HELENSBURGH WASTE DISPOSAL DEPOT ANNUAL REPORT 2023

For EPL 5861 (July 2023)

WOLLONGONG CITY COUNCIL (WASTE SERVICES)

Contact Information

Wollongong City Council

Waste Services

Document Information

Prepared for	NSW Environmental Protection Agency (EPA)
Project Name	Helensburgh Waste Disposal Depot Annual Report
Date	17 August 2023
Version Number	2

Author(s):

Nicole Diatloff

Senior Environmental Officer (Waste)

Wollongong City Council

Della Kutzner

WHS Quality Environmental Officer

Wollongong City Council

Approved By:

David Low

Waste + Resource Recovery Manager

Date Approved 27/07/2023

D.Low

Paul Tracey

Manager Open Space + Environmental Services

Date Approved 31/07/2022

Paul Tracey

Contents

1 Background

Wollongong City Council (WCC) maintains the former Helensburgh Landfill (the site), which is located at Nixon Place, Helensburgh NSW. The site ceased operation in 2012 and no longer receives waste with site activities limited to maintenance, upkeep and environmental monitoring. The site is legally identified as Lots 621 and 915 DP 752033 with the site boundary illustrated in **Figure 1**.

WCC holds Environmental Protection Licence 5861 issued by the NSW Environment Protection Authority (EPA) under the *Protection of the Environment Operations Act 1997* (POEO Act). The licence authorises the scheduled activity of waste disposal (application to land) at the site with no limit on the scale of activity.

A *Landfill Environmental Management Plan* (LEMP) was prepared in 2008 (GHD 2008) on behalf of WCC to ensure that environmental compliance is maintained throughout the site and following closure. The management measures provided in the LEMP were developed in consideration of the *NSW Environmental Guidelines: Solid Waste Landfills* (EPA 1996) and also addressed the monitoring and reporting requirements of EPL 5861. The *NSW Environmental Guidelines: Solid Waste Landfills* (EPA 1996) were superseded in 2016 and replaced with the *NSW Environmental Guidelines: Solid Waste Landfills*, *Second Edition (*EPA 2016).

The site is in a maintenance and closure phase and, as such, a revised LEMP is not considered necessary in response to the updated *Environment Guidelines* (EPA 2016). However, in December 2021 an updated Operational and Maintenance Plan was completed.

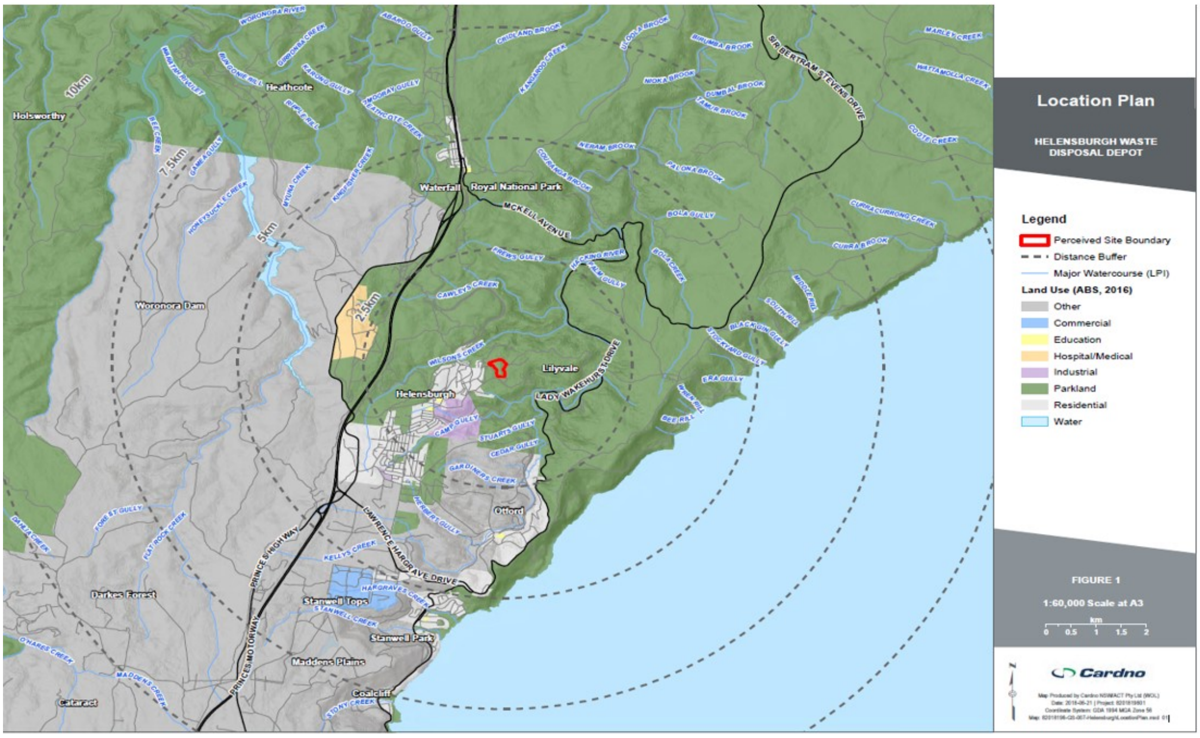


Figure 1: Helensburgh Location Plan

1.1 Objectives

The objectives of this Annual Report are to provide the EPA with the following:

- A summary of pollution monitoring data gathered during the reporting period of the 29th May 2022 to the 28th May 2023.
- Interpretation of monitoring data to assess the environmental performance of the site for compliance with conditions of the EPL.

1.2 Scope

1.2.1 Fieldwork

To meet the objectives of the Annual Report, the following scope of works was undertaken during the reporting period in accordance with the requirement of the EPL:

- Surface gas monitoring at areas where intermediate or final cover has been placed;
- Subsurface gas monitoring of the seven gas monitoring wells;
- Collection of surface water samples at the three surface water monitoring points;
- Collection of groundwater samples from eight existing groundwater monitoring wells; and
- Monitoring of trade wastewater at one sampling point located at the pre-treatment discharge.

1.2.2 Reporting

Section 6 (R1) of EPL 5861 states that an Annual Return and an Annual Report must be prepared by the license holder.

In accordance with Section 6 (R1.8) of the EPL, this Annual Report provides an assessment of environmental performance relevant to the license conditions including:

- Tabulated results of all monitoring data required to be collected by this licence;
- A graphical presentation of data from at least the last three years in order to show variability and/or trends;
- An analysis and interpretation of all monitoring data;
- An analysis of, and response to, any complaints received.
- Identification of any deficiencies in environmental performance identified by the monitoring data, trends or incidents, and of remedial action taken, or proposed to be taken to address the deficiencies; and
- Recommendations on improving the environmental performance of the facility.

This report has been prepared in accordance with the reporting conditions provided in Section 6 of the EPL and in consideration of the *NSW Environmental Guidelines: Solid Waste Landfill, Second Edition* (EPA 2016) *Requirements for publishing pollution monitoring data* (EPA 2013).

2 Site History

The LEMP (GHD) provides the following information in relation to the historical site use:

- *Prior to establishment of waste disposal operations, the site was vacant bushland.*
- *In the years the site operated as a 'trench and fill' operation, with a significant amount of waste burned within the trenches.*
- *It is understood that from the 1960's until approximately the early 1990's, the site operated as a sanitary depot accepting mainly nightsoil and putrescible wastes. Limited environmental controls were in place at this time. The site continued to accept these types of wastes until 1991, when putrescible waste ceased to be accepted at the site.*
- *Since 1991, the site has only been permitted by Wollongong City Council to accept 'Class 2' style wastes e.g. furniture, wood, paper, plastics, etc.*
- *Following the completion of the 'trench and fill' operations, landfilling operations shifted to 'land raise' operations which involved the construction of a small hill created from the deposited waste materials. Filling operations constituted 'land raising', which overtip previously landfilled waste in the site's central southern area.*
- *Material used for daily covering of the waste was obtained from a combination of clean fill materials delivered to the site.*

2.2 Topography and Drainage

The site is situated on the upper slopes of a hill on the northern eastern most outskirts of the suburb of Helensburgh. The gradient of the site slopes towards the north and east in the direction of the adjoining Garrawarra State Conservation Area. The final form of the landfill is mounded with a slight to moderate radial grade in all directions toward the site boundary.

An elevation profile was created utilising an aerial image taken in December 2021 from Nearmap which shows that the lowest elevations of the site are located in the eastern portion with an approximate relative level (RL) of 190 m Australian Height Datum (AHD). The highest elevations are located at the centre of the site at the location of the former waste deposition area with an approximate RL of 210 m AHD.

Approximate surface contours are shown on **Figure 2.**

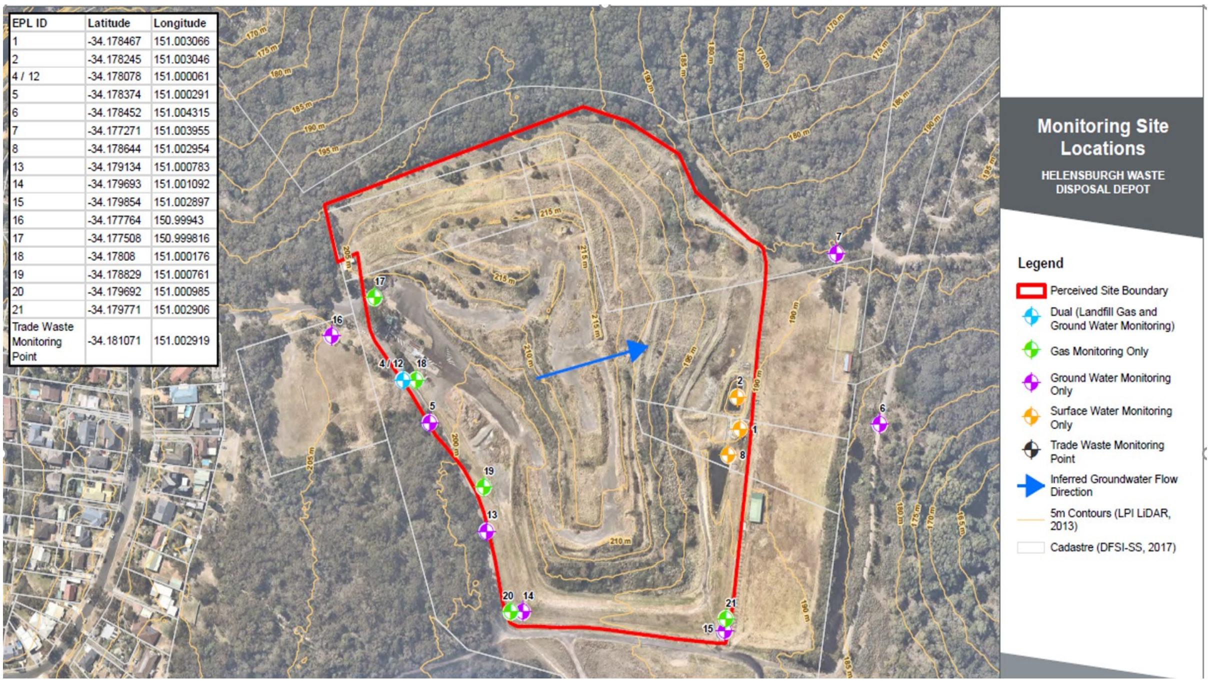


Figure 2: Monitoring Site Locations

2.3 Soil and Geology

The site is situated within the Sydney Basin and sits atop the Illawarra Escarpment. The natural geology beneath the site is part of the Cumberland Sub-Group of the Illawarra Coal Measures, which are Permian in age. A review of the 1:100,000 geological map 'Wollongong-Port Hacking' (Department of Mineral Resources, 1985) situates the site on Hawkesbury Sandstone, which is characterised by medium to coarse grained quartz sandstone with very minor shale and laminate lenses, which is generally consistent with soil observations noted during a previous intrusive investigation completed by GHD in 2008.

Test pitting completed by GHD (2008) as part of the LEMP suggests that the near surface natural geology of the area is as follows:

- Orange brown clayey Sand overlying;
- Orange mottled clayey Sand overlying;
- White clay Sand with red mottled Laterite (Ironstone) with clay Sand overlying;
- White loosely cemented Sandstone (assumed to be regional bedrock).

GHD noted that the thickness of residual soil was between 2.5m and 4m before bedrock was encountered. According to Council areas of the Site that were historically used for deposition of waste have been capped with virgin excavated natural material (VENM), a material type as defined by the NSW EPA, with a nominal thickness of 0.3m, however, earthworks at the Site since closure showed a capping thickness up to 3.0m.

2.4 Hydrogeology

2.4.1 Groundwater

Groundwater monitoring data has been collected from the Site since September 1996. Historical gauging of groundwater levels indicates that the local aquifer typically ranges from 1.5m to 4.5m below ground level (mbgl). Groundwater is inferred to flow in a north to easterly direction towards the Hacking River.

A groundwater bore search included in the LEMP (GHD 2008) indicates the presence of five registered groundwater wells within a 5 km radius of the Site. The registered uses of these bores are for domestic stock purposes.

2.4.2 Surface Waters

The LEMP (GHD 2008) identified a spring beneath the Site, which is understood to feed surface water to a stream east of the site that discharges to the Hacking River, located approximately 400 metres to the southeast.

All surface water runoff from the landfill is collected by a water collection system around the perimeter of the Site that drains to three stormwater ponds located along the eastern boundary of the Site.

2.5 Climate

Climate data for the Site was obtained from the nearby Bellambi Bureau of Meteorology (BOM) Weather Station (ID 068228). The weather station is located approximately 20 km south of the Site at the base of the escarpment. This data is considered to be a reliable representation of the Site conditions during the reporting period.

Table 1-1 summarises the key climatic data from the Bellambi weather station.

Table 1-1 Climatic Data – Bellambi Weather Station

2022								2023				
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Rainfall (mm)[1]	7.0	496	25	200	260	56	48.2	162	157	74.2	143	32.6
Mean max temperature (°C)[1]	17.2	16.7	18.4	18.6	20.4	21.6	22.5	24.3	25.4	26.3	22.2	19.3
Mean min temperature (°C)[1]	10.3	10.4	14.1	12.2	14.4	10.4	15.8	18.6	19.4	19.2	15.5	15.5
Mean 9am wind speed (km/h) [2]	18	23	16	17	17	17	19	17	16	14	15	16
Mean 3pm wind speed (km/h)[2]	20	25	22	25	23	26	23	25	25	20	21	19
Mean 9am relative humidity (%)[2]	57	69	61	70	73	61	67	77	72	70	67	56
Mean 3pm relative humidity (%)[2]	50	65	57	67	71	61	64	73	69	66	65	52

The averages from the previous reporting period for the Bellambi weather station are shown in **Table 1-2** and have been included for comparative purposes.

Table 1-2 Averages from Previous Reporting Period – Bellambi Weather Station

2021								2022				
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Rainfall (mm)[1]	54.2	481	65	36.2	74.4	112	93.2	108	397	218	269	173
Mean max temperature (°C)[1]	19.1	16.2	20.7	21.6	21.4	20.6	23.1	25.1	24.4	22	15.9	13.3
Mean min temperature (°C)[1]	12.4	10.4	12.8	12.9	13.6	15.4	17.2	20	18.5	16.8	22.4	20
Mean 9am wind speed (km/h) [2]	14	27	16	20	17	20	19	16	18	19	17	14
Mean 3pm wind speed (km/h)[2]	17	26	21	29	23	23	21	22	24	24	23	18
Mean 9am relative humidity (%)[2]	62	67	54	55	64	75	75	81	75	83	71	69
Mean 3pm relative humidity (%)[2]	60	70	50	55	64	73	72	78	73	77	73	66

This reporting period recorded over 1600 mm of rainfall with falls occurring every month. The lowest rainfall month was June 2022 with only 7 mm, whilst the highest was July with almost 500 mm. It is significant to note that rainfall was received every month of the reporting period.

Temperatures were mild with minimal fluctuations due to almost continual overcast conditions. The lowest average temperature was 10.3 degrees Celsius and the highest was 26.3. Wind speed and humidity were also mild throughout this reporting period.

3 Field Investigations

3.1 Fieldwork Methodology

The subsections below describe the frequency of monitoring, the monitoring methods, monitoring locations and analytes for surface gas, subsurface gas, stormwater, leachate and groundwater. The fieldwork methodologies implemented during the reporting period were developed in consideration of the guidance provided in the *NSW EPA Environmental Guidelines: Solid waste landfills (second edition)* (EPA 2016).

3.1.1 Surface Gas

Surface gas monitoring was completed during the reporting period to assess for potential surface emissions of landfill gases (LFG) emanating from the landfilled areas at the Site. The purpose of surface gas monitoring is to demonstrate that the cover material effectively controls the emission of landfill gas. The fieldwork methodology for surface gas monitoring is summarised below in **Table 1-3**. The location of each surface gas monitoring location is shown on **Figure 3**.

Figure 3: Surface Gas Monitoring Locations

Table 1-3 Surface Gas Monitoring Methodology

Activity	Description
Frequency and Dates of Monitoring	Surface gas monitoring for methane was completed annually during the reporting period in accordance with Section 5 (M2.2) of EPL 5861.
Monitoring Method	Methane was measured by a third party contractor, ALS Environmental, using an Inspectra Laser Gas Detector. The instrument used to measure methane concentrations was calibrated prior to each monitoring event. Surface gas monitoring was achieved by testing the atmosphere 5 centimetres above the ground surface in areas with intermediate or final cover where wastes have been placed. The monitoring was completed on calm days (winds below 10km/hr) and in transects with an approximate spacings of 25m.
Monitoring Locations	Surface gas monitoring for methane was undertaken at the following locations: ▪ Point 3: areas where intermediate or final cover has been placed ie transects A, B, C, E, F, G, H, I, J, K, L, M, N, O and P ▪ Weighbridge Office ▪ Nixon Place and Halls Road fence lines: transect Q

3.1.2 Subsurface Gas

Subsurface gas monitoring was completed during the reporting period to assess for potential offsite migration. The fieldwork methodology for subsurface gas monitoring is summarised below in **Table 1-4**. The location of each subsurface gas monitoring location is shown on **Figure 2**.

Table 1-4 Subsurface Gas Monitoring Methodology

Activity	Description
Frequency of Monitoring	Subsurface gas monitoring for methane was completed quarterly during the reporting period in accordance with Section 5 (M2.2) of EPL 5861.
Monitoring Method	Subsurface gas monitoring was measured by a third party contractor, ALS Environmental, using an Inspectra Laser Gas Detector. The instrument used to measure methane concentrations was calibrated prior to each monitoring event. Subsurface gas monitoring was achieved by testing the methane concentration in six landfill gas monitoring wells (listed below) that are situated around the northern, eastern and southern perimeters of the landfill. The contents of each well was sampled and analysed prior to potential dilution by air.
Monitoring Locations	Subsurface gas monitoring for methane was undertaken at landfill gas monitoring wells, Point 4, Point 17, Point 18, Point 19, Point 20 and Point 21.

3.1.3 Stormwater

Stormwater monitoring was scheduled to be completed during the reporting period to detect excess sediment loads in stormwater leaving the site and/or cross-contamination of stormwater with landfill leachate.

The fieldwork methodology for stormwater monitoring is summarised below in **Table 1-5**. The location of stormwater monitoring locations is shown on **Figure 2**.

Table 1-5 Stormwater Monitoring Methodology

Activity	Description
Frequency of Monitoring	Stormwater sampling was scheduled to be completed daily during any discharge in accordance with Section 5 (M2.3) of EPL 5861, however, stormwater monitoring was not undertaken during the reporting since overflows of the stormwater pond did not occur.
Monitoring Method	N/A
Monitoring Locations	Had an overflow from the stormwater pond occurred a water sample would have been collected from the following monitoring point in accordance with Section 5 (M2.3) of EPL 5861: ▪ 1 (overflow from stormwater pond)
Analytes	In accordance with Section 5 (M2.3) of EPL 5861 each stormwater sample would have been scheduled to be analysed for: ▪ pH ▪ Total Suspended Solids (TSS)

3.1.4 Leachate

Leachate monitoring was completed periodically during the reporting period to provide data on the composition, height levels and volumes of leachate produced by the Site, and to record details about any irregular discharges or overflows of leachate from the Site. The fieldwork methodology for leachate monitoring is summarised below in **Table 1-6**. The location of leachate monitoring locations is shown on **Figure 2.**

Table-1-6 Leachate Monitoring Methodology

Activity	Description
Frequency of Monitoring	Leachate sampling was completed quarterly to assess electrical conductivity and annually to assess for the remainder of parameters / contaminants (listed below) in accordance with Section 5 (M2.3) of EPL 5861.
Monitoring Method	Leachate monitoring was completed by a third party contractor, ALS Environmental. Grab samples of water were collected using a scoop at the nominated sampling point (summarised below). The instrument used to measure water quality parameters was calibrated prior to each monitoring event.

Activity	Description
Monitoring Locations	A leachate sample was collected from the Monitoring Point 2 (leachate pond) in accordance with Section 5 (M2.3) of EPL 5861.
Analytes	In accordance with Section 5 (M2.3) of EPL 5861 each leachate sample collected during the annual monitoring event was analysed for: ▪ Metals (aluminium, arsenic, barium, cadmium, chromium (hexavalent and total), cobalt (Point 5, 6 and 7 only), copper, lead, manganese, mercury, zinc) ▪ Benzene, toluene, ethylbenzene, xylene (BTEX) ▪ Fluoride ▪ Nitrate and nitrite ▪ OCP ▪ OPP ▪ PAH ▪ Alkalinity ▪ Calcium, magnesium, potassium, sodium, chloride, sulfate ▪ pH and conductivity ▪ Standing water level ▪ TDS ▪ TPH ▪ Total phenolics ▪ TOC ▪ Nitrogen (ammonia)

3.1.5 Surface Water

Surface water monitoring was completed periodically during the reporting period to verify that offsite surface water bodies were not being impacted by leachate or by sediment-laden stormwater from the landfill. The fieldwork methodology for surface water monitoring is summarised below in **Table 1-7**. The location of each stormwater monitoring location is shown on **Figure 2**.

Table 1-7 Surface Water Monitoring Methodology

Activity	Description
Frequency of Monitoring	Surface water sampling was completed quarterly in accordance with Section 5 (M2.3) of EPL 5861.
Monitoring Method	Surface water monitoring was completed by a third party contractor, ALS Environmental. Grab samples of water were collected using a scoop at the nominated sampling point (summarised below). The instrument used to measure water quality parameters was calibrated prior to each monitoring event.
Monitoring Locations	A surface water sample was collected from Monitoring Point 8 (pony club) in accordance with Section 5 (M2.3) of EPL 5861.
Analytes	In accordance with Section 5 (M2.3) of EPL 5861 each sample was analysed for: ▪ Conductivity ▪ Dissolved oxygen ▪ Faecal coliforms ▪ Nitrogen (ammonia) ▪ pH ▪ Potassium ▪ Redox potential ▪ Total dissolved solids ▪ Total organic carbon

3.1.6 Groundwater

Groundwater monitoring was completed periodically during the reporting period to track groundwater quality with time and evaluate interactions with leachate and potential contaminants. The fieldwork methodology for groundwater monitoring is summarised below in **Table 1-8**. The location of each groundwater monitoring location is shown on **Figure 2**.

Table 1.8 Groundwater Monitoring Methodology

Activity	Description
Frequency Monitoring	Groundwater monitoring was completed on a quarterly basis during the reporting period in accordance with Section 5 (2.3) of EPL 5861.
Monitoring Method	Groundwater was sampled by a third party contractor, ALS Environmental, using bailer technique. A pre-calibrated water quality meter used to measure groundwater quality parameters during monitor well purging. The collected groundwater samples were submitted to ALS Environmental for analysis of contaminants and parameters of interest (summarised below). Ground water levels were recorded before purging.
Monitoring Locations	Groundwater bores monitored during the reporting period included Point 5, Point 6, Point 7, Point 12, Point 13, Point 14, Point 15 and Point 16.
Analytes	In accordance with Section 5 (M2.3) of EPL 5861 groundwater monitoring points were analysed for: Annually ▪ Metals (aluminium, arsenic, barium, cadmium, chromium (hexavalent and total), cobalt (Point 5, 6 and 7 only), copper, lead, manganese, mercury, zinc) ▪ Benzene, toluene, ethylbenzene, xylene (BTEX) ▪ Fluoride ▪ Nitrate and nitrite ▪ OCP ▪ OPP ▪ PAH ▪ TPH ▪ Total phenolics Quarterly ▪ Alkalinity ▪ Calcium, magnesium, potassium, sodium, chloride, sulfate ▪ pH and conductivity ▪ Standing water level ▪ TDS ▪ TOC ▪ Nitrogen (ammonia)

3.1.6 Trade Wastewater

Monitoring of trade wastewater was completed periodically during the reporting period to confirm that water quality parameters of wastewater discharge were within the acceptable criteria. Discharge of trade waste to sewer was undertaken by Council in accordance with the *Consent to Discharge Industrial Trade Wastewater* (Sydney Water 2019) (the *Consent*). The fieldwork methodology for trade wastewater monitoring is summarised below in **Table 1-9**. The trade waste monitoring location is shown on **Figure 2**.

Table 1-9 Trade Wastewater Monitoring Methodology

Activity	Description
Frequency	Trade wastewater sampling was undertaken in July 2019 and approximately every 2 months thereafter. If trade wastewater was not discharged on the scheduled day, then the sample was taken on the next day that trade wastewater was discharged. The reading of the flowmeter was obtained at the commencement and conclusion of each sampling event. Discrete samples were collected and tested for pH at the start and finish of each sample day.
Monitoring Method	Trade wastewater was sampled by a third party contractor, ALS Environmental. Composite samples were collected over a 24 hour period using a Composite Auto-sampler, and pre and post monitoring samples were collected in the form of grab samples.

	The probe used to measure water quality parameters was calibrated prior to each monitoring event and the trade wastewater samples collected were submitted to ALS Environmental for analysis of parameters of interest (summarised below).
Monitoring Locations	In accordance with the *Consent* (Sydney Water, 2019) monitoring of trade wastewater was undertaken at a sampling point located at the pre-treatment discharge, excluding domestic sewage and prior to the point of connection to the Sewer. The specific monitoring location is shown on **Figure 2** .
Analytes	Composite samples were submitted to ALS Environmental for analysis of the following: ▪ Nitrogen (ammonia) ▪ Suspended solids; ▪ Total dissolved solids; and ▪ Iron. Discrete samples were tested on site for pH and temperature using a calibrated water quality meter. Additionally, the volume of wastewater discharged was obtained from the total flow reading presented on the flowmeter system.
Aesthetic Assessment	During sampling the sampler recorded the following aesthetic properties in accordance with the *Consent* (Sydney Water, 2019): ▪ Temperature; ▪ Colour; ▪ pH; ▪ Fibrous materials; ▪ Gross solids; and ▪ Flammability.

4 Data Quality Management

The NSW EPA (2017) Guidelines for the NSW Site Auditor Scheme (3rd Edition), which is endorsed by the NSW EPA under s105 of the *Contaminated Land Management Act 1997*, requires that Data Quality Objectives (DQOs) are to be adopted for all assessment and remediation programs. The DQO process as adopted by the NSW EPA is described within USEPA (2000) *Guidance for the Data Quality Objective Process and Data Quality Objectives Process for Hazardous Waste Site Investigations*.

4.1 Data Quality Objectives

The DQO process has been used to establish a systematic planning approach to setting the type, quantity and quality of the data required for making decisions based on the environmental condition of the Site. The DQO process involves the following six steps detailed in **Table 1-10**.

Table 1-10 The DQO Process

Activity	Description
Step 1: State the Problem	An Annual Report is required as a condition of EPL 5861 to assess the environmental performance of the site during the 2021/22 reporting period. The Annual Report will summarise the type, concentrations, and extent of potential contamination / parameters in the matrices sampled including landfill gas (surface and subsurface), leachate, surface water and groundwater.
Step 2: Identify the decision / goal of the study	The NSW EPA requires an Annual Report to confirm if the environmental performance of the site meets the licence conditions and regulatory obligations of EPL 5861.
Step 3: Identify the information inputs	The primary inputs to the decisions described above are: o Assessment of landfill gas, leachate, surface water and groundwater in accordance with direction of Section 5 (Monitoring and Recording Conditions) of EPL 5861. o Assessment of management procedures for waste tyres. o Laboratory analysis of samples for the contaminants and parameters of interest defined in Section 5 of EPL 5861. o Assessment of analytical results against applicable performance criteria and Section 3 (Limit Conditions) of EPL 5861. o Review of complaints recorded during the reporting period that relate to odour originating from the site. o Aesthetic observations material encountered during sampling. o Assessment of the suitability of the analytical data obtained, against the Data Quality Indicators (DQIs) outlined below. o The temporal boundaries of the study are from the 29th of May 2021 to the 29th of May 2022 (i.e. the reporting period).
Step 4: Define the boundaries of the study	The decision rules for the Annual Report include: o The sampling points, contaminants and parameters of interest, frequency of sampling and sampling method will meet the requirements EPL 5861. o Samples requiring laboratory analysis will be analysed at National Association of Testing Authorities (NATA) accredited laboratory. o Laboratory QA/QC results will indicate reliability and representativeness of the data set.
Step 5: Develop the analytical approach	Laboratory limits of reporting (LORs) will be below the applicable guideline criteria for the analysed contaminants and parameters of interest, where possible. Applicable guideline criteria will be sourced from EPL 5861 and other NSW EPA endorsed guidelines (as necessary). If the concentration of a contaminant or parameter of interest is outside of the acceptable limit additional works may be required to assess the potential risk.
Step 6: Specify performance or acceptance criteria	To ensure the results obtained are accurate and reliable, sampling and analysis was undertaken in accordance with the guidance provided in EPL 5861. DQIs are used to assess the reliability of field procedures and analytical results. In particular, the DQIs within NSW EPA (2017) are used to document and quantify compliance. DQIs are described below, and are presented in Table 4-2, below:

	Completeness – A measure of the amount of useable data (expressed as %) from a data collection activity. Comparability – The confidence (expressed qualitatively) that data are representative of each media present on the site. Precision – A quantitative measure of the variability (or reproducibility) of data. Accuracy (bias) – A quantitative measure of the closeness of reported data to the true value. Sampling and Analysis has been undertaken in compliance with EPL 5861 by qualified technical staff with analysis completed by a NATA accredited laboratory.

4.2 Data Quality Indicators

The following DQIs referenced in Step 6 in Table 1-7, have been adopted in accordance with the NSW EPA (2017) *Guidelines for the Site Auditor Scheme (3rd Edition).* The DQIs outlined in **Table 1-11** assist with decisions regarding the contamination status of the site, including the quality of the laboratory data obtained.

Data Quality Indicator	Frequency	Data Acceptance Criteria
Completeness		
Field documentation correct	Each sampling event	All samples
Suitably qualified and experienced sampler	Each sampling event	All samples
Appropriate laboratory methods and limits of reporting (LORs)	Each sampling event	All samples
Chain of custodies (COCs) completed appropriately	All samples	All samples
Compliance with sample holding times	All samples	All samples
Comparability		
Consistent standard operating procedure for collection of each sample		
Experienced sampler	All samples	All samples
Climatic conditions recorded and influence on samples quantified	Representativeness	
Consistent analytical methods, laboratories and units	Sampling technique appropriate for each media and analytes (appropriate collection, handling and storage)	
Samples homogenous	All samples	All samples
Detection of laboratory artefacts	-	Detected and assessed
Samples extracted and analysed within holding times	All samples	All samples

5 Performance Criteria

Environmental monitoring data gathered during the reporting period was screened against the applicable criteria for each sample type / matrix as summarised below.

5.1 Surface Gas

The results of surface gas monitoring were screened against the criteria provided in the *Environmental Guidelines* (EPA 2016). Specifically, the threshold level for closer investigation and potential action was detection of 500 parts per million of methane at any point of the landfill service.

5.2 Subsurface Gas

The results of subsurface gas monitoring were screened against the criteria provided in the *Environmental Guidelines* (EPA 2016). Specifically, the threshold levels for further investigation and corrective action were detection of methane at concentrations above 1% (v/v) and carbon dioxide at concentrations of 1.5% (v/v) above established natural background levels.

5.3 Stormwater

In accordance with Section 3 (L2.5) of EPL 5861, the performance criteria for stormwater was no discharge of contaminated stormwater (stormwater that exceeds the limits of pH and total suspended solids) under dry weather conditions or storm events that are less than a 5 day, 75th percentile. The license defines a 5 day, 75th percentile rainfall event as a rainfall depth of 35.6mm over any consecutive 5 day period.

5.4 Leachate

In accordance with Section 3 (L2.7) of EPL 5861 the limit for leachate was no discharge of leachate to waters under dry weather conditions or storm event(s) of less than 1:25 year, 24 hour recurrence interval. The license defines a 1:25 year, 24 hour duration rainfall event as a rainfall depth of 306 millimetres over any consecutive 24 hour period.

The performance criteria adopted for leachate discharges was based on records held by Council regarding the timing and nature of leachate discharges during the reporting period. Comparison was made to adopted surface and groundwater criteria below to provide and initial screening level.

5.5 Surface Water and Groundwater

The selected performance criteria for surface water and groundwater samples were based on the recommendations of the *Environmental Guidelines* (EPA 2016) and in consideration of the land use, site setting and the plausible interactions between potential contaminants and human and environmental receptors.

The new ANZAST (2018) guidelines are used in water quality assessment this reporting period. These water quality guidelines provide detailed approaches and advice on identifying appropriate **guideline values** for selected indicators. These guideline values help to ensure that agreed community values and their management goals are protected. For the protection of aquatic ecosystems, locally derived guideline values are most appropriate.

Assessment of water physical characteristics was based on the Australian Water Quality Guidelines (ANZAST 2018) South East Australia Lowland Physical Characteristics. This provides indicative threshold values for the suitability of site surface waters for discharge into nearby surface water systems.

5.6 Trade Wastewater

Trade wastewater analytical results were screened against the criteria provided in the *Consent* (Sydney Water, 2019). The *Consent* provides criteria for a variety of parameters for the long term average daily mass (LTADM) and the maximum daily mass (MDM).

In addition to analytical performance criteria the *Consent* provides limits for aesthetic properties of trade wastewater including temperature, colour, pH, fibrous materials, gross solids and flammability.

The *Consent* is due for renewal in October 2023.

5.7 Odour

In accordance with Section 8 (E1.3) of EPL 5861 offensive odour must not emit beyond the boundary of the premises. The performance criteria adopted for potential offensive odour emissions was occurrences (if any) of complaints from members of the public relating to odour and monthly staff monitoring.

6 Results

Monitoring results gathered during the reporting period are provided in the data tables in **Appendix A** and are summarised in the relevant subsections below. Laboratory certificates of analysis and quality reports have not been appended to this report due to the large number of files, however, they can be provided upon request.

6.1 Gas

6.1.1 Surface Gas

The highest reported concentration of methane was 7.5 ppm measured at Point 4 of transect J during the August 2022 monitoring event. This is well below the threshold level for further investigation and corrective action of 500 ppm.

Methane levels have consistently remained extremely low at this site and surface gas monitoring results from the reporting period are summarised in **Table 6** of **Appendix A**.

6.1.2 Subsurface Gas

No methane was recorded within subsurface gas monitoring wells above 0.1 % v/v threshold value in any monitoring location. Therefore, all subsurface gas monitoring results were below the threshold for further investigation and corrective action of 1% v/v.

Subsurface gas samples were also measured for carbon dioxide concentrations as part of the monitoring regime though this is not a requirement of EPL 5861. Five locations returned results above the threshold for further investigation of 1.5% (v/v) with the exception being Point 20 on the 15th August 2022. The highest continuous and peak results were from Point 17 with 6.7% (v/v) and 6.7% (v/v) peak on the 15th August 2022 when the sampling occurred. Further investigation is being undertaken as part of the future management of the Site.

A summary of subsurface gas readings is provided in **Table 5** of **Appendix A**.

6.2 Stormwater

Sampling was undertaken from the stormwater retention basin adjacent to the Pony Club on site at each of the quarterly monitoring events. Results showed an exceedance for nitrogen (ammonia) in all samples compared to the ANZAST guidelines (2018) for fresh water and the SE Australia Lowland River Physical Characteristics (ANZECC 2000).

The samples collected in August 2022, November 2022 and May 2023 after heavy rain events indicated elevated levels over the Freshwater guideline recommendation at 33.0 mg/L, 14.4 mg/L and 20.9 mg/L respectively, however there was no uncontrolled offsite discharge.

Monitoring results from the reporting period are summarised in **Table 4** of **Appendix A** with the following notable results presented in **Table 1.12.**

Table 1-12 Surface water guideline exceedances

			Nitrogen (Ammonia) mg/L
ANZAST 2000 SE Australia Lowland River Physical Characteristics			0.02
ANZAST 2018 Fresh Water (95%)			0.90
EPA Designation	Locations ID	Sample Date	
8	Stormwater adj. to Pony Club	08/08/2022	33.0
		15/11/2022	14.4
		07/02/2023	0.13
		02/05/2023	7.65

6.3 Leachate

No uncontrolled off-site discharges of leachate occurred during the reporting period under dry or wet weather conditions. Samples were collected from the leachate pond quarterly for electrical conductivity analysis and annually for a broader suite of analytes. All results were below the laboratory LOR or adopted guidelines for site waters.

Leachate monitoring results from the reporting period are summarised in **Table 3** of **Appendix A**.

6.4 Groundwater

6.4.1 Groundwater Levels

Groundwater levels measured at the site during the reporting period are summarised in **Table 5A** of **Appendix B** and ranged from 1.82 m below ground level (bgl) at groundwater monitoring point 4 to 3.59 m bgl at groundwater monitoring point 17. All bores were able to be measured this reporting period indicating that groundwater continues to flow consistently through the site.

6.4.2 Laboratory Results

Groundwater data tables are provided in **Table 1** of **Appendix B** with the pertinent findings summarised below:

Benzene, toluene, ethylbenzene and xylenes (BTEX) and TPH were not detected above the laboratory limit of response in any groundwater sample collected during the reporting period (refer to **Table 5B** of **Appendix B)**. PAHs were not detected above the laboratory limit of response in any sample.

A summary of heavy metals results is provided below and tabulated in **Table 1** of **Appendix B**:

Aluminium (total) concentrations ranged from 0.42 mg/L at groundwater monitoring point 16 to 51.5 mg/L groundwater monitoring point 13. All samples were above the ANZAST 95% protection trigger level of 0.055 mg/L.

Arsenic concentrations were reported below the adopted performance criteria for all samples.

Barium and mercury were reported at concentrations below the adopted performance criteria for all samples. Cadmium (total) concentrations at all monitoring points were below the freshwater guideline value of 0.0002 mg/L, with the exception being Point 6 that had a reading of 0.0005 mg/L.

Chromium (hexavalent) was not detected above the laboratory limit of response in all groundwater samples collected during the reporting period.

Copper (total) concentrations ranged from 0 - 0.043 mg/L throughout the groundwater network. Two values were above the freshwater guideline value of 0.014 mg/L at Point 6 (0.043 mg/L) and Point 13 (0.016 mg/L) respectively. All values are below the health guideline value of 2 mg/L.

Lead (total) concentrations were all recorded below the threshold criteria for freshwater (0.0034 mg/L) with the exception of Point 6 (0.041 mg/L) and Point 13 (0.023 mg/L). The results remained consistent with the last reporting period.

Manganese (total) concentrations ranged from 0.010 mg/L (Point 14) to 0.229 mg/L (Point 5). All samples had concentrations below the adopted performance criteria.

Zinc (total) concentrations ranged from 0.011 mg/L (Point 15) to 0.199 mg/L (Point 5) with almost all samples above the ANZAST 95% protection trigger level of 0.008 mg/L.

Specific trigger values were not provided in the adopted performance criteria for calcium, chromium (III + VI), cobalt, magnesium and potassium.

A summary of inorganics is provided below and tabulated in **Table 1** of **Appendix A**:

Ammonia concentrations ranged from below the laboratory LOR (multiple samples) to 0.51 mg/L in Point 5. All samples were under the threshold level for freshwater at 0.9 mg/L.

Fluoride was below the laboratory LOR in all samples and were therefore below the adopted performance criteria

Nitrate concentrations ranged from below laboratory LOR (multiple samples) to 0.57 mg/L at point 14.

Specific trigger values were not provided in the adopted performance criteria for alkalinity, chloride, nitrite, sodium, TDS, TOC and sulfate.

A summary organochlorine pesticides is provided below and tabulated in **Table 1** of **Appendix A**:

OCP contaminants aldrin and dieldrin, chlordane, dichlorodiphenyltrichloroethane (DDT), endrin, lindane and heptachlor were not detected above the laboratory limit of response in any sample, however, it is noted that the adopted criteria were below the laboratory limit of response. Therefore the results cannot be screened against the criteria.

A summary organophosphorus pesticides is provided below and tabulated in **Table 1** of **Appendix A**.

OPP contaminants azinophos methyl, chlorpyrifos, diazinon, dimethoate, malathion, methyl parathion and parathion were not detected above the laboratory limit of response in any sample.

Bromophos-ethyl, carbophenothion, chlorfenvinphos, dichlorvos, ethion, fenthion, fethyl parathion, monocrotophos, fenamiphos and pirimphos-ethyl were not detected above the laboratory limit of response and were therefore below the adopted performance criteria.

pH ranged from 4 (point 7) to 7.1 (Point 6) (refer to **Table 1** of **Appendix A**). This is consistent with previous years.

6.5 Trade Wastewater

Trade wastewater data tables are provided in **Table 6** of **Appendix A** with the pertinent findings summarised below.

Trade wastewater monitoring was undertaken six times during the reporting period. The results of monitoring showed that on every occasion the volume discharge, pH, ammonia (as N), suspended solids, total dissolved solids, temperature and iron were within acceptable criteria provided in the *Consent* (Sydney Water, 2019).

6.6 Waste Tyres

Section 3 (L3.2), (L3.3) and (L3.4) of the EPL provides limitations on the size and number of waste tyres that can be disposed of at the premises. The Site has ceased operation and therefore does not receive waste tyres.

6.7 Odour

No complaints were received by Council from members of the public during the reporting period relating to offensive odour detected at an offsite location.

7 Quality Assurance/Quality Control (QA/QC)

A summary of the results of the QA/QC results are included in the following section.

7.1 Laboratory QA/QC

The selected analytical laboratory, ALS Environmental, undertake internal QA/QC procedures which include the analysis of method blanks, internal duplicate samples, laboratory control samples, matrix spikes and surrogate recovery. Additionally, laboratory QA/QC measures include receipt, logging, storage, preservation, holding time and analysis of samples within the method specified.

A review of the laboratory QA/QC procedures indicates that laboratory QA/QC procedures were within specified ranges for all samples with the exception of four duplicates, three laboratory control samples and four matrix spikes. In addition, eight matrix spike recoveries were unable to be determined as the background level was greater than or equal to the 4 times the spike level, and one laboratory control spike recovery which was greater than the upper control limit.

7.2 Data Useability

The data validation process of field and laboratory QA/QC data indicates that the reported analytical results are representative of the conditions at the sample locations and that the analytical data can be relied upon for the purpose of the Annual Report for EPL 5861.

8 Discussion

The data and information gathered during the reporting period is discussed below in consideration of the performance criteria. In addition, and in accordance with Section 6 (R1.8) of EPL 5861, historical results have been tabulated and presented in graphical format that compares data from at least five years (where available).

Trend graphs are provided in **Appendix C** and summarised below in the sections below, however, discussion has not been provided for OCP, OPP, PAH, BTEXN or Phenolics as these contaminants have historically never been reported above the laboratory limit of response.

8.1 Surface Gas

Surface gas monitoring completed during the reporting period did not identify surface methane concentrations that exceeded the threshold level. As such non-conformances of the EPL did not occur during the reporting period with respect to surface gas emissions.

8.2 Subsurface Gas

Subsurface gas monitoring completed during the reporting period did not identify subsurface methane at concentrations that exceeded the threshold level. As such non-conformances of the EPL did not occur during the reporting period with respect to subsurface gas.

8.3 Stormwater

No discharges of stormwater from the site's stormwater system occurred during the reporting period and therefore additional monitoring was not required. As such non-conformances of the EPL did not occur with respect to stormwater.

8.4 Leachate

There were no exceedances above the adopted performance criteria during the reporting period for heavy metals. Concentrations reported were for total metals in accordance with the EPL requirement, however, it is important to note that the adopted screening criteria recommended by the *Environmental Guidelines* (EPA 2016) are intended for application to concentrations of dissolved metals. As such, when exceedances occur, they are not necessarily indicative of environmental concern with the contaminant concentrations most likely attributed to the presence of sediment in unfiltered samples.

Ammonia was reported above the ANZAST 95% protection trigger level. Given the nature of leachate at landfill sites an elevated concentration of ammonia is not unexpected. The sample was collected from a leachate pond located on Site and is not representative of water exiting the Site.

No uncontrolled releases of contaminated leachate occurred during the reporting period under dry weather or storm events. As such non-conformances of the EPL did not occur with respect to releases of leachate.

8.5 Surface Water

The surface water samples collected from Point 8 (pony club) had pH levels within range (6.5-8.5) with the exception of one elevated value of 9.4 on 7/2/2023. This was followed by a recorded value of 7.4 on the next sampling event on 2/05/2023. Fluctuations are most likely caused by continual heavy rainfall (almost 1600 mm) over the reporting period.

Ammonia levels were elevated from the previous reporting period, most likely influenced by heavy rainfall. No leachate overflows from the site were recorded, however there may be some influence from overflow waters from the nearby sullage depot. Levels of Total Dissolved Solids were also elevated (above 50 mg/L) due to continual heavy rainfall.

Faecal coliforms levels during this period were elevated compared to the previous reporting period. It is most likely that this is attributed to preceding rainfall and the subsequent surface runoff from the surrounding catchment (including the Pony Club and sullage depot) located in close proximity to the sampling site.

8.5.1 Trend Analysis

A series of graphs showing trends in surface water contaminant and parameter levels are provided in **Appendix B** and are discussed below. It appears that the hydrological system continues to strongly flow throughout the site after two years of heavy rainfall.

Dissolved oxygen, redox potential, potassium, and TOC all remained within normal limits and fluctuated due to seasonal variations as well as the heavy rainfall conditions.

No overflow events were recorded during this reporting period.

8.6 Groundwater

8.6.1 Groundwater Levels

Interpretation of groundwater levels across the Site from the reporting period indicate that the inferred groundwater flow direction is from the west to the north east, which is consistent with the local topography and is shown on **Figure 2**. Groundwater is situated at the greatest depths in the higher elevations of the Site toward the western boundary and is shallowest toward the eastern boundary in close proximity to the nearest surface water body, the Hacking River. Since the drought ended in 2020, the monitoring points at higher elevations along the western and southern boundaries began to flow after the prolonged period of drought was broken. This has resulted in an overall decrease in analyte concentrations in the water column across the Site.

8.6.1.1 Trend Analysis

A series of graphs showing groundwater analyte trends are provided in **Appendix B** and discussed below.

8.6.2 Laboratory Results

Groundwater analysis completed during the reporting period showed that the majority of contaminants and parameters of interest specified in EPL 5861 were below the laboratory limit of response or the performance criteria, including BTEX, TPH, PAH, fluoride and nitrate. Performance criteria are not provided for alkalinity, chloride, sodium, TDS, TOC and sulfate, however the results were generally comparable with historical data and are not considered unusual or concerning in the context of the Site use as an operational landfill.

Heavy metal concentrations were reported above the adopted performance criteria during the reporting period for heavy metals including aluminium, cadmium chromium (total), copper, lead and zinc. Concentrations reported were for total metals in accordance with the EPL requirement, however, it is important to note that the adopted screening criteria recommended by the *Environmental Guidelines* (EPA 2016) are intended for application to concentrations of dissolved metals. As such the exceedances are not necessarily indicative of environmental concern with the contaminant concentrations and may be attributed to the presence of sediment in unfiltered samples.

8.6.2.1 Trend Analysis

A discussion has not been provided for OCP, OPP, PAH, BTEXN or Phenolics as these contaminants have never been reported above the laboratory limit of response.

A series of graphs showing trends in groundwater contaminant and parameter levels are provided in **Appendix C** and are discussed below.

The trend graphs show that contaminant and parameter concentrations have remained steady and relatively consistent with the four years prior, with a general decline in contaminant concentrations (with the exception of total metals).

The heavy rainfall events of this and the previous reporting period, coupled with continuing rainfall in this period have impacted on water levels throughout the Site, with the stormwater and leachate ponds maintaining high levels. Groundwater levels have also risen significantly and remain steady.

8.7 Trade Wastewater

Trade wastewater was discharged into the sewer network in accordance with the Consent (Sydney Water 2019) with no non-conformances during the reporting period.

8.8 Waste Tyres

The Site has ceased operation and therefore does not receive waste tyres. As such, non-conformances of the EPL did not occur during the period with respect to waste tyres.

8.9 Odour

No complaints were received by Council from members of the public during the reporting period relating to offensive odour detected at an offsite location. As such non-conformances of the EPL did not occur during the reporting period with respect to odour.

8.10 Conceptual Site Model

Generally, a conceptual site model (CSM) provides an assessment of the fate and transport of contaminants of potential concern (CoPC) relative to site specific subsurface conditions with regard to their potential risk to human health and the environment. The CSM takes into account site-specific factors including:

- Source(s) of contamination;
- Identification of CoPC associated with past (and present) source(s);
- Vertical, lateral and temporal distribution of CoPC;
- Site specific lithologic information including soil type(s), depth to groundwater, effective porosity, and groundwater flow velocity; and
- Actual or potential receptors considering both current and future land use both for the site and adjacent properties, and any sensitive ecological receptors.

Based on the results discussed in this report a CSM has been developed and is outlined below in **Table 1-13**. Additional details are included in the sections that follow as necessary.

Table 1-13 Conceptual Site Model

CSM Element	Description
Contaminant Sources	Known contaminant sources at the Site include: ▪ Historical use for disposal of sanitary waste including 'nightsoil' as well as putrescible waste from the 1960s to 1991. From 1991 putrescible waste ceased to be accepted at the Site and the permitted waste was limited to "Class 2" style wastes such as furniture, wood paper, plastics (GHD, 2008). ▪ Leachate resulting from degradation of buried waste and interaction with groundwater.
Site Current and Future Use	The Site is a closed landfill that historically received waste from Wollongong City Council local government area. In accordance with site closure and the rehabilitation plan, the Site will be returned to the community in the future.
Site Geology	The Site lies within the Sydney Basin above the Illawarra escarpment, and is part of the Cumberland Sub-Group of the Illawarra Coal Measures, which are Permian in age. Review of the 1:100,000 geological map 'Wollongong-Port Hacking' (Department of Mineral Resources, 1985) situates the Site on Hawkesbury Sandstone – Medium to coarse grained quartz sandstone with very minor shale and laminate lenses, which is consistent with soil samples. Test pitting completed by GHD (2008) as part of the LEMP suggests that the near surface natural geology of the area is as follows. ▪ Orange Brown Clay Sand overlying; ▪ Orange Mottled Clay Sand overlying; ▪ White Clay Sand with Red Mottled Laterite (Ironstone) Clay Sand overlying; ▪ White Loosely Cemented Sandstone (assumed to be regional bedrock).
CoPCs	The CoPCs listed in EPL 5861 include heavy metals (aluminium, arsenic, barium, cadmium, chromium (hexavalent and total), cobalt, copper, lead, manganese, mercury, zinc), polycyclic aromatic hydrocarbon, total petroleum hydrocarbons, benzene, toluene, ethylbenzene, xylenes, naphthalene, organochlorine pesticides, organophosphate pesticides and phenolics.

CSM Element	Description
	In addition to CoPC the EPL identifies potentially hazardous landfill gasses including methane and carbon dioxide.
Extent of Impacts	The extent of potential contamination would primarily be located immediately below and down gradient of the tip face. It may also originate from upstream land uses such as mining and urban development. Monitoring undertaken during the reporting period indicates that contaminants above the adopted criteria are limited to heavy metals and ammonia in leachate and groundwater. Other CoPC were not reported above the laboratory limit of response or the adopted criteria. Methane was detected during the reporting period atop the current and previous tip face (surface gas) and subsurface, however, the concentrations were below the threshold level for further investigation and corrective action.
Potential Human Receptors	Potential human receptors include: • Pony club users ▪ Trespassers who illegally access the site; ▪ Contractors undertaking site maintenance including mowing, landscaping and fence repairs; ▪ Contractors undertaking scheduled environmental monitoring (surface water, groundwater and landfill gas); and ▪ Individuals working or living within close proximity to the Site.
Potential Ecological Receptors	Potential ecological receptors include: ▪ Tributaries to the Hacking River and Wilsons Creek, located to the south east and north, respectively; ▪ The Garrawarra State Conservation Area located immediately north and east of the Site boundary; ▪ Groundwater under the Site being impacted as a result of the vertical migration of contaminants from leachate and buried waste; and ▪ Flora and fauna on the Site interacting with contaminants in the soils including birds scavenging and nesting at the Site.
Potential Contaminant Pathways	Potential contaminant pathways include: ▪ Dermal contact with contaminated materials including soil, waste and hazardous building materials during maintenance and potential earthworks; ▪ Dermal contact with contaminated media including surface water, groundwater and leachate during environmental monitoring; ▪ Inhalation of hazardous landfill gases emanating from buried waste and leachate; ▪ Inhalation of volatile contaminants and/or asbestos fibres; ▪ Ingestion of contaminant impacted materials including soil, waste and hazardous building materials; ▪ Potential contaminant uptake by vegetation; and ▪ Potential ingestion of contaminant impacted fresh produce (fruit and vegetables) grown down gradient of the site.

8.10 Data Gaps and Uncertainties

The assessment of potential contamination at the site is based on monthly site inspection and review of available historical reports and information. As such, the lateral and vertical extent of potential contamination in soil profile is unknown.

Also, the extent that the surrounding catchment influence water quality flowing through the site also requires consideration and further investigation.

9 Conclusions and Recommendations

The following can be concluded based on the monitoring undertaken during the reporting period:

Council implemented an environmental monitoring program during the 2022/2023 reporting period that satisfied the conditions and requirements of EPL 5861 and the *Consent to Discharge Industrial Trade Wastewater* (Sydney Water, 2019). This *Consent* will require renewal in the next reporting period.

Water contained in stormwater and leachate ponds was managed such that uncontrolled releases of contaminated water did not occur during the reporting period.

Monitoring results show that surface and subsurface hazardous ground gases were not present at concentrations that exceed the adopted performance criteria.

Some elevated heavy metals and ammonia were present in leachate samples collected from the leachate pond, however, this is not considered unusual in the context of the historical site use as a landfill. Leachate was contained onsite within the pond and as such the concentrations are not considered a significant risk to human or environmental receptors.

Heavy metals were detected above the performance criteria in groundwater, however, samples were submitted for analysis of total metals. Therefore, the elevated concentrations may be due to the presence of sediments. Future monitoring events should also assess dissolved concentrations of heavy metals to determine if elevated metals are attributed to sediment or if they exist in dissolved phase, as discussed below

Complaints from the public relating to offensive odours originating from the Site were not received during the reporting period.

10 Recommendations

Based on the monitoring undertaken during the reporting period the following actions are recommended:

A desktop study to assess the effect of the surrounding catchment and behaviour of groundwater through the site to determine any influence (if any) on water quality in the Hacking River catchment.

Begin preliminary stakeholder consultation to determine management requirements and community needs for the site rehabilitation.

11 Limitations

This assessment has been undertaken in accordance with Environmental Protection Licence 5861.

The assessment may not identify contamination occurring in all areas of the site or occurring after sampling was conducted. Subsurface conditions may vary considerably away from the sample locations where information has been obtained.

This assessment report is not any of the following:

A preliminary site investigation (PSI), detailed site investigation (DSI) or environmental site assessment (ESA).

A Site Audit Report or Site Audit Statement (SAR/SAS) as defined under the *Contaminated Land Management Act, 1997* or an assessment sufficient for an Environmental Auditor to be able to conclude a SAR/SAS.

A geotechnical report.

A detailed hydrogeological assessment in conformance with NSW DEC (2007) Contaminated Sites: Guidelines for the Assessment and Management of Groundwater Contamination.

A total assessment of the site to determine suitability of the entire parcel of land at the site for one or more beneficial uses of land.

12 References

ANZECC (2000), Australian Water Quality Guidelines, 2000

ANZAST (2018), Australian Water Quality Guidelines, 2018

Australian Standards (1999), AS 4482.2-1999 Guide to the Sampling and Investigation of Potentially Contaminated Soil - Volatile Substances, 1999

GHD (2008), Landfill Environmental Management Plan, Helensburgh Landfill, 2008

NEPC (2013), National Environment Protection (Assessment of Site Contamination)

Measure, 2013 NHMRC (2014), Australian Drinking Water Guidelines, 2014)

NSW EPA (1996), NSW Environmental Guidelines: Solid Waste Landfills, 1996 NSW EPA (2013), Requirements for publishing pollution monitoring data, 2013 NSW EPA (2015), Asbestos and Waste Tyre Guidelines, 2015

NSW EPA (2016), Environmental Guidelines: Solid Waste Landfills (Second Edition), 2016

NSW EPA (2017), Guidelines for the NSW Site Auditor Scheme (3rd Edition), 2017

NSW DPI (1985), 1:100,000 geological map Wollongong-Port Hacking, 1985 Sydney Water (2019), Consent to Discharge Industrial Trade Wastewater, 2019

US EPA (2000), Guidance for the Data Quality Objectives Process and Data Quality Objectives Process for Hazardous Waste Site Investigations, 2000

APPENDICIES

Appendix A

Table 1: Groundwater Quality Data for the Reporting Period 2022-2023

		Alkalinity (as calcium carbonate)	Aluminium	Ammonia	Arsenic	Barium	Benzene	Cadmium	Calcium	Chloride	Chromium (Hexavalent)	Chromium (Total)	Cobalt	Copper	Depth	Ethylbenzene	Fluoride	Lead
Units		mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	Meters	µg/L	mg/L	mg/L
Site Name	Sample Date																	
Monitoring Point 5	08/08/2022	3	1.65	<0.01	<0.001	0.028	<1	<0.0001	18	148	<0.01	<0.001	0.003	0.002	2.80	<2	<0.1	0.003
	15/11/2022	2		0.24					12	116					4.88			
	08/02/2023	23		0.51					19	70					3.00			
	02/05/2023	26		0.10					13	49					2.48			
Monitoring Point 6	08/08/2022	219	18.1	<0.01	0.021	0.330	<1	0.0005	47	16	<0.01	0.088	0.020	0.043	1.74	<2	0.1	0.041
	15/11/2022	262		0.04					61	10					4.15			
	08/02/2023	146		0.06					46	20					3.24			
	02/05/2023	187		0.04					47	18					2.87			
Monitoring Point 7	08/08/2022	<1	2.49	<0.01	<0.001	0.018	<1	<0.0001	<1	135	<0.01	<0.001	0.001	0.002	1.66	<2	0.1	0.003
	15/11/2022	7		0.16					<1	139					3.42			
	08/02/2023	9		0.08					1	172					2.67			
	02/05/2023	2		0.01					<1	159					1.70			
Monitoring Point 12	08/08/2022	102	1.86	<0.01	0.002	0.043	<1	<0.0001	33	18	<0.01	0.001	<0.001	0.003	1.80	<2	<0.1	0.002
	15/11/2022	89		<0.01					35	24					1.85			
	08/02/2023	45		0.01					24	19					4.77			
	02/05/2023	140		<0.01					48	19					1.43			
Monitoring Point 13	08/08/2022	6	51.5	<0.01	0.004	0.044	<1	<0.0001	9	24	<0.01	0.076	0.001	0.016	2.25	<2	<0.1	0.023
	15/11/2022	72		0.13					28	29					1.60			
	08/02/2023	12		0.02					16	35					2.81			
	02/05/2023	18		<0.01					16	31					2.10			
Monitoring Point 14	08/08/2022	10	4.02	0.02	<0.001	0.014	<1	0.0001	8	32	<0.01	0.005	0.002	0.003	2.00	<2	<0.1	0.003
	15/11/2022	13		0.07					8	22					3.68			
	08/02/2023	15		0.05					7	23					2.42			
	02/05/2023	17		0.07					5	13					1.88			
Monitoring Point 15	08/08/2022	9	9.78	<0.01	<0.001	0.008	<1	0.0001	8	16	<0.01	0.011	<0.001	<0.001	1.46	<2	<0.1	0.005
	15/11/2022	9		0.05					8	13					1.95			
	08/02/2023	14		<0.01					10	14					2.40			
	02/05/2023	7		<0.01					7	11					1.54			
Monitoring Point 16	08/08/2022	<1	0.42	<0.01	<0.001	0.008	<1	<0.0001	4	44	<0.01	<0.001	0.034	0.002	4.18	<2	<0.1	0.001
	15/11/2022	2		0.01					6	42					7.32			
	08/02/2023	10		<0.01					4	42					2.28			
	02/05/2023	9		<0.01					5	39					3.82			

		Magnesium	Manganese	Mercury	Nitrate as N	Nitrite as N	Organochlorine Pesticides	Organophosphate Pesticides	pH	Polycyclic aromatic hydrocarbons	Potassium	Sodium	Sulfate	Toluene	Total Dissolved Solids	Total organic carbon	Total Petroleum Hydrocarbons	Total Phenolics	Xylene	Zinc
Units		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	pH	µg/L	mg/L	mg/L	mg/L	µg/L	mg/L	mg/L	mg/L	mg/L	µg/L	mg/L
Site Name	Sample Date																			
Monitoring Point 5	08/08/2022	17	0.229	<0.0001	0.16	<0.01	<0.5	<0.5	4.8	<0.5	<1	67	84	<2	338	3	<100	<0.05	<2	0.199
	15/11/2022	14							4.4		<1	63	46		290	2				
	08/02/2023	15							5.4		1	51	115		326	6				
	02/05/2023	11							5.3		<1	37	52		213	3				
Monitoring Point 6	08/08/2022	23	0.418	<0.0001	0.02	<0.01	<0.5	<0.5	7.1	<0.5	6	18	<1	<2	257	8	<100	<0.05	<2	0.064
	15/11/2022	28							6.5		5	16	1		276	9				
	08/02/2023	20							6.5		5	18	26		304	10				
	02/05/2023	23							6.5		7	18	13		274	10				
Monitoring Point 7	08/08/2022	5	0.044	<0.0001	0.70	<0.01	<0.5	<0.5	5.0	<0.5	1	106	104	<2	338	3	<100	<0.05	<2	0.046
	15/11/2022	6							4.0		<1	115	99		383	3				
	08/02/2023	6							4.4		1	123	85		380	2				
	02/05/2023	7							4.3		1	127	71		380	4				
Monitoring Point 12	08/08/2022	13	0.015	<0.0001	0.17	<0.01	<0.5	<0.5	6.1	4.7	<1	22	52	<2	215	3	<100	<0.05	<2	0.021
	15/11/2022	12							5.7		1	16	34		201	5				
	08/02/2023	9							4.7		<1	16	53		147	7				
	02/05/2023	13							6.3		1	17	32		263	9				
Monitoring Point 13	08/08/2022	5	0.024	<0.0001	0.01	<0.01	<0.5	<0.5	5.4	<0.5	4	20	38	<2	171	5	<100	<0.05	<2	0.048
	15/11/2022	8							6.2		2	11	8		133	7				
	08/02/2023	8							5.5		5	18	38		352	3				
	02/05/2023	8							5.5		4	18	38		173	3				
Monitoring Point 14	08/08/2022	4	0.010	<0.0001	0.57	<0.01	<0.5	<0.5	5.4	<0.5	3	16	12	<2	80	1	<100	<0.05	<2	0.027
	15/11/2022	3							4.9		3	12	14		70	2				
	08/02/2023	3							5.4		4	14	16		96	2				
	02/05/2023	2							5.2		2	10	13		57	1				
Monitoring Point 15	08/08/2022	4	0.029	<0.0001	0.50	<0.01	<0.5	<0.5	5.3	<0.5	15	13	38	<2	114	4	<100	<0.05	<2	0.011
	15/11/2022	3							4.7		14	11	33		94	3				
	08/02/2023	3							5.2		15	10	39		132	<1				
	02/05/2023	2							5.0		11	8	29		106	3				
Monitoring Point 16	08/08/2022	5	0.150	<0.0001	<0.01	<0.01	<0.5	<0.5	5.0	<0.5	<1	26	23	<2	112	<1	<100	<0.05	<2	0.022
	15/11/2022	6							4.6		2	26	28		128	2				
	08/02/2023	5							5.8		<1	25	24		116	1				
	02/05/2023	5							5.1		1	26	25		133	2				

Table 2: Stormwater Results 2022-2023 Reporting Period

		Ammonia	Conductivity	Dissolved Oxygen	Faecal Coliforms	pH	Potassium	Redox Potential	Total Dissolved Solids	Total organic carbon
Units		mg/L	µS/cm	mg/L	CFU/100mL	pH	mg/L	mV	mg/L	mg/L
Site Name	Sample Date									
Monitoring Point 8	08/08/2022	33.0	1680	6.73	~2	7.4	48	233	849	25
	15/11/2022	14.4	1170	18.3	80	7.7	34	171	585	27
	07/02/2023	0.13	589	23.6	12	9.4	28	152	408	50
	02/05/2023	7.65	650	4.34	340	7.3	21	226	325	15

Table 3: Leachate Results 2022-2023 Reporting Period

		Alkalinity (as calcium carbonate)	Aluminium	Ammonia	Arsenic	Barium	Benzene	Cadmium	Calcium	Chloride	Chromium (Hexavalent)	Chromium (Total)	Cobalt	Conductivity	Copper	Ethylbenzene	Fluoride	Lead	Magnesium	Manganese
Units		mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µS/cm	mg/L	µg/L	mg/L	mg/L	mg/L	mg/L
Site Name	Sample Date																			
Leachate	08/08/2022	898	<0.01	27.4	<0.001	0.319	<1	0.0001	126	55	<0.01	<0.001	0.002	1850	0.011	<2	0.2	<0.001	57	0.371
	15/11/2022													1890						
	07/02/2023													2160						
	02/05/2023													1570						

		Mercury	Nitrate as N	Nitrite as N	pH	Polycyclic aromatic hydrocarbons	Potassium	Sodium	Sulfate	Toluene	Total Dissolved Solids	Total organic carbon	Total Phosphorus as P	Total suspended solids	Xylene	Zinc
Units		mg/L	mg/L	mg/L	pH	µg/L	mg/L	mg/L	mg/L	µg/L	mg/L	mg/L	mg/L	mg/L	µg/L	mg/L
Site Name	Sample Date															
Leachate	08/08/2022	<0.0001	6.22	0.04	7.1	<0.5	46	157	29	<2	947	18	0.04	<5	<2	0.034
	15/11/2022															
	07/02/2023															
	02/05/2023															

Table 4: Trade Waste Results 2022-2023

Date Sampled (Date)		01/06/2022	02/06/2022	08/08/2022	09/08/2022	05/10/2022	06/10/2022	07/02/2023	08/02/2023	13/04/2023
Compound Name	Units									
Ammonia	mg/L		10.6		18.7		68.9		4.5	91.8
Filterable iron	mg/L		0.99		0.47		15.7		135.	24.6
Finish Time	hrs		0.		0.		0.		0.	0.
Temperature	°C		12.		14.		18.		20.	20.
Total Dissolved Solids (Calc.)	mg/L		1,080.		1,010.		1,250.		780.	1,330.
Total suspended solids	mg/L		0.		0.		30.		492.	50.
Volume Discharged	kL		52.8		42.3		27.3		0.19	0.22
Volume Discharged (corrected)	kL		52.8		42.3		27.3		0.19	0.22
Meter Reading (start)	kL		61,610.27		64,144.24		66,041.25		67,353.16	70,050.91
Meter Reading (finish)	kL		61,663.12		64,186.51		66,068.59		67,353.35	70,051.13
pH (start)	pH	7.3		7.2		6.5		7.		
pH (finish)	pH		7.5		7.		6.7		7.	6.8
Ammonia kg/day	kg/day		0.55968		0.79101		1.88097		0.00086	0.0202
Filterable iron kg/day	kg/day		0.05227		0.01988		0.42861		0.02565	0.00541
Total Dissolved Solids (Calc.) kg/day	kg/day		57.024		42.723		34.125		0.1482	0.2926
Total suspended solids kg/day	kg/day		0.		0.		0.819		0.09348	0.011

Table 5: Subsurface Gas Results 2022-2023 Reporting Period

			CH4	CH4 Peak	CO2	CO2 Peak	SWL
Units			%v/v	%v/v	%v/v	%v/v	Meters
Monitoring Point ID	Sample ID	Sample Date	Result	Result	Result	Result	Result
EPA 17	LGB5	15/8/2022	<0.1	<0.1	6.7	6.7	3.59
EPA 18	LGB6	15/8/2022	<0.1	<0.1	1	5.3	2.53
EPA 19	LGB7	15/8/2022	<0.1	<0.1	0.5	2.5	2.97
EPA 20	LGB8	15/8/2022	<0.1	<0.1	0.2	1.1	2.36
EPA 21	LGB9	15/8/2022	<0.1	<0.1	2.7	2.9	1.85
EPA 4	LFGMB1	15/8/2022	<0.1	<0.1	0.5	2.5	1.82

			CH4	CH4 Peak	CO2	CO2 Peak	SWL
Units			%v/v	%v/v	%v/v	%v/v	Meters
Monitoring Point ID	Sample ID	Sample Date	Result	Result	Result	Result	Result
EPA 17	LGB5	14/11/2022	0.00	0.00	1.0	3.5	4.30
EPA 18	LGB6	14/11/2022	0.00	0.00	3.4	3.4	2.44
EPA 19	LGB7	14/11/2022	0.00	0.00	0.1	2.8	2.77
EPA 20	LGB8	14/11/2022	0.00	0.00	0.4	0.4	2.18
EPA 21	LGB9	14/11/2022	0.00	0.00	2.1	2.1	2.02
EPA 4	LFGMB1	14/11/2022	0.00	0.00	1.1	1.1	1.85

			CH4	CH4 Peak	CO2	CO2 Peak	SWL
Units			%v/v	%v/v	%v/v	%v/v	Meters
Monitoring Point ID	Sample ID	Sample Date	Result	Result	Result	Result	Result
EPA 17	LGB5	9/1/2023	<0.1	<0.1	1.9	1.9	DRY
EPA 18	LGB6	9/1/2023	<0.1	<0.1	0.2	1.8	2.79
EPA 19	LGB7	9/1/2023	<0.1	<0.1	3.1	3.1	3.23
EPA 20	LGB8	9/1/2023	<0.1	<0.1	0.3	3	2.63
EPA 21	LGB9	9/1/2023	<0.1	<0.1	0.5	0.5	2.75
EPA 4	LFGMB1	9/1/2023	<0.1	<0.1	0.9	1.2	4.72

Document Set ID: 24484551
Version: 1, Version Date: 22/08/2023

			CH4	CH4 Peak	CO2	CO2 Peak	SWL
Units			%v/v	%v/v	%v/v	%v/v	Meters
Monitoring Point ID	Sample ID	Sample Date	Result	Result	Result	Result	Result
EPA 17	LGB5	17/4/2023	<0.1	<0.1	7.2	7.2	4.25
EPA 18	LGB6	17/4/2023	<0.1	<0.1	0.8	0.8	2.21
EPA 19	LGB7	17/4/2023	<0.1	<0.1	7.6	7.6	2.61
EPA 20	LGB8	17/4/2023	<0.1	<0.1	1.4	1.4	2.05
EPA 21	LGB9	17/4/2023	<0.1	<0.1	2.7	2.7	1.84
EPA 4	LFGMB1	17/4/2023	<0.1	<0.1	0.2	0.4	1.4

Table 6: Surface Gas Results 2022-2023 Reporting Period

Client:	Wollongong City Council			Date:	15/8/2022
Site:	Helensburgh Landfill			Sampler(s)	Robert & Michael
Transact / Location	Point	GPS North	GPS East	CH4 Conc (ppm)	Comments
A	1	6216097	315929	1.2	
A	2	6216098	315918	1.2	
A	3	6216099	315890	1.1	
A	4	6216102	315850	1.2	
A	5	6216103	315830	1.1	
A	6	6216107	315797	1.5	
B	1	6216129	315795	2.1	
B	2	6216124	315814	1.6	
B	3	6216124	315836	1.8	
B	4	6216122	315865	1.5	
B	5	6216118	315884	1.6	
B	6	6216116	315905	1.8	
B	6	6216117	315927	1.0	
C	1	6216231	315779	1.3	

C	2	6216203	315772	1.2	
C	3	6216185	315776	1.1	
C	4	6216173	315778	1.4	
C	5	6216157	315782	1.3	
C	6	6216195	315786	1.4	
D	1				No Access (Heavily Overgrown)
E	1	6216332	315790	1.6	
E	2	6216322	315791	1.7	
E	3				No Access (Heavily Overgrown)
F	1	6216371	315774	1.2	
F	2	6216368	315756	1.8	
F	3	6216369	315757	1.3	
F	4	6216379	315733	1.2	
F	5	6216385	315707	1.0	
F	6	6216389	315688	0.8	
F	7	6216387	315672	0.9	
F	8	6216383	315654	1.2	
G	1	6216144	315933	1.0	Very boggy and wet track risk of being bogged in area.
G	2	6216171	315929	1.1	Very boggy and wet track risk of being bogged in area.
G	3	6216213	315923	1.2	Very boggy and wet track risk of being bogged in area.

G	4	6216269	315905	2.8	Very boggy and wet track risk of being bogged in area.
G	5	6216335	315937	1.7	Very boggy and wet track risk of being bogged in area.
G	6	6216356	315944	1.6	Very boggy and wet track risk of being bogged in area.
H	1	6216202	315878	2.5	
H	2	6216221	315877	2.5	
H	3	6216243	315873	2.6	
H	4	6216266	315875	2.2	
H	5	6216289	315876	2.0	
H	6	6216303	315877	2.0	
H	7	6216318	315879	1.9	
H	8	6216338	315889	2.1	
I	1	6216360	315878	1.5	
I	2	6216342	315876	1.5	
I	3	6216305	315863	1.4	
I	4	6216291	315866	1.4	
I	5	6216277	315869	2.3	
I	6	6216253	315867	1.7	
I	7	6216245	315869	6.1	
I	8	6216223	315873	2.4	
J	1	6216349	315847	1.8	
J	2	6216323	315850	1.6	
J	3	6216294	315854	1.7	

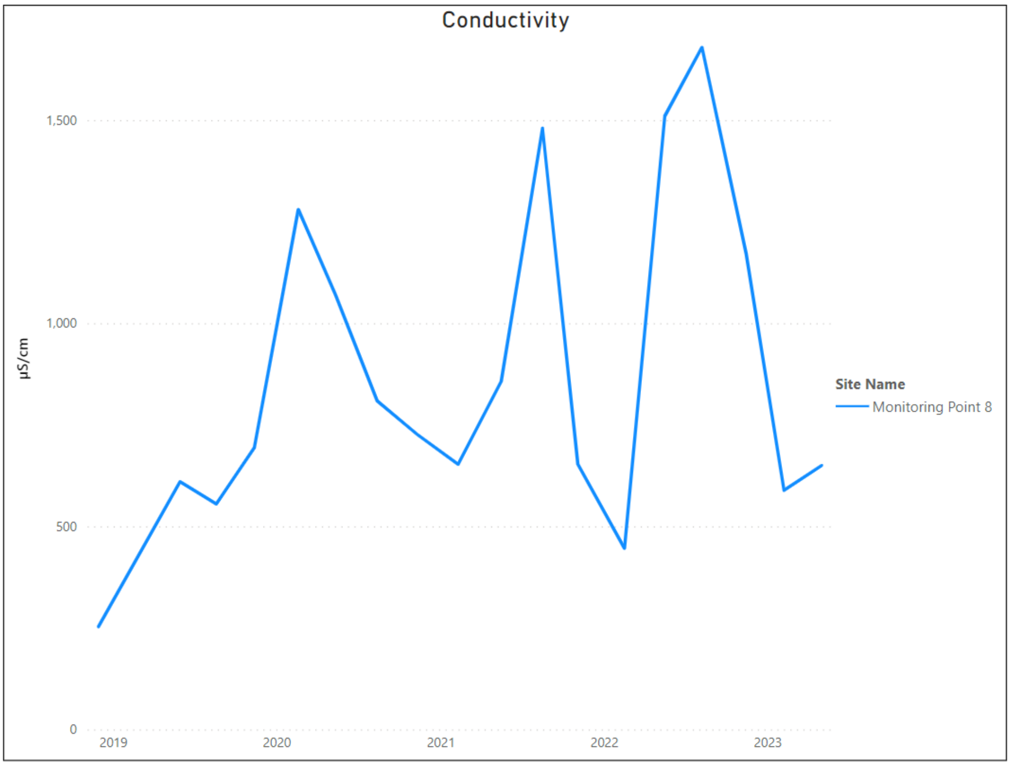
J	4	6216255	315857	7.5	
J	5	6216227	315858	2.1	
J	6	6216192	315870	2.2	
K	1	6216406	315658	2.2	
K	2	6216424	315699	2.4	
K	3	6216426	315723	2.5	
K	4	6216430	315757	2.5	
K	5	6216436	315797	2.4	
K	6	6216437	315830	2.3	
K	7	6216421	315849	2.3	
K	8	6216401	315855	3.9	
L	1	6216442	31575	1.5	
L	2	6216455	315806	1.6	
L	3	6216466	315837	1.5	
L	4	6216459	315817	1.5	
L	5	6216454	315787	2.0	
L	6	6216450	315752	2.1	
L	7	6216439	315712	2.1	
L	8	6216428	315660	2.0	
M	1	6216439	315626	1.3	
M	2	6216444	315647	1.1	
M	3	6216456	315666	1.1	
M	4	6216462	315701	1.1	
M	5	6216471	315745	1.4	
M	6	6216481	315772	1.7	
M	7	6216492	315809	1.8	
M	8	6216491	315833	1.7	

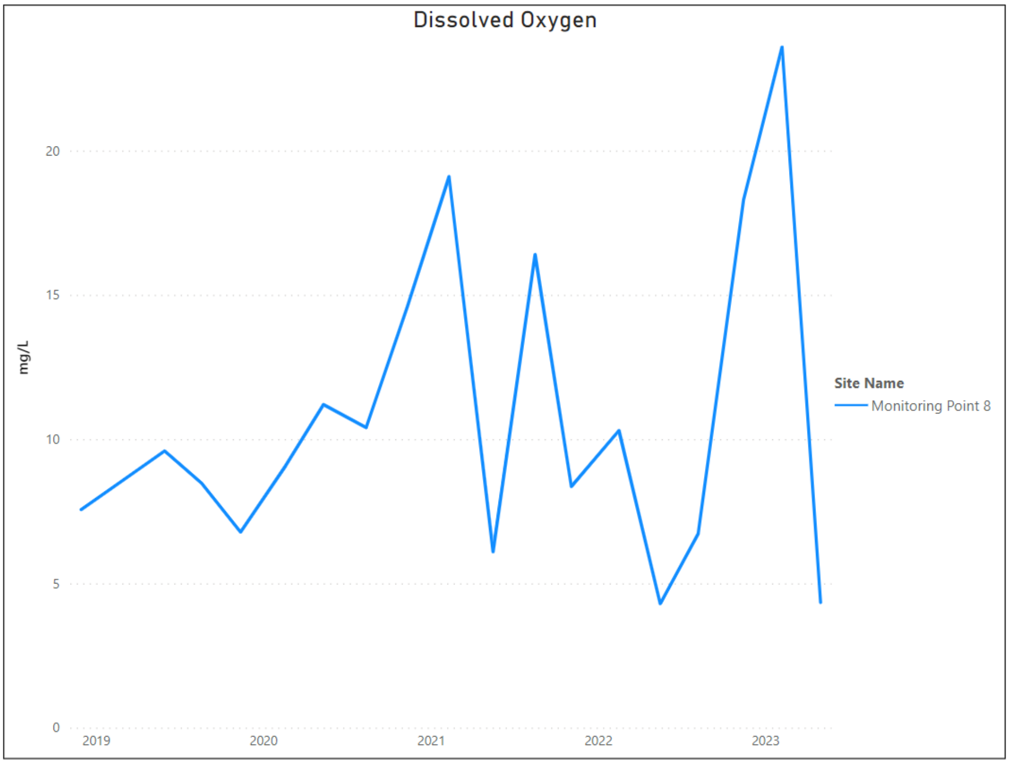
N	1	6216316	315887	1.5	
N	2	6216315	315901	1.5	
N	3	6216318	315911	1.7	
N	4	6216316	315923	1.8	
N	5	6316311	315928	1.7	
O	1	6216335	315946	1.8	
O	2	6216336	315941	1.9	
O	3	6216337	315930	1.7	
O	4	6216341	315912	1.7	
O	5	6216341	315913	1.9	
O	6	6216343	315900	5.0	
P	1	6216373	315945	1.9	
P	2	6216373	315932	1.7	
P	3	6216377	315923	1.9	
P	4	6216380	315906	1.9	
P	5	6216379	315889	1.8	
P	6	6216377	315871	1.9	
P	7	6216358	315855	1.5	
Methane Blank (Pre testing)	1			1.0	Taken at entrance to Helensburgh site before main gate
Methane Blank (Post testing)	1			1.1	Taken at entrance to Helensburgh site before main gate
Weighbridge office	1			2.0	Office Closed taken outside

					on the weighbridge
69 Halls Rd fenceline adjoining landfill	1	6216211	315534	1.5	
69 Halls Rd fenceline adjoining landfill	2	6216211	315535	1.6	
69 Halls Rd, Immediate gardens max value	1	6216212	315536	1.6	
75 Halls Rd fenceline adjoining landfill	1	6216241	315542	2.0	
75 Halls Rd, Immediate gardens max value	1	6216215	315535	1.9	
77 Halls Rd fenceline adjoining landfill	1	6216267	315545	2.1	
77 Halls Rd, Immediate gardens max value	1	6216255	315546	2.0	
79 Halls Rd fenceline adjoining landfill	1	6216270	315547	2.2	
79 Halls Rd, Immediate gardens max value	1	6216297	315550	2.2	
81 Halls Rd fenceline adjoining landfill	1	6216298	315551	2.2	
81 Halls Rd fenceline adjoining landfill	2	6216308	315553	2.5	
1 Nixon Pl, fenceline adjoining landfill	1	6216342	315536	2.6	
1 Nixon Pl, fenceline adjoining landfill	2	6216339	315520	2.4	
1 Nixon Pl, Immediate gardens max value	1	6216326	315491	2.5	

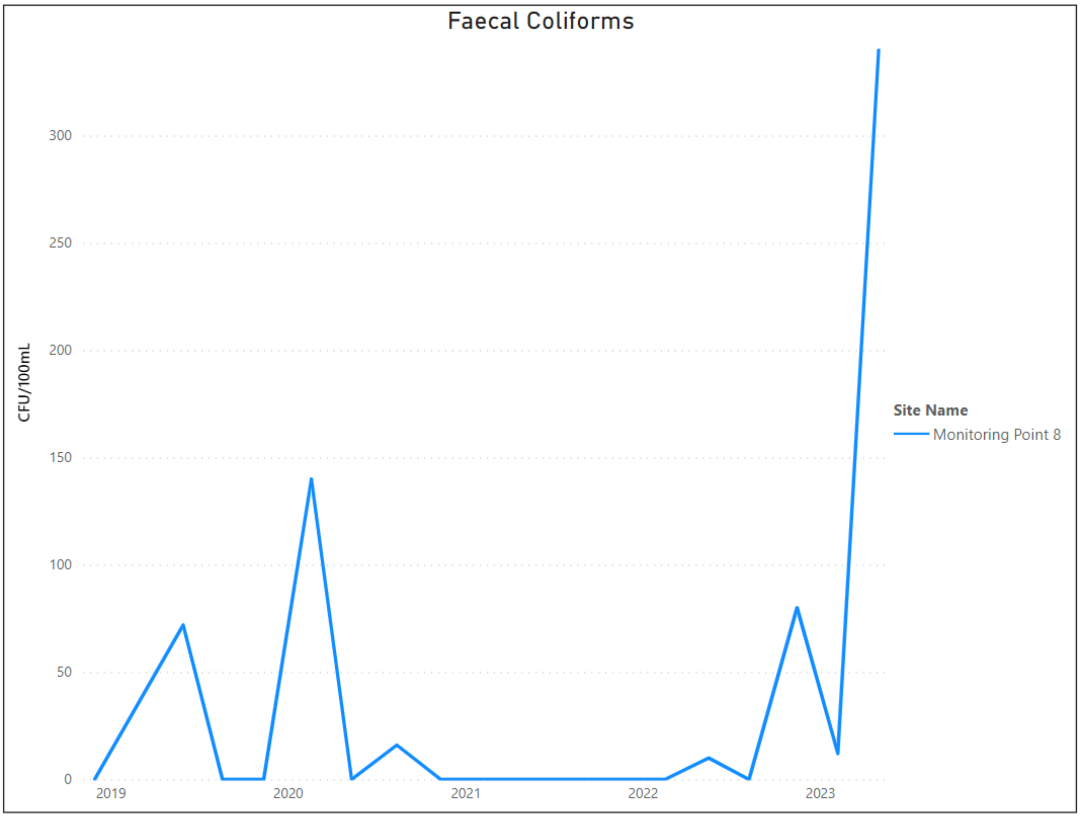
Appendix B

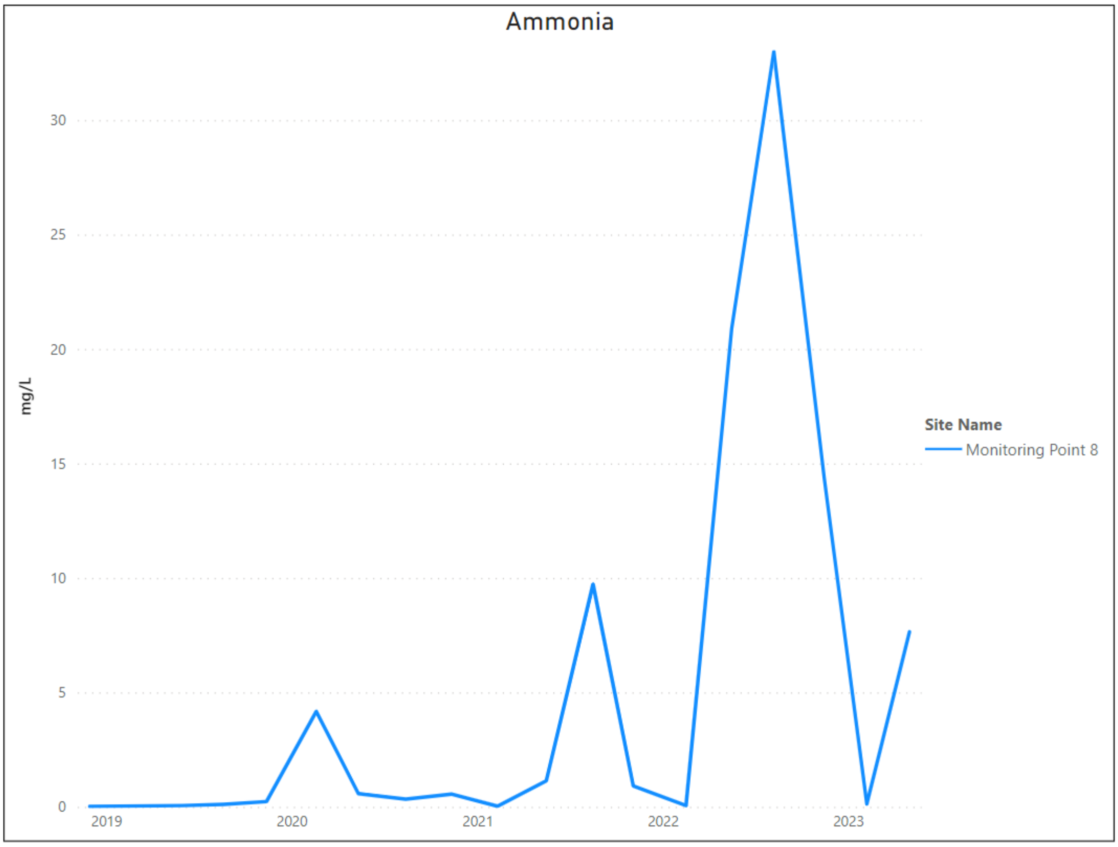
Helensburgh Surface Water Annual Results 2022/2023

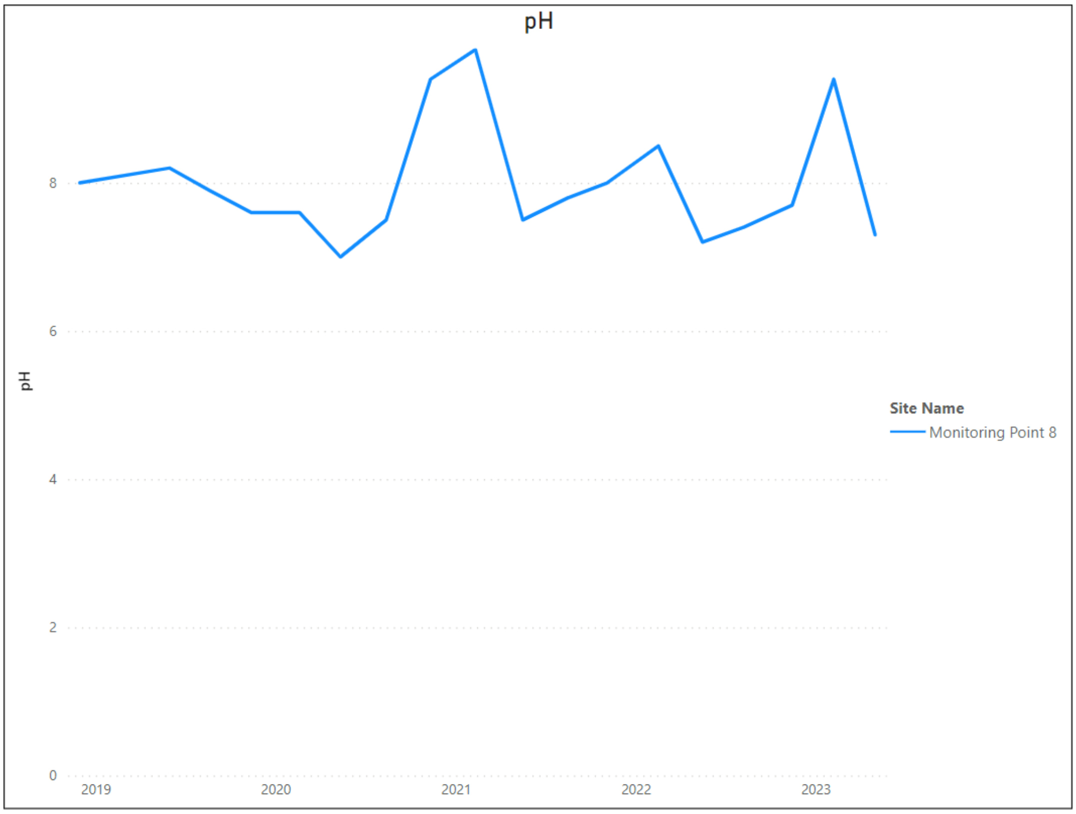


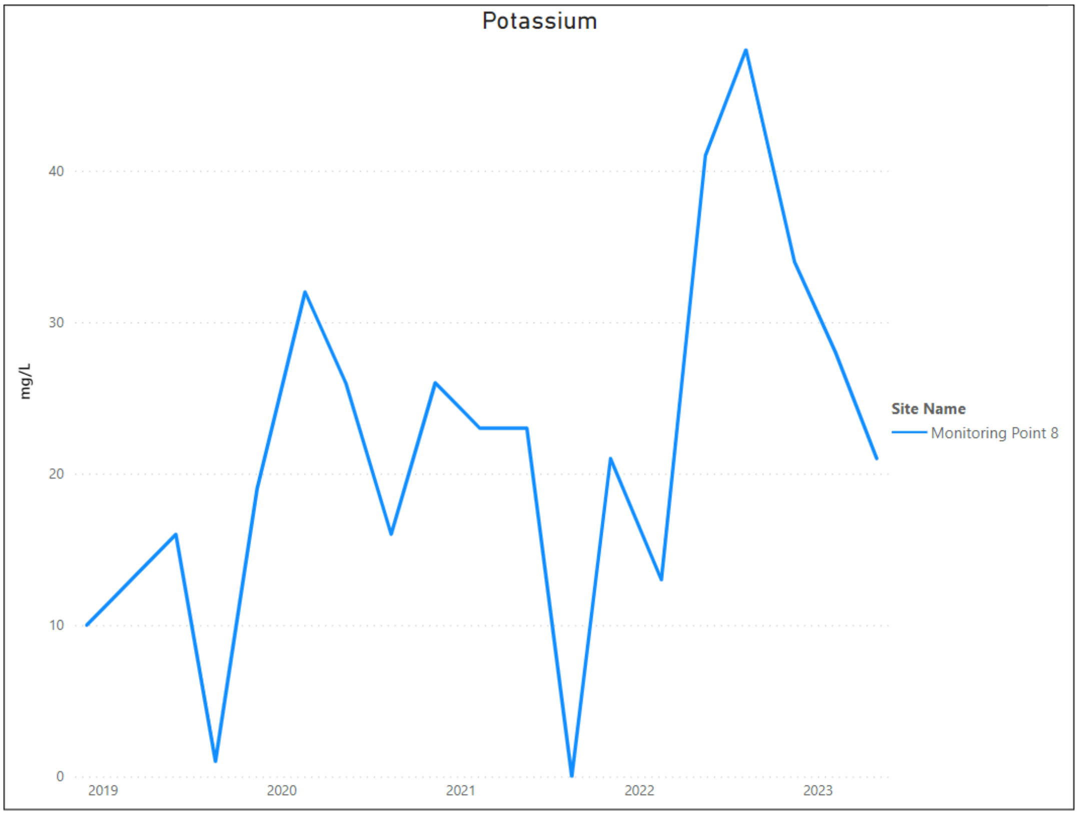


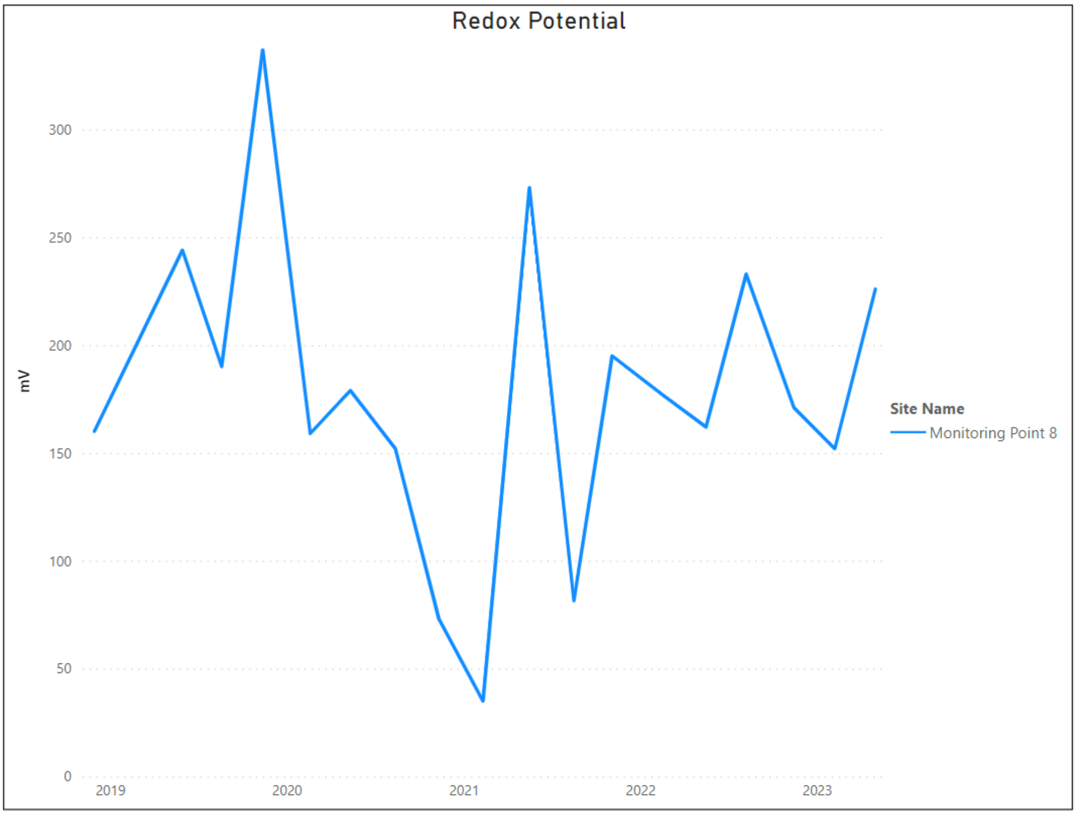
Document Set ID: 24484551
Version: 1, Version Date: 22/08/2023

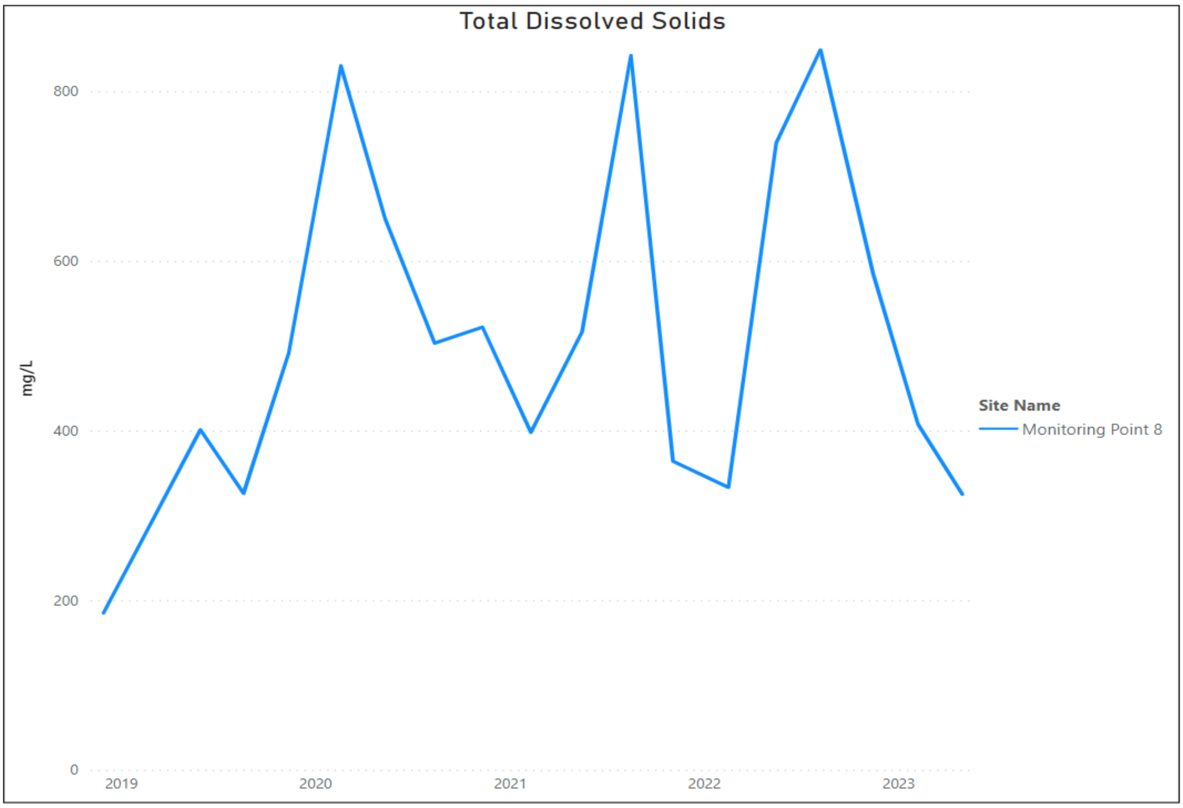

Faecal Coliforms
CFU/100mL
300
250
200
150
100
50
0
2019
2020
2021
2022
2023
Site Name
Monitoring Point 8

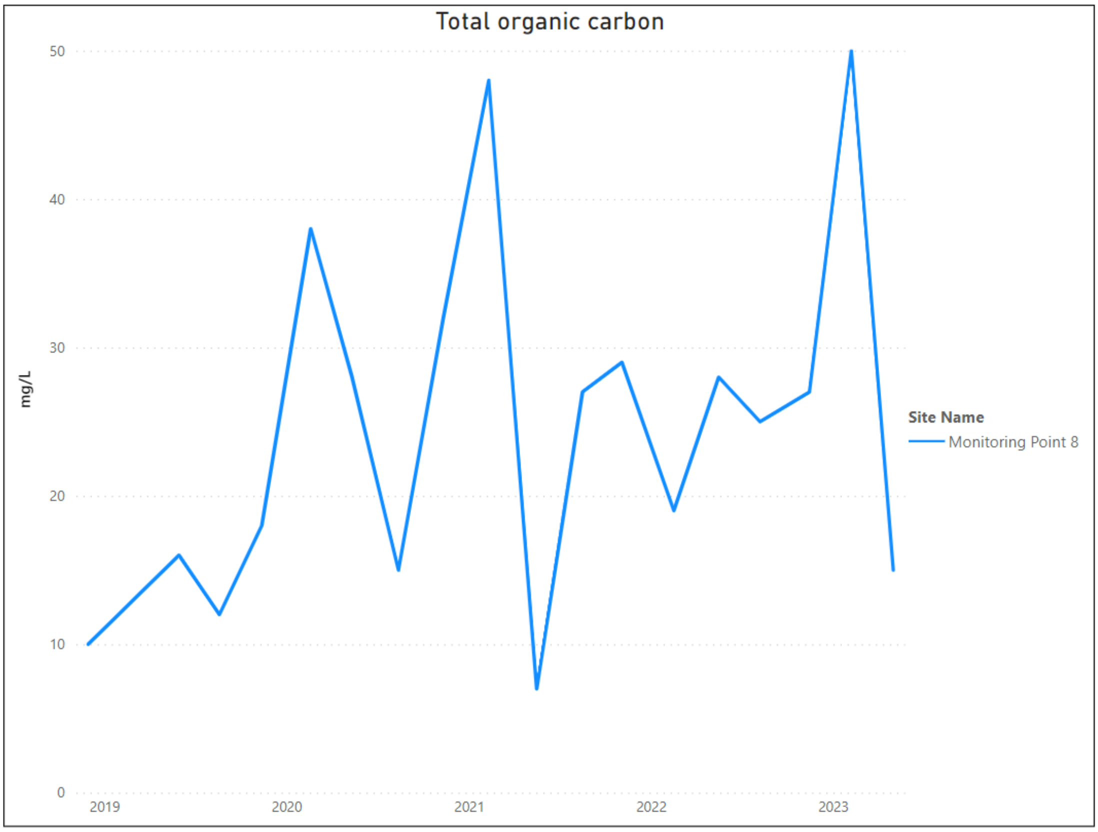

Ammonia
mg/L
30
25
20
15
10
5
0
2019
2020
2021
2022
2023
Site Name
Monitoring Point 8


pH
pH
0
2
4
6
8
2019
2020
2021
2022
2023
Site Name
Monitoring Point 8

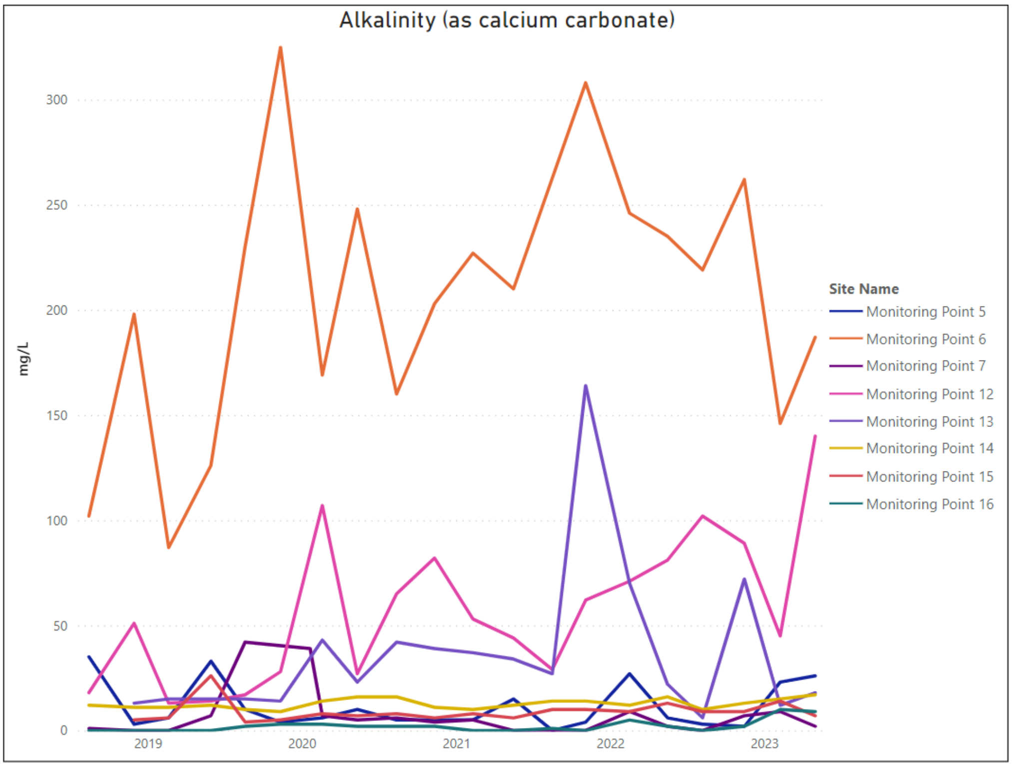

Potassium
mg/L
0
10
20
30
40
2019
2020
2021
2022
2023
Site Name
Monitoring Point 8

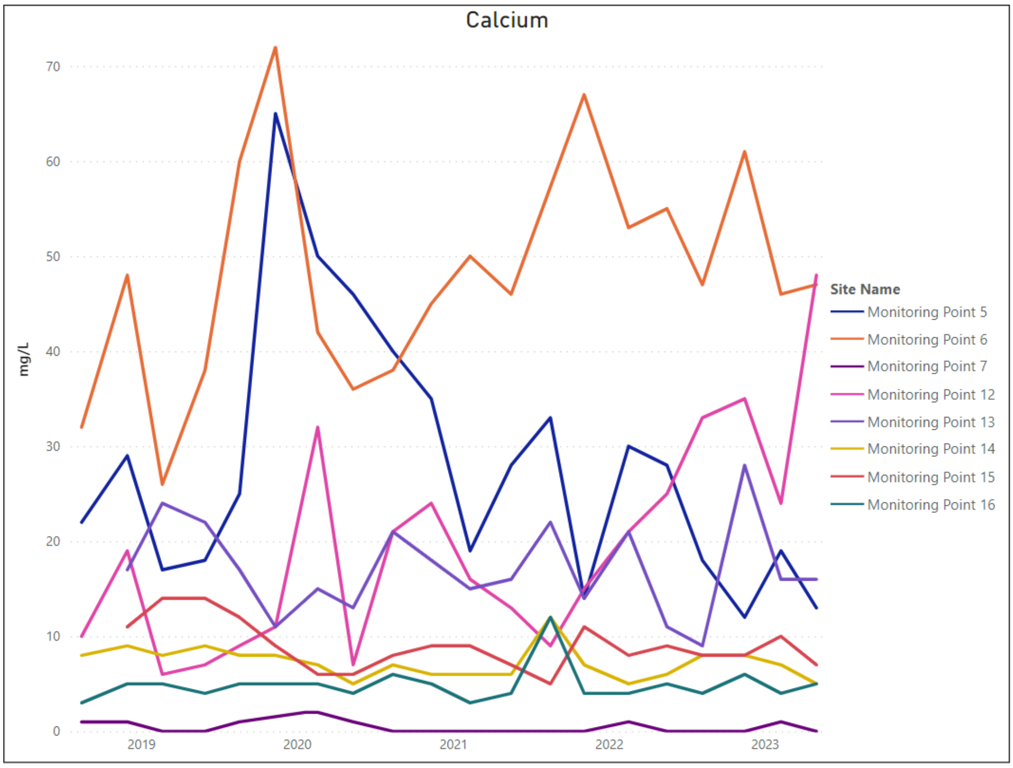

Redox Potential
mV
300
250
200
150
100
50
0
2019
2020
2021
2022
2023
Site Name
Monitoring Point 8

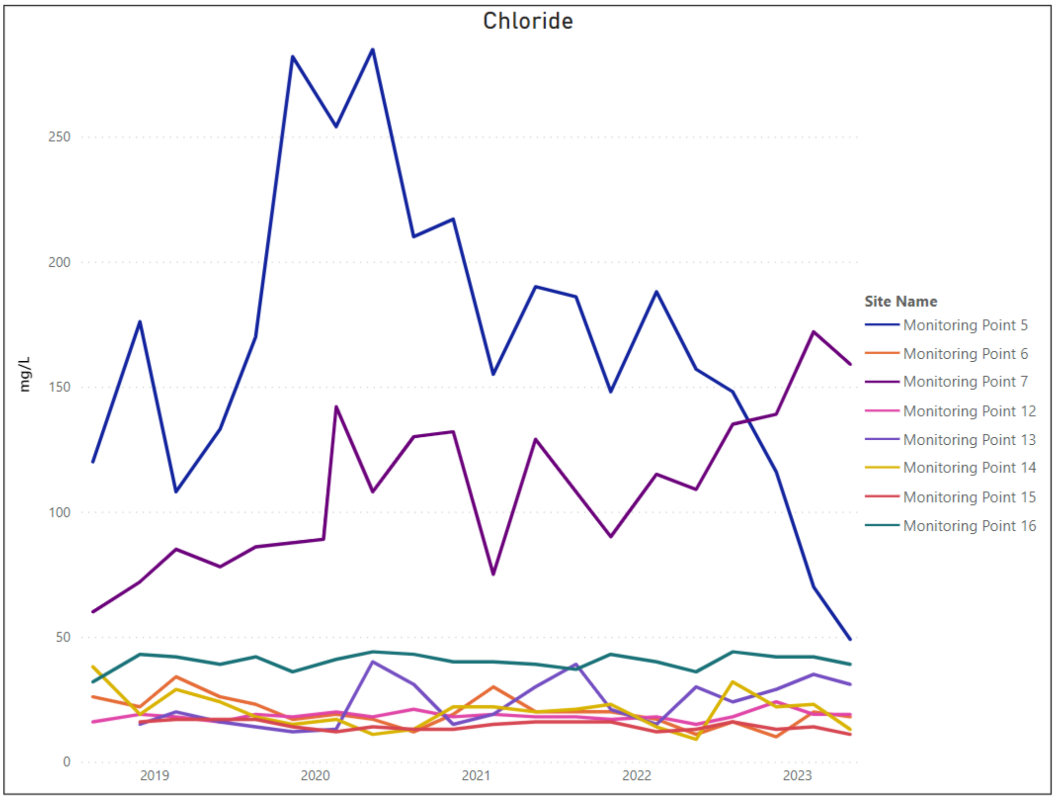

Total Dissolved Solids
mg/L
800
600
400
200
0
2019
2020
2021
2022
2023
Site Name
Monitoring Point 8

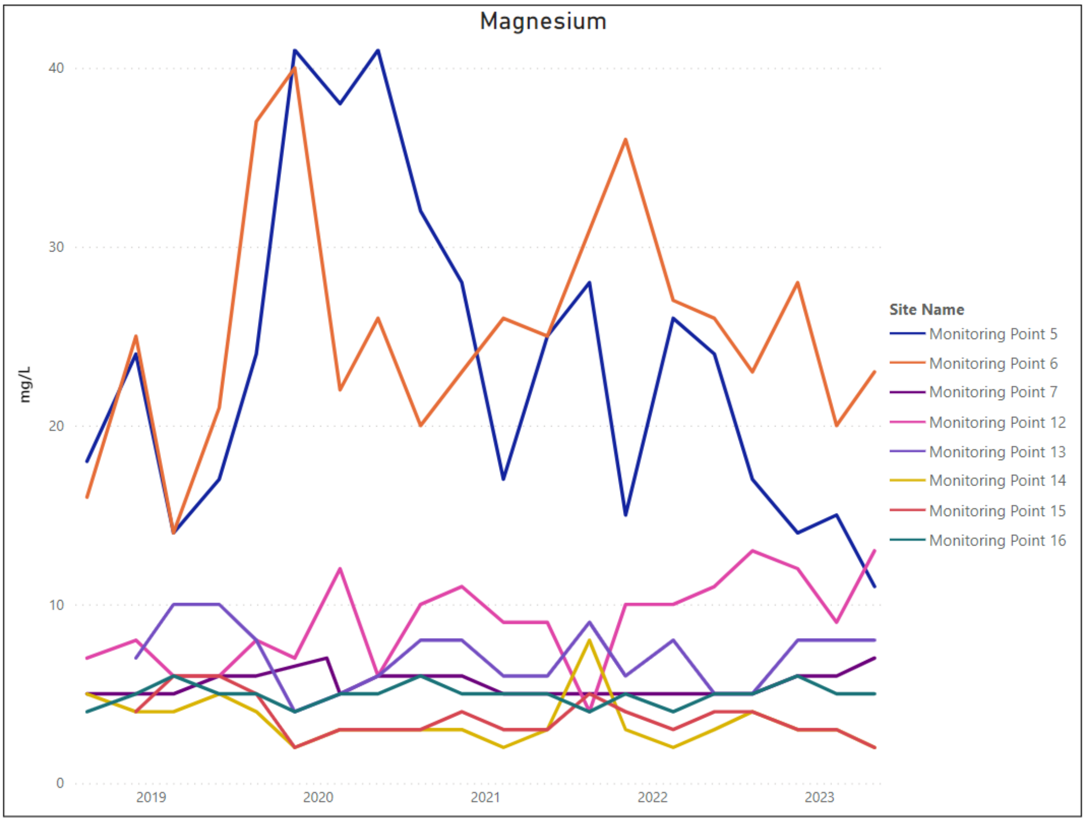


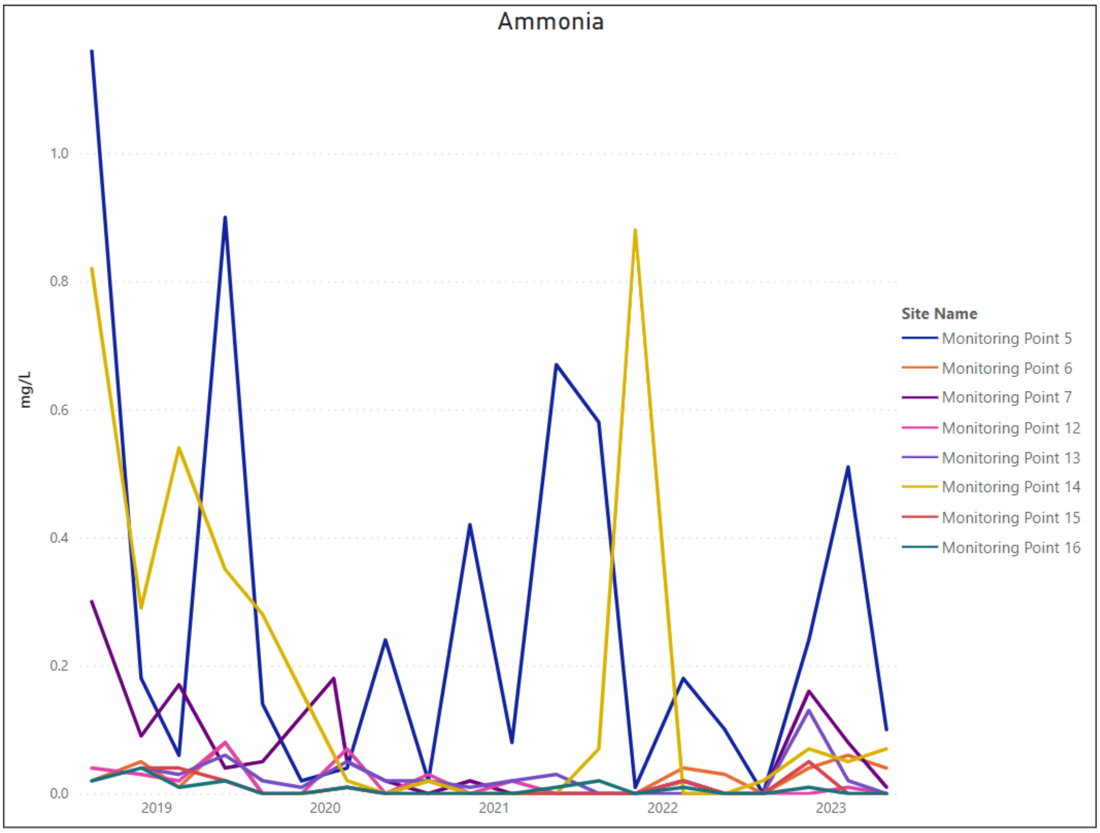
Helensburgh Quarterly Groundwater Results 2022-2023

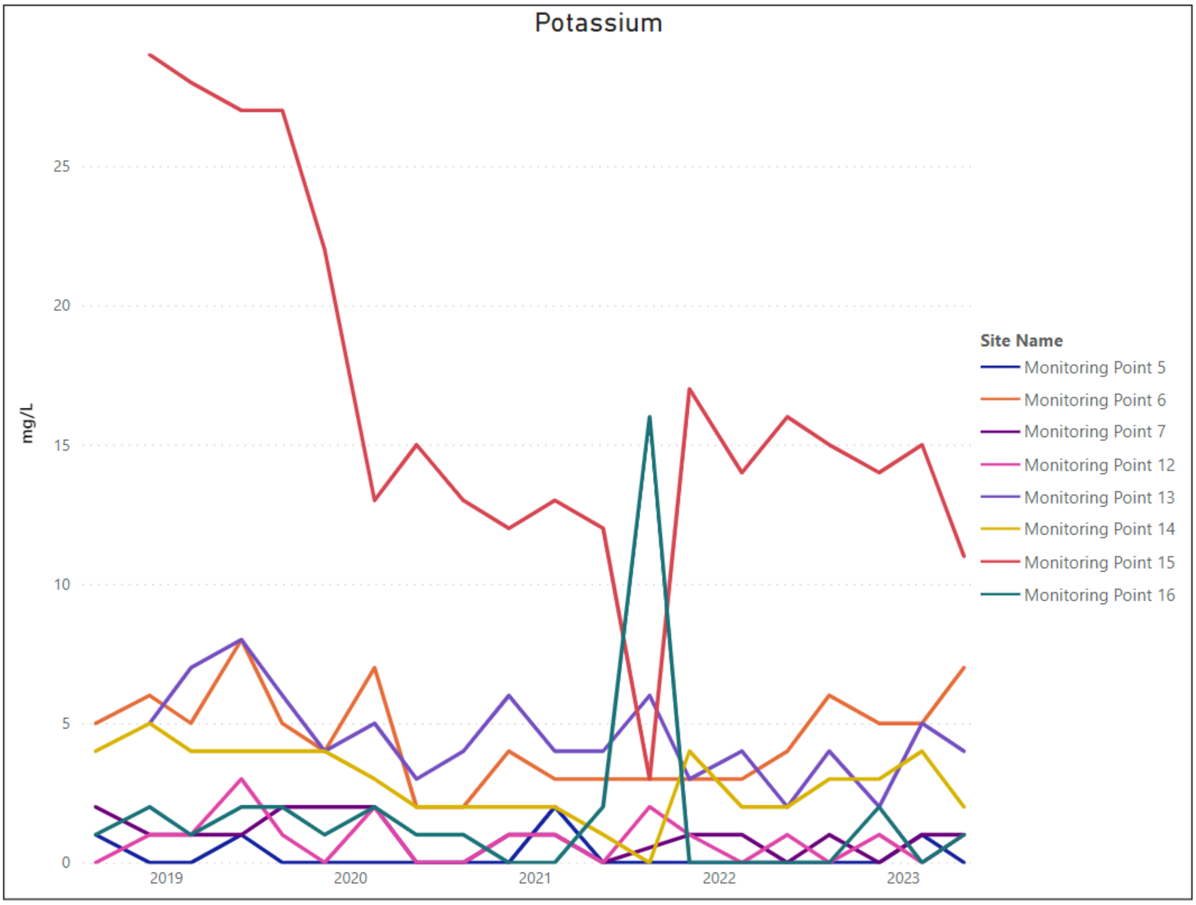



Calcium
mg/L
0
10
20
30
40
50
60
70
2019
2020
2021
2022
2023
Site Name
Monitoring Point 5
Monitoring Point 6
Monitoring Point 7
Monitoring Point 12
Monitoring Point 13
Monitoring Point 14
Monitoring Point 15
Monitoring Point 16

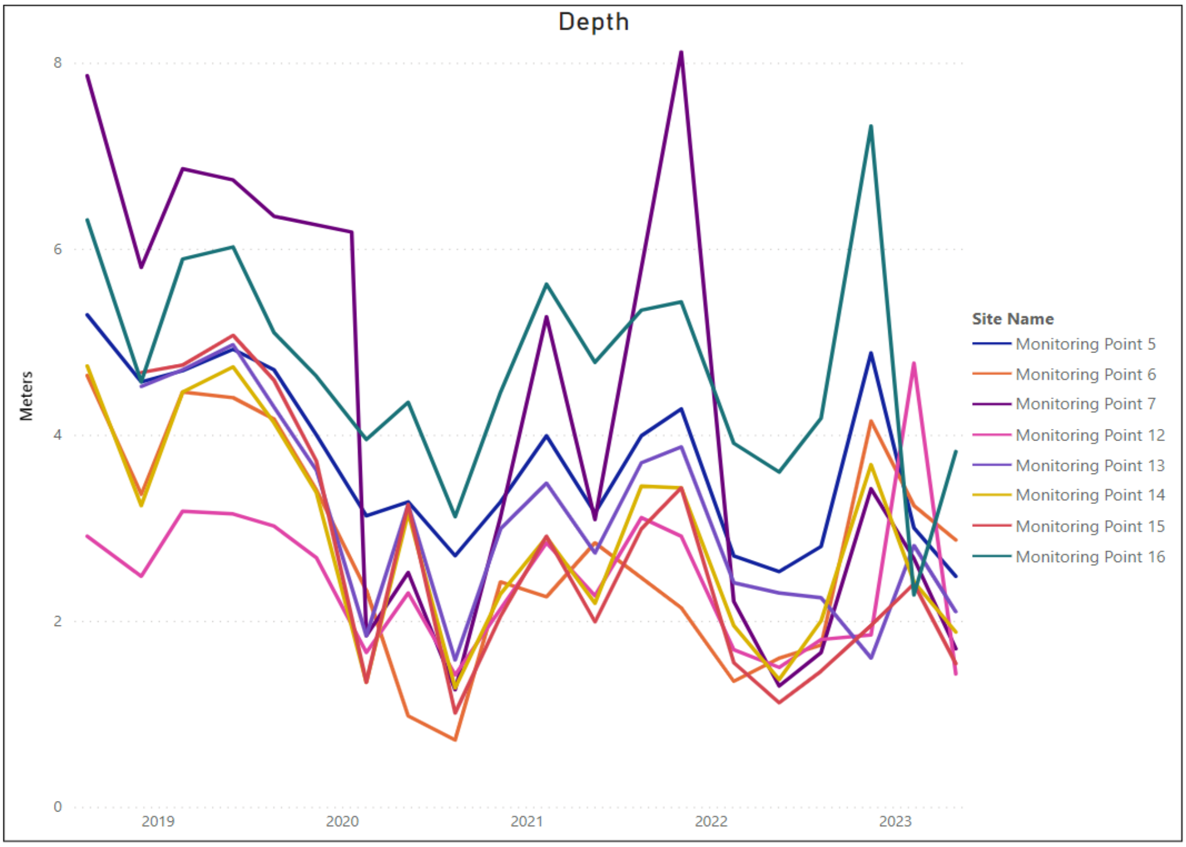

Chloride
mg/L
0
50
100
150
200
250
2019
2020
2021
2022
2023
Site Name
Monitoring Point 5
Monitoring Point 6
Monitoring Point 7
Monitoring Point 12
Monitoring Point 13
Monitoring Point 14
Monitoring Point 15
Monitoring Point 16


Magnesium
mg/L
40
30
20
10
0
2019
2020
2021
2022
2023
Site Name
Monitoring Point 5
Monitoring Point 6
Monitoring Point 7
Monitoring Point 12
Monitoring Point 13
Monitoring Point 14
Monitoring Point 15
Monitoring Point 16

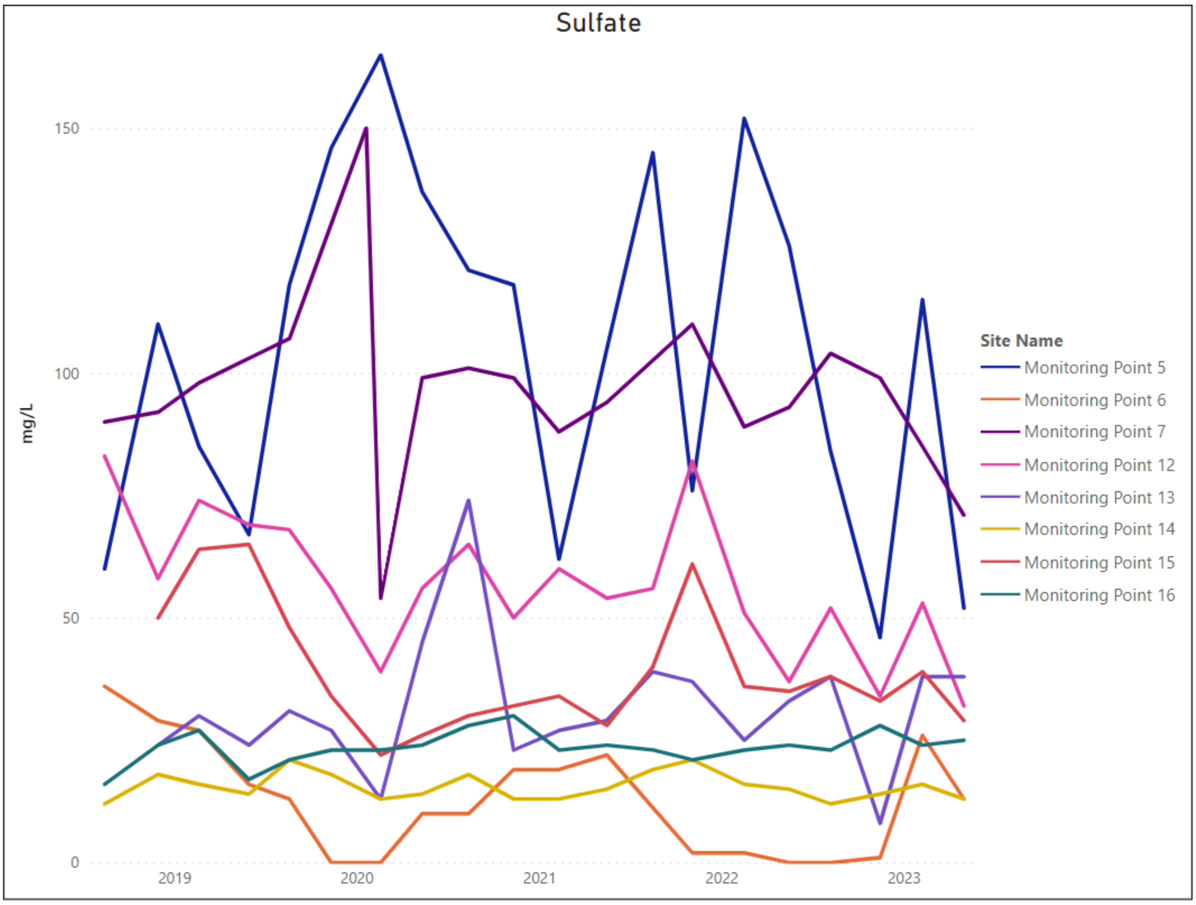

Ammonia
mg/L
1.0
0.8
0.6
0.4
0.2
0.0
2019
2020
2021
2022
2023
Site Name
Monitoring Point 5
Monitoring Point 6
Monitoring Point 7
Monitoring Point 12
Monitoring Point 13
Monitoring Point 14
Monitoring Point 15
Monitoring Point 16

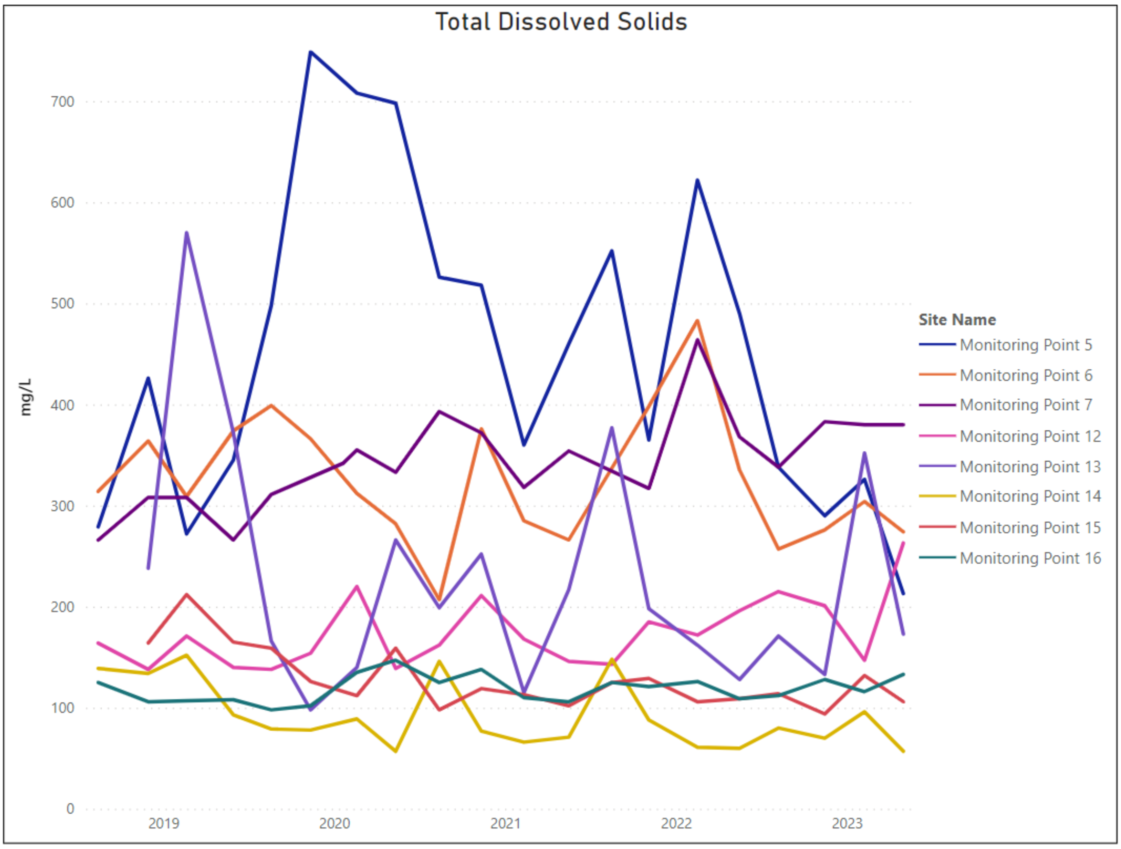


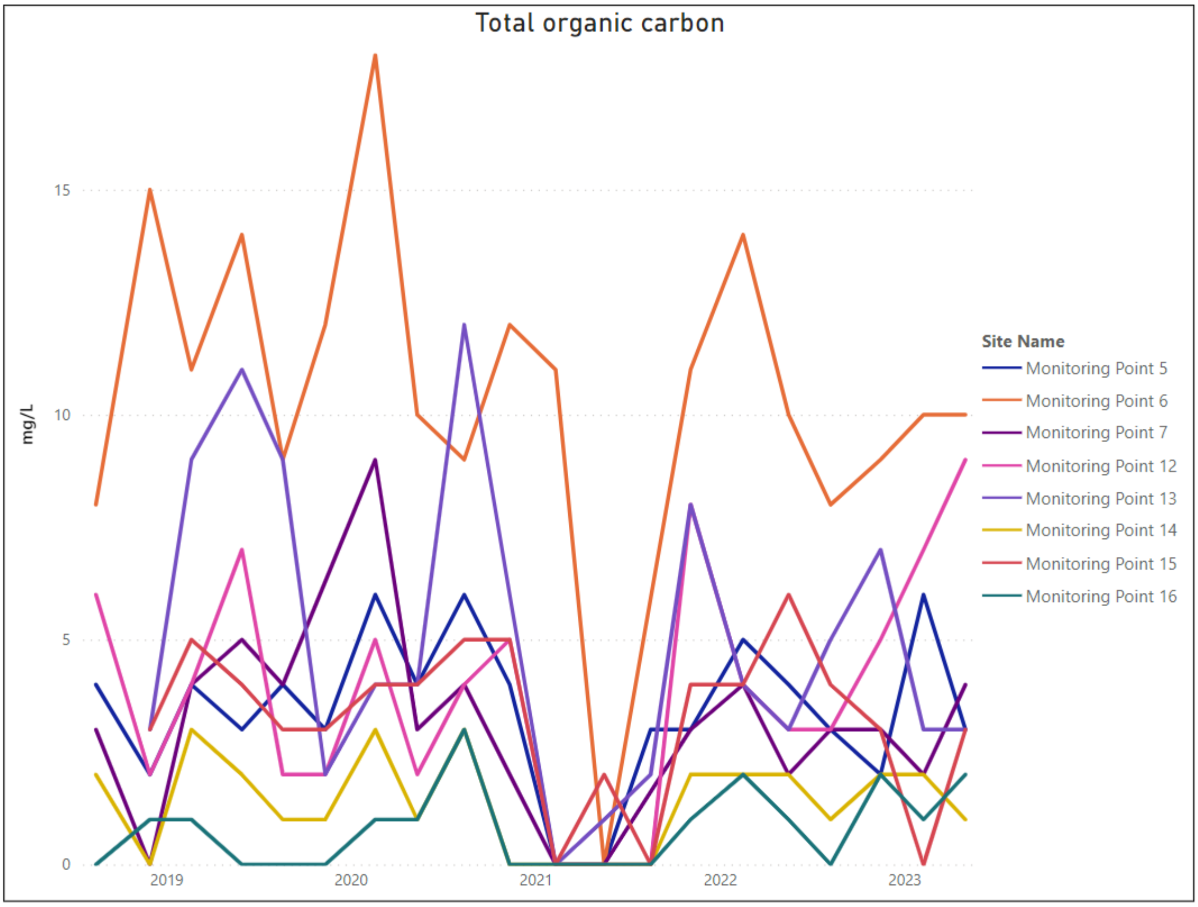
Potassium
mg/L
25
20
15
10
5
0
2019
2020
2021
2022
2023
Site Name
Monitoring Point 5
Monitoring Point 6
Monitoring Point 7
Monitoring Point 12
Monitoring Point 13
Monitoring Point 14
Monitoring Point 15
Monitoring Point 16

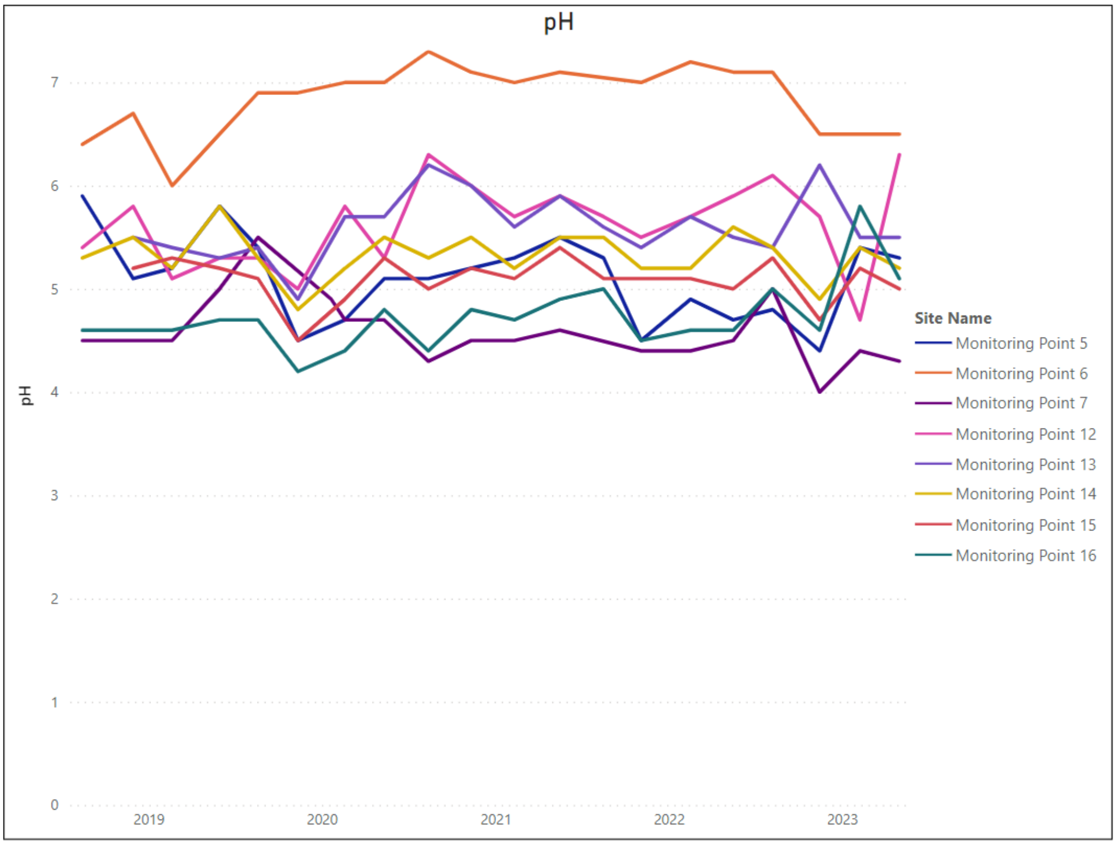


Depth
Meters
8
6
4
2
0
2019
2020
2021
2022
2023
Site Name
Monitoring Point 5
Monitoring Point 6
Monitoring Point 7
Monitoring Point 12
Monitoring Point 13
Monitoring Point 14
Monitoring Point 15
Monitoring Point 16

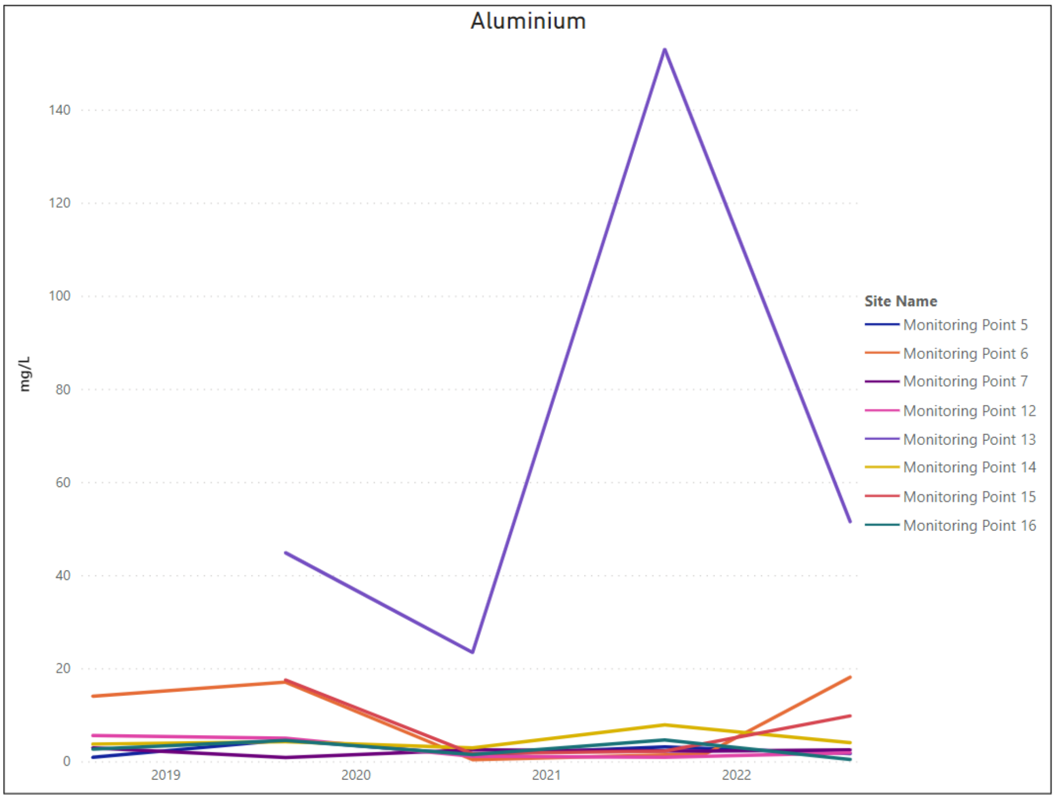

Sulfate
mg/L
150
100
50
0
2019
2020
2021
2022
2023
Site Name
Monitoring Point 5
Monitoring Point 6
Monitoring Point 7
Monitoring Point 12
Monitoring Point 13
Monitoring Point 14
Monitoring Point 15
Monitoring Point 16

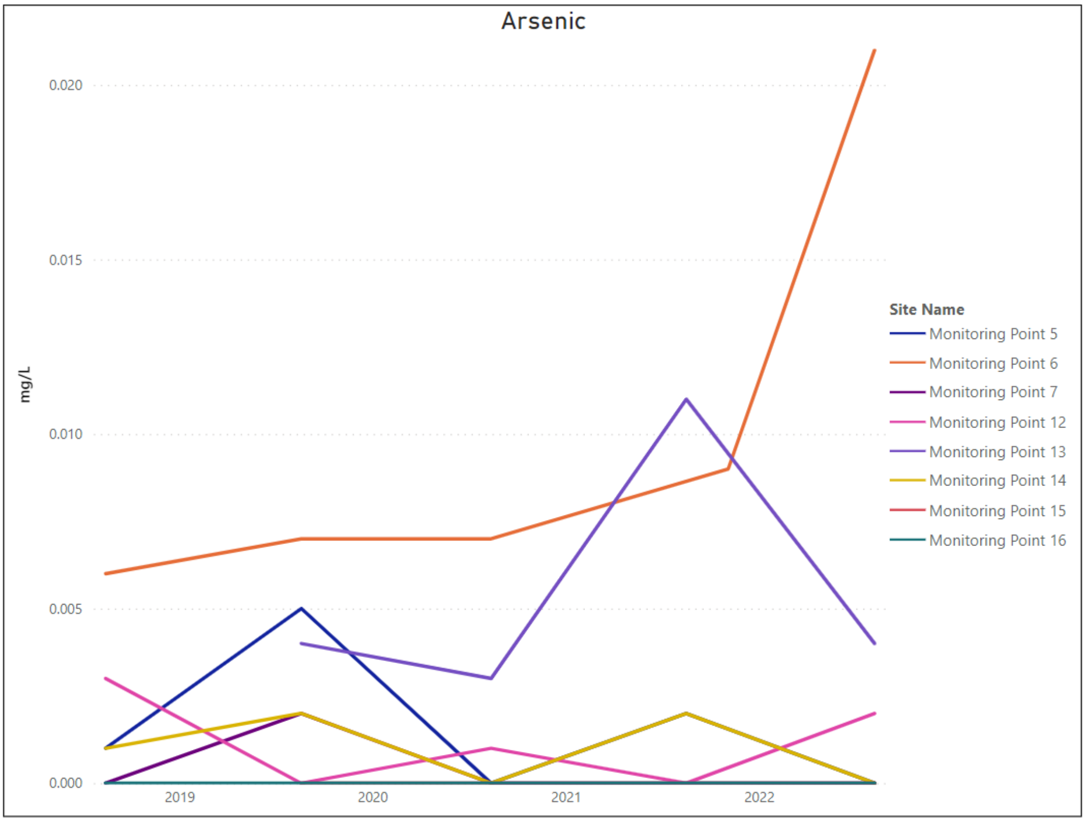

Total Dissolved Solids
mg/L
700
600
500
400
300
200
100
0
2019
2020
2021
2022
2023
Site Name
Monitoring Point 5
Monitoring Point 6
Monitoring Point 7
Monitoring Point 12
Monitoring Point 13
Monitoring Point 14
Monitoring Point 15
Monitoring Point 16

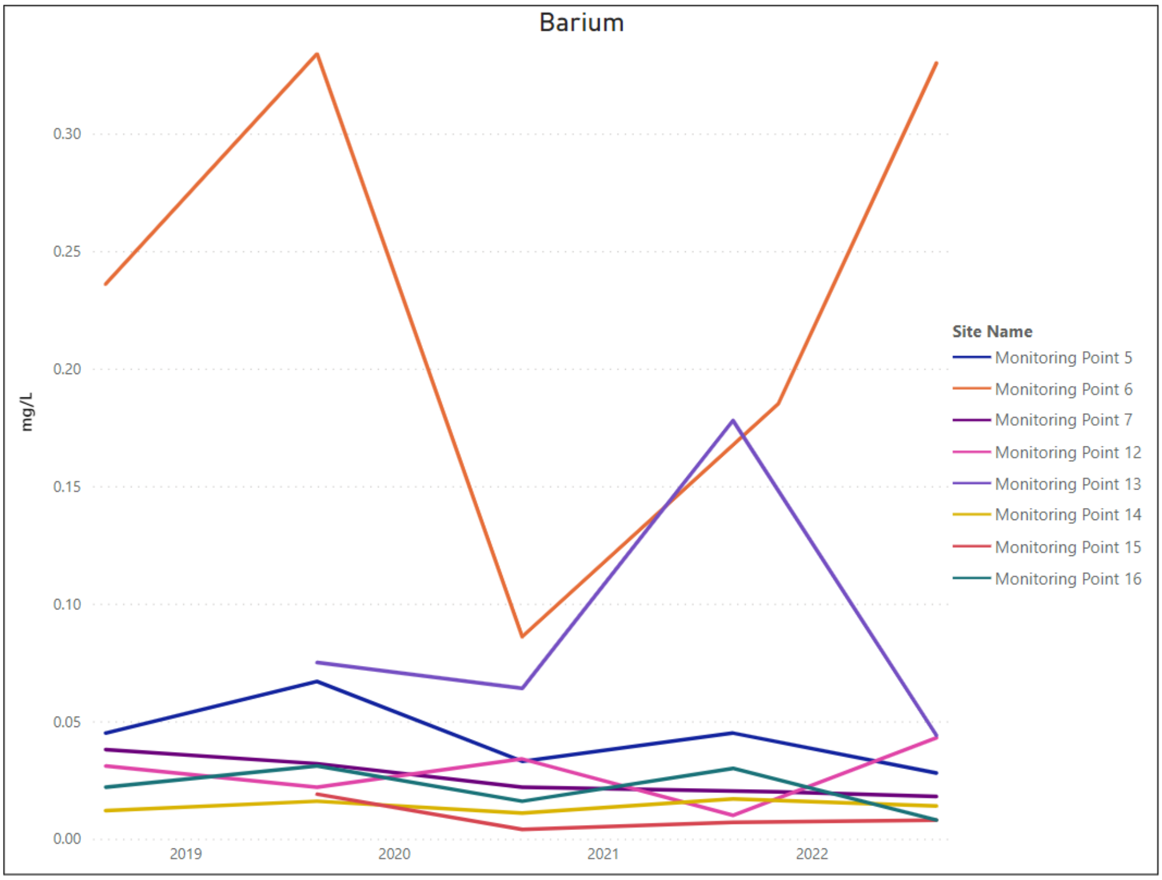

Total organic carbon
mg/L
15
10
5
0
2019
2020
2021
2022
2023
Site Name
Monitoring Point 5
Monitoring Point 6
Monitoring Point 7
Monitoring Point 12
Monitoring Point 13
Monitoring Point 14
Monitoring Point 15
Monitoring Point 16

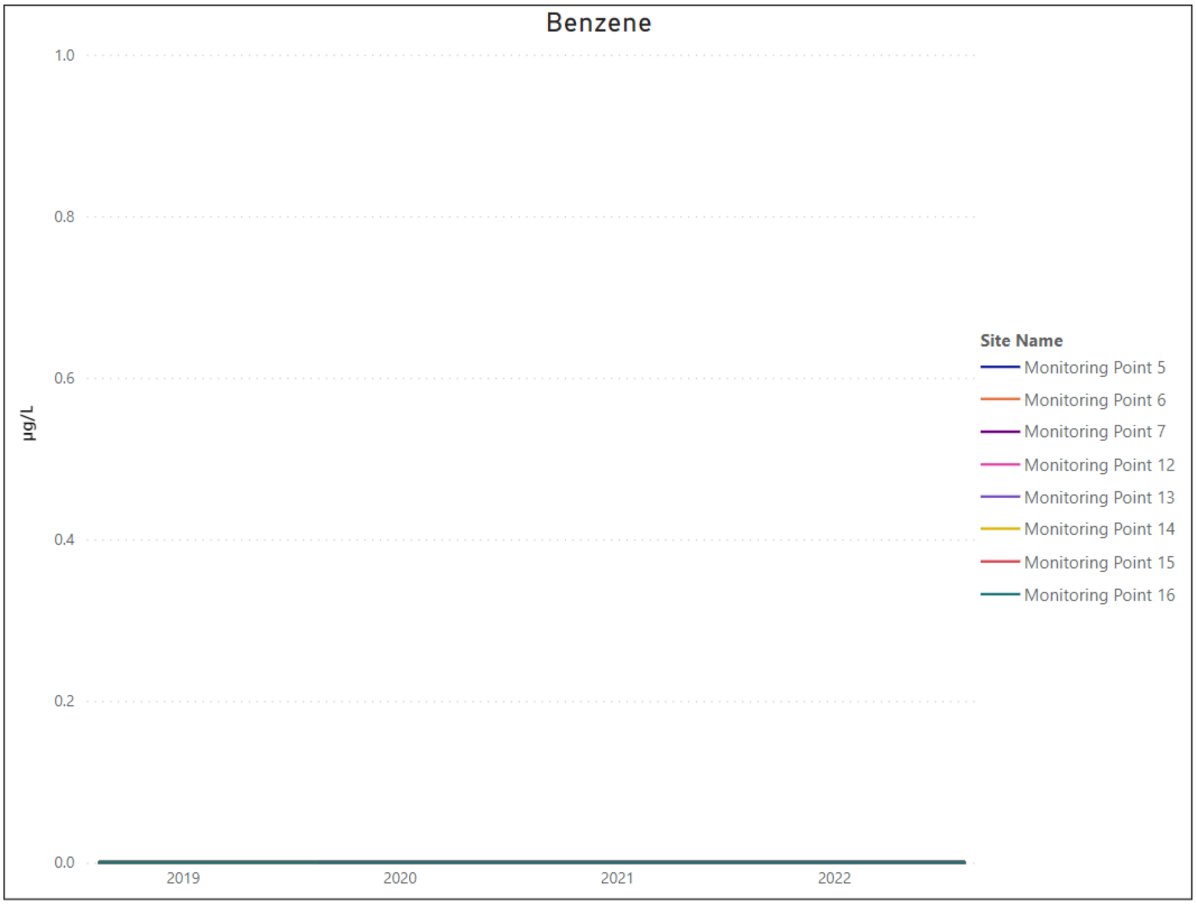

pH
pH
7
6
5
4
3
2
1
0
2019
2020
2021
2022
2023
Site Name
Monitoring Point 5
Monitoring Point 6
Monitoring Point 7
Monitoring Point 12
Monitoring Point 13
Monitoring Point 14
Monitoring Point 15
Monitoring Point 16

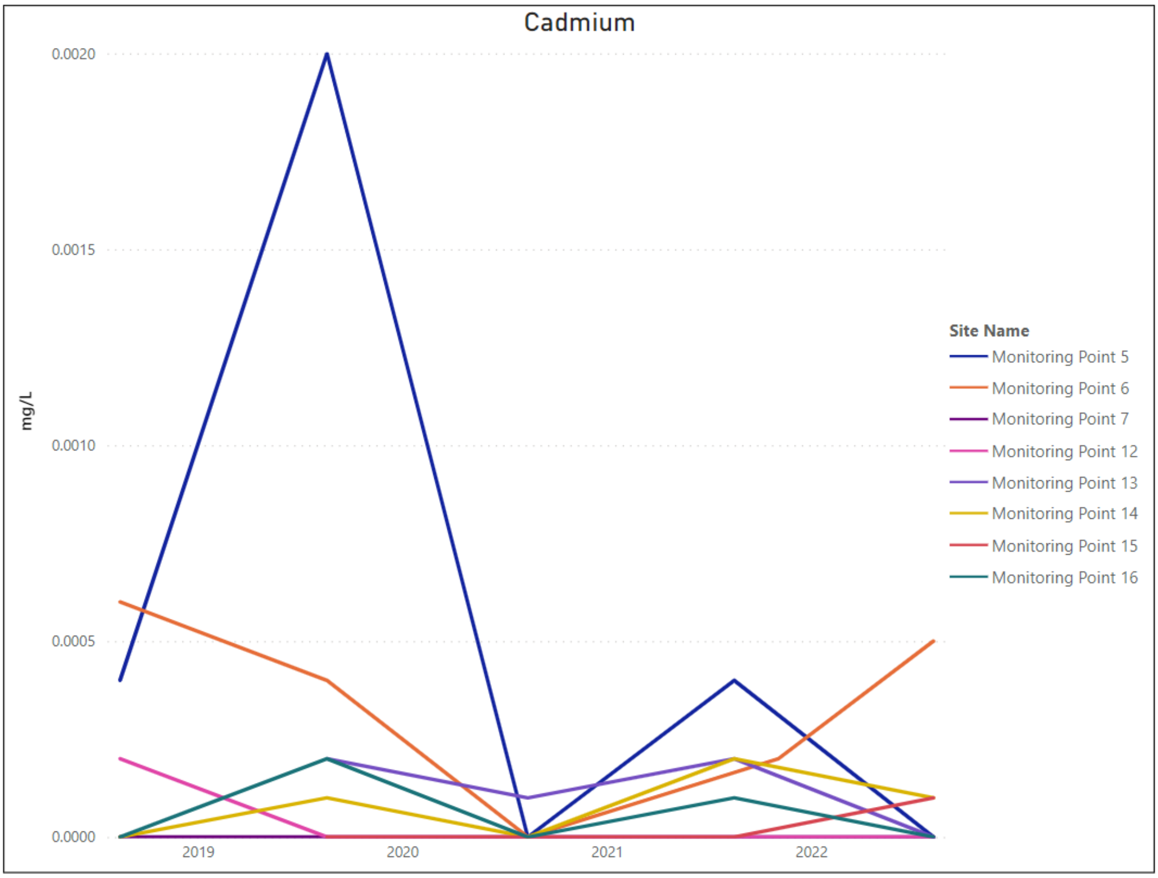
Helensburgh Annual Groundwater Results 2022-2023

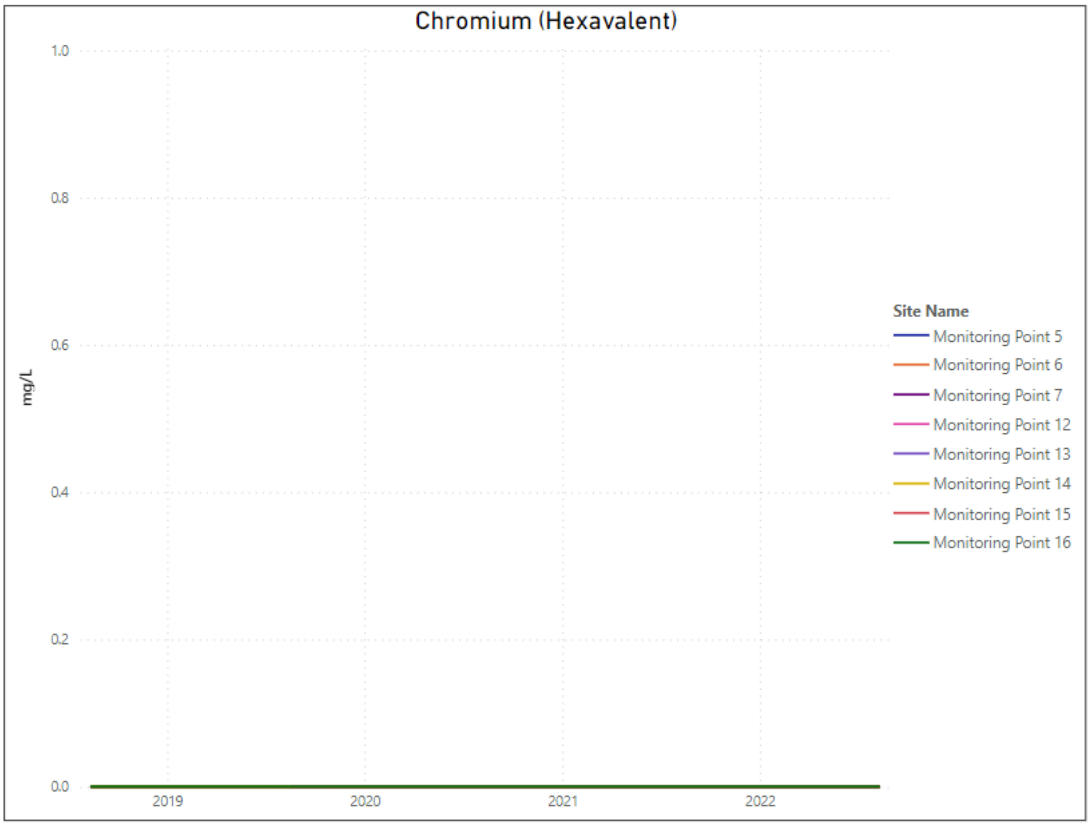


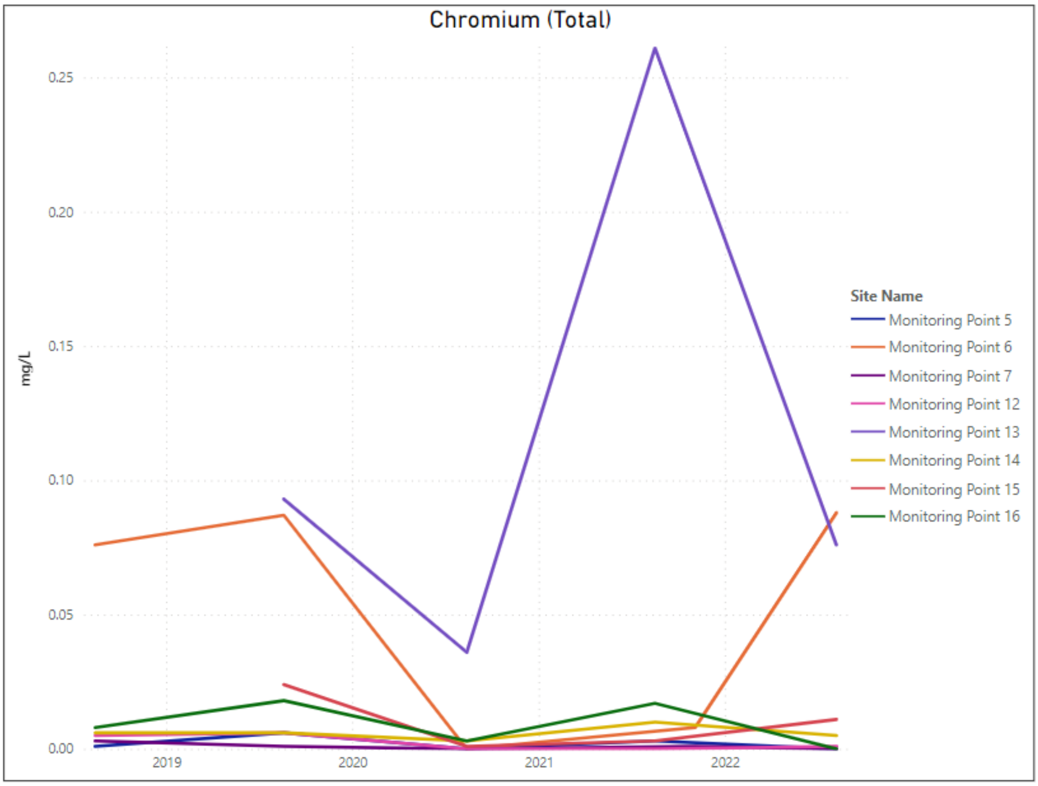


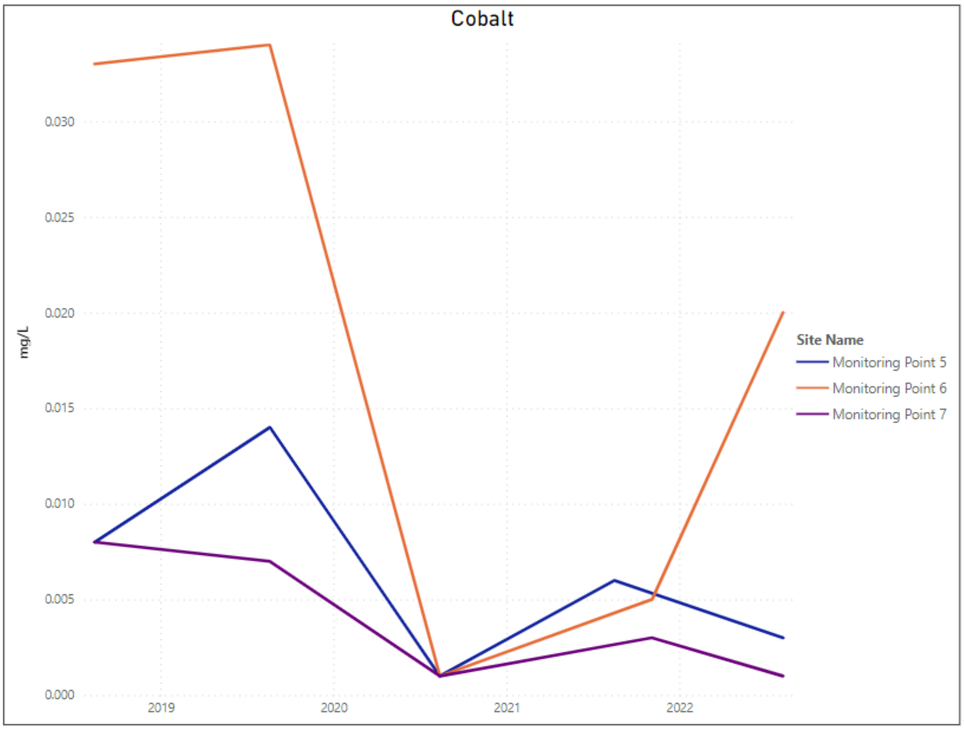

Barium
mg/L
0.30
0.25
0.20
0.15
0.10
0.05
0.00
2019
2020
2021
2022
Site Name
Monitoring Point 5
Monitoring Point 6
Monitoring Point 7
Monitoring Point 12
Monitoring Point 13
Monitoring Point 14
Monitoring Point 15
Monitoring Point 16

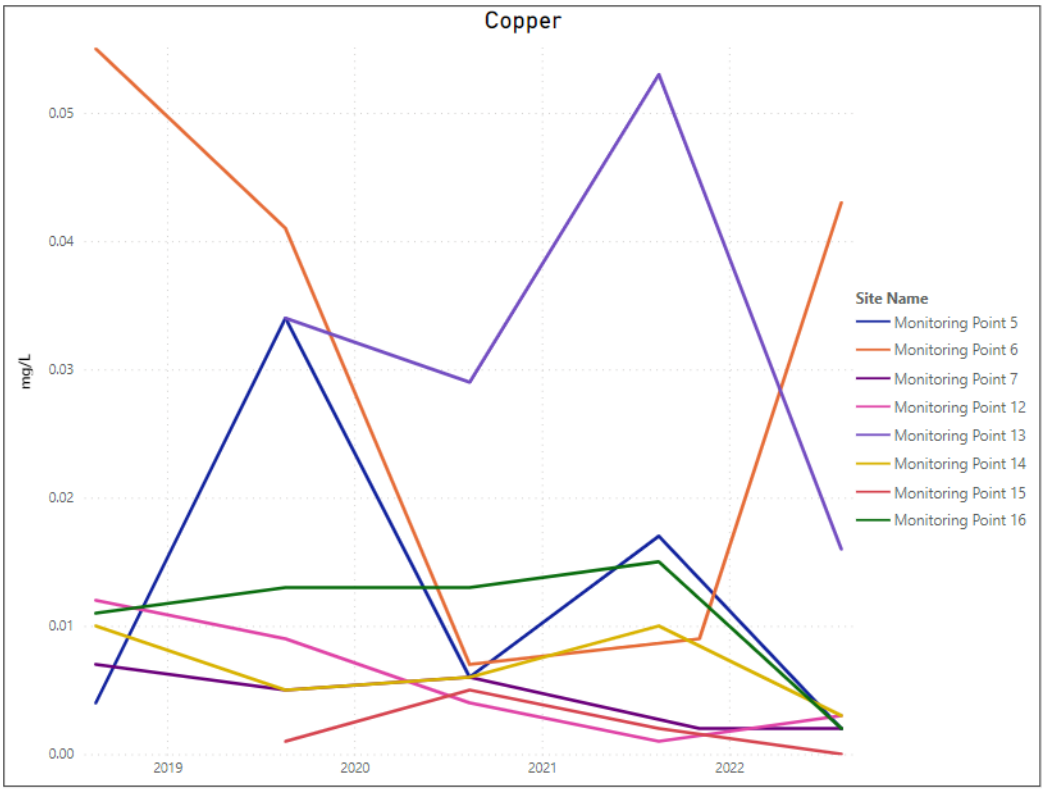

Benzene
µg/L
1.0
0.8
0.6
0.4
0.2
0.0
2019
2020
2021
2022
Site Name
Monitoring Point 5
Monitoring Point 6
Monitoring Point 7
Monitoring Point 12
Monitoring Point 13
Monitoring Point 14
Monitoring Point 15
Monitoring Point 16

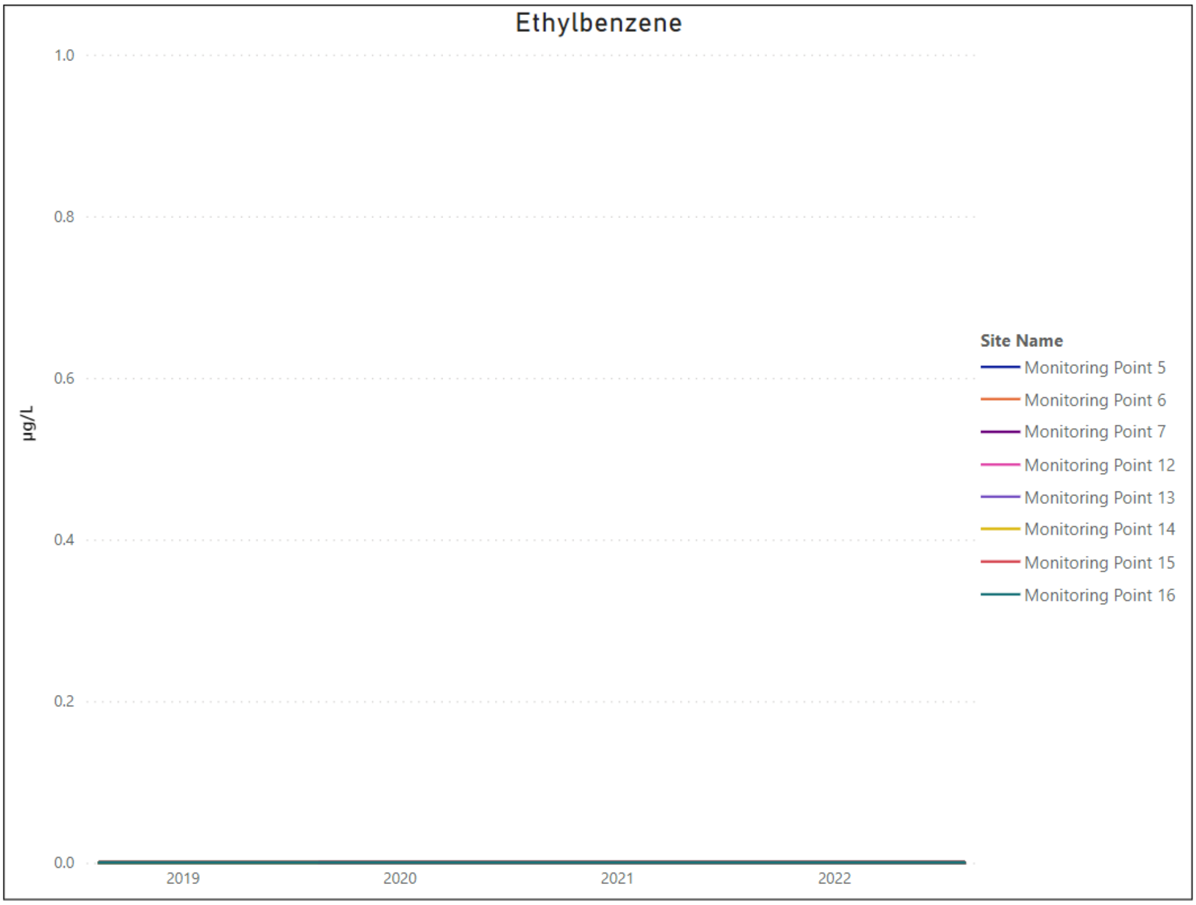

Cadmium
0.0020
0.0015
0.0010
0.0005
0.0000
mg/L
2019
2020
2021
2022
Site Name
Monitoring Point 5
Monitoring Point 6
Monitoring Point 7
Monitoring Point 12
Monitoring Point 13
Monitoring Point 14
Monitoring Point 15
Monitoring Point 16

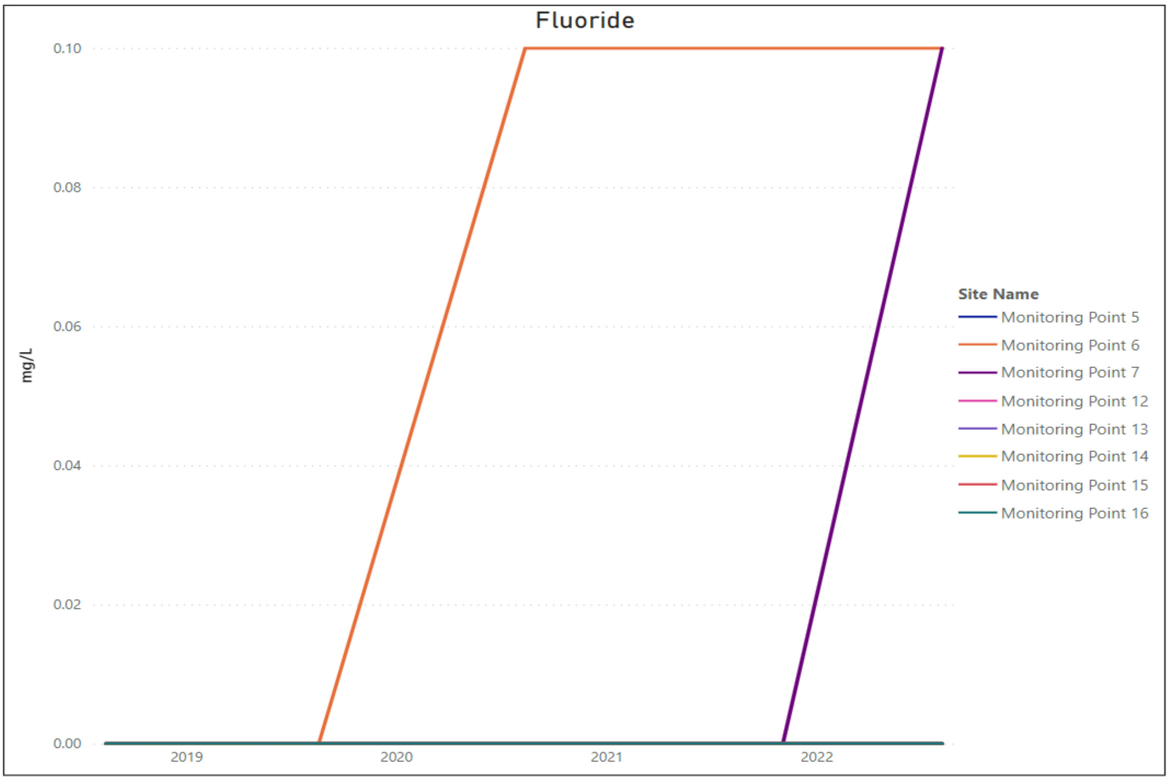

Chromium (Hexavalent)
1.0
0.8
0.6
0.4
0.2
0.0
mg/L
2019
2020
2021
2022
Site Name
Monitoring Point 5
Monitoring Point 6
Monitoring Point 7
Monitoring Point 12
Monitoring Point 13
Monitoring Point 14
Monitoring Point 15
Monitoring Point 16


Chromium (Total)
mg/L
0.25
0.20
0.15
0.10
0.05
0.00
2019
2020
2021
2022
Site Name
Monitoring Point 5
Monitoring Point 6
Monitoring Point 7
Monitoring Point 12
Monitoring Point 13
Monitoring Point 14
Monitoring Point 15
Monitoring Point 16

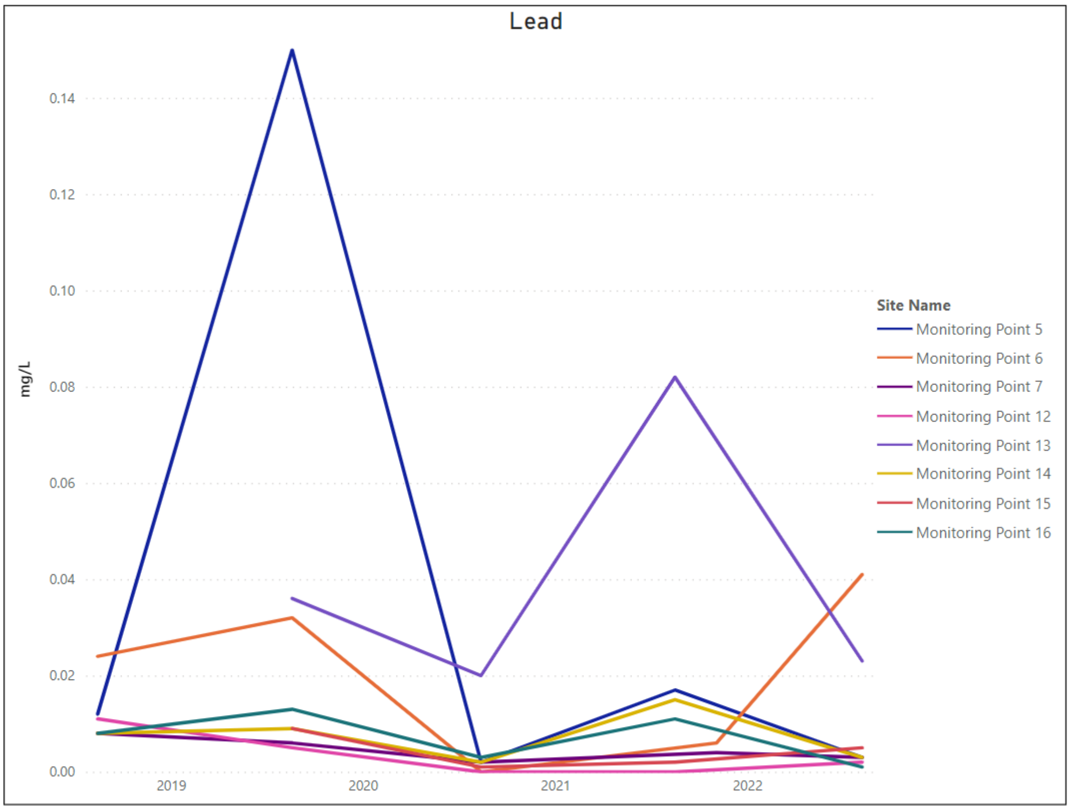

Cobalt
mg/L
0.030
0.025
0.020
0.015
0.010
0.005
0.000
2019
2020
2021
2022
Site Name
Monitoring Point 5
Monitoring Point 6
Monitoring Point 7


Copper
mg/L
0.05
0.04
0.03
0.02
0.01
0.00
2019
2020
2021
2022
Site Name
Monitoring Point 5
Monitoring Point 6
Monitoring Point 7
Monitoring Point 12
Monitoring Point 13
Monitoring Point 14
Monitoring Point 15
Monitoring Point 16

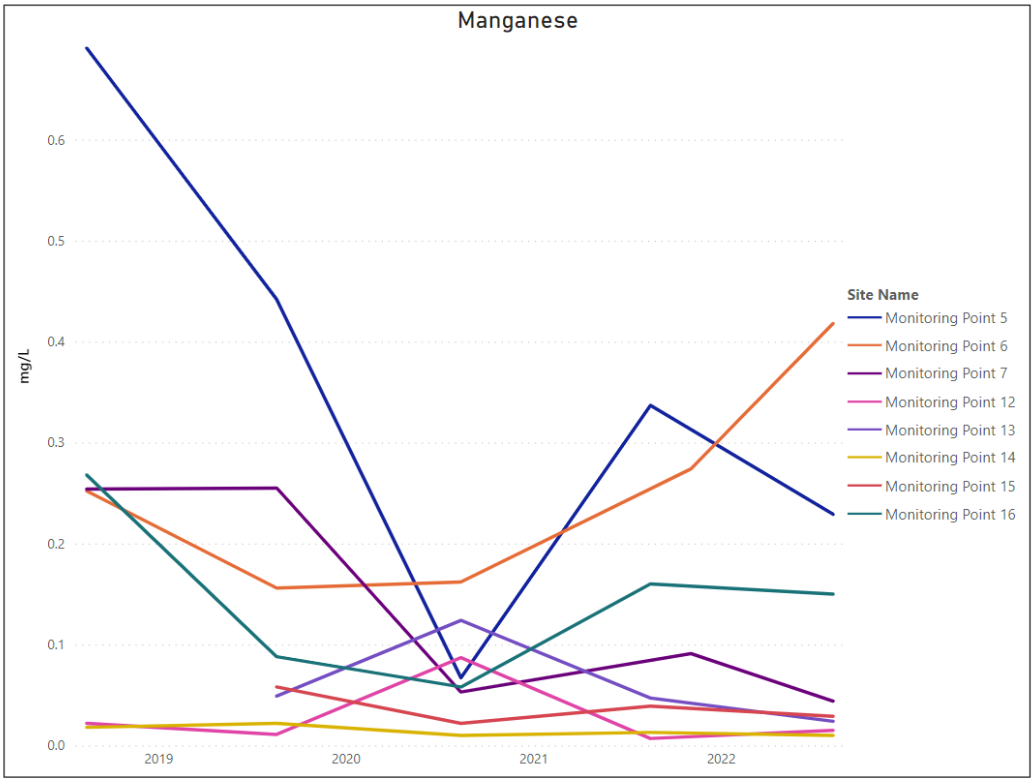

Ethylbenzene
µg/L
1.0
0.8
0.6
0.4
0.2
0.0
2019
2020
2021
2022
Site Name
Monitoring Point 5
Monitoring Point 6
Monitoring Point 7
Monitoring Point 12
Monitoring Point 13
Monitoring Point 14
Monitoring Point 15
Monitoring Point 16

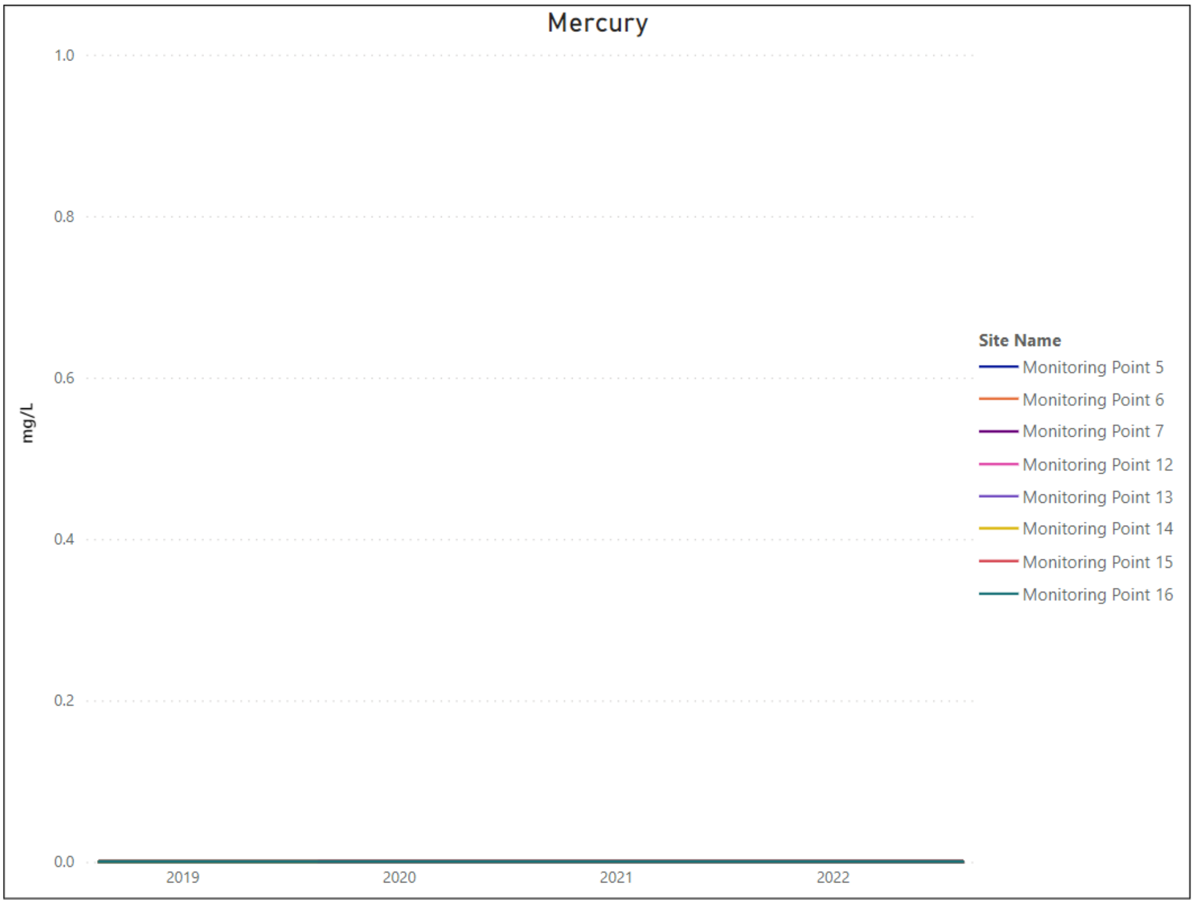


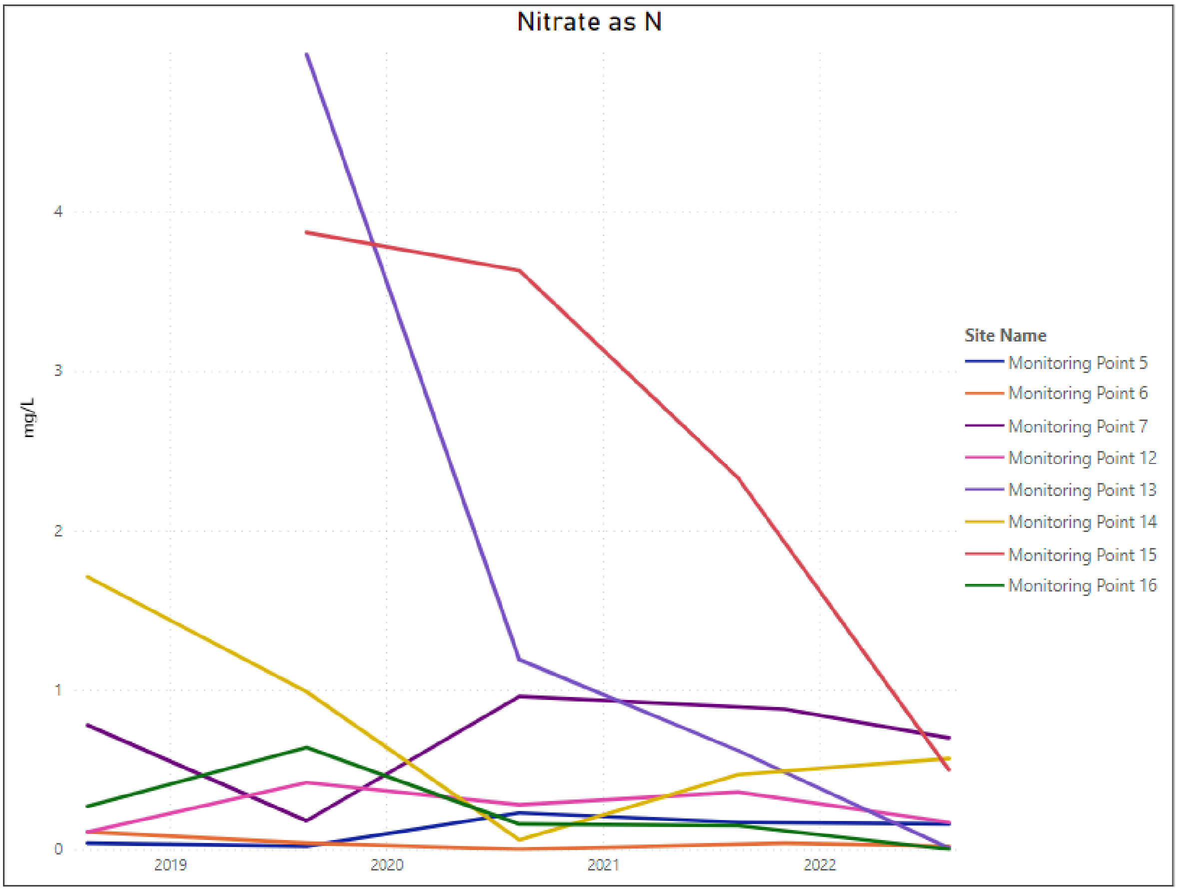
Fluoride
0.10
0.08
0.06
0.04
0.02
0.00
mg/L
2019
2020
2021
2022
Site Name
Monitoring Point 5
Monitoring Point 6
Monitoring Point 7
Monitoring Point 12
Monitoring Point 13
Monitoring Point 14
Monitoring Point 15
Monitoring Point 16

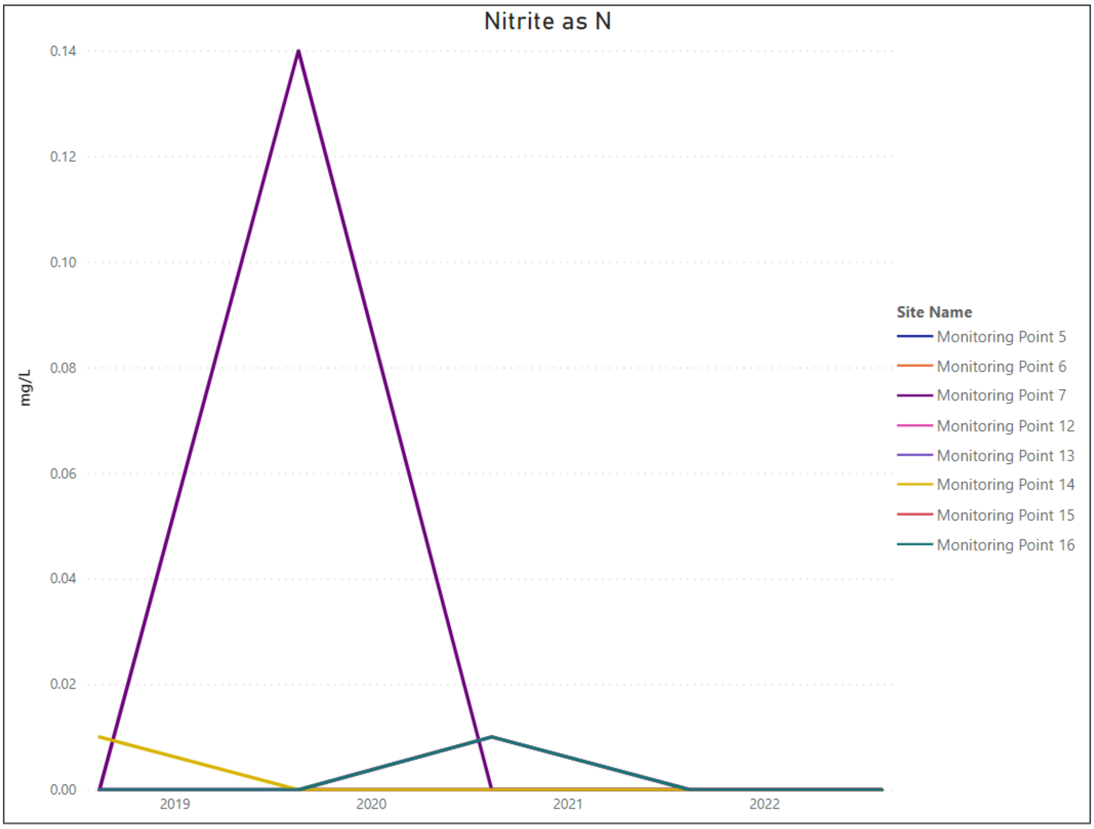


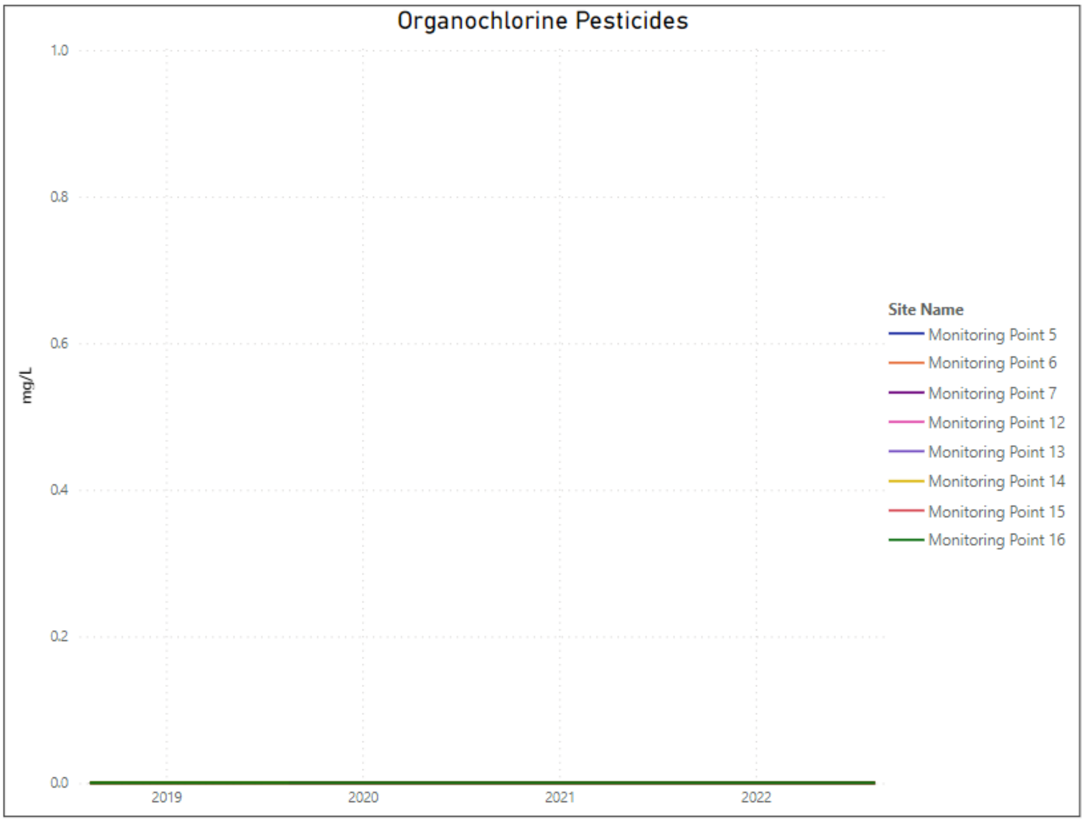
Lead
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
mg/L
2019
2020
2021
2022
Site Name
Monitoring Point 5
Monitoring Point 6
Monitoring Point 7
Monitoring Point 12
Monitoring Point 13
Monitoring Point 14
Monitoring Point 15
Monitoring Point 16

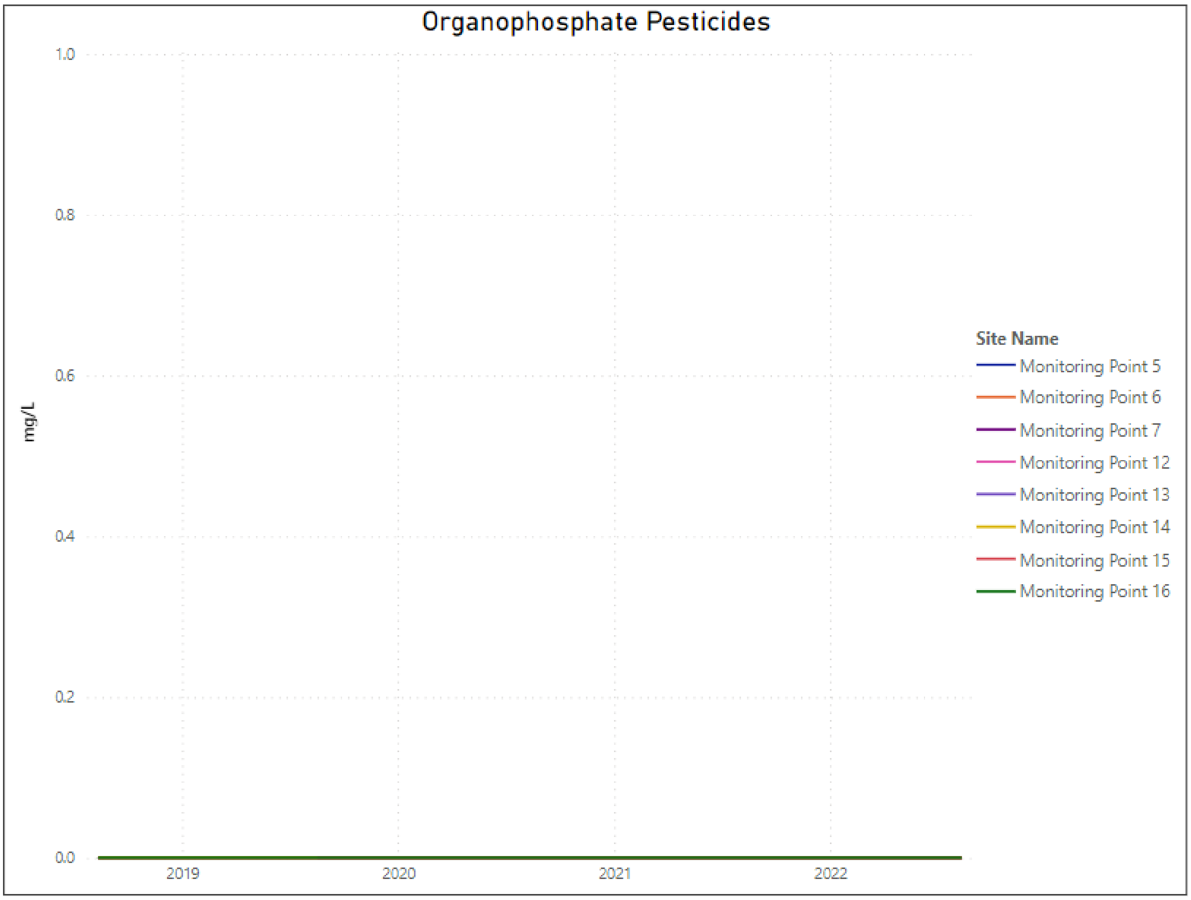

Manganese
0.6
0.5
0.4
0.3
0.2
0.1
0.0
mg/L
2019
2020
2021
2022
Site Name
Monitoring Point 5
Monitoring Point 6
Monitoring Point 7
Monitoring Point 12
Monitoring Point 13
Monitoring Point 14
Monitoring Point 15
Monitoring Point 16

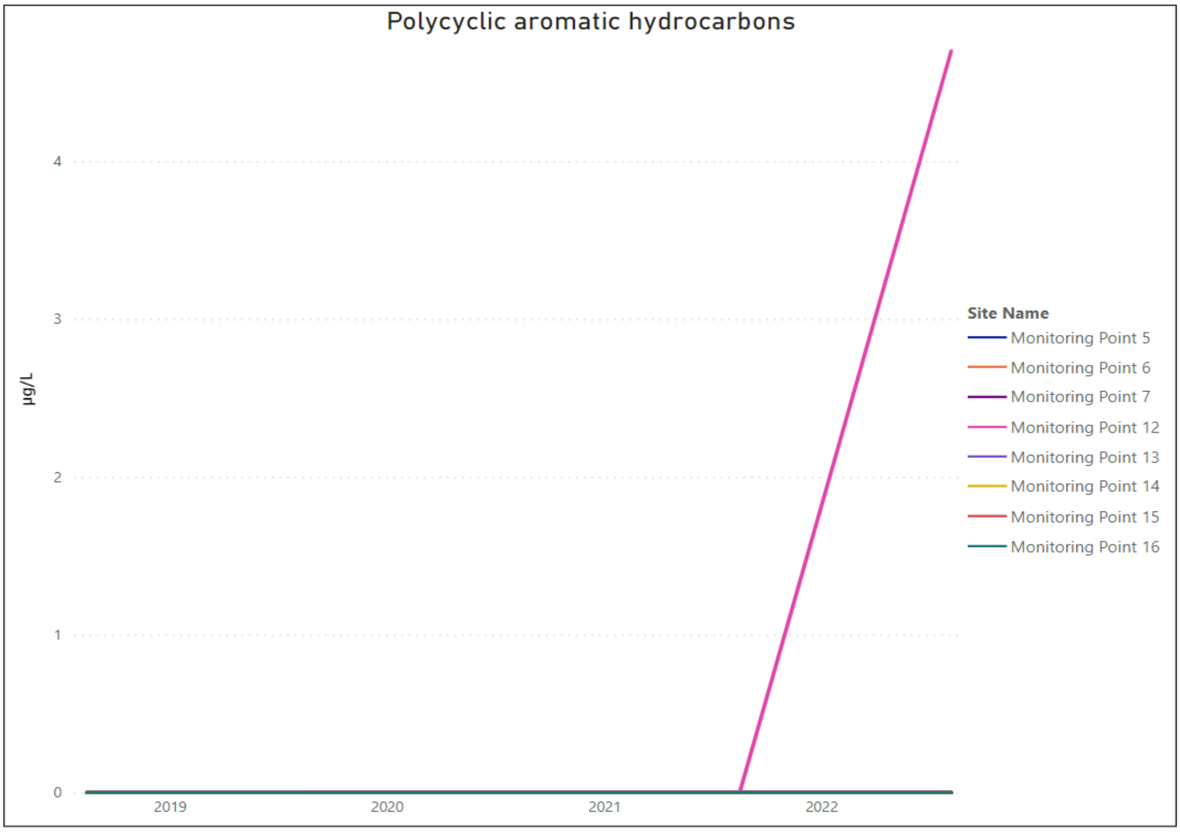

Mercury
1.0
0.8
0.6
0.4
0.2
0.0
mg/L
2019
2020
2021
2022
Site Name
Monitoring Point 5
Monitoring Point 6
Monitoring Point 7
Monitoring Point 12
Monitoring Point 13
Monitoring Point 14
Monitoring Point 15
Monitoring Point 16

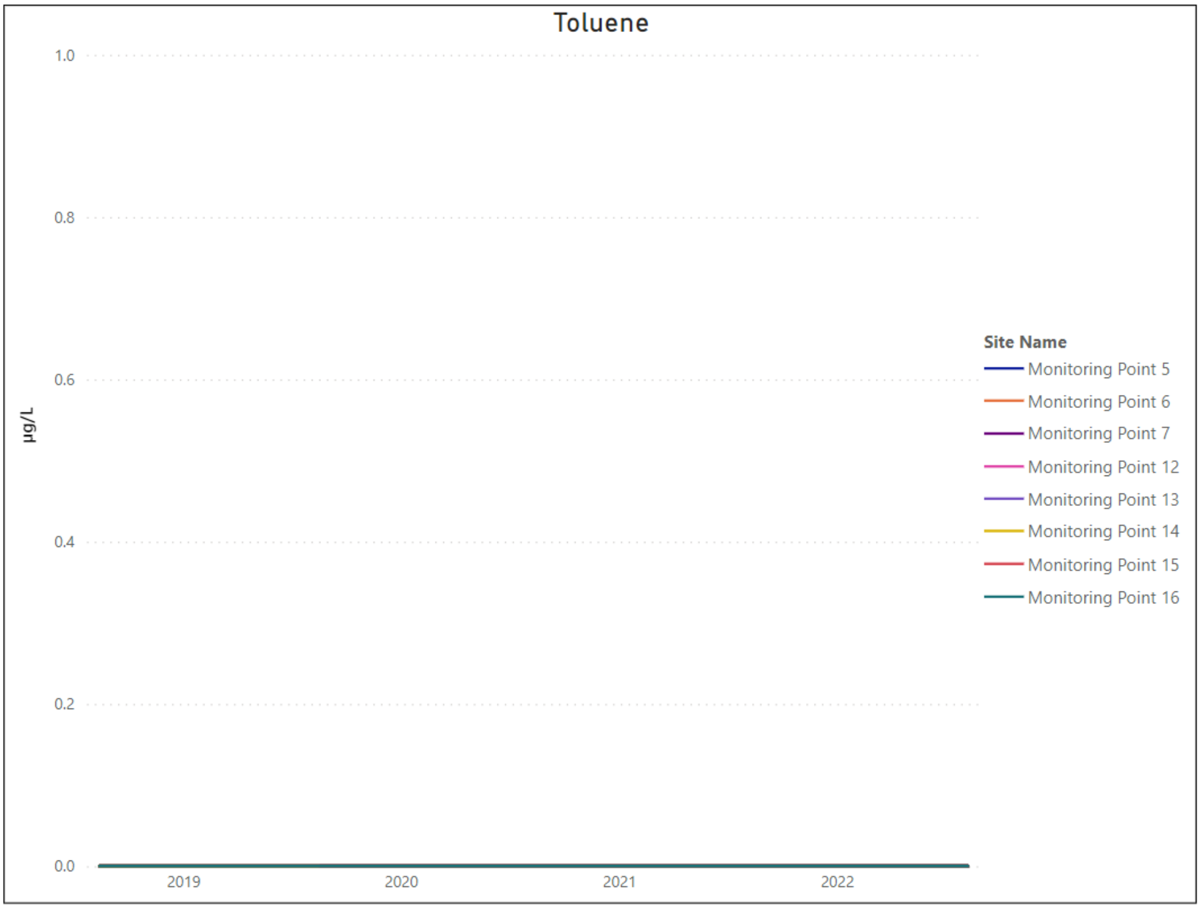

Nitrate as N
mg/L
0
1
2
3
4
2019
2020
2021
2022
Site Name
Monitoring Point 5
Monitoring Point 6
Monitoring Point 7
Monitoring Point 12
Monitoring Point 13
Monitoring Point 14
Monitoring Point 15
Monitoring Point 16

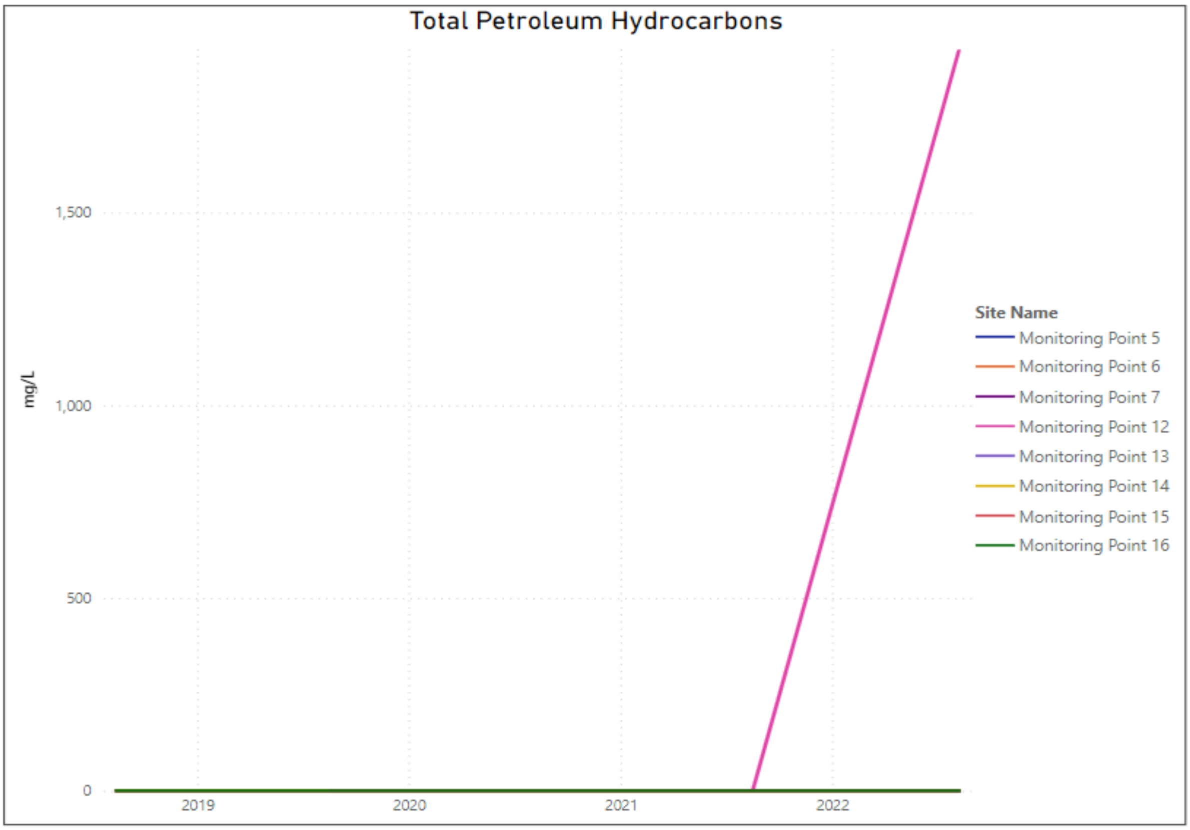

Nitrite as N
mg/L
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
2019
2020
2021
2022
Site Name
Monitoring Point 5
Monitoring Point 6
Monitoring Point 7
Monitoring Point 12
Monitoring Point 13
Monitoring Point 14
Monitoring Point 15
Monitoring Point 16

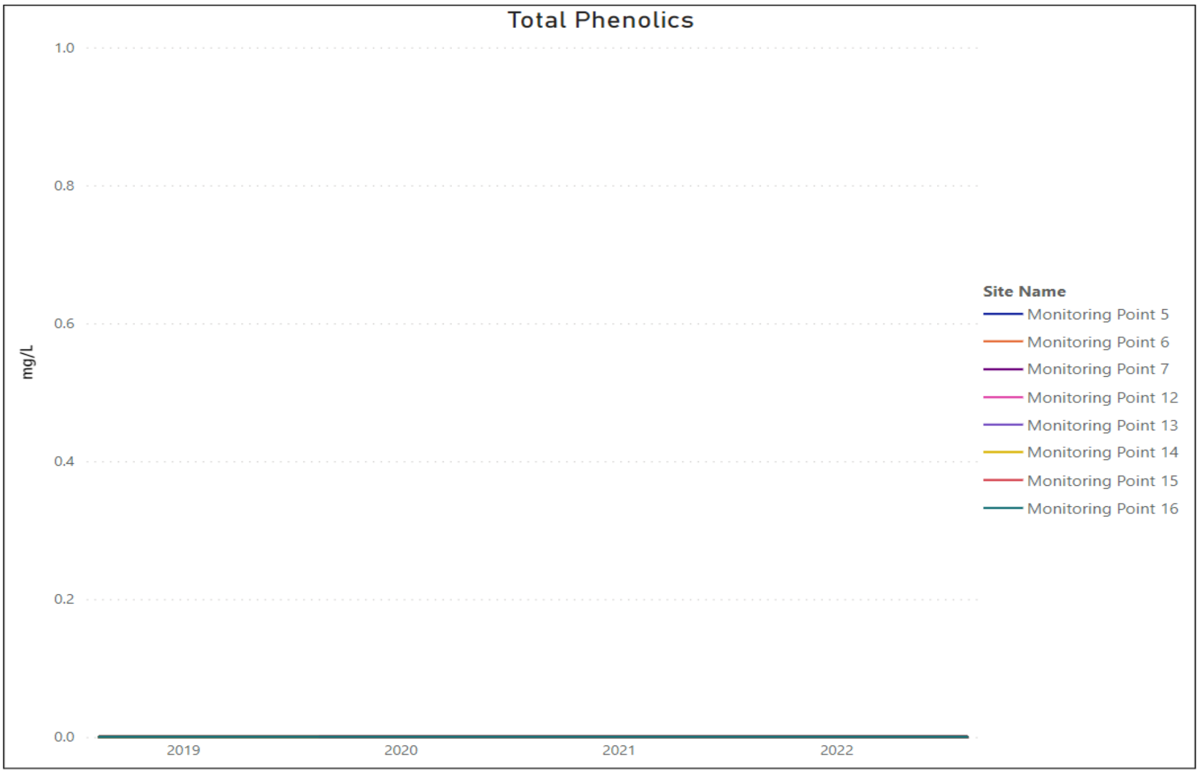

Organochlorine Pesticides
1.0
0.8
0.6
0.4
0.2
0.0
mg/L
2019
2020
2021
2022
Site Name
Monitoring Point 5
Monitoring Point 6
Monitoring Point 7
Monitoring Point 12
Monitoring Point 13
Monitoring Point 14
Monitoring Point 15
Monitoring Point 16

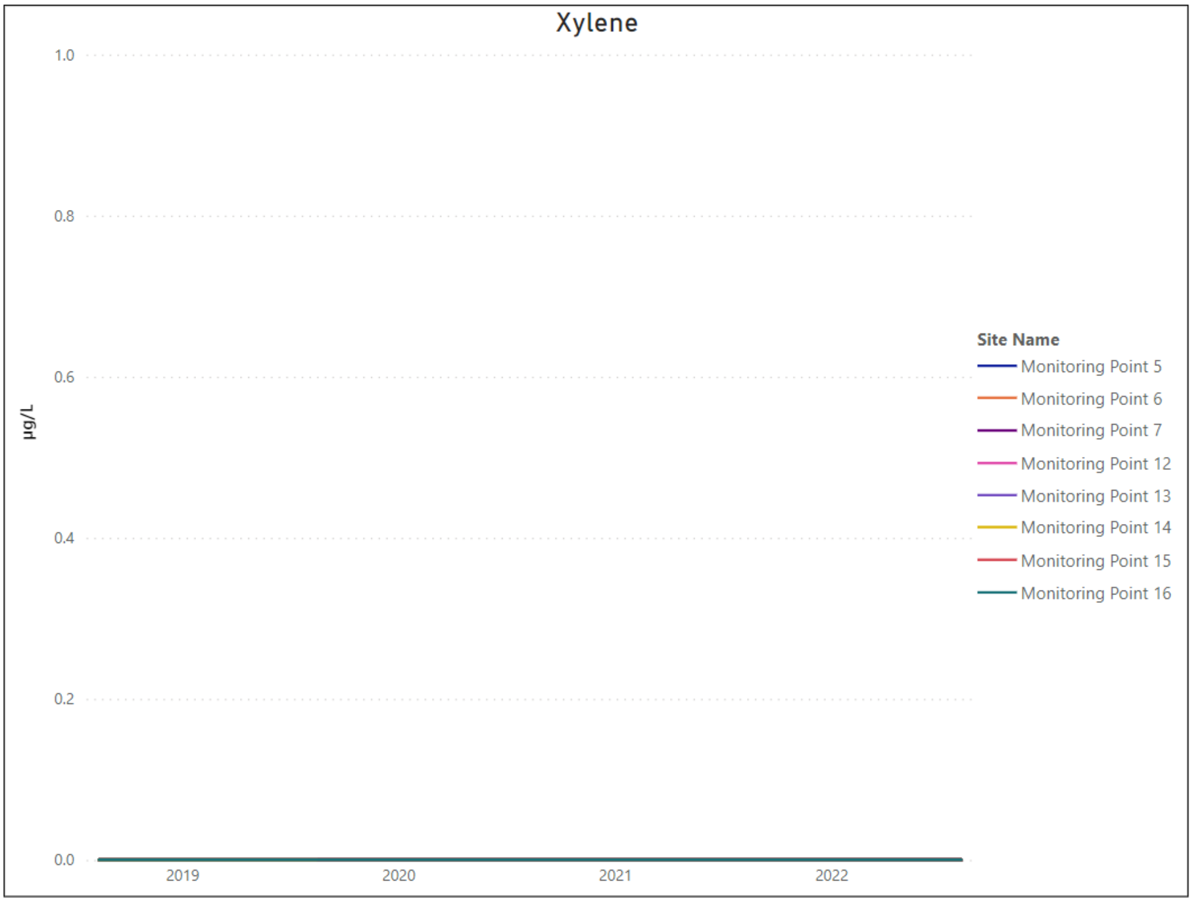

Organophosphate Pesticides
1.0
0.8
0.6
0.4
0.2
0.0
mg/L
2019
2020
2021
2022
Site Name
Monitoring Point 5
Monitoring Point 6
Monitoring Point 7
Monitoring Point 12
Monitoring Point 13
Monitoring Point 14
Monitoring Point 15
Monitoring Point 16


Polycyclic aromatic hydrocarbons
µg/L
4
3
2
1
0
2019
2020
2021
2022
Site Name
Monitoring Point 5
Monitoring Point 6
Monitoring Point 7
Monitoring Point 12
Monitoring Point 13
Monitoring Point 14
Monitoring Point 15
Monitoring Point 16

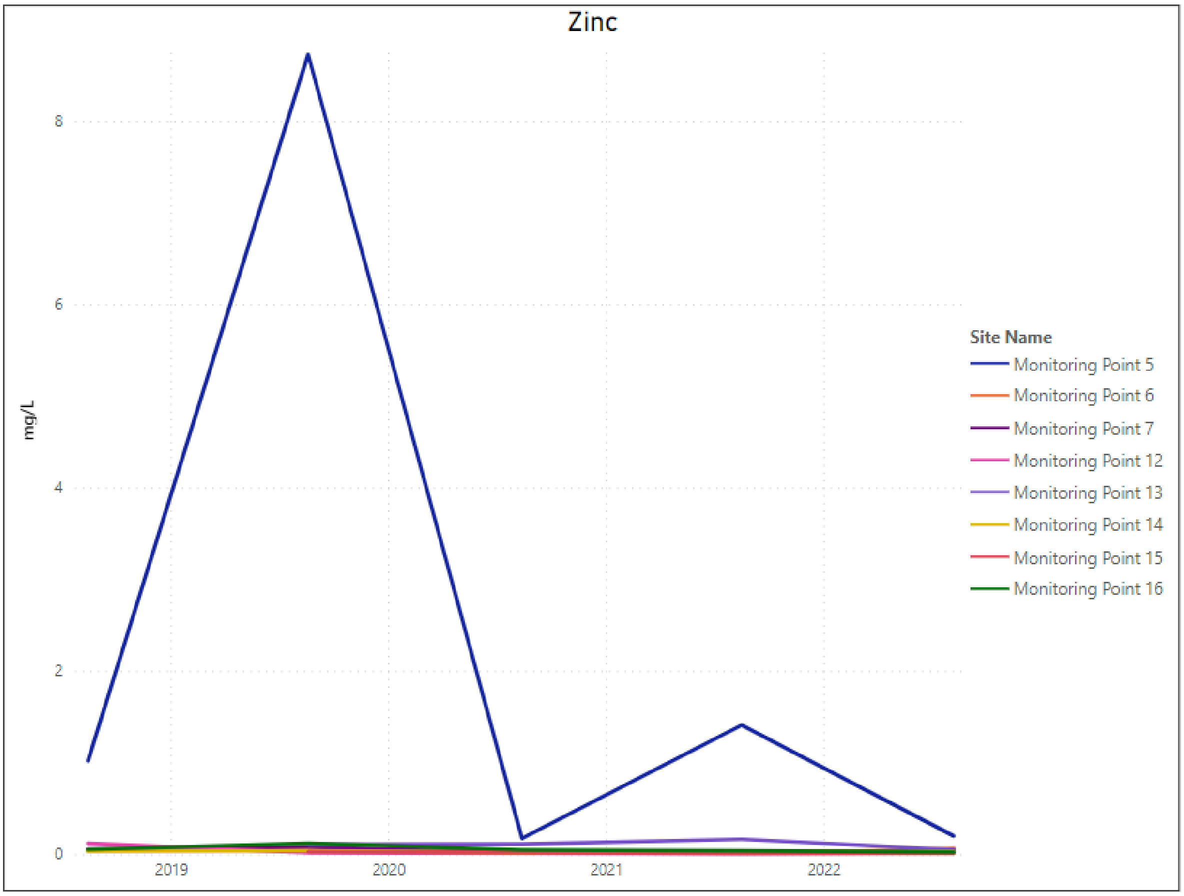

Toluene
µg/L
1.0
0.8
0.6
0.4
0.2
0.0
2019
2020
2021
2022
Site Name
Monitoring Point 5
Monitoring Point 6
Monitoring Point 7
Monitoring Point 12
Monitoring Point 13
Monitoring Point 14
Monitoring Point 15
Monitoring Point 16


Total Petroleum Hydrocarbons
mg/L
1,500
1,000
500
0
2019
2020
2021
2022
Site Name
Monitoring Point 5
Monitoring Point 6
Monitoring Point 7
Monitoring Point 12
Monitoring Point 13
Monitoring Point 14
Monitoring Point 15
Monitoring Point 16


Total Phenolics
mg/L
1.0
0.8
0.6
0.4
0.2
0.0
2019
2020
2021
2022
Site Name
Monitoring Point 5
Monitoring Point 6
Monitoring Point 7
Monitoring Point 12
Monitoring Point 13
Monitoring Point 14
Monitoring Point 15
Monitoring Point 16

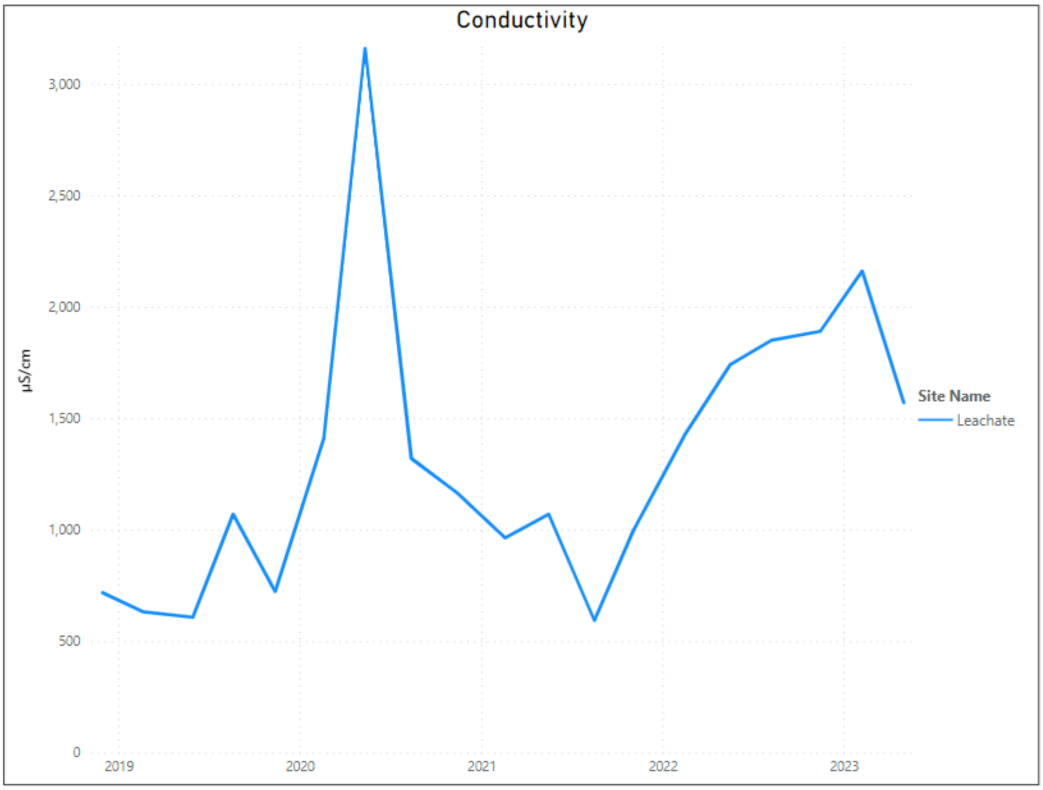


Xylene
1.0
0.8
0.6
0.4
0.2
0.0
µg/L
2019
2020
2021
2022
Site Name
Monitoring Point 5
Monitoring Point 6
Monitoring Point 7
Monitoring Point 12
Monitoring Point 13
Monitoring Point 14
Monitoring Point 15
Monitoring Point 16

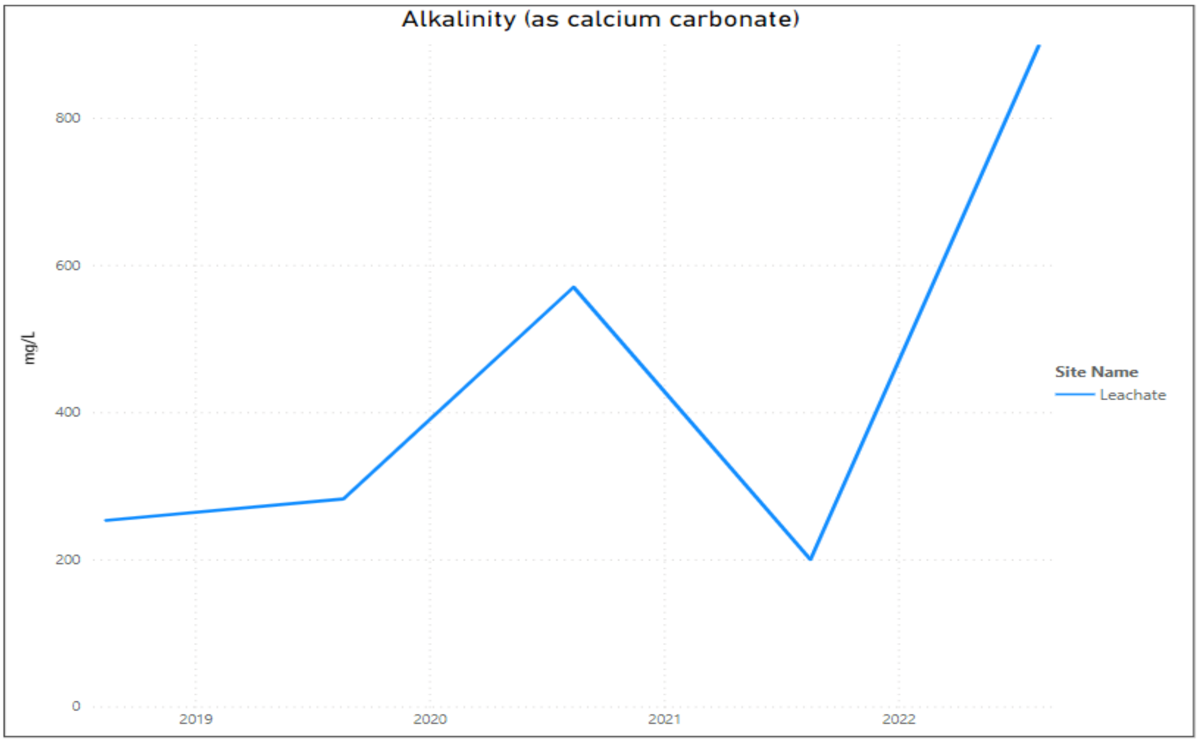


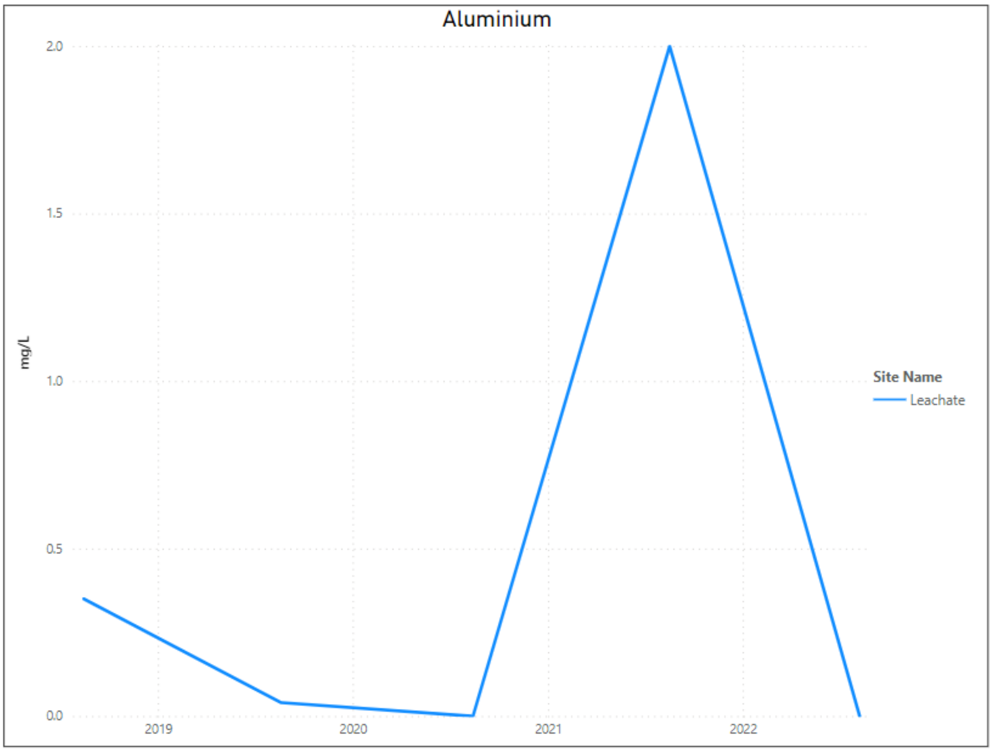
Zinc
8
6
4
2
0
mg/L
2019
2020
2021
2022
Site Name
Monitoring Point 5
Monitoring Point 6
Monitoring Point 7
Monitoring Point 12
Monitoring Point 13
Monitoring Point 14
Monitoring Point 15
Monitoring Point 16

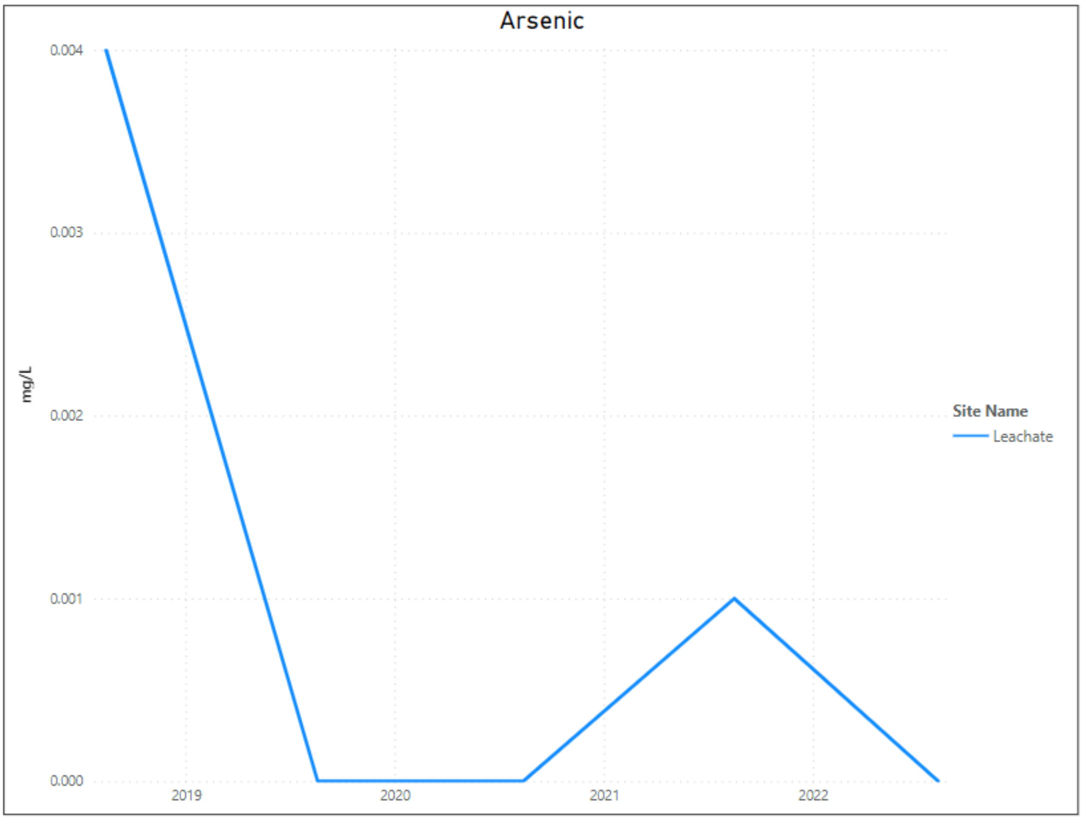
Helensburgh Quarterly Leachate Results 2022-2023

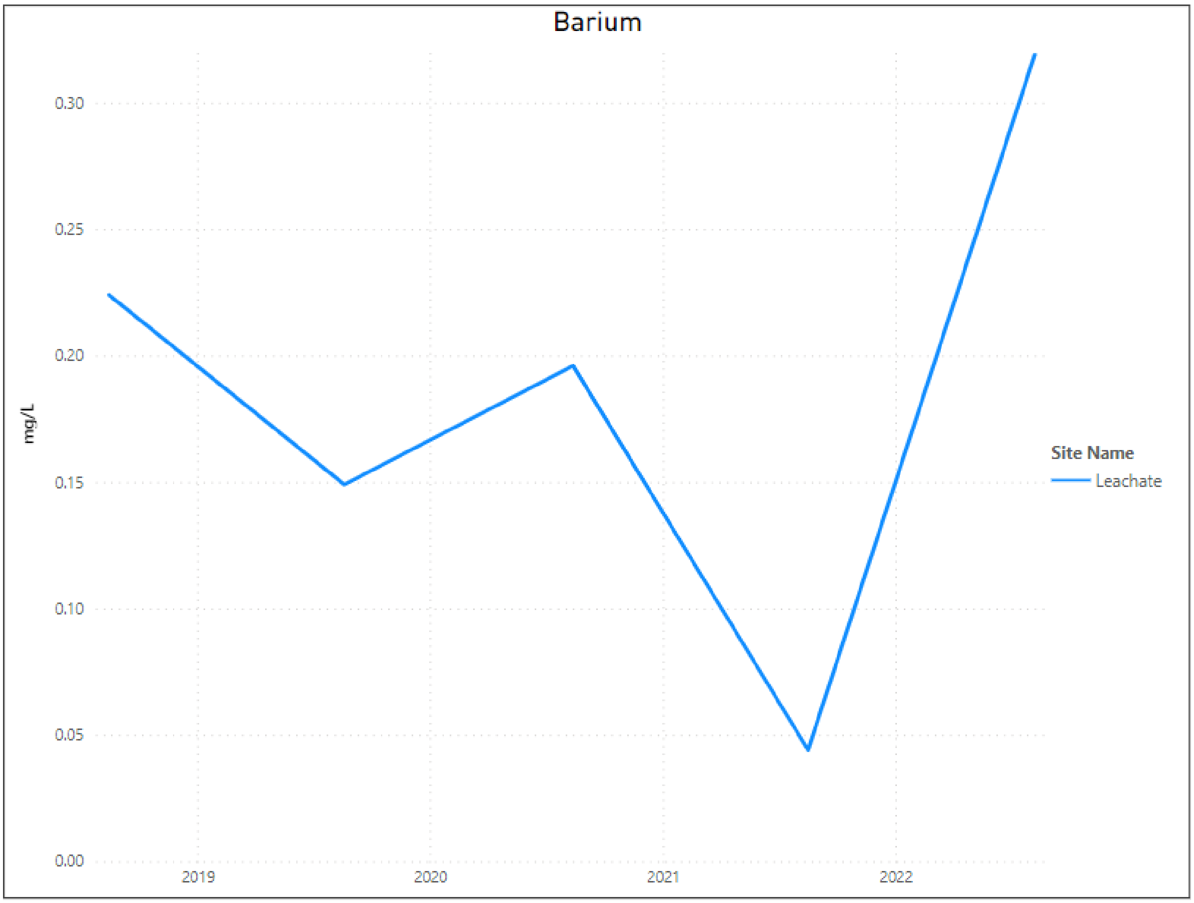


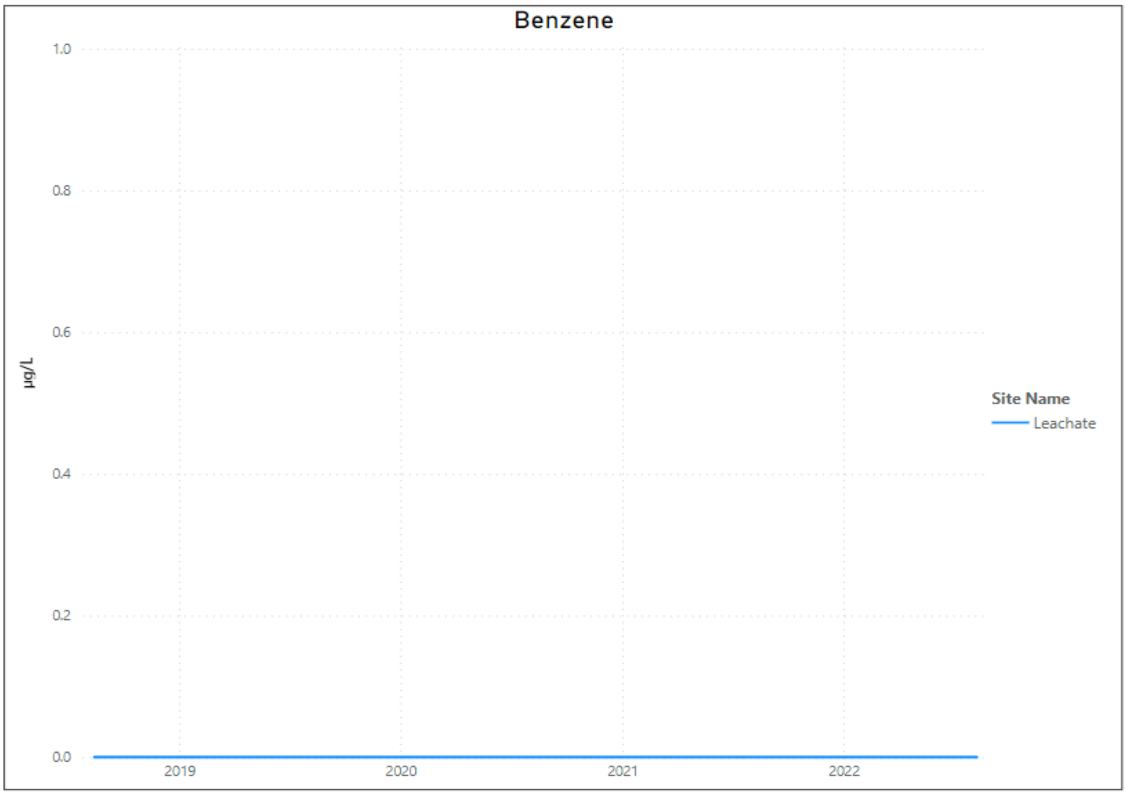
Helensburgh Annual Leachate Results 2022-2023

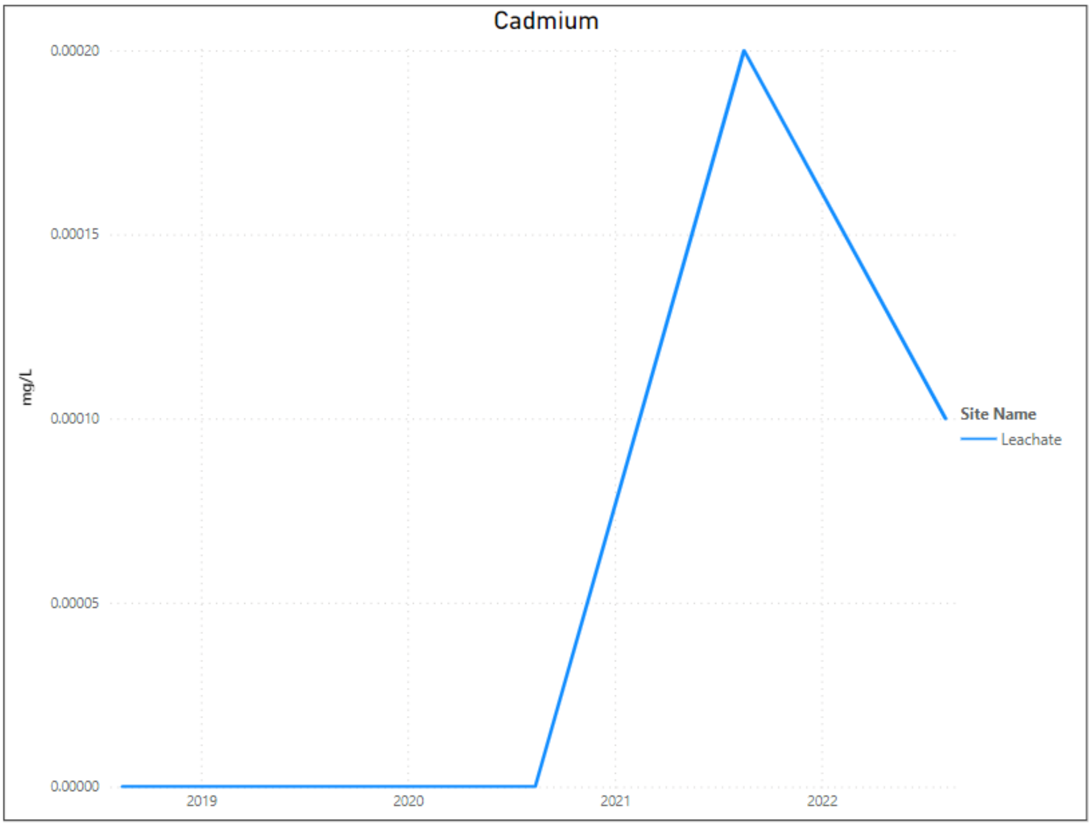


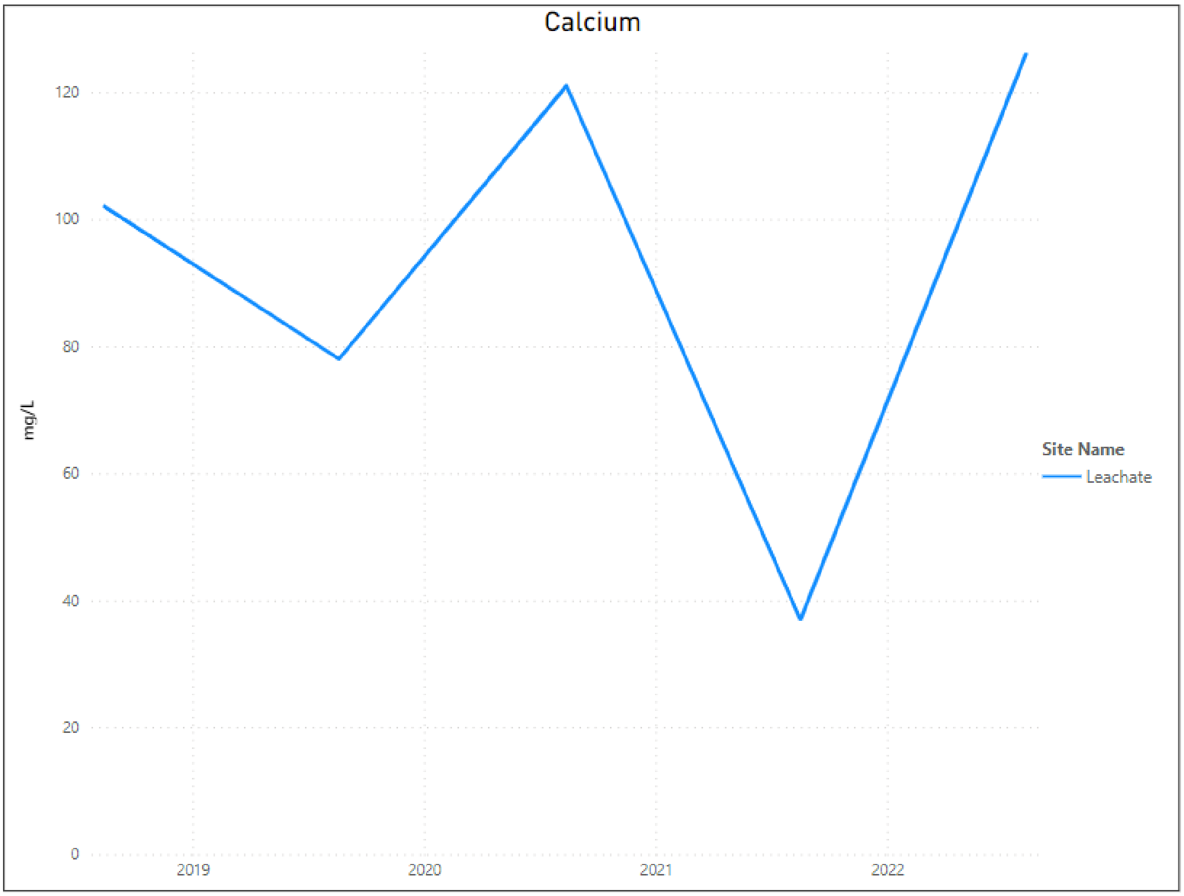

Aluminium
2.0
1.5
1.0
0.5
0.0
mg/L
2019
2020
2021
2022
Site Name
Leachate

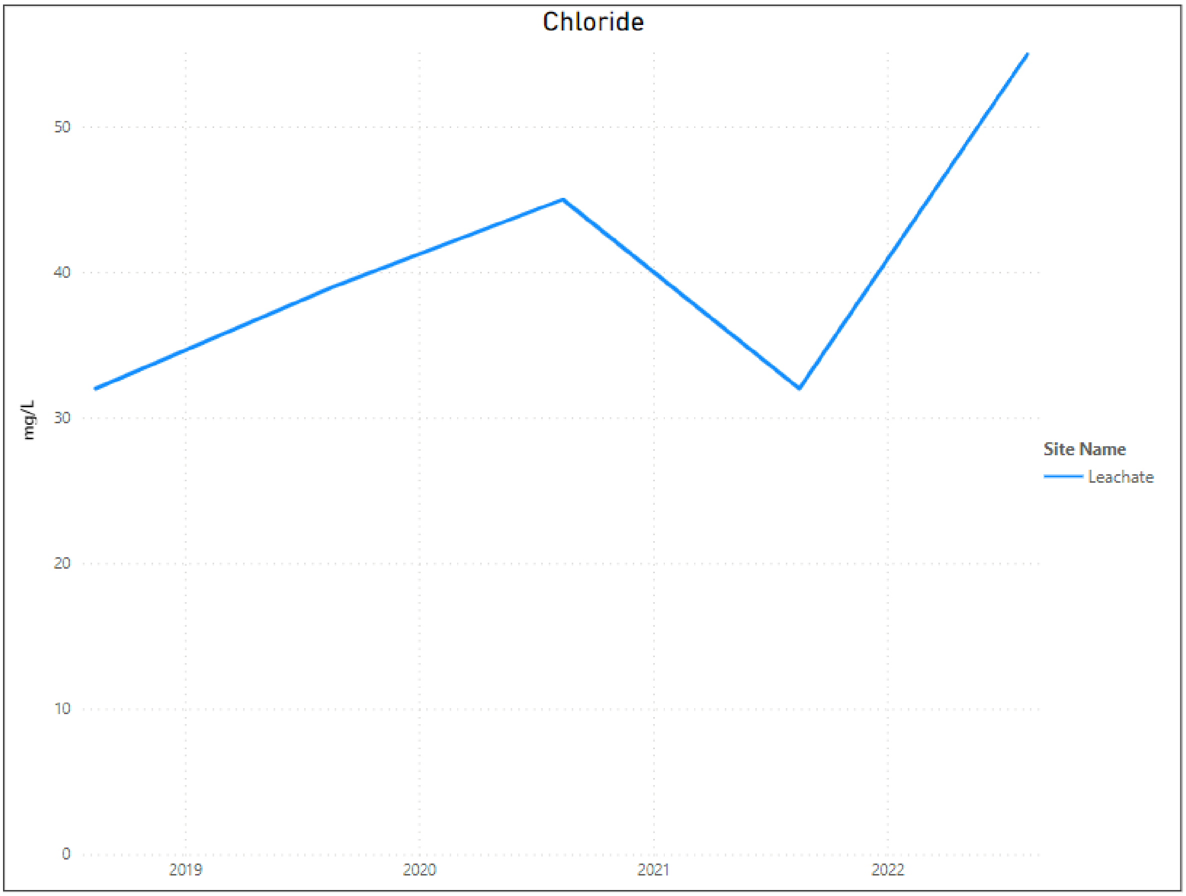

Arsenic
0.004
0.003
0.002
0.001
0.000
mg/L
2019
2020
2021
2022
Site Name
Leachate

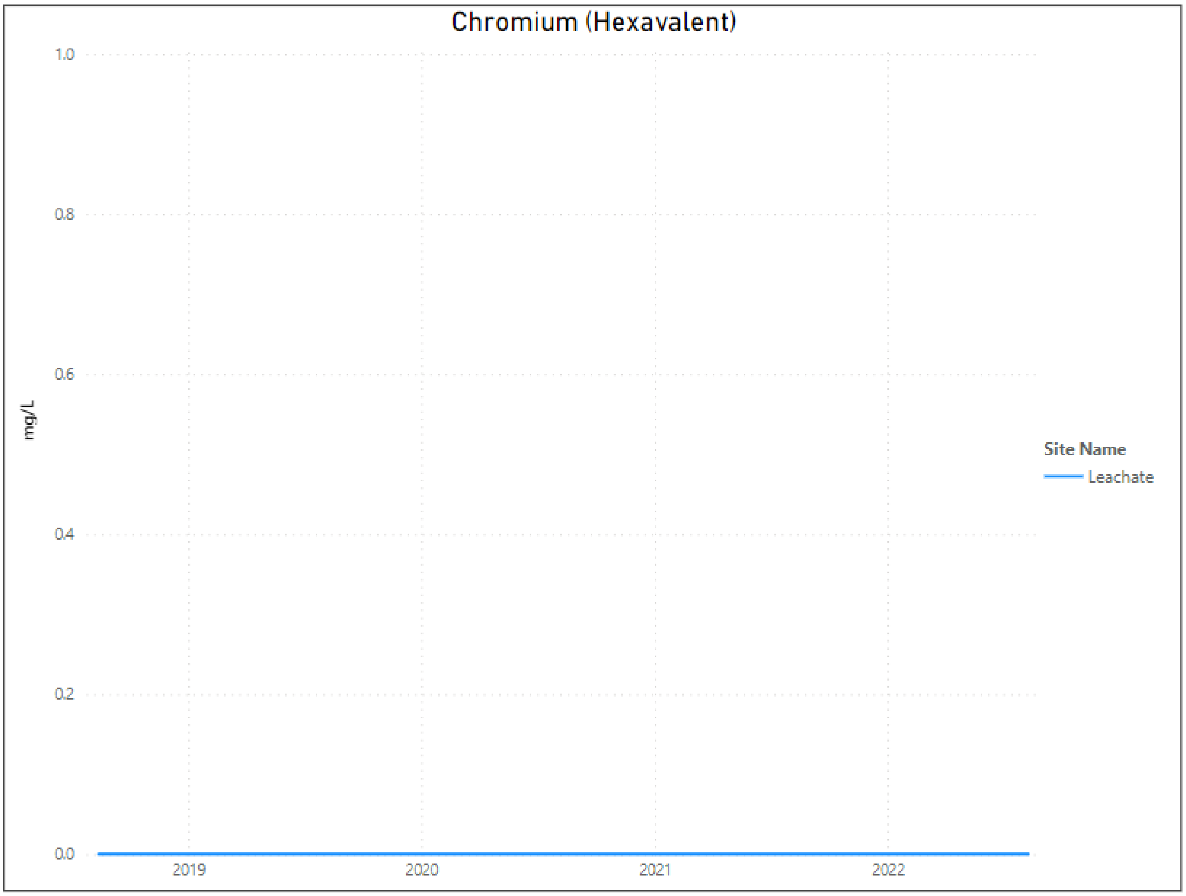

Barium
mg/L
0.30
0.25
0.20
0.15
0.10
0.05
0.00
2019
2020
2021
2022
Site Name
Leachate

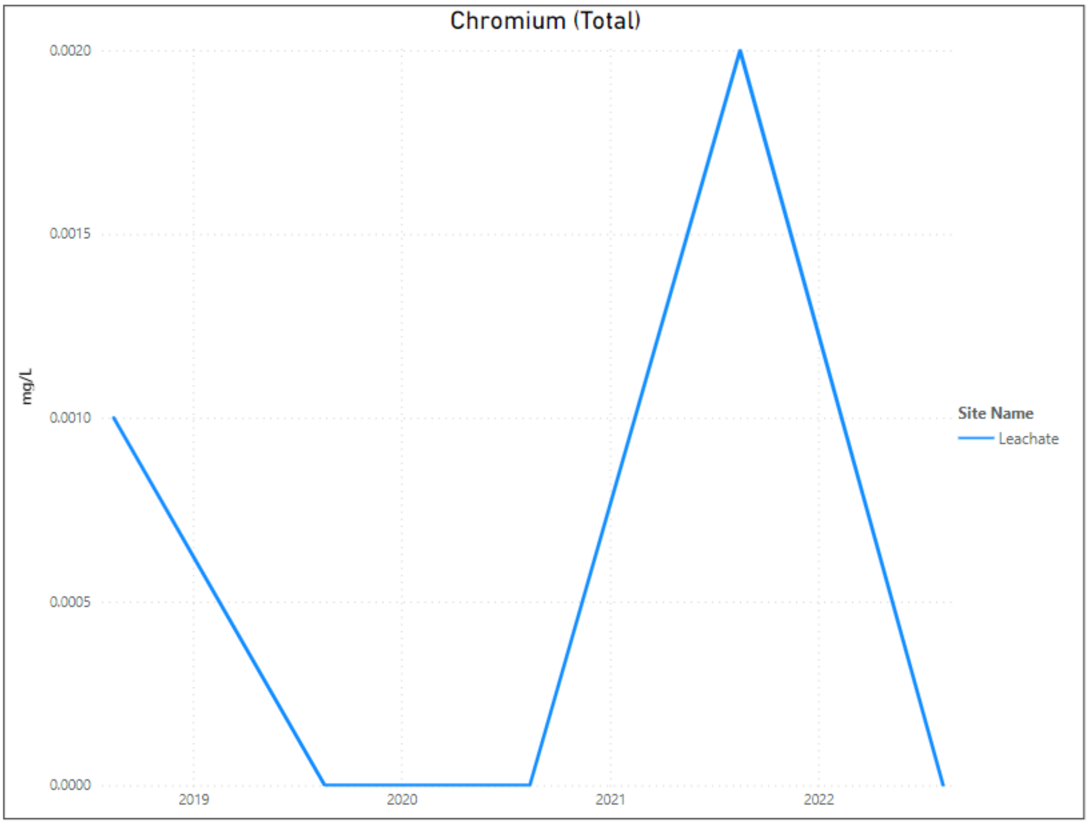

Benzene
µg/L
1.0
0.8
0.6
0.4
0.2
0.0
2019
2020
2021
2022
Site Name
Leachate

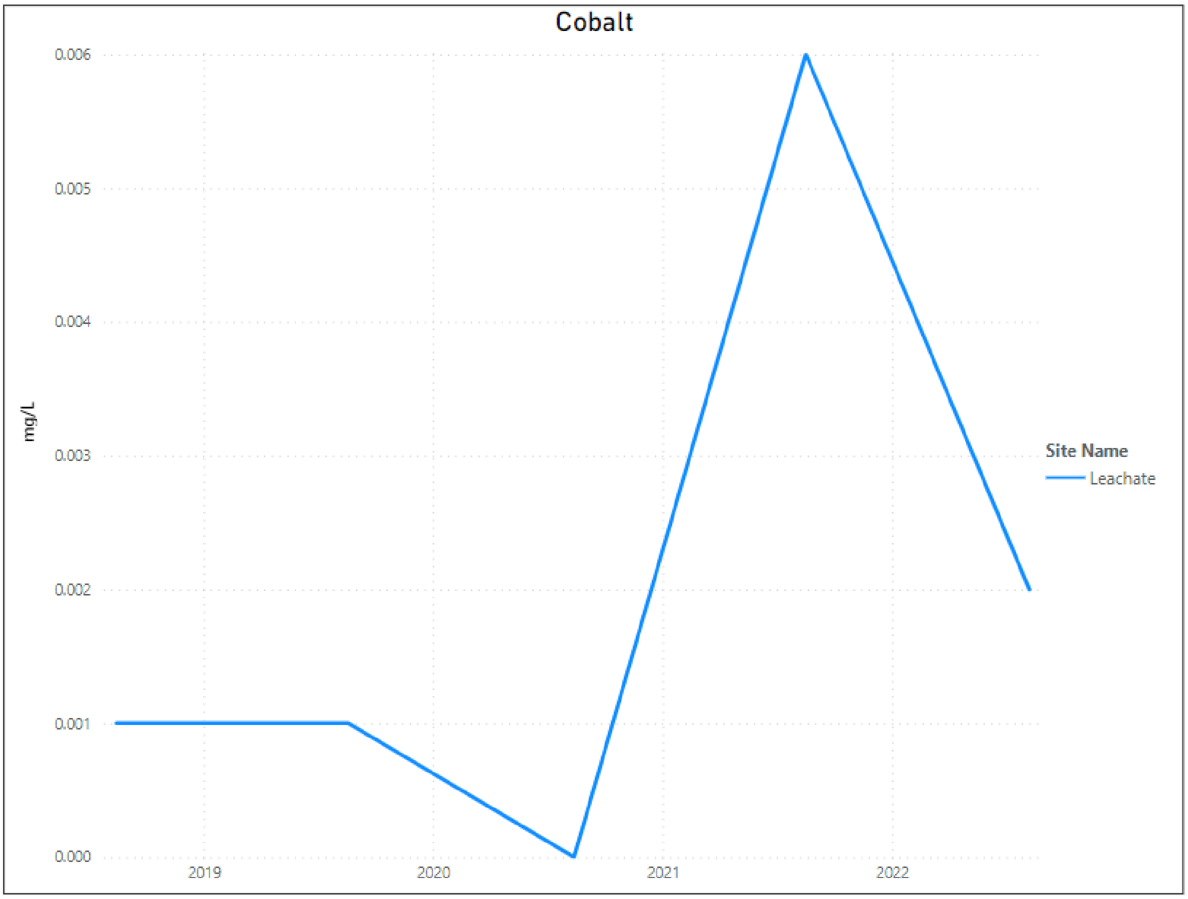

Cadmium
0.00020
0.00015
0.00010
0.00005
0.00000
mg/L
2019
2020
2021
2022
Site Name
Leachate

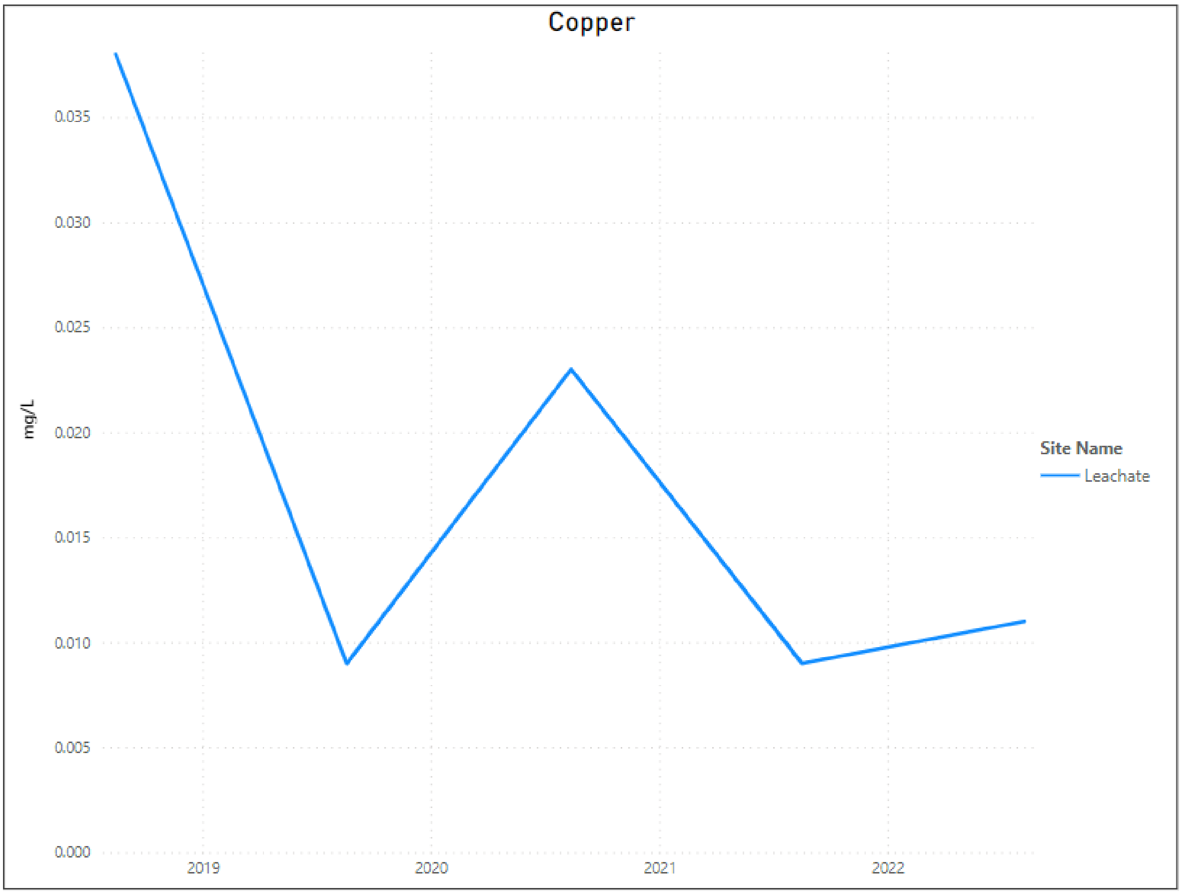

Calcium
120
100
80
60
40
20
0
mg/L
2019
2020
2021
2022
Site Name
Leachate

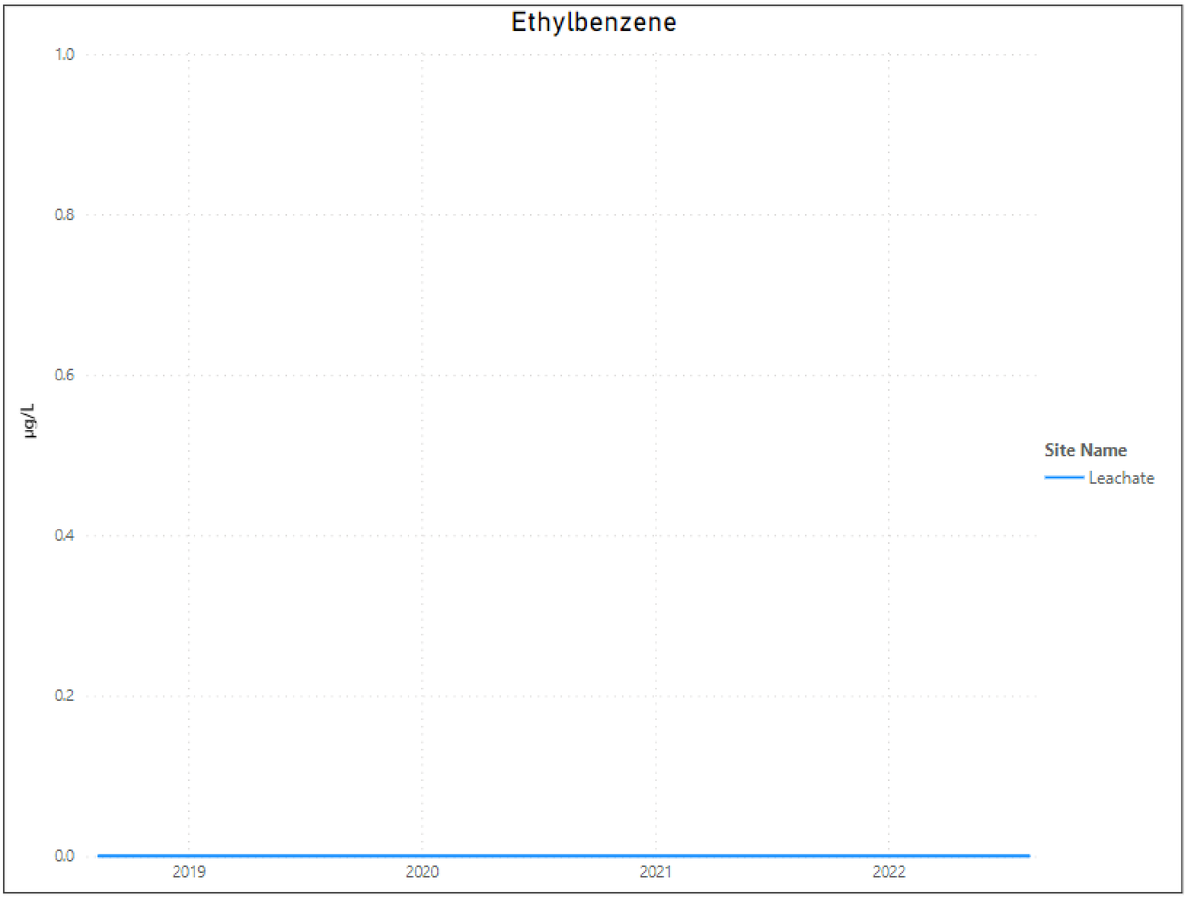

Chloride
mg/L
0
10
20
30
40
50
2019
2020
2021
2022
Site Name
Leachate

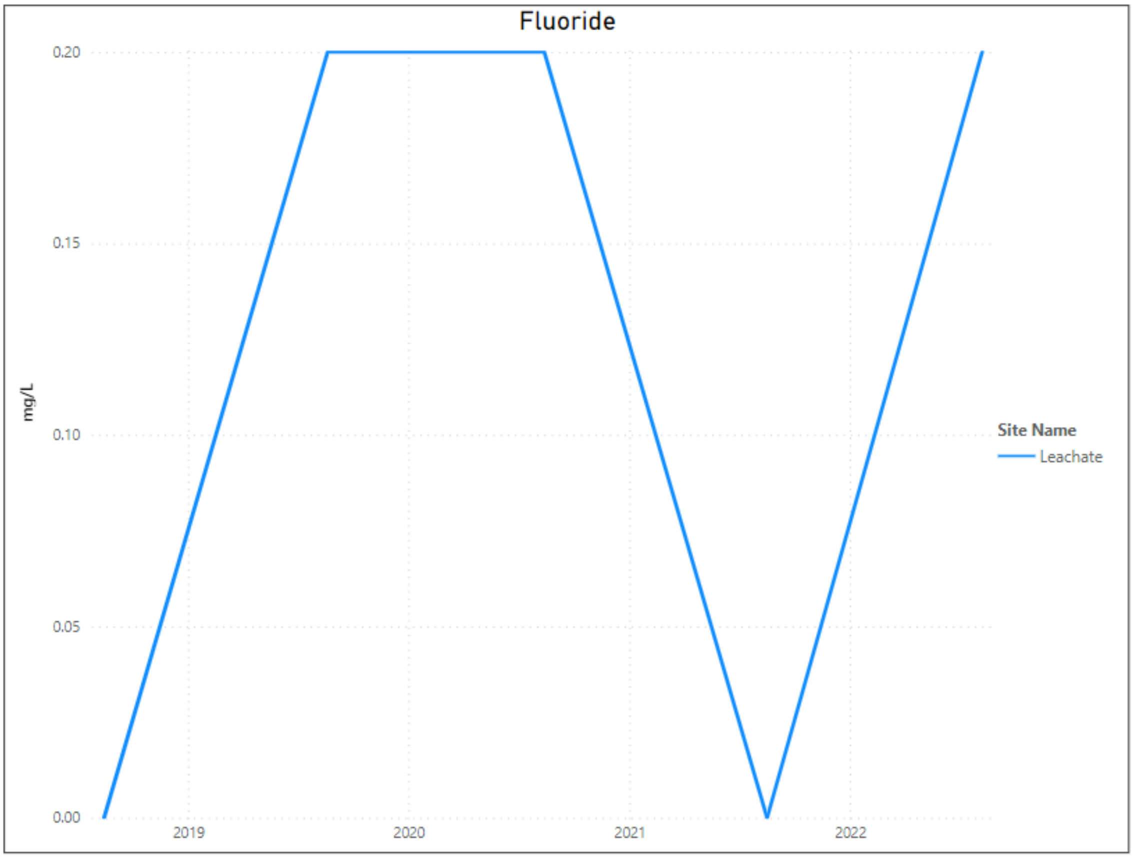

Chromium (Hexavalent)
mg/L
0.0
0.2
0.4
0.6
0.8
1.0
2019
2020
2021
2022
Site Name
Leachate


Chromium (Total)
0.0020
0.0015
0.0010
0.0005
0.0000
mg/L
2019
2020
2021
2022
Site Name
Leachate

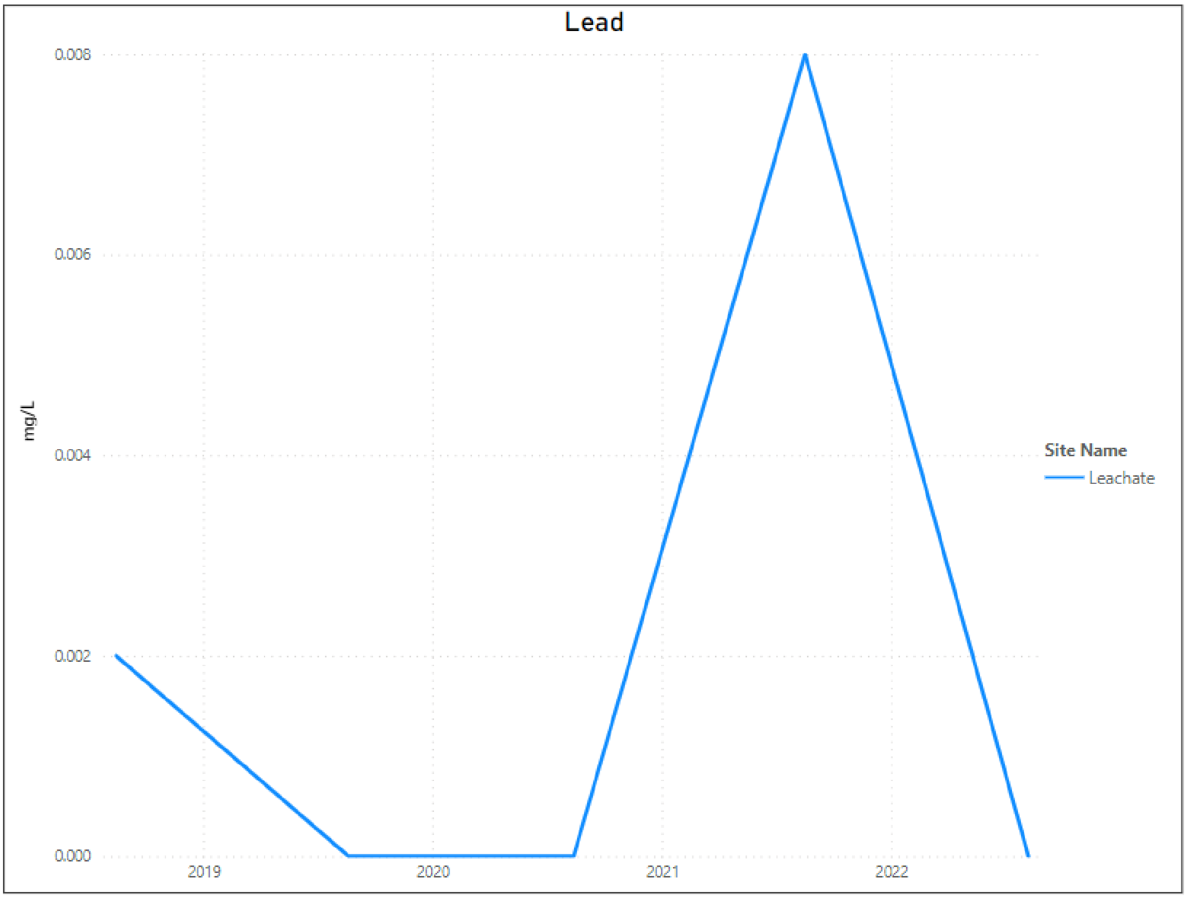

Cobalt
0.006
0.005
0.004
0.003
0.002
0.001
0.000
mg/L
2019
2020
2021
2022
Site Name
Leachate


Copper
mg/L
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
2019
2020
2021
2022
Site Name
Leachate

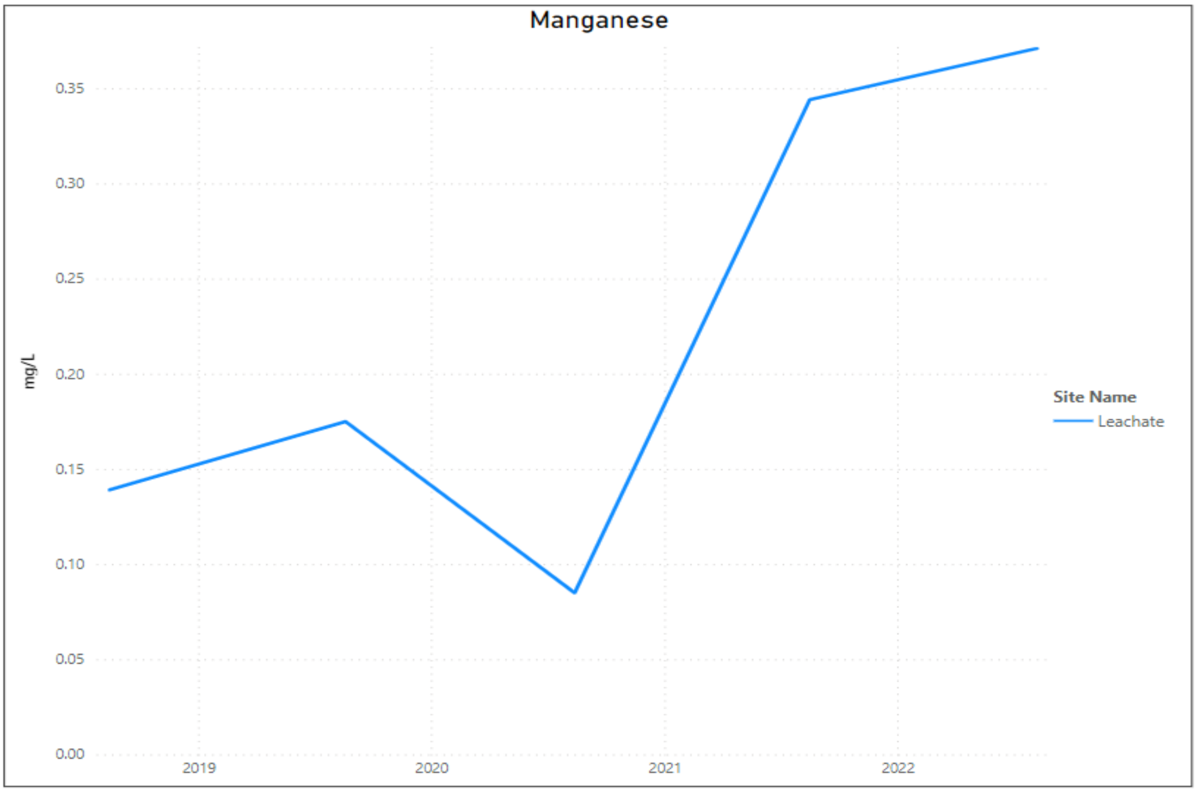

Ethylbenzene
µg/L
1.0
0.8
0.6
0.4
0.2
0.0
2019
2020
2021
2022
Site Name
Leachate

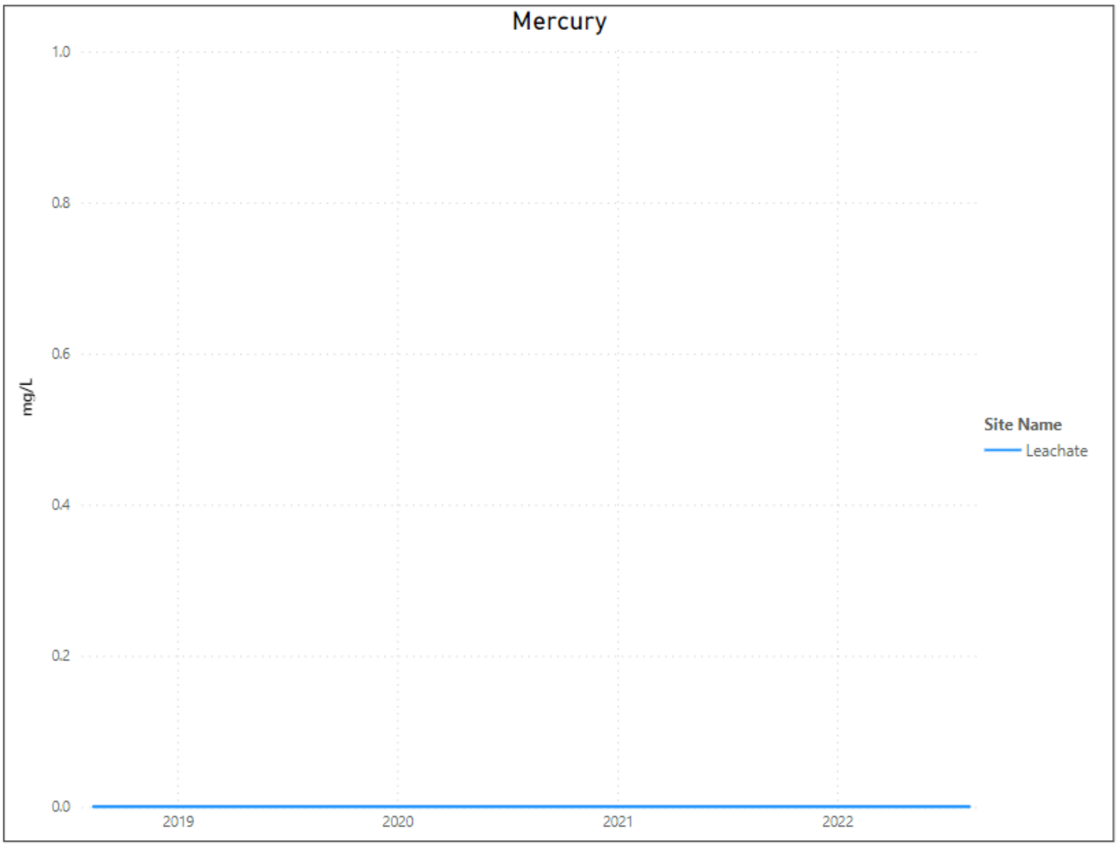


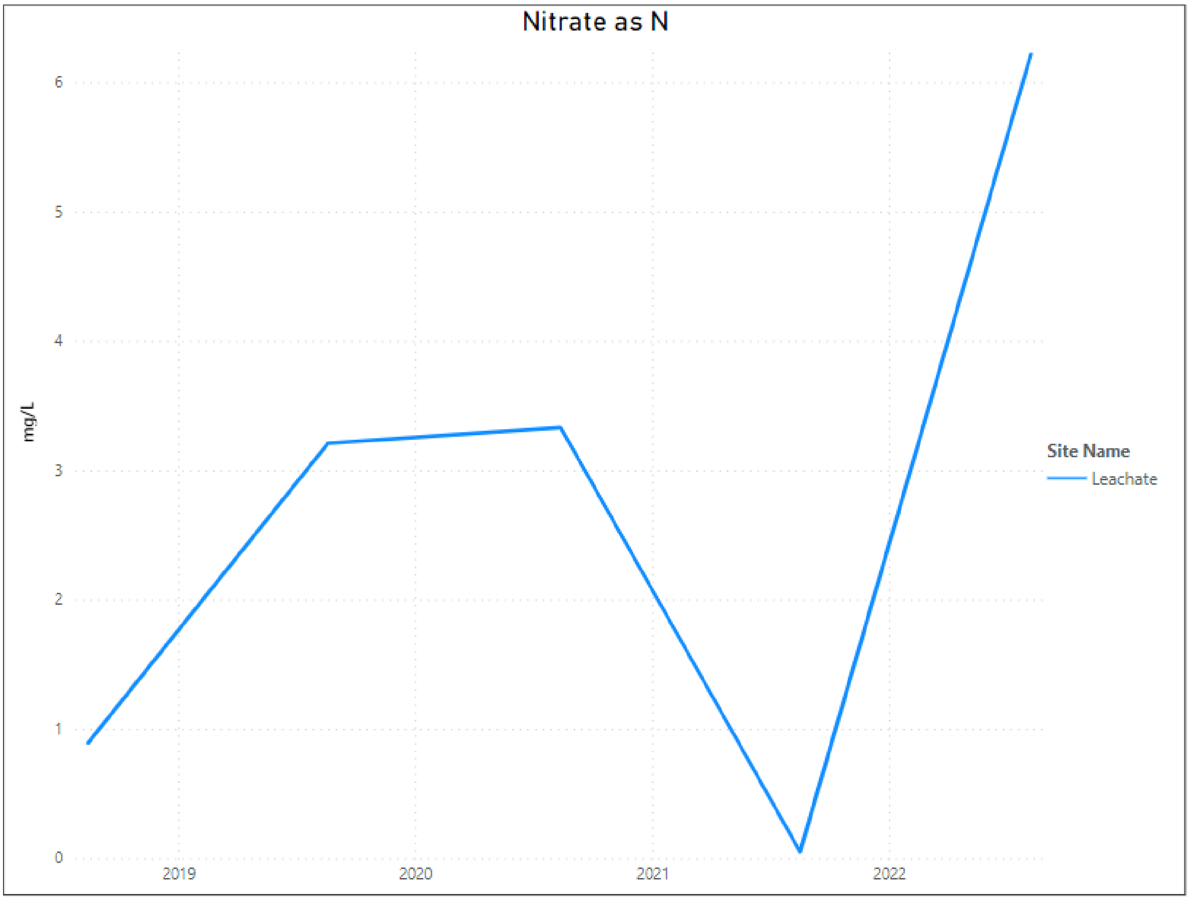
Fluoride
0.20
0.15
0.10
0.05
0.00
mg/L
2019
2020
2021
2022
Site Name
Leachate

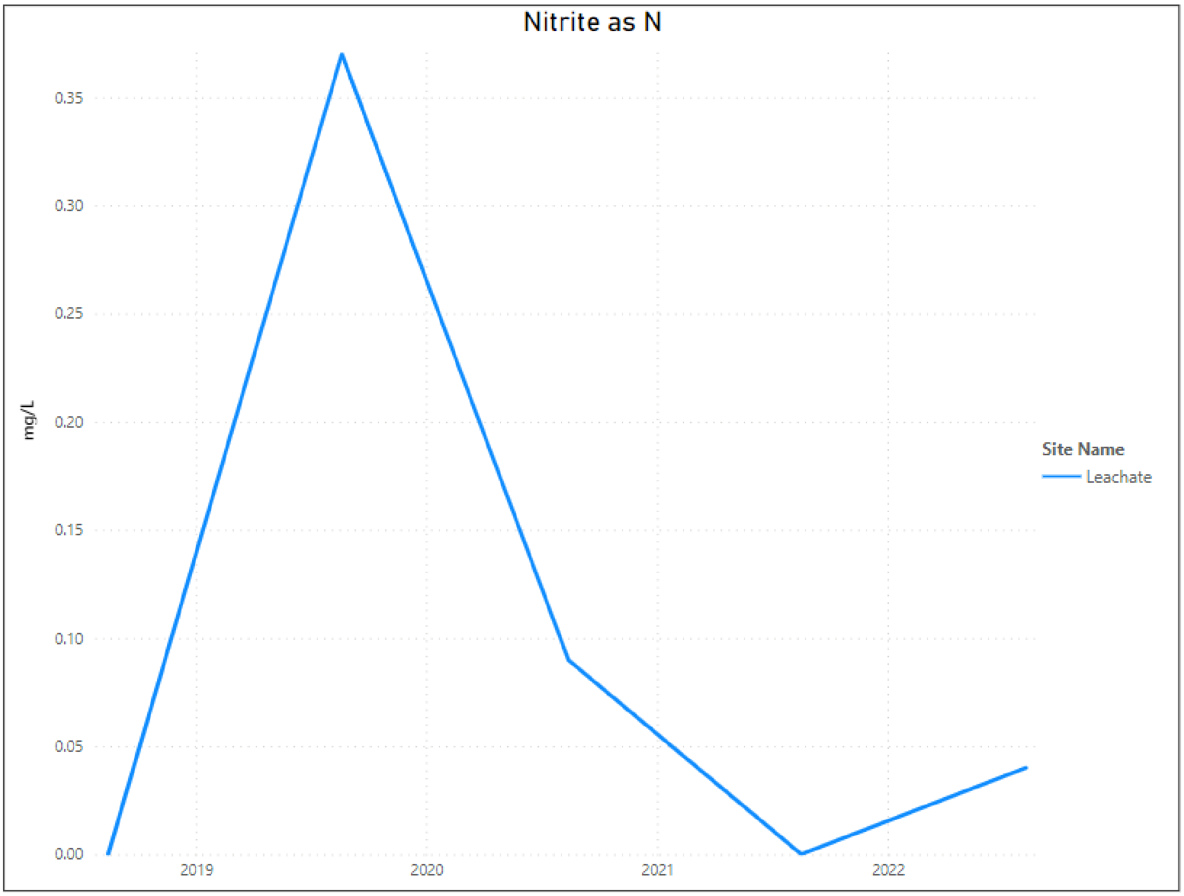


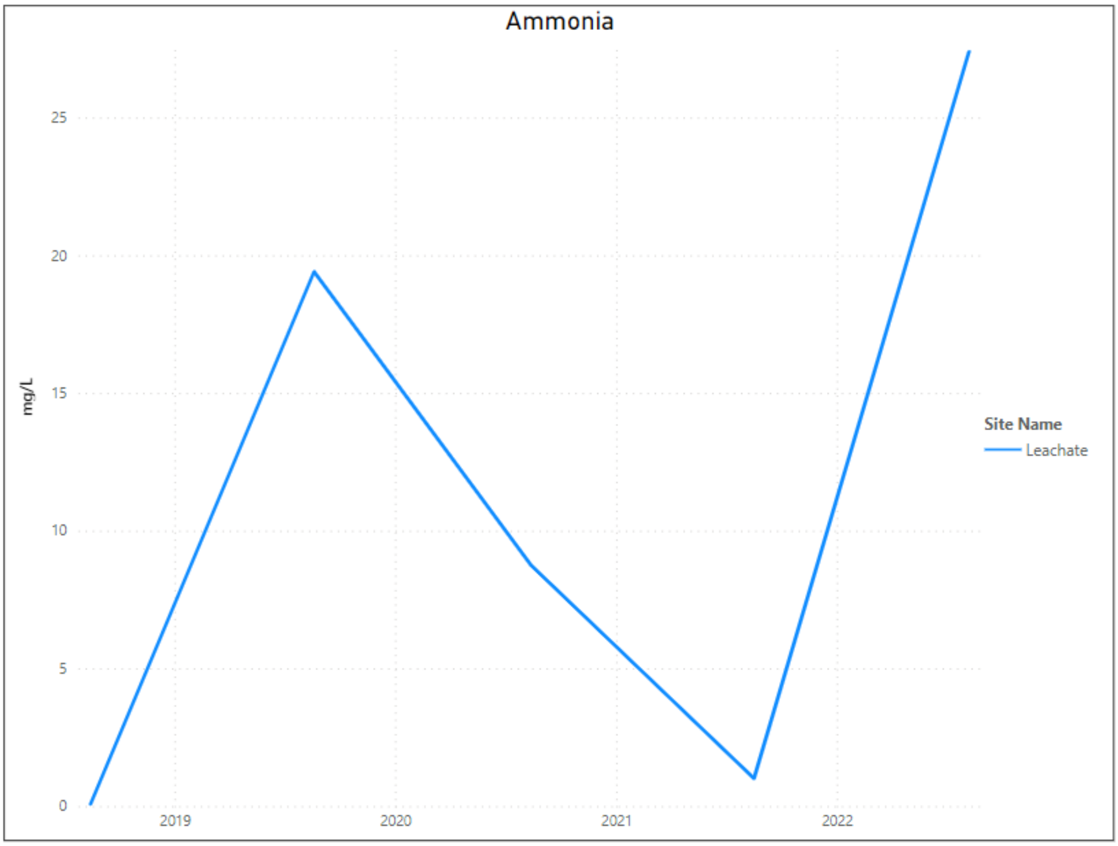
Lead
0.008
0.006
0.004
0.002
0.000
mg/L
2019
2020
2021
2022
Site Name
Leachate

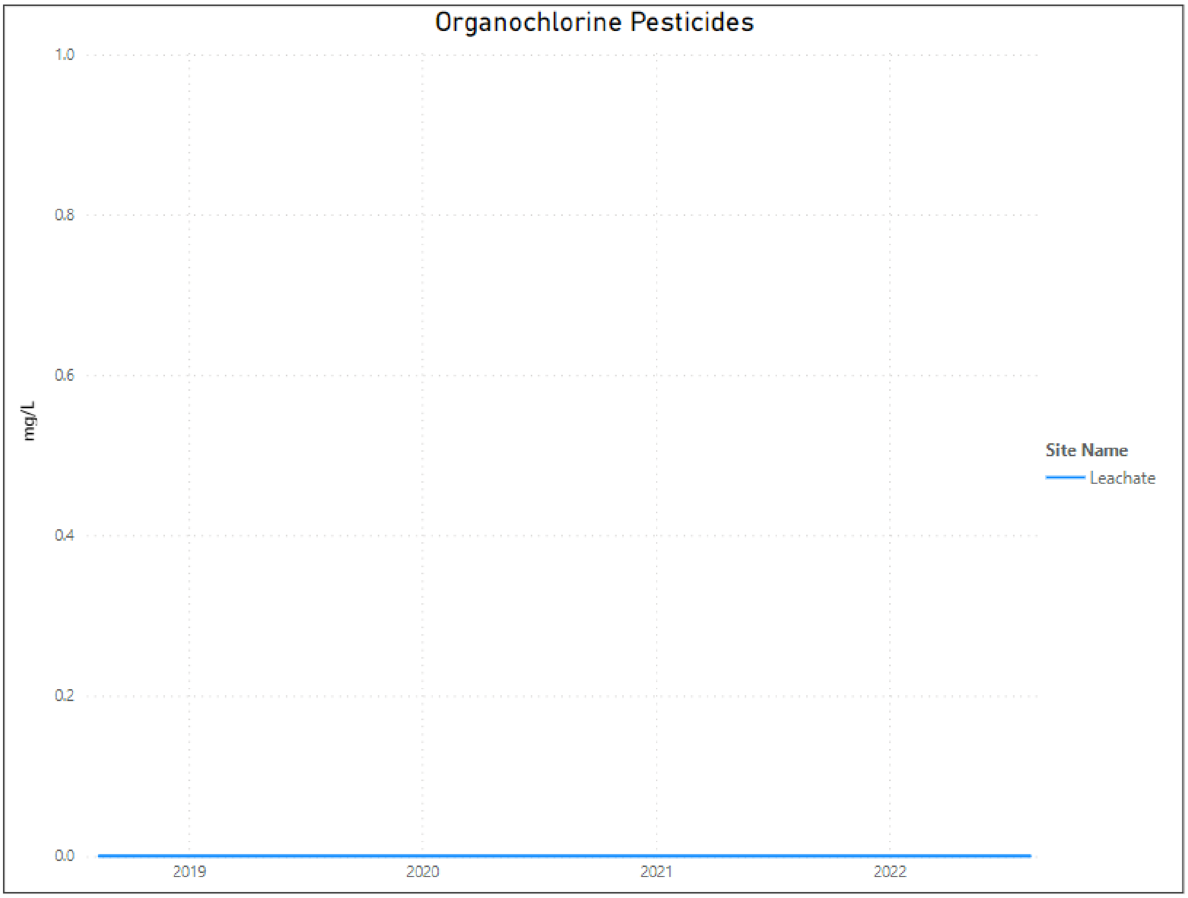

Manganese
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
mg/L
2019
2020
2021
2022
Site Name
Leachate

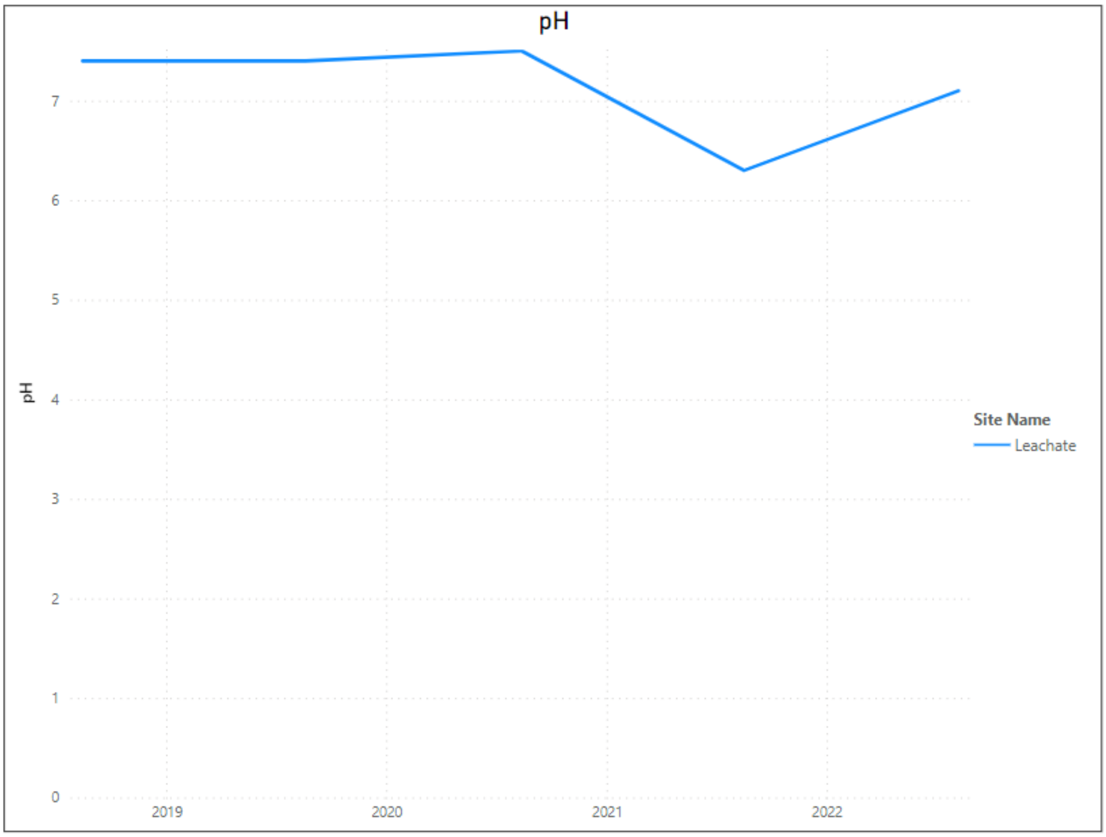

Mercury
1.0
0.8
0.6
0.4
0.2
0.0
mg/L
2019
2020
2021
2022
Site Name
Leachate

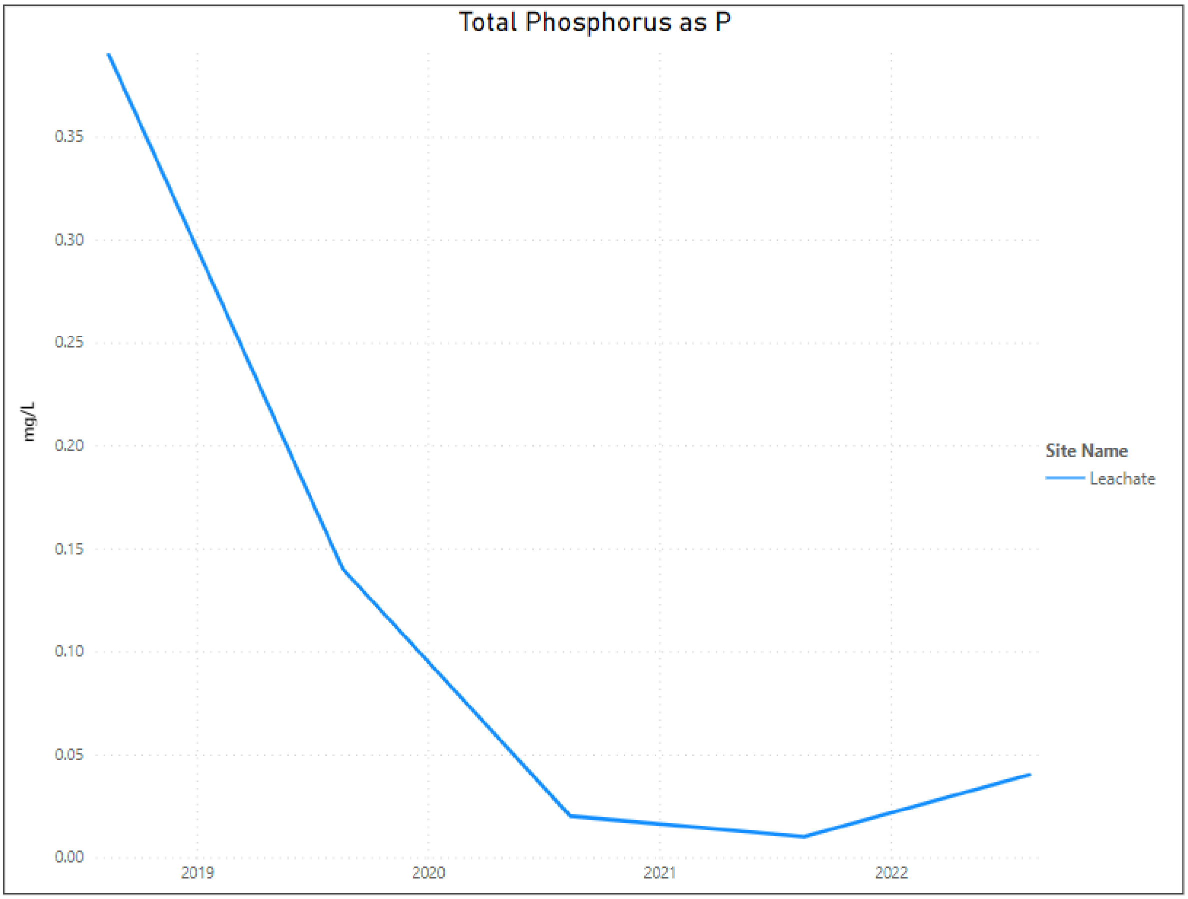

Nitrate as N
6
5
4
3
2
1
0
mg/L
2019
2020
2021
2022
Site Name
Leachate


Nitrite as N
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
mg/L
2019
2020
2021
2022
Site Name
Leachate

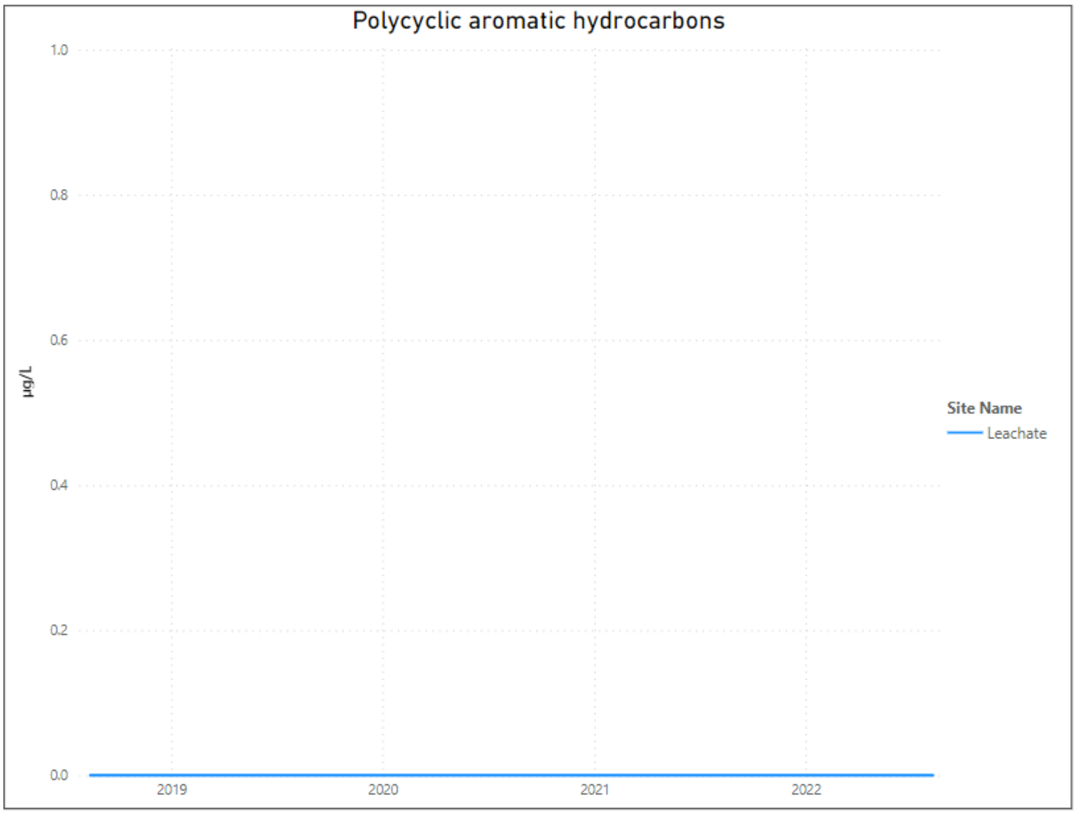

Ammonia
25
20
15
10
5
0
mg/L
2019
2020
2021
2022
Site Name
Leachate

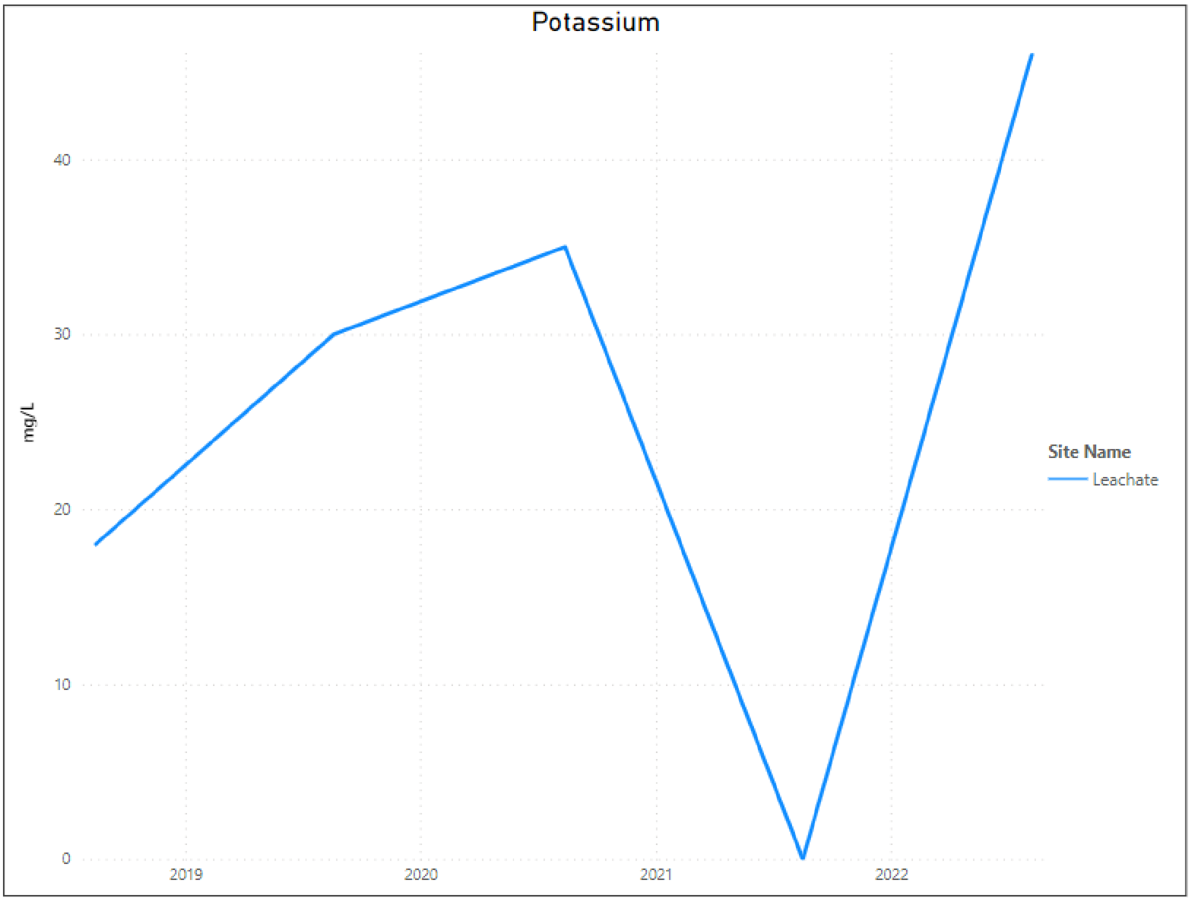

Organochlorine Pesticides
1.0
0.8
0.6
0.4
0.2
0.0
mg/L
2019
2020
2021
2022
Site Name
Leachate

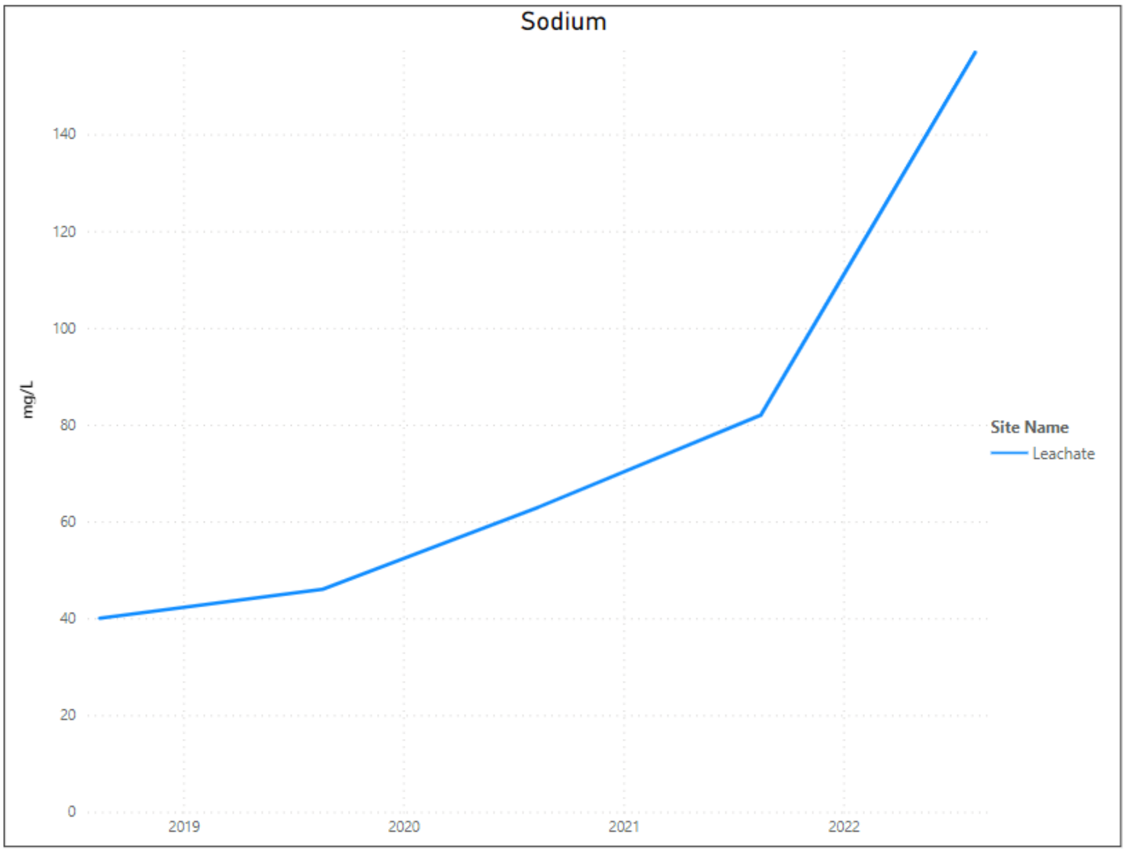


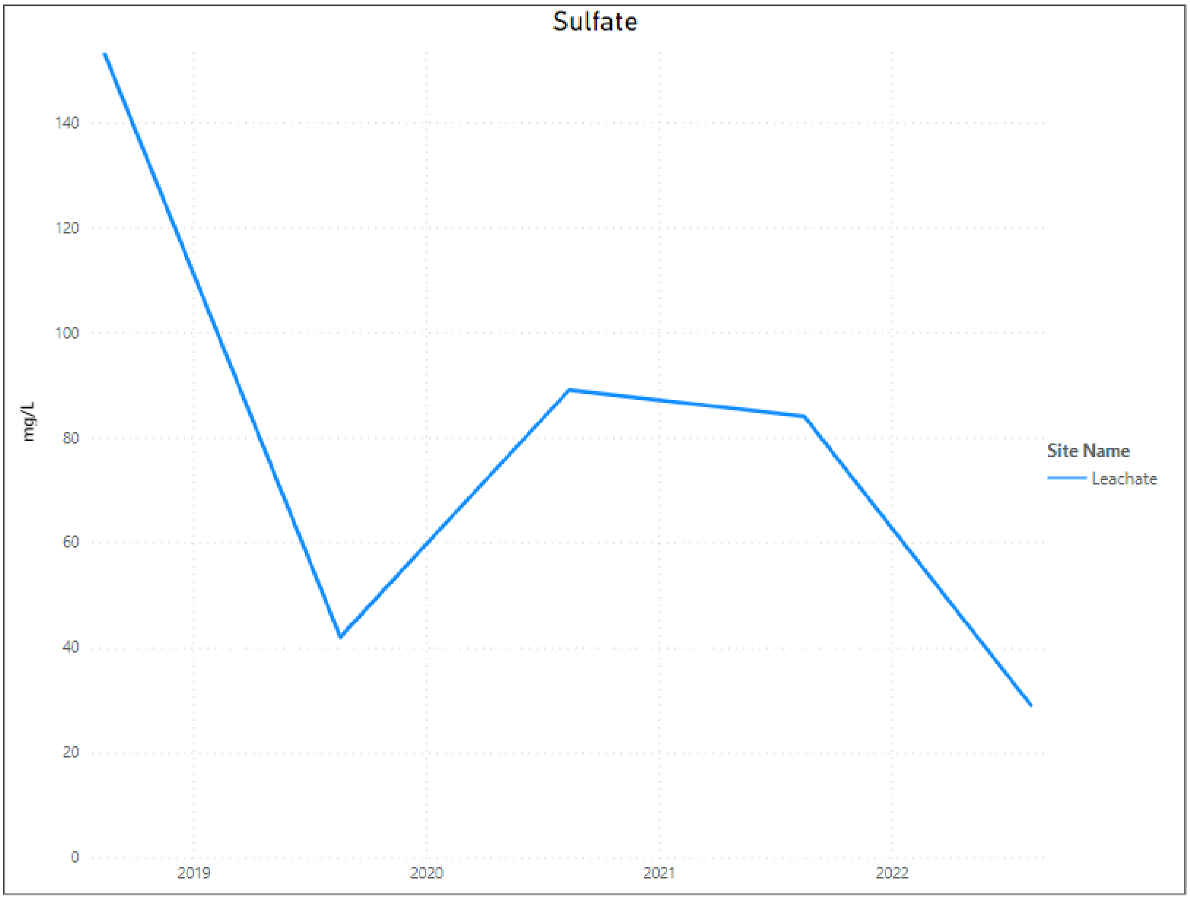


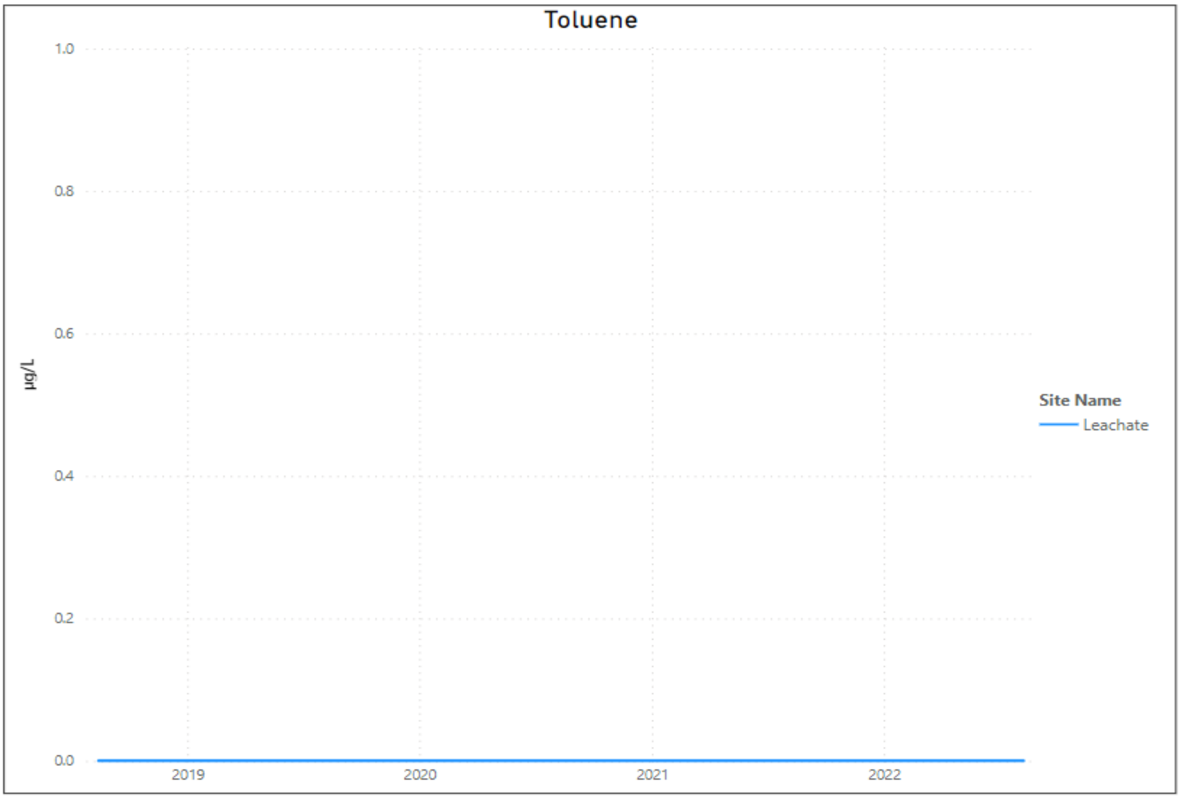
Document Set ID: 24484551
Version: 1, Version Date: 22/08/2023

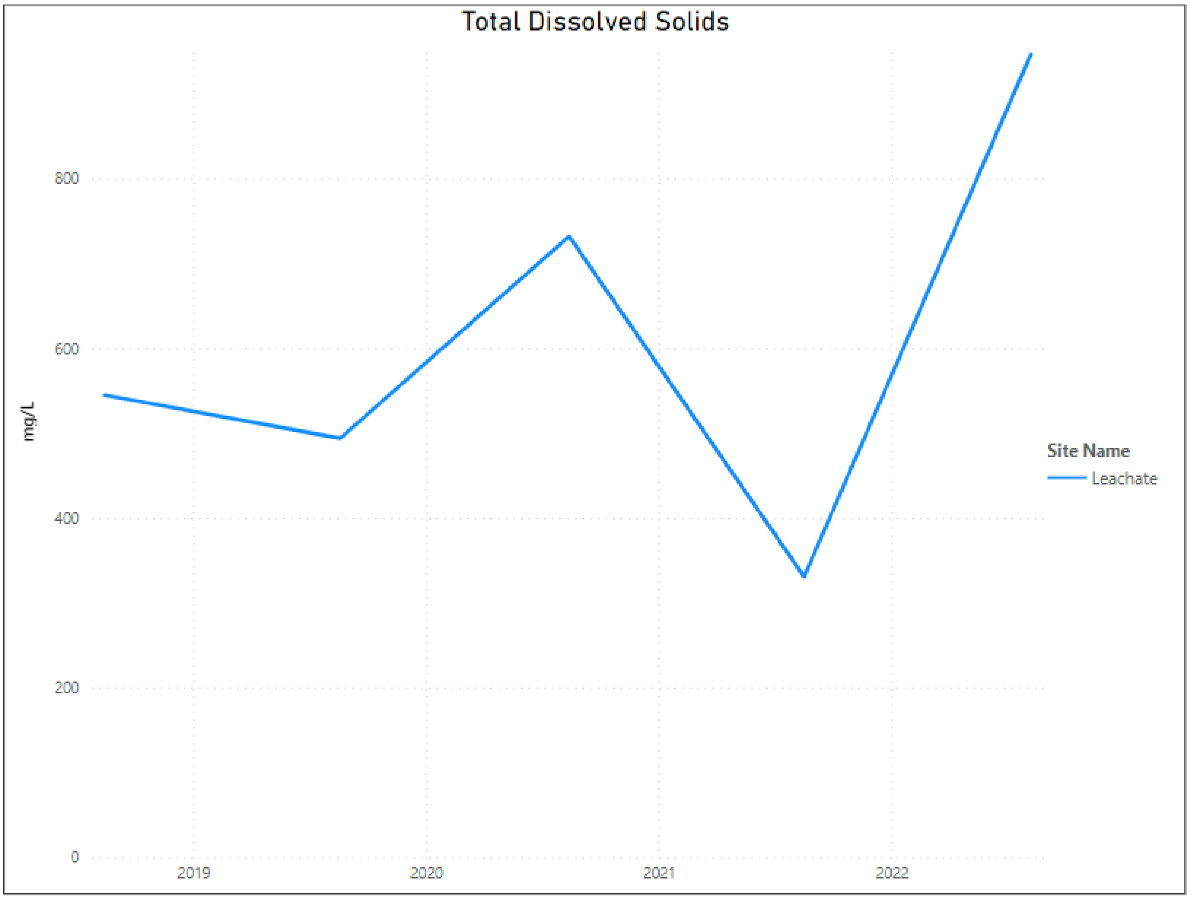

Polycyclic aromatic hydrocarbons
1.0
0.8
0.6
0.4
0.2
0.0
µg/L
2019
2020
2021
2022
Site Name
Leachate

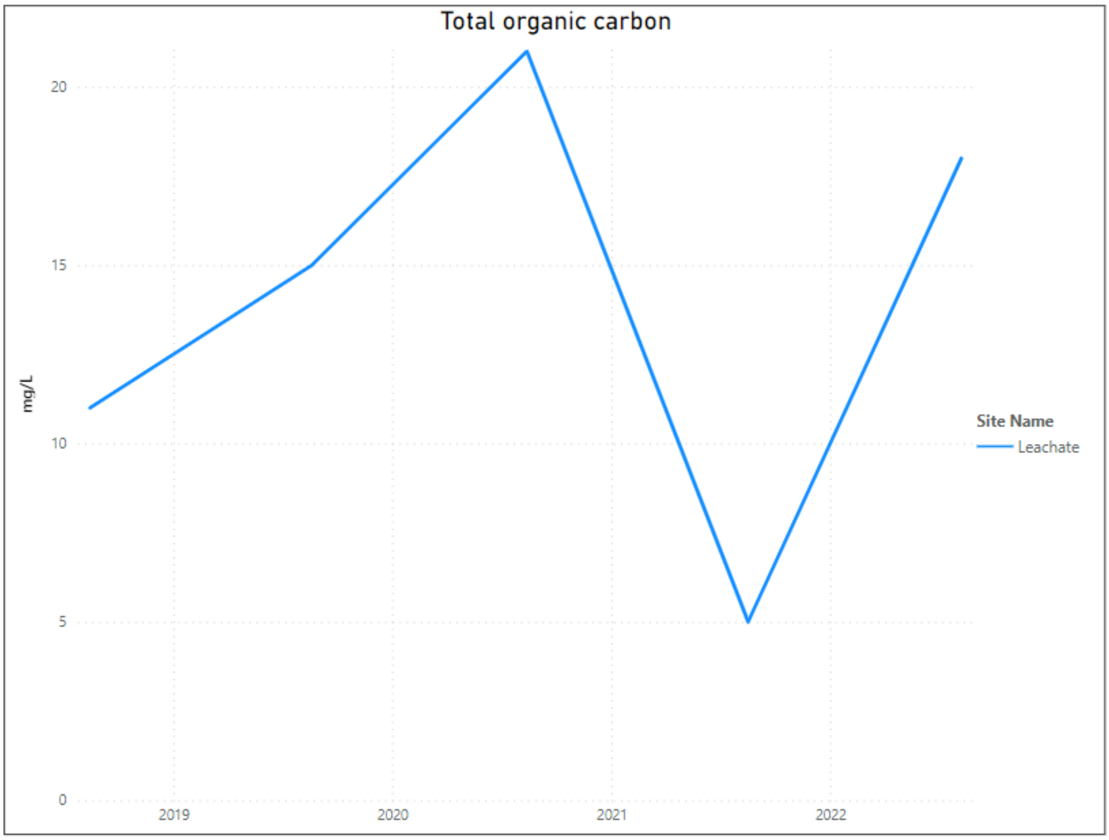

Potassium
40
30
20
10
0
mg/L
2019
2020
2021
2022
Site Name
Leachate

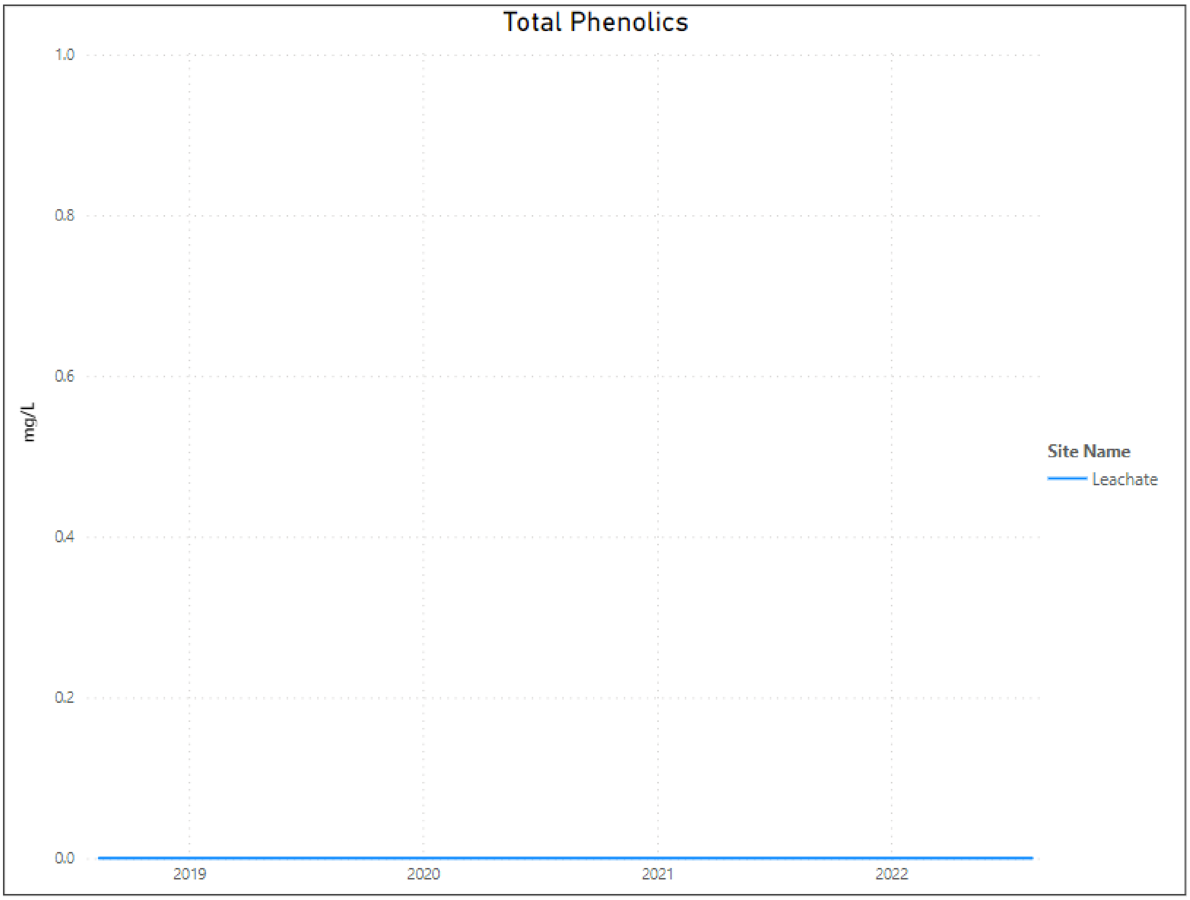

Sodium
140
120
100
80
60
40
20
0
mg/L
2019
2020
2021
2022
Site Name
Leachate

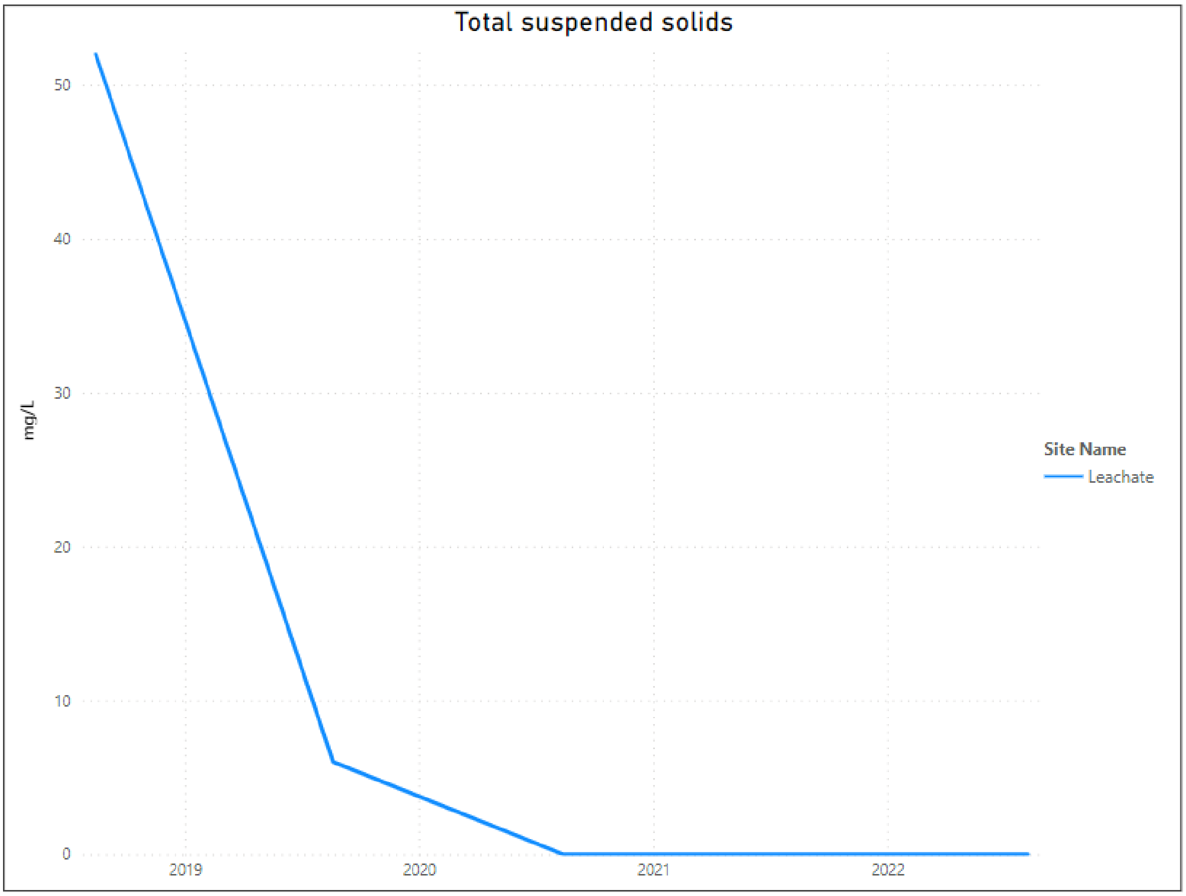

Sulfate
140
120
100
80
60
40
20
0
mg/L
2019
2020
2021
2022
Site Name
Leachate

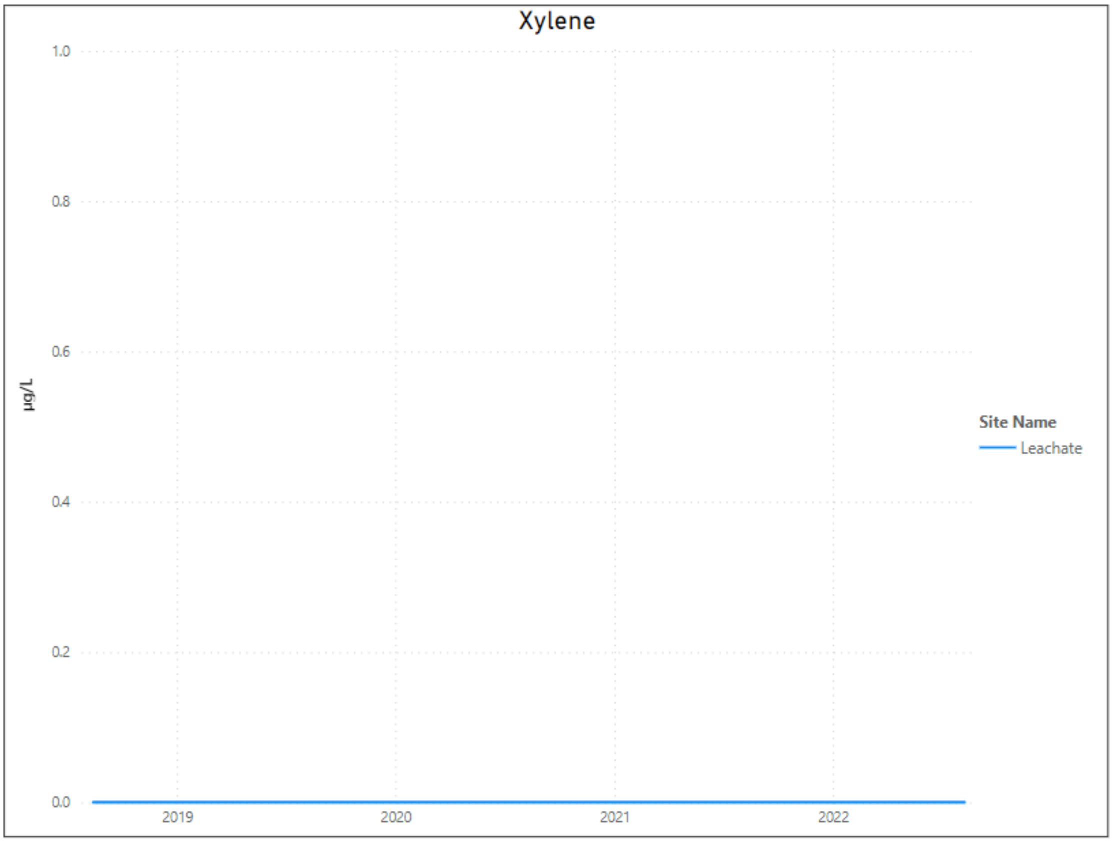

Toluene
1.0
0.8
0.6
µg/L
0.4
0.2
0.0
2019
2020
2021
2022
Site Name
Leachate

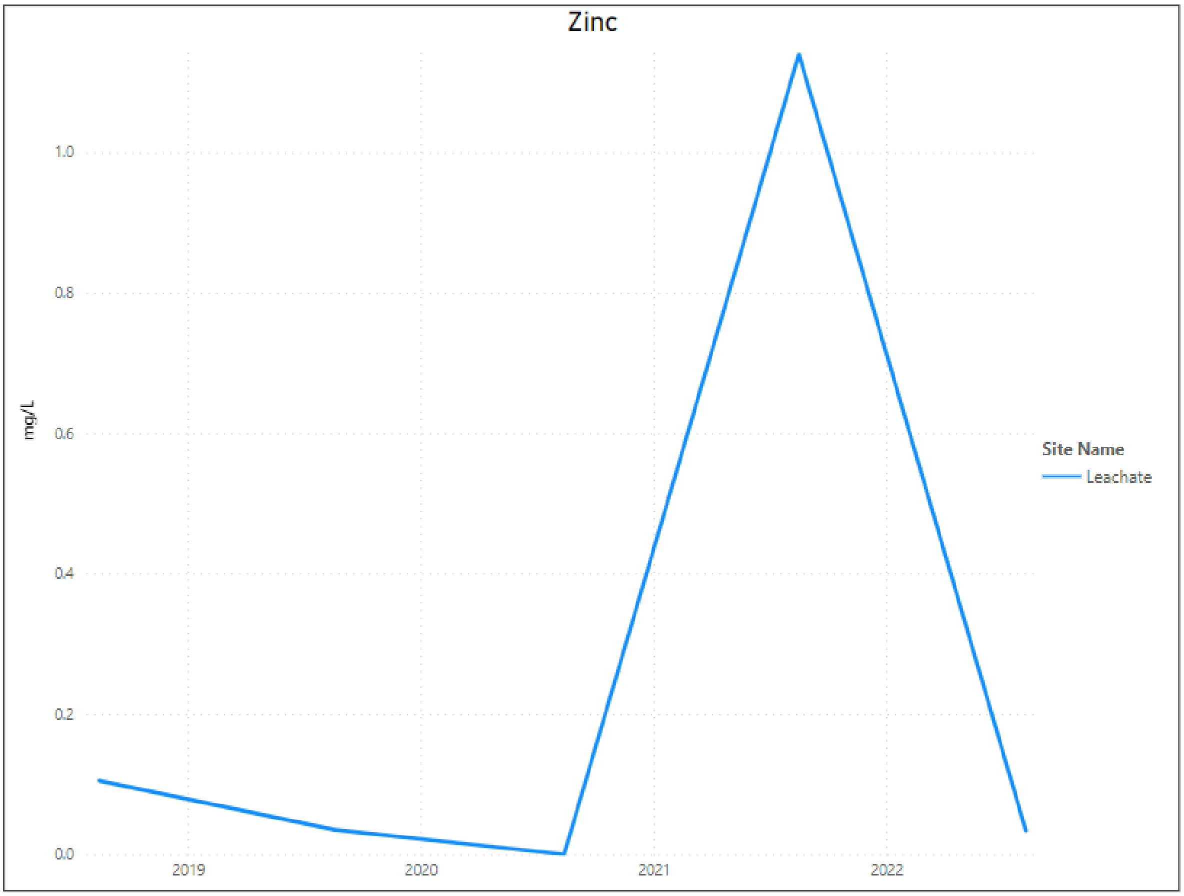

Total Dissolved Solids
800
600
mg/L
400
200
0
2019
2020
2021
2022
Site Name
Leachate


Total organic carbon
20
15
10
5
0
mg/L
2019
2020
2021
2022
Site Name
Leachate


Total Phenolics
1.0
0.8
0.6
0.4
0.2
0.0
mg/L
2019
2020
2021
2022
Site Name
Leachate


Total suspended solids
50
40
30
20
10
0
mg/L
2019
2020
2021
2022
Site Name
Leachate


Xylene
1.0
0.8
0.6
0.4
0.2
0.0
µg/L
2019
2020
2021
2022
Site Name
Leachate


Zinc
mg/L
1.0
0.8
0.6
0.4
0.2
0.0
2019
2020
2021
2022
Site Name
Leachate