Illawarra Metallurgical Coal

Appin Colliery

Appin Longwall 708 End of Panel groundwater and surface water assessment

HGEO Pty Ltd

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Cover Photo: Nepean River, looking upstream from location NR7 (9/9/2021)

QUALITY CONTROL

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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 7 (AA7) consists of ten approved longwalls (Longwalls 701 to 710), all located to the north of, and offset from, the Nepean River. Longwall 708 commenced on 2 April 2019 and was completed on 3 January 2022.

Potential impacts to watercourses and aquifers are monitored and managed through the AA7 Environmental Management Plan (WMP) (South32, 2015; 2021). This report presents results of the surface water and groundwater monitoring program following the end of Longwall 708 (End of Panel Report), including an assessment of data against performance criteria in the Trigger Action Response Plan (TARP). A summary of findings related to the TARP is provided below.

Summary of key surface water and groundwater findings compared to TARP:

Type / Location	Parameter	Observation	Trigger assessment
Surface water quality			
Nepean River: ▪ NR12 ▪ NR13 ▪ NR110 (background/upstream control site)	pH	Level 1 TARP for pH was triggered at NR12 (n=3) and NR13 (n=2). In both cases the TARP threshold exceedances are clear outliers related to preceding high rainfall events and there is no underlying adverse trend.	Level 1
	DO	Level 1 TARP was triggered for dissolved oxygen at NR12 on one occasion. As there is no underlying adverse trend the exceedance is not attributed to mining activities.	Level 1
	EC, Total Fe, Total Mn	Parameters within pre-Longwall 708 variability, with no significant change in trend or extended adverse changes.	Not triggered
	Gas plumes	Four gas zones reported to be active at some stage during Longwall 708 extraction. All gas zones were initially observed during previous longwalls. One gas zone (*AA7_LW703_Gas Zone 10)* featured in an update report during Longwall 708 however remains a Level 1 trigger. Estimated emission rates of <3000 L/min.	Level 1
Surface water level and flow			

Type / Location	Parameter	Observation	Trigger assessment
Nepean River within active mining area	Visual observations	No areas of dry and/or flooded riverbed for <two consecutive months	Not triggered
Surface water appearance			
Nepean River within active mining area	Iron staining, cloudiness	Not visible	Not triggered
1st and 2nd order watercourses ▪ HC10 ▪ FO1 ▪ NAV1	Visual observations (fracturing, water loss, turbidity, iron staining, algal growth)	No stream bed cracking or associated reduction in stream flow and pool desiccation has been observed. No other mining impacts have been observed.	Not triggered
Groundwater inflow to the mine	Inflow from the goaf (Over 20-day average)	Groundwater inflow remains low. Maximum 20-day average was 1.1 ML/day	Not triggered
Groundwater levels			
Private bores 10 registered bores – where accessible IMC Piezometers: ▪ S1913 (EAW5) ▪ S1936 (EAW7)	Reduction below predicted standing water level or pressure head in the Hawkesbury Sandstone.	Increasing pressure heads at VWP in Hawkesbury Sandstone sensors at S1913; recovery evident in the Bulgo Sandstone and Scarborough Sandstone sensors. Groundwater pressures in Hawkesbury Sandstone showed no trend in private bores.	Not triggered

1. INTRODUCTION

South32 Illawarra Metallurgical Coal (IMC) operates the Bulli Seam Operations (BSO) Appin Mine, extracting high quality hard coking coal for steel production. Appin Mine is an underground mine located near the township of Douglas Park in the Southern Coalfield of New South Wales (Figure 1). Mining is currently underway in two areas, referred to as Appin Area (AA) 7 and 9.

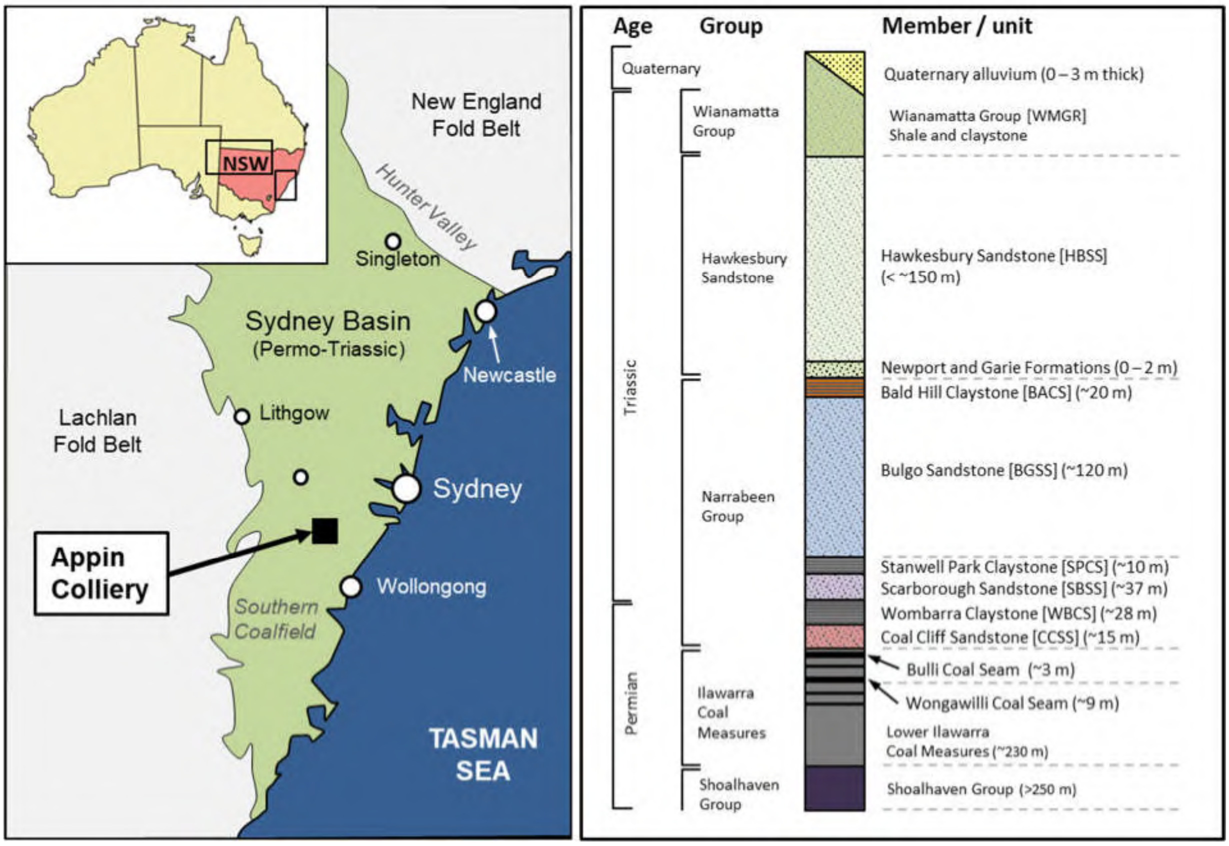


Figure 1 Stratigraphy of the southern Sydney Basin

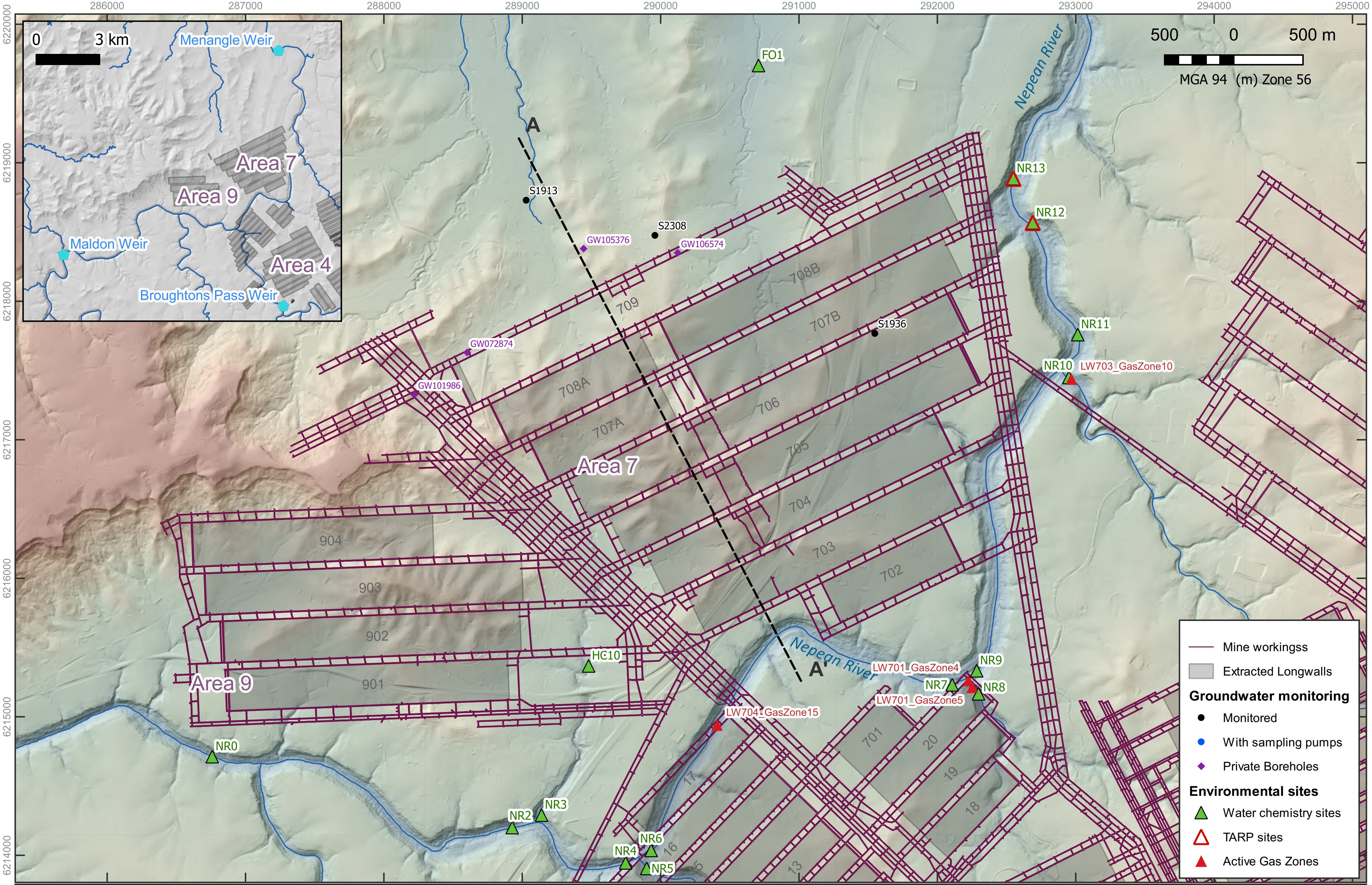
AA7 consists of ten approved longwalls (Longwalls 701 to 710) all located to the north and west of the Nepean River. IMC has previously extracted Longwalls 701 to 707 (October 2007 to June 2018) (Table 1, Figure 2). Extraction of Longwall 708 commenced on 2 April 2019 and was completed on 3 January 2022. The panel was extracted in two sections, Longwall 708A and Longwall 708B, with an approximately 170 m section of unmined coal left in between. The panel will hereon be referred to as Longwall 708.

Monitoring of potential impacts to watercourses and aquifers relevant to Longwall 708 has been carried out in accordance with the Appin Longwall 707 to 710 Environmental Management Plan (EMP), dated August 2015 and the revised EMP, dated August 2021. The revised EMP has been prepared in accordance with Conditions 13, Schedule 2 of the Appin Area 7 Subsidence Management Plan (SMP) Approval which was approved by the Resource Regulator on 17 April 2020.

This report presents results of the surface water and groundwater monitoring program following the end of Longwall 708, including an assessment of data against management criteria defined in the AA7 EMP.

Table 1. Appin Area 7 Longwall Extraction Details

Longwall	Start	Finish	Width (m)	Length (m)	Depth of Cover (m)
701	27/10/2007	09/05/2008	315	527	500 - 515
702	18/09/2008	20/04/2009	313	973	490 - 535
703	22/10/2009	03/03/2011	313	2,326	505 - 555
704	7/05/2011	29/07/2012	313	2,316	490 - 595
705	70/9/2012	27/03/2014	313	2,828	510 - 600
706	230/4/2014	28/11/2015	313	3,044	500 - 615
707A	7/01/2016	16/08/2016	313	1,035	475 - 600
707B	26/9/2016	19/06/2018	313	2,070	475 - 600
708A	2/04/2019	8/11/2019	319	1,201	550 - 620
708B	24/4/2020	3/01/2022	319	2,249	515 - 580



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Appin Area 7 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 1). 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 3).

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.
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 registered private groundwater supply bores in the vicinity of AA7 are between 70 m to 294 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. GW103161 at 17-18 m and GW104602 at 30 m; GeoTerra, 2018). Reported groundwater yields range from 0.1 L/s to 1.3 L/s, from inflow zones ranging from 9 – 225 m below ground level (bgl). Groundwater in the registered private bores, where reported, is generally fresh to brackish with salinity (total dissolved solids; TDS) between 400 and 2,500 mg/L. Most aquifer intersections over the Longwalls 701 to 708 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 S1913 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.

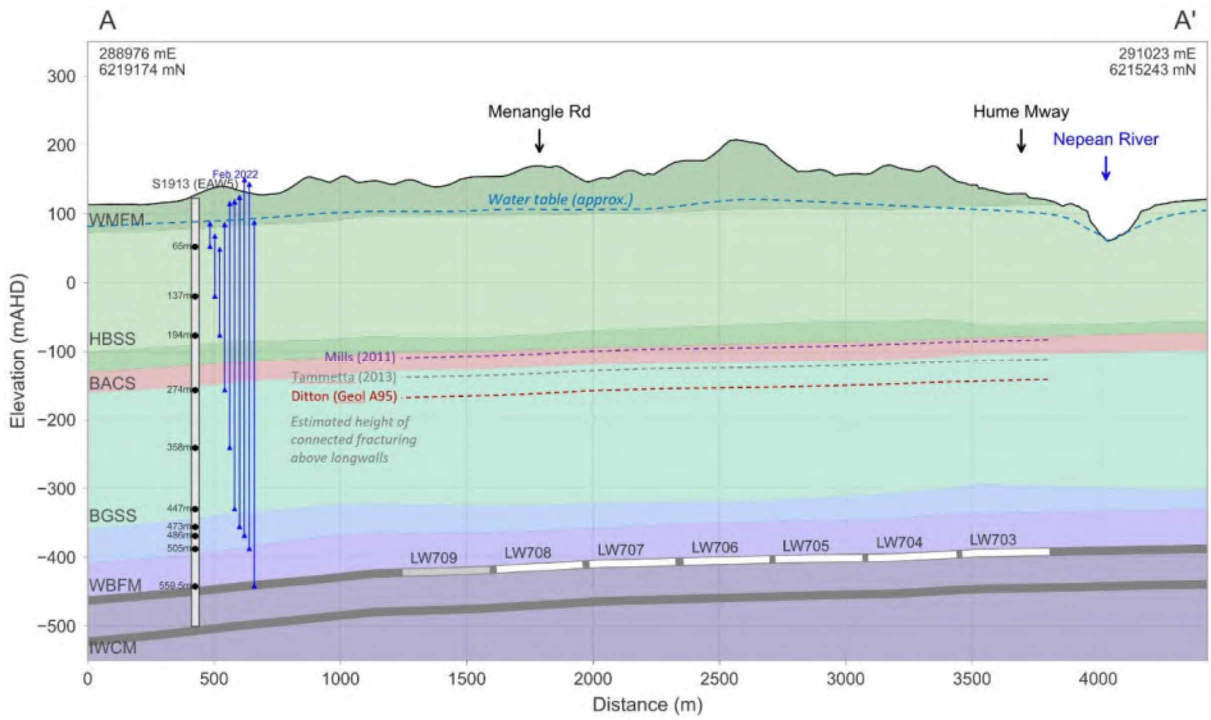

Figure 3 Hydrogeological cross section (N-S) through AA7

1.2 Surface water hydrology

Area 7 is generally undulating on the plateau and is incised by the Nepean River gorge which can be up to 70 m high, with vertical cliff faces up to 30 m. The gorge is steep sided with sandstone cliffs and steep slopes.

The Nepean River is part of the Hawkesbury-Nepean River system which originates in the uplands west of Wollongong and flows northward past Camden to its junction with the Warragamba Dam near Wallacia.

Water flows in the Nepean River are derived from several 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 water level is regulated by the Menangle Weir, which is 4.8 km downstream, and Douglas Park Weir at 1.9 km upstream, of the Area 7 longwalls. The weirs, which are outside the subsidence area of Longwalls 701 to 708, have transformed the natural free flowing regime of the river and have generated a sequence of stationary, regulated water bodies.

The section of the Nepean River that flows within the Study Area (approximately 3.6 km in length) is described as a flooded valley, because water level is controlled by the downstream Menangle Weir, and river flows are controlled by the licensed discharges form the Upper Nepean Dams, comprising the Cataract, Cordeaux, Avon and Nepean dams (MSEC, 2008).

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 at Menangle Weir).

- 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 much higher than the median flow rate at Maldon Weir, which is 21.3 ML/day, and approximately 15% less than the median flow rate at Menangle Weir, which is 56.5 ML/day. Therefore median (50 percentile) flow rate adjacent to Longwall 708 is about 48 ML/day.

Tributaries to the Nepean River within AA7 include:

- Harris Creek – an ephemeral creek with headwaters overlying the western end of Longwall 706 and flowing south-south westerly into the Nepean River. It has not been mined beneath by Longwalls 702 – 706.
- Foot Onslow Creek – an ephemeral creek with headwaters overlying the northern central section of Longwall 707B and flowing northerly until it joins the Nepean River, approximately 3 km north of the proposed Longwall 710.

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 Surface water quality

Baseline water qualities in the Nepean River, especially under the ecologically more critical low flow conditions (<50 percentile), are clearly dominated by the following processes:

- inputs of more acidic water from Cataract River
- low flow inputs of more saline water from Harris, Elladale and Ousedale Creeks which have negligible to minor bulk effect on overall river salinity
- consistent inputs of low dissolved oxygen (DO) water from Cataract River (and Elladale Creek) which is the primary driver of DO in the Nepean River immediately downstream of the Cataract River confluence
- a relatively low rate of re-aeration downriver of the Cataract River confluence (the flooded geomorphology of the River is such that it has a low re-aeration coefficient adjacent to Area 7
- consistent inputs of iron (Fe) and manganese (Mn) to the river from Cataract River and Elladale Creek (Ecoengineers, 2014).

Runoff into the Nepean River is dominated by a Cumberland Plains (Lowlands) landscape, comprising Hawkesbury Sandstone and Wianamatta Shale outcrops. Several tributaries of the Upper Nepean River naturally contribute relatively saline water to the Nepean River. For example, the Elladale Creek arises in Cumberland Plain landscape almost exclusively dominated by Wianamatta Shale. These shale-derived soils are such that salinities in the middle and lower sections of this creek frequently exceed 3000 µS/cm. However, the salinity (EC) of the Nepean River is unlikely to exceed 1000 µS/cm, even with the Appin West Colliery licensed discharge to Allens' Creek (Geoterra, 2018).

1.4 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 AA7 is unlikely to extend above the base of the Bald Hill Claystone. A recent review commissioned by the Department of Planning and the Environment (DPE) of published methods for estimating the height of fracturing (PSM, 2017) concluded that the empirical approaches of Ditton and Merrick (2014) and Tammetta (2013) may not be accurate for all mining settings and such estimates should be considered indicative only. However, the observation of low water make at AA7 and strata gas movements is consistent with the extent of connective fracturing being limited to below the Bald Hill Claystone.

1.4.1 Ground subsidence

Ground subsidence and potential effects on natural and built surface features was assessed by MSEC (2008), prior to commencement of mining of Longwalls 705 to 710. Contours of predicted subsidence after Longwall 708 are reproduced in (Figure 4) (based on the original mine plan). Approximately 20 mm or less subsidence was expected at the Nepean River in response to Longwall 708 (with the original and final mine plans) and approximately 1000 mm of subsidence is expected directly above the longwall.

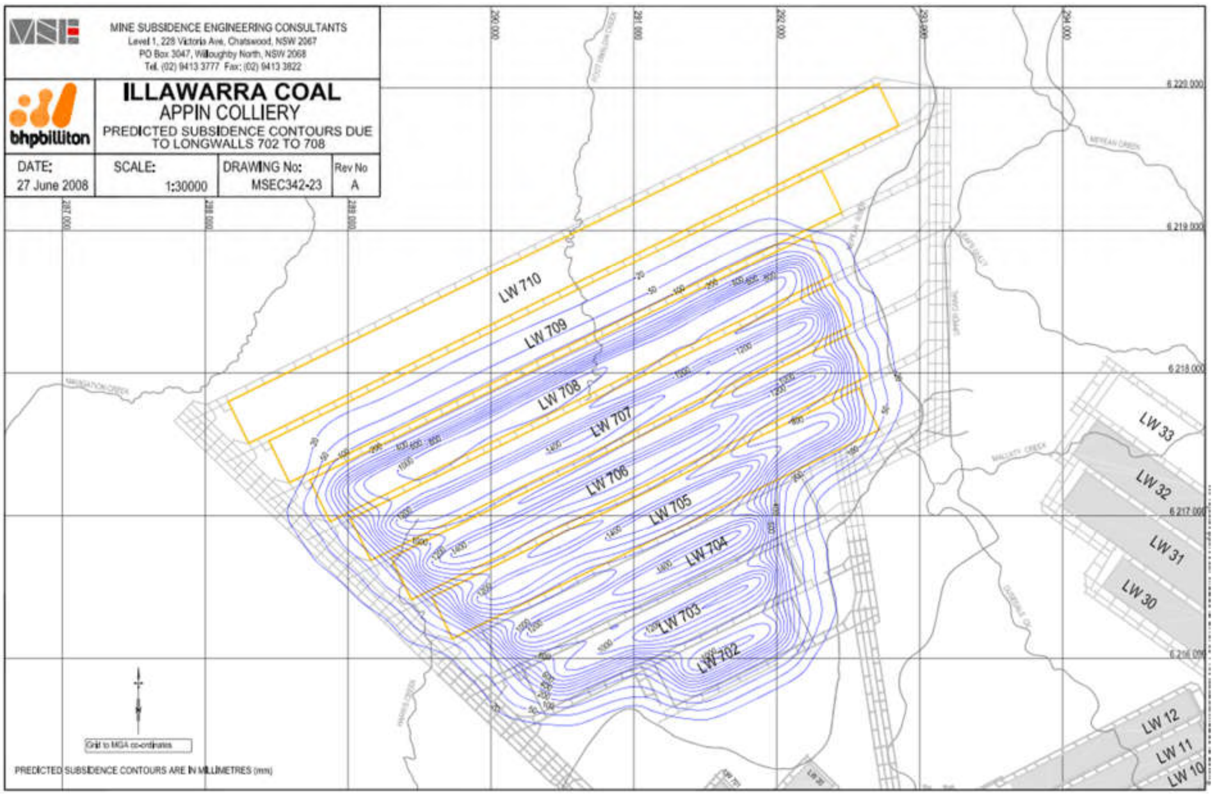

Figure 4. Contours of predicted subsidence due to Longwalls 705 to 708 (in mm, MSEC, 2008)

An End of Panel subsidence assessment was carried out following the completion of mining Longwall 708 (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 708 that flow into the Nepean River. The impacts on natural drainage lines associated with the extraction of Longwall 708 recorded by the IMC Environmental Field Team were similar to or less than the MSEC assessments.

1.4.2 Surface water and groundwater effects

Ecoengineers (2008) and GeoTerra (2008) identified a number of possible water related environmental consequences that may occur due to the extraction of Longwalls 705 to 710. Those consequences are summarised in Table 2.

Table 2. 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 one or more zones of gas emission will appear in the Nepean River as a consequence of mining Longwalls 705 to 710. Potential effects may include Dissolved Oxygen “sags”, and visible iron precipitates (localised iron staining).	Impact: Negligible Likelihood: High (Ecoengineers, 2008)
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, 2008)

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	The potential for the diversion of surface water in the Nepean River due to mining of longwalls 705 to 710 is very low as the riverbed is flooded and the gradient of the river is very flat. Any rockbars present along the riverbed are completely submerged.	Impact: Negligible Likelihood: Rare (Ecoengineers, 2008)
Impacts to streams and farm dams	Many farm dams have been mined under and monitored, with only a small number of dams exhibiting minor impacts following mining. It is predicted that the impact on farm dams from mining Longwalls 705 to 710 will be similar.	Impact: Minor Likelihood: Low (Ecoengineers, 2008)
Reduced groundwater yield	Ten registered bores are within the SMP for Longwalls 705 to 710 and may be affected by subsidence, where the bores predominantly obtain water from the Hawkesbury Sandstone, rather than the overlying Wianamatta Group shale and sandstones.	Impact: Negligible Likelihood: Likely (GeoTerra, 2008)
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. Potential impacts may include increased concentrations of iron and other metals, and precipitation of iron hydroxide. Monitoring of potentially affected bores within AA7 is conducted in consultation with the owners.	Impact: Negligible Likelihood: Likely (GeoTerra, 2008)
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, 2008)

1.5 Water management framework

Groundwater and surface water monitoring and reporting is carried out according to the AA7 EMP (South32, 2015; 2021). The objectives of the EMP are to identify at risk surface water and groundwater features and characteristics within the Longwalls 705 to 710 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.

1.5.1 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 Environmental Management Plan (South32, 2015; 2021) 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 3. Water chemistry TARP trigger levels calculated from baseline data (prior to the start of mining) are presented in Table 4.

Table 3. TARP performance criteria for AA7

<table>
<tr><th>Type / Location</th><th>Parameter</th><th>Level 1</th><th>Level 2</th><th>Level 3</th><th>Exceeding prediction</th></tr>
<tr><td>Surface water quality</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="4">Nepean River:
▪ NR12
▪ NR13

Notes:
Baseline upriver site NR110 will be used for cross-checking upriver perturbations

* Compared with baseline monitoring prior to mining</td><td>pH</td><td>Reduction* > 1SD < 2SD for two consecutive months</td><td>Reduction* > 2SD for two consecutive months</td><td rowspan="4">As for Level 2, for six consecutive months</td><td></td></tr>
<tr><td>DO</td><td>Reduction* > 1SD < 2SD for two consecutive months</td><td>Reduction* > 2SD for two consecutive months</td><td></td></tr>
<tr><td>EC, Total Fe, Total Mn</td><td>N/A</td><td>Increase* > 2SD for 2 consecutive months</td><td></td></tr>
<tr><td>Gas plumes</td><td>Plume <3000 L/min</td><td>Plume >3000 L/min</td><td>More than negligible</td></tr>
<tr><td>Surface water level and flow</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Nepean River within active mining area
Compared with baseline observations and flows</td><td>Visual observations</td><td>Areas of dry and/or flooded riverbed for <two consecutive months</td><td>Areas of dry and/or flooded riverbed for >two consecutive months</td><td>As for Level 2, for six consecutive months</td><td></td></tr>
</table>

Type / Location	Parameter	Level 1	Level 2	Level 3	Exceeding prediction
Surface water appearance					
Nepean River within active mining area	Iron staining, cloudiness	Visible from mining for two consecutive months	Greater than baseline for two consecutive months	As for Level 2, for six consecutive months	More than negligible
1st and 2nd order watercourses ▪ HC10 ▪ FO1 ▪ NAV1 *Compared with baseline observations*	Visual observations (fracturing, water loss, turbidity, iron staining, algal growth)	Fracturing with no surface water loss or pool water level reduction; increase in turbidity, iron staining, algal growth for two consecutive months	Fracturing with surface water loss or pool water level reduction; increase in turbidity, iron staining, algal growth for two consecutive months	Iron staining/cloudiness greater than baseline for six consecutive months	
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 10 registered bores – where accessible IMC Piezometers: ▪ S1913 (EAW5) ▪ S1936 (EAW7)	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. Mining results in private bores unsafe, unserviceable or damaged.	

In relation to surface water flows, BSO Approval Condition 13, Schedule 2 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 4. Baseline water chemistry TARP trigger levels

Parameter		NR110 (Reference)	NR12	NR13
EC	**Mean**	240	180	180
	Mean +1SD	332	230	229
	Mean +2SD	424	280	278
pH	**Mean**	7.90	7.54	7.43
	Mean -1SD	7.48	7.20	7.08
	Mean -2SD	7.06	6.86	6.73
DO	**Mean**	84.19	88.03	86.99
	Mean -1SD	68.97	77.41	74.17
	Mean -2SD	53.75	66.79	61.35
Fe (Total)	**Mean**	0.328	0.421	0.407
	Mean +1SD	0.459	0.556	0.536
	Mean +2SD	0.59	0.691	0.665
Mn (Total)	**Mean**	0.025	0.034	0.034
	Mean +1SD	0.040	0.046	0.047
	Mean +2SD	0.055	0.058	0.060

2. MONITORING NETWORK

2.1 Surface water monitoring

Surface water levels and chemistry are monitored at the sites listed in Table 5, below, in accordance with the EMP (South32, 2021).

Table 5. Surface water monitoring locations

Site	Watercourse	MGA_mE	MGA_mN	Field Observations	Chemistry (Lab)	Water level
Nepean River						
NR0	Nepean River	286759	6214712	Y	Y	Y
NR2	Nepean River	288927	6214200	Y	Y	Y
NR4	Nepean River	289747	6213945	Y	Y	Y
NR6	Nepean River	289931	6214035	Y	Y	
NR7	Nepean River	292107	6215231	Y	Y	
NR9	Nepean River	292284	6215332	Y	Y	Y
NR11	Nepean River	293014	6217759	Y	Y	
NR12	Nepean River	292689	6218566	Y	Y	Y
NR13	Nepean River	292549	6218885	Y	Y	Y
NR50	Nepean River	291846	6222440	Y	Y	
NRL05	Nepean River	289218	6214146			Y
NRL10	Nepean River	289798	6213946			Y
NRL20	Nepean River	289995	6214168			Y
NRL25	Nepean River	291203	6215541			Y
NRL30	Nepean River	291782	6215324			Y
NRL35	Nepean River	292333	6215367			Y
NRL40	Nepean River	292451	6215984			Y
NRL45	Nepean River	292273	6216848			Y
NRL48	Nepean River	292524	6217044			Y
Pump 1 - NRL	Nepean River	290080	6214380			Y
Pump 2 - NRL	Nepean River	290512	6215160			Y
Pump 5 - NRL	Nepean River	292880	6217510			Y
Pump 6 - NRL	Nepean River	292780	6218040			Y
NR110	Nepean River	284812	6213103	Y	Y	Y

Site	Watercourse	MGA_mE	MGA_mN	Field Observations	Chemistry (Lab)	Water level
1st and 2nd watercourses						
NR5	Cataract River	289899	6213905	Y	Y	Y
NRL15	Cataract River	289903	6213895			Y
NR8	Elladale Creek	292297	6215166	Y	Y	Y
NRL33	Elladale Creek	292299	6215165			Y
FO1	Foot Onslow Creek	290707	6219700	Y	Y	
NR3	Harris Creek	289139	6214290	Y	Y	
NR40	Menangle Creek	293350	6222117	Y	Y	
NAV1	Navigation Creek	289188	6220993	Y	Y	
NR10	Ousedale Creek	292950	6217450	Y	Y	
NRL50	Ousedale Creek	292999	6217419			Y
HC10	Upper Harris Creek	289479	6215367	Y	Y	
WaterNSW flow monitoring site*						
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

2.2 Groundwater monitoring

2.2.1 Vibrating wire piezometers

Groundwater levels are monitored using multi-level vibrating wire piezometers (VWP) which are grouted into boreholes. There are three groundwater monitoring sites relevant to AA7 operations and specified in the TARP, listed in Table 6, and shown in Figure 2.

Table 6. Groundwater (VWP) monitoring sites in AA7

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
S2308		630.5	8	HBSS, BGSS, SBSS, BUSM	2015

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 Section 4.1.1.

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 708.

2.2.2 Private bores

There are 10 private registered bores within the vicinity of Longwalls 705 to 710 (Table 7; Figure 1). Pre- and post-mining groundwater level and water quality assessments are undertaken where possible with consent of the relevant property/infrastructure owner and tenant.

For Longwall 708, pre- and post-mining groundwater assessment of private bores and groundwater level monitoring was undertaken at:

- GW072874 (Lot 10 DP245756)
- GW101986 (Lot 900 DP1072947)
- GW105376 (Lot 73 DP883462)

Table 7. Private bore summary

Bore ID	Easting	Northing	Depth	Lithology	Date drilled	Purpose
GW072874	6217630	288600	189	Sandstone	1992	Domestic
GW101986	6217328	288223	210	Sandstone	1998	Domestic
GW104602	6216148	288909	231	Sandstone	2002	Stock
GW104661	6216470	288973	219	Sandstone	2003	Domestic/stock
GW105339	6218356	291919	238	Sandstone	2003	Domestic/stock/irrigation
GW105376	6218379	289442	218.5	Sandstone	2002	Water supply
GW105388	6217892	289888	230	Sandstone/shale	2002	Domestic/stock
GW105534	6217297	288655	207	Sandstone	2003	Domestic/stock
GW105574	6218908	289656	210	Sandstone	2003	Domestic
GW106574	6218350	290123	238	Sandstone	2002	Domestic

2.2.3 Mine inflow

Groundwater inflow to AA7 is calculated from the daily mine water balance by accounting for water pumped in and out of the mine area.

2.3 Weather observations

Rainfall and solar exposure data have been collected at Douglas Park (Bureau of Meteorology site 068200) since 1974 (with some gaps). Average annual rainfall since 1974 is 752 mm (2.06 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. 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.

Monthly rainfall, cumulative rainfall residual and solar radiation since the start of 2012 are plotted in Figure 5. Since early 2020, and during much of the review period, rainfall has been well-above average, following a period of severe drought between 2017 and 2019.

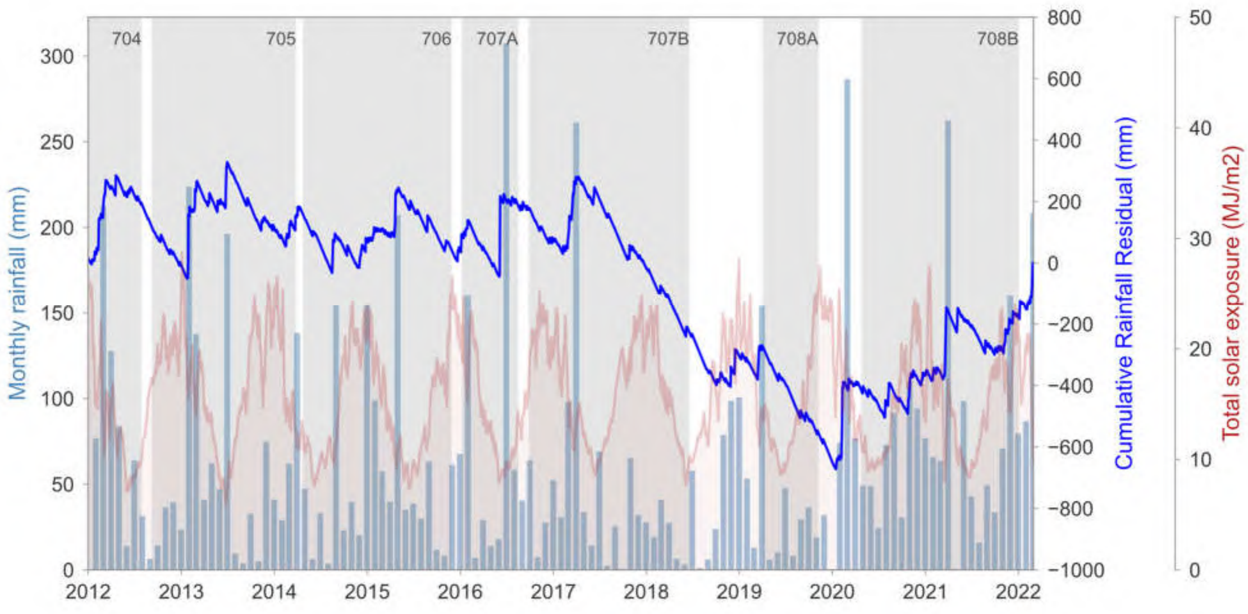

Figure 5. Weather observation at Douglas Park (St Mary's Tower)

3. SURFACE WATER ASSESSMENT

Observations and laboratory analyses of surface water level and chemistry are presented as time-series plots (hydrographs) in Appendix A. Comparison to surface water TARP are presented in Appendix B.

3.1 Water level and flow

3.1.1 Nepean River flow

Flow monitoring in the Nepean River is undertaken upstream (Maldon Weir) and downstream (Menangle Weir) of the AA7 mining area. Flow monitoring on the Cataract River at Broughtons Pass Weir measures the flow of the major tributary input to Nepean River between the two Nepean River flow stations.

The recorded flow rates at Menangle Weir (downstream of AA7) and Maldon Weir (upstream of AA7) are plotted in Figure 6. Monitoring of Nepean River gauging weirs at Maldon and Menangle and the Cataract River at Broughtons Pass showed that there were zero no-flow days recorded for the during the period April 2019 to January 2022 during LW708 extraction.

The Nepean River is a gaining system in the vicinity of AA7 and therefore the flowrate increases downstream due to baseflow contributions and inflow from minor catchments along the reach. The ratio of the flow rates at the Menangle and Maldon weirs is plotted in Figure 7 to assess any potential loss of surface water between the upstream and downstream monitoring sites. A Menangle/Maldon ratio <1 would indicate that flow at the upstream Maldon Weir was greater than the downstream Menangle Weir and could potentially indicate loss of surface water. The flow at Maldon Weir exceeded the flow in the downstream Menangle Weir during October 2019, but subsequently remained less than or equal to the flow at Menangle Weir throughout mining at Longwall 708.

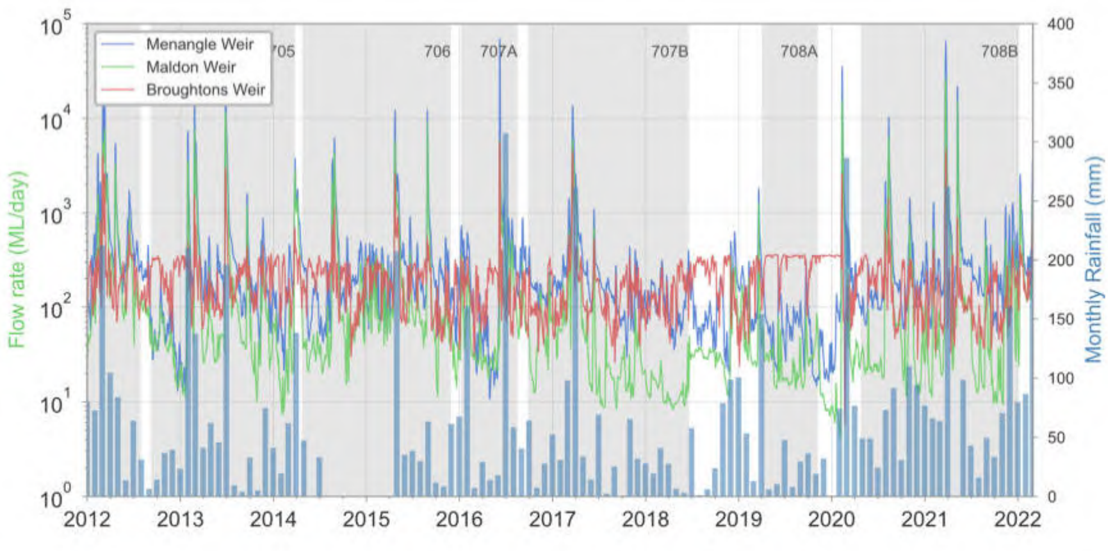

Figure 6. Nepean River flow rates at WaterNSW weirs

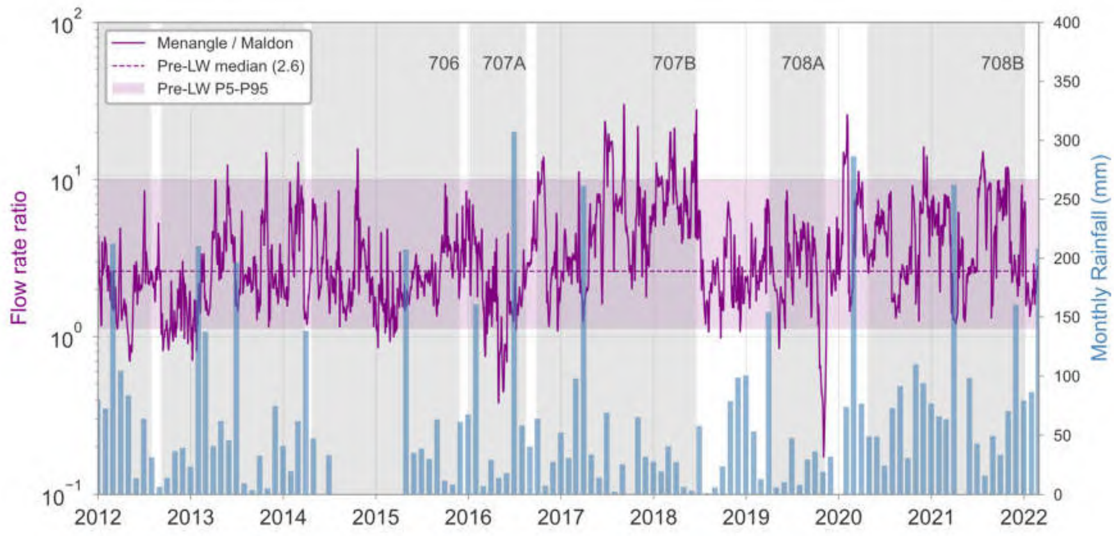

Figure 7. Flow ratio between the Menangle (upstream) and Maldon (downstream) weirs

3.1.2 Nepean River and tributaries water level

Water levels are measured monthly at benchmark sites along the Nepean River and some 1st and 2nd order water courses. Surface water levels are measured relative to a reference benchmark at the site. Water levels are displayed as a time-series with other field observations for the Nepean River and tributary monitoring sites in Appendix A. 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 that are within the baseline range during the reporting period for Longwall 708. Water levels at NR12 (adjacent to Longwall 707) and NR13 (adjacent to Longwall 708) were below the 5th percentile value on several occasions at the start of mining of Longwall 708 in 2019. However, water levels returned to within P5-P95 values in 2020, corresponding with above average rainfall during this time, and generally remained within the baseline range for the remaining Longwall 708 monitoring period. Water levels were also below the 5th percentile on several occasions at the upstream (control) monitoring site (NR110) for the same period, and therefore the water level declines are not attributed to mining activities.

Trigger Action Response Plan (TARP) levels for surface water flow/levels are listed in Table 3. Criteria for triggering TARP levels in the Nepean River are based on where dry and/or flooded areas of riverbed were observed during the extraction of Longwall 708. Criteria for triggering TARP levels for 1st and 2nd order watercourses (Upper Harris Creek, Foot Onslow Creek, and Navigation Creek) are based on fracturing resulting in loss of surface water flow or reduction in pool water levels.

During Longwall 708, no TARP trigger levels were attained for water level or flow in comparison to baseline observations.

3.2 Water quality

In line with the TARP monitoring requirements for surface water quality, the following discussion is focussed on sites NR110 (background), NR12 (directly upstream and adjacent to Longwall 707) and NR13 (adjacent to Longwall 708).

The TARP levels for surface water quality parameters are listed in Table 4. Criteria for triggering TARP levels are based on both magnitude and duration. For example, a TARP Level 2 is triggered at Site NR12 if the pH at that location is reduced by more than the baseline mean plus two standard deviations for at least two consecutive months, but less than six consecutive months.

Time-series plots of key surface water quality parameters for all relevant surface water monitoring sites (as listed in EMP and Table 4) are presented in Appendix A. Analysis of the water quality graphs in relation to the TARP criteria is provided in tabular format in Appendix B and summarised in Table 8.

During the Longwall 708 extraction period, the Nepean River salinity, measured as electrical conductivity (EC) generally maintained similar pre-Longwall 708 variability, with no significant change in trend or extended adverse changes in salinity. No TARP trigger levels were reached for EC at NR12 and NR13.

Level 1 TARPs were triggered for pH at NR12 on three occasions (April 2020, September 2020 and May 2021) and at NR13 on two occasions (September 2020 and May 2021). In both cases the TARP threshold exceedances are clear outliers related to preceding high rainfall events and there is no underlying adverse trend.

Level 1 TARPs were triggered for dissolved oxygen at NR12 on one occasion (February 2021). As there is no underlying adverse trend the exceedance is not attributed to mining activities.

Therefore, it is concluded that there was no significant change in trend or extended adverse changes that occurred for pH and DO during Longwall 708 extraction and variations are not attributed to mining activities.

During the Longwall 708 extraction period, the total iron and manganese concentrations within the water of the Nepean River at NR12 and NR13 maintained similar pre-Longwall 708 variability, with no significant change to the observed ranges as a result of extraction of Longwall 708. No significant change in trend or extended adverse changes occurred for iron and manganese. No TARP trigger levels were reached for iron or manganese.

At the upstream control site (NR110), EC TARP levels 2 and 3 for were triggered on several occasions. The EC has historically shown large variations at this location, related to fluctuations in rainfall and water level.

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

TARP Site	NR110 (Upstream control)	NR12 (upstream, adjacent to LW 707)	NR13 (Adjacent to LW708)
EC	TARP Level 2 (2) and TARP Level 3(1) triggered	No TARPs triggered	No TARPs triggered
pH	No TARPs triggered	TARP Level 1 triggered (3)	TARP Level 1 triggered (2)
DO	No TARPs triggered	TARP Level 1 triggered (1)	No TARPs triggered
Fe (Total)	No TARPs triggered	No TARPs triggered	No TARPs triggered
Mn (Total)	No TARPs triggered	No TARPs triggered	No TARPs triggered

Note: number of occasions presented in brackets

3.3 Water quality – visual observations

Visual observations of water quality, including iron staining, water cloudiness, and algal growth are undertaken along the Nepean River within the active mining area, and at three locations on 1st and 2nd order water courses (Upper Harris Creek (HC10), Foot Onslow Creek (FO1), and Navigation Creek (NAV1)). Signs of fracturing with loss of surface water and reduction in pool level is also undertaken at the three locations on the 1st and 2nd order water courses. Monitoring is undertaken by IMCEFT and reported in the End of Panel Landscape Report for Longwall 708 (South32, 2022a).

Trigger Action Response Plan (TARP) levels for surface water quality appearance are detailed in Table 3. For example, a TARP Level 1 is triggered when there is visual iron staining or water cloudiness for two consecutive months.

During extraction of Longwall 708, no observable iron staining or water cloudiness was noted along the Nepean River in active mining areas, or tributaries.

No stream bed cracking or associated reduction in stream flow and pool desiccation has been observed in the plateau streams during Longwall 708 extraction.

In summary, no TARP trigger levels were reached for water quality appearance along the Nepean River or 1st and 2nd order tributaries.

3.4 Gas emissions

Gas seepage was observed in the Nepean River prior to Longwall 708 extraction period at numerous locations in the Nepean River with three new gas zones (16, 17 and 18) identified during Longwall 705 extraction. During the monitoring period for Longwall 708, gas releases were detected at four sites, initially reported during previous longwalls. One gas release zone (AA7_LW703_Gas Zone 10) update was reported during Longwall 708 however the trigger level did not change.

Observed gas zones had estimated emission rates of <3000 L/min and are classified as TARP Level 1. Gas emissions are described in detail in the End of Panel Landscape Report for Longwall 708 (South32, 2022a) and summarised on Table 9. The locations of the gas zones are shown in Figure 2.

The following actions were initiated in response to the Level 1 triggers, in accordance with the WMP:

- Continue monitoring program
- Submit an Impact Report to relevant stakeholders
- Report in the End of Panel Report
- Summarise actions and monitoring in the AEMR.

Table 9. Summary of gas emissions during Longwall 708 extraction

Site ID	Identification Date	Status (as of 17/01/2022)	Description	TARP trigger level
AA7_LW701_ Gas Zone 4	15/01/2008	Inactive	Six constant, moderate gas releases within a 2 m^2 surface area. Identified on one inspection during Longwall 708.	1
AA7_LW701_ Gas Zone 5	1/02/2008	Active	Light to moderate intermittent gas release within a 2 m by 5 m surface area. Identified on two inspections during Longwall 708.	1
AA7_LW703_ Gas Zone 10 (Update)	21/05/2010 & 2/11/2020	Active	10 to 12 light, intermittent releases within a 15 m by 5 m surface area. Identified on 26 inspections during Longwall 708.	1
AA7_LW704_ Gas Zone 15	2/08/2012	Inactive	20 light to moderate gas releases within a 20 m by 10 m surface area. Identified on one inspection during Longwall 708.	1

4. GROUNDWATER ASSESSMENT

4.1 Groundwater levels

4.1.1 Vibrating wire piezometers

Groundwater bore hydrographs for VWP monitoring bores are presented in Figure 8 to Figure 10. Observations in relation to temporal trends in groundwater pressures are listed in Table 10. No changes outside of predictions for the VWP monitoring bores occurred during Longwall 708 and no groundwater level reduction TARP triggers were exceeded.

Table 10. Groundwater level observations (VWP)

Bore	Observations	TARP Level
S1913 (EAW5)	S1913 is located 1.2 km northwest of Longwall 708. It has three sensors in the Hawkesbury Sandstone at 65 m, 137 m and 194 m depth. During Longwall 708, groundwater level data was unavailable between October 2019 to August 2020. However, from April 2021 pressures at all three depths showed an increasing trend, following significant rainfall in March 2021 (262.5 mm). Pressures at the upper two Hawkesbury Sandstone sensors were above the level of the Nepean River during Longwall 708. Pressures at the 194 m sensor have been below the level of the Nepean River since prior to the commencement of mining in AA7. Other notable changes included: • 15 m increase in pressure head during May 2021 at the Bulgo Sandstone 274 m sensor • 20 m increase in pressure head in November 2020 at the Scarborough Sandstone 505 m sensor • Continuing declining trend in Bulli Seam. Pressure heads within the lower Bulgo Sandstone and Scarborough Sandstone remained artesian, and sub-artesian in the upper Bulgo Sandstone. There are clear differences in the behaviour of groundwater pressures above and below the Bald Hill Claystone, providing evidence that the Bald Hill Claystone is an effective confining unit across the area.	Not triggered
S1936 (EAW7)	S1936 is located approximately 400 m southeast of Longwall 708 and above Longwall 706. All sensors apart from the shallowest Hawkesbury Sandstone sensor (65 m) failed in 2014 due to subsidence in AA7. During Longwall 708, groundwater pressure at the 65 m Hawksbury Sandstone sensor showed a slight declining trend (<1 m during Longwall 708); however, no TARP triggers were exceeded.	Not triggered
S2308	S2308 is located approximately 500 m north of Longwall 708. It has three sensors in the Hawkesbury Sandstone at 70 m, 135.2 m and 200.3 m depth. No water head changes that could be associated with longwall extraction were recorded in the Hawkesbury Sandstone or underlying Bulgo and Scarborough sandstones. The top Hawkesbury Sandstone piezometer installed 70 m below ground level has recorded some 16 m water head increase during longwall extraction.	Not triggered

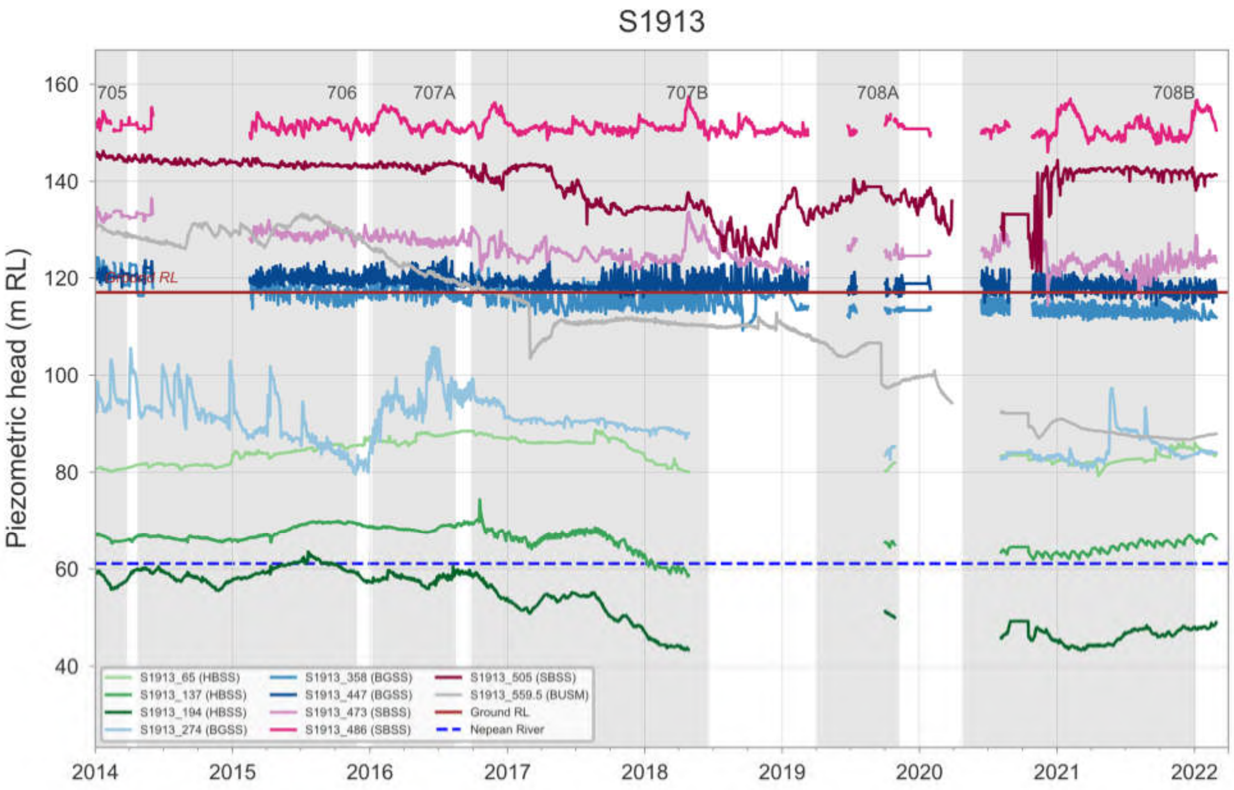

Figure 8. Groundwater hydrograph for VWP S1913

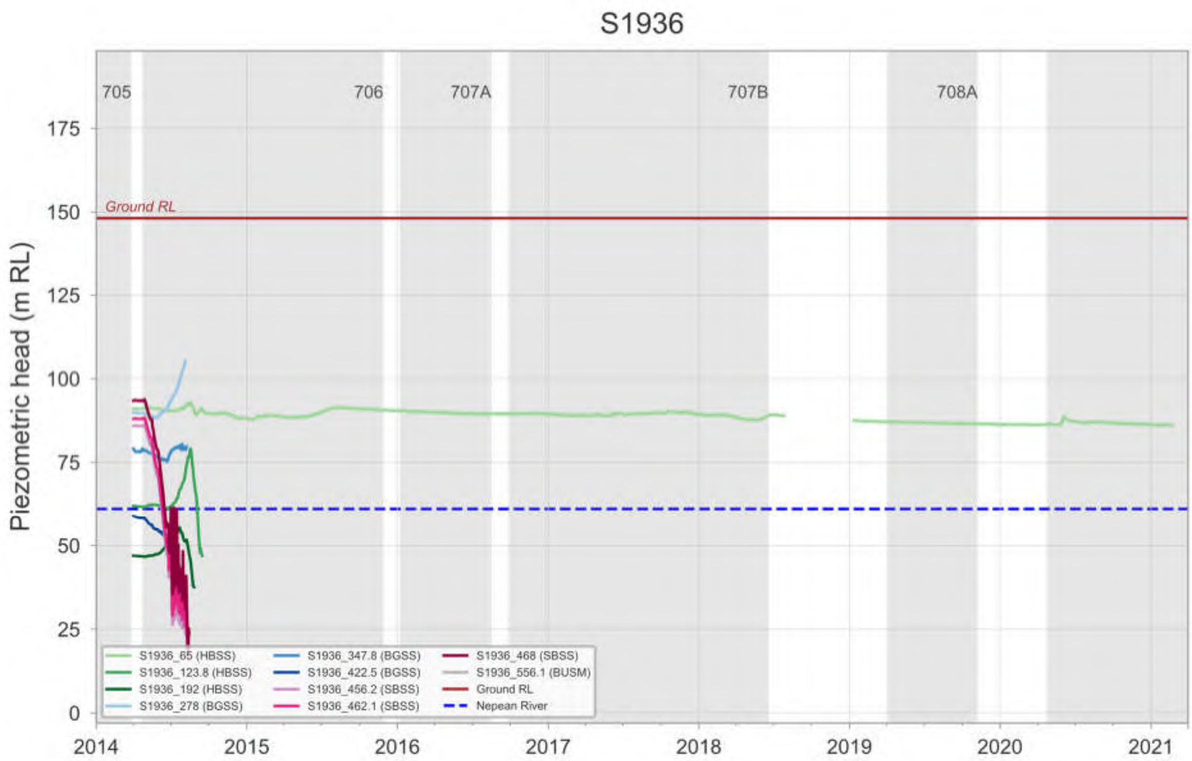

Figure 9. Groundwater hydrograph for piezometer S1936

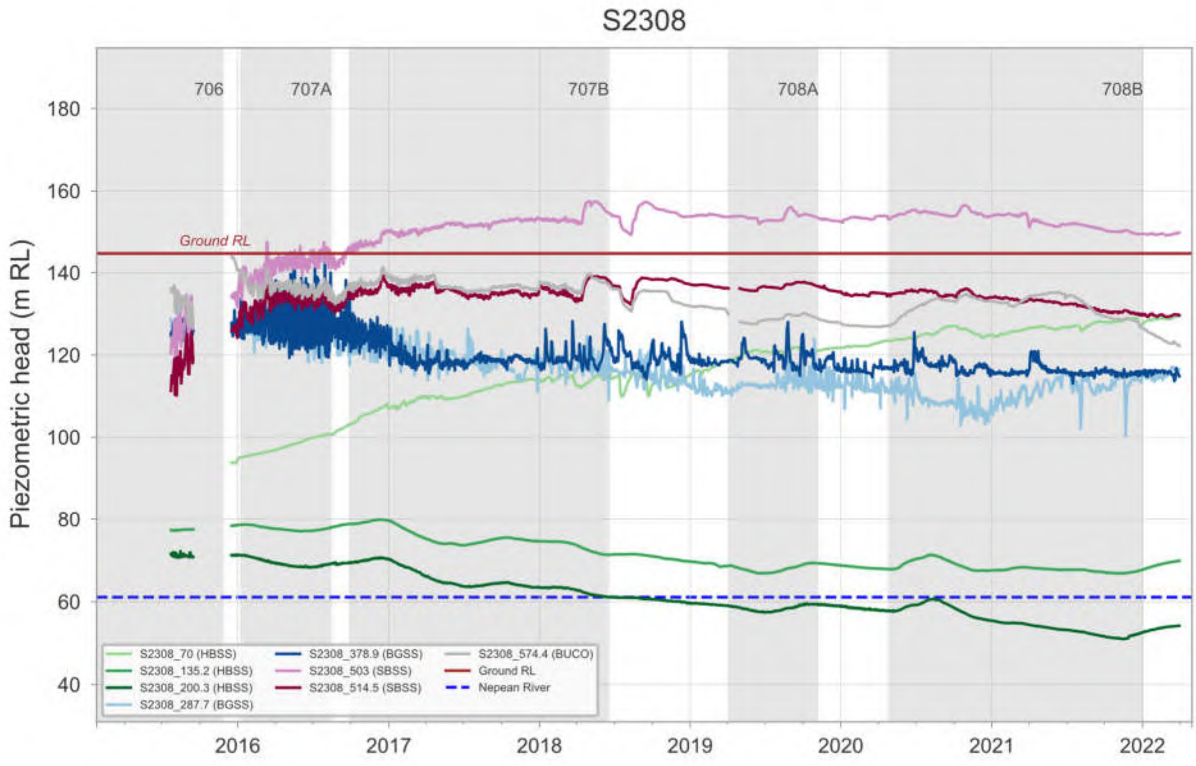

Figure 10. Groundwater hydrograph for piezometer S2308

4.1.2 Private registered bores

Groundwater bore hydrographs for private bores in the Hawkesbury Sandstone aquifer are presented in Figure 11 to Figure 13. Observations in relation to temporal trends in groundwater pressures are listed in Table 11. No groundwater level reduction TARP triggers were exceeded.

Table 11. Groundwater level observations (private registered bores)

Bore	Observations	TARP Level
GW072874	• Water levels monitored at ½ hourly intervals since 15/03/2021 • Large daily fluctuations in WL associated with pumping • No WL trend noted during monitoring period	Not triggered
GW105376	• Water levels monitored at ½ hourly intervals since 6/05/2021 • Piezometer was removed from hole by a 3rd party on 11 Aug 2021 and subsequently was returned to the hole at an estimated 121.7 (from 200m) • Large daily fluctuations in WL associated with pumping • No WL trend noted during monitoring period	Not triggered
GW106574	• Water levels monitored at hourly intervals since 24/04/2020. • No WL trend noted during monitoring period	Not triggered

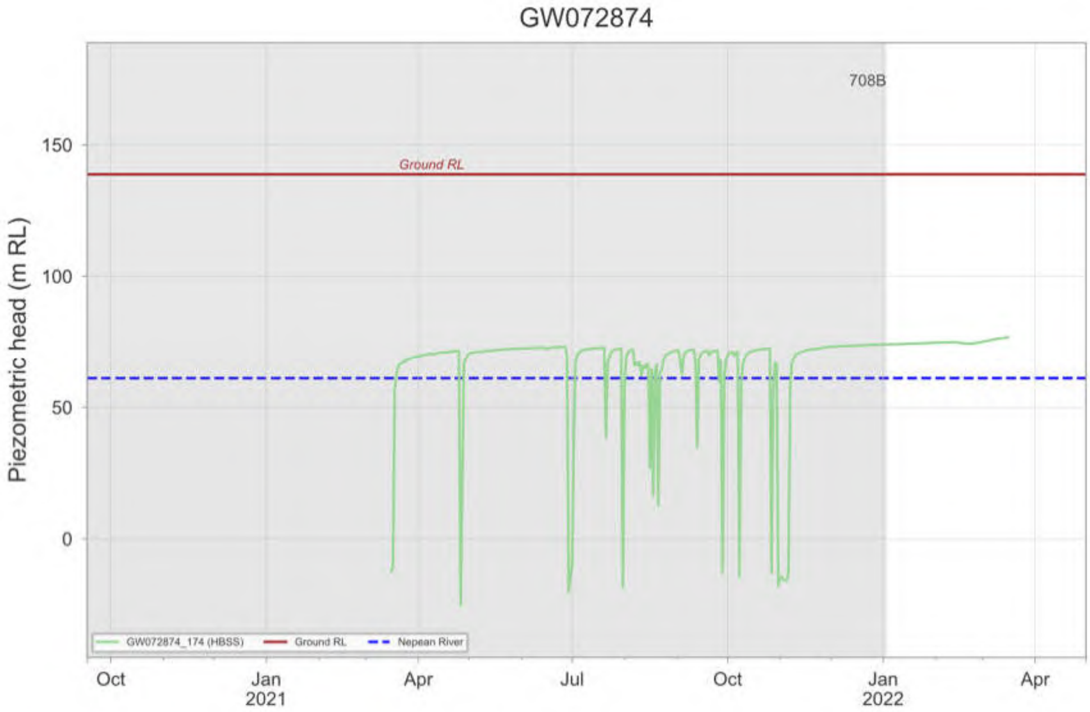

Figure 11. Groundwater hydrograph for GW072874

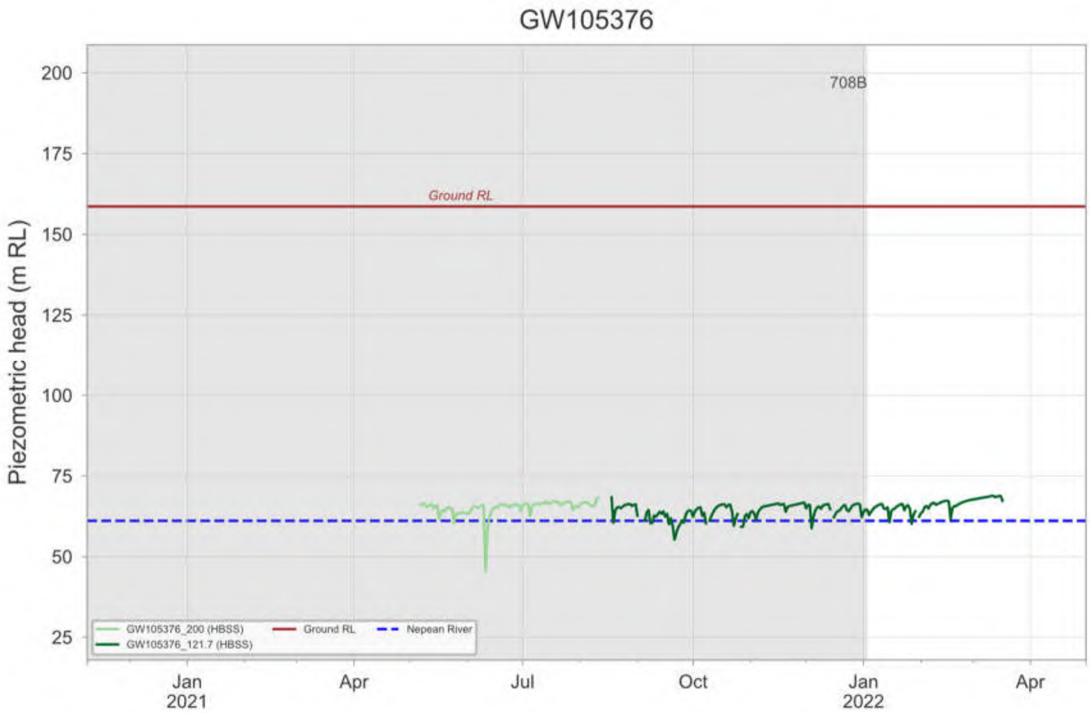

Figure 12. Groundwater hydrograph for GW105376

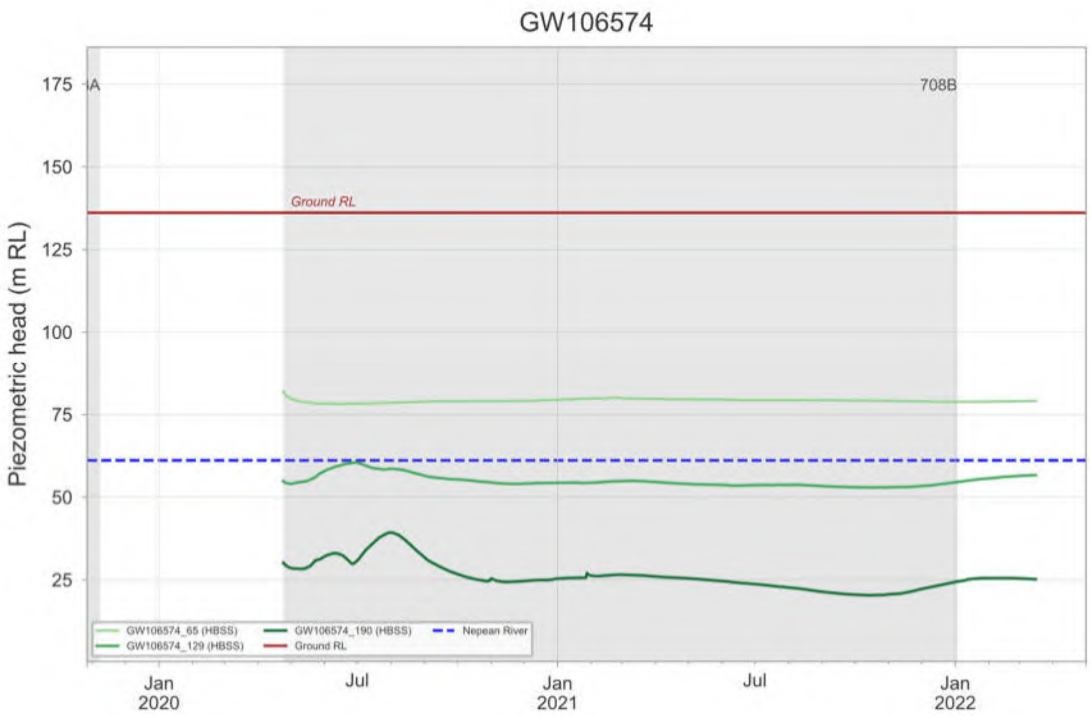

Figure 13. Groundwater hydrograph for GW106574

4.2 Groundwater chemistry

Groundwater chemistry was previously assessed in eight open standpipe piezometers (NGW3, 4, 5, 6, 7, 9, 10 and 11) installed by Illawarra Coal over, or in the vicinity of, Longwalls 701 – 703. However, due to the advancement of mining to the west, and the age of the installed equipment, no additional monitoring data was available for the NGW piezometer suite during Longwall 708 extraction.

Groundwater chemistry is assessed in pre- and post-mining inspections of private landholder bores (Appendix C) and results are discussed in Section 4.3.

There are no groundwater quality TARP trigger levels defined in the current EMP (South32, 2021).

4.3 Private groundwater bores and dams

Pre- and post-mining inspection of dams, boreholes and natural features above AA7 are conducted by the Illawarra Metallurgical Coal Environmental Field Team (IMCEFT) 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, 2022a).

TARPs are defined in Table 3. For example a Level 3 TARP is activated when mining results in private groundwater bores being unsafe, unserviceable, or damaged.

Post-mining inspections for Longwall 708 were undertaken in March 2022 at three properties: Lot 10 DP245756, Lot 73 DP883462 and Lot 900 DP1072947. 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 where possible. Key findings of the inspections are summarised in

Table 12 and water quality results are tabulated in Appendix C. Further details can be found in the relevant property reports (South32, 2022b; 2022c; 2022d).

No TARP triggers were exceeded during the extraction of Longwall 708.

Table 12. Summary of pre- and post-mining private bore and dam inspections

Lot	Observations	Subsidence impact status
Lot 10 DP245756	**GW072874:** • Pre-mining sample (25/07/2018) – brackish salinity, elevated dissolved and total iron. • Post-mining: water quality sample could not be collected, but no signs of iron or salinity staining around bore. **Property Dam (F11d01)** • No pre-mining data • Post-mining inspection (16/3/2022): dam full after heavy rainfall, water quality (turbid, brown, low salinity, total metals (Fe, Al, Mn) present. • Dam wall in good condition on post-mining inspection.	No confirmed impact
Lot 73 DP883462	**GW105376:** • No significant increases in dissolved metals between pre-mining (19/02/2018) and post-mining water quality samples. • Groundwater salinity and total iron concentrations increased following Longwall 708. • No signs of iron, salinity staining, or gas were observed in the water or around the borehole on post-mining inspection. **Property Dam (D21d01)** • Post-mining water level was higher than pre-mining inspection (19/02/2018). • Pre- and post-mining dissolved metals concentrations were comparable. • Post-mining salinity and total iron concentrations were lower than pre-mining concentrations.	No impact
Lot 900 DP1072947	**GW101986:** Post-longwall sampling could not be completed (landholder absent); however, no signs of iron, salinity staining, or gas were observed around the borehole or outlet. **Property Dam (F17d01)**: was observed to be in good condition, with the dam level close to full and no signs of leaks or slumping.	No confirmed impact

4.4 Mine water balance

The daily mine water balance is monitored by IMC. 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 AA7 is determined by subtracting the estimated water supply volume (to AA7) from the total volume of water pumped to storage. Total mine inflow to AA7 is calculated from 2 April 2019 to 3 January 2022.

TARP levels for mine inflow are based on the 20-day rolling average inflow to AA7 (Table 13). A time-series of groundwater inflow to AA7 based on water balance calculations is shown in Figure 14, including the 20-day rolling mean and TARP trigger levels.

The 20-day average for Area 7 remained low during the assessment period, fluctuating near zero (mean = -0.15 ML/day). The maximum 20-day average inflow rate was 1.1 ML/day, below the Level 1 TARP level of 2.7 ML/day. There has been no significant increase in groundwater inflow to Appin Area 7 during the assessment period, compared to the previous longwall periods. No mine inflow TARPs were triggered during the review period.

Table 13. Mine inflow TARP assessment

TARP Level	Criteria	Assessment
1	Abnormal rise in water flow from the goaf between 2.7 and 3 ML/day (over 20-day average). Fracturing with no observable loss of surface water flow.	Not triggered
2	Abnormal rise in water flow from the goaf between 3 and 3.4 ML/day (over 20-day average).	Not triggered
3	Abnormal rise in water flow from the goaf 3.4 ML/day (over 20-day average).	Not triggered

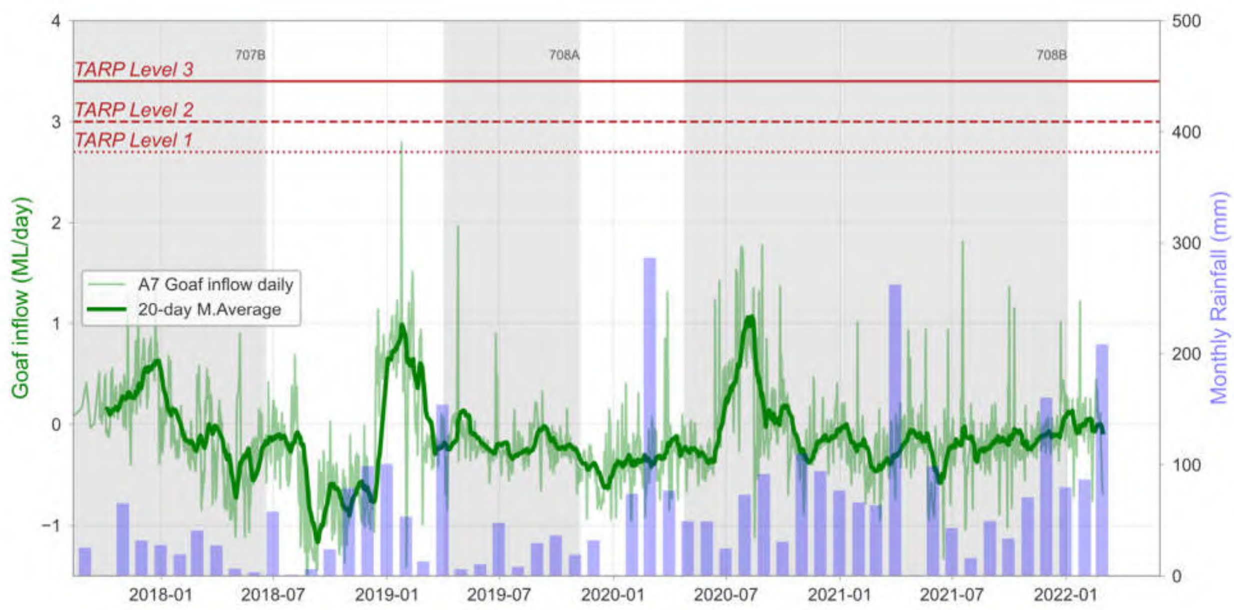

Figure 14. AA7 mine water balance

5. CONCLUSIONS

An assessment of groundwater and surface water monitoring data was carried out to assess the potential impacts from mining of Longwall 708 at Appin Colliery, in accordance with the EMP. The following conclusions are made:

Surface water assessment

- Monitoring of Nepean River gauging weirs at Maldon and Menangle and the Cataract River at Broughtons Pass showed that there were zero no-flow days recorded for the period April 2019 to January 2022 during LW708 extraction.
- Monthly monitoring indicated water levels at NR12 (adjacent to Longwall 707) and NR13 (adjacent to Longwall 708) were below the 5^{th} percentile value on several occasions in 2019. However, a similar observation was made in the upstream (control) monitoring location (NR110), and values returned to within the baseline range in 2020.
- During extraction of Longwall 708, no observable loss, diversion of water, flooding or dry reaches were observed in the Nepean River; and TARP trigger levels for surface water level and flow were not exceeded.
- No significant stream bed cracking or associated reduction in stream flow and pool desiccation has been observed in the 1st and 2nd order plateau streams.
- During the Longwall 708 extraction period, the Nepean River water quality parameters were generally within pre-Longwall 708 variability, with no significant change in trend or extended adverse changes in salinity, total iron, or total manganese at NR12 and NR13. No TARP trigger levels were reached for EC, total Fe or Mn at NR12 and NR13.
- Level 1 TARP for pH were triggered on a few occasions at NR12 (n=3) and NR13 (n=2). In both cases the TARP threshold exceedances are clear outliers related to preceding high rainfall events and there is no underlying adverse trend.
- Level 1 TARP was triggered for dissolved oxygen at NR12 on one occasion (February 2021). As there is no underlying adverse trend the exceedance is not attributed to mining activities.
- One update to an existing gas release zone (Gas Zone 10) was identified in the Nepean River during the monitoring period for Longwall 708. Three other previously reported gas zones were observed to be active at some point during Longwall 708. All observed gas zones had estimated emission rates of <3000 L/min and remain TARP Level 1 triggers under the EMP.

Groundwater assessment

- An increasing trend in groundwater pressures occurred in the Hawkesbury Sandstone at VWP S1913 from April 2021 and significant recovery in groundwater pressures in the Bulgo Sandstone (274 m) and Scarborough Sandstone (505 m) occurred at VWP S1913.
- A slight decreasing trend in groundwater pressure in the Hawkesbury Sandstone aquifer was observed at S1936; however, no groundwater level reduction TARP triggers were exceeded during the extraction of Longwall 708.
- No significant impacts from mining were identified in bores or dams on private properties.

- Groundwater inflow to the mine is calculated from the daily mine water balance. The 20-day moving average mine inflow remained low, fluctuating between 0 and 1.1 ML/day during and following the extraction of Longwall 708, below the TARP Level 1 trigger of 2.7 ML/day.

6. RECOMMENDATIONS

There are no recommendations for this reporting period.

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South32, 2022b, Appin Mine Longwall 708 Post-mining property inspection Lot 900 DP1072947: South32 Illawarra Coal, March 2022.

South32, 2022c, Appin Mine Longwall 708 Post-mining property inspection Lot 73 DP883462: South32 Illawarra Coal, March 2022.

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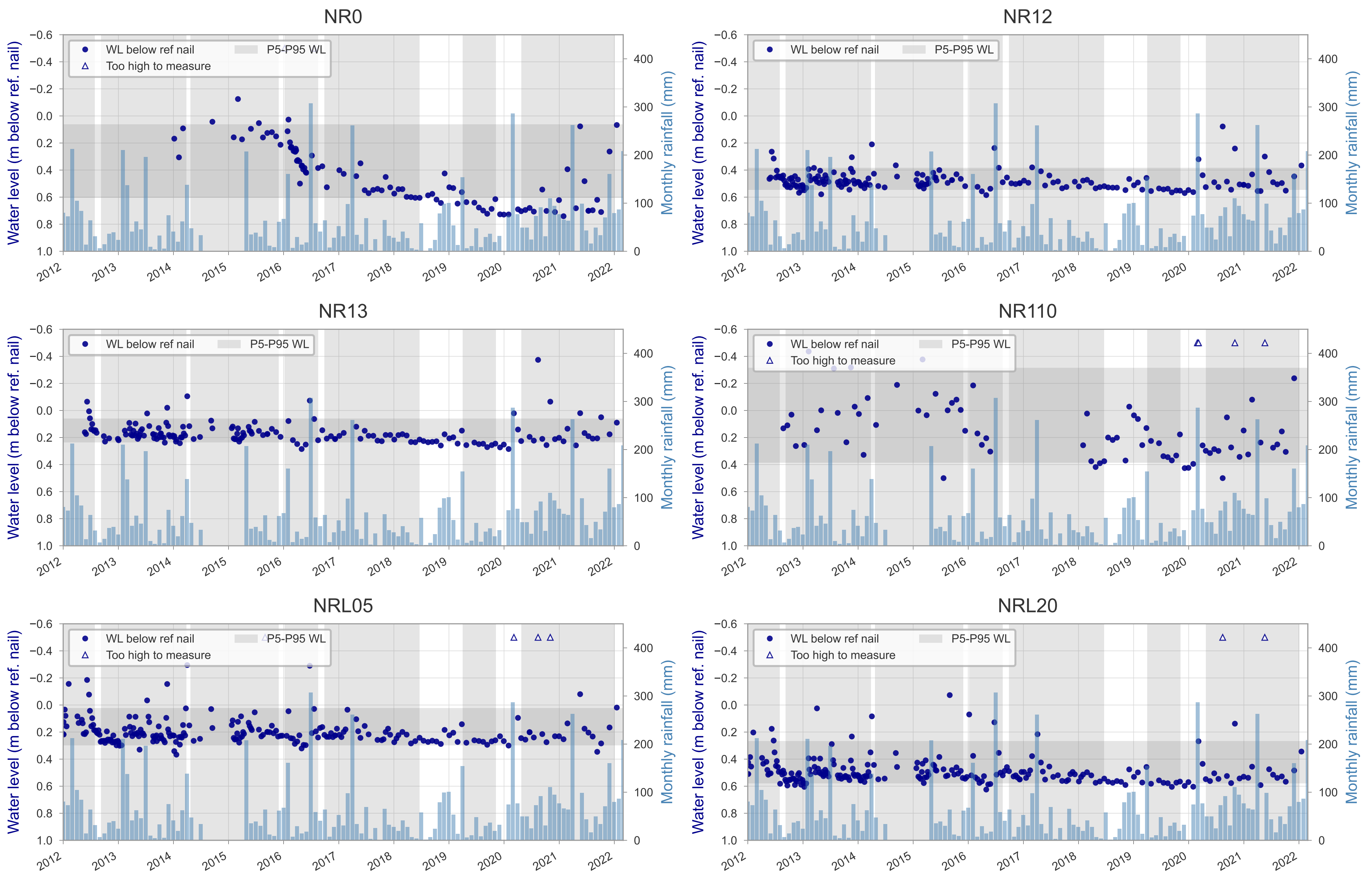
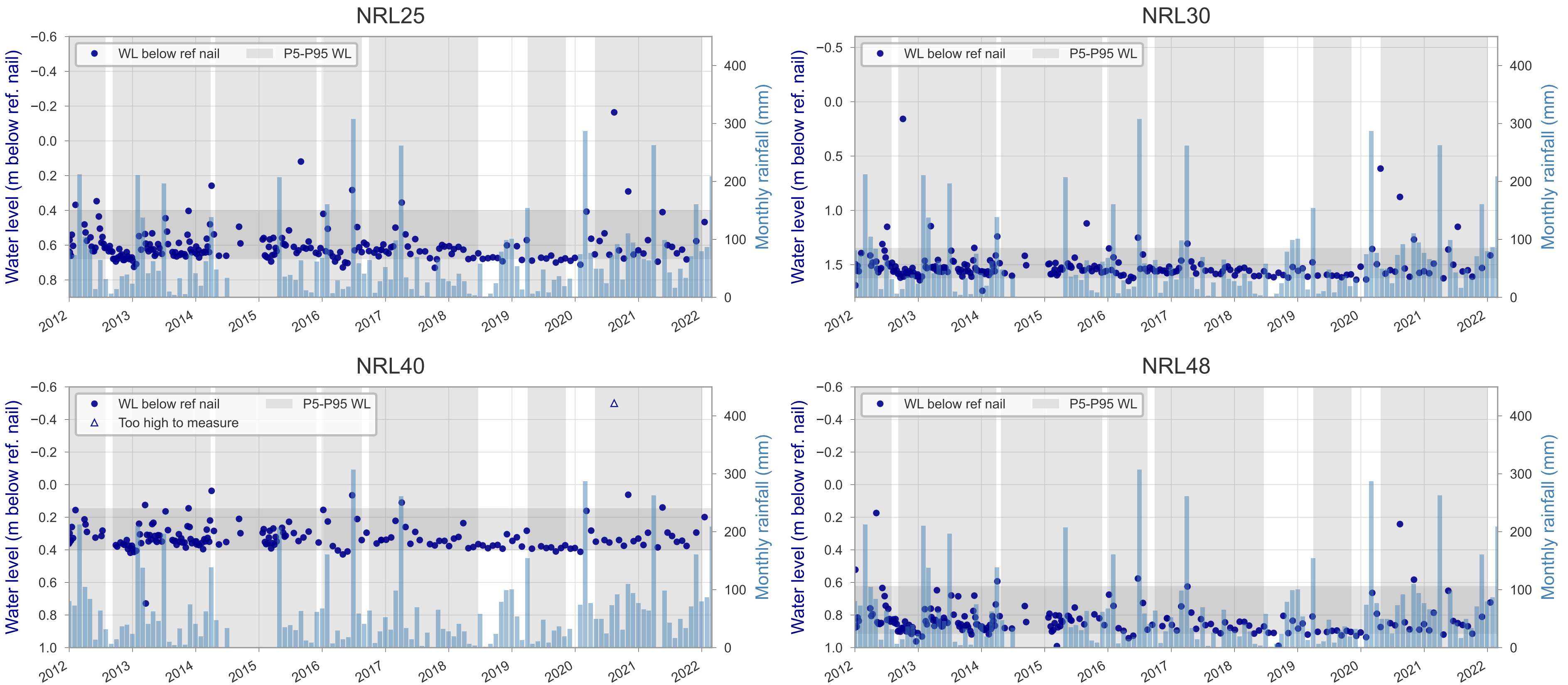
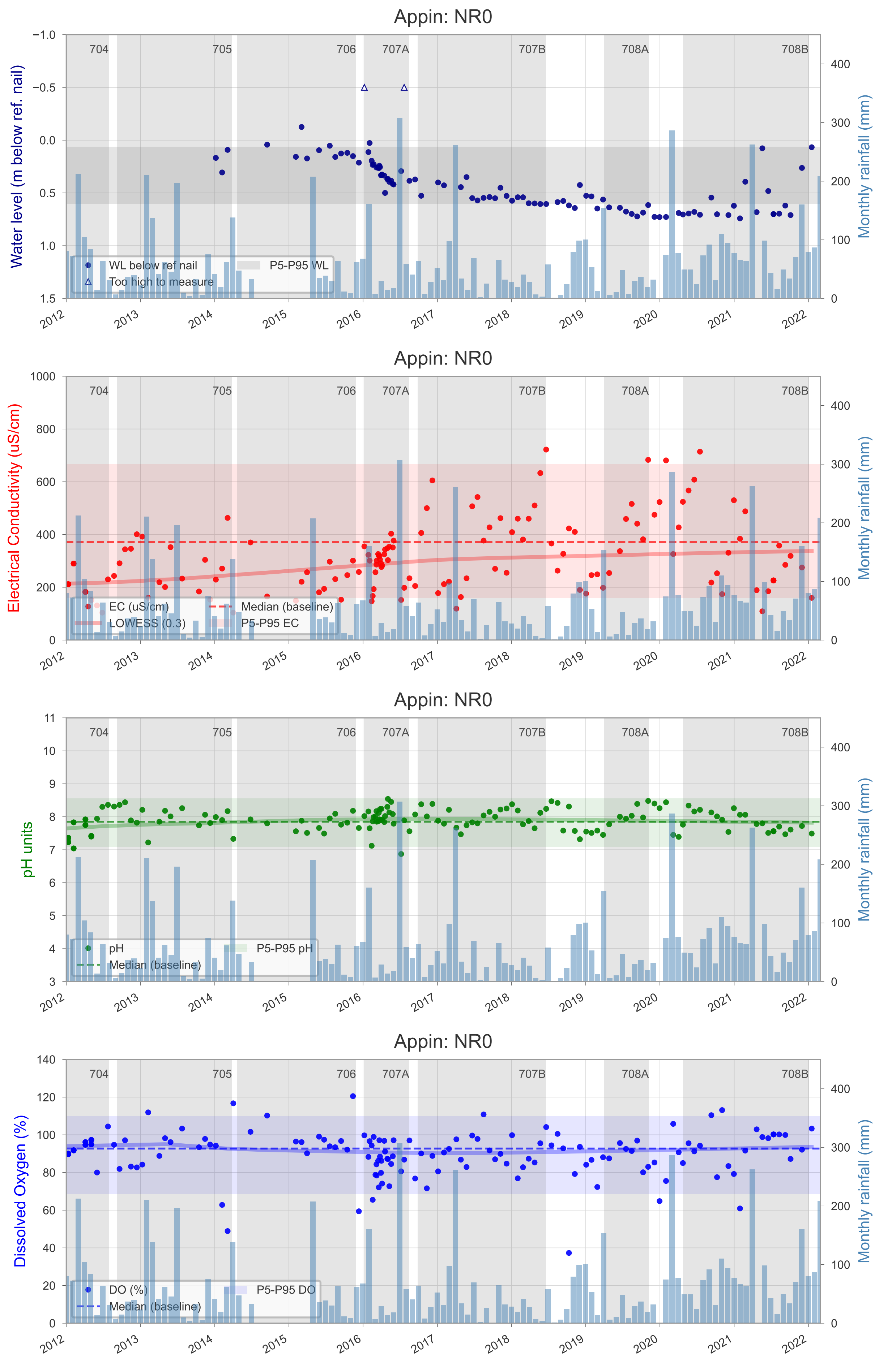
Tammetta, P., 2016, Estimation of the Change in Storage Capacity above Mined Longwall Panels: Groundwater, v. 54, no. 5, p. 646–655.

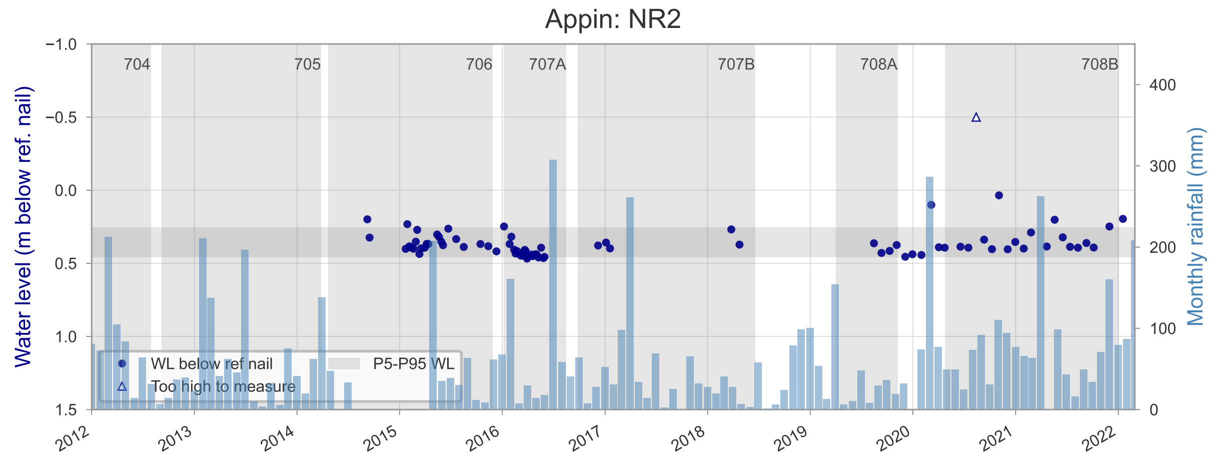
Tammetta, P., 2013, Estimation of the height of complete groundwater drainage above mined longwall panels: Groundwater, v. 52, no. 6, p. 826–826.

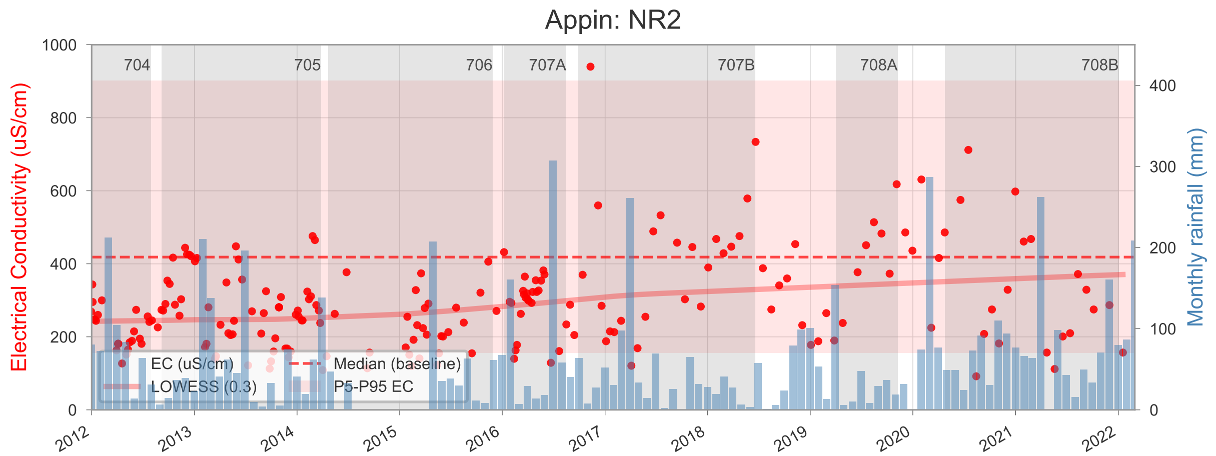
APPENDIX A – Surface water chemistry and water level

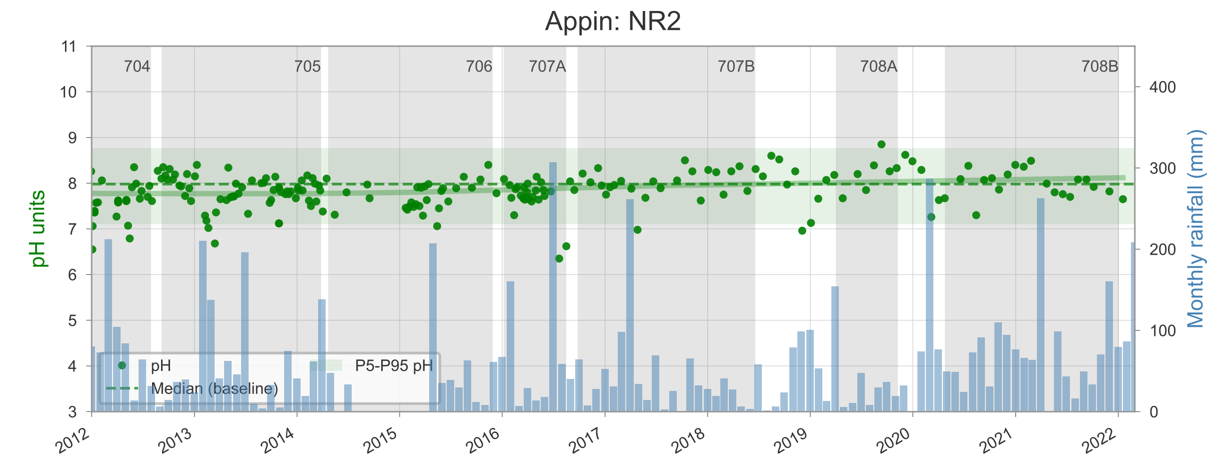

NR0
NR12
NR13
NR110
NRL05
NRL20
WL below ref nail
Too high to measure
P5-P95 WL
Water level (m below ref. nail)
Monthly rainfall (mm)
−0.6
−0.4
−0.2
0.0
0.2
0.4
0.6
0.8
1.0
0
100
200
300
400
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

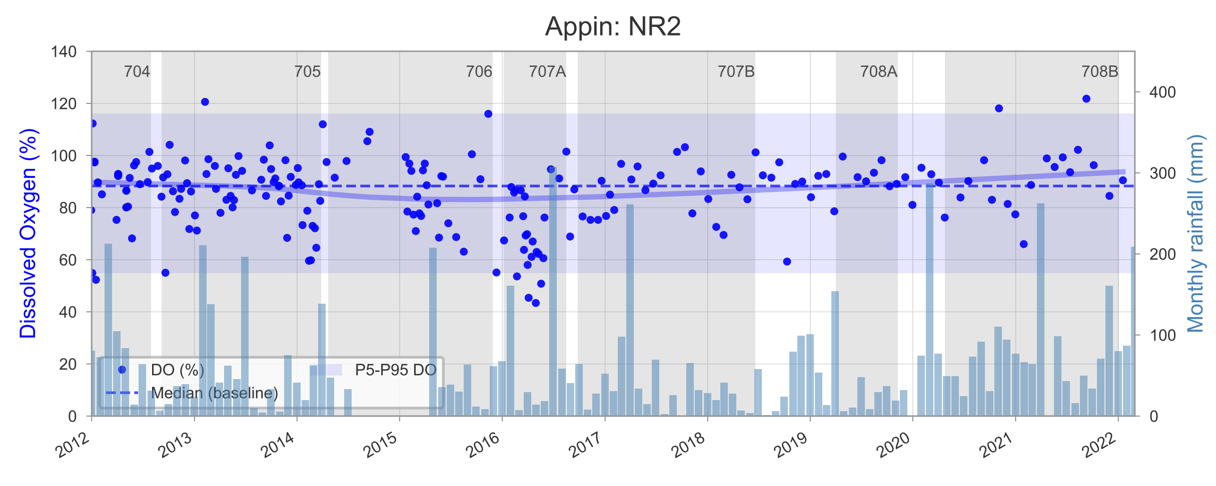

NRL25
NRL30
NRL40
NRL48
WL below ref nail
P5-P95 WL
Too high to measure
Water level (m below ref. nail)
Monthly rainfall (mm)
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

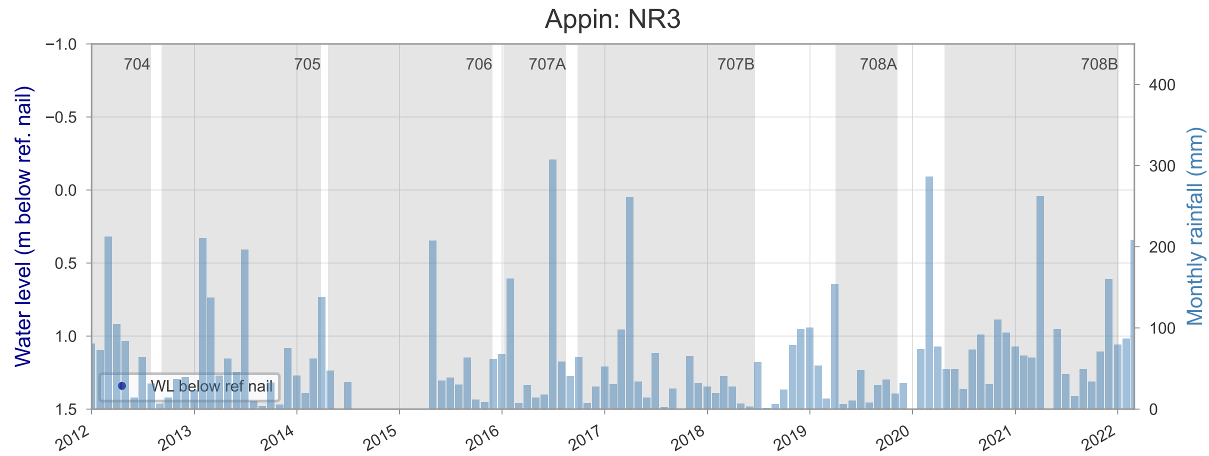

Appin: NR0
Water level (m below ref. nail)
Monthly rainfall (mm)
704
705
706
707A
707B
708A
708B
WL below ref nail
Too high to measure
P5-P95 WL
Appin: NR0
Electrical Conductivity (uS/cm)
EC (uS/cm)
LOWESS (0.3)
Median (baseline)
P5-P95 EC
Appin: NR0
pH units
pH
Median (baseline)
P5-P95 pH
Appin: NR0
Dissolved Oxygen (%)
DO (%)
Median (baseline)
P5-P95 DO

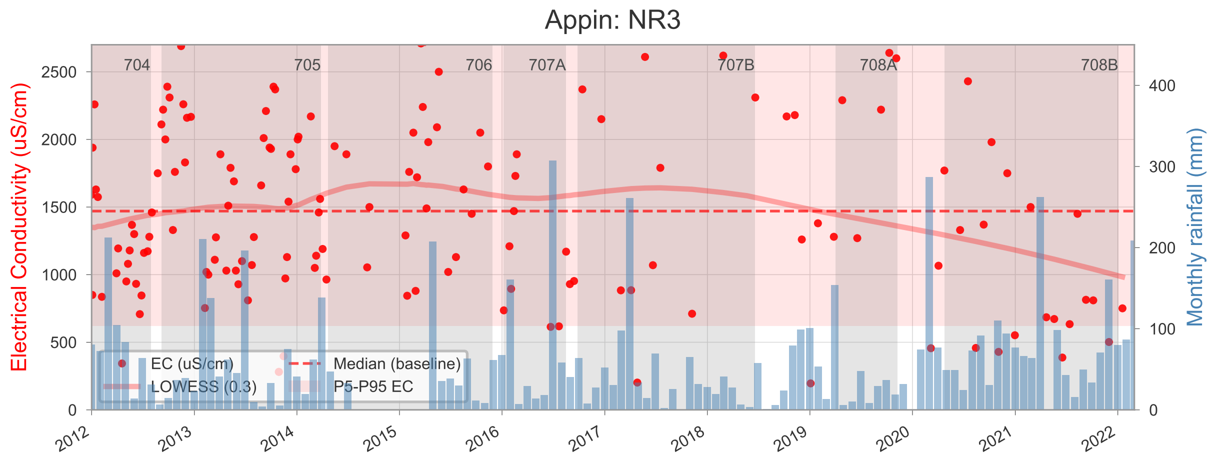

Appin: NR2
Water level (m below ref. nail)
Monthly rainfall (mm)
704
705
706
707A
707B
708A
708B
WL below ref nail
Too high to measure
P5-P95 WL

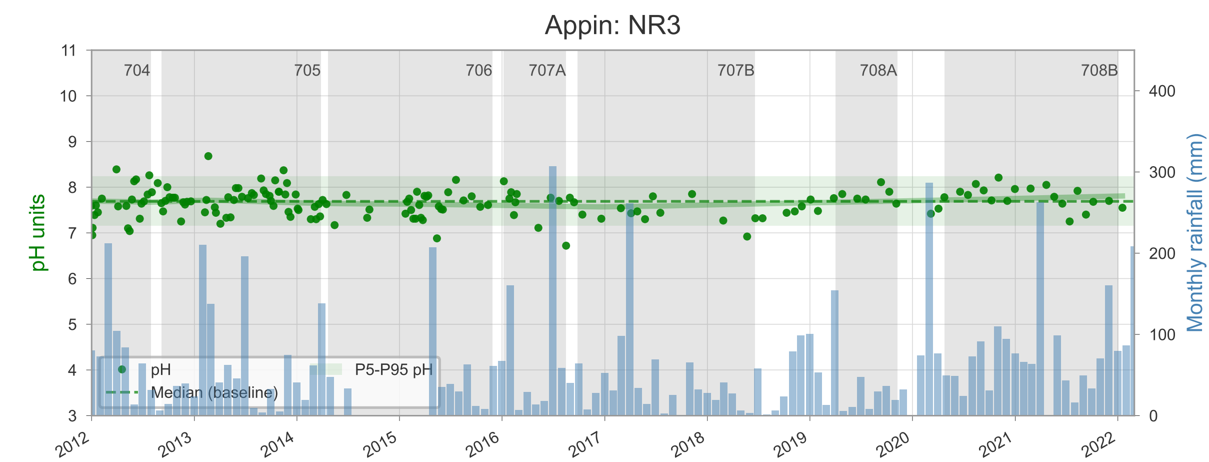

Appin: NR2
Electrical Conductivity (uS/cm)
Monthly rainfall (mm)
704
705
706
707A
707B
708A
708B
EC (uS/cm)
Median (baseline)
LOWESS (0.3)
P5-P95 EC

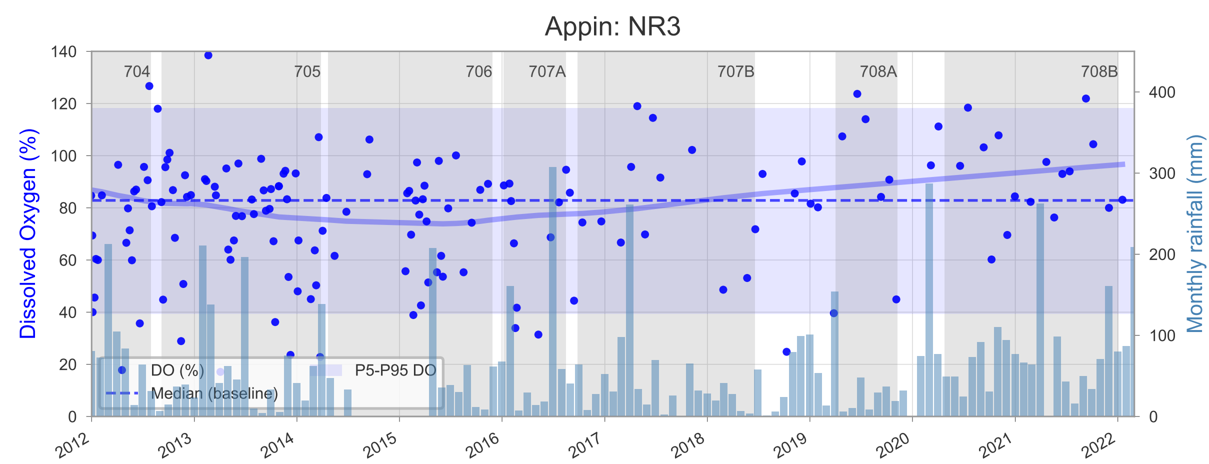

Appin: NR2
pH units
Monthly rainfall (mm)
704
705
706
707A
707B
708A
708B
pH
P5-P95 pH
Median (baseline)

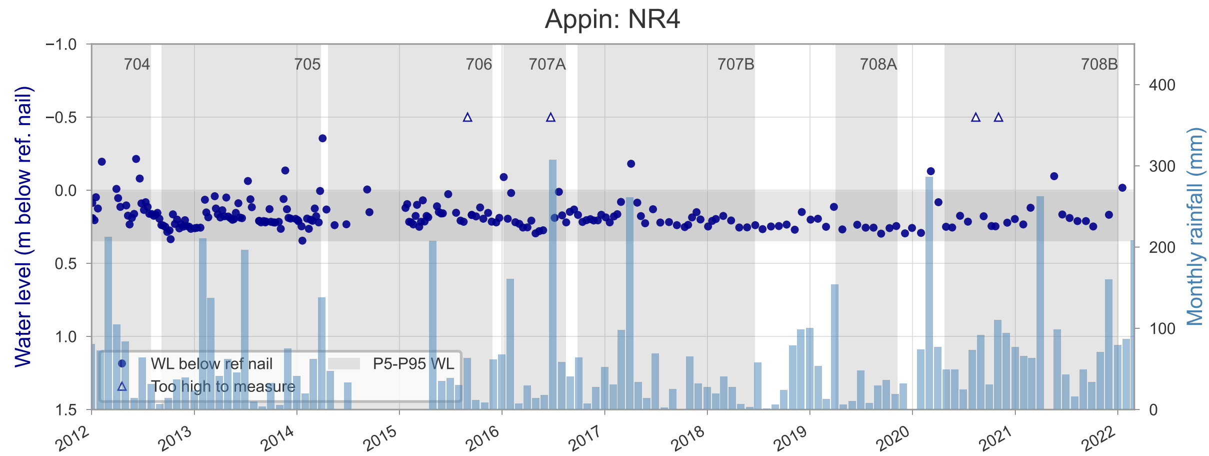

Appin: NR2
Dissolved Oxygen (%)
Monthly rainfall (mm)
704
705
706
707A
707B
708A
708B
DO (%)
P5-P95 DO
Median (baseline)

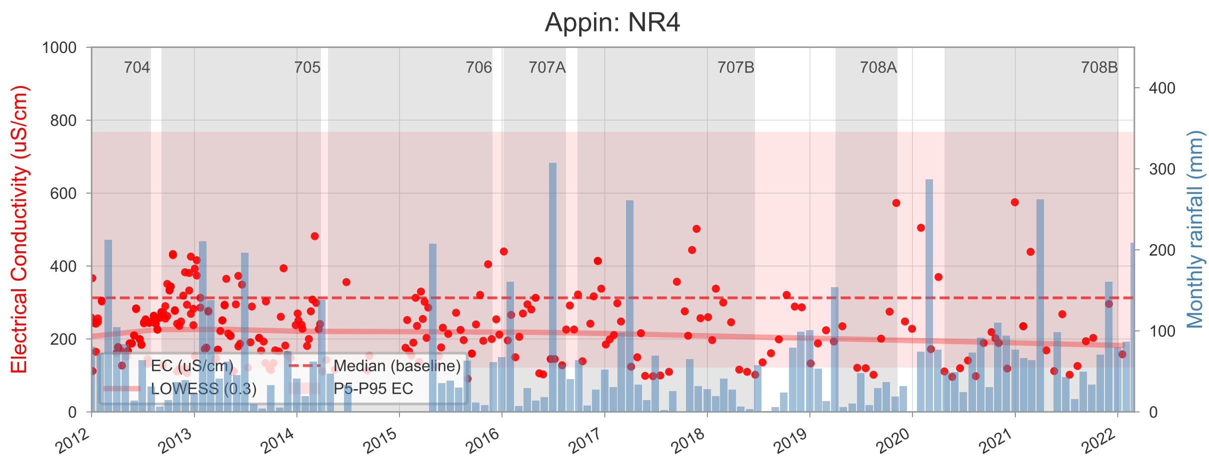

Appin: NR3
704
705
706
707A
707B
708A
708B
Water level (m below ref. nail)
Monthly rainfall (mm)
WL below ref nail

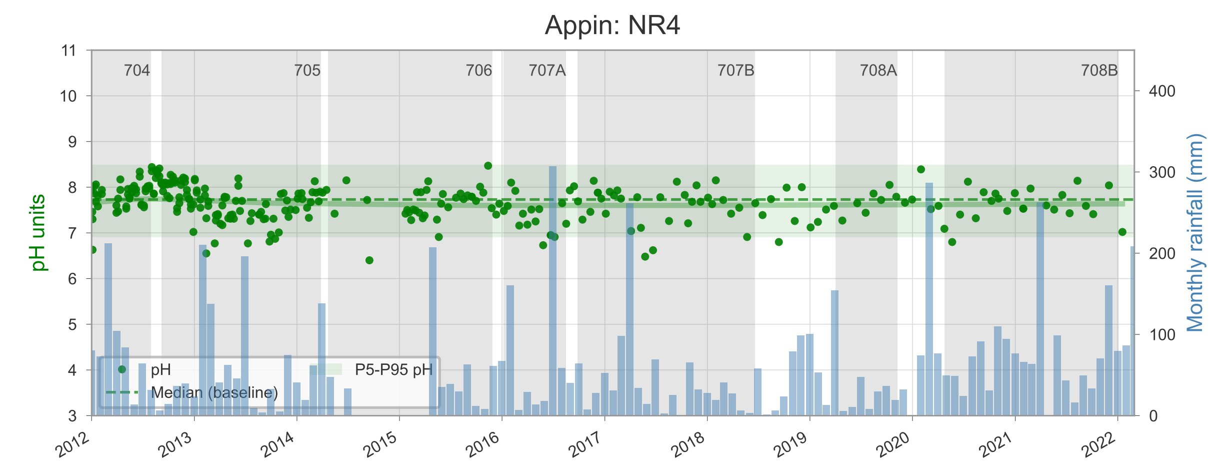

Appin: NR3
704
705
706
707A
707B
708A
708B
Electrical Conductivity (uS/cm)
Monthly rainfall (mm)
EC (uS/cm)
LOWESS (0.3)
Median (baseline)
P5-P95 EC

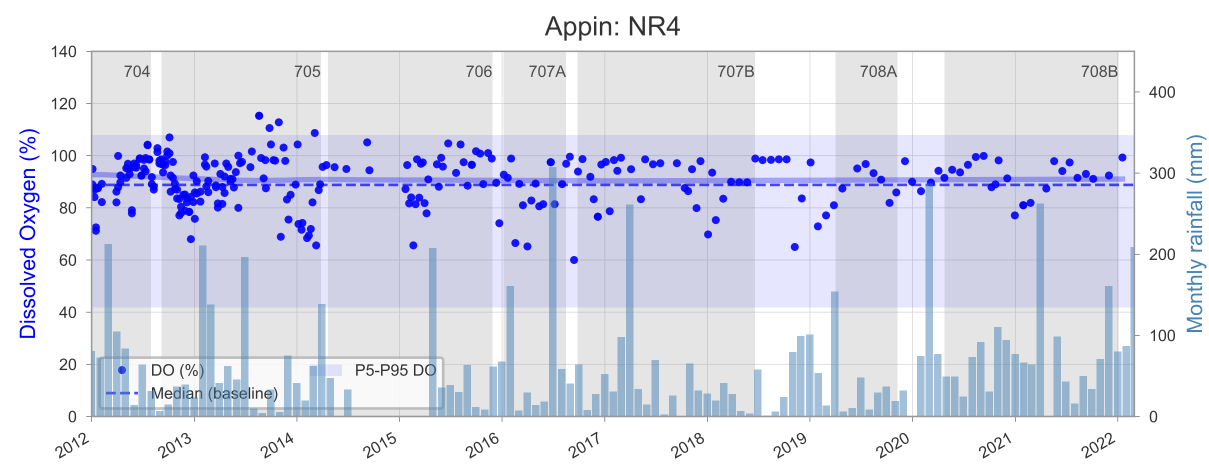

Appin: NR3
704
705
706
707A
707B
708A
708B
pH units
Monthly rainfall (mm)
pH
Median (baseline)
P5-P95 pH

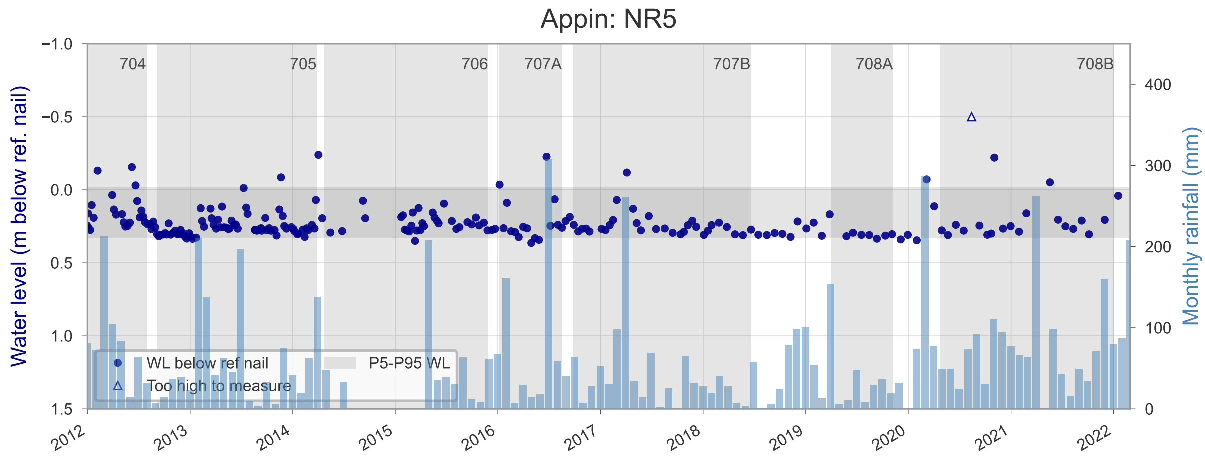

Appin: NR3
704
705
706
707A
707B
708A
708B
Dissolved Oxygen (%)
Monthly rainfall (mm)
DO (%)
Median (baseline)
P5-P95 DO

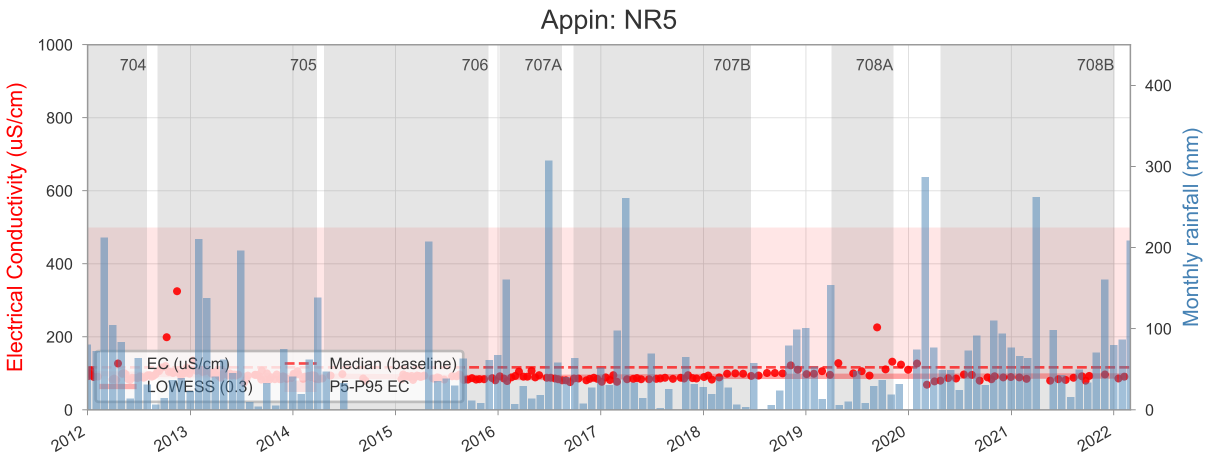

Appin: NR4
Water level (m below ref. nail)
Monthly rainfall (mm)
704
705
706
707A
707B
708A
708B
WL below ref nail
Too high to measure
P5-P95 WL

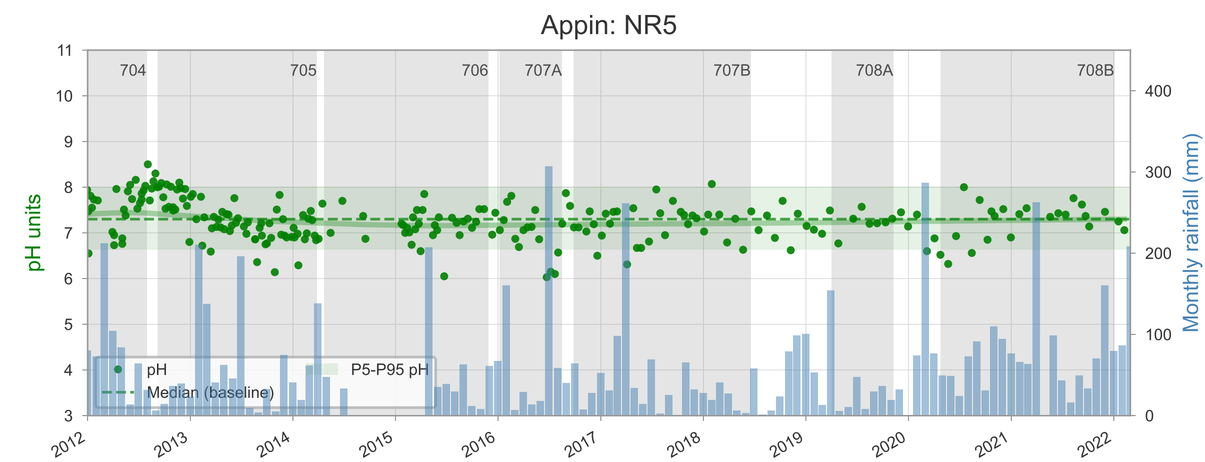

Appin: NR4
Electrical Conductivity (uS/cm)
Monthly rainfall (mm)
704
705
706
707A
707B
708A
708B
EC (uS/cm)
LOWESS (0.3)
Median (baseline)
P5-P95 EC

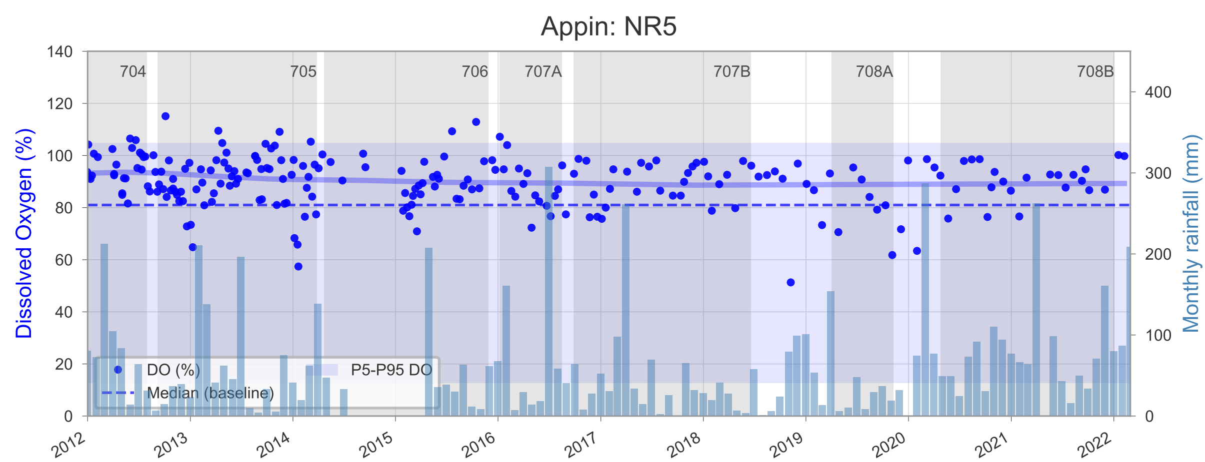

Appin: NR4
pH units
Monthly rainfall (mm)
704
705
706
707A
707B
708A
708B
pH
Median (baseline)
P5-P95 pH

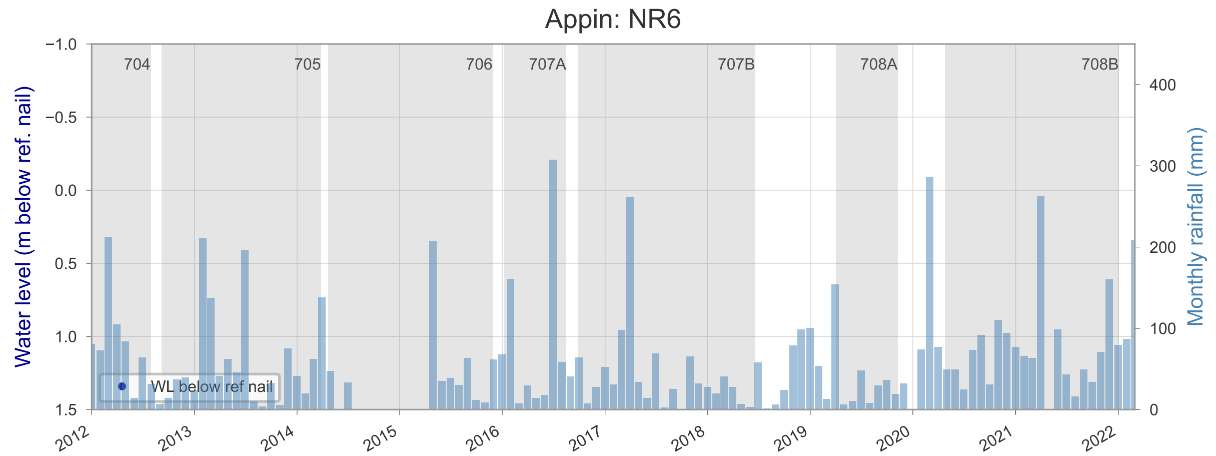

Appin: NR4
Dissolved Oxygen (%)
Monthly rainfall (mm)
704
705
706
707A
707B
708A
708B
DO (%)
Median (baseline)
P5-P95 DO

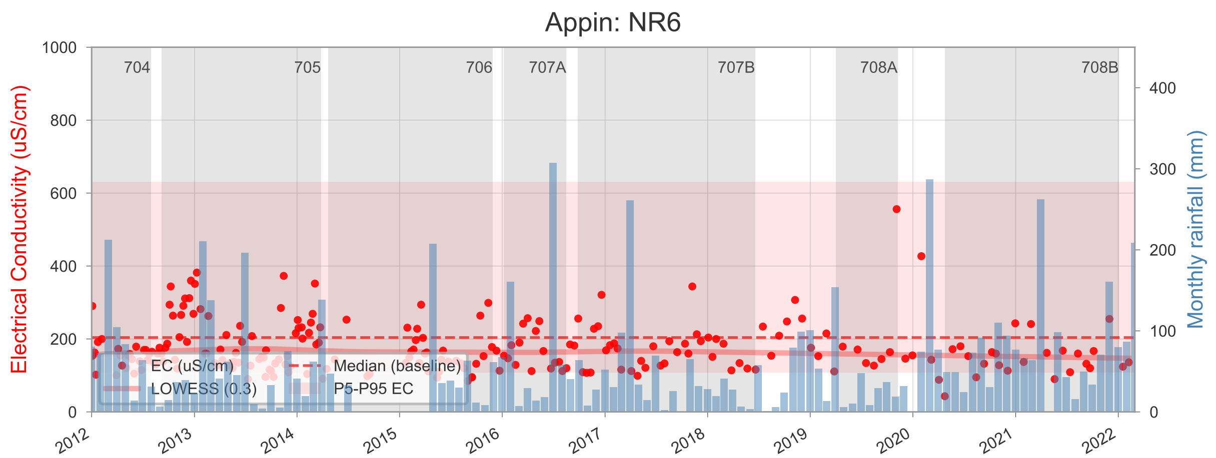

Appin: NR5
704
705
706
707A
707B
708A
708B
Water level (m below ref. nail)
Monthly rainfall (mm)
WL below ref nail
Too high to measure
P5-P95 WL

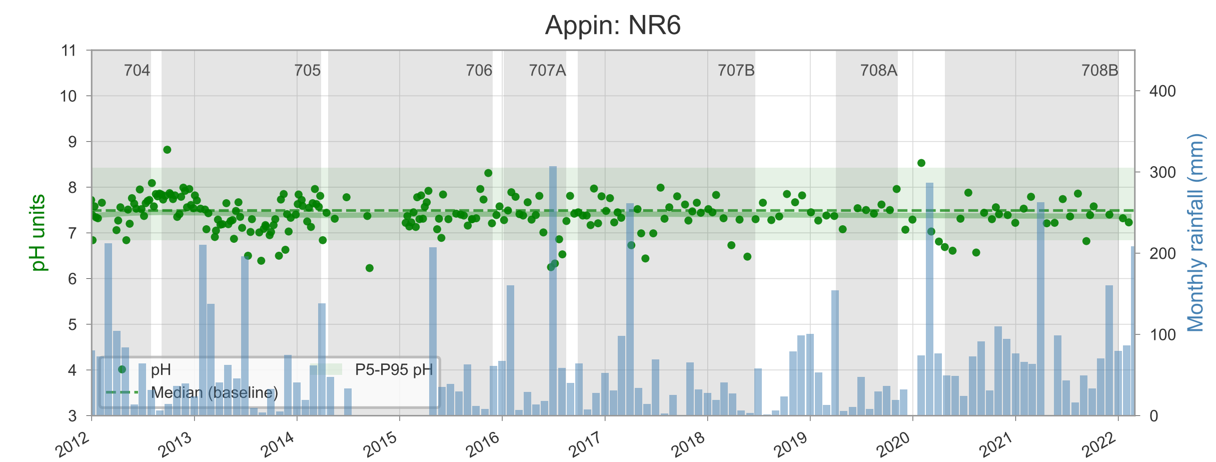

Appin: NR5
704
705
706
707A
707B
708A
708B
Electrical Conductivity (uS/cm)
Monthly rainfall (mm)
EC (uS/cm)
LOWESS (0.3)
Median (baseline)
P5-P95 EC

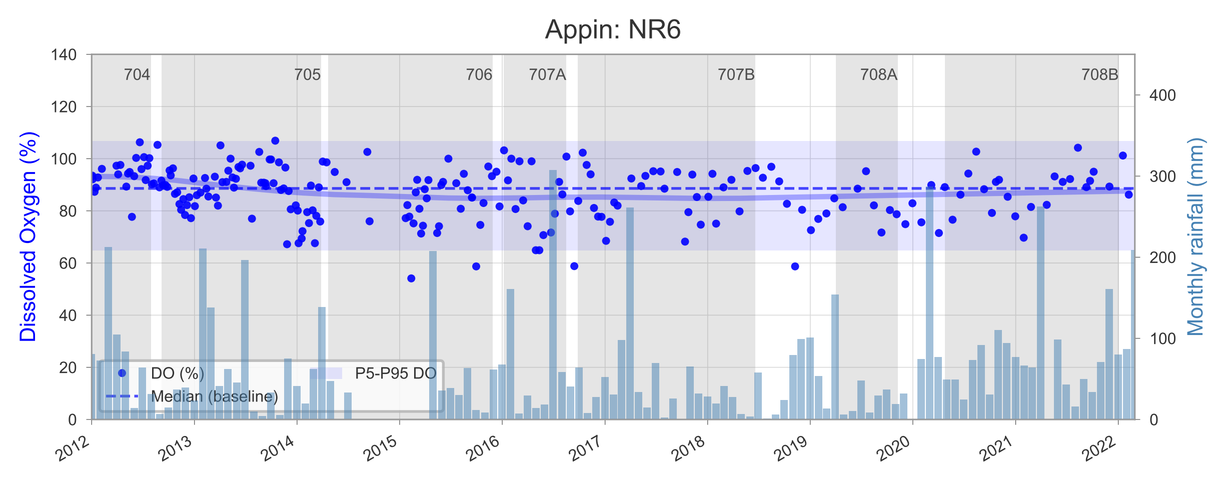

Appin: NR5
704
705
706
707A
707B
708A
708B
pH units
Monthly rainfall (mm)
pH
Median (baseline)
P5-P95 pH

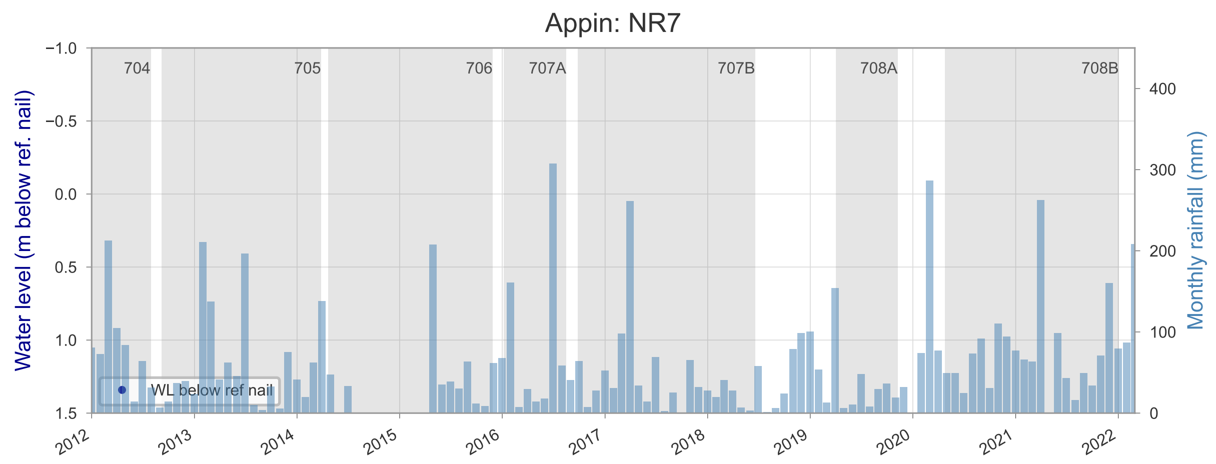

Appin: NR5
704
705
706
707A
707B
708A
708B
Dissolved Oxygen (%)
Monthly rainfall (mm)
DO (%)
Median (baseline)
P5-P95 DO

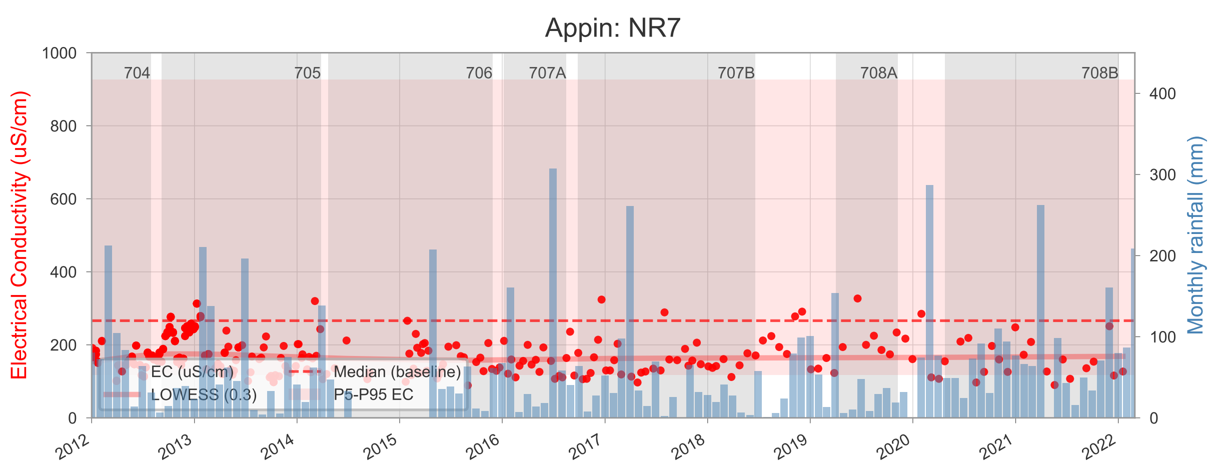

Appin: NR6
Water level (m below ref. nail)
Monthly rainfall (mm)
704
705
706
707A
707B
708A
708B
WL below ref nail

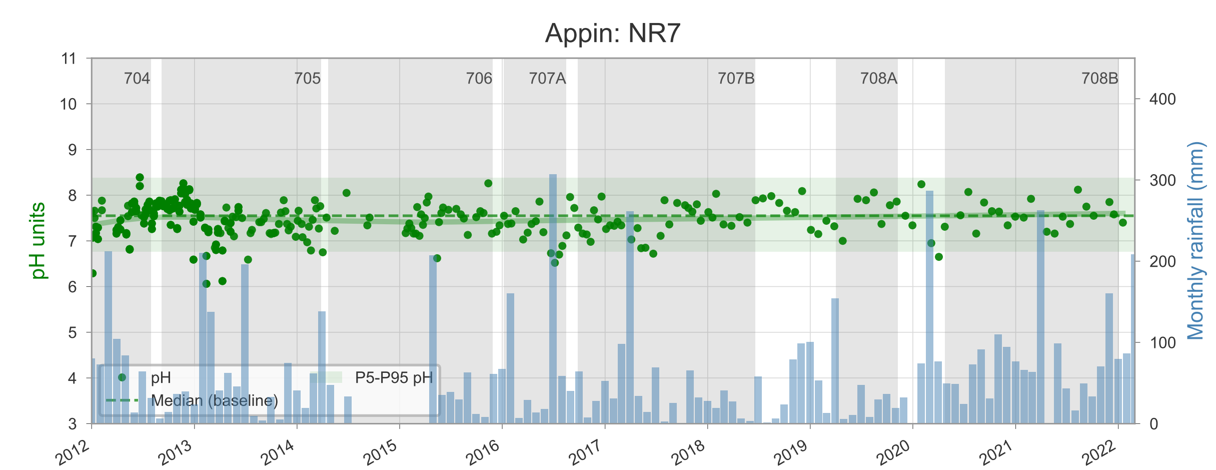

Appin: NR6
Electrical Conductivity (uS/cm)
Monthly rainfall (mm)
704
705
706
707A
707B
708A
708B
EC (uS/cm)
LOWESS (0.3)
Median (baseline)
P5-P95 EC

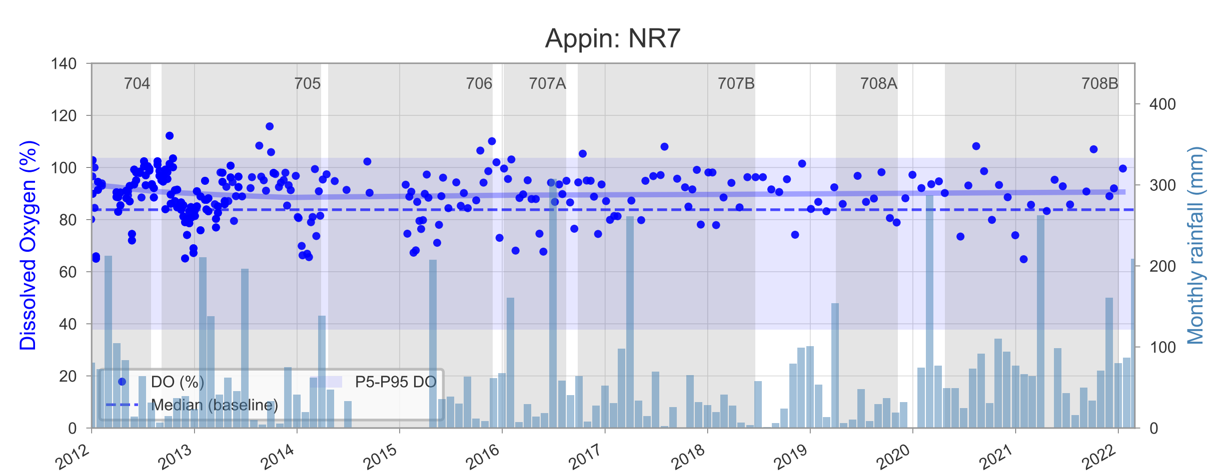

Appin: NR6
pH units
Monthly rainfall (mm)
704
705
706
707A
707B
708A
708B
pH
Median (baseline)
P5-P95 pH

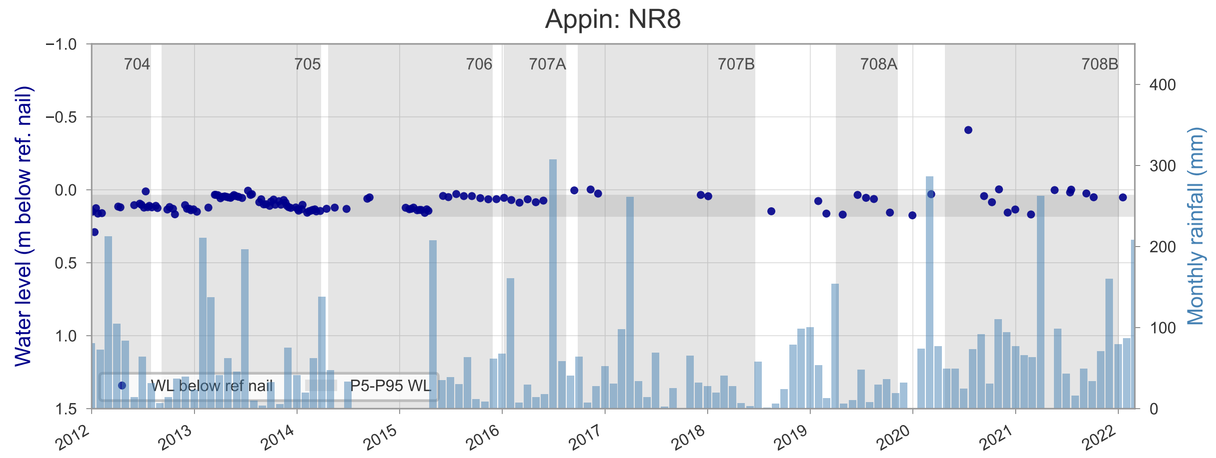

Appin: NR6
Dissolved Oxygen (%)
Monthly rainfall (mm)
704
705
706
707A
707B
708A
708B
DO (%)
Median (baseline)
P5-P95 DO

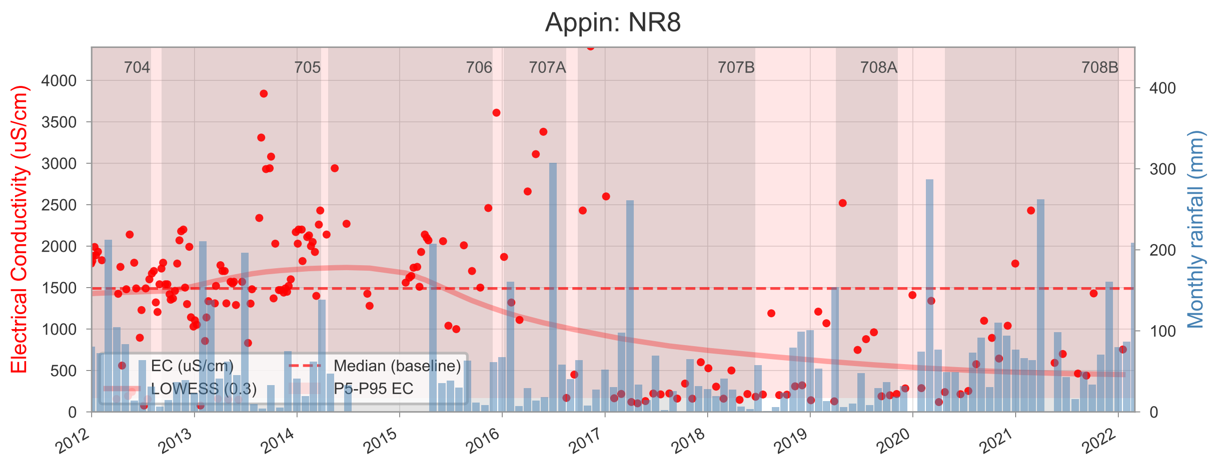

Appin: NR7
704
705
706
707A
707B
708A
708B
Water level (m below ref. nail)
Monthly rainfall (mm)
WL below ref nail

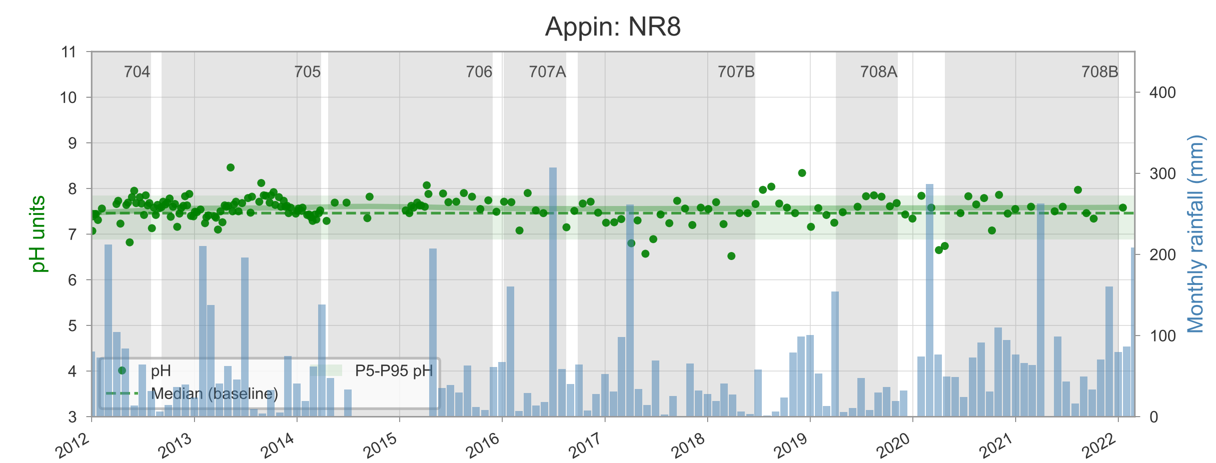

Appin: NR7
704
705
706
707A
707B
708A
708B
Electrical Conductivity (uS/cm)
Monthly rainfall (mm)
EC (uS/cm)
LOWESS (0.3)
Median (baseline)
P5-P95 EC

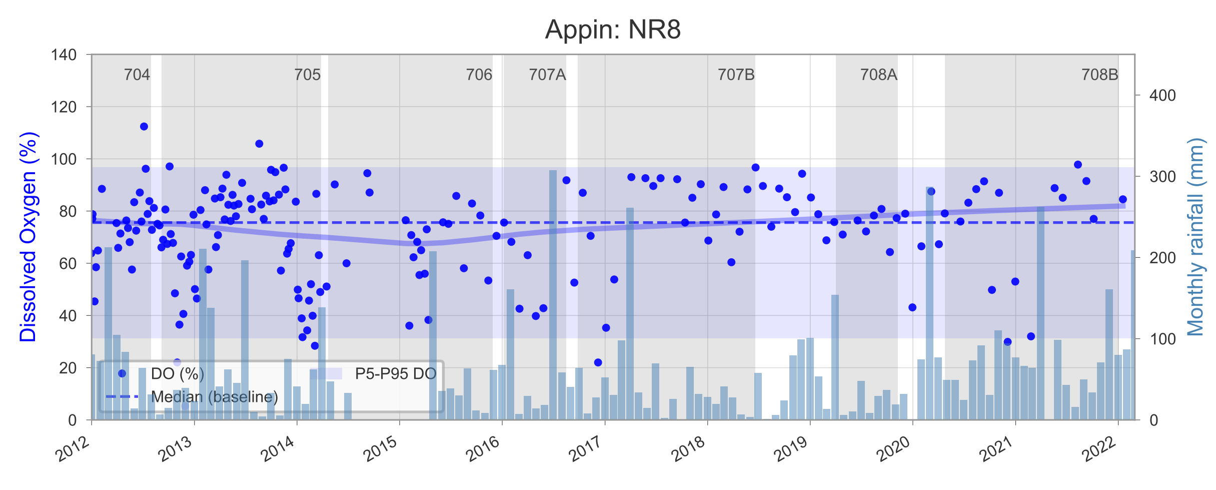

Appin: NR7
704
705
706
707A
707B
708A
708B
pH units
Monthly rainfall (mm)
pH
Median (baseline)
P5-P95 pH

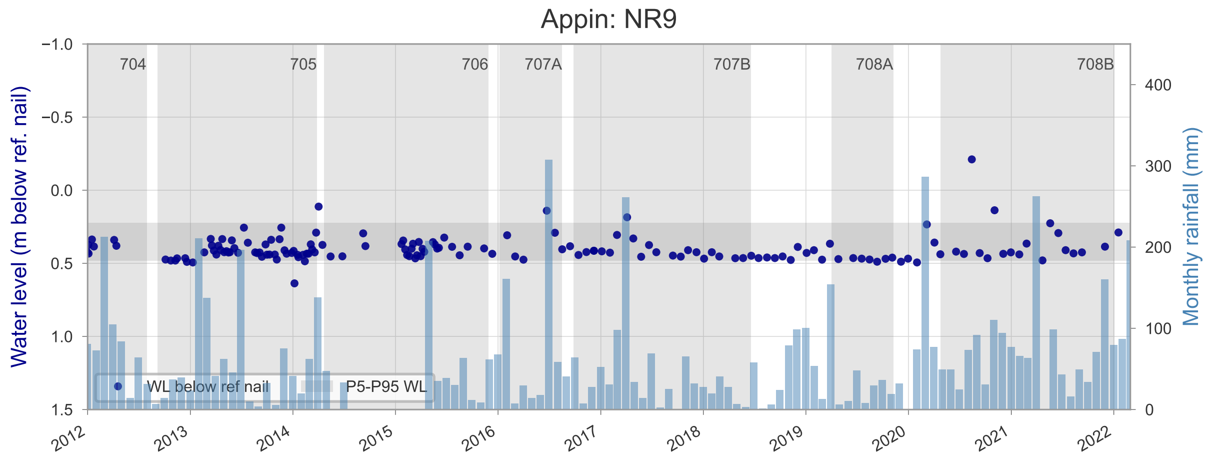

Appin: NR7
704
705
706
707A
707B
708A
708B
Dissolved Oxygen (%)
Monthly rainfall (mm)
DO (%)
Median (baseline)
P5-P95 DO

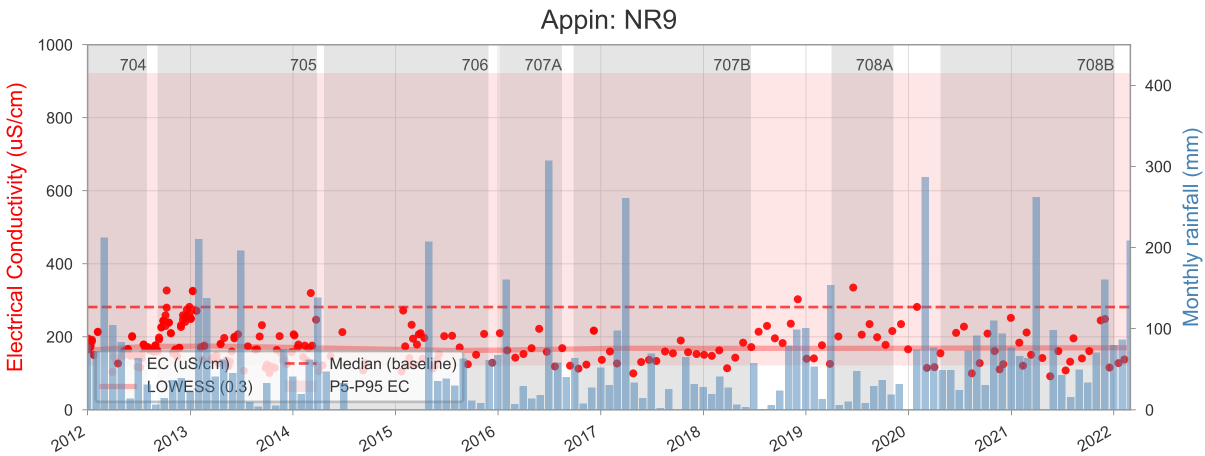

Appin: NR8
704
705
706
707A
707B
708A
708B
Water level (m below ref. nail)
Monthly rainfall (mm)
WL below ref nail
P5-P95 WL
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

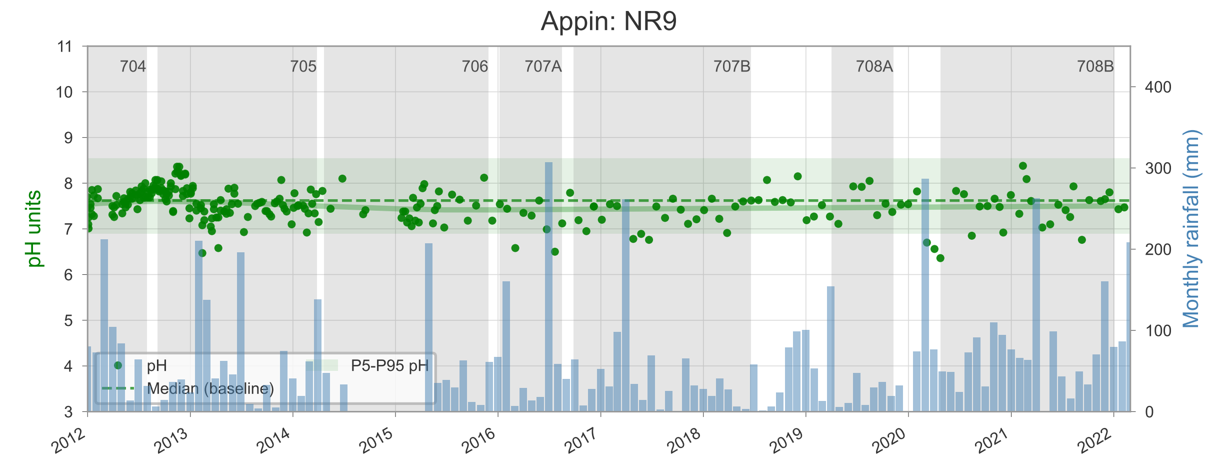

Appin: NR8
704
705
706
707A
707B
708A
708B
Electrical Conductivity (uS/cm)
Monthly rainfall (mm)
EC (uS/cm)
LOWESS (0.3)
Median (baseline)
P5-P95 EC
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

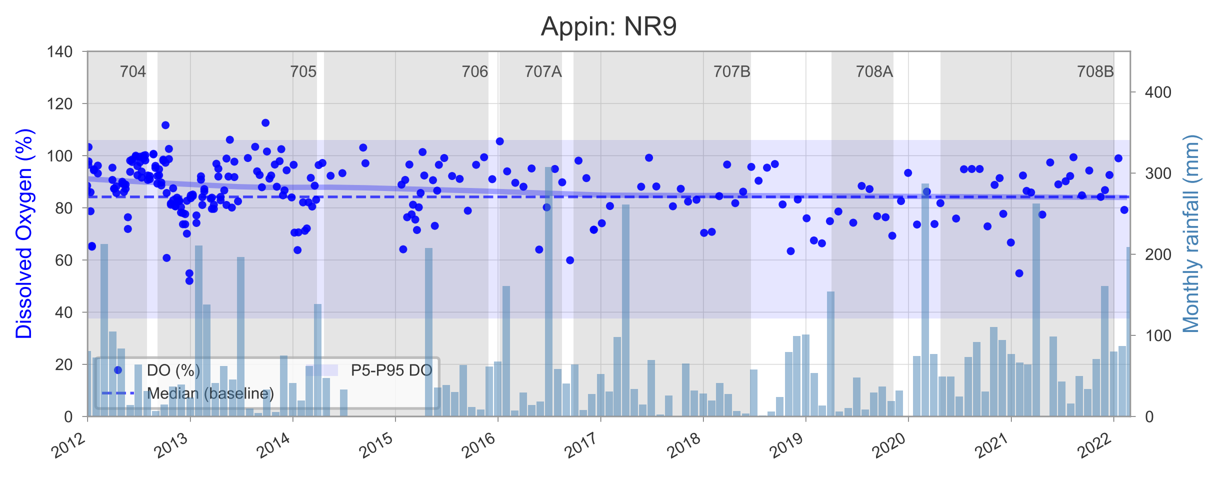

Appin: NR8
704
705
706
707A
707B
708A
708B
pH units
Monthly rainfall (mm)
pH
Median (baseline)
P5-P95 pH
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

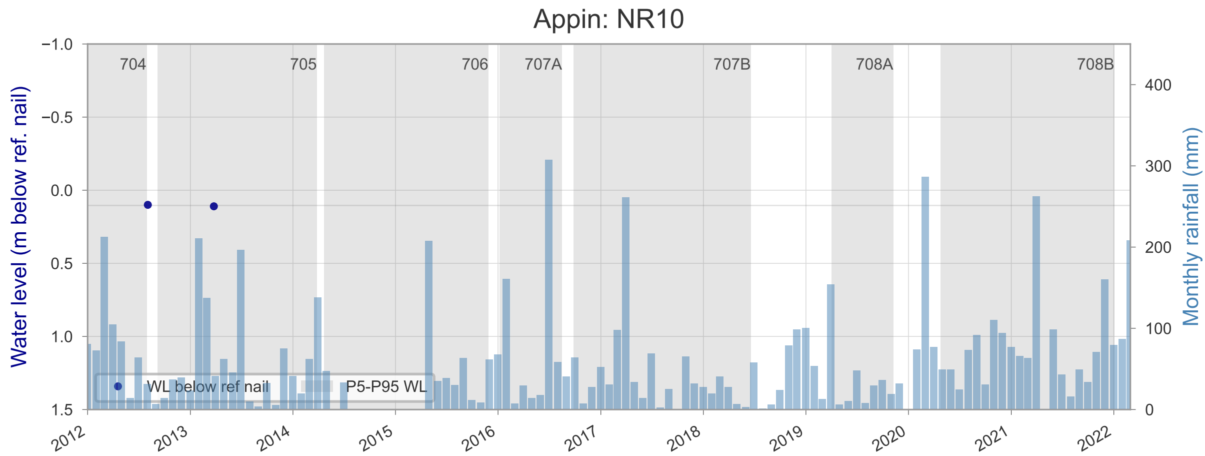

Appin: NR8
704
705
706
707A
707B
708A
708B
Dissolved Oxygen (%)
Monthly rainfall (mm)
DO (%)
Median (baseline)
P5-P95 DO
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

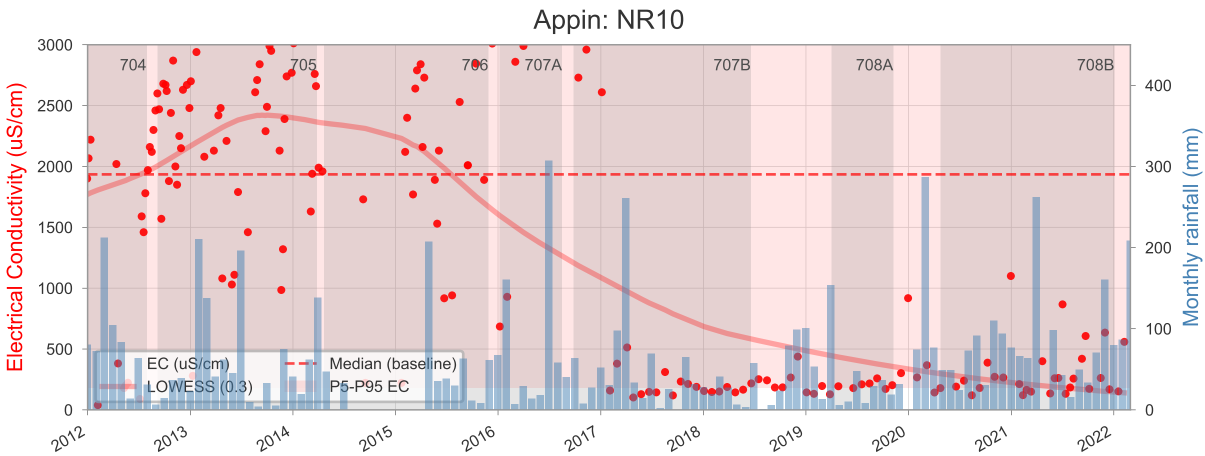

Appin: NR9
704
705
706
707A
707B
708A
708B
Water level (m below ref. nail)
Monthly rainfall (mm)
WL below ref nail
P5-P95 WL
-1.0
-0.5
0.0
0.5
1.0
1.5
0
100
200
300
400
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

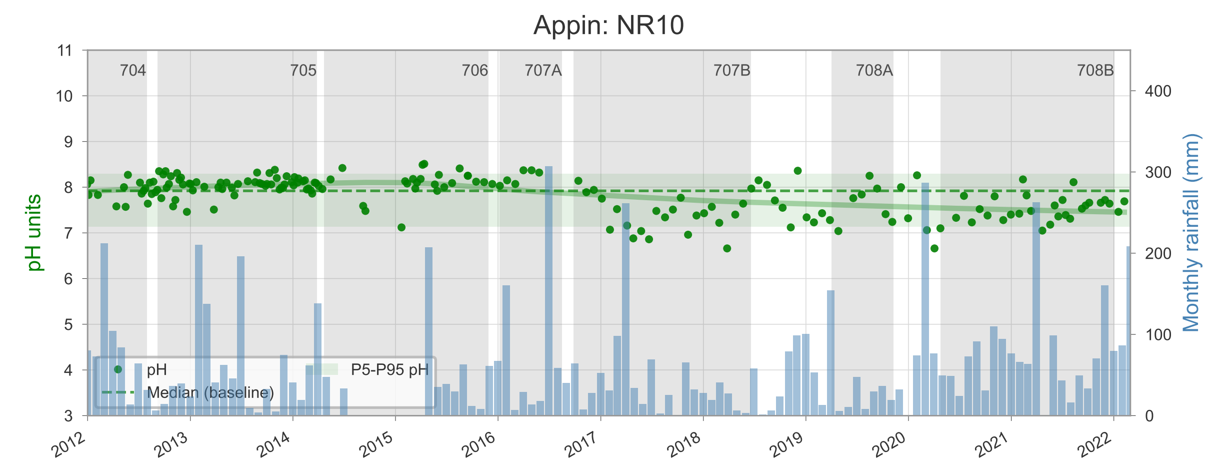

Appin: NR9
704
705
706
707A
707B
708A
708B
Electrical Conductivity (uS/cm)
Monthly rainfall (mm)
EC (uS/cm)
Median (baseline)
LOWESS (0.3)
P5-P95 EC
0
200
400
600
800
1000
0
100
200
300
400
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

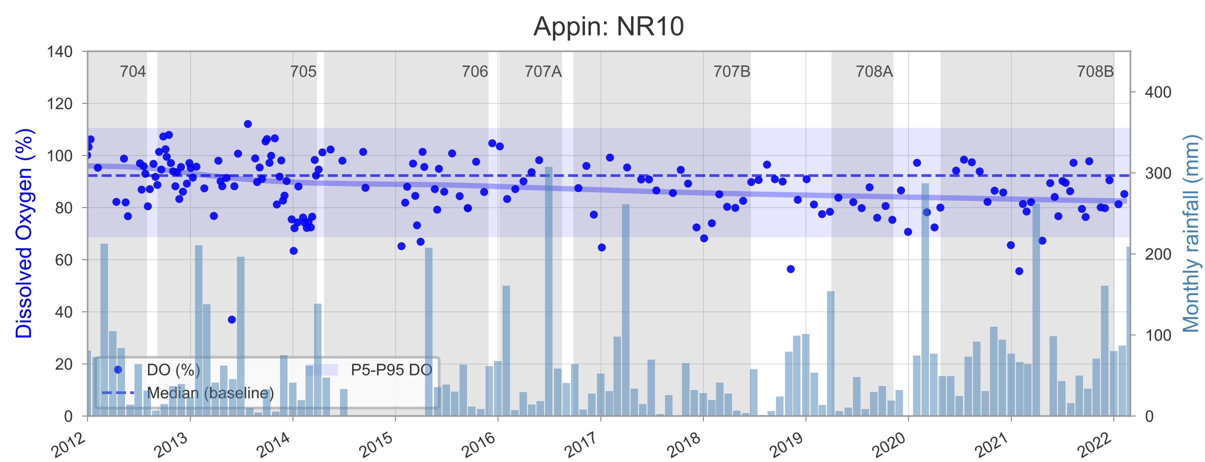

Appin: NR9
704
705
706
707A
707B
708A
708B
pH units
Monthly rainfall (mm)
pH
P5-P95 pH
Median (baseline)
3
4
5
6
7
8
9
10
11
0
100
200
300
400
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

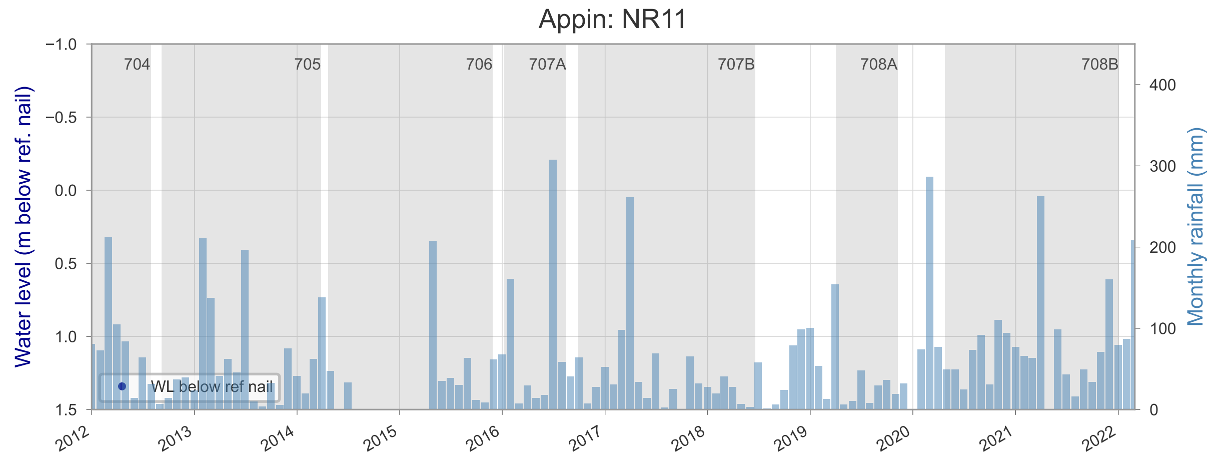

Appin: NR9
704
705
706
707A
707B
708A
708B
Dissolved Oxygen (%)
Monthly rainfall (mm)
DO (%)
P5-P95 DO
Median (baseline)
0
20
40
60
80
100
120
140
0
100
200
300
400
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

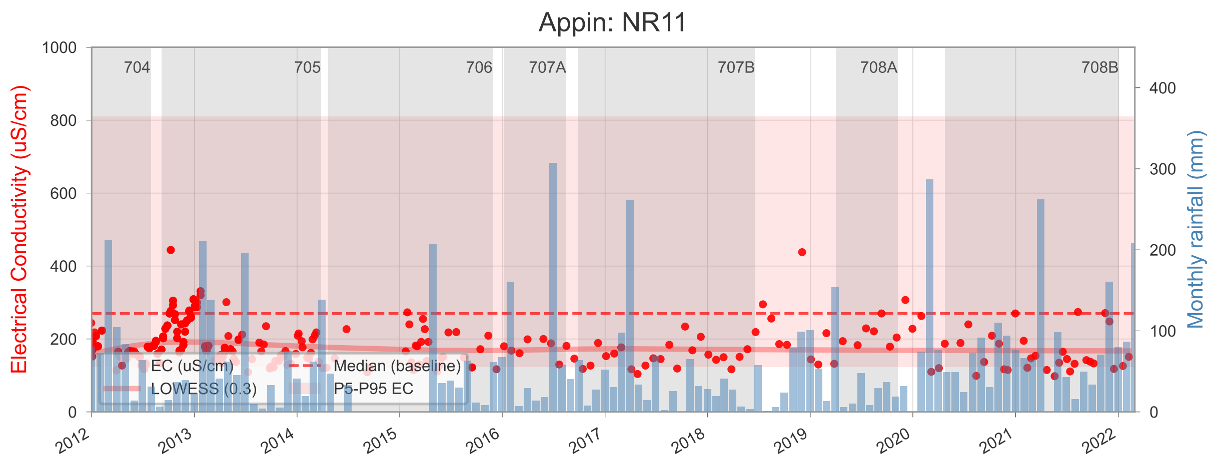

Appin: NR10
Water level (m below ref. nail)
Monthly rainfall (mm)
704
705
706
707A
707B
708A
708B
WL below ref nail
P5-P95 WL

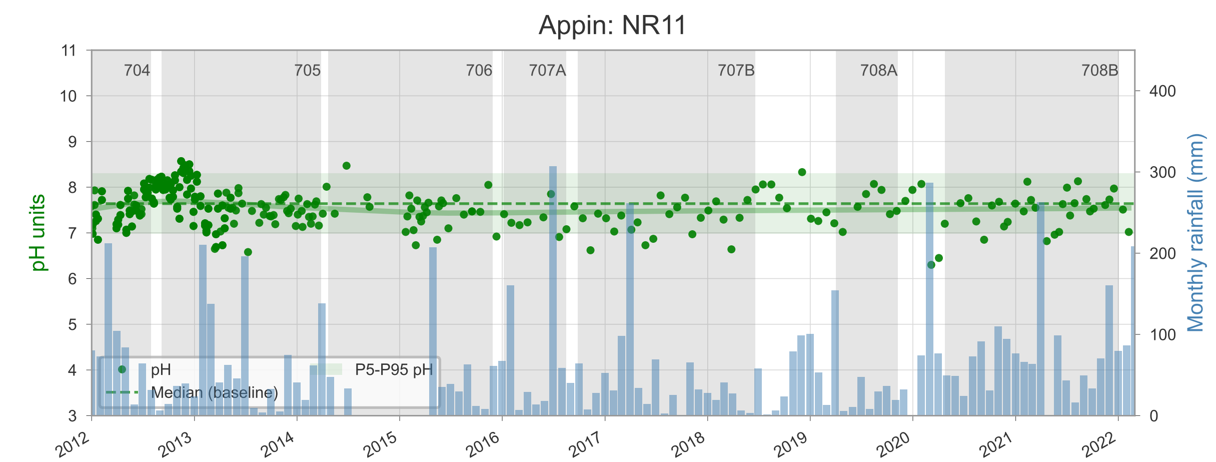

Appin: NR10
Electrical Conductivity (uS/cm)
Monthly rainfall (mm)
704
705
706
707A
707B
708A
708B
EC (uS/cm)
LOWESS (0.3)
Median (baseline)
P5-P95 EC

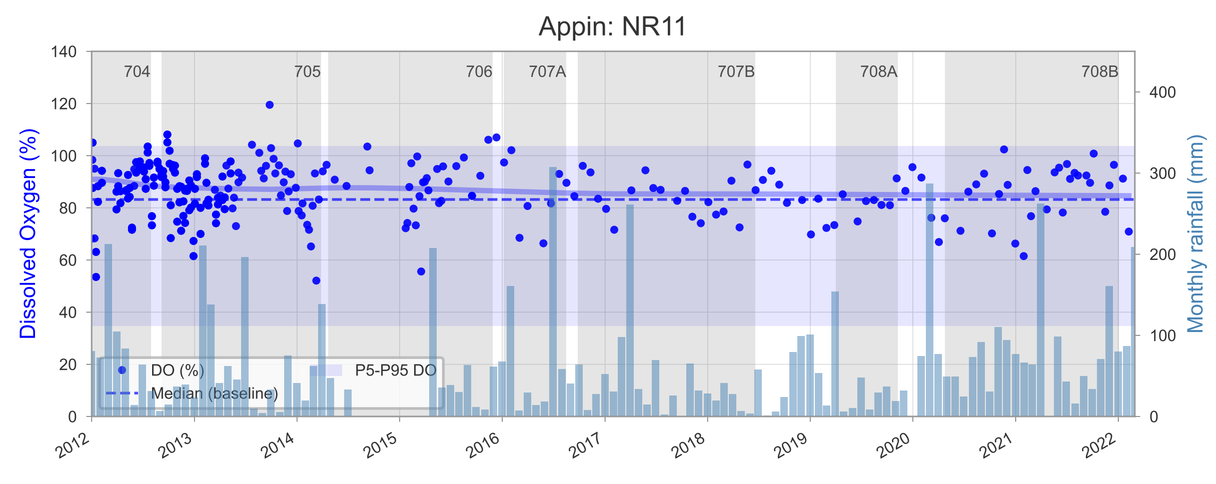

Appin: NR10
pH units
Monthly rainfall (mm)
704
705
706
707A
707B
708A
708B
pH
Median (baseline)
P5-P95 pH

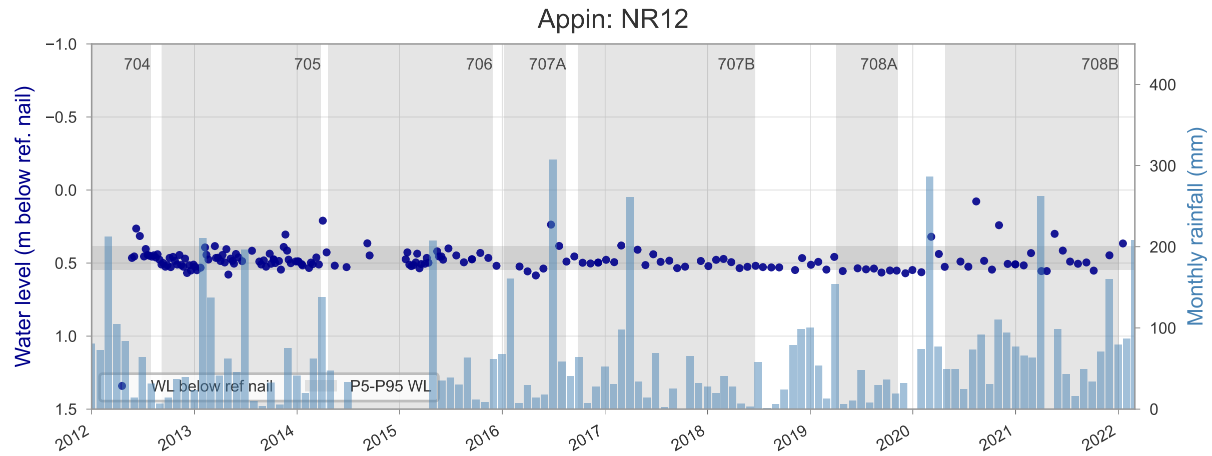

Appin: NR10
Dissolved Oxygen (%)
Monthly rainfall (mm)
704
705
706
707A
707B
708A
708B
DO (%)
Median (baseline)
P5-P95 DO

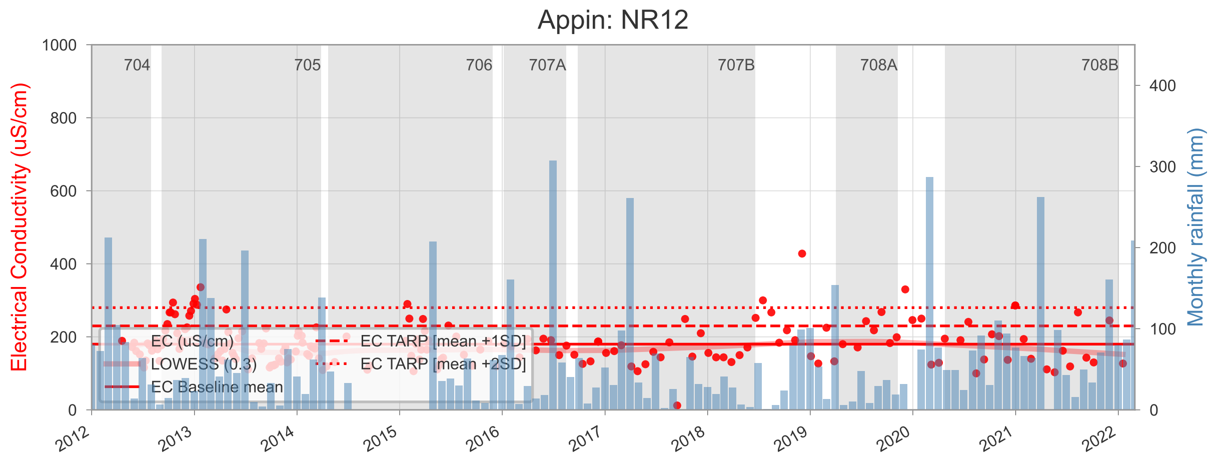

Appin: NR11
704
705
706
707A
707B
708A
708B
Water level (m below ref. nail)
Monthly rainfall (mm)
WL below ref nail
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

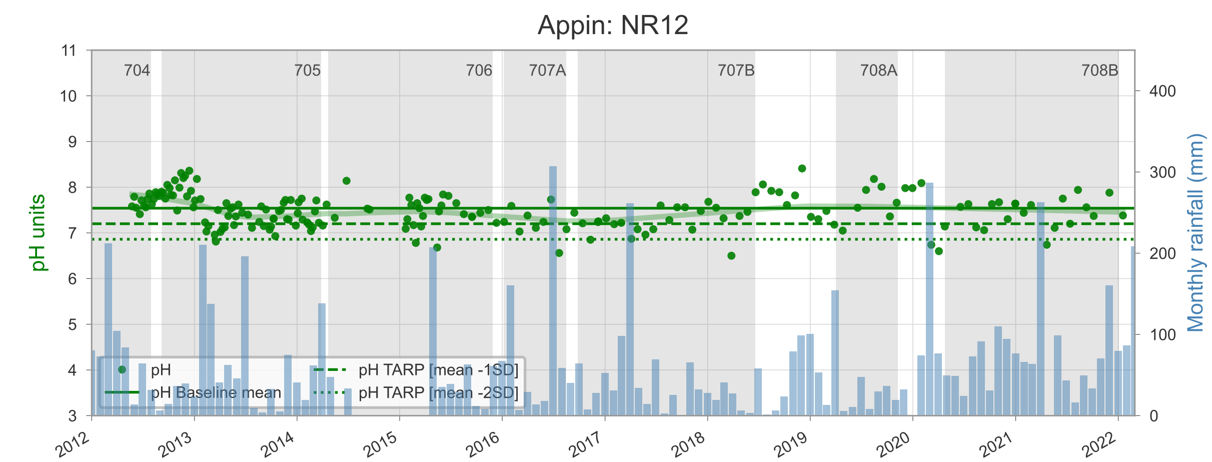

Appin: NR11
704
705
706
707A
707B
708A
708B
Electrical Conductivity (uS/cm)
Monthly rainfall (mm)
EC (uS/cm)
LOWESS (0.3)
Median (baseline)
P5-P95 EC
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

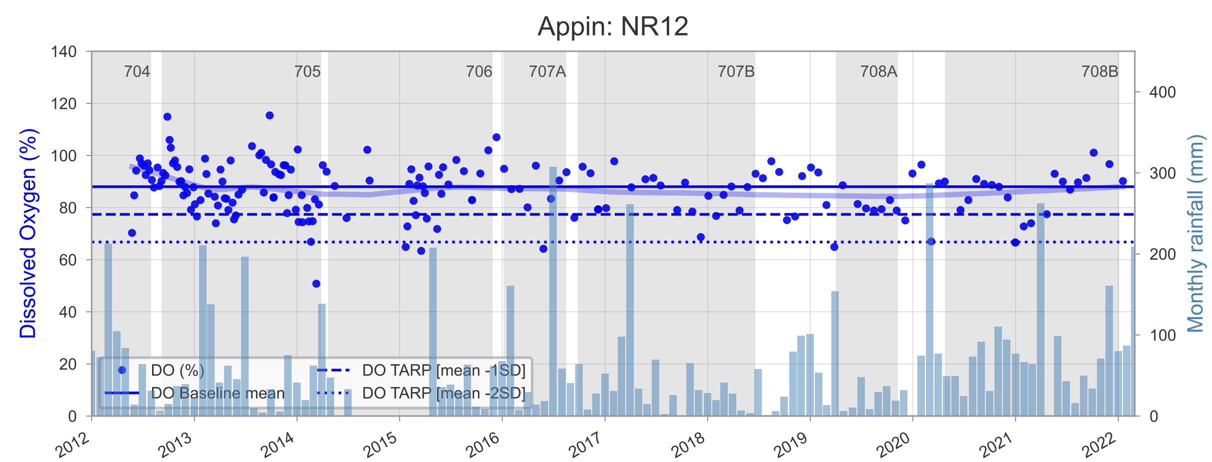

Appin: NR11
704
705
706
707A
707B
708A
708B
pH units
Monthly rainfall (mm)
pH
Median (baseline)
P5-P95 pH
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

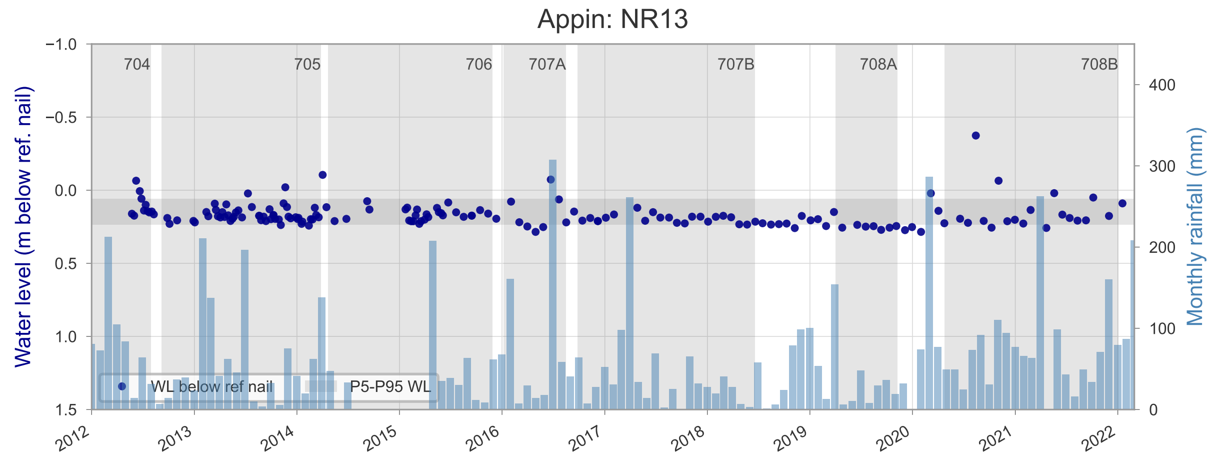

Appin: NR11
704
705
706
707A
707B
708A
708B
Dissolved Oxygen (%)
Monthly rainfall (mm)
DO (%)
Median (baseline)
P5-P95 DO
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

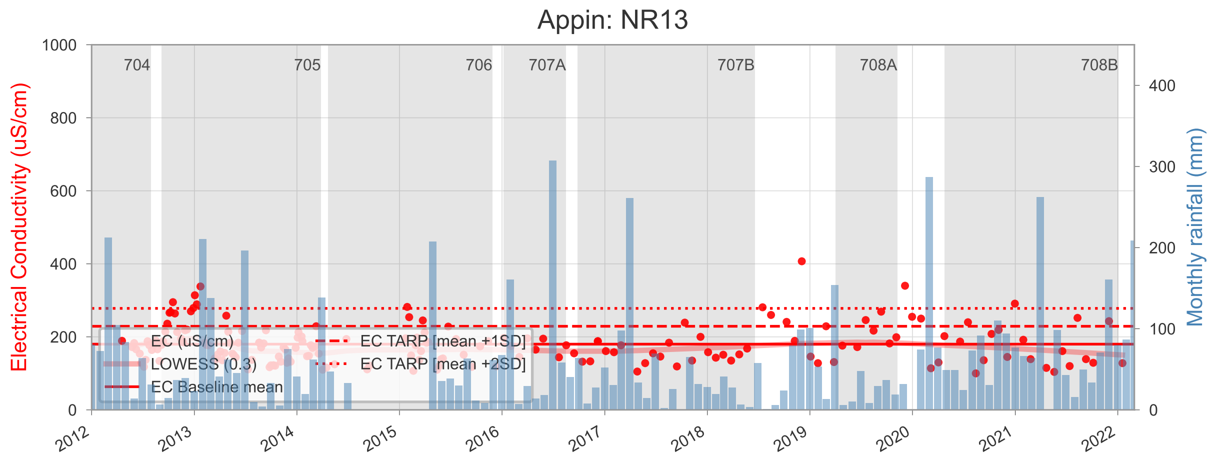

Appin: NR12
704
705
706
707A
707B
708A
708B
Water level (m below ref. nail)
Monthly rainfall (mm)
−1.0
−0.5
0.0
0.5
1.0
1.5
0
100
200
300
400
WL below ref nail
P5-P95 WL
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

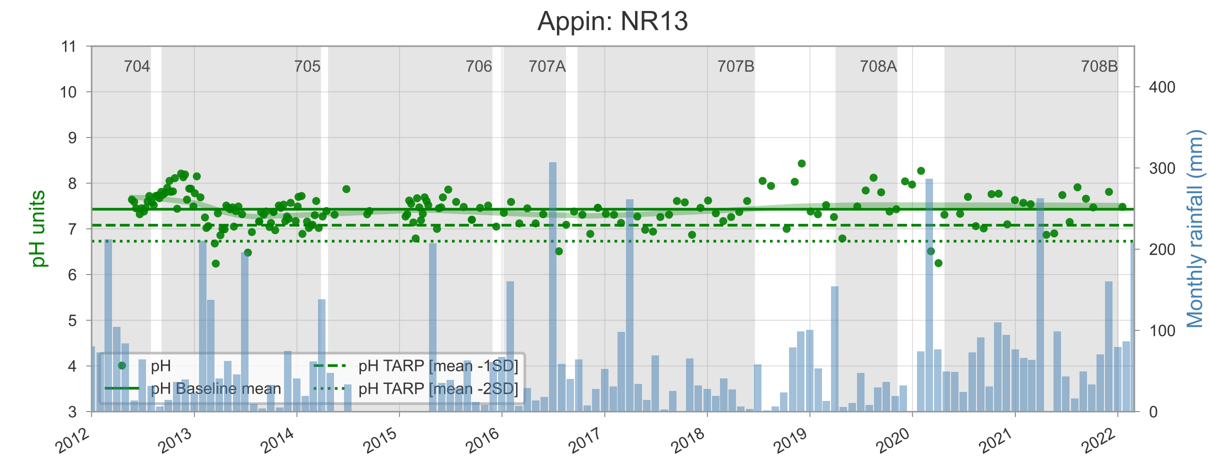

Appin: NR12
704
705
706
707A
707B
708A
708B
Electrical Conductivity (uS/cm)
Monthly rainfall (mm)
0
200
400
600
800
1000
0
100
200
300
400
EC (uS/cm)
LOWESS (0.3)
EC Baseline mean
EC TARP [mean +1SD]
EC TARP [mean +2SD]
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

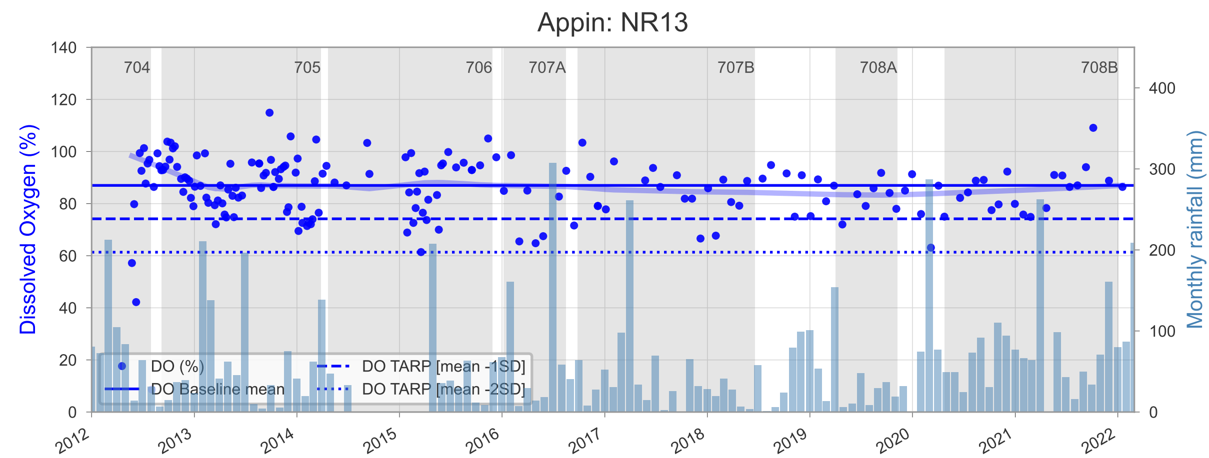

Appin: NR12
704
705
706
707A
707B
708A
708B
pH units
Monthly rainfall (mm)
3
4
5
6
7
8
9
10
11
0
100
200
300
400
pH
pH Baseline mean
pH TARP [mean -1SD]
pH TARP [mean -2SD]
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

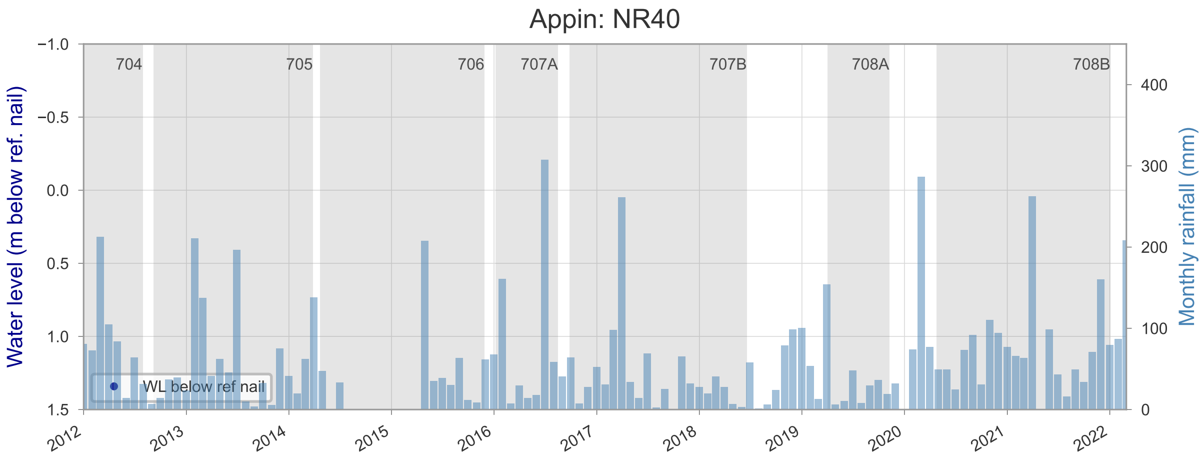

Appin: NR12
704
705
706
707A
707B
708A
708B
Dissolved Oxygen (%)
Monthly rainfall (mm)
0
20
40
60
80
100
120
140
0
100
200
300
400
DO (%)
DO Baseline mean
DO TARP [mean -1SD]
DO TARP [mean -2SD]
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

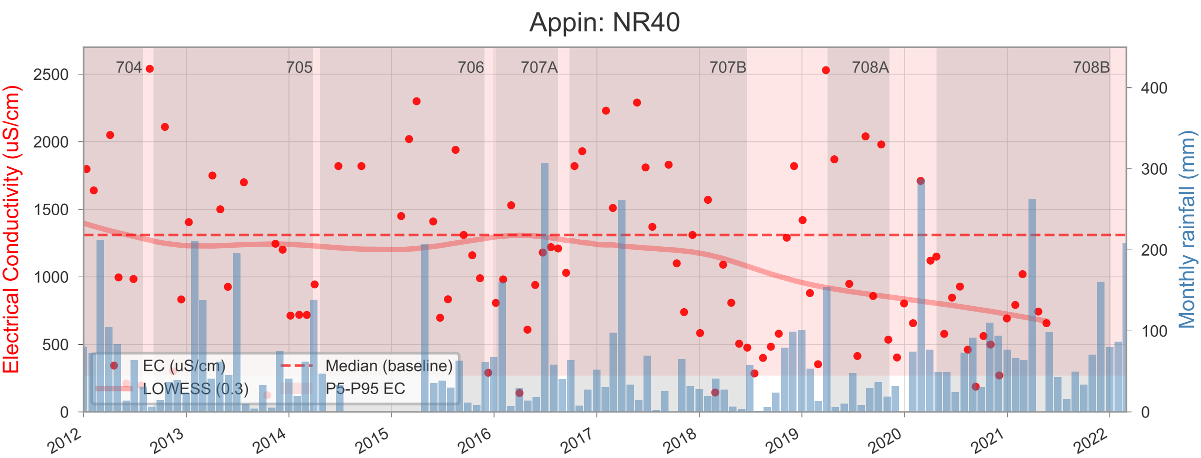

Appin: NR13
Water level (m below ref. nail)
Monthly rainfall (mm)
704
705
706
707A
707B
708A
708B
WL below ref nail
P5-P95 WL
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

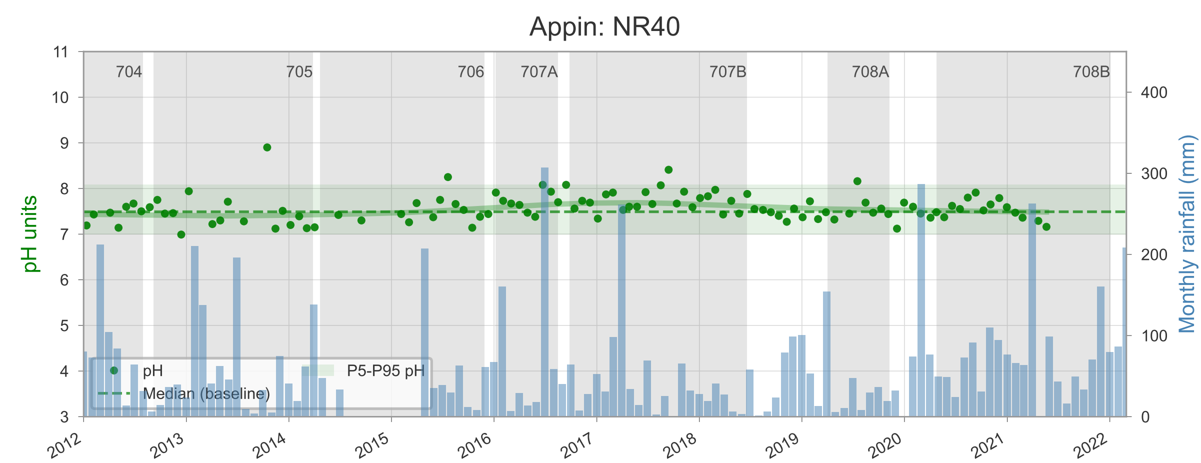

Appin: NR13
Electrical Conductivity (uS/cm)
Monthly rainfall (mm)
704
705
706
707A
707B
708A
708B
EC (uS/cm)
LOWESS (0.3)
EC Baseline mean
EC TARP [mean +1SD]
EC TARP [mean +2SD]
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

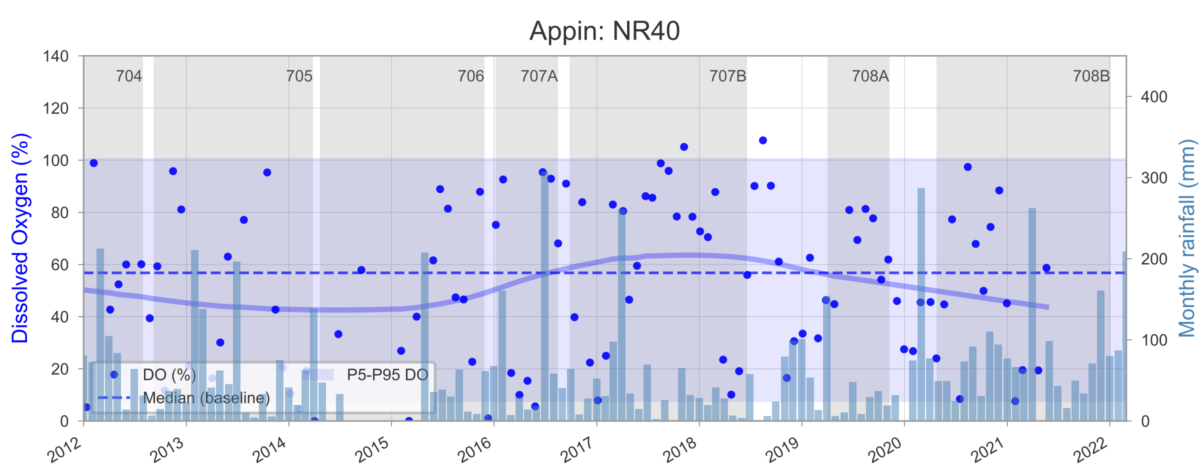

Appin: NR13
pH units
Monthly rainfall (mm)
704
705
706
707A
707B
708A
708B
pH
pH Baseline mean
pH TARP [mean -1SD]
pH TARP [mean -2SD]
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

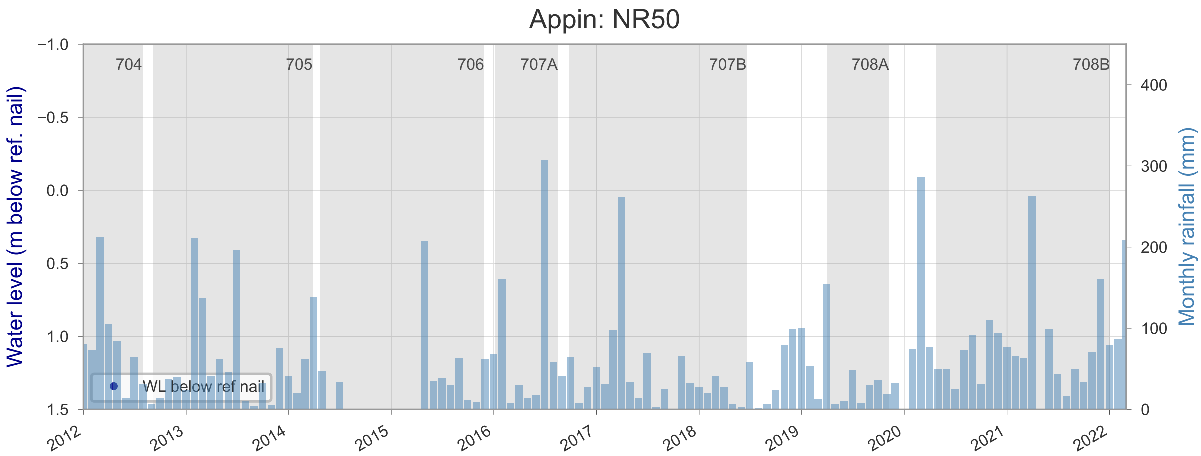

Appin: NR13
Dissolved Oxygen (%)
Monthly rainfall (mm)
704
705
706
707A
707B
708A
708B
DO (%)
DO Baseline mean
DO TARP [mean -1SD]
DO TARP [mean -2SD]
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

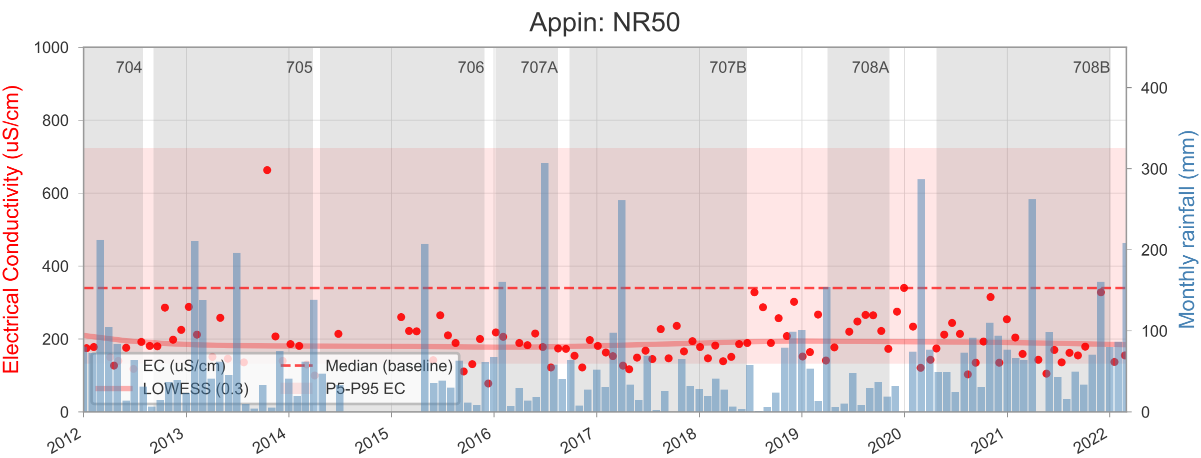

Appin: NR40
704
705
706
707A
707B
708A
708B
Water level (m below ref. nail)
Monthly rainfall (mm)
WL below ref nail
−1.0
−0.5
0.0
0.5
1.0
1.5
0
100
200
300
400
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

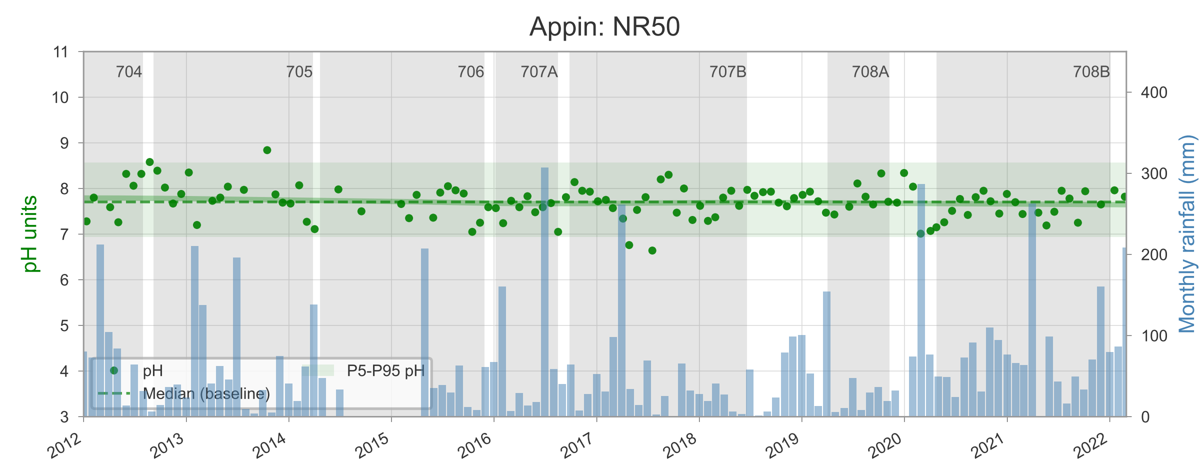

Appin: NR40
704
705
706
707A
707B
708A
708B
Electrical Conductivity (uS/cm)
Monthly rainfall (mm)
EC (uS/cm)
LOWESS (0.3)
Median (baseline)
P5-P95 EC
0
500
1000
1500
2000
2500
0
100
200
300
400
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

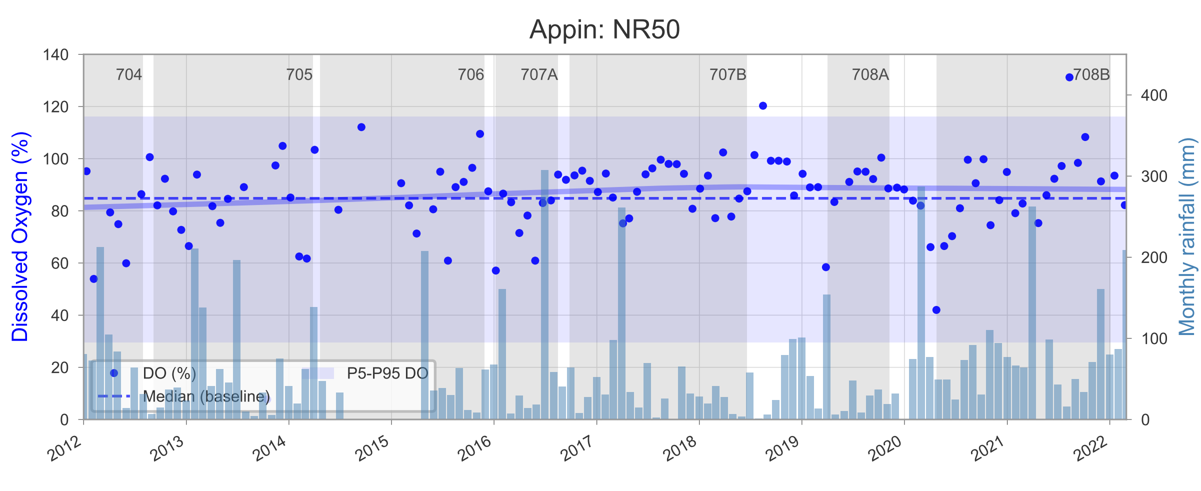

Appin: NR40
704
705
706
707A
707B
708A
708B
pH units
Monthly rainfall (mm)
pH
Median (baseline)
P5-P95 pH
3
4
5
6
7
8
9
10
11
0
100
200
300
400
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

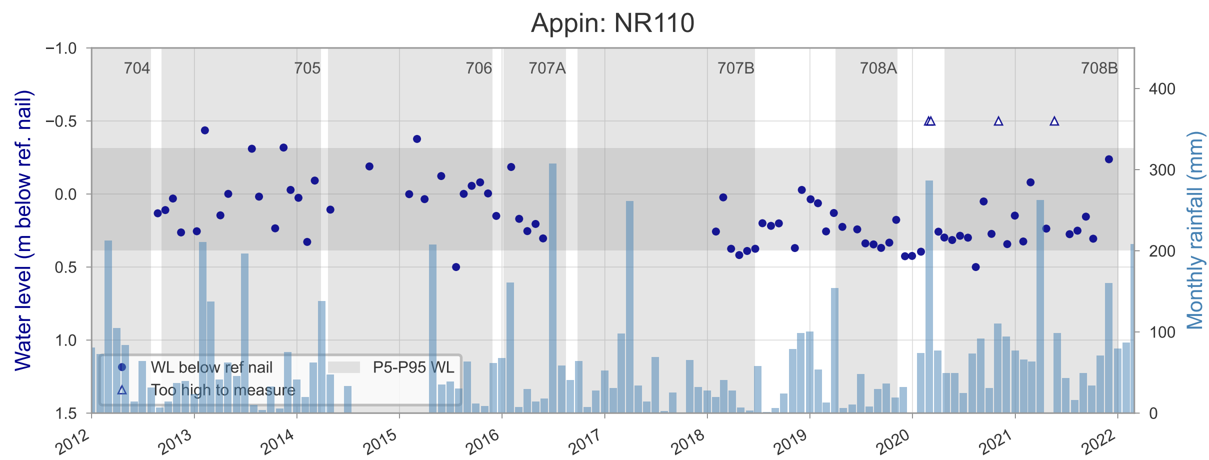

Appin: NR40
704
705
706
707A
707B
708A
708B
Dissolved Oxygen (%)
Monthly rainfall (mm)
DO (%)
Median (baseline)
P5-P95 DO
0
20
40
60
80
100
120
140
0
100
200
300
400
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

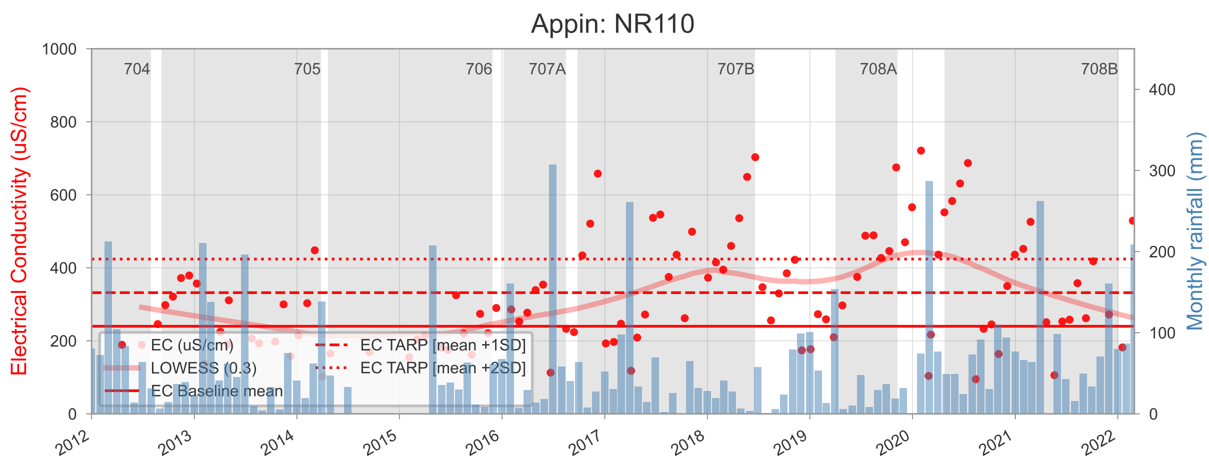

Appin: NR50
Water level (m below ref. nail)
Monthly rainfall (mm)
704
705
706
707A
707B
708A
708B
WL below ref nail

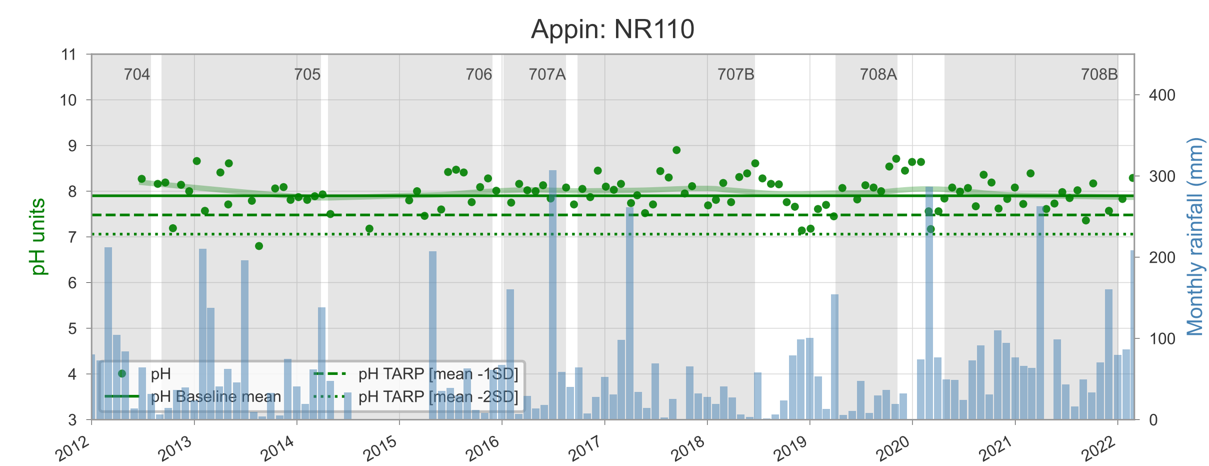

Appin: NR50
Electrical Conductivity (uS/cm)
Monthly rainfall (mm)
704
705
706
707A
707B
708A
708B
EC (uS/cm)
LOWESS (0.3)
Median (baseline)
P5-P95 EC

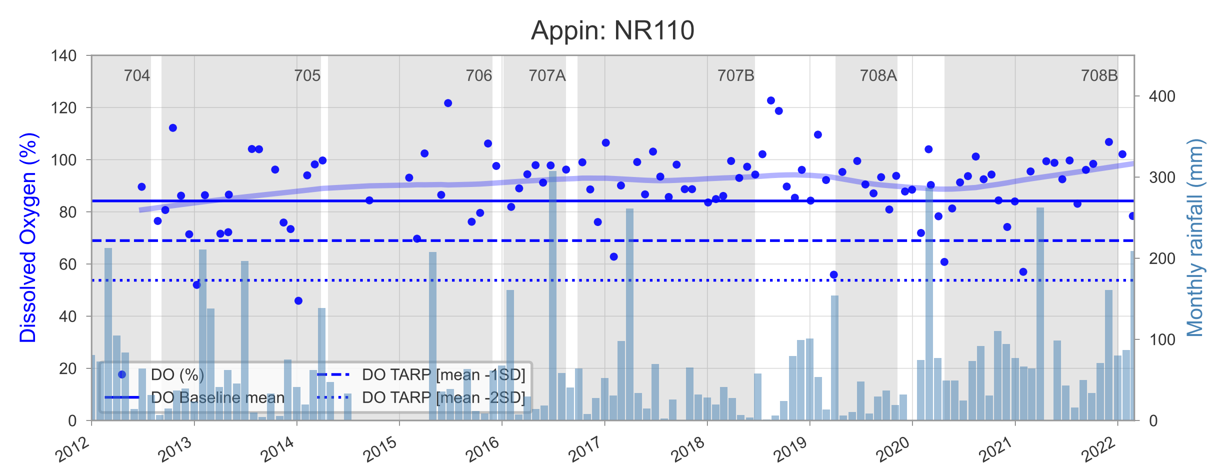

Appin: NR50
pH units
Monthly rainfall (mm)
704
705
706
707A
707B
708A
708B
pH
Median (baseline)
P5-P95 pH

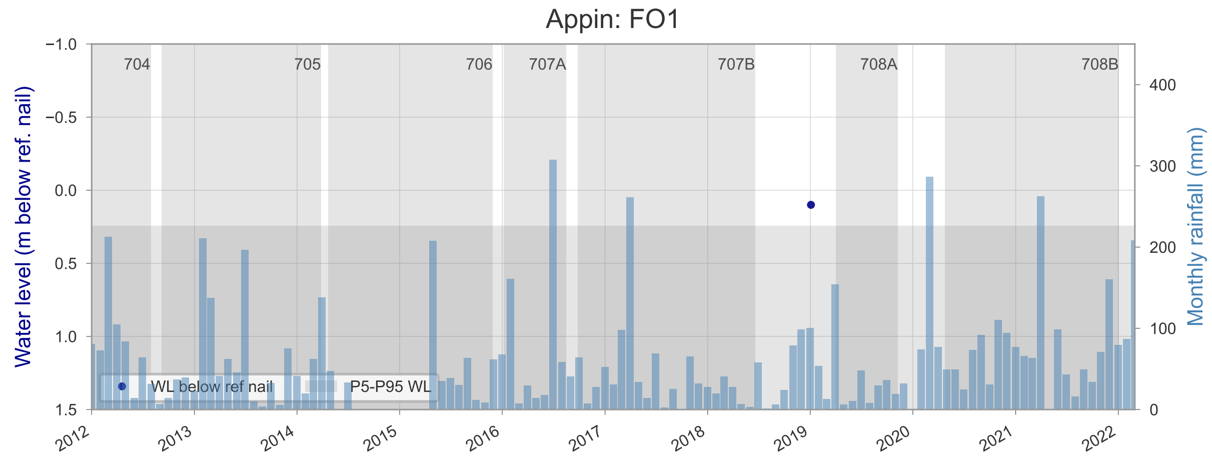

Appin: NR50
Dissolved Oxygen (%)
Monthly rainfall (mm)
704
705
706
707A
707B
708A
708B
DO (%)
Median (baseline)
P5-P95 DO

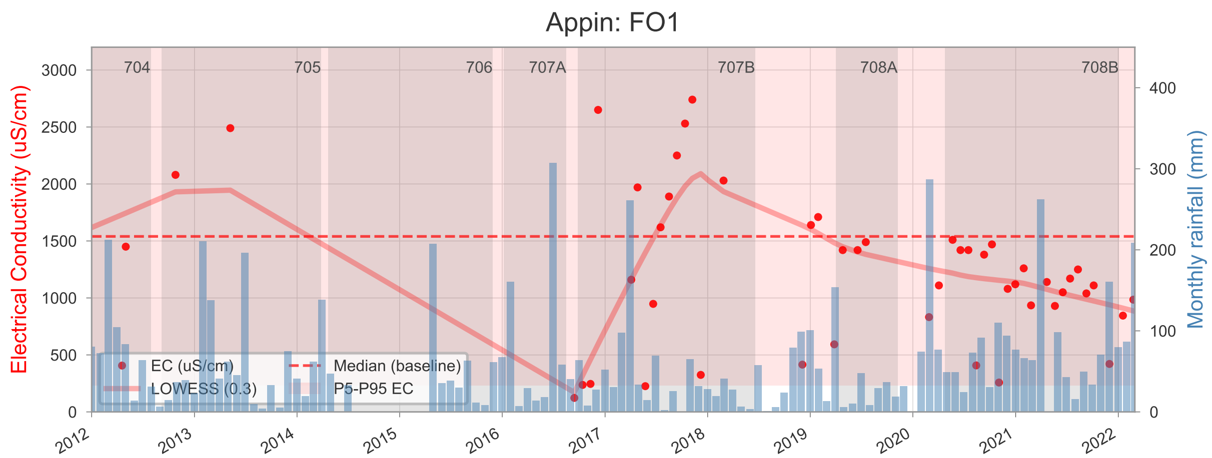

Appin: NR110
Water level (m below ref. nail)
Monthly rainfall (mm)
704
705
706
707A
707B
708A
708B
WL below ref nail
Too high to measure
P5-P95 WL

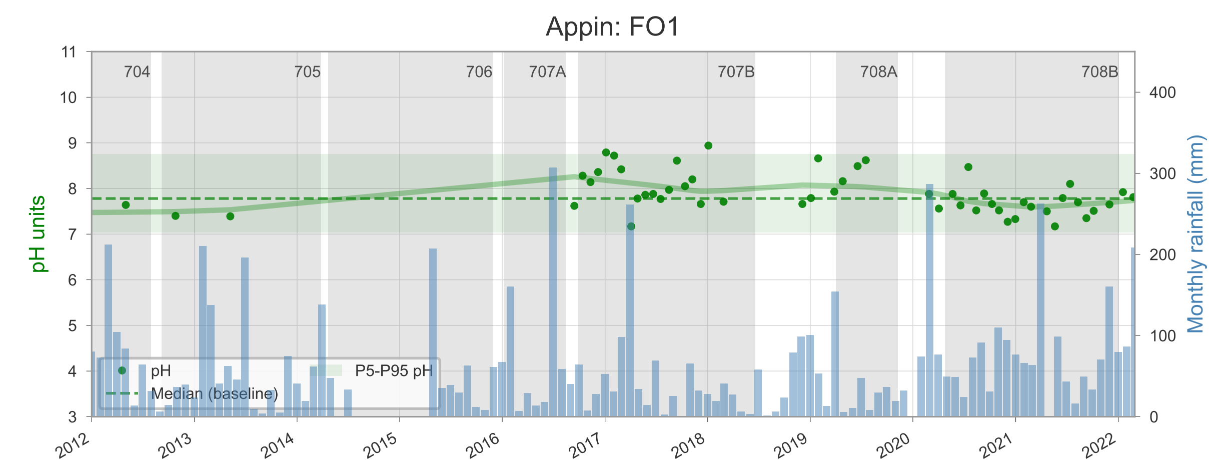

Appin: NR110
Electrical Conductivity (uS/cm)
Monthly rainfall (mm)
704
705
706
707A
707B
708A
708B
EC (uS/cm)
LOWESS (0.3)
EC Baseline mean
EC TARP [mean +1SD]
EC TARP [mean +2SD]

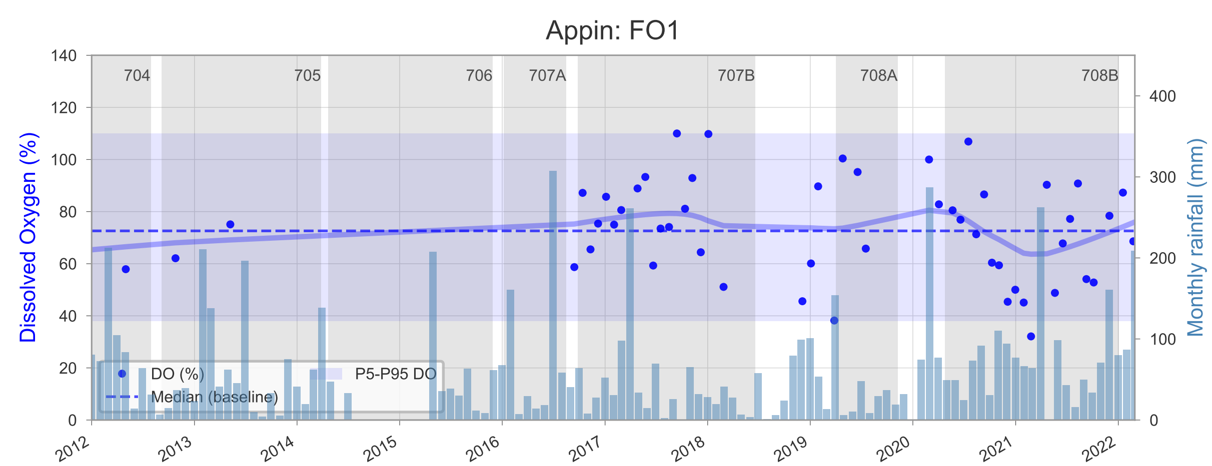

Appin: NR110
pH units
Monthly rainfall (mm)
704
705
706
707A
707B
708A
708B
pH
pH Baseline mean
pH TARP [mean -1SD]
pH TARP [mean -2SD]

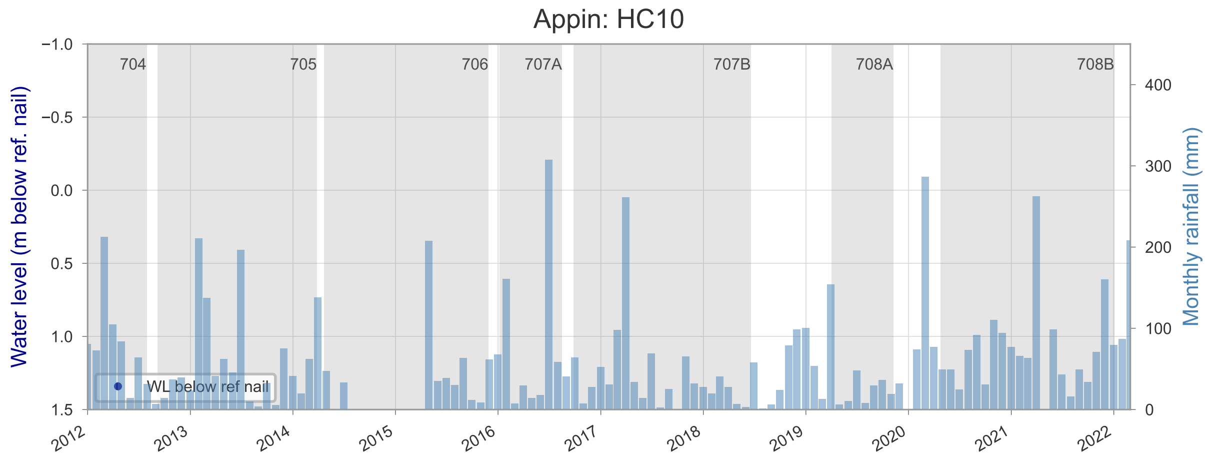

Appin: NR110
Dissolved Oxygen (%)
Monthly rainfall (mm)
704
705
706
707A
707B
708A
708B
DO (%)
DO Baseline mean
DO TARP [mean -1SD]
DO TARP [mean -2SD]

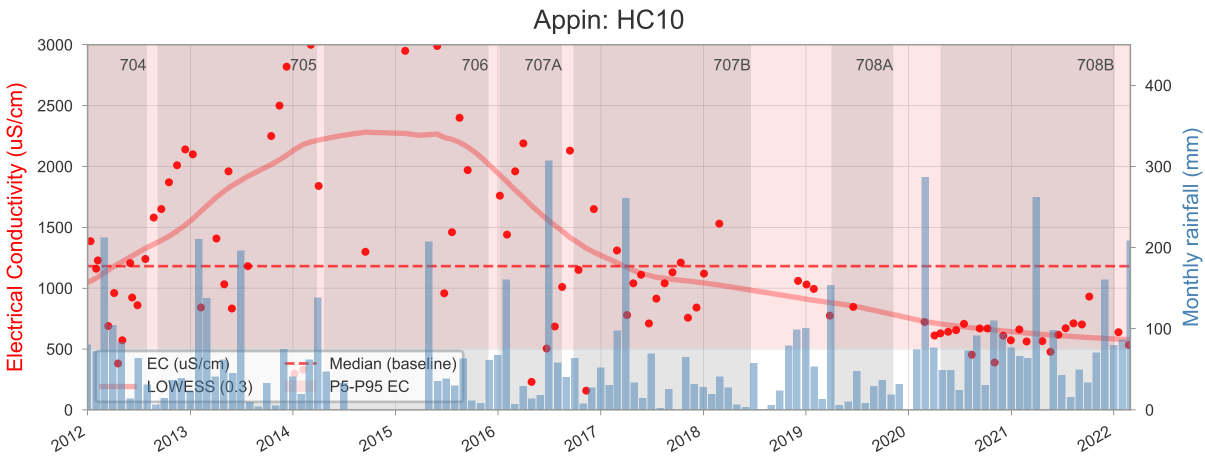

Appin: FO1
704
705
706
707A
707B
708A
708B
Water level (m below ref. nail)
Monthly rainfall (mm)
WL below ref nail
P5-P95 WL
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

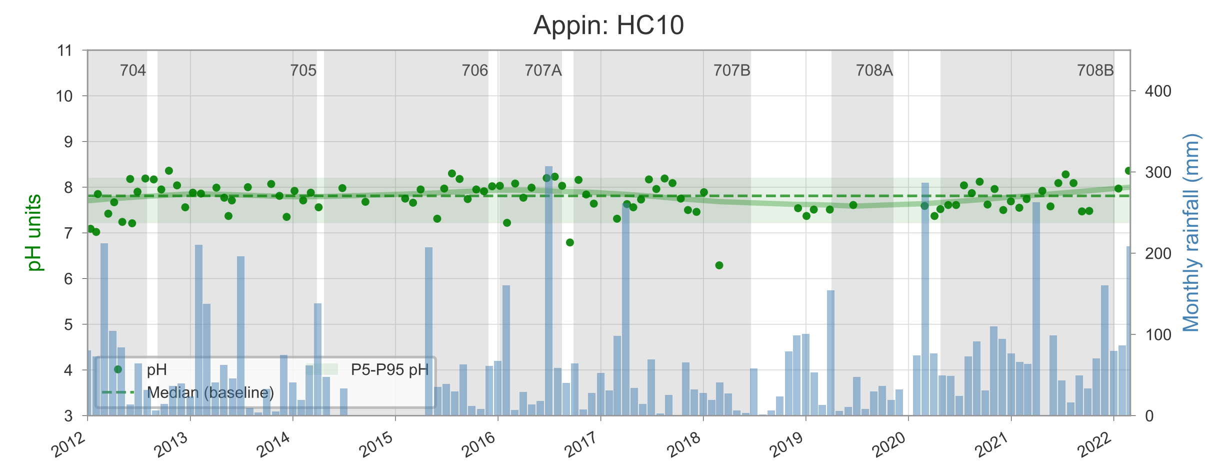

Appin: FO1
704
705
706
707A
707B
708A
708B
Electrical Conductivity (uS/cm)
Monthly rainfall (mm)
EC (uS/cm)
LOWESS (0.3)
Median (baseline)
P5-P95 EC
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

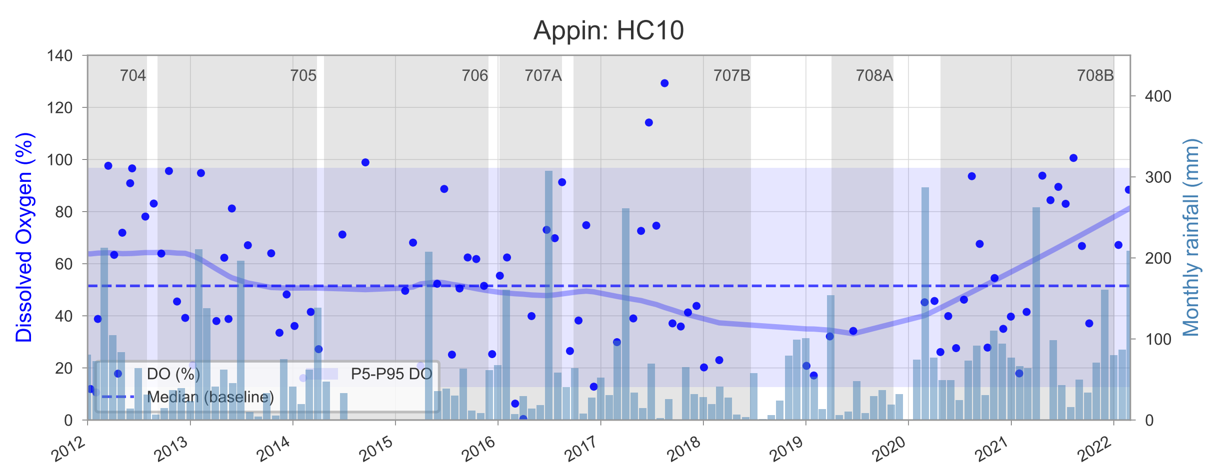

Appin: FO1
704
705
706
707A
707B
708A
708B
pH units
Monthly rainfall (mm)
pH
Median (baseline)
P5-P95 pH
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

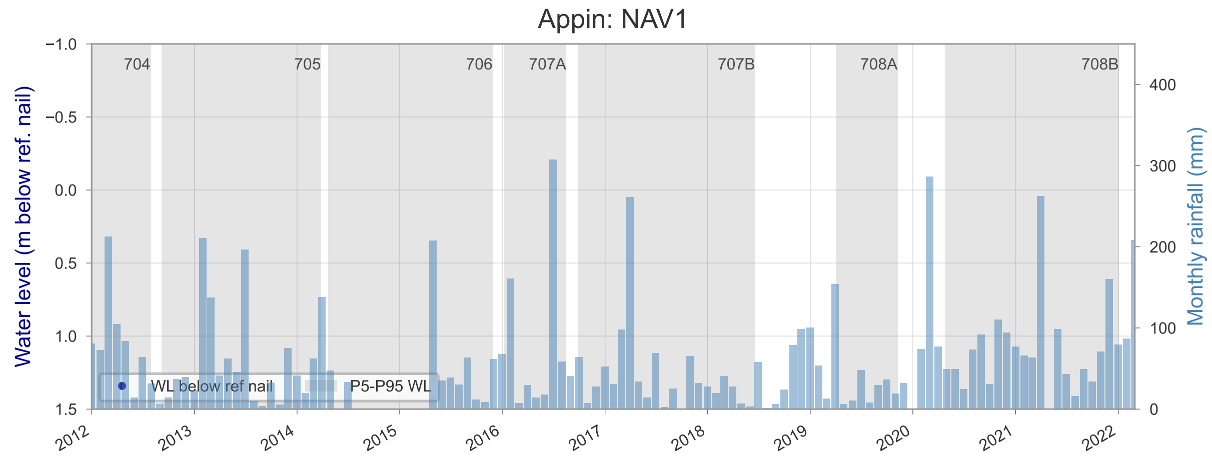

Appin: FO1
704
705
706
707A
707B
708A
708B
Dissolved Oxygen (%)
Monthly rainfall (mm)
DO (%)
Median (baseline)
P5-P95 DO
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

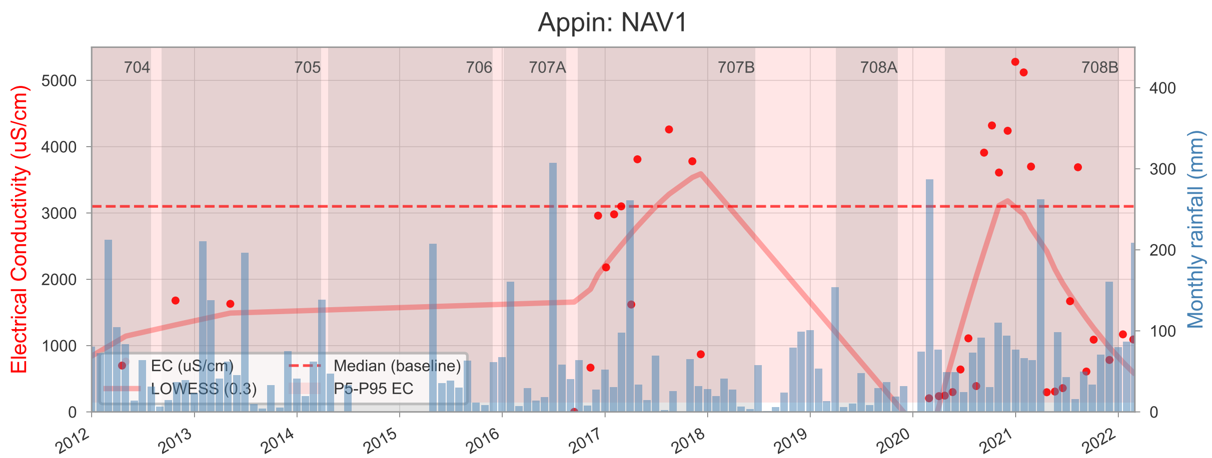

Appin: HC10
704
705
706
707A
707B
708A
708B
Water level (m below ref. nail)
Monthly rainfall (mm)
WL below ref nail
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

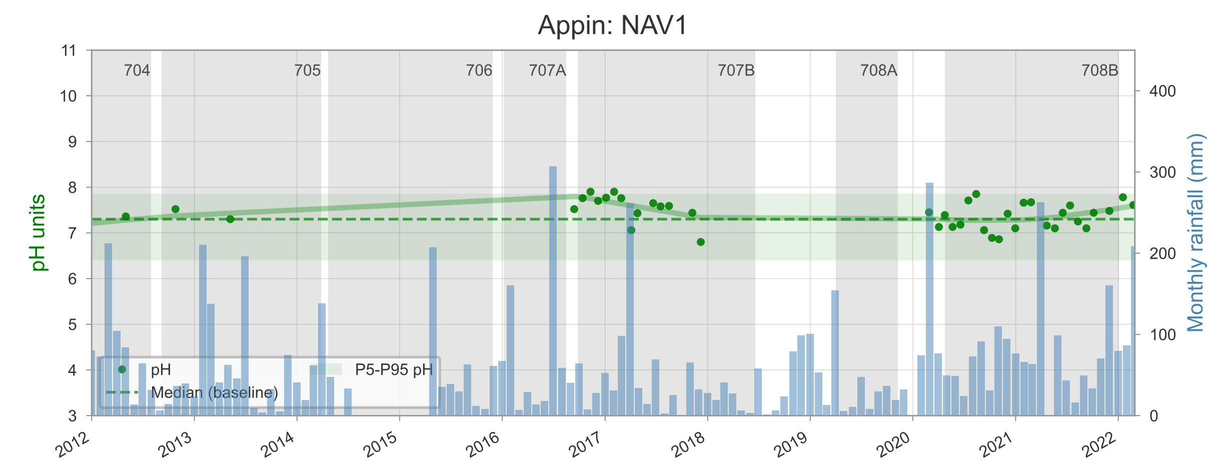

Appin: HC10
704
705
706
707A
707B
708A
708B
Electrical Conductivity (uS/cm)
Monthly rainfall (mm)
EC (uS/cm)
LOWESS (0.3)
Median (baseline)
P5-P95 EC

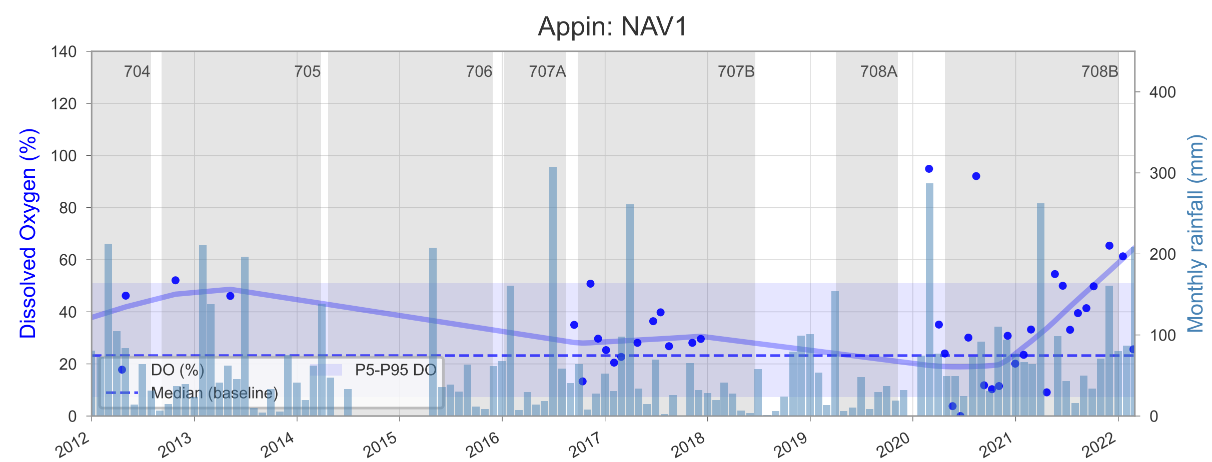

Appin: HC10
704
705
706
707A
707B
708A
708B
pH units
Monthly rainfall (mm)
pH
Median (baseline)
P5-P95 pH

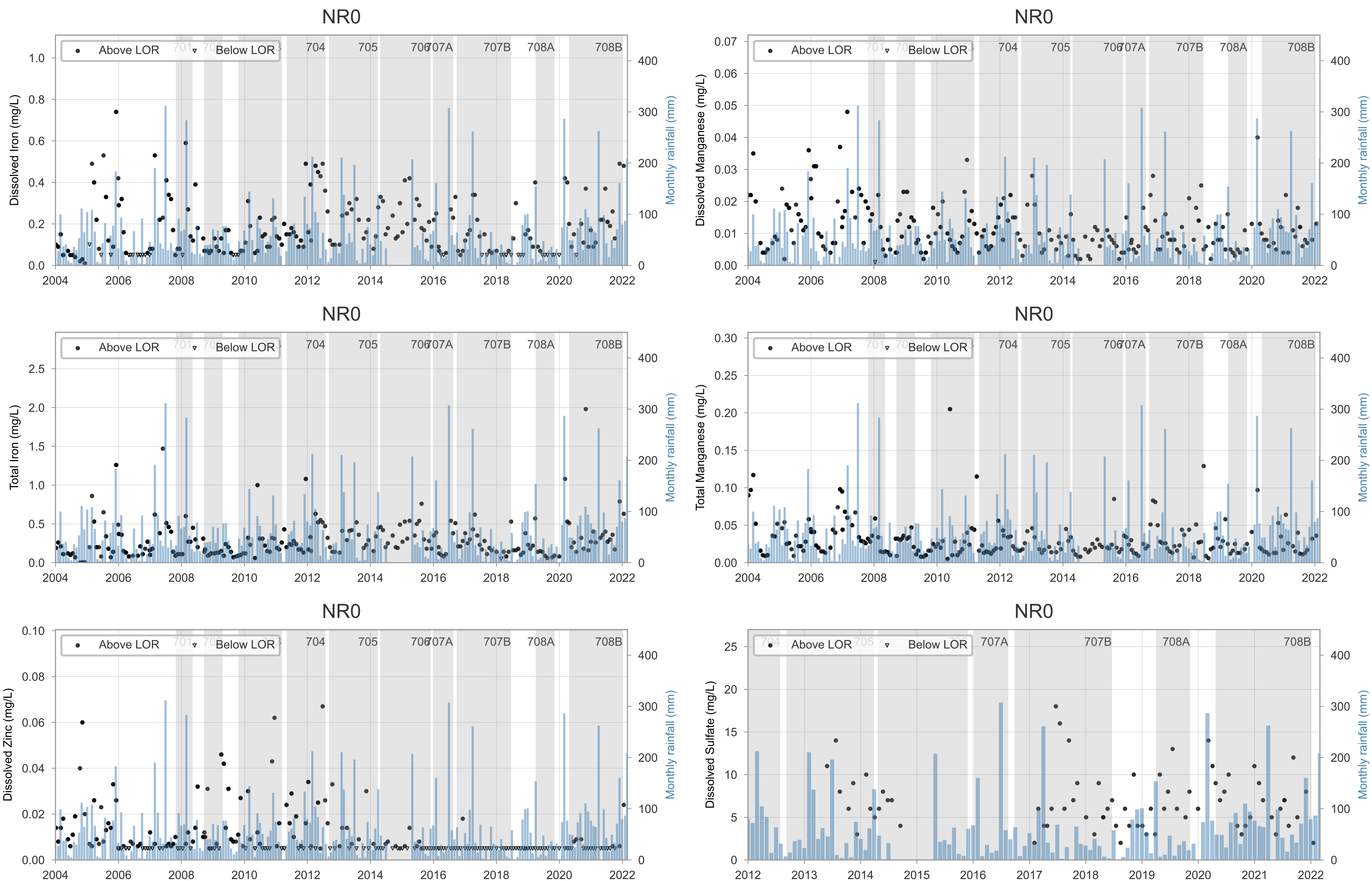

Appin: HC10
704
705
706
707A
707B
708A
708B
Dissolved Oxygen (%)
Monthly rainfall (mm)
DO (%)
Median (baseline)
P5-P95 DO

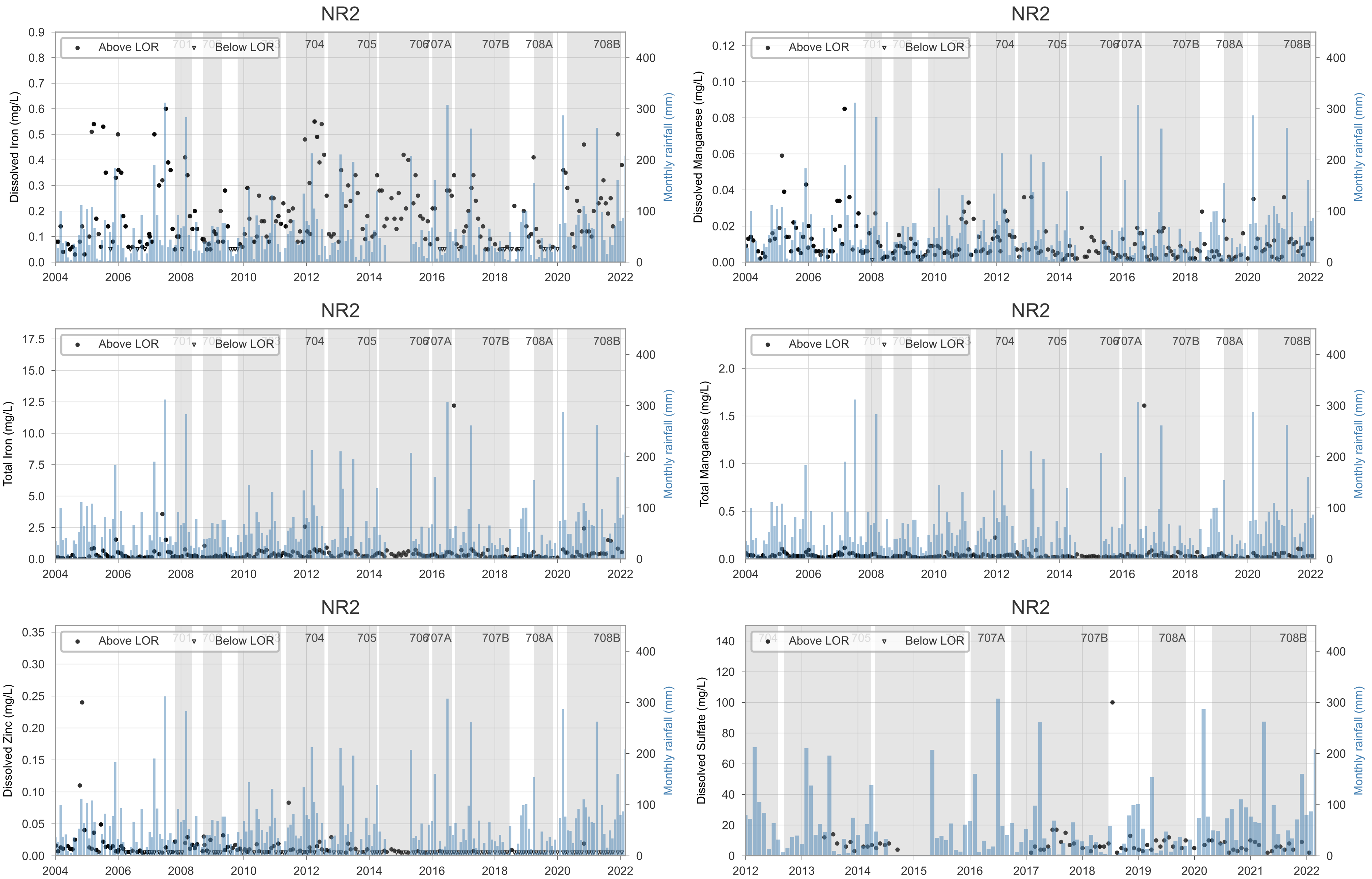

Appin: NAV1
704
705
706
707A
707B
708A
708B
Water level (m below ref. nail)
Monthly rainfall (mm)
WL below ref nail
P5-P95 WL
−1.0
−0.5
0.0
0.5
1.0
1.5
0
100
200
300
400
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

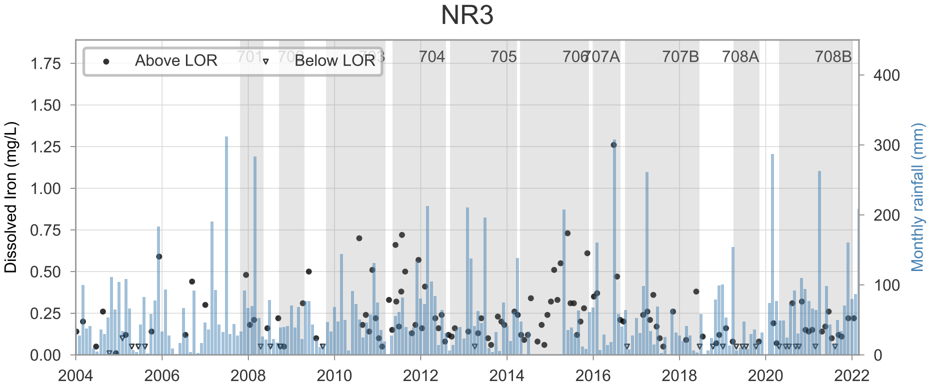

Appin: NAV1
704
705
706
707A
707B
708A
708B
Electrical Conductivity (uS/cm)
Monthly rainfall (mm)
EC (uS/cm)
LOWESS (0.3)
Median (baseline)
P5-P95 EC
0
1000
2000
3000
4000
5000
0
100
200
300
400
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

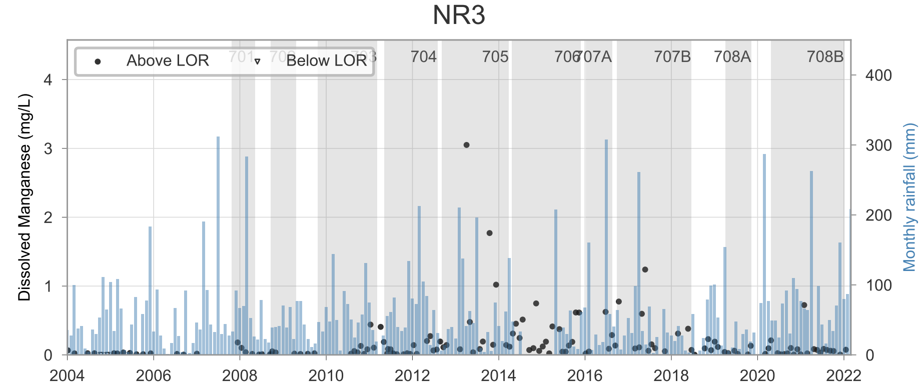

Appin: NAV1
704
705
706
707A
707B
708A
708B
pH units
Monthly rainfall (mm)
pH
Median (baseline)
P5-P95 pH
3
4
5
6
7
8
9
10
11
0
100
200
300
400
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

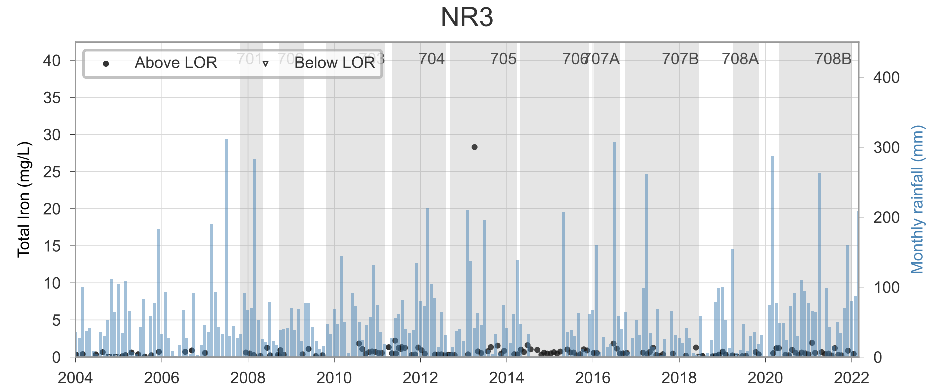

Appin: NAV1
704
705
706
707A
707B
708A
708B
Dissolved Oxygen (%)
Monthly rainfall (mm)
DO (%)
Median (baseline)
P5-P95 DO
0
20
40
60
80
100
120
140
0
100
200
300
400
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

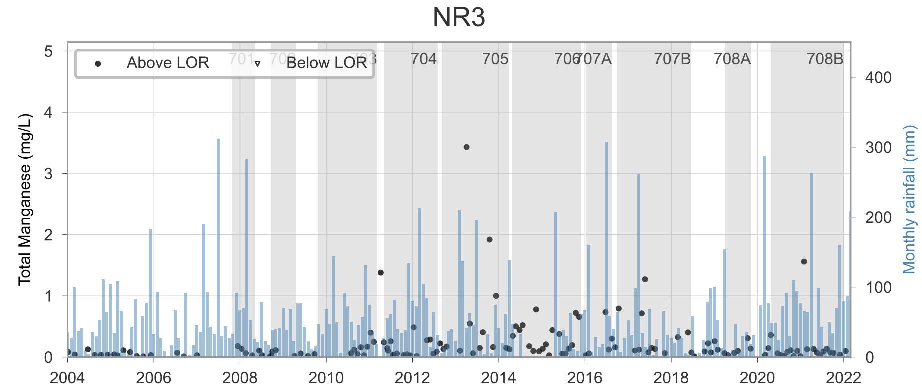

NR0
Dissolved Iron (mg/L)
Monthly rainfall (mm)
Above LOR
Below LOR
701
702
703
704
705
706
707A
707B
708A
708B
NR0
Dissolved Manganese (mg/L)
Monthly rainfall (mm)
NR0
Total Iron (mg/L)
Monthly rainfall (mm)
NR0
Total Manganese (mg/L)
Monthly rainfall (mm)
NR0
Dissolved Zinc (mg/L)
Monthly rainfall (mm)
NR0
Dissolved Sulfate (mg/L)
Monthly rainfall (mm)

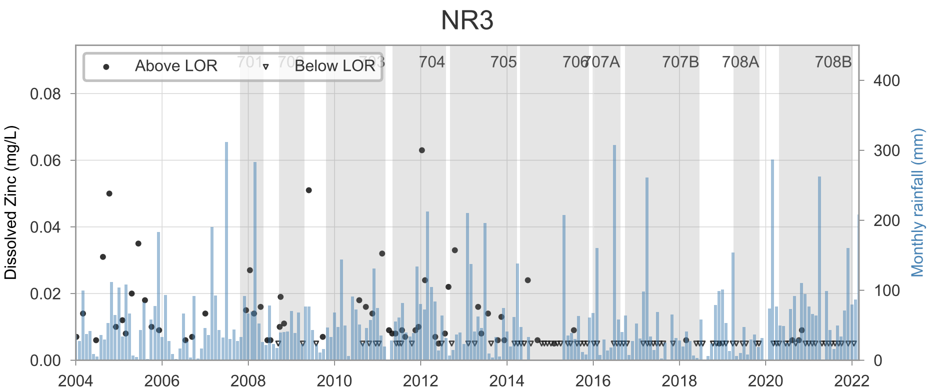

NR2
Above LOR
Below LOR
701
702
703
704
705
706
707A
707B
708A
708B
Dissolved Iron (mg/L)
Dissolved Manganese (mg/L)
Total Iron (mg/L)
Total Manganese (mg/L)
Dissolved Zinc (mg/L)
Dissolved Sulfate (mg/L)
Monthly rainfall (mm)
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022

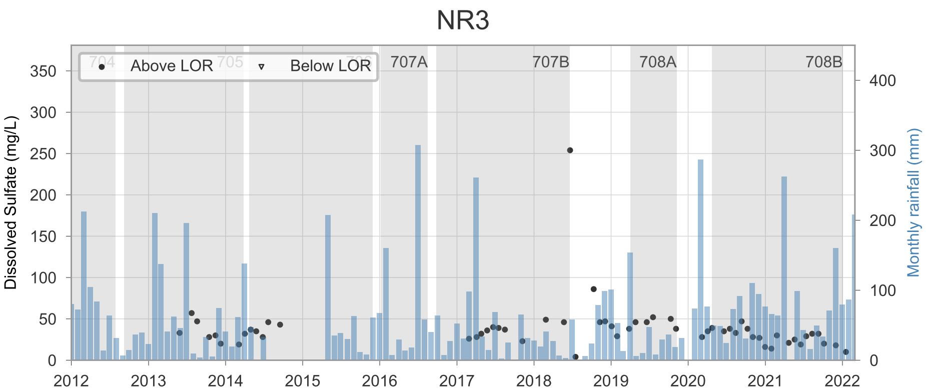

NR3
Above LOR
Below LOR
704
705
706
707A
707B
708A
708B
Dissolved Iron (mg/L)
Monthly rainfall (mm)
0.00
0.25
0.50
0.75
1.00
1.25
1.50
1.75
0
100
200
300
400
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022

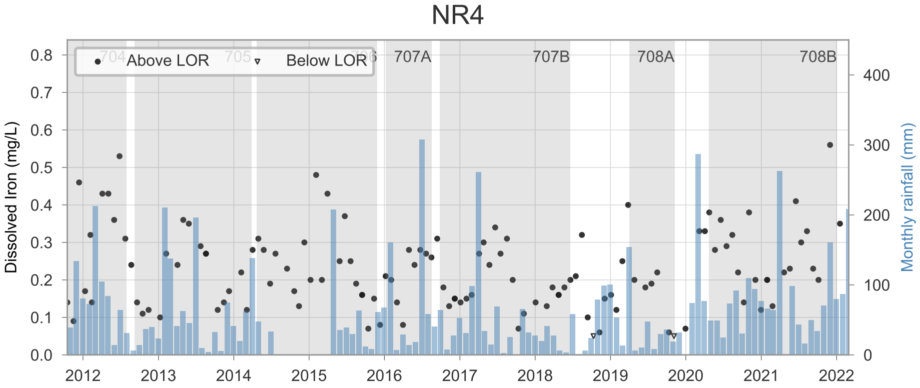

NR3
Above LOR
Below LOR
704
705
706
707A
707B
708A
708B
Dissolved Manganese (mg/L)
Monthly rainfall (mm)
0
1
2
3
4
0
100
200
300
400
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022

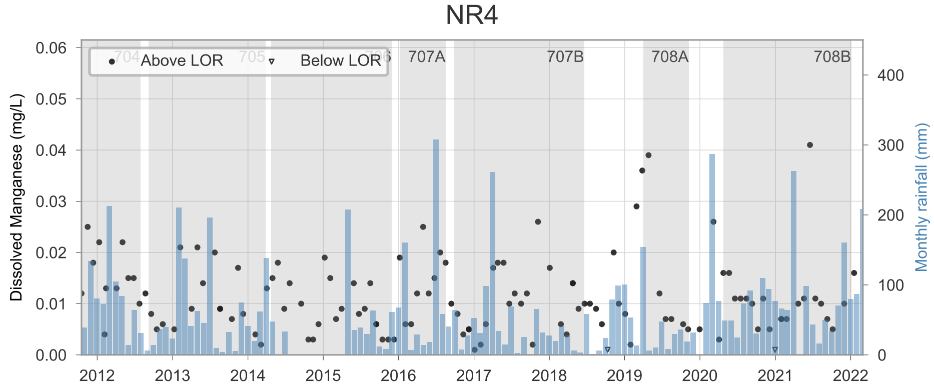

NR3
Above LOR
Below LOR
704
705
706
707A
707B
708A
708B
Total Iron (mg/L)
Monthly rainfall (mm)
0
5
10
15
20
25
30
35
40
0
100
200
300
400
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022

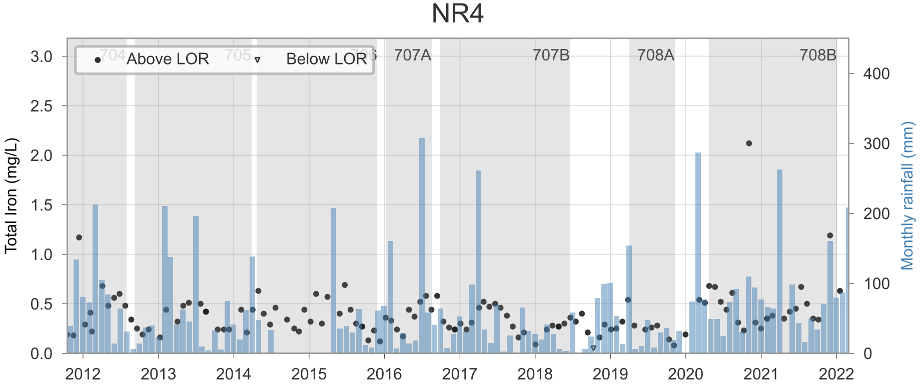

NR3
Above LOR
Below LOR
704
705
706
707A
707B
708A
708B
Total Manganese (mg/L)
Monthly rainfall (mm)
0
1
2
3
4
5
0
100
200
300
400
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022

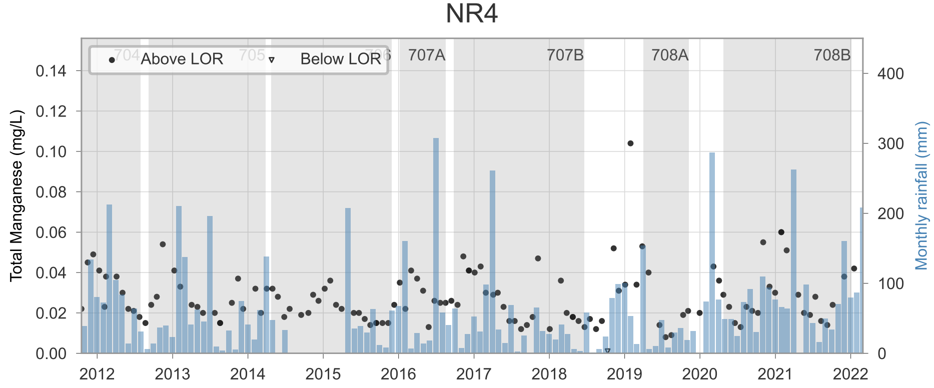

NR3
Above LOR
Below LOR
704
705
706
707A
707B
708A
708B
Dissolved Zinc (mg/L)
Monthly rainfall (mm)
0.00
0.02
0.04
0.06
0.08
0
100
200
300
400
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022

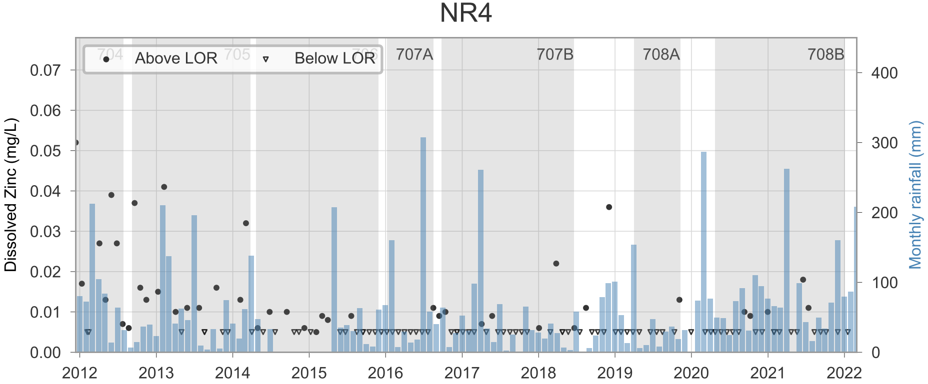

NR3
Above LOR
Below LOR
707A
707B
708A
708B
Dissolved Sulfate (mg/L)
Monthly rainfall (mm)
0
50
100
150
200
250
300
350
0
100
200
300
400
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

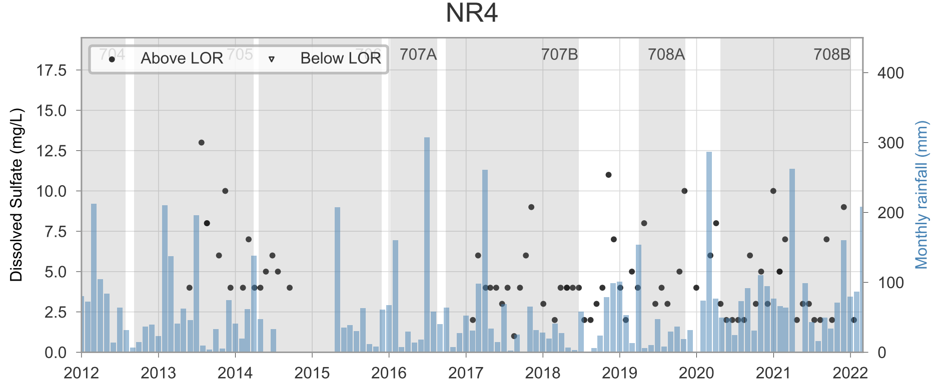

NR4
Dissolved Iron (mg/L)
Monthly rainfall (mm)
Above LOR
Below LOR
707A
707B
708A
708B

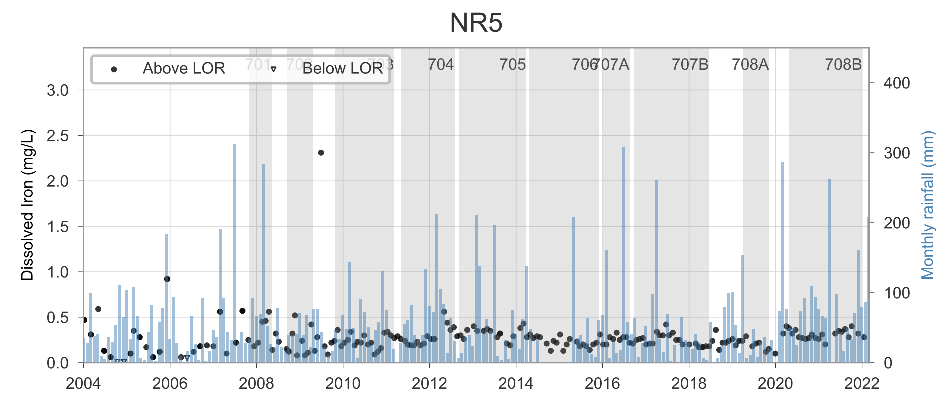

NR4
Dissolved Manganese (mg/L)
Monthly rainfall (mm)
Above LOR
Below LOR
707A
707B
708A
708B

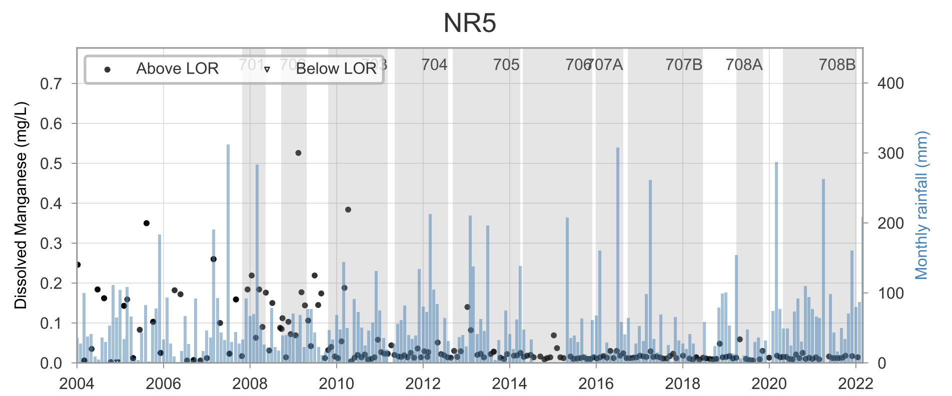

NR4
Total Iron (mg/L)
Monthly rainfall (mm)
Above LOR
Below LOR
707A
707B
708A
708B

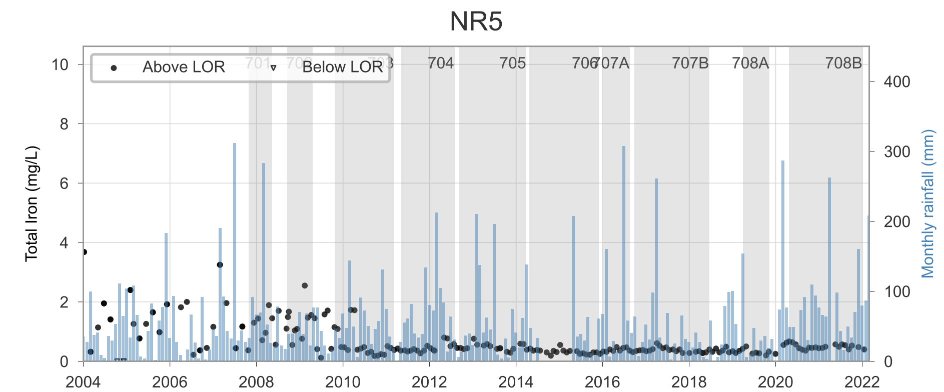

NR4
Total Manganese (mg/L)
Monthly rainfall (mm)
Above LOR
Below LOR
707A
707B
708A
708B

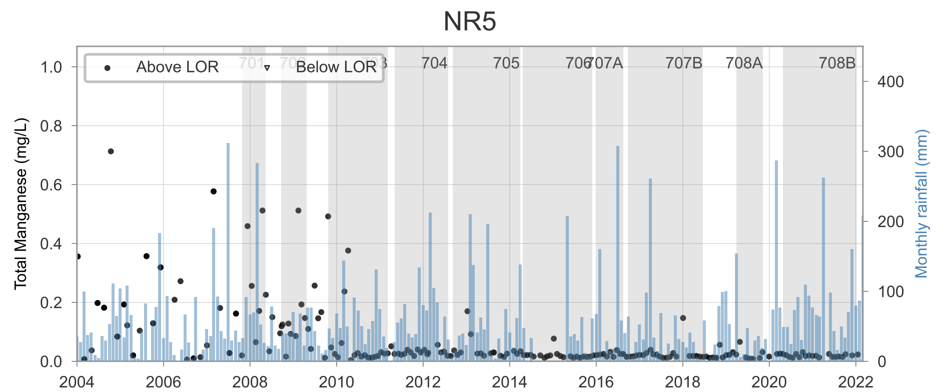

NR4
Dissolved Zinc (mg/L)
Monthly rainfall (mm)
Above LOR
Below LOR
707A
707B
708A
708B

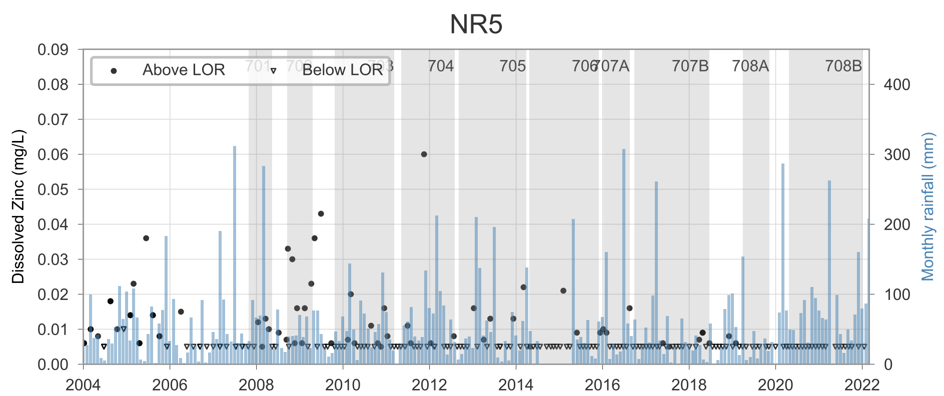

NR4
Dissolved Sulfate (mg/L)
Monthly rainfall (mm)
Above LOR
Below LOR
707A
707B
708A
708B

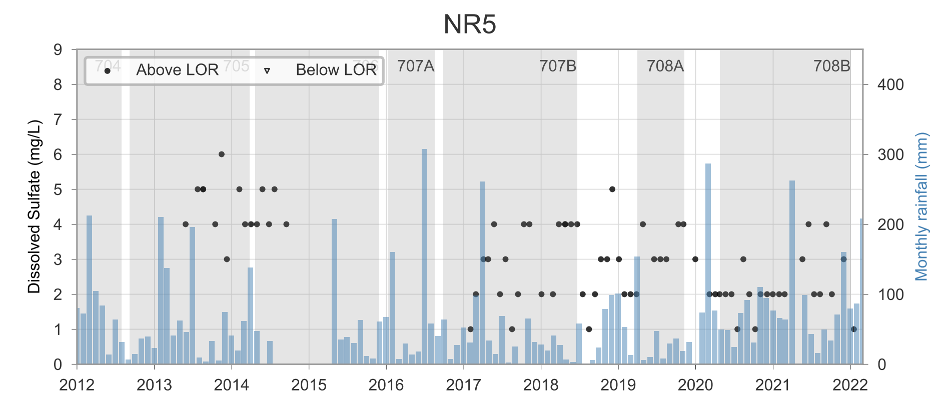

NR5
Above LOR
Below LOR
704
705
706
707A
707B
708A
708B
Dissolved Iron (mg/L)
Monthly rainfall (mm)

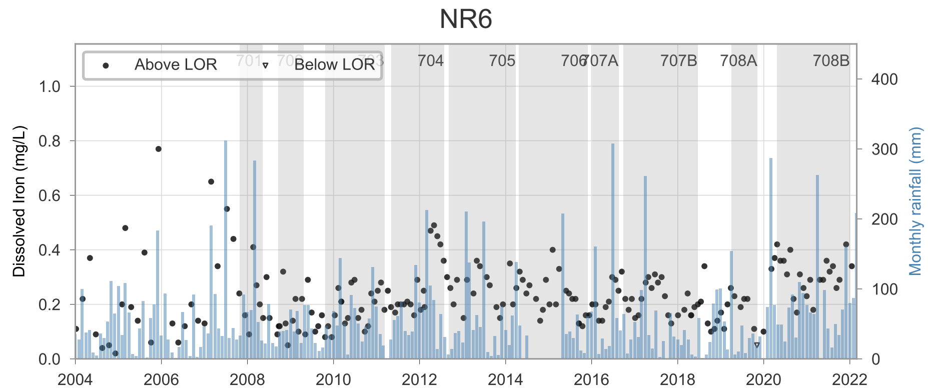

NR5
Above LOR
Below LOR
704
705
706
707A
707B
708A
708B
Dissolved Manganese (mg/L)
Monthly rainfall (mm)

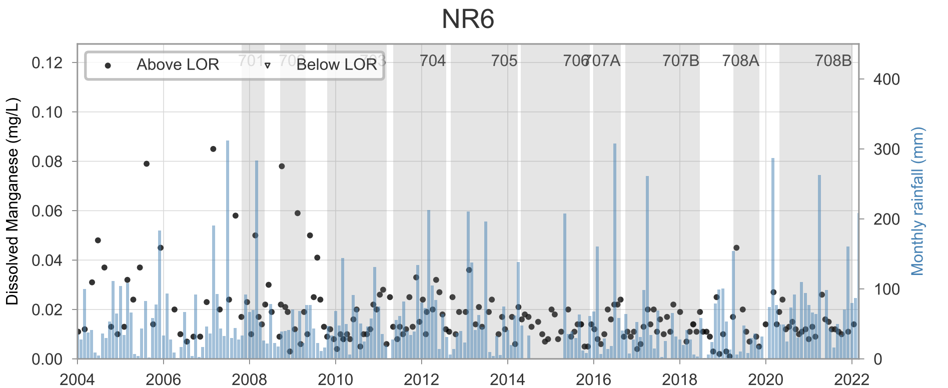

NR5
Above LOR
Below LOR
704
705
706
707A
707B
708A
708B
Total Iron (mg/L)
Monthly rainfall (mm)

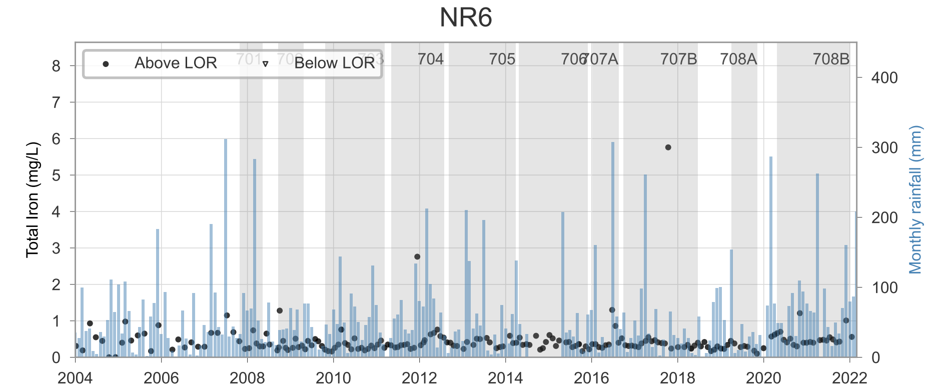

NR5
Above LOR
Below LOR
704
705
706
707A
707B
708A
708B
Total Manganese (mg/L)
Monthly rainfall (mm)

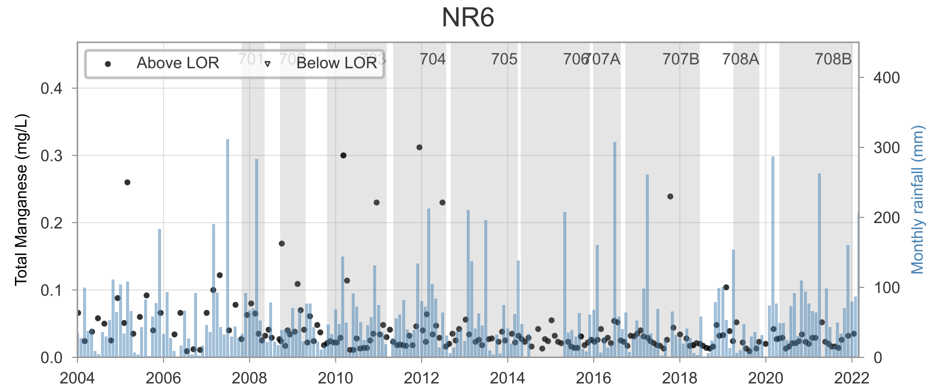

NR5
Above LOR
Below LOR
704
705
706
707A
707B
708A
708B
Dissolved Zinc (mg/L)
Monthly rainfall (mm)

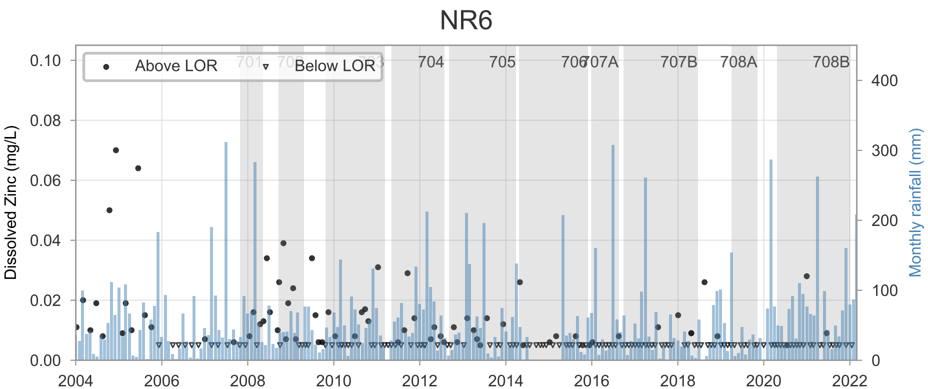

NR5
Above LOR
Below LOR
707A
707B
708A
708B
Dissolved Sulfate (mg/L)
Monthly rainfall (mm)

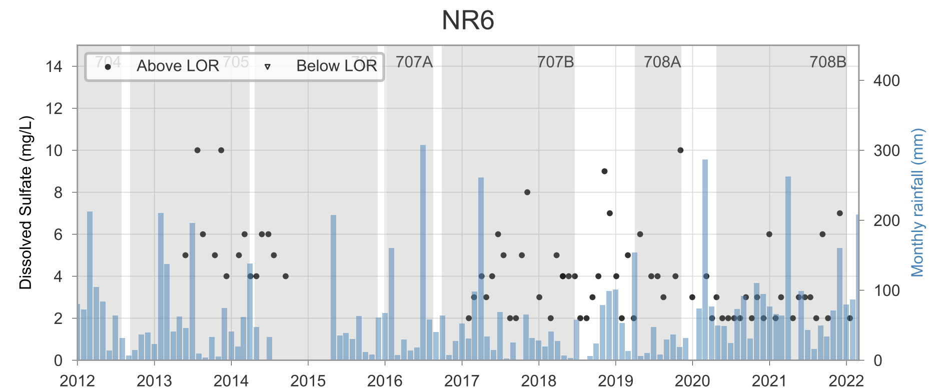

NR6
Above LOR
Below LOR
704
705
706
707A
707B
708A
708B
Dissolved Iron (mg/L)
Monthly rainfall (mm)
0.0
0.2
0.4
0.6
0.8
1.0
0
100
200
300
400
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022

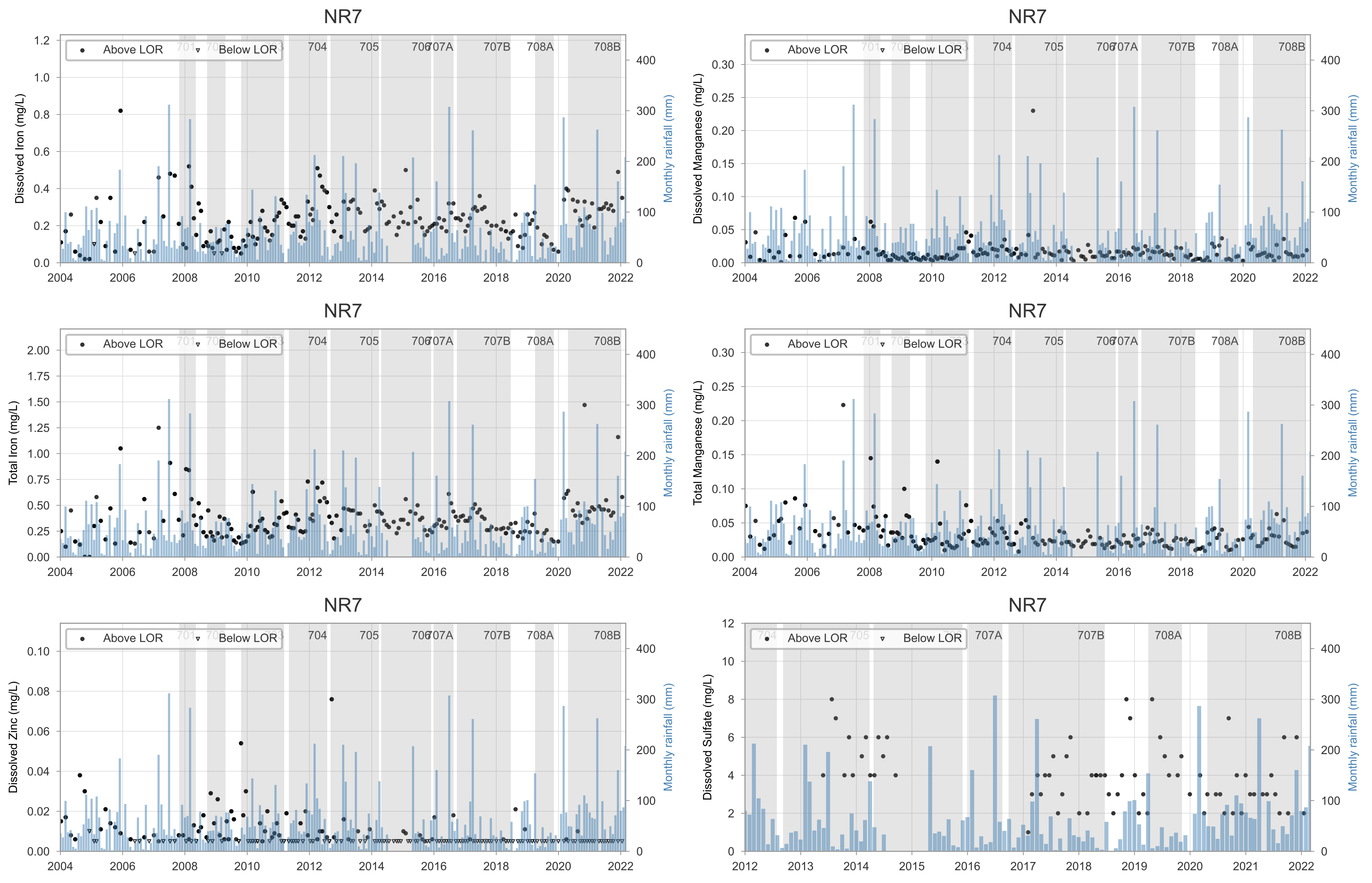

NR6
Above LOR
Below LOR
704
705
706
707A
707B
708A
708B
Dissolved Manganese (mg/L)
Monthly rainfall (mm)
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0
100
200
300
400
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022

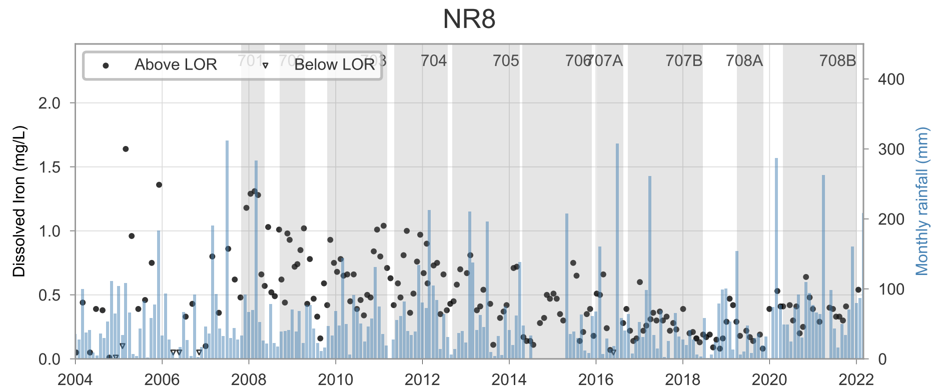

NR6
Above LOR
Below LOR
704
705
706
707A
707B
708A
708B
Total Iron (mg/L)
Monthly rainfall (mm)
0
1
2
3
4
5
6
7
8
0
100
200
300
400
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022

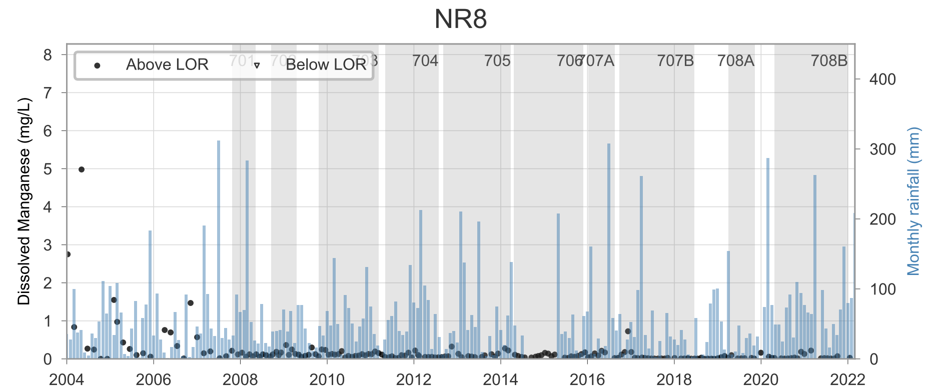

NR6
Above LOR
Below LOR
704
705
706
707A
707B
708A
708B
Total Manganese (mg/L)
Monthly rainfall (mm)
0.0
0.1
0.2
0.3
0.4
0
100
200
300
400
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022

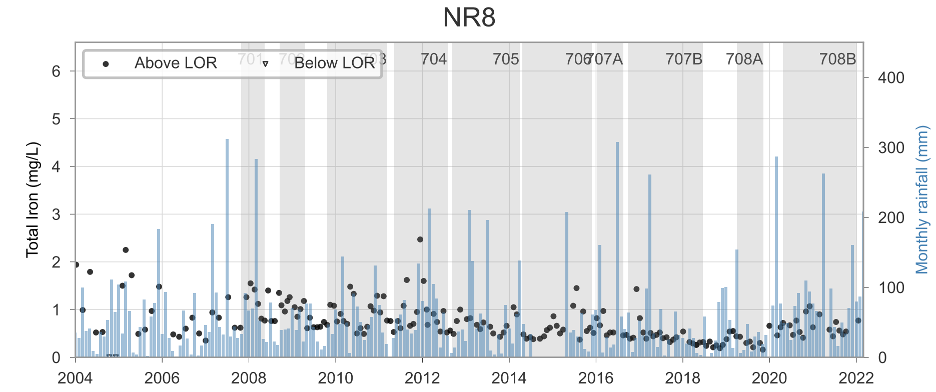

NR6
Above LOR
Below LOR
704
705
706
707A
707B
708A
708B
Dissolved Zinc (mg/L)
Monthly rainfall (mm)
0.00
0.02
0.04
0.06
0.08
0.10
0
100
200
300
400
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022

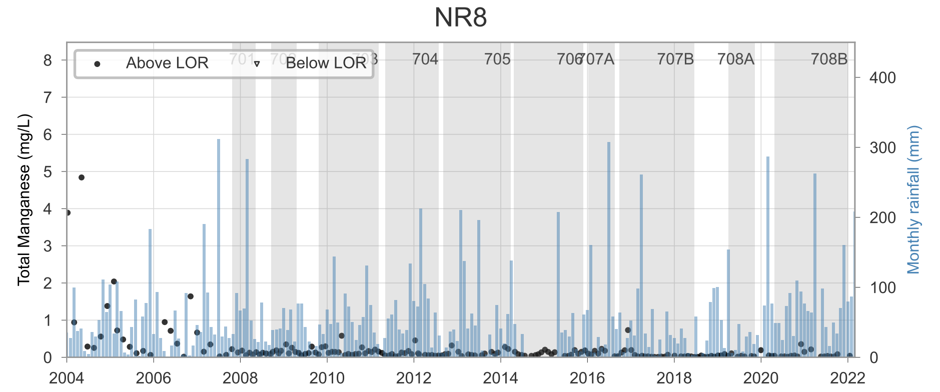

NR6
Above LOR
Below LOR
707A
707B
708A
708B
Dissolved Sulfate (mg/L)
Monthly rainfall (mm)
0
2
4
6
8
10
12
14
0
100
200
300
400
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

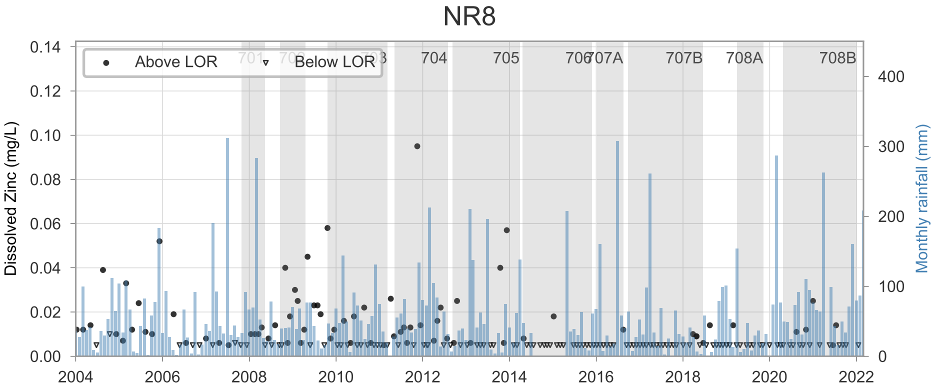

NR7
Above LOR
Below LOR
Dissolved Iron (mg/L)
Monthly rainfall (mm)
701
702
703
704
705
706
707A
707B
708A
708B
NR7
Dissolved Manganese (mg/L)
NR7
Total Iron (mg/L)
NR7
Total Manganese (mg/L)
NR7
Dissolved Zinc (mg/L)
NR7
Dissolved Sulfate (mg/L)

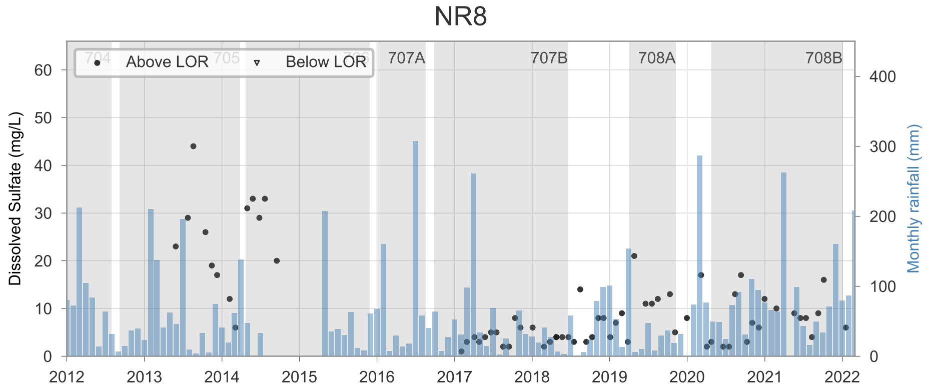

NR8
Above LOR
Below LOR
704
705
706
707A
707B
708A
708B
Dissolved Iron (mg/L)
Monthly rainfall (mm)

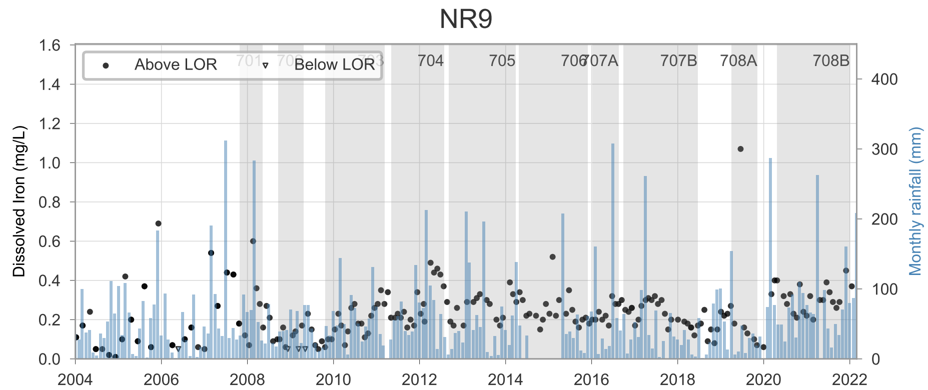

NR8
Above LOR
Below LOR
704
705
706
707A
707B
708A
708B
Dissolved Manganese (mg/L)
Monthly rainfall (mm)

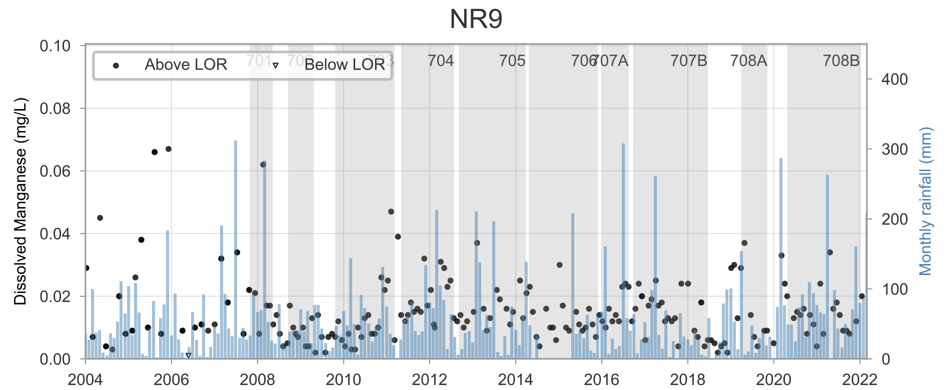

NR8
Above LOR
Below LOR
704
705
706
707A
707B
708A
708B
Total Iron (mg/L)
Monthly rainfall (mm)

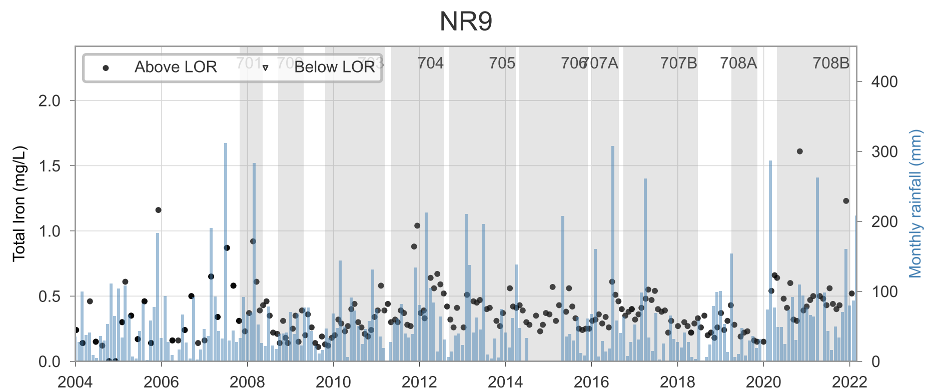

NR8
Above LOR
Below LOR
704
705
706
707A
707B
708A
708B
Total Manganese (mg/L)
Monthly rainfall (mm)

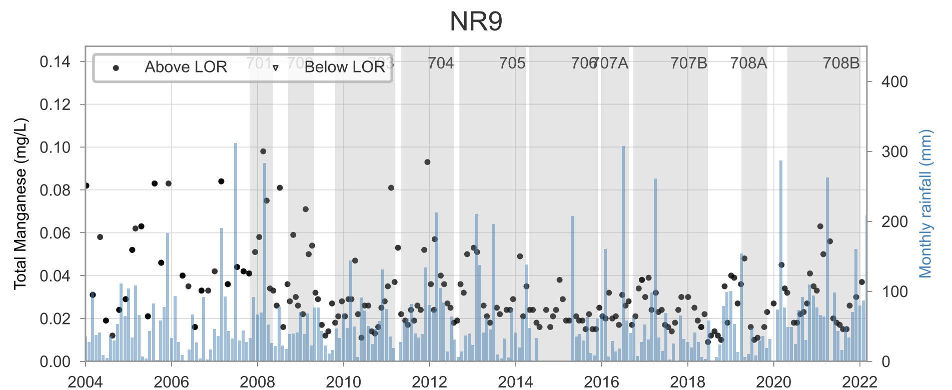

NR8
Above LOR
Below LOR
704
705
706
707A
707B
708A
708B
Dissolved Zinc (mg/L)
Monthly rainfall (mm)

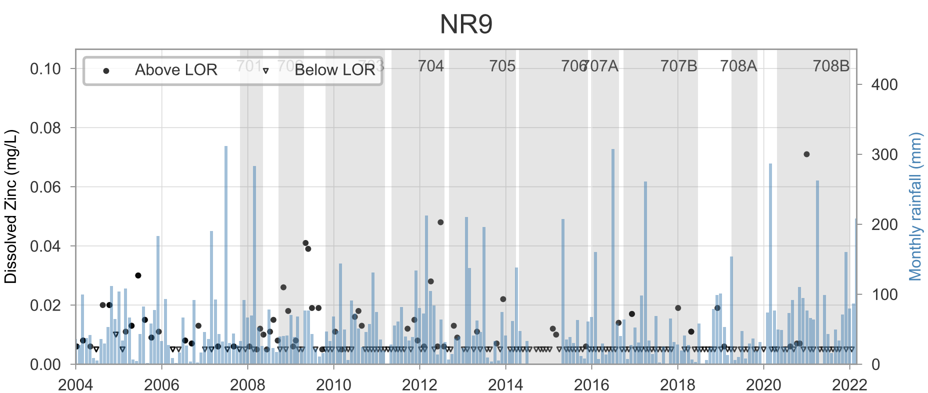

NR8
Above LOR
Below LOR
707A
707B
708A
708B
Dissolved Sulfate (mg/L)
Monthly rainfall (mm)

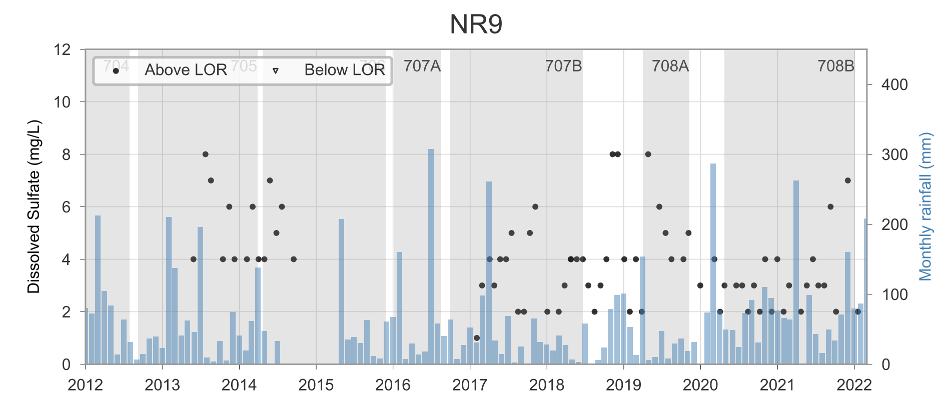

NR9
Above LOR
Below LOR
704
705
706
707A
707B
708A
708B
Dissolved Iron (mg/L)
Monthly rainfall (mm)

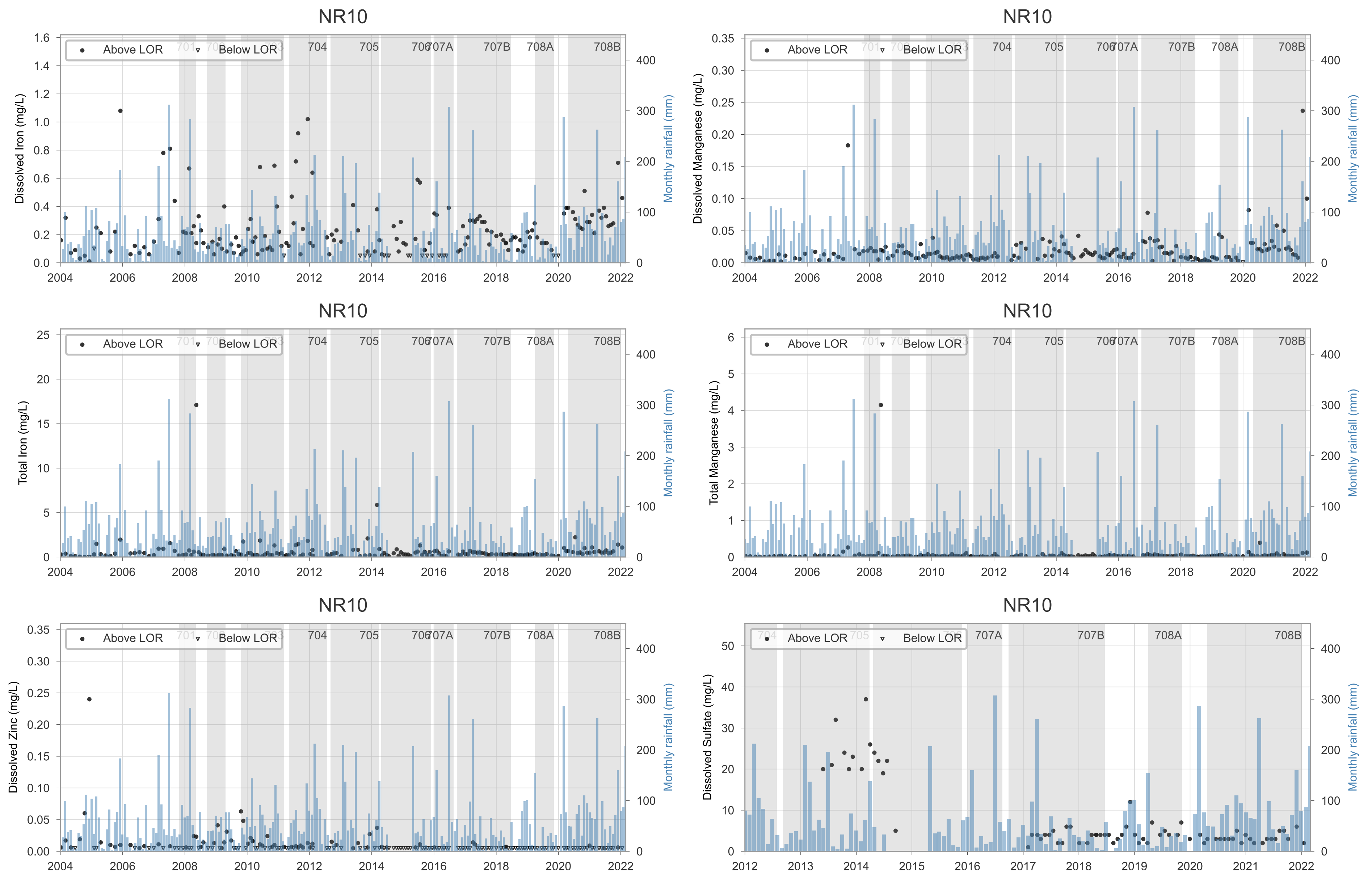

NR9
Above LOR
Below LOR
704
705
706
707A
707B
708A
708B
Dissolved Manganese (mg/L)
Monthly rainfall (mm)

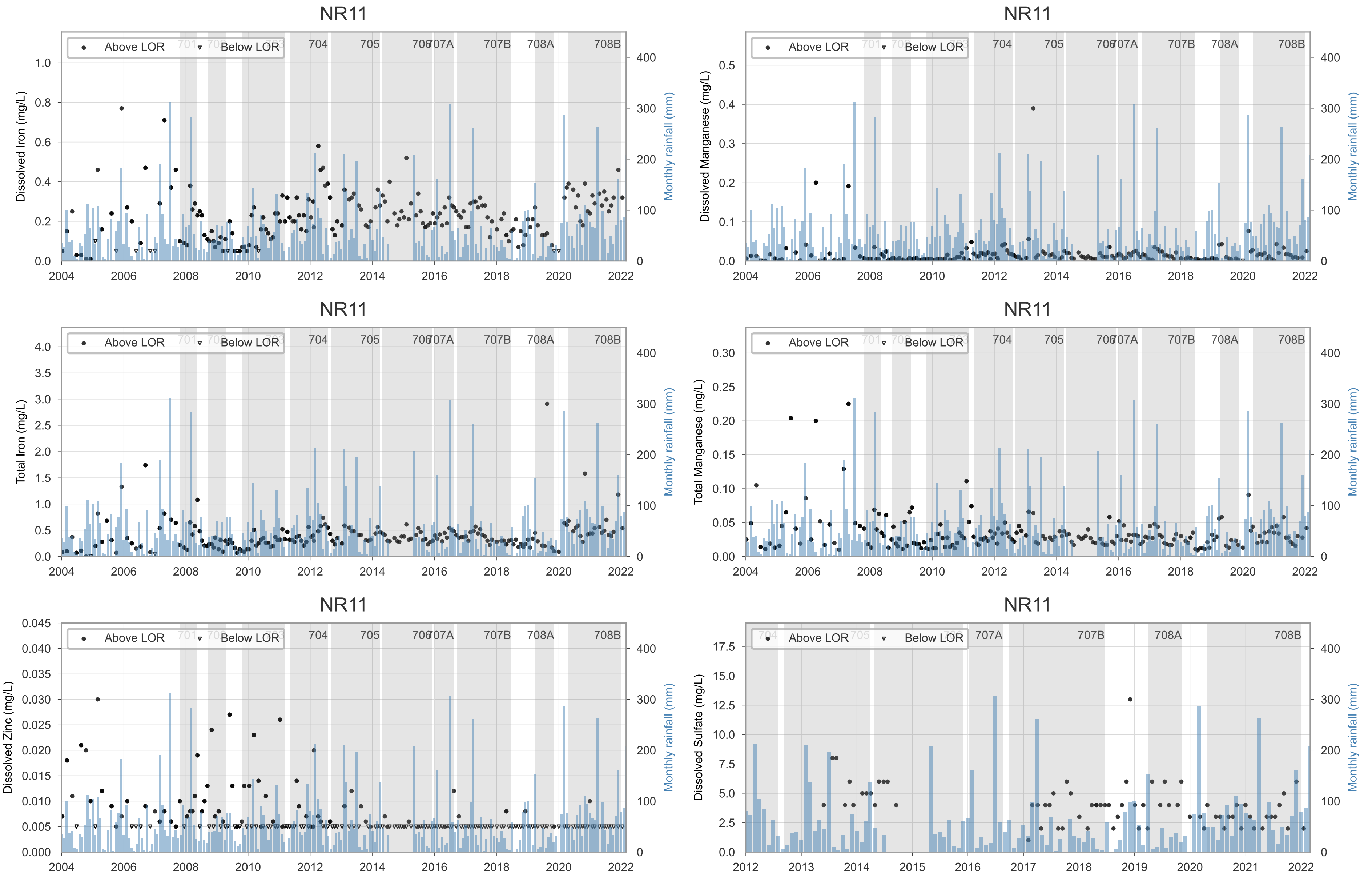

NR9
Above LOR
Below LOR
704
705
706
707A
707B
708A
708B
Total Iron (mg/L)
Monthly rainfall (mm)

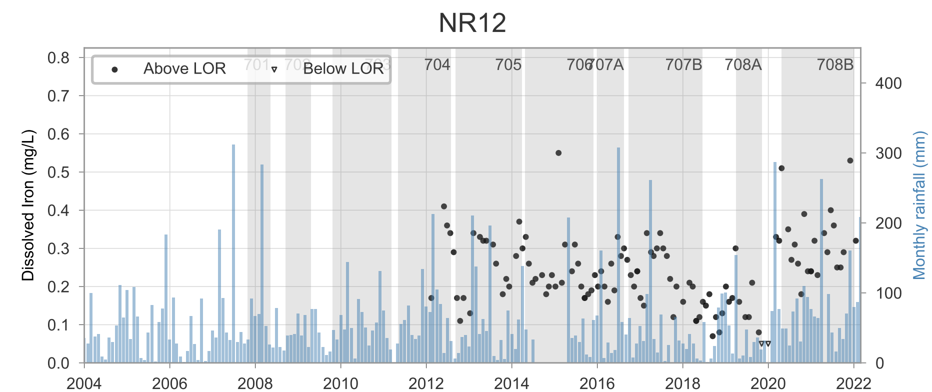

NR9
Above LOR
Below LOR
704
705
706
707A
707B
708A
708B
Total Manganese (mg/L)
Monthly rainfall (mm)

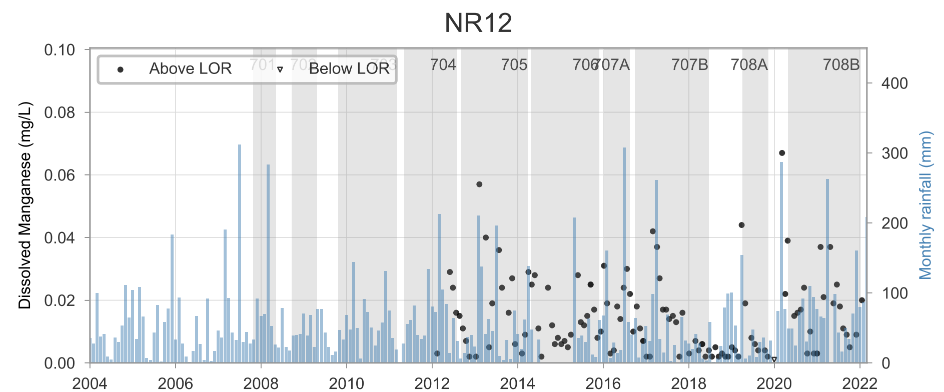

NR9
Above LOR
Below LOR
704
705
706
707A
707B
708A
708B
Dissolved Zinc (mg/L)
Monthly rainfall (mm)

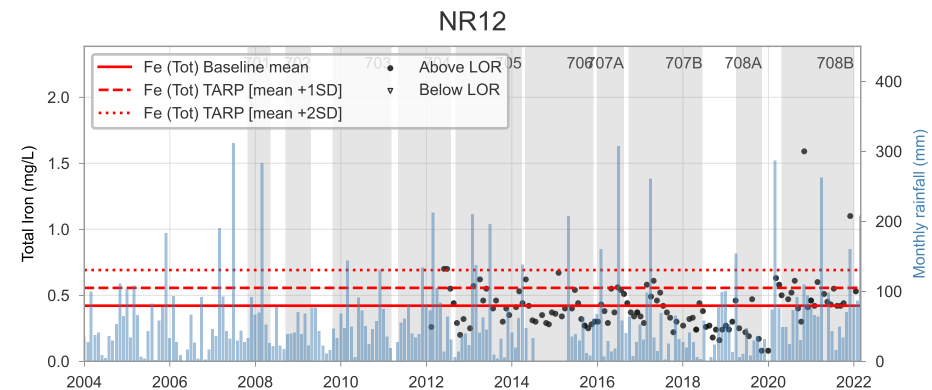

NR9
Above LOR
Below LOR
707A
707B
708A
708B
Dissolved Sulfate (mg/L)
Monthly rainfall (mm)

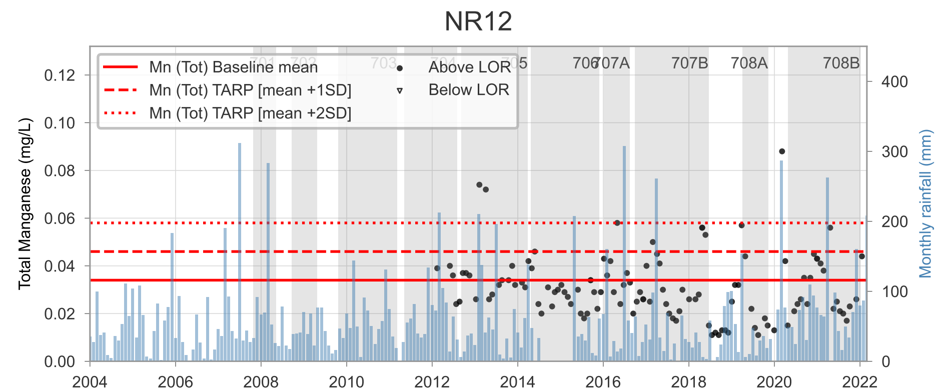

NR10
Dissolved Iron (mg/L)
Total Iron (mg/L)
Dissolved Zinc (mg/L)
Dissolved Manganese (mg/L)
Total Manganese (mg/L)
Dissolved Sulfate (mg/L)
Monthly rainfall (mm)
Above LOR
Below LOR
704
705
706
707A
707B
708A
708B

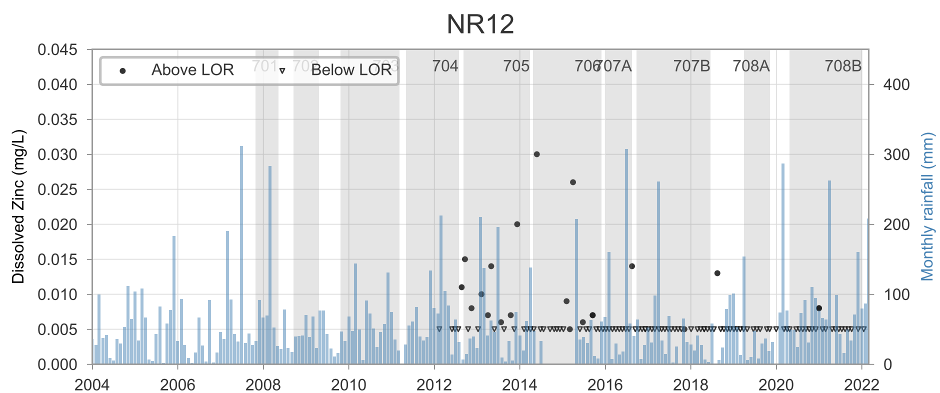

NR11
Dissolved Iron (mg/L)
Monthly rainfall (mm)
Above LOR
Below LOR
701
702
703
704
705
706
707A
707B
708A
708B
NR11
Dissolved Manganese (mg/L)
Monthly rainfall (mm)
NR11
Total Iron (mg/L)
Monthly rainfall (mm)
NR11
Total Manganese (mg/L)
Monthly rainfall (mm)
NR11
Dissolved Zinc (mg/L)
Monthly rainfall (mm)
NR11
Dissolved Sulfate (mg/L)
Monthly rainfall (mm)

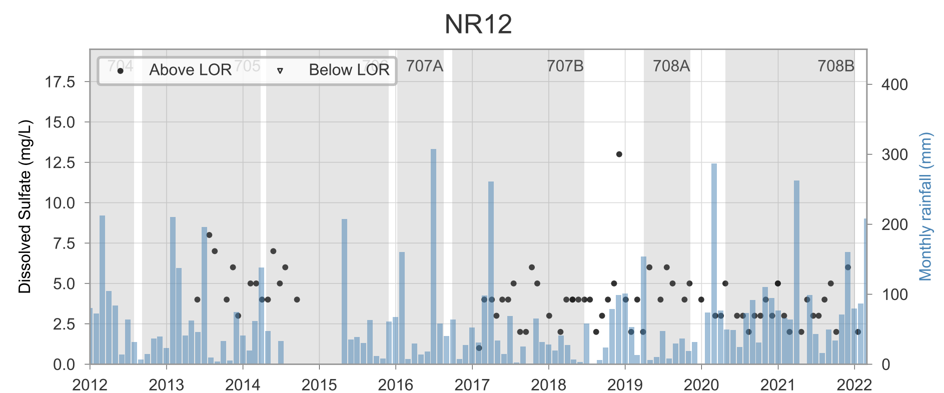

NR12
Above LOR
Below LOR
704
705
706
707A
707B
708A
708B
Dissolved Iron (mg/L)
Monthly rainfall (mm)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0
100
200
300
400
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022

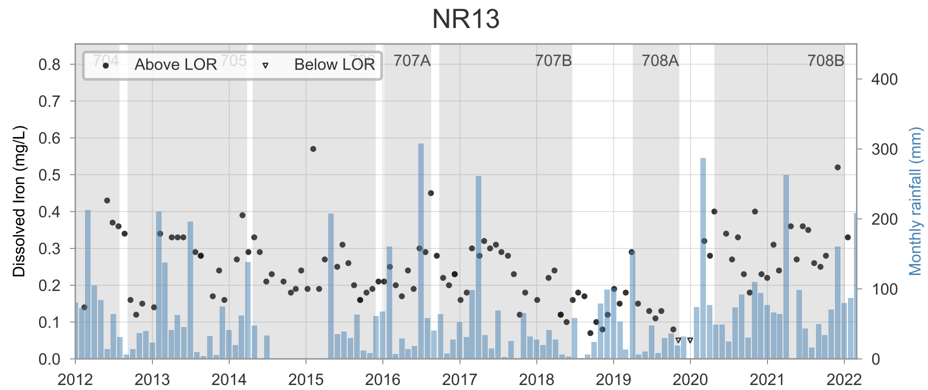

NR12
Above LOR
Below LOR
704
705
706
707A
707B
708A
708B
Dissolved Manganese (mg/L)
Monthly rainfall (mm)
0.00
0.02
0.04
0.06
0.08
0.10
0
100
200
300
400
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022

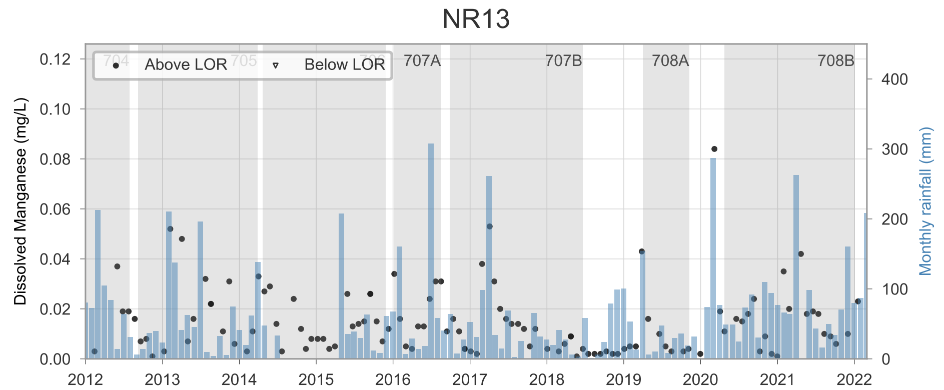

NR12
Fe (Tot) Baseline mean
Fe (Tot) TARP [mean +1SD]
Fe (Tot) TARP [mean +2SD]
Above LOR
Below LOR
706
707A
707B
708A
708B
Total Iron (mg/L)
Monthly rainfall (mm)
0.0
0.5
1.0
1.5
2.0
0
100
200
300
400
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022

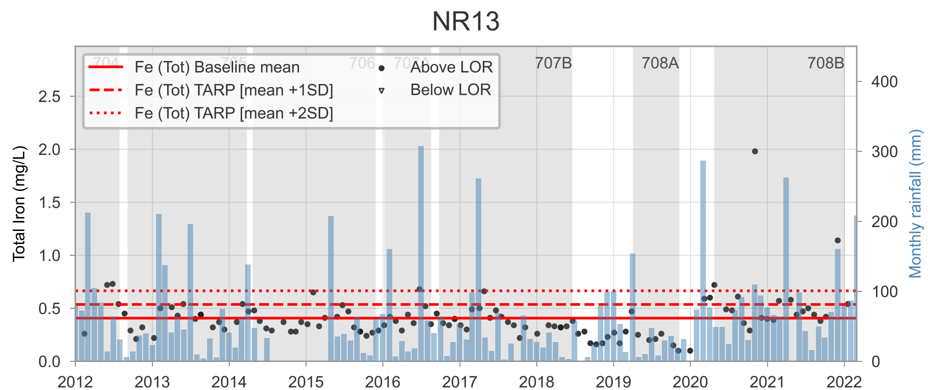

NR12
Mn (Tot) Baseline mean
Mn (Tot) TARP [mean +1SD]
Mn (Tot) TARP [mean +2SD]
Above LOR
Below LOR
706
707A
707B
708A
708B
Total Manganese (mg/L)
Monthly rainfall (mm)
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0
100
200
300
400
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022

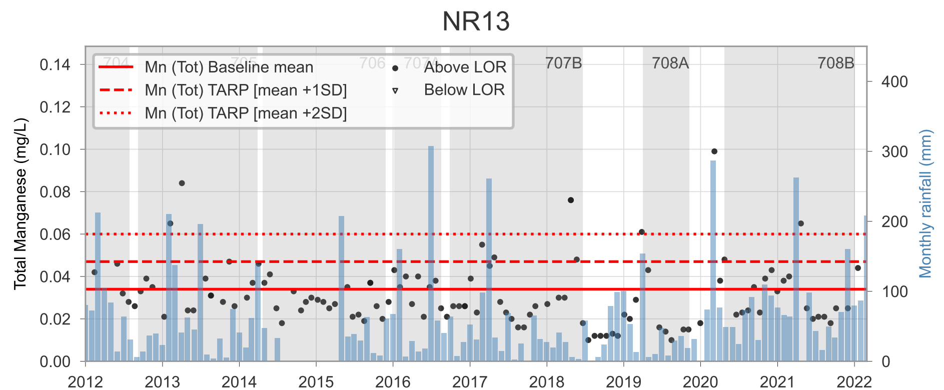

NR12
Above LOR
Below LOR
704
705
706
707A
707B
708A
708B
Dissolved Zinc (mg/L)
Monthly rainfall (mm)
0.000
0.005
0.010
0.015
0.020
0.025
0.030
0.035
0.040
0.045
0
100
200
300
400
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022

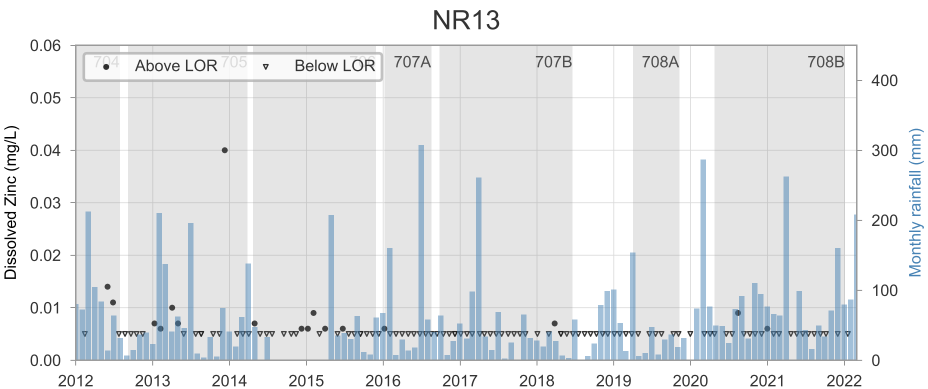

NR12
Above LOR
Below LOR
707A
707B
708A
708B
Dissolved Sulfate (mg/L)
Monthly rainfall (mm)
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
0
100
200
300
400
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

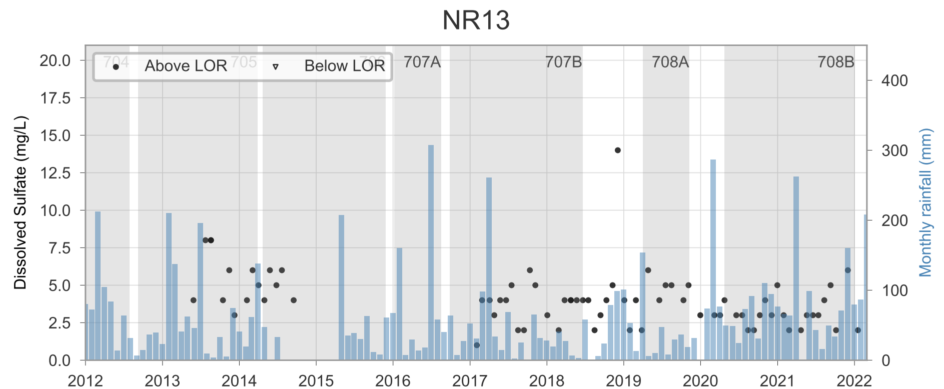

NR13
Above LOR
Below LOR
704
705
707A
707B
708A
708B
Dissolved Iron (mg/L)
Monthly rainfall (mm)

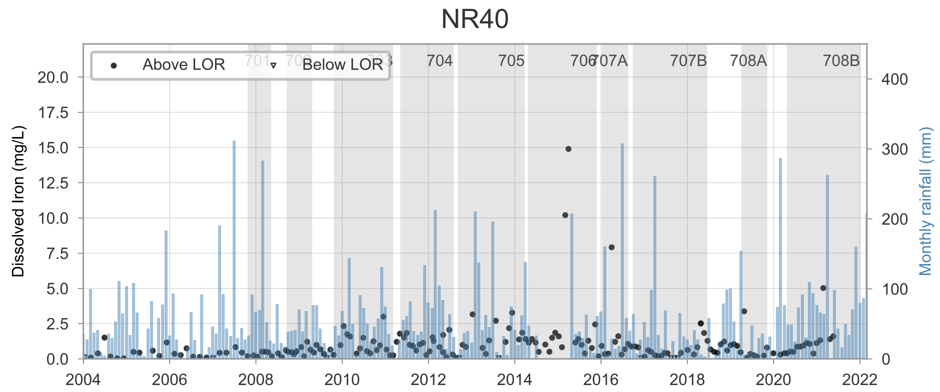

NR13
Above LOR
Below LOR
704
705
707A
707B
708A
708B
Dissolved Manganese (mg/L)
Monthly rainfall (mm)

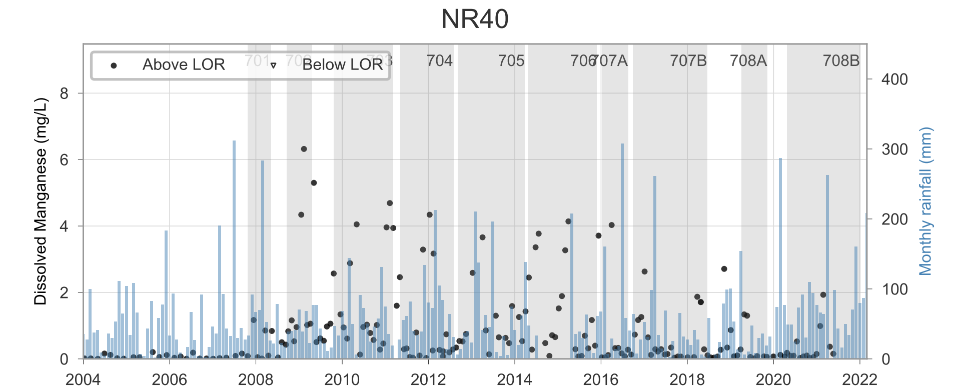

NR13
Fe (Tot) Baseline mean
Fe (Tot) TARP [mean +1SD]
Fe (Tot) TARP [mean +2SD]
Above LOR
Below LOR
707B
708A
708B
Total Iron (mg/L)
Monthly rainfall (mm)

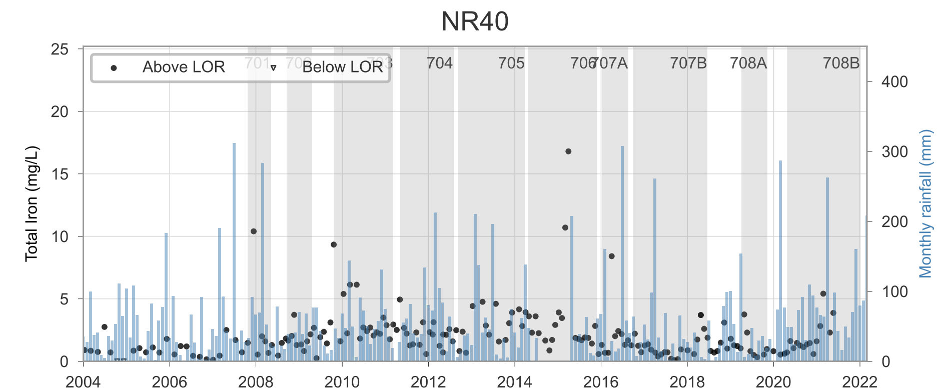

NR13
Mn (Tot) Baseline mean
Mn (Tot) TARP [mean +1SD]
Mn (Tot) TARP [mean +2SD]
Above LOR
Below LOR
707B
708A
708B
Total Manganese (mg/L)
Monthly rainfall (mm)

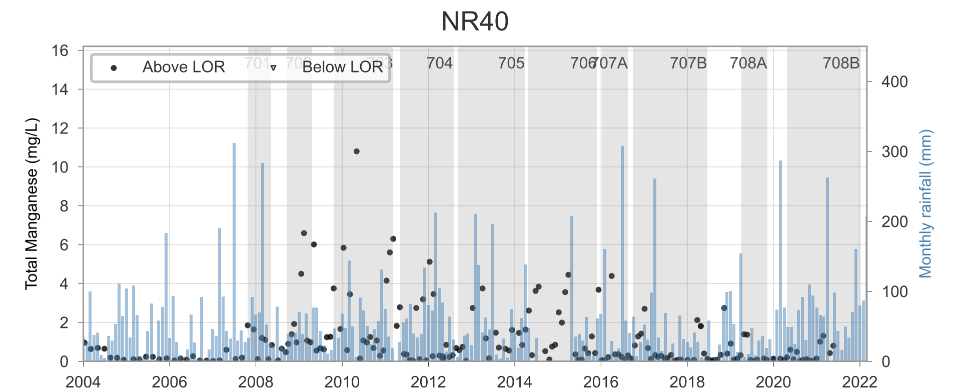

NR13
Above LOR
Below LOR
704
705
707A
707B
708A
708B
Dissolved Zinc (mg/L)
Monthly rainfall (mm)

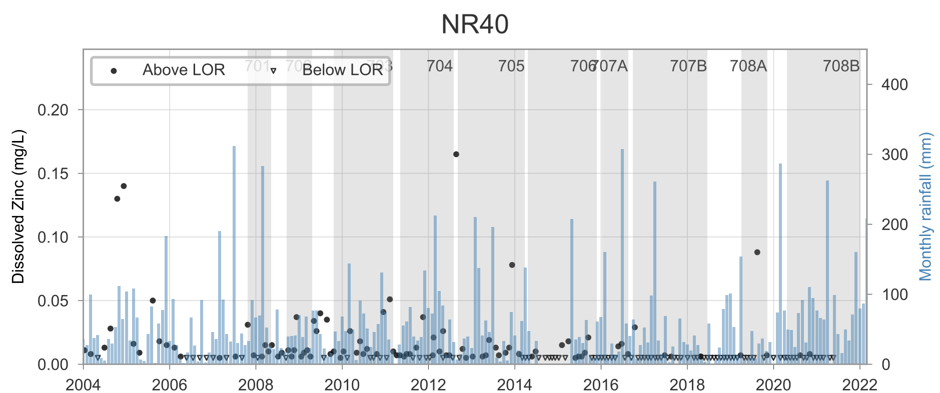

NR13
Above LOR
Below LOR
704
705
707A
707B
708A
708B
Dissolved Sulfate (mg/L)
Monthly rainfall (mm)

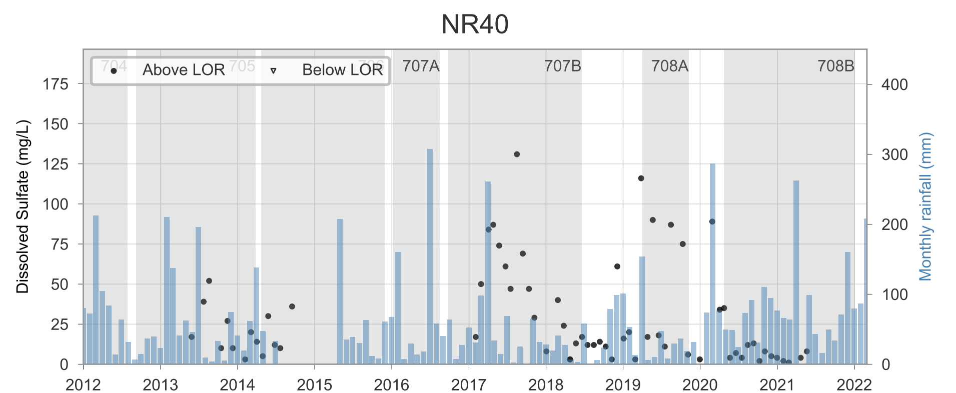

NR40
Above LOR
Below LOR
704
705
706
707A
707B
708A
708B
Dissolved Iron (mg/L)
Monthly rainfall (mm)
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
0
100
200
300
400
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022

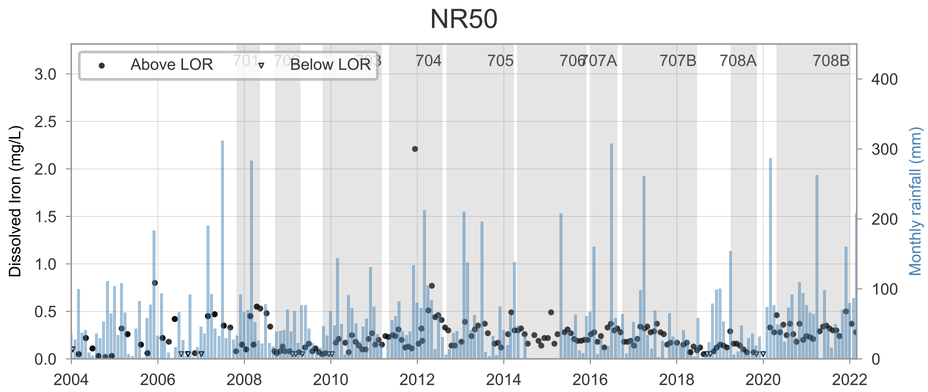

NR40
Above LOR
Below LOR
704
705
706
707A
707B
708A
708B
Dissolved Manganese (mg/L)
Monthly rainfall (mm)
0
2
4
6
8
0
100
200
300
400
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022

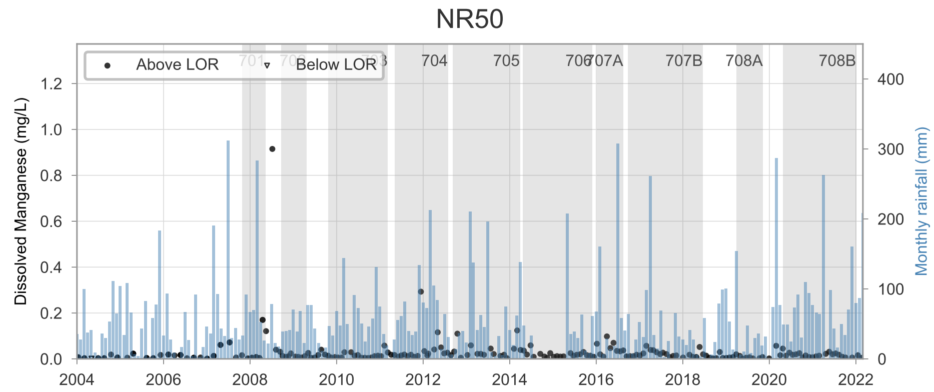

NR40
Above LOR
Below LOR
704
705
706
707A
707B
708A
708B
Total Iron (mg/L)
Monthly rainfall (mm)
0
5
10
15
20
25
0
100
200
300
400
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022

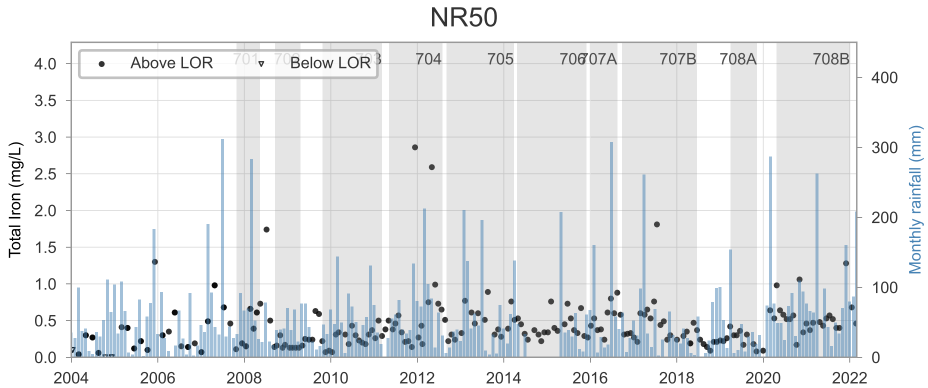

NR40
Above LOR
Below LOR
704
705
706
707A
707B
708A
708B
Total Manganese (mg/L)
Monthly rainfall (mm)
0
2
4
6
8
10
12
14
16
0
100
200
300
400
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022

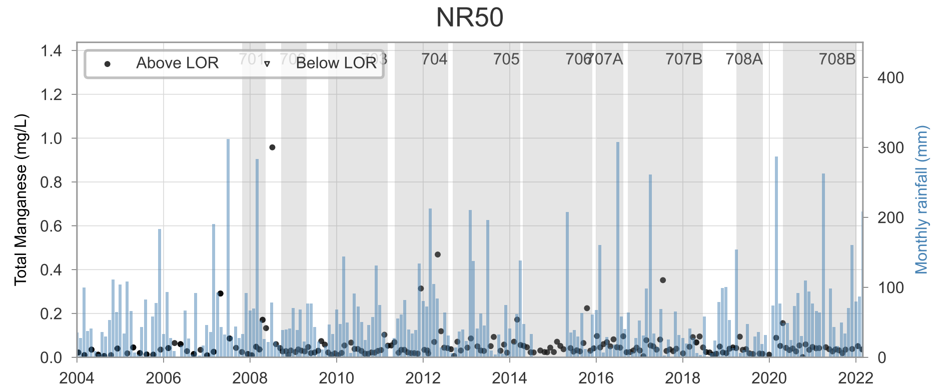

NR40
Above LOR
Below LOR
704
705
706
707A
707B
708A
708B
Dissolved Zinc (mg/L)
Monthly rainfall (mm)
0.00
0.05
0.10
0.15
0.20
0
100
200
300
400
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022

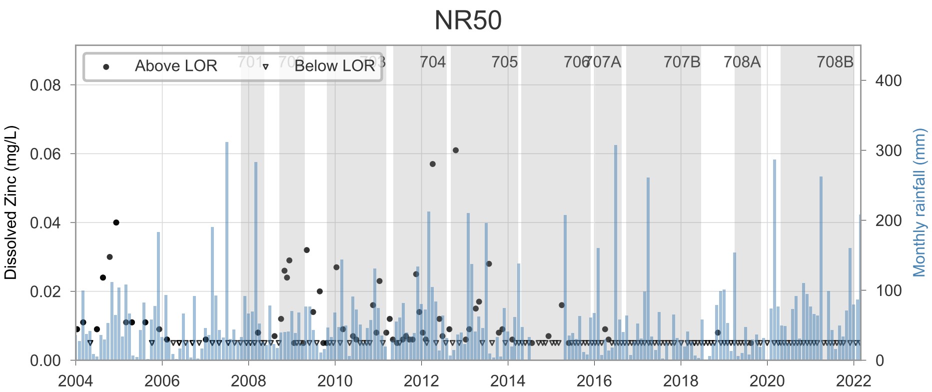

NR40
Above LOR
Below LOR
707A
707B
708A
708B
Dissolved Sulfate (mg/L)
Monthly rainfall (mm)
0
25
50
75
100
125
150
175
0
100
200
300
400
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

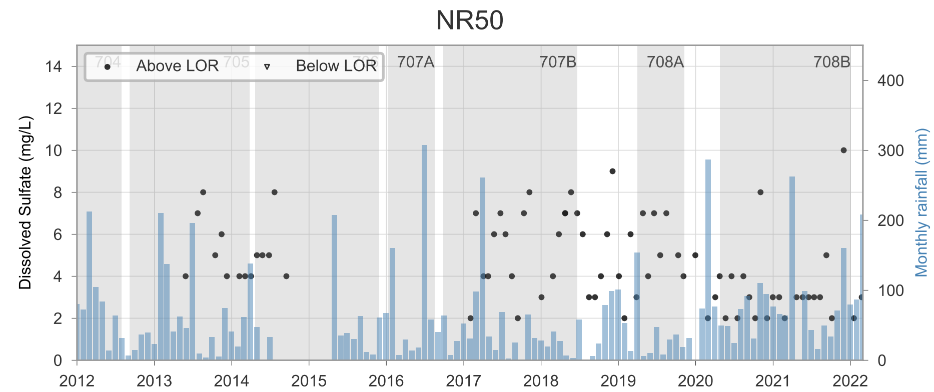

NR50
Above LOR
Below LOR
701
702
703
704
705
706
707A
707B
708A
708B
Dissolved Iron (mg/L)
Monthly rainfall (mm)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
0
100
200
300
400
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022

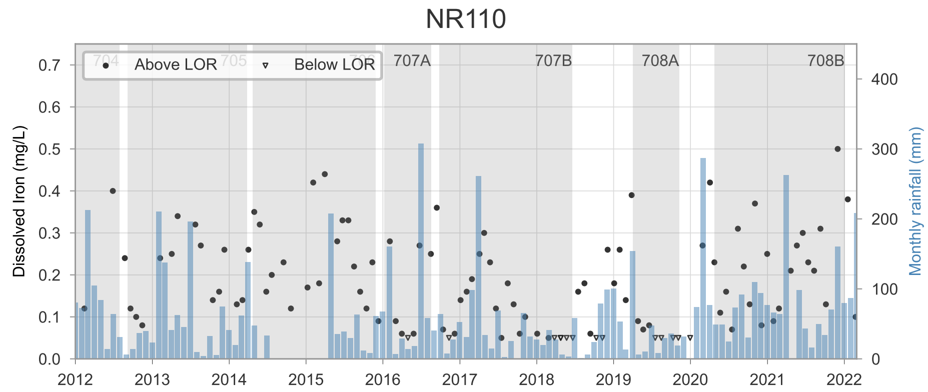

NR50
Above LOR
Below LOR
701
702
703
704
705
706
707A
707B
708A
708B
Dissolved Manganese (mg/L)
Monthly rainfall (mm)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
0
100
200
300
400
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022

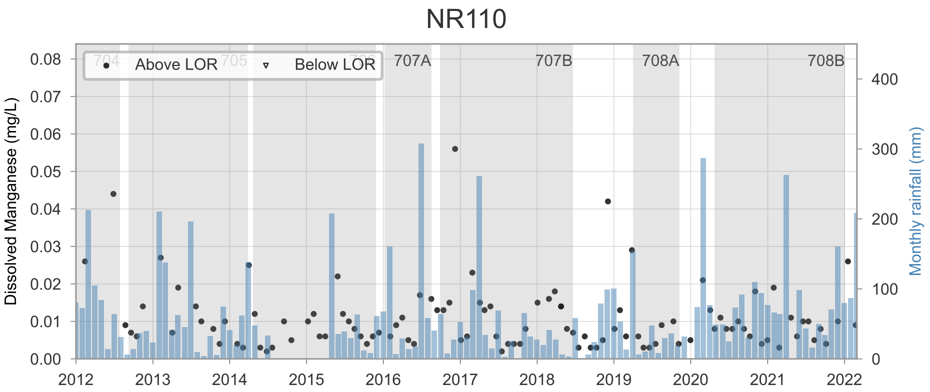

NR50
Above LOR
Below LOR
701
702
703
704
705
706
707A
707B
708A
708B
Total Iron (mg/L)
Monthly rainfall (mm)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
0
100
200
300
400
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022

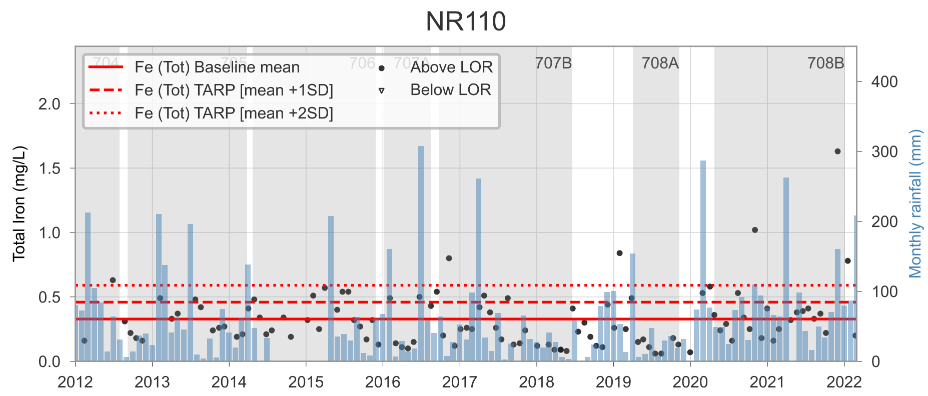

NR50
Above LOR
Below LOR
701
702
703
704
705
706
707A
707B
708A
708B
Total Manganese (mg/L)
Monthly rainfall (mm)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
0
100
200
300
400
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022

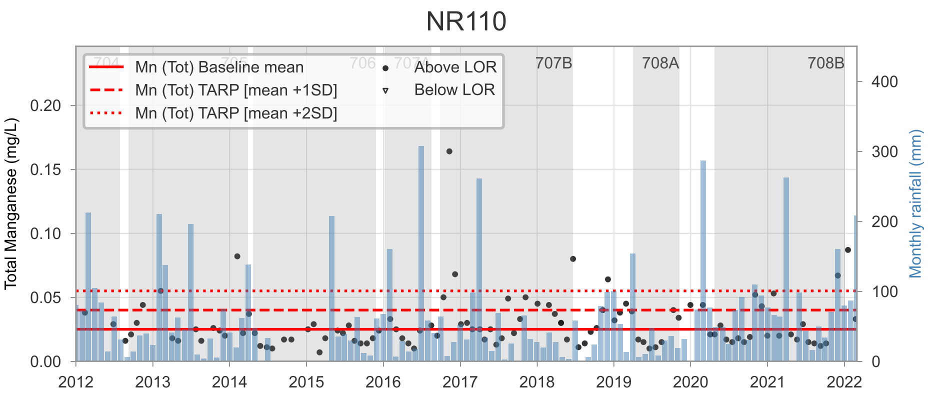

NR50
Above LOR
Below LOR
701
702
703
704
705
706
707A
707B
708A
708B
Dissolved Zinc (mg/L)
Monthly rainfall (mm)
0.00
0.02
0.04
0.06
0.08
0
100
200
300
400
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022

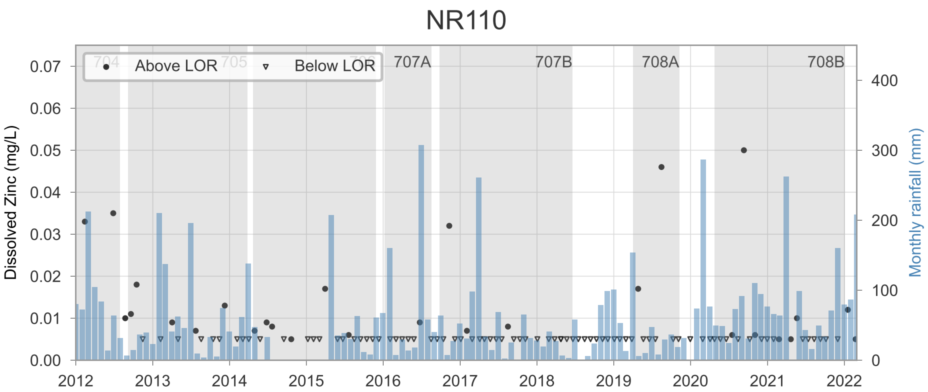

NR50
Above LOR
Below LOR
704
705
707A
707B
708A
708B
Dissolved Sulfate (mg/L)
Monthly rainfall (mm)
0
2
4
6
8
10
12
14
0
100
200
300
400
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

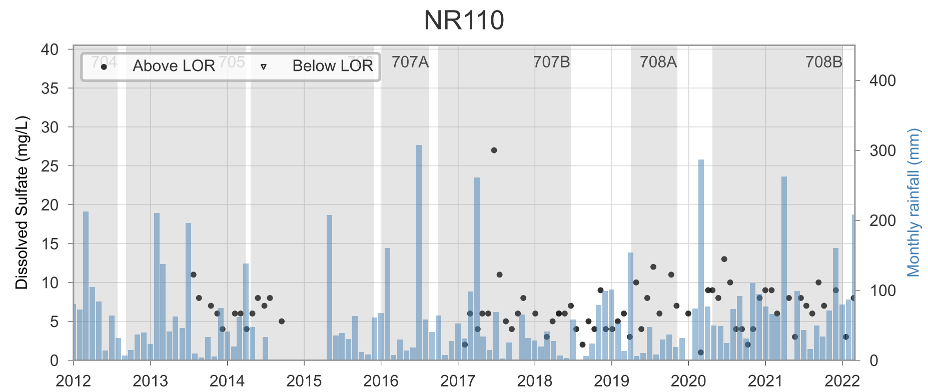

NR110
Dissolved Iron (mg/L)
Monthly rainfall (mm)
Above LOR
Below LOR
707A
707B
708A
708B

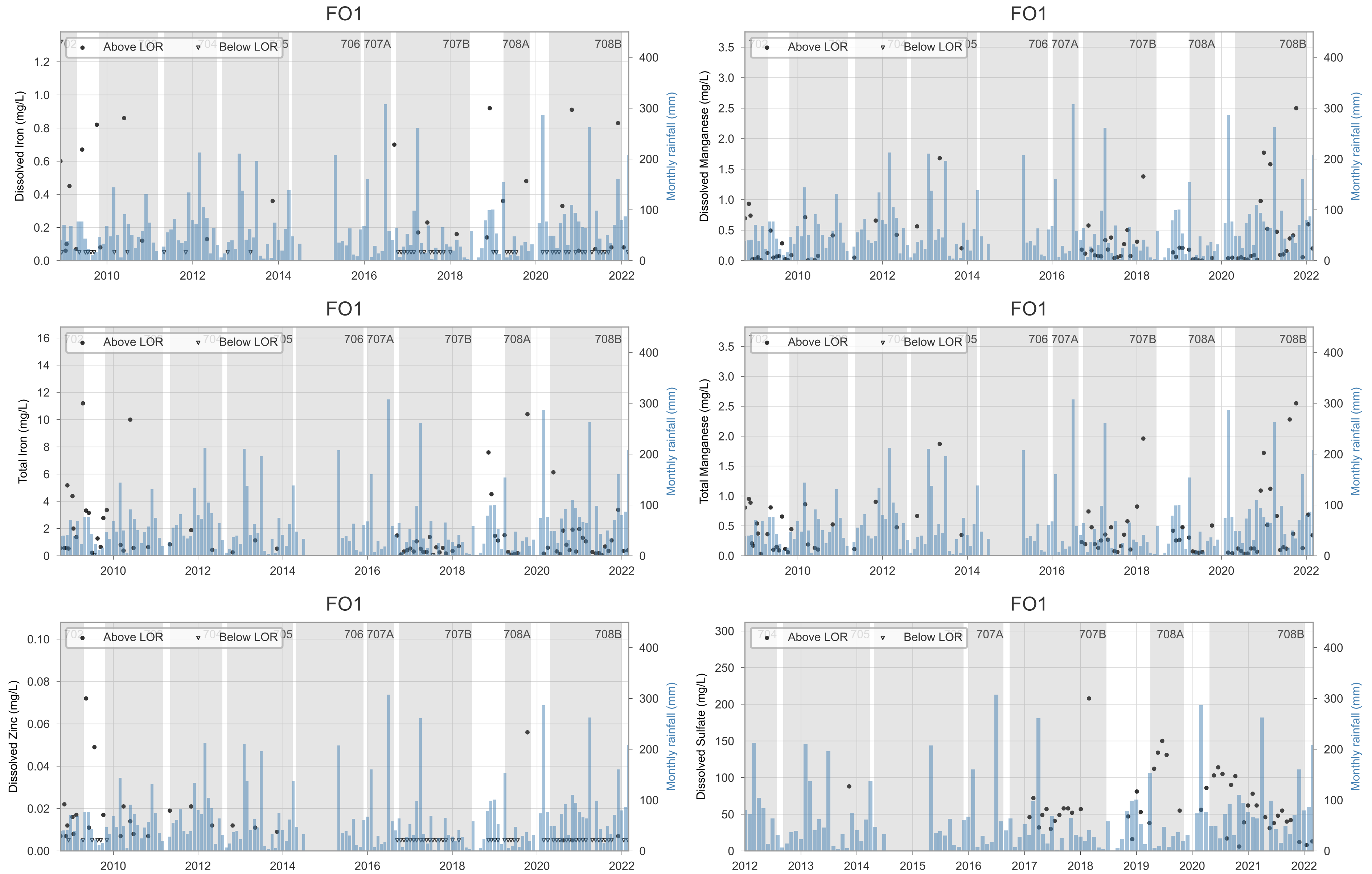

NR110
Dissolved Manganese (mg/L)
Monthly rainfall (mm)
Above LOR
Below LOR
707A
707B
708A
708B

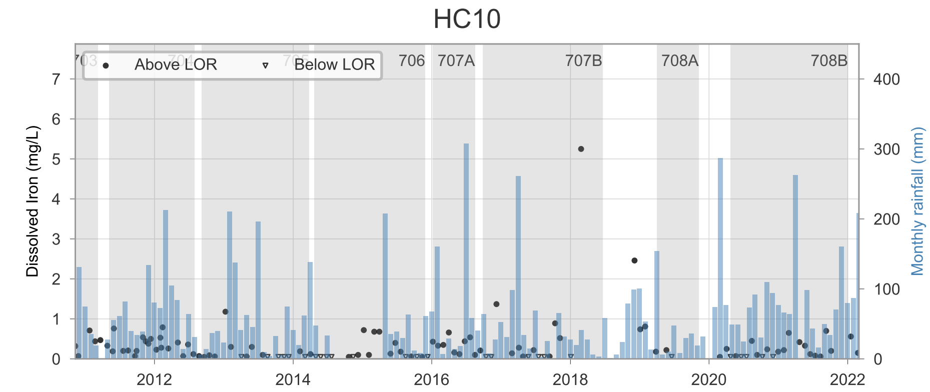

NR110
Total Iron (mg/L)
Monthly rainfall (mm)
Fe (Tot) Baseline mean
Fe (Tot) TARP [mean +1SD]
Fe (Tot) TARP [mean +2SD]
Above LOR
Below LOR
707B
708A
708B

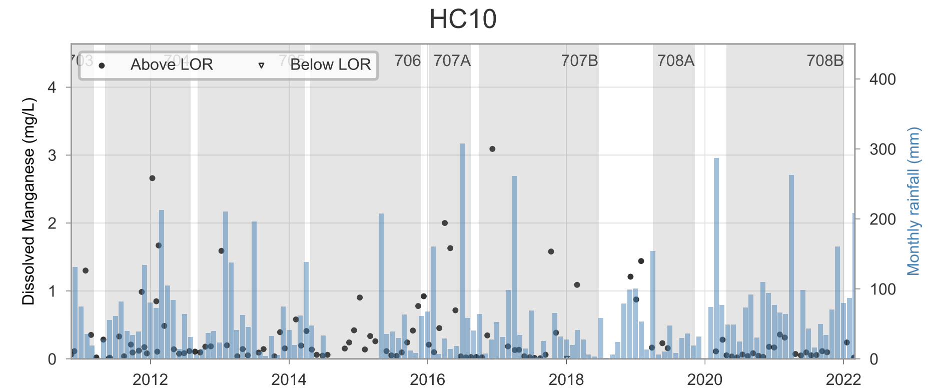

NR110
Total Manganese (mg/L)
Monthly rainfall (mm)
Mn (Tot) Baseline mean
Mn (Tot) TARP [mean +1SD]
Mn (Tot) TARP [mean +2SD]
Above LOR
Below LOR
707B
708A
708B

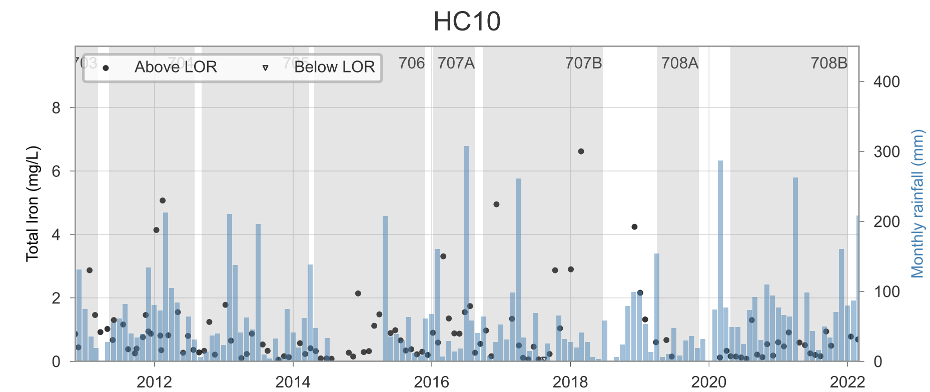

NR110
Dissolved Zinc (mg/L)
Monthly rainfall (mm)
Above LOR
Below LOR
707A
707B
708A
708B

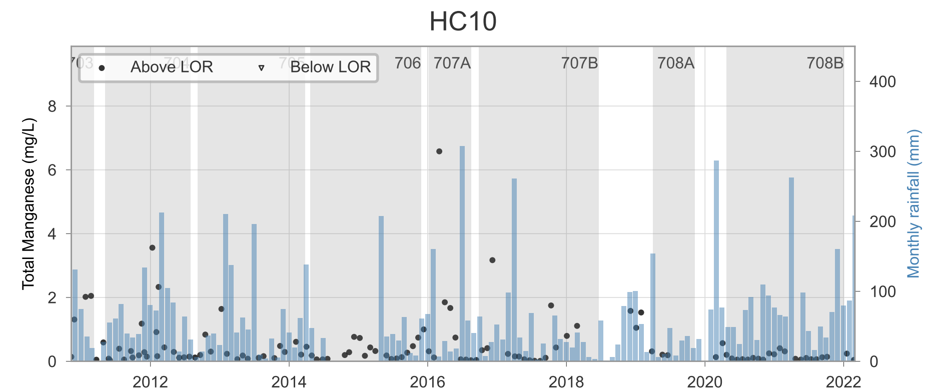

NR110
Dissolved Sulfate (mg/L)
Monthly rainfall (mm)
Above LOR
Below LOR
707A
707B
708A
708B

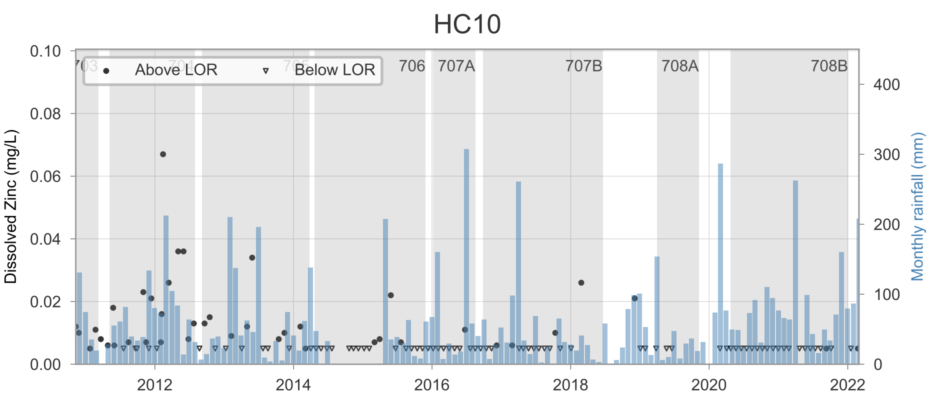

FO1
Dissolved Iron (mg/L)
Monthly rainfall (mm)
Above LOR
Below LOR
706 707A
707B
708A
708B
FO1
Dissolved Manganese (mg/L)
Monthly rainfall (mm)
Above LOR
Below LOR
706 707A
707B
708A
708B
FO1
Total Iron (mg/L)
Monthly rainfall (mm)
Above LOR
Below LOR
706 707A
707B
708A
708B
FO1
Total Manganese (mg/L)
Monthly rainfall (mm)
Above LOR
Below LOR
706 707A
707B
708A
708B
FO1
Dissolved Zinc (mg/L)
Monthly rainfall (mm)
Above LOR
Below LOR
706 707A
707B
708A
708B
FO1
Dissolved Sulfate (mg/L)
Monthly rainfall (mm)
Above LOR
Below LOR
707A
707B
708A
708B

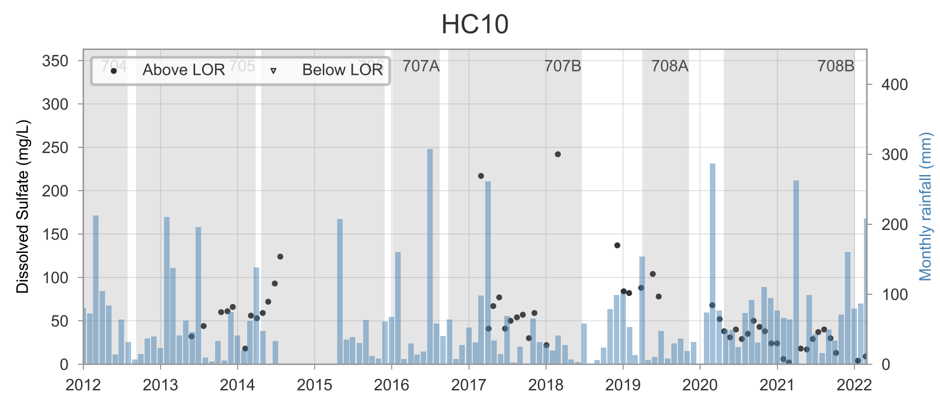

HC10
Above LOR
Below LOR
706
707A
707B
708A
708B
Dissolved Iron (mg/L)
Monthly rainfall (mm)
2012
2014
2016
2018
2020
2022

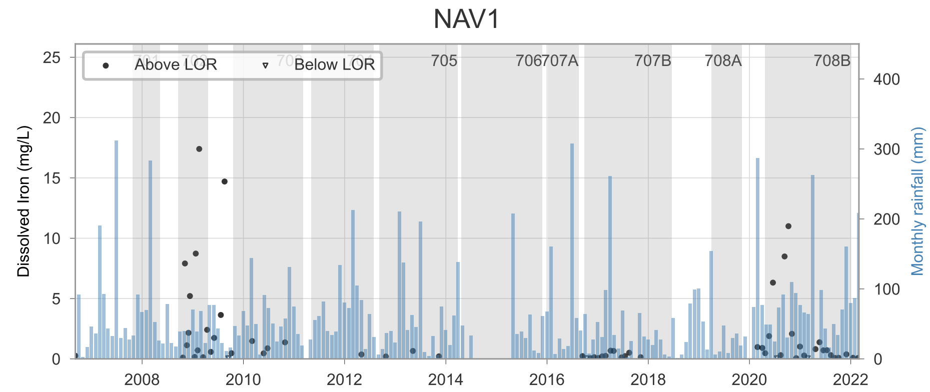

HC10
Above LOR
Below LOR
706
707A
707B
708A
708B
Dissolved Manganese (mg/L)
Monthly rainfall (mm)
2012
2014
2016
2018
2020
2022

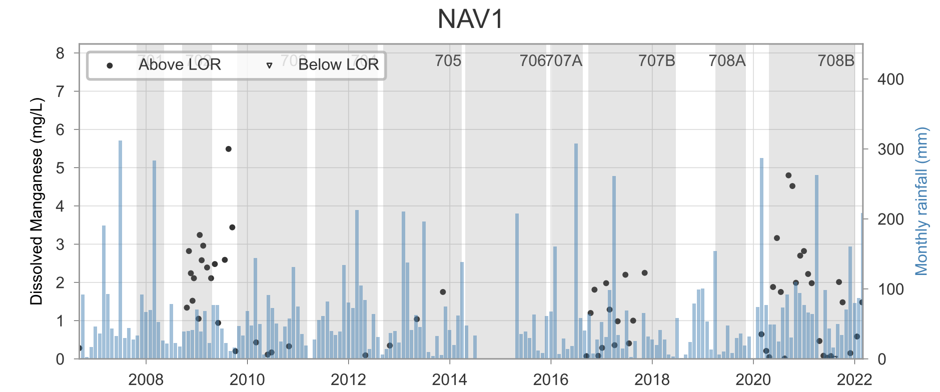

HC10
Above LOR
Below LOR
706
707A
707B
708A
708B
Total Iron (mg/L)
Monthly rainfall (mm)
2012
2014
2016
2018
2020
2022

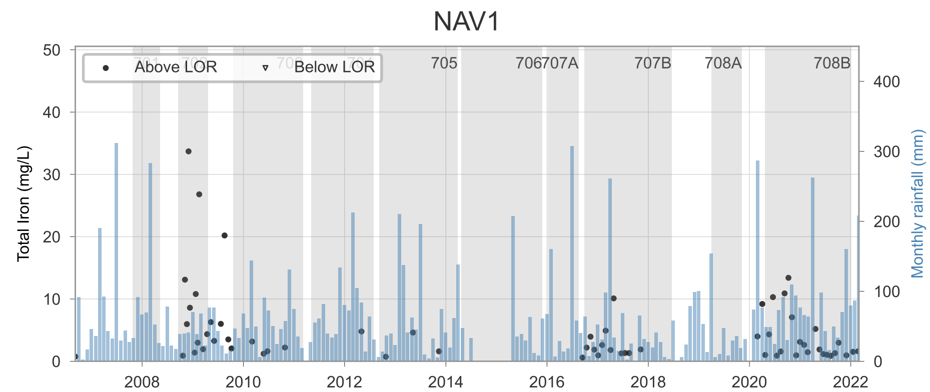

HC10
Above LOR
Below LOR
706
707A
707B
708A
708B
Total Manganese (mg/L)
Monthly rainfall (mm)
2012
2014
2016
2018
2020
2022

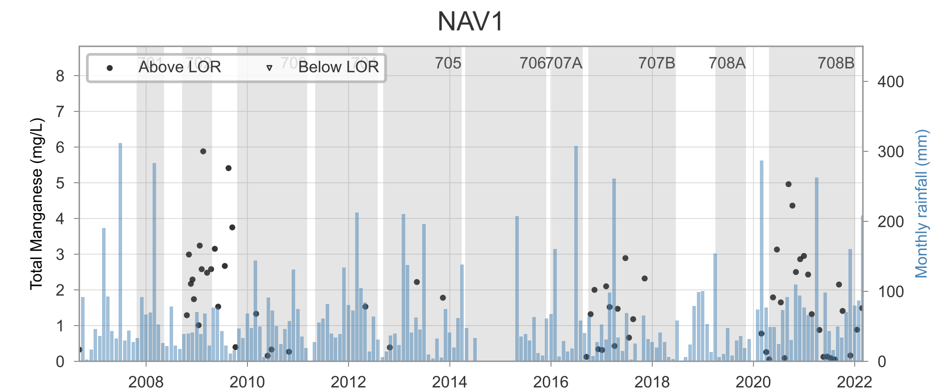

HC10
Above LOR
Below LOR
706
707A
707B
708A
708B
Dissolved Zinc (mg/L)
Monthly rainfall (mm)
2012
2014
2016
2018
2020
2022

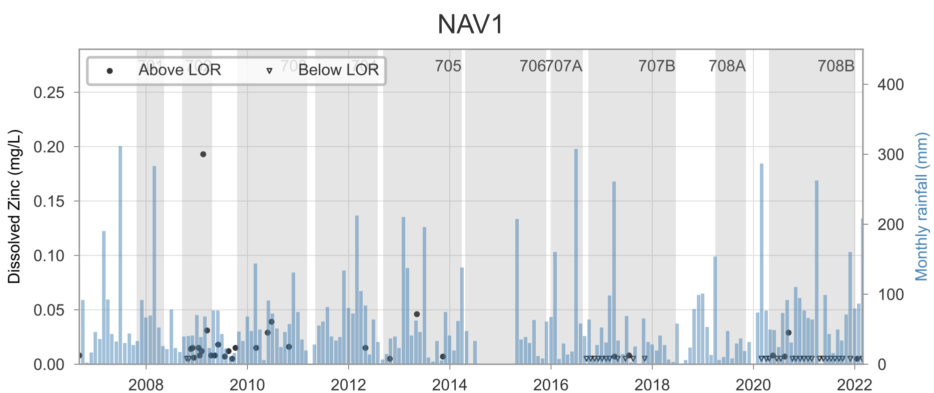

HC10
Above LOR
Below LOR
707A
707B
708A
708B
Dissolved Sulfate (mg/L)
Monthly rainfall (mm)
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

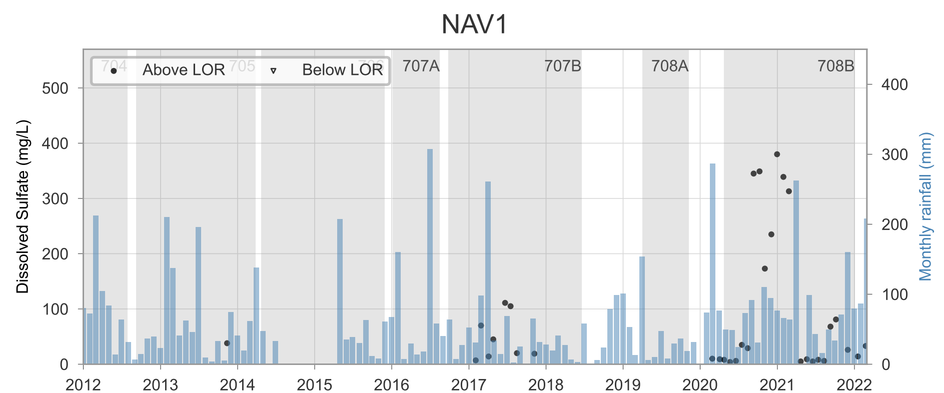

NAV1
Above LOR
Below LOR
705
706707A
707B
708A
708B
Dissolved Iron (mg/L)
Monthly rainfall (mm)
2008
2010
2012
2014
2016
2018
2020
2022


NAV1
Above LOR
Below LOR
705
706707A
707B
708A
708B
Dissolved Manganese (mg/L)
Monthly rainfall (mm)
2008
2010
2012
2014
2016
2018
2020
2022


NAV1
Above LOR
Below LOR
705
706707A
707B
708A
708B
Total Iron (mg/L)
Monthly rainfall (mm)
2008
2010
2012
2014
2016
2018
2020
2022


NAV1
Above LOR
Below LOR
705
706707A
707B
708A
708B
Total Manganese (mg/L)
Monthly rainfall (mm)
2008
2010
2012
2014
2016
2018
2020
2022


NAV1
Above LOR
Below LOR
705
706707A
707B
708A
708B
Dissolved Zinc (mg/L)
Monthly rainfall (mm)
2008
2010
2012
2014
2016
2018
2020
2022


NAV1
Above LOR
Below LOR
707A
707B
708A
708B
Dissolved Sulfate (mg/L)
Monthly rainfall (mm)
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

APPENDIX B – Surface water TARP chemistry summary

Water Quality TARP Assessment

Month_End	Site_ID	EC_max	pH_max	DO_max	Fe_tot_max	Mn_tot_max
30/04/2019	NR12	180	7.05	88.6	0.25	0.044
31/05/2019	NR12					
30/06/2019	NR12	171	7.55	81.4	0.22	0.022
31/07/2019	NR12	243	7.94	79.7	0.19	0.014
31/08/2019	NR12	218	8.18	78.9	0.47	0.011
30/09/2019	NR12	268	8.01	79.4		
31/10/2019	NR12	183	7.36	82.9	0.17	0.018
30/11/2019	NR12	199	7.66	78.9	0.08	0.015
31/12/2019	NR12	330	7.98	93.1	0.08	0.013
31/01/2020	NR12	250	8.09	96.5		
29/02/2020	NR12					
31/03/2020	NR12	124	6.74	67	0.63	0.088
30/04/2020	NR12	195	7.14	90	0.58	0.042
31/05/2020	NR12					
30/06/2020	NR12	191	7.57	79.1	0.47	0.021
31/07/2020	NR12	241	7.63	82.9	0.52	0.024
31/08/2020	NR12	100	7.12	91	0.61	0.026
30/09/2020	NR12	138	7.06	89.1	0.4	0.035
31/10/2020	NR12	207	7.63	88.7	0.3	0.024
30/11/2020	NR12	202	7.67	88	1.59	0.035
31/12/2020	NR12	286	7.64	83.9	0.46	0.045
31/01/2021	NR12	194	7.44	72.8	0.42	0.041
28/02/2021	NR12	140	7.61	74	0.6	0.038
31/03/2021	NR12					
30/04/2021	NR12	111	6.74	77.5	0.51	0.056
31/05/2021	NR12	103	7.11	93	0.45	0.022
30/06/2021	NR12	162	7.75	90	0.43	0.025
31/07/2021	NR12	119	7.2	86.9	0.55	0.021
31/08/2021	NR12	267	7.94	89.7	0.42	0.02
30/09/2021	NR12	143	7.56	91.4	0.42	0.017
31/10/2021	NR12	130	7.37	101.1	0.44	0.023
30/11/2021	NR12	245	7.88	96.7	1.1	0.026
31/12/2021	NR12					
31/01/2022	NR12	127	7.38	90.2	0.53	0.044
30/04/2019	NR13	176	6.79	72	0.25	0.043
31/05/2019	NR13					
30/06/2019	NR13	172	7.49	83.6	0.2	0.016
31/07/2019	NR13	246	7.84	79.1	0.21	0.014
31/08/2019	NR13	217	8.12	85.9	0.26	0.01
30/09/2019	NR13	269	7.8	91.8		
31/10/2019	NR13	182	7.38	84.1	0.15	0.015
30/11/2019	NR13	199	7.43	78	0.1	0.015
31/12/2019	NR13	340	8.04	91.3	0.1	0.018
31/01/2020	NR13	250	8.27	76		
29/02/2020	NR13					
31/03/2020	NR13	114	6.51	63.1	0.59	0.099
30/04/2020	NR13	202	7.31	86.9	0.72	0.048
31/05/2020	NR13					
30/06/2020	NR13	187	7.33	82.2	0.49	0.022
31/07/2020	NR13	240	7.7	84.3	0.48	0.023
31/08/2020	NR13	100	7.06	88.8	0.61	0.024
30/09/2020	NR13	136	7.01	89.1	0.36	0.035
31/10/2020	NR13	208	7.76	77.5	0.29	0.023
30/11/2020	NR13	219	7.77	79.7	1.98	0.039
31/12/2020	NR13	291	7.63	92.3	0.41	0.043
31/01/2021	NR13	192	7.57	75.8	0.39	0.038
28/02/2021	NR13	139	7.54	74.9	0.57	0.04
31/03/2021	NR13					
30/04/2021	NR13	115	6.87	78.3	0.58	0.065
31/05/2021	NR13	104	6.9	91	0.44	0.025
30/06/2021	NR13	161	7.74	90.8	0.47	0.02
31/07/2021	NR13	120	7.15	86.4	0.5	0.021
31/08/2021	NR13	252	7.91	87	0.44	0.021
30/09/2021	NR13	139	7.66	94	0.38	0.018
31/10/2021	NR13	129	7.47	109.1	0.42	0.025
30/11/2021	NR13	243	7.81	88.8	1.14	0.025
31/12/2021	NR13					
31/01/2022	NR13	128	7.48	86.4	0.54	0.044
UPSTREAM CONTROL NR110						
30/04/2019	NR110	297	8.07	95.3	0.15	0.017
31/05/2019	NR110				0.17	0.015
30/06/2019	NR110	375	7.82	99.5	0.11	0.01
31/07/2019	NR110	488	8.13	90.5	0.06	0.011
31/08/2019	NR110	489	8.08	87.1	0.06	0.015
30/09/2019	NR110	427	8	93.3		
31/10/2019	NR110	446	8.54	80.9	0.18	0.04
30/11/2019	NR110	675	8.71	93.8	0.13	0.034
31/12/2019	NR110	566	8.64	88.5	0.07	0.044
31/01/2020	NR110	721	8.64	71.9		
29/02/2020	NR110	104	7.56	104	0.53	0.044
31/03/2020	NR110	217	7.17	90.3		
30/04/2020	NR110	552	7.84	78.3	0.58	0.021
31/05/2020	NR110	583	8.08	81.3	0.24	0.028
30/06/2020	NR110	631	7.99	91.3	0.29	0.017
31/07/2020	NR110	687	8.07	93.7	0.16	0.015
31/08/2020	NR110	95	7.67	101.2	0.53	0.018
30/09/2020	NR110	233	8.36	92.5	0.34	0.015
31/10/2020	NR110	245	8.19	94.3	0.25	0.019
30/11/2020	NR110	164	7.62	84.4	1.02	0.052
31/12/2020	NR110	436	8.08	84	0.41	0.043
31/01/2021	NR110	452	7.72	57	0.16	0.053
28/02/2021	NR110	526	8.39	95.5	0.25	0.02
31/03/2021	NR110					
30/04/2021	NR110	251	7.61	99.4	0.32	0.021
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
31/10/2021	NR110	418	8.17	98.4	0.22	0.014
30/11/2021	NR110	272	7.57	106.8	1.63	0.067
31/12/2021	NR110					
31/01/2022	NR110	182	7.83	102.1	0.78	0.087
28/02/2022	NR110	529	8.29	78.4	0.2	0.033

(yellow)	Reduction >1SD and <2SD
(orange)	Reduction >2SD

APPENDIX C – Private bores and dams water quality

Property		Lot 73 DP883462						Lot 900 DP1072947					Lot 10 DP245756	
Sample location		GW105376	GW105376	GW105376	D21d01	D21d01	D21d01	GW101986	GW101986	GW101986	F17d01	F17d01	GW072874	F11d01
Water source		Groundwater	Groundwater	Groundwater	Dam	Dam	Dam	Groundwater	Groundwater	Groundwater	Dam	Dam	Groundwater	Dam
Mining status		Pre-mining	Follow-up inspection	Post-mining	Pre-mining	Follow-up inspection	Post-mining	Pre-mining	Follow-up inspection	Follow-up inspection	Mining	Post-mining	Mining	Mining
Sample date		19/02/2018	25/07/2018	17/32022	19/02/2018	25/07/2018	17/32022	22/02/2018	6/08/2018	14/09/2018	14/09/2018	17/03/2022	25/07/2018	16/03/2022
Field parameters														
Field pH	pH unit	7.15	7.2	7.12	7.47	8.33	7.63	8.25	6.99	7.84	8.45	7.85	6.92	7.43
Dissolved oxygen	% sat	63	32	59.7	38.2	95.3	28.6	51	55.9	70.7	100.2	80.2	16.8	61
Final ORP	mV	291	179	159	184	270	138	289	204	351	330	398	-128	140
Electrical conductivity	µS/cm	-	3070	3060	-	2500	265	-	3780	7310	4080	246	4880	228
Temperature	mg/L	21.97	16.52	20.57	25.52	12.72	20.95	-	-	-	-	22.04	20.34	20.3
Laboratory analytes	mg/L													
Dissolved Arsenic	mg/L	<0.001	<0.001	<0.001	0.001	0.002	0.001	<0.001	-	-	-	<0.001		
Dissolved Copper	mg/L	0.005	<0.001	<0.001	0.003	<0.001	0.002	0.001	<0.001	0.017	-	0.001	<0.001	0.003
Dissolved Iron	mg/L	0.07	0.37	<0.05	<0.05	<0.05	0.69	0.14	0.72	<0.05	-	0.15	3.11	0.5
Dissolved Lead	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	-	<0.001		
Dissolved Manganese	mg/L	0.031	0.02	0.012	0.2	0.018	0.25						0.018	0.074
Dissolved Nickel	mg/L	<0.001	<0.001	<0.001	0.002	0.001	0.001	<0.001	<0.001	<0.001	-	0.001	<0.001	0.002
Dissolved Sulfate as SO4 2-	mg/L	13	17	16	9	21	1	47	28	22	-	3	6	
Dissolved Zinc	mg/L	0.008	<0.005	0.007	<0.005	<0.005	0.009	0.011	0.008	0.156	-	0.009	0.006	0.007
Electrical Conductivity @ 25 degrees C	uS/cm	2280	3070	3110	1950	2470	264	5650	3570	4110	-	248	4730	222
pH Value	pH	7.87	7.66	8	8.05	8.32	7.38	7.76	7.34	7.28	-	7.15	7.7	7.21
Suspended solids	mg/L	8	-	<5	114		9	28	8	<5	-	<5		
Total Aluminium	mg/L	<0.01	0.02	0.04	2.5	0.25	1.25	<0.01	<0.01	<0.01	-	1.09	<0.01	0.84
Total dissolved solids @180°C	mg/L	1100	-	1620	985	-	182	2900	1900	2080	-	140		
Total Iron	mg/L	0.13	0.39	0.93	5.24	0.97	2.33	0.29	0.82	0.67	-	1.03	2.9	1.67
Total Manganese	mg/L	0.03	0.023	0.018	0.248	0.079	0.259	0.007	0.006	0.01	-	0.112	0.018	0.138