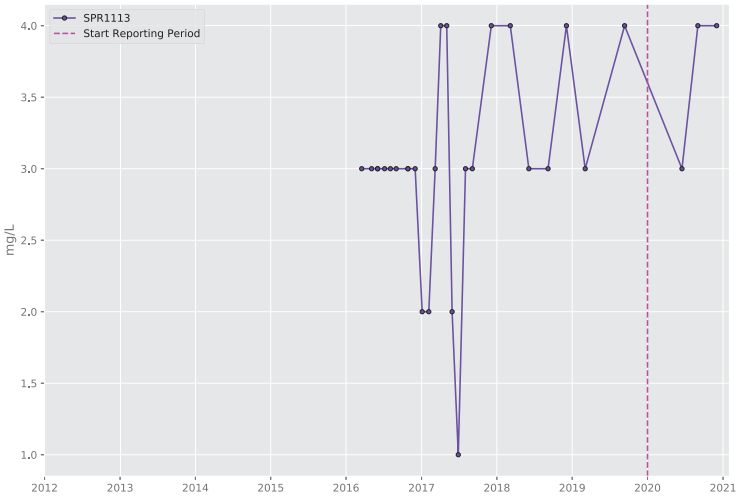
Carbonate



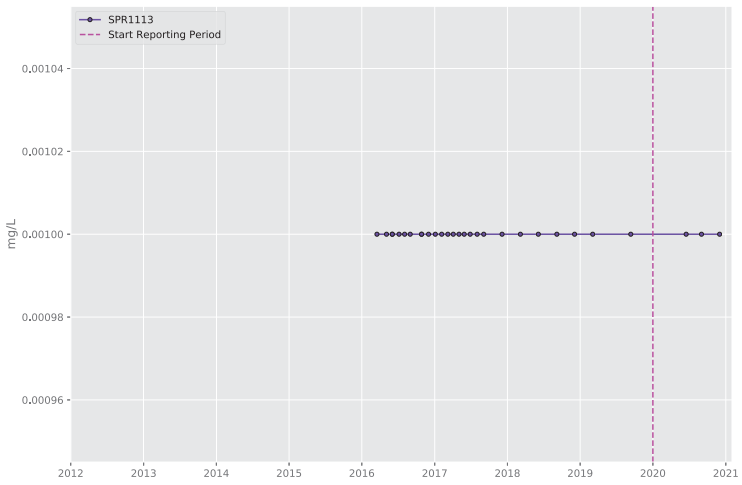
Cations Total



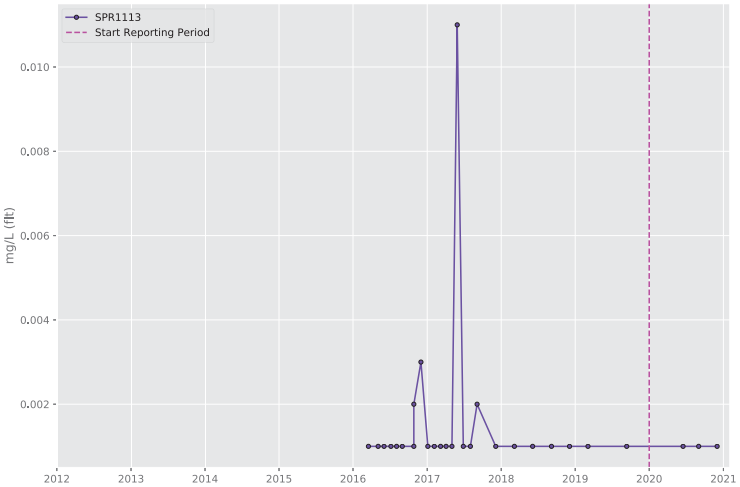
Chloride



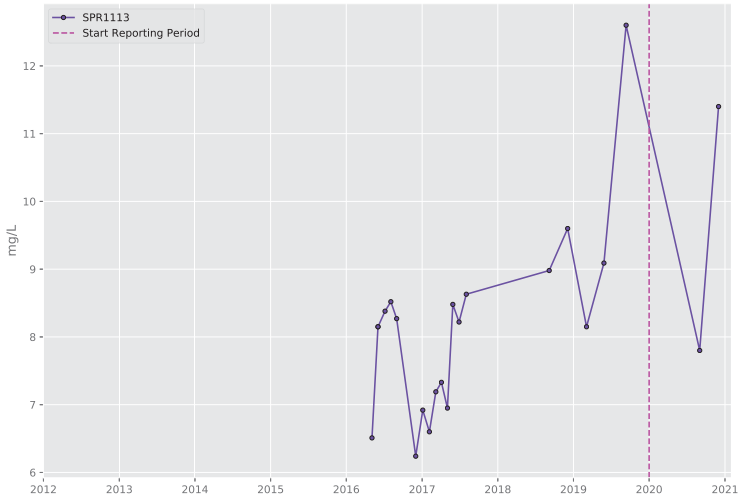
Chromium (soluble)



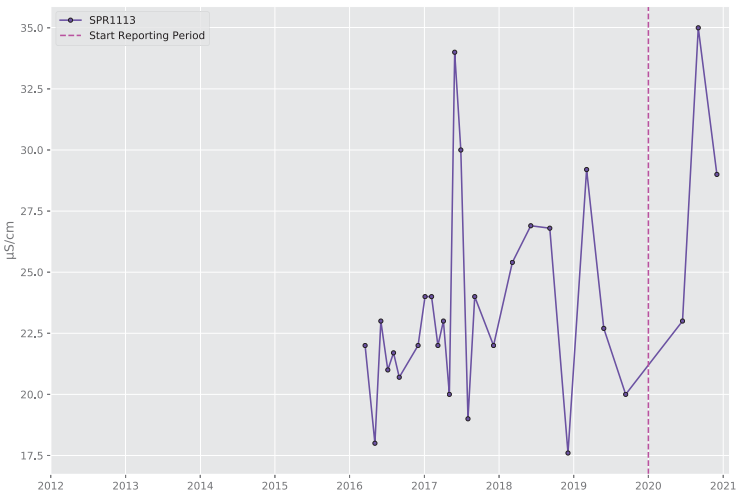
Copper



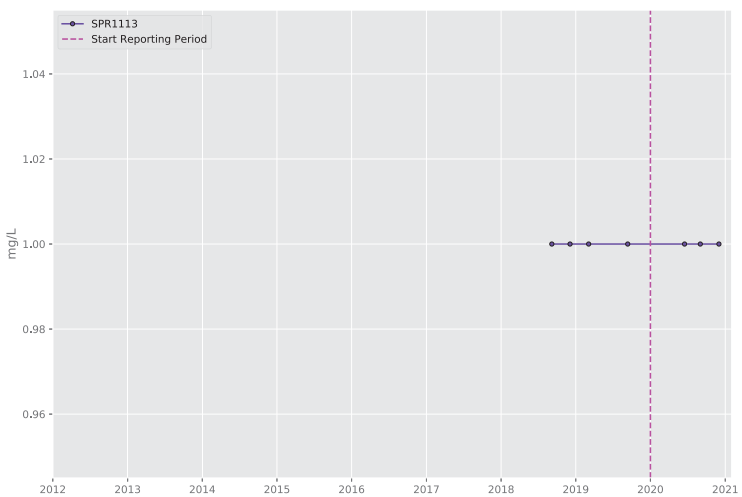
DO (Field)



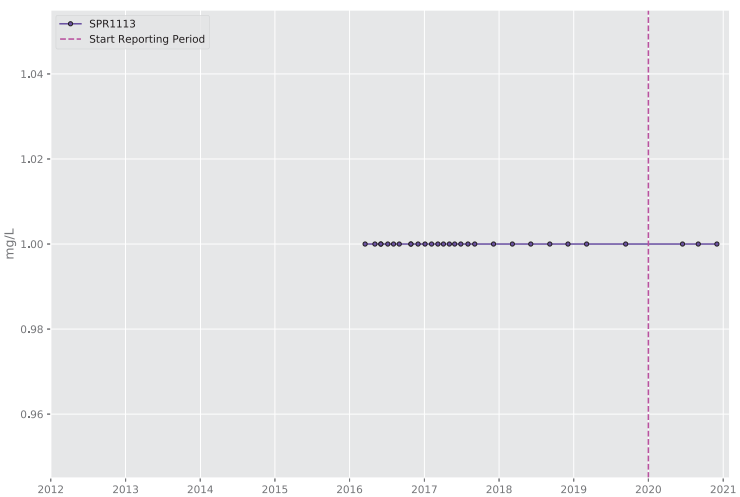
Electrical Conductivity (EC)



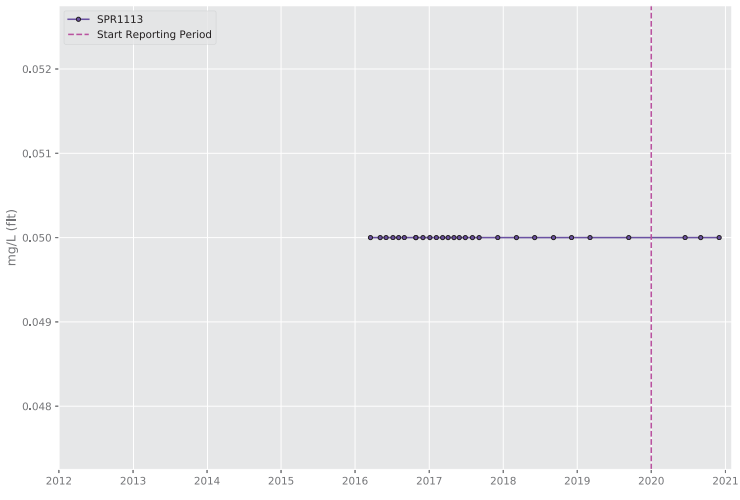
Hardness as CaCO3



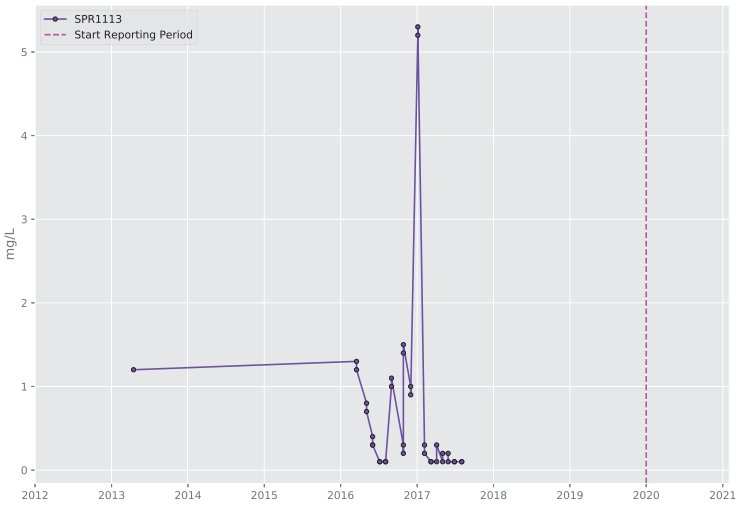
Hydroxide as CaCO3



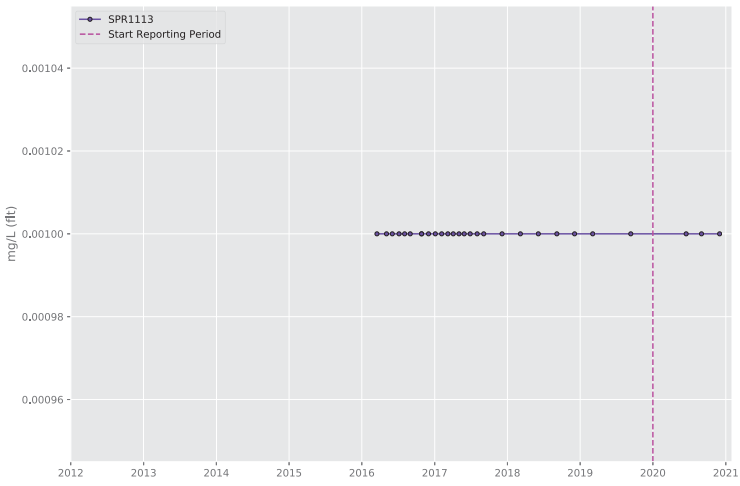
Iron



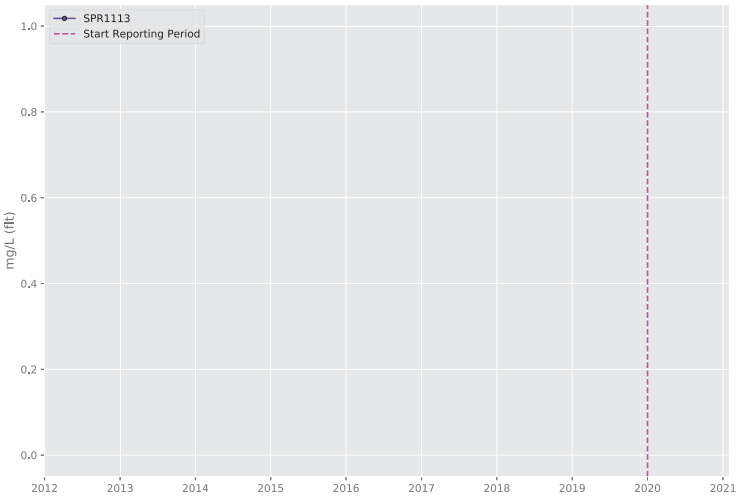
Kjeldahl Nitrogen Total



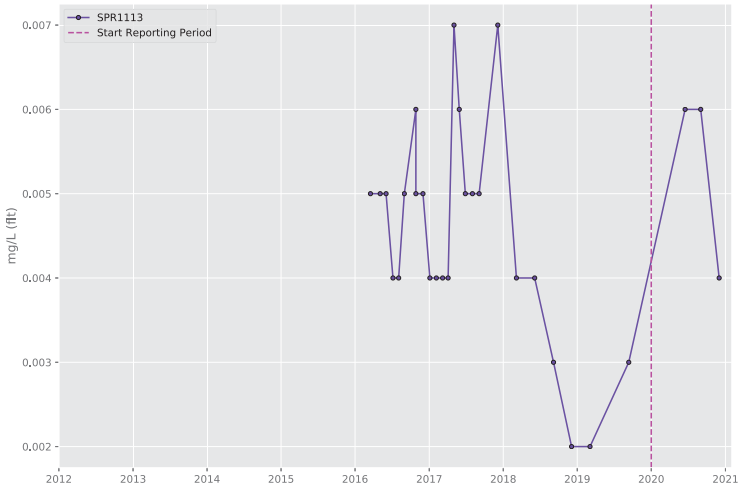
Lead



Magnesium



Manganese



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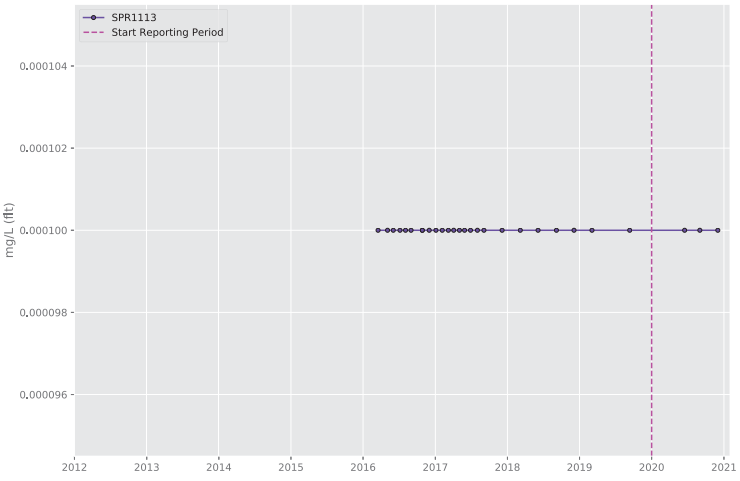

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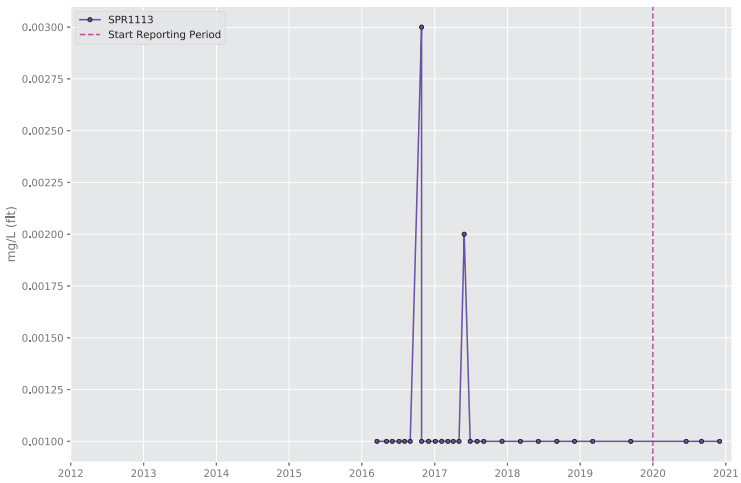
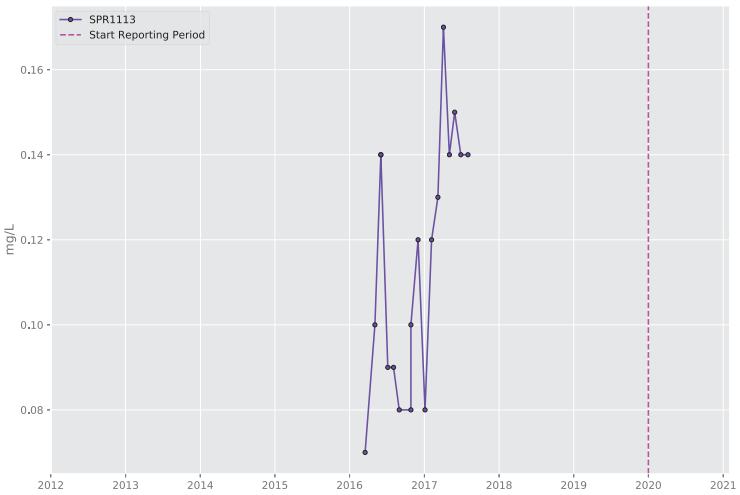
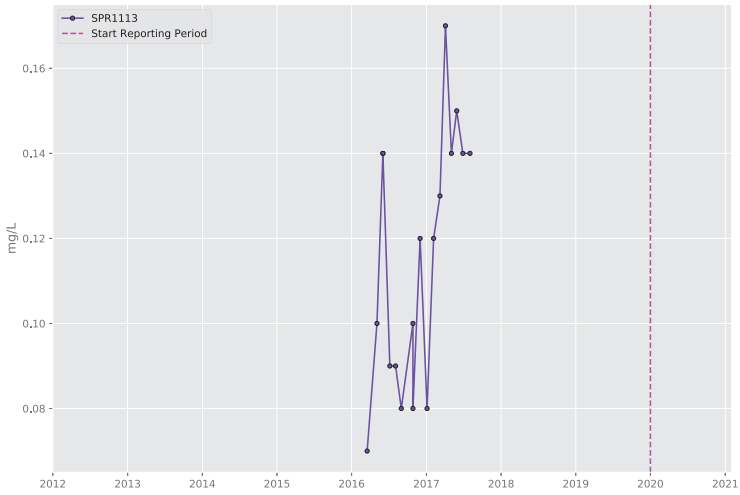


Nitrate & Nitrite (as N)



Nitrate (as N)



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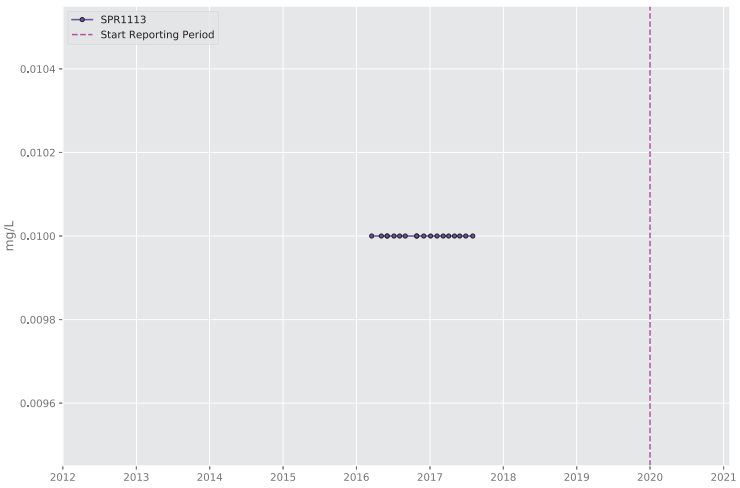
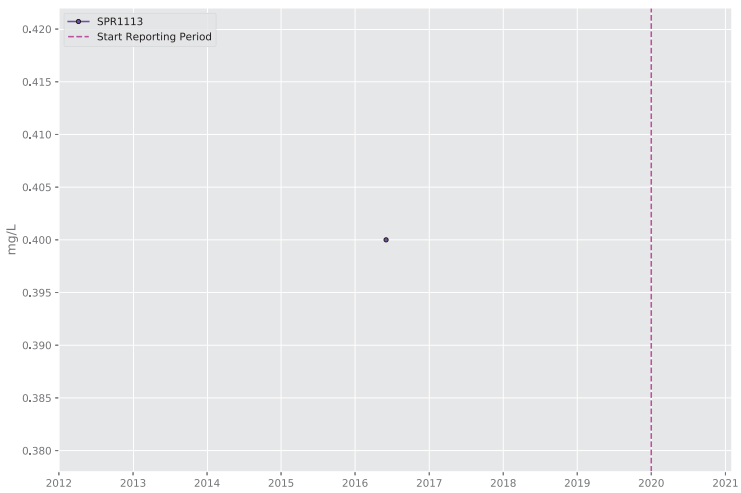
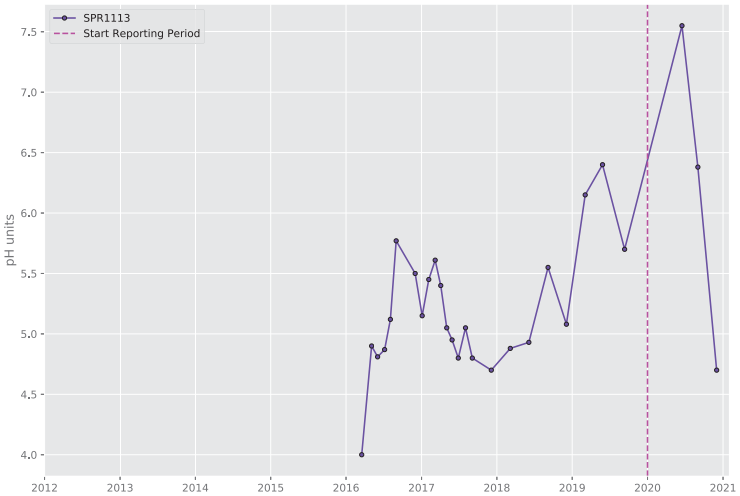


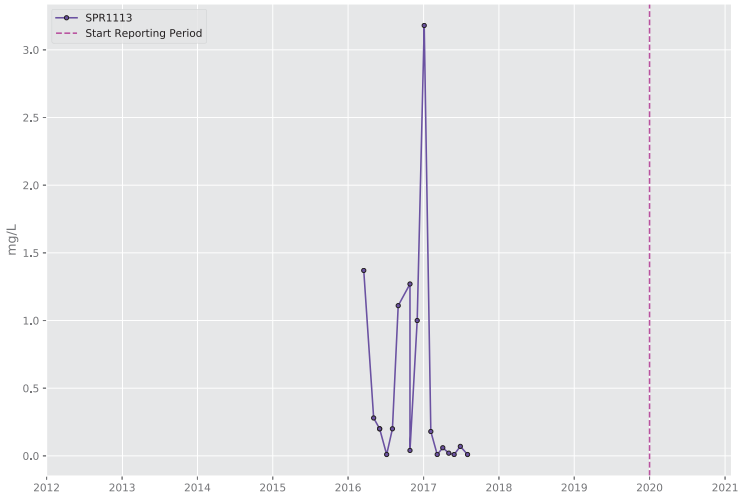
Nitrogen (Total)



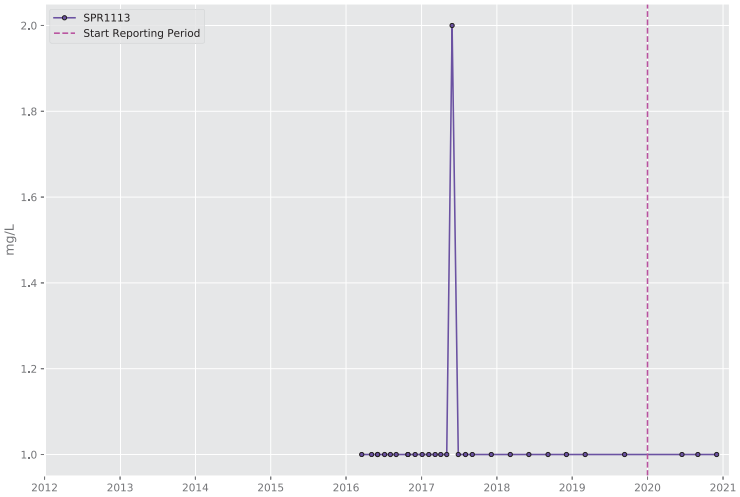
pH_0



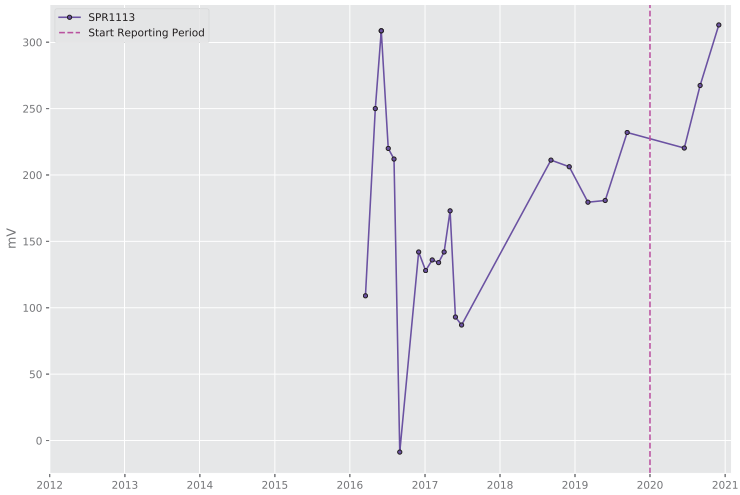
Phosphorus



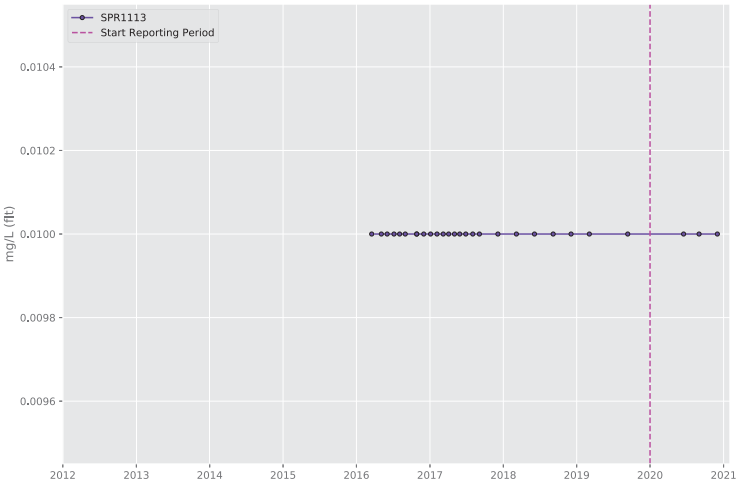
Potassium



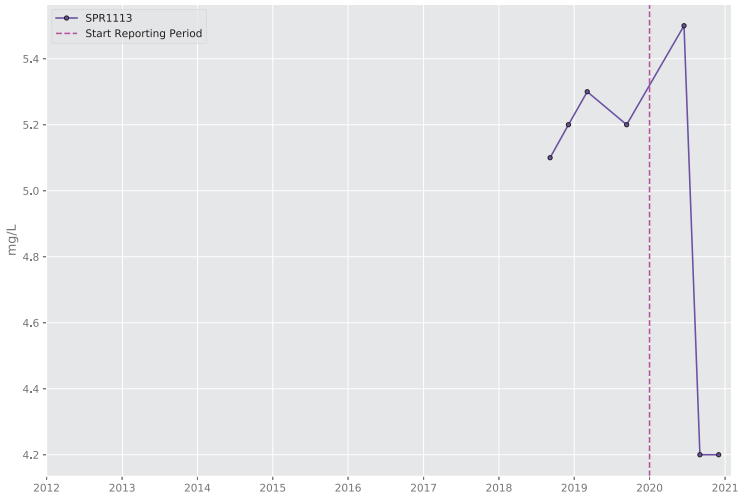
Redox Potential



Selenium



Silicon as SiO2



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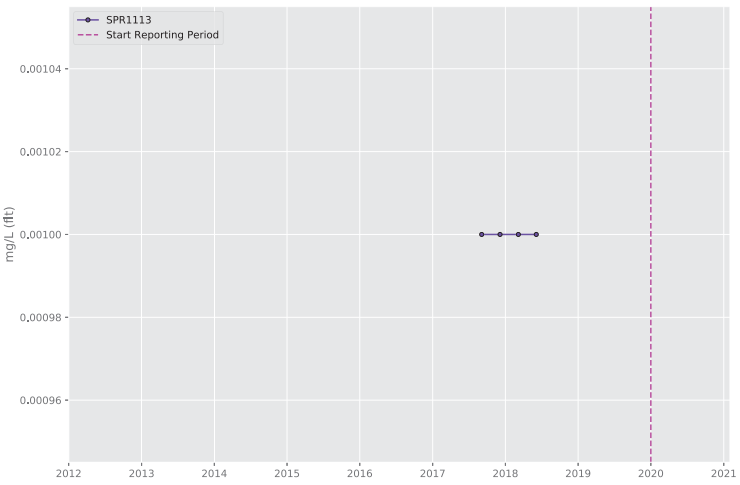
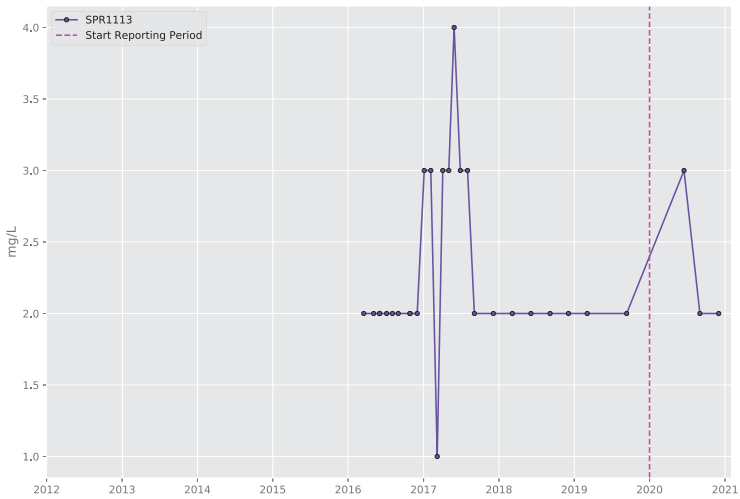
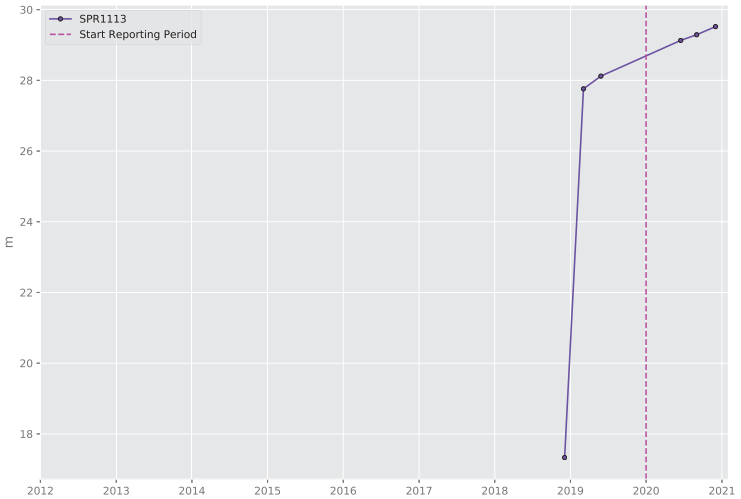


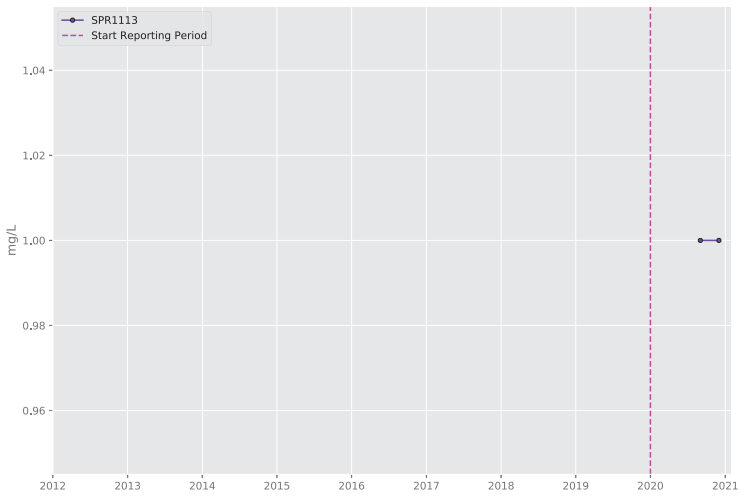
Sodium



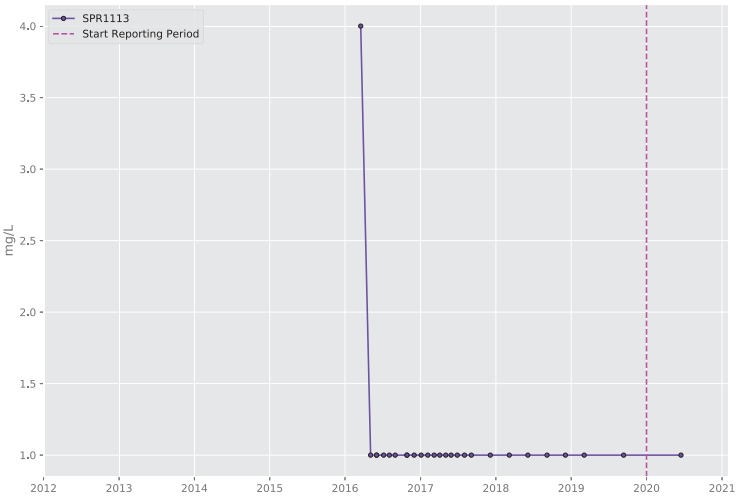
Standing water level



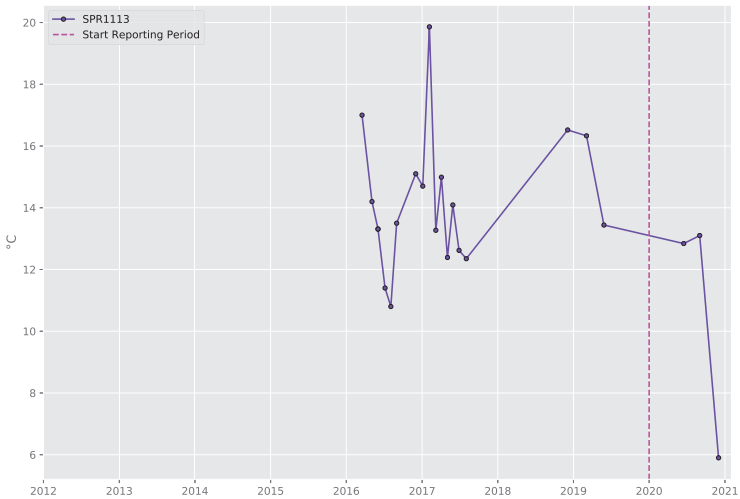
Sulfate as SO4 - Turbidimetric



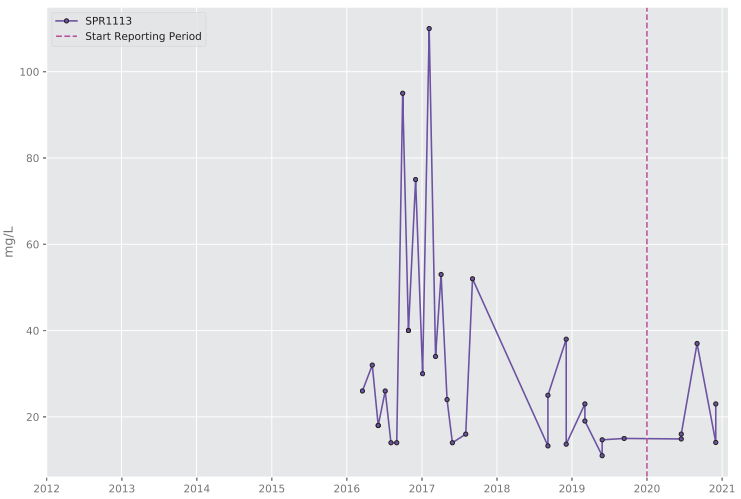
Sulphate



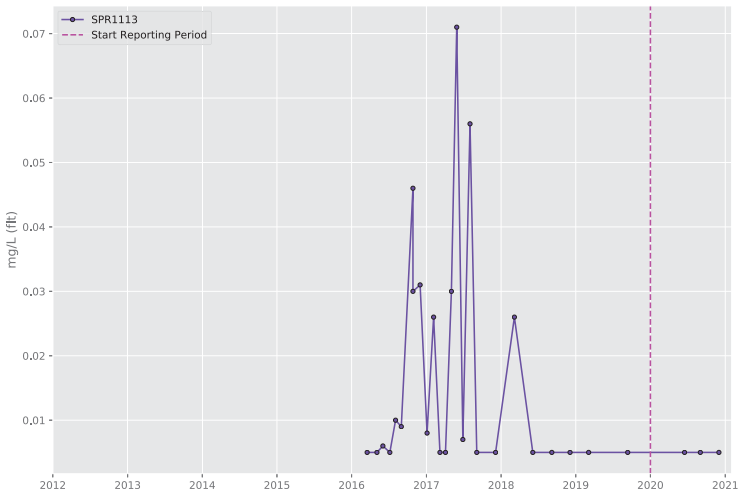
Temp



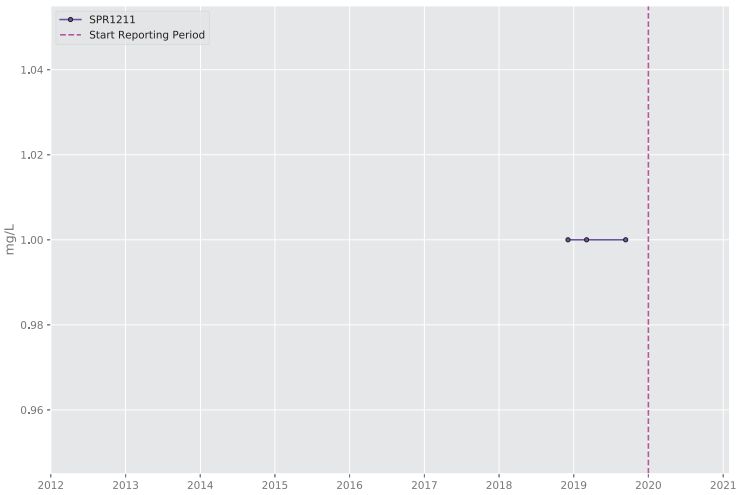
Total Dissolved Solids



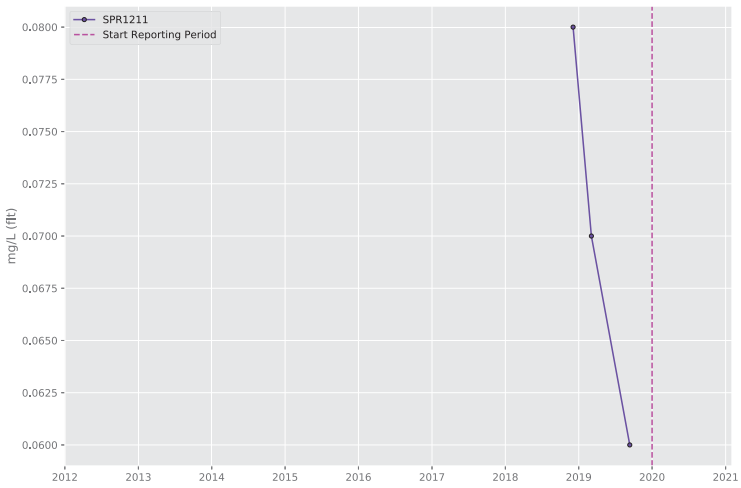
Zinc



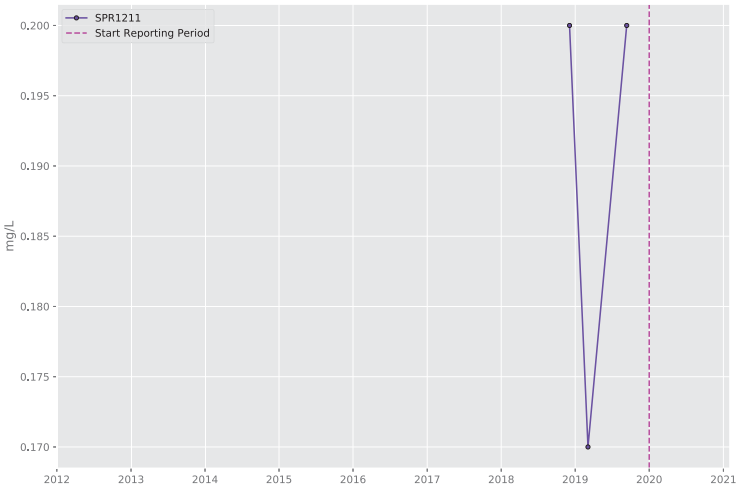
Alkalinity (total) as CaCO3



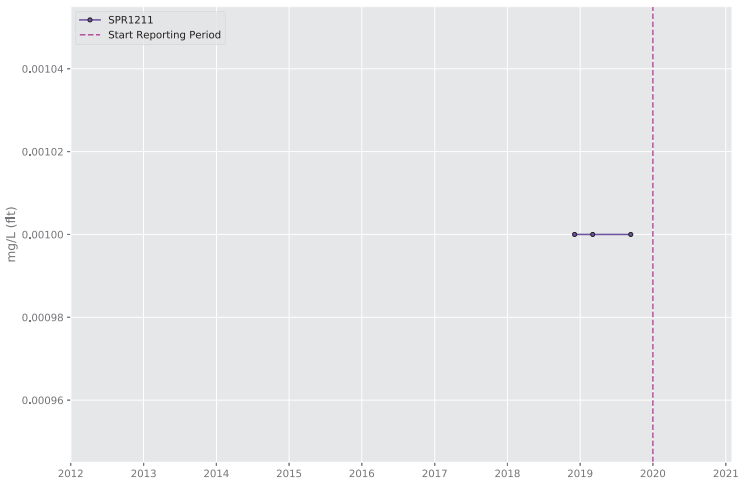
Aluminium



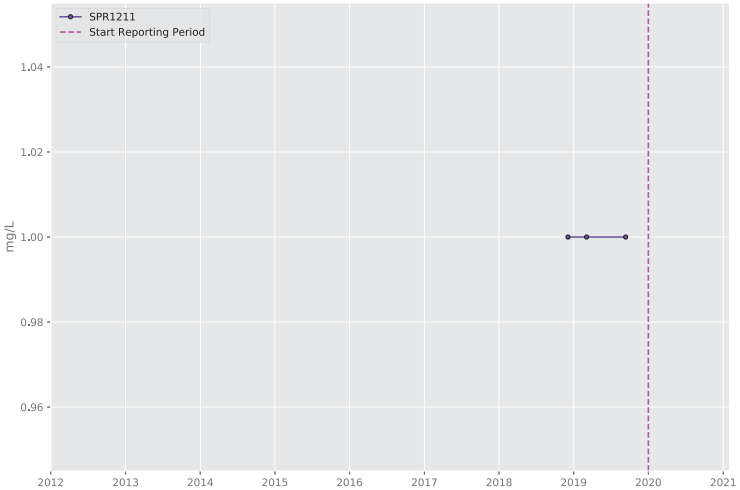
Anions Total



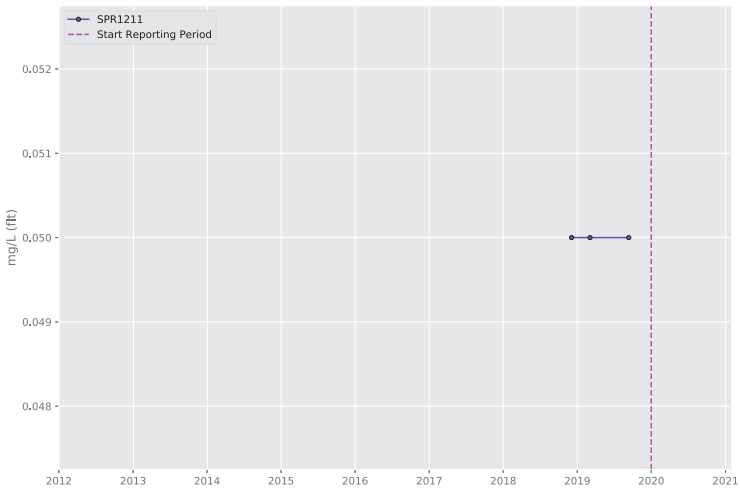
Arsenic



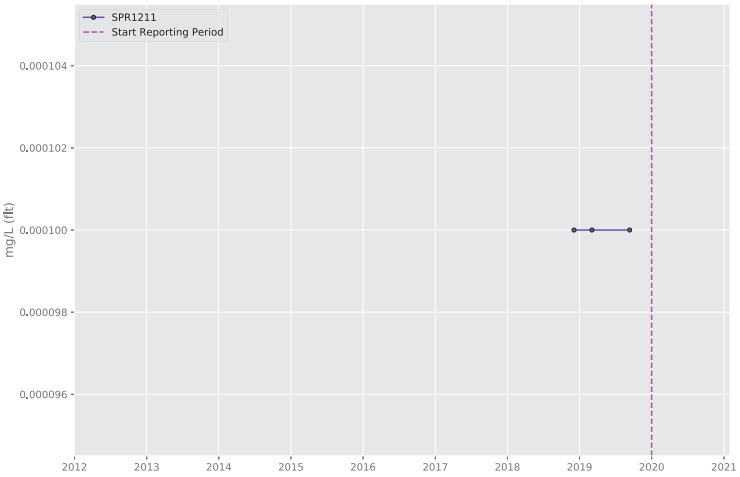
Bicarbonate Alkalinity as CaCO3



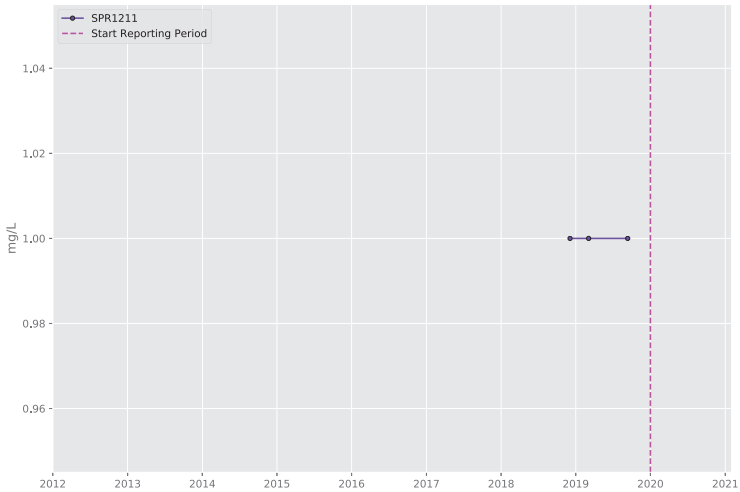
Boron



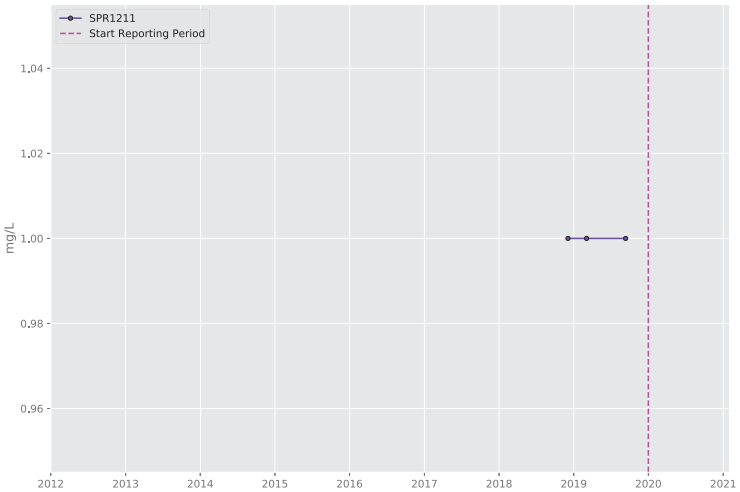
Cadmium



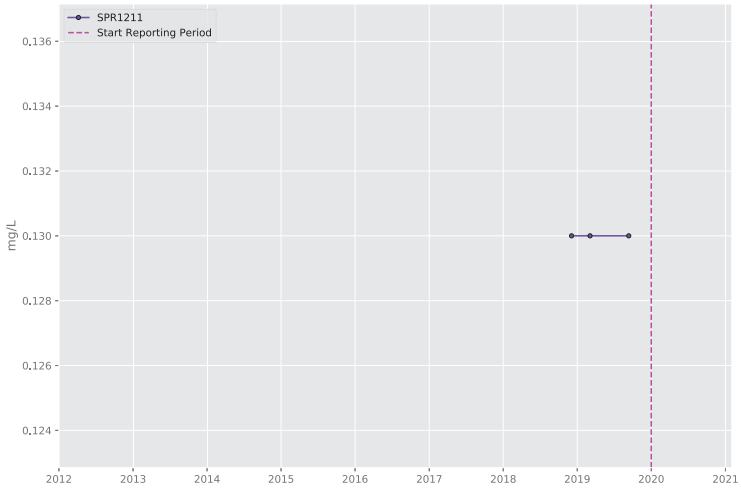
Calcium



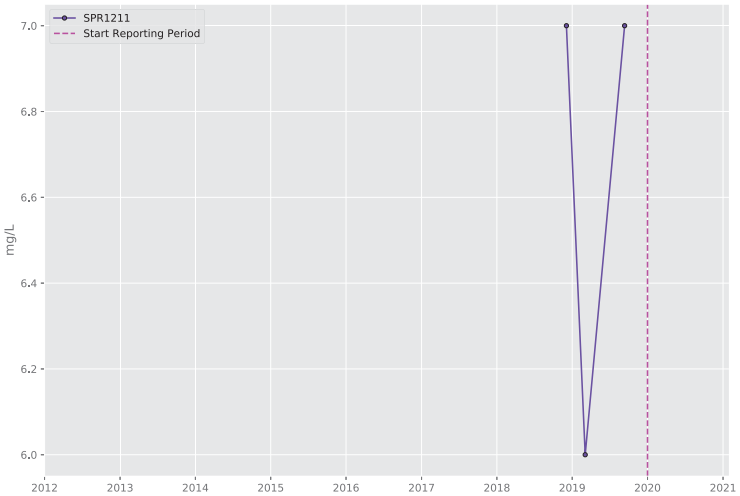
Carbonate



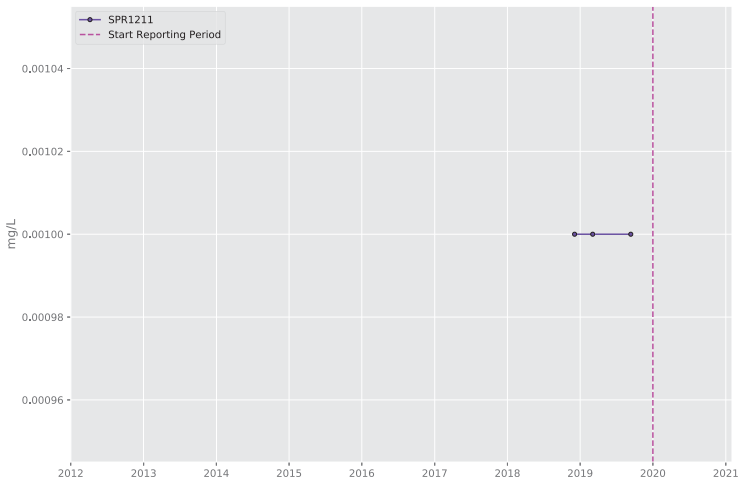
Cations Total



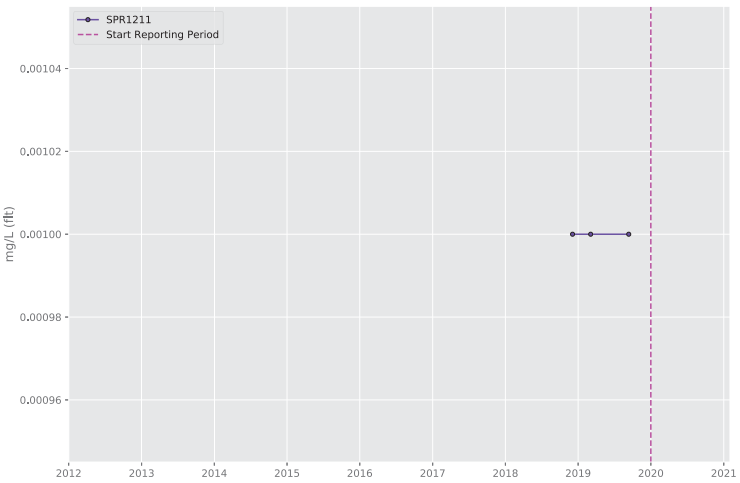
Chloride



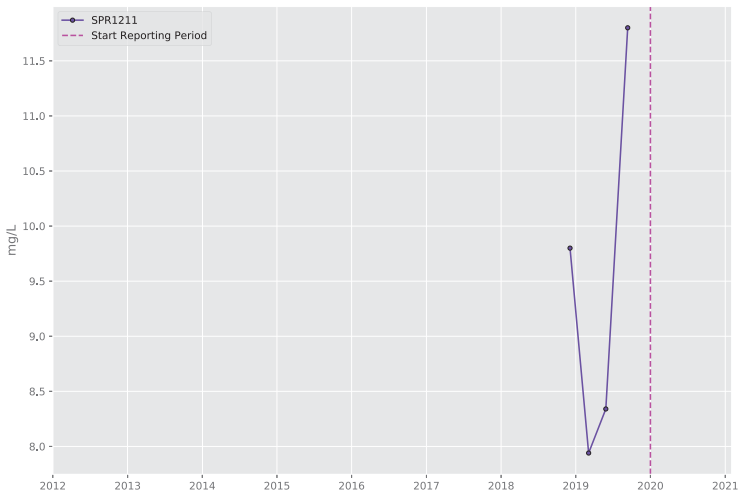
Chromium (soluble)



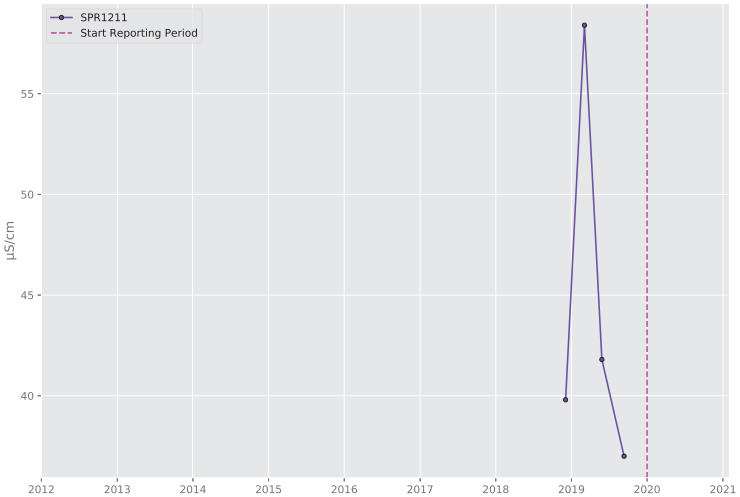
Copper



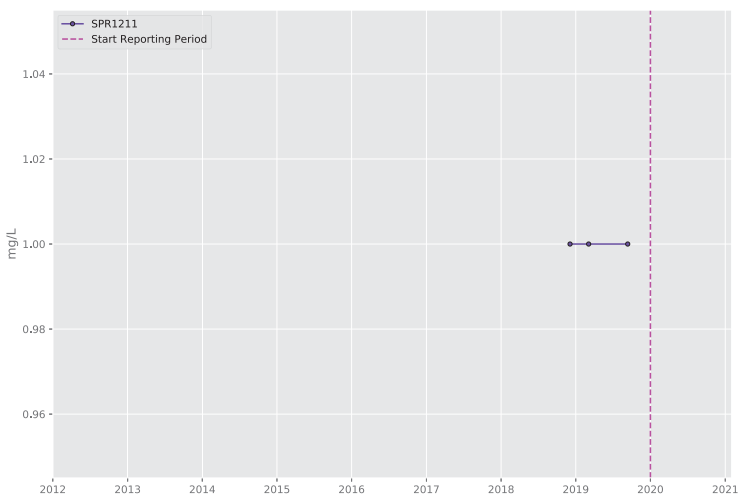
DO (Field)



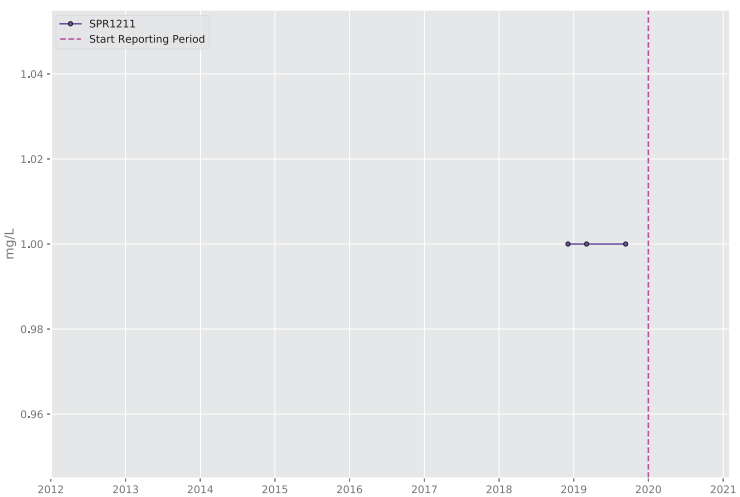
Electrical Conductivity (EC)



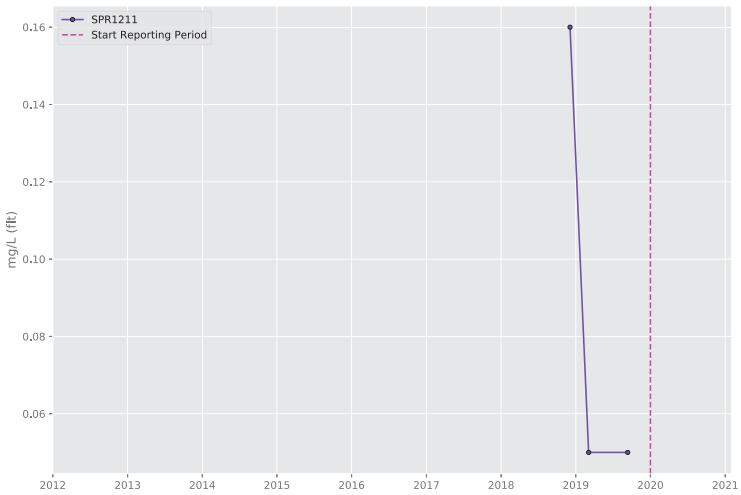
Hardness as CaCO3



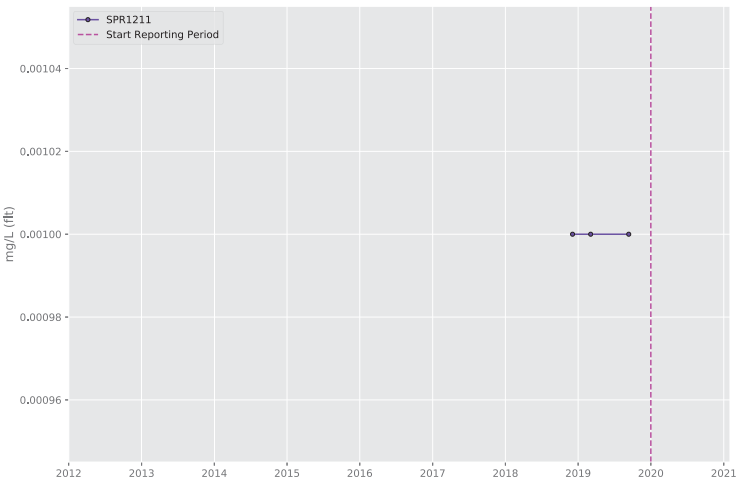
Hydroxide as CaCO3



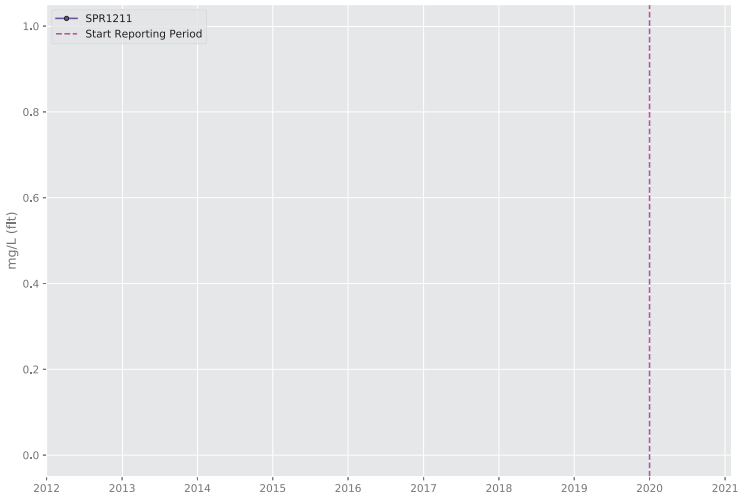
Iron



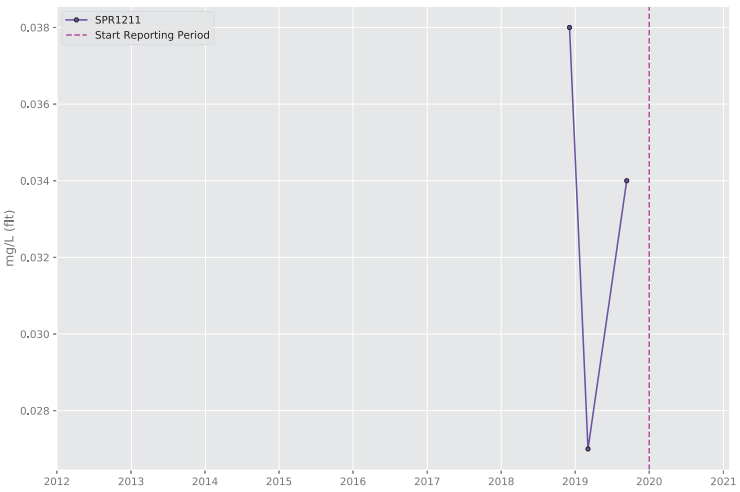
Lead



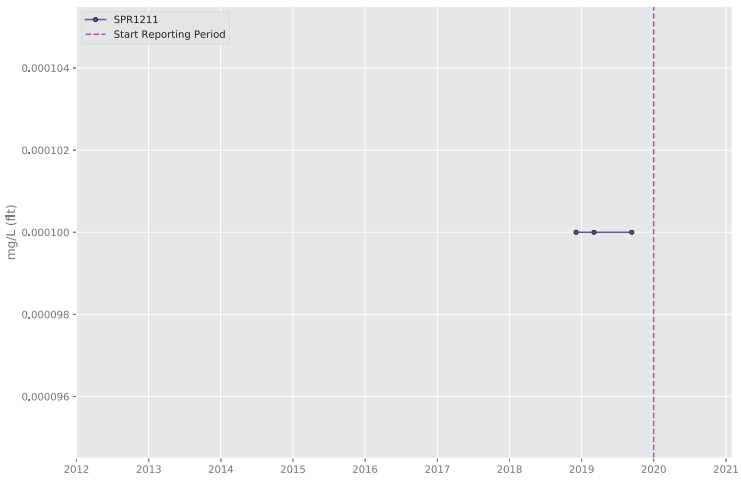
Magnesium



Manganese



Mercury



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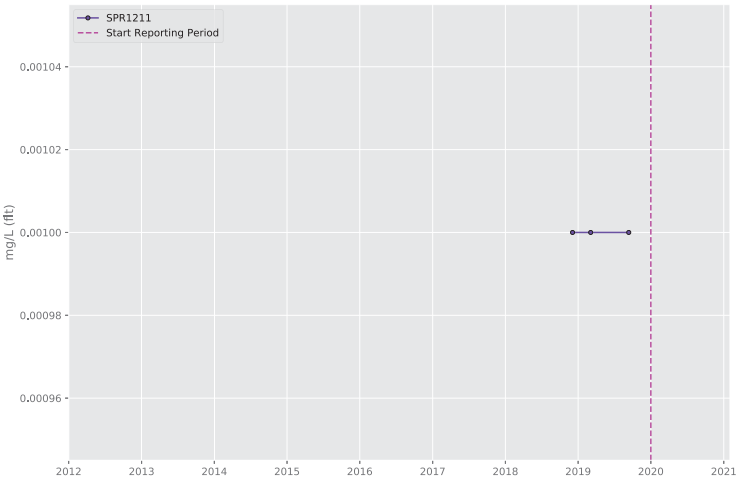
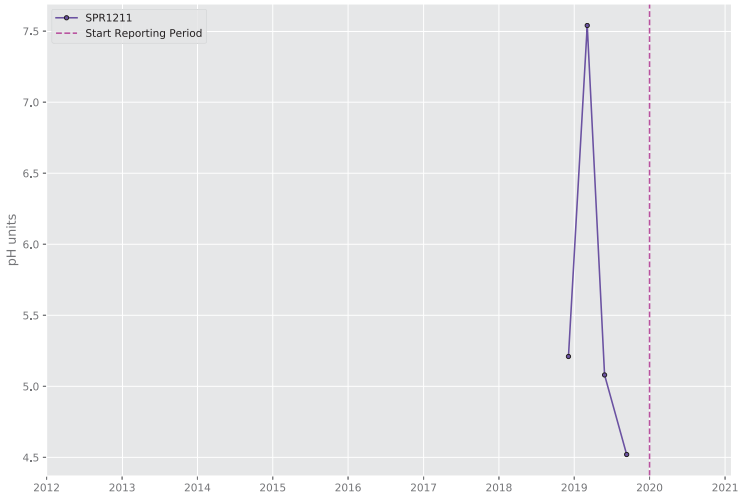
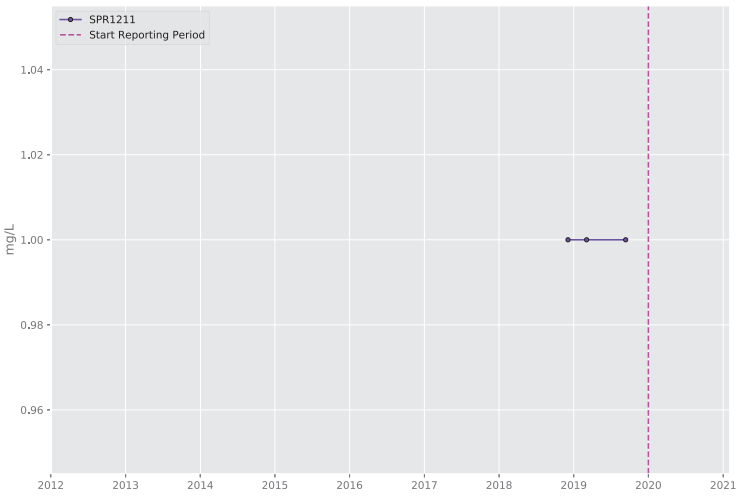


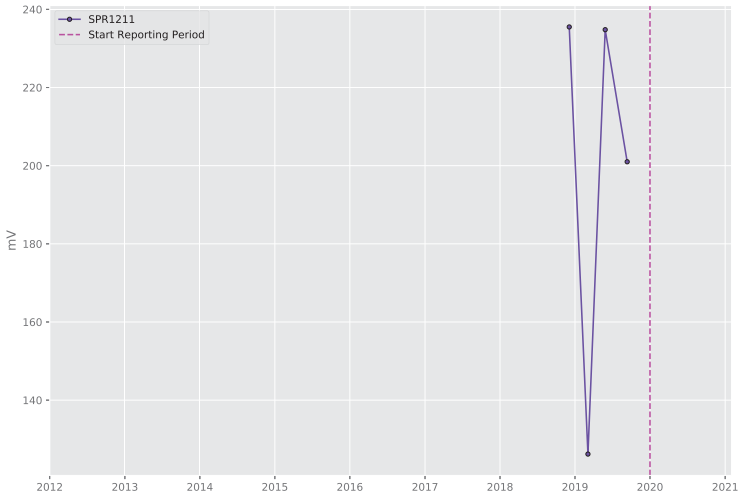
pH_0



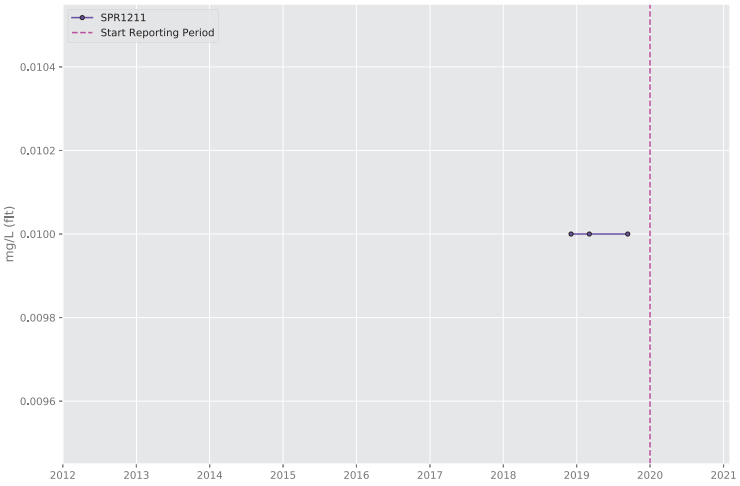
Potassium



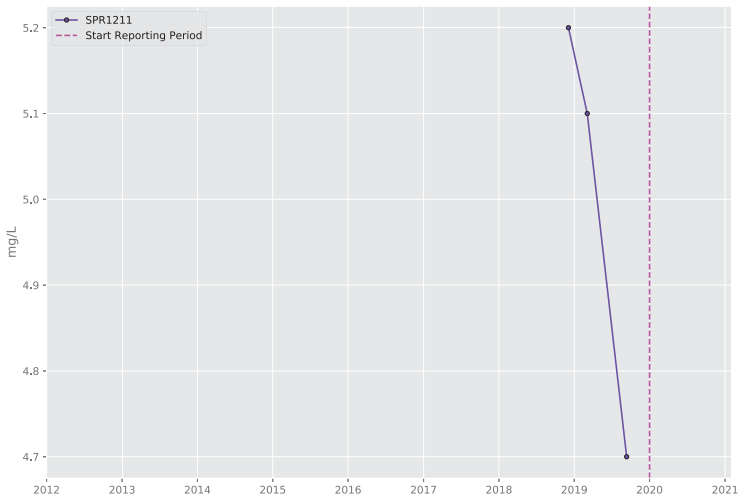
Redox Potential



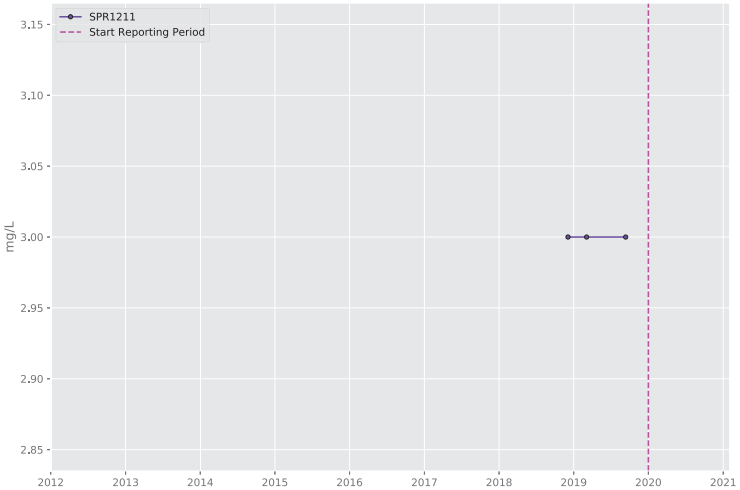
Selenium



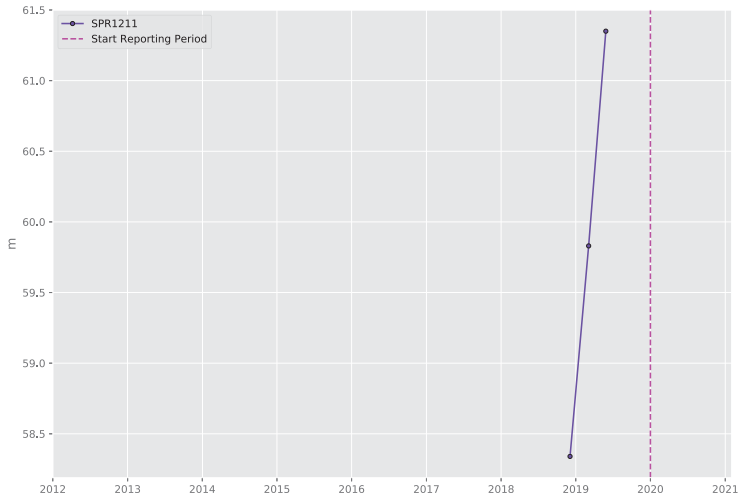
Silicon as SiO2



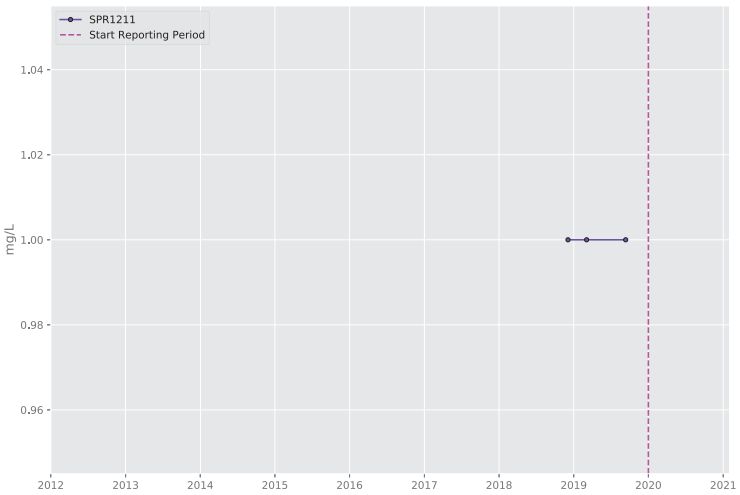
Sodium



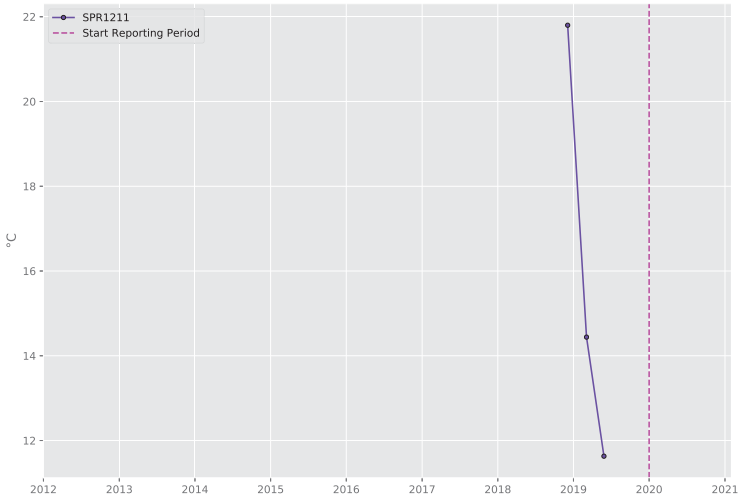
Standing water level



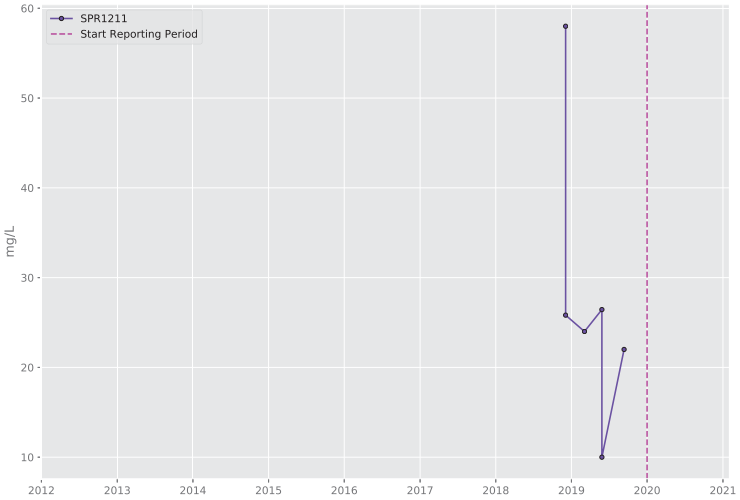
Sulphate



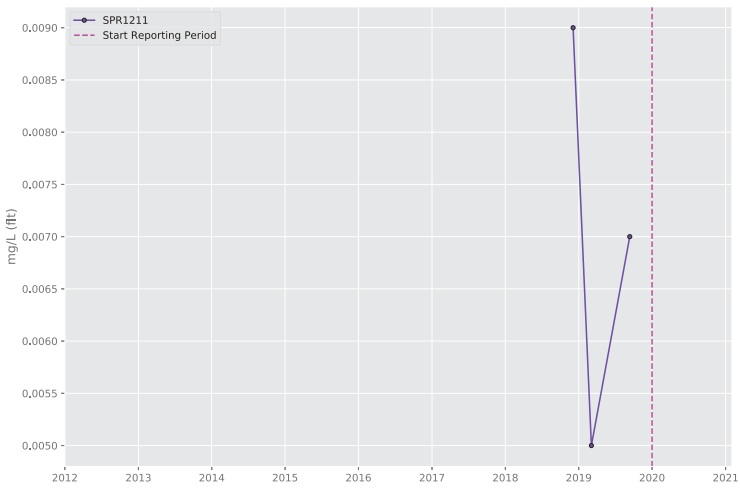
Temp



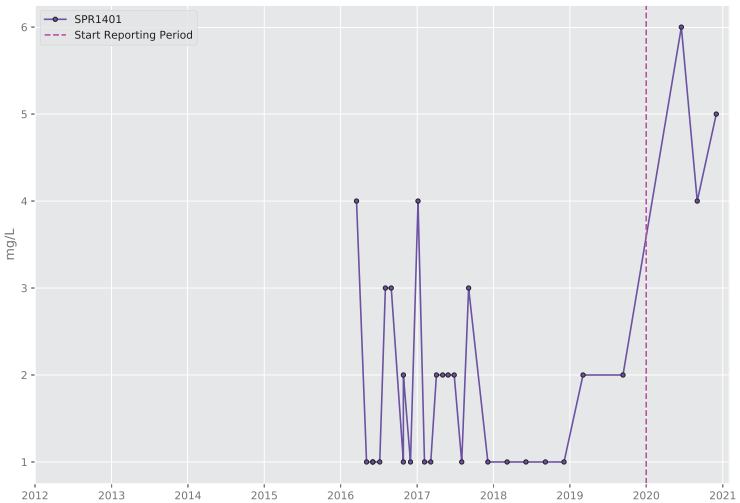
Total Dissolved Solids



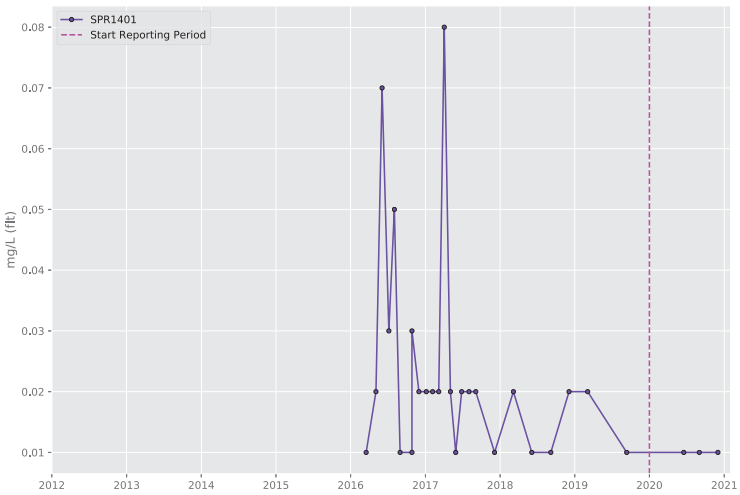
Zinc



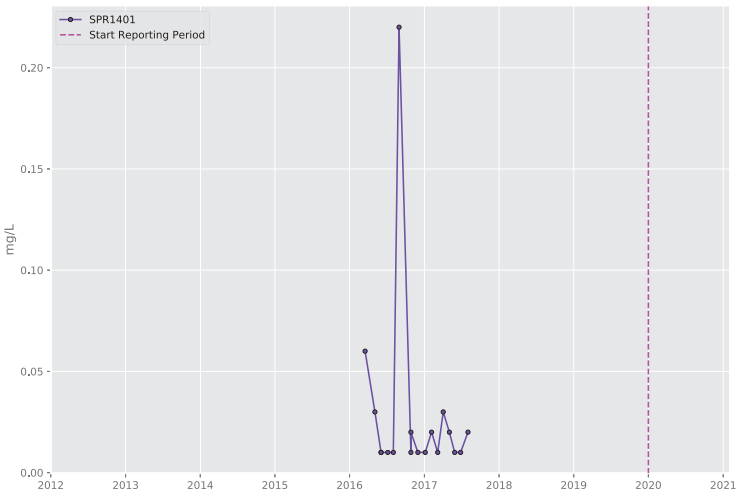
Alkalinity (total) as CaCO3



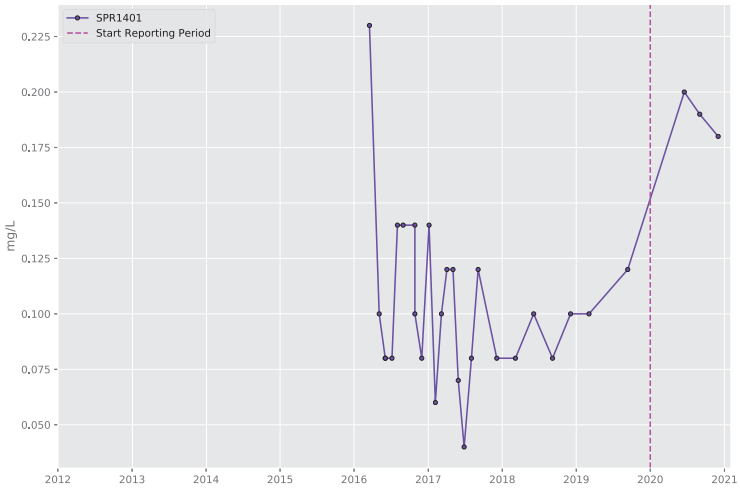
Aluminium



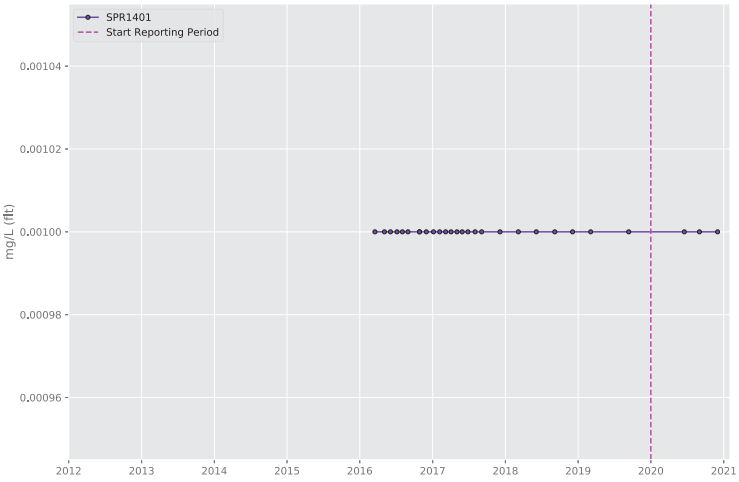
Ammonia as N



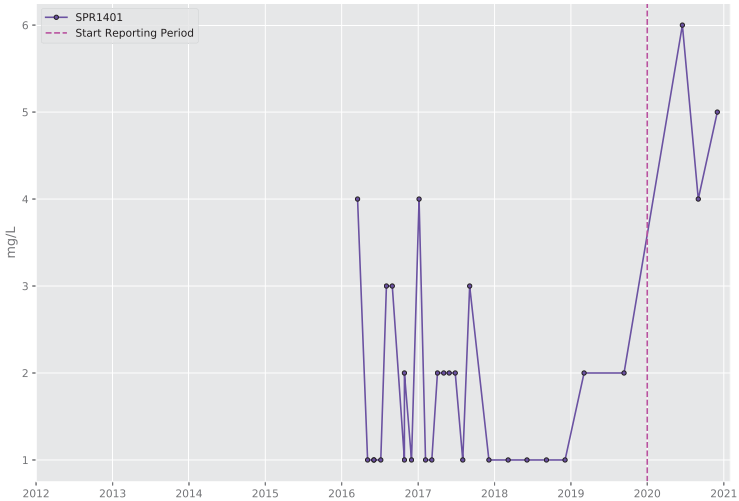
Anions Total



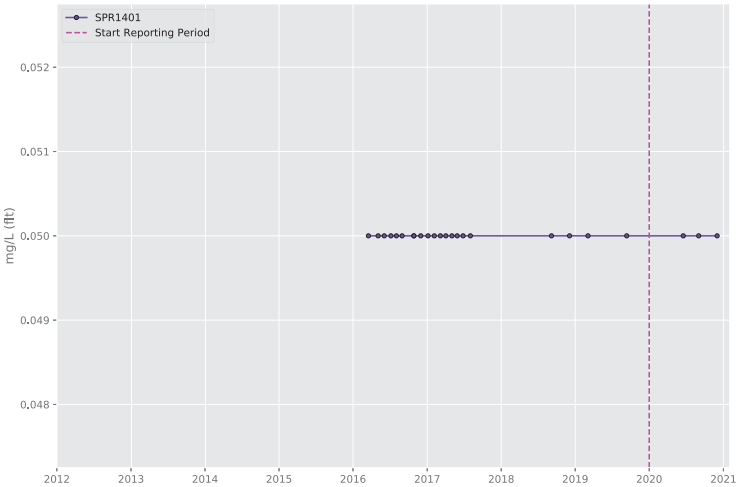
Arsenic



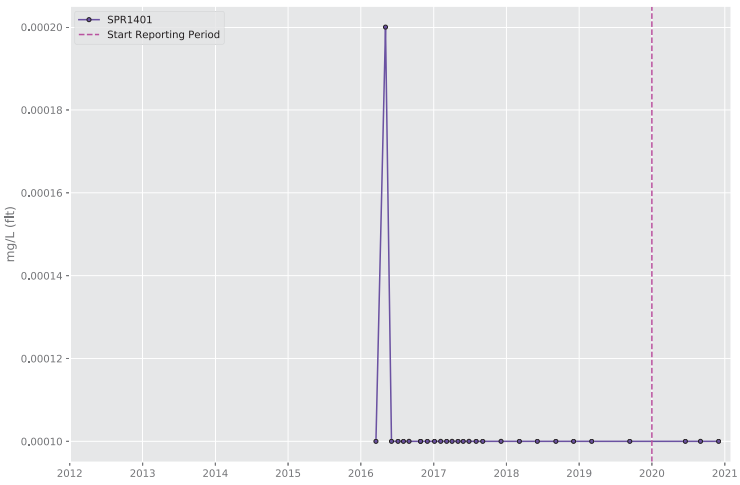
Bicarbonate Alkalinity as CaCO3



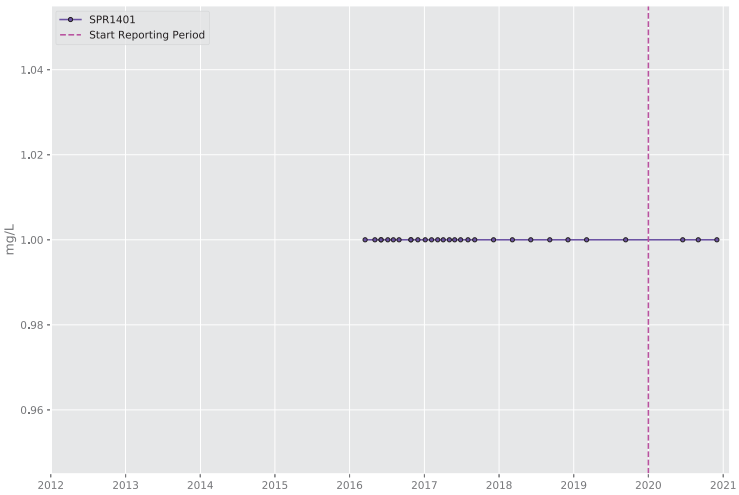
Boron



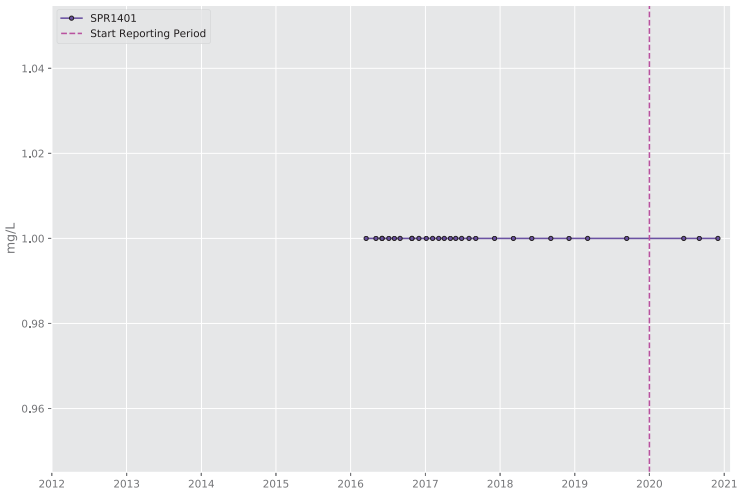
Cadmium



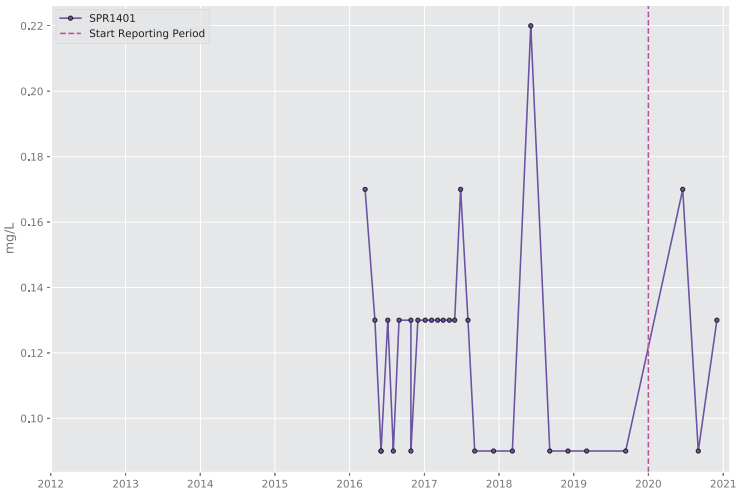
Calcium



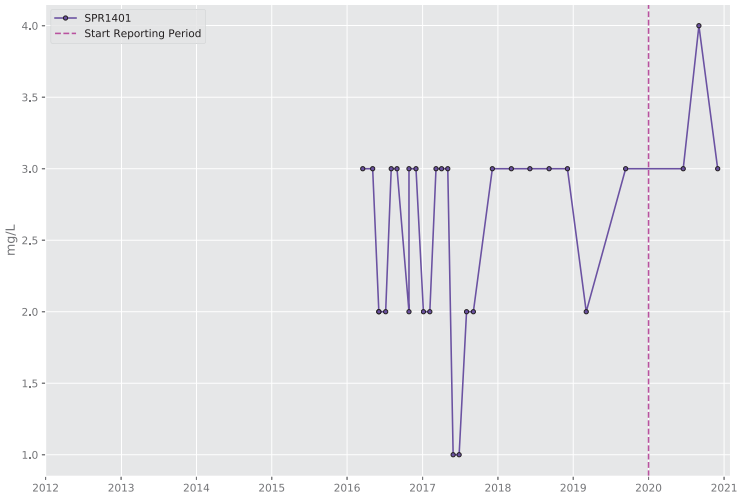
Carbonate



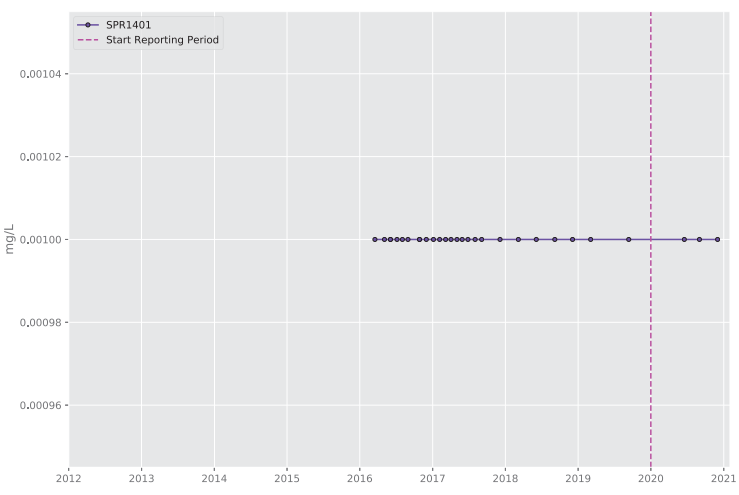
Cations Total



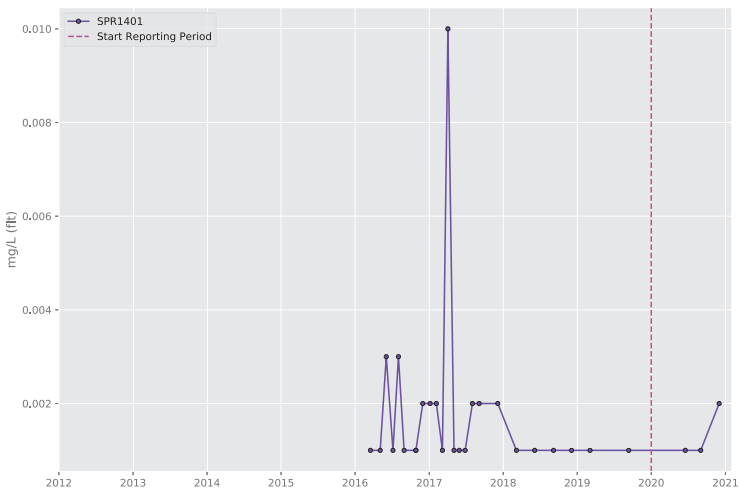
Chloride



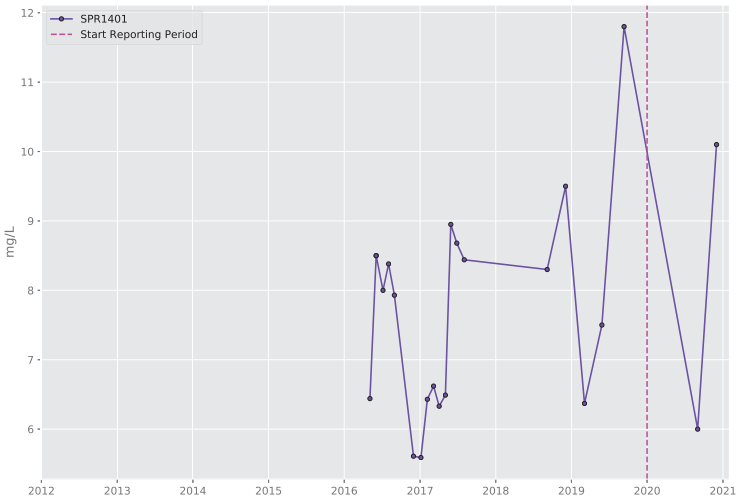
Chromium (soluble)



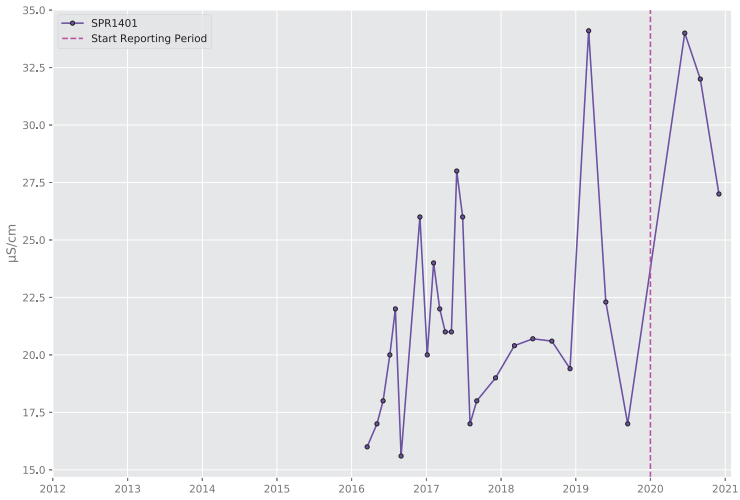
Copper



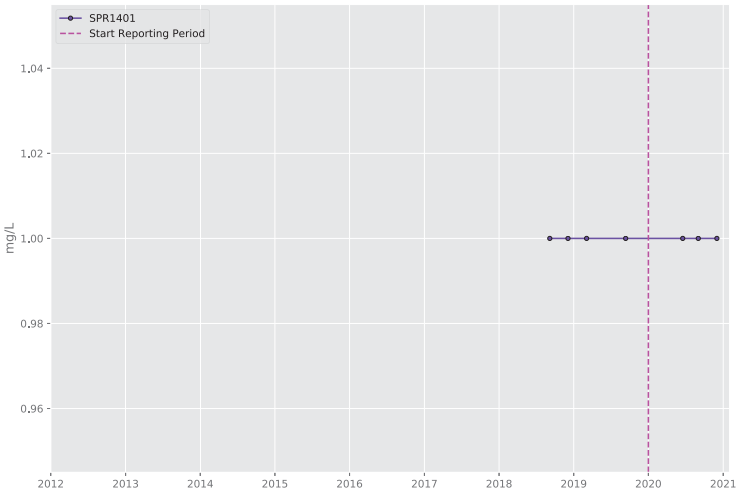
DO (Field)



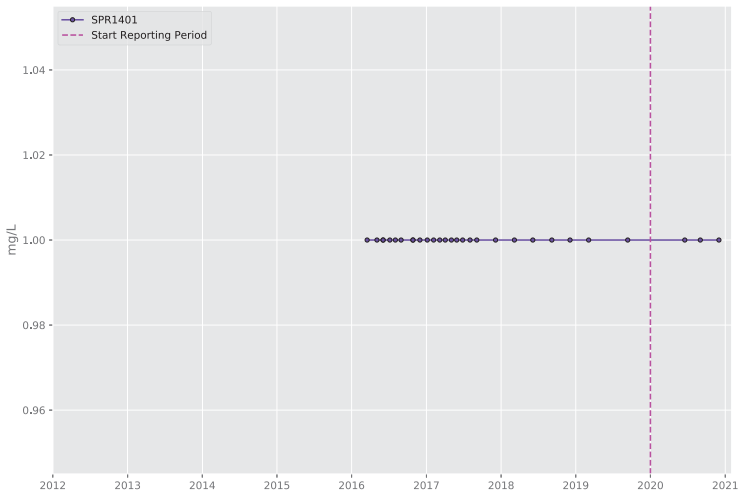
Electrical Conductivity (EC)



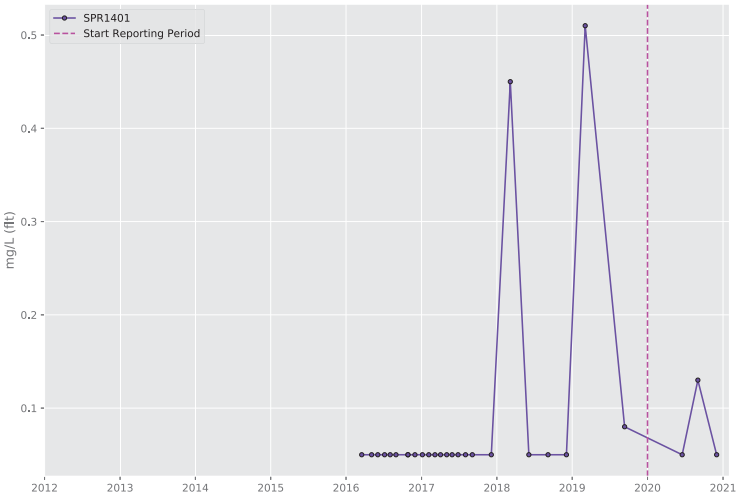
Hardness as CaCO3



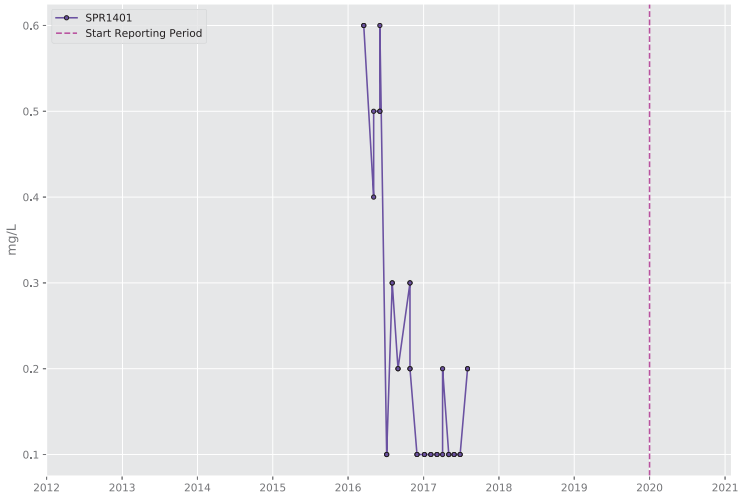
Hydroxide as CaCO3



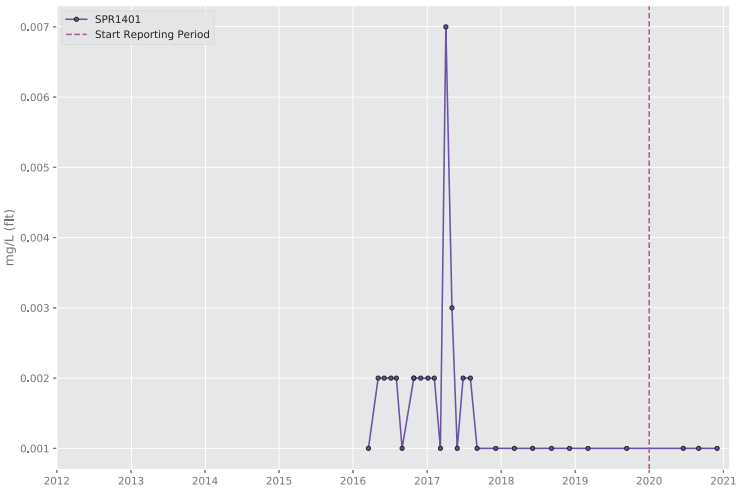
Iron



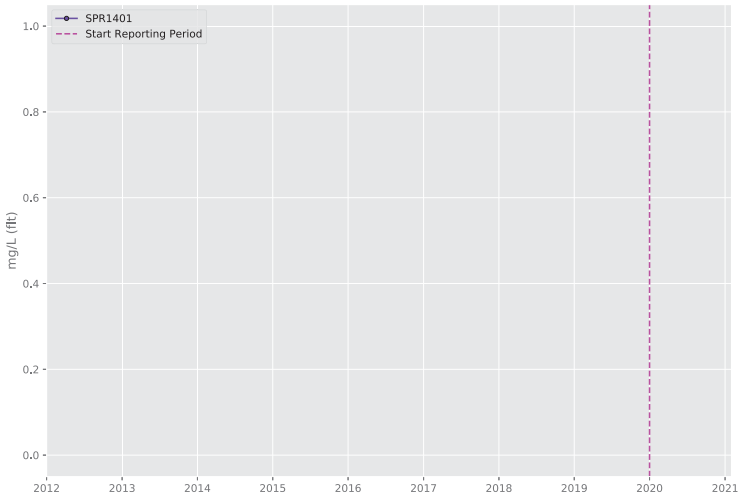
Kjeldahl Nitrogen Total



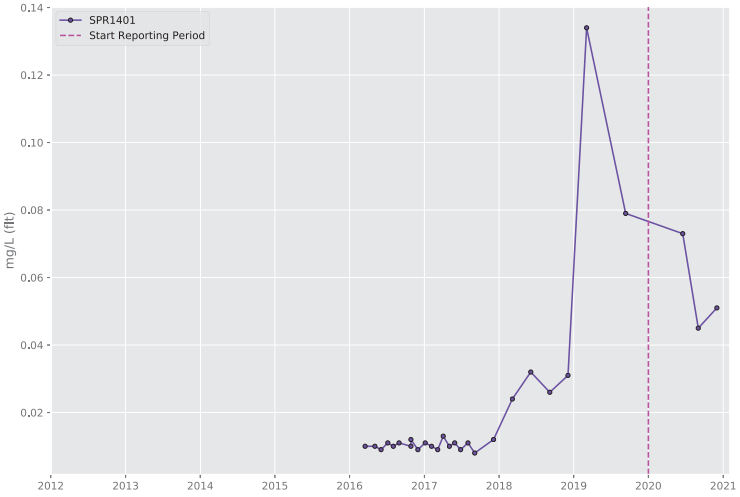
Lead



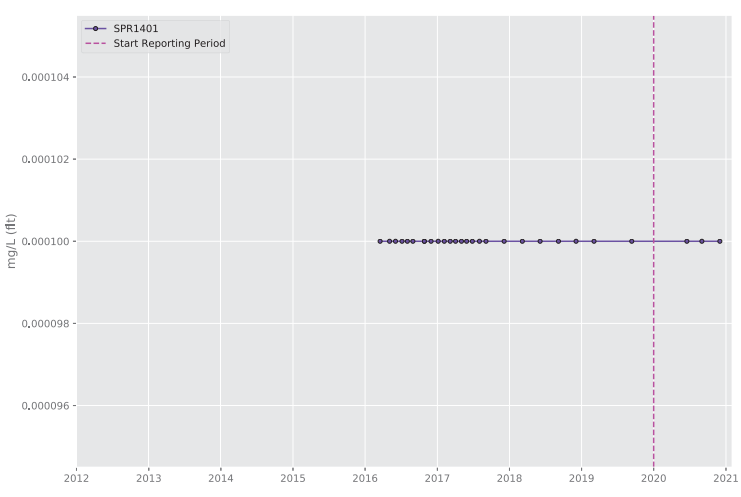
Magnesium



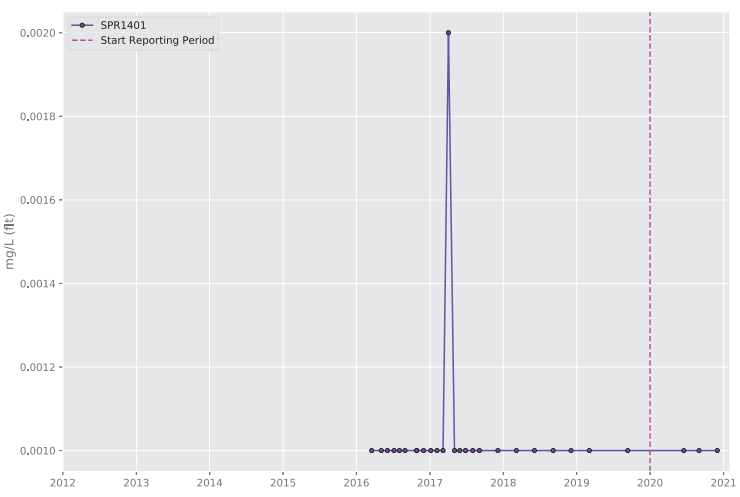
Manganese



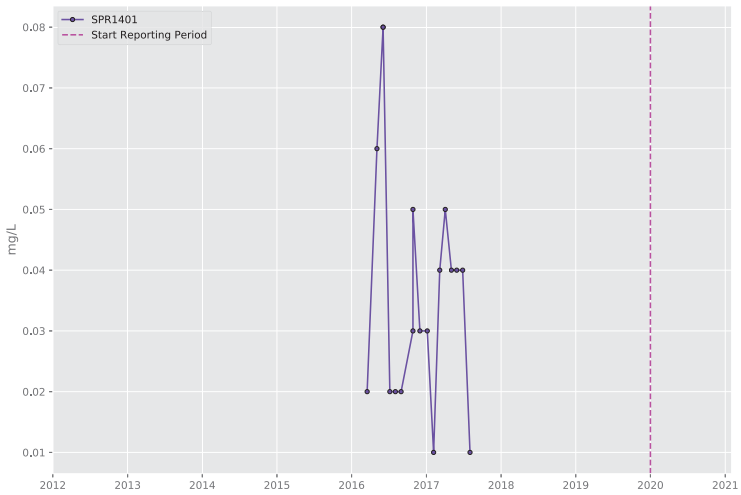
Mercury



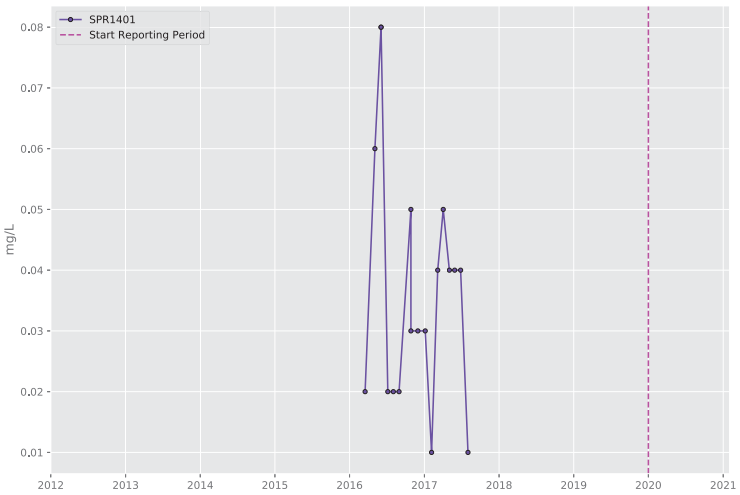
Nickel



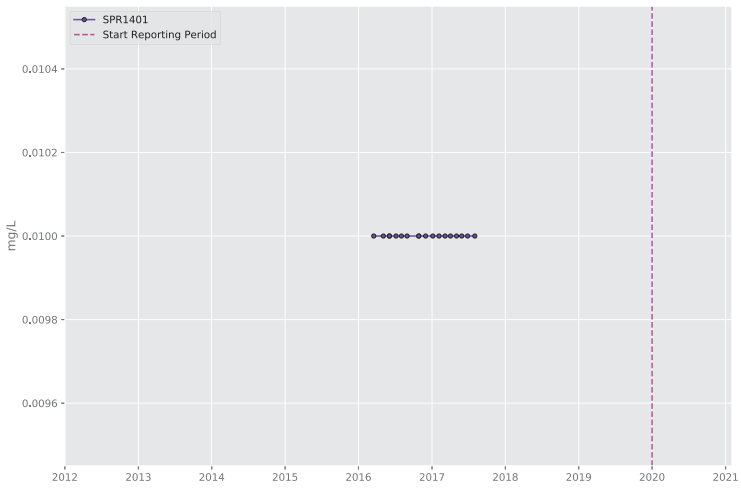
Nitrate & Nitrite (as N)



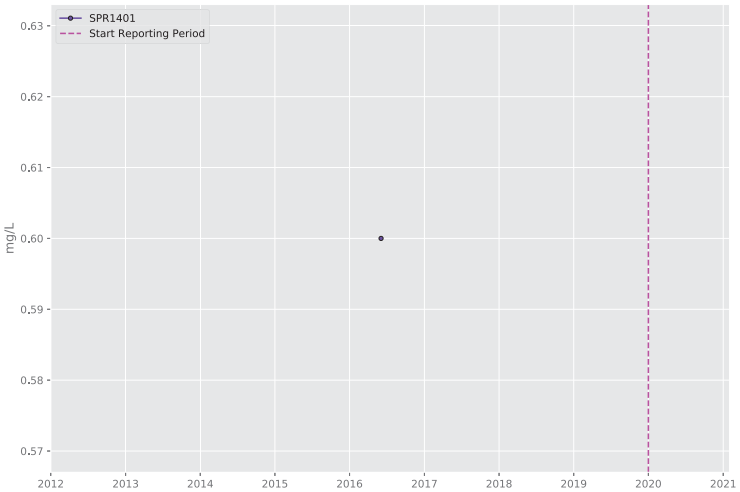
Nitrate (as N)



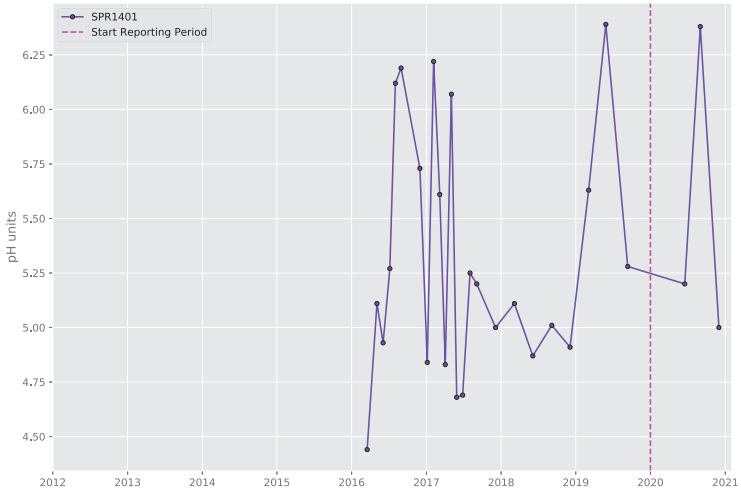
Nitrite (as N)



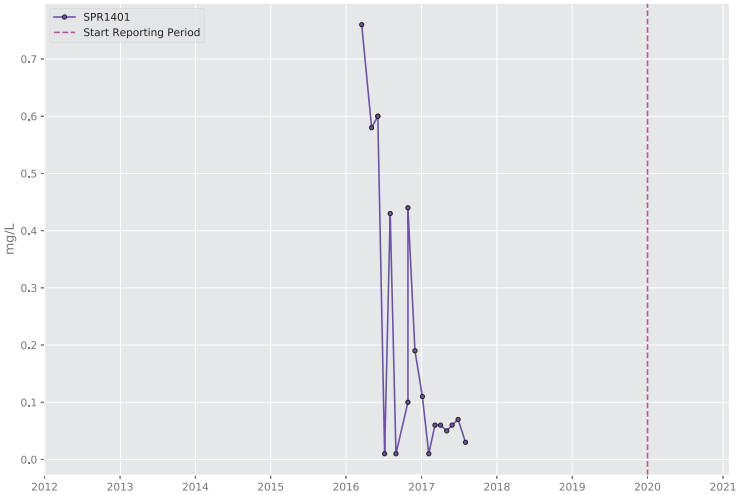
Nitrogen (Total)



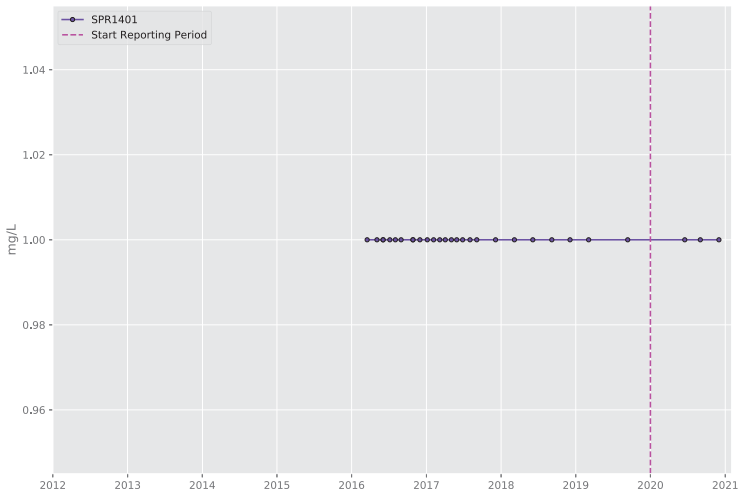
pH_0



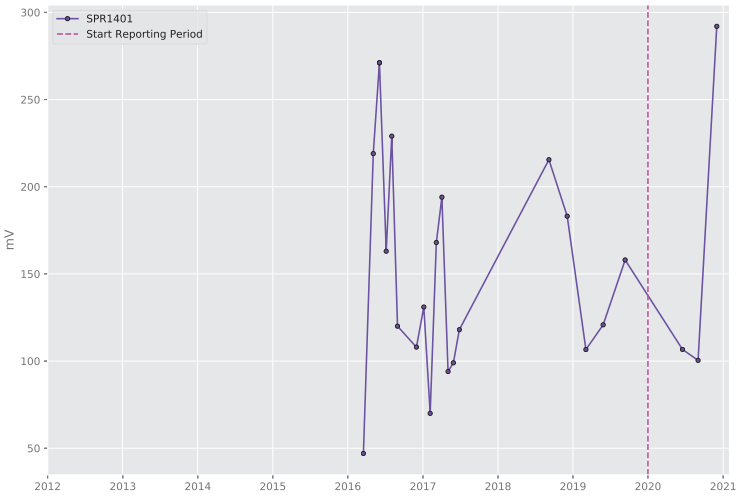
Phosphorus



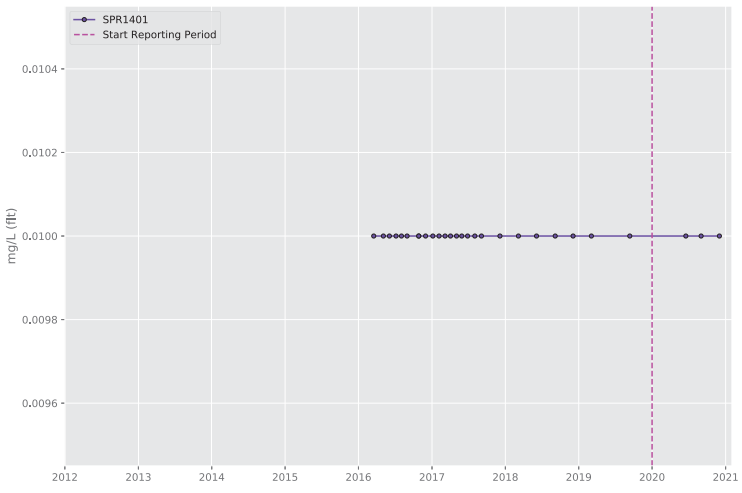
Potassium



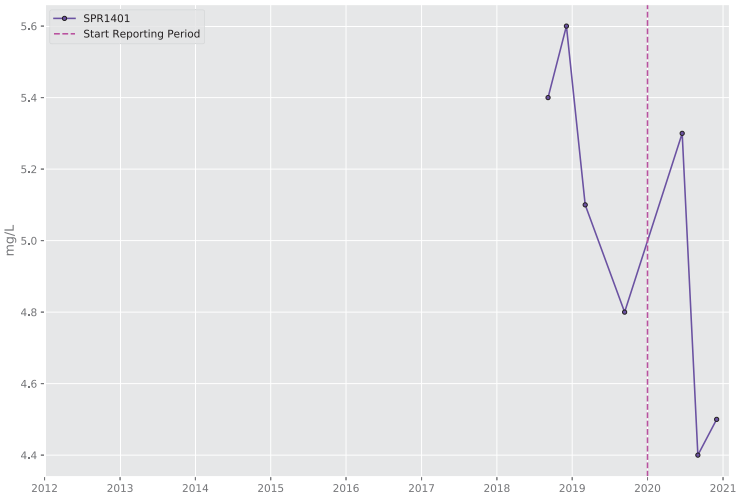
Redox Potential



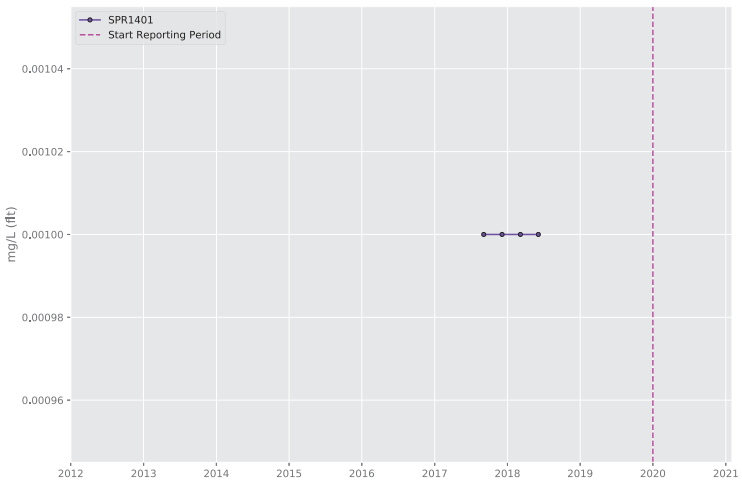
Selenium



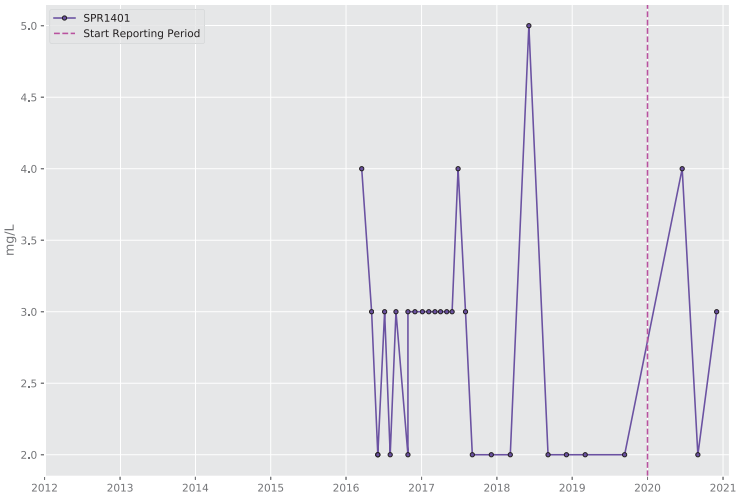
Silicon as SiO2



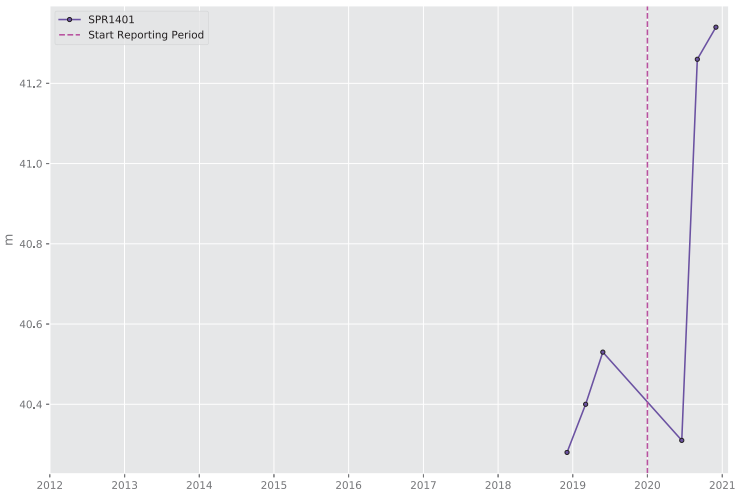
Silver



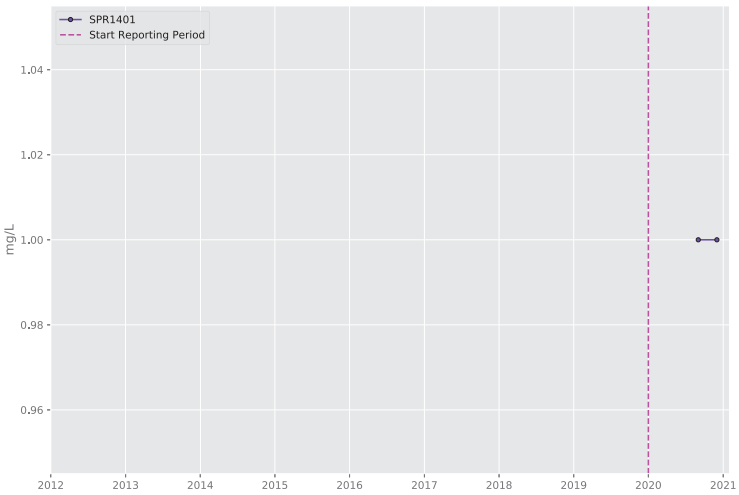
Sodium



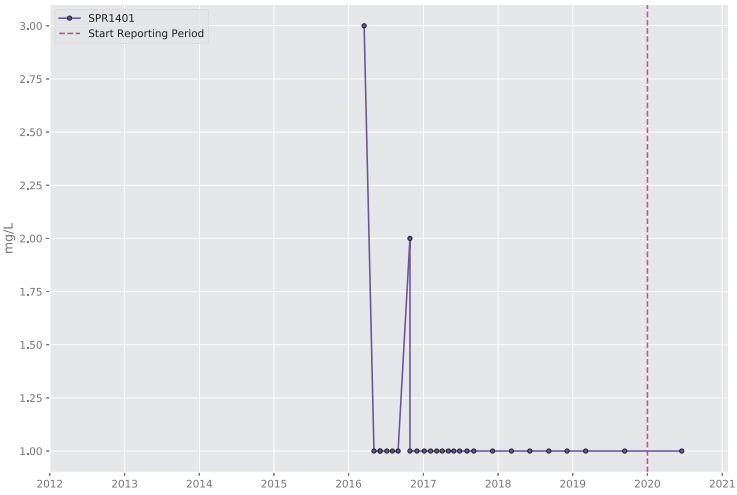
Standing water level



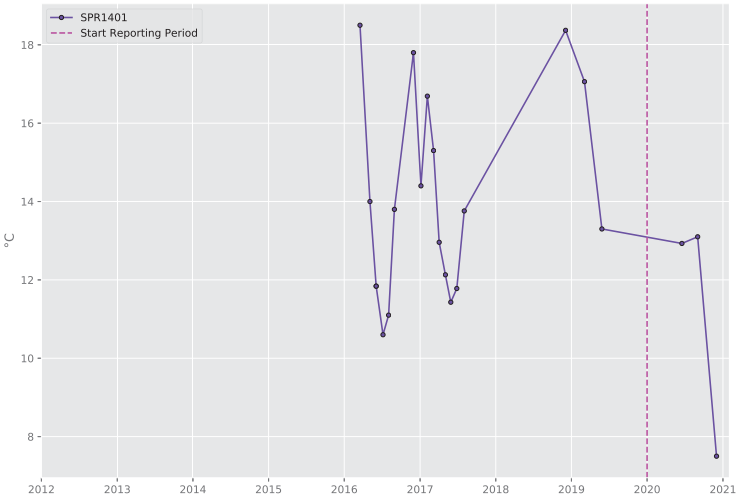
Sulfate as SO4 - Turbidimetric



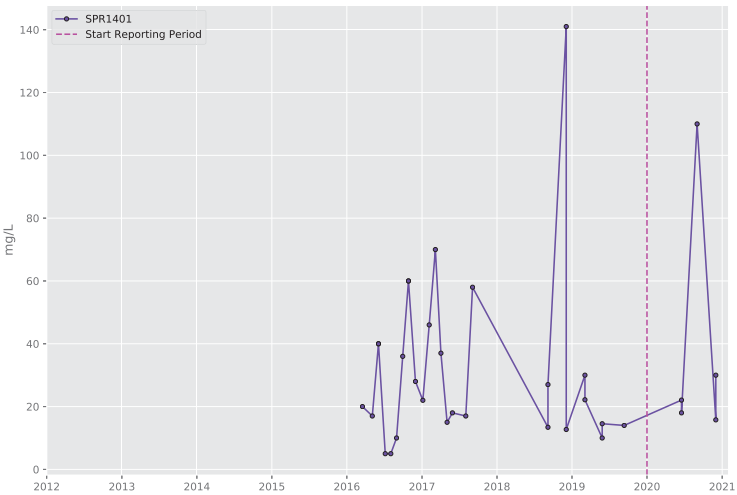
Sulphate



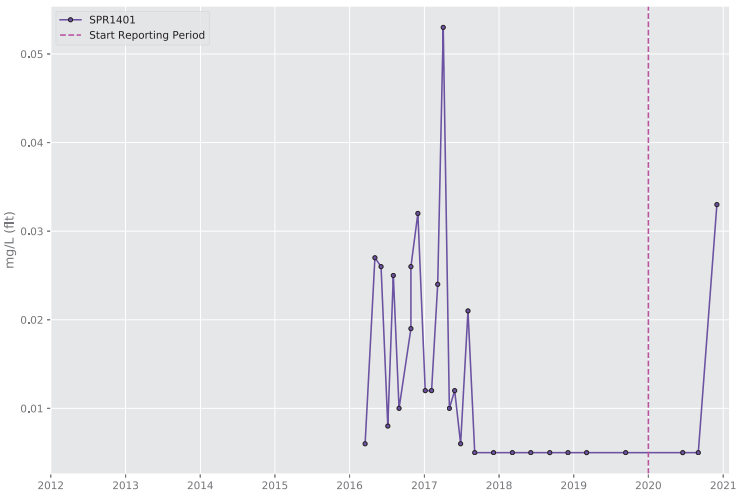
Temp



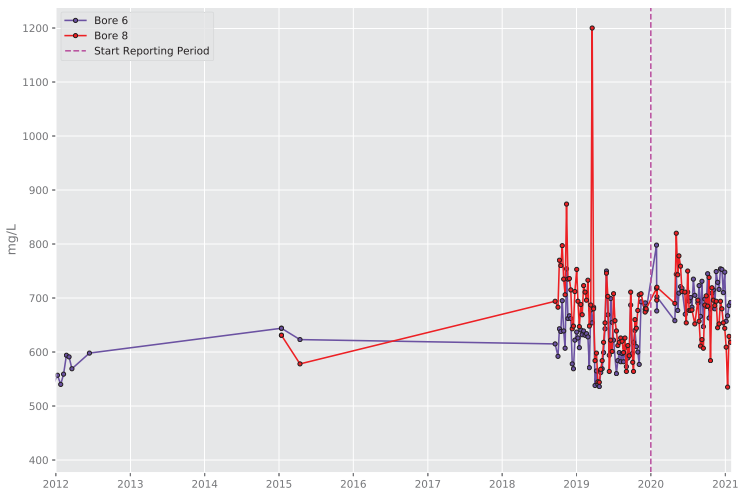
Total Dissolved Solids



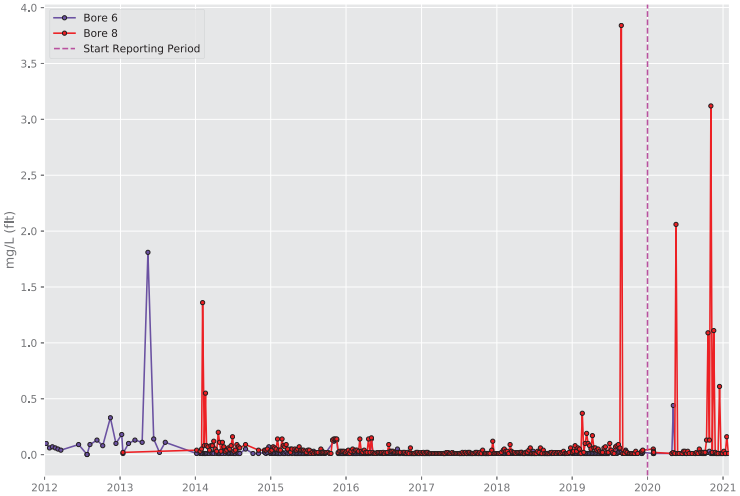
Zinc



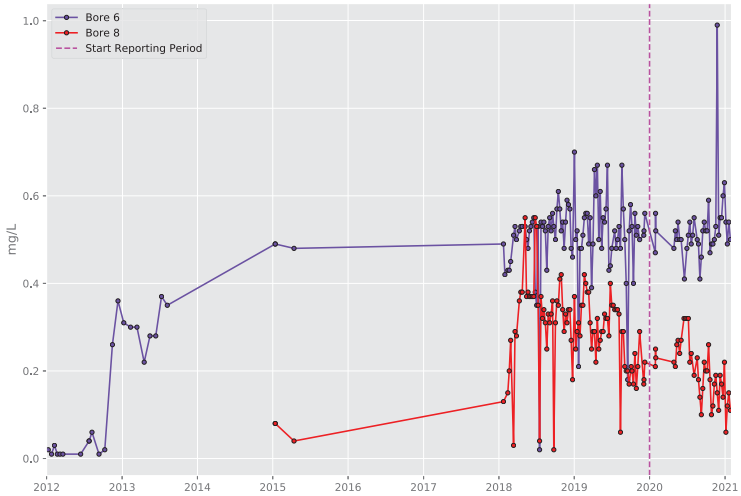
Alkalinity (total) as CaCO3



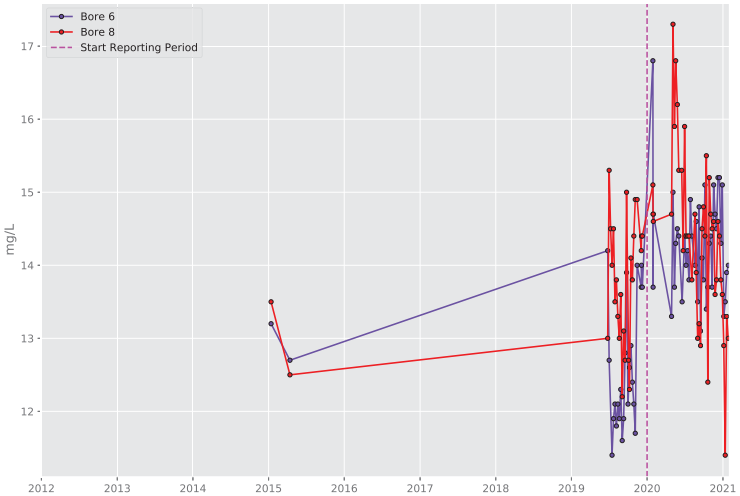
Aluminium



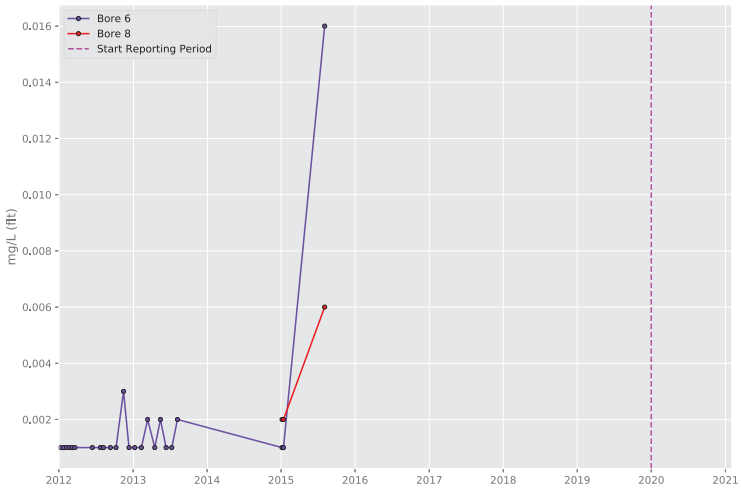
Ammonia as N



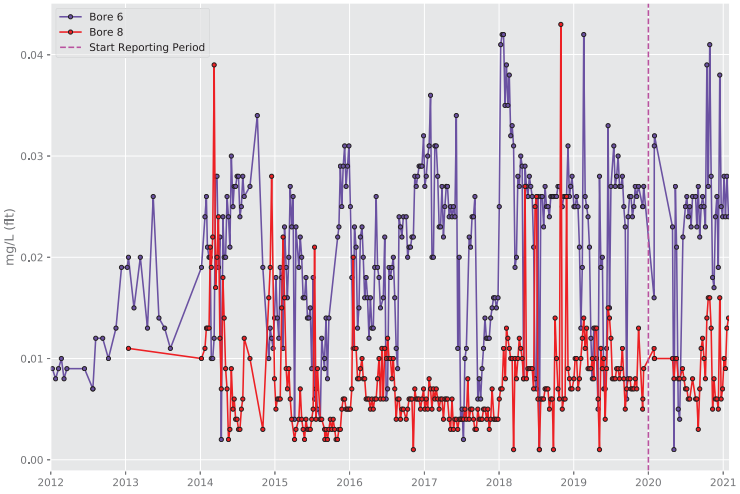
Anions Total



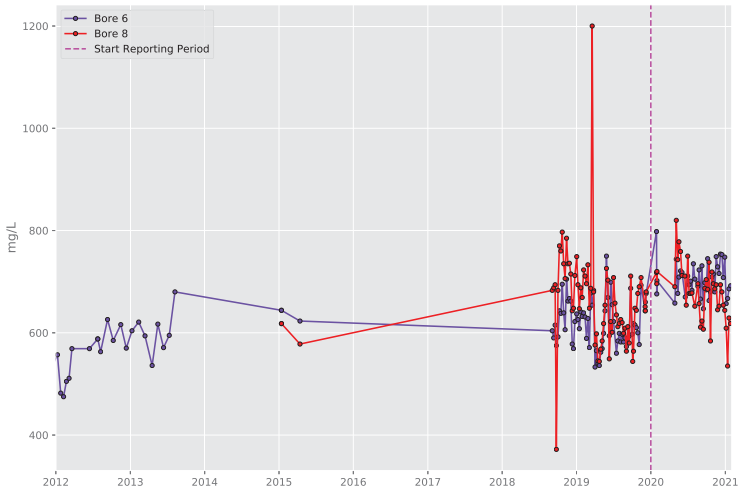
Antimony



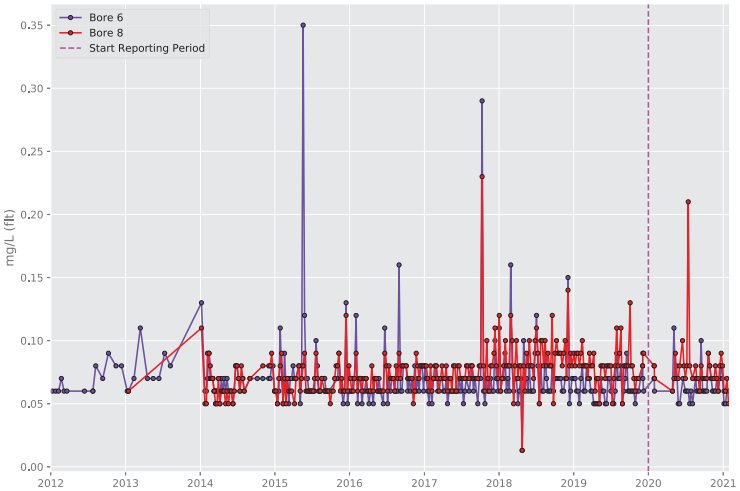
Arsenic



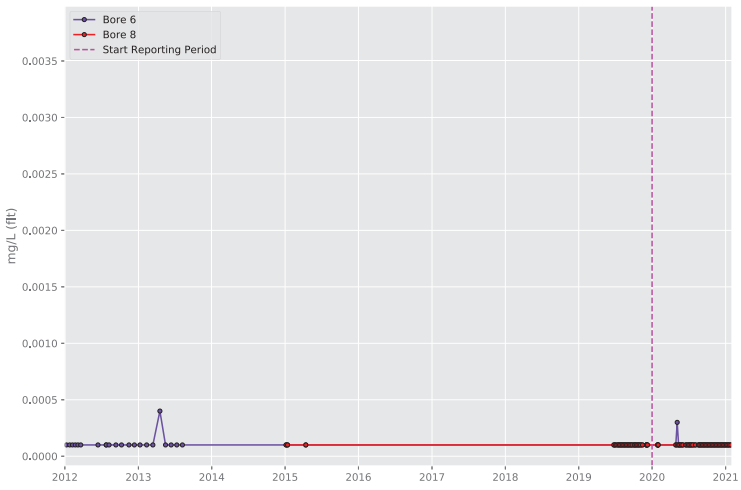
Bicarbonate Alkalinity as CaCO3



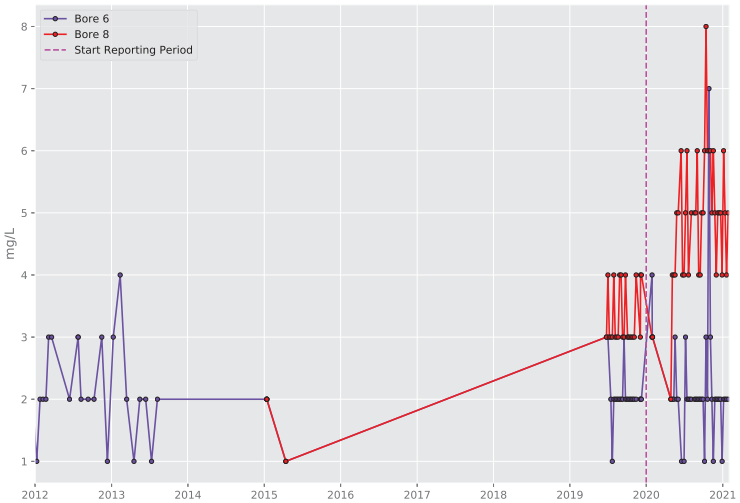
Boron



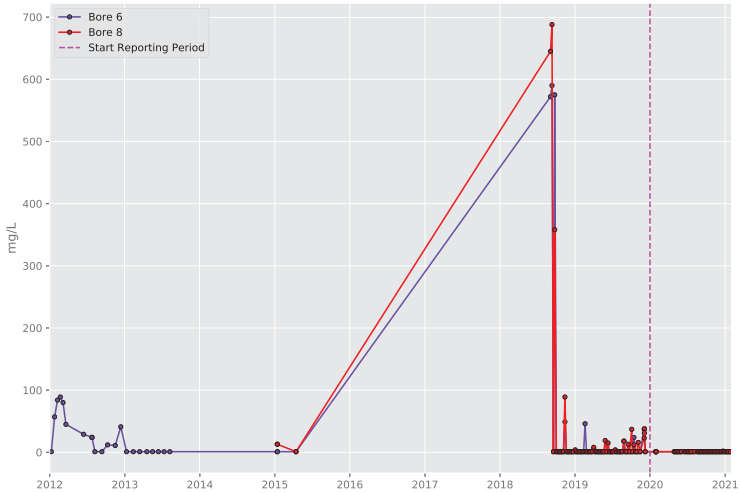
Cadmium



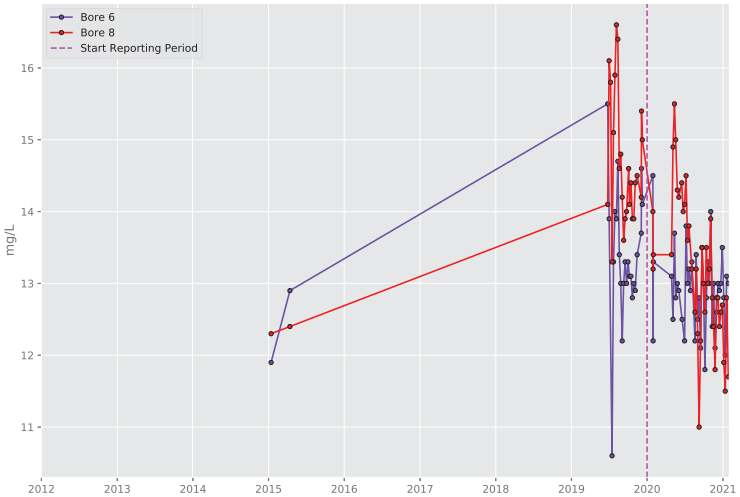
Calcium



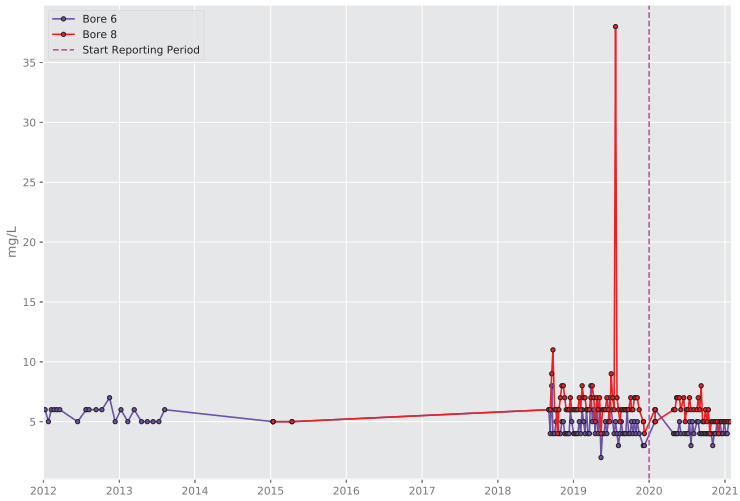
Carbonate



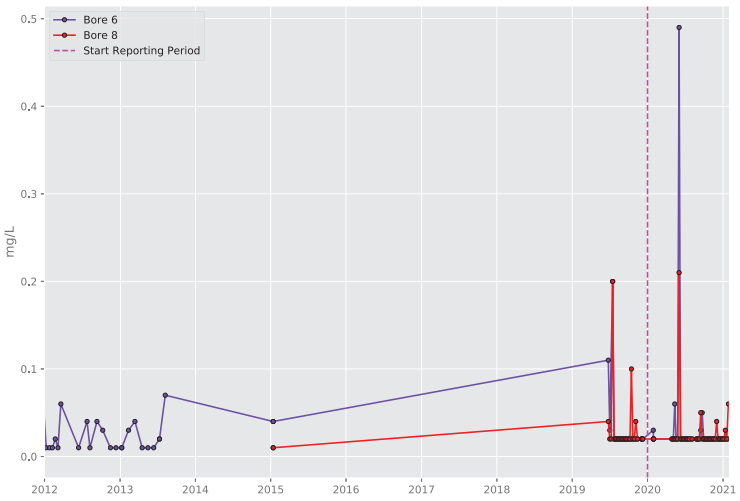
Cations Total



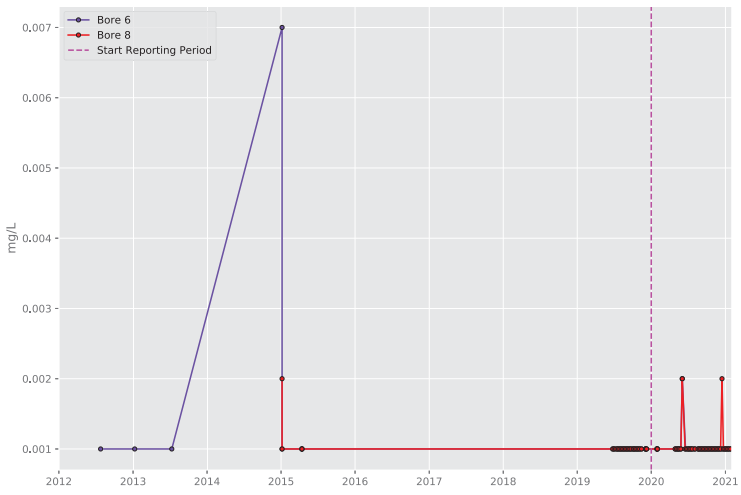
Chloride



Chlorine (Free)



Chromium (soluble)



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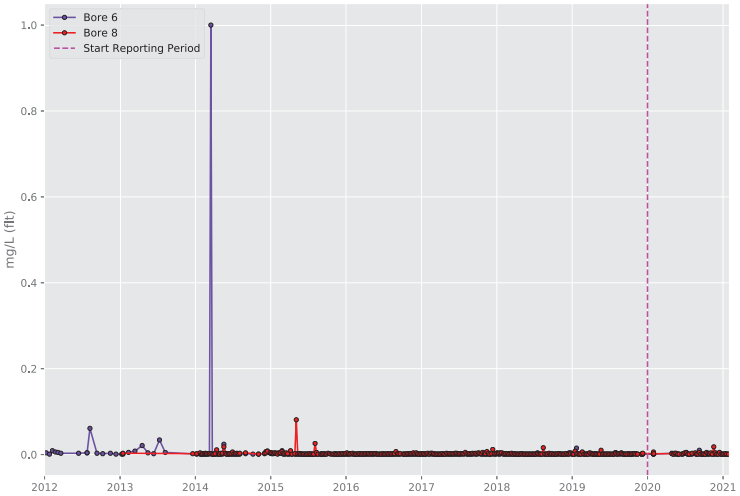
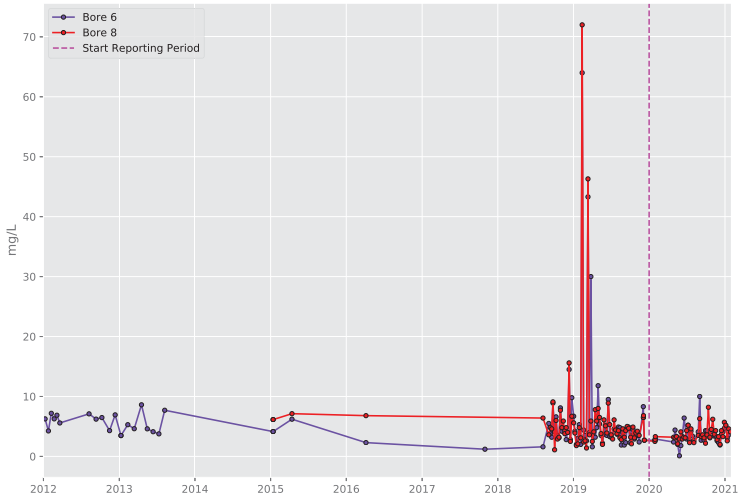
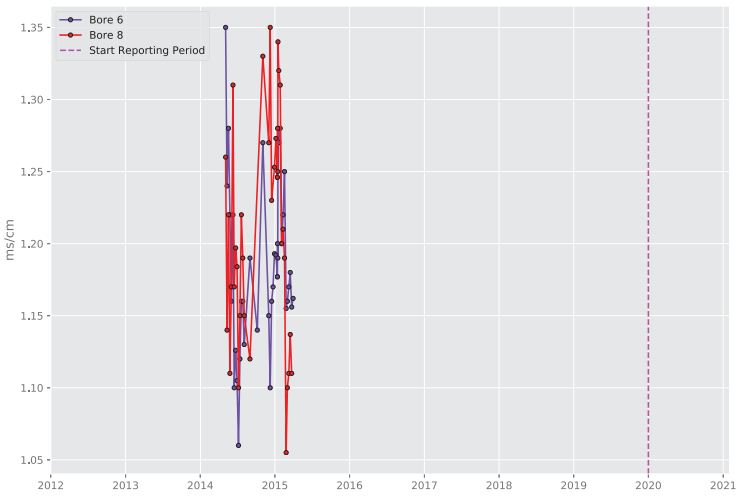


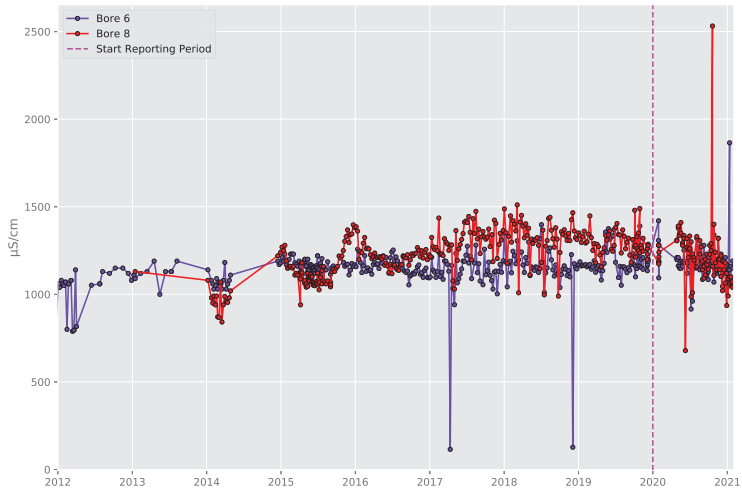
DO (Field)



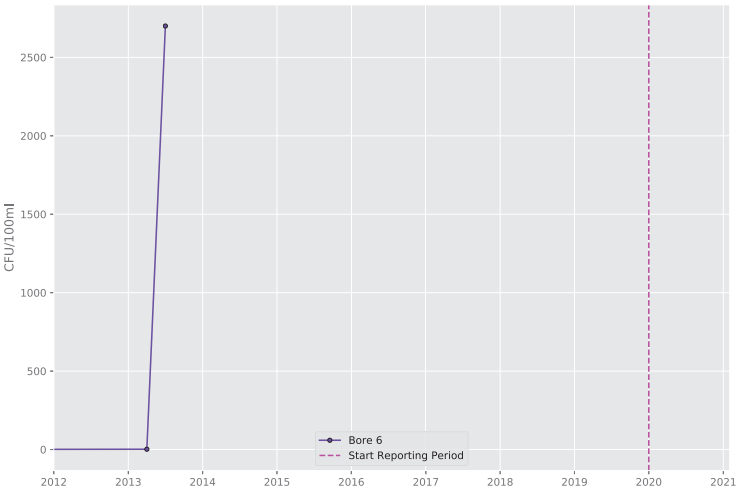
EC (field)



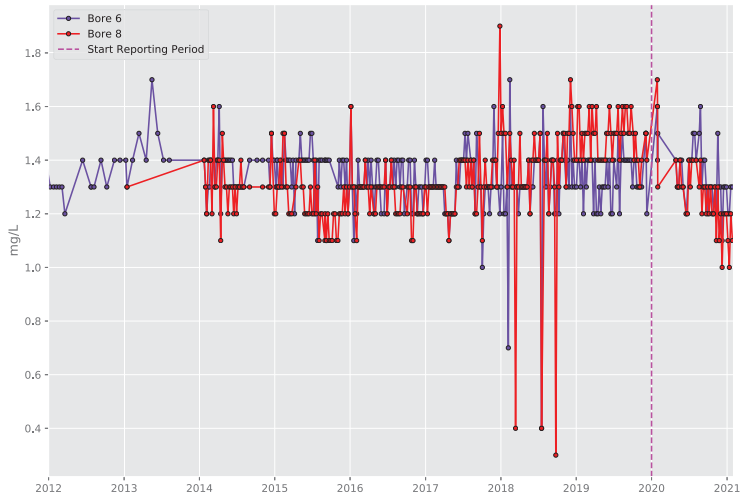
Electrical Conductivity (EC)



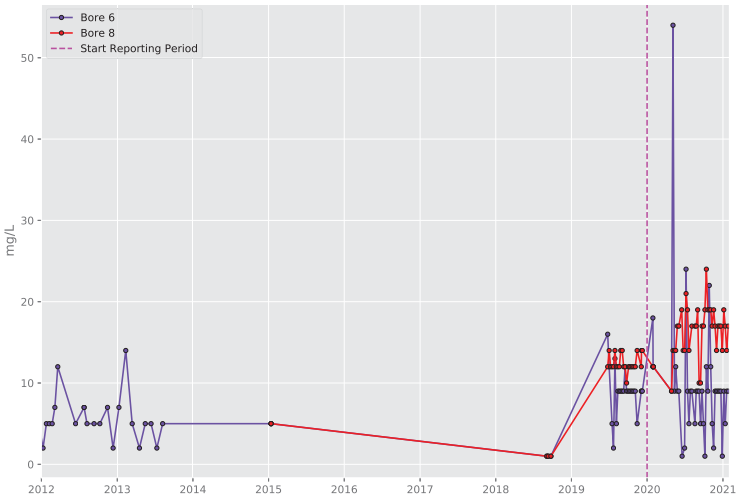
Faecal Coliforms



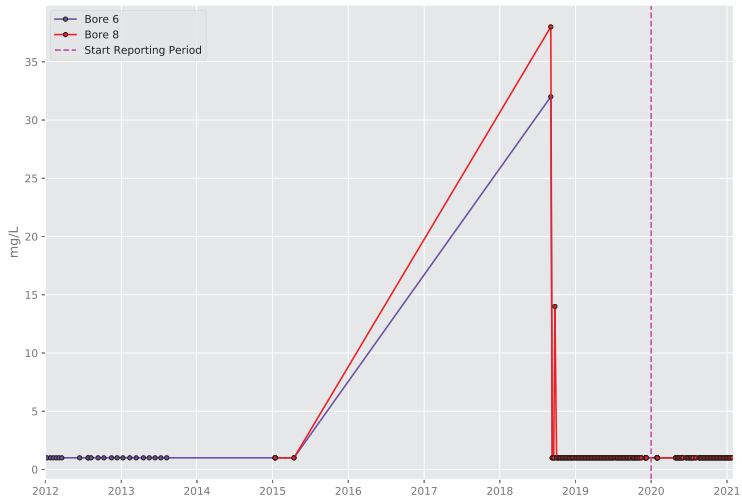
Fluoride



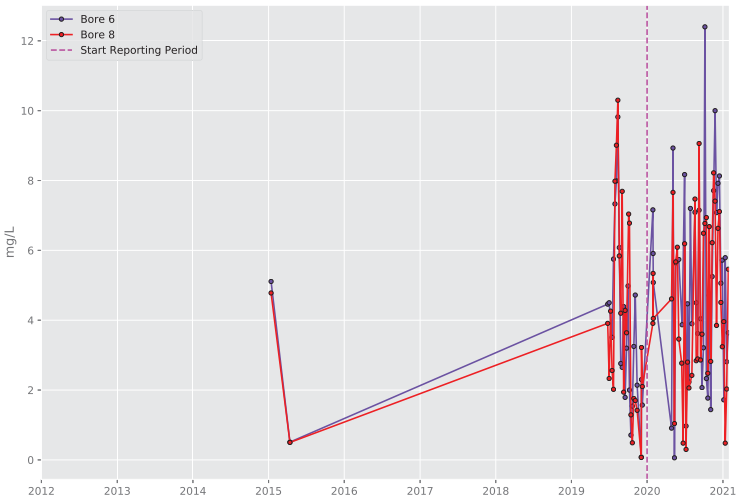
Hardness as CaCO3



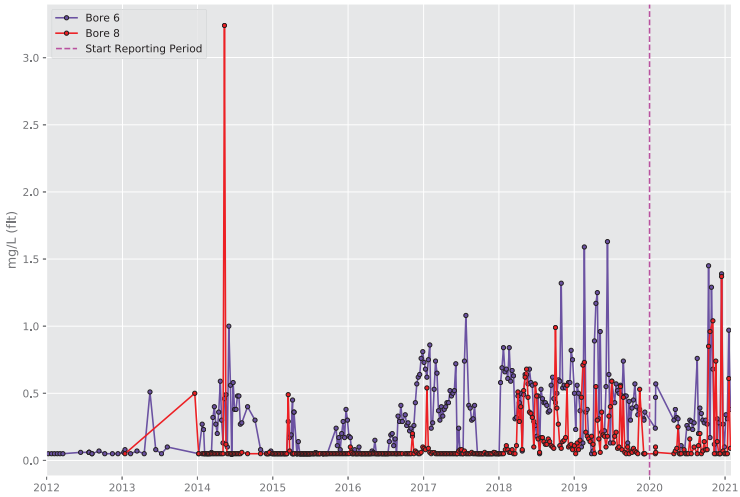
Hydroxide as CaCO3



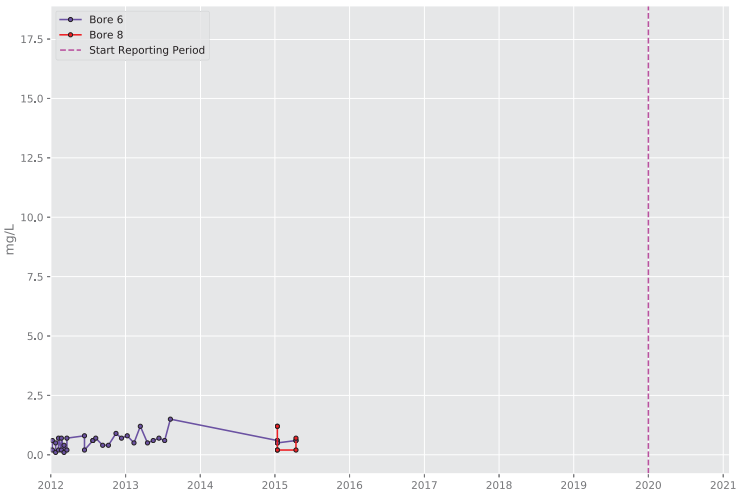
Ionic Balance



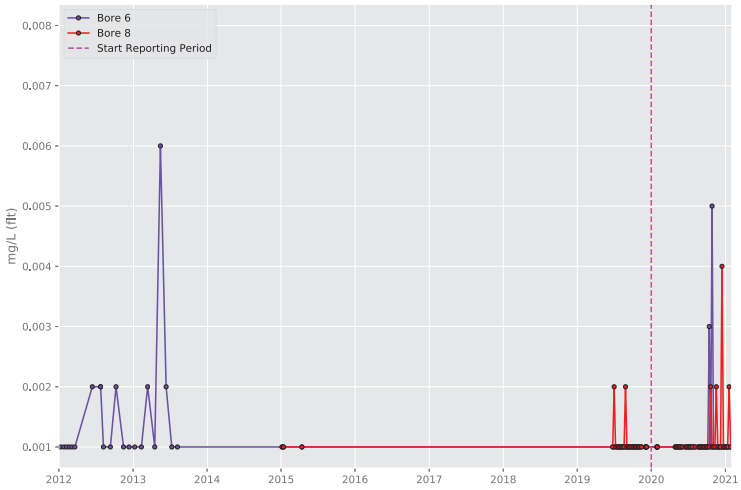
Iron



Kjeldahl Nitrogen Total

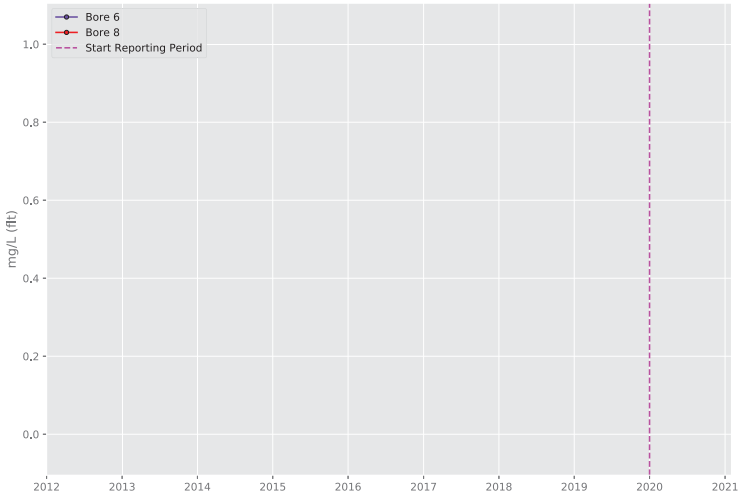


Lead

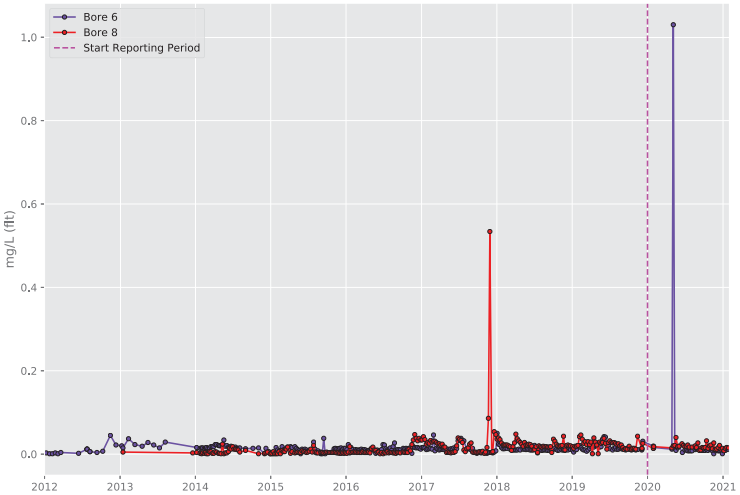


Magnesium

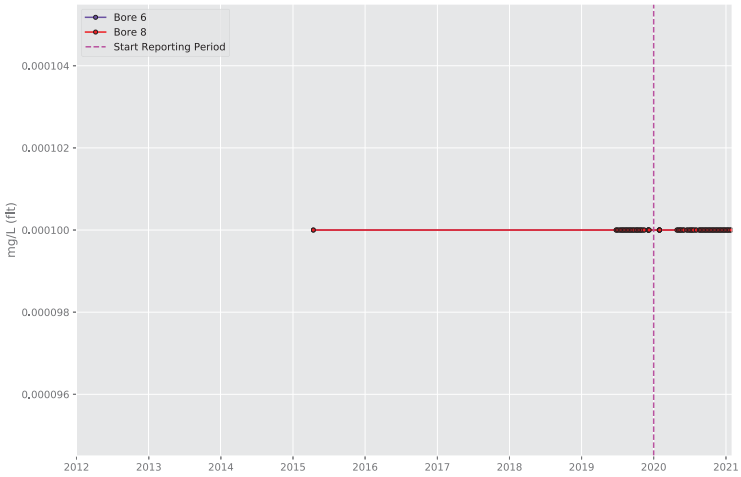
Manganese Tot



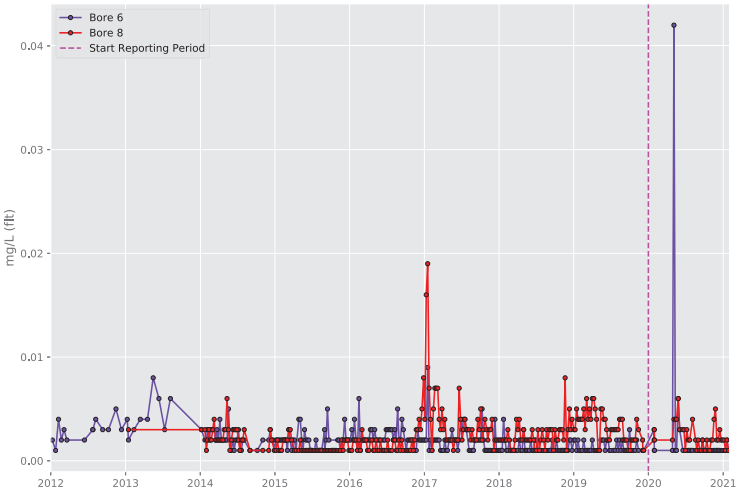
Manganese



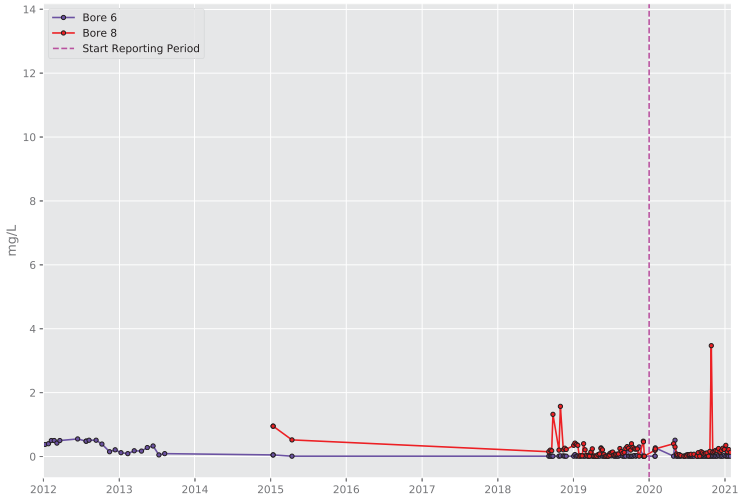
Mercury



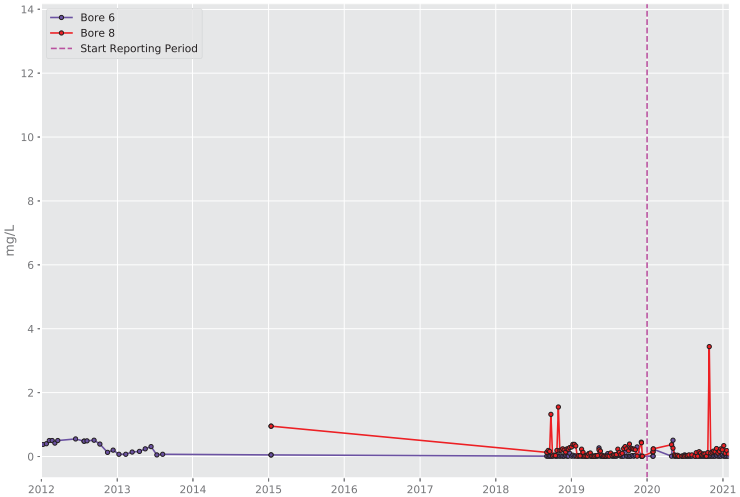
Nickel



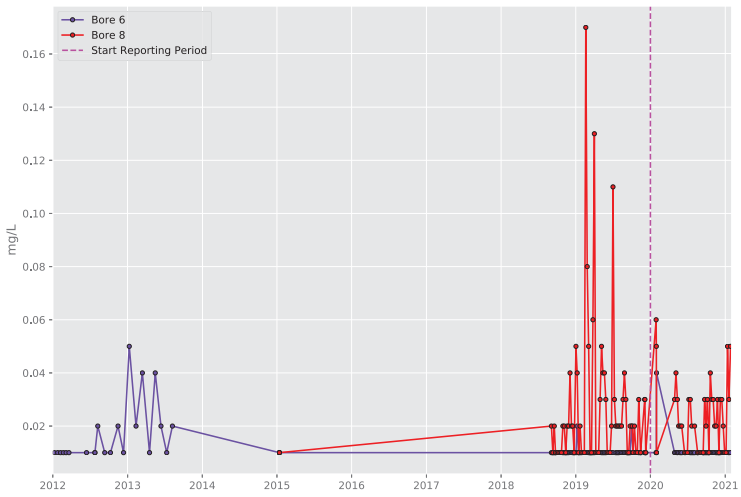
Nitrate & Nitrite (as N)



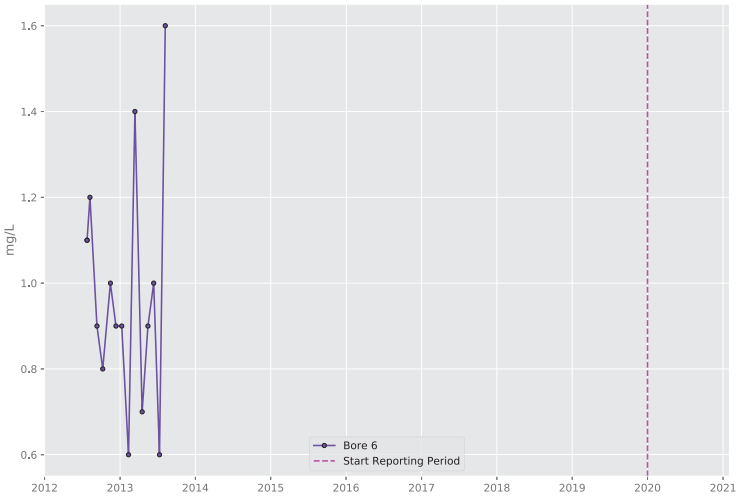
Nitrate (as N)



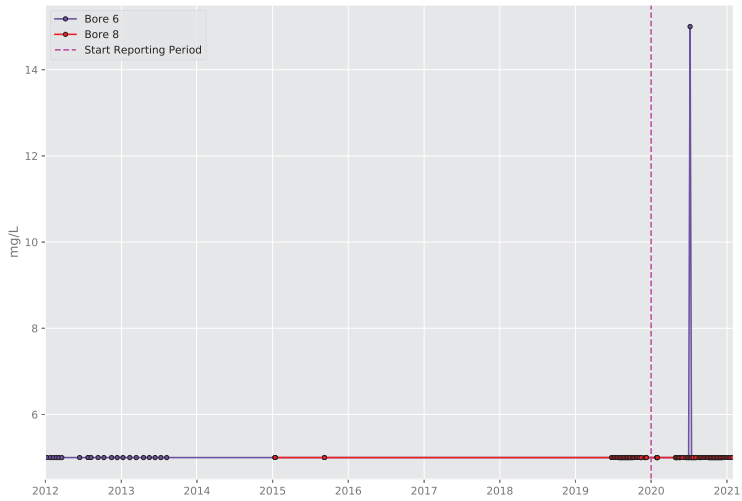
Nitrite (as N)



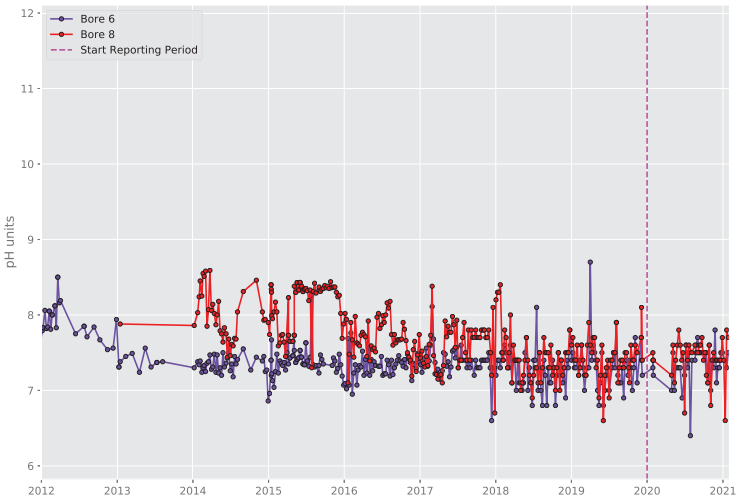
Nitrogen (Total)



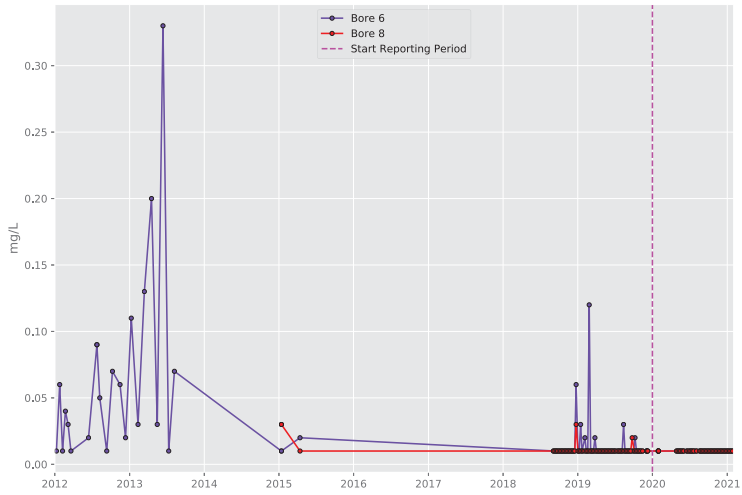
Oil and Grease



pH_0



Phosphorus



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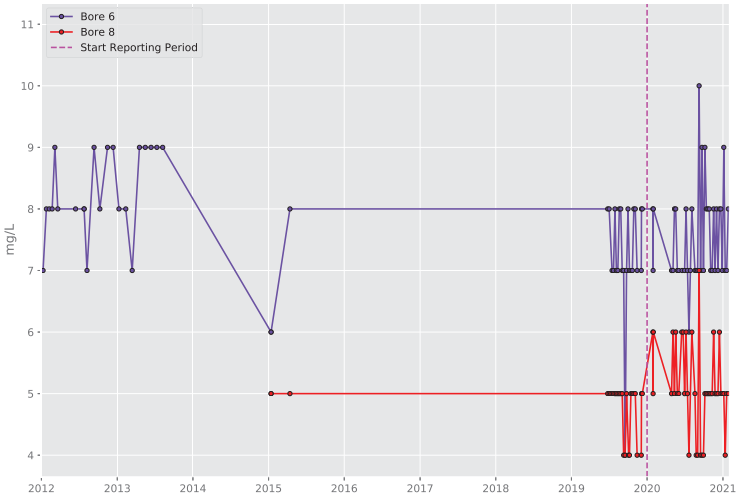
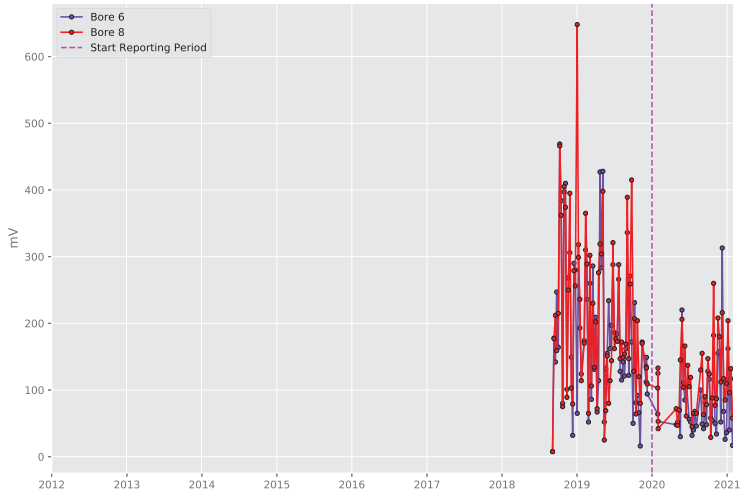
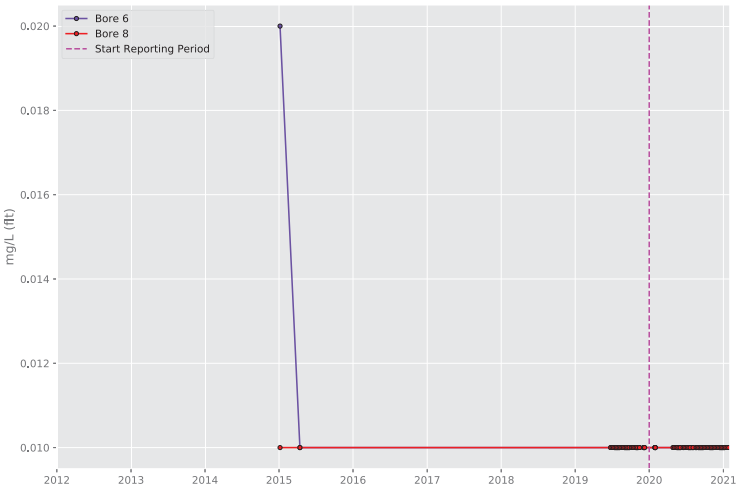


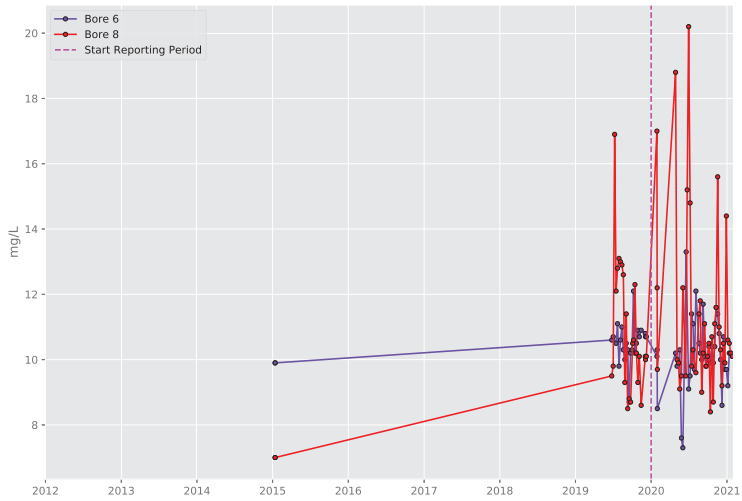
Redox Potential



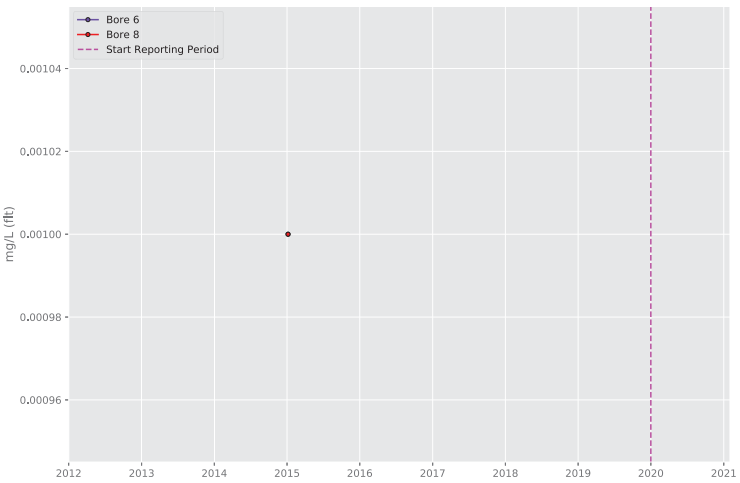
Selenium



Silicon as SiO2



Silver



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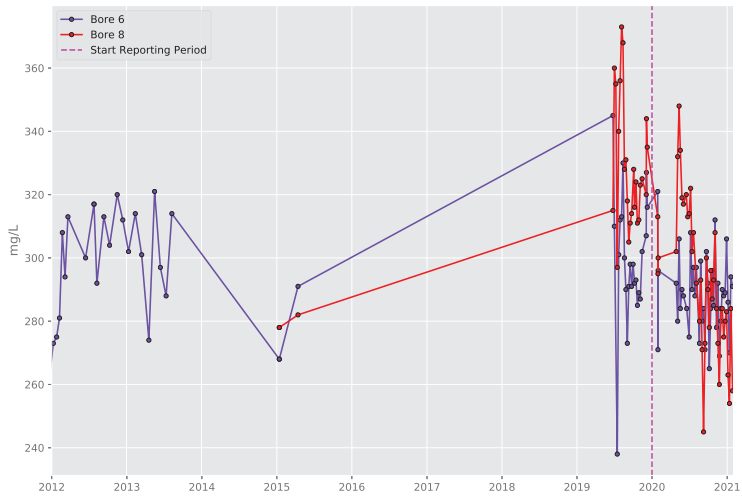
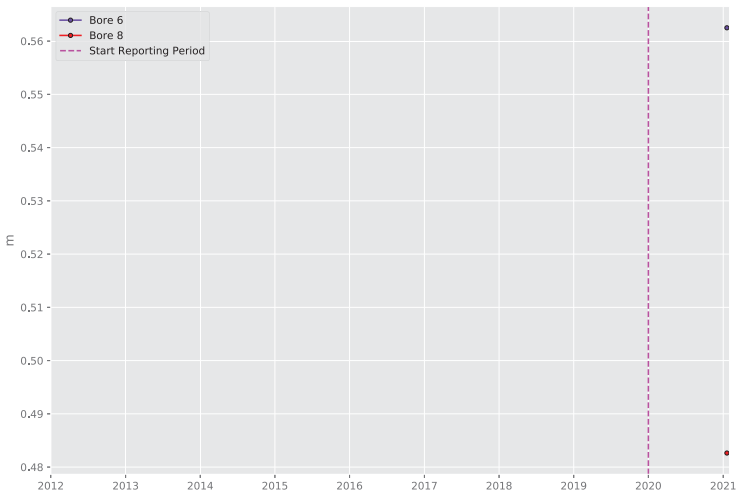
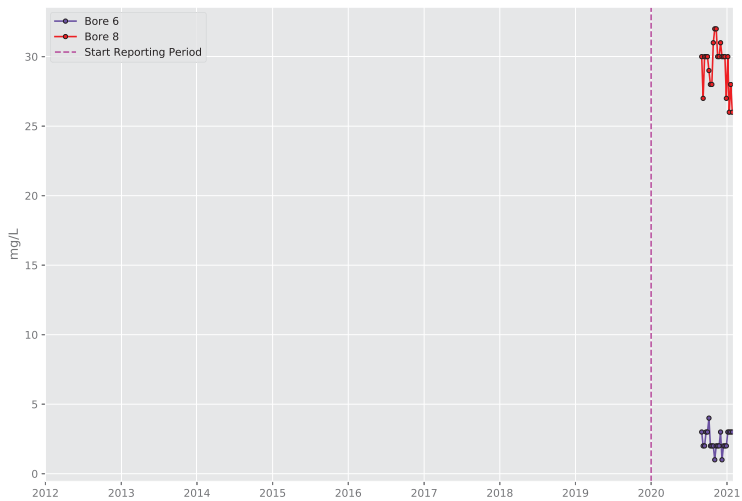


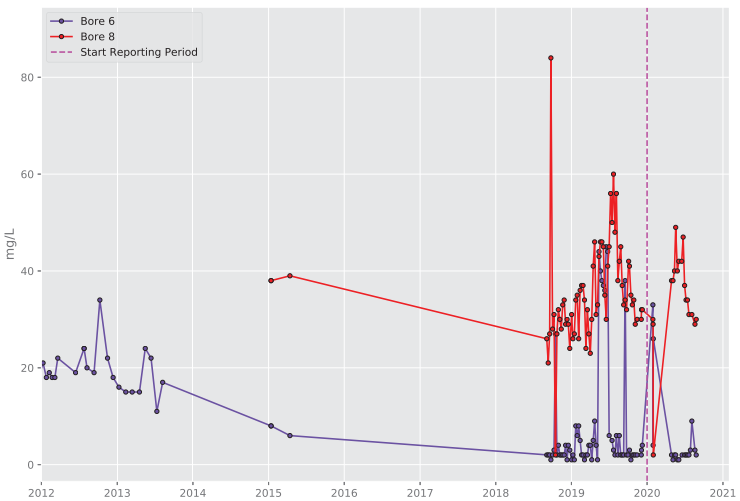
Standing water level



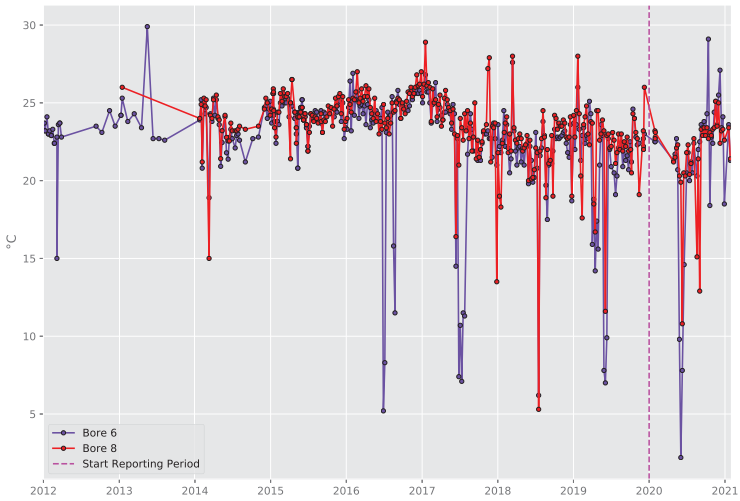
Sulfate as SO4 - Turbidimetric



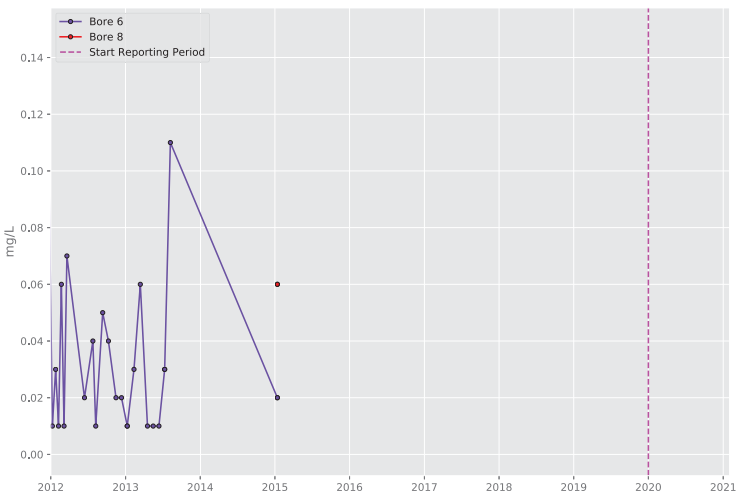
Sulphate



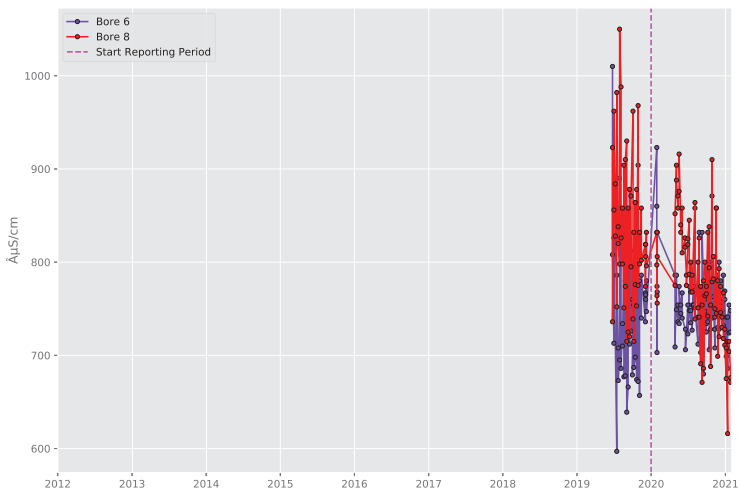
Temp



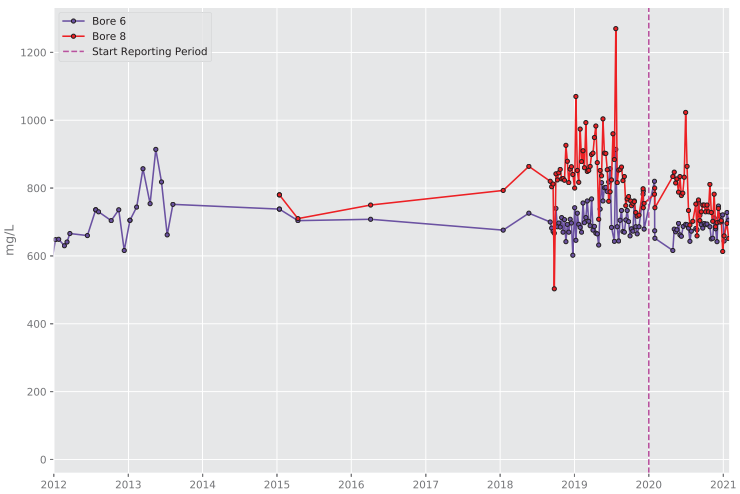
Total Chlorine



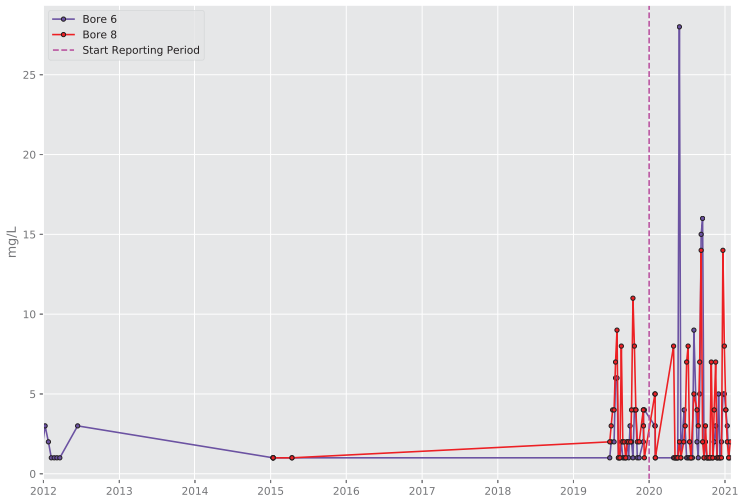
Total Dissolved Solids (Calc.)



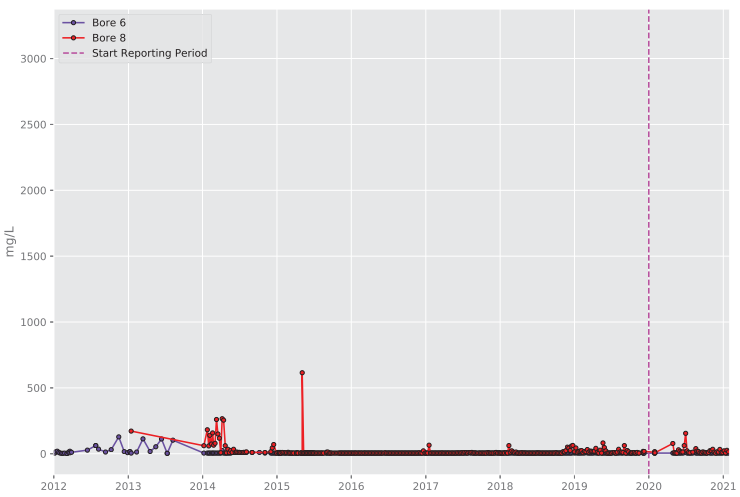
Total Dissolved Solids



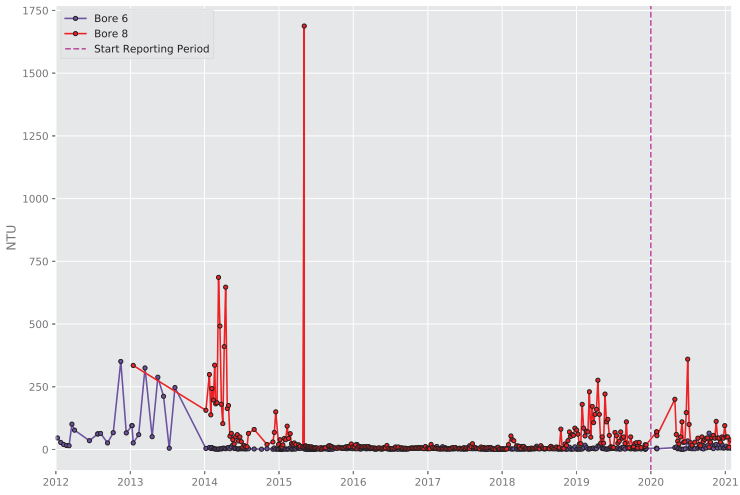
Total Nostocales



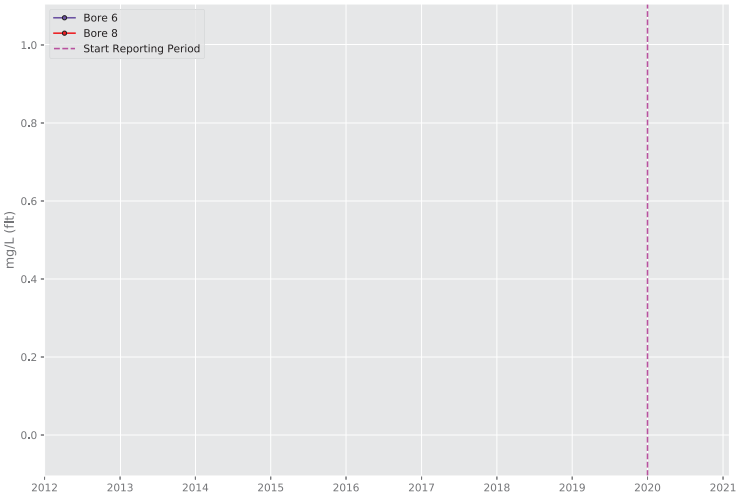
TSS



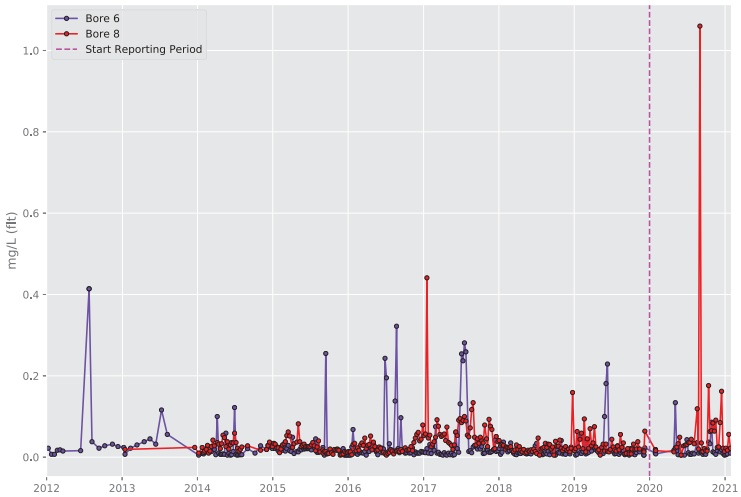
Turbidity



Zinc Tot



Zinc



Appendix F. Soil Moisture

SPRINGVALE

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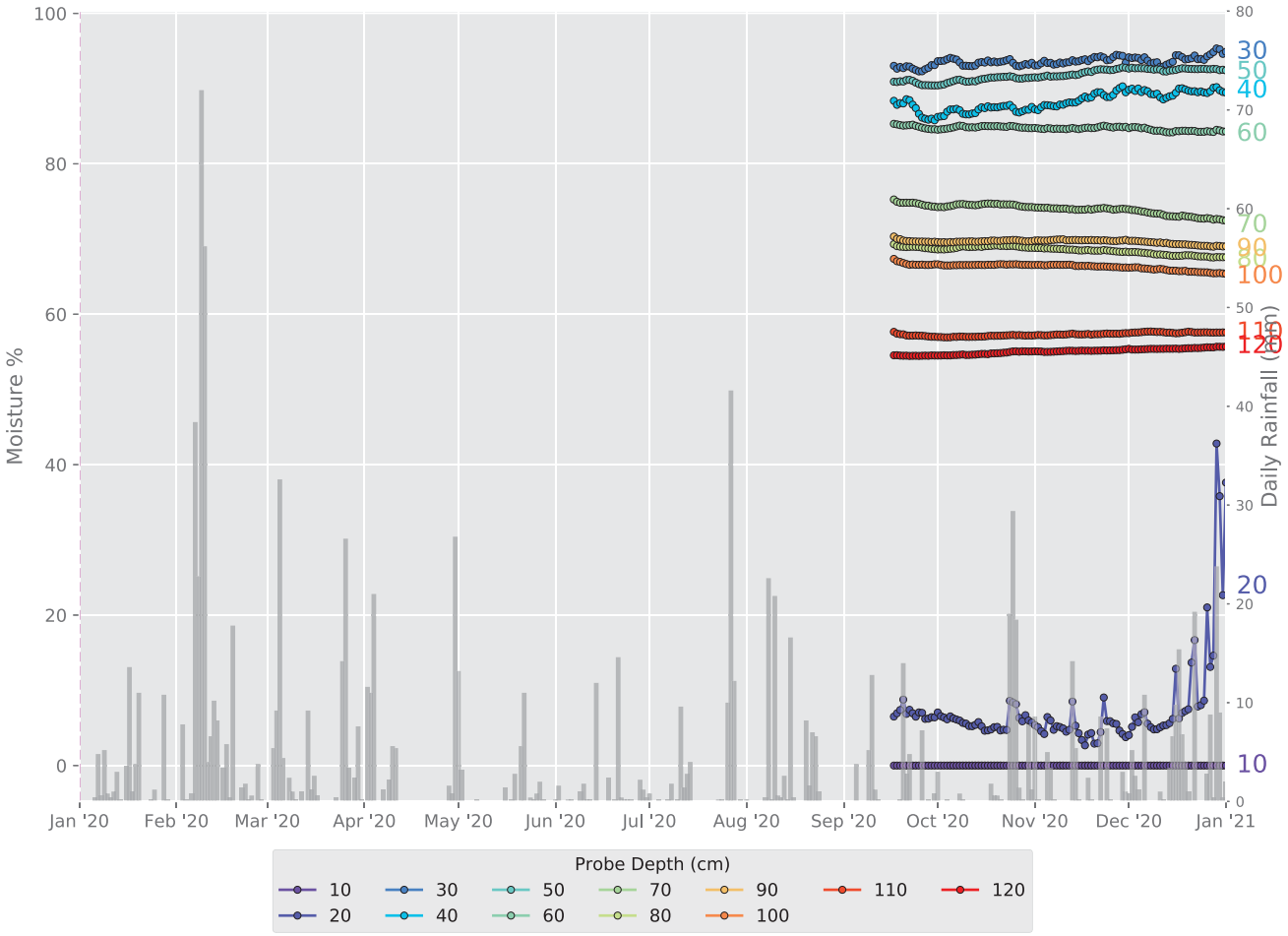

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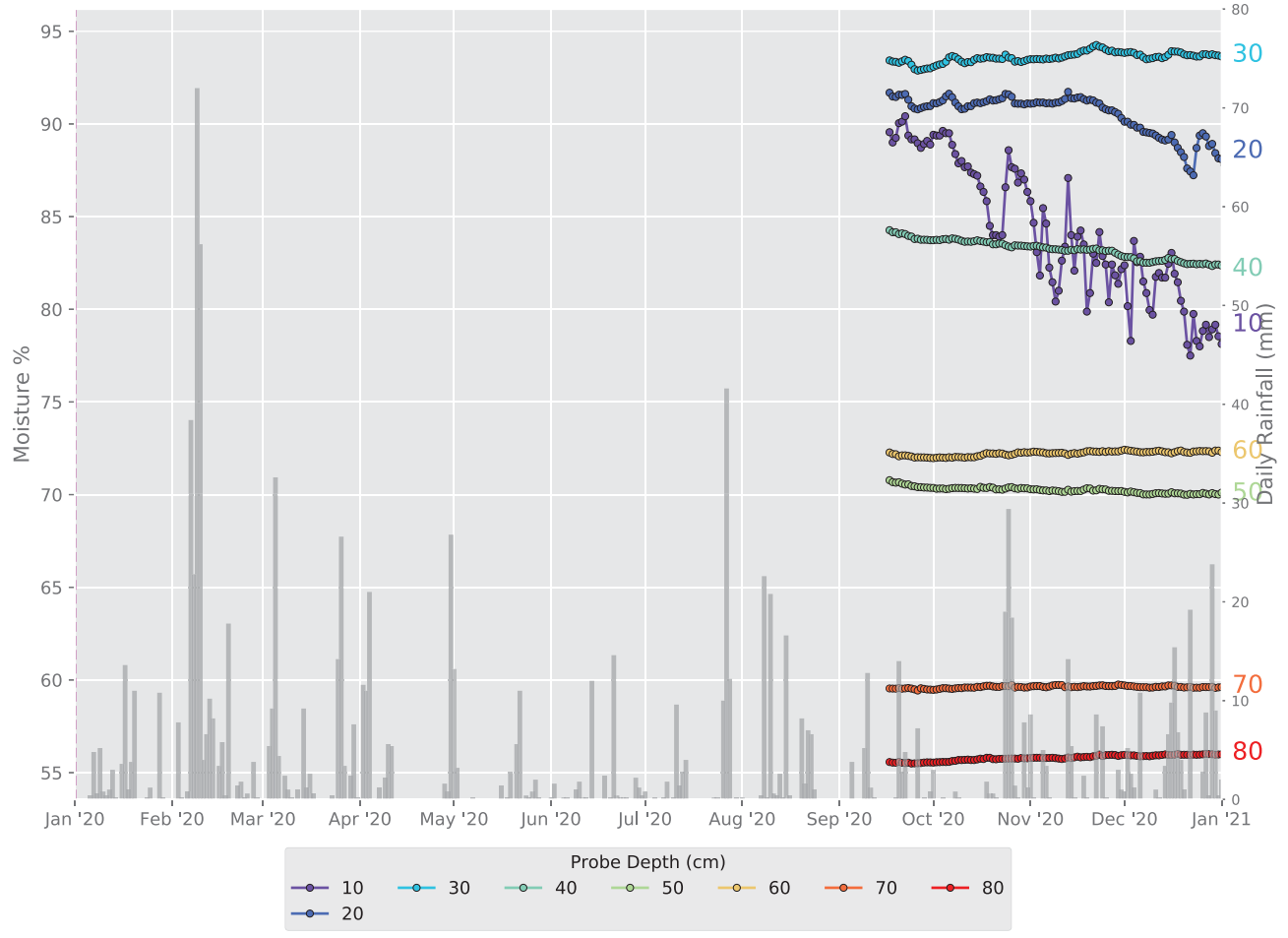

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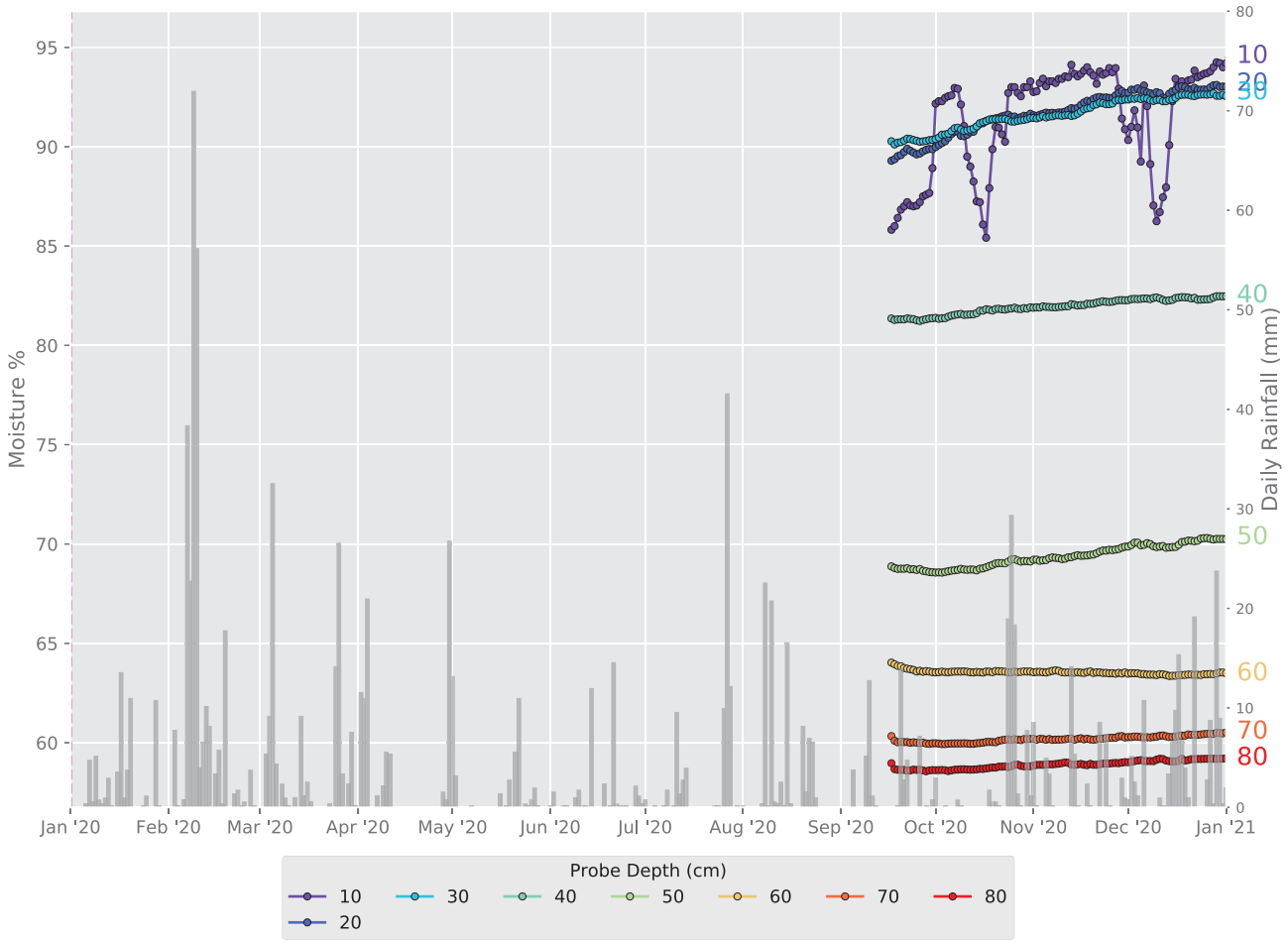

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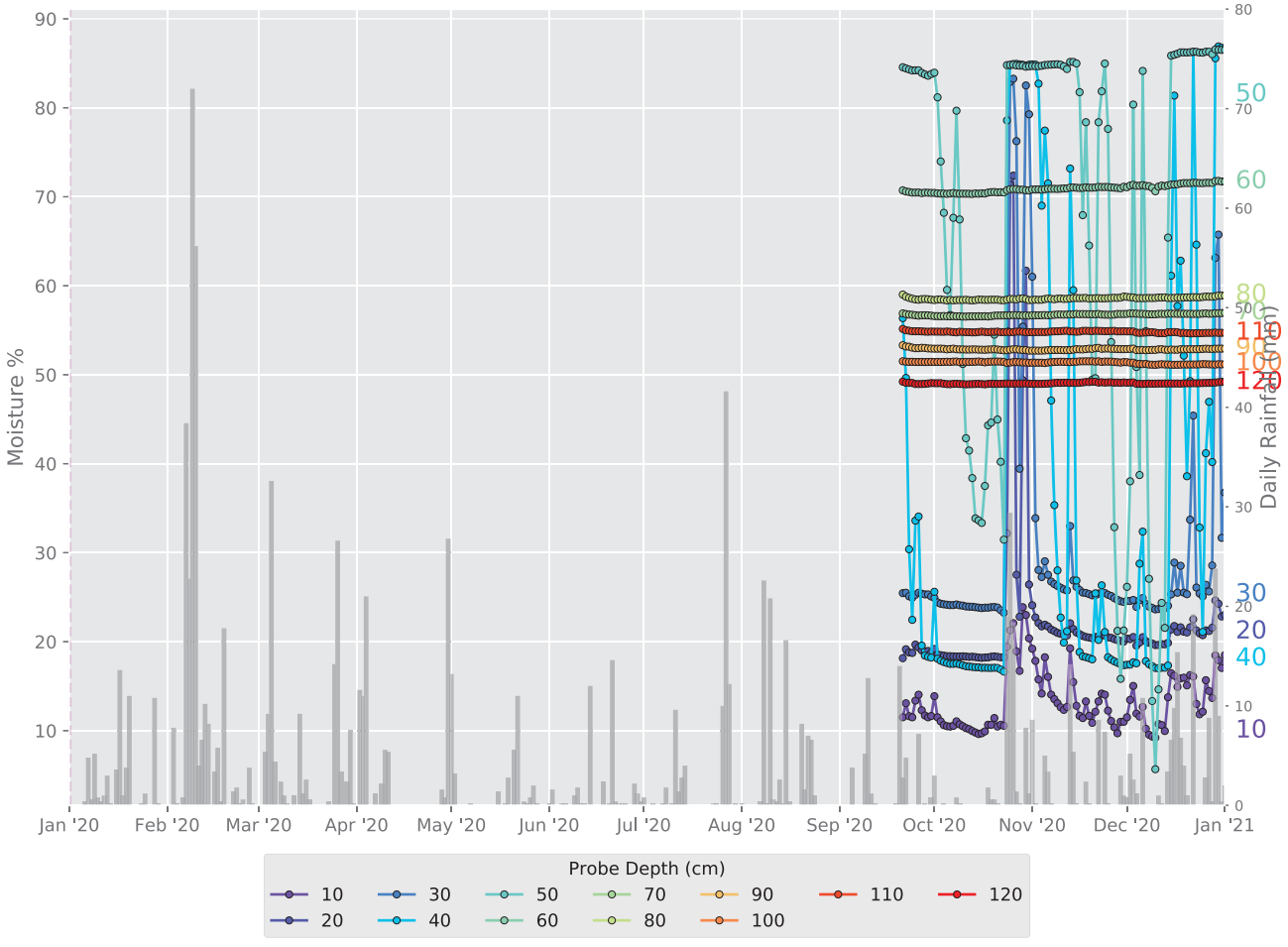

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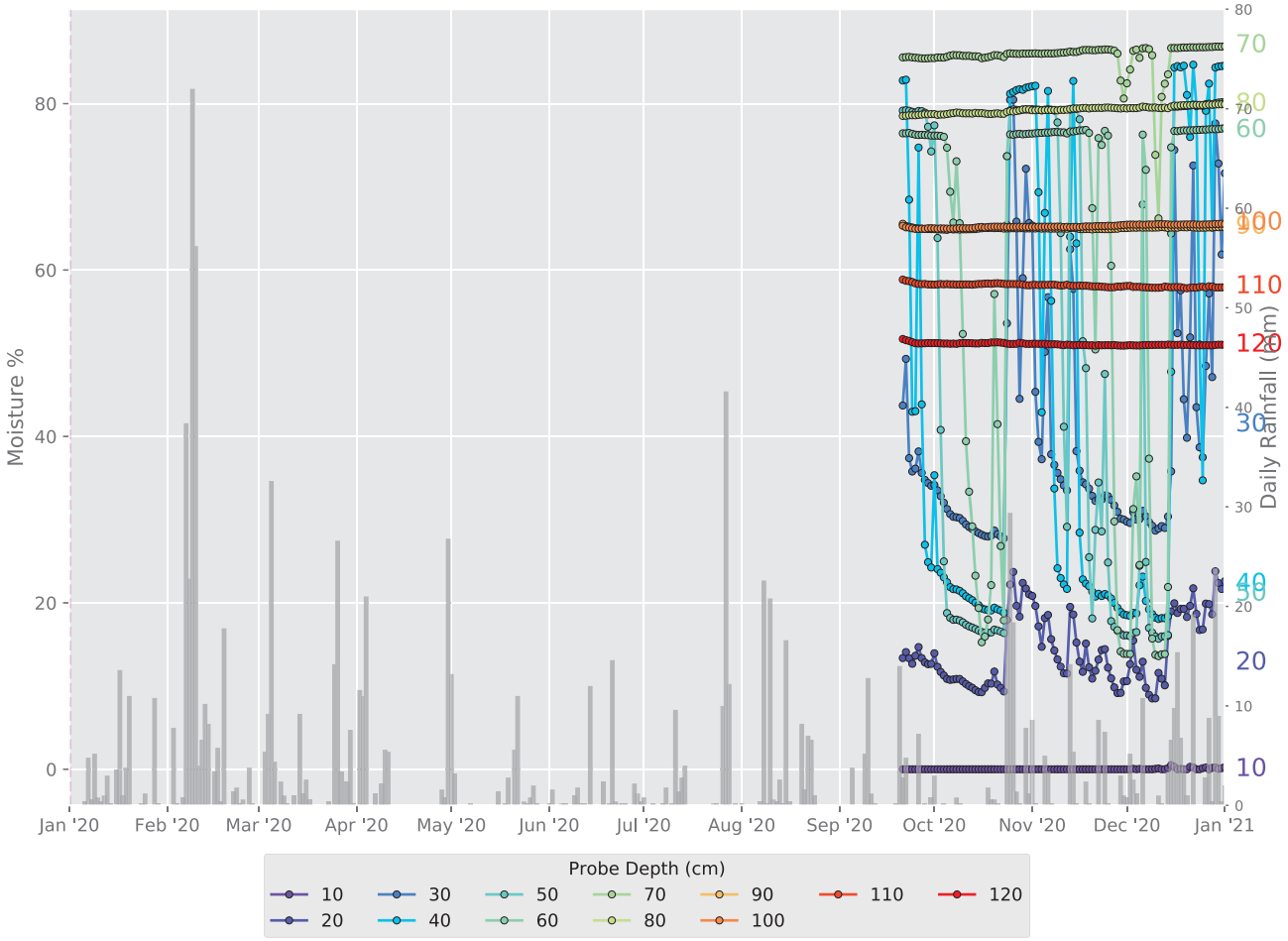

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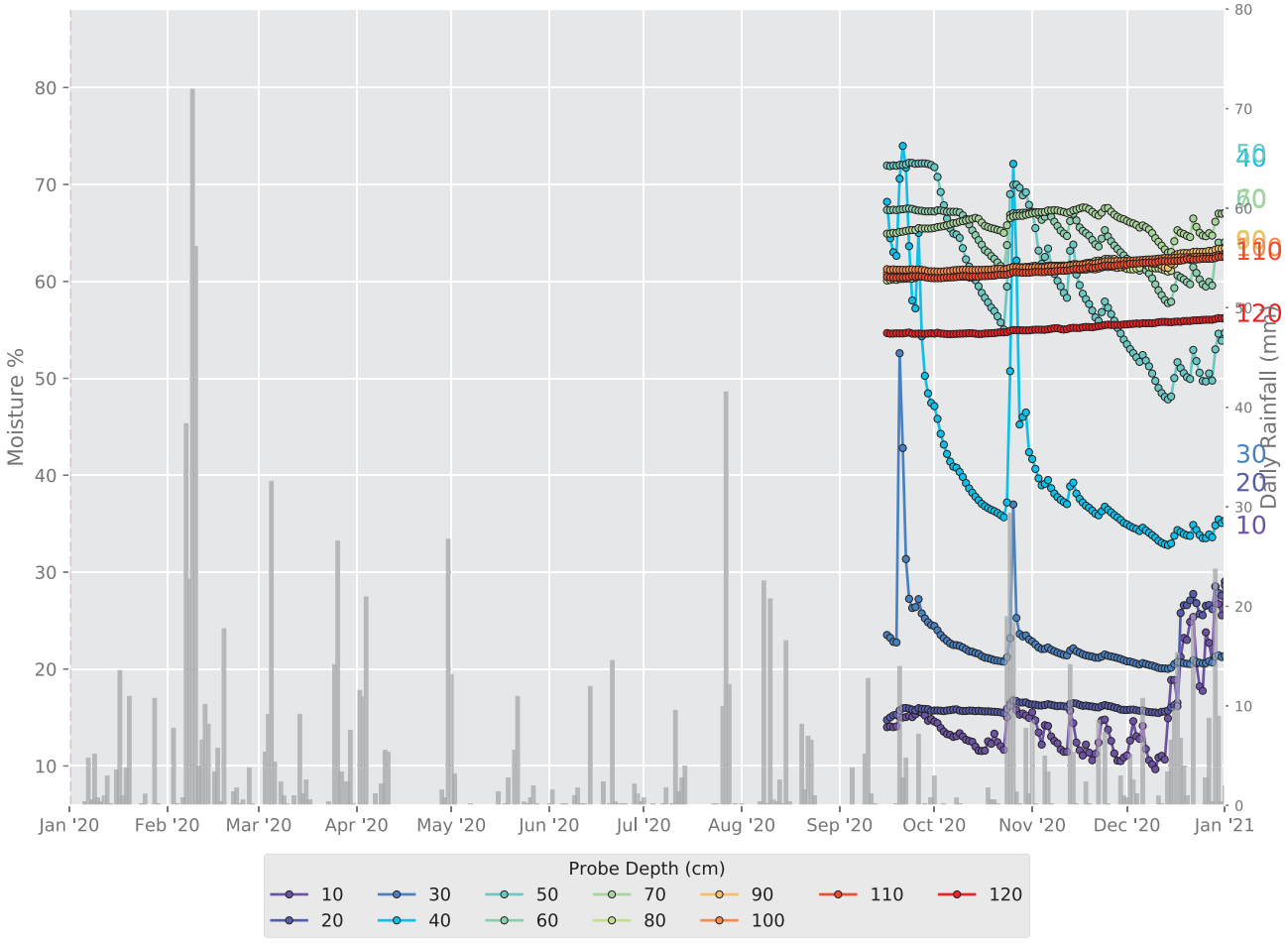

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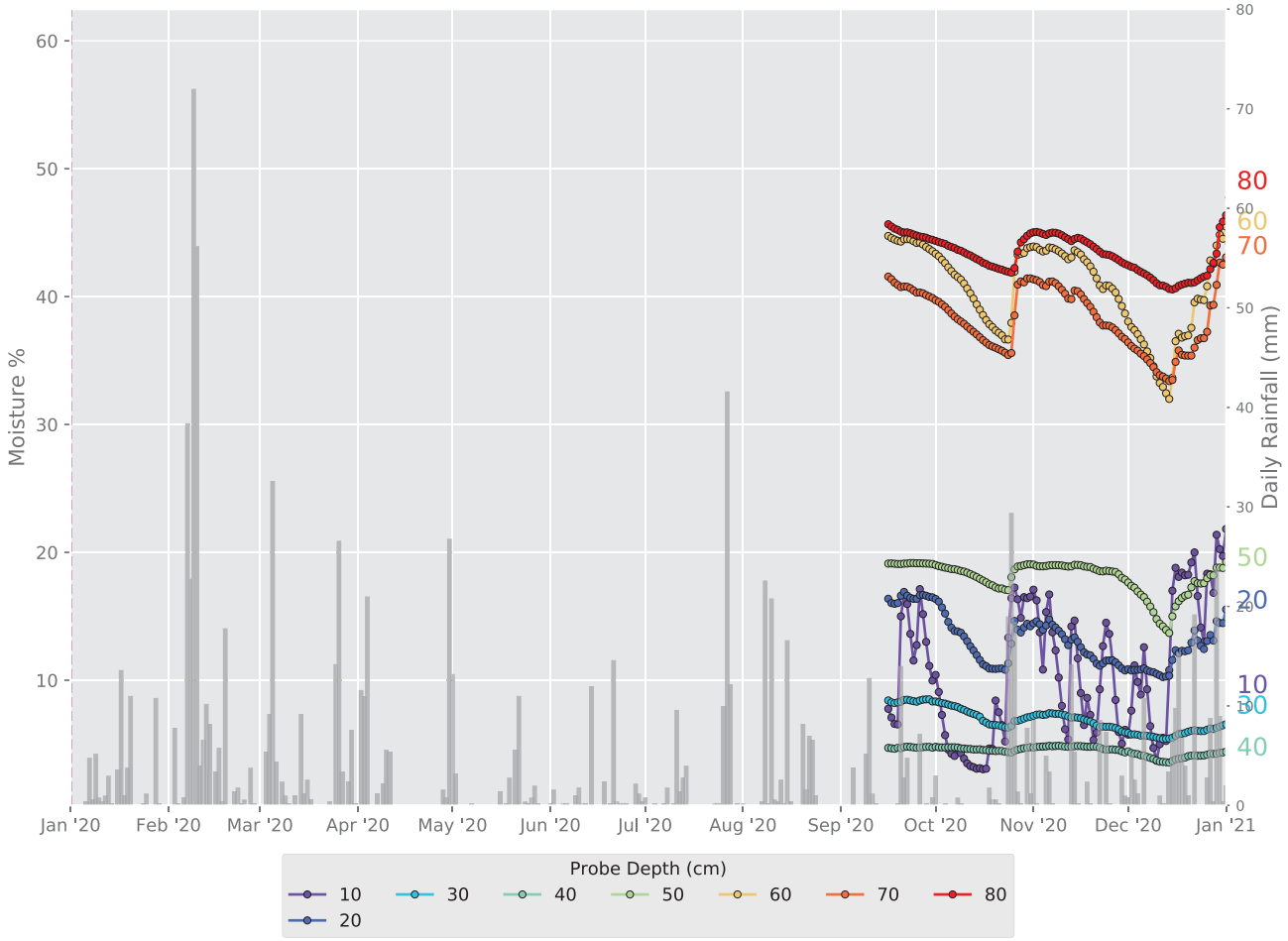

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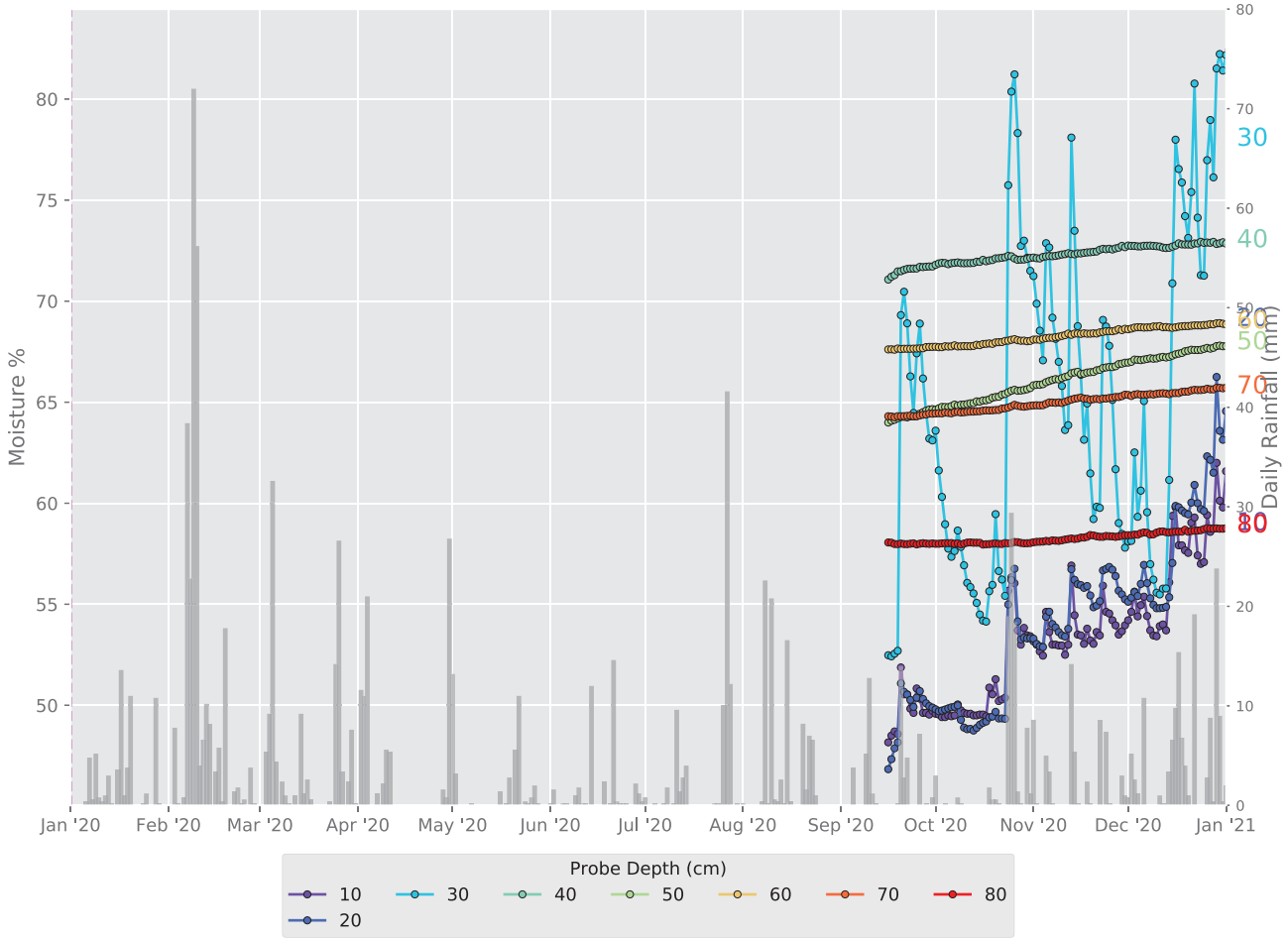

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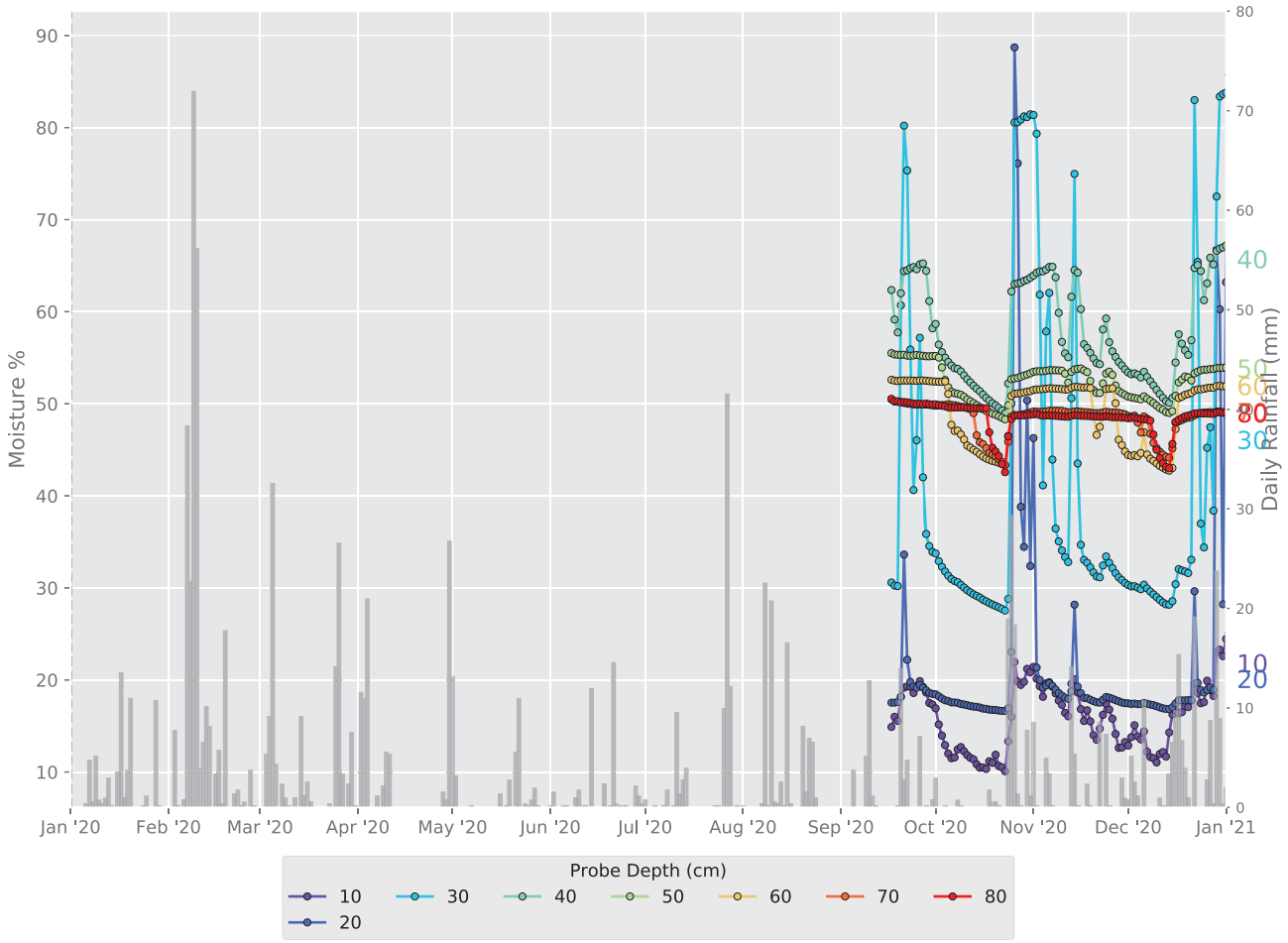

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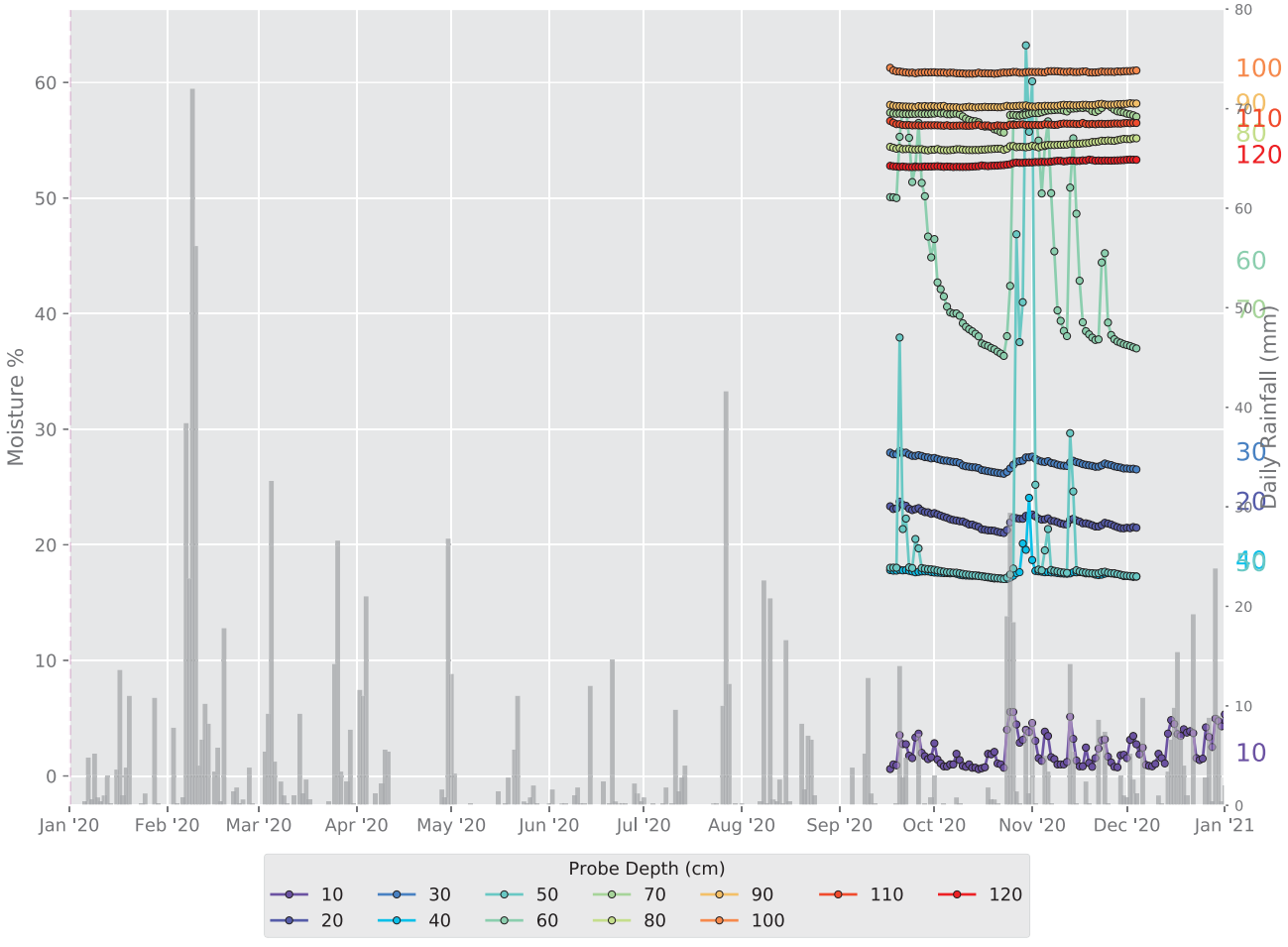

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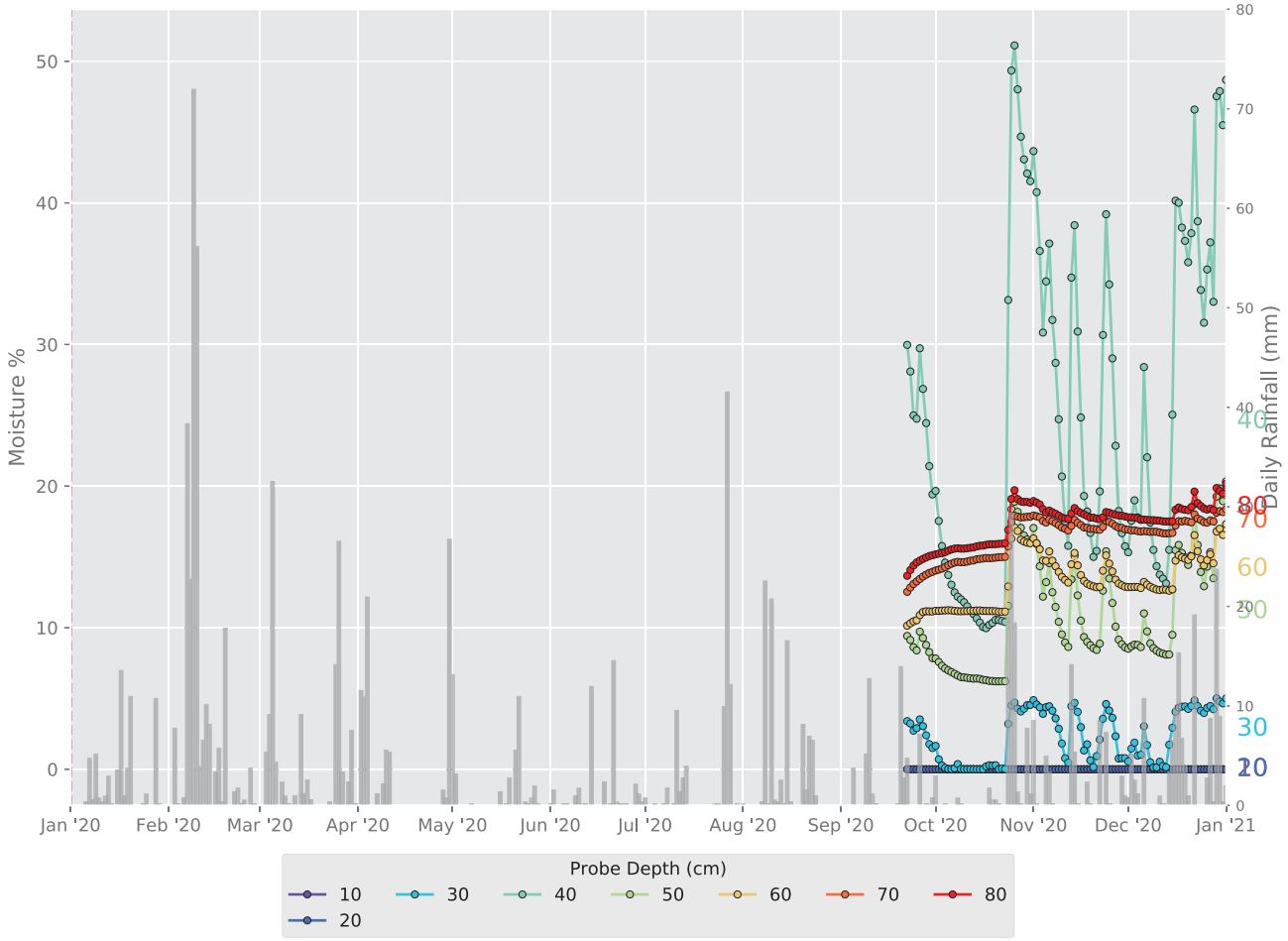

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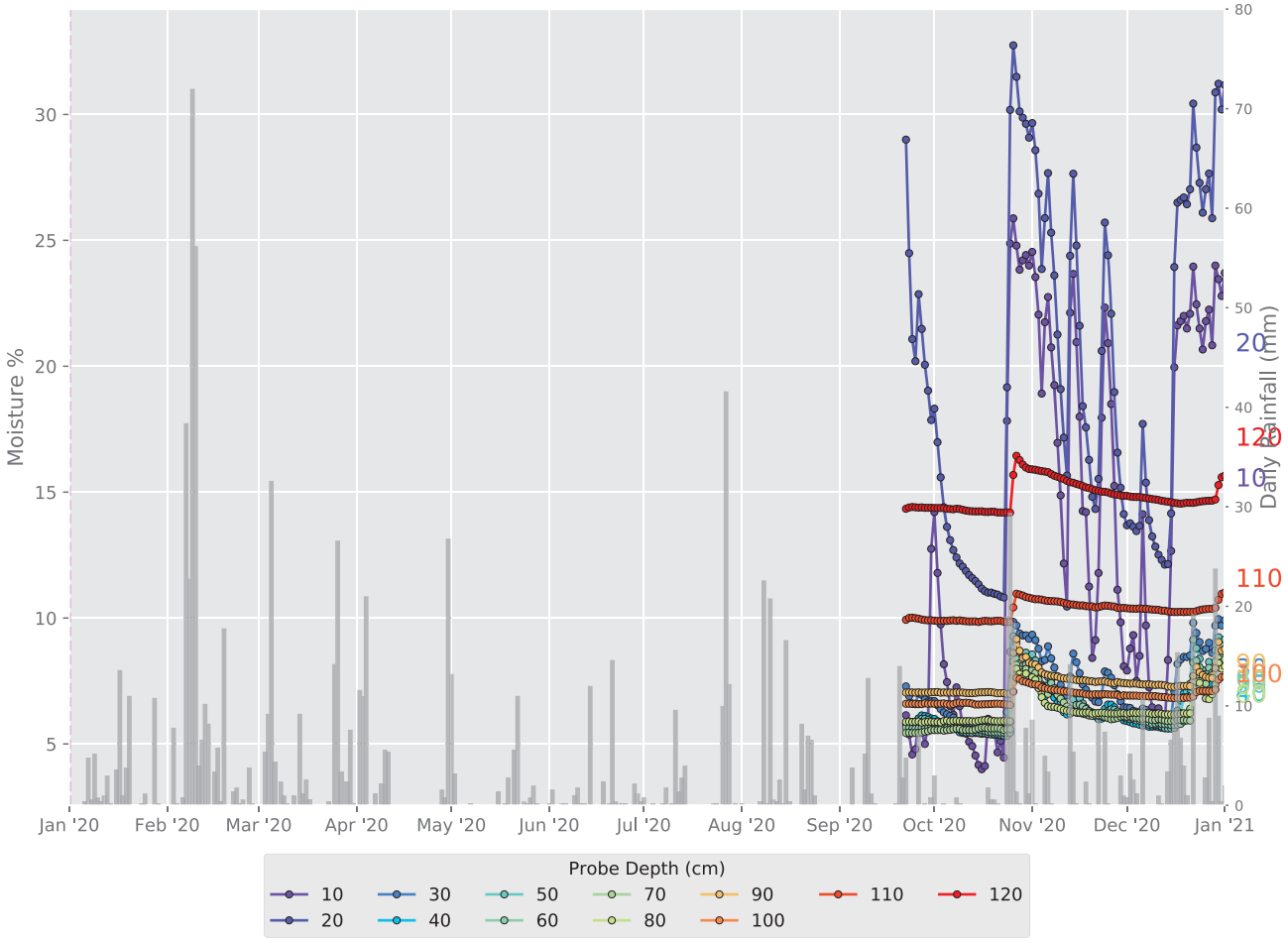

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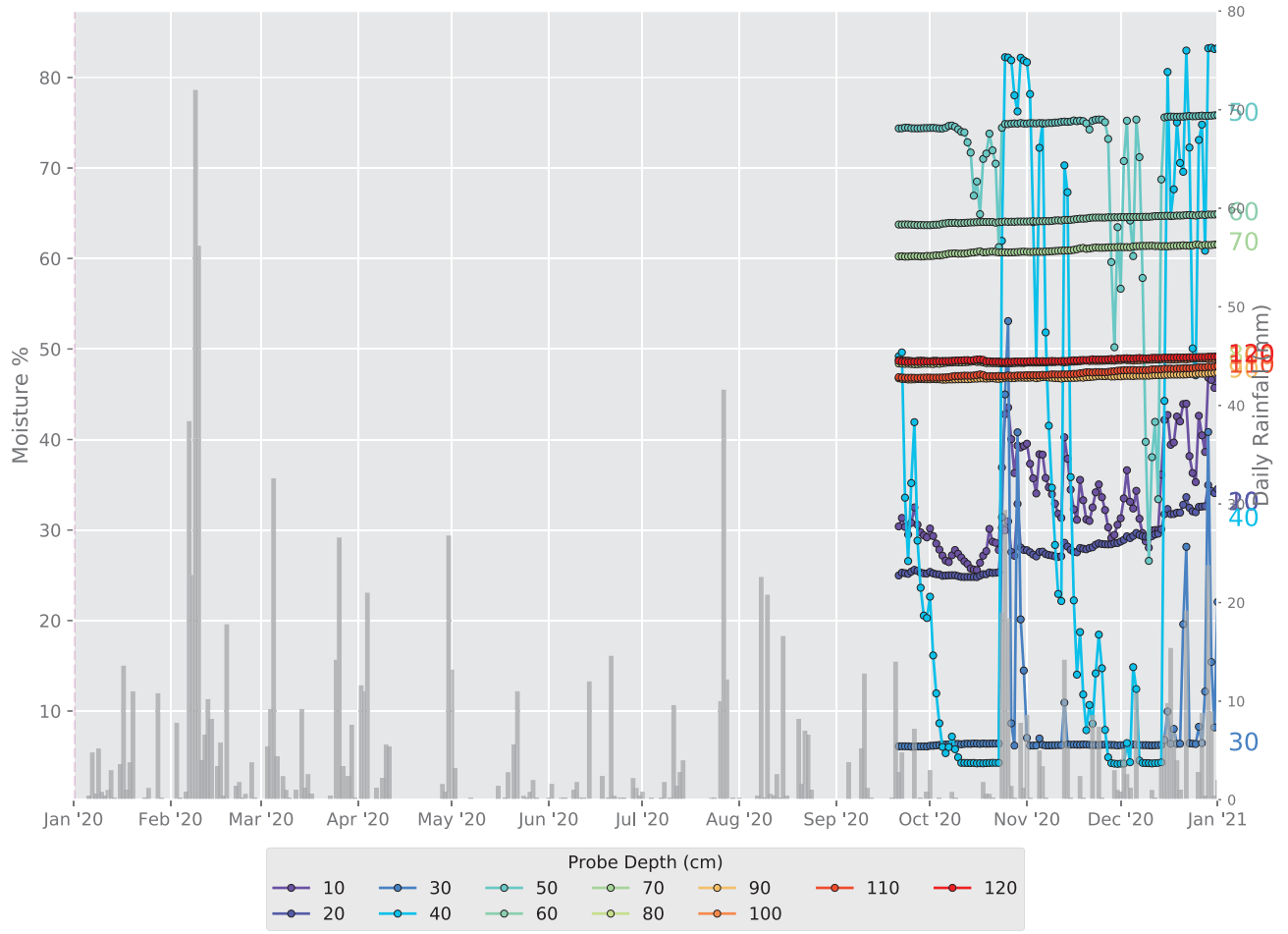

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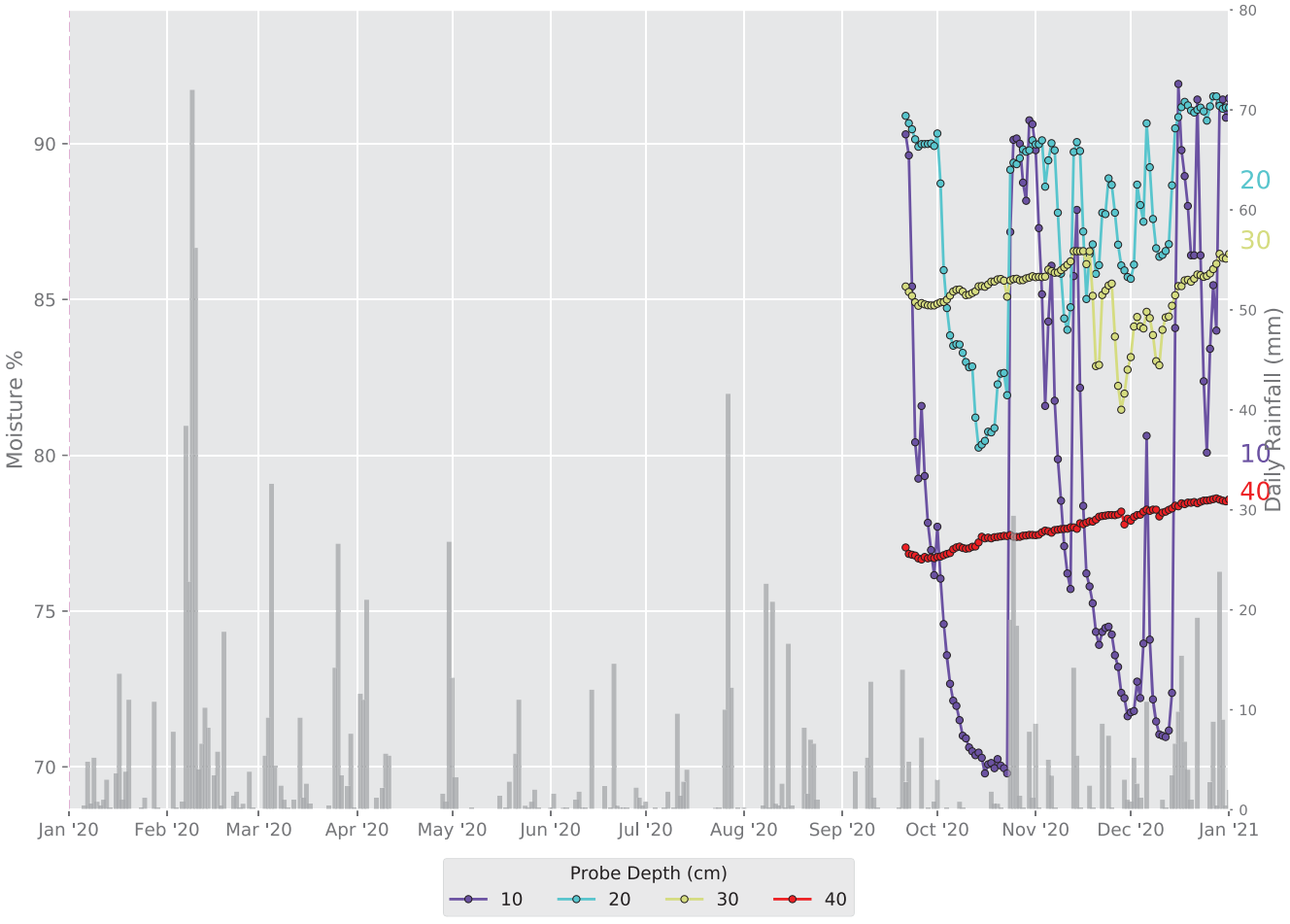

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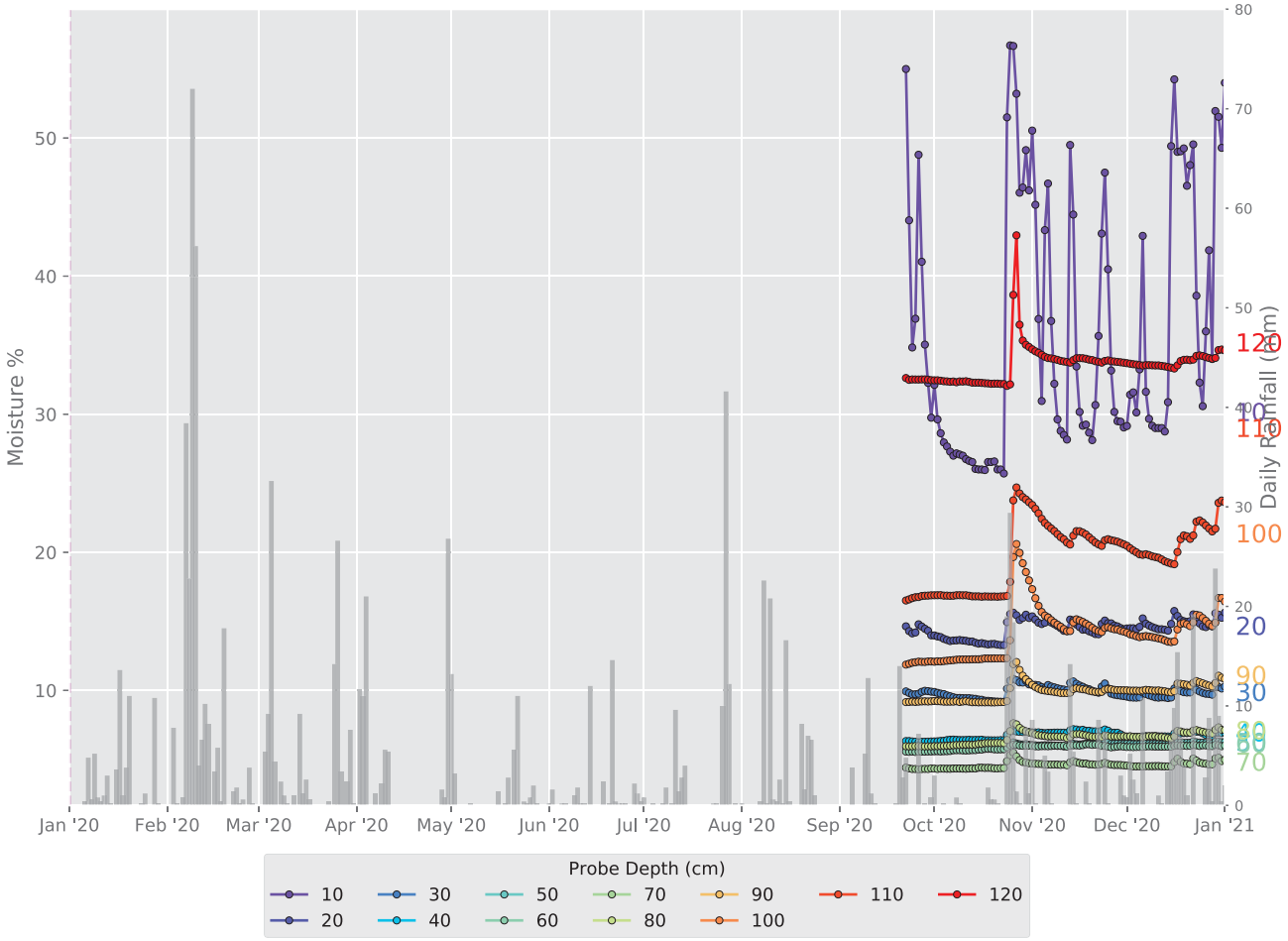

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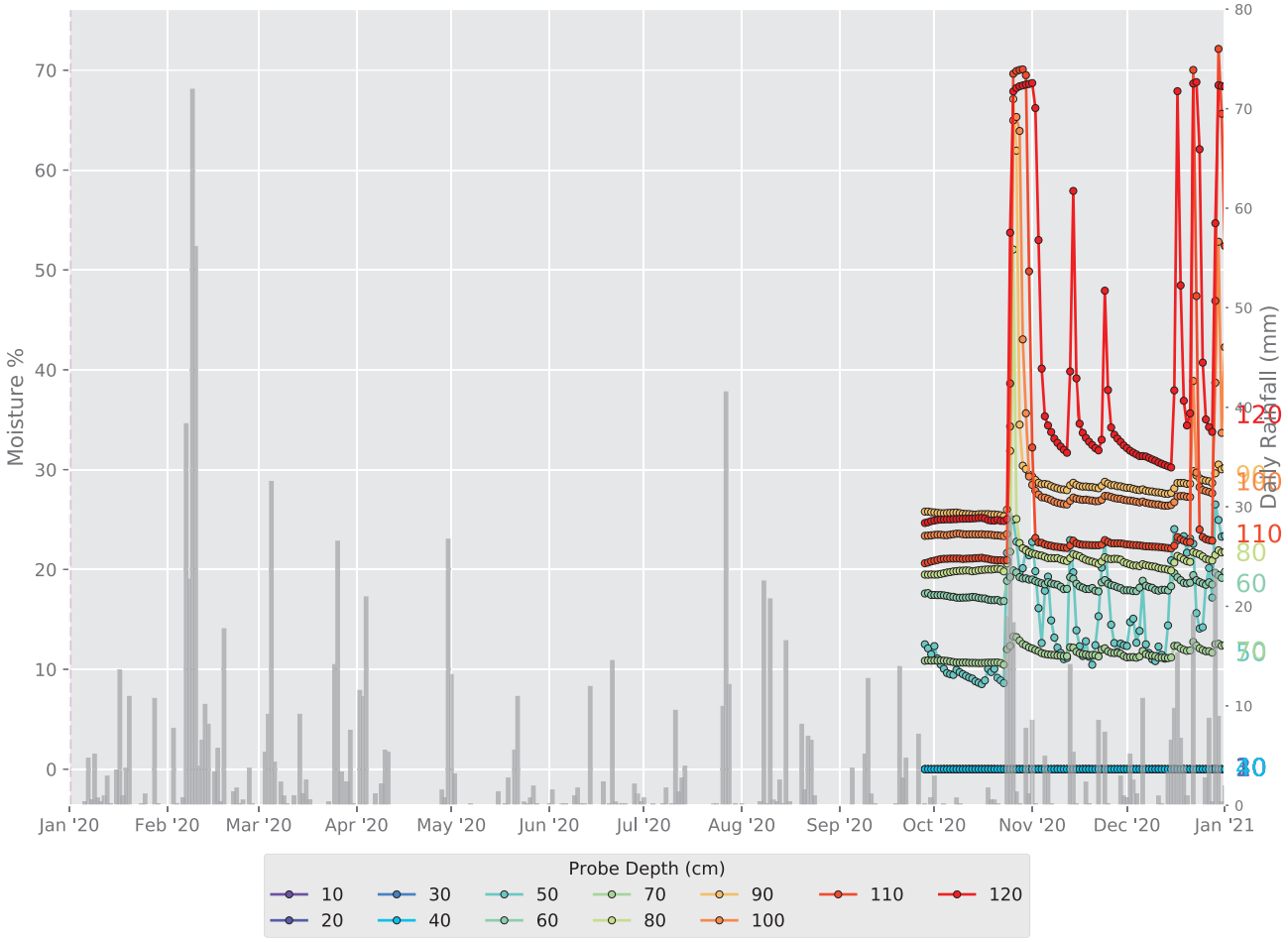

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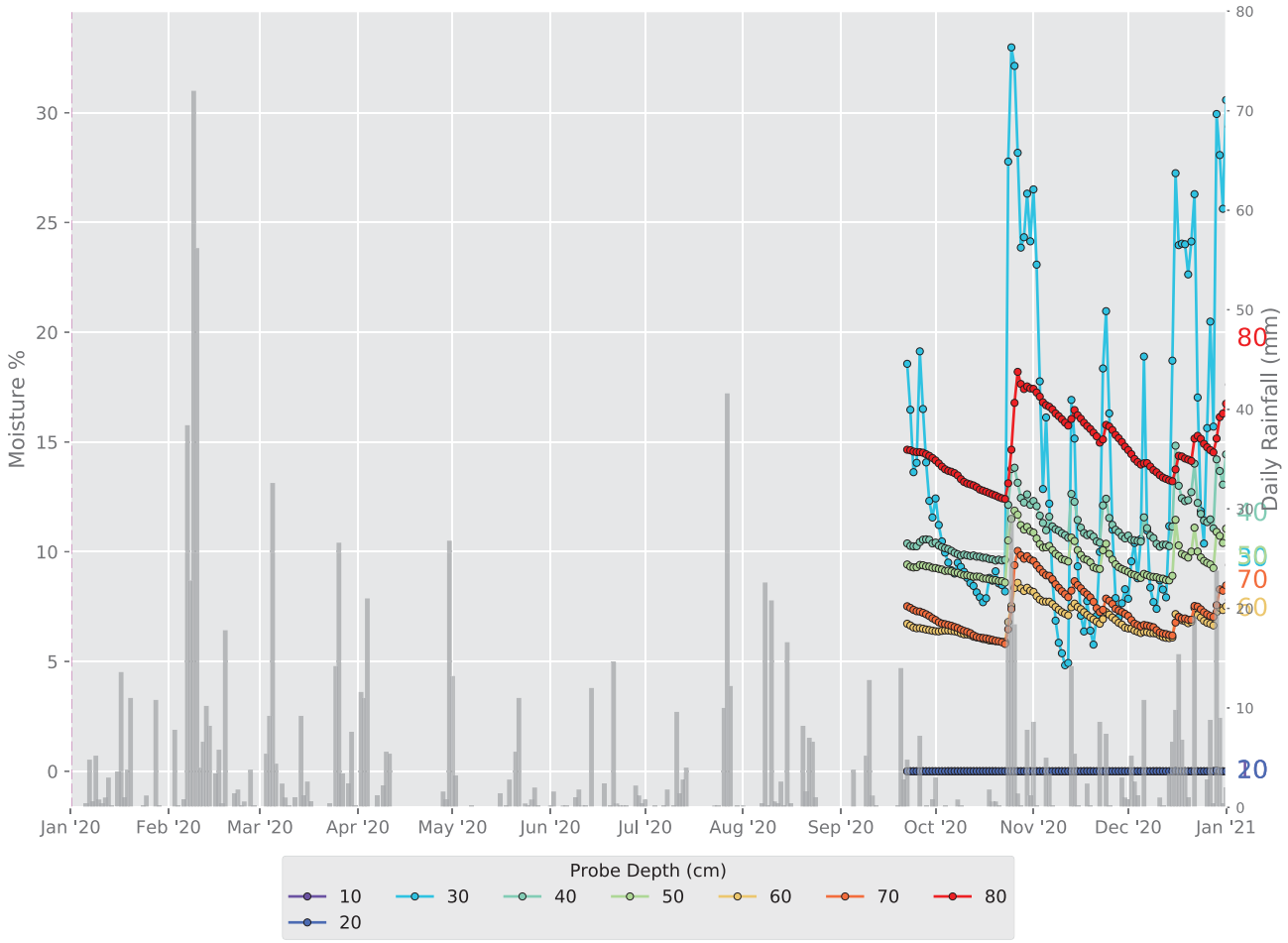

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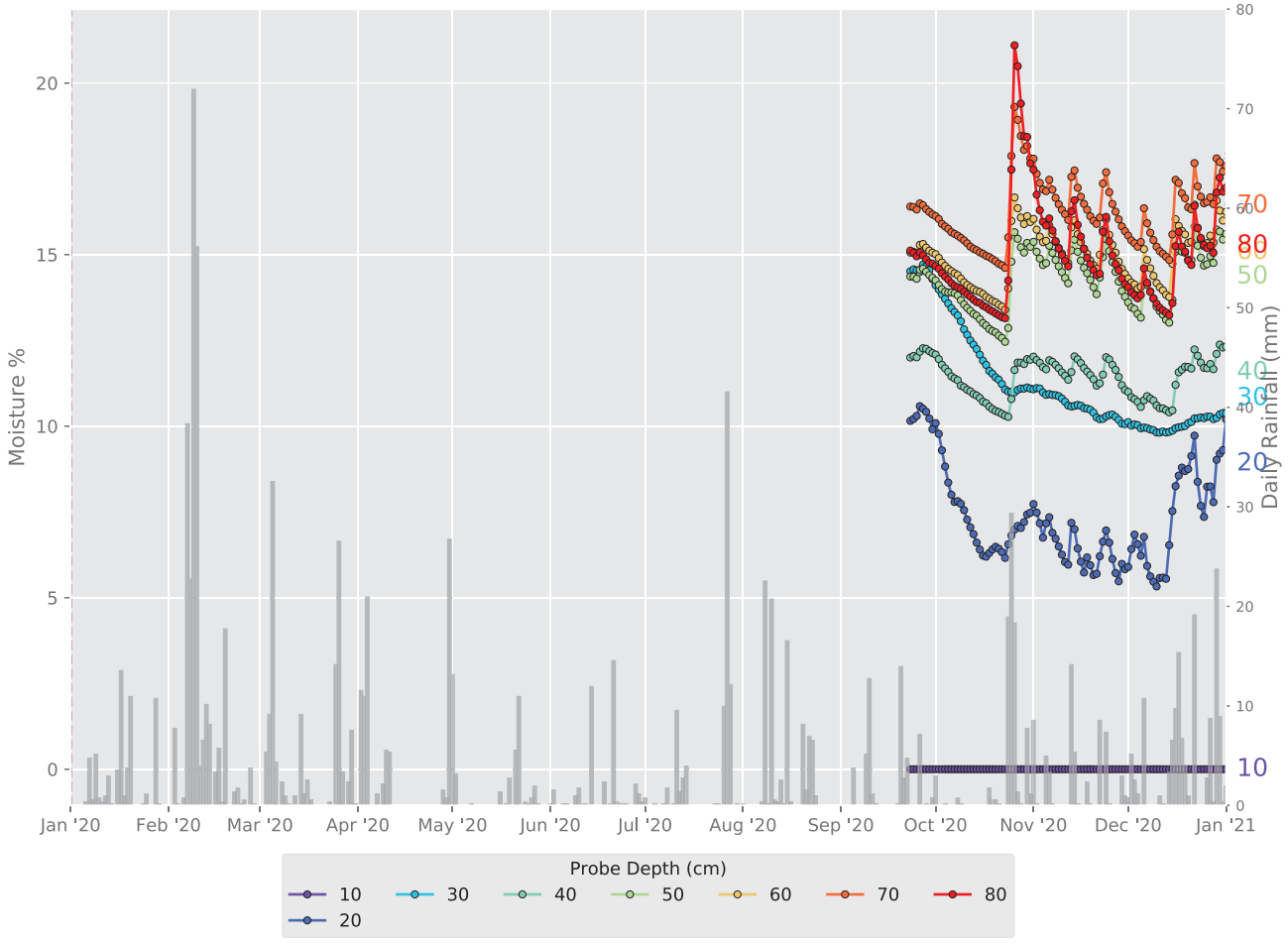

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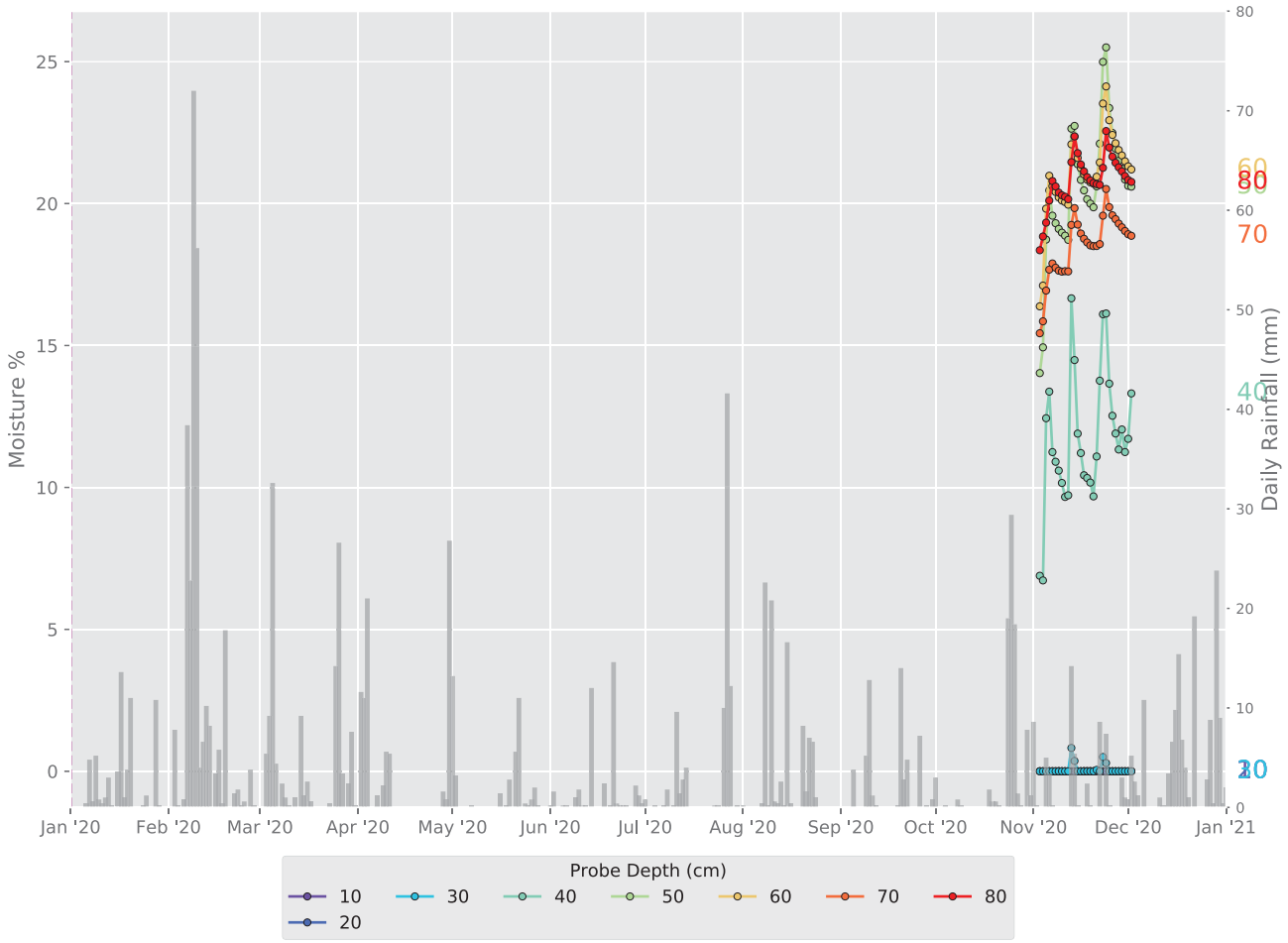

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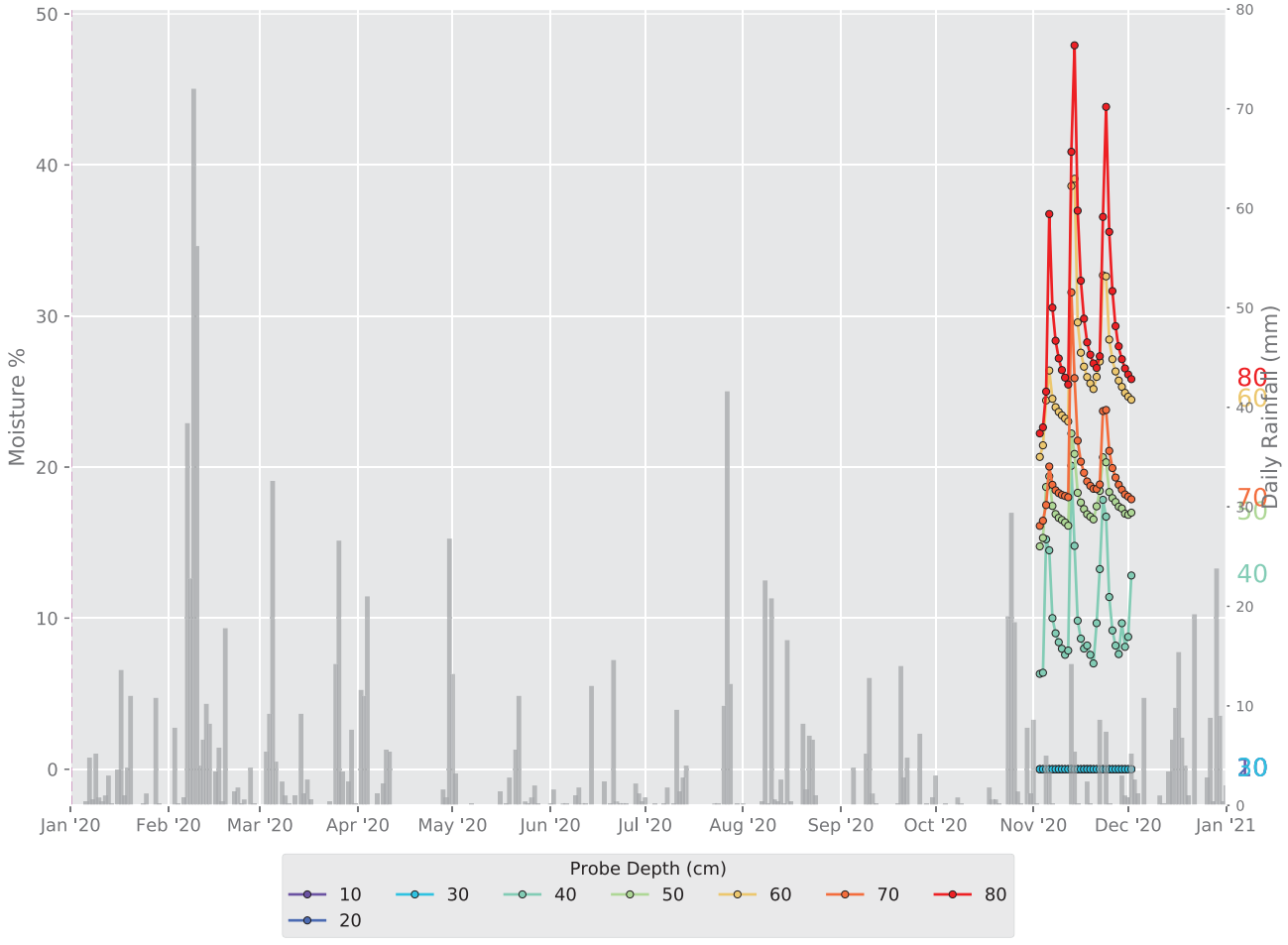

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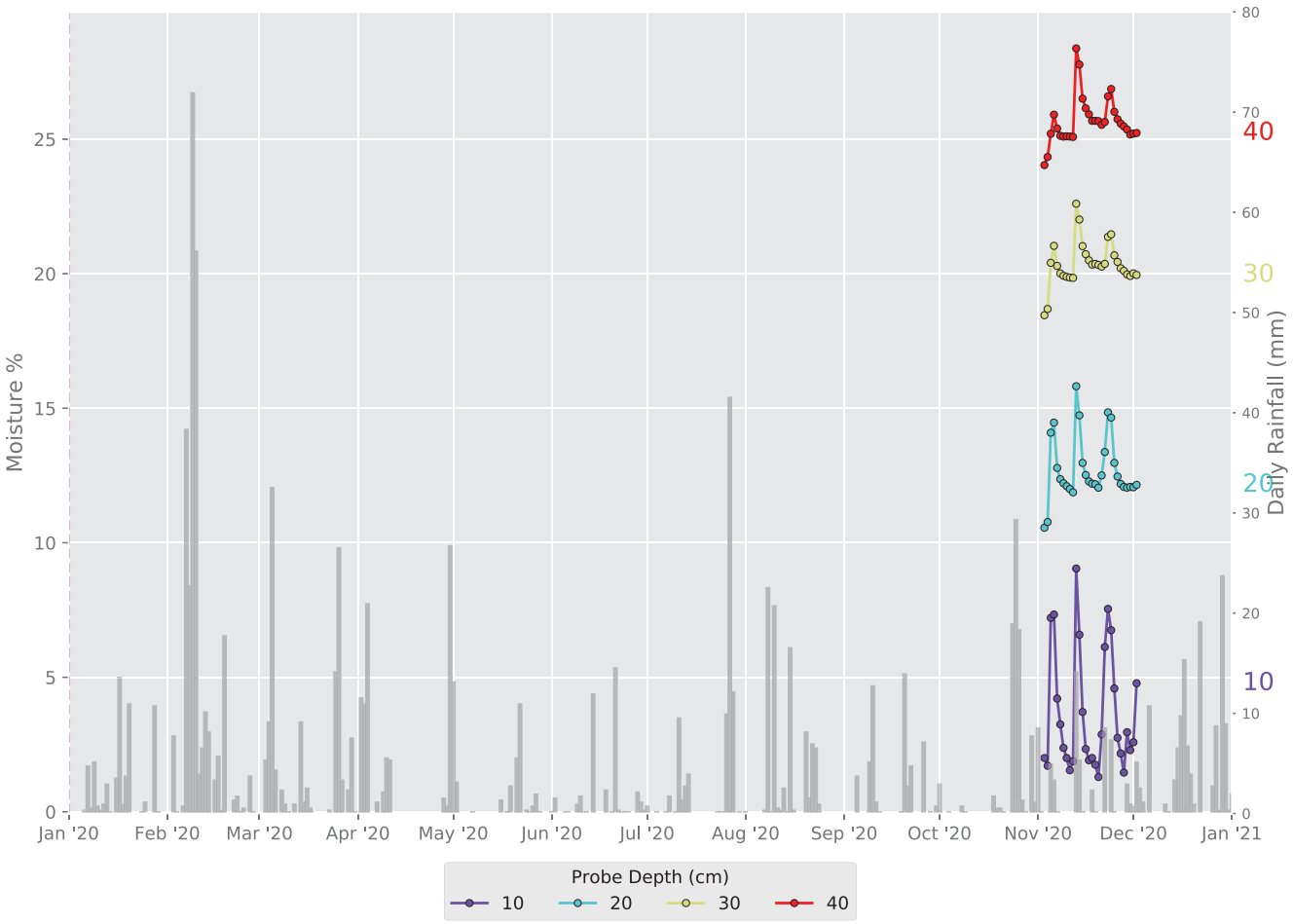

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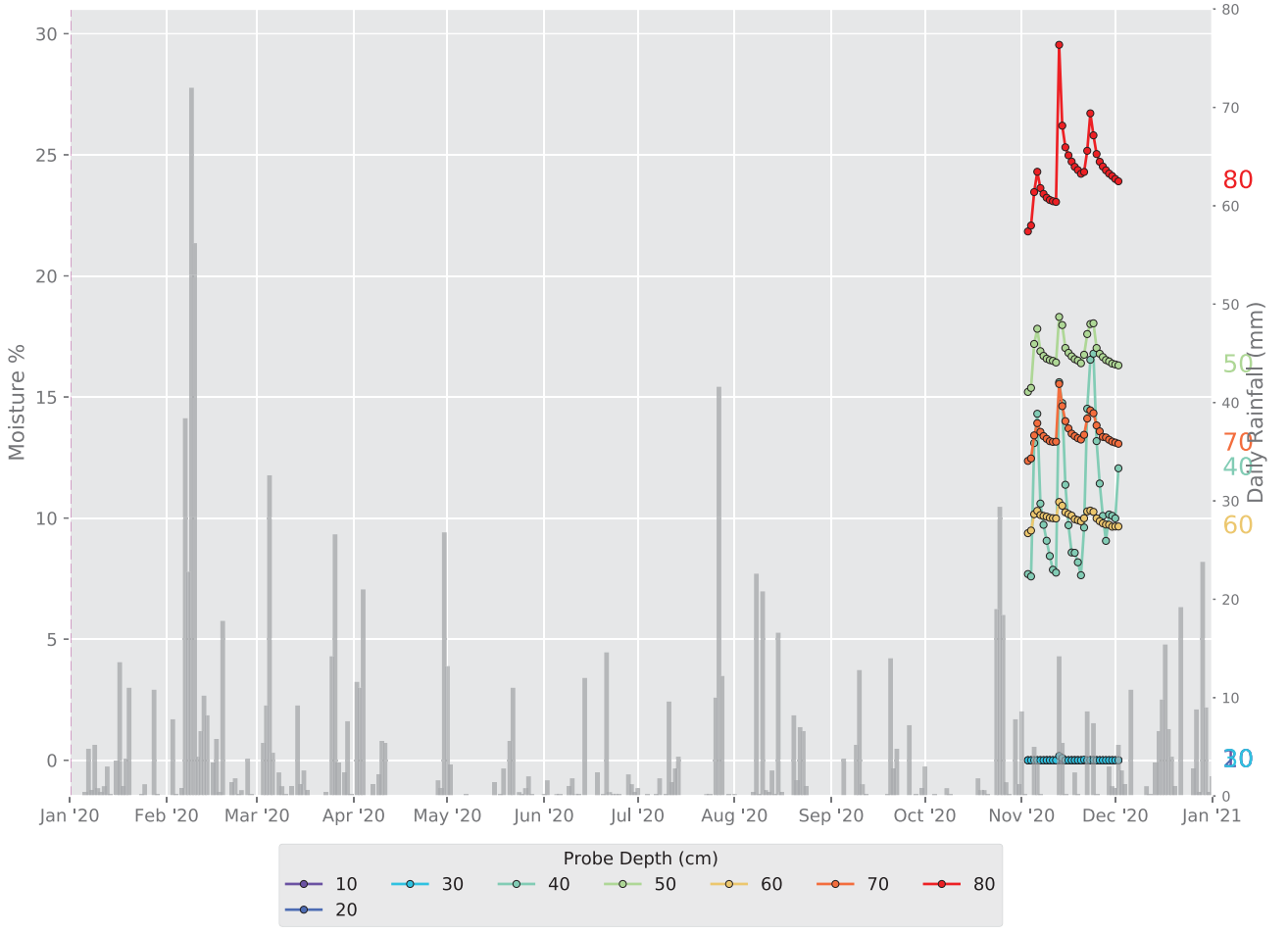

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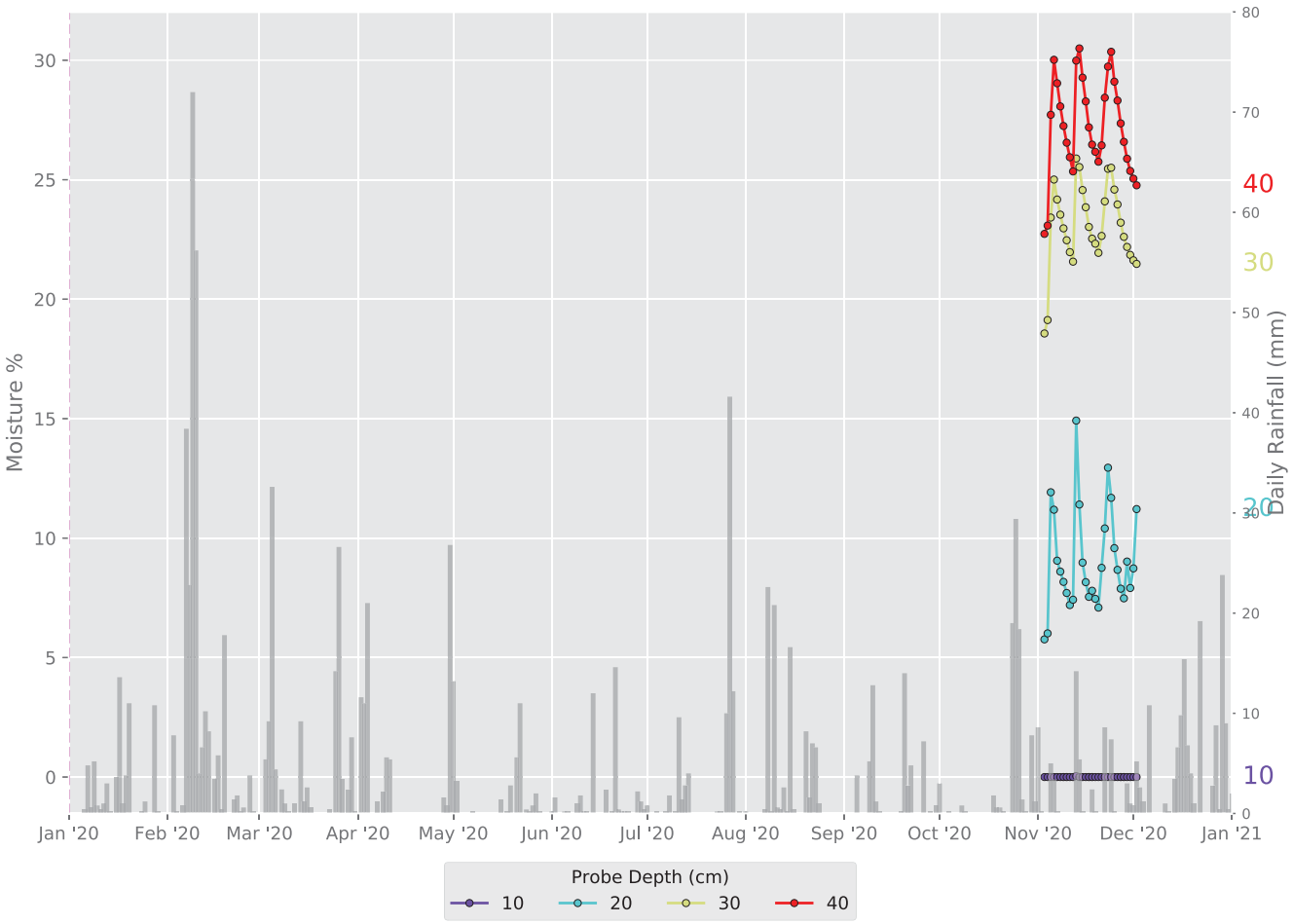

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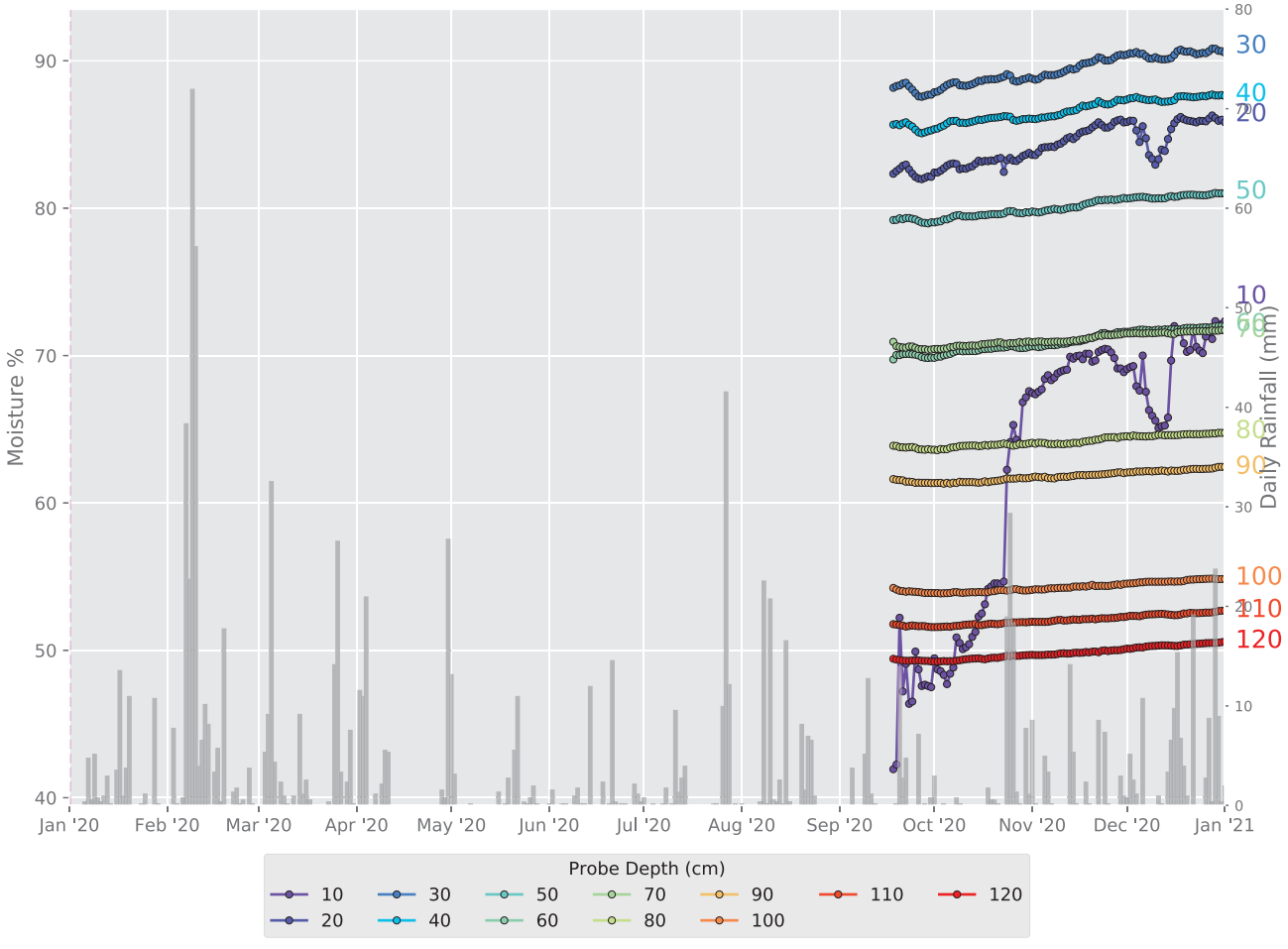

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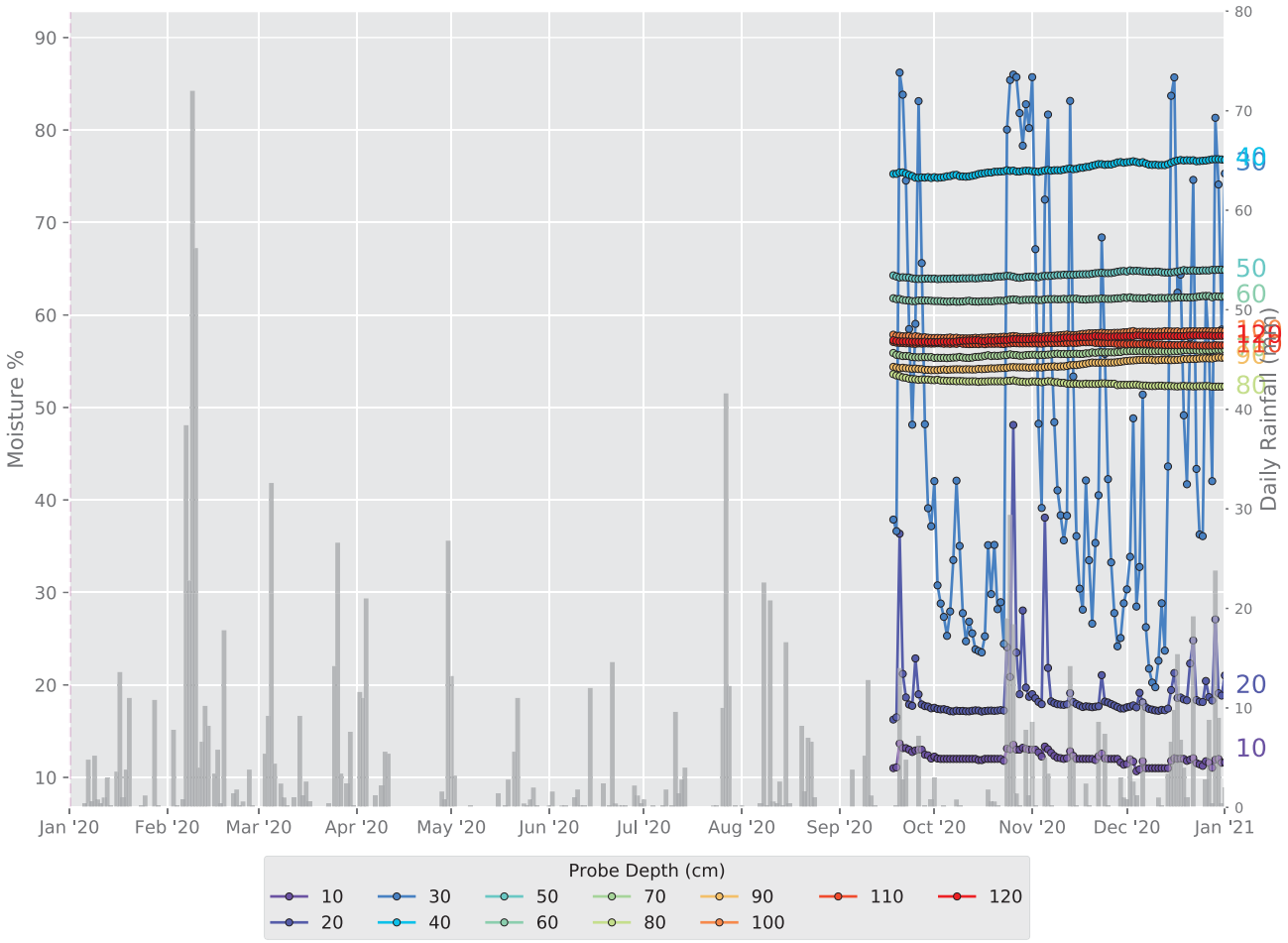

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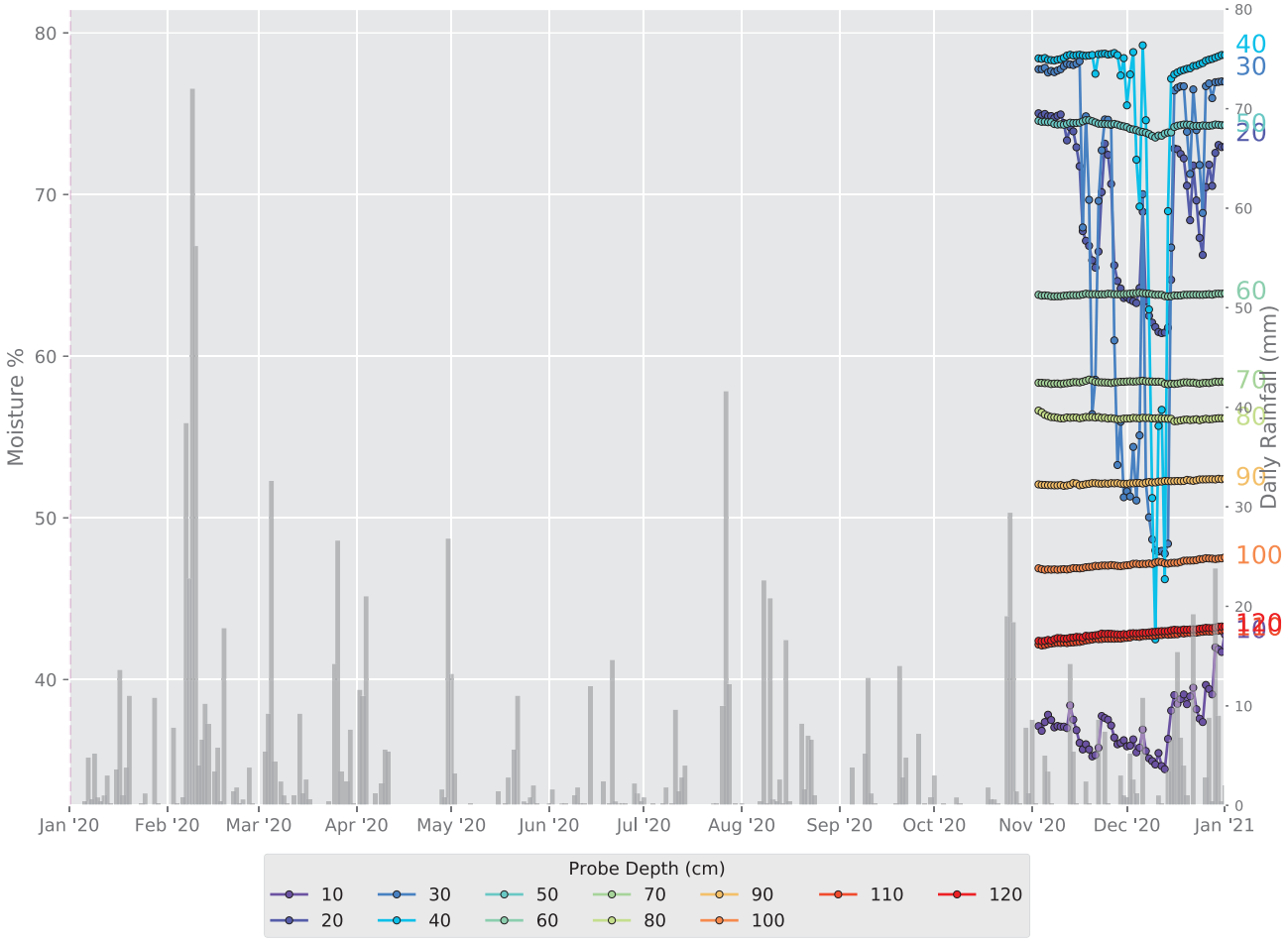
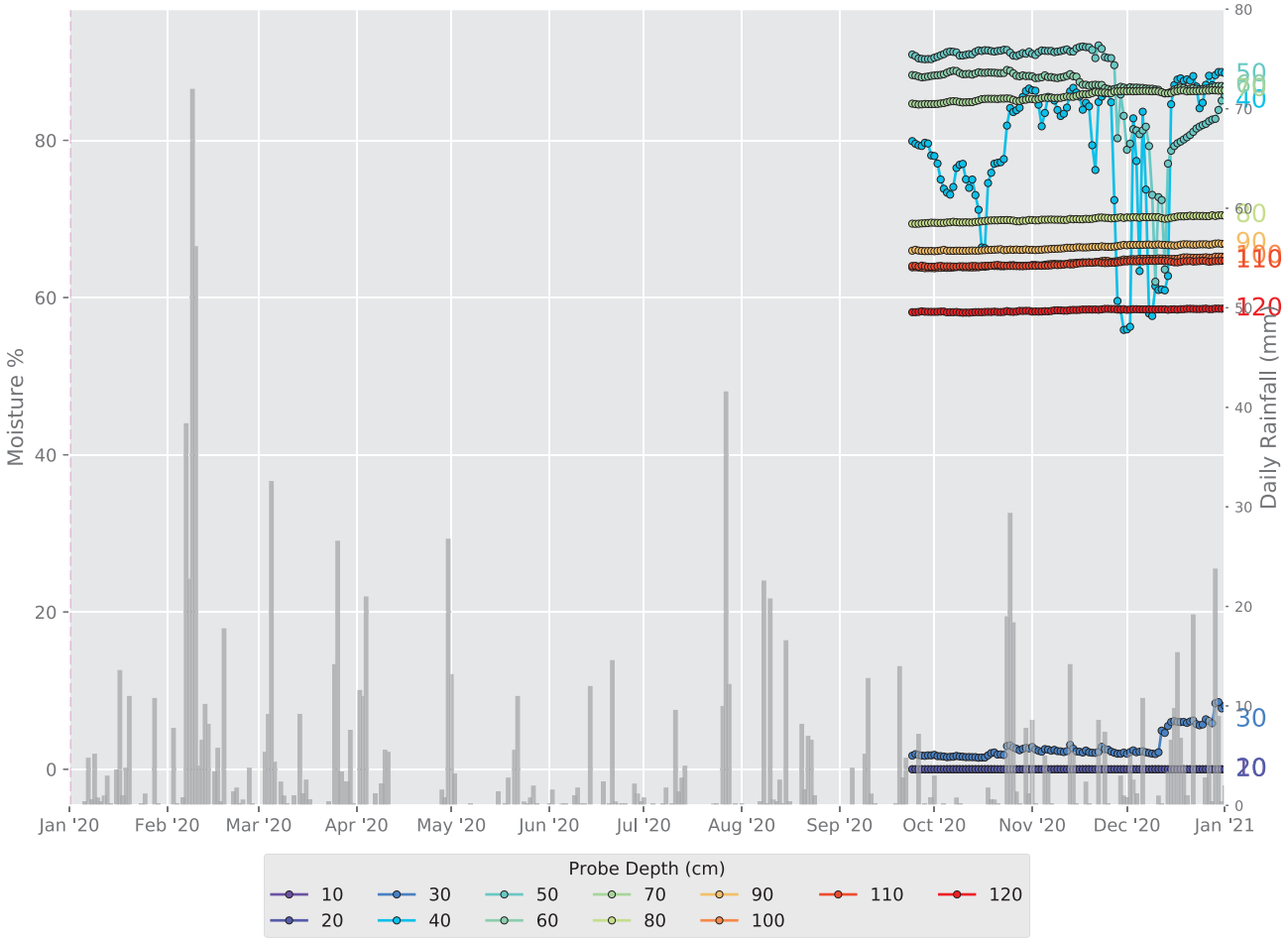


NMSS0120CM



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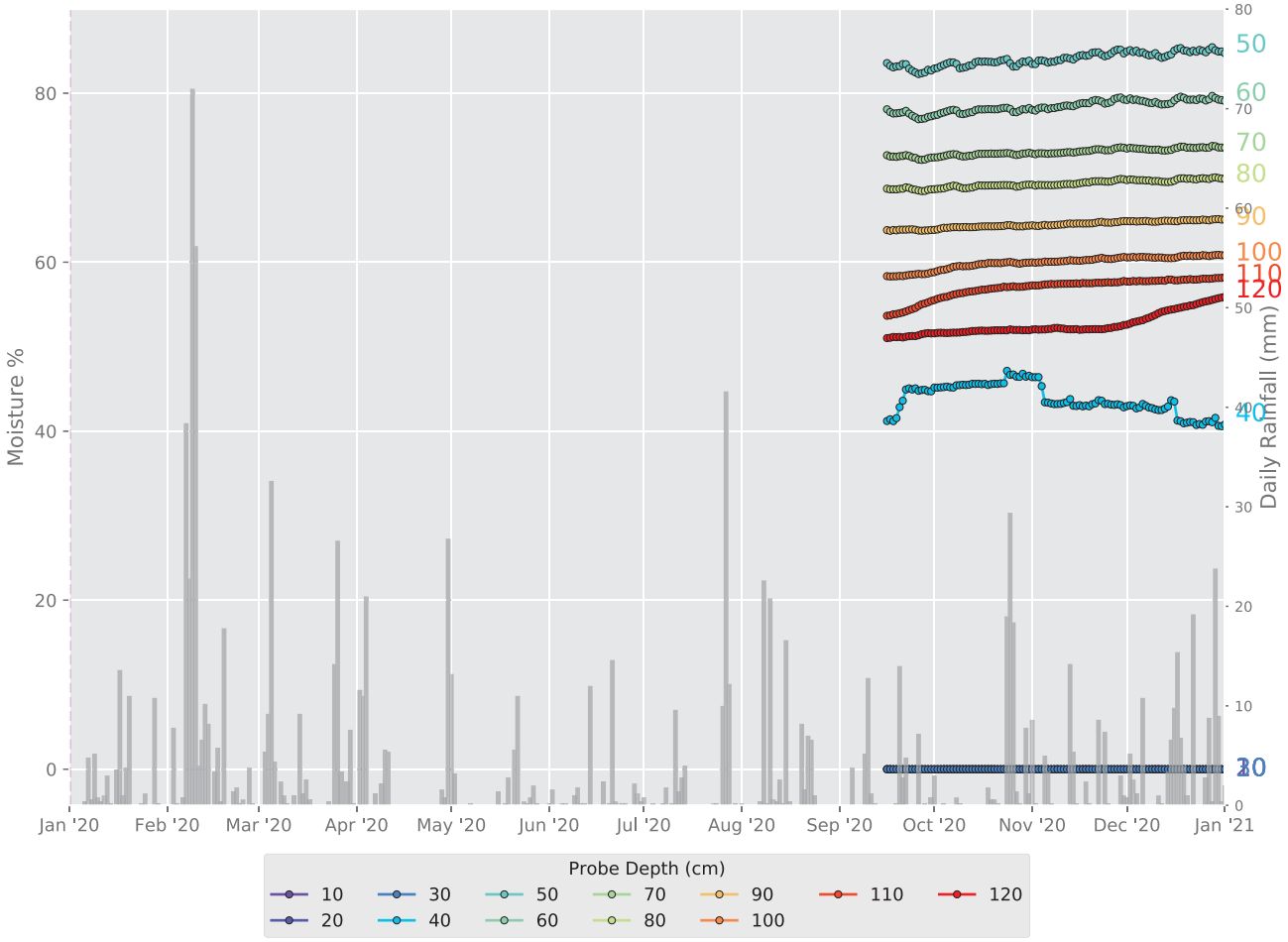

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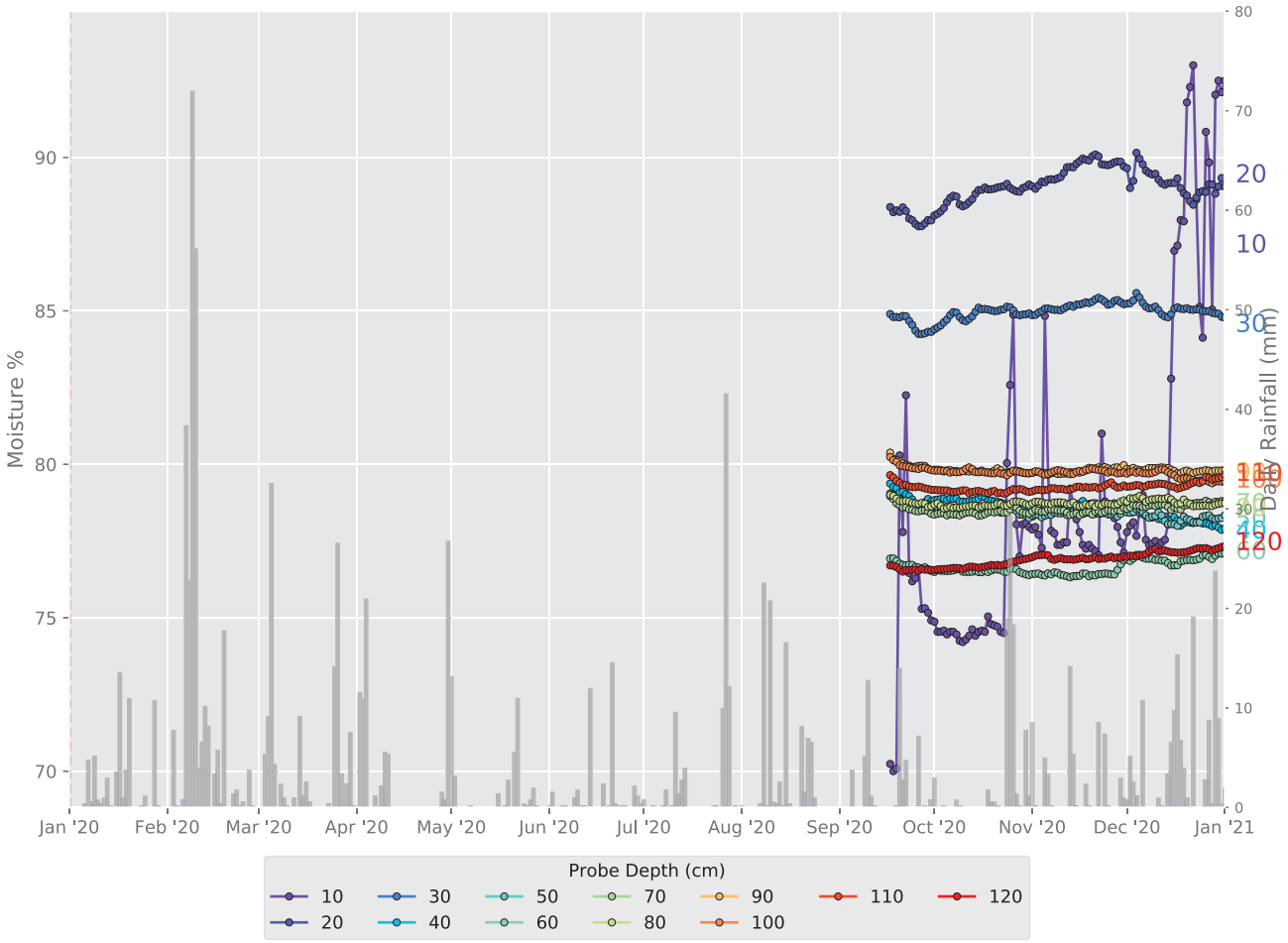

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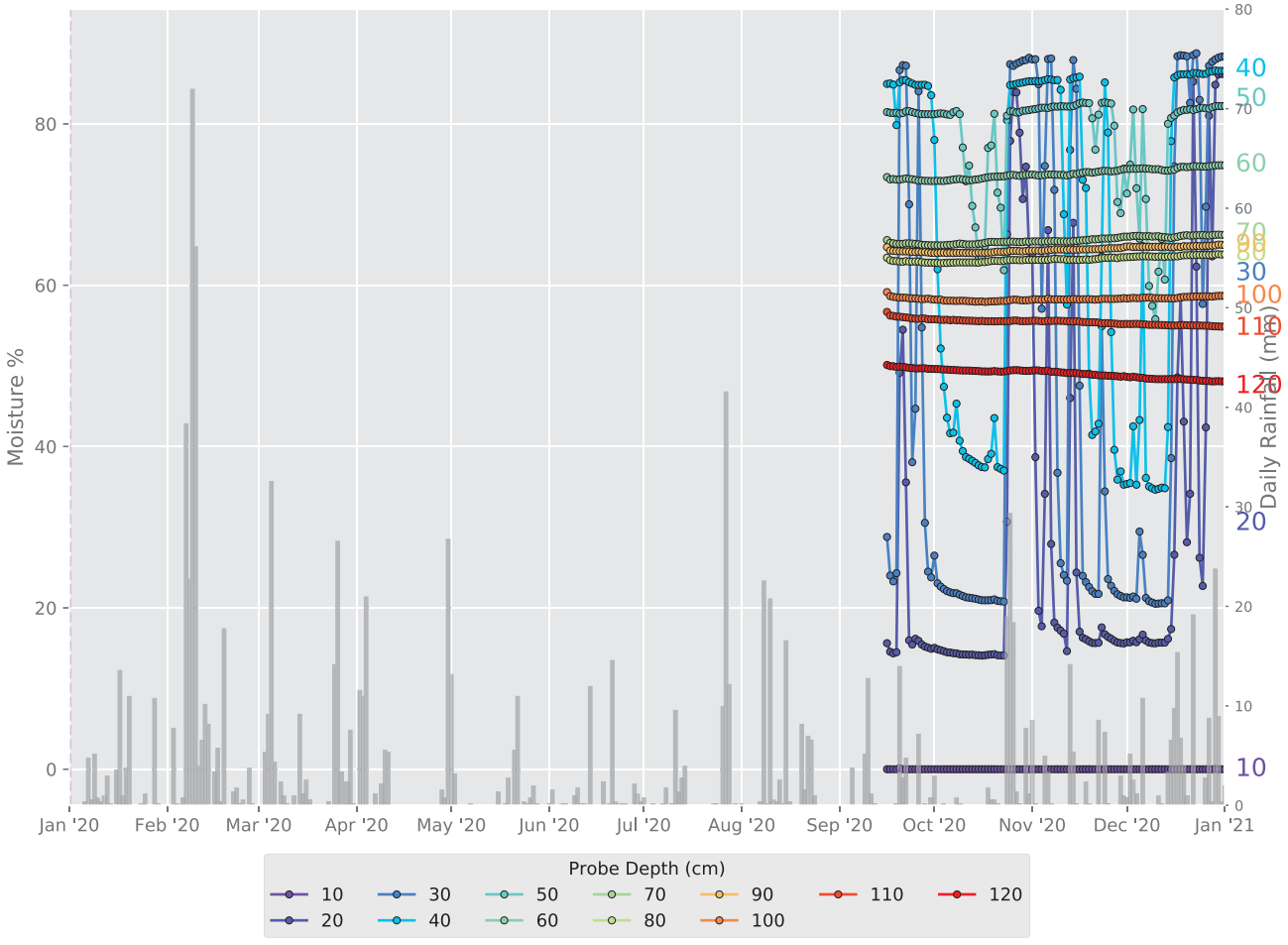
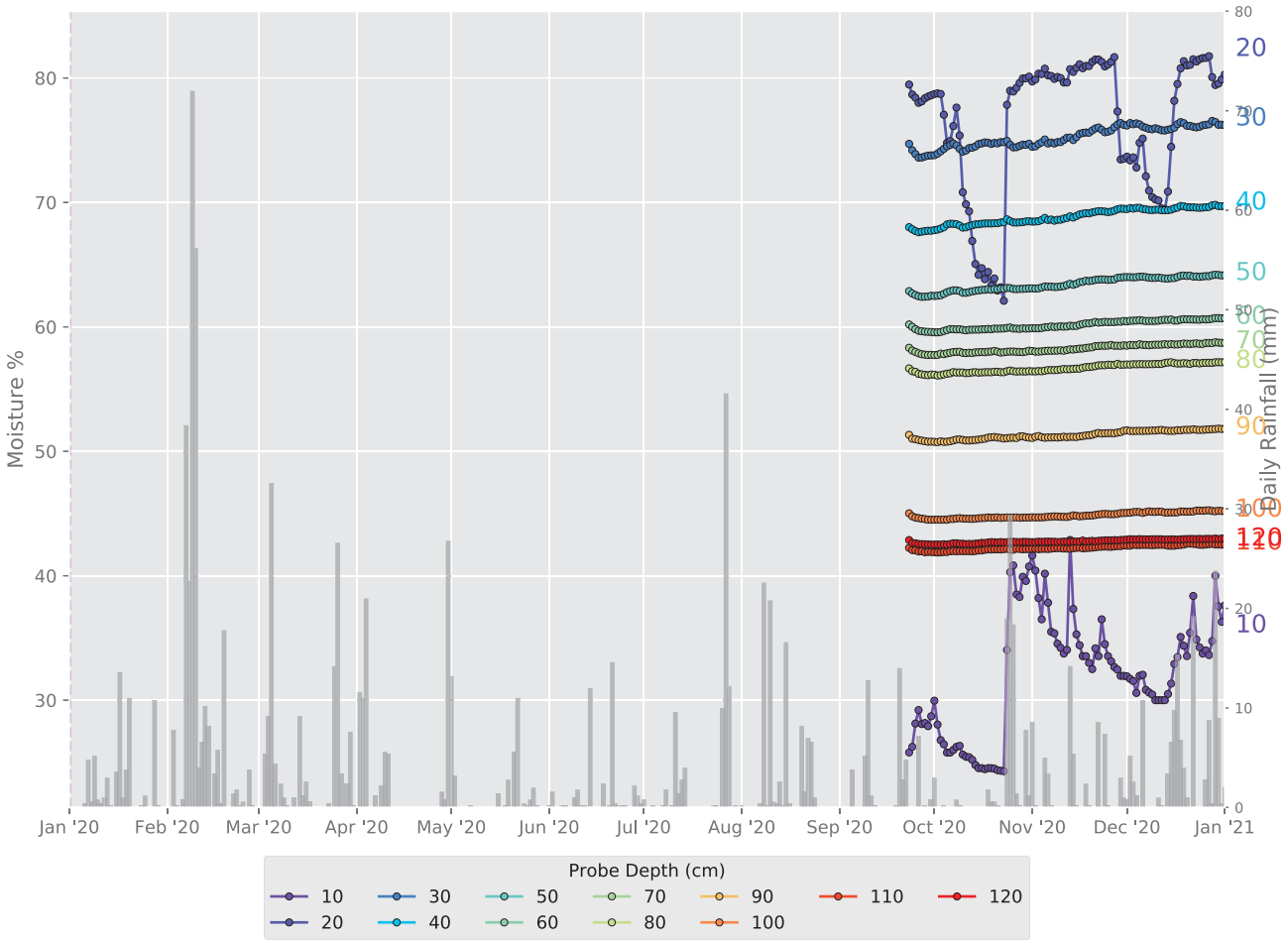
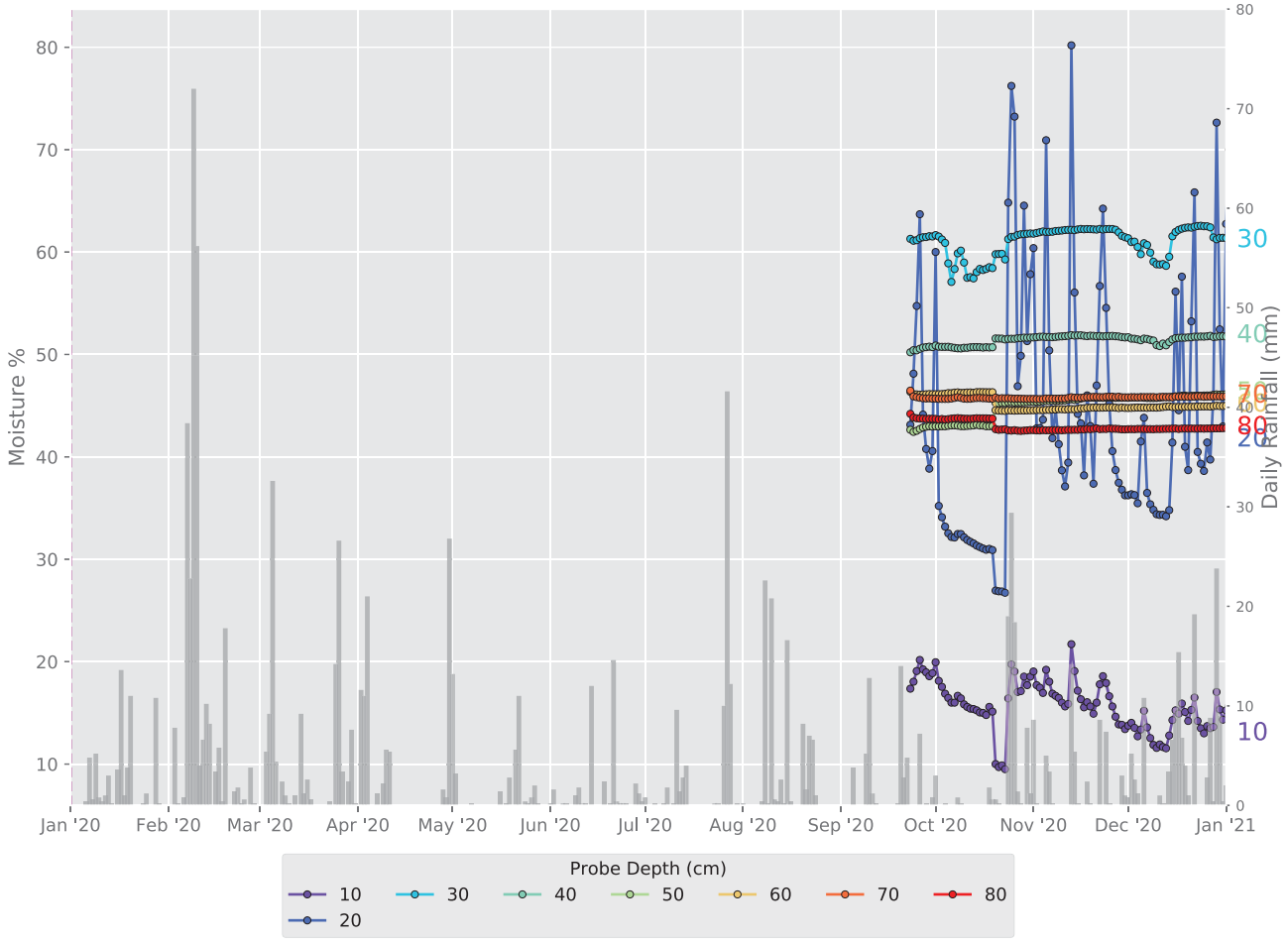


TG100120CM



TG200080CM



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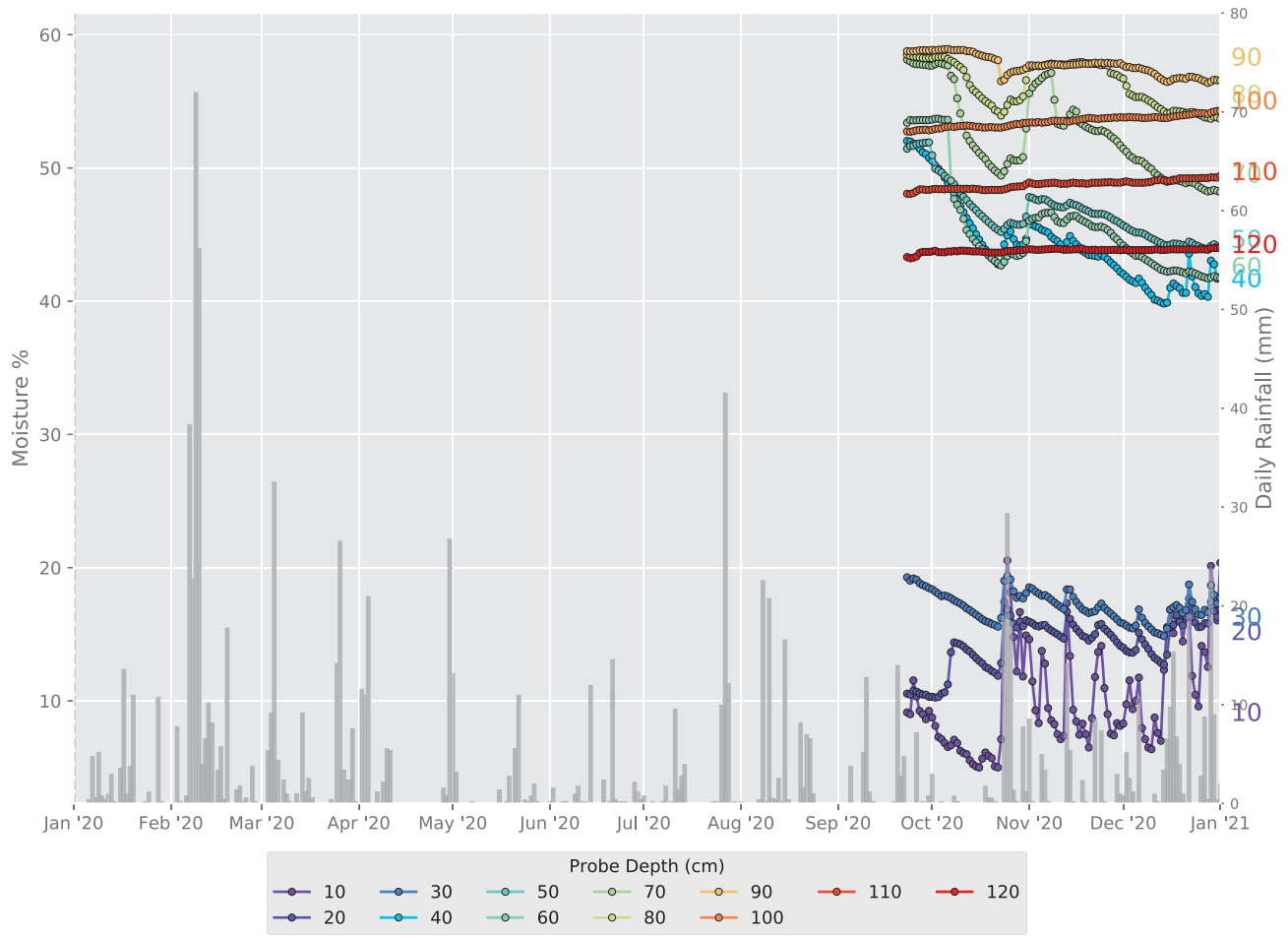

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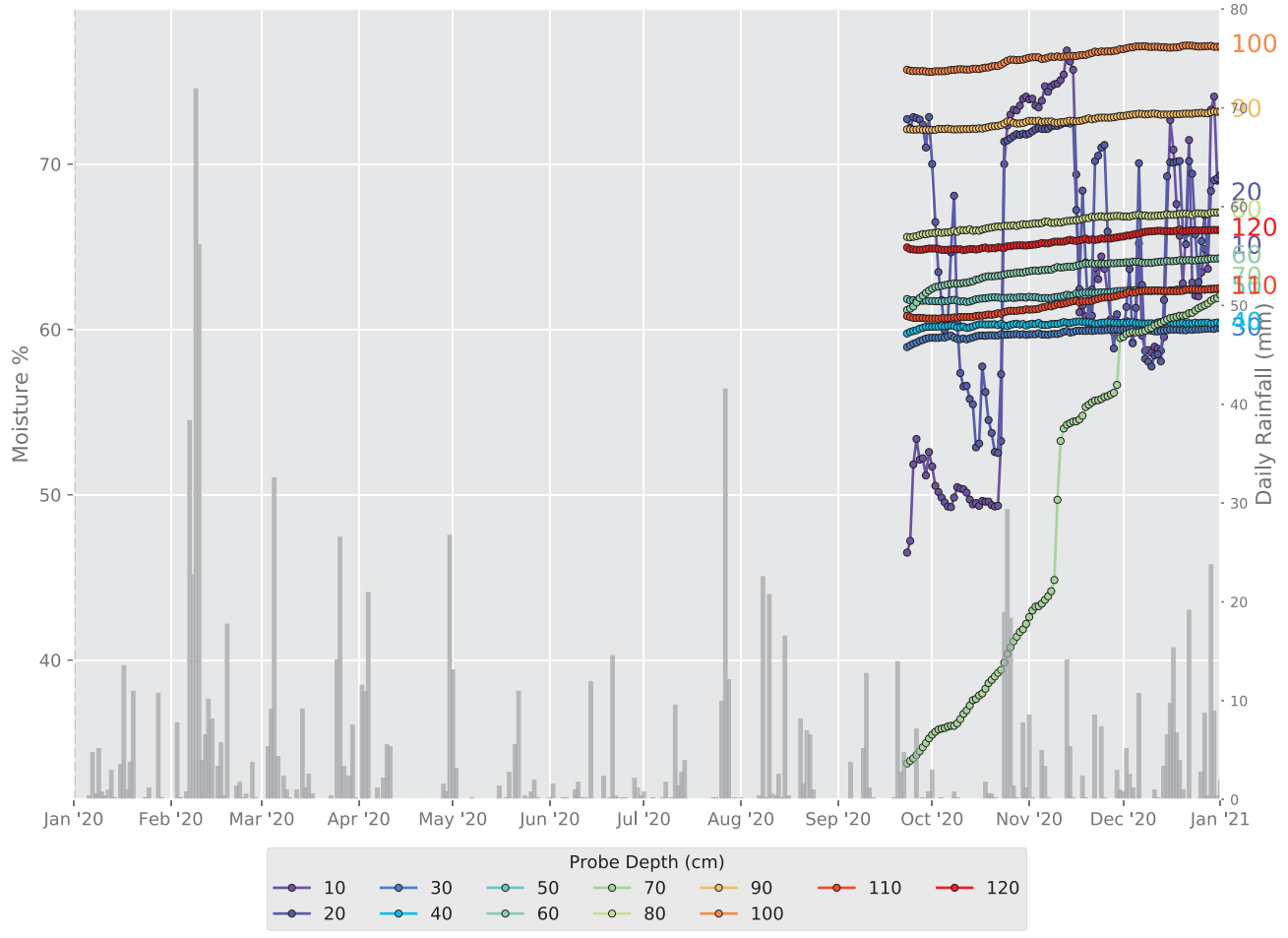


Appendix G. Surface Water Flow Rate and Water Quality

SPRINGVALE

Appendix H. Additional Information

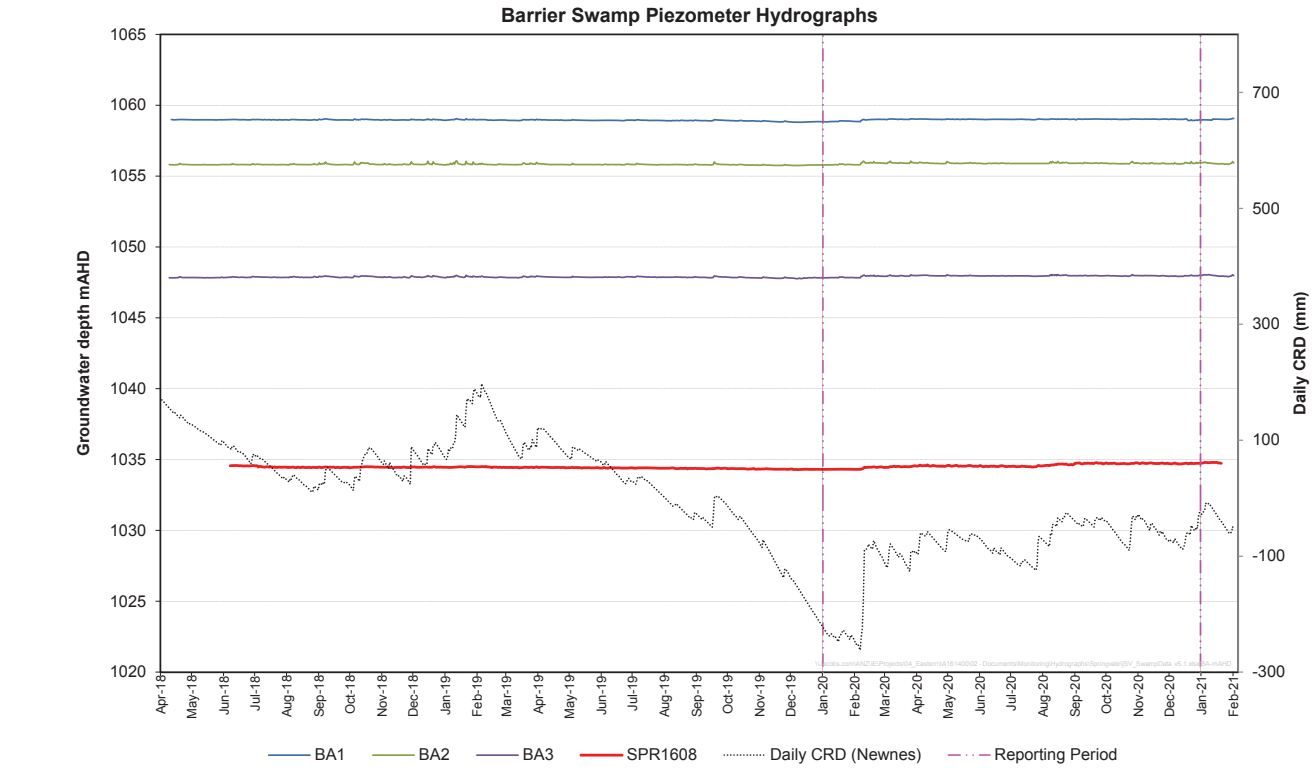
Table H.1: Details of soil moisture probes

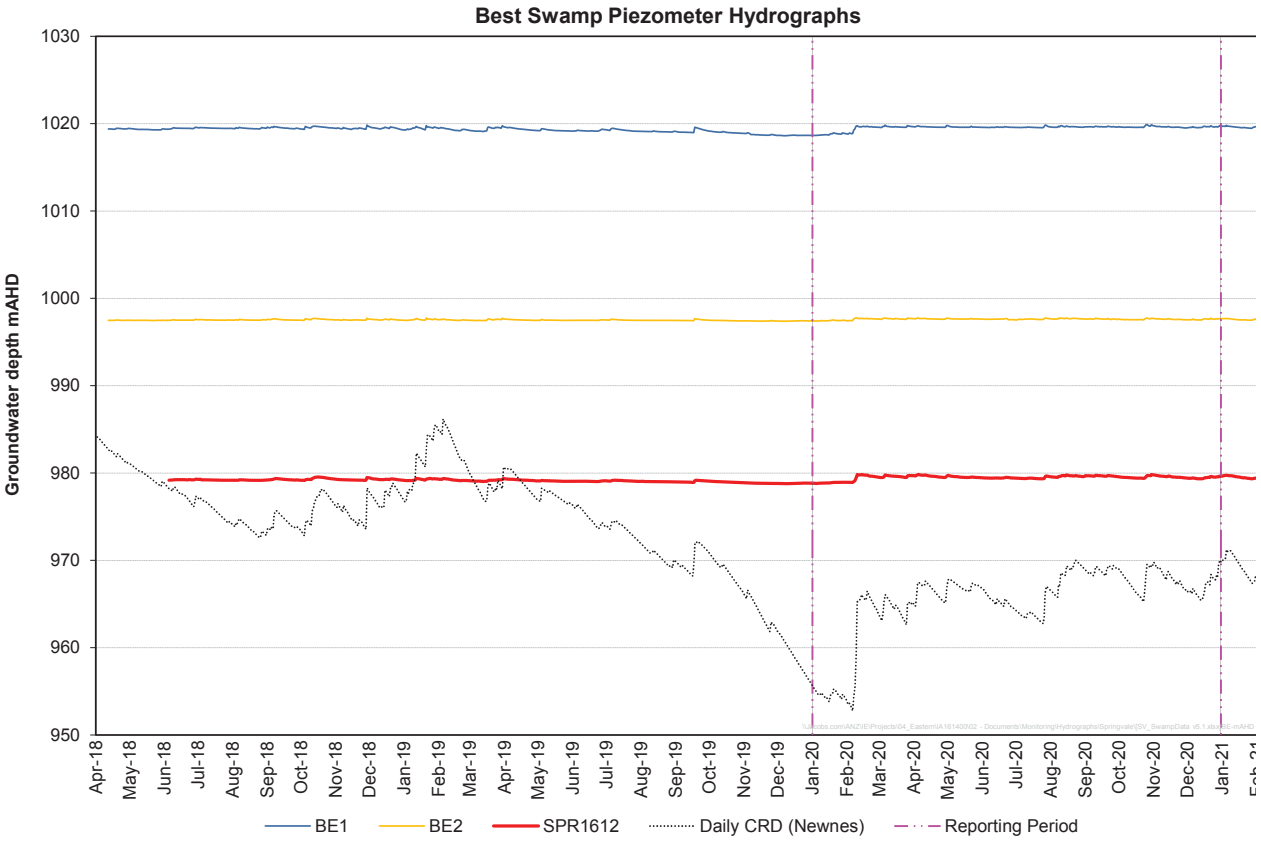
Bore ID	Easting (m)	Northing (m)	Swamp Piezometer Depth (mbgl)	Probe Length (m)	Installed Length (mbgl)	Comments
BA1	242024	6302814	1.18	1.20	1.05	Installed using 25 mm auger. Refusal on weathered sandstone at 1.05 mbgl.
BA2	242099	6303297	0.95	0.80	0.80	Installed at target depth using 25 mm auger.
BA3	242070	6303923	0.90	0.80	0.80	Installed at target depth using 25 mm auger.
BE1	245818	6307614	1.39	1.20	1.20	Installed at target depth using 25 mm auger.
BE2	246565	6308274	1.47	1.20	1.10	Installed using 25 mm auger. Refusal at 1.10 mbgl on compacted sand.
BS1	241054	6301326	1.20	1.20	1.20	Installed at target depth using 25 mm auger.
BS2	240814	6300171	1.10	0.80	0.80	Installed at target depth using 25 mm auger.
BS3	241981	6301243	0.85	0.80	0.80	Installed at target depth using 25 mm auger.
PSS (BS4)	241959	6301202	1.19	1.20	1.15	Installed at target depth using 25 mm auger.
NMSS (BS5)	241913	6301328	1.00	1.20	0.95	Installed at target depth using 25 mm auger.
CC1	241190	6302690	0.96	0.80	0.80	Installed at target depth using 25 mm auger.
CC2	241131	6303290	1.20	1.20	1.20	Installed at target depth using 25 mm auger.
CW1	239350	6303195	0.73	1.20	0.73	Installed using 80 mm auger. Refusal on coarse grained sand/ cobbles at 0.73 mbgl.
CW4	239379	6303249	1.41	1.20	1.20	Installed at target depth using 80 mm auger.
FS1	246893	6306485	2.83	1.20	1.20	Installed at target depth using 25 mm auger.
FS2	247489	6307074	0.50	0.40	0.40	Installed at target depth using 25 mm auger.

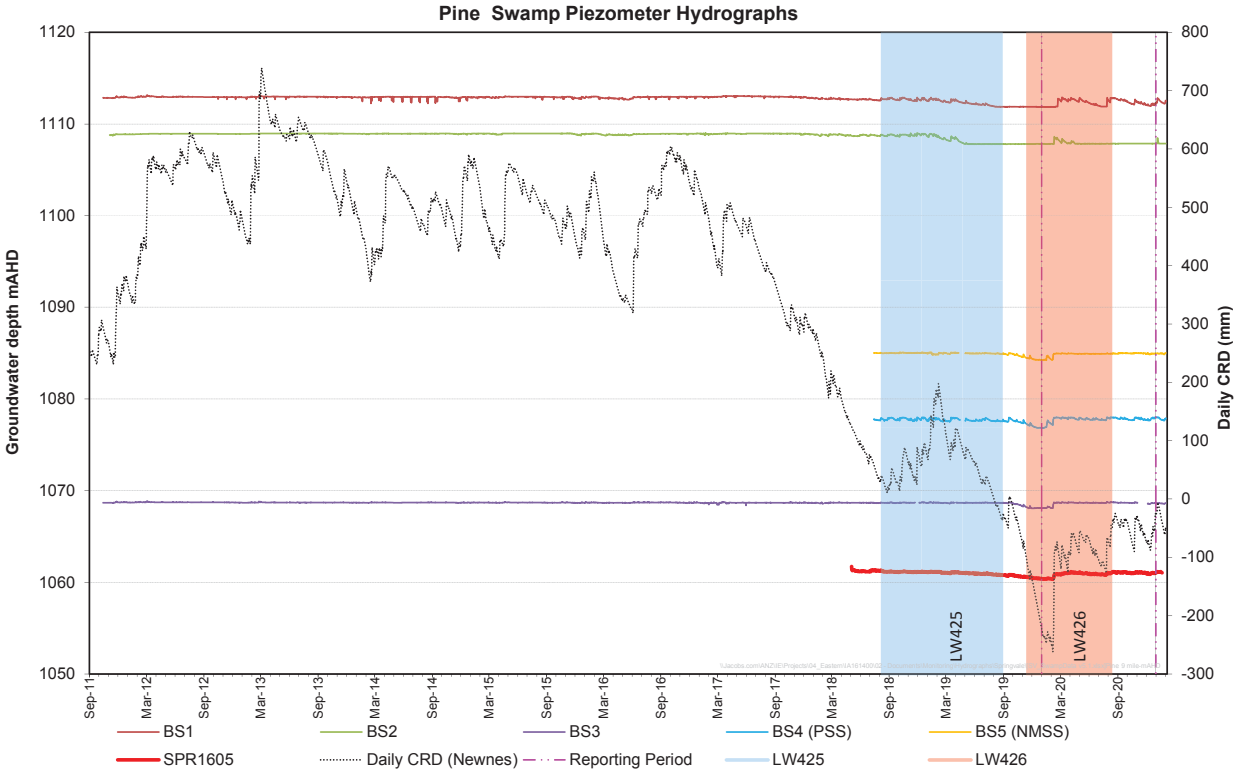
SPRINGVALE

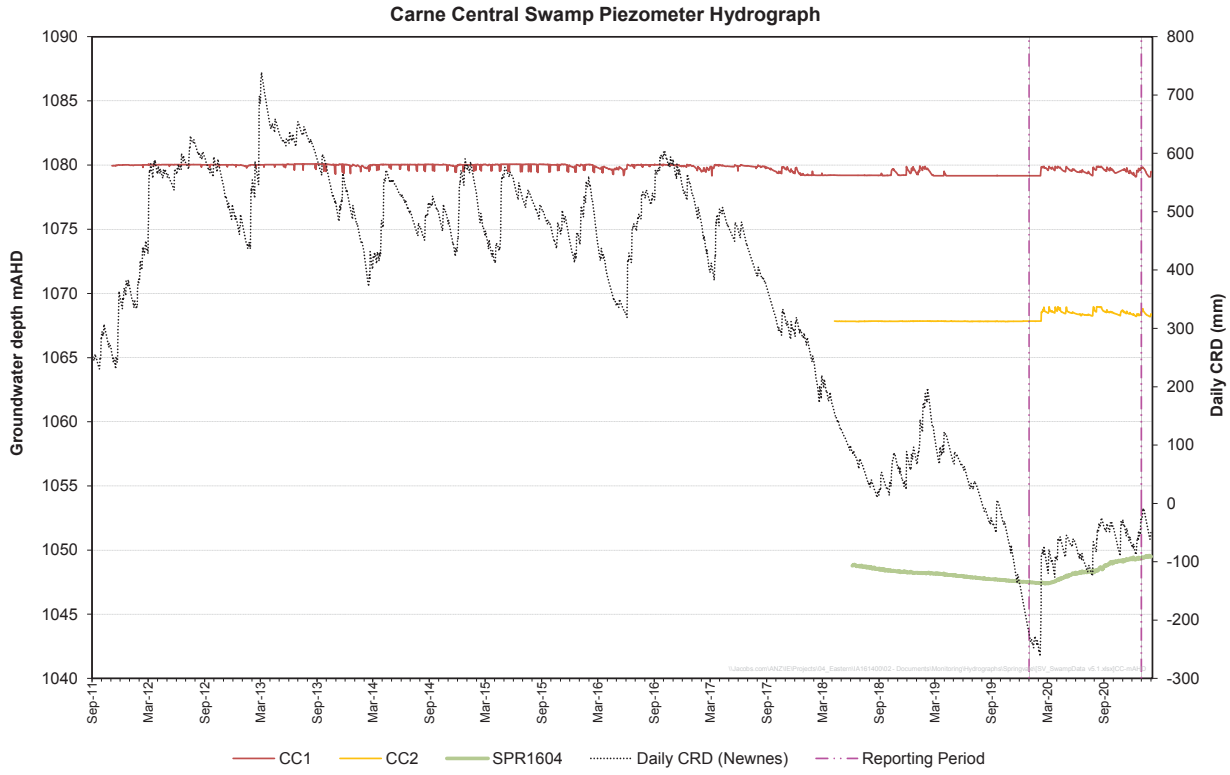
Bore ID	Easting (m)	Northing (m)	Swamp Piezometer Depth (mbgl)	Probe Length (m)	Installed Length (mbgl)	Comments
MS1	238860	6299170	1.36	1.20	1.20	Installed at target depth using 25 mm auger.
MS2	239046	6299049	1.29	1.20	1.20	Installed at target depth using 25 mm auger.
MS3	239359	6298208	2.40	1.20	1.20	Installed at target depth using 25 mm auger.
PC1	241204	6298832	1.20	1.20	1.00	Installed using 80 mm auger. Refusal at 1.00 mbgl on compacted sand.
PC2	240913	6298663	1.62	1.20	1.20	Installed at target depth using 25 mm auger.
TG1	236437	6308766	1.20	1.20	1.20	Installed at target depth using 25 mm auger.
TG2	236043	6308932	0.85	0.80	0.80	Installed at target depth using 25 mm auger.
TS2	237446	6306781	2.06	1.20	1.20	Installed at target depth using 25 mm auger.
TS3	236896	6307162	1.77	1.20	1.20	Installed at target depth using 25 mm auger.

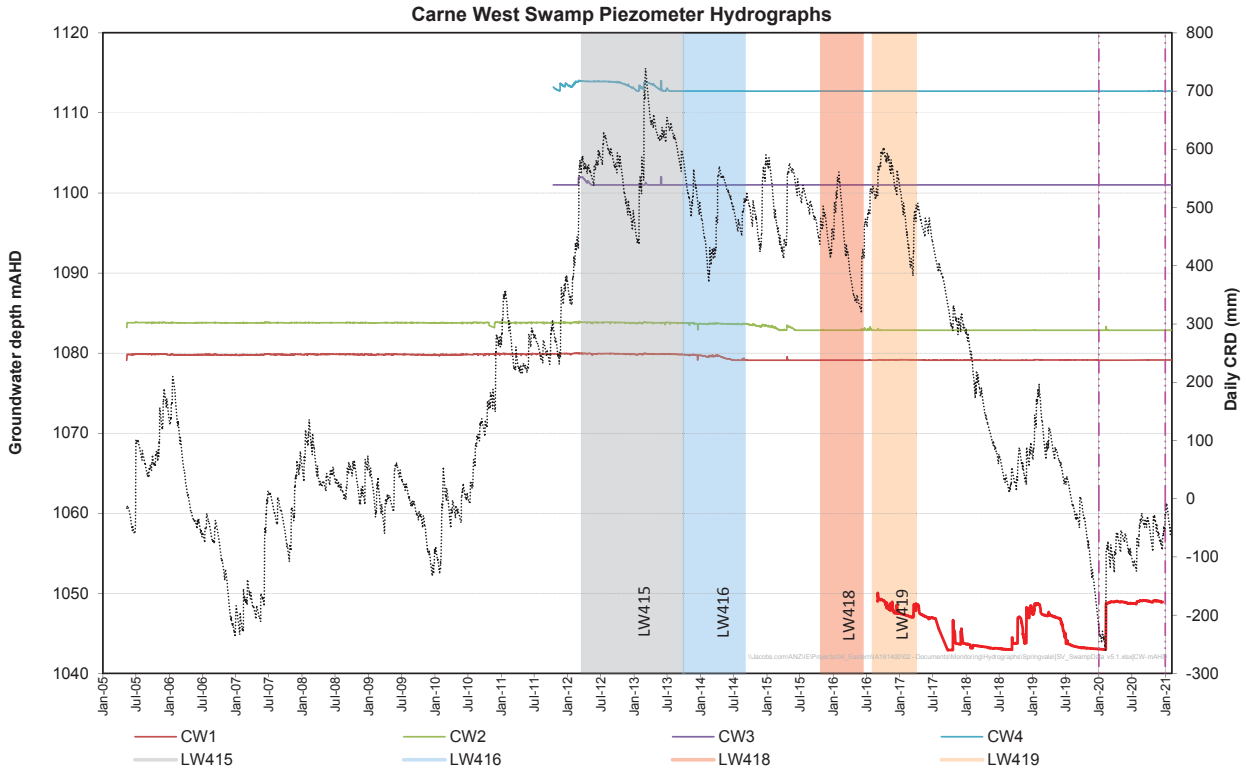
SPRINGVALE

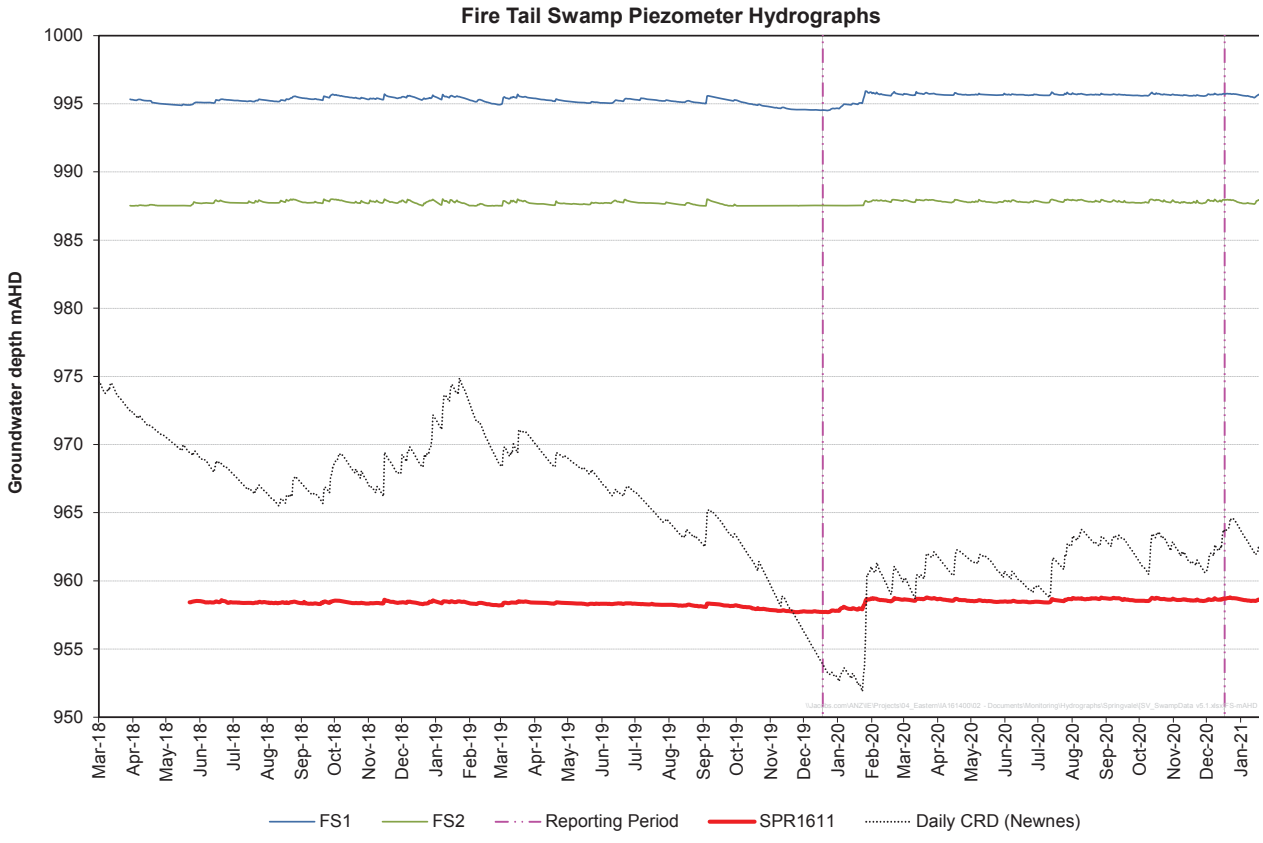

Barrier Swamp Piezometer Hydrographs
Groundwater depth mAHD
Daily CRD (mm)
1065
1060
1055
1050
1045
1040
1035
1030
1025
1020
700
500
300
100
-100
-300
Apr-18
May-18
Jun-18
Jul-18
Aug-18
Sep-18
Oct-18
Nov-18
Dec-18
Jan-19
Feb-19
Mar-19
Apr-19
May-19
Jun-19
Jul-19
Aug-19
Sep-19
Oct-19
Nov-19
Dec-19
Jan-20
Feb-20
Mar-20
Apr-20
May-20
Jun-20
Jul-20
Aug-20
Sep-20
Oct-20
Nov-20
Dec-20
Jan-21
Feb-21
BA1
BA2
BA3
SPR1608
Daily CRD (Newnes)
Reporting Period

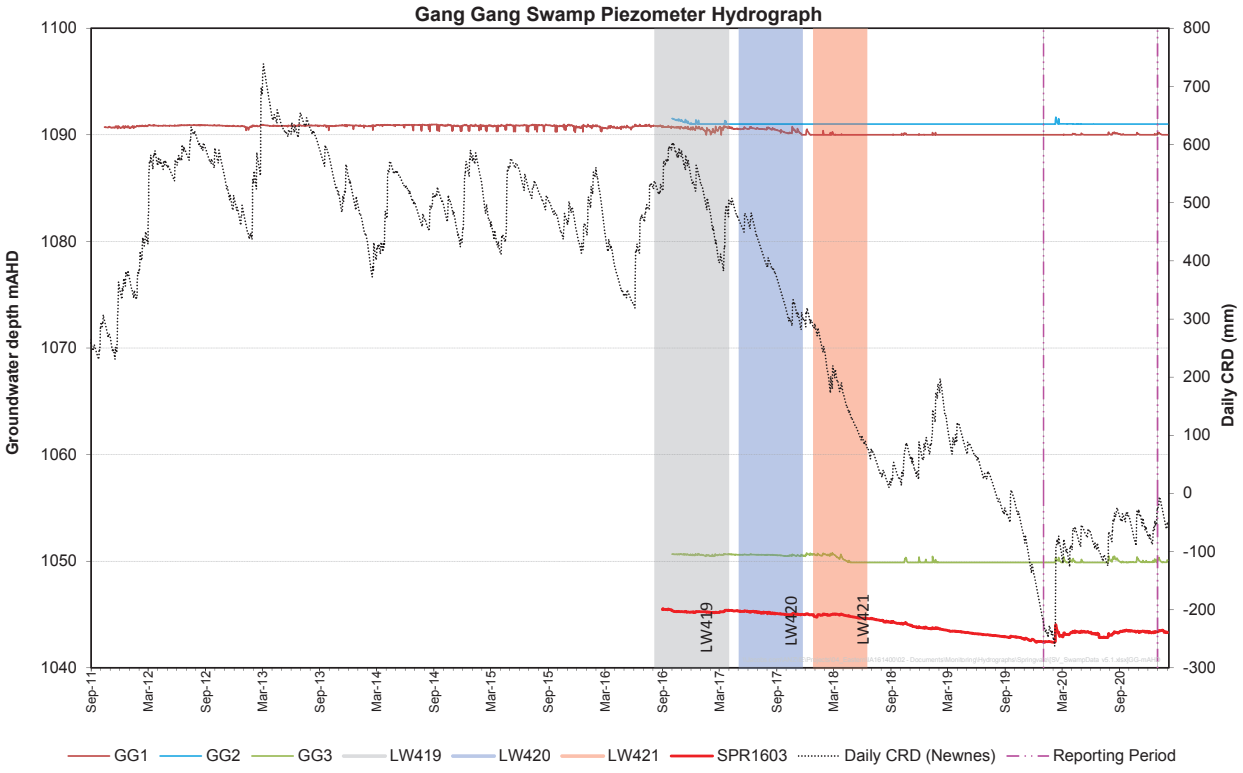

Best Swamp Piezometer Hydrographs
Groundwater depth mAHD
1030
1020
1010
1000
990
980
970
960
950
Apr-18
May-18
Jun-18
Jul-18
Aug-18
Sep-18
Oct-18
Nov-18
Dec-18
Jan-19
Feb-19
Mar-19
Apr-19
May-19
Jun-19
Jul-19
Aug-19
Sep-19
Oct-19
Nov-19
Dec-19
Jan-20
Feb-20
Mar-20
Apr-20
May-20
Jun-20
Jul-20
Aug-20
Sep-20
Oct-20
Nov-20
Dec-20
Jan-21
BE1
BE2
SPR1612
Daily CRD (Newnes)
Reporting Period

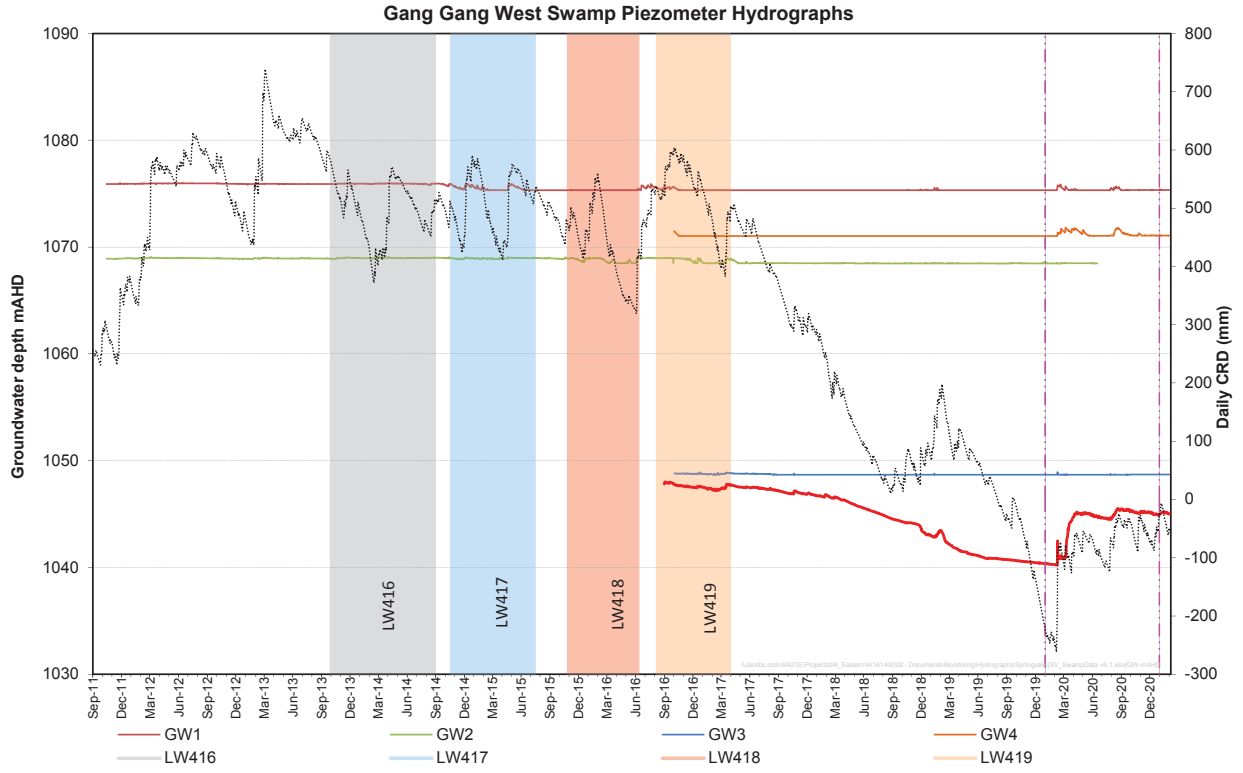

Pine Swamp Piezometer Hydrographs
Groundwater depth mAHD
Daily CRD (mm)
LW425
LW426
BS1
BS2
BS3
BS4 (PSS)
BS5 (NMSS)
SPR1605
Daily CRD (Newnes)
Reporting Period
LW425
LW426

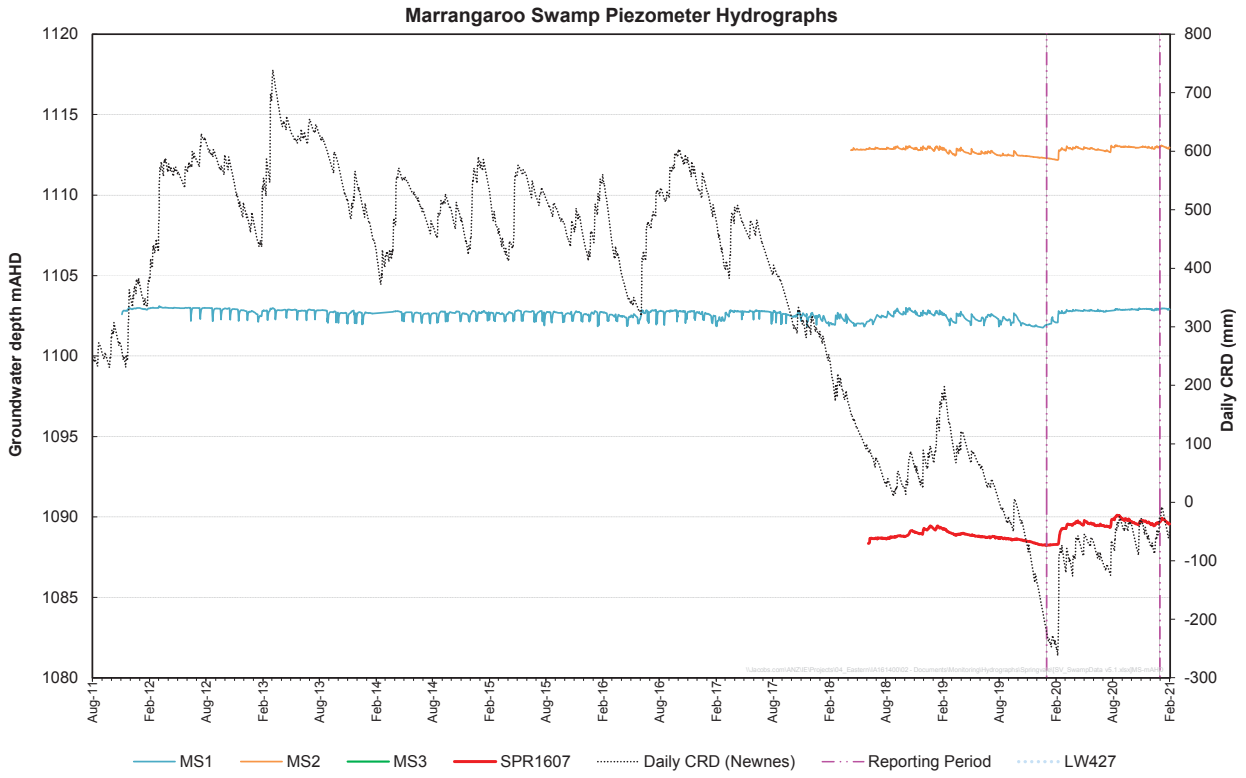

Carne Central Swamp Piezometer Hydrograph
Groundwater depth mAHD
Daily CRD (mm)
CC1
CC2
SPR1604
Daily CRD (Newnes)
Reporting Period

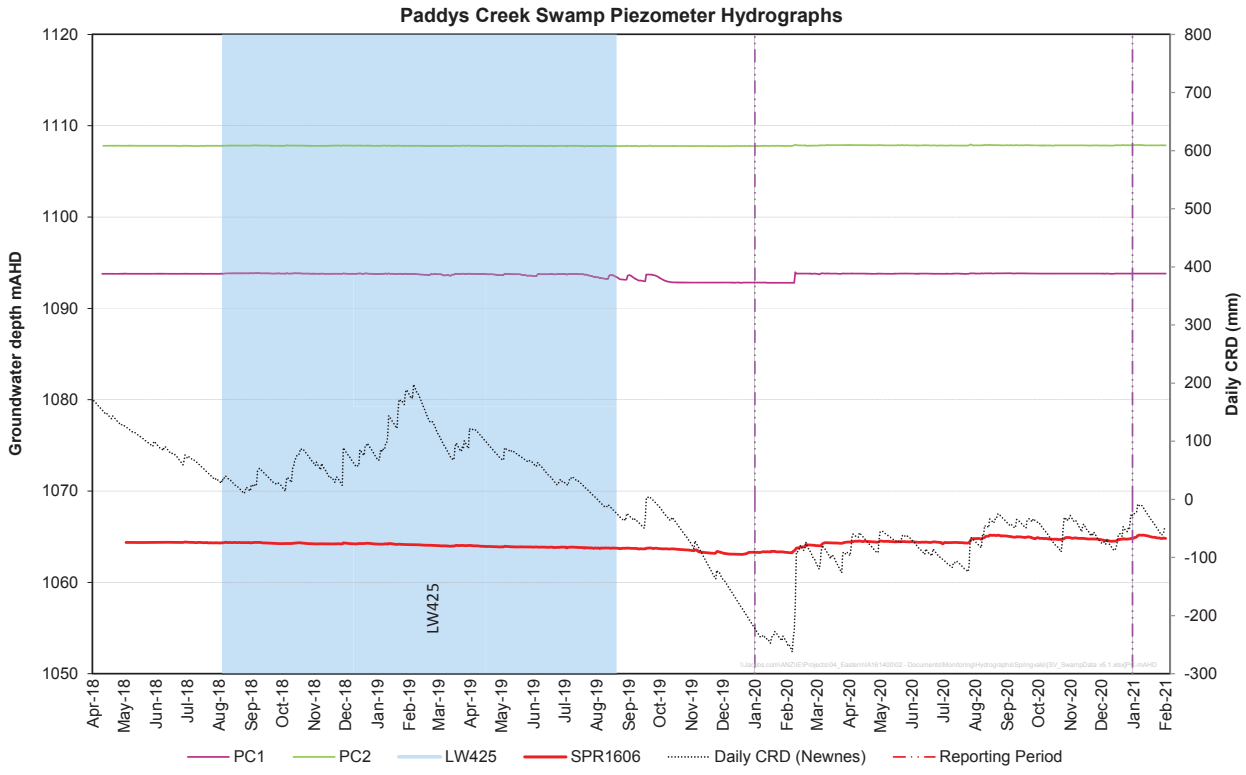

Carne West Swamp Piezometer Hydrographs
Groundwater depth mAHD
Daily CRD (mm)
LW415
LW416
LW418
LW419
CW1
CW2
CW3
CW4
LW415
LW416
LW418
LW419


Fire Tail Swamp Piezometer Hydrographs
Groundwater depth mAHD
FS1
FS2
Reporting Period
SPR1611
Daily CRD (Newnes)


Gang Gang Swamp Piezometer Hydrograph
Groundwater depth mAHD
Daily CRD (mm)
LW419
LW420
LW421
GG1
GG2
GG3
LW419
LW420
LW421
SPR1603
Daily CRD (Newnes)
Reporting Period

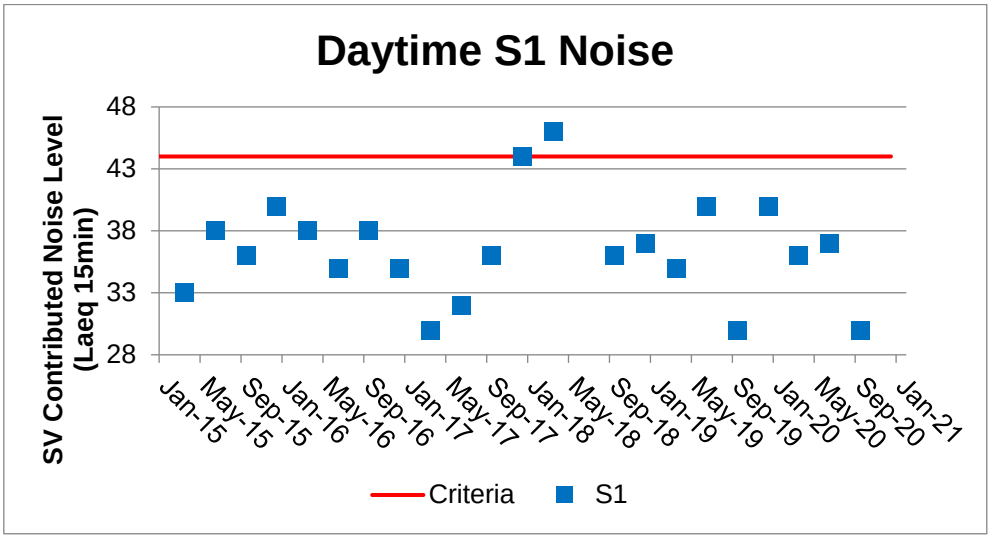

Gang Gang West Swamp Piezometer Hydrographs
Groundwater depth mAHD
Daily CRD (mm)
LW416
LW417
LW418
LW419
GW1
GW2
GW3
GW4
LW416
LW417
LW418
LW419

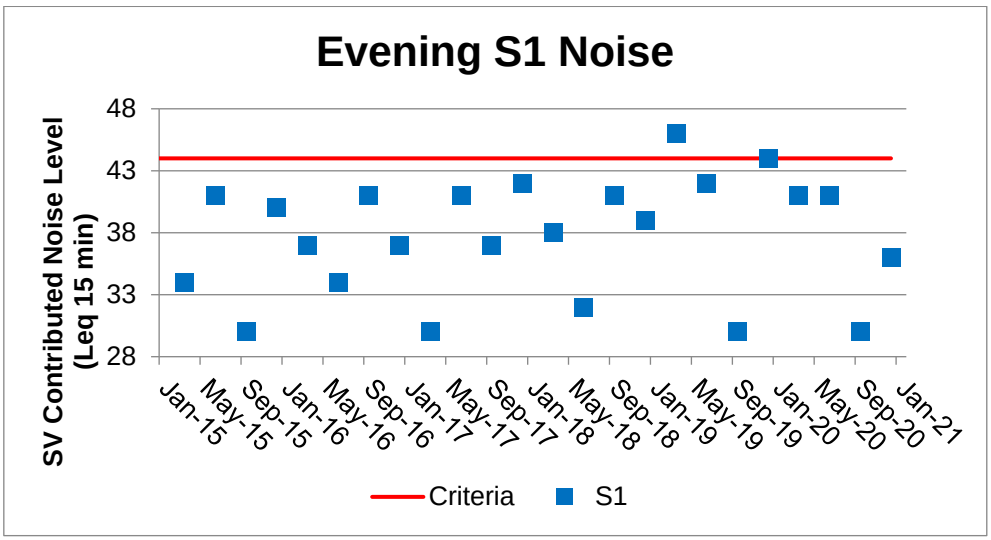

Marrangaroo Swamp Piezometer Hydrographs
Groundwater depth mAHD
Daily CRD (mm)
MS1
MS2
MS3
SPR1607
Daily CRD (Newnes)
Reporting Period
LW427

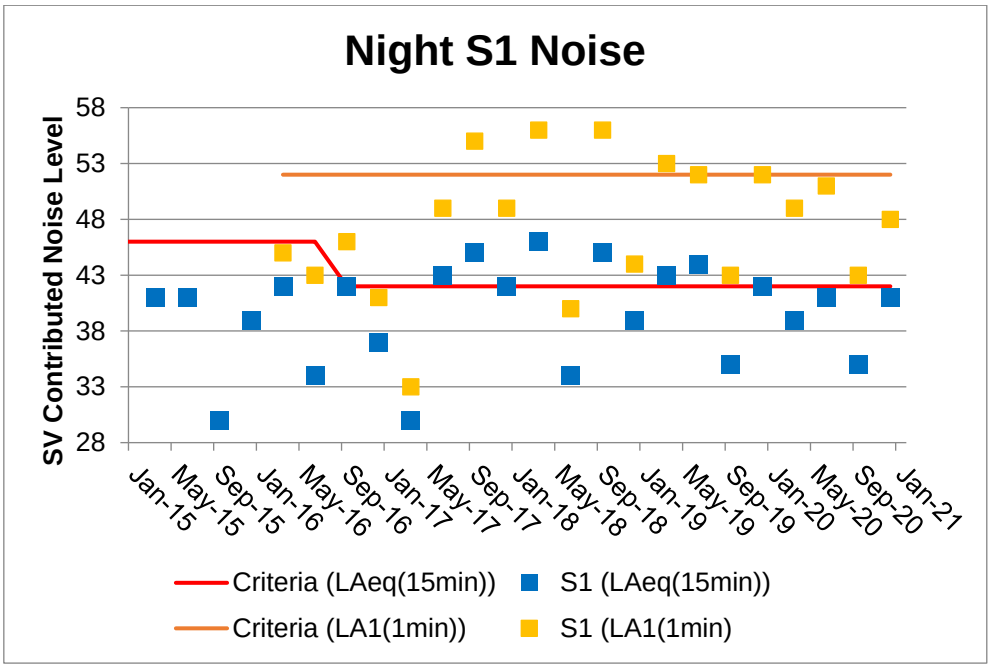

Paddys Creek Swamp Piezometer Hydrographs
Groundwater depth mAHD
Daily CRD (mm)
LW425
PC1
PC2
LW425
SPR1606
Daily CRD (Newnes)
Reporting Period

APPENDIX 4 – NOISE MONITORING RESULTS

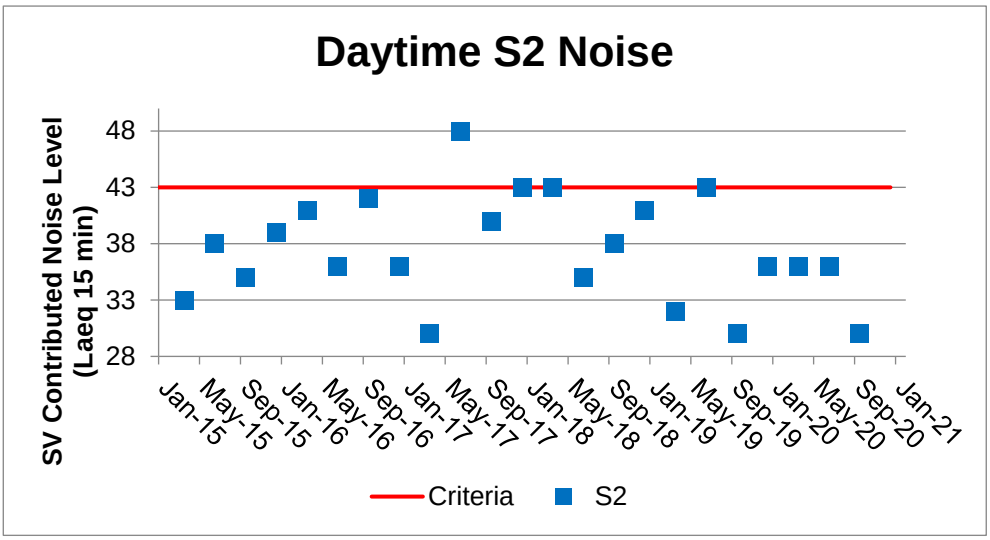
Noise Monitoring Location S1 (EPL Identification Number 3)

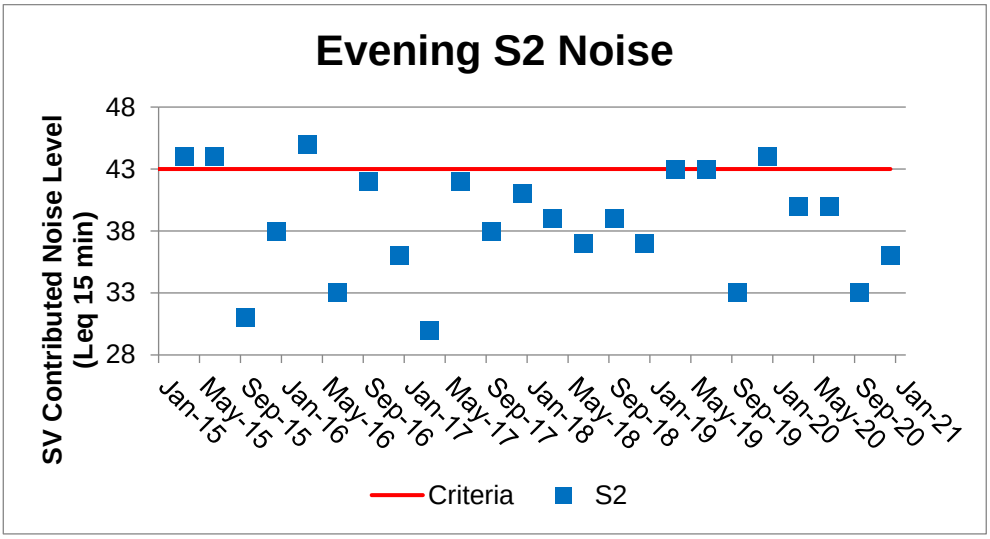


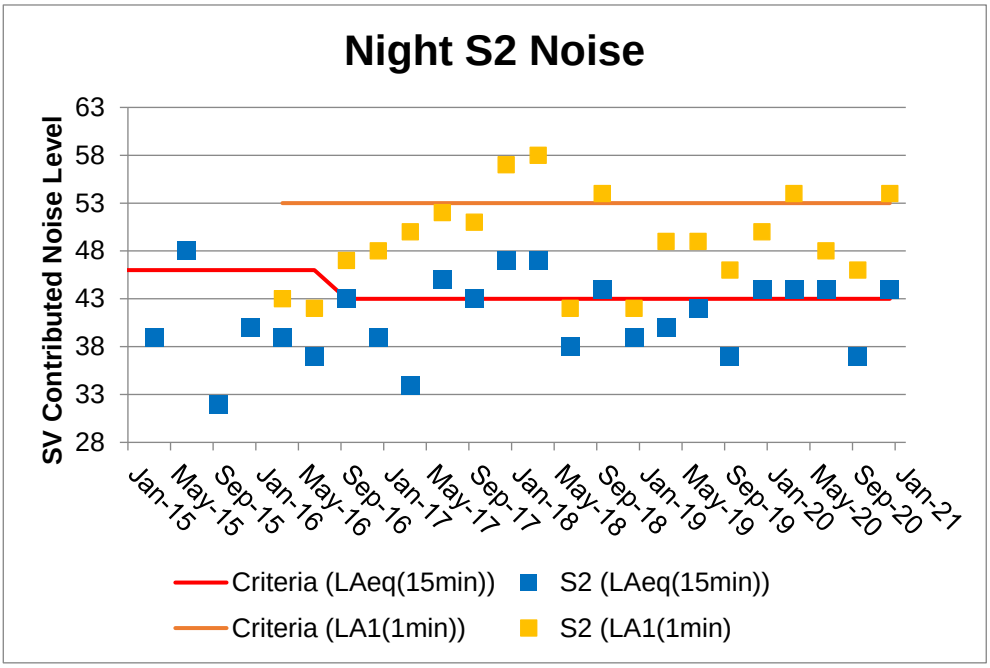




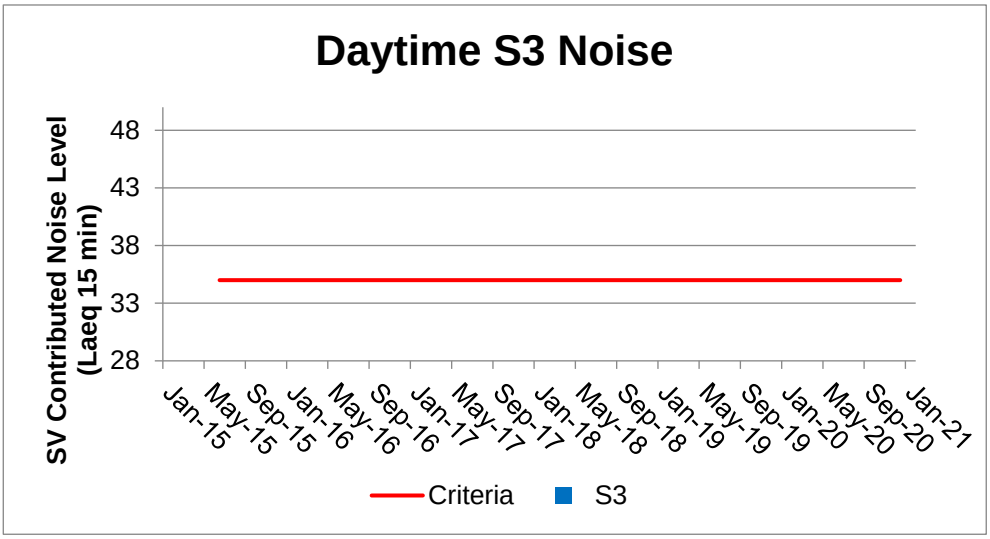
Noise Monitoring Location S2 (EPL Identification Number 4)



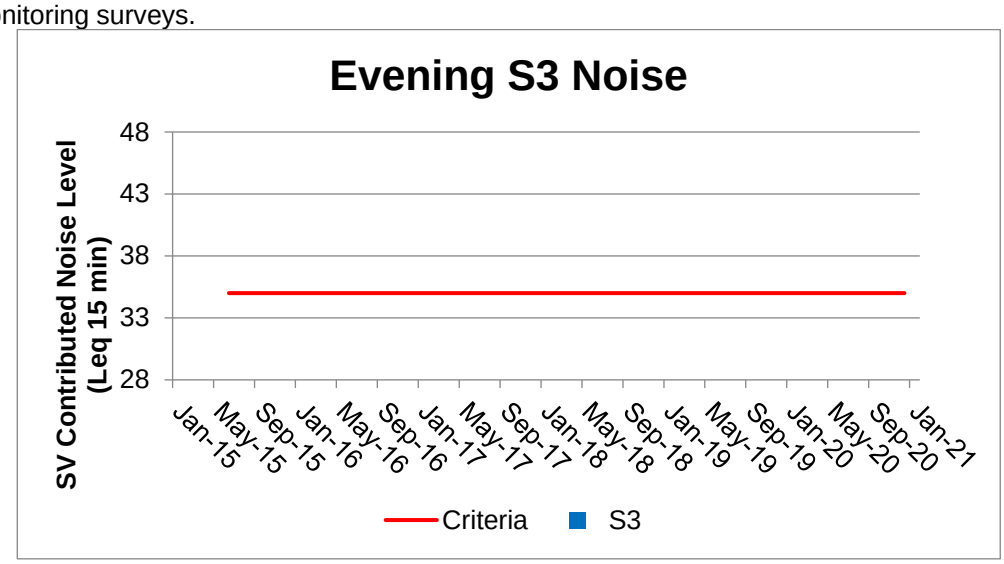




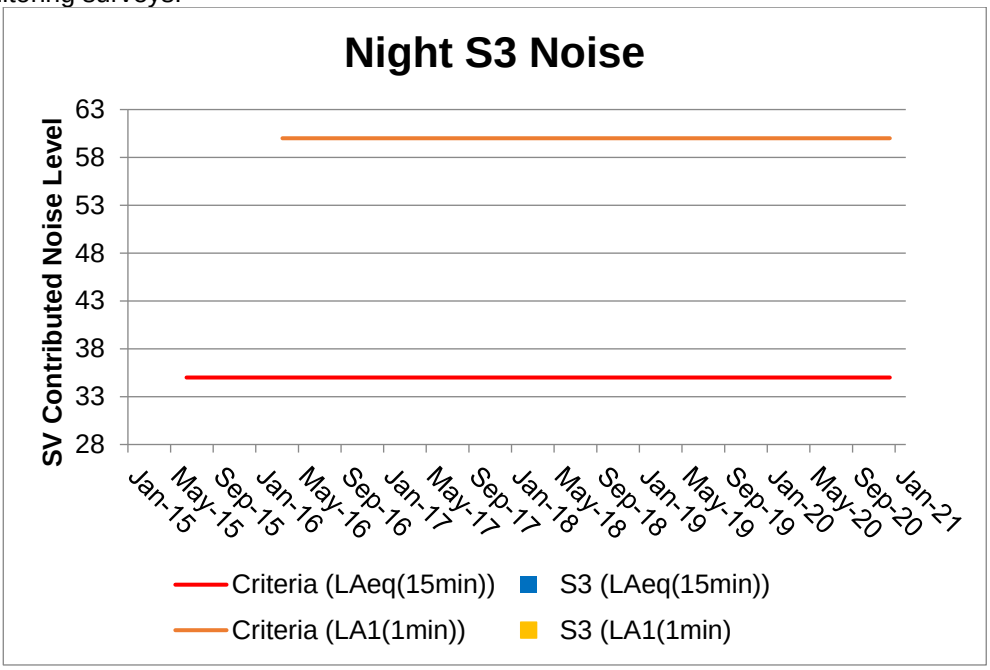
Noise Monitoring Location S3



Note: Monitoring of this location commenced in Q2 2015. Springvale operations inaudible during all monitoring surveys.

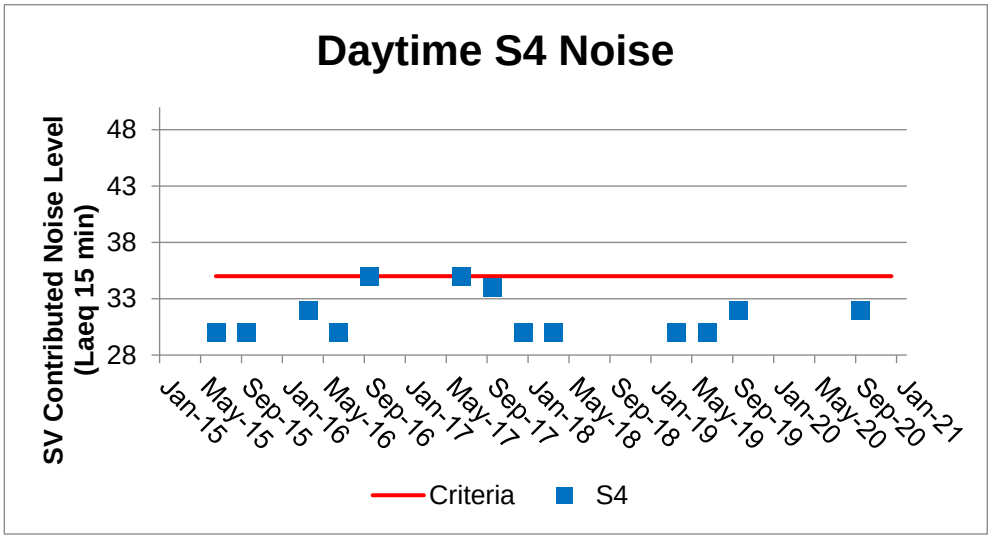


Note: Monitoring of this location commenced in Q2 2015. Springvale operations inaudible during all monitoring surveys.

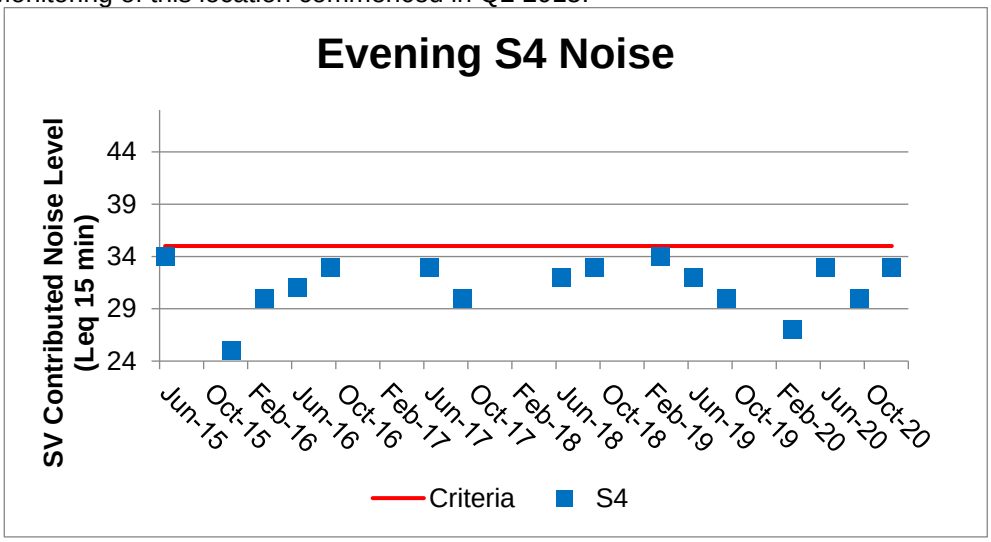


Note: Monitoring of this location commenced in Q2 2015. Springvale operations inaudible during all monitoring surveys.

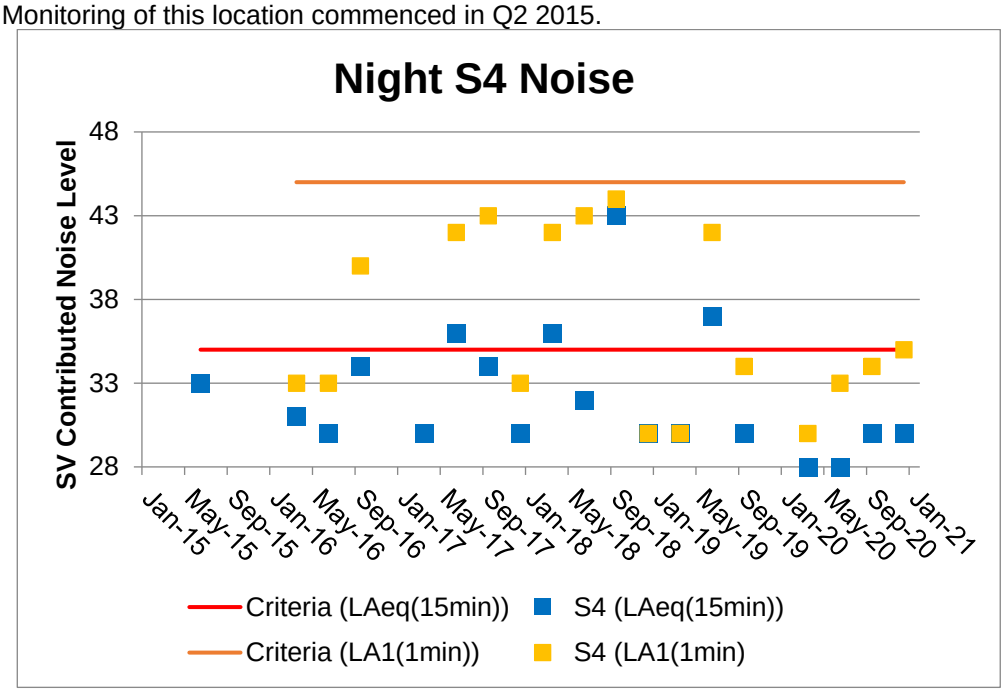
Noise Monitoring Location S4 (EPL Identification Number 5)



Note: Monitoring of this location commenced in Q2 2015.

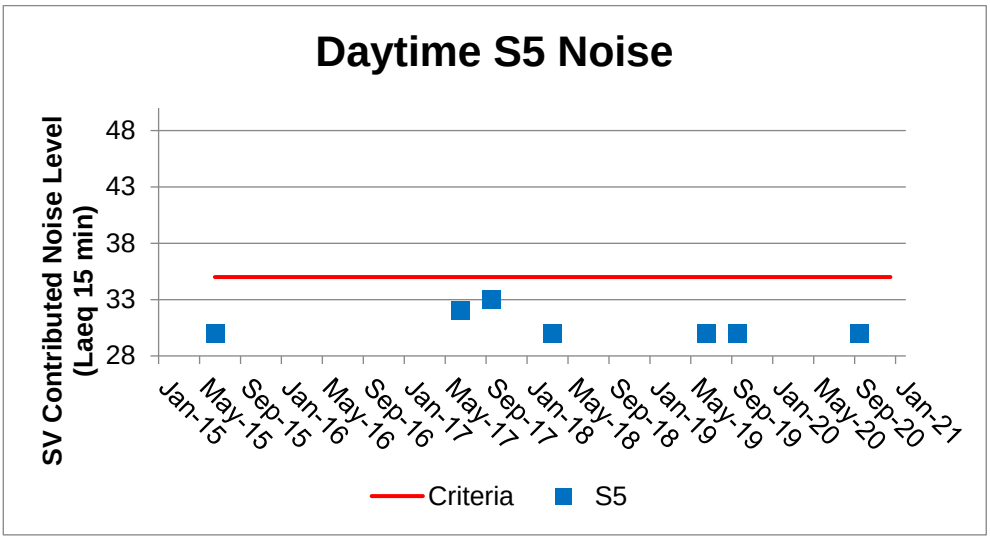


Note: Monitoring of this location commenced in Q2 2015.

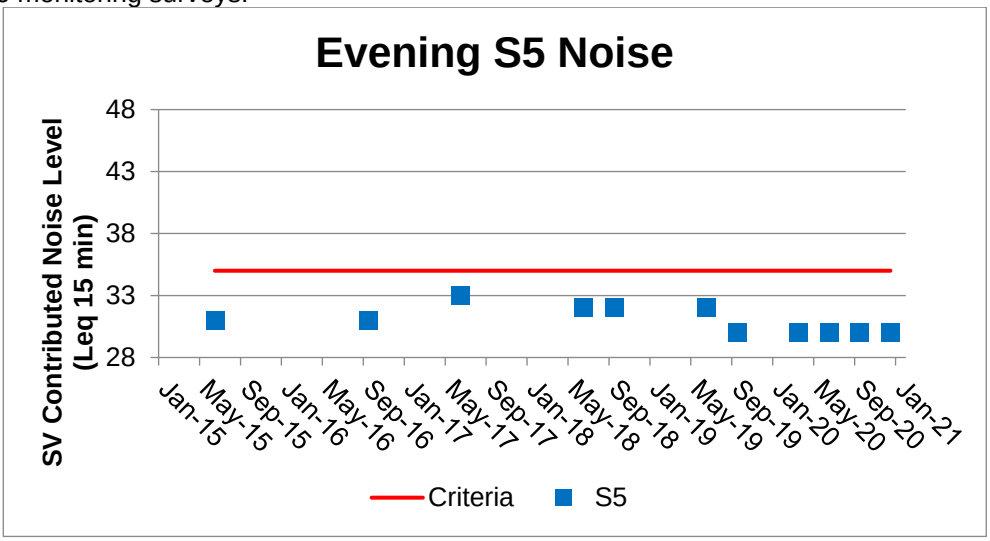


Note: Monitoring of this location commenced in Q2 2015.

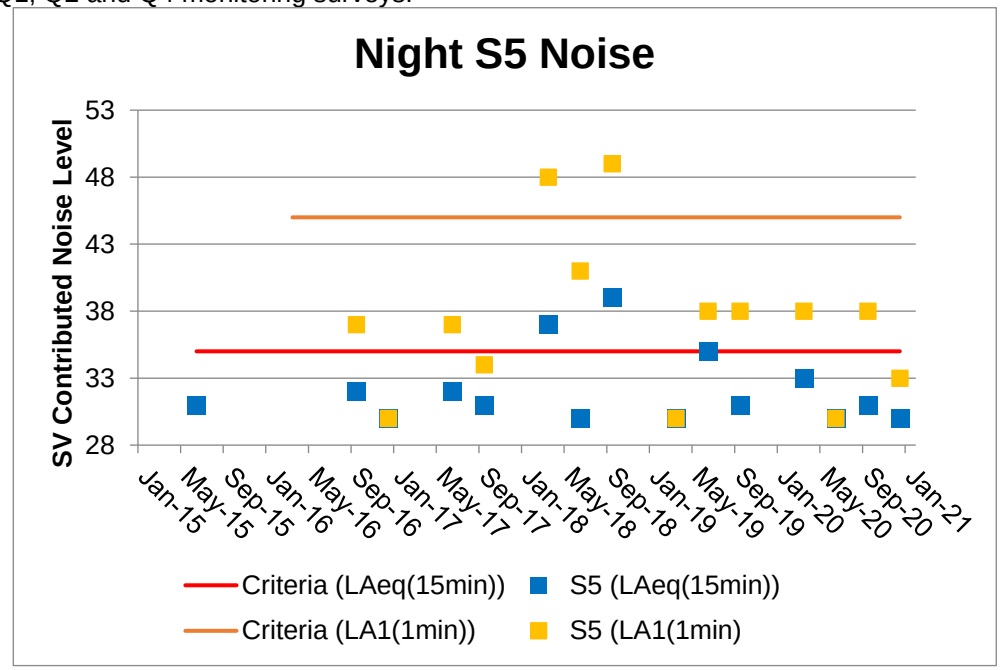
Noise Monitoring Location S5



Note: Monitoring of this location commenced in Q2 2015. Springvale operations inaudible during all 2016 monitoring surveys.



Note: Monitoring of this location commenced in Q2 2015. Springvale operations inaudible during 2016 Q1, Q2 and Q4 monitoring surveys.



Note: Monitoring of this location commenced in Q2 2015. Springvale operations inaudible during Q1 and Q2 monitoring surveys.

APPENDIX 5 – COMPLAINT REGISTER

As required under Schedule 6, Condition 15 of Springvale Mine's Consent (SSD_5594) a complaints register must be updated on a monthly basis. The monthly EPL Monitoring Report uploaded on the Centennial Coal website also includes a community complaints section. This register will be updated monthly as triggered by a complaint to form a log. The following lists community complaints received since the Consent grant date.

Date	Complaint/Enquiry	Method	Description	Investigation/Cause	Springvale Response
28/09/2015	Complaint	Phone	A complaint was made to the colliery regarding a vehicle entering the highway from the mine access road at 5:30am on the 28/9. It is unknown whether the vehicle has come from the colliery.	Failure to abide by road rules and failure to abide by road signage.	Springvale apologised to the complainant and explained such behaviour was not condoned and should be reported to authorities. The mine committed to logging the incident as a complaint although it is a public road and it was not known whether the vehicle has come from the colliery. A toolbox talk was issued to the workforce in relation to road safety.
23/10/2016	Complaint	Phone	Resident called Springvale Coal Services (SCS) Control Room to lodge a noise complaint regarding the empty haul trucks travelling from SCS to Springvale Mine.	Springvale Mine is temporarily hauling ROM coal to Springvale Coal Services (SCS) via the Castlereagh Highway. The complaint was regarding the speed and noise (tail gates not secured properly) of the returning empty trucks travelling along the Highway to Springvale Mine.	Centennial representative contacted complainant on 23/10. The following actions were implemented: • Minimise truck movements and truck speed leaving SCS to 80kmph. • Check tailgates on trucks are fastened. • Limit truck movements to weekdays where possible. • Notify complainant if weekend hauling is planned. Complainant was advised of actions to be implemented. 1/11 – Agreed to cease truck movements on weekends.
24/02/2017	Complaint	Phone	A complaint was received in relation to noise generated from the haulage of coal	Springvale Mine is temporarily hauling ROM coal to Springvale Coal	The following actions had been implemented for the duration of hauling: • Minimise truck movements and truck speed leaving SCS.

Date	Complaint/Enquiry	Method	Description	Investigation/Cause	Springvale Response
			along the Castlereagh Highway at Blackman's Flat. The complainant stated that: • The haulage of coal should be undertaken via the existing conveyor infrastructure and additional private haul road links should be constructed if this activity is to continue; • The trucks with trailers are the noisiest on the return journey along Blackman's Flat due to increased noise generated from the uneven road surface; • The haulage of coal along public roads results in more regular truck movements and therefore has an increased noise and amenity impact.	Services (SCS) via the Castlereagh Highway.	• Check tailgates on trucks are fastened. • Truck movements only to occur on weekdays. Complainant acknowledged actions being taken by Springvale to reduce impacts. Hauling is being undertaken in accordance with Springvale SSD_5594.
14/05/2017	Complaint	Email	Springvale received an email from the EPA advising that they had received a complaint to the Environment Line	Likely cause of noise is Springvale stockpile dozer/s. Analysis of noise monitor (situated at Springvale	CHP Supervisor was notified of the noise complaint received and subsequently spoke with dozer operators regarding the complaint and control measures to be adhered to while operating. A subsequent

Date	Complaint/Enquiry	Method	Description	Investigation/Cause	Springvale Response
			regarding noise potentially associated with pit-top activities at Springvale. Relevant components from the complaint made to EPA are below. "The caller has been woken at around 6am for three out of the past four Sundays by noise from the Springvale Colliery. The caller indicates that they believe that the noise is associated with machinery known as the coal pusher. The caller resides about 2km away. The caller notes that this work has often been done at other times of the day and night which are not a big problem, but that early on a Sunday morning is quite disturbing. The caller suggests that if the work could commence from 8am it would significantly reduce the impact on their household".	pit-top) showed that there were elevated noise levels from the stockpile dozer on the identified Sunday mornings. Weather conditions during these times also indicated a potential inversion which would have exacerbated any noise levels.	Toolbox Talk was issued to the dozer operators. The focus of the discussion and Toolbox Talk was proactive management and reducing noise in the morning when noise enhancing conditions may be occurring. Noise management of the stockpile dozer remains ongoing.
04/06/2017	Complaint	Phone	Springvale received a phone call from the EPA advising that they had received a complaint regarding noise potentially associated	Likely noise source is stockpile dozer/s. Weather conditions during these times also indicated a potential inversion which would	The dozer has been inspected by Westrac technicians and a guard removed that is thought to be increasing the noise levels while it is operating. Further investigation and management of the stockpile dozer is ongoing.

Date	Complaint/Enquiry	Method	Description	Investigation/Cause	Springvale Response
			with pit-top activities at Springvale. Relevant components from the complaint made to EPA are below. “Dozer operation was audible at Skelly Road at 6am on a Sunday morning. Noise levels were fine the previous couple of weekends but were once again obtrusive at 6am Sunday 4 June 2016”.	have exacerbated any noise levels.	
29/07/2017	Complaint	Email	Springvale received an email from the EPA advising that they had received a complaint to the Environment Line. Details of complaint made to EPA are below: “Machinery noise coming from mining equipment at Centennial Coal Springvale. The noise lasted 2 hours on 28/07/2017 from 23.30”.	Likely cause of machinery noise is stockpile dozer/s. Analysis of weather conditions indicated still conditions between 23:30 - 01:30 - wind velocity recorded 0m/s. Atmospheric conditions indicated potential inversion during preceding and during the complaint time. Weather conditions and current stockpile dozer operations both likely factors in noise levels causing complaint.	Springvale has already undertaken the following actions in relation to noise management: • Toolbox Talk issued to dozer operators. • Dozers inspected by Westrac technicians. • Guard on dozer, thought to be exacerbating noise levels, removed. • Re-commissioning of real time monitor. Springvale are investigating further opportunities to manage/mitigate noise. Additional actions underway include: • Additional noise monitoring to correlate noise sources and assess potential for managing noise sources at high risk times. • Investigation of noise attenuation engineering solutions for dozers.

Date	Complaint/Enquiry	Method	Description	Investigation/Cause	Springvale Response
11/05/2018	Complaint	Email	Complaint received from resident stating that their complaints are not being recorded at the Springvale Community Consultative Committee (CCC).	Following a review of the Community Complaints Register it is confirmed that all complaints received in relation to Springvale are registered in the Springvale Community Complaints Register. On review of the Springvale CCC presentations, it is found that one complaint (received 23/10/2016) was not recorded in the CCC presentation. All other complaints had been recorded in CCC presentations.	Springvale will continue to record complaints in the Community Complaints Register and report any complaints received to the CCC.
01/08/2019	Complaint	Phone	Springvale received a phone call from a resident with noise concern from the operation.	Monitoring to be undertaken to determine the plant or activity or metro conditions which are causing the resident concern.	Discussions with Group Manager of Stakeholder Engagement and resident have occurred. Consultant engaged for monitoring and future actions will be driven from the investigation findings

APPENDIX 6 – PLANS

awang
Wolgan Road
Commonwealth
Cal
Newcom
Angus Place
ML1424
ML1670
ML1588
Springvale Mine
ML1326
Kerosenevale Open Cuts
ML1323
ML1303
ML1537
Renown
MPL314
Springvale Pit Top
Wallerawang Power Stn
CL377
State Mine
Fernbrook
EL6974
ML1727
Clarence
Steelworks
New State Mine
Hermitage

SCALE
0 1 2 3 4 Km

LEGEND:

- Current Workings
- Proposed First Workings
- Mining Leases

NOTES:

ENDORSEMENT: All information has been provided by others (excluding SVC Mine Workings) and is indicative only.

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DRAWN	Madison Haddon
REFERENCE	N:\Z_Plans
SEAM	LITHGOW
INFORMATION SUPPLIED FROM	N/A
SCALE	1:40000

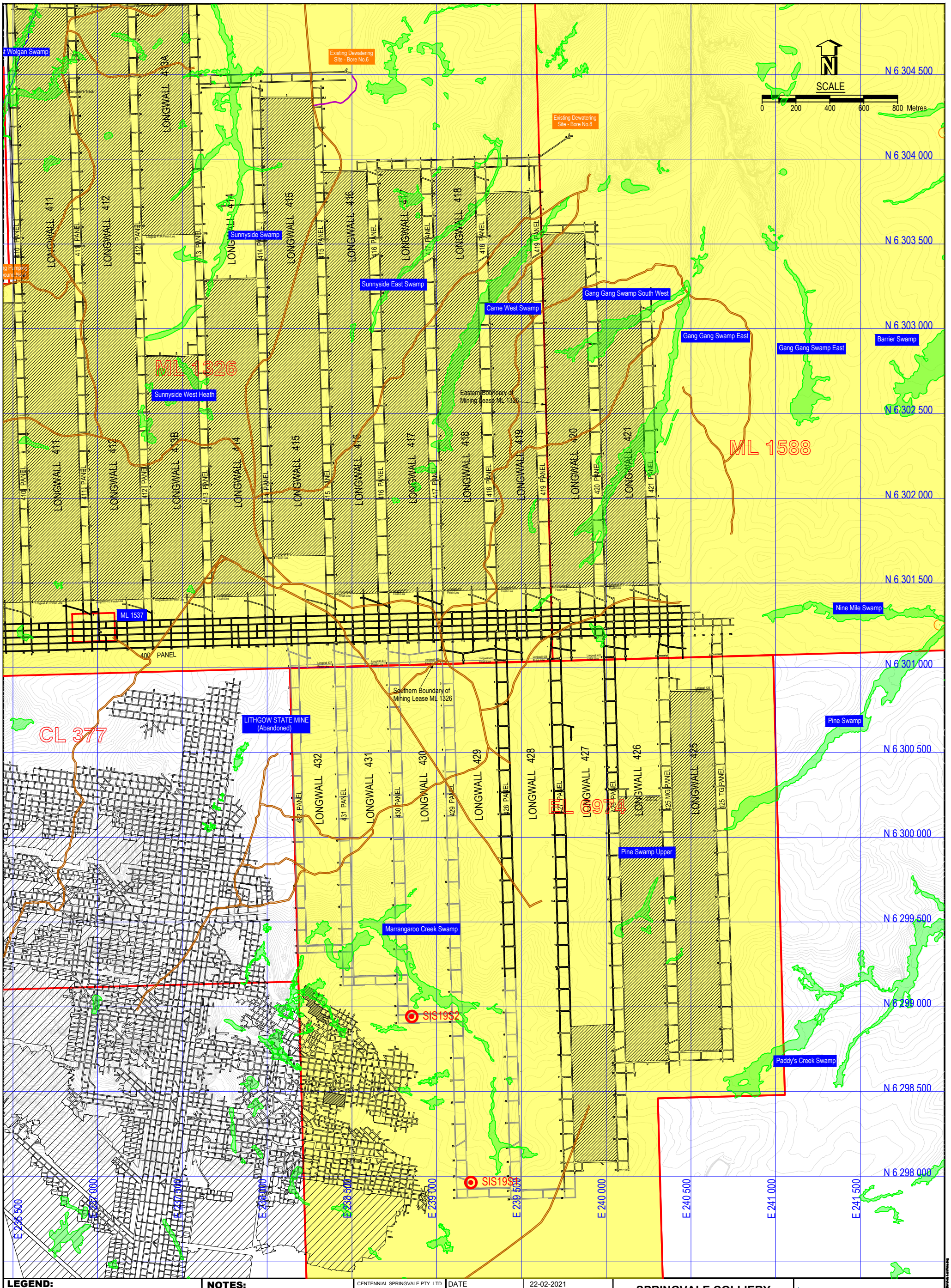
SPRINGVALE COLLIERY

Regional Location Plan

CENTENNIAL SPRINGVALE

Plan No. SVY06851.1 A3H

N:\Z_Environmental\Annual Review 2020\1 Fig No 1 Regional Location Plan.dwg



LEGEND:

- Swamp Area
- Lease Boundary
- Access track
- Exploration License EL6974
- Monitoring Boreholes Completed 2020

NOTES:

ENDORSEMENT: All information has been provided by others (excluding SVC Mine Workings) and is indicative only.

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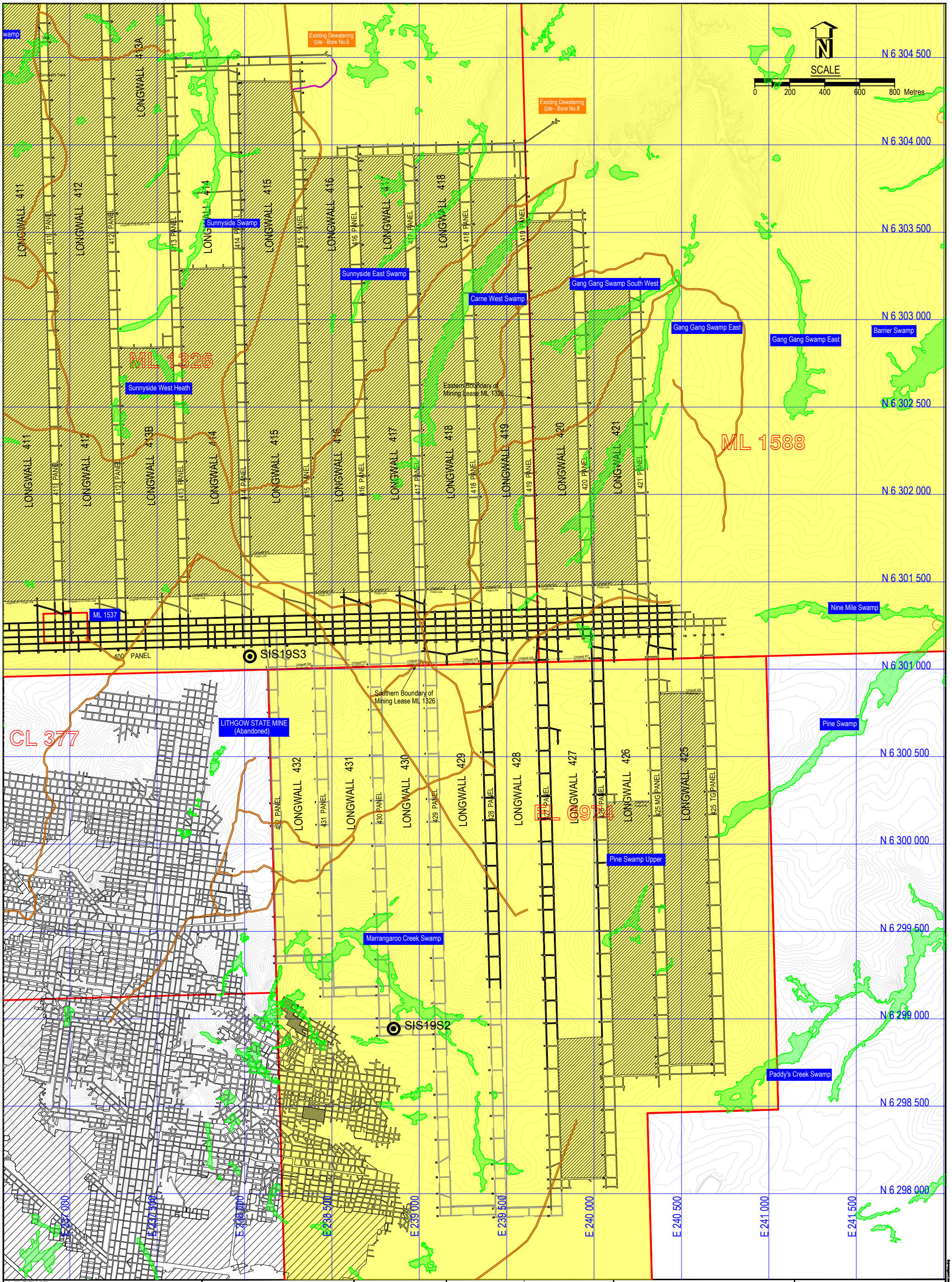
SEAM	LITHGOW
INFORMATION SUPPLIED FROM	Mine Geologist
SCALE	1:20000

SPRINGVALE COLLIERY

Annual Review 2020
2020 Completed Boreholes

CENTENNIAL SPRINGVALE

Plan No. SVY06851.3A | A3V



LEGEND:

- Swamp Area
- Lease Boundary
- Access track
- Exploration License EL6974
- Monitoring Boreholes Proposed 2021

NOTES:

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REFERENCE	N:\Z_Plans
SEAM	LITHGOW
INFORMATION SUPPLIED FROM	Mine Geologist
SCALE	1:20000

SPRINGVALE COLLIERY

Annual Review 2020
2021 Proposed Boreholes

CENTENNIAL SPRINGVALE

Plan No. SVY06851.3B A3V

ML 1303

MPL 314
(Overlays ML 1303)

LDP006

GREAT WESTERN RAIL LINE

925

905

920

1
2
3
4
5
6
7
8
9

TOP DAM

SUPPORT STORAGE AREA

SPRAY IRRIGATION PUMP SHED

SEWAGE TREATMENT WORKS

STOCKPILE AREA

PERMANENT 11kVA LINES

CONVEYORS

SUBSTATION No. 3

SIZER HOUSE

CONVEYOR EQUIPMENT STORAGE AREA

BOXCUT ENTRANCE

STOCKPILE DAM

SECONDARY DAM

MINING SUPPLIES STORAGE AREA

SUBSTATION No.1

HELIPAD

CARPARK AREA

AIR COMPRESSOR HOUSE

INACTIVE BOREHOLE (UNSEALED)

INACTIVE SHAFT (SEALED)

INACTIVE PORTAL (UNSEALED) TRIAL SHALE TUNNEL

DAM

MINE OFFICE

BATH HOUSE

SUBSTATION No.2

POTABLE WATER TANKS

TRAINING ROOM

ENGINEERS OFFICE

ACTIVE PORTAL

OIL SEPERATOR

GROUT

SEPTIC TANK

MAIN MINE ACCESS

DUST & CHEMICAL

STORE ROOM

FIRE-FIGHTING DAM (REHABILITATED)

INACTIVE PORTAL (SEALED)

SOLCENIC TANK BUND

TRANSPORT SHED

WORKSHOP

LPG TANK

ISOLATOR SHED 11kVA

WASH-DOWN BAY

SCALE

0 50 100 150 Metres

LEGEND:

- Clean Water
- Dirty Water
- Dirty Water Catchment
- Clean Water Catchment

ENDORSEMENT: All information has been provided by others (excluding SVC Mine Workings) and is indicative only.

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PLAN No: SVY06269/6	COMPUTER PATH: N:\Z_Plans
INFORMATION SUPPLIED BY: -	
SCALE: SCALE 1:2500	A3V Sheet 1 of 1

SPRINGVALE MINE

TITLE:

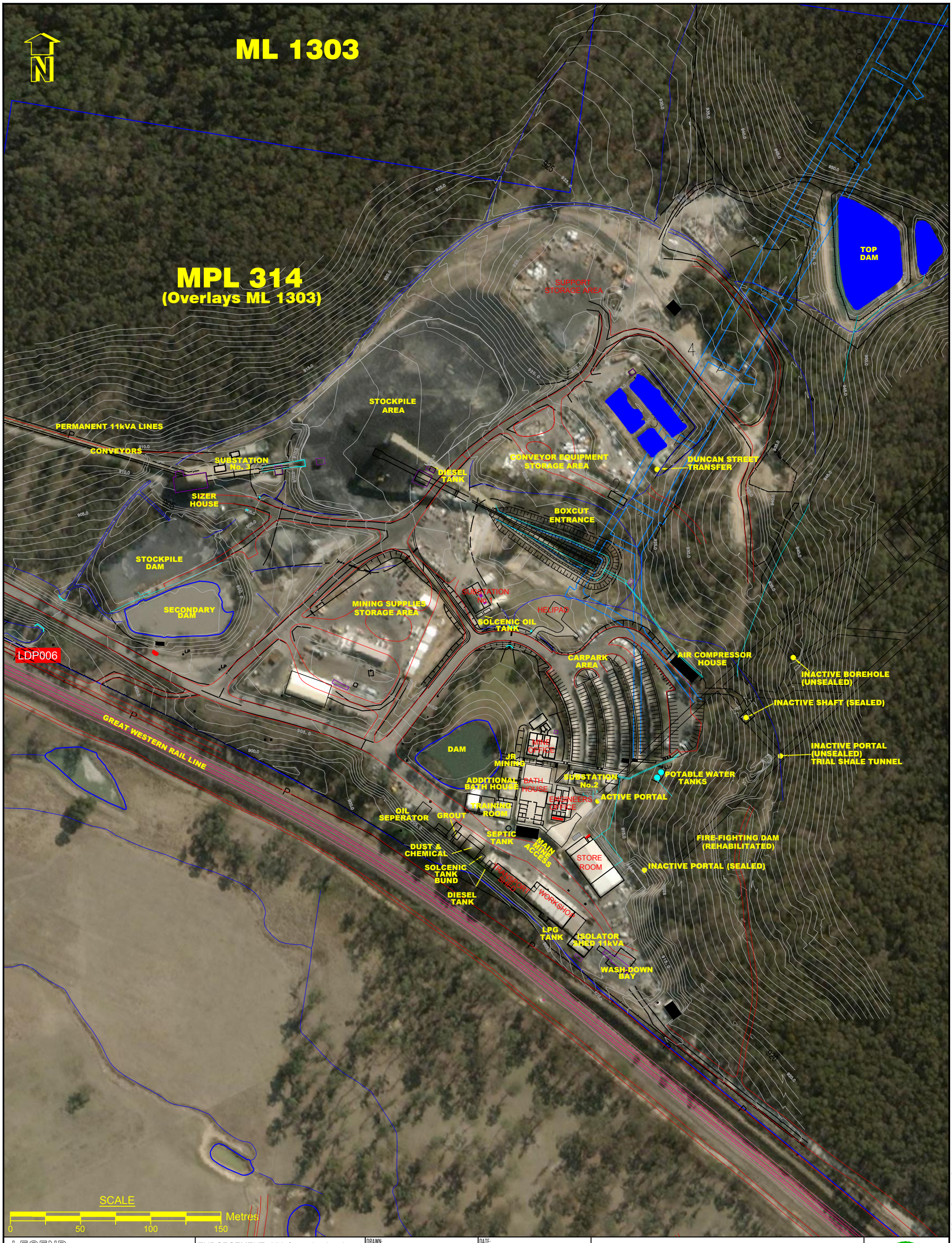
Annual Review 2020

Pit Top Plan - Surface Water Management

SpringvaleCoal

SPRINGVALE MINE
Castlereagh HWY
Lidsdale NSW 2790
PO Box 198
Wallerawang NSW 2845
Phone: 02-63501600
Fax: 02-63551052

N:\Z_Environmental\Annual Review 2019\6 Fig. No.6A Pit Top Plan-Vectorised Mapping.dwg



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PLAN No: SVY06260/7	COMPUTER PATH: N:\Z_Plans
INFORMATION SUPPLIED BY: -	
SCALE: SCALE 1:2500	A3V Sheet 1 of 1

SPRINGVALE MINE

TITLE:

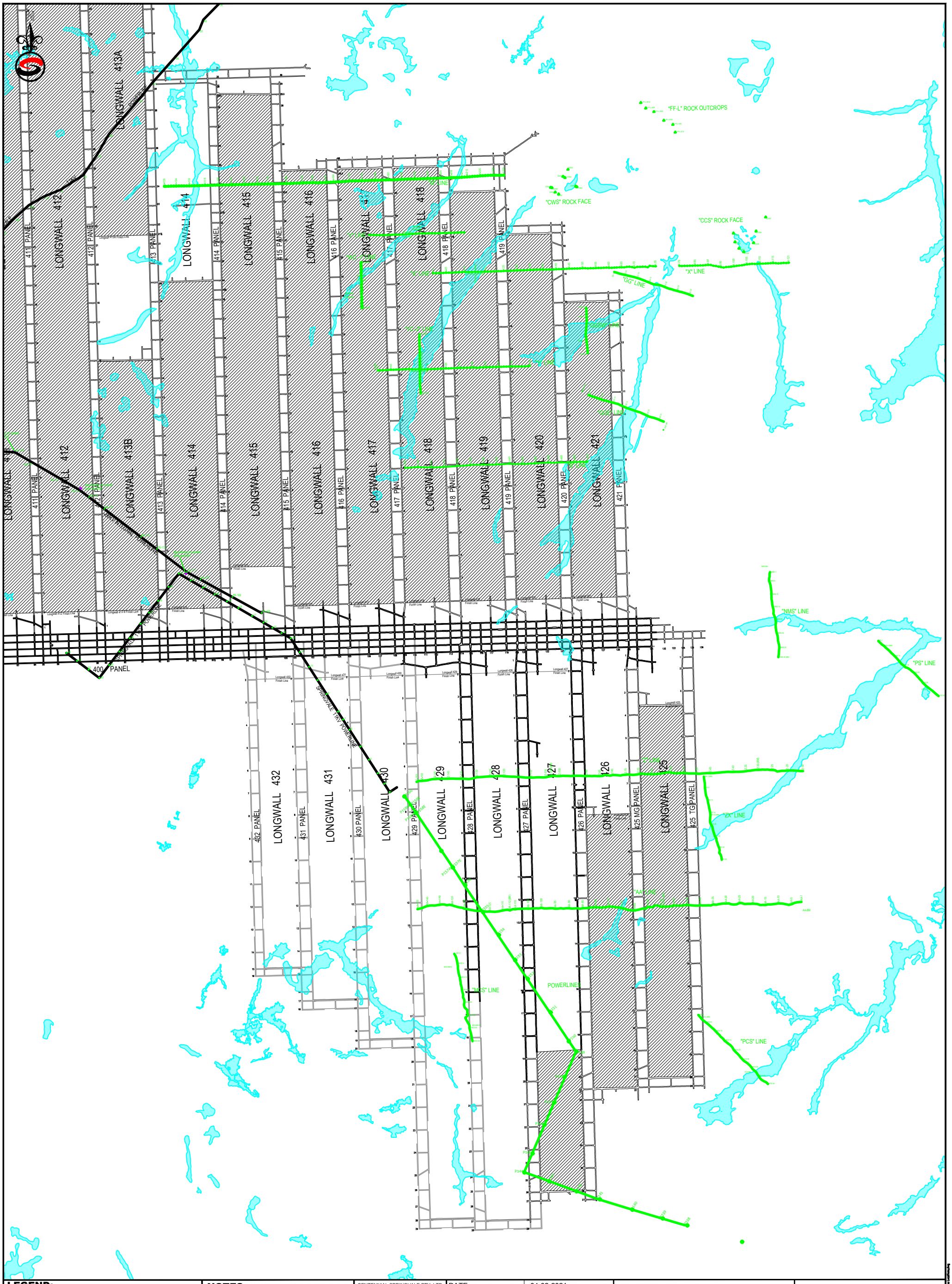
Annual Report 2020

Pit Top Plan - Aerial Photograph

SpringvaleCoal

SPRINGVALE MINE
Castlereagh HWY
Lidsdale NSW 2790
PO Box 198
Wallerawang NSW 2845
Phone: 02-63501600
Fax: 02-63551052

N:\Z_Environmental\Annual Review 2019\17 Fig. No.6B Pit Top Plan-Aerial Photo - updated.dwg



LEGEND:

- SMP Monitored Subsidence Line
- Newnes Plateau Shrub Swamp
- Powerlines

NOTES:

ENDORSEMENT: All information has been provided by others (excluding SVC Mine Workings) and is indicative only.

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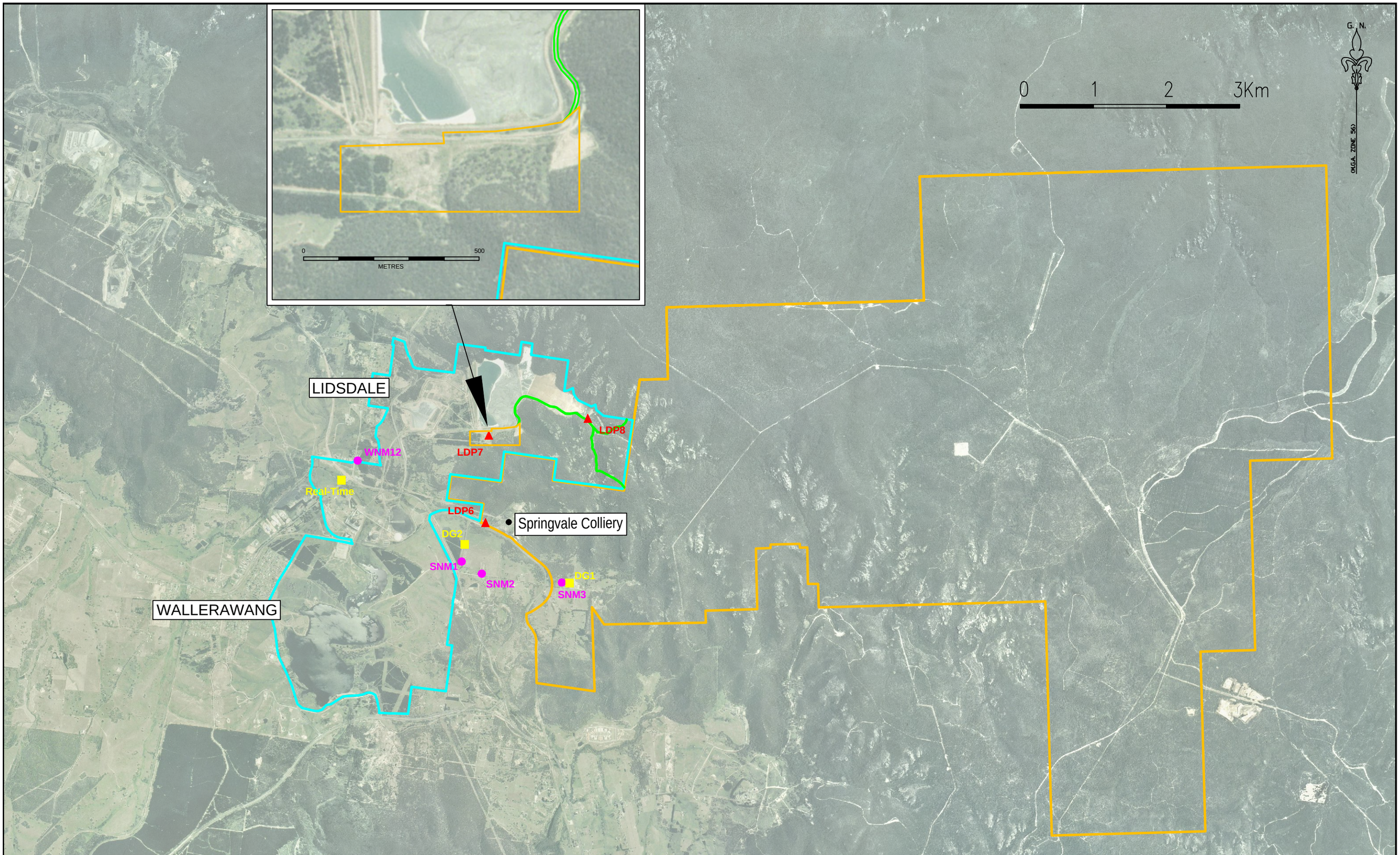
SEAM	LITHGOW
INFORMATION SUPPLIED FROM	-
SCALE	1:20000

SPRINGVALE COLLIERY

Annual Review 2020
Subsidence Monitoring

CENTENNIAL SPRINGVALE

Plan No. SVY06851.9 A3V



Legend

- EPL Boundary
- Air Quality Monitoring Location
- Noise Monitoring Location
- Licenced Discharge Point
- Cadastral Boundary
- ENERGYAUSTRALIA Boundary
- Water Treatment Facilities and Easements

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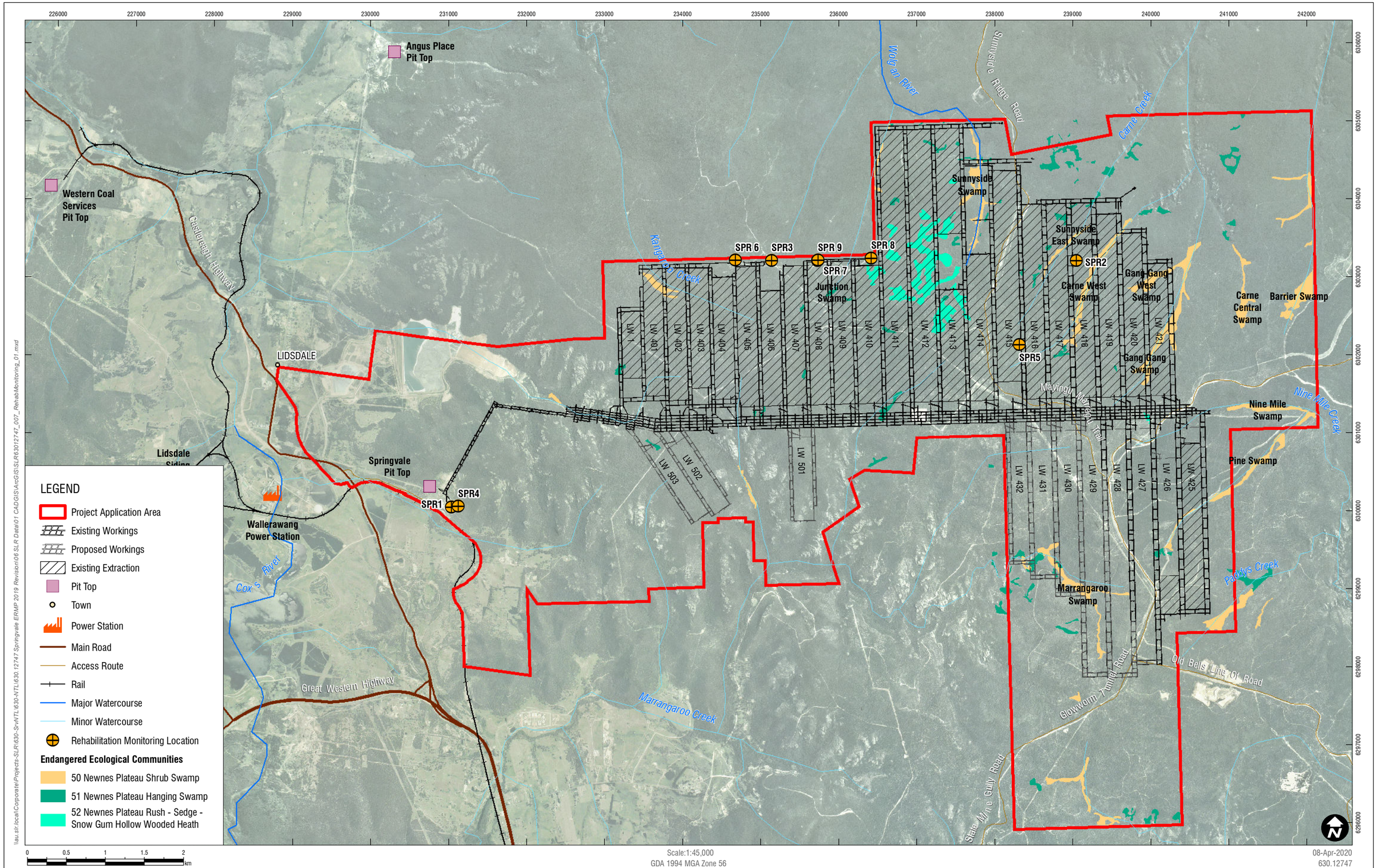
LOCATION	Western
SEAM	NA
DRAWN	C.P.T.
CHECKED	L.H.
APPROVED	P.W.
SCALE	Refer to scalebar

Springvale Colliery EPL Boundaries

Centennial Coal

DATE 17-04-2019

PC7025



LEGEND

- Project Application Area
- Existing Workings
- Proposed Workings
- Existing Extraction
- Pit Top
- Town
- Power Station
- Main Road
- Access Route
- Rail
- Major Watercourse
- Minor Watercourse
- Rehabilitation Monitoring Location

Endangered Ecological Communities

- 50 Newnes Plateau Shrub Swamp
- 51 Newnes Plateau Hanging Swamp
- 52 Newnes Plateau Rush - Sedge - Snow Gum Hollow Wooded Heath

0 0.5 1 1.5 2 km

Scale:1:45,000
GDA 1994 MGA Zone 56

08-Apr-2020
630.12747

\\au.slr.local\Corporate\Projects-SLR\630-SrvNTL\630.12747 Springvale ERMP 2019 Revision\06 SLR Data\01 CAD\GIS\ArcGIS\SLR630.12747_007_RehabMonitoring_01.mxd

Sheet Size : A3

SLR

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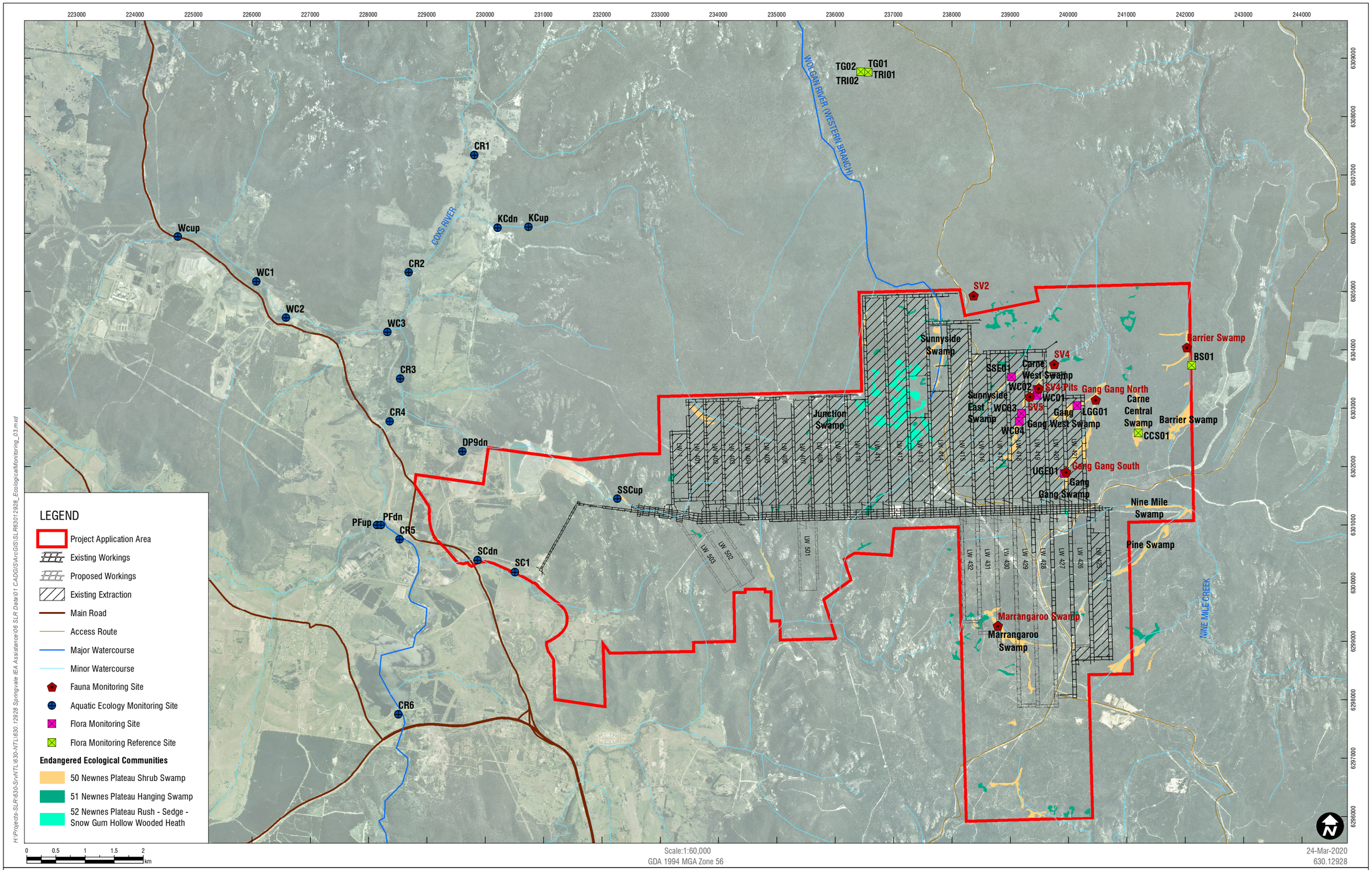
Rehabilitation Monitoring Sites

FIGURE 7



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Scale:1:60,000
GDA 1994 MGA Zone 56

24-Mar-2020
630.12928

Note: Flora monitoring locations under approved Extraction Plans have been excluded for clarity.

Sheet Size : A3

SLR

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Ecological Monitoring

awang
Wolgan Road
Commonwealth
Cal
Newcom
Angus Place
Springvale Mine
Kerosenevale Open Cuts
Renown
Springvale Pit Top
Wallerawang Power Stn
Fernbrook
State Mine
Steelworks
Clarence
New State Mine
Hermitage
N
SCALE
0 0.5 1 2 3 Km

LEGEND:

- Subsidence Protection Zone
- Shrub Swamp
- Hanging Swamp
- Snow Gum Wooded Heath Swamp

NOTES:

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SEAM	LITHGOW
INFORMATION SUPPLIED FROM	-
SCALE	1:40000

SPRINGVALE COLLIERY

Annual Review 2020
Subsidence Protection Zones

CENTENNIAL SPRINGVALE

Plan No. SVY06851.10 A3H

N:\Z_Environmental\Annual Review 2020\10 Fig No.7 Subsidence Protection Zones.dwg

Angus Place Colliery

Mount Piper Power Station

Springvale Colliery

Springvale Colliery Pit Top

Booster Station 2

Booster Station 1

Shaft 3

Hawkesbury / Nepean Catchment

Coxs River Catchment

LDP006

LDP007

LDP008

940 Bore

Discontinued Bore No.1

Discontinued Bore No.2

Discontinued Bore No.3

Discontinued Bore No.4

Discontinued Bore No.5

Active Bore No.6

Active Bore No.8

SCALE

0 0.5 1 2 3 Km

LEGEND:

- Water Transfer Route
- Mining Lease Boundary
- Catchment Watershed
- Pumping Compound

ENDORSEMENT: All information has been provided by others (excluding SVC Mine Workings) and is indicative only.

DRAWN: Madison Haddon	DATE: 21-02-2020
PLAN No: SVY06269/11	COMPUTER PATH: N:\Z_Plans
INFORMATION SUPPLIED BY: -	
SCALE: SCALE 1:45000	A3H Sheet 1 of 1

SPRINGVALE MINE

TITLE:

Annual Review 2020

Water Transfer Route
To Mount Piper Power Station
And Licensed Discharge Points

SpringvaleCoal

SPRINGVALE MINE
Castlereagh HWY
Lidsdale NSW 2790
PO Box 198
Wallerawang NSW 2845
Phone: 02-63501600
Fax: 02-63551052

N:\Z_Environmental\Annual Review 2019\11 Fig. No.8 Springvale-Delta Water Transfer Scheme.dwg

228000 229000 230000 231000 232000 233000 234000 235000 236000 237000 238000 239000 240000 241000

6305000 6304000 6303000 6302000 6301000 6300000 6299000 6298000

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Scale1:35,000
GDA 1994 MGA Zone 56

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630.12886

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LEGEND

- Springvale SSD-5594 Project Application Area
- SWTP SSD-7592 Project Application Area
- Land not Maintained by Springvale
- Existing 11KV Powerline
- 2021 Proposed Disturbance - 0.8Ha
- 2020 Disturbance - 1.7Ha
- Active Disturbance - 38.9Ha
- Existing Rehabilitation - 8.4Ha

2020 Disturbance and Rehabilitation

CENTENNIAL