HELENSBURGH WASTE DISPOSAL DEPOT ANNUAL REPORT 2020/2021

For EPL 5861 (August 2021)

WOLLONGONG CITY COUNCIL (WASTE SERVICES)

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Document Information

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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 The *NSW Environmental Guidelines: Solid Waste Landfills* (EPA 1996) were superseded in 2016 and replaced with the *NSW Environmental Guidelines: Solid Waste Landfills*, *Second Edition (*EPA 2016).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).

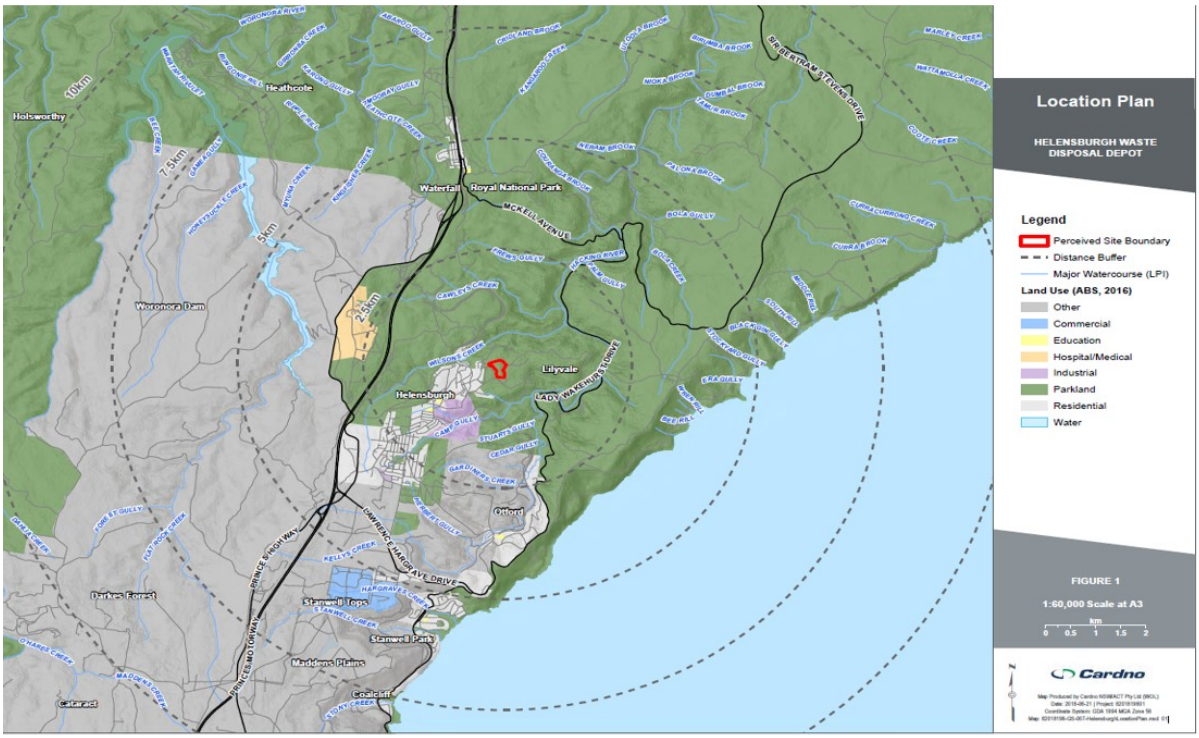

Figure 1: Helensburgh Location Plan

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 2020 to the 28th May 2021.
- 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 2019 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.**

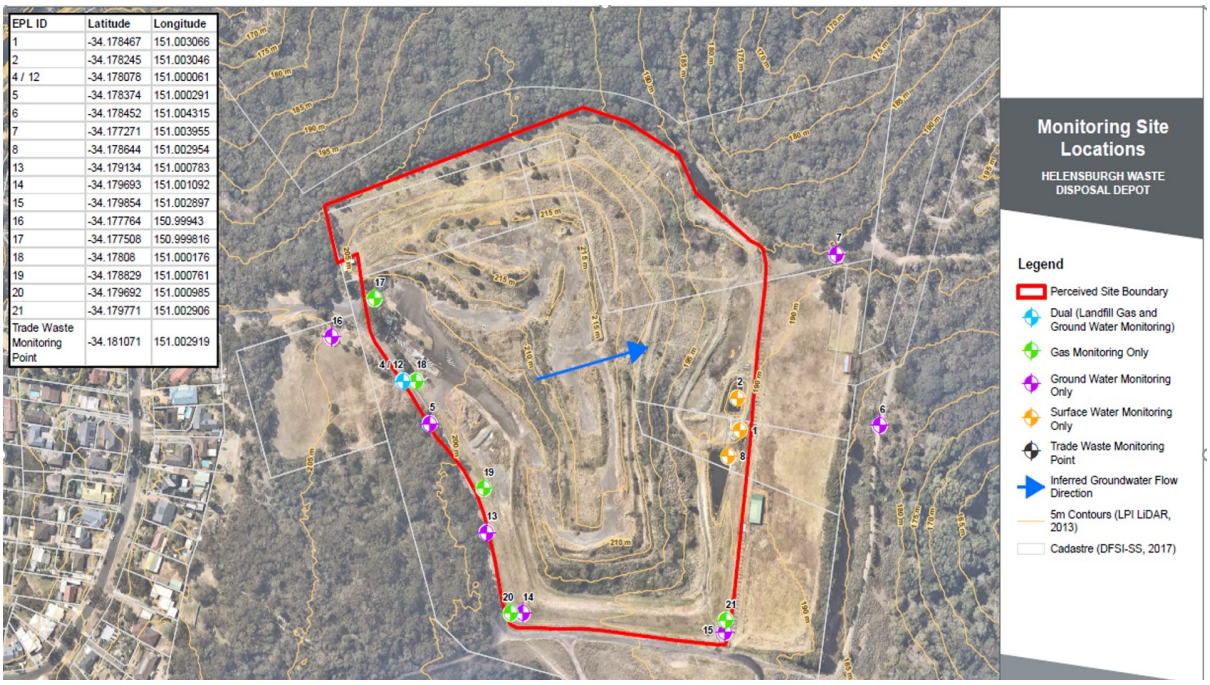

Figure 2: Monitoring Site Locations

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

2020	2021											
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Rainfall (mm)[1]	21.8	208	167	18	115	63.4	136	125	94	118.6	12.6	107
Mean max temperature (°C)[1]	22.6	22.4	18.1	20.8	21.3	23.4	23.4	24.1	23.5	22.9	22.7	21.1
Mean min temperature (°C)[1]	7.6	8.2	10	13	14.8	16.1	17.2	18.2	18.5	17.8	15	12.8
Mean 9am wind speed (km/h) [2]	12	15	17	17	19	20	15	19	19	18	11	14
Mean 3pm wind speed (km/h)[2]	20	21	20	24	21	23	22	21	24	23	17	18
Mean 9am relative humidity (%)[2]	67	65	55	61	70	69	71	73	77	72	60	65
Mean 3pm relative humidity (%)[2]	20	60	50	55	72	67	67	71	74	68	58	59

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

2019	2020											
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Rainfall (mm)	126.2	27.4	85.6	100.4	65.6	19.0	6.2	64	399.4	164.0	33.8	99.4
Mean max temperature (°C)	22.8	22.2	24.3	27.5	34.1	35.6	36.0	39.6	32.3	35.1	26.3	25.5
Mean min temperature (°C)	13.1	14.0	13.6	15.1	14.9	18.5	20.1	19.8	21.7	18.1	17.3	16.7
Mean 9am wind speed (km/h)	15	15	20	16	16	18	13	18	14	15	14	18
Mean 3pm wind speed (km/h)	18	19	24	23	21	23	23	2	21	22	17	21
Mean 9am relative humidity (%)	68	52	48	59	64	58	66	70	76	73	62	61
Mean 3pm relative humidity (%)	63	40	47	59	63	58	65	75	73	68	61	58

The climate data shows that once drought conditions were broken at the beginning of February 2020, regular heavy rainfall continued throughout this reporting period. The lowest rainfall month was September 2020, with only 18 mm falling and the highest was July 2020, with 208 mm falling over the month. It is significant to note that over 100 mm/month was received in seven months of the 12-month reporting period.

Temperatures were mild when compared to the extremes of the previous year (high temperature in 2019/2020 lead to a sever bushfire season). The lowest average temperature was 7.6 degrees Celsius and the highest was 24.1. 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.
Monitoring Locations	A leachate sample was collected from the Monitoring Point 2 (leachate pond) in accordance with Section 5 (M2.3) of EPL 5861.

Activity	Description
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 **0 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: <u>Annually</u> ▪ 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 <u>Quarterly</u> ▪ 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 2018/2019 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: ○ Assessment of landfill gas, leachate, surface water and groundwater in accordance with direction of Section 5 (Monitoring and Recording Conditions) of EPL 5861. ○ Assessment of management procedures for waste tyres. ○ Laboratory analysis of samples for the contaminants and parameters of interest defined in Section 5 of EPL 5861. ○ Assessment of analytical results against applicable performance criteria and Section 3 (Limit Conditions) of EPL 5861. ○ Review of complaints recorded during the reporting period that relate to odour originating from the site. ○ Aesthetic observations material encountered during sampling. ○ Assessment of the suitability of the analytical data obtained, against the Data Quality Indicators (DQIs) outlined below. ○ The temporal boundaries of the study are from the 29th of May 2020 to the 29th of May 2021(i.e. the reporting period).
Step 4: Define the boundaries of the study	The decision rules for the Annual Report include: ○ The sampling points, contaminants and parameters of interest, frequency of sampling and sampling method will meet the requirements EPL 5861. ○ Samples requiring laboratory analysis will be analysed at National Association of Testing Authorities (NATA) accredited laboratory. ○ 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.

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 B** 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 methane was 4.5 ppm measured at Point 5 of transect I during the August 2020 monitoring event. This is well below the threshold level for further investigation and corrective action of 500 ppm.

Surface gas monitoring results from the reporting period are summarised in **Table 6** of **Appendix B**.

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. All locations returned results above the threshold for further investigation of 1.5% (v/v) except Point 20 on the 18th August 2020. The highest continuous and peak results were from Point 19 with 14.2% (v/v) and 14.2% (v/v) peak on the 13th November 2020 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 B**.

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 sample collected in May 2021 after a moderate rain event indicated elevated levels over the Freshwater guideline recommendation at 1.14 mg/L, however there was no uncontrolled offsite discharge.

Monitoring results from the reporting period are summarised in **Table 4** of **Appendix B** 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	13/08/2020	0.34
		11/11/2020	0.56
		10/02/2021	0.03

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. With the exception of copper, 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 B**.

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 0.72 below ground level (bgl) at groundwater monitoring point 6 to 5.62 bgl in groundwater monitoring point 16. All bores were able to be measured this reporting period indicating that groundwater is continuing to flow 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, however, it is noted that the adopted criteria for anthracene and benzo(a)pyrene were below the laboratory limit of response (refer to **Table** 1 of **Appendix B)**. Therefore, the results of anthracene and benzo(a)pyrene cannot be screened against the criteria.
- A summary of heavy metals results is provided below and tabulated in **Table 1** of **Appendix B**:
  - Aluminium (total) concentrations ranged from 0.36 mg/L at groundwater monitoring point 6 to 23.4 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 most samples being below the laboratory LOR and therefore below the screening criteria.

- Chromium (hexavalent) was not detected above the laboratory limit of response in all groundwater samples collected during the reporting period, however, it is noted that the adopted criteria is below the laboratory limit of response. Therefore, the results cannot be screened against the performance criteria, which is further discussed in the following section.
- Copper (total) concentrations ranged above the freshwater guideline value of 0.0014 mg/L ranging from 0.004 mg/L to 0.029 mg/L, however 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) apart from point 13 that recorded 0.02 mg/L. Lead levels have dropped significantly from the last reporting period.
- Manganese (total) concentrations ranged from 0.01 mg/L (Point 14) to 0.124 mg/L (Point 5). All samples had concentrations below the adopted performance criteria.
- Zinc (total) concentrations ranged from 0.009 mg/L (Point 12) to 0.111 mg/L (Point 13) with 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 0.42 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 3.64 mg/L at point 15, below the ANZECC 95% protection trigger level of 7.2.

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, however, it is noted that the adopted criteria were below the laboratory limit of response. Therefore the results cannot be screened against the criteria.
- 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 4.3 (point 7) to 7.3 (Point 6) (refer to **Table 1** of **Appendix A**).

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 three years (where available).

Trend graphs are provided in **Appendix C** and summarised below in the sections below, however, trend graphs and a 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 stormwater pond occurred during the reporting period and therefore monitoring was not required. As such non-conformances of the EPL did not occur with respect to stormwater.

8.4 Leachate

Only copper was reported 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, the exceedances 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 elevated readings of pH on two occasions (11/11/20 and 10/02/2021) of 9.4 and 9.8 respectively. Anecdotal evidence from ALS sampling personnel indicated that samples were collected in non-flowing waters which historically had high pH levels. These levels will be investigated further, however they did settle back to 7.5 at the last sampling event on the 17/05/2021.

Ammonia levels were within the guideline value of 0.9 mg/L for freshwater ecosystems for the first three sampling events. There was a moderate spike of 1.14 mg/L recorded on the 17/05/2021 which would most likely be attributed to a preceding rainfall event.

Faecal coliforms were slightly elevated at 16 CFU/100ml on the 13/08/2020. It is most likely that this is attributed to preceding rainfall and the subsequent surface runoff from the surrounding catchment (including the Pony Club) located in close proximity to the sampling site.

Quarterly samples that were taken in the subsequent events recorded no faecal coliforms.

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 flow throughout the site after the prolonged period of drought that was only broken with the rain events in February 2020.

Dissolved oxygen, redox potential, TDS and TOC all remained within normal limits and fluctuated due to seasonal variations. Potassium stabilised between 16 – 26 mg/L.

No overflow events occurred 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.

In the previous reporting period, many of the monitoring points at the 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 trend graph and 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 the previous reporting period and continuing rainfall in this period have impacted on water levels throughout the Site, with the stormwater and leachate ponds maintaining at 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. 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.

CSM Element	Description
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 2020/2021 reporting period that satisfied the conditions and requirements of EPL 5861 and the *Consent to Discharge Industrial Trade Wastewater* (Sydney Water, 2019).

> 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:

- The effect of the surrounding catchment and behaviour of groundwater through the site should be investigated to determine any influence on water quality in the Hacking River catchment.
- The laboratory limit of response was above the adopted screening criteria for several contaminants including PAHs, OCPs and OPPs. Future analysis of these contaminants should be undertaken at an ultra-trace level to ensure the limit of response is below the applicable criteria.
- Historically water samples have been submitted for laboratory analysis of total heavy metals in accordance with EPL 5861. Water samples should also be analysed for dissolved metals (ie filtered) to determine if elevated metals are attributed to sediment or if they exist in dissolved phase.

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

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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 2020/2021

Site Name	Sample Date	Alkalinity (as calcium carbonate) mg/L	Aluminium mg/L	Ammonia mg/L	Arsenic mg/L	Barium mg/L	Benzene µg/L	Cadmium mg/L	Calcium mg/L	Chloride mg/L	Chromium (hexavalent) mg/L	Chromium (Total) mg/L	Cobalt mg/L	Copper mg/L	Depth m	Ethyl benzene µg/L	Fluoride mg/L	Lead mg/L	Magnesium mg/L	Manganese mg/L
Monitoring Point 5	13/08/2020	5	1.42	0.02	0	0.033	0	0	40	210	0	0	0.001	0.006	2.7	0	0	0.002	32	0.067
	11/11/2020	5		0.42					35	217					3.28				28	
	10/02/2021	5		0.08					19	155					3.99				17	
	17/05/2021	15		0.67					28	190					3.16				25	
Monitoring Point 6	13/08/2020	160	0.36	0.02	0.007	0.086	0	0	38	12	0	0	0.001	0.007	0.72	0	0.1	0	20	0.162
	11/11/2020	203		0					45	19					2.42				23	
	10/02/2021	227		0					50	30					2.26				26	
	17/05/2021	210		0					46	20	2.84				25					
Monitoring Point 7	13/08/2020	6	2.48	0	0	0.022	0	0	0	130	0	0	0.001	0.006	1.26	0	0	0.002	6	0.053
	11/11/2020	4		0.02					0	132					3.12				6	
	10/02/2021	5		0					0	75					5.27				5	
	17/05/2021	0		0					0	129					3.09				5	
Monitoring Point 12	13/08/2020	65	1.09	0.03	0.001	0.034	0	0	21	21	0	0	0	0.004	1.42	0	0	0	10	0.087
	11/11/2020	82		0					24	18					2.13				11	
	10/02/2021	53		0.02					16	19					2.84				9	
	17/05/2021	44		0					13	18					2.27				9	
Monitoring Point 13	13/08/2020	42	23.4	0.02	0.003	0.064	0	0.0001	21	31	0	0.036	0.003	0.029	1.58	0	0	0.02	8	0.124
	11/11/2020	39		0.01					18	15					2.99				8	
	10/02/2021	37		0.02					15	19					3.48				6	
	17/05/2021	34		003					16	30					2.73				6	
Monitoring Point 14	13/08/2020	16	2.91	0.02	0	0.011	0	0	7	13	0	0.003	0.001	0.006	1.28	0	0	0.002	3	0.01
	11/11/2020	11		0					6	22					2.29				3	
	10/02/2021	10		0					6	22					2.9				2	
	17/05/2021	12		0					6	20					2.19				3	
Monitoring Point 15	13/08/2020	8	1.66	0	0	0.004	0	0	8	13	0	0.001	0	0.005	1.01	0	0	0.001	3	0.022
	11/11/2020	6		0					9	13					2.05				4	
	10/02/2021	8		0					9	15					2.91				3	
	17/05/2021	6		0					7	16					1.99				3	
Monitoring Point 16	13/08/2020	2	1.46	0	0	0.016	0	0	6	43	0	0.003	0.014	0.013	3.12	0	0	0.003	6	0.058
	11/11/2020	2		0					5	40					4.46				5	
	10/02/2021	0		0					3	40					5.62				5	
	17/05/2021	0		0.01					4	39					4.78				5	

Site Name	Sample Date	Mercury mg/L	Nitrate mg/L	Nitrite as N mg/L	Organochlorine Pesticides mg/L	Organophosphate Pesticides mg/L	pH pH	Polycyclic aromatic hydrocarbons µg/L	Potassium mg/L	Sodium mg/L	Sulfate mg/L	Toluene µg/L	Total Dissolved Solids mg/L	Total organic carbon mg/L	Total Petroleum Hydrocarbons mg/L	Total Phenolics mg/L	Xylene µg/L	Zinc mg/L
Monitoring Point 5	13/08/2020	0	0.23	0	0	0	5.1	0	0	93	121	0	526	6	0	0	0	0.173
	11/11/2020						5.2		0	86	118		518	4				
	10/02/2021						5.3		2	74	62		360	0				
	17/05/2021						5.5		0	81	105		460	0				
Monitoring Point 6	13/08/2020	0	0	0	0	0	7.3	0	2	13	10	0	207	9	0	0	0	0.014
	11/11/2020						7.1		4	17	19		376	12				
	10/02/2021						7		3	21	19		285	11				
	17/05/2021						7.1		3	15	22		266	0				
Monitoring Point 7	13/08/2020	0	0.96	0	0	0	4.3	0	0	126	101	0	393	4	0	0	0	0.023
	11/11/2020						4.5		1	111	99		372	2				
	10/02/2021						4.5		1	87	88		318	0				
	17/05/2021						4.6		0	108	94		354	0				
Monitoring Point 12	13/08/2020	0	0.29	0.01	0	0	6.3	0	0	22	65	0	162	4	0	0	0	0.009
	11/11/2020						6		1	20	50		211	5				
	10/02/2021						5.7		1	24	60		168	0				
	17/05/2021						5.9		0	19	54		146	0				
Monitoring Point 13	13/08/2020	0	1.19	0	0	0	6.2	0	4	16	74	0	199	12	0	0	0	0.111
	11/11/2020						6		6	14	23		252	6				
	10/02/2021						5.6		4	15	27		115	0				

	17/05/2021						5.9			4	15	29			217		1						
Monitoring Point 14	13/08/2020	0	0.06	0	0	0	5.3	0		2	8	18	0		146		3	0	0	0	0.019		
	11/11/2020						5.5			2	12	13			77		0						
	10/02/2021						5.2			2	12	13			66		0						
	17/05/2021						5.5			1	10	15			71		0						
Monitoring Point 15	13/08/2020	0	3.64	0.01	0	0	5	0		13	9	30	0		98		5	0	0	0	0.019		
	11/11/2020						5.2			12	9	32			119		5						
	10/02/2021						5.1			13	9	34			113		0						
	17/05/2021						5.4			12	8	28			102		2						
Monitoring Point 16	13/08/2020	0	0.17	0.01	0	0	4.4	0		1	26	28	0		125		3	0	0	0	0.048		
	11/11/2020						4.8			0	25	30			138		0						
	10/02/2021						4.7			0	24	23			110		0						
	17/05/2021						4.9			2	22	24			106		2						

Table 2: Stormwater Results 2020-2021 Reporting Period

- Location Point 8 – adjacent to pony club

Site Name	Sample Date	Ammonia mg/L	Conductivity µS/cm	Dissolved Oxygen mg/L	Faecal Coliforms CFU/100mL	pH pH	Potassium mg/L	Redox Potential mV	Total Dissolved Solids mg/L	Total organic carbon mg/L
Monitoring Point 8	13/08/2020	0.34	809	10.4	16	7.5	16	152	503	15
	11/11/2020	0.56	726	14.6	0	9.4	26	73	522	32
	10/02/2021	0.03	653	19.1	0	9.8	23	35	398	48
	17/05/2021	1.14	857	6.1	0	7.5	23	273	516	7

Table 3: Leachate Results 2020-2021 Reporting Period

Site Name	Sample Date	Alkalinity (as calcium carbonate) mg/L	Aluminium mg/L	Ammonia mg/L	Arsenic mg/L	Barium mg/L	Benzene µg/L	Cadmium mg/L	Calcium mg/L	Chloride mg/L	Chromium (hexavalent) mg/L	Chromium (Total) mg/L	Cobalt mg/L	Conductivity µS/cm	Copper mg/L	Ethyl benzene µg/L	Fluoride mg/L	Lead mg/L	Magnesium mg/L	Manganese mg/L
LEACHATE	13/08/2020	570	0	8.75	0	0.196	0	0	121	45	0	0	0	1,320	0.023	0	0.2	0	56	0.085
	11/11/2020													1,170						
	18/02/2021													964						
	17/05/2021													1,070						

Site Name	Sample Date	Mercury mg/L	Nitrate mg/L	Nitrite as N mg/L	Organochlorine Pesticides mg/L	Organophosphate Pesticides mg/L	pH pH	Polycyclic aromatic hydrocarbons µg/L	Potassium mg/L	Sodium mg/L	Sulfate mg/L	Toluene µg/L	Total Dissolved Solids mg/L	Total organic carbon mg/L	Total Petroleum Hydrocarbons mg/L	Total Phosphorus as P mg/L	Total suspended solids mg/L	Xylene µg/L	Zinc mg/L
LEACHATE	13/08/2020	0	3.42	0.09	0	0	7.5	0	35	63	89	0	732	21	0	0.02	0	0	0
	11/11/2020																		
	18/02/2021																		
	17/05/2021																		

Table 4: Trade Waste Results 2020-2021

Compound Name	Units	09/07/2020	10/07/2020	31/08/2020	01/09/2020	11/11/2020	12/11/2020	17/02/2021	18/02/2021	09/03/2021	17/05/2021	18/05/2021
Ammonia	mg/L		17.9		33.9		23.8		0	0		17.2
Biochemical Oxygen Demand	mg/L						2					
Electrical Conductivity @ 25°C	µS/cm						1,380					
Filterable iron	mg/L		2.4		12.1				0.25	0.39		5.33
Finish Time	hrs		0		0		0		0	0		0
Temperature	°C		16		20		21		21	22		15
Total Dissolved Solids (Calc.)	mg/L		754		1,010		897		663	689		774
Total suspended solids	mg/L		13		49		13		5	27		23
Volume Discharged	kL		82.8		109		22.4		0	0.01		0.14
Volume Discharged (corrected)	kL		82.8		109		22.4		0	0.01		0.14
Meter Reading (start)	kL		37,008.08		43,249.98		46,669.6		47,532.27	47,533.05		51,447.9
Meter Reading (finish)	kL		37,090.86		43,359.01		46,692.02		47,532.27	47,533.06		51,448.04

Compound Name	Units	09/07/2020	10/07/2020	31/08/2020	01/09/2020	11/11/2020	12/11/2020	17/02/2021	18/02/2021	09/03/2021	17/05/2021	18/05/2021
Ammonia	mg/L		17.9		33.9		23.8		0	0		17.2
Biochemical Oxygen Demand	mg/L						2					
Electrical Conductivity @ 25°C	µS/cm						1,380					
Filterable iron	mg/L		2.4		12.1				0.25	0.39		5.33
Finish Time	hrs		0		0		0		0	0		0
Temperature	°C		16		20		21		21	22		15
Total Dissolved Solids (Calc.)	mg/L		754		1,010		897		663	689		774
Total suspended solids	mg/L		13		49		13		5	27		23
Volume Discharged	kL		82.8		109		22.4		0	0.01		0.14
Volume Discharged (corrected)	kL		82.8		109		22.4		0	0.01		0.14
Meter Reading (start)	kL		37,008.08		43,249.98		46,669.6		47,532.27	47,533.05		51,447.9
Meter Reading (finish)	kL		37,090.86		43,359.01		46,692.02		47,532.27	47,533.06		51,448.04
pH (start)	pH	7.1		6.7		6.7		7.2			7.7	
pH (finish)	pH		7.2		6.6		6.8		7.2	7.2		7.8
Ammonia kg/day	kg/day		1.48212		3.6951		0.53312		0	0		0.00241
Biochemical Oxygen Demand kg/day	kg/day						0.0448					
Filterable iron kg/day	kg/day		0.19872		1.3189				0	0		0.00075
Total Dissolved Solids (Calc.) kg/day	kg/day		62.4312		110.09		20.0928		0	0.00689		0.10836
Total suspended solids kg/day	kg/day		1.0764		5.341		0.2912		0	0.00027		0.00322

Table 5: Subsurface Gas Results 2020-2021 Reporting Period

	CH4	CH4 Peak	CO2	CO2 peak	SWL
	% v/v	% v/v	% v/v	% v/v	m
NSW EPA (2016) Solid Waste Landfills	1 % v/v	1 % v/v	1.5 % v/v	1.5 % v/v	

Monitoring Point ID	Sample ID	Sample Date	CH4 %v/v	CH4 Peak %v/v	CO2 %v/v	CO2 Peak %v/v	SWL m
17	LGB5	13/08/2020	0	0	6.6	6.7	1.98
18	LGB6	13/08/2020	0	0	1.9	6.1	2.39
19	LGB7	13/08/2020	0	0	7.6	8	2.63
		13/11/2020	0	0	14.2	14.2	4.28
20	LGB8	13/08/2020	0	0	0.3	0.6	1.23
		13/11/2020	0	0	4.4	4.4	3.32
21	LGB9	13/08/2020	0	0	5.5	5.5	1.25
		13/11/2020	0	0	5.7	5.7	3.7
4	LFGMB1	13/08/2020	0	0	2.4	2.4	1.42

Monitoring Point ID	Sample ID	Sample Date	CH4 %v/v	CH4 Peak %v/v	SWL m
17	LGB5	13/08/2020	0	0	1.98
18	LGB6	13/08/2020	0	0	2.39
19	LGB7	13/08/2020	0	0	2.63
20	LGB8	13/08/2020	0	0	1.23
21	LGB9	13/08/2020	0	0	1.25
4	LFGMB1	13/08/2020	0	0	1.42

EPL 5861-Point 3 : Areas where intermediate or final cover has been placed

Client:	Wollongong City Council	Date:	13/08/2020	Sampler(s)
Site:	Helensburgh Landfill			Robert & Arrian

Transact / Location	Point	GPS North	GPS East	CH4 Conc (ppm)	Comments
A	1	6215914	315809	2.4	
A	2	6215913	315784	2.4	
A	3	9215916	315757	2.4	
A	4	9215917	315735	2.4	
A	5	9215917	315707	2.5	
B	1	6215933	315696	2.4	
B	2	6215932	315713	2.4	
B	3	6215934	315740	2.4	
B	4	6215934	315762	2.4	
B	5	6215932	315786	2.4	
B	6	6215930	315803	2.4	
C	1	6216022	315666	2.3	
C	2	6215990	315669	2.4	
C	3	6215974	315673	2.4	
C	4	6215950	315683	2.4	
C	5	6215939	315688	2.4	
D	1				No Access (Overgrown)
E	1	6216141	315684	2.3	
E	2	6216115	315688	2.3	
E	3	6216089	315699	2.3	
E	4	6216068	315708	2.3	
E	5	6216042	315717	2.4	
E	6	6216000	315719	2.4	

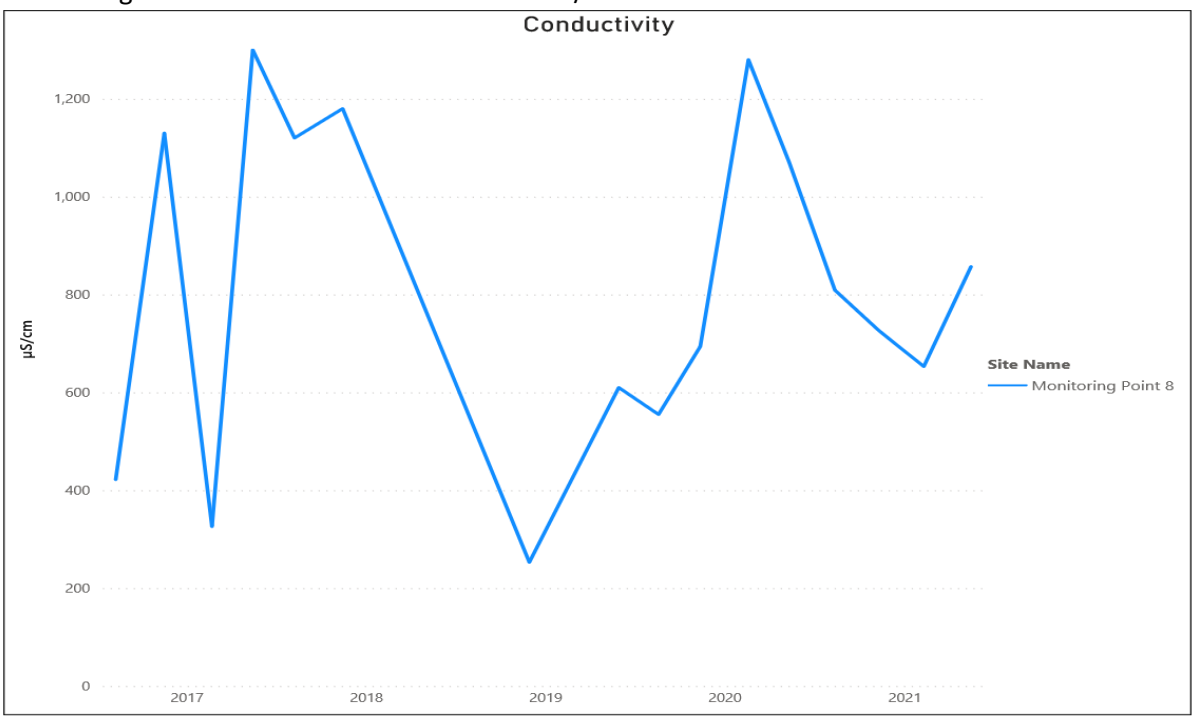
F	1	6171463	304264	2.3	
F	2	6216155	315645	2.3	
F	3	6216150	315658	2.3	
F	4	6216147	315666	2.3	
G	1	6215936	315828	2.3	
G	2	6215981	315828	2.3	
G	3	6216016	315825	2.3	
G	4	6216048	315821	2.4	
G	5	6216086	315805	2.5	
G	6	6216123	315828	2.5	
G	7	6216160	315842	2.5	
H	1	6216160	315792	2.3	
H	2	6216139	315786	2.3	
H	3	6216128	315784	2.3	
H	4	6216109	315782	2.3	
I	1	6216000	315777	2.6	
I	2	6216009	315774	2.5	
I	3	6216034	315771	2.5	
I	4	6216050	315766	2.8	
I	5	6216071	315766	4.5	
I	6	6216105	315772	2.6	
I	7	6216145	315780	2.3	
J	1	6216154	315744	2.3	
J	2	6216138	315745	2.3	
J	3	6216123	315740	2.3	
J	4	6216105	315747	2.3	
J	5	6216082	315750	2.3	
J	6	6216055	315753	2.3	
K	1	6216189	315753	2.3	
K	2	6216214	315750	2.9	
K	3	6216241	315735	2.4	
K	4	6216249	315719	2.4	
K	5	6216244	315694	2.4	
K	6	6216239	315662	2.3	
K	7	6216236	315623	2.3	
K	8	6216218	315572	2.3	
L	1	6216223	315542	2.3	
L	2	6216242	315560	2.3	

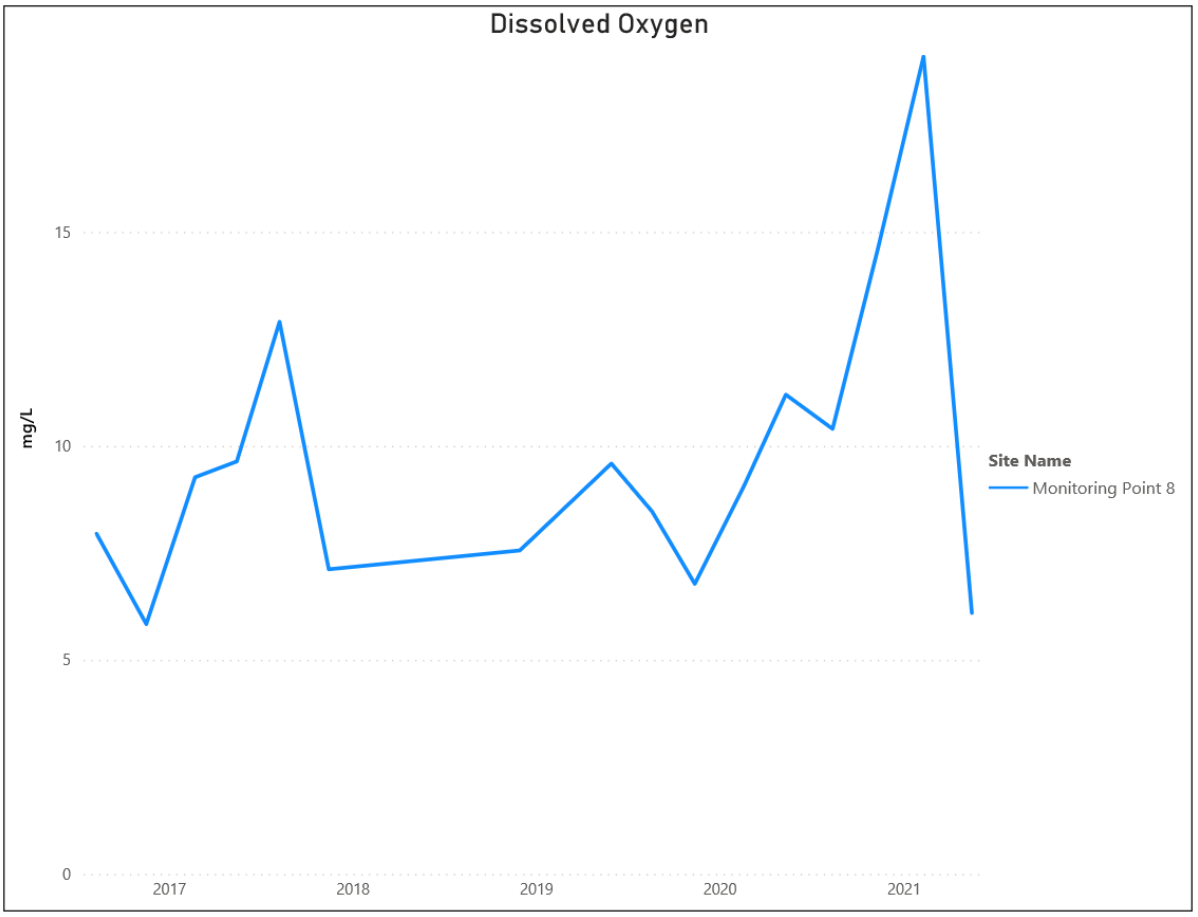
L	3	6216241	315583	2.3	
L	4	6216250	315616	2.3	
L	5	6216259	315655	2.3	
L	6	6216262	315682	2.4	
L	7	6216267	315706	2.3	
M	1	6216236	315691	2.3	
M	2	6216294	315687	2.3	
M	3	6216291	315671	2.4	
M	4	6216287	315665	2.3	
M	5	6216281	315652	2.3	
M	6	6216277	315634	2.4	
M	7	6216273	315619	2.3	
M	8	6216241	315532	2.3	
N	1	6216157	315791	2.3	
N	2	6216155	315803	2.3	
N	3	6216153	315817	2.3	
N	4	6216151	315826	2.3	
N	5	6216149	315836	2.3	
O	1	6216119	315824	2.3	
O	2	6216118	315817	2.3	
O	3	6216121	315809	2.3	
O	4	6216126	315799	2.4	
O	5	6216123	315793	2.4	
O	6	6216123	315787	2.4	
P	1	6216181	315833	2.5	
P	2	6216181	315819	2.5	
P	3	6216183	315805	2.5	
P	4	6216185	315790	2.5	
P	5	6216182	315771	2.5	
Q	1				No Access Overgrown
Methane Blank (Pre testing)	1			2.3	Taken at entrance to Helensburgh site before main gate
Methane Blank (Post testing)	1			2.4	Taken at entrance to Helensburgh site before main gate
Weighbridge office	1				Closed

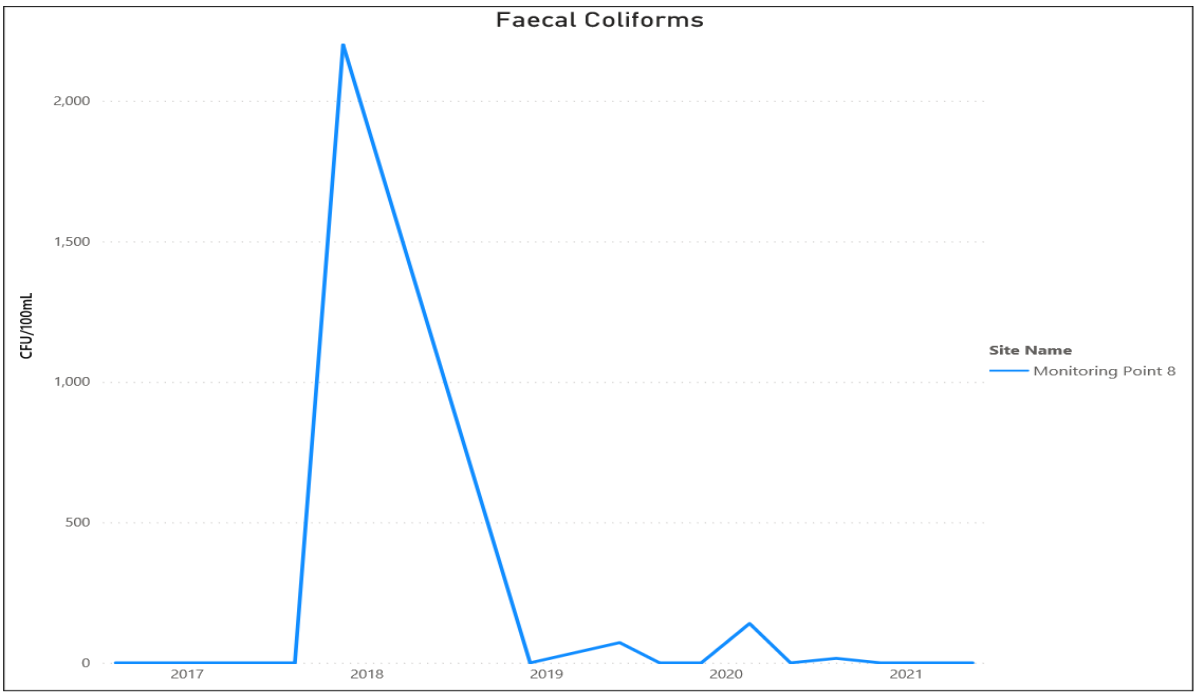
81 Halls Rd fenceline adjoining landfill	1	6216143	315521	2.3	
79 Halls Rd fenceline adjoining landfill	2	6216165	315538	2.3	
77 Halls Rd fenceline adjoining landfill	3	6216203	315542	2.3	
77Halls Rd fenceline adjoining landfill	4	6216231	315544	2.3	
75 Halls Rd fenceline adjoining landfill	5	6215996	315436	2.3	
69 Halls Rd fenceline adjoining landfill	6	6216092	315446	2.3	
1 Nixon Pl fenceline adjoining landfill	7	6216320	554549	2.3	

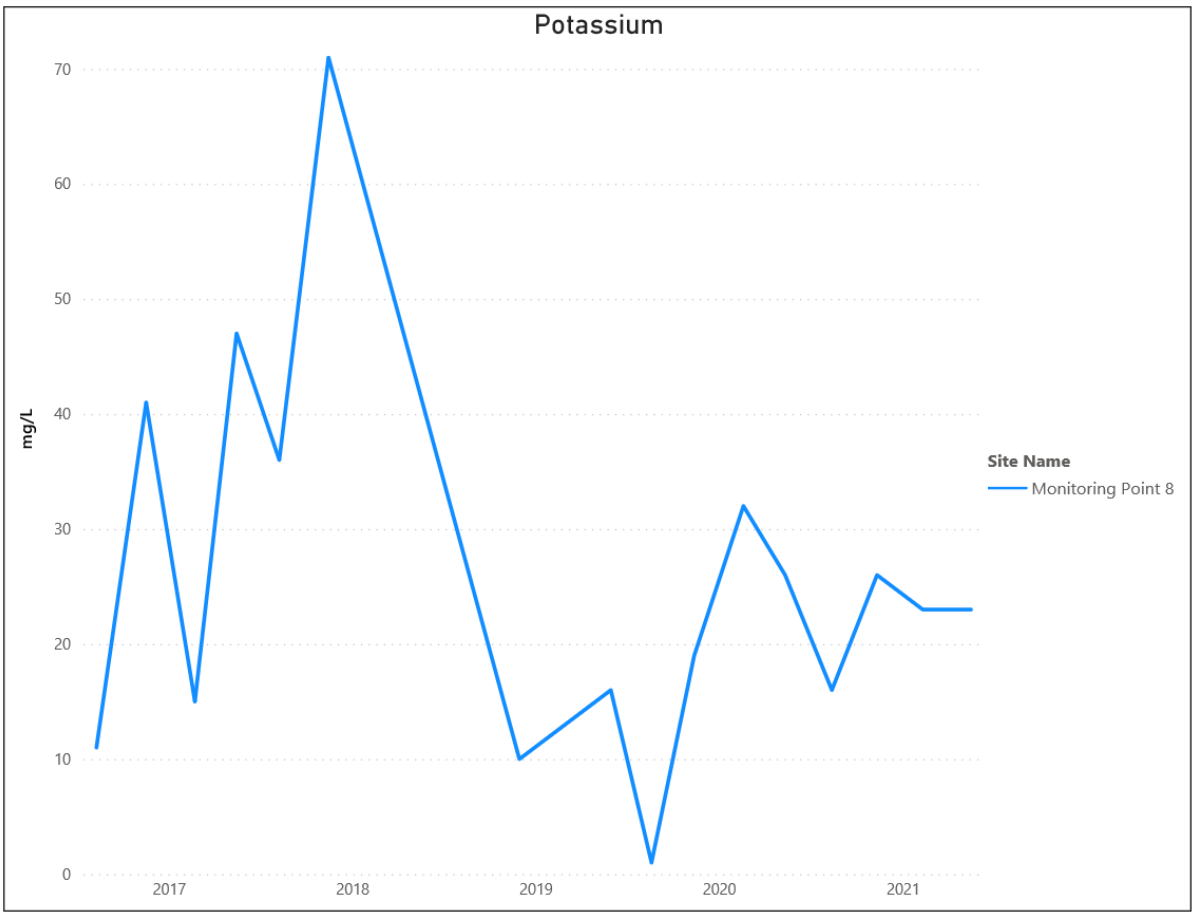
Appendix B

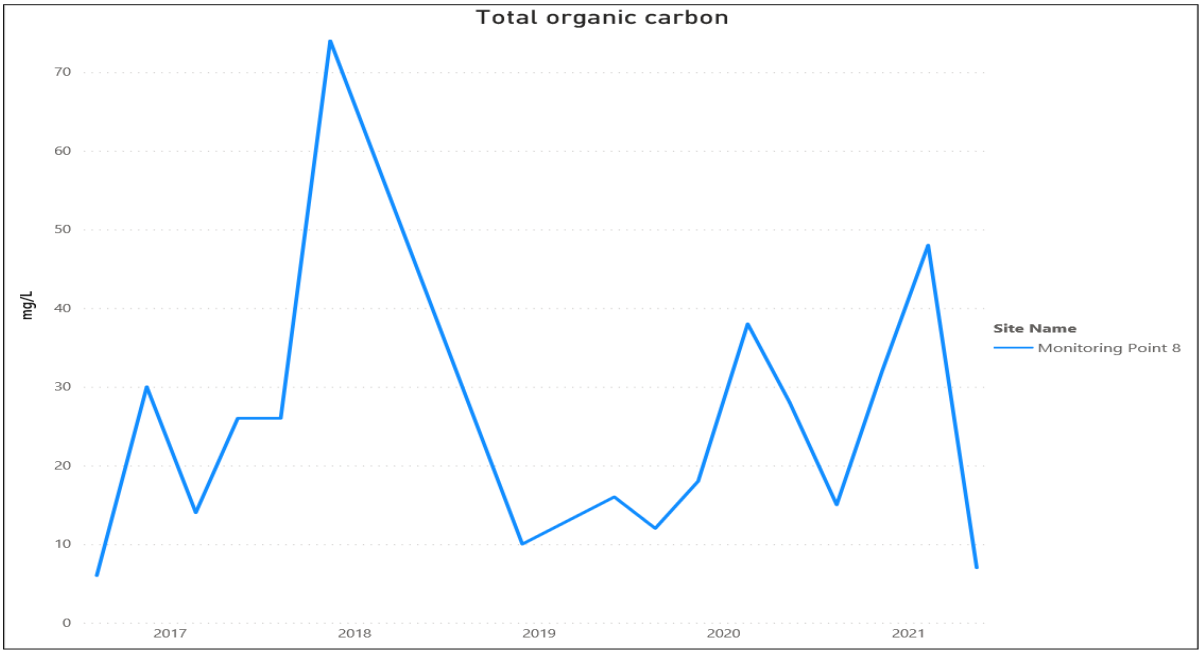
Helensburgh Surface Water Annual Results 2020/2021

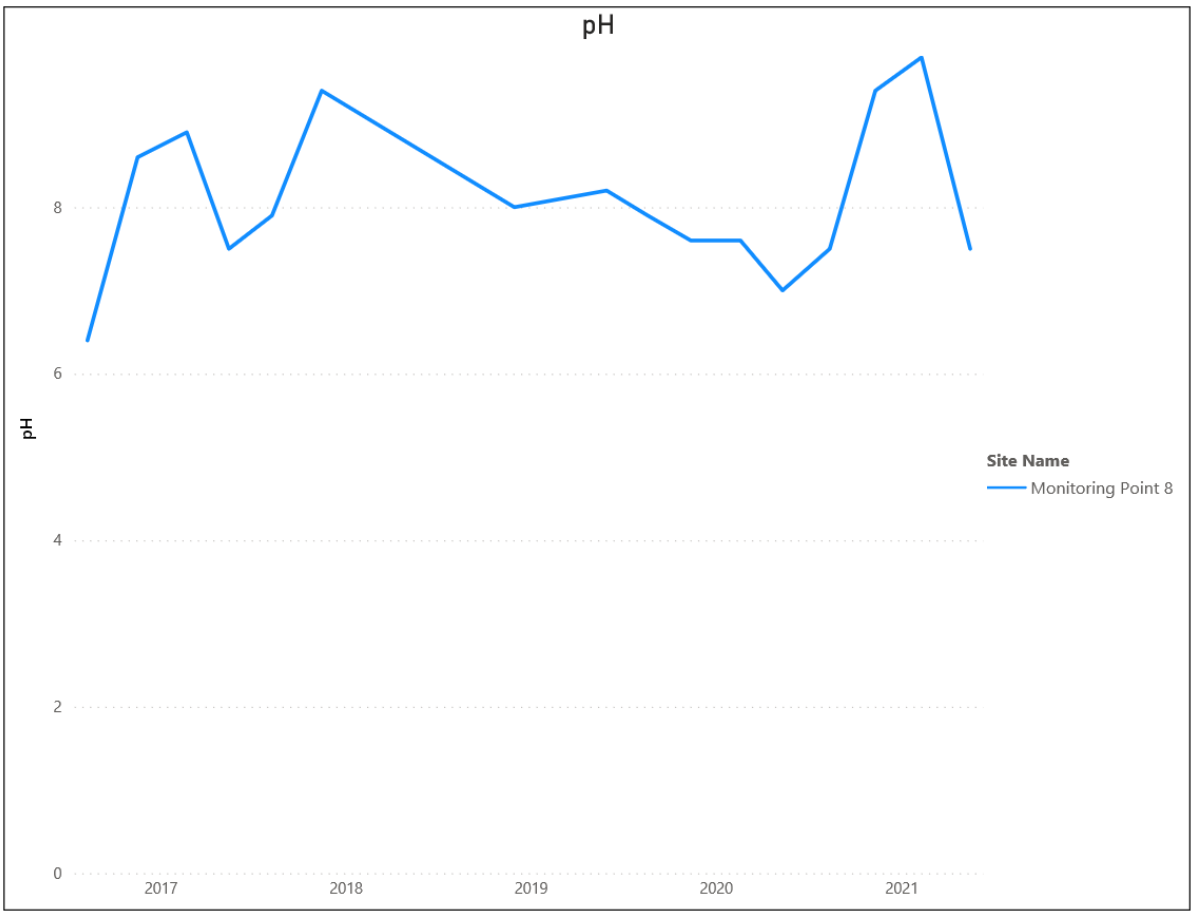


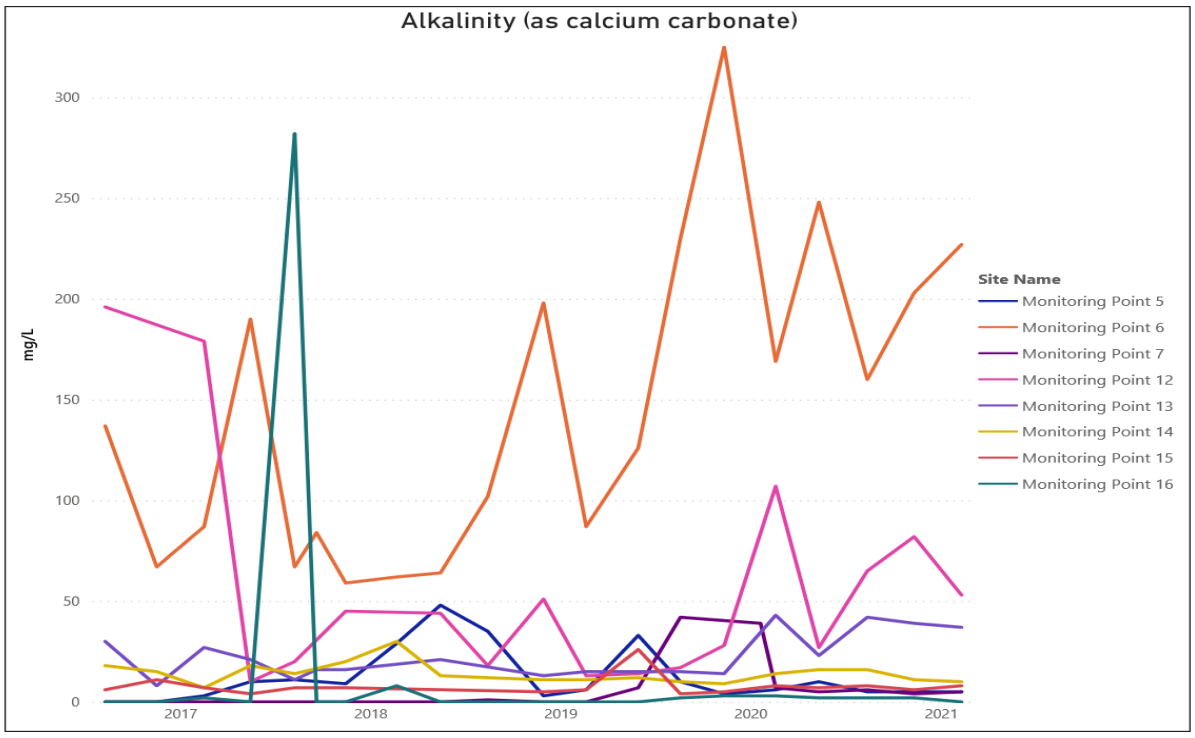


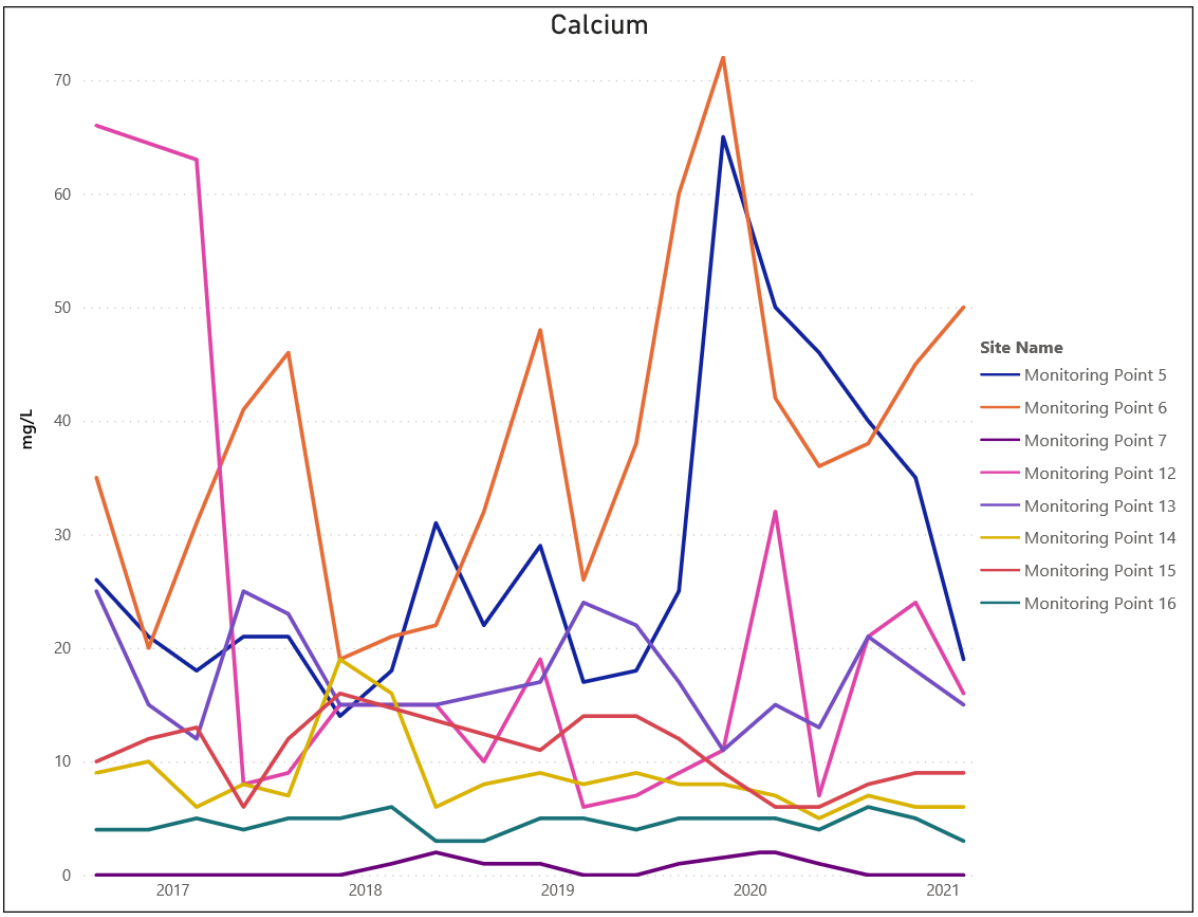

Faecal Coliforms
CFU/100mL
2,000
1,500
1,000
500
0
2017
2018
2019
2020
2021
Site Name
Monitoring Point 8

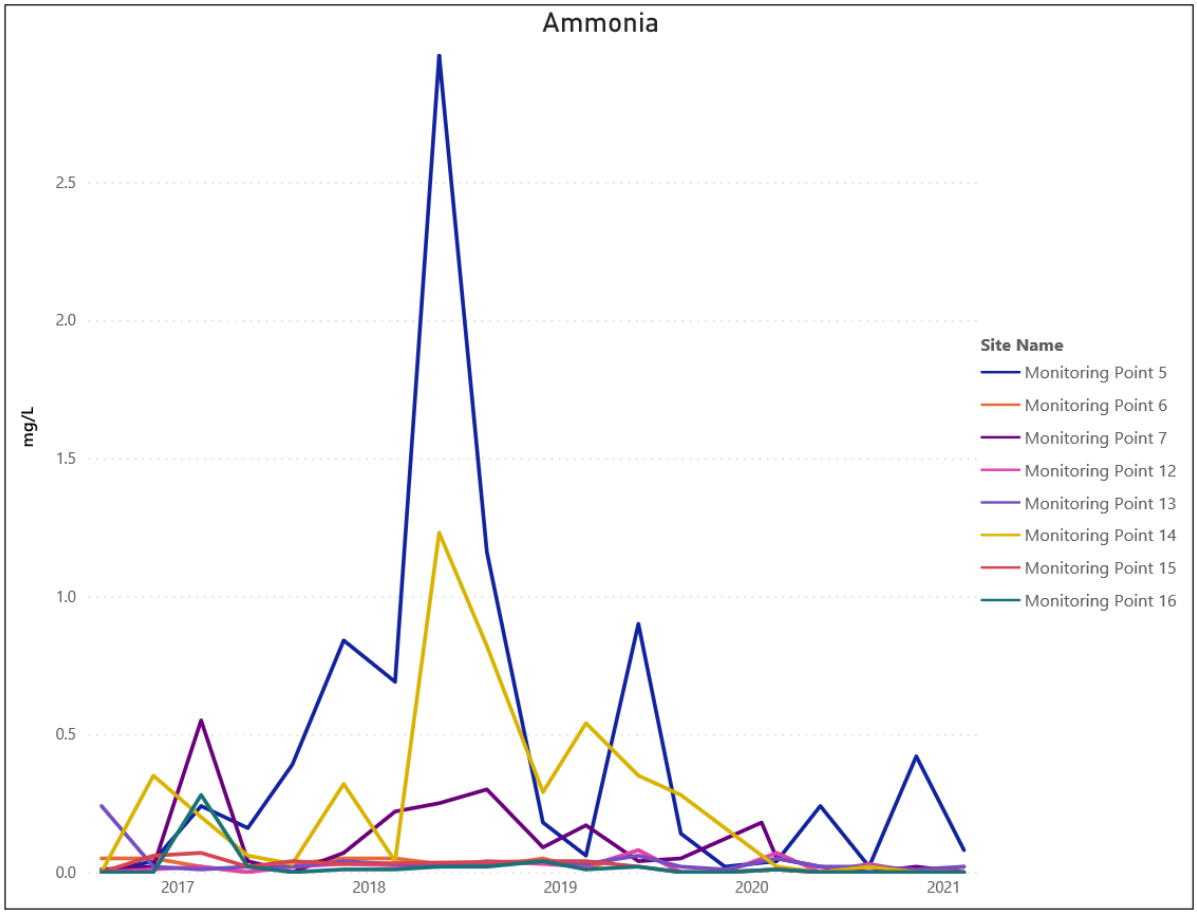

Potassium
mg/L
70
60
50
40
30
20
10
0
2017
2018
2019
2020
2021
Site Name
Monitoring Point 8

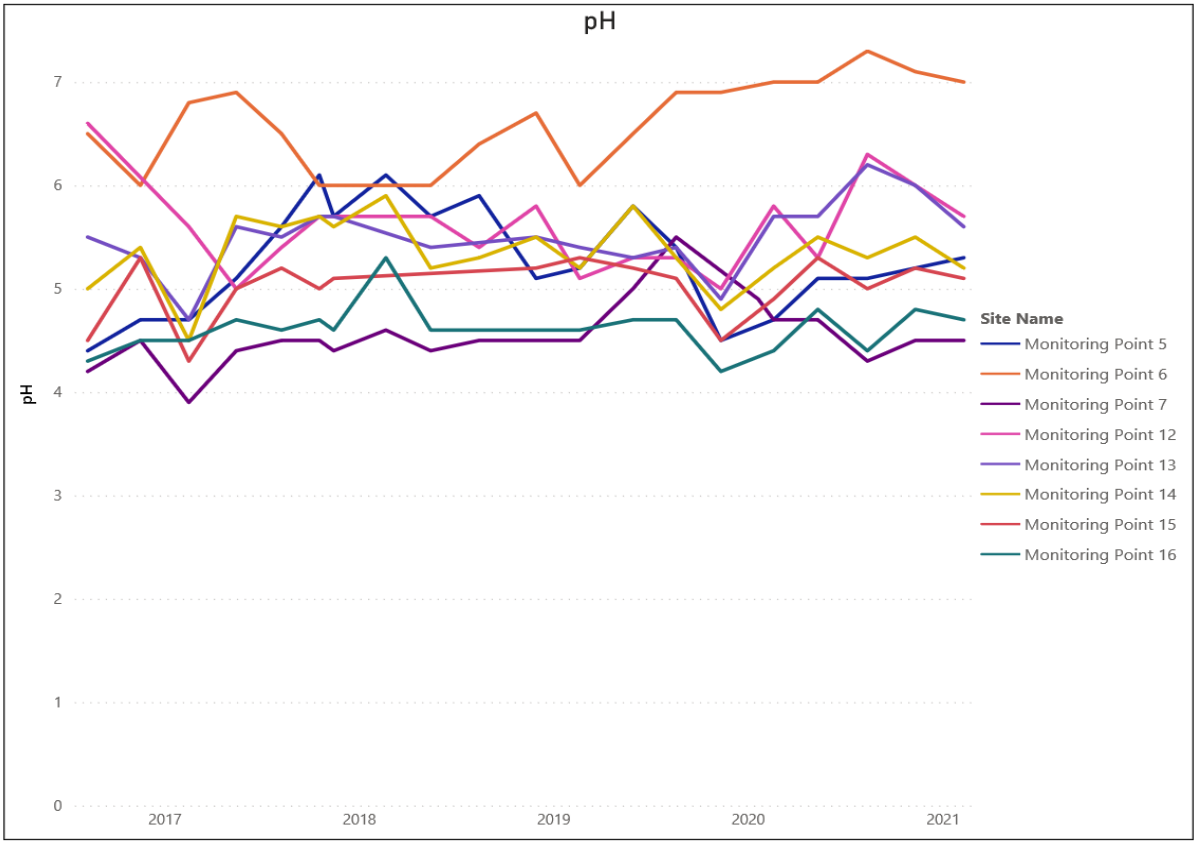

Total organic carbon
mg/L
70
60
50
40
30
20
10
0
2017
2018
2019
2020
2021
Site Name
Monitoring Point 8

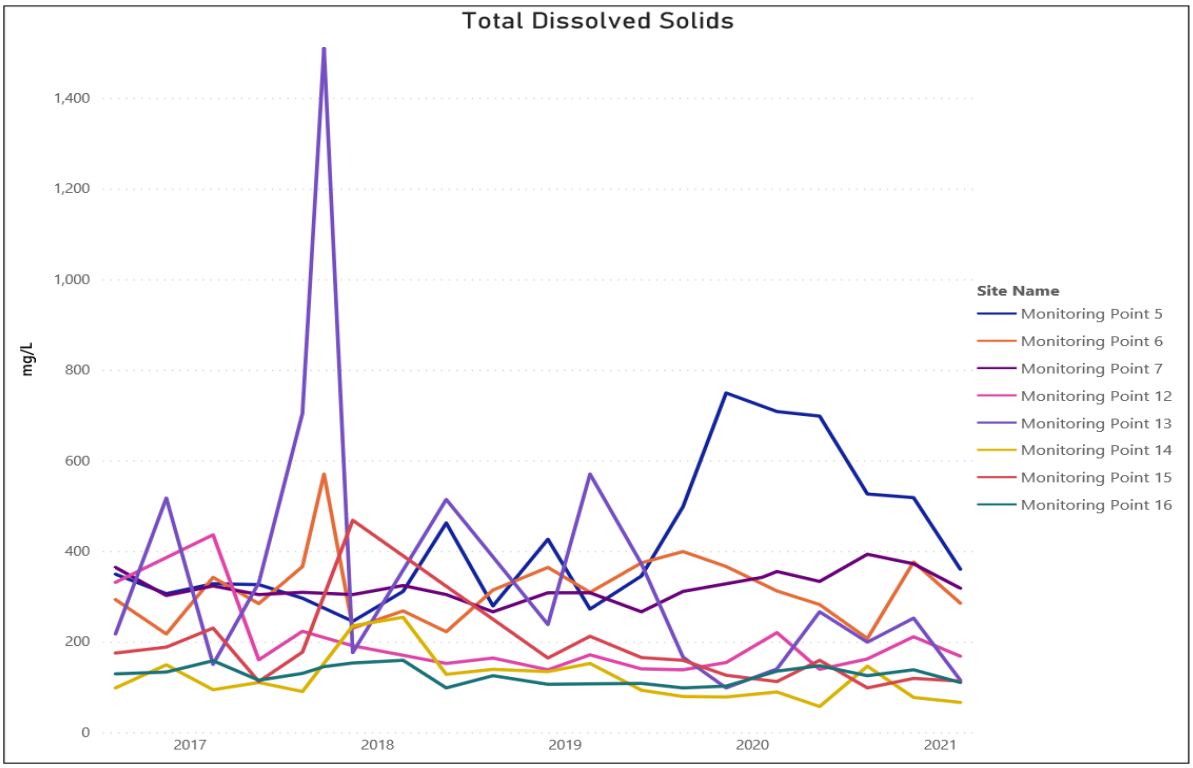

pH
pH
8
6
4
2
0
2017
2018
2019
2020
2021
Site Name
Monitoring Point 8

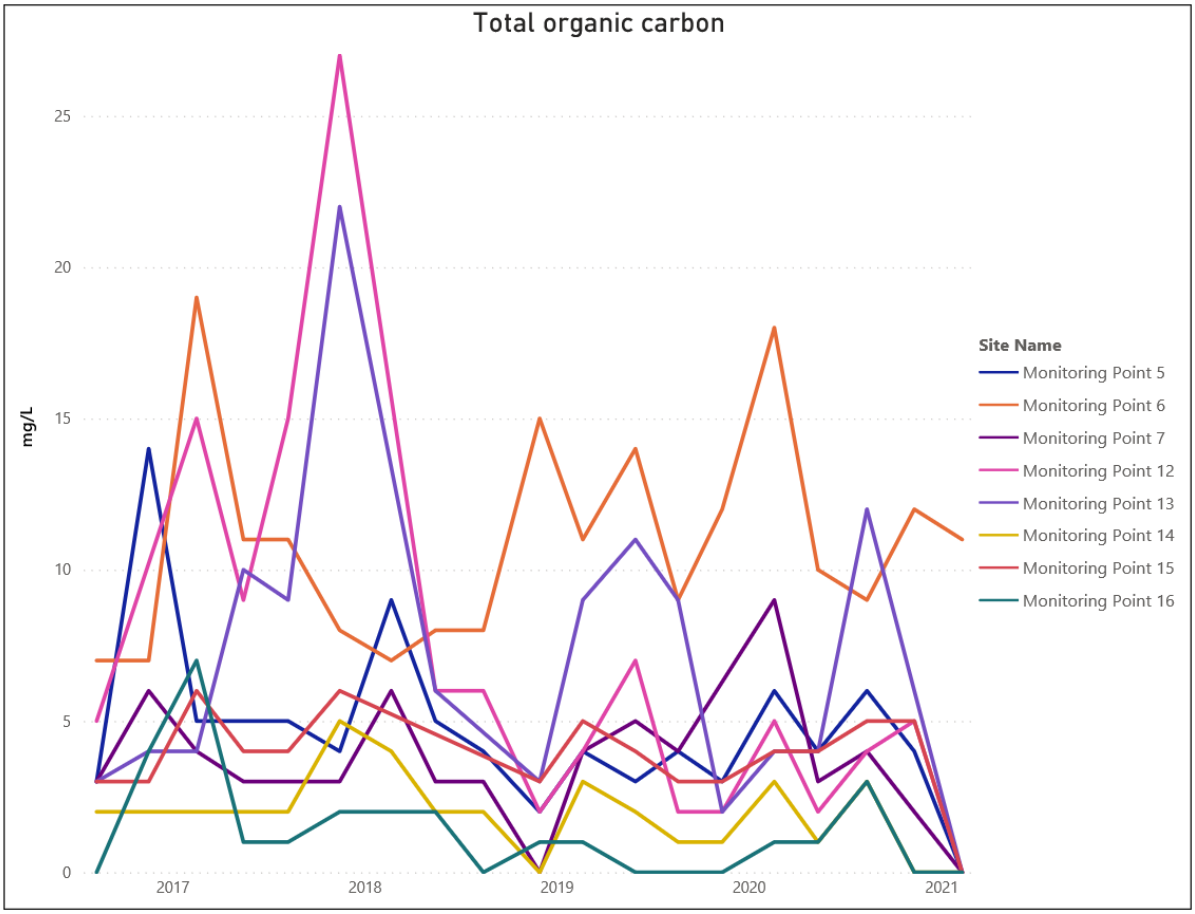

Alkalinity (as calcium carbonate)
mg/L
300
250
200
150
100
50
0
2017
2018
2019
2020
2021
Site Name
Monitoring Point 5
Monitoring Point 6
Monitoring Point 7
Monitoring Point 12
Monitoring Point 13
Monitoring Point 14
Monitoring Point 15
Monitoring Point 16


Calcium
mg/L
70
60
50
40
30
20
10
0
2017
2018
2019
2020
2021
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
2.5
2.0
1.5
1.0
0.5
0.0
2017
2018
2019
2020
2021
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
2017
2018
2019
2020
2021
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
1,400
1,200
1,000
800
600
400
200
0
2017
2018
2019
2020
2021
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
25
20
15
10
5
0
2017
2018
2019
2020
2021
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