Illawarra Metallurgical Coal

Appin Mine

Longwall 709 End of Panel Surface Water and Groundwater Monitoring Review

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EXECUTIVE SUMMARY

South32 Illawarra Metallurgical Coal (IMC) operates the Appin Colliery, extracting hard coking coal used for steel production. Appin Colliery is an underground mine located near the township of Douglas Park in the Southern Coalfield of New South Wales (Figure 1). Mining is currently underway in Appin Area 7 (AA7). Longwall 709 commenced on 22/2/2022 and was completed on 8/10/2023, overlapping in time with the extraction of Longwall 905 in AA9 which was completed on 28/2/2023. The longwall panel has a width of 325 m (including first workings) and a total length of 2615 m.

Potential impacts to watercourses and aquifers are monitored and managed through the Longwalls 709 to 711 and 905 Water Management Plan (WMP). This report presents results of the surface water and groundwater monitoring program following the end of Longwall 709, including an assessment of data against performance criteria in the Trigger Action Response Plan (TARP).

Groundwater assessment

Groundwater levels are monitored at fifteen bores within and surrounding AA7 and AA9 as part of a much wider groundwater monitoring network covering the Appin, West Cliff and Dendrobium mining areas. Longwall 709 mined beneath private groundwater bores GW105534 and GW105388. Post-mining inspection or private bores and dams at three properties found no evidence for significant impacts to bore or dam water quality. In general, groundwater levels in the Hawksbury Sandstone have declined over the last 12 months due to the drier conditions experienced in 2023. No groundwater level TARPs were triggered during the review period. Groundwater inflow to the mine is calculated from the daily mine water balance. During the Longwall 709 review period mine averaged 0.99 ML/day and remained well below the TARP Level 1 trigger of 2.7 ML/day.

Surface water assessment

As of November 2023, there is no evidence for loss of flow in the Nepean River as a result of mining in AA7 and AA9. The ratio of downstream flow (at Menangle Weir) to upstream flow (at Maldon Weir) has fluctuated around the baseline median value of 2.7 since the start of mining and there is no apparent systematic change in the ratio over time. There are no apparent systematic changes in the minimum recession rate at Menangle, Maldon and Broughtons Pass Weirs since the start of mining.

Monthly monitoring of stream pool levels by IMC shows that water levels at most pools remain within the baseline range, noting that at many sites, pool levels were at their lowest in the latter part of 2023 due to the dry weather conditions. Nepean River monitoring site NR0 shows an apparent decline in water level of ~0.5 m relative to the baseline range during Longwalls 901 to 903. The change does not appear to be related to a change in flow, and previous reviews identified similar water level changes at the upstream control site NR110. This suggests the changes are unrelated to mining and may be related to changes in riverbed morphology during floods. It is recommended that IMC investigate the changes using archived photograph and LiDAR data.

During the reporting period for Longwall 709 water quality TARPs were triggered at five impact sites with similar exceedances noted at two control sites. The triggers relate to elevated electrical conductivity (EC) and decreased dissolved oxygen (DO) and pH relative to baseline. The triggers are accompanied by trends of increasing EC during 2023, including at control sites at Appin and Dendrobium and reflect the return to low rainfall and low-flow conditions in 2023.

No new gas releases were observed during the extraction of Longwall 709. Three previously identified AA7 gas releases were active during the extraction of the Longwall 709. One of these gas zones was observed to be active on the most recent inspection (2/11/2023)

1. INTRODUCTION

South32 Illawarra Metallurgical Coal (IMC) operates the Appin Colliery, extracting hard coking coal used for steel production. Appin Colliery is an underground mine located near the township of Douglas Park in the Southern Coalfield of New South Wales (Figure 1). Mining is currently underway in Appin Areas 7 (AA7) as part of IMC Bulli Seam Operations (BSO), approved on 22 December 2011. IMC received Subsidence Management Plan (SMP) approval to extract Longwalls 709 and 710B in AA7 on 23 November 2020. A consolidated Extraction Plan for Longwalls 709 to 711 (AA7) and Longwall 905 (Appin Area 9; AA9) was prepared in accordance with Conditions 5 and 6, Schedule 3 of the BSO Approval.

Longwall 709 commenced on 22/2/2022 and was completed on 8/10/2023, overlapping in time with the extraction of Longwall 905 in AA9 which was completed on 28/2/2023. The longwall panel has a width of 324 m (including first workings) and a total length of 2615 m with a cutting height of up to 3 m (full seam extraction). The top of the Bulli Coal seam ranges between 528 m and 593 m below the ground surface over the area of the longwall with an average depth of 560 m. This report presents a review of surface water, groundwater and mine water balance monitoring and an assessment of impacts against performance criteria defined in the Longwalls 709 to 711 and 905 Water Management Plan (WMP).

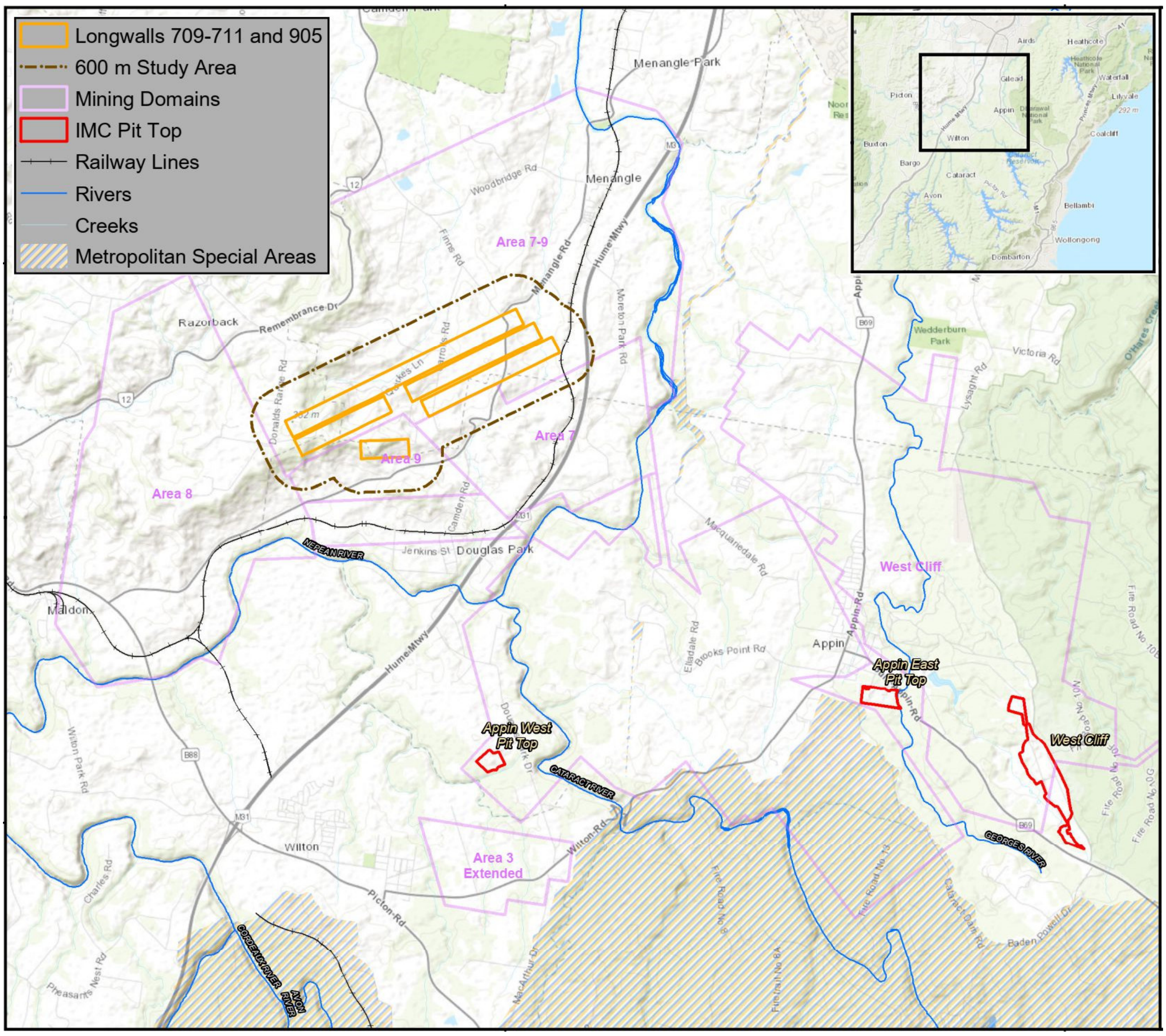


Figure 1. Location of Appin Colliery Area 9

1.1 Scope

As part of the reporting framework for the Longwalls 709 to 711 and 905 Extraction Plan, IMC prepares an End of Panel Report to be submitted to stakeholders within four months of the completion of each longwall in the series. The report describes subsidence impacts with reference to the environmental impacts and consequences outlined in the Extraction Plan. The End of Panel Report includes:

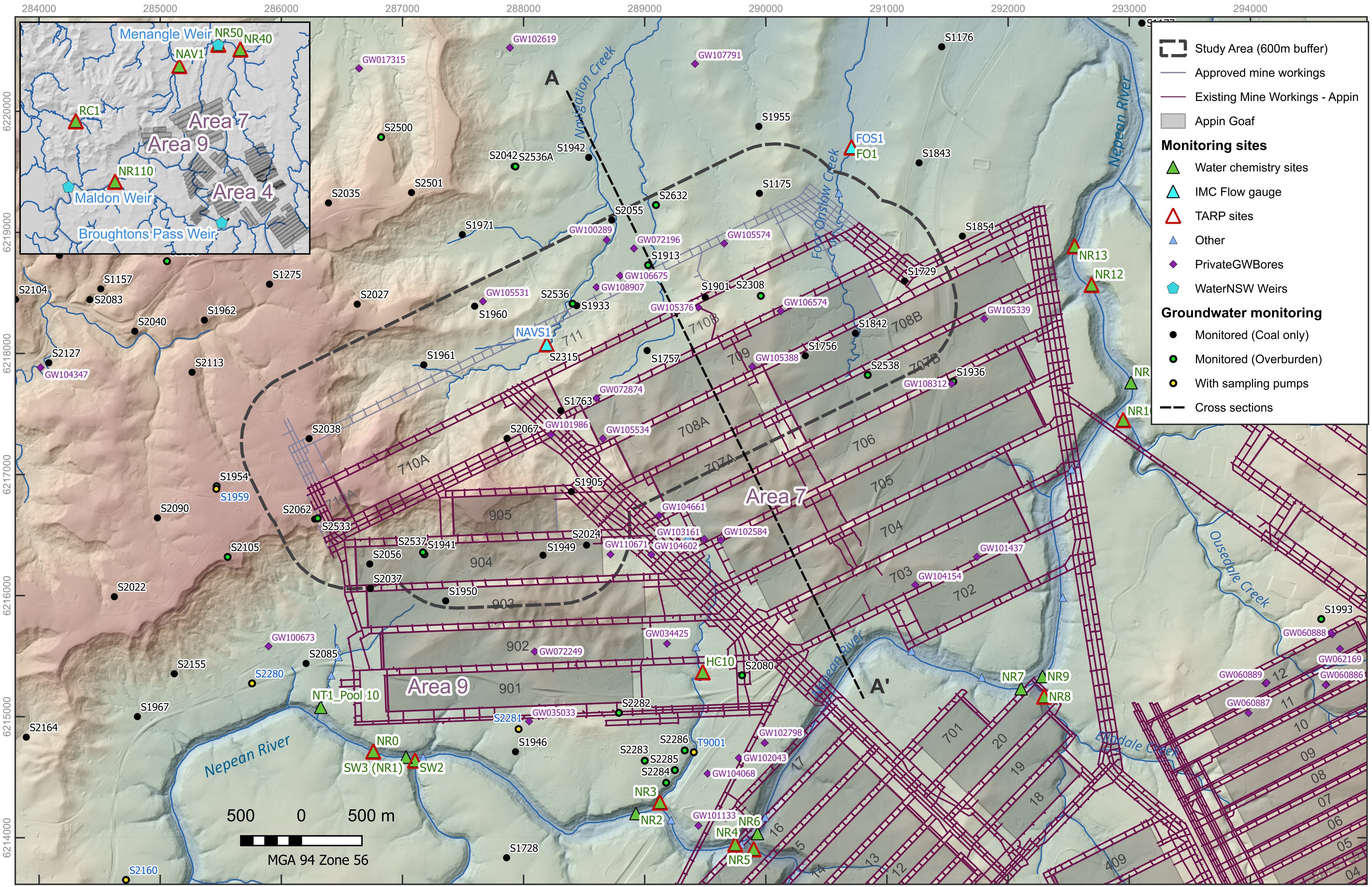
- a summary of all subsidence impacts, including an assessment according to the relevant Trigger Action Response Plan criteria (TARPs);
- any proposed actions resulting from triggers being met in the TARP(s), or other actions;
- assessment of compliance with all relevant subsidence impact performance measures and indicators; and
- a summary of all quantitative and qualitative environmental monitoring results, including landscape monitoring, water quality data, water flow and pool level data, piezometer readings, etc.

This End of Panel surface water and groundwater monitoring review forms part of the IMC End of Panel Report. It provides an independent specialist assessment of monitoring data against performance measures specified in the Longwalls 709 to 711 and 905 Water Management Plan in relation to surface water quality and flow, groundwater level and quality and mine water inflows. It provides recommendations for ongoing monitoring and management of surface and groundwater.

1.2 Study Area

The Study Area for the Extraction Plan and this assessment is defined as the surface area predicted to be affected by the proposed mining of Longwalls 709 to 711 and 905 and encompasses the areas bounded by the following limits:

- A 35° angle of draw line from the maximum depth of cover, which equates to a horizontal distance varying between 530 m and 750 m around the extents of Longwalls 709 to 711 and 905.
- The predicted limit of vertical subsidence, taken as the 20 mm subsidence contour, resulting from the extraction of the proposed Longwalls 709 to 711 and 905.
- A 600 m buffer around all longwalls, which is a conservative envelope to encompass potential far field effects beyond the 20 mm subsidence zone and 35° angle of draw line.



Appin Area 7 and 9 EOP Surface water and groundwater monitoring

Monitoring site locations

Figure 2

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2. Background

2.1 Climate and weather

Average annual rainfall at Douglas Park is 772 mm. On average, rainfall is evenly distributed throughout the year, with slightly higher monthly average rainfall in late summer (Figure 3). In any one year, 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). Potential evaporation varies seasonally in line with temperature, peaking during the summer months. Rainfall in 2023 was significantly below average with just 423 mm recorded to the end of October 2023 (58% of the average for Jan-Oct). The current dry period follows three years of above average rainfall between 2020 and 2022 (Figure 4).

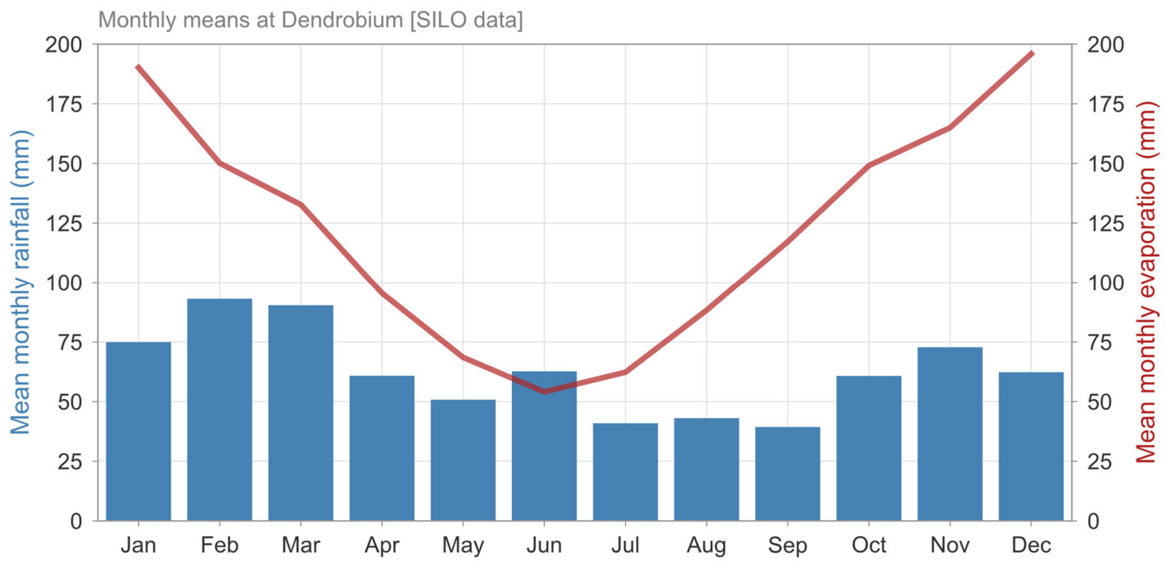

Figure 3. Monthly average rainfall and pan evaporation at Douglas Park

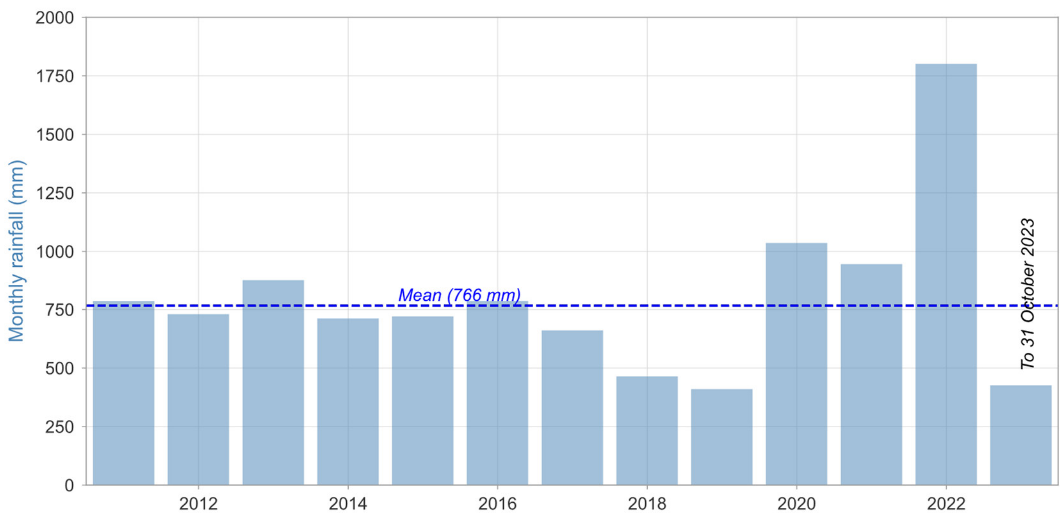

Figure 4. Annual rainfall at Douglas Park since 2010

2.2 Hydrogeology

Appin Colliery is located within the Southern Coalfield within the Sydney Geological Basin. 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 5.

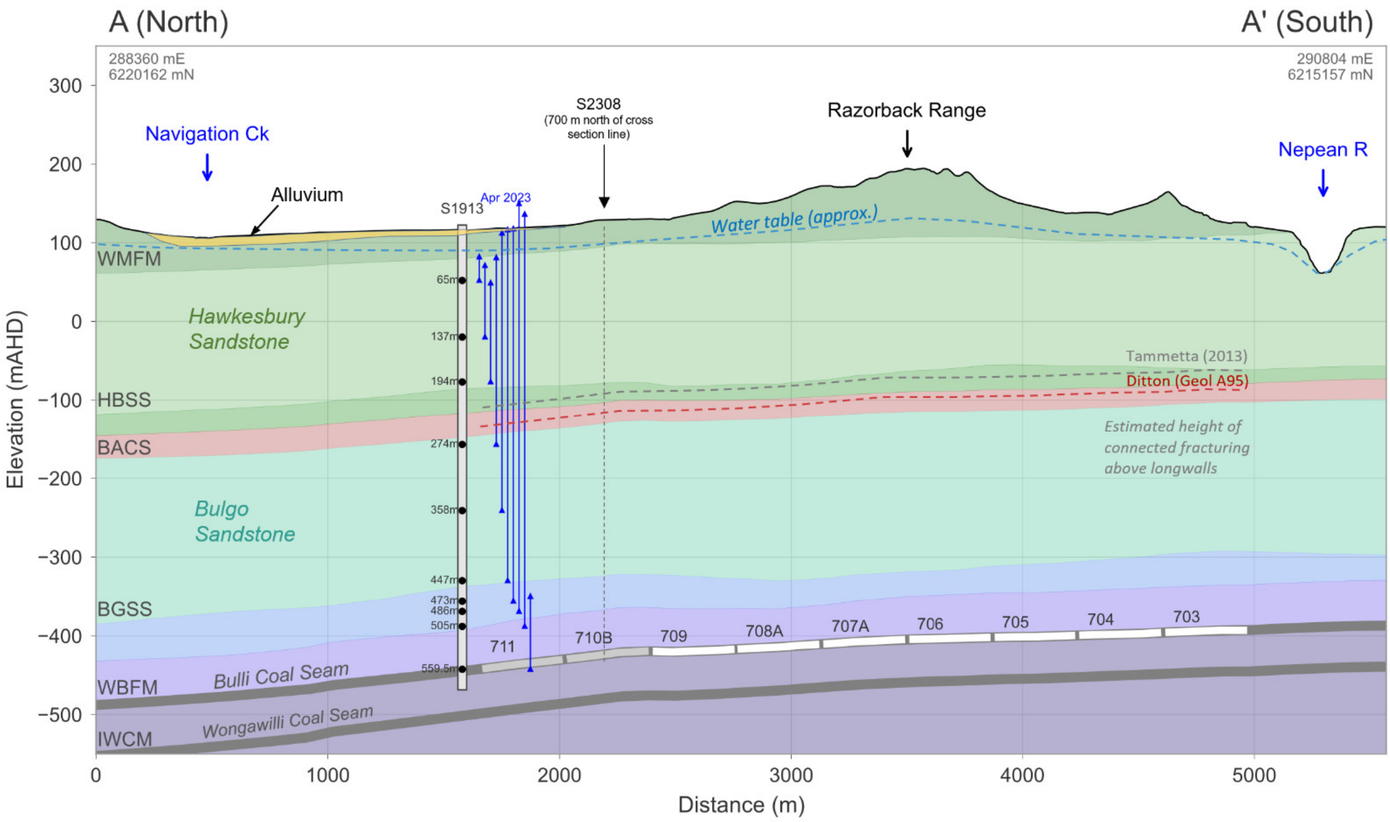

Figure 5. Hydrogeological cross section (N-S) through AA7 / 9

The primary hydro stratigraphic units within the Appin Mine area are:

- **Quaternary alluvium:** localised along rivers and creeks, likely unconfined and recharged from rainfall and surface water flow. Discharge to surface water (baseflow contributions) possible where gradients enable this, with potential for downward seepage where unconformity overlies HBSS. Groundwater flow likely follows topography and streamflow direction towards the north.

- **Hawkesbury Sandstone:** The Hawkesbury sandstone is the main groundwater source and widely accessed for groundwater supply and provides baseflow contributions where incised along major rivers (i.e. Cataract River, Nepean River and Georges River). Groundwater flow generally in a northerly direction, and locally influenced where intersected by rivers and private abstraction bores.

- **Narrabeen Group**: Includes the Bulgo sandstone which can be used for groundwater supply. Low permeability claystones (e.g. Stanwell park Claystone) generally act as aquitards. The Narrabeen

Group is a confined aquifer in the Study Area. Multi-level piezometers indicate locally artesian groundwater pressures (e.g. Bore S1913; Figure 5)

- **Illawarra Coal Measures (IWCM):** Groundwater occurrence largely associated with the more permeable coal seams, with confined groundwater conditions. Groundwater flow generally in a northerly direction, and locally depressurised due to current and historical mining and coal seam gas.

The private groundwater supply bores in the Study Area are between 70 m to 240 m deep, with water obtained primarily from water-bearing horizons within the Hawkesbury Sandstone, and minor perched horizons within the Wianamatta Group shale. Groundwater quality in registered bores is generally fresh to brackish with salinity (total dissolved solids; TDS) between 260 and 2500 mg/L. The details of the registered groundwater bores in the Appin Mine area are listed in the Groundwater assessment for Longwalls 709-711 and 905 (SLR, 2022).

2.3 Surface water hydrology

Rivers in the Appin Mine area generally flow in a northerly direction and have perennial flows influenced by dam releases, catchment runoff and baseflow contributions from the incised Hawkesbury Sandstone. There are no drinking water catchment areas, or declared special areas within the Study Area. The mine area overlaps with the Hawksbury-Nepean Catchment which has a total area of 21,400 km2.

No major rivers pass through the Study Area itself; Longwalls 709-711 and 905 are set back from the Nepean River by 1.5 km or more. The Razorback Range forms a topographic and sub-catchment divide such that minor tributaries flow to the south towards the Nepean River in AA9 and generally to the north towards the Nepean River in the future mining areas of AA7. Longwall 709 mined directly under a 384 m length of Foot Onslow Creek in late August 2023.

2.3.1 Nepean River

Water flows from the Nepean River are derived from a number of sources and include flows from catchment areas, licensed discharges, including Appin and Tahmoor Mines, and runoff from agricultural and urban areas. The Nepean River has the following characteristics:

- Flows in a northerly direction, with a mean flow of around 310 ML/day (Maldon Weir) since 2010.
- Flow rate varies greatly and is highly responsive to rain events due to the significant catchment area.
- Natural flow within the Nepean River and its associated watercourses have been significantly altered by water storages such as dams and weirs. Some natural catchment flows are retained by large storage dams upstream of Appin Mine for the purpose of the Sydney water supply system. Water is also retained by numerous farm dams within the local part of the Nepean River catchment.

Surface water monitoring is conducted at the main rivers at government stream gauges (Maldon, Menangle and Broughtons Weirs). The locations of the Maldon, Menangle and Broughtons Pass gauging sites are included in Figure 2. These flow monitoring stations are located on the Cataract or Nepean River, being directly upstream and downstream of the approved BSO footprint. 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.

Nepean River is a ‘gaining river’ in terms of surface water - groundwater interaction, being situated in a well incised gorge that defines a regional low point in the piezometric surface. Water levels in the Nepean River and its tributaries are monitored using observations and measured benchmarks. The water level is recorded before, during and after mining and is assessed against catchment rainfall and discharges from the WaterNSW controlled weirs. This method of monitoring has been used for the previous AA7 and AA9 and will be implemented for future longwalls. IMC also conducts monitoring of surface water levels and water quality at the major rivers as well as creeks and tributaries across the site and to the north. This includes monitoring of ponded water (pools) along the Georges River and Nepean River. Surface water monitoring has been undertaken at the site for a baseline period between 2002 – 2020.

2.3.2 Watercourses within the Study Area

Minor creeks and tributaries of the Nepean River that pass within or near the Appin Mine Study Area include Navigation Creek, Foot Onslow Creek, Harris Creek and Nepean River Tributary 1 (NT1).

The upper reaches of watercourses within the Study Area are incised into clay-rich soils and alluvium derived from the Wianamatta Group, and have natural gradients ranging from 2-40%. The lower third-order reaches of these creeks form gullies within alluvium, with sandstone platforms exposed in the creek beds and locally, sandstone outcrops in the valley sides. Natural gradients of third order streams range from 0.5-4%.

Watercourses within the Study Area drain predominately cleared, agricultural land with small pockets of remnant vegetation. The creeks are largely ephemeral, but pools have naturally formed in some areas. Like the receiving Nepean River, flows within ephemeral creeks have been altered by farm dams which intersect the drainage lines at a number of locations. Runoff from within the catchments is influenced by input of nutrients from adjacent farmland and salinity from the marine sediments of the Wianamatta Shale (SLR, 2021).

2.4 Predicted impacts from mining.

Subsidence impacts are defined in terms of:

- **Subsidence effects**: the deformation of ground mass such as horizontal and vertical movement, curvature and strains.
- **Subsidence impacts**: the physical changes to the ground that are caused by subsidence effects, such as tensile and sheer cracking and buckling of strata.
- **Environmental consequences**: as a result of subsidence effects and impacts, such as losses of surface water flow, drawdown of groundwater and anomalous gas releases.

Predicted subsidence impacts to surface water and groundwater resources is summarised in the WMP for Appin Mine Areas 7 and 9 (South32, 2022). Details regarding predictions of subsidence effects and potential impacts to surface water and groundwater are given in specialist consultant reports by MSEC (2021) SLR (2021; 2022). In summary:

Nepean River: Located > 1.5 km from Longwalls 709-711 and 905 and well-outside the predicted 20 mm subsidence contour for those longwalls. It is considered unlikely that the Nepean River will experience additional adverse physical impacts due to those longwalls. Gas release zones have been observed along the river during the mining of longwalls in Areas 7 and 9. Further gas release zones could develop due to the mining of the proposed longwalls (MSEC, 2021).

Tributaries: Sections of Foot Onslow Creek, Harris Creek, Navigation Creek and Nepean River Tributary 1 (NT1). Fracturing of the uppermost bedrock can occur along the streams that are located directly above or adjacent to the proposed mining area. Surface water flow diversions could occur along the creeks and tributaries that are located directly above the mining area. It is unlikely that there would be a net loss of water from the catchment. It is possible that localised increased ponding could develop in some locations, where the natural grades are small, and upstream of the chain pillars and the edges of the mining area (MSEC, 2021).

Groundwater bores: Bores that directly overlie or are adjacent to extracted longwalls may experience adverse impacts including lowering of bore water level, blockage caused by strata movement, and changes to groundwater quality. More than 2 m of groundwater drawdown is predicted at five bores: GW105376, GW105574, GW072874, GW105534 and GW112481 (SLR, 2022).

Mine inflow: Numerical groundwater model predictions indicate that the average total mine inflow rate over the duration of mining Longwalls 709-711 and 905 will be approximately 0.45 ML/day, peaking in 2024 (SLR, 2022).

2.5 Performance measures and indicators

Surface water and groundwater monitoring and reporting is carried out according to the Area 7 and 9 WMP (South32, 2022). The objectives of the WMP are to identify at risk surface water and groundwater features and characteristics within the Longwalls 709 to 711 and 905 Study Area and to manage the potential impacts and/or environmental consequences of the proposed workings on watercourses and aquifers. The WMP 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 TARP is included in Appendix 4. Water chemistry TARP trigger levels calculated from baseline measurements, as calculated by SLR (2021) are presented in Table 1

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

Table 1. Baseline water chemistry TARP trigger levels

Location	NR110	NR0	NR4	NR12	NR13	NR50	SW2	NR5
Watercourse	Nepean R	Nepean R	Nepean R	Nepean R	Nepean R	Nepean R	Allens Ck	Cataract R
EC [mean] (µS/cm)	319	378	223	186	182	296	704	169
EC [mean+1SD]	466	551	327	253	237	536	933	287
EC [mean+2SD]	613	724	431	320	292	776	1162	405
pH [mean]	7.9	7.9	7.6	7.4	7.4	7.6	8.1	7.2
pH [mean-1SD]	7.6	7.4	7.2	7.1	7.1	7.2	7.7	6.7
pH [mean-2SD]	7.3	6.9	6.8	6.8	6.8	6.8	7.3	6.2
DO [mean] (%)	90.5	89.5	85.7	87.2	85.7	84.1	95.7	73.1
DO [mean-1SD]	75.7	76.3	67.3	77.1	73.1	64.4	77.3	43.5
DO [mean-2SD]	60.9	63.1	48.9	67	60.5	44.7	58.9	13.9
TDS [mean] (mg/L)	171	208	128	107	105	167	394	97
TDS [mean+1SD]	247	297	185.8	146	136	302	545	158
TDS [mean+2SD]	323	386	243.6	185	167	437	696	219
Fe_tot [mean] (mg/L)	0.3	0.3	0.4	0.4	0.4	0.4	0.5	0.7
Fe_tot [mean+1SD]	0.5	0.5	0.6	0.5	0.5	0.8	0.9	1.5
Fe_tot [mean+2SD]	0.7	0.7	0.8	0.6	0.6	1.2	1.3	2.3
Mn_tot [mean] (mg/L)	0.03	0.03	0.03	0.03	0.03	0.05	0.02	0.08
Mn_tot [mean+1SD]	0.05	0.05	0.04	0.04	0.04	0.14	0.04	0.2
Mn_tot [mean+2SD]	0.07	0.07	0.05	0.05	0.05	0.23	0.06	0.32

Location	NR8	NR10	NR40	FO1	NAV1	HC10	NR3
Watercourse	Elladale Ck	Ousedale	Menangle	Foot Onslow	Navigation	Harris Ck	Harris Ck
EC [mean] (µS/cm)	1640	1486	1376	1616	2565	1561	1550
EC [mean+1SD]	2869	2493	2148	2517	4508	2249	2506
EC [mean+2SD]	4098	3500	2920	3418	6451	2937	3462
pH [mean]	7.6	7.8	7.7	8	7.6	7.9	7.9
pH [mean-1SD]	7.3	7.3	7.3	7.6	7.2	7.6	7.6
pH [mean-2SD]	7	6.8	6.9	7.2	6.8	7.3	7.3
DO [mean] (%)	72.4	91.4	54.1	73.5	27.8	81.5	53.1
DO [mean-1SD]	51.9	77.5	22.4	51.2	6.4	56.5	26.2
DO [mean-2SD]	31.4	63.6	0**	28.9	0**	31.5	0**
TDS [mean] (mg/L)	909	805	727	909	1470	935	864
TDS [mean+1SD]	1605	1353	1138	1434	2594	1360	1395
TDS [mean+2SD]	2301	1901	1549	1959	3718	1785	1926
Fe_tot [mean] (mg/L)	0.8	0.6	2.1	1.5	5.1	0.7	0.7
Fe_tot [mean+1SD]	1.3	2	4.1	3.5	11.1	3	1.8
Fe_tot [mean+2SD]	1.8	3.4	6.1	5.5	17.1	5.3	2.9
Mn_tot [mean] (mg/L)	0.32	0.05	1.1	0.3	1.8	0.2	0.5
Mn_tot [mean+1SD]	1.14	0.37	2.7	0.7	2.8	0.6	1.4
Mn_tot [mean+2SD]	1.96	0.69	4.3	1.1	3.8	1	2.3

* From baseline water quality statistics in Table 4 of SLR (2022) and Table 5 of the Appin Area 7 and 9 WMP;

2.6 Monitoring network

Groundwater levels are monitored using multi-level vibrating wire piezometers (VWP) which are grouted into boreholes. Eleven groundwater monitoring sites are relevant to AA7 and AA9 operations, ten of which are listed in the TARP for Longwalls 709 to 711 and 905, shown in Figure 2 and listed in Table 2.

Table 2. Groundwater monitoring sites in AA7

Bore ID	Total depth	Number of piezometers	Formations monitored	Date installed
S1913	612.1	10	HBSS, BGSS, SBSS, BUSM	2008
S1936	611.0	10	HBSS, BGSS, SBSS, BUSM	2008
S1941	605.2	11 [1 active]	HBSS [BGSS, SBSS, BUSM]	2008
S1954	797.2	13	WMGR, HBSS, BUSM	2008
S2157	626.9	10	WMGR, HBSS, KGSS, BUSM	2013
S2308*	574.4	9	HBSS, BGSS, SBSS, BUSM	2015
S2315	576.4	9	HBSS, BGSS, SBSS, BUSM	2015
S2536	16	1 (+pump)	WMGR	2021
S2536A	616.6	2 (+pump)	HBSS, BUSM	2021
S2537	130	1 (+pump)	HBSS	2021
S2538	130	1 (+pump)	HBSS	2021
S2632	16	1 (+pump)	ASSH	2022

Note*: Bore S2308 is not listed as a groundwater TARP site.

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

2.6.1 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.

2.7 Surface water monitoring

Surface water levels and chemistry are monitored at the sites shown in Figure 2. Surface water monitoring sites assessed in this report include:

- 19 Surface water observation and chemistry sampling sites
- 3 River flow monitoring sites (Water NSW Weirs: Maldon, Menangle, Broughtons Pass)
- 2 Stream flow monitoring sites (NAVS1 and FOS1)

3. GROUNDWATER ASSESSMENT

3.1 Groundwater levels

Performance measures for groundwater level focus of changes in groundwater level within the Hawkesbury Sandstone during the longwall review period, compared with the 12-month period prior to the longwall start. TARP thresholds correspond to decreases in groundwater level or pressure of 10 m (Level 1), 15 m (Level 2) and 20 m (Level 3) over a minimum of two months. This approach allows for transient decreases in groundwater level associated with pumping at the well or at a well nearby.

Groundwater bore hydrographs are presented in Appendix 1 for IMC monitoring bores and private bores that are equipped with dataloggers. Observations in relation to temporal trends in groundwater pressures and TARP thresholds are listed in Table 3. Because TARP thresholds are based on groundwater level changes in the Hawkesbury Sandstone, an additional set of hydrographs is presented in Appendix 1B showing groundwater level timeseries for the review period relative to calculated thresholds. An example is shown in Figure 6, below. Note that for this assessment, a median value was used instead of an average, since the median is less sensitive to extreme values caused by intermittent pumping.

In general, groundwater levels in the Hawksbury Sandstone were slightly higher during Longwall 709 compared with the previous 12 months, due to the relatively high rainfall during 2022. Groundwater levels have declined from the late 2022 peak due to the dry conditions in 2023. Despite the overall decline, no groundwater level TARPs were triggered during the review period (Table 3). Groundwater levels declined below the TARP thresholds at GW072874, GW101986 and GW105376 for short periods due to pumping; however, non-pumping groundwater levels remained above the thresholds.

Monitoring bore S1941 is located directly above Longwall 904 and was affected by subsidence after the longwall passed beneath the bore in August 2021. All sensors except the shallowest sensor (65 m depth) were sheared and became inoperable. An additional monitoring bore (S2537) was installed near S1941 in 2021.

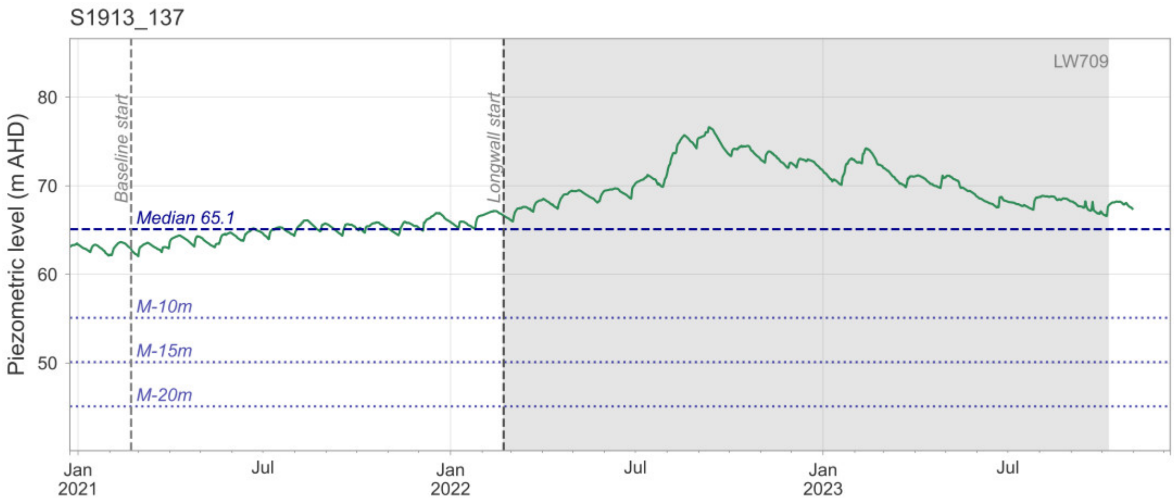

Figure 6. Groundwater hydrograph for piezometer S1913 (137 m depth)

Table 3. Groundwater level assessment (Hawkesbury Sandstone)

Piezometer	Groundwater level (mAHD)		Comments	TARP Level (0 = not triggered)
	Median: Prev. 12 months	Median: LW Review period		
S1913_65	82.7	84.5		0
S1913_137	65.1	70.0		0
S1913_194	46.8	49.6		0
S1941_65	104.8	113.9		0
S1954_245	87.8	91.3		0
S1954_273.1	118.3	120.5		0
S1954_316.3	96.1	99.2		0
S1954_359.4	76.2	77.8		0
S1954_392.5	74.5	72.4		0
S2157_135	208.4	204.9		0
S2157_207	100.2	102.2		0
S2157_284	97.3	98.8		0
S2315_65	56.0	56.7		0
S2536A_134.5	73.8	75.7		0
S2537_129	89.3	92.4		0
S2538_129.5	38.1	38.0		0
GW072874_174	71.9	79.9	Pumping effects	0
GW100673_78	110.9	113.8		0
GW101986_119	77.0	81.5	Pumping effects	0
GW105376_121.7	64.9	67.5	Pumping effects	0
GW106574_65	79.3	83.2		0
GW106574_129	53.7	66.0		0
GW106574_190	23.9	25.2		0
GW108907_149	78.7	81.2		0

3.1.1 Monitoring bore S2308

Monitoring bore S2308 is a fully grouted VWP array, located near the midline of planned Longwall 710B and 198 m north of the recently extracted Longwall 709. The monitoring bore has nine operational piezometers installed between the Bulli Coal Seam (BUSM) and the mid-HBSS. The array was installed in 2015 and continued to function after the Longwall 709 passed at a distance of 198 m on 19/5/2023. A hydrograph of piezometric head at each of the nine sensors in shown in Figure 7.

The previous End of Panel Report for Longwall 708 was reviewed by the Biodiversity Conservation and Science Division (BCD), (now within the Department of Climate Change, Energy, the Environment and Water (DCCEEW)), in 2022. Following the review, BCD requested further information regarding monitoring bore S2308, specifically in relation to the reliability of the VWP sensor installed at 70 m depth within the Hawkesbury Sandstone. BCD noted that the sensor recorded changes in groundwater level without explanation, including 16 m increase in piezometric head during the extraction of Longwall 708. No comment was made in relation to the other eight sensors in S2308.

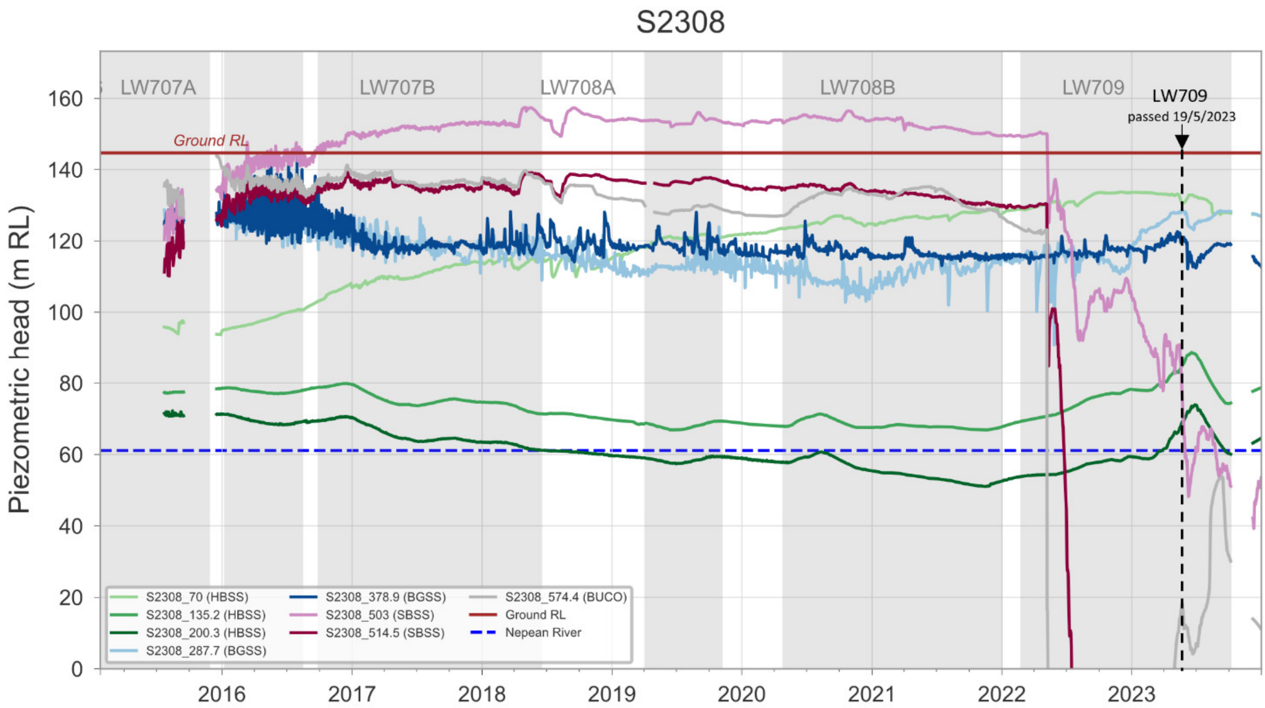

Figure 7. Hydrograph of piezometric heads at monitoring bore S2308

Data from S2308 was assessed by John Doyle who designed the installation and manages numerous monitoring installations across the Southern Coalfield. In an email dated 7/6/2023, Mr Doyle concluded that there was no evidence for a technical fault in the 70 m sensor. However, it is clear from Figure 7 that long term trends in piezometric head in the 70 m sensor are anomalous compared with two other piezometers located within the HBSS (at 135.2 m and 200.3 m depth), despite showing some small variations in common with other sensors. The 70 m sensor records an increase in head during a period of severe drought (2017-2019) whereas the deeper two HBSS sensors record a decline as expected. The bore is located near a ridgeline and there are no obvious sources of (artificial) recharge near the bore that could account for the head increase. It is concluded that the 70 m sensor should be regarded as unreliable. The remaining sensors within the HBSS appear to be functioning correctly and consistently.

Figure 7 shows that sensors located within the BUSM and Scarborough Sandstone (SBSS) at depths of 574.4 m, 514.4 m and 503 m, record sharp decrease in head on 7/5/2022, approximately 10 weeks after the start of Longwall 709 and when the longwalls was still ~1.5 km southwest of S2308. Sensors in the shallower geological units show little or no drawdown at that time but record transient increases and decreases in head as the longwall passed by S2308 and over the following month. Those transient changes are related to strata compression and tension associated with longwall subsidence. As of January 2024, piezometric head in the lower HBSS (135.2 m and 200.3 m depth) are similar to heads recorded prior to Longwall 708, implying minimal drawdown within the HBSS, and consistent with numerical model predictions.

3.2 Groundwater chemistry

Groundwater samples are collected from three IMC monitoring bores and three private bores in the vicinity of AA7 and AA9. Three bores (S1954, S2157) are sampled at multiple depths. Key groundwater quality parameters are summarised in Table 4 and water chemistry time-series plots are in Appendix 2. Groundwater in the Hawkesbury Sandstone is typically brackish (EC ~ 1400 to 6100 µS/cm; TDS ~ 840 to 3660 mg/L) and near neutral in pH. In contrast, the Nepean River has water of low salinity (fresh; EC typically 140 to 460 µS/cm; TDS 85 to 280 mg/L).

There are no specific performance indicators in relation to groundwater quality. With reference to Table 4, most bores sampled during the review period returned EC and pH values similar to, or within the range of the pre-longwall measurements. An exception is S2537 at which the EC has markedly varied at several sampling depths between the first and second sampling rounds. It is noted that S2537 is a relatively new monitoring bore and directly overlies extracted longwall 904. Groundwater quality can take several months to stabilise following installation due to influences from drilling and bore construction materials.

Table 4. Summary of groundwater quality

Sample pump	Prior to longwall (mean)			During / post longwall (mean)		
	n	EC (µS/cm)	pH	n	EC (µS/cm)	pH
GW105534	1	2530	7.8	3	2537	8.1
S1954_198M	8	3320	8.8	2	3430	8.8
S1954_255M	8	2836	8.0	2	2595	8.0
S2157_106M	5	5628	8.2	1	6920	8.0
S2157_150M	5	4224	8.4	1	1610	8.8
S2157_215M	5	1158	8.6	1	538	8.4
S2157_250M	5	2018	8.2	1	524	8.4
S2157_47M	5	4864	8.8	1	6140	8.3
S2536A_135M	2	3600	7.9	2	1750	7.6
S2537_135M	2	2980	8.0	1	5450	7.4
S2538_135M	2	4860	7.9	2	5140	7.6

3.3 Private groundwater bores and dams

Pre- and post-mining inspection of dams, boreholes and natural features above AA7 and AA9 (set out in the Built Feature Management Plans) are conducted by the IMCEFT with the consent of the relevant property/infrastructure owner and tenant.

Post-mining inspections were undertaken at four properties during the current review period. 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. Full inspection details are presented in South32 Private Property Inspection Reports for each property. No impact report was writted for Lot 11 DP775437, since the property does not have a pump installed in the bore and has no dam. Key findings of the inspection reports are summarised in Table 5.

Table 5. Summary of property inspection results water assets

Property	Inspection date	Bore observations	Dam observations
Lot 73 DP883462	28/92023	Bore GW105376 (340 m north of LW709) Bore sample: Clear and colourless. Water EC: 2540 uS/cm; pH: 6.7 (field) Metals: Total and dissolved Fe <1 mg/L as previous. Water level: Not measured. **No significant change**	Dam D21d01. Soil desiccation cracks around the dam, as for pre-mining inspection. Water: Green/brown, slightly turbid. EC: 788 uS/cm; pH 8.3 **No significant change.**
Lot 900 DP1072947	28/92023	Bore: GW101986 (320 m from LW709) Bore sample: Clear and colourless. Water EC: 3700 uS/cm; pH: 7.2 (field) Metals: Total and dissolved Fe <1 mg/L as previous. Water level: Not measured. **No significant change**	Dam F17d01 Condition: Good; No signs of subsidence damage. Water: Green/brown and turbid. EC 2760 uS/cm; pH 8.5 **No significant change.**
Lot 16 DP251063	28/9/2023	Bore: GW105534 (LW709 passed beneath 10/3/2022) Bore sample: Initial sulphide odour; slight yellow tinge (with only 2 mins purging) Water EC: 2160 uS/cm; pH: 7.2 (field) Metals: Dissolved Fe 5.26 mg/L; higher than previous, noting limited purging. Water level: Not measured. **No significant change; Dissolved iron slightly higher**	Dam condition: No signs of subsidence damage. Water: slightly turbid EC: 1760 uS/cm, pH: 8.03 **No significant change.**

Note: * Water level not able to be measured due to pumping equipment in the bore

In summary, no significant or adverse changes in water quality or bore performance was noted at the three properties inspected towards the end of Longwall 709. The most recent water sample from bore GW105534 at Lot 16 DP251063 was found to contain dissolved and total iron at a higher concentration than previous samples. However, it is noted that the bore was purged for only 2 minutes whereas the bores are usually purged for at least 10 minutes prior to sampling. Elevated iron is not uncommon in bore water, and it is not necessarily a mining effect. A review of iron concentration data from 9,650 bores in the Appin area (BOM Australian Groundwater Explorer database) indicates that ~10 % of bore water analyses exceed 5 mg/L.

3.4 Mine water balance

The daily mine water balance is monitored by South32. The balance tracks daily volumes of water pumped into the mine (supply), within the mine, and from the mine into storage and/or discharge. The rate of groundwater inflow to AA7 is determined by subtracting the estimated water supply volume (to AA7) from the total volume of water pumped to storage.

The TARP level for mine inflow is based on the 20-day rolling average inflow to AA7. TARP Levels 1, 2 and 3 are triggered if there is an increase of more than 2.7, 3.0 and 3.4 ML/day respectively. These thresholds were derived from numerical groundwater modelling by Heritage Computing (2010). More recent modelling by SLR indicates that the average total mine inflow rate over the duration of mining Longwalls 709-711 and 905 will be approximately 0.45 ML/day, peaking in 2024 before declining.

A time-series of groundwater inflow to AA7 based on water balance calculations is shown in Figure 8, including the 20-day rolling average and TARP trigger levels.

The average inflow over the longwall review period was 0.99 ML/day, slightly above the predicted inflow of 0.45. However, the 20-day rolling average inflow remained well below the TARP Level 1 trigger during the longwall review period. There is an apparent slight declining trend in net water make since July 2022 which may reflect the relatively dry conditions in 2023 compared with the very high rainfall in 2022. Peaks in net water make do not appear to be consistently correlated with individual large rainfall events.

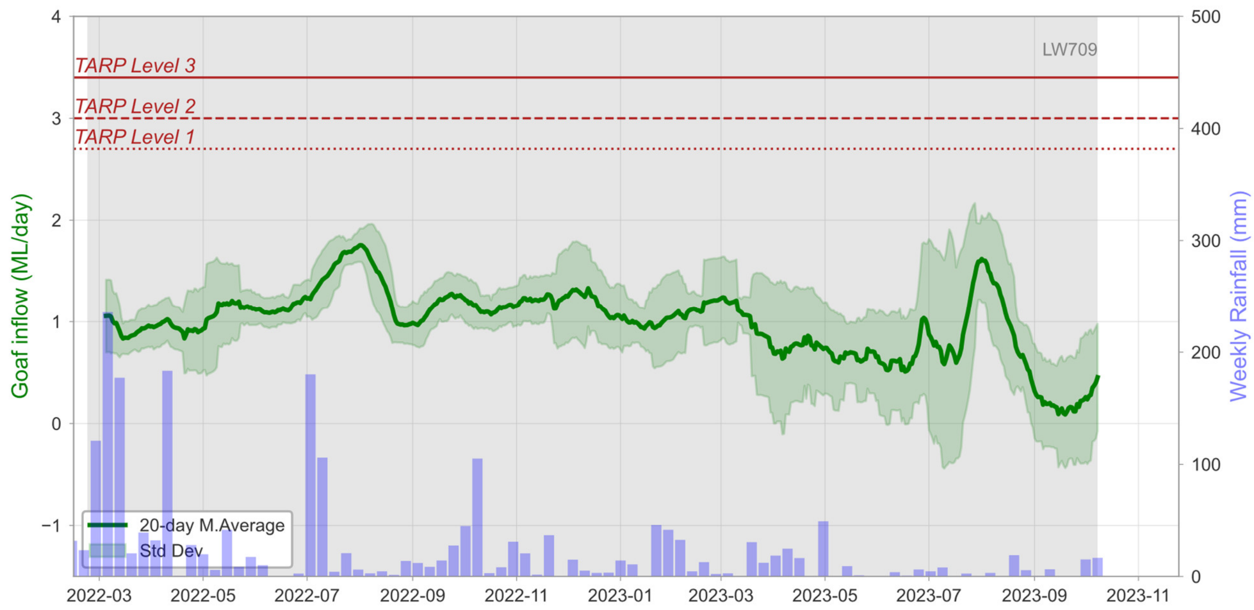

Figure 8. Appin Area 7 mine water balance

4. SURFACE WATER ASSESSMENT

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

4.1 Surface water flow and level

4.1.1 Nepean River flow

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

The Nepean River is a gaining system in the vicinity of AA9 and AA7 and therefore the flow rate increases downstream due to baseflow contributions (groundwater discharge) and inflow from minor catchments along the reach, unless water use, and other losses exceed those contributions. Under such conditions, the ratio of downstream flow (at Menangle Weir) to upstream flow (at Maldon Weir) should be typically greater than 1. A timeseries of the ratio of downstream to upstream flows is plotted in Figure 9. The ratio prior to mining in AA7 fluctuates around a median of 2.7. The ratio has fluctuated over a similar range since the start of mining in AA7 and during the current longwall review period and there is no apparent systematic change in the ratio over time.

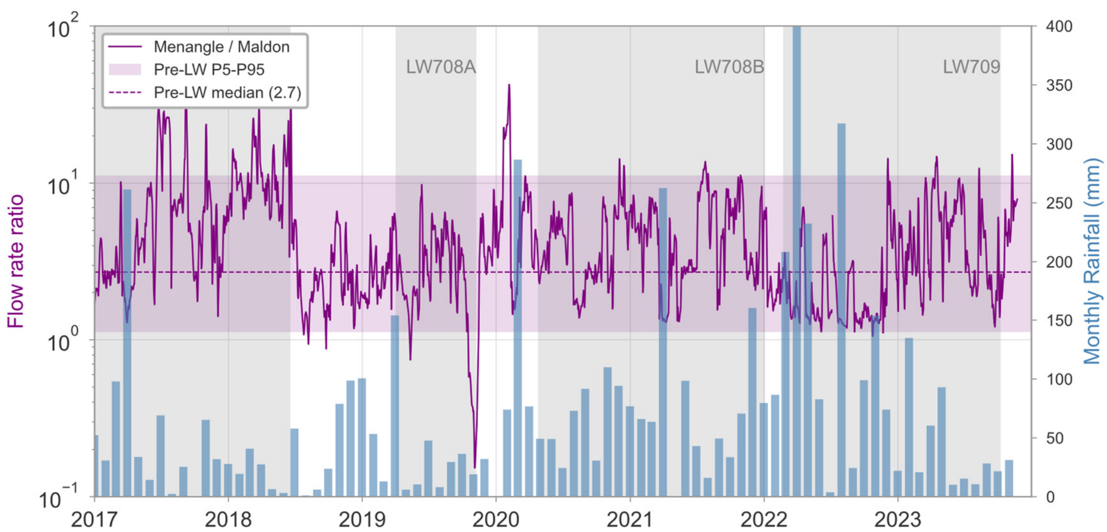

Figure 9. Ratio between downstream and upstream flow on the Nepean River

Flow duration curves for the Menangle and Maldon Weirs on the Nepean River and the Broughtons Pass Weir on the Cataract River are plotted in Figure 10. Flow duration curves are shown for the entire flow record prior to the current longwall review period (solid lines) and during the current review period (dashed lines). The pre-longwall record shows that the Nepean River ceased to flow 6 days per year at the Maldon Weir and 4 days per year at the downstream Menangle Weir. At Broughtons Pass Weir, the Cataract River ceased to flow 148 days per year. As a result of high rainfall between 2020 and 2022, no no-flow days were recorded at any of the monitoring sites during the review period and despite the drying conditions in 2023.

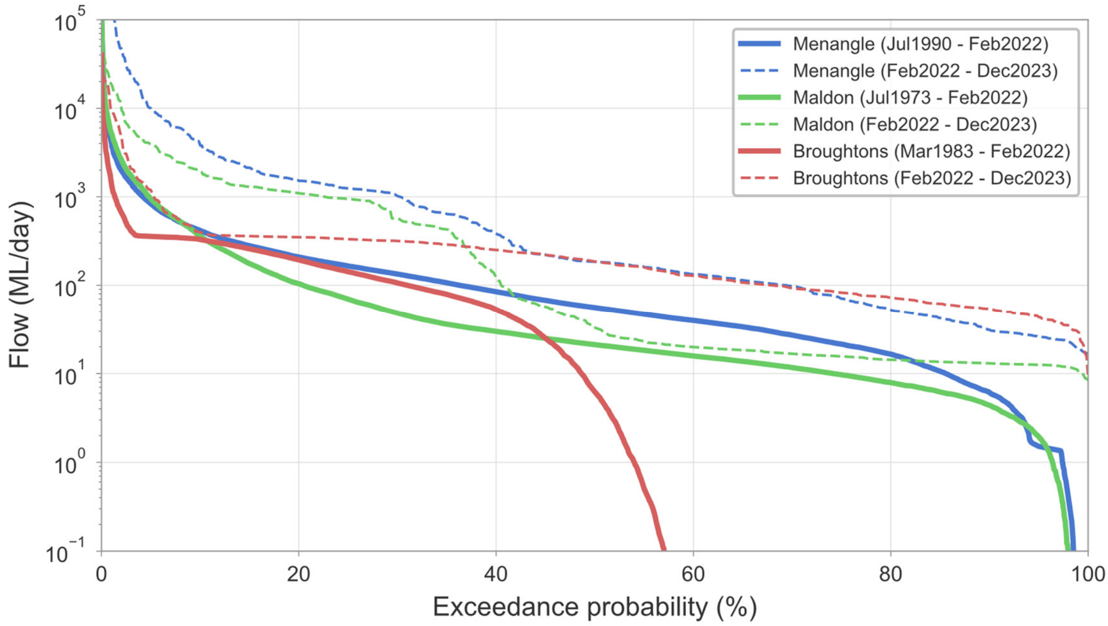

Figure 10. Flow duration curves prior to and during the longwall assessment period

Water level recession rates at Menangle, Maldon and Broughtons Pass Weirs are shown in Figure 11. Recession rates are calculated from measured water level changes over successive two-day periods. The data are filtered to include only periods that occur after 5 or more days of no rainfall, as recorded at the Bureau of Meteorology site at Douglas Park. Recession rates tend to cluster around 10 mm/day or less during dry periods but can exceed 50 mm/day after heavy or frequent rain events. A systematic increase in minimum recession rates during dry conditions may indicate increased losses due to seepage through the riverbed or weir structure. No systematic changes in the minimum recession rate are apparent during this or previous longwall review periods and therefore no TARP is triggered for flow in the Nepean River.

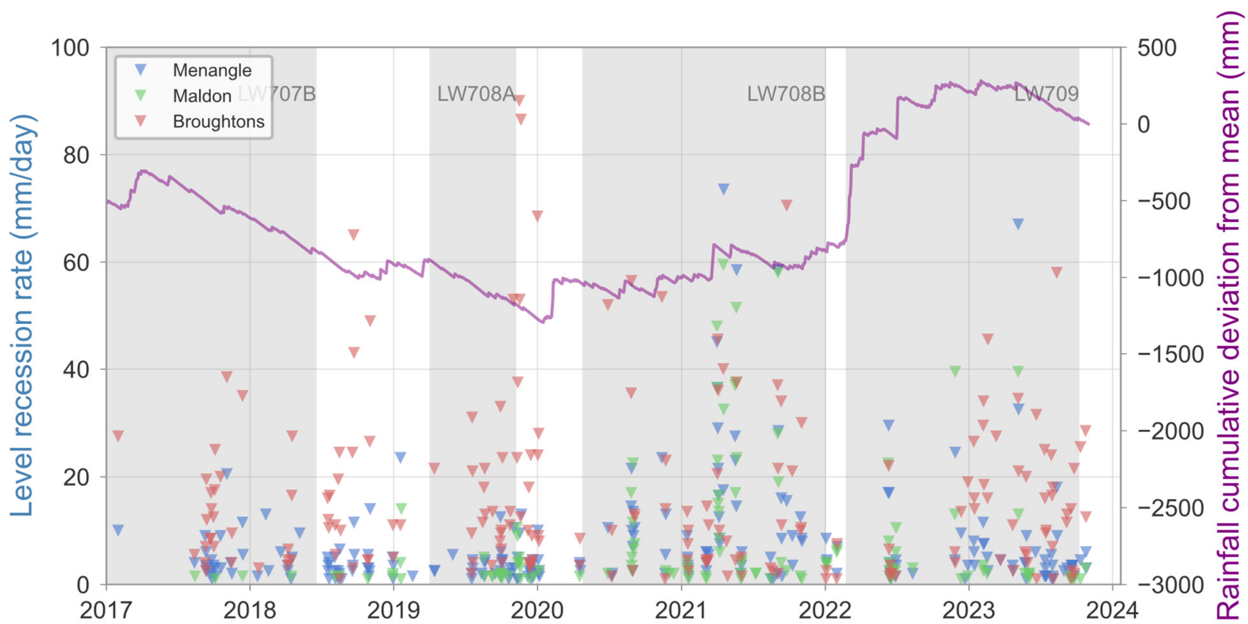

Figure 11. Water level recession rates at Menangle Weir

4.1.2 Creeks and tributaries

Stream flow gauges are installed on Foot Onslow Creek and Navigation Creek (gauges FOS1 and NAVS1). The sites record water level and flow daily. Data are collected and pre-processed by ALS hydrological consultants.

The gauging stations were installed and became operative in early September 2023. As of the date of reporting only 80 days of data are available with no flow recorded at NAVS1 over that period due to the dry conditions. Assessment of flow conditions at the two creek sites will be carried out in the next assessment when there is more data available.

During the review period, no fracturing resulting in loss of flow was observed in either creek and therefore there are no TARP triggers for creeks and tributaries.

4.1.3 Pool water levels

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

Of the sites where water levels are measured, most show water levels during the reporting period that are within the baseline range, noting that at many sites, pool levels were at their lowest in the latter part of 2023 due to the dry weather conditions.

Nepean River monitoring site NR0 shows an apparent decline in water level of ~0.5 m relative to the baseline range during Longwalls 901 to 903. The change does not appear to be related to a change in flow, and previous reviews identified similar water level changes at the upstream control site NR110. This suggests the changes are unrelated to mining and may be related to changes in riverbed morphology during floods. IMCEFT reported that flooding during the high rainfall events of 2022 resulted in significant damage to riparian vegetation and movement of soil and boulders in the riverbed and along the banks. No subsidence related impacts have been observed at the site.

The field team use a small boat to access the NR0 site. The river narrows leading up to the site, causing turbulence and even rapids during high flow. As a safety precaution, access to NR0 restricted to low to moderate flow conditions, which may result in potential bias to low water levels.

4.2 Water quality

Trigger Action Response Plan (TARP) levels for surface water quality parameters are listed in Appendix 4. Criteria for triggering TARP levels are based on both magnitude and duration, as well as comparison with upstream reference site. For example, a TARP Level 1 is triggered for pH if the pH at a location is lower than the baseline mean minus 1 standard deviation (at that location), for at least 2 consecutive months but less than 6 consecutive months. To facilitate comparison between sites with different sampling frequencies, each time-series is resampled to monthly, whereby a maximum value is considered where there is more than one sampling event per month. In addition to the nominated TARP sites for the Nepean River, the WMP recommends comparison with control sites, located upstream of impact sites. In addition, the TARP includes analysis of timeseries trend in key water quality parameters. A trend is identified where a timeseries of parameter values (Appendix 3A) shows an increase (in EC) or decrease (pH and DO) over the review period such that the values are projected to exceed the TARP thresholds in the next longwall period. Statistical (LOWESS) trends are shown in each timeseries plot.

Time-series plots of key water quality parameters are presented in Appendix 3. Analysis of the hydrographs in relation to the TARP criteria is provided in tabular format in Appendix 4. The table identifies months in which the TARP thresholds were exceeded, for each monitoring site. A TARP is triggered only if thresholds are exceeded for 2 consecutive months. A summary of TARP triggers identified at impact sites (and assessed at control sites) is provided in Table 6.

During the reporting period for Longwall 709 water quality TARPs were triggered at five impact and two control sites. Most of the triggers relate to elevated EC relative to baseline and a trend of increasing EC during 2023. Increasing EC in streams during 2023 has been observed at control sites at Appin and Dendrobium. It is likely related to a return to dry weather conditions during which rainfall runoff has sharply declined and both evaporation and relative groundwater contributions increase (both of which result in increasing EC). Similarly, low-flow during drier conditions is often accompanied by a reduction in DO which is observed at control sites (e.g. NR10). The TARP triggers related to elevated and increasing EC in 2023 are therefore most likely related to drying weather conditions and do not reflect a mining impact.

TARP triggers for pH are noted at FO1 (level 1) and at NR3 (Level 2). At both sites, pH has trended slightly lower during the dry conditions of 2023; however, pH values generally remain within the baseline range and there is no long-term adverse trend. The triggers do not represent an adverse trend due to mining.

Table 6. Summary of surface water TARP levels for reporting period

Site	Watercourse	EC*	pH	DO	Gas plume identified	Trend analysis
Upstream control sites						
NR110	Nepean R	Level 2	N/T	N/T	None identified	No adverse trends
SW2	Allens Ck	N/T	N/T	N/T	None identified	No adverse trends
NR5	Cataract R	N/T	N/T	N/T	None identified	No adverse trends
NR8	Elladale Ck	N/T	N/T	N/T	None identified	Returning to baseline
NR10	Ousedale Ck	N/T	N/T	Level 2	None identified	Returning to baseline
NR40	Menangle Ck	N/T	N/T	N/T	None identified	No adverse trends
Impact sites						
RC1	Racecourse Ck	N/T	N/T	N/T	None identified	↗EC during 2023
NR0	Nepean R	Level 2	N/T	N/T	None identified	↗EC during 2023
NR4	Nepean R	Level 2	N/T	N/T	None identified	↗EC during 2023
NR12	Nepean R	N/T	N/T	N/T	None identified	No adverse trends
NR13	Nepean R	N/T	N/T	N/T	None identified	↗EC during 2023
NR50	Nepean R	N/T	N/T	N/T	None identified	No adverse trends
NAV1	Navigation Ck	N/T	N/T	N/T	None identified	↗EC during 2023
FO1	Foot Onslow Ck	N/T	Level 1	N/T	None identified	Returning to baseline

Site	Watercourse	EC*	pH	DO	Gas plume identified	Trend analysis
Upstream control sites						
HC10	Harris Ck	N/T	N/T	Level 2	None identified	Returning to baseline
NR3	Harris Ck	N/T	Level 2	N/T	None identified	No adverse trends

Note*: N/T = TARP Not triggered; Numbers refer to TARP levels 1,2,3; EP = Exceeds Prediction.

4.3 Gas emissions

Monitoring of the Nepean River and other watercourses for the occurrence of gas release zones was carried out by IMCEFT monthly during the extraction of Longwall 709. No new gas releases were observed during Longwall 709. Three previously identified AA7 gas releases were active during the extraction of the Longwall 709. One of these gas zones was observed to be active on the most recent inspection (2/11/2023).

5. RECOMMENDATIONS

1. It is recommended that the IMCEFT investigate possible causes for water level changes at NR0 and NR110. A study could include inspection of archived site photographs, LiDAR and satellite data to identify possible changes to the controlling channels and riverbed.

6. REFERENCES

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MSEC, 2021, Subsidence Predictions and Impact Assessments, Subsidence Predictions and Impact Assessments for the Natural and Built Features due to the Extraction of the Proposed Longwalls 709, 710A, 710B, 711 and 905 at Appin Colliery.:

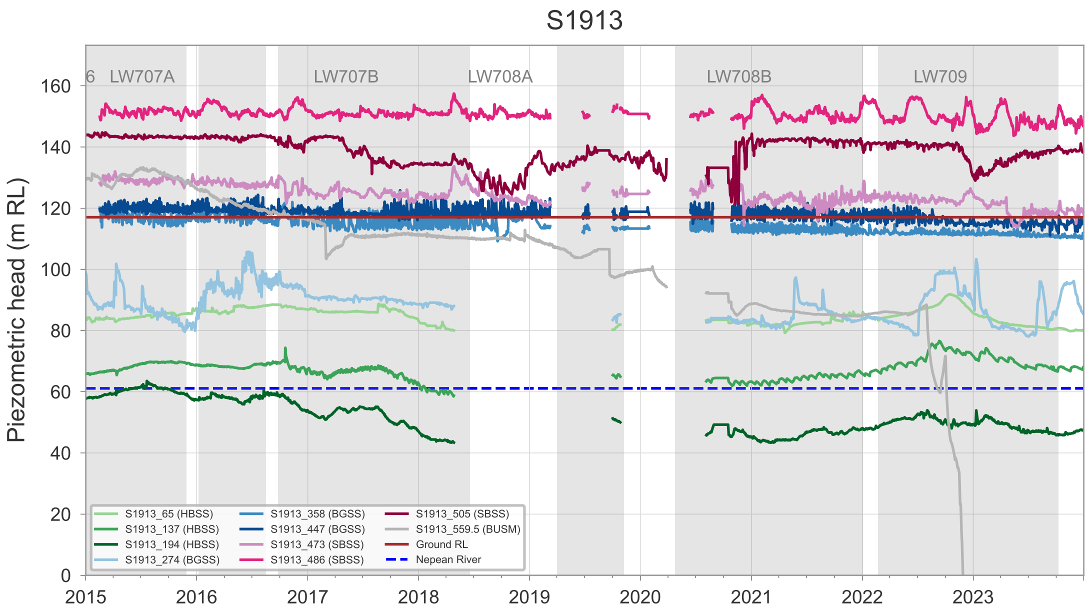
SLR, 2022, Appin Mine Extraction Plan groundwater impact assessment: 665.10015-R01.

SLR, 2021, Appin Mine Extraction Plan surface water assessment, Longwalls 709 to 711 and 905: 630.30102-R01.

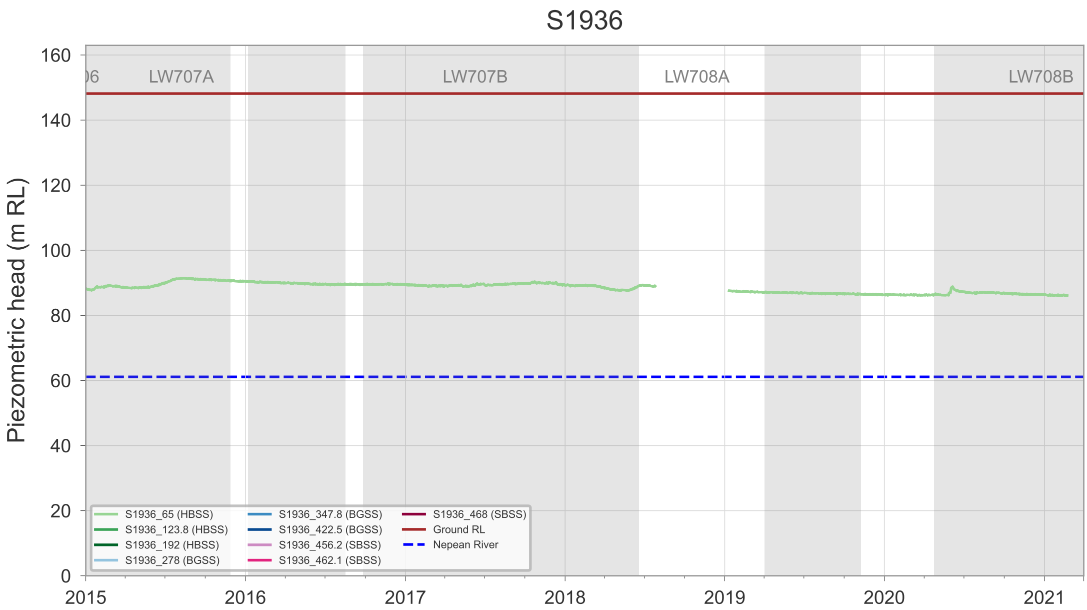
SOUTH32, 2023, Appin Mine Longwall 905 Landscape Report: Report.

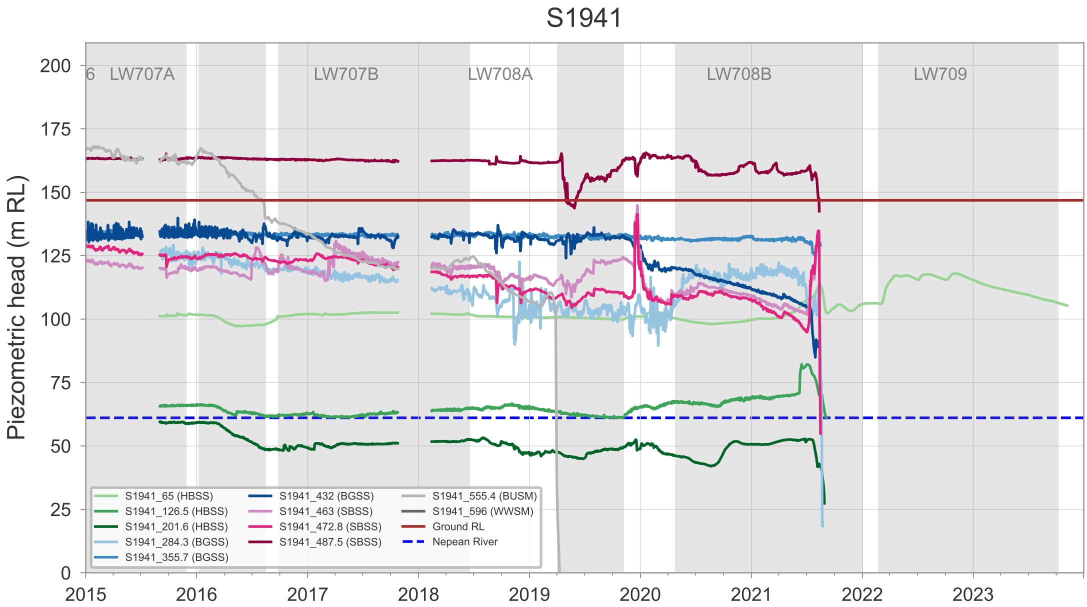
SOUTH32, 2022, Longwalls 709 to 711 and 905 Water Management Plan: Management Plan.

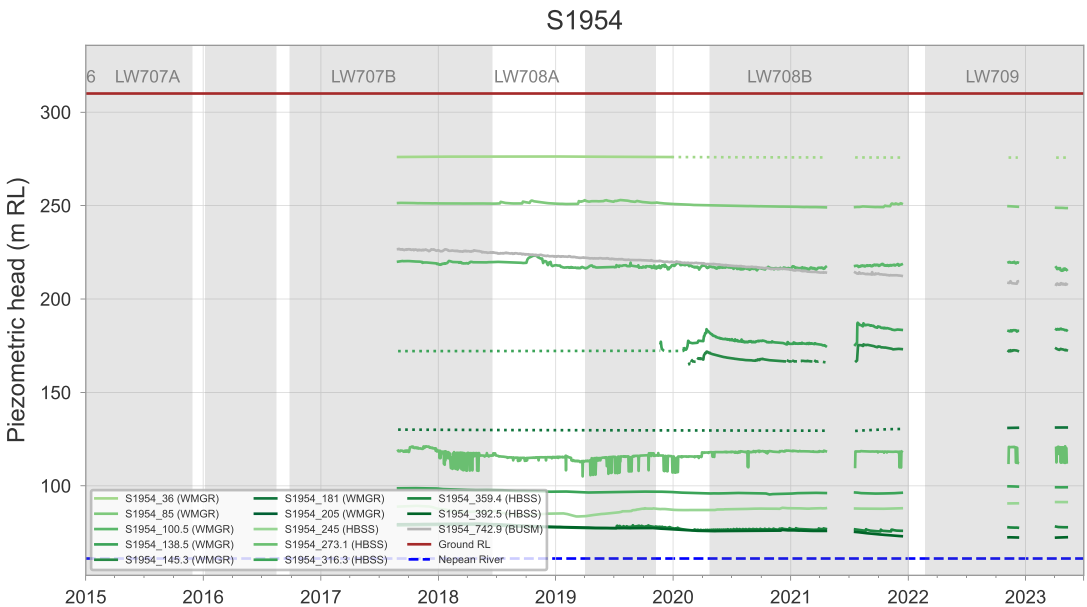
APPENDIX 1 – Groundwater bore hydrographs



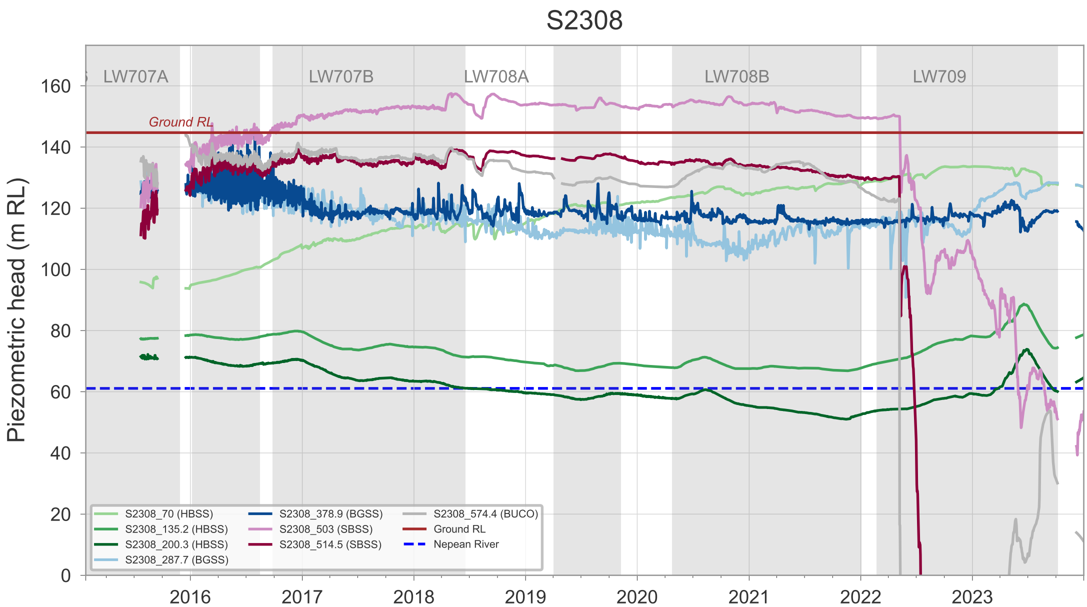
S1913
Piezometric head (m RL)
160
140
120
100
80
60
40
20
0
2015
2016
2017
2018
2019
2020
2021
2022
2023
6
LW707A
LW707B
LW708A
LW708B
LW709
S1913_65 (HBSS)
S1913_137 (HBSS)
S1913_194 (HBSS)
S1913_274 (BGSS)
S1913_358 (BGSS)
S1913_447 (BGSS)
S1913_473 (SBSS)
S1913_486 (SBSS)
S1913_505 (SBSS)
S1913_559.5 (BUSM)
Ground RL
Nepean River

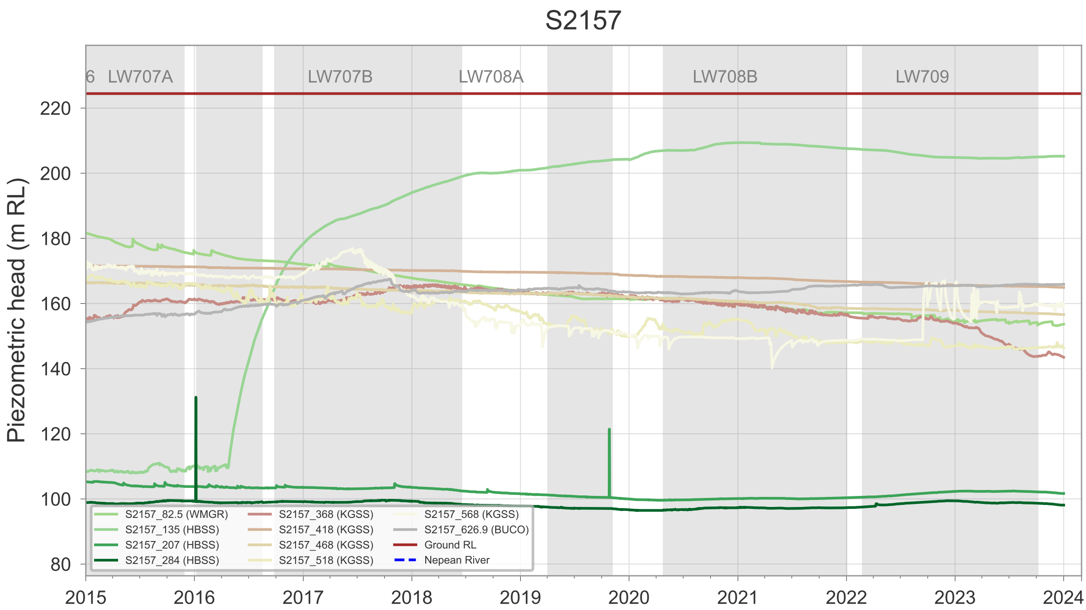

S1936
Piezometric head (m RL)
160
140
120
100
80
60
40
20
0
2015
2016
2017
2018
2019
2020
2021
)6
LW707A
LW707B
LW708A
LW708B
S1936_65 (HBSS)
S1936_123.8 (HBSS)
S1936_192 (HBSS)
S1936_278 (BGSS)
S1936_347.8 (BGSS)
S1936_422.5 (BGSS)
S1936_456.2 (SBSS)
S1936_462.1 (SBSS)
S1936_468 (SBSS)
Ground RL
Nepean River


S1941
Piezometric head (m RL)
6
LW707A
LW707B
LW708A
LW708B
LW709
200
175
150
125
100
75
50
25
0
2015
2016
2017
2018
2019
2020
2021
2022
2023
S1941_65 (HBSS)
S1941_126.5 (HBSS)
S1941_201.6 (HBSS)
S1941_284.3 (BGSS)
S1941_355.7 (BGSS)
S1941_432 (BGSS)
S1941_463 (SBSS)
S1941_472.8 (SBSS)
S1941_487.5 (SBSS)
S1941_555.4 (BUSM)
S1941_596 (WWSM)
Ground RL
Nepean River

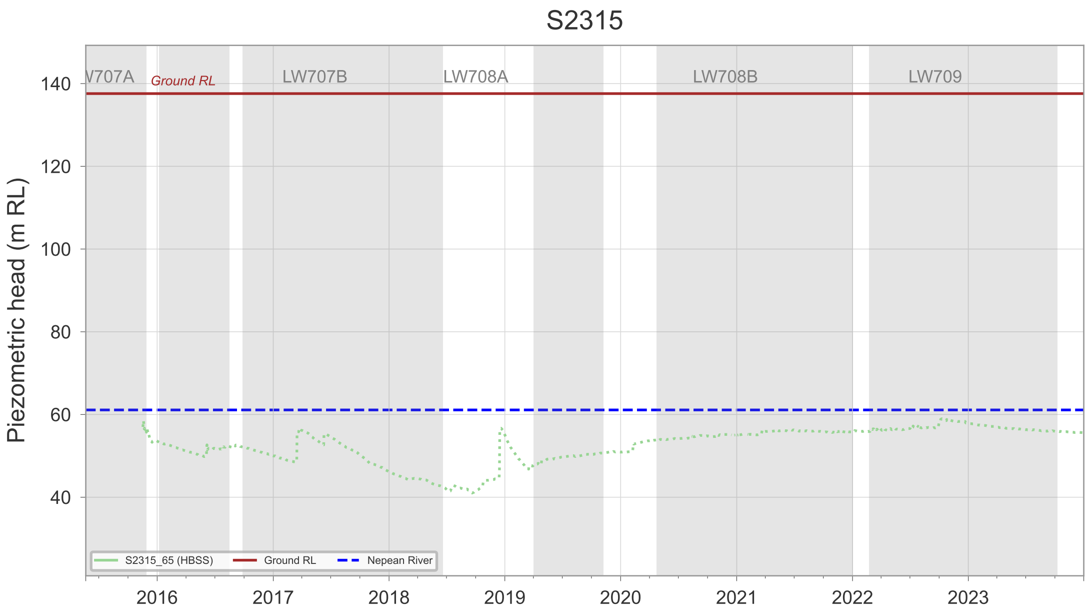


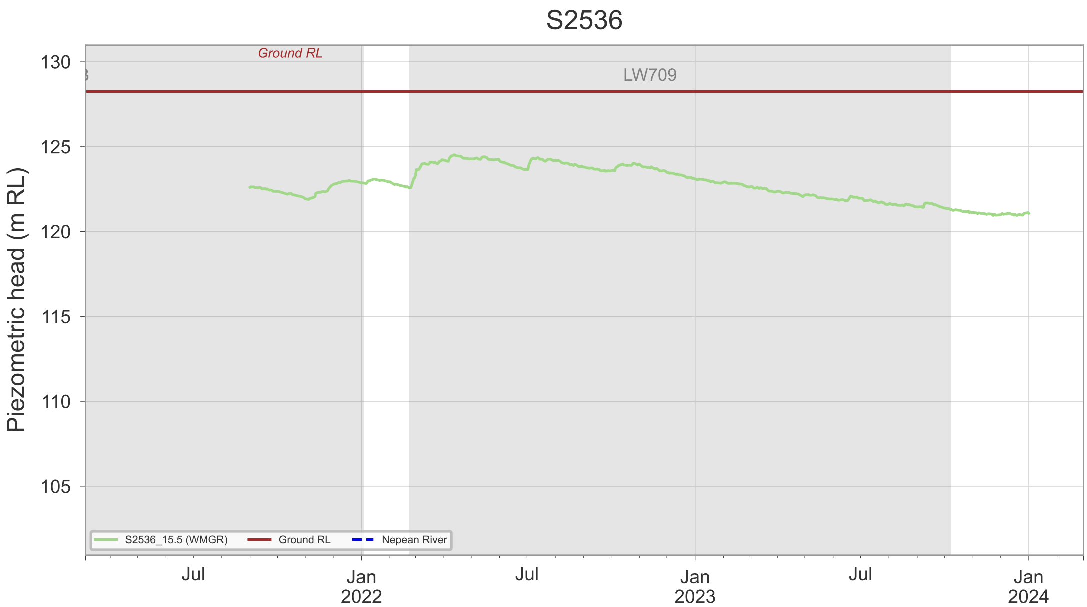
S1954
6
LW707A
LW707B
LW708A
LW708B
LW709
Piezometric head (m RL)
300
250
200
150
100
2015
2016
2017
2018
2019
2020
2021
2022
2023
S1954_36 (WMGR)
S1954_85 (WMGR)
S1954_100.5 (WMGR)
S1954_138.5 (WMGR)
S1954_145.3 (WMGR)
S1954_181 (WMGR)
S1954_205 (WMGR)
S1954_245 (HBSS)
S1954_273.1 (HBSS)
S1954_316.3 (HBSS)
S1954_359.4 (HBSS)
S1954_392.5 (HBSS)
S1954_742.9 (BUSM)
Ground RL
Nepean River


S2308
Piezometric head (m RL)
LW707A
LW707B
LW708A
LW708B
LW709
Ground RL
0
20
40
60
80
100
120
140
160
2016
2017
2018
2019
2020
2021
2022
2023
S2308_70 (HBSS)
S2308_135.2 (HBSS)
S2308_200.3 (HBSS)
S2308_287.7 (BGSS)
S2308_378.9 (BGSS)
S2308_503 (SBSS)
S2308_514.5 (SBSS)
S2308_574.4 (BUCO)
Ground RL
Nepean River

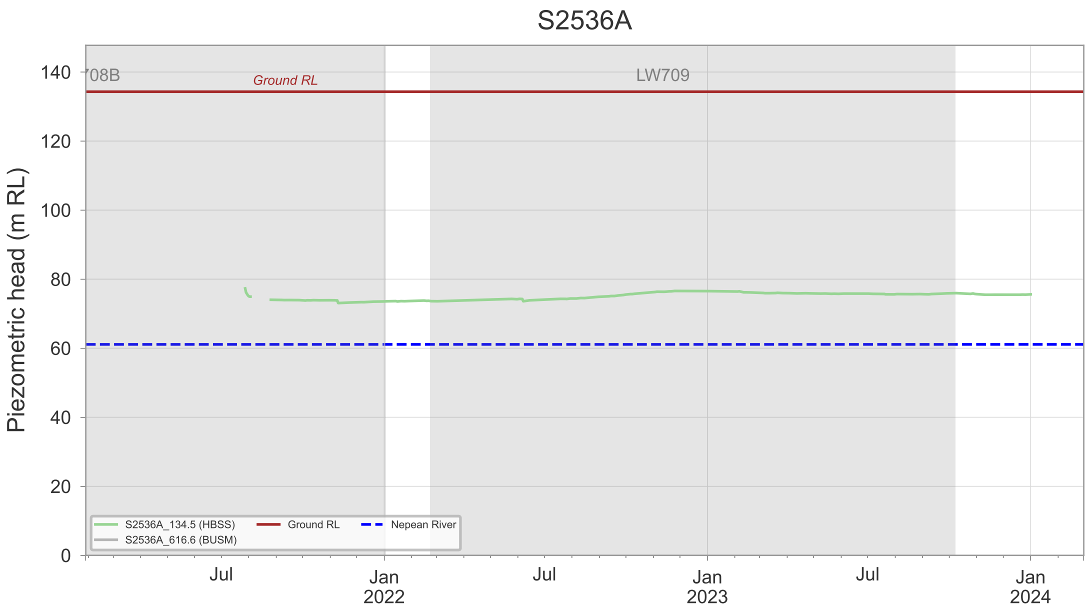


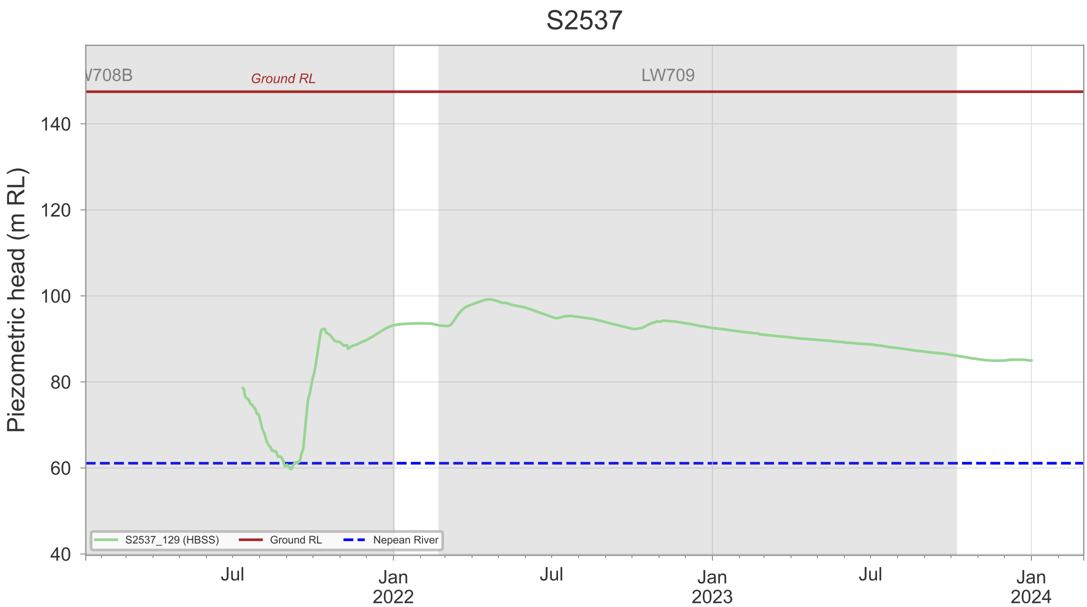
S2157
Piezometric head (m RL)
220
200
180
160
140
120
100
80
6
LW707A
LW707B
LW708A
LW708B
LW709
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
S2157_82.5 (WMGR)
S2157_135 (HBSS)
S2157_207 (HBSS)
S2157_284 (HBSS)
S2157_368 (KGSS)
S2157_418 (KGSS)
S2157_468 (KGSS)
S2157_518 (KGSS)
S2157_568 (KGSS)
S2157_626.9 (BUCO)
Ground RL
Nepean River


S2315
W707A
Ground RL
LW707B
LW708A
LW708B
LW709
Piezometric head (m RL)
140
120
100
80
60
40
2016
2017
2018
2019
2020
2021
2022
2023
S2315_65 (HBSS)
Ground RL
Nepean River

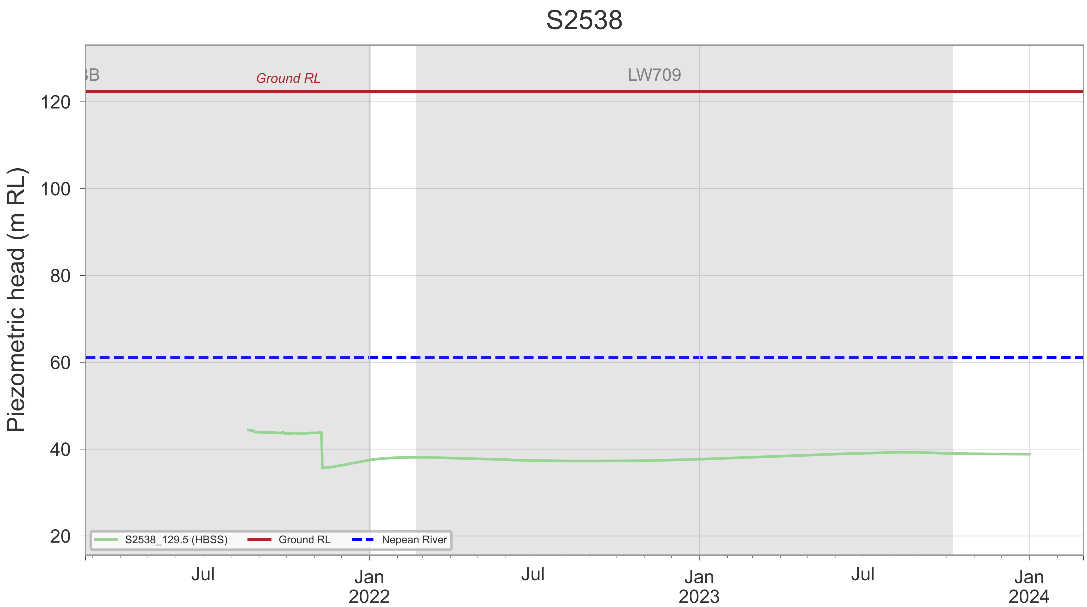


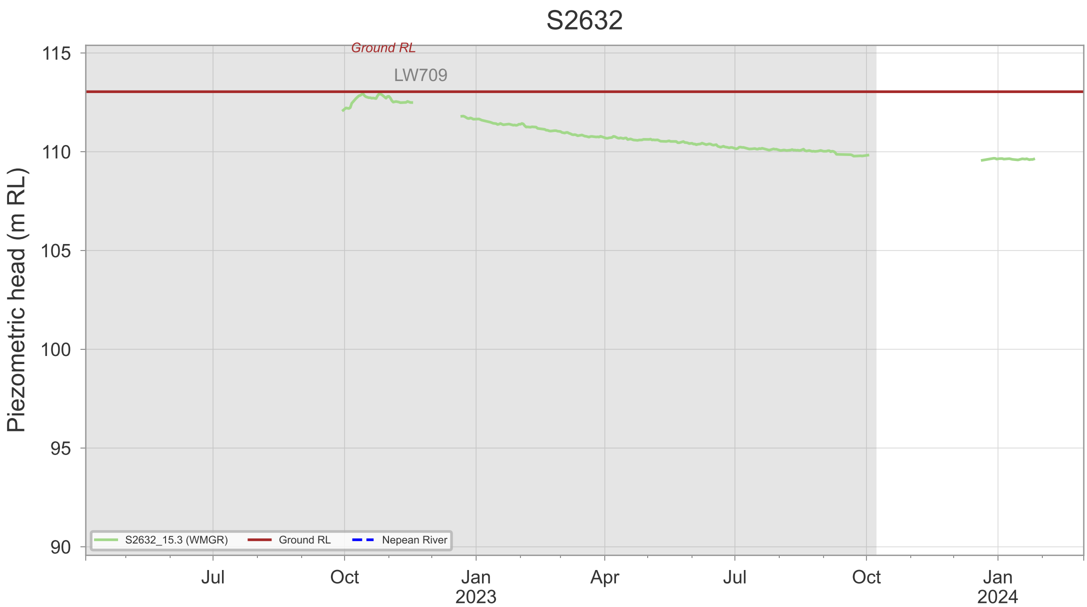
S2536
Ground RL
LW709
Piezometric head (m RL)
130
125
120
115
110
105
Jul
Jan
2022
Jul
Jan
2023
Jul
Jan
2024
S2536_15.5 (WMGR)
Ground RL
Nepean River


S2536A
Piezometric head (m RL)
140
120
100
80
60
40
20
0
'08B
LW709
Ground RL
Jul
Jan
2022
Jul
Jan
2023
Jul
Jan
2024
S2536A_134.5 (HBSS)
S2536A_616.6 (BUSM)
Ground RL
Nepean River

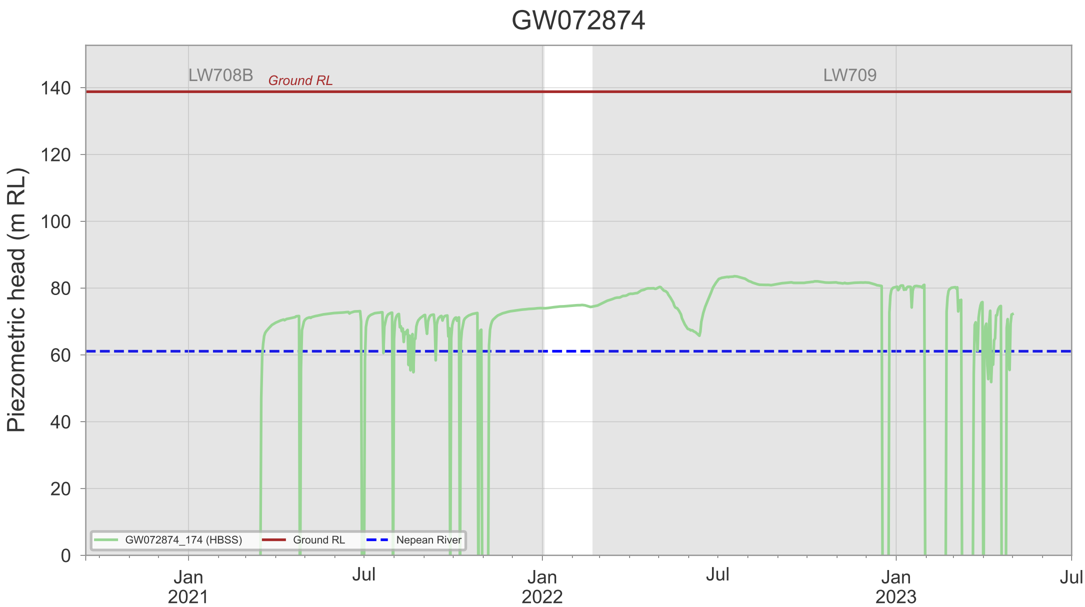


S2537
Piezometric head (m RL)
/708B
Ground RL
LW709
140
120
100
80
60
40
Jul
Jan
2022
Jul
Jan
2023
Jul
Jan
2024
S2537_129 (HBSS)
Ground RL
Nepean River

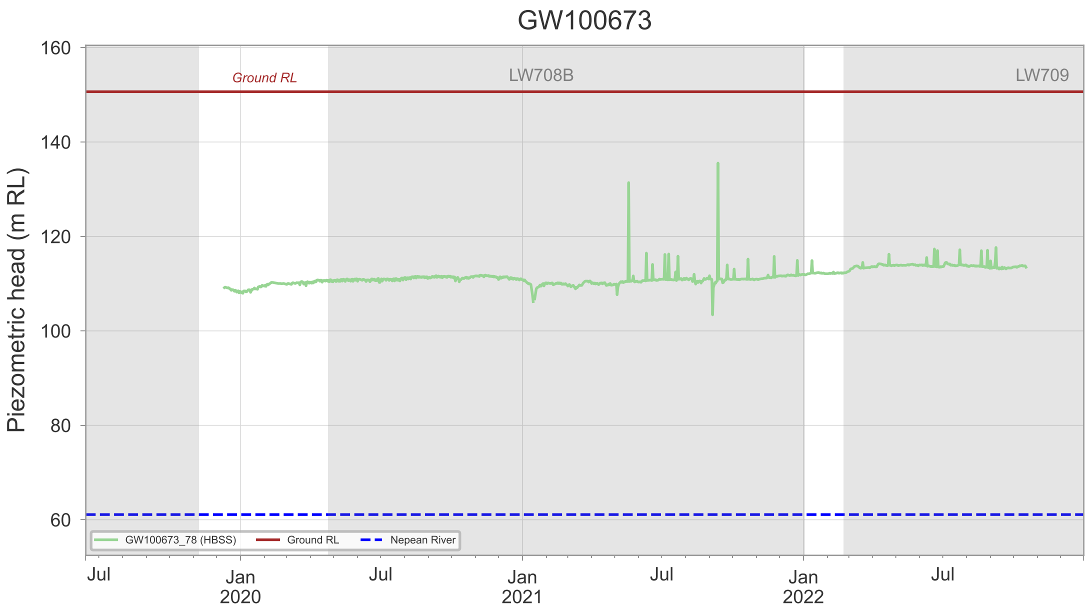

S2538
Piezometric head (m RL)
120
100
80
60
40
20
B
Ground RL
LW709
S2538_129.5 (HBSS)
Ground RL
Nepean River
Jul
Jan
2022
Jul
Jan
2023
Jul
Jan
2024



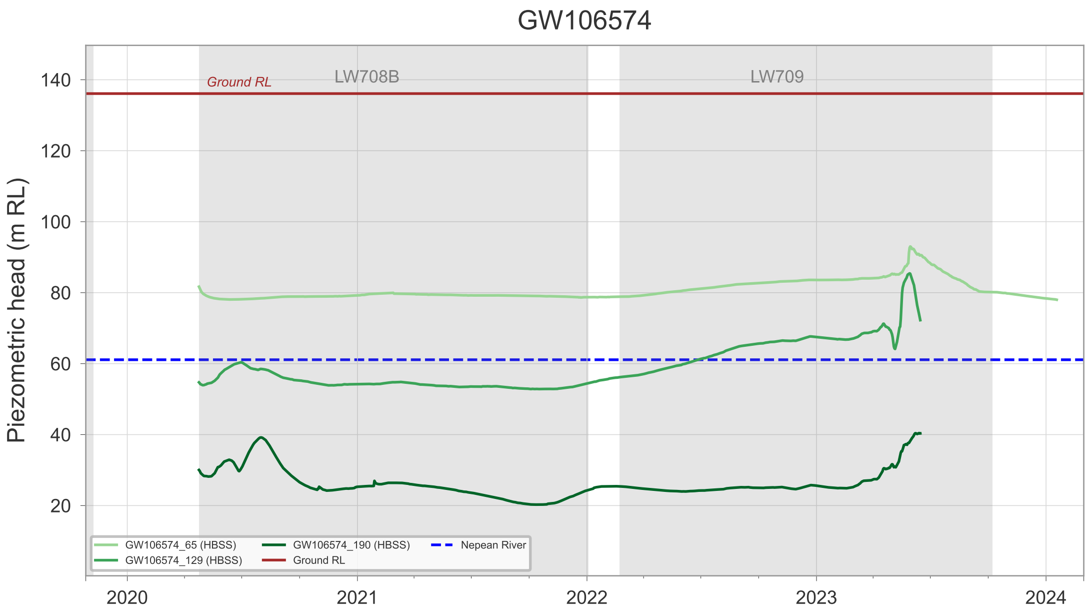
S2632
Ground RL
LW709
Piezometric head (m RL)
115
110
105
100
95
90
Jul
Oct
Jan
2023
Apr
Jul
Oct
Jan
2024
S2632_15.3 (WMGR)
Ground RL
Nepean River



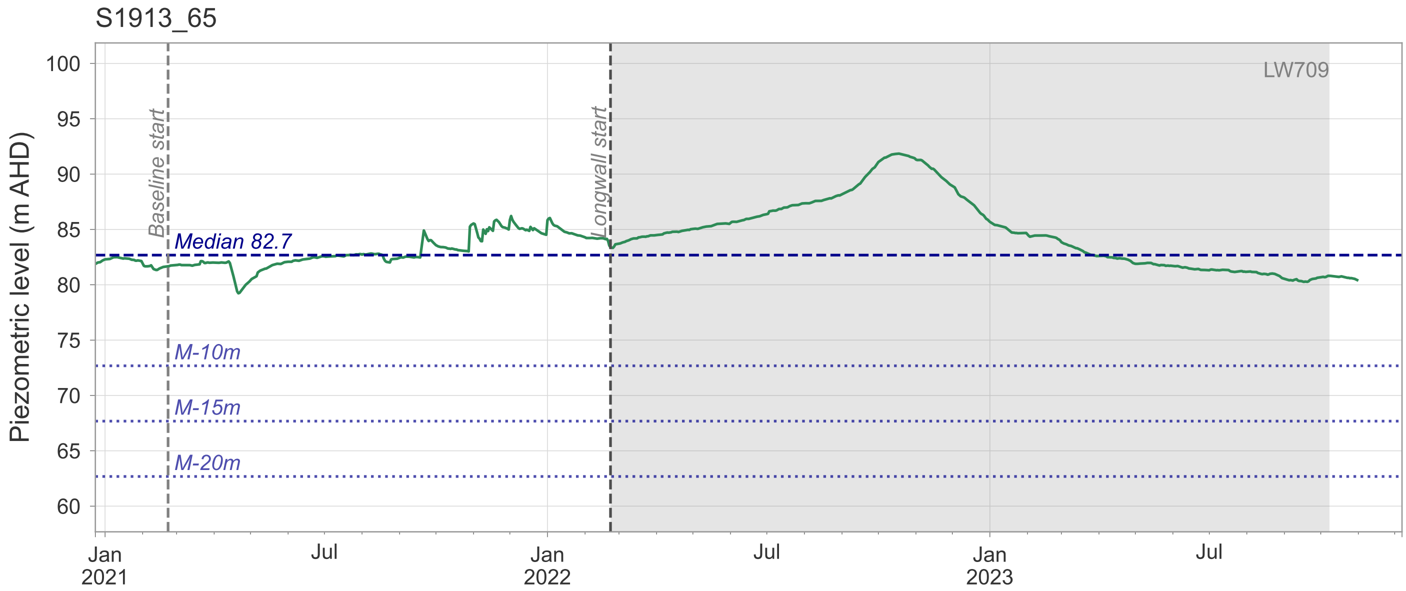
GW072874
Piezometric head (m RL)
LW708B
Ground RL
LW709
0
20
40
60
80
100
120
140
Jan 2021
Jul
Jan 2022
Jul
Jan 2023
Jul
GW072874_174 (HBSS)
Ground RL
Nepean River

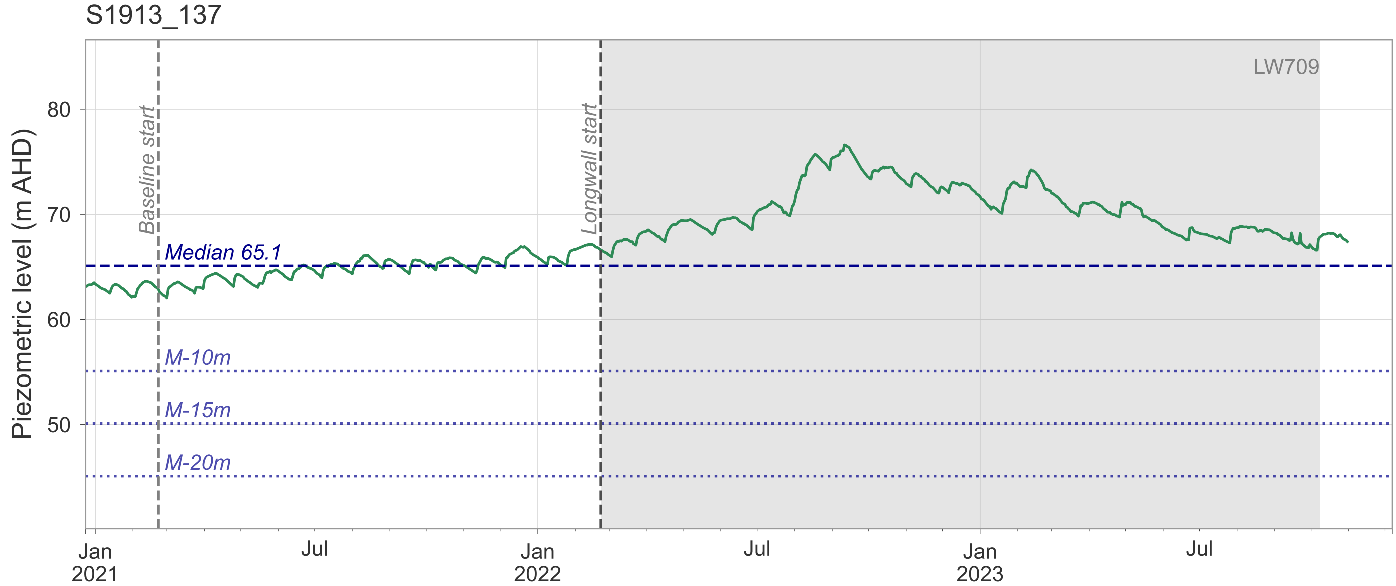


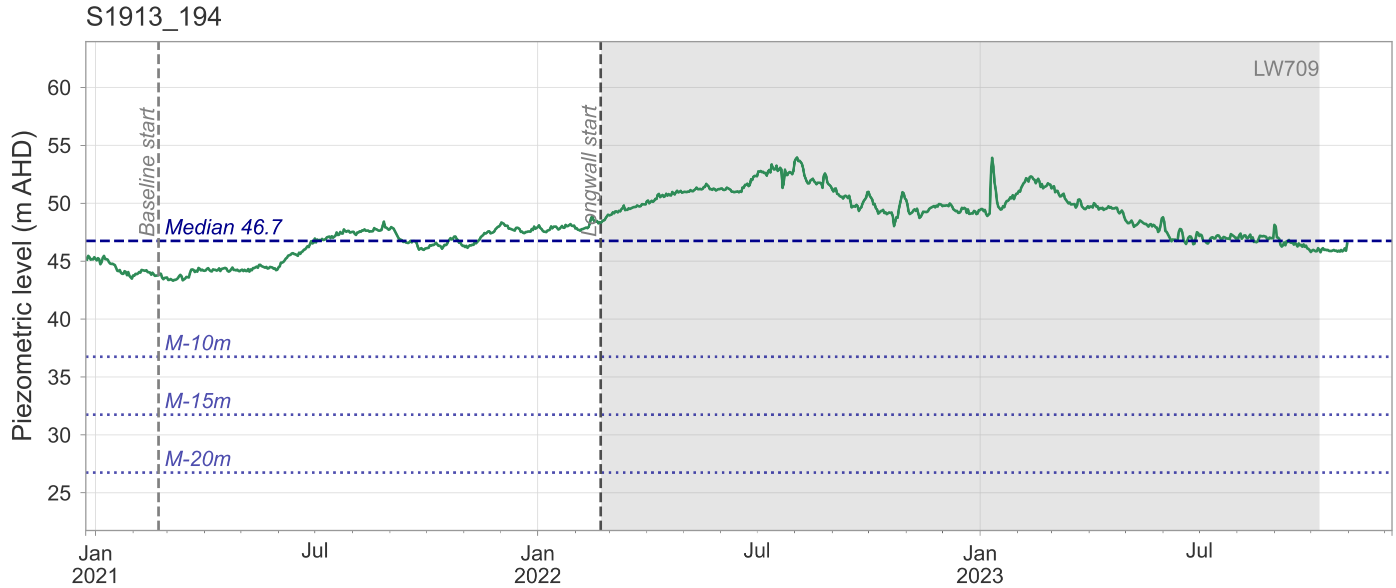
GW100673
Piezometric head (m RL)
160
140
120
100
80
60
Ground RL
LW708B
LW709
GW100673_78 (HBSS)
Ground RL
Nepean River
Jul
Jan
2020
Jul
Jan
2021
Jul
Jan
2022
Jul


GW106574
Piezometric head (m RL)
Ground RL
LW708B
LW709
140
120
100
80
60
40
20
2020
2021
2022
2023
2024
GW106574_65 (HBSS)
GW106574_129 (HBSS)
GW106574_190 (HBSS)
Ground RL
Nepean River

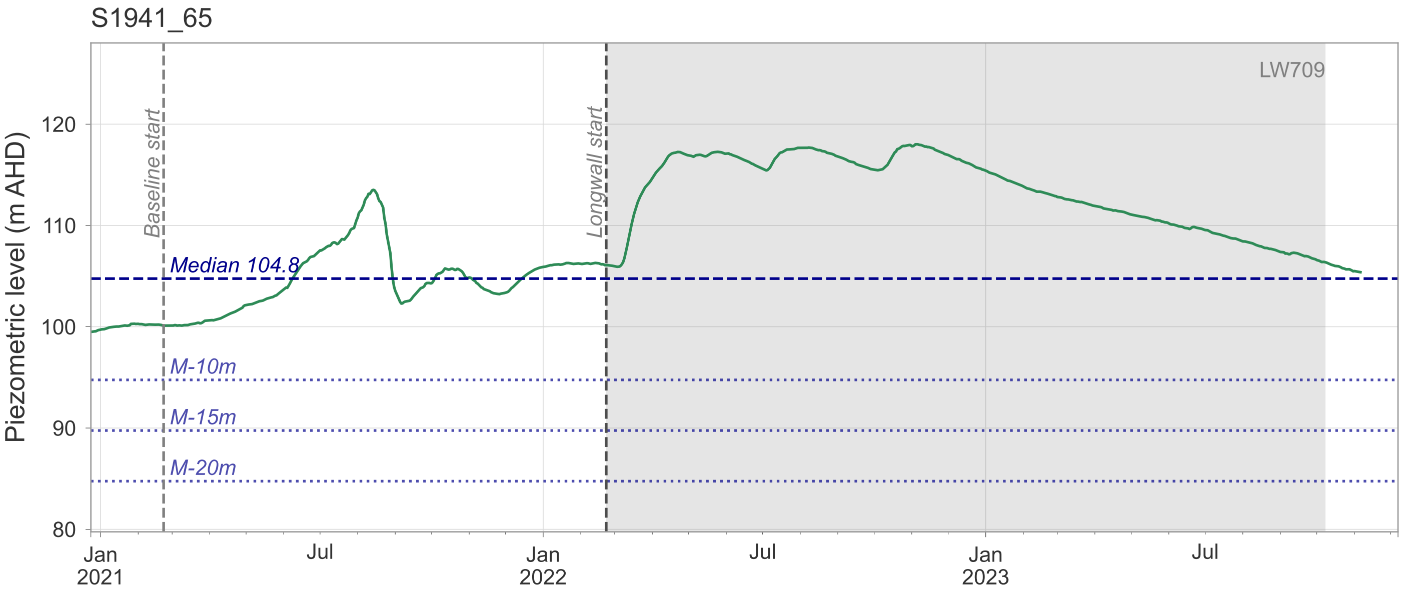
Appendix 1B: Appin Areas 7-9 Groundwater TARP analysis

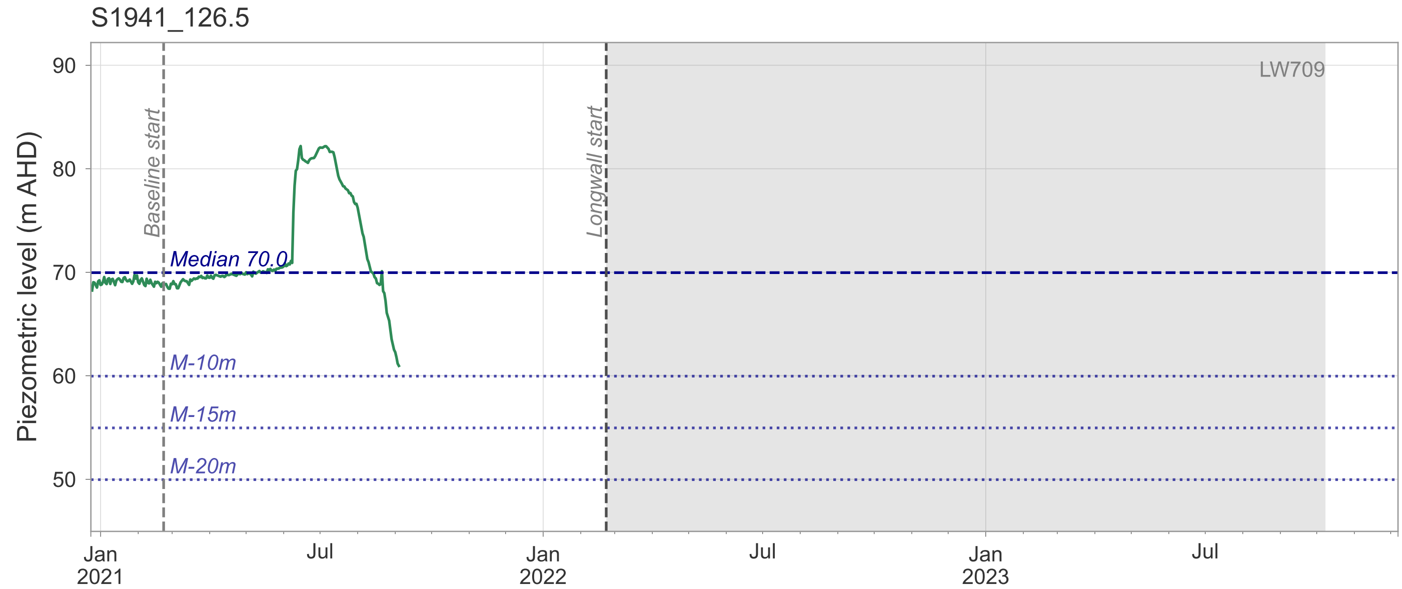


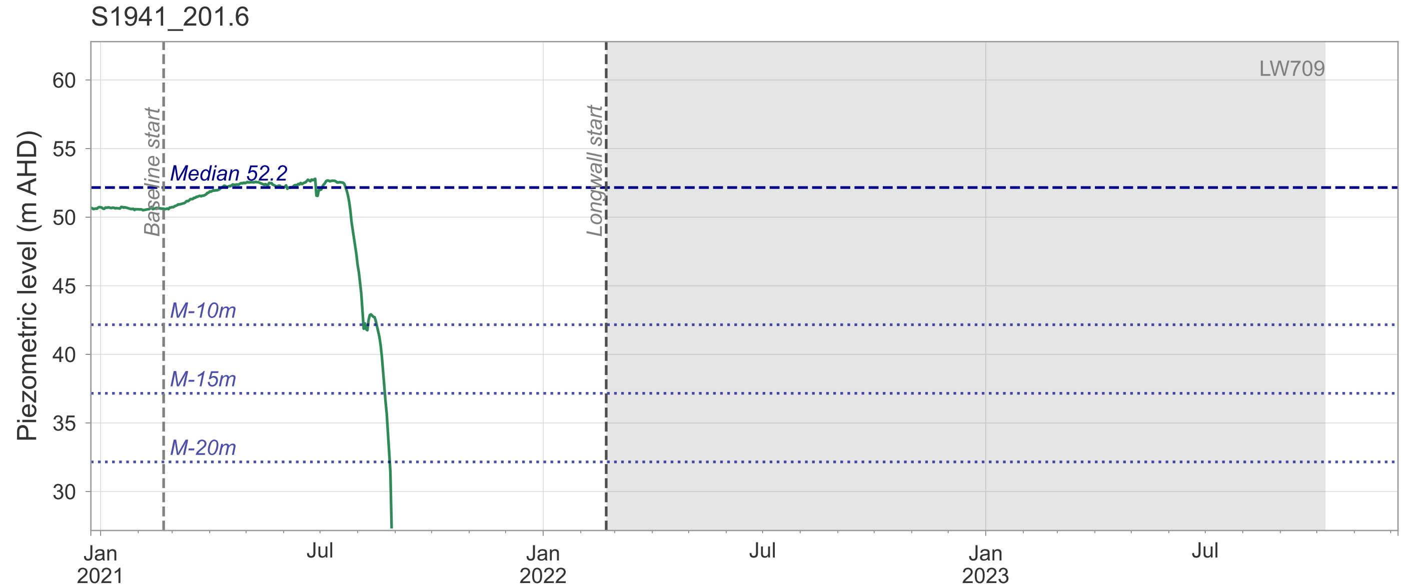




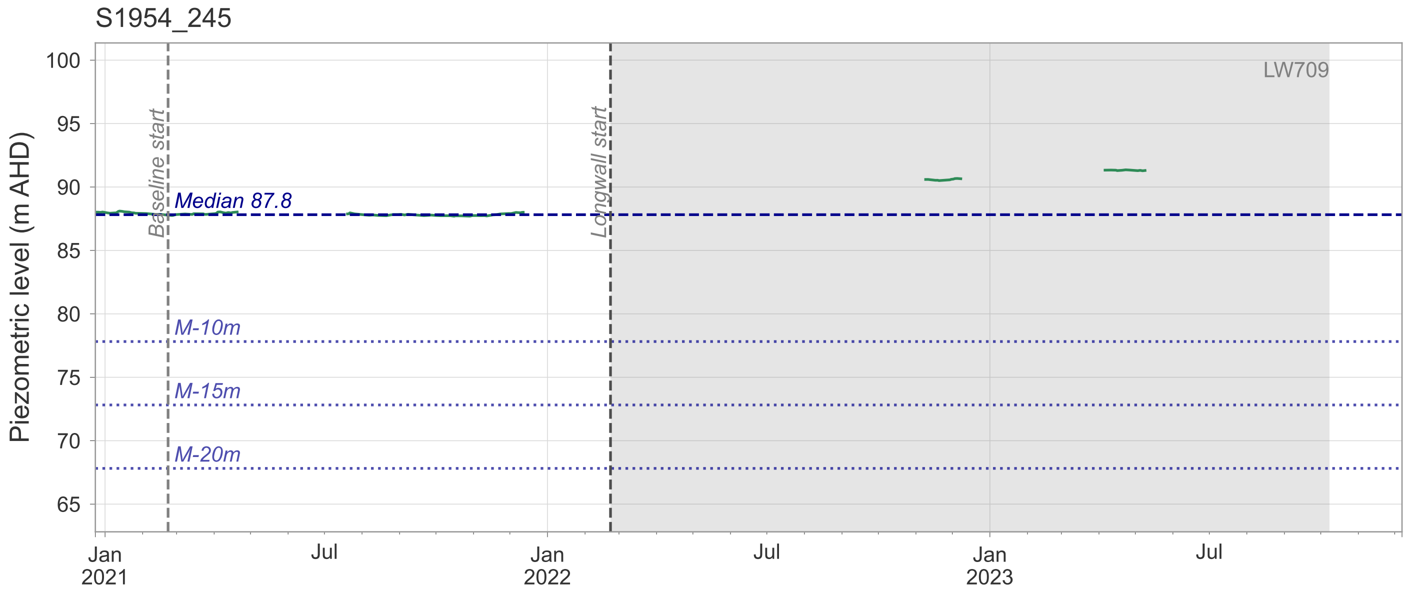
Appendix 1B: Appin Areas 7-9 Groundwater TARP analysis

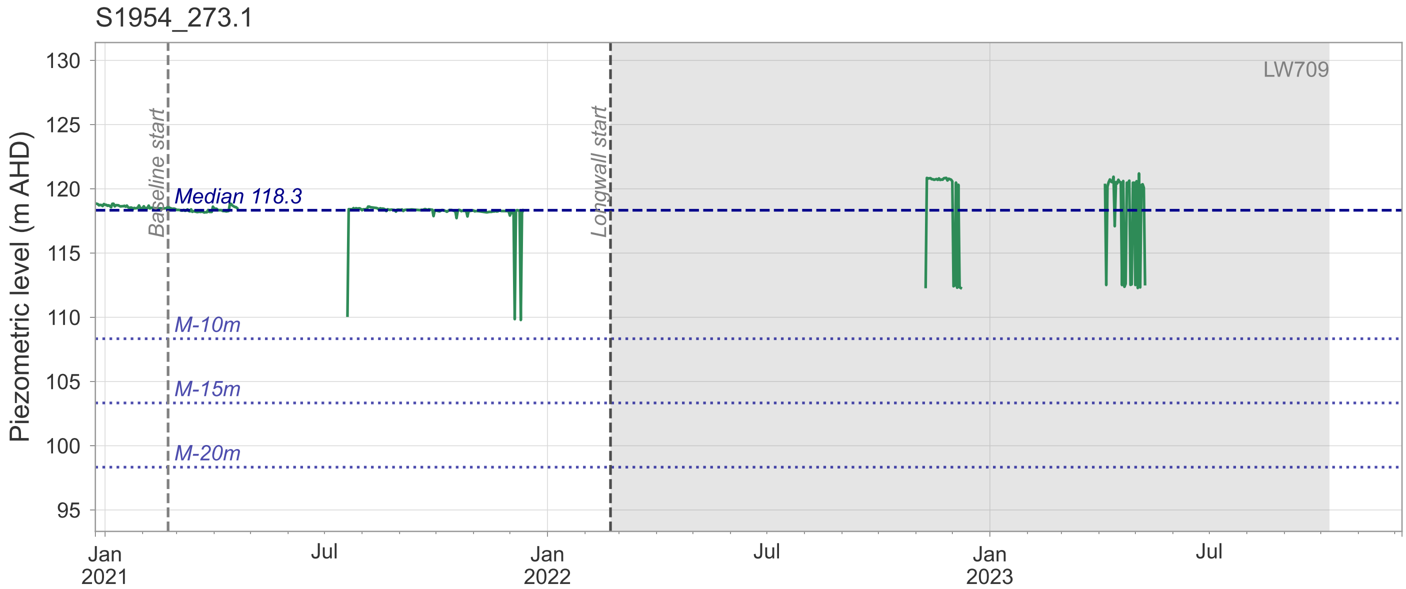


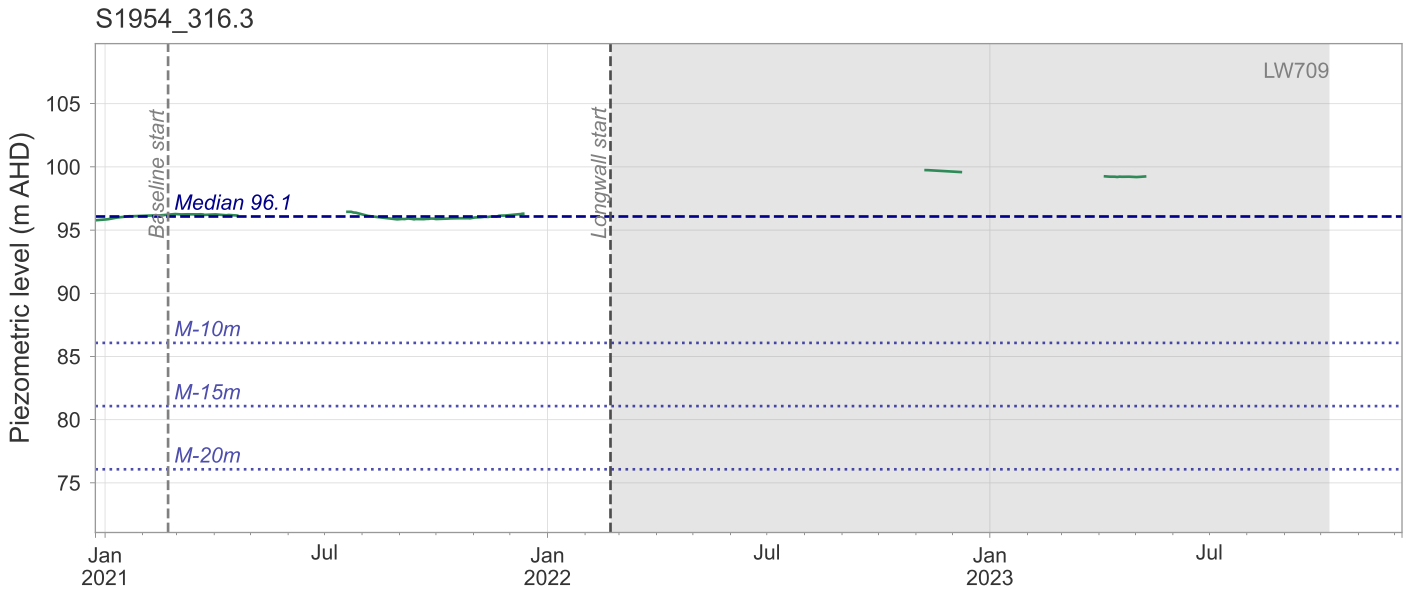




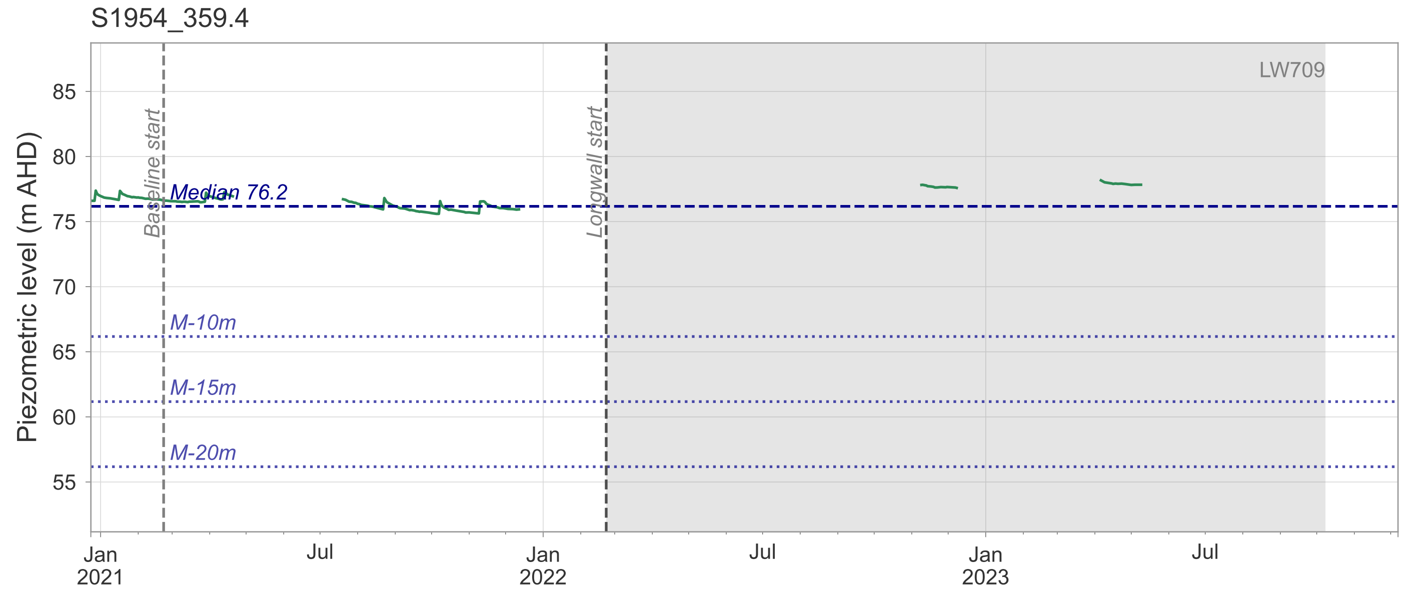
Appendix 1B: Appin Areas 7-9 Groundwater TARP analysis

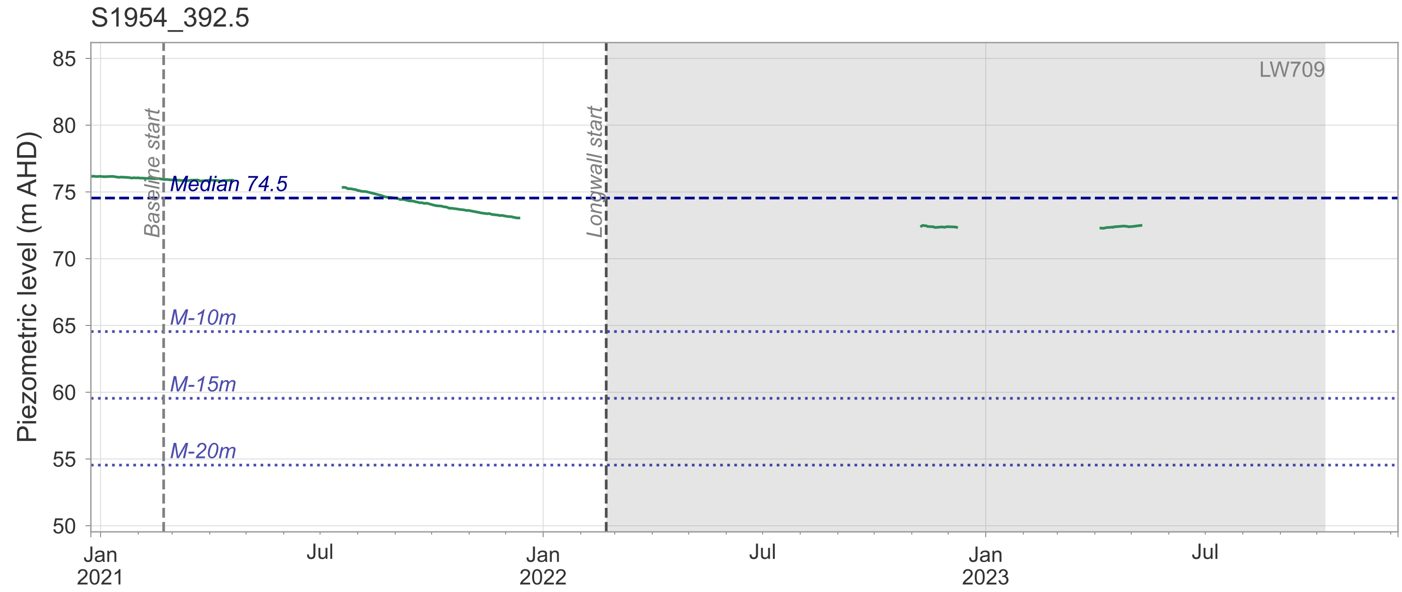


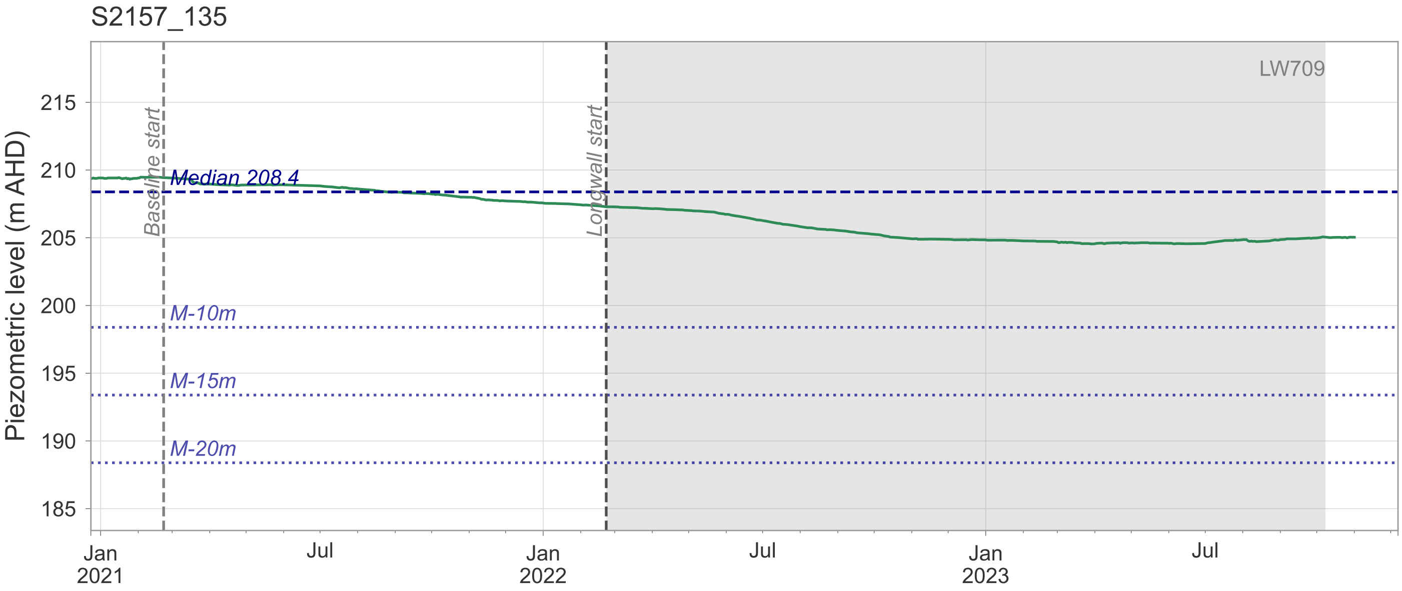




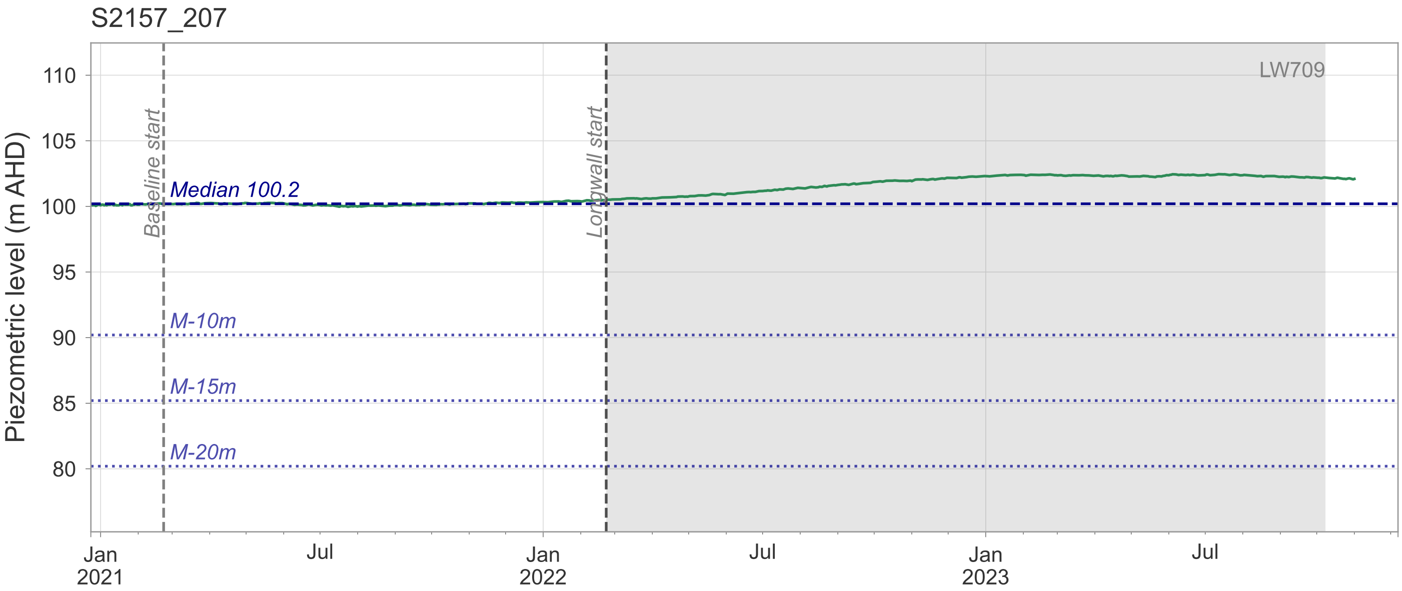
Appendix 1B: Appin Areas 7-9 Groundwater TARP analysis

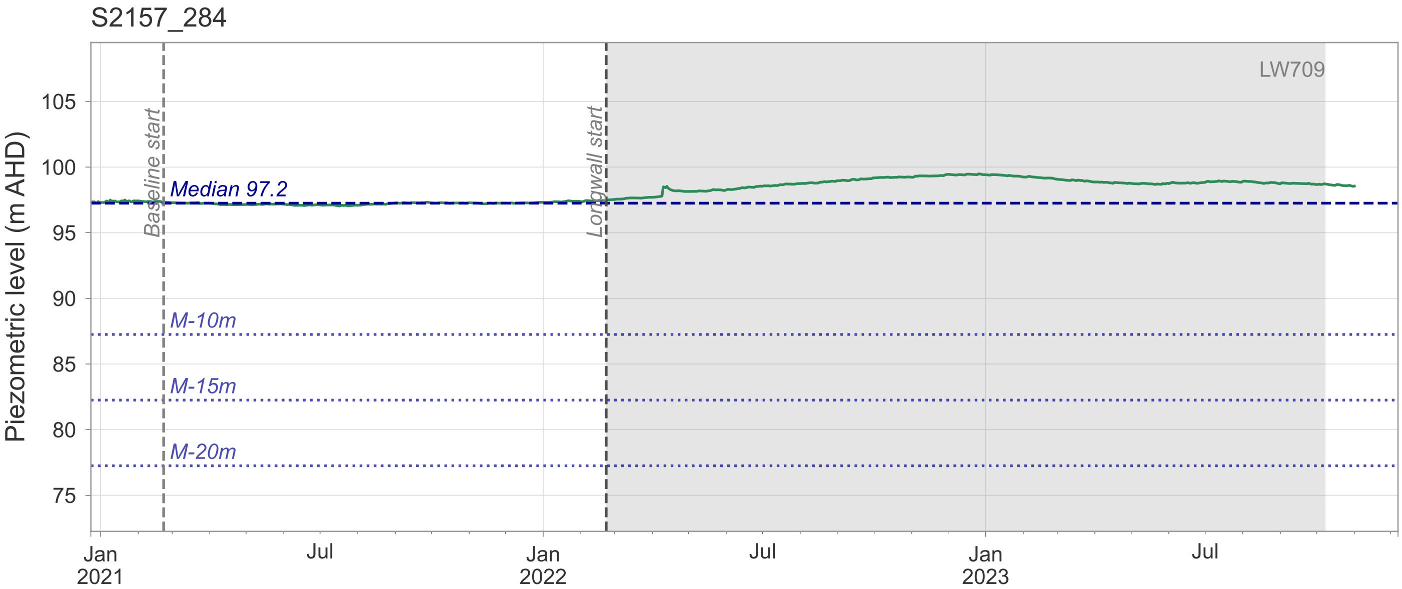


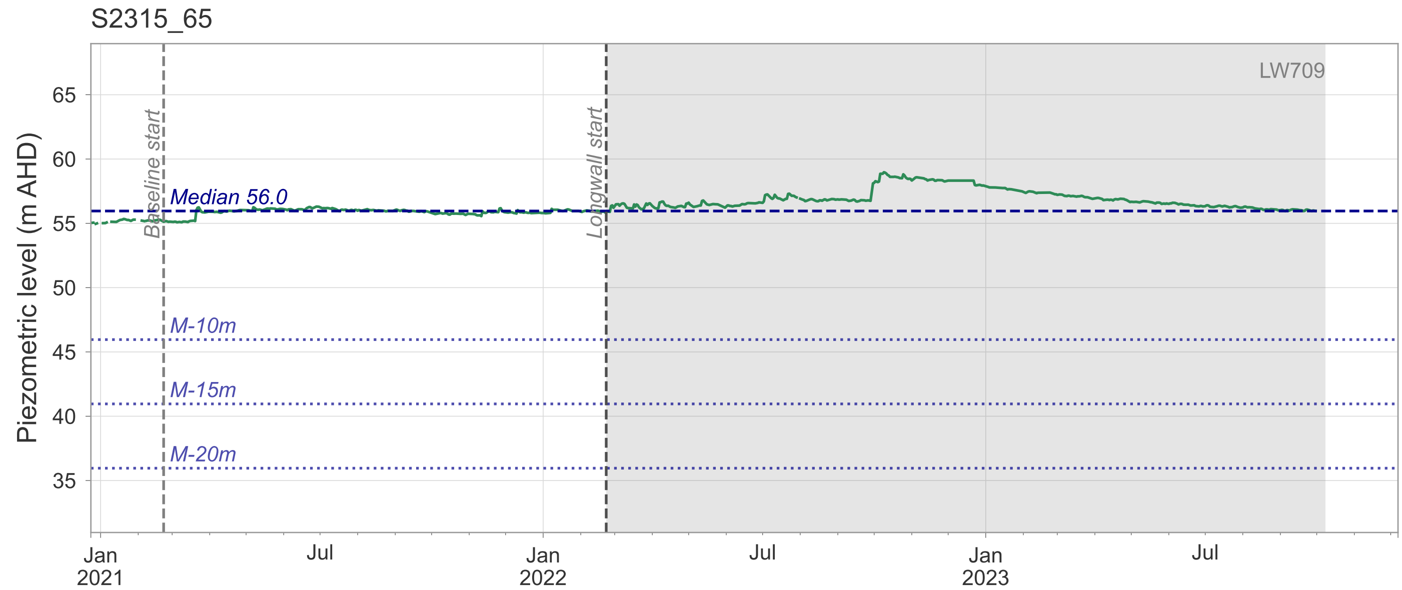




Appendix 1B: Appin Areas 7-9 Groundwater TARP analysis

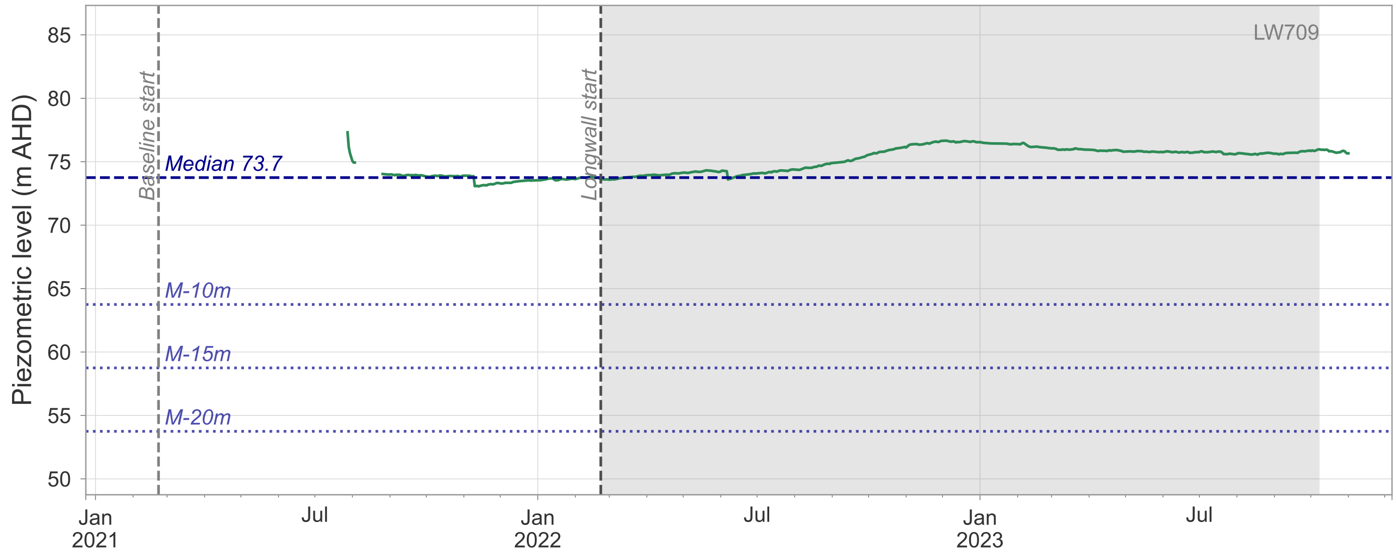




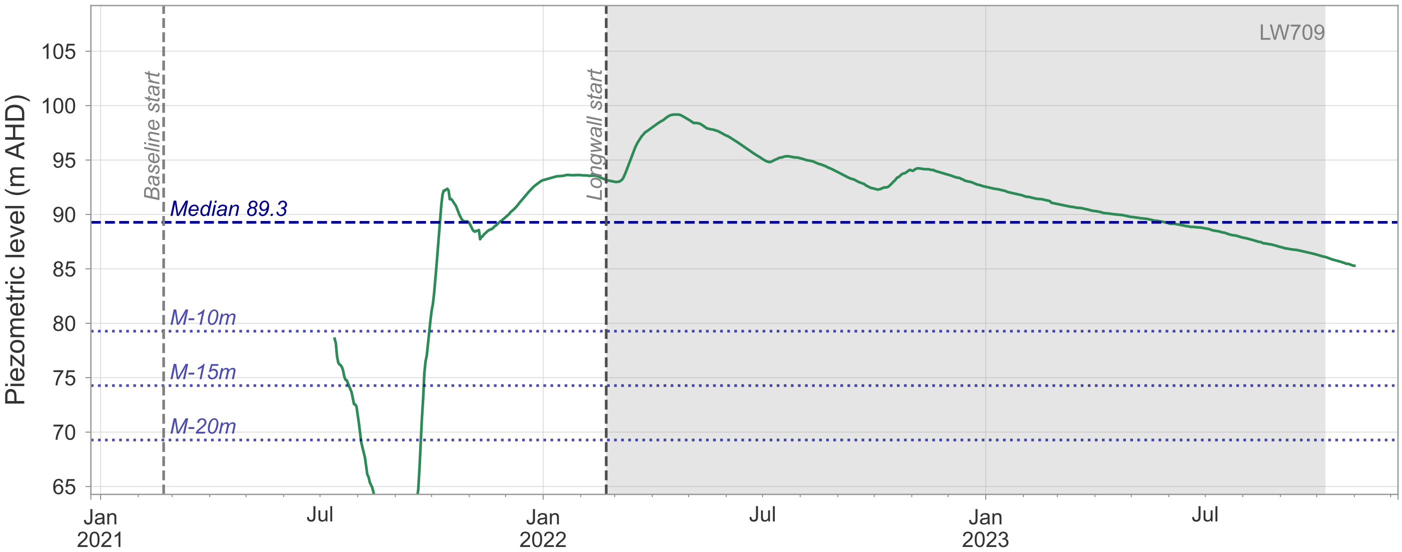


Appendix 1B: Appin Areas 7-9 Groundwater TARP analysis

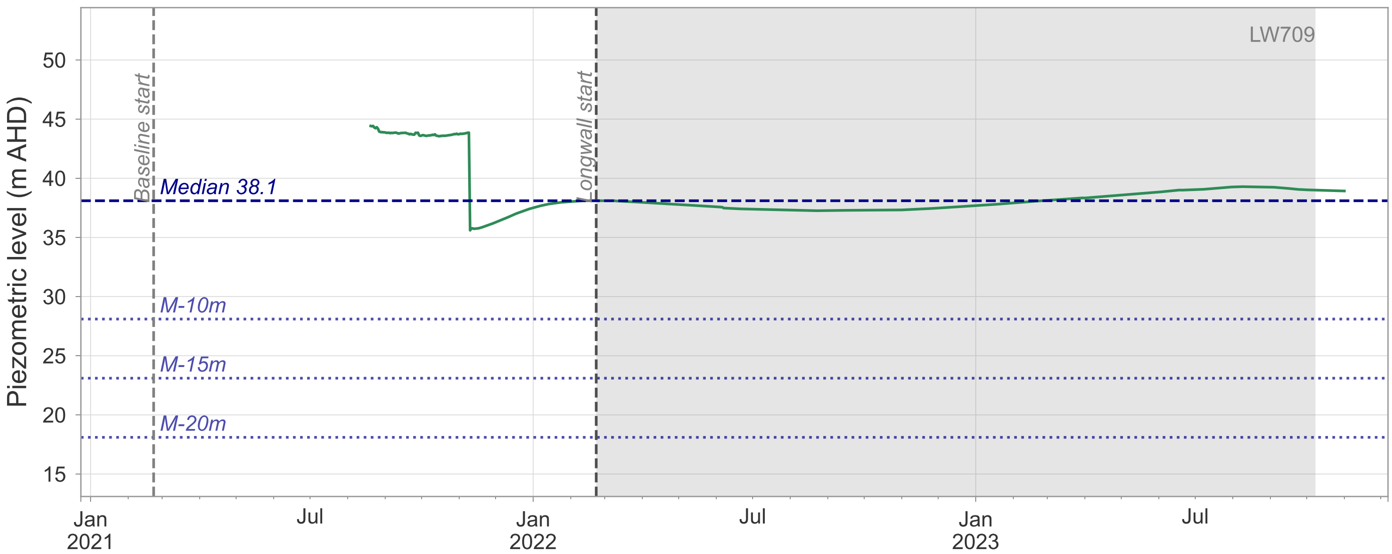
S2536A_134.5



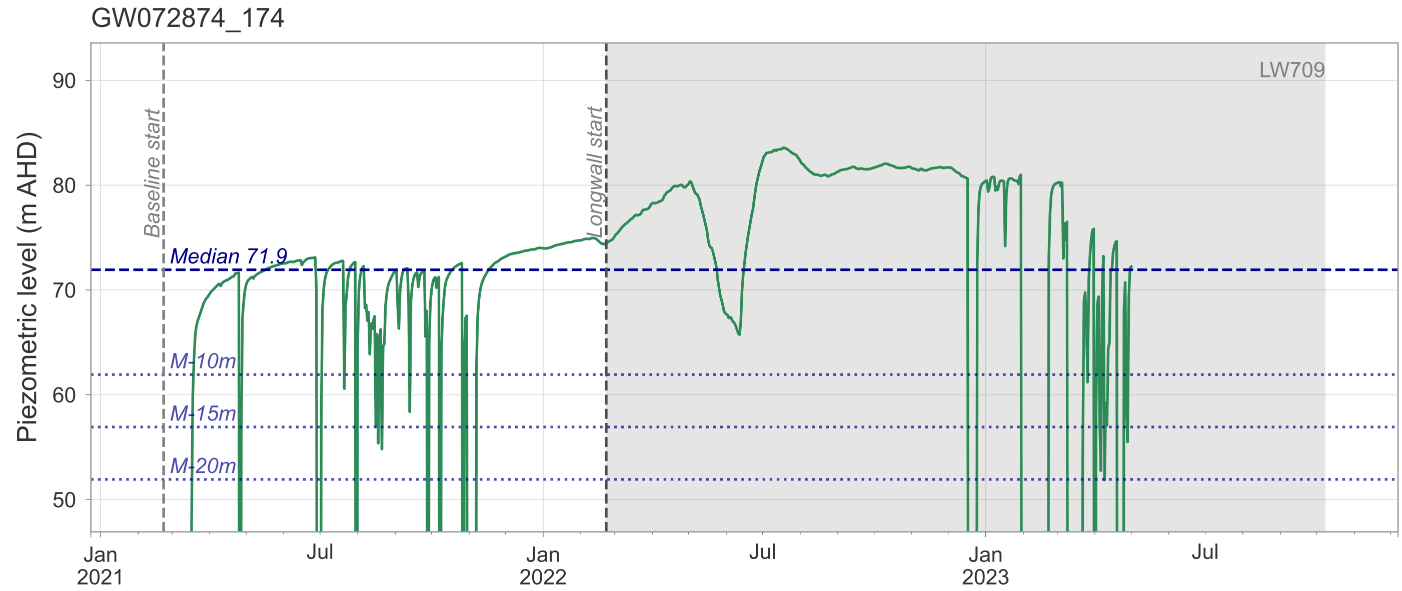
S2537_129

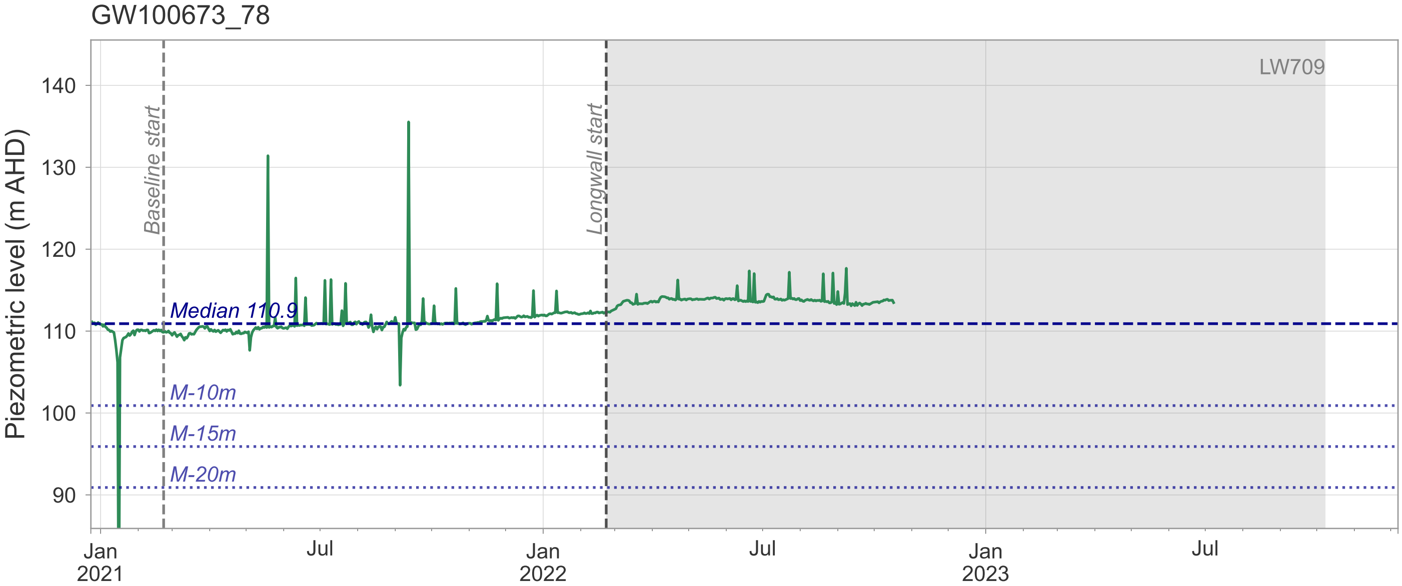


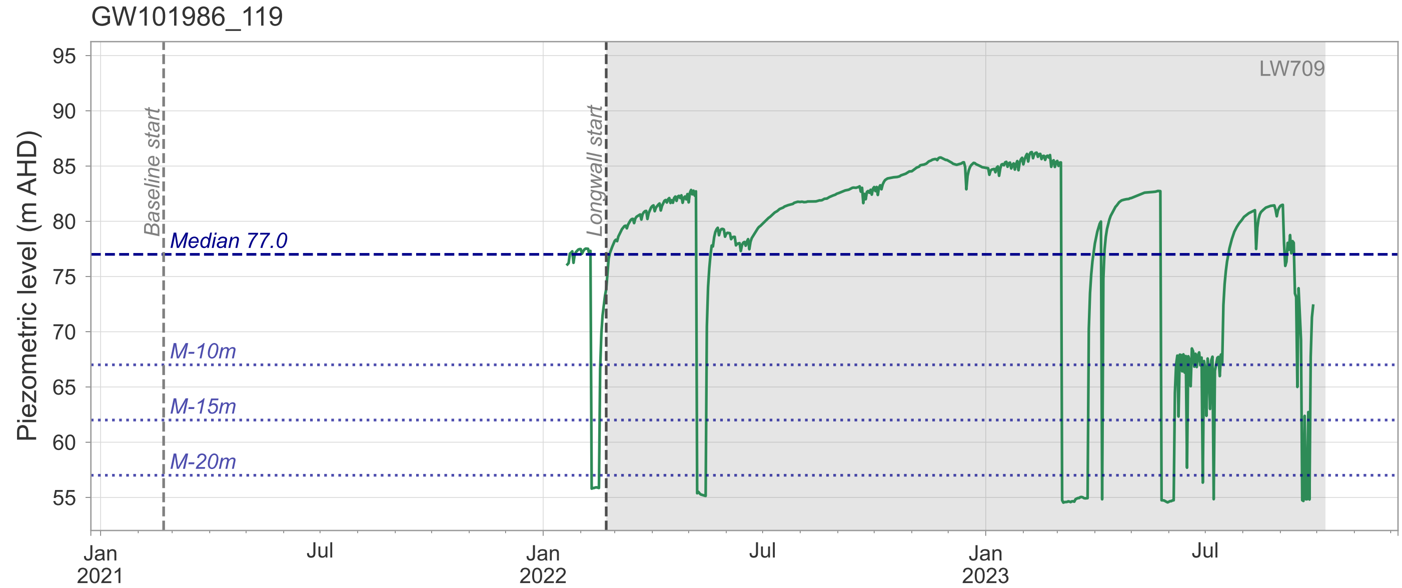
S2538_129.5



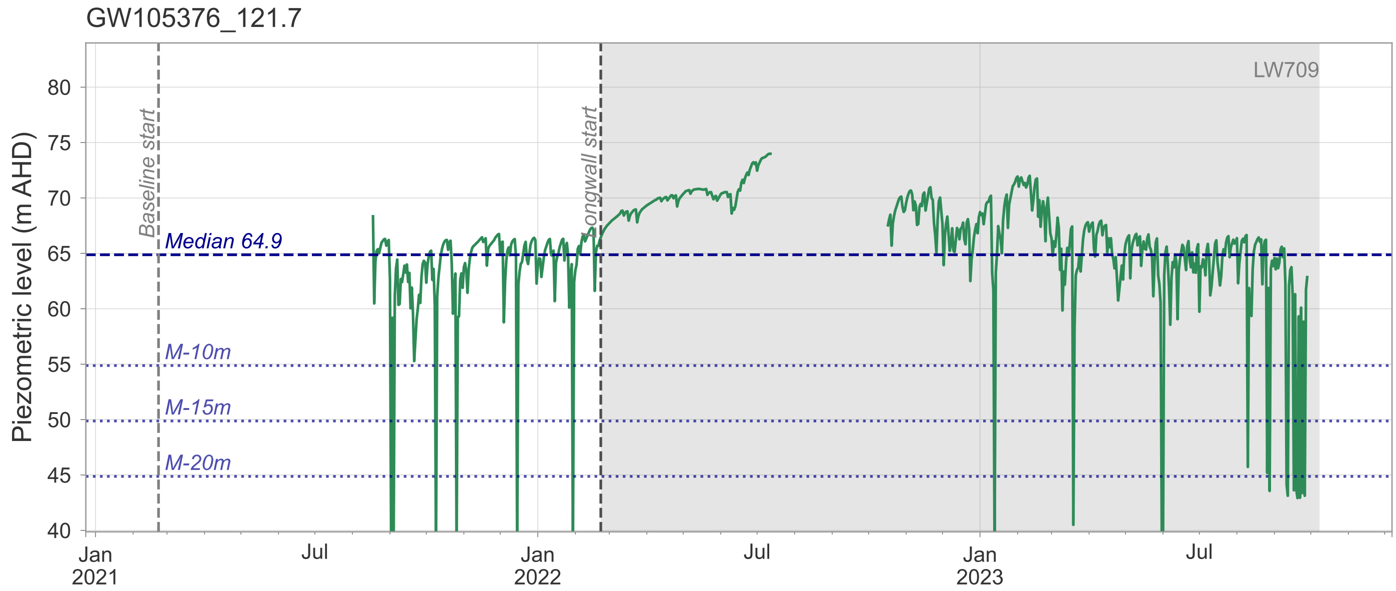
Appendix 1B: Appin Areas 7-9 Groundwater TARP analysis

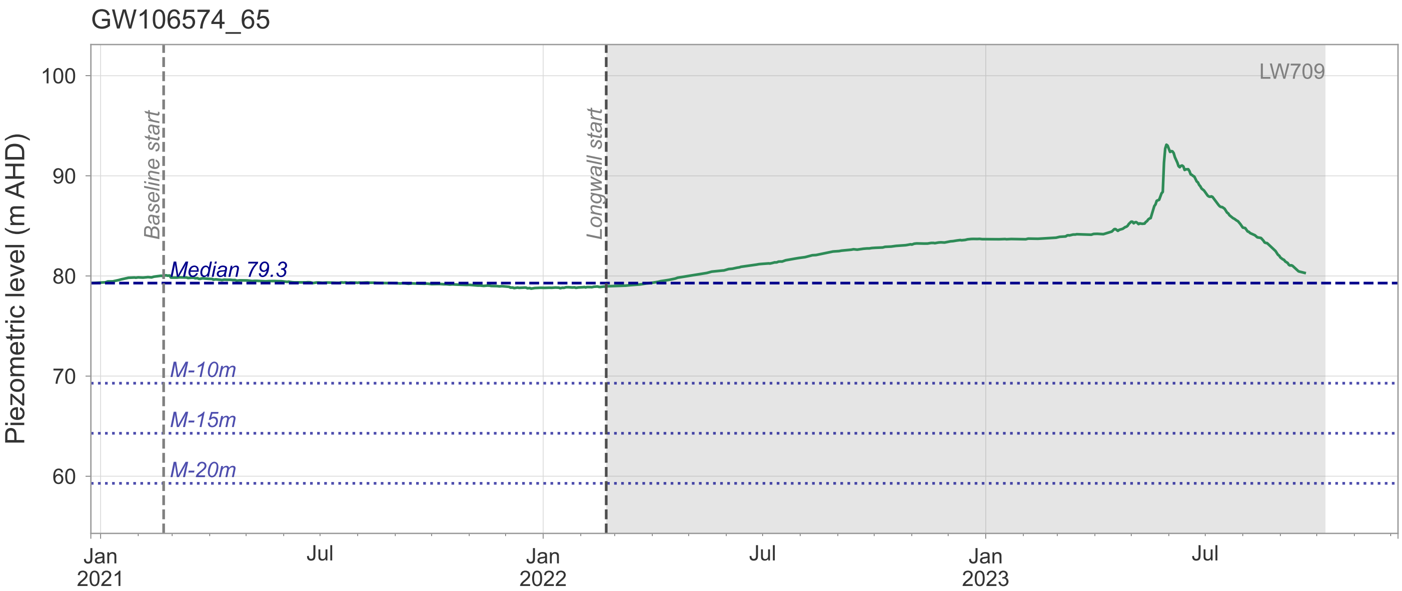


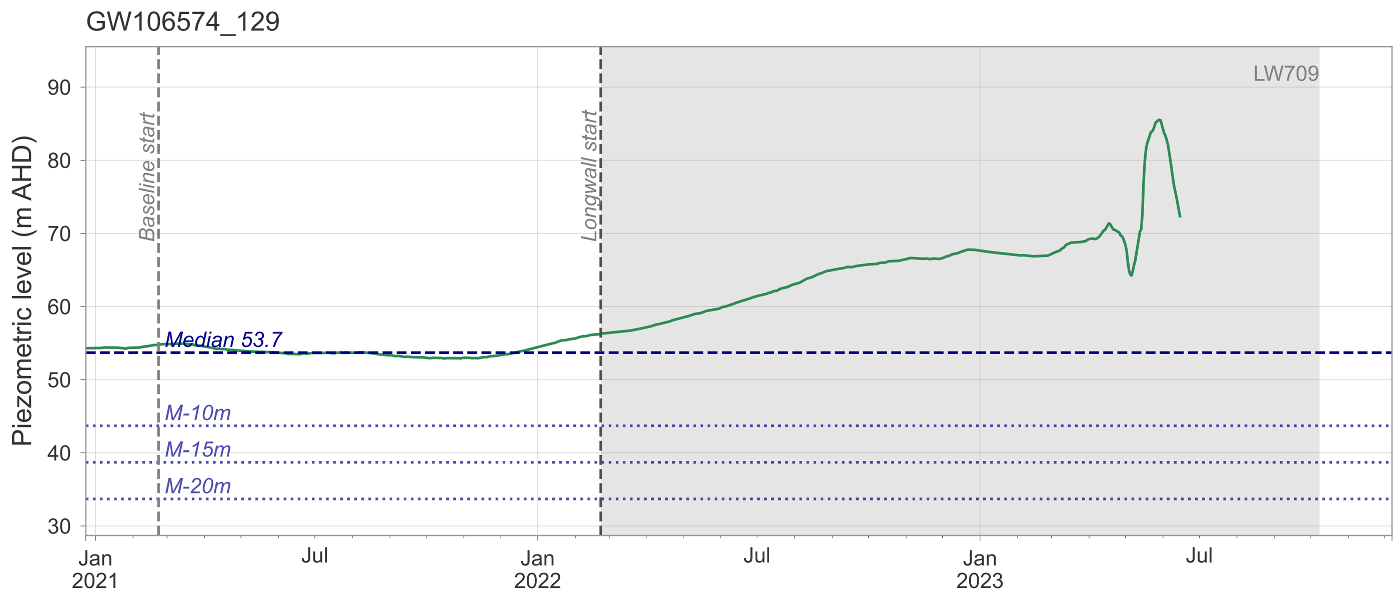




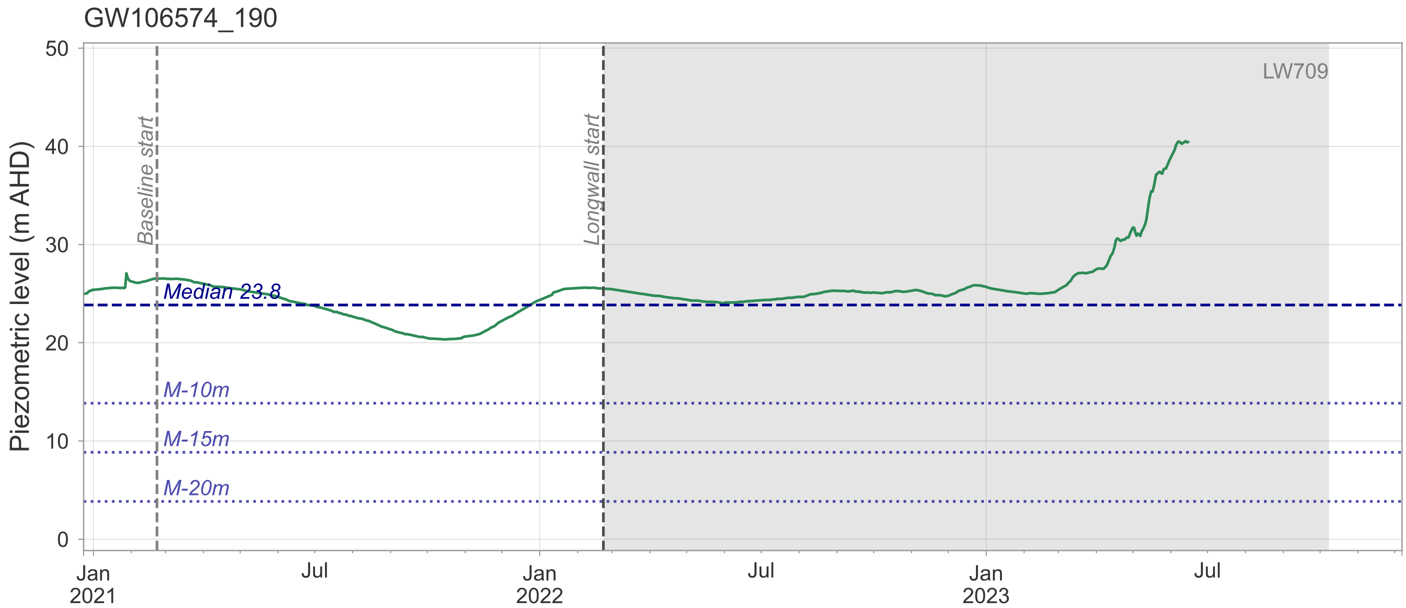
Appendix 1B: Appin Areas 7-9 Groundwater TARP analysis

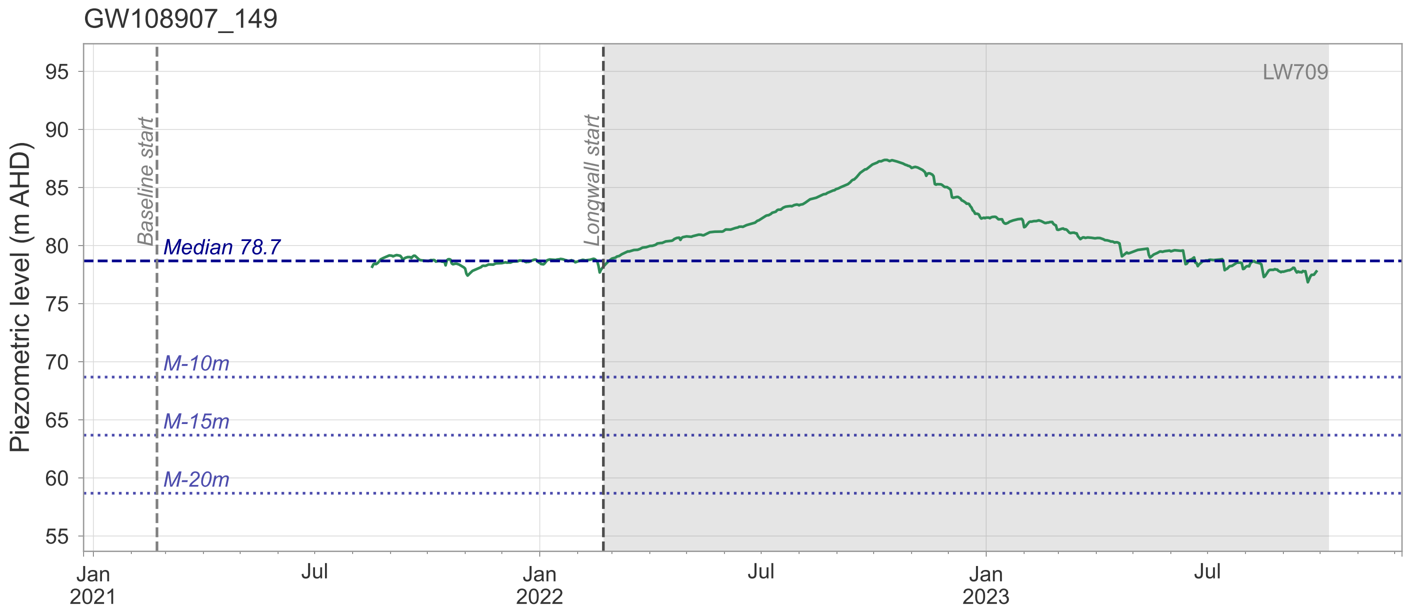




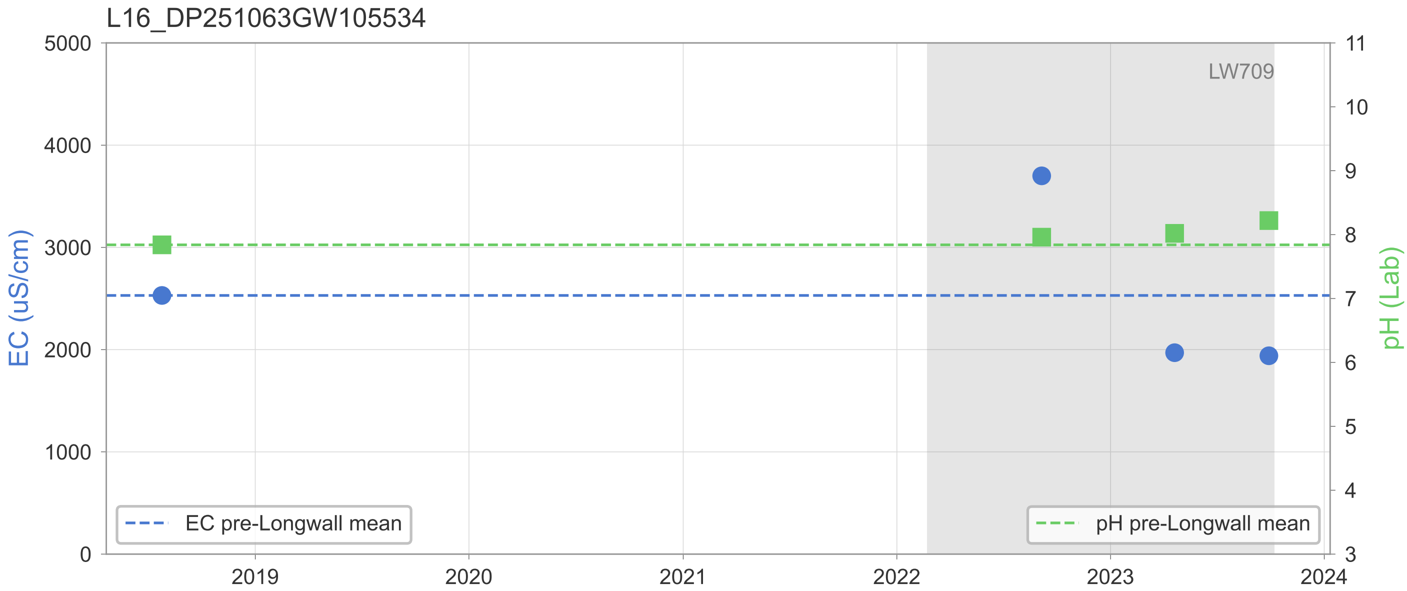


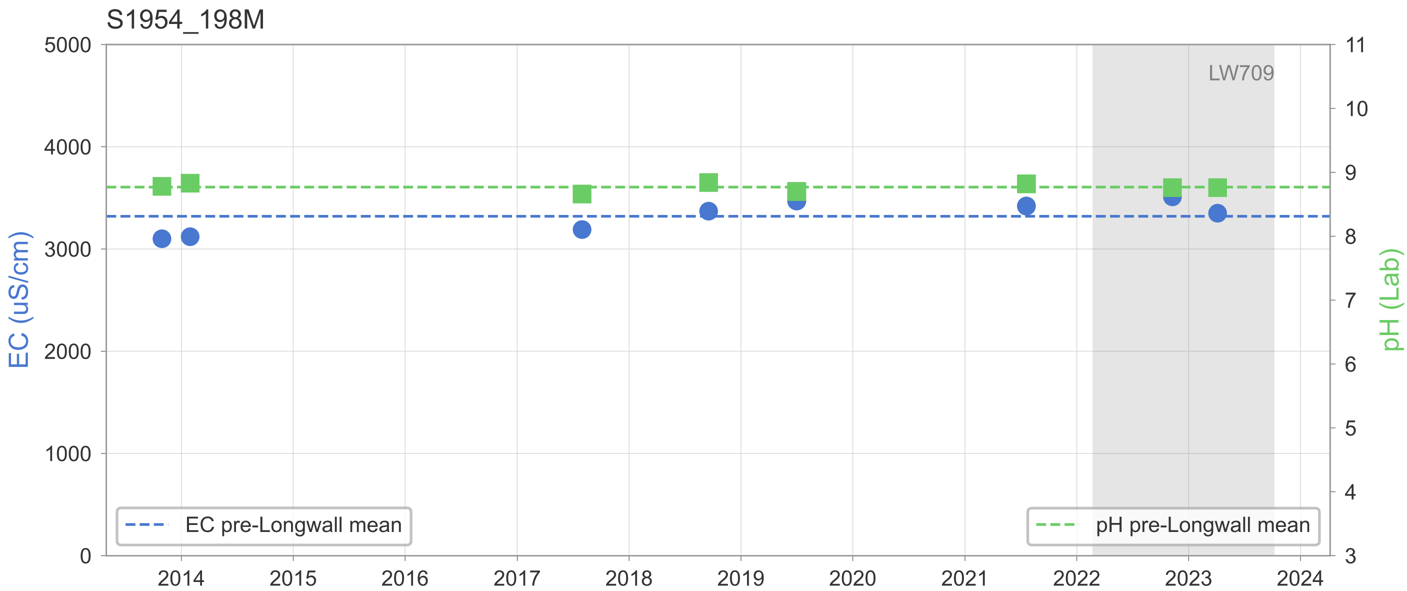
Appendix 1B: Appin Areas 7-9 Groundwater TARP analysis

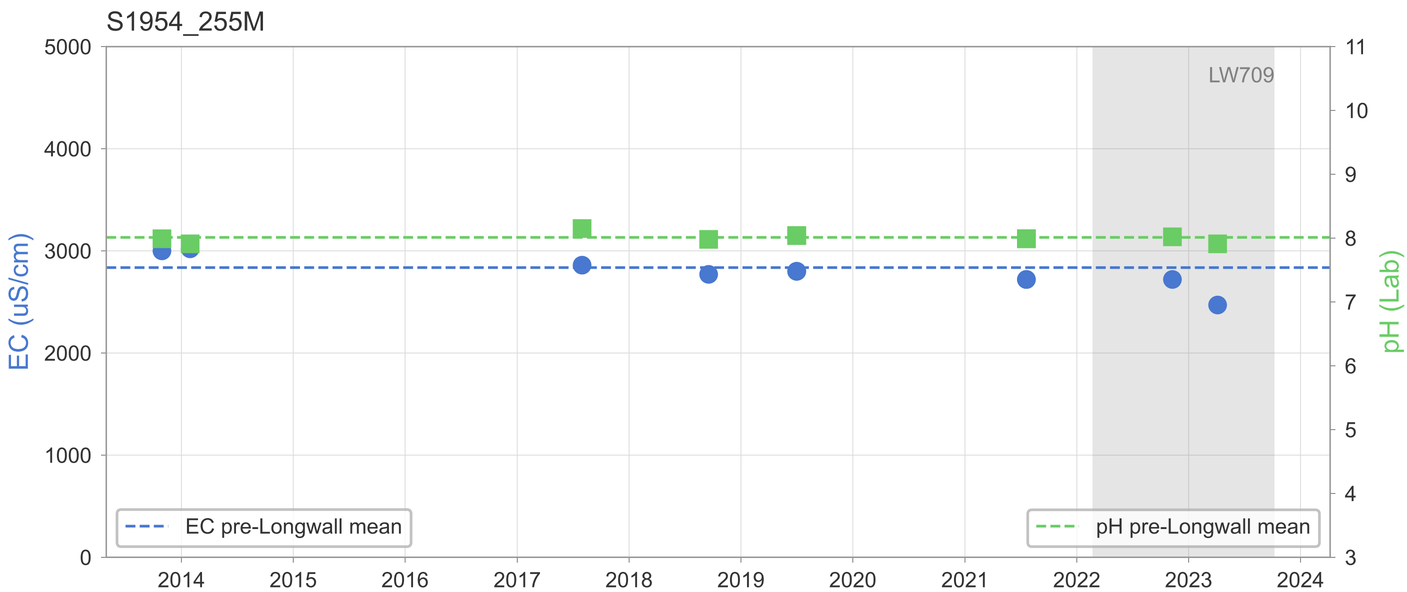




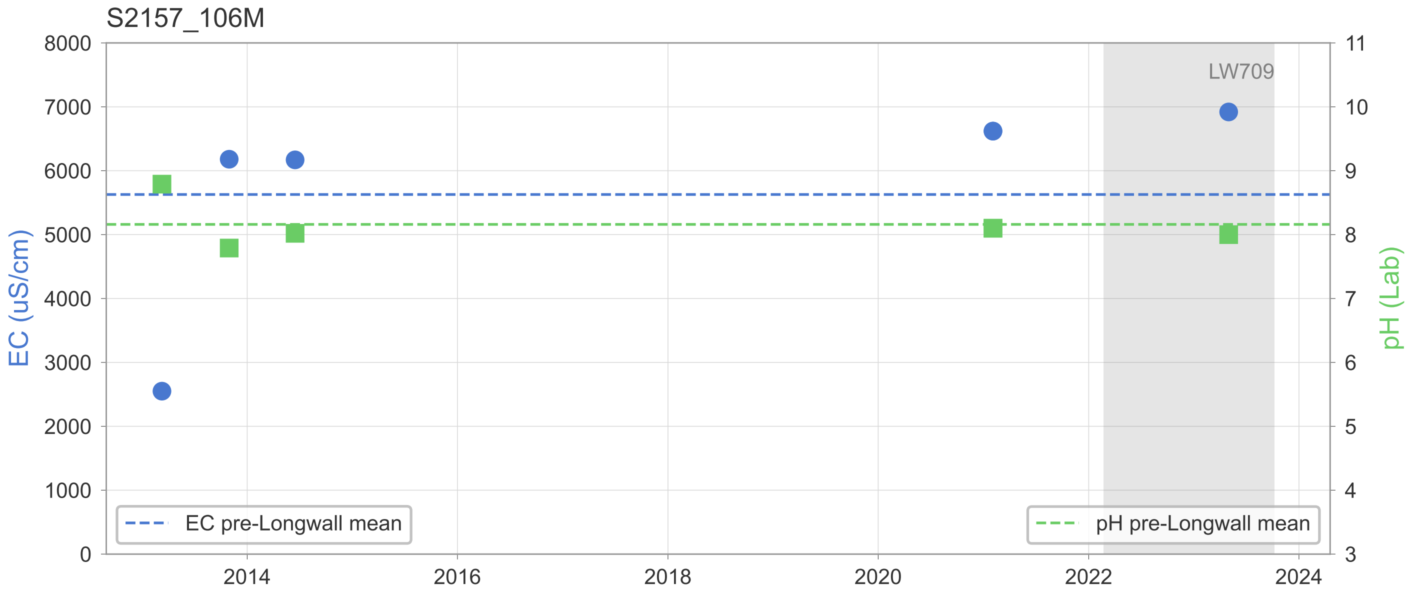
APPENDIX 2 – Groundwater chemistry time-series plots

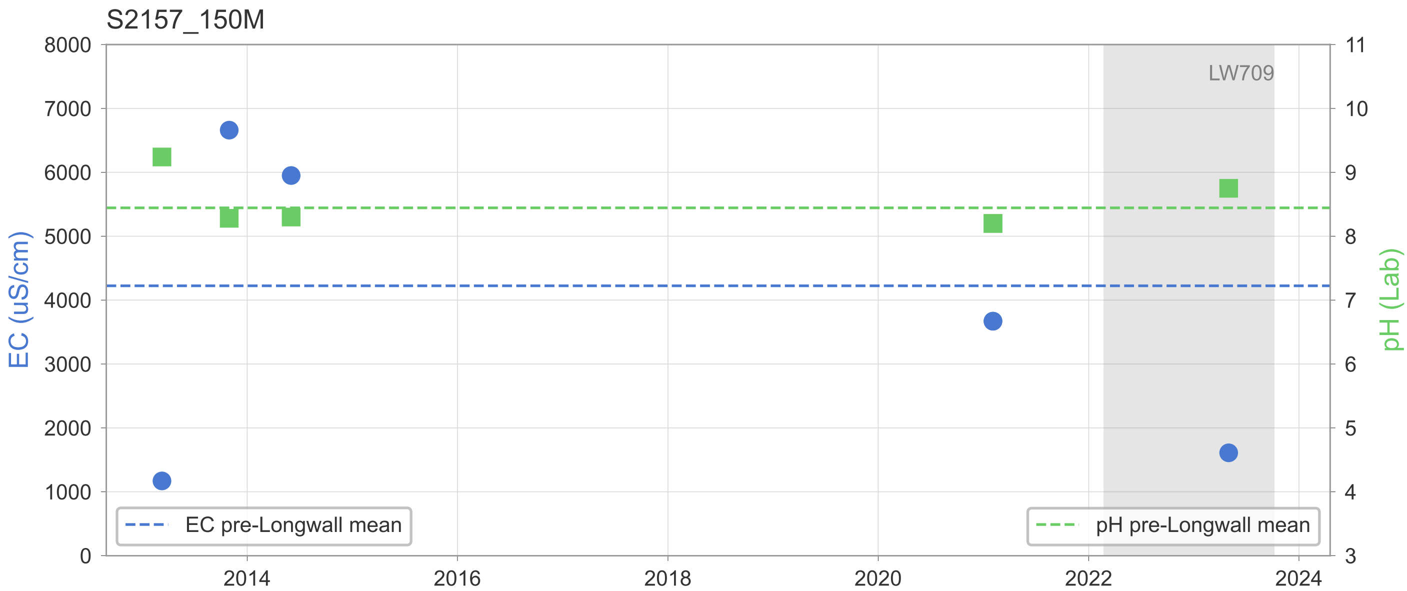

L16_DP251063GW105534
EC (uS/cm)
pH (Lab)
LW709
EC pre-Longwall mean
pH pre-Longwall mean
0
1000
2000
3000
4000
5000
3
4
5
6
7
8
9
10
11
2019
2020
2021
2022
2023
2024

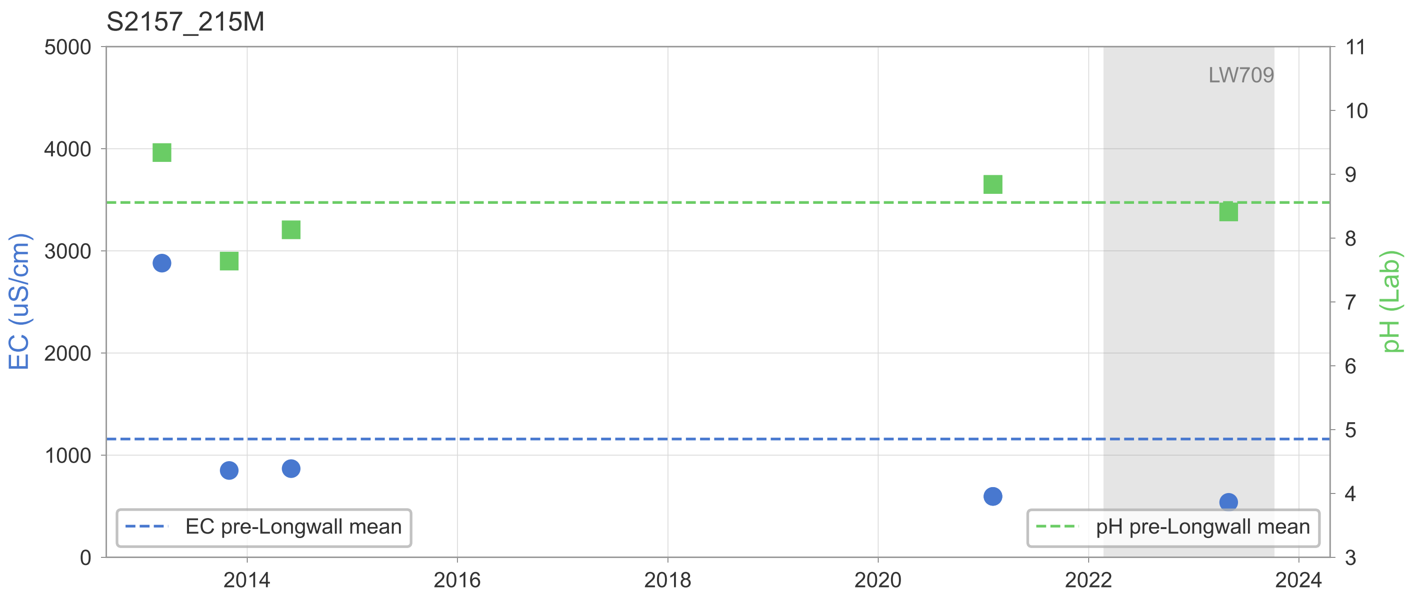

S1954_198M
EC (uS/cm)
pH (Lab)
LW709
EC pre-Longwall mean
pH pre-Longwall mean
0
1000
2000
3000
4000
5000
3
4
5
6
7
8
9
10
11
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024

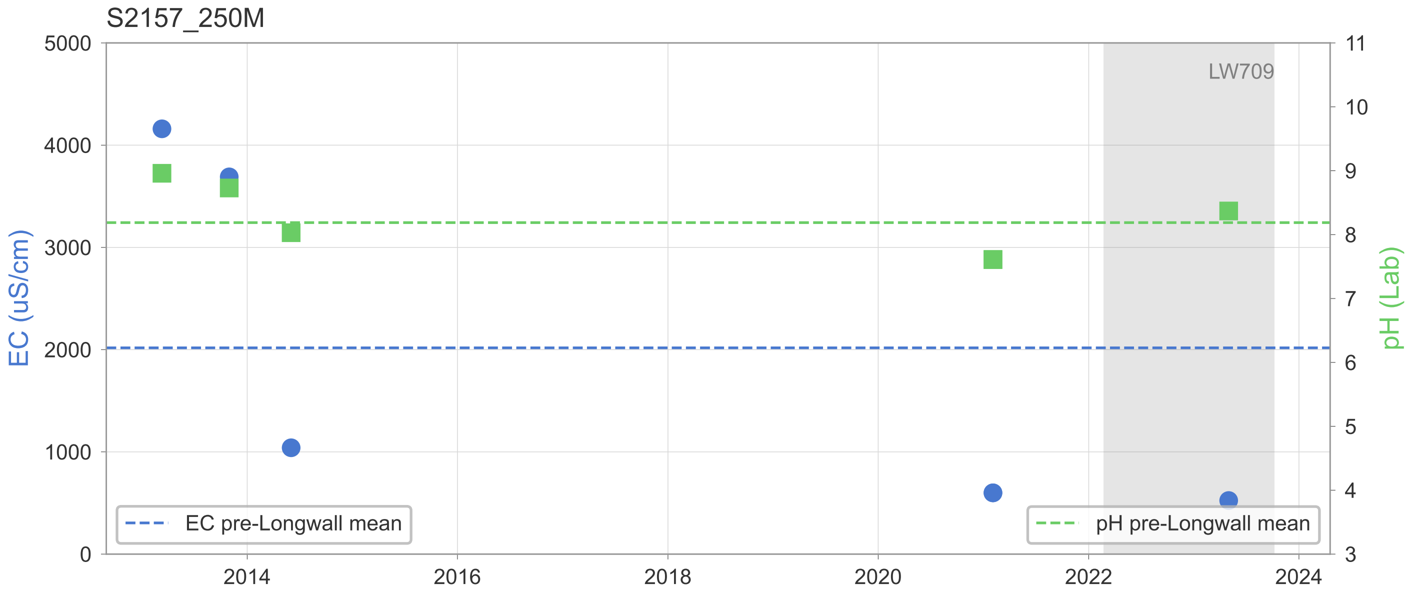

S1954_255M
EC (uS/cm)
pH (Lab)
LW709
EC pre-Longwall mean
pH pre-Longwall mean
0
1000
2000
3000
4000
5000
3
4
5
6
7
8
9
10
11
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024

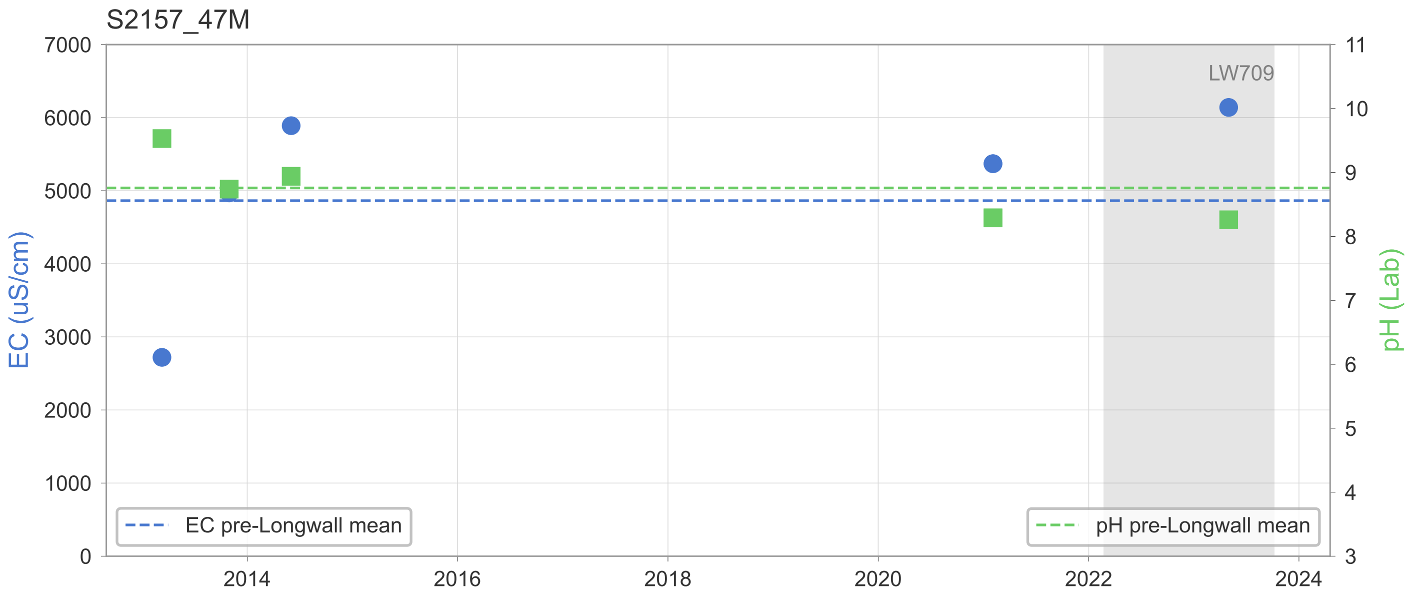
Appendix 2: Appin Areas 7-9 Groundwater Quality timeseries

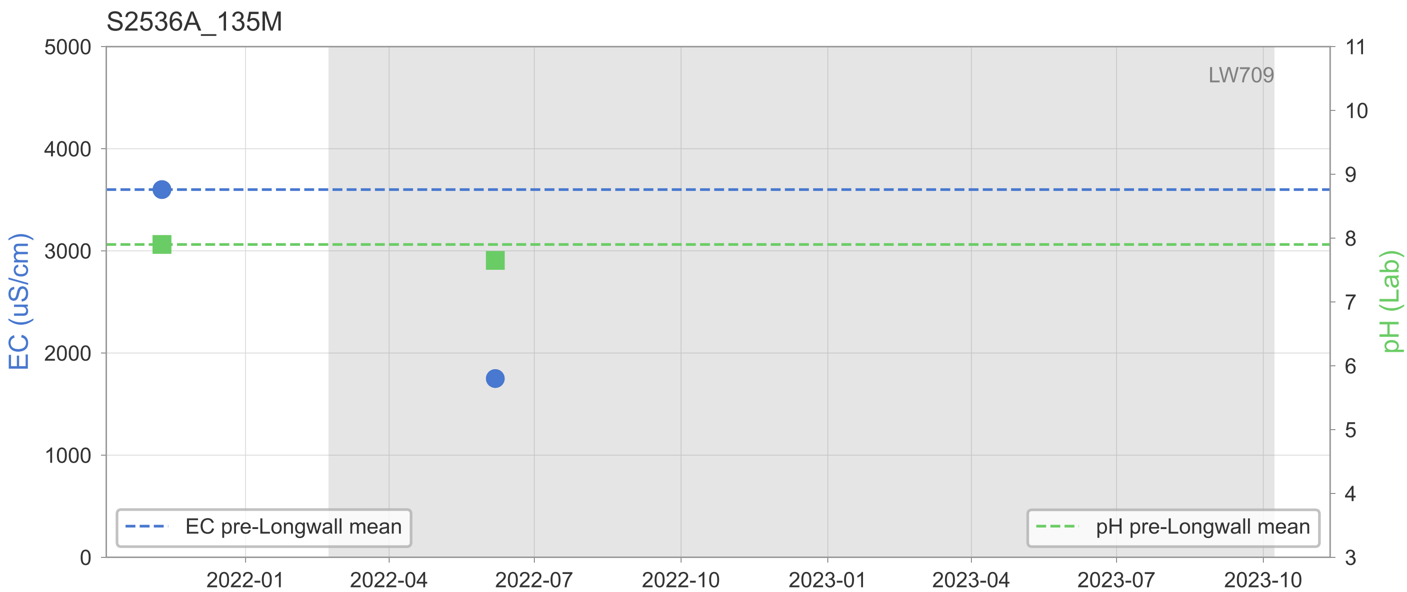




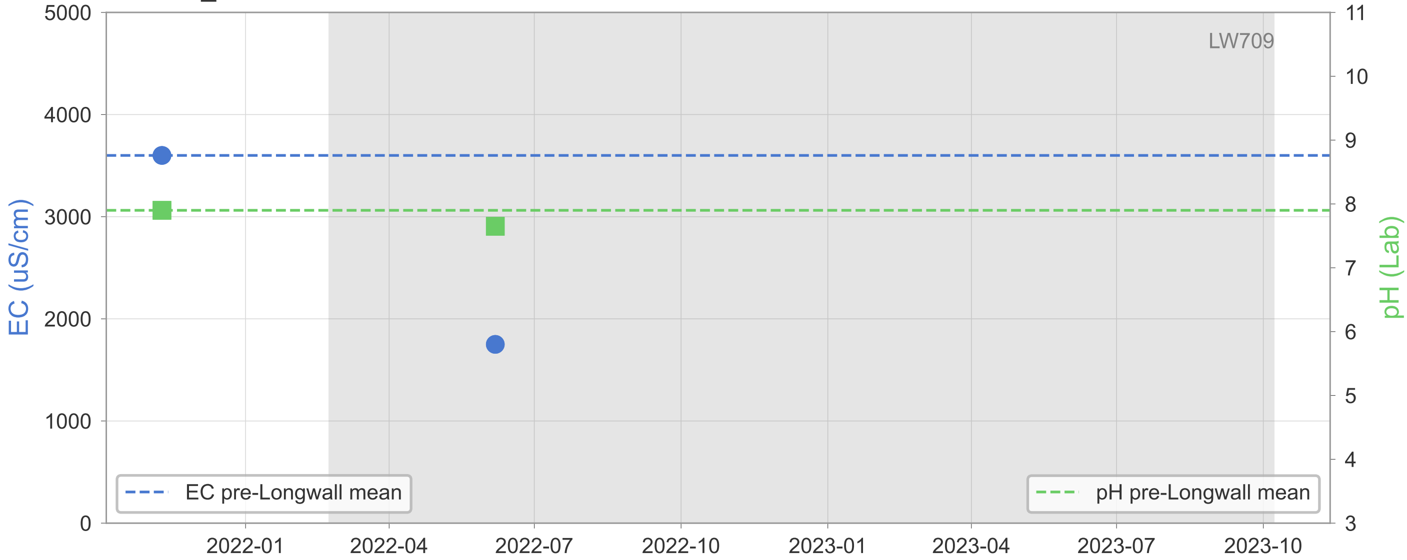



S2157_250M
LW709
EC (uS/cm)
pH (Lab)
EC pre-Longwall mean
pH pre-Longwall mean
0
1000
2000
3000
4000
5000
3
4
5
6
7
8
9
10
11
2014
2016
2018
2020
2022
2024

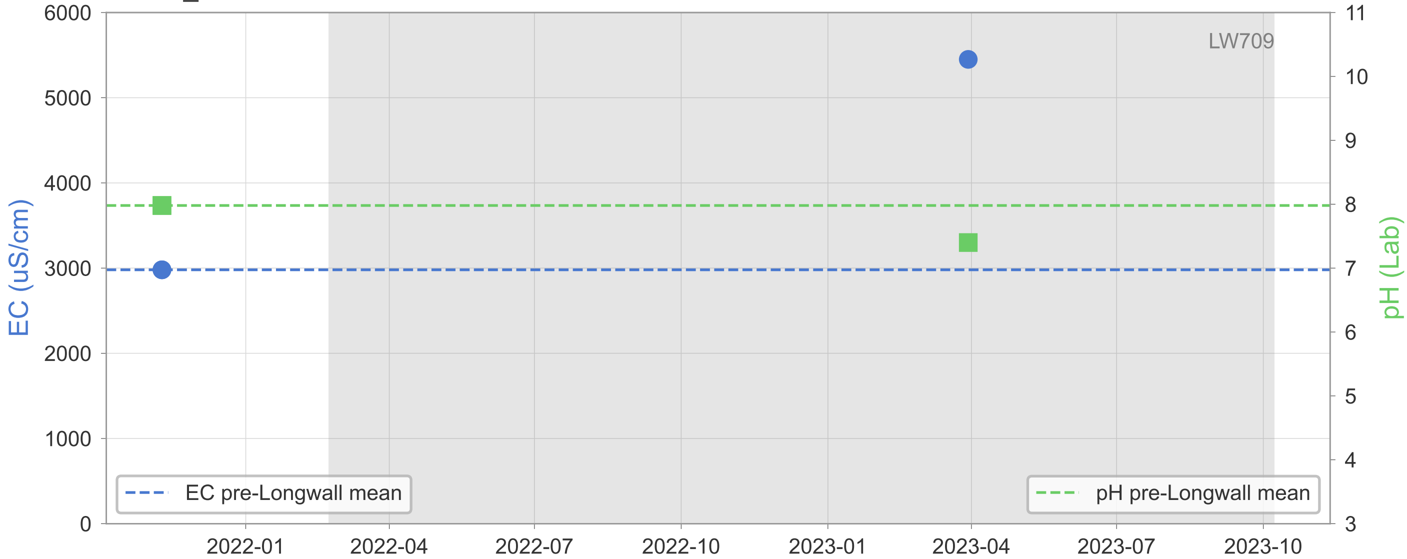

S2157_47M
LW709
EC (uS/cm)
pH (Lab)
EC pre-Longwall mean
pH pre-Longwall mean
0
1000
2000
3000
4000
5000
6000
7000
3
4
5
6
7
8
9
10
11
2014
2016
2018
2020
2022
2024


S2536A_135M
LW709
EC (uS/cm)
pH (Lab)
EC pre-Longwall mean
pH pre-Longwall mean
0
1000
2000
3000
4000
5000
3
4
5
6
7
8
9
10
11
2022-01
2022-04
2022-07
2022-10
2023-01
2023-04
2023-07
2023-10

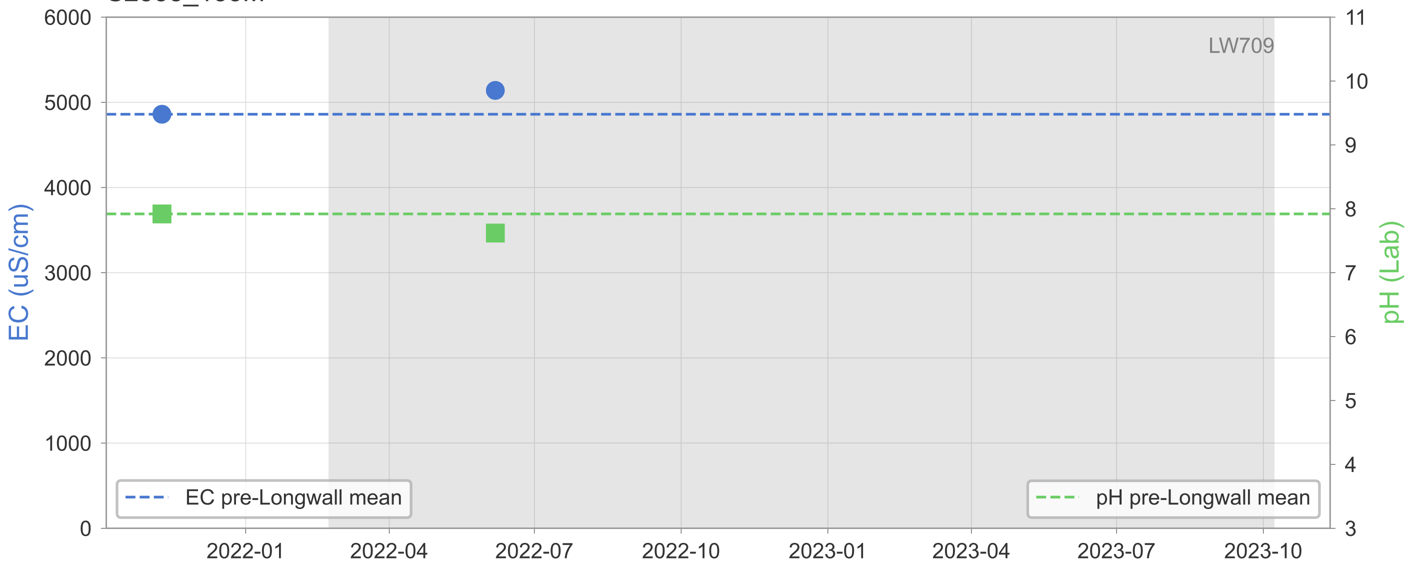
S2536A_135M



S2537_135M

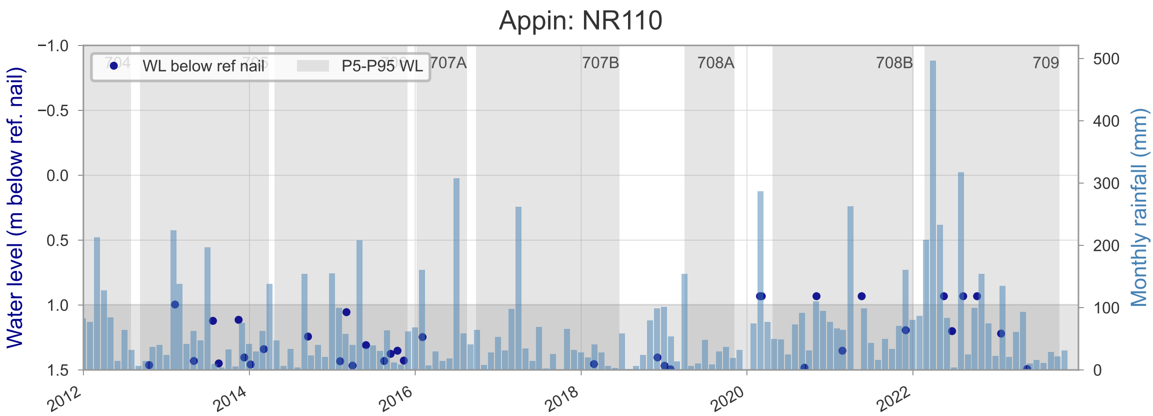


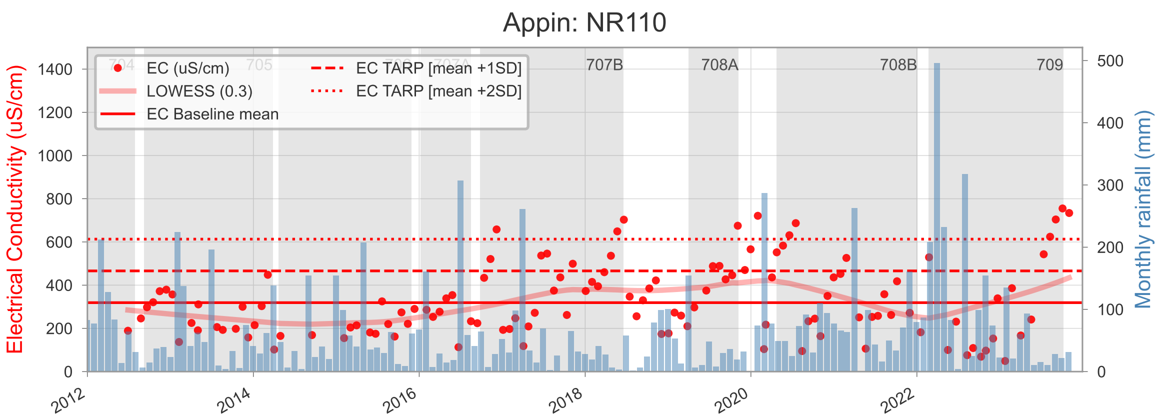
S2538_135M

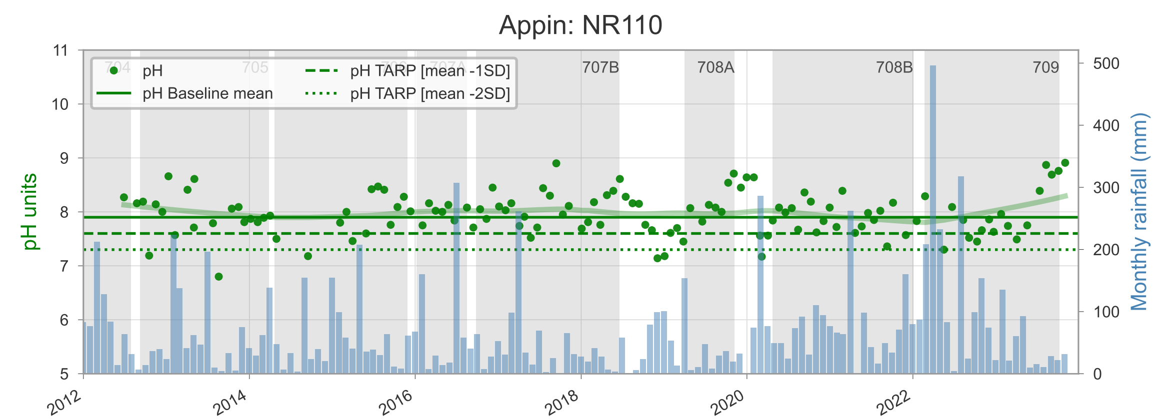


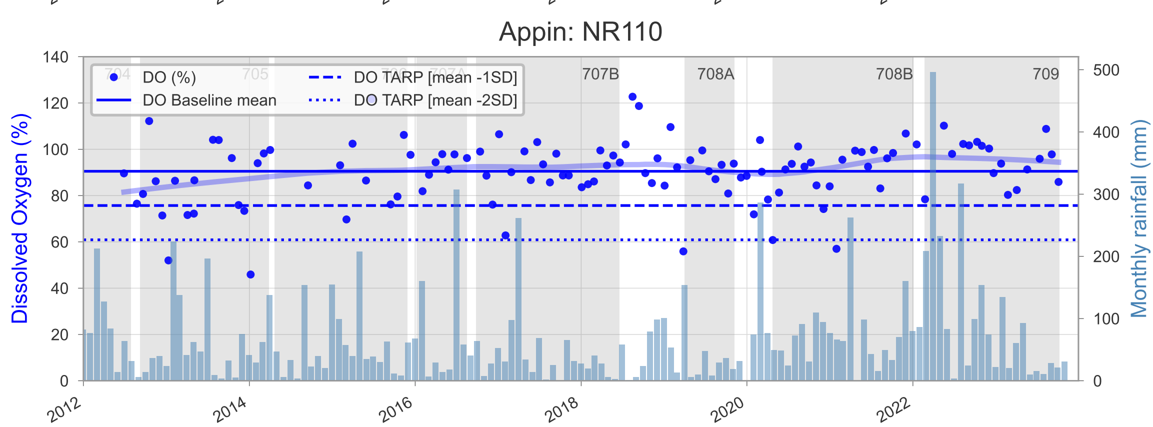
APPENDIX 3 – Surface water chemistry time-series plots

Appendix 3A: Appin AA7&9 Surface water quality timeseries (field)

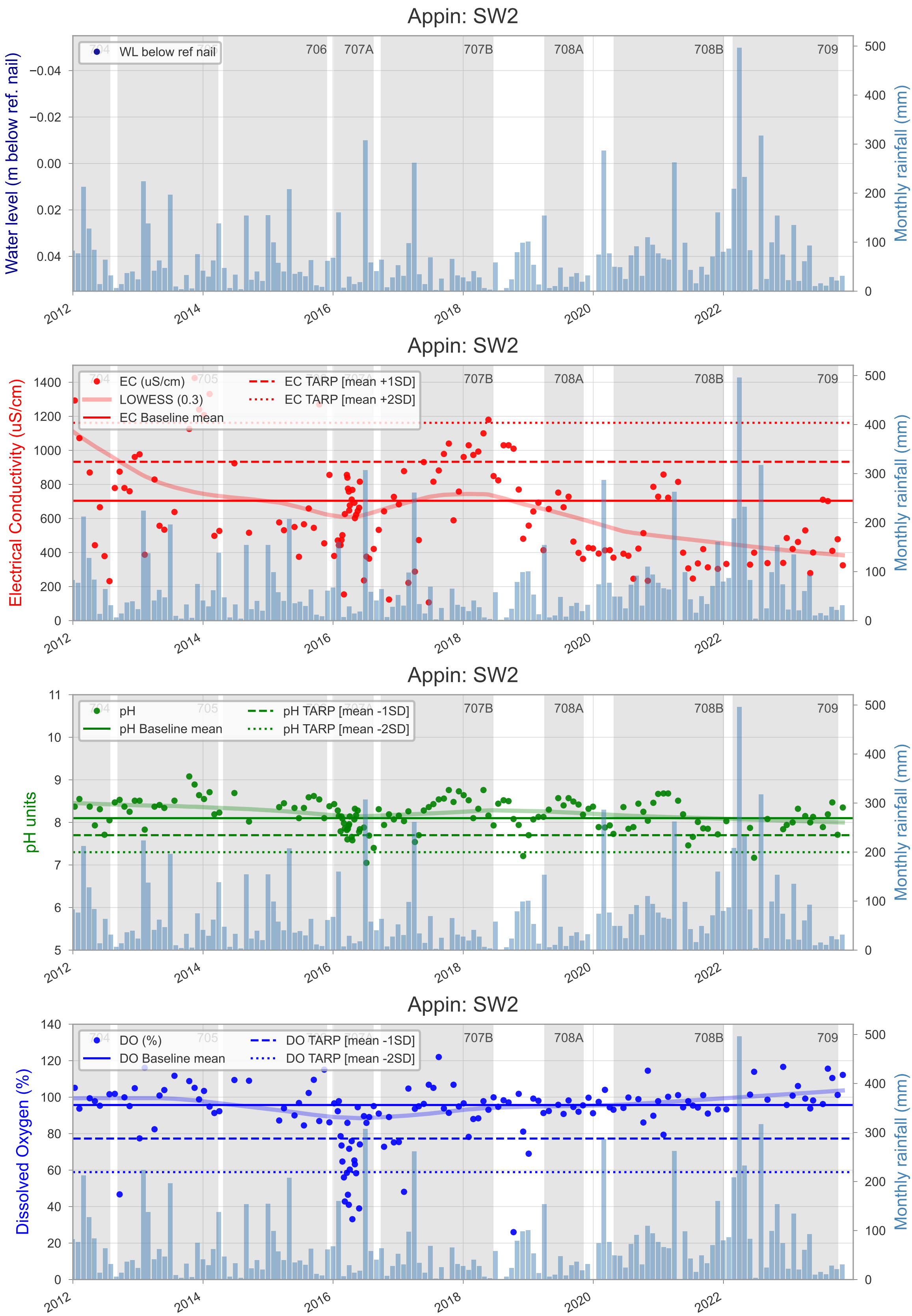




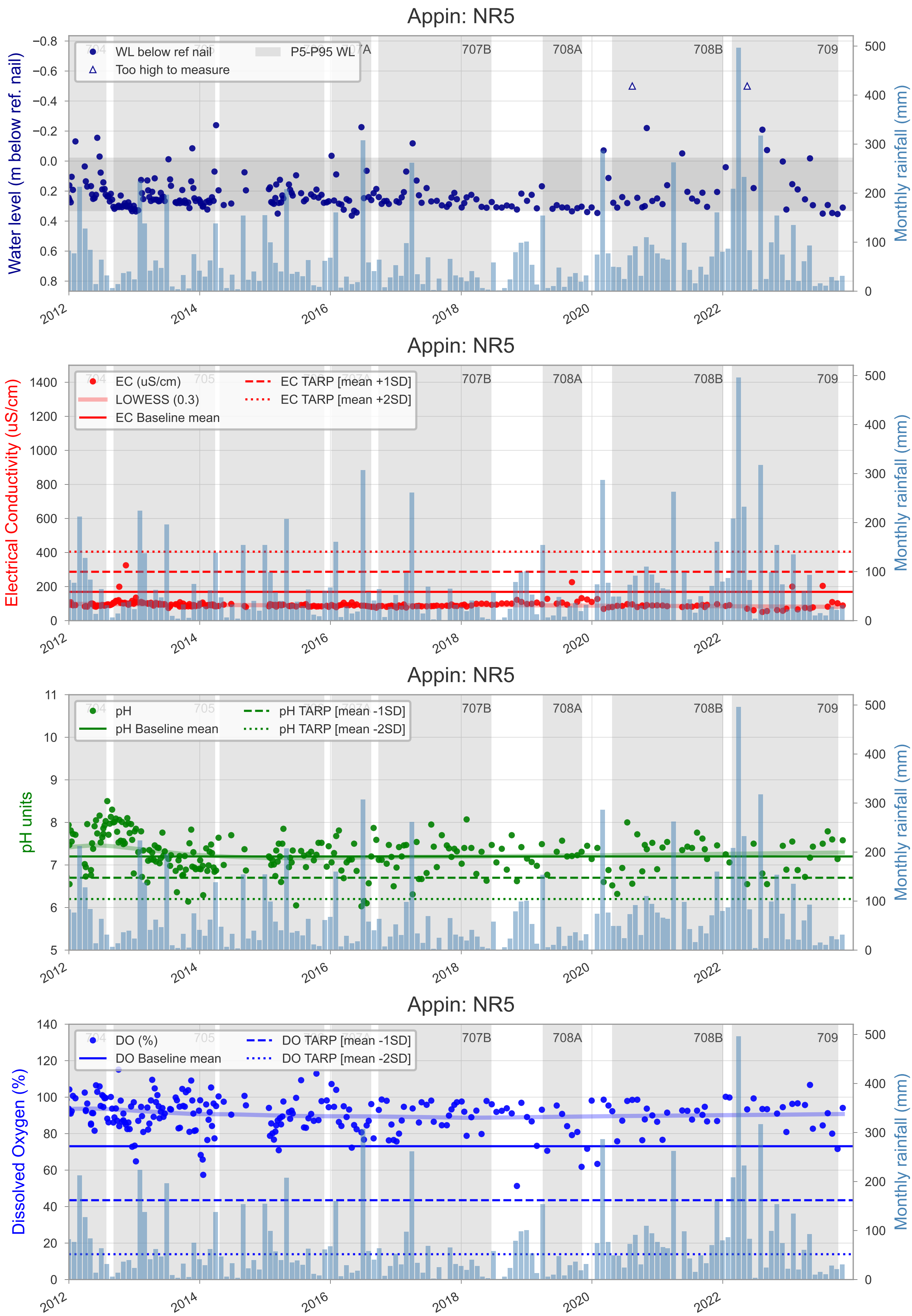




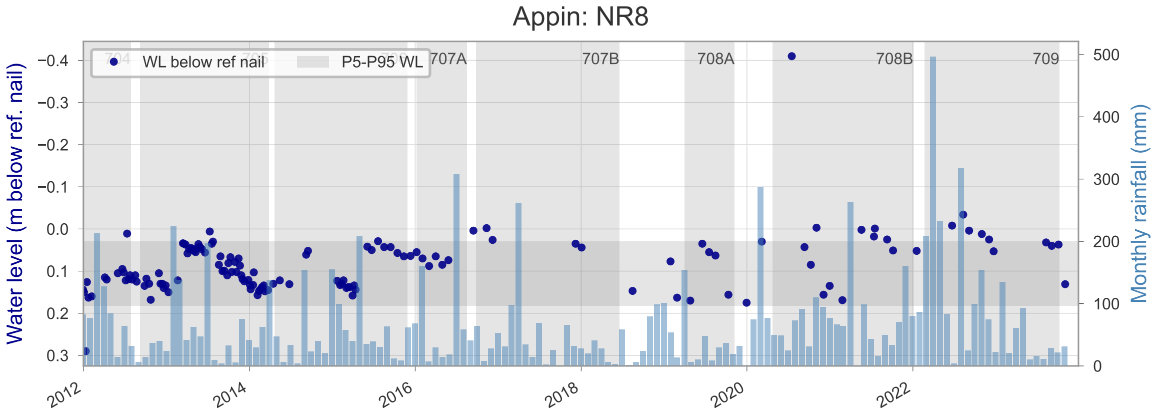
Appendix 3A: Appin AA7&9 Surface water quality timeseries (field)

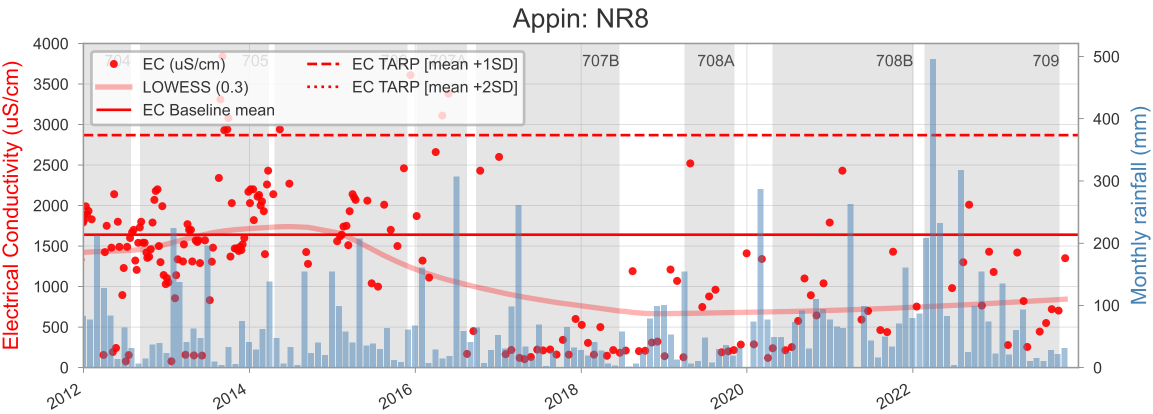


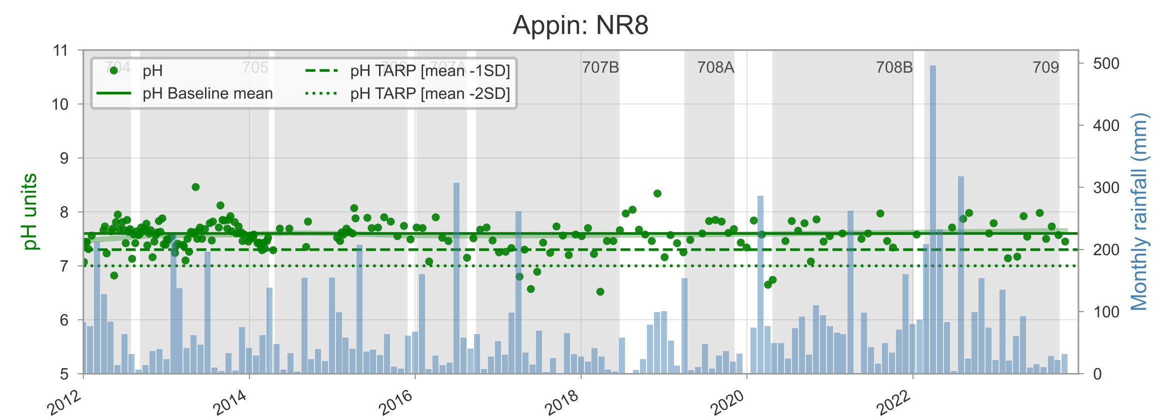
Appendix 3A: Appin AA7&9 Surface water quality timeseries (field)

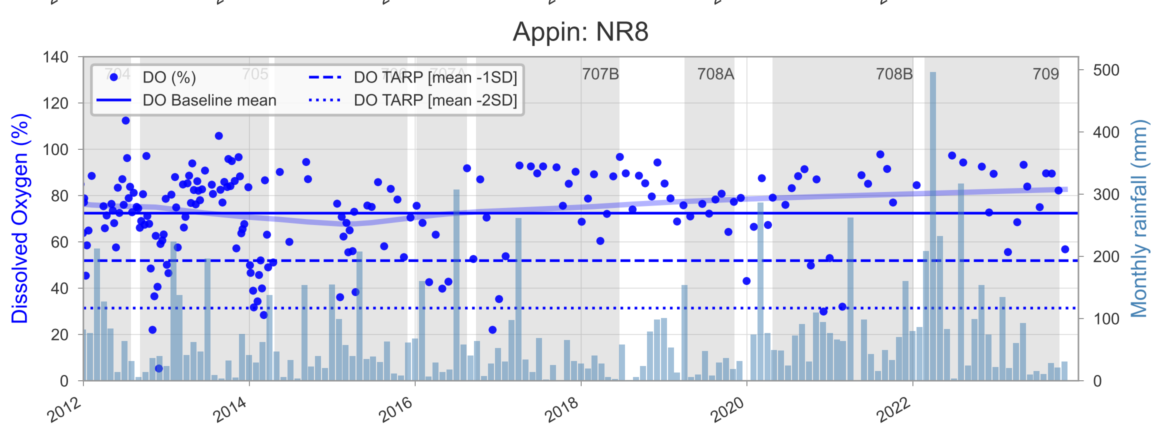


Appendix 3A: Appin AA7&9 Surface water quality timeseries (field)



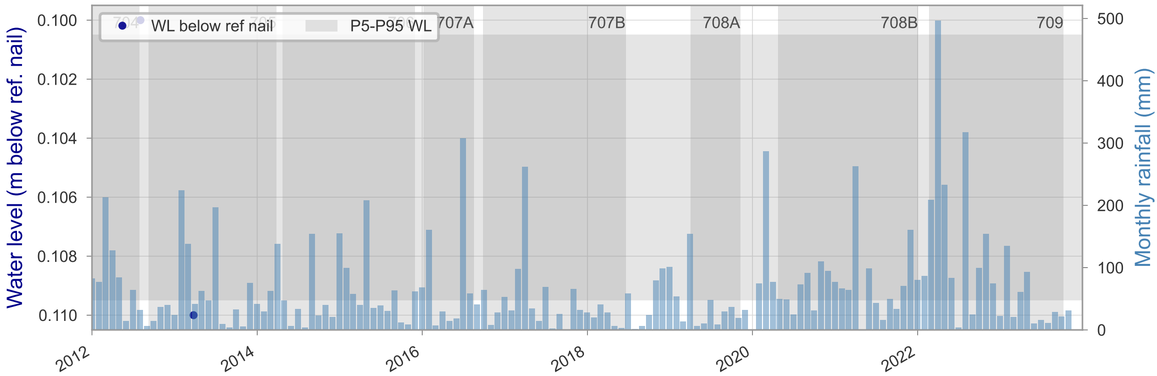




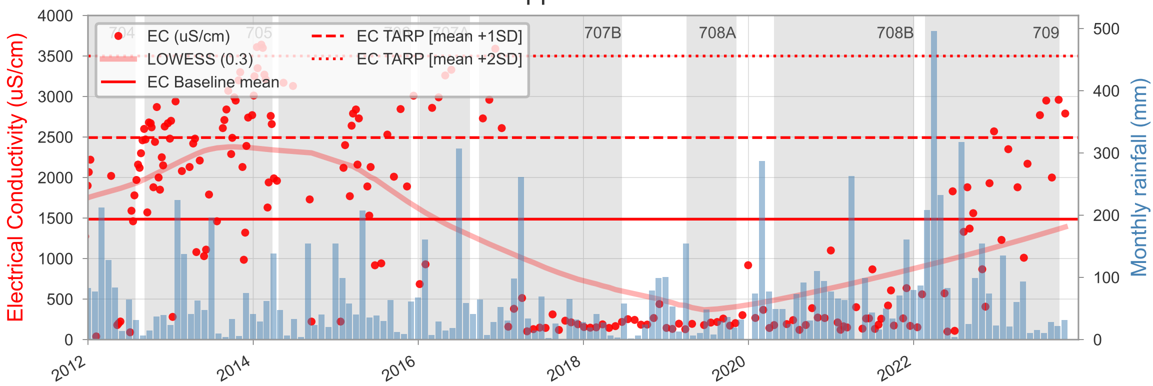


Appendix 3A: Appin AA7&9 Surface water quality timeseries (field)

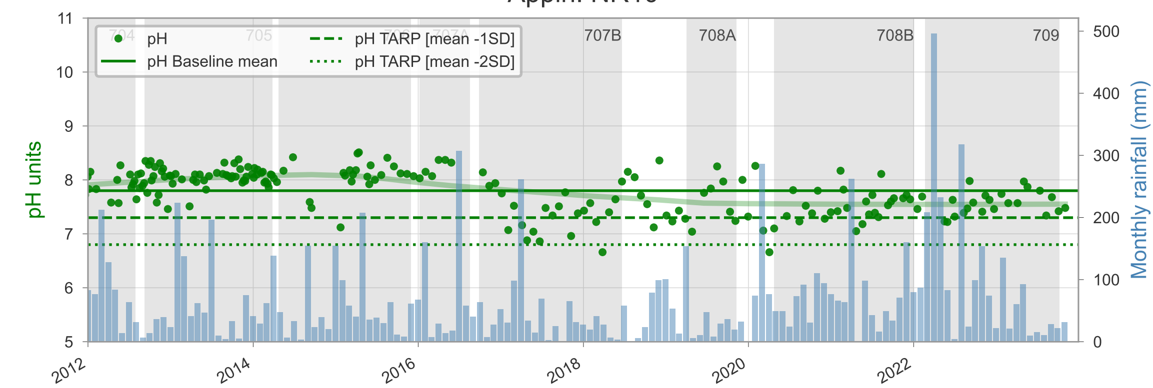
Appin: NR10



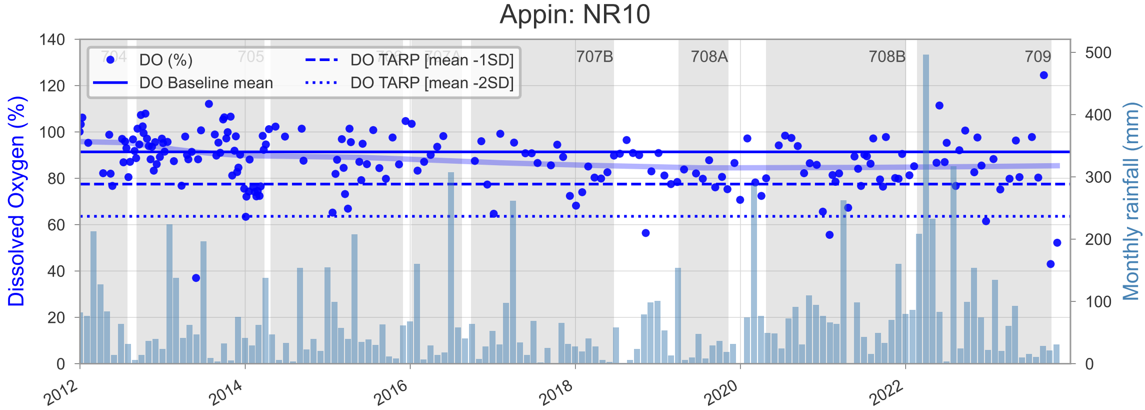
Appin: NR10



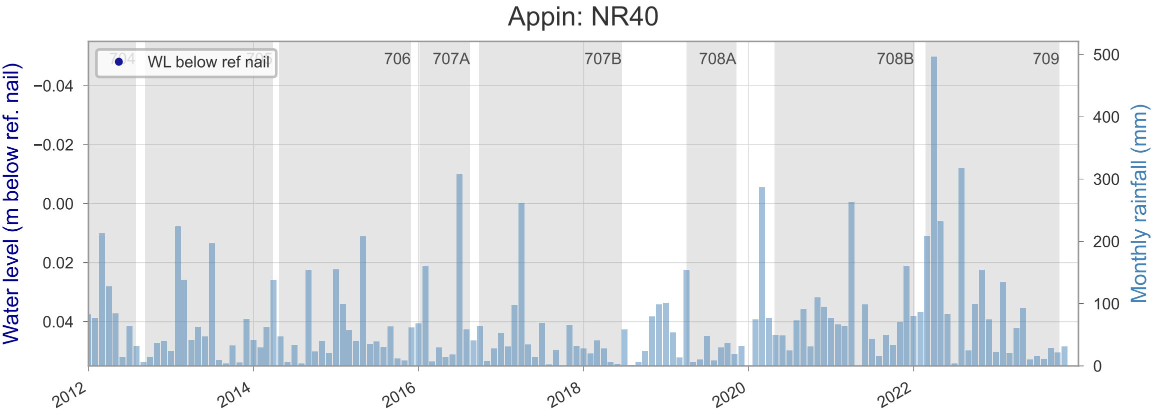
Appin: NR10

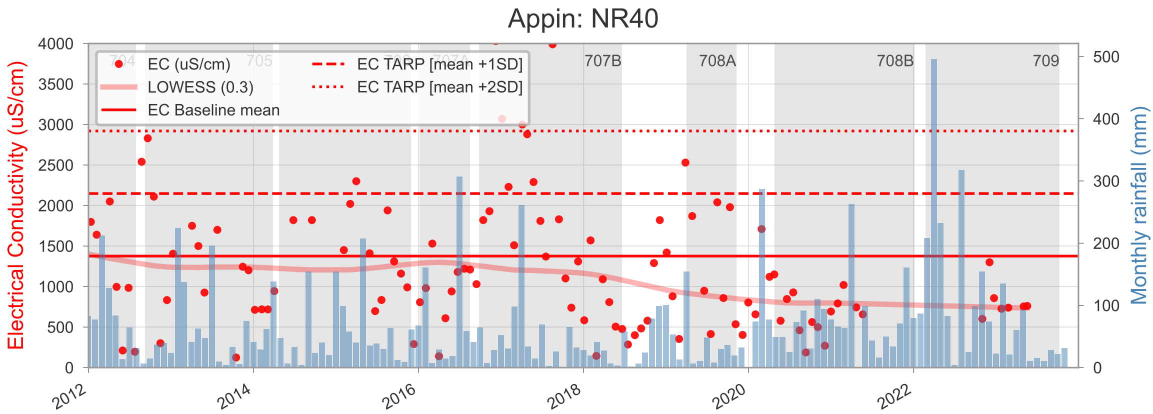


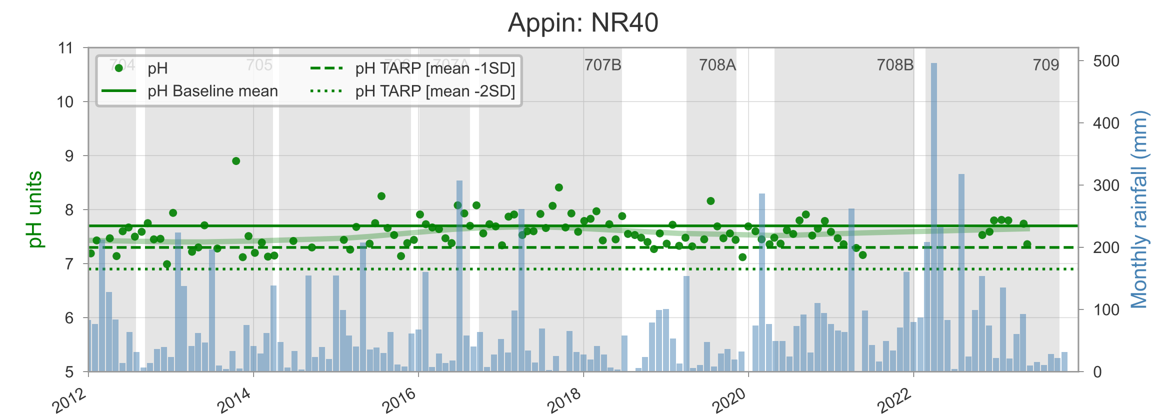
Appin: NR10

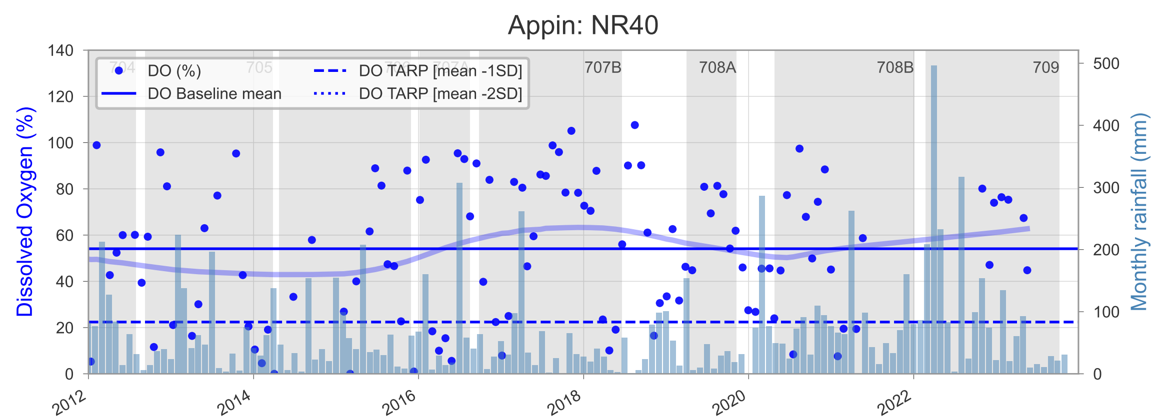


Appendix 3A: Appin AA7&9 Surface water quality timeseries (field)

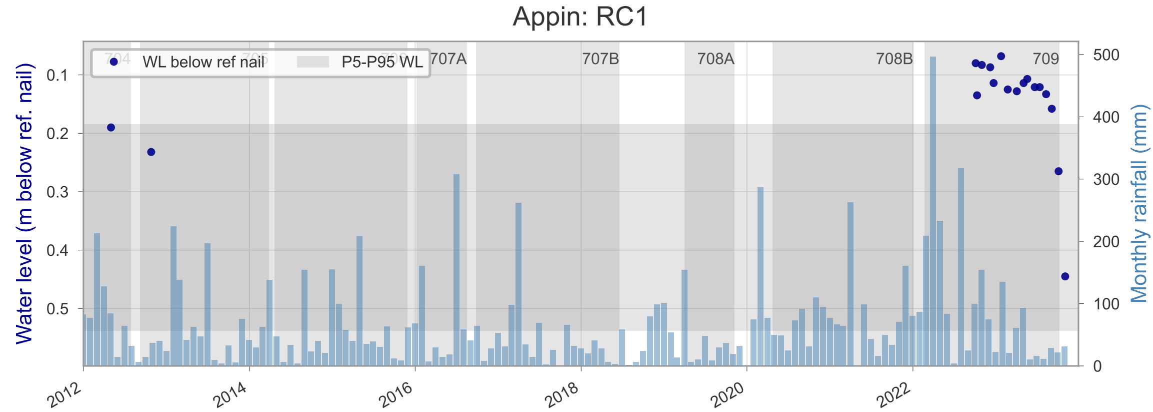


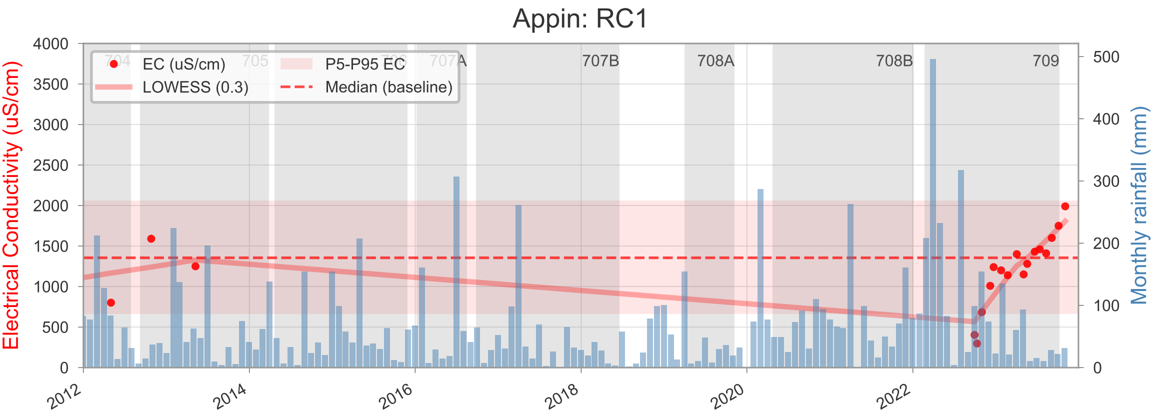


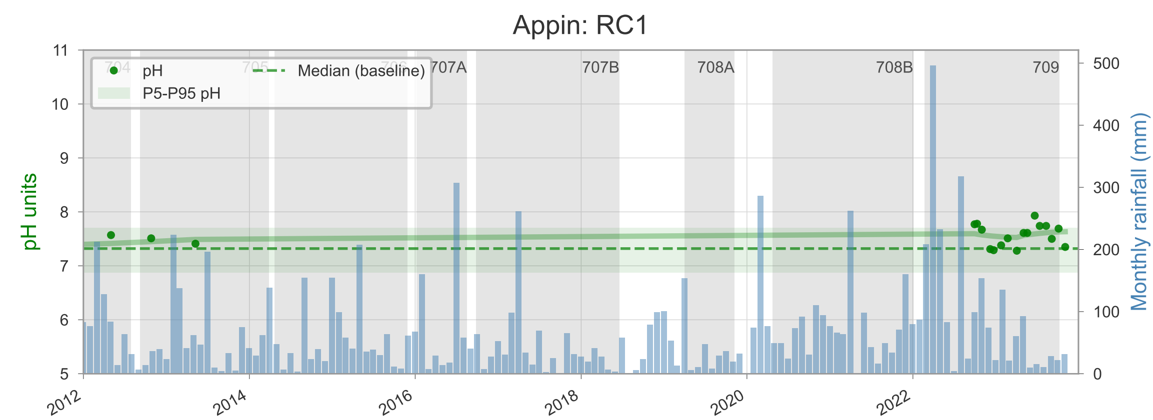


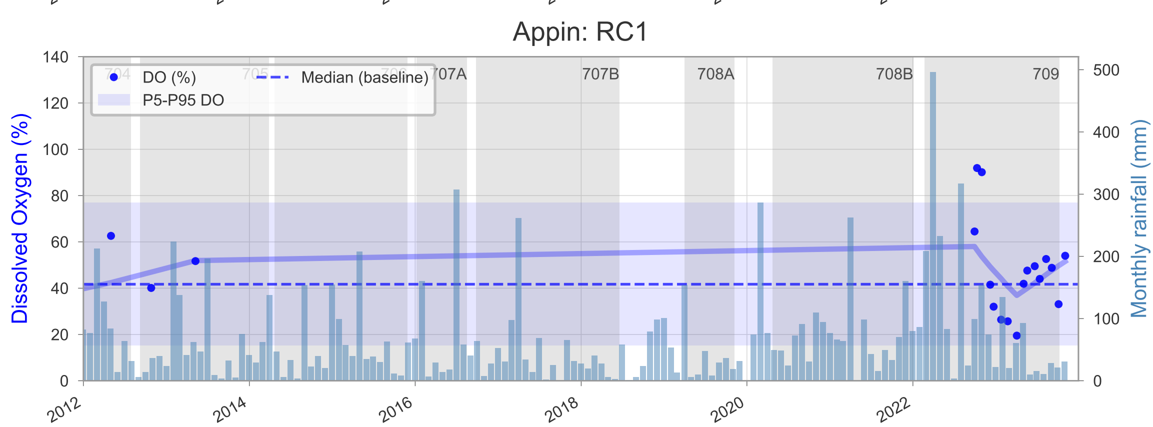


Appendix 3A: Appin AA7&9 Surface water quality timeseries (field)

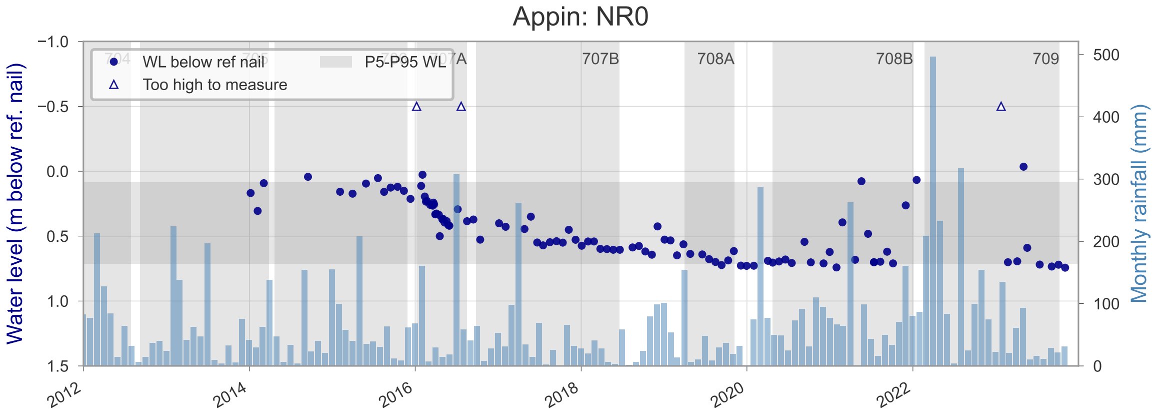


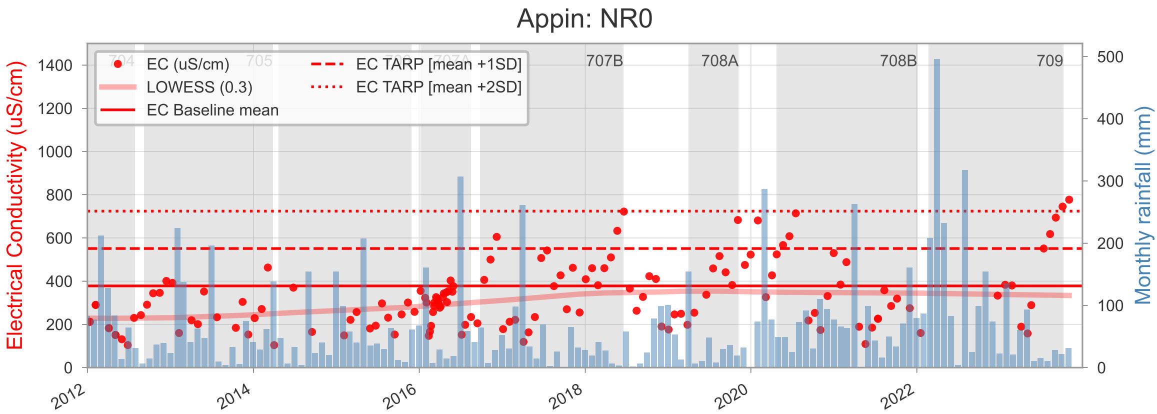


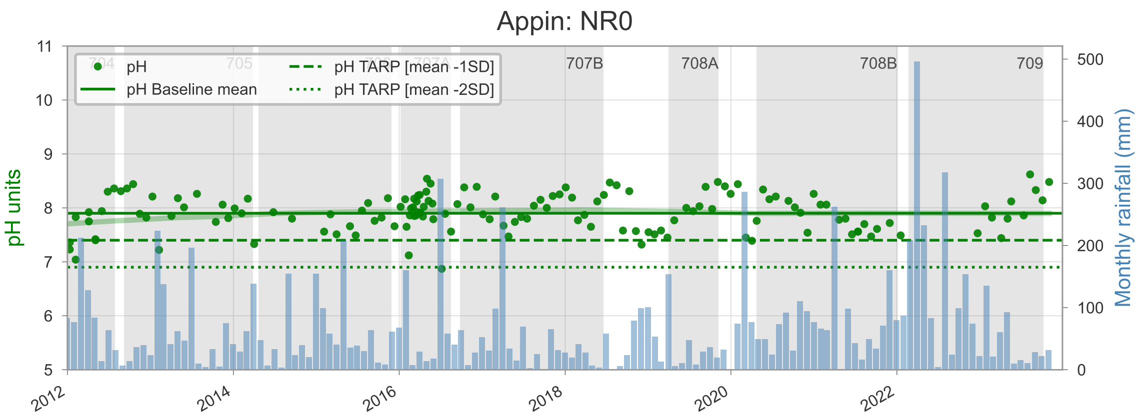


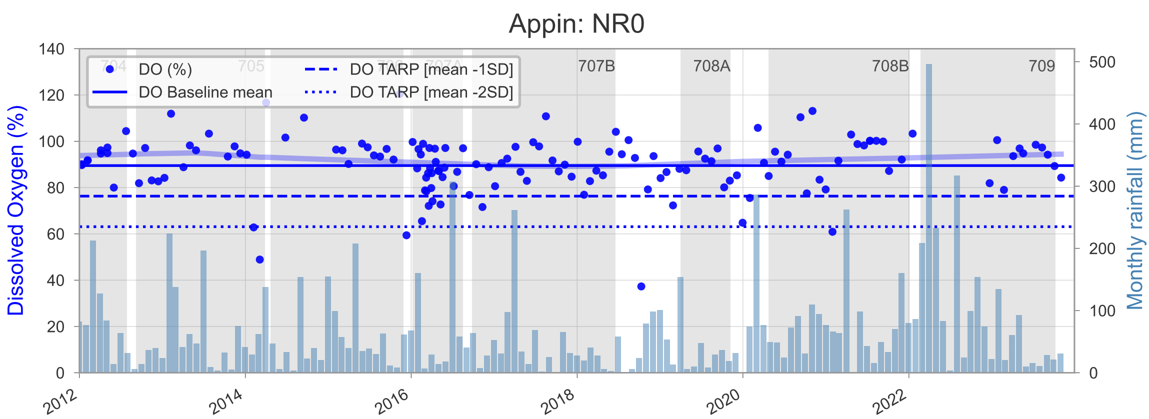


Appendix 3A: Appin AA7&9 Surface water quality timeseries (field)



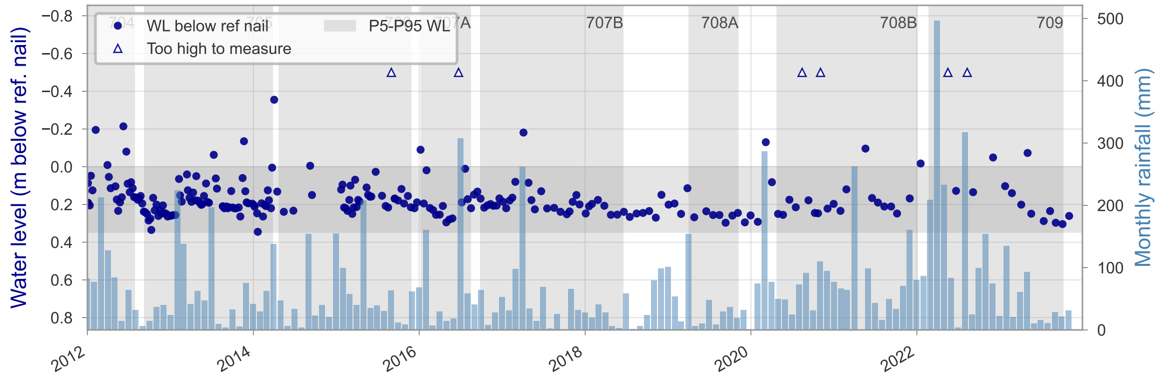






Appendix 3A: Appin AA7&9 Surface water quality timeseries (field)

Appin: NR4



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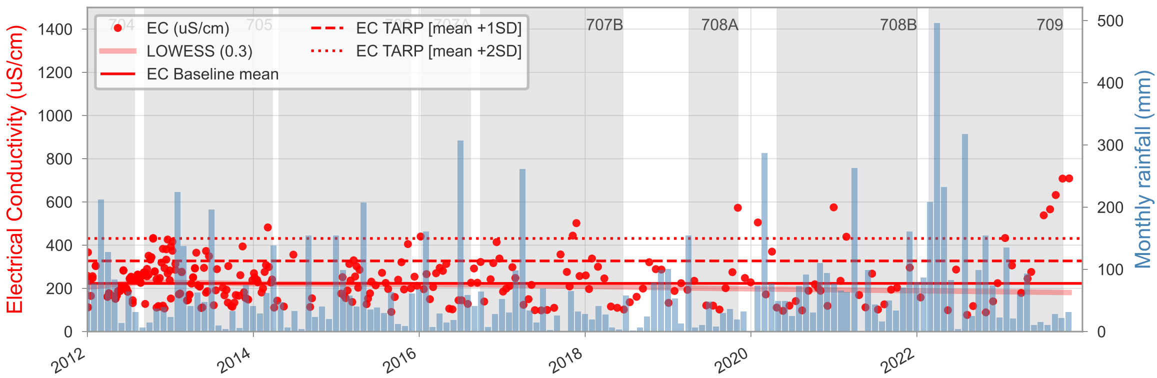

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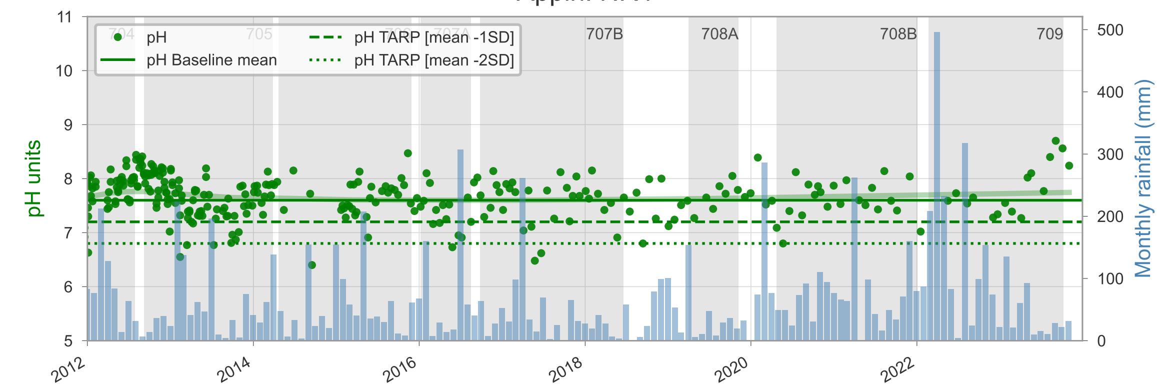

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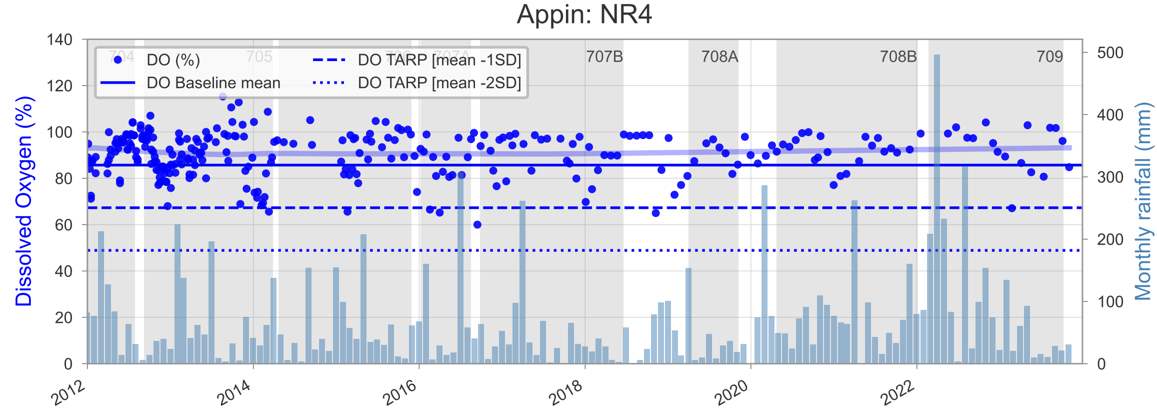
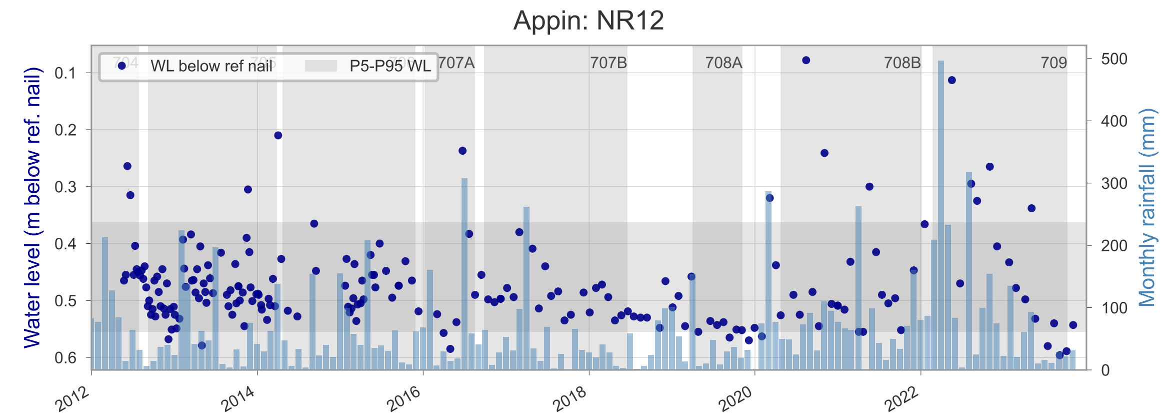
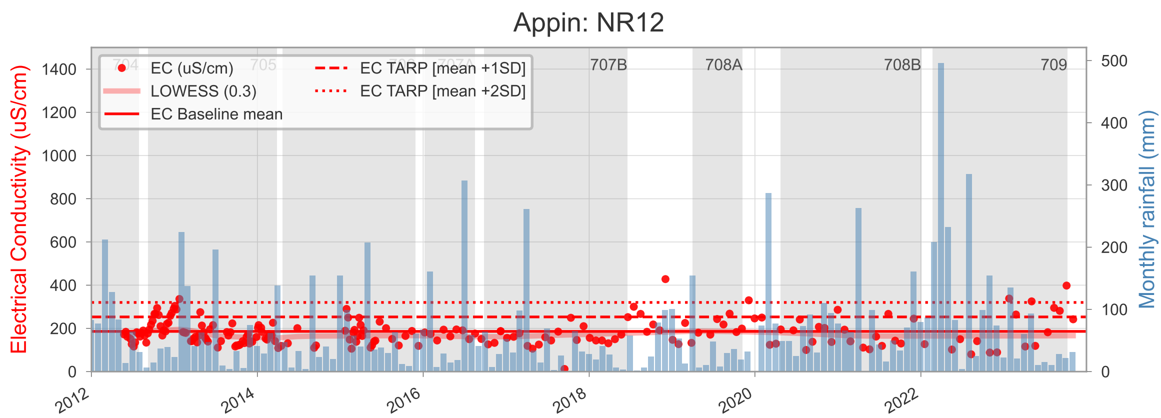
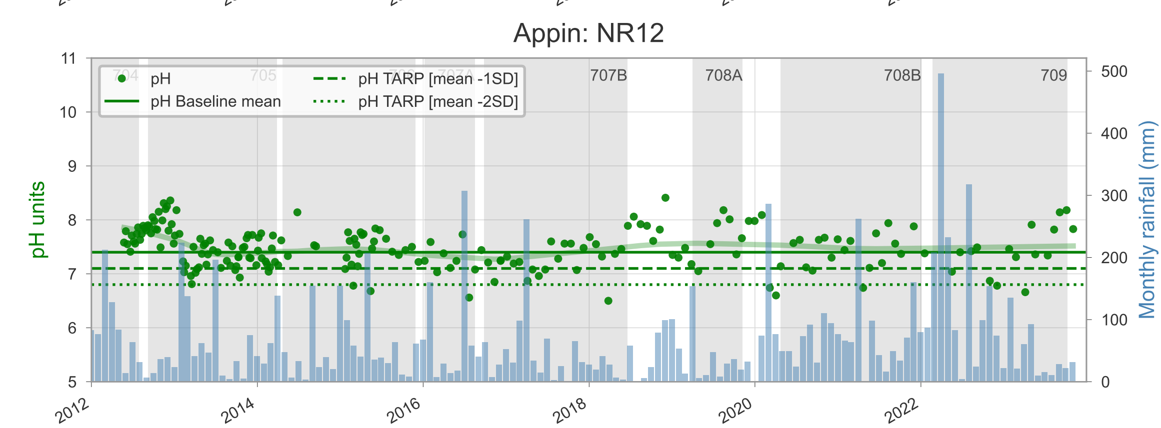
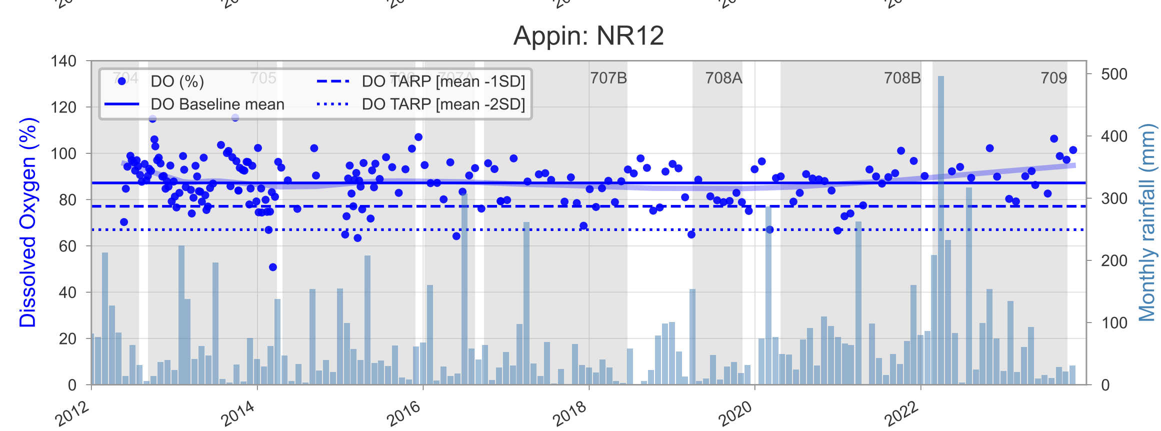


Appendix 3A: Appin AA7&9 Surface water quality timeseries (field)



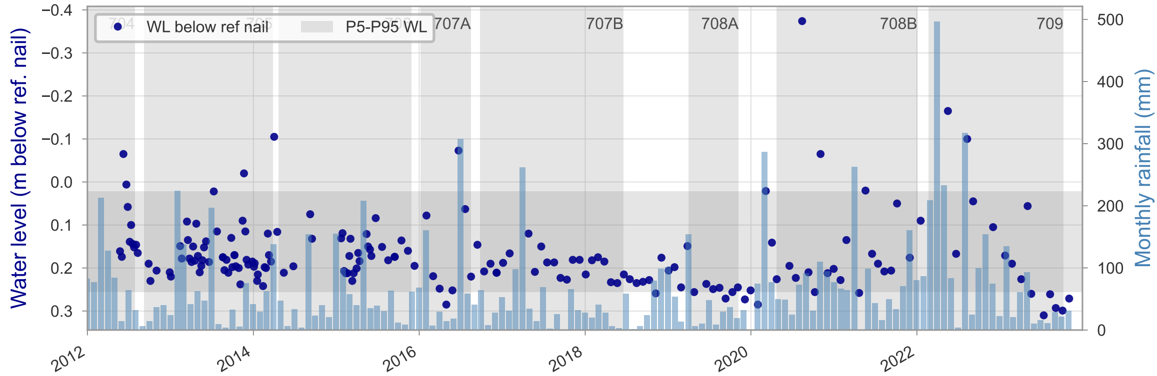






Appendix 3A: Appin AA7&9 Surface water quality timeseries (field)

Appin: NR13



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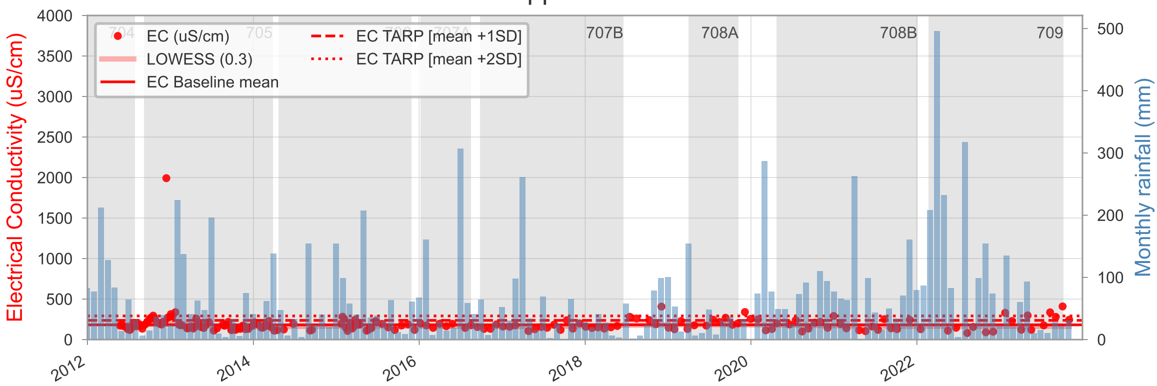

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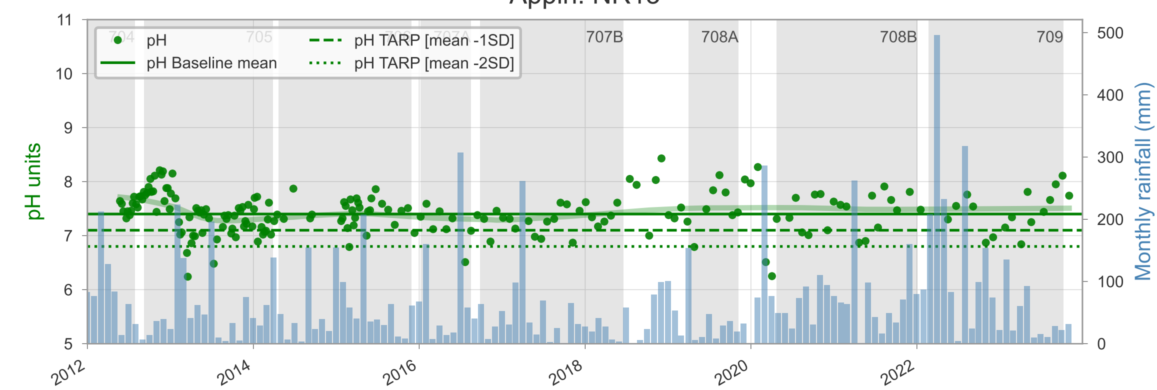

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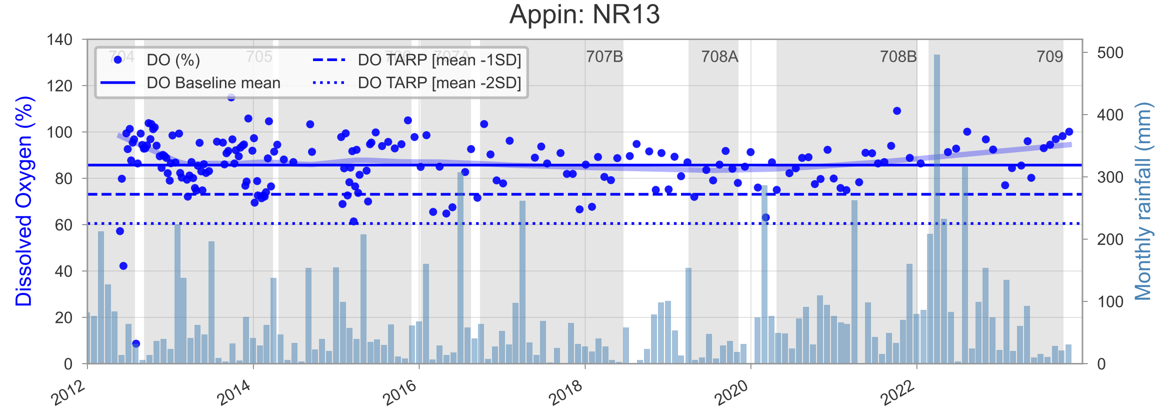
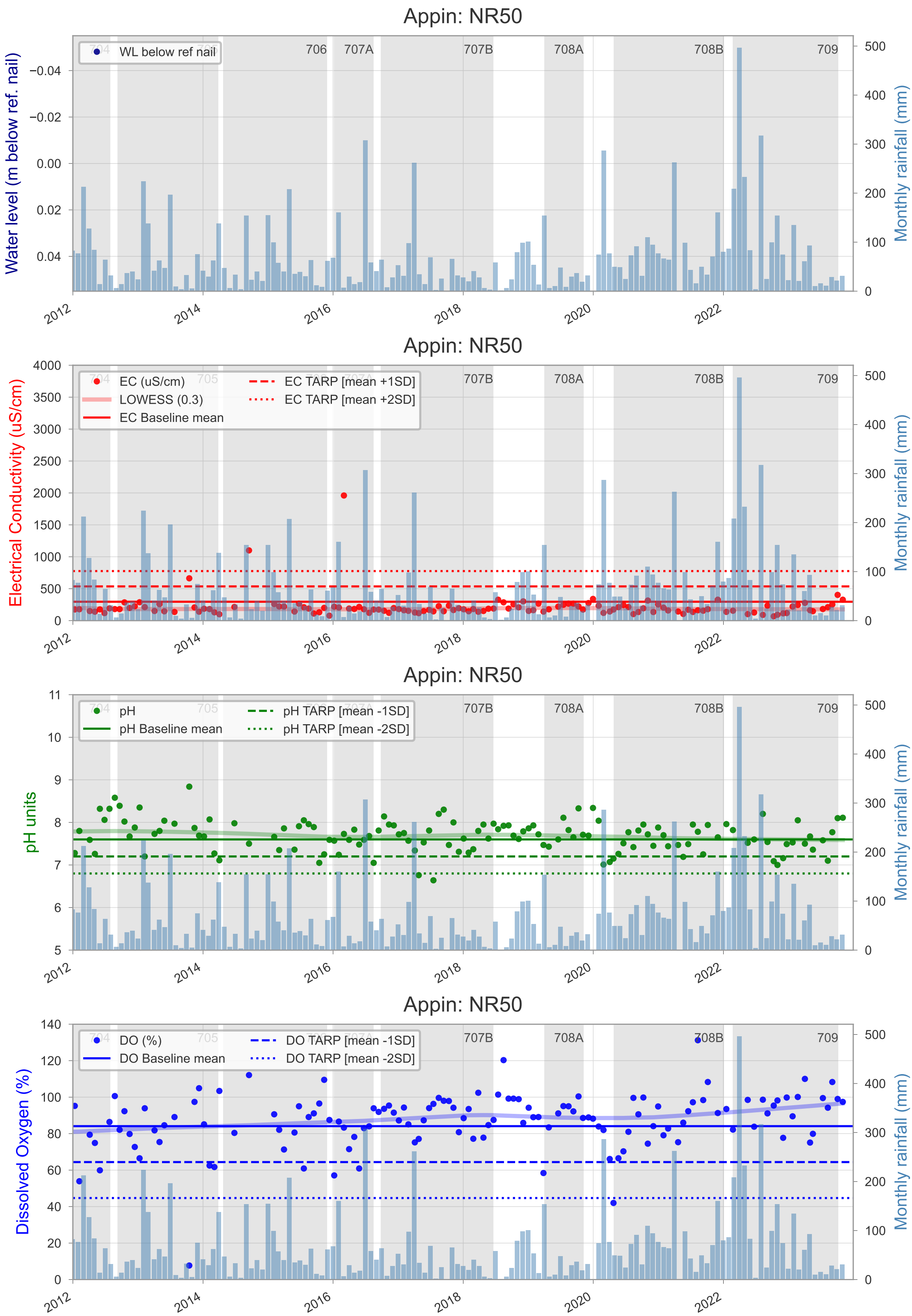
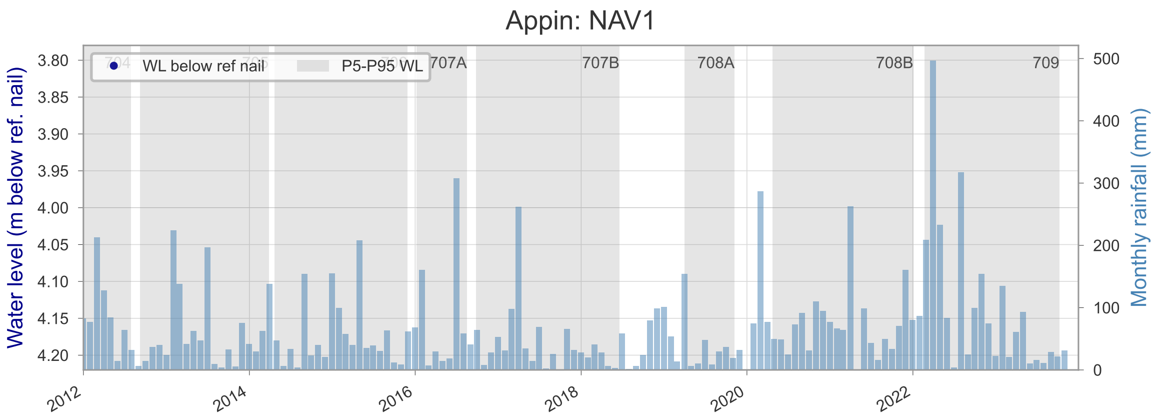
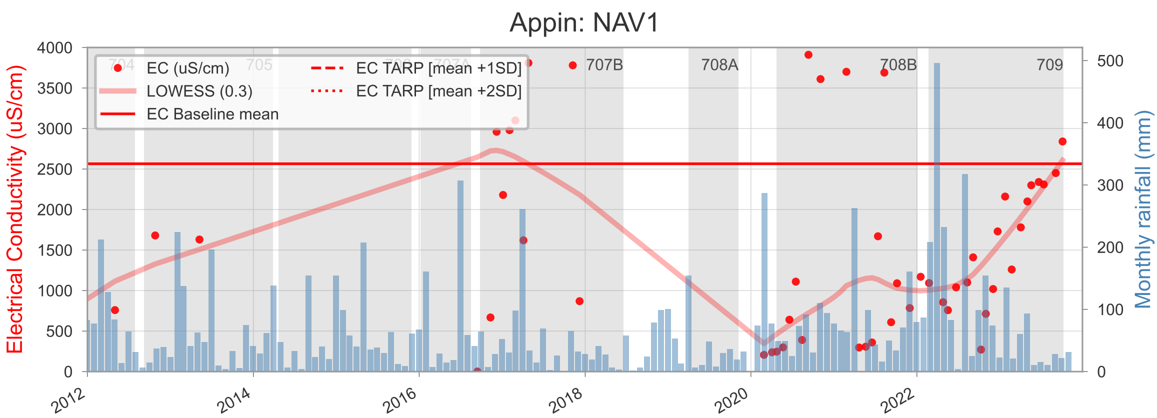


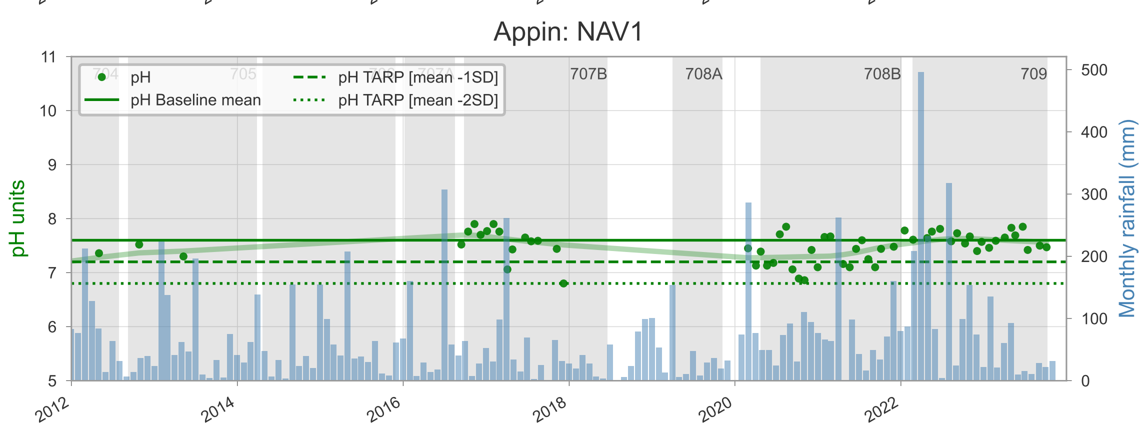
Appendix 3A: Appin AA7&9 Surface water quality timeseries (field)

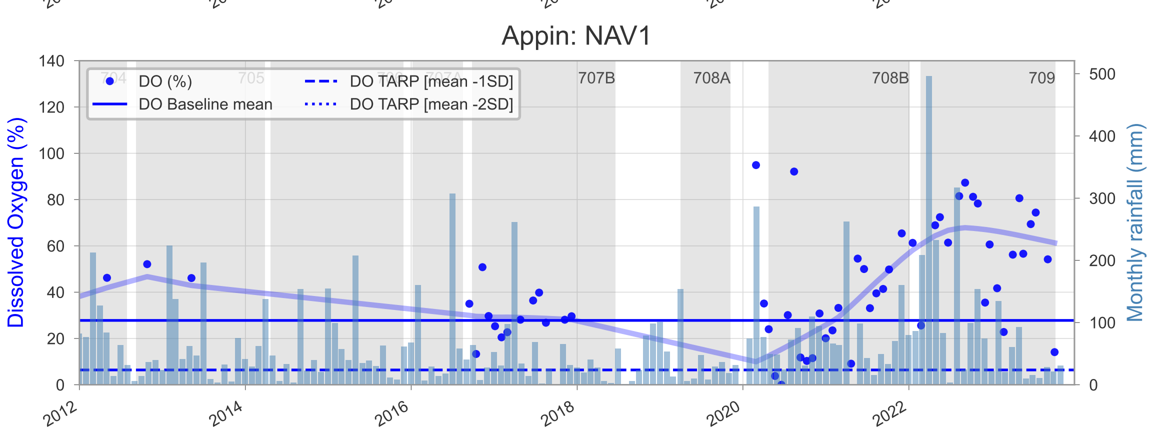


Appendix 3A: Appin AA7&9 Surface water quality timeseries (field)

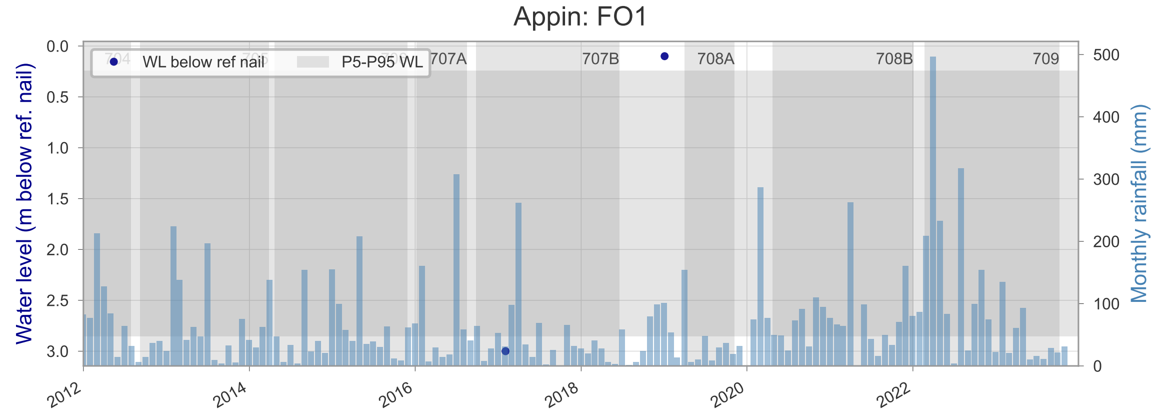


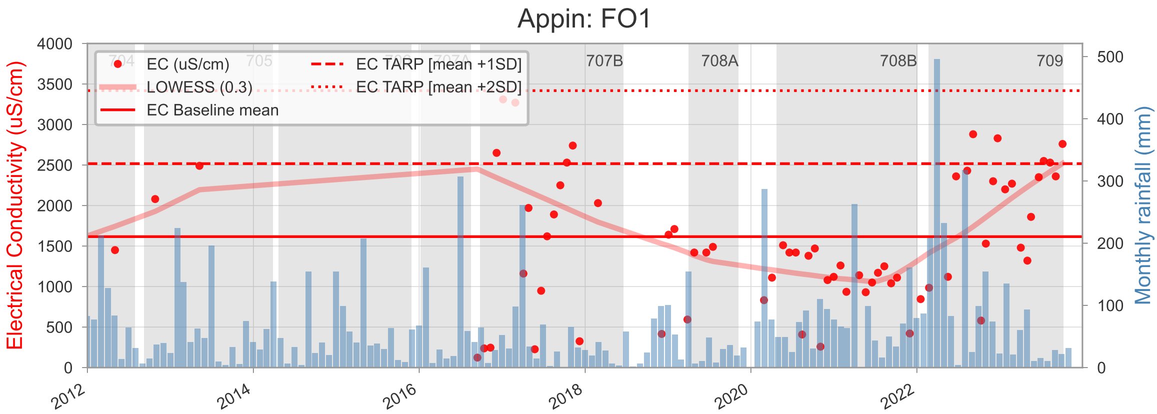


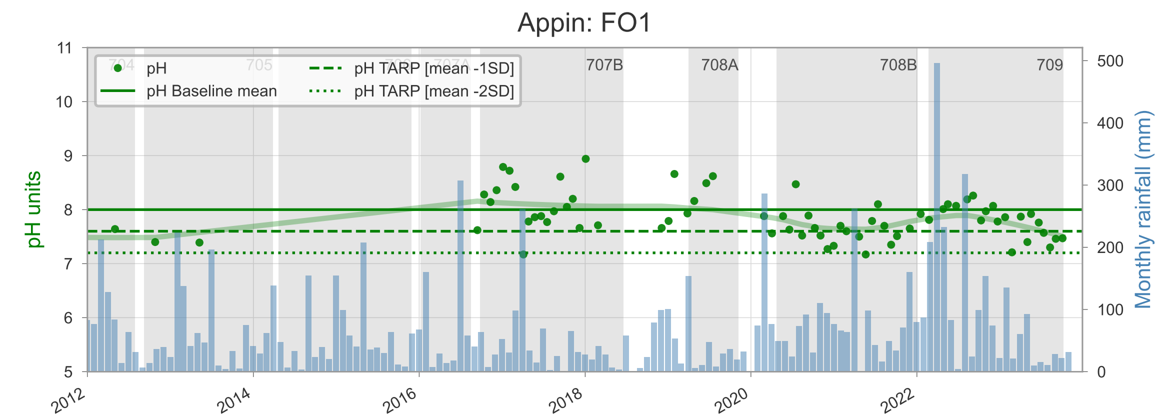


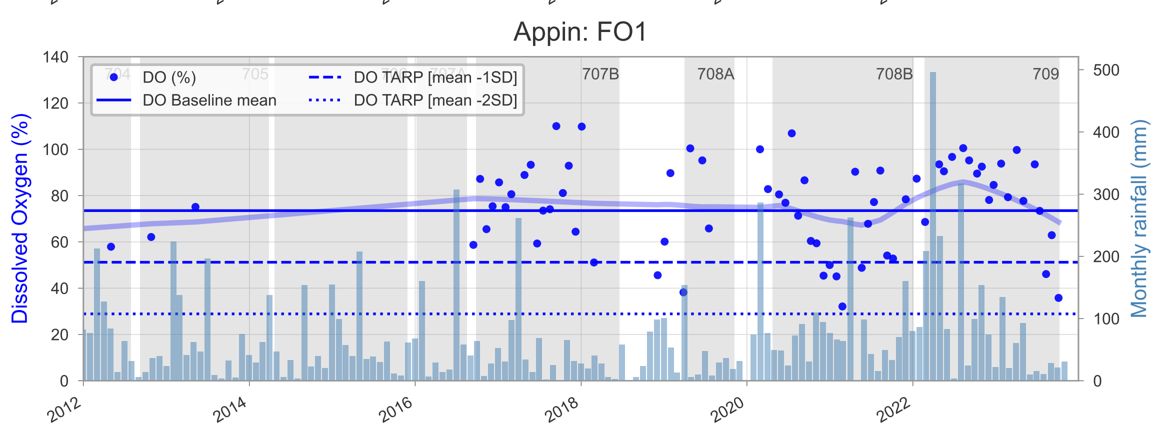


Appendix 3A: Appin AA7&9 Surface water quality timeseries (field)

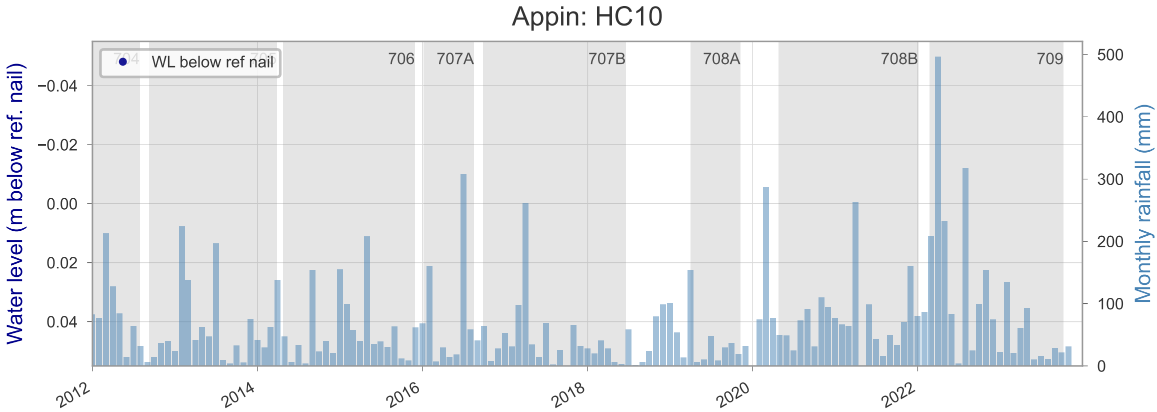


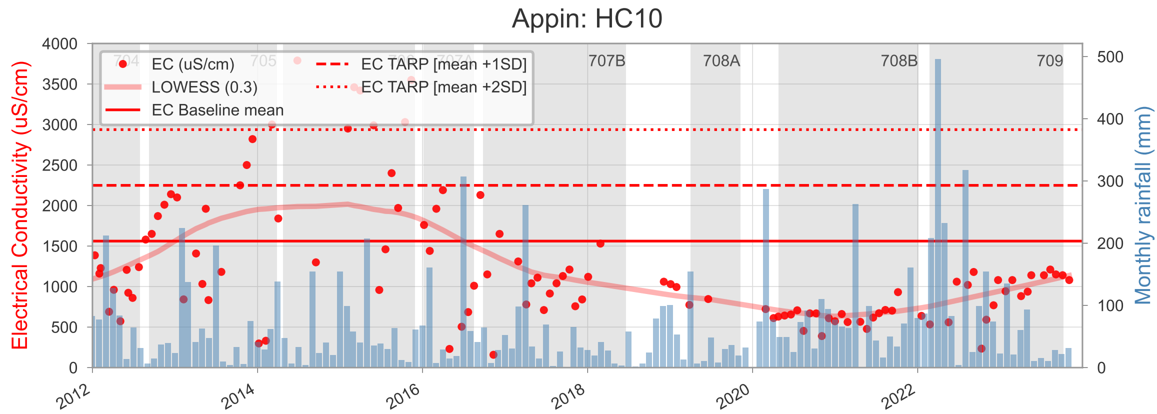


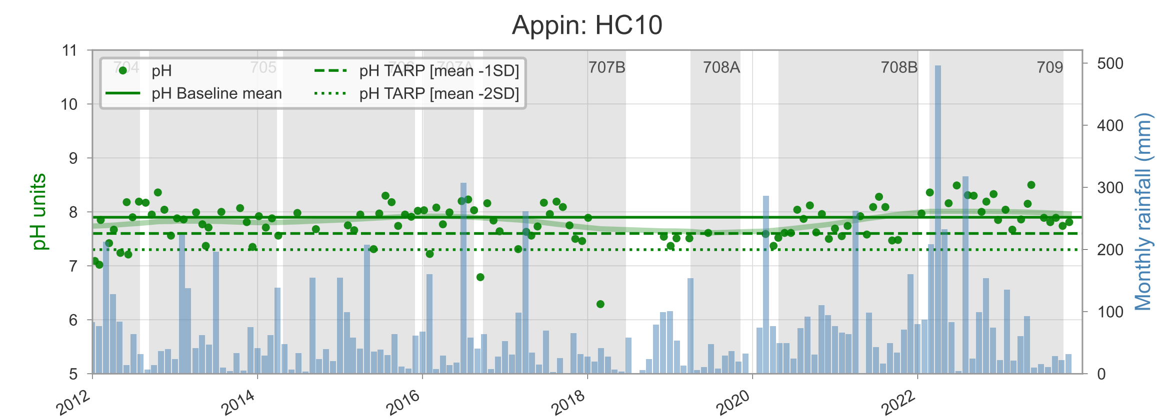


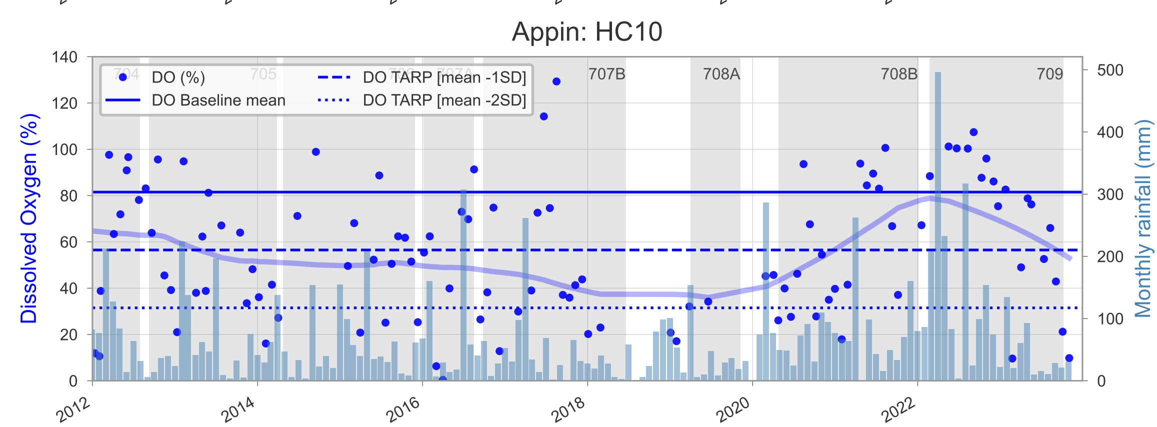


Appendix 3A: Appin AA7&9 Surface water quality timeseries (field)

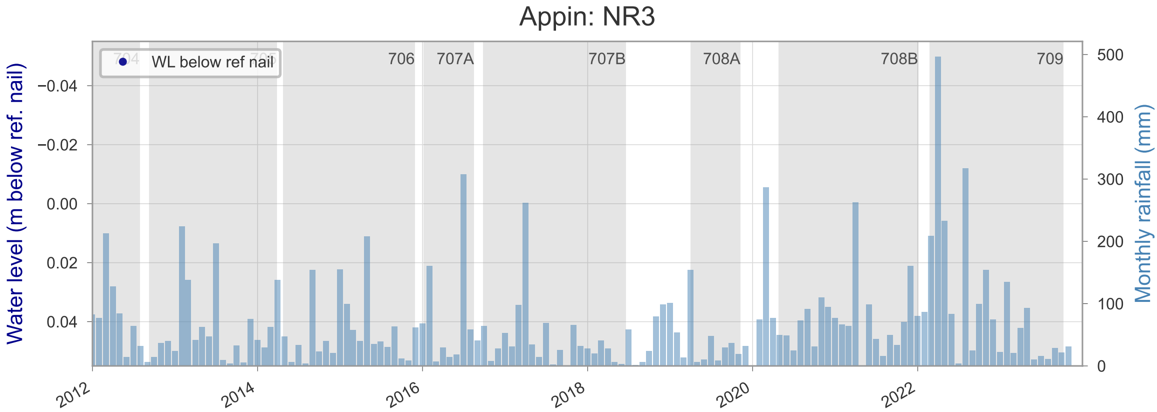


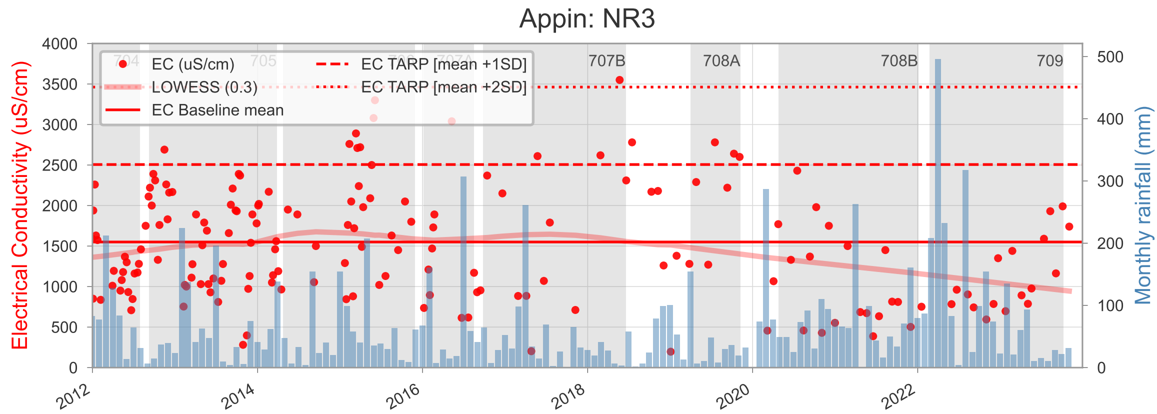


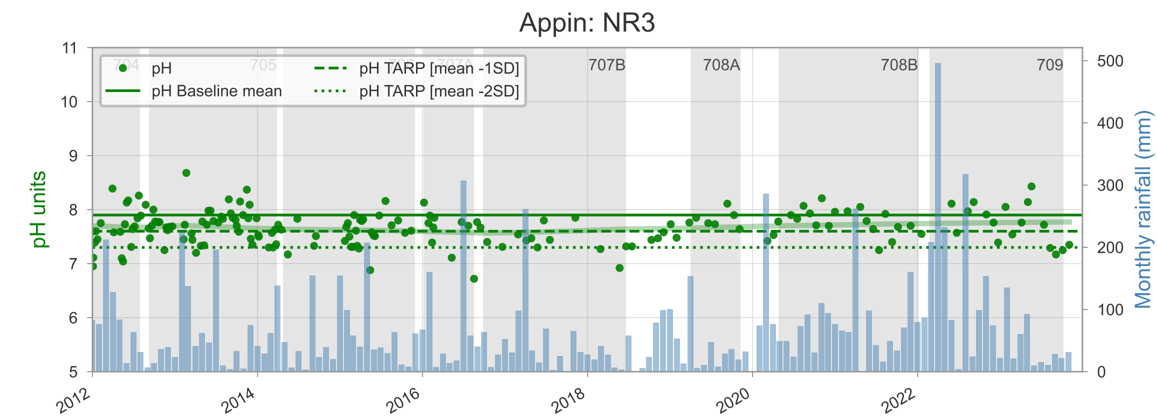


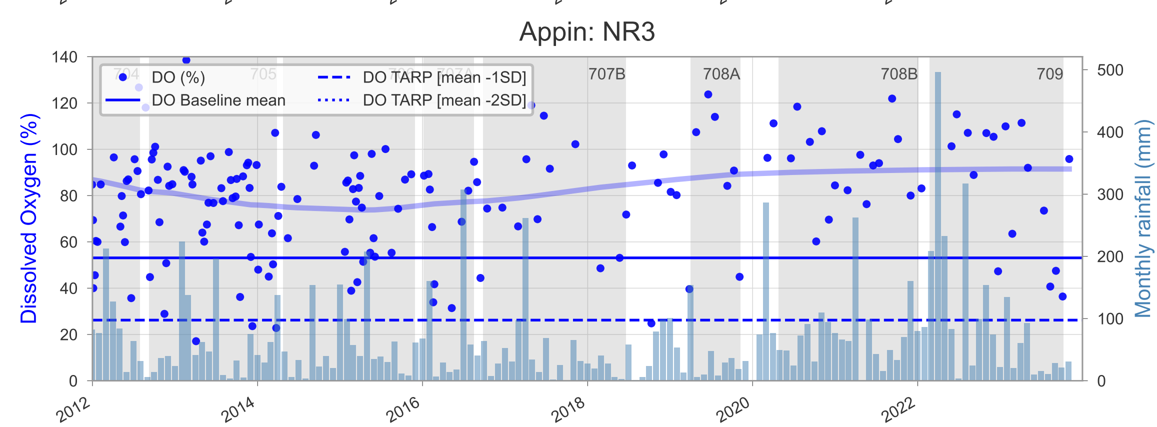


Appendix 3A: Appin AA7&9 Surface water quality timeseries (field)









Appendix 3B: Appin AA7&9 Surface water metals timeseries

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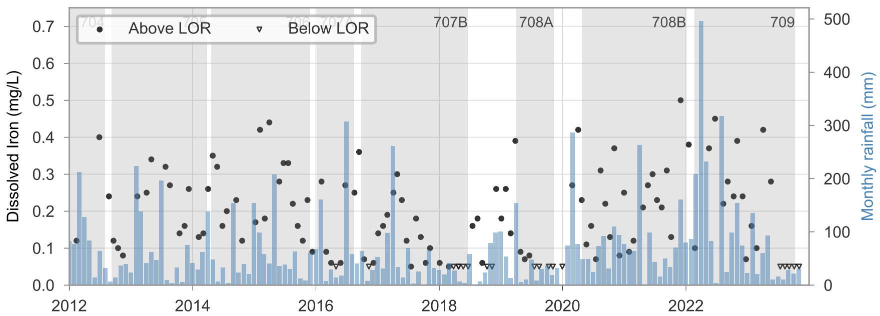

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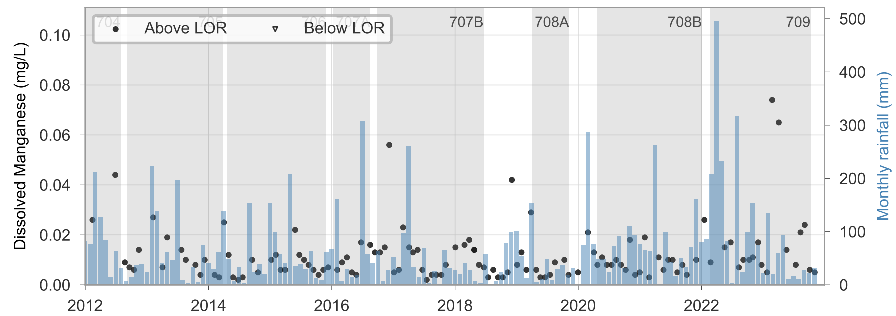

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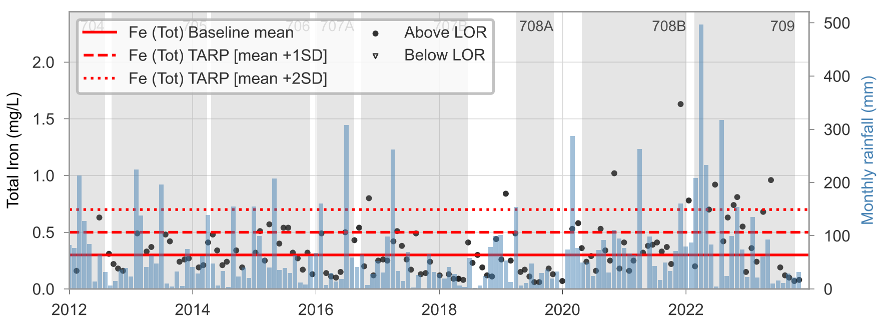

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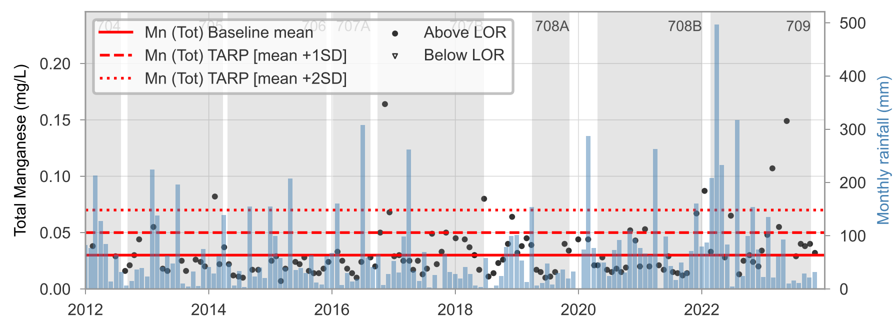

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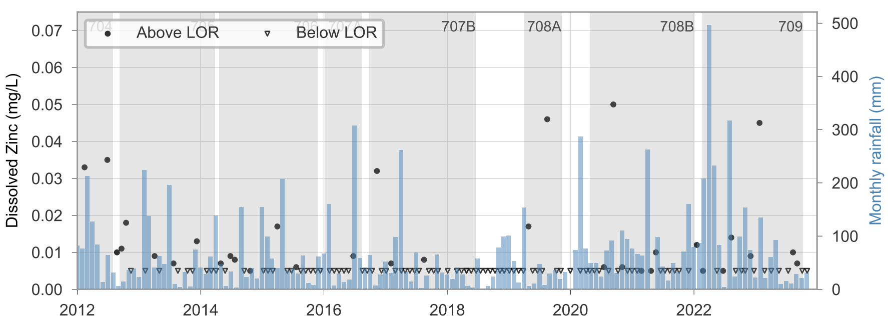

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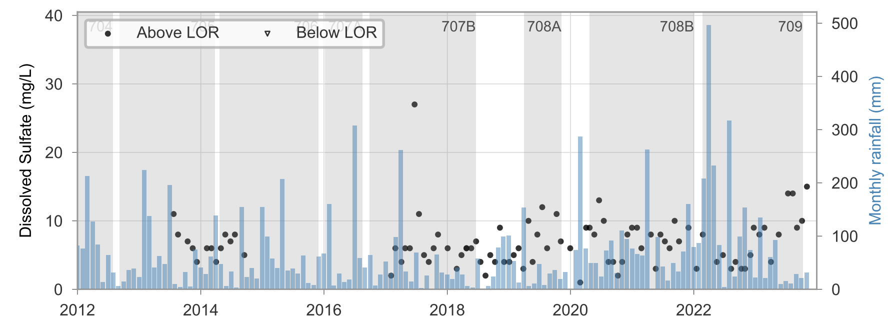
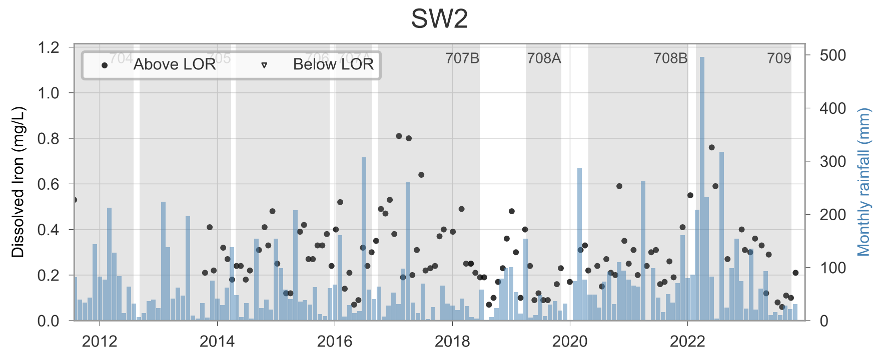
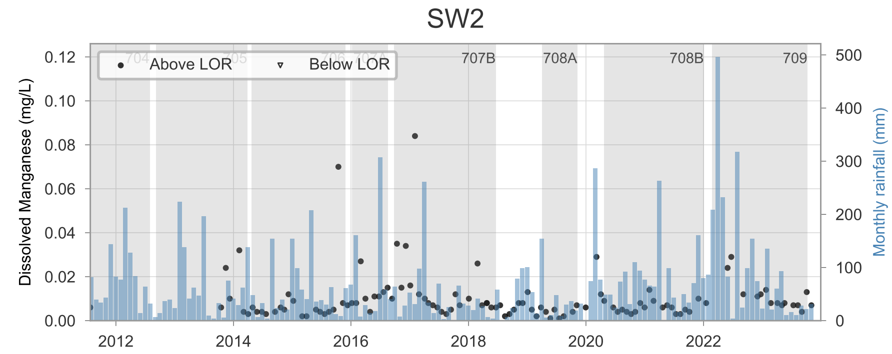
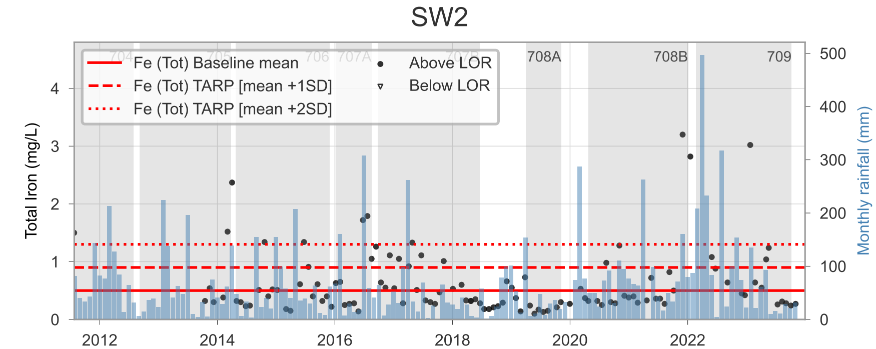
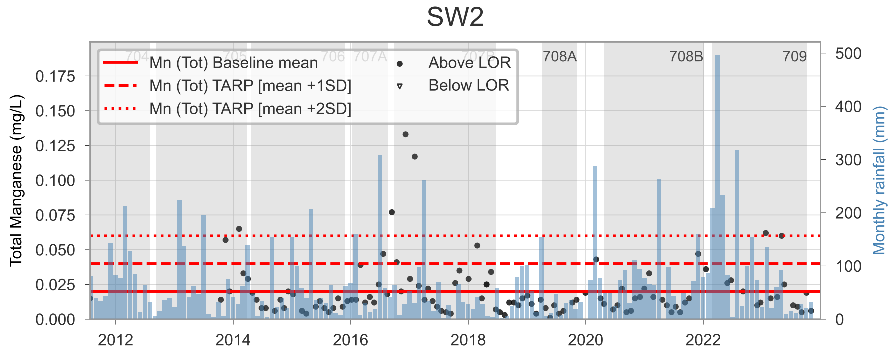


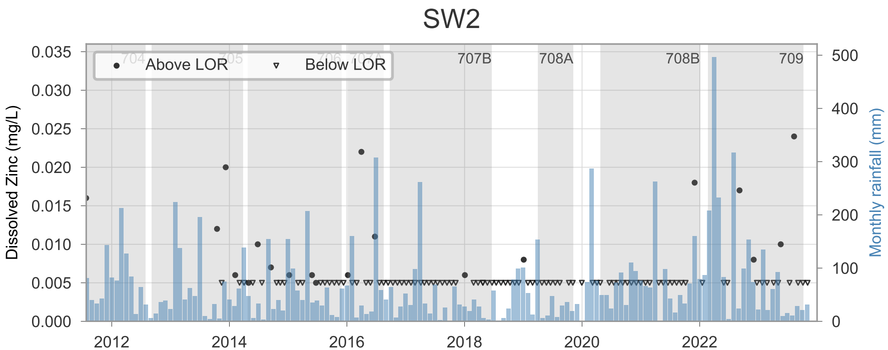
Appendix 3B: Appin AA7&9 Surface water metals timeseries

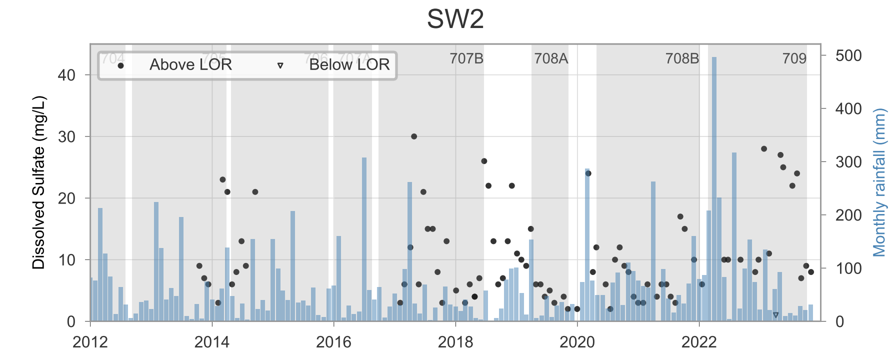




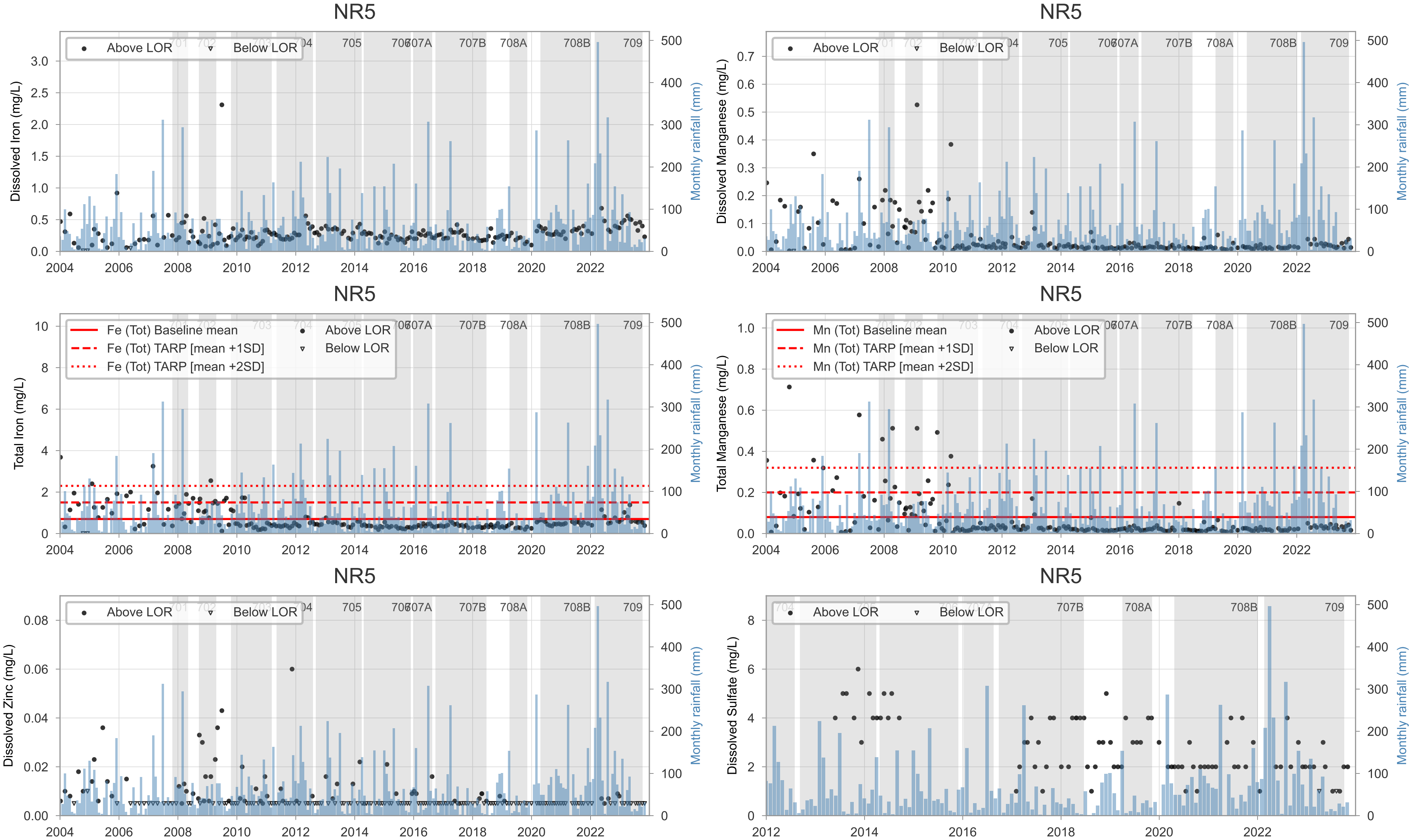




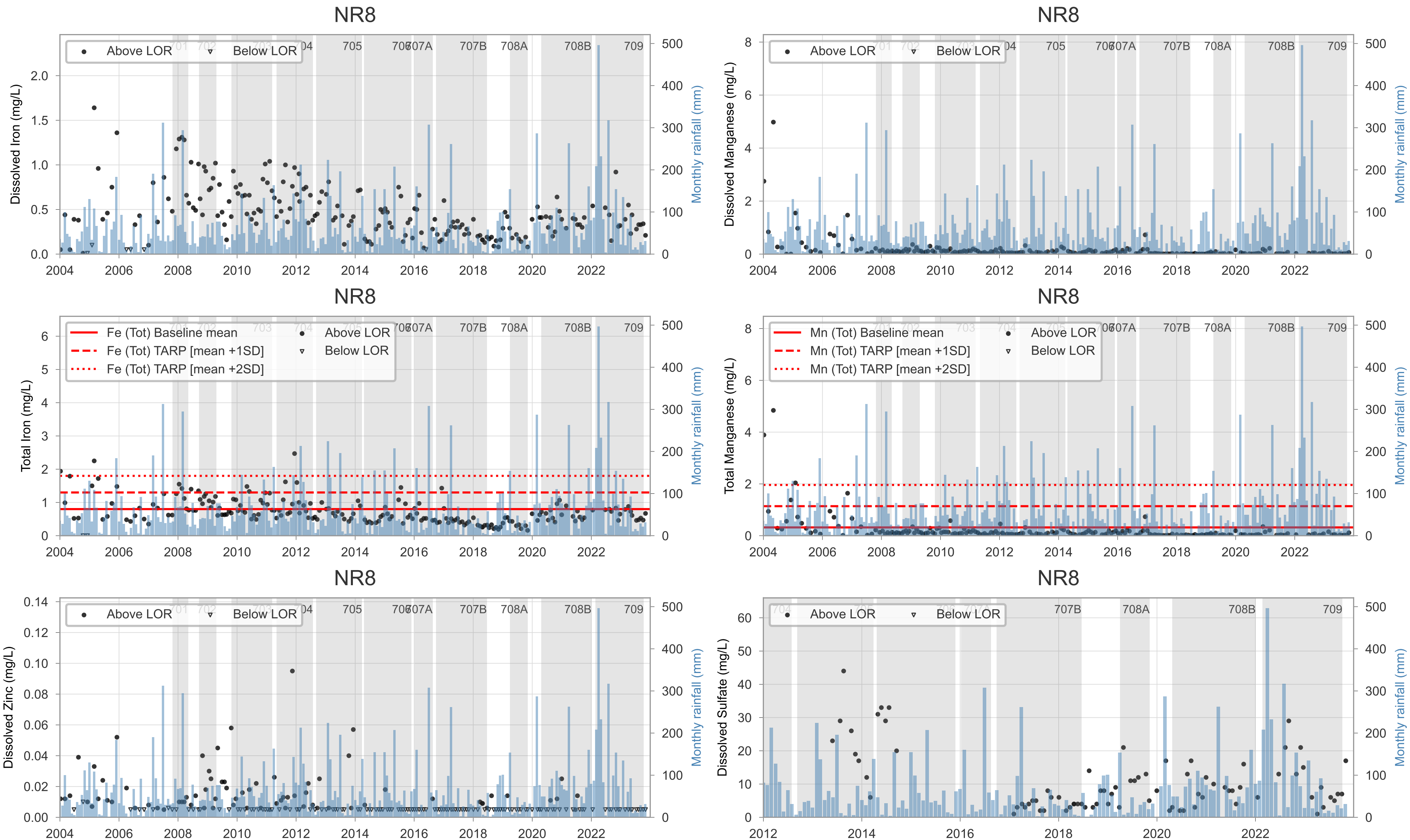




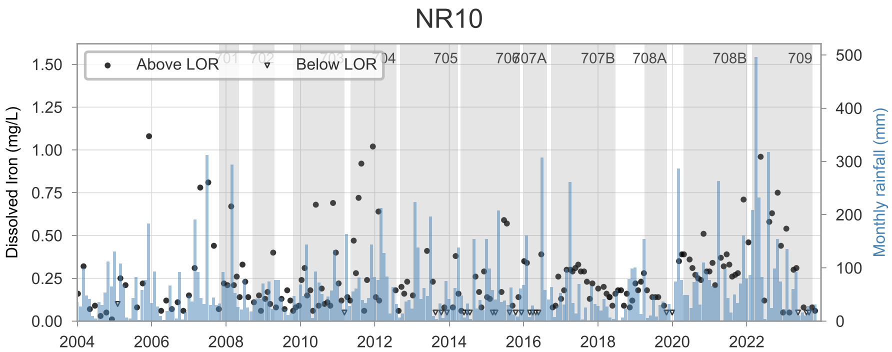
Appendix 3B: Appin AA7&9 Surface water metals timeseries

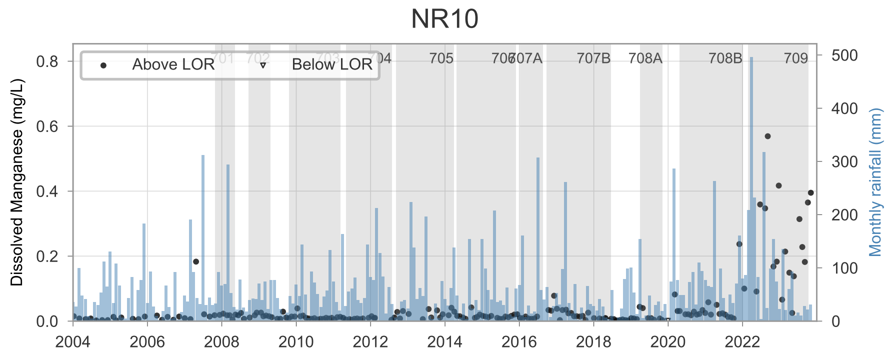


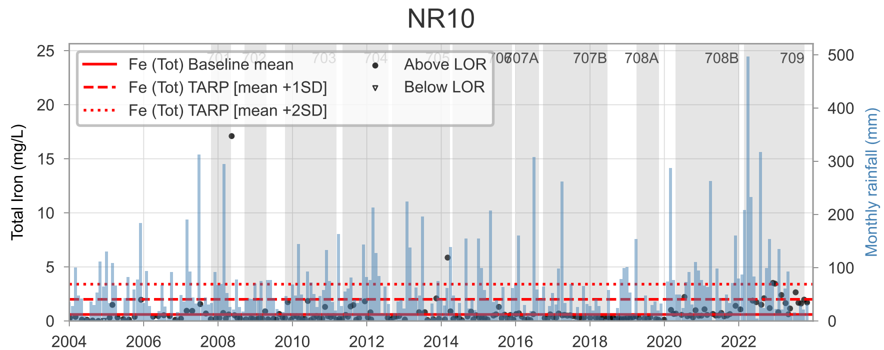
Appendix 3B: Appin AA7&9 Surface water metals timeseries

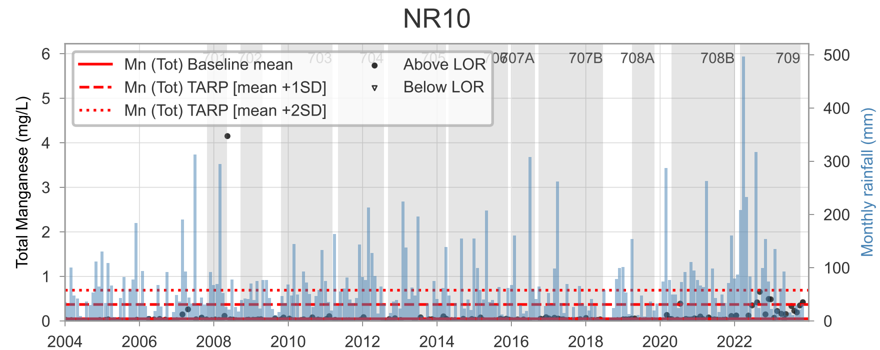


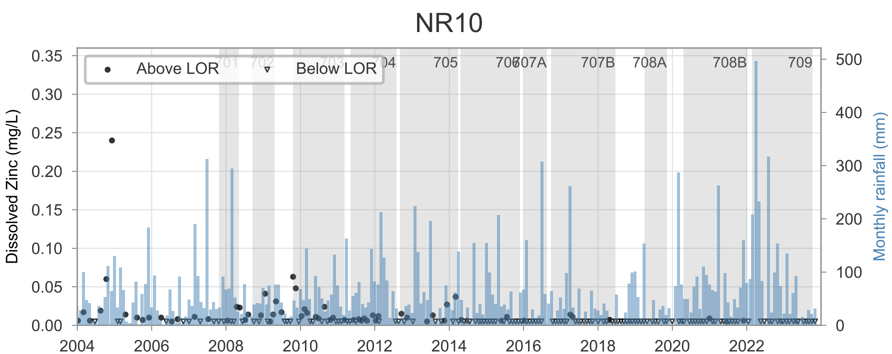
Appendix 3B: Appin AA7&9 Surface water metals timeseries

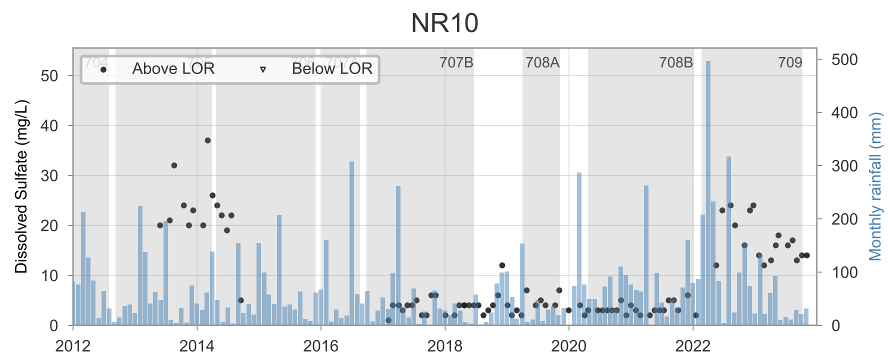




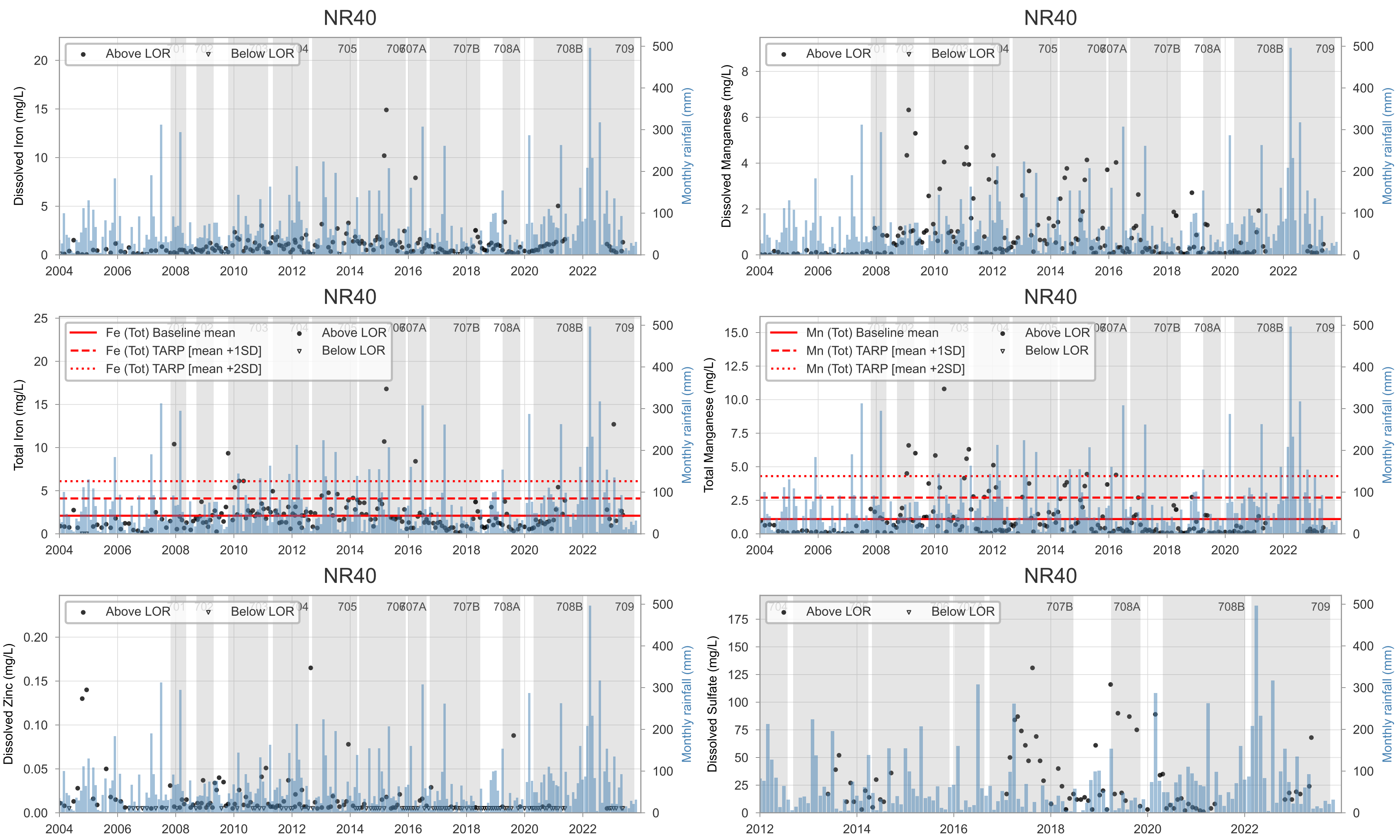




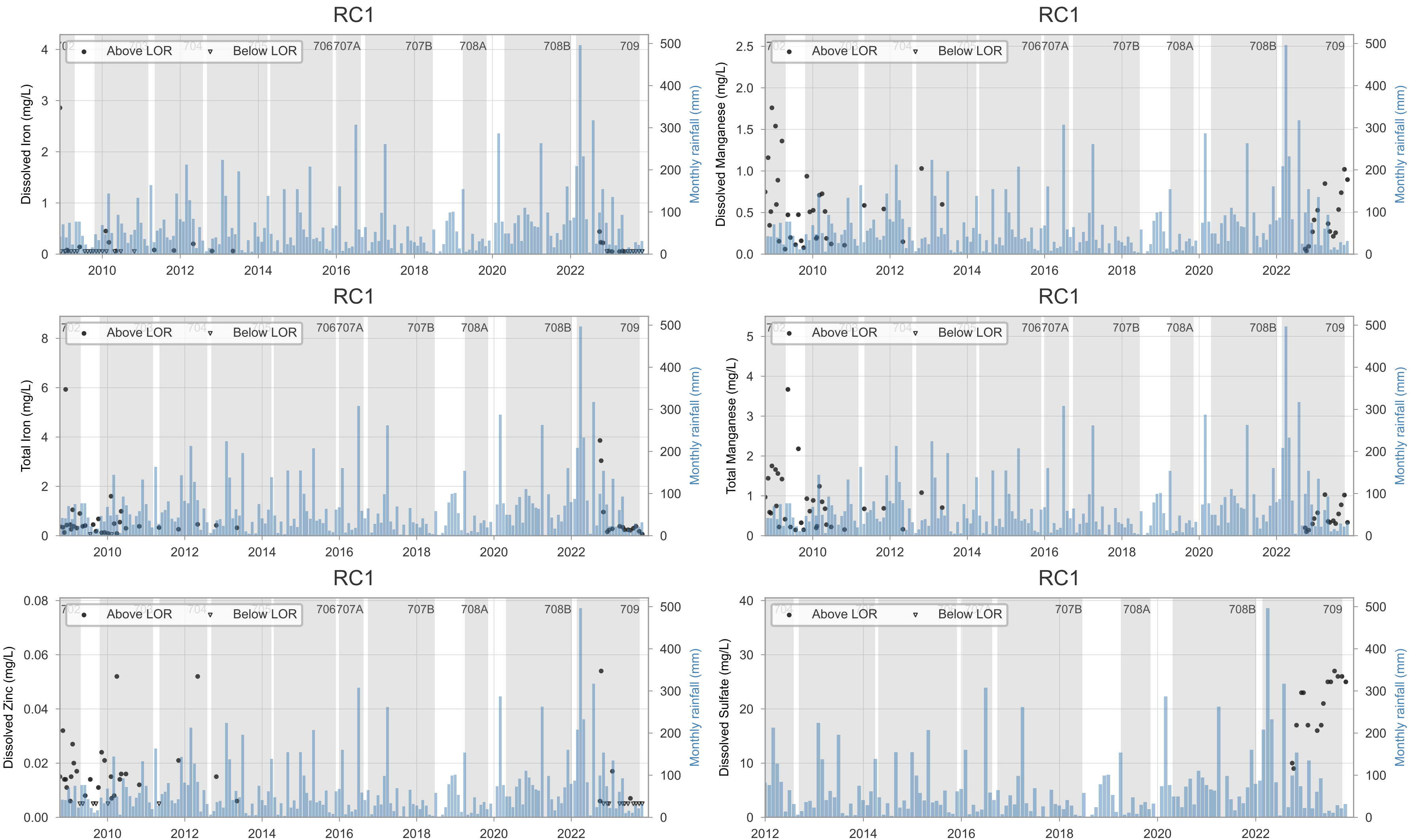




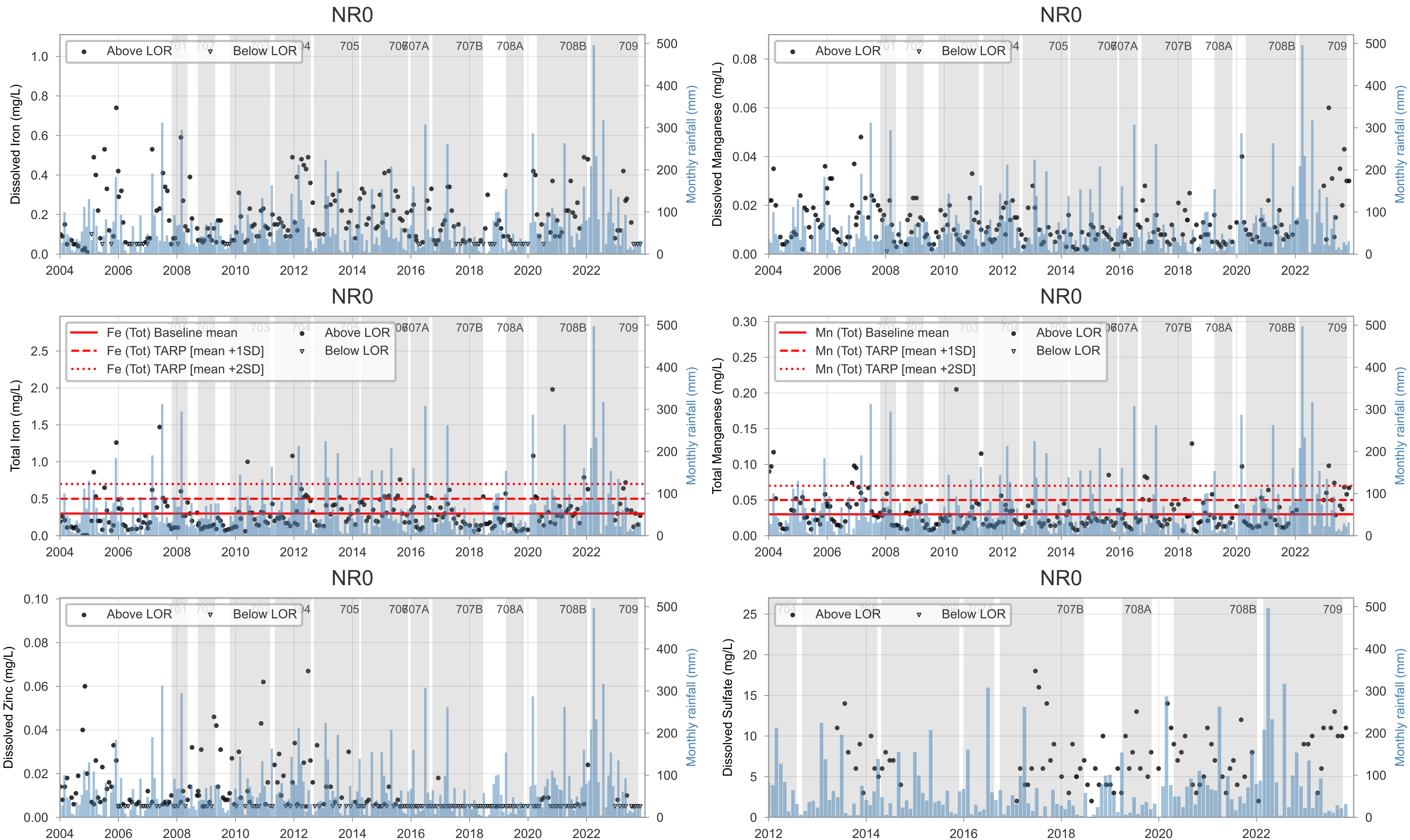
Appendix 3B: Appin AA7&9 Surface water metals timeseries



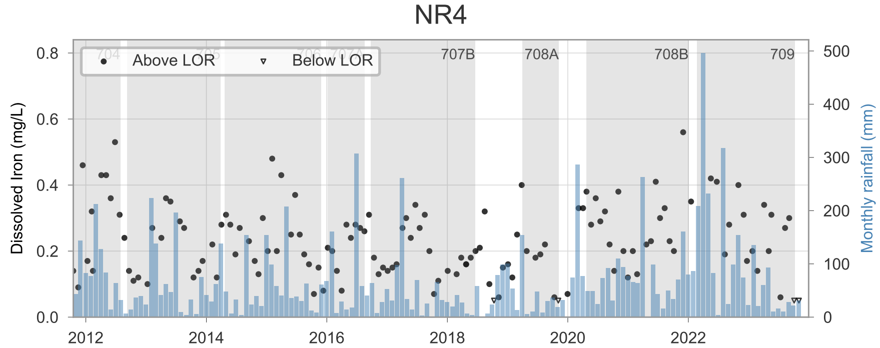
Appendix 3B: Appin AA7&9 Surface water metals timeseries

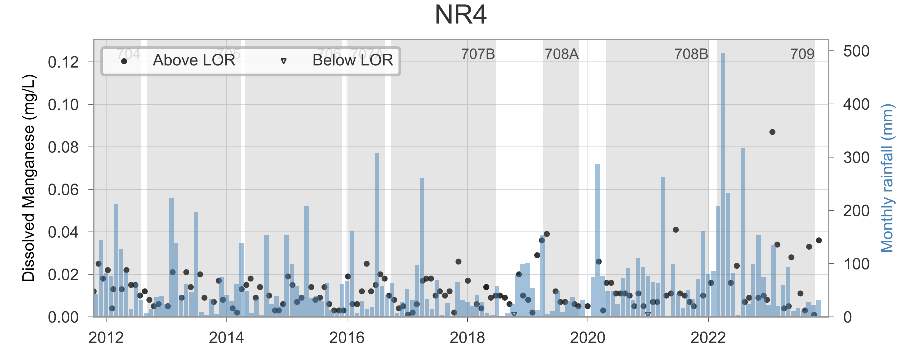


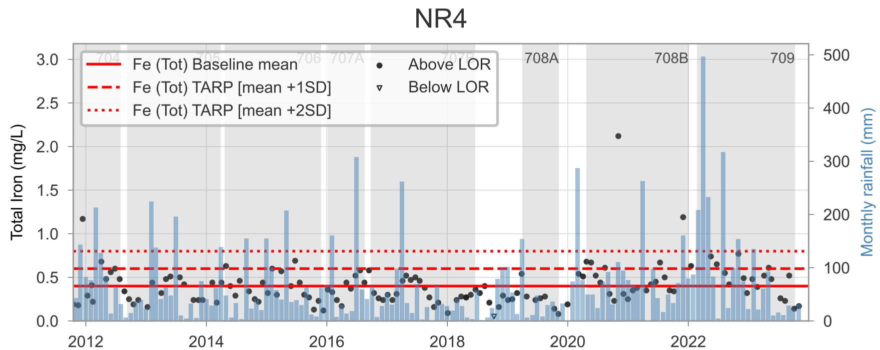
Appendix 3B: Appin AA7&9 Surface water metals timeseries

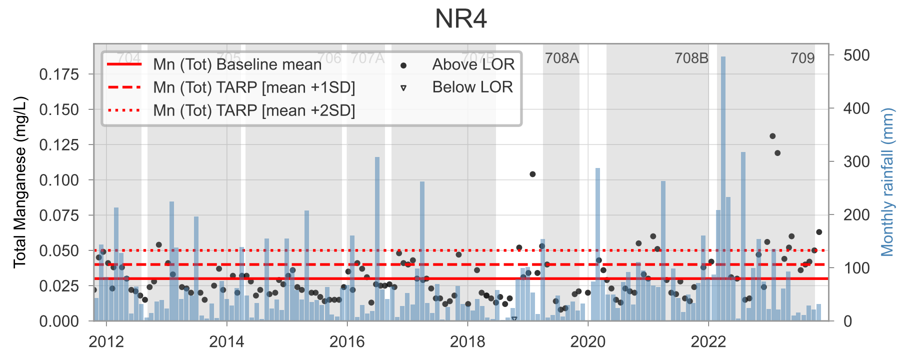


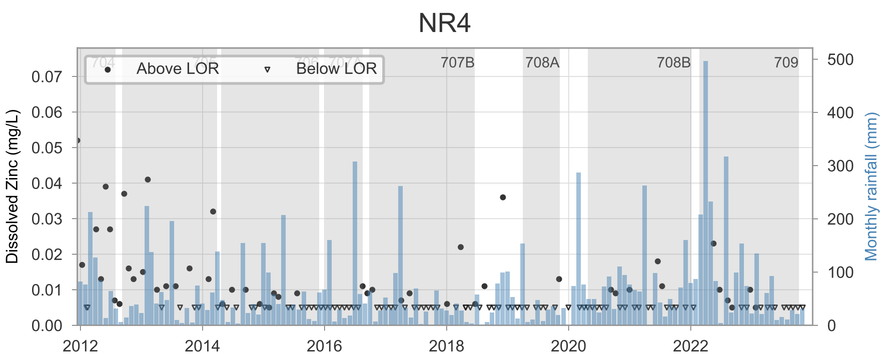
Appendix 3B: Appin AA7&9 Surface water metals timeseries

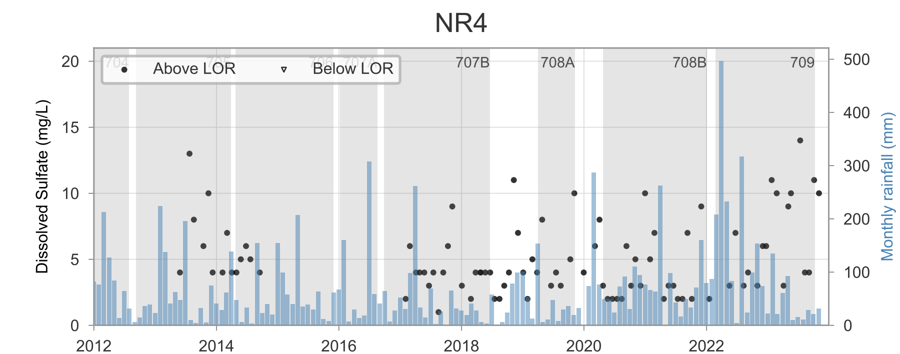




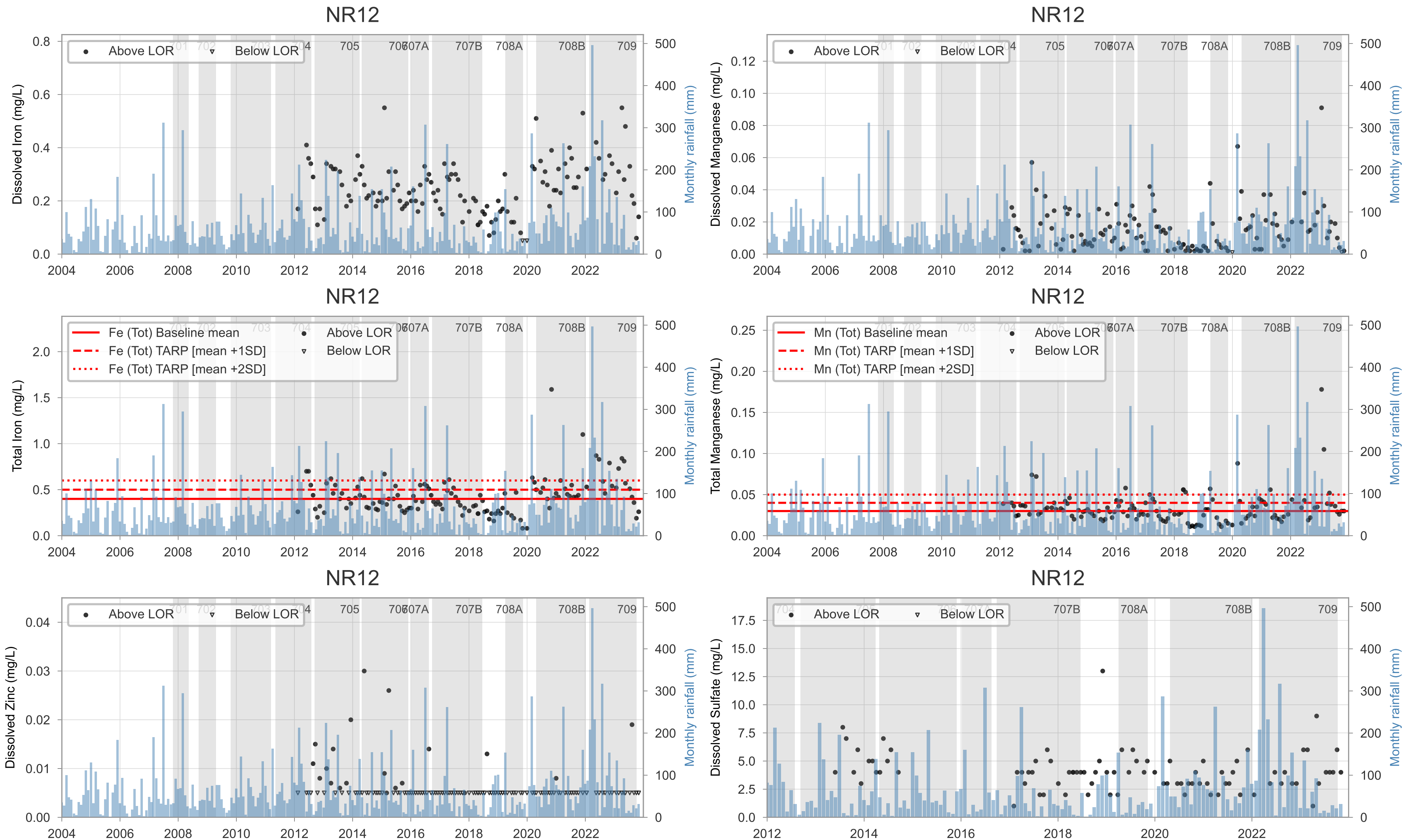




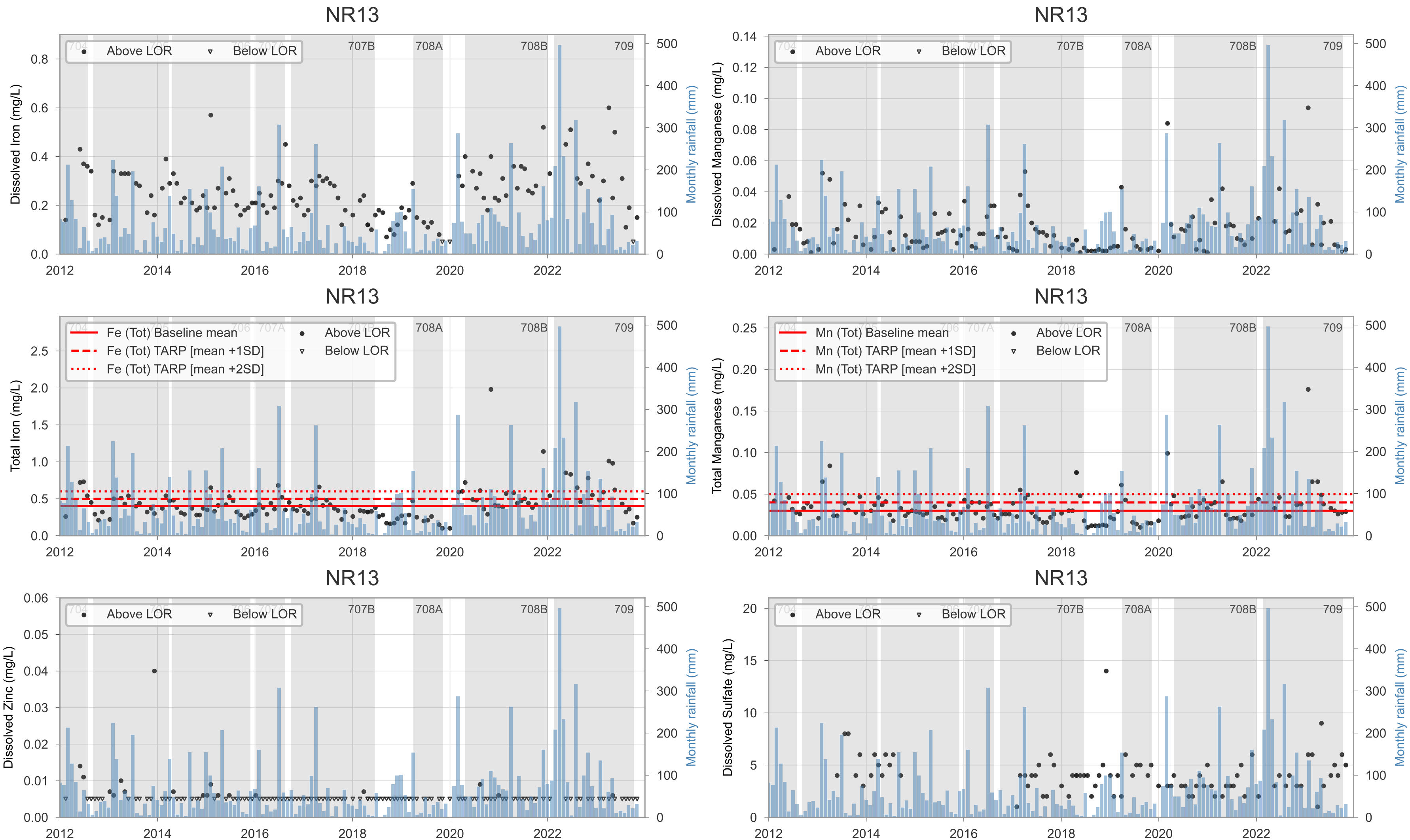




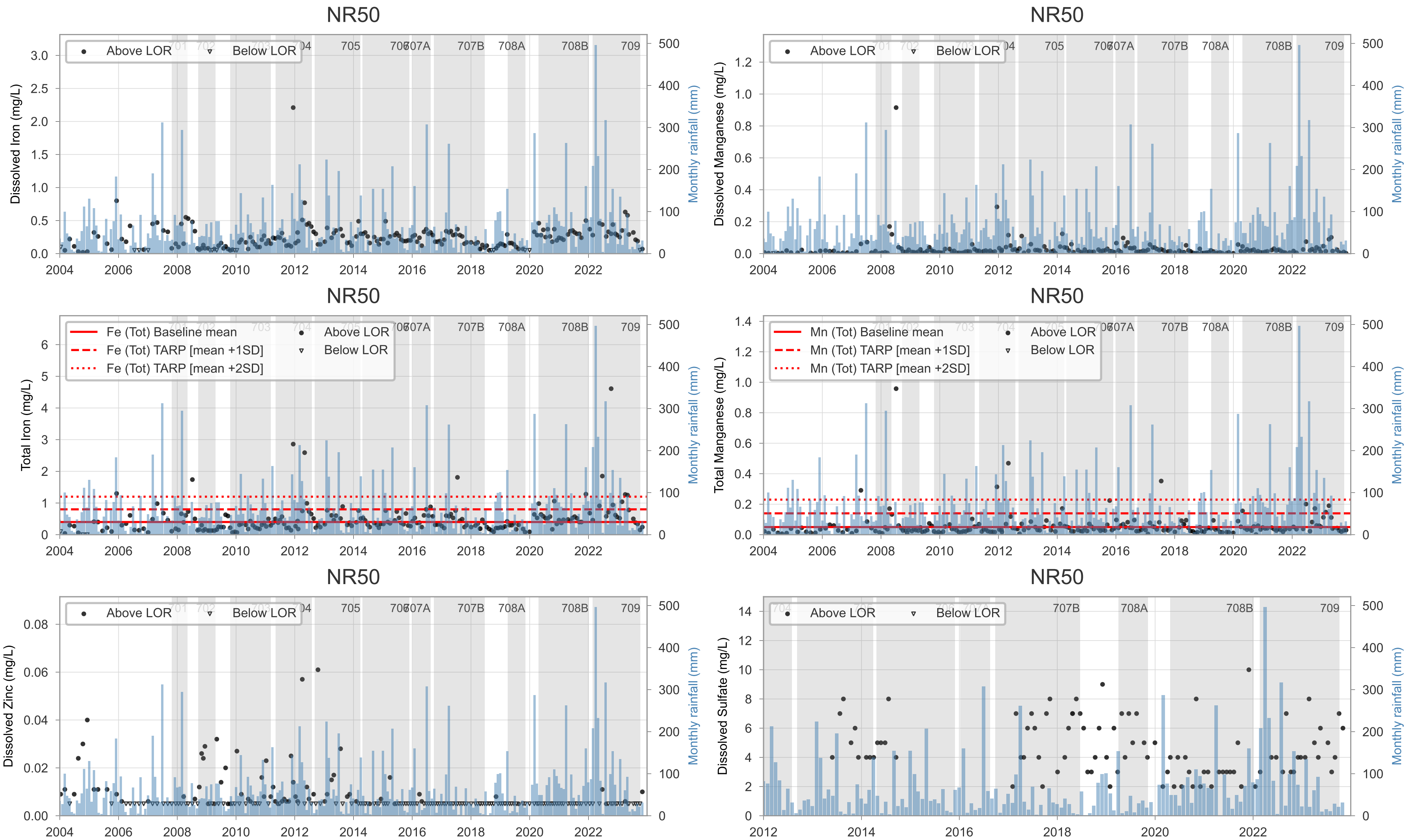
Appendix 3B: Appin AA7&9 Surface water metals timeseries



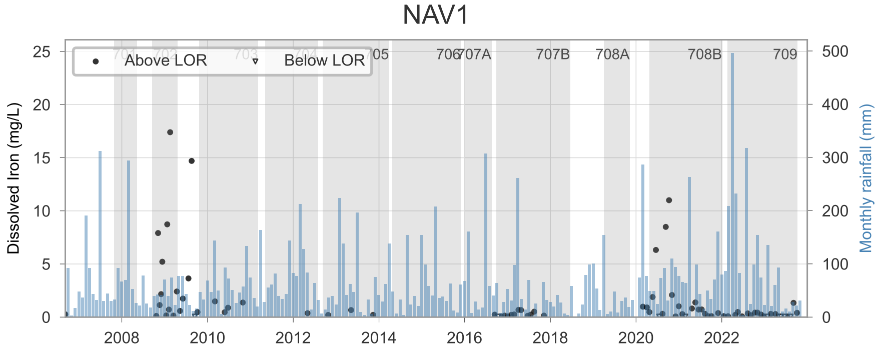
Appendix 3B: Appin AA7&9 Surface water metals timeseries

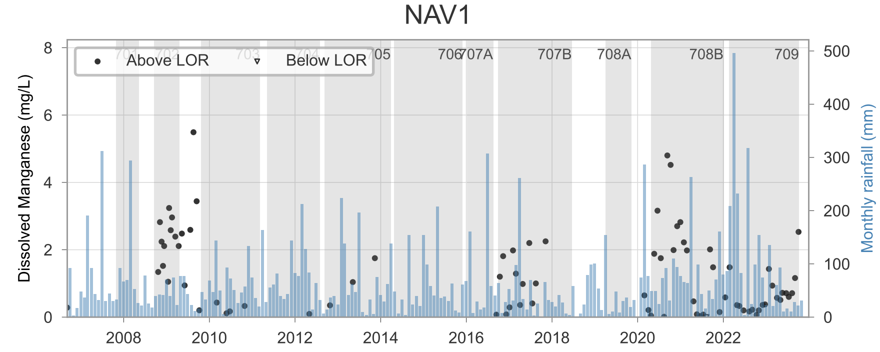


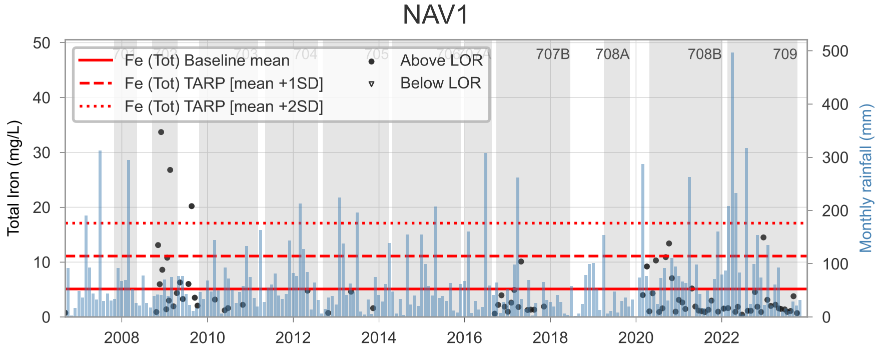
Appendix 3B: Appin AA7&9 Surface water metals timeseries

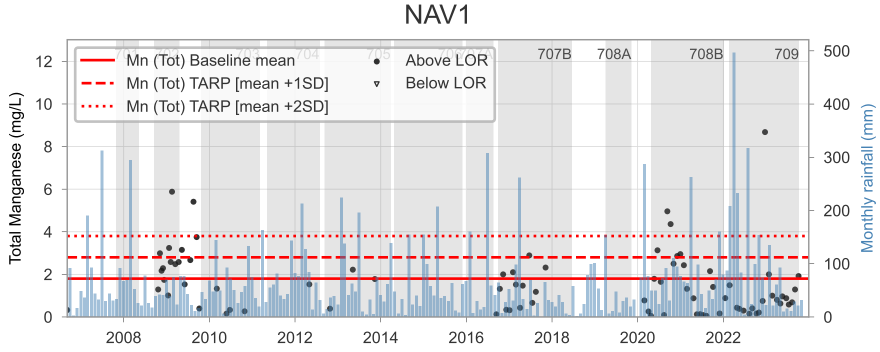


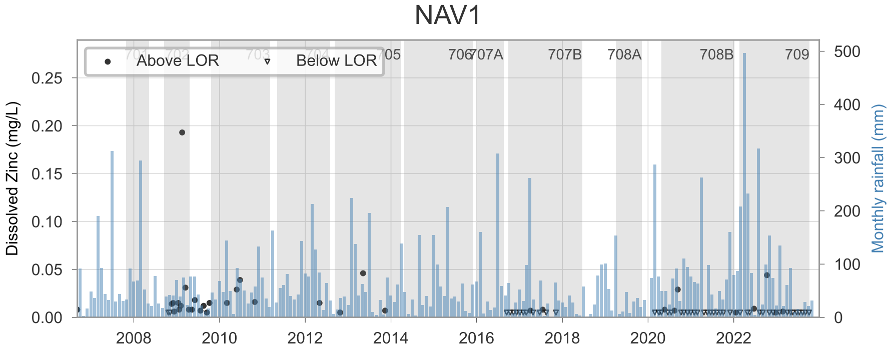
Appendix 3B: Appin AA7&9 Surface water metals timeseries

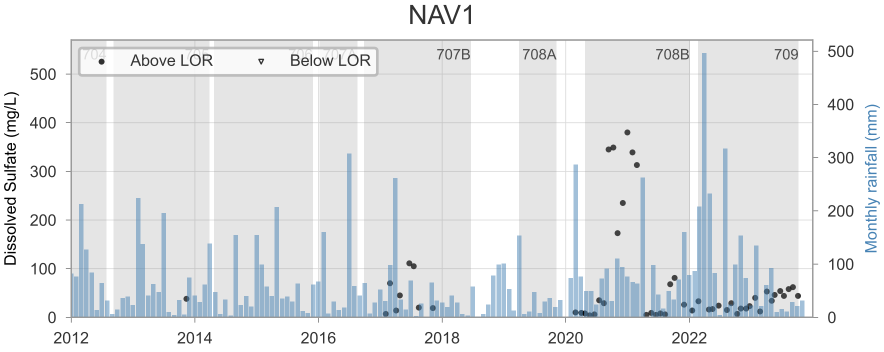




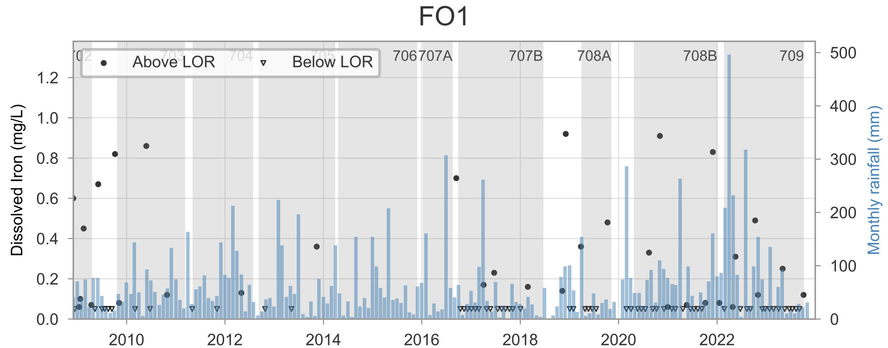


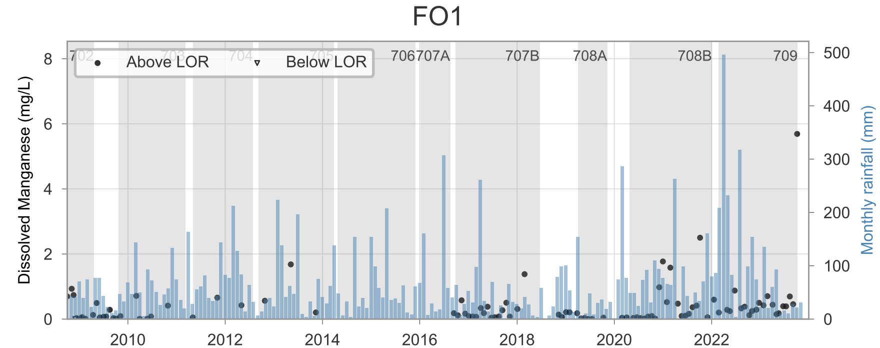


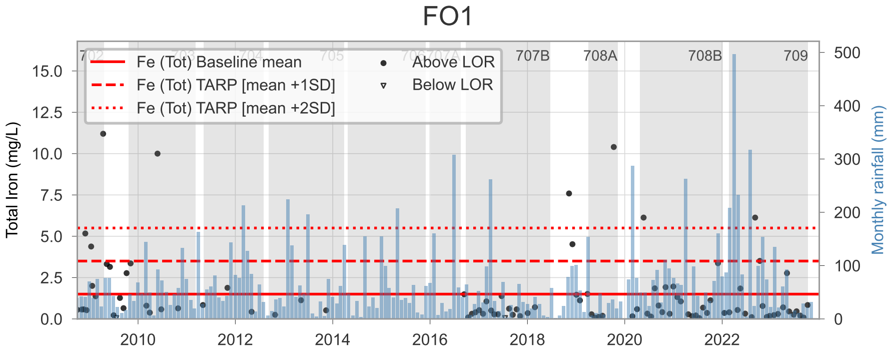


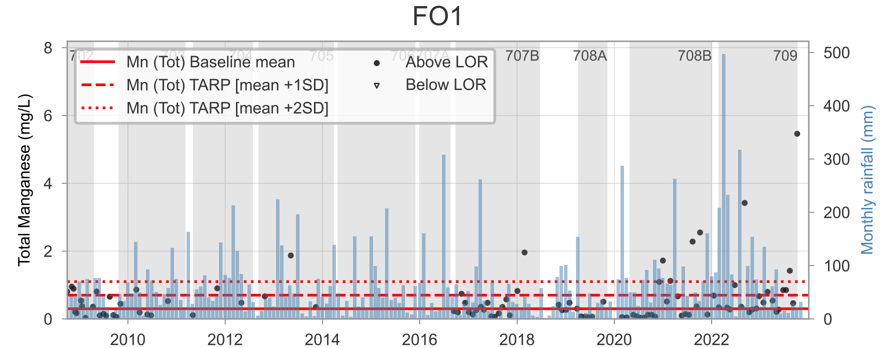


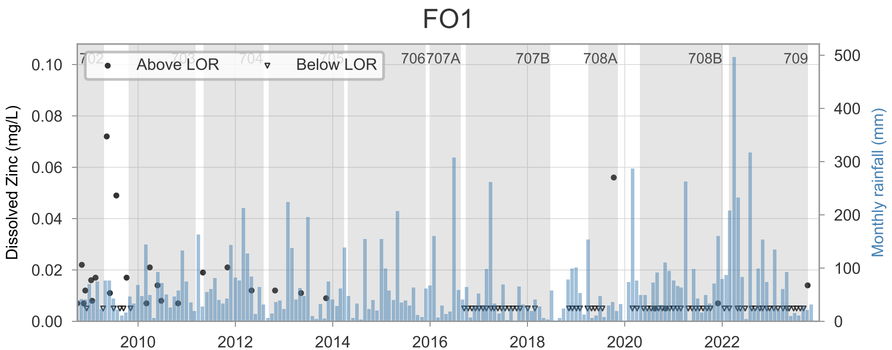
Appendix 3B: Appin AA7&9 Surface water metals timeseries

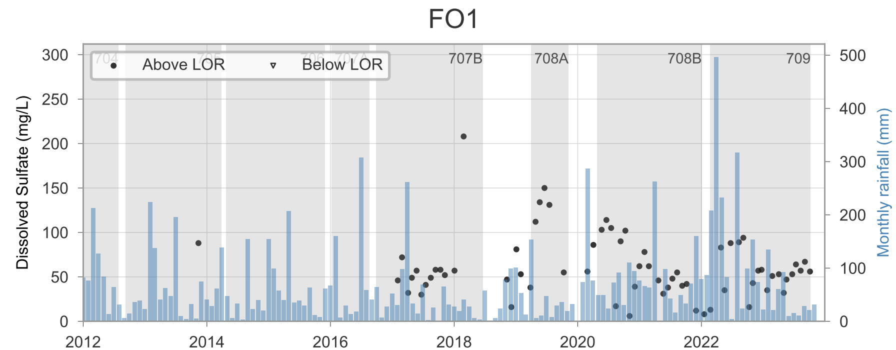




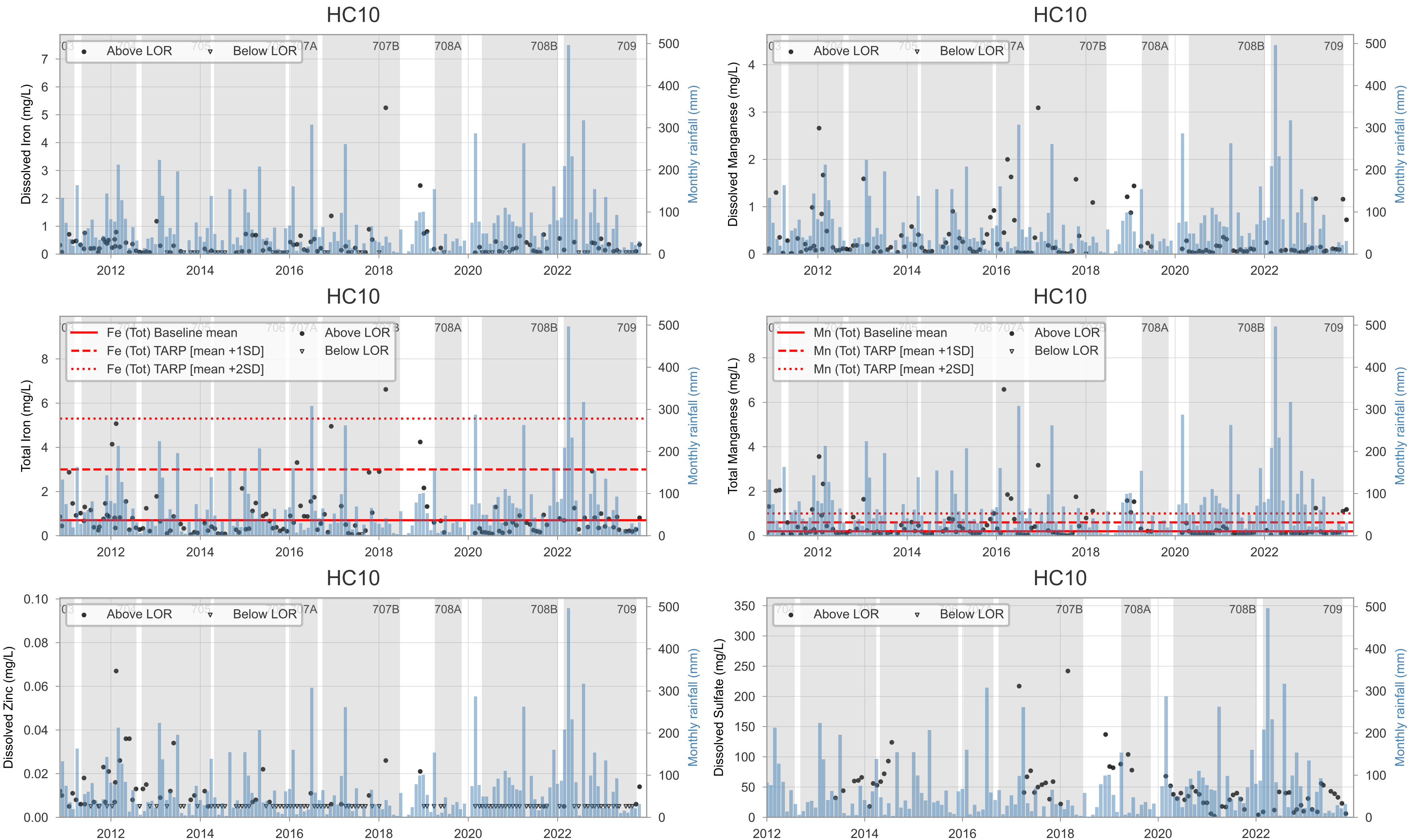




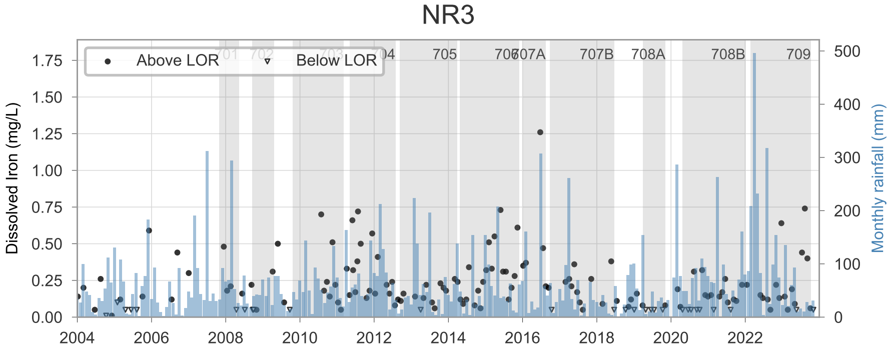


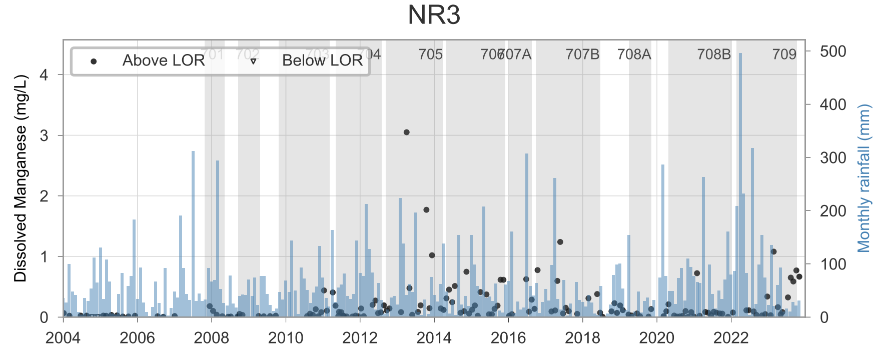


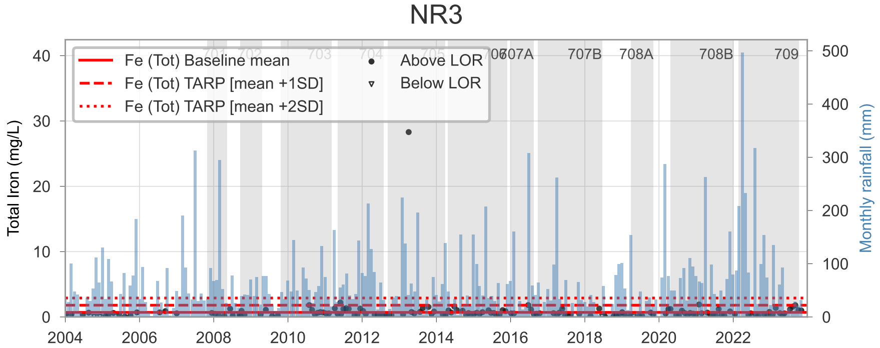
Appendix 3B: Appin AA7&9 Surface water metals timeseries

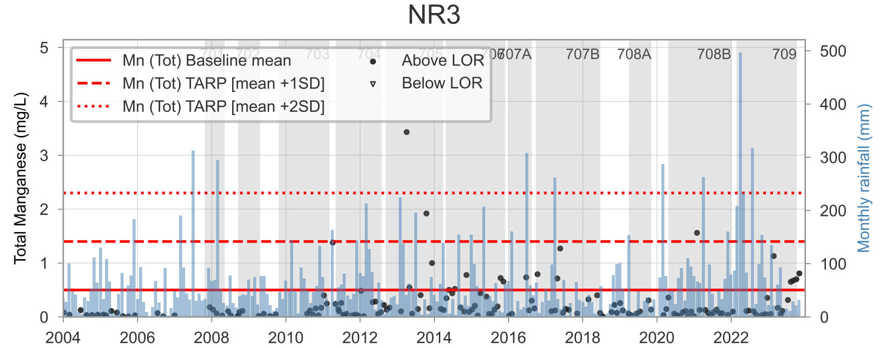


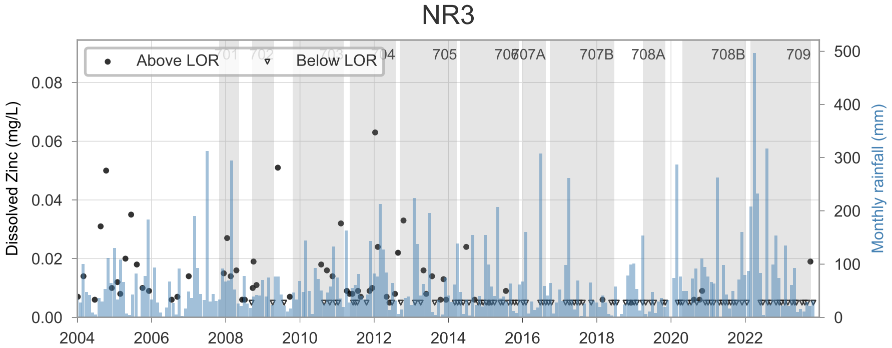
Appendix 3B: Appin AA7&9 Surface water metals timeseries

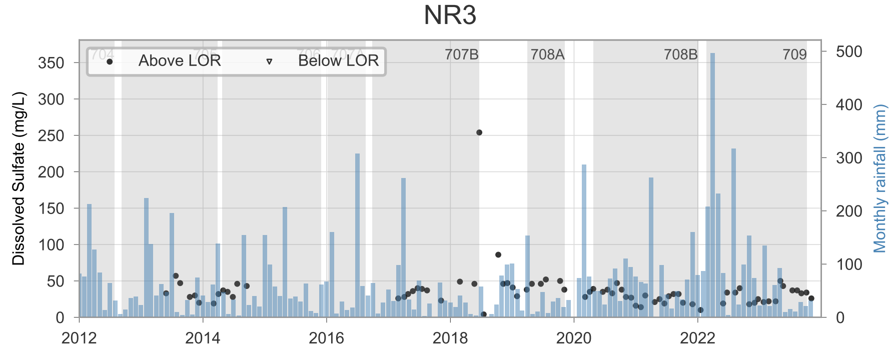


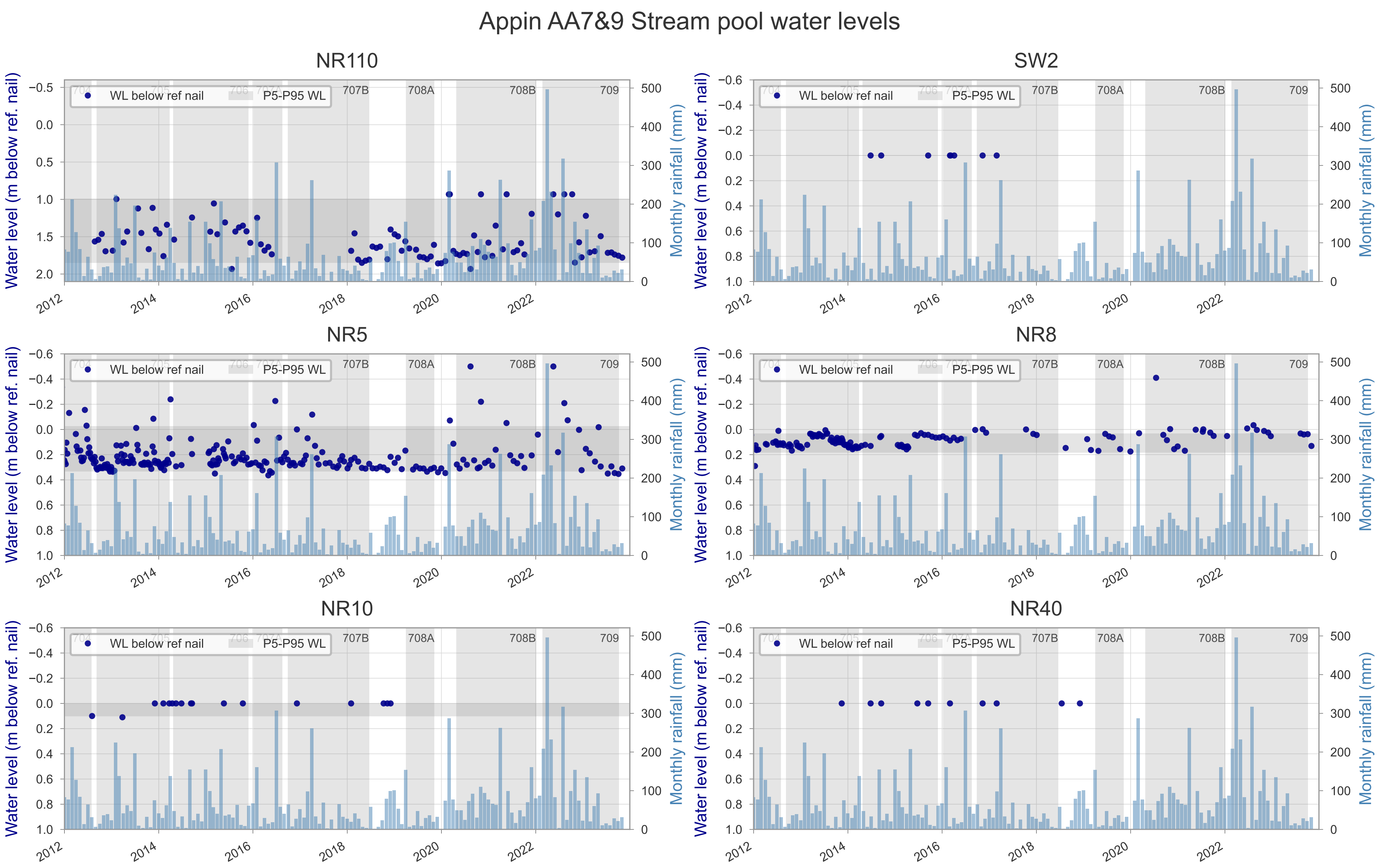








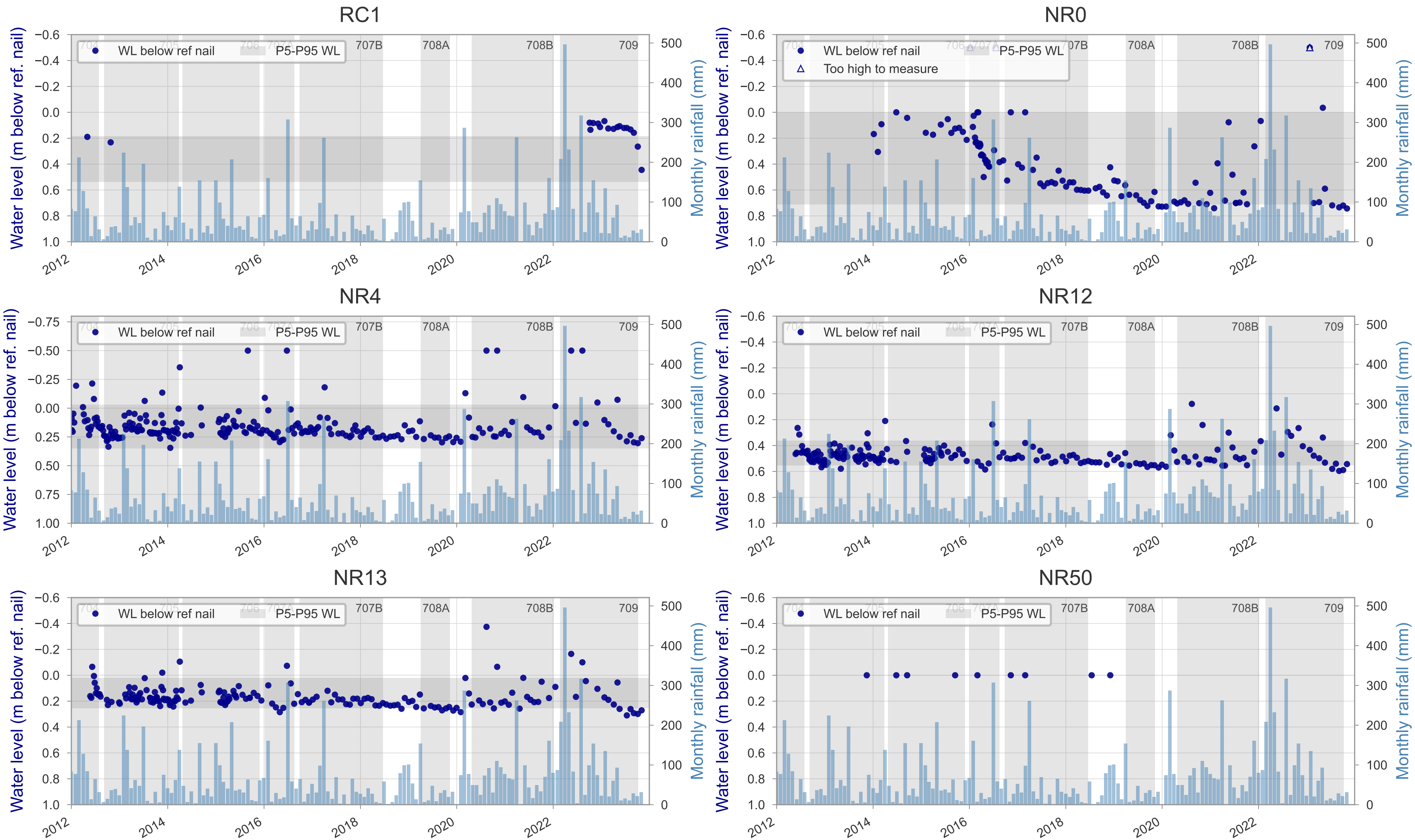




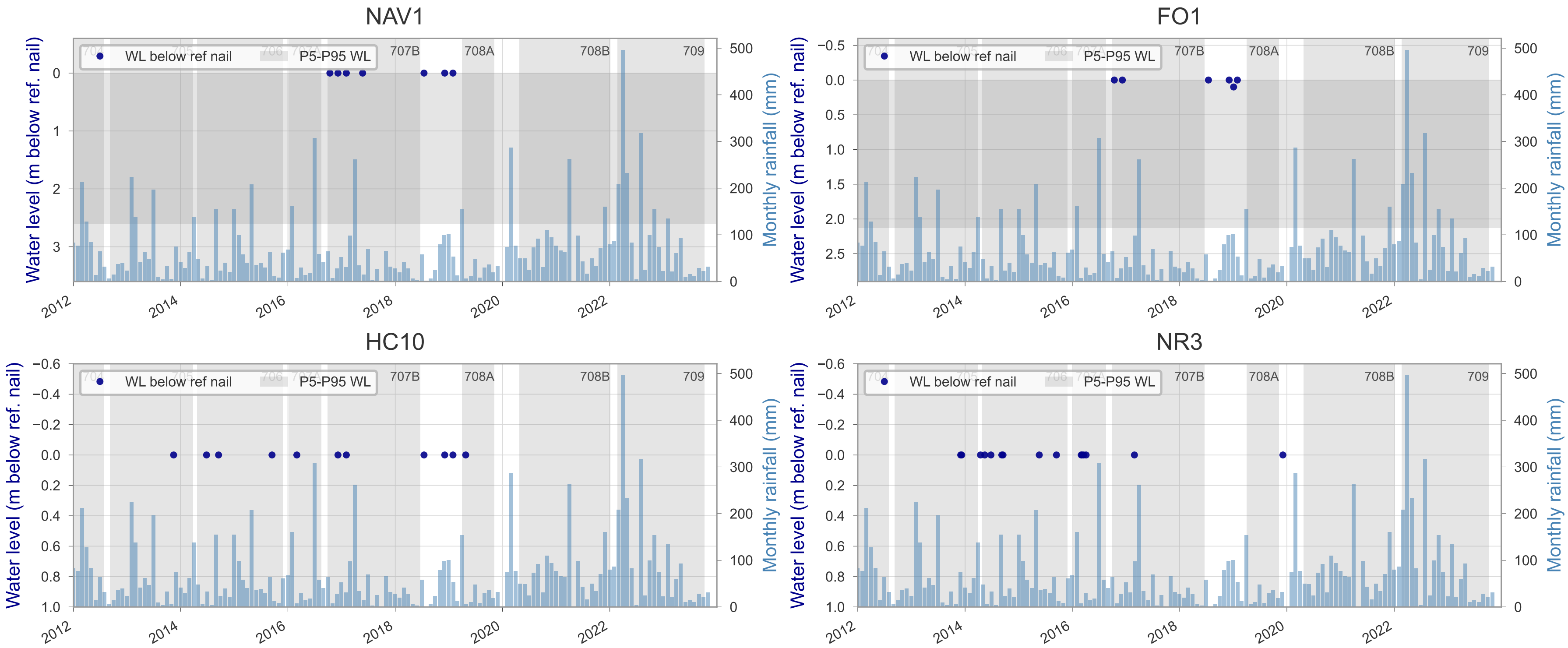
Appin AA7&9 Stream pool water levels
NR110
SW2
NR5
NR8
NR10
NR40
WL below ref nail
P5-P95 WL
704
705
706
707A
707B
708A
708B
709
Water level (m below ref. nail)
Monthly rainfall (mm)

A-01

Appin AA7&9 Stream pool water levels



Appin AA7&9 Stream pool water levels



APPENDIX 4 – Surface water chemistry TARP summary

Water quality TARP Assessment: Appin Areas 7 and 9										
Month_End	**Site_ID**	**Type**	**EC_max**	**pH_max**	**DO_max**	**Fe_tot_max**	**Mn_tot_ma**	**EC_TARP**	**pH_TARP**	**DO_TARP**
28/02/2022	NR110	Impact	529	8.29	78.4	0.20	0.03			
31/03/2022	NR110									
30/04/2022	NR110									
31/05/2022	NR110		100	7.30	110.2	0.70	0.03		2	
30/06/2022	NR110		231	8.09	98.0	0.92	0.07			
31/07/2022	NR110									
31/08/2022	NR110		76	7.85	102.3	0.42	0.01			
30/09/2022	NR110		109	7.52	101.7	0.63	0.03		1	
31/10/2022	NR110		97	7.66	103.2	0.81	0.03			
30/11/2022	NR110									
31/12/2022	NR110		339	7.86	100.3	0.55	0.03			
31/01/2023	NR110		49	7.96	93.8	0.36	0.05			
28/02/2023	NR110		386	7.74	80.3	0.24	0.11			
31/03/2023	NR110									
30/04/2023	NR110		167	7.49	82.4	0.68	0.06		1	
31/05/2023	NR110		241	7.75	91.3	0.96	0.15			
30/06/2023	NR110									
31/07/2023	NR110		543	8.39	95.9	0.19	0.03			
31/08/2023	NR110		624	8.87	108.8	0.12	0.04	2		
30/09/2023	NR110		704	8.69	97.8	0.10	0.04	2		
31/10/2023	NR110		755	8.76	85.9	0.07	0.04	2		
30/11/2023	NR110		734	8.91		0.08	0.03	2		
28/02/2022	NR0	Impact								
31/03/2022	NR0									
30/04/2022	NR0									
31/05/2022	NR0									
30/06/2022	NR0									
31/07/2022	NR0									
31/08/2022	NR0									
30/09/2022	NR0									
31/10/2022	NR0									
30/11/2022	NR0									
31/12/2022	NR0		333	7.53	81.9	0.21	0.05			
31/01/2023	NR0		383	8.03	100.5	0.30	0.06			
28/02/2023	NR0		380	7.82	79.0	0.43	0.10			
31/03/2023	NR0									
30/04/2023	NR0		189	7.44	93.6	0.64	0.05			
31/05/2023	NR0		289	8.12	96.9	0.72	0.07			
30/06/2023	NR0									
31/07/2023	NR0		551	7.86	98.5	0.34	0.04			
31/08/2023	NR0		618	8.62	97.3	0.12	0.04			
30/09/2023	NR0		694	8.33	94.2	0.30	0.07			
31/10/2023	NR0		745	8.14	89.3	0.15	0.06	2		
30/11/2023	NR0		777	8.48	84.3	0.27	0.07	2		
28/02/2022	NR4	Impact								
31/03/2022	NR4									
30/04/2022	NR4									
31/05/2022	NR4		99	7.59	99.3	0.74	0.03			
30/06/2022	NR4		287	7.73	102.0	0.65	0.03			
31/07/2022	NR4									
31/08/2022	NR4		77	7.54	97.5	0.55	0.02			
30/09/2022	NR4		118	7.65	97.3	0.42	0.02			
31/10/2022	NR4		89		104.1	0.77	0.05			
30/11/2022	NR4									
31/12/2022	NR4		224	7.34	95.2	0.49	0.06			
31/01/2023	NR4		433	7.55	89.4	0.48	0.13	2		
28/02/2023	NR4		306	7.39	67.1	0.39	0.12			1
31/03/2023	NR4									
30/04/2023	NR4		179	7.27	86.6	0.52	0.04			
31/05/2023	NR4		276	8.10	102.9	0.61	0.06			
30/06/2023	NR4									

Water quality TARP Assessment: Appin Areas 7 and 9										
Month_End	**Site_ID**	**Type**	**EC_max**	**pH_max**	**DO_max**	**Fe_tot_max**	**Mn_tot_ma**	**EC_TARP**	**pH_TARP**	**DO_TARP**
31/07/2023	NR4		538	7.77	80.7	0.26	0.04	2		
31/08/2023	NR4		566	8.40	101.8	0.23	0.04	2		
30/09/2023	NR4		632	8.70	101.7	0.52	0.04	2		
31/10/2023	NR4		708	8.56	96.1	0.14	0.05	2		
30/11/2023	NR4		709	8.24	84.8	0.17	0.06	2		
28/02/2022	NR12	Impact								
31/03/2022	NR12									
30/04/2022	NR12									
31/05/2022	NR12		102	7.04	92.2	0.87	0.03		1	
30/06/2022	NR12		150	7.40	94.1	0.83	0.04			
31/07/2022	NR12									
31/08/2022	NR12		80	7.42	89.4	0.59	0.02			
30/09/2022	NR12		141	7.49		0.46	0.02			
31/10/2022	NR12		88	6.87	102.2	0.79	0.03		1	
30/11/2022	NR12									
31/12/2022	NR12		89	6.78	89.9	0.54	0.04		2	
31/01/2023	NR12		338	7.46	80.3	0.52	0.18	2		
28/02/2023	NR12		264	7.31	79.2	0.73	0.11			
31/03/2023	NR12									
30/04/2023	NR12		116	6.66	90.1	0.84	0.04		2	
31/05/2023	NR12		325	7.91	92.3	0.81	0.05	2		
30/06/2023	NR12									
31/07/2023	NR12		182	7.34	82.6	0.51	0.04			
31/08/2023	NR12		295	7.82	106.3	0.42	0.03			
30/09/2023	NR12		281	8.14	98.8	0.36	0.03			
31/10/2023	NR12		398	8.18	97.2	0.19	0.03	2		
30/11/2023	NR12		242	7.83	101.4	0.26	0.03			
28/02/2022	NR13	Impact								
31/03/2022	NR13									
30/04/2022	NR13									
31/05/2022	NR13		110	7.30	91.3	0.85	0.03			
30/06/2022	NR13		146	7.55	92.8	0.83	0.05			
31/07/2022	NR13									
31/08/2022	NR13		81	7.76	100.1	0.65	0.02			
30/09/2022	NR13		155	7.54		0.46	0.02			
31/10/2022	NR13		90	6.87	96.8	0.78	0.04		1	
30/11/2022	NR13									
31/12/2022	NR13		97	6.97	92.4	0.55	0.04		1	
31/01/2023	NR13		330	7.15	77.0	0.48	0.18	2		
28/02/2023	NR13		229	7.34	84.4	0.59	0.07			
31/03/2023	NR13									
30/04/2023	NR13		121	6.84	85.5	1.01	0.07		1	
31/05/2023	NR13		298	7.81	96.0	0.98	0.05	2		
30/06/2023	NR13									
31/07/2023	NR13		175	7.44	93.0	0.43	0.03			
31/08/2023	NR13		336	7.66	94.5	0.32	0.03	2		
30/09/2023	NR13		280	7.95	96.9	0.36	0.03			
31/10/2023	NR13		409	8.11	98.2	0.17	0.03	2		
30/11/2023	NR13		245	7.74	100.1	0.25	0.03			
28/02/2022	NR50	Impact	155	7.82	82.2	0.46	0.04			
31/03/2022	NR50									
30/04/2022	NR50									
31/05/2022	NR50		102	7.52	98.5	0.91	0.04			
30/06/2022	NR50		127	7.60	83.8	1.85	0.20			
31/07/2022	NR50									
31/08/2022	NR50		90	8.20	98.6	0.58	0.02			
30/09/2022	NR50		235	7.54	91.1	0.71	0.08			
31/10/2022	NR50		92	7.09	98.2	4.61	0.17		1	
30/11/2022	NR50									
31/12/2022	NR50		118	7.49	99.8	0.62	0.06			
31/01/2023	NR50		221	7.53	89.5	0.52	0.11			

Water quality TARP Assessment: Appin Areas 7 and 9										
Month_End	**Site_ID**	**Type**	**EC_max**	**pH_max**	**DO_max**	**Fe_tot_max**	**Mn_tot_ma**	**EC_TARP**	**pH_TARP**	**DO_TARP**
28/02/2023	NR50		246	8.05	100.1	1.04	0.15			
31/03/2023	NR50									
30/04/2023	NR50		278	7.50	110.0	1.27	0.19			
31/05/2023	NR50		163	7.67	79.9	1.25	0.11			
30/06/2023	NR50									
31/07/2023	NR50		182	7.58	99.5	0.50	0.04			
31/08/2023	NR50		211	7.10	94.2	0.38	0.03		1	
30/09/2023	NR50		253	7.77	108.3	0.34	0.02			
31/10/2023	NR50		403	8.10	99.0	0.15	0.03			
30/11/2023	NR50		328	8.11	97.4	0.24	0.03			
28/02/2022	SW2	Control								
31/03/2022	SW2									
30/04/2022	SW2									
31/05/2022	SW2		329	7.87	101.4	1.08	0.03			
30/06/2022	SW2		399	7.17	113.9	0.88	0.03		2	
31/07/2022	SW2									
31/08/2022	SW2									
30/09/2022	SW2		338	8.08	98.6	0.64	0.02			
31/10/2022	SW2									
30/11/2022	SW2									
31/12/2022	SW2		485	7.94	116.6	0.45	0.01			
31/01/2023	SW2		421	8.00	100.8	3.02	0.06			
28/02/2023	SW2		462	8.32	106.1	0.64	0.02			
31/03/2023	SW2									
30/04/2023	SW2		530	8.15	99.2	0.55	0.02			
31/05/2023	SW2		400	8.13	98.2	1.24	0.06			
30/06/2023	SW2									
31/07/2023	SW2		710	7.89	96.2	0.26	0.01			
31/08/2023	SW2		702	8.19	115.6	0.31	0.01			
30/09/2023	SW2		410	8.47	110.5	0.28	0.01			
31/10/2023	SW2		478	7.71	101.2	0.24	0.02			
30/11/2023	SW2		325	8.35	112.2	0.27	0.01			
28/02/2022	NR5	Control	91	7.06	99.8					
31/03/2022	NR5									
30/04/2022	NR5									
31/05/2022	NR5		70	6.55	93.3	1.15	0.05		1	
30/06/2022	NR5		61	7.50	99.3	0.82	0.03			
31/07/2022	NR5									
31/08/2022	NR5		51	6.80	93.5	0.49	0.04			
30/09/2022	NR5		56	6.55	93.4	0.52	0.03		1	
31/10/2022	NR5		62		91.0	0.76	0.04			
30/11/2022	NR5									
31/12/2022	NR5		70	7.45	94.5	0.61	0.03			
31/01/2023	NR5		200	7.55	96.3	0.67	0.03			
28/02/2023	NR5		66	6.88	96.6	1.02	0.05			
31/03/2023	NR5									
30/04/2023	NR5		75	6.72	95.7	0.80	0.03			
31/05/2023	NR5		78	7.43	106.7	1.38	0.04			
30/06/2023	NR5									
31/07/2023	NR5		204	7.50	84.5	0.59	0.03			
31/08/2023	NR5		82	7.79	91.2	0.54	0.02			
30/09/2023	NR5		109	7.60	80.0	0.61	0.04			
31/10/2023	NR5		102	7.14	71.6	0.54	0.04			
30/11/2023	NR5		89	7.58	94.1	0.38	0.02			
28/02/2022	NR8	Control								
31/03/2022	NR8									
30/04/2022	NR8									
31/05/2022	NR8									
30/06/2022	NR8		981	7.71	97.3	0.78	0.04			
31/07/2022	NR8									
31/08/2022	NR8		1300	7.87	94.3	0.80	0.05			

Water quality TARP Assessment: Appin Areas 7 and 9										
Month_End	**Site_ID**	**Type**	**EC_max**	**pH_max**	**DO_max**	**Fe_tot_max**	**Mn_tot_ma**	**EC_TARP**	**pH_TARP**	**DO_TARP**
30/09/2022	NR8		2010	7.98		0.73	0.08			
31/10/2022	NR8		765		92.5	0.83	0.02			
30/11/2022	NR8									
31/12/2022	NR8		1430	7.79	89.4	0.65	0.07			
31/01/2023	NR8									
28/02/2023	NR8		278	7.14	55.6	0.79	0.15		1	
31/03/2023	NR8									
30/04/2023	NR8		1420	7.17	68.5	0.88	0.03		1	
31/05/2023	NR8		821	7.92	93.3	0.73	0.05			
30/06/2023	NR8									
31/07/2023	NR8		444	7.98	75.0	0.46	0.03			
31/08/2023	NR8		550	7.50	89.6	0.48	0.01			
30/09/2023	NR8		721	7.73	89.5	0.53	0.02			
31/10/2023	NR8		703	7.57	82.2	0.47	0.03			
30/11/2023	NR8		1350	7.45	56.8	0.67	0.12			
28/02/2022	NR10	Control	559	7.69	85.2					
31/03/2022	NR10									
30/04/2022	NR10									
31/05/2022	NR10		571	7.23	111.4	1.88	0.12		1	
30/06/2022	NR10		1830	7.63	87.0	1.74	0.35			
31/07/2022	NR10		108	7.32	95.3					
31/08/2022	NR10		1880	7.47	92.1	1.50	0.42			
30/09/2022	NR10		1560	7.98	100.6	2.10	0.65			
31/10/2022	NR10		868	7.41	82.6	1.19	0.15			
30/11/2022	NR10		406	7.71	97.6					
31/12/2022	NR10		2570	7.63	85.5	3.52	0.49			
31/01/2023	NR10		1230	7.74	88.3	0.81	0.07			
28/02/2023	NR10		2350	7.57	75.2	2.40	0.22			1
31/03/2023	NR10									
30/04/2023	NR10		1880	7.57	79.8	1.65	0.16			
31/05/2023	NR10		2170	7.97	96.3	1.15	0.15			
30/06/2023	NR10									
31/07/2023	NR10		2770	7.80	97.8	2.65	0.34			
31/08/2023	NR10		2950	7.34	80.3	1.68	0.23			
30/09/2023	NR10		2000	7.68	124.5	1.61	0.19			
31/10/2023	NR10		2960	7.42	43.0	1.97	0.35			2
30/11/2023	NR10		2790	7.48	52.2	1.71	0.42			2
28/02/2022	NR40	Control								
31/03/2022	NR40									
30/04/2022	NR40									
31/05/2022	NR40									
30/06/2022	NR40									
31/07/2022	NR40									
31/08/2022	NR40									
30/09/2022	NR40									
31/10/2022	NR40		601	7.53	80.1	2.80	0.18			
30/11/2022	NR40									
31/12/2022	NR40		1300	7.80	74.0	1.73	0.37			
31/01/2023	NR40		726	7.81	76.4	12.70	0.24			
28/02/2023	NR40		739	7.80	75.3	1.51	0.12			
31/03/2023	NR40									
30/04/2023	NR40									
31/05/2023	NR40		761	7.74	67.4	2.64	0.49			
28/02/2022	FO1	Impact	985	7.81	68.6	0.40	0.34			
31/03/2022	FO1									
30/04/2022	FO1			8.01	93.5	0.54	0.33			
31/05/2022	FO1		1120	8.10	90.5	1.84	0.28			
30/06/2022	FO1		2360	8.07	96.7	0.32	1.00			
31/07/2022	FO1									
31/08/2022	FO1		2430	8.19	100.5	0.11	0.36			
30/09/2022	FO1		2880	8.26	95.2	6.13	3.42			

Water quality TARP Assessment: Appin Areas 7 and 9										
Month_End	Site_ID	Type	EC_max	pH_max	DO_max	Fe_tot_max	Mn_tot_ma	EC_TARP	pH_TARP	DO_TARP
31/10/2022	FO1		1530	7.97	92.5	3.51	0.27			
30/11/2022	FO1									
31/12/2022	FO1		2830	8.07	84.6	0.18	0.67			
31/01/2023	FO1		2200	7.86	93.8	0.23	0.48			
28/02/2023	FO1		2270	7.21	79.3	0.30	0.80		1	
31/03/2023	FO1									
30/04/2023	FO1		1480	7.87	99.7	0.70	0.54			
31/05/2023	FO1		1860	7.92	77.7	2.77	0.27			
30/06/2023	FO1		2350	7.76	93.5	0.26	0.85			
31/07/2023	FO1		2550	7.57	73.4	0.46	0.85		1	
31/08/2023	FO1		2530	7.30	46.1	0.20	1.42		1	1
30/09/2023	FO1		2360	7.46	62.9	0.08	0.46		1	
31/10/2023	FO1		2760	7.47	35.8	0.84	5.46		1	1
28/02/2022	NAV1	Impact	1093	7.61	25.6	1.61	1.49			
31/03/2022	NAV1									
30/04/2022	NAV1		856	7.64	68.9	0.93	0.43			
31/05/2022	NAV1		758	7.76	72.4	1.85	0.38			
30/06/2022	NAV1		1040	7.81	61.4	0.42	0.30			
31/07/2022	NAV1									
31/08/2022	NAV1		1100	7.58	81.5	1.12	0.15			
30/09/2022	NAV1		1410	7.73	87.3	1.12	0.40			
31/10/2022	NAV1		713	7.67	81.2	4.55	0.21			
30/11/2022	NAV1									
31/12/2022	NAV1		1730	7.57	60.6	14.50	8.68			
31/01/2023	NAV1		2160	7.46	41.7	3.12	2.00			
28/02/2023	NAV1		1260	7.59	22.8	2.01	1.00			
31/03/2023	NAV1									
30/04/2023	NAV1		1780	7.65	56.2	2.23	0.80			
31/05/2023	NAV1		2300	7.83	80.6	1.56	0.97			
30/06/2023	NAV1		2340	7.85	69.4	1.38	0.88			
31/07/2023	NAV1		2310	7.42	74.4	0.92	0.58			
31/08/2023	NAV1					1.09	0.69			
30/09/2023	NAV1		2450	7.50	54.2	3.78	1.29			
31/10/2023	NAV1		2840	7.47	14.1	0.70	1.92			
28/02/2022	HC10	Impact	533	8.36	88.4	0.69	0.04			
31/03/2022	HC10									
30/04/2022	HC10									
31/05/2022	HC10		559	8.16	101.2	1.25	0.11			
30/06/2022	HC10		1060	8.49	100.4	0.29	0.10			
31/07/2022	HC10									
31/08/2022	HC10		1020	8.31	100.3	0.81	0.13			
30/09/2022	HC10		1180	8.30	107.4	0.39	0.09			
31/10/2022	HC10		591	8.19	96.0	2.92	0.12			
30/11/2022	HC10									
31/12/2022	HC10		1080	8.33	86.1	1.00	0.17			
31/01/2023	HC10		942	8.04	82.6	0.42	0.16			
28/02/2023	HC10		1080	7.67	9.6	0.76	1.24			2
31/03/2023	HC10									
30/04/2023	HC10		882	7.86	49.0	0.38	0.19			1
31/05/2023	HC10		1140	8.50	78.8	0.85	0.09			
30/06/2023	HC10									
31/07/2023	HC10		1140	7.89	52.6	0.20	0.13			1
31/08/2023	HC10		1210	7.81	66.0	0.22	0.14			
30/09/2023	HC10		1150	7.89	42.9	0.19	0.15			1
31/10/2023	HC10		1140	7.74	21.2	0.28	1.10			2
30/11/2023	HC10		1080	7.81	9.8	0.81	1.18			2
28/02/2022	NR3	Impact								
31/03/2022	NR3									
30/04/2022	NR3									
31/05/2022	NR3		783	8.11	101.3	0.32	0.11			
30/06/2022	NR3		961	7.57	115.1	0.56	0.12		1	

Water quality TARP Assessment: Appin Areas 7 and 9										
Month_End	Site_ID	Type	EC_max	pH_max	DO_max	Fe_tot_max	Mn_tot_ma	EC_TARP	pH_TARP	DO_TARP
31/07/2022	NR3									
31/08/2022	NR3		903	7.97	107.1	0.34	0.10			
30/09/2022	NR3		743	8.14	88.9	0.17	0.04			
31/10/2022	NR3		594	7.91	107.0	0.44	0.03			
30/11/2022	NR3									
31/12/2022	NR3		1350	7.76	105.4	0.77	0.36			
31/01/2023	NR3		696	8.05	109.9	0.37	0.06			
28/02/2023	NR3		1440	7.54	63.5	1.38	1.13		1	
31/03/2023	NR3									
30/04/2023	NR3		892	7.76	111.4	0.58	0.17			
31/05/2023	NR3		976	8.43	164.1	0.55	0.11			
30/06/2023	NR3									
31/07/2023	NR3		1590	7.72	73.5	1.16	0.32			
31/08/2023	NR3		1930	7.29	40.7	1.58	0.65		2	
30/09/2023	NR3		1163	7.17	47.5	1.79	0.68		2	
31/10/2023	NR3		1990	7.25	36.4	1.04	0.70		2	
30/11/2023	NR3		1740	7.35	95.8	0.98	0.81		1	

Table 11 Trigger Action Response Plan

<table>
<tr><th>Monitoring</th><th>Trigger</th><th>Action</th></tr>
<tr><td colspan="3">Surface Water Quality#</td></tr>
<tr><td rowspan="3">Nepean River
Control Sites:
NR110 (Upstream perturbations)
SW2 (Upstream perturbations from Allens Creek)
NR5 (Upstream perturbations from Cataract River)
NR8 (Upstream perturbations from Elladale Creek)
NR10 (Upstream perturbations from Ouesdale Creek)
NR40 (Upstream perturbation from Menangle Creek)

Impact Sites:
NR0
NR4 (assess influence from Harris Creek)
NR12
NR13
NR50

Creeks and Tributaries
Control Site:
RC1

Impact Sites:
NAV1
FO1
HC10
NR3</td><td>Level 1*
Impact monitoring sites when comparing the baseline period to the mining period for that site:
• Mining results in pH reduction greater than 1 standard deviation but less than 2 standard deviations from pre-mining mean resulting from the mining for two consecutive months
• Mining results in DO reduction greater than 1 standard deviation but less than 2 standard deviations from pre-mining mean resulting from the mining for two consecutive months
• Identification of strata gas plume of flow rate <3000 L/min
• Trend analysis shows deviation from baseline post mining.</td><td>• Continue monitoring program
• Submit an Impact Report to BCS, DPE – Water, WaterNSW and other relevant stakeholders
• Report in the End of Panel Report
• Summarise actions and monitoring in Annual Review</td></tr>
<tr><td>Level 2*
Impact monitoring sites when comparing the baseline period to the mining period for that site:
• Mining results in pH reduction greater than 2 standard deviations from pre-mining mean resulting from the mining for two consecutive months
• Mining results in DO reduction greater than 2 standard deviations from pre-mining mean resulting from the mining for two consecutive months
• Mining results in EC increases greater than 2 standard deviations from pre-mining mean resulting from the mining for two consecutive months
• Identification of strata gas plume of flow rate >3000 L/min
• Trend analysis shows significant deviation from baseline post-mining.</td><td>• Actions as stated for Level 1
• Review monitoring program
• Notify relevant technical specialists and seek advice on any CMA required
• Implement agreed CMAs as approved

Note: CMAs are to be proposed based on appropriate management of environmental and other consequences of mining impacts i.e. water quality changes with insignificant consequences may not require specific CMAs other than ongoing monitoring to confirm there are no ongoing impacts

Strata Gas Emission Plume:
• Estimate gas emission flow rates. Re-estimate should significant change be observed
• Take sample of plume (if possible) for:
- chemical composition
- dissolved methane from exactly above gas plume and at established downriver monitoring site
- dissolved sulfide and total phenols from exactly above gas plume and at nearest downriver monitoring site</td></tr>
<tr><td>Level 3*
Impact monitoring sites when comparing the baseline period to the mining period for that site:</td><td>• Actions stated for Level 2
• Notify BCS, DPE - Water, WaterNSW and relevant resource managers and technical specialists and seek advice on any CMA required
• Invite stakeholders for site visit</td></tr>
</table>

	• Level 2-type reduction in water quality resulting from the mining observed for six consecutive months	• Develop site CMA (subject to stakeholder feedback) • Completion of works following approvals, including monitoring and reporting on success • Review the TARP and Management Plan in consultation with key stakeholders *Note: CMAs are to be proposed based on appropriate management of environmental and other consequences of mining impacts i.e. water quality changes with insignificant consequences may not require specific CMAs other than ongoing monitoring to confirm there are no ongoing impacts*
	Exceeding Performance Measures Mining results in more than negligible gas releases, iron staining or water cloudiness on Nepean River. Mining results in greater subsidence impact or environmental consequences than predicted in the EA and PPR	• *Actions stated for Level 3* • Investigate reasons for the exceedance • Update future predictions based on the outcomes of the investigation • Provide environmental offset if CMAs are unsuccessful
Surface Water Flow and Level		
Nepean River Maldon Weir Broughtons Pass Weir Menangle Weir **Creeks and Tributaries** NAV1 FO1 HC10 NR3	***Level 1**** • Mining results in observational changes to pool level (dry and/or flooded) in comparison to baseline observations and flows, for less than two consecutive months.	• Continue monitoring program • Submit an Impact Report to BCS, DPE – Water, WaterNSW and other relevant stakeholders • Report in the End of Panel Report • Summarise actions and monitoring in Annual Review
	Level 2* • Mining results in observational changes to pool level (dry and/or flooded) in comparison to baseline observations and flows, for more than two consecutive months.	*Actions as stated for Level 1* • Review monitoring program • Notify relevant technical specialists and seek advice on any CMA required • Implement agreed CMAs as approved
	Level 3* • Mining results in observational changes to pool level (dry and/or flooded) in comparison to baseline observations and flows, for six consecutive months.	*Actions stated for Level 2* • Notify BCS, DPE - Water, WaterNSW and relevant resource managers and technical specialists and seek advice on any CMA required • Invite stakeholders for site visit • Develop site CMA (subject to stakeholder feedback) • Completion of works following approvals, including monitoring and reporting on success • Review the TARP and Management Plan in consultation with key stakeholders
	Exceeding Performance Measures Mining results in more than negligible diversion of flows or changes in the natural drainage behaviour of pools in the Nepean River	*Actions stated for Level 3* • Investigate reasons for the exceedance • Update future predictions based on the outcomes of the investigation

		• Provide environmental offset if CMAs are unsuccessful
Creeks and Tributaries **Foot Onslow Creek** FO1 FOS1 **Navigation Creek** NAV1 NAVS1	***Level 1**** • Fracturing with no observable loss of surface water flow	• Continue monitoring program • Submit an Impact Report to BCS, DPE – Water, WaterNSW and other relevant stakeholders • Report in the End of Panel Report • Summarise actions and monitoring in Annual Review
	Level 2* • Fracturing resulting in loss of surface flow in some creeks or tributary	*Actions as stated for Level 1* • Review monitoring program • Notify relevant technical specialists and seek advice on any CMA required Implement agreed CMAs as approved
	Level 3* • Fracturing resulting in total loss of surface flow in all sections of a creek or tributary	*Actions stated for Level 2* • Notify BCS, DPE - Water, WaterNSW and relevant resource managers and technical specialists and seek advice on any CMA required • Invite stakeholders for site visit • Develop site CMA (subject to stakeholder feedback) • Completion of works following approvals, including monitoring and reporting on success • Review the TARP and Management Plan in consultation with key stakeholders
	Exceeding Performance Measures • Mining results in greater subsidence impact or environmental consequences than predicted in the EA and PPR	*Actions stated for Level 3* • Investigate reasons for the exceedance • Update future predictions based on the outcomes of the investigation • Provide environmental offset if CMAs are unsuccessful
Groundwater		
Groundwater inflows to the mine **Private Bores** GW072196 GW072874 GW100289 GW100673 GW101986 GW104661 GW105376 GW105388	***Level 1**** • Increase in water flow from the goaf between 2.7 to 3 ML/day (over 20-day average) • >10 m reduction in water level/pressure in the HBSS from the average level in the period of 12 months prior to the start of a longwall, over a minimum of two months	• Continue monitoring program • Submit an Impact Report to BCS, DPE - Water, WaterNSW and other relevant stakeholders • Report in the End of Panel Report • Summarise actions and monitoring in Annual Review
	Level 2* • Increase in water flow from the goaf between 3 to 3.4ML (over 20-day average) • >15 m reduction in water level/pressure in the HBSS from the average level in the period of 12 months prior to the start of a longwall, over a minimum of two months	• *Actions as stated for Level 1* • Review monitoring frequency • Notify relevant technical specialists and seek advice on any CMA required • Implement agreed CMAs as approved

GW105531 GW105534 GW105574 GW106574 (grouted) GW106675 GW108907 GW112381 GW112441 (grouted) **IMC Boreholes** S1913 S1941 S1954 S2157 S2315 S2536 S2536A S2537 S2538 S2632		*Note: CMAs are to be proposed based on appropriate management of environmental and other consequences of mining impacts i.e. cracking at the surface with insignificant consequences may not require specific CMAs other than ongoing monitoring to confirm there are no ongoing impacts*
	Level 3* • Abnormal increase in water flow from the goaf >3.4ML (20-day average) • >20 m reduction in water level/pressure in the HBSS from the average level in the period of 12 months prior to the start of a longwall, over a minimum of two months • Mining results in groundwater bores unsafe, unserviceable or damaged	• Actions as stated for Level 2 • Notify BCS, DPE - Water, WaterNSW and relevant resource managers and technical specialists and seek advice on any CMA required • Invite stakeholders for site visit • Develop site CMA (subject to stakeholder feedback). This may include: - Make area safe - Any actions agreed to in the Property Subsidence Management Plan - Provisions of alternate water supply where this has been impacted by mining • Completion of works following approvals, including monitoring and reporting on success • Review the Groundwater Model, TARP and Management Plan in consultation with key stakeholders *Note: CMAs are to be proposed based on appropriate management of environmental and other consequences of mining impacts i.e. cracking at the surface with insignificant consequences may not require specific CMAs other than ongoing monitoring to confirm there are no ongoing impacts*

* These may be revised in consultation with DPE and other key stakeholders following analysis of natural variability within the pre-mining baseline data.

The upstream monitoring site NR110 and a series of sites within tributaries of the Nepean River are utilised to indicate non-mining-related perturbations at the proposed Longwalls 709 to 711 and 905 impact monitoring sites within the Nepean River. This provides a means of distinguishing upstream or mid-river effects unrelated to the mining of the proposed longwalls. The following premise applies:

- A TARP at River site NR0 should only be considered to have been triggered whenever an equivalent change (from the long term mean) is not exhibited for the same parameter at the upstream site NR110.
- A TARP at River site NR4 should only be considered to have been triggered whenever an equivalent change (from the long term mean) is not exhibited for the same parameter at the upstream sites NR110 or SW2 (monitors for upstream perturbation from Allens Creek).
- A TARP at River site NR12 and NR13 should only be considered to have been triggered when an equivalent change (from the long term mean) is not exhibited for the same water quality analyte at the upriver sites; NR110, SW2, NR5, NR8 or NR10 (monitors upstream perturbation from Allens Creek, Cataract River, Elladale Creek and Ousedale Creek).
- A TARP at River site NR50 should only be considered to have been triggered when an equivalent change (from the long term mean) is not exhibited for the same water quality analyte at the upriver sites; NR110, SW2, NR5, NR8, NR10 or NR40 (monitors upstream perturbation from Allens Creek, Cataract River, Elladale Creek, Ousedale Creek and Menangle Creek).