Illawarra metallurgical Coal

Appin Mine

Area 9 Longwall 904 End of Panel surface water and groundwater monitoring review

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Process	Staff	Signature	Date
Authors	Stuart Brown		
Approved	Stuart Brown		13/12/2022

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

South32 Illawarra Metallurgical Coal operates Appin Colliery extracting hard coking coal used for steel production. Appin Colliery is an underground mine located near the township of Douglas Park in the Southern Coalfield of New South Wales. Appin Area 9 (AA9) consists of four approved longwalls (Longwalls 901 to 904), all located to the north of, and offset from, the Nepean River. Longwall 904 commenced on 20/5/2021 and was completed on 9/8/2022.

Potential impacts to watercourses and aquifers are monitored and managed through the AA9 Water Management Plan (WMP) (BHPBilliton, 2014). This report presents results of the surface water and groundwater monitoring program following the end of Longwall 904 (End of Panel Report), including an assessment of data against performance criteria in the Trigger Action Response Plan (TARP).

Groundwater assessment

Groundwater levels are monitored at seven bores within and surrounding AA9 as part of a much wider groundwater monitoring network covering the Appin, West Cliff and Dendrobium mining areas. Longwall 904 mined beneath groundwater monitoring bore S1941 in mid-August 2021, after which all sensors except the shallowest sensor (65 m depth) became inoperable. The remaining sensor indicated recovery of groundwater levels with no TARP trigger during Longwall 904. No TARPs were triggered at other groundwater monitoring sites during Longwall 904. No significant change in groundwater chemistry is noted for the reporting period.

Groundwater inflow to the mine is calculated from the daily mine water balance. The 20-day moving average mine inflow fluctuated between 0 and ~1.2 ML/day following the extraction of Longwall 904, well below the TARP Level 1 trigger of 2.7 ML/day.

Surface water assessment

There is no evidence for loss of flow in the Nepean River as a result of mining in AA9. The ratio of downstream flow (at Menangle Weir) to upstream flow (at Maldon Weir) has fluctuated around the baseline median value of 2.7 since the start of mining in AA9 and there is no apparent systematic change in the ratio over time. There are no apparent systematic changes in the minimum recession rate at Menangle, Maldon and Broughtons Pass Weirs since the start of mining in AA9.

Monthly monitoring by South32 indicates a decline in pool water levels at site NR0 of 0.49 m from the baseline range. Water levels at the upstream control site NR110 show a decline of 0.25 m from the baseline range over the same period. Ongoing monitoring at NR0 and NR110 is recommended.

The reporting period for Longwall 904 is characterised by variable water quality in the Nepean River. In general water quality has improved during Longwalls 903 and 904 due to the high rainfall and runoff since 2020 (EC has decreased and DO increased). High total iron and manganese is noted at several locations, including TARP locations SW3 and NR2, representing Level 2 TARP triggers. Elevated total iron was also reported at the upstream control site NR110 suggesting the high iron (and manganese) is not a mining effect and most likely related to high runoff and mobilisation of clays, silts and associated sorbed metals. A Level 1 TARP was triggered for pH at SW3, noting that pH remains in the near neutral range.

Fifteen active gas release zones were observed during the review period, including one new occurrence in the Cataract River. All 15 gas release zones have estimated emission rates of <3000 L/min, representing a Level 1 TARP trigger under the WMP.

1. INTRODUCTION

South32 Illawarra Metallurgical Coal (IMC) operates the Appin Colliery, extracting hard coking coal used for steel production. Appin Colliery is an underground mine located near the township of Douglas Park in the Southern Coalfield of New South Wales (Figure 1).

AA9 consists of four approved longwalls (Longwalls 901 to 904), all located to the north of, and offset from, the Nepean River (Figure 2). Longwall 901 commenced on 19/1/2016. Longwall 904 commenced on 20/5/2021 and was completed on 9/8/2022. Longwall 904 has a width of 305 m, a length of 2031 m and a cutting height of up to 3 m (full seam extraction).

Potential impacts to watercourses and aquifers are monitored and managed through the AA9 WMP (BHP Billiton, 2014), developed in accordance with the Bulli Seam Operations (BSO) Approval Condition 5 (h), Schedule 3. This report presents results of the surface water and groundwater monitoring program following the end of Longwall 904 (End of Panel Report), including an assessment of data against management criteria defined in the AA9 WMP.

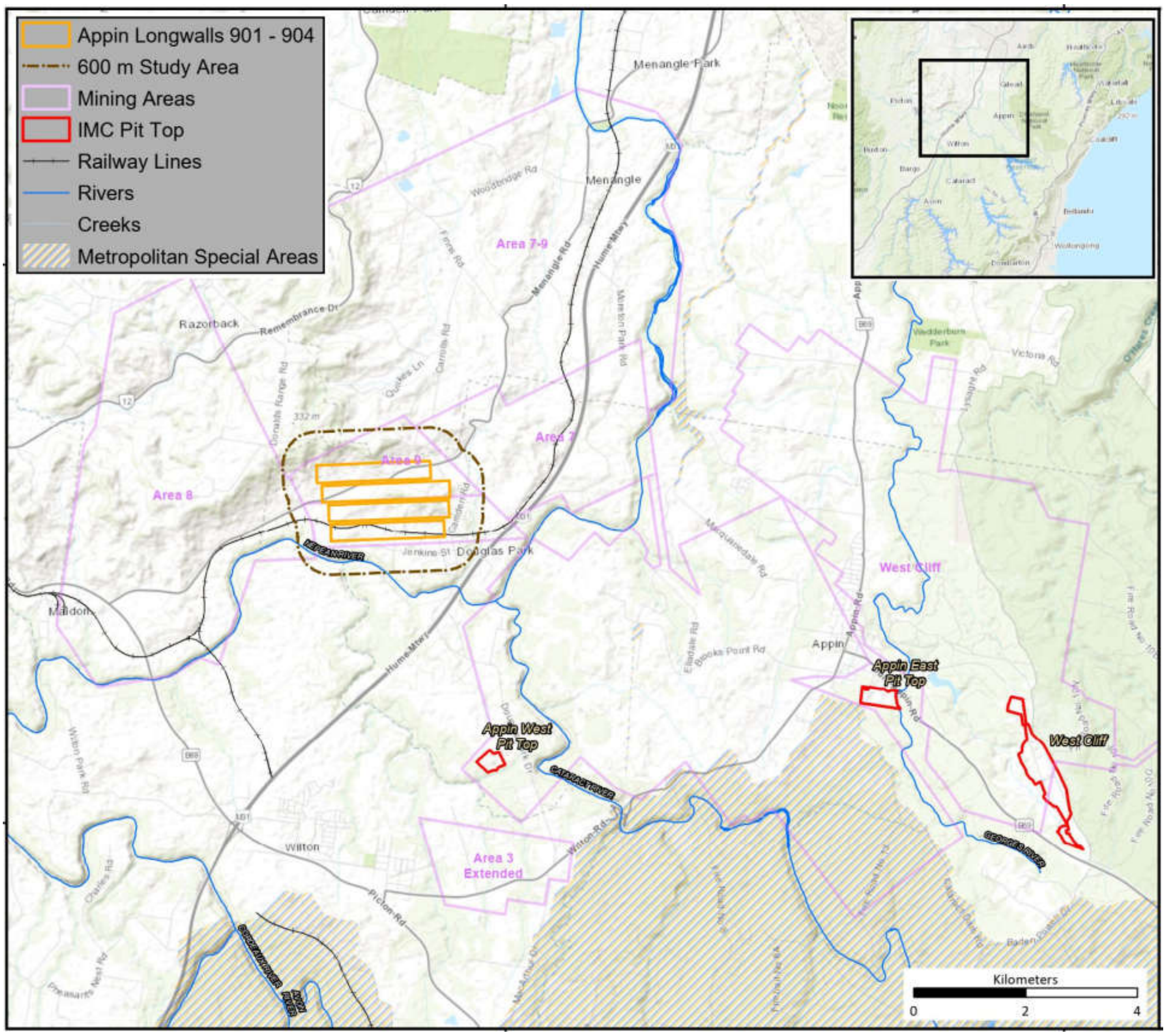
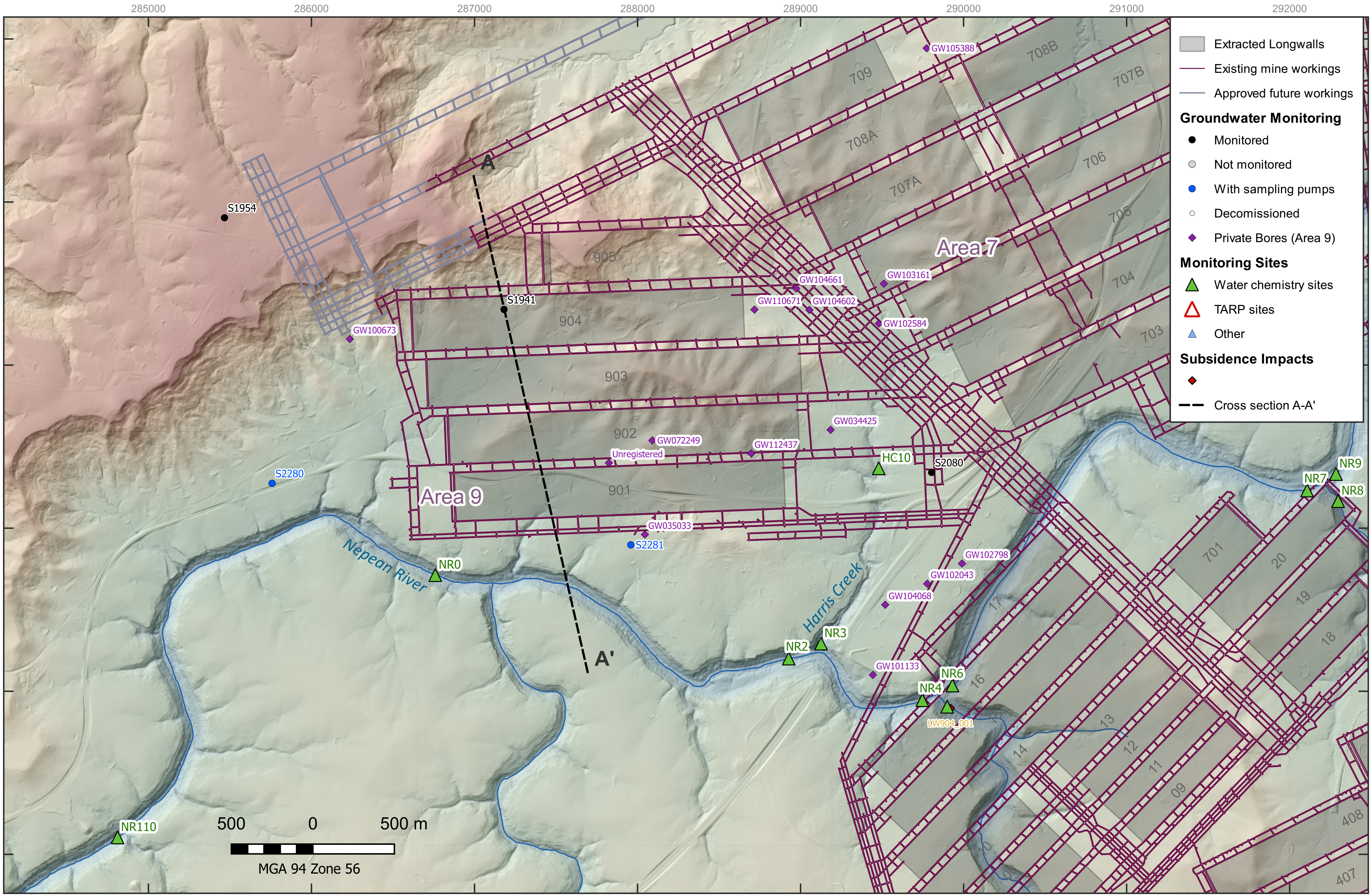


Figure 1. Location of Appin Colliery Area 9



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Appin Area 9 EOP Surface water and groundwater monitoring

Monitoring site locations

Figure 2

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1.1 Hydrogeology

Appin Colliery is located within the Southern Coalfield which is one of the five major coalfields that lie within the Sydney Geological Basin. The Basin is a Permo-Triassic sedimentary rock sequence, underlain by undifferentiated sediments of Carboniferous and Devonian age (Figure 3). The Bulli and Wongawilli Coal Seams are the primary target seams in the top part of the Illawarra Coal Measures. The Coal Measures are overlain by Triassic sandstones, siltstones and claystones of the Narrabeen Group, the Hawkesbury Sandstone and the Wianamatta Group. The Hawkesbury Sandstone is the dominant outcropping formation adjacent to, and underlying, the Nepean River Gorge. Wianamatta Group shales and claystone-dominated units underlie elevated areas including the Razorback Range. The geology and hydrogeology of the area is illustrated in a north-south cross section in Figure 4.

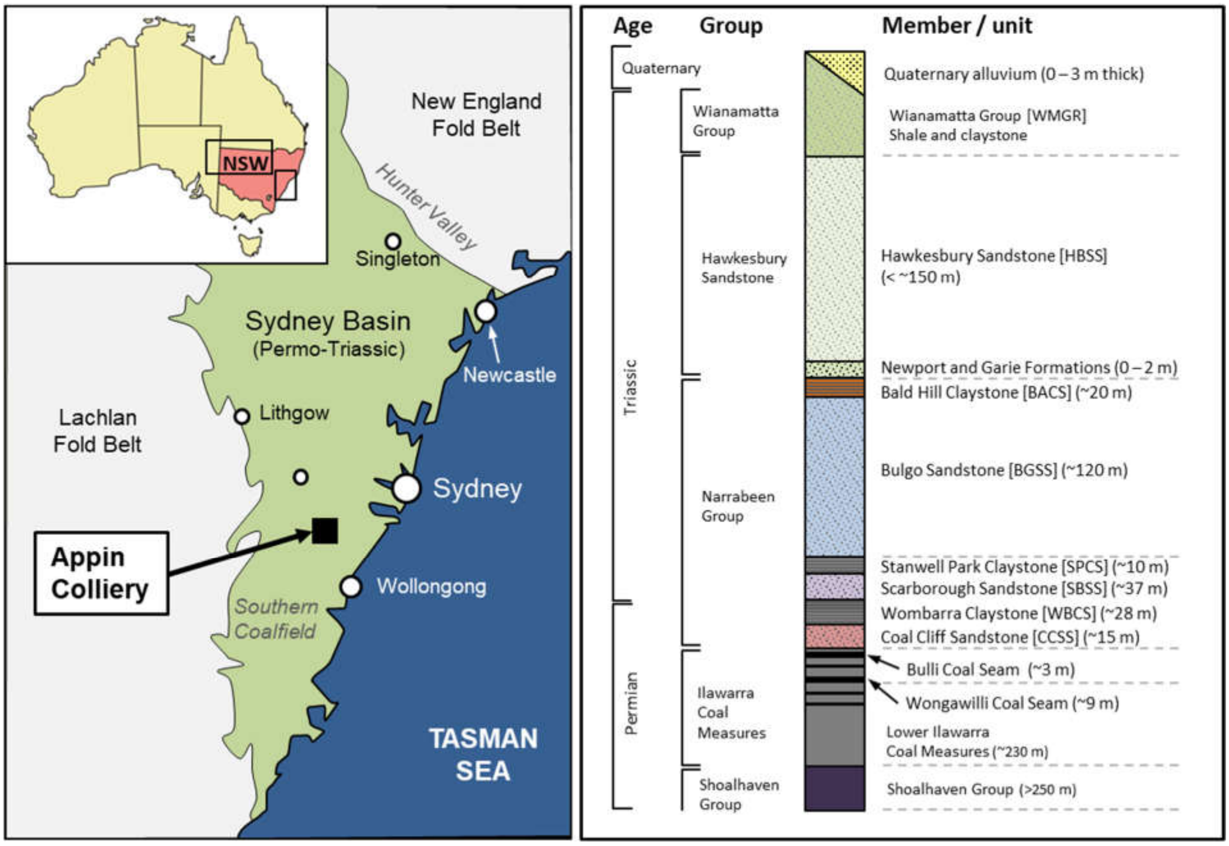

Figure 3. Stratigraphy of the Southern Sydney Basin

Three main groundwater systems are recognised:

1. Perched groundwater systems associated with fractures and bedding planes within the shallow sandstone and shale units of the Wianamatta Group and Hawkesbury Sandstone. These may be ephemeral and/or disconnected from the deeper groundwater systems;

2. Shallow groundwater systems: layered water-bearing zones within the saturated Hawkesbury Sandstone. The highest yielding groundwater bores are typically associated with coarse sandstone units and/or fractured sandstone; and

3. Deeper groundwater systems within the Narrabeen Group and the Illawarra Coal Measures. These units typically are of much lower permeability than the Hawkesbury Sandstone and produce low bore yields and poorer water quality.

The private groundwater supply bores in the vicinity of AA9 are between 70 m to 240 m deep, with water obtained primarily from water-bearing horizons within the Hawkesbury Sandstone, and minor perched horizons within the Wianamatta Group shale (e.g. GW104602 at 29.9 m; GeoTerra, 2011). Groundwater in the New South Wales Office of Water (NoW) registered bores, where reported, is generally fresh to brackish with salinity (total dissolved solids; TDS) between 260 and 2500 mg/L. Most aquifer intersections over the Longwalls 901 to 904 Study Area lie at or below the elevation of the Nepean River.

The Nepean River is a ‘gaining’ system, where groundwater flows from the plateau under a regional hydraulic gradient to the river. These flows are predominantly horizontal and determined by a confined flow along discrete layers underlain by fine grained or relatively impermeable strata within the Hawkesbury Sandstone. Vibrating wire piezometers at monitoring bore S1941 show that groundwater pressures (potentiometric levels) are higher in the Narrabeen Group than in the Hawkesbury Sandstone and may be sub-artesian to artesian in some areas (the potentiometric level is near or above the ground surface). The lower groundwater pressures within the Hawkesbury Sandstone may be due to pumping from bores as well as discharges to the Nepean River gorge. These observations suggest that the Bald Hill Claystone is an effective confining unit in this area.

Recharge of the groundwater system occurs after rainfall infiltrates into the plateau soil, as well as the underlying Wianamatta Shale and/or Hawkesbury Sandstone. Most infiltrating water discharges from temporary seeps in the cliffs of the Nepean River gorge (“interflow”). The low permeability of the Bald Hill Claystone acts as an aquitard between the Hawkesbury Sandstone and the Bulgo Sandstone. It has been observed to maintain its low permeability after subsidence and inhibit the movement of water and gas.

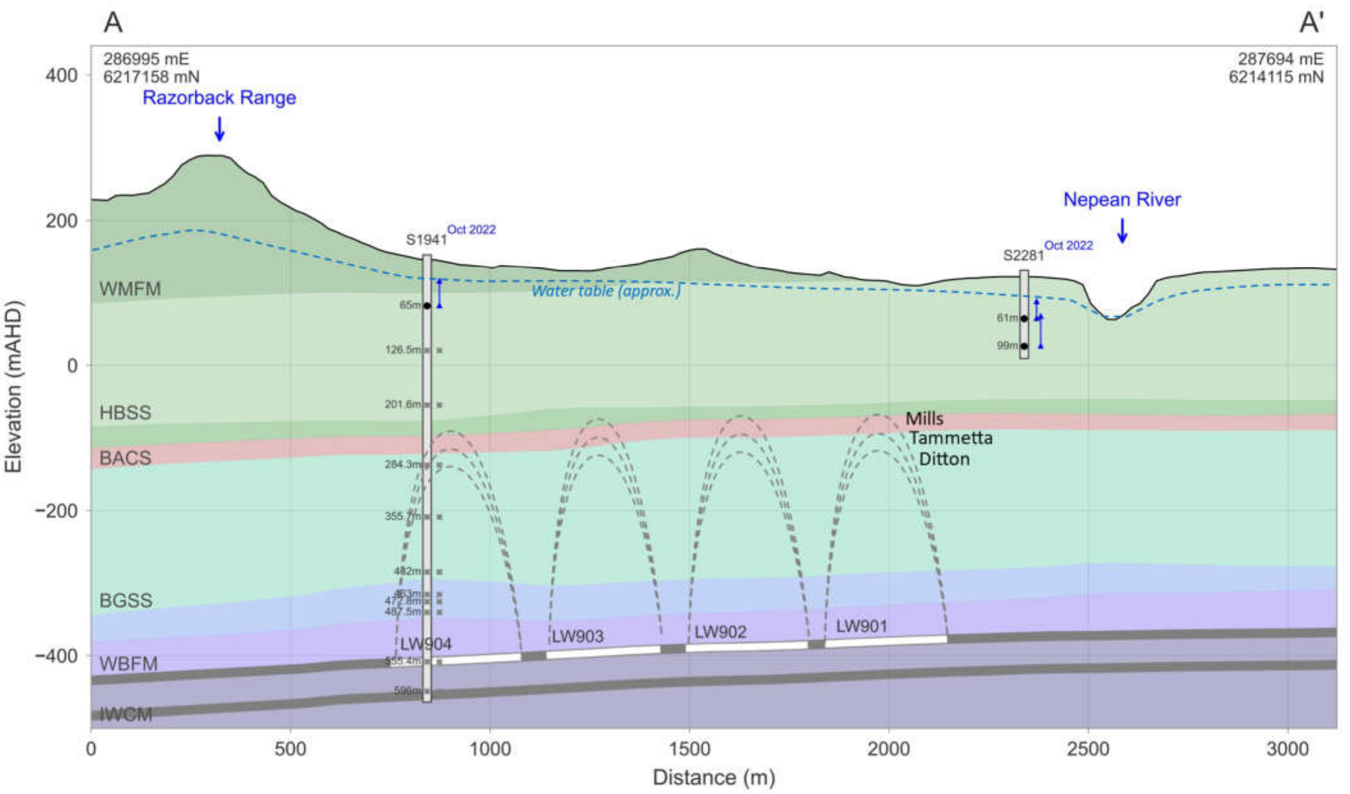

Figure 4. Hydrogeological cross section (N-S) through AA9

1.2 Surface water hydrology

Drainage lines within AA9 predominantly flow south to the Nepean River, which itself flows in an easterly direction. MSEC (2012) subdivided the Nepean River into two sections based on streambed morphology:

- Section 1 (upstream of Allens Creek) where flow is controlled by boulder fields, two rockbars and a small weir.
- Section 2 (downstream of Allens Creek) where the river is a flooded valley controlled by the Douglas Park Causeway.

Water flows in the Nepean River are derived from a number of sources, which include flows from catchment areas, licensed discharges (including Appin Colliery and Tahmoor Colliery) and runoff from agricultural and urban areas. Within the Study Area, river flow is predominantly controlled by the Maldon Weir (upstream) and the Douglas Park Weir (downstream). Water levels down river of the Study Area (i.e. down river of Douglas Park Causeway), are regulated by the Menangle Weir.

Water flows in the Nepean River:

- Vary greatly and are highly responsive to rain events due to the significant areas of catchment.
- Reach very high levels during sustained storm events, while minimum flow is rarely less than 1.5 ML/day (approx. 5 percentile flow).
- Cease on a small number of occasions, usually only when the rate of pumping out of the River exceeds the rate of inflow under low flow/drought conditions.

Median flow in the river section adjacent to the proposed longwalls is likely to be ~15% more than the median flow rate at Maldon Weir, which is 16.5 ML/day, and a little less than the median flow rate at Menangle Weir, which is 34.7 ML/day. Therefore median (50 percentile) flow rate adjacent to Longwall 901 is about 30 ML/day.

Baseline surface water monitoring for AA9 has been ongoing since October 2008 and provides a comprehensive baseline data set prior to extraction of Longwalls 901 to 904.

Tributaries to the Nepean River within the Longwalls 901 to 904 Study Area include:

- Nepean River Tributary 1 located directly above the proposed Longwalls 902 to 904.
- Harris Creek located east of AA9 and 400 m from Longwall 903 at its closest point. It is located just outside the Study Area, although Harris Creek has experienced valley related and far-field horizontal subsidence movements.

First and second order channels also flow to the Nepean River, and form smaller gullies along the cliffs of the gorge which generally discharge via elevated streams cascading down cliffs after sufficient rain. The majority of rainfall in the smaller catchments would infiltrate into these plateau soils and enter the groundwater system.

There are no areas considered flood prone and there are no upland swamps in the Study Area. A number of earth farm dams are located in the streams and are used as water sources on rural properties. All major streams have dams within their channels and catchment areas.

1.3 Potential mining effects

Extraction of coal using longwall methods commonly results in ground subsidence, deformation and fracturing of overlying strata and depressurisation of adjacent geological units (Peng and Chiang, 1984). The distribution of fracturing and its effects on aquifer characteristics has been well documented from numerous case studies (Booth, 1986; Forster and Enever, 1992; Guo et al., 2007; Mills, 2011; Tammetta, 2016; Tammetta, 2014; Tammetta, 2013).

While authors differ slightly in their terminology, there is general agreement on the overall sequence and pattern of fracturing that develops above a longwall. Immediately above a mined coal seam, the roof collapses into the void to form a caved zone that extends tens of metres above the seam. As the mining proceeds, a network of connected fractures extends above the caved zone to a height above the seam that is largely dictated by the width and mining height of the panel relative to the depth of cover (Mills, 2011; Ditton and Merrick, 2014; Tammetta, 2013). The development of fractures above (and below) the mined seam results in changes to aquifer properties; specifically, the permeability of the rock mass increases and groundwater pathways are potentially created between shallow and deeper groundwater systems. Subsidence and associated phenomena such as valley closure commonly result in increased surface cracking due to the unconfined nature of the surface rock. This type of surface cracking is typically limited to the top 10 to 20 m and may not be connected to the deeper fracture zones. Nevertheless, surface fracturing can affect shallow and perched groundwater systems and stream flow characteristics.

Calculations based on published geotechnical models indicate that the zone of connected fracturing above longwalls in AA9 is unlikely to extend above the base of the Bald Hill Claystone (Figure 4). Observation of low water make at AA9 and strata gas movements is consistent with the extent of connective fracturing being limited to below the Bald Hill Claystone.

1.3.1 Ground subsidence

Ground subsidence and potential effects on natural and built surface features was assessed by MSEC (2012), prior to the commencement of mining at AA9. Contours of predicted subsidence after Longwall 904 are reproduced in Figure 5. Approximately 20 mm or less subsidence was expected at the Nepean River in response to Longwalls 901 to 904, with negligible incremental subsidence at the river associated with Longwall 904. Approximately 800 to 900 mm of subsidence is expected directly above the longwall.

Actual changes in surface level due to the mining in Area 9 were measured using Airborne Laser Scan (ALS) / Light Detection and Ranging (LiDAR) surveys. The results, reported by MSEC (2022), show that observed subsidence due to the extraction of LW901 to LW904 is consistent with predictions.

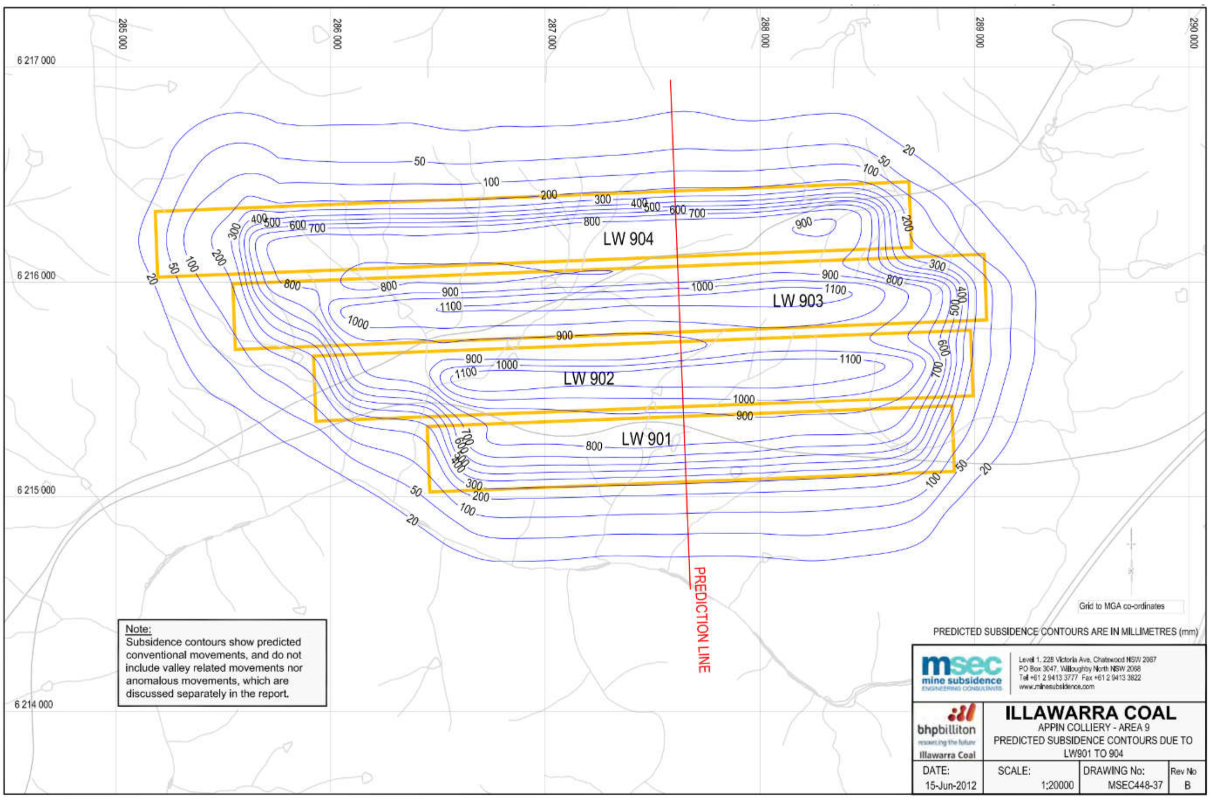

Figure 5. Contours of predicted subsidence due to Longwall 904 (in mm; MSEC 2012)

An End of Panel subsidence assessment was carried out following the completion of mining Longwall 904 (MSEC, 2022). The report assessed subsidence impacts to nearby natural drainage features including the Nepean River, and Harris Creek and the natural drainage lines directly above Longwall 904 that flow into the Nepean River. The impacts on natural drainage lines associated with the extraction of Longwall 904 recorded by the IMC Environmental Field Team were less than the MSEC assessments (predictions) provided in Reports Nos. MSEC488, MSEC829 and MSEC1005.

1.3.2 Surface water and groundwater effects

Ecoengineers (2012) and GeoTerra (2011) identified a number of possible water related environmental consequences that may occur due to the extraction of Longwalls 901 to 904. Those consequences are summarised in Table 1.

Table 1. Summary of potential water-related mining impacts

Consequence	Description	Impact / Likelihood
Gas emissions in the Nepean River and other areas	Based on observations at (AA7) it is likely that “minor” gas emissions will appear in the Nepean River as a consequence of mining Longwalls 901 to 904. Potential effects may include Dissolved Oxygen “sags”, and visible iron precipitates (localised iron staining).	Impact: Negligible Likelihood: Likely (Ecoengineers, 2012)
Groundwater outflows and ferruginous springs	The appearance of ferruginous springs due to mining has been noted in some Bulli Seam mining areas especially along margins of outcropping Wianamatta Shale. Ferruginous springs have not been detected in relation to	Impact: Negligible Likelihood: Low (Ecoengineers, 2012)

Consequence	Description	Impact / Likelihood
	mining of Longwalls 701 and 702, either in the walls of the Nepean River gorge or along adjacent tributaries.	
Sub-bed flow diversions and un-natural pool drainage	Section 1 of the Nepean River is characterised by boulder fields, which are less susceptible to fracturing than rockbars. Two rockbars have been identified in the Study Area: Rockbar NR-A9-RB01 is located 370 m from the nearest longwall. Rockbar NR-A9RB02 is submerged at times of high flow, and therefore does not restrict the surface water at these times.	Impact: Negligible Likelihood: Low (Ecoengineers, 2012) Nepean River Tributary 1: Likely impact
Impacts to streams and farm dams	Many farm dams have been mined under and monitored, with only a small number of dams exhibiting impacts (becoming dry) following mining. It is predicted that the impact on farm dams from mining Longwalls 901 to 904 will be similar.	Impact: Minor Likelihood: Likely (Ecoengineers, 2012)
Reduced groundwater yield	Six NoW registered bores within or near the proposed Longwalls 901 to 904 may be affected by subsidence, where the bores predominantly obtain water from the Hawkesbury Sandstone, rather than the overlying Wianamatta Group shale and sandstones. Groundwater levels in the Hawkesbury Sandstone are predicted to reduce by up to 10 m (WMP, p.14)	Impact: Negligible Likelihood: Likely (GeoTerra, 2011)
Groundwater quality impacts	It is likely that some [minor and localised] water quality changes will occur but there is a relatively low level of groundwater resource use in the area. Monitoring of potentially affected bores within AA9 is conducted in consultation with the owners.	Impact: Negligible Likelihood: Likely (GeoTerra, 2011)
Gas emissions	There is potential for strata gas emissions into private bores. Any such emissions are likely to diminish over time. Any bores with gas releases are decommissioned during the mining period.	Impact: Negligible Likelihood: Likely (GeoTerra, 2011)

1.4 Water management framework

Groundwater monitoring and reporting is carried out according to the AA9 WMP (BHP Billiton, 2014). The objectives of the WMP are to identify at risk surface water and groundwater features and characteristics within the Longwalls 901 to 904 Study Area and to manage the potential impacts and/or environmental consequences of the proposed workings on watercourses and aquifers, with specific focus on the Nepean River and its tributaries.

1.4.1 Trigger Action Response Plan (TARP)

Effects of mining on surface water and groundwater are managed through ongoing monitoring and regular reporting against agreed performance measures. The Water Management Plan (BHP Billiton, 2014) includes a Trigger Action Response Plan (TARP) which outlines specific performance measures and management actions to be taken in the event of a trigger event. The water related performance levels are listed in Table 2. Water chemistry TARP trigger levels calculated from baseline data (prior to the start of mining on 19/1/2016) are presented in Table 3.

Table 2. TARP Performance Criteria for AA9

Type / Location	Parameter	Level 1	Level 2	Level 3
Surface water quality				
Nepean River: ▪ NR0 ▪ SW3 ▪ NR2 If and where gas plumes above 3000 L/min are detected ** Compared with baseline monitoring prior to mining*	pH	Reduction* > 1SD < 2SD for two consecutive months	Reduction > 2SD for two consecutive months	As for level 2, for 6 consecutive months
	DO	Reduction > 1SD < 2SD for two consecutive months	Reduction > 2SD for two consecutive months	
	EC, Total Fe, Total Mn	N/A	Increase > 2SD for 2 consecutive months	
	Gas plumes	Plume <3000 L/min	Plume >3000 L/min	
	Cloudiness, iron staining	More than negligible		
Groundwater inflow to the mine	Inflow from the goaf (Over 20-day average)	Increase of between 2.7 and 3.0 ML/day	Increase of between 3.0 and 3.4 ML/day	Abnormal increase greater than 3.4 ML/day
Groundwater levels				
Private bores South32 Piezometers: ▪ S1913 (EAW5) ▪ S1936 (EAW7) ▪ S1941 (EAW9) ▪ S1954 (EAW18) ▪ S2080 (EAW58) ▪ S2280 (Harris Ck 7) ▪ S2281 (Harris Ck 6)	Reduction below predicted standing water level or pressure head in the Hawkesbury Sandstone.	5.0 to 7.5 m over a minimum two-month period.	7.5 to 10.0 m over a minimum two-month period.	>10 m over a minimum two-month period.

In relation to surface water flows, BSO Approval Condition 1, Schedule 3 stipulates that there should be *negligible diversion of flows or changes in the natural drainage behaviour of pools* in the Nepean River. In relation to other watercourses, there should be *no greater subsidence impact or environmental consequences than predicted in the Environmental Assessment and PPR.* The term “negligible” is defined within the Project Approval as “small and unimportant, such as not to be worth considering”.

Table 3. Baseline water chemistry TARP trigger levels

Parameter		NR110 (Reference)	NR0	SW3	NR2
Baseline samples (n):		33	254	21	389
EC	**Mean**	240	388	242	422
	Mean +1SD	320	586	328	652
	Mean +2SD	401	783	414	883
pH	**Mean**	7.9	7.8	7.9	8.0
	Mean -1SD	7.5	7.3	7.6	7.5
	Mean -2SD	7.1	6.8	7.4	7.0
DO	**Mean**	86.5	91.8	88.0	88.2
	Mean -1SD	69.7	78.7	74.6	70.1
	Mean -2SD	53.0	65.5	61.2	51.9
Fe (Total)	**Mean**	0.33	0.28	0.32	0.34
	Mean +1SD	0.46	0.50	0.45	0.74
	Mean +2SD	0.60	0.72	0.59	1.14
Mn (Total)	**Mean**	0.024	0.032	0.020	0.033
	Mean +1SD	0.038	0.057	0.029	0.058
	Mean +2SD	0.052	0.083	0.039	0.083

2. MONITORING NETWORK

2.1 Groundwater monitoring

Groundwater levels are monitored using multi-level vibrating wire piezometers (VWP) which are grouted into boreholes. There are seven groundwater monitoring sites relevant to AA9 operations and specified in the TARP, shown in Figure 2 and listed in Table 4.

Table 4. Groundwater monitoring sites in AA9

Bore ID	Alternate name	Total depth	Number of piezometers	Formations monitored	Date installed
S1913	EAW5	612.1	10	HBSS, BGSS, SBSS, BUSM	2008
S1936	EAW2	611.0	10	HBSS, BGSS, SBSS, BUSM	2008
S1941	EAW9	605.2	11 [1 active]	HBSS, BGSS, SBSS, BUSM	2008
S1954	EAW18	797.2	13	WMGR, HBSS, BUSM	2008
S2080	EAW58	524.2	10	HBSS, BGSS, SBSS, CCSS	2010
S2280	Harris Creek 7	110.0	2	HBSS	2014
S2281	Harris Creek 6	110.0	2	HBSS	2014

Deep groundwater responses to mining are assessed primarily through the use of time-series hydrographs for multi-level piezometer sites (VWPs). Noisy data are filtered and removed where practical. Hydrographs are presented in Appendix 1 and discussed in Section 3.1.

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

Hydrographs presented in this assessment include the ground elevation at the bore site and the elevation of the Nepean River adjacent to Longwall 901. Note also that individual hydrograph traces are presented as dotted lines at times when the ***pressure head*** is below a threshold of 2 m. The pressure head is the absolute pore pressure at the sensor expressed in m of water. When the pressure head is below that threshold it is an indication that the rock matrix is approaching complete desaturation at the location of the sensor. This condition is not always apparent from plots of total piezometric head alone. Hydrographs of pressure head are also presented in Appendix 1.

2.1.1 Mine inflow

Groundwater inflow to AA9 is calculated from the daily mine water balance by accounting for water pumped in and out of the mine area.

2.2 Surface water monitoring

Surface water levels and chemistry are monitored at the sites shown in Figure 2 and listed in Table 5.

Table 5. Surface water monitoring sites

Site	Watercourse	MGA_mE	MGA_mN	Field Observations	Chemistry (Lab)	Flow
NR0	Nepean River	286759	6214712	Y	Y	
SW3 (NR1)	Nepean River	287029	6214666	Y	Y	
NR2	Nepean River	288927	6214200	Y	Y	
NR3	Harris Creek	289139	6214290	Y	Y	
SW2	Allens Creek	287103	6214637	Y	Y	
SW4	Nepean River	287170	6214663	Y		
NR110	Nepean River	284812	6213103	Y	Y	
NT1_Pool 10	Nepean Trib. 1	286324	6215077	Y	Y	
NT1_Pool 20	Nepean Trib. 1	286391	6215227	Y		
NT1_Pool 30	Nepean Trib. 1	286411	6215341	Y		
NT1_Pool 40	Nepean Trib. 1	286472	6215492	Y		
NT1_Pool 50	Nepean Trib. 1	286458	6215569	Y		
Maldon Weir	Nepean River	281633	6212737			Y*
Menangle Weir	Nepean River	291843	6222415			Y*
Broughtons Pass Weir	Cataract River	292076	6210296			Y*

Note* Weirs operated by WaterNSW : Water level and flow at 15-minute frequency. **Bold** = TARP / Control site

2.2.1 Weather observations

Rainfall and solar exposure data have been collected at Douglas Park (Bureau of meteorology site 068200) since 1974 (with some gaps). Monthly rainfall, cumulative rainfall residual and solar radiation since the start of 2015 are plotted in Figure 6. Daily temperatures range between 10 to 46 °C in January and between -3.7 and 27 °C in July (at Campbelltown). Evapotranspiration also varies seasonally in line with temperature and solar radiation, peaking during the summer months.

Average annual rainfall since 1974 is 771 mm (2.11 mm/day). Rain can fall year-round with slightly higher monthly average rainfall in late summer months (February-March). It is common for a substantial proportion of the annual rainfall to be delivered in one or two large rainfall events, during which significant surface water runoff and groundwater recharge is generated. This was the case during the reporting period with heavy rainfall in March and April 2022. Rainfall over the last three years (2022-2022) has been well above the long-term average, resulting in widespread groundwater recharge and recovery.

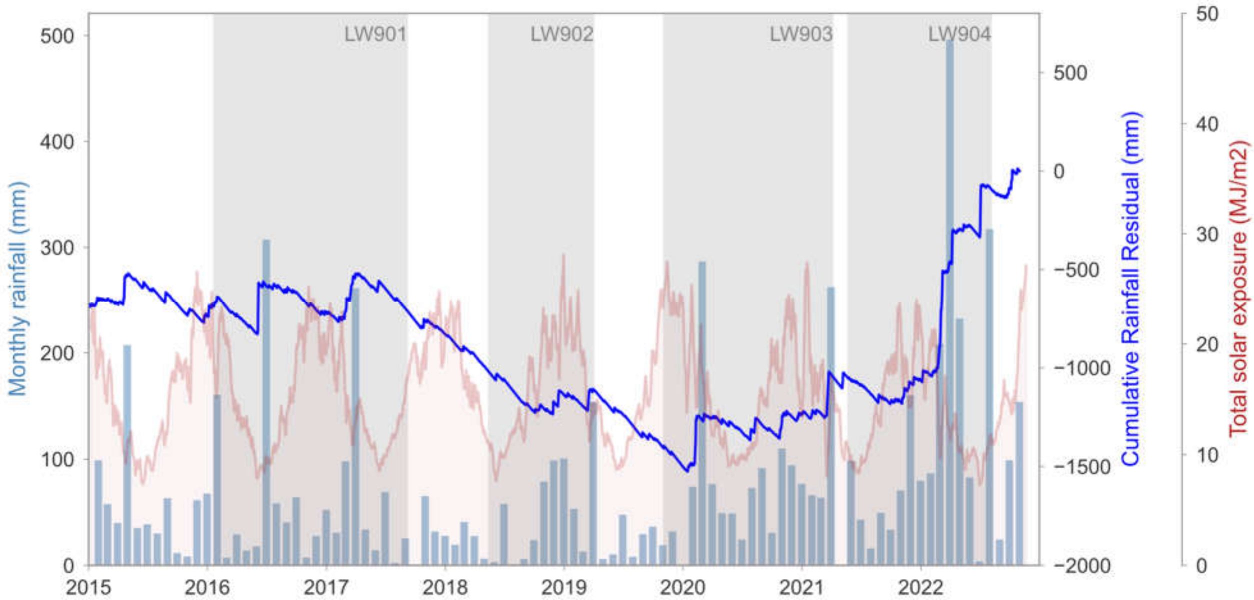

Figure 6. Rainfall and solar exposure at Douglas Park

3. GROUNDWATER ASSESSMENT

3.1 Groundwater levels

Groundwater bore hydrographs are presented in Figures 7, 8, 9 and 10 and Appendix 1. Observations in relation to temporal trends in groundwater pressures are listed in Table 6.

During Longwall 903, the Level 1 TARP was triggered at monitoring bore S1941 for the Hawkesbury Sandstone sensor at 201.6 m depth (groundwater pressure decline of between 5.0 and 7.5 m more than predicted in the WMP for a period of more than 2 months). All sensors except the shallowest sensor (65 m depth) were sheared and became inoperable following the passage of Longwall 904 directly beneath the bore in mid-August 2021. The remaining sensor indicated recovery of groundwater levels with no TARP trigger during Longwall 904.

No TARPs were triggered at other groundwater monitoring sites during Longwall 904.

Table 6. Groundwater level observations

Bore	Observations	TARP Level
S1913 (EAW5)	S1913 is located 2.3 km north of Longwall 904. It has three sensors in the Hawkesbury Sandstone at 65 m, 137 m and 194 m depth. During Longwall 904, groundwater pressures at all three Hawkesbury Sandstone sensors increased in response to higher than average rainfall in 2022. Pressures at the upper two Hawkesbury Sandstone sensors remained above the level of the Nepean River during Longwall 904. Pressures at the 194 m sensor have been below the level of the Nepean River since prior to the commencement of mining in AA9. Pressures at the 194 m sensor increased to within the predicted maximum reduction of 10 m.	Not triggered
S1936 (EAW7)	S1936 is located 3.2 km north east of Longwall 904 and above Longwall 706 in AA7. All sensors apart from the shallowest Hawkesbury Sandstone sensor (65 m) failed in 2014 due to subsidence in AA7. The groundwater at the 65 m sensor shows a slight declining trend since Longwall 901 which is likely to be related to AA7 rather than AA9.	Not triggered
S1941 (EAW9)	S1941 is located above Longwall 904 and was mined beneath in mid-August 2021. Following the passage of Longwall 904 beneath the bore, only one of the three sensors in the Hawkesbury sandstone remains active (65 m). All other sensors are inoperable. The groundwater level in the 65 m sensor increased to its highest recorded level during Longwall 904 due to above average rainfall over the period.	Not triggered
S1954 (EAW 18)	S1954 is located 1.2 km north west of Longwall 904, on the far side of the Razorback range from AA9. S1954 has seven sensors within the Wianamatta Group shales and five sensors within the Hawkesbury Sandstone. Loggers were inoperative from early 2014 to mid-2017 with monitoring re-commencing at the end of mining at Longwall 901. Average groundwater levels in the Hawkesbury Sandstone declined up to ~4.3 m during Longwall 902 and have recovered since that time. Piezometric levels in all sensors remain above the elevation of the Nepean River.	Not triggered
S2080 (EAW58)	S2080 is located 1.4 km southeast of Longwall 904. It has three sensors in the Hawkesbury Sandstone at 65 m, 95 m and 170 m depth. Groundwater pressures in the uppermost Hawkesbury Sandstone sensor (65 m) declined by approximately 8 m during mining at longwalls 901 to 903 and recovered slightly during Longwall 904. The piezometric head in the upper most sensor remains ~20 m above the elevation of the Nepean River, and the 95 m sensor recovered to just above the level of the river. The 170 m sensor remains several metres below the level of the river.	Not triggered
S2280 (Harris Ck 7)	S2280 is located 1.1 km southwest of Longwall 904 and has two sensors within the Hawkesbury Sandstone (60 m and 99 m depth). The piezometric level at both sensors	Not triggered

Bore	Observations	TARP Level
	recovered slightly during Longwall 904 and both remain above the elevation of the Nepean River.	
S2281 (Harris Ck 6)	S2281 is located between Longwall 901 and the Nepean River. It has two sensors within the Hawkesbury Sandstone at 61 m and 99 m depth. Groundwater pressures at both sensors responded to the passage of Longwall 901, initially increasing (due to strata compression) as the longwall approached and then declining as the longwall moved away. Piezometric levels at both sensors has recovered since the start of Longwall 903 and both remain above the elevation of the Nepean River.	Not triggered

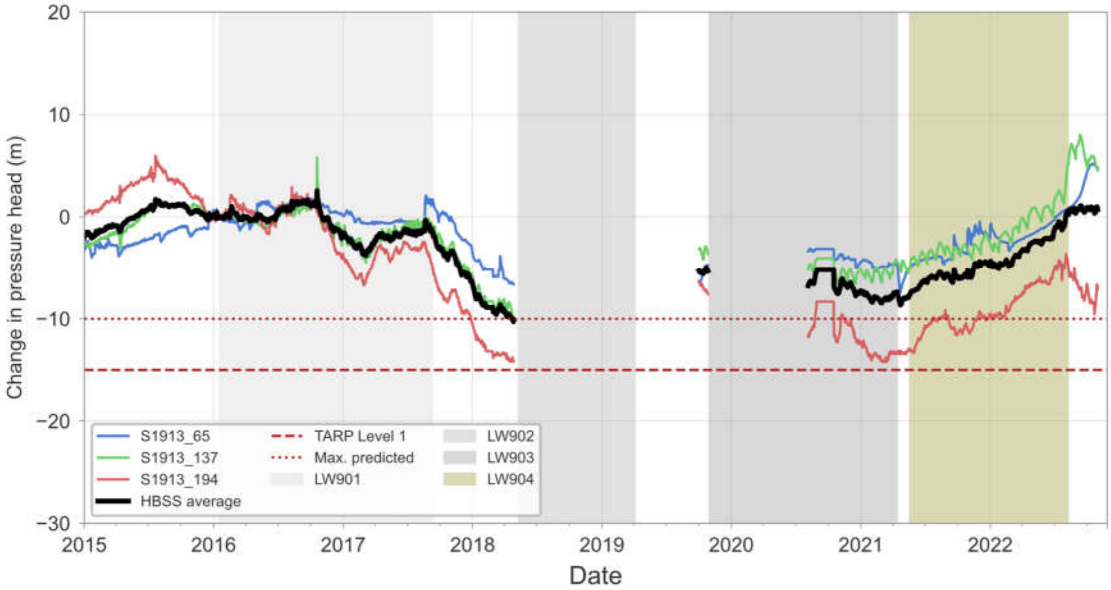

Figure 7. Pressure head change hydrograph for S1913

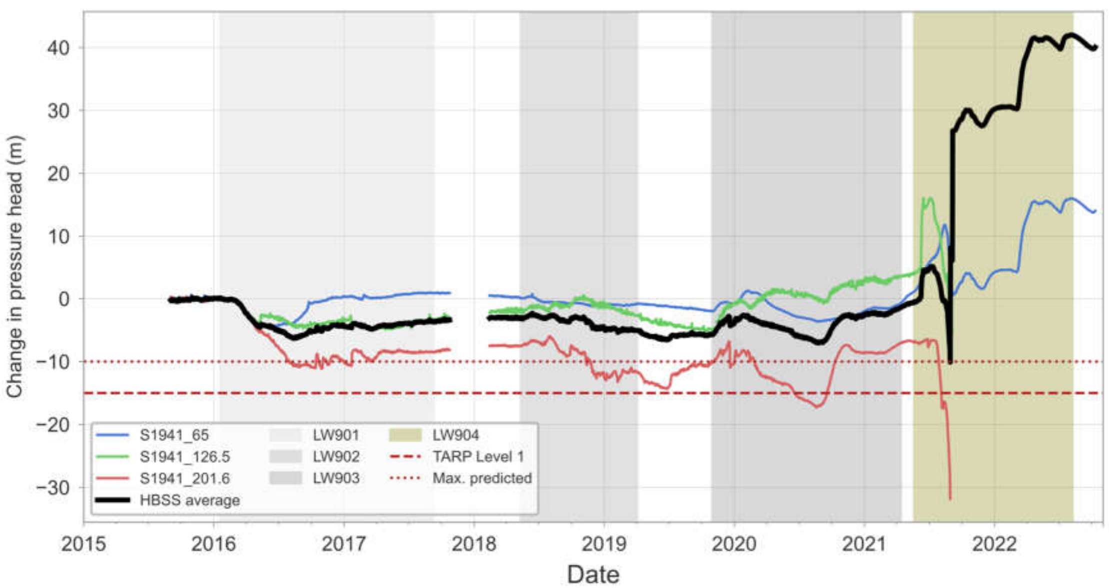

Figure 8. Pressure head change hydrograph for S1941

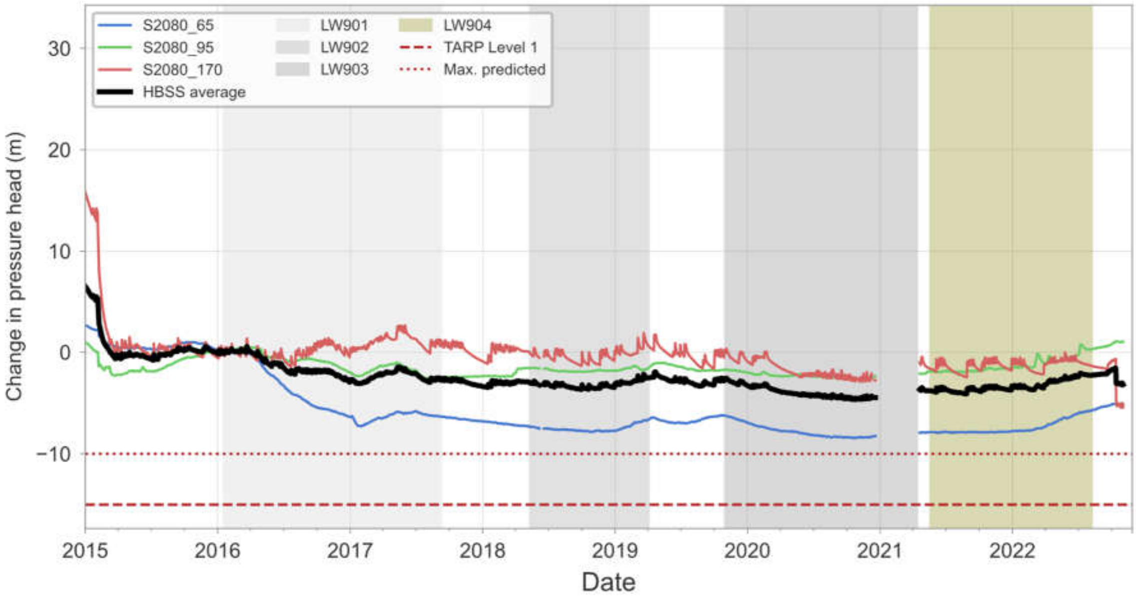

Figure 9. Pressure head change hydrograph for S2080

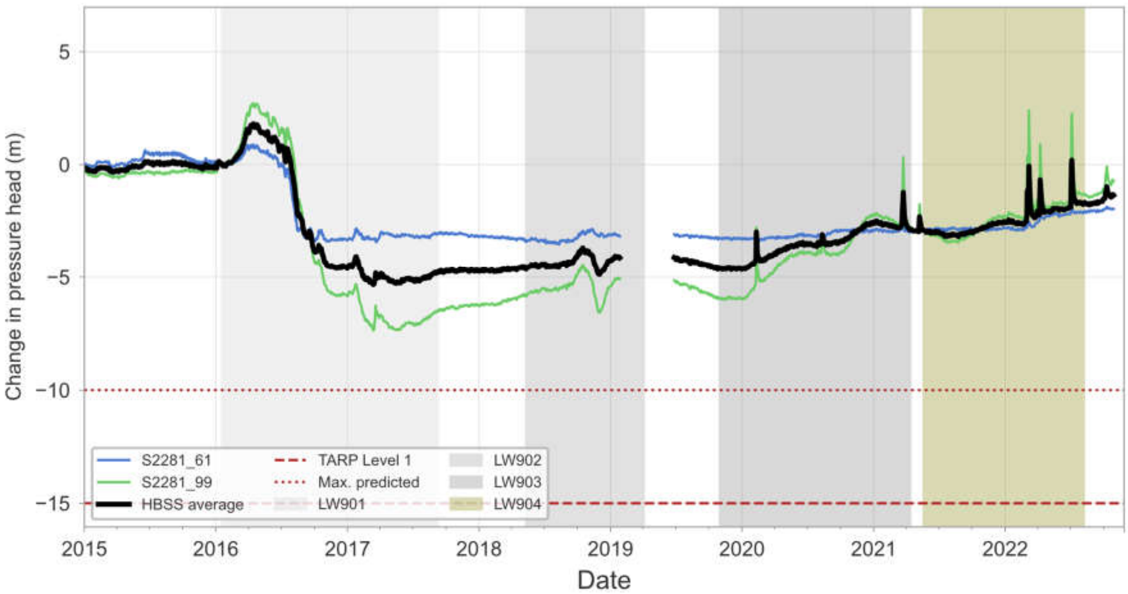

Figure 10. Pressure head change hydrograph for S2281

3.2 Groundwater chemistry

Groundwater samples are collected from four monitoring bores in the vicinity of AA9. Two bores (S1954, S2080) are sampled at multiple depths. Key groundwater quality parameters are summarised in Table 7 and water chemistry time-series plots are in Appendix 2. Groundwater in the Hawkesbury Sandstone is typically brackish (EC ~ 1400 to 6100 µS/cm; TDS ~ 840 to 3660 mg/L) and near neutral in pH. In contrast, the Nepean River has water of low salinity (fresh; EC typically 140 to 460 µS/cm; TDS 85 to 280 mg/L).

Time-series plots of key water quality parameters (Appendix 2) show no significant change in water quality as a result of mining at AA9.

Table 7. Summary of groundwater and surface water quality near AA9

Site / depth	Statistic	Field EC (µS/cm)	Field pH	Na/Cl (meq)
S1954_198m (Wianamatta Grp)	P5%	3423	8.71	1.51
	Median	3445	8.76	1.51
	P95%	3468	8.81	1.52
S1954_255m (Hawkesbury Sst)	P5%	2724	7.99	0.95
	Median	2760	8.02	0.97
	P95%	2796	8.04	0.99
S2080_158m (Hawkesbury Sst)	P5%	1133	7.53	1.11
	Median	1245	7.56	1.14
	P95%	1358	7.60	1.18
S2080_290m (Bulgo Sst)	P5%	4972	7.74	7.46
	Median	5165	7.85	10.56
	P95%	5359	7.96	13.66
S2280_60m (Hawkesbury Sst)	P5%	3644	7.29	0.70
	Median	3830	7.72	0.72
	P95%	3914	7.87	0.73
S2281_60m (Hawkesbury Sst)	P5%	5620	7.23	0.59
	Median	6105	7.57	0.65
	P95%	6327	7.78	0.69
Nepean River Surface Water Sites (NR0, SW3 / NR1, NR2)	P5%	140	7.00	1.00
	Median	295	7.9	1.62
	P95%	602	8.4	2.76

3.3 Private groundwater bores and dams

Pre and post-mining inspection of dams, boreholes and natural features above AA9 (set out in the Built Feature Management Plans) are conducted by the ICEFT with the consent of the relevant property/infrastructure owner and tenant. Significant changes or impacts are reported in the End of Panel Landscape Report (South32, 2022).

Post-mining inspections were undertaken at properties Lot 1 DP810978, Lot 9 DP810978, Lot 3 DP1133989, Lot 22 DP803255. Lot 15 DP803255 was also reinspected following a recommendation in the Longwall 903 EoP Report.

The inspections included recording key observations for private bores and dams and collection of in-situ water quality parameters and water samples for laboratory analysis. Key findings of the inspections are summarised below. Minor changes to groundwater quality are noted in some private groundwater bores. In most cases those changes reflect normal variation between sampling events. The observed changes do not represent a change in beneficial use category (ANZG, 2018). Further details can be found in the relevant property reports.

Lot 1 DP810978

Bore GW110671 on Lot 1 DP810978 is located approximately 50 m east of Longwall 904. The bore is 240 m deep and is mainly used to water a garden. The property and bore were inspected by the IMCEFT on 26/8/2022 following the completion of Longwall 904, and on 2 previous occasions (15/11/2017 and 25/5/2021). The bore was not directly mined beneath by Longwall 904, nor previous longwalls.

Analysis of a water sample from the bore indicates that groundwater EC was 2320 µS/cm, similar to previous samples. Groundwater pH was near-neutral (6.91), slightly lower than previous measurements. On sampling there was an initial smell of hydrogen sulphide, and the water sample was initially effervescent, indicating dissolved gas which is not unusual for bore water samples. Dissolved and total iron concentrations were 0.49 mg/L and 1.38 mg/L, slightly higher than previous samples. Other dissolved metal concentrations are slightly higher than previous samples, possibly associated with the decrease in pH. It is recommended that the water quality be reassessed after completion of the next longwall.

A dam is located towards the north-eastern corner of the property. During the Longwall 904 post-mining inspection on 26/8/2022, the dam level was full. The water in the dam was dark brown/grey and turbid. The dam walls remain in good condition, with no signs of leaks or slumping.

Lot 15 DP803255

Bore GW112437 on Lot 15 DP803255 is located approximately 685 m south of Longwall 904, is 156 m deep. The landholder advised that the bore water is used for land care and domestic purposes. The bore and dam were inspected and sampled on 5/10/2022.

The position of the pump in the bore prevented measurement of the standing water level during the post-Longwall 904 inspection. In previous inspections the groundwater level in the bore was 77.05 m below ground level (bgl) in April 2021 (pump running) and 70.71 mbgl in June 2019 (pump not running). Bore yield during most recent inspection remained steady at 2 L/s, matching the extraction rate observed in the pre-mining inspection.

Analysis of a water sample from the bore indicates that groundwater EC was 2,110 µS/cm and pH was neutral (6.98), similar to previous measurements. Dissolved and total iron concentrations were 0.56

mg/L and 0.63 mg/L, similar to the 2017 measurements of 0.44 mg/L and 0.54 mg/L. Total iron has decreased from the 1.44 mg/L reported in 2021.

A water sample collected from the dam on Lot 15 DP803255 was significantly fresher (EC 323 µS/cm) than the previous sample collected in 2021 (1020 µS/cm) as a result of the high rainfall since that time. No adverse changes are noted.

Lot 9 DP810978

Bore GW104602 on Lot 9 DP810978 is located 400m m east of Longwall 904. The bore is approximately 231 m deep and is used to water a garden. The bore was not directly mined beneath by Longwall 904, nor previous longwalls. The property and bore were inspected by the IMCEFT on 26/8/2022 following the completion of Longwall 904, and on 2 previous occasions (16/4/2018 and 3/5/2021).

Analysis of a water sample from the bore indicates that groundwater EC was 1,930 µS/cm and pH was neutral (7.09), similar to previous measurements and consistent with typical groundwater quality from the Hawkesbury Sandstone. On sampling there was an initial smell of hydrogen sulphide and the water sample was initially effervescent, indicating dissolved gas which is not unusual for bore water samples. Dissolved and total iron concentrations were 0.37 mg/L and 0.47 mg/L, slightly higher than the April 2018 samples but similar to the May 2021 sample. Dissolved metal concentrations remain low. There is no evidence for changes to groundwater quality related to mining.

The position of the pump in the bore prevented measurement of the standing water level during the post-Longwall 904 inspection. In previous inspections the groundwater level in the bore was 71.71 m below ground level (bgl) in May 2021.

Lot 3 DP1133989

Bore GW100673 on Lot 3 DP1133989 is located 390 m west of Longwall 904. The bore is 146 m deep and is used for livestock. The bore was not directly mined beneath by Longwall 904, nor previous longwalls. The property and bore were inspected by the IMCEFT on 26/8/2022 following the completion of Longwall 904, and on 2 previous occasions (16/5/2018 and 29/4/2021).

The position of the pump in the bore prevented measurement of the standing water level during the post-Longwall 904 inspection. In previous inspections the groundwater level in the bore was 43.13 m bgl in April 2021.

A sample collected from the bore had an EC of 2,840 µS/cm and pH was near-neutral (6.83), similar to previous measurements and consistent with typical groundwater quality from the Hawkesbury Sandstone. Dissolved and total iron concentrations were 0.89 mg/L and 1.55 mg/L, similar to the April 2018. Other dissolved metal concentrations remain low. There is no evidence for changes to groundwater quality related to mining.

Lot 22 DP803255

Bore GW072249 on Lot 22 DP803255 is located 600 m south of Longwall 904. The bore is approximately 97 m deep and is used for land care and domestic purposes. The bore was directly mined beneath by Longwall 902 on ~2/11/2018. The property and bore were inspected by the IMCEFT on 26/8/2022 following the completion of Longwall 904, and on 3 previous occasions (6/6/2019, 2/11/2017 and 29/6/2015).

Analysis of a water sample from the bore indicates that groundwater EC was 3760 µS/cm. Groundwater EC appears to have increased slightly in the two post-mining samples, compared with samples collected prior to Longwall 902 (~2,700 µS/cm). Groundwater pH remains near-neutral (7.13) and has not changed significantly over the four sampling periods. Dissolved iron was below detection in the most recent sample. Some dissolved metals (Cu, Zn, Mn, Ni) are slightly higher in concentration in the most recent sample compared with those collected prior to Longwall 902. It is recommended that the water quality be reassessed after completion of the next longwall.

The position of the pump in the bore prevented measurement of the standing water level during the post-Longwall 904 inspection. In previous inspections the groundwater level in the bore was 65.4 m below ground level (bgl) in June 2019.

3.4 Mine water balance

The daily mine water balance is monitored by South32. The balance tracks daily volumes of water pumped into the mine (supply), within the mine, and from the mine into storage and/or discharge. The rate of groundwater inflow to AA9 is determined by subtracting the estimated water supply volume (to AA9) from the total volume of water pumped to storage. Total mine inflow to AA9 is calculated from 31 July 2017.

The TARP level for mine inflow is based on the 20-day rolling average inflow to AA9, with level triggers listed in Table 2. A time-series of groundwater inflow to AA9 based on water balance calculations is shown in Figure 11, including the 20-day rolling average and TARP trigger levels. No TARP was triggered during the reporting period.

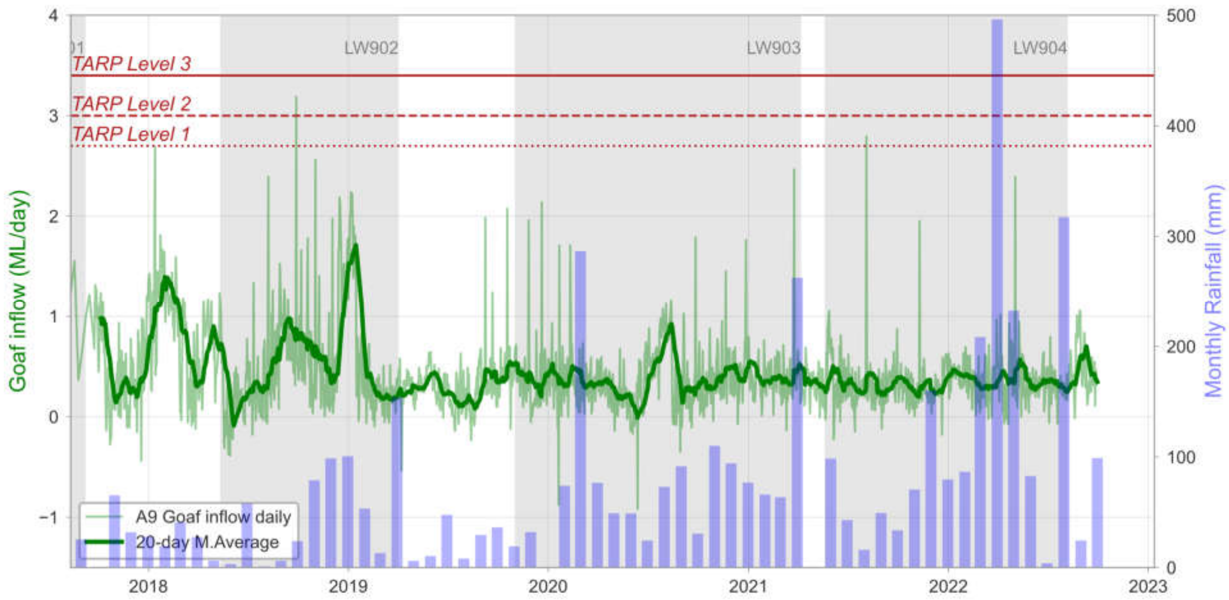

Figure 11. AA9 mine water balance

4. SURFACE WATER ASSESSMENT

Observations and laboratory analyses of surface water level and chemistry are presented as time-series plots (hydrographs) in Appendix 3.

4.1 Water level and flow

4.1.1 Nepean River flow

The Water Management Plan recommends that flow in the Nepean River is monitored by assessing dry weather recession characteristics for the Maldon, Menangle and Broughtons Pass weirs, based on daily flow records from those sites, as for the AA7 monitoring reviews.

The Nepean River is a gaining system in the vicinity of AA9 and therefore the flowrate increases downstream due to baseflow contributions and inflow from minor catchments along the reach, unless water use, and other losses exceed those contributions. Under such conditions, the ratio of downstream flow (at Menangle Weir) to upstream flow (at Maldon Weir) should be typically greater than 1. A timeseries of the ratio of downstream to upstream flows is plotted in Figure 12. The ratio prior to mining in AA9 fluctuates around a median of 2.7. The ratio has fluctuated over a similar range since the start of mining in AA9 and during the current longwall review period and there is no apparent systematic change in the ratio over time.

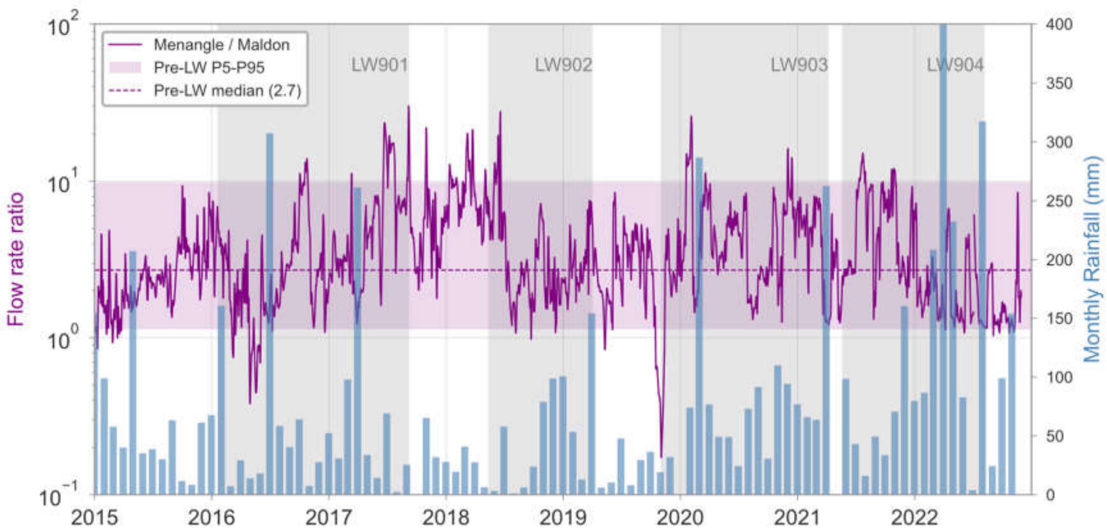

Figure 12. Ratio between downstream and upstream flow on the Nepean River

Flow duration curves for the Menangle and Maldon Weirs on the Nepean River and the Broughtons Pass Weir on the Cataract River are plotted in Figure 13. Flow duration curves are shown for the entire flow record prior to the current longwall review period (solid lines) and during the current review period (dashed lines). The pre-longwall record shows that the Nepean River ceased to flow 6 days per year at the Maldon Weir and 4 days per year at the downstream Menangle Weir. At Broughtons Pass Weir, the Cataract River ceased to flow 151 days per year. As a result of high rainfall over the last two years, no no-flow days were recorded at any of the monitoring sites during the review period.

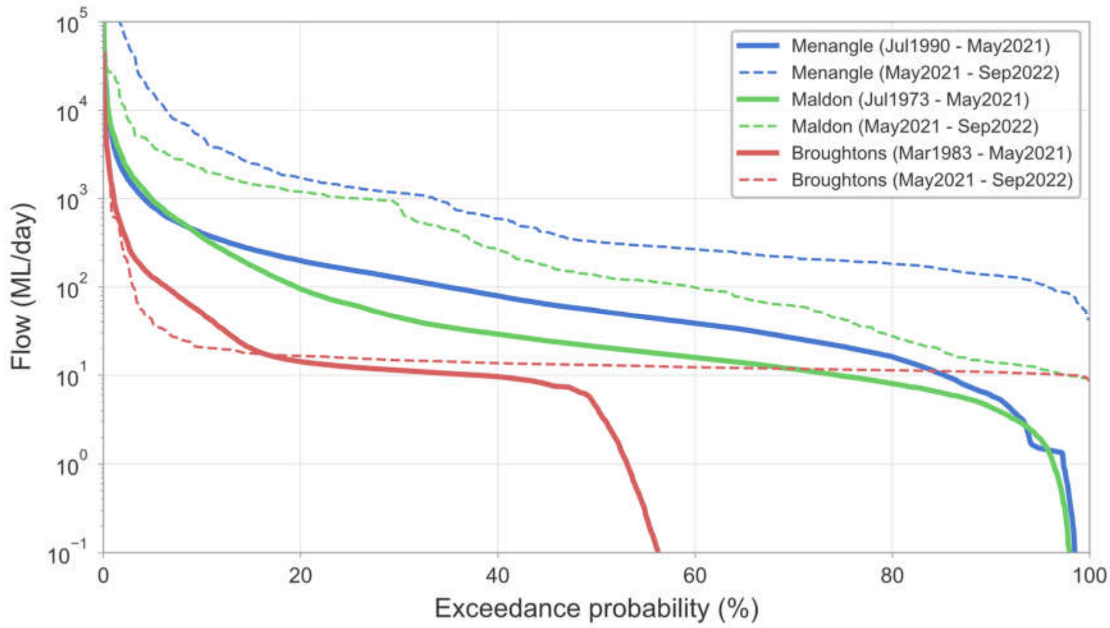

Figure 13. Flow duration curves prior to and during the longwall assessment period

Water level recession rates at Menangle, Maldon and Broughtons Pass Weirs are shown in Figure 14. Recession rates are calculated from measured water level changes over successive two-day periods. The data are filtered to include only periods that occur after 5 or more days of no rainfall, as recorded at the Bureau of Meteorology site at Douglas Park. Recession rates tend to cluster around 10 mm/day or less during dry periods but can exceed 50 mm/day after heavy or frequent rain events. A systematic increase in minimum recession rates during dry conditions may indicate increased losses due to seepage through the riverbed or weir structure. No systematic changes in the minimum recession rate are apparent during this or previous longwall review periods at AA9.

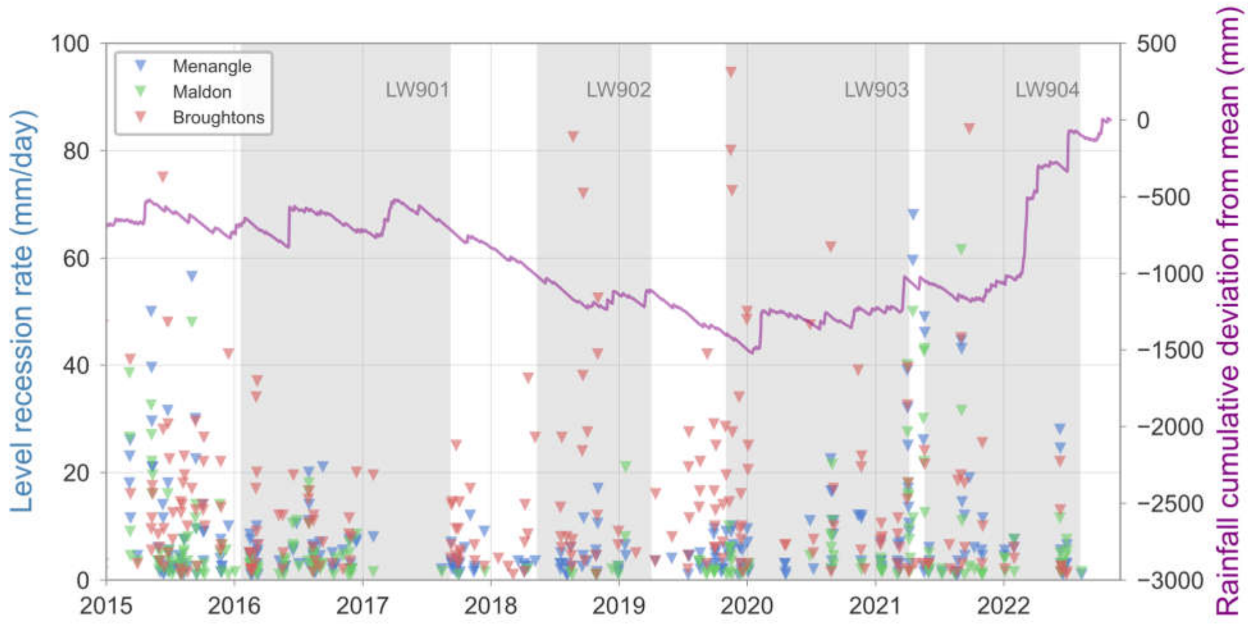

Figure 14. Water level recession rates at Menangle Weir

4.1.2 Pool water levels

Water levels are monitored at some pools during regular sampling events. Pool water levels are measured relative to a reference benchmark at the pool. Water levels are displayed as a time-series with other field observations in Appendix 3. The 5th to 95th percentile range for water levels measured during the pre-mining baseline period is also shown for reference.

Of the sites where water levels are measured, most show water levels during the reporting period that are within the baseline range. Nepean River monitoring site NR0 shows a decline in water level of 0.49 m relative to the baseline range during Longwalls 901 to 903. Water levels increased to within the baseline range during the latter part of Longwall 903 and during Longwall 904 in response to high rainfall during the period. Water levels at site NR110 located 3.5 km upstream of AA9 show a decline of ~0.25 m below the baseline range over the same period, suggesting a cause other than mining at Appin Area 9. However, it is recommended that monitoring of water levels at NR0 and NR110 be continued to assess water levels in the Nepean River.

4.2 Water quality

Trigger Action Response Plan (TARP) levels for surface water quality parameters are listed in Table 3. Criteria for triggering TARP levels are based on both magnitude and duration, as well as comparison with upstream reference site. For example, a TARP Level 1 is triggered for pH at site NR0 if the pH at that location is lower than the baseline mean minus 1 standard deviation (at that location), for at least 2 consecutive months but less than 6 consecutive months. To facilitate comparison between sites with different sampling frequencies, each time-series is resampled to monthly, whereby a maximum value is considered where there is more than one sampling event per month. In addition to the three nominated TARP sites for the Nepean River, the WMP recommends comparison with site NR110, located more than 3.5 km upstream of longwall 901.

Time-series plots of key water quality parameters are presented in Appendix 3. Analysis of the hydrographs in relation to the TARP criteria is provided in tabular format in Appendix 4 and summarised in Table 8 below.

The reporting period for Longwall 904 is characterised by variable water quality in the Nepean River. In general water quality has improved during Longwalls 903 and 904 due to the high rainfall and runoff since 2020 (EC has decreased and DO increased). High total iron and manganese is noted at several locations, including TARP locations SW3 and NR2, likely as a result of high runoff and mobilisation of clays, silts and associated sorbed metals. Elevated levels of dissolved iron, manganese and sulfate are noted at NR10 on Ousedale Creek just above the confluence with the Nepean River, during 2022. Ousedale Creek is 4.2 km to the east of AA9 at its closest point. Water quality effects are therefore not related to current mining activity and are likely remated to increased runoff during record heavy rainfall and runoff.

Level 2 TARPs were triggered for total Iron at SW3 and NR2 and for total manganese at NR2. Note that elevated total iron was also reported at the upstream control site NR110 suggesting the high iron (and manganese) is not a mining effect.

A Level 1 TARP was triggered for pH at SW3. The slightly lower pH values correspond to a trend of generally improved water quality (lower EC and higher DO) as a result of increased runoff over the period. pH remains in the near neutral range.

Ongoing monitoring at all sites is recommended to assess the trends in water chemistry as mining progresses.

Table 8. Summary of surface water TARP levels for reporting period

TARP Site	NR110 (Upstream control)	NR0 (Adjacent/ slightly upstream)	SW3 (Adjacent)	NR2 (Downstream)
EC	No TARPs triggered	No TARPs triggered	No TARPs triggered	No TARPs triggered
pH	No TARPs triggered	No TARPs triggered	**Level 1 TARP**	No TARPs triggered
DO	No TARPs triggered	No TARPs triggered	No TARPs triggered	No TARPs triggered
Fe (Total)	**Level 2 TARP**	No TARPs triggered	**Level 2 TARP**	**Level 2 TARP**
Mn (Total)	No TARPs triggered	No TARPs triggered	No TARPs triggered	**Level 2 TARP**
Clarity / staining	None noted	None noted	None noted	None noted
TARP Level	Upstream Control Site	TARP technically triggered for total Fe **suggesting downstream Fe TARP triggers are not associated with mining**.		

4.3 Gas emissions

Monitoring of the Nepean River and other watercourses for the occurrence of gas release zones is carried out by the IMCEFT on a weekly basis during mining. During the most recent reporting period, 15 gas release zones were found to be active along the river.

Of those 15 active zones, 14 were previously reported. One new gas release zone was noted in the Cataract River on 9/9/2021 (reference AA9_LW904_001), located approximately 100m upstream of the Nepean River and Cataract River confluence. The site is comprised of 6 light intermittent releases within a 60 m^2 area with a total estimated release rate of less than 3000 L/min. The site is approximately 3.4 km from Longwall 904. The occurrence was reported by IMC in an impact report dated 15/9/2021.

The occurrence represents a Level 1 TARP trigger, requiring the following management actions:

• Continue monitoring program

• Submit an Impact Report to relevant stakeholders

• Report in the End of Panel Report

• Summarise actions and monitoring in the AEMR.

5. CONCLUSIONS

An assessment of groundwater and surface water monitoring data was carried out to assess the potential impacts from mining of Longwall 904 at Appin Colliery, in accordance with the WMP. The following conclusions are made:

Groundwater assessment

- Longwall 904 mined beneath groundwater monitoring bore S1941 in mid-August 2021, after which all sensors except the shallowest sensor (65 m depth) became inoperable. The remaining sensor indicated recovery of groundwater levels with no TARP trigger during Longwall 904. No TARPs were triggered at other groundwater monitoring sites during Longwall 904.
- No significant change in groundwater chemistry is noted for the reporting period.
- Minor changes to groundwater quality are noted in some private groundwater bores. In most cases those changes reflect normal variation between sampling events and do not represent a change in beneficial use category. Bore GW072249 on Lot 22 DP803255 was directly mined beneath by Longwall 902 in November 2018. A slight increase in groundwater EC and some metal concentrations is noted in post-mining samples; however the water quality remains within water quality guidelines for irrigation and stock use. Ongoing monitoring of the bores is recommended.
- Groundwater inflow to the mine is calculated from the daily mine water balance. The 20-day moving average mine inflow fluctuated between 0 and ~1.2 ML/day following the extraction of Longwall 904, well below the TARP Level 1 trigger of 2.7 ML/day.

Surface water assessment

- The Nepean River is a gaining system in the vicinity of AA9 such that the flowrate increases downstream and the ratio of downstream flow (at Menangle Weir) to upstream flow (at Maldon Weir) is typically greater than 1 (pre-mining baseline is ~2.7). The ratio fluctuated over a similar range since the start of mining in AA9 and during the current longwall review period and there is no apparent systematic change in the ratio over time.
- There are no apparent systematic changes in the minimum recession rate at Menangle, Maldon and Broughtons Pass Weirs during this or previous longwall review periods at AA9.
- Monthly monitoring by South32 indicates a decline in pool water levels at site NR0 of 0.49 m from the baseline range. Water levels at the upstream control site NR110 show a decline of 0.25 m from the baseline range over the same period. Ongoing monitoring at NR0 and NR110 is recommended.
- The reporting period for Longwall 904 is characterised by variable water quality in the Nepean River. In general water quality has improved during Longwalls 903 and 904 due to the high rainfall and runoff since 2020 (EC has decreased and DO increased). High total iron and manganese is noted at several locations, including TARP locations SW3 and NR2, representing Level 2 TARP triggers. Note that elevated total iron was also reported at the upstream control site NR110 suggesting the high iron (and manganese) is not a mining effect and most likely related to high runoff and mobilisation of clays, silts and associated sorbed metals.
- A Level 1 TARP was triggered for pH at SW3. The slightly lower pH values correspond to a trend of generally improved water quality (lower EC and higher DO) as a result of increased runoff over the period. pH remains in the near neutral range.

- Fifteen active gas release zones were observed during the review period, including one new occurrence in the Cataract River. All 15 gas release zones have estimated emission rates of <3000 L/min, representing a Level 1 TARP trigger under the WMP.

6. RECOMMENDATIONS

1. There are no recommendations for this reporting period.

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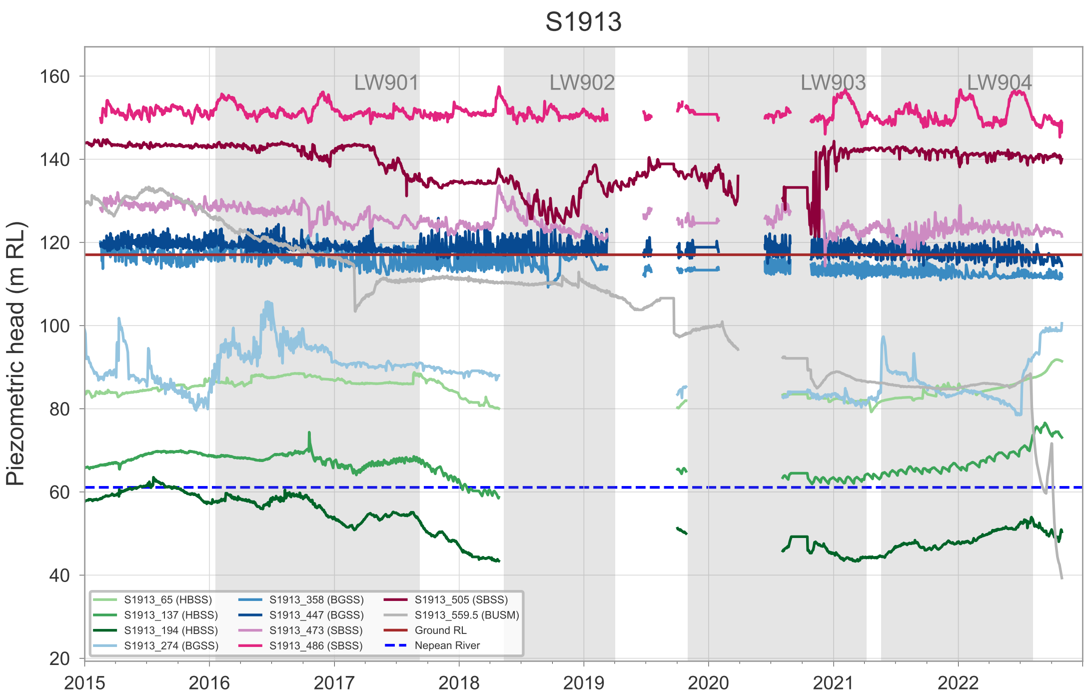
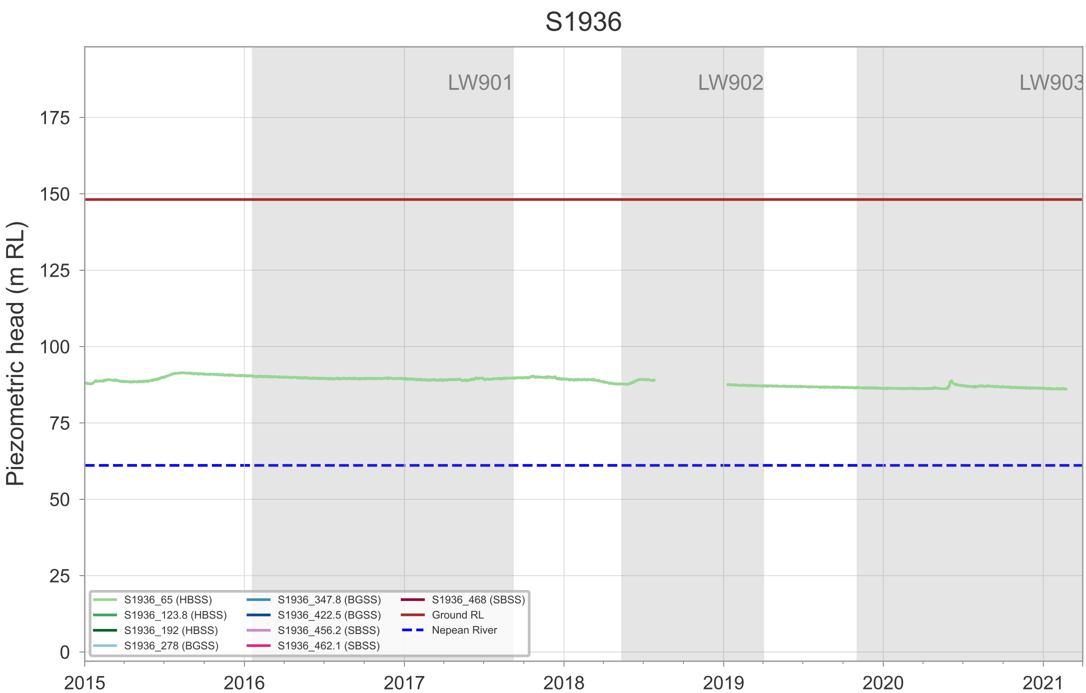
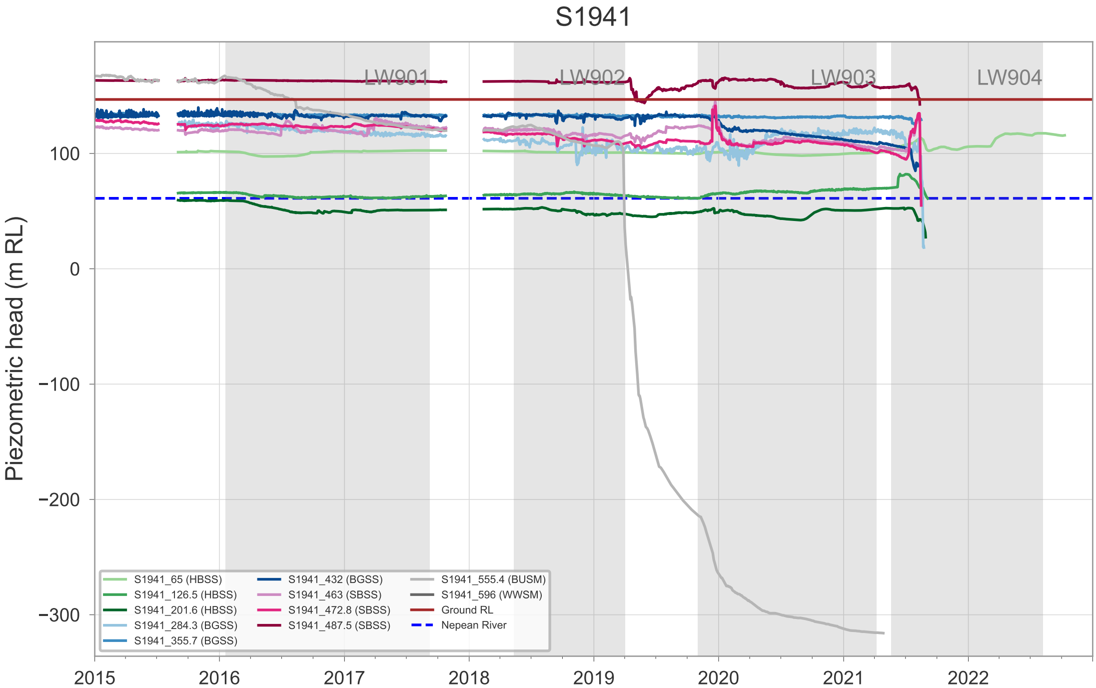
APPENDIX 1 – Groundwater bore hydrographs

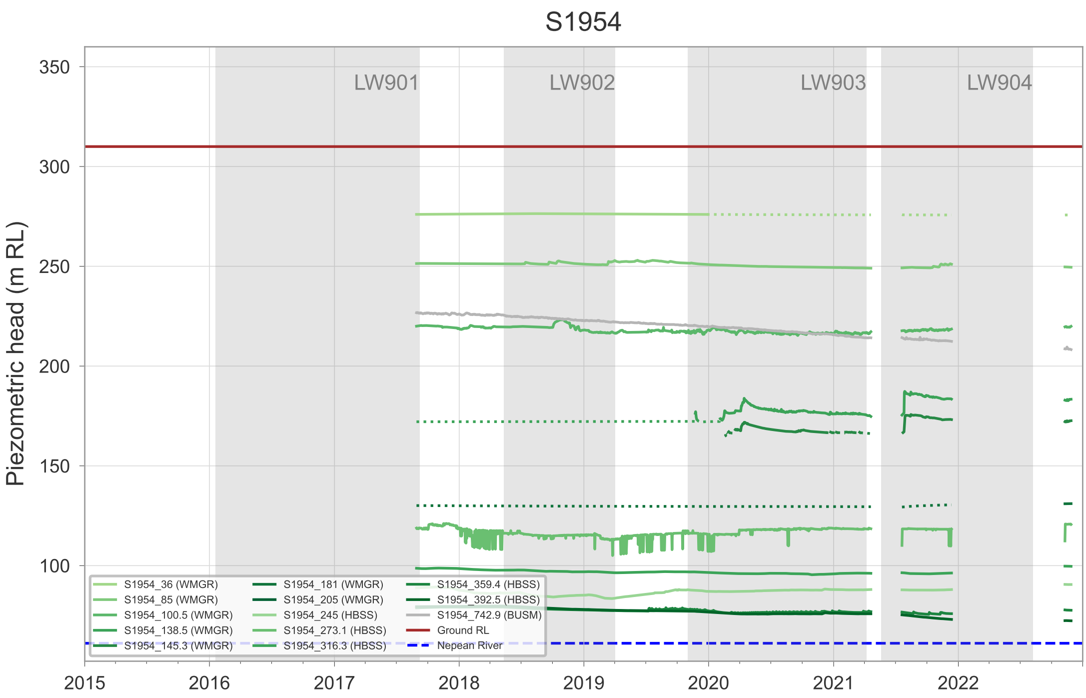


S1913
LW901
LW902
LW903
LW904
Piezometric head (m RL)
160
140
120
100
80
60
40
20
2015
2016
2017
2018
2019
2020
2021
2022
S1913_65 (HBSS)
S1913_137 (HBSS)
S1913_194 (HBSS)
S1913_274 (BGSS)
S1913_358 (BGSS)
S1913_447 (BGSS)
S1913_473 (SBSS)
S1913_486 (SBSS)
S1913_505 (SBSS)
S1913_559.5 (BUSM)
Ground RL
Nepean River

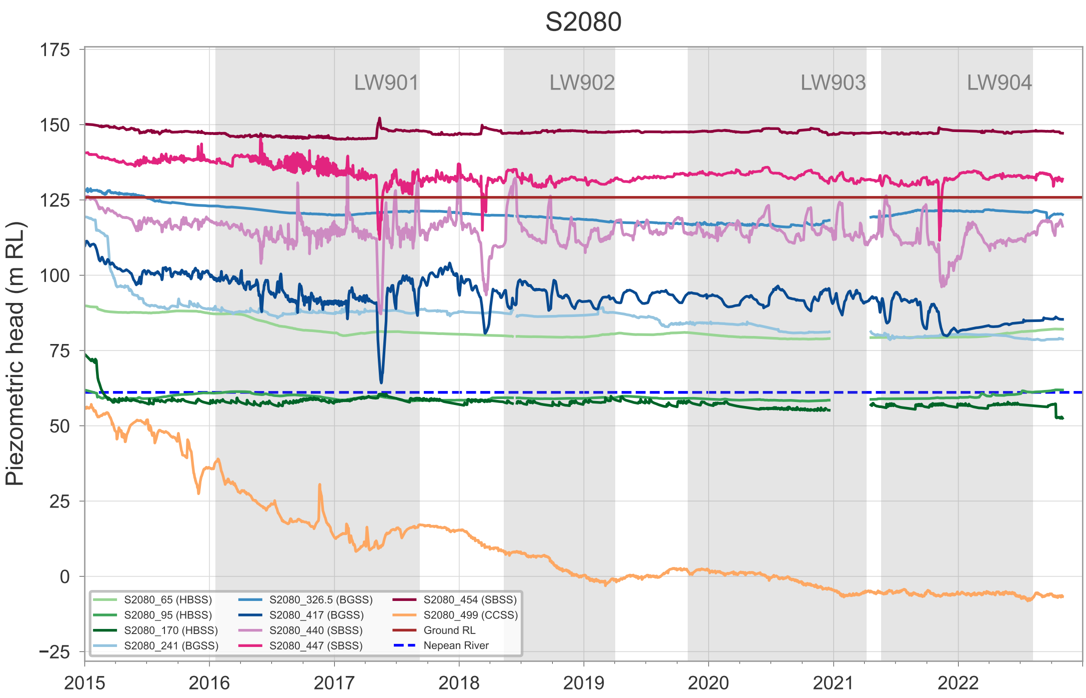


S1936
Piezometric head (m RL)
175
150
125
100
75
50
25
0
2015
2016
2017
2018
2019
2020
2021
LW901
LW902
LW903
S1936_65 (HBSS)
S1936_123.8 (HBSS)
S1936_192 (HBSS)
S1936_278 (BGSS)
S1936_347.8 (BGSS)
S1936_422.5 (BGSS)
S1936_456.2 (SBSS)
S1936_462.1 (SBSS)
S1936_468 (SBSS)
Ground RL
Nepean River

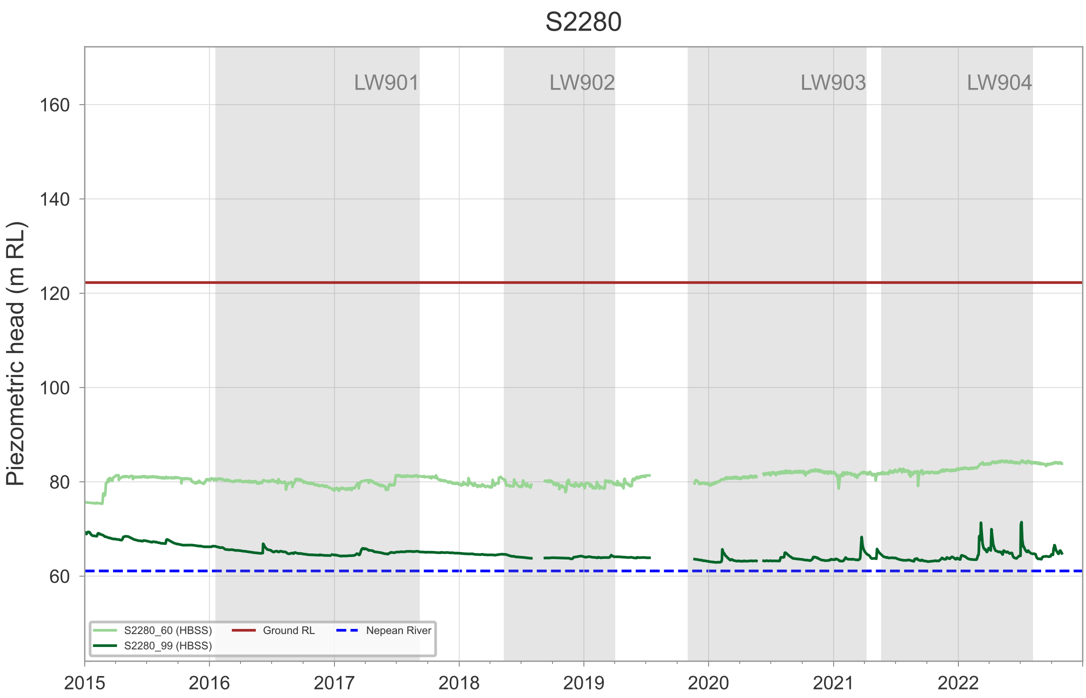

S1941
LW901
LW902
LW903
LW904
Piezometric head (m RL)
100
0
−100
−200
−300
2015
2016
2017
2018
2019
2020
2021
2022
S1941_65 (HBSS)
S1941_126.5 (HBSS)
S1941_201.6 (HBSS)
S1941_284.3 (BGSS)
S1941_355.7 (BGSS)
S1941_432 (BGSS)
S1941_463 (SBSS)
S1941_472.8 (SBSS)
S1941_487.5 (SBSS)
S1941_555.4 (BUSM)
S1941_596 (WWSM)
Ground RL
Nepean River



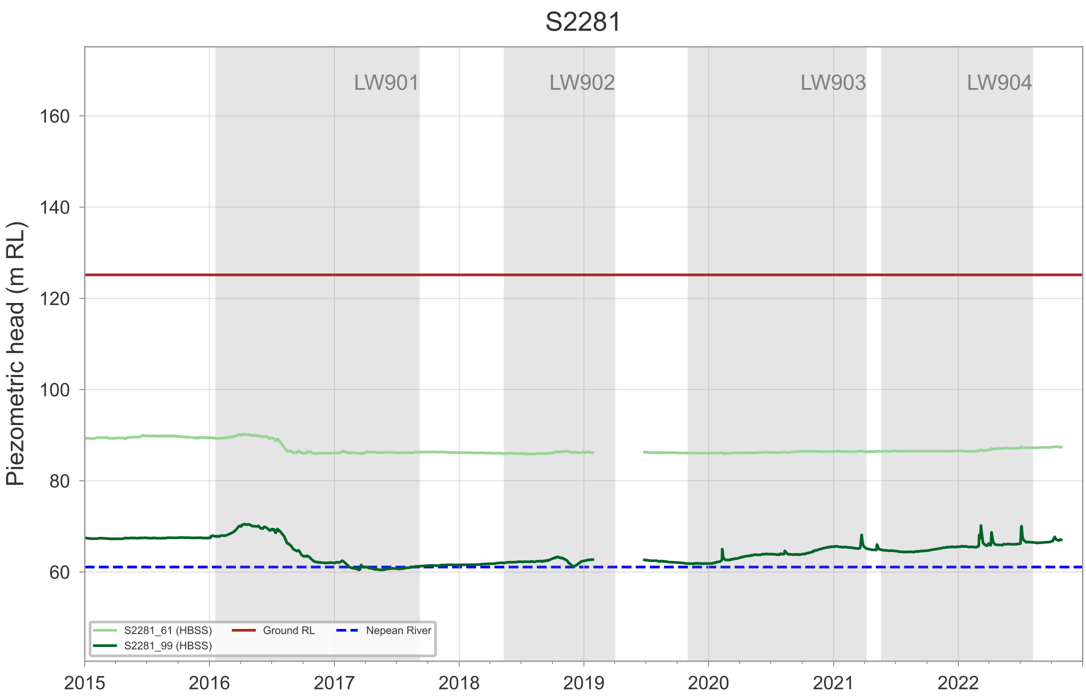
S1954
LW901
LW902
LW903
LW904
Piezometric head (m RL)
350
300
250
200
150
100
2015
2016
2017
2018
2019
2020
2021
2022
S1954_36 (WMGR)
S1954_85 (WMGR)
S1954_100.5 (WMGR)
S1954_138.5 (WMGR)
S1954_145.3 (WMGR)
S1954_181 (WMGR)
S1954_205 (WMGR)
S1954_245 (HBSS)
S1954_273.1 (HBSS)
S1954_316.3 (HBSS)
S1954_359.4 (HBSS)
S1954_392.5 (HBSS)
S1954_742.9 (BUSM)
Ground RL
Nepean River



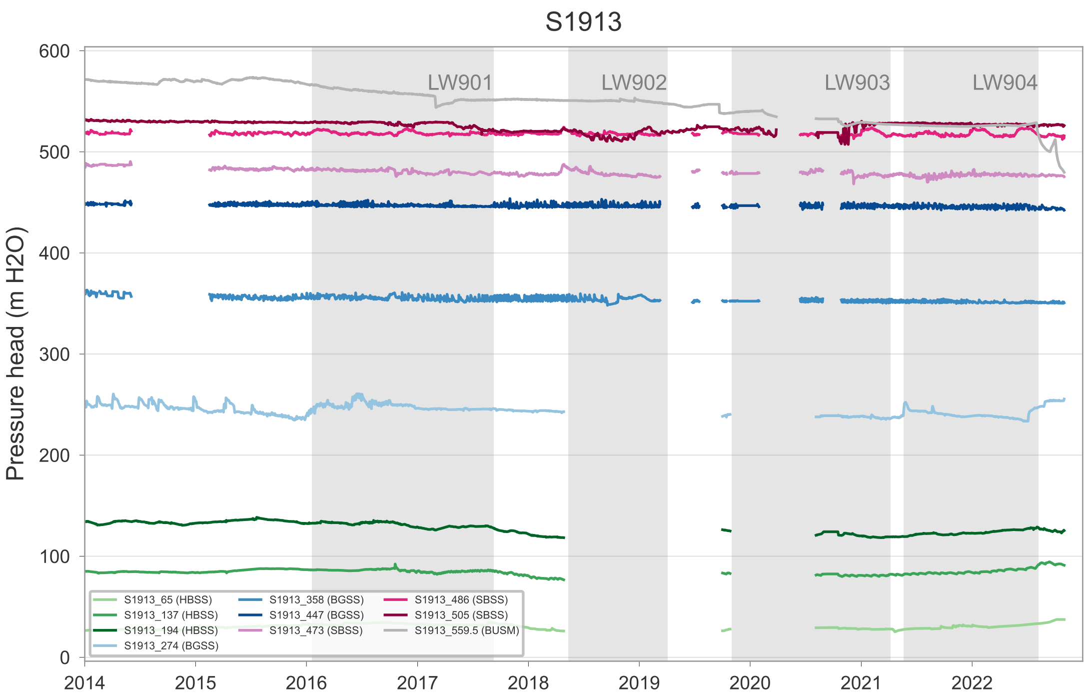
S2080
Piezometric head (m RL)
175
150
125
100
75
50
25
0
−25
2015
2016
2017
2018
2019
2020
2021
2022
LW901
LW902
LW903
LW904
S2080_65 (HBSS)
S2080_95 (HBSS)
S2080_170 (HBSS)
S2080_241 (BGSS)
S2080_326.5 (BGSS)
S2080_417 (BGSS)
S2080_440 (SBSS)
S2080_447 (SBSS)
S2080_454 (SBSS)
S2080_499 (CCSS)
Ground RL
Nepean River



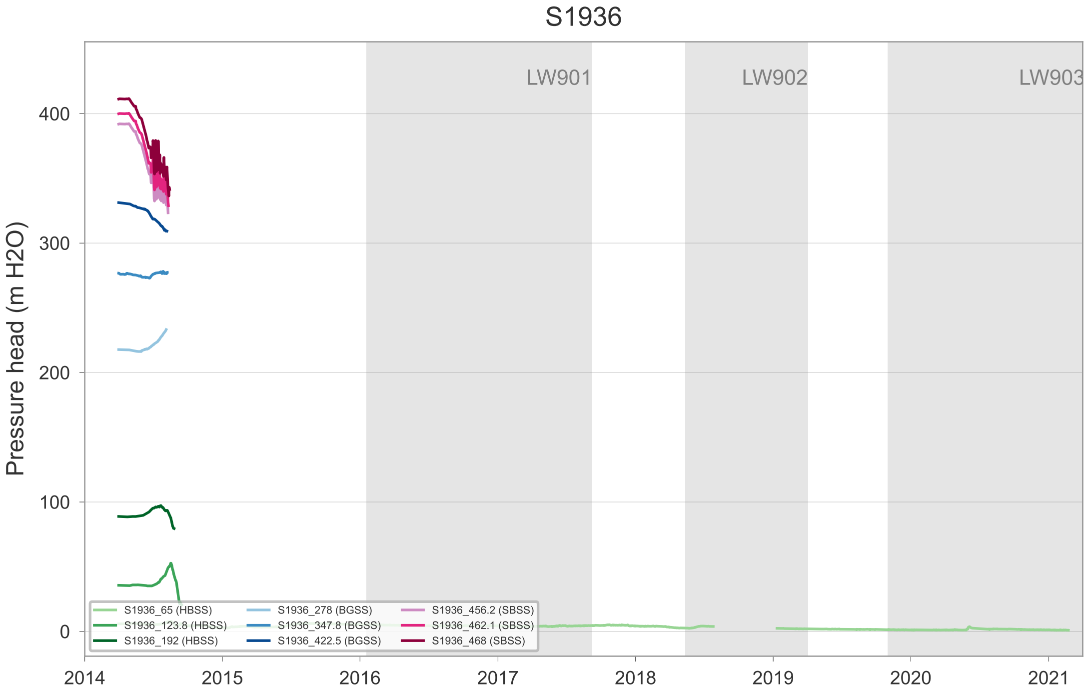
S2280
LW901
LW902
LW903
LW904
Piezometric head (m RL)
160
140
120
100
80
60
2015
2016
2017
2018
2019
2020
2021
2022
S2280_60 (HBSS)
S2280_99 (HBSS)
Ground RL
Nepean River

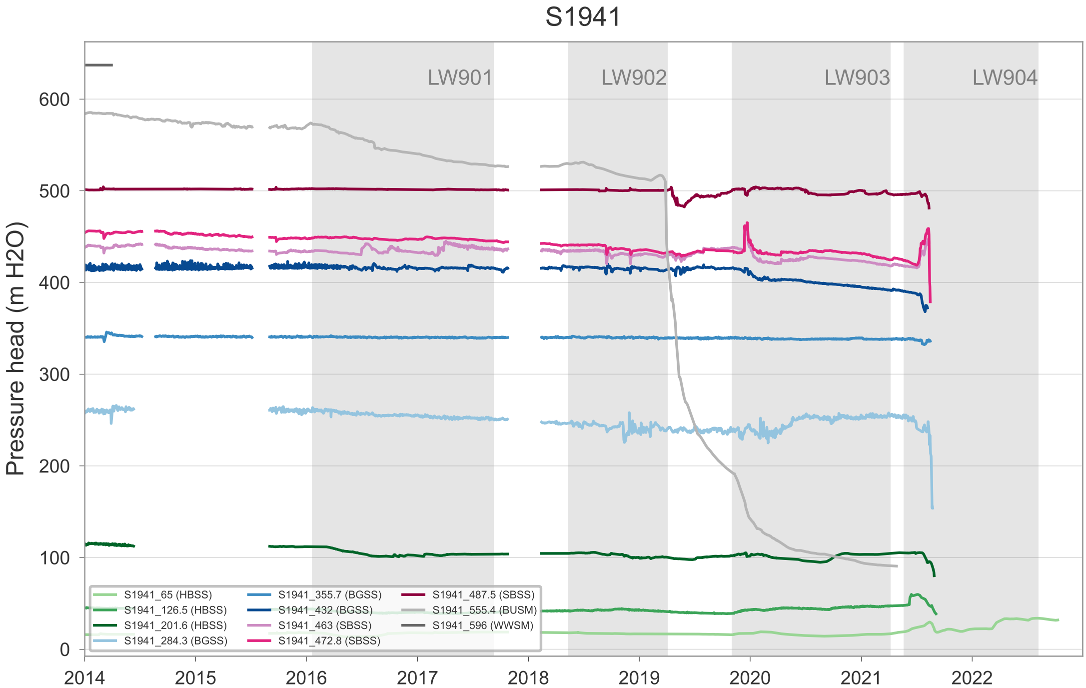


S2281
LW901
LW902
LW903
LW904
160
140
120
100
80
60
Piezometric head (m RL)
S2281_61 (HBSS)
S2281_99 (HBSS)
Ground RL
Nepean River
2015
2016
2017
2018
2019
2020
2021
2022

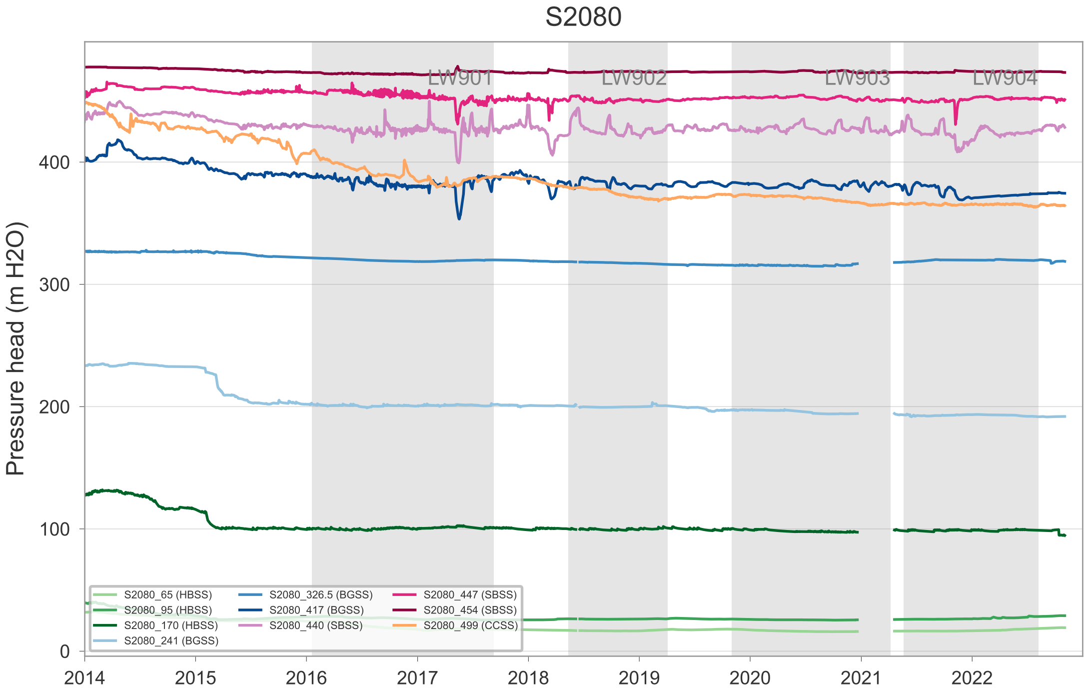


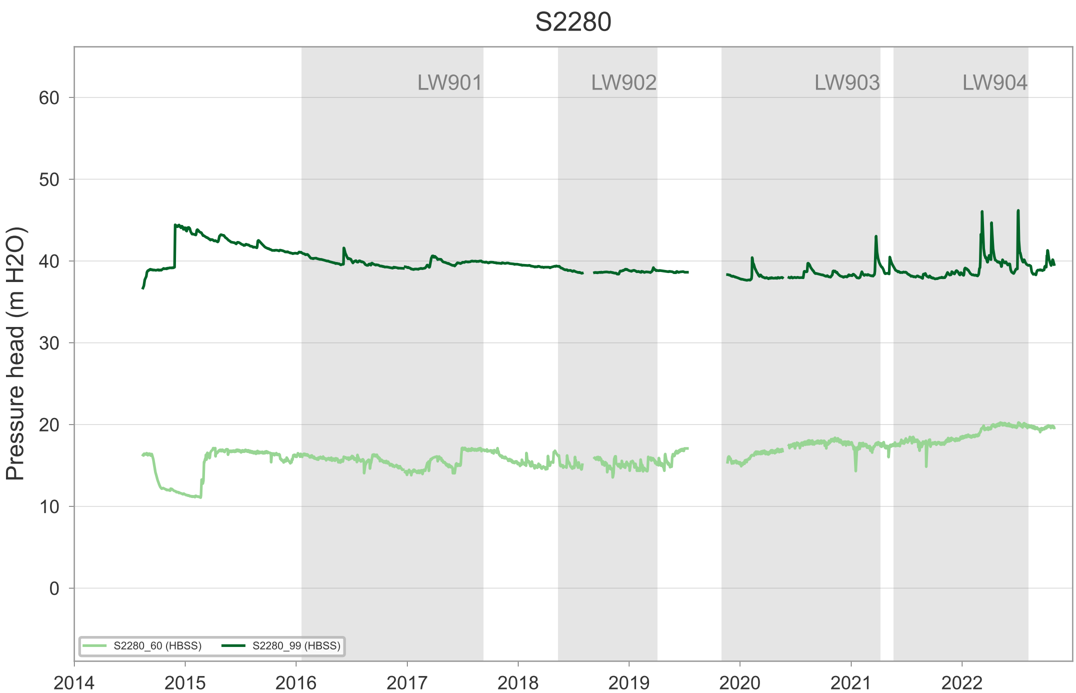
S1913
Pressure head (m H2O)
600
500
400
300
200
100
0
2014
2015
2016
2017
2018
2019
2020
2021
2022
LW901
LW902
LW903
LW904
S1913_65 (HBSS)
S1913_137 (HBSS)
S1913_194 (HBSS)
S1913_274 (BGSS)
S1913_358 (BGSS)
S1913_447 (BGSS)
S1913_473 (SBSS)
S1913_486 (SBSS)
S1913_505 (SBSS)
S1913_559.5 (BUSM)


S1936
LW901
LW902
LW903
Pressure head (m H2O)
400
300
200
100
0
2014
2015
2016
2017
2018
2019
2020
2021
S1936_65 (HBSS)
S1936_123.8 (HBSS)
S1936_192 (HBSS)
S1936_278 (BGSS)
S1936_347.8 (BGSS)
S1936_422.5 (BGSS)
S1936_456.2 (SBSS)
S1936_462.1 (SBSS)
S1936_468 (SBSS)

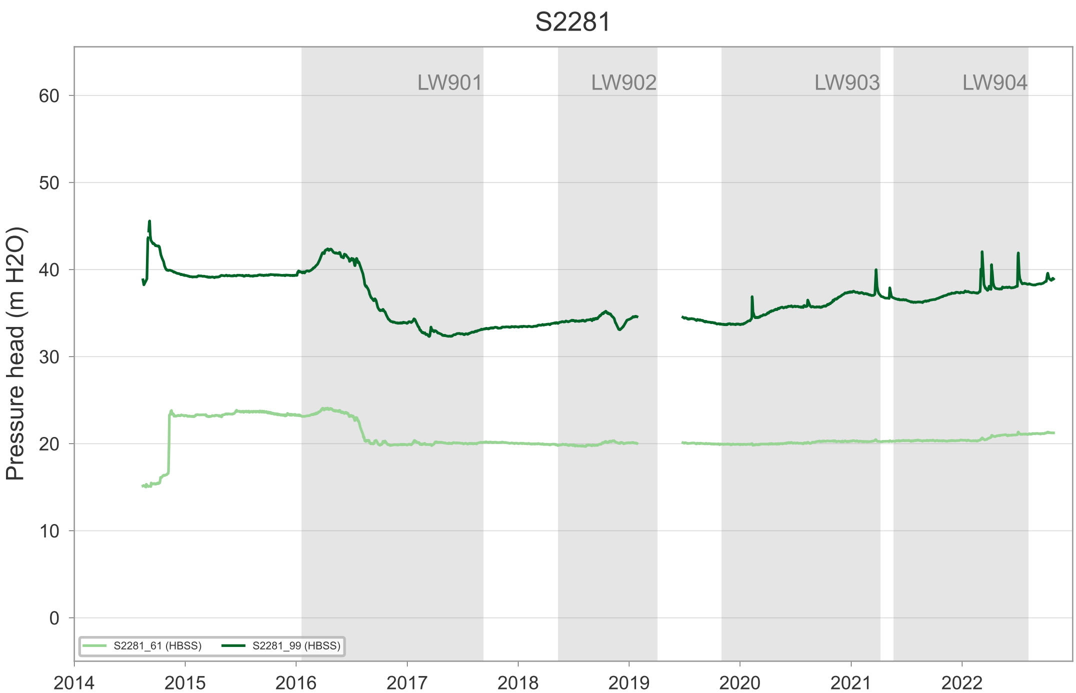


S1941
Pressure head (m H2O)
600
500
400
300
200
100
0
2014
2015
2016
2017
2018
2019
2020
2021
2022
LW901
LW902
LW903
LW904
S1941_65 (HBSS)
S1941_126.5 (HBSS)
S1941_201.6 (HBSS)
S1941_284.3 (BGSS)
S1941_355.7 (BGSS)
S1941_432 (BGSS)
S1941_463 (SBSS)
S1941_472.8 (SBSS)
S1941_487.5 (SBSS)
S1941_555.4 (BUSM)
S1941_596 (WWSM)


S2080
Pressure head (m H2O)
LW901
LW902
LW903
LW904
0
100
200
300
400
2014
2015
2016
2017
2018
2019
2020
2021
2022
S2080_65 (HBSS)
S2080_95 (HBSS)
S2080_170 (HBSS)
S2080_241 (BGSS)
S2080_326.5 (BGSS)
S2080_417 (BGSS)
S2080_440 (SBSS)
S2080_447 (SBSS)
S2080_454 (SBSS)
S2080_499 (CCSS)

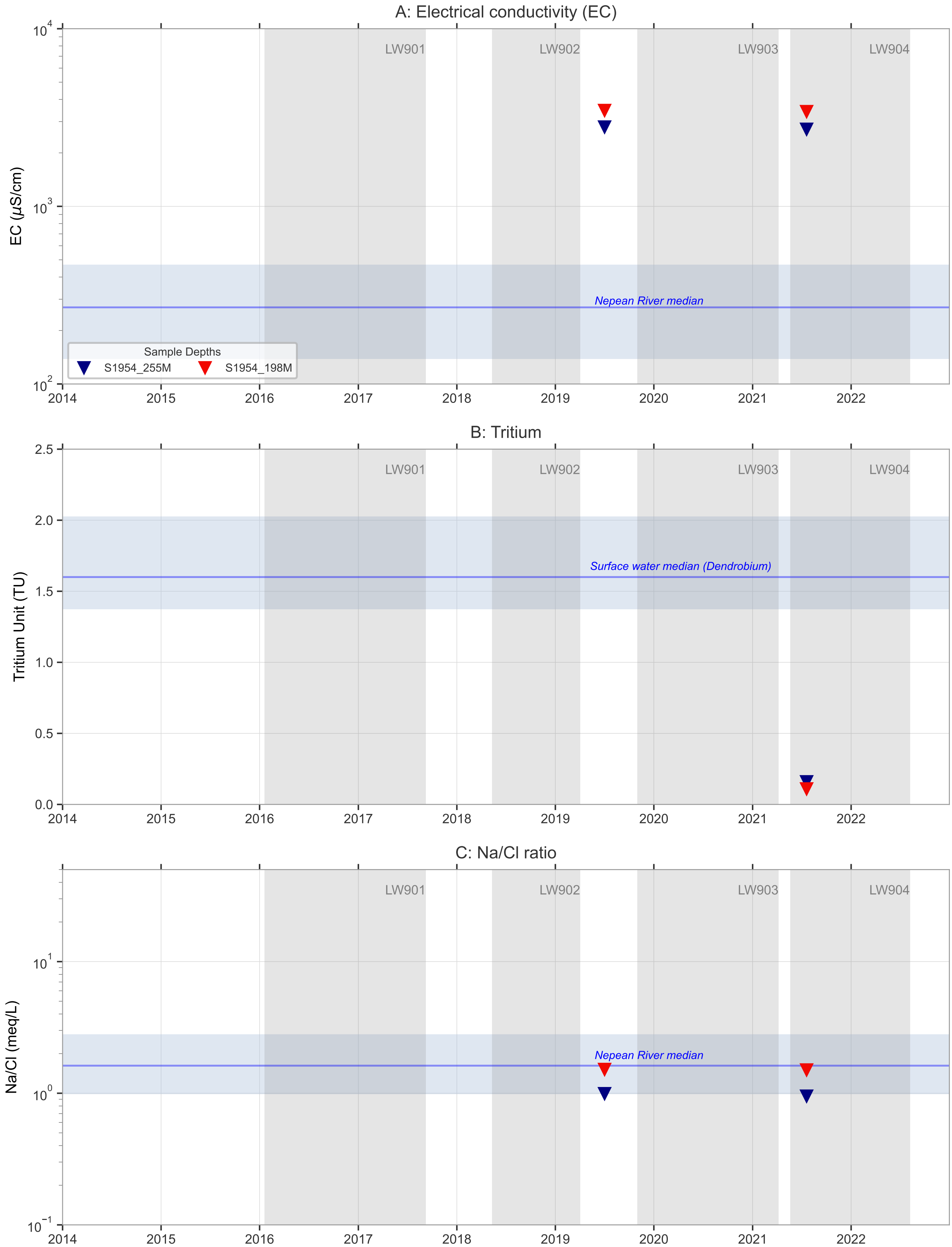


S2280
LW901
LW902
LW903
LW904
Pressure head (m H2O)
60
50
40
30
20
10
0
2014
2015
2016
2017
2018
2019
2020
2021
2022
S2280_60 (HBSS)
S2280_99 (HBSS)

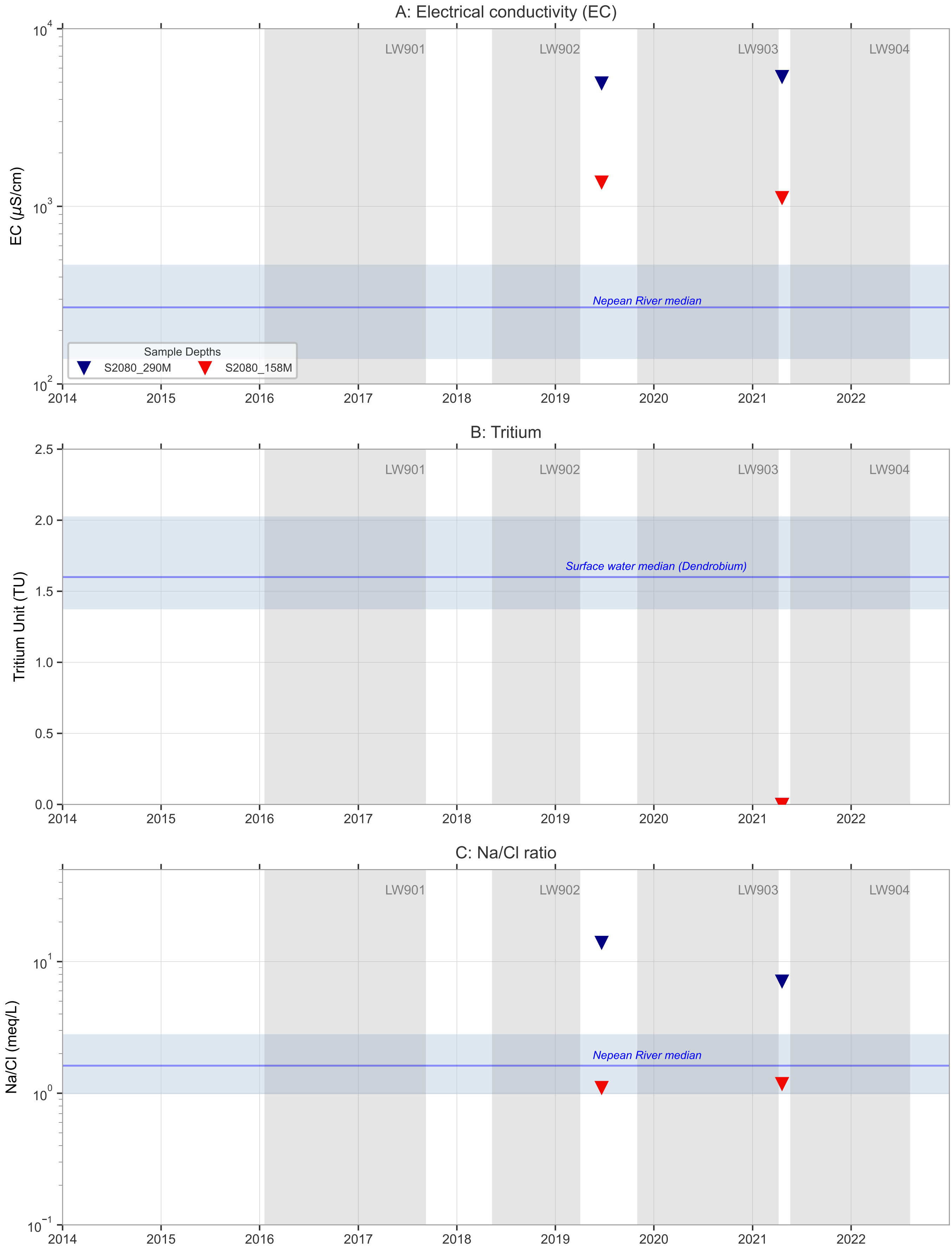

S2281
LW901
LW902
LW903
LW904
Pressure head (m H2O)
60
50
40
30
20
10
0
2014
2015
2016
2017
2018
2019
2020
2021
2022
S2281_61 (HBSS)
S2281_99 (HBSS)

APPENDIX 2 – Groundwater chemistry time-series plots

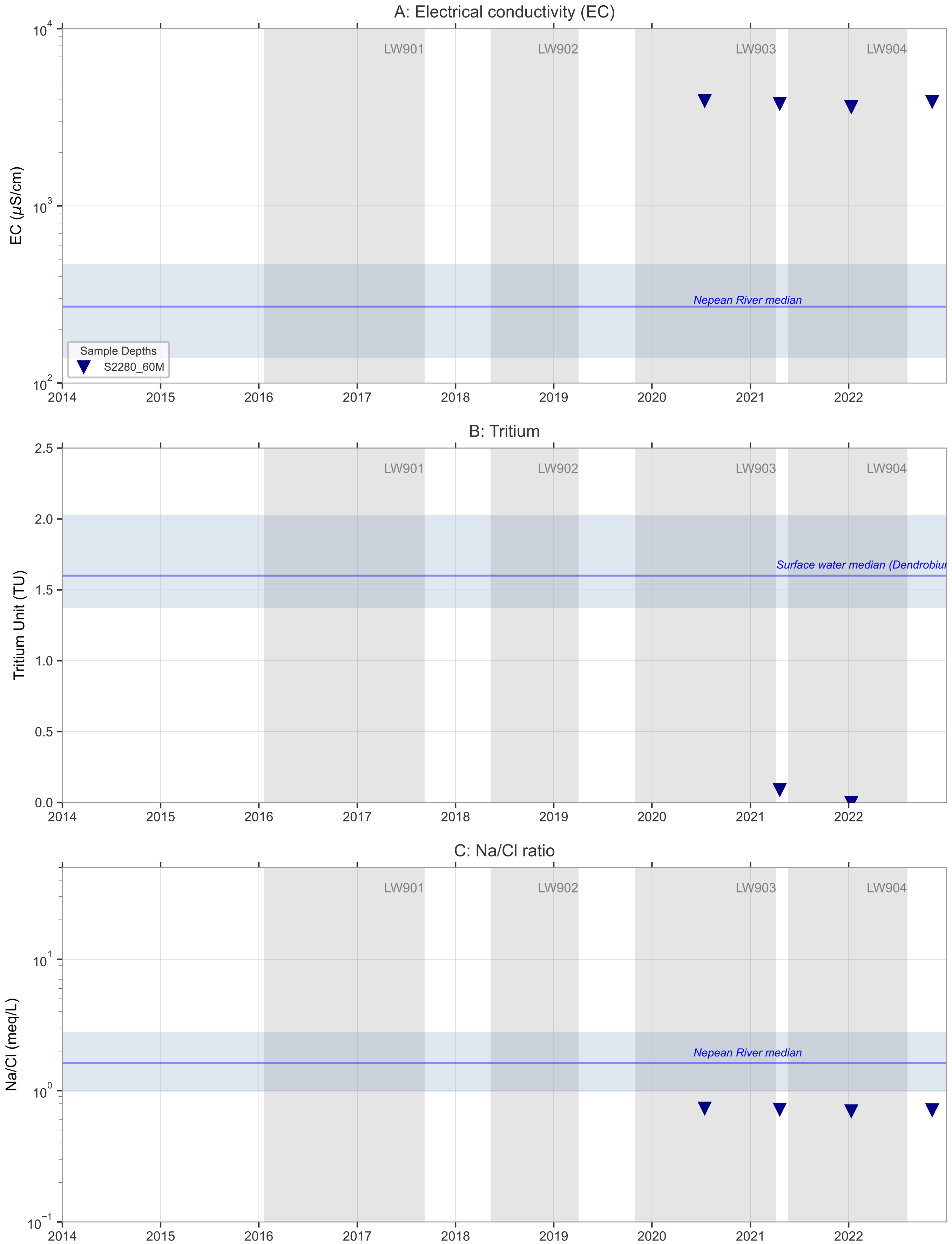
Groundwater chemistry: Appin Bore S1954



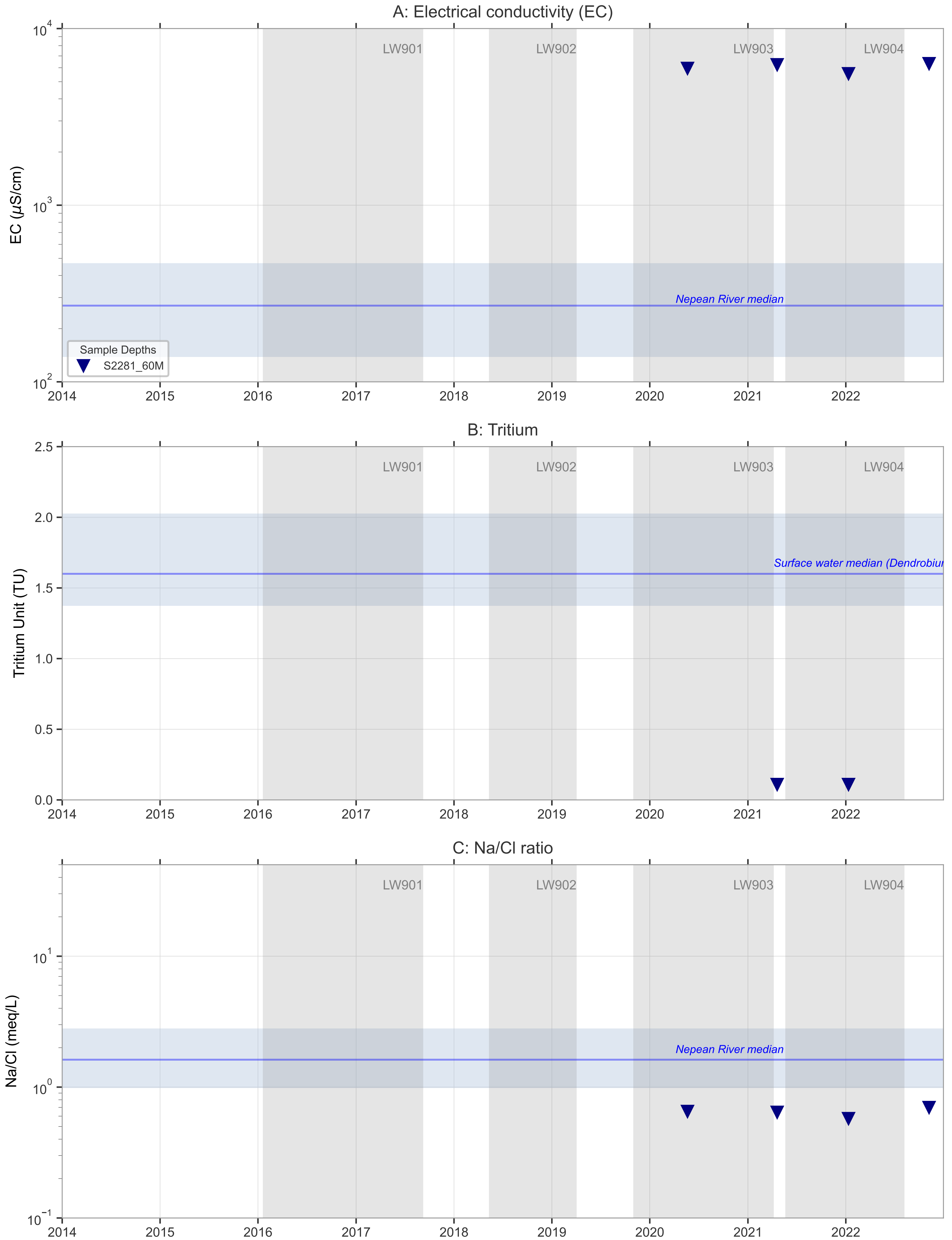
Groundwater chemistry: Appin Bore S2080



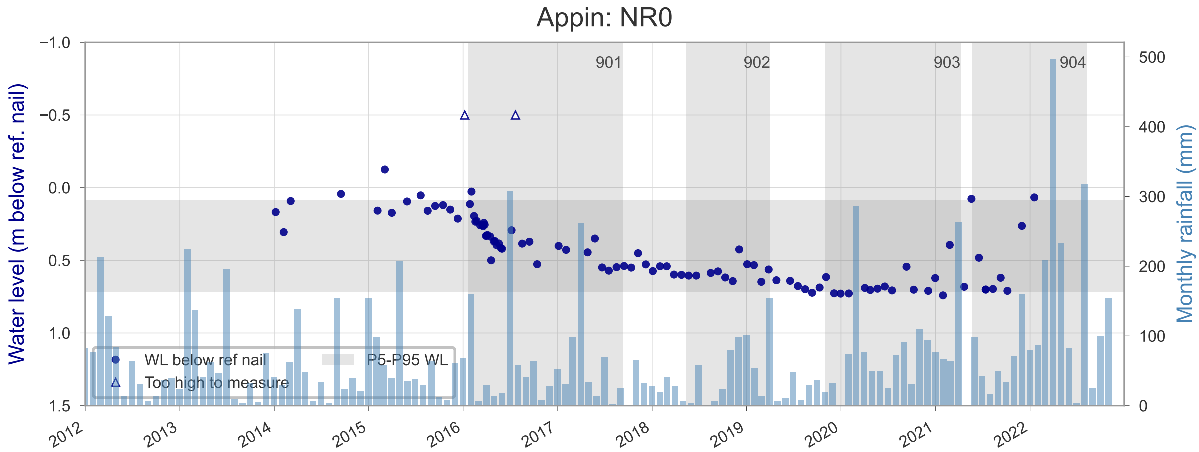
Groundwater chemistry: Appin Bore S2280



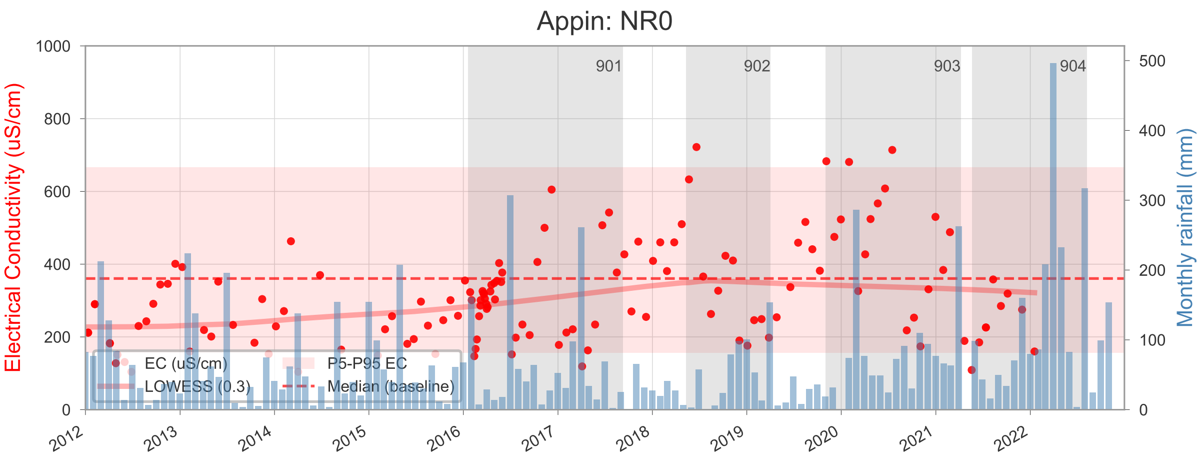
Groundwater chemistry: Appin Bore S2281



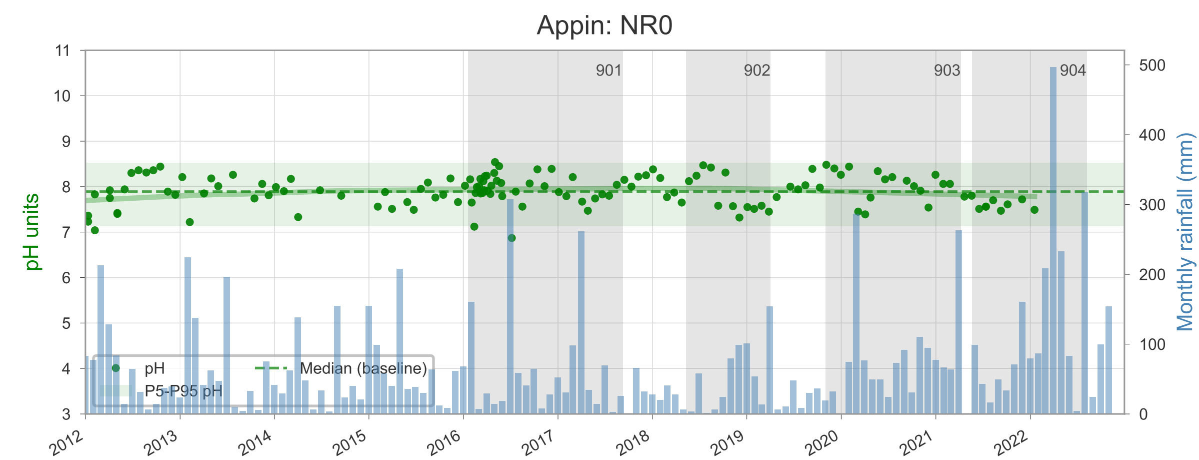
APPENDIX 3 – Surface water chemistry time-series plots



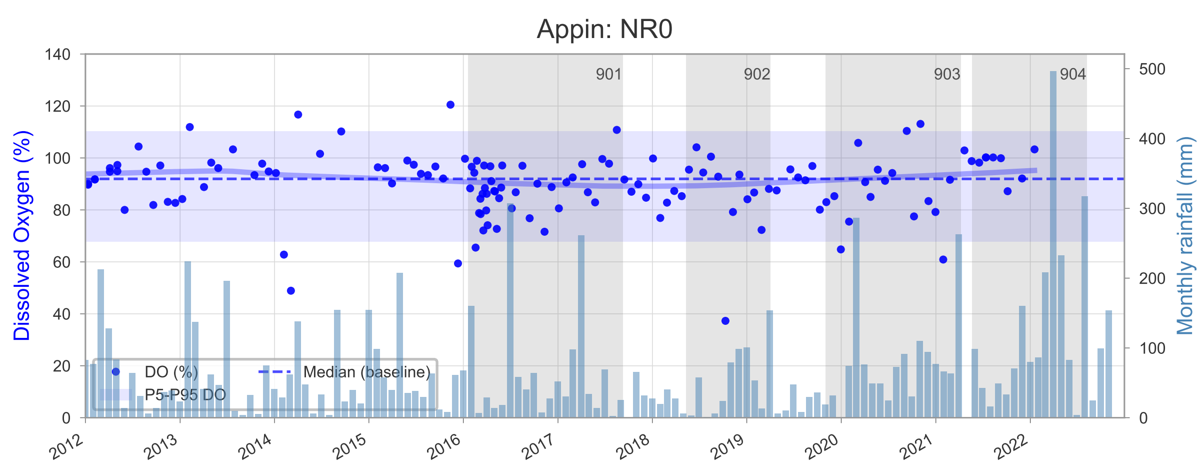
Appin: NR0
901
902
903
904
Water level (m below ref. nail)
Monthly rainfall (mm)
WL below ref nail
Too high to measure
P5-P95 WL



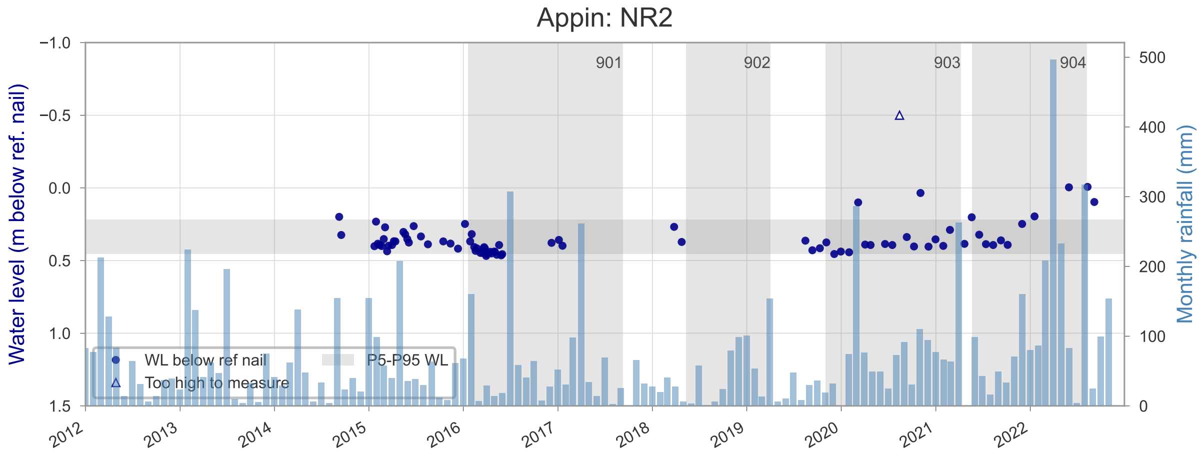
Appin: NR0
901
902
903
904
Electrical Conductivity (uS/cm)
Monthly rainfall (mm)
EC (uS/cm)
LOWESS (0.3)
P5-P95 EC
Median (baseline)

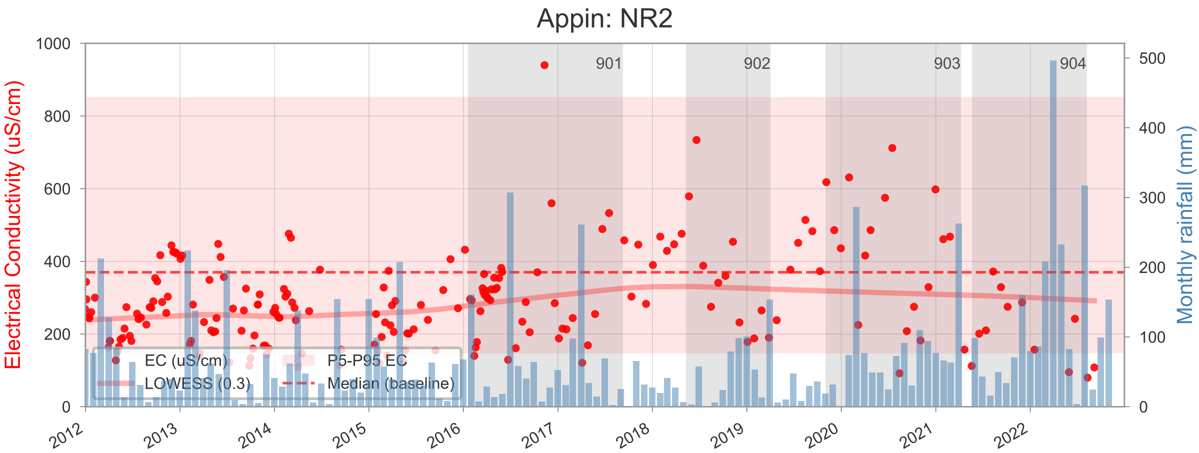


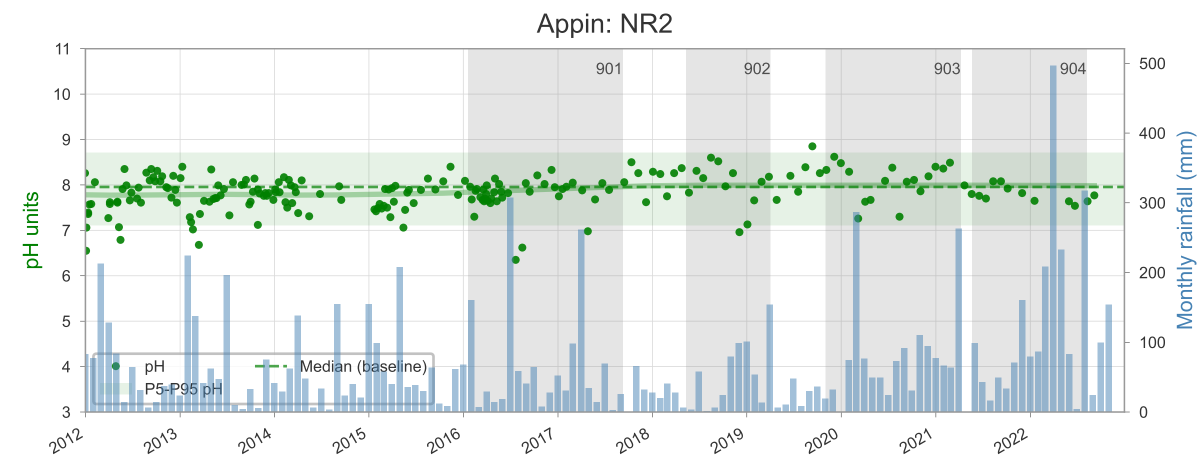
Appin: NR0
901
902
903
904
pH units
Monthly rainfall (mm)
pH
P5-P95 pH
Median (baseline)

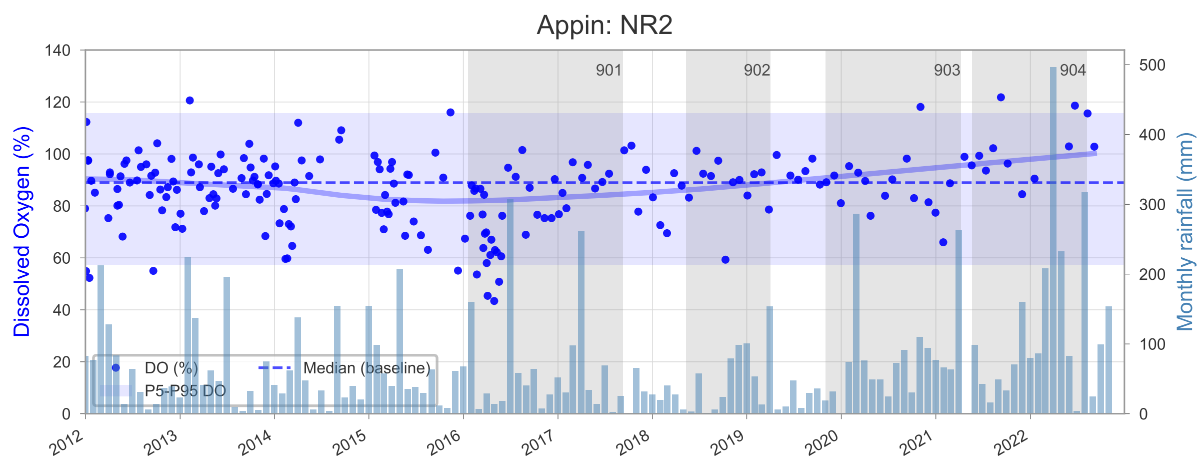


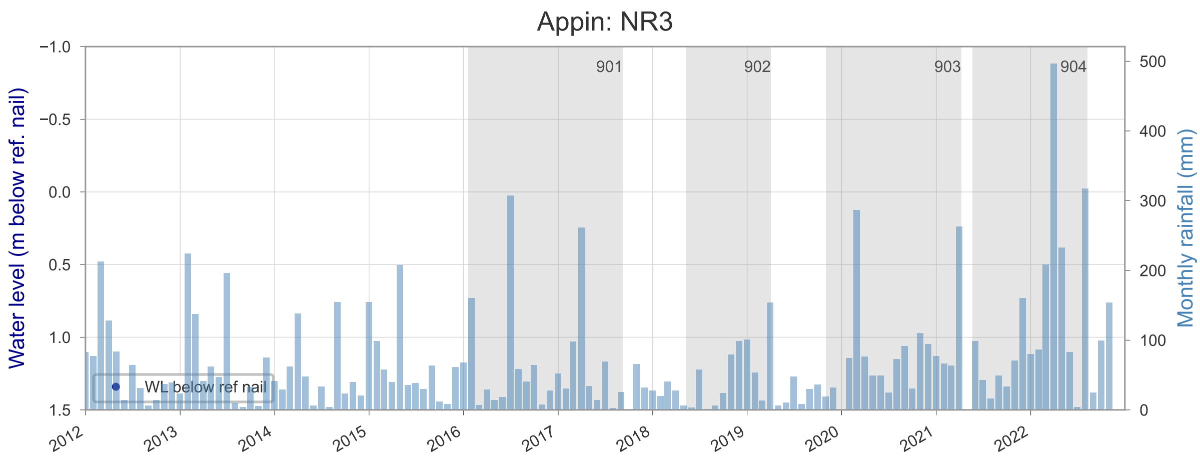
Appin: NR0
901
902
903
904
Dissolved Oxygen (%)
Monthly rainfall (mm)
DO (%)
P5-P95 DO
Median (baseline)

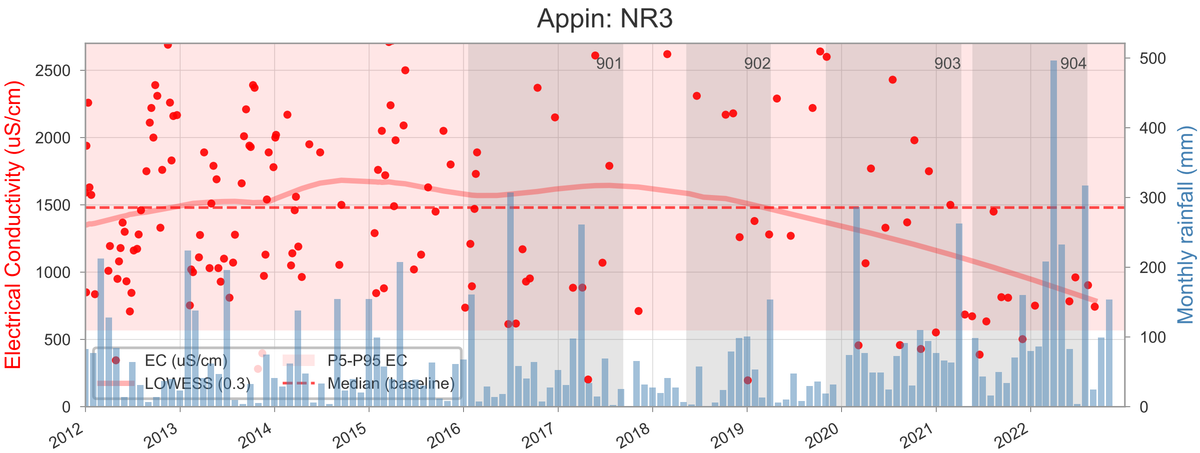

Appin: NR2
Water level (m below ref. nail)
Monthly rainfall (mm)
901
902
903
904
WL below ref nail
Too high to measure
P5-P95 WL

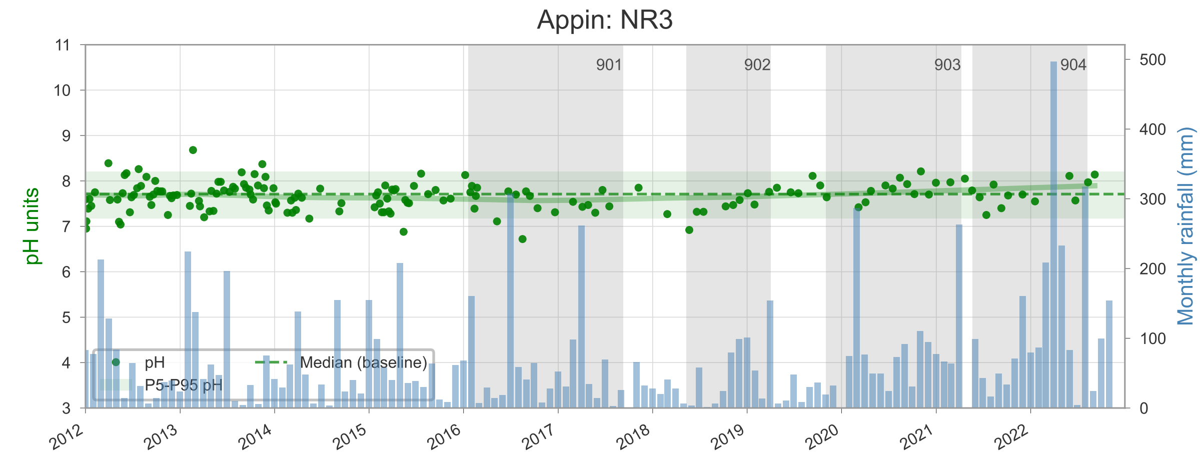

Appin: NR2
Electrical Conductivity (uS/cm)
Monthly rainfall (mm)
901
902
903
904
EC (uS/cm)
LOWESS (0.3)
P5-P95 EC
Median (baseline)

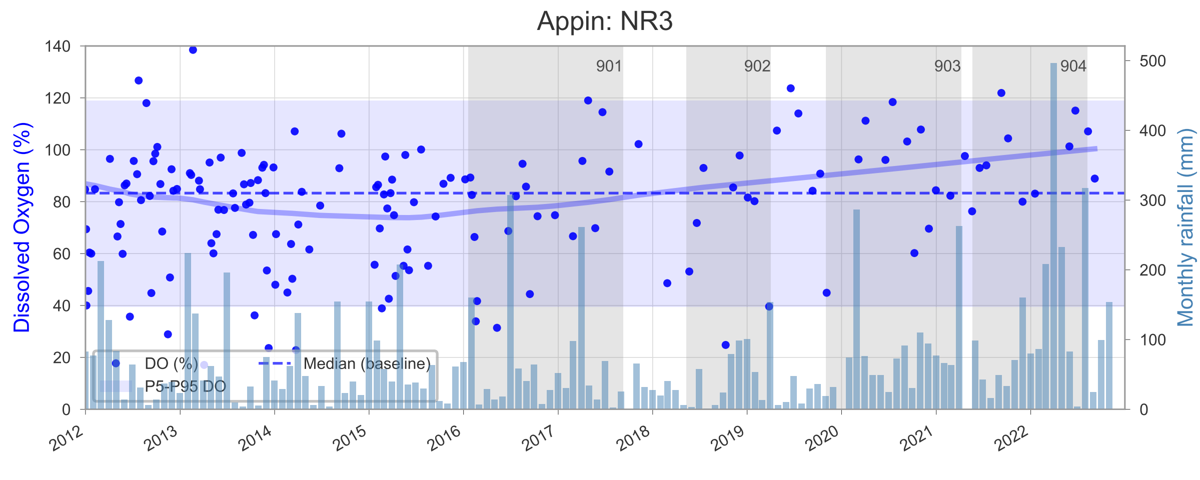

Appin: NR2
pH units
Monthly rainfall (mm)
901
902
903
904
pH
P5-P95 pH
Median (baseline)

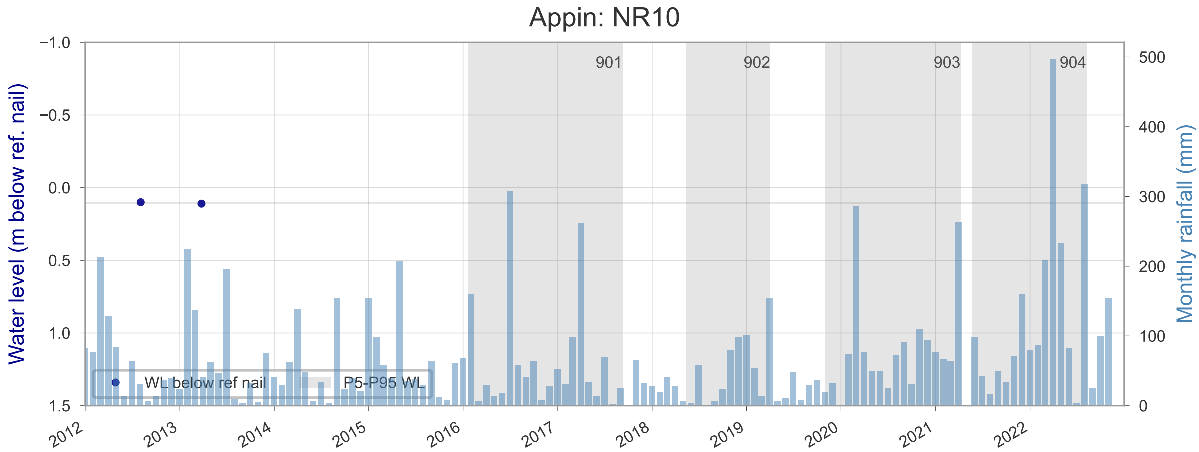

Appin: NR2
Dissolved Oxygen (%)
Monthly rainfall (mm)
901
902
903
904
DO (%)
P5-P95 DO
Median (baseline)

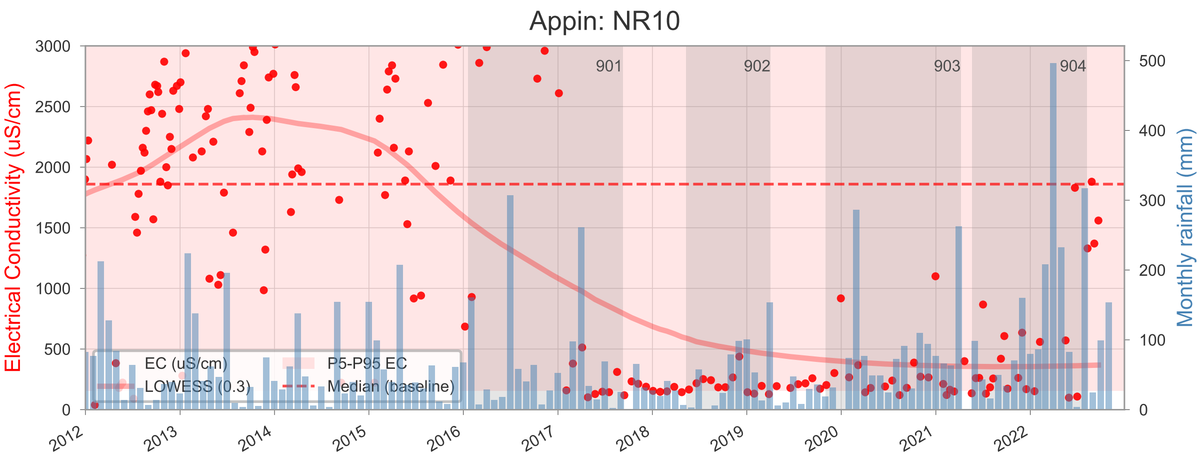

Appin: NR3
Water level (m below ref. nail)
Monthly rainfall (mm)
WL below ref nail
901
902
903
904
−1.0
−0.5
0.0
0.5
1.0
1.5
0
100
200
300
400
500
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

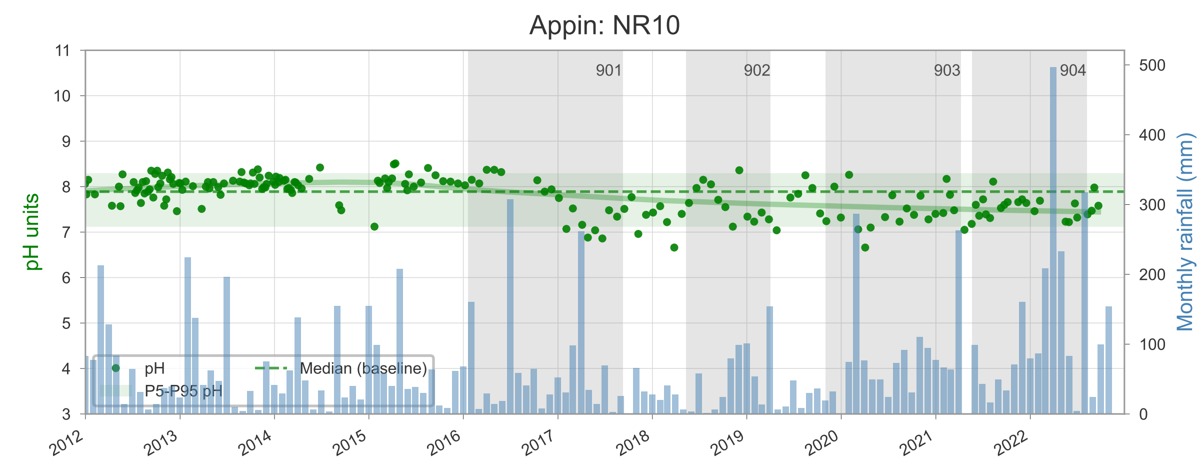

Appin: NR3
Electrical Conductivity (uS/cm)
Monthly rainfall (mm)
EC (uS/cm)
LOWESS (0.3)
P5-P95 EC
Median (baseline)
901
902
903
904
0
500
1000
1500
2000
2500
0
100
200
300
400
500
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

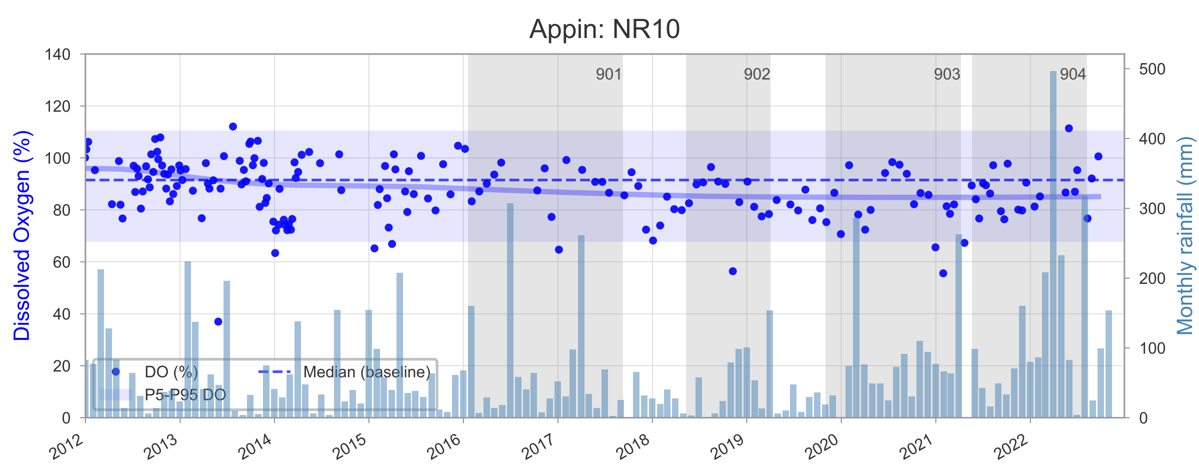

Appin: NR3
pH units
Monthly rainfall (mm)
pH
P5-P95 pH
Median (baseline)
901
902
903
904
3
4
5
6
7
8
9
10
11
0
100
200
300
400
500
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

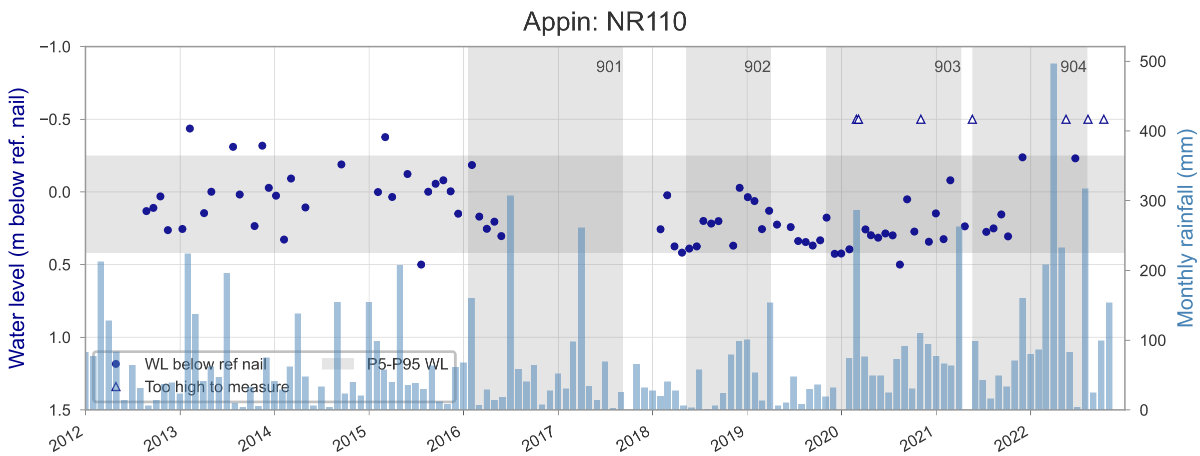

Appin: NR3
Dissolved Oxygen (%)
Monthly rainfall (mm)
DO (%)
P5-P95 DO
Median (baseline)
901
902
903
904
0
20
40
60
80
100
120
140
0
100
200
300
400
500
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

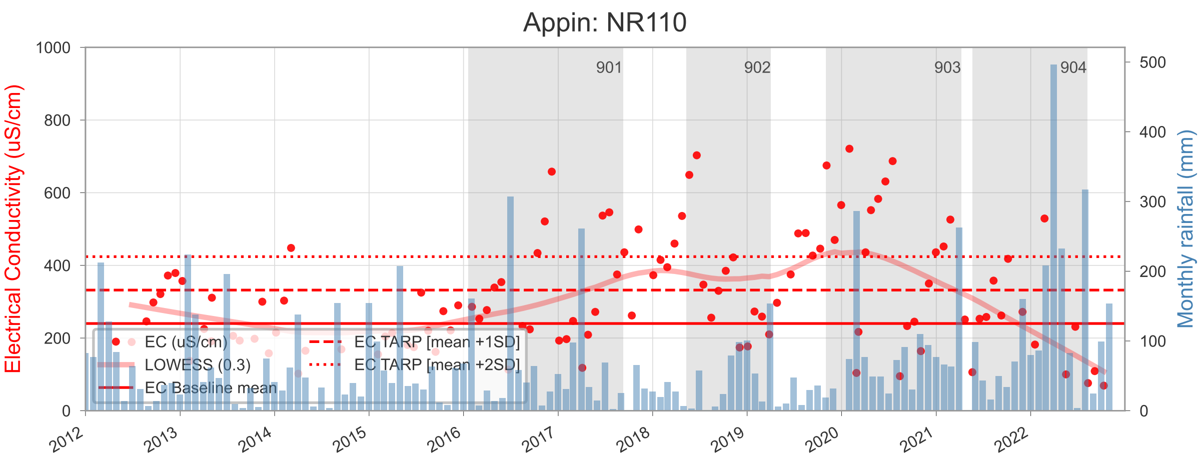

Appin: NR10
Water level (m below ref. nail)
Monthly rainfall (mm)
901
902
903
904
WL below ref nail
P5-P95 WL

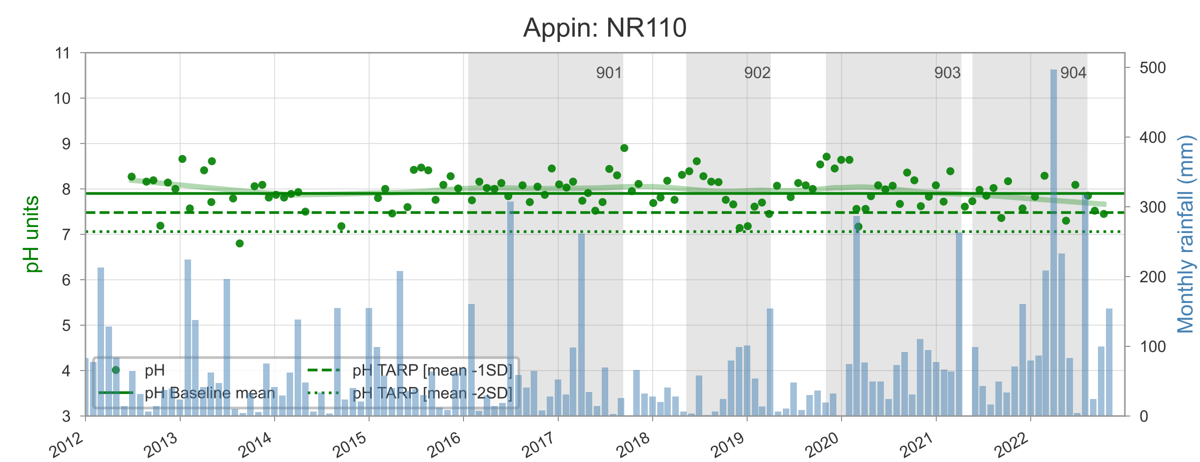

Appin: NR10
Electrical Conductivity (uS/cm)
Monthly rainfall (mm)
901
902
903
904
EC (uS/cm)
P5-P95 EC
LOWESS (0.3)
Median (baseline)

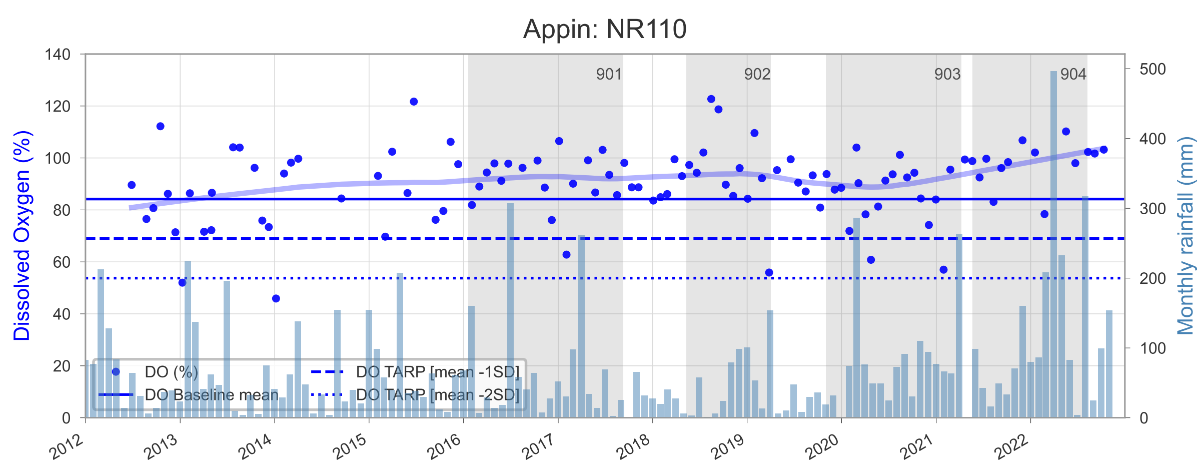

Appin: NR10
pH units
Monthly rainfall (mm)
901
902
903
904
pH
Median (baseline)
P5-P95 pH

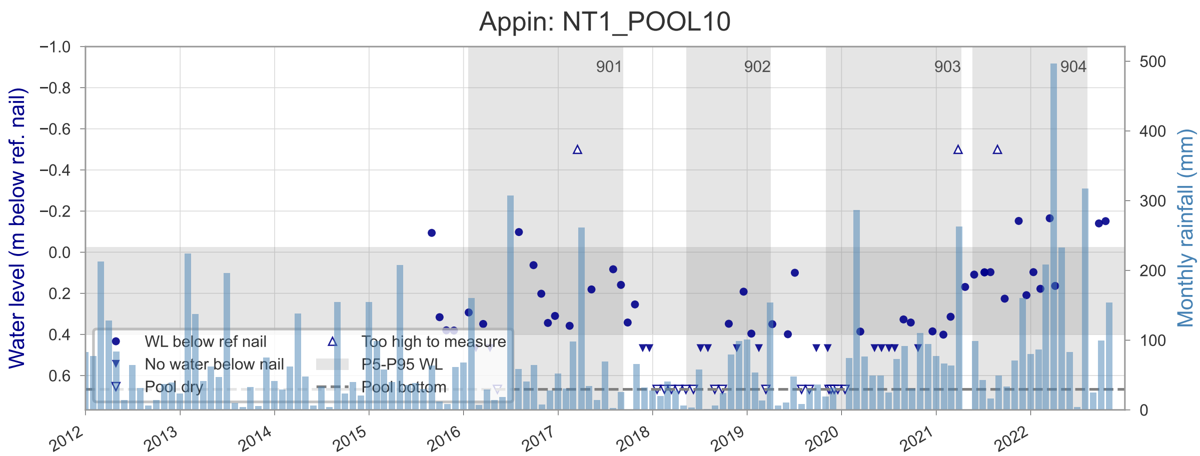

Appin: NR10
Dissolved Oxygen (%)
Monthly rainfall (mm)
901
902
903
904
DO (%)
Median (baseline)
P5-P95 DO

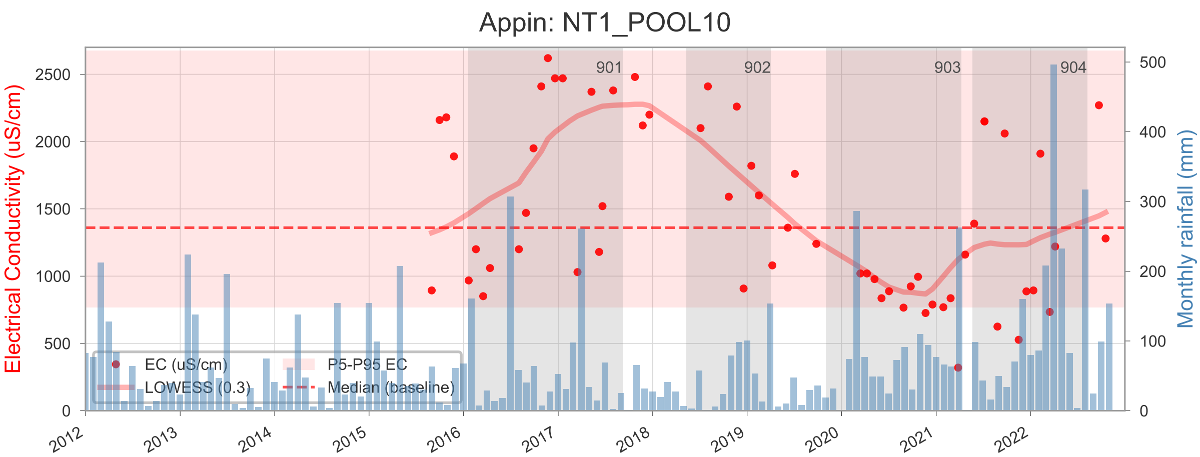

Appin: NR110
Water level (m below ref. nail)
Monthly rainfall (mm)
901
902
903
904
WL below ref nail
Too high to measure
P5-P95 WL

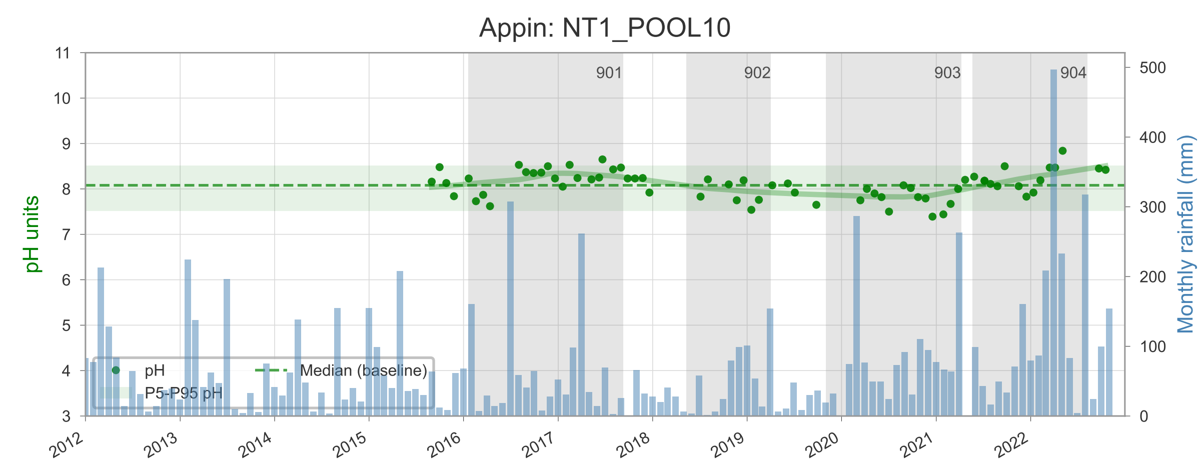

Appin: NR110
Electrical Conductivity (uS/cm)
Monthly rainfall (mm)
901
902
903
904
EC (uS/cm)
LOWESS (0.3)
EC Baseline mean
EC TARP [mean +1SD]
EC TARP [mean +2SD]

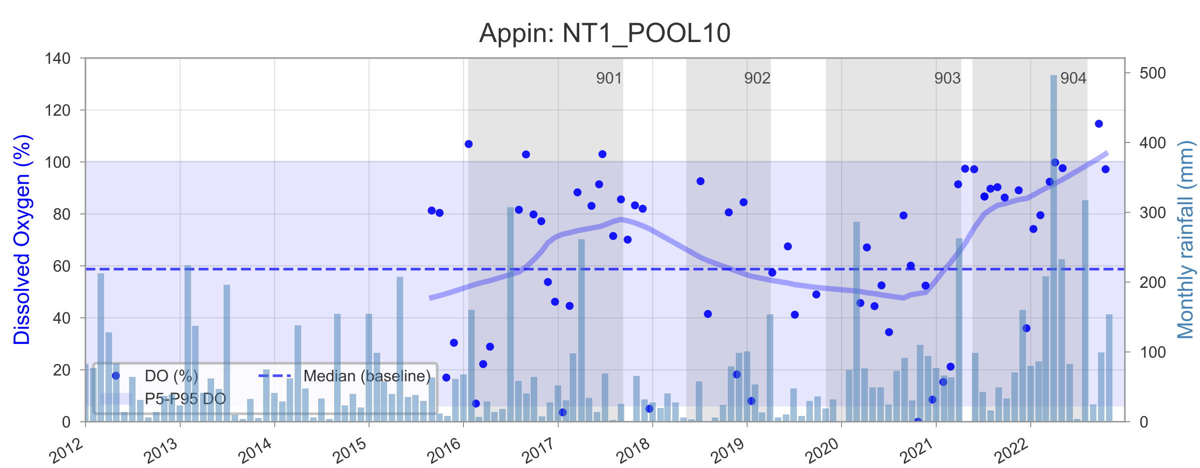

Appin: NR110
pH units
Monthly rainfall (mm)
901
902
903
904
pH
pH Baseline mean
pH TARP [mean -1SD]
pH TARP [mean -2SD]

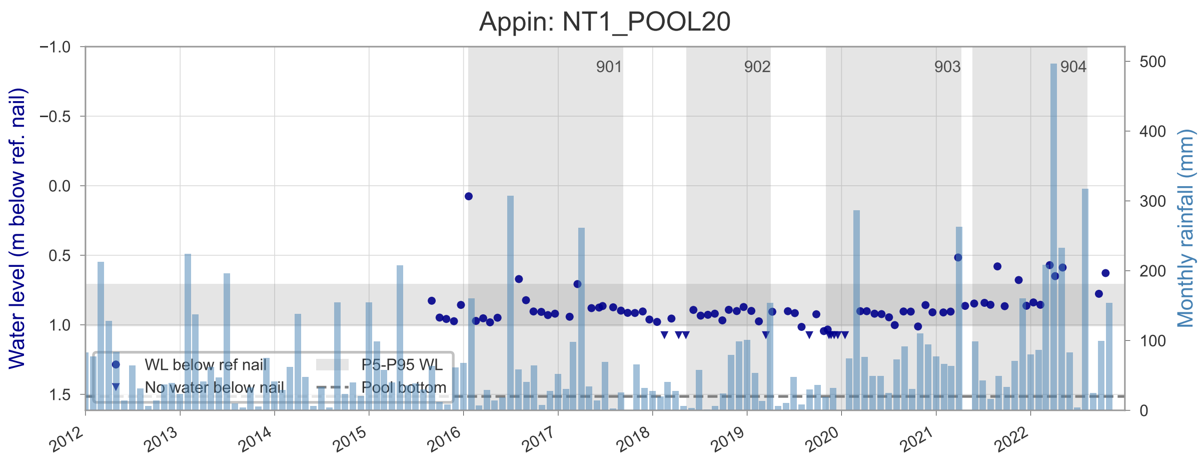

Appin: NR110
Dissolved Oxygen (%)
Monthly rainfall (mm)
901
902
903
904
DO (%)
DO Baseline mean
DO TARP [mean -1SD]
DO TARP [mean -2SD]

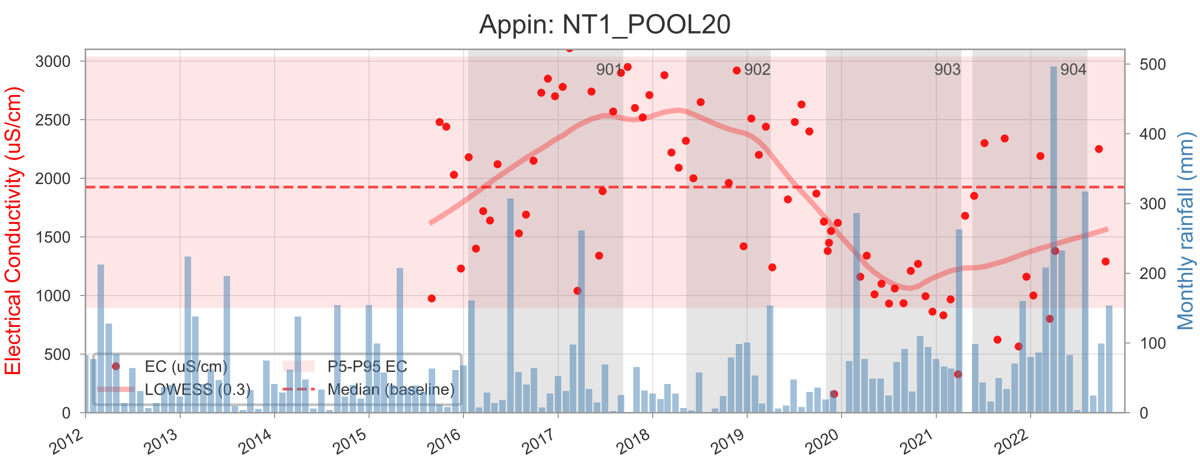

Appin: NT1_POOL10
Water level (m below ref. nail)
Monthly rainfall (mm)
901
902
903
904
WL below ref nail
No water below nail
Pool dry
Too high to measure
P5-P95 WL
Pool bottom

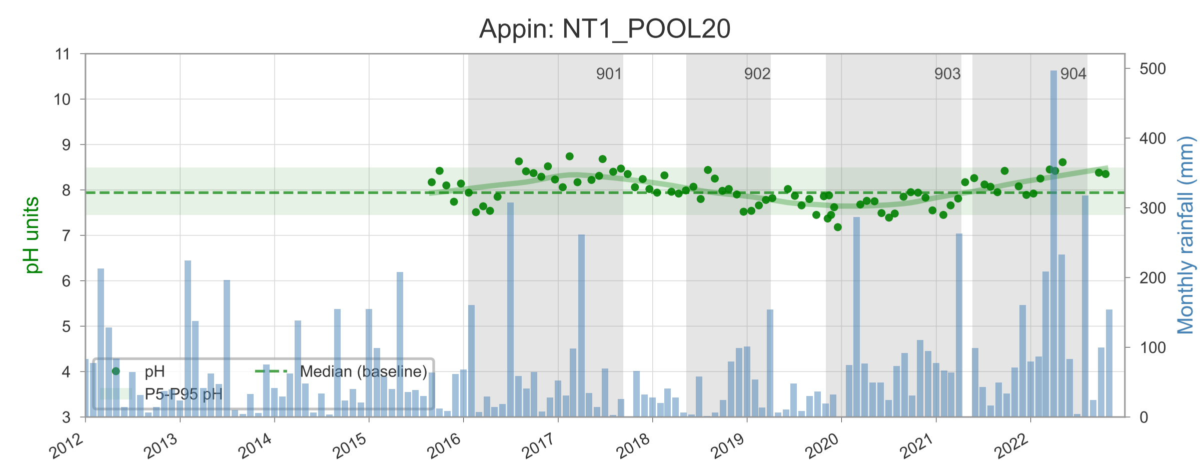

Appin: NT1_POOL10
Electrical Conductivity (uS/cm)
Monthly rainfall (mm)
901
902
903
904
EC (uS/cm)
LOWESS (0.3)
P5-P95 EC
Median (baseline)

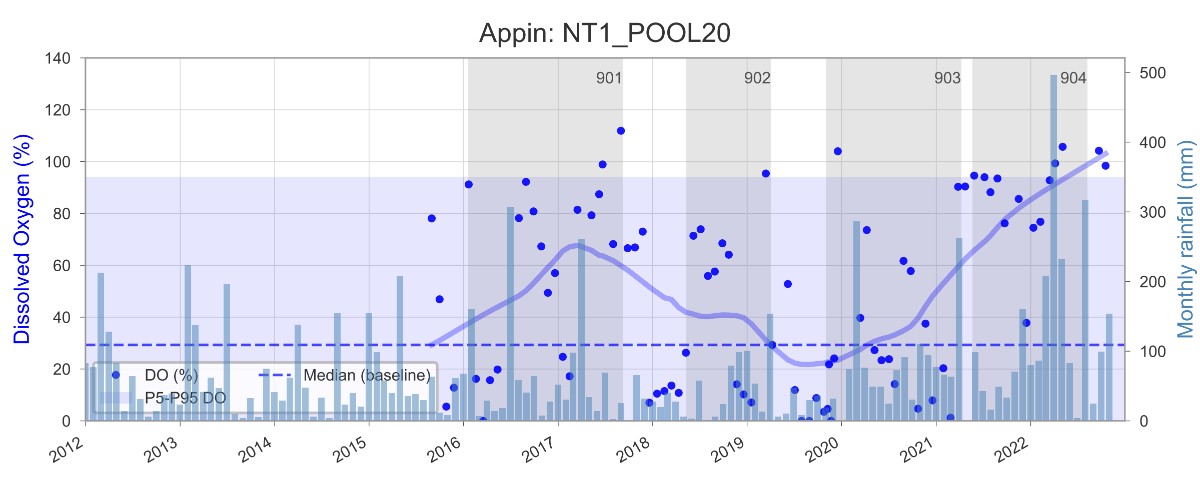

Appin: NT1_POOL10
pH units
Monthly rainfall (mm)
901
902
903
904
pH
P5-P95 pH
Median (baseline)

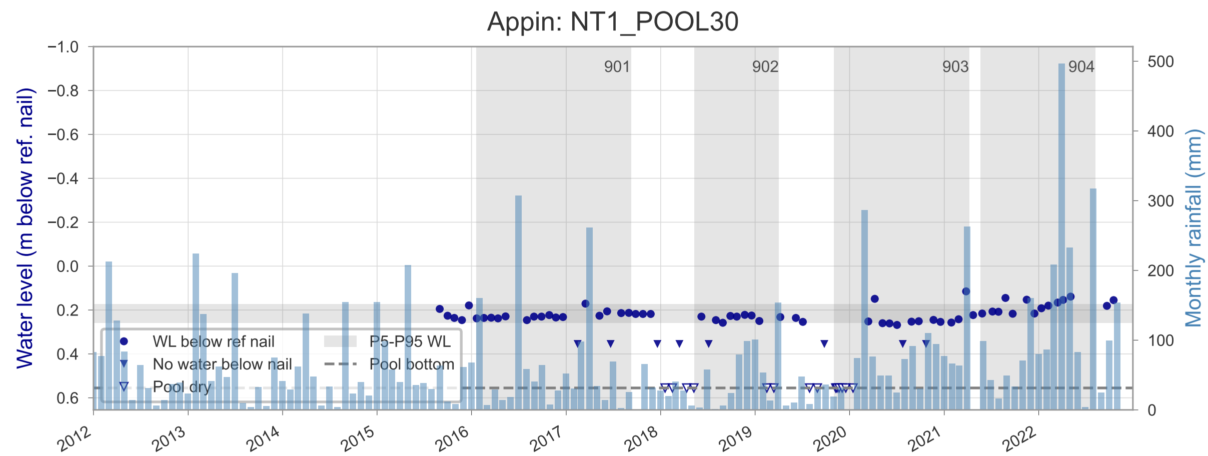

Appin: NT1_POOL10
Dissolved Oxygen (%)
Monthly rainfall (mm)
901
902
903
904
DO (%)
P5-P95 DO
Median (baseline)

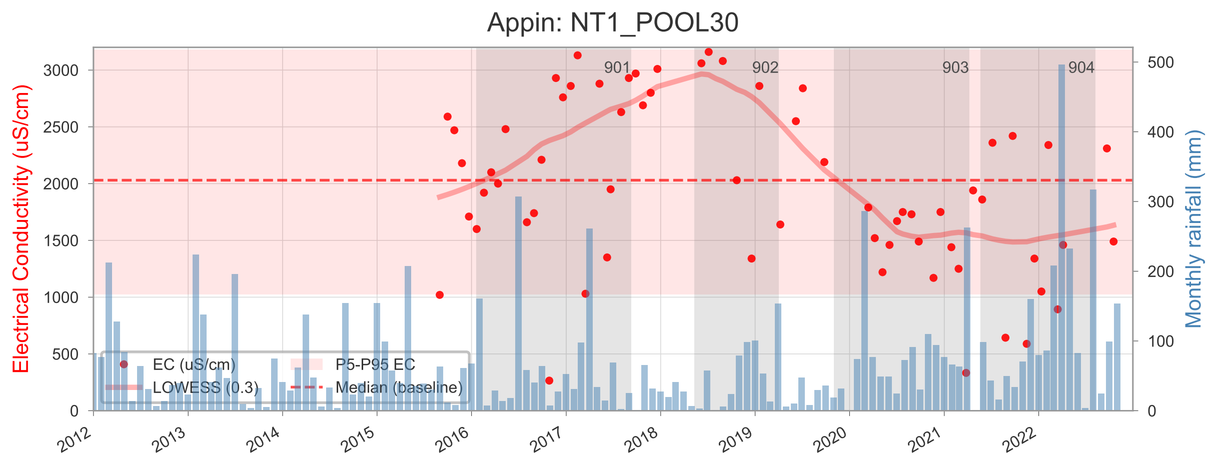

Appin: NT1_POOL20
Water level (m below ref. nail)
Monthly rainfall (mm)
901
902
903
904
WL below ref nail
No water below nail
P5-P95 WL
Pool bottom
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

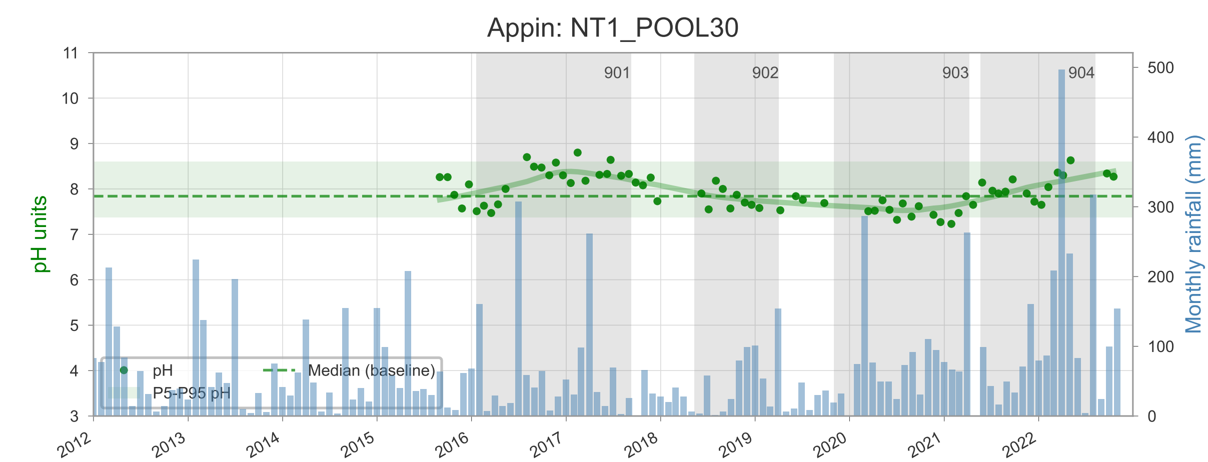

Appin: NT1_POOL20
Electrical Conductivity (uS/cm)
Monthly rainfall (mm)
901
902
903
904
EC (uS/cm)
LOWESS (0.3)
P5-P95 EC
Median (baseline)

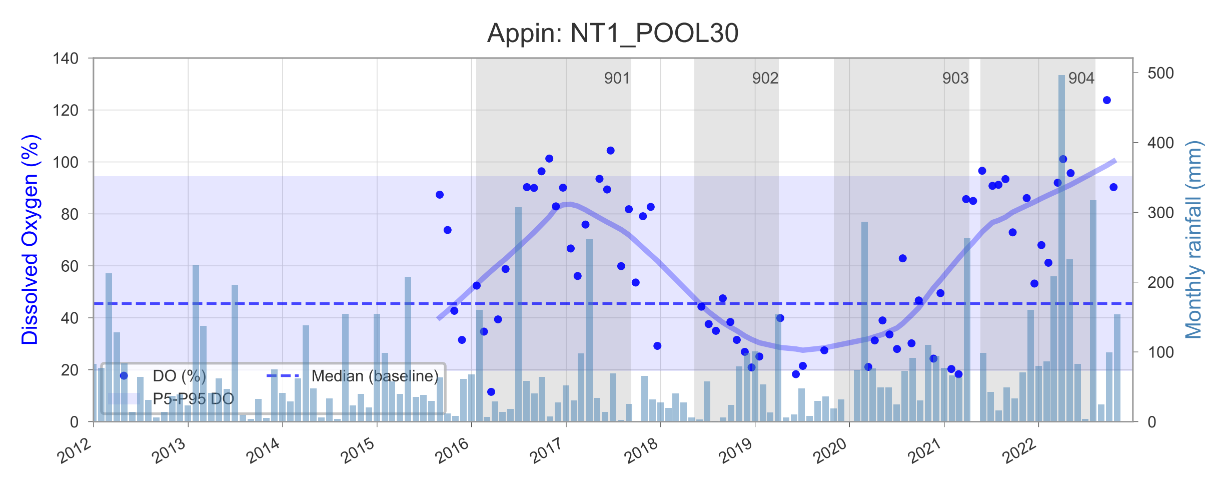

Appin: NT1_POOL20
pH units
Monthly rainfall (mm)
901
902
903
904
pH
P5-P95 pH
Median (baseline)

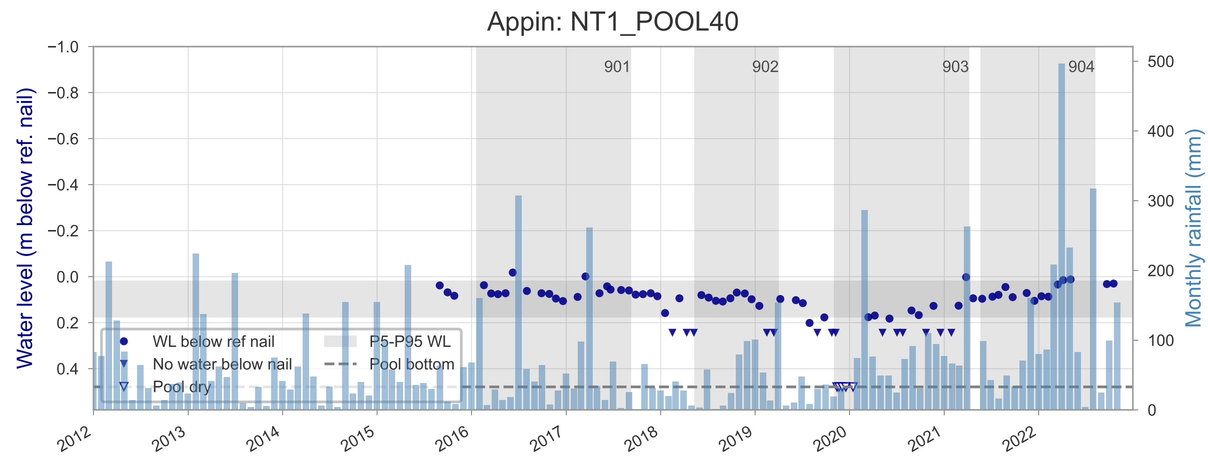

Appin: NT1_POOL20
Dissolved Oxygen (%)
Monthly rainfall (mm)
901
902
903
904
DO (%)
P5-P95 DO
Median (baseline)

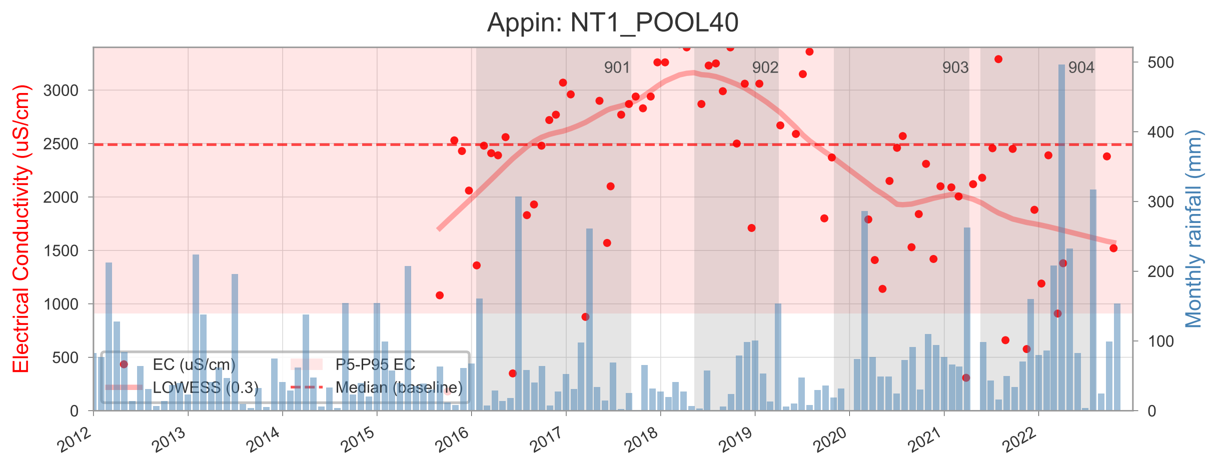

Appin: NT1_POOL30
Water level (m below ref. nail)
Monthly rainfall (mm)
901
902
903
904
WL below ref nail
No water below nail
Pool dry
P5-P95 WL
Pool bottom

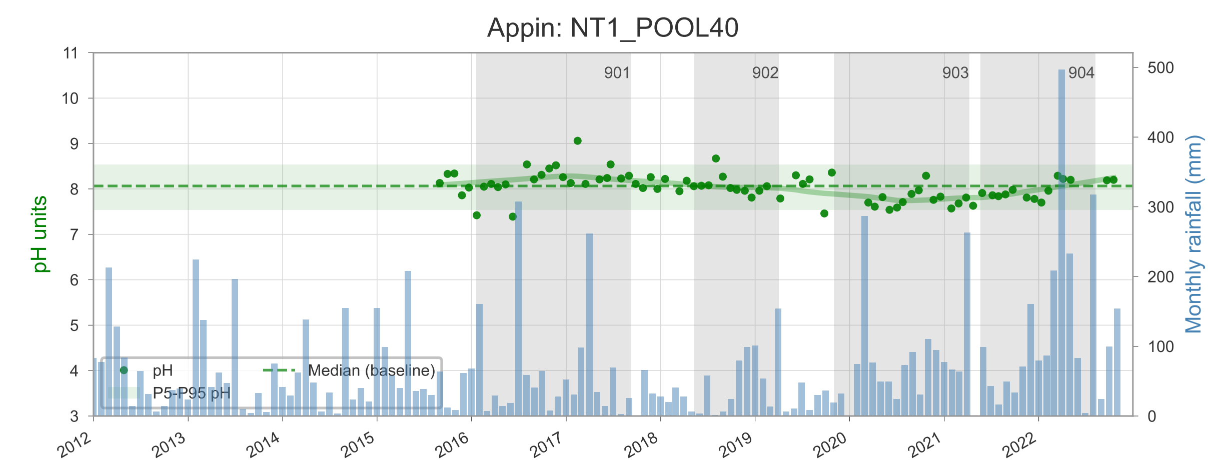

Appin: NT1_POOL30
Electrical Conductivity (uS/cm)
Monthly rainfall (mm)
901
902
903
904
EC (uS/cm)
LOWESS (0.3)
P5-P95 EC
Median (baseline)

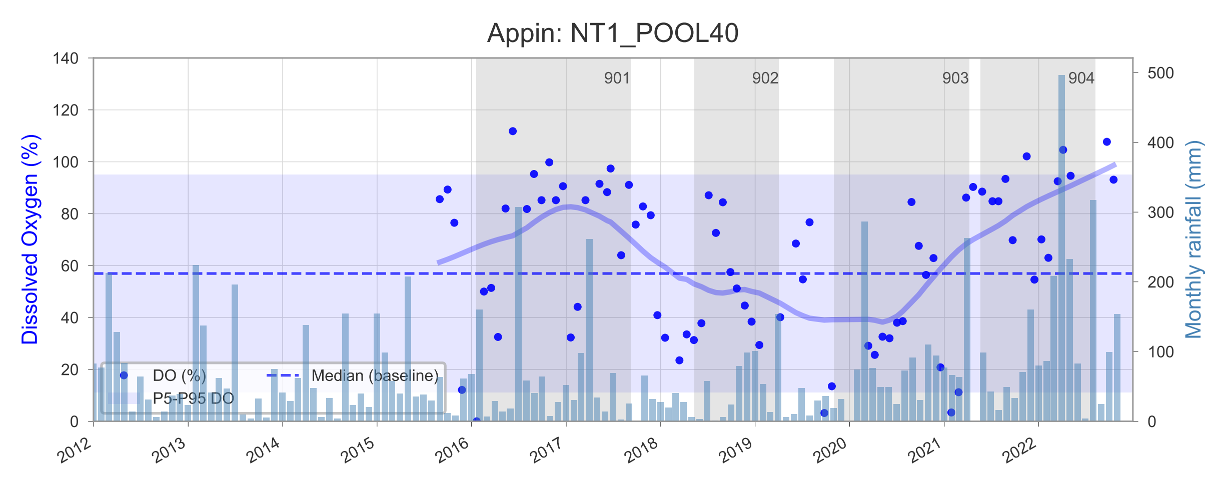

Appin: NT1_POOL30
pH units
Monthly rainfall (mm)
901
902
903
904
pH
P5-P95 pH
Median (baseline)

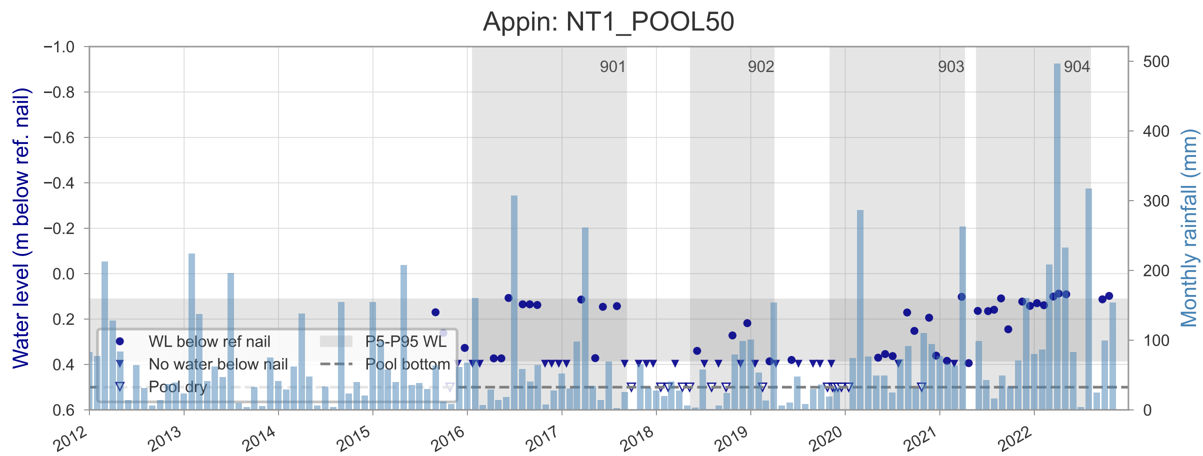

Appin: NT1_POOL30
Dissolved Oxygen (%)
Monthly rainfall (mm)
901
902
903
904
DO (%)
P5-P95 DO
Median (baseline)


Appin: NT1_POOL40
Water level (m below ref. nail)
Monthly rainfall (mm)
901
902
903
904
WL below ref nail
No water below nail
Pool dry
P5-P95 WL
Pool bottom
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

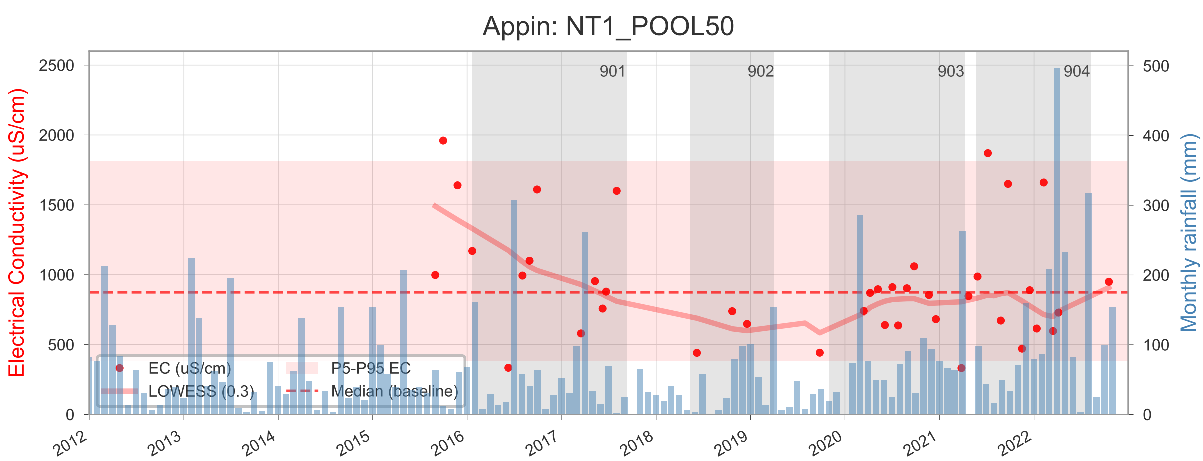

Appin: NT1_POOL40
Electrical Conductivity (uS/cm)
Monthly rainfall (mm)
901
902
903
904
EC (uS/cm)
LOWESS (0.3)
P5-P95 EC
Median (baseline)
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022


Appin: NT1_POOL40
pH units
Monthly rainfall (mm)
901
902
903
904
pH
P5-P95 pH
Median (baseline)
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

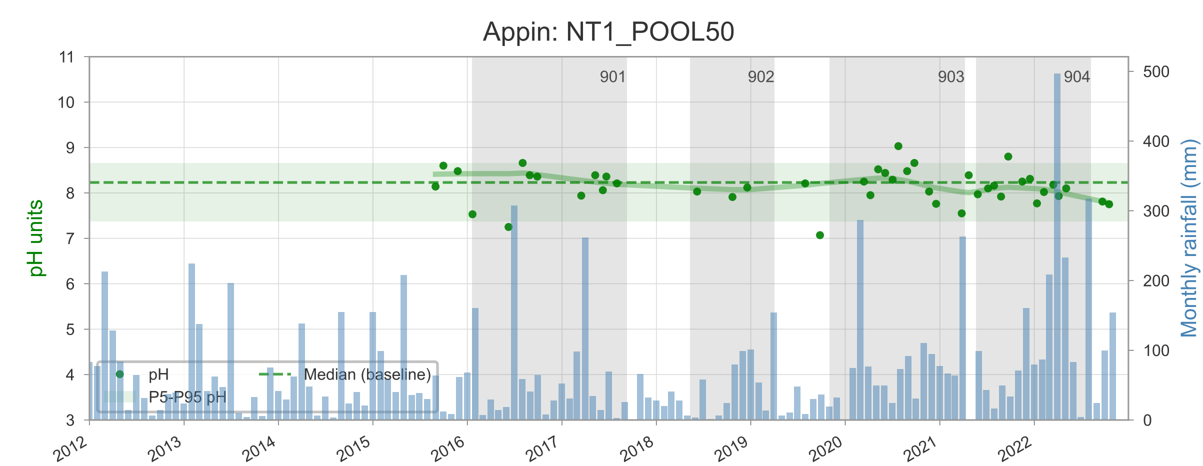

Appin: NT1_POOL40
Dissolved Oxygen (%)
Monthly rainfall (mm)
901
902
903
904
DO (%)
P5-P95 DO
Median (baseline)
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022



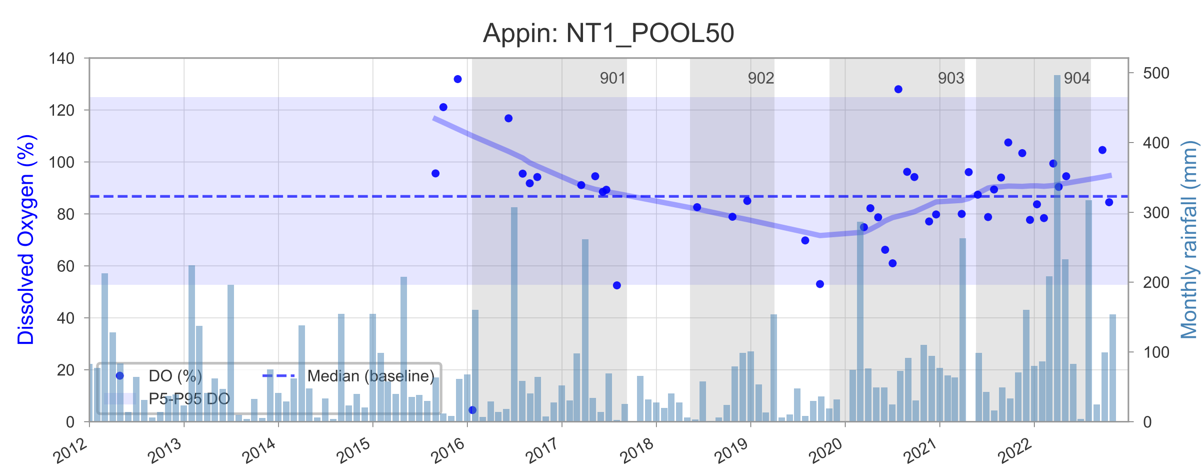
Appin: NT1_POOL50
Water level (m below ref. nail)
Monthly rainfall (mm)
901
902
903
904
WL below ref nail
No water below nail
Pool dry
P5-P95 WL
Pool bottom



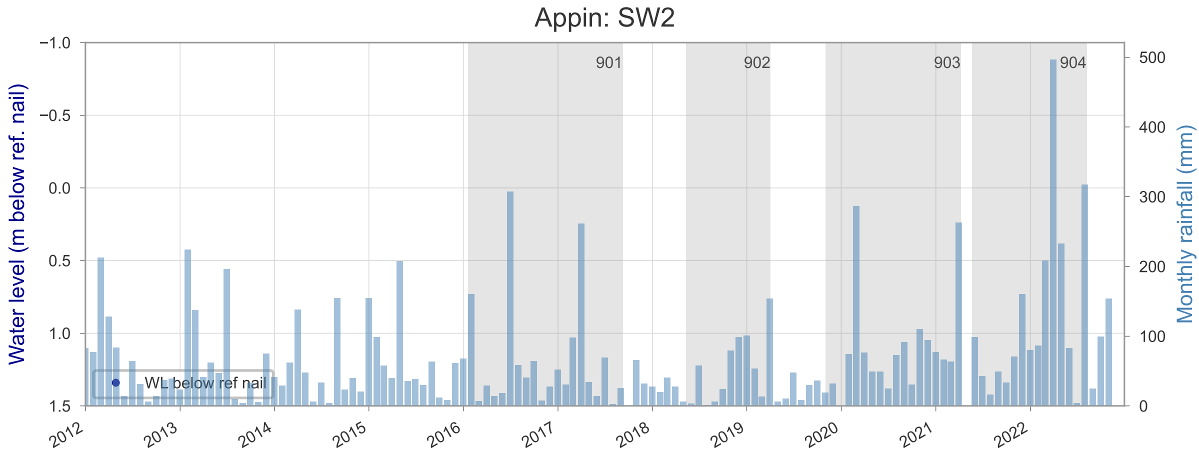
Appin: NT1_POOL50
Electrical Conductivity (uS/cm)
Monthly rainfall (mm)
901
902
903
904
EC (uS/cm)
LOWESS (0.3)
P5-P95 EC
Median (baseline)

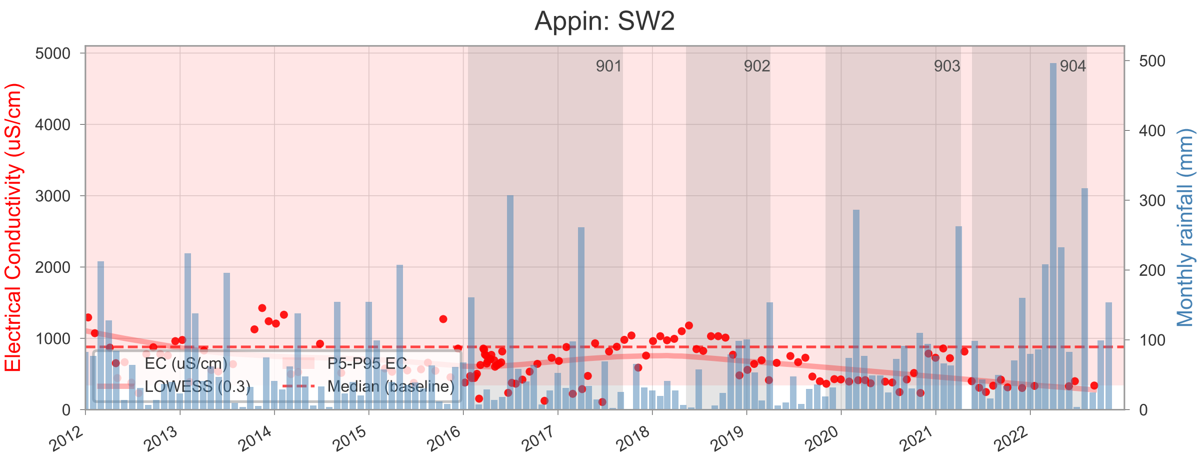


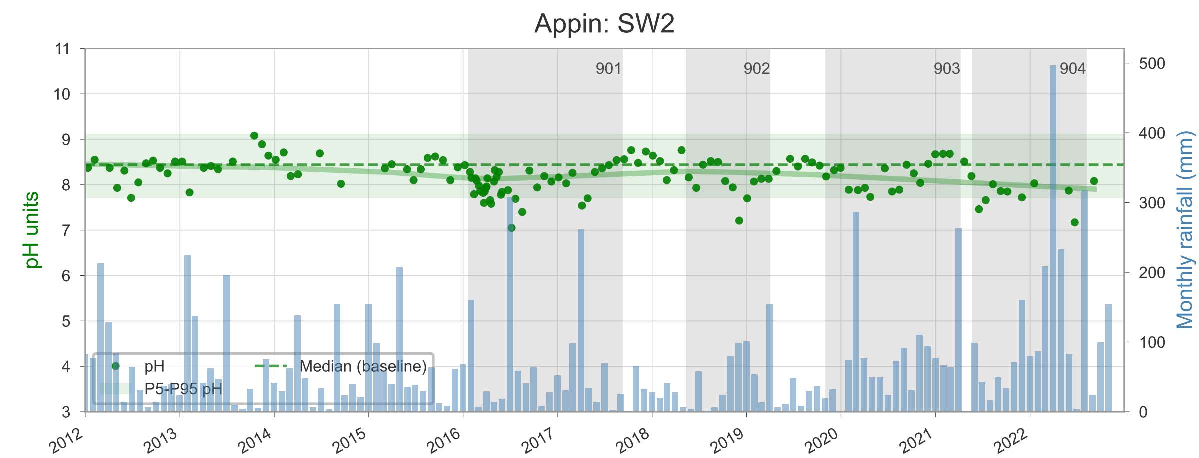
Appin: NT1_POOL50
pH units
Monthly rainfall (mm)
901
902
903
904
pH
P5-P95 pH
Median (baseline)

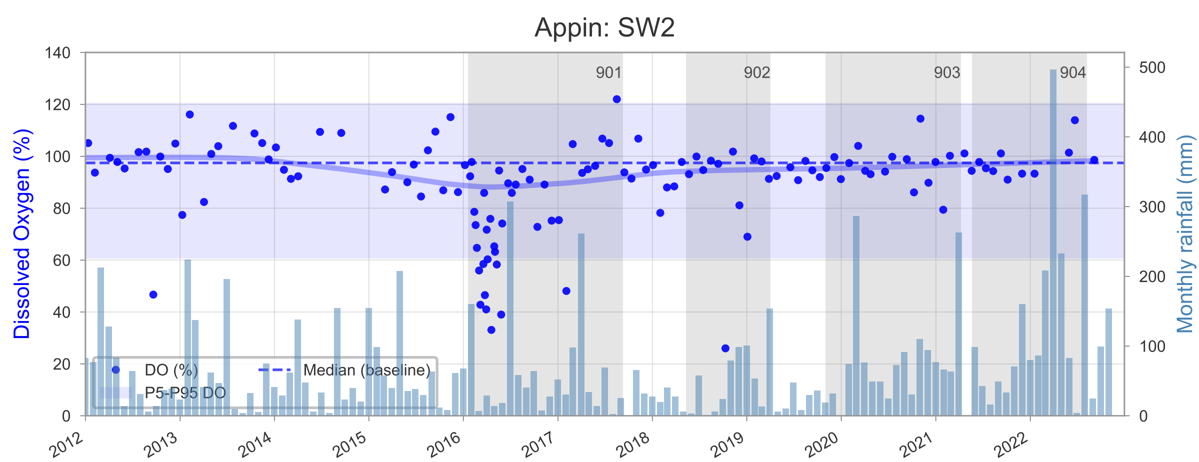


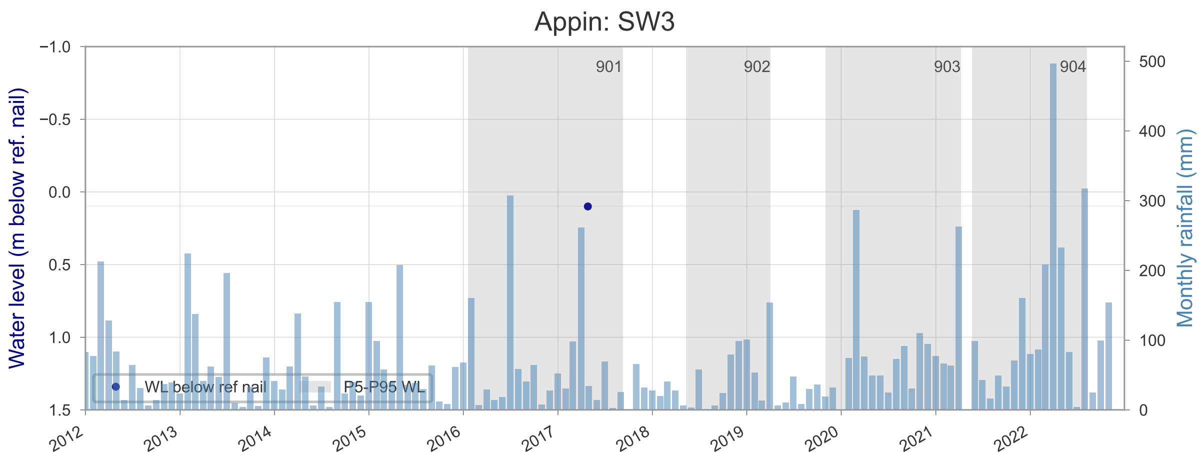
Appin: NT1_POOL50
Dissolved Oxygen (%)
Monthly rainfall (mm)
901
902
903
904
DO (%)
P5-P95 DO
Median (baseline)

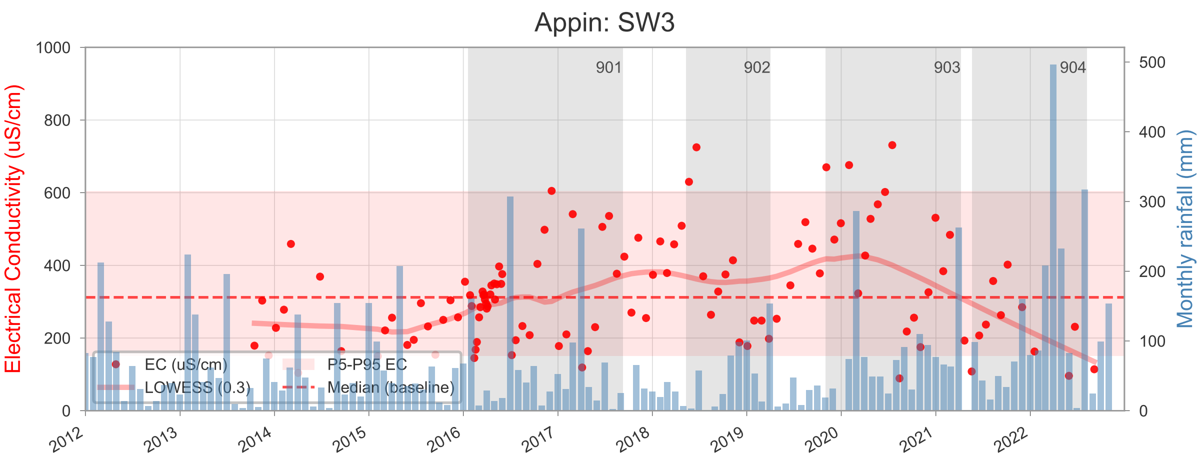

Appin: SW2
Water level (m below ref. nail)
Monthly rainfall (mm)
WL below ref nail
901
902
903
904

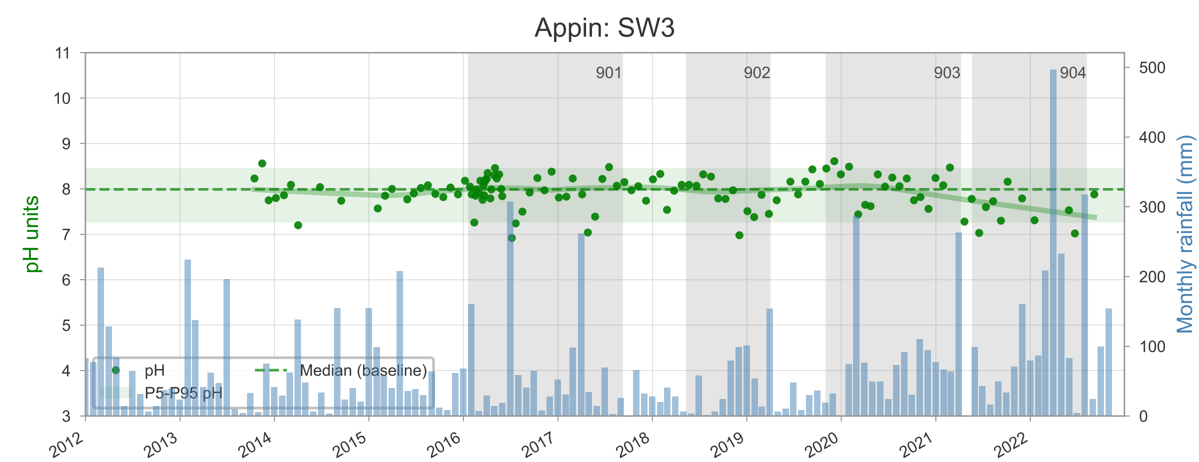

Appin: SW2
Electrical Conductivity (uS/cm)
Monthly rainfall (mm)
EC (uS/cm)
LOWESS (0.3)
P5-P95 EC
Median (baseline)
901
902
903
904

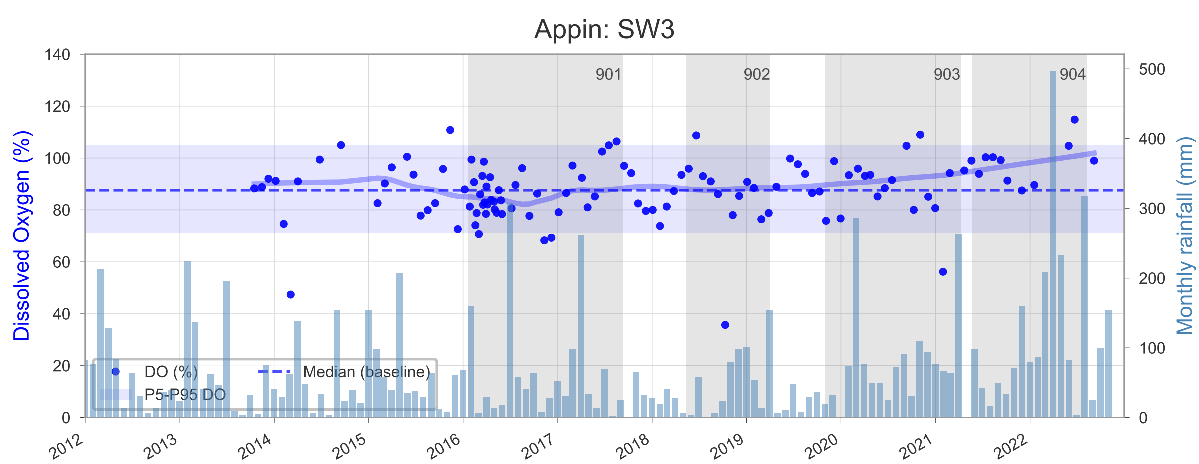

Appin: SW2
pH units
Monthly rainfall (mm)
pH
P5-P95 pH
Median (baseline)
901
902
903
904

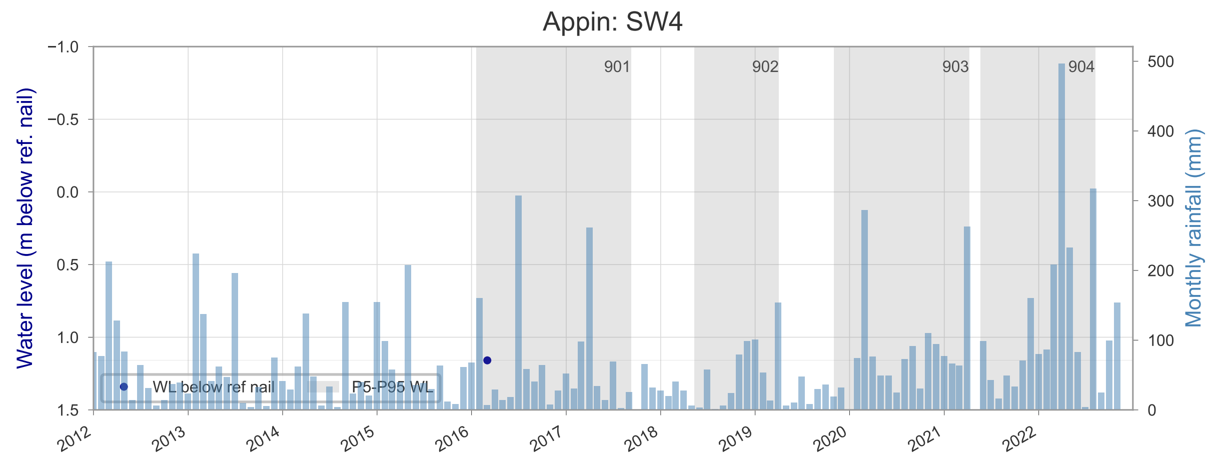

Appin: SW2
Dissolved Oxygen (%)
Monthly rainfall (mm)
DO (%)
P5-P95 DO
Median (baseline)
901
902
903
904

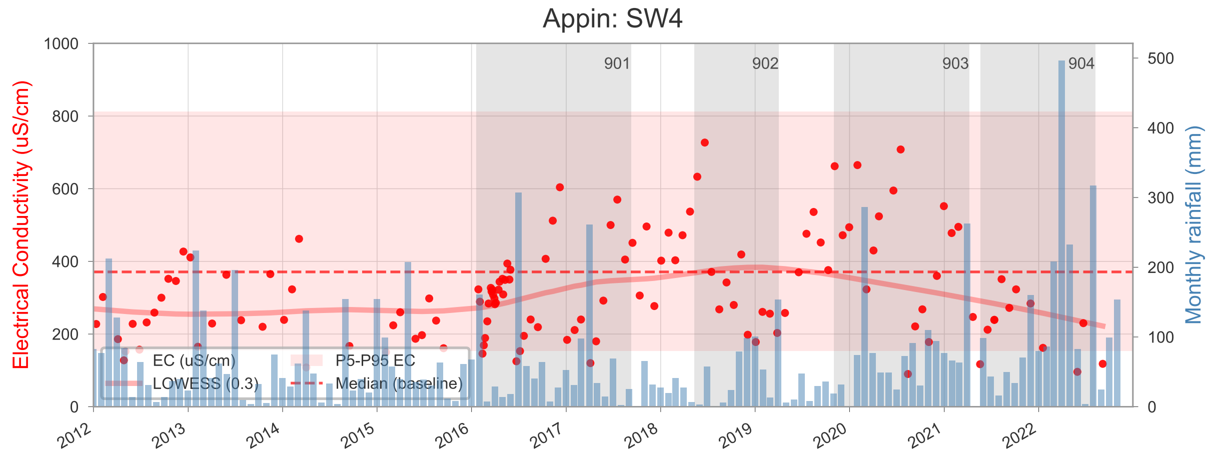

Appin: SW3
Water level (m below ref. nail)
Monthly rainfall (mm)
901
902
903
904
WL below ref nail
P5-P95 WL
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

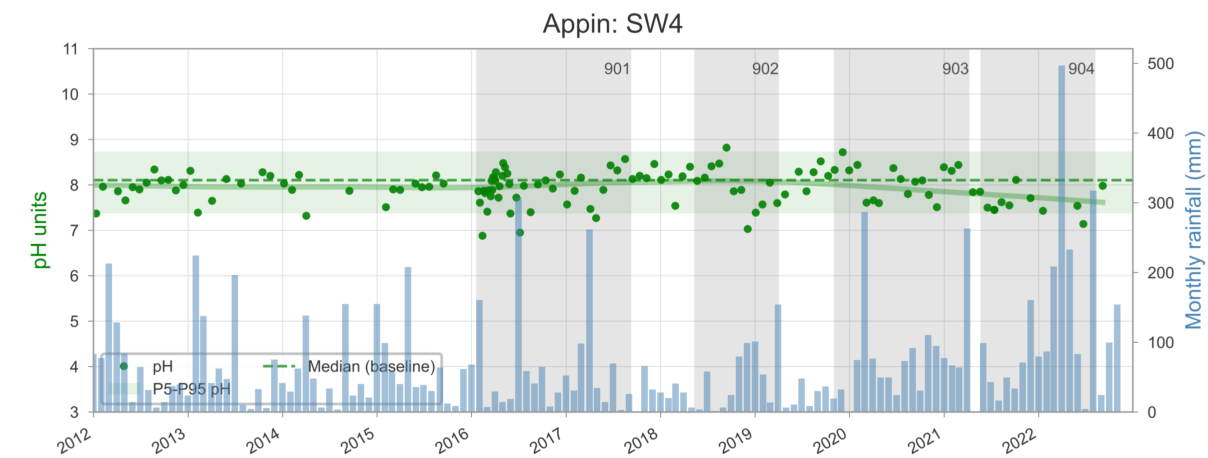

Appin: SW3
Electrical Conductivity (uS/cm)
Monthly rainfall (mm)
901
902
903
904
EC (uS/cm)
P5-P95 EC
LOWESS (0.3)
Median (baseline)

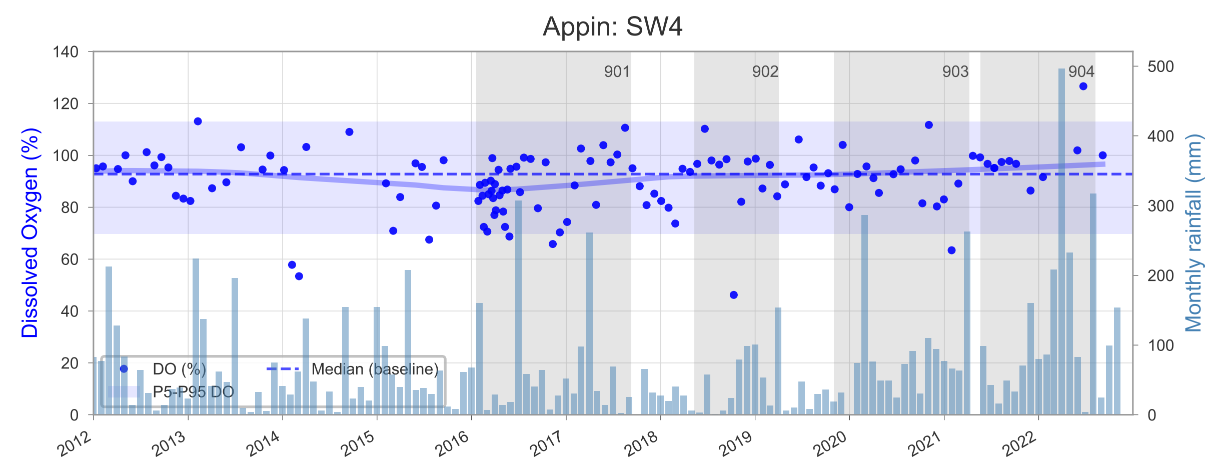

Appin: SW3
pH units
Monthly rainfall (mm)
901
902
903
904
pH
Median (baseline)
P5-P95 pH

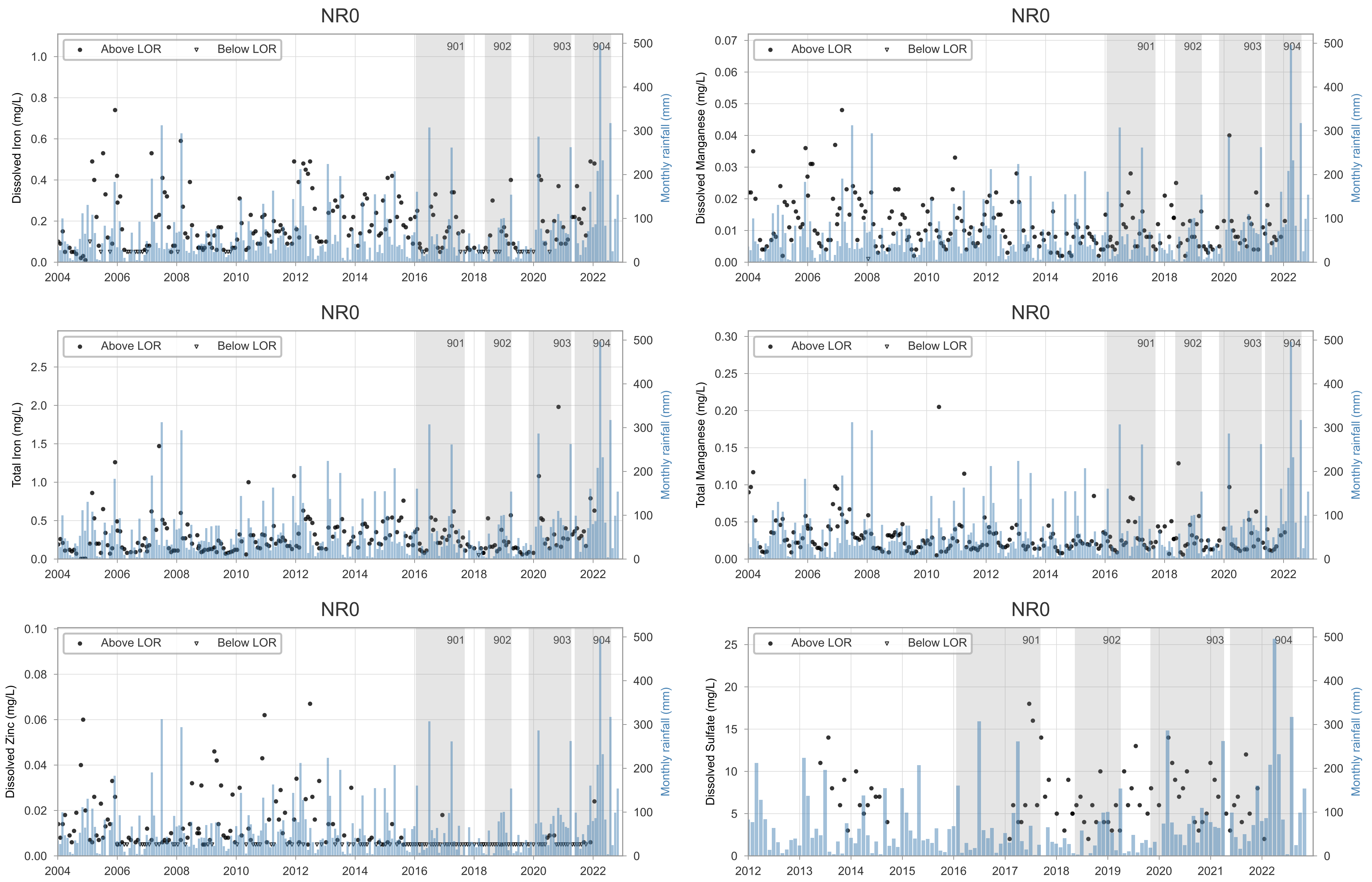

Appin: SW3
Dissolved Oxygen (%)
Monthly rainfall (mm)
901
902
903
904
DO (%)
Median (baseline)
P5-P95 DO

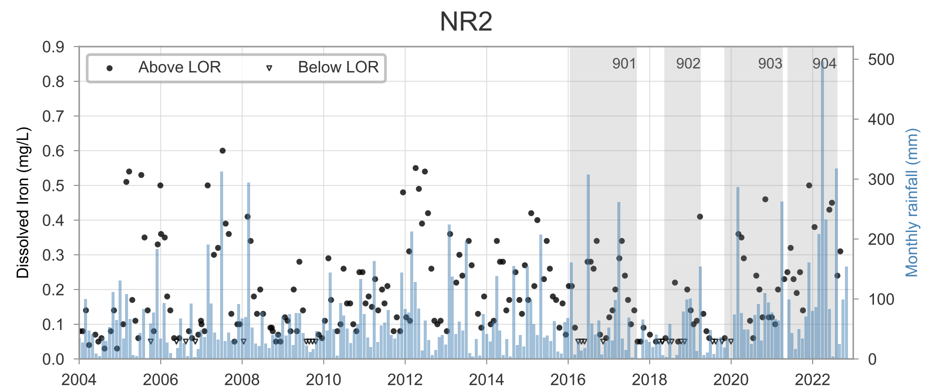

Appin: SW4
901
902
903
904
Water level (m below ref. nail)
Monthly rainfall (mm)
WL below ref nail
P5-P95 WL

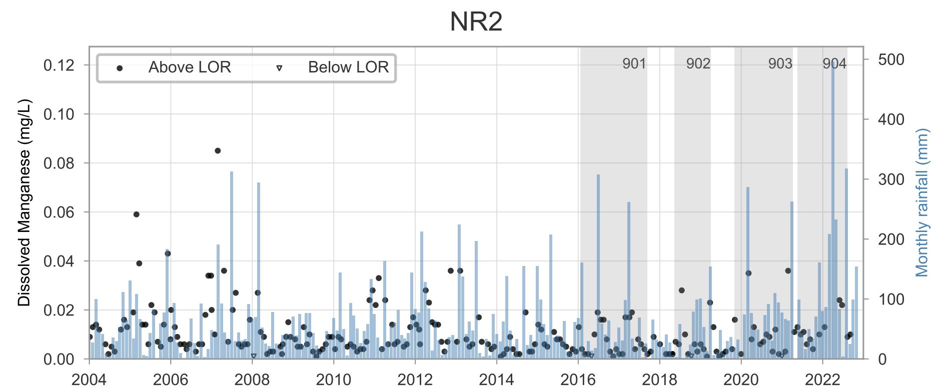

Appin: SW4
901
902
903
904
Electrical Conductivity (uS/cm)
Monthly rainfall (mm)
EC (uS/cm)
P5-P95 EC
LOWESS (0.3)
Median (baseline)

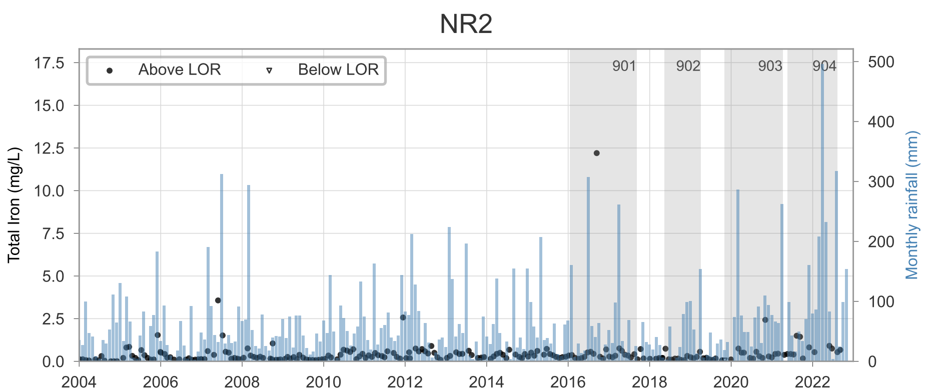

Appin: SW4
901
902
903
904
pH units
Monthly rainfall (mm)
pH
Median (baseline)
P5-P95 pH

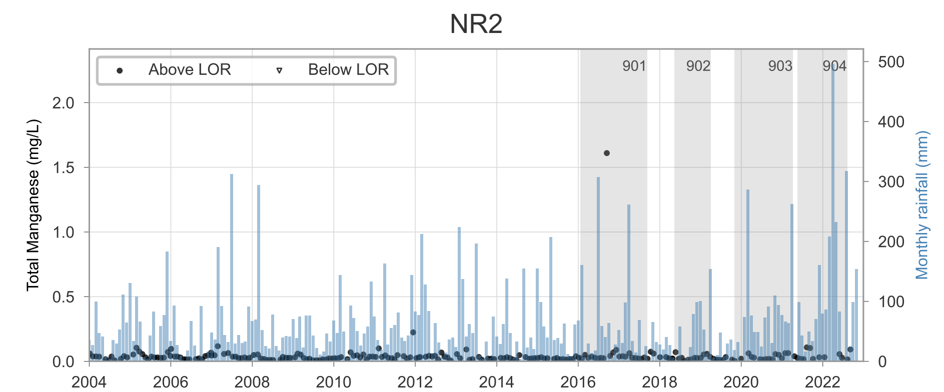

Appin: SW4
901
902
903
904
Dissolved Oxygen (%)
Monthly rainfall (mm)
DO (%)
Median (baseline)
P5-P95 DO

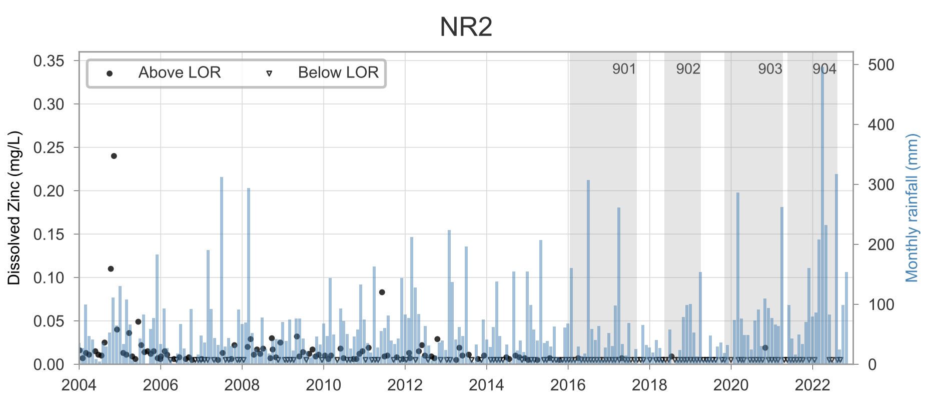

NR0
Dissolved Iron (mg/L)
Monthly rainfall (mm)
Above LOR
Below LOR
901
902
903
904
NR0
Dissolved Manganese (mg/L)
Monthly rainfall (mm)
Above LOR
Below LOR
901
902
903
904
NR0
Total Iron (mg/L)
Monthly rainfall (mm)
Above LOR
Below LOR
901
902
903
904
NR0
Total Manganese (mg/L)
Monthly rainfall (mm)
Above LOR
Below LOR
901
902
903
904
NR0
Dissolved Zinc (mg/L)
Monthly rainfall (mm)
Above LOR
Below LOR
901
902
903
904
NR0
Dissolved Sulfate (mg/L)
Monthly rainfall (mm)
Above LOR
Below LOR
901
902
903
904

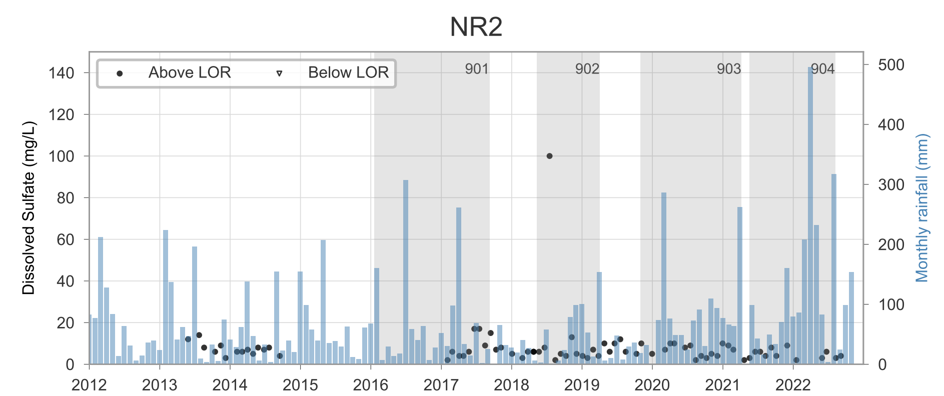

NR2
Above LOR
Below LOR
901
902
903
904
Dissolved Iron (mg/L)
Monthly rainfall (mm)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
0
100
200
300
400
500
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022

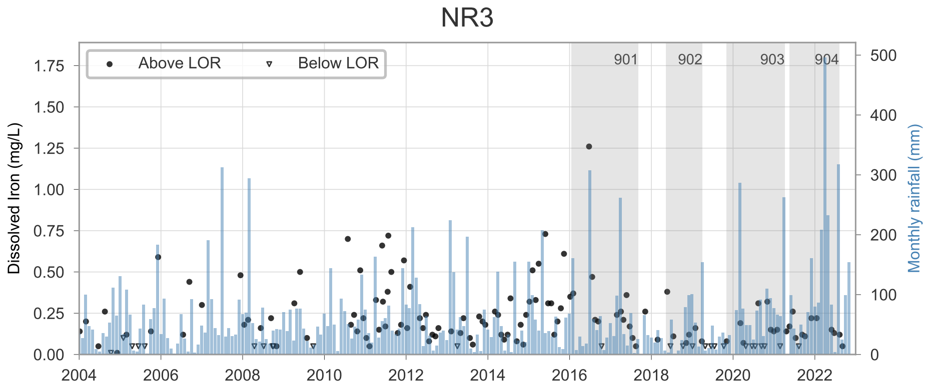

NR2
Above LOR
Below LOR
901
902
903
904
Dissolved Manganese (mg/L)
Monthly rainfall (mm)
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0
100
200
300
400
500
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022

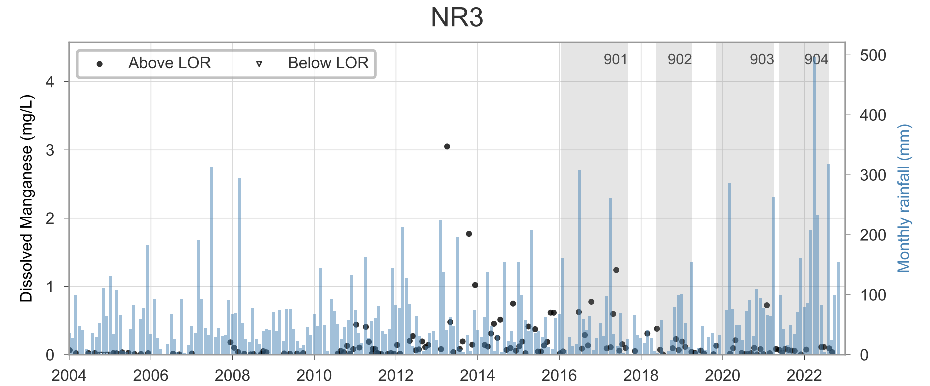

NR2
Above LOR
Below LOR
901
902
903
904
Total Iron (mg/L)
Monthly rainfall (mm)
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
0
100
200
300
400
500
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022

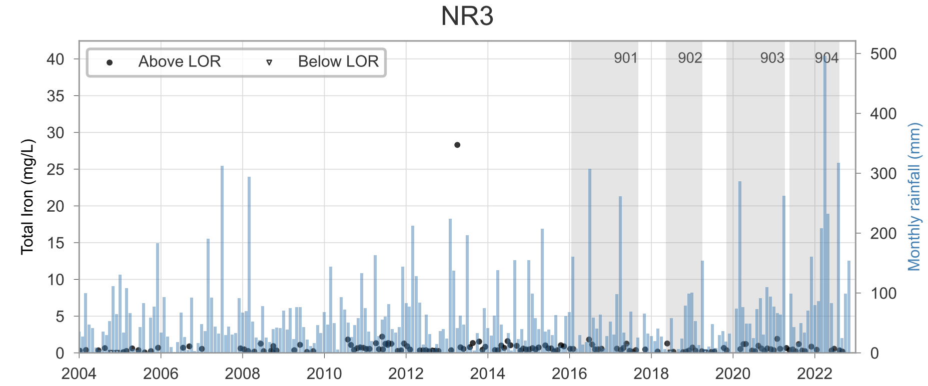

NR2
Above LOR
Below LOR
901
902
903
904
Total Manganese (mg/L)
Monthly rainfall (mm)
0.0
0.5
1.0
1.5
2.0
0
100
200
300
400
500
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022

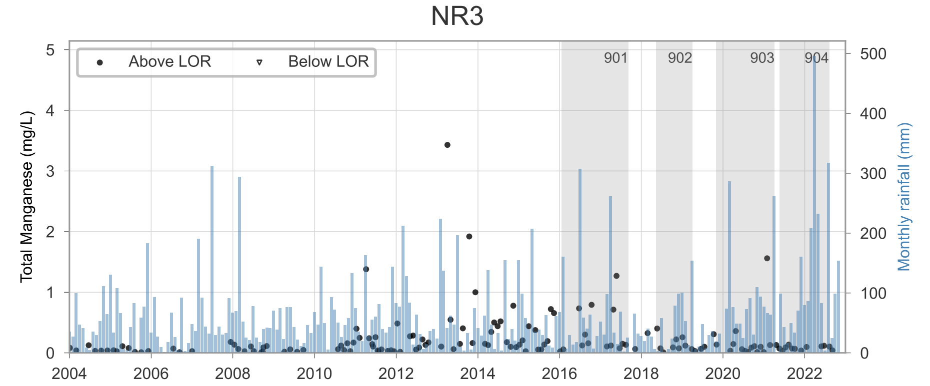

NR2
Above LOR
Below LOR
901
902
903
904
Dissolved Zinc (mg/L)
Monthly rainfall (mm)
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0
100
200
300
400
500
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022

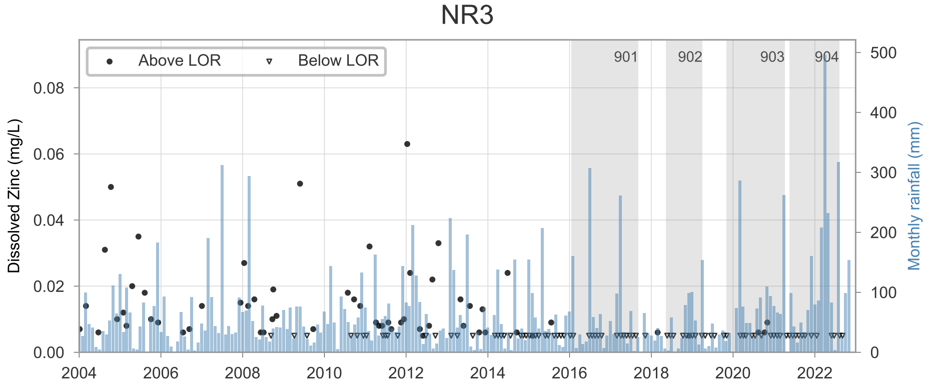

NR2
Above LOR
Below LOR
901
902
903
904
Dissolved Sulfate (mg/L)
Monthly rainfall (mm)
0
20
40
60
80
100
120
140
0
100
200
300
400
500
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

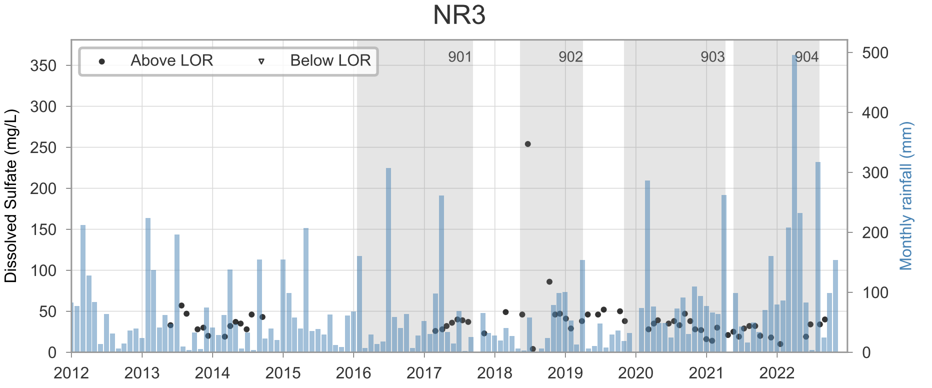

NR3
Above LOR
Below LOR
901
902
903
904
Dissolved Iron (mg/L)
Monthly rainfall (mm)

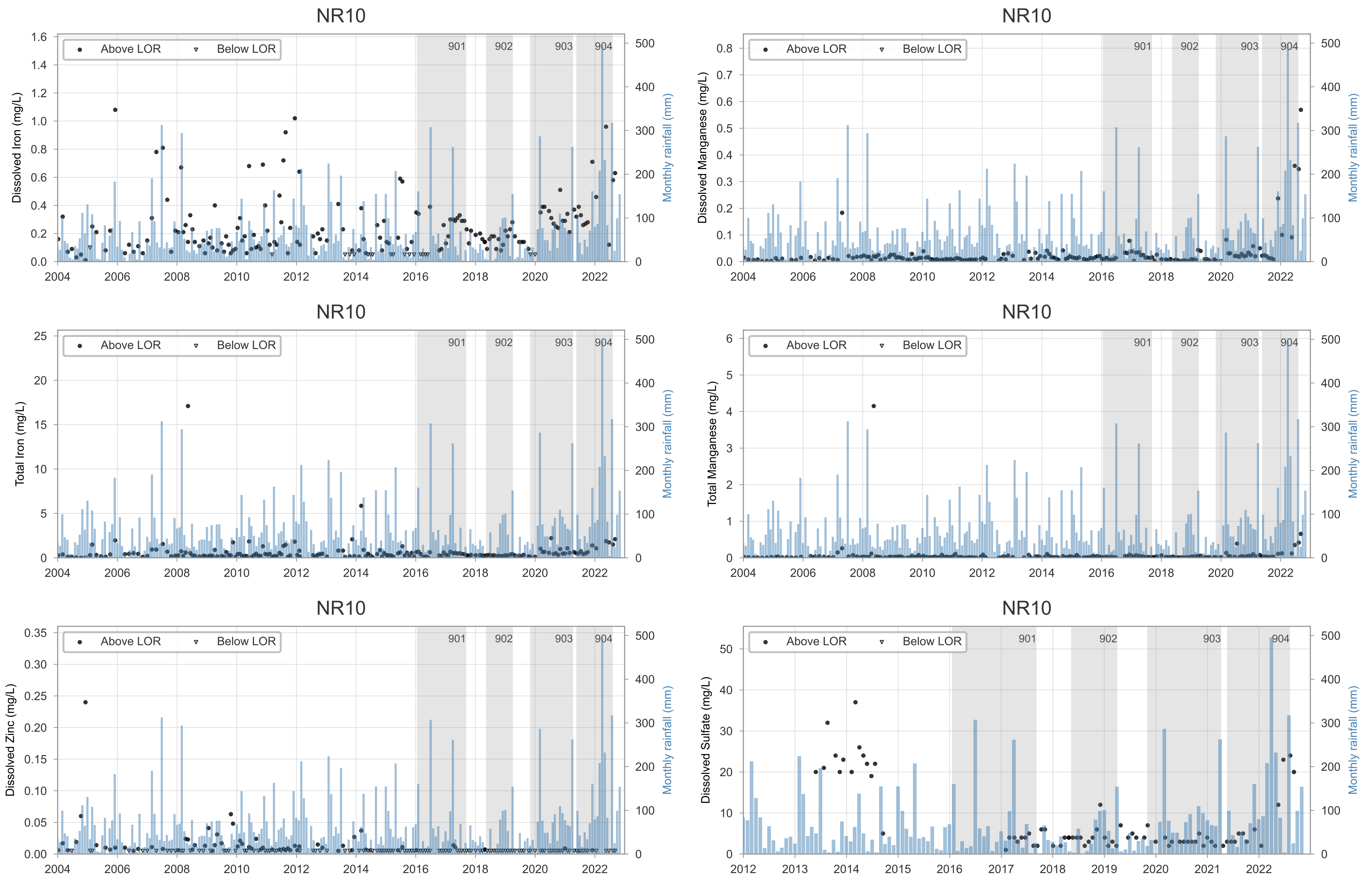

NR3
Above LOR
Below LOR
901
902
903
904
Dissolved Manganese (mg/L)
Monthly rainfall (mm)

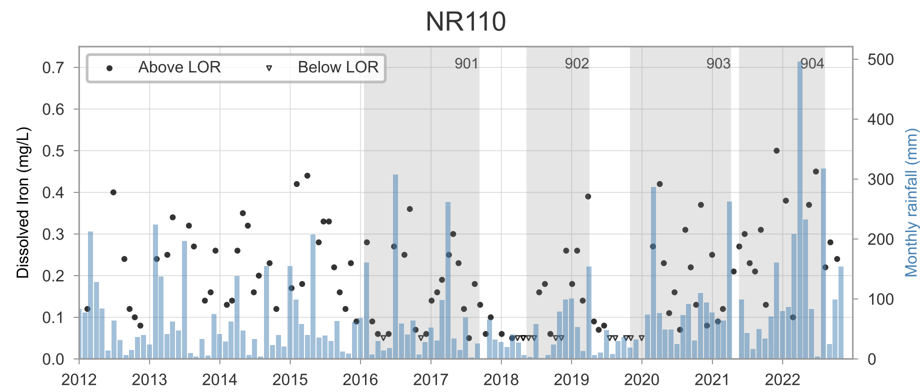

NR3
Above LOR
Below LOR
901
902
903
904
Total Iron (mg/L)
Monthly rainfall (mm)

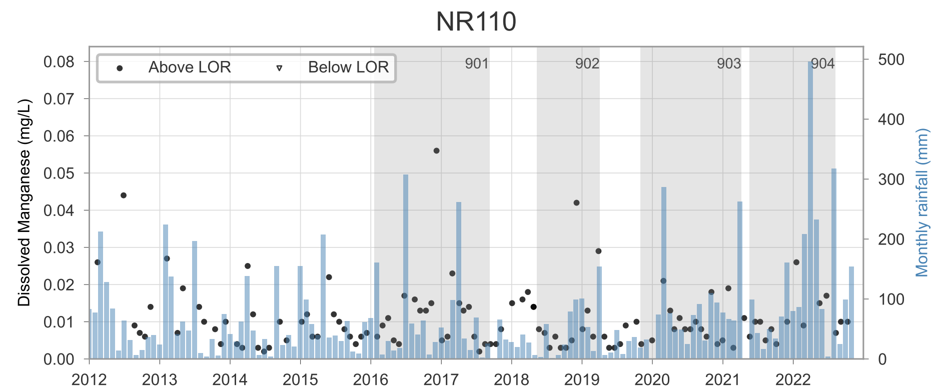

NR3
Above LOR
Below LOR
901
902
903
904
Total Manganese (mg/L)
Monthly rainfall (mm)

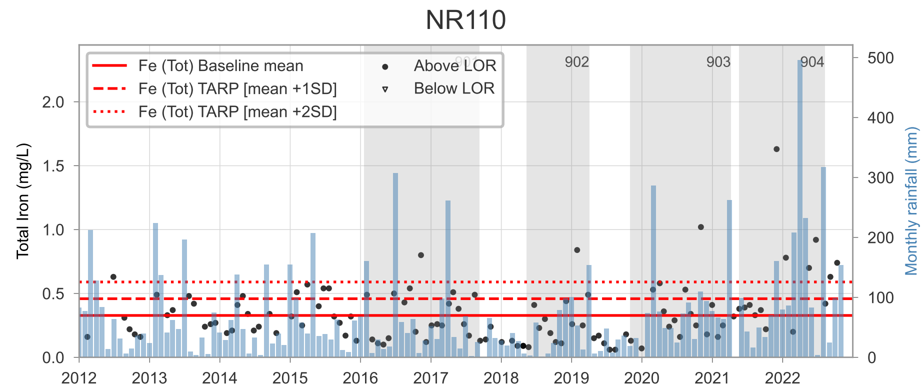

NR3
Above LOR
Below LOR
901
902
903
904
Dissolved Zinc (mg/L)
Monthly rainfall (mm)

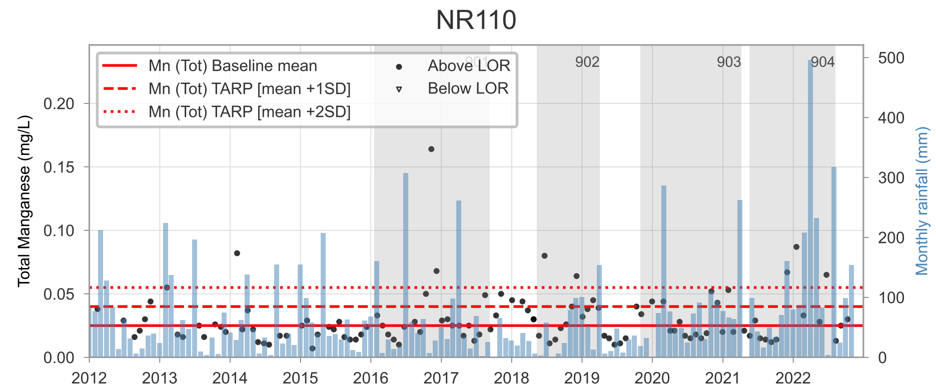

NR3
Above LOR
Below LOR
901
902
903
904
Dissolved Sulfate (mg/L)
Monthly rainfall (mm)

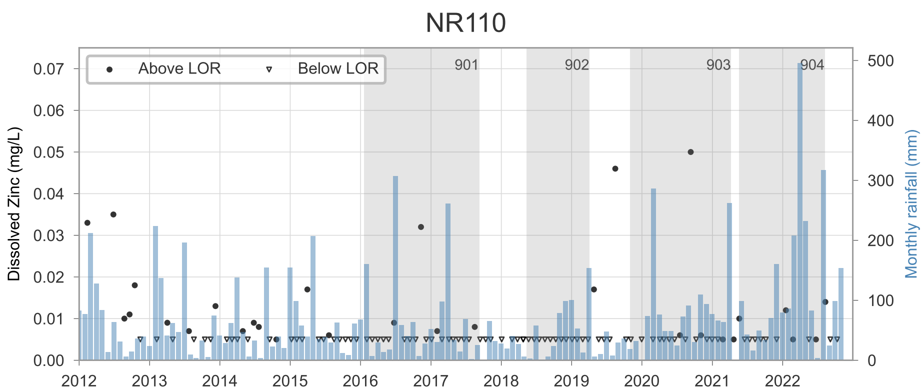

NR10
Dissolved Iron (mg/L)
Monthly rainfall (mm)
Above LOR
Below LOR
901
902
903
904
NR10
Dissolved Manganese (mg/L)
Monthly rainfall (mm)
NR10
Total Iron (mg/L)
Monthly rainfall (mm)
NR10
Total Manganese (mg/L)
Monthly rainfall (mm)
NR10
Dissolved Zinc (mg/L)
Monthly rainfall (mm)
NR10
Dissolved Sulfate (mg/L)
Monthly rainfall (mm)

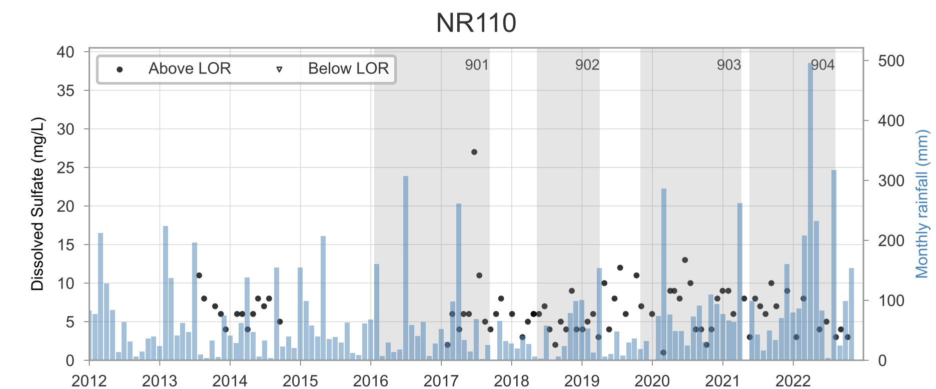

NR110
Above LOR
Below LOR
901
902
903
904
Dissolved Iron (mg/L)
Monthly rainfall (mm)
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022

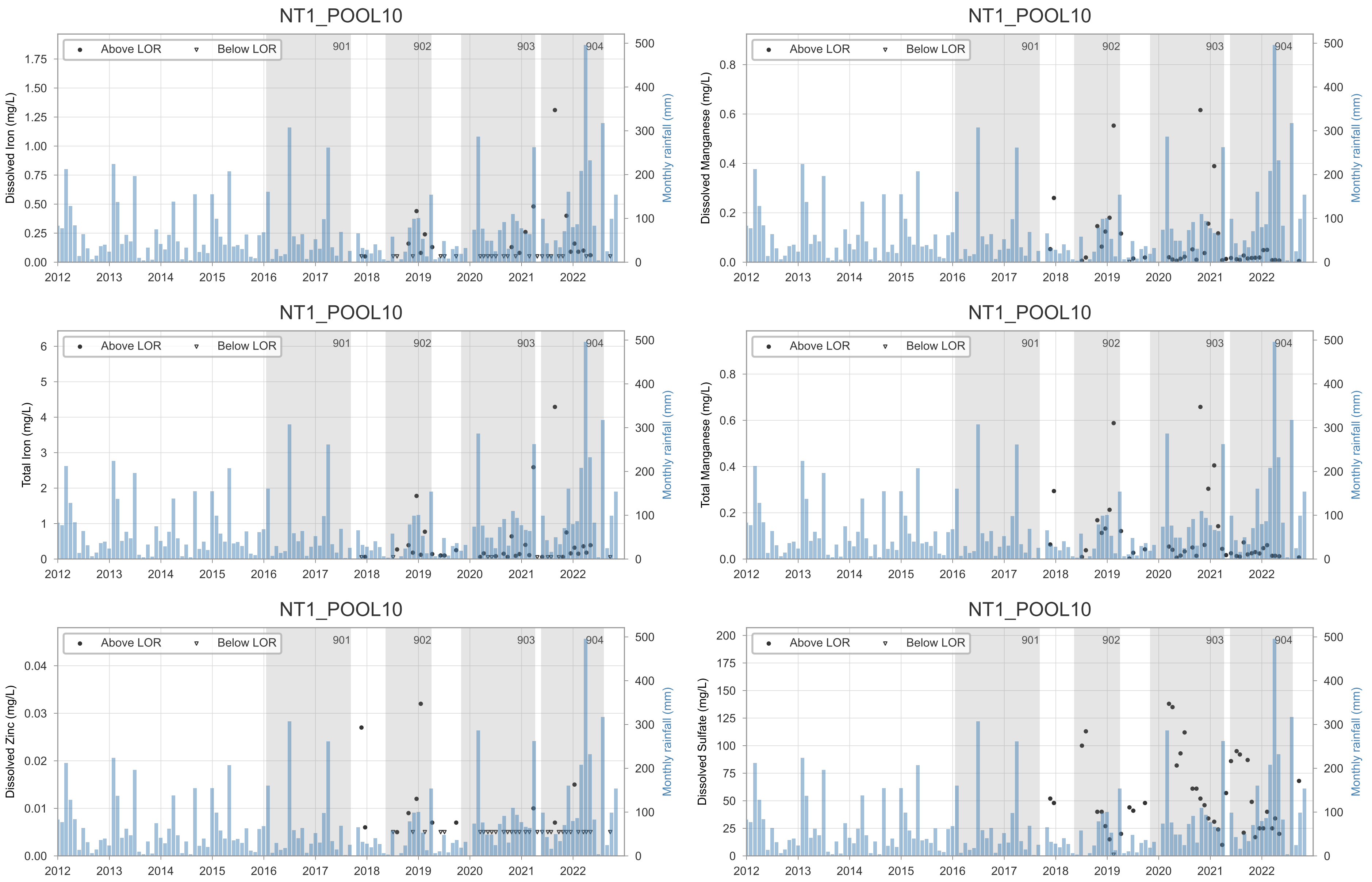

NR110
Above LOR
Below LOR
901
902
903
904
Dissolved Manganese (mg/L)
Monthly rainfall (mm)
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022


NR110
Fe (Tot) Baseline mean
Fe (Tot) TARP [mean +1SD]
Fe (Tot) TARP [mean +2SD]
Above LOR
Below LOR
902
903
904
Total Iron (mg/L)
Monthly rainfall (mm)
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022

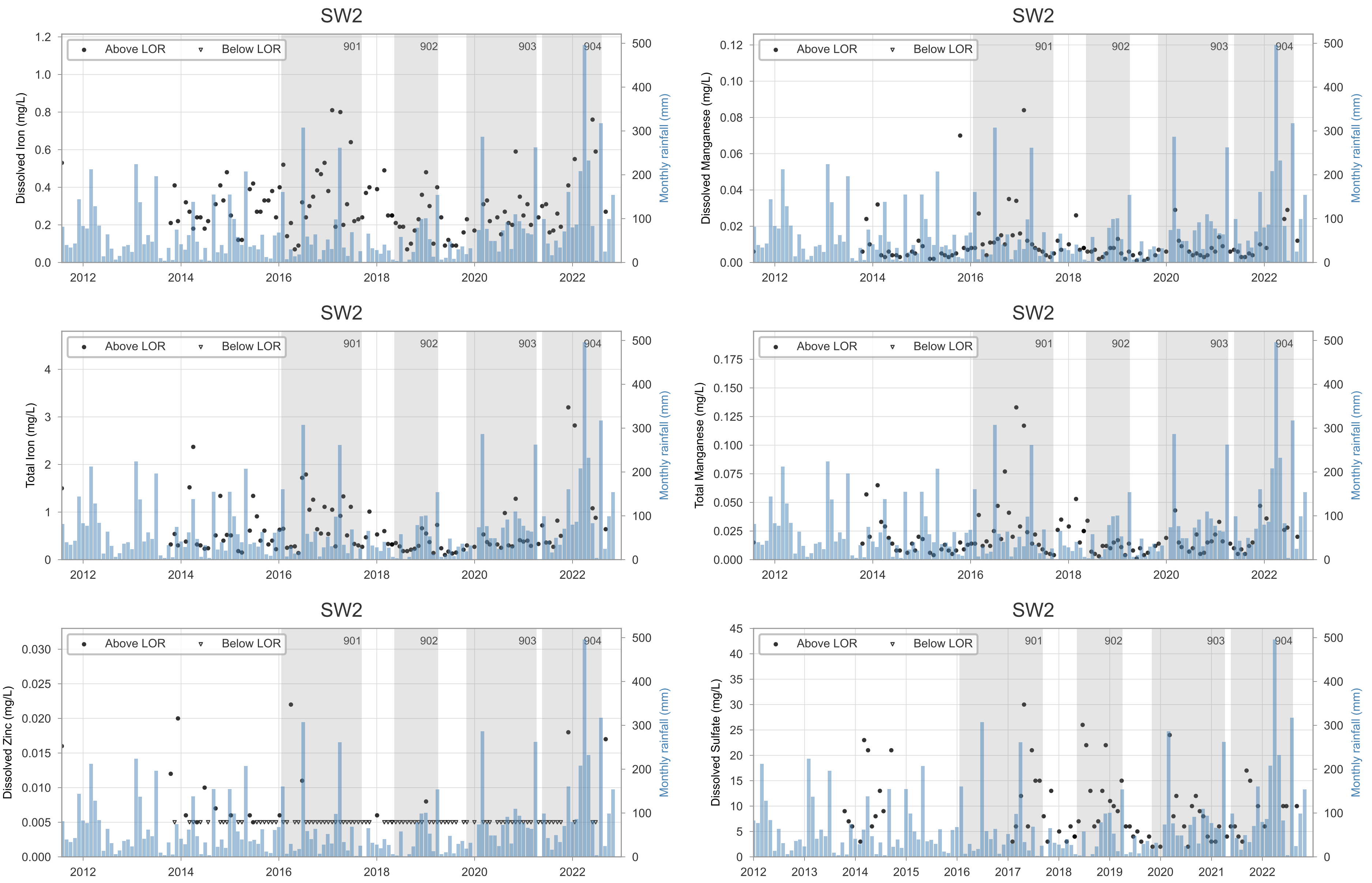

NR110
Mn (Tot) Baseline mean
Mn (Tot) TARP [mean +1SD]
Mn (Tot) TARP [mean +2SD]
Above LOR
Below LOR
902
903
904
Total Manganese (mg/L)
Monthly rainfall (mm)
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022

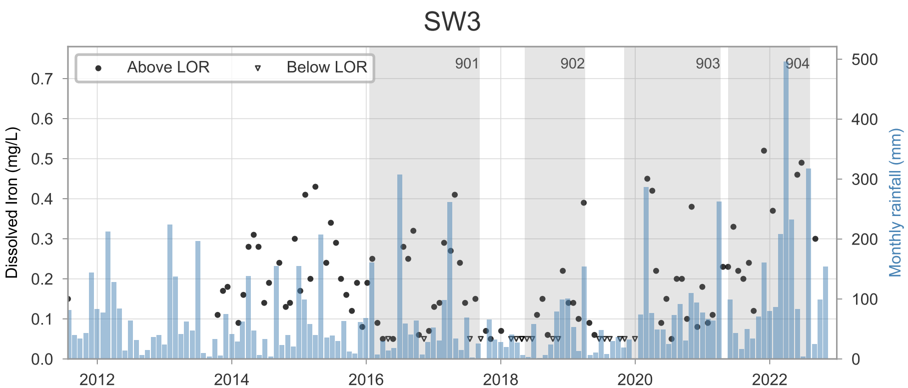

NR110
Above LOR
Below LOR
901
902
903
904
Dissolved Zinc (mg/L)
Monthly rainfall (mm)
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022

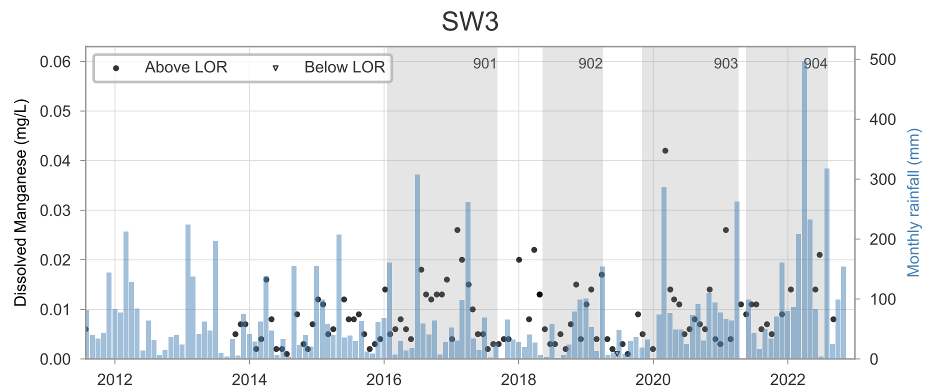

NR110
Above LOR
Below LOR
901
902
903
904
Dissolved Sulfate (mg/L)
Monthly rainfall (mm)
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022

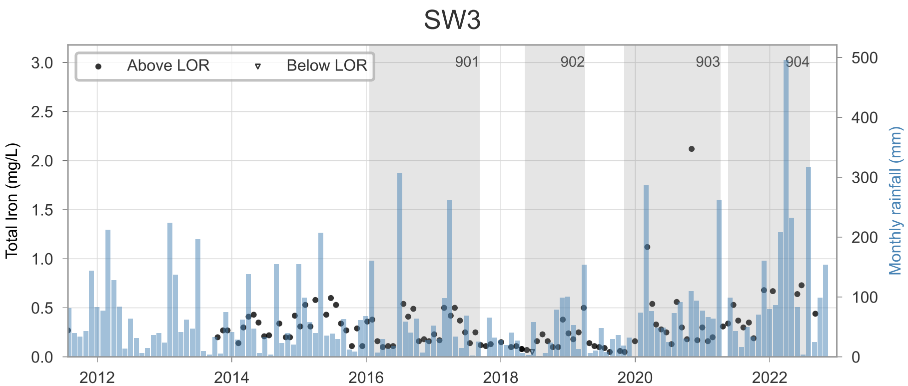


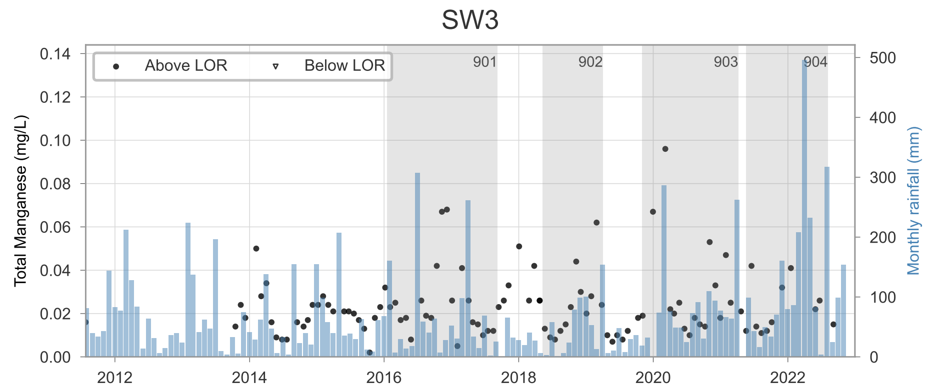
NT1_POOL10
Above LOR
Below LOR
901
902
903
904
Dissolved Iron (mg/L)
Monthly rainfall (mm)
NT1_POOL10
Dissolved Manganese (mg/L)
Monthly rainfall (mm)
NT1_POOL10
Total Iron (mg/L)
Monthly rainfall (mm)
NT1_POOL10
Total Manganese (mg/L)
Monthly rainfall (mm)
NT1_POOL10
Dissolved Zinc (mg/L)
Monthly rainfall (mm)
NT1_POOL10
Dissolved Sulfate (mg/L)
Monthly rainfall (mm)
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

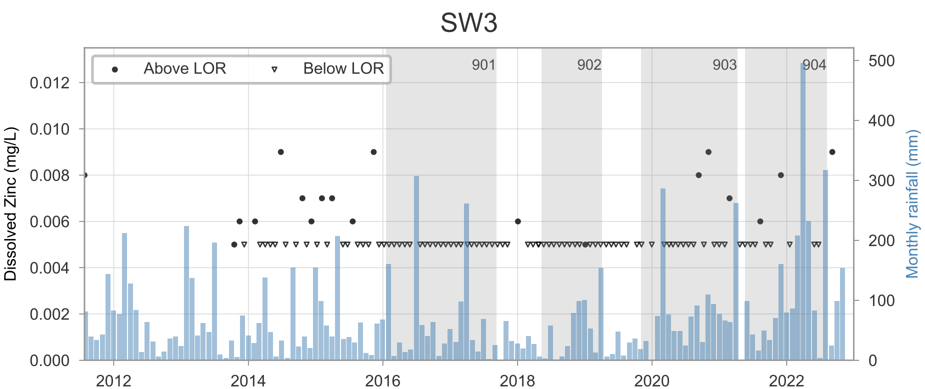

SW2
Above LOR
Below LOR
901
902
903
904
Dissolved Iron (mg/L)
Total Iron (mg/L)
Dissolved Zinc (mg/L)
Dissolved Manganese (mg/L)
Total Manganese (mg/L)
Dissolved Sulfate (mg/L)
Monthly rainfall (mm)

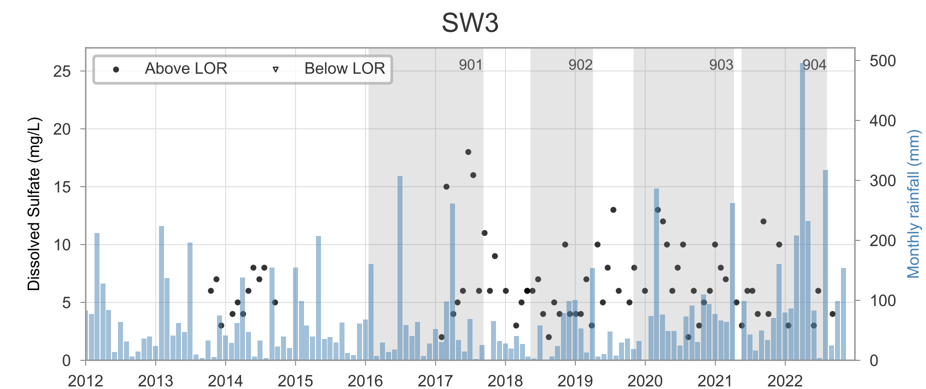

SW3
Above LOR
Below LOR
901
902
903
904
Dissolved Iron (mg/L)
Monthly rainfall (mm)
2012
2014
2016
2018
2020
2022

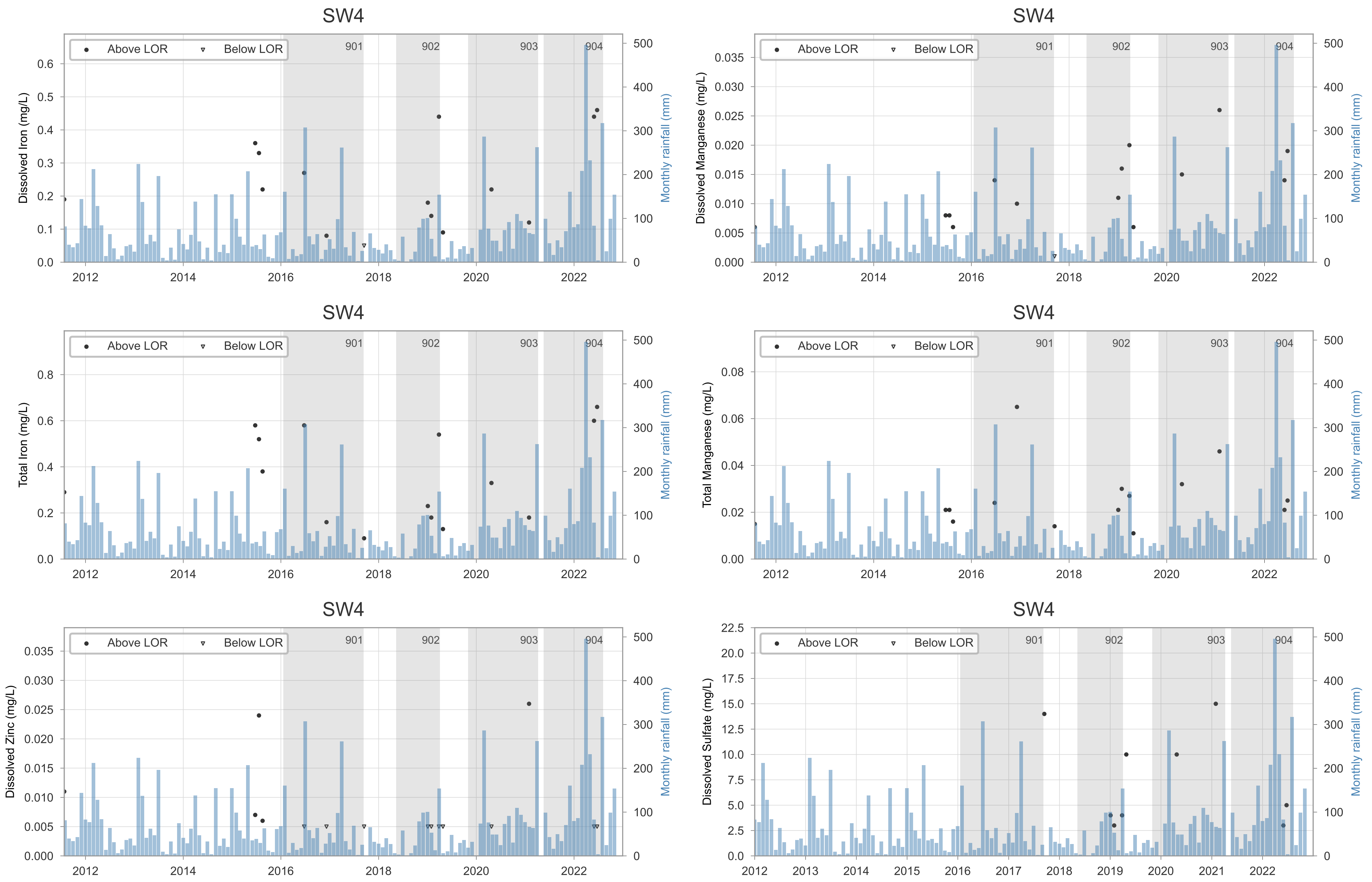

SW3
Above LOR
Below LOR
901
902
903
904
Dissolved Manganese (mg/L)
Monthly rainfall (mm)
2012
2014
2016
2018
2020
2022


SW3
Above LOR
Below LOR
901
902
903
904
Total Iron (mg/L)
Monthly rainfall (mm)
2012
2014
2016
2018
2020
2022


SW3
Above LOR
Below LOR
901
902
903
904
Total Manganese (mg/L)
Monthly rainfall (mm)
2012
2014
2016
2018
2020
2022


SW3
Above LOR
Below LOR
901
902
903
904
Dissolved Zinc (mg/L)
Monthly rainfall (mm)
2012
2014
2016
2018
2020
2022


SW3
Above LOR
Below LOR
901
902
903
904
Dissolved Sulfate (mg/L)
Monthly rainfall (mm)
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022


SW4
Above LOR
Below LOR
901
902
903
904
Dissolved Iron (mg/L)
Monthly rainfall (mm)
SW4
Dissolved Manganese (mg/L)
Monthly rainfall (mm)
SW4
Total Iron (mg/L)
Monthly rainfall (mm)
SW4
Total Manganese (mg/L)
Monthly rainfall (mm)
SW4
Dissolved Zinc (mg/L)
Monthly rainfall (mm)
SW4
Dissolved Sulfate (mg/L)
Monthly rainfall (mm)

APPENDIX 4 – Surface water chemistry TARP summary

Water quality TARP Assessment

Month_End	Site_ID	EC_max	pH_max	DO_max	Fe_tot_max	Mn_tot_max	EC_TARP	pH_TARP	DO_TARP	Fe_tot_TARP	Mn_tot_TARP
31/05/2021	NR0	109	7.8	98.8	0.36	0.015					
30/06/2021	NR0	185	7.51	98.2	0.4	0.04					
31/07/2021	NR0	226	7.56	100.2	0.27	0.012					
31/08/2021	NR0	358	7.7	100.2	0.3	0.011					
30/09/2021	NR0	285	7.47	99.9	0.36	0.013					
31/10/2021	NR0	319	7.61	87.2	0.17	0.017					
30/11/2021	NR0	275	7.72	92.1	0.79	0.032				2	
31/12/2021	NR0										
31/01/2022	NR0	160	7.49	103.3	0.63	0.036					
31/05/2021	SW3	108	7.78	99	0.34	0.012					
30/06/2021	SW3	207	7.03	93.9	0.53	0.042		2			2
31/07/2021	SW3	237	7.6	100.3	0.37	0.014		1			
31/08/2021	SW3	357	7.73	100.3	0.3	0.011					
30/09/2021	SW3	263	7.3	99.2	0.35	0.012		2			
31/10/2021	SW3	402	8.16	91.3	0.19	0.016					
30/11/2021	SW3	285	7.79	87.5	0.68	0.032				2	
31/12/2021	SW3										
31/01/2022	SW3	163	7.31	89.6	0.67	0.041		2		2	2
28/02/2022	SW3										
31/03/2022	SW3										
30/04/2022	SW3										
31/05/2022	SW3	96	7.53	104.7	0.64	0.022		1		2	
30/06/2022	SW3	231	7.02	114.8	0.73	0.026		2		2	
31/07/2022	SW3										
31/08/2022	SW3										
30/09/2022	SW3	114	7.88	99	0.44	0.015					
31/05/2021	NR2	112	7.8	95.6	0.43	0.027					
30/06/2021	NR2	201	7.76	99.3	0.43	0.019					
31/07/2021	NR2	210	7.7	93.6	0.4	0.017					
31/08/2021	NR2	372	8.08	102.2	1.5	0.108				2	2
30/09/2021	NR2	329	8.08	121.8	1.44	0.103				2	2
31/10/2021	NR2	275	7.92	96.3	0.17	0.019					
30/11/2021	NR2	287	7.82	84.5	0.82	0.032					
31/12/2021	NR2										
31/01/2022	NR2	157	7.65	90.5	0.54	0.032					
28/02/2022	NR2										
31/03/2022	NR2										
30/04/2022	NR2										
31/05/2022	NR2	95	7.64	102.9	0.91	0.056					
30/06/2022	NR2	242	7.54	118.6	0.75	0.028					
31/07/2022	NR2										
31/08/2022	NR2	80	7.64	115.6	0.54	0.015					
30/09/2022	NR2	108	7.77	102.8	0.67	0.092					2
31/05/2021	NR110	106	7.73	98.8	0.38	0.017					
30/06/2021	NR110	253	7.98	92.5	0.39	0.029					
31/07/2021	NR110	258	7.85	99.7	0.41	0.015					
31/08/2021	NR110	358	8.02	83.1	0.33	0.014					
30/09/2021	NR110	262	7.36	96.1	0.37	0.012		1			
31/10/2021	NR110	418	8.17	98.4	0.22	0.014	2				
30/11/2021	NR110	272	7.57	106.8	1.63	0.067				2	2
31/12/2021	NR110										
31/01/2022	NR110	182	7.83	102.1	0.78	0.087				2	2
28/02/2022	NR110	529	8.29	78.4	0.2	0.033	2				
31/03/2022	NR110										
30/04/2022	NR110										
31/05/2022	NR110	100	7.3	110.2	0.7	0.028		1		2	
30/06/2022	NR110	231	8.09	98	0.92	0.065				2	2
31/07/2022	NR110										
31/08/2022	NR110	76	7.85	102.3	0.42	0.013					
30/09/2022	NR110	109	7.52	101.7	0.63	0.025				2	
31/10/2022	NR110	69	7.45	103.2	0.74	0.03		1		2	

TARPs Triggered							**EC**	**pH**	**DO**	**Fe (Tot)**	**Mn (Tot)**
NR110	Upstream control site									2	
NR0											
SW3								1		2	
NR2										2	2