



**MORFA NON-
HAZARDOUS LANDFILL,
PORT TALBOT**

PERMIT BV7311IE

**2022 Annual Review of
Environmental
Monitoring**

Report Number 2295r1v1d0223

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Executive Summary

Since December 2004, Tata Steel (UK) Limited (Tata Steel) has operated the Morfa Non-Hazardous Landfill (MNHL) in accordance with an Environmental Permit. Each year, an annual review report is required by the Permit. This report covers the period to the end of December 2022 and evaluates the leachate, groundwater, surface water, gas and dust data collected since 2005. A recent topographic survey of the site is also presented.

The landfill is designed upon the containment principle. Pollutants are kept within the wastes by surrounding the wastes with barriers that are virtually impermeable to water, liquids and ultimately gases. The landfill is currently being constructed as a series of cells; one currently accepts wastes with a possibility of producing landfill gas and the other accepting wastes with a low gassing potential. Within each cell, leachate produced by the action of rainfall infiltrating and leaching the wastes is managed by extraction and then treatment in the main steelworks. Until 2016, this management programme maintained the leachate at low levels and below Permit control levels. Since 2016 these levels persistently breached the Permit criteria and the landfill was operating outside of the original design parameters and Permit conditions. In response, Tata Steel initially increased the tankering of leachate and in 2019 completed the installation of a float-controlled pumping system to enable leachate removal 24/7. This system became fully operational in late 2019 and leachate levels have since reduced significantly and are now compliant.

Leachate chemistry is currently characterised by strongly alkaline pH and elevated concentrations of chloride, considered to be due to the combined leaching of slag wastes (source of alkalinity) and filter cake (source of chloride). Other parameters are currently present at low concentrations. Leachate from the unlined upgradient Morfa Closed Landfill is continuing to influence groundwater quality. As the closed landfill was finally fully restored in 2013 this influence has started to decline as rainfall can no longer infiltrate and leach the unlined waste. At this stage, there is no clear discernible evidence that the active MNHL is influencing groundwater quality.

1 INTRODUCTION

Tata Steel (UK) Limited (Tata Steel) operates the Morfa Non-Hazardous Landfill (MNHL) in accordance with Environmental Permit No. BV7311Ie dated 17 December 2004. Since this time the Permit has undergone Variation on several occasions. The latest Variation Notice number is EPR/BV7311IE/V007.

The Permit applies to only part of the original Morfa Landfill waste management site, with approximately 40% being closed upon the commencement of MNHL and Morfa Hazardous Landfill (MHL). The closed part of the site is referred to as Morfa Closed Landfill (MCL). The location of MNHL and its position relative to key site features including MNHL and MCL is shown on Figure 1 and Figure 2.

Tata Steel submits a report to Natural Resources Wales (NRW) on a three-monthly basis which compares the monitoring results for landfill gas, leachate, surface and groundwater against the relevant emission limits, assessment limits, control levels and compliance limits specified in the permit. Permit Condition 4.2 requires that a further summary review of all monitoring data is produced on an annual basis. This report is the annual monitoring report for MNHL for the period January–December 2022. This report also includes scale plans from the annual topographic survey, as required by the Permit. A record of Permit update is provided in Appendix 1 for reference.

The environmental monitoring commenced in 2005. This report has been compiled and completed by Geotechnology Ltd (Geotechnology) to provide an independent review of the monitoring data collected. Previous annual reports have also been prepared by Geotechnology.

Separate annual monitoring reports describing the monitoring undertaken at MHL and MCL have also been compiled by Geotechnology.

The Permit was eight years old in December 2012 which prompted a review of the initial Hydrogeological Risk Assessment (HRA). The review was provided in Geotechnology report 1177r1v1d0712 and follows the first review in report 711r1v1d0908. In 2017, Geotechnology completed a further review of the HRA (Geotechnology report 1739r1v1d1217). NRW provided feedback on this report during 2020 which prompted the latest Variation. NRW requires a HRA between nine and six months prior to every six years after the sixth anniversary of the granting of the permit. As the Permit was issued in December 2004, the HRA review was submitted in 2022. The next HRA should be submitted in 2028.

2 SITE DESCRIPTION AND ENVIRONMENTAL SETTING

The Morfa Site has been extensively investigated in support of landfill development. Since the issue of Environmental Permits (EPs) Tata Steel has maintained an extensive monitoring network that includes air quality monitoring, recording and investigating any visual or amenity issues, groundwater and surface water monitoring, landfill gas and landfill settlement. The information gathered to date is used in the following sections to describe the current site setting.

Based on the findings to date, a conceptual site model has been developed. This is illustrated in Figure 3 with each element discussed further below.

2.1 Location

The centre of the site is located at National Grid Reference SS781 838, as shown on Figure 1. The site currently comprises a mixture of casually over-tipped land, landfills constructed in accordance with the current Landfill Directive since 2004 (MNHL and MHL), the unlined but capped MCL, partially excavated sand dunes and pristine dune fields. Aerial photographs of the site are provided in Plates 2-1 and 2-2.

The site was granted planning consent for sand extraction and waste disposal in 1973 and has been used in part for these purposes since. The planning boundary covers a large area (as shown on Figure 2), though restrictions within the conditions required a stand-off to be observed between the landfill site and the River Kenfig to the south and Margam Sands to the west. Tata Steel also adopted a voluntary stand-off between the development of MNHL and MHL and Margam Moors, which was designated a SSSI in 1984, 11 years after planning consent for the landfill had been granted.

The site occupies a coastal location, adjacent to the dune system behind Margam Sands. The ground is generally flat with only 2 metres of relief between 6m and 8m AOD, though the western edge of the development encroaches into the dune system, where elevation rises to 14m AOD. The western edge of the site is the coastal dune field over its entire length and is roughly parallel to the beach which lies 75 metres further to the west. The southern edge of the site is occupied by MCL with the eastern edge following the fence line at the western edge of Margam Moors. The central part of the site is occupied by the current MNHL while the northwestern corner is occupied by MHL. The northern edge of the site is defined by a disused access track crossing from the coast road to the edge of the moors. These key features are illustrated in Figure 4.

The site is remote and located at the southern end of the Port Talbot steel plant. It is surrounded by land entirely owned by the company. The adjacent Margam Moors as far as the railway line to the east is owned by Tata Steel as is the site as far south as the River Kenfig. KNNR is located to the south of the River Kenfig and is bound by the southern bank of the River Kenfig.

There are no inhabited buildings within 1.9km and the nearest industrial buildings are close to 1km from the site. There are no public roads within 1km of the site and the adjacent beach is also under the private ownership of Tata Steel (UK) Ltd. There are no services crossing the site. One public footpath crosses the moors close to the site.

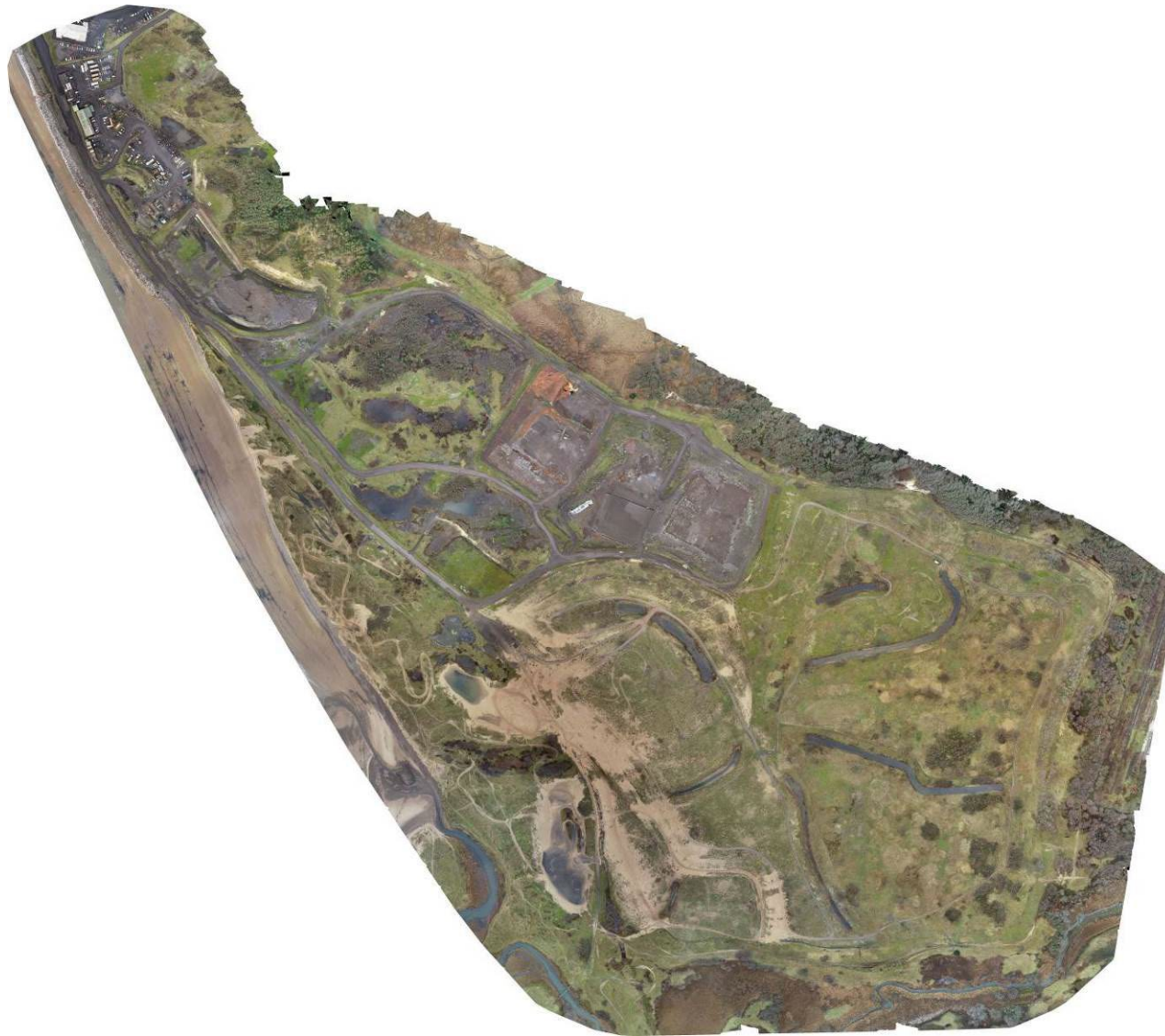


Plate 2-1 Aerial view over site (taken January 2021)



Plate 2-2 Close-up aerial view of MNHL (taken January 2022)

The site lies in an area of great ecological interest. Some 40m to the south of MCL, on the opposite side of the River Kenfig is the Kenfig National Nature Reserve, a Special Area of Conservation (SAC). The site shares a common boundary to the east with the Margam Moors which has also been granted statutory protection by its SSSI (Site of Special Scientific Interest) designation.

The principal watercourse in the area is the River Kenfig, which drains a catchment to the east of the site. The water quality of the river is routinely monitored by the Environment Agency. Both chemical and biological indicators are used to classify the quality of the river water and the water course. The Kenfig flows to the south of the site, where it breaks the confines of its river valley to spread into a coastal wetland that gives rise in part to the ecological interest of the area. The wetland extends across the entire southern boundary of the closed landfill site, until the river discharges over a pebble bank onto Margam Sands. The pebble bank represents the highest point to which normal tides flow.

Margam moors is a flat, poorly drained moorland which has been artificially managed over many centuries with a ditch or reen system. Precipitation is slow to run-off and the poor vegetation cover supports a small livestock rearing effort. The moors are characterised by the deep man-made reed filled ditches which allow the moors to drain water northwards where it is collected and pumped into the steel plant to be used as process water.

2.2 Geology

Much of the site is underlain by an irregular sheet of wind-blown sand which extends from the ground surface down to an organic/alluvial clay layer. The sand deposit is typically several metres thick, though this locally increases due to sand dune topography. Being wind-blown, the dune sand is poorly graded, with a very uniform grain size throughout. The sand has blown inland from Margam Beach which lies to the west. Locally, the wind-blown sand is overlain by made ground comprising steel making wastes. The small woodland patches along the base of the northeastern flank of the site appear to be dune migration barriers and mark the extent of the blown sand.

Underlying the wind-blown sand at every trial pit and borehole, except those along the southern boundary, is an organic and alluvial clay layer of up to 2.8m thickness. The alluvial clay layer is continuous with the clays found at the surface on the adjacent Margam Moors and therefore this layer represents the moorland surface prior to the deposition of the wind-blown sands.

An examination of the reduced elevation of the clay layer has revealed that it is not completely flat, as it falls from 4.1m AOD at Borehole 14 to 3.2m in Borehole 2, adjacent to Margam Moors. Further, the upper surface of the clay aquitard has been found to have a broad shallow valley or trough running centrally through the site from south to north. Sufficient density of ground investigation data has allowed this feature to be identified and it explains the occurrence of contaminated groundwater emanating from MCL as a springline near SW3/SW2.

Ground investigation works in the southern part of the site has revealed that the clay layer is absent alongside the River Kenfig. The precise line along which it terminates is not known, though this line is considered to lie between Boreholes 14 and 10 and 9 and 16 (see Figures 4 and Figure 5). It is considered most likely that the River Kenfig, in its meandering past has eroded the clay layer, resulting in the sequence of strata seen in Boreholes 16, 15 and 10, where wind-blown sand directly overlies estuarine alluvium.

Throughout the area, the clay layer overlies an estuarine alluvium sequence, comprising principally dirty sands with shell fragments. Locally, finer lenses are seen and on occasions the upper surface of the estuarine fines layer supports a thin organic layer. In the extreme north of the site the estuarine fines dominate the sequence, with the upper 10m of the stratum comprising sandy silt and clays. Locally, within the estuarine deposits, gravels and even cobbles are noted occurring in bands, with one of these traceable between Boreholes 14 and 15.

The estuarine sands overlie glacial gravels at depth, which have been encountered in nearby deep boreholes. None of the investigation boreholes drilled at the site have continued sufficiently deep to intersect these strata. The glacial gravels, which also crop out beneath the seaward edge of the coastal barrier dunes extend inland for some distance. Coal Measures Bedrock underlies the glacial gravels at a depth of approximately 26m at the nearby Newlands Colliery.

2.3 Meteorology

In recent years the on-site weather stations have not been fully functional but in 2020 a new weather station was installed at the landfill offices.

2.4 Hydrogeology

Ground investigation boreholes and trial pits excavated around the site have been used to obtain basic groundwater data, including groundwater levels and strata permeabilities. During the investigation works it was apparent that the site is underlain by two water bodies. The first has been encountered throughout the site at shallow depth and lies within the wind-blown sand. This shallow water body sits above the alluvial clay sequence and drilling into the clay has been seen repeatedly to seal off water inflows from this "shallow aquifer".

When the clay layer is breached by drilling works and the underlying estuarine sand sequence is struck, groundwater rises in the drill casing to a different (and normally lower), height than the shallow aquifer. Continued drilling into the estuarine sand sequence maintains a uniform water level, indicating that there is no stratification within the "deep aquifer". The sequence of upper and lower aquifer observed in drilling works has been confirmed to be consistent across the site, except for a strip adjacent to the River Kenfig, where the clay layer separating the aquifer is absent. However, even in this area, shallow piezometers and boreholes reveal a head differential with the wells placed into the lower aquifer indicating stratification of the water body here too.

2.4.1 Shallow Aquifer

The shallow aquifer is the wind-blown sand deposit with vertical downward percolation eliminated or restricted by the presence of the underlying clay. Permeability tests have been undertaken (rising head tests) and these reveal a variation in permeability ranging from $2 \times 10^{-3} \text{ms}^{-1}$ to $5 \times 10^{-5} \text{ms}^{-1}$, with an average permeability of $2.3 \times 10^{-4} \text{ms}^{-1}$. Due to the sand deposits limited thickness the aquifer is thin, with perched water depths typically around 2 to 3 metres, extending from close to ground surface down to the underlying clay layer.

The position of each monitoring point has been established with a differential GPS instrument so that the spatial location of the data can be mapped. This has allowed groundwater surfaces to be constructed onto a base plan of the site.

An examination of the shallow groundwater surface shows that it is typically domed, with a concentric series of groundwater elevation contours centred on the highest elevation close to the centre of the site (see Figure 6). Groundwater flows in response to head loss and accordingly flow lines will be normal to the contours, radiating outward from the central dome. This radial flow pattern is considered to be a response to groundwater recharge in the shallow aquifer, which has very limited extent, following almost exactly the footprint of the site. Clearly, shallow groundwater flow from beneath the Morfa site would be expected toward Margam Moors, Margam Beach, the River Kenfig and the railway sidings.

In Section 2.2, the dune sand was noted to have limited extent, petering out along the site's boundary with Margam Moors. The moorland, which lies directly on the clay layer, is continuous with the clay underlying the dune sand and therefore the presence of a spring-line where the groundwater surface meets the edge of the sand deposit is not unexpected. A significant spring-line 40m from the northeast edge of the boundary along Margam Moors can be seen on the ground and this strip of wet ground supports a fen habitat which has been protected by SSSI status.

To the west of the site, the shallow aquifer discharges into Margam Beach in the inter-tidal zone. It is difficult to see the spring-line under conditions other than dry periods with spring tides but a linear seepage line at an elevation of 2.5m is present.

The shallow aquifer may or may not have localised areas where it is in continuity with the underlying deep aquifer. At every point where an investigation borehole has been drilled sufficiently deep, the presence of the underlying clay layer has been confirmed. It is likely, therefore, that the clay aquitard is either complete or near complete.

Ground investigation data has revealed that the ground alongside the Kenfig and along the southern part of the existing site comprises wind-blown sand over estuarine sands. The clay layer, characteristic of a large part of the existing site and the entire PPC permit boundary, is absent. This absence, most likely due to river erosion as described earlier, has prevented the clear separation between the upper and lower aquifers. However, there is a permeability contrast between the wind-blown sand aquifer and the underlying estuarine sands and this causes stratification within the groundwater. Greater heads in the shallow groundwater indicates that recharge from the shallow aquifer is active, explaining the difference in chemistry between shallow and deep groundwater along this edge.

Water quality in the shallow aquifer is variably impacted due to seepage from the unlined MCL. Shallow groundwater quality is poorest in the northeast (Margam Moors) downgradient flow zone of MCL where hazardous substances and elevated concentrations of non-hazardous pollutants have been historically found e.g. BH18–20 on Figure 4. When this shallow groundwater eventually discharges along the fringe with the Margam Moors as a springline (SW3 and SW2) it has had an observable ecological impact due to its alkaline mineralised load. Capping of MCL is intended to improve groundwater quality along this fringe line by recharging the system with clean surface water runoff. In topographically low areas secondary precipitates have accumulated where shallow groundwater interacts with the atmosphere. NRW has previously approved the covering of these areas to prevent direct access.

2.4.2 Deep Aquifer

Beneath the alluvial clay layer, the estuarine sands are saturated and piezometric levels are higher than the base of the clay. The water in the lower aquifer is therefore confined by the

clay layer. Using data from the monitoring boreholes it has been possible to produce a map of the piezometric surface in the area surrounding the site. The piezometric surface plan of the deep aquifer is included in Figure 7.

Rising head permeability tests have been undertaken in many of the boreholes and these reveal that the lower aquifer is of lower permeability than the upper aquifer, with permeabilities ranging from $5.2 \times 10^{-4} \text{ms}^{-1}$ to $1.5 \times 10^{-7} \text{ms}^{-1}$. This is consistent with descriptions of the lower aquifer stratum as being silty sand.

Locally, thicker deposits of estuarine fines are found interbedded with the sands, with one principal fines stratum shown on the geological sections. At the northern edge of MHL, Boreholes 26 and 27 intersected a sequence dominated by silts and clays, with sand occurring as a minor constituent. Permeabilities here are expected to be accordingly smaller.

Typical deep groundwater piezometric levels are indicated on Figure 7 and the plan shows a pattern of decreasing head towards the north and west. There is no element of a radial pattern to the contours as seen in the overlying shallow groundwater, but rather a uniform loss of head from the east towards the west. Recharge to the deep aquifer takes place at some distance to the east of the site, where the sand and gravel deposits form undulating farmland in the Cornelly/Pyle/Margam district. Groundwater migrating seaward from this higher ground passes beneath the industrial areas (where it has been utilised for water resources), beneath the railway and then beneath the site.

An examination of Figure 7 shows that the deep groundwater surface is at the same level as the River Kenfig at the southern boundary of the site, strongly indicating a degree of interaction with the surface water. In this area drilling has also revealed that the clay aquitard is absent, with the wind-blown sand aquifer directly overlying the estuarine sequence.

The chemistry of the deep aquifer is generally far less contaminated with slag source pollutants than the upper aquifer. Most monitoring results show lower pH, lower alkalinity and lower calcium levels. Generally, water quality in the lower aquifer is like or better than the overlying shallow aquifer. However, the lower aquifer is contaminated with other pollutants, with ammoniacal nitrogen and nitrate in greater concentration than the shallow aquifer. The chemical profiles are evidence of pollution from various sources, MCL is the source of pollutants for the shallow aquifer, whilst industrial and farmland to the east is the source for the deep aquifer. Where water quality of the upper aquifer is good (i.e. little contamination with Ca, pH and alkalinity) the lower aquifer beneath is also low in these pollutants. Where the upper aquifer can be seen to be affected, the lower aquifer remains less so. This supports the observation that the clay aquitard provides effective separation of the two water bodies over much of the site.

2.5 Hydrology

The site is surrounded by a sand dune field and there are no surface water courses within the site, or at its immediate perimeter. Surface water features near the site comprise the River Kenfig to the south, the Margam Moors ditch system to the north and the Bristol Channel to the west. A small number of isolated ponds are found on the low-lying area to the north of MCL in an area that will be developed as part of MNHL.

The flat lying moors have been managed for centuries for agricultural production by draining the clay soils using a deep network of ditches. The configuration of ditches has been

developed to address local ground conditions. The ditches are at their densest along the southern and western edge of the moors where there is a need to drain surface water originating from the pronounced springline. All the ditches feed into the Mother Ditch which flows northward to a single gauged collection point. From here the entire flow of water is abstracted into the works for use as process water. The pumping is carried out after the water discharges over a weir and therefore pumping cannot affect water levels in the ditches.

The River Kenfig drains a small catchment to the east of the site to the sea at Margam Beach. This is the principal watercourse in the area and separates the site from Kenfig National Nature Reserve which is bound by the southern bank of the Kenfig. The river has a 95-percentile low flow of 950 litres/sec. The river is monitored routinely by Natural Resources Wales. Based on 36 measurements made in 2007, the upstream and downstream river stretches were chemically classified by the Agency as Grade B, with low levels of phosphorous but moderately elevated nitrates. The biology of the river stretches is classified as Grade E. The chemical and biological scale used by the Agency runs from A to F (very good to bad). The lack of deterioration in the quality of the River Kenfig demonstrated by the Agency is backed up by the routine monitoring of the River Kenfig undertaken by Tata Steel.

2.6 Conceptual Hydrogeological Models

As the intrusive investigation programme has evolved and further monitoring data gathered, Geotechnology has developed and refined a conceptual hydrogeological model of the site that summarises the current level of understanding of the geology beneath the site and groundwater flow. The flow of water through the ground is a direct result of the geometry of the strata beneath and around the site and the physical properties of each stratum.

Due to the shallow trough in the clay aquitard between MCL and MHL, two conceptual models have been developed. One describes the shallow aquifer on the southern side of the trough around MCL and MNHL and one for the northern side of the trough around MHL. In both models the deep groundwater generally moves to the north and west, being recharged off-site in the surrounding industrial and agricultural areas.

In both conceptual models there is a degree of radial flow within the shallow aquifer. In the northern conceptual model, shallow groundwater moves towards Margam Moors and Margam beach. In the southern conceptual model, the radial component results in most flow in the shallow aquifer moving toward the Margam Moors with a small contribution flowing towards the Kenfig, although the hydraulic gradient in this area is shallow and subject to sporadic reversal.

Flow to both the Moors and Kenfig is contaminated due to the leaching of wastes from MCL and other areas where historical deposits remain. As the dominant flow path is towards the Margam Moors this results in a concentration of pollution along the springline where the shallow aquifer discharges. This area is typically characterised by alkaline groundwater and precipitates can be found in topographically low areas. Leaching and dispersion of precipitates from this area is also impacting on surface water in Margam Moors.

Along the fringe with the River Kenfig, groundwater is found to be mineralised near MCL. However, the River Kenfig shows no evidence of any impact related to MCL. This is primarily considered to be due to the flat gradients along this fringe limiting advective transport from

MCL to the Kenfig and dilution within the Kenfig. Waterlevels in the River Kenfig are higher than those in Margam Moors.

The monitoring conducted to date shows that there is no impact related to either MHL or MNHL. Shallow groundwater is currently polluted due to leaching of wastes deposited at MCL, whilst deep groundwater is polluted due largely to off-site recharge with a small contribution from MCL.

3 MONITORING AND ANALYSIS

The full monitoring network available to Tata Steel for all the landfills is shown in Figure 4. The specific monitoring points referenced in the MNHL Permit are shown on Figure 8.

3.1 Management

All aspects of the analytical and monitoring programme are directly managed by Tata Steel Environment Department.

Under the direction of the Environment Department, the landfill operator (Darlow Lloyd and Sons Ltd) has appointed Geotechnology to undertake several aspects of the sampling. These include surface water, groundwater and leachate samples for laboratory analysis, measurement of groundwater and surface water levels and the on-site monitoring of landfill and ground gas. An annual topographic survey is also undertaken to enable assessment of waste settlement and slope stability.

All analysis is undertaken at the Tata Steel Harbourside laboratory facilities under the direction of Tata Steel.

The landfill operator undertakes the routine leachate level monitoring required by the Permit.

Tata Environmental Department undertakes all other aspects.

3.2 Sample Analysis

Analytical data is reported directly to Tata Steel. Several weeks sometimes passes between the time of sampling and data reporting. This data is subsequently reported each quarter to NRW and then compiled at the end of each year as part of this annual review. During the compilation of the annual report several errors have been noted with the data reported by the laboratory. This has resulted in the lab reports being re-issued. This has not affected the parameters that have either control or trigger levels.

During the last quarter of 2022 there is understood to have been an unfortunate loss of samples whilst being transported from the Tata Steel facilities at Harbourside, Port Talbot to sub-contracted ALS facilities in Coventry. As a result of the loss of samples, several samples have not been tested for Arsenic, Boron, Cadmium, Molybdenum, Selenium and Vanadium. Where there was sufficient water, the samples were collected but, unfortunately, it appears the samples were mis-placed by a reputable courier familiar with transporting environmental samples. This is evidently outside the control of Tata and thankfully a rare incident.

As part of QA / QC checks, duplicates samples were collected during the monitoring undertaken in Q2 2022. One was taken from a borehole (BH20S) and one from surface after (P1). Comparison of the analytical results using the Relative Percentage difference (RPD) in Table 3-1 indicates that the value for RPD is <20% for most parameters despite the low levels of some parameters. The main differences are associated with several major ions/ bulk parameters and selenium. This suggests that sampling techniques are producing representative repeat samples but the high pH of the groundwater samples may mean that there is some sample variation / instability. Some of the variations observed in the surface water sampling are surprising given that both samples will have been collected from the same body of water at the same time using the same techniques. Importantly, the key trace

elements of concern have low RPD values which provides confidence in the monitoring programme. This aspect will be further reviewed during 2023 alongside the laboratory.

Table 3-1 Duplicate Relative Percentage Difference

		Original	Duplicate		Duplicate	Original	
		BH20S	BH 201S	RPD	P11	Pond 1	RPD
pH		11.5	11	4.4%	9.1	8.7	4.5%
EC	µS/cm	747	749	-0.3%	531	509	4.2%
Alkalinity	mg/l	106	156	-38.2%	220	230	-4.4%
NH3-N	mg/l	3.32	3.13	5.9%	<0.01	<0.01	
Fluoride	mg/l	<0.03	<0.03		0.27	0.25	7.7%
Chloride	mg/l	125	161	-25.2%	54.2	50.7	6.7%
Nitrate	mg/l	1.16	1.07	8.1%	1.22	<0.03	190.4%
Nitrite	mg/l	<0.03	<0.03		<0.03	<0.03	
Phosphate	mg/l	<0.03	<0.03		<0.03	<0.03	
As	µg/l	44.4	45.2	-1.8%	<0.75	<0.75	
B	µg/l	71.6	62.3	13.9%	14.9	15.3	-2.6%
Ca	mg/l	21.1	22.9	-8.2%	66.1	98.4	-39.3%
Cd	µg/l	<0.75	<0.75		<0.75	<0.75	
Cu	µg/l	<1.00	<1.00		<1.00	<1.00	
K	mg/l	94.9	89.9	5.4%	1.8	1.8	0.0%
Mo	µg/l	<1.50	<1.50		<1.50	<1.50	
Na	mg/l	25.5	59.6	-80.1%	Check	23.1	
Se	mg/l	<1.50	<1.50		3.7	19.9	-137.3%
V	µg/l	1.4	1.6	-13.3%	<0.75	<0.75	

3.3 Integrity of Monitoring Infrastructure

Each time samples are collected by Geotechnology, the monitoring infrastructure is inspected. The landfill operator also inspects parts of the monitoring infrastructure during more routine site checks.



Plate 3-1 Head height vegetation growth along access route to Margam Moors from MNHL

As shown by the grass height in Plate 3-1, routine vegetation clearance during the growing season is critical to ensuring that all monitoring points remain safely accessible.

3.3.1 Landfill Leachate Monitoring Infrastructure

The landfill leachate infrastructure is performing well. Dedicated pumps were provided for the purging and sampling of each sump to prevent cross contamination, but samples are now retrieved using a sampling container connected to a length of rope from the sumps that are actively pumped.

3.3.2 Groundwater Monitoring Infrastructure

The integrity of the groundwater monitoring network is inspected monthly. The monitoring infrastructure continues to perform well although vandalism is sometimes a problem. Routine maintenance and repairs are rapidly undertaken by the contractor commissioned by Tata Steel to manage the landfill. Routine clearance of vegetation is required to ensure safe and full access to the whole monitoring network. As some of the vegetation that requires clearance is in the SSSI, Tata Steel should ensure that all necessary agreements are in place with NRW.

During 2021, BH17 (and BH28 adjacent to MHL) were found to be blocked. Replacement wells were installed in February 2022.

Access to several monitoring positions in Margam Moors (particularly BH1, BH2 and several surface water monitoring positions) has recently changed as new farm gates and agricultural fencing have been erected.

3.3.3 Shallow Piezometer Monitoring Network

A series of shallow piezometers have been manually installed into the shallow aquifer along the boundary with Margam Moors, as shown on Figure 4.

Geotechnology understands that the lease arrangement for Margam Moors has recently changed and that there is a new farmer with livestock. During 2021 it was evident that some of the piezometers (P2-P4) were knocked over by the activities of the farmer/livestock and therefore Geotechnology suggests protecting all monitoring points, including those in the Moors. This could simply involve placing used tyres around each point.

During 2022, a new piezometers was installed at P2.

3.3.4 Surface Water Monitoring Network

The integrity, access and safety of each of the surface monitoring locations are inspected monthly. Installation of hand/rope rails would aid in the safe recovery of surface water samples as would routine vegetation clearance. Dense vegetation sometimes prevents routine safe access.

Part way through 2022, Gauge 1 in the Moors was found to be missing. Given the timing of the disappearance, it would appear that it was inadvertently removed during the ditch clearance works. In response, a new gauge has been installed.

3.3.5 External Gas Monitoring Infrastructure

The integrity of the external gas monitoring wells is inspected monthly. Some of the well heads would benefit from being raised due to seasonal flooding, although as the gas wells contain groundwater, their use as gas wells is compromised.

During the recent installation of a new section of recharge trench, perimeter gas well positions GA7 and GA16 were removed. Each position is scheduled to be re-installed once the localised flooding has receded.

3.3.6 Internal Gas Monitoring Infrastructure

According to the Permit, there is no requirement to monitor the internal gas wells that are free to vent to atmosphere. Rather, Tata Steel is now required to undertake a survey of surface missions from the portion of Biocell A and B that is now permanently capped. The technique used needs to be agreed with NRW.

In this context, Geotechnology suggests undertaking a detailed walkover and methane inspection using a tuneable diode laser that is specific to methane. Such instruments can be hand-held and fitted with GPS so that the methane results can be plotted as a contour map across the landfill surface. This approach should be agreed with NRW.

3.4 Meteorology

DLS maintains a weather station at the site compound.

3.5 Actions required

Based on recent observations of the available monitoring network, the following items require addressing to ensure that the series of high quality data continues to be collected:

- Vegetation near several sampling points requires routine clearance to enable continual safe access throughout the year
- Undertake survey of methane emissions at permanently capped landfill

4 SITE ACTIVITY

4.1 Waste Treatment Centre

Since 2007, Tata Steel has operated a waste treatment centre that comprises recycling, screening, sorting and bailing facilities, together with areas for the storage of processed and unprocessed materials prior to recovery. The facility mostly treats general wastes comprising plastics, paper, timber, glass, brick and concrete. Consequently, these wastes are largely diverted from landfill. This facility is located to the northwest of the active landfill cells of MNHL, as shown on Figure 4.

4.2 Construction of MNHL

Since issue of the Permit, four cells have been constructed; two biodegradable cells used for the deposition of wastes with a gassing potential and two cells for the deposition of non-hazardous waste without a significant gassing potential. A current topographic plan of the cells, as required by Permit condition 3.5.3 is provided in Figure 9. This is based on a topographic survey completed on 19 January 2023. Table 4-1 provides a summary of the cells constructed to date.

Table 4-1 Landfill Cell Details

Cell Name	Leachate Sump	Waste Types
Cell 1	L7	Non-hazardous non-biodegradable
Cell 2	L8	
Biocell A	L1	Non-hazardous biodegradable
Biocell B	L6	

Each cell of MNHL is designed upon the containment principle. Pollutants are kept within the wastes by surrounding the wastes with barriers that are virtually impermeable to water, liquids and gases. The landfill is currently being constructed as a series of cells, each measuring some 200m x 115m. The Engineered Barrier System (EBS) of each cell comprises Bentonite Enhanced Sand (BES) overlain by a High-Density Polyethylene (HDPE) liner. Above the EBS is a leachate collection system. A cross-section of the key landfill engineering systems is provided in Figure 10.

Despite diminishing waste inputs (as shown in Chart 4-1), the original biodegradable waste cells (A and B) are full and during 2022 were permanently capped. To address the future shortage of biodegradable waste capacity, waste was recovered from Cell 1 to create a new biodegradable Cell C. This configuration is shown in Figure 11.

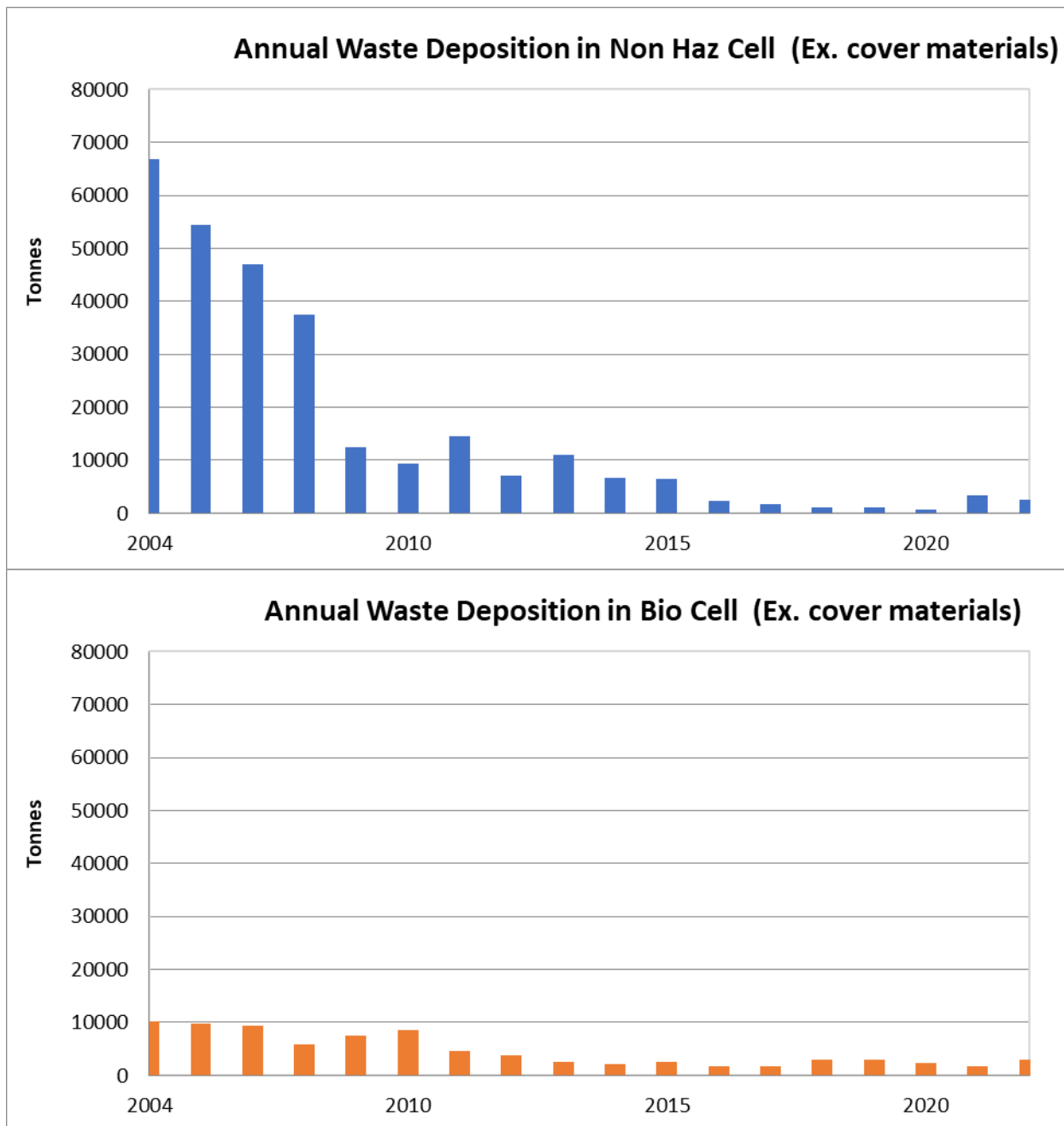


Chart 4-1 Tonnes of waste deposited each month at MNHL

The existing Biocell was separated from non-hazardous Cell 1 by a deep narrow valley where the opposing south flank of Cell 1 met the north flank of the Biocell, as shown in Plate 4-1. The approved restoration contours for the landfill require that this valley is infilled to produce a single elevated landform. To secure additional biodegradable void space, NRW approved a cut into the upper part of the southern flank of Cell 1 and extension of the biodegradable waste cell lining system into the void to provide sufficient biodegradable waste capacity to 2028. The new biocell extension is referred to as Cell C at this stage.



Plate 4-1 View north towards Non-Hazardous Cell 1, valley feature and Biocell

4.3 Sand Extraction

Restoration of MCL was completed in 2013. Following completion, there was no immediate demand for sand. However, since this time parts of the restored cap of MCL have been subject to wind erosion as the self-seeding vegetation is yet to take hold. Therefore, approximately 5000 tonnes has been excavated from Borrow Pit 1, as part of aftercare maintenance. Further extraction is envisaged as set out in the ROMP phasing plans (see Geotechnology report 1914r1v1d0819).

Tata Steel has also been trialling new techniques for reducing wind-blow with the ecologist who prepared the Ecological Monitoring Plan.

4.4 Landfilling at MNHL

4.4.1 Waste from Steelworks

A summary of the waste types and tonnages deposited at the landfill as recorded by the landfill operator is regularly submitted to NRW in accordance with the Permit requirements. A full graphical record of waste deposition is presented in Appendix 9 and a summary in Chart 4-1. The mass of waste being landfilled is declining significantly.

During 2006, part of the filter cake from the unlined Storage Bays located on MCL started to be deposited within Cell 1 of MNHL. Any leachate contained within or produced by this material would report to landfill sump L7. Leachate from similar material that has been

historically landfilled in the upgradient unlined MCL is already impacting groundwater upgradient and down gradient of MNHL.

Since October 2008, hot mill sludge (HMS) filter cake generated by the steelworks has been landfilled in Biocell B. This process has subsequently continued at a rate of approximately 500-700 tonnes/month. In accordance with Improvement Condition 1 of the Variation Notice this prompted the monthly monitoring of Benzo(a)pyrene (BaP) on samples collected from sump L6. In September 2010, this data was reviewed by Geotechnology to establish whether BaP control levels were required (see report 993r1v1d0910). As the data showed that BaP was not detected in the leachate, control levels were not considered to provide additional environmental protection. Benzo(a)pyrene has continued to be present in leachate below the analytical detection limit.

4.4.2 Third Party Waste Storage

The Tata Steel landfills are only permitted to accept wastes generated by the company. However, in 2011, during an exceptional fire at an industrial unit in Fforestfach, Swansea Tata Steel was approached to assist. The unit contained an estimated 5000t of tyre fluff from the treatment of shredded tyres. During the days immediately following the fire, the Fire Rescue Service (FRS) discovered that the fire could not be readily extinguished using conventional firefighting techniques. A crust was forming on the surface of the material, limiting the effectiveness of the cooling water so the mass kept burning. Using expertise from elsewhere in the country a means of extinguishing the burning waste was developed: a quenching technique that involved mechanically placing excavated masses of the burning material into large water filled skips. This proved to be the only means of extinguishing the fire.

After quenching large volumes, the extinguished material required immediate removal as there was no space at the fire site. Following a request by the multi-agency task force coordinating the response to the incident, Tata Steel agreed to the use of Cell 2 of MNHL for the temporary storage of the waste. On 25 June Tata Steel started to accept waste into Cell 2 of MNHL. This process continued until 20 July 2011. This waste was moved from Cell 2 of MNHL into Cell 2 MHL in March 2014. This work was inspected by NRW at the time and a Construction Quality Assurance (CQA) report produced by Geotechnology following the works (see Geotechnology report 1327r1v1d0314).

4.5 Construction of Morfa Hazardous Landfill

Two cells have been constructed at MHL. Cell 2 was completed in August 2012. This new cell received the fire waste from Cell 2 of MNHL in March 2014. The rate of landfilling at the hazardous landfill has also reduced in recent years, as shown in Chart 4-2. The reader should note that the y-axis units used in Charts 4-1 and 4-2 are identical to enable direct visual comparison of the tonnages landfilled.

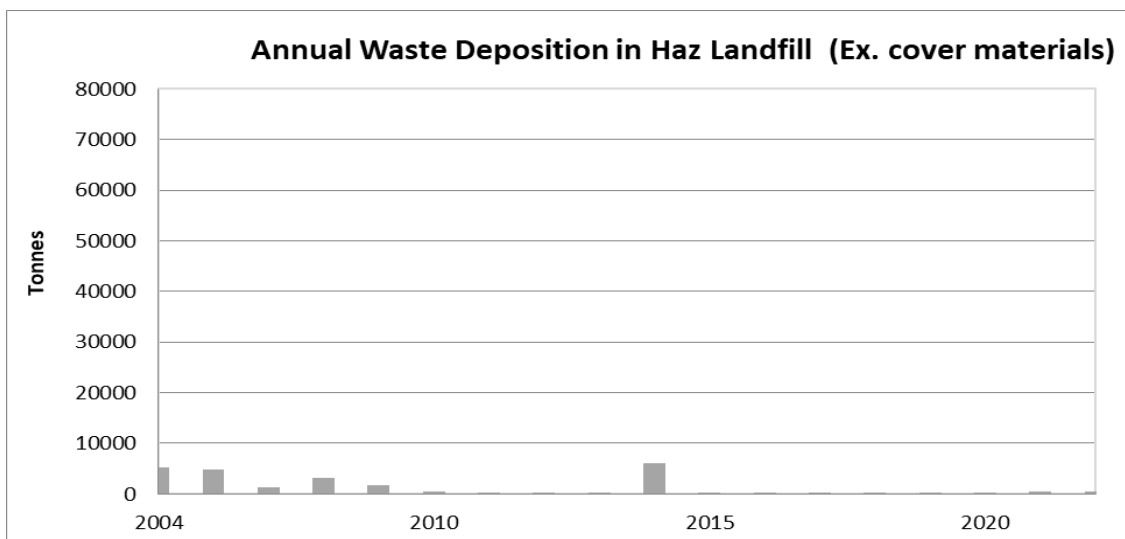


Chart 4-2 Landfilling at Hazardous Landfill

4.6 Progressive Restoration

Progressive restoration of each cell should occur once it has been filled. This will limit leachate generation and enable better environmental control.

At this stage, Bio-cells A and B have been permanently capped. The new Biocell C covers Cell 1 and so this is also effectively capped with a lined operational cell.

Once restoration does take place the final landform will ultimately be similar to that described for the restored adjacent closed landfill.

4.7 Leachate Management

Leachate levels are regularly monitored in the sumps with the data summarised as a series of time series graphs in Appendix 2.

Until 2019, leachate was collected from the sump by vacuum pumps and tankered away from the landfill using 10m³ or 15m³ road-going tankers. These tankers took the leachate to the Tata Steel wastewater treatment facility at the steel works. This system has now been replaced by a fixed pumped system, discharging directly into the works via a holding/balancing tank facility. A plan of the as-built system is reproduced in Figure 12.

The new system involves pumping leachate from all cells at MNHL and MHL (currently five cells). There are currently three individual leachate pipe runs, one for the two MNHL Biocell sumps, one for the two Non-Hazardous cell sumps and one for the MHL cell sump. Pumping at each cell is float controlled to ensure that leachate heads are within permitted trigger and maximum limits.

The three individual pipe runs discharge initially into a holding/balancing tank located on the permitted Waste Transfer Station hardstanding (concreted) area near to the DLS offices. The balance tank is also float controlled and combines all leachates for further pumping into the end discharge sump within the main works, located at Morfa Coke Ovens, Gas Holder Deep Sump. Flowmeters are located at each sump location, and at the balance tank, to

record individual and cumulative leachate outflows. The use of flowmeters will provide a check on the potential for leakage from any of the three pipes entering the balance tank.

Since the new system has become fully operational in early 2020, leachate levels have been reduced as the quantity of leachate removed from each cell has increased. This data is summarised in Appendix 2 and shows that leachate levels have been compliant with the Permit requirement of <1m depth at the leachate sump in recent months. Controlling leachate levels in this way reduces the risk to the environment as it reduces the hydraulic pressure gradients within each cell. During 2021 and 2022 90,196m³ and 233,985m³ of leachate respectively was removed. The quantity removed from each Non-Hazardous sump is summarised in Table 4-2.

Table 4-2 Leachate removed from MNHL sumps

	Bio-cell A	Bio-cell B	Cell 1	Cell 2
Year	Sump L1	Sump L6	Sump L7	Sump L8
2022	8775	7624	6806	10780

4.8 Restoration of Morfa Closed Landfill (MCL)

Phased restoration of unlined MCL was undertaken between 2004 and 2013. The restoration involved the placement of site won dune sand over the plateau and parts of the re-profiled slopes. Below the sand, the restoration scheme involved placement of geomembranes which, in combination, provide gas and surface water management as well as providing barriers to precipitation ingress and gas egress. The sympathetic restoration also involves the placement of sand on top of the geomembranes, creating dune morphology like the surrounding land. The restoration landscape is shown in Plate 4-3.



Plate 4-2 Typical restoration profile on surface of MCL

During 2012 and 2013, restoration included the short-term recovery of materials to be used in the steel making process as the topography was re-profiled. During this phase, waste which had remained undisturbed for several decades was exposed. Such wastes will therefore have been temporarily susceptible to weathering and leaching prior to being capped. Seepage infiltrating to groundwater in these areas would be expected to pass beneath and around MNHL as MCL is hydraulically upgradient of MNHL.

4.8.1 Recharge Trench

The sand restoration layer that has been placed on MCL will permit infiltration to the underlying drainage composite, where it will be directed to percolate toward collector ponds. Overflow pipes from the ponds then transport the water into stilling chambers before flowing out into a series of ditches excavated into the natural sand along the boundary with Margam moors. Currently, part of the recharge trench system adjacent to MCL is complete with most of captured rainfall now being directed under gravity towards the boundary with Margam Moors near BH17, towards the River Kenfig near to BH15 and to the south near BH10.

The accumulation of secondary precipitation in localised areas along the boundary of the site with Margam Moors is well documented. These have formed due to near surface interactions between shallow groundwater that is impacted by leachate from the unlined MCL and the atmosphere. Precipitates and poor-quality groundwater are present throughout this area but become visible in topographically low areas, where groundwater may be sometimes exposed. Wider dispersion and leaching of these previously accumulated precipitates and groundwater has been previously observed in response to changes in shallow groundwater levels. NRW has approved the covering of these areas with site won sand to limit direct access.



**Plate 4-3 Accumulation of secondary precipitates adjacent to MCL
(between BH17 and P12)**

During 2020, a review of the current recharge trench system was completed. This concluded that the system was largely continuing to protect groundwater levels despite several elements not being fully functional. In this context, the recharge trench was re-designed so that the trench system could operate more passively than originally envisaged whilst still being acceptable to NRW and sustaining water levels in the Margam Moors. These design modifications were accepted by NRW and the works largely completed in 2022.

The recharge trench system will ultimately comprise a series of 6 trenches that are to be constructed progressively from south to north. The trenches are referenced A through to F. To date, trenches A-C have been constructed.

In the new passive configuration, the system works in the same way as a toilet cistern Ballcock Valve – when water levels drop, the float also drops, allowing the arm to open a valve, allowing piped water to flow into the chamber from the ponds on the surface of the landfill. Conversely, when sufficient water is in the chamber, the float lifts the arm, shutting off further inflows.

As the system is now passive, there is now less precise control over the water levels in the chamber and the duration of water demand i.e. it is likely that water will be directed into the chambers for longer periods under the passive system as the float switch is less sensitive than the originally designed electrical control system.

At times when there is no demand for water at the recharge chamber but the ponds on the surface of the closed landfill are filling due to rainfall and cap run-off, excess water will initially be discharged directly into the Margam Moors via a large diameter pipe from a Header Tank. If waterlevels in the ponds continue to rise further there is also a series of high level large emergency overflow diameter pipes that were installed as part of the original design. These discharge water to the toe of the landfill.

The system in its current configuration only became operational in November 2022 following a protracted period of dry weather and then a period of very heavy intense rainfall. Prior to this time, all of the pipework was in place but there were no controls.

4.9 Summary of Landfilling and Restoration Activity

The timeline of landfill construction and operation is summarised in Table 4-3.

Table 4-3 Summary of site activity to date

Activity	Start	Finish
Construction of MNHL Cell 1	1 June 2004	19 October 2004
Construction of MHL Cell 1	1 June 2004	19 October 2004
Restoration of MCL	September 2004	8 June 2013
Construction of MNHL Biocell A	14 June 2004	8 September 2004
Construction and operation of waste treatment centre	5 December 2006	Ongoing
Construction of MNHL Biocell B	August 2007	13 October 2007
Construction of MNHL Cell 2	6 May 2008	31 July 2009
Landfilling of HMS filter cake in MNHL Biocell 2	28 October 2008	Ongoing
Construction of MHL Cell 2	October 2011	Ongoing
Temporary storage of fire waste	25 June 2011	14 March 2014
Construction of recharge trench pipeline sections A & B	30 Aug 2012	12 Oct 2012
Connection of recharge trenches to ponds and commissioning of system	Ongoing	(Partly completed during 2016 but damaged due to vandalism)
Installation and operation of new leachate pumping system	2018	October 2019
Construction of Biocell Extension Ci	April 2020	Estimated March 2022
Capping of Biocells	December 2021	Estimated March 2022
Re-engineering of recharge trench system with passive control system	April 2022	November 2022

5 TOPOGRAPHIC SURVEY, SETTLEMENT AND VOID SPACE

5.1 Topographic Survey

A topographic survey of the operational landfill cells was carried out on 14 January 2022 and a repeat survey on 19 January 2023. Following data acquisition, the digital data was imported into a digital terrain model for each of the cells to calculate the available void space.

Since 2013 the surveys have been completed using an unmanned aerial vehicle (UAV) with survey control established using dGPS land-based Hiper-SR survey equipment. The UAV data is then used together with ground control points to create a digital terrain model. This method of surveying collects data points at significantly closer intervals than methods previously used and is therefore able to create a more detailed topographic model, as shown in Figure 9.

5.2 Remaining Void Space

Based on a comparison of the topographic levels observed at the start of 2022 with those in January 2023, an updated assessment of void space available in each active cell has been made. This is summarized in Table 5-1. A contour plan of the topographic surface generated by the drone survey is included in Figure 9.

Between 2020 and 2022, work has been undertaken to extend the Biodegradable Cell. This work has involved excavating material from the southeastern face of Non-Hazardous Cell 1 to generate additional Biodegradable Cell capacity. The extension was undertaken in 2 phases. The first phase was complete prior to the 2020 survey, with the remainder completed early in 2022. Both phases of the new sub-cell (Cell C) are now active.

As the Biocell extension now overlaps a substantial section of Non-Hazardous Cell 1, this cell is now considered to be full and partially capped and is therefore not included in the volumetric assessment. Furthermore, during 2022 Biocells A & B have been capped and restored. These cells have also been removed from the volumetric assessment. While individual volumes are not reported for these cells on Table 5-1, the waste volume has been accounted for in the landfill totals reported in Table 5-1. The void space available in each cell is reported in Table 5-1.

Table 5-1 Individual Cell Volume Totals

Volumes (m ³)	Biodegradable Cell C	Non-Hazardous Cell 2
Total	70115.00	208340.25
Used	16144.65	85220.94
Available 2023	53970.35	123119.31
% Available Space	76.97	59.10

The total volume remaining for the whole of the Non-Hazardous Landfill is summarised in Table 5-2.

Table 5-2 Remaining Volume Estimate

Void Space (m ³)	Non-Hazardous
Total	2777086
Used	439461.95
Available	2337624.05
% Available Space	84.18

To aid in understanding where remaining capacity is located, an isopachyte generated by subtracting the existing topographic model from the approved top of waste surface is provided in Figure 13.

5.3 Settlement

As part of the annual review, an assessment of the settlement behaviour of the landfill body is required by NRW. However, as most of the landfill cells are still undergoing regular material movements, it is not possible to make a meaningful assessment of settlement at this stage.

Now that the capping of Biocells A & B is complete, a series of permanent settlement markers will need to be installed for the purposes of monitoring on an annual basis. This methodology is the same as that followed at MCL.

5.4 Waste Slopes

The stability risk assessment (Geotechnology Report 244.1, August 2003) for the Non-Hazardous landfill allows for Temporary waste slopes at the working face to have a gradient of 1V:1.75H. The report states that permanent slopes should have a gradient no greater than 1V:2.5H.

A slope gradient map for the Non-Hazardous Landfill is included as Figure 14.

5.4.1 Bio-cell

Both the internal and external slopes of Biocell C exceed permissible permanent and temporary slope gradients. This is largely due to the placement of waste which has been compacted into bales which is inherently more stable than loose waste. The vertical sided bales are placed in a

stack which will stand at an angle much steeper than the loose waste accounted for in the original SRA, though these bales should not form the external face of any permanent slopes.

The internal western slope of the Biocell also shows areas in excess of 1:1.75. Again, this is due to the placement of stacked bales, creating a stepped side slope profile. Care should be taken to ensure that the overall profile of the slope should not exceed 1:1.75 as it currently does in some localised areas.

5.4.2 Non-Hazardous Cell 1

The external slopes of Non-Hazardous Cell 1 are generally shallower than a 1:2 gradient, though it does appear that some reprofiling will be required to achieve a 1:2.5 gradient prior to capping. The exceptions to this are the short slopes either side of the southern access track, where slope gradients are in excess of 1:1.75. These slopes should be reprofiled to ensure both short and long-term stability.

The western slope of the cell also has areas where slope gradient locally exceeds 1:1.75. However, when the overall slope gradient is considered, it is found to range between 1:1.75 and 1:2. This entire face will eventually be buried by wastes deposited in Non-Hazardous Cell 2.

5.4.3 Non-Hazardous Cell 2

This cell is currently hosting the screening and storage of aggregates associated with the construction and capping of adjacent cells. Most of the over-steepened slopes within the cell are accounted for by aggregate stockpiles which typically stand at friction angles in excess of 1:1.75. These deposits are temporary and not covered by the SRA.

There are some over-steep slopes in the waste deposits within the cell. These slopes are generally very short, with typical slope lengths <2m. However, effort should be made to reduce the angle of these working faces as additional waste is deposited against them.

6 LEACHATE

6.1 Leachate Level and Volumes

Based on the monitoring results provided by the landfill operator, the variation of leachate levels above the base of the sump is fully illustrated in Appendix 2 and summarised in Chart 6-1. The monitoring reveals that leachate levels exceeded 0.75m above the concrete slab in the winter periods of 2013, 2014 and 2015. Between 2016 and winter 2019, the leachate levels regularly breached the compliance 1.0m level which means that this aspect was not in accordance with the Permit requirements.

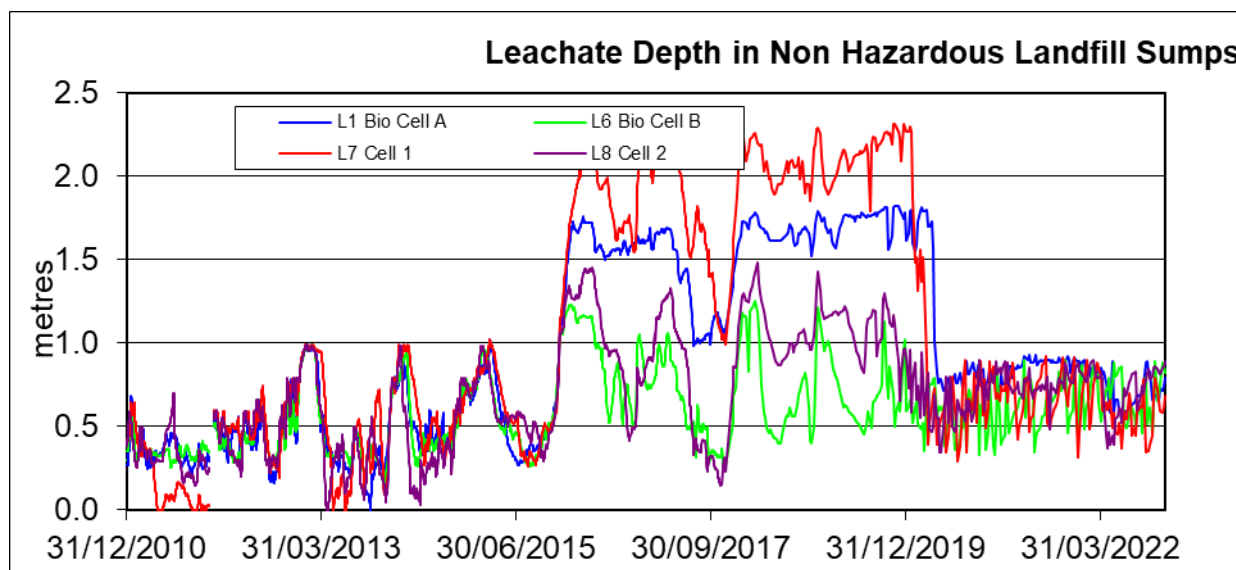


Chart 6-1 Leachate levels

Since 2019, the new leachate management system has had a dramatic influence on leachate levels with significant leachate level reductions in all cells. This step change is a direct consequence of the new system enabling the volume of leachate extracted to be significantly increased. This has enabled the landfill to be compliant with the 1.0m leachate level compliance limit set in the Permit.

6.2 Leachate Chemistry

Each landfill cell is monitored at a separate landfill sump. Leachate samples L1 and L6 are in the sumps in Biocells A and B and L7 and L8 in Cell 1 and Cell 2 respectively. In each cell the daily cover used to encapsulate the wastes typically comprises slag. Temporal variations of leachate chemistry are illustrated in Appendix 3.

6.2.1 Non-Volatile Species

Analysis of the leachate samples to date has revealed that it is typically dominated by a highly characteristic signature comprising elevated pH, calcium and alkalinity and low sulphate. This signature is strongest in the leachate in Cells 1 and 2 (sumps L7 and L8). The hydrochemistry of the leachate is illustrated in the graphs included in Appendix 2.

As noted previously, the leachate has continued to become more dilute with the electrical conductivity declining, most likely because of dilution due to high rainfall and previously persistent high leachate levels. The lower mineralisation is characterised by lower levels of ammonia, calcium, alkalinity and most notably chloride.

Against this declining trend, the short-term spike in Electrical Conductivity observed in several leachate sumps in September 2021 and August 2022 is unusual. As the electrical conductivity was also found to be uncharacteristically elevated in a wide number of samples at the same time in September 2021, including the rainwater fed ponds on MCL and groundwater upgradient of MNHL, it would appear that this particular data should be viewed with caution. Similarly, the spike in chloride in August 2022 at L6 also appears out of context with all previous and subsequent data.

Filter cake (EWC code 11 01 10) has been placed into Cells 1 and 2 (with leachate draining to sumps L7 and L8) at a rate of up to 500 - 800t/month since the start of monitoring. Produced by the lime neutralisation of acidic ferrous chloride and pickling solutions at the cold mill effluent treatment plant, the waste principally comprises iron oxyhydroxide chloride phases, calcium chloride, iron chloride and mixed oxides. Within the landfill, the soluble components of the waste are leached by infiltration. This process is suspected to be the main source of the elevated levels of chloride and calcium. As the waste becomes buried and less oxygenated, the oxyhydroxide iron phases may also start to undergo changes. Some may start to age and crystallise, forming more stable iron oxide phases and some may undergo reductive dissolution in anaerobic conditions that may be present in parts of the landfill. This latter process could potentially release iron into the leachate along with other trace metals adsorbed to the iron precipitates.



Plate 6-1 Cell 2 leachate sump L8. Note staining due to iron.

This latter process was previously considered to be occurring within Cell 2 at L8, as iron significantly increased in concentration from <1mg/l to over 1000 mg/l during the latter part of 2012 and was elevated on several occasions during 2013. At the same time, the leachate sampled at sump L8 was found to be green in colour and the laboratory measured pH variable over a relatively brief time i.e. dropping from over pH 11 to pH 4 and then returning to pH 11 within 12 weeks (see chart below). Similar patterns were observed during 2014, 2015 and 2016. Since 2019, these variations have been less pronounced.

Nitrogen and phosphorous species are not typically persistently detected within the leachate.

Hazardous substances such as mercury, lead and cadmium are rarely found and only at very low concentrations. Many non-hazardous pollutants are also either not detected above the analytical detection levels or present at very low levels, some of which are comparable to or below current Environmental Quality Standards (EQS). The mobility of most of these substances is being limited by the elevated pH, although substances capable of forming oxyanions, such as vanadium, are more frequently detected.

6.2.2 Volatile Species

Due to the nature of the waste streams very low levels of hydrocarbons, volatile organic compounds (VOCs) and semi VOCs have been detected to date. No substances have been detected in the recent years.

6.3 Evaluation against Control Levels and LandSim Criteria

One of the objectives of the HRA review undertaken every 6 years is to ensure that the computer simulations used as part of the design of the landfill do not become detached from the reality of landfill construction and operation. Therefore, in addition to evaluating the data against the assessment criteria set out in the Permit, Geotechnology also uses the preparation of the annual report as an opportunity to compare the actual leachate chemistry with that modelled as part of the most recent HRA. These were not modified as part of the 2022 HRA review as the assessment concluded that they are still protective of the controlled water environment. This position will be evaluated when the next HRA review is completed.

Table 6-1 provides a comparison of recent leachate chemistry with the leachate inventory used in the most recent HRA and the Permit Control Levels. This demonstrates that recent leachate chemistry is well within the Probability Density Functions (PDFs) used to describe the leachate inventory in the most recent HRA and is below the Permit control levels.

Table 6-1 Evaluation of Leachate Chemistry

	Ammonia mg/l	Arsenic mg/l	Chloride mg/l
LandSim PDF*	Triangular (0.05, 10, 50)	Triangular (0.005, 0.3, 3)	Log Triangular (1000, 10000, 61000)
Control Levels	70	3	70000
Leachate chemistry 2018			
Maximum 2018 Leachate chemistry (L1, L6, L7, L8)	2.15	0.004	2160
Leachate chemistry 2019			
Maximum 2019 Leachate chemistry (L1, L6, L7, L8)	1.19	1.09	3010
Leachate chemistry 2020			
Maximum 2020 Leachate chemistry (L1, L6, L7, L8)	6.08	0.005	14690
Leachate chemistry 2021			
Maximum 2021 Leachate chemistry (L1, L6, L7, L8)	5.53	3.04	15970
Leachate chemistry 2022			
Maximum 2022 Leachate chemistry (L1, L6, L7, L8)	4.7	0.057	9470

*PDF – Probability Density Function used to describe statistical distribution of parameter. Triangular and Log Triangular are the PDFs used in most recent HRA. Values in parenthesis are minimum, most likely and maximum values used in LandSim model

6.4 Contingency Actions Taken

No specific contingency actions have been required.

7 GROUNDWATER

7.1 Groundwater Level and Flow

Groundwater levels in the shallow and deep aquifers are presented in Appendix 4 and Plate 7-1. The patterns of groundwater flow encountered during 2022 are similar to those observed previously.

The impact of the record breaking hot and dry summer of 2022 can, however, be clearly seen influencing waterlevels with new low levels temporarily reached at several positions.

7.2 Groundwater Chemistry

7.2.1 Shallow Aquifer

The latest monitoring results are very similar to those observed previously with temporal variations illustrated in Appendix 5.

Upgradient of Landfill

The monitoring programme continues to confirm the continued but diminishing impact of leachate from the adjacent unlined but capped MCL on groundwater directly upgradient of MNHL.

Over the past few years, upgradient groundwater along the northern boundary of MCL has shown a sustained decrease in mineralisation, suggesting an overall change and improvement in water quality, most likely due to capping. This is most obvious at monitoring positions BH17S-BH20S which are directly upgradient of MNHL and downgradient of MCL. More recently, similar changes have also started to be observed to the south of MCL.

There have been sustained decreases in the concentration of several parameters including pH Electrical Conductivity, ammonia, chloride, calcium, alkalinity and Chemical Oxygen Demand (COD) in the shallow aquifer as shown by the time series charts in Appendix 5 and charts below. With time, the water quality is likely to become less alkaline as less slag-based waste is exposed. As the water quality changes, trace metals may potentially become slightly more mobile and this may explain some of the impersistent variations in trace metal concentrations.

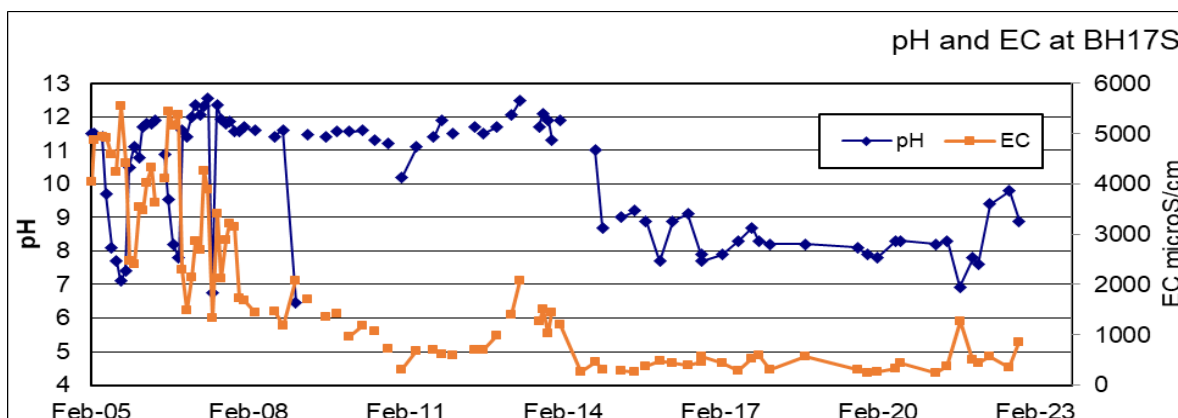


Chart 7-1 Temporal variation of water chemistry at BH17S

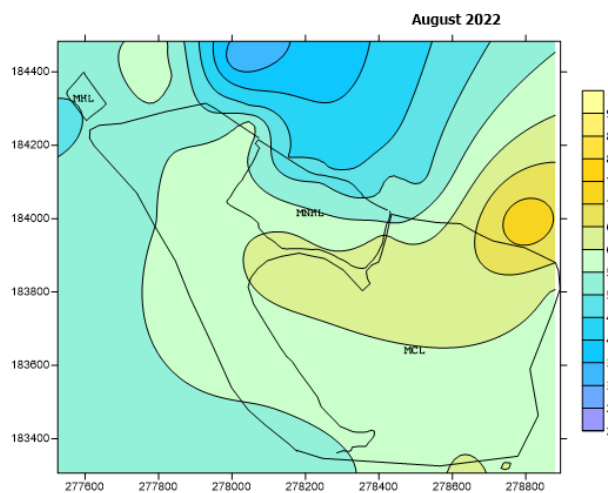
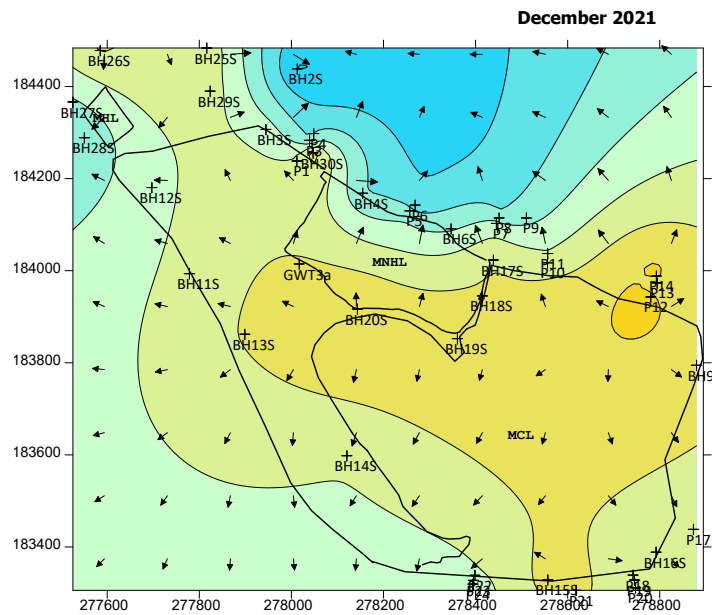
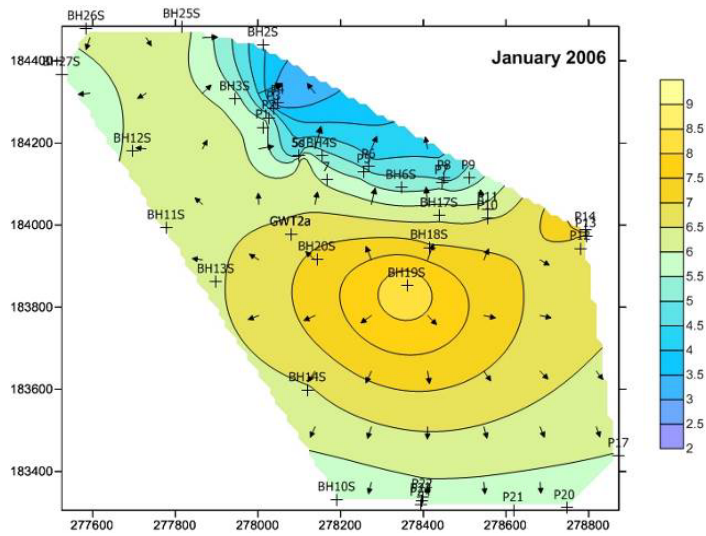


Plate 7-1 Shallow Groundwater Level Contours (mAOD)

Downgradient of Landfill

In the shallow aquifer downgradient of the active cells, samples of groundwater have for some time revealed relatively short-term increases in alkalinity. These are considered to be related to the leaching of alkaline components from MCL, other areas of unlined waste and variations in shallow groundwater levels. Short-term variations (spikes) in the concentration of ammonia, calcium and several trace metals may also be due to the same processes and such occurrences are not currently persistent. There is currently no evidence to suggest seepage from MNHL is the cause of these variations as chloride, a key indicator of MNHL leachate, is not sustainably increased.

In general, groundwater quality downgradient of MNHL, along the boundary with Margam Moors SSSI (as monitored at BH3, BH30, BH4 and BH6) is similar to the upgradient chemistry observed at GWT3A and BH17S – BH20S. At BH30 and BH4, the groundwater is less mineralised than groundwater to the west at BH3 and to the east at BH6. This may be indicative of variations in shallow groundwater quality caused by the occurrence of the springline to the west and historical seepage from MCL to the east. At all of these positions there appears to be signs of overall improvement in shallow groundwater water quality, with groundwater becoming less mineralised and more dilute. This would appear to be most likely as a consequence of MCL capping.

7.2.2 Deep Aquifer

This is the tenth annual report since the introduction of the reduced monitoring schedule for the deep aquifer. Samples are now only collected annually.

The data suggests that there has been minor change in deep groundwater chemistry and that the reduced monitoring programme is not hampering understanding of the site conditions.

Interestingly, some of the deep groundwater wells around the toe of MCL and upgradient of MNHL have shown improvements in groundwater quality since the on-set of MCL capping. Others, such as BH19D and BH20D have sometimes revealed slightly different trends with increased concentration of sodium, arsenic and ammonia. These contrasting variations may be indicative of different drainage patterns below and around MCL, the anticipated short-term influence from the exposure of wastes during capping and the absence of clay between the shallow and deep aquifer.

7.3 Assessment against Permit Compliance Limits and EQS

The graphs presented in Appendix 5 reveal temporal trends. Tables 7-1 and 7-2 compare the 2021 and 2022 downgradient groundwater chemistry with the Permit trigger levels. This reveals no persistent breaches or trends.

Table 7-1 Evaluation of 2021 downgradient Groundwater data against Trigger Levels

		Arsenic	Chloride
		microg/l	mg/l
	Trigger Level	50	200
BH3S	23/03/2021	21.8	51.4
BH3S	29/06/2021	<60	66.5
BH3S	06/09/2021	0.08	84.94
BH3S	06/12/2021	33.3	72.6
BH4S	23/03/2021	5.1	73.7
BH4S	29/06/2021	22	67.1
BH4S	06/09/2021	0.15	75.01
BH4S	06/12/2021	8.2	74.8
BH6S	23/03/2021	1.6	26.58
BH6S	29/06/2021	<60	39.67
BH6S	06/09/2021	0.06	0.00
BH6S	06/12/2021	1.8	55.9
BH30	23/03/2021	10.7	46.48
BH30	29/06/2021	21.6	95.8
BH30	06/09/2021	0.06	67.31
BH30	06/12/2021	34.5	71.1

Table 7-2 Evaluation of 2022 downgradient Groundwater data against Trigger Levels

		Arsenic	Chloride
		microg/l	mg/l
	Trigger Level	50	200
BH3S	12/01/2022	33.3	71.126
BH3S	04/04/2022	33.5	67.5
BH3S	16/08/2022	29.4	61.3
BH3S	25/10/2022	37.1	44.86
BH4S	12/01/2022	6.7	77
BH4S	04/04/2022	22.0	77
BH4S	16/08/2022	12.0	79
BH4S	25/10/2022		61
BH6S	12/01/2022	1.4	49.39
BH6S	04/04/2022	2.4	45.02
BH6S	16/08/2022	4.2	55.70
BH6S	25/10/2022		76.50
BH30	12/01/2022	17.6	60.708
BH30	04/04/2022	10.5	66.4
BH30	16/08/2022	21.4	93.9
BH30	25/10/2022	9.8	78.8

7.4 Contingency Actions Taken

No specific contingency actions have been required.

8 SURFACE WATER LEVELS

The results of the surface water monitoring are presented in Appendix 6 and 7.

8.1 Assessment against Permit Control Levels

Due to the low risk that MNHL directly poses to surface water under active management control and the historical impact of seepage from MCL, there are no Permit Compliance Limits for surface water. Instead, there are two assessment levels (AL1 and AL2). An evaluation of the 2022 dataset against these levels is presented in Table 8-1. This analysis reveals no persistent breaches since 2020 although chloride was elevated in October 2022, as well as Calcium, as shown in Plate 8-1.

Table 8-1 Comparison of SW4 surface water quality with assessment levels

	Arsenic	Chloride
	microg/l	mg/l
Control level 1	35.00	100.00
Control level 2	40.00	150.00
05/02/2020	8	216
30/06/2020	13.3	68.9
20/07/2020	20	75.1
04/12/2020	2.1	63.9
23/03/2021	2.2	51.7
10/06/2021	34.9	60.8
06/09/2021	0.12	98.82
06/12/2021	1.8	71.8
12/01/2022	2.10	93.28
04/04/2022	<0.75	81.70
16/08/2022	12.80	80.00
25/10/2022	2.10	752.00 (65.2 repeat)
Data from SW2 not available as insufficient water at springline at time of sampling		

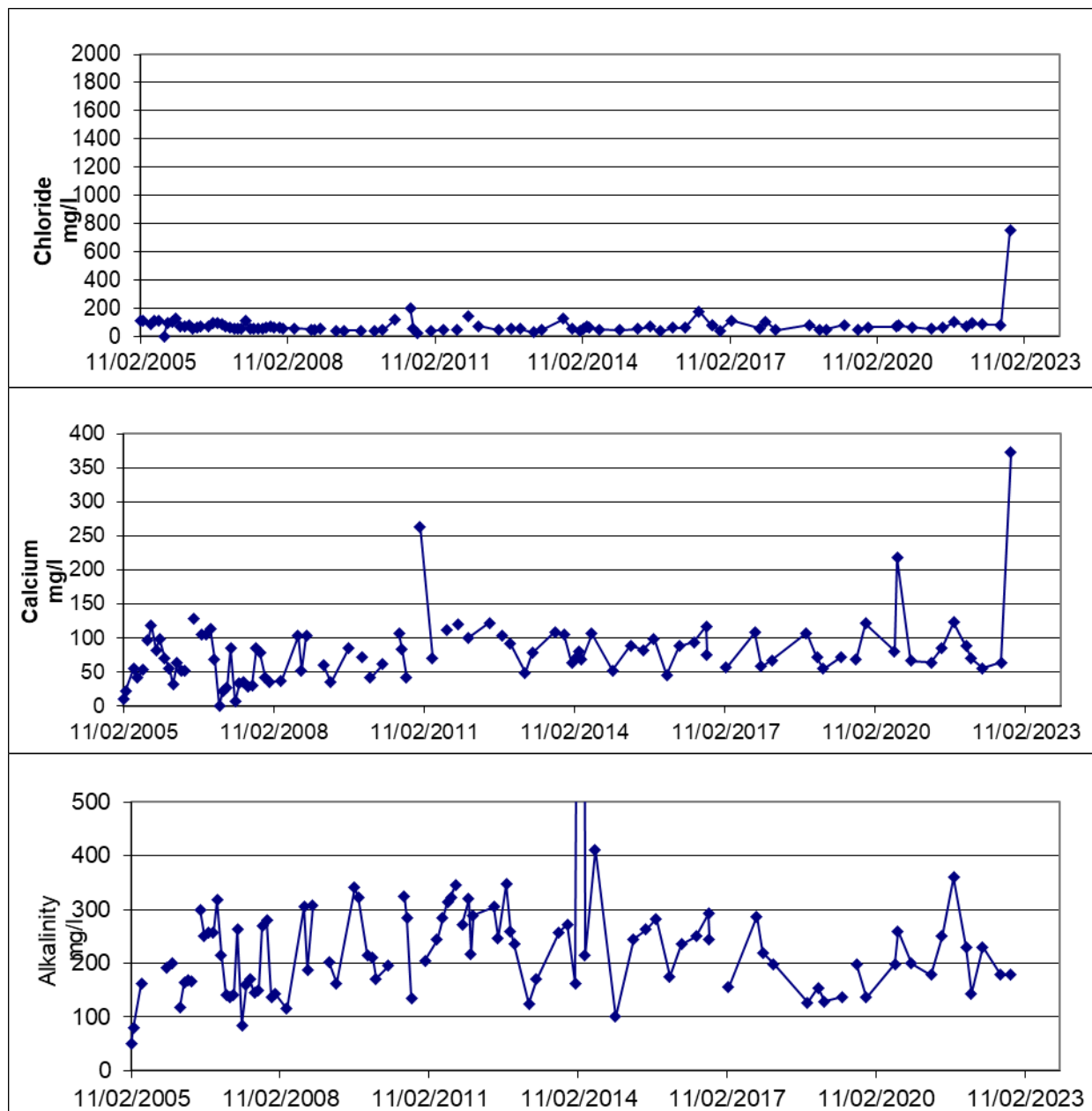


Plate 8-1 Chloride, Calcium and Alkalinity at SW4

Surface water immediately northeast of MHL on Margam Moors is already known to be significantly impacted by seepage from MCL, as there is a well-developed highly alkaline springline.

Over the past four years, elevated alkalinity has been observed at SW4, particularly during the period May-November.

Other surface water sample locations immediately downstream of the landfill (SW13 and SW14) do not show such variations and the chemistry observed during recent years is consistent.

Sample SW15 is taken from pooled water (because of the ground surface intersecting shallow groundwater) to the north of the landfill. This position is close to a slag hardstanding used for vehicle storage and maintenance. The water chemistry observed at this position has also remained relatively consistent, like that at SW13 and SW14, although the alkalinity concentration has been variable since 2015. The cause of these variations is unclear but could be related to variations in pool water level resulting in exposure and subsequent flushing of made ground dominated by slag.

8.2 Contingency Actions Taken

No contingency actions were required.

9 AMENITY

9.1 Complaints

As far as Geotechnology is aware, no complaints relating to the landfill have been received by either Tata Steel, the Landfill Operators or NRW.

9.2 Particulates

Historically, Tata Steel has routinely monitored dust around the Morfa landfills for many years. A previous review of data lead Tata Steel to question the environmental benefit of monitoring at the continued frequency. A full description of the work that led to this conclusion was set out in the 2017 annual report for MNHL (see Geotechnology report 1761r1v1d0218). On this basis, Tata Steel previously requested that dust monitoring is no longer undertaken. Therefore, during 2022, no dust monitoring occurred and it is no longer a routine Permit requirement.

During dry periods the landfill operator actively suppresses all trafficked routes with surface water extracted from SW1. This limits the opportunity for release of particulates during vehicular movements.

9.3 Odour

The landfill is not a significant source of odour.

9.4 Pests

The landfill does not attract significant pest numbers.

9.5 Noise and Vibration

The landfilling operations is not a significant source of noise and there are few receptors within close proximity apart from SSSI.

9.6 Litter

The industrial wastes deposited in Cells 1 and 2 contain no light fractions. In comparison, the waste deposited in the Biocells is a mixture of materials, some of which can be wind-blown. Although the waste is baled before being deposited and quickly covered there is sometimes opportunity for light fractions to escape the immediate cell area during high winds. The current programme of litter collection should ensure that such materials are not allowed to escape into the wider environment where they could be a source of microplastics following degradation.

10 LANDFILL GAS & PERIMETER MONITORING

10.1 Perimeter Wells

External landfill gas is monitored around the northern (GA7, GA15 & GA16), eastern (GA8, GA9 & GA10) and southern (GA11 & GA12) boundaries of the Biocell (see Figure 4).

Along the southern and eastern boundaries, ground gas has been infrequently detected. Since 2014, methane has not been detected and carbon dioxide has not been detected above 0.2%. Low levels (<10 ppm) of carbon monoxide and hydrogen sulphide have been infrequently detected. These variations are illustrated in Appendix 8.

Historically, the situation has been different along the northern boundary as ground gas has been detected along this boundary for several years, most notably at GA16 but more recently at GA7. In response, the compliance limits for GA16 were increased following an evaluation of the likely ground gas sources that concluded that the landfill was not the source of the gas. At no point since 2012 have the monitoring results breached the compliance limits at GA15 or GA16. At no point since 2012 has the concentration of methane or carbon dioxide exceeded 0.5%, which is the tolerance of the GA5000 instrument used to undertake the monitoring. Low levels (<10 ppm) of carbon monoxide and hydrogen sulphide have been infrequently found. On 14 March 2017 a reading of 193ppm hydrogen sulphide was detected. A repeat of the measurement at the time failed to detect any hydrogen sulphide. Such elevated levels have never been detected at any monitoring location and all monitoring since March 2017 has failed to detect hydrogen sulphide above 2ppm at any position.

The reader should note that each of these perimeter wells often contain groundwater and so any ground gas monitoring data should be viewed with caution as the headspace within the well is limited and the data unlikely to be truly reflective of the soil pore space. During the construction of the latest section of recharge trench, GA7 and GA16 were removed with the new wells to be installed once groundwater levels have sufficiently receded.

10.2 Contingency Actions Taken

No contingency actions were required but Tata Steel has recognised that improvements to the headworks at several gas monitoring locations are required. Some of these changes are necessary due to localised flooding occurring along the toe of MCL and MNHL (between BH17 and BH6 on Figure 4). Such flooding could also influence ground gas chemistry.

11 SUMMARY AND RECOMMENDATIONS

11.1 Evaluation and Summary

At MNHL there will always be difficulty in determining influences on groundwater as both the shallow and deep aquifers have been impacted to varying degrees by seepage from unlined areas of waste and other off-site sources. Additionally, as the construction of the landfill was subject to CQA during construction, the volume of predicted leakage is small. Identifying seepage from the landfill is not, therefore, straightforward given variations and similarities between the leachate and upgradient groundwater and the low volume predicted to leak.

There is, however, one key tracer and this is currently chloride. Although the current concentration of chloride has reduced in the leachate sumps it remains above most levels observed in shallow groundwater and surface water. Based on the hydrochemical monitoring data collected to date there is no evidence to suggest that the landfill is not behaving as initially predicted and the identified receptors remain protected from impacts related to MNHL. Leachate levels have, until recently, been elevated above the compliance level for many months but there has been a step-change reduction in leachate levels since 2020 with all levels now compliant. As cells cease to operate, progressive restoration should also be taking place as this limits the amount of leachate requiring management, potentially reduces the mineralised content requiring treatment and reduces the potential flux of contaminants.

11.2 Environmental Protection

The initial risk assessments, completed as part of the Permit Application, clearly demonstrated the potential for the landfill to emit non-hazardous pollutants to groundwater and potentially surface water. There was also the potential that the landfill would generate dust during landfilling activity and associated vehicular movements and earthworks. Landfill gas is not likely to be associated with the industrial components of the waste, but the generation of small amounts could not be wholly discounted, particularly within the biodegradable cell.

To ensure that the landfill performs at least as well as predicted throughout the lifespan of the Permit, a monitoring programme was put in place to evaluate the leachate source concentrations, leachate head, groundwater flow, surface water chemistry, gas generation and dust deposition. Based on the monitoring data reviewed to date, there is no evidence to suggest that the landfill is not behaving as initially predicted and the identified receptors remain protected.

11.3 Actions Required

The annual report has identified several items requiring action:

- Vegetation near several sampling points requires routine clearance to enable continual safe access.
- Undertake survey of methane emissions at permanently capped landfill.
- Install permanent settlement markers on surface of Biocell A and B to allow annual assessment of settlement.

Figure 1 Site Location Plan



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Figure 2 Detailed Site Plan Showing Planning and Permit Boundaries

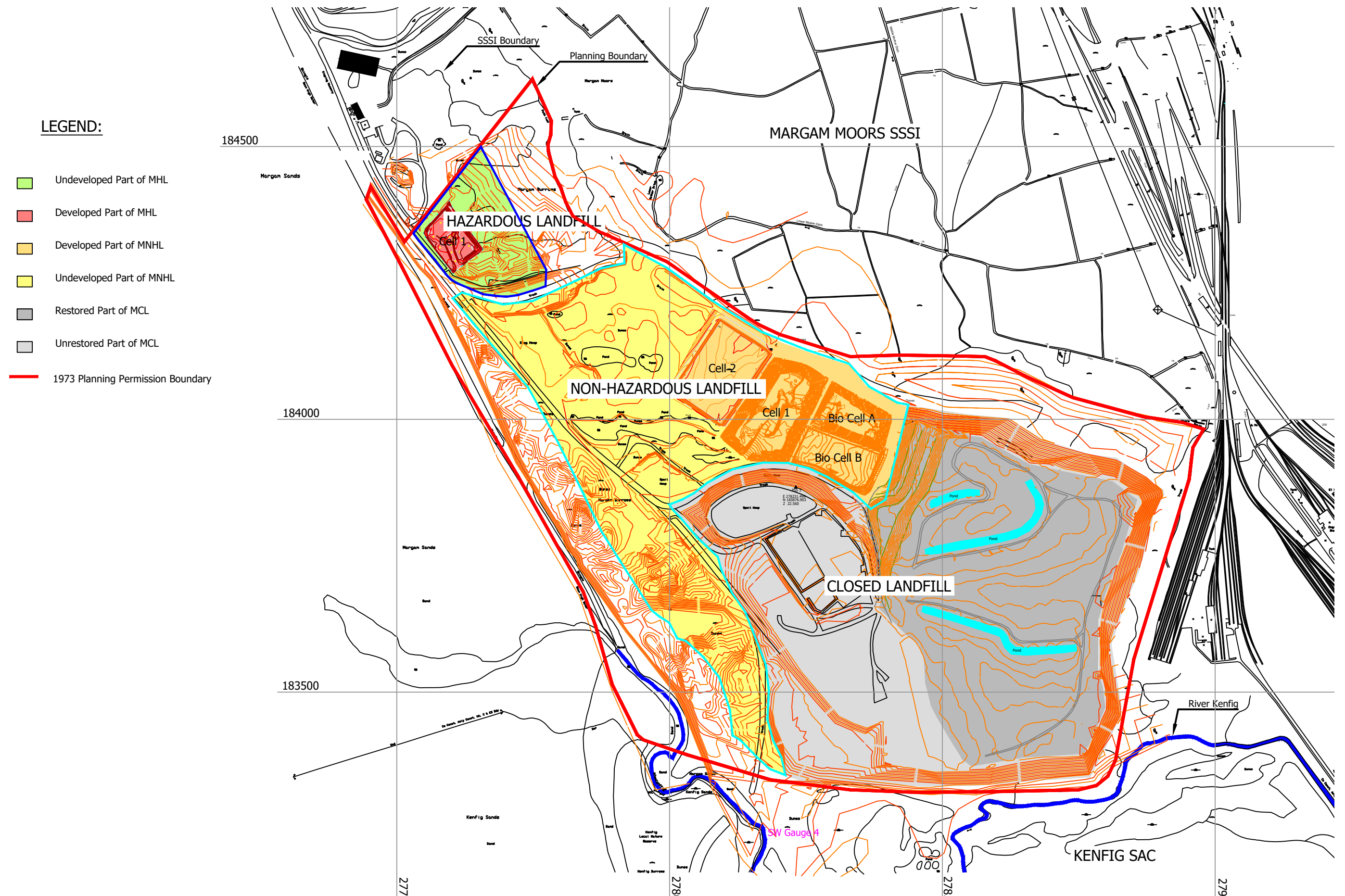


Figure 3 Conceptual Site Model

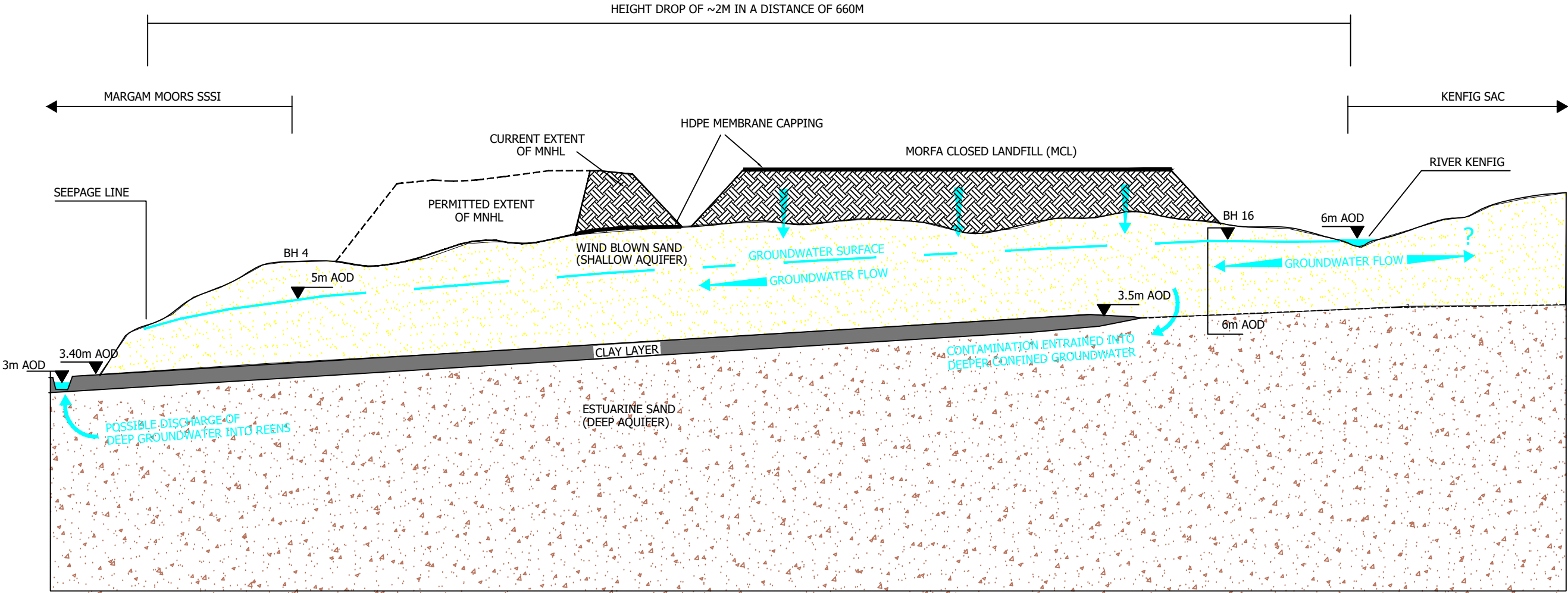


Figure 4 Available Monitoring Network

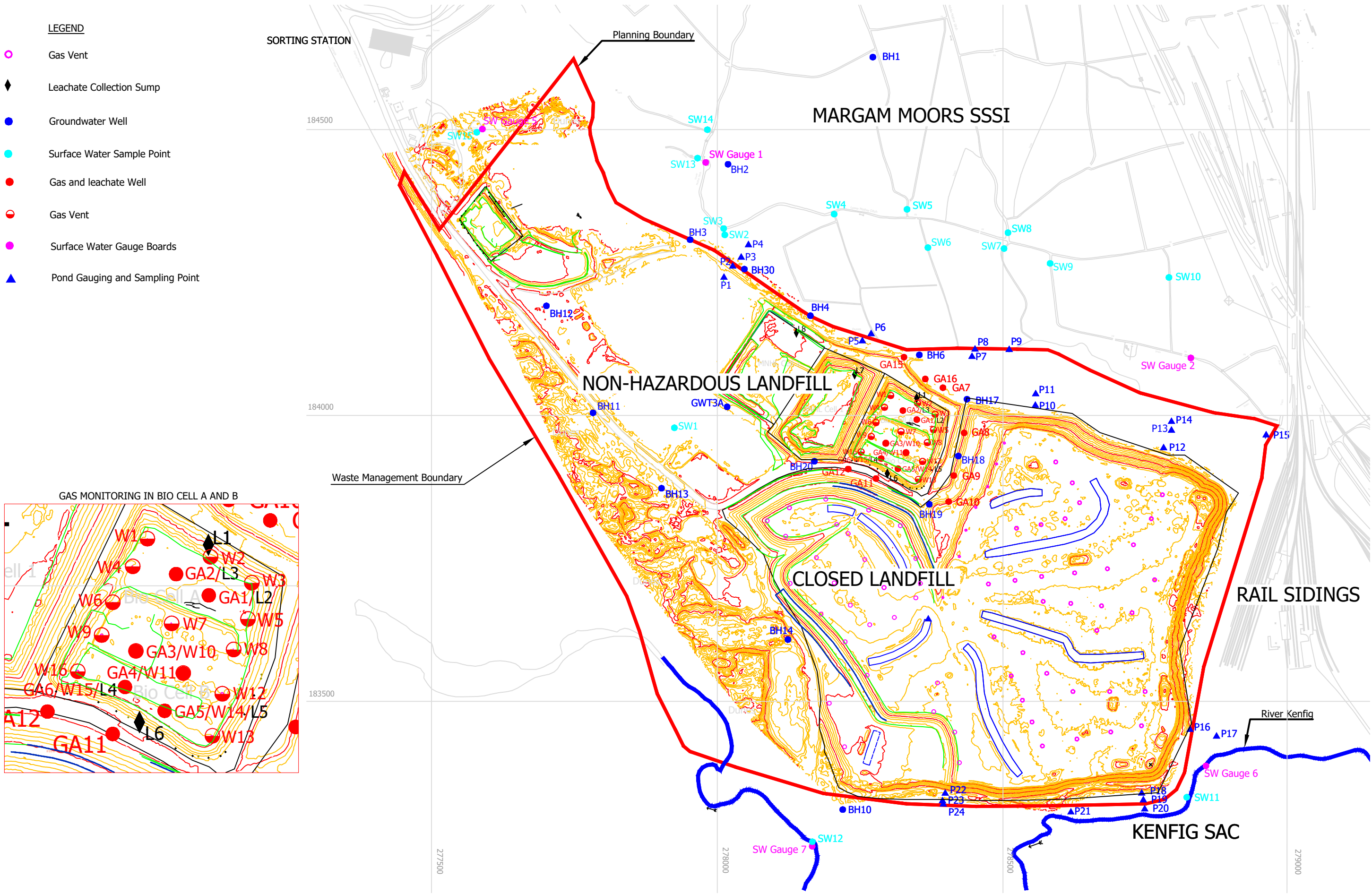


Figure 5 Extent of Clay Layer

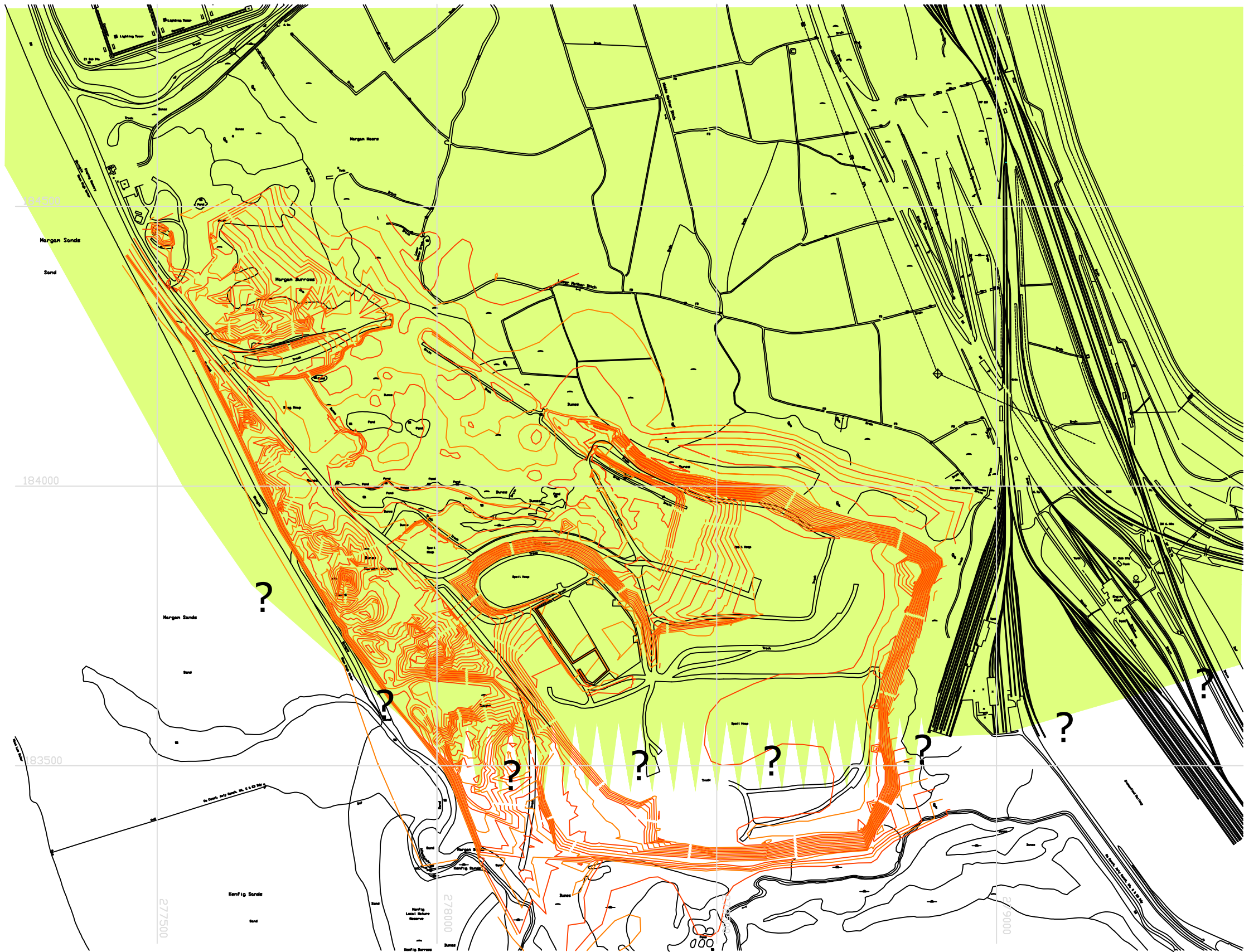


Figure 6 Typical Contour Plan of Piezometric Surface in Shallow Aquifer

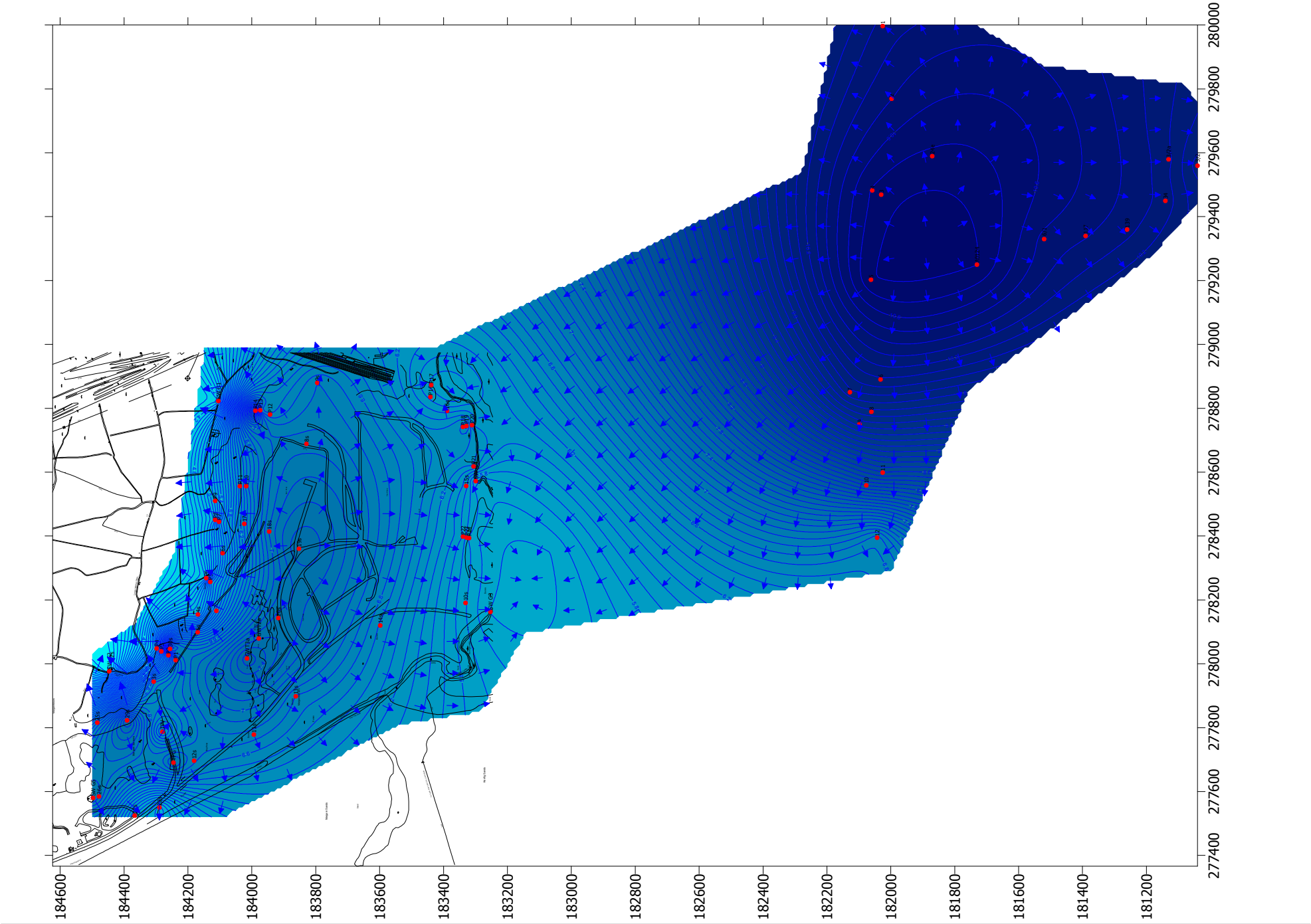


Figure 7 Typical Contour Plan of Piezometric Surface in Deep Aquifer

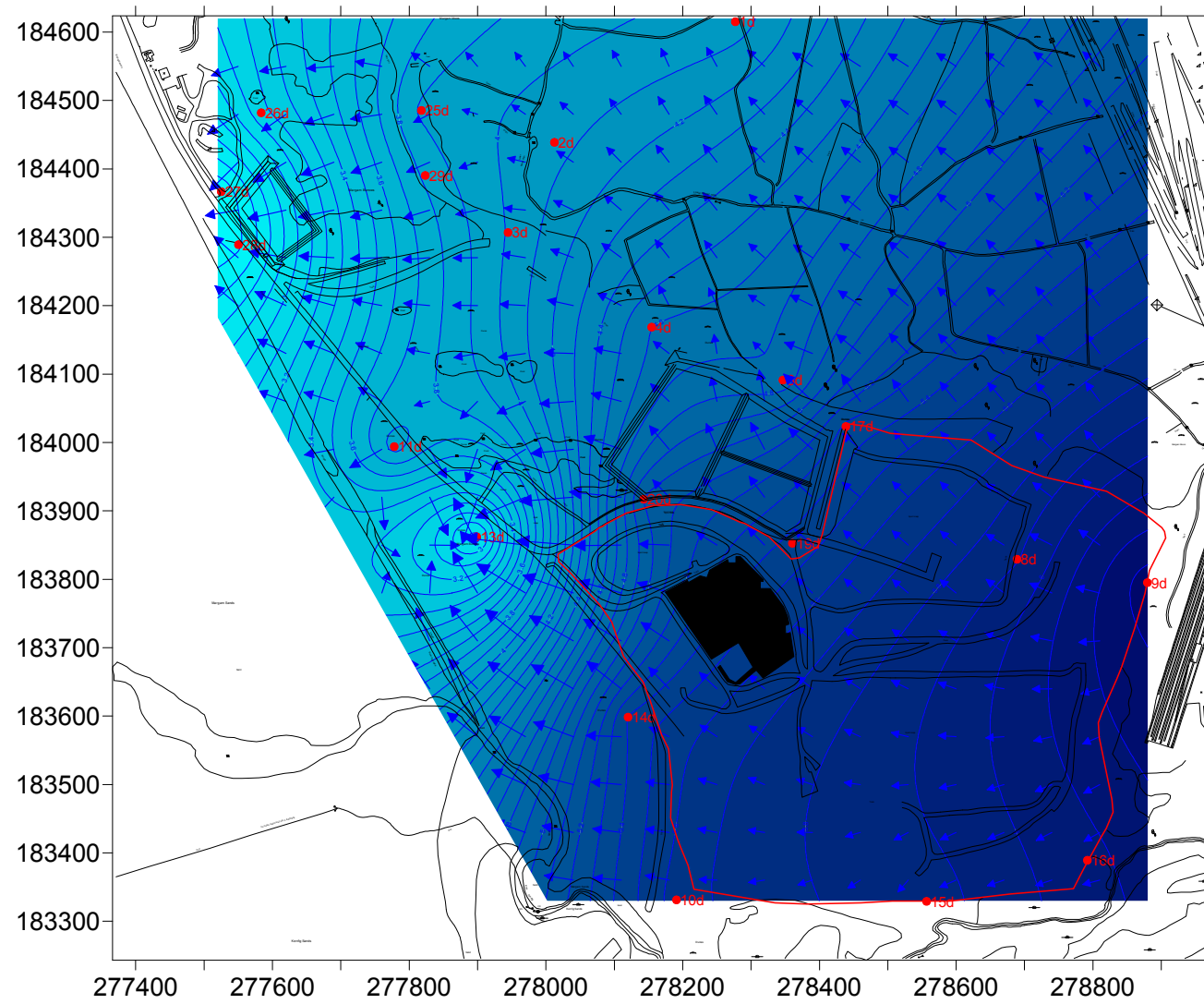
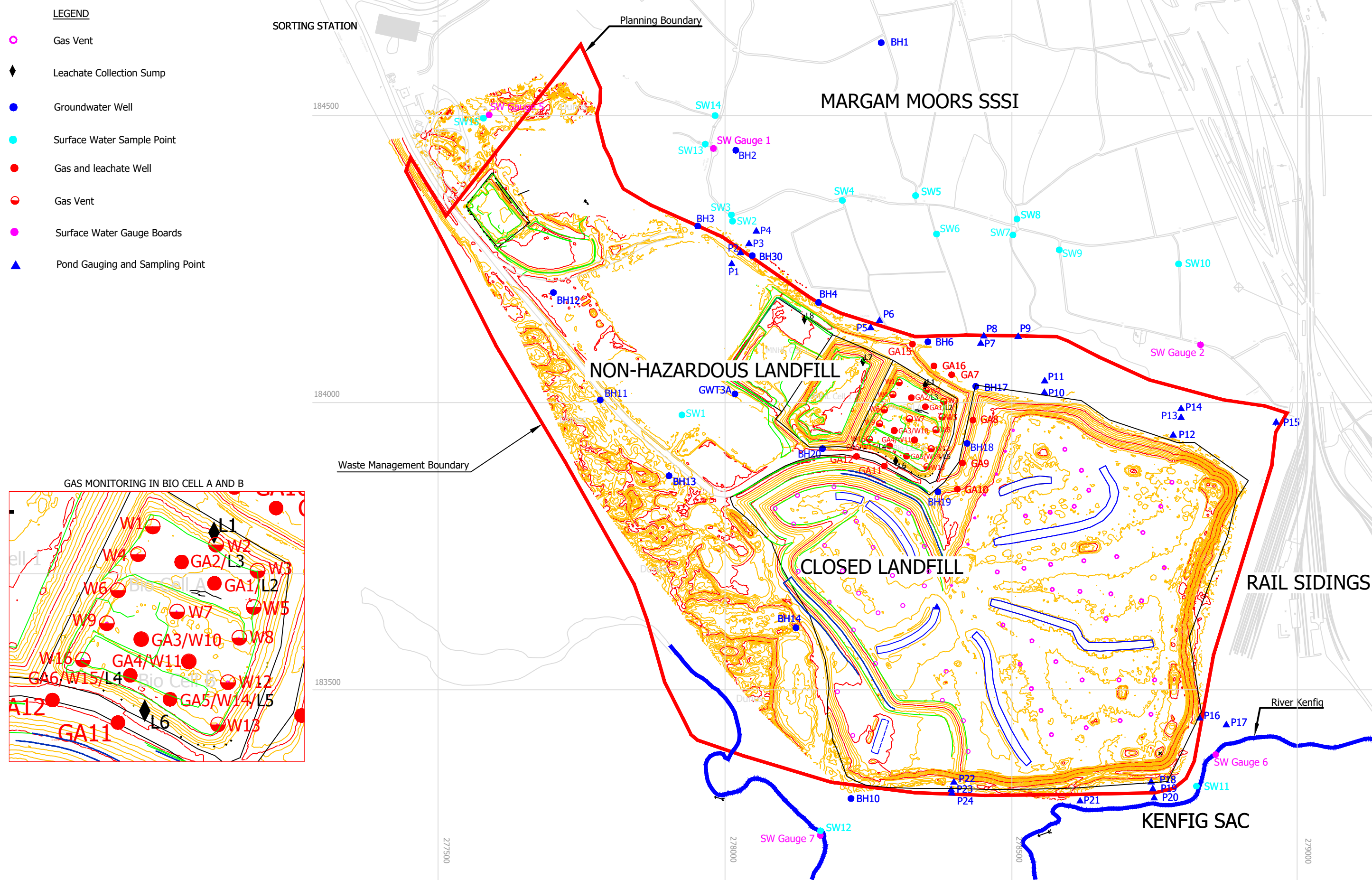


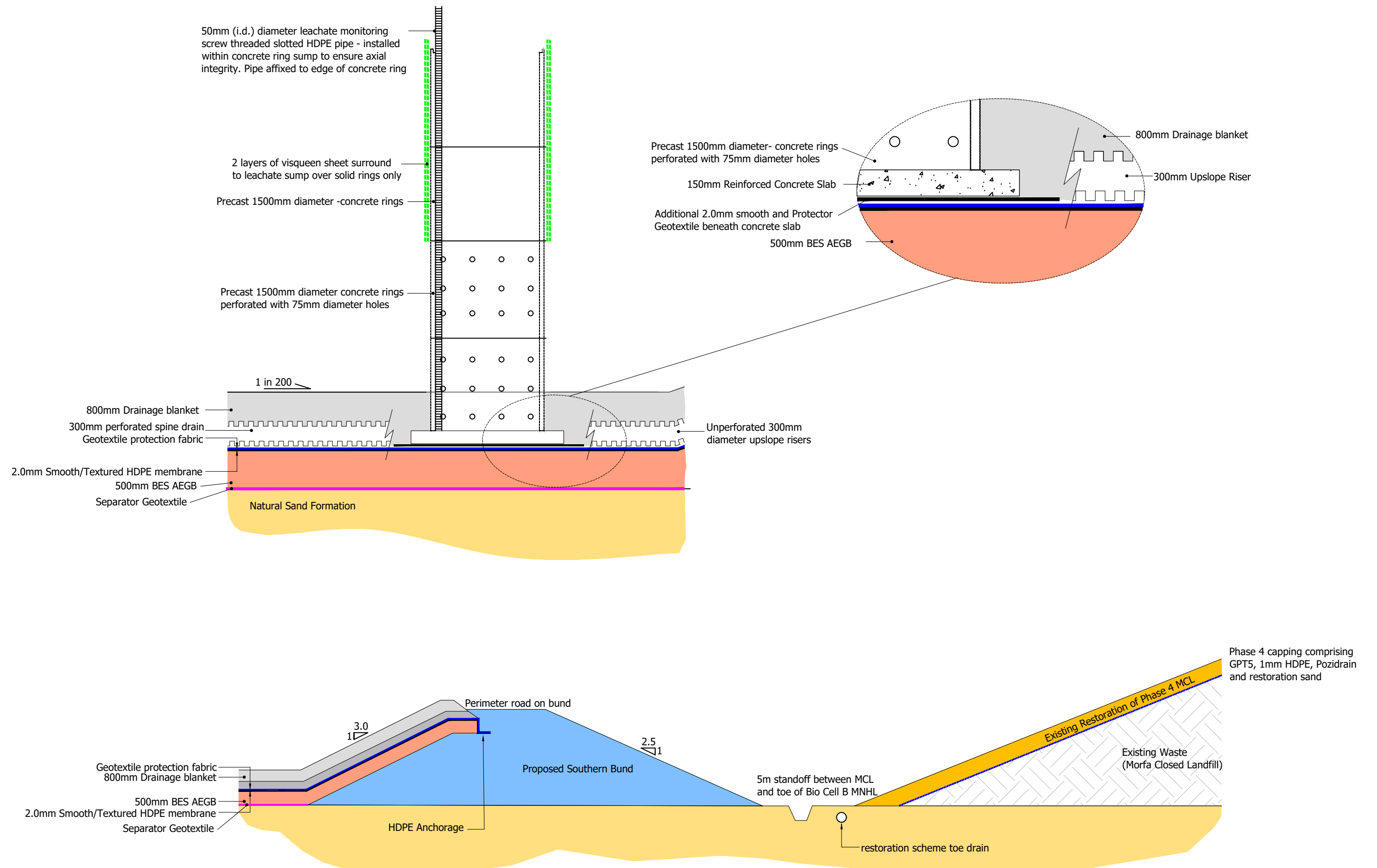
Figure 8 MNHL Monitoring Network

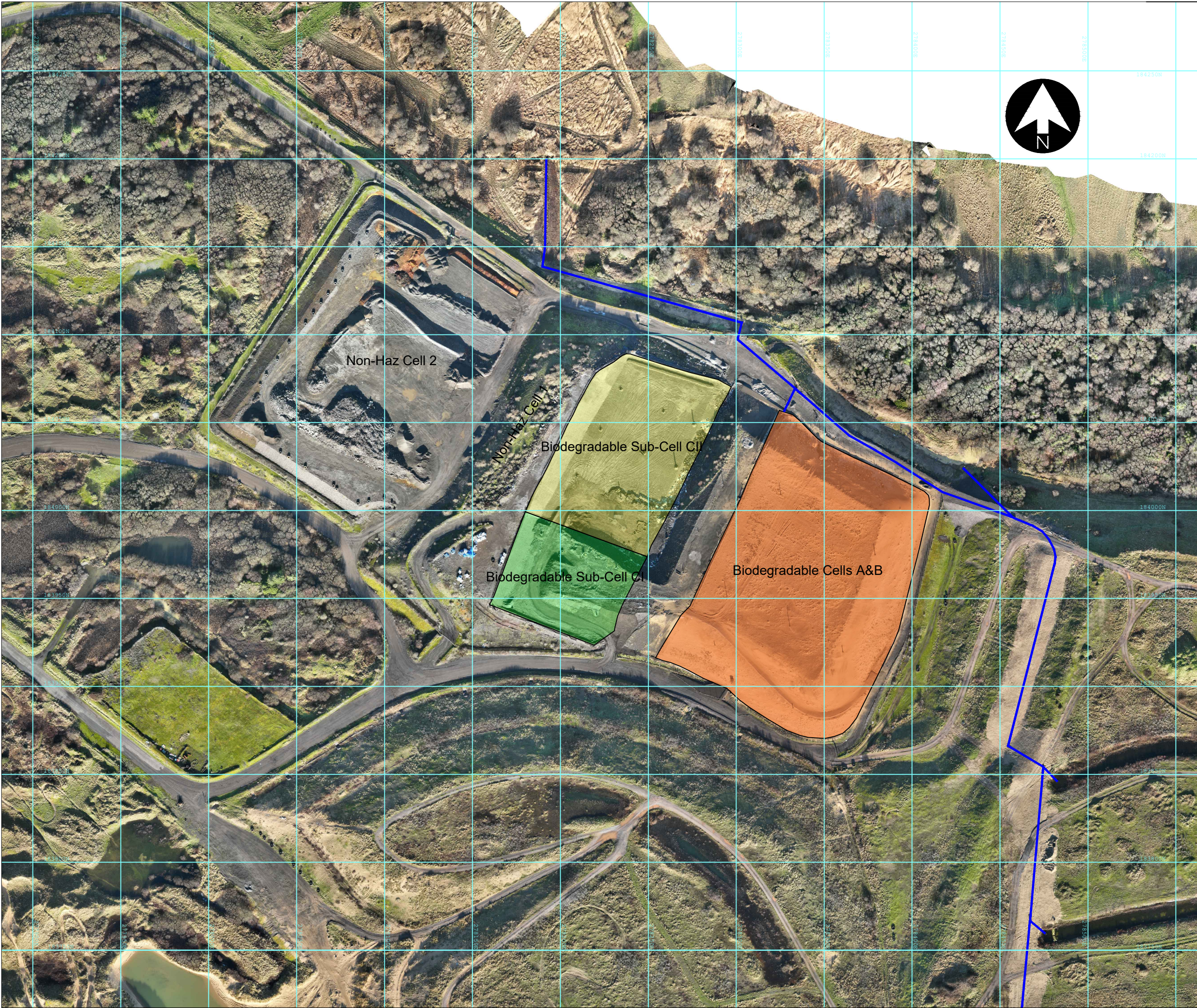




Drawing Number 2295/9			
Legend  Prominent Contour (2.5m)  Normal Contour (0.5m)			
Notes Digital survey model generated using Pix4D image processing software. Imagery acquired by DJI Phantom 4 pro RTK photogrammetry survey on 19 January 2023. Survey control installed using Topcon Hiper SR dGPS Network Rover. OS Grid spacing at 50m			
Rev	Date	Status/Ammendments	
CLIENT			
Tata Steel (UK) Ltd.			
PROJECT			
Morfa Non-Hazardous Landfill 2022 Annual Review of Environmental Monitoring			
TITLE			
Non-Hazardous Landfill Topographic Survey			
DRAWING NUMBER			REVISION
2295/9			0
DATE	DRAWN	CHECKED	SCALE AT A3
02.23	KJT		1:1250
Geotechnology Limited Ty Coed, Cefn-yr-Allt, Aberdulais, Neath SA10 8HE 01639 775293 www.geotechnology.net			

Figure 10 Cross Sections of Key Landfill Engineering Systems





Drawing Number 2295/11

- Legend
- Biodegradable Sub Cell CI
 - Biodegradable Sub Cell CII - Completed During 2022
 - Biocells A & B - Restored During 2022
 - Approximate Alignment of MCL Recharge Trench Works

Notes

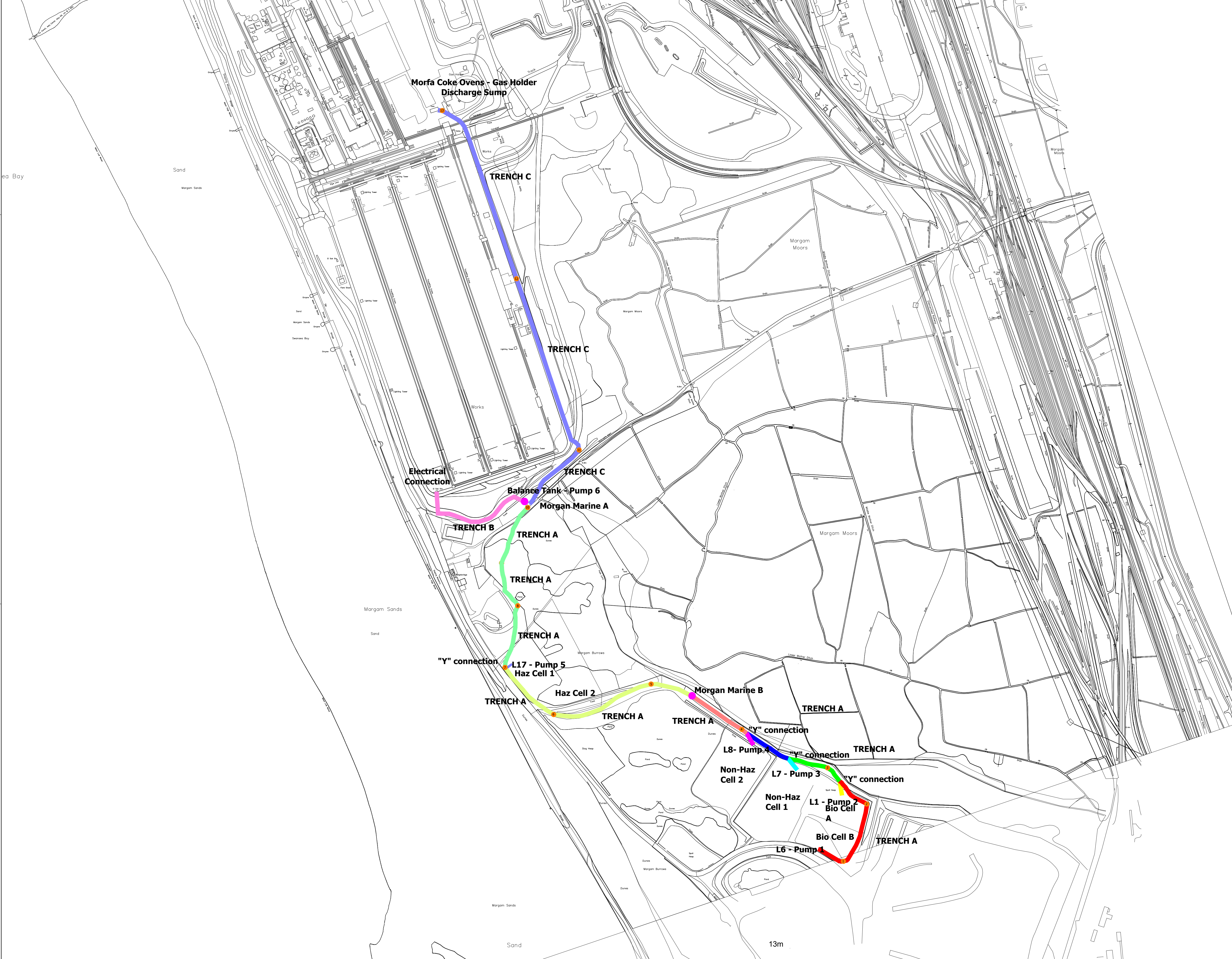
Imagery acquired by DJI Phantom 4 pro RTK photogrammetry survey on 19 January 2023.

Biodegradable Sub-Cell C now active.

Biocells A&B capped and restored during 2022.

Morfa Closed Landfill (MCL) recharge trench improvement works undertaken during 2022. Approximate pipework alignment marked on drawing.

Rev	Date	Status/Ammendments
CLIENT		
Tata Steel (UK) Ltd.		
PROJECT		
Morfa Non-Hazardous Landfill 2022 Annual Review of Environmental Monitoring		
TITLE		
2022 Improvement Works		
DRAWING NUMBER		REVISION
2295/11		0
DATE	DRAWN	CHECKED
02.23	KJT	
		SCALE AT A3
		1:2000
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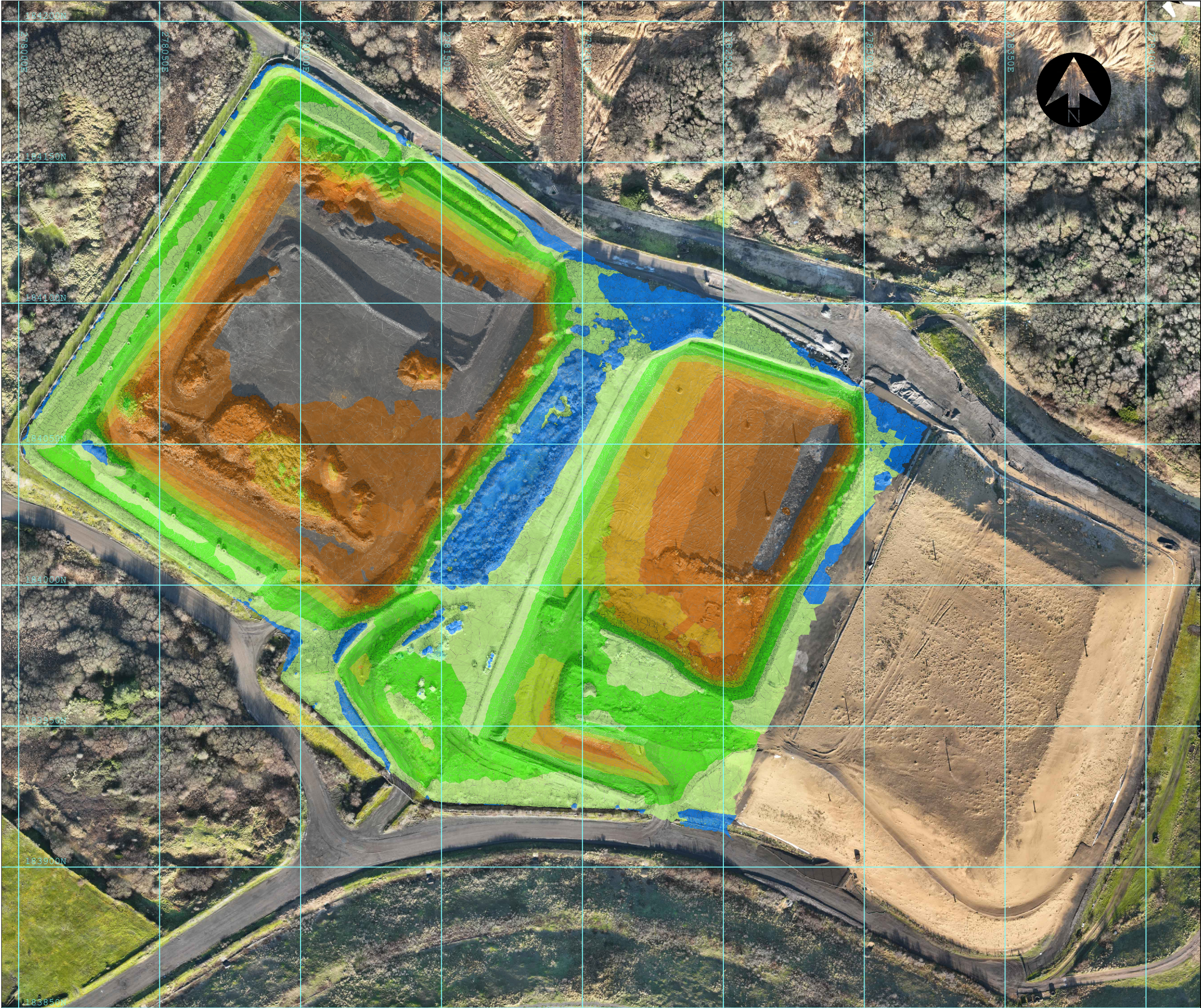
Drawing Number 2295/12

Legend

-  Sump Number
-  Survey Check Point (see Table 7-1)
-  Location of Electrical Control Panel - Morgan Marine A or B
-  Chainage A
-  Chainage B
-  Chainage C
-  Chainage D
-  Chainage E
-  Chainage F
-  Chainage G
-  Chainage H
-  Chainage I
-  Chainage J
-  Chainage K
-  Chainage L

NOTE

Rev	Date	Status/Amendments
CLIENT		
TATA STEEL (UK) Ltd.		
PROJECT		
MORFA NON-HAZARDOUS LANDFILL 2022 ANNUAL REVIEW OF ENVIRONMENTAL MONITORING		
TITLE		
LEACHATE COLLECTION SYSTEM		
DRAWING NUMBER		REVISION
2295/12		FINAL
SCALE AT A1	DATE	DRAWN
1:4000	2.23	AJ/KT
CHECKED		
Geotechnology Ty Coad, Cefn-yr-Allt, Aberdulais, Neath SA10 8HE 01639 775293 www.geotechnology.net		
		



Drawing Number 2295/13

Legend

Height ranges

8

7

6

5

4

3

2

1

0

-1

-2

-3

-4

Notes

Isopachyte generated by subtracting approved top of waste contours from 19 January 2023 topographic drone survey.

Positive levels indicate remaining capacity.

Negative levels indicate waste is currently over-height.

OS Grid spacing at 50m

Rev	Date	Status/Ammendments
CLIENT		
Tata Steel (UK) Ltd.		
PROJECT		
Morfa Non-Hazardous Landfill 2022 Annual Review of Environmental Monitoring		
TITLE		
Non-Hazardous Landfill Waste Profile Isopachyte		
DRAWING NUMBER		REVISION
2295/13		0
DATE	DRAWN	CHECKED
02.23	KJT	
SCALE AT A3		1:1250

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SA10 8HE
01639 775293
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Drawing Number 2295/14			
Legend  >1:1.75  <1:1.75  <1:2  <1:2.5  <1:3  <1:3.5			
Notes Slope gradients in Vertical:Horizontal ratio format OS Grid spacing at 50m			
Rev	Date	Status/Ammendments	
CLIENT			
Tata Steel (UK) Ltd.			
PROJECT			
Morfa Non-Hazardous Landfill 2022 Annual Review of Environmental Monitoring			
TITLE			
Morfa Non-Hazardous Landfill Slope Gradient Map			
DRAWING NUMBER			REVISION
2295/14			0
DATE	DRAWN	CHECKED	SCALE AT A3
02.23	KJT		1:1250
Geotechnology Limited Ty Coed, Cefn-yr-Allt, Aberdulais, Neath SA10 8HE 01639 775293 www.geotechnology.net			

**MORFA NON-
HAZARDOUS LANDFILL,
PORT TALBOT**

PERMIT BV7311IE

**2022 Annual Review of
Environmental
Monitoring**

**Appendix 1
Record of Permit
Update**

Report Number 2295r1v1d0223

Record of Permit Update

This summary is intended to signpost the reader to reports and correspondence related to changes to the monitoring programme that have occurred since Permit issue.

- Subsequent to the issue of the Permit, Geotechnology presented a revised set of Assessment Criteria for groundwater, surface water and leachate in accordance with the Permit Improvement Conditions. These revised Assessment Criteria were initially presented by Geotechnology following a review of the Hydrogeological Risk Assessment (HRA) (see Geotechnology report 403.1/1/1006 Review of Hydrogeological Risk Assessment) after commencement of landfilling. These criteria were further updated following feedback from NRW in Geotechnology letter 403/reviewHRA/lt1/BR/kp (dated 17 January 2007) to the Agency and also in the 2006 annual monitoring report (see Geotechnology report 528.1/0/0307).
- During 2007, NRW commented upon the revised criteria presented in the 2006 annual report and after slight modification, a revised set of Assessment Criteria for groundwater and surface water were agreed (see Geotechnology correspondence 244Permit_lt1/BR/kp and NRW correspondence dated 30 April 2007 and 7 June 2007 (ref: BV7311IE)).
- The 2006 annual monitoring report also indicated that dust levels regularly exceeded the Permit limit of 100 mg/m²/day and that the generation of dust was not solely related to landfilling activities according to Tata Steel. On 28 September 2007, Tata Steel submitted a request to NRW that suggested apportioning 50% of the measured dust to the landfill with a limit value of 200 mg/m²/day and the other 50% allocated to other activities at the works and natural deposition.
- Further minor operational changes to the Permit were requested by Tata Steel on 13 June 2008 (Tata Steel reference LANDFILLPPC_017). The request related to leachate control levels, surface water assessment levels, dust levels and Compliance Limits at external gas well GA16. These changes were prompted by the 2007 annual monitoring report (see Geotechnology report 620.1/0/0108), a meeting with the NRW on 10 June 2008 and NRW Compliance Assessment Reports 01718 and 01770. In response, NRW agreed the minor changes to the Permit in a letter dated 30 July 2008. For clarity, this letter summarised the changes and the applicable assessment criteria.
- As part of a Permit Variation Notice (Variation Notice No. GP3430MH) an Improvement Programme required Tata Steel to undertake a review of copper trigger levels. Geotechnology undertook this assessment at the request of Tata Steel (see Geotechnology report 990r1v1d0610 dated June 2010) and NRW has reviewed and accepted the new groundwater copper trigger levels. The NRW review and acceptance is set out in Compliance Assessment Report 03451 issued 25 November 2010.
- As part of the 2011 annual review (Geotechnology report 1130r1v1d0412) new assessment levels for carbon monoxide and compliance levels for methane were derived in accordance with The Industry Code of Practice (ICOP) guidance.
- As part of the 2012 HRA review, new assessment levels were presented for leachate, groundwater and surface water (see Geotechnology report 1177r1v1d0712). These were also consolidated in a letter to NRW from Tata Steel on 4 February 2013. Given the acceptance of these new levels towards the end of 2012, Tata Steel only started implementing the use of these new control and compliance levels in January 2013.
- In the 2017 annual review a series of new control and trigger levels were proposed alongside modifications to the analytical and monitoring programme. These were verbally agreed by NRW at a Technical Working Party meeting but written feedback was not provided until 2020.

- In January 2021, Tata Steel submitted Permit Variation aimed at consolidating changes previously discussed with NRW but not formally documented. This application was accepted and new Permit issued October 2021 (EPR/BV7311IE/V007)

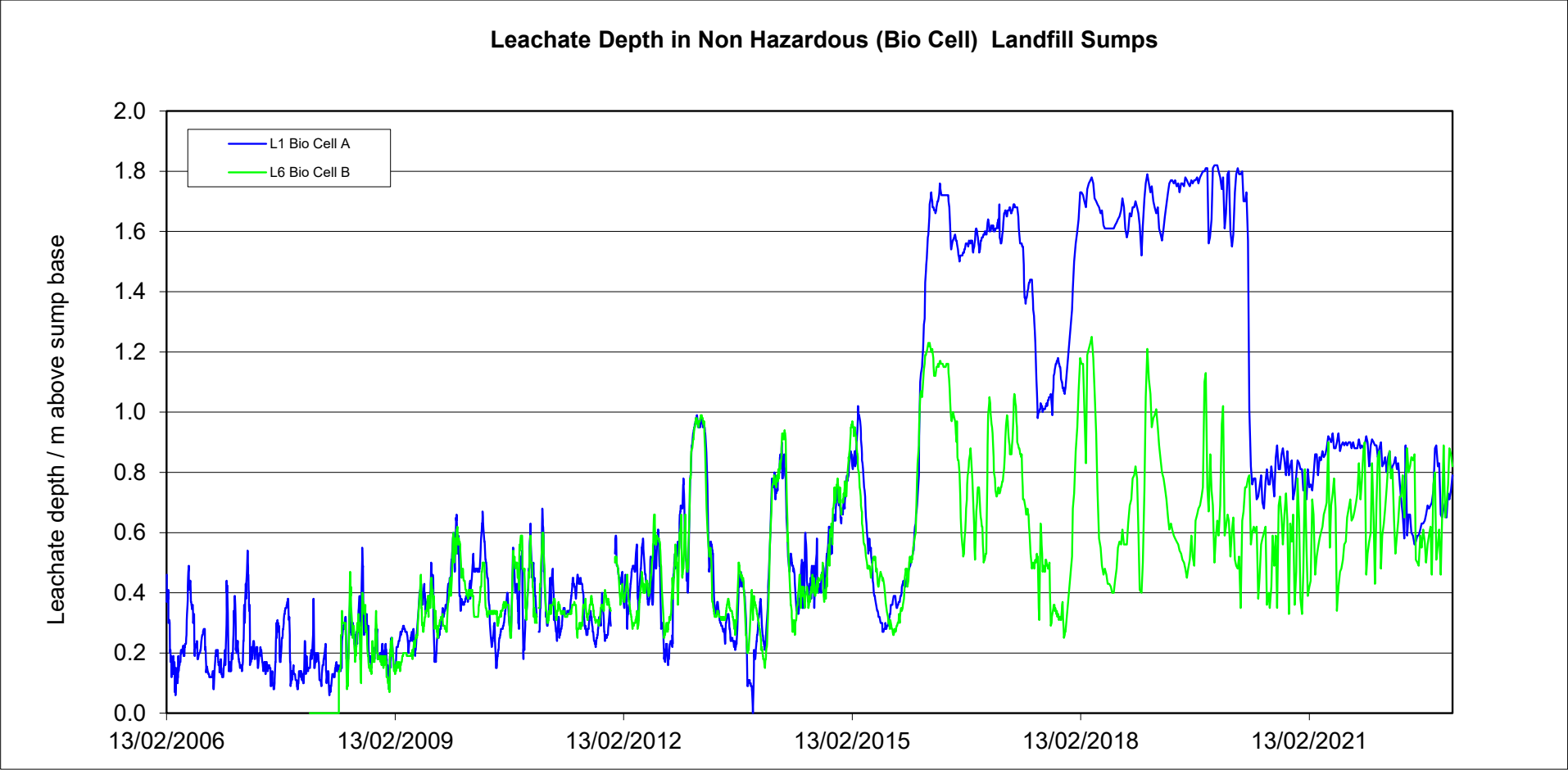
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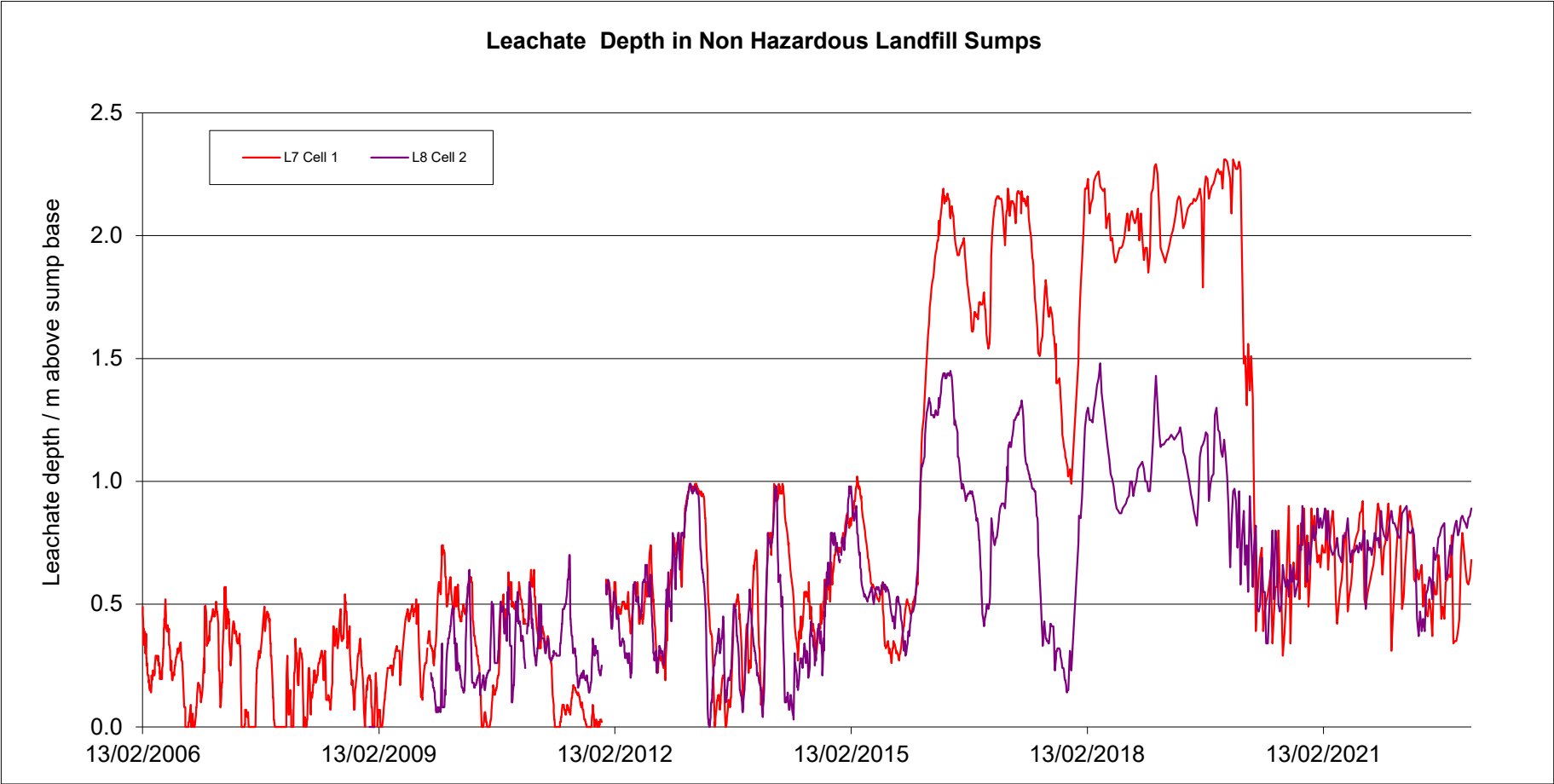
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**2022 Annual Review of
Environmental
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**Appendix 2
Temporal Variation of
Leachate Levels and
Leachate Pumping
Volumes**

Report Number 2295r1v1d0223





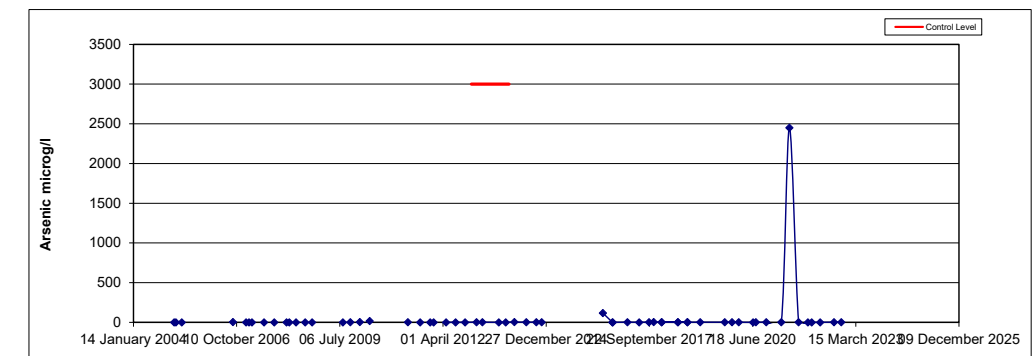
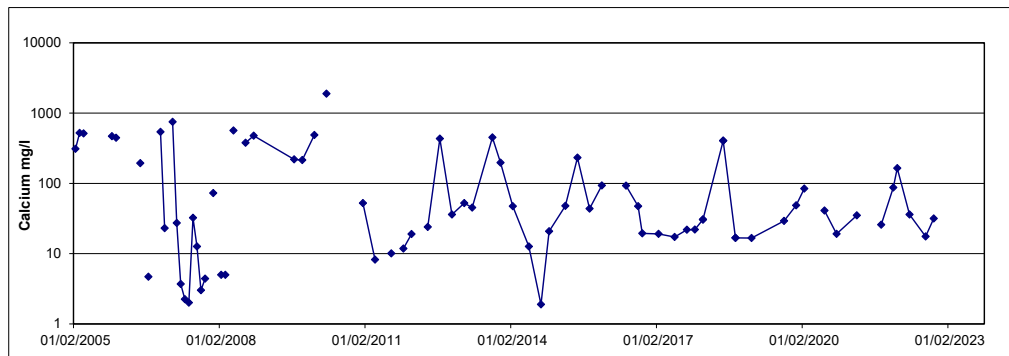
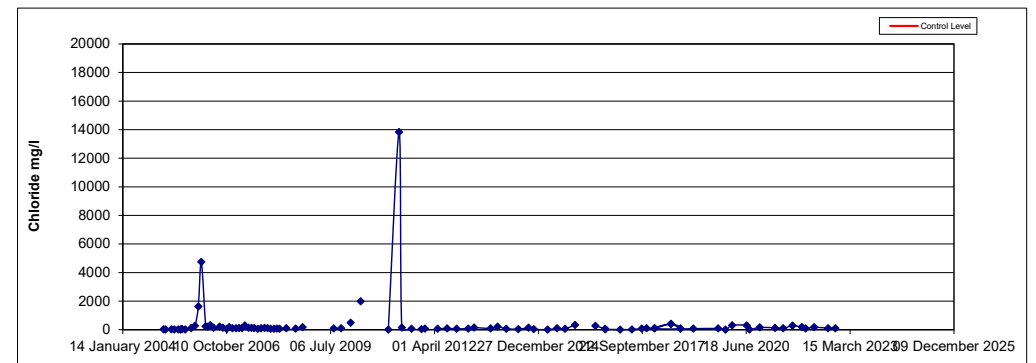
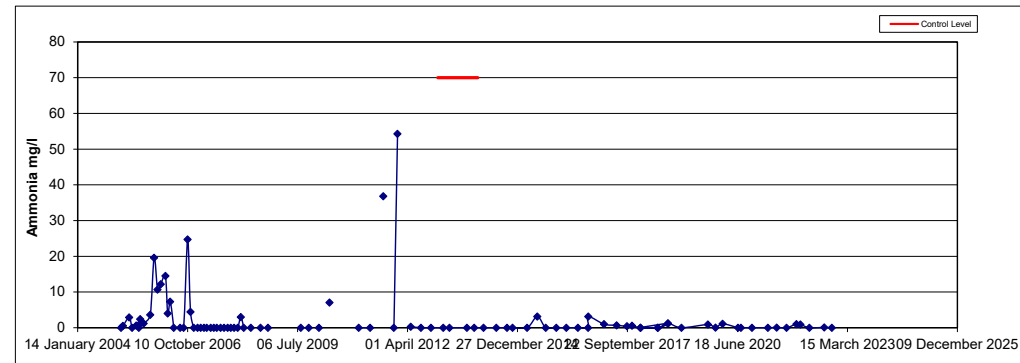
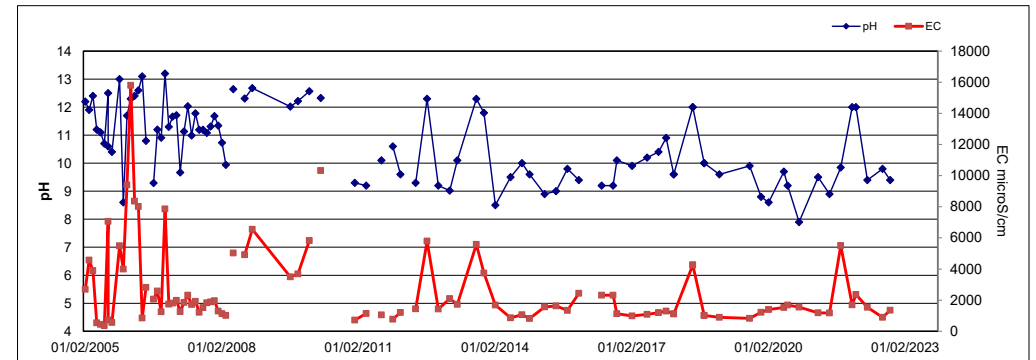
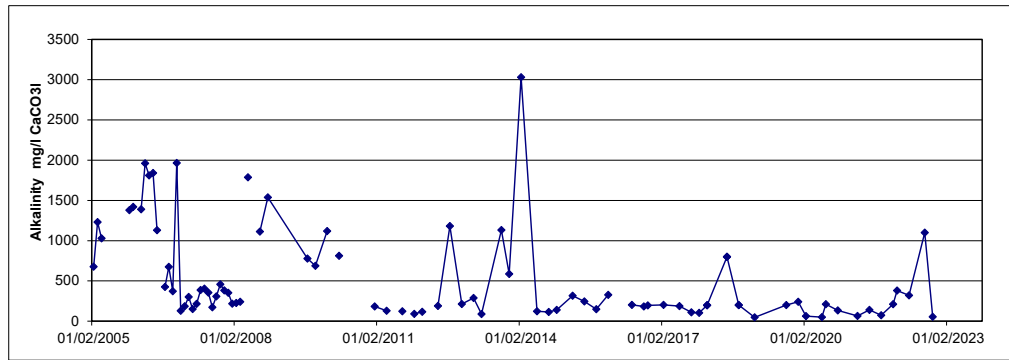
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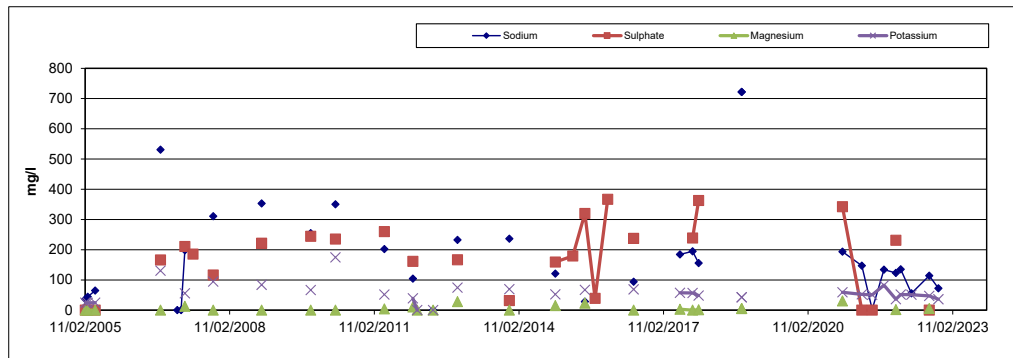
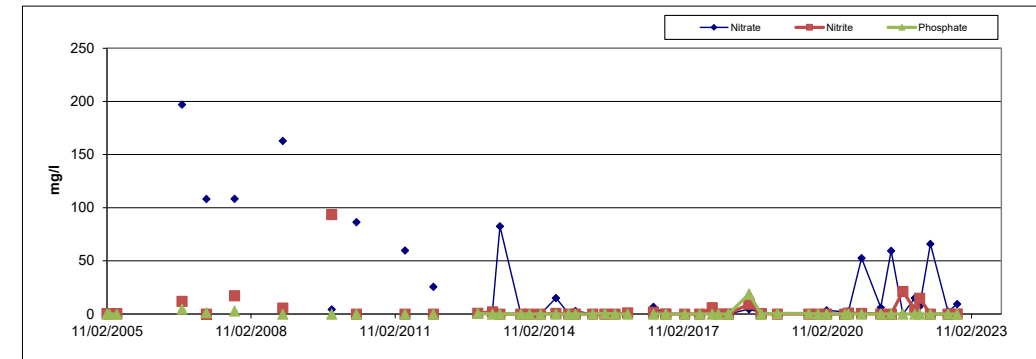
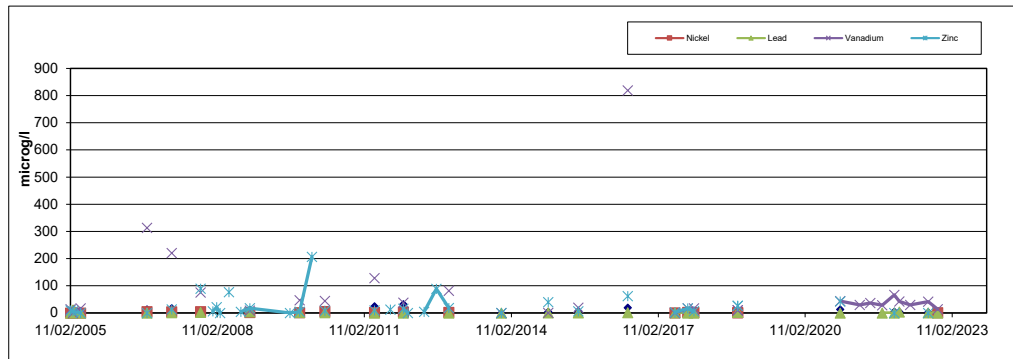
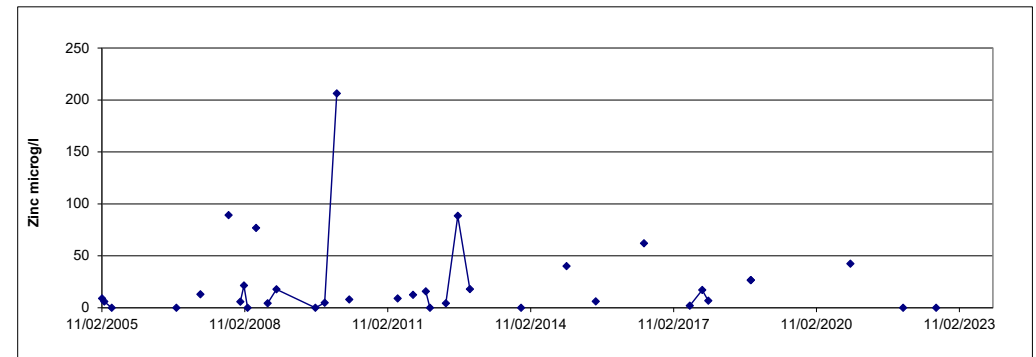
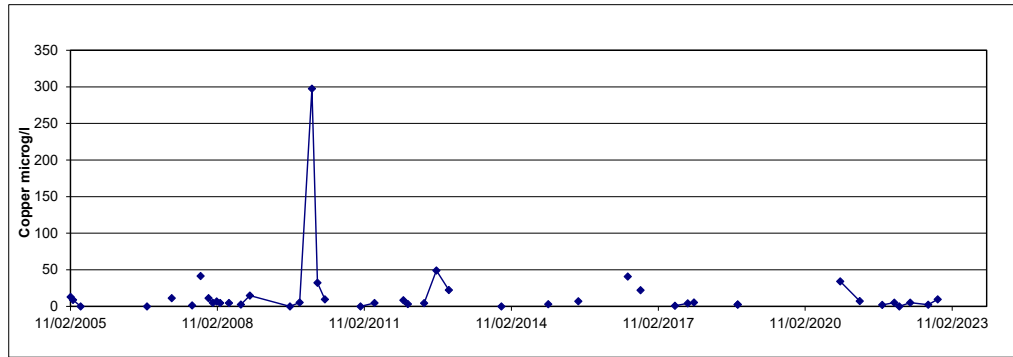
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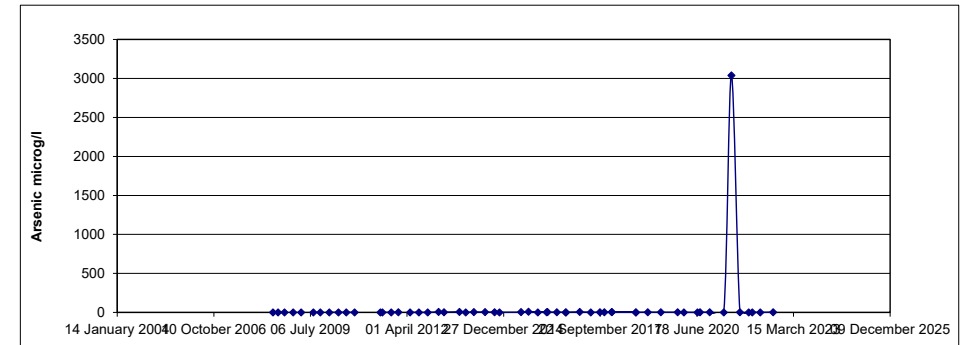
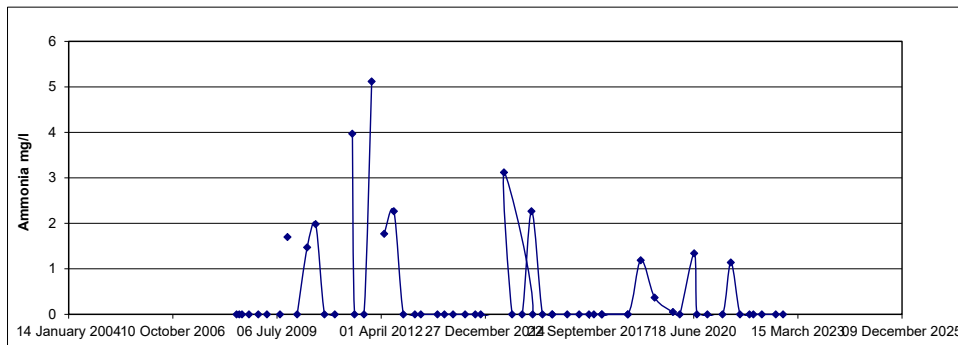
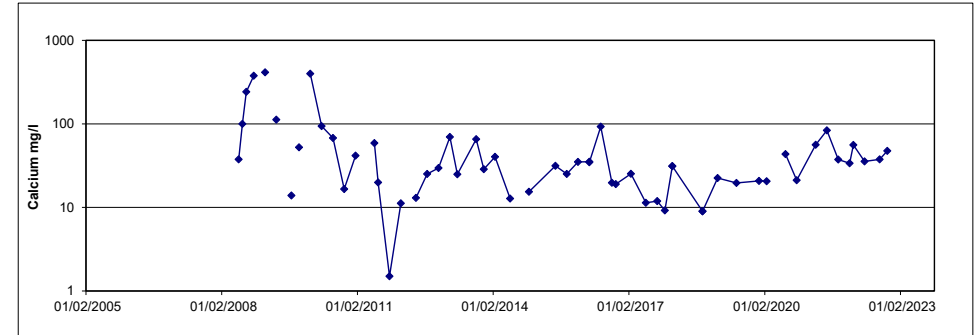
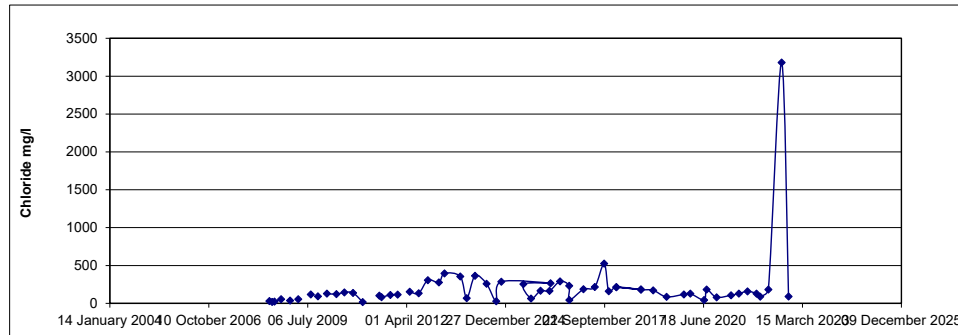
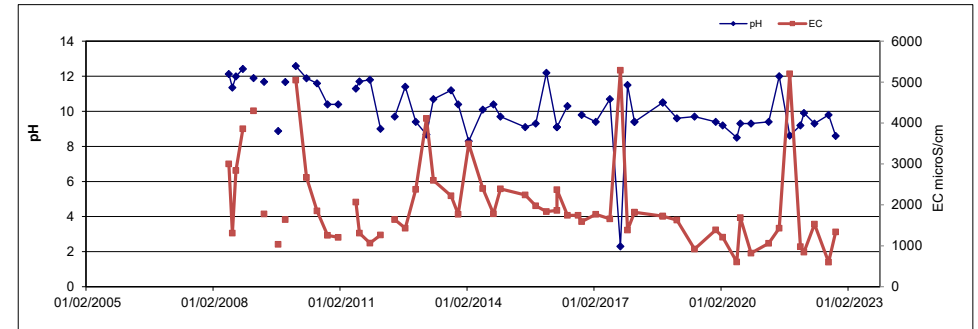
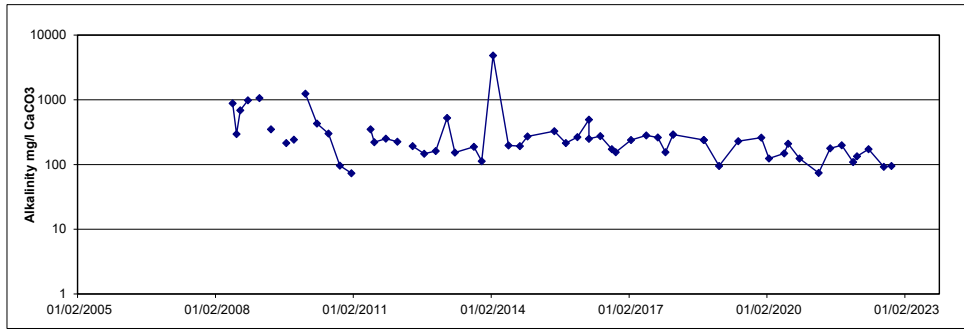
**2022 Annual Review of
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Monitoring**

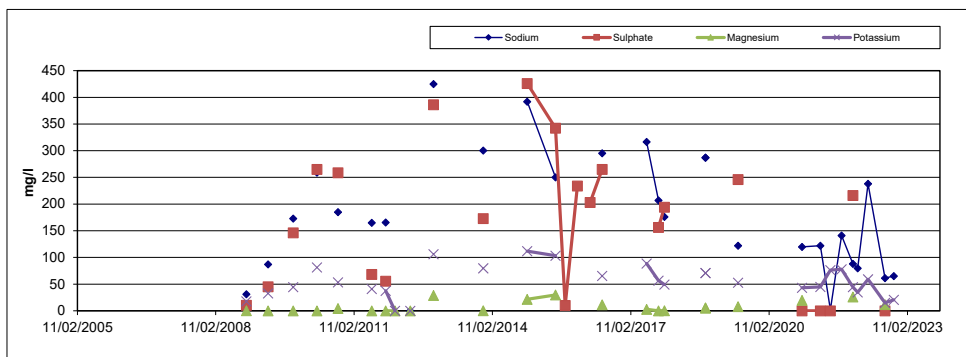
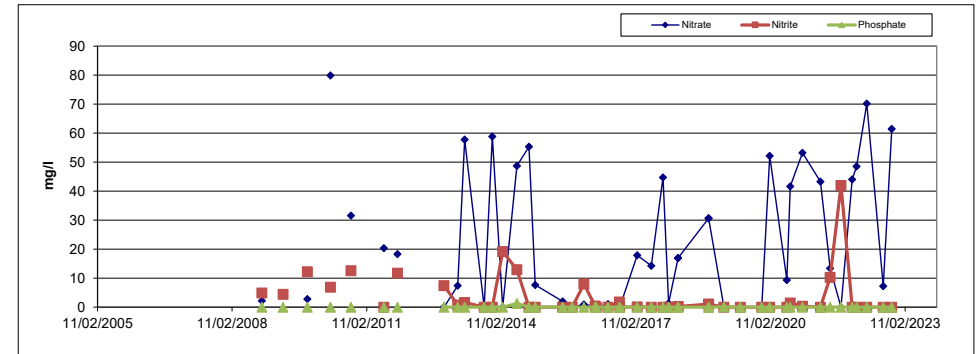
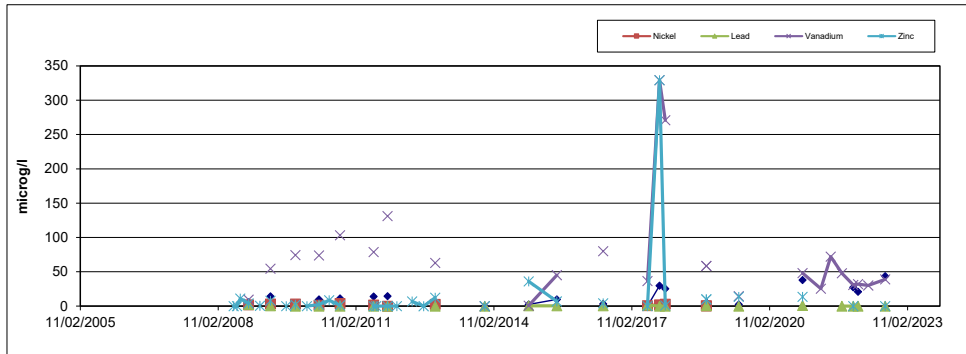
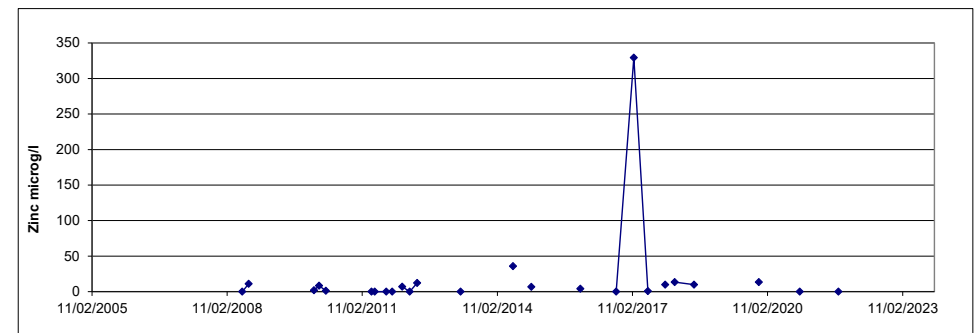
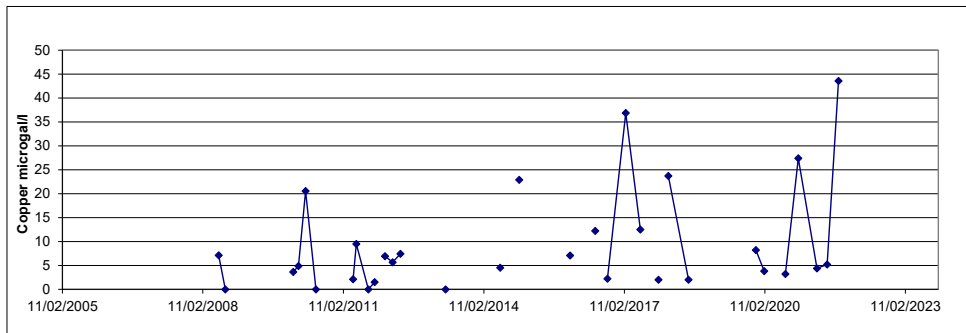
**Appendix 3
Temporal Variation of
Leachate Chemistry**

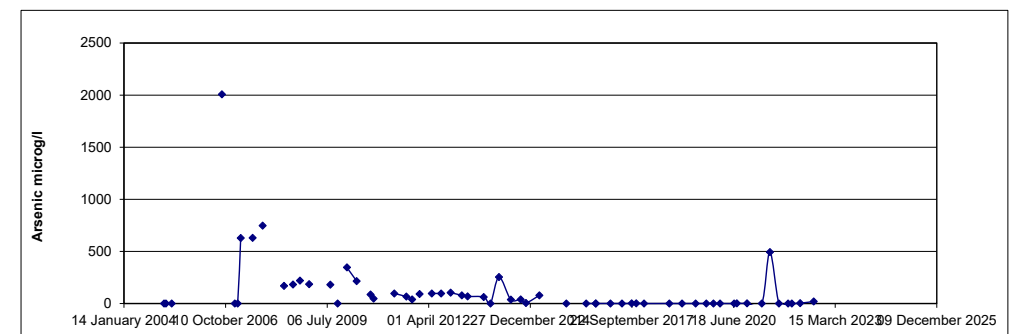
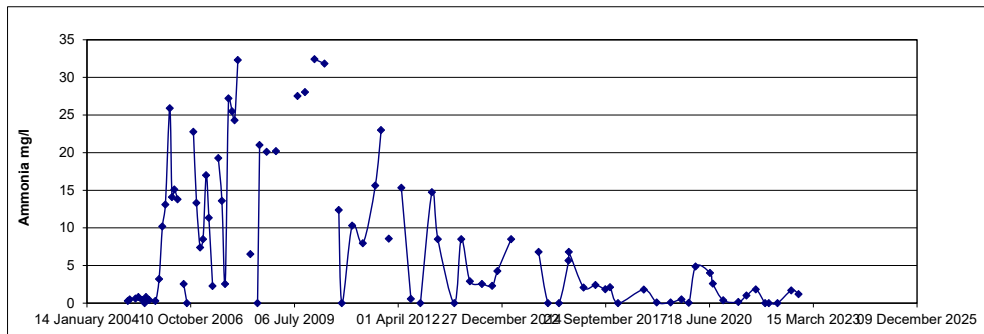
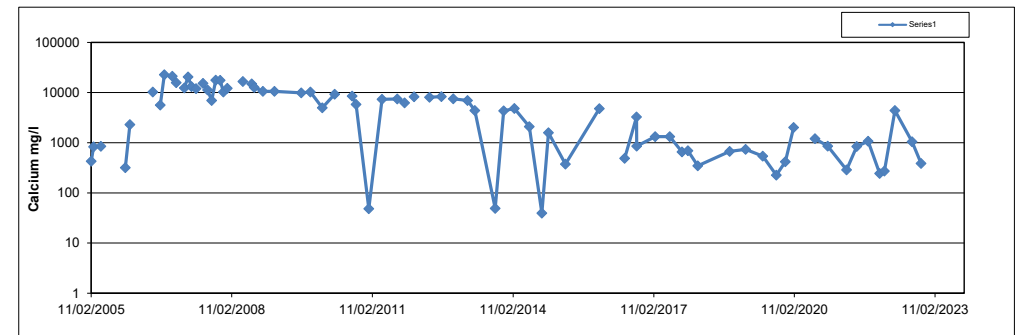
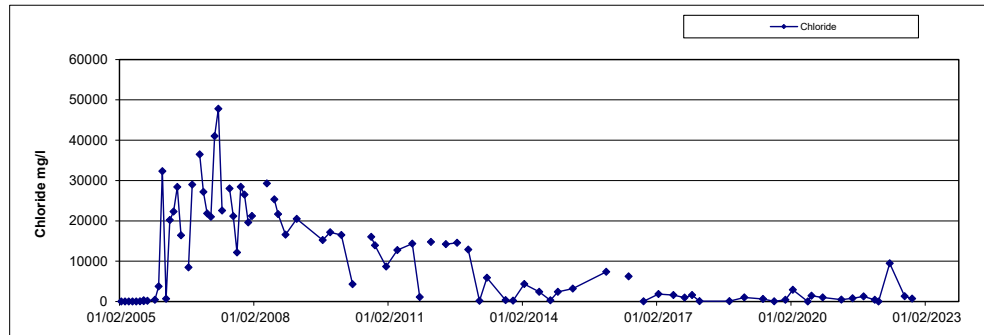
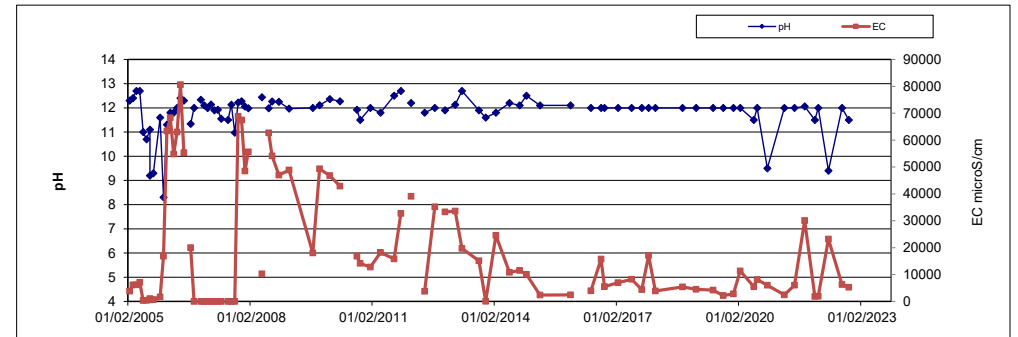
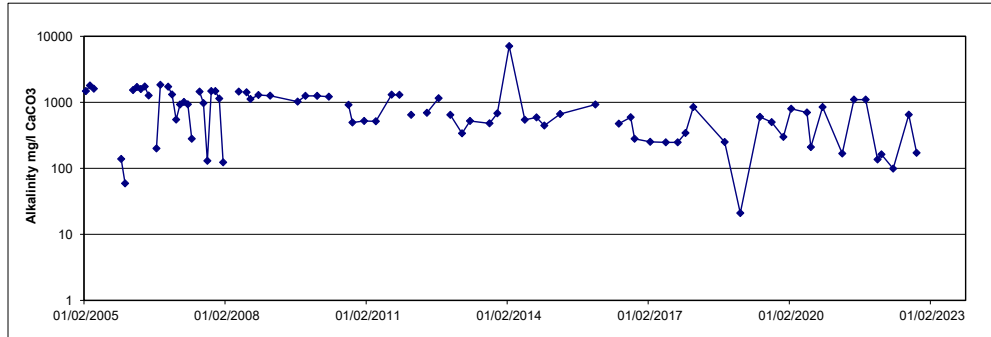
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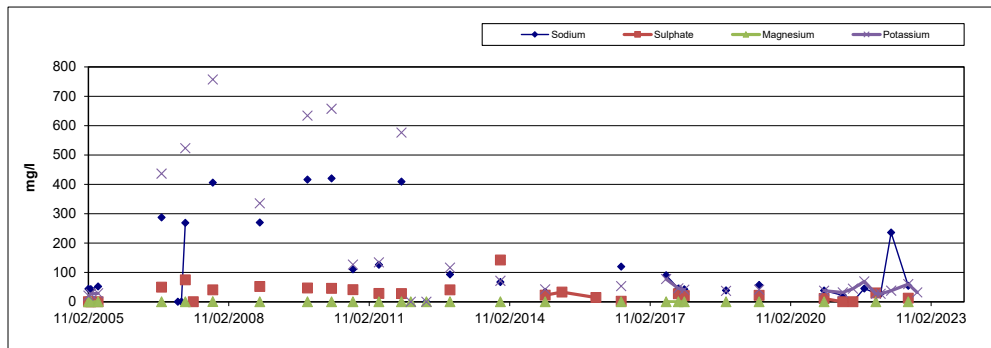
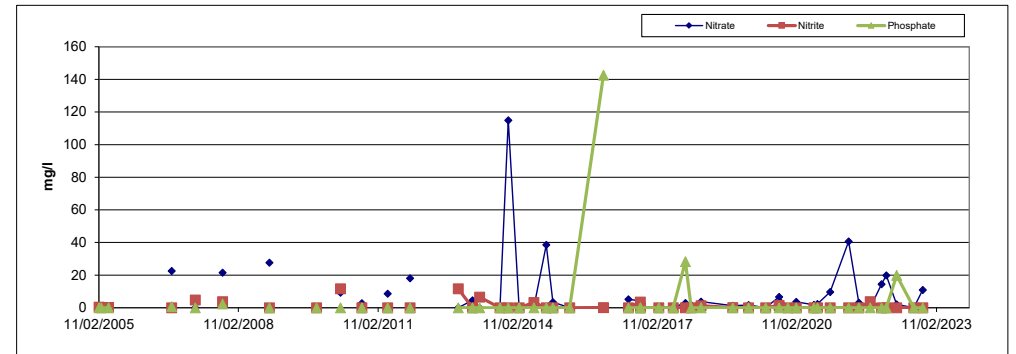
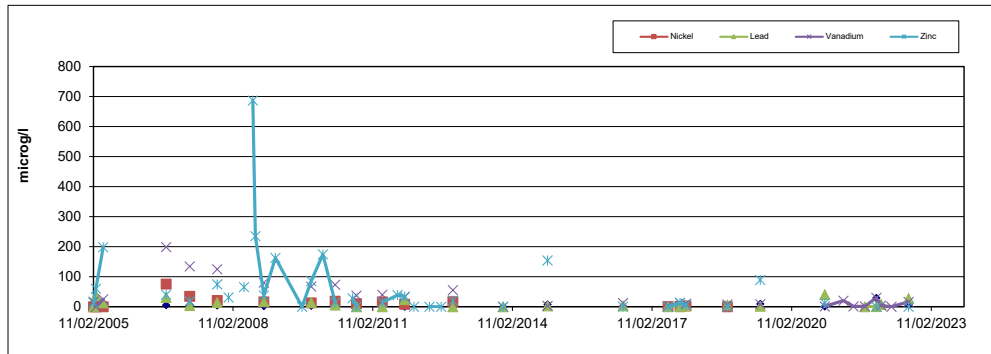
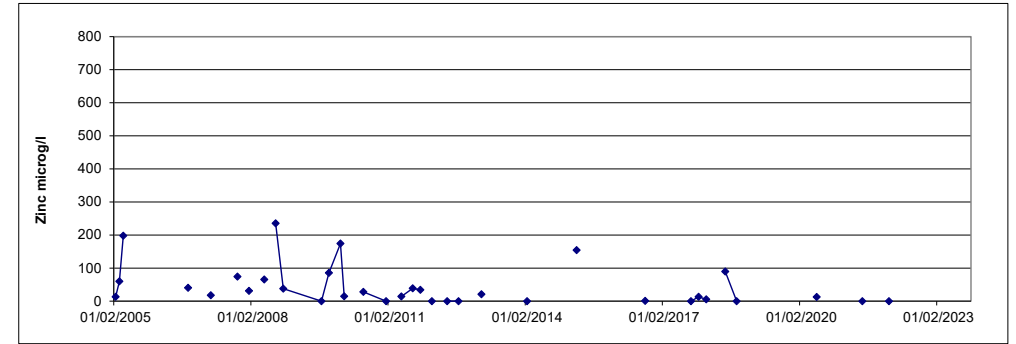
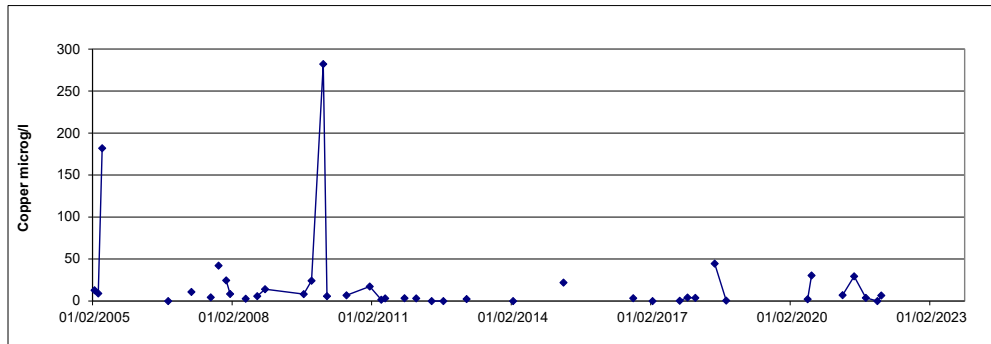


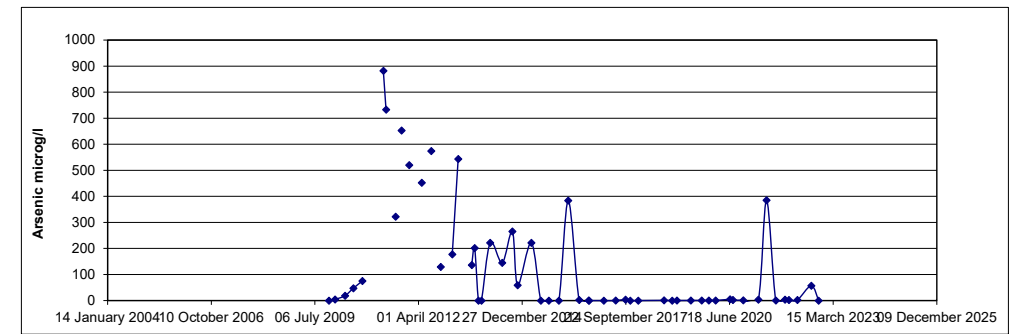
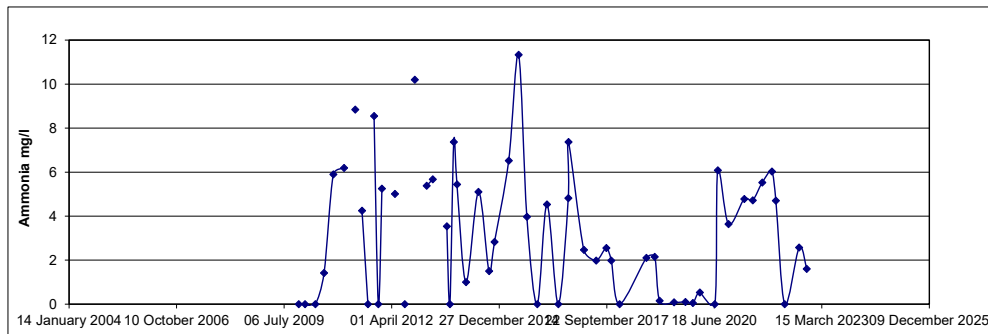
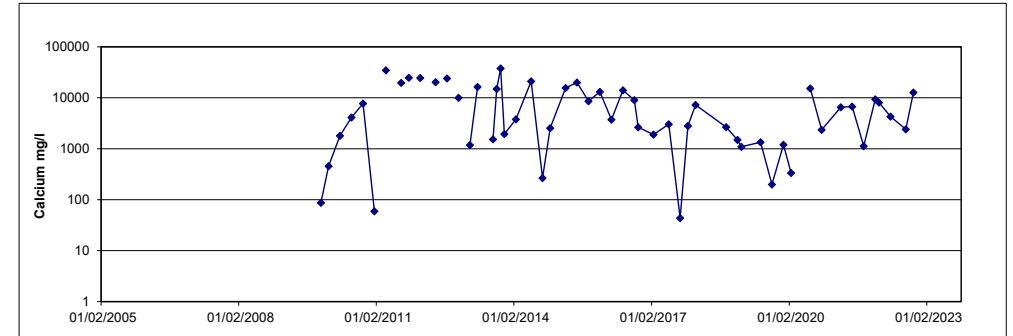
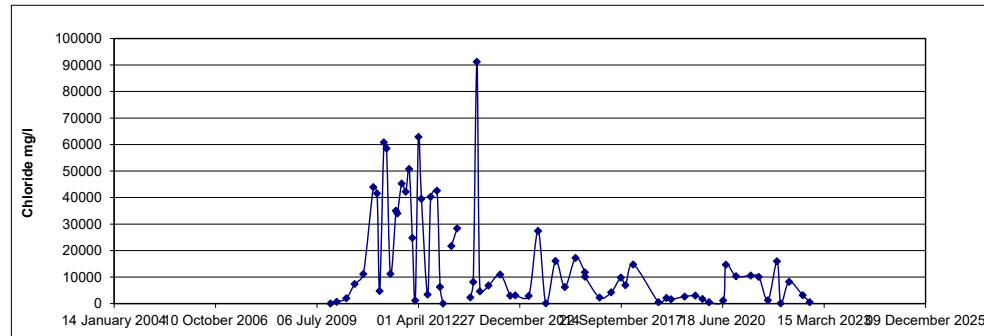
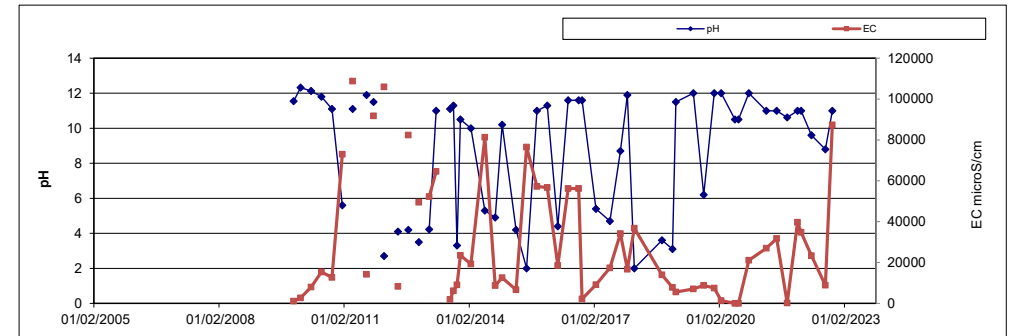
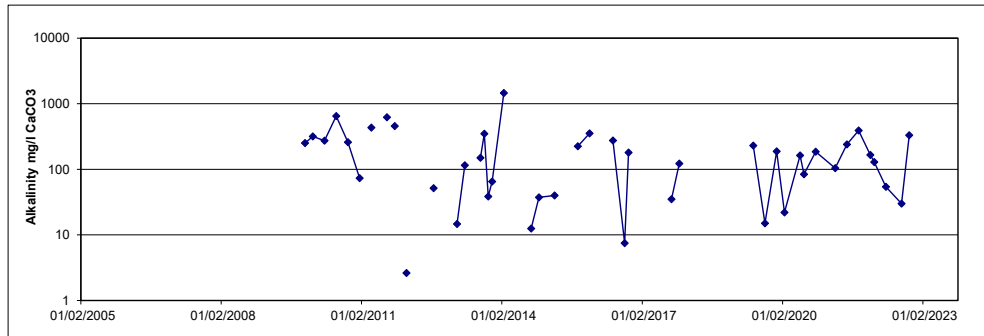


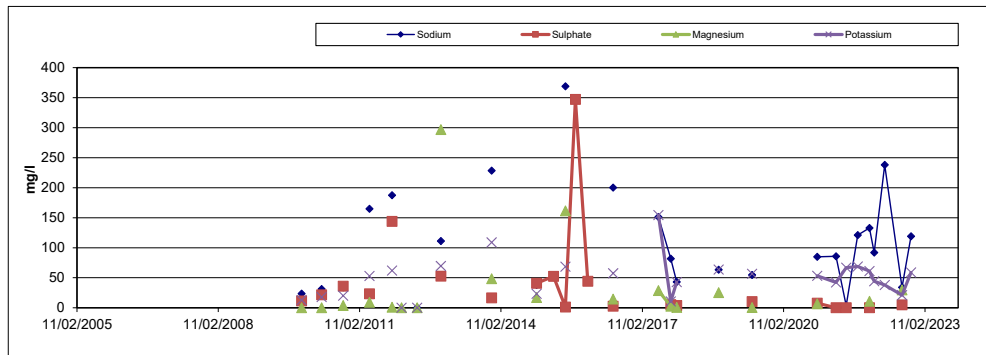
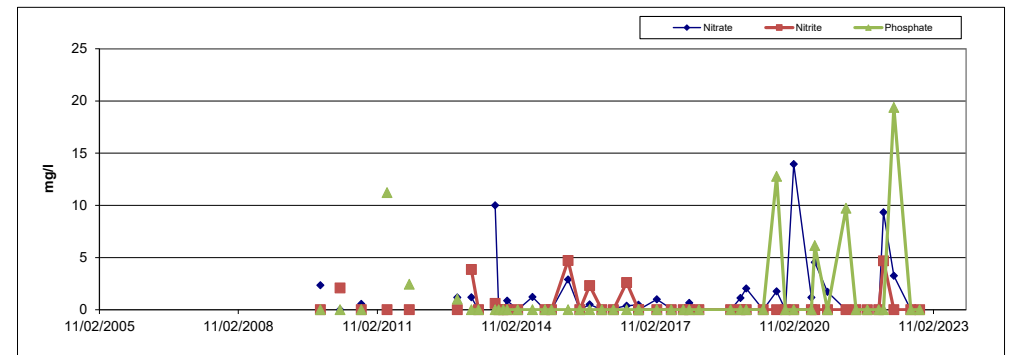
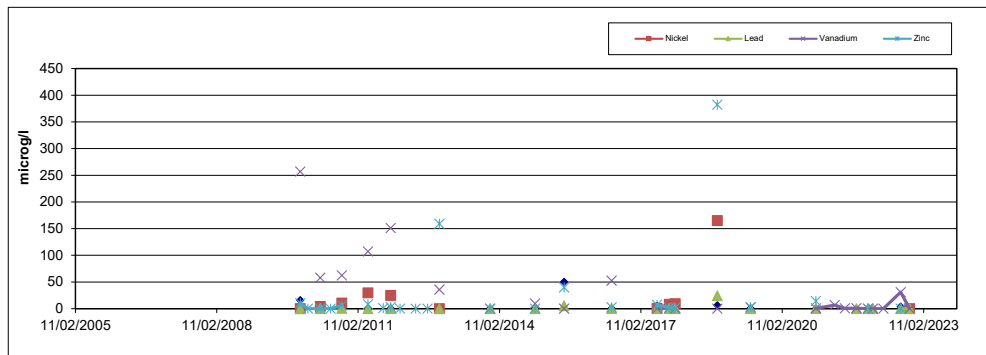
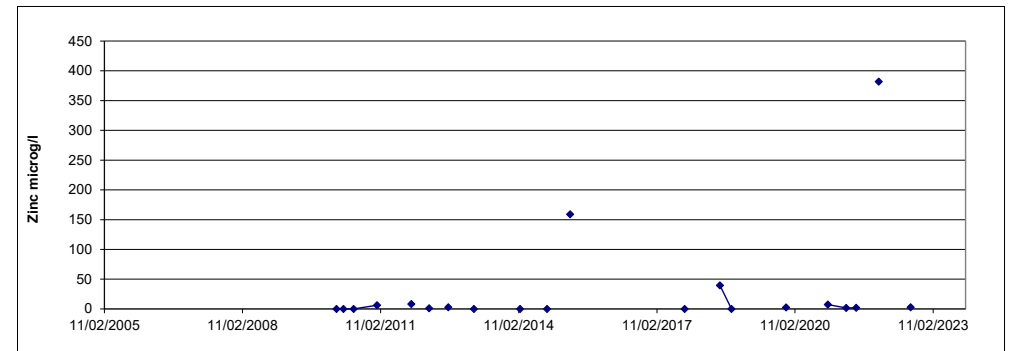
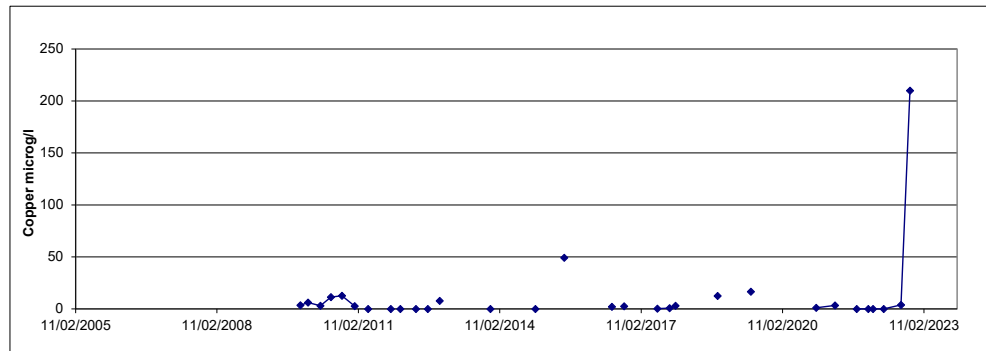












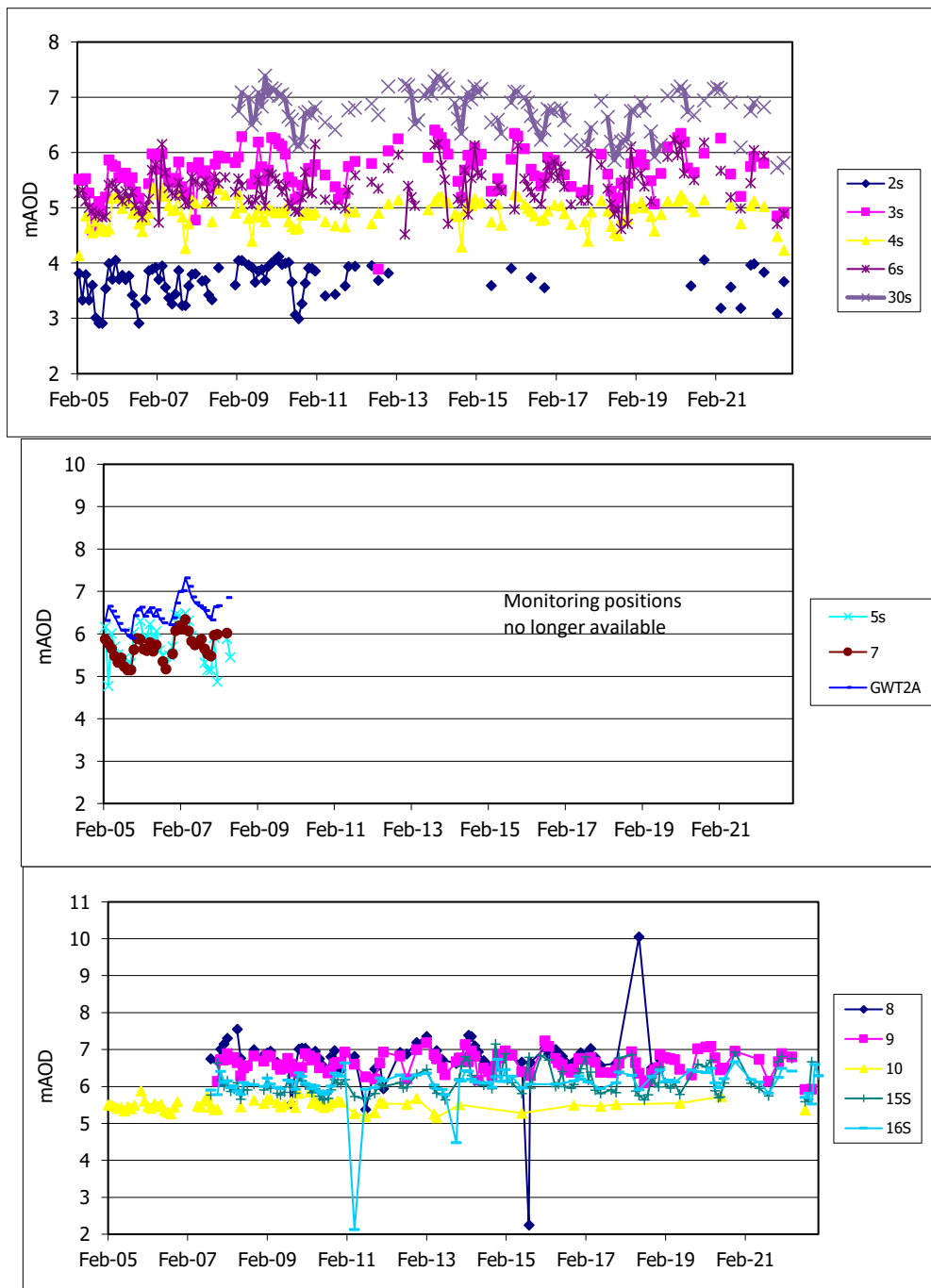
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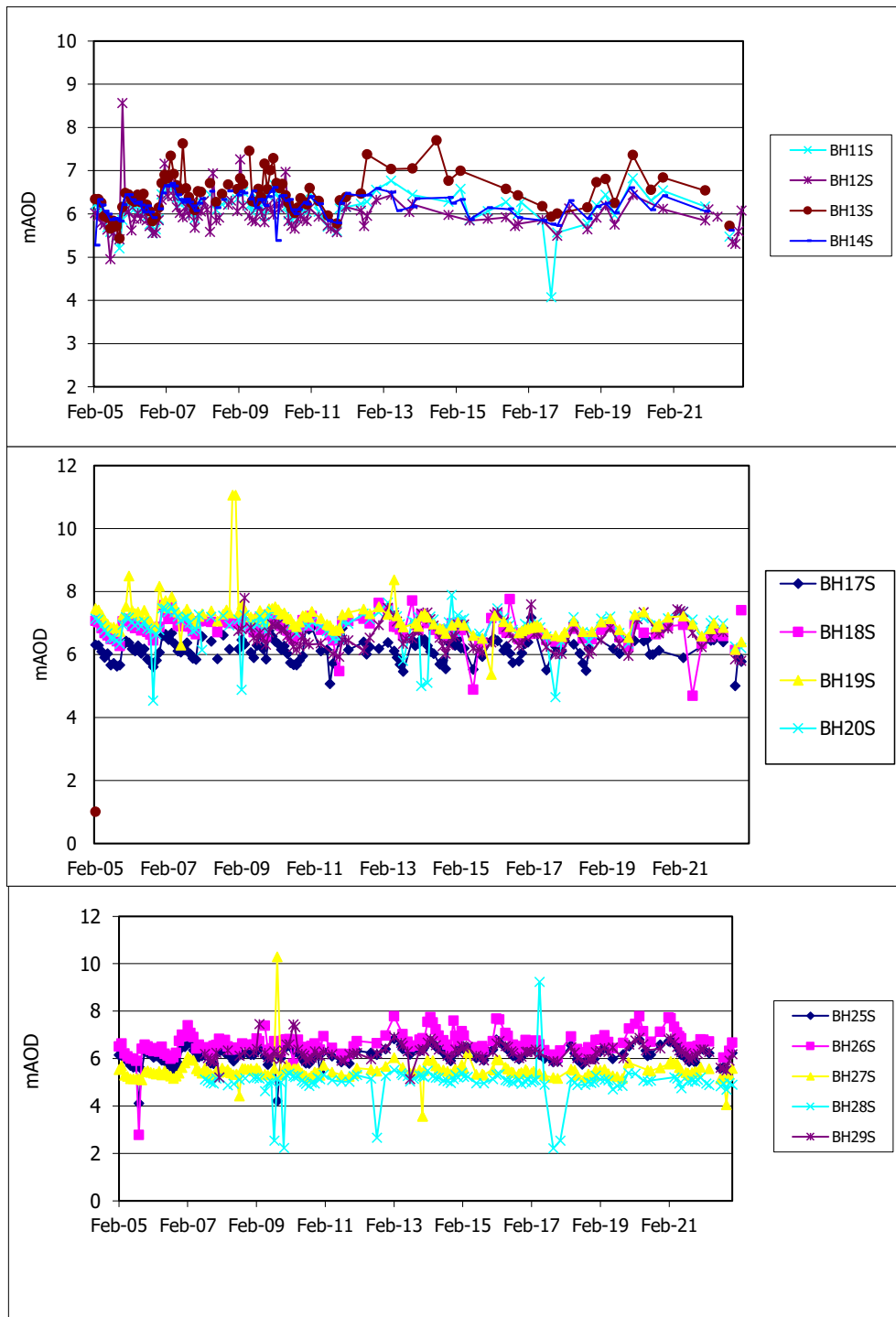
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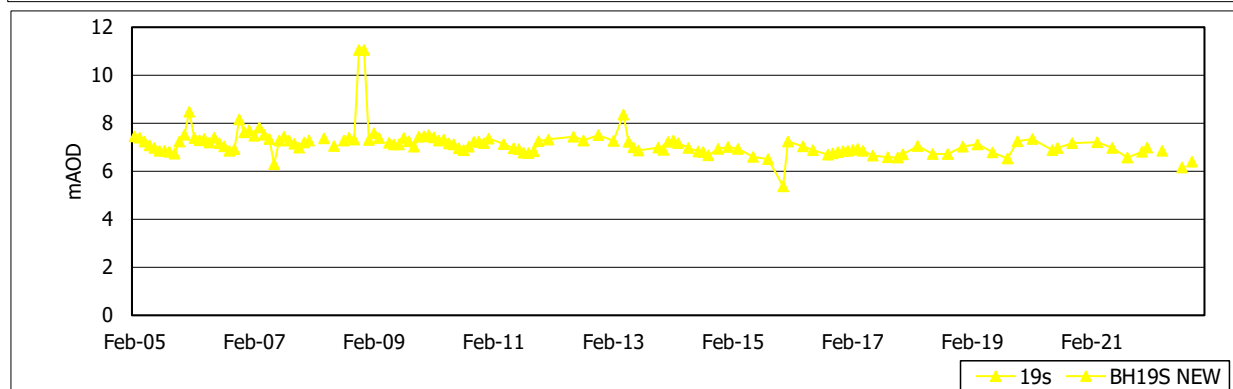
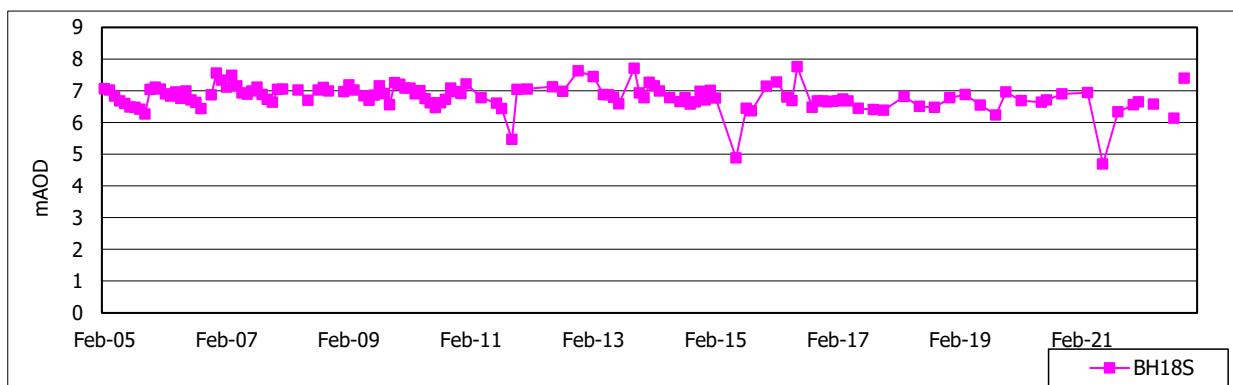
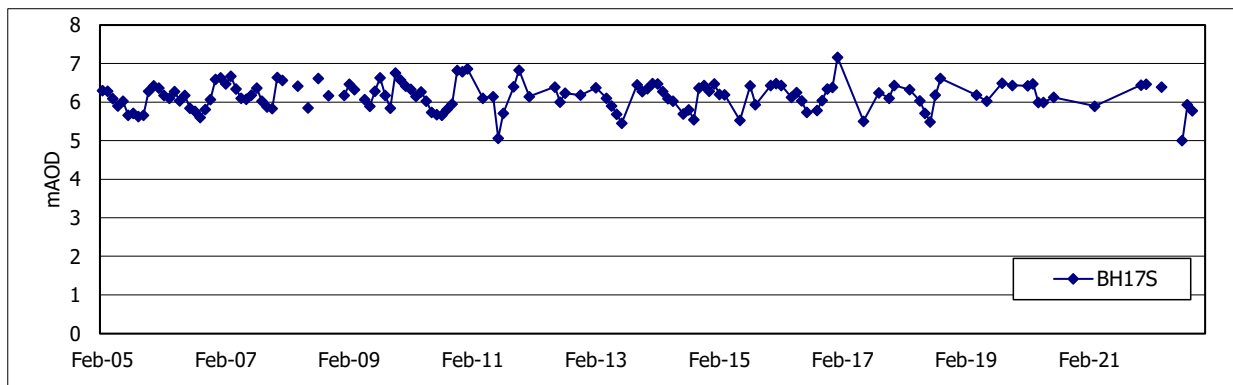
**2022 Annual Review of
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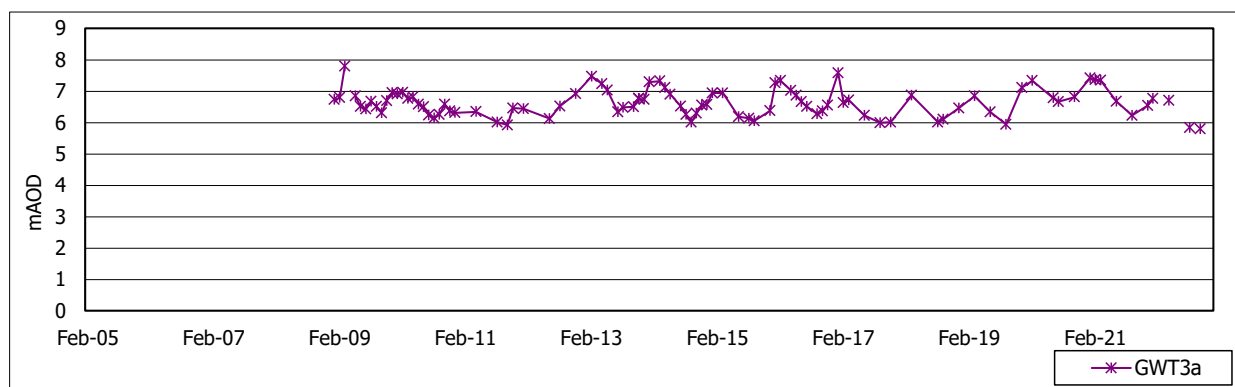
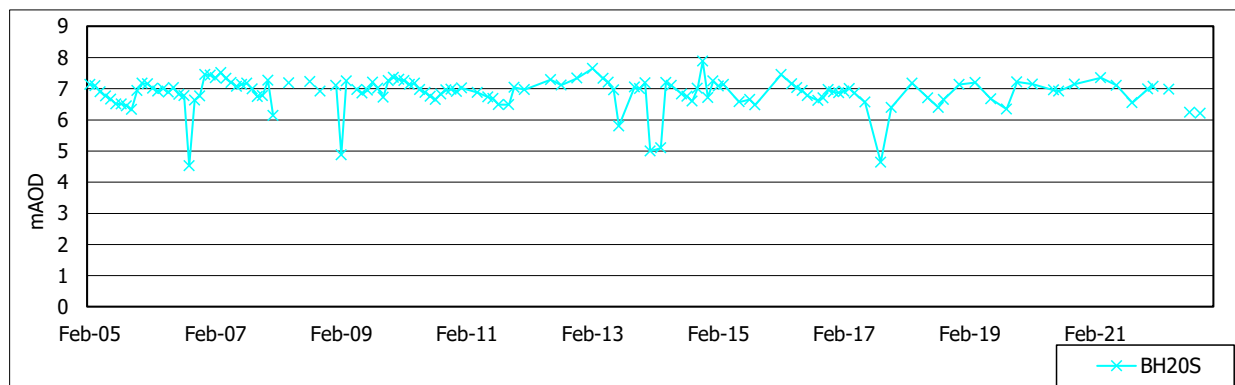
**Appendix 4
Temporal Variation of
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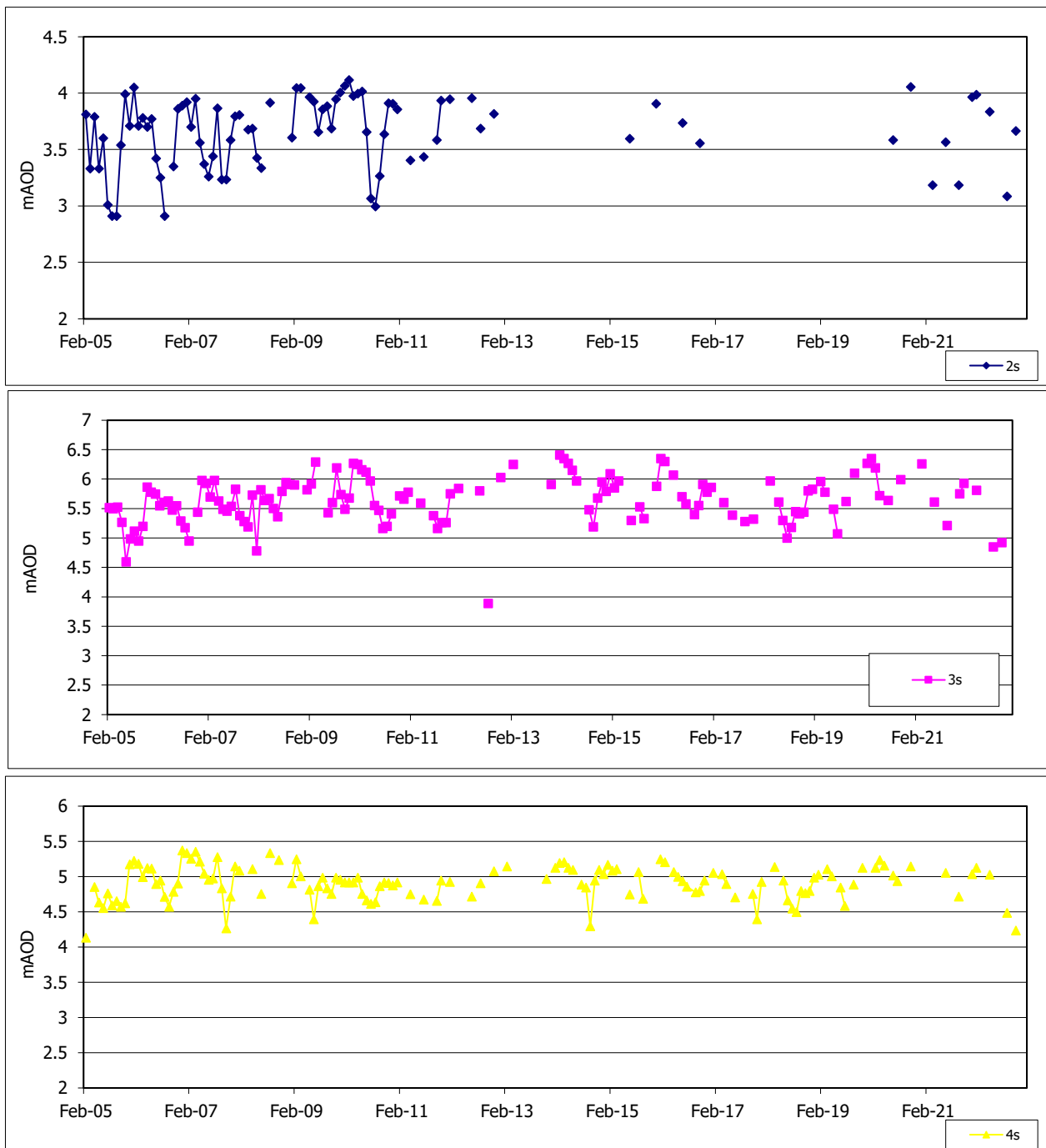
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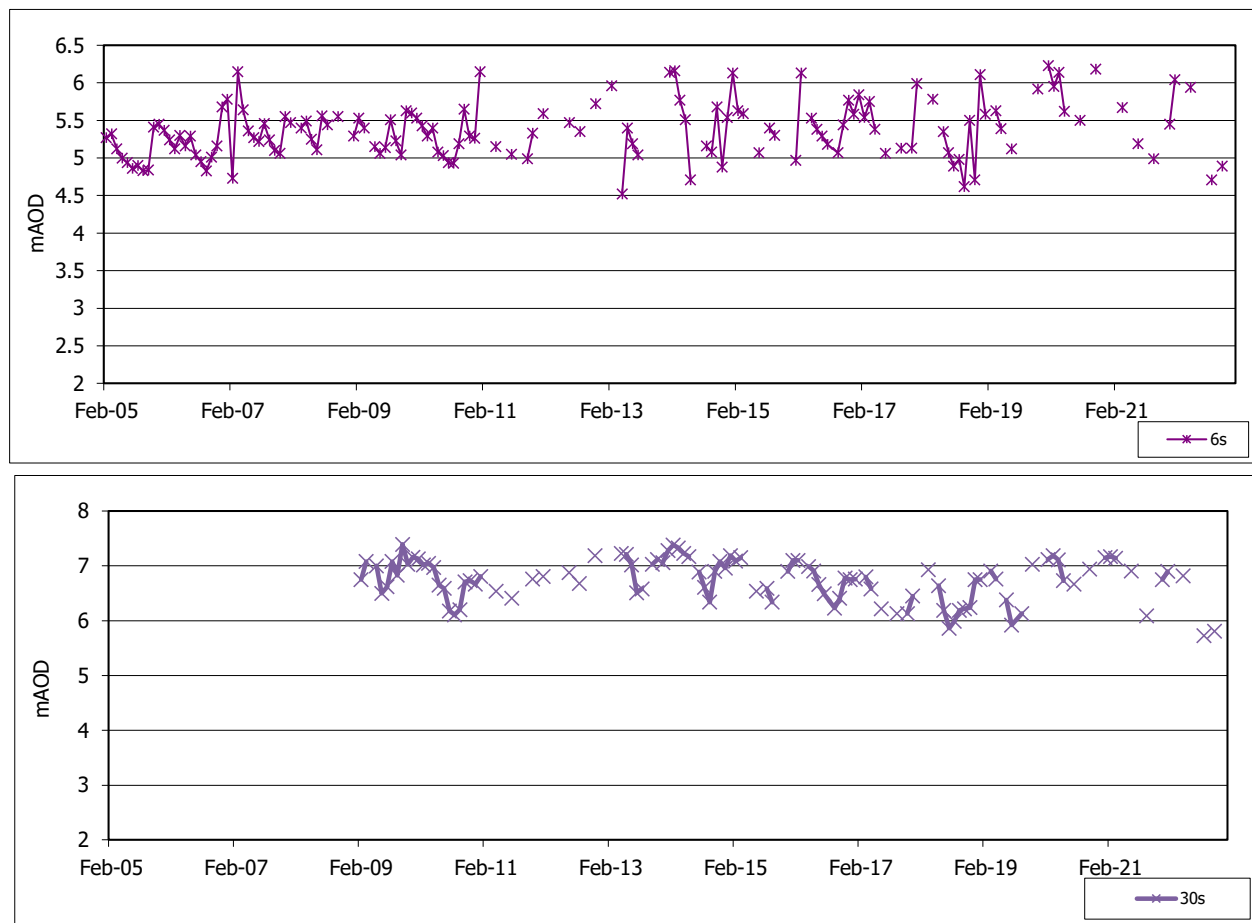


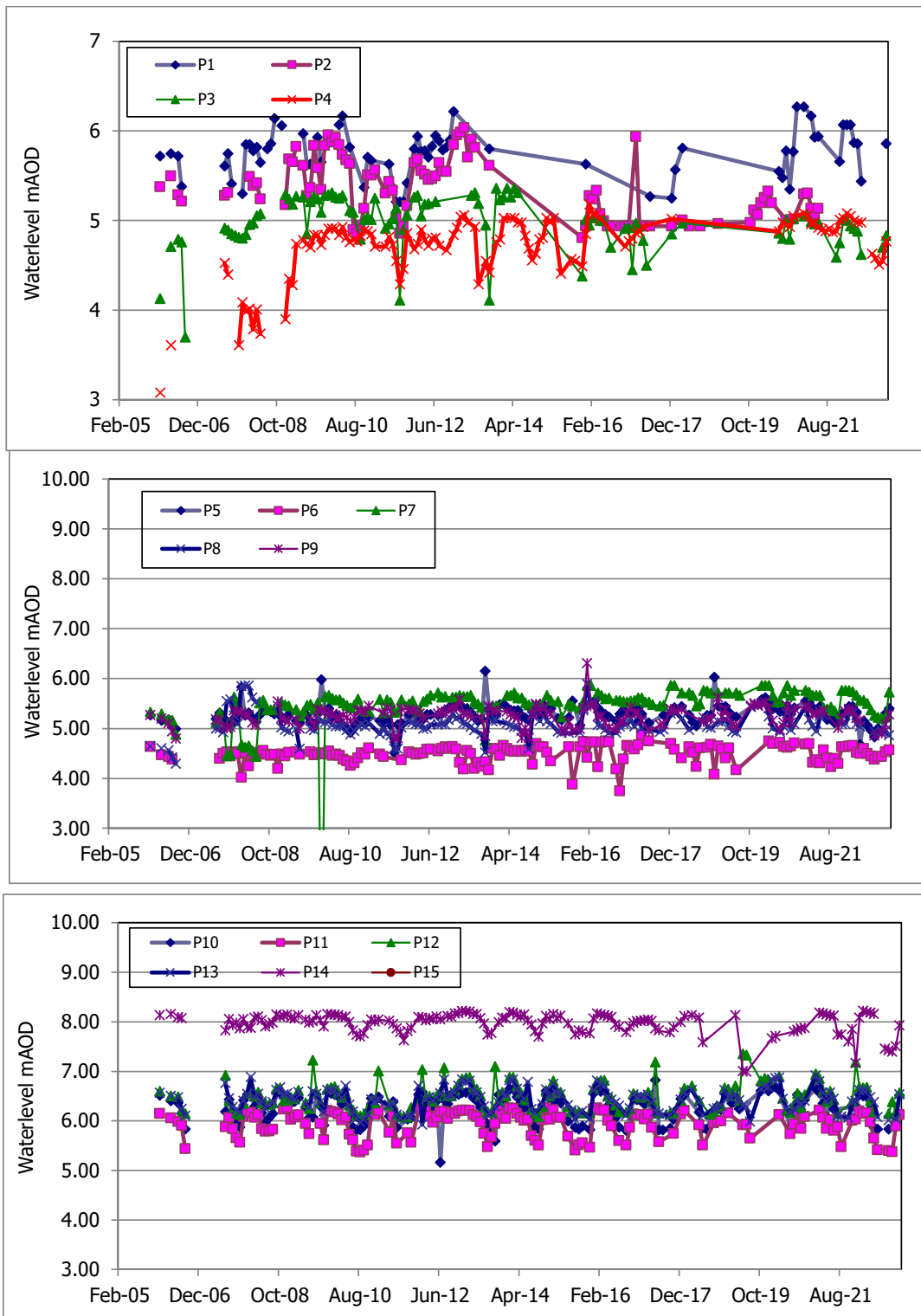


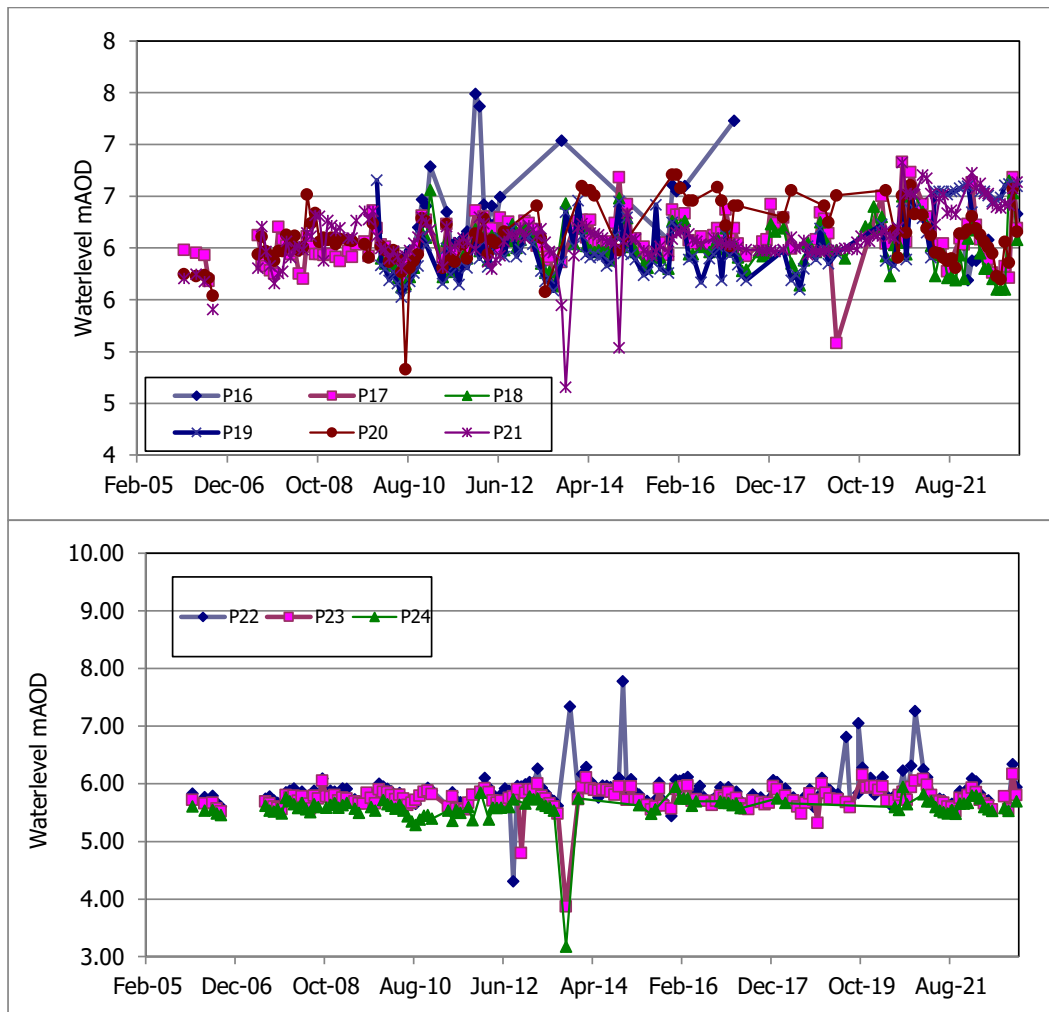


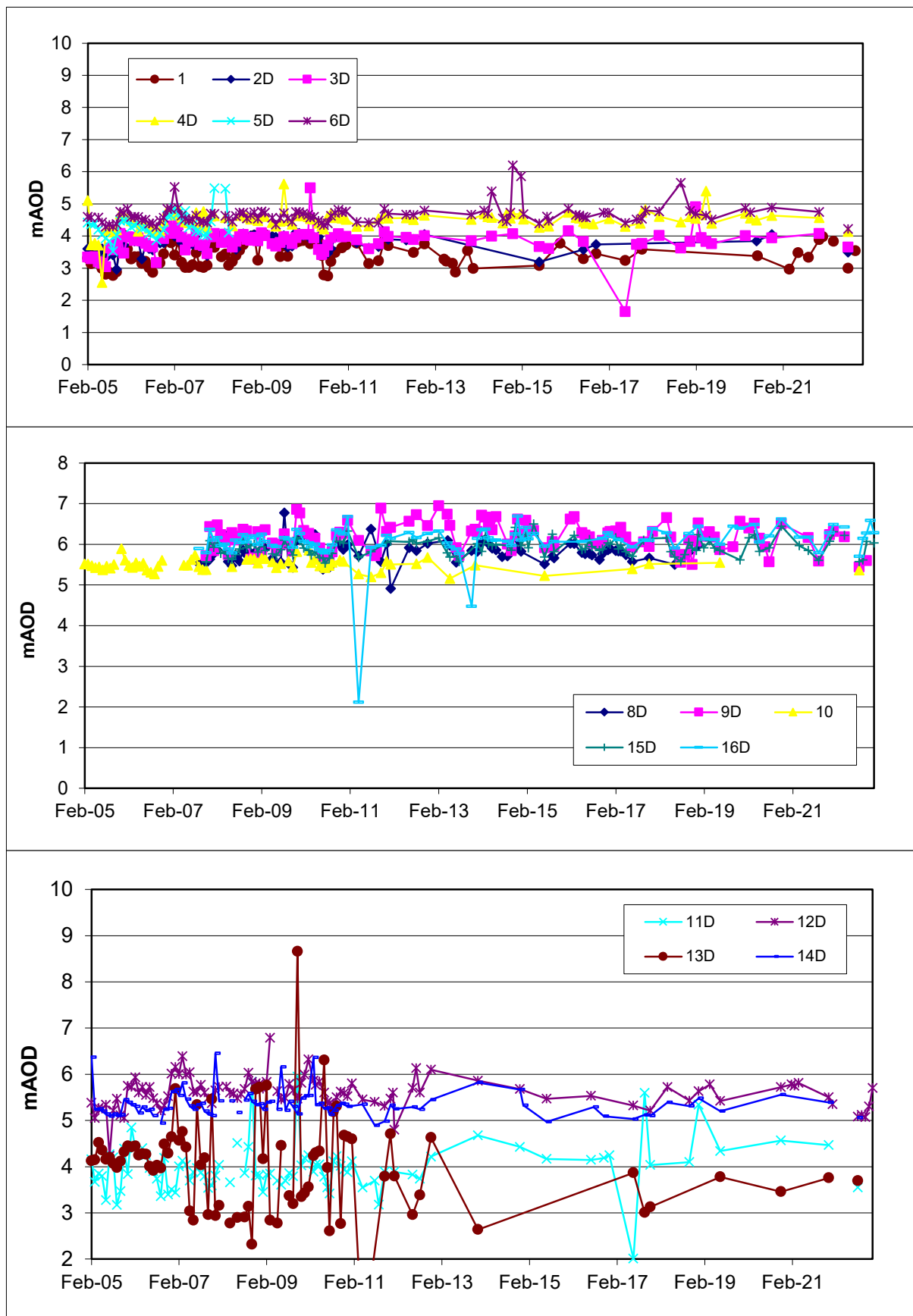


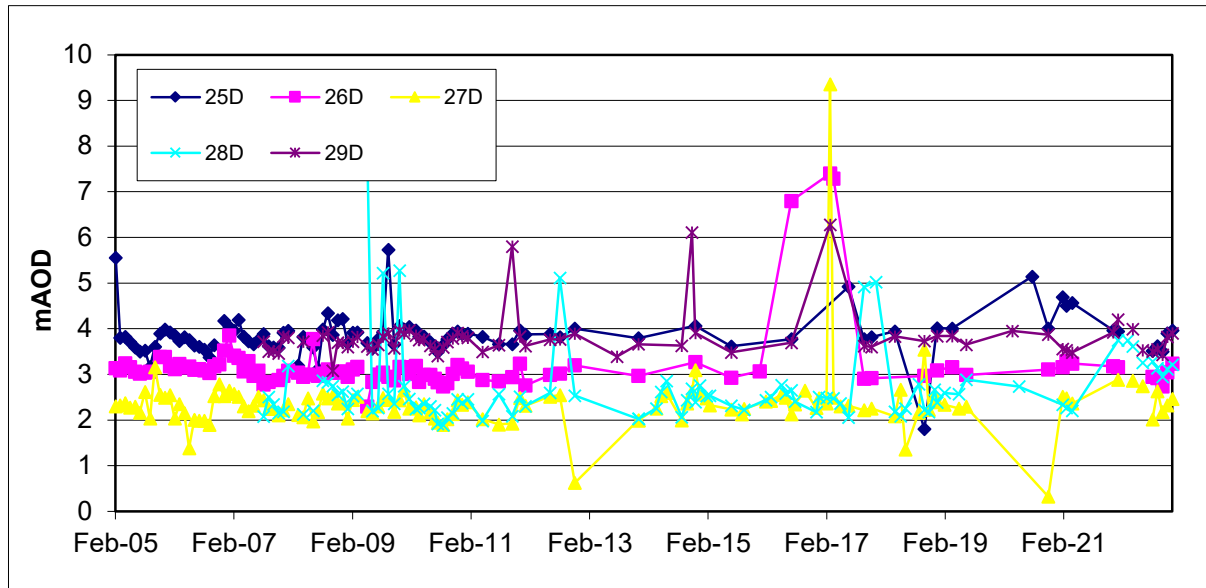
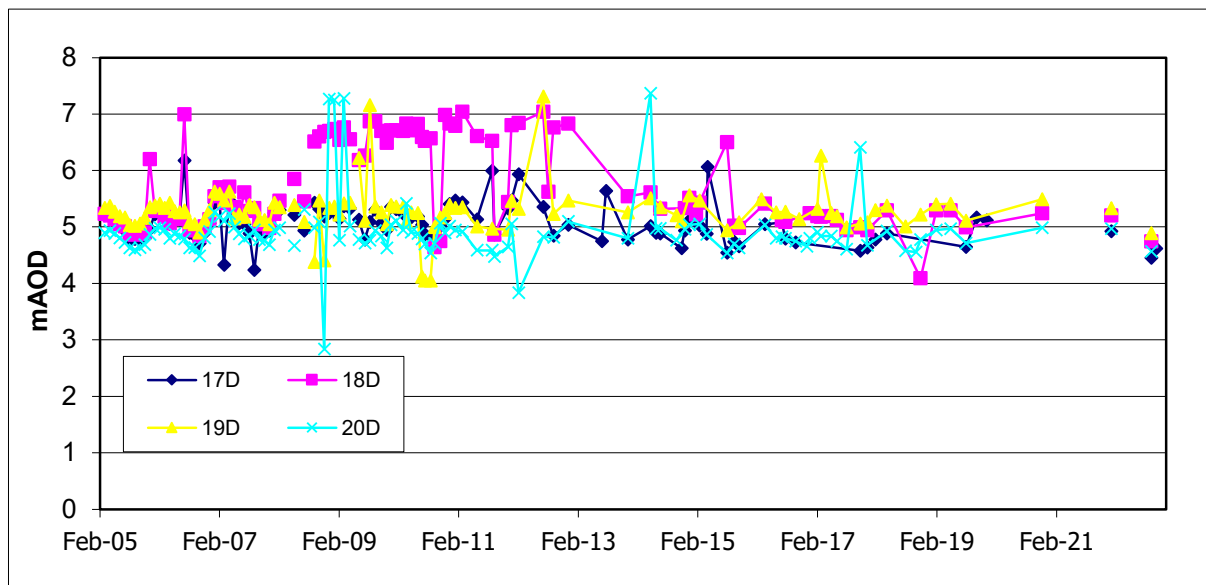












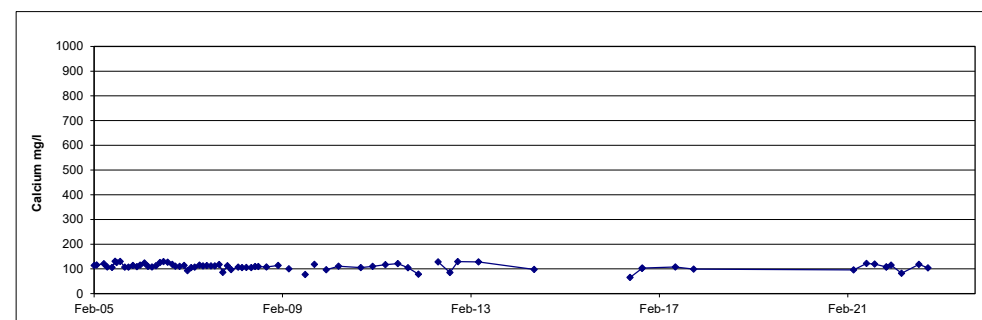
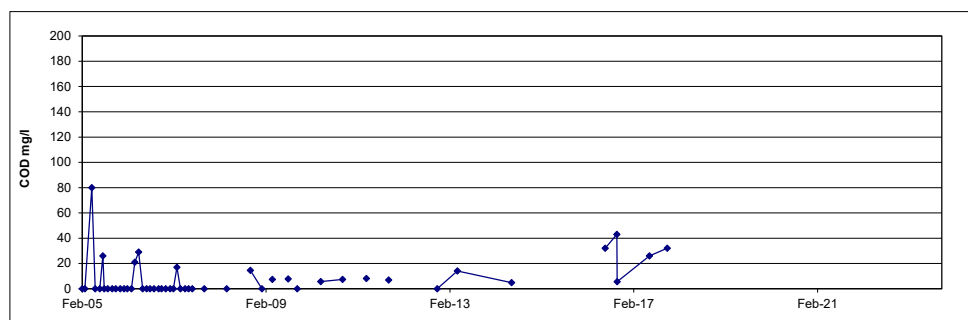
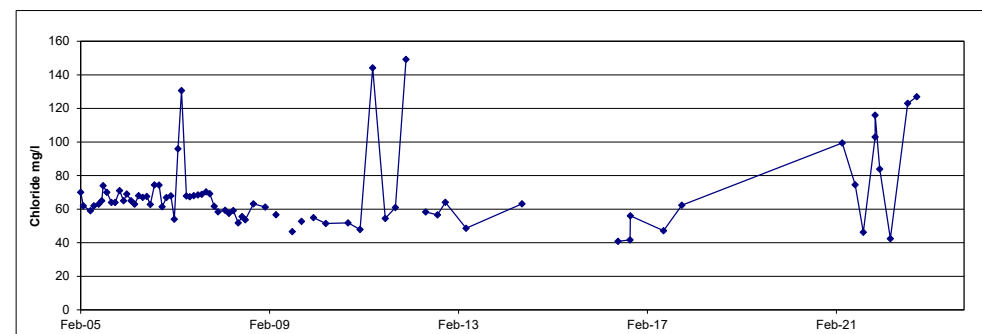
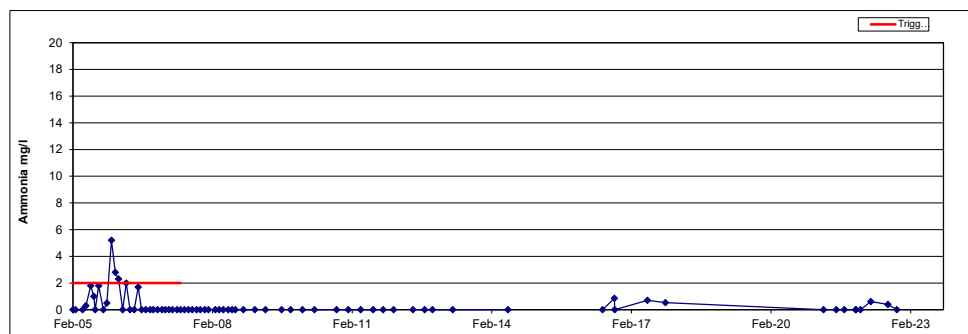
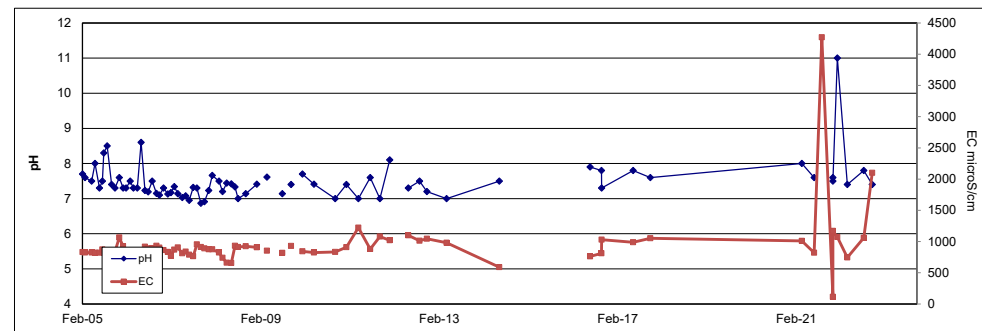
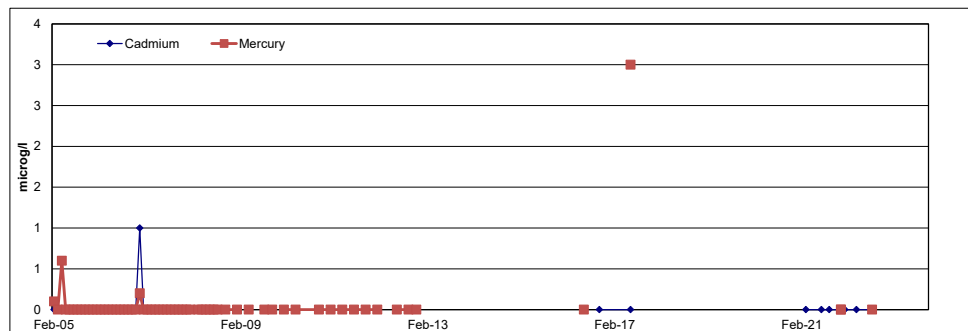
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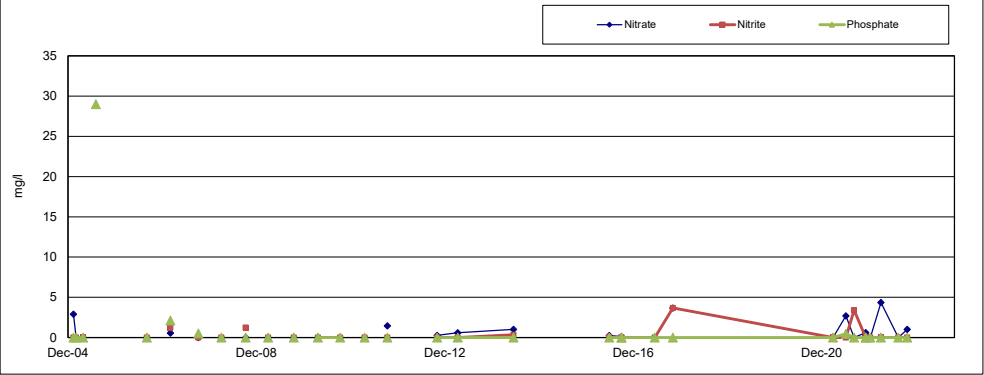
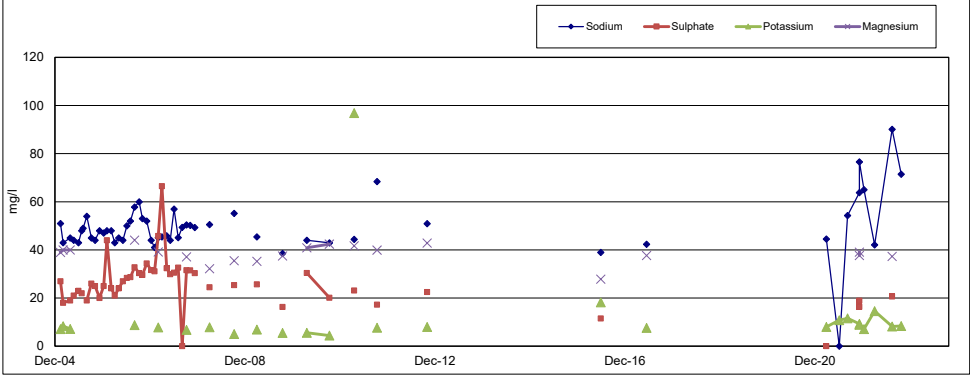
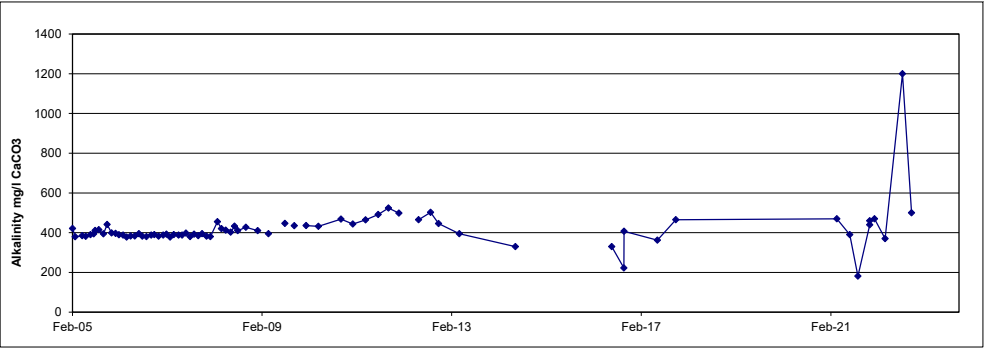
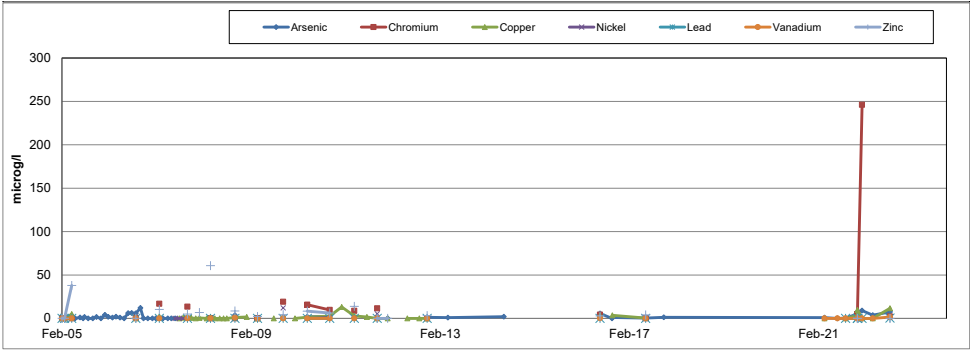
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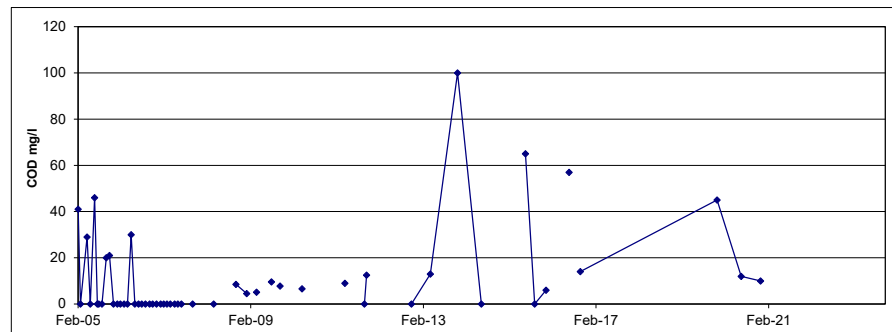
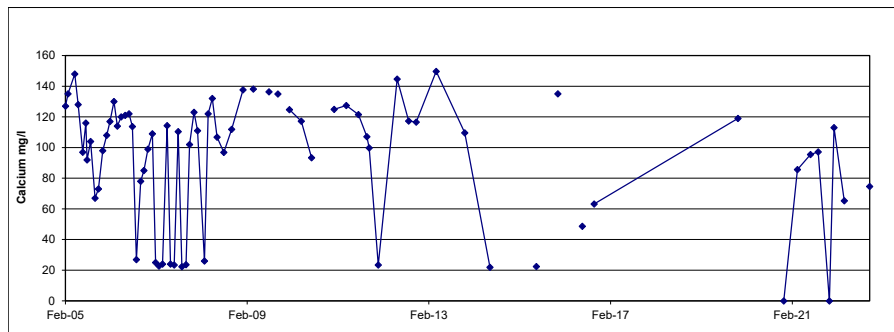
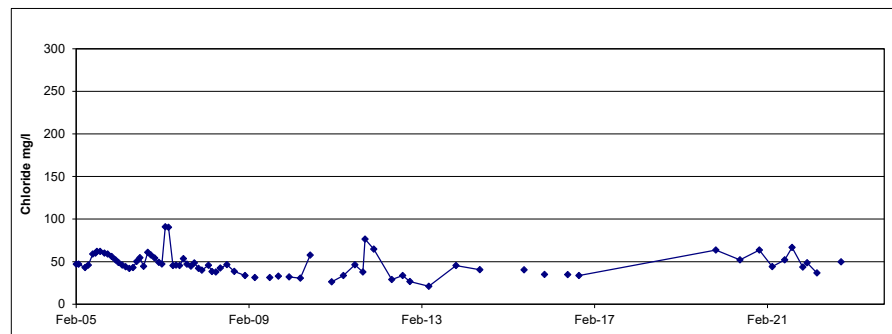
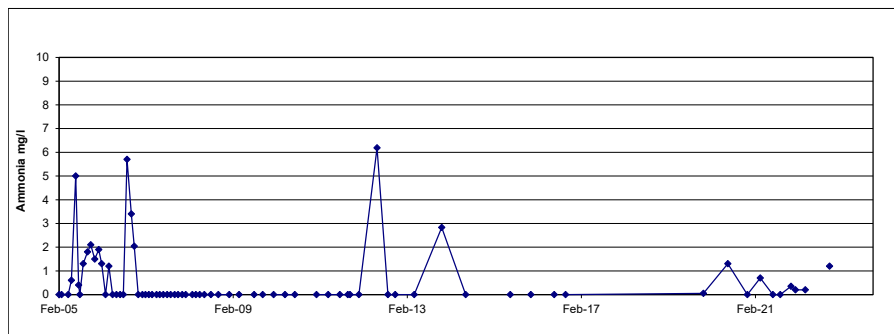
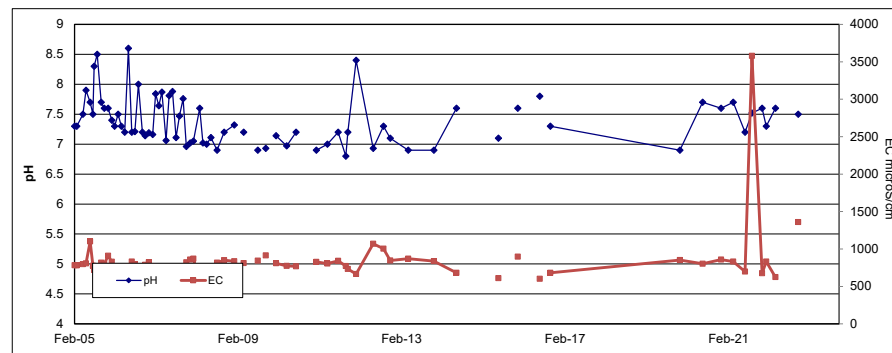
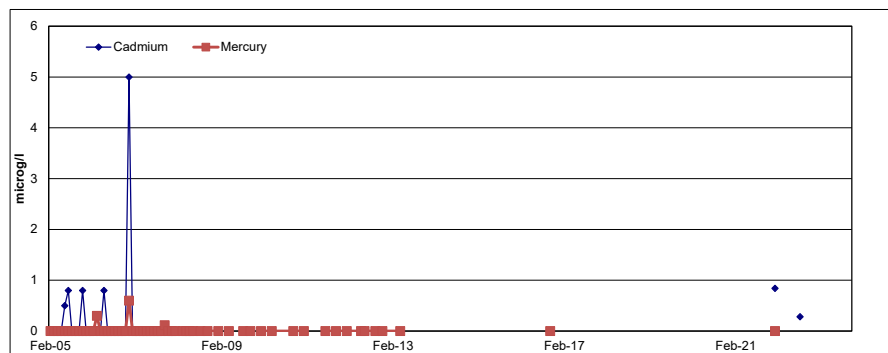
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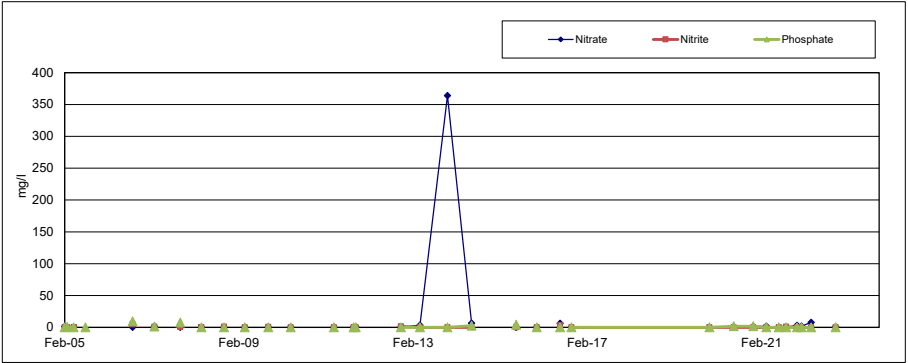
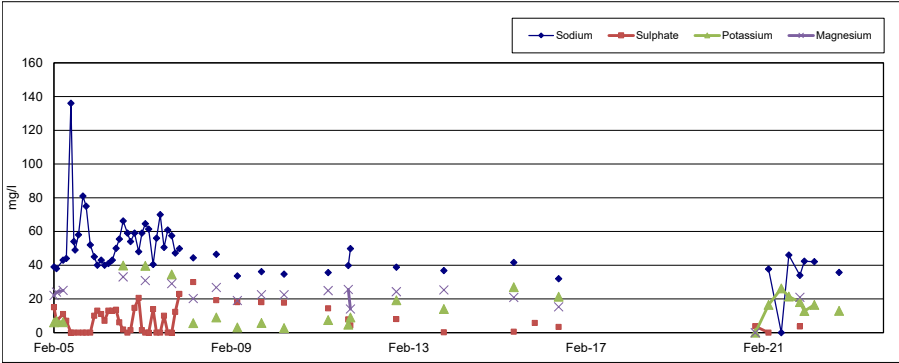
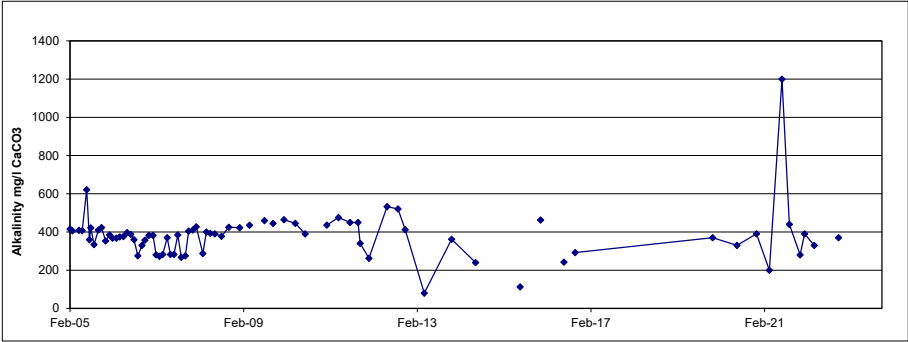
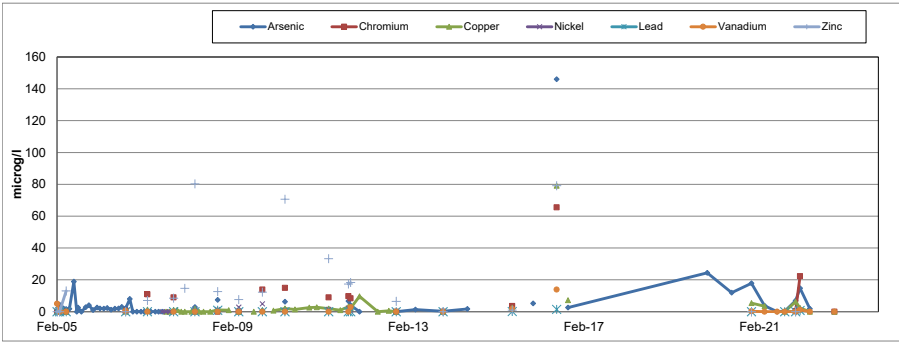
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Temporal Variation of
Groundwater Chemistry**

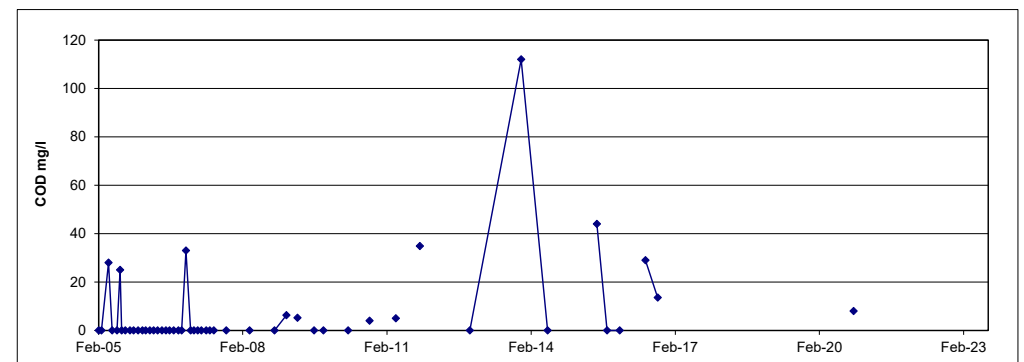
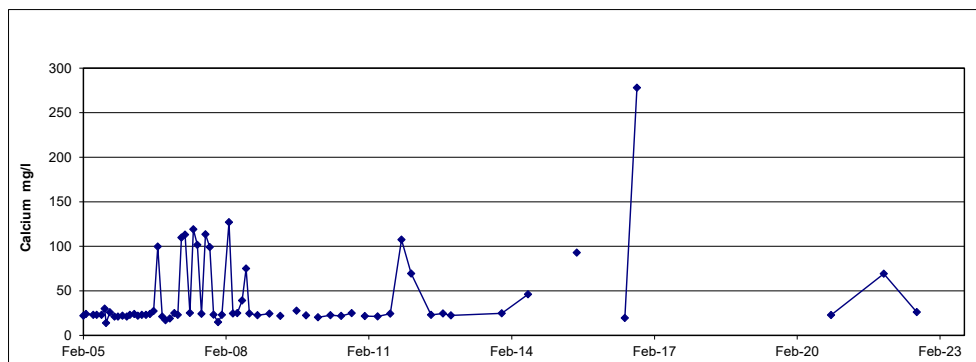
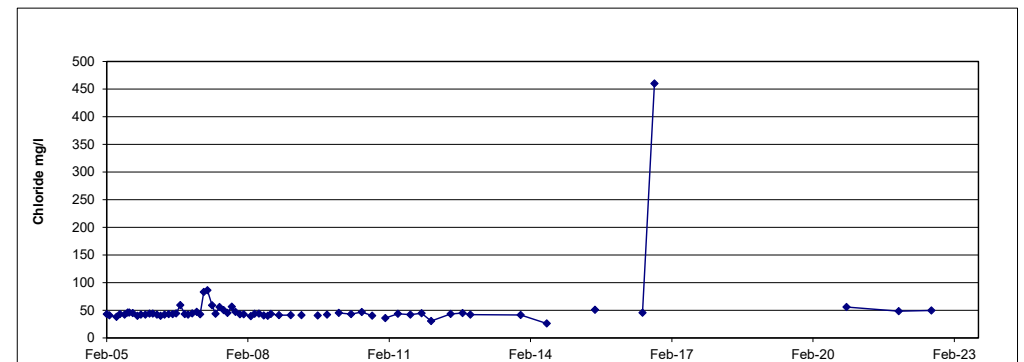
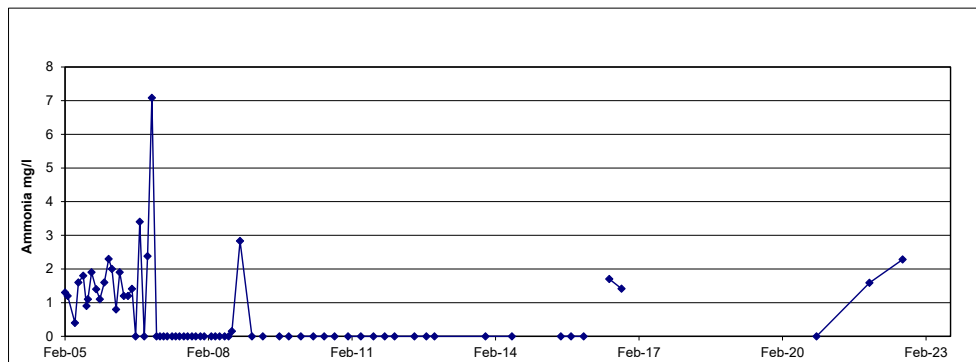
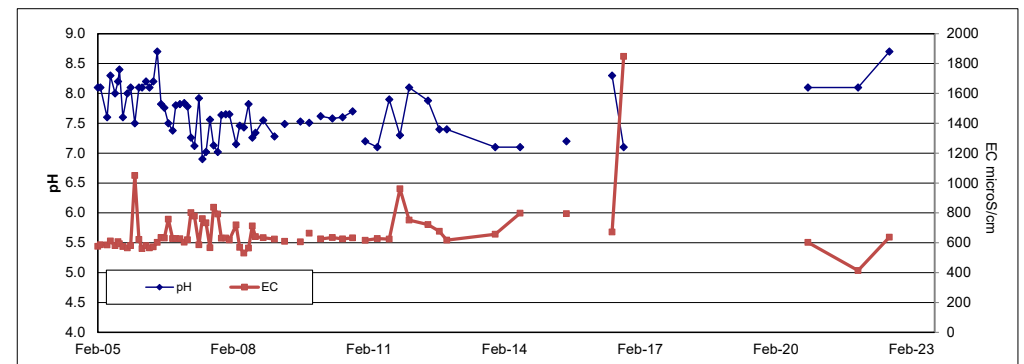
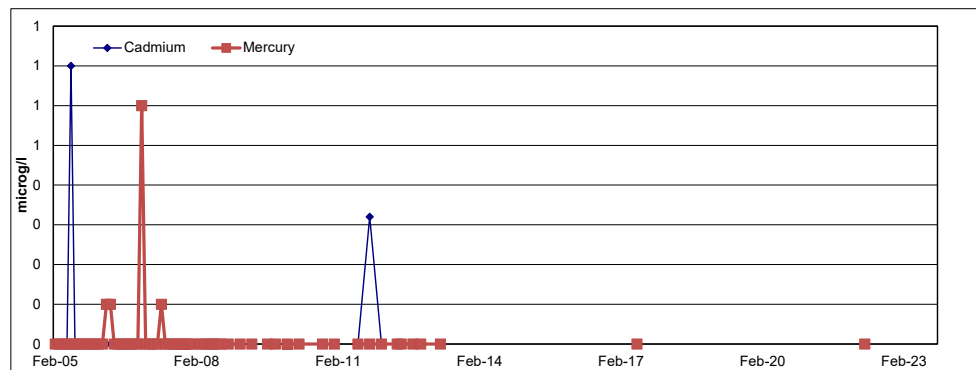
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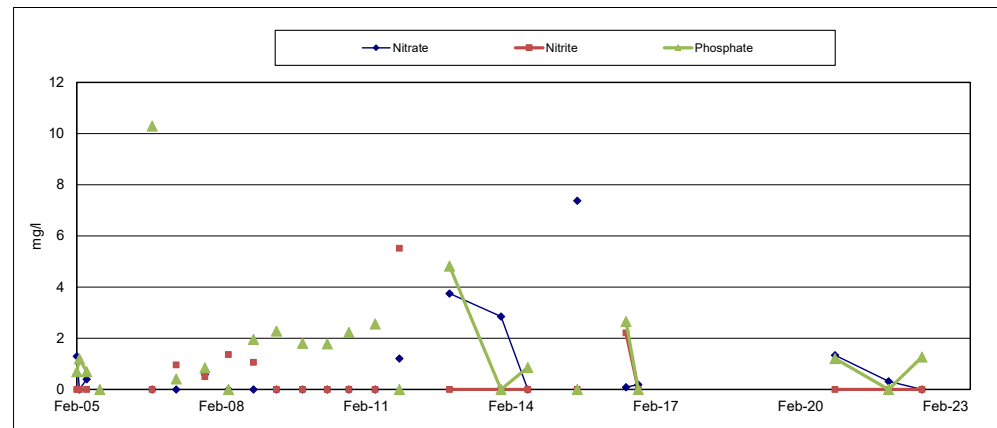
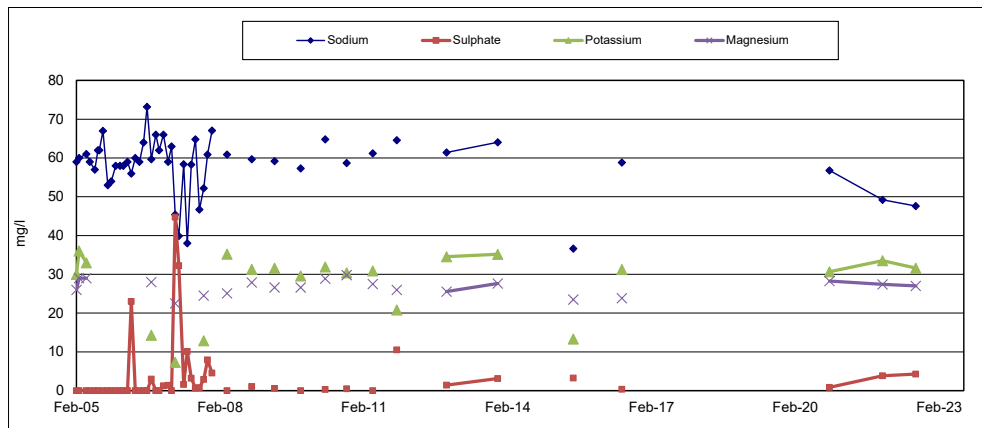
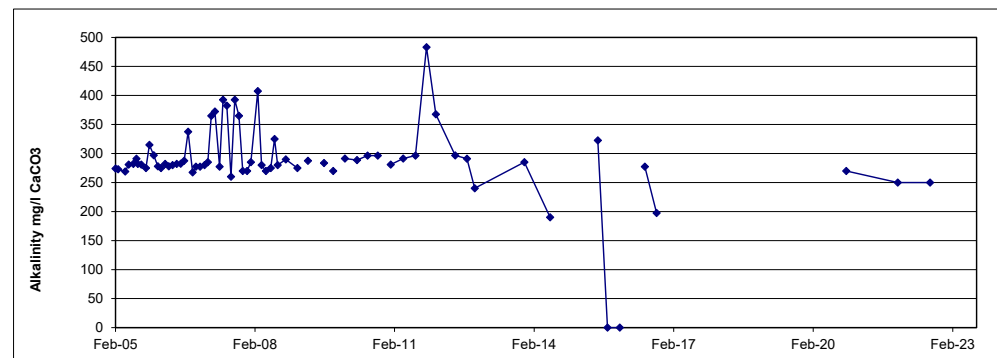
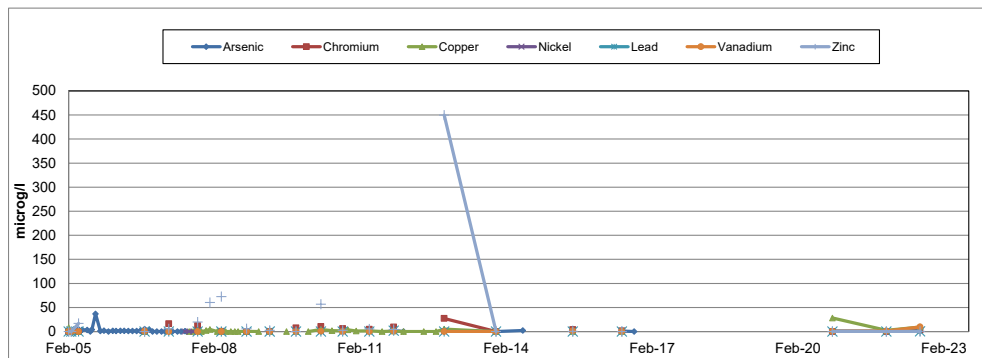


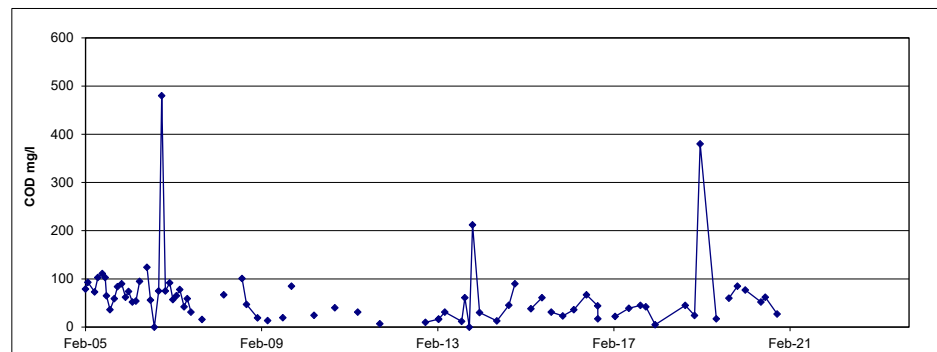
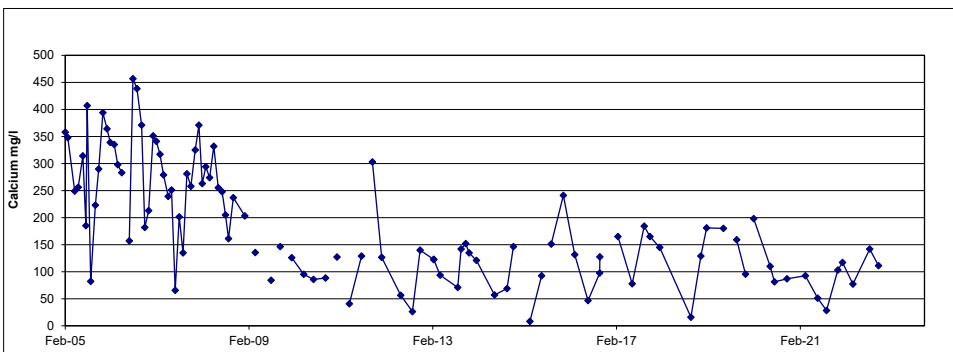
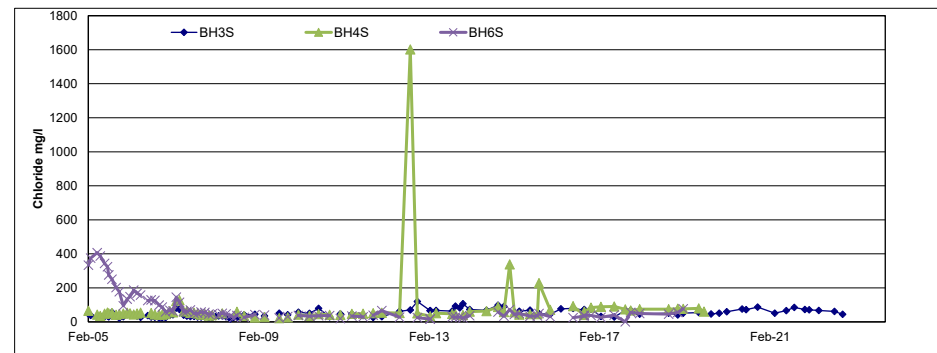
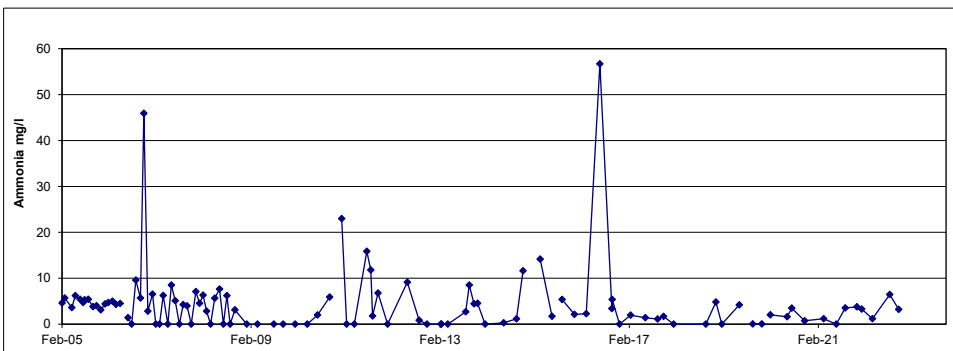
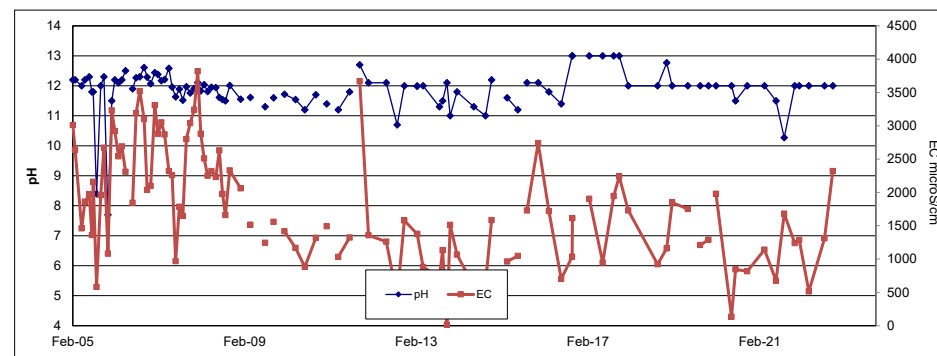
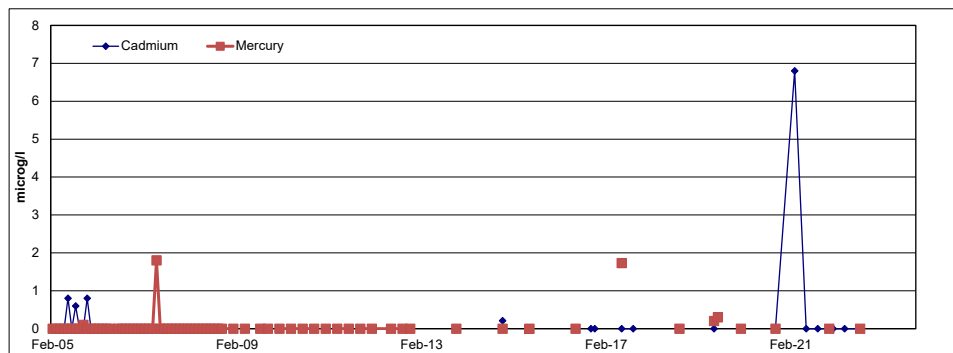


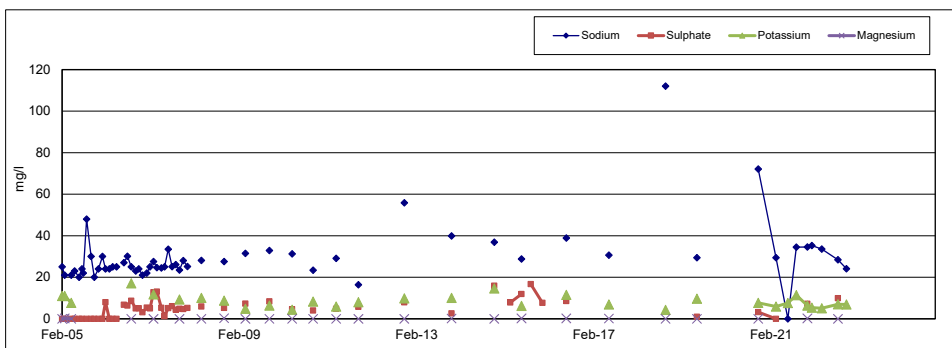
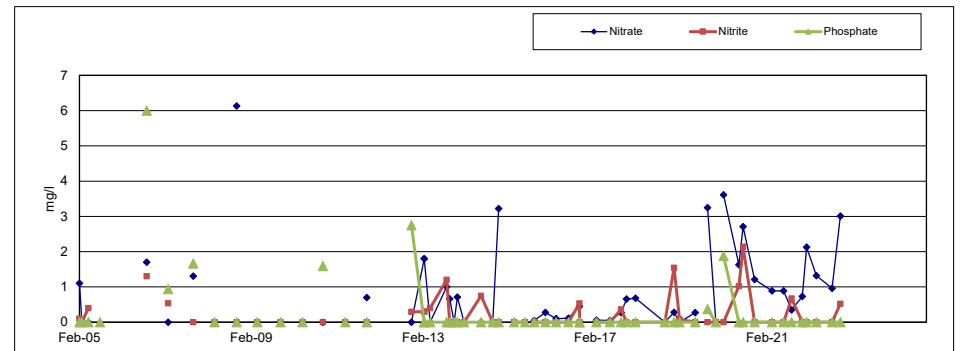
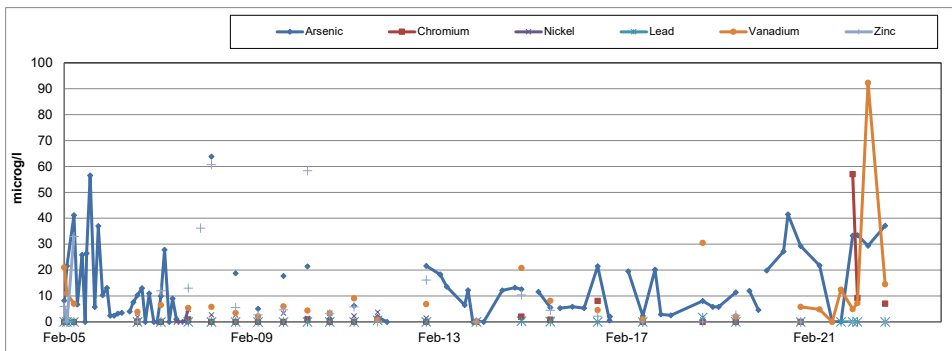
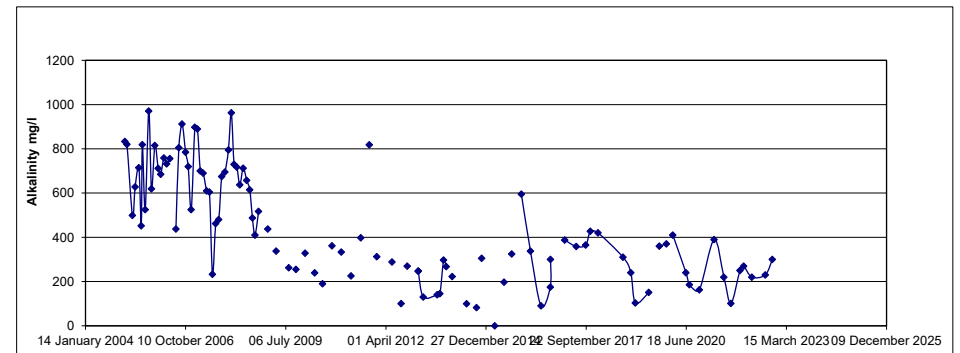
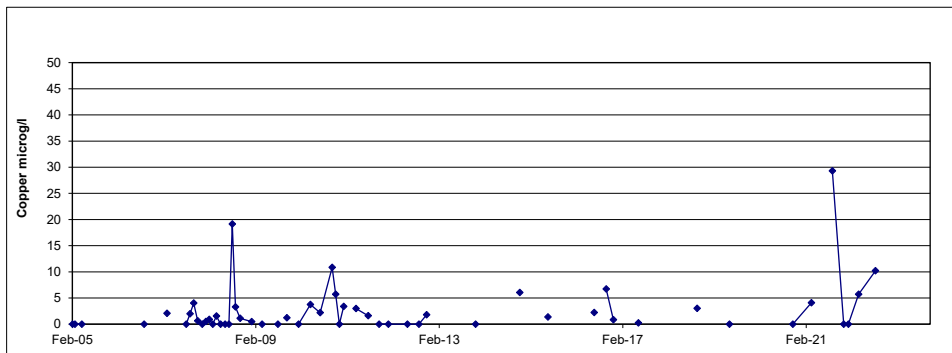


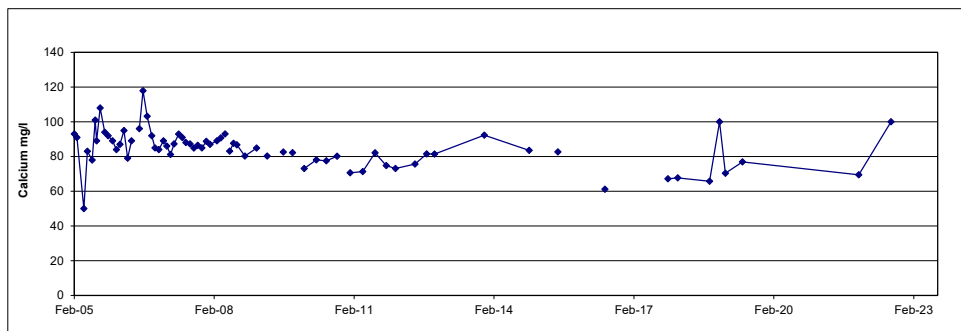
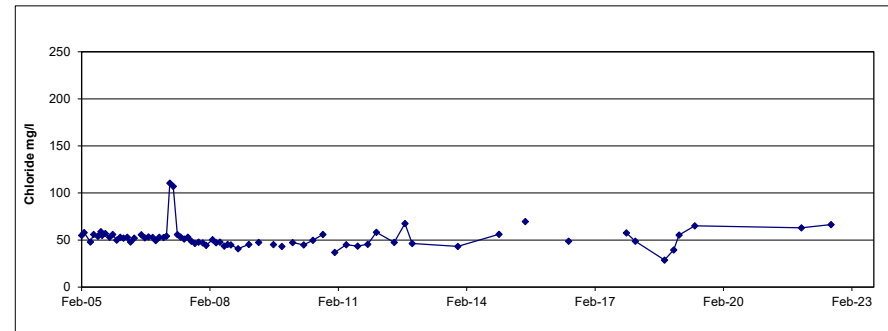
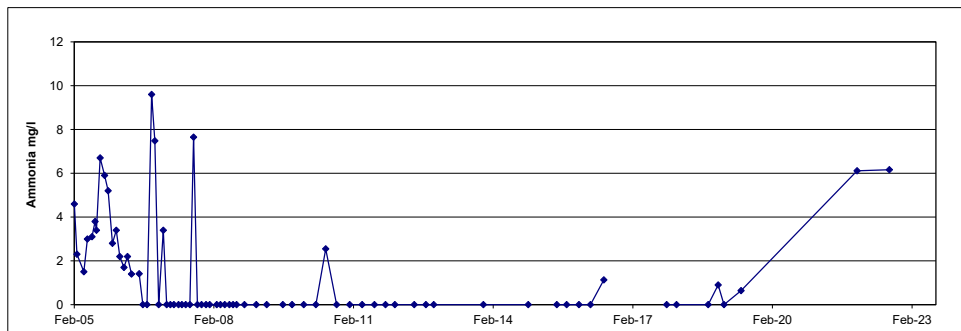
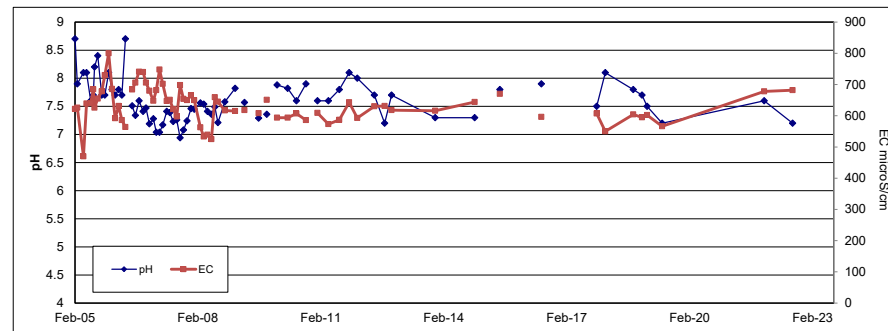
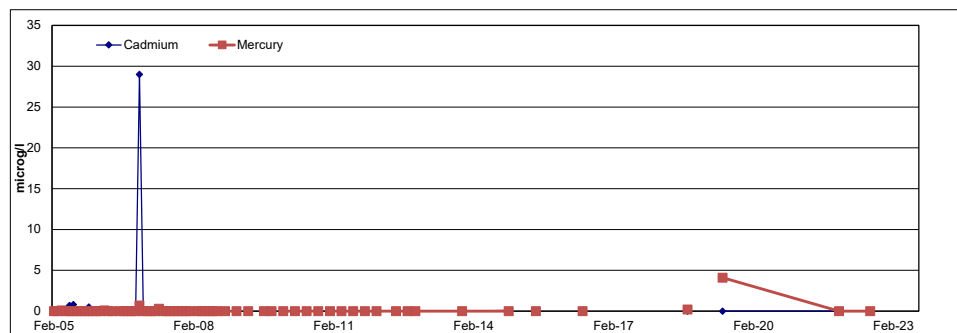


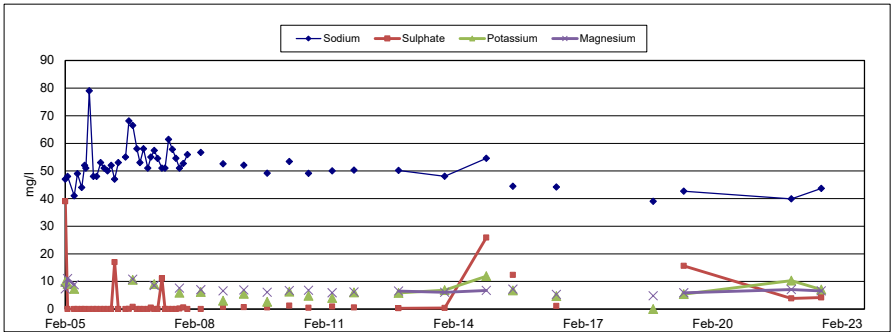
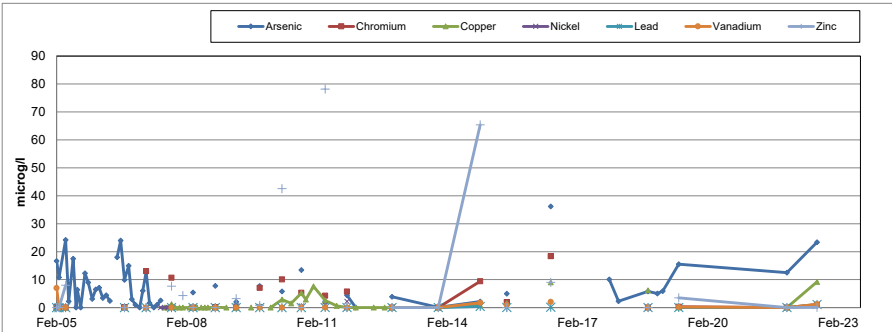
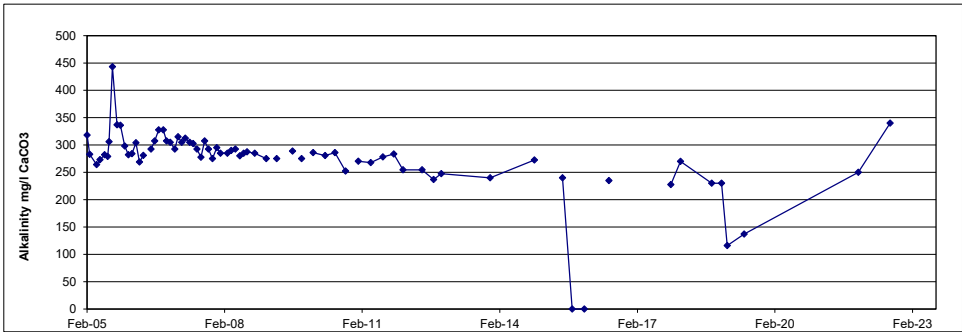
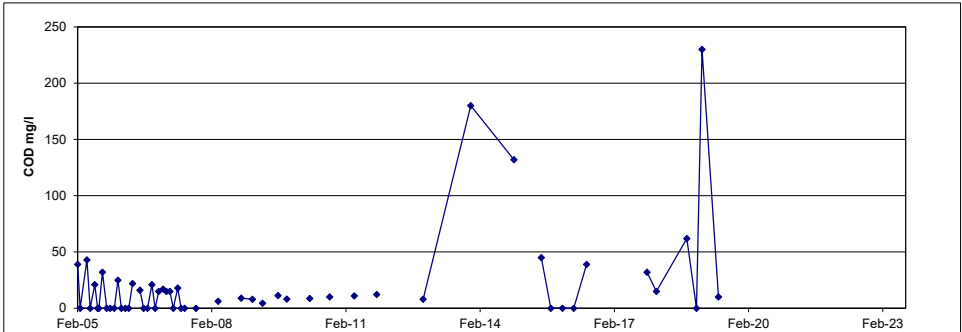


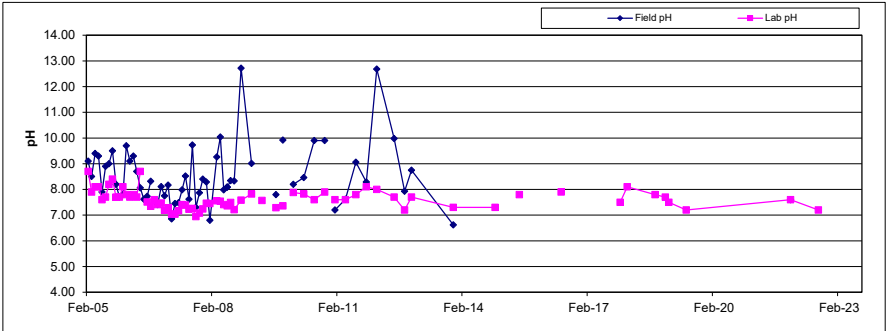
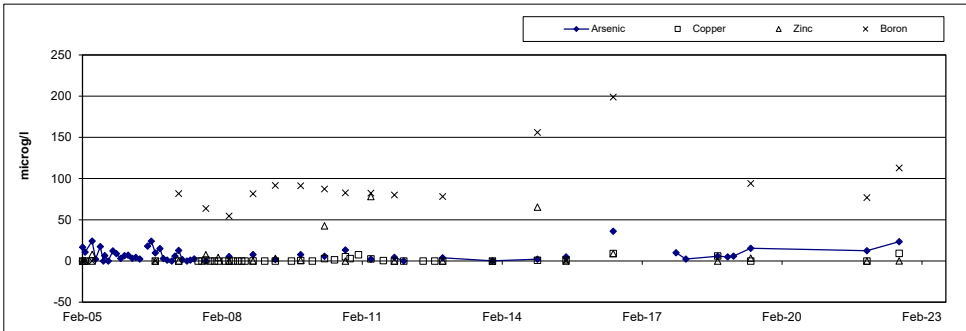
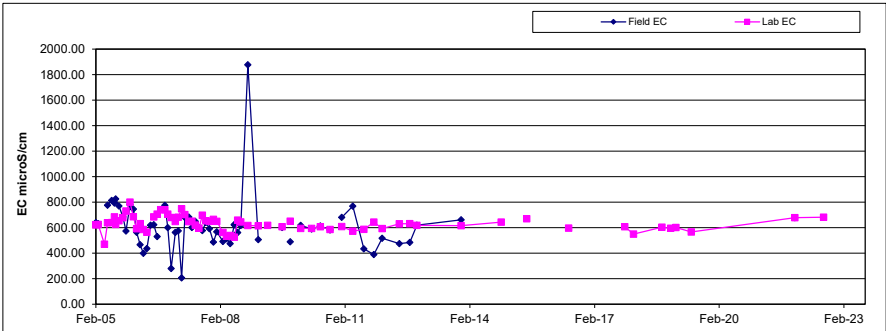
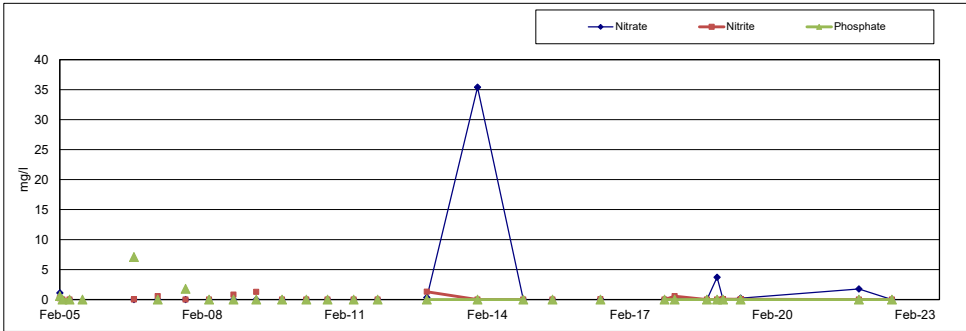


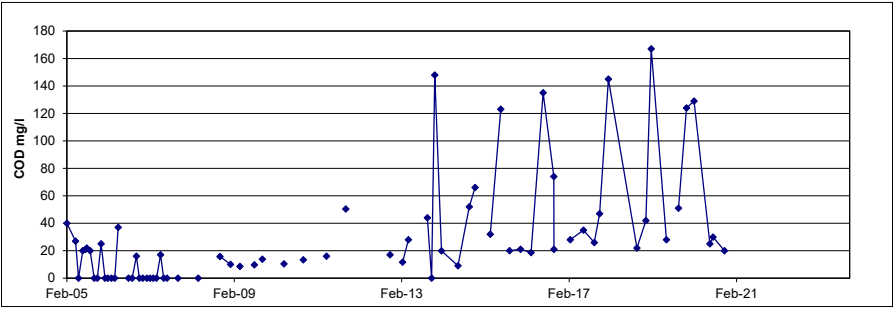
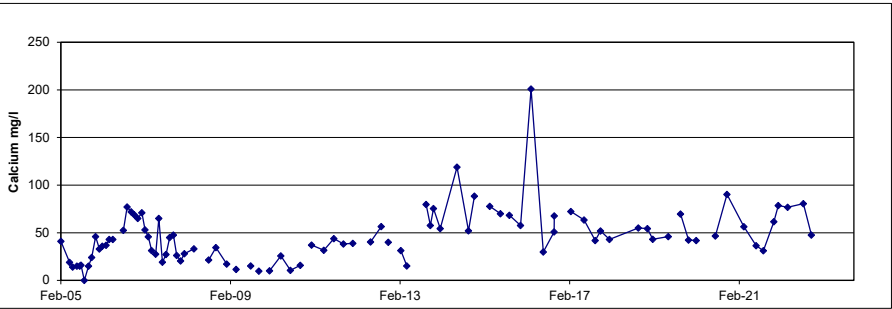
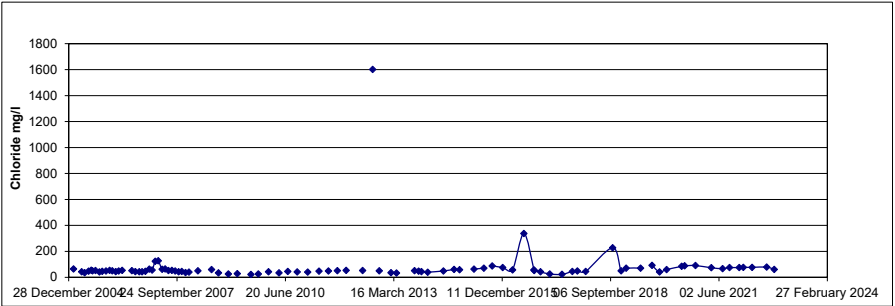
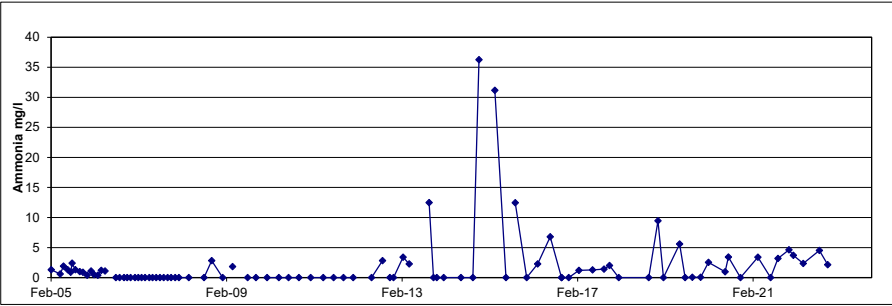
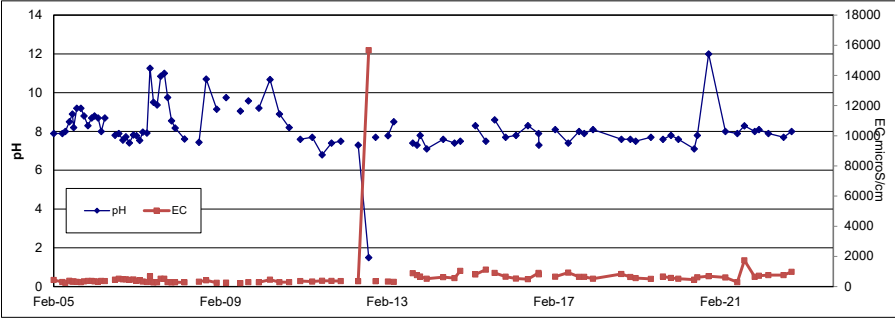
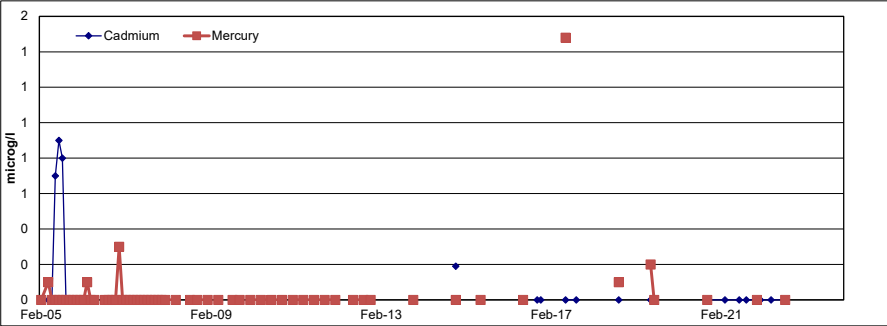


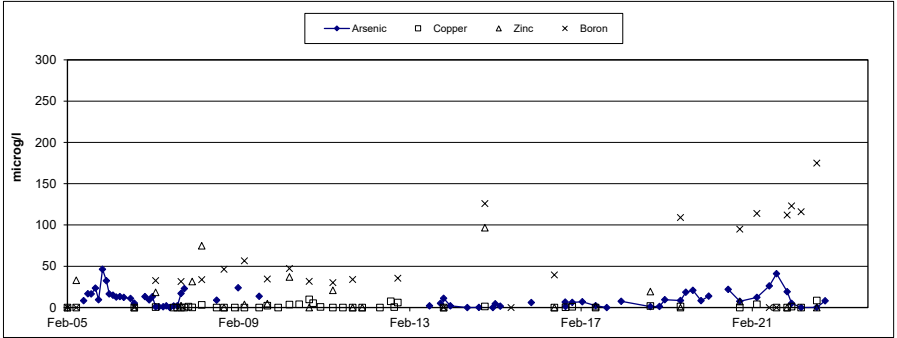
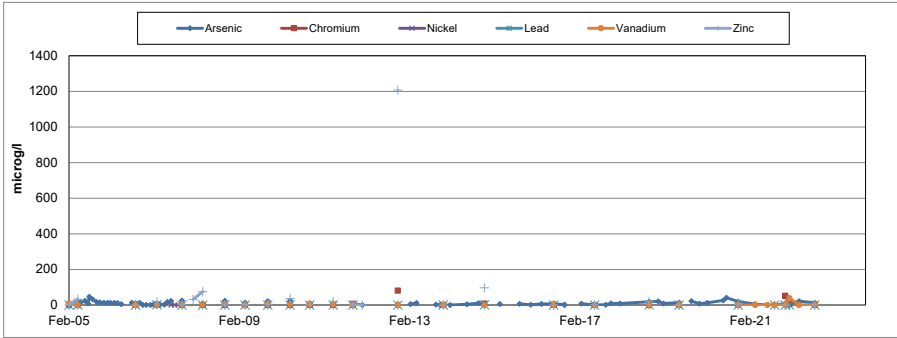
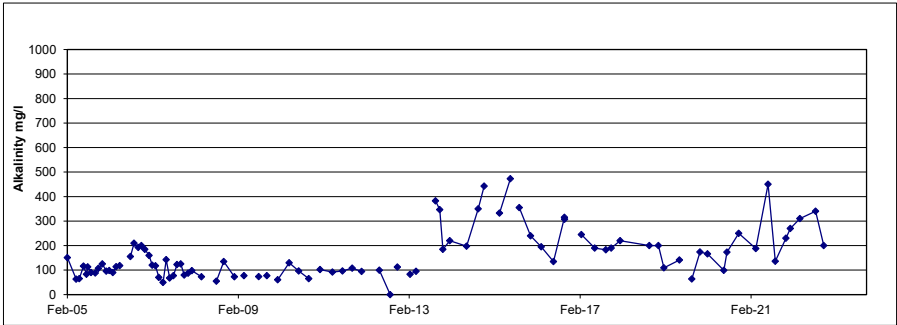
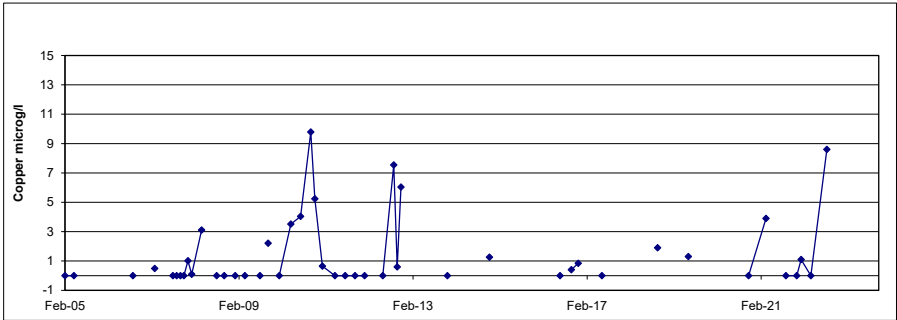


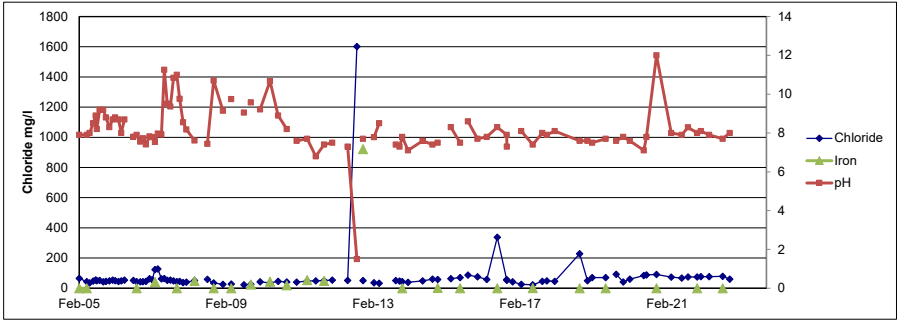
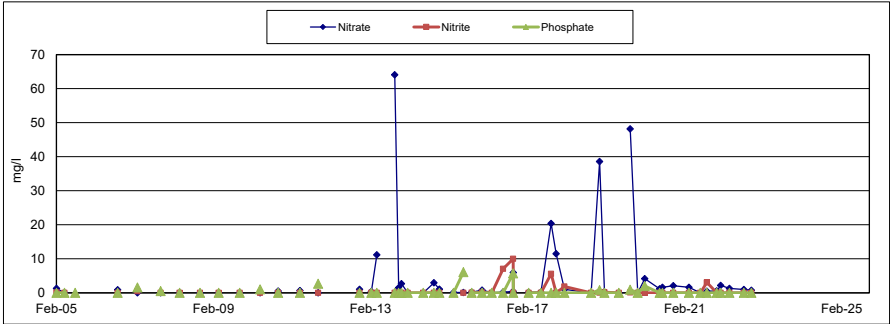
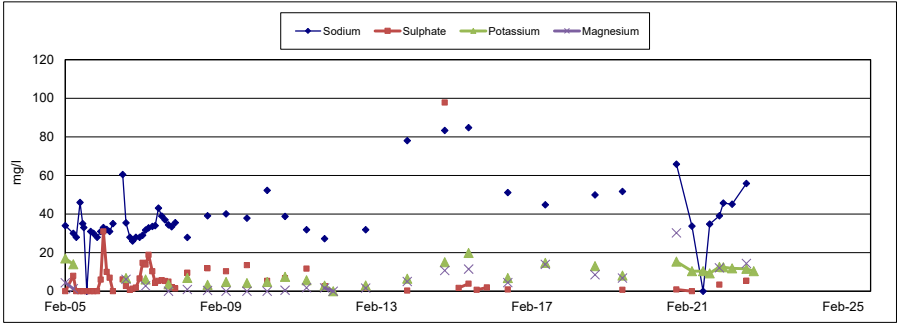


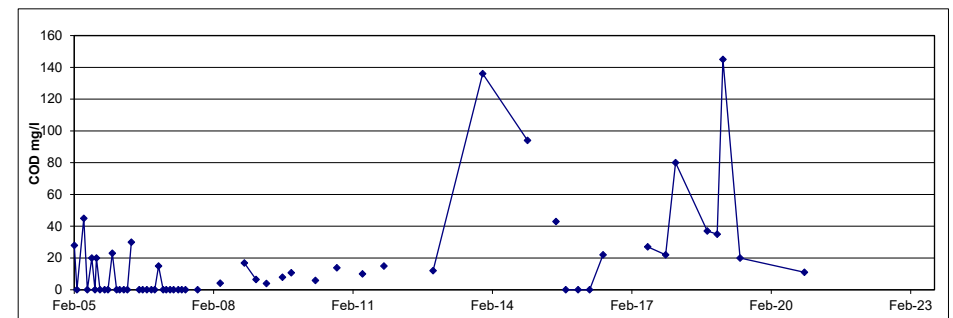
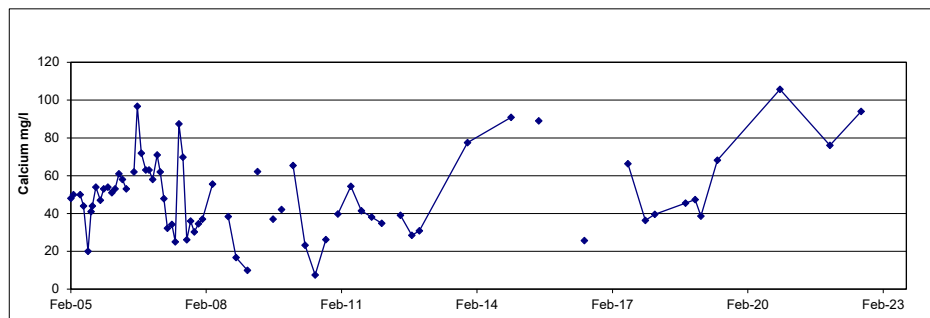
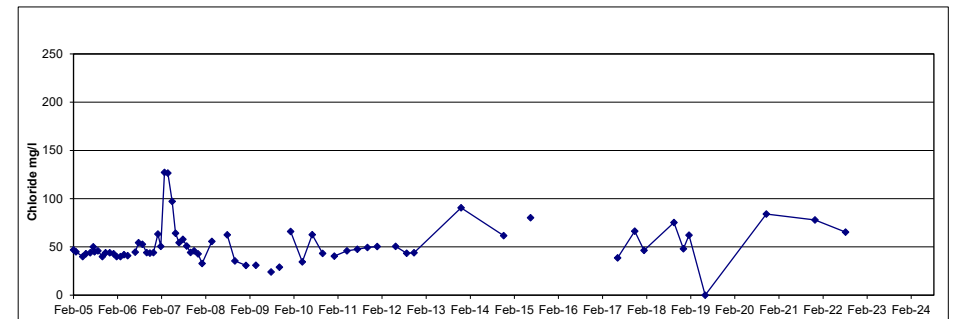
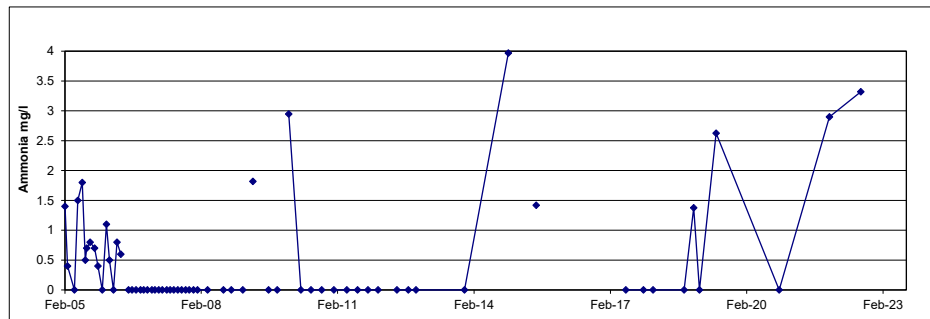
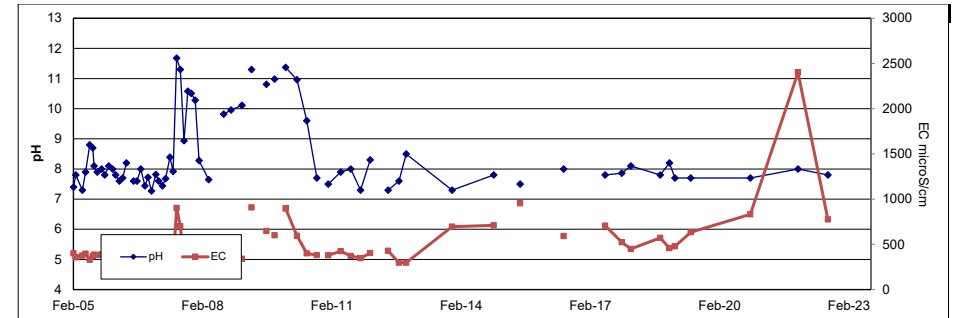
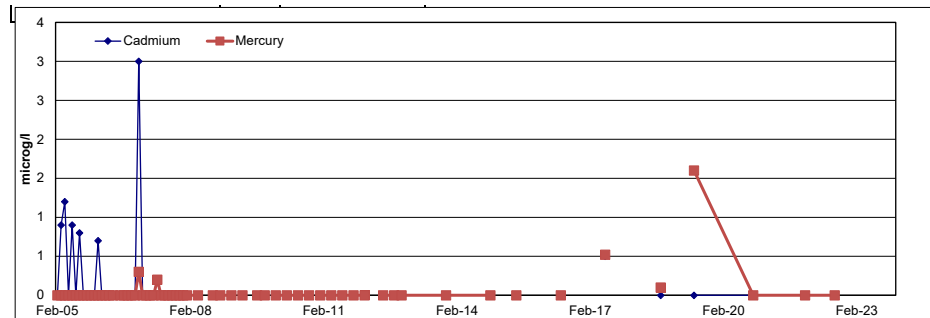


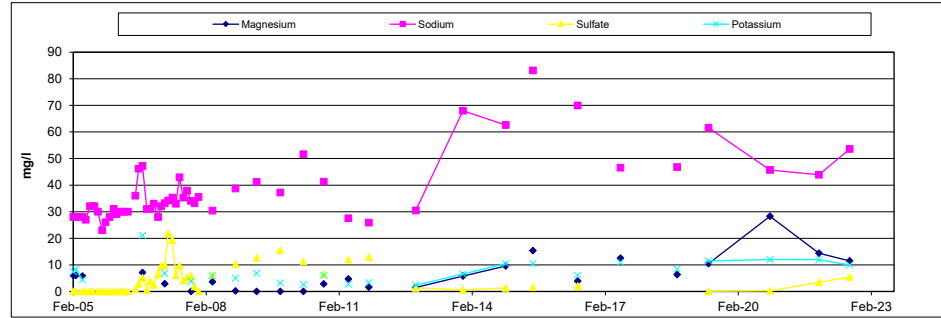
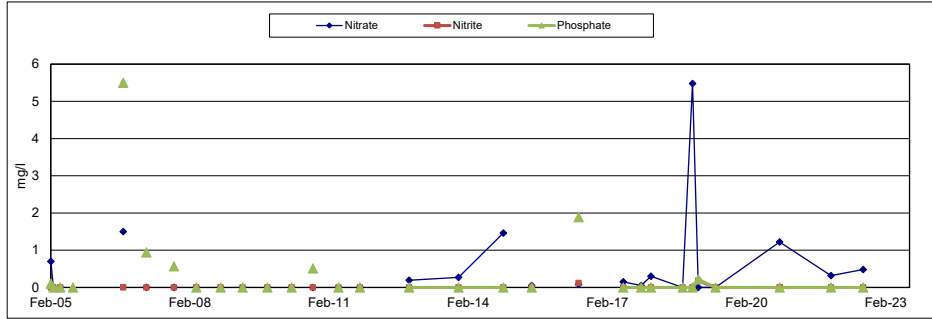
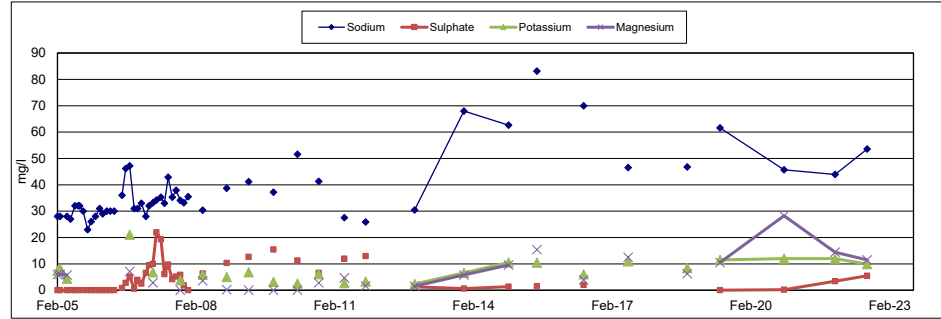
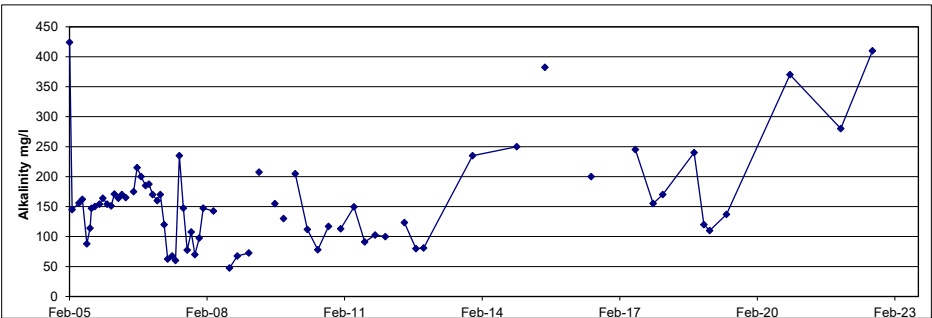
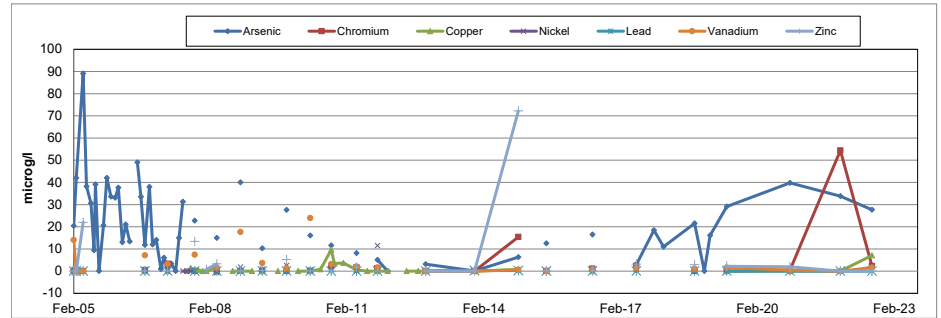


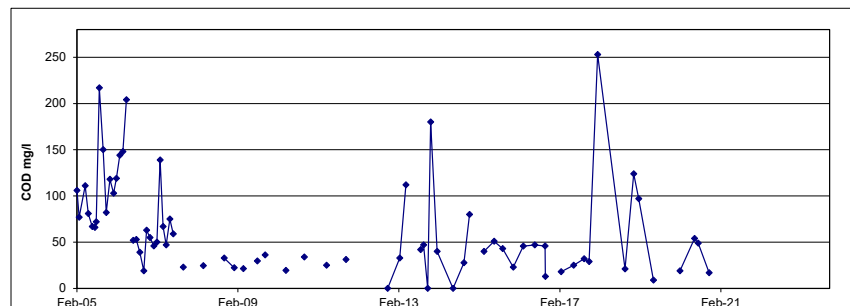
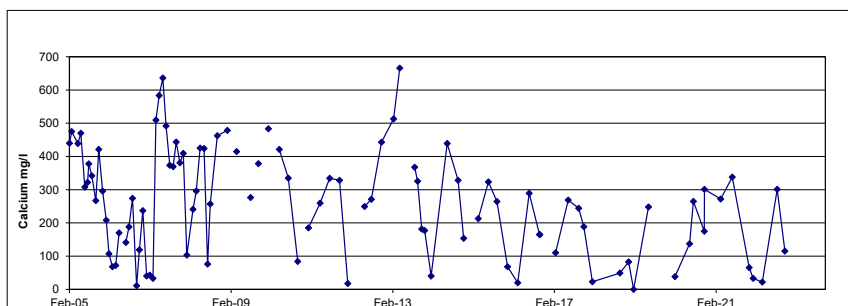
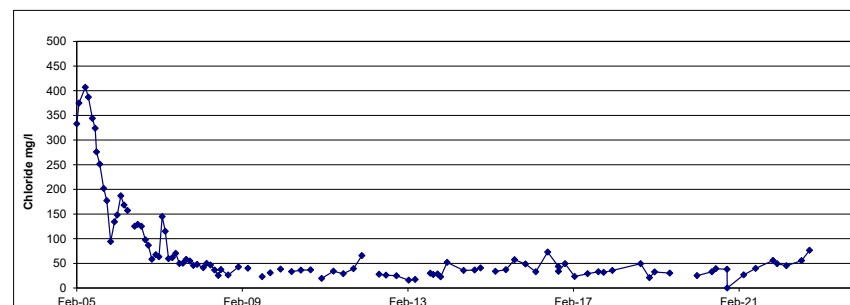
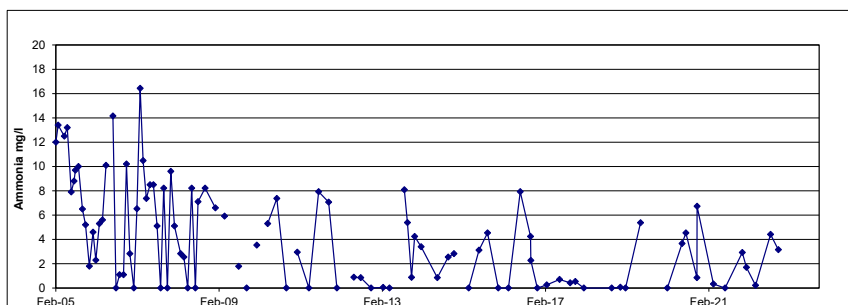
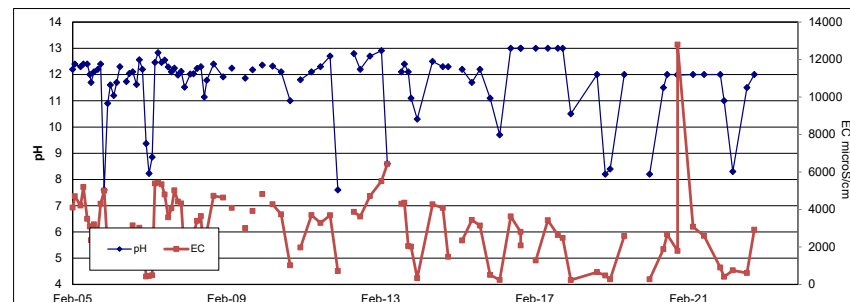
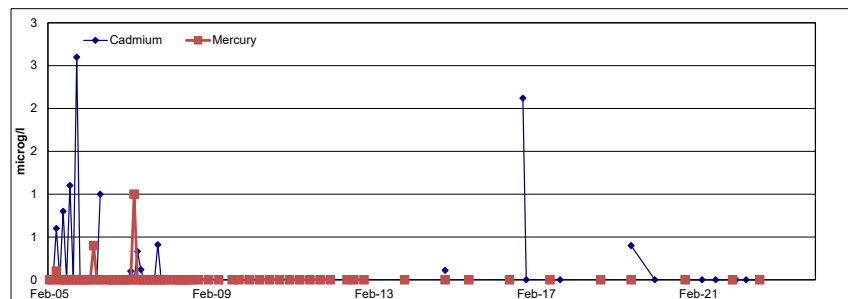


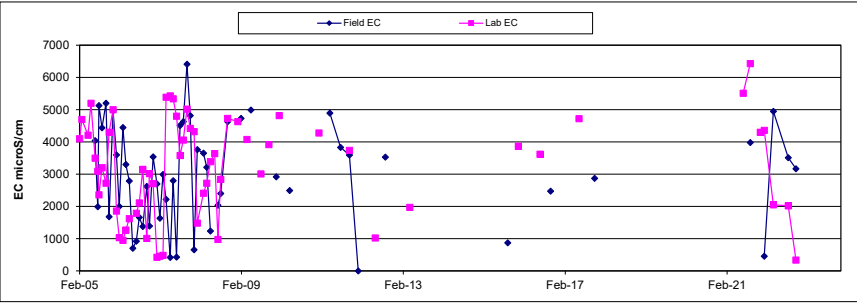
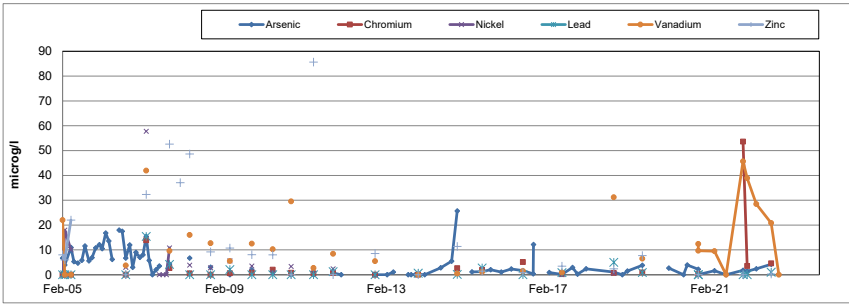
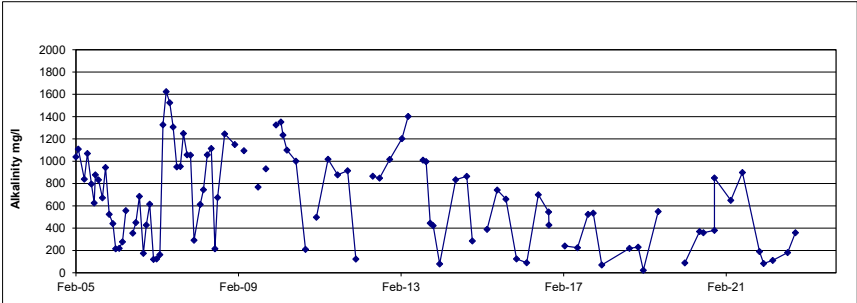
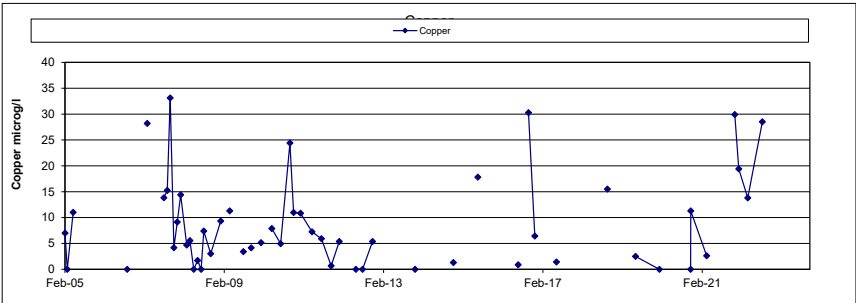


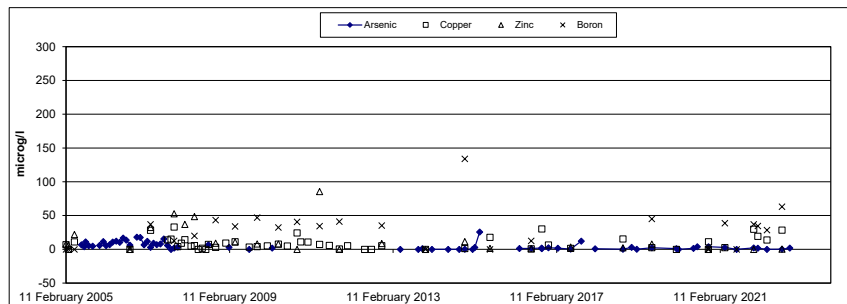
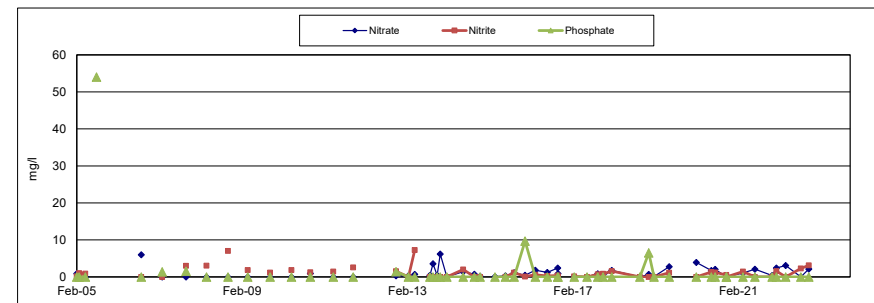
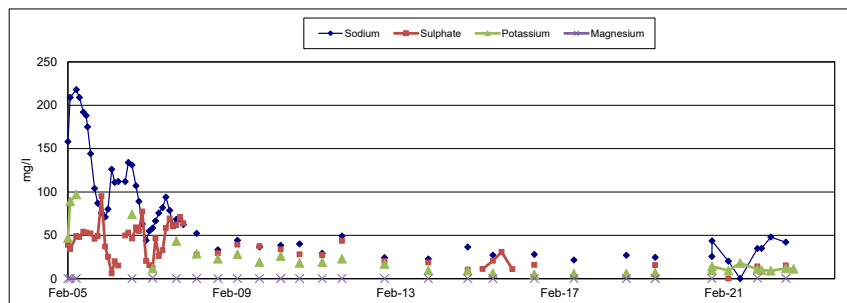


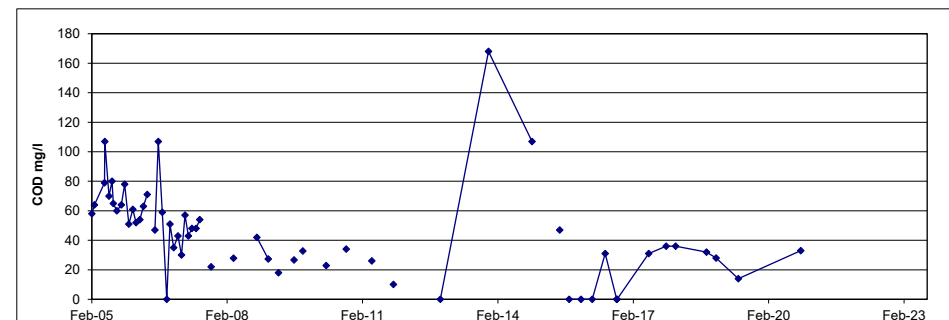
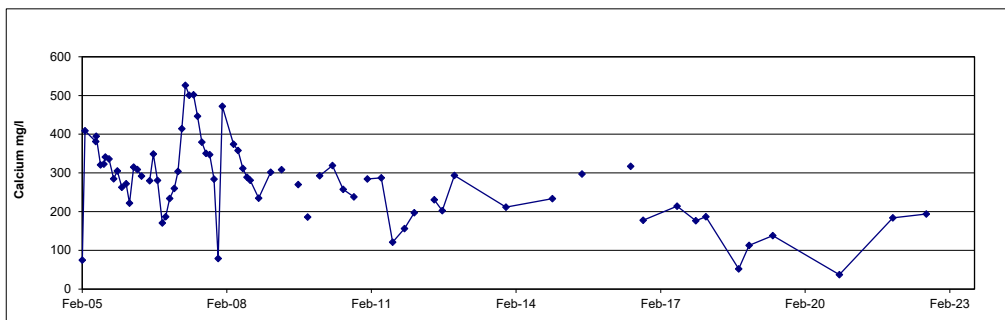
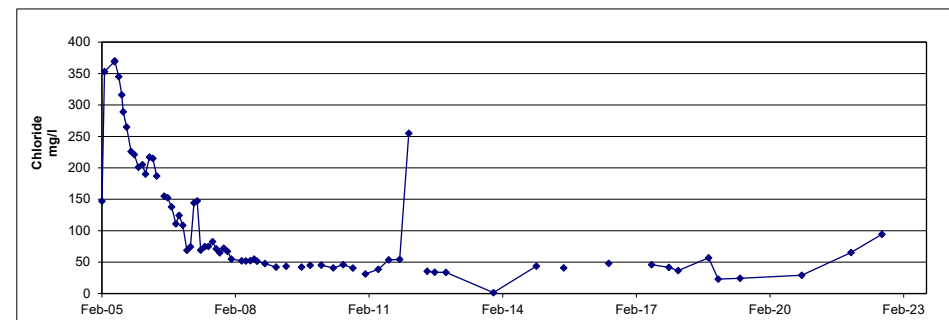
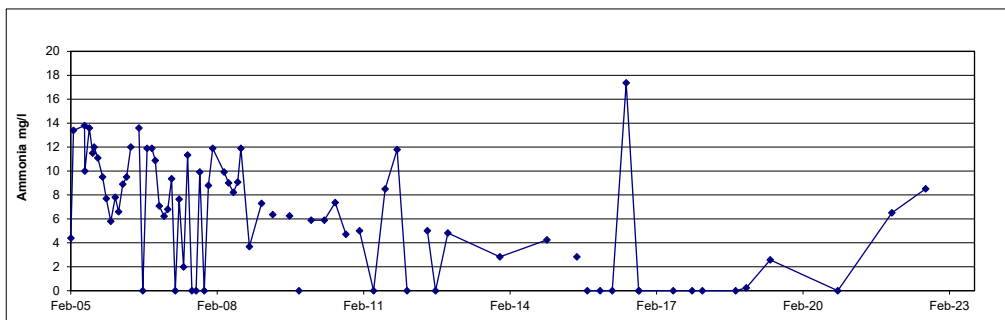
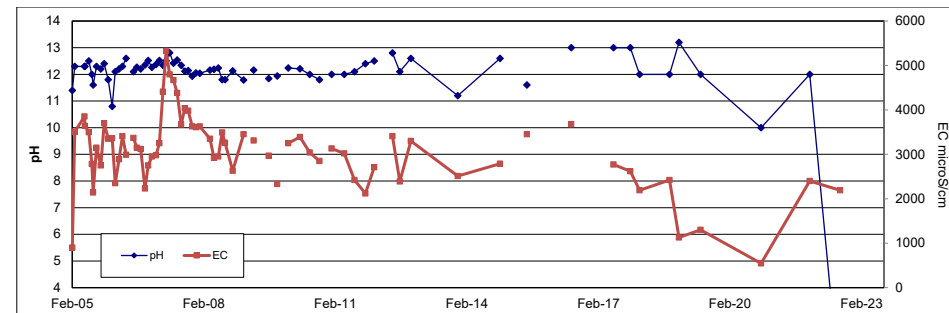
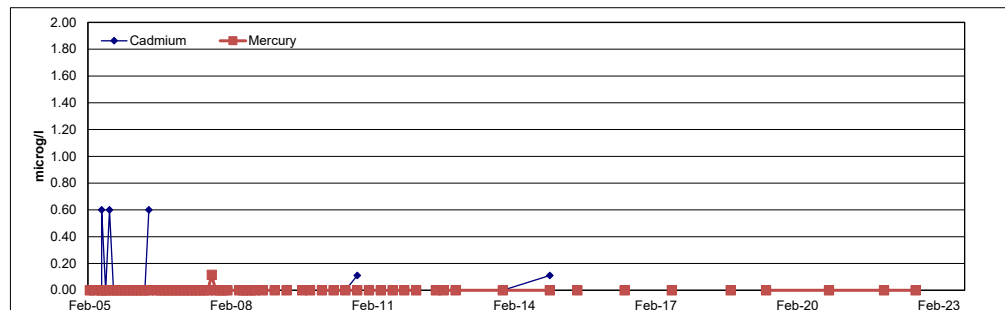


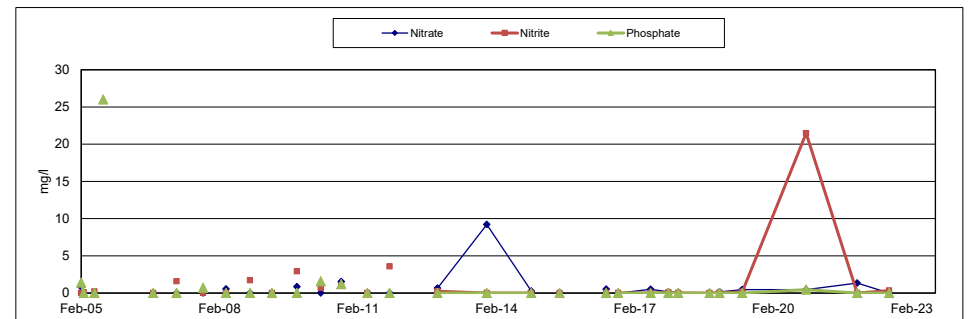
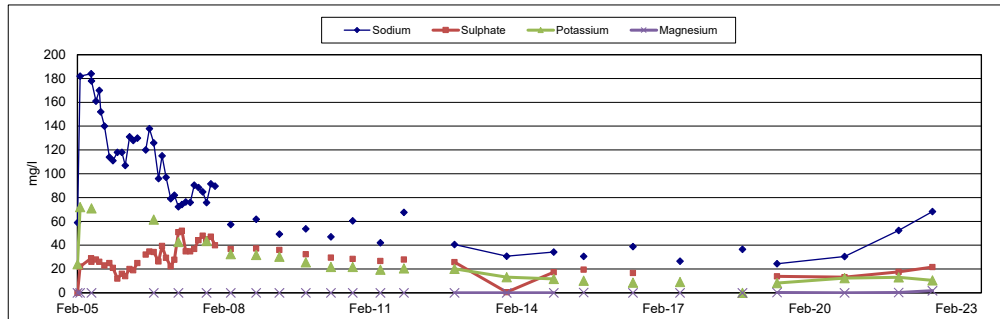
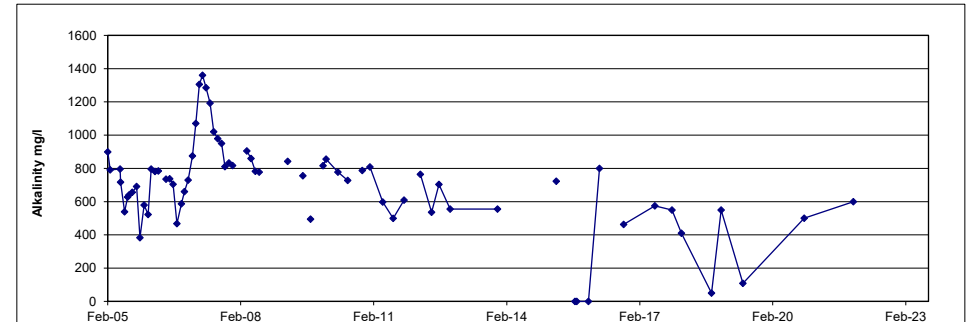
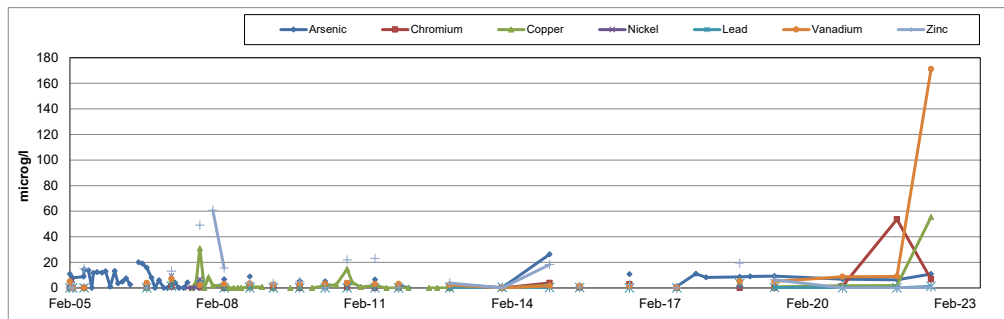


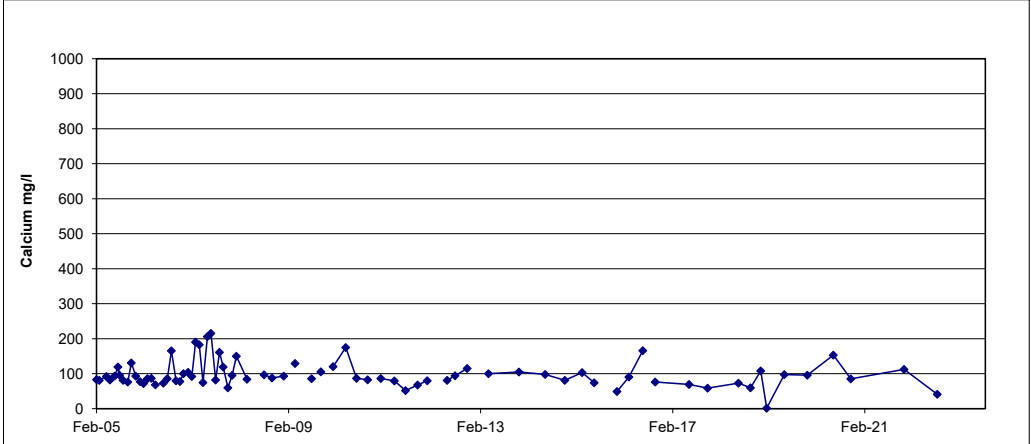
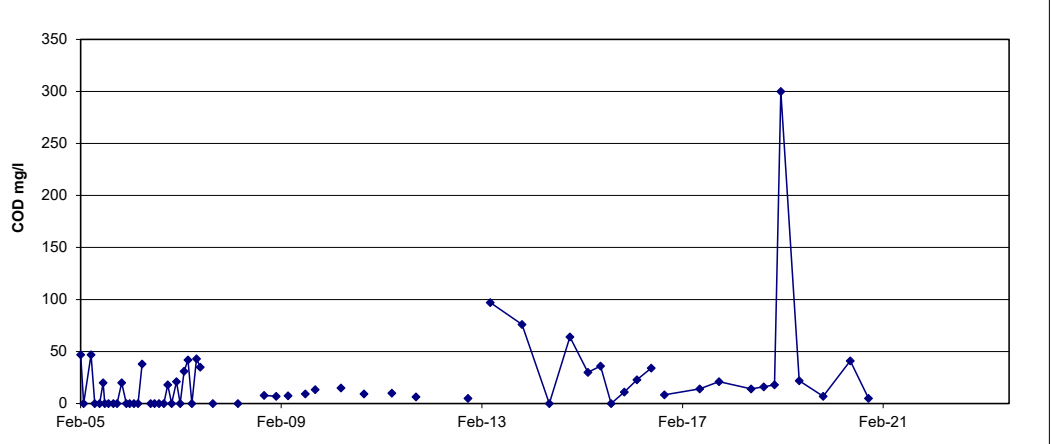
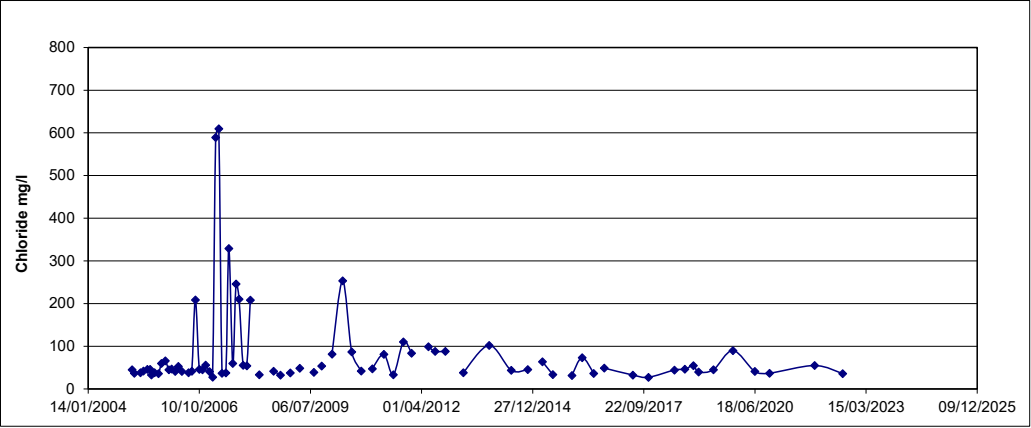
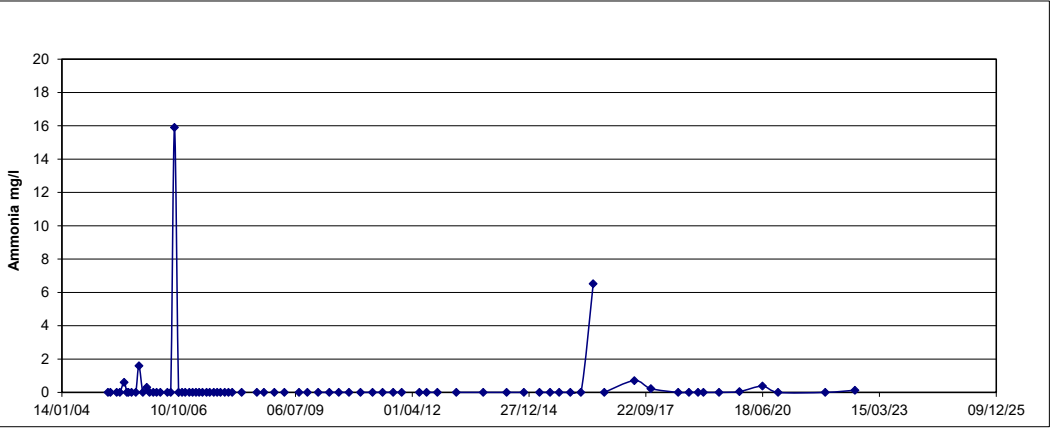
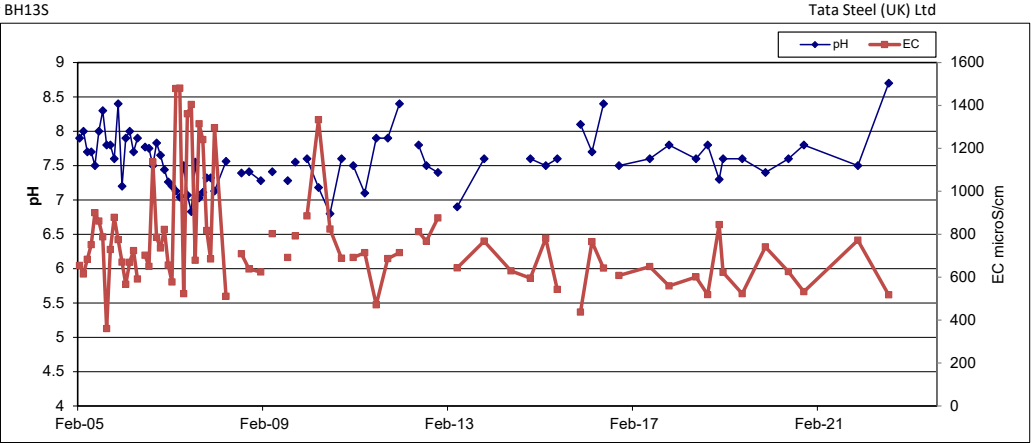
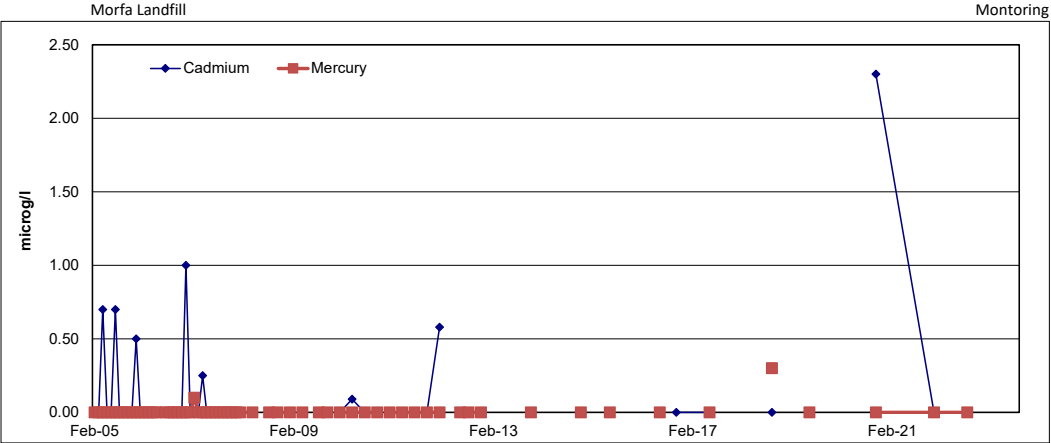




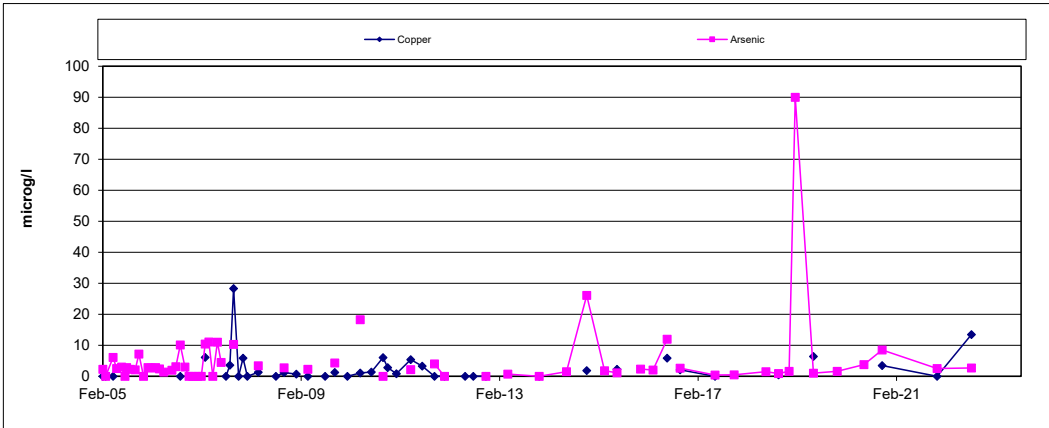




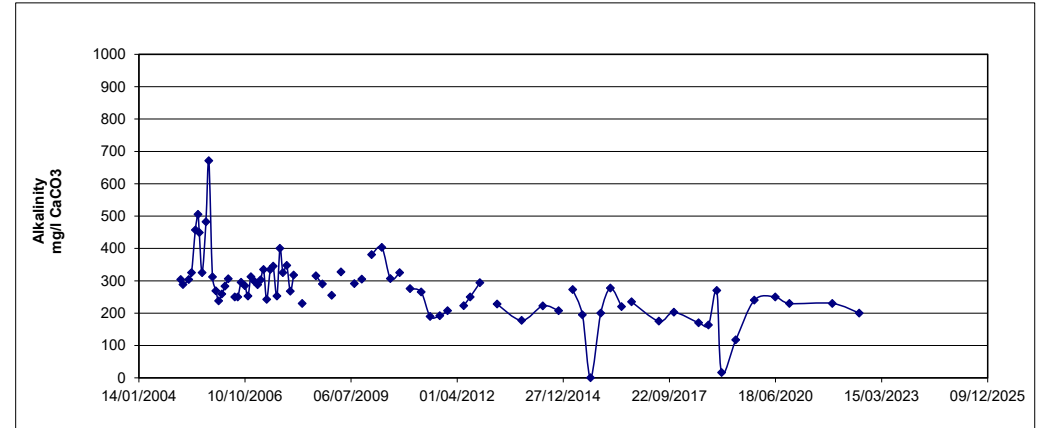




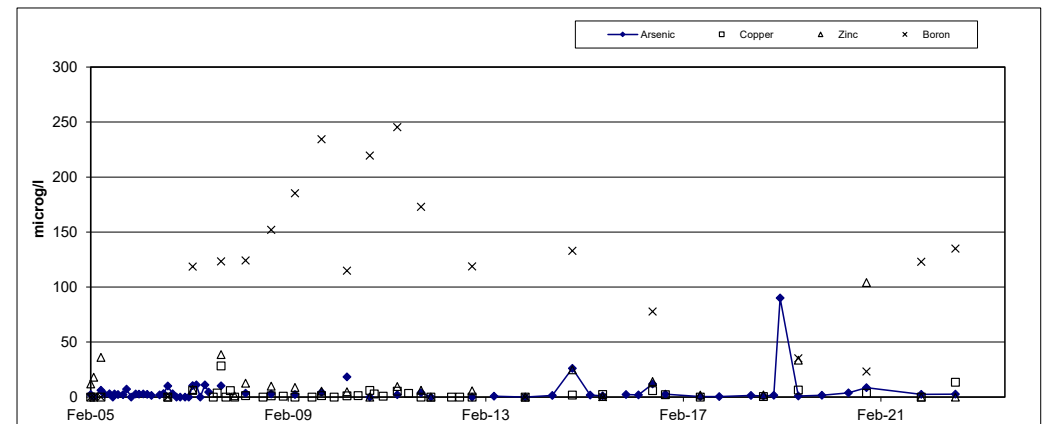
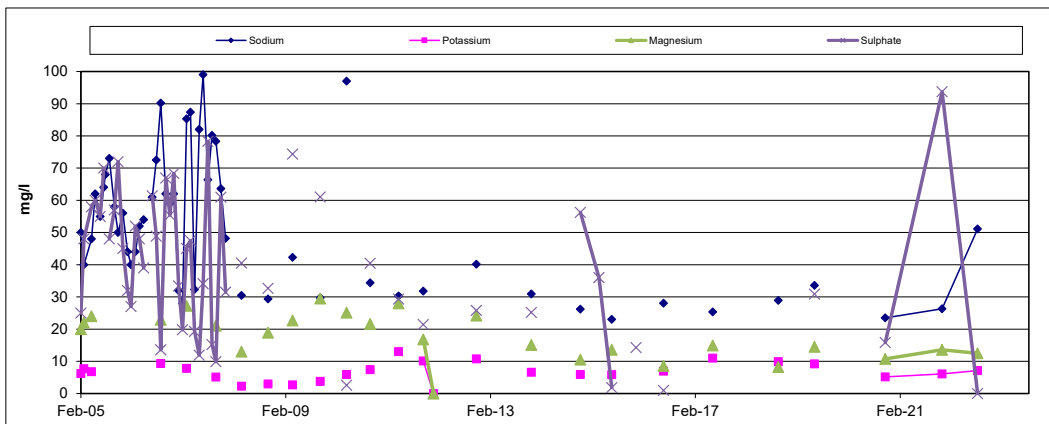
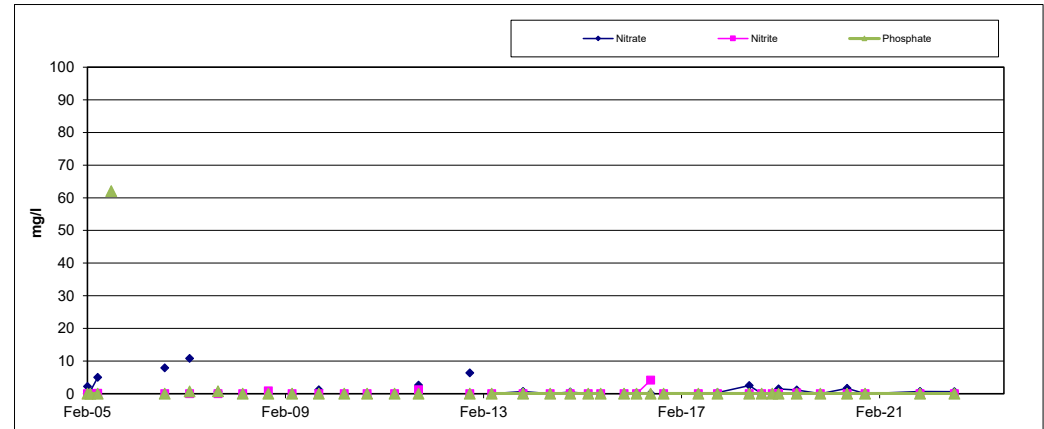
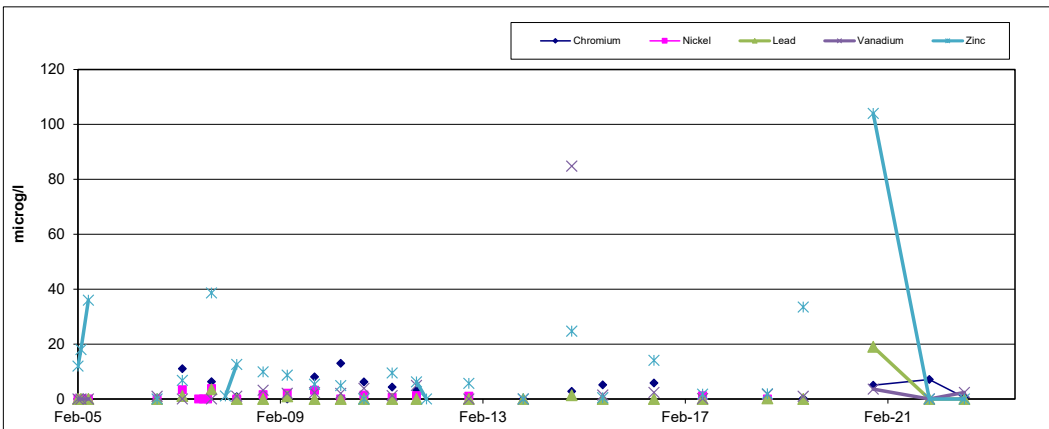
Morfa Landfill

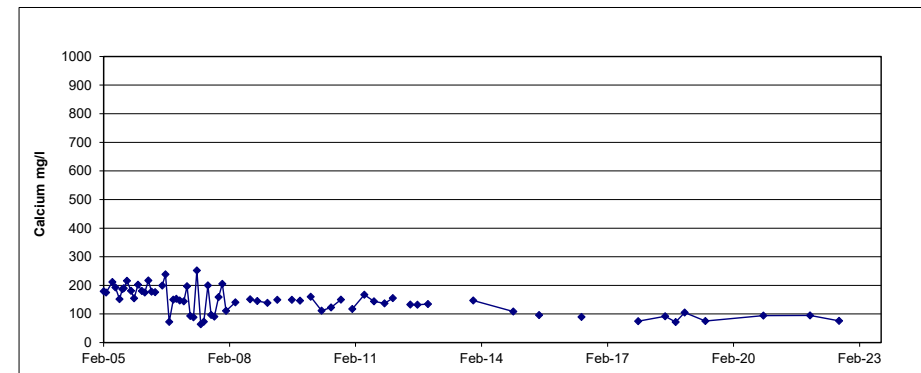
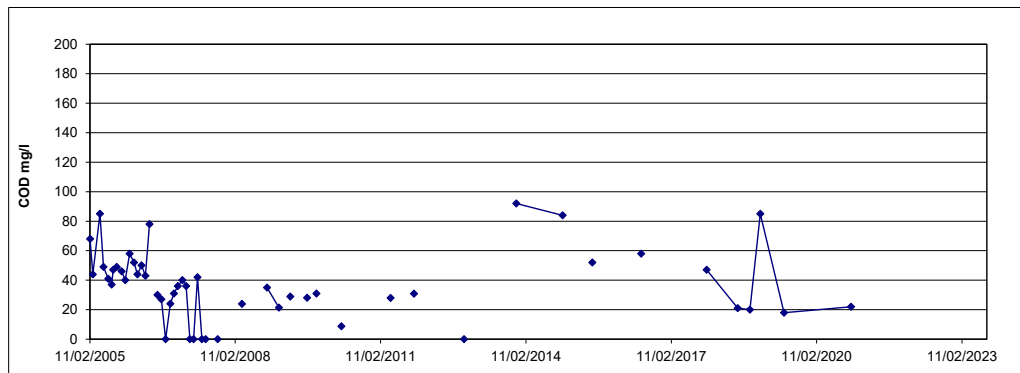
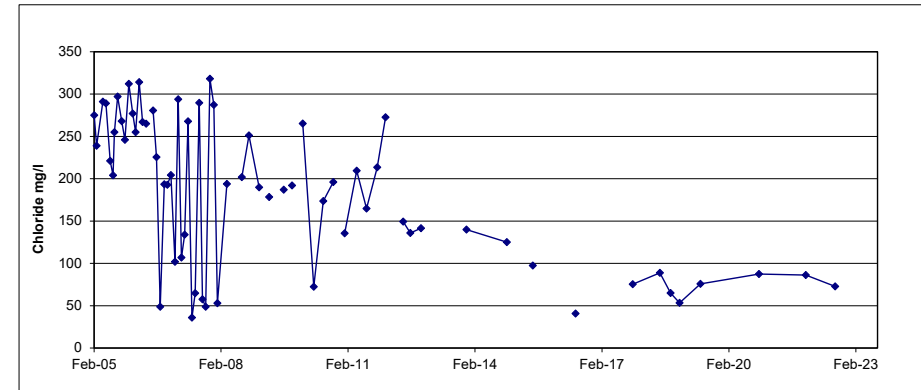
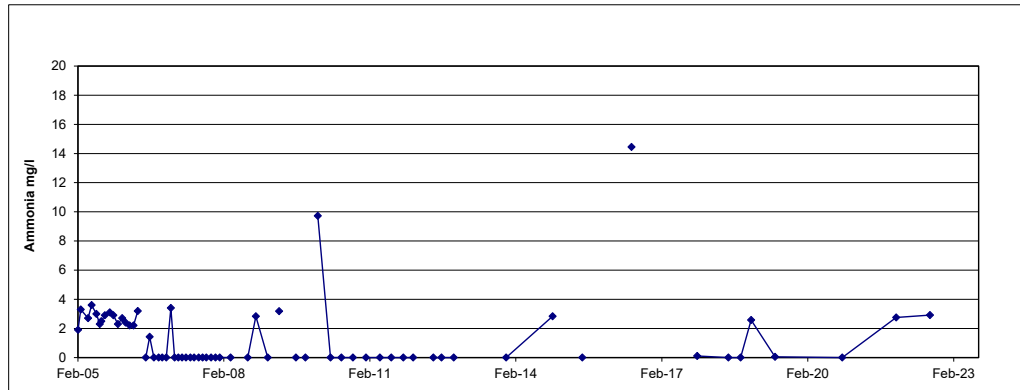
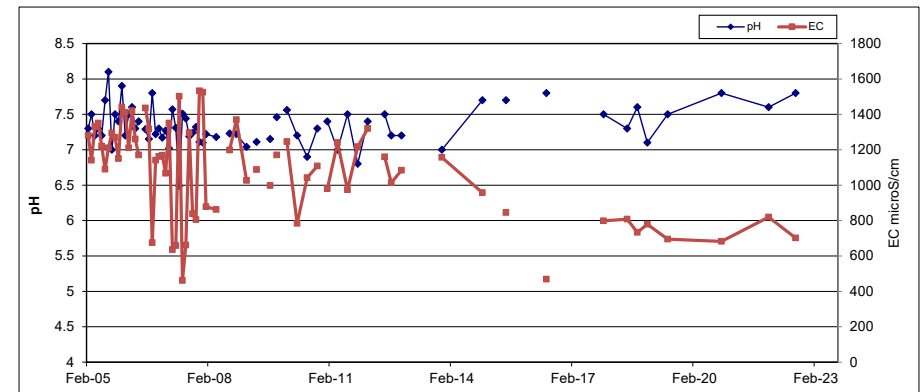
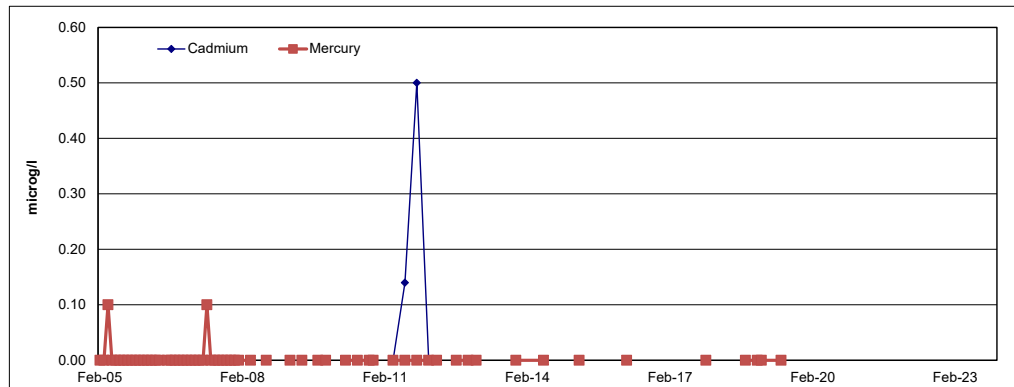


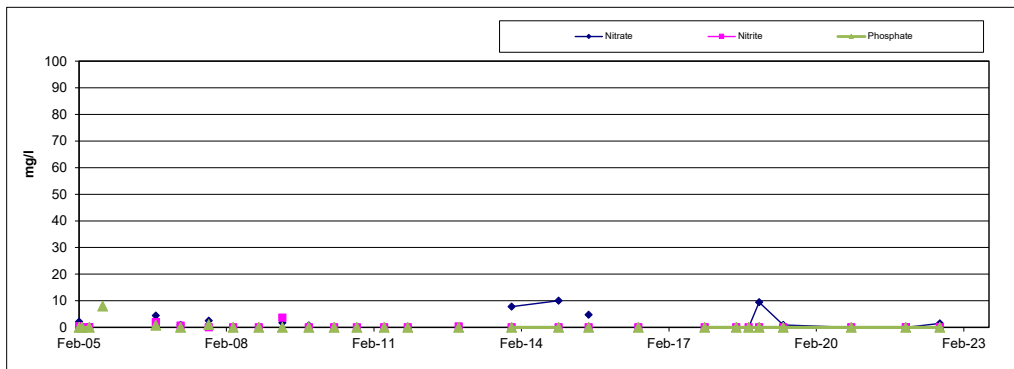
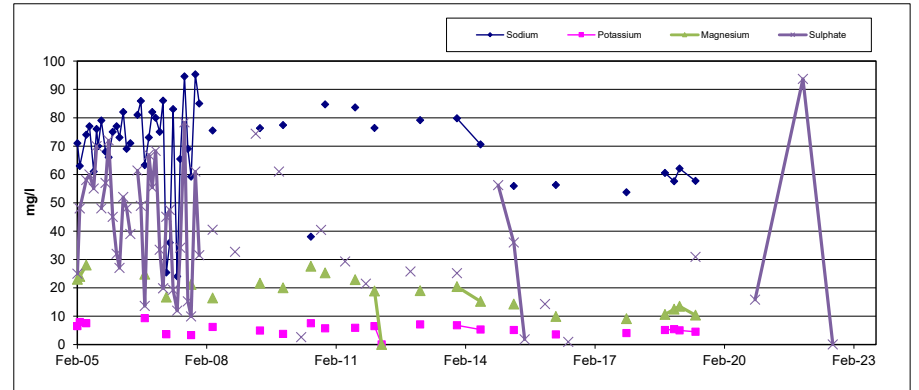
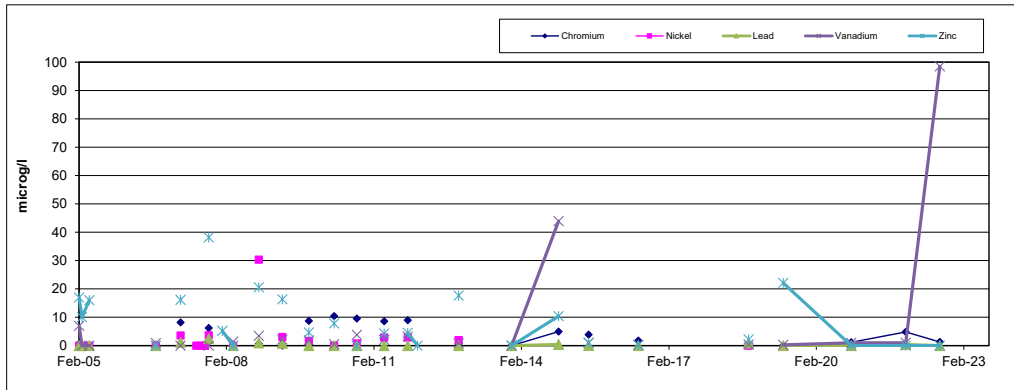
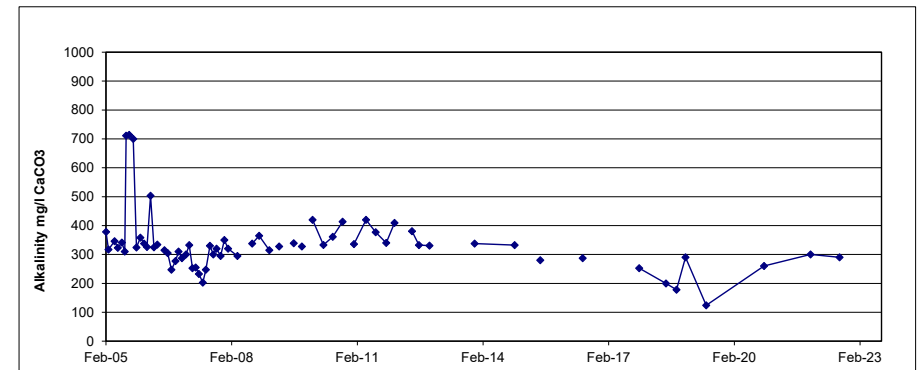
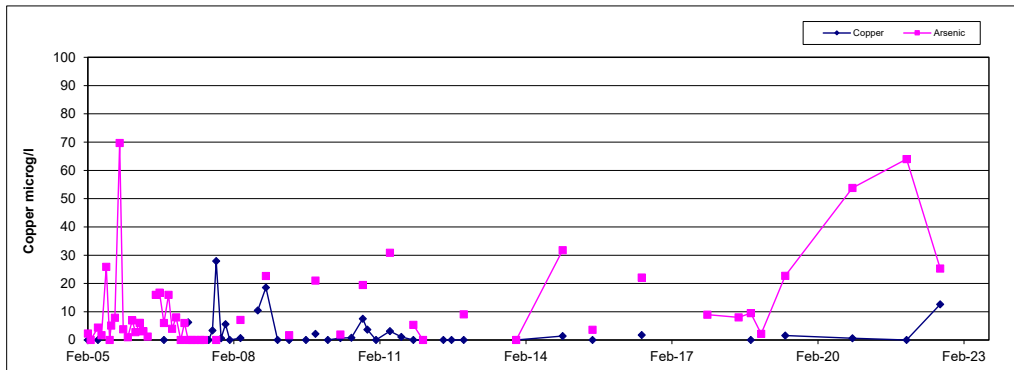
Monitoring data for BH13S

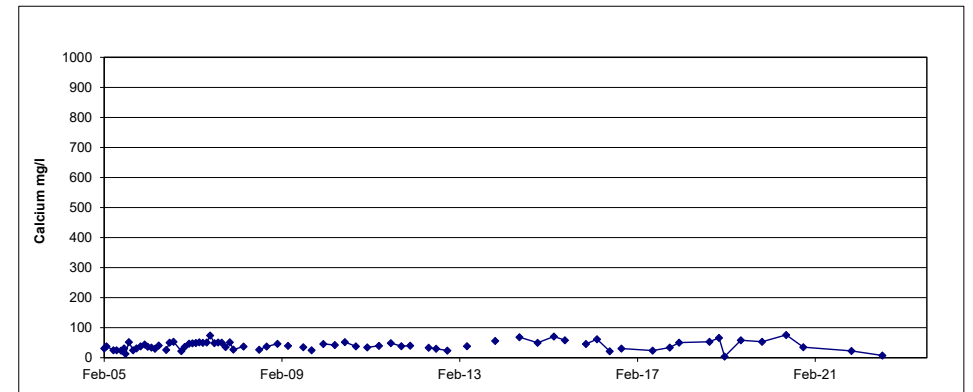
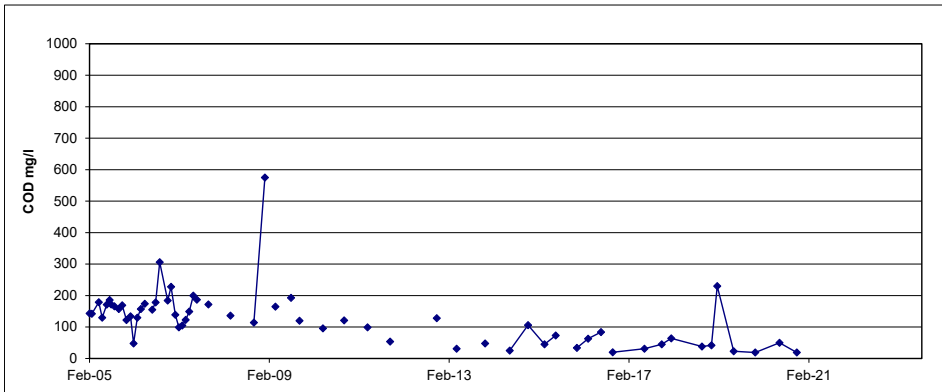
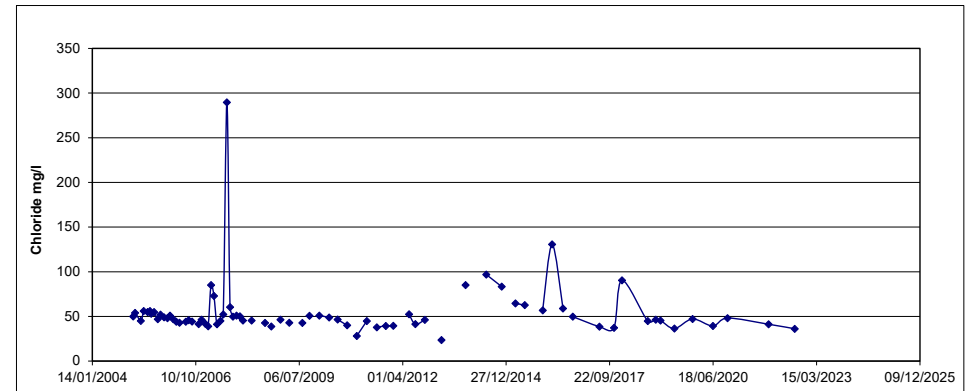
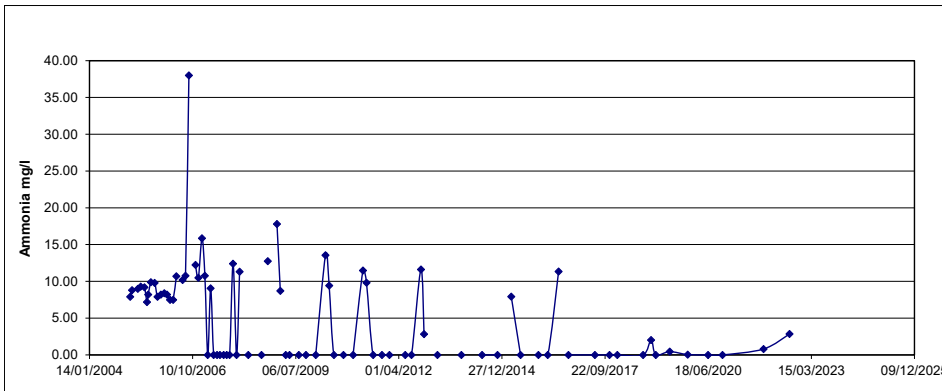
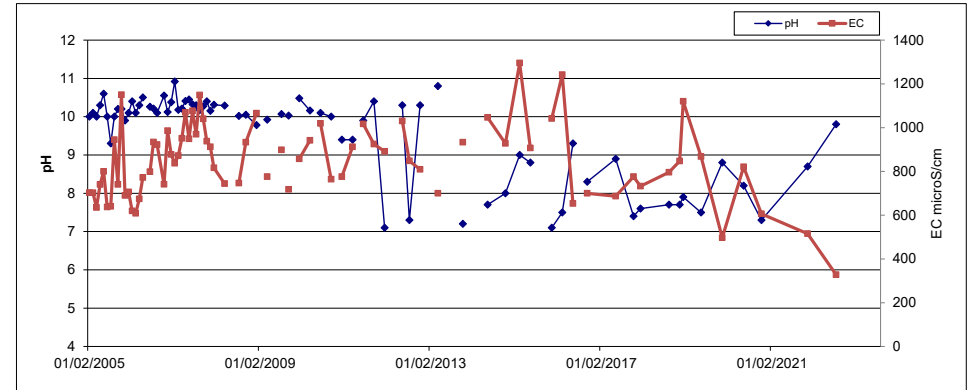
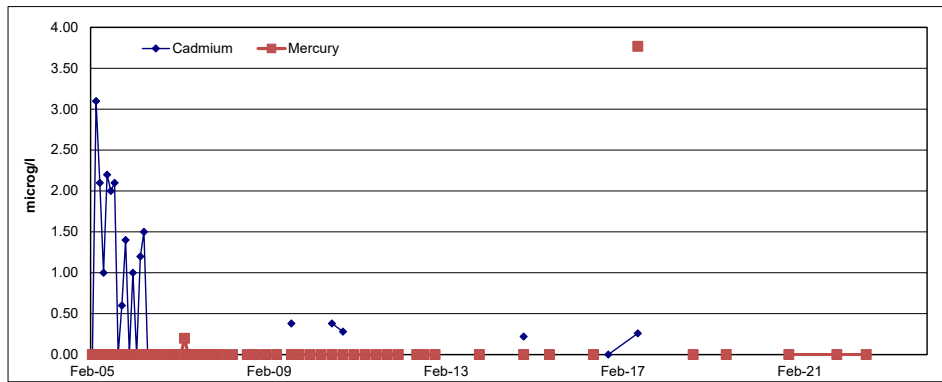


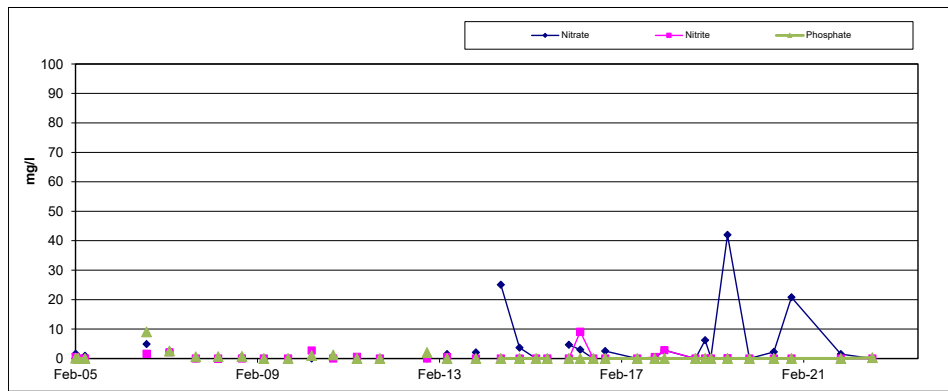
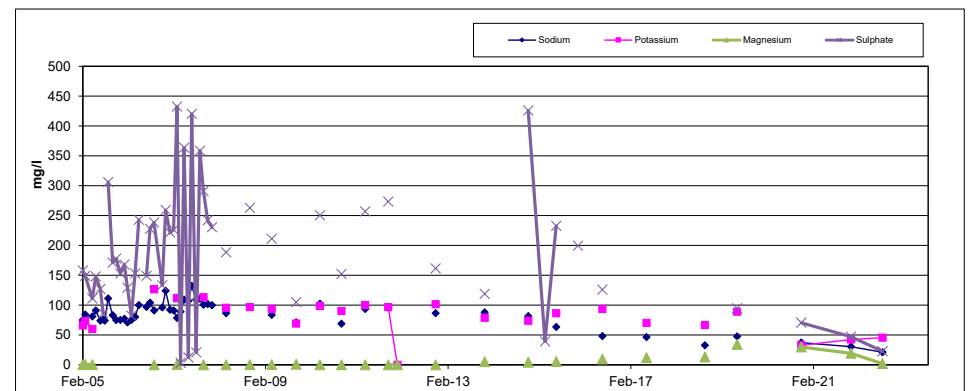
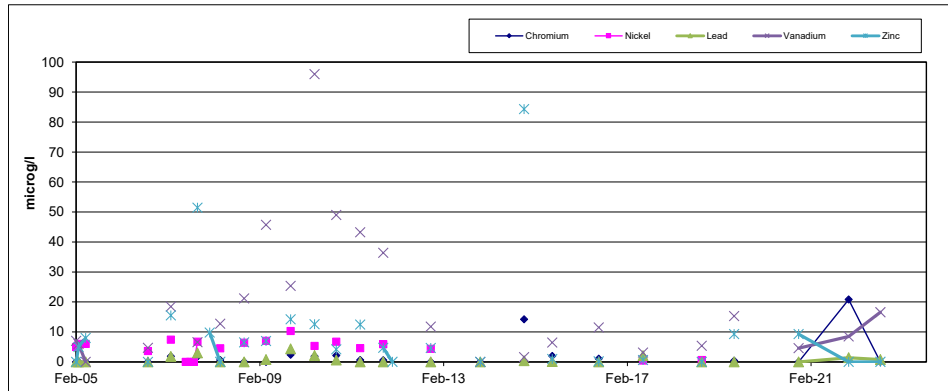
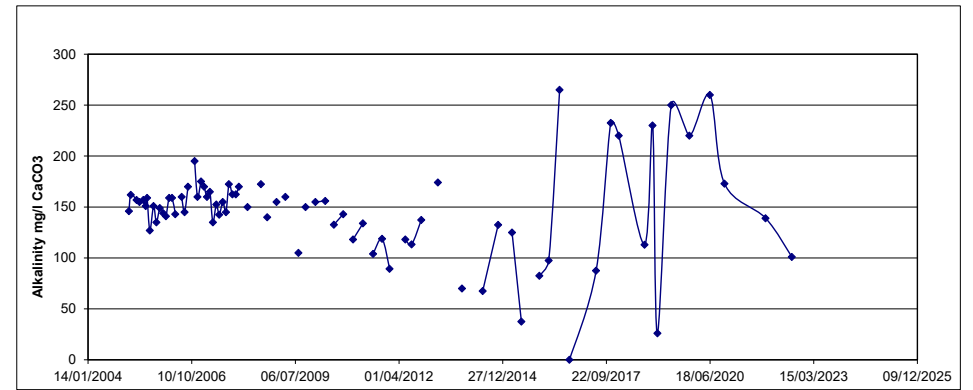
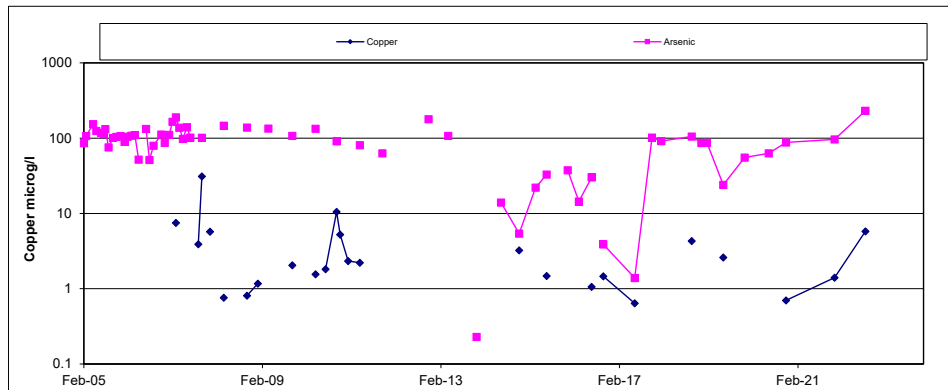
Tata Steel (UK) Ltd

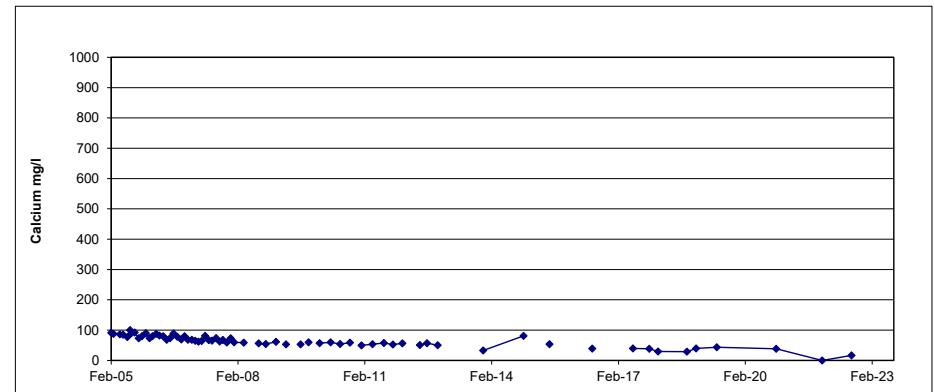
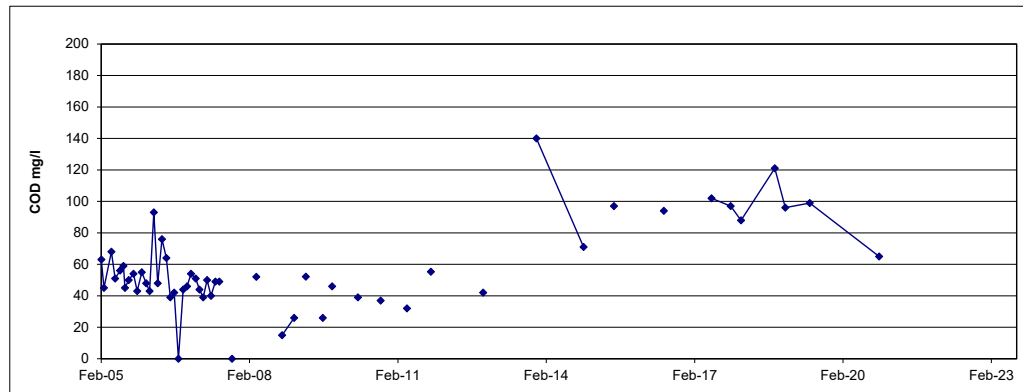
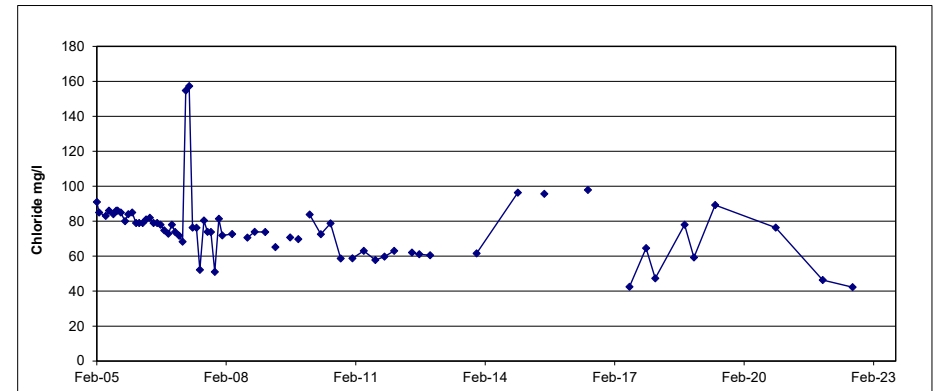
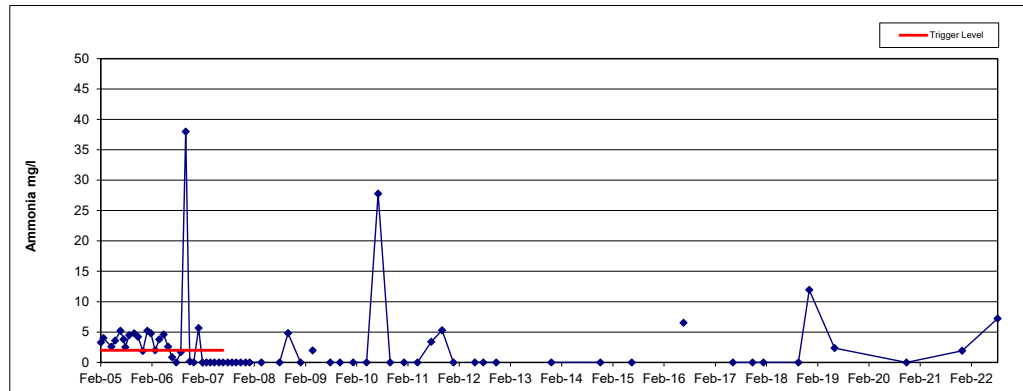
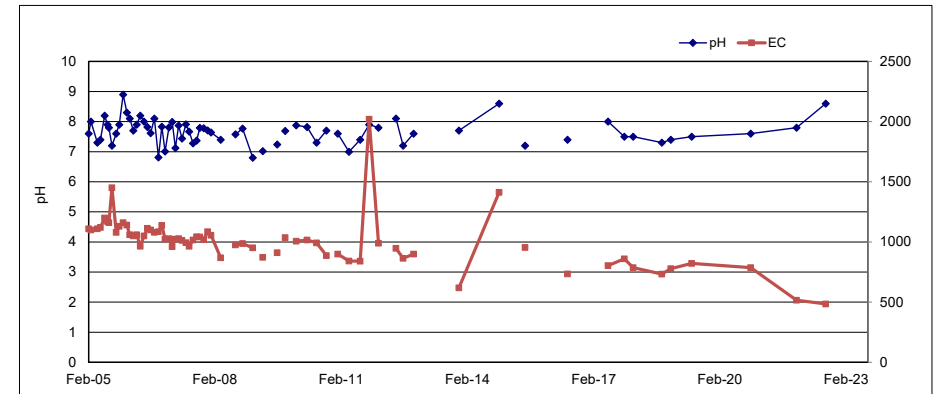
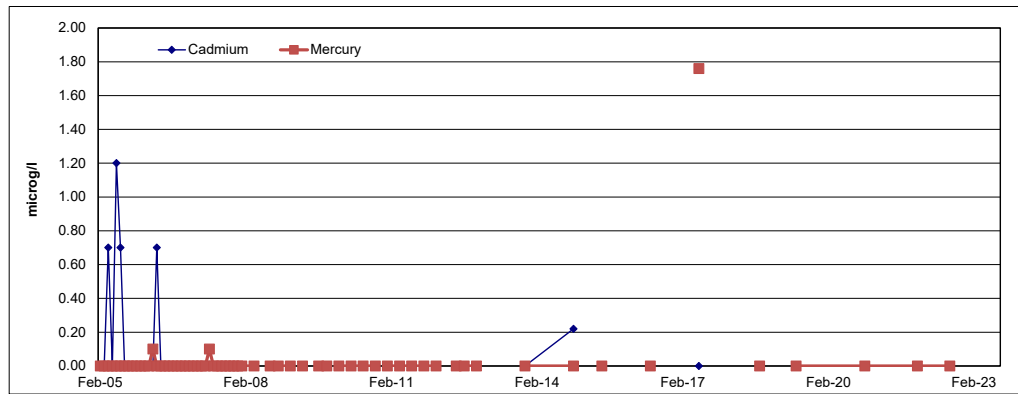


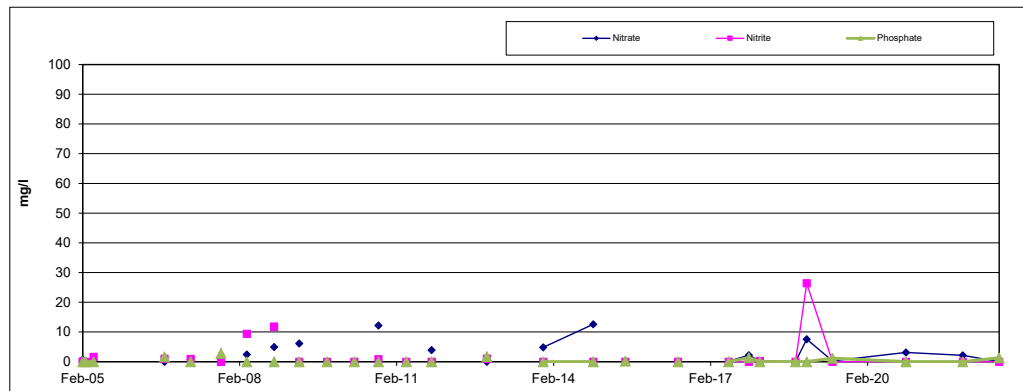
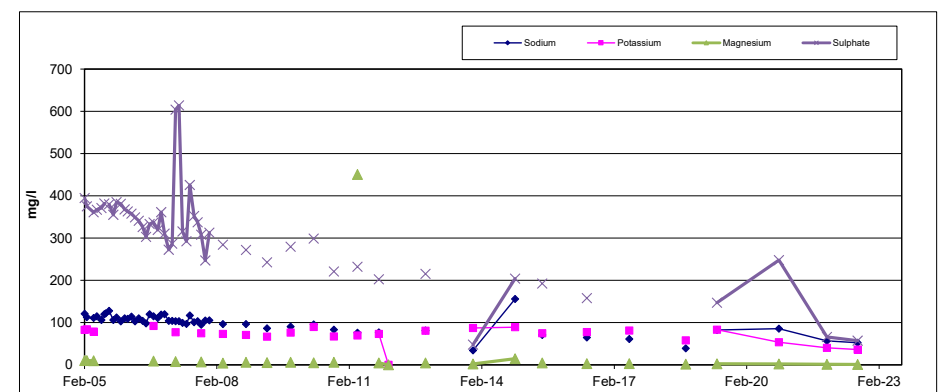
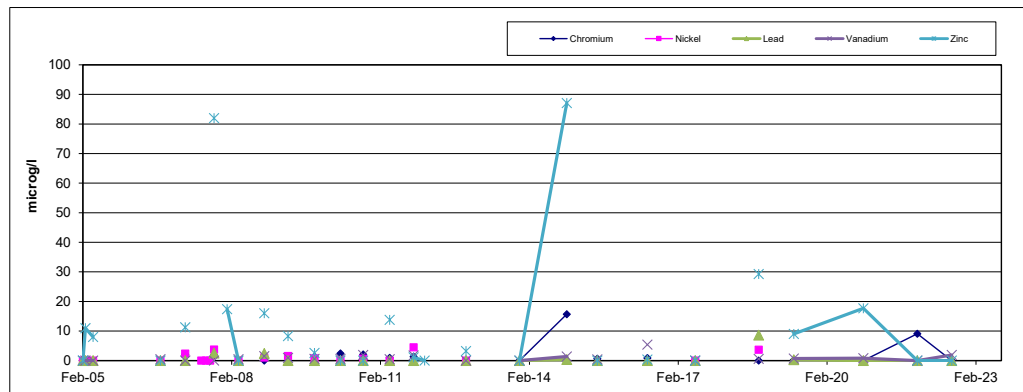
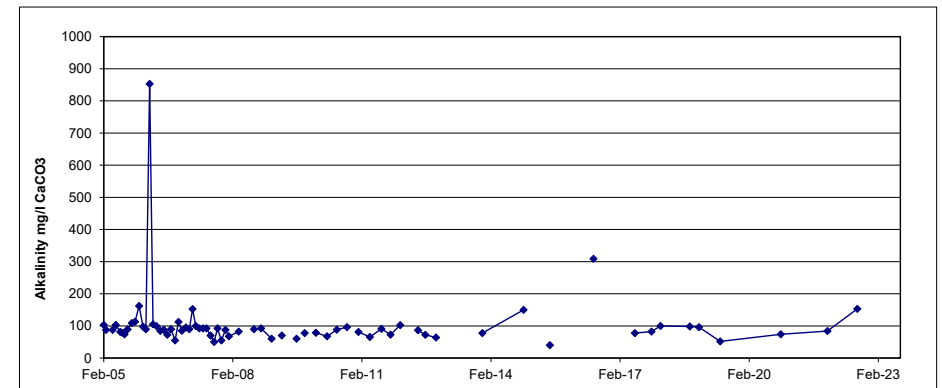
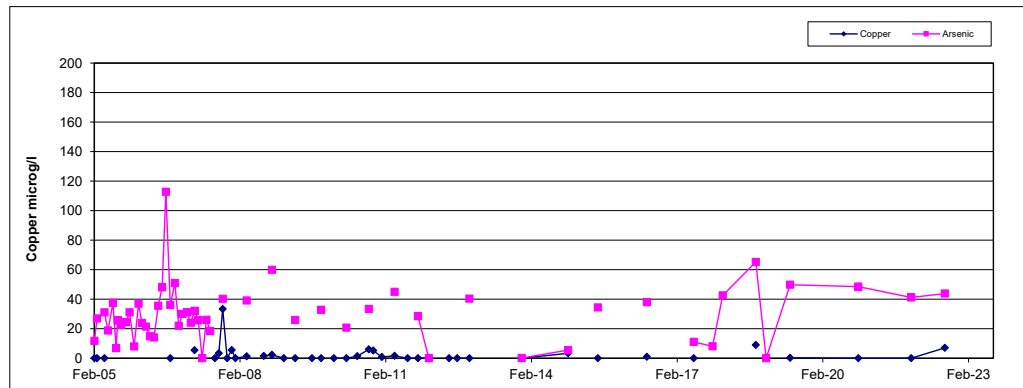


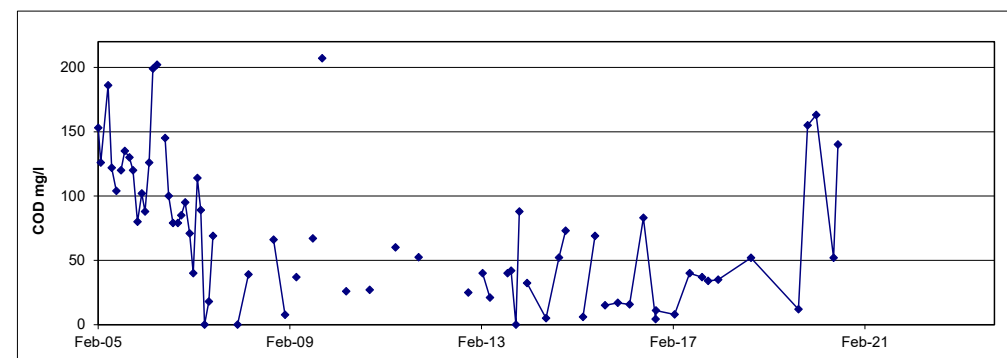
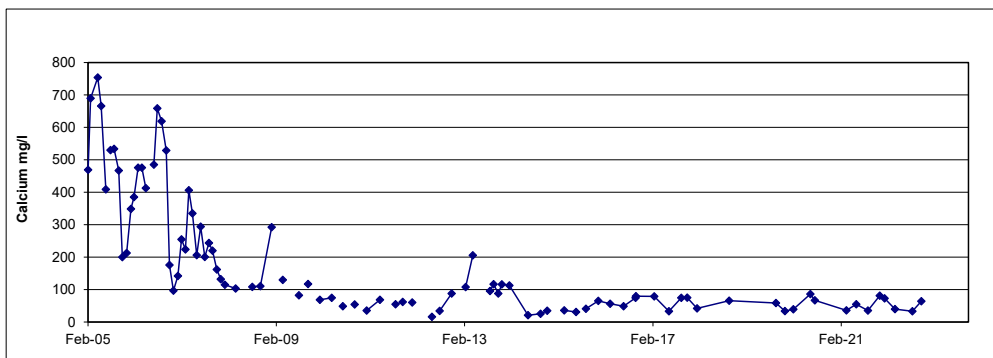
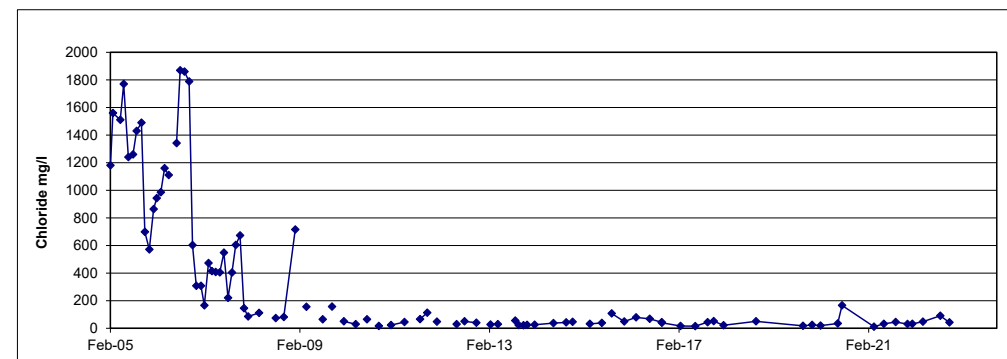
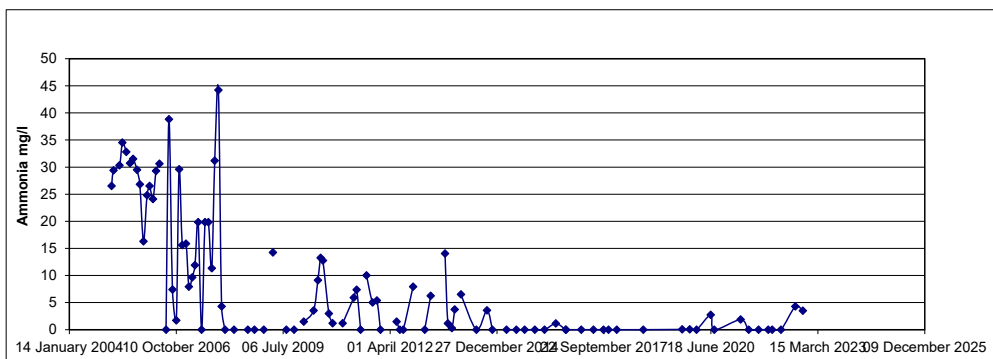
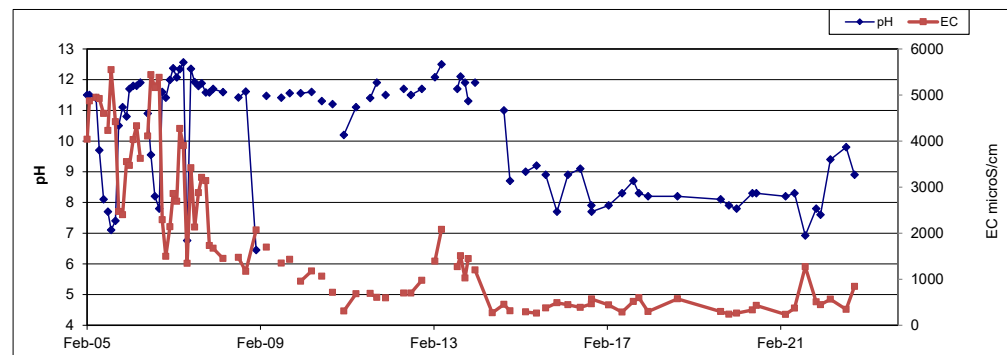
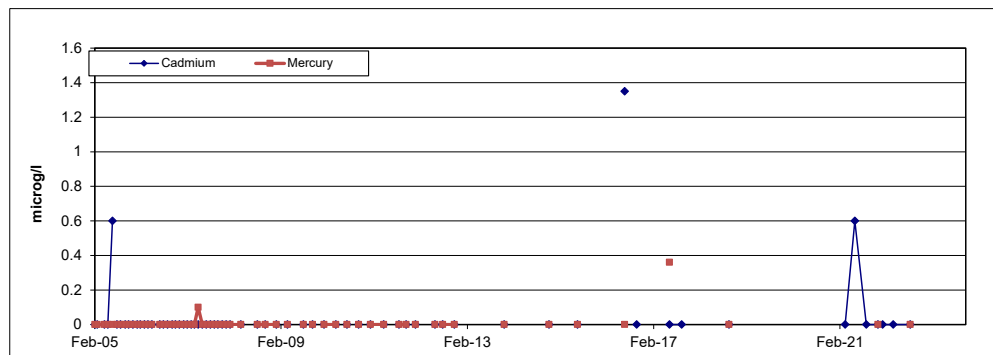


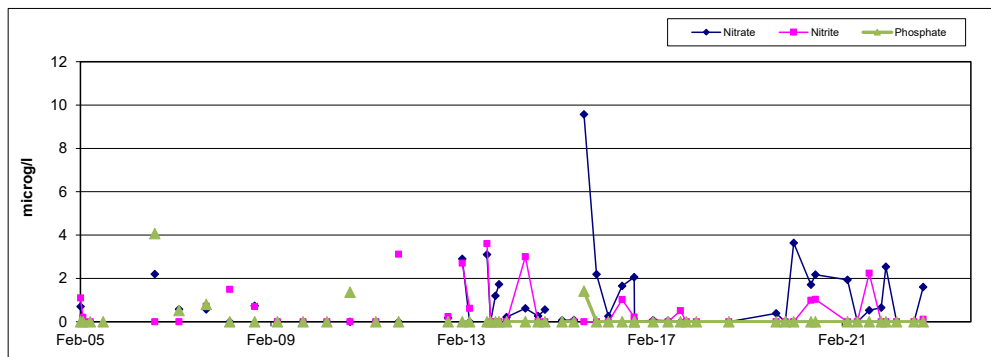
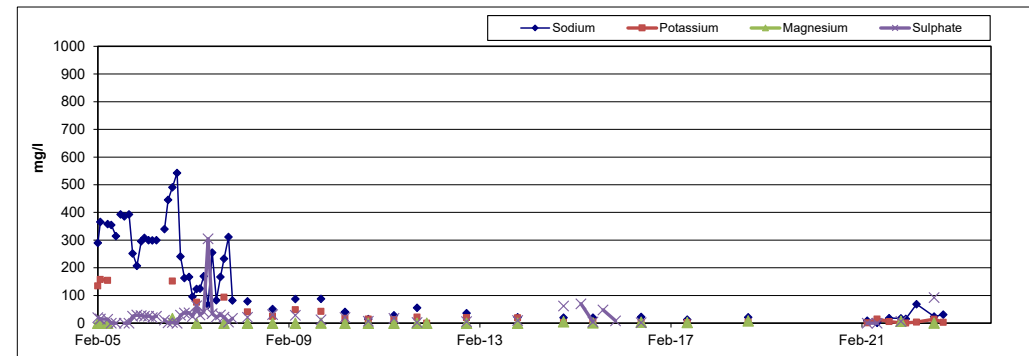
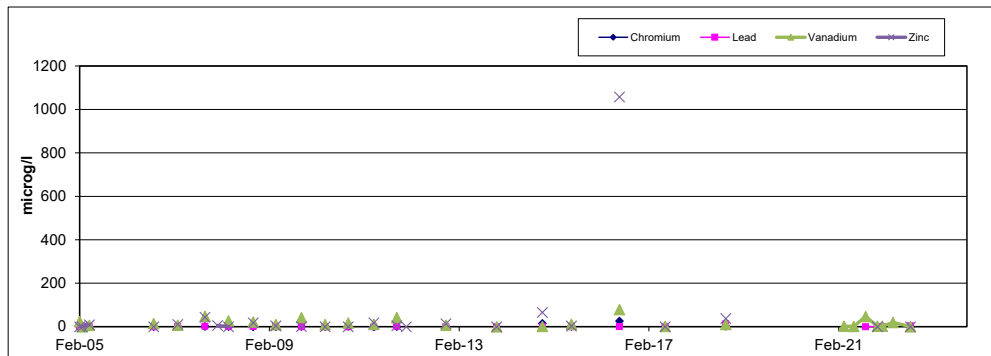
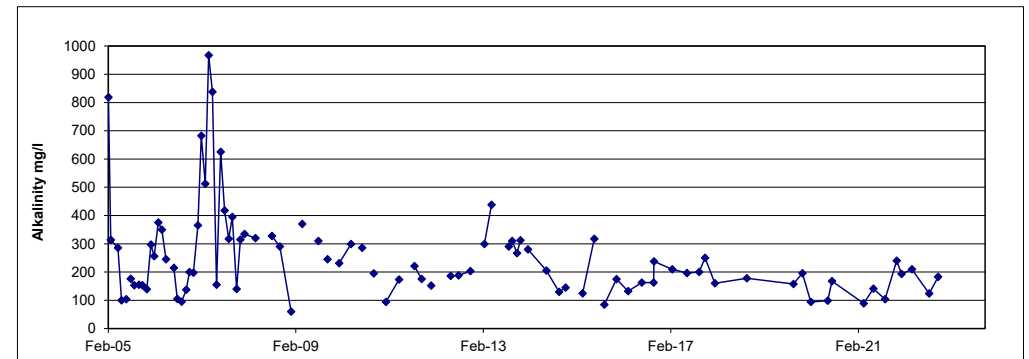
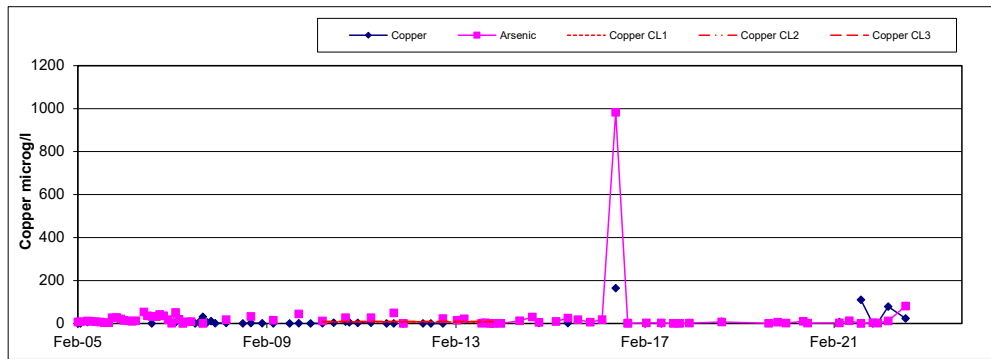


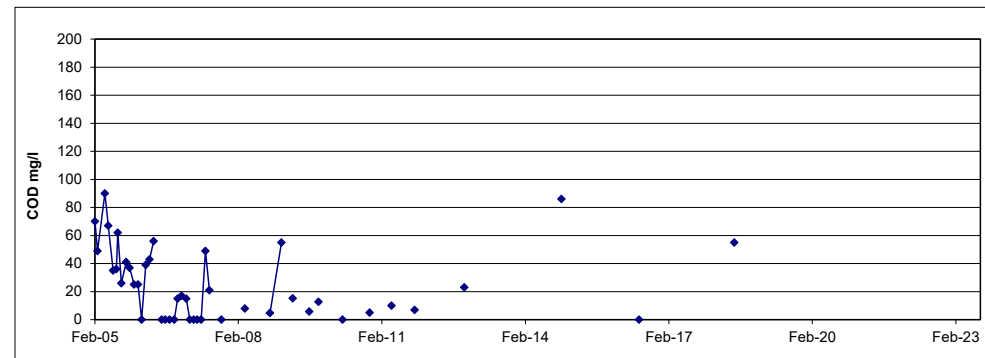
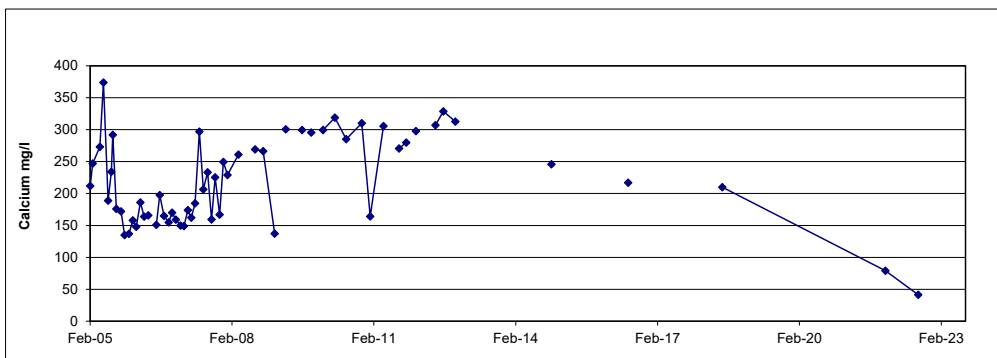
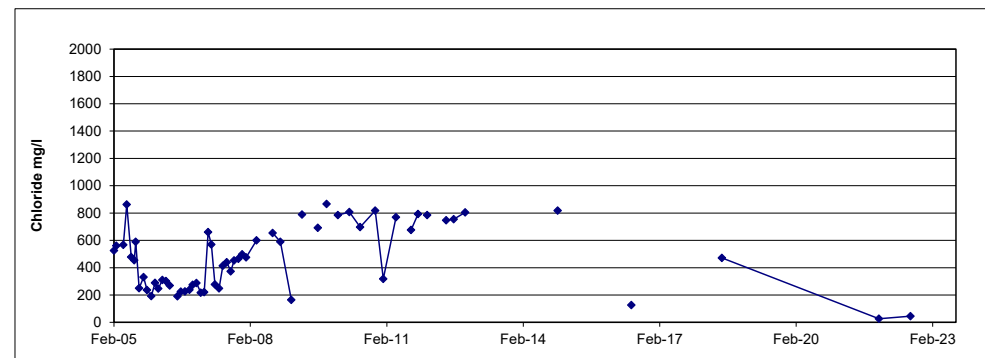
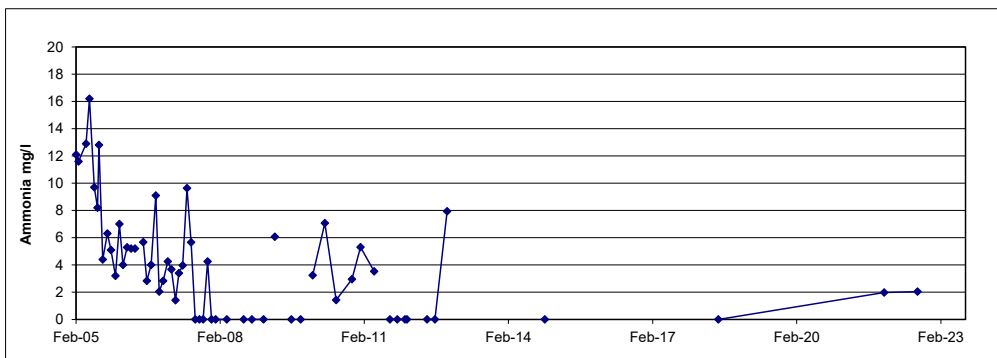
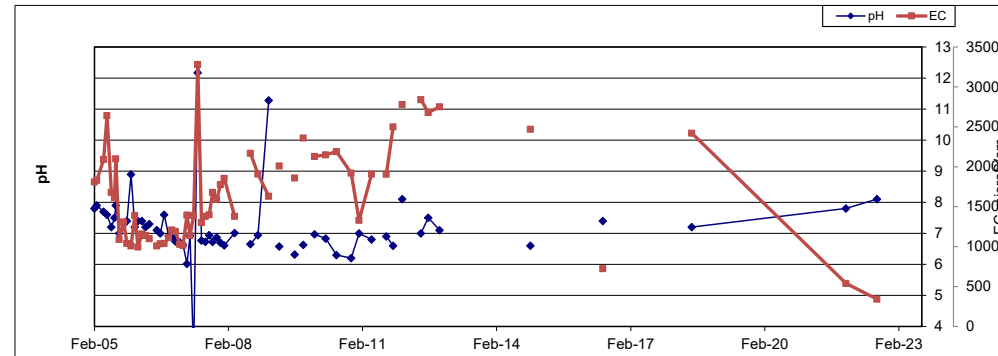
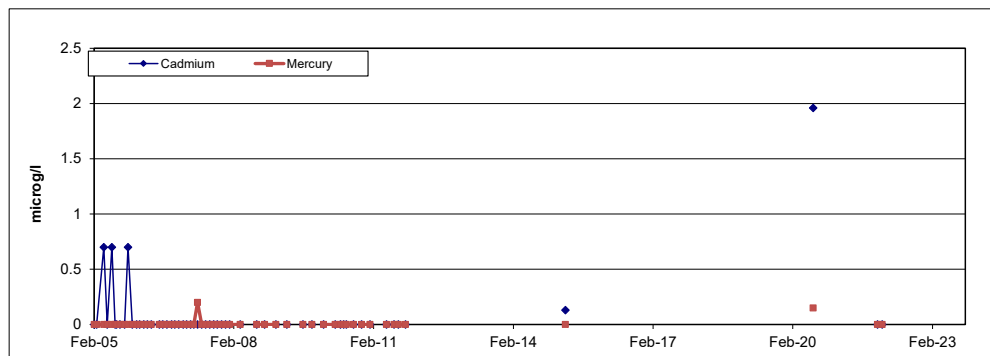


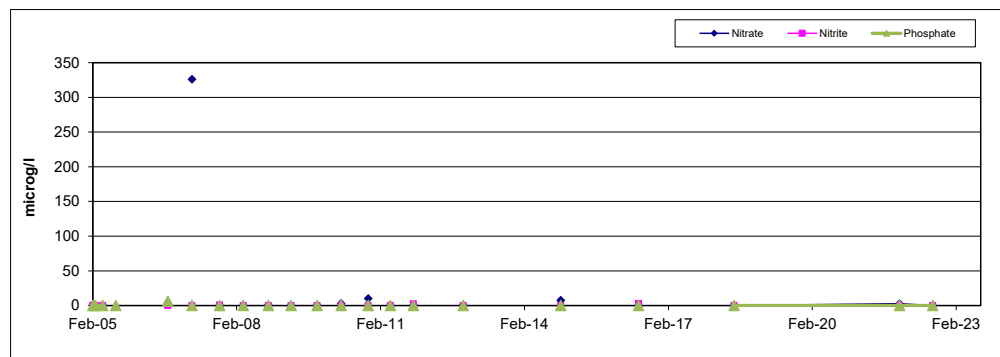
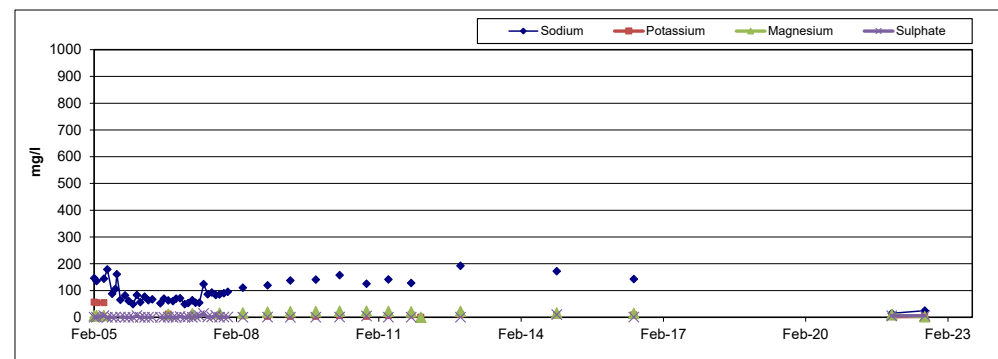
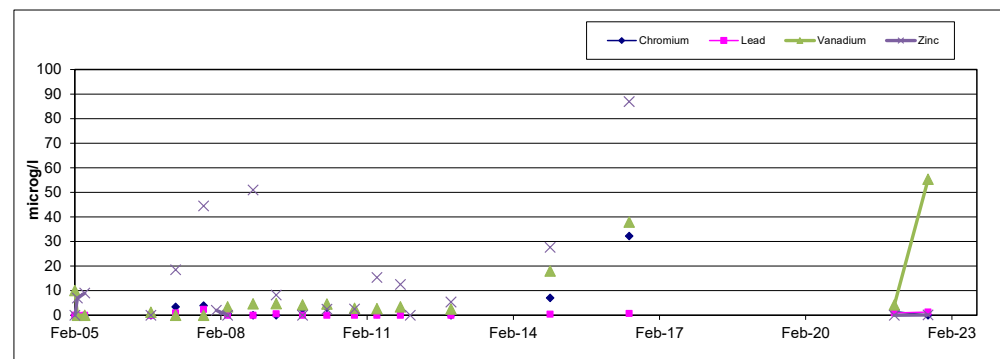
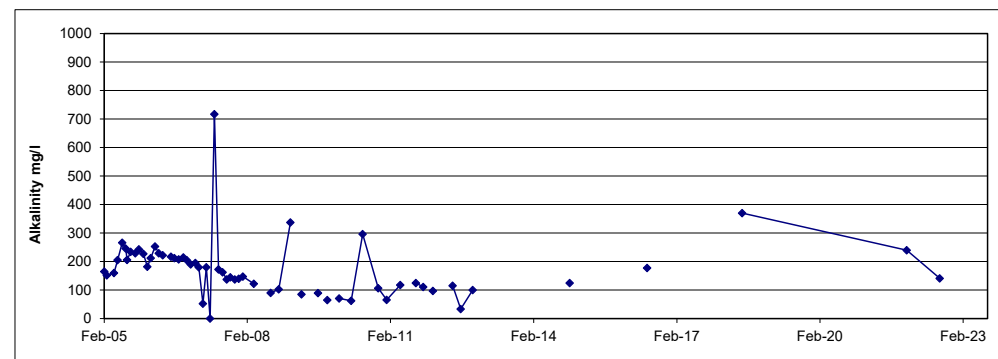
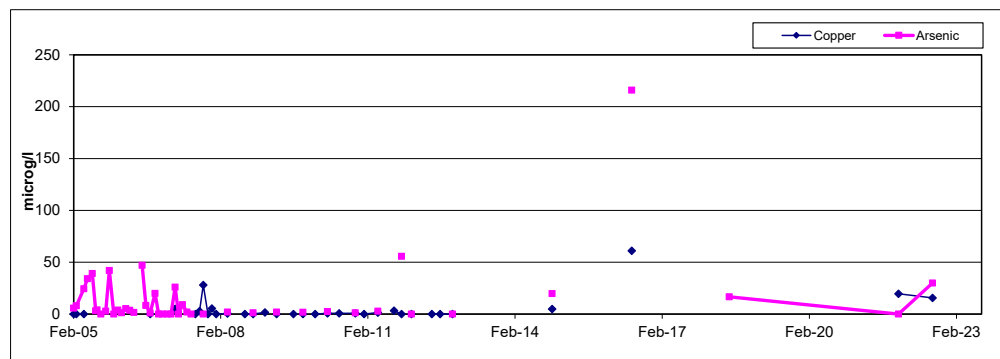


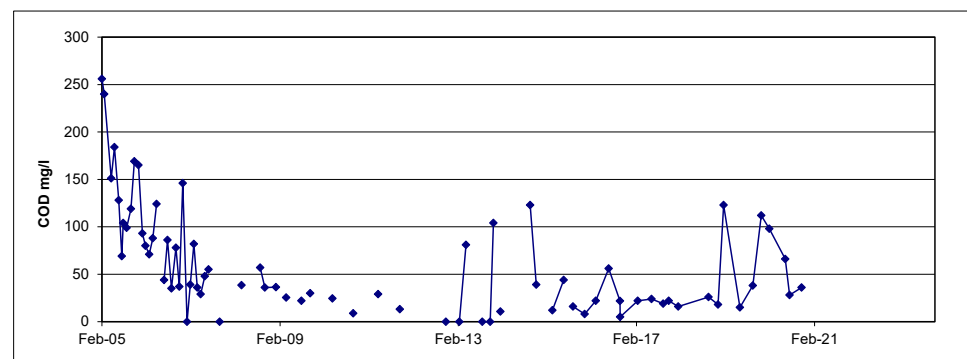
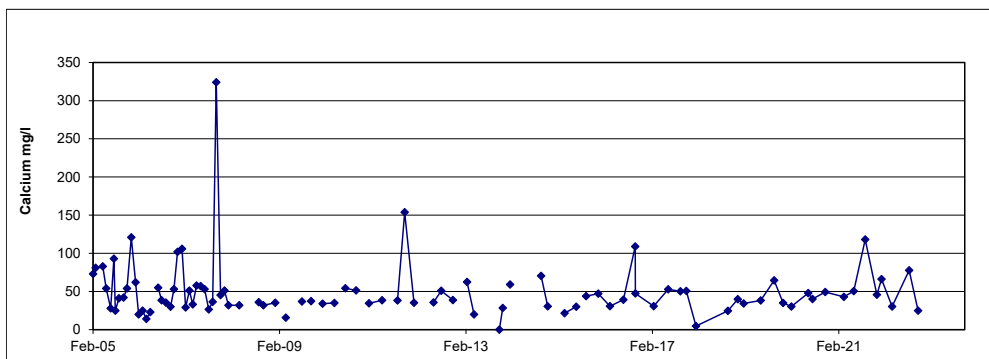
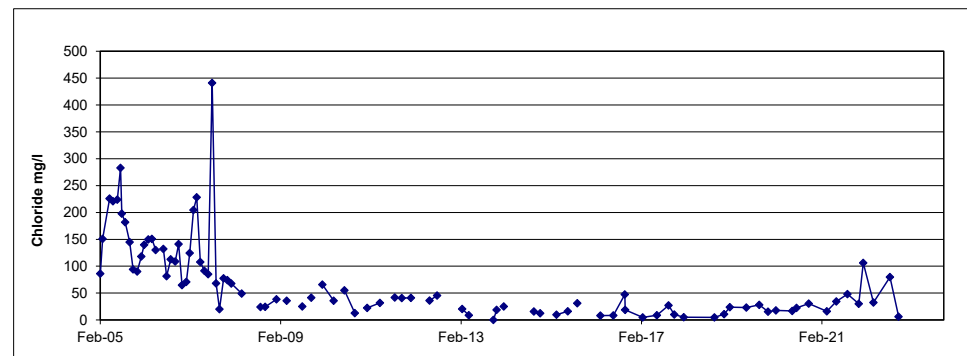
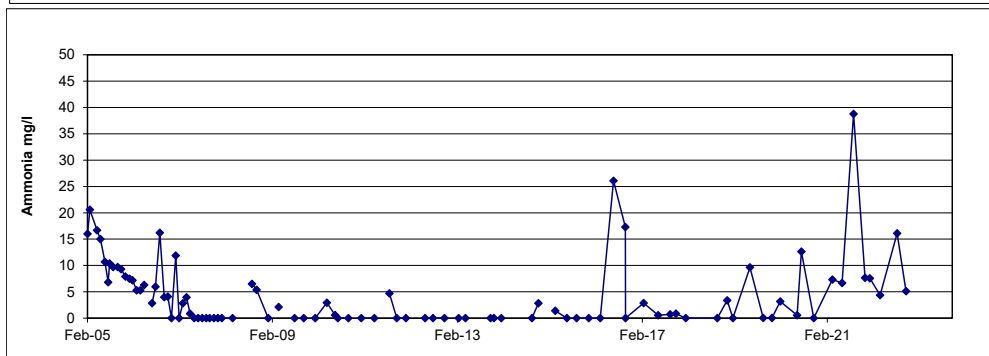
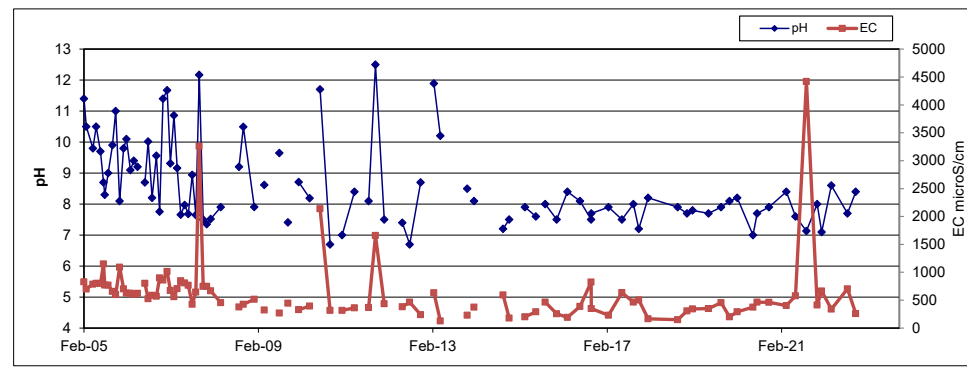
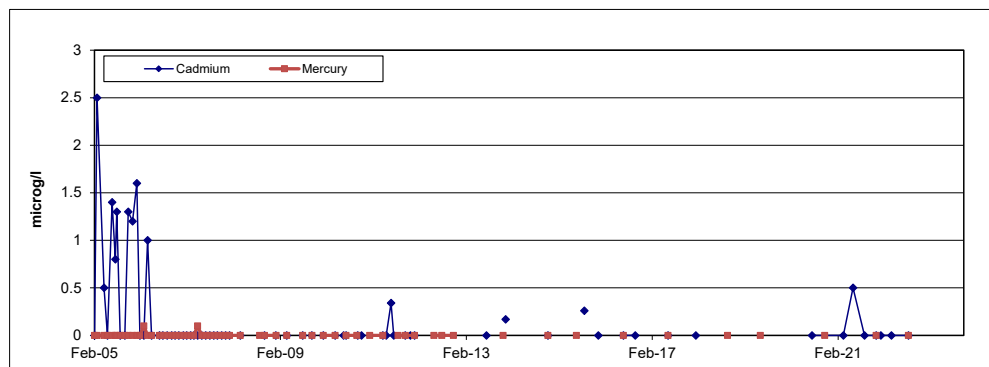


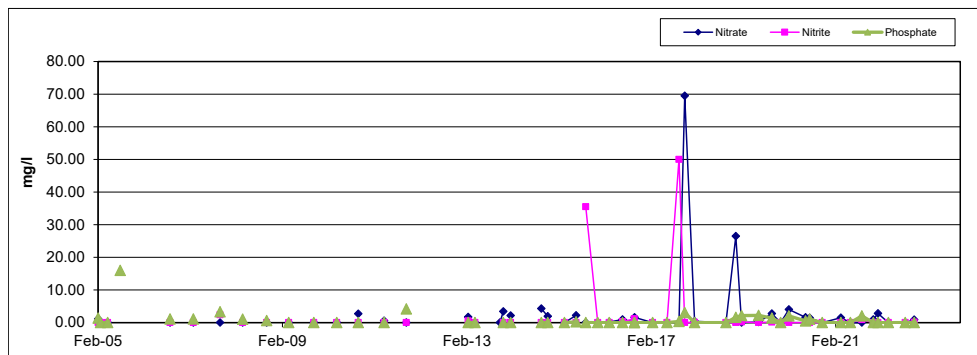
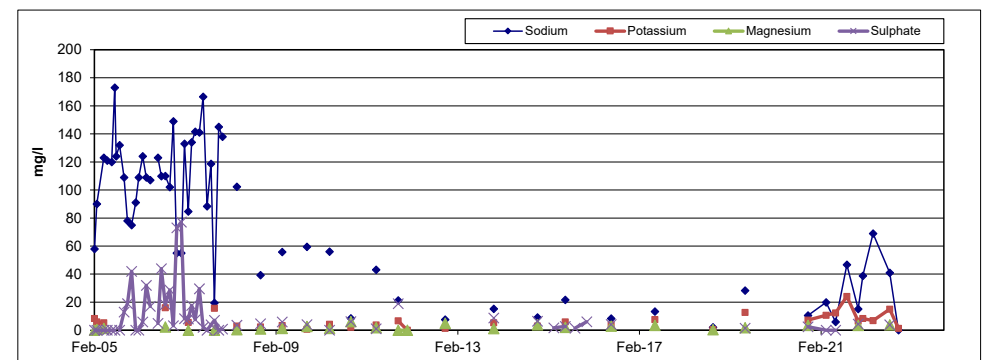
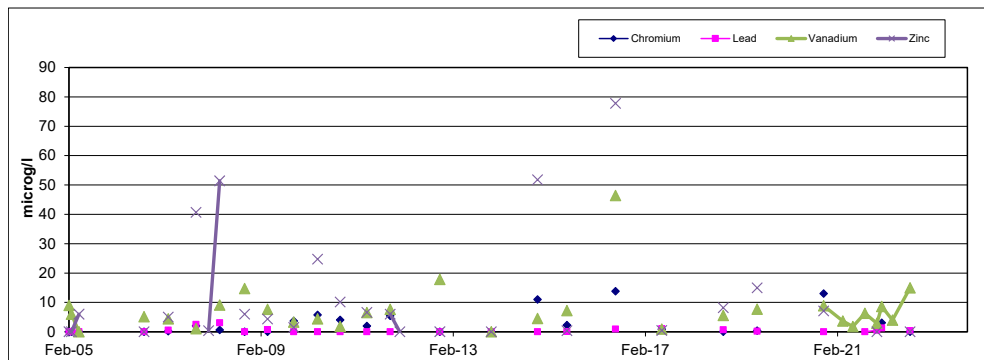
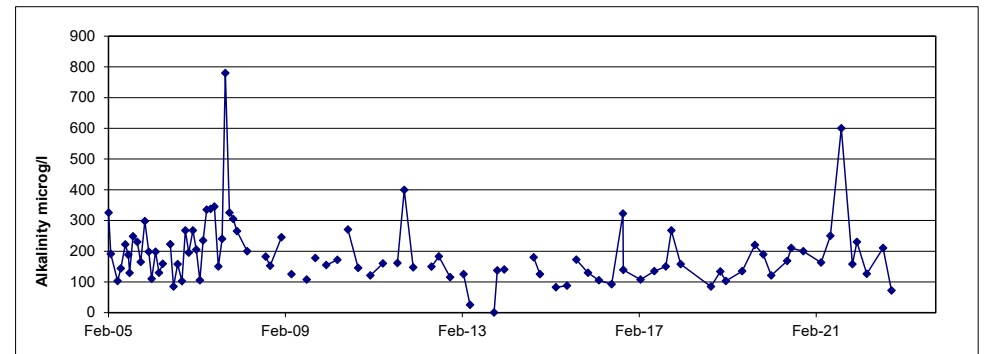
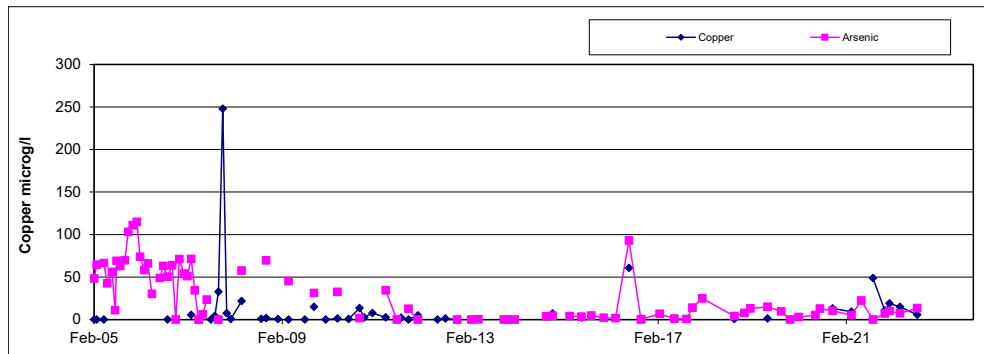


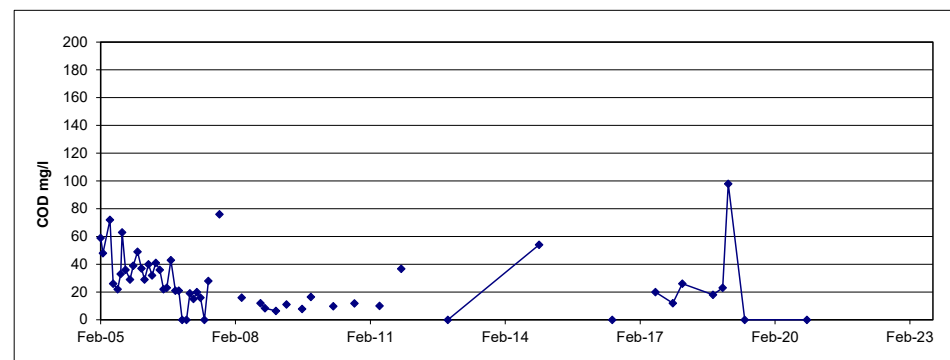
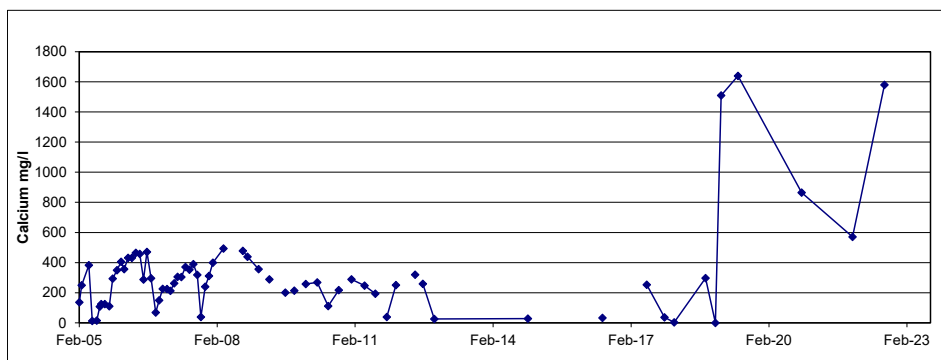
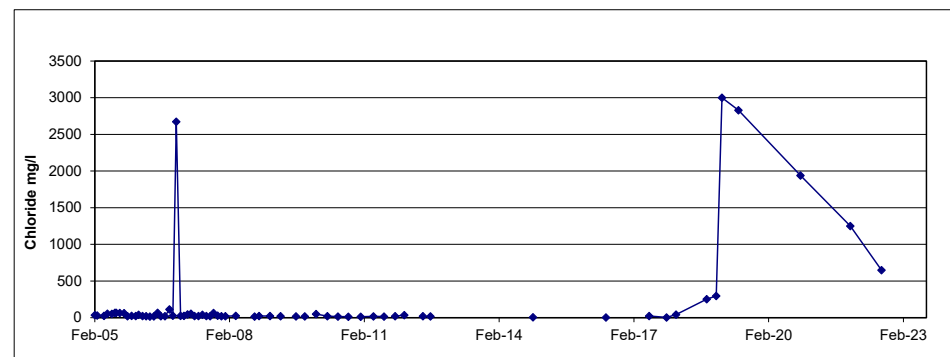
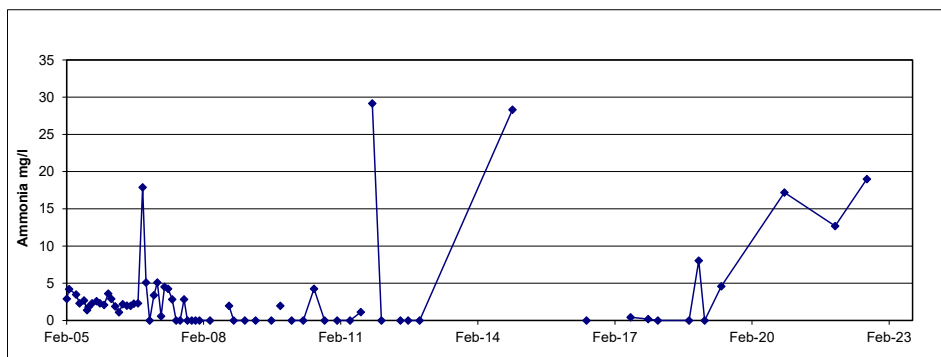
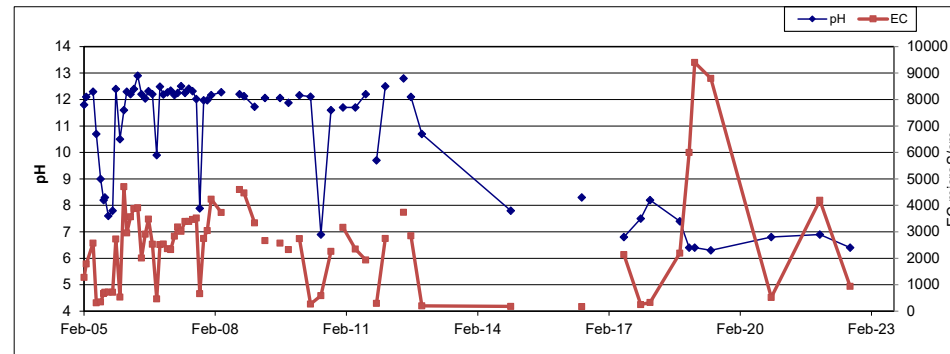
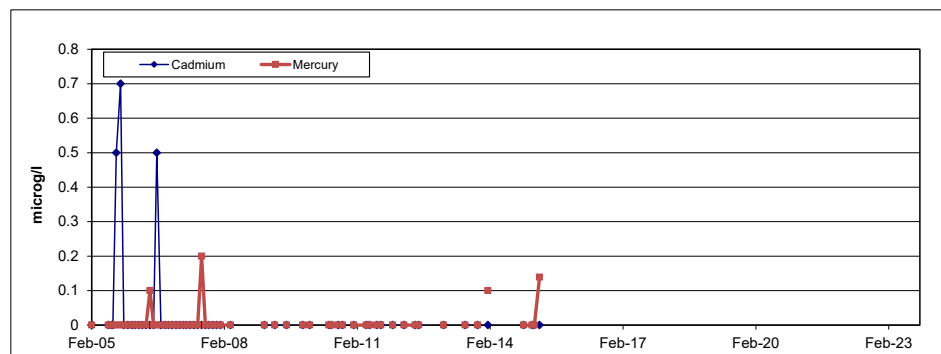


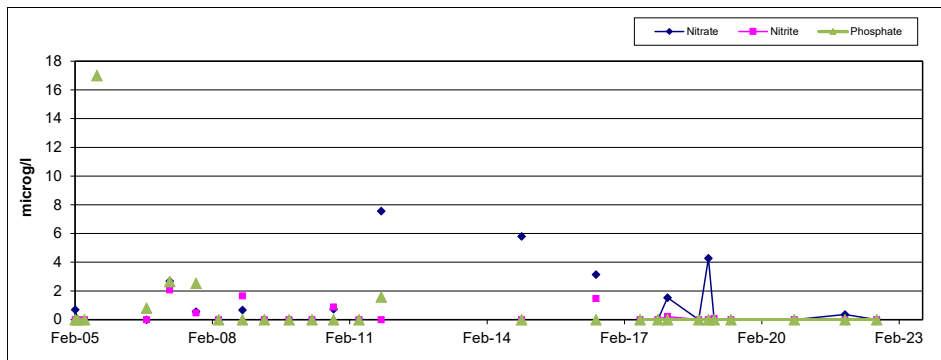
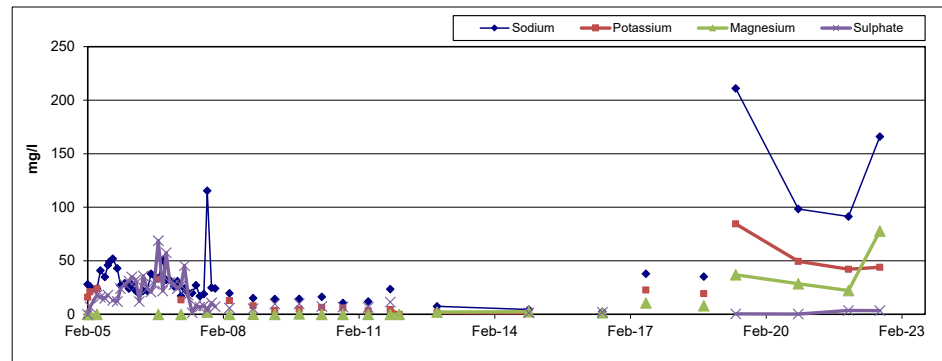
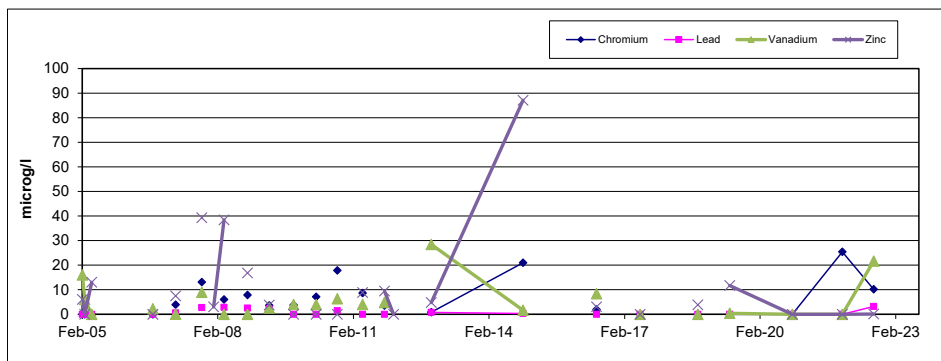
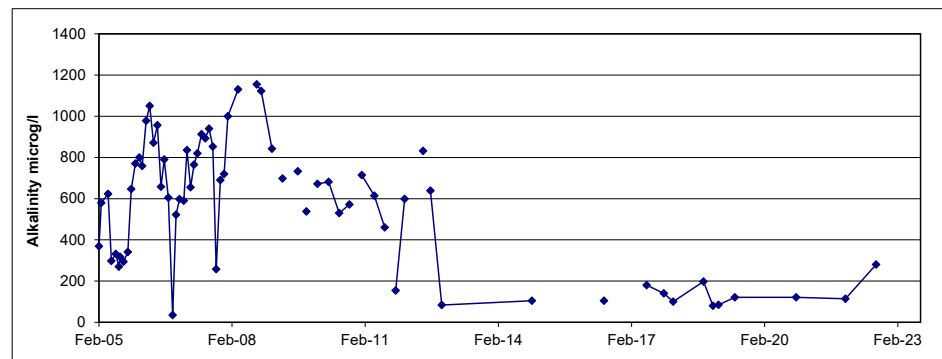
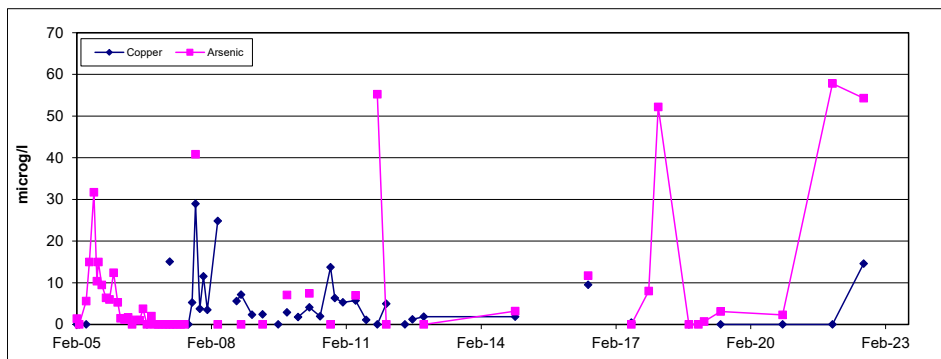


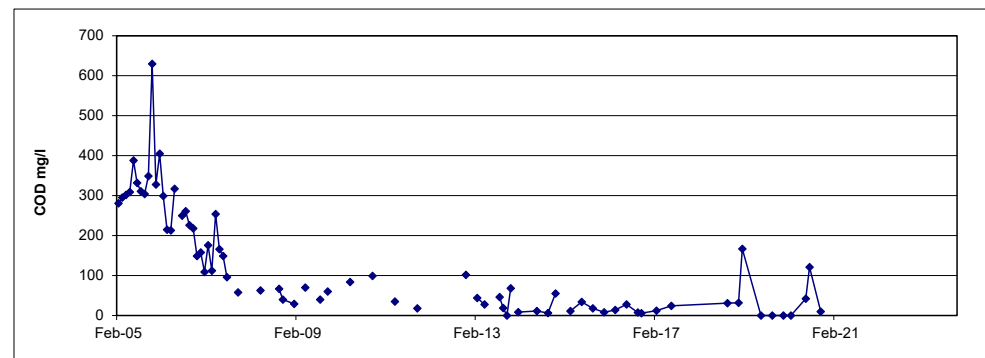
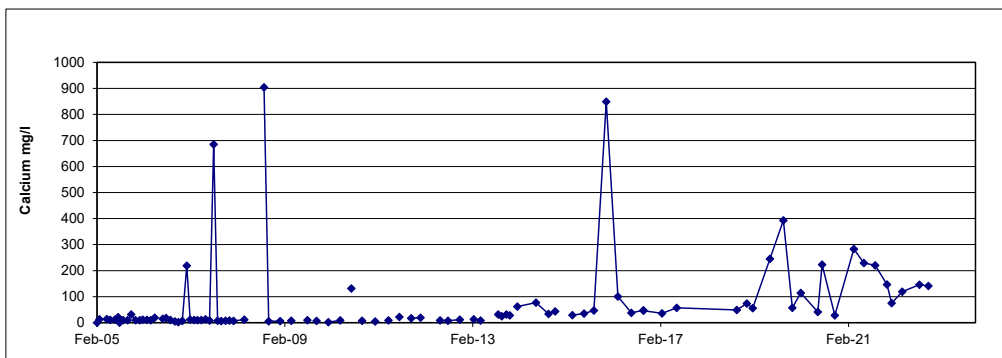
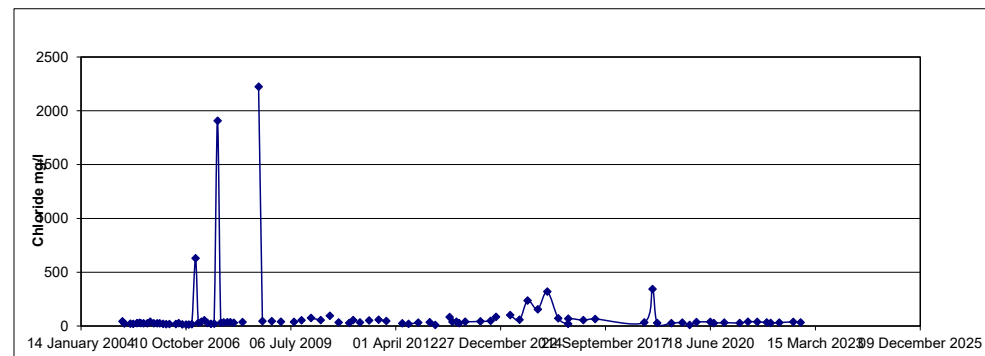
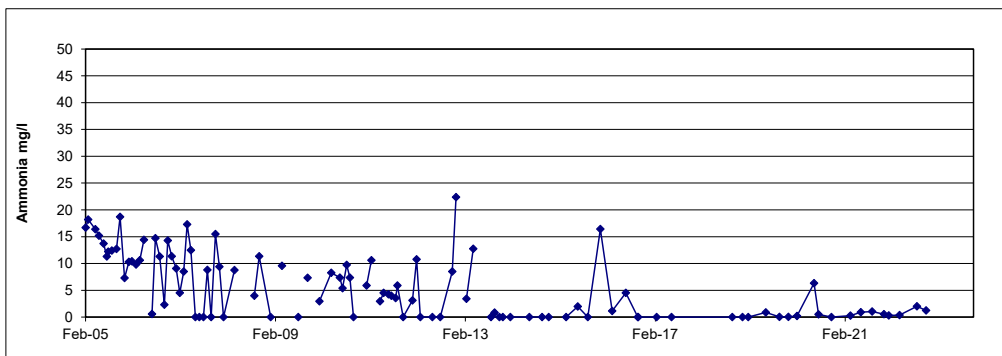
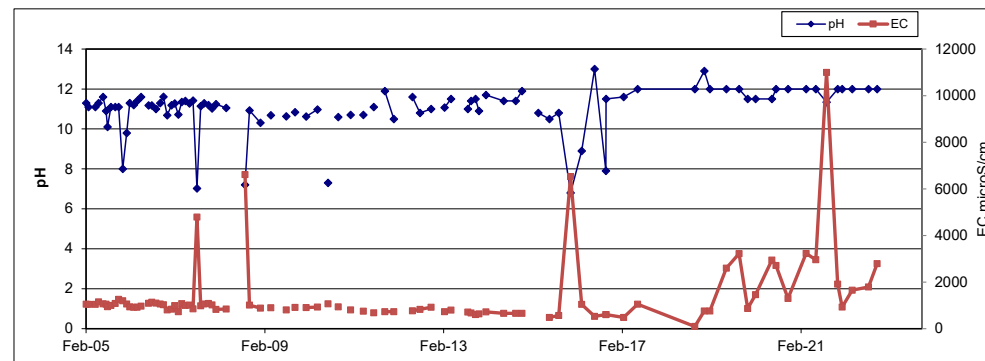
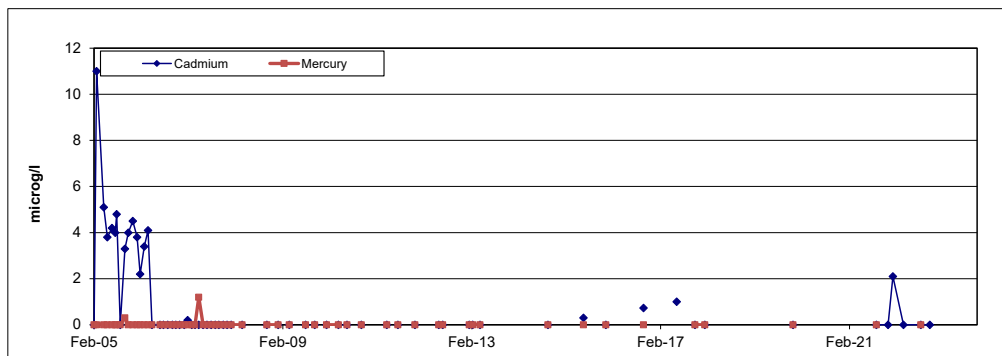


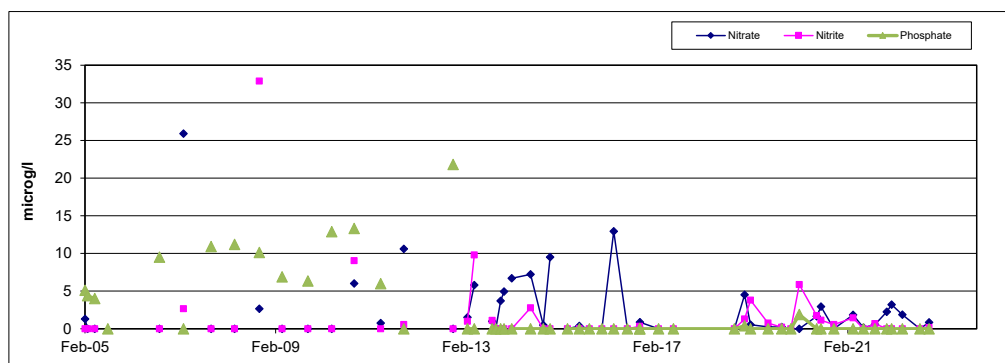
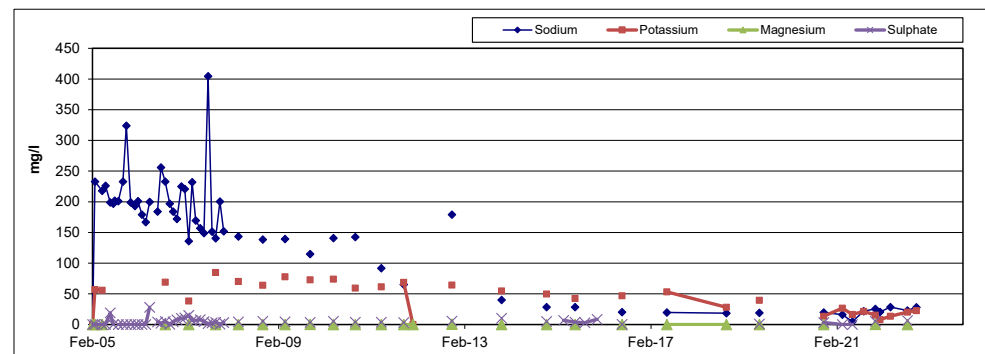
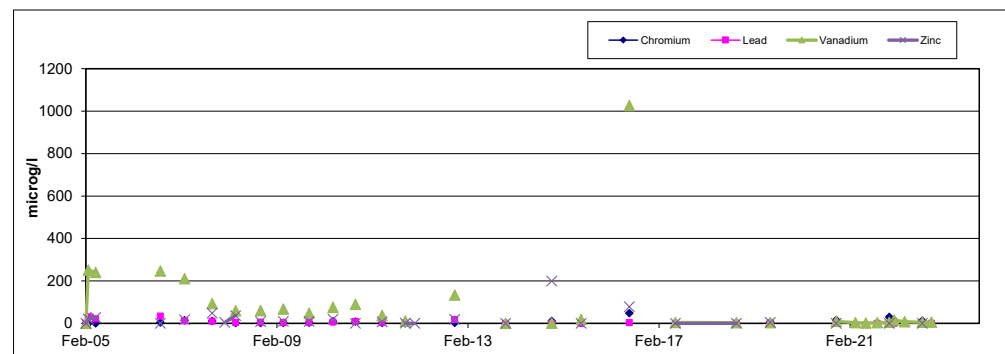
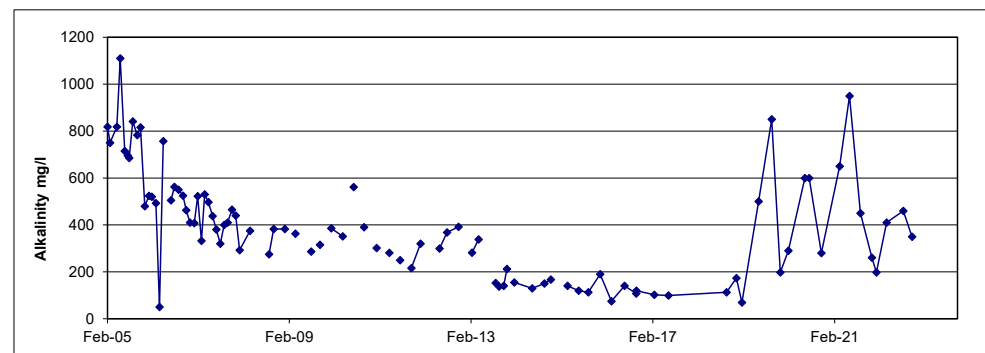
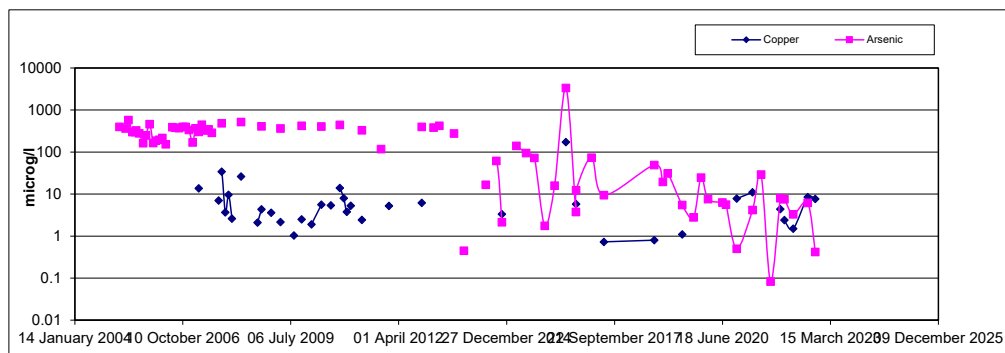


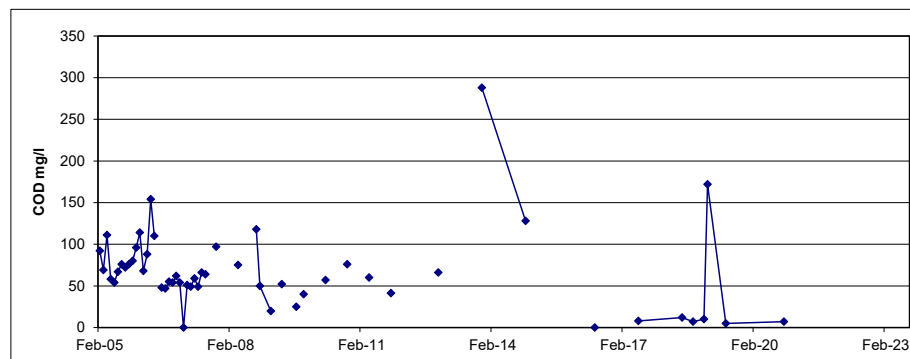
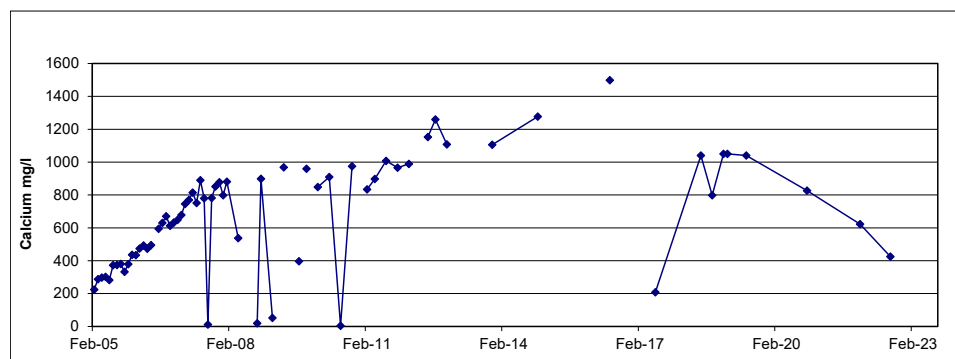
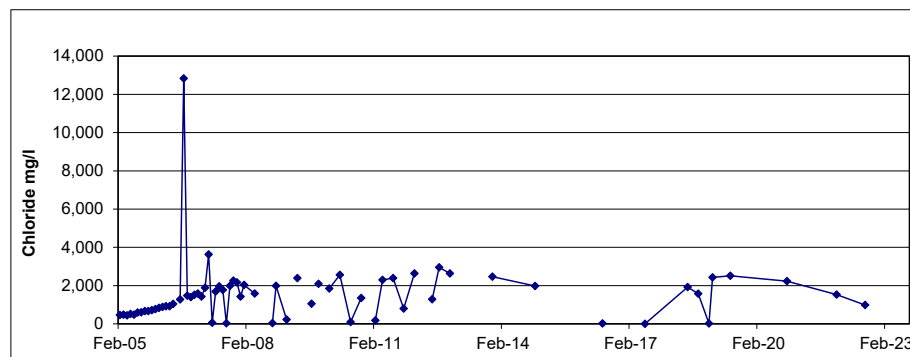
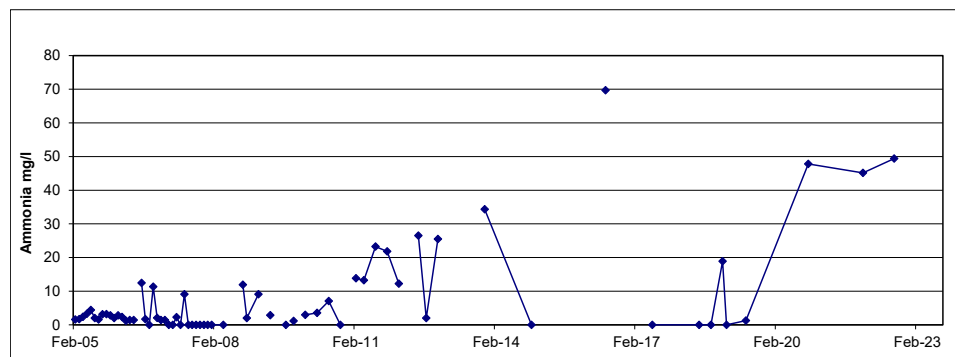
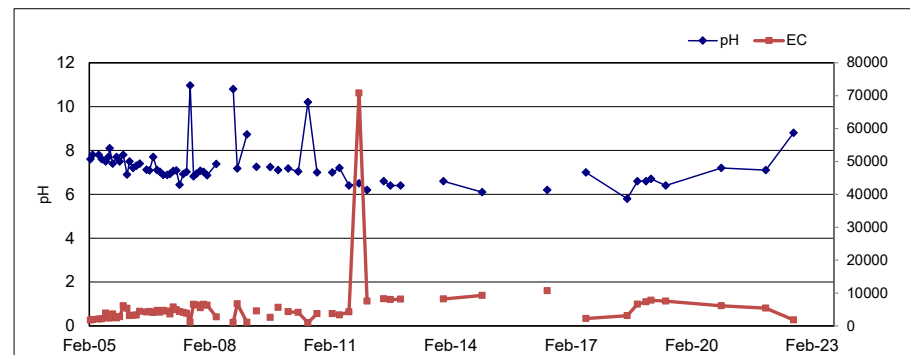
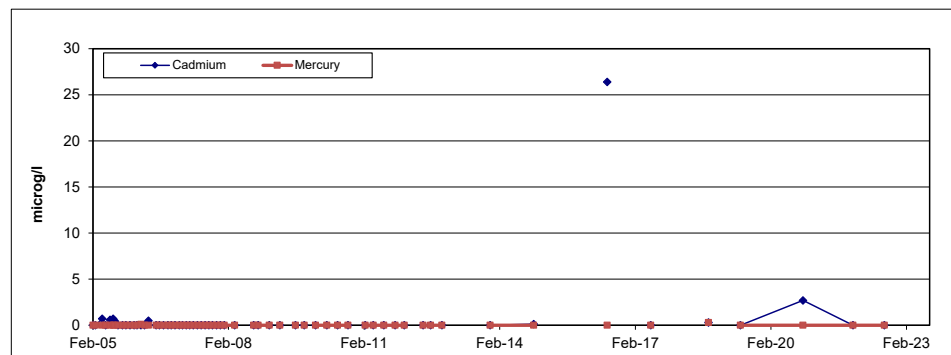


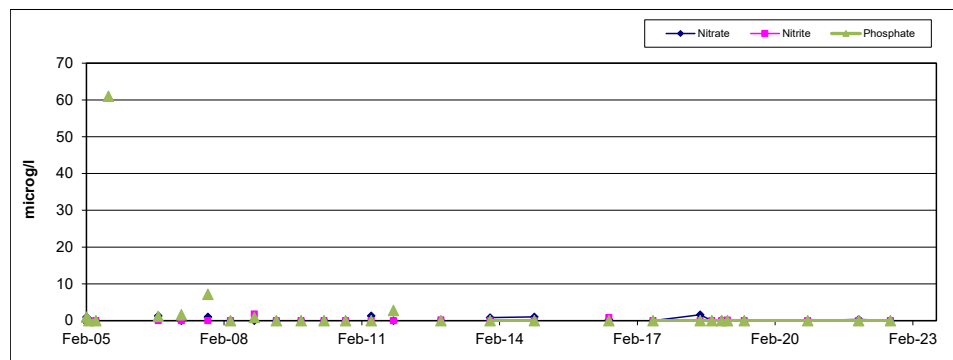
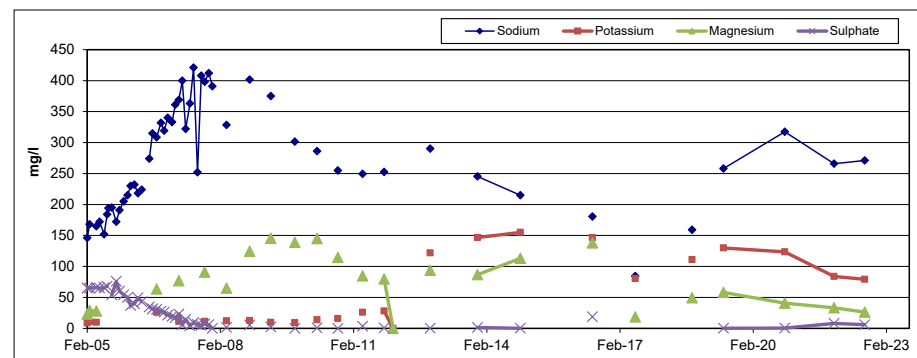
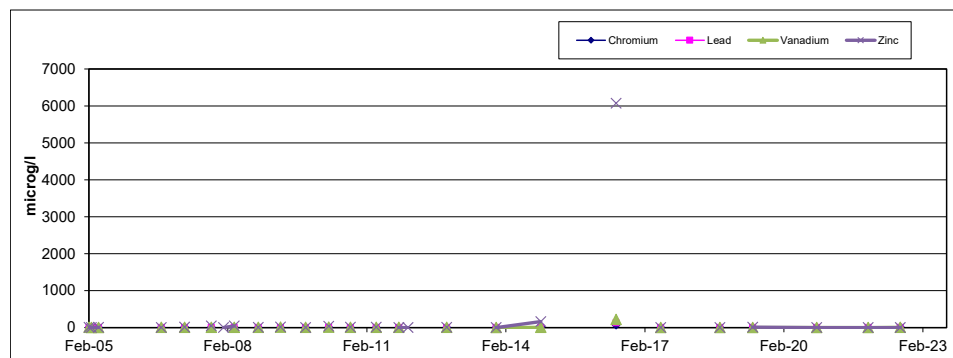
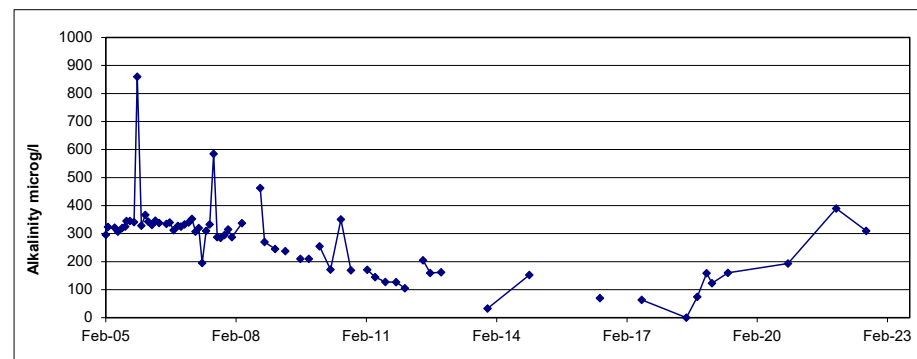
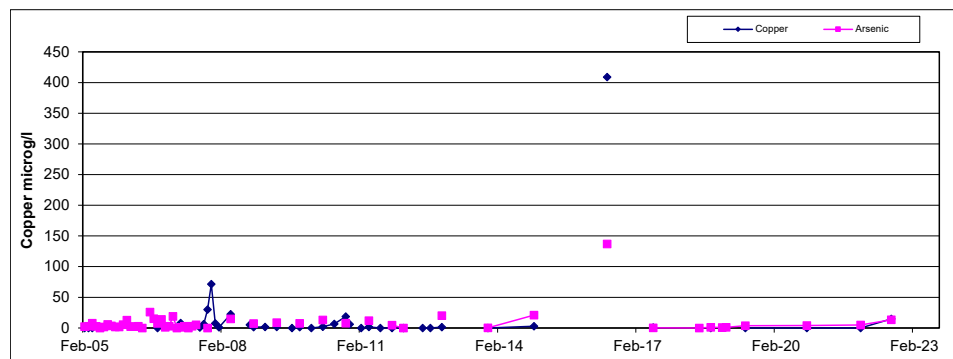


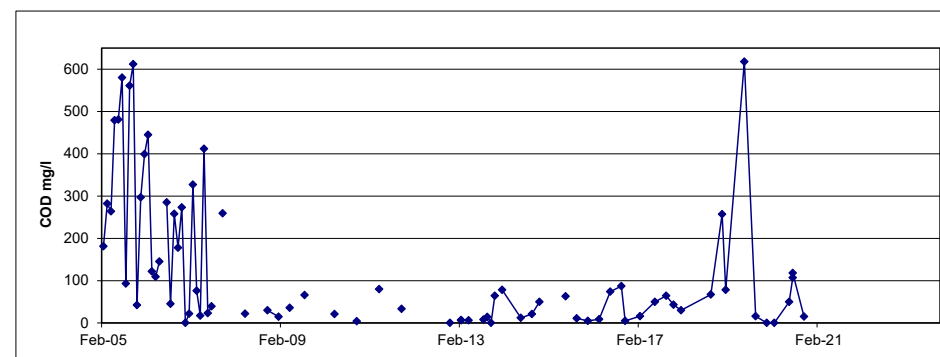
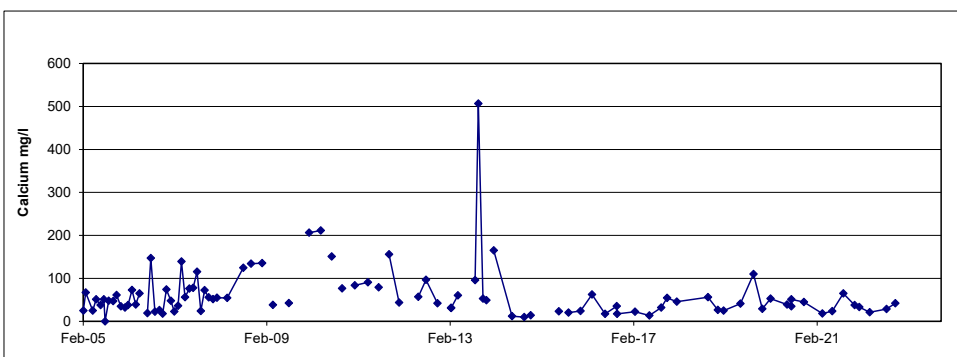
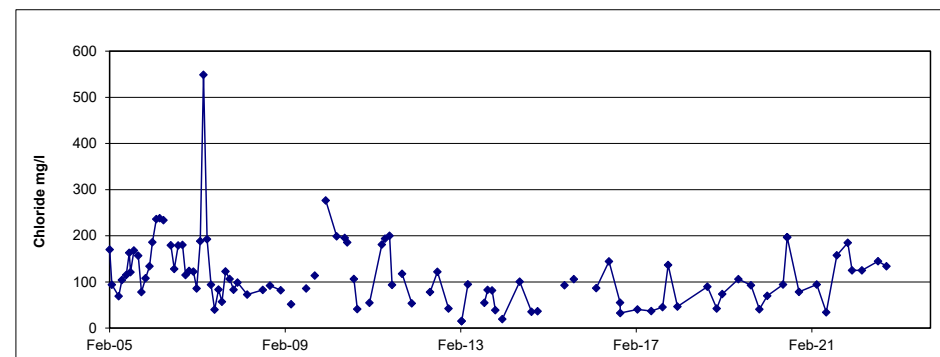
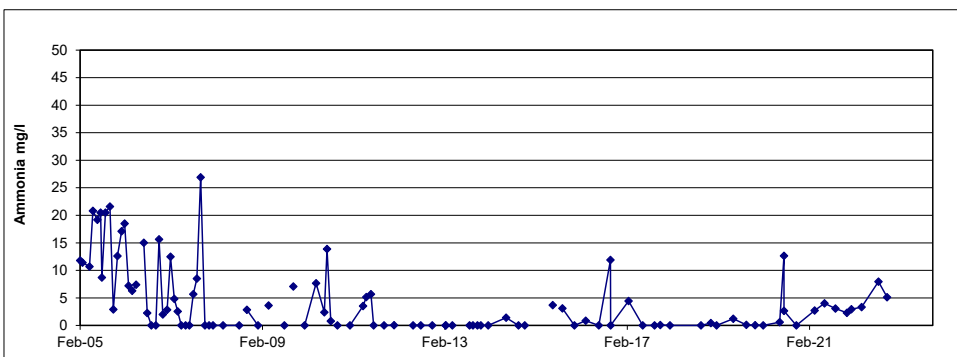
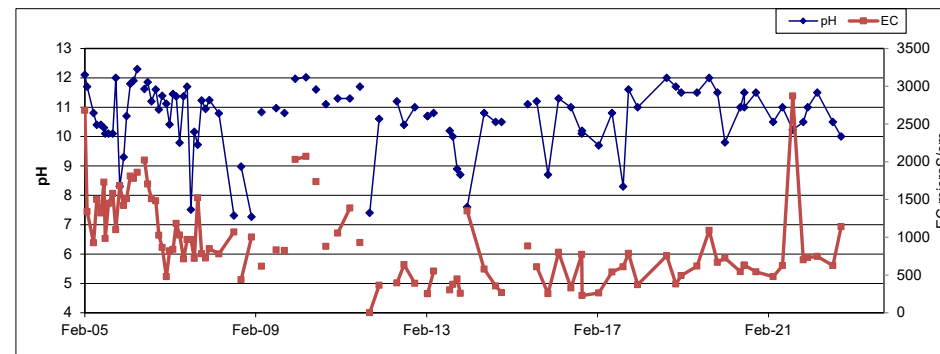
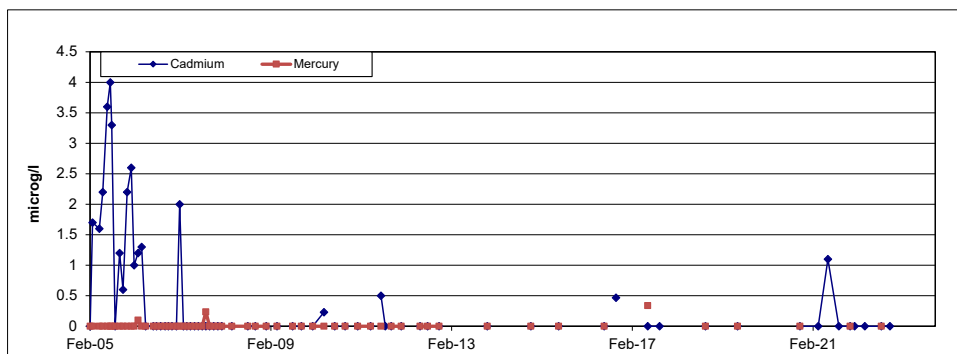


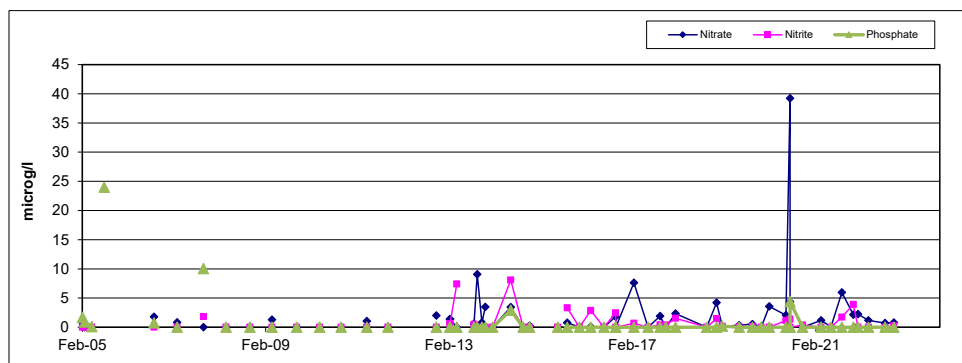
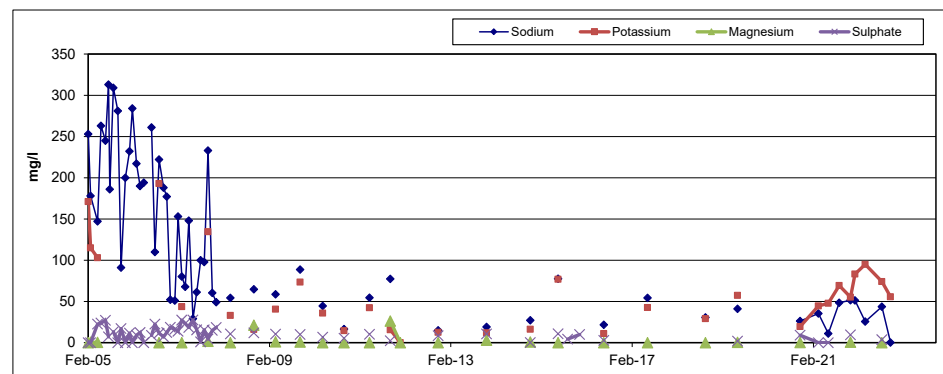
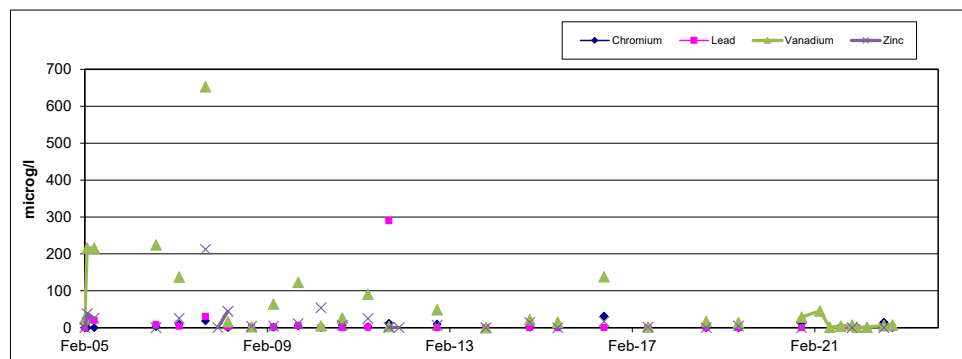
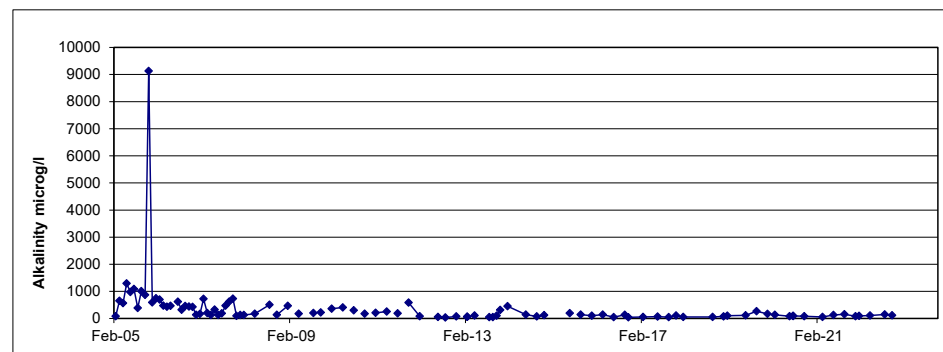
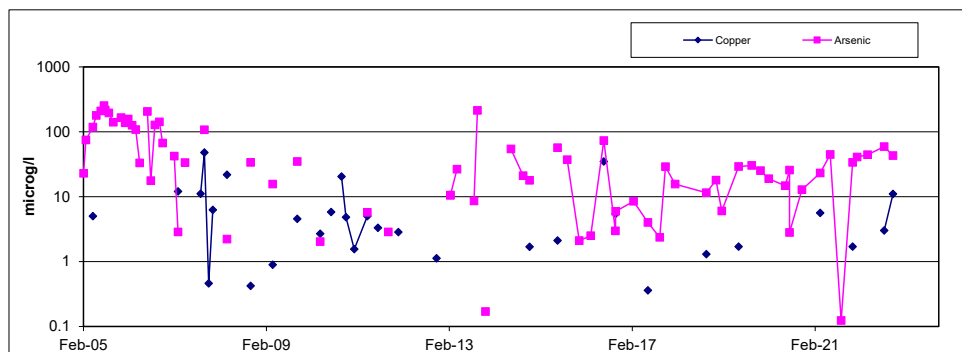


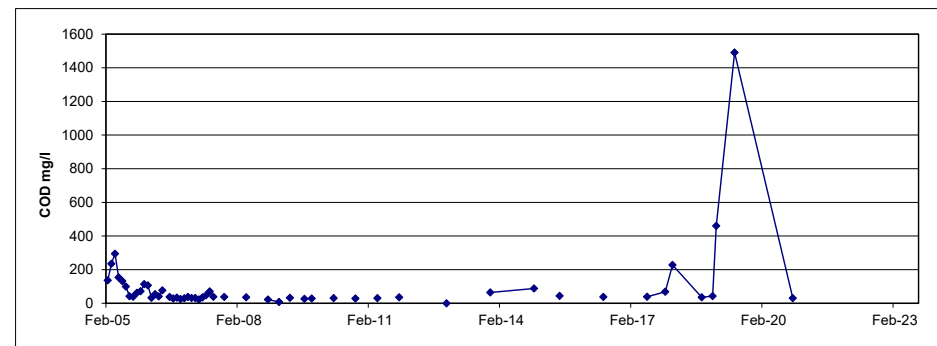
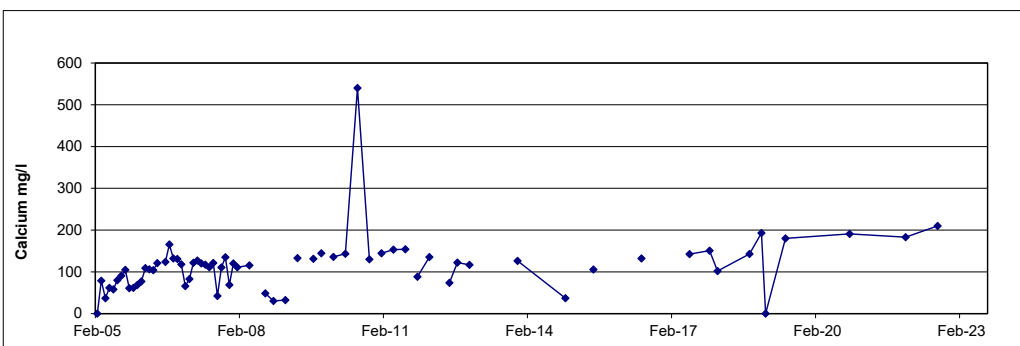
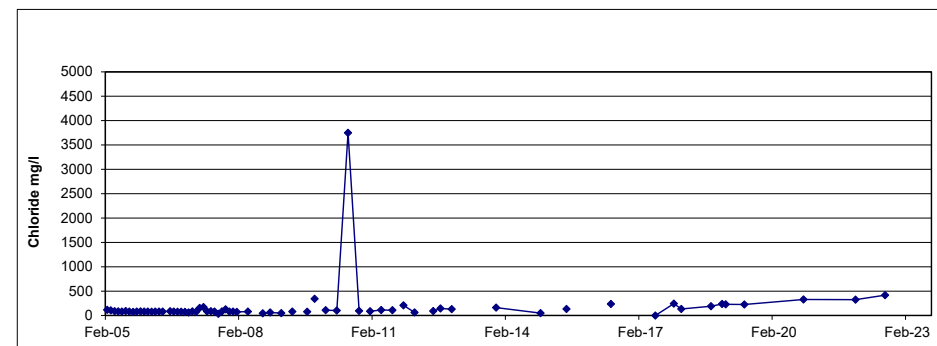
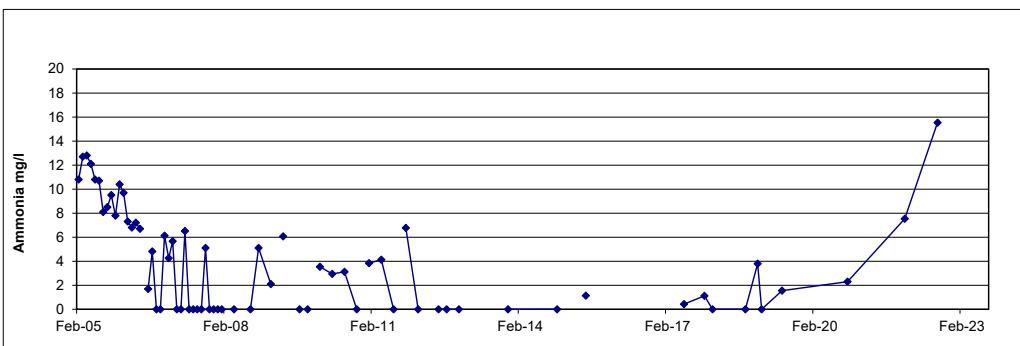
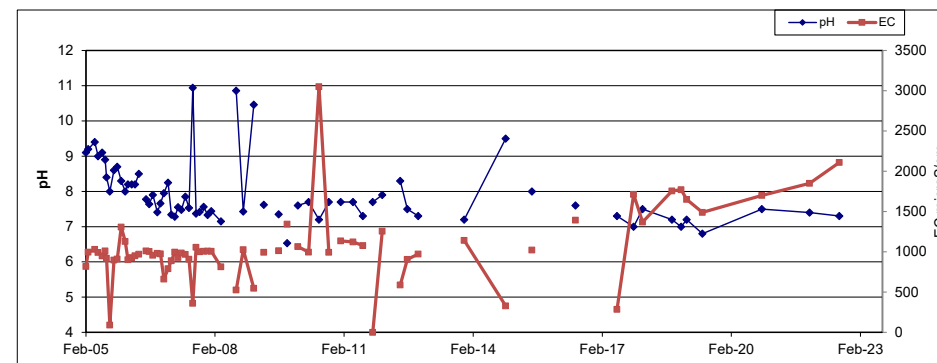
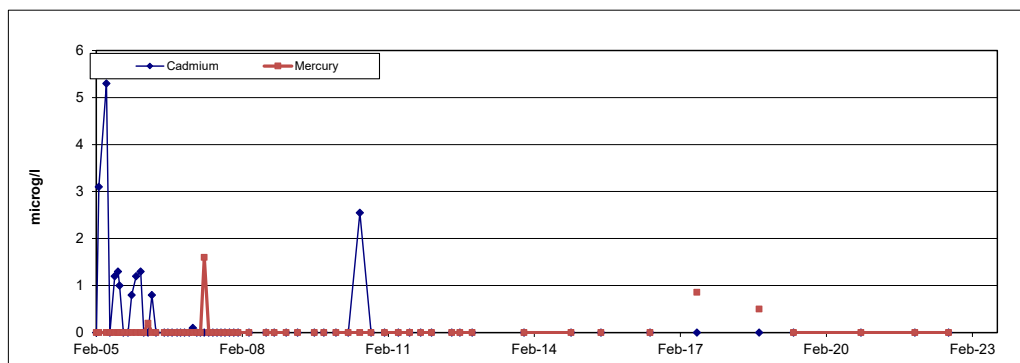


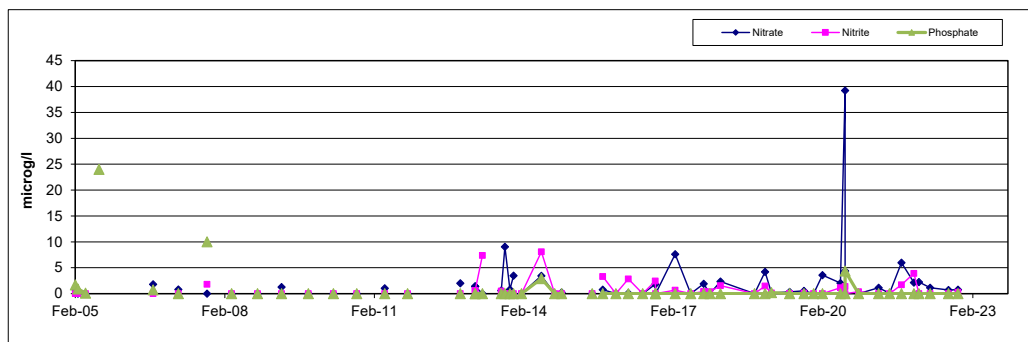
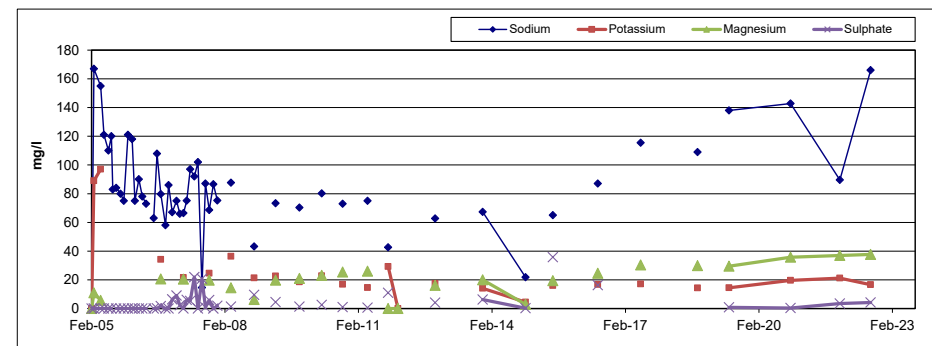
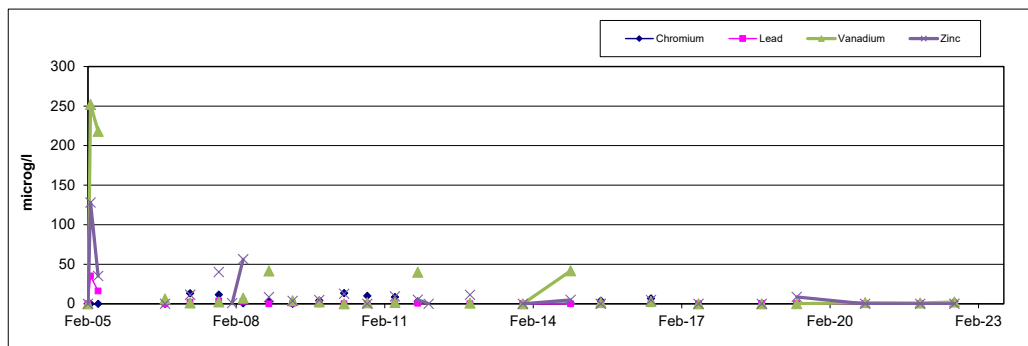
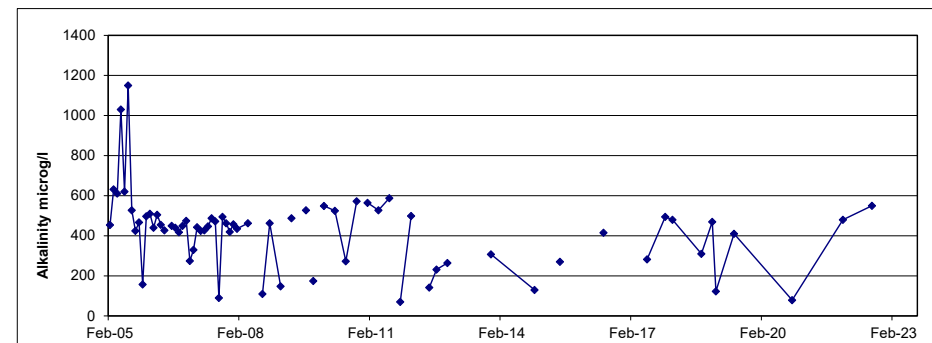
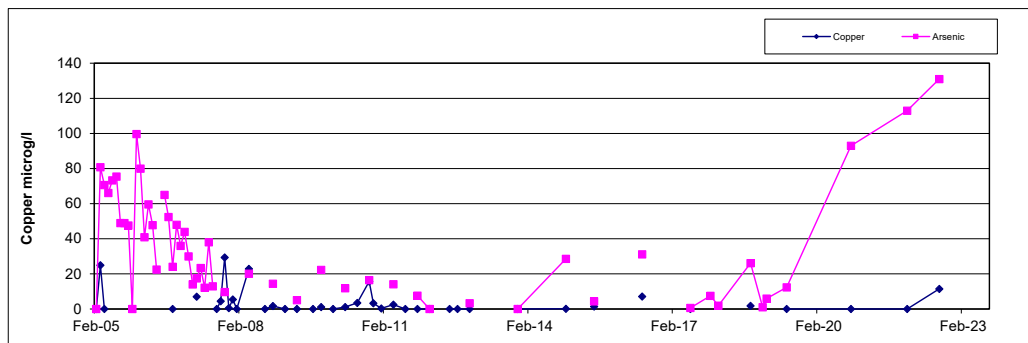


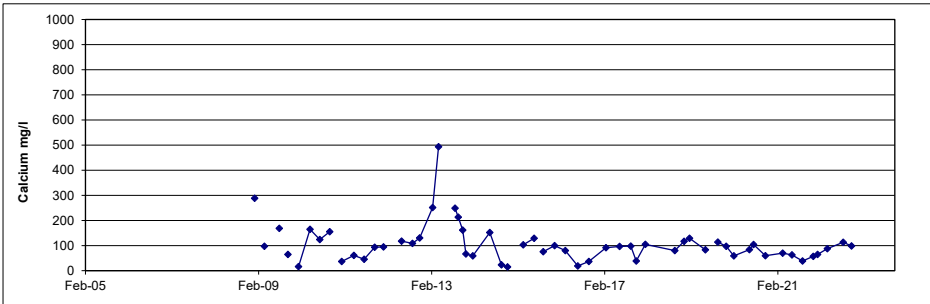
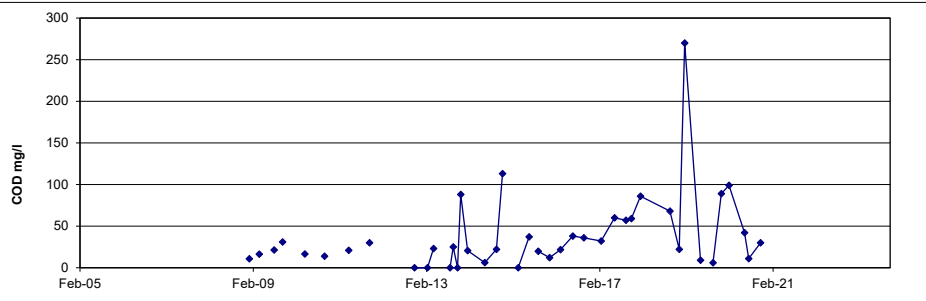
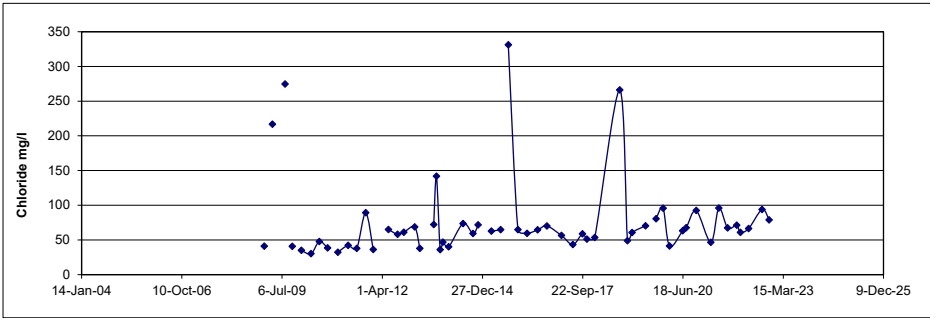
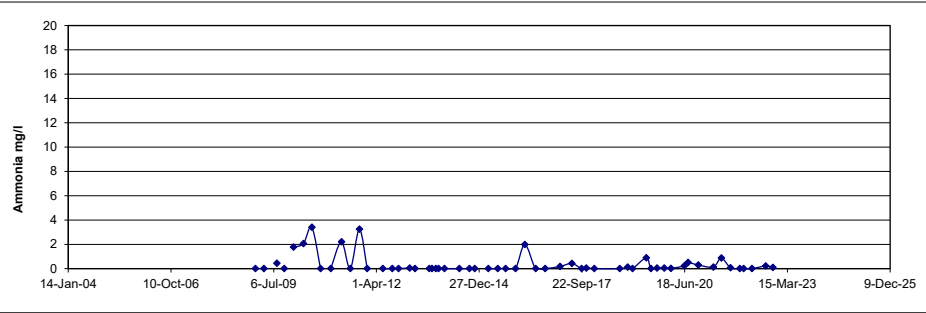
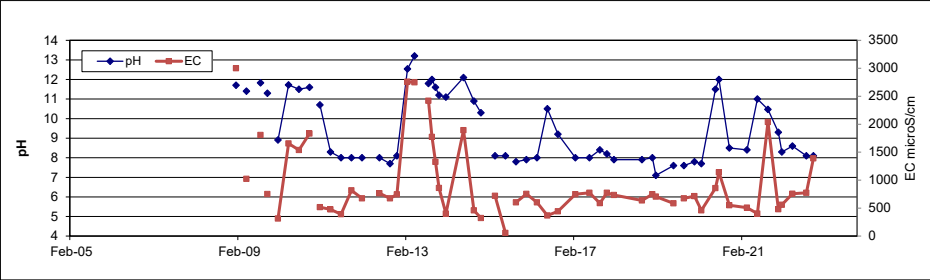
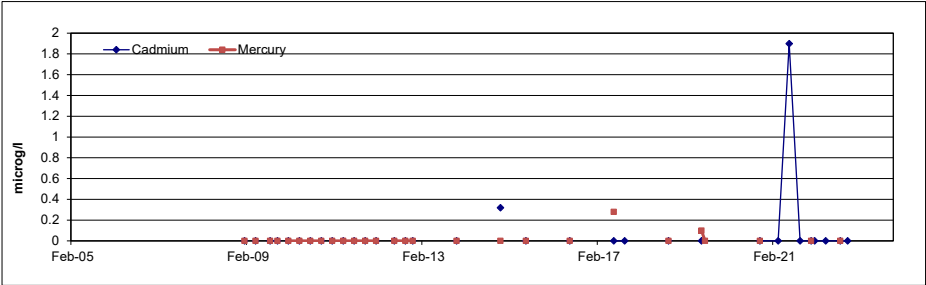


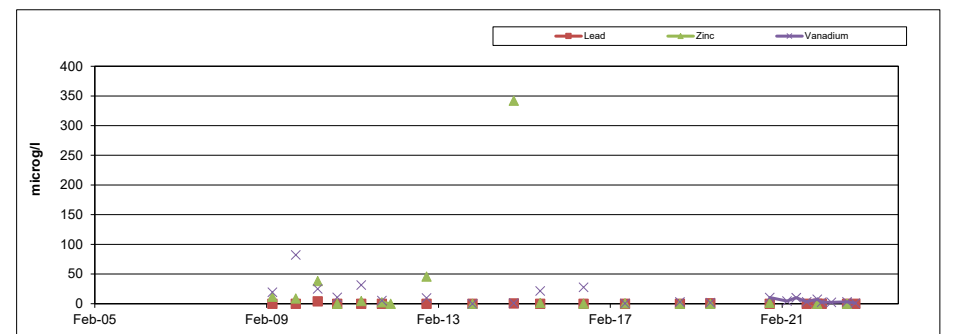
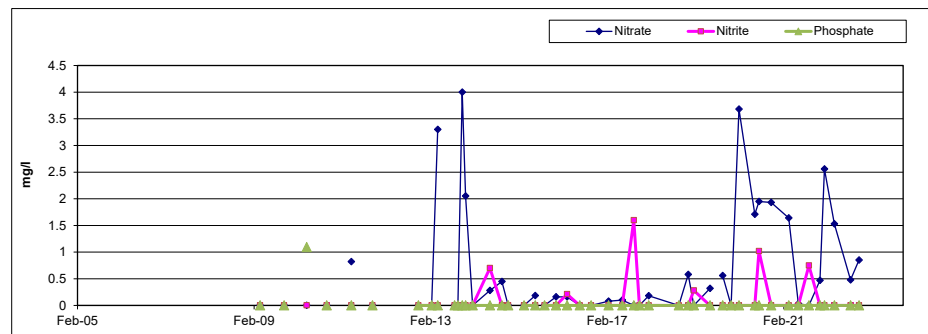
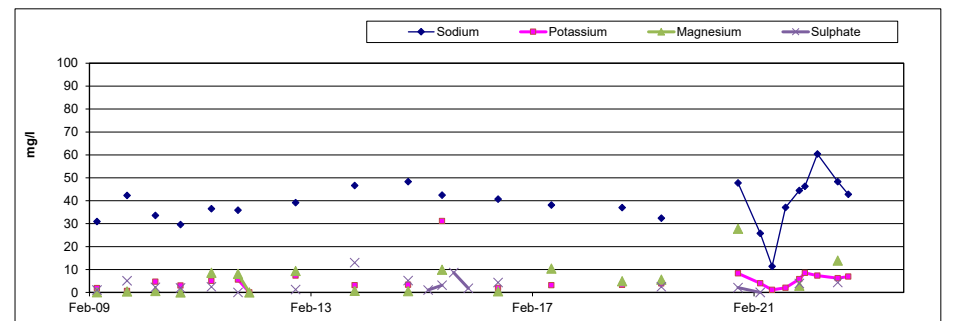
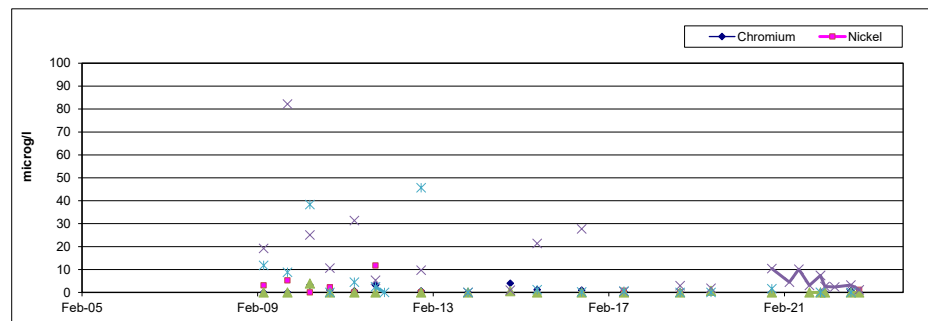
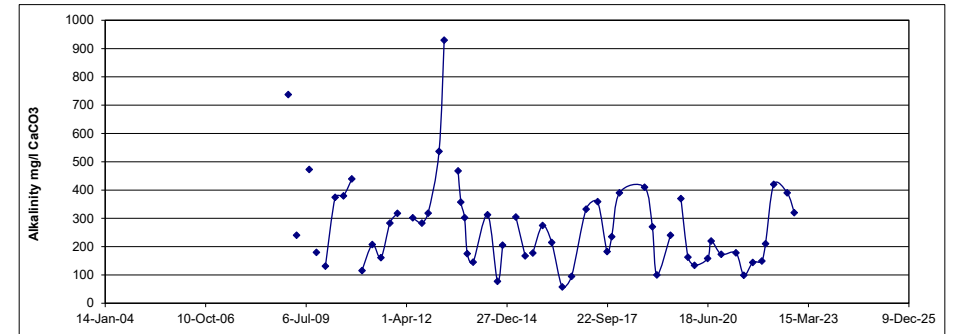
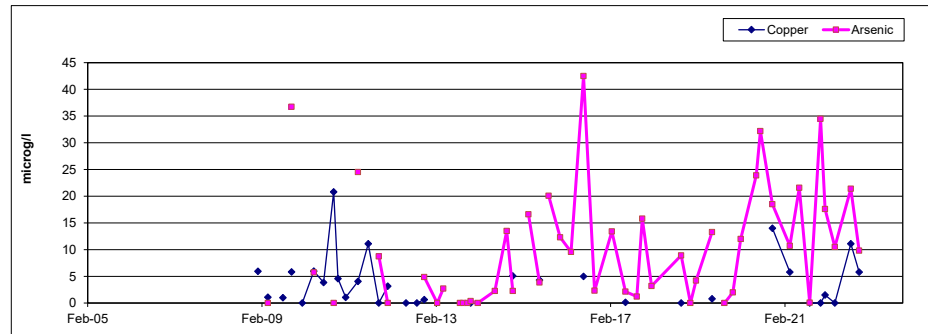


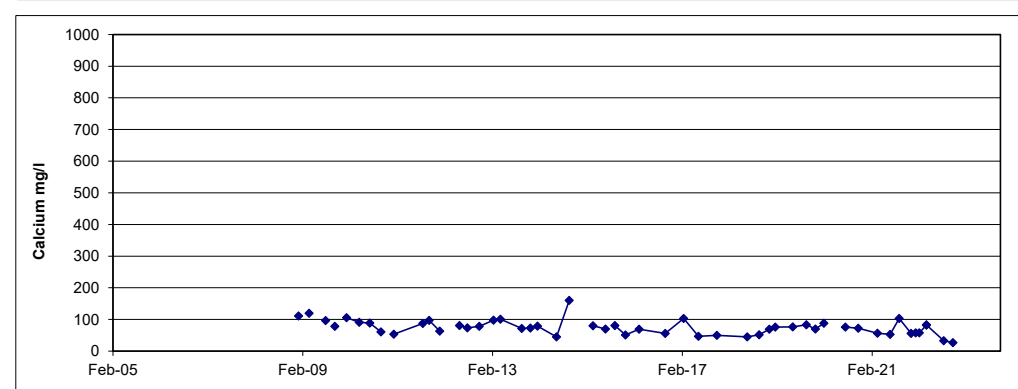
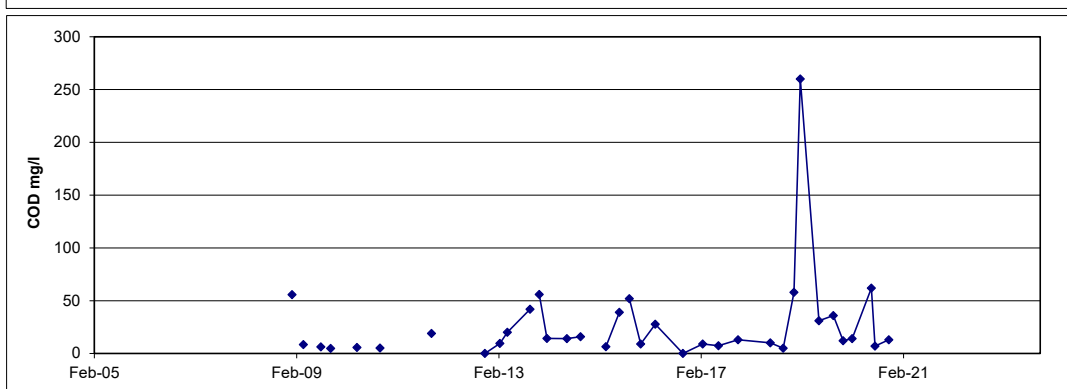
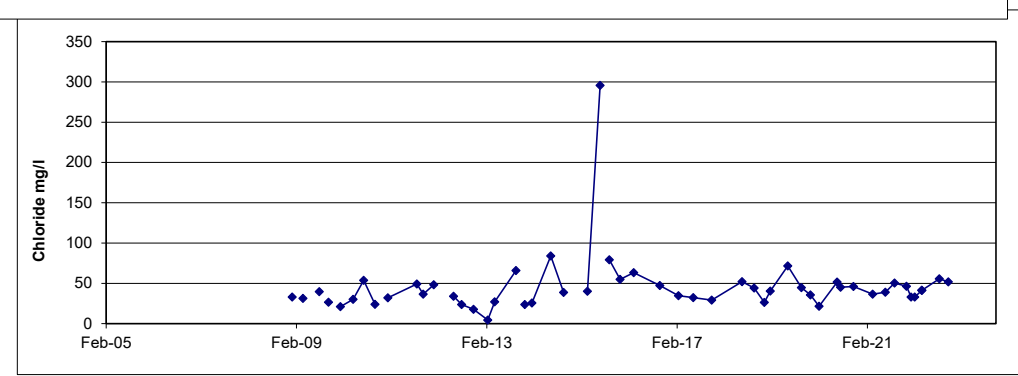
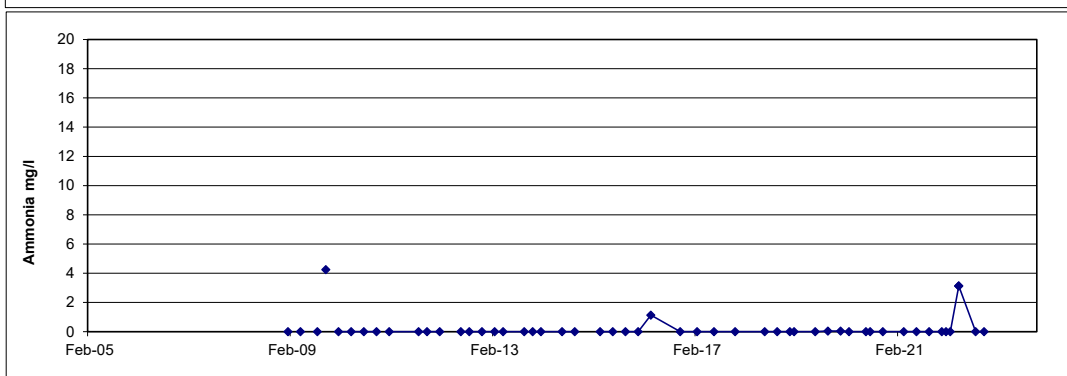
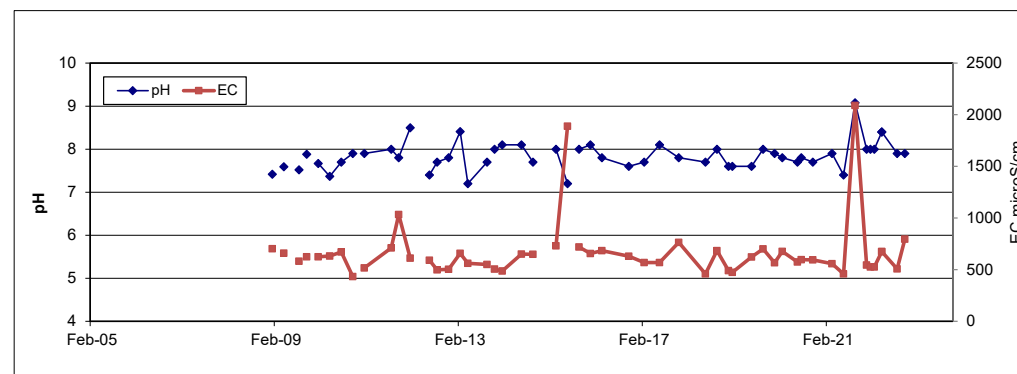
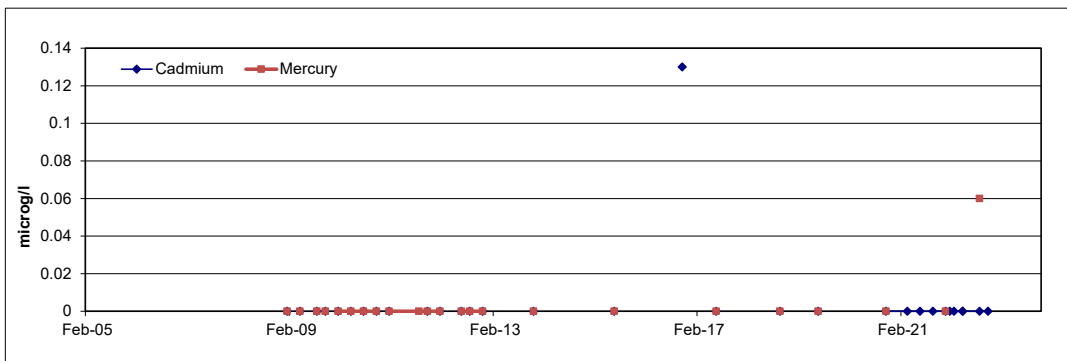


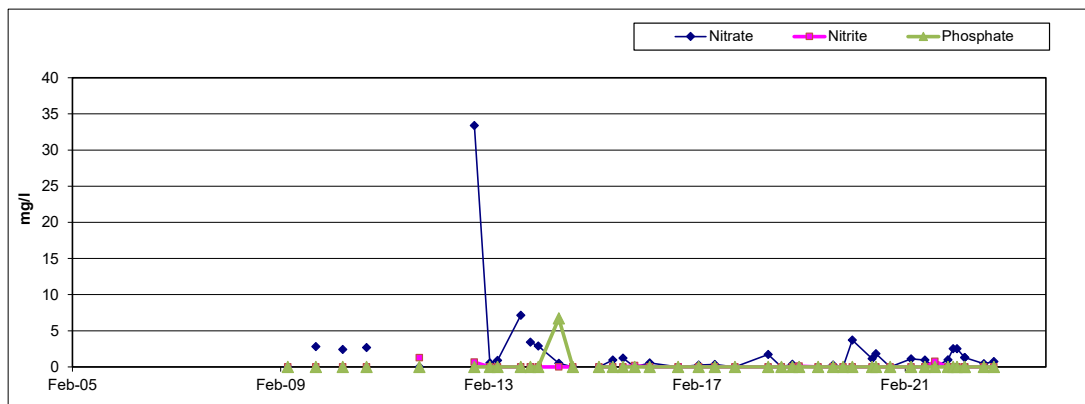
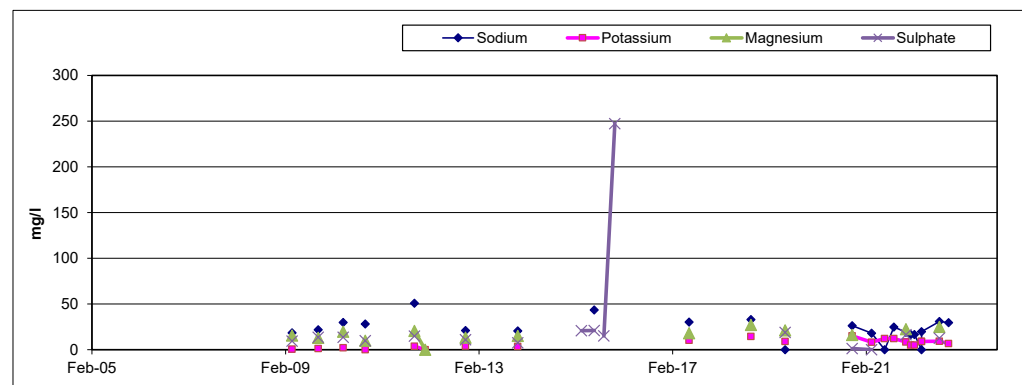
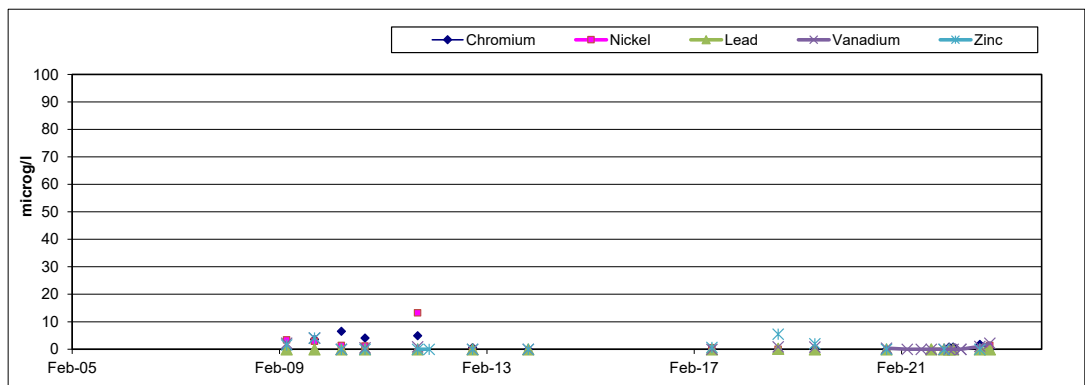
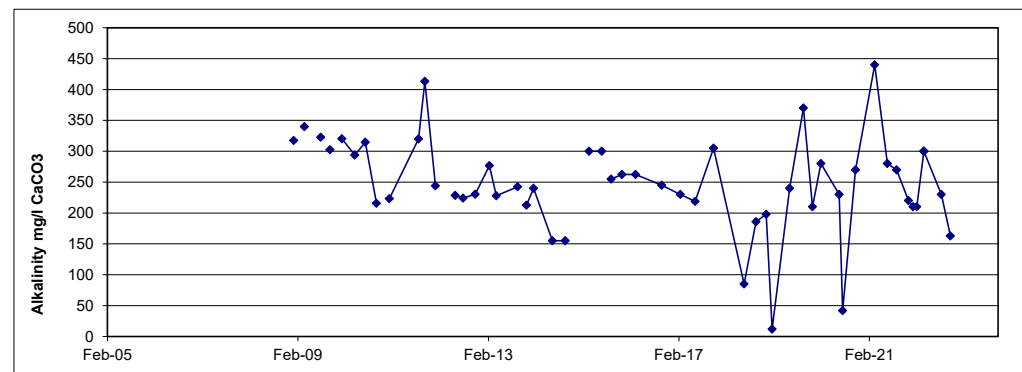
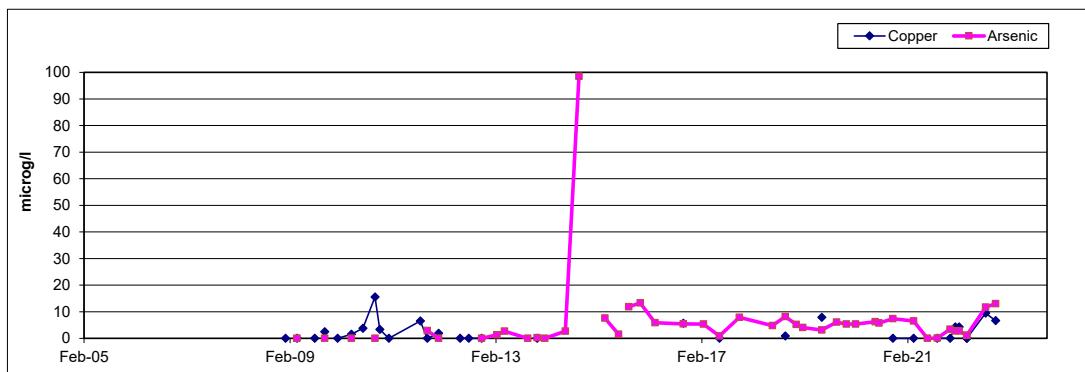












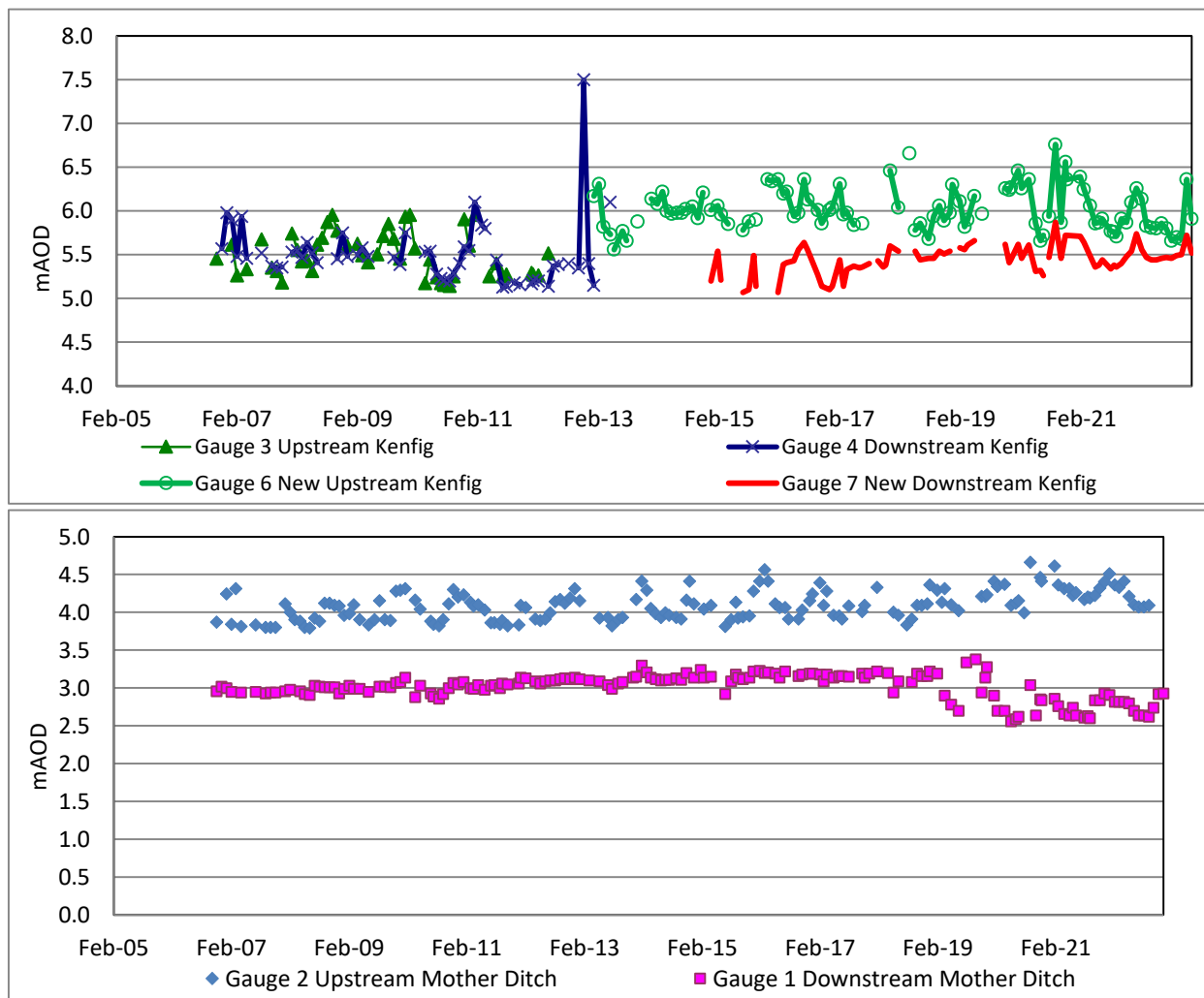
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HAZARDOUS LANDFILL,
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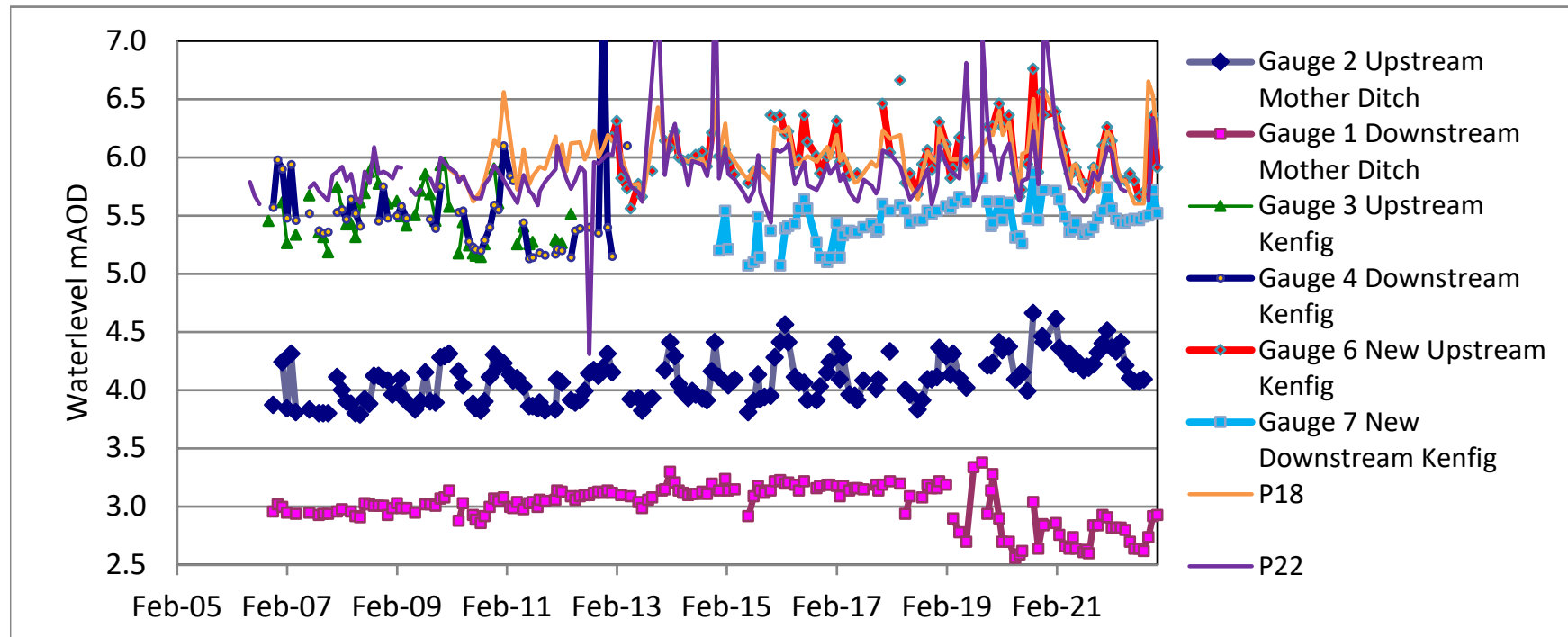
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**Appendix 6
Temporal Variation of
Surface Water Levels**

Report Number 2295r1v1d0223





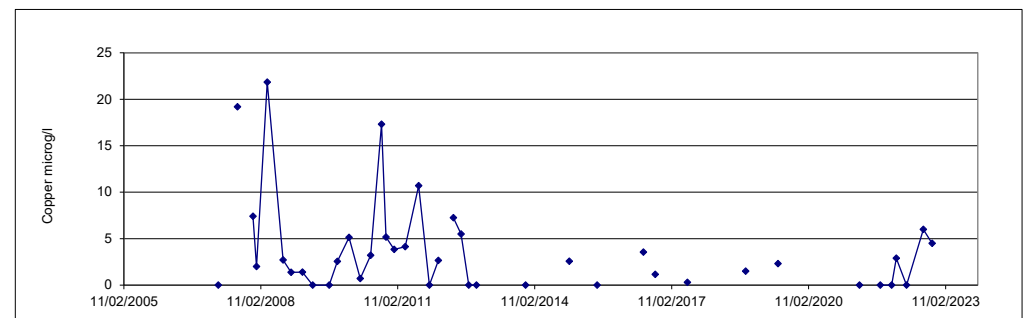
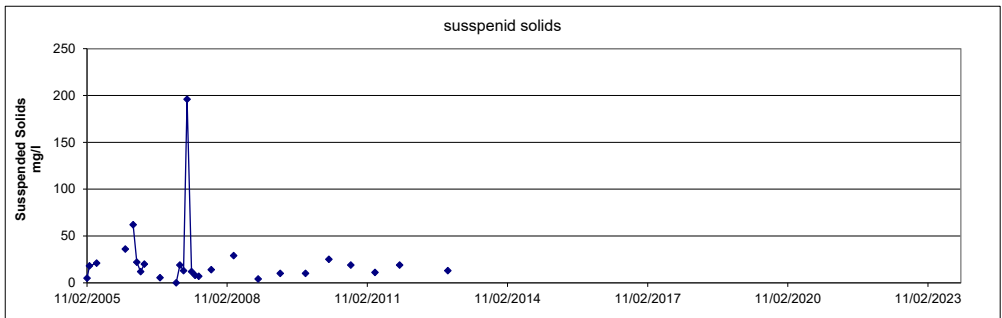
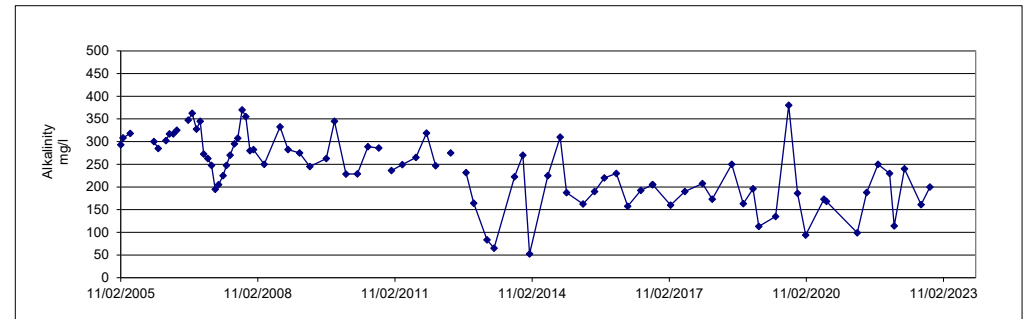
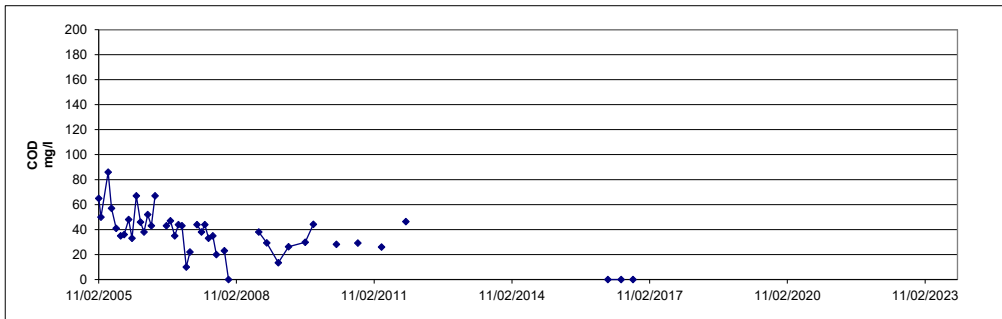
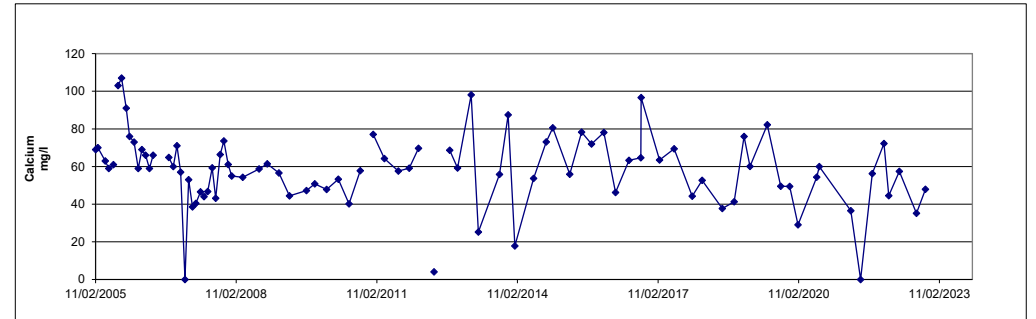
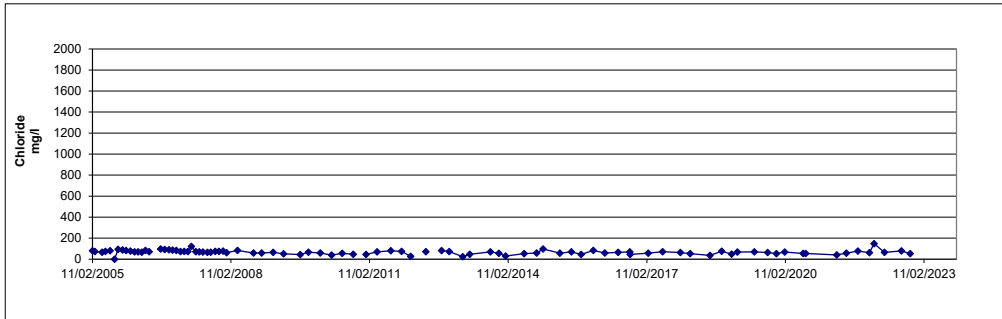
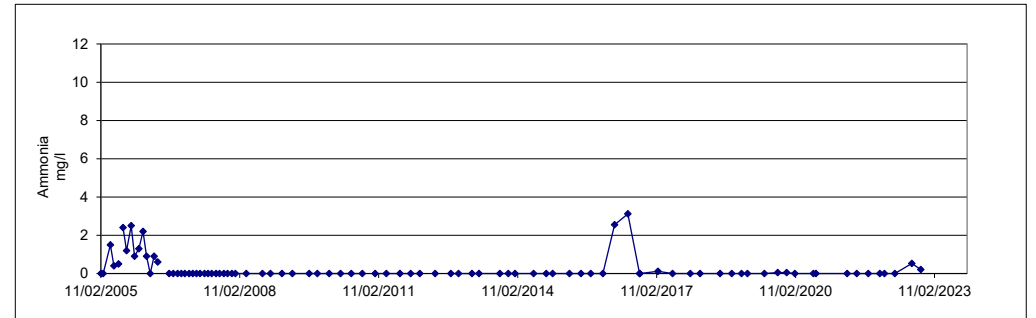
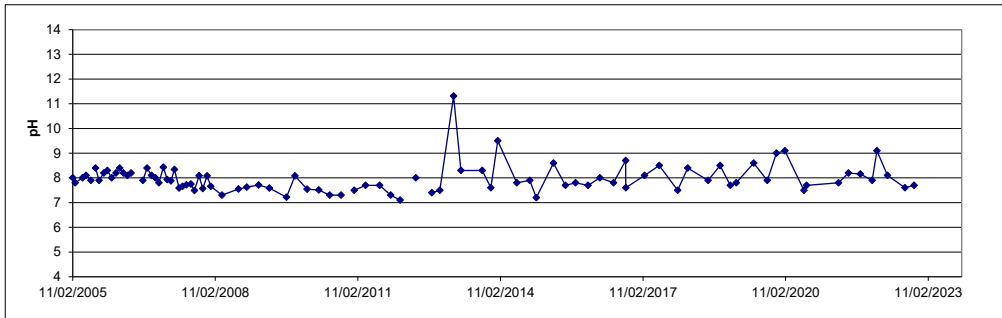
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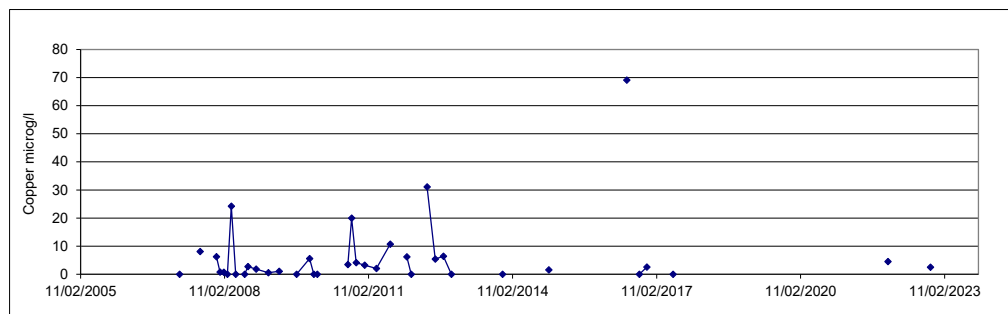
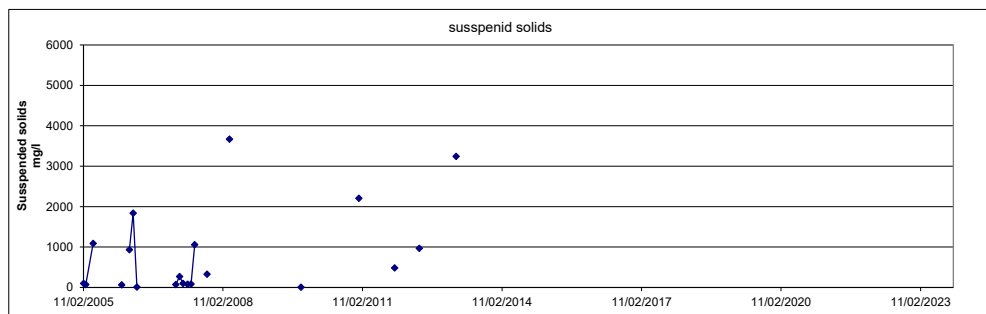
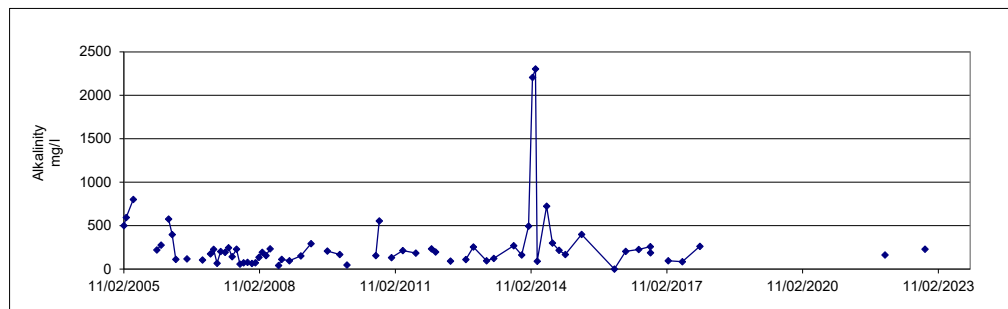
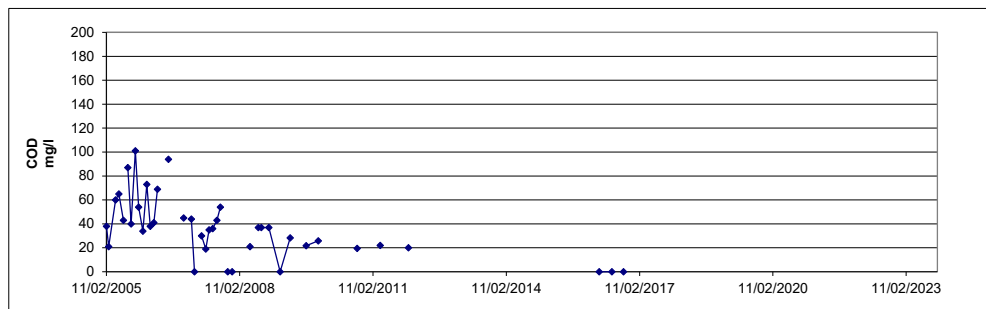
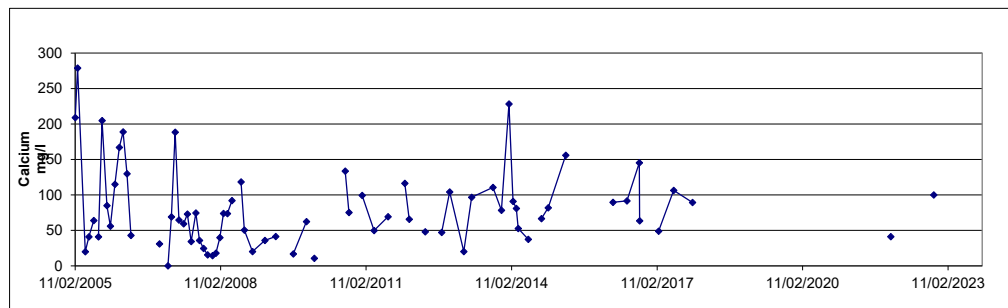
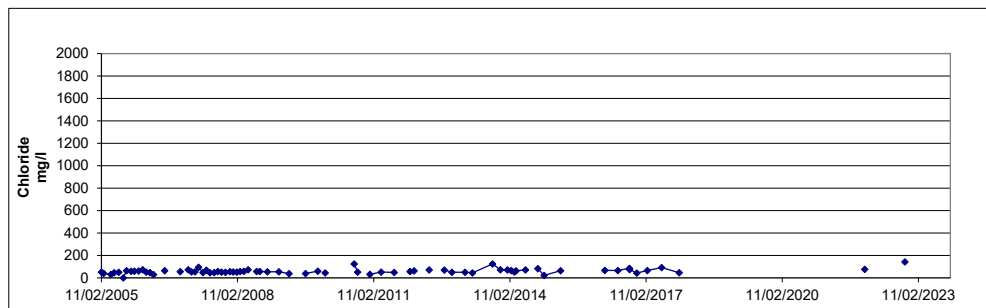
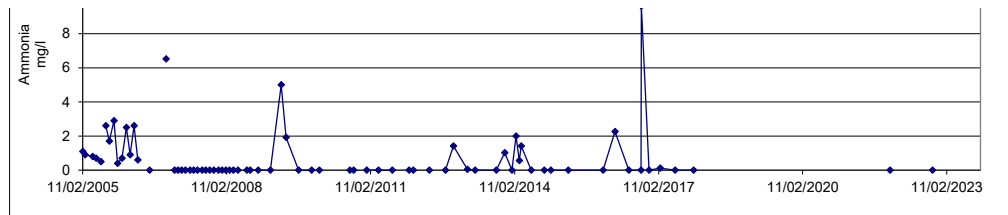
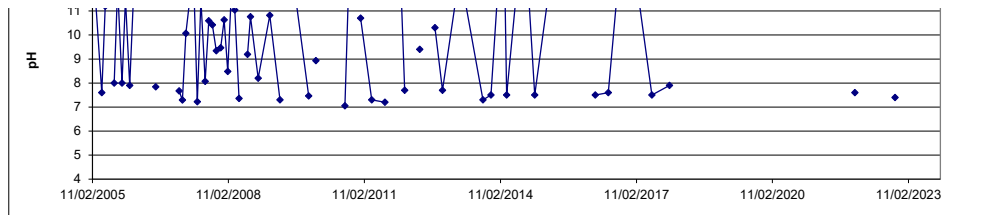
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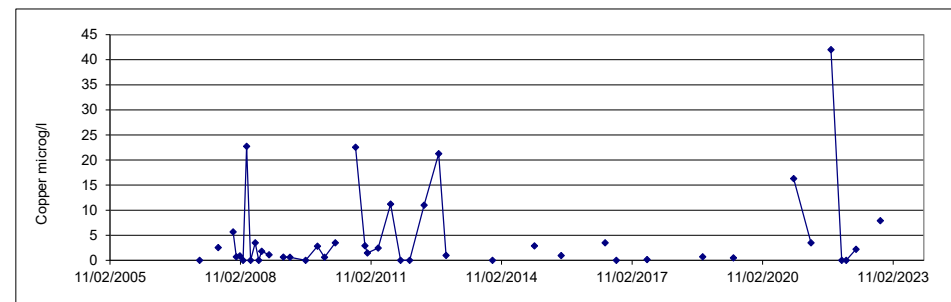
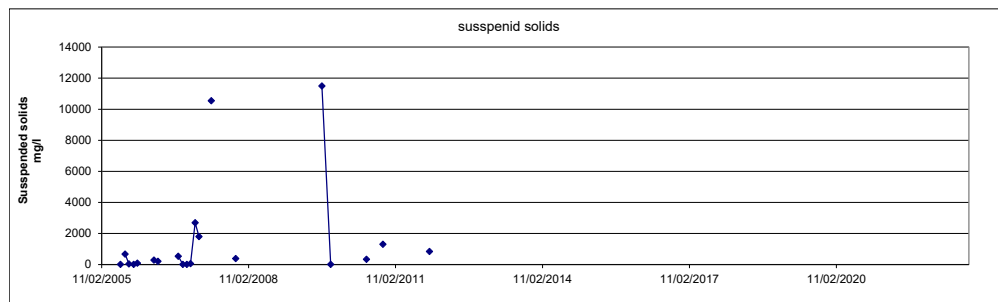
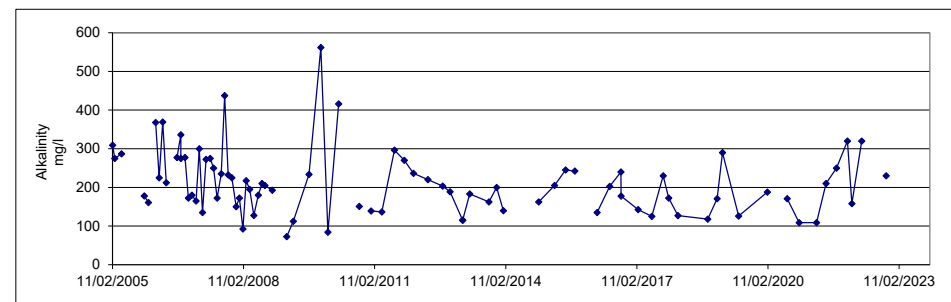
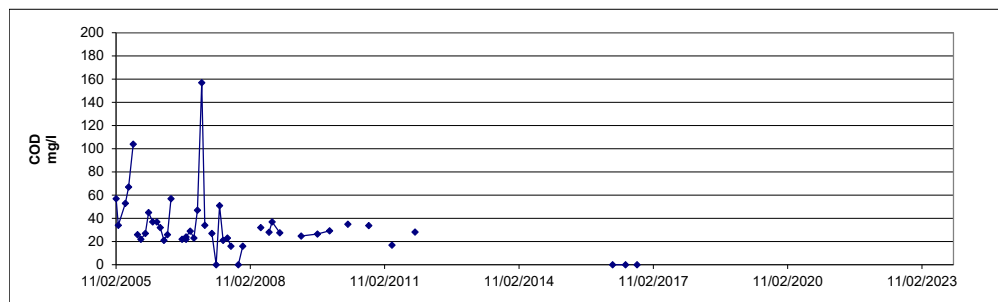
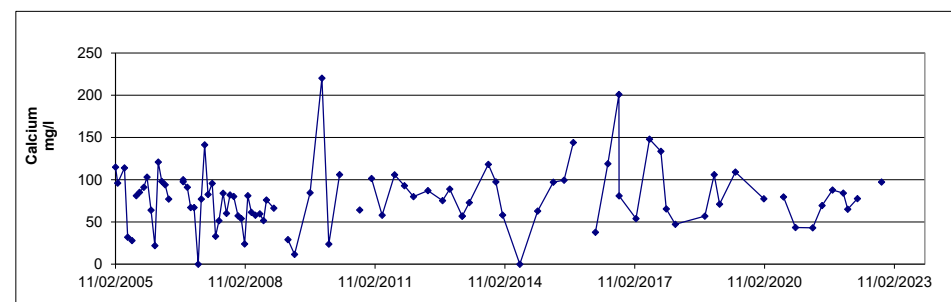
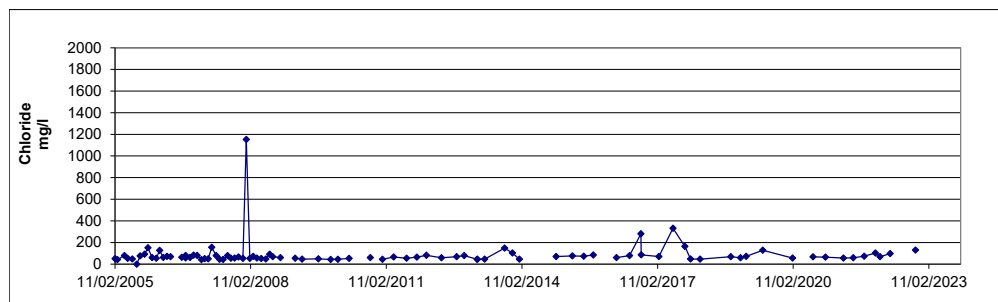
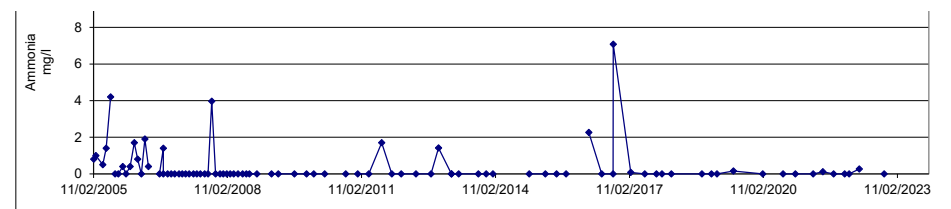
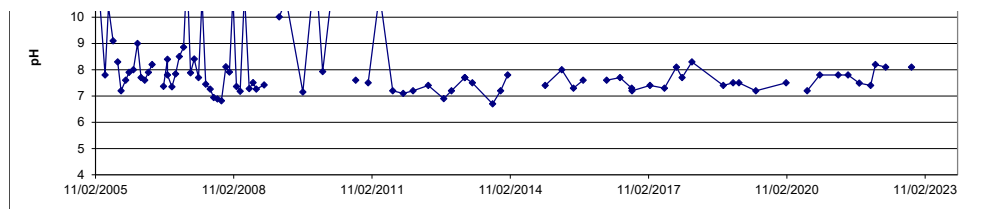
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Monitoring**

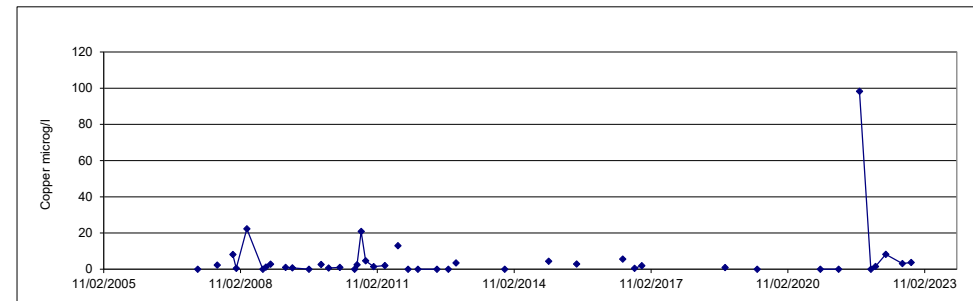
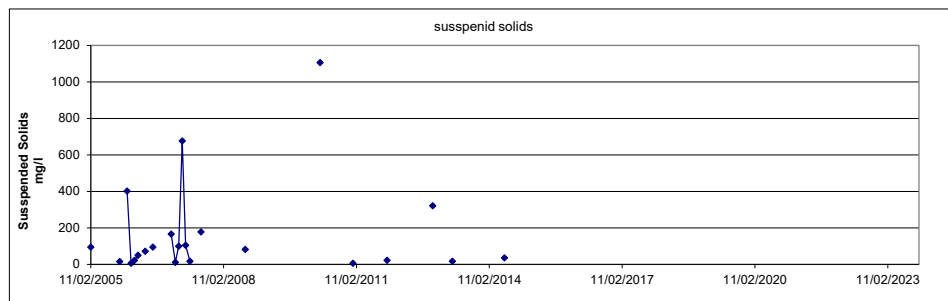
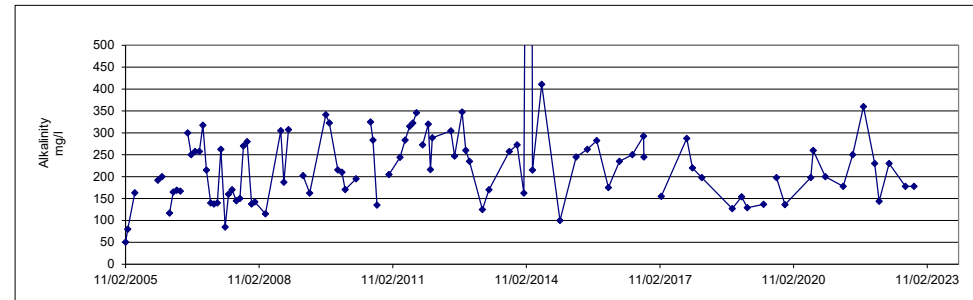
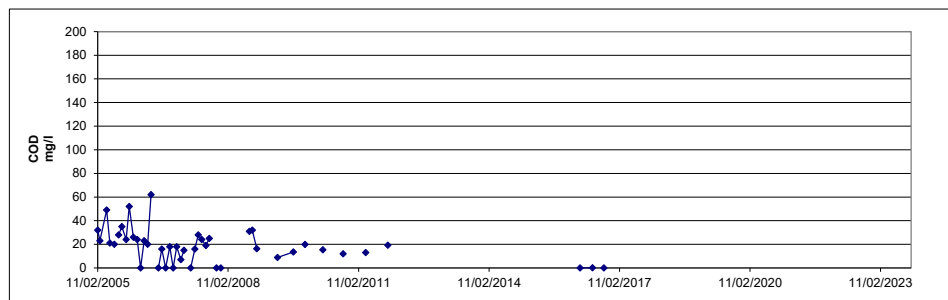
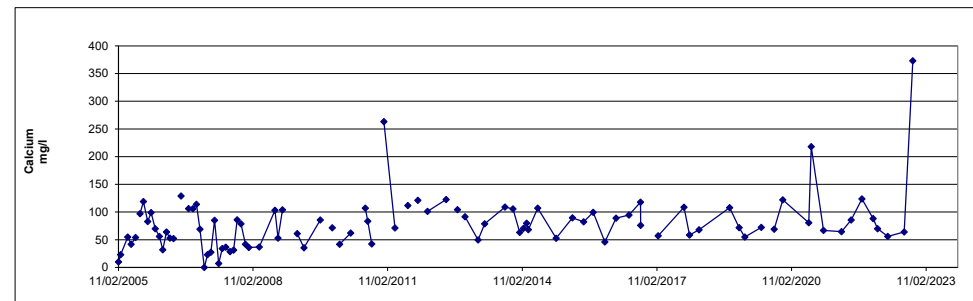
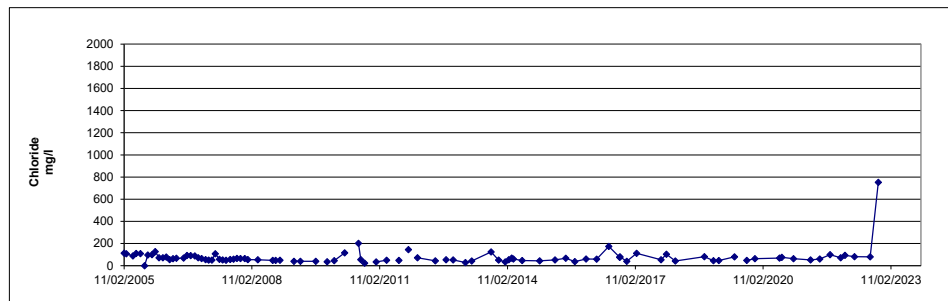
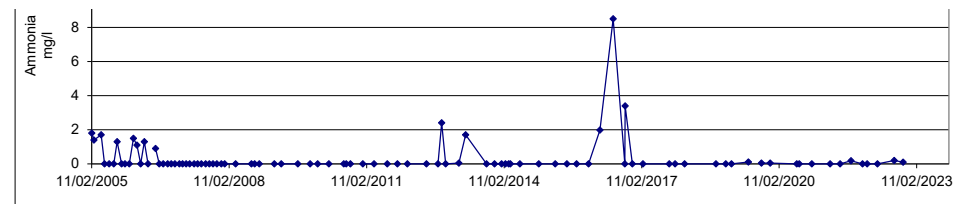
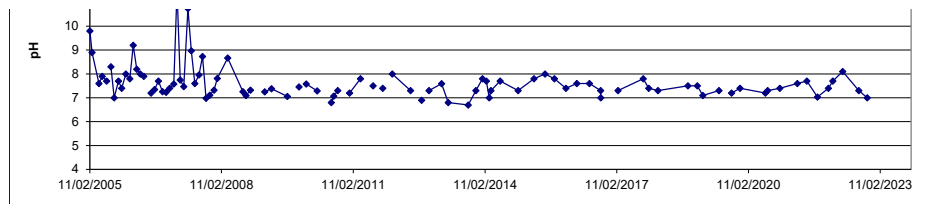
**Appendix 7
Temporal Variation of
Surface Water Chemistry**

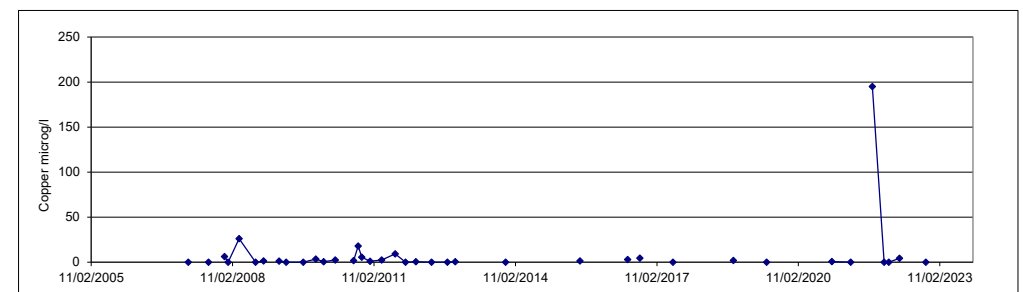
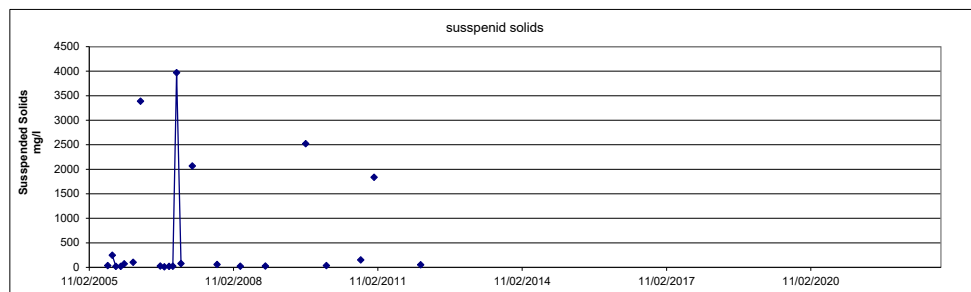
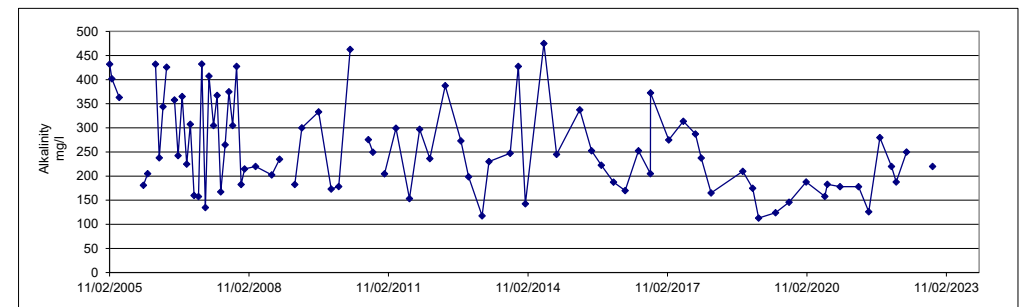
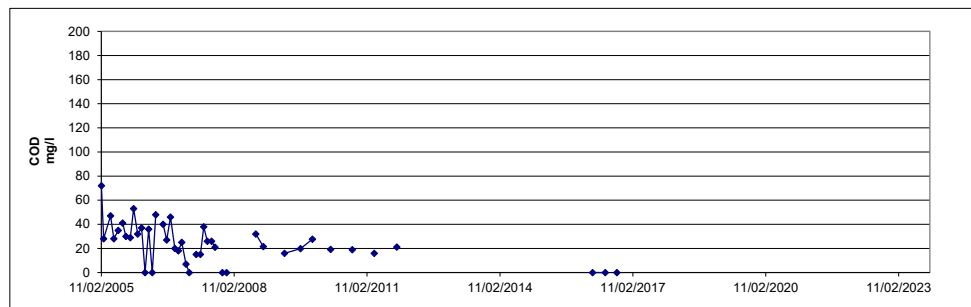
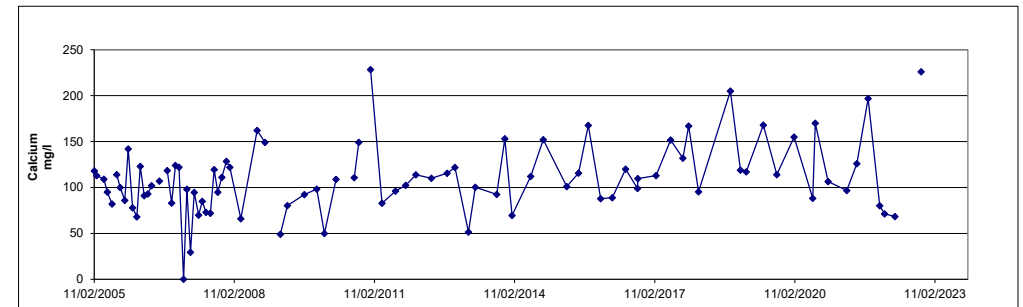
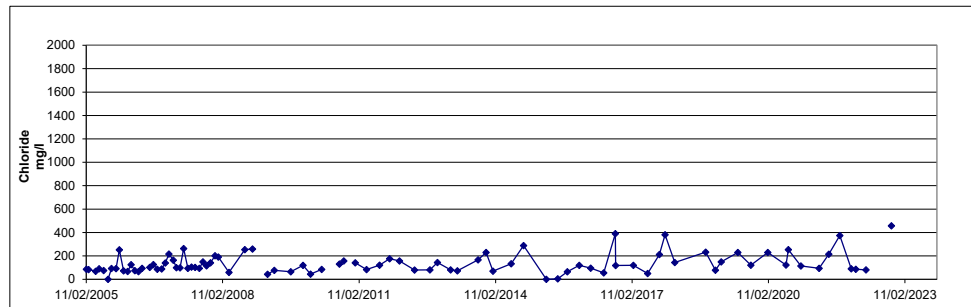
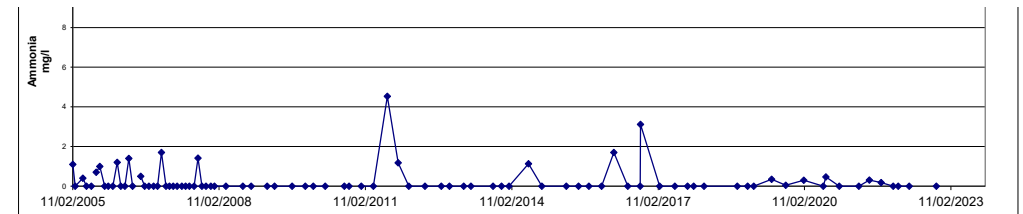
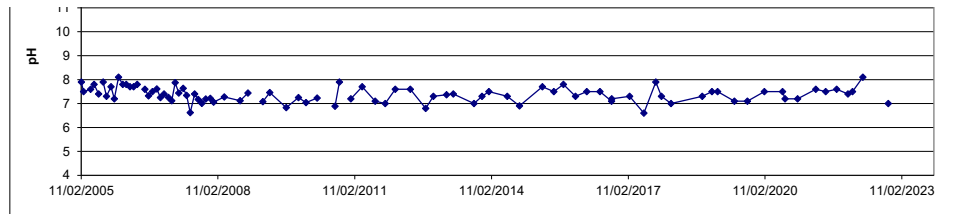
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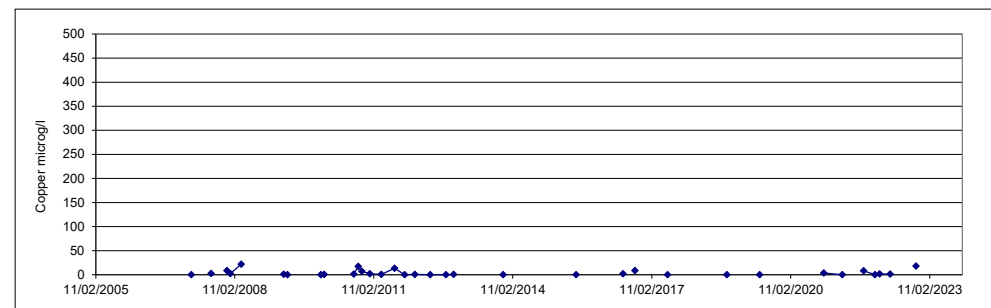
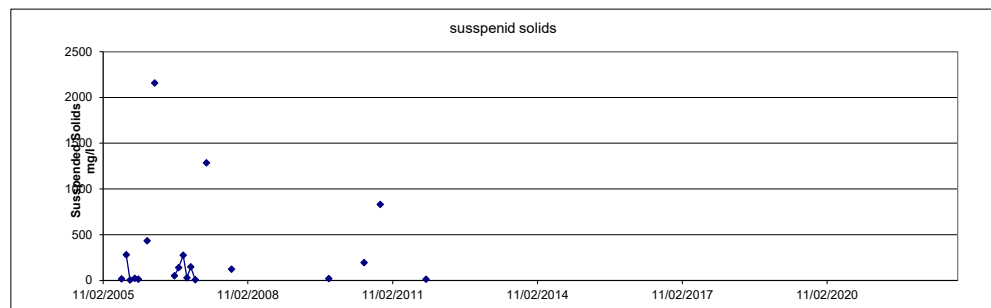
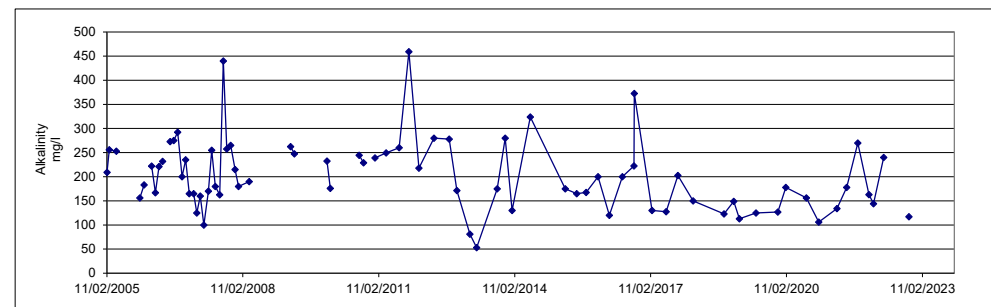
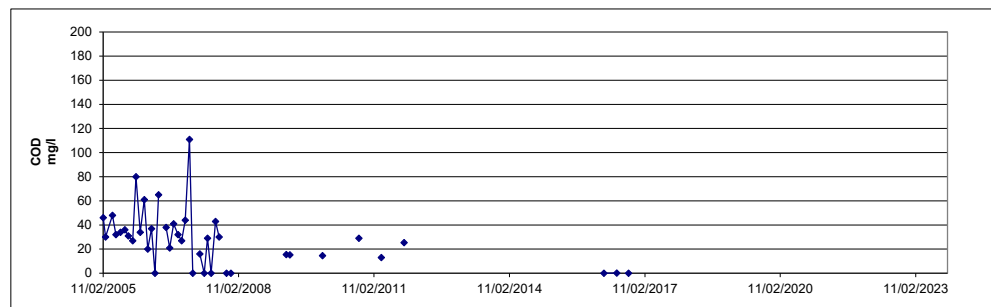
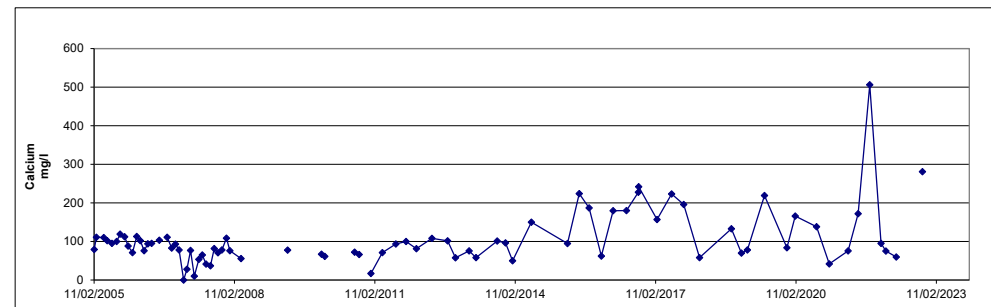
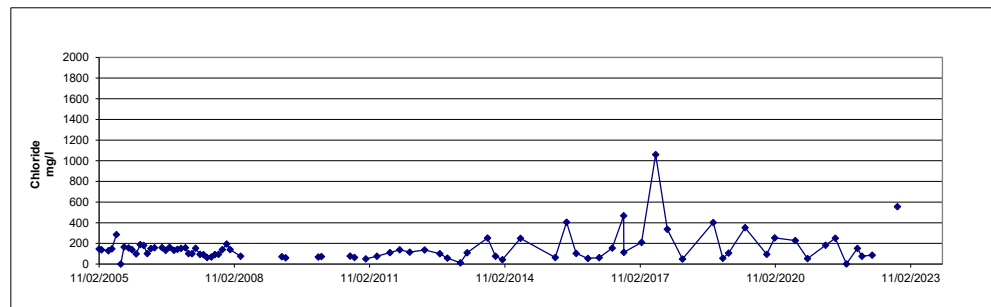
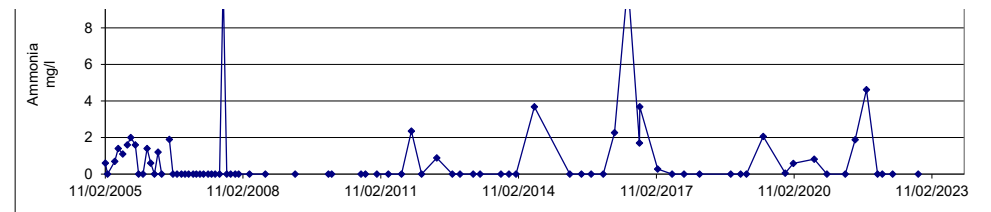
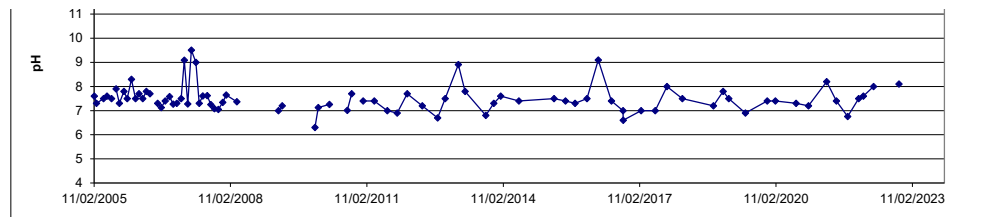




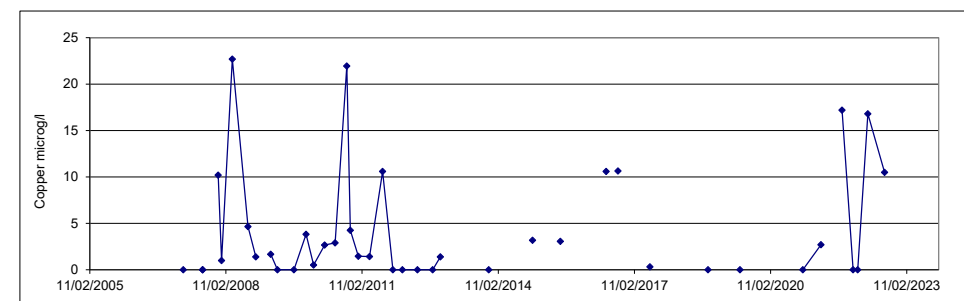
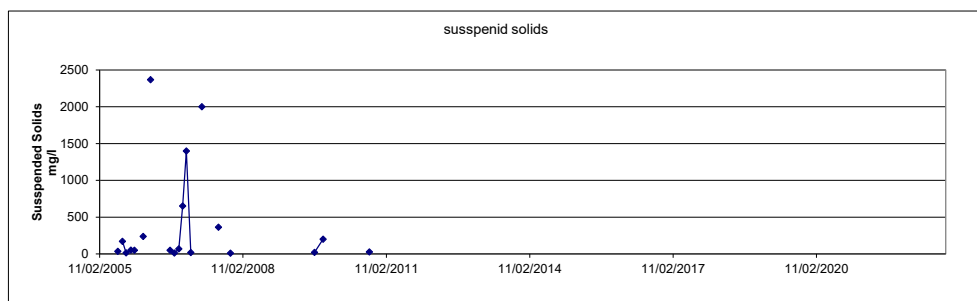
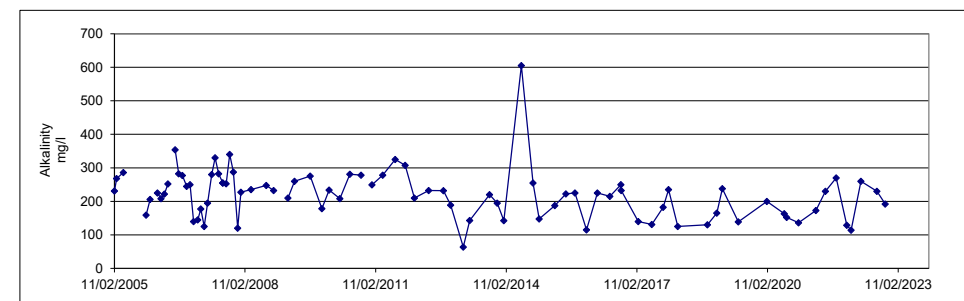
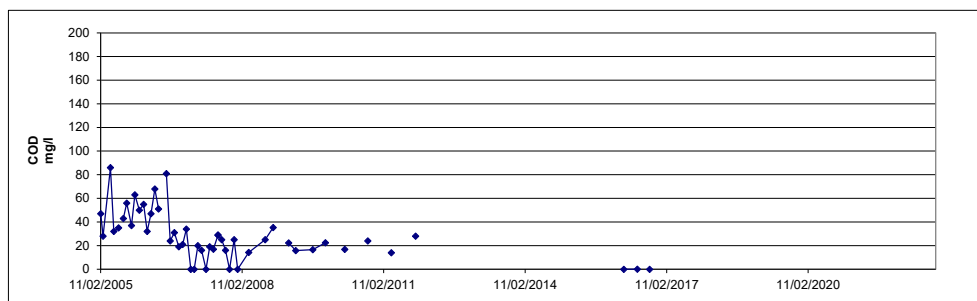
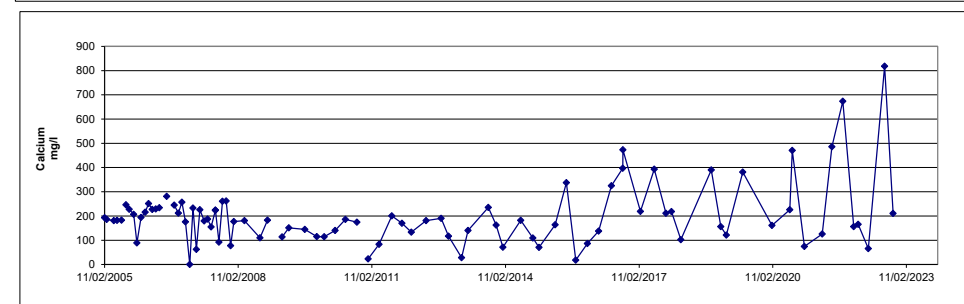
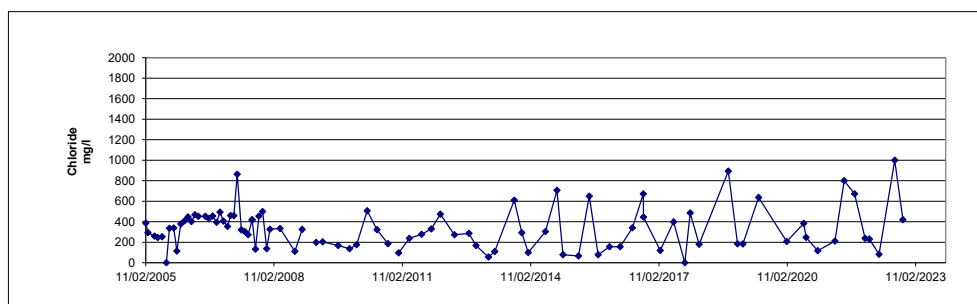
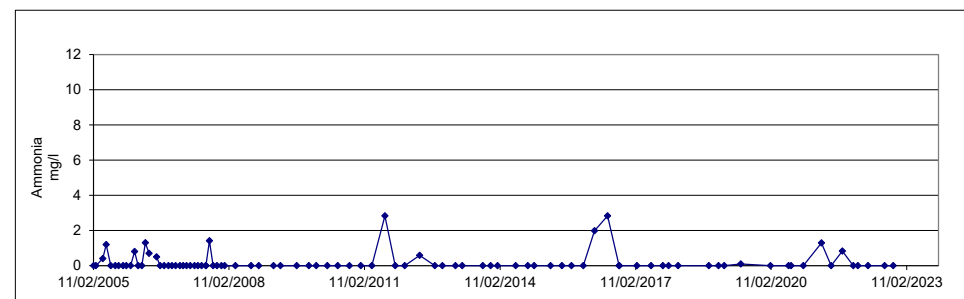
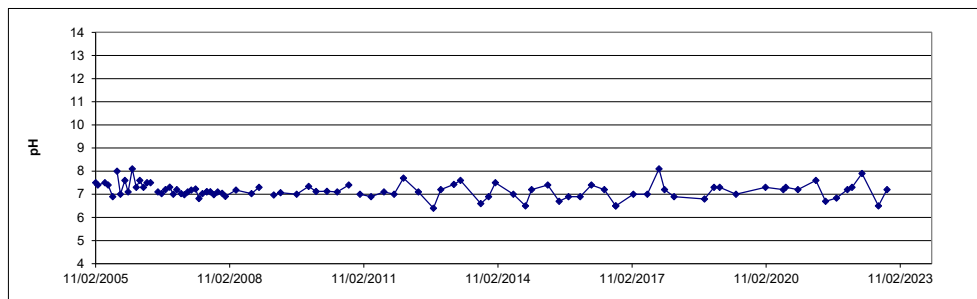


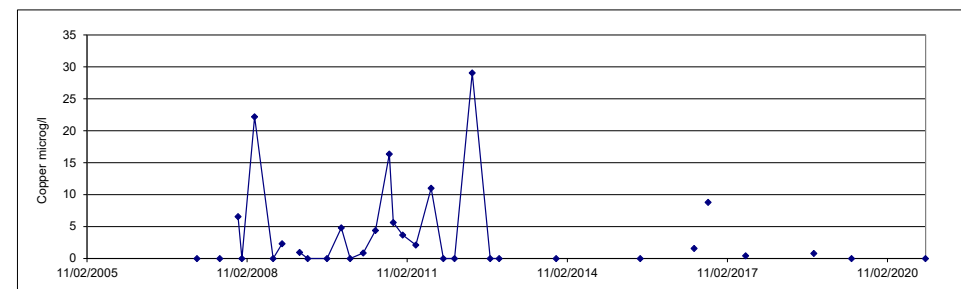
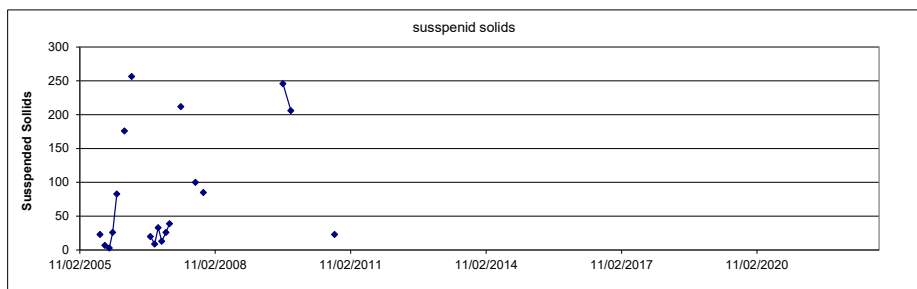
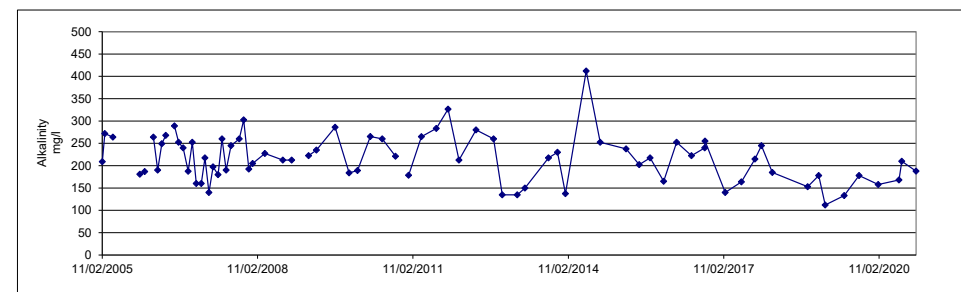
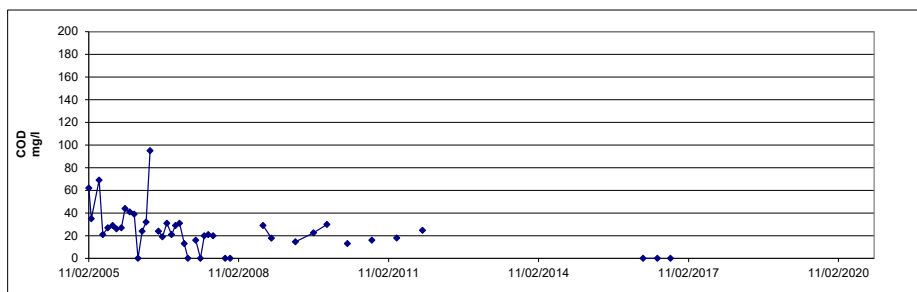
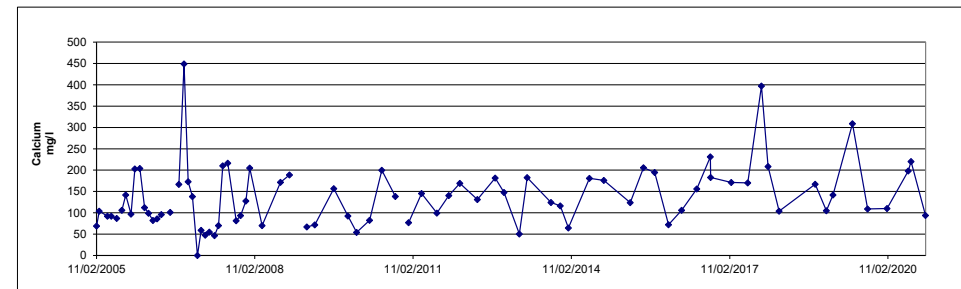
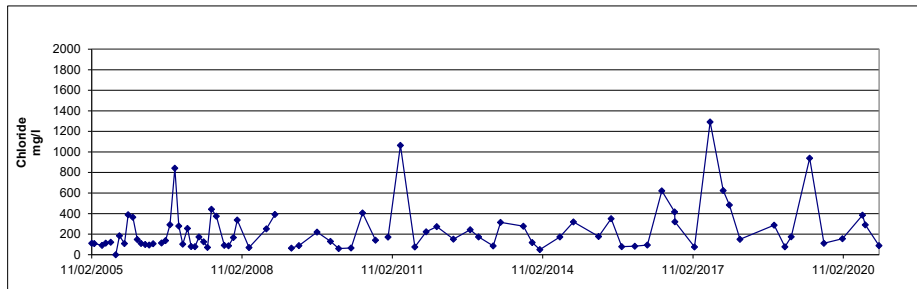
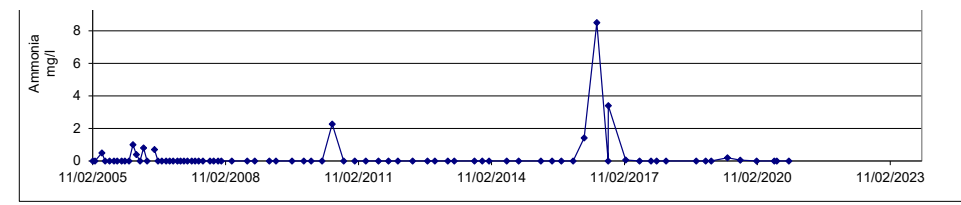
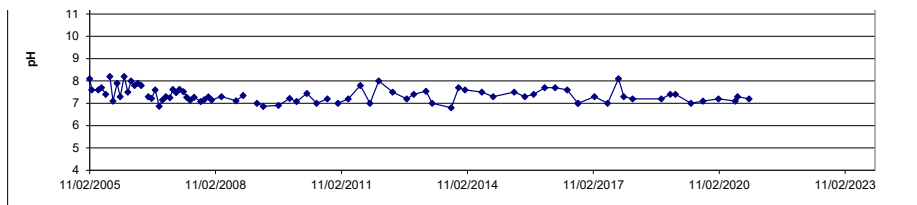


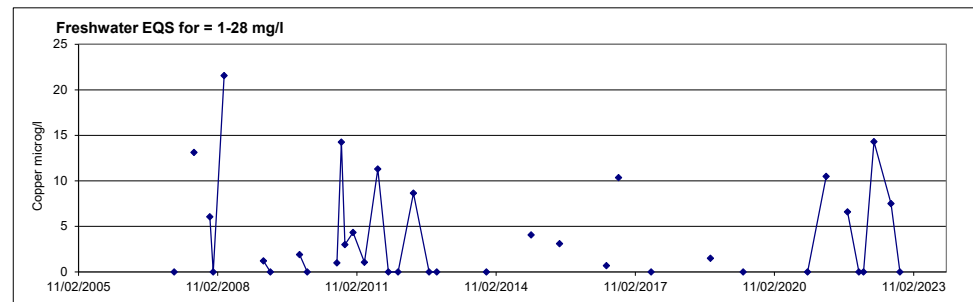
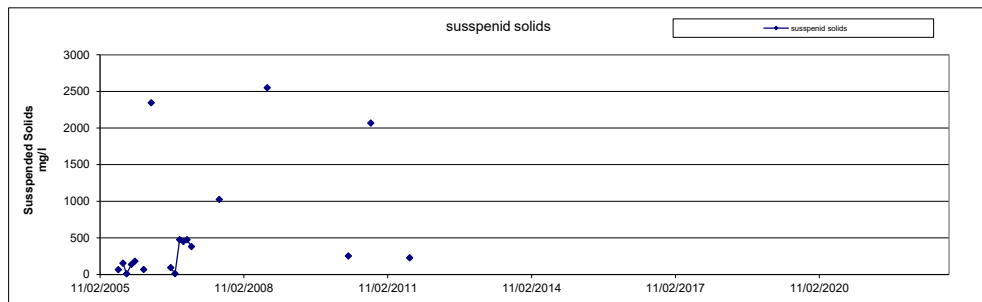
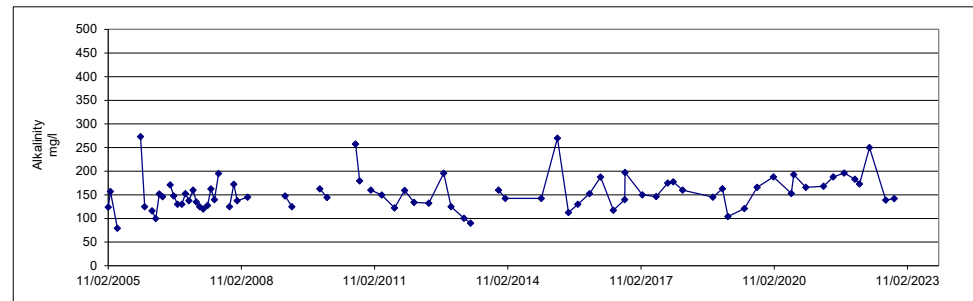
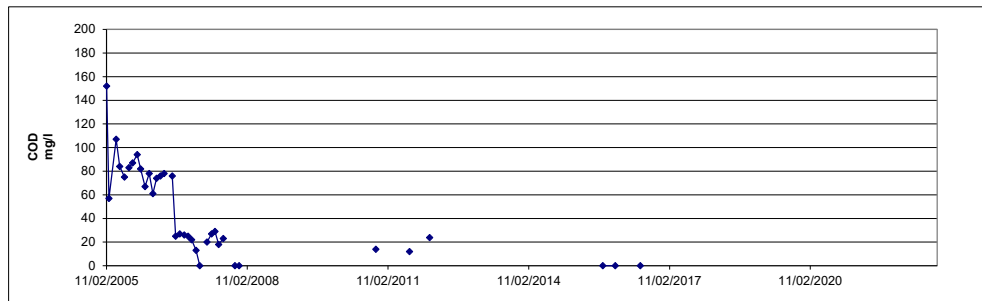
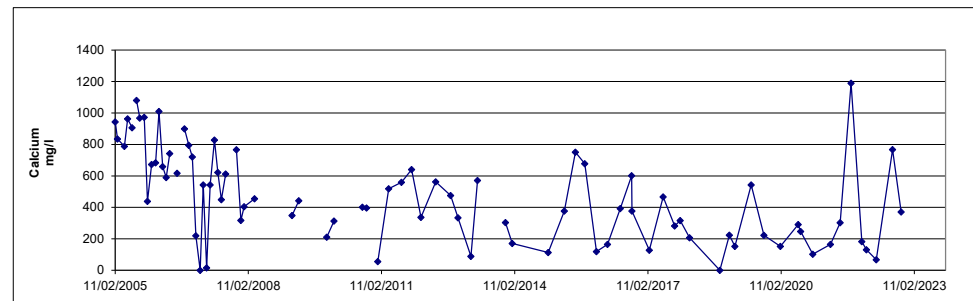
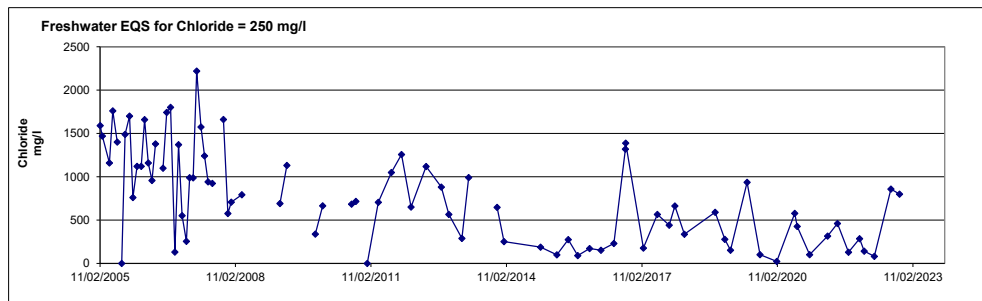
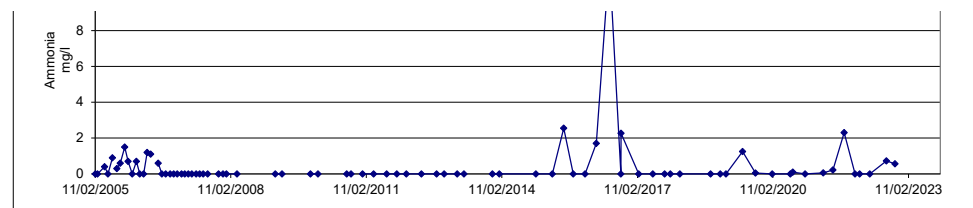
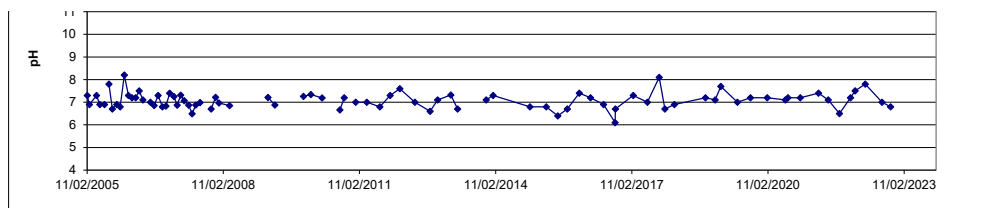


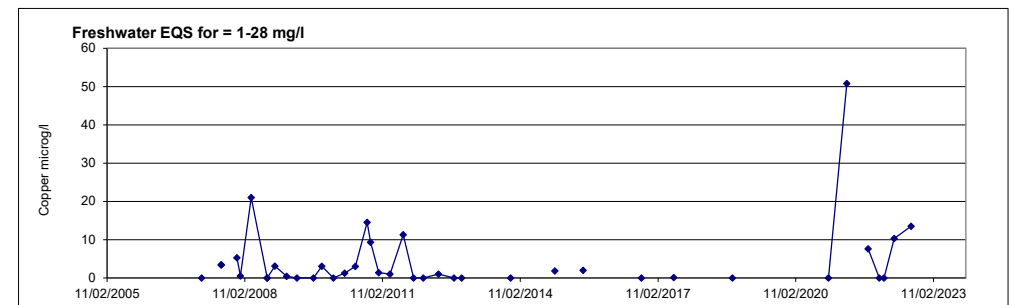
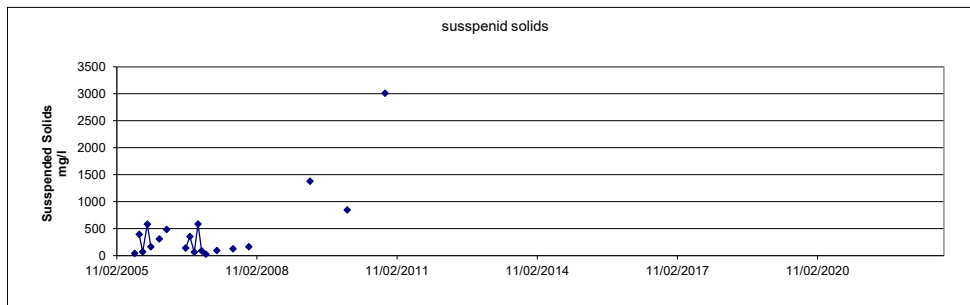
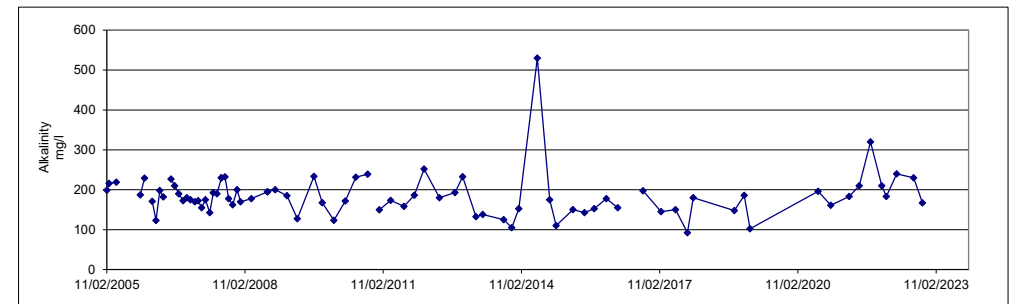
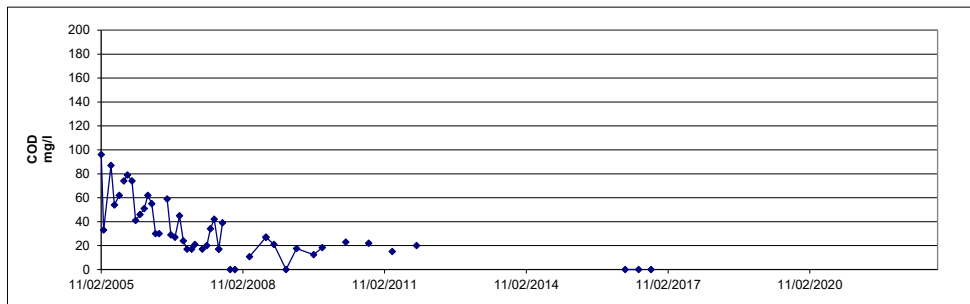
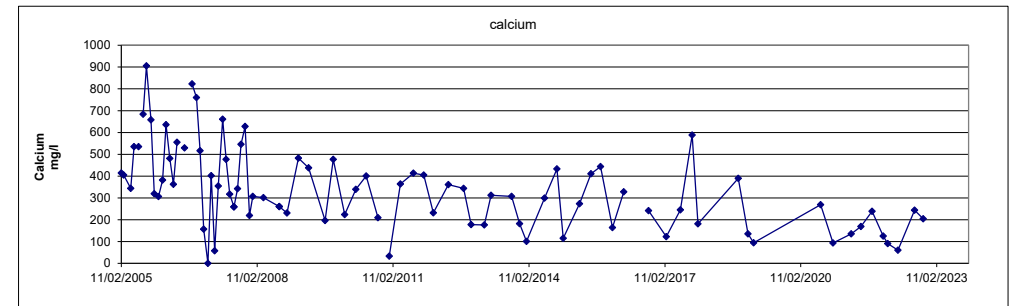
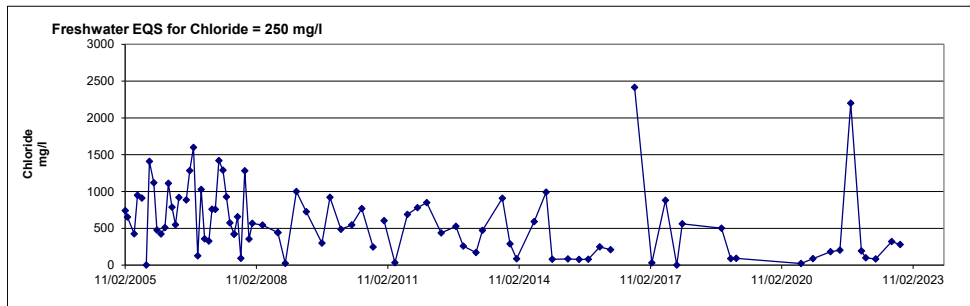
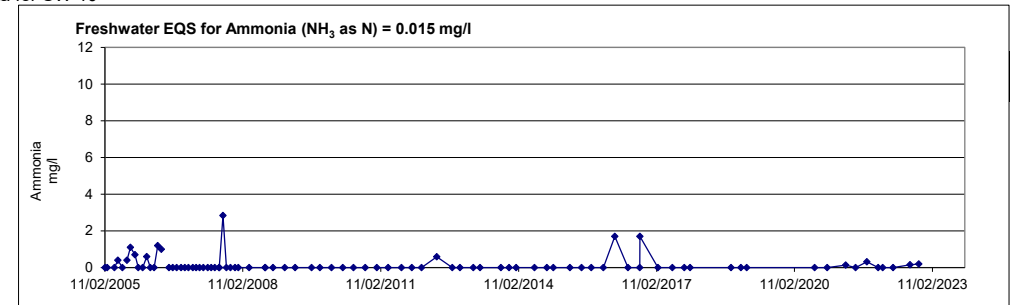
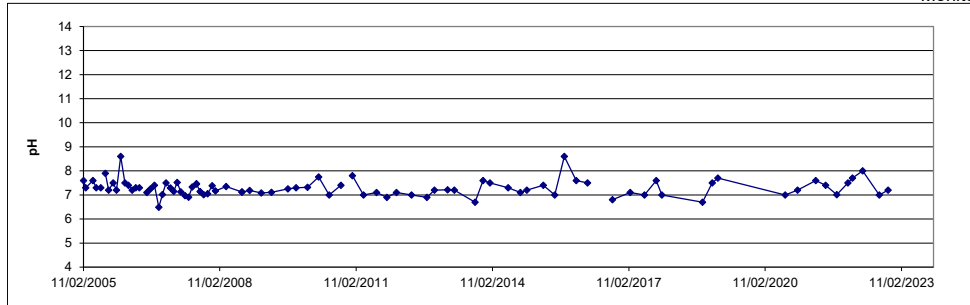


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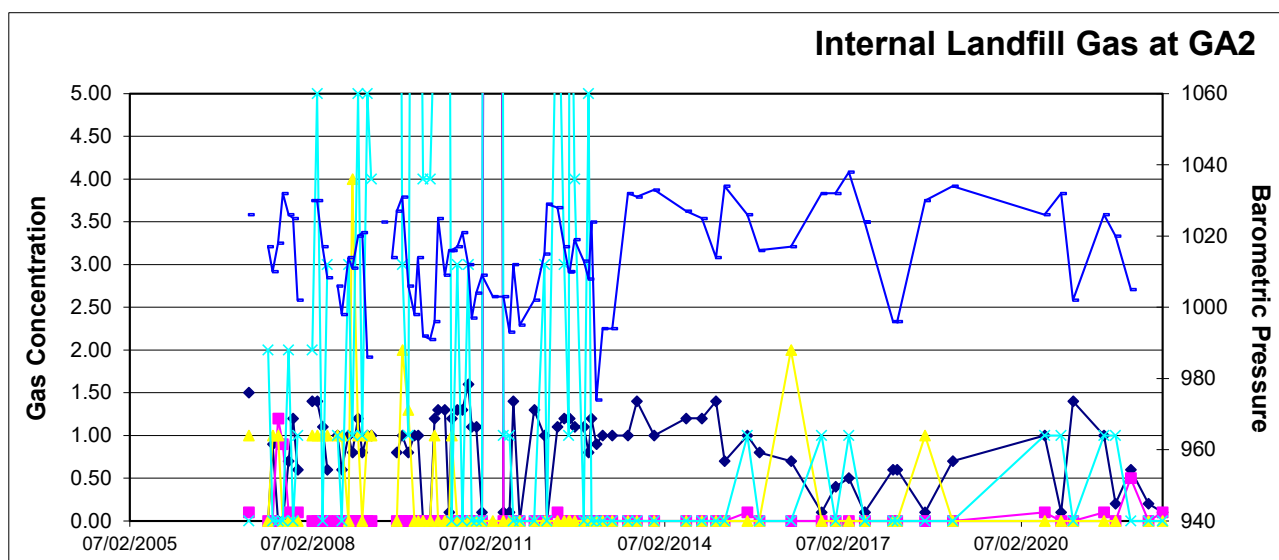
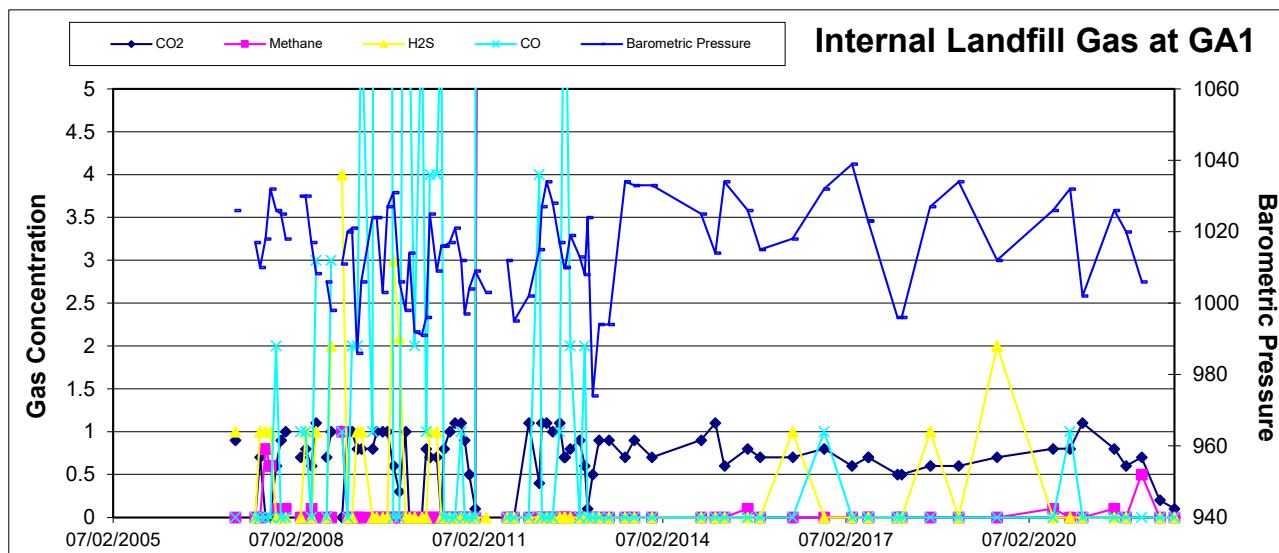
**MORFA NON-
HAZARDOUS LANDFILL,
PORT TALBOT**

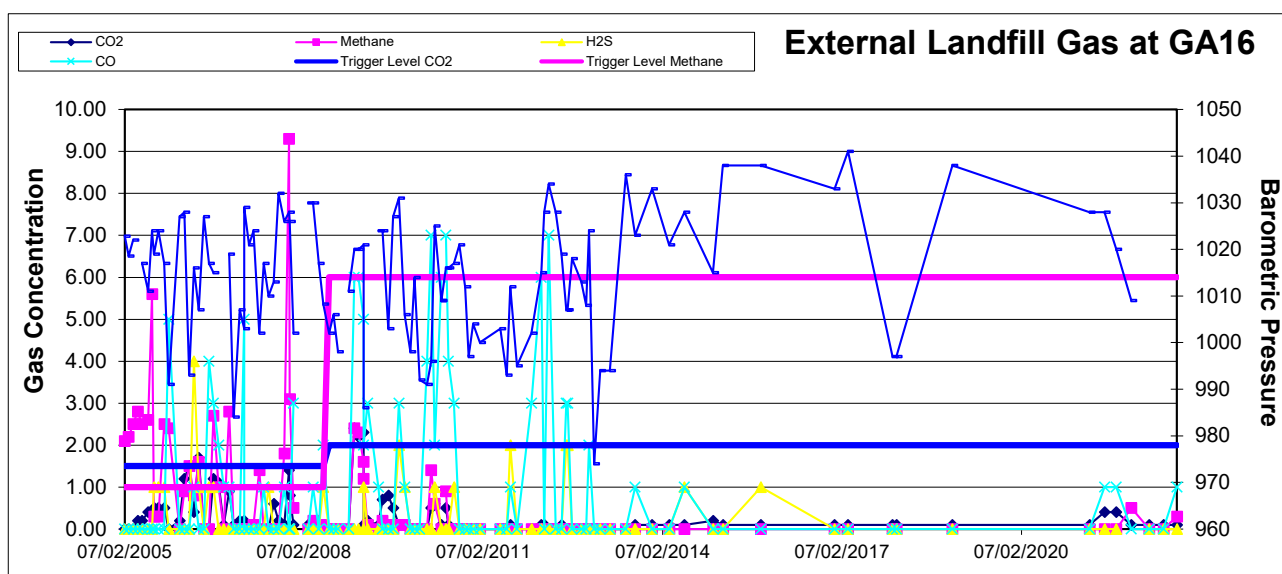
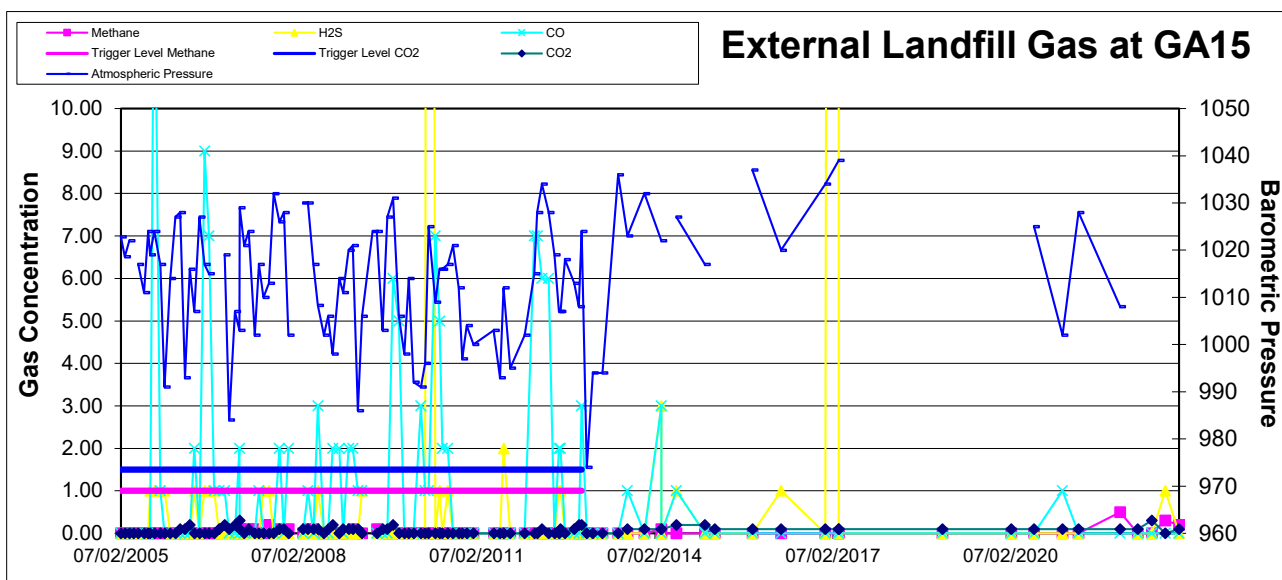
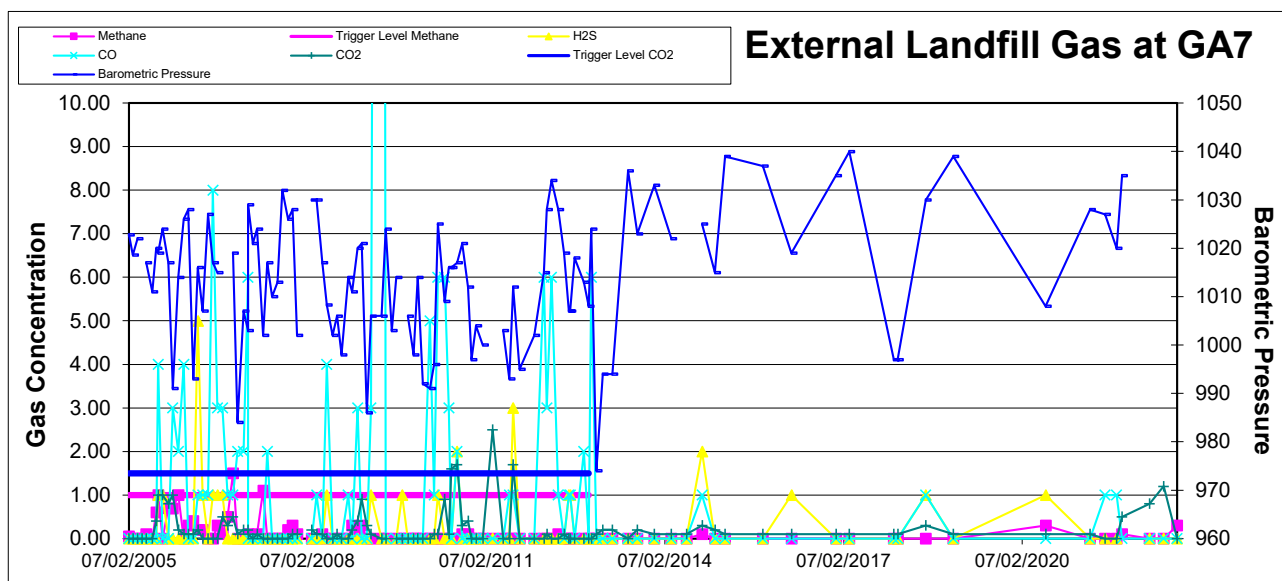
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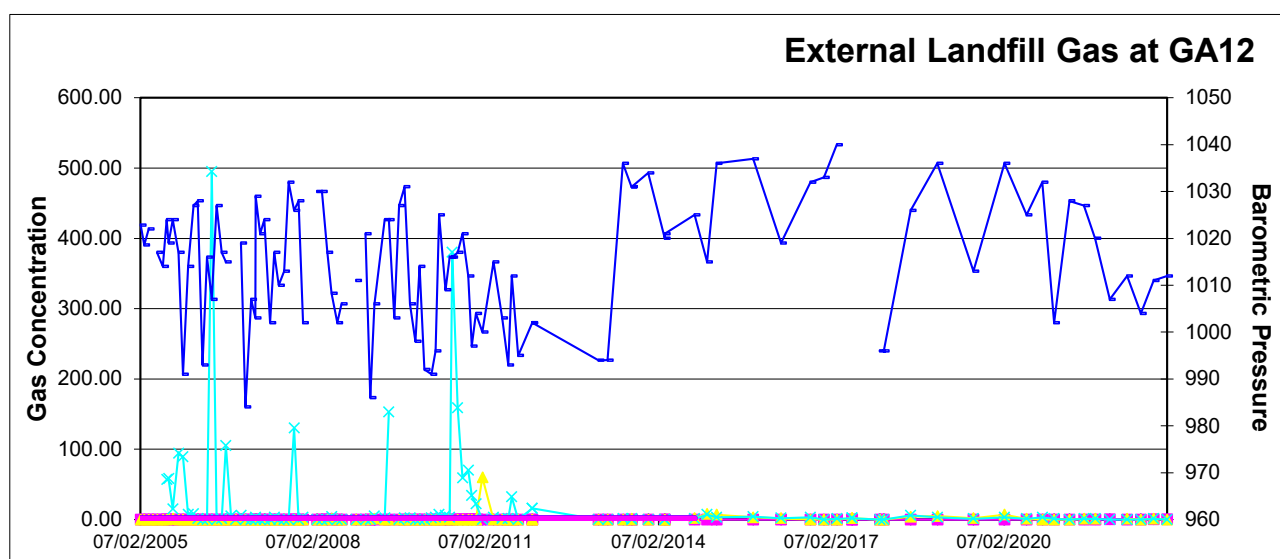
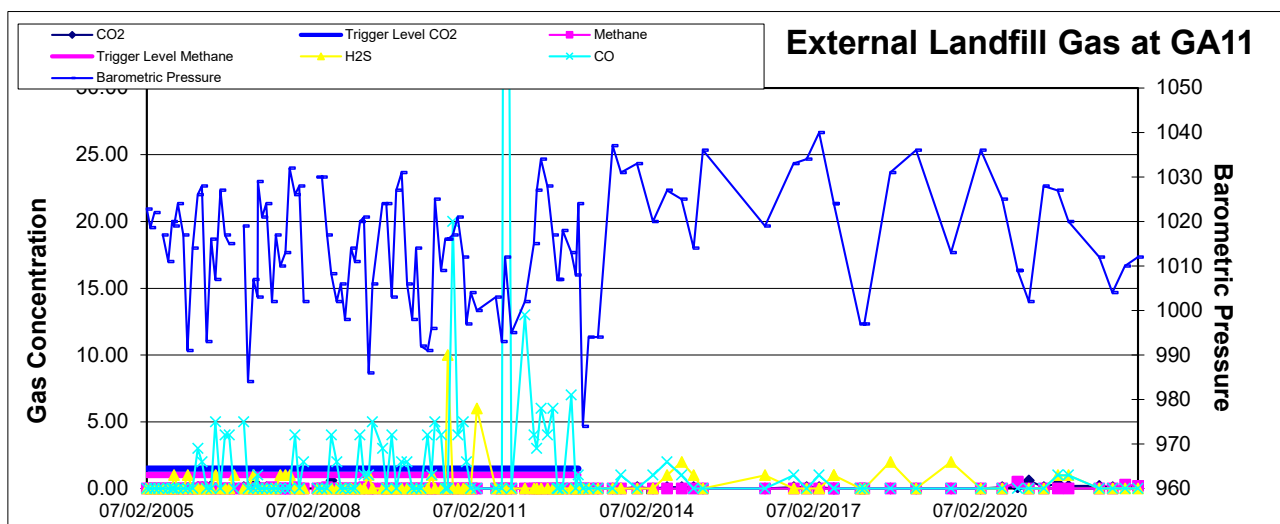
**2022 Annual Review of
Environmental
Monitoring**

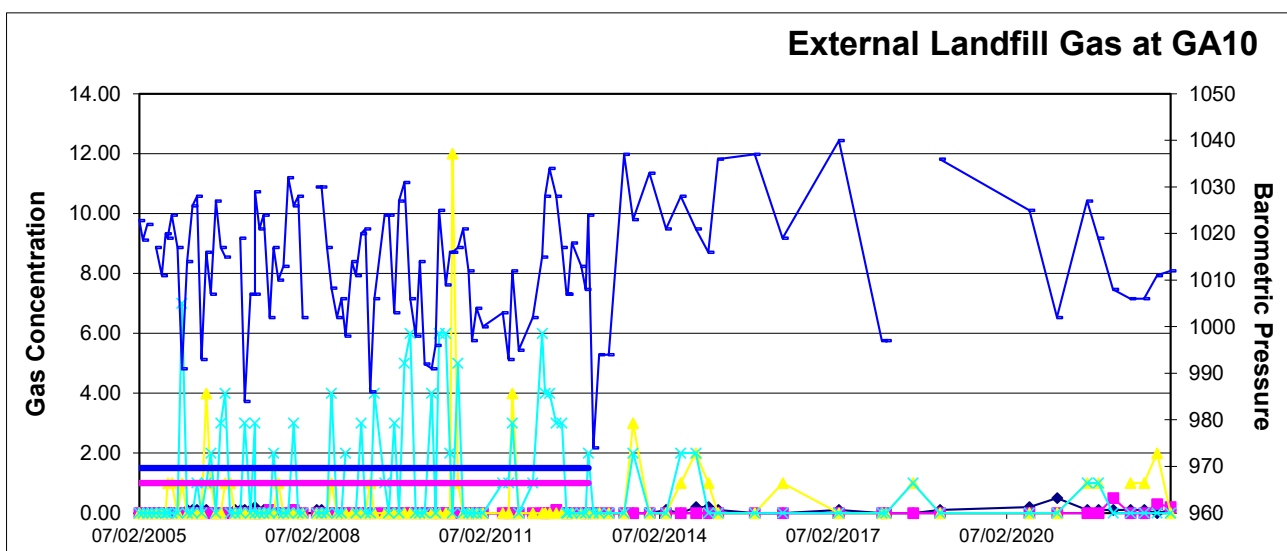
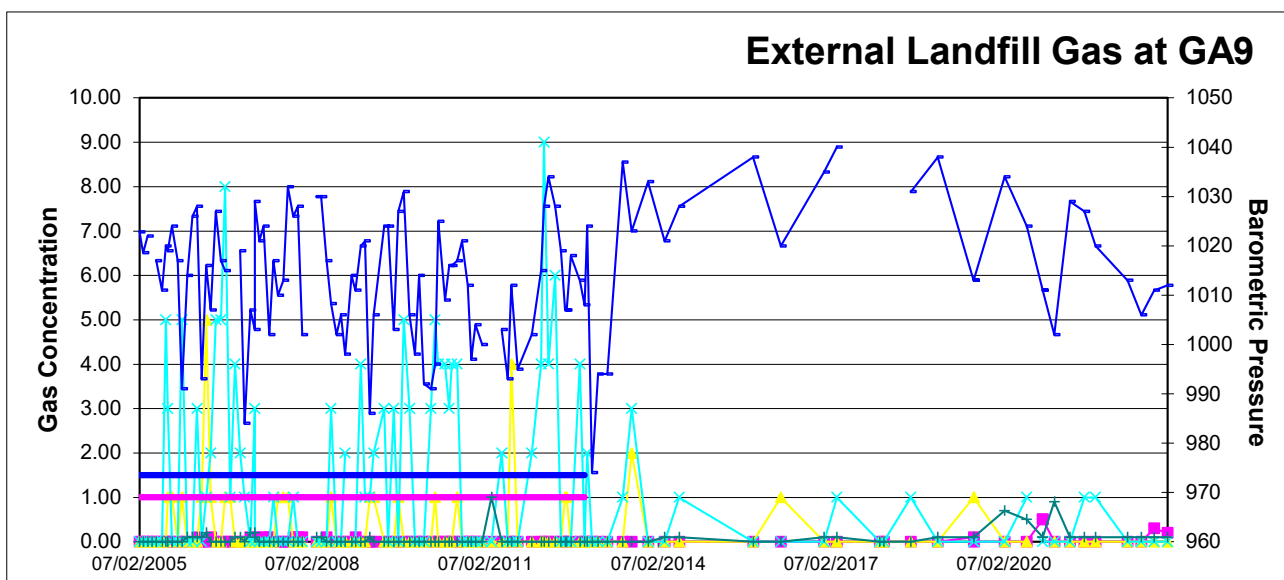
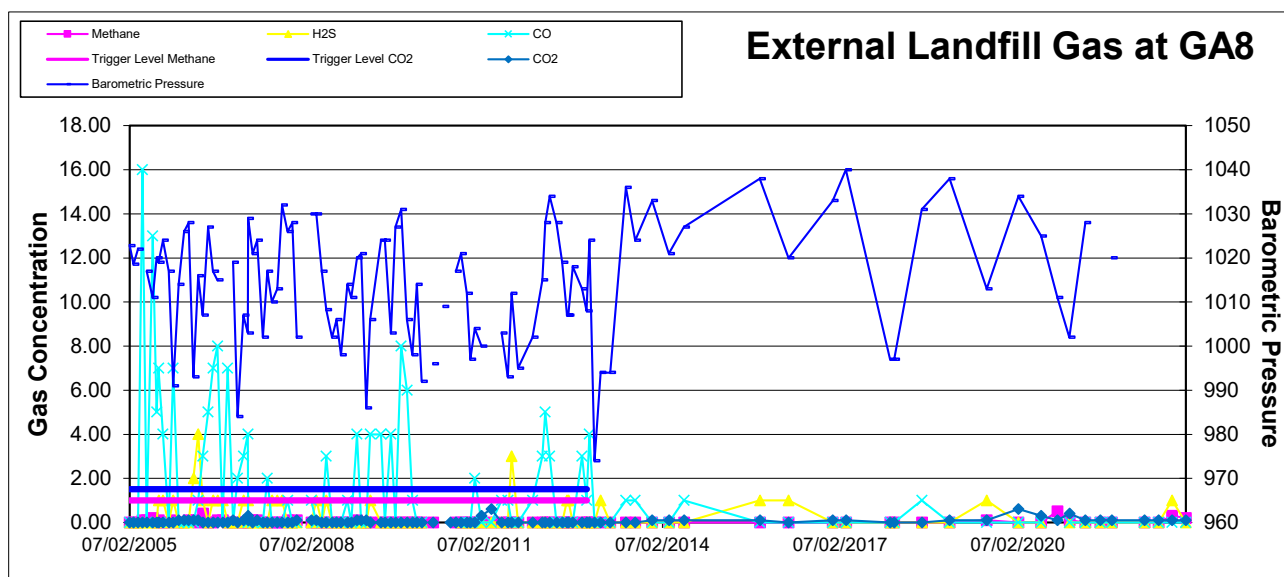
**Appendix 8
Temporal Variation of
Landfill Gas Chemistry**

Report Number 2295r1v1d0223









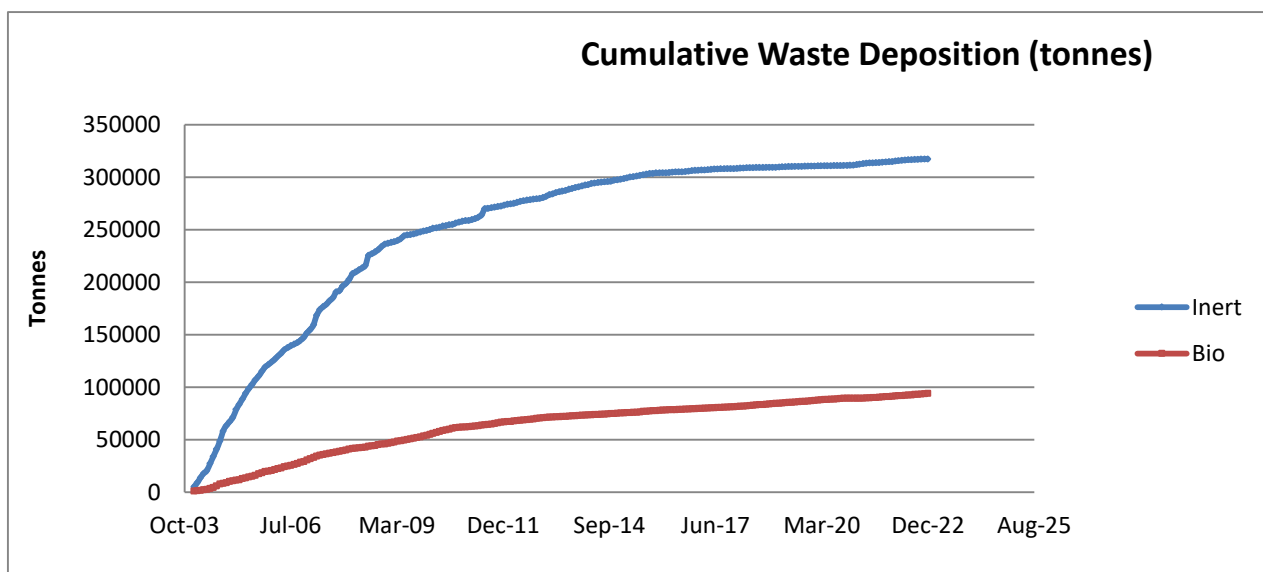
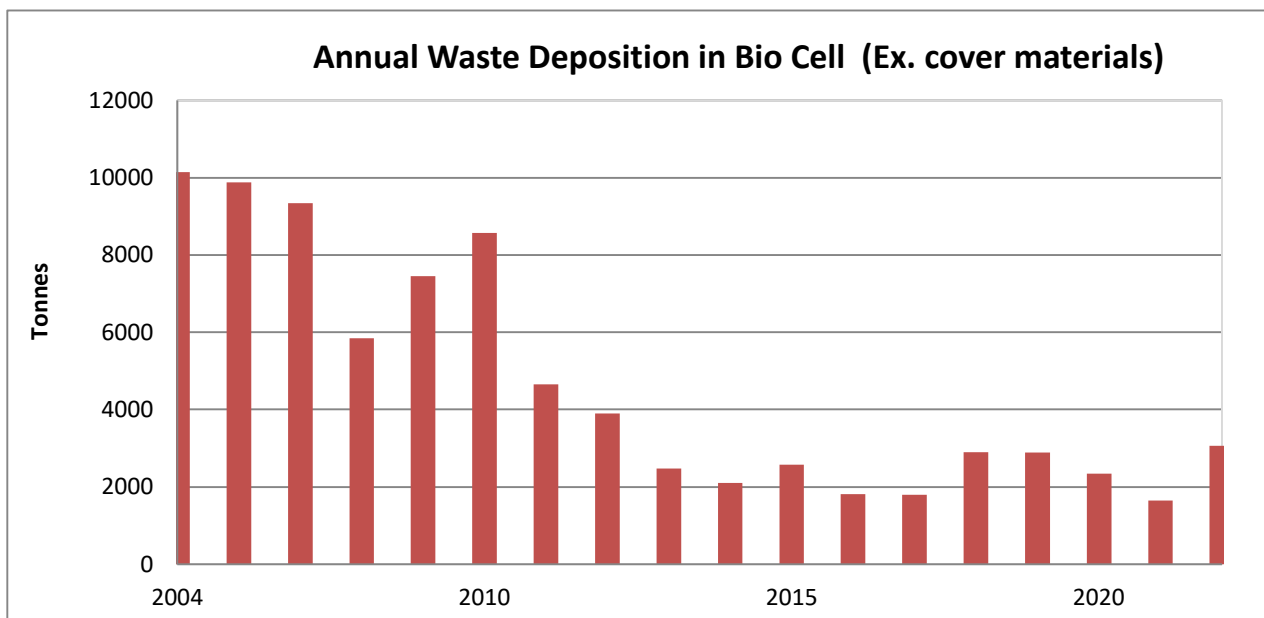
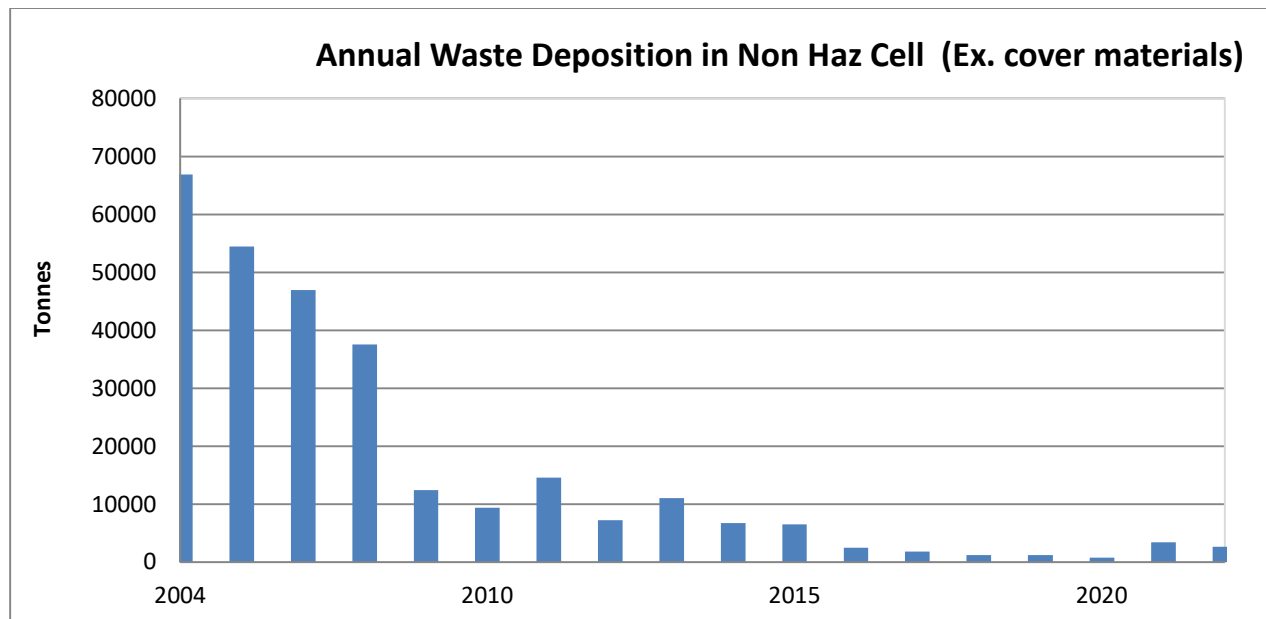
**MORFA NON-
HAZARDOUS LANDFILL,
PORT TALBOT**

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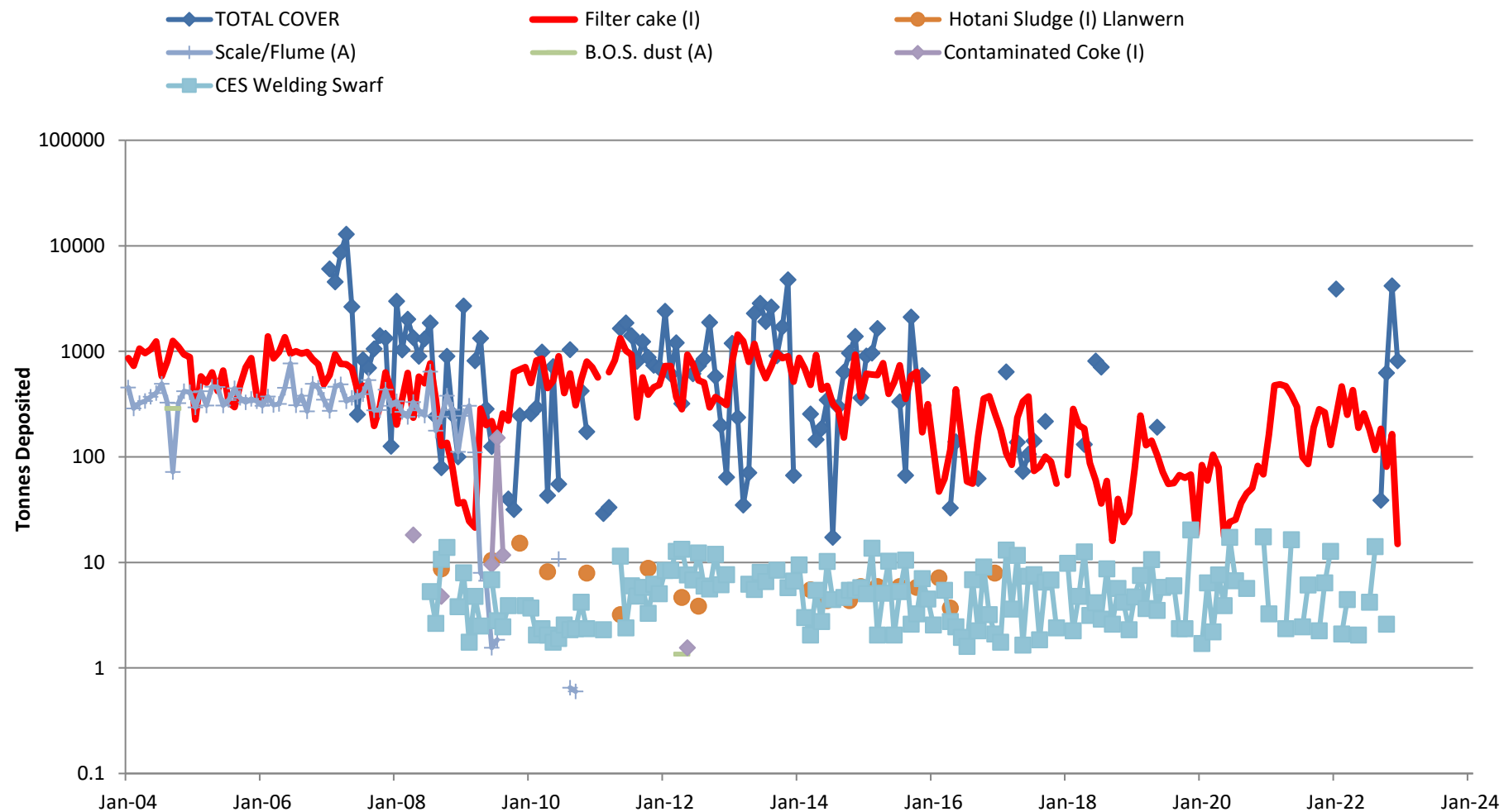
**2022 Annual Review of
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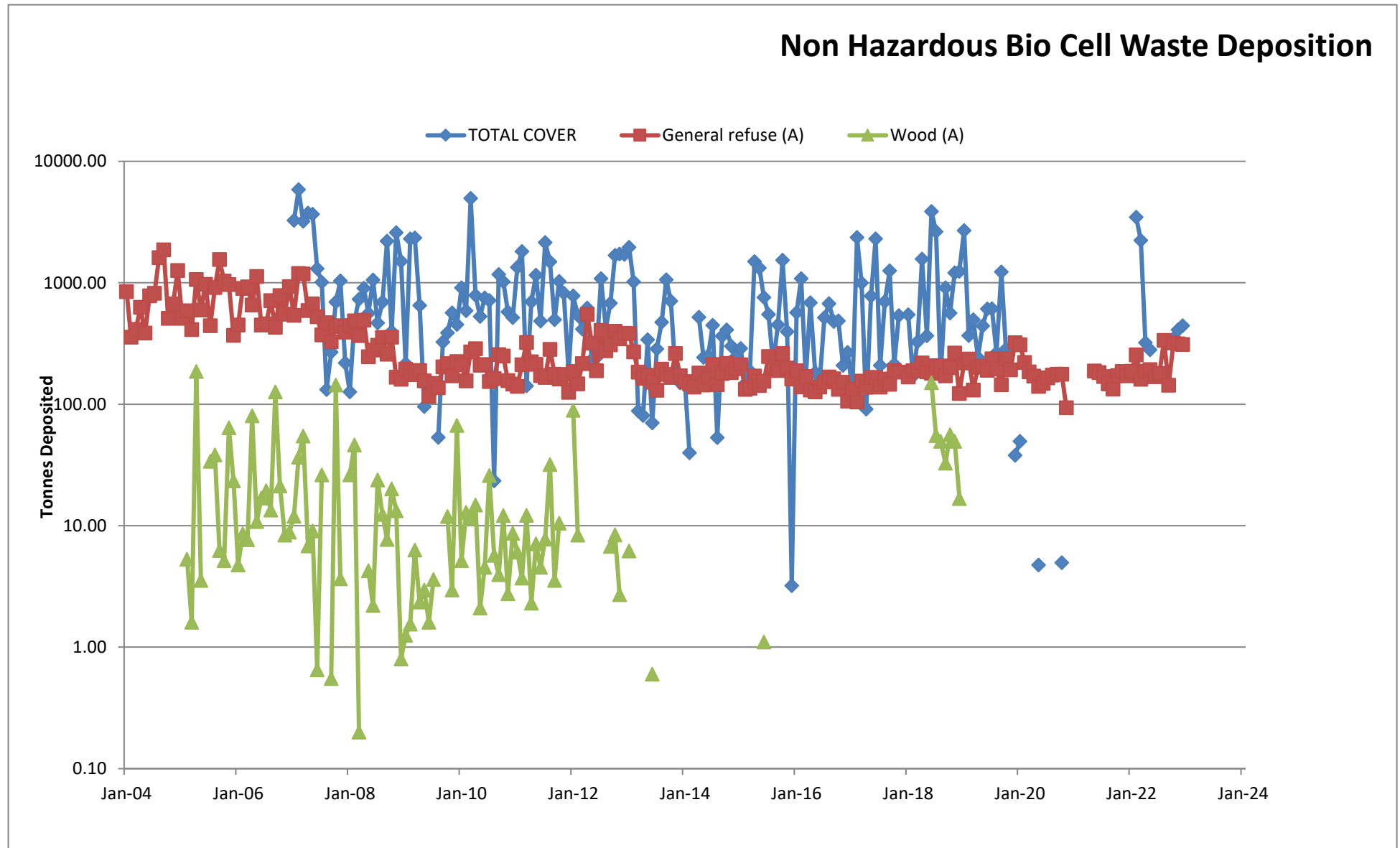
**Appendix 9
Record of Landfilled
Waste**

Report Number 2295r1v1d0223



Non Hazardous Waste Deposition







GEO
TECHNOLOGY

Geotechnical &
Environmental Services

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