SOUTH SIDE QUEENSWAY WASTE MANAGEMENT SITE, LLANWERN STEELWORKS

2023 Annual Review of Environmental Monitoring

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Executive Summary

The SSQ landfill area has been an area of industrial waste disposal for many years having initially been developed in the 1970's to accept wastes from the Llanwern Steel Works. The landfill was one of two landfill sites operated at the Llanwern site, the other being the East Waste Management Site (EWMS). The landfill accepted industrial wastes from the steel making activity whilst the EWMS accepted general wastes, refuse, biodegradable wastes as well as industrial waste.

Groundwater and surface water sampling around the perimeter of the site reveals that groundwater within the upper layer of made ground is dominated by an elevated pH and alkalinity due to slaking of lime. Some potential contaminants, such as several metals, are sometimes detected at increased concentrations, although these are not typically persistent. The elevated pH and alkalinity is likely limiting their mobility.

Visible oil has again been noted on groundwater recovered from BH16. This borehole is to be decommissioned and a replacement installed to the south to make room for future site development.

Deeper groundwater within the alluvial sequence has low concentrations of most non-hazardous pollutants and hazardous substances but has a pH of approximately 8. As this pH is very different from the pH in the overlying made ground there would appear to be little hydraulic connectivity between the groundwater bodies encountered. This is not unexpected due to the sequence of low permeability sediments present.

The data gathered during the past 12 months continues to suggest surface water is becoming increasingly alkaline. The ditch should be inspected to ensure that all potential on-site and off-site run-off sources are understood.

There is scope for rationalising the monitoring programme, but Tata Steel should first consider the potential impact of any development proposals in the area. NRW should also be consulted and agree any changes to the monitoring programme.

Routine vegetation clearance is required to ensure safe, reliable access to all monitoring points, particularly at SW2, SW3 and BH202,BH203, BH17, BH19, BH24.

1 INTRODUCTION

Natural Resources Wales issued a Closure Notice (No. GR/EM4/01) for Llanwern Landfill, South Side of Queensway (SSQ) which specified that the landfill must cease accepting waste for disposal as of 25 February 2008 and that it must be maintained, monitored and controlled as required by the conditions of the authorisation numbered 024/79. In response, Tata Steel commissioned Geotechnology to prepare a Closure Report and Aftercare Monitoring Plan (see Geotechnology Report 664.1/0/0708).

One of the requirements of the Aftercare monitoring period is the production of annual interpretive reports that evaluate the most recent environmental monitoring results. This report reviews the data collected up to December 2023.

2 SITE SETTING

2.1 Site Location and Extent

The Llanwern Landfill is in an area referred to as South Side of Queensway (SSQ) which lies immediately to the south of Llanwern Steelworks to the east of Newport. The centre of the landfill site is at Ordnance Survey Grid Reference ST375 858, as shown on the site location plan (Figure 1). Access to the site is only possible off Queensway Road which runs east to west along the northern boundary of the area. An aerial image of the site captured in February 2020 using an in-house survey drone is provided in Plate 2-1.

Plate 2-1 Main SSQ Areas – Queen's Way is road running east-west across top of image

Until recently, Queensway was a road entirely within the works boundary, but the road has become a public road as the steelworks boundary has shrunk following closure of the "heavy end", where iron and steel was produced. The parcel of land to the south of Queensway (known as South Side Queensway or SSQ for short) is now separated from the secure part of the works. Parts of the site can be accessed by members of the public directly from this road.

In the 1970's, Newport Borough Council issued a COPA licence for the disposal of waste materials from the works within SSQ. The licence was never surrendered or rescinded and the licence transferred into the Waste Management regime. Various parts of the SSQ Waste Management site were subsequently taken into the IPPC permit for the steelworks, but this permit ceased with the cessation of steelmaking in 2002. Subsequently, several parts of the SSQ Site were taken into the existing steelworks PPC Permit (Permit BS3905). A Non-Hazardous landfill has also been permitted under the PPC regime within SSQ (PPC Permit GP 3331SV). This PPC landfill is referred to as South Side Queensway Non-Hazardous Landfill (SSQNHL) and its location is shown on Figure 2. This landfill has yet to be constructed and has not yet entered its pre-operational phase.

Due to the different waste management activities and changes in regulatory regime, the boundary positions of the currently applicable regulatory regime are complex. To assist with understanding the current situation the position of all relevant boundaries are shown in Figures 2 and 3. The position of key surface water collection ditches within the site boundary are also shown on Figure 3. These ditches collect surface run-off from SSQ which is diverted to the main works treatment plant prior to discharge in accordance with the current discharge consent. The regulatory boundaries shown on Figure 2 are:

- Current Waste Management Licence Boundary No. 024/79
- Boundary of SSQNHL PPC Permit GP 3331SV
- Relevant boundaries of Llanwern Steelworks PPC Permit BS3905

In the context of the areas of SSQ which have now been definitively closed and which are of most relevance to this report, these are distinguished from the other site areas as coloured blocks on Figure 3. On Figure 3, the area which has been definitively closed is outlined with a black dashed line with key sub-areas shaded. The closure plan, therefore, only referred to the areas within the dashed closure boundary and no other areas. The areas bound by the closure plan are:

- Slag Area W
- Slag Area E
- Lagoons 25 and 12 comprising slurry from the BOS and Blast Furnace plants
- Powerline Valley

There are also small areas outside of these distinguished areas although these have not been impacted by waste activities.

2.2 Site Setting

The site lies within an existing industrial area. The northern area of land within SSQ is occupied by Newport Galvanizers Ltd. and Air Products Ltd. North of Queensway road is the steel plant itself. To the west of the site lies an area currently occupied by Multiserv. To the east of the site lies the works effluent treatment reed beds. The steel plant boundary lies some 57m to the south of the site with the land ownership boundary lying further to the south again.

Land to the south of Tata Steel's ownership comprises Bowleaze Common which is part of the Wentloog levels, an area of ecological interest benefiting from statutory protection with a SSSI (Site of Special Scientific Interest) designation. This land comprises flat, low lying, sparsely populated and reclaimed grazing land.

2.3 Ground Conditions

The geology of the site has been determined from published information and several phases of site investigations.

The site is located on a Holocene sequence of low permeability sediments that overlie Mercia Mudstone. The mudstones, exposed to the north of the site, show a shallow dip to the SSW.

2.3.1 Holocene sediments

A Holocene sequence of clays and peat overlie bedrock at the site. This sequence of clays and peats are typically 10 to 15 meters thick across the Gwent levels and were formed within the last 10,000 years or so. At the site, these sediments have been found to be locally up to 17 meters thick and to comprise an upper and lower clay layer separated by a peat horizon.

The upper clay layer varies in thickness from 3.1m (borehole 18) and 7m (borehole 21) across the site and has been found in all site investigation boreholes. Laboratory testing of 4 undisturbed samples of the upper clay layer have established permeabilities in the range 1.4 x 10^{-10} and 9.2 x 10^{-10} ms^{-1}.

A peat layer has been encountered, below the upper clay, in all the boreholes at the site and has been found to be between 1 and 2 m thick. Six variable head permeability tests have been undertaken in boreholes completed within the peat which have established a range of permeabilities between 4.8 x 10^{-7} ms^{-1} and 7.2 x 10^{-6} ms^{-1}. The peat, in relative terms, is the "most permeable" unit within the Holocene sediments beneath the site.

The lower clay layer has been found to vary in thickness between 1 metre (borehole 21) and 8.9 metres (borehole 23) and once again has been identified in all the site investigation boreholes. Whilst no sampling and testing for permeability has been undertaken from this unit, lithologically it is closely related to the upper clay unit and, as such, it would be expected to have a permeability of 5 x 10^{-10} ms^{-1}.

There is some evidence that limited thin lenses of gravel occur between the lower clay and the weathered Mercia Mudstone.

2.3.2 Bedrock

The bedrock found below the Holocene sediments at the site is Mercia Mudstone (formally known as Keuper Marl). The Mercia Mudstones of the area are documented to consist of red or chocolate fine silty mudstones with conchoidal fractures.

From site investigation boreholes, the Mercia Mudstone has been found to have a weathered surface of approximately 1 to 2 meters in thickness. Falling head tests have been carried out in four piezometers completed within this weathered horizon. Borehole 23 on site, as well as 3 boreholes adjacent to the site, have established permeabilities of around 1 x 10^{-5} ms^{-1}.

The un-weathered Mercia Mudstone, which has very low matrix permeability and extremely limited secondary fracture permeability, is an important unit in terms of groundwater flow at the site, in that it is considered to provide the impermeable base to the groundwater "flow" system within the overlying Holocene sediments.

Rockhead below the Holocene sediments of the Gwent Levels is between -5m and -7.5 m below OD.

2.3.3 Made Ground

The area is currently covered with a blanket of fill materials comprising mainly steelmaking BOS slag (steel slag) which was deposited in the 1970's. This development platform is approximately 1m thick with a typical shallow profile shown in Plate 2-2.

Plate 2-2 Near surface slag development platform

2.4 Hydrogeology

2.4.1 Aquifer Characteristics

There are no Source Protection Zones (SPZ) near the site, the nearest SPZ is that for the Great Spring which at its nearest point is more than 5km away from the site and is hydraulically isolated from the site by the intervening geology.

The strata below and near the site is considered by Natural Resources Wales as a non-aquifer (as shown on published Vulnerability Maps). Both the Holocene sediments and the underlying Mercia Mudstone are of low to extremely low permeability, which supports the classification of the area as a Non-Aquifer. There is no known licensed or unlicensed groundwater abstraction from strata underlying the Caldicot Levels.

The upper clay, with proven permeabilities in the range of 4×10^{-10} and 9.2×10^{-10} ms^{-1} and with a thickness of between 3.1 meters (borehole 18) and 7 meters (borehole 21) is a natural geological barrier that prevents vertical flow from the ground surface to the water table. Both the smaller drainage ditches around the site and the larger reens such as Hundred Perch Reen are founded within and do not pass through the upper clay layer.

Permeability values for the upper clay were acquired from testing undisturbed samples (U100's) in the laboratory and can, therefore, be relied upon to reflect field conditions. Uncertainty in the quality of the permeability results is reduced when all samples are considered, thus giving a narrow range and the fact that one of the results comes from testing during the Site Investigation carried out by Enviros in 2002.

The lower clay, having a thickness across the site of between 1 meter (borehole 21) and 8.9 meters (borehole 23) has the same lithological and sedimentological characteristics as the upper clay. Whilst its permeability has not been directly tested, it is considered to have permeabilities in a narrow range centred around 5×10^{-10} ms^{-1}, similar to that of the upper clay. As such the lower clay, like the upper clay, likely presents a significant barrier to vertical flow.

The peat horizon that has been identified across the site has permeabilities in the range of 4.8 x 10^{-7} ms^{-1} and 7.2 x 10^{-6} ms^{-1} and a thickness varying between 1 and 2 meters. It can be considered permeable in a relative sense, when compared to the upper and lower clays. Its position below the site, sandwiched between two layers of low permeability clay results in it becoming a credible route for the horizontal movement of limited volumes of groundwater. This is not because the peat is particularly permeable, or that it represents an aquifer but simply that it represents a "permeability contrast" when considering its location between two very low permeability clays. No significant amount of groundwater can be extracted from the peat.

There are possible localised lenses of gravels between the lower clay and the weathered Mercia Mudstone. The evidence for these gravels comes from samples taken at the depth of the weathered mudstone and there is a potential for some confusion between the two. However, with respect to groundwater flow, were there gravels in such circumstances, they would have a permeability like that attributed to the weathered mudstone which is considered contiguous across the site, so in hydrogeological terms their presence or absence is irrelevant.

The weathered layer of Mercia Mudstone located below the lower clay and above the un-weathered Mercia Mudstone has similar hydrogeological significance as the peat layer, in that its permeability, as established from variable head tests, is of the order of 1 x 10^{-5} ms^{-1}**.** As with the peat layer, this provides opportunity for horizontal movement of groundwater.

The significance of the underlying un-weathered Mercia Mudstone is that it is the impermeable base above which the limited groundwater movement occurring in this geological setting, takes place.

The absence of any groundwater abstractions from this hydrogeological setting, in an area where mains supply requires significant investment in infrastructure, supports the assertion that groundwater is not a viable resource in this low permeability setting.

2.4.2 Groundwater Flow

Historical hydrographs developed from the collection of groundwater level data show a variation between summer and winter groundwater levels of less than 0.5 meters. The small variation in groundwater levels over a 12 month period demonstrates that the amounts of recharge reaching the groundwater system within the peat and weathered mudstone horizon are very limited, particularly when considering the low specific yield of each formation.

Groundwater below the site has been encountered within the made ground, peat and weathered mudstone (bedrock) layers. Rest groundwater levels within the peat and bedrock units are observed as being almost identical suggesting that the peat and weathered mudstone horizons are in hydraulic continuity with one another. There is no lithological evidence for linkage between these two units directly below the site as all boreholes demonstrate the presence of the lower clay layer.

The historical groundwater gradient within the low permeability Holocene sediments has been previously found to be approximately 0.0033 towards the east-southeast, that is Hundred Perch Reen. Groundwater gradients are very shallow, reflecting extremely low rates of recharge to the peat due to the overlying low permeability upper clay layer and the frequency of reens which groundwater within the peat discharges to.

2.5 Hydrology

The site is located close to the boundary of the Caldicot Levels which are part of the larger Gwent Levels. The Gwent Levels are an important and extensive low-lying area of estuarine alluvium located on the north side of the Severn estuary in Southeast Wales between Cardiff and the River Rhymney in the west and Chepstow on the River Wye in the east.

The Levels were created through the enclosing and draining of tidal saltmarshes and their continued existence requires the ongoing management of seawalls which prevent their frequent inundation by the sea. To manage runoff from the low permeability sediments that make up the levels and to transport runoff from adjacent areas of higher ground a complex system of channels has been constructed. The channels make up a hierarchical network, smaller ditches discharging into larger water courses known as reens, which in turn discharge into the sea via pumps and tidal gates. This network is the key feature of the Levels, both in terms of their ecological importance and the historic landscape. The minor ditches around the site are completed above the water table whilst the deeper reens around the site are completed within the Upper Clay, just below the water table. The drainage network and flows within it are managed by the Caldicot and Wentloog Drainage Board (an IDB).

Almost all the annual recharge falling on the site leaves via surface runoff due to the low permeability nature of the sites soils and the underlying low permeability Holocene sediments.

The closest water courses to the site which are not part of the sites own drainage infrastructure, are the Elver Pill Reen and the Hundred Perches Reen, some 359 meters to the ESE of the site. Due to their managed nature, flows within the reens can be variable and flow data is limited. Previous spot gauging of Hundred Perches Reen taken at the point where Queensway crosses the reen to the north of the site, shows flows to be in the order of 78 litres per second.

The Caldicot Levels are a SSSI, primarily as they are representative of a grazing marsh/reen habitat and also due to their invertebrate assemblages, plant species, otters, water voles and breeding birds. The nearest SAC to the site is the River Usk some 4 kilometres to the west of the site. There is no hydraulic connection between the site and the River Usk with all surface water from the levels draining directly into the Severn Estuary.

2.6 Conceptual Site Model

To enable the risks posed to groundwater and surface water to be evaluated, a conceptual hydrogeological model was developed as part of the closure process. The diagrammatic representation of the model is provided in Figure 4.

3 LAND USE AND CLOSURE PLANNING

3.1 Overview

The landfill area has been an area of industrial waste disposal for many years, initially developing in the 1970's to accept wastes from the Llanwern Steel Works. The landfill was one of two landfill sites operated at the Llanwern site, the other being the East Waste Management Site (EWMS). The landfill accepted industrial wastes from the steel making activity whilst the EWMS accepted general wastes, refuse, biodegradable wastes as well as industrial waste.

The 89 Ha occupied by the site was developed in a series of cells, historically termed lagoons. Lagoon 12 was constructed first on the west by raising four large bunds on top of the stabilising slag layer placed over the majority of the 89 Ha. Fine metallic dust (50% iron, 3% zinc) washed from the flues of the BOS plant was suspended in water and pumped from the steel works into Lagoon 12. There it settled and hardened to form the waste deposit seen today. Infilling in Lagoon 12 was completed by the mid 1980's with Lagoon 25 coming on stream as a replacement. Lagoon 25 was also constructed by developing slag bunds onto the stabilising slag layer, with the metallic fines pumped into the Lagoon. Infilling in Lagoon 25 was completed in 2002 with the demise of the steel making plant. There are no lining systems for either the base or side slopes of either Lagoon 12 or 25.

Throughout the duration of disposal activities, steel and iron slag was deposited to the north and east of Lagoons 12 and 25. Deposits of coarse granular slag of up to 7m thickness covered the areas indicated on Figure 3 as Slag Area W, Slag Area E and the SSQ Non-Hazardous Landfill. Since its deposition, both steel slag and blast furnace slag have become commercially viable for a variety of applications and most of the deposit has now been removed. The entire area now occupied by SSQ Non-Hazardous Landfill has, therefore, been reduced to a 1m thick slag stabilising layer.

Lagoon 27 is divided into four equal quarters and has accepted wastes from the Hot Mill under an IPC and now an Environmental Permit. This area lay outside the scope of the closure report for the areas in SSQ. Similarly, the water treatment lagoons in the NE of the site now fall under the works PPC Permit and therefore did not form part of the closure report.

Some of the activities in these areas have been carried out by Tata Steel and its predecessors (Corus and British Steel) whilst some have been carried out by contractors (such as Harsco and Multiserv) and others by third parties (such as Air Products, Newport Galvanisers, and Tarmac).

3.2 Areas Comprising Slag

These areas have been re-worked by Multiserv and Tarmac. Multiserv first recovered the steel from the material to enable excavation of secondary aggregate by Tarmac. This recovery operation went on for several years but is now largely complete. The recovery process worked from east to west, from the area of SSQNHL towards Slag Area W. To enable working in the area and the tracking of vehicles, a development platform of weathered slag approximately 1m thick was first placed and this is now all that remains following removal of the workable slag.

3.3 Lagoons 12 and 25

Lagoons 12 and 25 are very similar in terms of their site position, construction and deposit. Lagoon 12, however, is approximately 20 years old whilst Lagoon 25 is 10 years old. The typical surface condition of the lagoons is shown in Plates 3-1 and 3-2.

Plate 3-1 Surface of Lagoon 12

Plate 3-2 Surface of Lagoon 25

Assessments completed as part of the closure report demonstrated that the lagoons were not likely to pose a significant risk to controlled waters due to the chemical stability of the stored material, the lack of sensitivity of the hydrogeological setting and the collection of surface run-off by the sites' surface water drainage system. Further, the stability assessment demonstrated that there were no concerns over their long-term stability.

As the lagoons are predicted to pose no significant risk to the aquatic environment and have been shown to be geotechnically stable, the restoration plan focussed on preventing the release of dust during dry conditions, improving the overall site aesthetics and ensuring that the surface water collection ditches are regularly maintained. As can be seen from Plates 3-1 and 3-2, both lagoons are currently partially naturally vegetated, with the vegetation at Lagoon 12 more advanced than Lagoon 25. Consequently, there have been no recorded issues regarding dust blow events. Therefore, there is no intention to disturb this habitat currently. Rather, the occurrence of dust release at both lagoons will be monitored and only, if necessary, will additional soil cover be placed. Such an approach will also benefit the appraisal of recovery operations, which is ongoing.

3.4 Powerline Valley

No specific restoration plans were planned for this area as no waste activities have occurred within the area.

3.5 Other Areas

No specific restoration plans were planned for these areas at this stage as no waste activities have occurred within these areas.

4 MONITORING PROGRAMME

The current available monitoring network is illustrated in Figure 5.

4.1 Groundwater and Surface Water

The AMP set out the determinants to be examined in groundwater and surface water. During 2014 and 2015, Tata Steel commissioned more frequent monitoring than required by the AMP and implemented most of the characterisation suite. Following the completion of the first 12 months of monitoring a review was presented in the 2014 Annual Monitoring Report and the monitoring programme implemented from 2016. This has been recently reviewed and rationalised by Tata Steel. The current monitoring programme is presented in Table 4-1

Table 4-1 Monitoring Programme

Monitoring Parameter	Monitoring Location	Frequency	Type of Monitoring Point
Groundwater	BH13 to BH19, BH24, BH201 to BH205	Quarterly	50mm diameter piezometer wells
Surface water	SW1, SW2 and SW3	Quarterly	Surface water body comprising reens
Leachate	Lagoon 12 and 25 embankments	Six Monthly	Visual observation and physical measurement
Dust and Particulates	As required	As required	Dust gauges as required
Odour	As required	As required	Subjective assessment area
Stability	Lagoon 12 embankment	Annual	Visual observation and physical measurement

The monitoring network is, overall, performing as designed. There are, however, several aspects that require consideration and improvement:

- Samples cannot always be collected from the surface water sample monitoring locations due to dense vegetation growth. This needs to be subject to preventative maintenance to ensure safe and timely access.
- Buddleia growth along the southern boundary sometimes limits access and monitoring, particularly during the summer months.
- In 2019, no sample was collected from BH24 as the headworks were found to have been destroyed. During 2020, further investigations located the well and a sample was collected, although the headworks remain damaged and require repair. Samples have continued to be collected from the damaged well but the situation is not ideal. There were plans to replace this position in Q1 2022 but this did not occur.
- With the drill rig on site to replace BH24, Tata Steel also plans to replace BH16, BH18 and BH205 as all have damaged headworks and require moving to allow for future redevelopment in the area.

The reader should also be aware that the laboratory is currently reporting pH values above 12 as >12 pH units as they do not have the capability to accurately define pH values above pH 12.

4.2 Dust

The AMP details the dust monitoring programme to be implemented. Geotechnology understands that there have been no amenity issues related to dust or any other aspect.

4.3 Waste Stability

The previous assessment of the stability of the waste mass, its containment bunds and the surrounding ground did not reveal the possibility of slope failure with even the most pessimistic model parameters. Waste settlement is not expected as the site has not received biodegradable wastes, simply hydraulically placed industrial wastes that are now becoming consolidated and partly cemented by mineral precipitation. Accordingly, waste settlement monitoring and waste/ bund stability monitoring is not required by the AMP.

However, in recognising that there is a possibility that part of the eastern bund of Lagoon 12 is not cemented and could have an inadequate Factor of Safety (though failure is not indicated) there should be an annual walk-over each springtime to look for evidence of shallow translational slips.

During the 2022 walkover, tension cracks on the upper surface of the embankment of Lagoon 27 were observed, as shown in Plate 4-1. These have not notably changed during 2023.

Plate 4-1 Tension Cracks on Surface of Embankment of Lagoon 27

4.4 Leachate Breakout

The AMP suggested leachate breakout monitoring should comprise six monthly site walkovers, particularly around the embankments of Lagoons 12 and 25. These areas are not however readily accessible.

During 2023, there were no signs of leachate breakout in the areas accessible.

4.5 Analytical Testwork

All aspects of the analytical and monitoring programme are directly managed by Tata Steel Environment Department. Under the direction of the Environment Department, Geotechnology and TDC Harbourside undertake several aspects of the sampling and analysis. These include surface water and groundwater laboratory analysis and measurement of groundwater levels. Tata Steel Environmental Department undertakes all other monitoring aspects when required. All analysis is undertaken by TDC based at the Engineering Centre for Manufacturing and Materials (ECM) in Margam, adjacent to the Port Talbot steelworks.

4.6 Actions required

- Safe access to the surface water sampling points needs to be improved. Given that vegetation growth is inevitable, routine maintenance and/or signage would be beneficial. Alternate sample positions could be considered and agreed with NRW, if necessary.
- Several of the headworks are open and not secure. The headworks at monitoring positions BH17, BH19, and BH201 need particular attention (as BH16, 18, 24 and 205 are to be replaced) due to inadvertent damage over the years.
- Buddleia growth along the southern boundary sometimes limits access and monitoring. The vehicular access route and monitoring positions should be routinely maintained.

5 GROUNDWATER LEVEL AND QUALITY

5.1 Groundwater Flow

Piezometric plans in Appendix 1 present groundwater levels encountered in the shallow made ground and peat layer. These plans have been developed from measurements of water level at the piezometers summarised in Table 5-1, where accessible.

Table 5-1 Groundwater Monitoring Wells

ID	Monitoring Interval
BH13S	Made Ground
BH16S	Made Ground
BH18S	Made Ground
BH201S	Made Ground
BH203S	Made Ground
BH13D	Peat
BH16D	Peat
BH17	Peat
BH18D	Peat
BH19	Peat
BH201D	Peat
BH202D	Peat
BH203D	Peat
BH205D	Peat

5.2 Groundwater Chemistry

Appendix 1 contains temporal charts showing how the recent data compares with historical measurements. The data is presented as a series of hydrochemical plans and time series charts.

The data indicates that groundwater within the shallow made ground is distinct and characterised by elevated pH (typically > pH 11). This is principally because most of the made ground comprises steel slag that releases a strongly alkaline pH during weathering. In comparison, the groundwater in the peat is circumneutral (pH 6 – 8) although the elevated pH at BH202 suggests that there could be localised interconnection between the made ground and peat at this point. Groundwater chemistry tends to become more dilute from north to south.

Because of the highly alkaline pH, many non-hazardous and hazardous substances are sometimes below detection limits or at low concentrations in the groundwater recovered from the made ground. In recent years, hazardous substance cadmium has been detected on several occasions, and sometimes at elevated concentration. During 2022 and 2023, cadmium was not found above the analytical detection limit. Surprisingly, significantly elevated concentrations of mercury were, however, detected in 2022 with 0.621 mg/l reported at BH203D. Elevated concentrations were also detected at BH13D and BH205D, as shown in Plate 5-1. Mercury was also found at elevated concentration in surface water, with the highest concentration at QSW1, downstream of the lagoons. Mercury was not, however, detectable in groundwater during 2023. Nickel and lead were detected at several positions in 2022 and 2023 but at lower concentrations than observed previously.

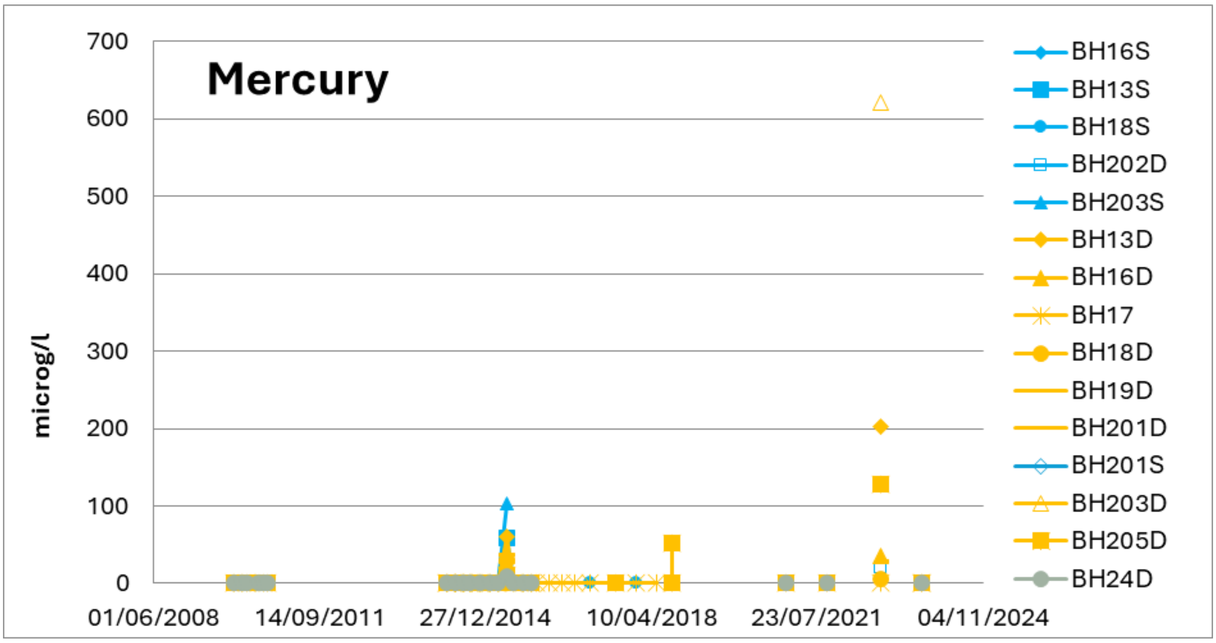


Plate 5-1 Mercury concentrations in groundwater

Chromium, copper, lead (and other metals) have also been found above their freshwater Environmental Quality Standards (EQS) from time to time, although there is no general upward trend. Exceptions do however occur, with copper detected at its highest concentration at BH17 in December 2022 and copper increasing at BH205D during 2022. As shown in Plate 5-2, such trends have not, however, persisted it 2023. This position is upstream of the lagoons and has also shown increasing concentrations of chloride, phosphate and ammonia in recent years.

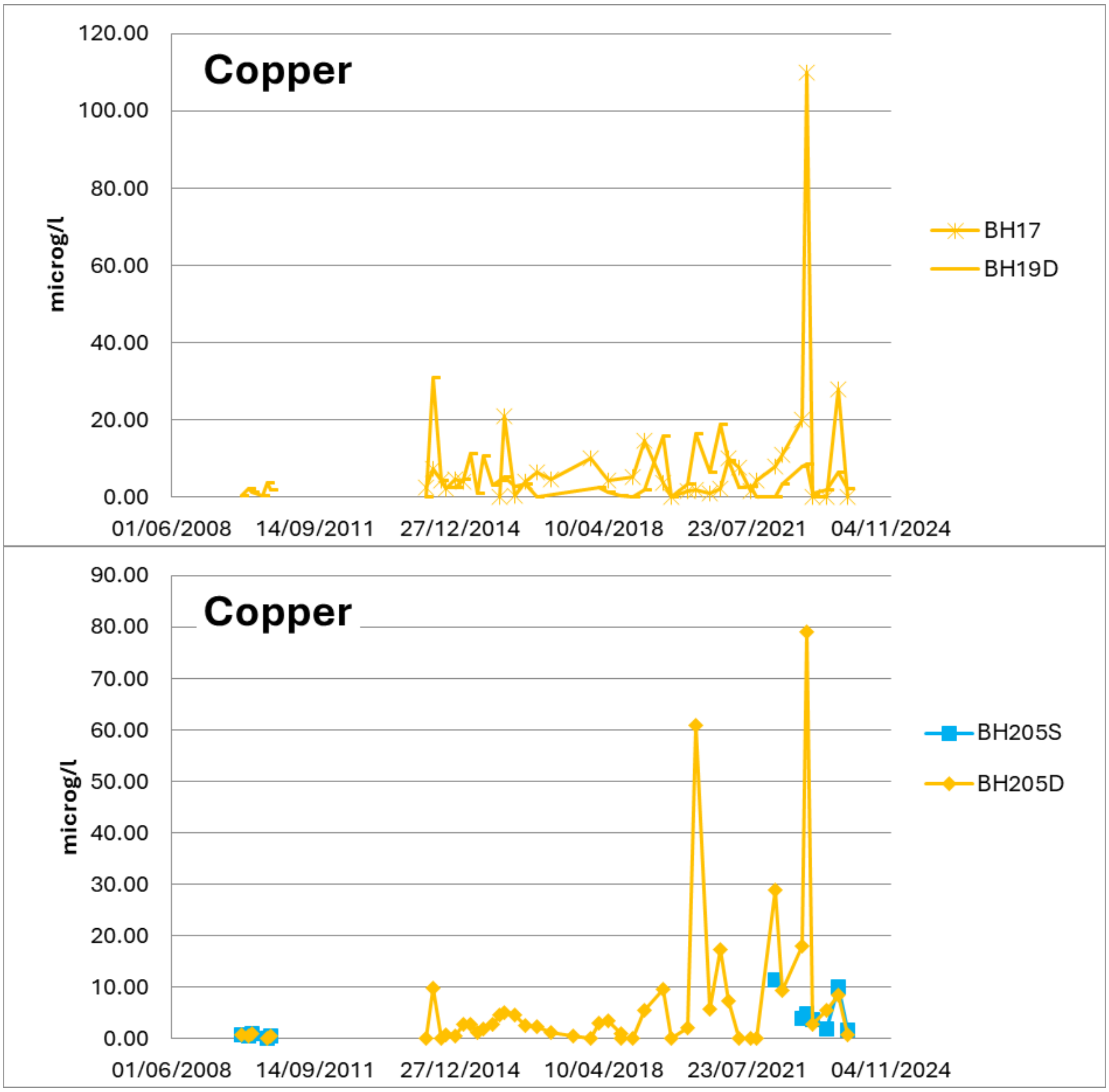


Plate 5-2 Copper concentrations at BH205

The temporal variation of many trace metals could be described as 'spikey' with no clear trends. This variation may be a consequence of the low analytical detection limits (that sometimes appears to change) and potentially suggests that there is no widespread persistent change or deterioration in groundwater quality. Rather, the shallow perched groundwater chemistry is suspected to be influenced by antecedent rainfall and leaching/flushing of primary and secondary precipitates within the made ground. Previously, long-term increases in mineralisation were evident at several positions (e.g. BH17, BH19, BH201) but these trends are less distinct since 2020.

Ammonia is also sometimes present in groundwater sampled from the made ground, peat and bedrock. At the high prevalent pH, the ammonia would be expected to be dominated by un-ionised ammonia, the most toxic form. Within the underlying peat, the less toxic ammonium ion would be expected to dominate as the pH is lower.

At BH16, an oil sheen has been noted on several occasions whilst sampling. Unfortunately, samples could not be collected from this position during 2018 and 2019 but following further excavation, the headworks (although damaged) have been accessible since 2020. Analysis of a sample in May 2021 confirmed the presence of free product (and most likely emulsions) as the lab reported total hydrocarbons of 250 mg/l to be present. Following a review of the chromatogram, the lab considers the hydrocarbon to be indicative of a mid to high boiling point mineral oil. Hydrocarbons were again observed and detected in 2023.

Interestingly, the slow moving groundwater within the peat is as mineralised as the perched groundwater within the shallow made ground. This is not considered to be due to infiltration of groundwater from the made ground through the intervening clay as several parameters are at higher concentration in the peat (e.g. chloride, sodium, chromium) and pH is significantly lower. The cause of the increased mineralisation is suspected to be due to processes within and possibly below the peat, including the potential influence of sub-artesian groundwater in the underlying bedrock and a potential saline contribution. There are variations in the hydrochemistry in the peat, but these are not considered to be related to the passage of groundwater from the overlying made ground.

Groundwater in the Mercia mudstone is only monitored at BH24, to the south of Lagoon 25. Like the groundwater found in the peat, the groundwater in the bedrock has a circumneutral pH and elevated electrical conductivity (typically 4000-6000 microS/cm). Some of the variations observed in the groundwater chemistry at this point may be influenced by the significantly damaged headworks.

6 SURFACE WATER

The results of the surface water monitoring are graphically presented in Appendix 2.

The data gathered during the past 12 months continues to suggest that surface water is becoming increasingly alkaline. This is based on the upwards inflection of the pH observed at all sample points over the past 24 months. It appears that the there is a long-term underlying upwards trend in surface water pH with short-term spikes in pH, particularly at SW2. This is clearly shown in Plates 6-1 and 6-2. Sample position SW2 is downstream of SW3 and upstream of SW1, adjacent to powerline alley.

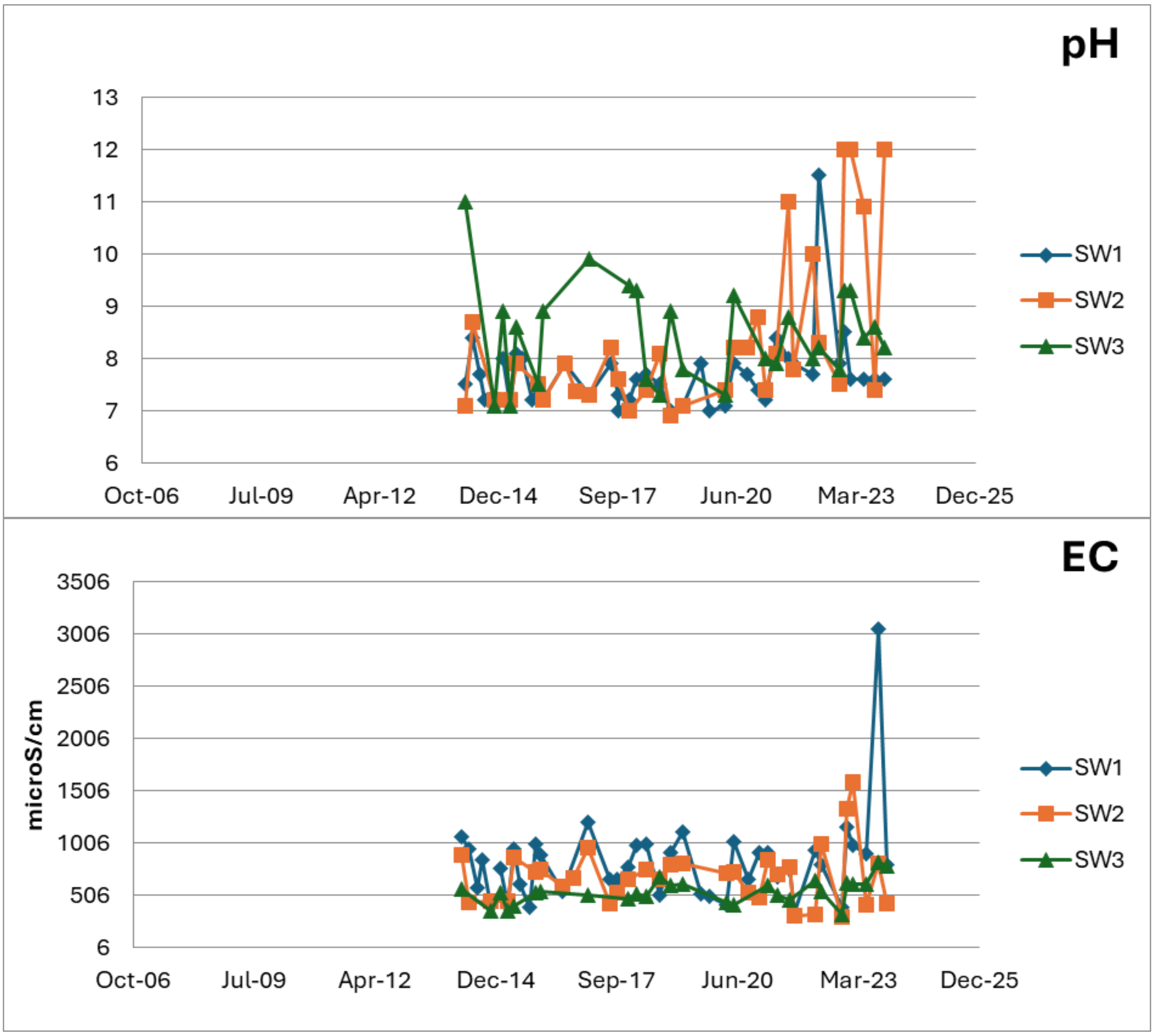


Plate 6-1 Variations in surface water chemistry

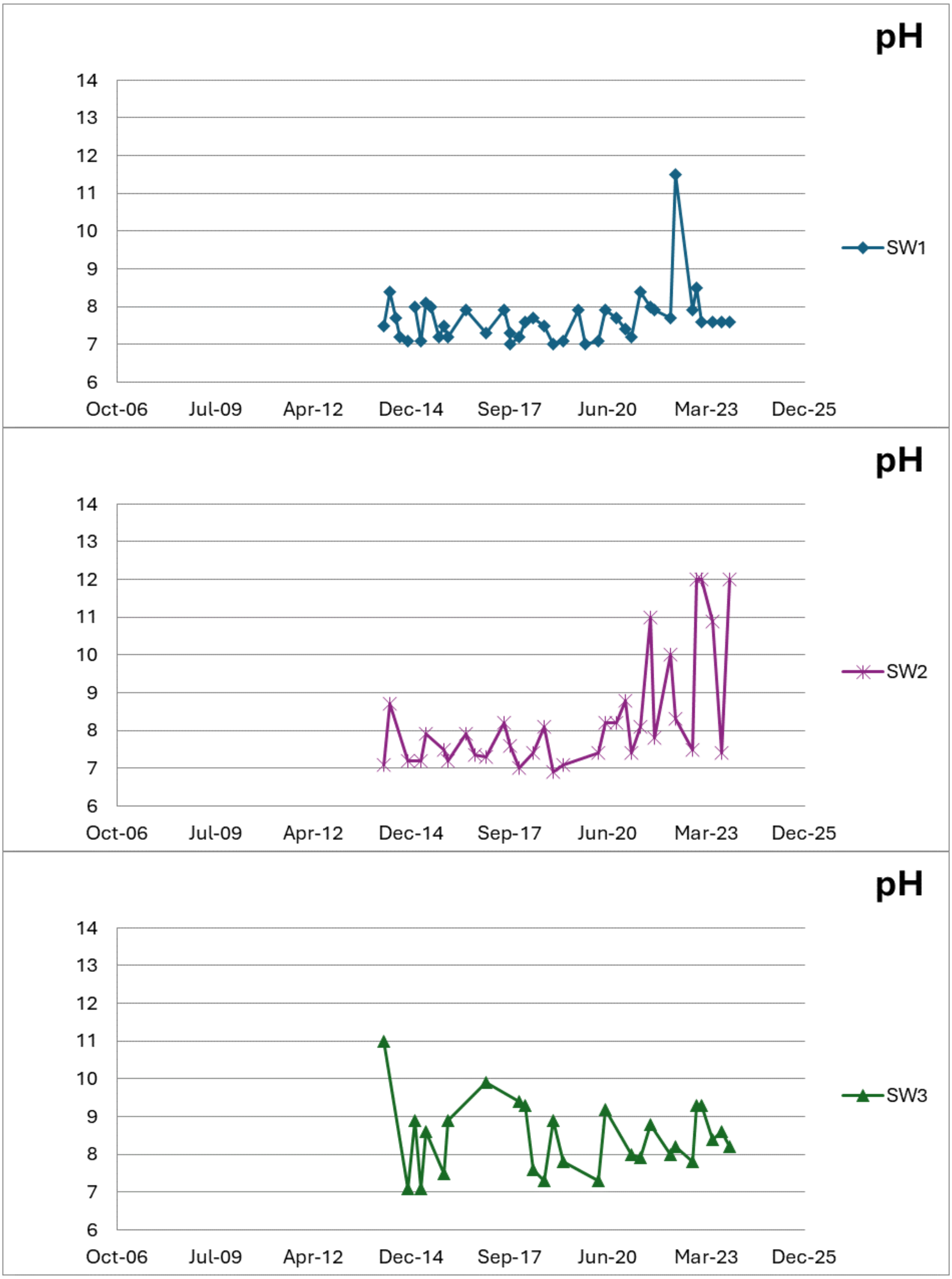


Plate 6-2 Changes in pH at SW1, SW2 and SW3

Whilst pH has increased, there is no clear trend with Electrical Caducity or any other parameter apart from possibly potassium and nickel (see Appendix 2). The data varies considerably for several parameters with Electrical Conductivity sometimes doubling/halving between quarterly sampling events, as shown in Plate 6-3. There are sometimes short-term variations in trace metal concentrations but no persistent trends indicating deteriorating water quality.

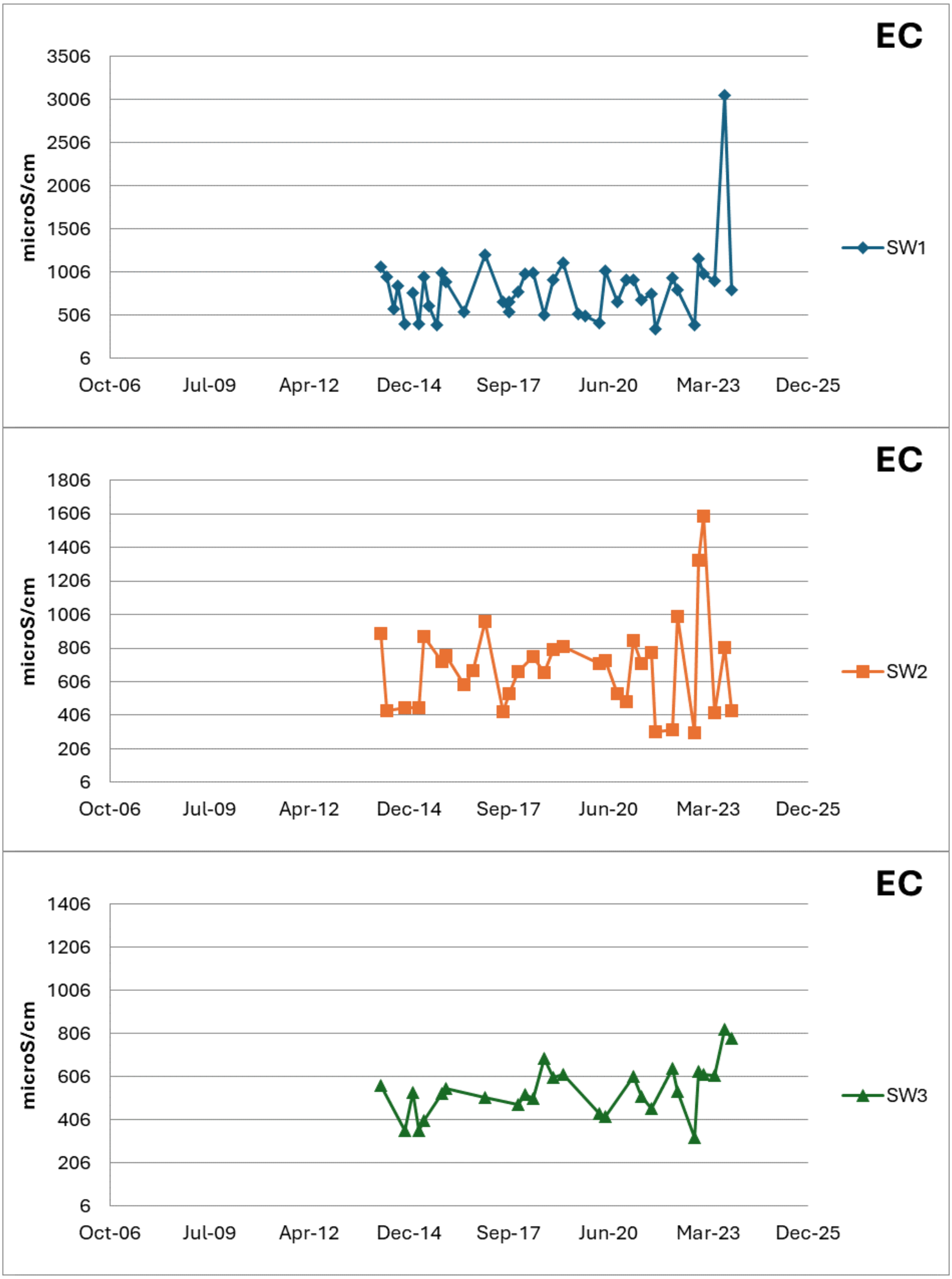


Plate 6-3 Variation in Electrical Conductivity (EC) in surface water

Some of the data trends may be influenced by the timing of sampling relative to ditch clearance and maintenance, as shown in Plate 6-4. In October 2021, some of the highest surface water levels observed were found at SW1 (compare Plates 6-4 and 6-5). This was due to significant rainfall in the preceding 24 hrs.

Plate 6-4 Ditch maintenance during August 2021 sampling upstream of sample point SW1

Plate 6-5 Raised surface water levels in October 2021

Such changes in surface water levels would be expected to alter water quality and could explain the variations observed. Consideration should also be given to other sources and the ditch should be inspected to ensure that all potential on-site and off-site run-off sources are understood.

7 AMENITY ISSUES

There have been no requirements for any dust, noise or odour monitoring or investigations.

8 SUMMARY AND RECOMMENDATIONS

8.1 Evaluation and Summary

Monitoring of groundwater and surface water has revealed conditions like those previously observed. Shallow groundwater chemistry is dominated by the leaching of slag-based wastes with elevated pH and alkalinity. Such chemistry is not widely evident in the underlying peat as the made ground and peat are separated by low permeability clays. Mineralised groundwater within the peat is not considered to be a consequence of downwards percolation from the overlying made ground.

Shallow groundwater in the made ground is perched on the underlying clay surface. This groundwater has been found to contain several trace metals at concentrations that sometimes exceed Environmental Quality Standards.

Free oil has once again been observed at BH16.

Like the groundwater in the peat, surface water on the southern, downgradient edge of the site is circumneutral. The concentration of non-hazardous and hazardous substances tend to be lower in surface water, with more parameters meeting Environmental Quality Standards. The data gathered during the past 12 months suggests surface water is becoming increasingly alkaline. The ditch should be inspected to ensure that all potential on-site and off-site run-off sources are understood.

The lagoon embankments should also be closely inspected as tension cracks were observed on the surface of the southern embankment of Lagoon 27.

8.2 Monitoring Programme

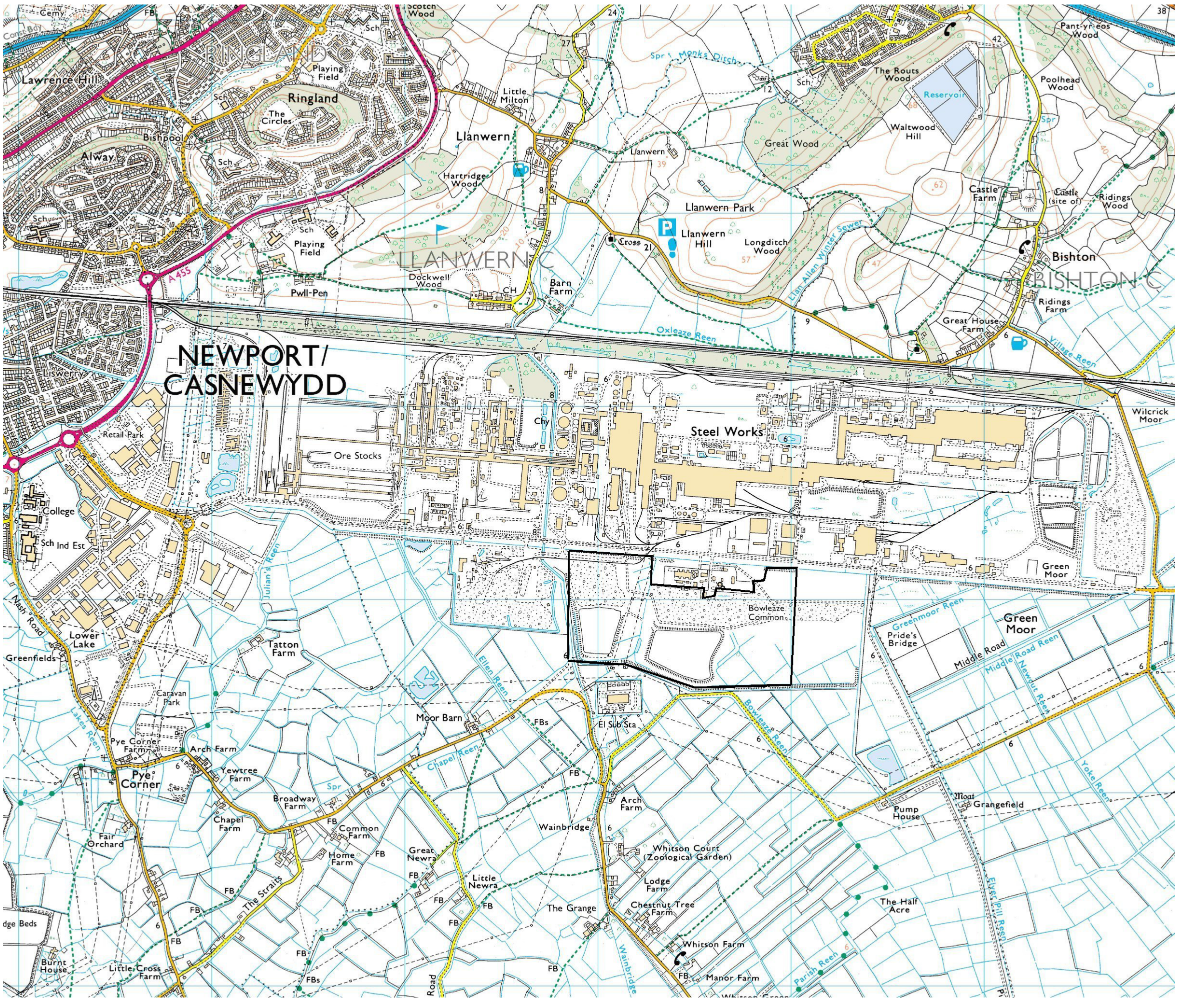
As noted previously, the monitoring programme could be rationalised as the current datasets reveal that groundwater gradients are low, and conditions relatively stable. For instance, the frequency of groundwater monitoring could be reduced to six monthly and monitoring at BH203, BH16 and BH24 either stopped or reduced to annual. This latter suggestion is on the basis that BH203 is close to BH13, BH16 (which has been buried) is close to BH18 and BH24 monitors the deep bedrock.

Before requesting NRW to evaluate this suggestion, Geotechnology suggests that Tata Steel first considers the potential impact of any development proposed for the site and immediate area and the potential benefit of the current monitoring programme. Consideration could also be given to utilising information and infrastructure from the boreholes drilled by others along the southern part of the site to inform the M4 relief road design. It is unclear if these boreholes contain groundwater wells that could be utilised.

8.3 Actions Required

- Check integrity of the site boundary to ensure members of the public cannot gain access.
- Conduct six monthly walkovers around embankments of Lagoons 12 and 25 to check for leachate breakout. This may require access to be created.
- Conduct walk-over to look for instability in lagoon embankments and potential contributions to surface water quality.
- Improve year-round access to the surface water monitoring positions.

- Ensure safe and reliable access to all sample positions.
- Manage buddleia growth along the southern boundary as it is limiting access and monitoring.



Reproduced from the Ordnance Survey Land Ranger Map
with the permission of The Controller of Her Majesty's Stationery Office

Figure 2 Site Plan Showing Permit Boundaries

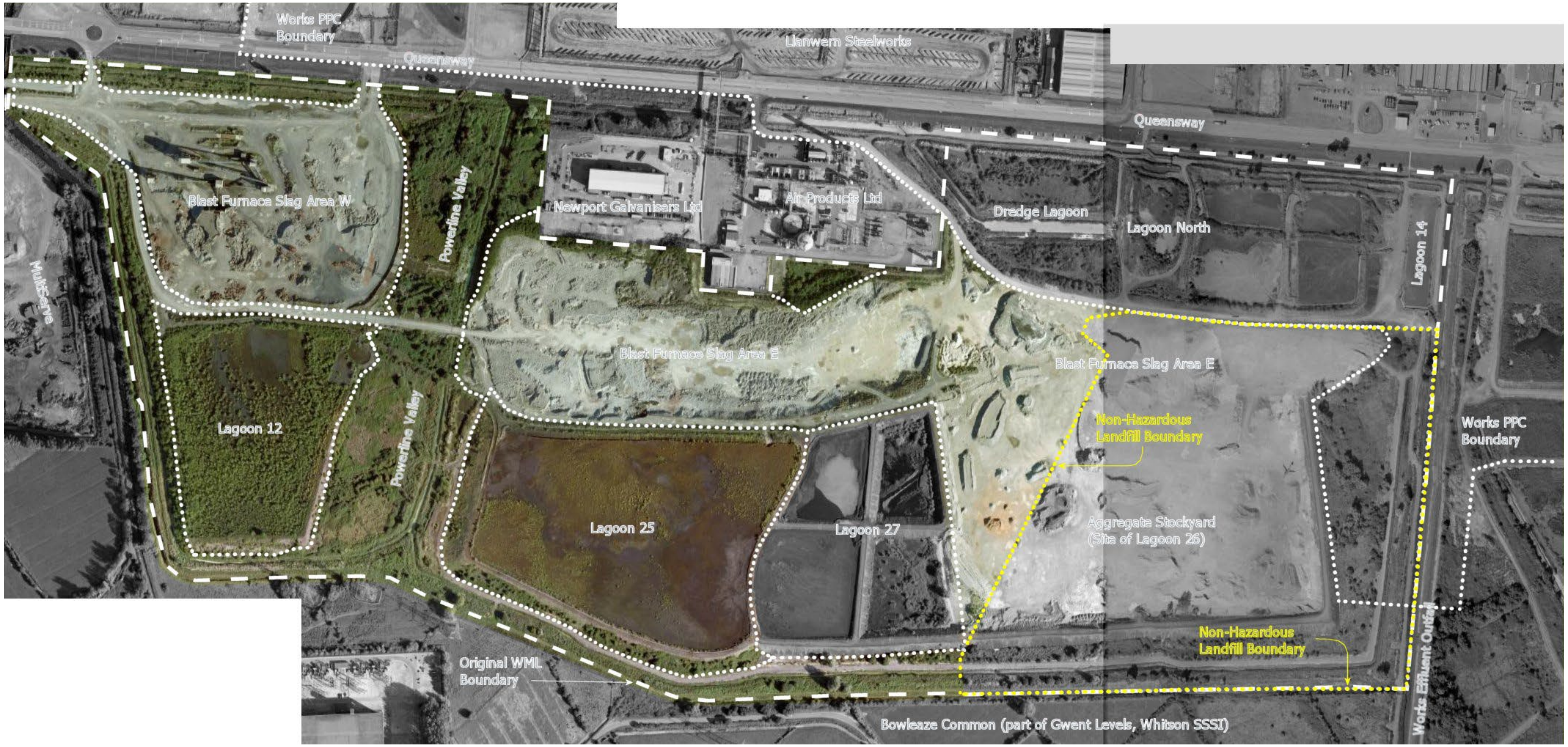
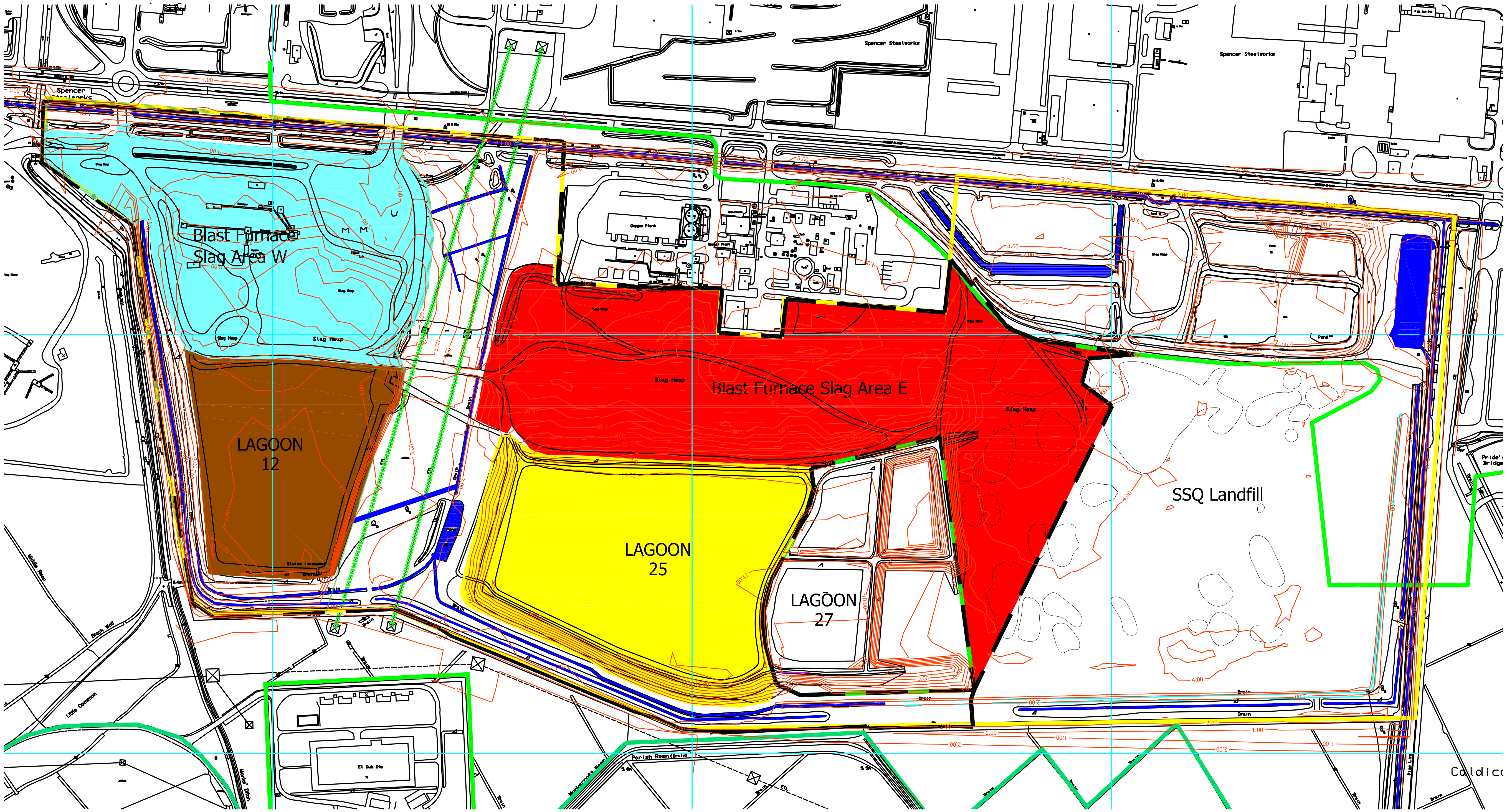


Figure 3 Areas of Site Included in Closure Plan



Blast Furnace Slag Area E

Blast Furnace Slag Area W

Lagoon 25

Lagoon 12

Definitive Closure Boundary

Figure 4 Conceptual Site Model

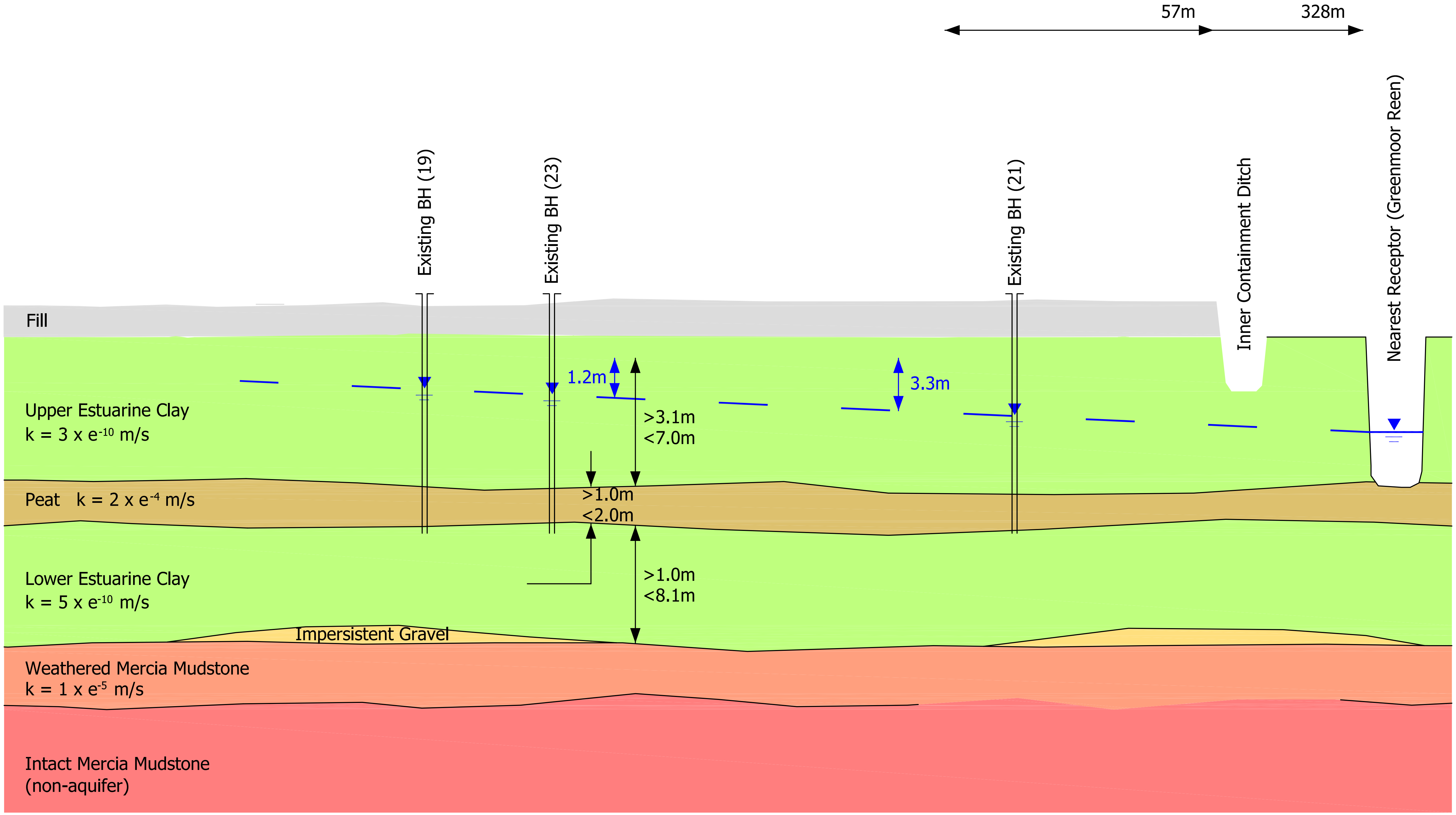
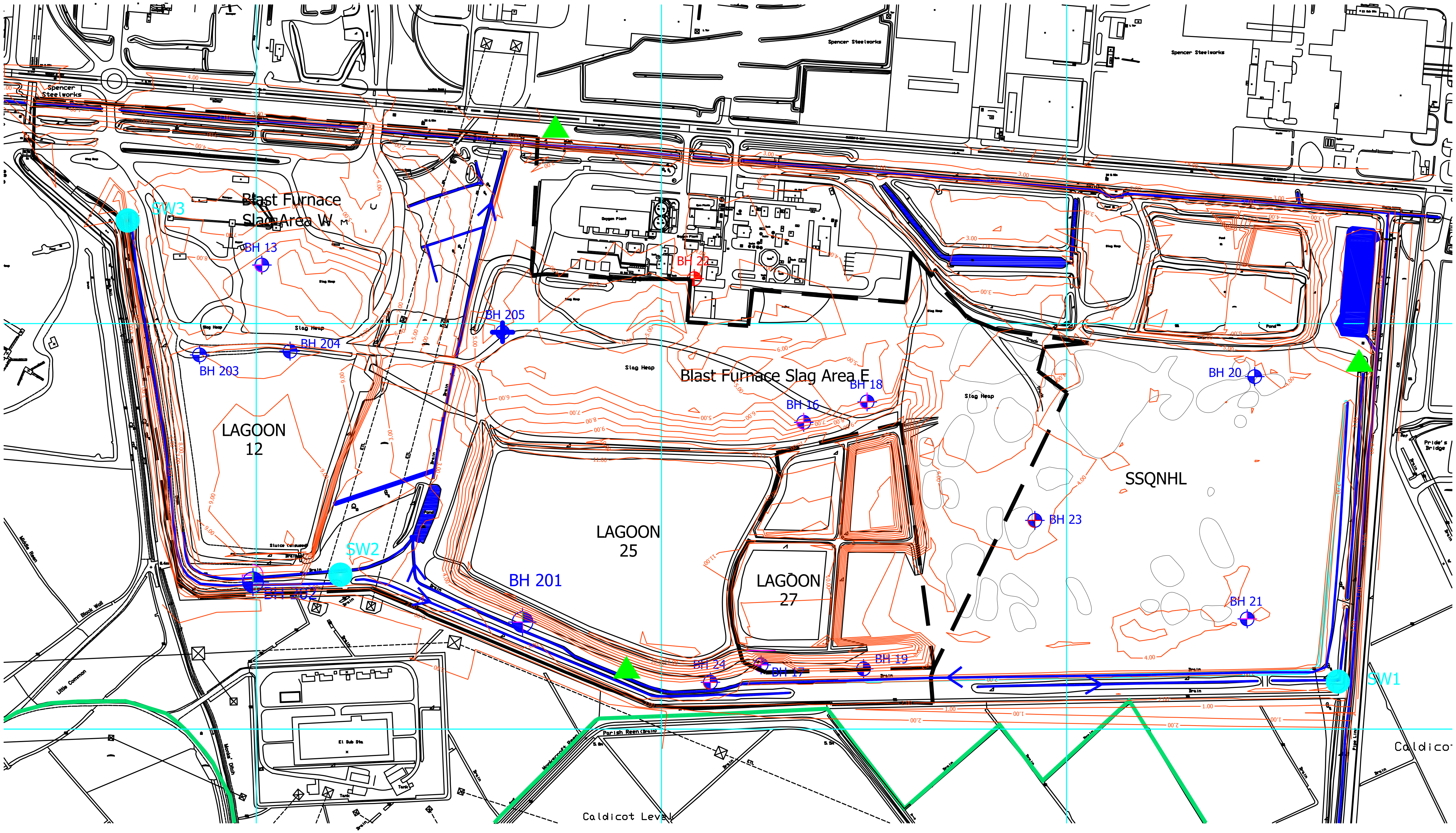
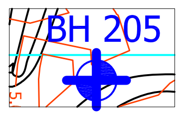
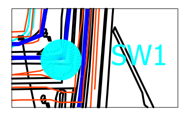


Figure 5 Available Monitoring Network





Monitoring Position to be replaced



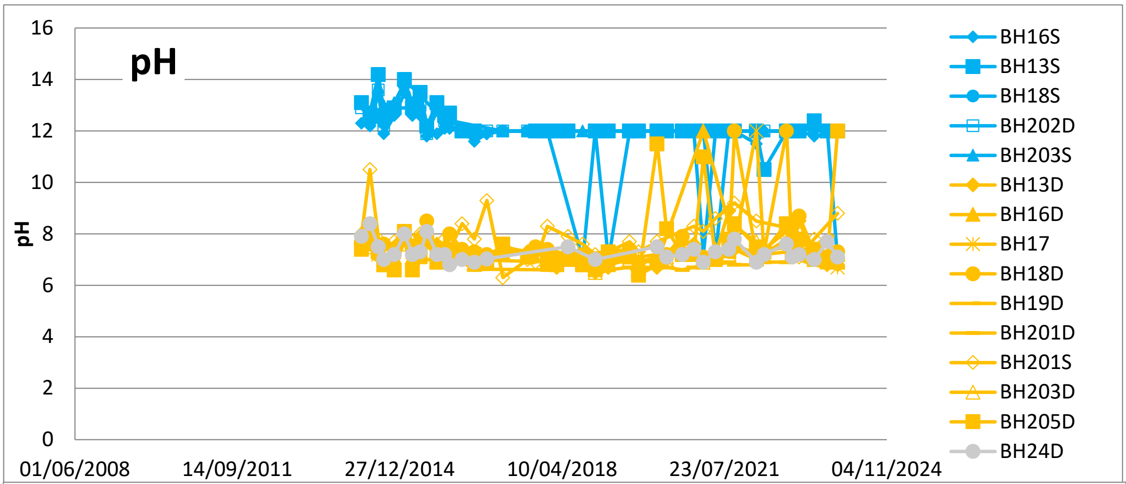
Surface Water and Leachate Monitoring Position

SOUTH SIDE QUEENSWAY WASTE MANAGEMENT SITE, LLANWERN STEELWORKS

2023 Annual Review of Environmental Monitoring

Appendix 1
Groundwater Level and Chemistry Analysis

Report Number 2299r2v1d0124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23/07/2021
04/11/2024
BH16S
BH13S
BH18S
BH202D
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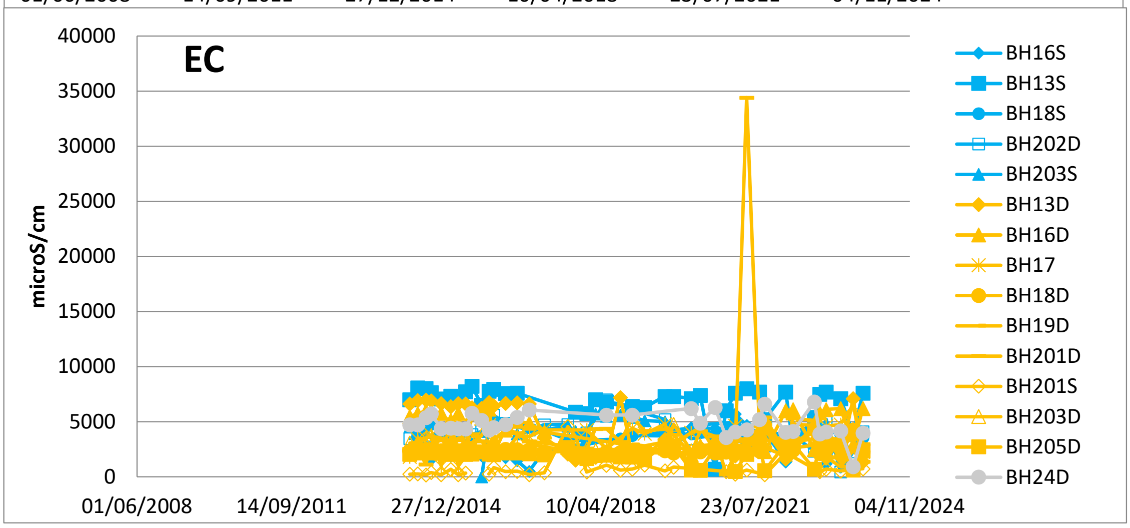
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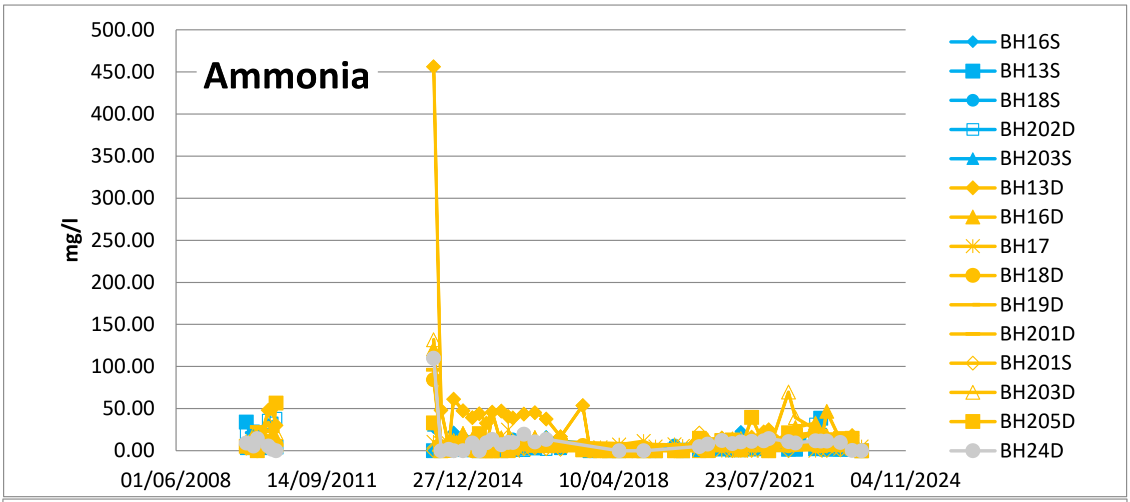
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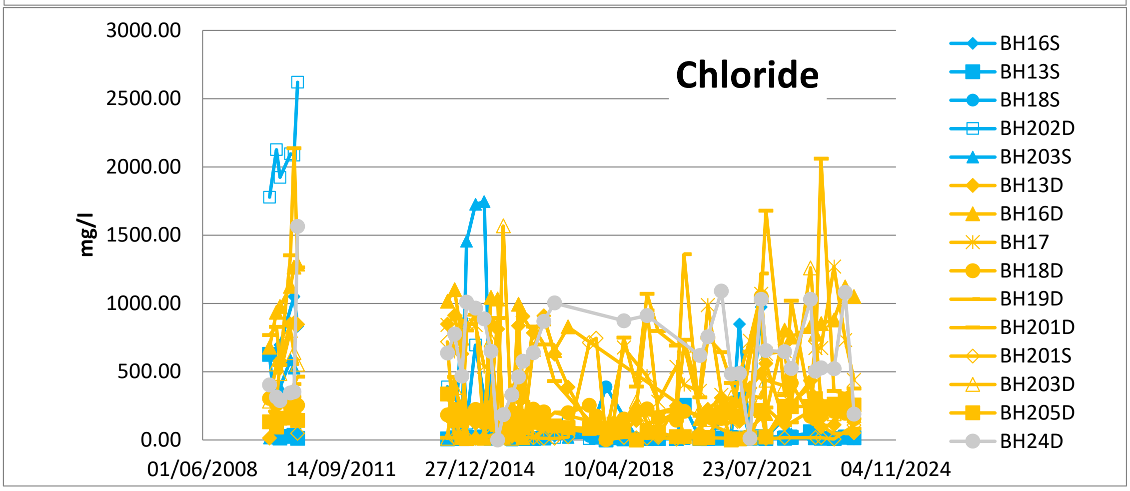
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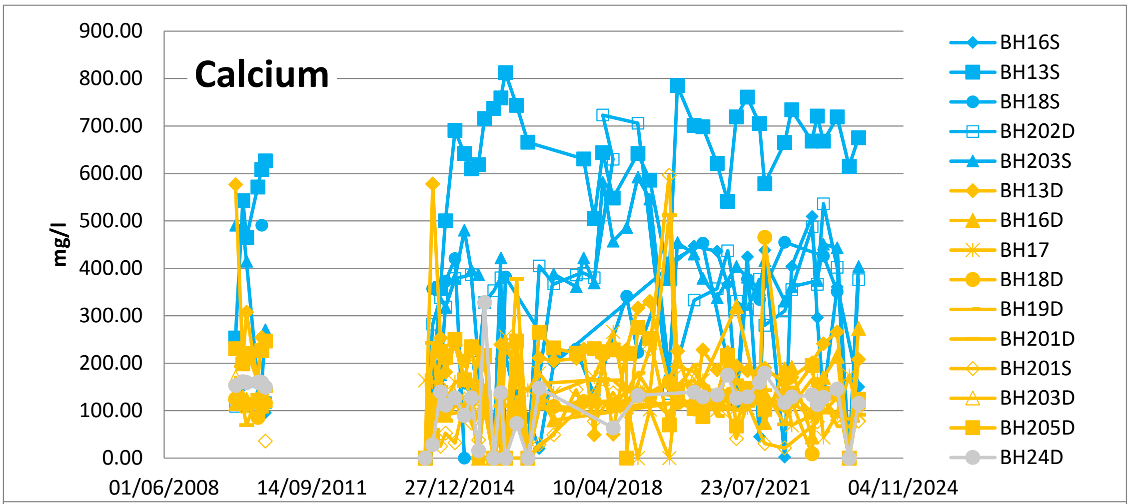
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23/07/2021
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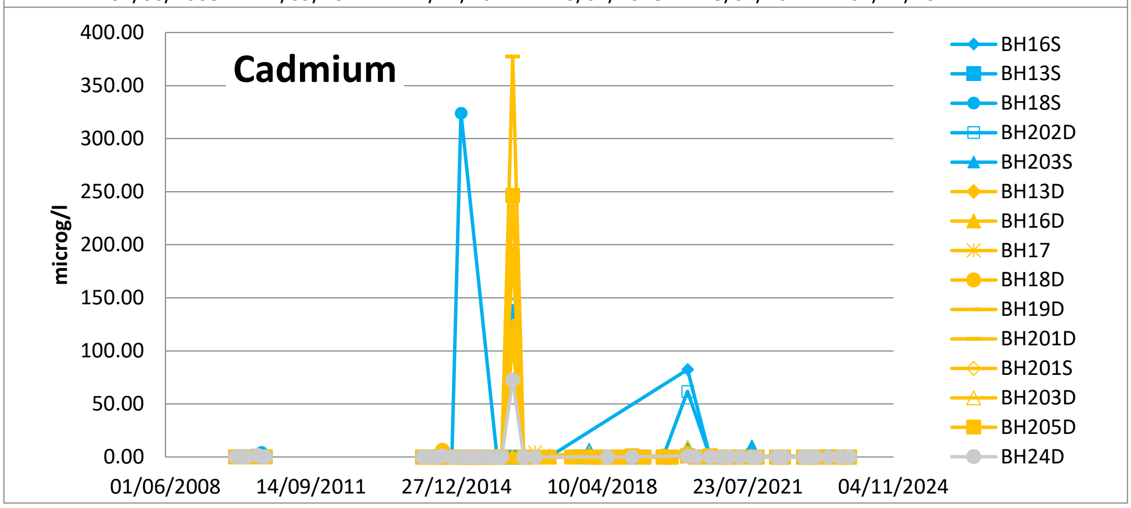
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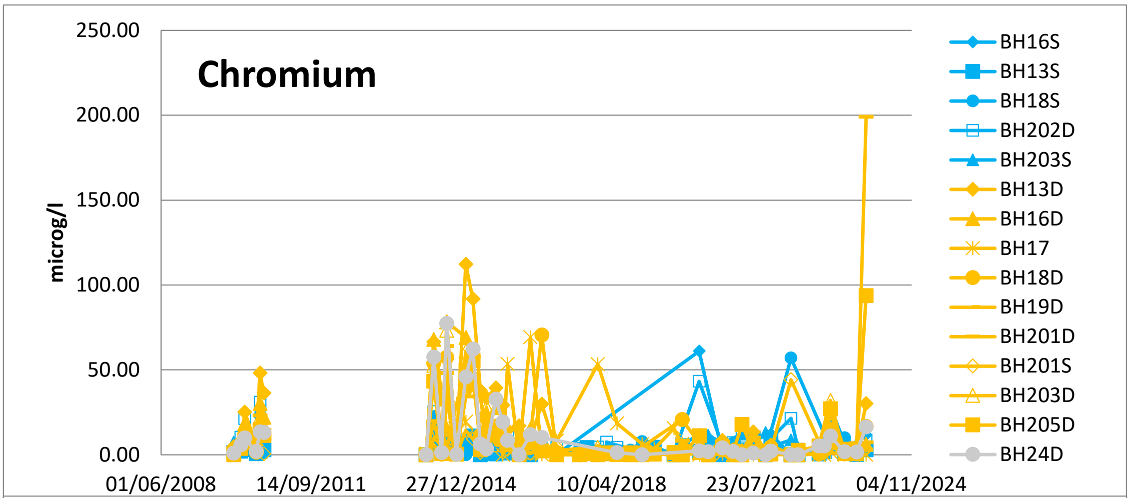
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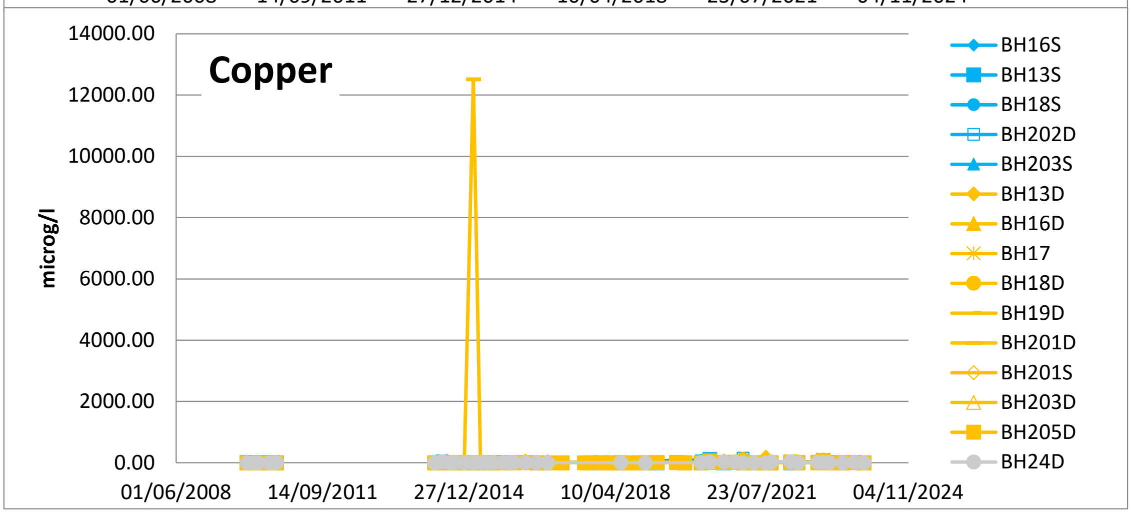
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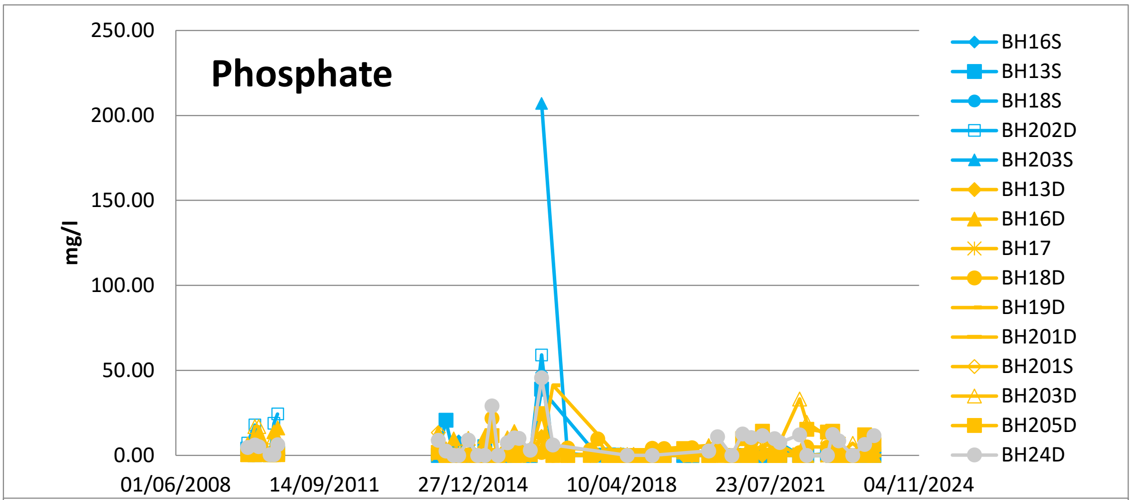
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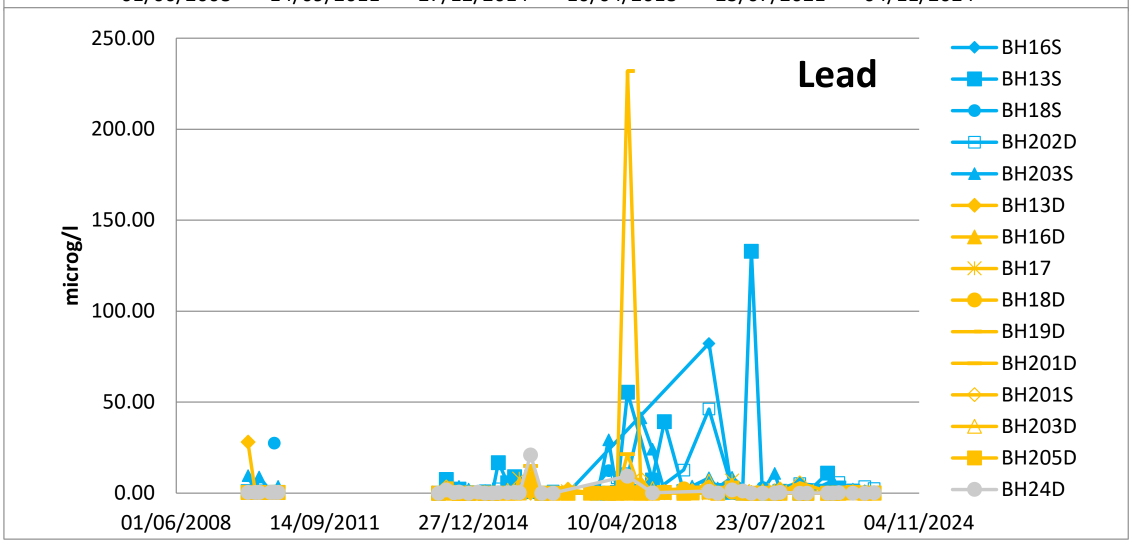
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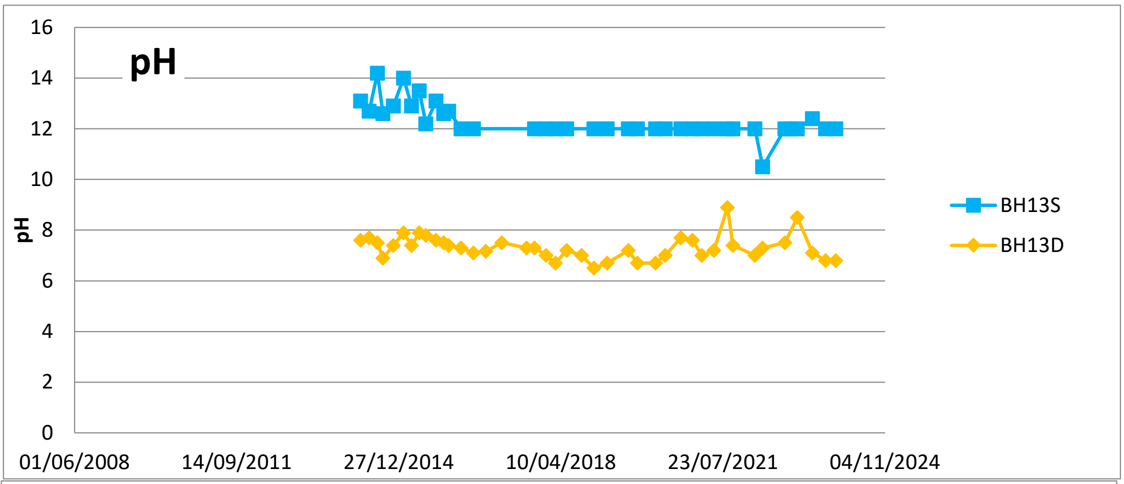
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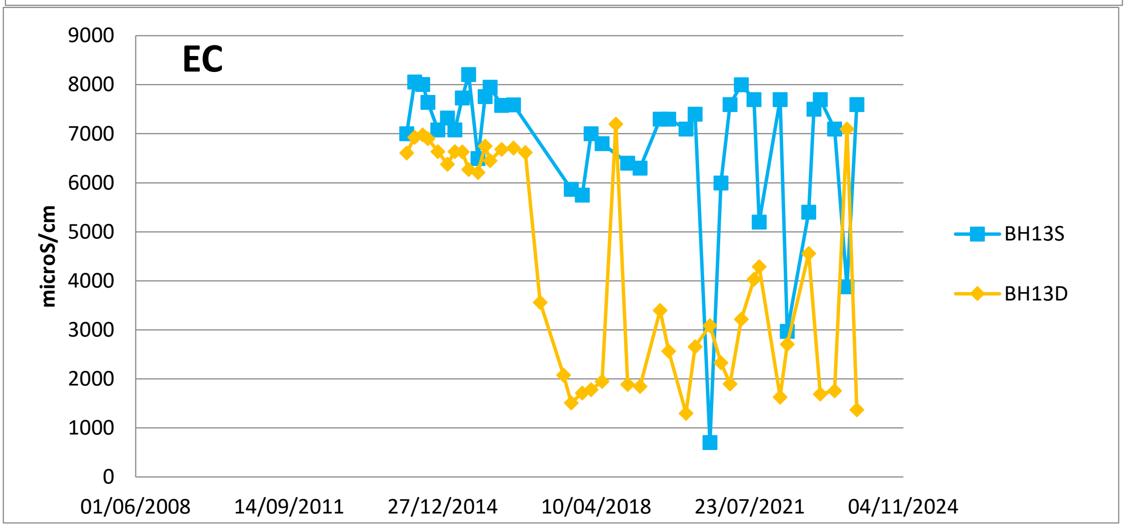
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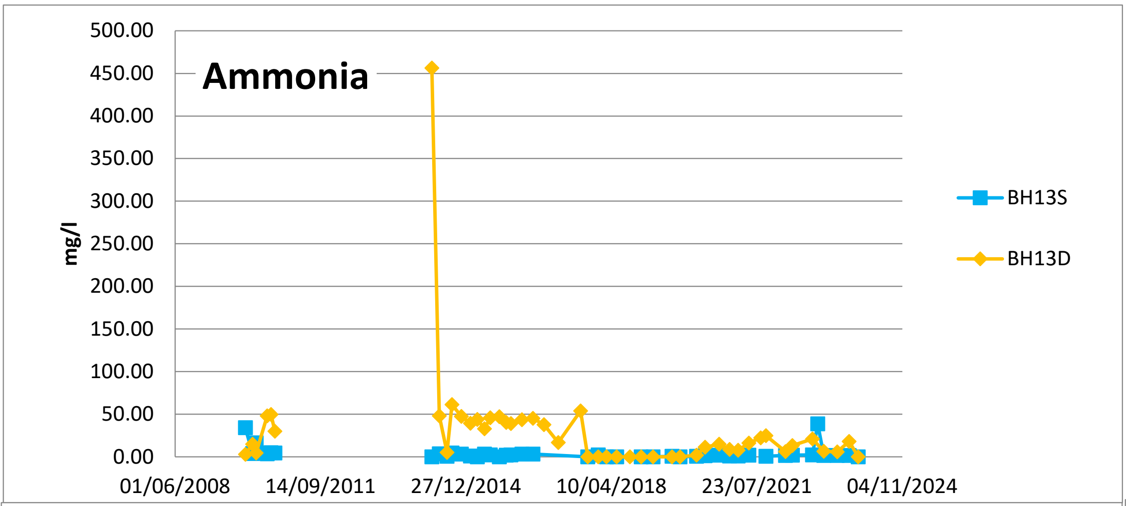
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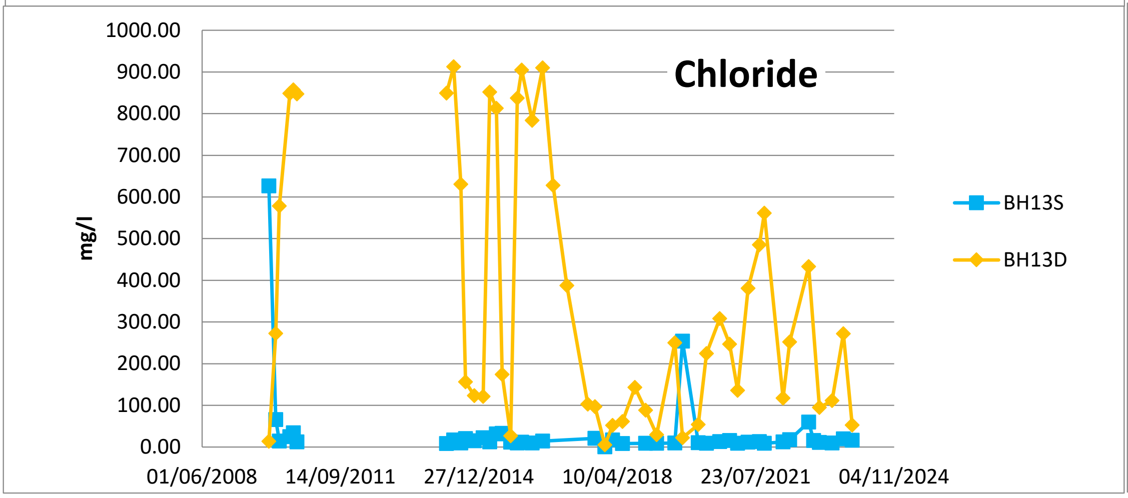
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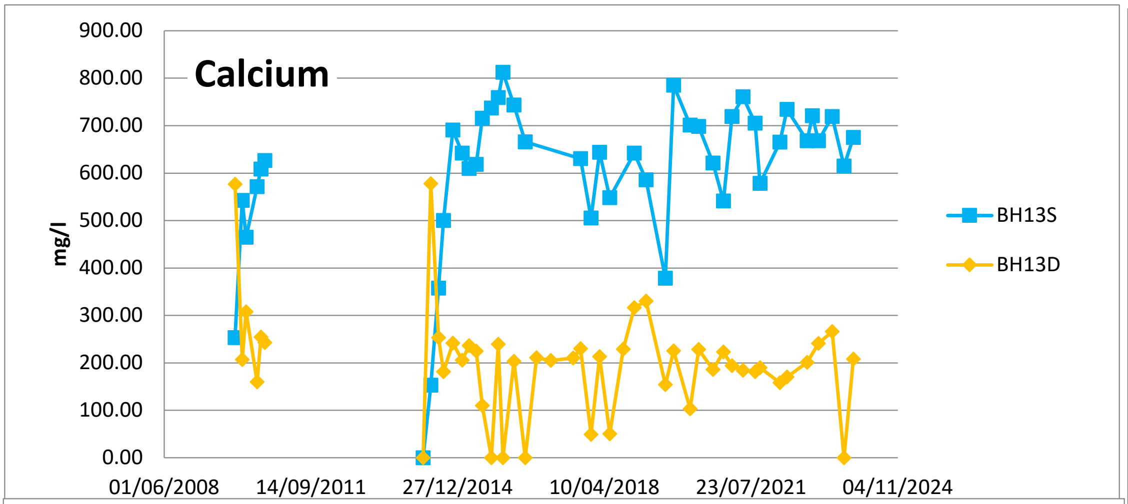
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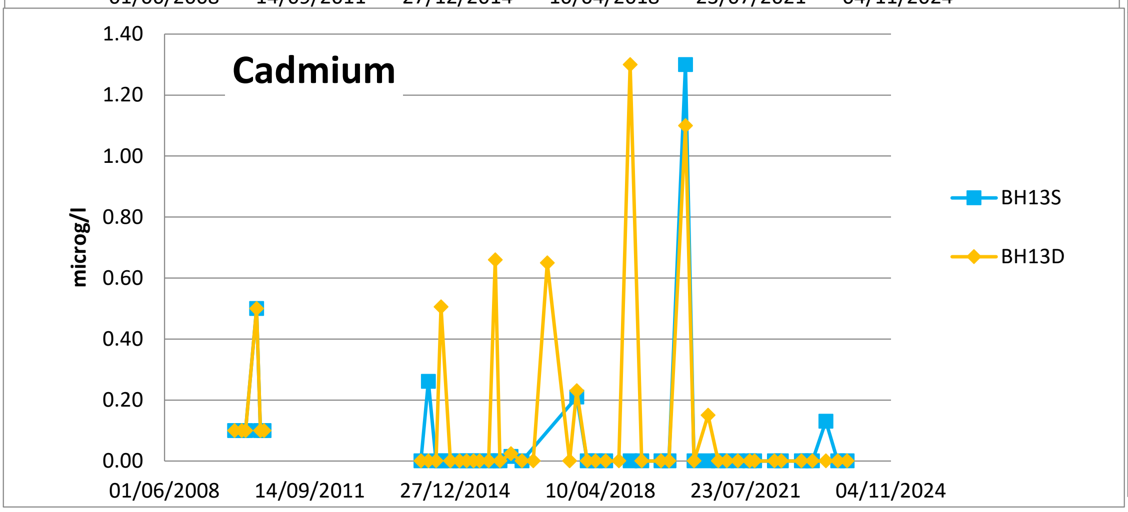
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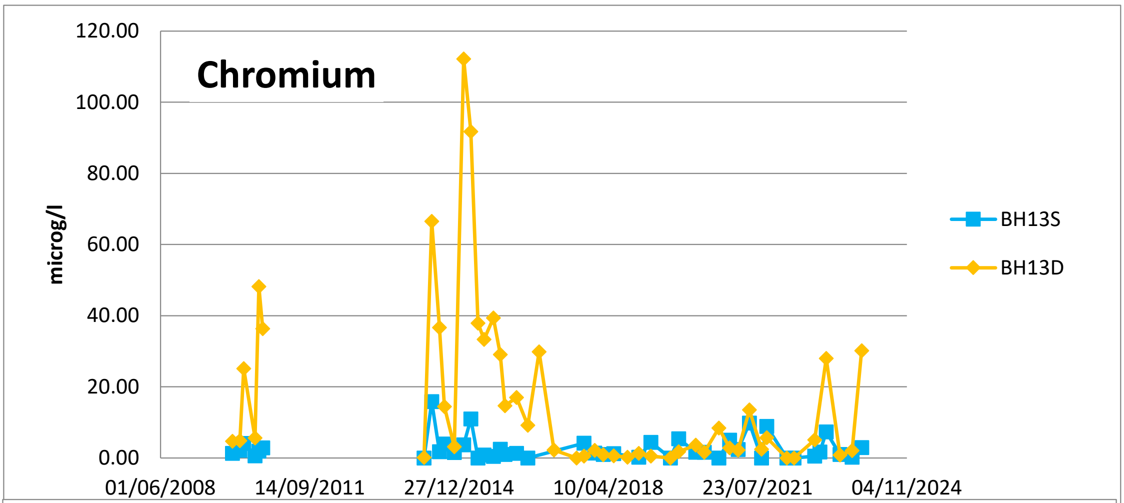
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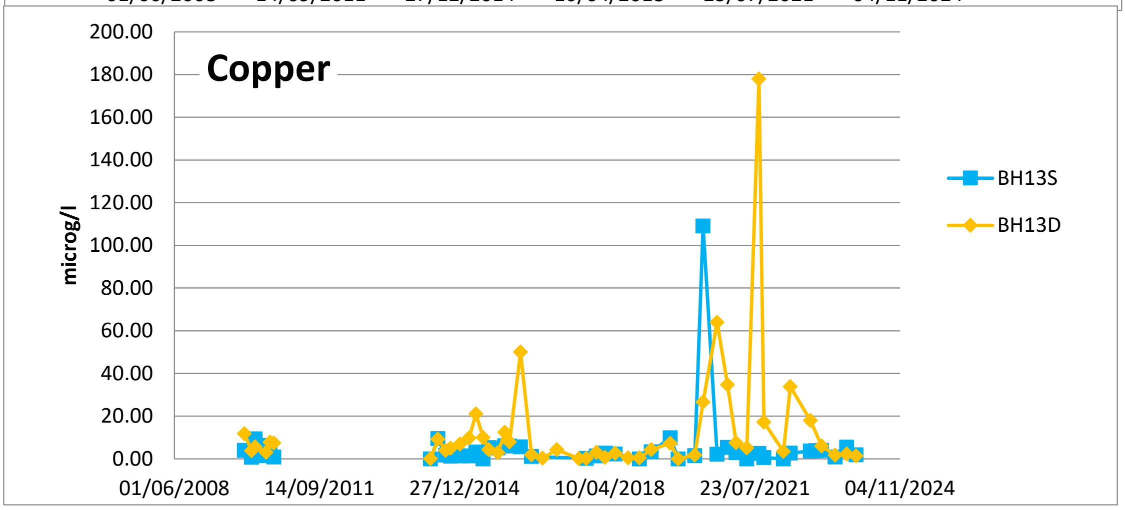
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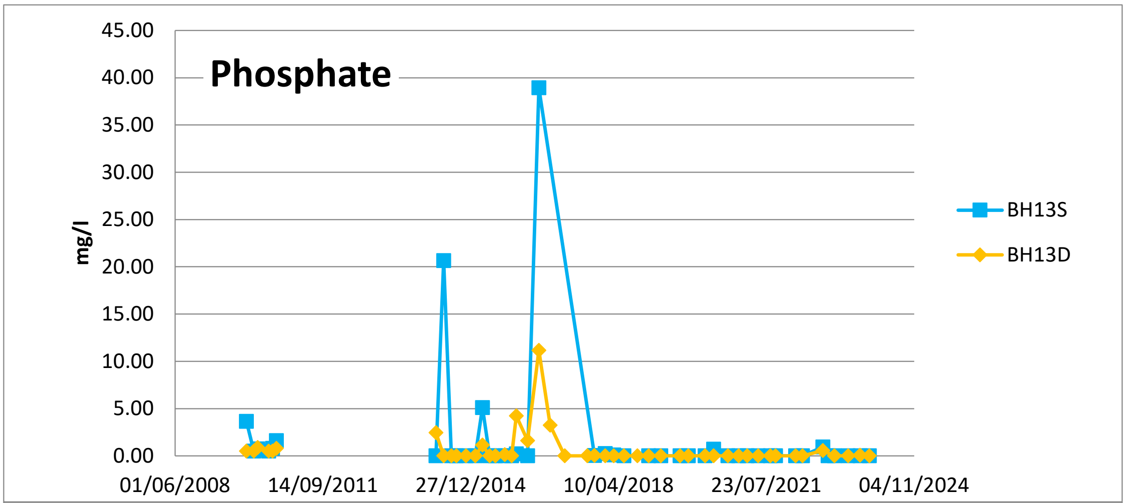
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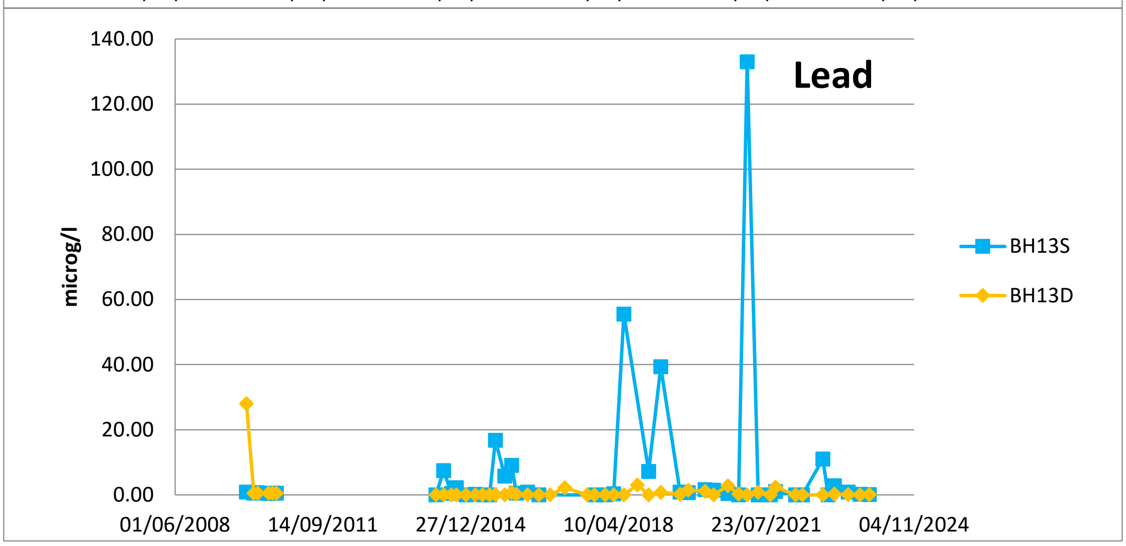
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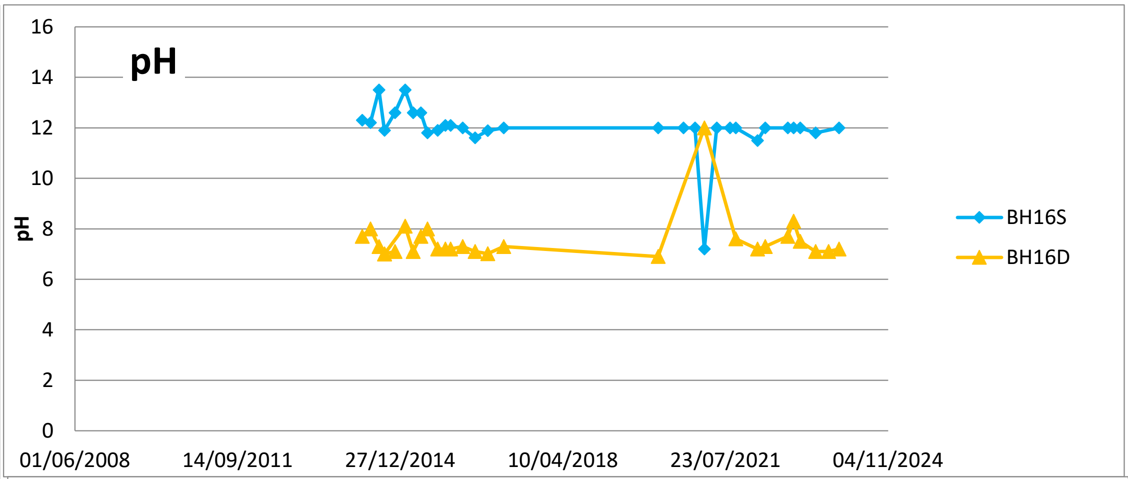
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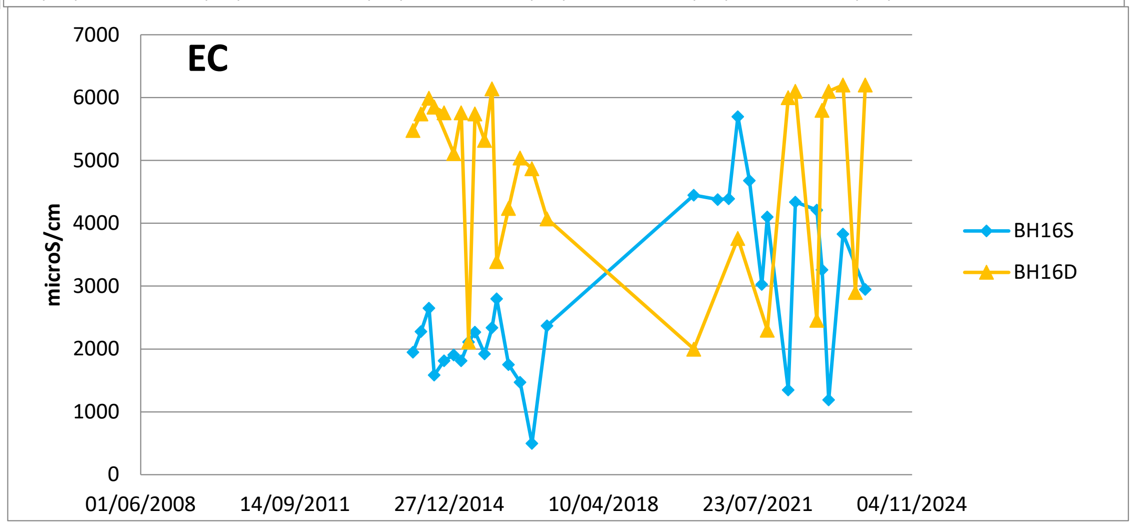
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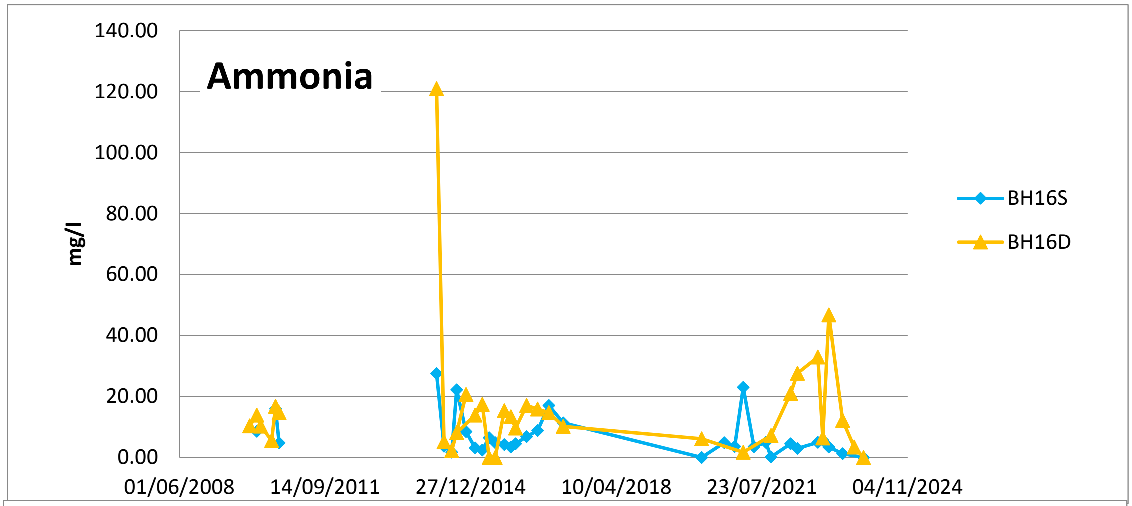
BH16D


Ammonia
mg/l
140.00
120.00
100.00
80.00
60.00
40.00
20.00
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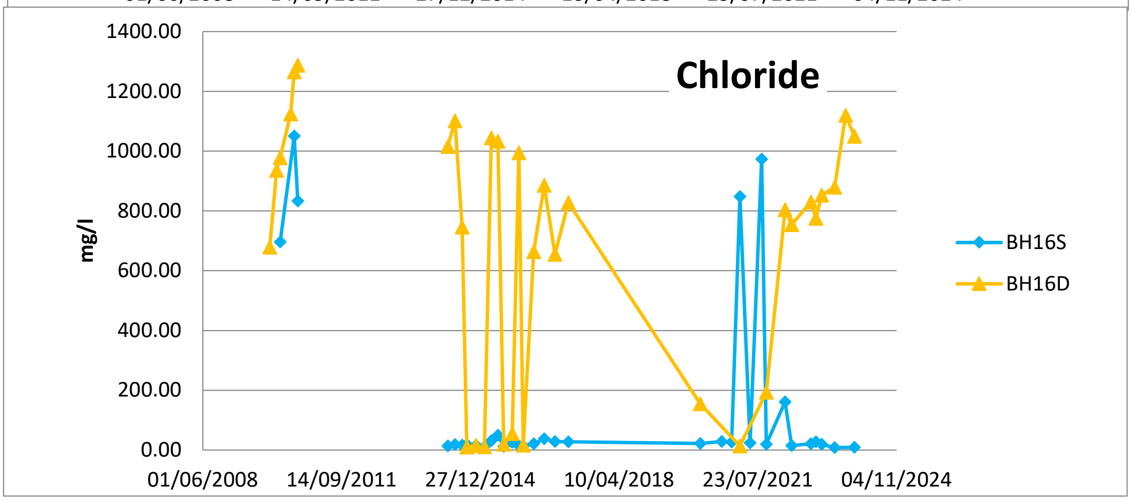
01/06/2008
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH16S
BH16D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mg/l
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1200.00
1000.00
800.00
600.00
400.00
200.00
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14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
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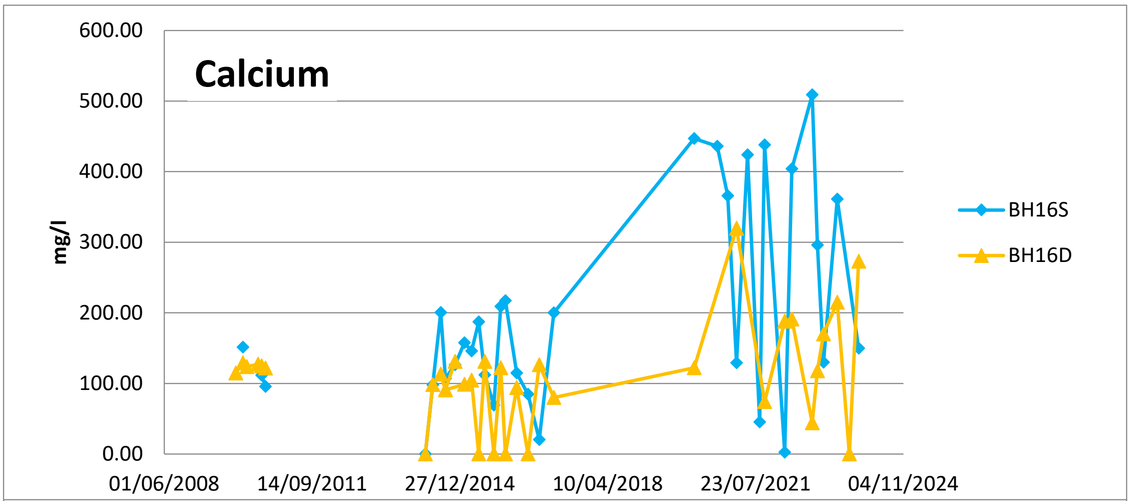
Calcium
mg/l
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400.00
300.00
200.00
100.00
0.00
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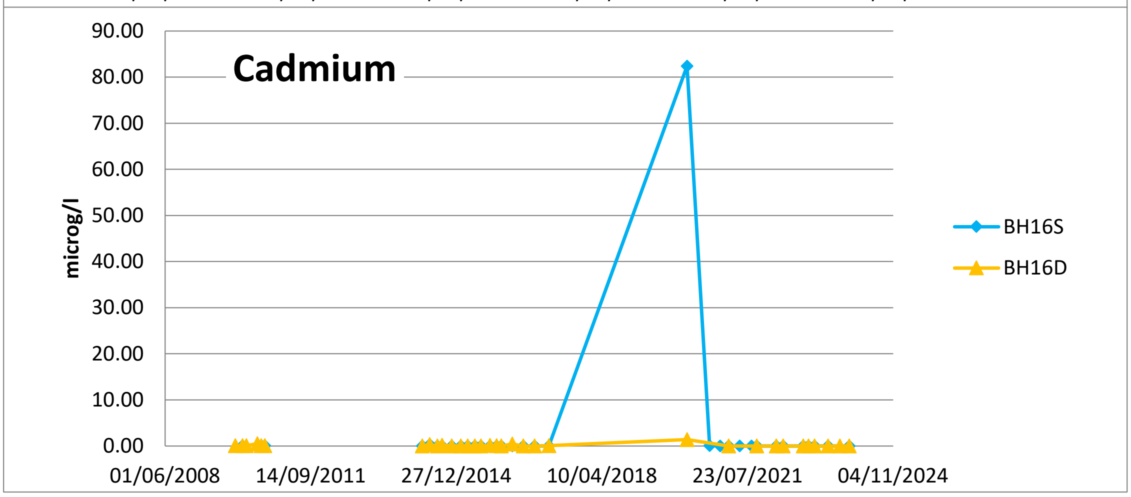
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH16S
BH16D


Cadmium
microg/l
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
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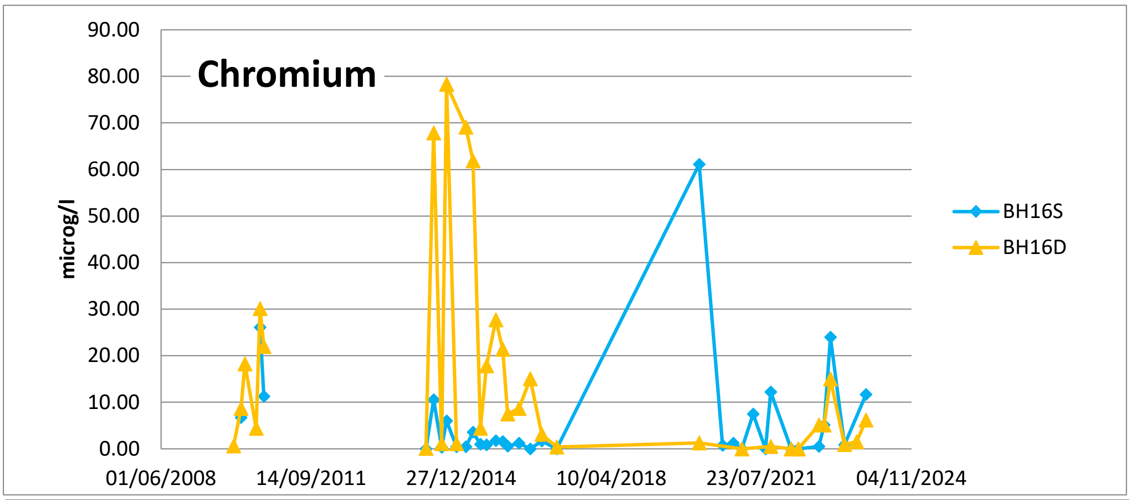
01/06/2008
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH16S
BH16D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microg/l
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
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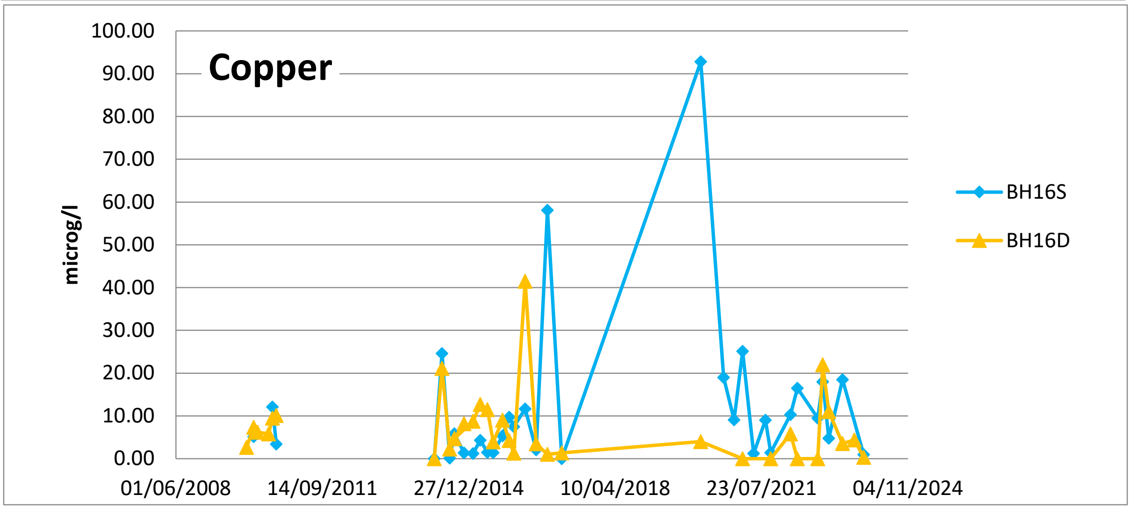
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH16S
BH16D


Copper
microg/l
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
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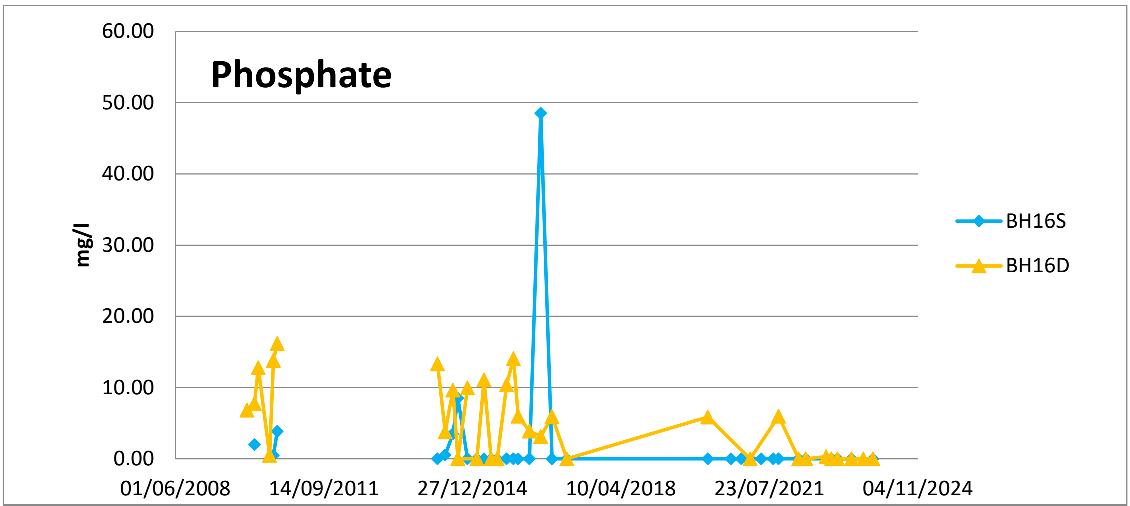
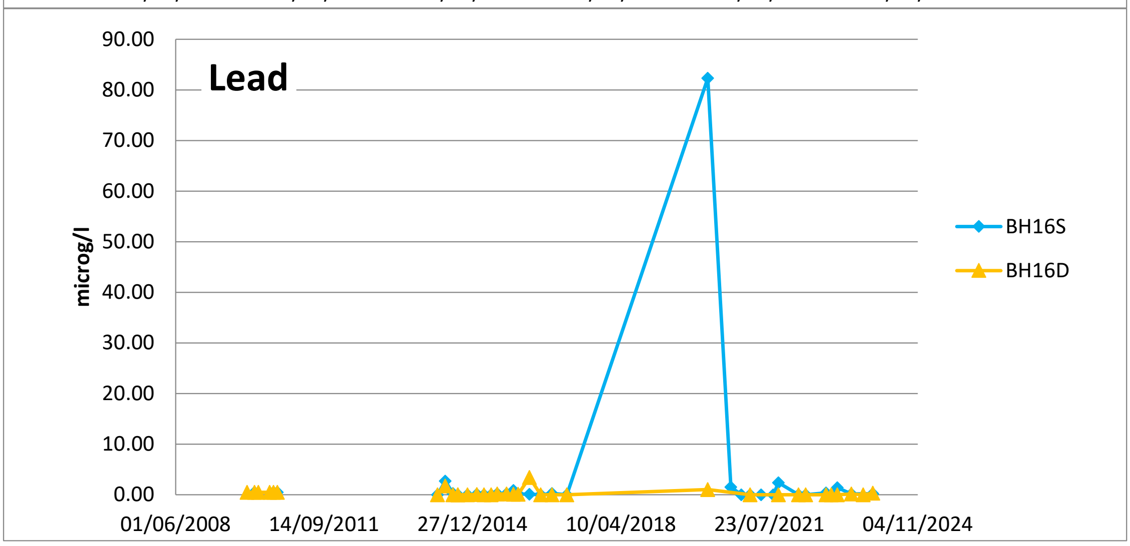
01/06/2008
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH16S
BH16D


Phosphate
mg/l
60.00
50.00
40.00
30.00
20.00
10.00
0.00
01/06/2008
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH16S
BH16D


Lead
microg/l
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
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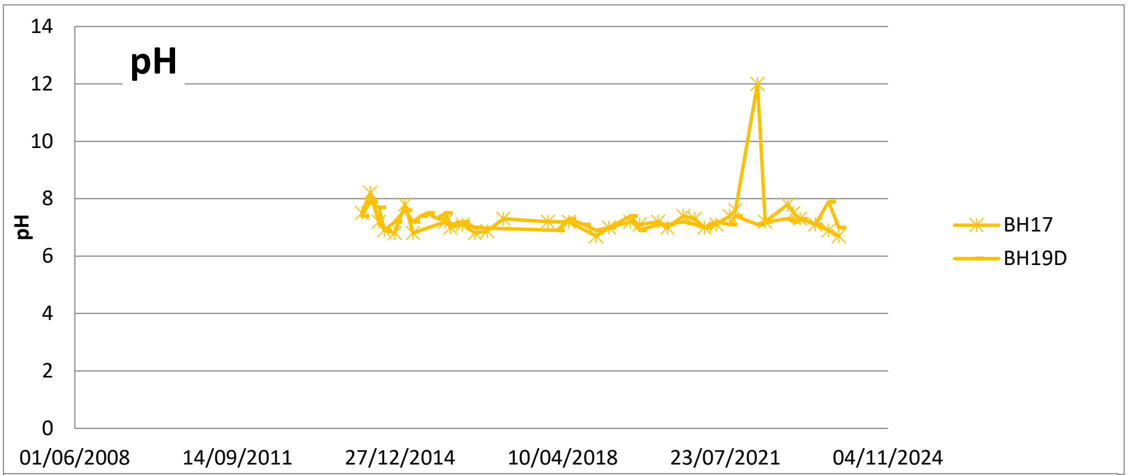
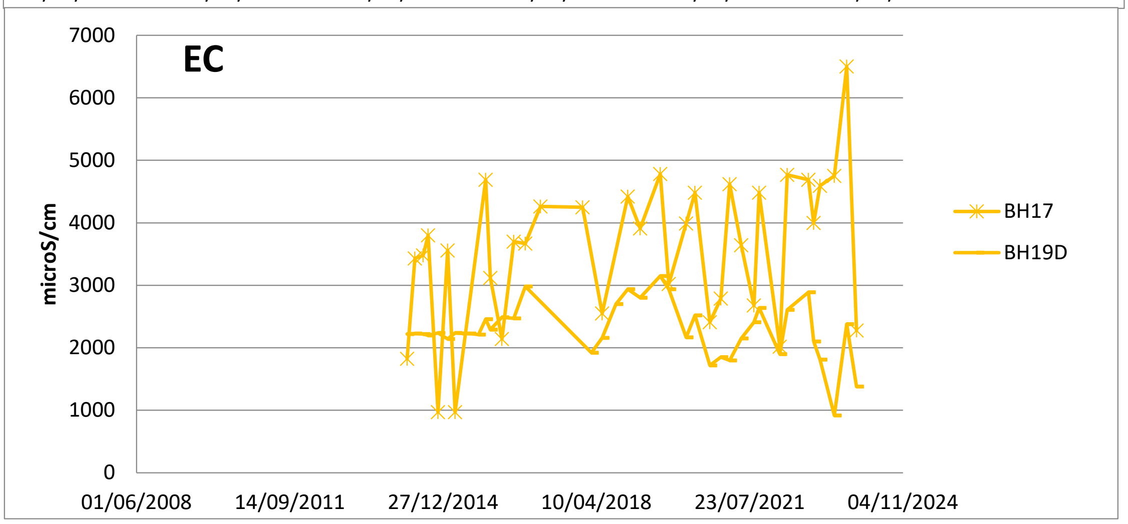
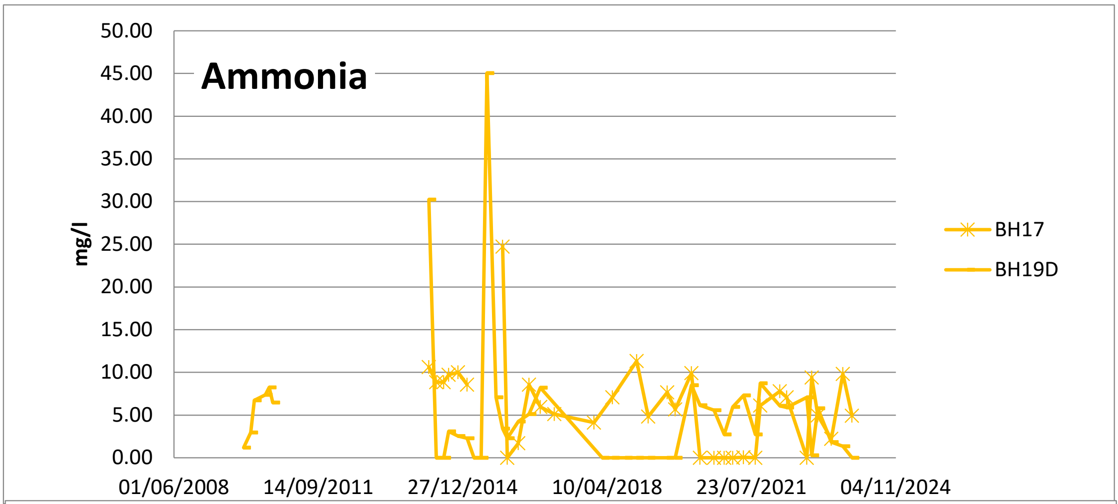
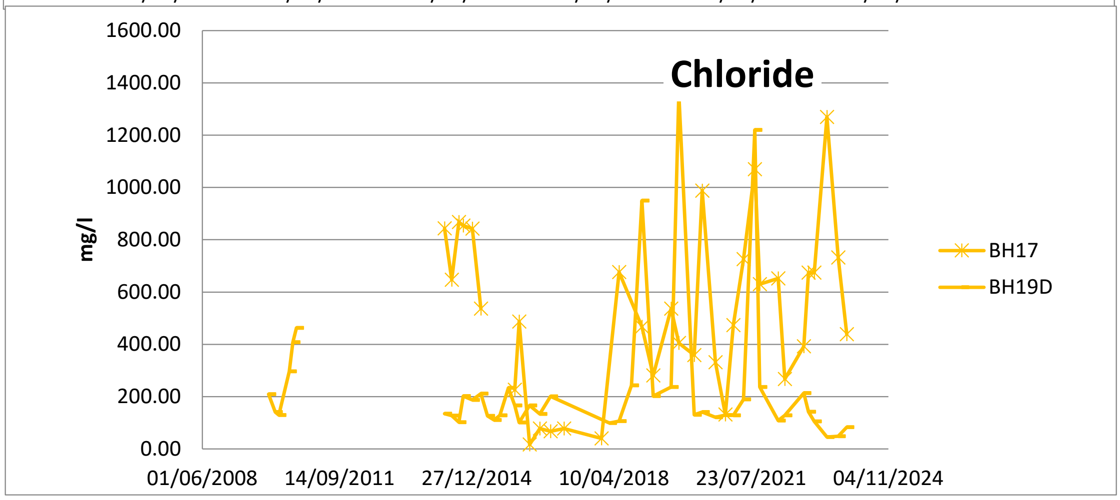
01/06/2008
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH16S
BH16D


pH
14
12
10
8
6
4
2
0
pH
01/06/2008
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH17
BH19D


EC
7000
6000
5000
4000
3000
2000
1000
0
microS/cm
01/06/2008
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH17
BH19D


Ammonia
mg/l
50.00
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
01/06/2008
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH17
BH19D


Chloride
mg/l
1600.00
1400.00
1200.00
1000.00
800.00
600.00
400.00
200.00
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14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
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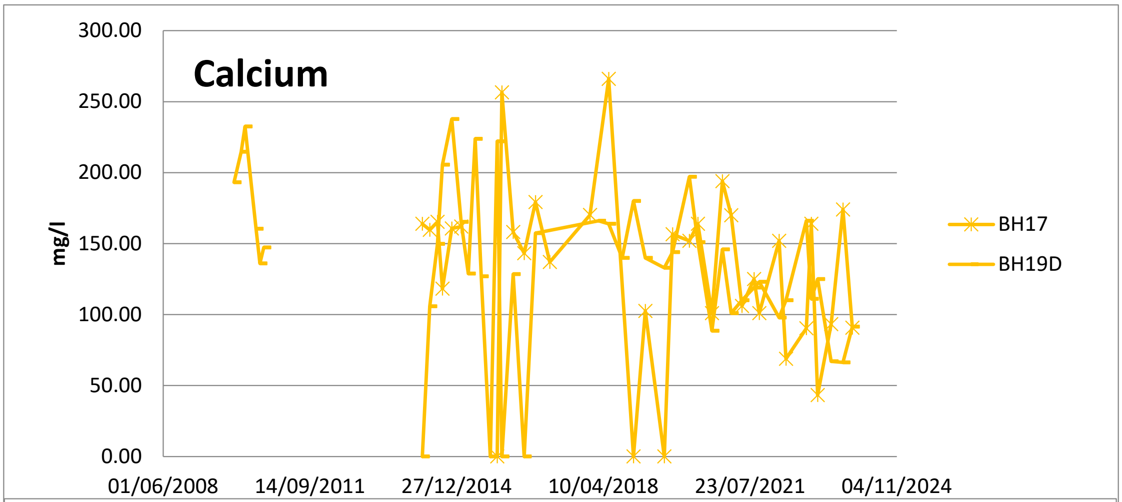
BH19D


Calcium
mg/l
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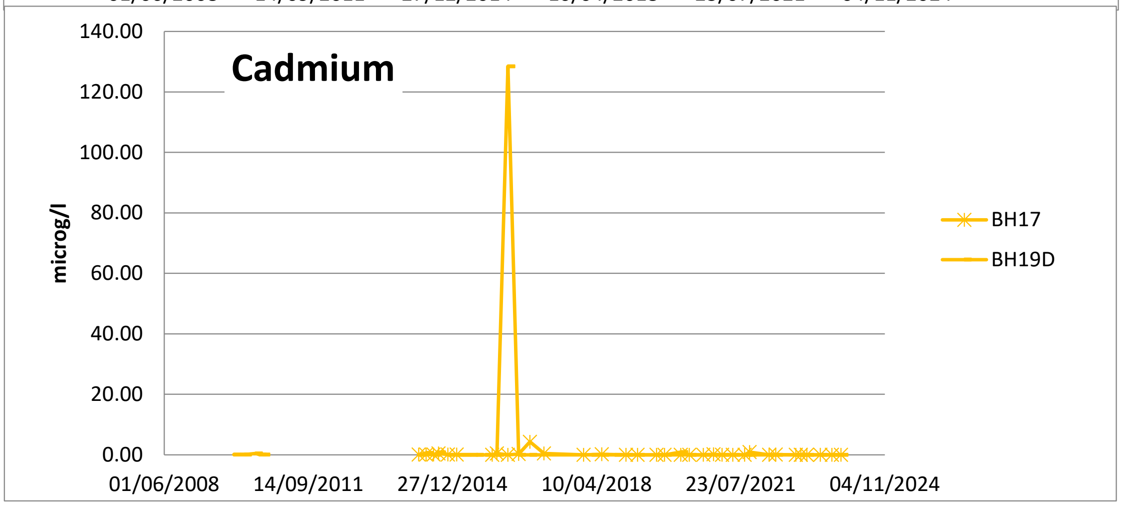
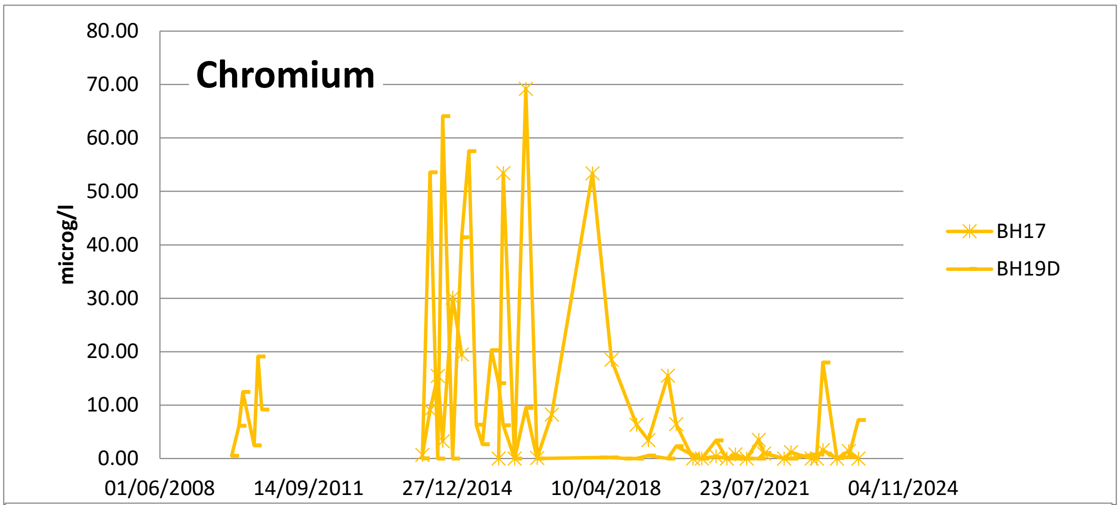
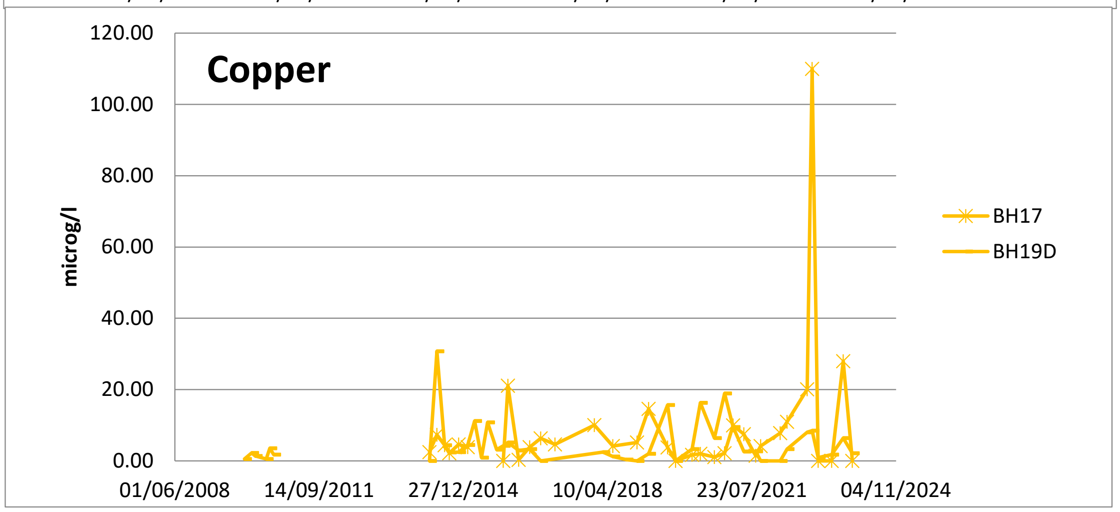
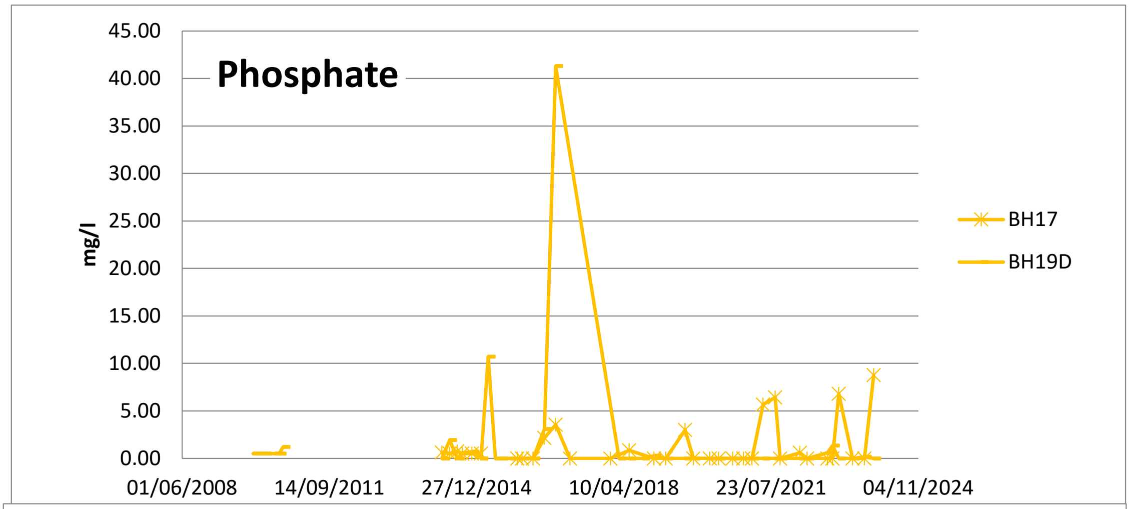
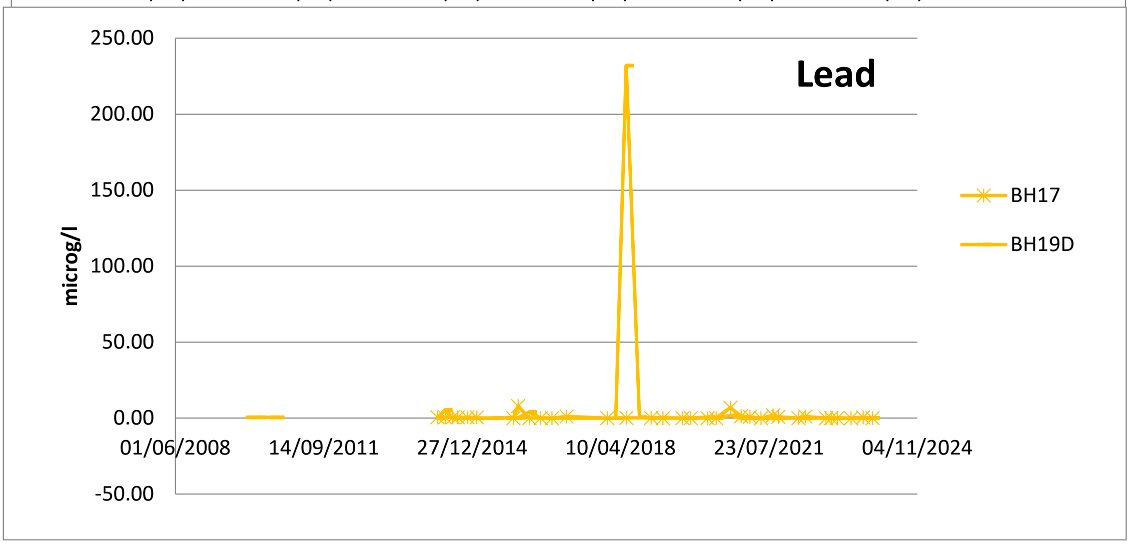
250.00
200.00
150.00
100.00
50.00
0.00
01/06/2008
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH17
BH19D


Cadmium
microg/l
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
01/06/2008
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH17
BH19D


Chromium
microg/l
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
01/06/2008
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH17
BH19D


Copper
microg/l
120.00
100.00
80.00
60.00
40.00
20.00
0.00
01/06/2008
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH17
BH19D


Phosphate
mg/l
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
01/06/2008
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH17
BH19D


Lead
microg/l
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200.00
150.00
100.00
50.00
0.00
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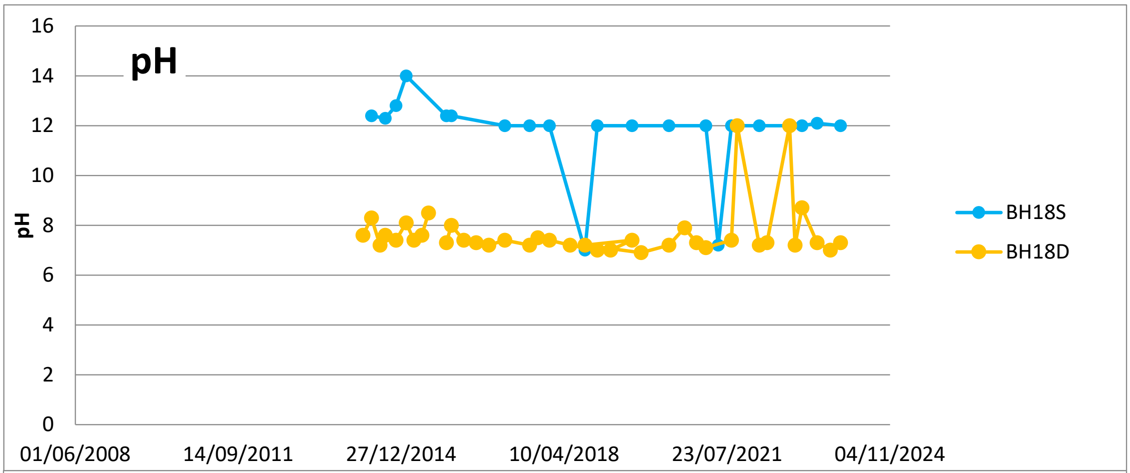
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH17
BH19D


pH
pH
16
14
12
10
8
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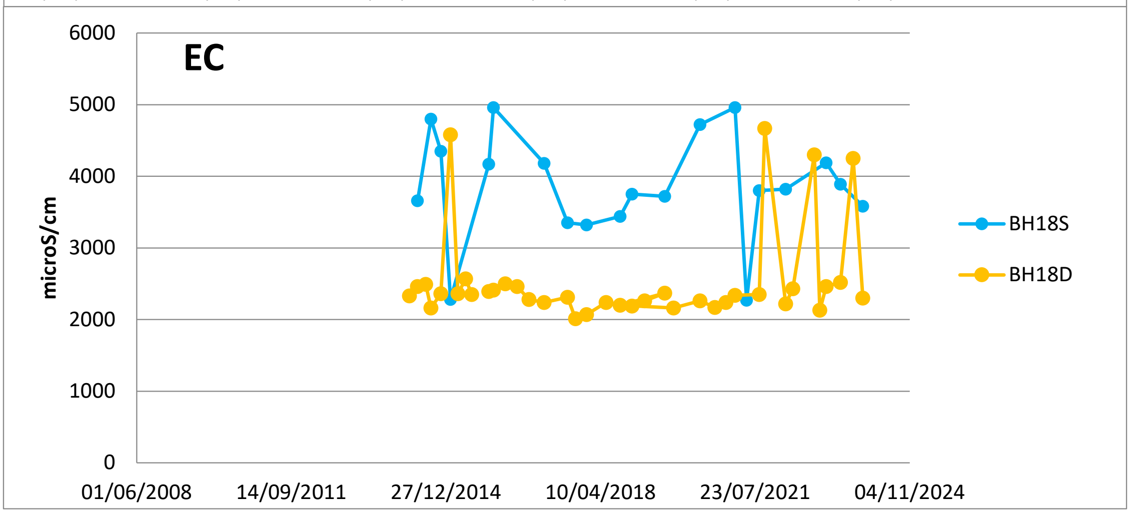
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH18S
BH18D


EC
microS/cm
6000
5000
4000
3000
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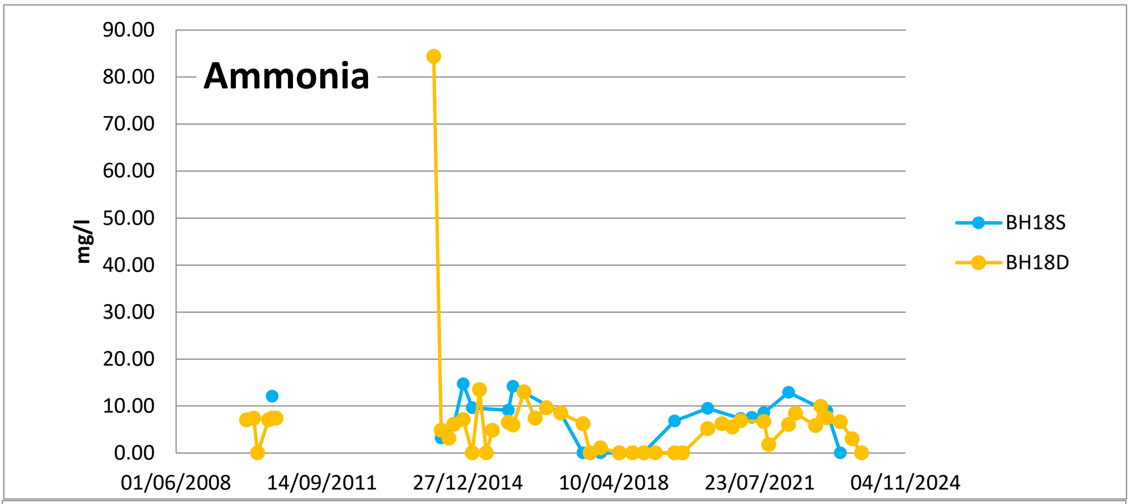
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH18S
BH18D


Ammonia
mg/l
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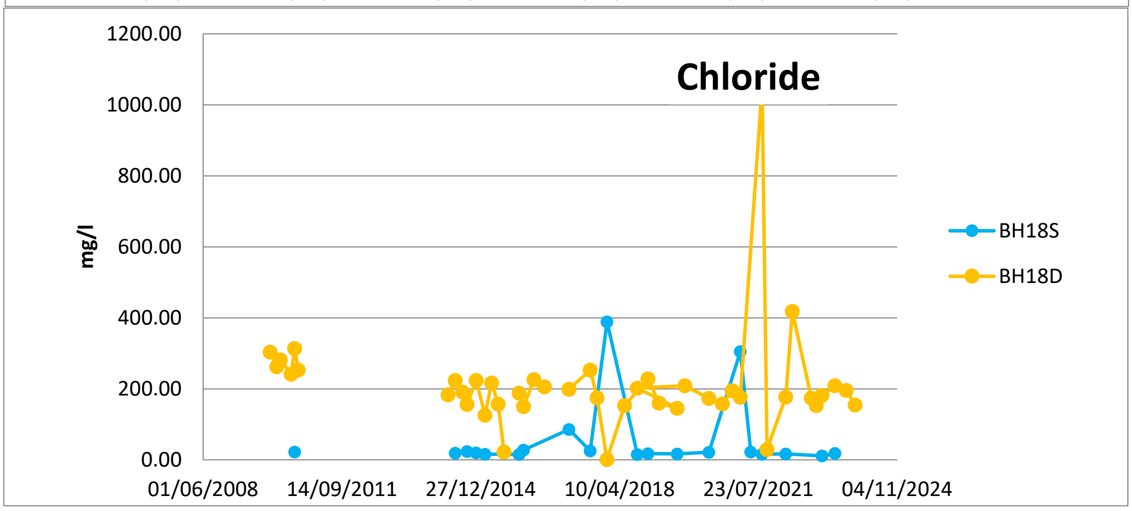
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
01/06/2008
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH18S
BH18D


Chloride
mg/l
1200.00
1000.00
800.00
600.00
400.00
200.00
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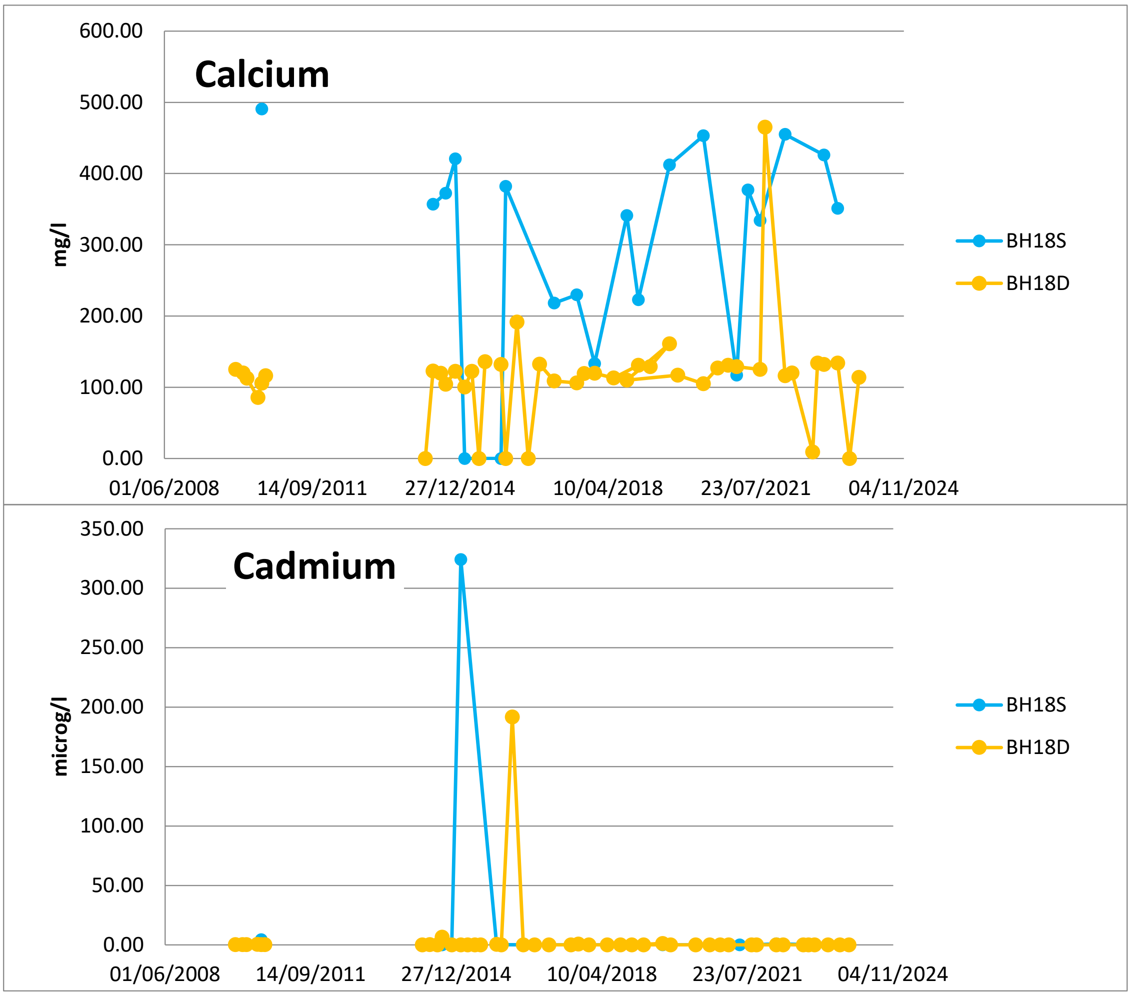
01/06/2008
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH18S
BH18D


Calcium
mg/l
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500.00
400.00
300.00
200.00
100.00
0.00
01/06/2008
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH18S
BH18D
Cadmium
microg/l
350.00
300.00
250.00
200.00
150.00
100.00
50.00
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01/06/2008
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
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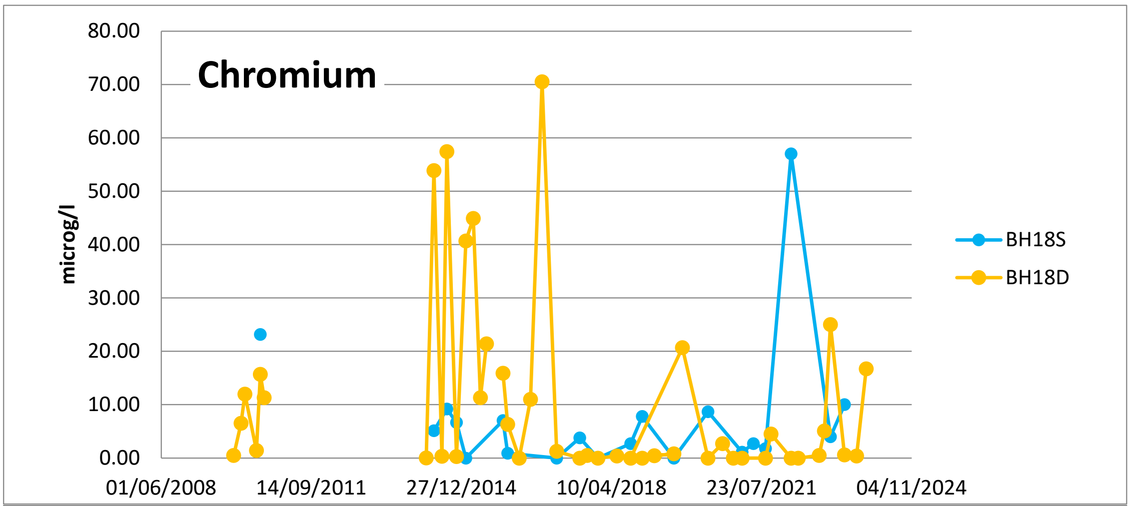
BH18D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microg/l
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40.00
30.00
20.00
10.00
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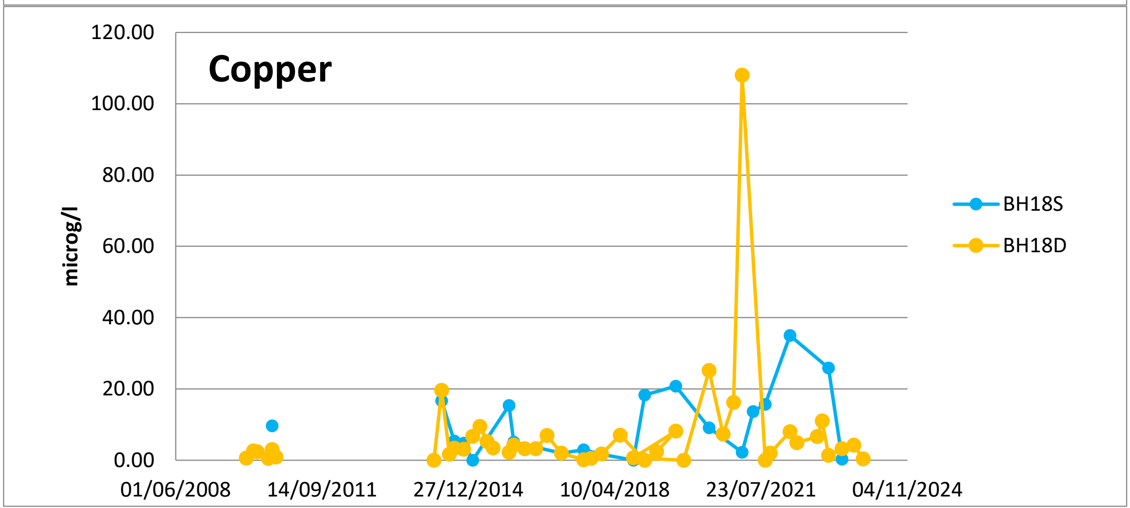
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH18S
BH18D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microg/l
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20.00
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14/09/2011
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10/04/2018
23/07/2021
04/11/2024
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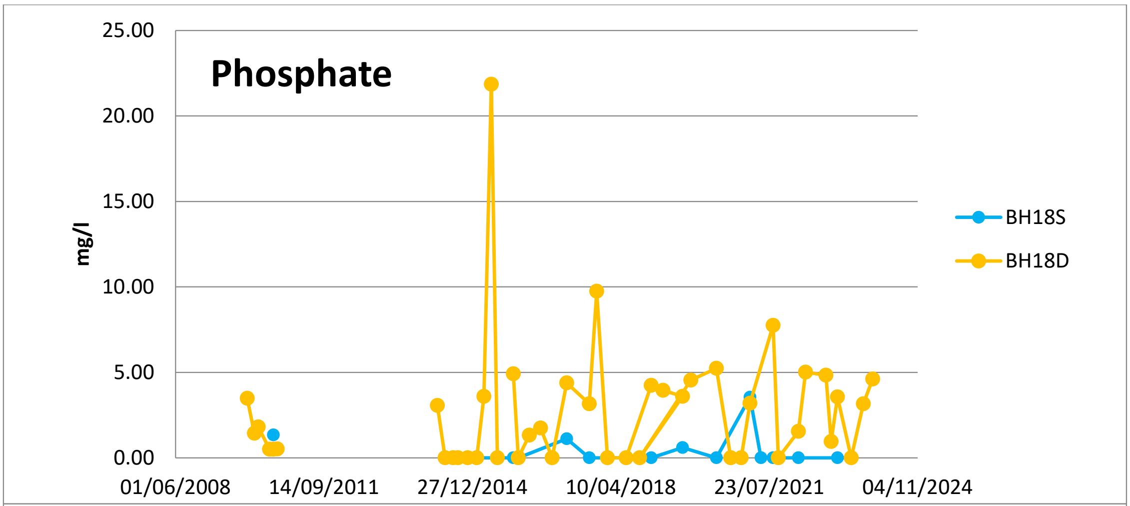
BH18D


Phosphate
mg/l
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15.00
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5.00
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14/09/2011
27/12/2014
10/04/2018
23/07/2021
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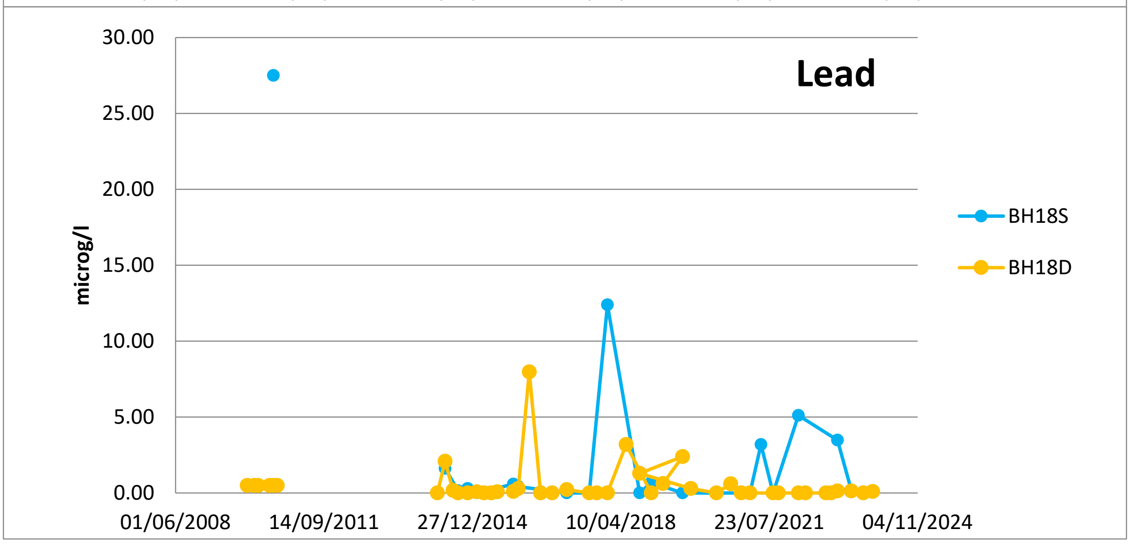
BH18S
BH18D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microg/l
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20.00
15.00
10.00
5.00
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14/09/2011
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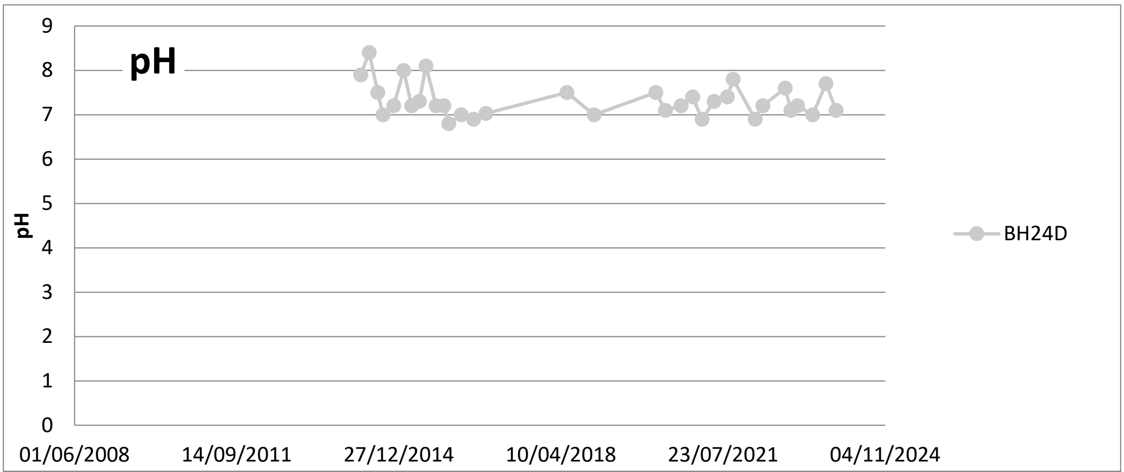
10/04/2018
23/07/2021
04/11/2024
BH18S
BH18D


pH
9
8
7
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5
4
3
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pH
01/06/2008
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27/12/2014
10/04/2018
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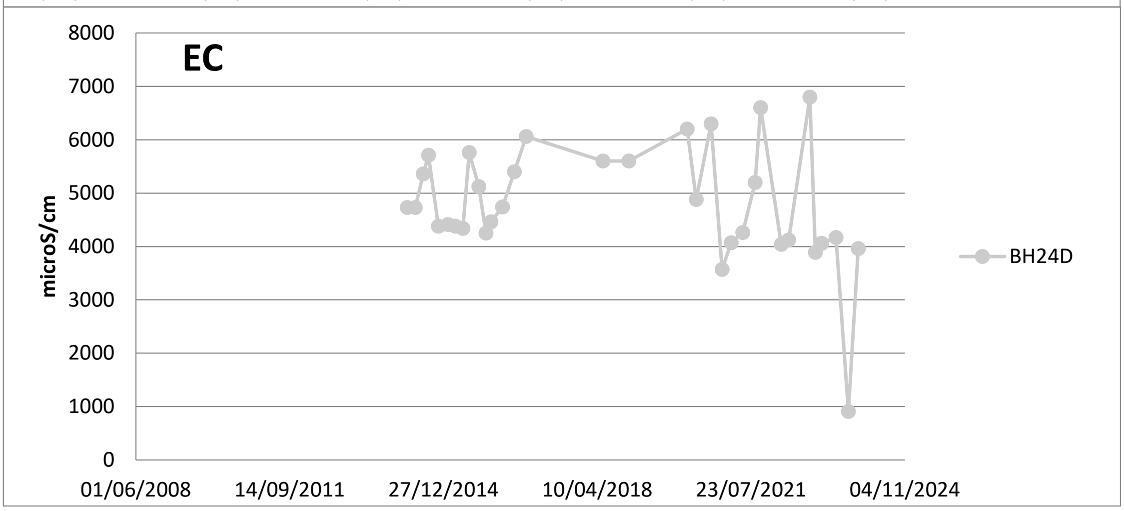
04/11/2024
BH24D


EC
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7000
6000
5000
4000
3000
2000
1000
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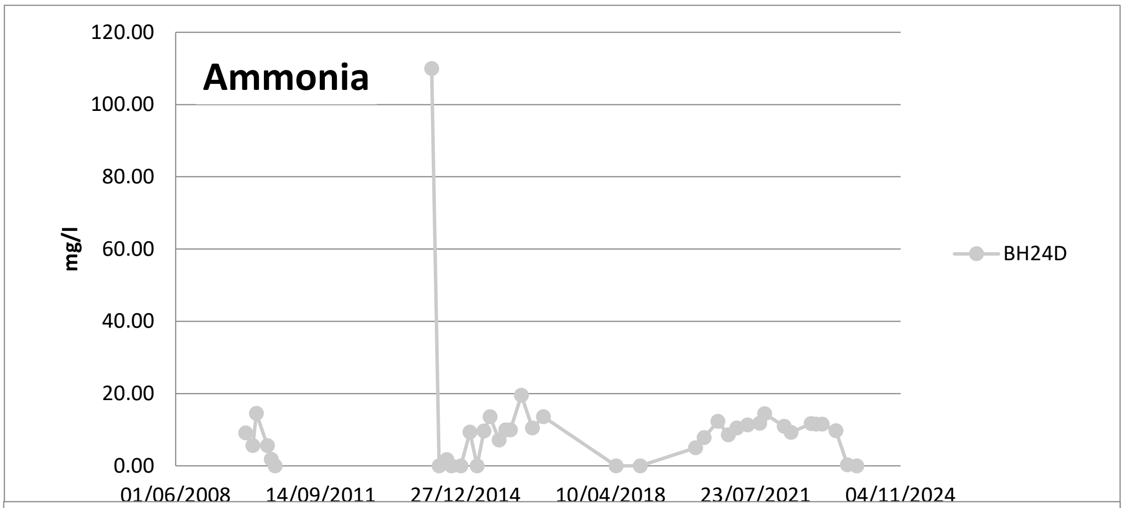
microS/cm
01/06/2008
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH24D


Ammonia
mg/l
120.00
100.00
80.00
60.00
40.00
20.00
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01/06/2008
14/09/2011
27/12/2014
10/04/2018
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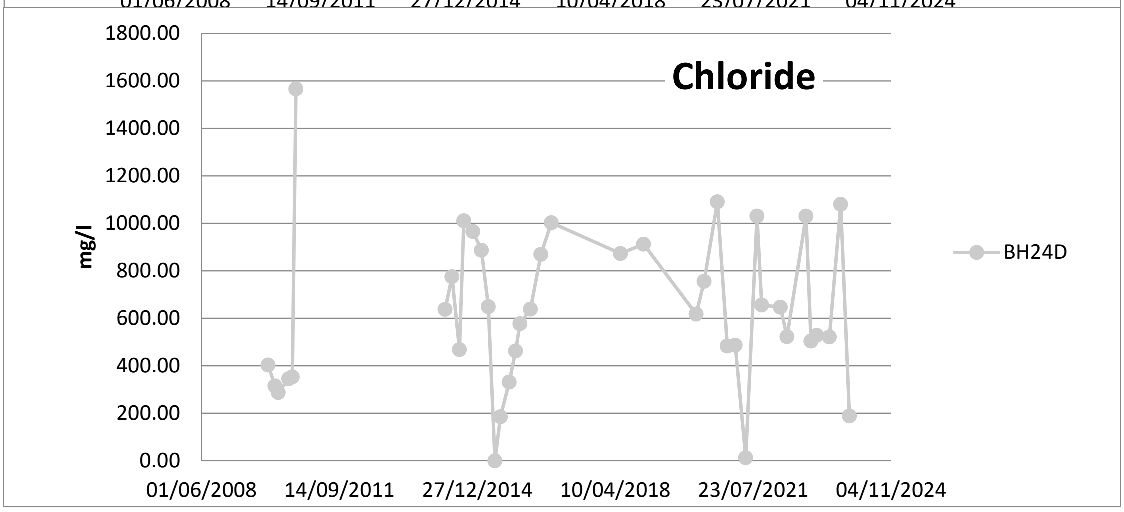
04/11/2024
BH24D


Chloride
mg/l
1800.00
1600.00
1400.00
1200.00
1000.00
800.00
600.00
400.00
200.00
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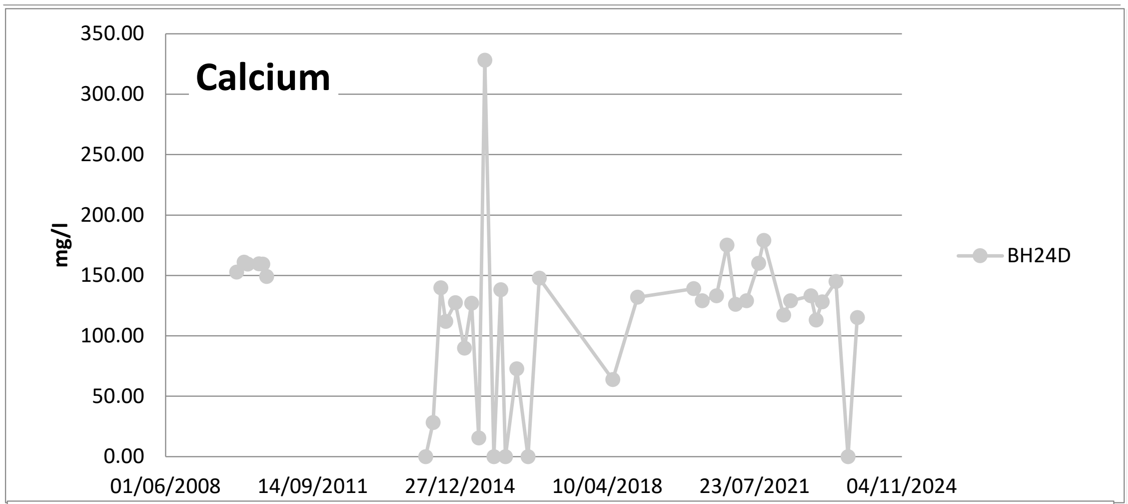
01/06/2008
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH24D


Calcium
mg/l
350.00
300.00
250.00
200.00
150.00
100.00
50.00
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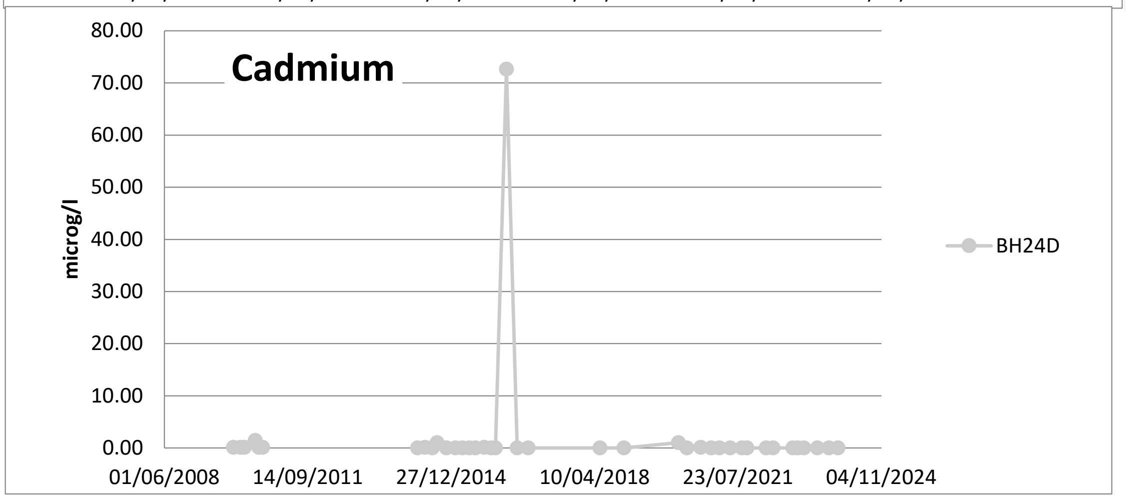
01/06/2008
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH24D


Cadmium
microg/l
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
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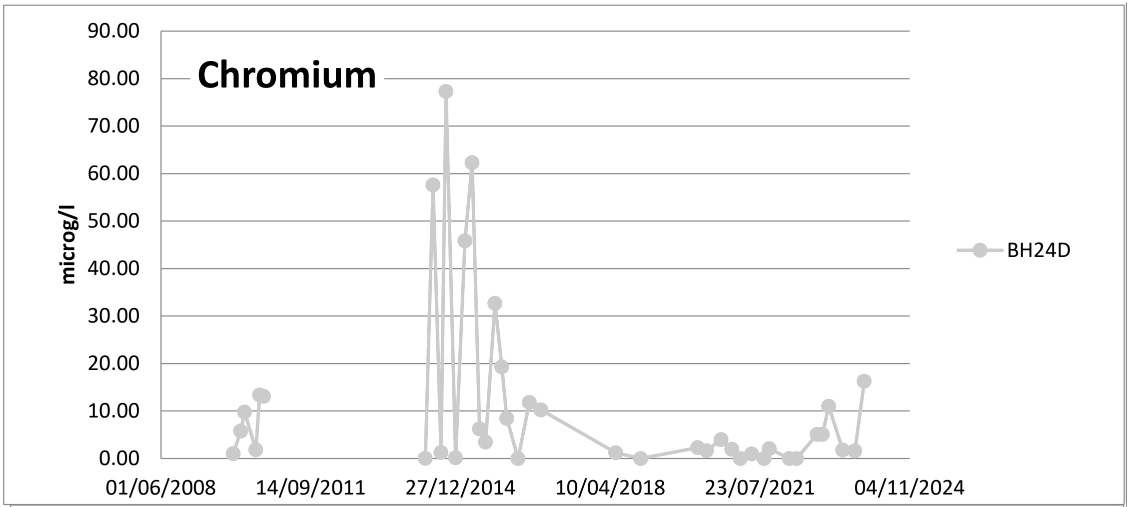
04/11/2024
BH24D


Chromium
microg/l
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
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01/06/2008
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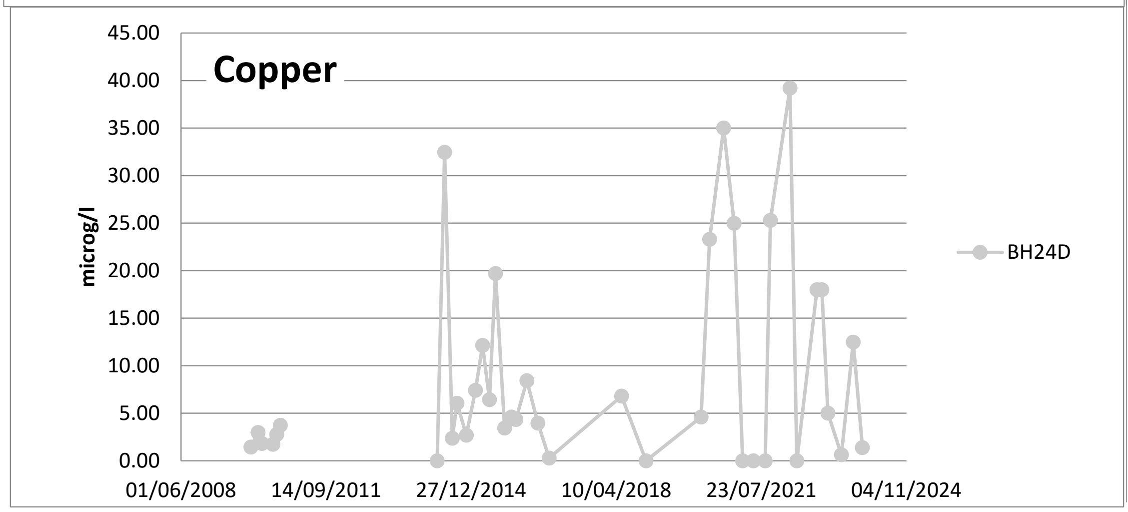
04/11/2024
BH24D


Copper
microg/l
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
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01/06/2008
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10/04/2018
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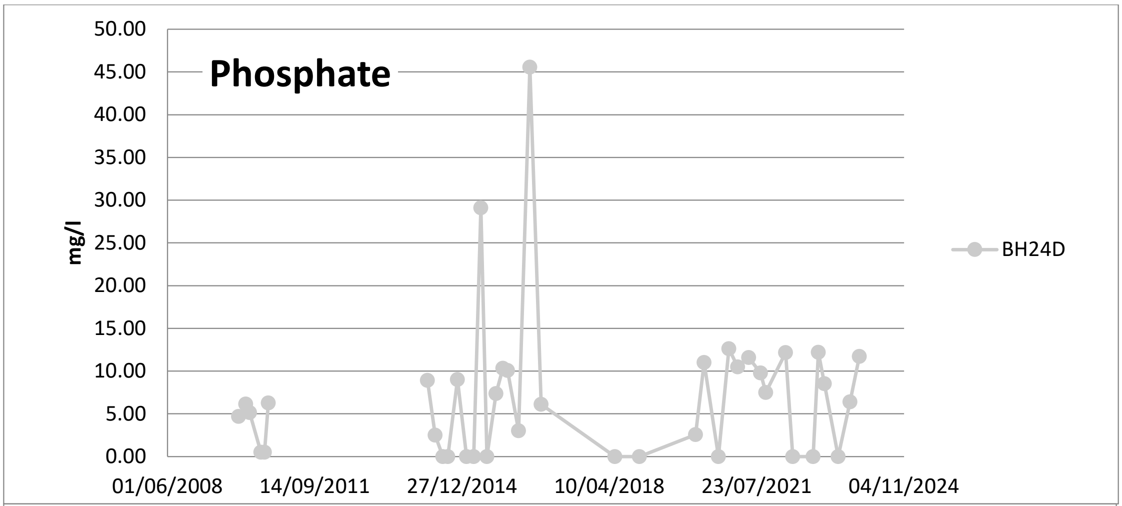
04/11/2024
BH24D


Phosphate
mg/l
50.00
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
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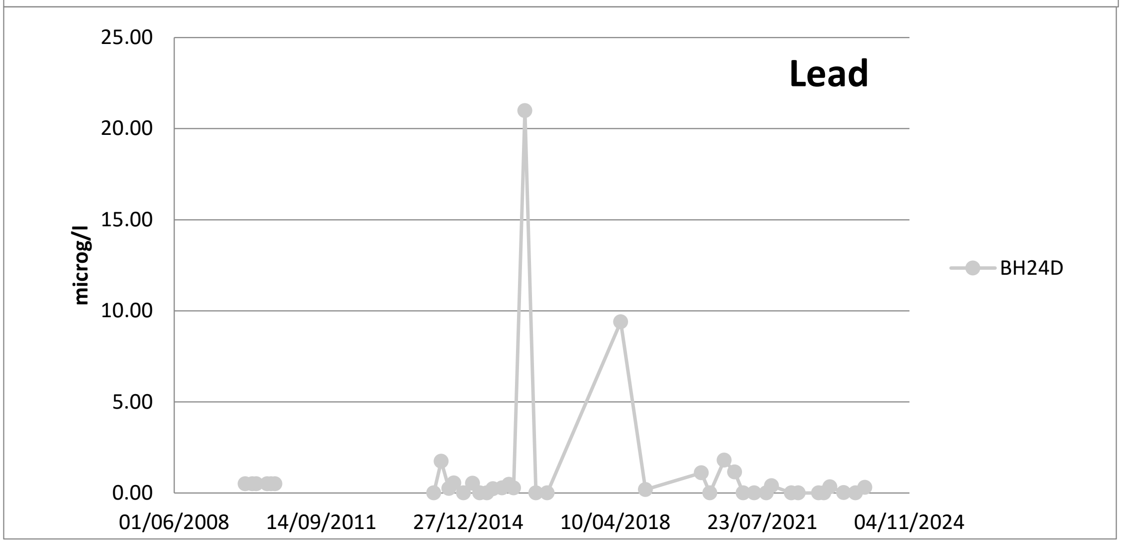
04/11/2024
BH24D


Lead
microg/l
25.00
20.00
15.00
10.00
5.00
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01/06/2008
14/09/2011
27/12/2014
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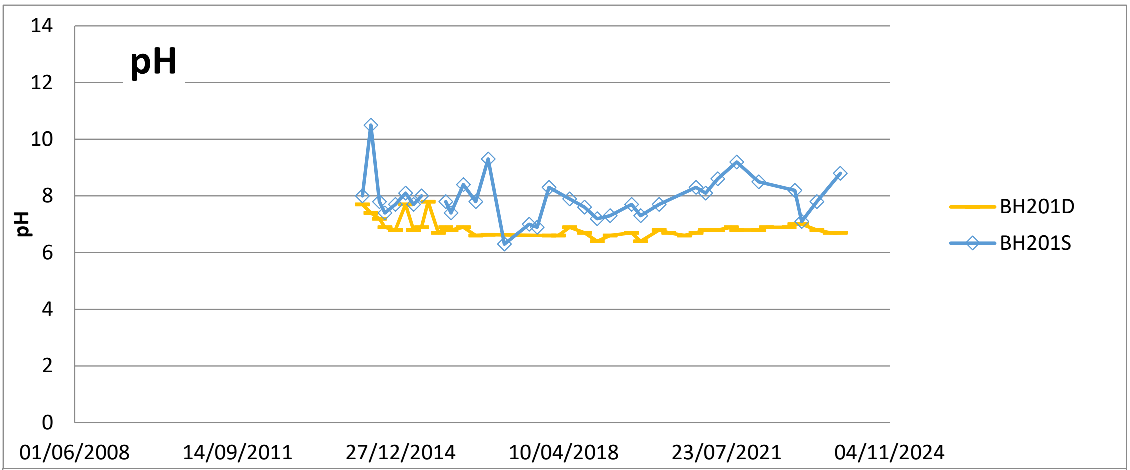
04/11/2024
BH24D


pH
pH
14
12
10
8
6
4
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0
01/06/2008
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
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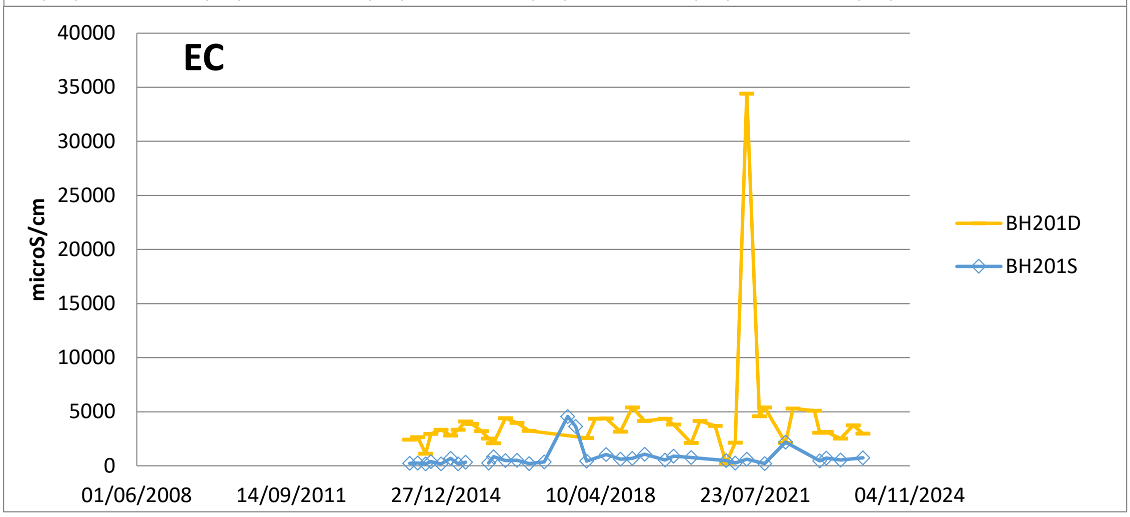
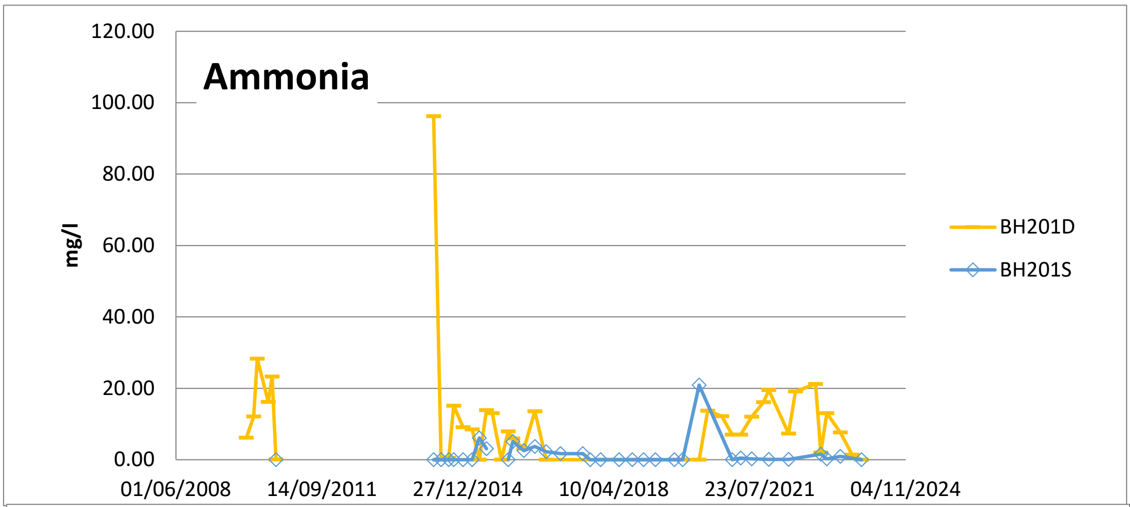
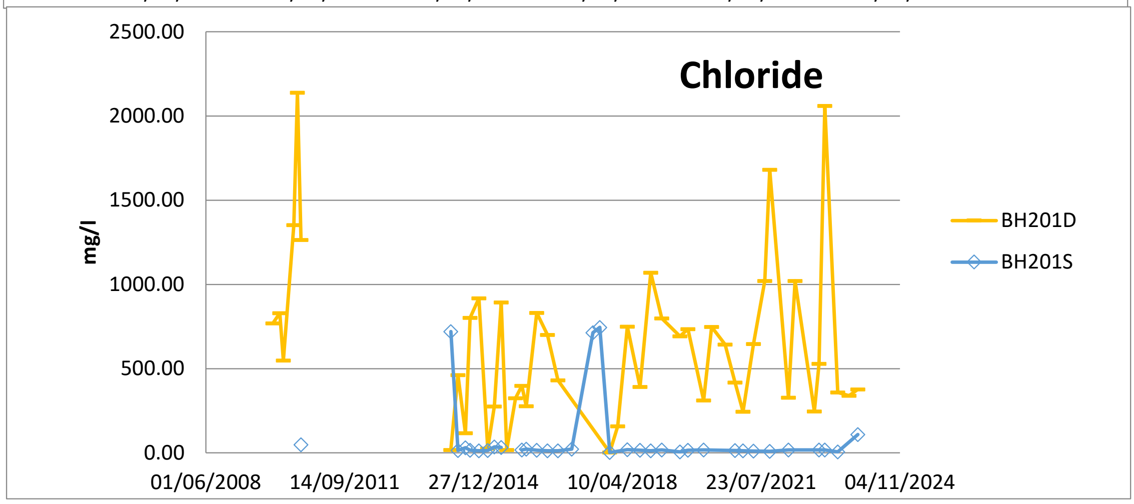
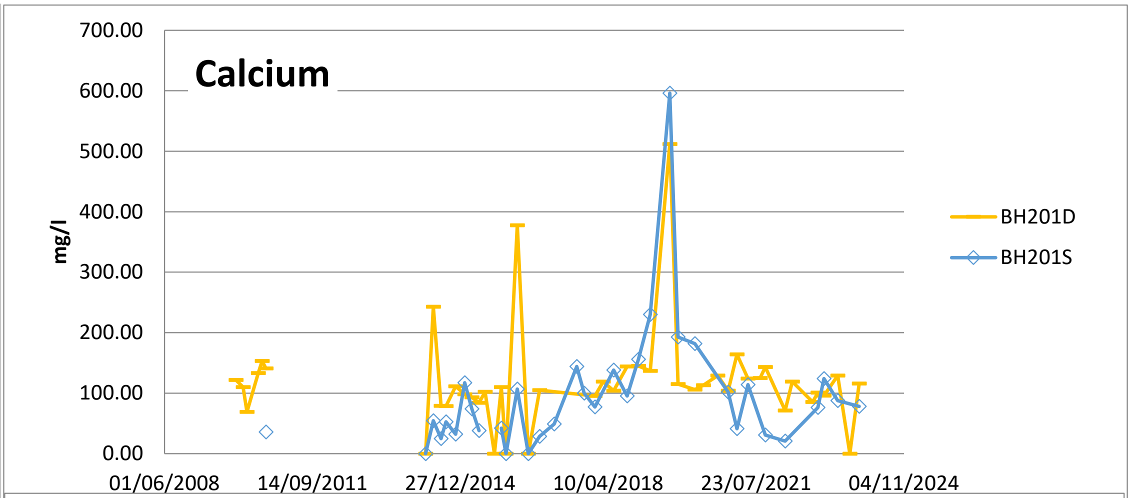

EC
microS/cm
40000
35000
30000
25000
20000
15000
10000
5000
0
01/06/2008
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH201D
BH201S


Ammonia
120.00
100.00
80.00
60.00
40.00
20.00
0.00
mg/l
01/06/2008
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH201D
BH201S


Chloride
2500.00
2000.00
1500.00
1000.00
500.00
0.00
mg/l
01/06/2008
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH201D
BH201S


Calcium
mg/l
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
01/06/2008
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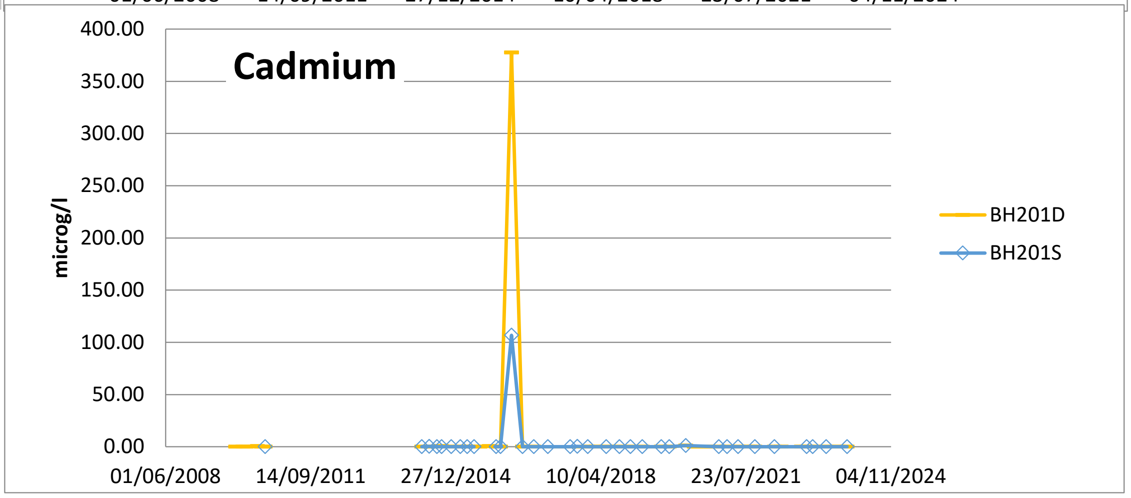
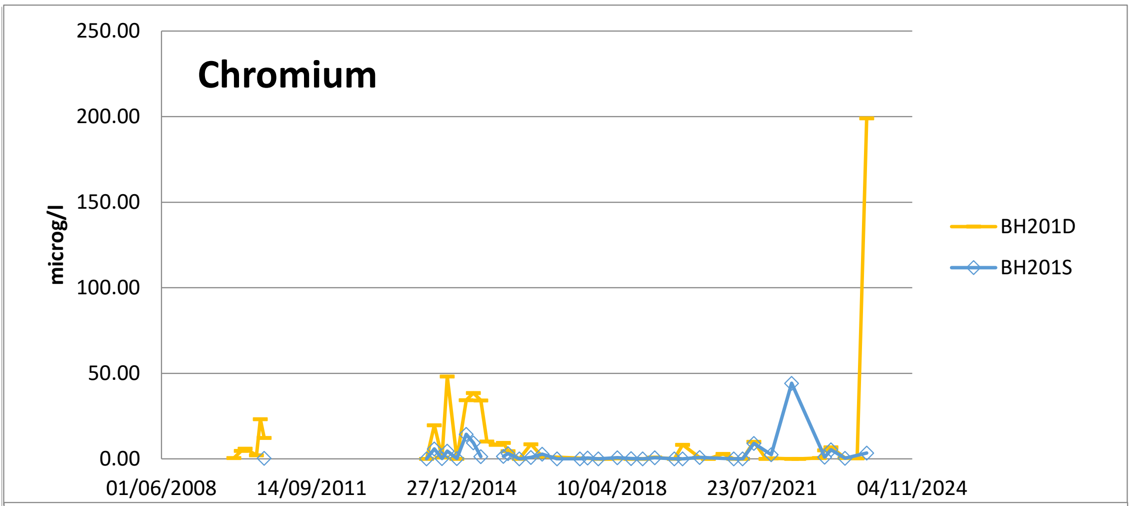
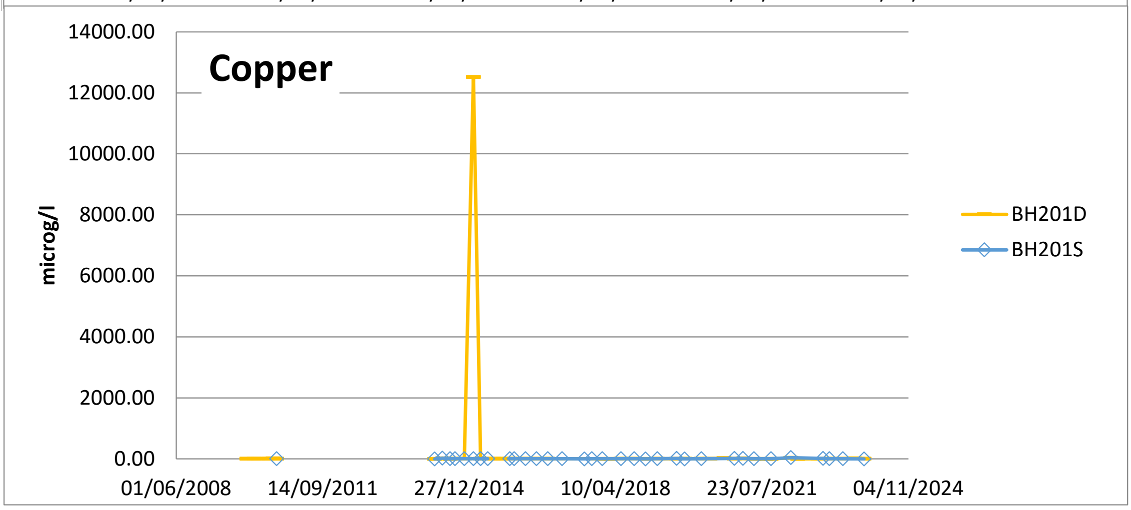
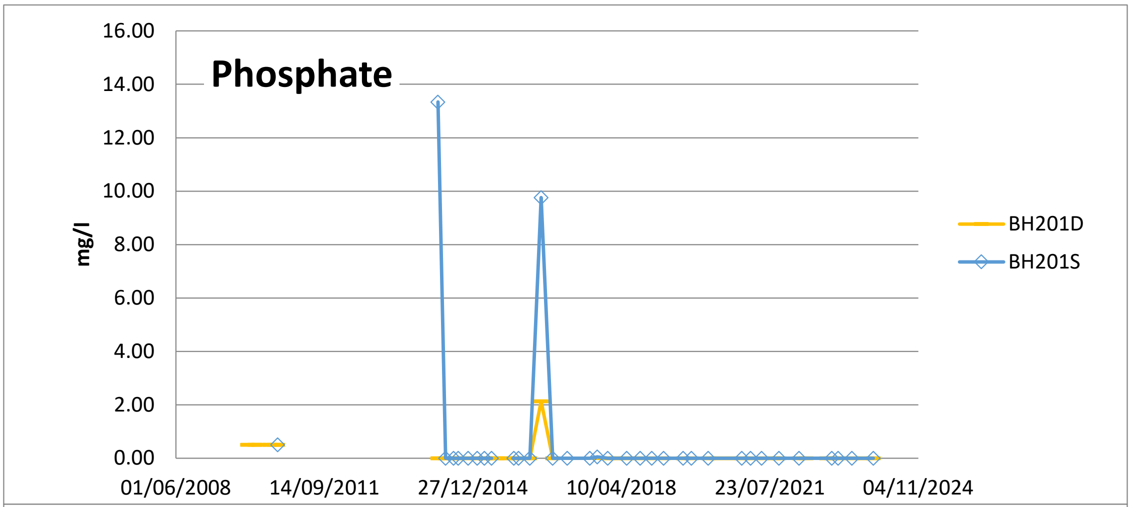
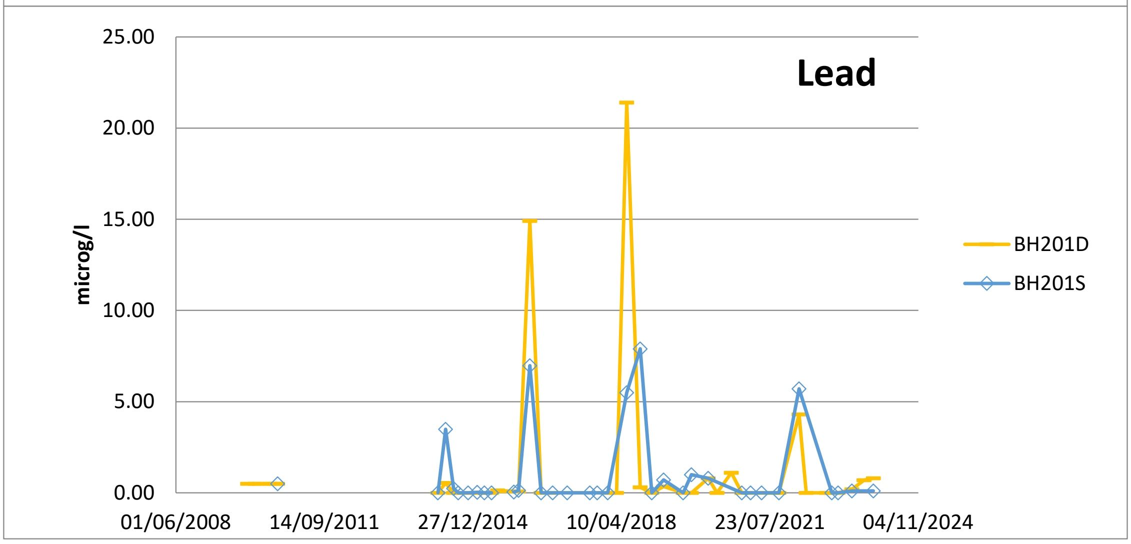
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH201D
BH201S

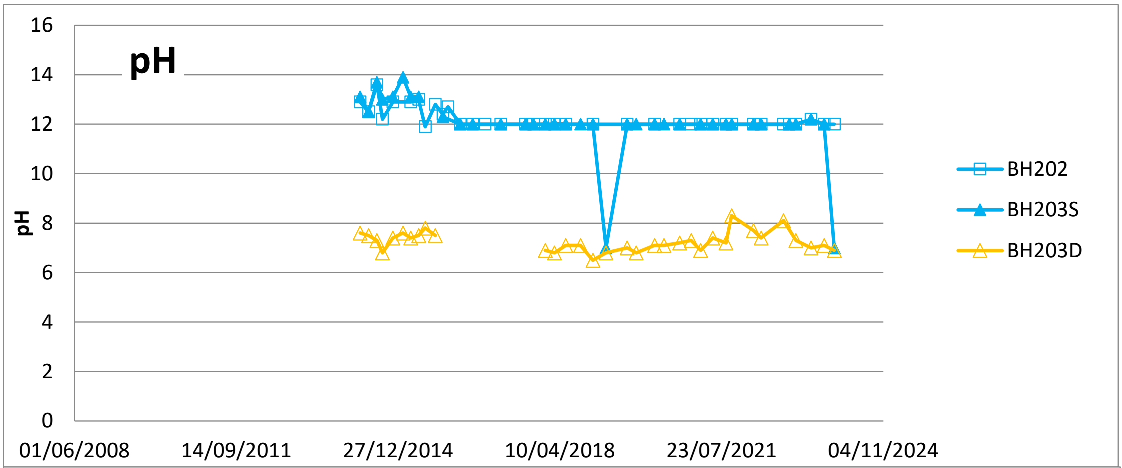

Cadmium
microg/l
400.00
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
01/06/2008
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH201D
BH201S

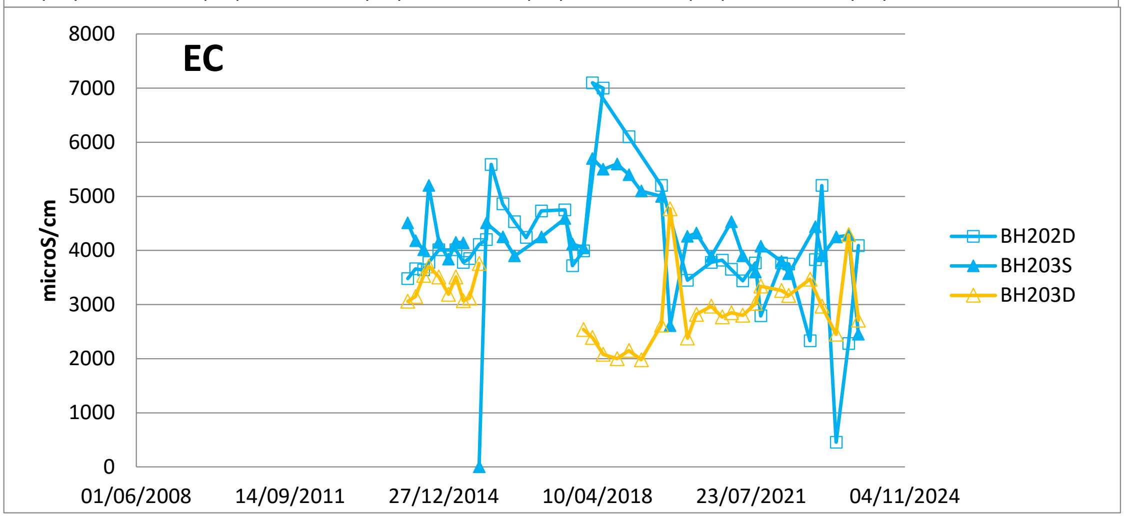

Chromium
microg/l
250.00
200.00
150.00
100.00
50.00
0.00
01/06/2008
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH201D
BH201S

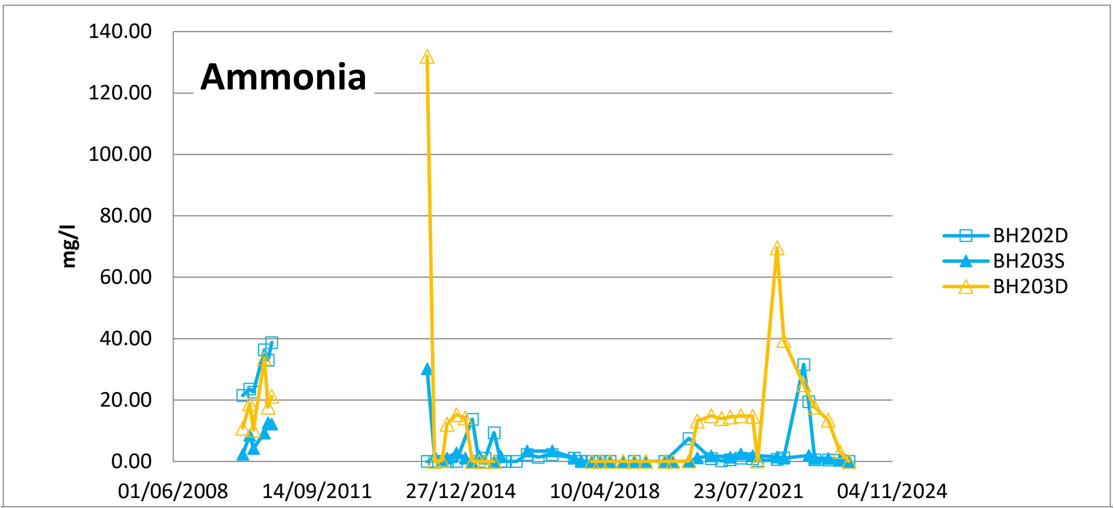

Copper
microg/l
14000.00
12000.00
10000.00
8000.00
6000.00
4000.00
2000.00
0.00
01/06/2008
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH201D
BH201S

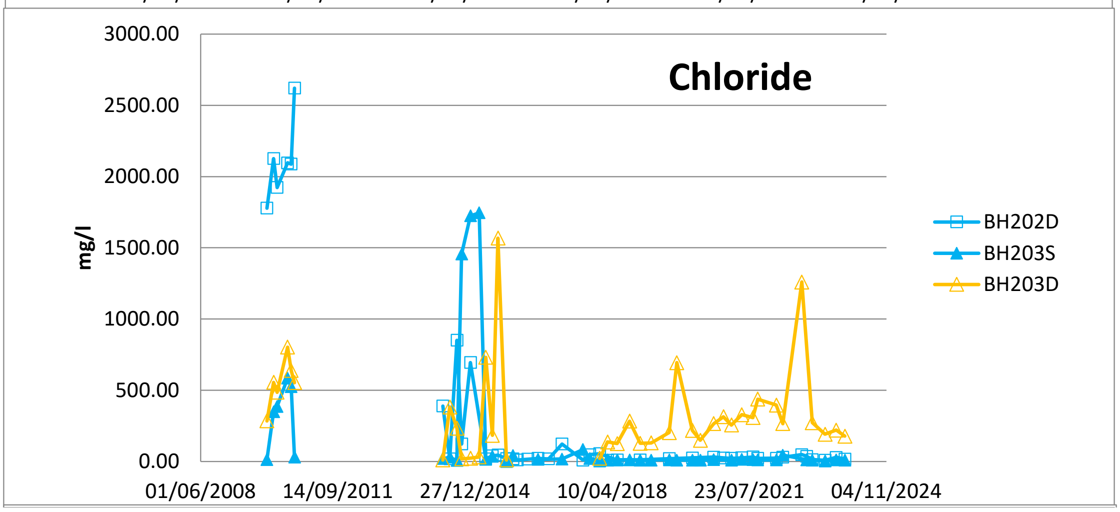

Phosphate
mg/l
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
01/06/2008
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH201D
BH201S

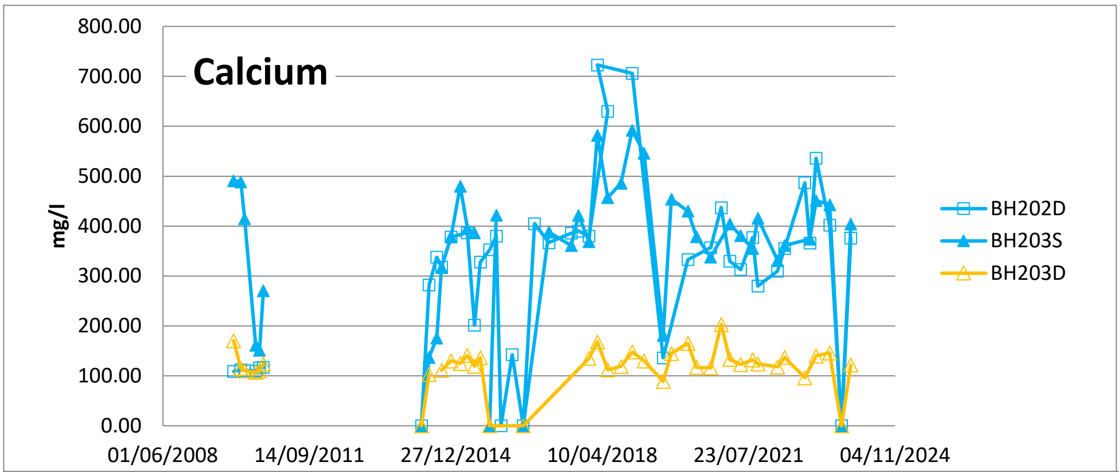

Lead
microg/l
25.00
20.00
15.00
10.00
5.00
0.00
01/06/2008
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH201D
BH201S

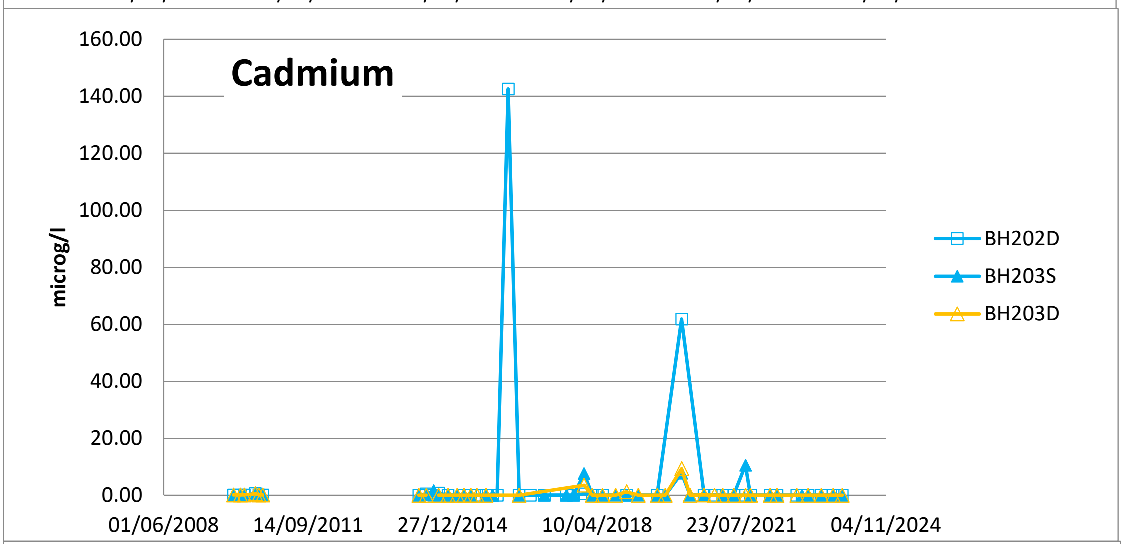

pH
pH
16
14
12
10
8
6
4
2
0
01/06/2008
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH202
BH203S
BH203D

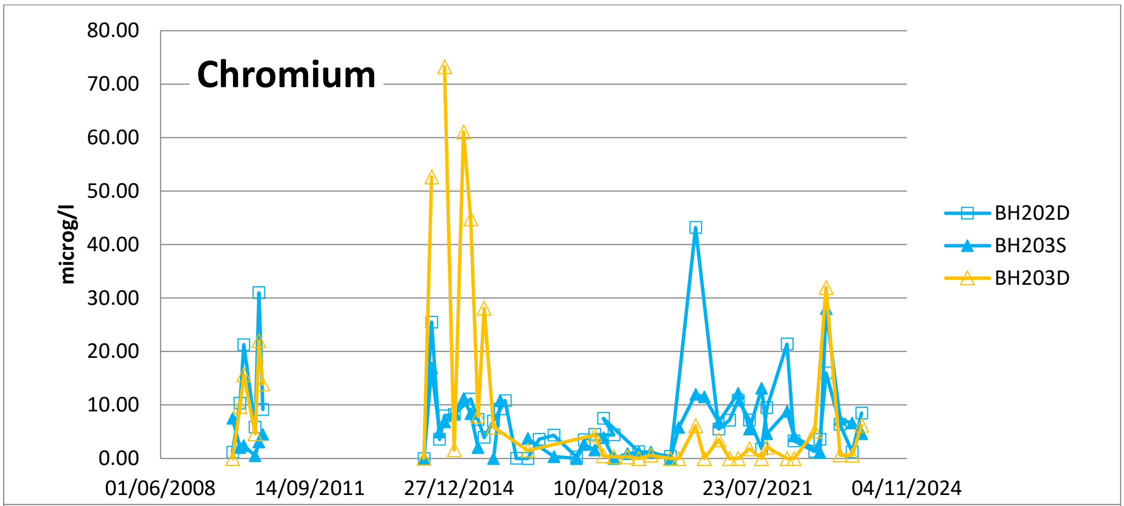

EC
microS/cm
8000
7000
6000
5000
4000
3000
2000
1000
0
01/06/2008
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH202D
BH203S
BH203D

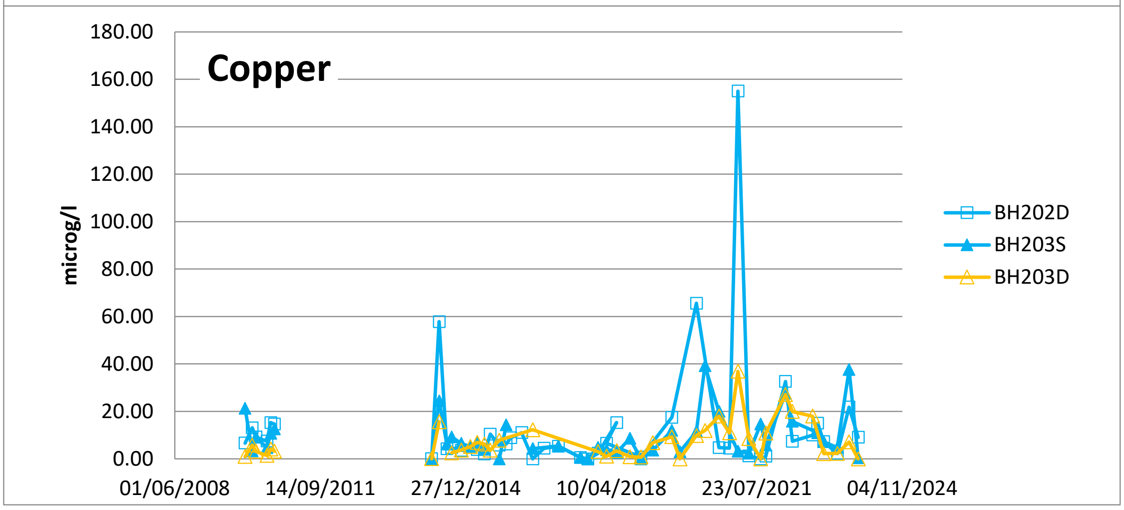

Ammonia
mg/l
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
01/06/2008
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH202D
BH203S
BH203D

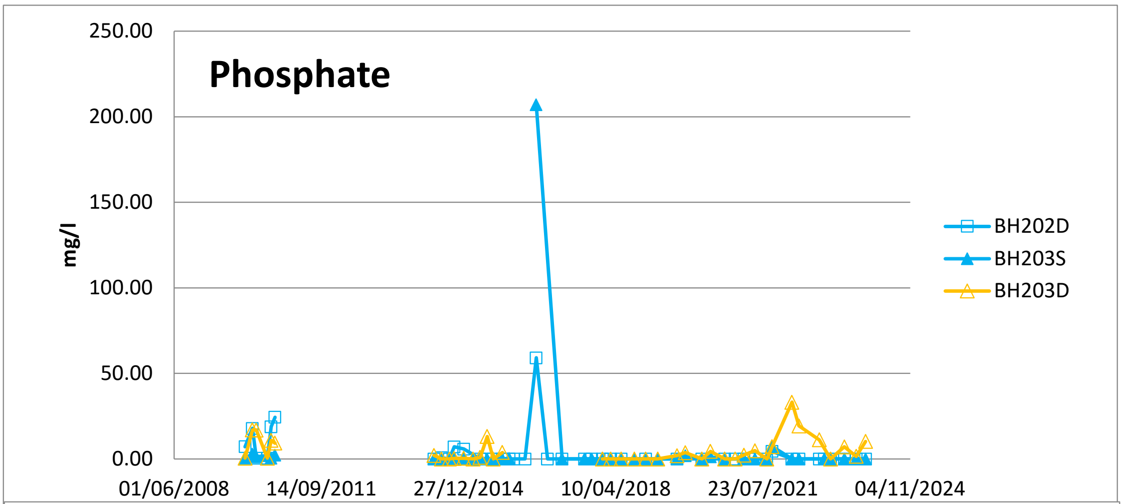

Chloride
mg/l
3000.00
2500.00
2000.00
1500.00
1000.00
500.00
0.00
01/06/2008
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH202D
BH203S
BH203D

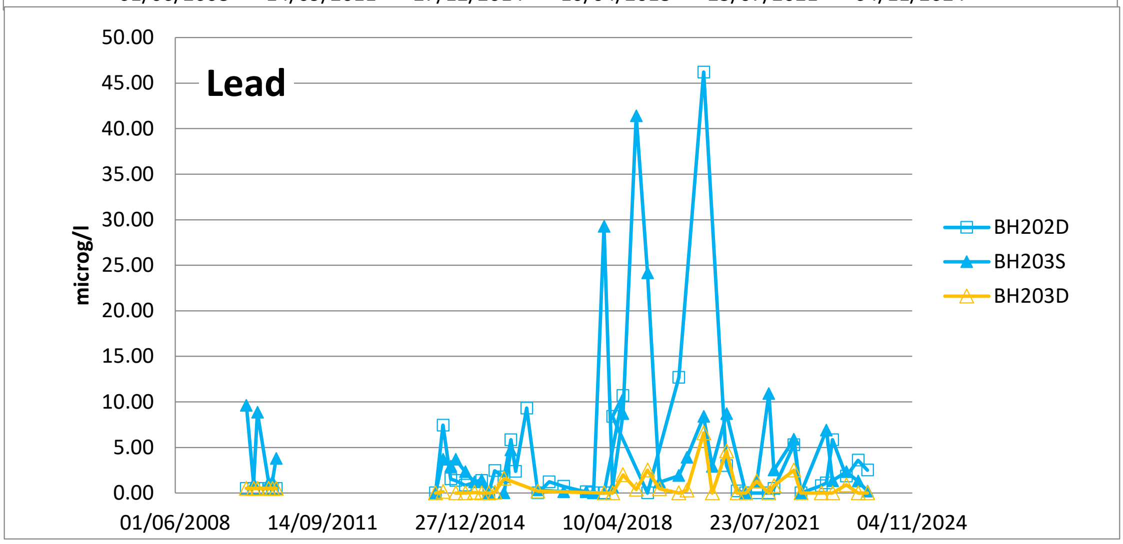

Calcium
mg/l
800.00
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
01/06/2008
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH202D
BH203S
BH203D

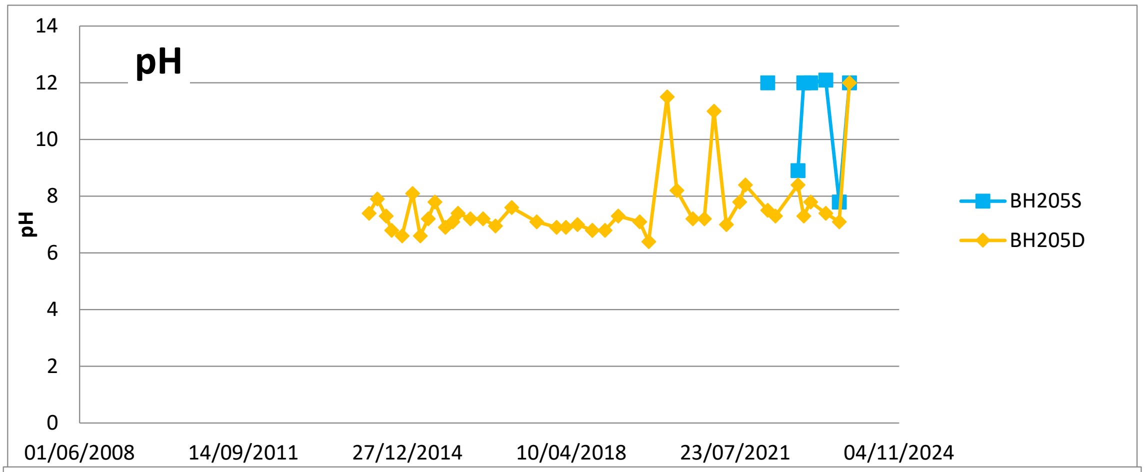

Cadmium
microg/l
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
01/06/2008
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH202D
BH203S
BH203D

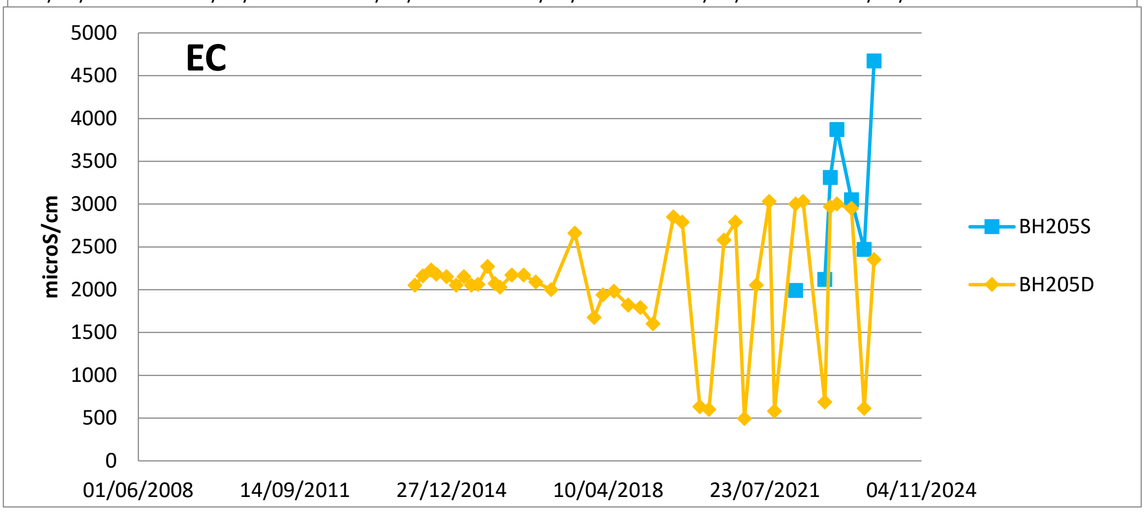

Chromium
microg/l
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
01/06/2008
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH202D
BH203S
BH203D

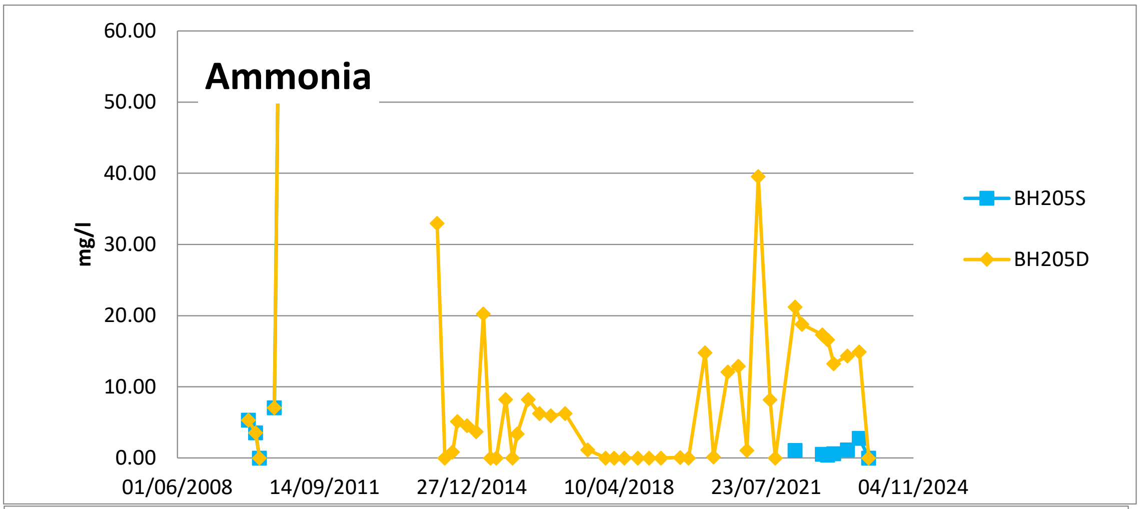

Copper
microg/l
180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
01/06/2008
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH202D
BH203S
BH203D

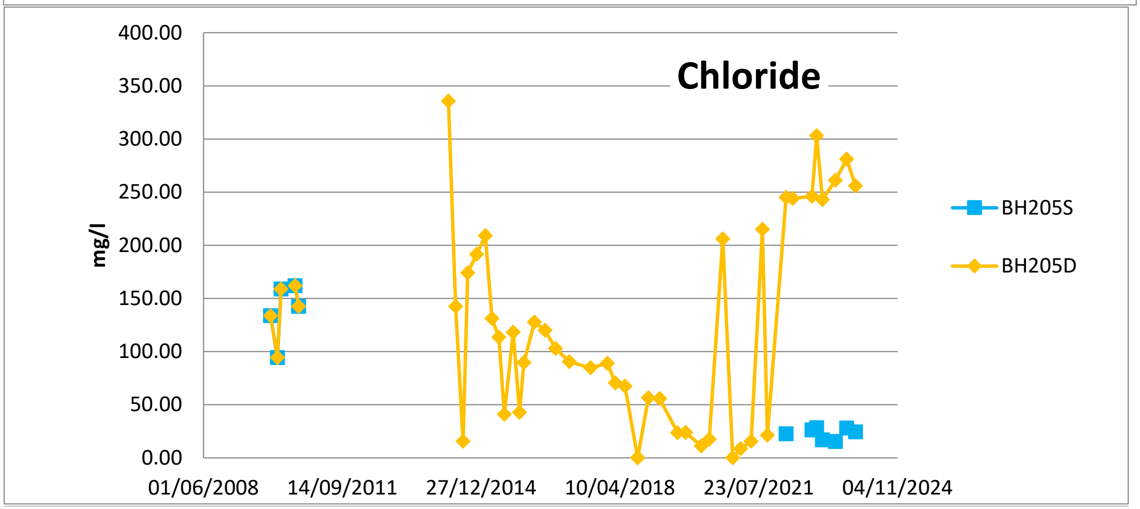

Phosphate
mg/l
250.00
200.00
150.00
100.00
50.00
0.00
01/06/2008
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH202D
BH203S
BH203D

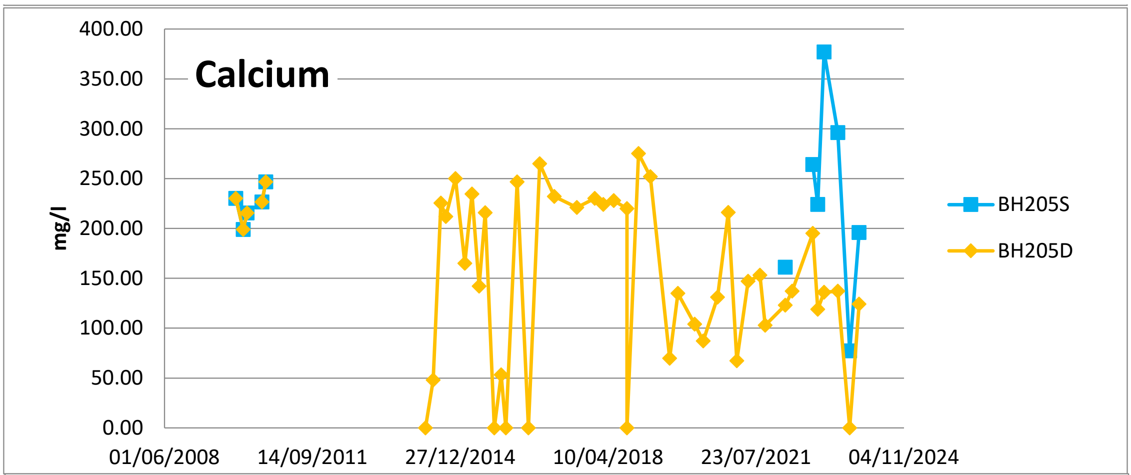

Lead
microg/l
50.00
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
01/06/2008
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH202D
BH203S
BH203D


pH
pH
14
12
10
8
6
4
2
0
01/06/2008
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH205S
BH205D


EC
microS/cm
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
01/06/2008
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH205S
BH205D


Ammonia
mg/l
60.00
50.00
40.00
30.00
20.00
10.00
0.00
01/06/2008
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH205S
BH205D


Chloride
mg/l
400.00
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
01/06/2008
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH205S
BH205D


Calcium
mg/l
400.00
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
01/06/2008
14/09/2011
27/12/2014
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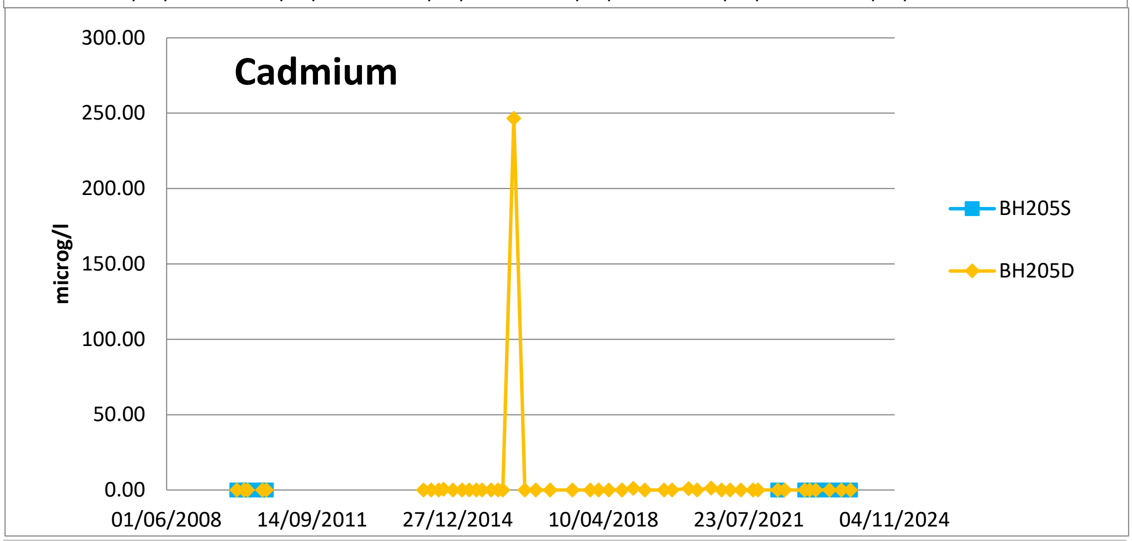
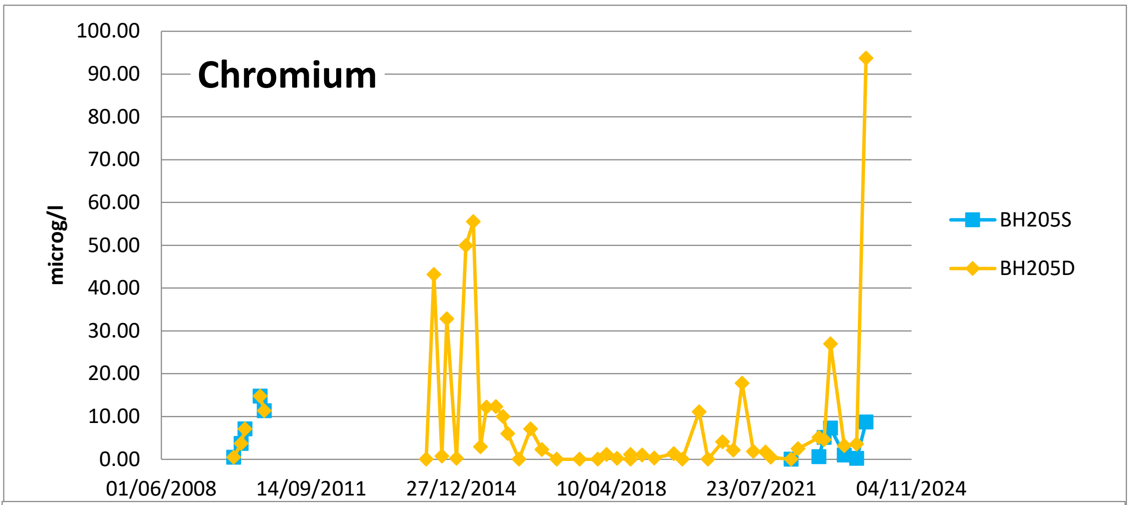
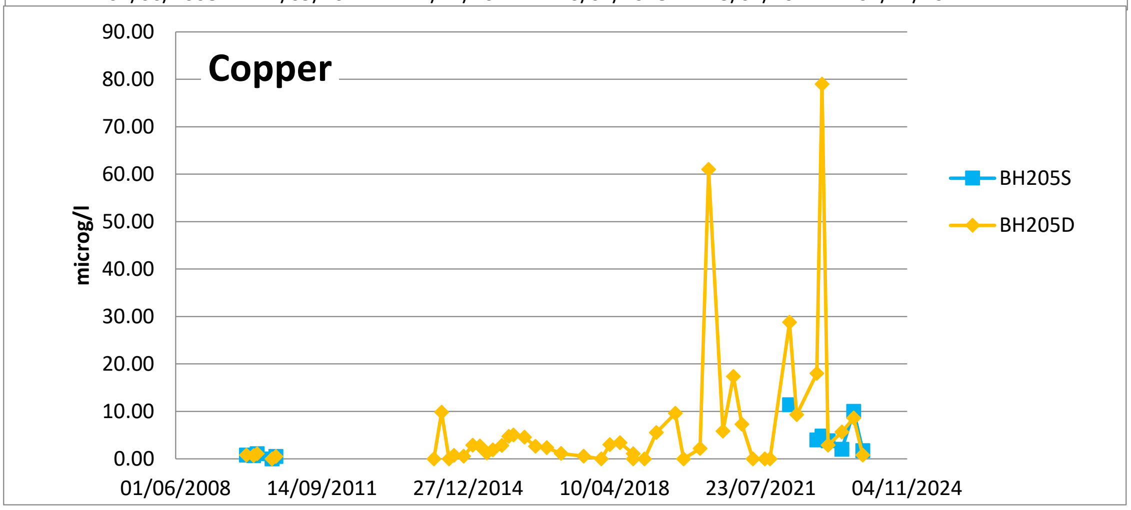
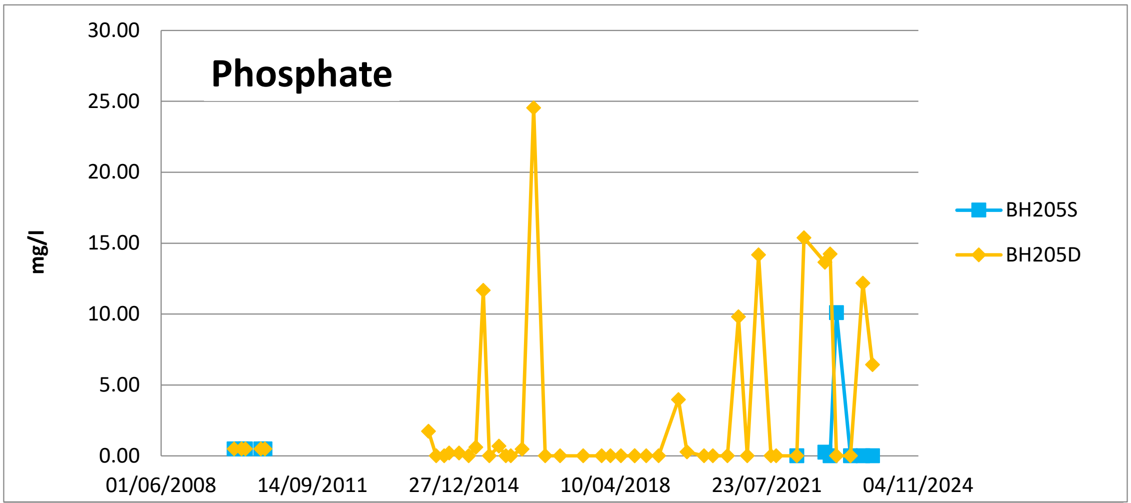
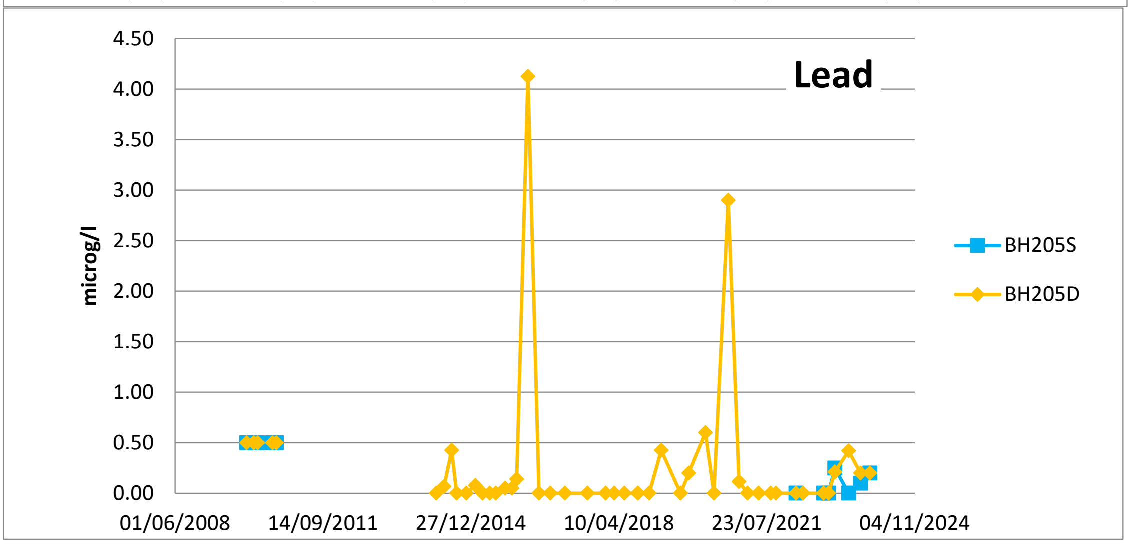
04/11/2024
BH205S
BH205D


Cadmium
microg/l
300.00
250.00
200.00
150.00
100.00
50.00
0.00
01/06/2008
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH205S
BH205D


Chromium
microg/l
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
01/06/2008
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH205S
BH205D


Copper
microg/l
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
01/06/2008
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH205S
BH205D

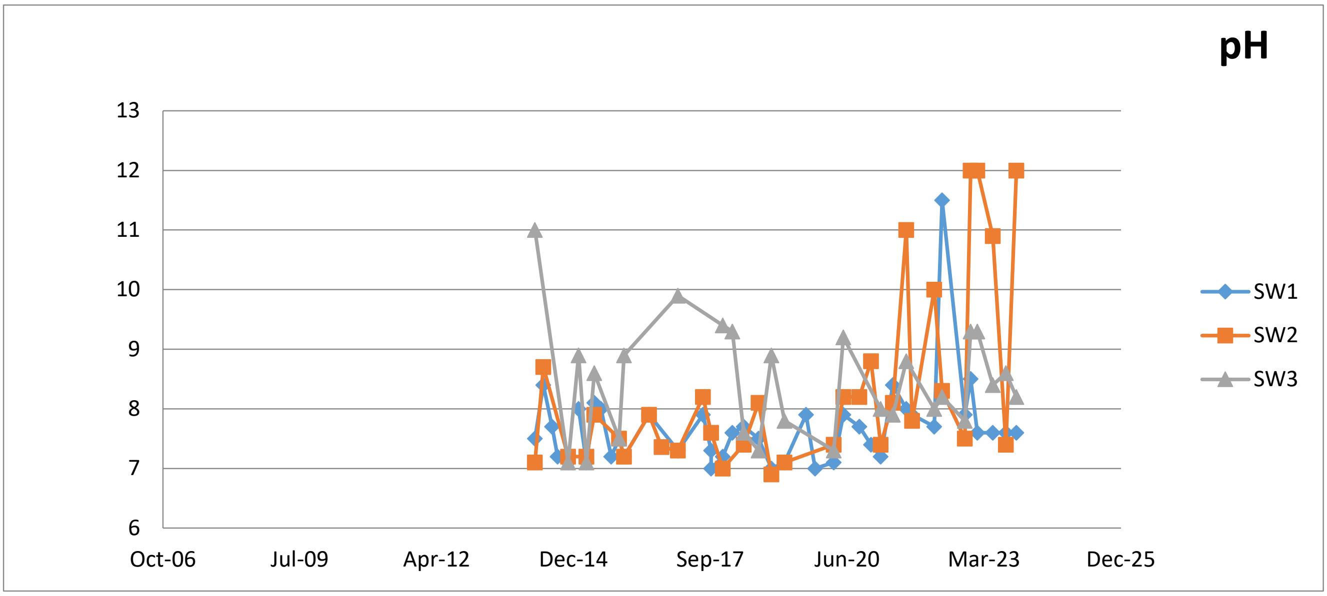

Phosphate
mg/l
30.00
25.00
20.00
15.00
10.00
5.00
0.00
01/06/2008
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH205S
BH205D

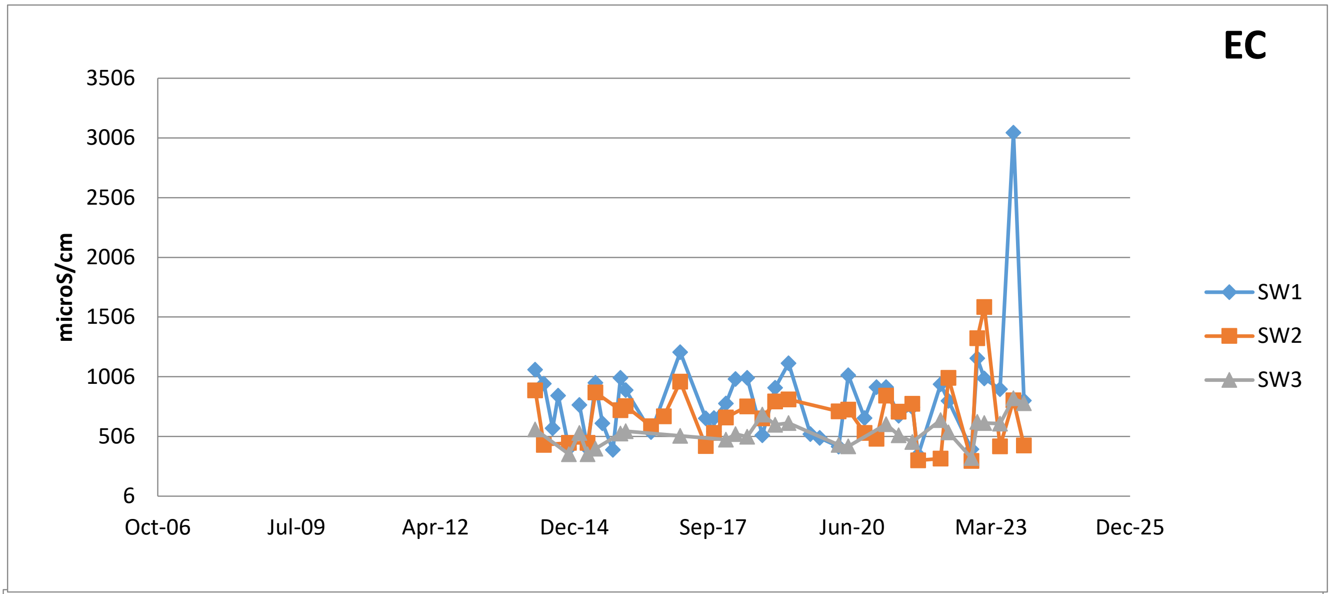

Lead
microg/l
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
01/06/2008
14/09/2011
27/12/2014
10/04/2018
23/07/2021
04/11/2024
BH205S
BH205D

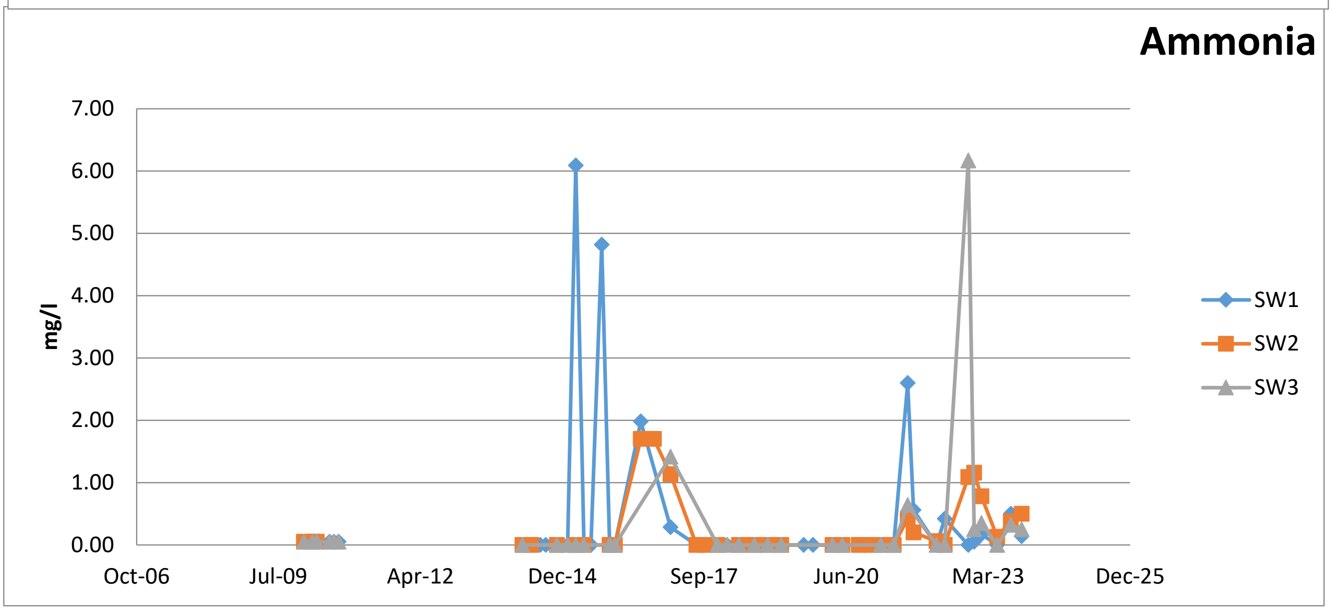
SOUTH SIDE QUEENSWAY WASTE MANAGEMENT SITE, LLANWERN STEELWORKS

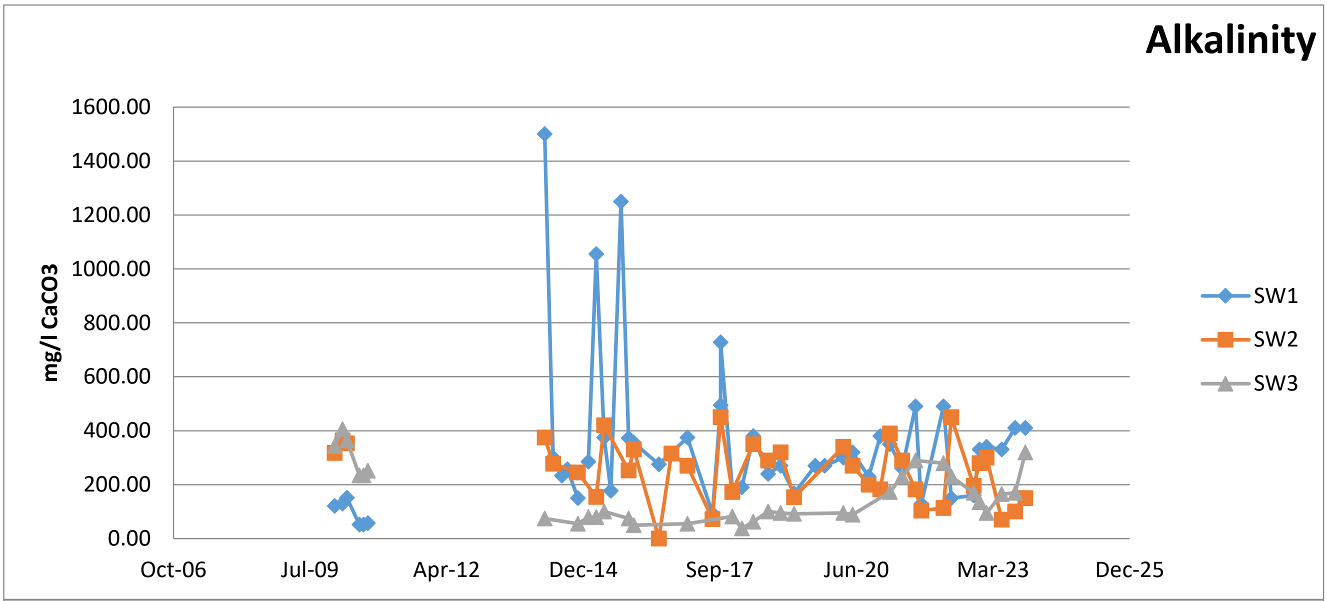
2023 Annual Review of Environmental Monitoring

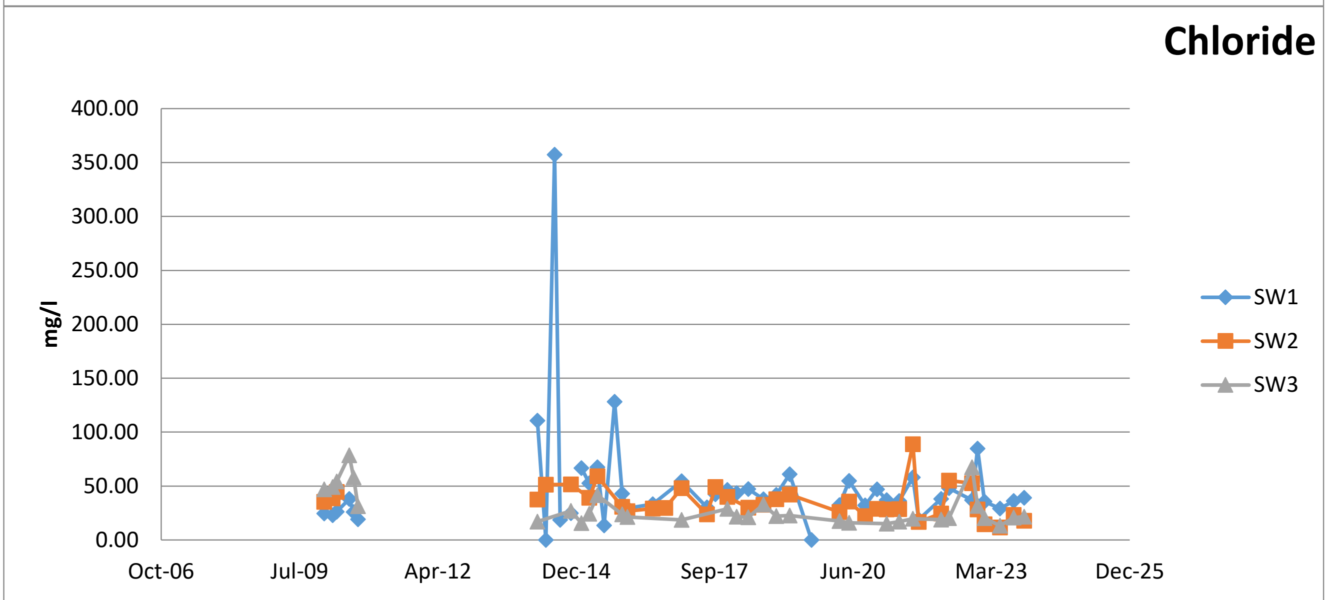
Appendix 2
Surface Water Chemistry Analysis
Report Number 2299r2v1d0124

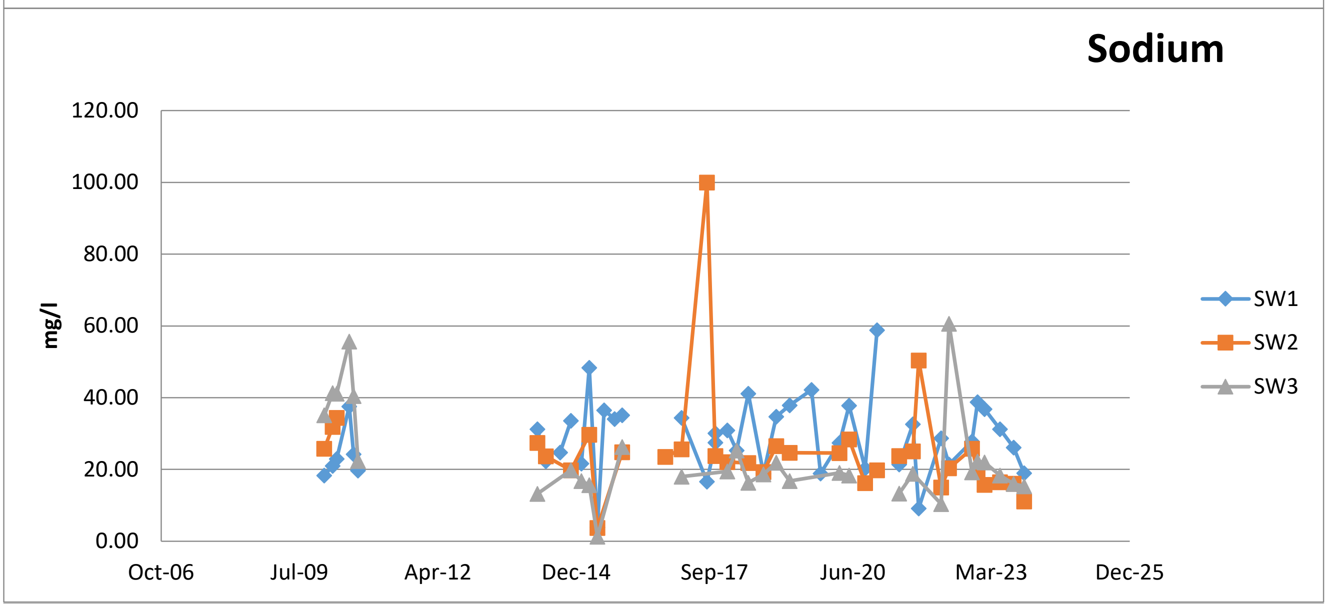

pH
13
12
11
10
9
8
7
6
Oct-06
Jul-09
Apr-12
Dec-14
Sep-17
Jun-20
Mar-23
Dec-25
SW1
SW2
SW3

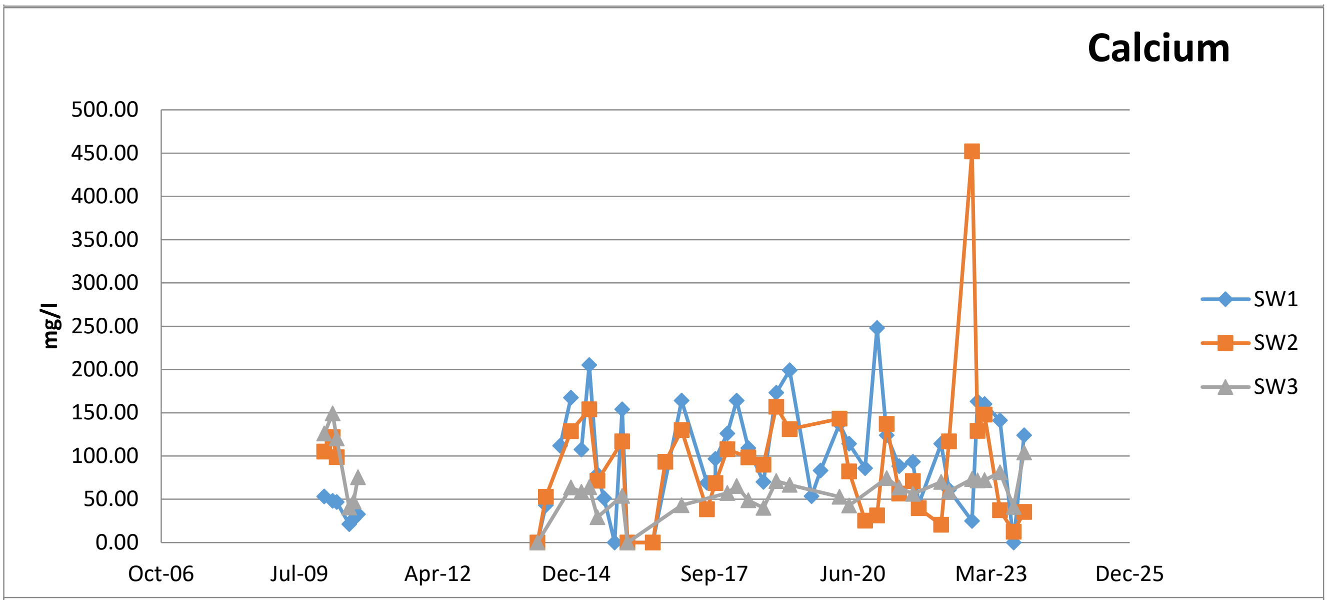

EC
microS/cm
3506
3006
2506
2006
1506
1006
506
6
Oct-06
Jul-09
Apr-12
Dec-14
Sep-17
Jun-20
Mar-23
Dec-25
SW1
SW2
SW3


Ammonia
mg/l
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Oct-06
Jul-09
Apr-12
Dec-14
Sep-17
Jun-20
Mar-23
Dec-25
SW1
SW2
SW3

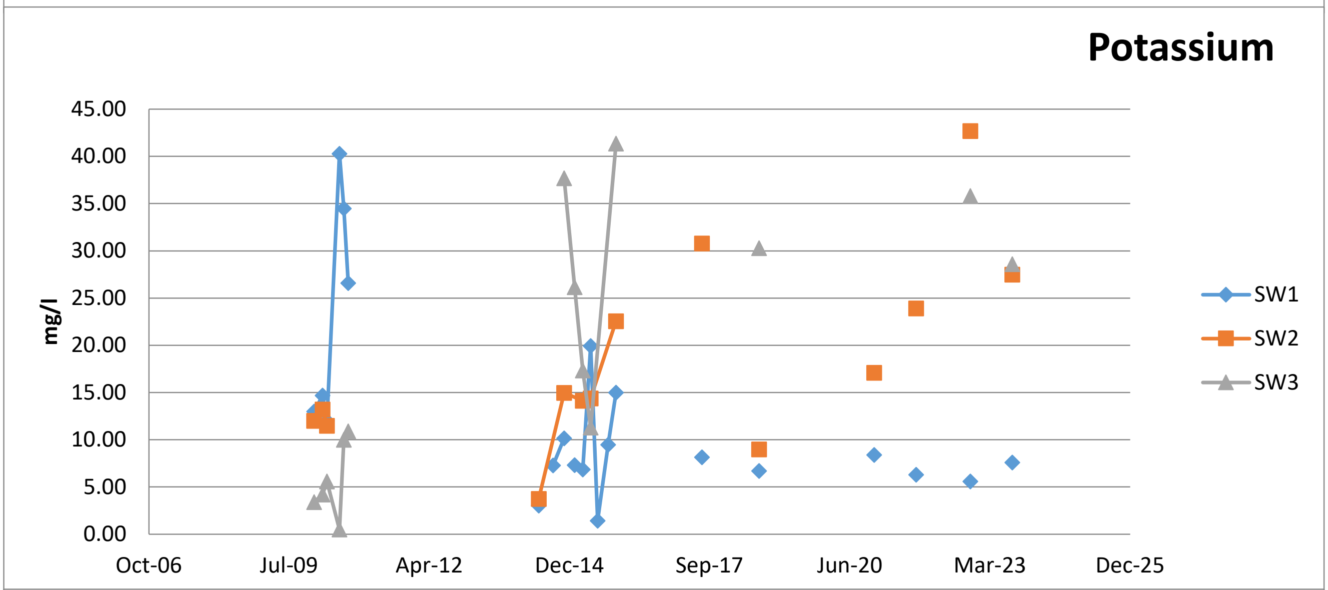

Alkalinity
mg/l CaCO3
1600.00
1400.00
1200.00
1000.00
800.00
600.00
400.00
200.00
0.00
Oct-06
Jul-09
Apr-12
Dec-14
Sep-17
Jun-20
Mar-23
Dec-25
SW1
SW2
SW3


Chloride
mg/l
400.00
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
Oct-06
Jul-09
Apr-12
Dec-14
Sep-17
Jun-20
Mar-23
Dec-25
SW1
SW2
SW3

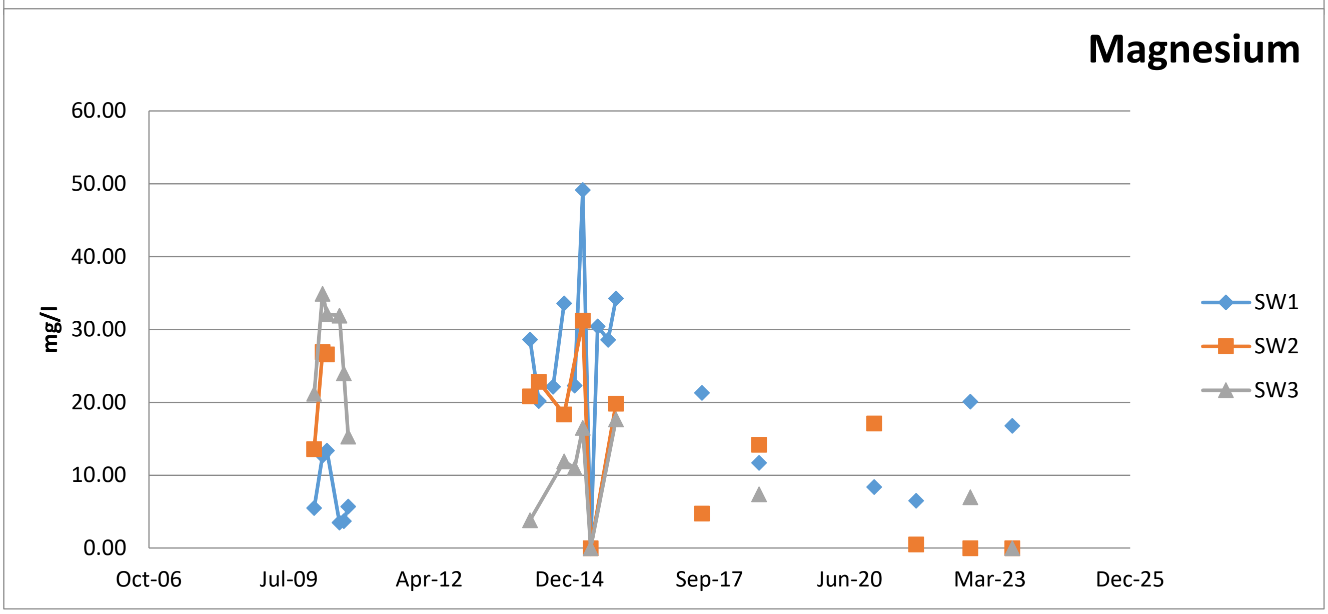

Sodium
mg/l
120.00
100.00
80.00
60.00
40.00
20.00
0.00
Oct-06
Jul-09
Apr-12
Dec-14
Sep-17
Jun-20
Mar-23
Dec-25
SW1
SW2
SW3



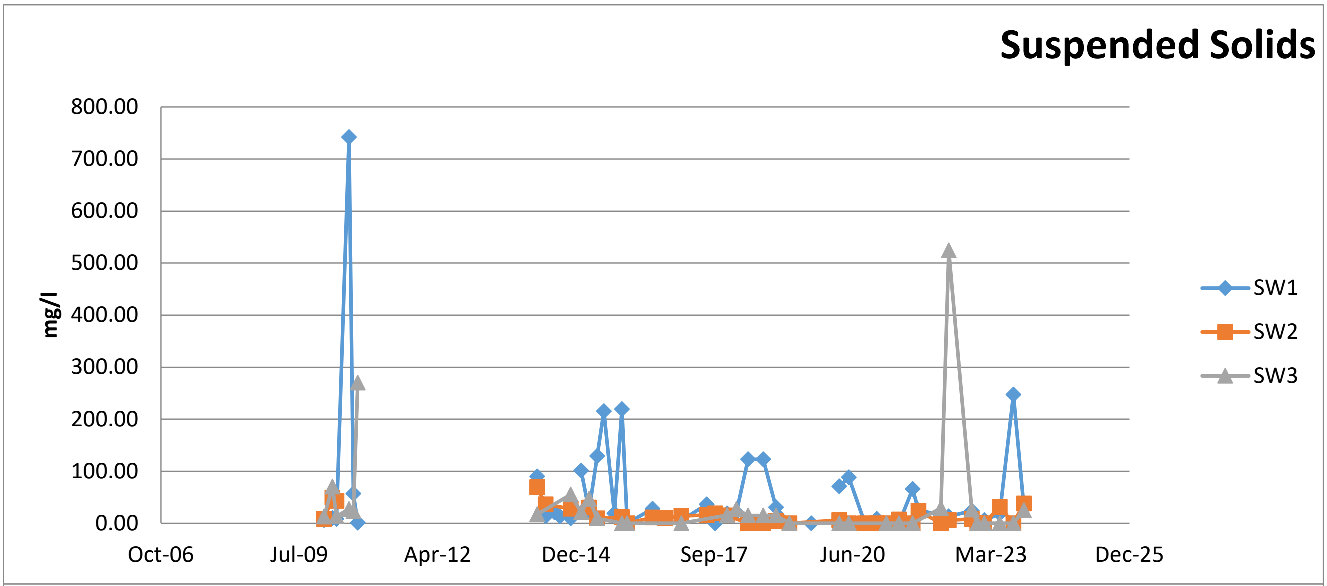
Calcium
mg/l
500.00
450.00
400.00
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
Oct-06
Jul-09
Apr-12
Dec-14
Sep-17
Jun-20
Mar-23
Dec-25
SW1
SW2
SW3

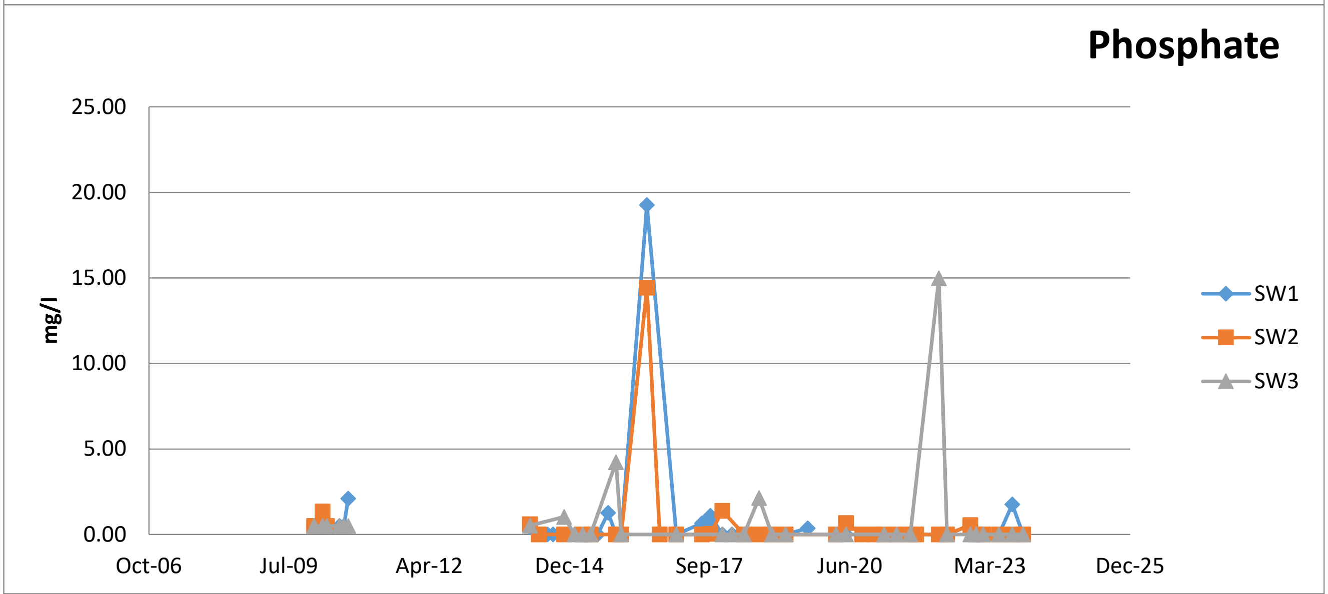


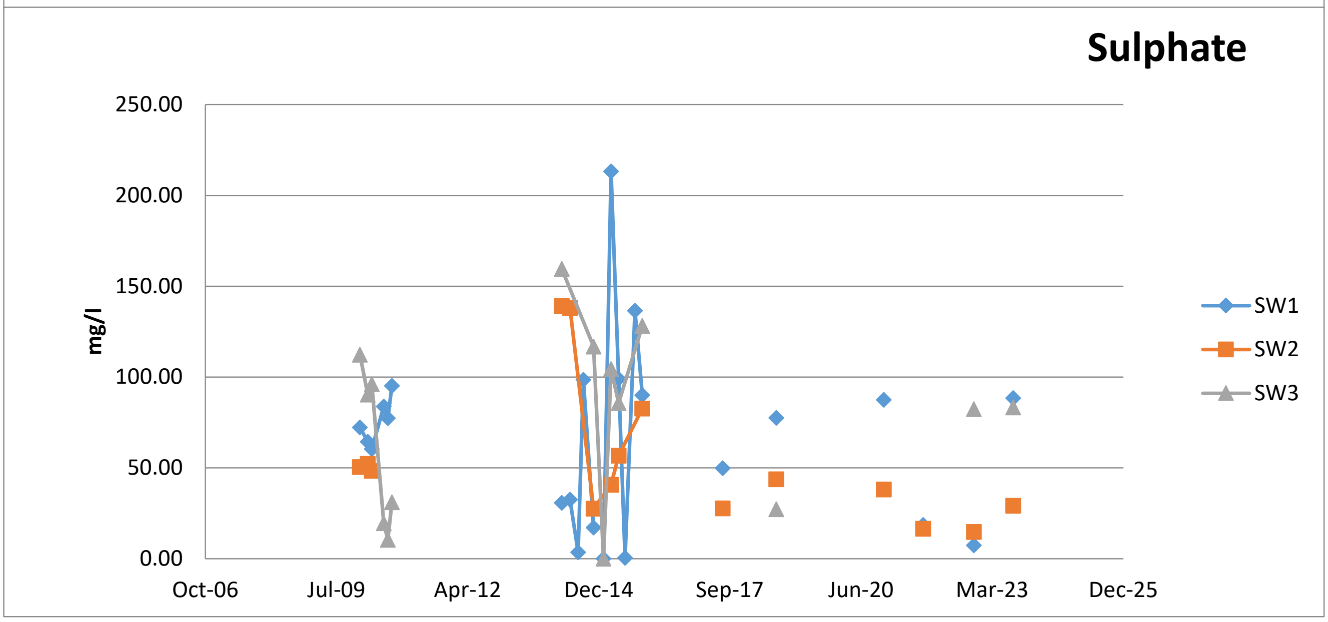
Potassium
mg/l
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Oct-06
Jul-09
Apr-12
Dec-14
Sep-17
Jun-20
Mar-23
Dec-25
SW1
SW2
SW3



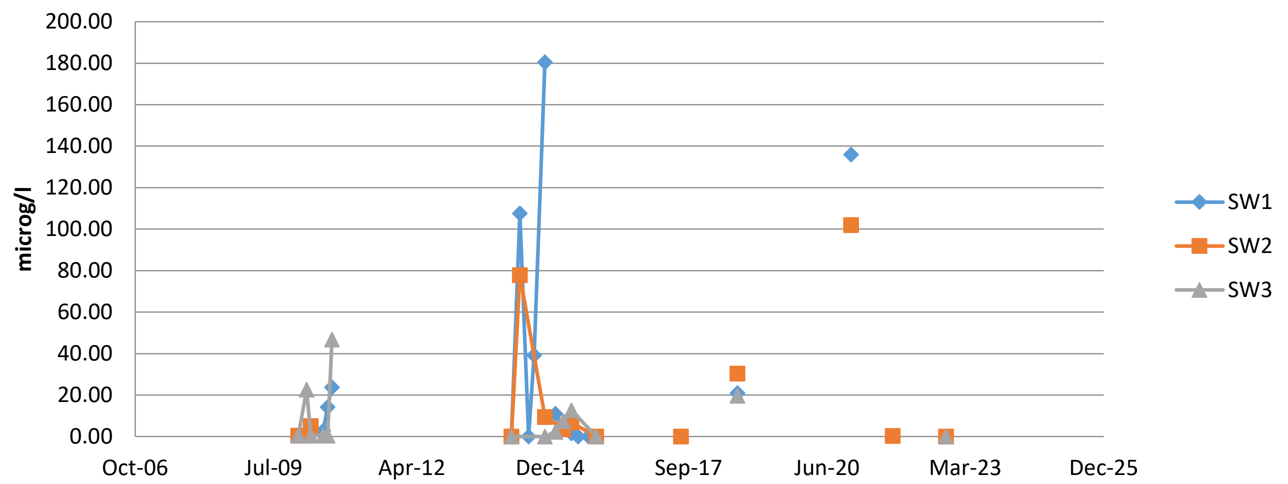
Magnesium
mg/l
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Oct-06
Jul-09
Apr-12
Dec-14
Sep-17
Jun-20
Mar-23
Dec-25
SW1
SW2
SW3


Suspended Solids
800.00
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
mg/l
Oct-06
Jul-09
Apr-12
Dec-14
Sep-17
Jun-20
Mar-23
Dec-25
SW1
SW2
SW3

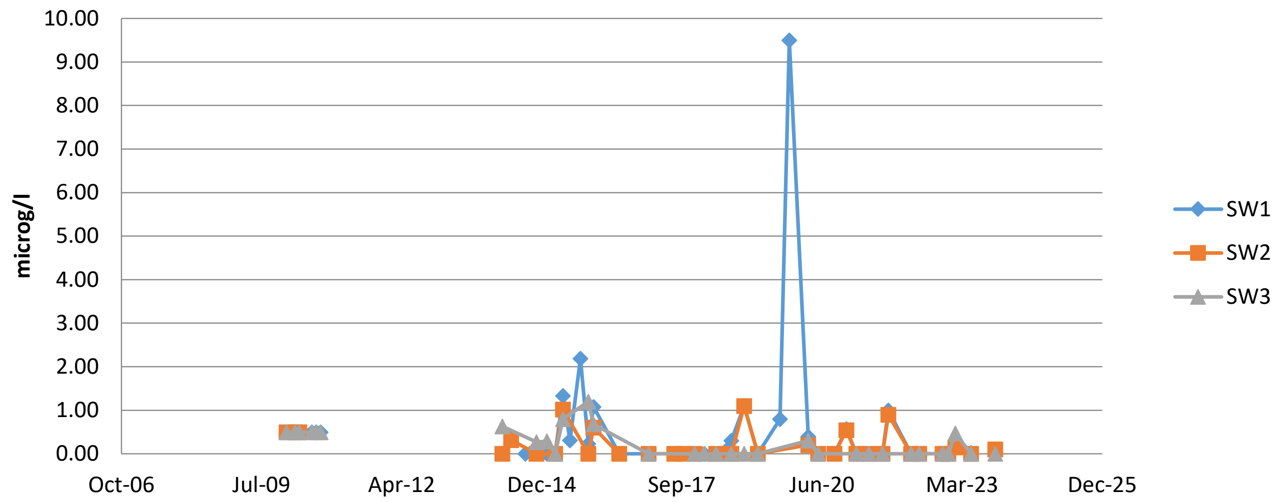

Phosphate
25.00
20.00
15.00
10.00
5.00
0.00
mg/l
Oct-06
Jul-09
Apr-12
Dec-14
Sep-17
Jun-20
Mar-23
Dec-25
SW1
SW2
SW3


Sulphate
250.00
200.00
150.00
100.00
50.00
0.00
mg/l
Oct-06
Jul-09
Apr-12
Dec-14
Sep-17
Jun-20
Mar-23
Dec-25
SW1
SW2
SW3

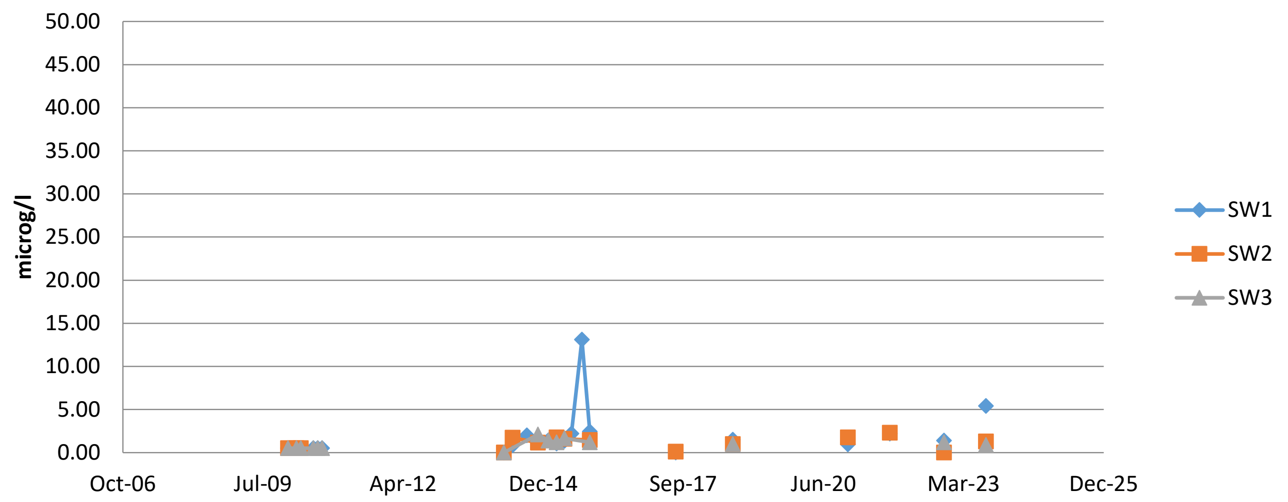
Aluminium

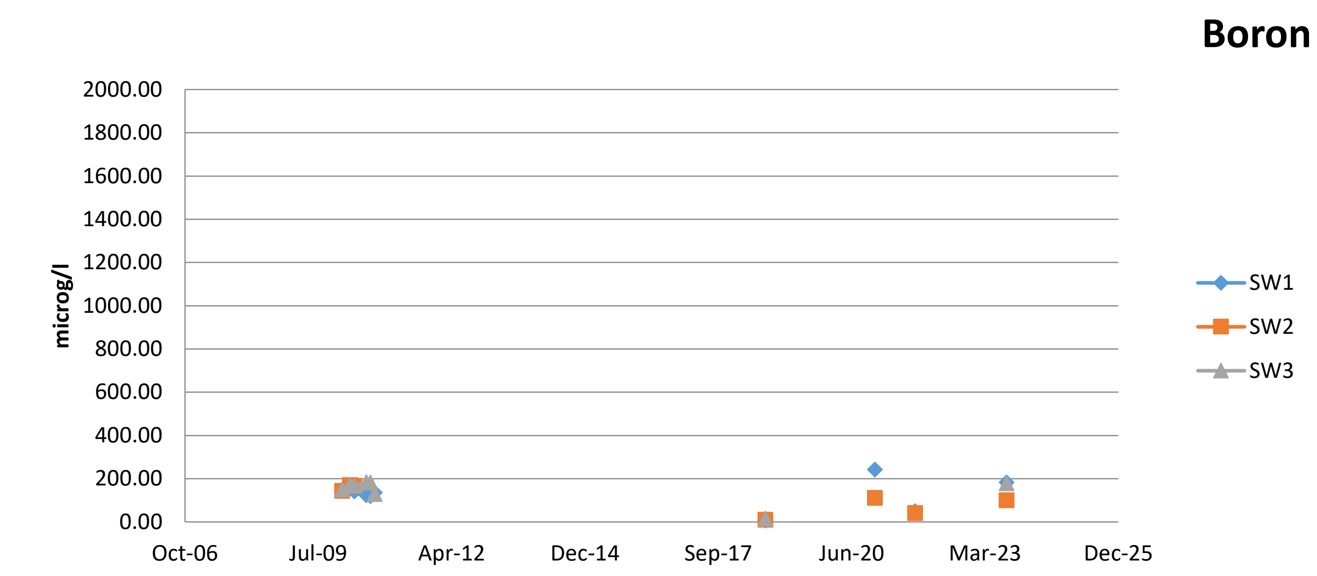


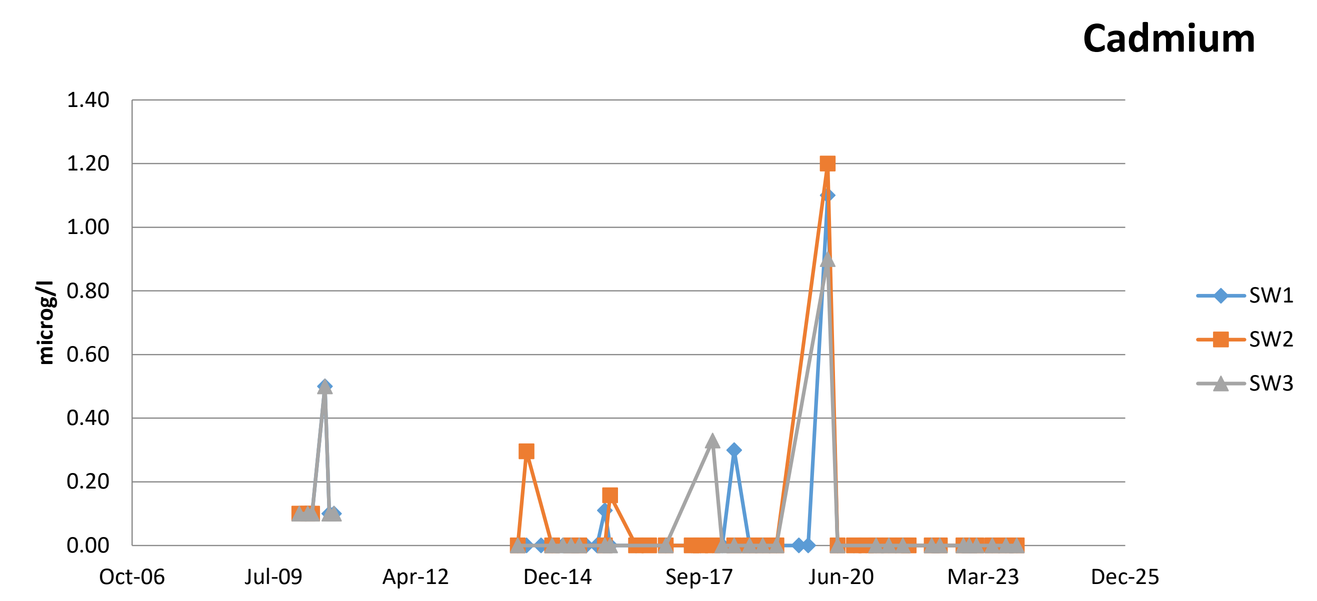
Antimony

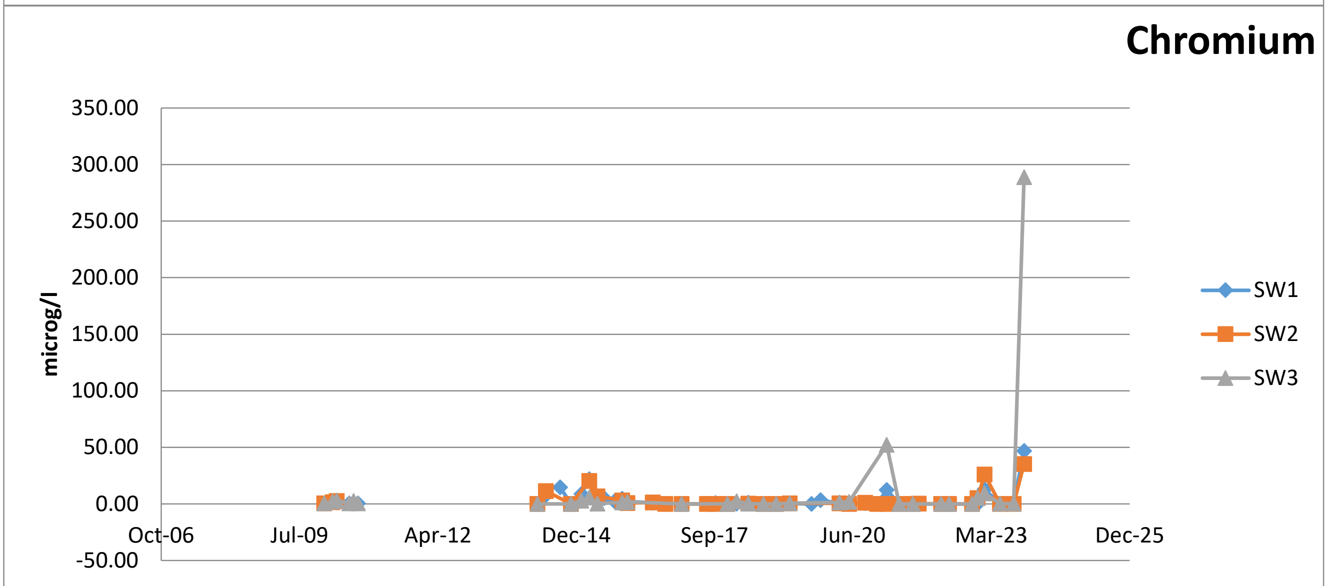


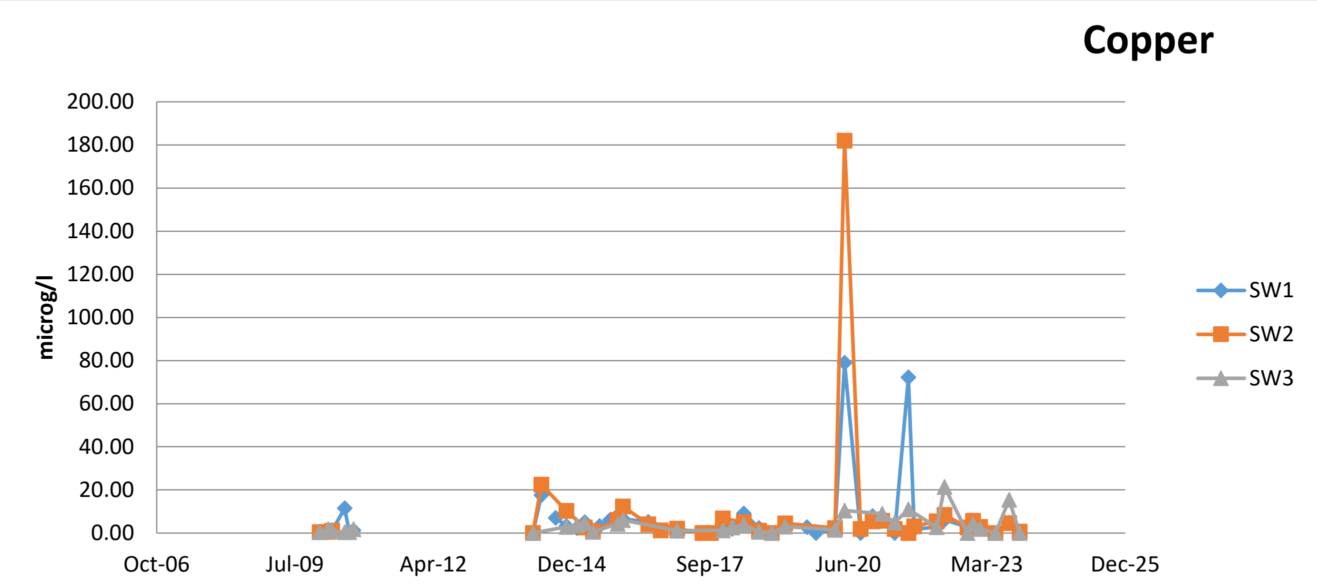
Arsenic

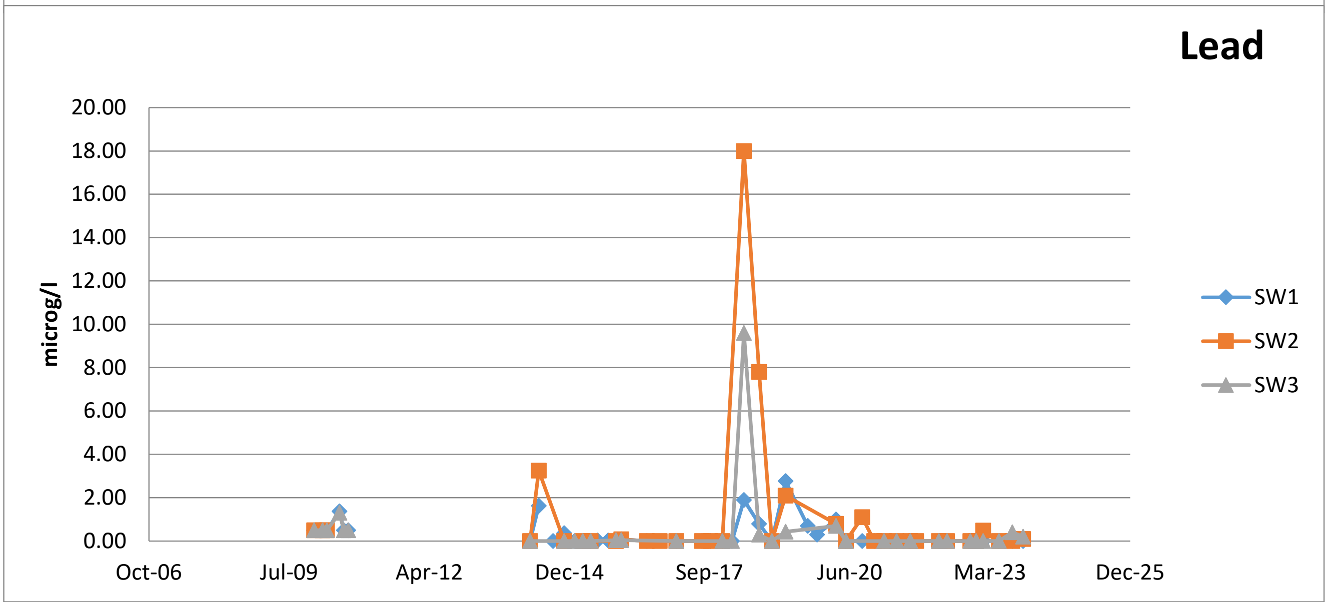


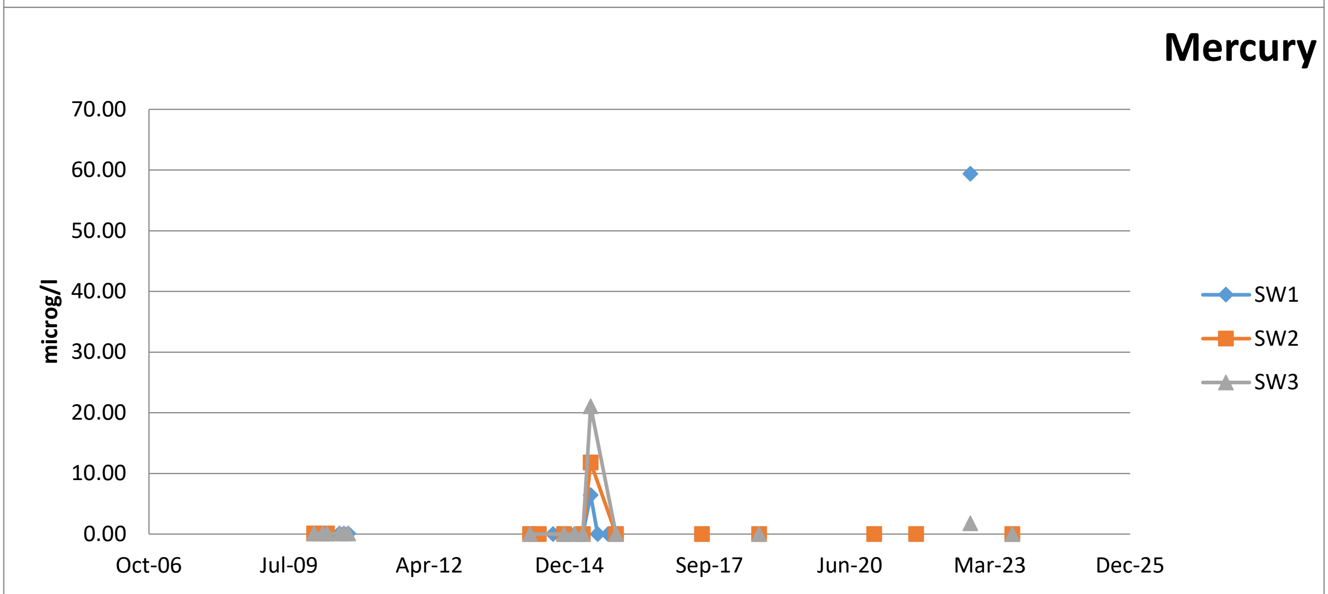

Boron
2000.00
1800.00
1600.00
1400.00
1200.00
1000.00
800.00
600.00
400.00
200.00
0.00
microg/l
Oct-06
Jul-09
Apr-12
Dec-14
Sep-17
Jun-20
Mar-23
Dec-25
SW1
SW2
SW3

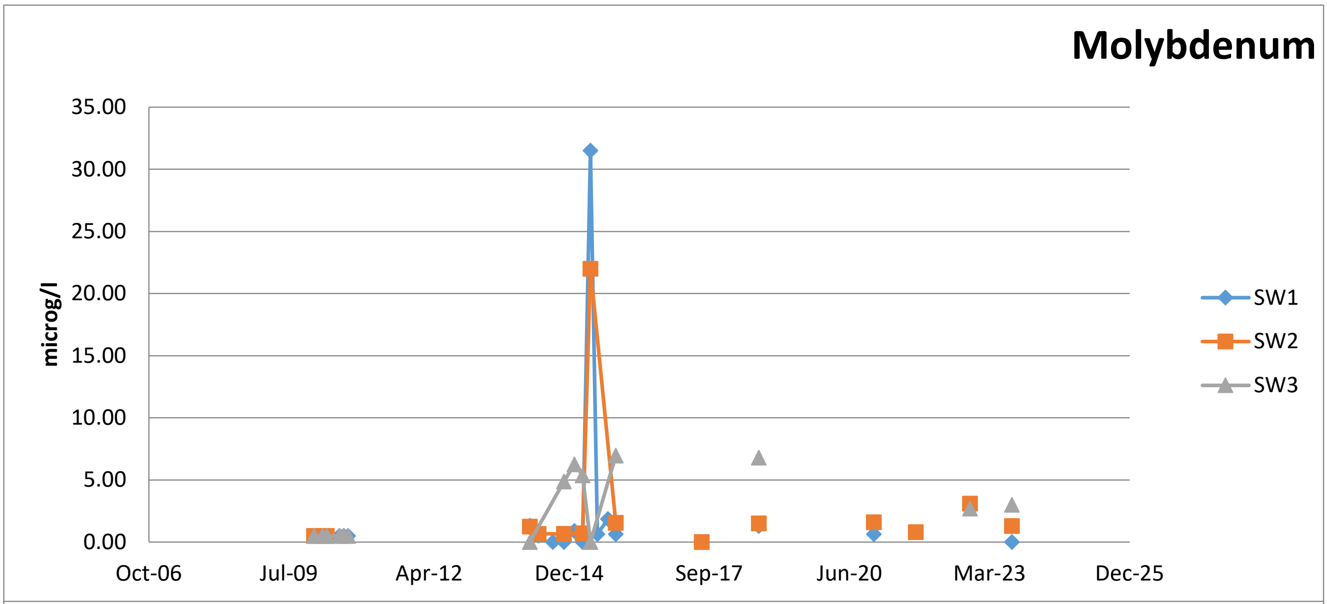

Cadmium
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
microg/l
Oct-06
Jul-09
Apr-12
Dec-14
Sep-17
Jun-20
Mar-23
Dec-25
SW1
SW2
SW3

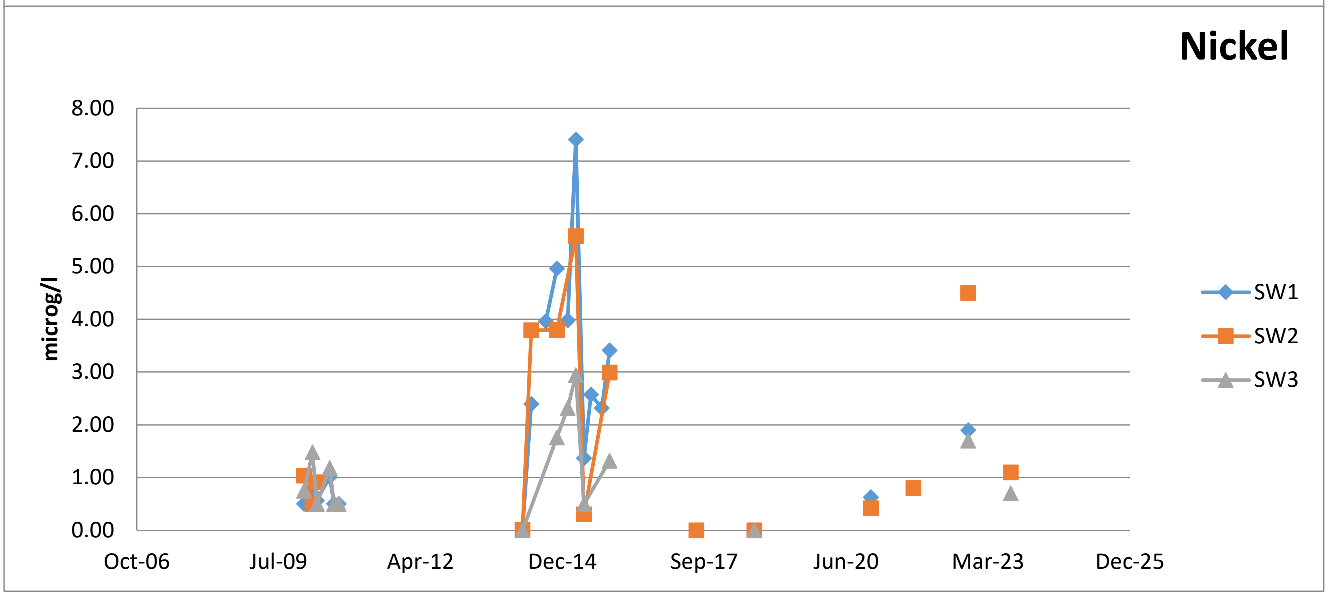

Chromium
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
-50.00
microg/l
Oct-06
Jul-09
Apr-12
Dec-14
Sep-17
Jun-20
Mar-23
Dec-25
SW1
SW2
SW3

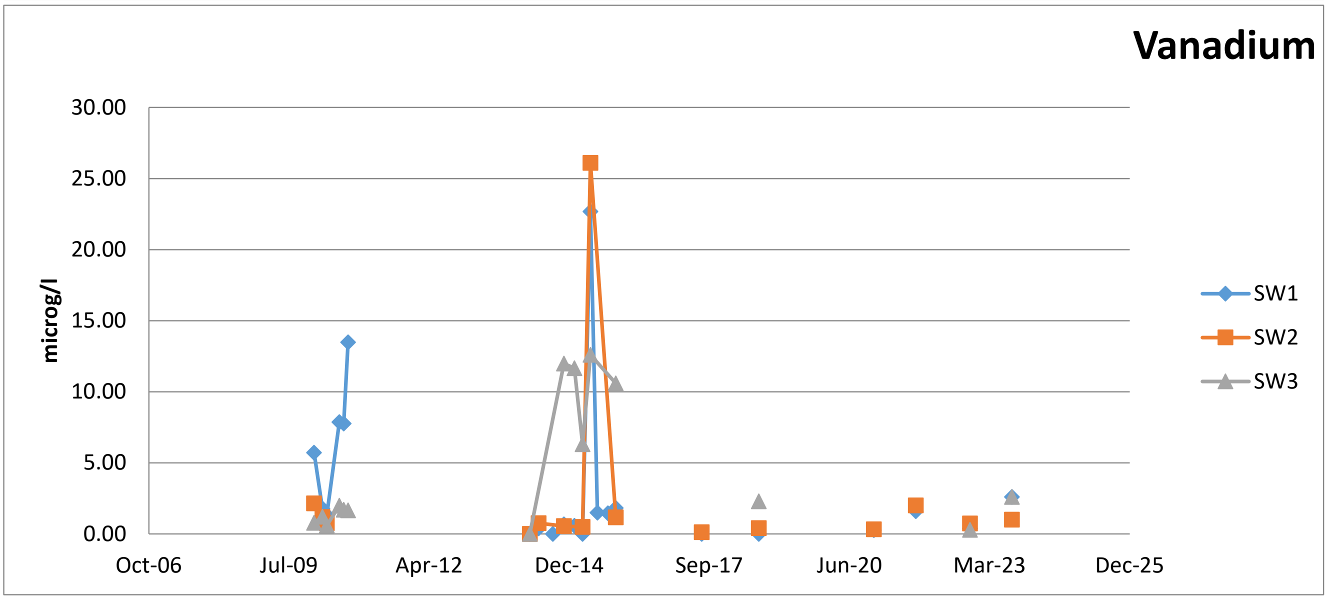

Copper
200.00
180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
microg/l
Oct-06
Jul-09
Apr-12
Dec-14
Sep-17
Jun-20
Mar-23
Dec-25
SW1
SW2
SW3

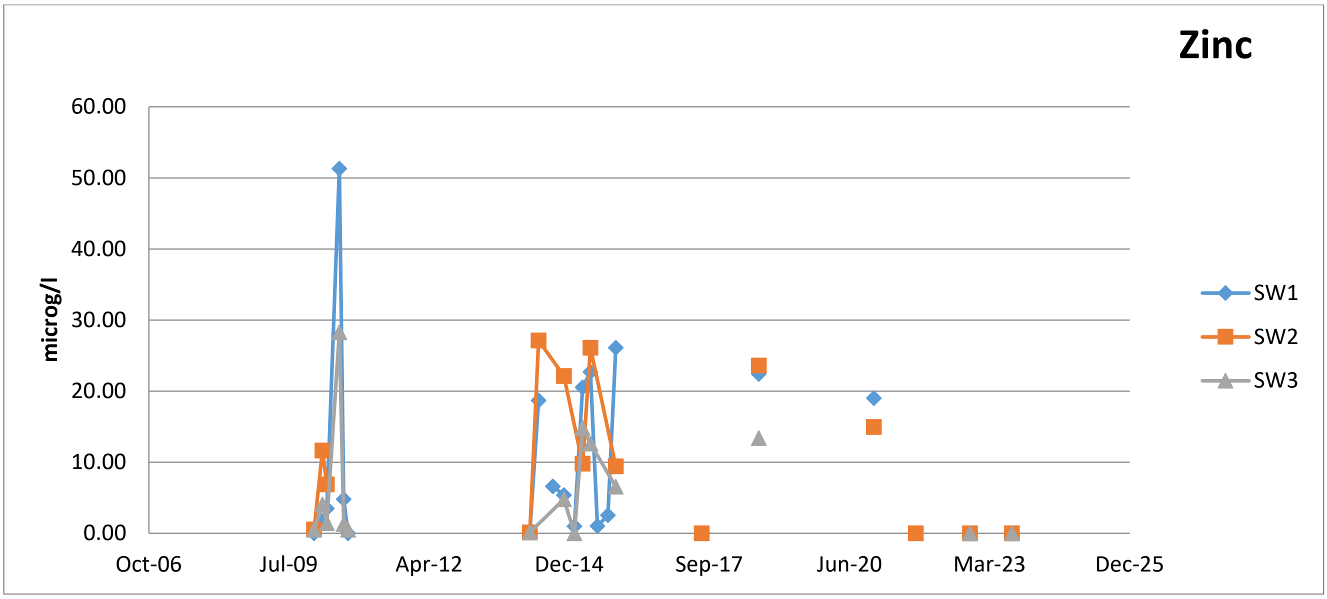

Lead
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
microg/l
Oct-06
Jul-09
Apr-12
Dec-14
Sep-17
Jun-20
Mar-23
Dec-25
SW1
SW2
SW3


Mercury
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
microg/l
Oct-06
Jul-09
Apr-12
Dec-14
Sep-17
Jun-20
Mar-23
Dec-25
SW1
SW2
SW3


Molybdenum
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
microg/l
Oct-06
Jul-09
Apr-12
Dec-14
Sep-17
Jun-20
Mar-23
Dec-25
SW1
SW2
SW3


Nickel
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
microg/l
Oct-06
Jul-09
Apr-12
Dec-14
Sep-17
Jun-20
Mar-23
Dec-25
SW1
SW2
SW3


Vanadium
30.00
25.00
20.00
15.00
10.00
5.00
0.00
microg/l
Oct-06
Jul-09
Apr-12
Dec-14
Sep-17
Jun-20
Mar-23
Dec-25
SW1
SW2
SW3


Zinc
microg/l
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Oct-06
Jul-09
Apr-12
Dec-14
Sep-17
Jun-20
Mar-23
Dec-25
SW1
SW2
SW3

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