MORFA TIP CLOSED LANDFILL, PORT TALBOT

PERMIT EPR/AP3292LT

2021 Annual Review of Environmental Monitoring Results

Report Number 2192r1v1d0222

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Table of Contents

List of Tables

List of Plates

List of Charts

List of Figures

List of Appendices

1 INTRODUCTION

Tata Steel UK Limited (Tata) maintains the unlined Morfa Closed Landfill (MCL) that formerly operated under Waste Management Licence EAWML/34000. The WML was previously taken into the Environmental Permitting regulations by Natural Resources Wales (NRW) and is currently managed under Permit EPR/AP3292LT/V010 following a Variation issued in May 2021.

Tata also actively operates adjacent separate down-gradient non-hazardous and hazardous landfills referred to as Morfa Non-Hazardous Landfill (MNHL) and Morfa Hazardous Landfill (MHL). These are managed under separate Environmental Permits. The site location and the relative position of each of these landfills is indicated on Figures 1 and 2.

Following a final site inspection by NRW on 15 April 2014, the site is now definitively closed and in Aftercare. Between 2004 and 2013 the upper surface of the landfill was capped with geomembranes and restored with site won sand. The steep but stable naturally vegetated sides were not altered during restoration.

1.1 Objective of Report

This report is the fourteenth independent annual report to be produced by Geotechnology Ltd (Geotechnology) following issue of the Aftercare Monitoring Plan (AMP). The report has been prepared to satisfy the Permit condition that requires Tata to submit an Annual Report summarising the monitoring undertaken. This report summarises the data gathered during 2021. The previous annual reports are listed in Table 1-1.

Table 1-1 List of Annual Monitoring Reports

Geotechnology Report Reference	Title
766r1v1d0309	Morfa Closed Landfill. 2008 Annual Review of Landfill Monitoring Results. March 2009.
909r1v1d0310	Morfa Closed Landfill. 2009 Annual Review of Landfill Monitoring Results. March 2010.
1047r1v1d0211	Morfa Closed Landfill. 2010 Annual Review of Landfill Monitoring Results. February 2011.
1131r1v1d0412	Morfa Closed Landfill. 2011 Annual Review of Landfill Monitoring Results. April 2012.
1212r1v1d0313	Morfa Closed Landfill. 2012 Annual Review of Landfill Monitoring Results. March 2013.
1293r1v1d0214	Morfa Closed Landfill. 2013 Annual Review of Landfill Monitoring Results. February 2014.
1394r1v1d0315	Morfa Closed Landfill. 2014 Annual Review of Landfill Monitoring Results. March 2015.
1504r1v1d0316	Morfa Closed Landfill. 2015 Annual Review of Landfill Monitoring Results. March 2016.
1620r1v1d0217	Morfa Closed Landfill. 2016 Annual Review of Landfill Monitoring Results. February 2017.
1763r1v1d0218	Morfa Closed Landfill. 2017 Annual Review of Landfill Monitoring Results. February 2018.
1867r1v1d0219	Morfa Closed Landfill. 2018 Annual Review of Landfill Monitoring Results. February 2019.
1967r1v1d0220	Morfa Closed Landfill. 2019 Annual Review of Landfill Monitoring Results. February 2020.
2094r1v1d0221	Morfa Closed Landfill. 2020 Annual Review of Landfill Monitoring Results. February 2021.

2 RESTORATION OF MORFA CLOSED LANDFILL

An aerial photograph of the site taken in January 2021 and January 2022 is provided in Plates 2-1 and 2-2 respectively.

2.1 Historical Landfilling

In the early 1970's, Morfa Landfill was constructed as an ad-hoc deposition of wastes onto natural ground. A more structured depositional regime was implemented in the late 1980's with end tipped waste being placed into slag constructed cells. However, the identification of specific waste depositional areas cannot be readily made. A planning restriction on height has resulted in the topography of MCL comprising steep slopes with a large flat plateau area.

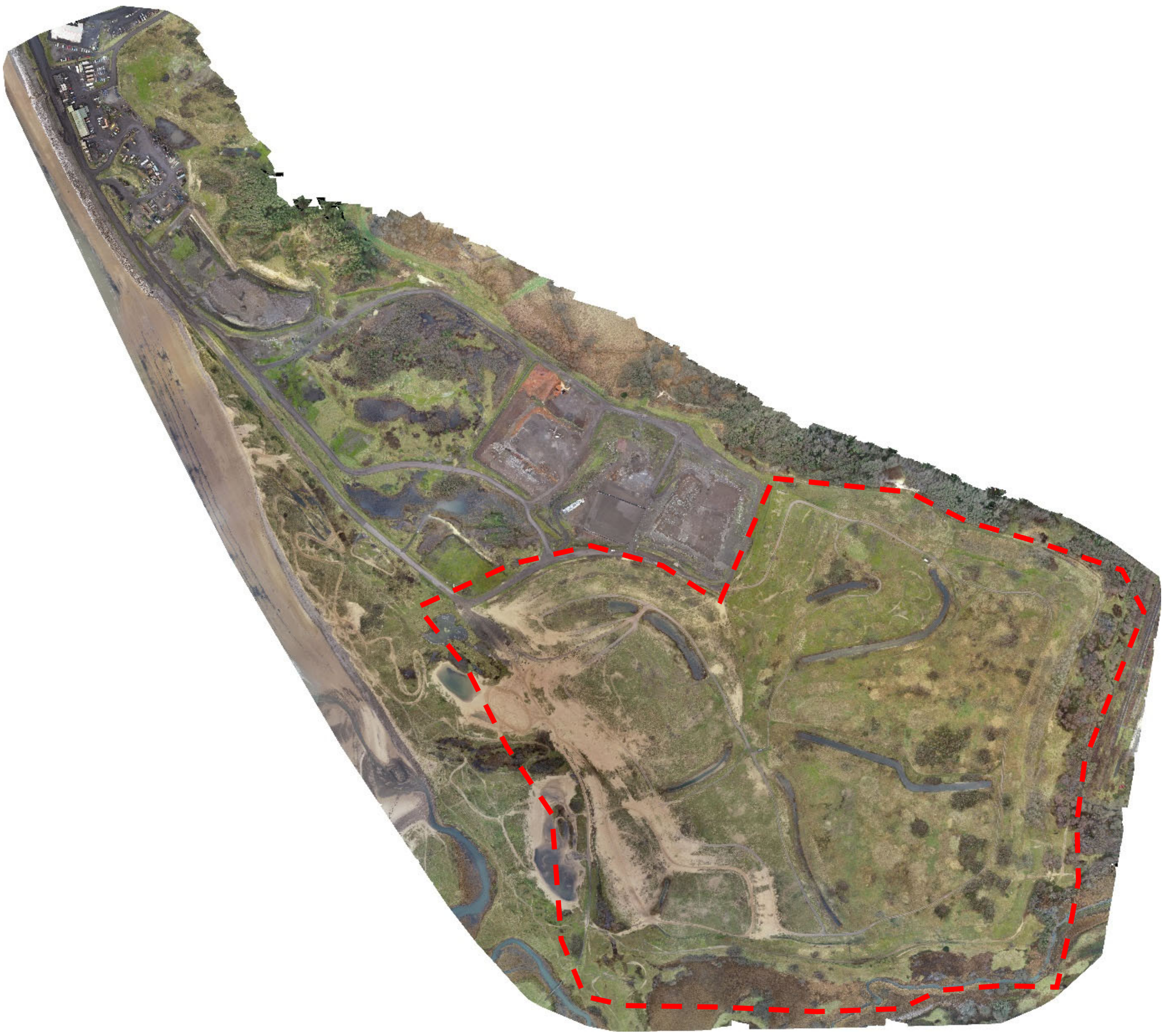


Plate 2-1 2020 Aerial photograph of Morfa Site with MCL boundary dashed red

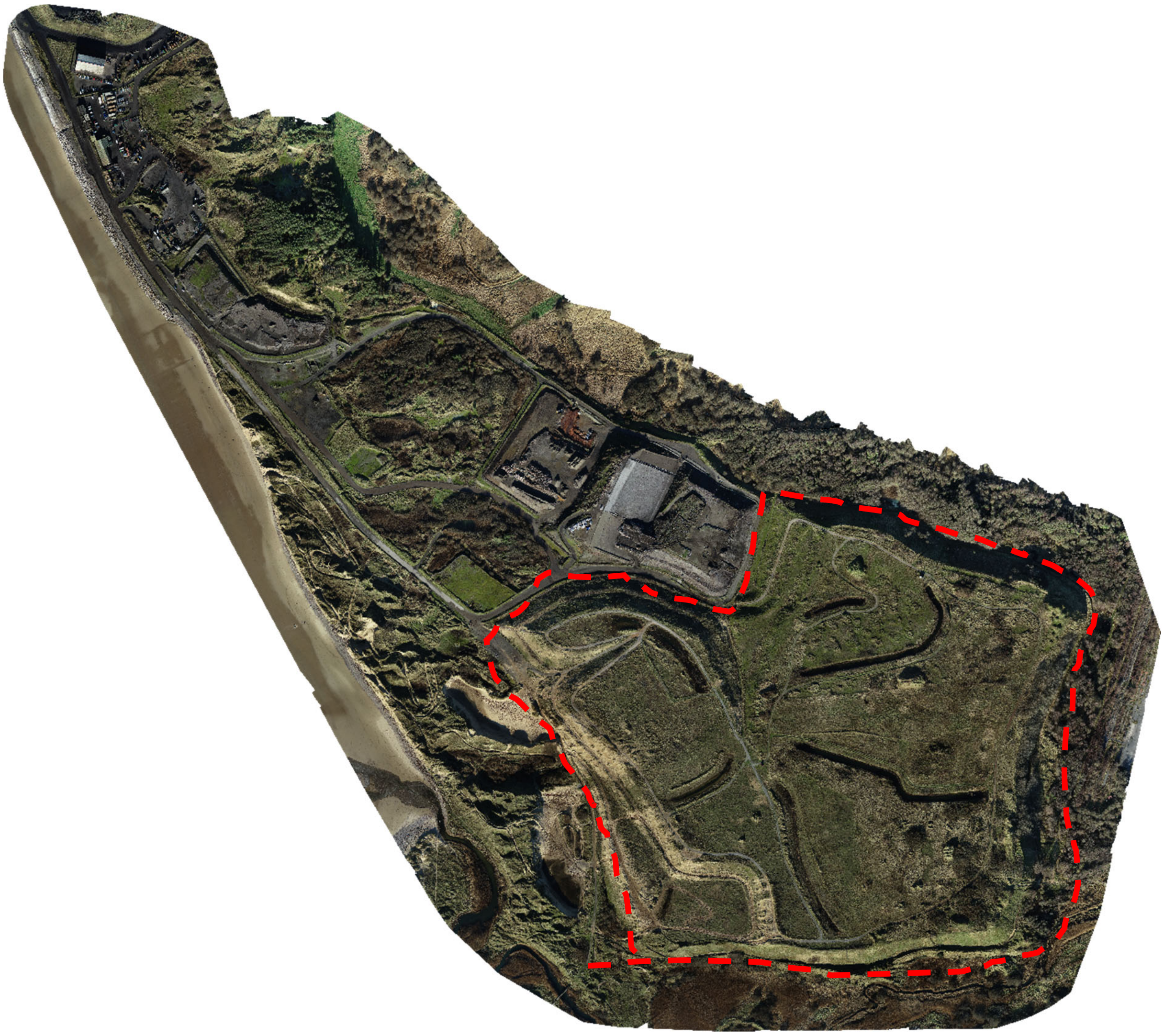


Plate 2-2 2022 Aerial photograph of Morfa Site with MCL boundary dashed red

No basal liner was placed beneath the deposited wastes at MCL and there is no leachate collection or leachate management system. This has resulted in leachate from the wastes infiltrating the shallow groundwater. In areas where the clay aquitard is absent, this leachate is also potentially recharging the deep aquifer, if and when, the head differential is suitable.
MCL accepted all the waste originating within the steel plant between the mid 1970's and 2004. Since December 2004, no additional waste has been deposited. During the landfill operation, the waste comprised the principle sources listed in Table 2-1. The total tonnage deposited is approximately 10 million tonnes. The waste is dominated by BOS and BF slag.

Table 2-1 Estimated Waste Composition of MCL

Waste Material	Percentage of Total Waste
BOS and BF Slag, Refractory material and Rubble	89%
Water treatment solids, mill scale, wood and general commercial waste	7%
Canteen and Horticultural waste	0.3%
Filter Cake	3.7%
Asbestos	0.002%

2.2 Restoration of Morfa Closed Landfill (MCL)

Phased restoration of MCL was completed during 2013 having commenced in September 2004. The restoration scheme involved placement of geomembranes over the surface of the waste which, in combination, provide gas and surface water management as well as providing barriers to precipitation ingress and gas egress. The sympathetic restoration has also involved placement of sand on top of the geomembranes, creating dune morphology like the surrounding land.

The cap is designed to prevent infiltration into the underlying waste mass. At this stage, the captured rainfall is directed through pipework under gravity towards the boundary with Margam Moors near BH17, towards Kenfig near to BH15 and towards BH10. These areas are indicated on Figure 4. This water will ultimately be directed to a recharge trench which has been partly constructed on the northern boundary between MCL and the Margam Moors.

Since completion, several elements of the restoration system have been damaged by direct and determined vandalism, indirect action caused by trespassers on scramblers and wind action, as shown in Plate 2-2. The wind turbine intended to power the recharge trench penstocks has been severely damaged and where capping membranes have been exposed by wind action, these have been subsequently punctured by the passage of scramblers. Geotechnology is aware that Tata is reviewing boundary security at the site and maintenance of the cap. These aspects are routinely discussed by the Technical Working party overseeing management of the site that includes NRW.

Plate 2-3 Exposed geomembranes on southwestern flank

During 2021, following advice from the ecologist who prepared the site Ecological Management Plan, Tata started to trial new techniques for stabilising exposed flanks prone to wind-blow causing sands redistribution.

2.3 Materials Recovery

As part of the last phase of restoration, the existing waste surface needed to be reprofiled to achieve side slopes that are stable and a restoration surface that sheds water toward collection ponds. As part of this process, materials were recovered for use in the steelworks and as part of restoration. Based on a comparison of surveys completed prior to and after completion of this aspect, an estimated 30,000m^3 was recovered. During this phase, areas of waste that had not been directly exposed to the environment for many years, possibly decades, were exposed. These areas were available to react with the atmosphere and open to weathering and leaching. The products from these processes could ultimately reach the underlying groundwater system.

2.4 Alteration to Recharge Trench Design and Operation

Since issue of the Permit for MNHL two biodegradable cells (Biocells) and two of the non-hazardous waste cells have been constructed. Two hazardous waste cells have also been constructed.

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 is currently being re-designed so that the trench system can operate more passively than originally envisaged whilst still being acceptable to NRW. These modifications will only be made once approval is given by NRW.

3 REGULATORY FRAMEWORK

On 13 June 2006, a Closure Notice was issued for MCL (Licence Number 1/77 (EAWML/34000)). In response, Geotechnology was commissioned by Tata to compile a Closure Report that demonstrated Definitive Closure could be achieved and addressed specific actions prompted by the Closure Notice (see Geotechnology report 498.1/0/1106).

A key element of the Closure Report was an Aftercare Monitoring Plan (AMP) that detailed the monitoring to be completed to support the ultimate application for surrender. Following submission of the Closure Report, several comments were made by NRW, which lead to the AMP being updated in 2007 (see Geotechnology Report 498.1/1/1007 Appendix 2). The update only applied to the AMP (Appendix 2 of the original Closure Report) and the main body of text of the Closure Report was not modified.

During 2009, NRW consulted with Tata to ensure the new Permit met the expectations of all parties. Following this consultation period, the new Permit was issued on 9 October 2009. The new Permit required Tata to revise the AMP updated in 2007 as part of an Improvement Programme. In response, Geotechnology was commissioned to update the AMP (see Geotechnology report 843r1v1d0210 *Revised Closure and Aftercare Monitoring Plan).* The revised AMP consolidates all changes to the Environmental Management and Monitoring Programme.

In January 2021, Tata submitted a Permit Variation aimed at consolidating the current monitoring programme.

3.1 Groundwater

Interim Control Levels were previously established to provide the required assurance that any deterioration in groundwater quality around MCL would be recognised and relevant contingency plans promptly implemented. These interim levels were presented in Geotechnology report *498.1/1/1007* Appendix 2. At the time, interim levels were established for the shallow and deep aquifer at BH8, BH9, BH15 and BH16 (see Figure 2 and 3).

Subsequently, NRW requested that consideration be given to the development of emission limits and control levels for other groundwater monitoring positions around the periphery of MCL; along the boundary with the Kenfig (BH10, BH15, BH16, BH9), along the northern boundary facing Margam Moors (BH17 – BH20) and along the boundary with Margam Sands (BH14 and BH13). These emission limits were presented in Geotechnology report *795r2d0409* (*Hydrogeological Risk Assessment in Support of Environmental Permit Review).* In their review of this document (EA Ref 1/77 (34000)), NRW indicated they were largely satisfied with the approach adopted for the derivation of proposed emission limits, but they wished to see the concentration of the limits reduced to take account of site conditions. Consequently, lower compliance and control levels were developed in accordance with the Improvement Programme set out in the new Permit at the start of 2010 (see Geotechnology report *964r1v1d0310 Review of Groundwater Emission Limits).* The new emission limits were accepted by the EA on 7 April 2010 in Compliance Assessment Report 3276.

Due to different flow conditions and receptors around MCL each boundary is discussed separately in the following sections.

3.1.1 Boundary with the River Kenfig

The agreed emission limits for the groundwater at monitoring positions BH8, BH9, BH15 and BH16 are presented in Table 3-1 and Table 3-2.

Table 3-1 Summary of trigger and control levels for BH8S and BH8D

	Ammonia	Chloride	Calcium	Copper	Cadmium	Mercury
Trigger Level (50% above maximum)	122	27279	8423	0.036	0.003	<0.0001
Control Level 2 (30% above maximum)	106	23642	7300	0.0312	0.0026	<0.0001
Control Level 1 (20% above maximum)	98	21823	6738	0.0288	0.0024	<0.0001
All values mg/l						

Table 3-2 Summary of trigger and control levels for BH9S, BH15S and BH16S

	Ammonia	Chloride	Calcium	Copper	Cadmium	Mercury
Concentration needed in groundwater to reach EQS in Kenfig	7	118750	118750	13	0.0475	0.00475
Trigger Level (50% above maximum)	2.1	1689	663	0.012	<0.0001	<0.0001
Control Level 2 (30% above maximum)	1.8	1464	575	0.0104	<0.0001	<0.0001
Control Level 1 (20% above maximum)	1.7	1351	530	0.0096	<0.0001	<0.0001
All values mg/l						

In deriving these emission limits, Geotechnology reviewed the applicability of setting limits for both the shallow and deep aquifers. As discussed in previous annual reports and report *964r1v1d0310 Review of Groundwater Emission Limits*, MCL is not the only potential source of contaminants impacting deep groundwater. Groundwater migrating seaward from higher ground to the east passes beneath industrial and agricultural areas (where it is utilised for water resources), beneath the railway and then beneath the site. In comparison, the shallow aquifer is solely recharged by direct precipitation and leaching of the waste materials contained at MCL and other unlined locations across the site. As discussed in Geotechnology report *795r2v1d0409*, setting emission limits for the deep aquifer is not considered useful or workable as there are other off-site contributions impacting groundwater around MCL. In their review, NRW did not comment upon this position. However, the new Permit for MCL requires Tata to set trigger levels for the deep groundwater.

To satisfy the requirements of the Permit, Geotechnology adopted the same approach used to set emission limits for shallow groundwater in deriving emission limits for the deep groundwater. These emission limits are summarised in Table 3-3.

Table 3-3 Summary of trigger and control levels for BH9D, BH15D and BH16D

	Ammonia	Chloride	Calcium	Copper	Cadmium	Mercury
Trigger Level (50% above maximum)	203	4208	2538	0.009	<0.0001	<0.0001
Control Level 2 (30% above maximum)	176	3647	2200	0.0078	<0.0001	<0.0001
Control Level 1 (20% above maximum)	162	3366	2030	0.0072	<0.0001	<0.0001
All values mg/l						

3.1.2 Boundary with Margam Moors

Unlike the boundary with the River Kenfig, a well-documented significant and discernible impact is occurring along the boundary of MCL with Margam Moors. This situation has been evident for some time and is a consequence of the flow regime within the shallow aquifer. As the surface of MCL is now fully capped and the recharge trench partly constructed, the impact along the boundary with Margam Moors is expected to change as recharge will be dominated by captured rainfall.

Water quality along this boundary with MCL has shown recent improvement because of site restoration. Geotechnology previously considered that there was little advantage to be gained from setting formal numeric emission limits to warn of deteriorating water quality and to enable contingency actions to be implemented. In report *795r2v1d0409* Geotechnology suggested that a more useful and practicable approach would be to set criteria that would enable sustained deterioration in water quality along the boundary to be detected. Geotechnology proposed continuing to monitor and if levels increase over three consecutive sampling rounds, this will trigger contingency actions. Given the improvements in water quality along this boundary, NRW agreed with this philosophy but requested that numeric upper limits still needed to be set.

To satisfy the requirements of NRW, Geotechnology reviewed the monitoring data in report *964r1v1d0310*. Although the overall trend is for improving water quality, there remains unpredictable variations in the data which needed to be accommodated within the numeric limits and in the way the limits are applied.

Trigger levels were previously in place for the monitoring boreholes along this boundary. In agreement with NRW these were removed in 2007 following review of their applicability. Consequently, rather than set new trigger levels along a boundary where water quality is improving, Tata suggested establishing three sets of controls levels for evaluating the shallow groundwater data. These are presented in Table 3-4. Control levels for the deep groundwater along this boundary were not considered applicable due to the contribution from off-site sources.

Table 3-4 Summary of control levels for shallow groundwater at BH17 – BH20

	Ammonia	Chloride	Calcium	Copper	Cadmium	Mercury
Previous trigger levels	2	215	850		0.005	0.001
Control Level 3	2	215	500	0.01	<0.0001	<0.0001
Control Level 2	1.6	172	400	0.008	<0.0001	<0.0001
Control Level 1	1.4	151	350	0.007	<0.0001	<0.0001
All values mg/l. Control levels apply to shallow groundwater at BH17, BH18, BH19 and BH20						

3.1.3 Boundary with Margam Beach

In report *795r2v1d0409* Geotechnology discussed the setting of emission limits for BH13 and BH14. However, the new Permit for MCL does not require emission limits for BH13 and BH14.

3.2 Recharge Chambers

Tata is currently discussing a new way of monitoring waterlevels within the recharge chambers given the potential transition to a more passive recharge trench system.

In addition to water levels, quarterly spot samples are also recovered from the recharge chambers.

3.3 Landfill Gas

The potential for landfill gas evolvement at MCL is relatively unknown at this stage, although it is not expected to follow the route of a conventional municipal waste landfill due to the nature of the wastes. The Permit Compliance Limit for these wells is 1% methane above background concentrations.

4 MONITORING NETWORK PERFORMANCE

4.1 Monitoring Programme

The full groundwater monitoring network available to Tata for all the landfills is shown in Figure 2. The specific monitoring positions for MCL are shown in Figure 3. From this network the infrastructure used for the monitoring of MCL is summarised in Table 4-1. The table also summarises the key features of the current monitoring programme. To assist with understanding the processes occurring at MCL, this annual report also draws on data collected from aspects of the adjacent MNHL monitoring network. The current monitoring programme for MCL is summarised in Table 4-1.

Table 4-1 Current Monitoring Schedule

	Lab analysis	Surface water samples	Quarterly Groundwater samples	Recharge Chambers	Monthly levels	Gas
Q1 (Jan–Mar)	Indicator Suite	SW11, SW12 Ponds 1 – 7 on surface of MCL	BH9S, BH9D, BH15S, BH15D, BH16S, BH16D	Chambers A & B – weekly level and quarterly chemistry	SW gauges 1,2,6, 7 Piezometers P7-P24 Sampled groundwater wells	GV1 – GV8
Q2 (Apr–Jun)	Indicator suite	SW11, SW12 Ponds 1 – 7 on surface of MCL	BH9S, BH9D, BH15S, BH15D, BH16S, BH16D	Chambers A & B – weekly level and quarterly chemistry	SW gauges 1,2,6, 7 Piezometers P7-P24 Sampled groundwater wells	GV1 – GV8
Q3 (Jul-Sep)	Indicator suite	SW11, SW12 Ponds 1 – 7 on surface of MCL	BH9S, BH9D, BH15S, BH15D, BH16S, BH16D	Chambers A & B – weekly level and quarterly chemistry	SW gauges 1,2,6, 7 Piezometers P7-P24 Sampled groundwater wells	GV1 – GV8
Q4 (Oct–Dec)	Characterisation suite	SW11, SW12 Ponds 1 – 7 on surface of MCL	BH9S, BH9D, BH15S, BH15D, BH16S, BH16D	Chambers A & B – weekly level and quarterly chemistry	SW gauges 1,2,6, 7 Piezometers P7-P24 Sampled groundwater wells	GV1 – GV8

4.2 Monitoring Infrastructure

4.2.1 Landfill Leachate

As the landfill is unlined there is no system to allow the collection, management and sampling of leachate.

4.2.2 Groundwater Monitoring Infrastructure

The integrity of the groundwater monitoring network is inspected during each sampling event. Due to the remote location of the site, the monitoring network is frequently vandalised e.g. locks broken, pumps stolen. Tata is aware of the on-going vandalism and that replacement monitoring equipment and maintenance is required at times.

Monitoring at BH8 is no longer feasible and it was suggested in the previous annual report that sampling at this point should be abandoned. This was acknowledged in the May 2021 Permit Variation.

4.2.3 Shallow Piezometer Monitoring Infrastructure

A series of shallow piezometers have been manually installed into the shallow aquifer along the boundary with Margam Moors, as shown on Figure 2. These have been routinely monitored since 2006. Replacement piezometers were installed at P1-P4 and P16 during 2015. During 2016, P16 was vandalised once again but has since been replaced. Many of the piezometers are not readily accessible during the period March – August due to the growth of dense vegetation. Routine vegetation clearance and the erection of marker posts would facilitate monitoring at these times.

4.2.4 Surface Water Monitoring Infrastructure

In August 2006, four surface water level gauge boards (Gauge Boards 1-4) were installed at the positions shown on Figure 2. These were monitored monthly as part of the monitoring programmes for MNHL and MHL. During 2010, detailed consideration was given to the safety of the approach to Gauge 3. As the gauge was located on the outside of a meander and only accessible down a steep grassed bank, which can be very slippery, a safer location was identified. The new gauge (referred to as gauge 6) was installed at a more accessible upstream location at the position shown on Figure 3.

During 2013, a fire, potentially arson, destroyed the gauge on the Kenfig at SW4. A new gauge (Gauge 7) has been installed at the position shown on Figure 3.

A rope rail (or similar) would improve safety whilst sampling adjacent to deep water.

4.2.5 Gas Monitoring Infrastructure

Because of the completion of the capping system, four new gas wells have been selected for monitoring. These are referred to as GV5, 6, 7 and 8 and are in addition to the four vents already monitored (GV1 – GV4), as shown on Figure 3. The monitoring of these additional vents started in December 2013.

The integrity of the internal landfill gas monitoring network is inspected monthly and no improvements are considered necessary at this stage. The vents currently vent direct to atmosphere and gas flow / differential pressure is not possible to measure. This aspect should be considered further given the Permit monitoring requirements.

Elevated hydrogen has been found at several of these positions. This significantly impacts the ability to monitor as the sensors within the instrument take time to recover once exposed to such concentrations and the gas can cause permanent (expensive) damage.

4.2.6 Dust Monitoring Infrastructure

Dust monitoring is coordinated, when necessary, by Tata Environment Department, particularly in response to complaints or earthworks. Dust monitoring has not been necessary for many years.

5 LANDFILL STABILITY AND SETTLEMENT

5.1 Stability

Visual inspection for signs of settlement and instability are undertaken as part of the quarterly monitoring programme and more frequently by the landfill manager. To date, the only area where settlement has been observed is a small area (<20m^2) on an access track on the lower northwestern bench between the site and MNHL Biocells. The suspected cause of this settlement is the removal of restoration materials from below the access road by the flow of run-off from the cap.

5.2 Settlement Monitoring

Now that the landfill is capped, evaluation of settlement is being undertaken using a network of settlement markers. The location of these markers is shown on Figure 5. Monitoring of these positions will satisfy the requirements of Permit condition 4.2.2. NRW has agreed that this approach will mean that a topographic survey, as required by Permit condition 3.5.3, is required each year.

Plate 5-1 Permanent Settlement Marker on MCL (Before Final Installation)

Twenty-five settlement markers were installed in December 2013 along with two fixed survey stations in the stable ground approximately 100m to the southwest of the closed landfill. At each monitoring position a hand dug hole was made in the restoration soils and the settlement monitoring marker (as seen above) was placed directly onto the pozidrain. The marker was then secured in place with a bag of ready mixed cement and covered over with restoration soil. Monitoring data gathered from annual repeat surveys of the settlement markers identifies changes in elevation which are within the tolerance of the survey method. This would suggest negligible settlement has taken place, which is to be expected given the age and nature of the deposited wastes.

The recent survey found that 6 markers have been destroyed and require replacement.

6 LEACHATE

As the landfill is unlined there is no formal leachate collection and management system.

Visual inspection of the landfill boundary has not revealed the presence of any new leachate breakout. Monitoring has previously shown leachate from MCL to be impacting shallow groundwater, particularly to the northwest of the site, where it is most visible due to topographic lows. Since completion of the capping, excess surface run-off shed from the cap has, at times, inundated these areas causing localised flooding.

7 GROUNDWATER

7.1 Groundwater Level and Flow

Examination of the shallow groundwater surface shown in contour plans included in Appendix 1 and Plate 7-1, shows that it is domed and largely stable, with a concentric series of groundwater elevation contours centred on the highest elevation, close to the centre of the site. Groundwater flows in response to head loss and accordingly, flow lines will be normal to the contours, radiating outwards from the dome. This radial flow pattern is 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 site would be expected toward Margam Moors, Margam Beach, the River Kenfig and the railway sidings. Despite the full cap being in place since 2014, groundwater levels and flow patterns are still similar to those observed prior to capping. At BH15, ponding of run-off from the cap is resulting in localised increased groundwater levels and dilution of groundwater.

The shallow groundwater body lies within a wind-blown sand aquifer that overlies a low permeability clay layer which in turn overlies an alluvial sand and gravel sequence. The deeper aquifer is water saturated and beneath the clay layer it is confined, with a piezometric head above the clay layer, but beneath the shallow groundwater surface.

Deep groundwater piezometric levels shown in Appendix 1 indicate an overall decrease in head toward the north and west. Typically, there is no suggestion of a radial pattern to the contours, but rather a uniform loss of head from the east toward the west is indicated. The principle 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 is utilised for water resources), beneath the railway and then beneath the site.

An examination of the deep groundwater plan 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 absence of the clay appears to have resulted in both groundwater bodies coming together along the northern bank of the River Kenfig, though deep and shallow monitoring reveals that both water pressures and chemistry remain distinctly different in the wind-blown sand and the estuarine sand beneath.

The groundwater contour plan in Appendix 1 reveals that the deep groundwater is recharged to the east before flowing beneath the site as a confined aquifer. Along the edge of the Kenfig and for some 200m into the southern part of Morfa site, the confining clay layer is absent, and the deeper water is free to mix with the shallow water. The elevation of the deeper groundwater surface appears to coincide with the elevation of the River Kenfig, though the groundwater gradients between the deep groundwater and the river are flat. This suggests little inflow or outflow between deeper groundwater and the Kenfig, although some exchange would be expected.

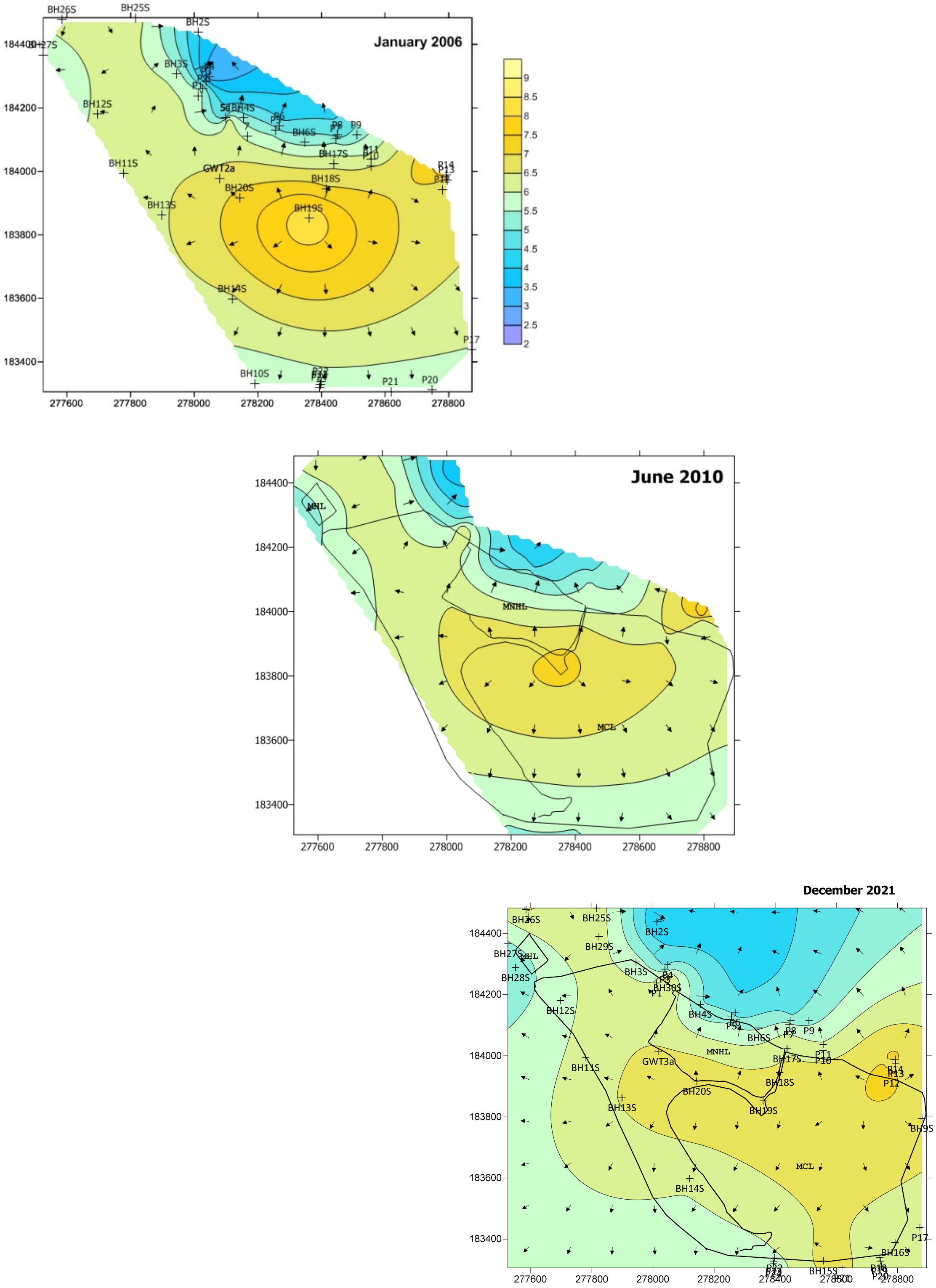


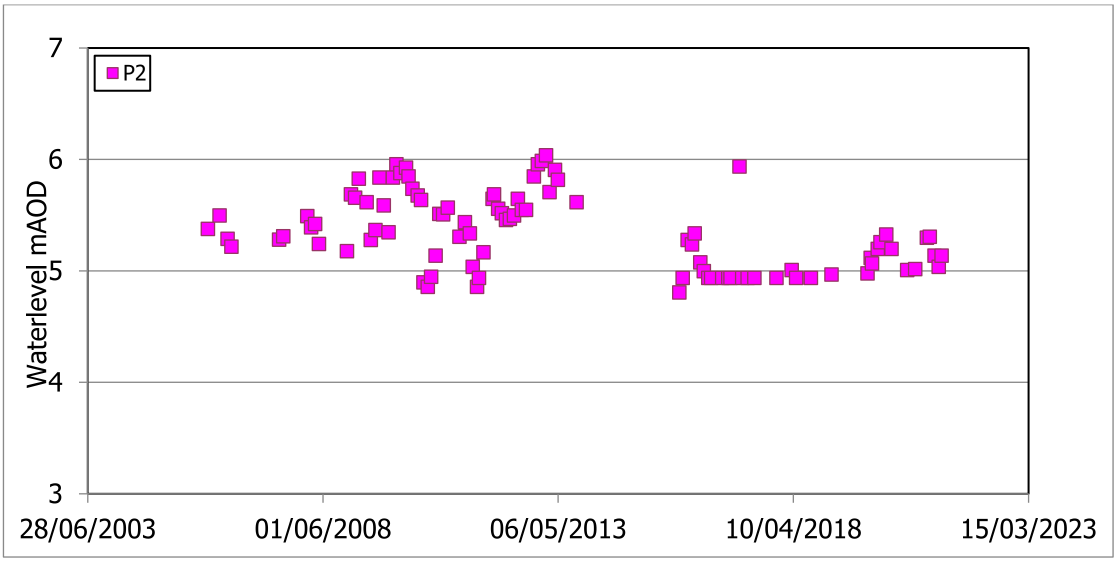
Plate 7-1 Groundwater contours in shallow aquifer

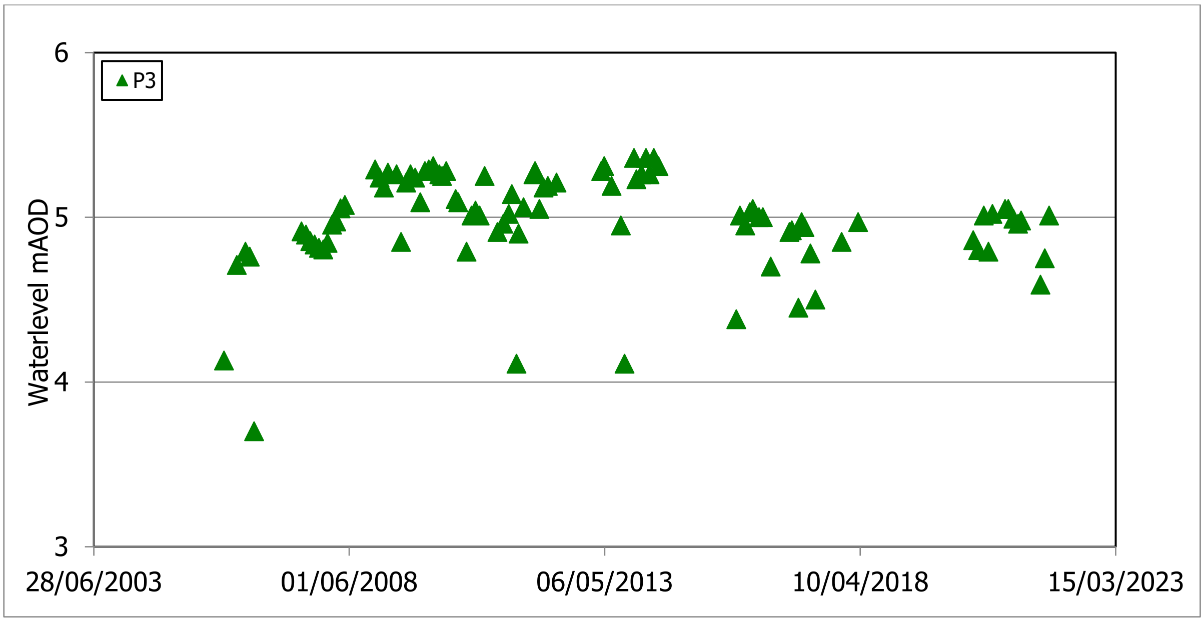
Based on the predicted groundwater flow directions from the accessible monitoring network, all shallow groundwater monitoring infrastructure can be considered downgradient of MCL, as there appears to be a radial component to flow direction. This is partly due to the lack of direct access to groundwater below MCL. For this reason, the boreholes within the shallow aquifer around the perimeter of the site are grouped according to their hydrogeological position relative to MCL as follows:

- BH9, BH10, BH15, BH16 – Between MCL and the rail sidings and River Kenfig.
- BH11, BH12, BH13, BH14 – Down gradient to the west and north. Adjacent to Margam Sands.
- BH17, BH18, BH19, BH20 – Down gradient to the north. Between MCL and Margam Moors.

Groundwater levels measured at the shallow piezometers and at the gauges installed in the Margam Moors Mother Ditch and River Kenfig are graphically illustrated in Appendix 1. Water levels in the shallow aquifer do not appear to have fallen significantly according to this analysis despite the completion of the capping systems in 2013 as the recharge trench system is partly constructed and directing collected surface water to the perimeter of the landfill. Along the southern and eastern boundaries some water levels have shown a slight rise in recent years due to localised inundation caused by storm run-off from the cap.

Close review of the data does however potentially indicate that some of the previous winter high waterlevels have not been recently reached, as suggested in Chart 7-1. Some of these variations are likely due to a change in the management of the reens with clearance occurring more often in recent years.





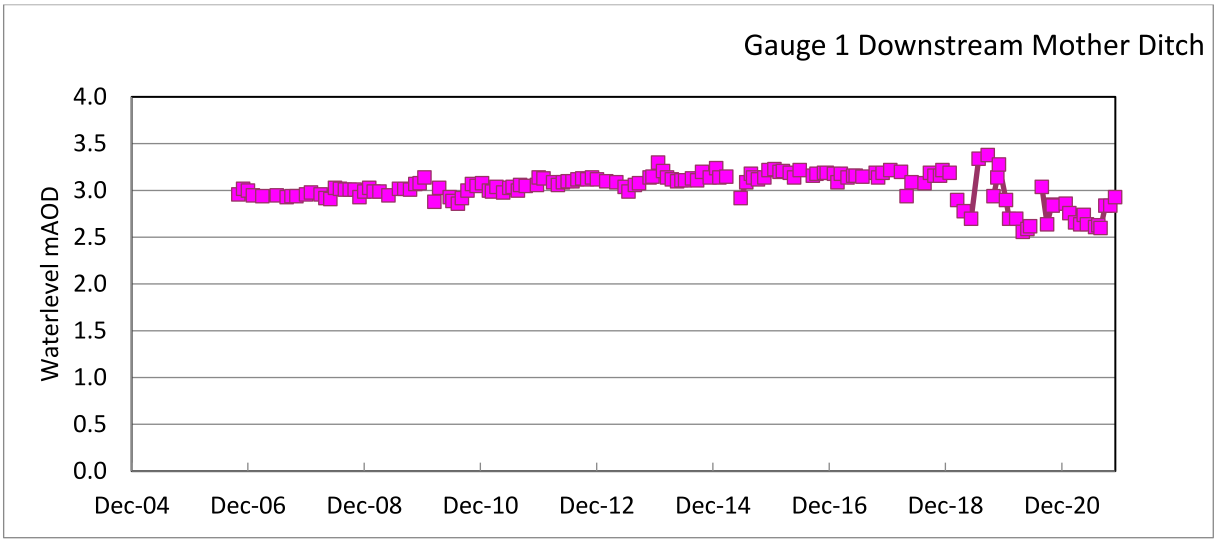


Chart 7-1 Selected waterlevel monitoring results from P2, P3 and surface water gauge 1

7.2 Groundwater Chemistry

To assist with understanding variations in water chemistry at monitoring positions around MCL, temporal and spatial summaries are provided in Appendix 2.

Historically, groundwater within the vicinity of MCL is impacted by a wide range of low level inorganic and organic contaminants. Given the predominance of slag-based wastes in the unlined landfill, key indicators of slag leaching in the shallow aquifer are pH, calcium and alkalinity. Other parameters such as chloride and ammonia are reflective of the leaching of other waste types; at BH8 some of the concentrations observed in groundwater did sometimes exceed the concentrations observed in leachate from the active MNHL and MHL. In addition to the groundwater below MCL being potentially vertically stratified, there are also considerable spatial variations around the perimeter of MCL. Such differences in water chemistry between the monitoring boreholes around MCL likely reflect differences in waste types contained within MCL, as the waste in the landfill is known to be heterogeneous and of different ages.

The groundwater chemistry observed during 2021 is very similar to that noted previously. At some locations, such as BH15S on the southern side and BH17S on the northern side, groundwater quality appears to be sustainably improving with falls in pH and EC (see graphs below). This is thought to be the direct consequence of capping directing dilute run-off around the edge of the site.

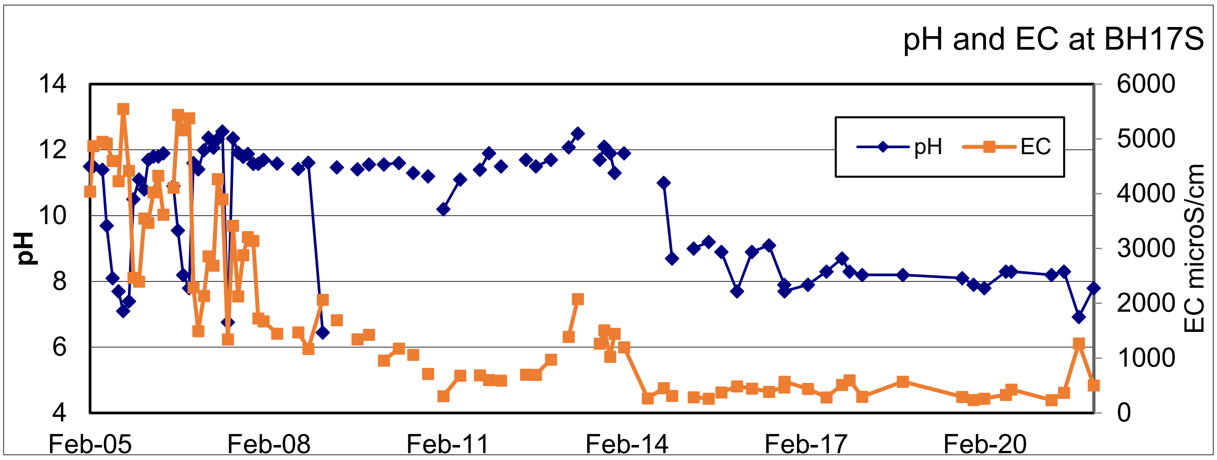


Chart 7-2 Temporal variations of water chemistry at BH17S

7.2.1 Boundary with the River Kenfig

All groundwater chemistry has been well within the emission limits established for the groundwater monitoring positions along the boundary with the River Kenfig during the past few years, as summarised in Tables 7-1 and 7-2. During 2019, increased copper was detected but this was not persistent and still below the concentration that would cause a discernible impact on the River Kenfig. At BH9S, arsenic has remained at a concentration typically higher than the Environmental Quality Standard (EQS) of 50 microg/l but well below the concentration that would cause a discernible impact on either groundwater or surface water. This can be seen by comparing the arsenic concentrations shown in Chart 7-2 with the magnitude of the trigger levels for other trace metals summarised in Table 7-1 i.e. there would need to be more arsenic detected at BH9S for there to be any possibility of surface water being discernibly impacted.

The mobility of arsenic, and other trace metals may be influenced by the improving water quality. As rainwater is largely prevented from leaching the wastes beneath the cap, groundwater at BH9 (and other positions) is transitioning from being strongly alkaline to more circumneutral. As these changes occur, the mobility of trace metals such as arsenic, that can form oxyanions, may alter.

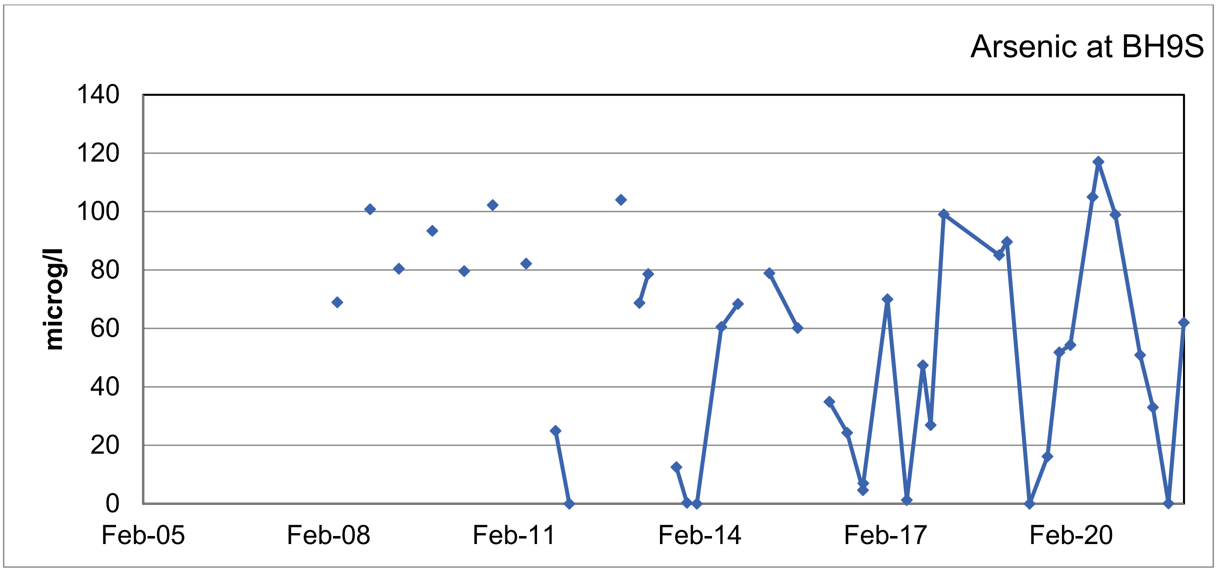


Chart 7-3 Temporal variation of Arsenic at BH9S

Table 7-1 Evaluation of data against trigger and control levels for BH9S, BH15S and BH16S

	Ammonia	Chloride	Calcium	Copper	Cadmium	Mercury	Comments
Units	**mg/l**	**mg/l**	**mg/l**	**mg/l**	**mg/l**	**mg/l**	
ASSESSMENT CRITERIA							
Concentration needed in groundwater to reach EQS in Kenfig	7	118750	118750	13	0.0475	0.00475	
Trigger Level	2.1	1689	663	0.012	<0.0001	<0.0001	
Control Level 2 (CL2)	1.8	1464	575	0.0104	<0.0001	<0.0001	
Control Level 1 (CL1)	1.7	1351	530	0.0096	<0.0001	<0.0001	
MONITORING RESULTS							
2017 Data evaluation (max concentration)	1.7 (BH16S)	126 (BH15S)	93.41 (BH9S)	0.0002	0.00029 (BH9S)	<0.0001	All data below control levels
2018 Data evaluation (max concentration)	0.25	56.8	72.8	0.0027	<0.0001	<0.0001	All data below control levels
2019 Data evaluation (max concentration)	0.4	77.1	382	0.094 (BH15S)	0.0023 (BH15S)	<0.0001	Increased in June. Not persistent.
2020 Data evaluation (max concentration)	2.44	146	92.78	<0.0002	<0.00015	<0.0001	All data below control levels
2021 Data evaluation (max concentration)	0.48	79.18	118.07	0.465	0.019	0.0006	All data below control levels

Table 7-2 Evaluation of data against trigger and control levels for BH9D, BH15D and BH16D

	Ammonia	Chloride	Calcium	Copper	Cadmium	Mercury	Comments
Units	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	
ASSESSMENT CRITERIA							
Trigger Level	203	4208	2538	0.009	<0.0001	<0.0001	
Control Level 2 (CL2)	176	3647	2200	0.0078	<0.0001	<0.0001	
Control Level 1 (CL1)	162	3366	2030	0.0072	<0.0001	<0.0001	
MONITORING RESULTS							
2017 Data evaluation (max concentrations)	0.85 (BH15D)	83 (BH9D)	115.06 (BH9D)	0.00026 (BH16D)	0.00012 (BH9D)	<0.0001	All data below control levels
2018 Data evaluation (max concentrations)	1.2	156	227	0.004	<0.0001	<0.0001	All data below control levels
2019 Data evaluation (max concentrations)	1.1	149	126	0.0014	<0.00015	<0.0001	All data below control levels
2020 Data evaluation (max concentrations)	3.46	117.00	175.00	<0.0002	<0.00015	<0.0001	All data below control levels
2021 Data evaluation (max concentrations)	11.64	110	139	0.027	0.0096	<0.0005	All data below control levels

7.2.2 Boundary with Margam Moors

On the northeastern side of the existing landfill a noticeable discharge of high pH water has been observed for some time. The water issues from a series of spring lines at the edge of Margam Moors where it drops a distinctive white calcium precipitate. This phenomenon has been described in detail previously and is known to be locally impacting the Moors in proximity to the site. Directly up (groundwater) gradient of the spring lies the unlined waste deposits of MCL and it is the leaching of these components, and other unlined areas, that generates the characteristic precipitates, primarily due to the leaching of lime and other alkaline phases. Shallow groundwater quality has been improving at monitoring positions BH17S - BH20S over the past few years. This is thought to be due to the capping of MCL as this is directing clean dilute run-off towards the edge of the site. Along this northern boundary there has been sustained decrease in the concentration of several parameters including ammonia, arsenic, chloride, calcium and Chemical Oxygen Demand. These variations are not yet as distinct in all other parts of the edge monitoring network, although variations at BH15S may be indicative of wider expected improvements. Geotechnology previously suspected that these trends may be temporarily reversed if poor quality seepage issues from waste exposed during the landfill restoration. With time, the water quality may also become less alkaline as less slag-based waste is now exposed to leaching due to the capping. As the water quality changes, trace metals may potentially become slightly more mobile. These processes may explain why increased concentration of several parameters such as arsenic, vanadium, ammonia, copper and cadmium are sometimes detected at low concentrations for short periods during recent years (see Table 7-3 and graphs in Appendix 2). Each year, elevated concentrations of ammonia are detected but the occurrence is not typically persistent. Interestingly, the data summarised in Table 7-3 suggests that ammonia is increasing each year with some of the shallow wells. However, review of the time series datasets reveals that such a trend is not widespread but that some of the spikes have reached higher concentrations in recent years, particularly at BH18S. This could potentially be due to changes in drainage patterns related to the capping of upgradient MCL. This will continue to be closely scrutinised.

Table 7-3 Summary of control levels for shallow groundwater at BH17 – BH20

	Ammonia	Chloride	Calcium	Copper	Cadmium	Mercury	Comments on data trends
Units	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	
Control Level 3	2	215	500	0.01	<0.0001	<0.0001	
Control Level 2	1.6	172	400	0.008	<0.0001	<0.0001	
Control Level 1	1.4	151	350	0.007	<0.0001	<0.0001	
2017 Data evaluation (max concentrations)	4.45 (BH20S)	136.6 (BH20S)	79.1 (BH17S)	0.00073 (BH19S)	<0.0001	0.0003 (BH17 & BH20)	
2018 Data evaluation (max concentrations)	3.37 (BH18S, Dec-18)	343 (BH19S, Dec-18)	73.9	0.0087	<0.0001	<0.0001	Impersistent breach
2019 Data evaluation (max concentrations)	9.627 (BH18S, Jun-19)	106	393 (BH19S, Sep-19)	0.0017	<0.00015	<0.0001	Impersistent breach at BH18S and BH19S
2020 Data evaluation (max concentrations)	12.65	197.00	223.00	0.00131	<0.00015	<0.0001	Impersistent breaches ammonia at BH17S, BH18S, BH19S & BH20S
2021 Data evaluation (max concentrations)	38.78	157.57	283	0.11	0.0006	<0.000005	Impersistent breaches ammonia at BH18S, BH19S & BH20S

7.2.3 Boundary with Margam Beach

Groundwater flow towards Margam beach in the shallow aquifer has been estimated at 3 l/sec along the 1236m boundary with the site. Discharge of groundwater from the shallow aquifer is very difficult to discern due to the low volumes involved, but a linear seepage line at an elevation of approximately 2.5m AOD is present during very low tides and this is thought to be mixed groundwater and tidal water. The discharge was previously considered analogous to a point source discharge to the coastal water. In this analogy, the groundwater concentration that would result in EQS concentrations in the coastal water (hereafter termed the critical groundwater concentration) was derived at the time using the approach presented *in IPPC Horizontal Guidance Note for Environmental Assessment and Appraisal of BAT*.

In the guidance, three levels of dispersion rate (low, medium and high) were provided to approximate the mixing that occurs in the coastal water. To ensure a conservative approach, the lowest dispersion rate of 2500 l/sec was adopted. Multiplying this value by the EQS therefore quantifies the pollutants required to reach the EQS in the mixing zone. If this is divided by the groundwater flow rate, the critical groundwater concentration can be calculated.

The 3 l/sec of groundwater that moves towards Margam beach will not behave as a point source discharge. The flow rate and therefore the flux of potential contaminants will be distributed along the entire 1236m long flow boundary. Therefore, the intermixing will be significantly greater than has been assumed so this approach can be considered a highly conservative approach to determining the critical groundwater concentration.

The pollutant concentrations observed in groundwater, and summarised in Table 7-4, are significantly lower than those calculated to be required to cause the water chemistry to reach EQS levels in the coastal water.

Table 7-4 Comparison of Groundwater Chemistry with Critical Groundwater Concentration along Boundary with Margam Beach

		Ammonia	Calcium	Arsenic	Copper	Cadmium	Mercury
Critical groundwater concentration	mg/l	16	208333	20	4	2	0.25
Maximum value in 2017 at BH13S and BH14S	mg/l	0.71 (BH13S)	69.3 (BH13S)	0.1 BH14S)	0.0006 (BH14S)	0.0002 (BH14S)	0.0037 (BH14S)
Maximum value in 2018 at BH13S and BH14S	mg/l	2.04	108	0.1	0.0043	<0.0001	0.0003 (BH13S, Sep- 18)
Maximum value in 2019 at BH13S and BH14S	mg/l	0.45	97.4	0.09	0.0064	<0.00015	<0.0001
Maximum value in 2020 at BH13S and BH14S	mg/l	0.38	153	0.0877	0.003 5	0.0023	<0.0001
Maximum value in 2021 at BH13S and BH14S	mg/l	0.8	112	0.096	0.0014	<0.0007 5	<0.0001

8 SURFACE WATER

8.1 Surface Water Levels

The results of the surface water level monitoring are presented in Appendix 3.

The data indicates that waterlevels recorded during 2021 in the River Kenfig to the south are comparable to earlier years. The monitoring of the Mother Ditch, however, indicates that waterlevels at the downstream gauge have variable, and slightly lower, particularly since more active ditch clearance commenced in 2019. Geotechnology understands that further ditch clearance was undertaken in 2021 and more is planned for 2022.

8.2 River Kenfig

Appendix 3 provides a summary of temporal variations of the water chemistry encountered at SW11 (upstream of the landfill) and SW12 (downstream of the landfill) in the River Kenfig. Infrequently, and for short periods of time, the downstream concentrations of several parameters have been higher than those upstream e.g. Boron and potassium.

Although the groundwater in this area is slightly mineralised because of historical seepage from MCL, the concentration levels in groundwater at BH15S and BH16s are typically lower than the concentrations observed in SW12. Groundwater is also becoming less mineralised, presumably because of capping. On this basis, groundwater seepage from the landfill is not likely to be the cause of the variations in water quality observed in the Kenfig, although this position should continue to be scrutinised. The variations observed could be influenced by tidal variations and sea salt deposition.

8.3 Dune Slacks and Restoration Ponds

A key element of the restoration of MCL is the construction of a recharge trench that will direct surface water collected in restoration ponds on the cap into a network of trenches to sustain shallow groundwater levels. Now, the water being captured on the cap is still recharging groundwater but with no formal control.

The water chemistry encountered in the ponds on the surface of MCL, and which ultimately drains to the surrounding groundwater and surface water, is compared against the current limits set for the recharge chambers. This analysis, presented in Table 8-1, suggests that the average water chemistry in the ponds (collectively) is comparable overall with the water quality targets, but variable, particularly in the case of calcium and alkalinity. In 2019, very low calcium was detected in Q1. This is likely to be related to dilution by rainwater. Following Q1, only one of twenty-one samples contained less than the required 40 mg/l calcium. During 2020 and 2021, all of the data was compliant with the emission limits except a small number of impersistent breaches.

Table 8-1 Comparison of pond chemistry with emission limits for Recharge Chambers

	Control level	Emission level	2020 Concentration	2021 Concentrations	Old Slack in KNNR
	mg/l	**mg/l**			
Phosphate	0.5	1.0	<0.03	<0.03	<0.5 (0.7 on one occasion)
Alkalinity	300	350	250	270.0	36-265, 166
Chloride	50	100	111 (max), 34.95 (average)	84.51	3-114, 38
Calcium	>40		152	97.5	10 -107, 57
Total Ammonia	0.5	1.0	3.26 (max), 0.2 (average)	<0.05	<0.05 (6.48 on one occasion)

During a Technical Working Party meeting in 2020, the ecologist currently assisting Tata with the implementation of the ecological monitoring plan suggested that weathered slag could potentially be used on the restored surface to assist with the control of wind erosion damage. It was also suggested that run-off from the slag, once combined with run-off from the sand capped areas, could be beneficial to site management. Geotechnology understands that on-site trials using slag in this way are ongoing, having commenced in 2021.

9 INTERNAL LANDFILL GAS

Monitoring of gas vents on the surface of MCL did not commence until mid-way through 2008 when part of the restoration had been completed. The monitoring network has now been extended to include 4 more vents now that the capping is complete. The vents are referred to as GV1- GV8.

9.1 Assessment against Permit Compliance Levels

All data collected to date indicates that the gas concentration levels are below the relevant control levels for carbon dioxide and methane (see Appendix 4).

Since 2014, neither methane or carbon dioxide were detected above 1.2%. Despite undertaking sampling during times of falling and rising atmospheric pressures, many sampling occasions revealed that the gases were not found above detection limits.

The monitoring does, however, reveal that there are localised areas (particularly around GV7 and GV8, and GV2 and GV3) where the gas has been found, on occasion, to have low levels of oxygen (<10%) and elevated carbon monoxide and hydrogen sulphide. At some vents, the on-site monitoring has also revealed elevated levels of hydrogen. During these occasions, monitoring has had to stopped as the machine warns that the elevated concentrations could damage the sensors within the monitoring instrument.

Tata could potentially explore capturing the hydrogen for use as a fuel if there was sufficient flux. This would require gas taps to be fitted to vents and samples collected for laboratory analysis to enable the full gas chemistry to be understood.

10 SUMMARY AND RECOMMENDATIONS

10.1 Environmental Protection

Groundwater and surface water monitoring has previously shown MCL to be negatively impacting shallow groundwater draining towards Margam Moors. In recent years, this shallow groundwater has started to show sustained improvements in quality and, based on the most recent data this trend has continued and is potentially becoming more widespread. Groundwater in some areas is becoming less mineralised and less alkaline. This is thought to be as a consequence of the restoration and capping.

The River Kenfig and Margam Beach show no clear signs of impact from the leaching of wastes within MCL. Increased calcium and alkalinity has been detected downstream of the landfill, but these variations do not appear to be related to seepage from the landfill as the concentration of these parameters in shallow groundwater was lower than detected in surface water. This situation will, however, continue to be more closely evaluated.

Based on the available data, Morfa Closed Landfill is not considered to be a significant source of landfill gas due to the lack of biodegradable wastes deposited. All data collected to date indicates that the gas concentration levels are below the relevant control levels for carbon dioxide and methane. The data does, however, suggest that there are oxygen depleted parts and that carbon monoxide, hydrogen sulphide and hydrogen are present – the presence of these gases should continue to be scrutinised and integrated into any relevant human health risk assessments for maintenance workers etc. The presence of active hydrogen production at elevated concentration (but unknown flux) could also be considered as a potential resource.

10.2 Monitoring Network Maintenance

Tata is aware of vandalism to part of the monitoring network and that replacement monitoring equipment is, at times, required.

- Settlement markers need to be maintained with vegetation cut back to ensure identification and access. New marker posts should also be installed.
- Vegetation should be routinely cut back to enable safe access to all monitoring locations.

10.3 Recommendations

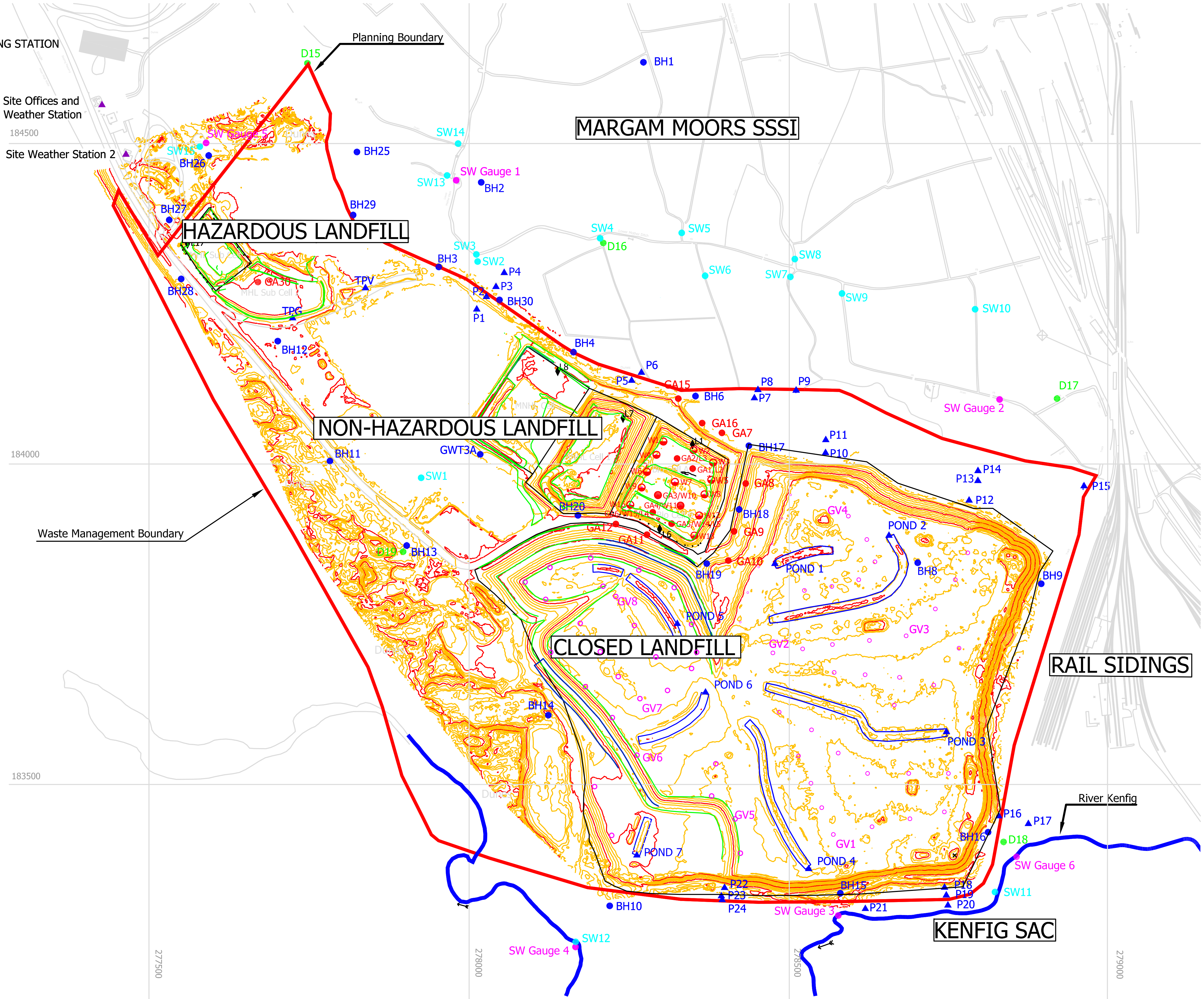
Since completion, several elements of the restoration system have been damaged by direct and determined vandalism, indirect action caused by trespassers on scramblers and wind action. Geotechnology is aware that Tata is reviewing site boundary security and maintenance of the cap.

Figure 1 Site Location Plan

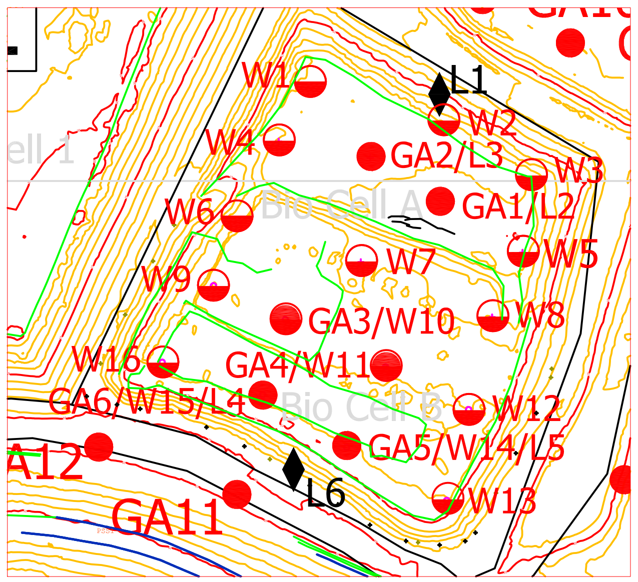
Reproduced from the Ordnance Survey Land Ranger Map
with the permission of The Controller of Her Majesty's Stationery Office

LEGEND

- Gas Vent
- Leachate Collection Sump
- Weather Station
- Groundwater Well
- Surface Water Sample Point
- Dust Monitor
- Gas and GW Well
- Gas Vent
- Surface Water Gauge Boards
- Pond Gauging and Sampling Point

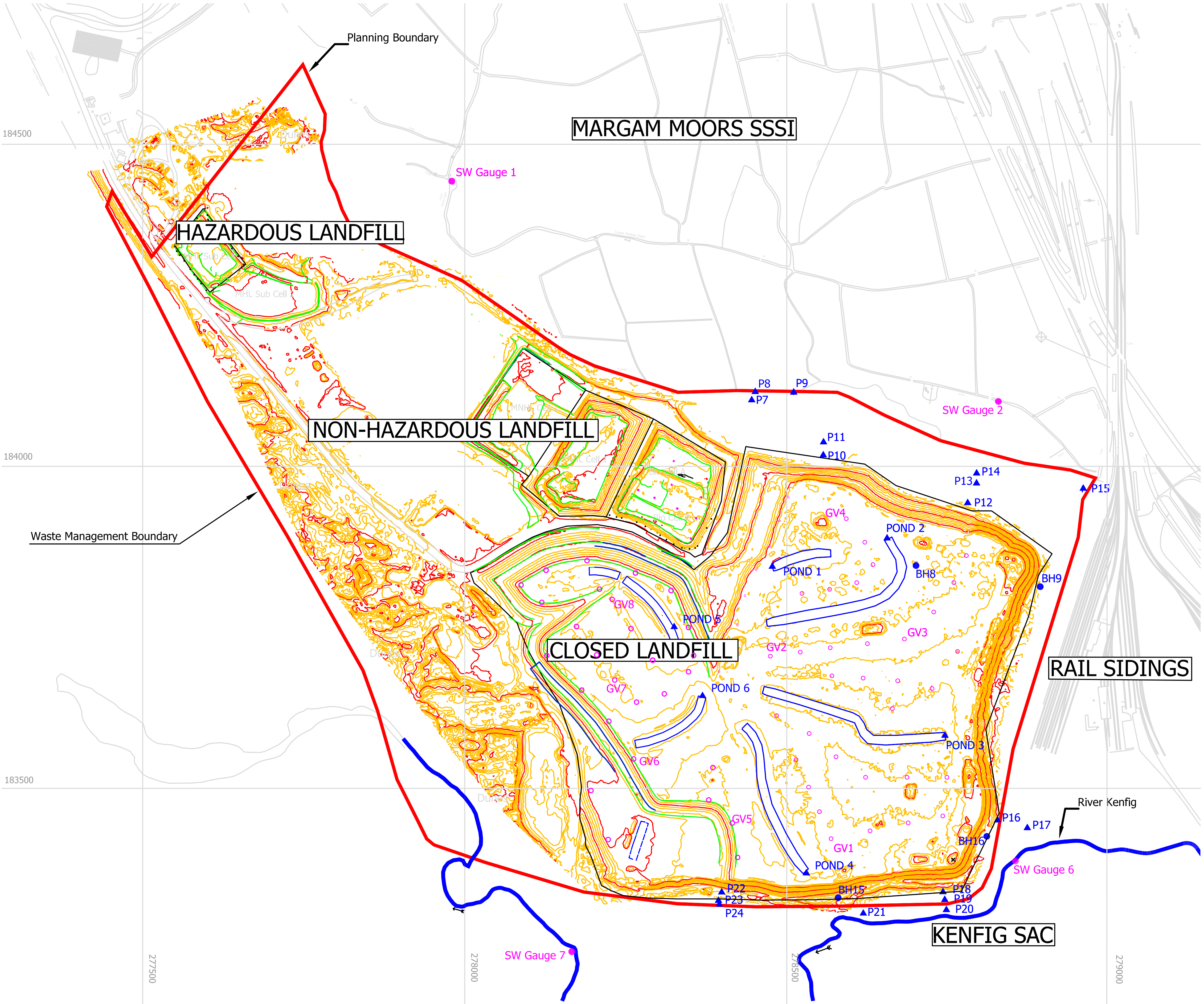


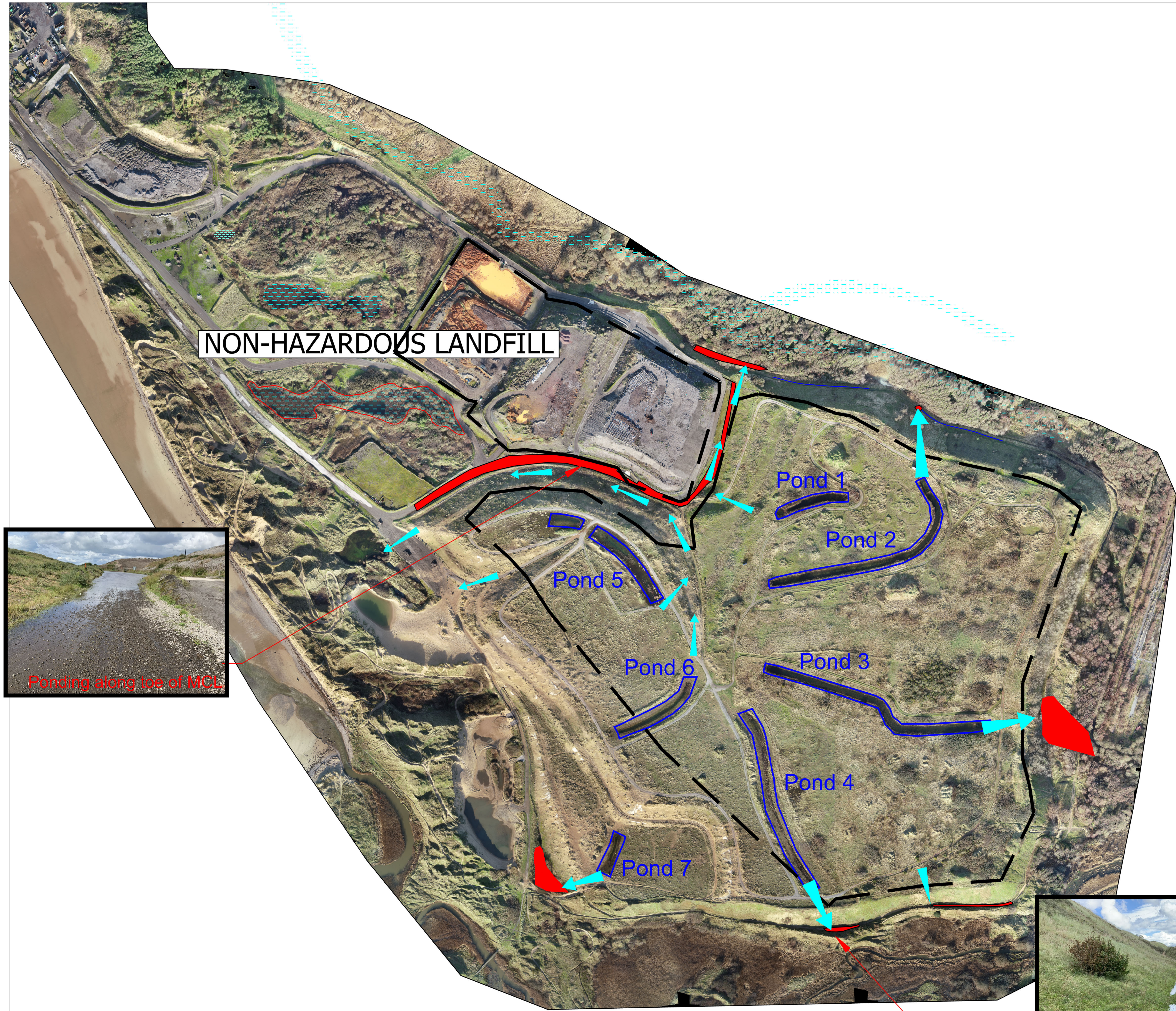
GAS MONITORING IN BIO CELL



LEGEND

- Gas Vent
- Groundwater Well
- Surface Water Gauge Boards
- Pond Sampling Point





Runoff from Pond 3

Discharge from Pond 4 and surface ponding

Drawing Number 2192/4

Legend

- Recharge zone
- Extent of lost recharge to Margam Moors
- Point Source Surface Runoff
- Springline in Moors
- Ponds in undeveloped areas of MNHL

Notes

Rev	Date	Status/Ammendments

CLIENT

TATA STEEL UK LIMITED

PROJECT

Morfa Closed Landfill Annual Report

TITLE

Aerial Image of Key Features

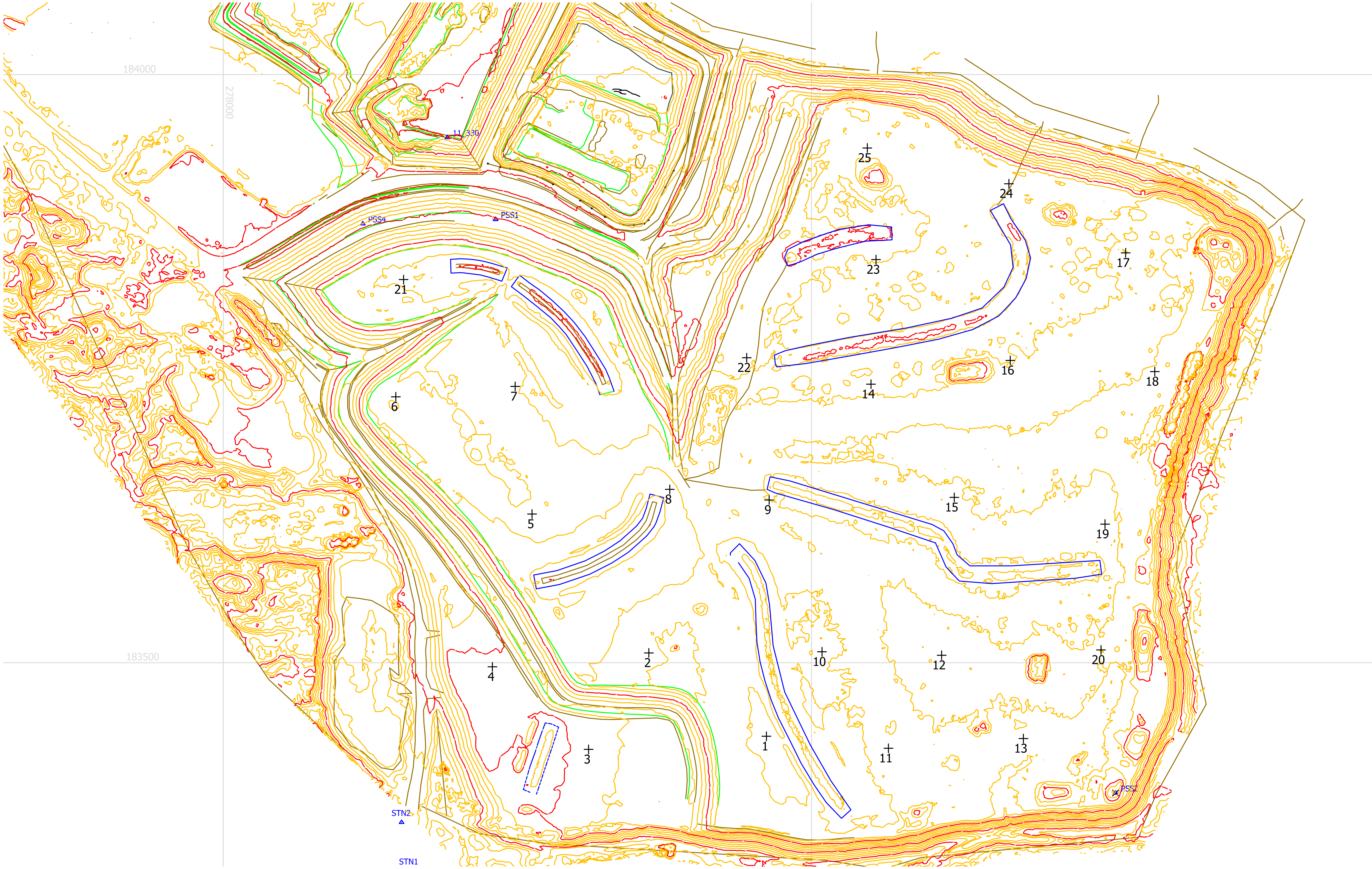
DRAWING NUMBER	REVISION
2192/4	0

DATE	DRAWN	CHECKED	SCALE AT A3
10.20	BR	DRAFT	1:500

Geotechnology Limited
Ty Coed, Cefn-yr-Allt,
Aberdulais, Neath
SA10 8HE
01639 775293
www.geotechnology.net

GEO TECHNOLOGY

Figure 5 Settlement Markers on Morfa Closed Landfill



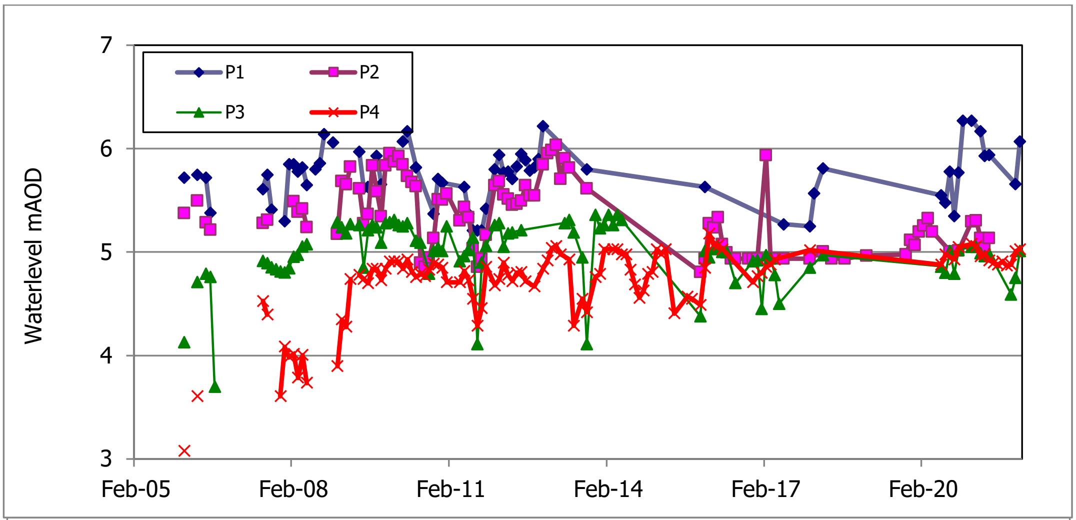
MORFA CLOSED LANDFILL,
PORT TALBOT

PERMIT EPR/AP3292LT

2021 Annual Review of Environmental Monitoring Results

Appendix 1
Water Levels in Shallow and Deep Aquifer, River Kenfig and Mother Ditch

Report Number 2192r1v1d0222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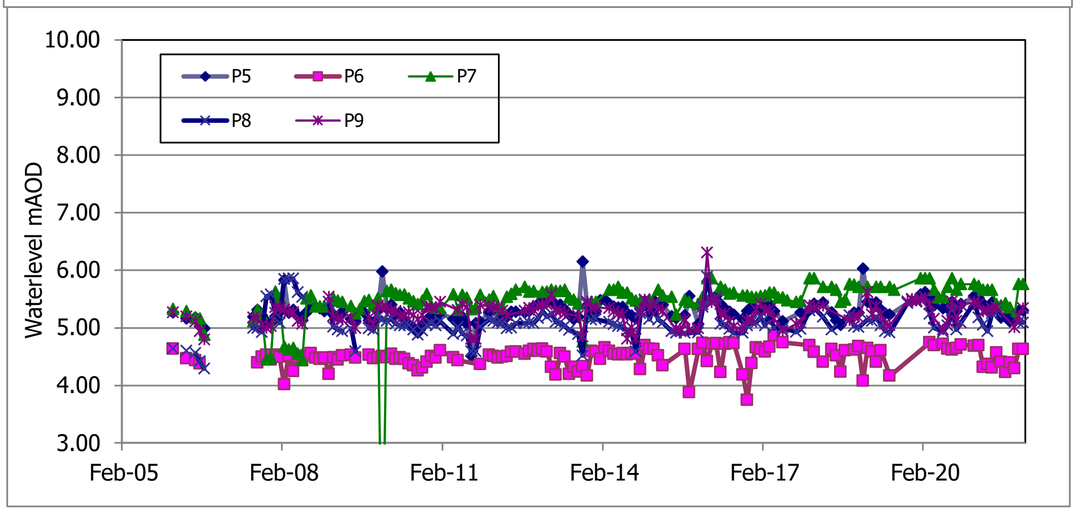
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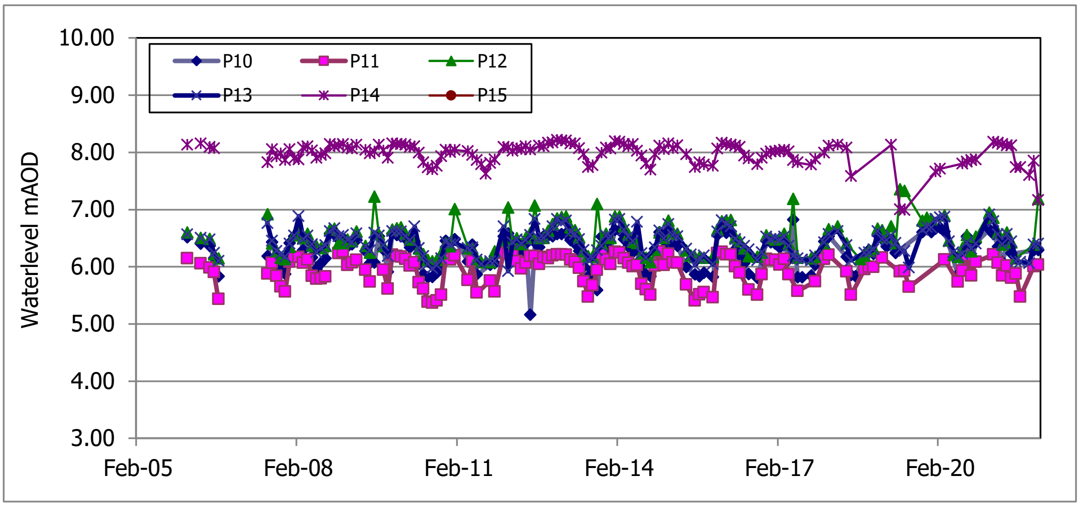
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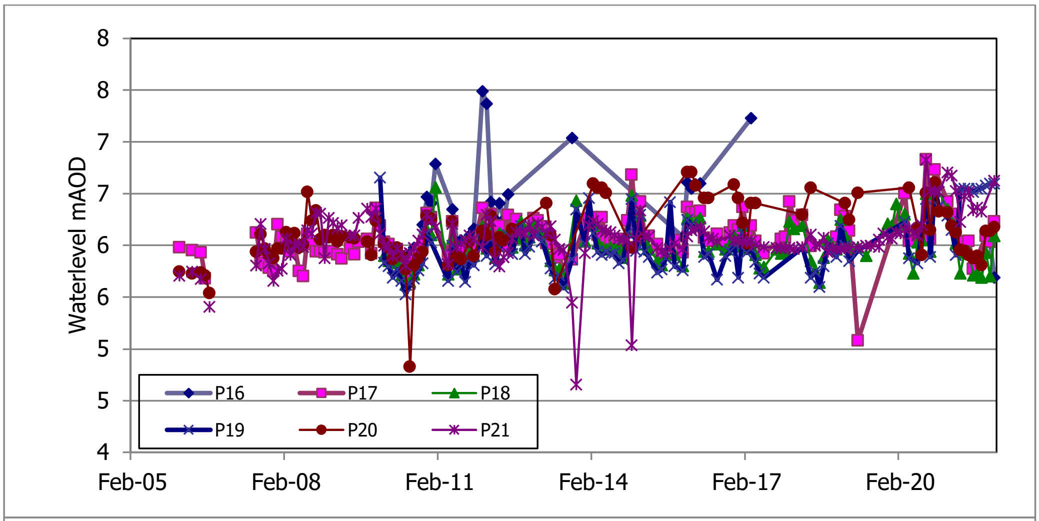
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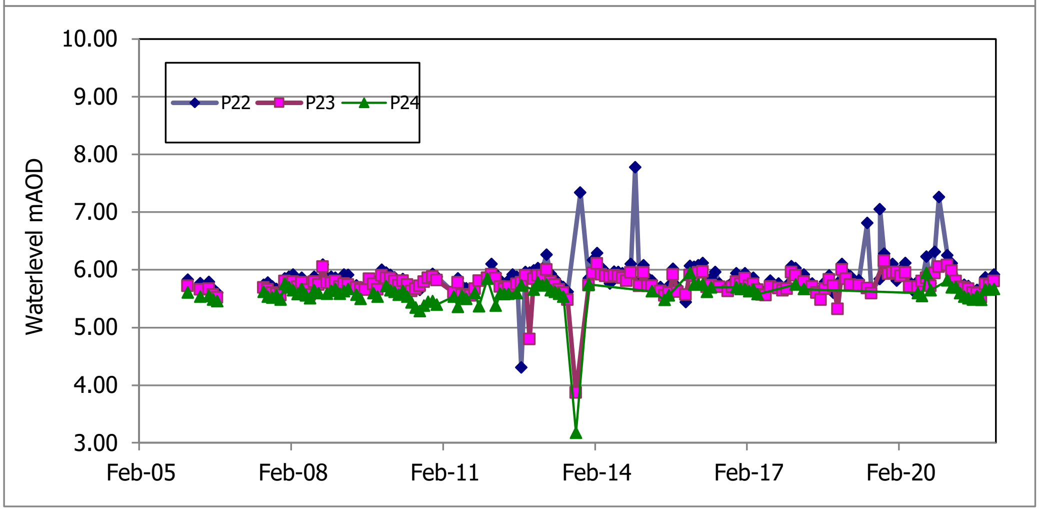
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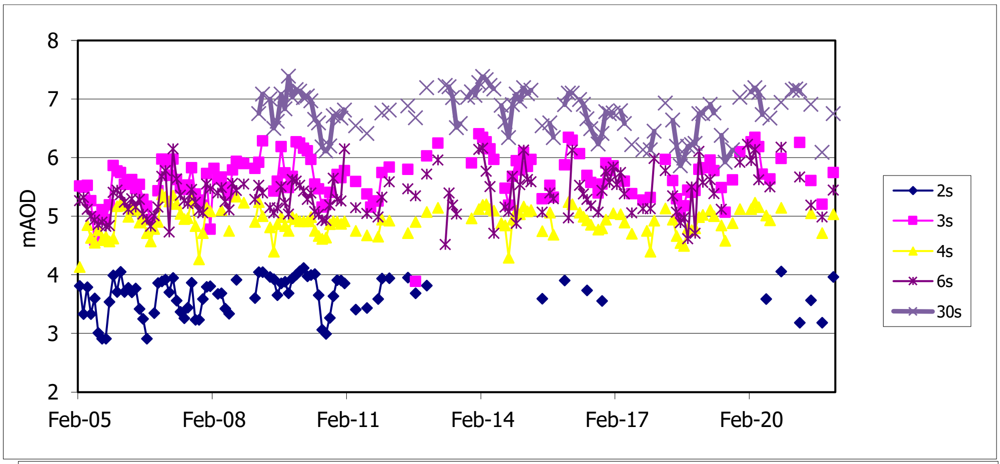
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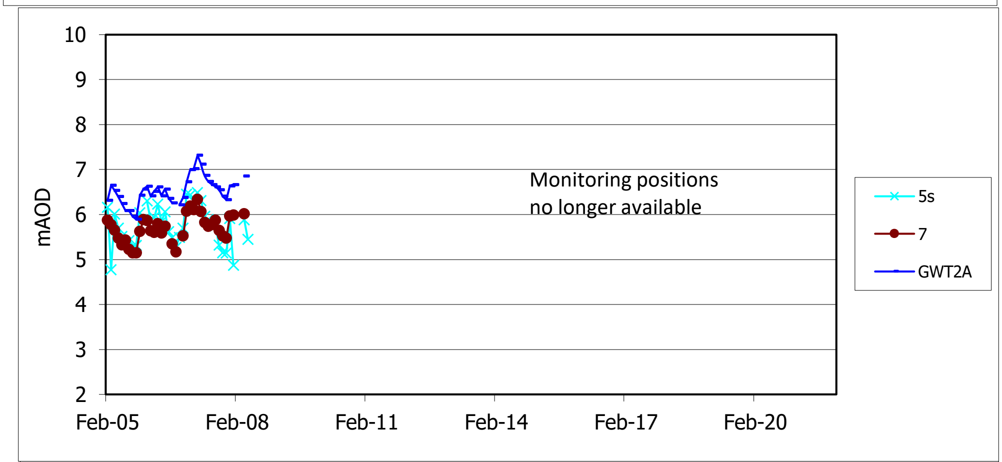
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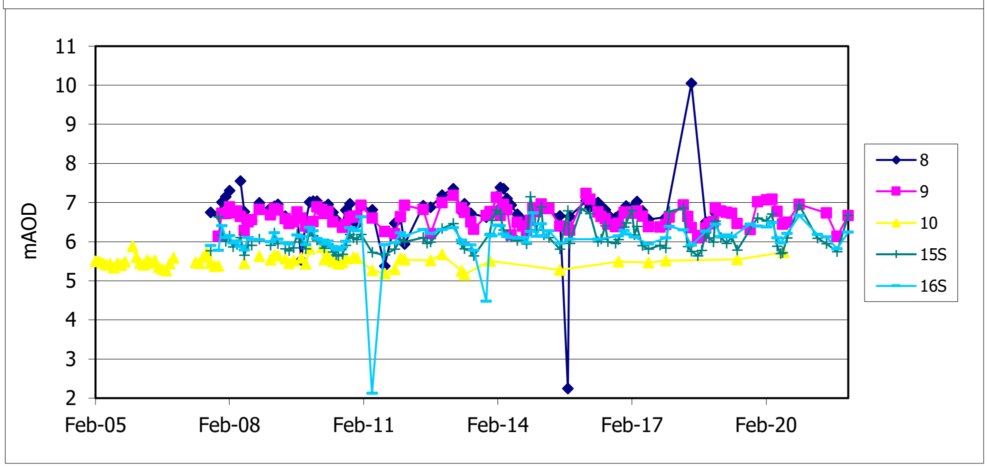
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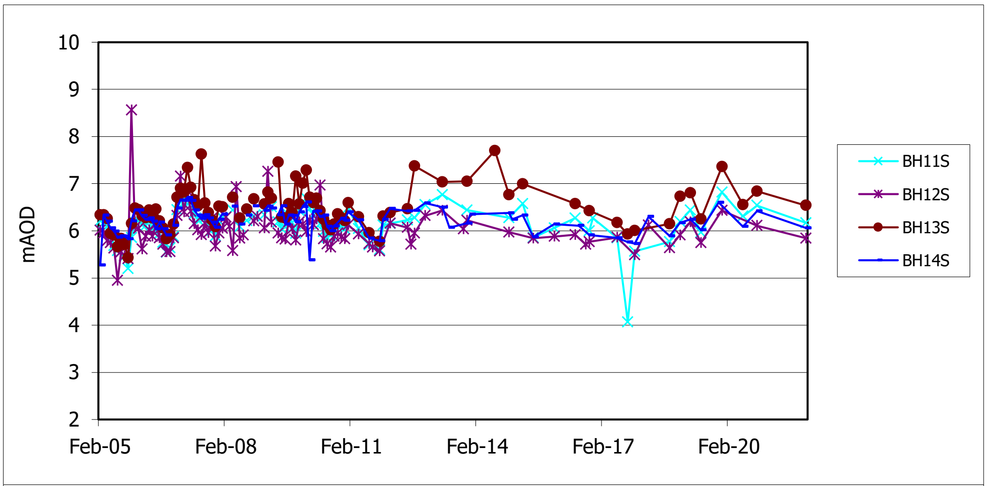
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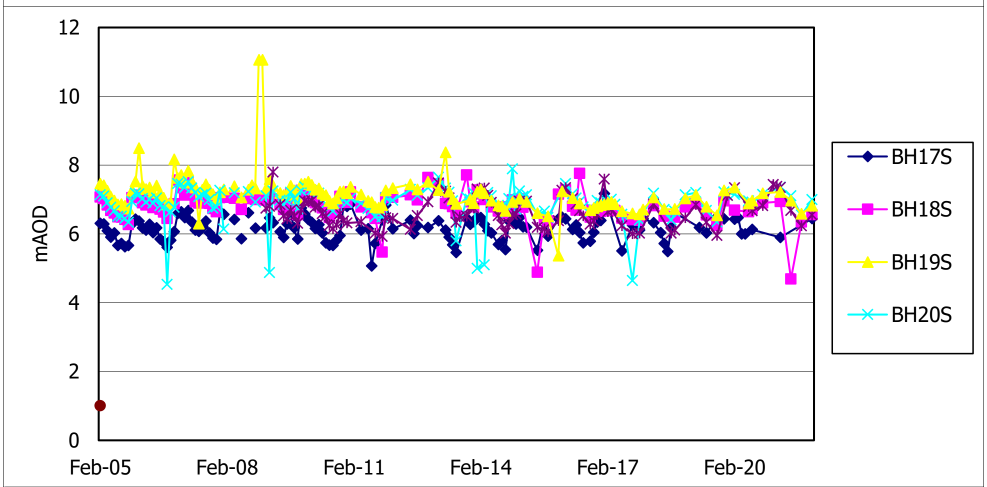
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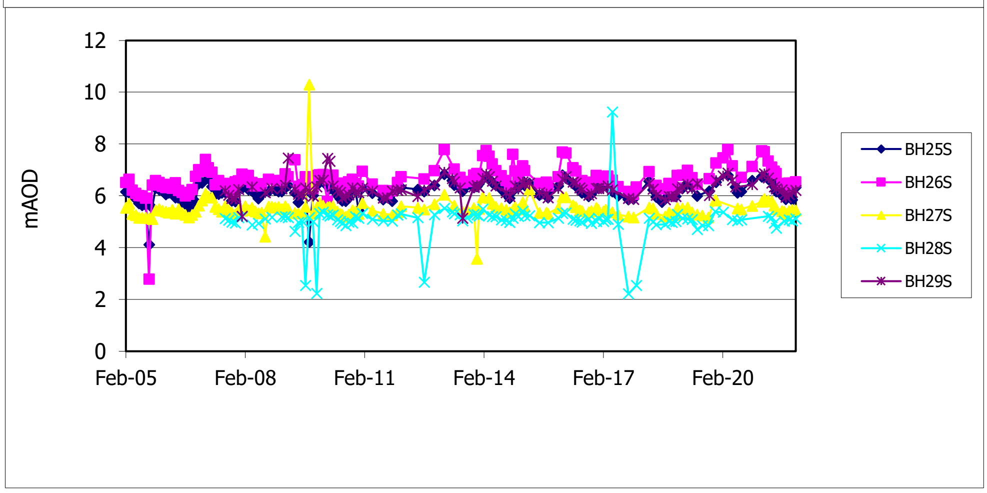
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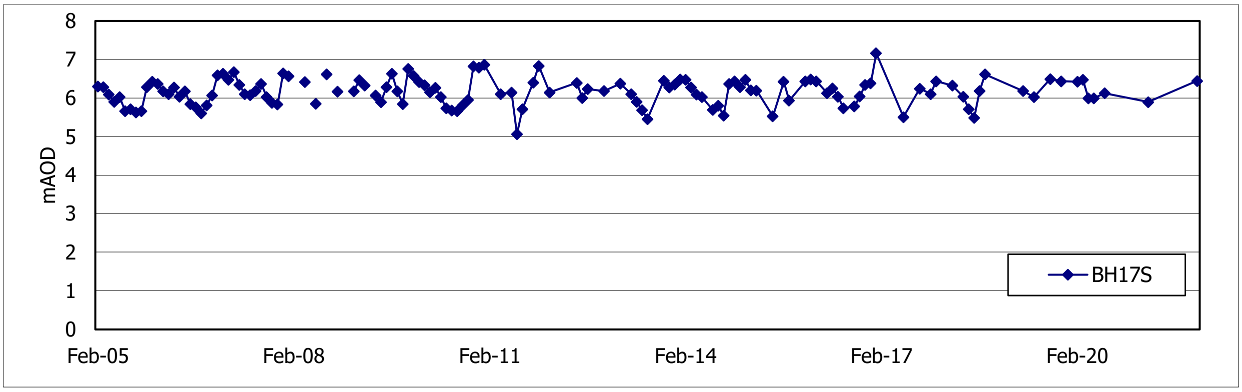
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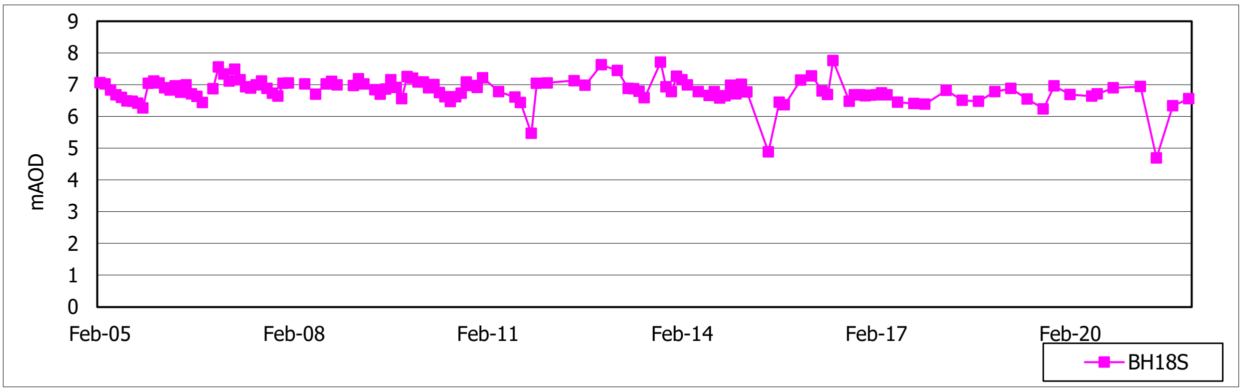
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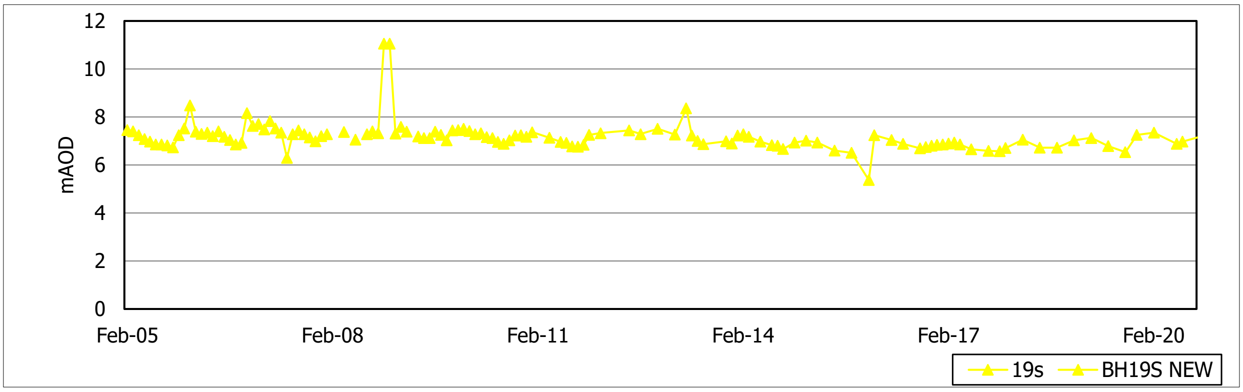
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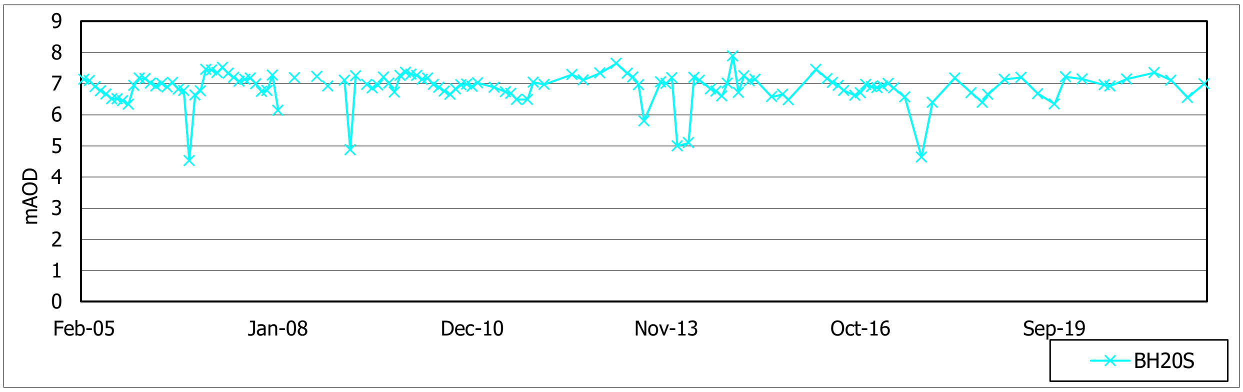
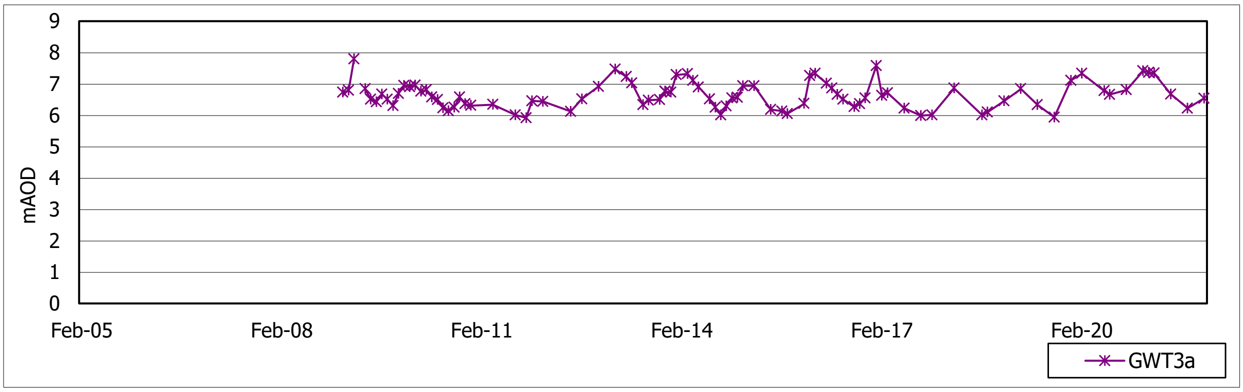
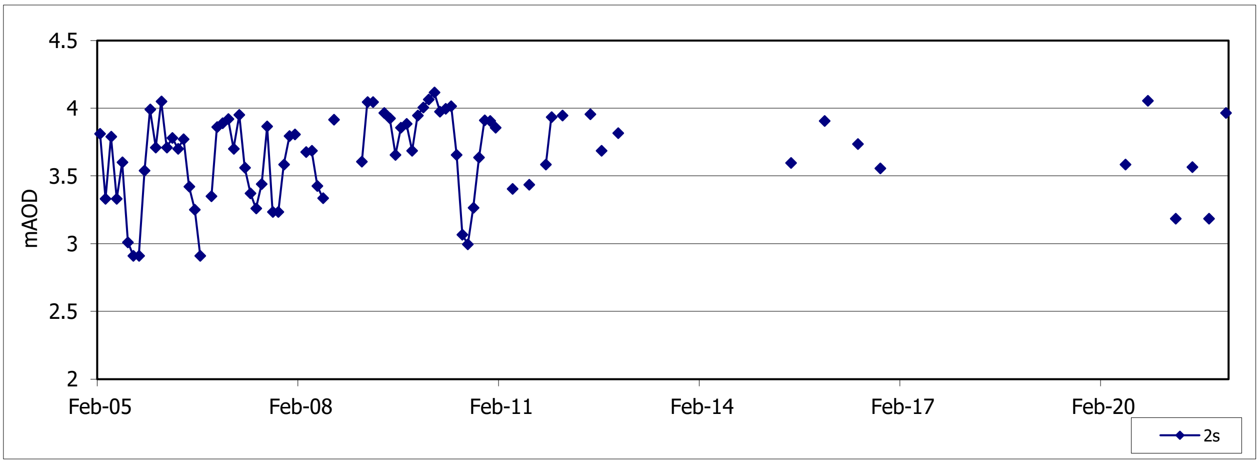
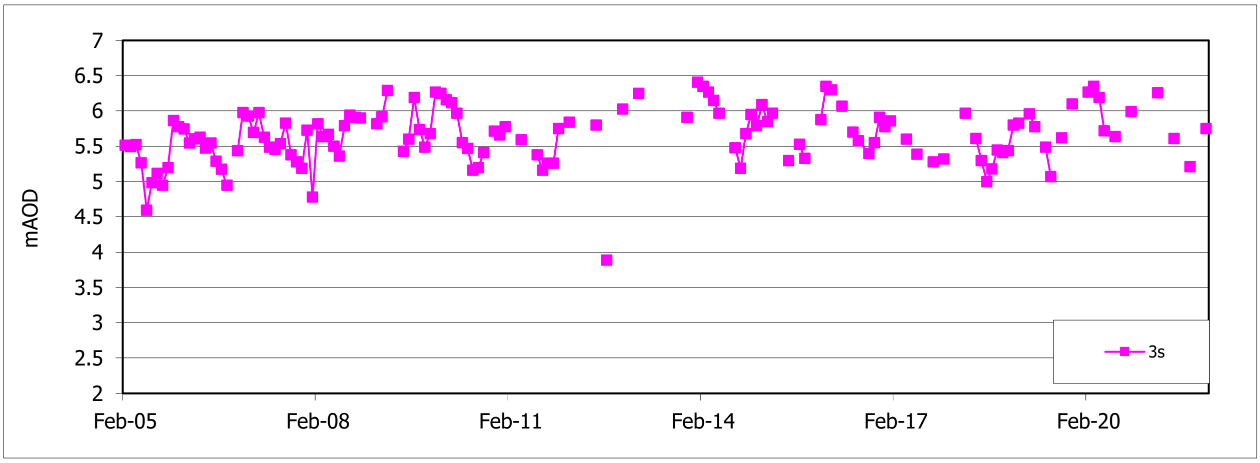
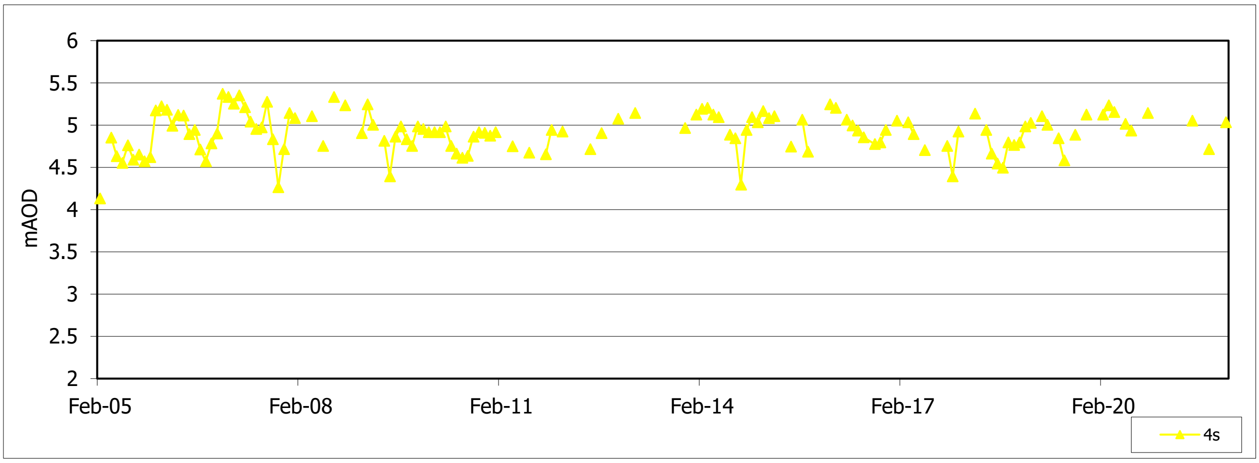
Feb-20
19s
BH19S NEW

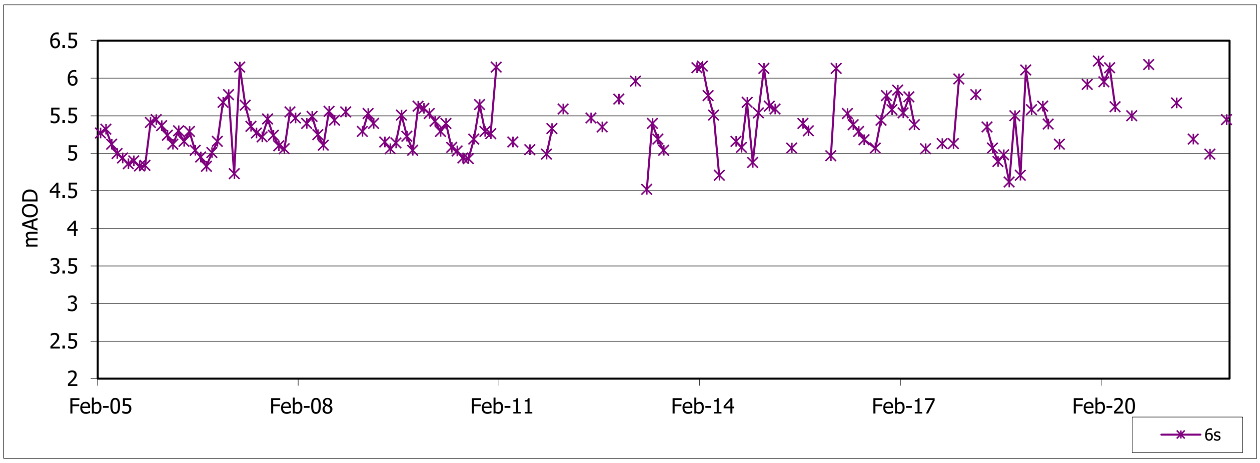

9
8
7
6
5
4
3
2
1
0
mAOD
Feb-05
Jan-08
Dec-10
Nov-13
Oct-16
Sep-19
BH20S

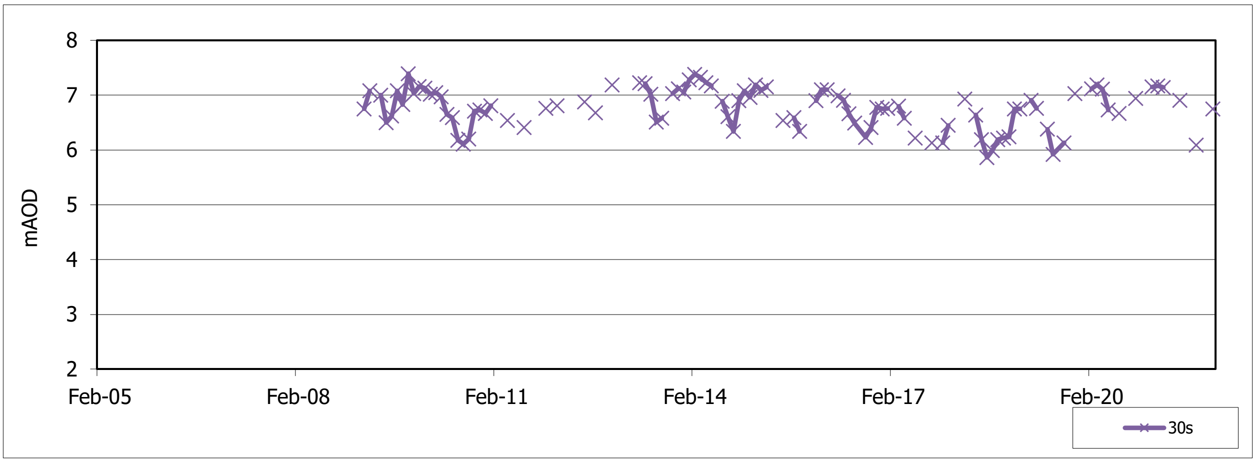

9
8
7
6
5
4
3
2
1
0
mAOD
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20
GWT3a

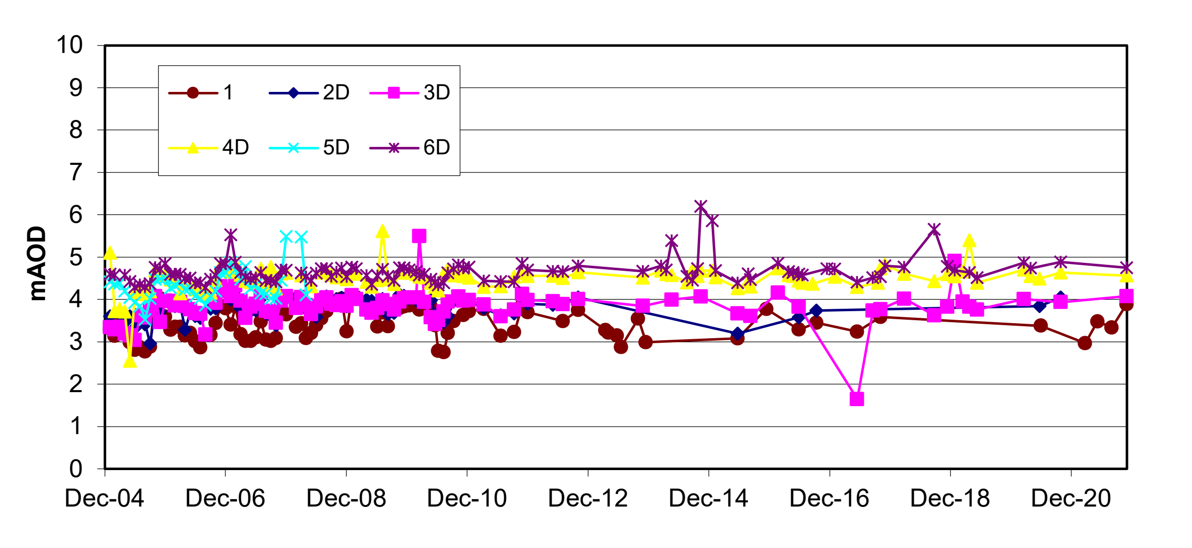

4.5
4
3.5
3
2.5
2
mAOD
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20
2s

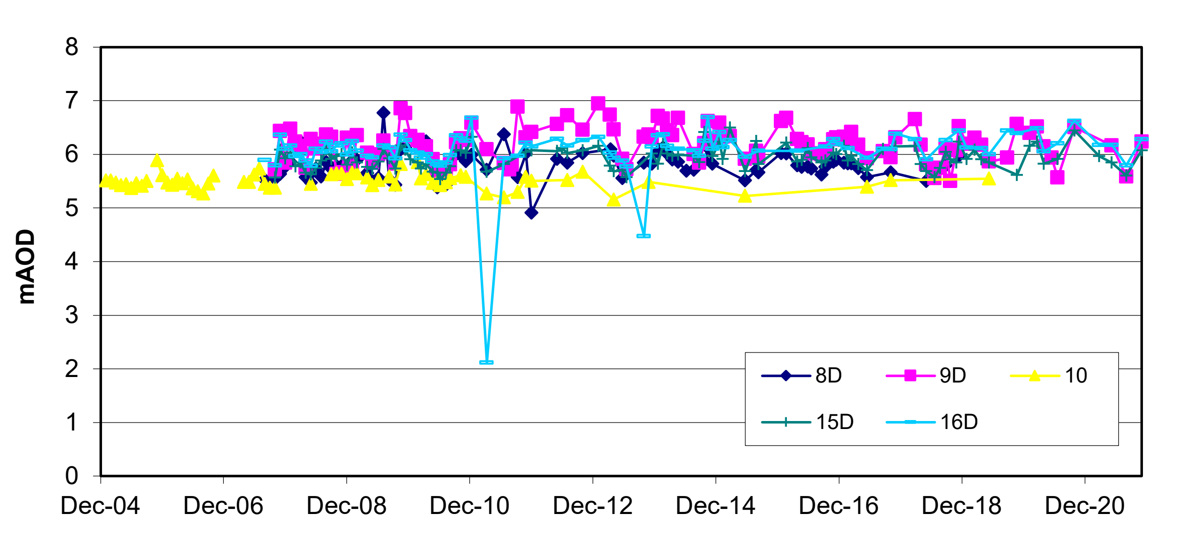

7
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
mAOD
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20
3s

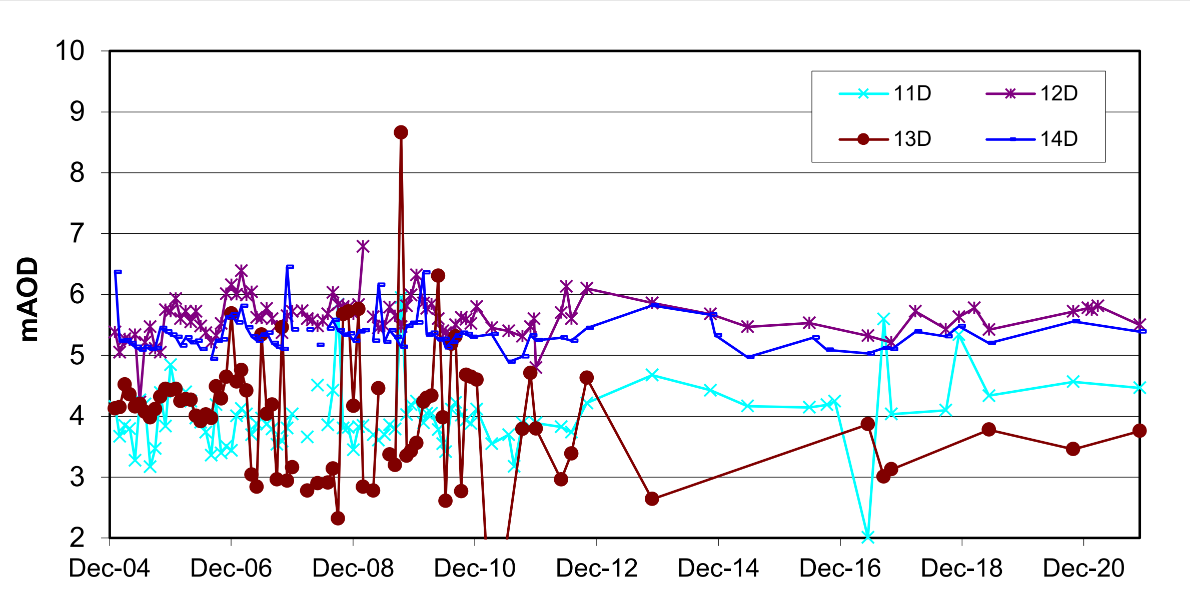

6
5.5
5
4.5
4
3.5
3
2.5
2
mAOD
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20
4s

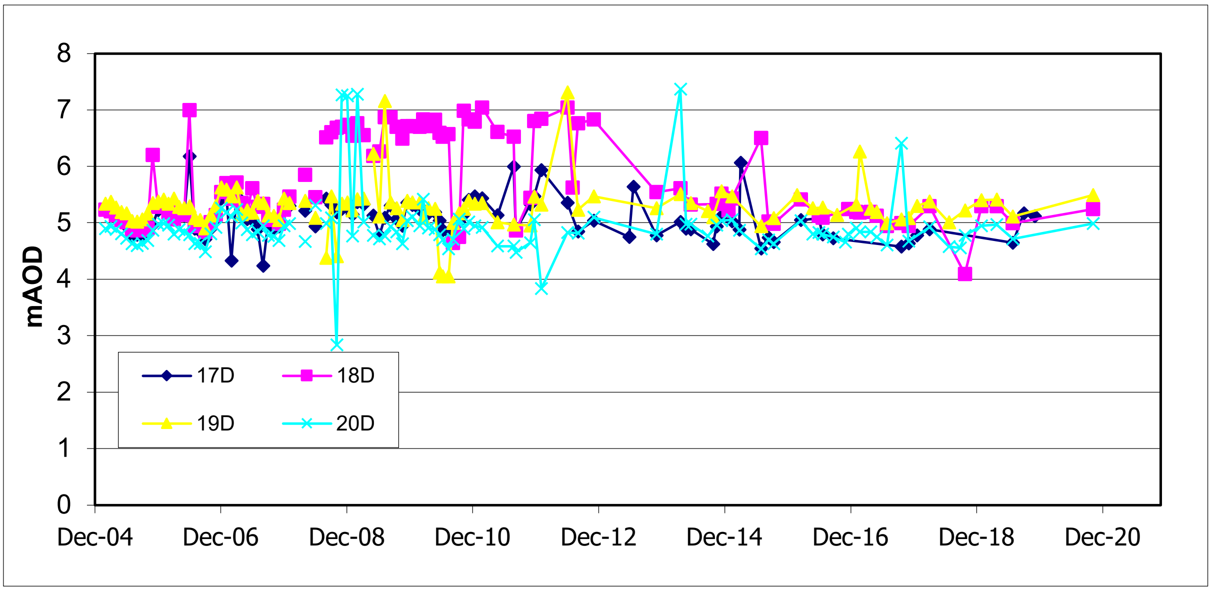

6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
mAOD
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20
6s

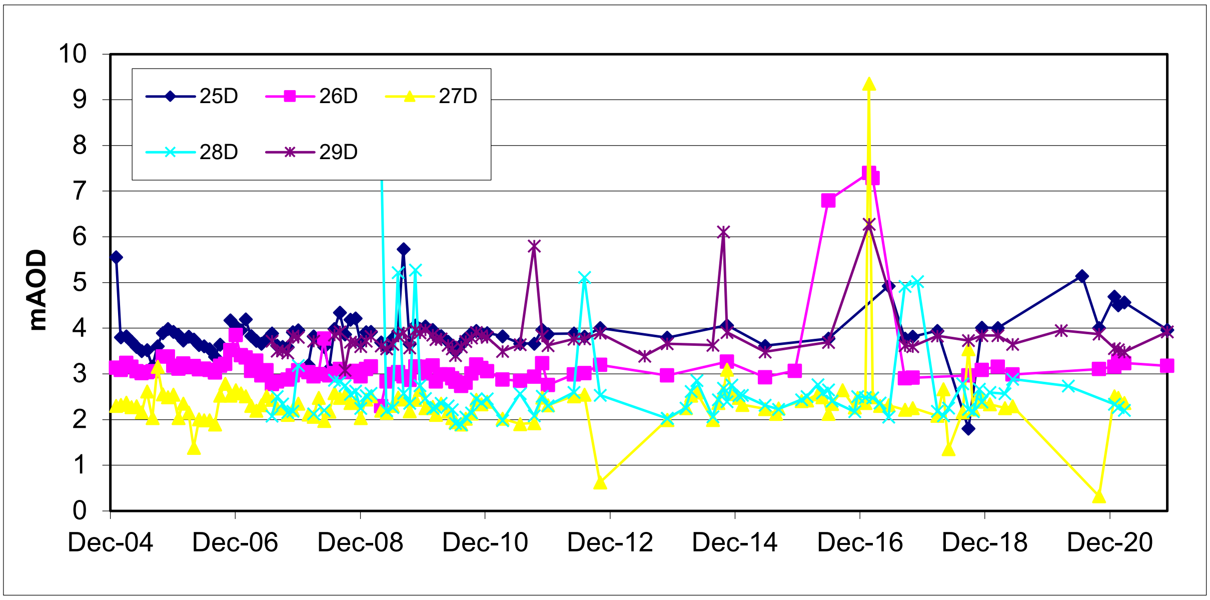

8
7
6
5
4
3
2
mAOD
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20
30s

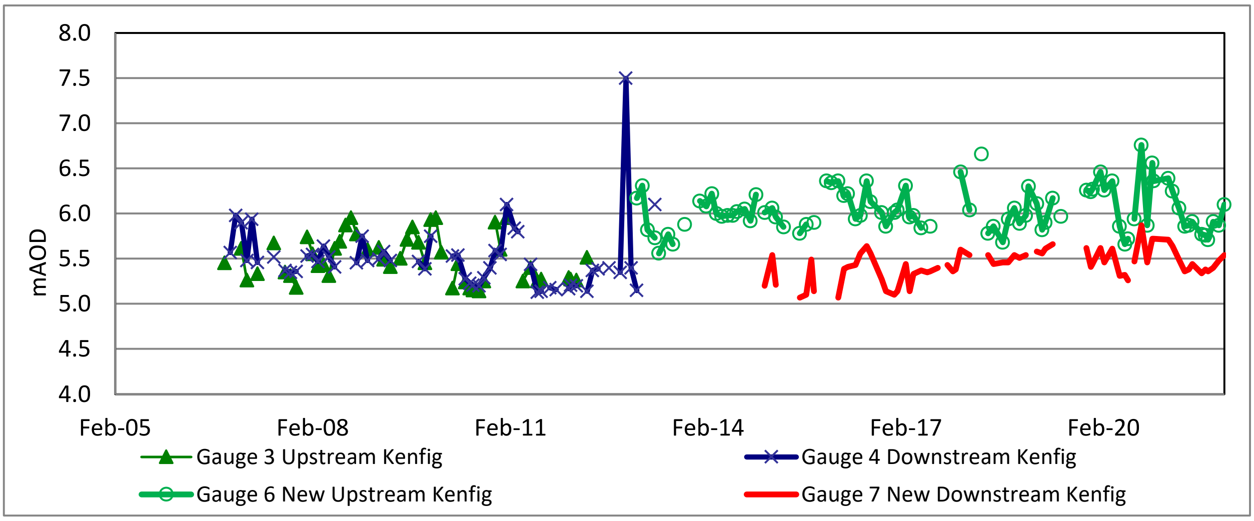

10
9
8
7
6
5
4
3
2
1
0
mAOD
1
2D
3D
4D
5D
6D
Dec-04
Dec-06
Dec-08
Dec-10
Dec-12
Dec-14
Dec-16
Dec-18
Dec-20

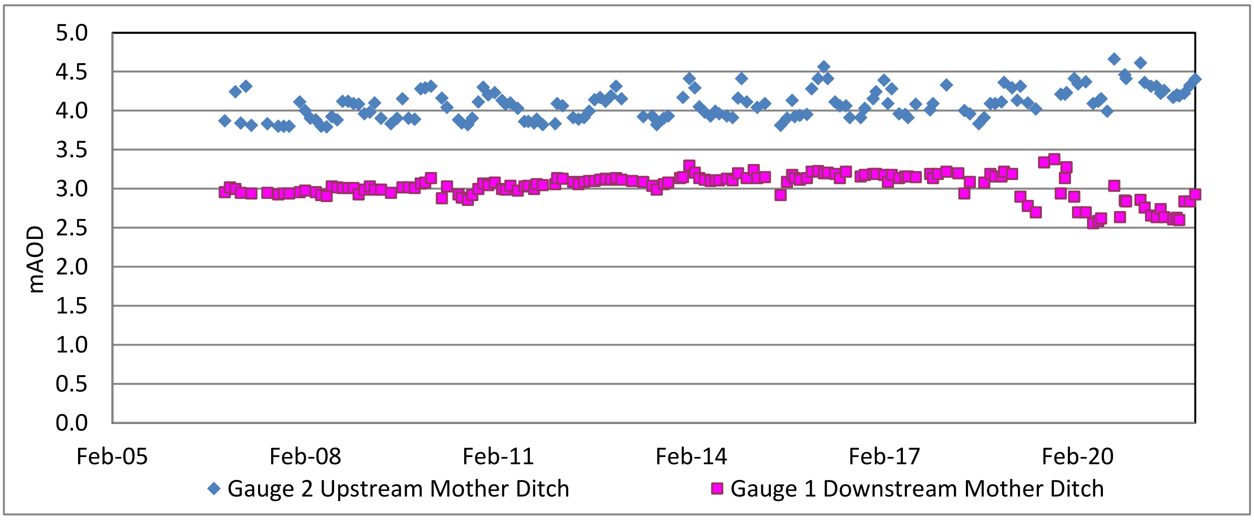

8
7
6
5
4
3
2
1
0
mAOD
8D
9D
10
15D
16D
Dec-04
Dec-06
Dec-08
Dec-10
Dec-12
Dec-14
Dec-16
Dec-18
Dec-20

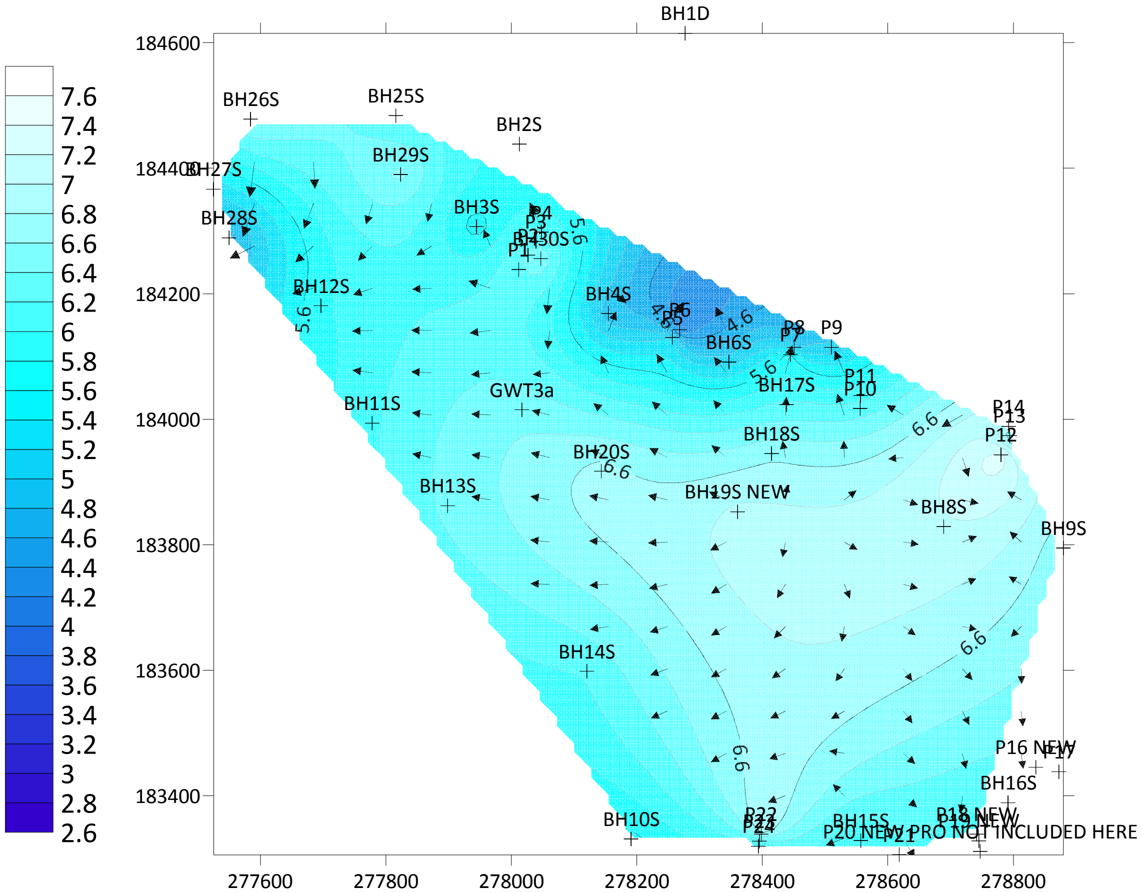

10
9
8
7
6
5
4
3
2
mAOD
11D
12D
13D
14D
Dec-04
Dec-06
Dec-08
Dec-10
Dec-12
Dec-14
Dec-16
Dec-18
Dec-20


mAOD
8
7
6
5
4
3
2
1
0
Dec-04
Dec-06
Dec-08
Dec-10
Dec-12
Dec-14
Dec-16
Dec-18
Dec-20
17D
18D
19D
20D


mAOD
10
9
8
7
6
5
4
3
2
1
0
Dec-04
Dec-06
Dec-08
Dec-10
Dec-12
Dec-14
Dec-16
Dec-18
Dec-20
25D
26D
27D
28D
29D

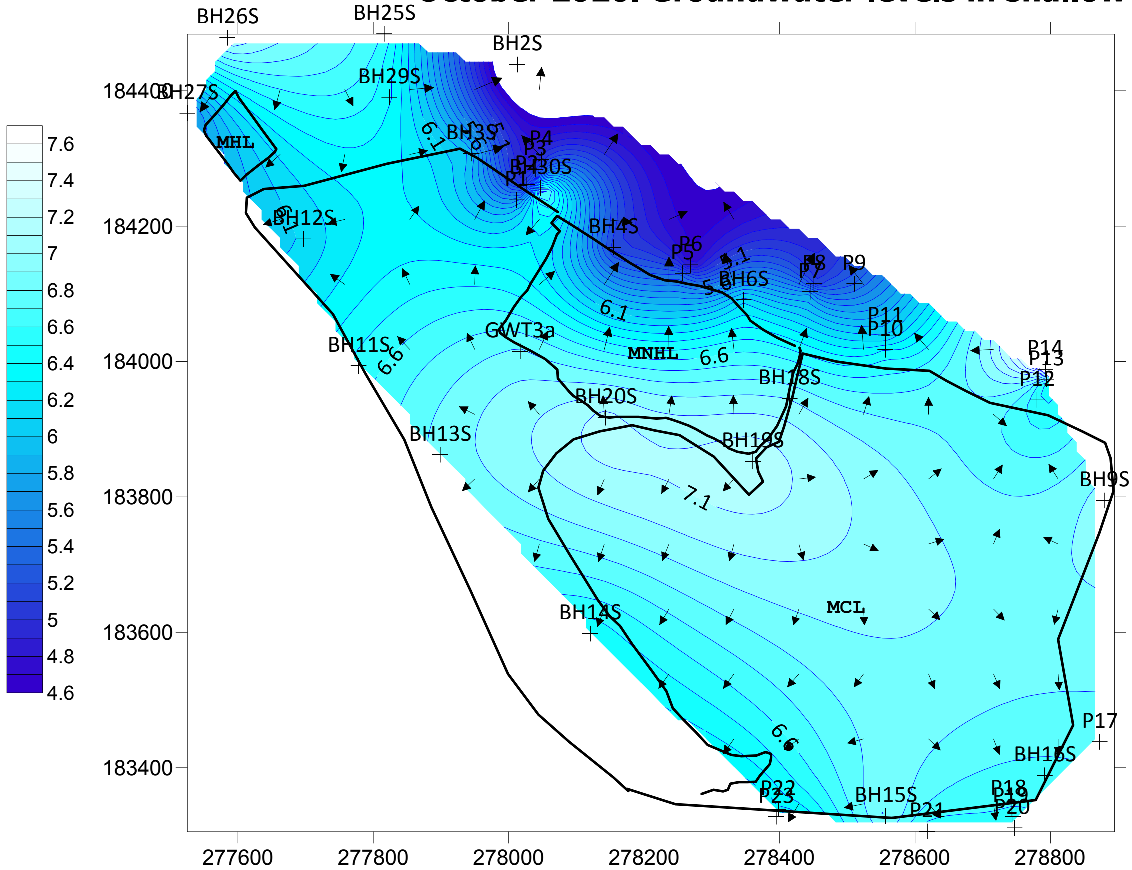

8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
mAOD
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20
Gauge 3 Upstream Kenfig
Gauge 4 Downstream Kenfig
Gauge 6 New Upstream Kenfig
Gauge 7 New Downstream Kenfig

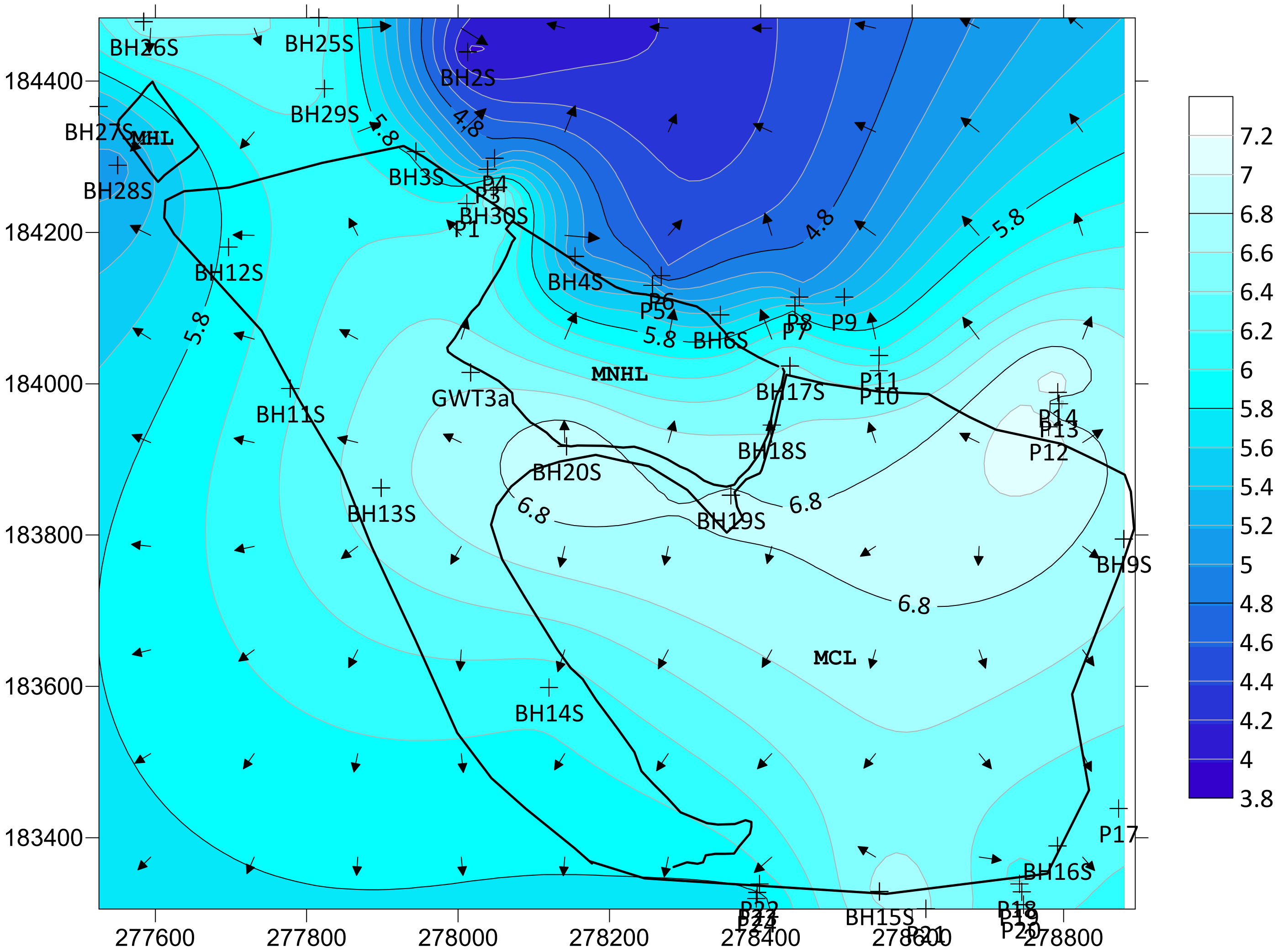

5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
mAOD
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20
Gauge 2 Upstream Mother Ditch
Gauge 1 Downstream Mother Ditch



Shallow Groundwater Contours, June 2019

October 2020. Groundwater levels in shallow aquifer





December 2021. Groundwater levels in shallow aquifer

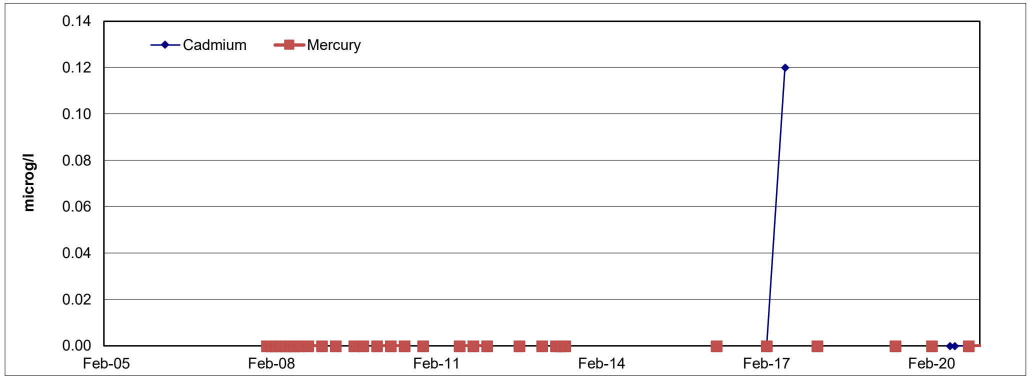
MORFA CLOSED LANDFILL,
PORT TALBOT

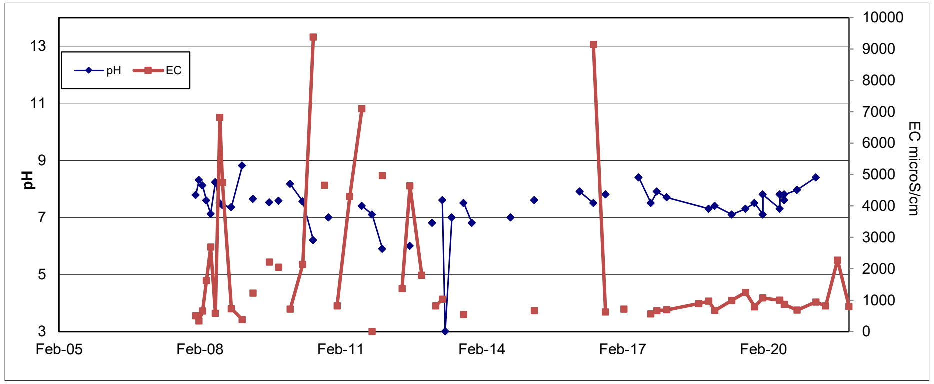
PERMIT EPR/AP3292LT

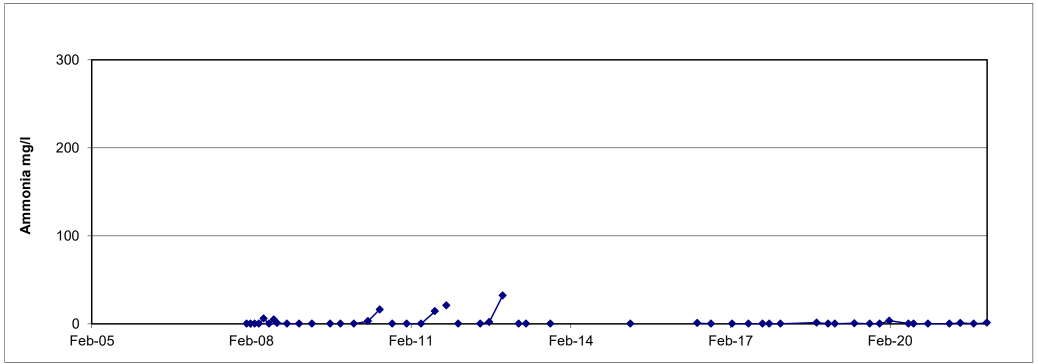
2020 Annual Review of Environmental Monitoring Results

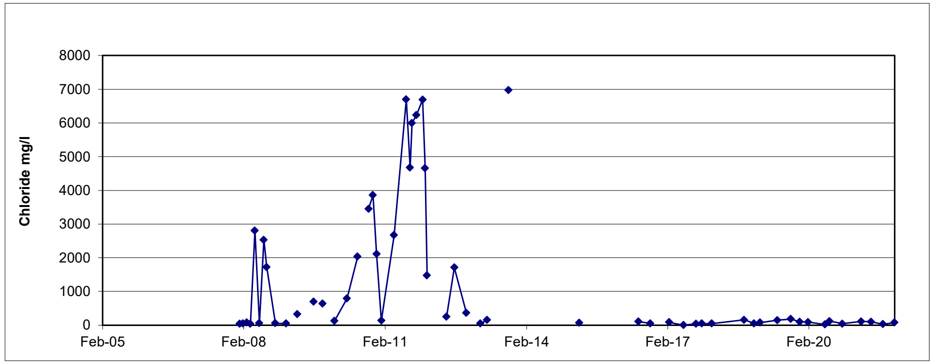
Appendix 2
Temporal & Spatial Variation of Groundwater Chemistry

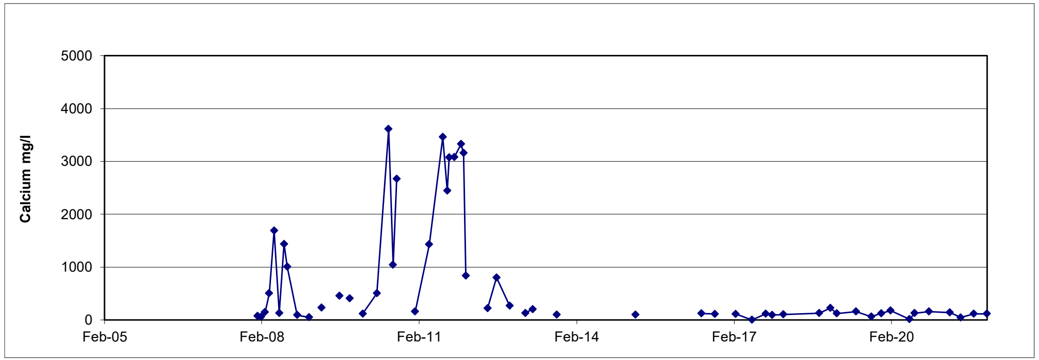
Report Number 2192r1v1d0222

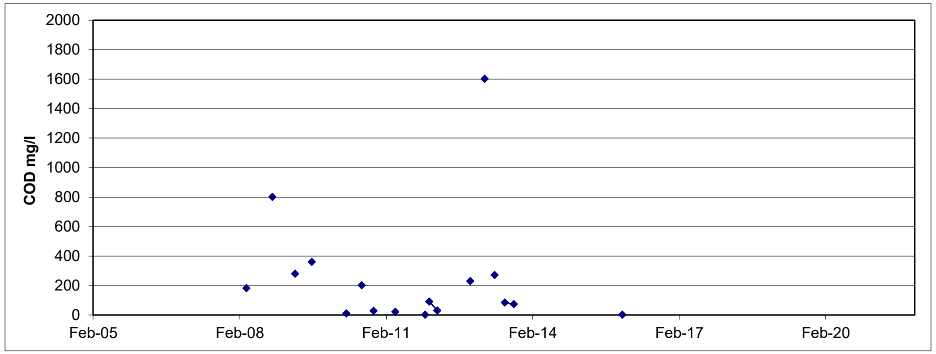

Cadmium
Mercury
microg/l
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

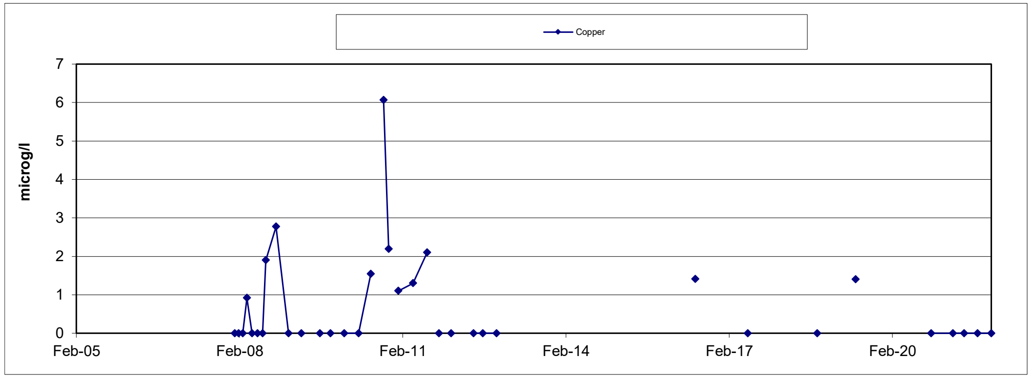

pH
EC
pH
EC microS/cm
13
11
9
7
5
3
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

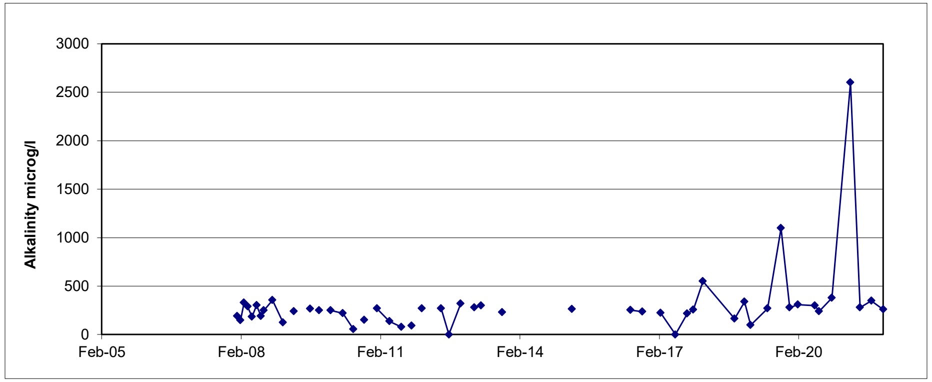

Ammonia mg/l
300
200
100
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

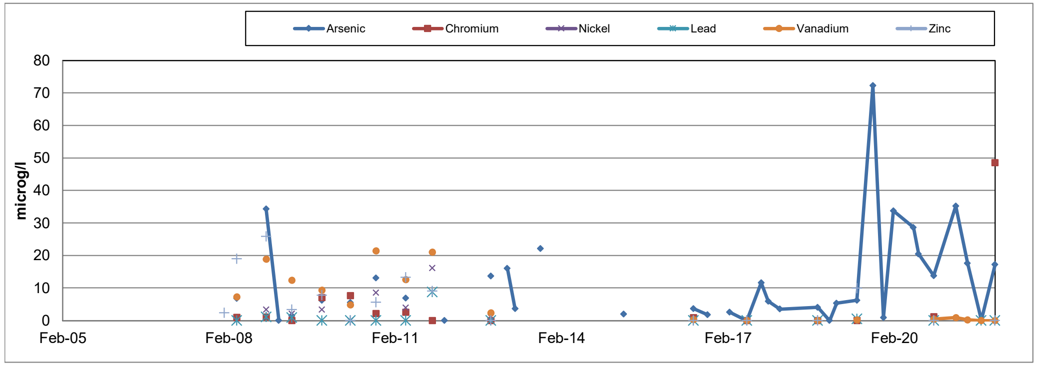

Chloride mg/l
8000
7000
6000
5000
4000
3000
2000
1000
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

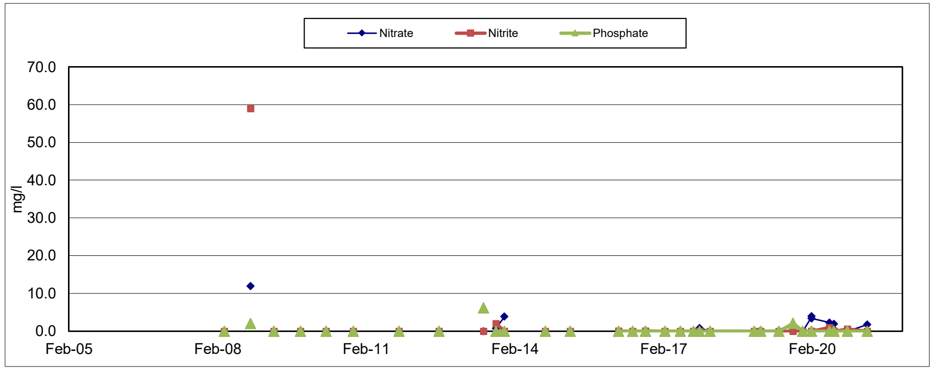

Calcium mg/l
5000
4000
3000
2000
1000
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

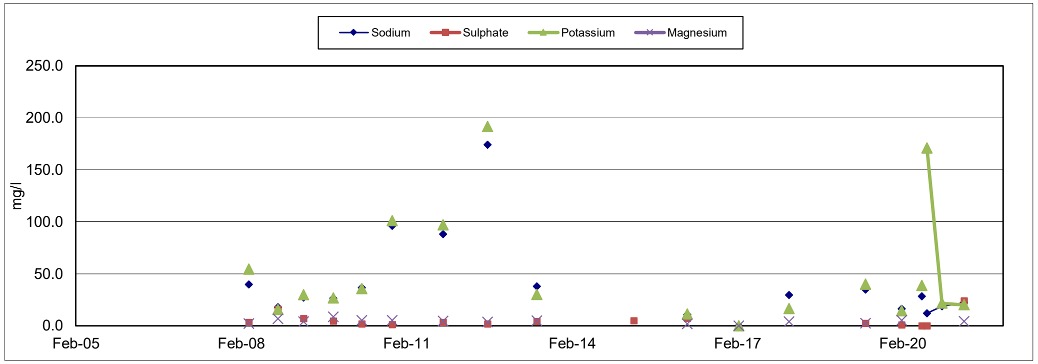

COD mg/l
2000
1800
1600
1400
1200
1000
800
600
400
200
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

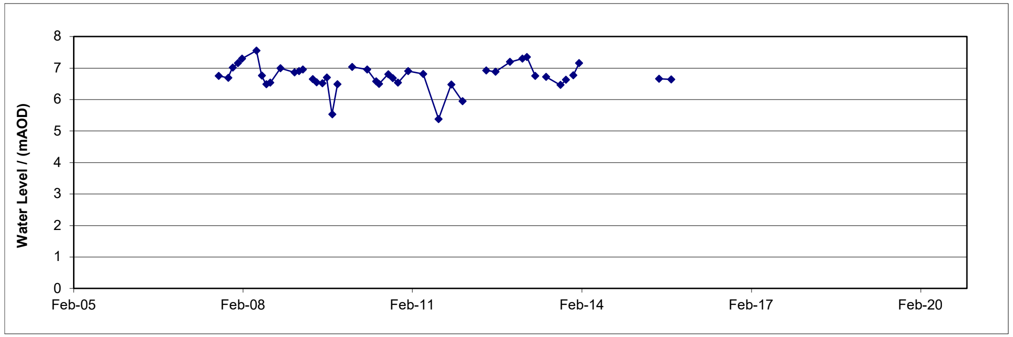

Copper
microg/l
0
1
2
3
4
5
6
7
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

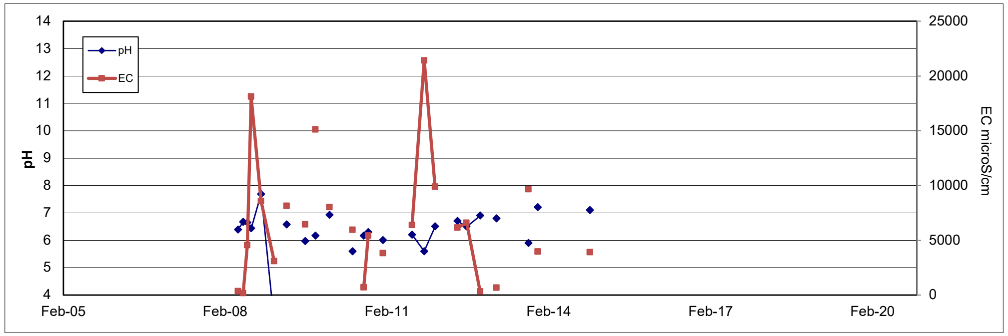

Alkalinity microg/l
0
500
1000
1500
2000
2500
3000
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

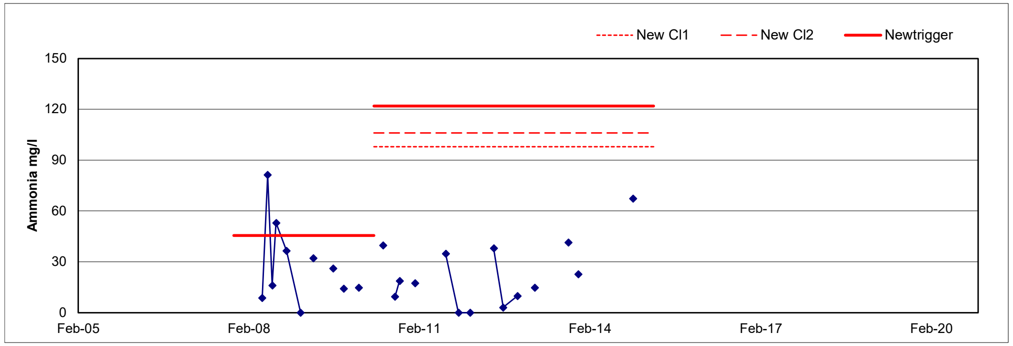

Arsenic
Chromium
Nickel
Lead
Vanadium
Zinc
microg/l
0
10
20
30
40
50
60
70
80
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

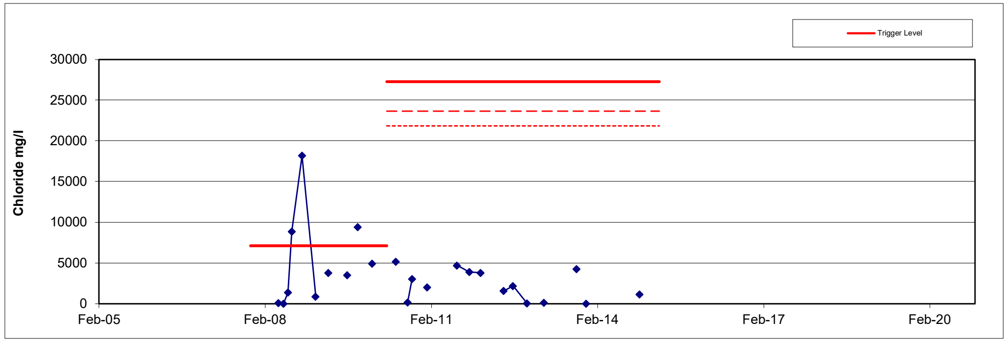

Nitrate
Nitrite
Phosphate
mg/l
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

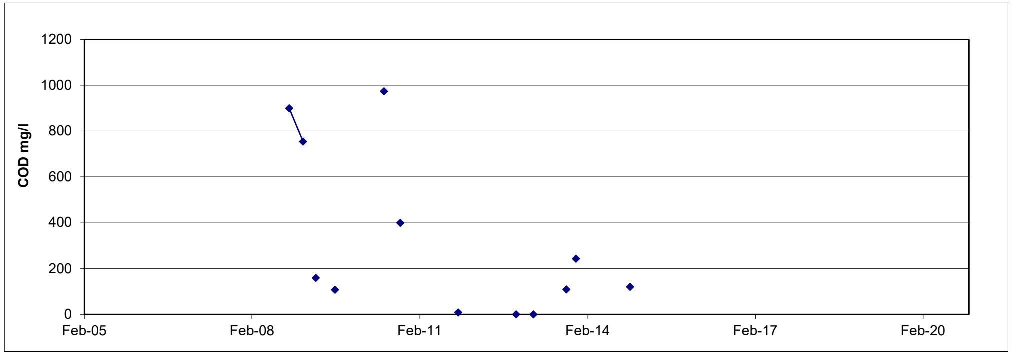

Sodium
Sulphate
Potassium
Magnesium
mg/l
0.0
50.0
100.0
150.0
200.0
250.0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

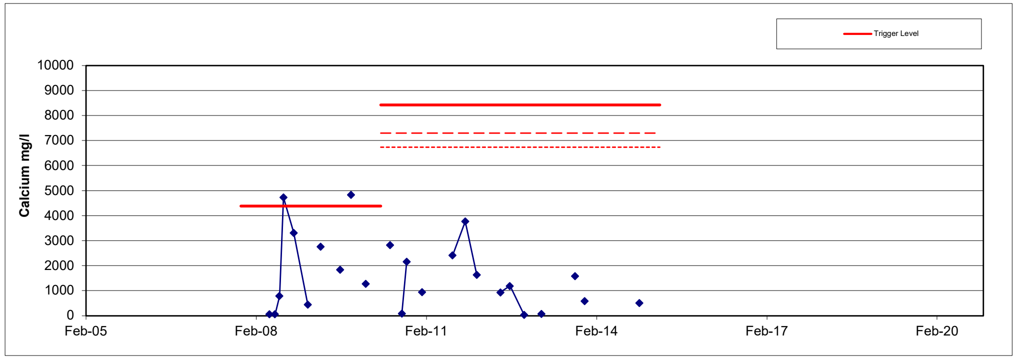

Water Level / (mAOD)
0
1
2
3
4
5
6
7
8
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

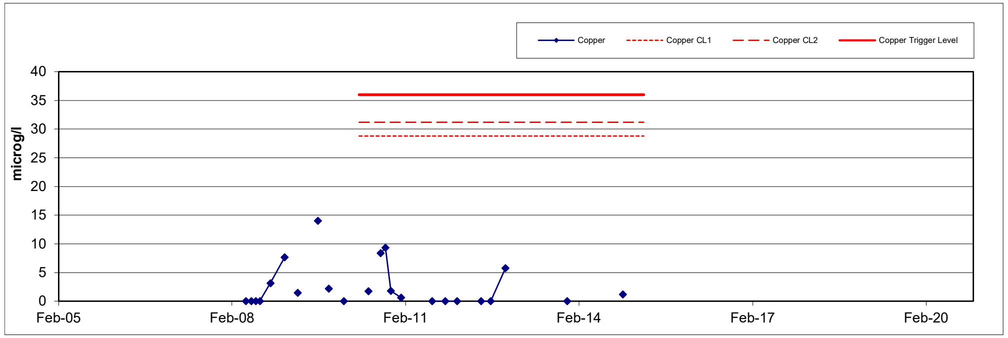

pH
EC
pH
EC microS/cm
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

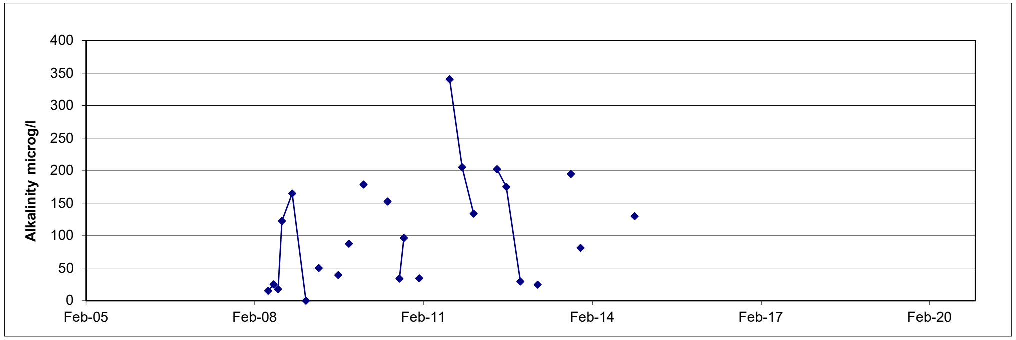

New Cl1
New Cl2
Newtrigger
Ammonia mg/l
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

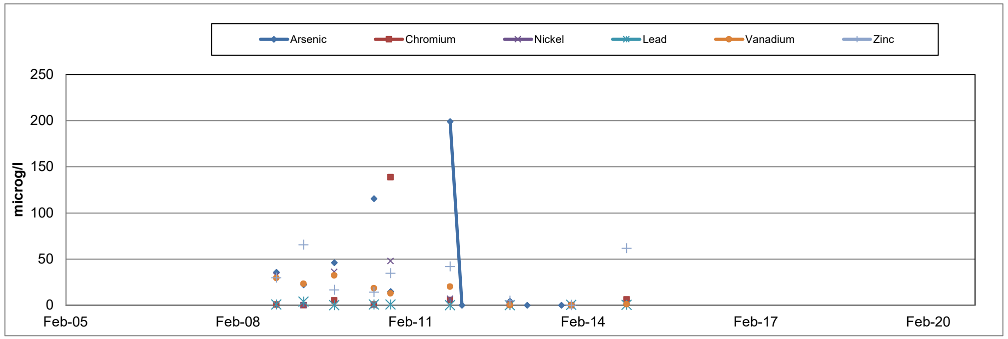

Trigger Level
Chloride mg/l
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

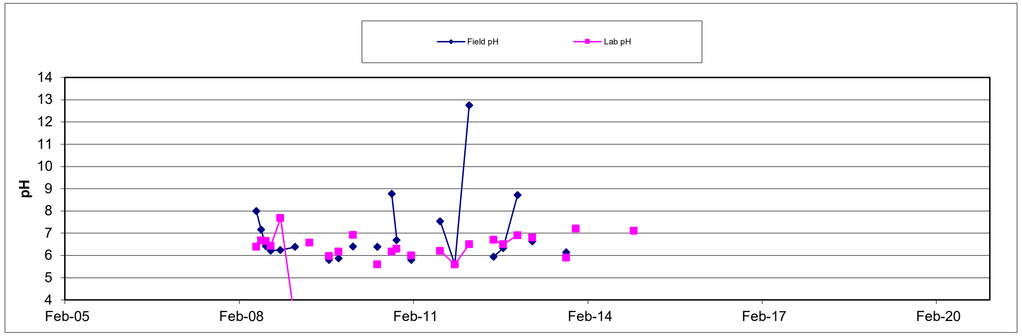

COD mg/l
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

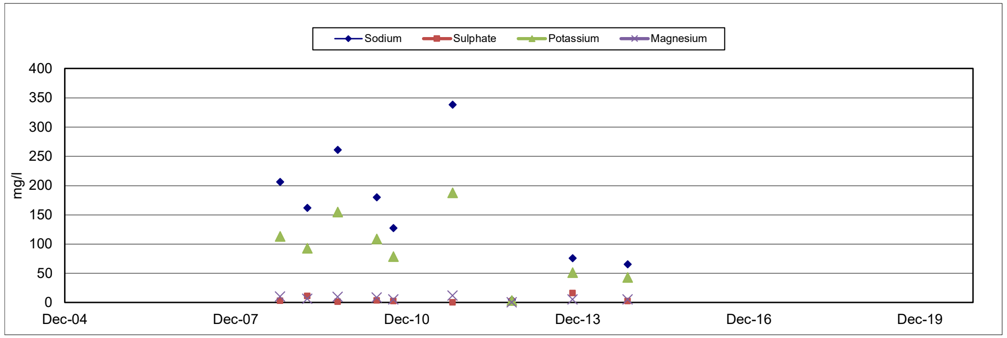

Trigger Level
Calcium mg/l
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

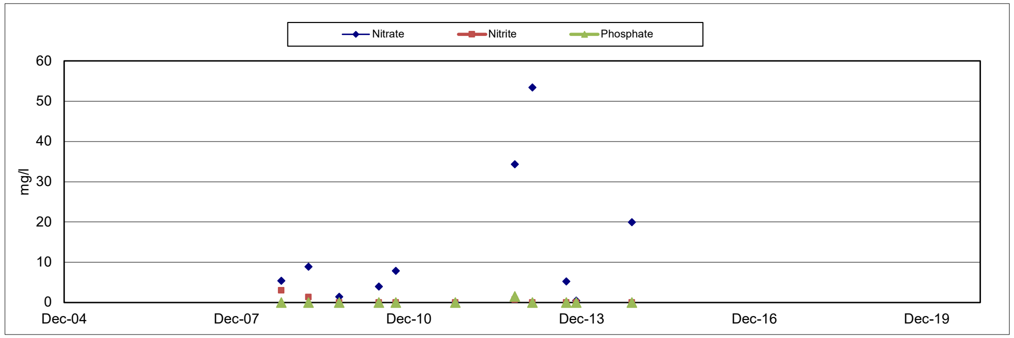

Copper
Copper CL1
Copper CL2
Copper Trigger Level
microg/l
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

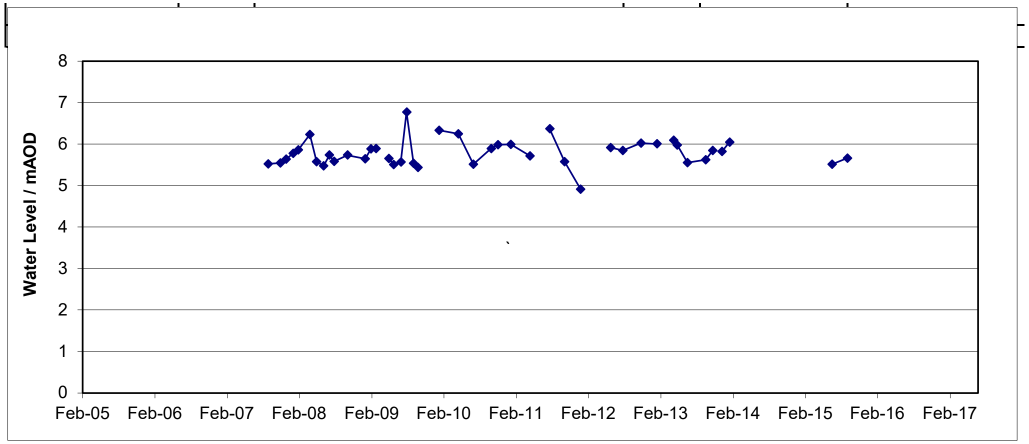

Alkalinity microg/l
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

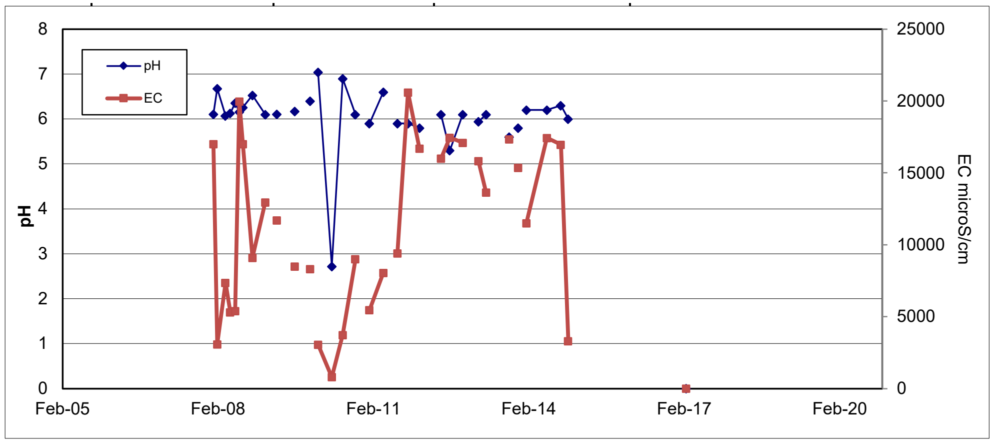

Arsenic
Chromium
Nickel
Lead
Vanadium
Zinc
microg/l
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

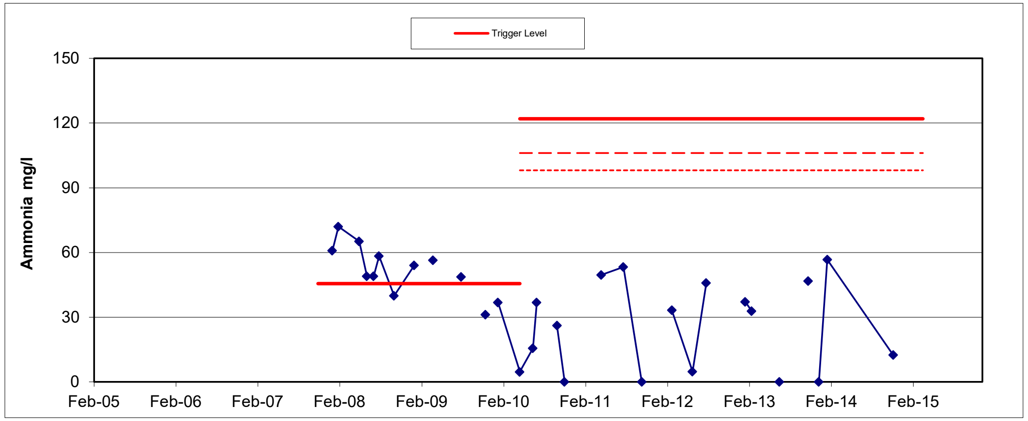

Field pH
Lab pH
pH
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

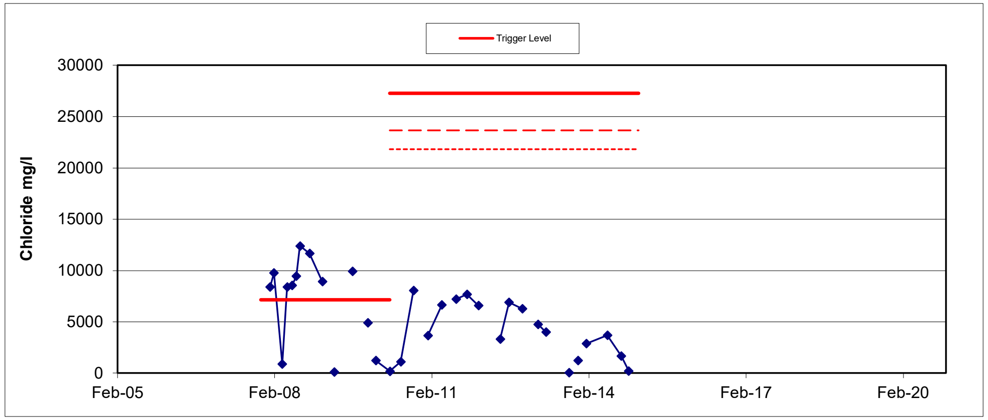

Sodium
Sulphate
Potassium
Magnesium
mg/l
Dec-04
Dec-07
Dec-10
Dec-13
Dec-16
Dec-19

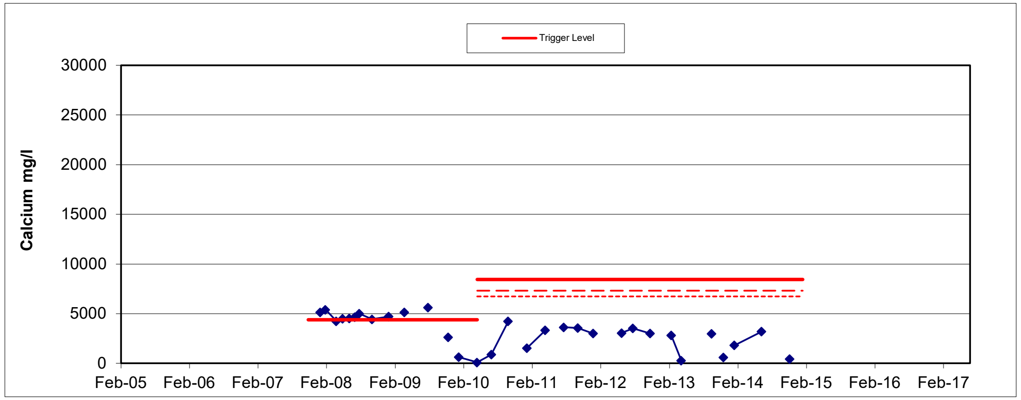

Nitrate
Nitrite
Phosphate
mg/l
Dec-04
Dec-07
Dec-10
Dec-13
Dec-16
Dec-19

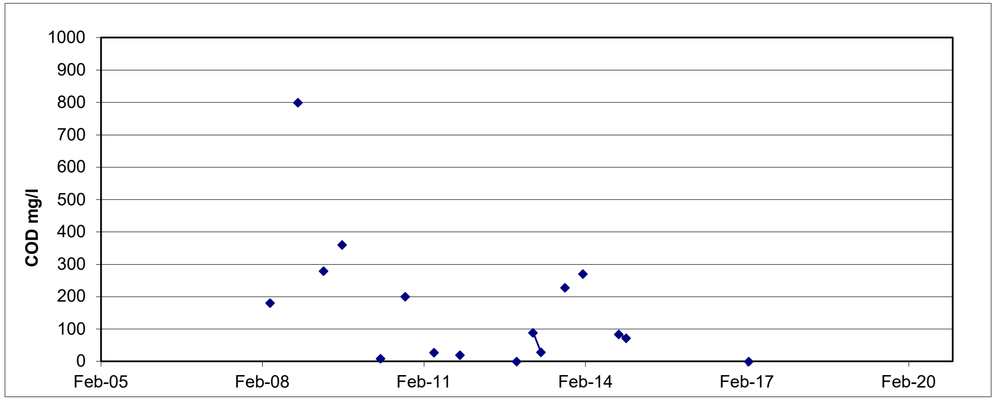

Water Level / mAOD
8
7
6
5
4
3
2
1
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17

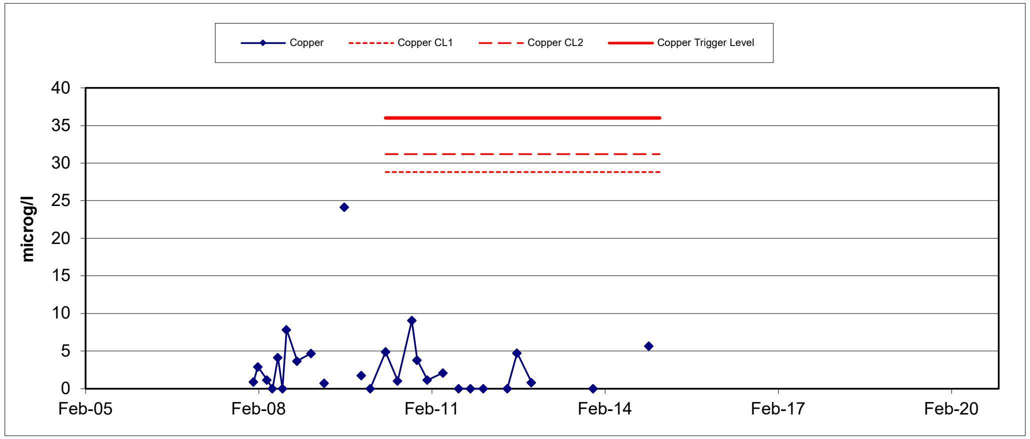

pH
EC
pH
EC microS/cm
8
7
6
5
4
3
2
1
0
25000
20000
15000
10000
5000
0
Feb-05 Feb-08 Feb-11 Feb-14 Feb-17 Feb-20

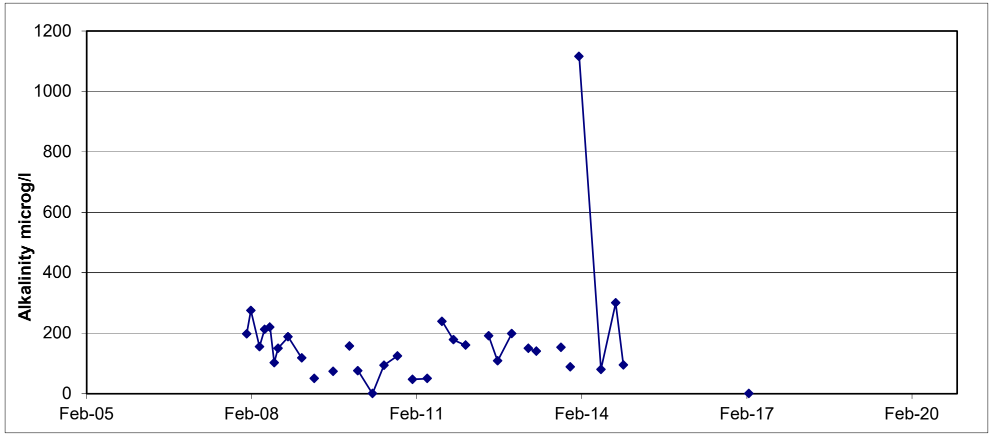

Trigger Level
Ammonia mg/l
150
120
90
60
30
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15

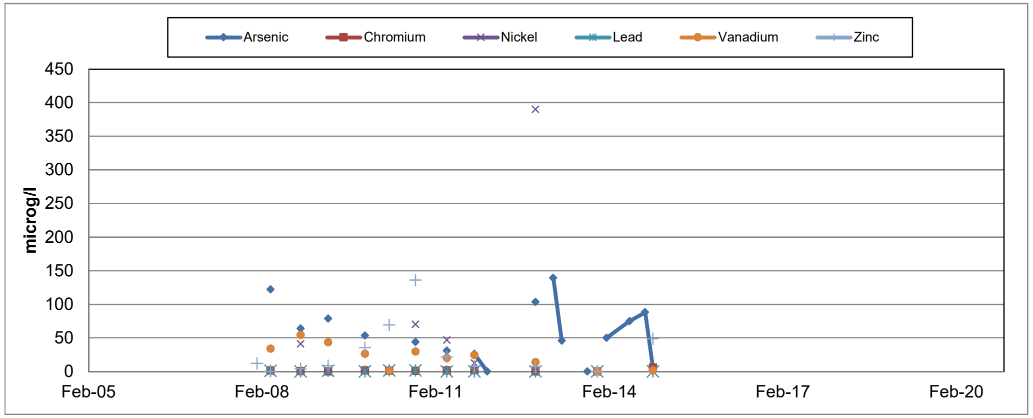

Trigger Level
Chloride mg/l
30000
25000
20000
15000
10000
5000
0
Feb-05 Feb-08 Feb-11 Feb-14 Feb-17 Feb-20

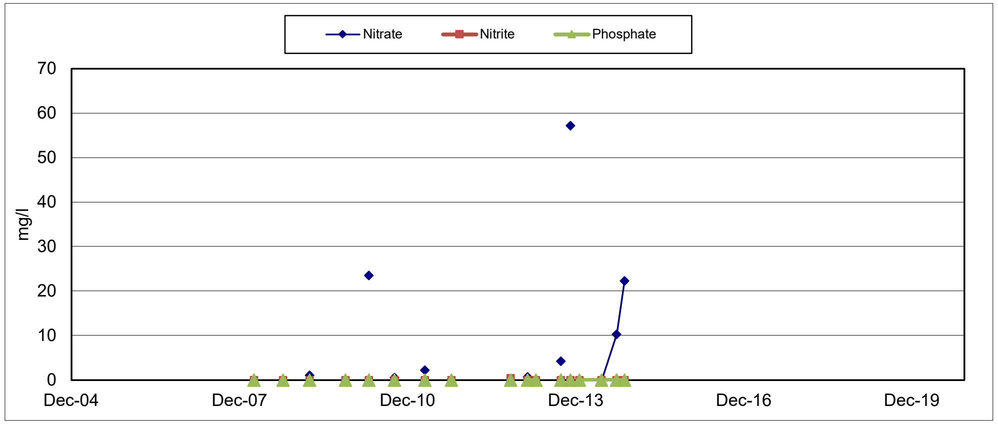

Trigger Level
Calcium mg/l
30000
25000
20000
15000
10000
5000
0
Feb-05 Feb-06 Feb-07 Feb-08 Feb-09 Feb-10 Feb-11 Feb-12 Feb-13 Feb-14 Feb-15 Feb-16 Feb-17

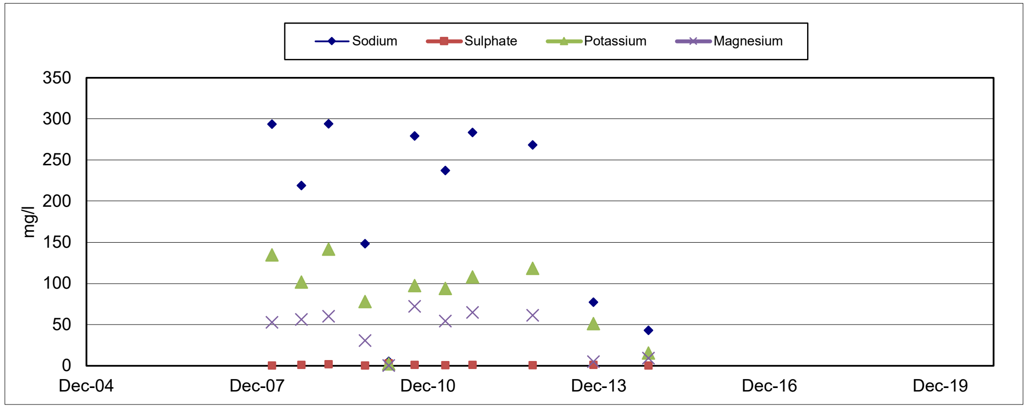

COD mg/l
1000
900
800
700
600
500
400
300
200
100
0
Feb-05 Feb-08 Feb-11 Feb-14 Feb-17 Feb-20

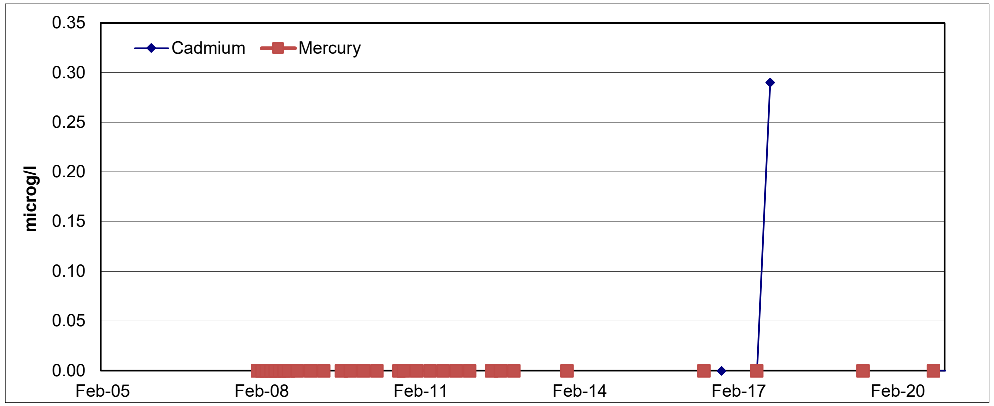

Copper
Copper CL1
Copper CL2
Copper Trigger Level
microg/l
40
35
30
25
20
15
10
5
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

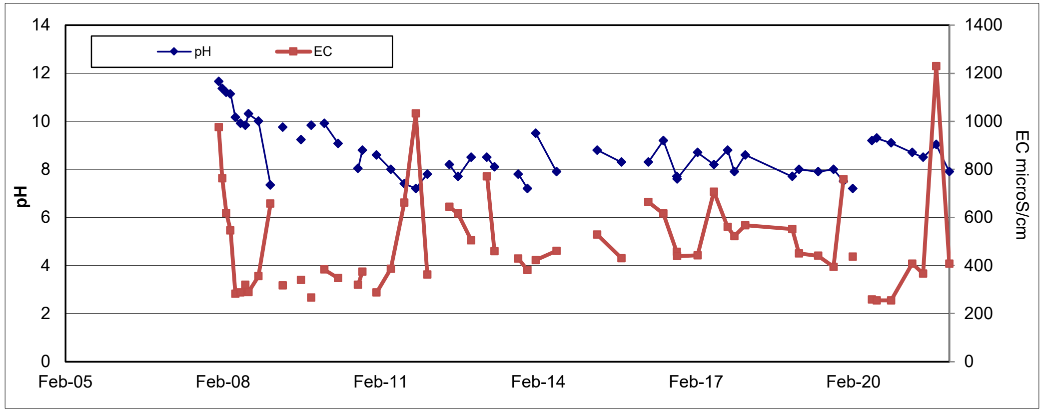

Alkalinity microg/l
1200
1000
800
600
400
200
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

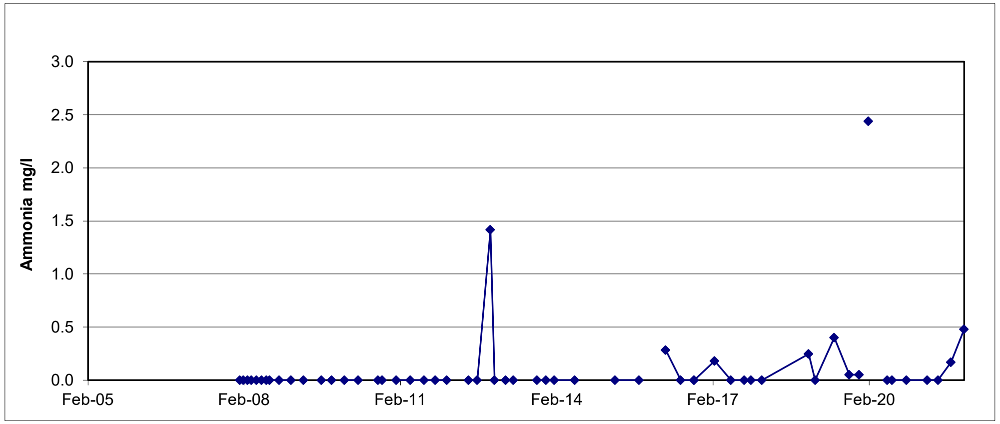

Arsenic
Chromium
Nickel
Lead
Vanadium
Zinc
microg/l
450
400
350
300
250
200
150
100
50
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

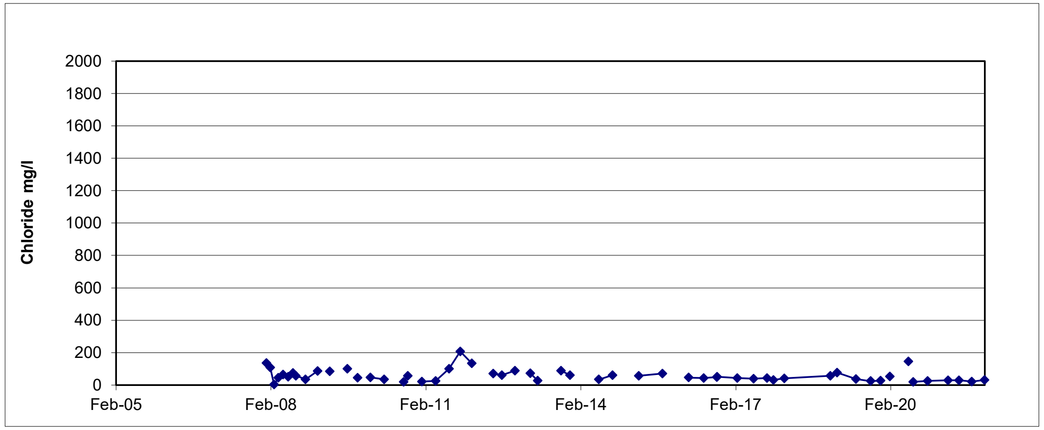

Nitrate
Nitrite
Phosphate
mg/l
70
60
50
40
30
20
10
0
Dec-04
Dec-07
Dec-10
Dec-13
Dec-16
Dec-19

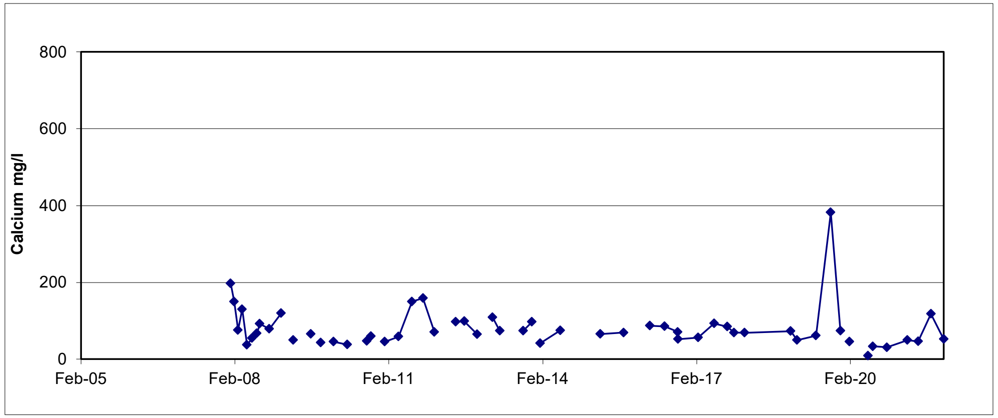

Sodium
Sulphate
Potassium
Magnesium
mg/l
350
300
250
200
150
100
50
0
Dec-04
Dec-07
Dec-10
Dec-13
Dec-16
Dec-19

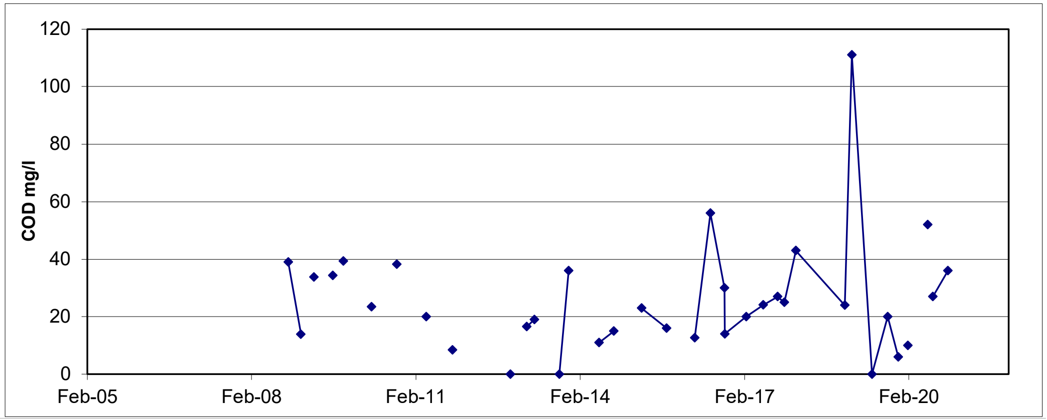

Cadmium
Mercury
microg/l
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

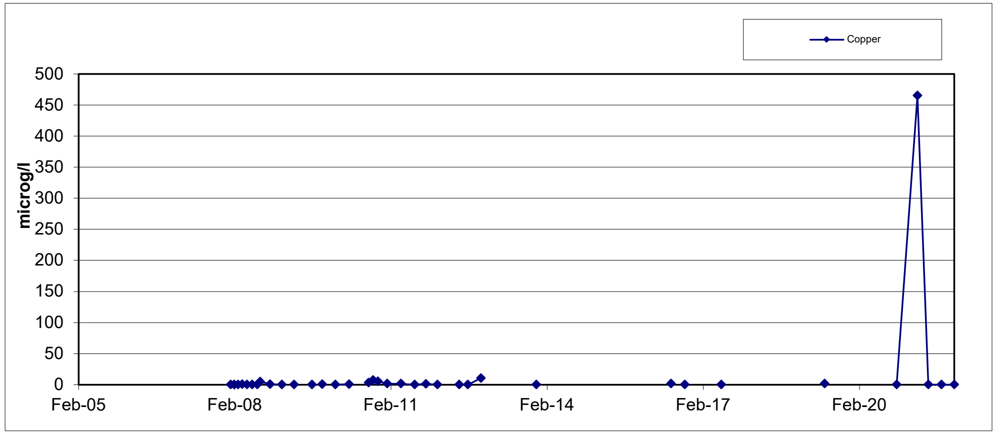

pH
EC
EC microS/cm
14
12
10
8
6
4
2
0
1400
1200
1000
800
600
400
200
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

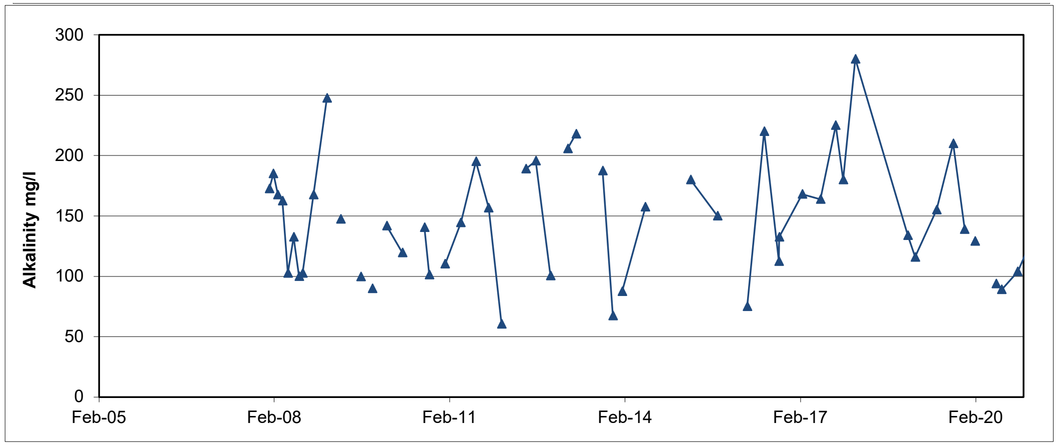

Ammonia mg/l
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

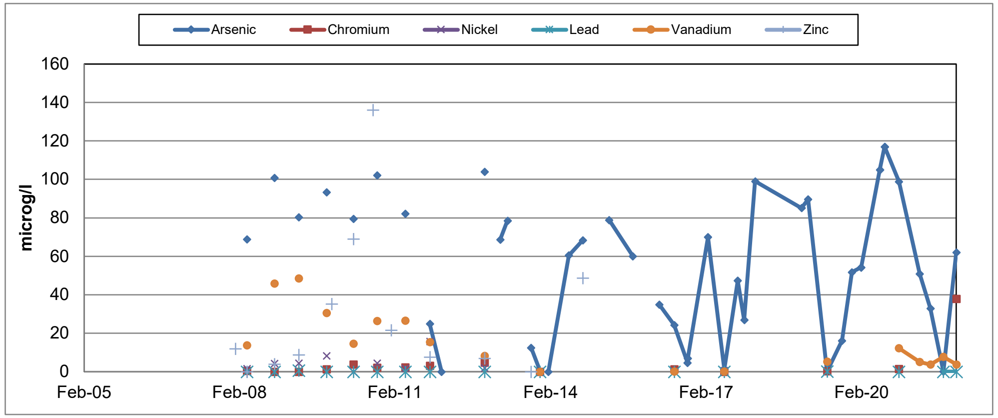

Chloride mg/l
2000
1800
1600
1400
1200
1000
800
600
400
200
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

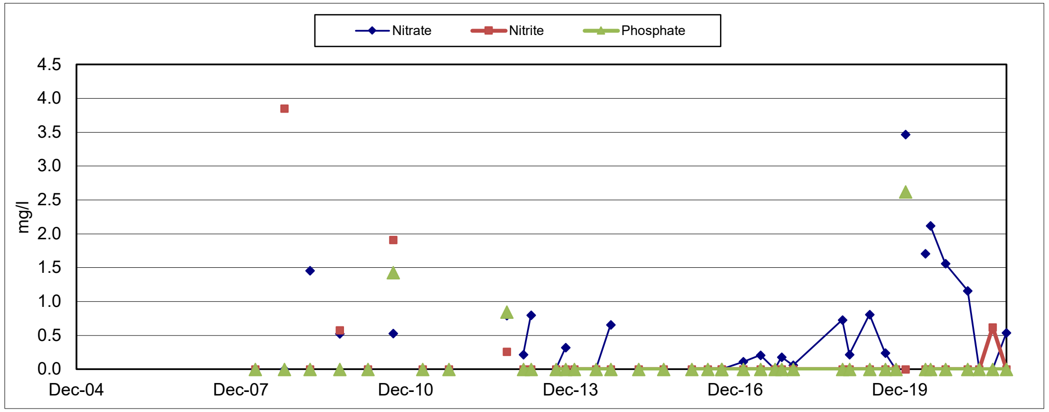

Calcium mg/l
800
600
400
200
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

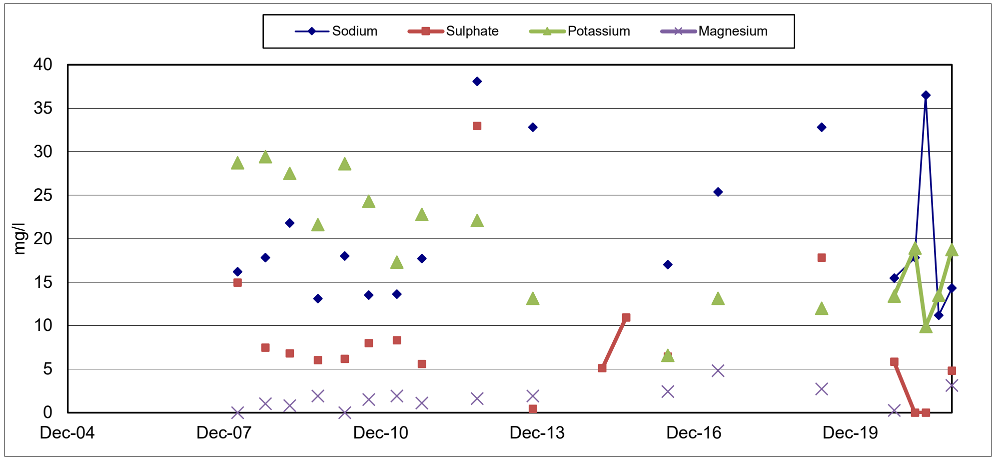

COD mg/l
120
100
80
60
40
20
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

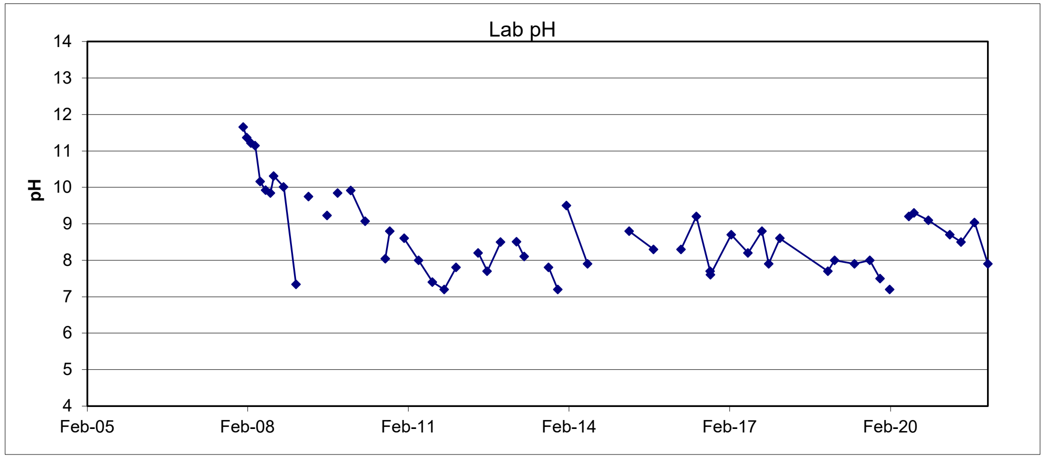

Copper
microg/l
500
450
400
350
300
250
200
150
100
50
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

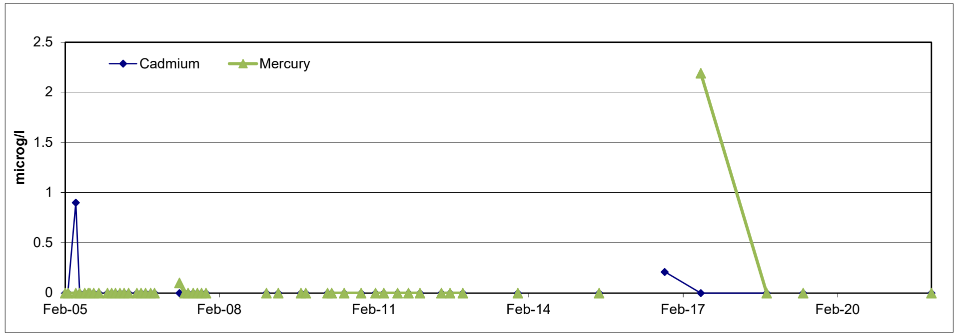

Alkalinity mg/l
300
250
200
150
100
50
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20


Arsenic
Chromium
Nickel
Lead
Vanadium
Zinc
microg/l
160
140
120
100
80
60
40
20
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

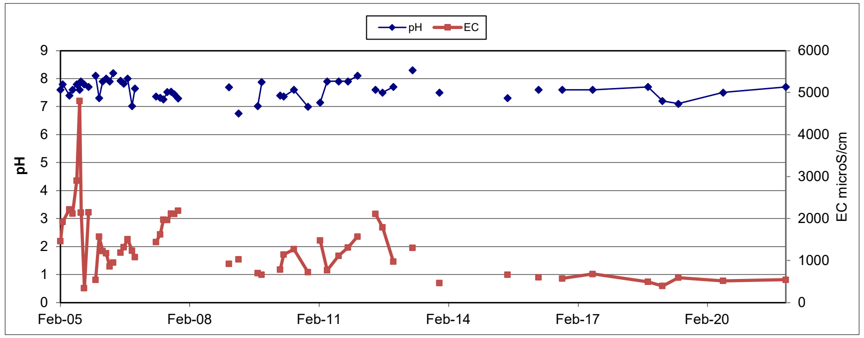

Nitrate
Nitrite
Phosphate
mg/l
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Dec-04
Dec-07
Dec-10
Dec-13
Dec-16
Dec-19


Sodium
Sulphate
Potassium
Magnesium
mg/l
40
35
30
25
20
15
10
5
0
Dec-04
Dec-07
Dec-10
Dec-13
Dec-16
Dec-19

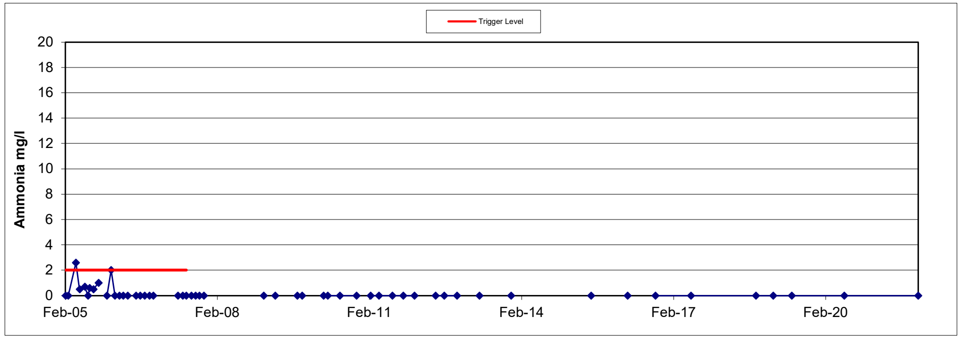

Lab pH
pH
14
13
12
11
10
9
8
7
6
5
4
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20



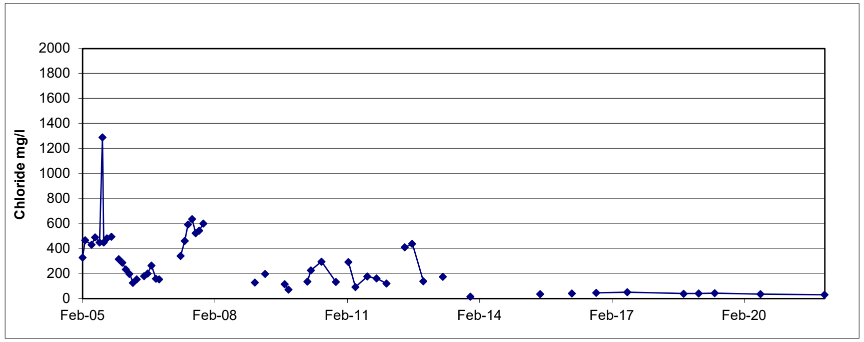
Cadmium
Mercury
microg/l
2.5
2
1.5
1
0.5
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20



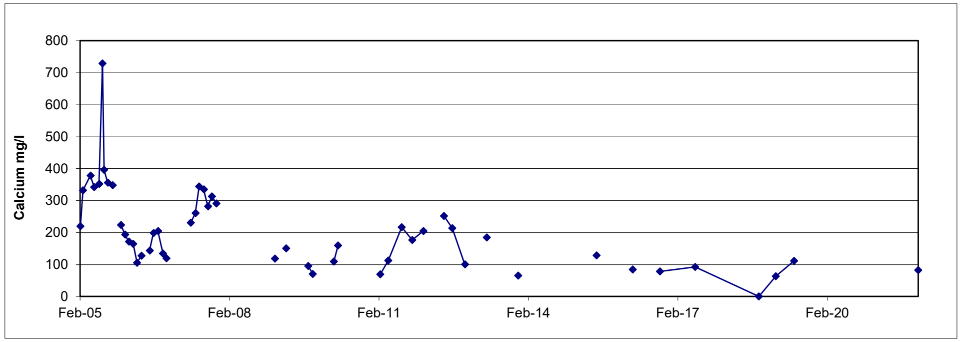
pH
EC
pH
EC microS/cm
9
8
7
6
5
4
3
2
1
0
6000
5000
4000
3000
2000
1000
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20



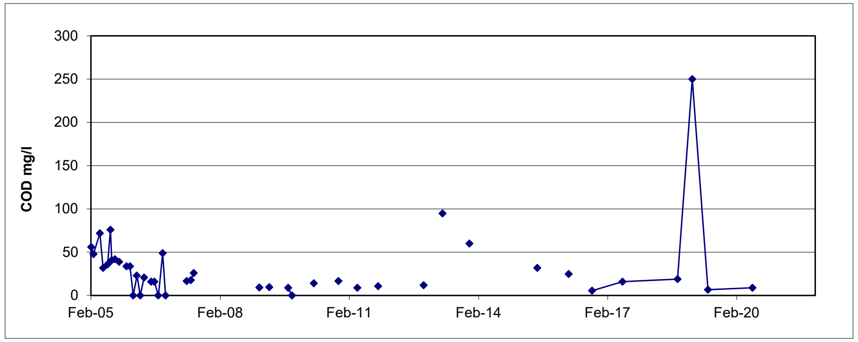
Trigger Level
Ammonia mg/l
20
18
16
14
12
10
8
6
4
2
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20



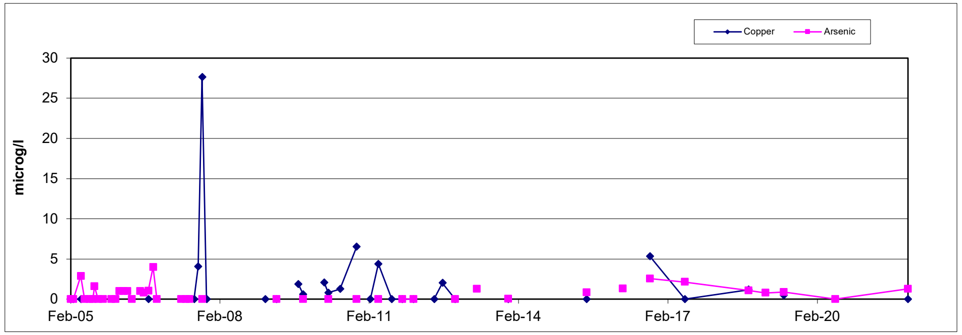
Chloride mg/l
2000
1800
1600
1400
1200
1000
800
600
400
200
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

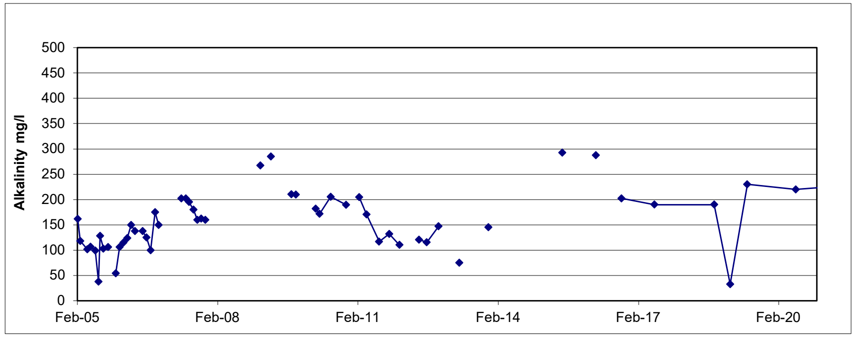


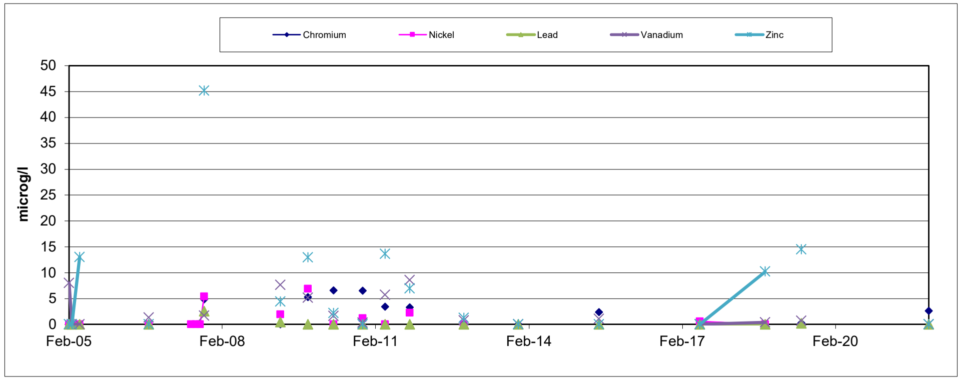
Calcium mg/l
800
700
600
500
400
300
200
100
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

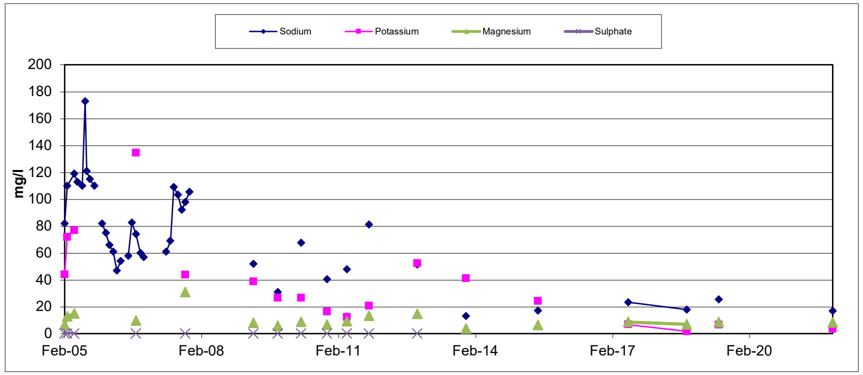


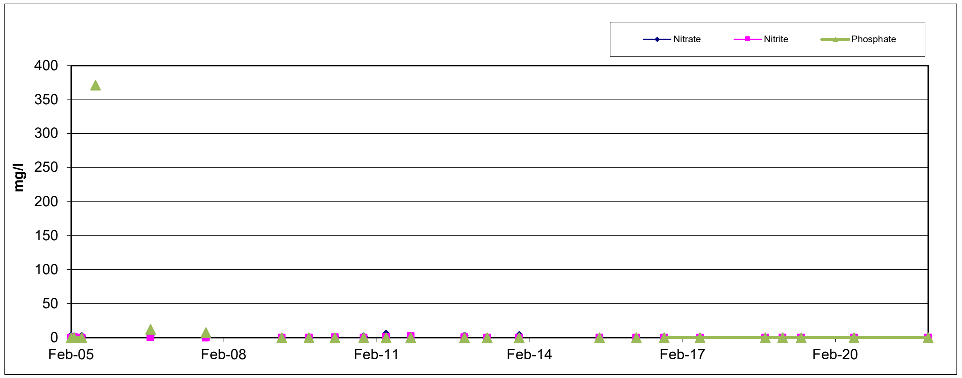
COD mg/l
300
250
200
150
100
50
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

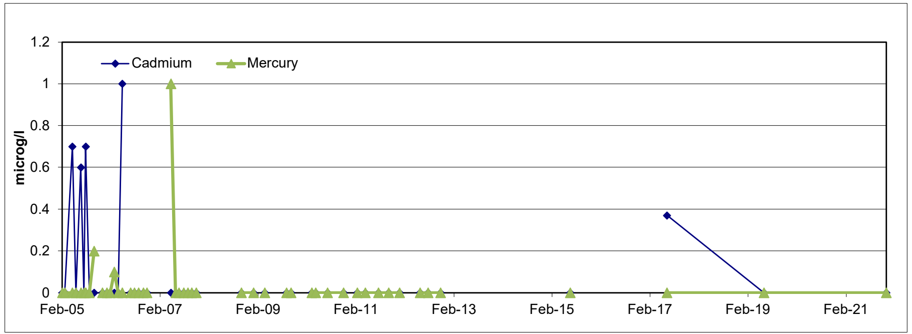

Copper
Arsenic
microg/l
30 25 20 15 10 5 0
Feb-05 Feb-08 Feb-11 Feb-14 Feb-17 Feb-20

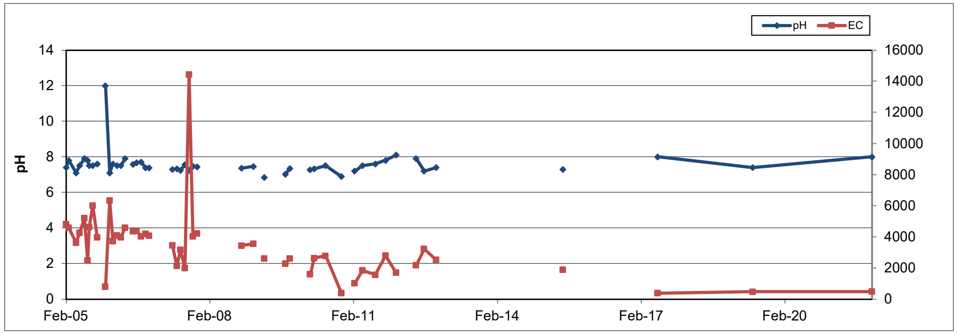

Alkalinity mg/l
500 450 400 350 300 250 200 150 100 50 0
Feb-05 Feb-08 Feb-11 Feb-14 Feb-17 Feb-20

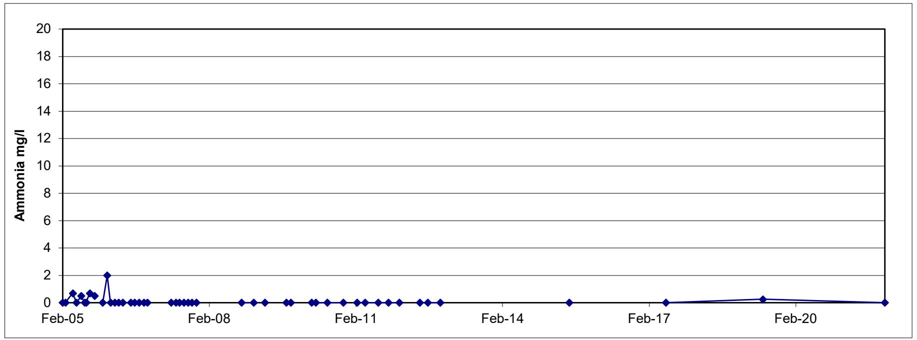

Chromium
Nickel
Lead
Vanadium
Zinc
microg/l
50 45 40 35 30 25 20 15 10 5 0
Feb-05 Feb-08 Feb-11 Feb-14 Feb-17 Feb-20

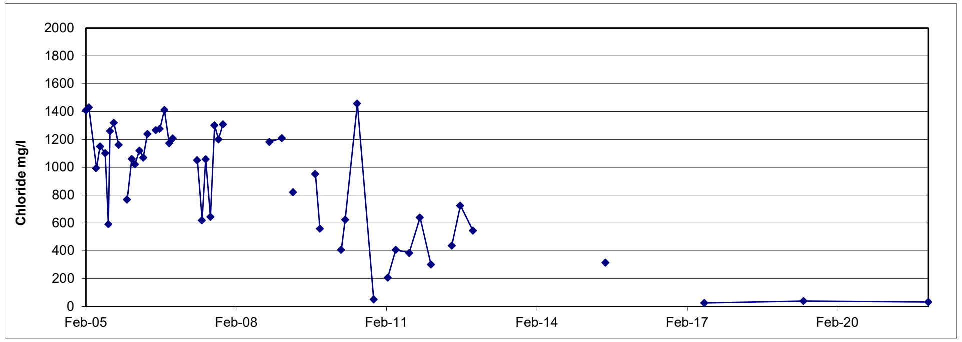

Sodium
Potassium
Magnesium
Sulphate
mg/l
200 180 160 140 120 100 80 60 40 20 0
Feb-05 Feb-08 Feb-11 Feb-14 Feb-17 Feb-20

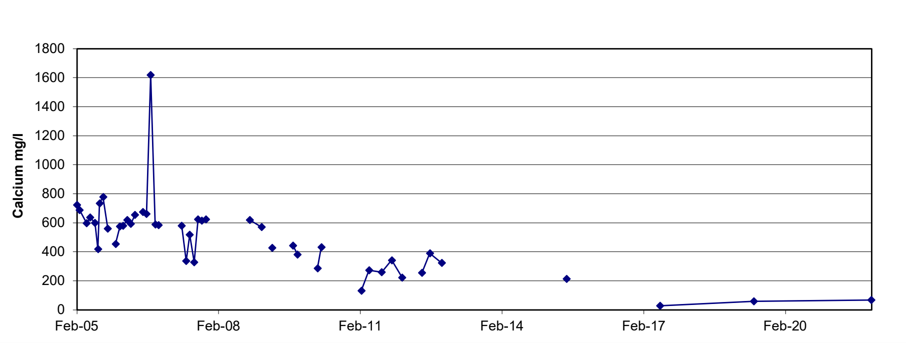

Nitrate
Nitrite
Phosphate
mg/l
400 350 300 250 200 150 100 50 0
Feb-05 Feb-08 Feb-11 Feb-14 Feb-17 Feb-20

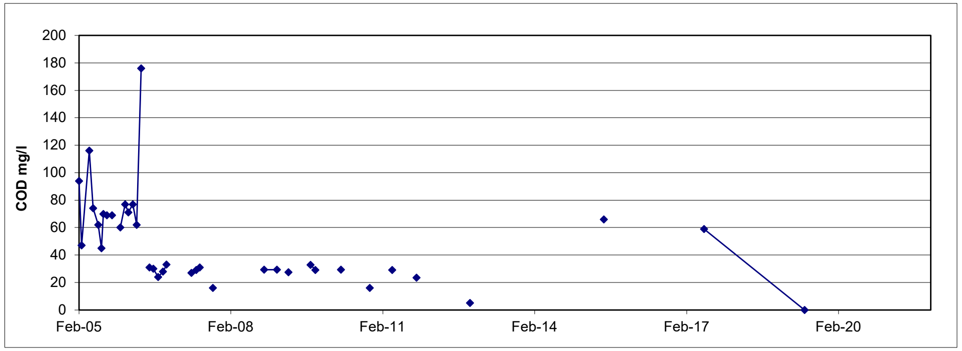

Cadmium
Mercury
microg/l
1.2
1
0.8
0.6
0.4
0.2
0
Feb-05
Feb-07
Feb-09
Feb-11
Feb-13
Feb-15
Feb-17
Feb-19
Feb-21

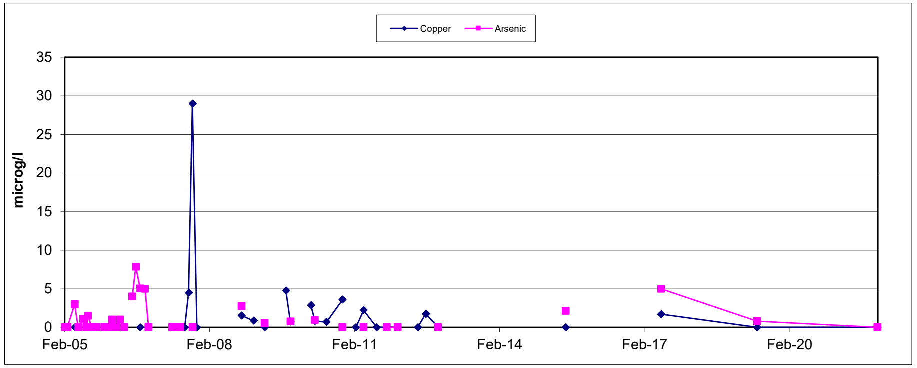

pH
EC
pH
14
12
10
8
6
4
2
0
16000
14000
12000
10000
8000
6000
4000
2000
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

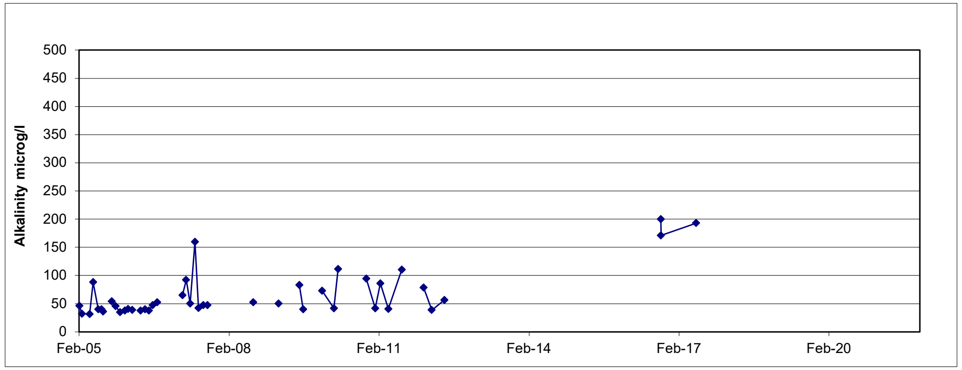

Ammonia mg/l
20
18
16
14
12
10
8
6
4
2
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

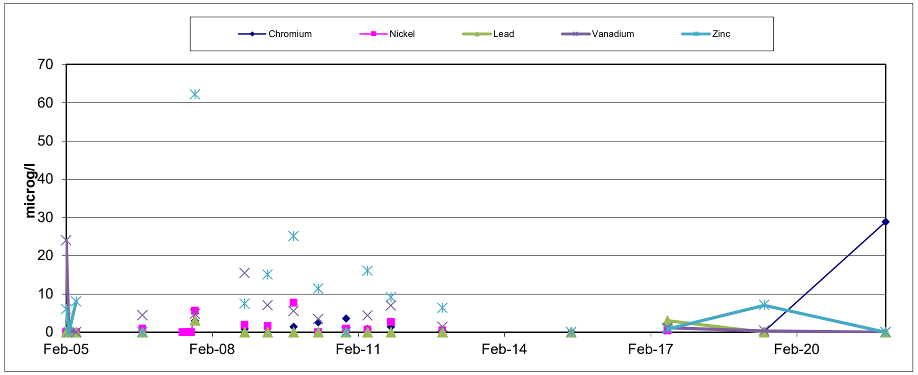

Chloride mg/l
2000
1800
1600
1400
1200
1000
800
600
400
200
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

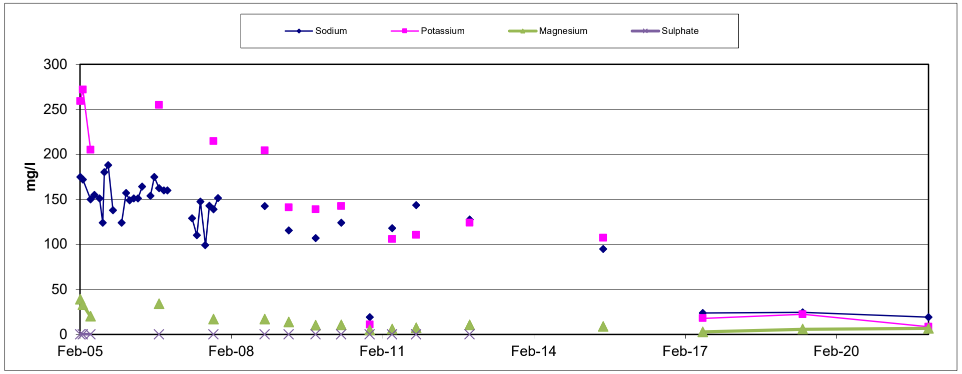

Calcium mg/l
1800
1600
1400
1200
1000
800
600
400
200
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

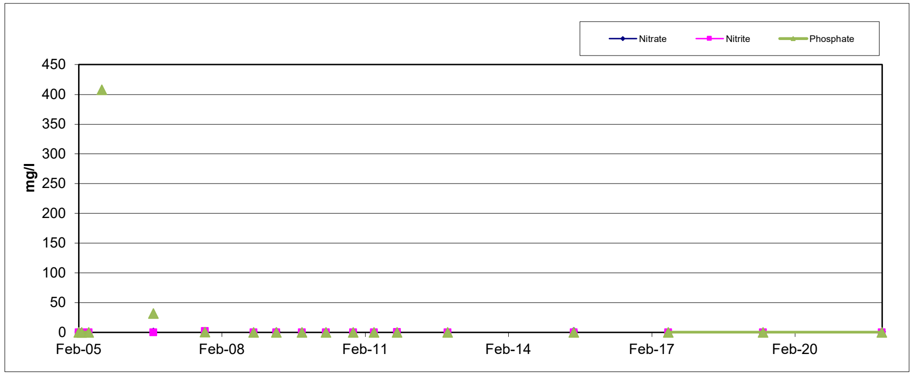

COD mg/l
200
180
160
140
120
100
80
60
40
20
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

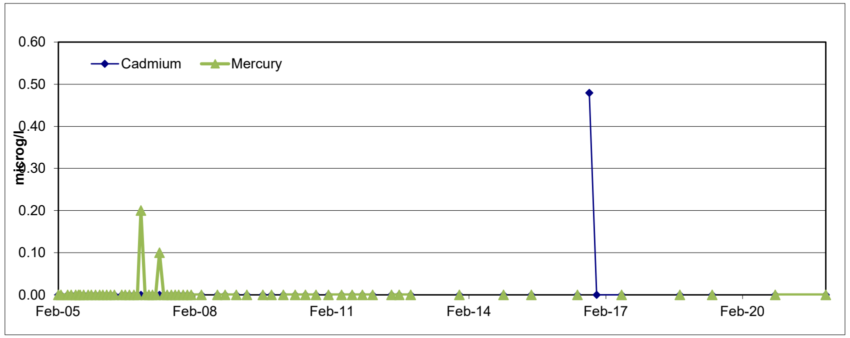

Copper
Arsenic
microg/l
35
30
25
20
15
10
5
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20


Alkalinity microg/l
500
450
400
350
300
250
200
150
100
50
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

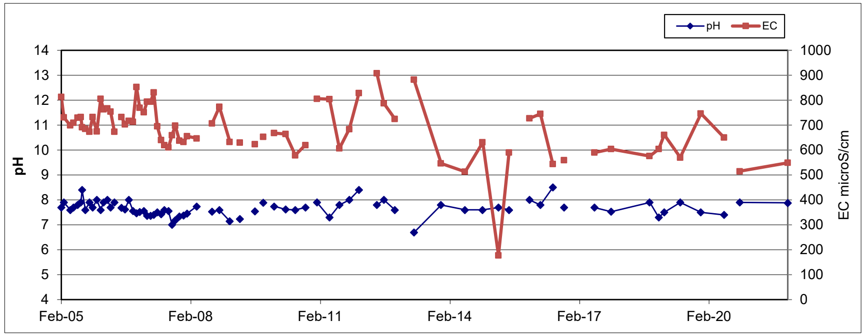

Chromium
Nickel
Lead
Vanadium
Zinc
microg/l
70
60
50
40
30
20
10
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20


Sodium
Potassium
Magnesium
Sulphate
mg/l
300
250
200
150
100
50
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

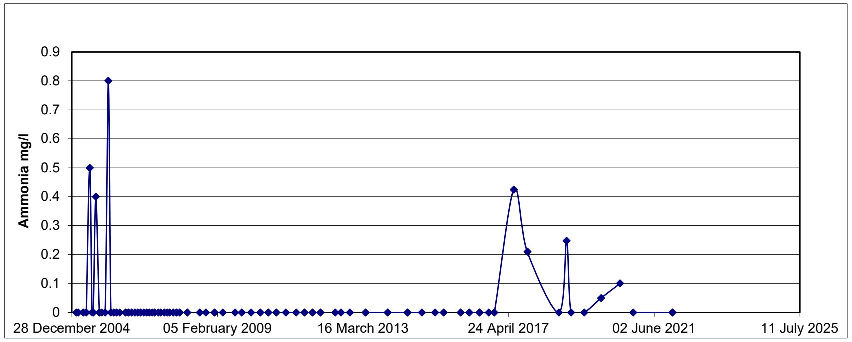

Nitrate
Nitrite
Phosphate
mg/l
450
400
350
300
250
200
150
100
50
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20



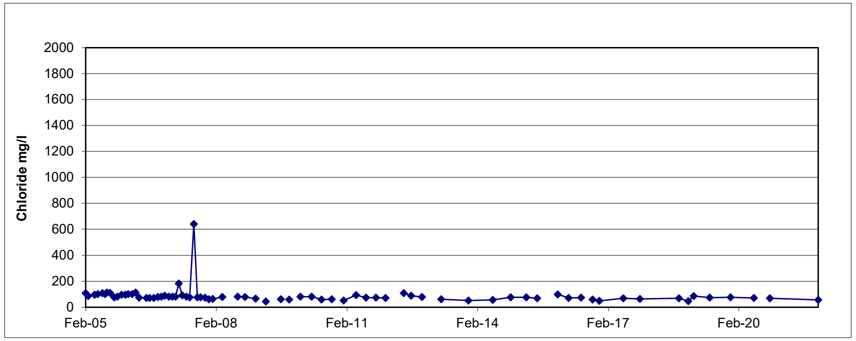
Cadmium
Mercury
microg/l
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20



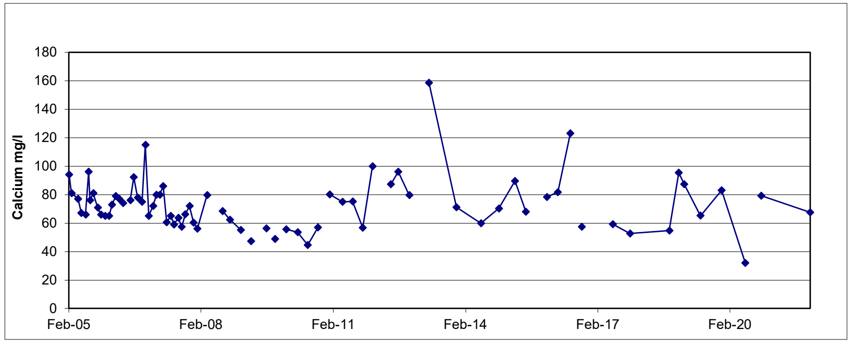
pH
EC
pH
EC microS/cm
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20



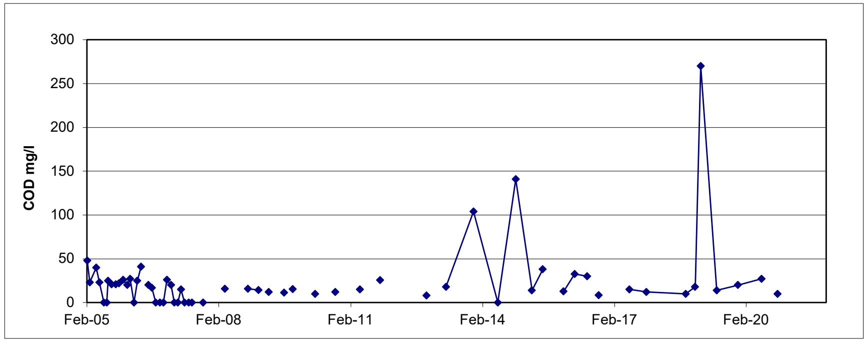
Ammonia mg/l
28 December 2004
05 February 2009
16 March 2013
24 April 2017
02 June 2021
11 July 2025



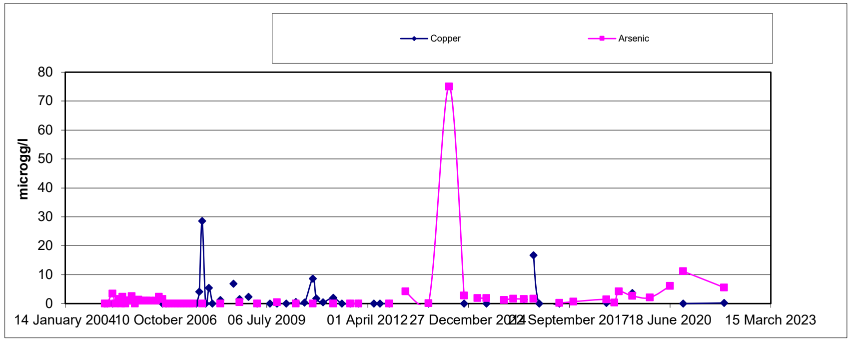
Chloride mg/l
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

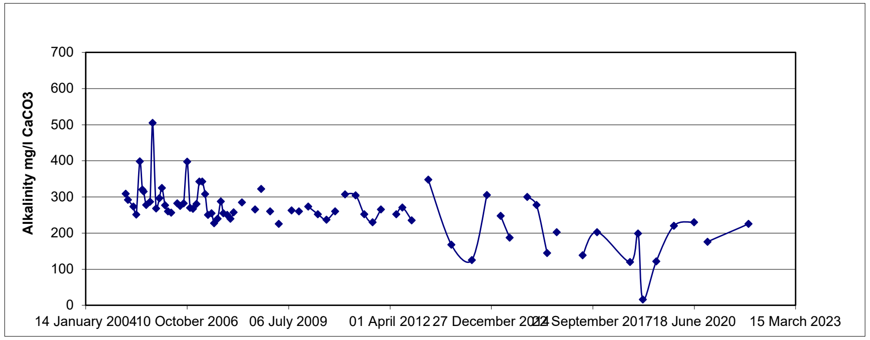


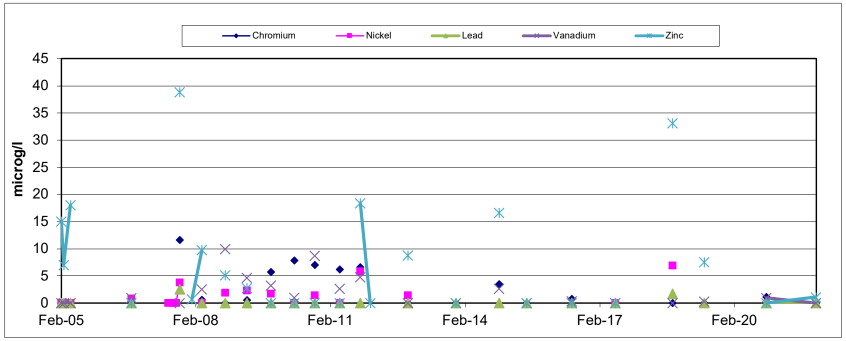
Calcium mg/l
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

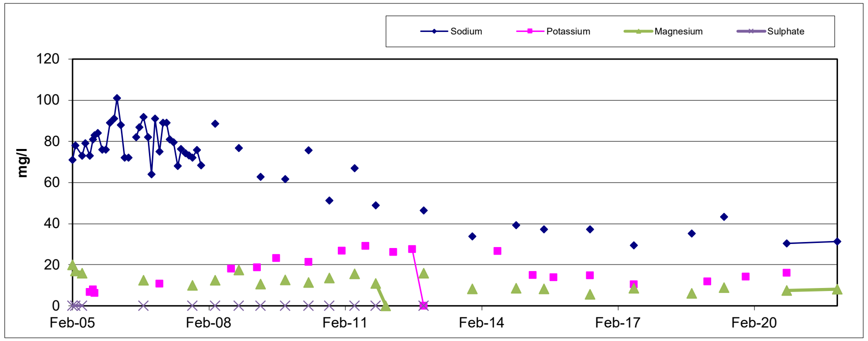


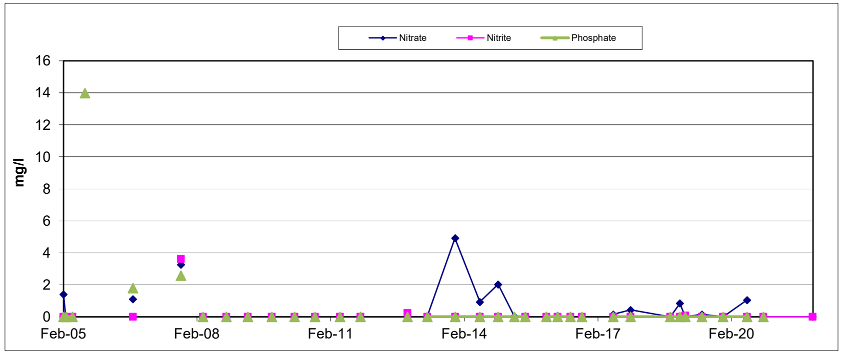
COD mg/l
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

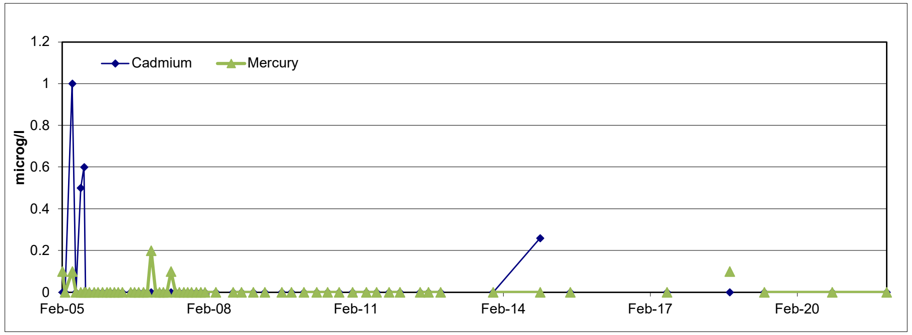

Copper
Arsenic
microgg/l
80
70
60
50
40
30
20
10
0
14 January 2004
10 October 2006
06 July 2009
01 April 2012
27 December 2014
23 September 2017
18 June 2020
15 March 2023

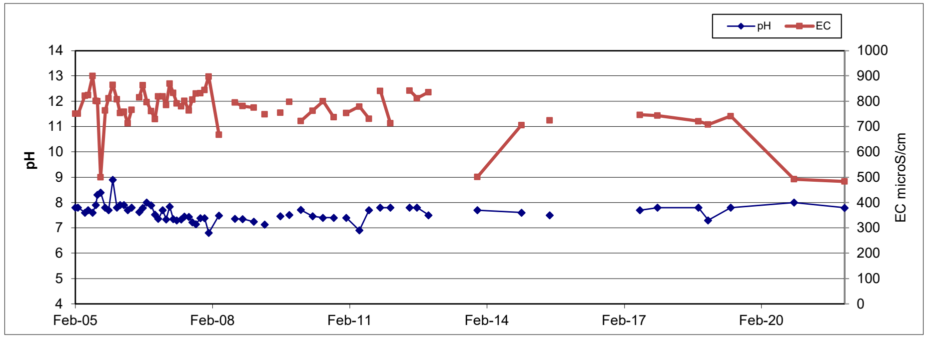

Alkalinity mg/l CaCO3
700
600
500
400
300
200
100
0
14 January 2004
10 October 2006
06 July 2009
01 April 2012
27 December 2014
23 September 2017
18 June 2020
15 March 2023

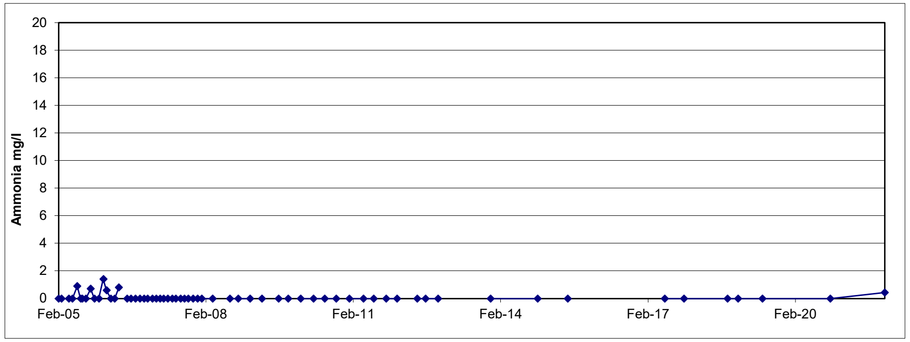

Chromium
Nickel
Lead
Vanadium
Zinc
microg/l
45
40
35
30
25
20
15
10
5
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

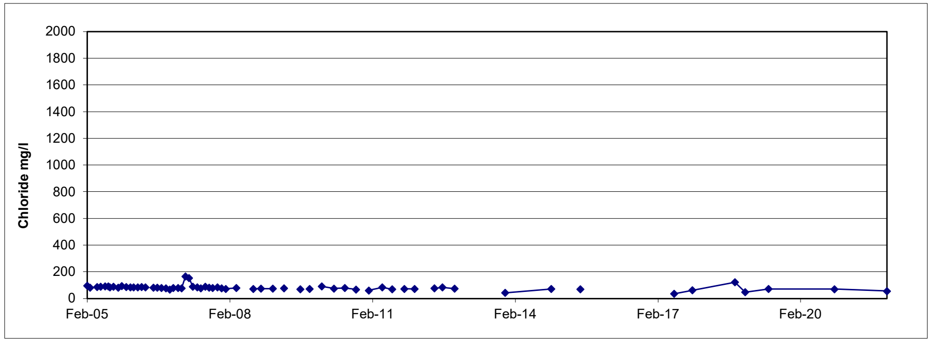

Sodium
Potassium
Magnesium
Sulphate
mg/l
120
100
80
60
40
20
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

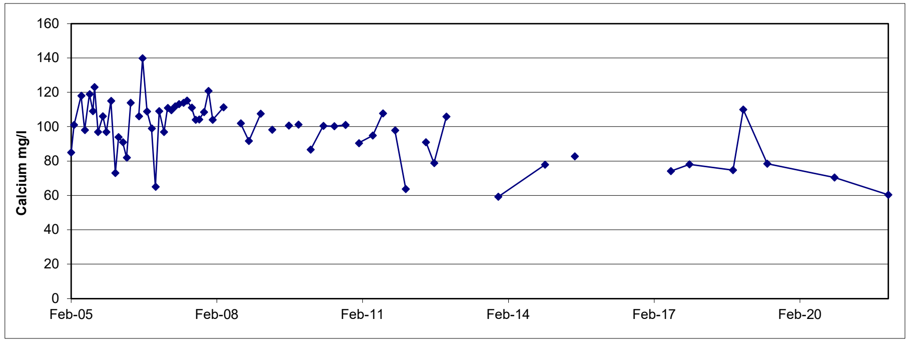

Nitrate
Nitrite
Phosphate
mg/l
16
14
12
10
8
6
4
2
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

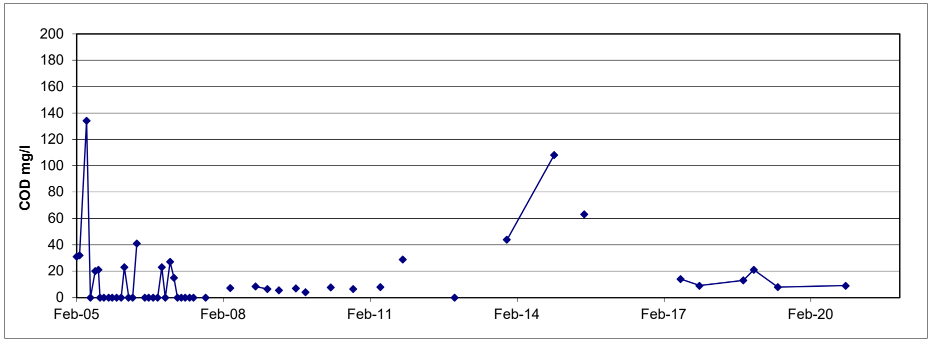

Cadmium
Mercury
microg/l
1.2
1
0.8
0.6
0.4
0.2
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

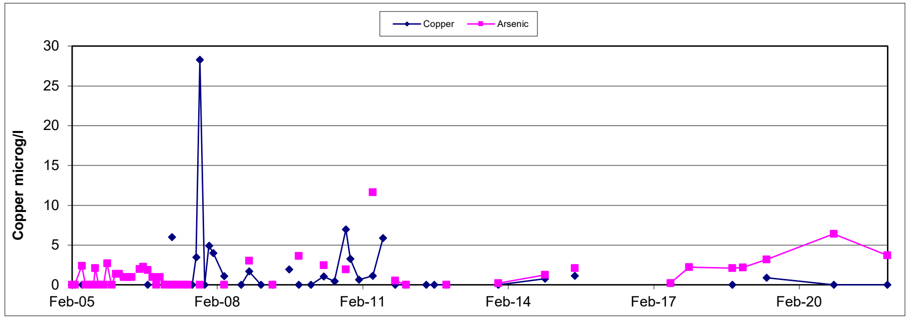

pH
EC
pH
EC microS/cm
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

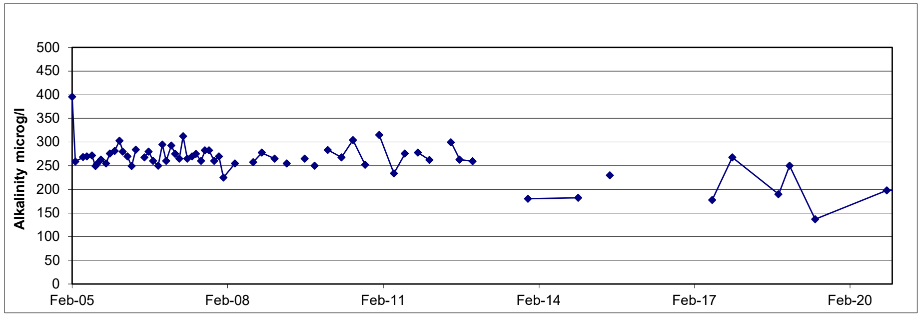

Ammonia mg/l
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

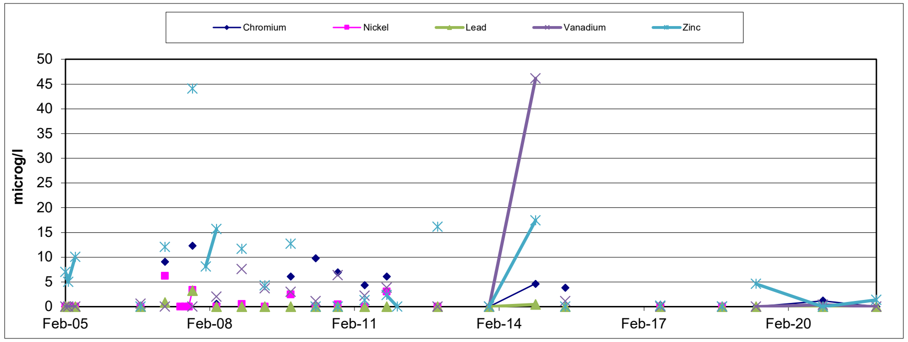

Chloride mg/l
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

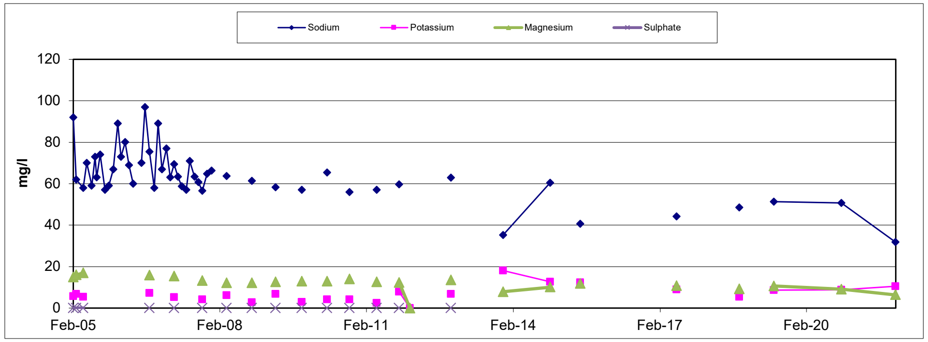

Calcium mg/l
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

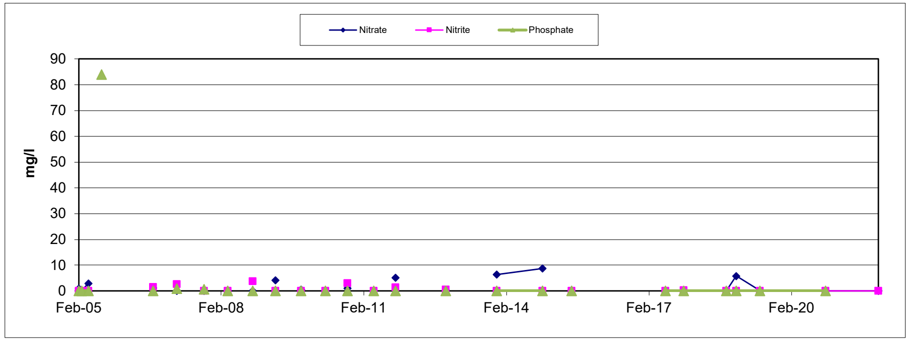

COD mg/l
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

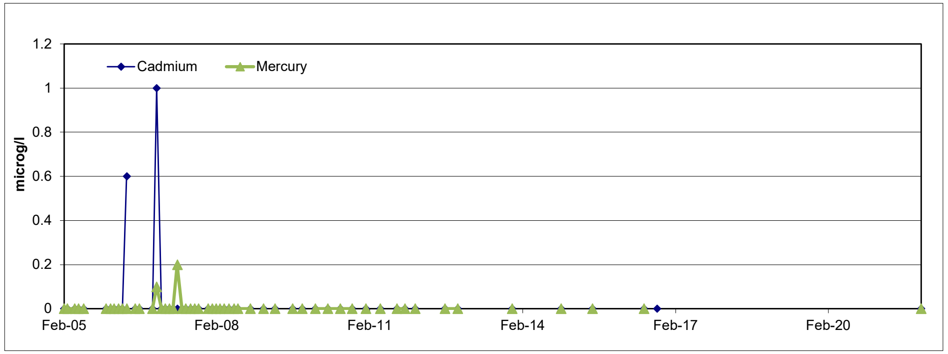

Copper
Arsenic
Copper microg/l
0 5 10 15 20 25 30
Feb-05 Feb-08 Feb-11 Feb-14 Feb-17 Feb-20

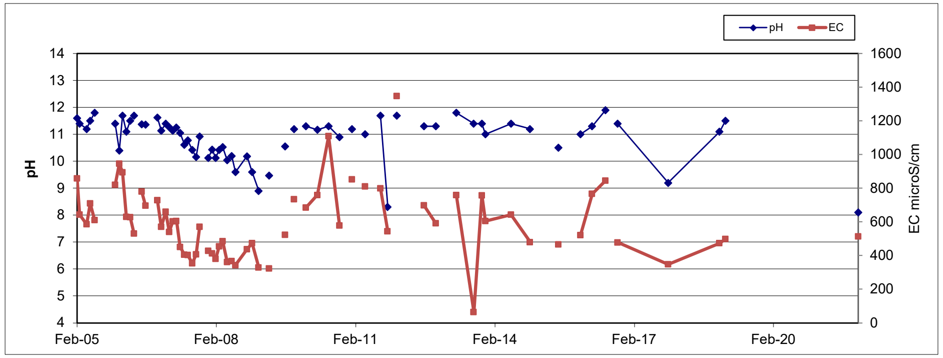

Alkalinity microg/l
0 50 100 150 200 250 300 350 400 450 500
Feb-05 Feb-08 Feb-11 Feb-14 Feb-17 Feb-20

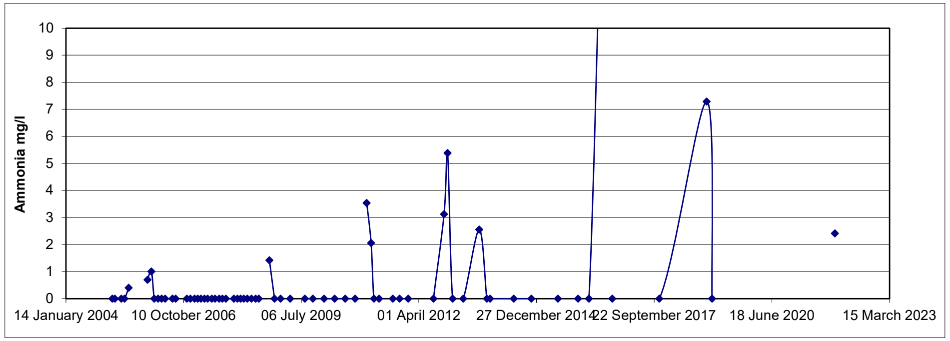

Chromium
Nickel
Lead
Vanadium
Zinc
microg/l
0 5 10 15 20 25 30 35 40 45 50
Feb-05 Feb-08 Feb-11 Feb-14 Feb-17 Feb-20

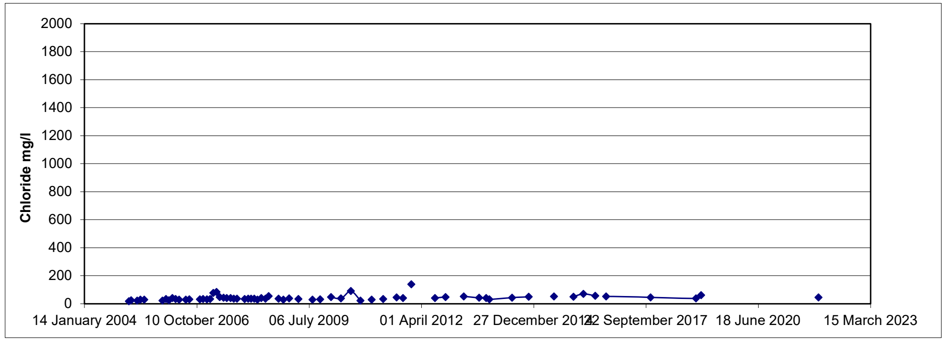

Sodium
Potassium
Magnesium
Sulphate
mg/l
0 20 40 60 80 100 120
Feb-05 Feb-08 Feb-11 Feb-14 Feb-17 Feb-20

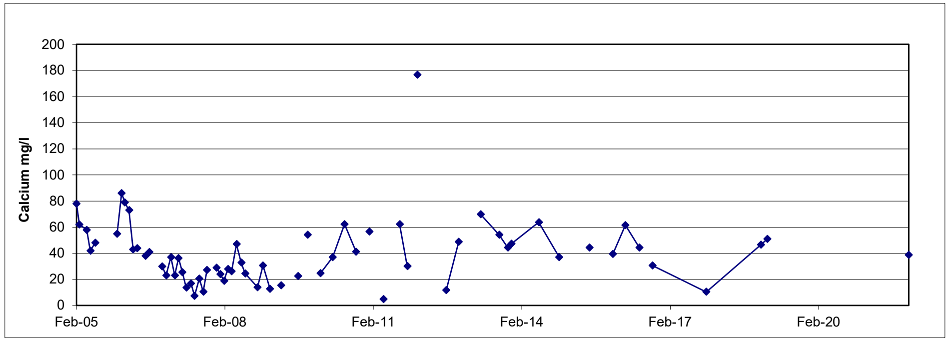

Nitrate
Nitrite
Phosphate
mg/l
0 10 20 30 40 50 60 70 80 90
Feb-05 Feb-08 Feb-11 Feb-14 Feb-17 Feb-20

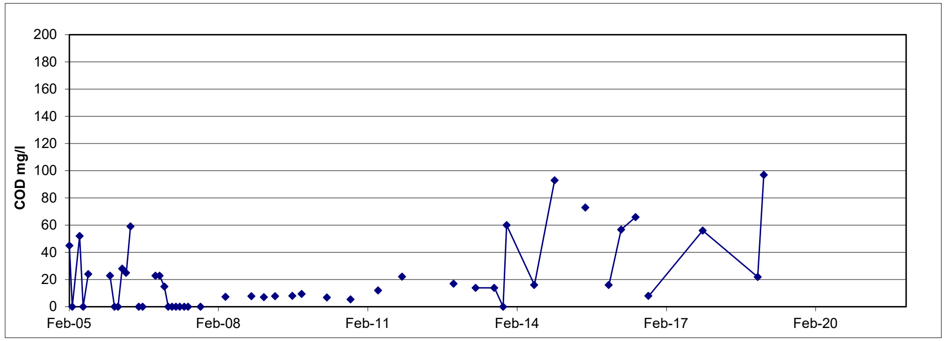

Cadmium
Mercury
microg/l
1.2
1
0.8
0.6
0.4
0.2
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

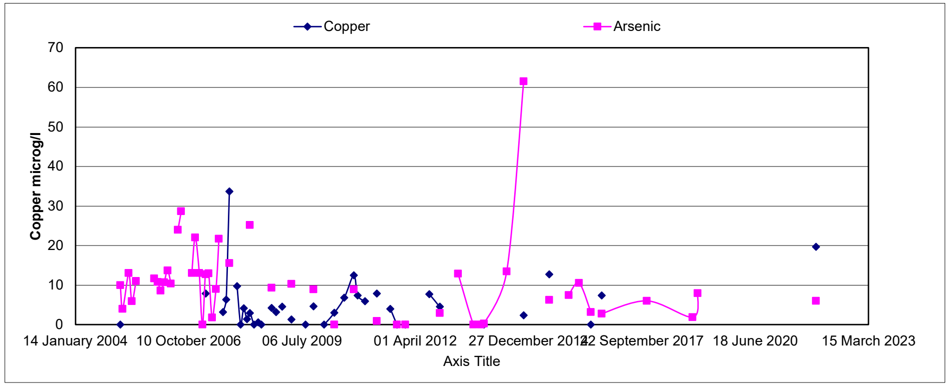

pH
EC
pH
EC microS/cm
14
13
12
11
10
9
8
7
6
5
4
1600
1400
1200
1000
800
600
400
200
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

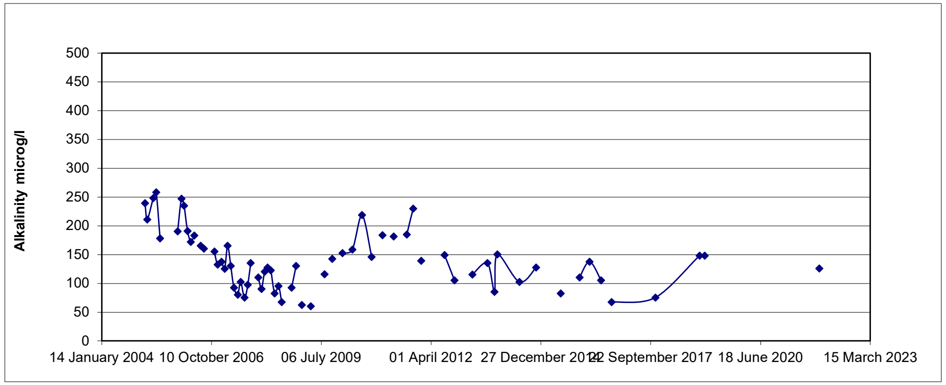

Ammonia mg/l
10
9
8
7
6
5
4
3
2
1
0
14 January 2004
10 October 2006
06 July 2009
01 April 2012
27 December 2014
22 September 2017
18 June 2020
15 March 2023

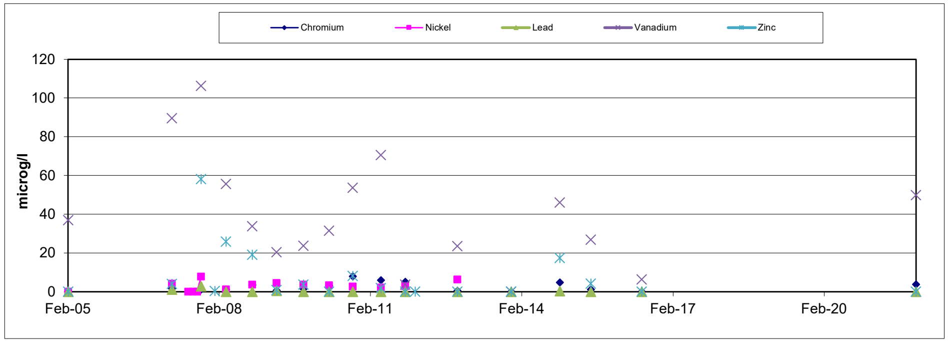

Chloride mg/l
2000
1800
1600
1400
1200
1000
800
600
400
200
0
14 January 2004
10 October 2006
06 July 2009
01 April 2012
27 December 2014
22 September 2017
18 June 2020
15 March 2023

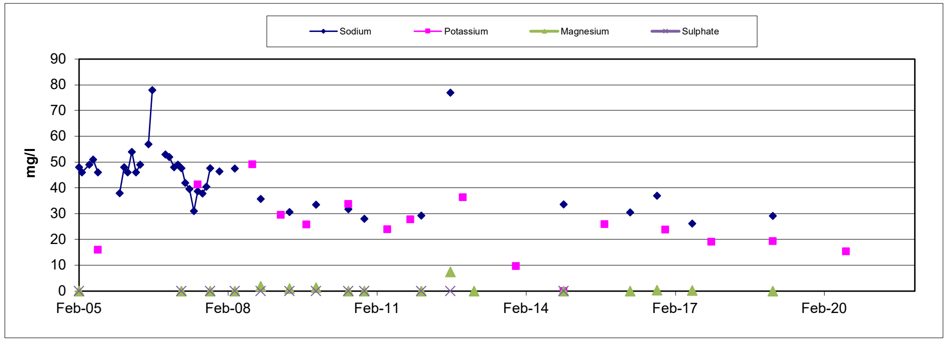

Calcium mg/l
200
180
160
140
120
100
80
60
40
20
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

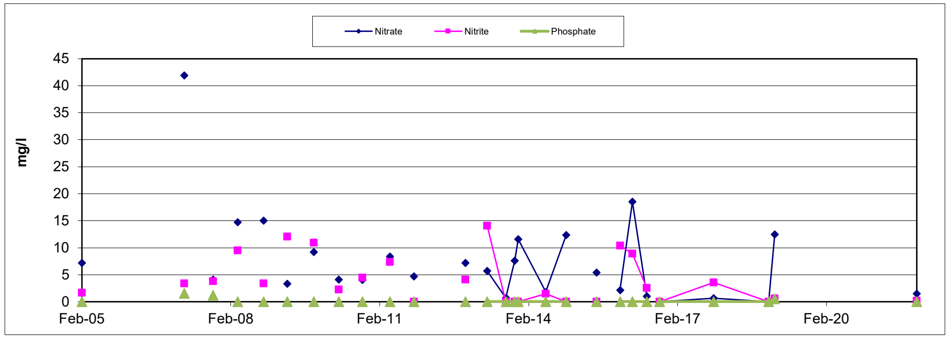

COD mg/l
200
180
160
140
120
100
80
60
40
20
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

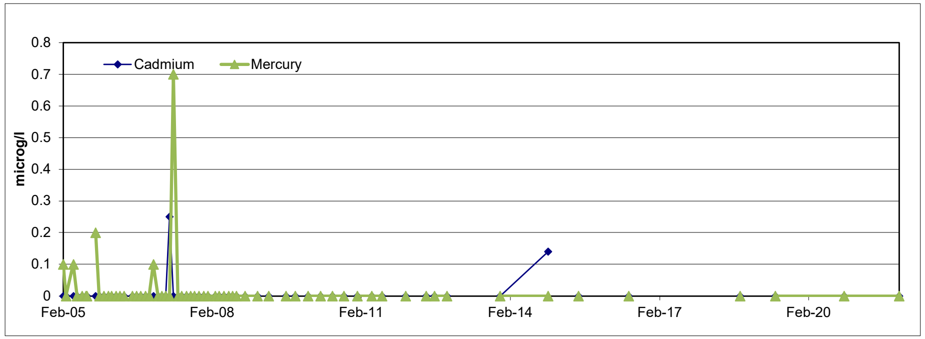

Copper
Arsenic
Copper microg/l
Axis Title

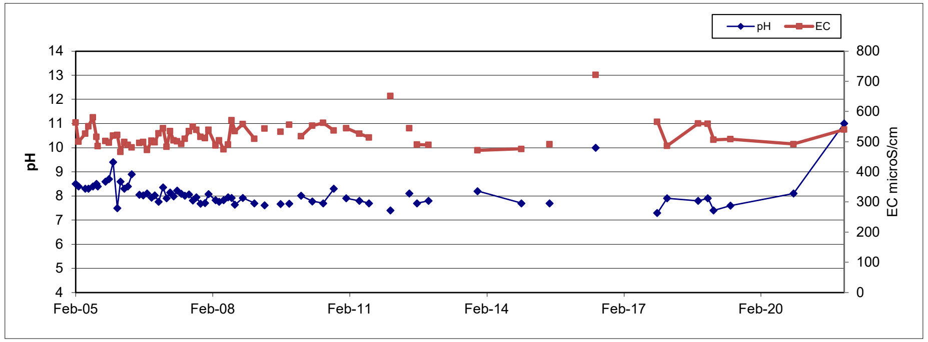

Alkalinity microg/l

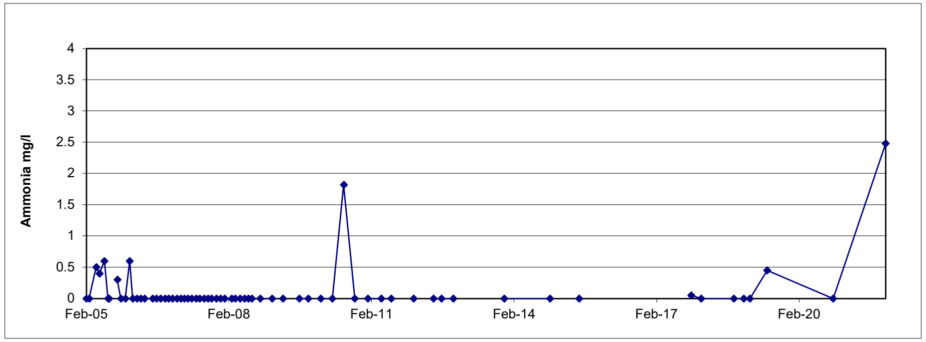

Chromium
Nickel
Lead
Vanadium
Zinc
microg/l

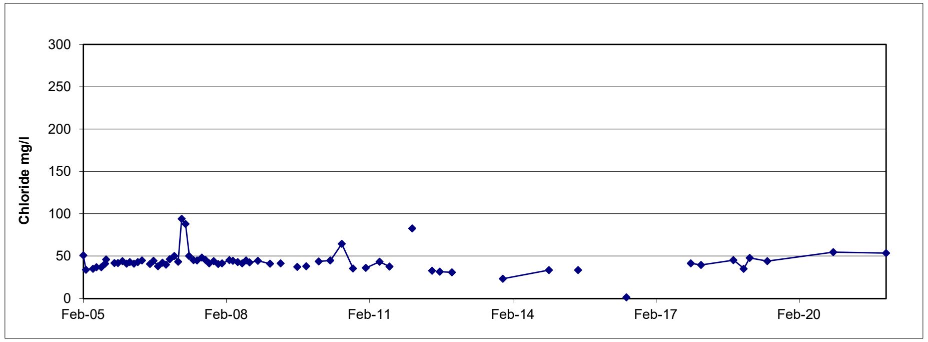

Sodium
Potassium
Magnesium
Sulphate
mg/l

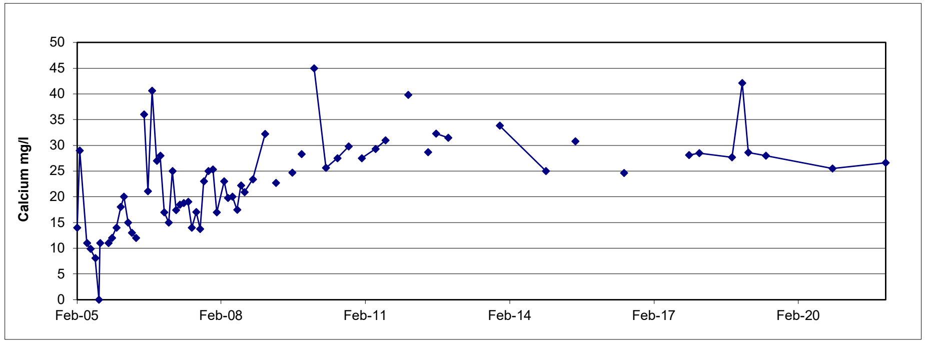

Nitrate
Nitrite
Phosphate
mg/l

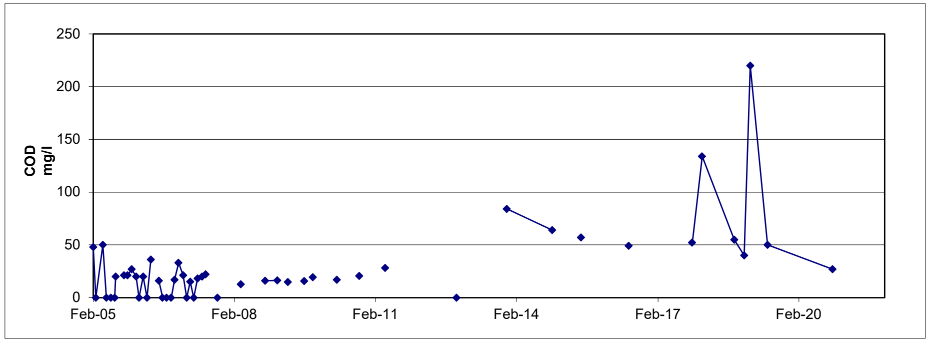

Cadmium
Mercury
microg/l
0.8 0.7 0.6 0.5 0.4 0.3 0.2 0.1 0
Feb-05 Feb-08 Feb-11 Feb-14 Feb-17 Feb-20

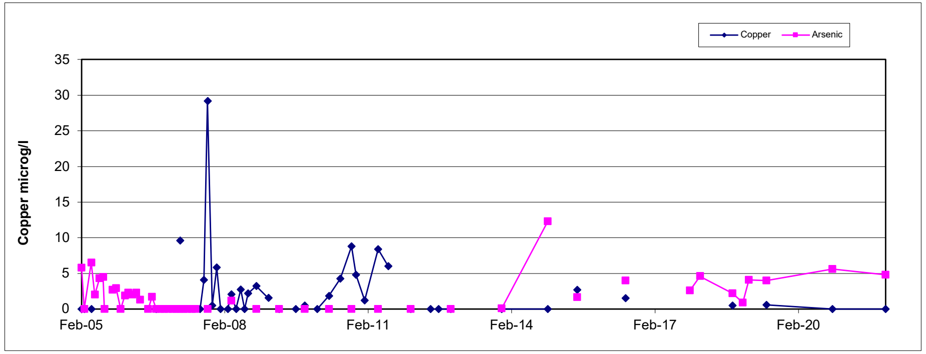

pH
EC
pH
EC microS/cm
14 13 12 11 10 9 8 7 6 5 4
800 700 600 500 400 300 200 100 0
Feb-05 Feb-08 Feb-11 Feb-14 Feb-17 Feb-20

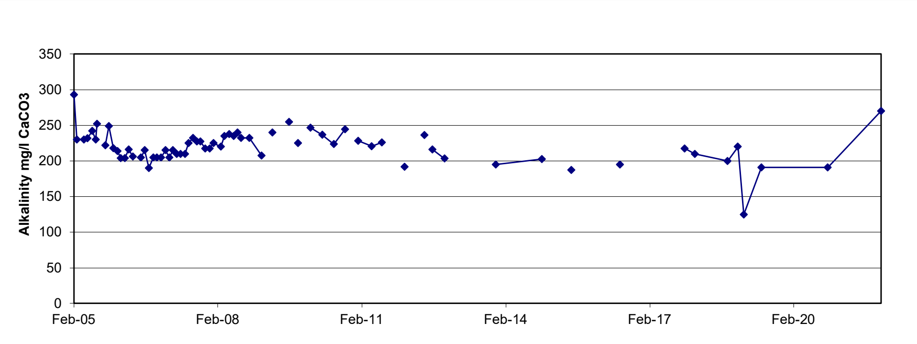

Ammonia mg/l
4 3.5 3 2.5 2 1.5 1 0.5 0
Feb-05 Feb-08 Feb-11 Feb-14 Feb-17 Feb-20

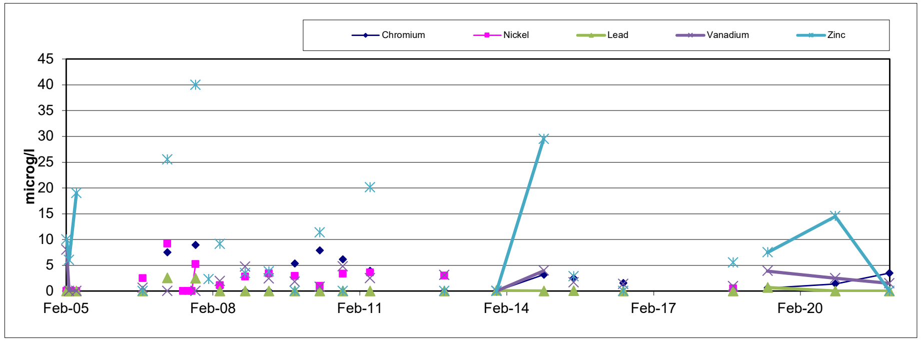

Chloride mg/l
300 250 200 150 100 50 0
Feb-05 Feb-08 Feb-11 Feb-14 Feb-17 Feb-20

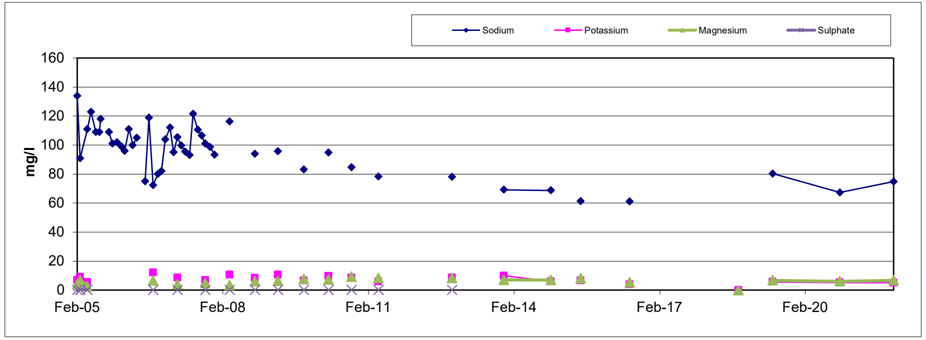

Calcium mg/l
50 45 40 35 30 25 20 15 10 5 0
Feb-05 Feb-08 Feb-11 Feb-14 Feb-17 Feb-20

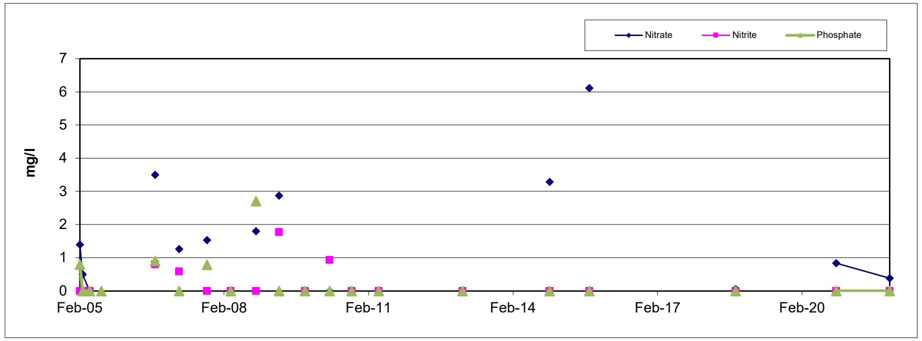

COD mg/l
250 200 150 100 50 0
Feb-05 Feb-08 Feb-11 Feb-14 Feb-17 Feb-20

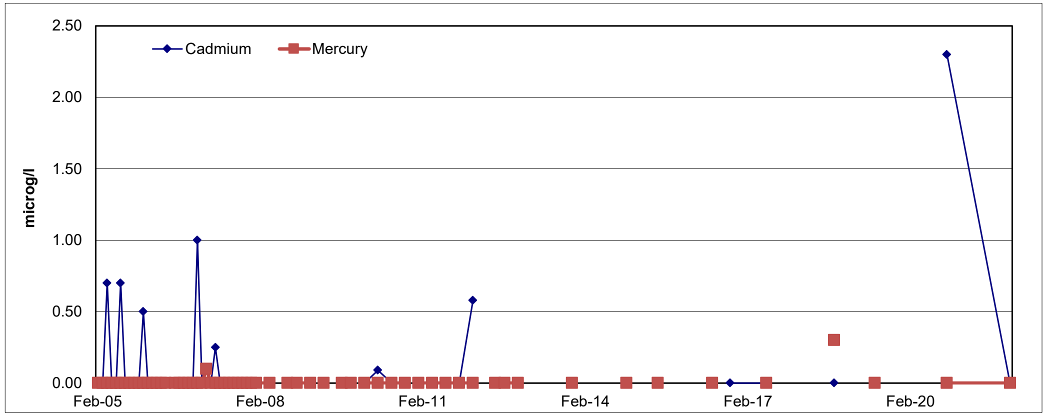

Copper
Arsenic
Copper microg/l
35
30
25
20
15
10
5
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

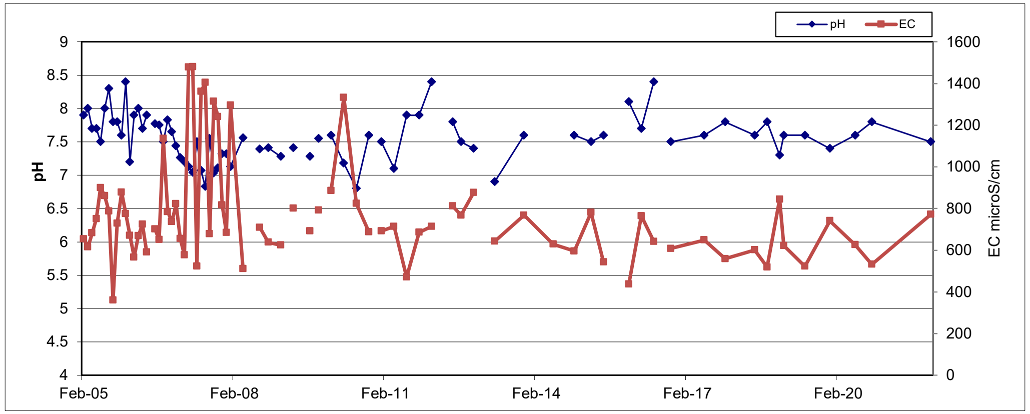

Alkalinity mg/l CaCO3
350
300
250
200
150
100
50
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

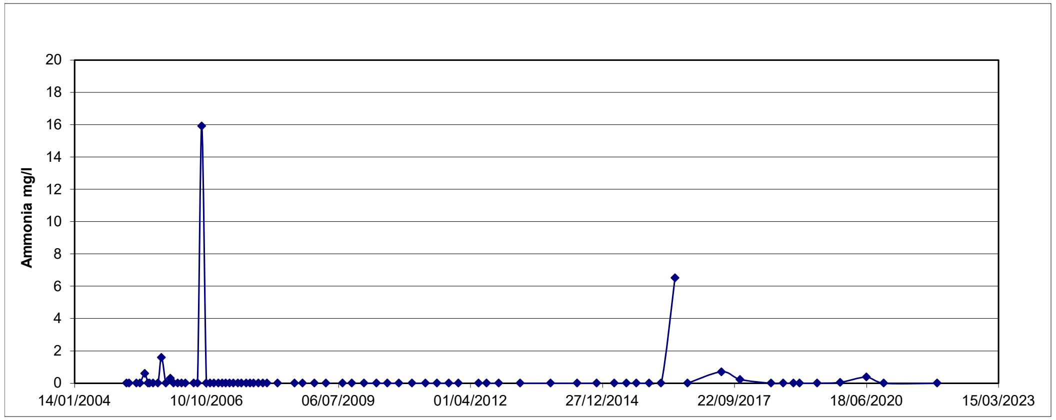

Chromium
Nickel
Lead
Vanadium
Zinc
microg/l
45
40
35
30
25
20
15
10
5
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

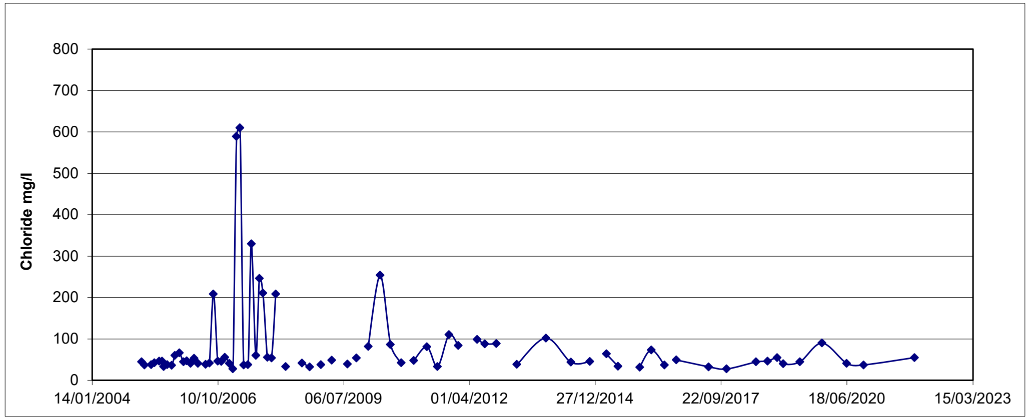

Sodium
Potassium
Magnesium
Sulphate
mg/l
160
140
120
100
80
60
40
20
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

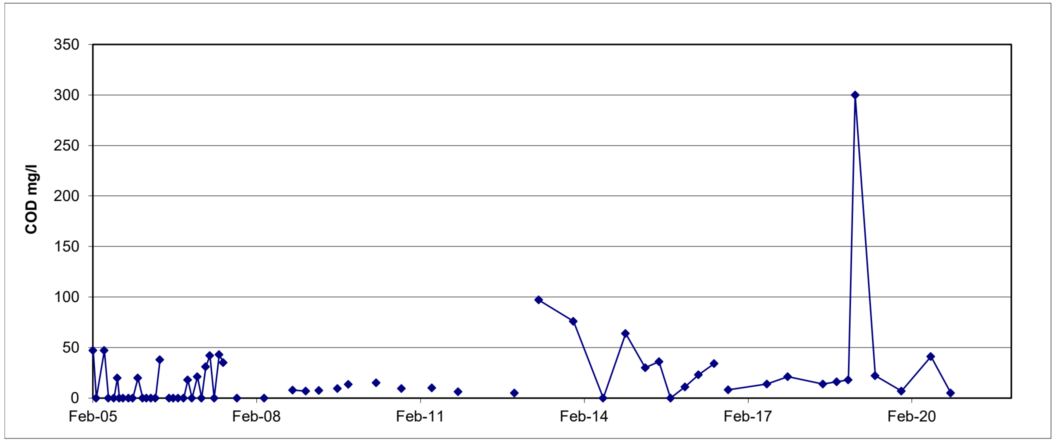

Nitrate
Nitrite
Phosphate
mg/l
7
6
5
4
3
2
1
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

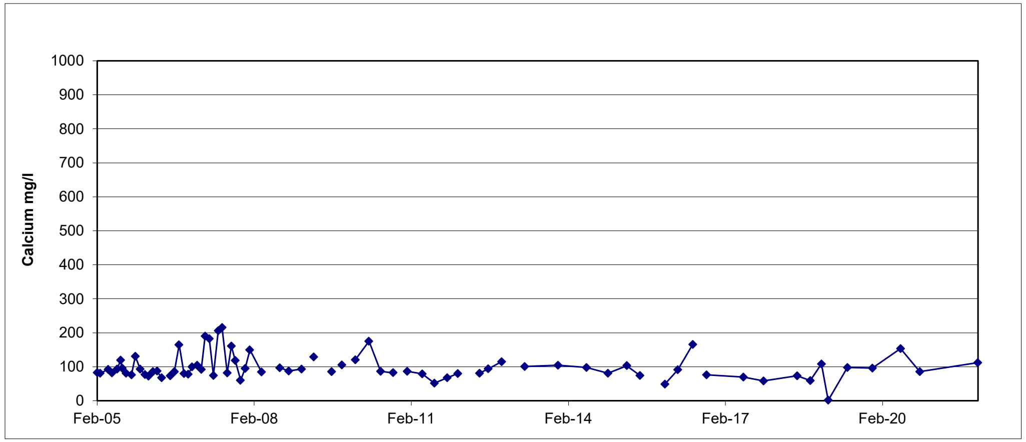

Cadmium
Mercury
microg/l
2.50
2.00
1.50
1.00
0.50
0.00
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

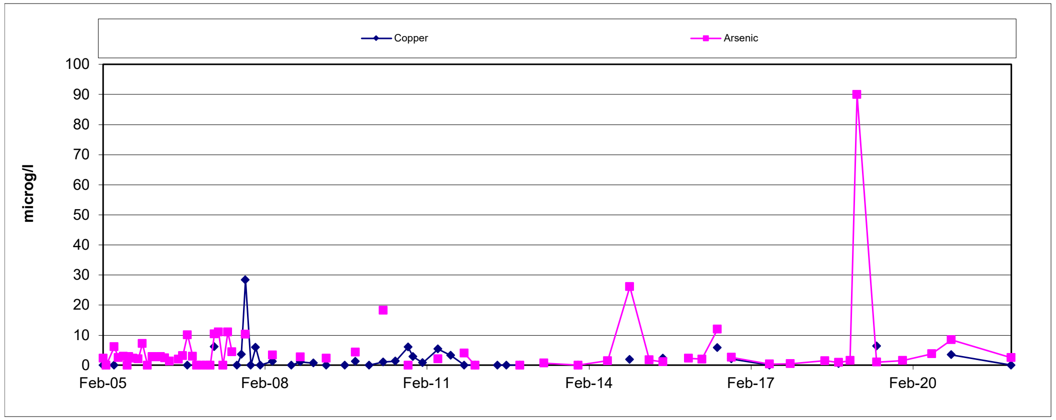

pH
EC
EC microS/cm
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

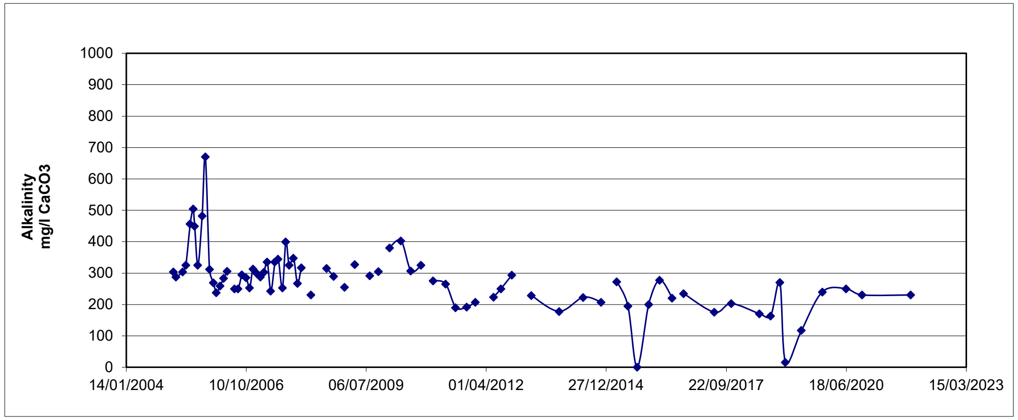

Ammonia mg/l
14/01/2004
10/10/2006
06/07/2009
01/04/2012
27/12/2014
22/09/2017
18/06/2020
15/03/2023

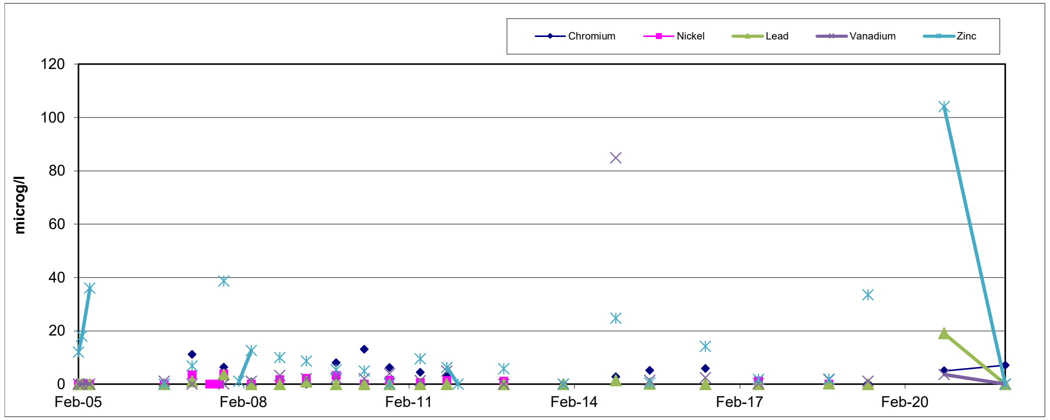

Chloride mg/l
14/01/2004
10/10/2006
06/07/2009
01/04/2012
27/12/2014
22/09/2017
18/06/2020
15/03/2023

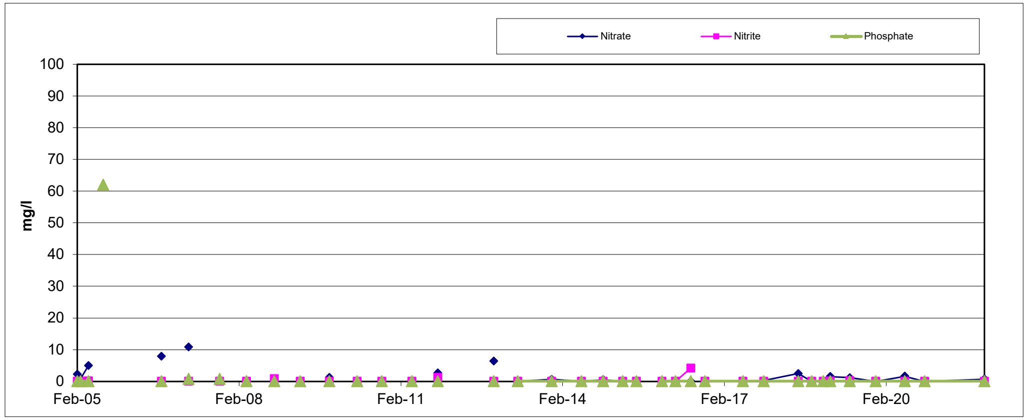

COD mg/l
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

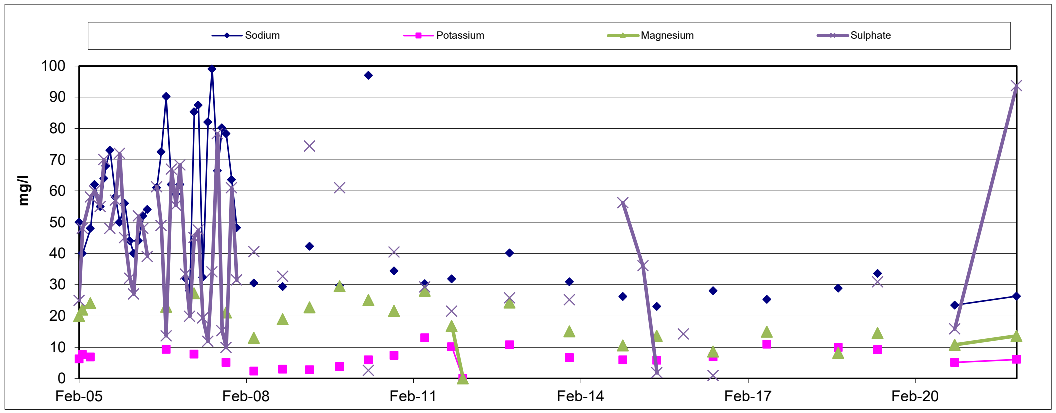

Calcium mg/l
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

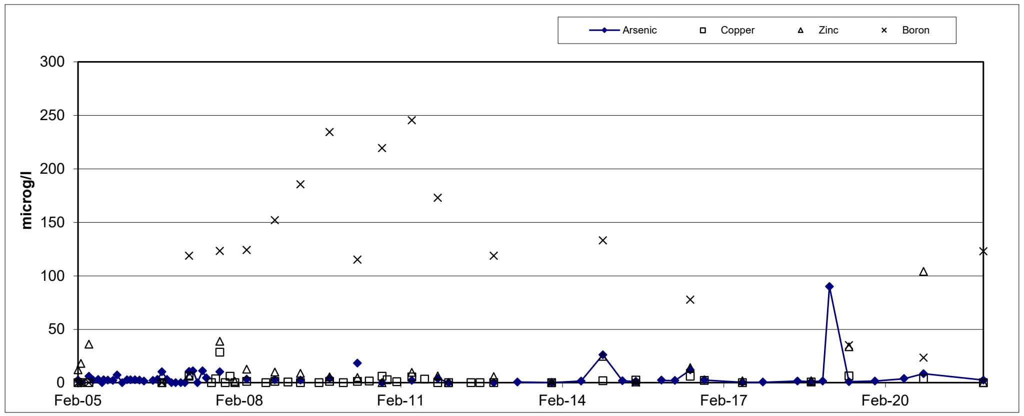

Copper
Arsenic
microg/l
Feb-05 Feb-08 Feb-11 Feb-14 Feb-17 Feb-20

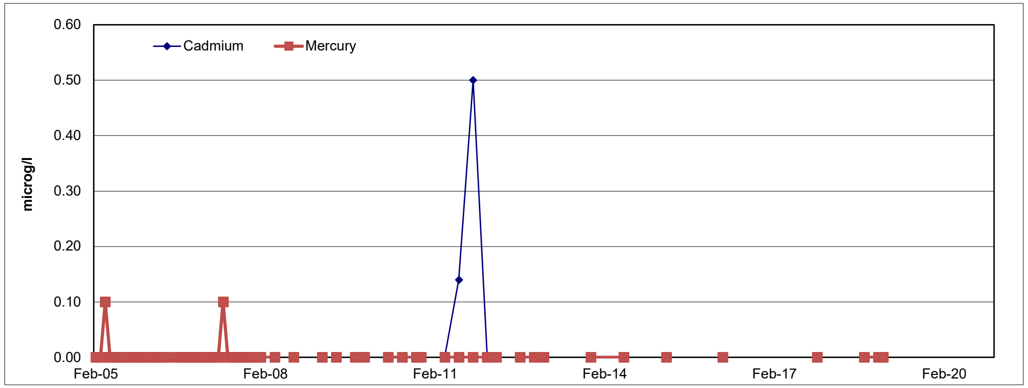

Alkalinity
mg/l CaCO3
14/01/2004 10/10/2006 06/07/2009 01/04/2012 27/12/2014 22/09/2017 18/06/2020 15/03/2023

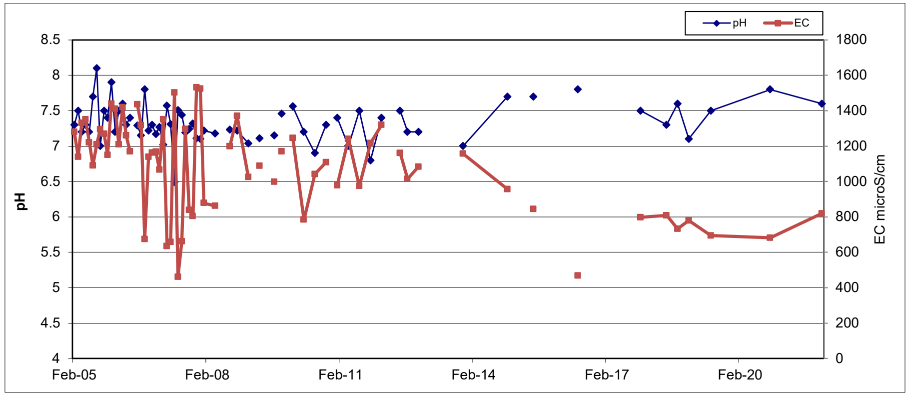

Chromium
Nickel
Lead
Vanadium
Zinc
microg/l
Feb-05 Feb-08 Feb-11 Feb-14 Feb-17 Feb-20

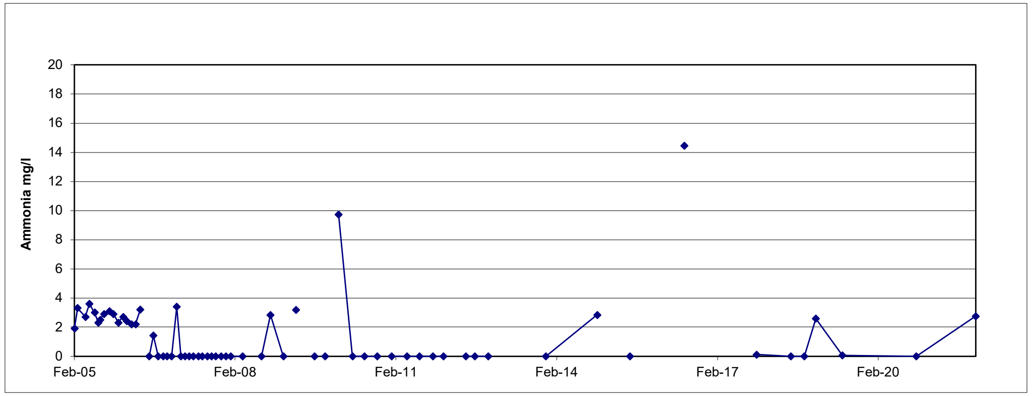

Nitrate
Nitrite
Phosphate
mg/l
Feb-05 Feb-08 Feb-11 Feb-14 Feb-17 Feb-20

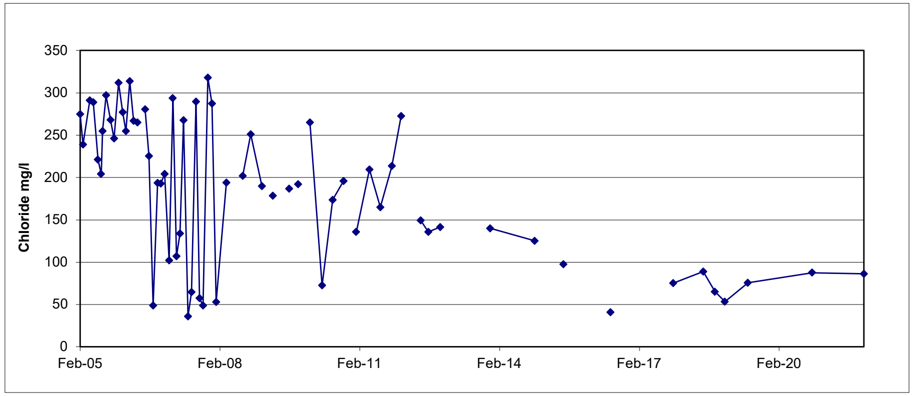

Sodium
Potassium
Magnesium
Sulphate
mg/l
Feb-05 Feb-08 Feb-11 Feb-14 Feb-17 Feb-20

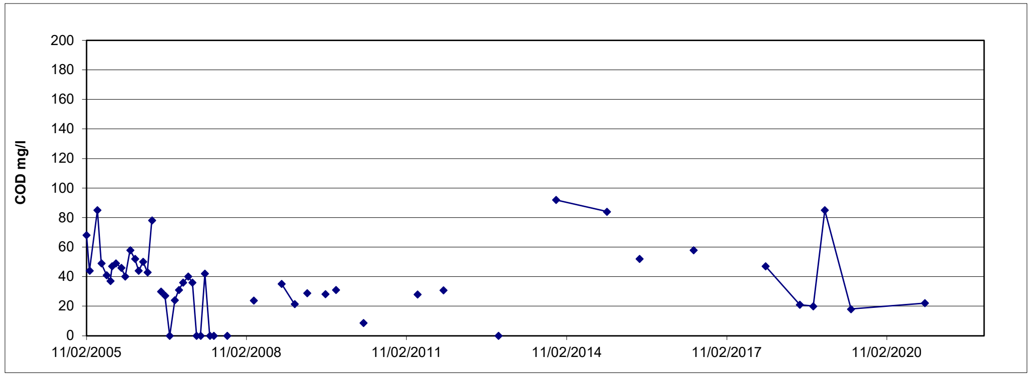

Arsenic
Copper
Zinc
Boron
microg/l
Feb-05 Feb-08 Feb-11 Feb-14 Feb-17 Feb-20

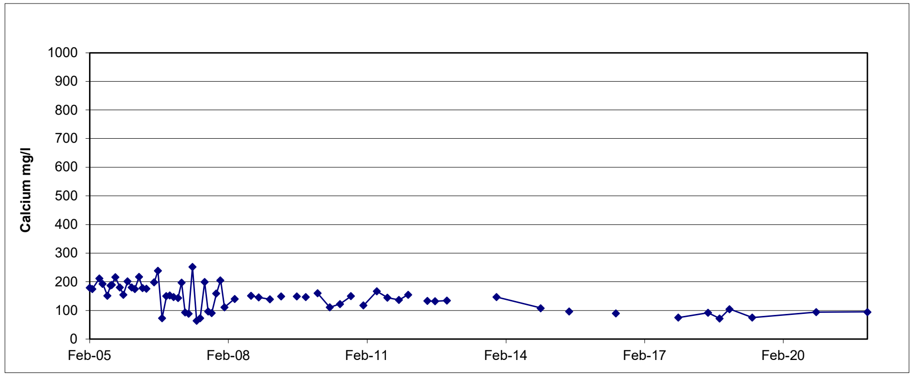

Cadmium
Mercury
microg/l
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

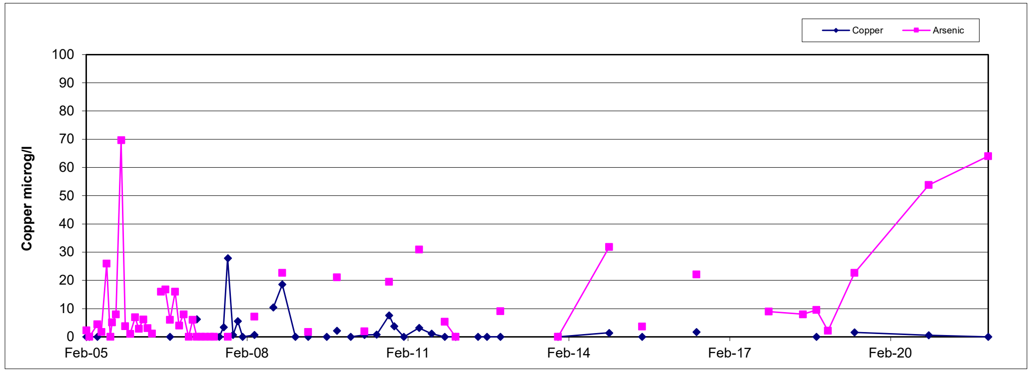

pH
EC
pH
EC microS/cm
8.5
8
7.5
7
6.5
6
5.5
5
4.5
4
1800
1600
1400
1200
1000
800
600
400
200
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

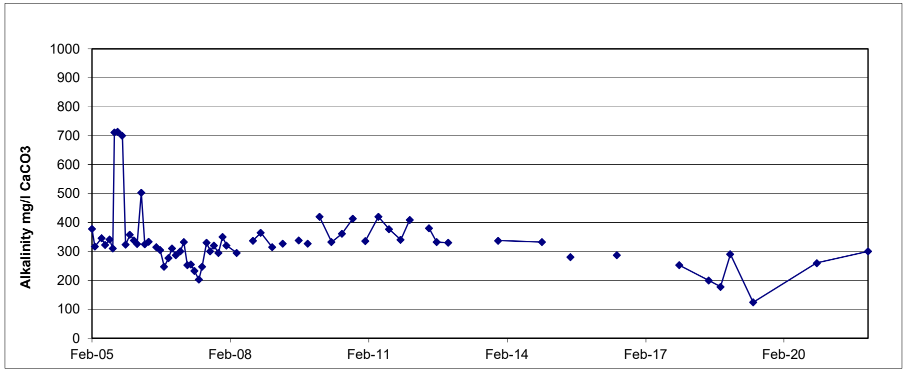

Ammonia mg/l
20
18
16
14
12
10
8
6
4
2
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

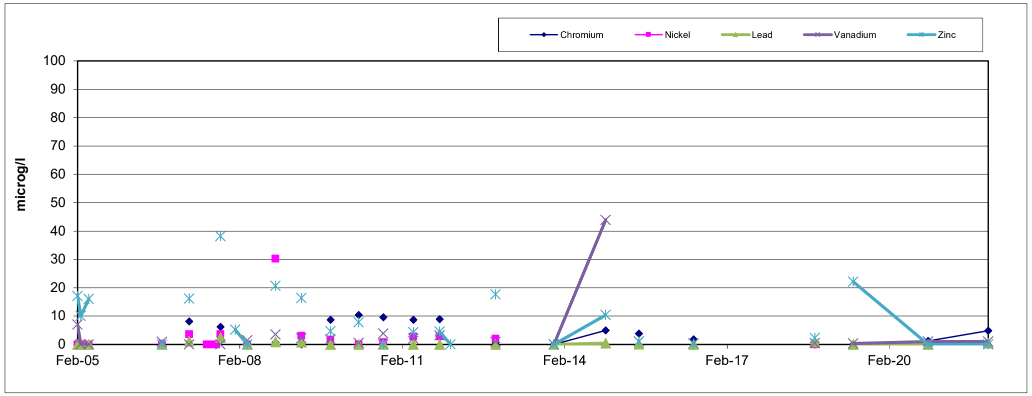

Chloride mg/l
350
300
250
200
150
100
50
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

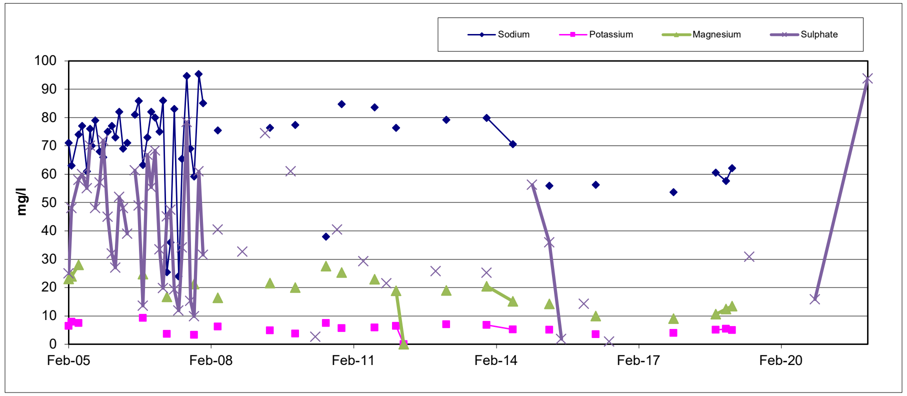

COD mg/l
200
180
160
140
120
100
80
60
40
20
0
11/02/2005
11/02/2008
11/02/2011
11/02/2014
11/02/2017
11/02/2020

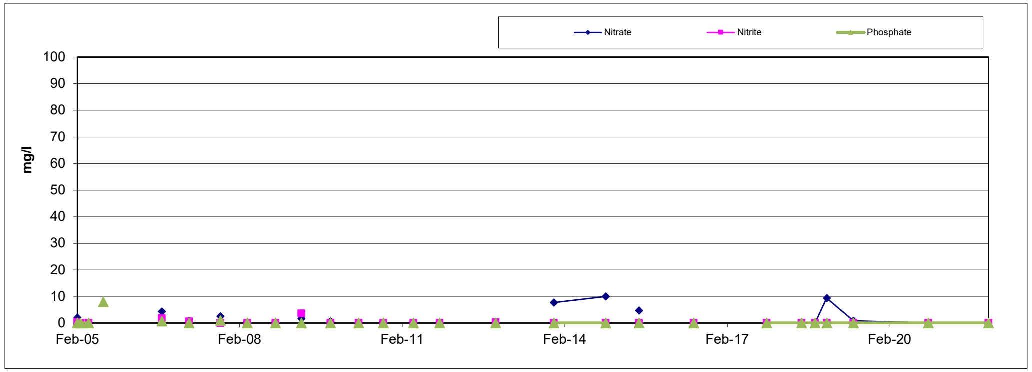

Calcium mg/l
1000
900
800
700
600
500
400
300
200
100
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

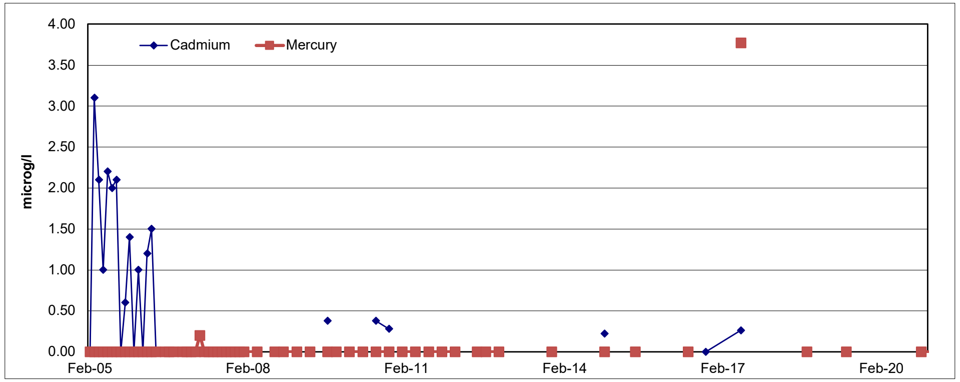

Copper
Arsenic
Copper microg/l
100
90
80
70
60
50
40
30
20
10
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

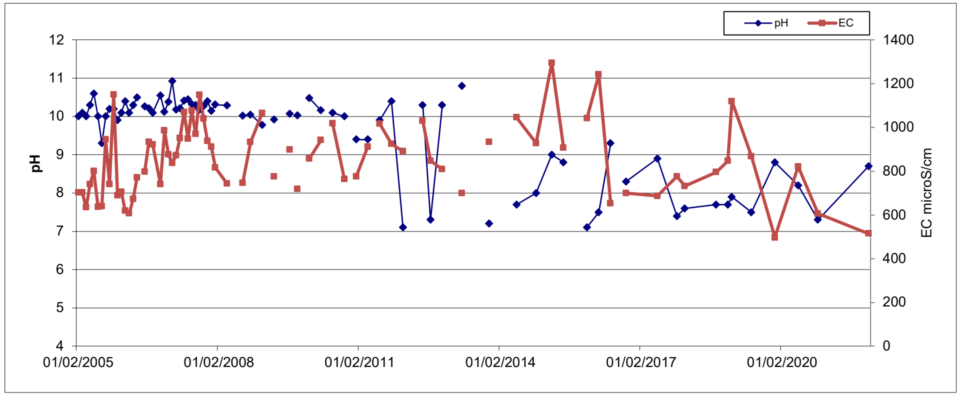

Alkalinity mg/l CaCO3
1000
900
800
700
600
500
400
300
200
100
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

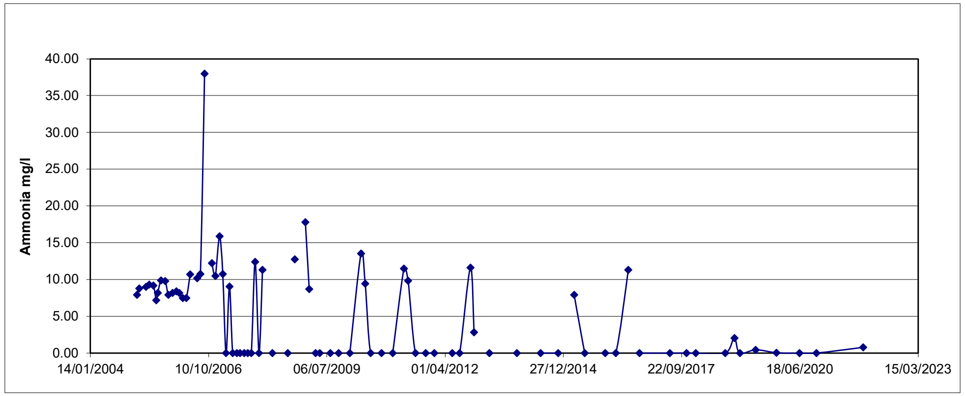

Chromium
Nickel
Lead
Vanadium
Zinc
microg/l
100
90
80
70
60
50
40
30
20
10
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

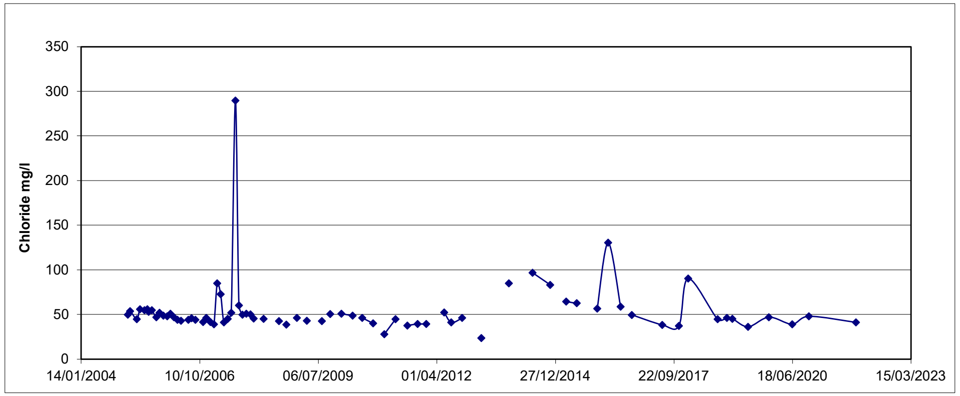

Sodium
Potassium
Magnesium
Sulphate
mg/l
100
90
80
70
60
50
40
30
20
10
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

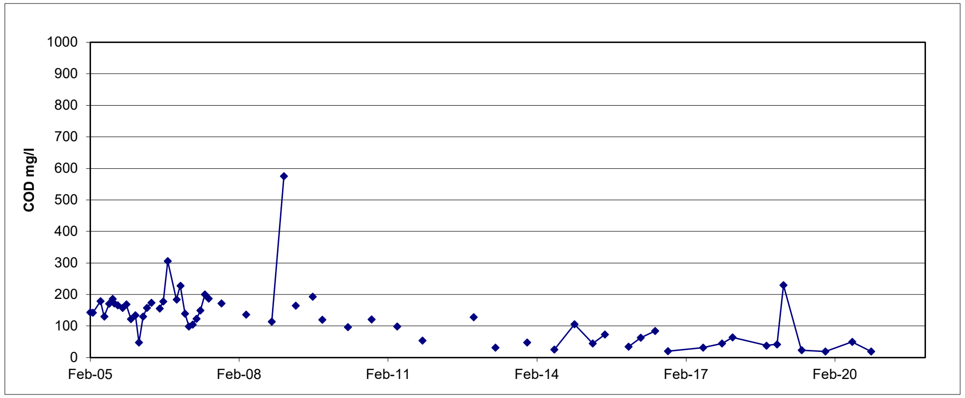

Nitrate
Nitrite
Phosphate
mg/l
100
90
80
70
60
50
40
30
20
10
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

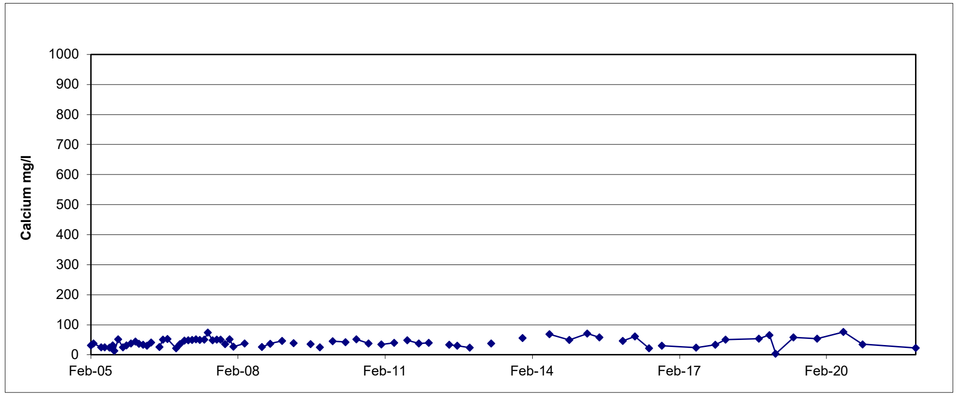

microg/l
Cadmium
Mercury
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

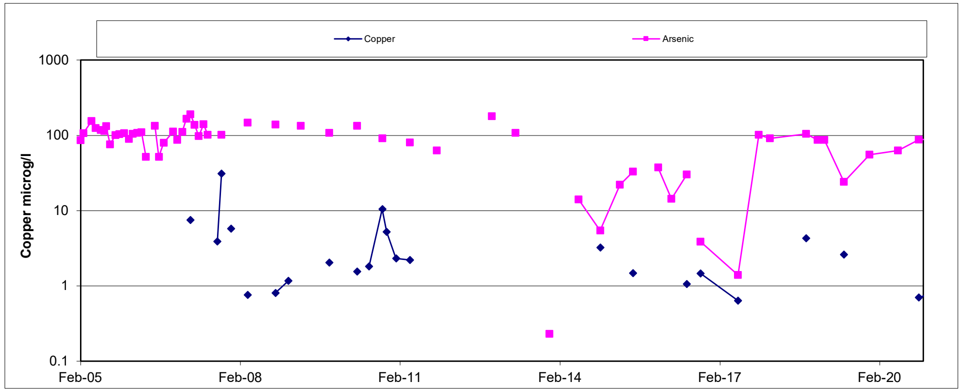

pH
EC
pH
EC microS/cm
12
11
10
9
8
7
6
5
4
1400
1200
1000
800
600
400
200
0
01/02/2005
01/02/2008
01/02/2011
01/02/2014
01/02/2017
01/02/2020

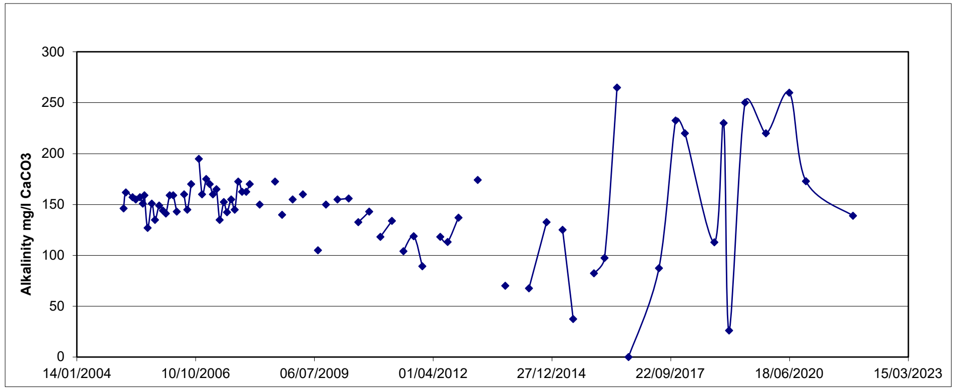

Ammonia mg/l
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
14/01/2004
10/10/2006
06/07/2009
01/04/2012
27/12/2014
22/09/2017
18/06/2020
15/03/2023

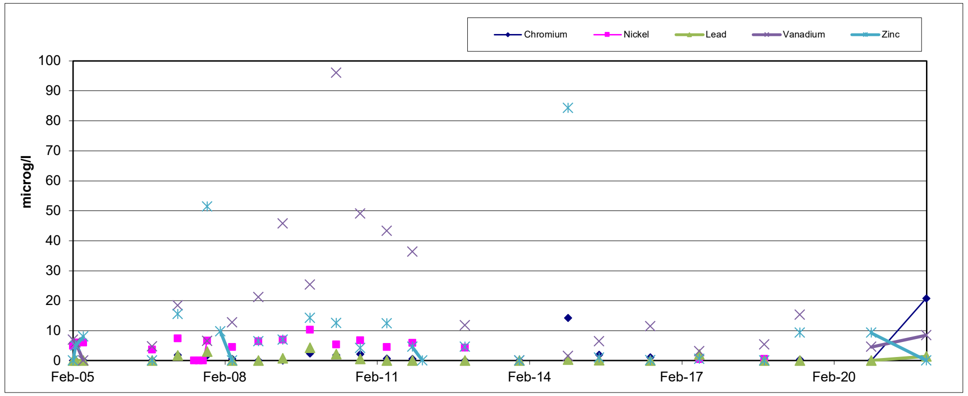

Chloride mg/l
350
300
250
200
150
100
50
0
14/01/2004
10/10/2006
06/07/2009
01/04/2012
27/12/2014
22/09/2017
18/06/2020
15/03/2023

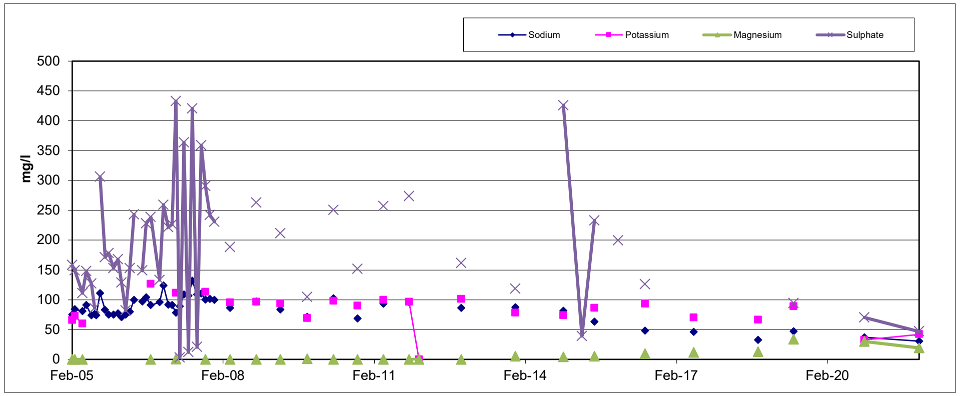

COD mg/l
1000
900
800
700
600
500
400
300
200
100
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

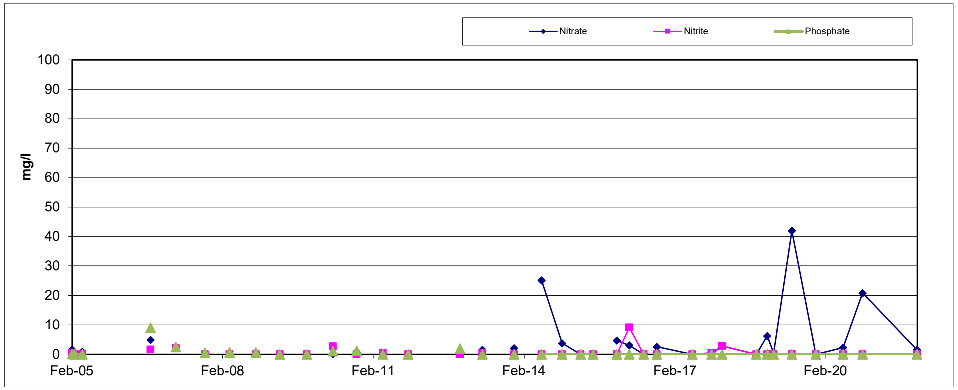

Calcium mg/l
1000
900
800
700
600
500
400
300
200
100
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

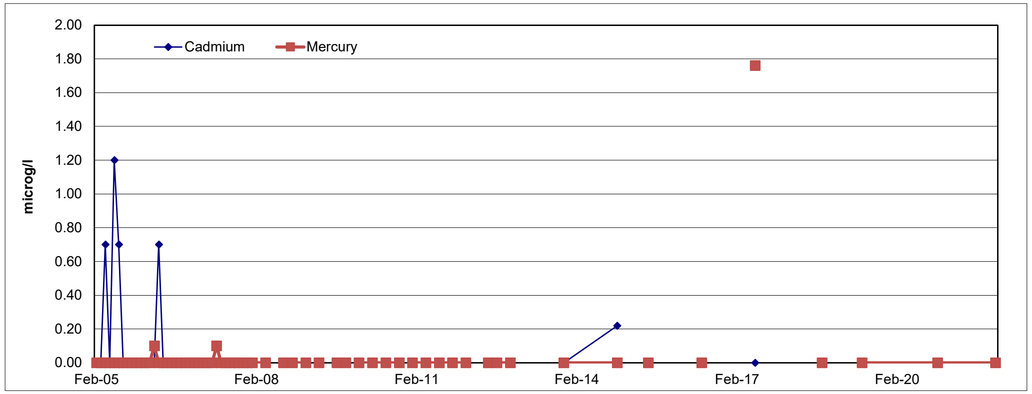

Copper
Arsenic
Copper microg/l
1000
100
10
1
0.1
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

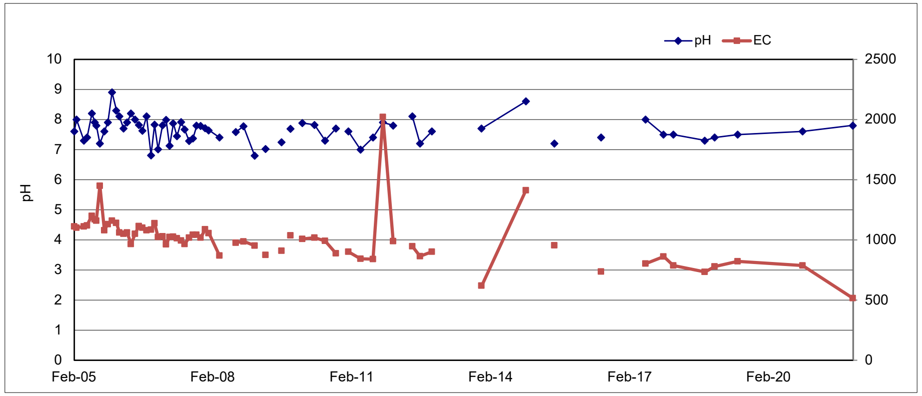

Alkalinity mg/l CaCO3
300
250
200
150
100
50
0
14/01/2004
10/10/2006
06/07/2009
01/04/2012
27/12/2014
22/09/2017
18/06/2020
15/03/2023

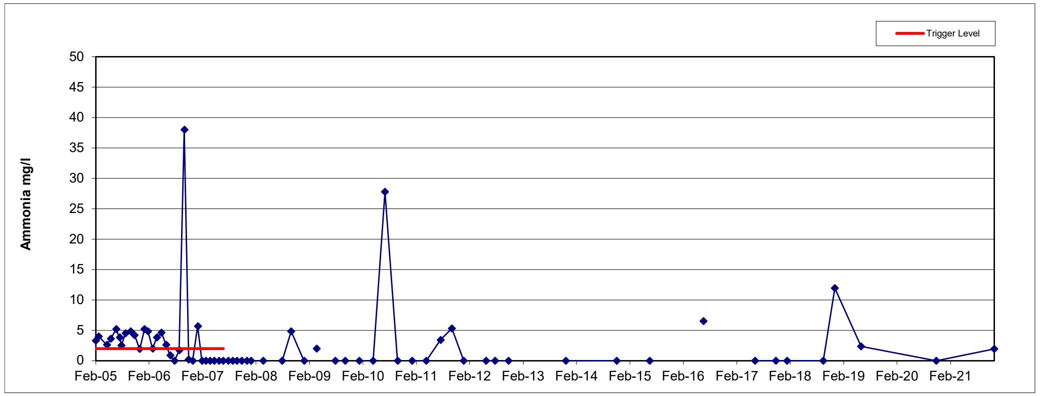

Chromium
Nickel
Lead
Vanadium
Zinc
microg/l
100
90
80
70
60
50
40
30
20
10
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

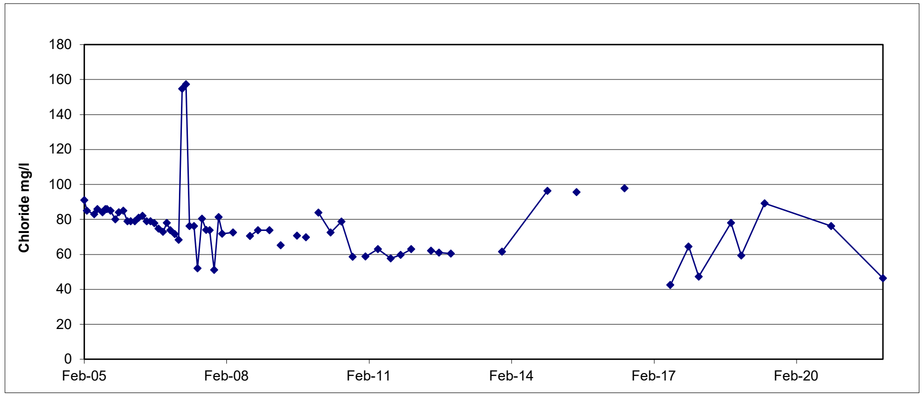

Sodium
Potassium
Magnesium
Sulphate
mg/l
500
450
400
350
300
250
200
150
100
50
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

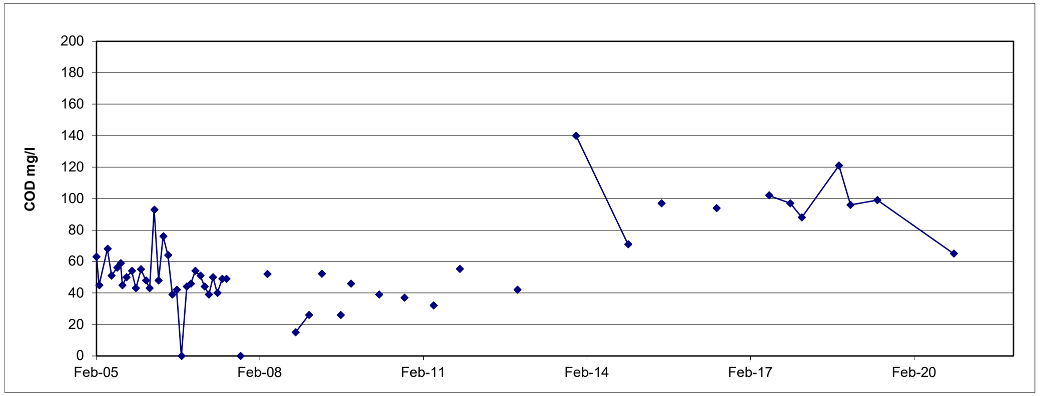

Nitrate
Nitrite
Phosphate
mg/l
100
90
80
70
60
50
40
30
20
10
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

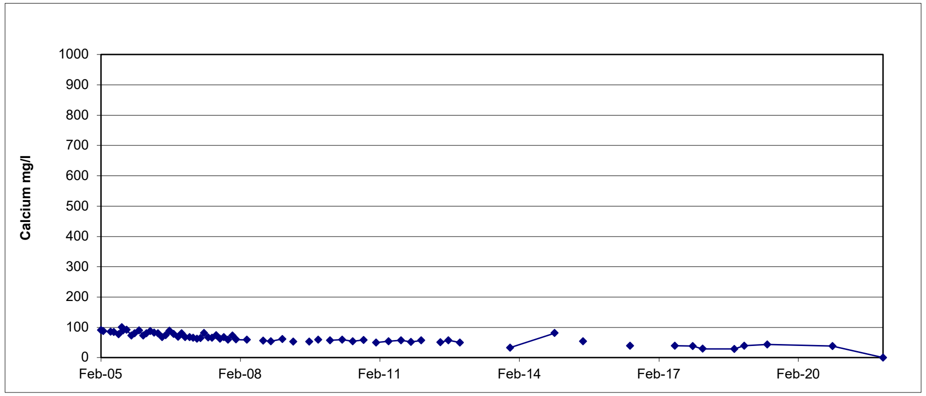

microg/l
Cadmium
Mercury
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

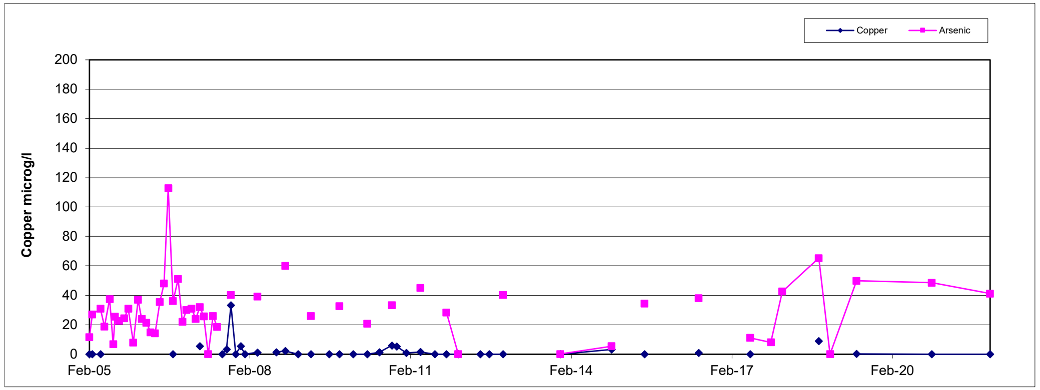

pH
EC
10
9
8
7
6
5
4
3
2
1
0
2500
2000
1500
1000
500
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

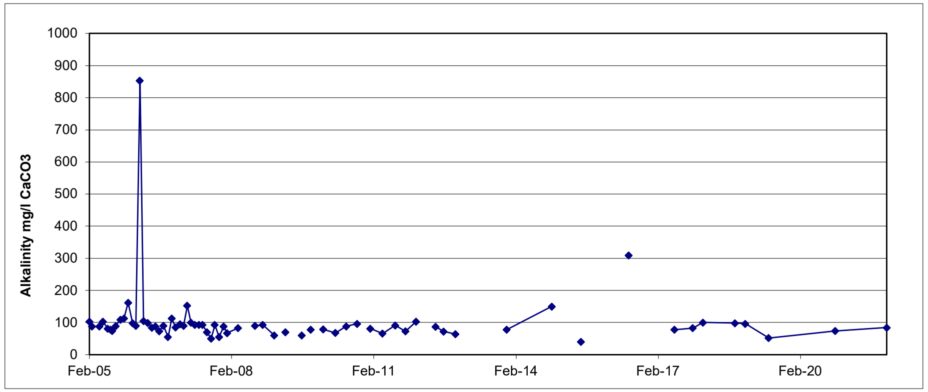

Ammonia mg/l
Trigger Level
50
45
40
35
30
25
20
15
10
5
0
Feb-05
Feb-06
Feb-07
Feb-08
Feb-09
Feb-10
Feb-11
Feb-12
Feb-13
Feb-14
Feb-15
Feb-16
Feb-17
Feb-18
Feb-19
Feb-20
Feb-21

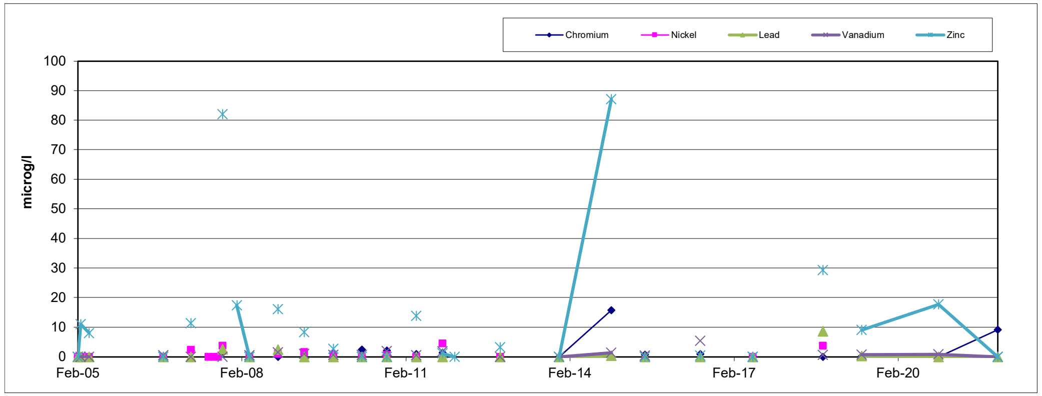

Chloride mg/l
180
160
140
120
100
80
60
40
20
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

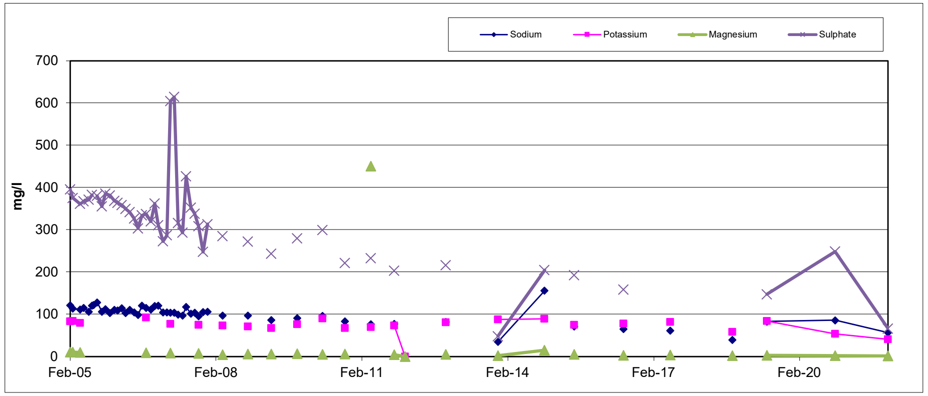

COD mg/l
200
180
160
140
120
100
80
60
40
20
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

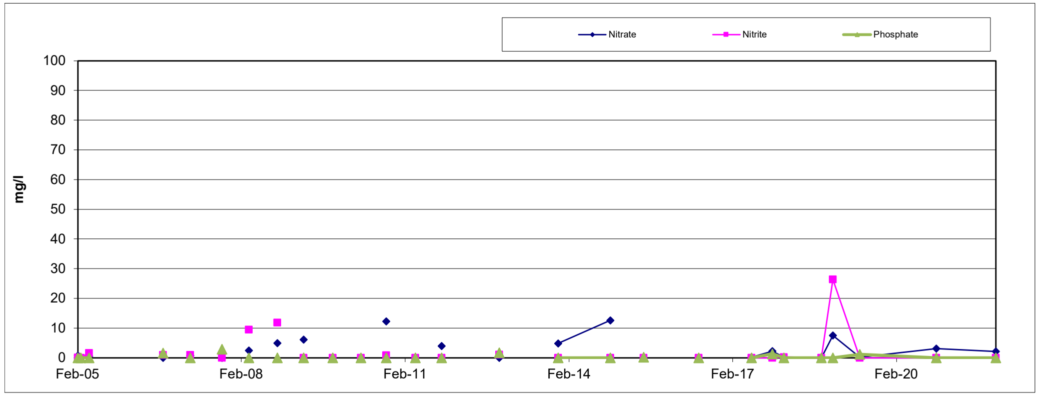

Calcium mg/l
1000
900
800
700
600
500
400
300
200
100
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

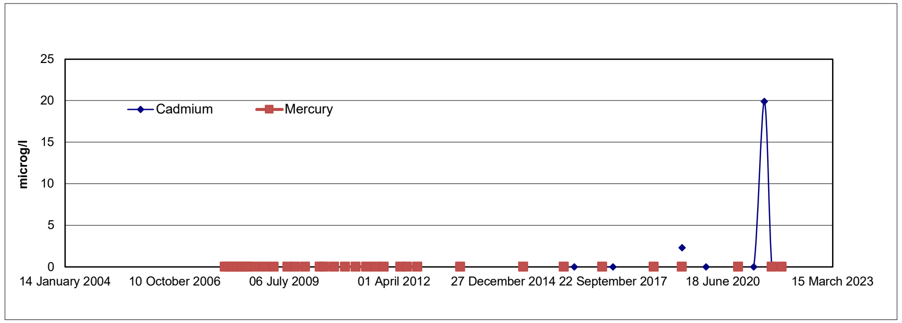

Copper
Arsenic
Copper microg/l
200
180
160
140
120
100
80
60
40
20
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

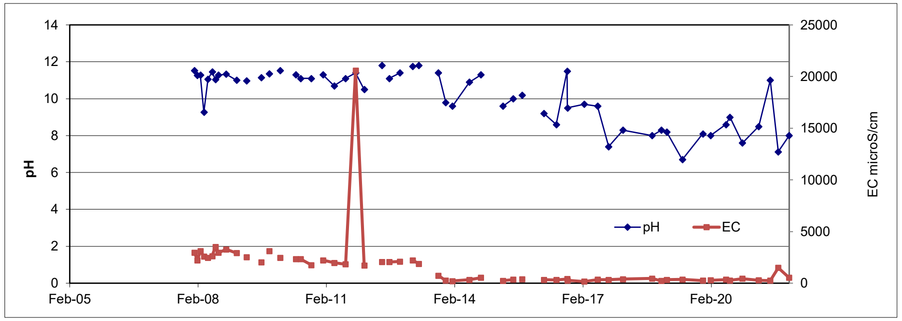

Alkalinity mg/l CaCO3
1000
900
800
700
600
500
400
300
200
100
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

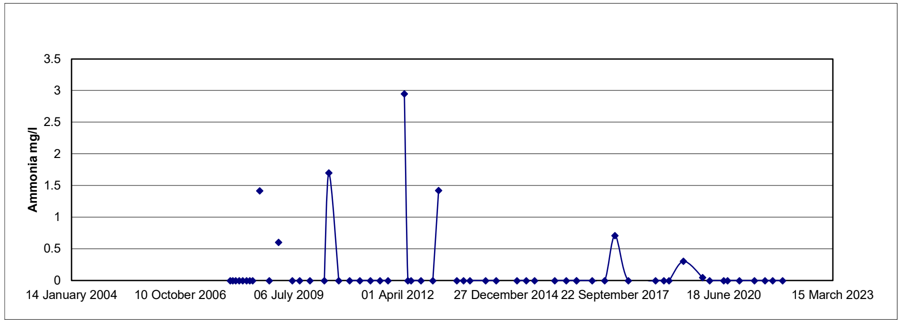

Chromium
Nickel
Lead
Vanadium
Zinc
microg/l
100
90
80
70
60
50
40
30
20
10
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

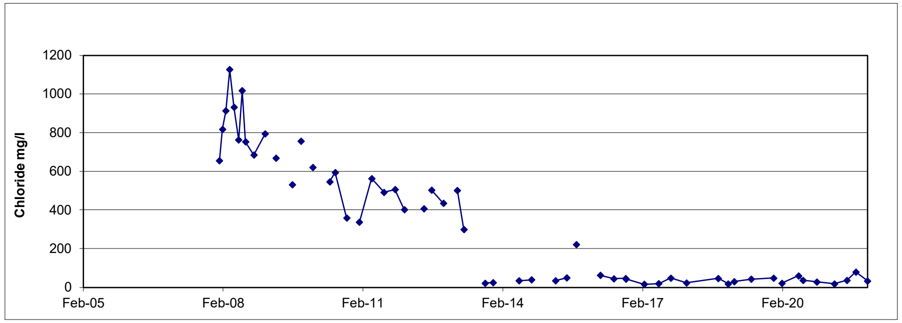

Sodium
Potassium
Magnesium
Sulphate
mg/l
700
600
500
400
300
200
100
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

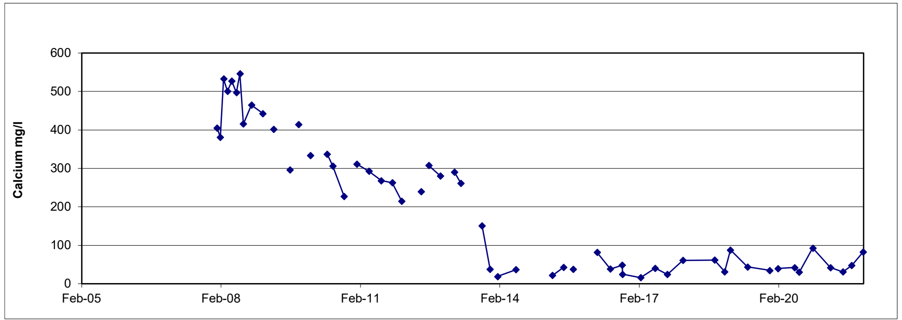

Nitrate
Nitrite
Phosphate
mg/l
100
90
80
70
60
50
40
30
20
10
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

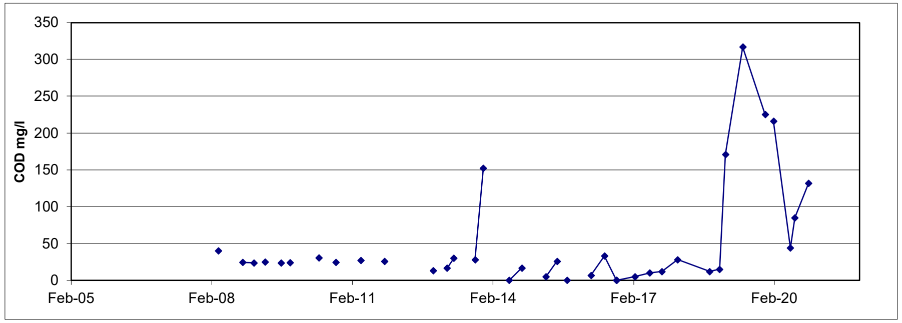

Cadmium
Mercury
microg/l
25
20
15
10
5
0
14 January 2004
10 October 2006
06 July 2009
01 April 2012
27 December 2014
22 September 2017
18 June 2020
15 March 2023

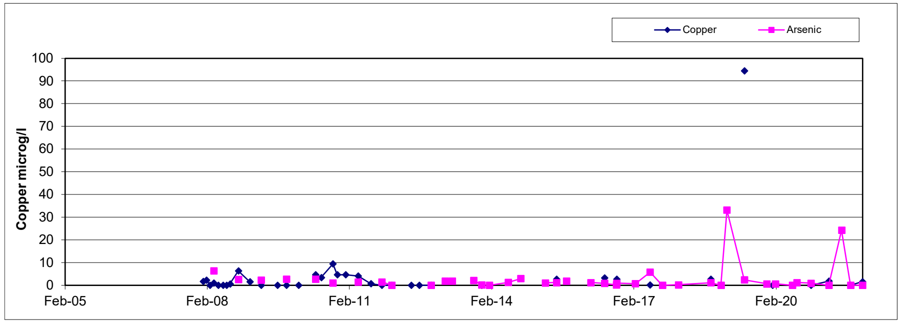

pH
EC
EC microS/cm
14
12
10
8
6
4
2
0
25000
20000
15000
10000
5000
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

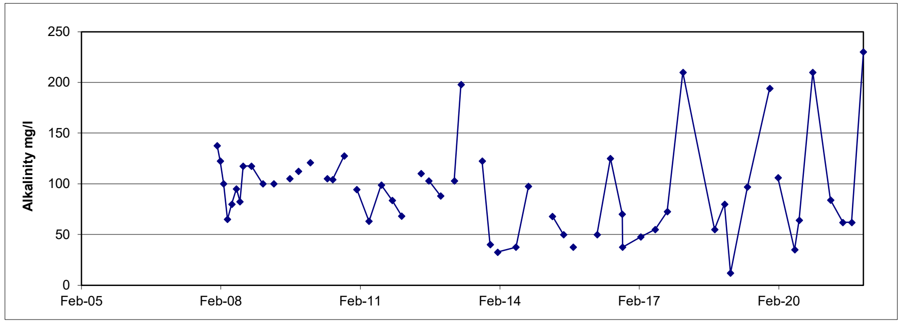

Ammonia mg/l
3.5
3
2.5
2
1.5
1
0.5
0
14 January 2004
10 October 2006
06 July 2009
01 April 2012
27 December 2014
22 September 2017
18 June 2020
15 March 2023

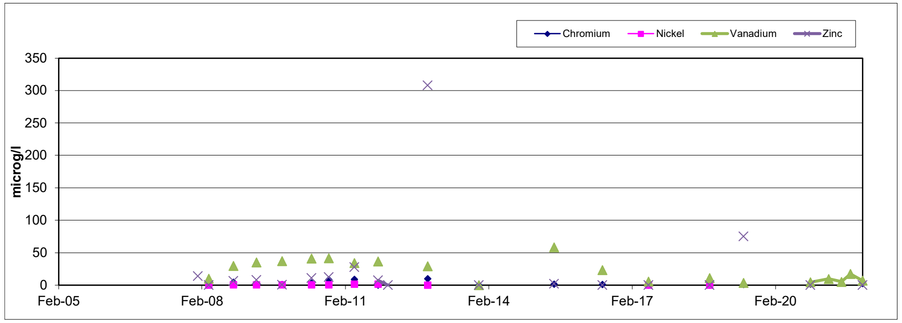

Chloride mg/l
1200
1000
800
600
400
200
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

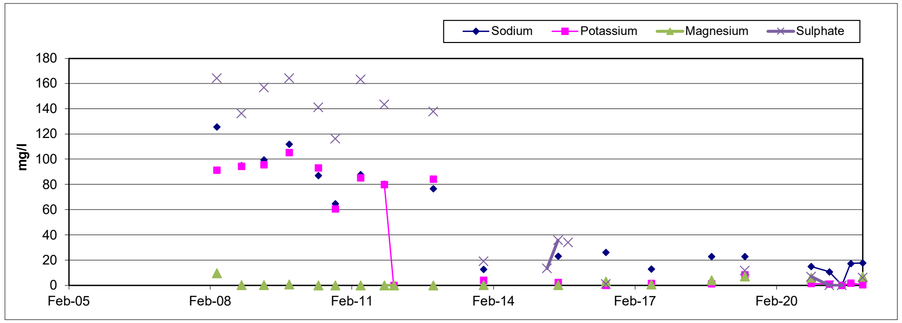

Calcium mg/l
600
500
400
300
200
100
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

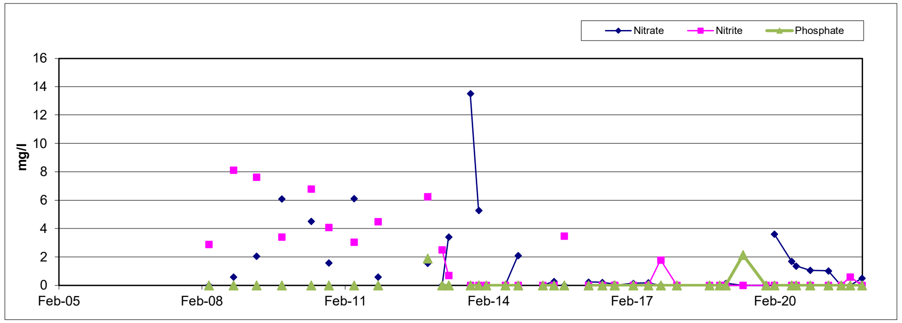

COD mg/l
350
300
250
200
150
100
50
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

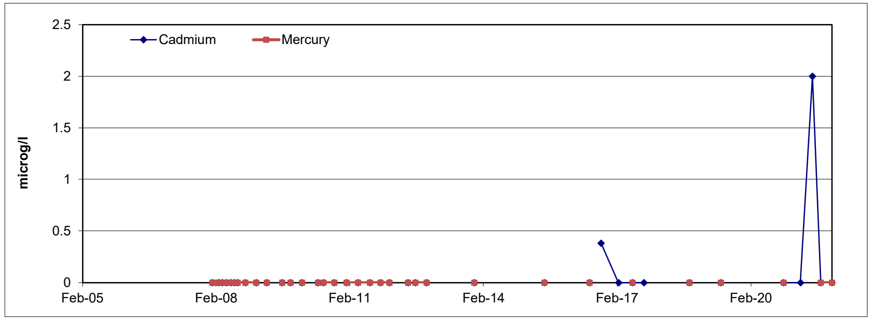

Copper
Arsenic
Copper microg/l
100
90
80
70
60
50
40
30
20
10
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

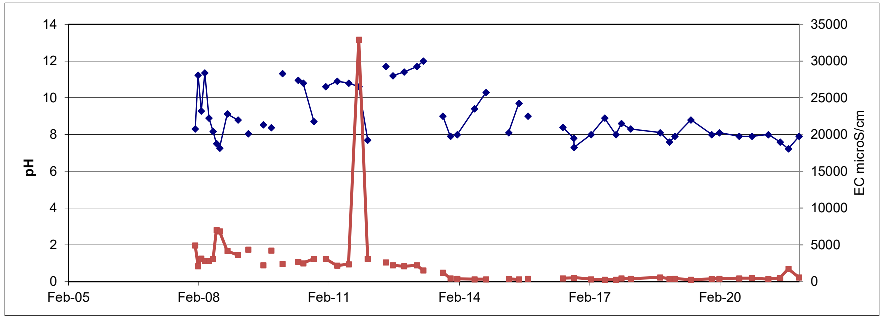

Alkalinity mg/l
250
200
150
100
50
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

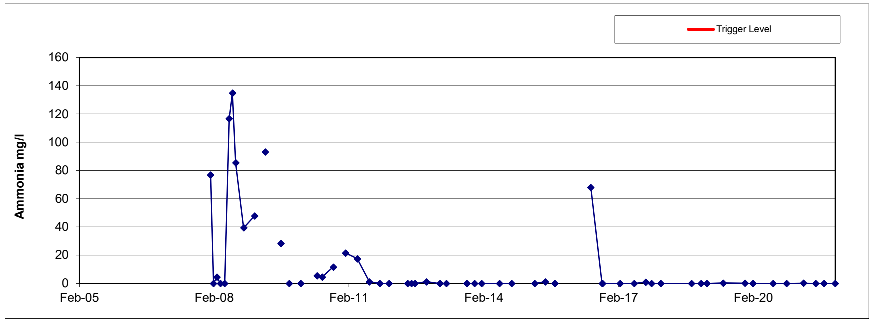

Chromium
Nickel
Vanadium
Zinc
microg/l
350
300
250
200
150
100
50
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

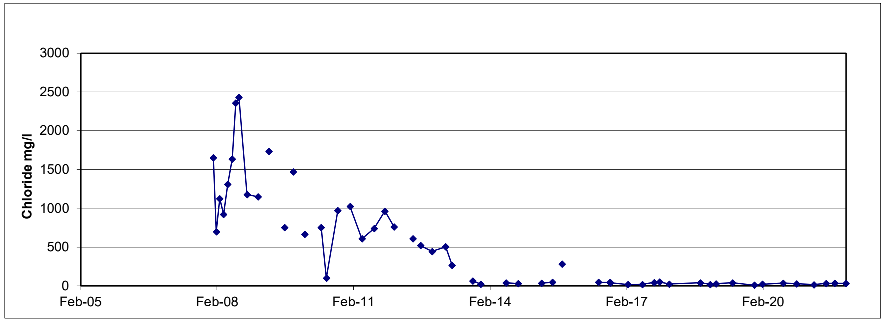

Sodium
Potassium
Magnesium
Sulphate
mg/l
180
160
140
120
100
80
60
40
20
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

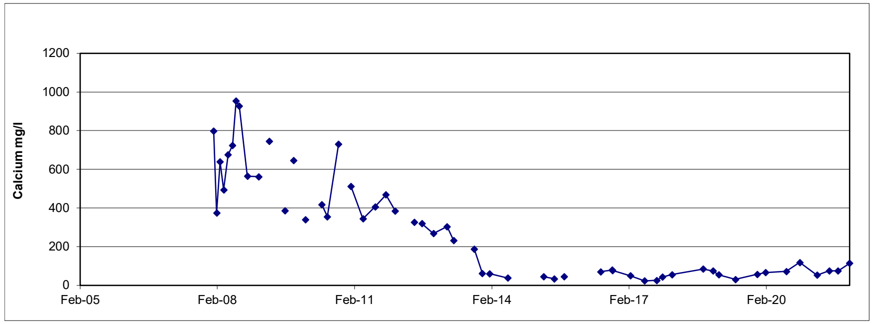

Nitrate
Nitrite
Phosphate
mg/l
16
14
12
10
8
6
4
2
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

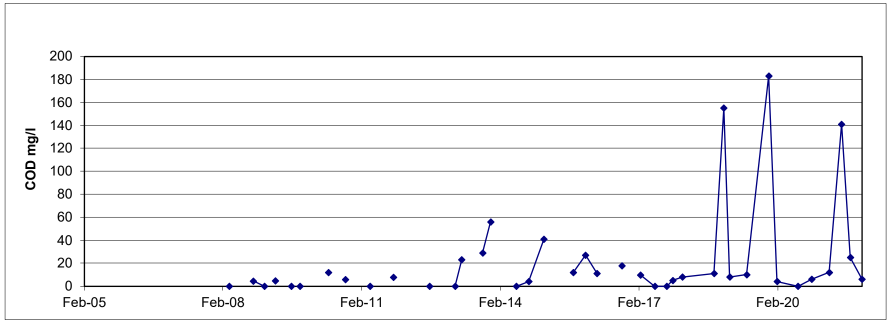

Cadmium
Mercury
microg/l
2.5
2
1.5
1
0.5
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

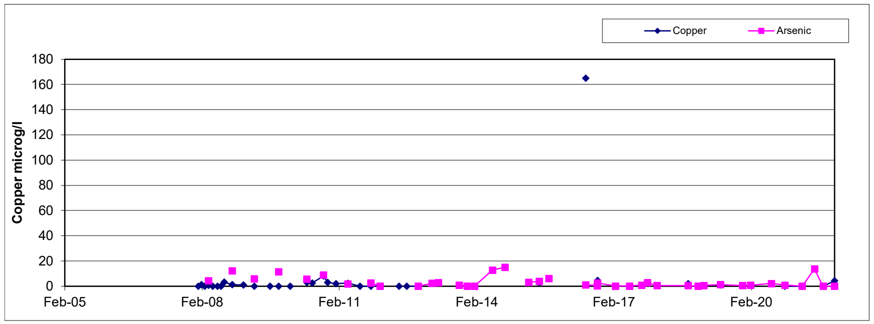

pH
EC microS/cm
14
12
10
8
6
4
2
0
35000
30000
25000
20000
15000
10000
5000
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

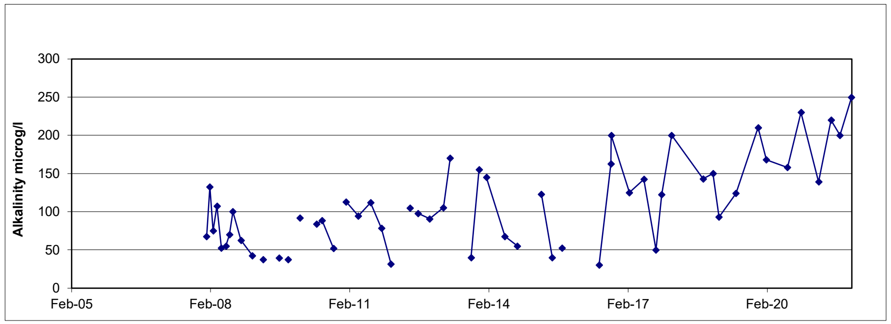

Trigger Level
Ammonia mg/l
160
140
120
100
80
60
40
20
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

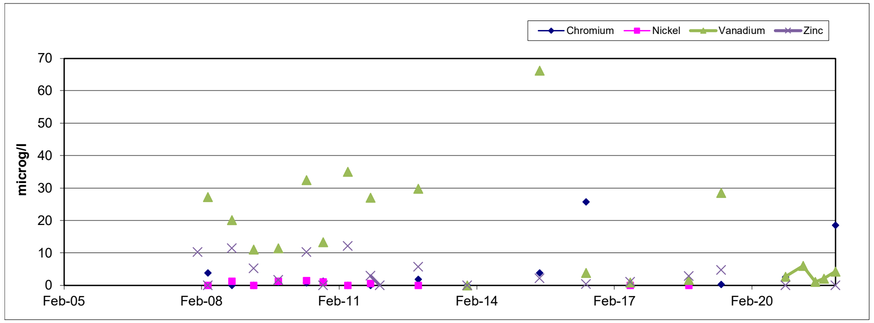

Chloride mg/l
3000
2500
2000
1500
1000
500
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

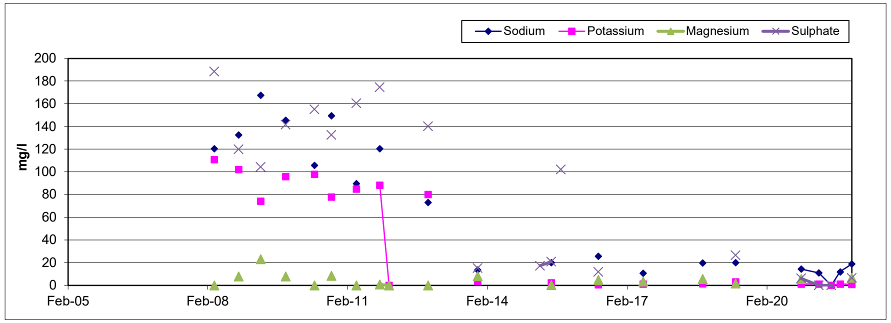

Calcium mg/l
1200
1000
800
600
400
200
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

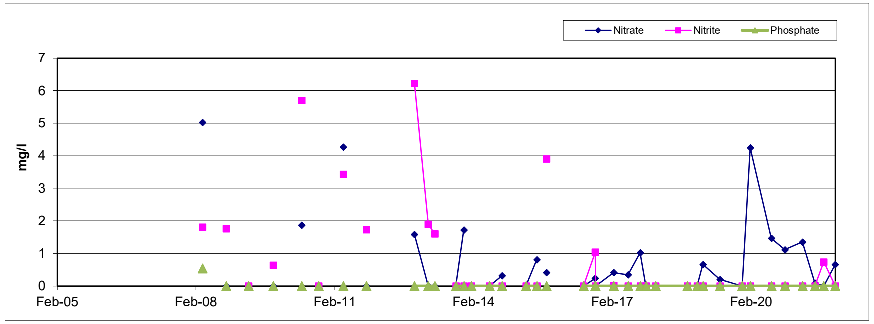

COD mg/l
200
180
160
140
120
100
80
60
40
20
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

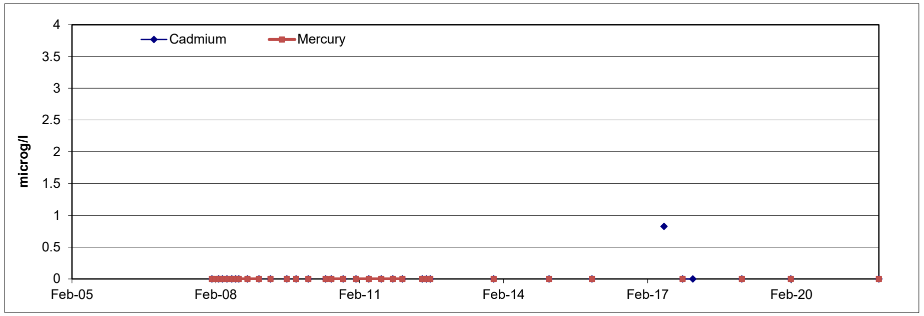

Copper
Arsenic
Copper microg/l
180
160
140
120
100
80
60
40
20
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

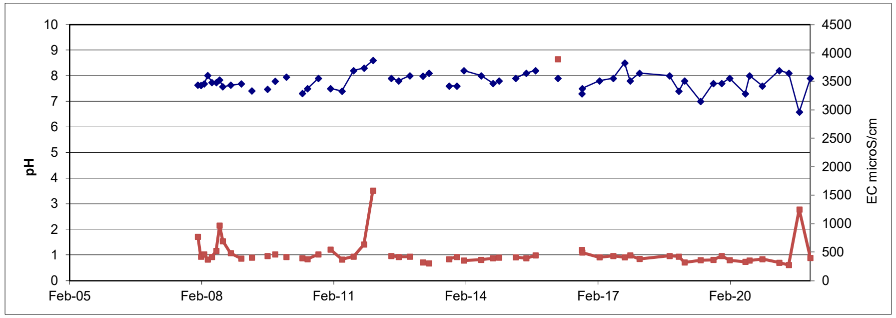

Alkalinity microg/l
300
250
200
150
100
50
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

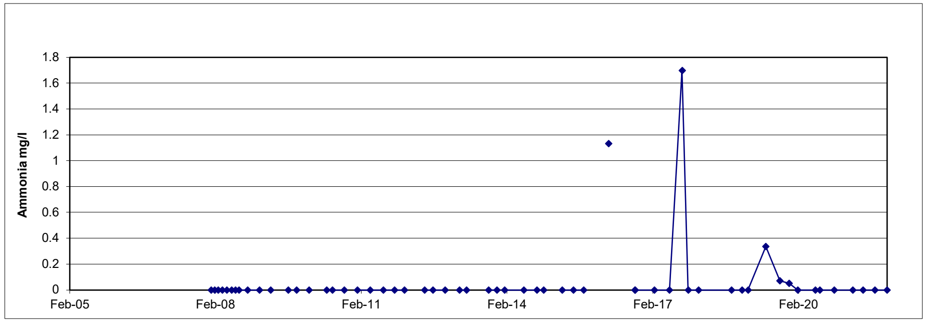

Chromium
Nickel
Vanadium
Zinc
microg/l
70
60
50
40
30
20
10
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

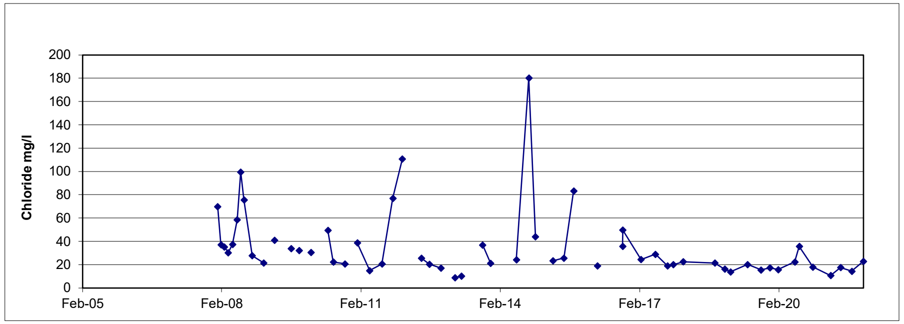

Sodium
Potassium
Magnesium
Sulphate
mg/l
200
180
160
140
120
100
80
60
40
20
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

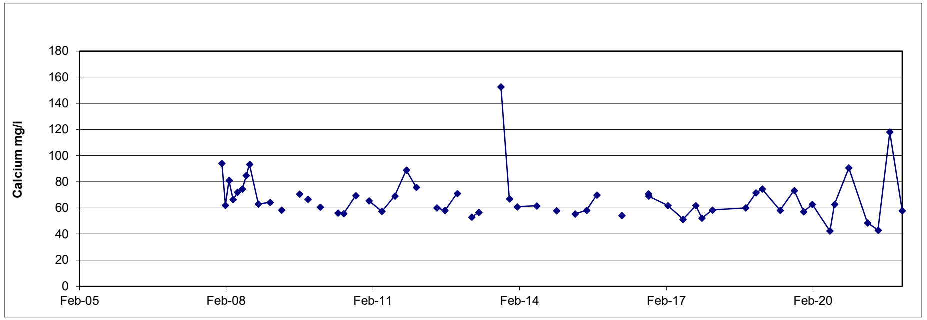

Nitrate
Nitrite
Phosphate
mg/l
7
6
5
4
3
2
1
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

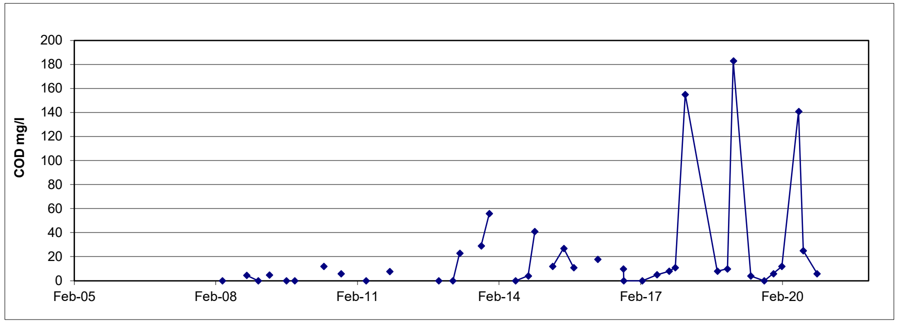

Cadmium
Mercury
microg/l
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

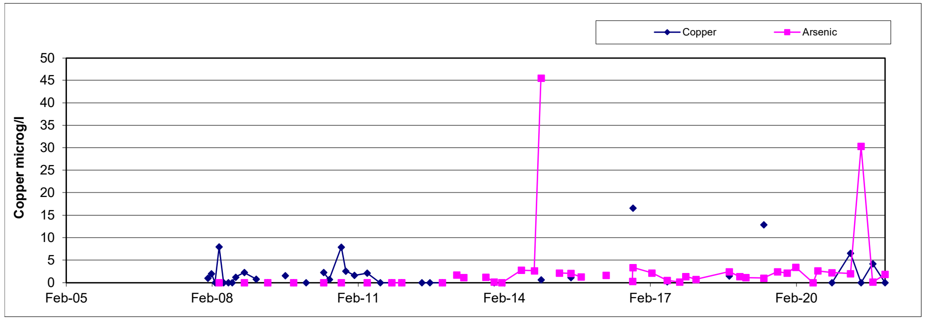

pH
EC microS/cm
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

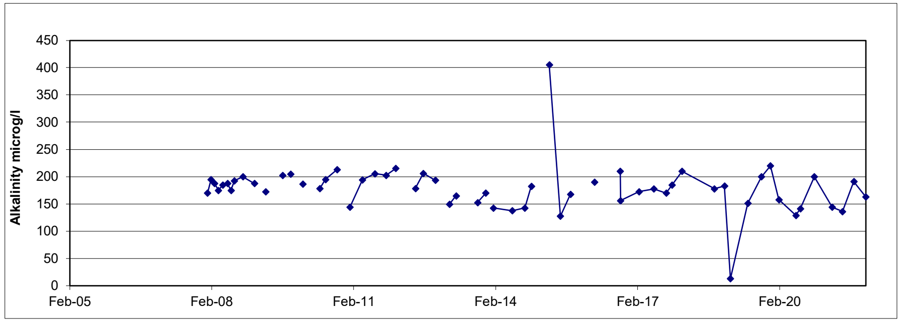

Ammonia mg/l
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

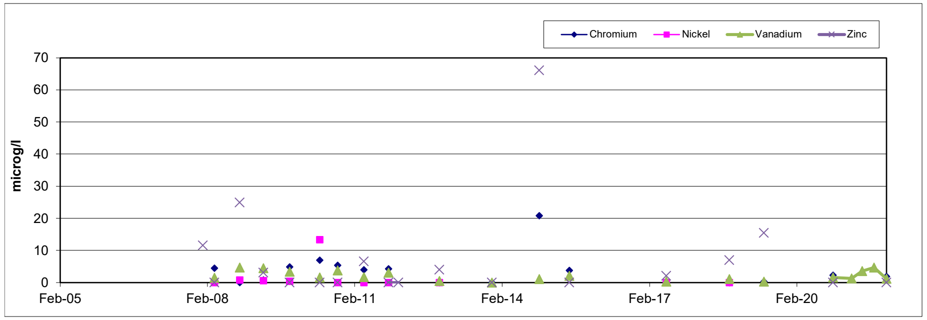

Chloride mg/l
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

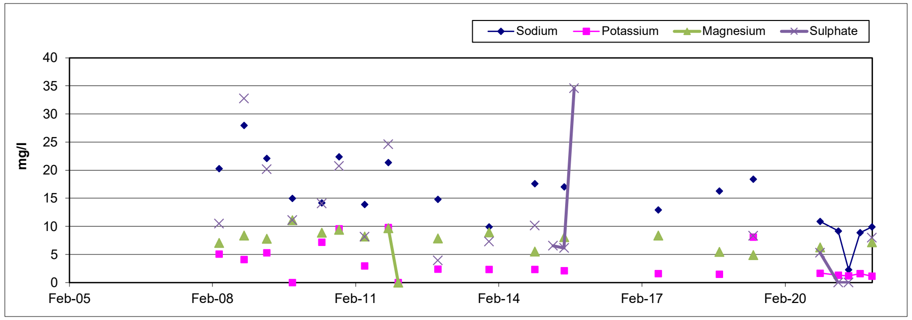

Calcium mg/l
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

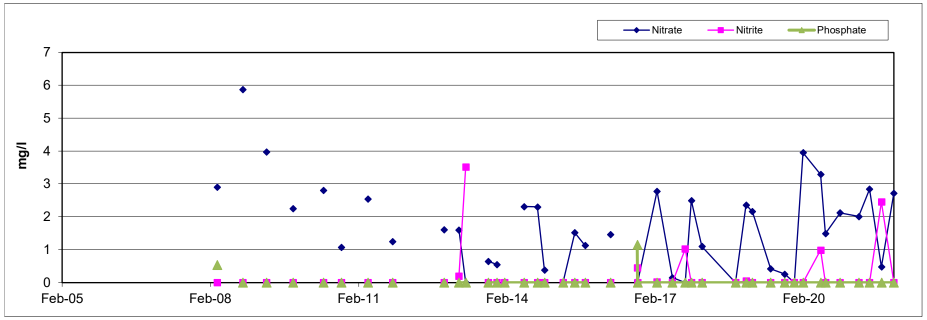

COD mg/l
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

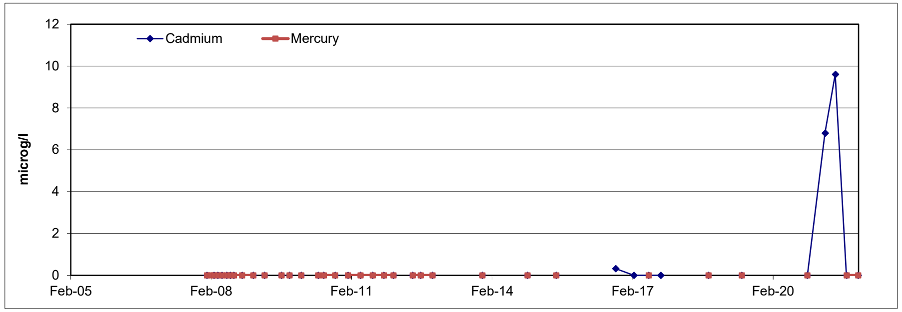

Copper
Arsenic
Copper microg/l
50
45
40
35
30
25
20
15
10
5
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

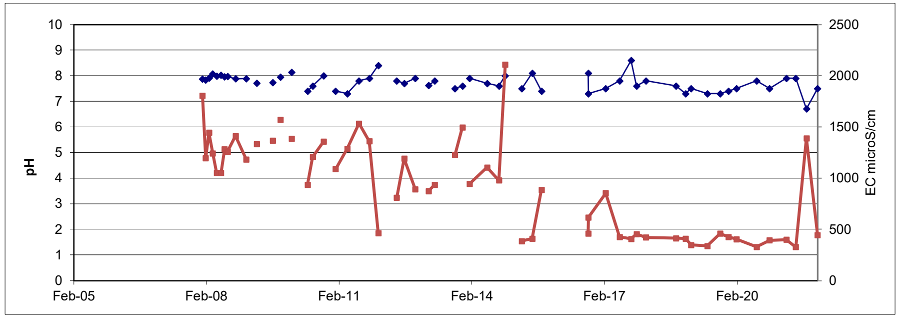

Alkalinity microg/l
450
400
350
300
250
200
150
100
50
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20


Chromium
Nickel
Vanadium
Zinc
microg/l
70
60
50
40
30
20
10
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20


Sodium
Potassium
Magnesium
Sulphate
mg/l
40
35
30
25
20
15
10
5
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20


Nitrate
Nitrite
Phosphate
mg/l
7
6
5
4
3
2
1
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20


Cadmium
Mercury
microg/l
12
10
8
6
4
2
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20


pH
EC microS/cm
10
9
8
7
6
5
4
3
2
1
0
2500
2000
1500
1000
500
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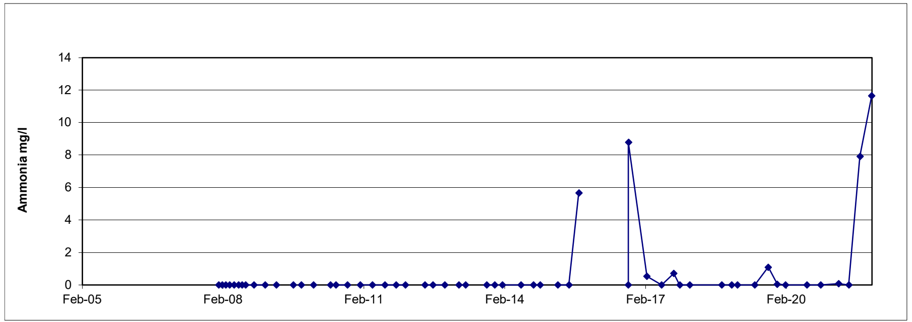
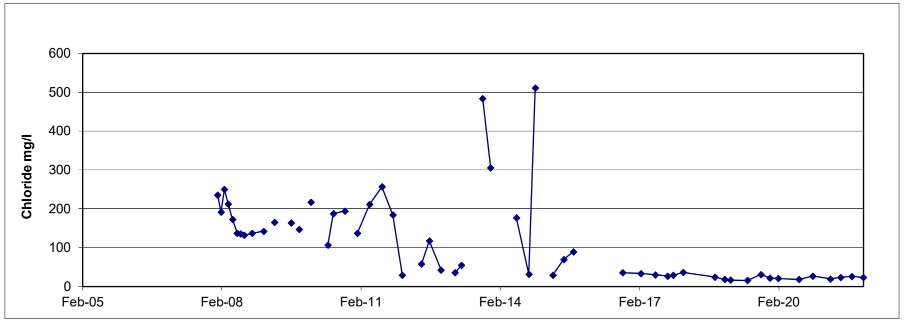
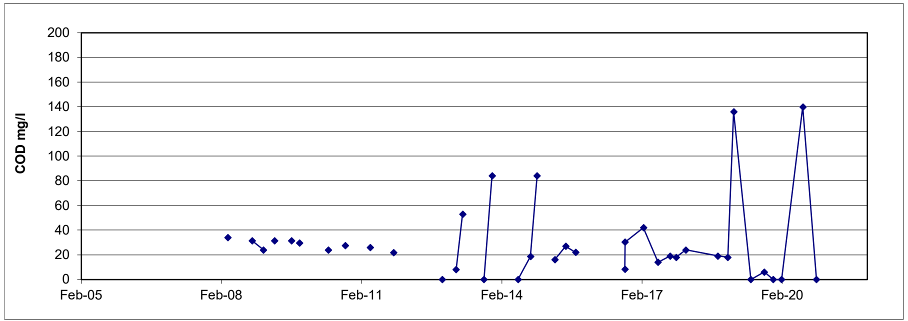
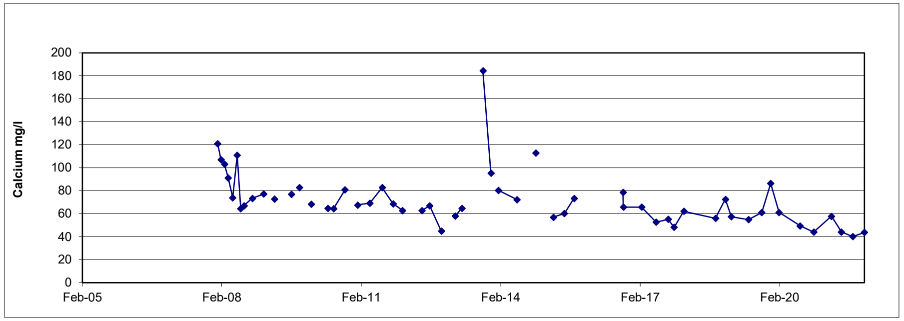
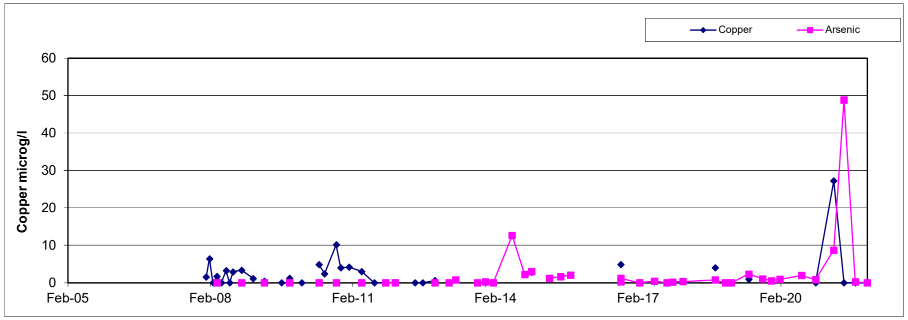
Feb-14
Feb-17
Feb-20

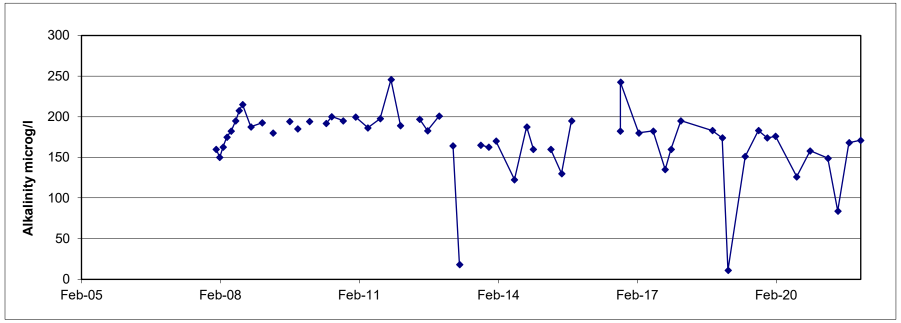

Ammonia mg/l
14
12
10
8
6
4
2
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

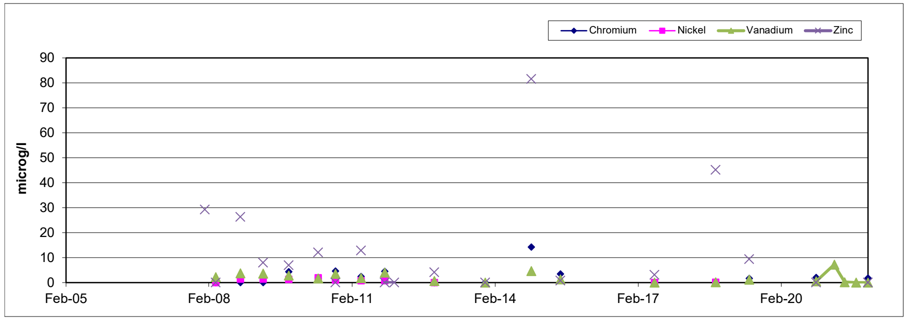

Chloride mg/l
600
500
400
300
200
100
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

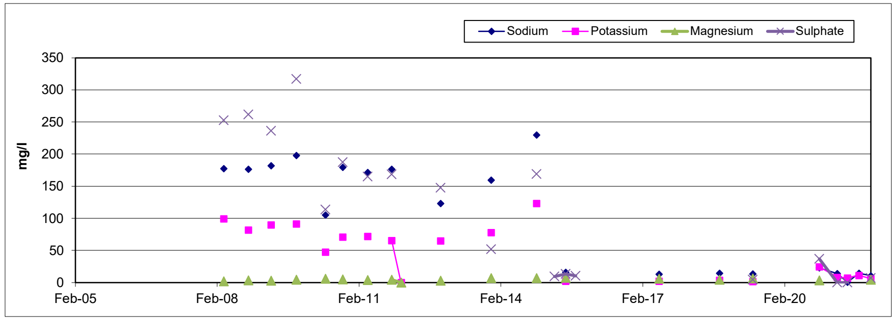

COD mg/l
200
180
160
140
120
100
80
60
40
20
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

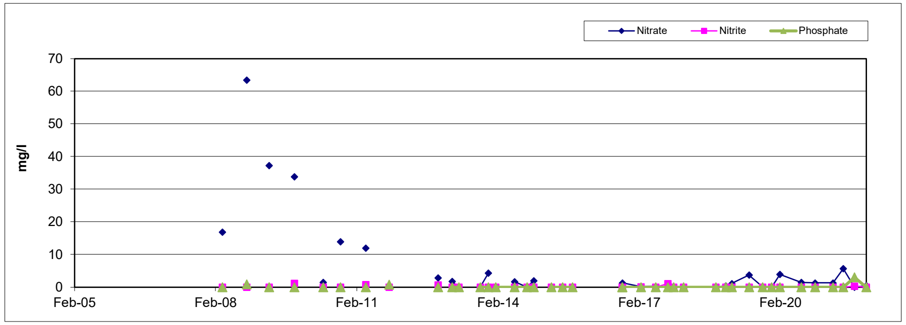

Calcium mg/l
200
180
160
140
120
100
80
60
40
20
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20


Copper
Arsenic
Copper microg/l
60
50
40
30
20
10
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

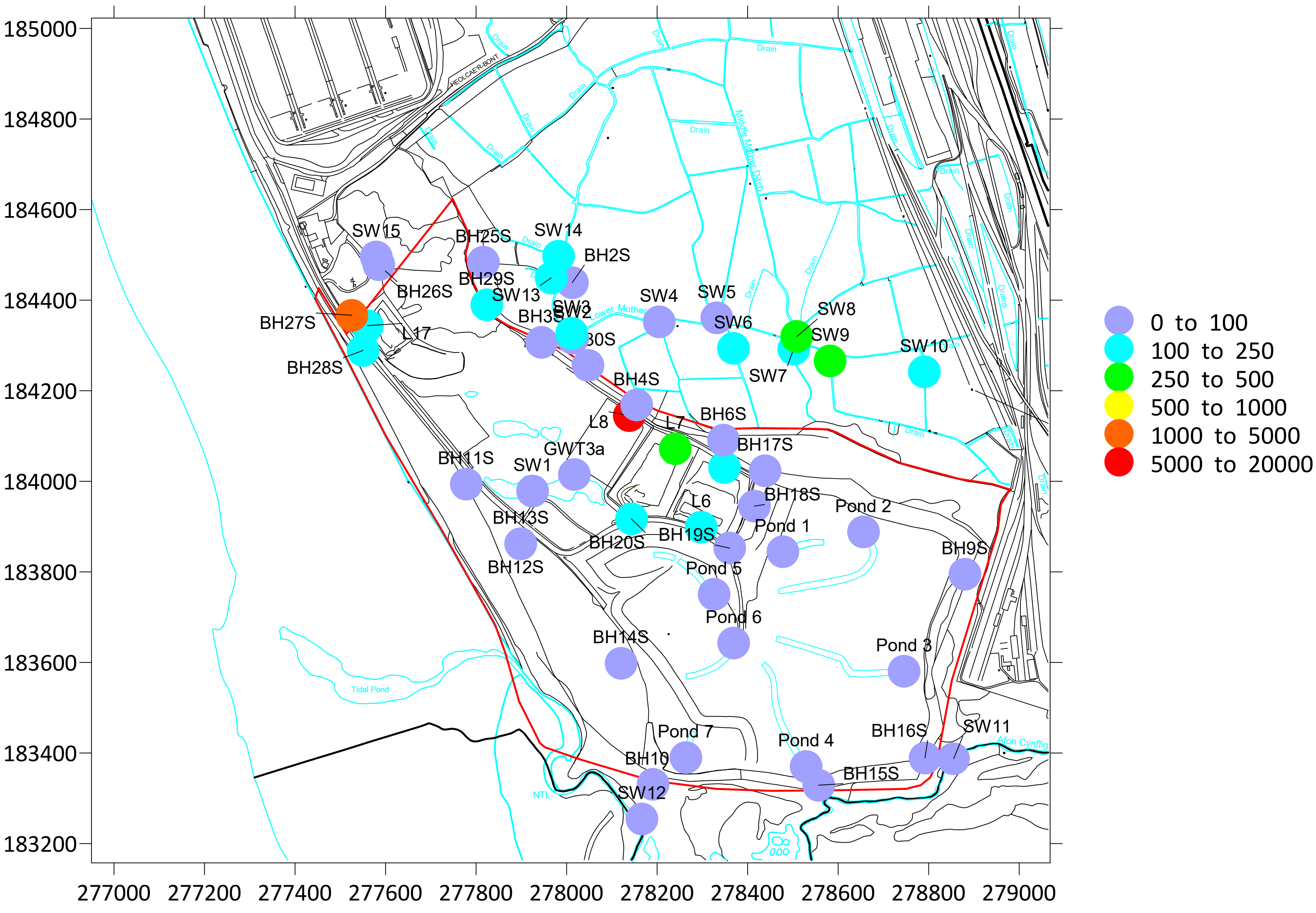

Alkalinity microg/l
300
250
200
150
100
50
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20


Chromium
Nickel
Vanadium
Zinc
microg/l
90
80
70
60
50
40
30
20
10
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20


Sodium
Potassium
Magnesium
Sulphate
mg/l
350
300
250
200
150
100
50
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

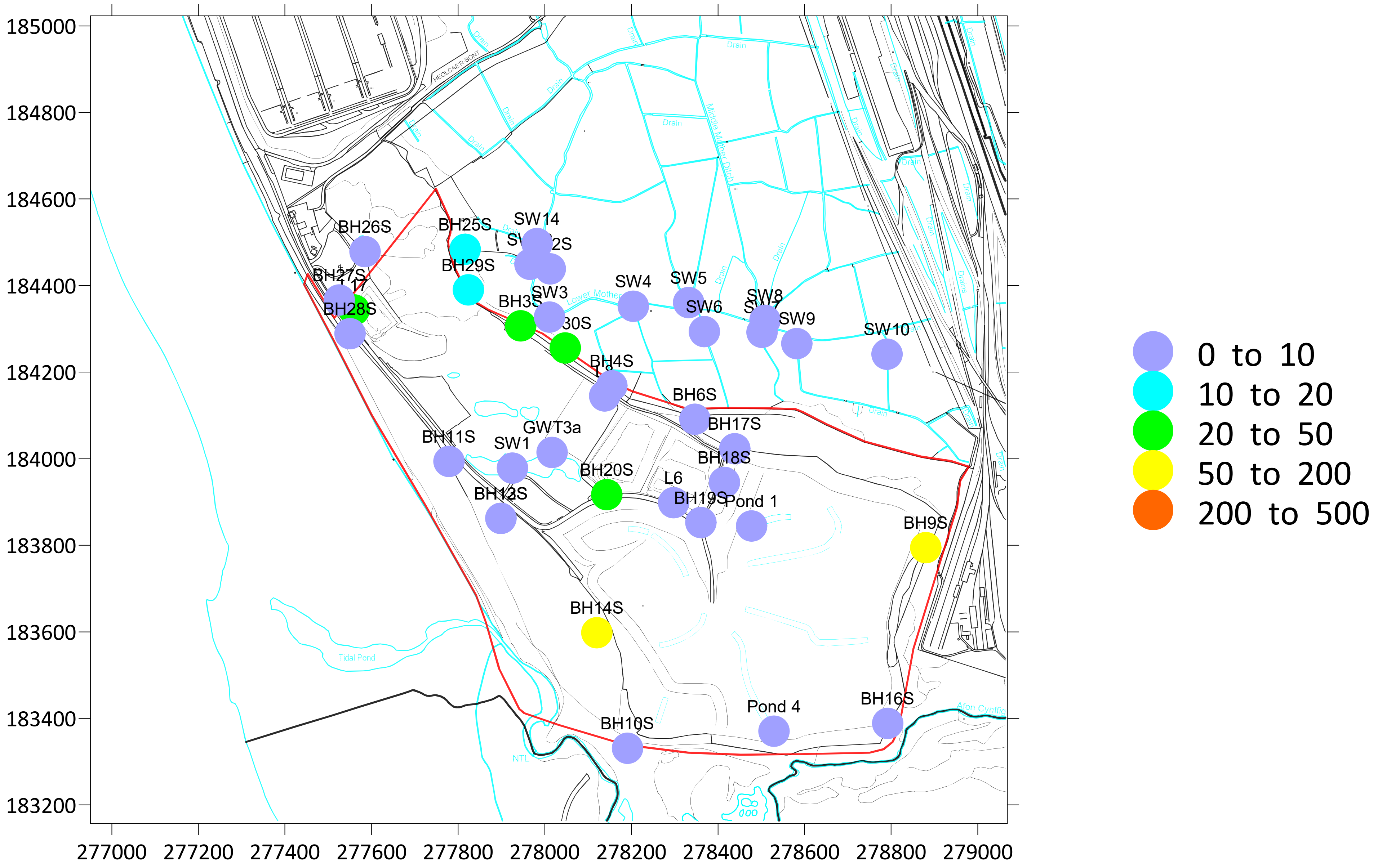

Nitrate
Nitrite
Phosphate
mg/l
70
60
50
40
30
20
10
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

Chloride in Groundwater, Leachate and Surface Water (mg/l)



Q4 2021

Arsenic in Groundwater, Leachate and Surface Water (microg/l)



Q4, 2021 - Shallow GW, Leachate, Ponds and Surface Water

MORFA CLOSED LANDFILL,
PORT TALBOT

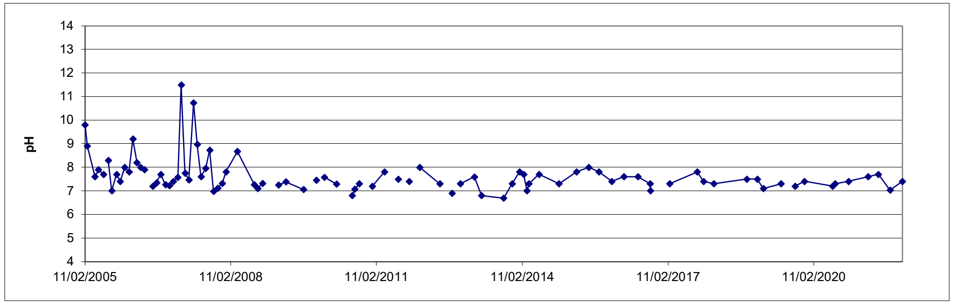
PERMIT EPR/AP3292LT

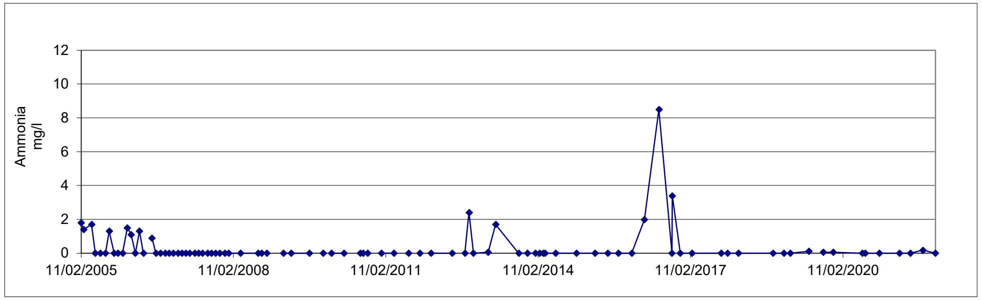
2020 Annual Review of Environmental Monitoring Results

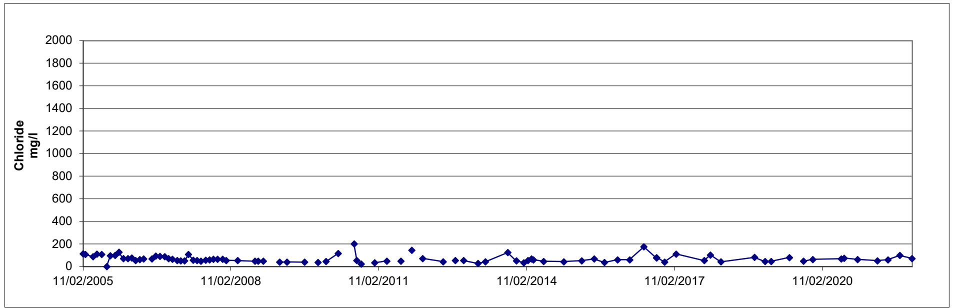
Appendix 3
Temporal Variation of Surface Water Chemistry

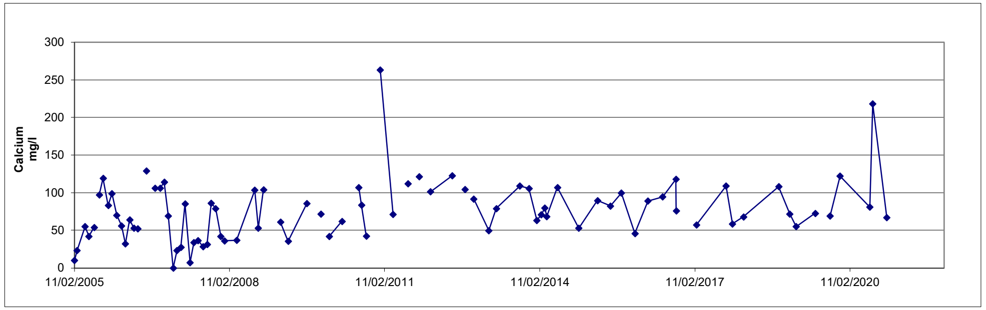
Report Number 2192r1v1d0222

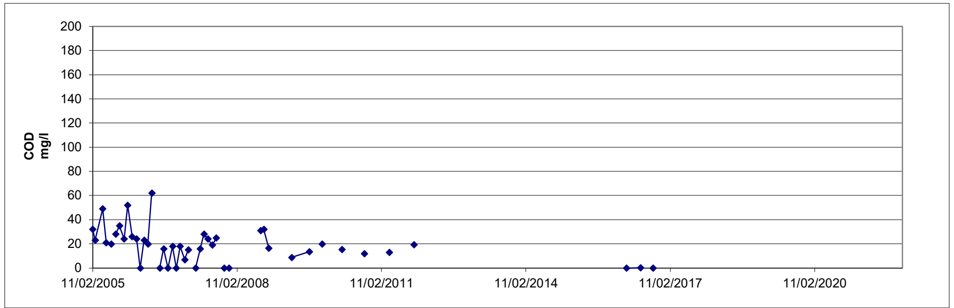
Monitoring data for SW 4

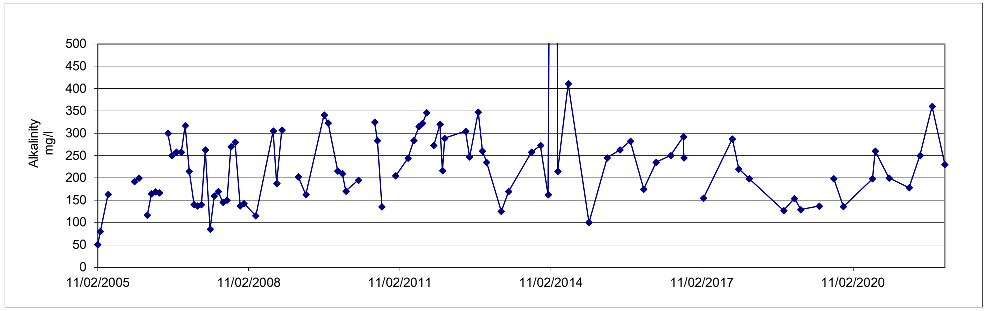


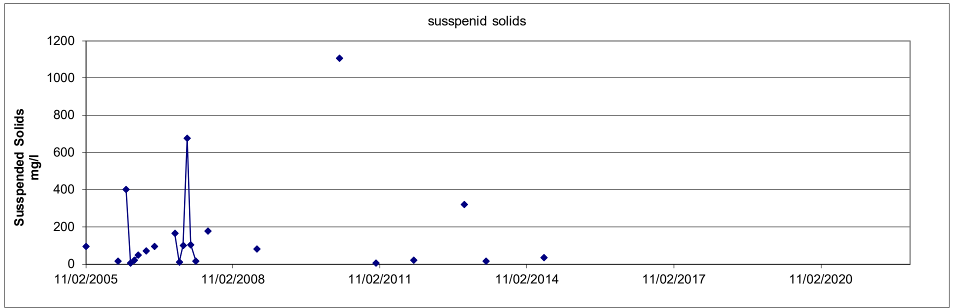


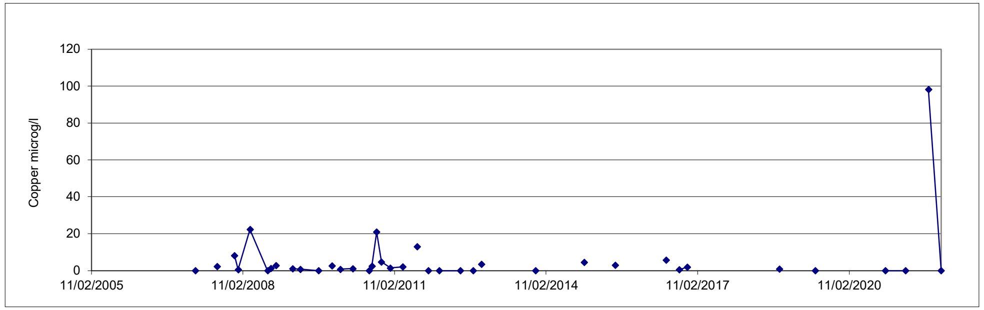




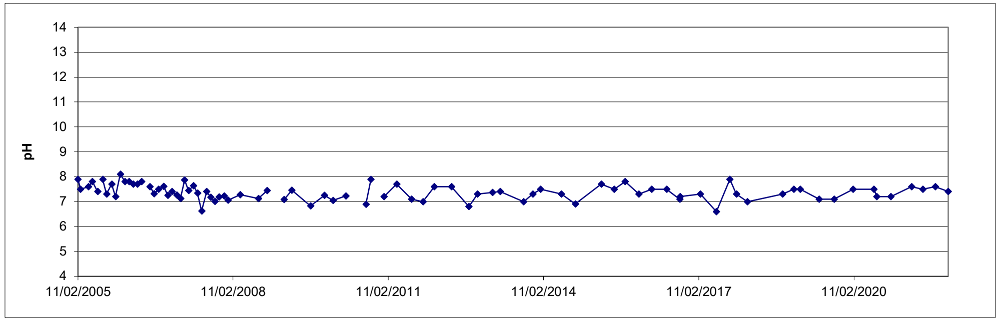


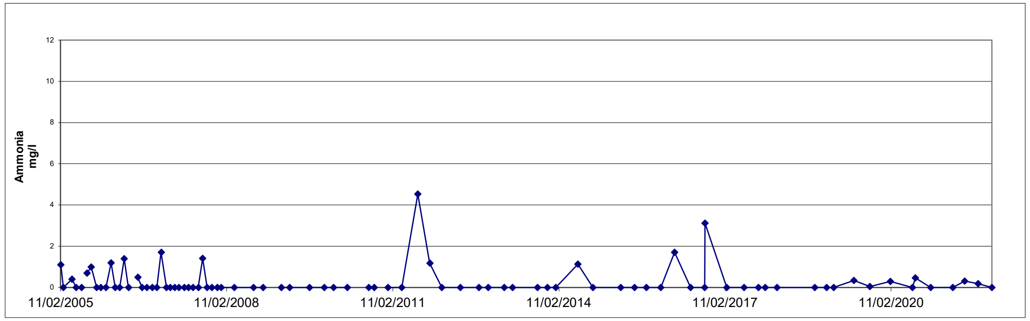


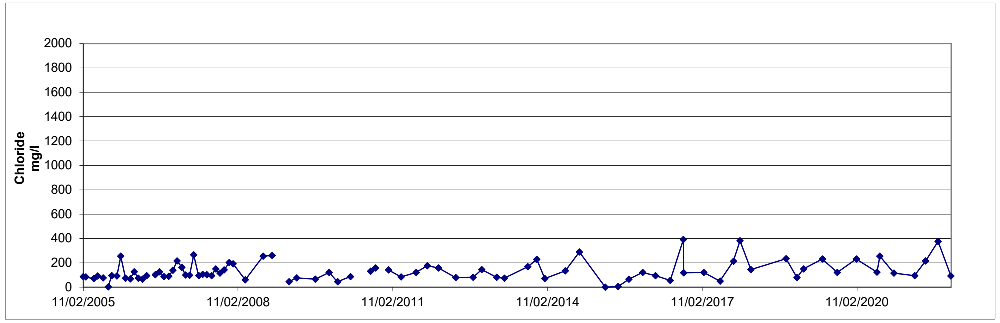


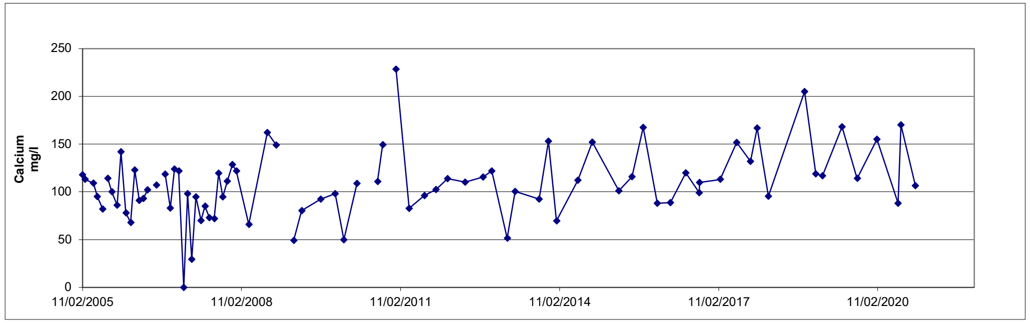


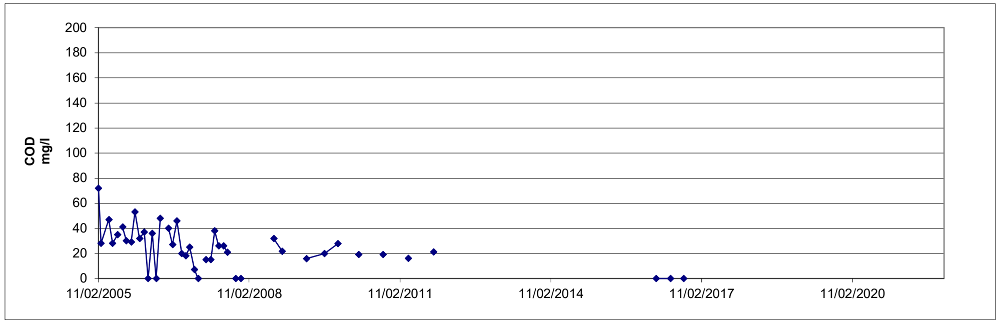
Monitoring data for SW 5

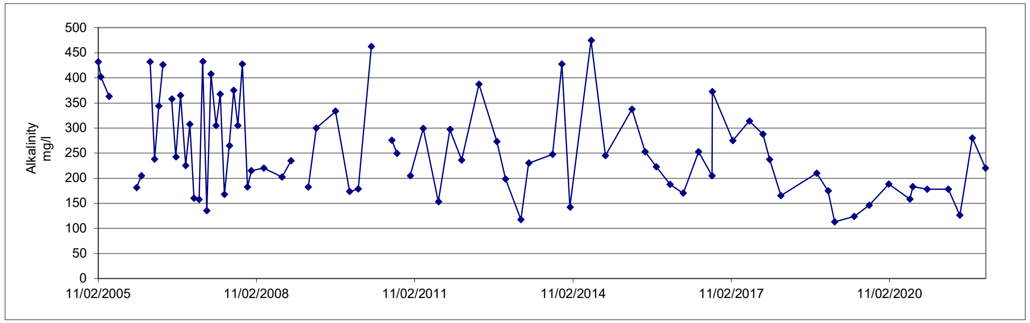


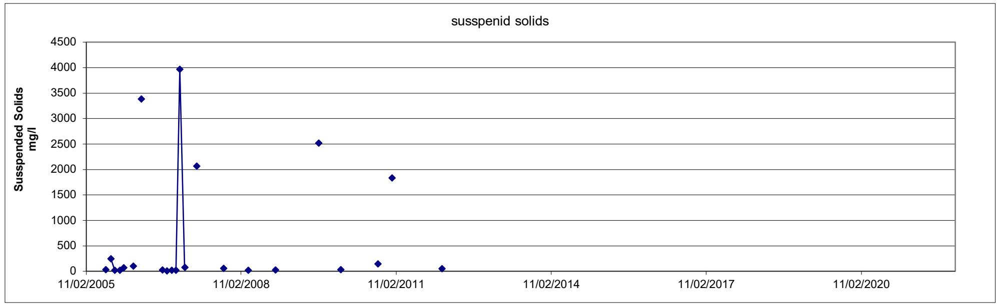


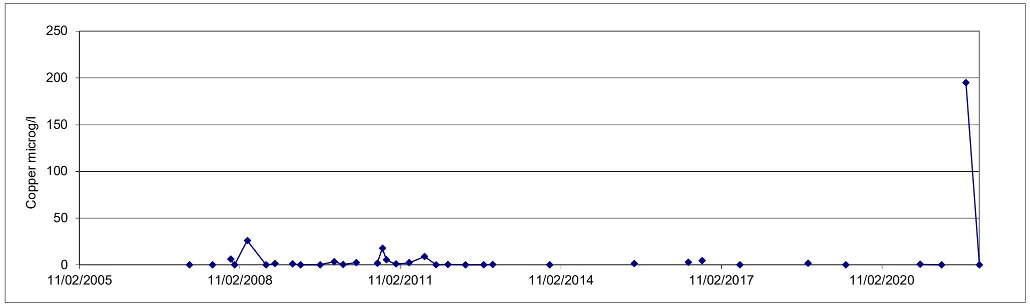




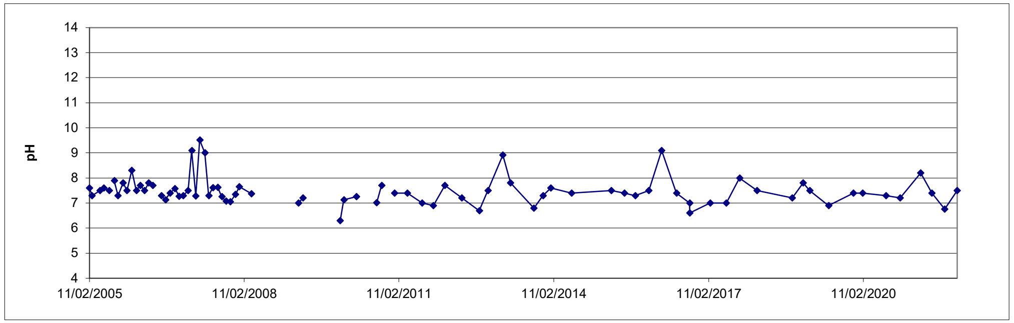


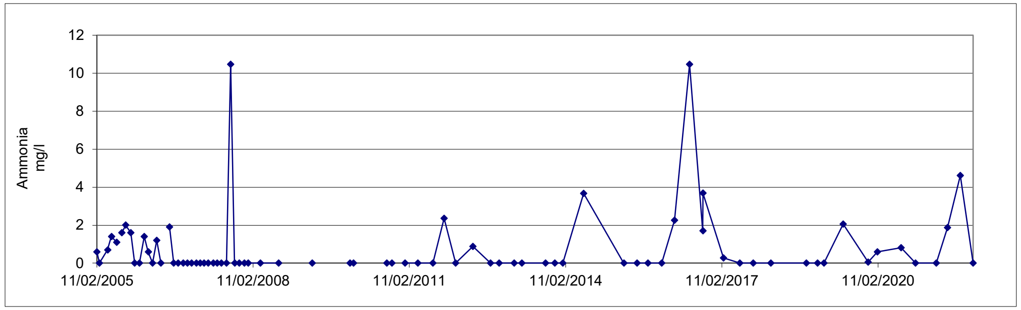


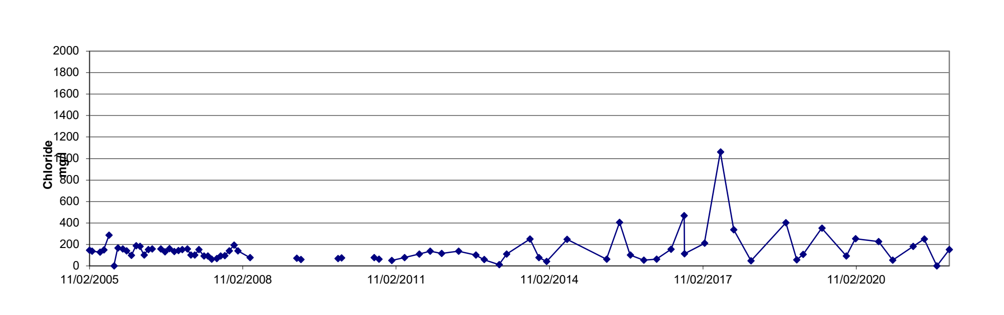


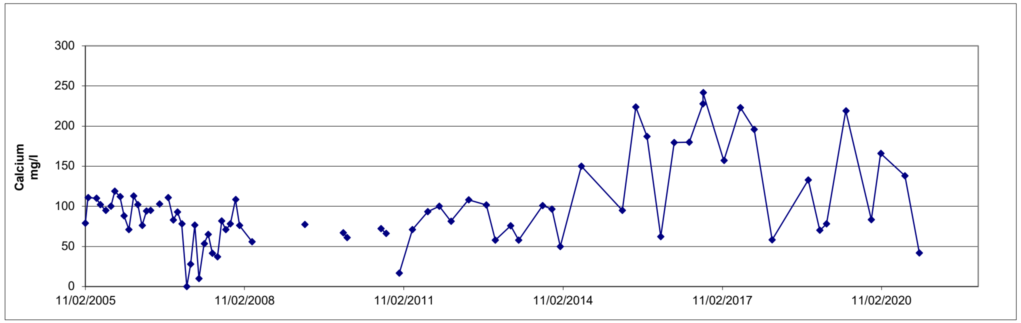


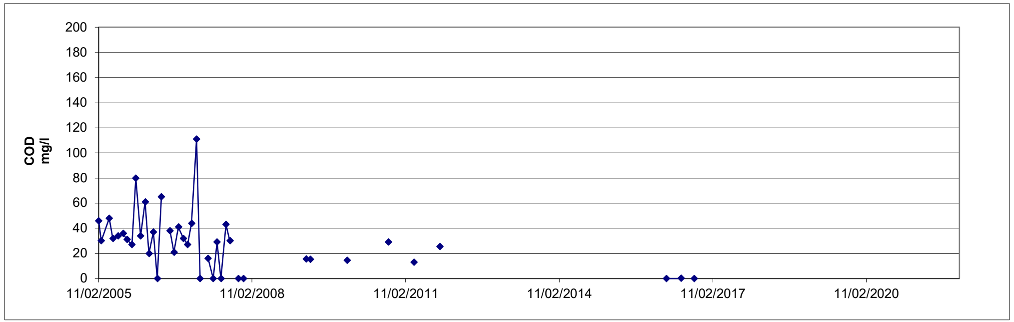
Monitoring data for SW 6

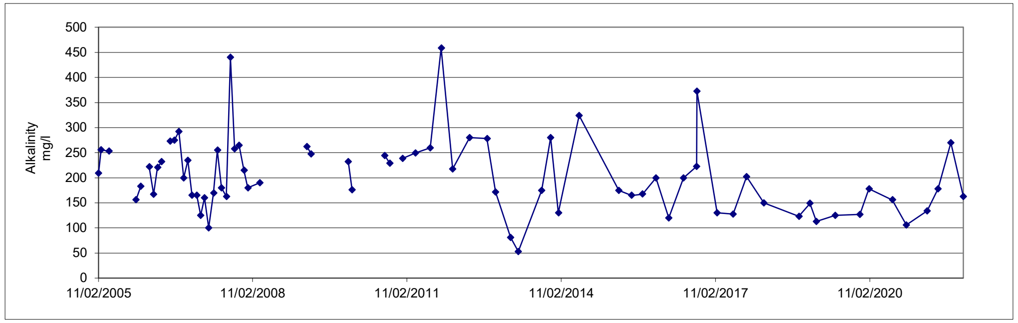


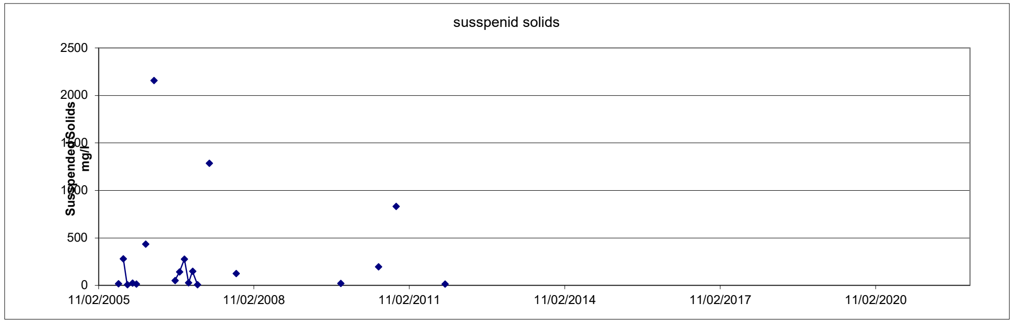


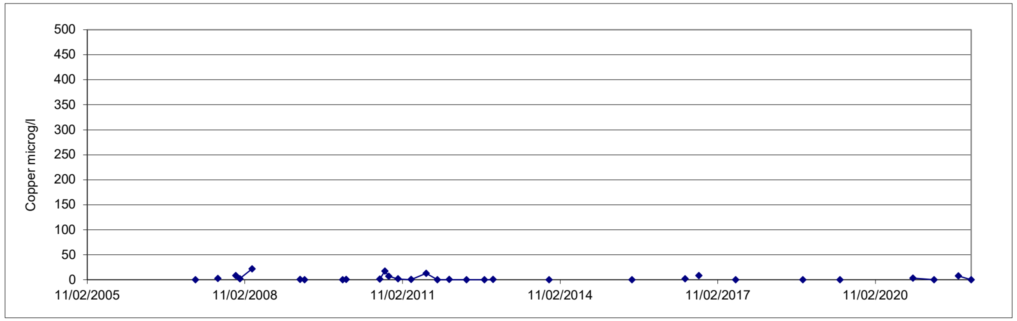




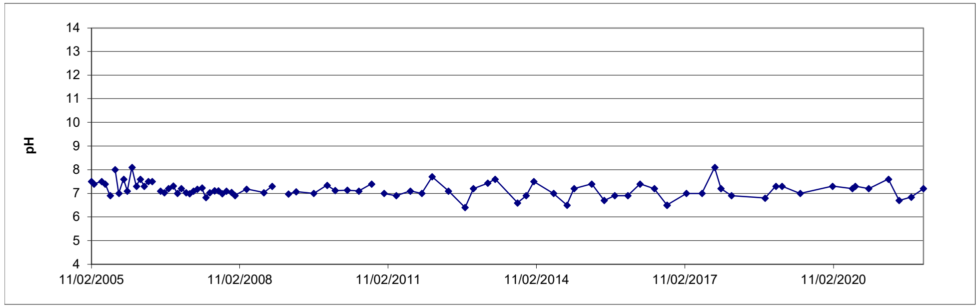


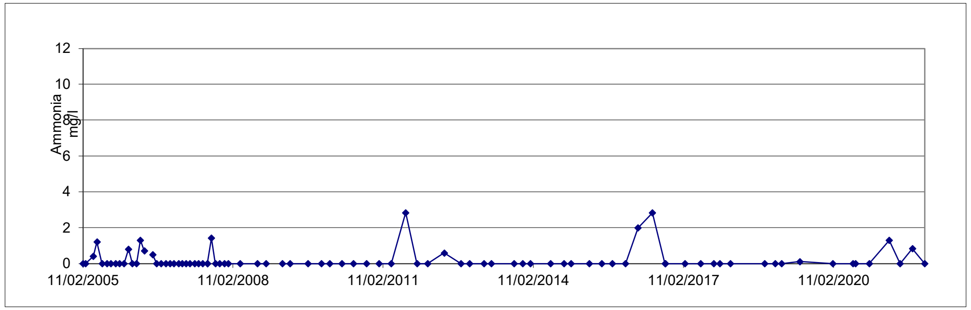


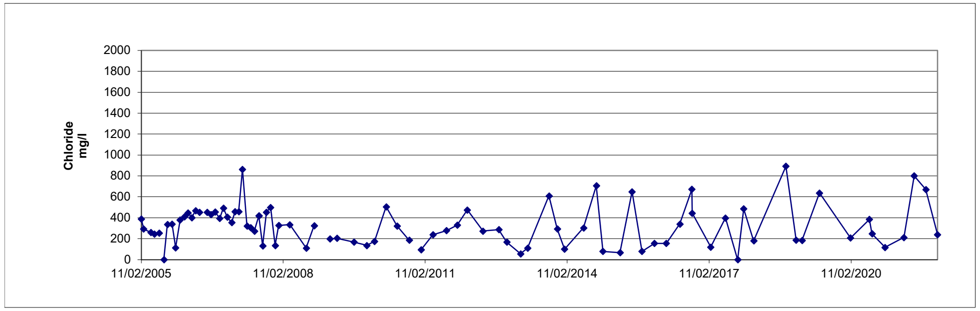


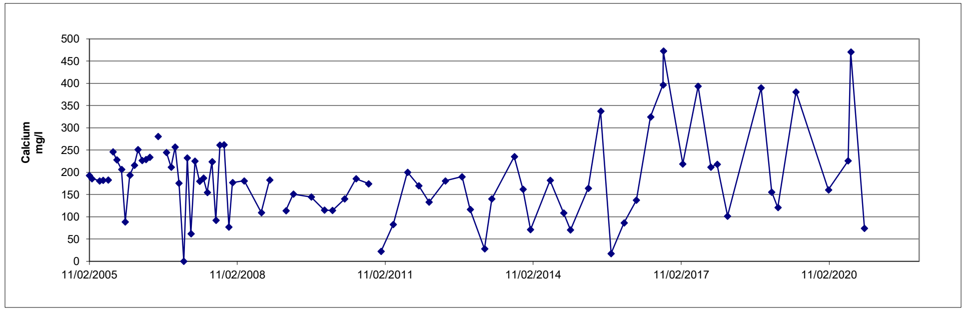


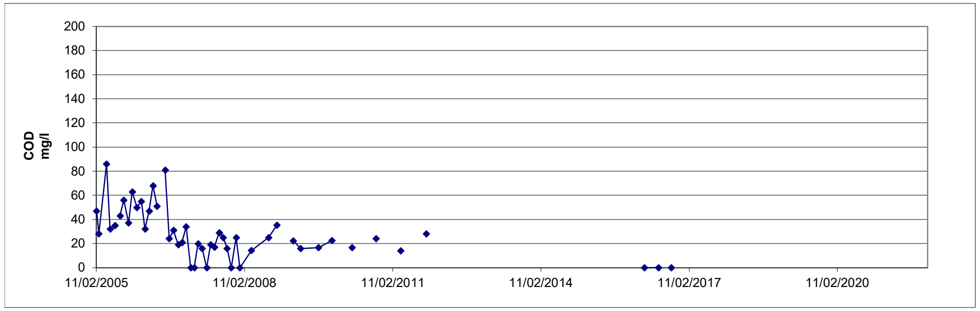
Monitoring data for SW 7

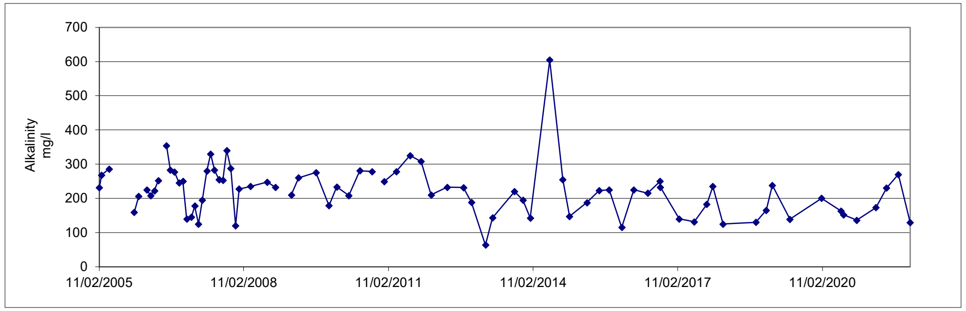


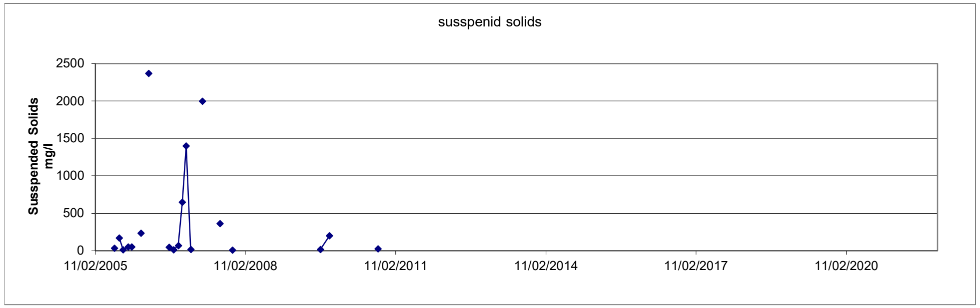


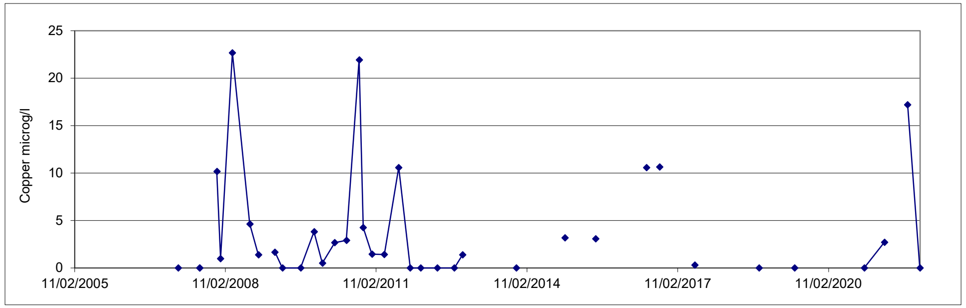


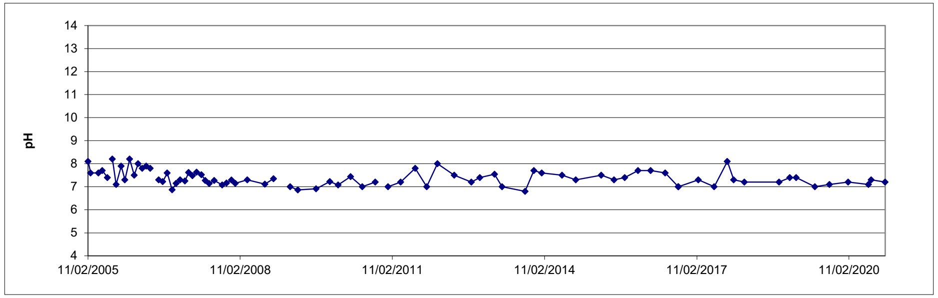


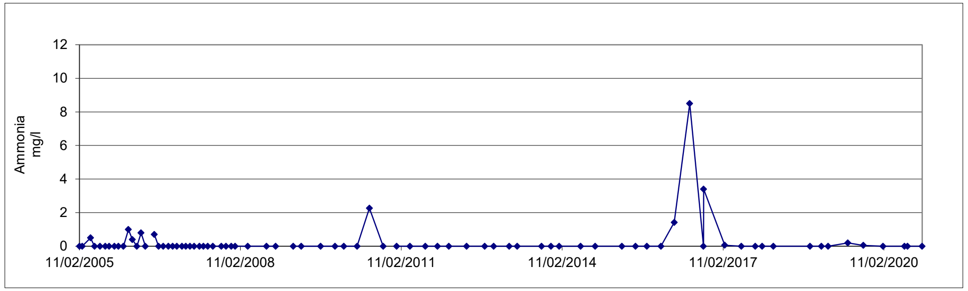


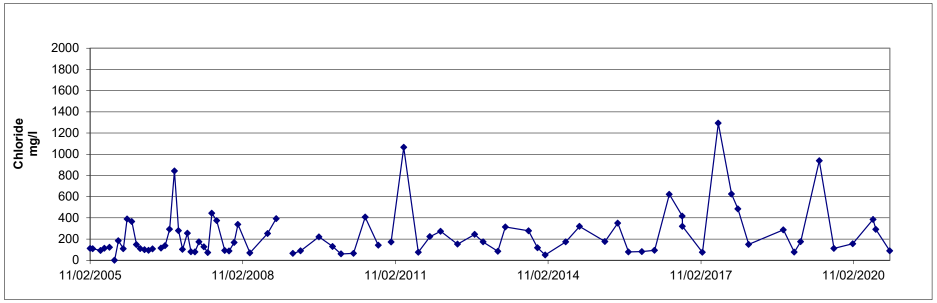


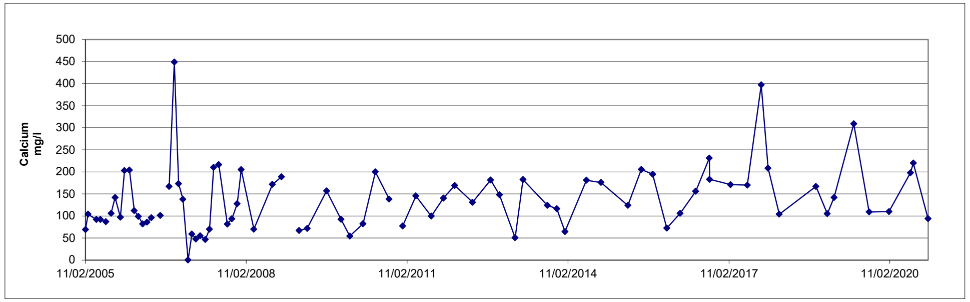


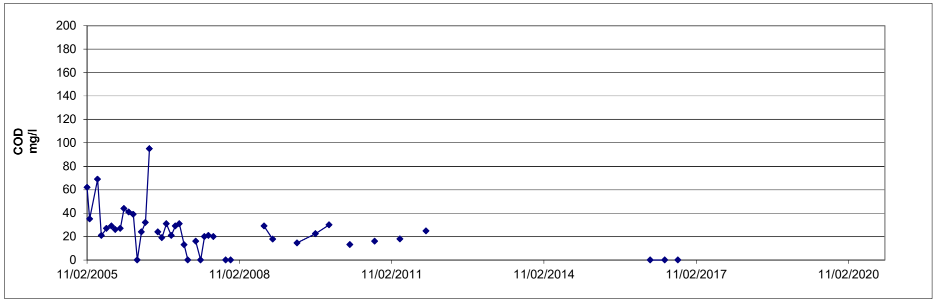


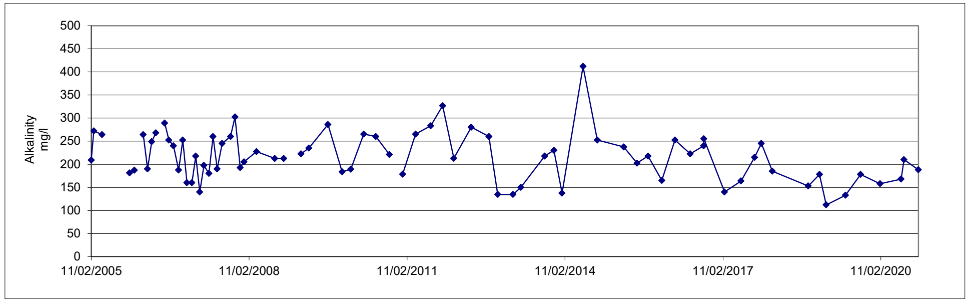

pH
11/02/2005
11/02/2008
11/02/2011
11/02/2014
11/02/2017
11/02/2020

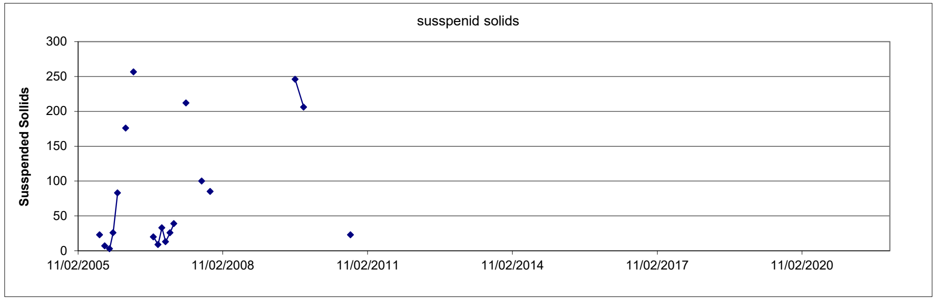

Ammonia mg/l
11/02/2005
11/02/2008
11/02/2011
11/02/2014
11/02/2017
11/02/2020

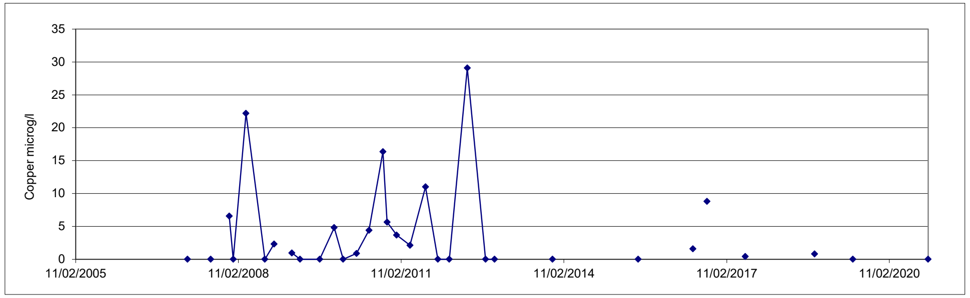

Chloride mg/l
11/02/2005
11/02/2008
11/02/2011
11/02/2014
11/02/2017
11/02/2020

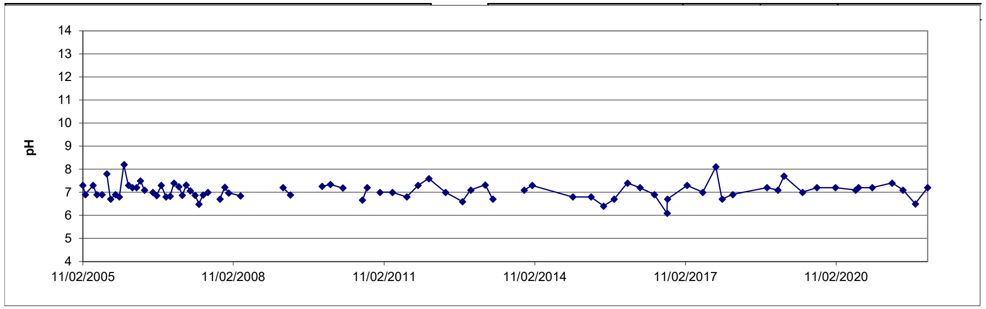

Calcium mg/l
11/02/2005
11/02/2008
11/02/2011
11/02/2014
11/02/2017
11/02/2020

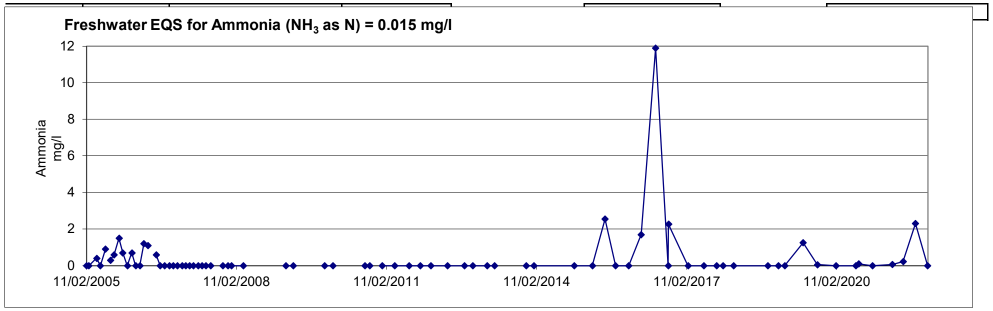

COD mg/l
11/02/2005
11/02/2008
11/02/2011
11/02/2014
11/02/2017
11/02/2020

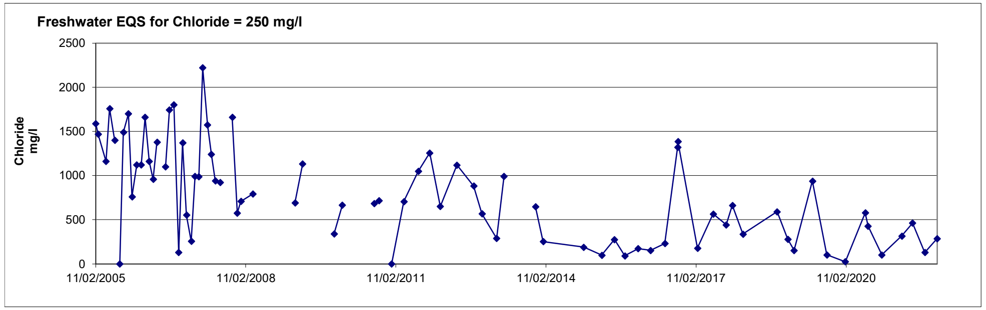

Alkalinity mg/l
11/02/2005
11/02/2008
11/02/2011
11/02/2014
11/02/2017
11/02/2020

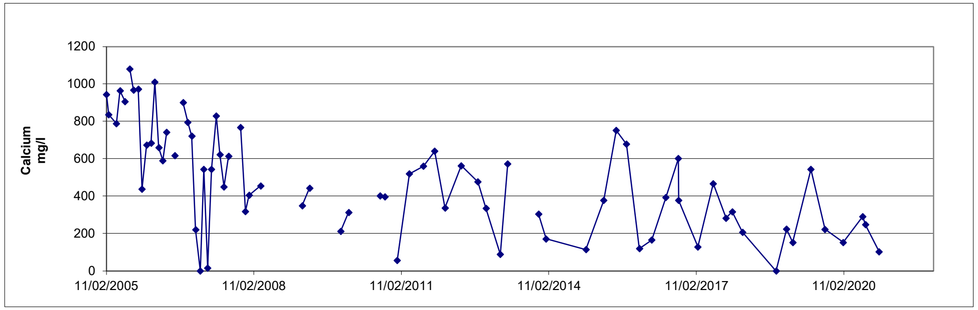

susspenid solids
Susspended Sollids
11/02/2005
11/02/2008
11/02/2011
11/02/2014
11/02/2017
11/02/2020

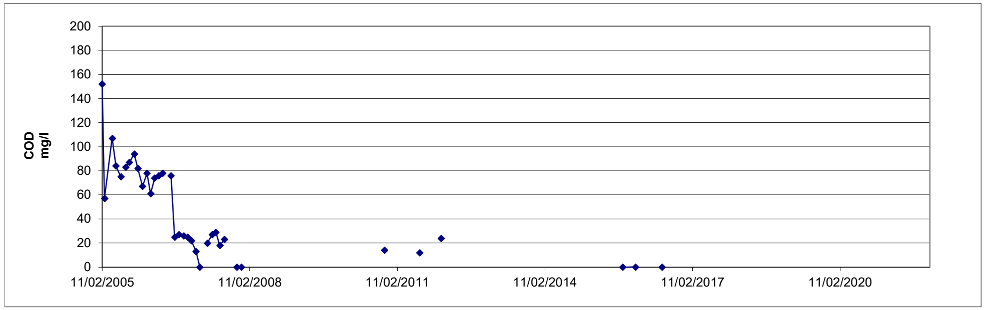

Copper microg/l
11/02/2005
11/02/2008
11/02/2011
11/02/2014
11/02/2017
11/02/2020

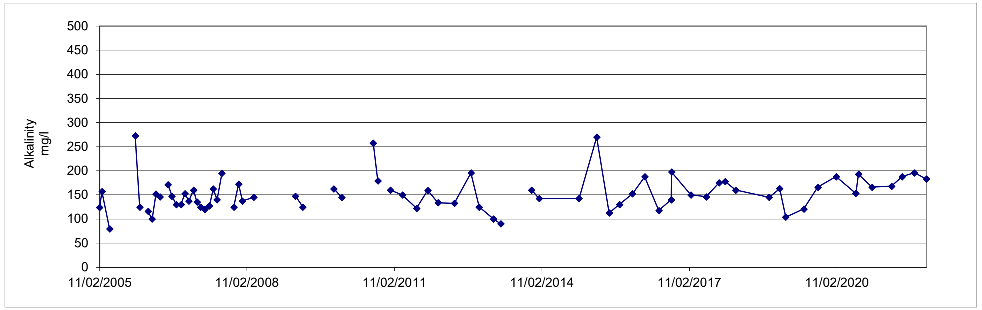

pH
11/02/2005
11/02/2008
11/02/2011
11/02/2014
11/02/2017
11/02/2020

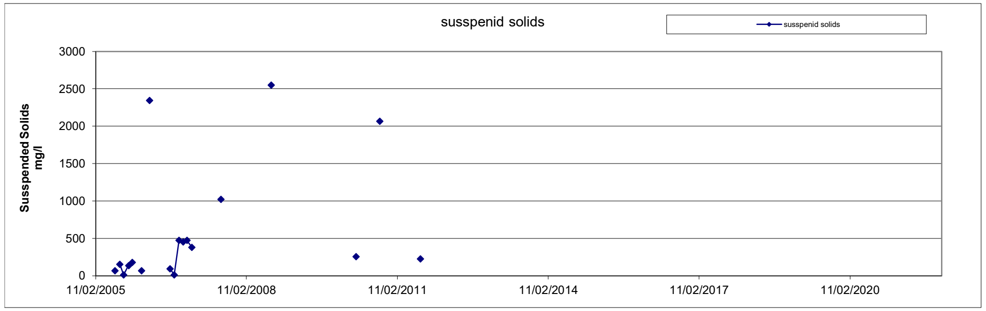

Freshwater EQS for Ammonia (NH_3 as N) = 0.015 mg/l
Ammonia
mg/l
11/02/2005
11/02/2008
11/02/2011
11/02/2014
11/02/2017
11/02/2020

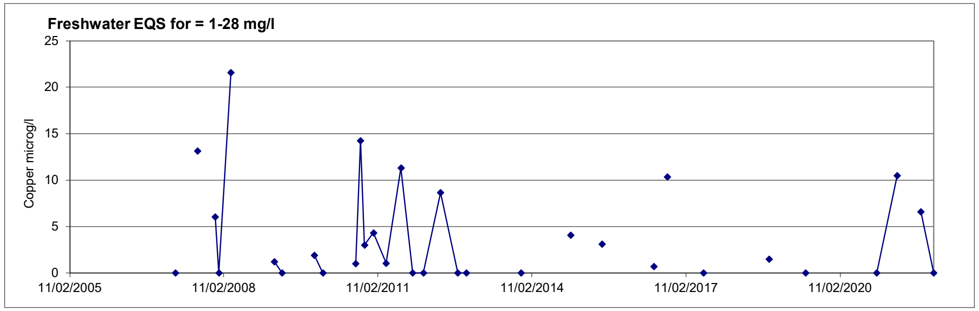

Freshwater EQS for Chloride = 250 mg/l
Chloride
mg/l
11/02/2005
11/02/2008
11/02/2011
11/02/2014
11/02/2017
11/02/2020


Calcium
mg/l
11/02/2005
11/02/2008
11/02/2011
11/02/2014
11/02/2017
11/02/2020

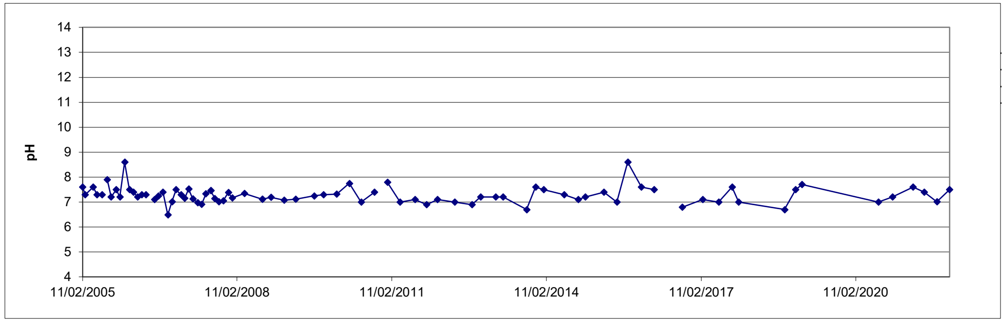

COD
mg/l
11/02/2005
11/02/2008
11/02/2011
11/02/2014
11/02/2017
11/02/2020

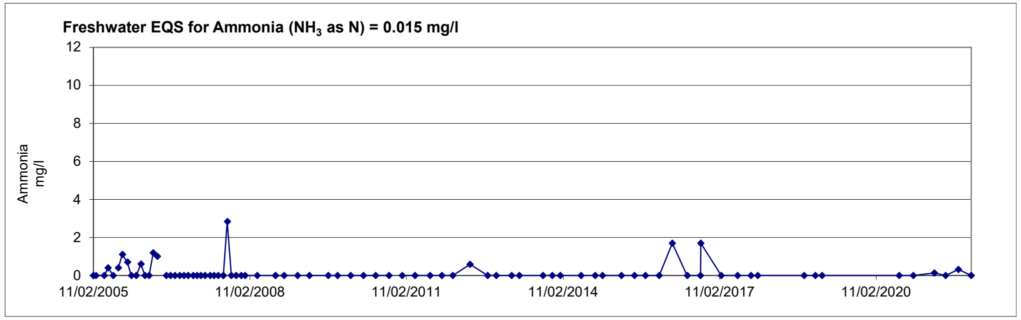

Alkalinity
mg/l
11/02/2005
11/02/2008
11/02/2011
11/02/2014
11/02/2017
11/02/2020

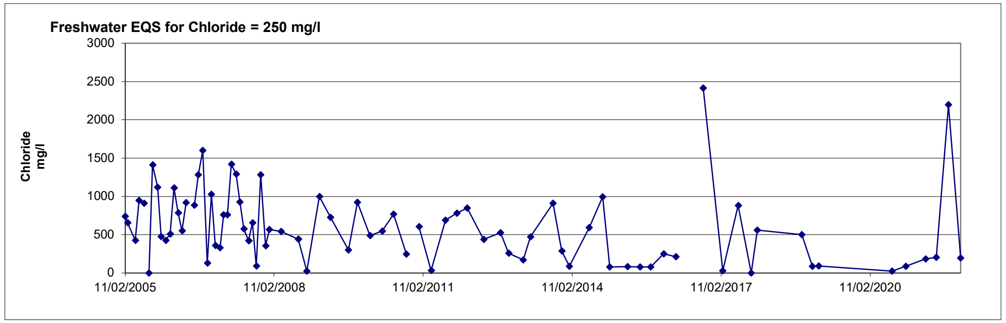

susspenid solids
susspenid solids
Susspended Solids
mg/l
11/02/2005
11/02/2008
11/02/2011
11/02/2014
11/02/2017
11/02/2020

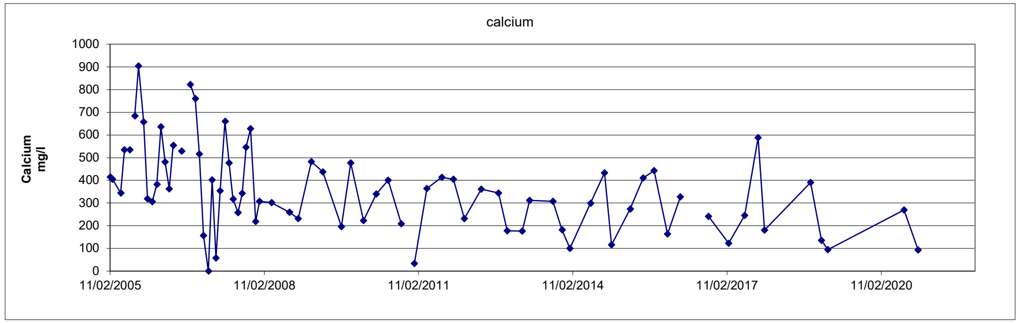

Freshwater EQS for = 1-28 mg/l
Copper microg/l
11/02/2005
11/02/2008
11/02/2011
11/02/2014
11/02/2017
11/02/2020

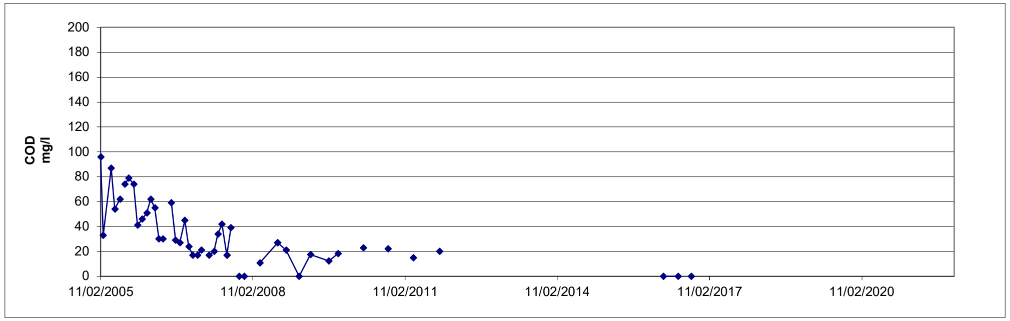
Monitoring data for SW 10

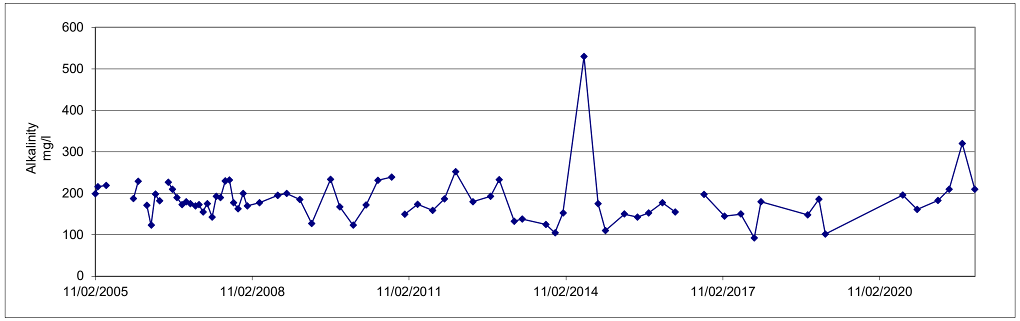


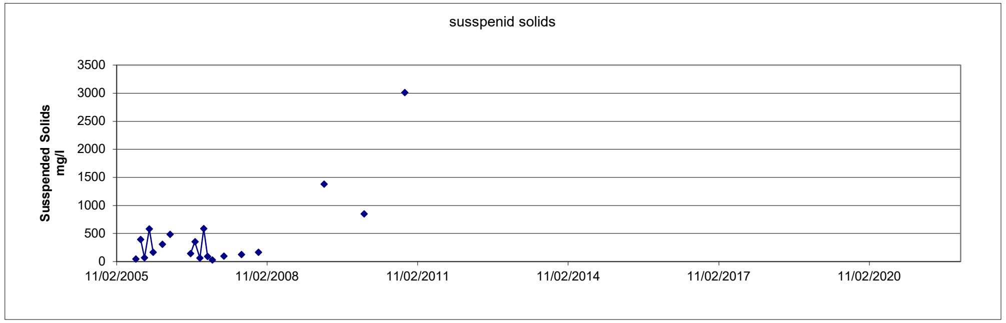


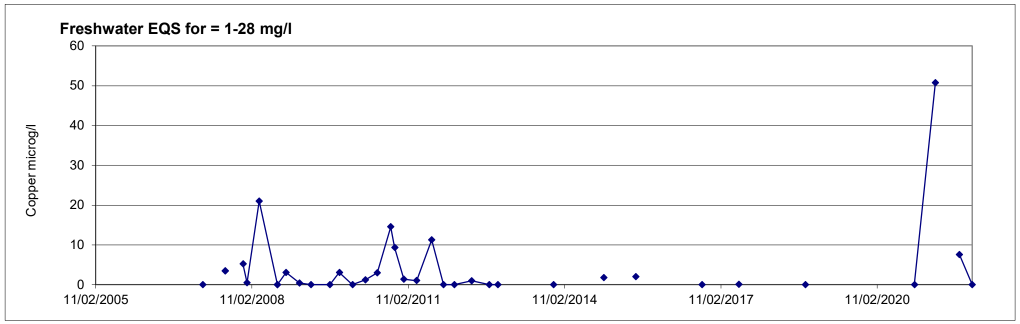


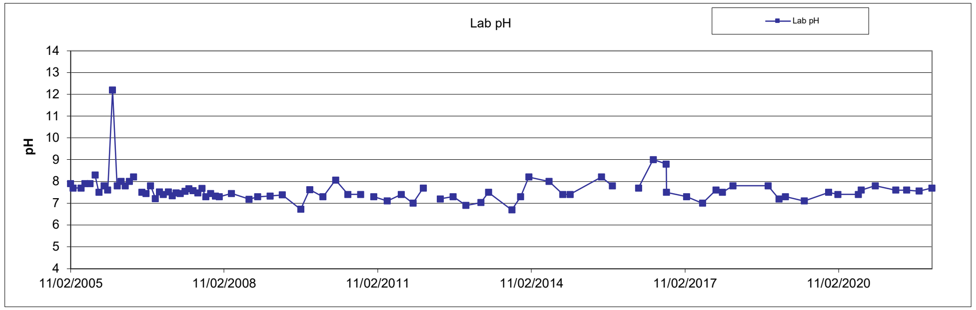


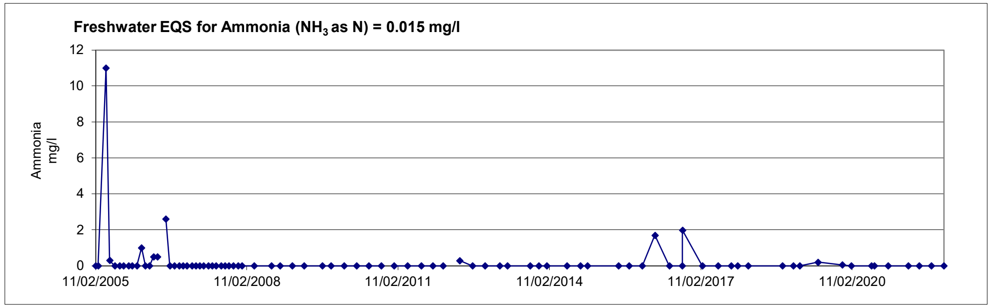


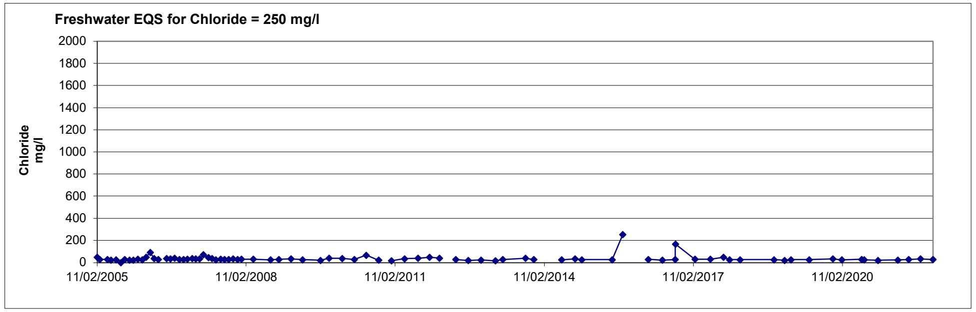


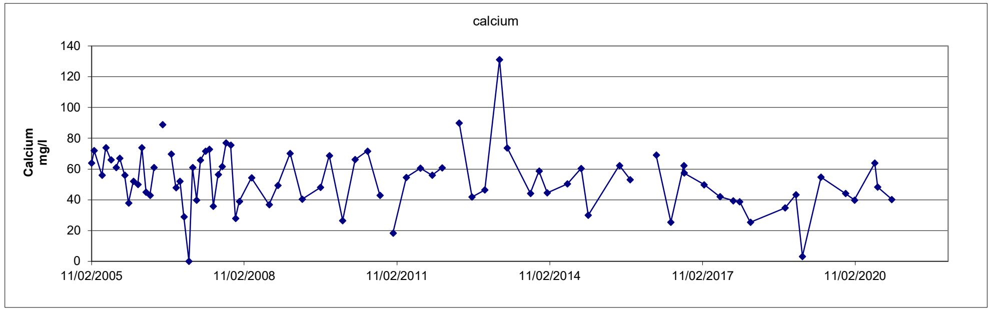


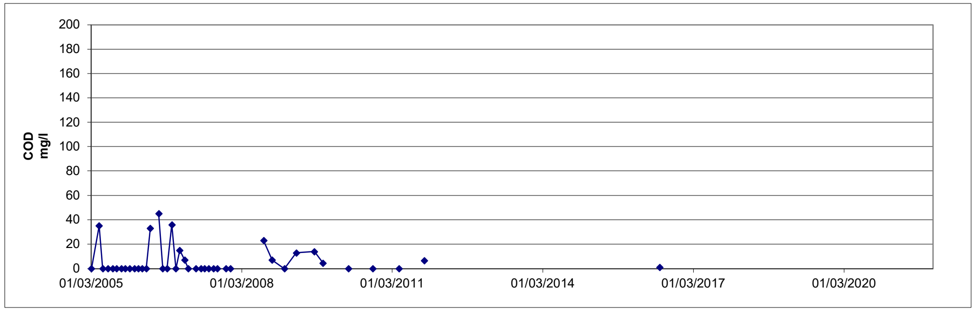


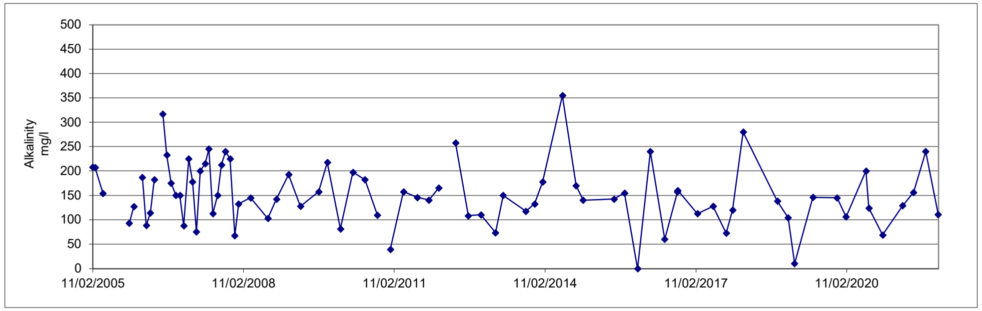

Lab pH
Lab pH
pH
14
13
12
11
10
9
8
7
6
5
4
11/02/2005
11/02/2008
11/02/2011
11/02/2014
11/02/2017
11/02/2020

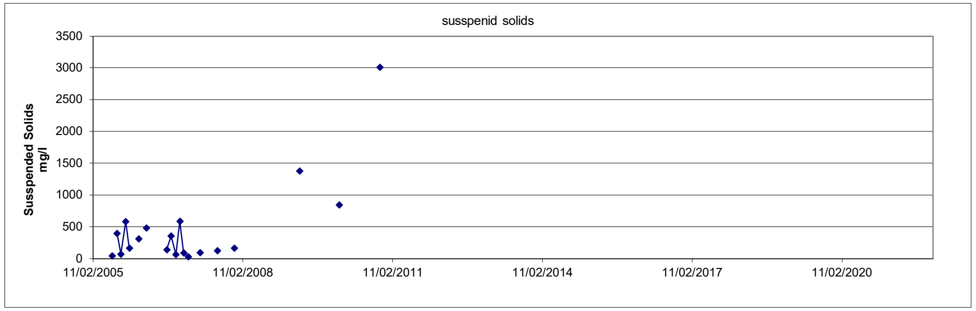

Freshwater EQS for Ammonia (NH_3 as N) = 0.015 mg/l
Ammonia
mg/l
12
10
8
6
4
2
0
11/02/2005
11/02/2008
11/02/2011
11/02/2014
11/02/2017
11/02/2020

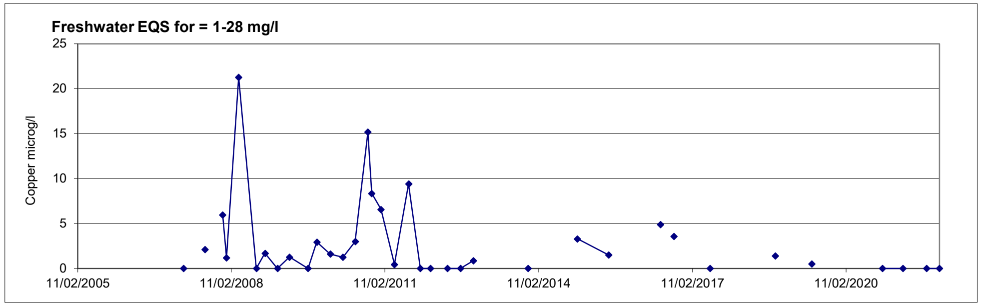

Freshwater EQS for Chloride = 250 mg/l
Chloride
mg/l
2000
1800
1600
1400
1200
1000
800
600
400
200
0
11/02/2005
11/02/2008
11/02/2011
11/02/2014
11/02/2017
11/02/2020


calcium
Calcium
mg/l
140
120
100
80
60
40
20
0
11/02/2005
11/02/2008
11/02/2011
11/02/2014
11/02/2017
11/02/2020

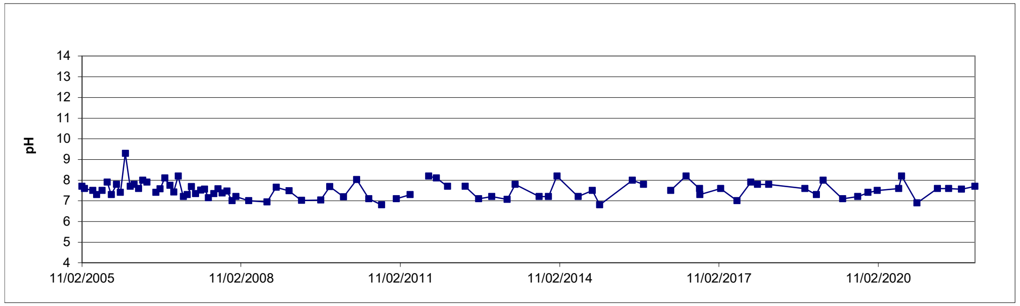

COD
mg/l
200
180
160
140
120
100
80
60
40
20
0
01/03/2005
01/03/2008
01/03/2011
01/03/2014
01/03/2017
01/03/2020

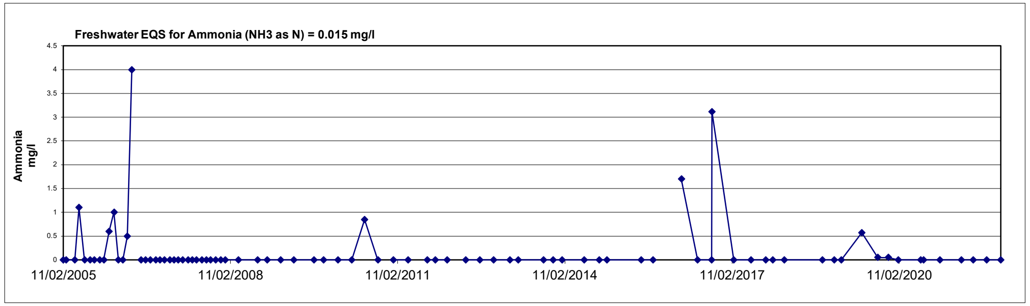

Alkalinity
mg/l
500
450
400
350
300
250
200
150
100
50
0
11/02/2005
11/02/2008
11/02/2011
11/02/2014
11/02/2017
11/02/2020

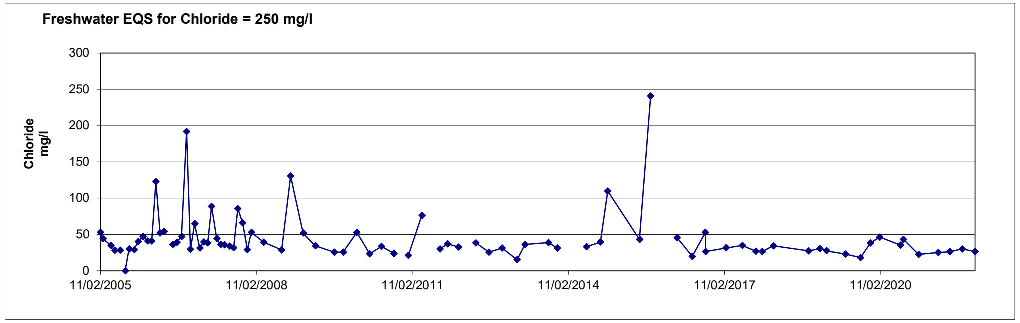

susspenid solids
Susspended Solids
mg/l
3500
3000
2500
2000
1500
1000
500
0
11/02/2005
11/02/2008
11/02/2011
11/02/2014
11/02/2017
11/02/2020

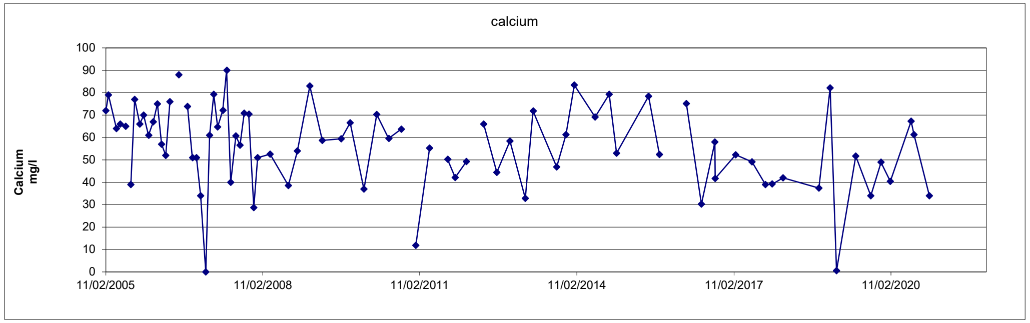

Freshwater EQS for = 1-28 mg/l
Copper microg/l
25
20
15
10
5
0
11/02/2005
11/02/2008
11/02/2011
11/02/2014
11/02/2017
11/02/2020

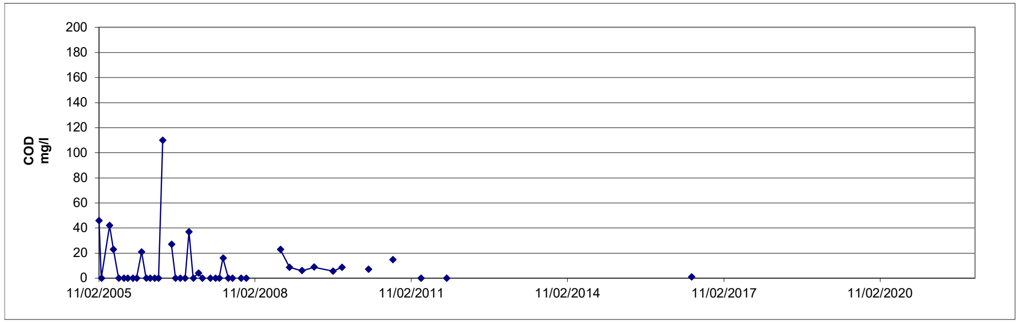
Monitoring data for SW 12

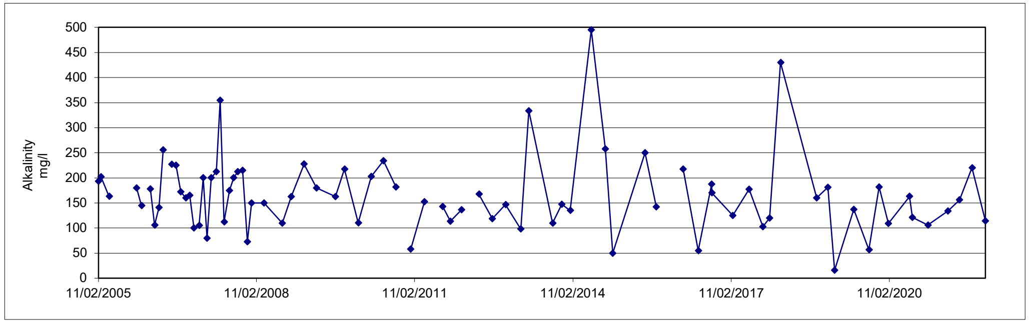


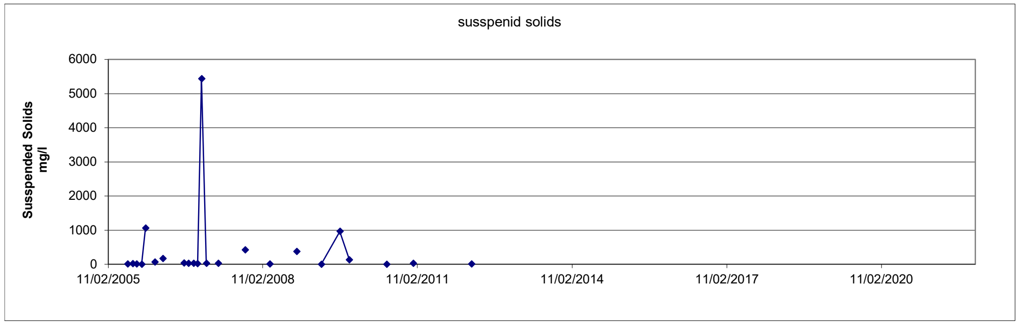


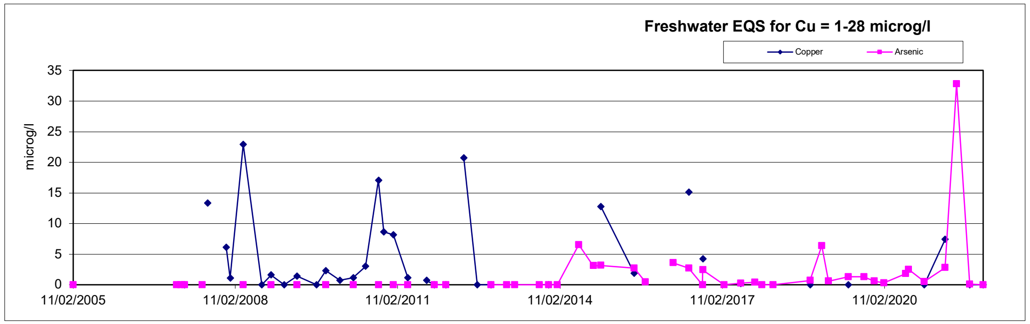


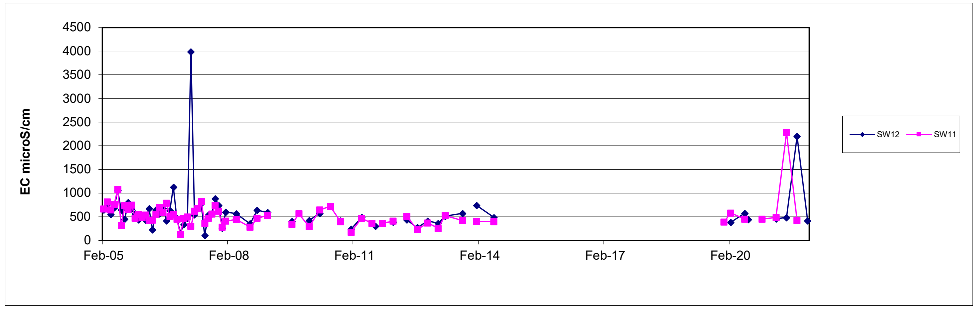


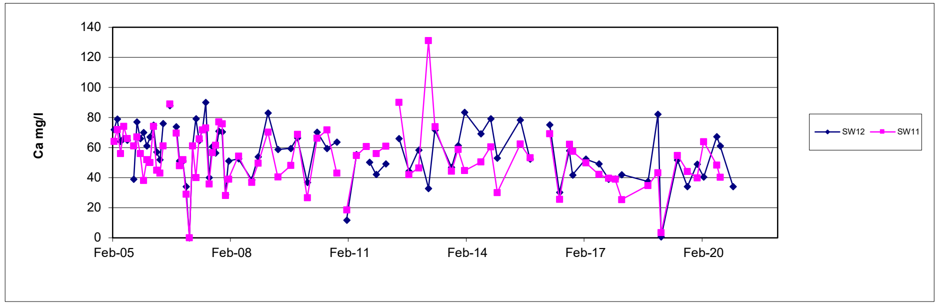


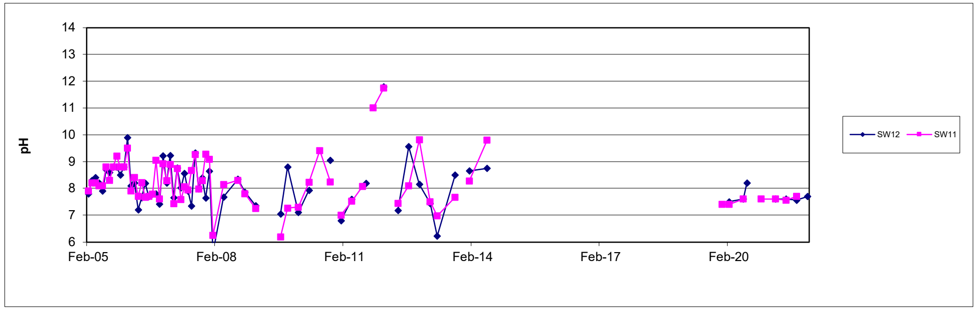


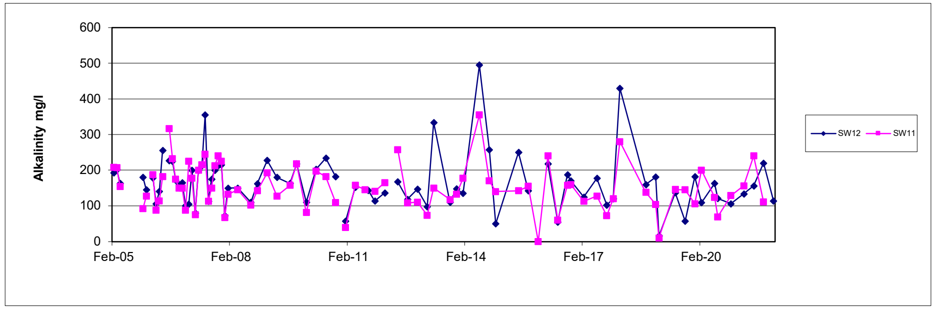


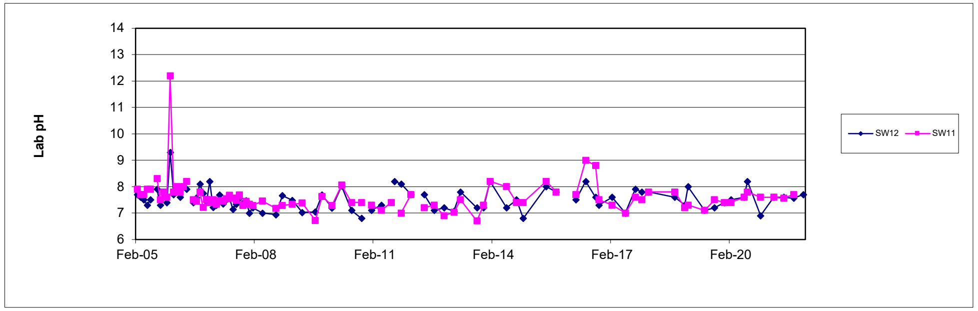


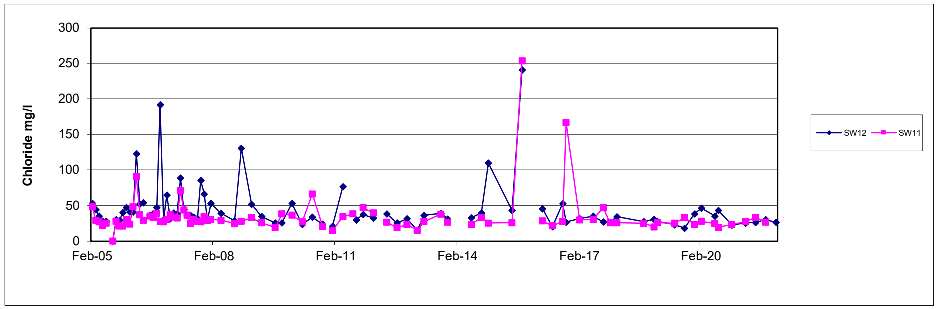

EC microS/cm
4500
4000
3500
3000
2500
2000
1500
1000
500
0
Feb-05 Feb-08 Feb-11 Feb-14 Feb-17 Feb-20
SW12 SW11

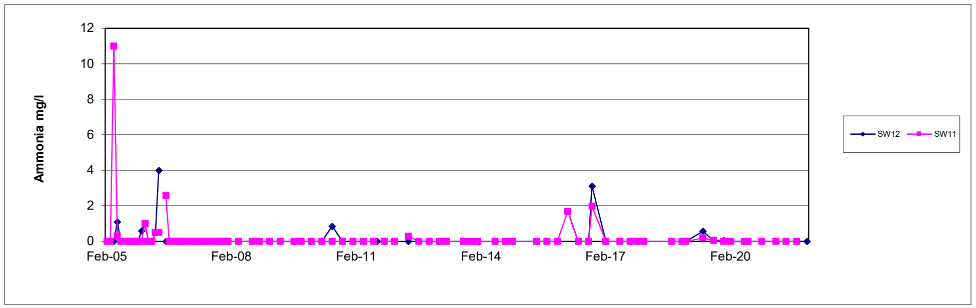

Ca mg/l
140
120
100
80
60
40
20
0
Feb-05 Feb-08 Feb-11 Feb-14 Feb-17 Feb-20
SW12 SW11

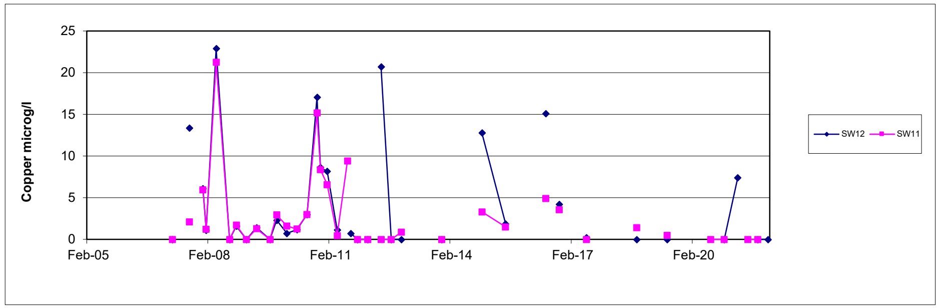

pH
14
13
12
11
10
9
8
7
6
Feb-05 Feb-08 Feb-11 Feb-14 Feb-17 Feb-20
SW12 SW11

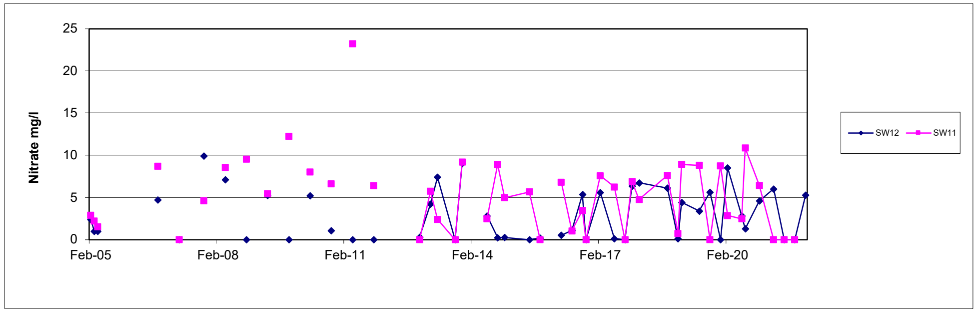

Alkalinity mg/l
600
500
400
300
200
100
0
Feb-05 Feb-08 Feb-11 Feb-14 Feb-17 Feb-20
SW12 SW11

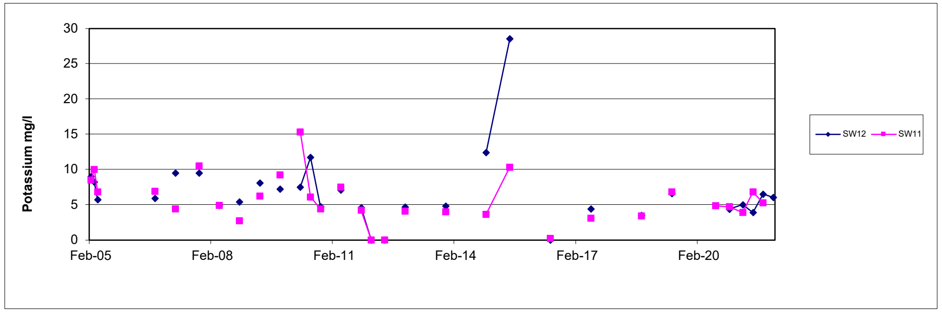

Lab pH
14
13
12
11
10
9
8
7
6
Feb-05 Feb-08 Feb-11 Feb-14 Feb-17 Feb-20
SW12 SW11

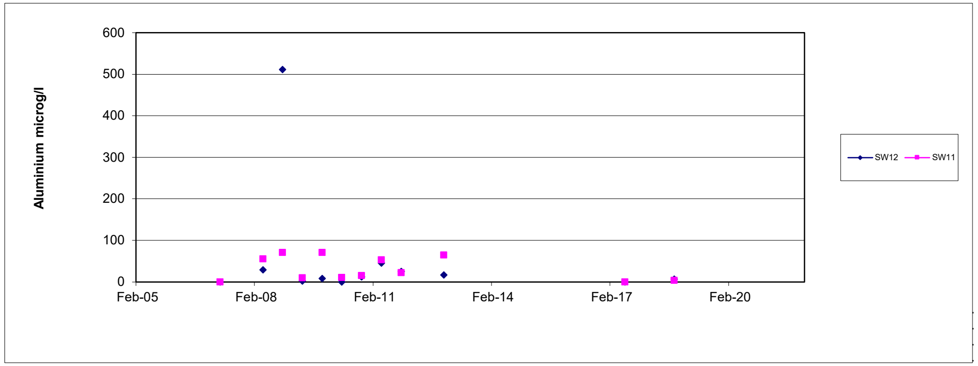

Chloride mg/l
300
250
200
150
100
50
0
Feb-05 Feb-08 Feb-11 Feb-14 Feb-17 Feb-20
SW12 SW11

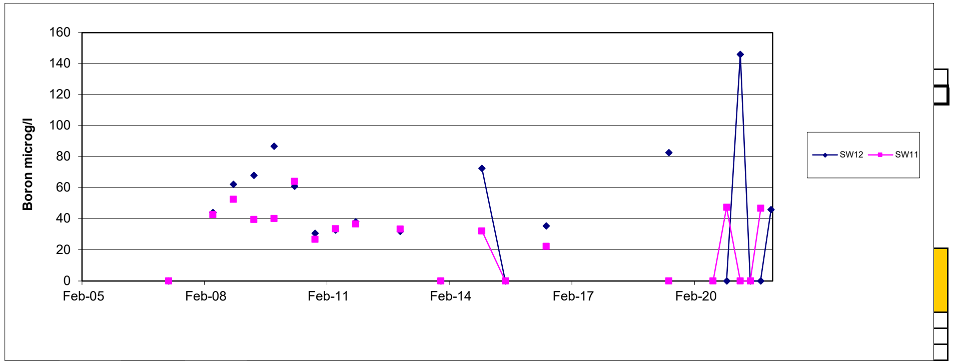

Ammonia mg/l
12
10
8
6
4
2
0
Feb-05 Feb-08 Feb-11 Feb-14 Feb-17 Feb-20
SW12 SW11

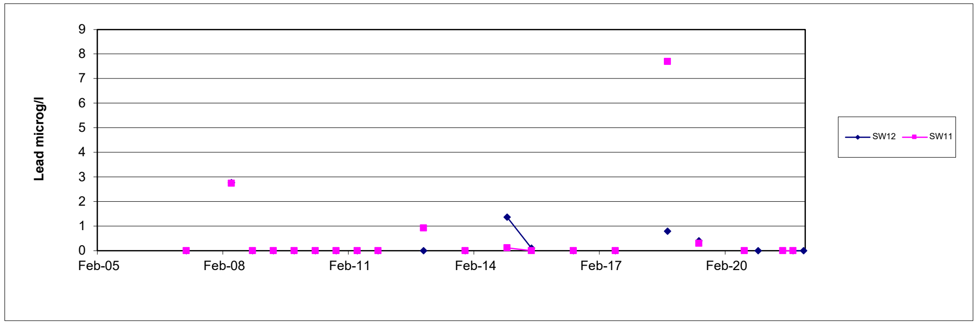

Copper microg/l
25
20
15
10
5
0
Feb-05 Feb-08 Feb-11 Feb-14 Feb-17 Feb-20
SW12 SW11

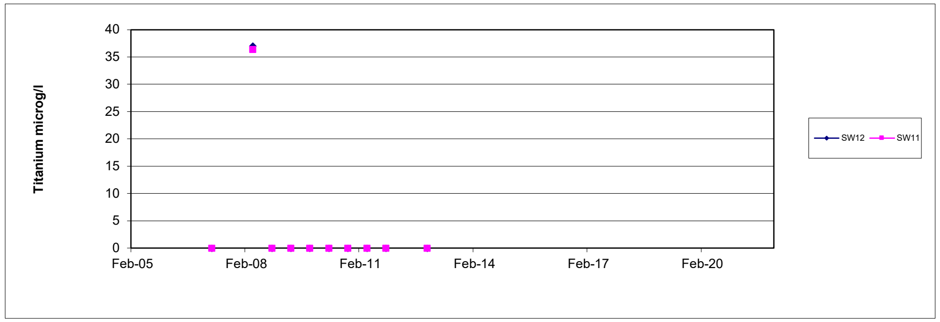

Nitrate mg/l
25
20
15
10
5
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20
SW12
SW11

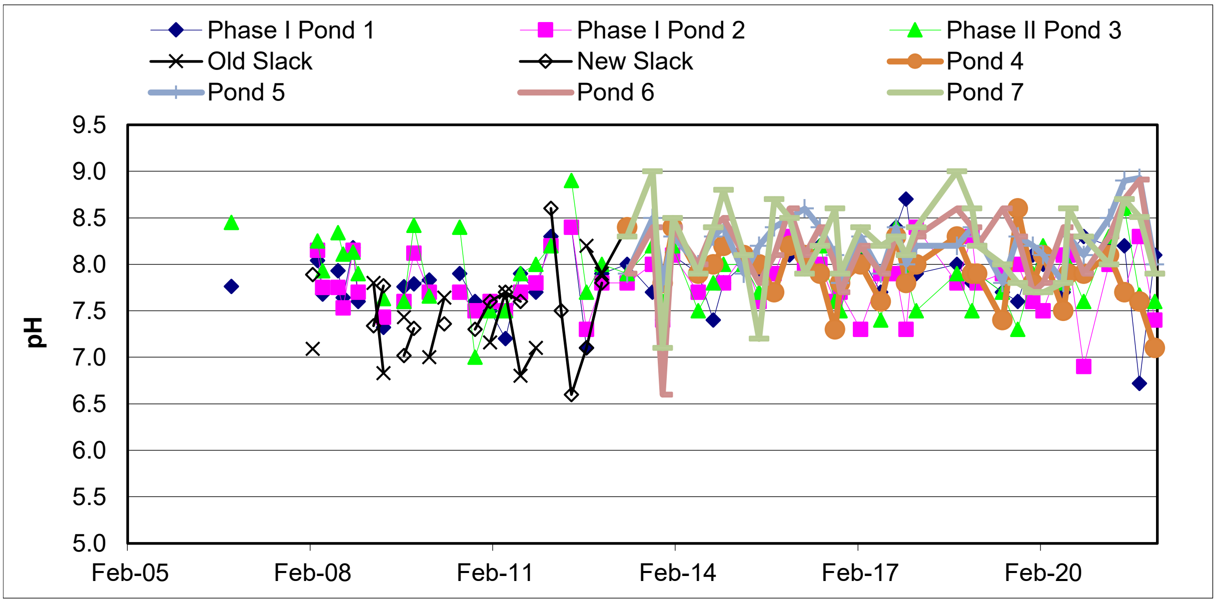

Potassium mg/l
30
25
20
15
10
5
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20
SW12
SW11

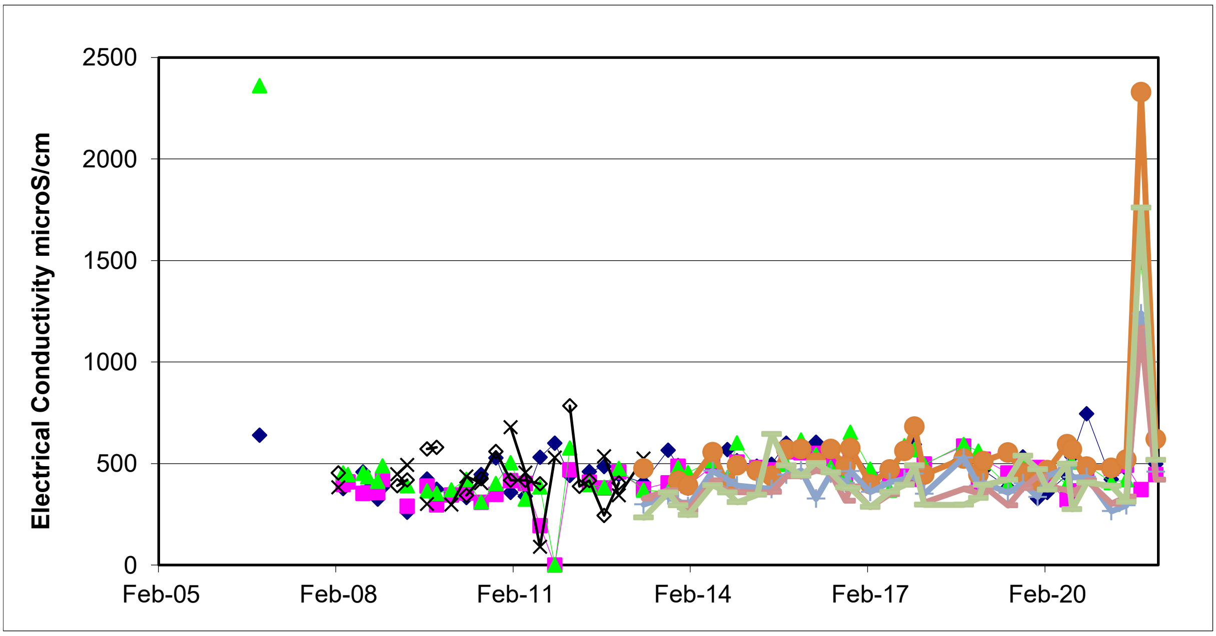

Aluminium microg/l
600
500
400
300
200
100
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20
SW12
SW11

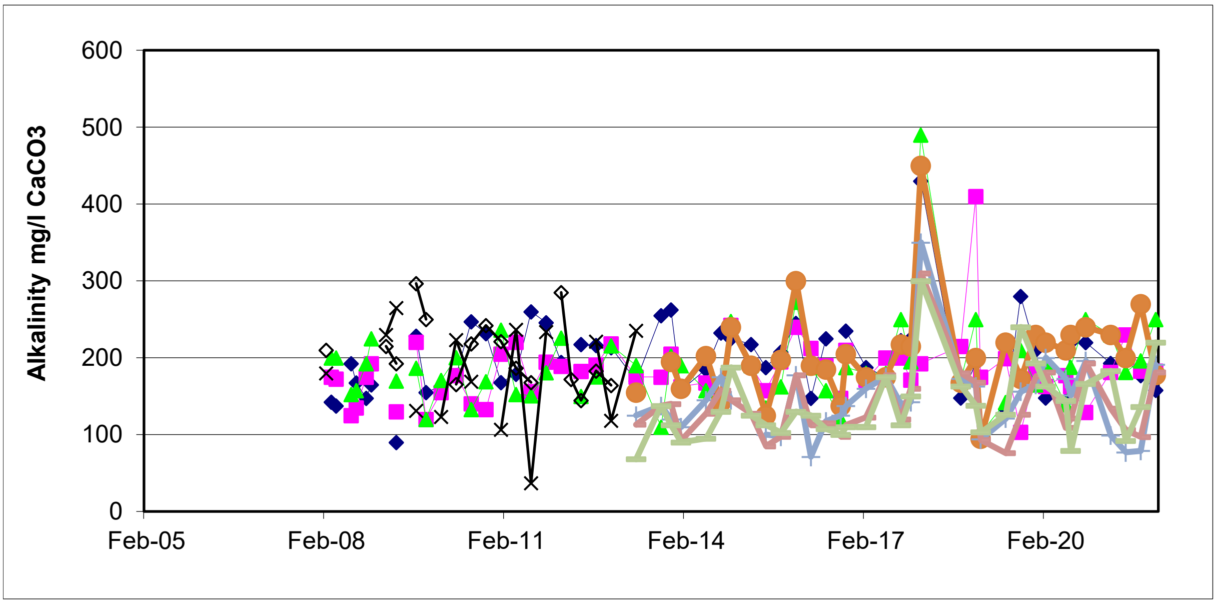

Boron microg/l
160
140
120
100
80
60
40
20
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20
SW12
SW11

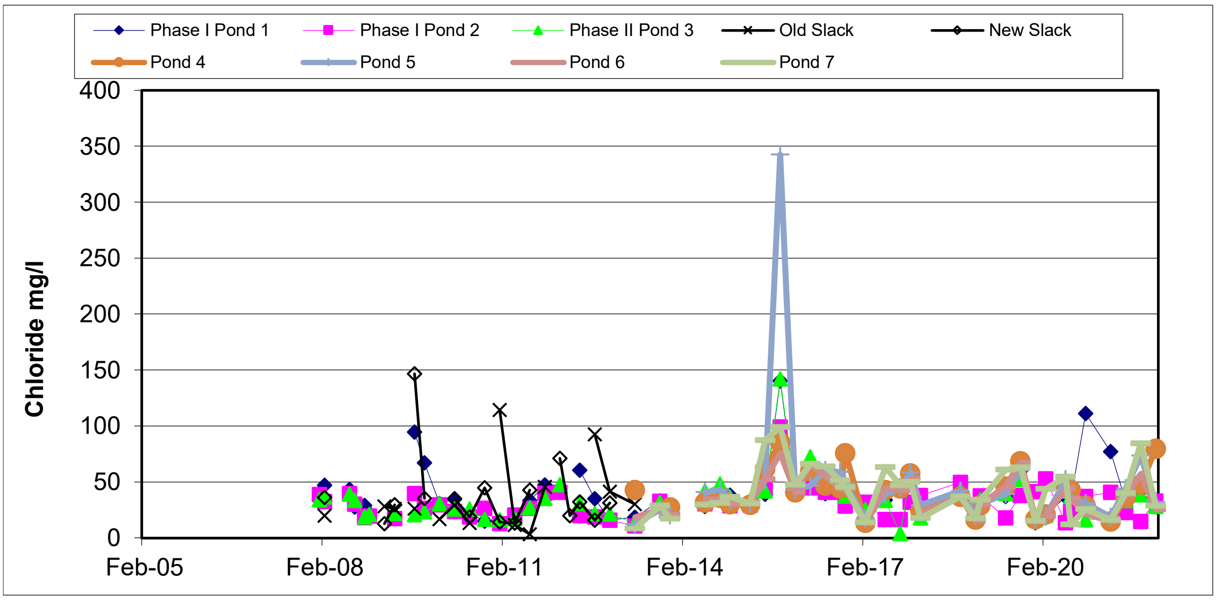

Lead microg/l
9
8
7
6
5
4
3
2
1
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20
SW12
SW11

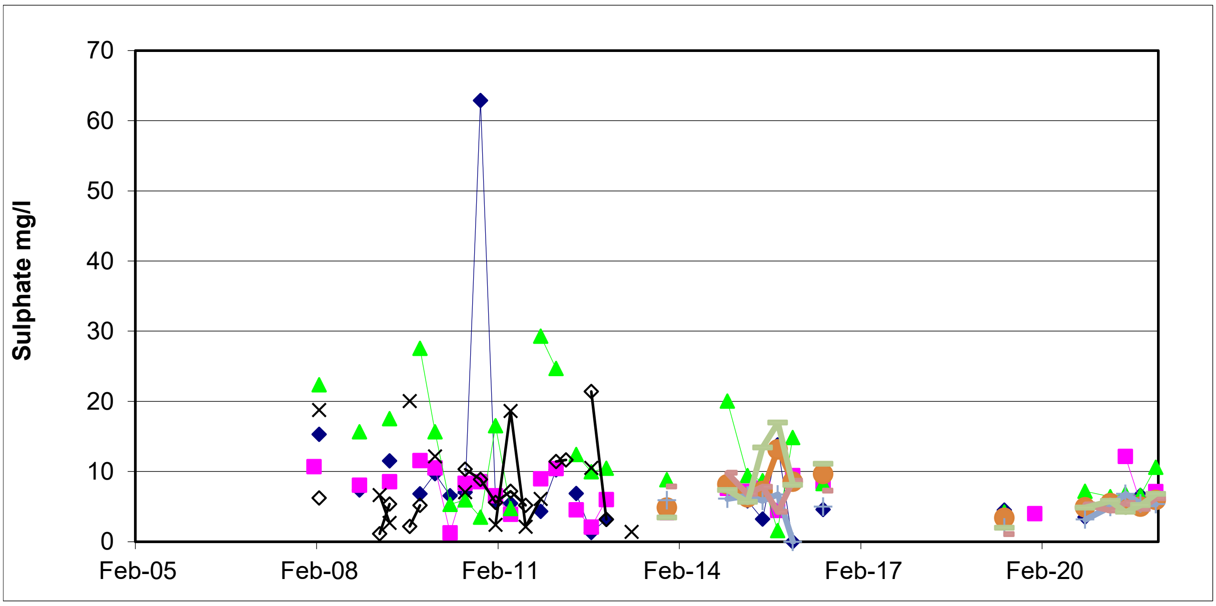

Titanium microg/l
40
35
30
25
20
15
10
5
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20
SW12
SW11

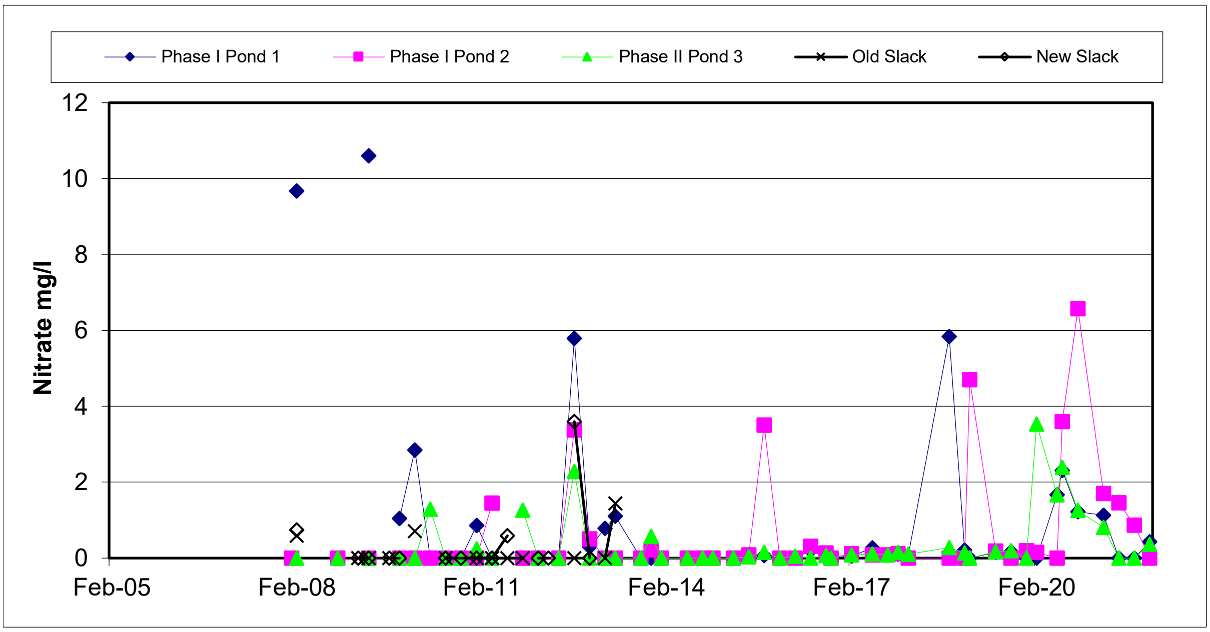

Phase I Pond 1
Phase I Pond 2
Phase II Pond 3
Old Slack
New Slack
Pond 4
Pond 5
Pond 6
Pond 7
pH
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

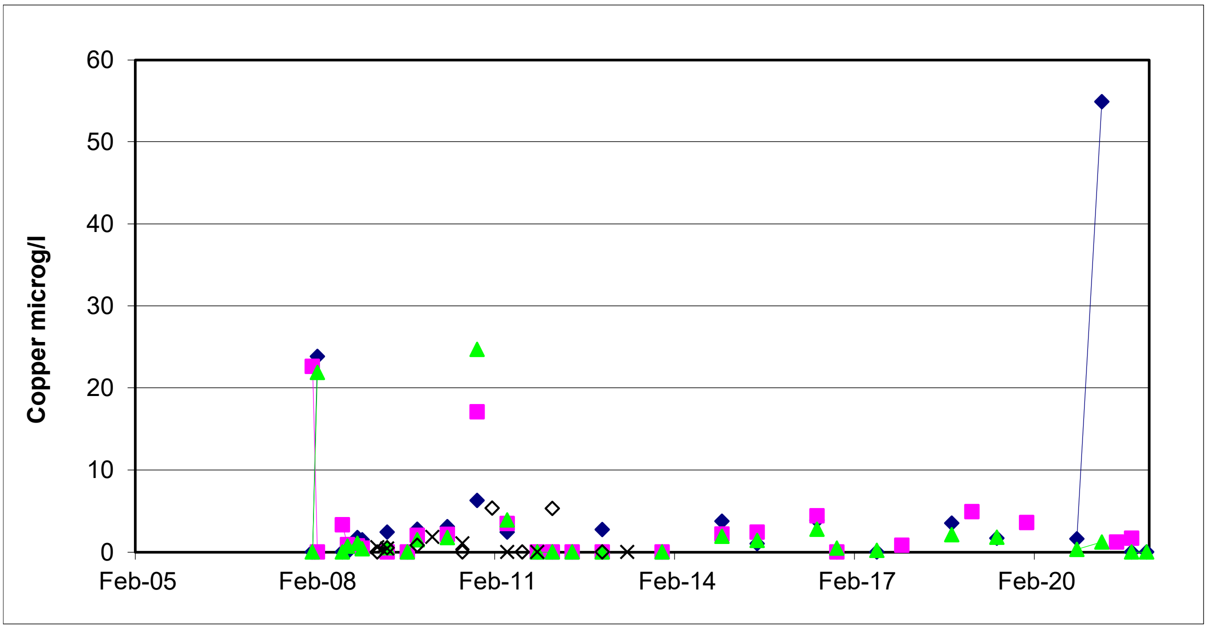

Electrical Conductivity microS/cm
2500
2000
1500
1000
500
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

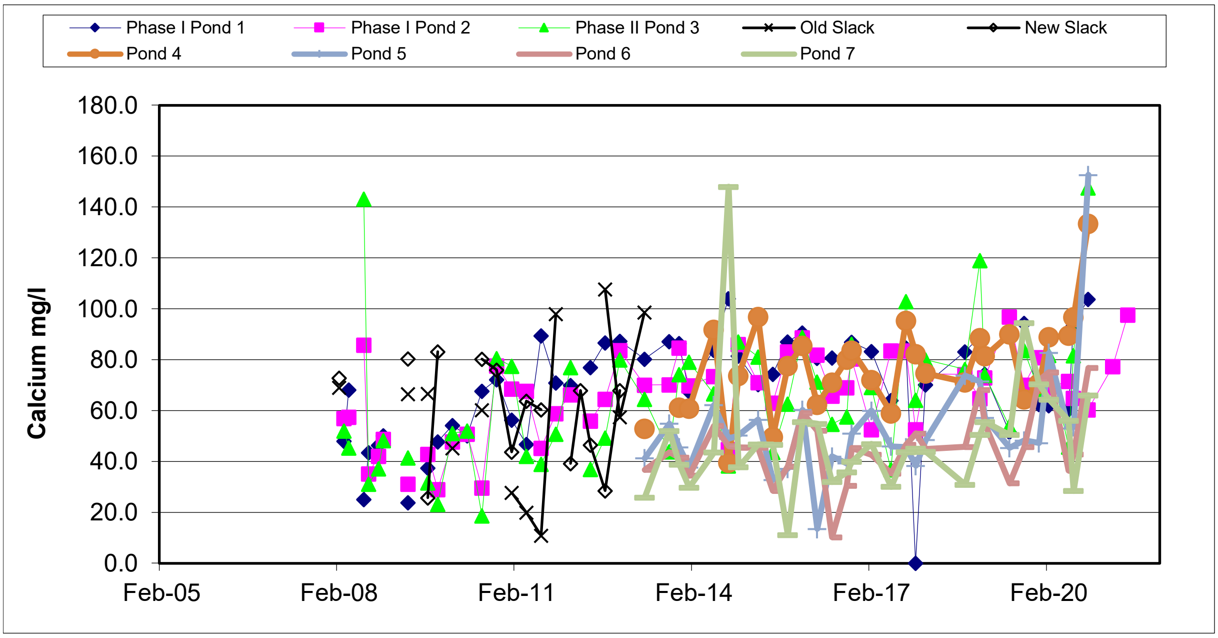

Alkalinity mg/l CaCO3
600
500
400
300
200
100
0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

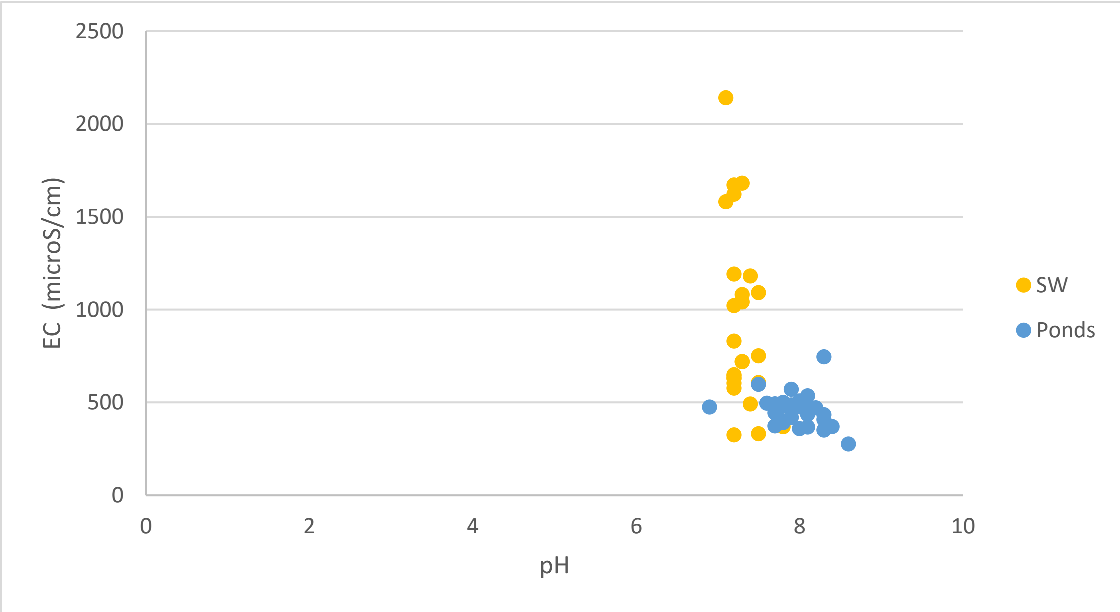

Phase I Pond 1
Phase I Pond 2
Phase II Pond 3
Old Slack
New Slack
Pond 4
Pond 5
Pond 6
Pond 7
Chloride mg/l
0
50
100
150
200
250
300
350
400
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20


Sulphate mg/l
0
10
20
30
40
50
60
70
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

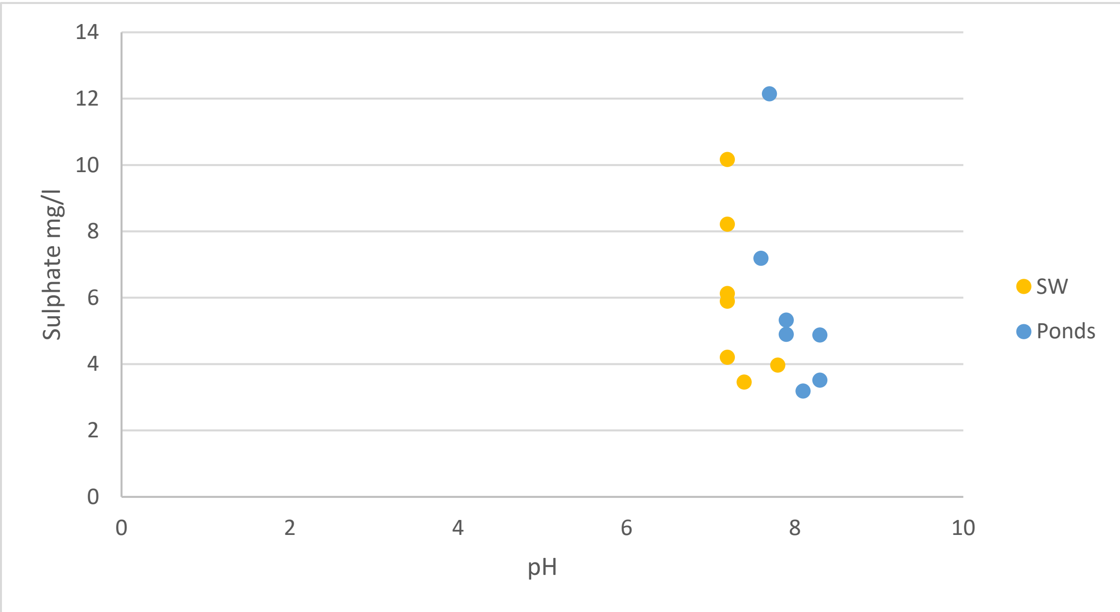

Phase I Pond 1
Phase I Pond 2
Phase II Pond 3
Old Slack
New Slack
Nitrate mg/l
0
2
4
6
8
10
12
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20


Copper microg/l
0
10
20
30
40
50
60
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20

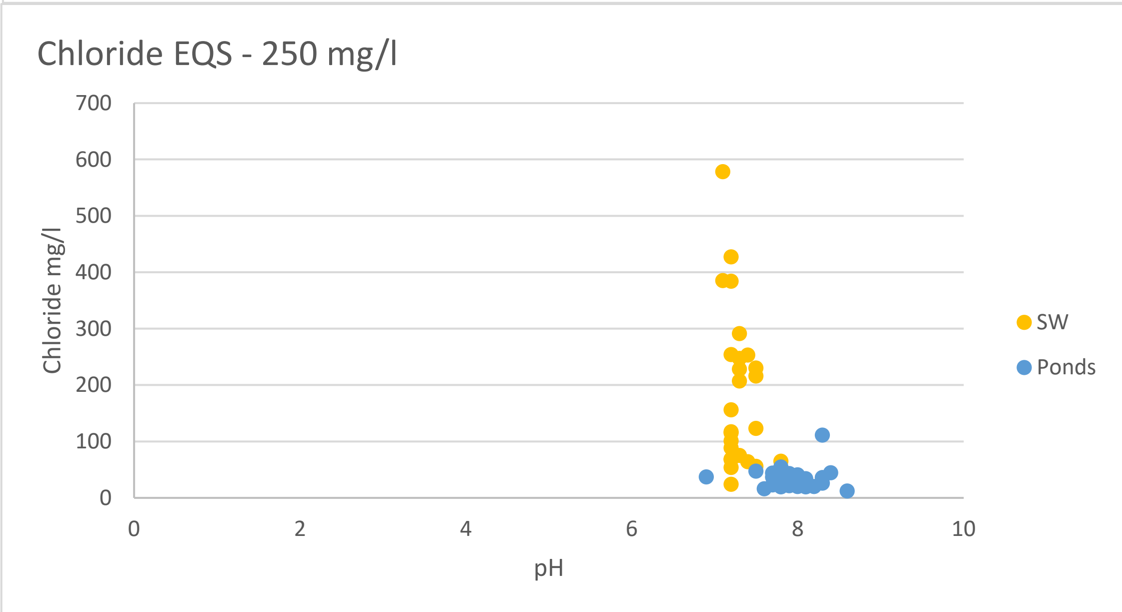

Phase I Pond 1
Phase I Pond 2
Phase II Pond 3
Old Slack
New Slack
Pond 4
Pond 5
Pond 6
Pond 7
Calcium mg/l
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
160.0
180.0
Feb-05
Feb-08
Feb-11
Feb-14
Feb-17
Feb-20



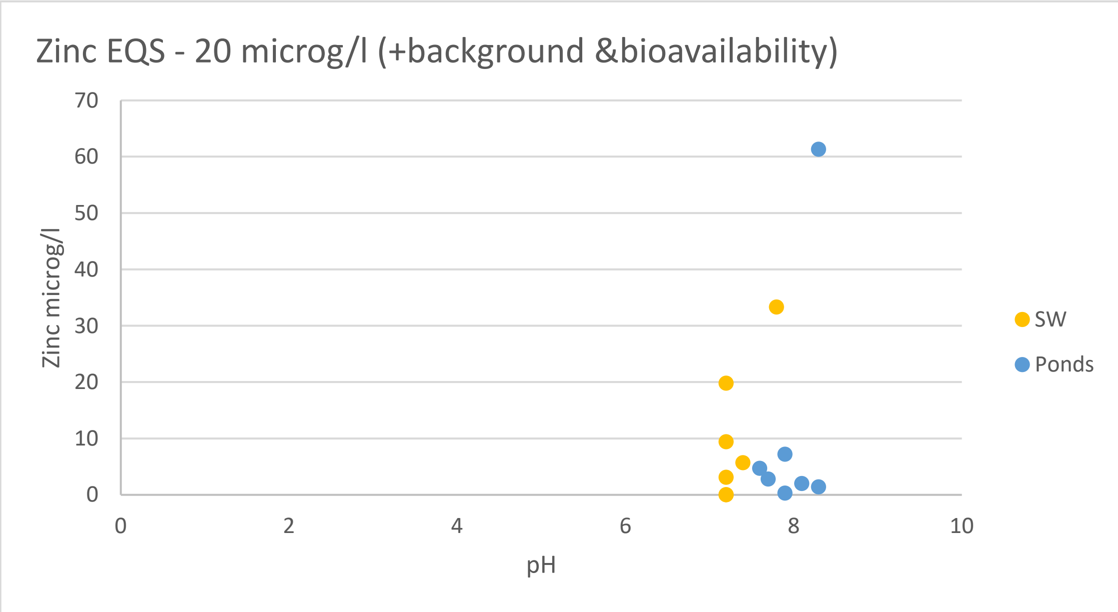
EC (microS/cm)
2500
2000
1500
1000
500
0
0
2
4
6
8
10
pH
SW
Ponds



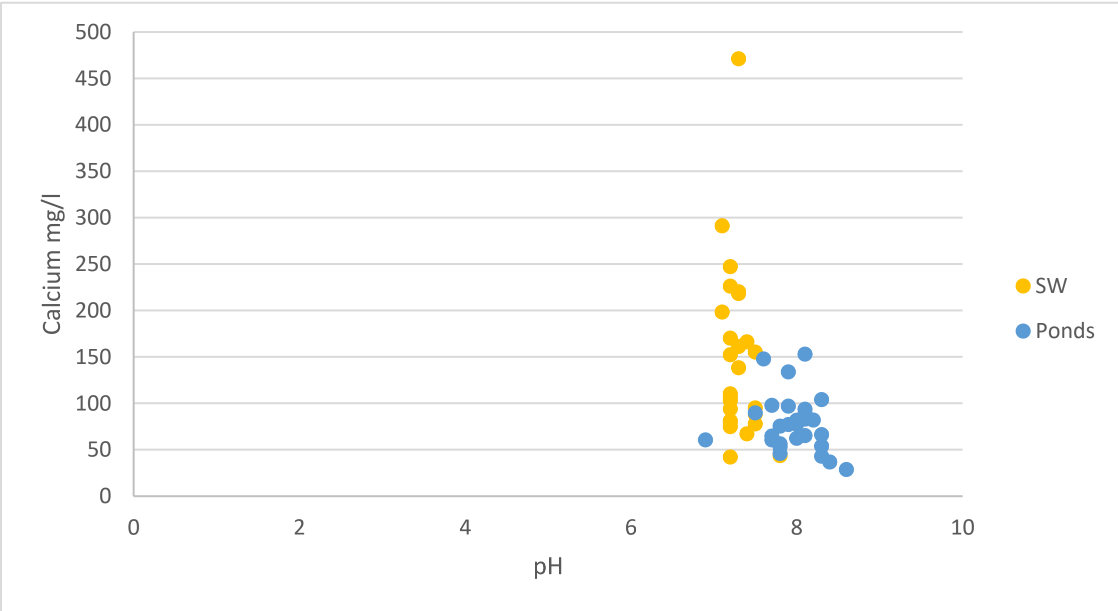
Sulphate mg/l
14
12
10
8
6
4
2
0
0
2
4
6
8
10
pH
SW
Ponds



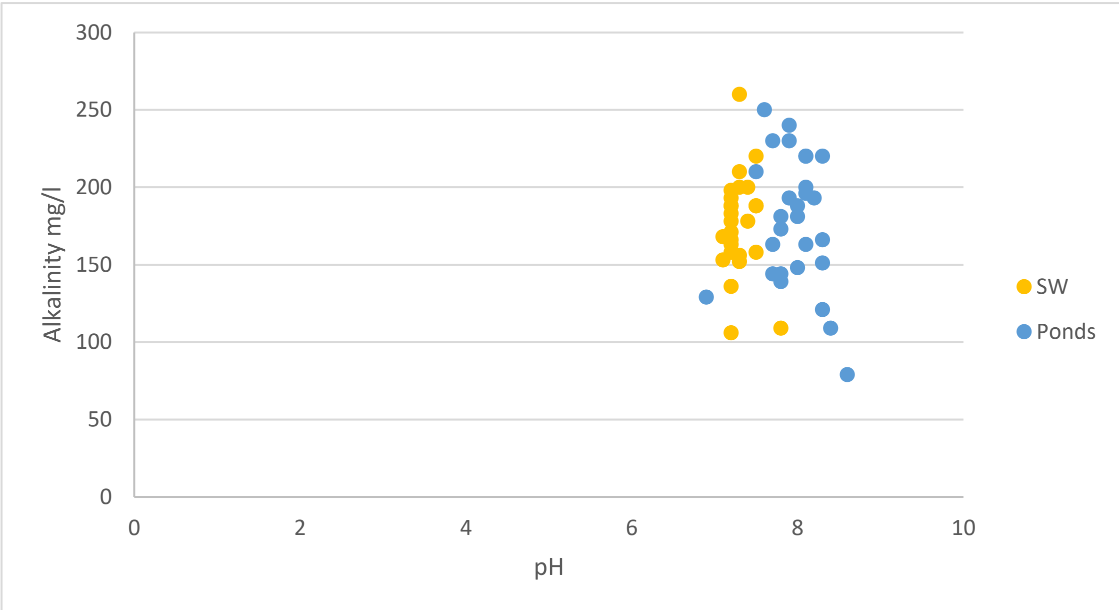
Chloride EQS - 250 mg/l
Chloride mg/l
700
600
500
400
300
200
100
0
0
2
4
6
8
10
pH
SW
Ponds



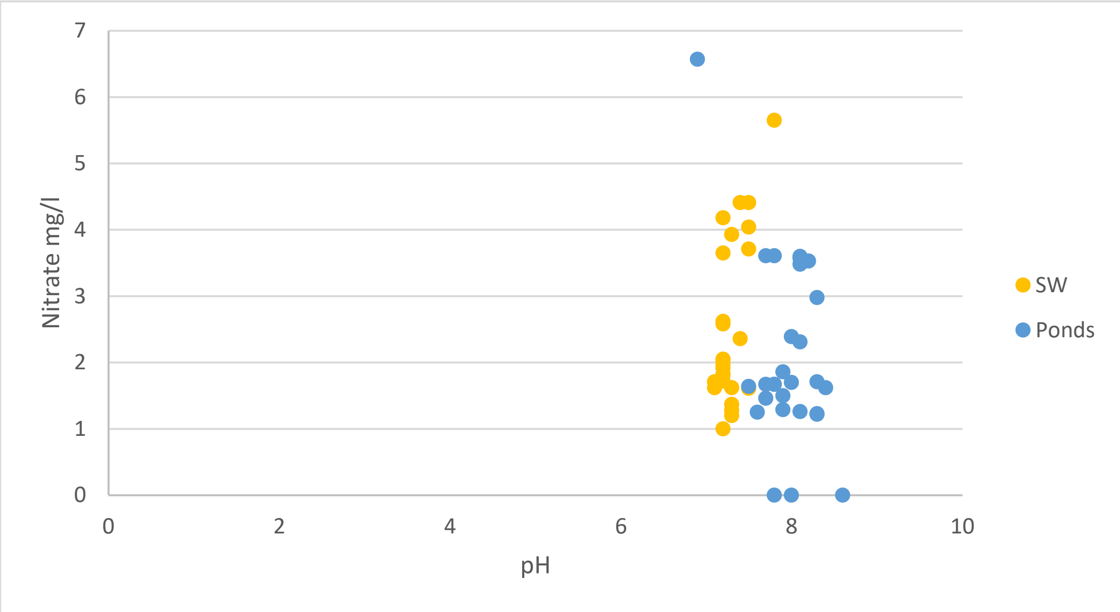
Zinc EQS - 20 microg/l (+background &bioavailability)
Zinc microg/l
70
60
50
40
30
20
10
0
0
2
4
6
8
10
pH
SW
Ponds

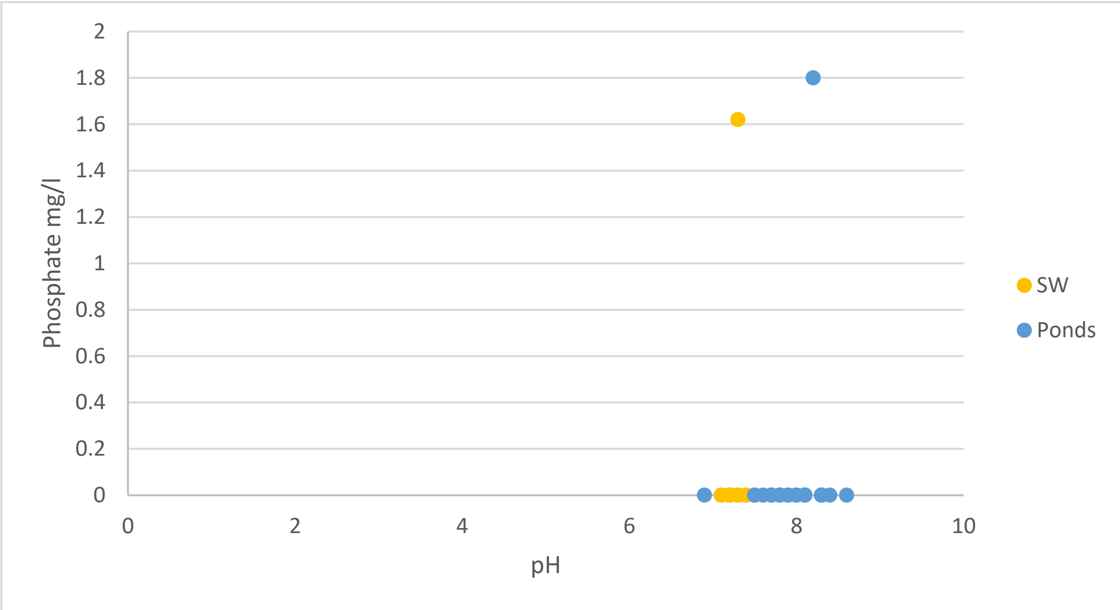


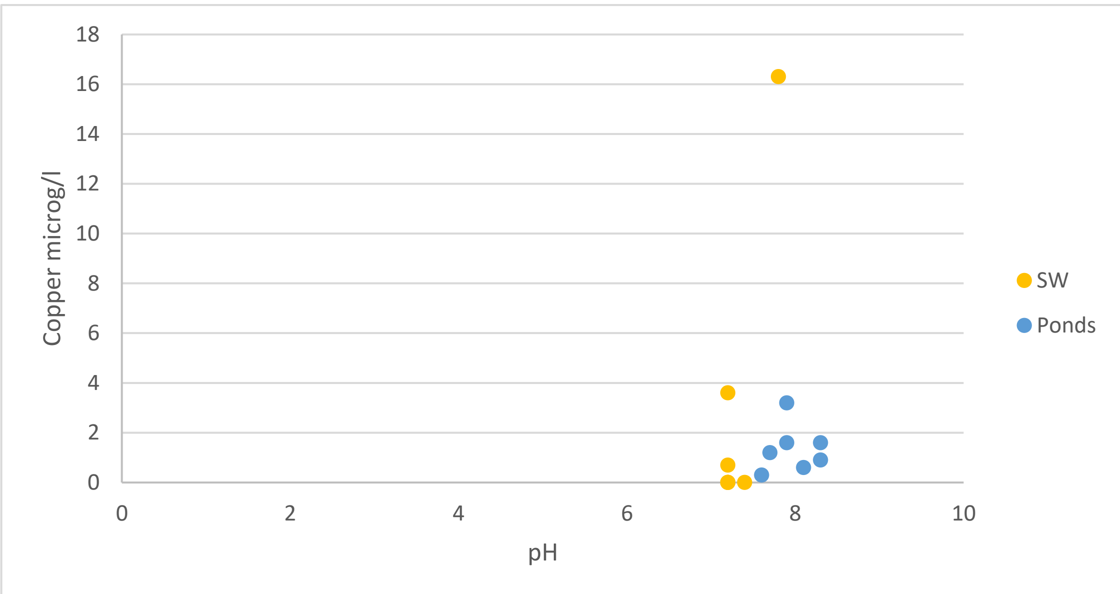
Calcium mg/l
500
450
400
350
300
250
200
150
100
50
0
0
2
4
6
8
10
pH
SW
Ponds



Alkalinity mg/l
300
250
200
150
100
50
0
0
2
4
6
8
10
pH
SW
Ponds


Nitrate mg/l
pH
SW
Ponds
0
1
2
3
4
5
6
7
0
2
4
6
8
10


Phosphate mg/l
pH
SW
Ponds
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
0
2
4
6
8
10

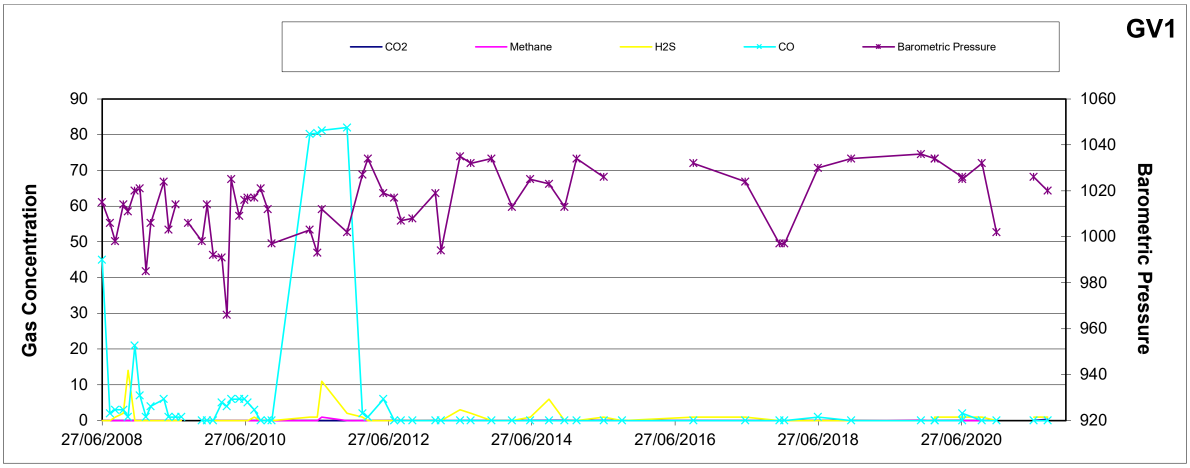

Copper microg/l
pH
SW
Ponds
0
2
4
6
8
10
12
14
16
18
0
2
4
6
8
10

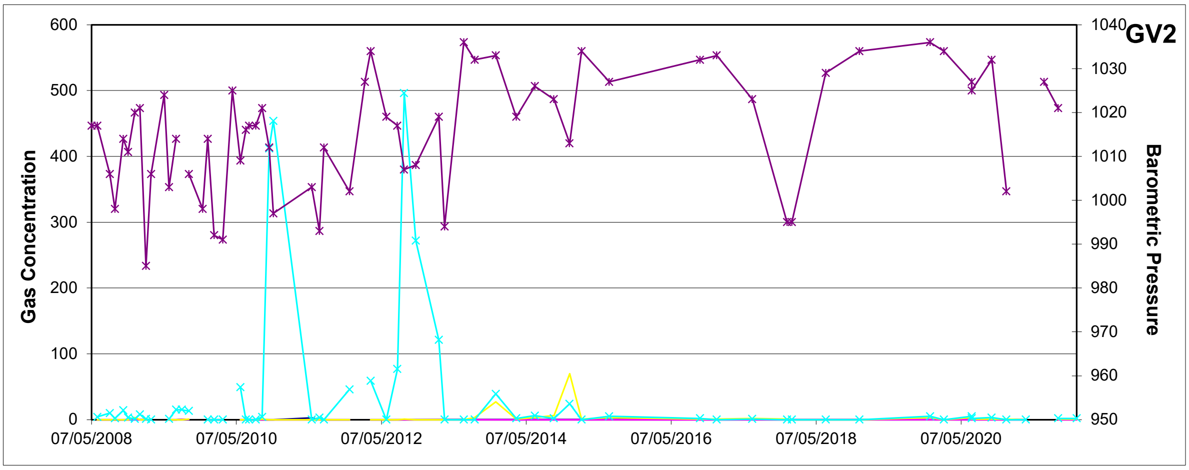
MORFA CLOSED LANDFILL,
PORT TALBOT

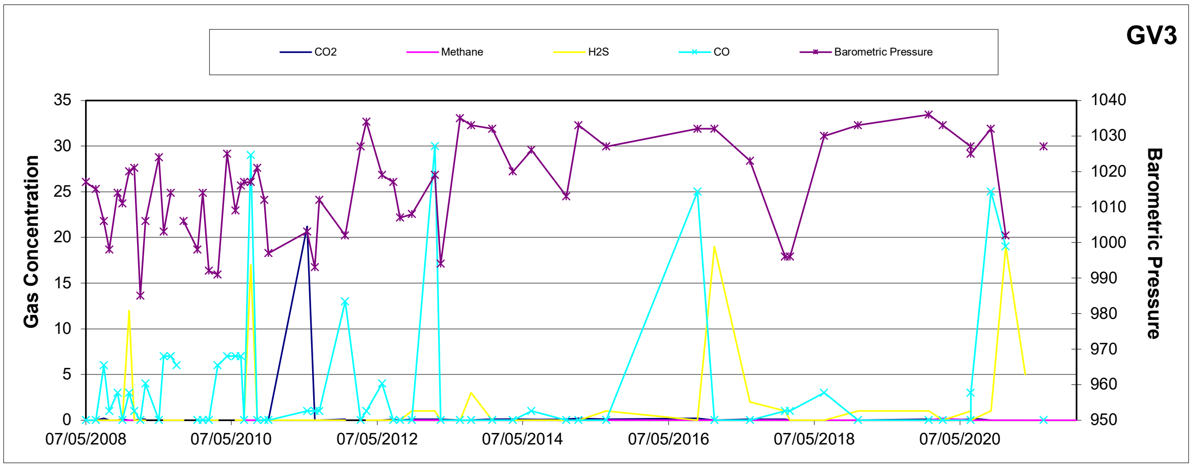
PERMIT EPR/AP3292LT

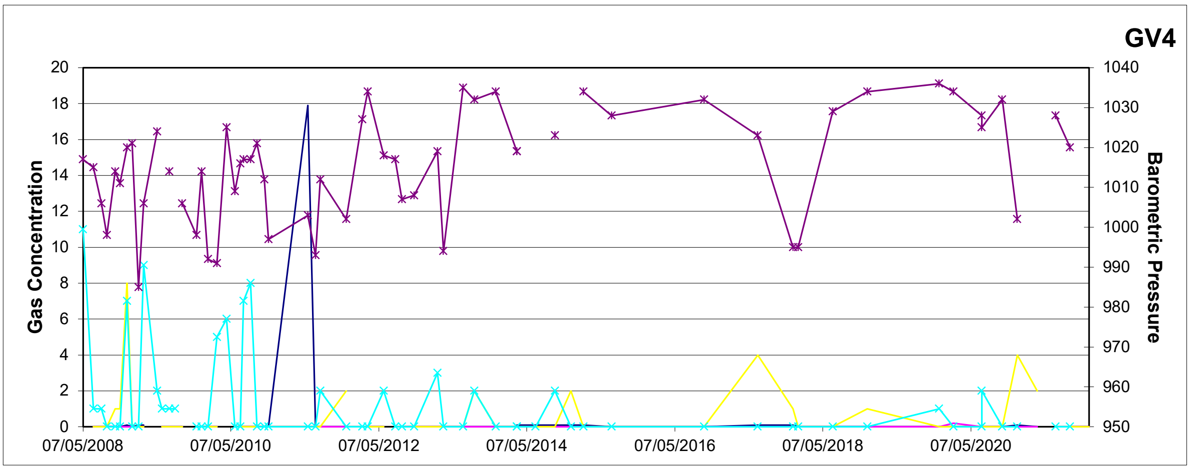
2020 Annual Review of Environmental Monitoring Results

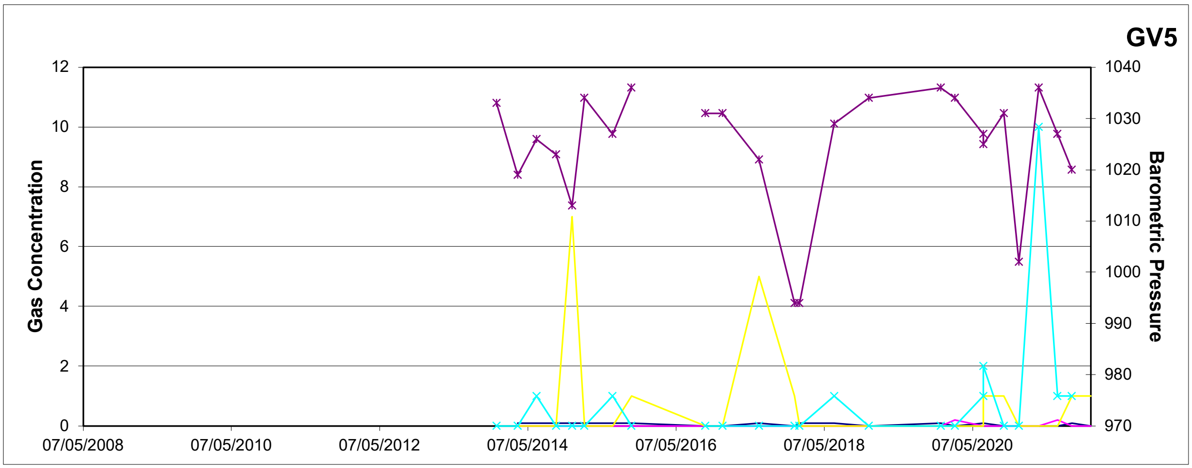
Appendix 4
Temporal Variation of Landfill Gas Chemistry
Report Number 2192r1v1d0222

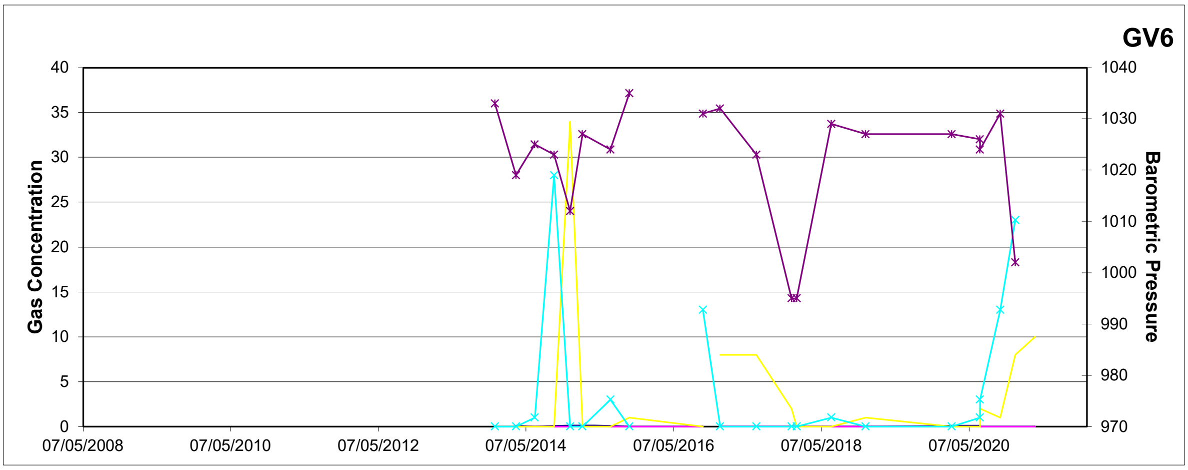

GV1
CO2
Methane
H2S
CO
Barometric Pressure
Gas Concentration
Barometric Pressure
90
80
70
60
50
40
30
20
10
0
1060
1040
1020
1000
980
960
940
920
27/06/2008
27/06/2010
27/06/2012
27/06/2014
27/06/2016
27/06/2018
27/06/2020

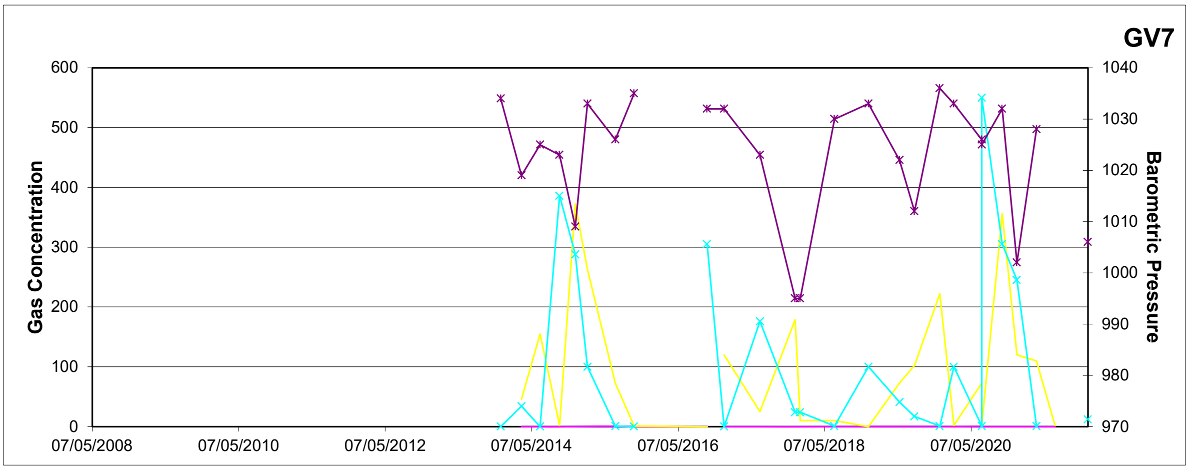

GV2
Gas Concentration
Barometric Pressure
600
500
400
300
200
100
0
1040
1030
1020
1010
1000
990
980
970
960
950
07/05/2008
07/05/2010
07/05/2012
07/05/2014
07/05/2016
07/05/2018
07/05/2020

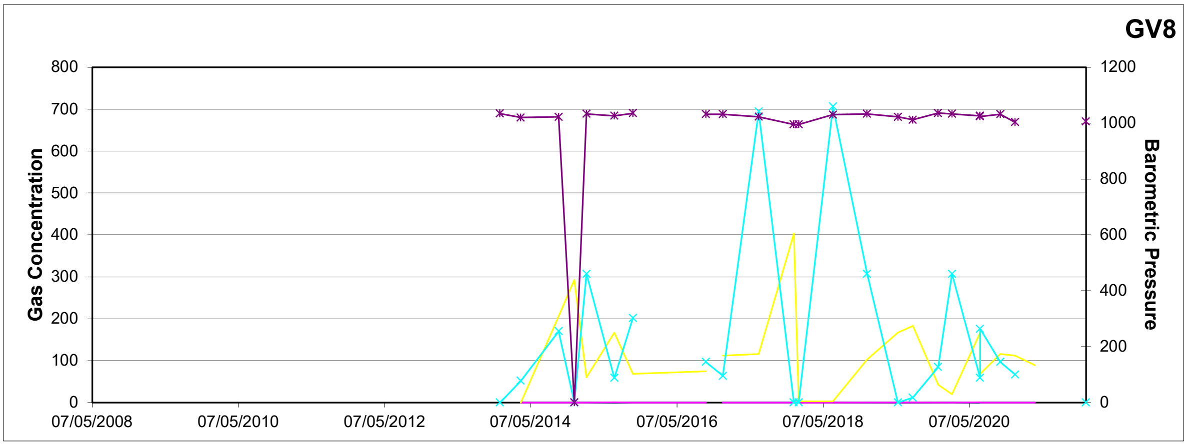

GV3
CO2
Methane
H2S
CO
Barometric Pressure
Gas Concentration
Barometric Pressure
35
30
25
20
15
10
5
0
1040
1030
1020
1010
1000
990
980
970
960
950
07/05/2008
07/05/2010
07/05/2012
07/05/2014
07/05/2016
07/05/2018
07/05/2020


GV4
Gas Concentration
Barometric Pressure
20
18
16
14
12
10
8
6
4
2
0
1040
1030
1020
1010
1000
990
980
970
960
950
07/05/2008
07/05/2010
07/05/2012
07/05/2014
07/05/2016
07/05/2018
07/05/2020


GV5
Gas Concentration
Barometric Pressure
12
10
8
6
4
2
0
1040
1030
1020
1010
1000
990
980
970
07/05/2008
07/05/2010
07/05/2012
07/05/2014
07/05/2016
07/05/2018
07/05/2020


GV6
Gas Concentration
Barometric Pressure
40
35
30
25
20
15
10
5
0
1040
1030
1020
1010
1000
990
980
970
07/05/2008
07/05/2010
07/05/2012
07/05/2014
07/05/2016
07/05/2018
07/05/2020


GV7
Gas Concentration
Barometric Pressure
600
500
400
300
200
100
0
1040
1030
1020
1010
1000
990
980
970
07/05/2008
07/05/2010
07/05/2012
07/05/2014
07/05/2016
07/05/2018
07/05/2020


GV8
Gas Concentration
Barometric Pressure
800
700
600
500
400
300
200
100
0
1200
1000
800
600
400
200
0
07/05/2008
07/05/2010
07/05/2012
07/05/2014
07/05/2016
07/05/2018
07/05/2020

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