Helensburgh Landfill Annual Report 2017-2018

Environmental Protection Licence 5861

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Prepared for

Wollongong City Council

26 July 2018

wollongong
city of innovation

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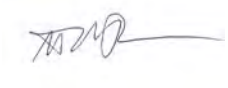

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1 Introduction

1.1 Background

Wollongong City Council (Council) owns and operates the Helensburgh Landfill (the Site), which is located on 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 situated at the north eastern periphery of the township of Helensburgh and is located approximately 300 metres to the east of the Helensburgh Railway Station. The Site is legally identified as Lots 621 and 915 in DP 752033 with the Site boundary illustrated on **Figure 1** of **Appendix A**.

Council holds an Environmental Protection Licence (EPL) Number 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 the activity.

A *Landfill Environmental Management Plan* (LEMP) was prepared in 2008 (GHD 2008) on behalf of Council to ensure that environmental compliance is maintained throughout Site operations 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 The NSW *Environmental Guidelines: Solid Waste Landfills* (EPA 1996) were superseded in 2016 and replaced with the *Environmental Guidelines: Solid Waste Landfills, Second edition* (EPA, 2016).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 *Environmental Guidelines* (EPA 2016).

1.2 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 of May 2017 to the 28th of May 2018.
- Interpretation of monitoring data to assess the environmental performance of the Site considerate of the conditions of the EPL.

1.3 Scope

1.3.1 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 seven landfill gas monitoring wells;
- Water monitoring at three surface water monitoring points;
- Groundwater monitoring at eight groundwater monitoring wells; and
- Monitoring of trade wastewater at one sampling point located at the pre-treatment discharge.

1.3.2 Reporting

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

In accordance with Section 6 (R1.8) of the EPL this Annual Report provides an assessment of environmental performance relevant to the licence 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 these 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 *Environmental Guidelines: Solid Waste Landfills, Second edition* (EPA, 2016) *Requirements for publishing pollution monitoring data* (EPA, 2013).

2 Site Setting

2.1 Site History

The LEMP (GHD, 2008) 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 initial 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 waste 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 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.*
- *Wollongong City Council ordered two "Landfill Lids", to reduce daily cover requirements at this site by approximately 50%. Landfill Lids are used as alternative daily cover and are comprised of a portable rigid steel frame with a tarpaulin attachment.*

2.2 Topography and Drainage

The Site is situated on the upper slopes of a hill on the north 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 on the 23rd of September 2017, 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), and 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** of **Appendix A**.

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 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).

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 Water

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) and the Lucas Heights ANSTO station (ID 066078) to provide indicative climate conditions The Bellambi weather station is located approximately 20 km south of the Site at the base of the escarpment and the Lucas Heights weather station is located 16km north of the site. The data from both stations are considered a reliable representation of the Site conditions during the reporting period.

Table 2-1 summarises the key climatic data from the Bellambi weather station.

Table 2-1 Climatic Data – Bellambi Weather Station

2017								2018			
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Rainfall (mm)	75.2	2.4	21.6	0.4	53.2	75.2	59.6	16.4	62.2	78.2	22.6	8.2
Mean max temperature (°C)	17.4	18.5	18.0	22.0	21.8	21.8	25.3	24.8	25.4	24.7	24.0	20.5
Mean min temperature (°C)	11.3	9.9	10.6	12.4	15.0	15.5	18.6	18.2	18.8	18.5	17.3	12.9
Mean 9am wind speed (km/h)	15	15	20	19	17	14	15	16	17	16	15	14
Mean 3pm wind speed (km/h)	18	19	24	24	22	20	21	22	26	21	19	21
Mean 9am relative humidity (%)	68	52	48	39	68	73	74	72	69	71	65	58
Mean 3pm relative humidity (%)	63	40	47	43	66	66	74	69	68	65	65	56

Long-term averages for the Bellambi weather station are shown in **Table 2-2** and have been included for comparative purposes.

Table 2-2 Long Term Averages – Bellambi Weather Station

2017								2018			
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Rainfall (mm)[1]	129.8	76.7	93.7	54.4	70.8	96.7	73.6	81.4	137.0	121.4	97.4	80.3
Mean max temperature (°C)[1]	17.6	17.0	18.0	20.2	21.7	22.3	24.0	24.9	24.9	24.1	22.2	19.9

2017	2018											
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Mean min temperature (°C)[1]	11.2	10.1	10.6	12.5	14.1	15.8	17.6	19.0	19.2	18.2	15.6	13.1
Mean 9am wind speed (km/h) [2]	17.0	16.7	17.7	18.1	18.2	18.7	17.5	17.0	15.9	15.0	16.1	15.8
Mean 3pm wind speed (km/h)[2]	21.0	20.7	23.6	24.8	24.7	24.6	25.4	24.5	23.9	23.7	22.0	20.9
Mean 9am relative humidity (%)[2]	63	60	56	59	62	72	71	75	76	74	66	63
Mean 3pm relative humidity (%)[2]	59	56	54	61	64	70	69	72	74	70	67	61

[1] Data recorded from 1997 – 2018

[2] Data recorded from 1997 – 2010

Long-term averages for the Lucas Heights Weather station are shown in **Table 2-3** below and have been included for comparative purposes.

Table 2-3 Long Term Averages – Lucas Heights Weather Station

	2017							2018				
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Rainfall (mm)[1]	105.3	53.8	70.9	50.9	69.1	91.3	77.8	96.4	104.8	119.1	92.6	75.6
Mean max temperature (°C)[2]	16.2	15.8	17.2	19.5	21.6	23.4	25.7	25.9	26.0	24.7	22.3	18.9
Mean min temperature (°C)[2]	8.2	6.6	7.4	9.4	11.9	13.7	15.9	17.4	17.6	16.1	13.3	10.1
Mean 9am wind speed (km/h)[2]	8.5	8.3	9.9	9.5	9.8	9.4	8.9	8.5	7.9	7.4	7.3	7.7
Mean 3pm wind speed (km/h)[2]	9.8	10.5	12.6	13.2	13.1	14.1	14.9	13.7	12.5	11.1	10.4	9.3
Mean 9am relative humidity (%)[2]	73	68	65	63	64	66	67	72	74	73	70	72
Mean 3pm relative humidity (%)[2]	61	52	51	52	57	57	57	62	63	63	58	58

[1] Data recorded from 1958 – 2018

[2] Data recorded from 1962 – 1982

The climate data shows relatively dry weather during the reporting period compared to the long term averages. The winter months were particularly dry as was early spring with almost no rainfall recorded in the month of September.

The average maximum and minimum temperatures were generally similar to the long term averages. Mean wind speeds were similar with long-term trends and humidity was lower than long-term trends indicating a dry year which correlates with the low rainfall.

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 gasses (LFG) emanating from the landfill areas at the Site. The purpose of the 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 3-1**. The location of each surface gas monitoring location is shown on **Figure 3** of **Appendix A**.

Table 3-1 Surface Gas Monitoring Methodology

Activity	Description
Frequency and Dates of Monitoring	Surface gas monitoring for methane was completed monthly 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 3-2**. The location of each subsurface gas monitoring location is shown on **Figure 2** of **Appendix A**.

Table 3-2 Subsurface Gas Monitoring Methodology

Activity	Description
Frequency of Monitoring	Subsurface gas monitoring for methane was completed annually 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 seven 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 3-3**. The location of stormwater monitoring locations is shown on **Figure 2** of **Appendix A**.

Table 3-3 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 3-4**. The location of leachate monitoring locations is shown on **Figure 2** of **Appendix A**.

Table 3-4 Leachate Monitoring Methodology

Activity	Description
Frequency of Monitoring	Leachate sampling was completed quarterly to assess electrical conductivity and annually to asses 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.
Analytes	In accordance with Section 5 (M2.3) of EPL 5861 each leachate sample collected during the annual monitoring event was analysed for: ▪ Alkalinity ▪ Aluminium ▪ Arsenic ▪ Barium ▪ Benzene ▪ Cadmium ▪ Calcium ▪ Chloride ▪ Chromium (hexavalent) ▪ Chromium (total) ▪ Cobalt ▪ Copper ▪ Ethylbenzene ▪ Nitrate ▪ Nitrite ▪ Nitrogen (ammonia) ▪ Organochlorine pesticides (OCP) ▪ Organophosphate pesticides (OPP) ▪ pH ▪ Phosphorous (total) ▪ Polycyclic aromatic hydrocarbons (PAH) ▪ Potassium ▪ Sodium ▪ Sulfate ▪ Toluene ▪ TSS

Activity	Description
	▪ Fluoride ▪ Lead ▪ Magnesium ▪ Manganese ▪ Mercury ▪ Total organic carbon (TOC) ▪ Total petroleum hydrocarbons (TPH) ▪ Total phenolics ▪ Total suspended solids (TSS) In accordance with Section 5 (M2.3) of EPL 5861 each leachate sample collected during the (quarterly) monitoring event was analysed for electrical conductivity

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 3-5**. The location of each stormwater monitoring location is shown on **Figure 2** of **Appendix A**.

Table 3-5 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 3-6**. The location of each groundwater monitoring location is shown on **Figure 2** of **Appendix A**.

Table 3-6 Groundwater Monitoring Methodology

Activity	Description
Frequency of 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 <u>Quarterly</u> ▪ Alkalinity

Activity	Description
	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 ▪ Calcium, magnesium, potassium, sodium, chloride, sulfate ▪ pH and conductivity ▪ Standing water level ▪ TDS ▪ TOC ▪ Nitrogen (ammonia)

3.1.7 Trade Wastewater

Monitoring of trade wastewater was completed periodically during the reporting period to confirm that water quality parameters of waste water 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 2017) (the *Consent*). The fieldwork methodology for trade wastewater monitoring is summarised below in **Table 3-7**. The trade waste monitoring location is shown on **Figure 2** of **Appendix A**.

Table 3-7 Trade Wastewater Monitoring Methodology

Activity	Description
Frequency	Trade wastewater sampling was undertaken on the 18th of September 2017 and every 60 days 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. Composite samples were obtained over one full production day by combining equal volumes taken at 1 kilolitre intervals with a minimum volume of 5,000 millilitres obtained over the full day. The reading of the flowmeter was obtained at the commencement and conclusion of each sampling day. 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, 2017) 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** of **Appendix A**.
Analytes	Composite samples were submitted to ALS Environmental for analysis of the following: ▪ Ammonia (as Nitrogen); ▪ 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, 2017): ▪ Temperature; ▪ Colour; ▪ pH; ▪ Fibrous materials; ▪ Gross solids; and ▪ Flammability.

4 Data Quality Objectives

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 US EPA (2000) *Guidance for the Data Quality Objectives 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 data required for making decisions based on the environmental condition of the Site. The DQO process involves the following seven steps detailed in **Table 4-1**.

Table 4-1 Data Quality Objectives

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 2017/2018 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.
Step 4: Define the boundaries of the study	The study site is located at Nixon Place, Helensburgh NSW. The lateral extent of the study is the site boundaries, as shown on **Figure 2** of **Appendix A**. The vertical extent of the study extends into the landfill gas and groundwater monitoring wells installed during previous investigations. The temporal boundaries of the study are from the 29th of May 2017 to the 29th of May 2018 (i.e. the reporting period).
Step 5: Develop the analytical approach	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. ▪ 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.

Activity	Description
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 may be considered to be equivalent for each sampling and analytical event. ▪ Representativeness – 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.

4.2 Data Quality Indicators

The following DQIs referenced in Step 6 in **Table 4-1**, have been adopted in accordance with the NSW EPA (2017) *Guidelines for the NSW Site Auditor Scheme (3rd Edition)*. The DQIs outlined in **Table 4-2** assist with decisions regarding the contamination status of the site, including the quality of the laboratory data obtained.

Table 4-2 Summary of Data Quality Indicators

Data Quality Indicator	Frequency	Data Acceptance Criteria
Completeness		
Field documentation correct	Each sampling event	All samples
Suitably qualified and experience sampler	Each sampling event	All samples
Appropriate lab methods and limits of reporting (LORs)	Each sampling event	All samples
Chain of custodies (COCs) completed appropriately	Each sampling event	All samples
Compliance with all sample holding times	All samples	All samples
Comparability		
Consistent standard operating procedures for collection of each sample. Samples should be collected, preserved and handled in a consistent manner	All samples	All samples
Experienced sampler	All samples	All samples
Climatic conditions (temperature, rain, wind etc) recorded and influence on samples quantified (if required)	All samples	All samples
Consistent analytical methods, laboratories and units	All samples	All samples
Representativeness		
Sampling technique appropriate for each media and analytes (appropriate collection, handling and storage)	All samples	All Samples
Samples homogenous	All samples	All Samples
Detection of laboratory artefacts, e.g. contamination blanks	-	Laboratory artefacts detected and assessed

Data Quality Indicator	Frequency	Data Acceptance Criteria
Samples extracted and analysed within holding times	All samples	All samples
Precision		
Laboratory duplicates	1 per 20 samples	<20% RPD Result > 20 × LOR <50% RPD Result 10-20 × LOR No Limit RPD Result <10 × LOR
Accuracy (Bias)		
Surrogate spikes	All organic samples	50-150%
Matrix spikes	1 per 20 samples	70-130%
Laboratory control samples	1 per 20 samples	70-130%
Method blanks	1 per 20 samples	<LOR

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 Water

5.3.1 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.

5.3.2 Leachate Discharge

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.

5.3.3 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. A conceptual site model is provided in **Section 8.10** that further discusses these interactions.

The *Environmental Guidelines* (EPA 2016) recommends screening groundwater analytical results against the *National Environment Protection (Assessment of Site Contamination) Measure* (National Environment Protection Council, 2013), specifically:

> Schedule B1, Table 1C Groundwater Investigation Levels, which summarises trigger values from:
  - *Australian Water Quality Guidelines* (ANZECC 2000):

    The results were screened against the criteria for 80%, 90% and 95% species protection trigger levels, which refers to the percentage of species expected to be protected. A brief overview of each protection level is provided below:

    - The 80% protection level trigger values apply to ecosystems that are highly disturbed with limited conservation value;
    - The 90% protection level trigger values apply to ecosystems that are moderately disturbed with low conservation value; and
    - The 95% protection level trigger values apply to ecosystems that are slightly to moderately disturbed with a moderate conservation value.

Each protection trigger level was applied to groundwater data gathered during the reporting period, however, given the high level of disturbance at the site and the adjacent state Garrawarra State Conservation Area to the north and east the 95% levels are considered most appropriate to adopt as a performance criteria.

- *Australian Drinking Water Guidelines* (ADWG) (National Health and Medical Research Council and the Natural Resource Management Ministerial Council, 2011, updated 2014).

  Surface water and groundwater are not utilised for human consumption at the Site, however, surface water and groundwater originating at the Site are inferred to discharge into the Hacking River which is a plausible source for human consumption and stock watering. As such the *ADWG* have been adopted.

> Schedule B1, Table 1A (4) Health Screening Levels groundwater for petroleum hydrocarbons.

Surface water results were also screened against the ANZECC (2000) and ADWG (2014) guidelines.

5.3.4 Trade Wastewater

Trade wastewater analytical results were screened against the criteria provided in the *Consent* (Sydney Water, 2017). 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.

5.4 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.

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.

A list of ALS Environmental Work Order numbers applicable to environmental monitoring and analysis completed during the reporting period are summarised below in **Table 6-1**.

Table 6-1 Laboratory Work Order Numbers

Sample Media	Work Order Number	
Groundwater	EW1702162	EW1704667
	EW1703403	EW1704719
	EW1703407	EW1800698
	EW1704002	EW1802028
	EW1704319	
Stormwater	EW1703405	EW1800700
	EW1704721	EW1802030
Leachate	EW1703403	EW1704720
	EW1703404	EW1800699
Trade Wastewater	EW1702189	EW1704747
	EW1703143	EW1800220
	EW1703856	EW1801159

6.2 Surface Gas

The highest reported concentration of methane was 22.2 ppm measured at point 1 of transect K during the August 2017 monitoring event, below the threshold level for further investigation and corrective action of 500 ppm.

A summary of surface gas readings is provided in **Table 1A** to **1C** of **Appendix B**.

6.3 Subsurface Gas

The highest reported concentration of methane was 0.1% (v/v), measured in monitoring point 18 (LGB6) during the July and November 2017 and February 2018 monitoring events, below the threshold level for further investigation and corrective action of 1% (v/v).

A summary of subsurface gas readings is provided in **Table 2** of **Appendix B**.

6.4 Stormwater

Stormwater monitoring did not take place during the reporting period since overflows of the Site stormwater pond did not occur.

6.5 Leachate

No uncontrolled discharges of leachate occurred during the reporting period under dry or wet weather.

Leachate data tables are provided in **Tables 3A** to **3E** 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 3A** of **Appendix B**).

- PAH was 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 3B** of **Appendix B)**. Therefore the results of anthracene and benzo(a)pyrene cannot be screened against the criteria, which is further discussed in **Section 9.2**.
- A summary of heavy metals results is provided below and tabulated in **Table 3B** of **Appendix B**:
  - Copper (total) was reported at a concentration of 0.012 mg/L, above the ANZECC 95% protection trigger level of 0.0014 mg/L but below the ADWG criteria of 2 mg/L.
  - Zinc (total) was reported at a concentration of 0.016 mg/L, above the ANZECC 95% protection trigger level of 0.008 mg/L.
  - Specific trigger values were not provided in the adopted performance criteria for arsenic, barium, calcium, chromium, cobalt, magnesium and potassium.
- A summary of inorganics is provided below and tabulated in **Table 3C** of **Appendix B**:
  - Ammonia was reported at a concentration of 3.73 mg/L, above the ANZECC 95% protection trigger level of 0.9 mg/L.
  - Nitrate was reported at a concentration below the ANZECC 95% protection trigger level.
  - Specific trigger values were not provided in the adopted performance criteria for alkalinity, chloride, fluoride, nitrite, phosphorous, sodium, TDS, TOC, TSS and sulfate.
- A summary organochlorine pesticides is provided below and tabulated in **Table 3D** of **Appendix B**:
  - OCP contaminants aldrin and dieldrin, chlordane, dichlorodiphenyltrichloroethane (DDT), endrin, lindane and heptachlor were not detected above the laboratory limit of response, however, it is noted that the adopted criteria were below the laboratory limit of response. Therefore the results cannot be screened against the criteria, which is further discussed in **Section 9.2**.
- A summary organophosphorus pesticides is provided below and tabulated in **Table 3E** of **Appendix B**:
  - OPP contaminants azinophos methyl, chlorpyrifos, diazinon, dimethoate, malathion, methyl parathion and parathion were not detected above the laboratory limit of response, however, it is noted that the adopted criteria were below the laboratory limit of response. Therefore the results cannot be screened against the criteria, which is further discussed in **Section 9.2**.
  - 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.
- Electrical conductivity was recorded at 1,440 µS/cm (refer to **Table 3C** of **Appendix B)**.
- pH was recorded at 7.6 (refer to **Table 3C** of **Appendix B)**.

6.6 Surface Water

Surface water data tables are provided in **Table 4** of **Appendix B** with the pertinent findings summarised below:

- Faecal coliforms was reported at a maximum concentration of 2,200 CFU/100mL during the November 2017 sampling event, above the ANZECC trigger value for lowland rivers of 1,000 CFU/100mL.
- Ammonia was reported at a maximum concentration of 0.55 mg/L, below the adopted performance criteria.
- pH was recorded at a maximum of 9.4 during the November 2017 sampling event, outside of the acceptable limit for stormwater in EPL 5861 of 6.5 to 8.5.

6.7 Groundwater

6.7.1 Groundwater Levels

Groundwater levels measured at the site during the reporting period are summarised in **Table 5A** of **Appendix B** and ranged from 1.73m below ground level (bgl) in groundwater monitoring point 6 (BH6) to 7.9m bgl in groundwater monitoring point 16 (BH5).

6.7.2 Laboratory Results

Groundwater data tables are provided in **Tables 5B** to **5G** 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 5B** of **Appendix B)**. Therefore the results of anthracene and benzo(a)pyrene cannot be screened against the criteria, which is further discussed in **Section 9.2**.
- A summary of heavy metals results is provided below and tabulated in **Table 5C** of **Appendix B**:
  - Aluminium (total) concentrations ranged from less than the laboratory LOR in monitoring point 14 during the November 2017 monitoring event to 272 mg/L in point 13 during the August 2017 monitoring event. All samples, with the exception of Point 14, contained aluminium above the ANZECC 95% protection trigger level of 0.055 mg/L. The dissolved concentration of aluminium in points 5 and 14 during the November 2017 monitoring event were below the ANZECC 95% trigger level.
  - Arsenic concentrations in Point 6 and Point 13 were both 0.018 mg/L, above the ADWG guideline of 0.01 mg/L.
  - Barium and mercury were reported at concentrations below the adopted performance criteria for all samples.
  - Cadmium (total) concentrations ranged from below the laboratory limit of response (multiple samples) to 0.002 mg/L in monitoring Point 6. Cadmium was reported above the screening criteria in samples collected from Point 5, 6, 13, 14 and 16. The dissolved concentration of cadmium in points 5 and 14 were 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 **Section 9.2**.
  - Copper (total) concentrations ranged from 0.001 mg/L (multiple samples) to 0.138 mg/L (Point 6). Copper was reported above the screening criteria in samples collected from Point 5, 6, 7, 11, 12, 13, 14, 15 and 16. Dissolved copper was below the laboratory LOR for Point 5 and 14.
  - Lead (total) concentrations ranged from below the laboratory limit of reporting (multiple samples) to 0.15 mg/L (Point 13). Lead was reported above the screening criteria in samples collected from Point 5, 6, 7, 11, 12, 13, 14, 15 and 16. Dissolved lead was below the laboratory LOR for Point 5 and 14.
  - Manganese (total) concentrations ranged from 0.011 (Point 12) to 5.92 mg/L (Point 5). The sample collected from Point 5 was above the ADWG guideline of 0.5 mg/L but below the ANZECC 95% protection trigger level of 1.9 mg/L.
  - Zinc (total) concentrations ranged from 0.013 mg/L (Point 14) to 2.4 mg/L (Point 5) with all samples above the ANZECC 95% protection trigger level of 0.008 mg/L. Dissolved zinc was above the ANZECC 95% level in a sample collected from Point 14.
  - 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 5D** of **Appendix B**:
  - Ammonia concentrations ranged from below the laboratory LOR (multiple samples) to 2.96 mg/L in Point 5. Two samples exceeded the adopted criteria with the sample collected from Point 5 and a sample collected from Point 14 exceeding the ANZECC 95% protection trigger level of 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 5.57 mg/L in 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 5E** of **Appendix B**:

- 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, which is further discussed in **Section 9.2**.

> A summary organophosphorus pesticides is provided below and tabulated in **Table 5F** of **Appendix B**:

- 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, which is further discussed in **Section 9.2**.
- 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 4.4 (multiple samples) to 6.9 (Point 6) (refer to **Table 5G** of **Appendix B**).

6.8 Trade Wastewater

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

Trade wastewater monitoring was undertaken six times during the reporting period. The results of monitoring showed that on each 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, 2017).

6.9 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.

6.10 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

A detailed overview of the QA/QC program including, collection of triplicates, duplicates and internal laboratory QA/QC is included in **Appendix C**. A summary of the results of the QA/QC results are included in the following sections.

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.

Samples were received and stored appropriately and all samples with the exception of two occurrences satisfied holding time compliance.

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 D** 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

Heavy metals copper and zinc were reported above the adopted performance criteria during the reporting period. The 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 ANZECC 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.

8.4.1 Trend Analysis

A series of graphs showing trends in leachate contaminant and parameter levels with time are provided in **Sheets 1A** to **1J** of **Appendix D** and are discussed below.

The contaminants and parameters did not deviate significantly from the concentrations reported during the previous three years. Leachate pond water quality parameters including pH and ammonia were either stable or in steady decline.

8.5 Surface Water

The surface water sample collected from Point 8 (pony club) recorded a pH of 9.5, which is outside of the acceptable range for stormwater in EPL 5861 and an elevated concentration of faecal coliforms was reported in excess of the ANZECC trigger value for lowland rivers. The LEMP (GHD, 2008) indicates that the Site historically received “nightsoil and putrescible waste” between the 1960’s and 1991, which may be an attributing factor to the elevated faecal coliform concentration. It is noted also noted that the Helensburgh Pony Club is located immediately east of the site and is cross-gradient of surface water sampling Point 8. Horse manure from the Pony Club therefore may be contributing to the elevated faecal coliform concentrations at Point 8.

The results were unable to be verified due to dry weather conditions during subsequent sampling events. The alkaline pH and presence of faecal coliforms in surface water may be the result of sediment laden run-off or leachate entering the water body including sediments originating from the Helensburgh Pony Club.

8.5.1 Trend Analysis

A series of graphs showing trends in surface water contaminant and parameter levels are provided in **Sheets 2A** to **2C** of **Appendix D** and are discussed below.

Potassium, pH and total organic carbon showed a slight upward trend in concentrations during the reporting period compared with previous years, however, due to dry weather, samples were unable to be collected during the last two scheduled monitoring events and the trend was unable to be confirmed.

The elevated concentration of faecal coliforms was significantly higher than the three years prior, however, it is noted that concentrations of 2,400 CFU/100mL and 8,600 CFU/100mL were reported in 2014 and 2013, respectively.

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** of **Appendix A**. 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.

It is noted that groundwater monitoring points 12, 13 and 15 were dry during the February 2018 monitoring event and monitoring point 15 was dry again during the May 2018 monitoring event. Each of these wells are located in the higher elevations of the site along the western and southern boundaries. Climatic data from the Bellambi weather station summarised in **Table 2-1** indicates that rainfall below average for every month. Consequently the groundwater level in the wells that were dry during the February and May monitoring events were unable to be recorded.

8.6.1.1 Trend Analysis

A series of graphs showing groundwater level trends are provided in **Sheet 3** of **Appendix D** and discussed below. The depth to groundwater was generally greater than previous years and is most likely attributed to drier than usual weather conditions. A slight recovery in groundwater levels (ie a shallower aquifer) was evident in May and may be representative of recharge following a rainfall event.

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.

Numerous heavy metal concentrations were reported above the adopted performance criteria during the reporting period including aluminium, arsenic, cadmium, copper, lead, manganese, and zinc. The 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. Monitoring Points 5, 13 and 14 typically had the highest concentrations of total metals. Points 5 and 14 were analysed for both total and dissolved metals during a November 2017 monitoring with the results showing that that dissolved heavy metal concentrations were significantly lower than total metals (mostly below LOR), with exceedances of the adopted criteria limited to zinc in Point 14, which marginally exceeded the ANZECC 95% protection trigger level.

An elevated concentration of ammonia was reported in samples collected from Points 5 and 14 during the May 2018 sampling event, exceeding the ANZECC 95% protection limit. Ammonia concentrations were significantly lower in the prior monitoring events during the reporting period with no exceedances of the

performance criteria. The elevated ammonia concentrations may indicate potential groundwater interaction with leachate originating at the Site or the results may be anomalous.

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 **Sheet 4A** to **4I** of **Appendix D**, and are discussed below.

The trend graphs shows that contaminant and parameter concentrations have remained steady and relatively consistent with the three years prior, with a general decline in contaminant concentrations. Manganese in point 5 and point 16 increased sharply from the previous year but remained stable in all other wells. Ammonia in point 5 and point 14 also increased sharply from the previous year but are within the long-term range.

It is noted that several monitoring wells were dry during the reporting period and therefore trend analysis was unable to be completed for the entire monitoring well network.

8.7 Trade Wastewater

Trade wastewater was discharged into the sewer network in accordance with the Consent (Sydney Water 2017) with no non-conformances recorded 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 reporting 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 8-1**. Additional details are included in the sections that follow as necessary.

Table 8-1 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.

CSM Element	Description
Site Current and Future Use	The Site is a closed landfill that historically received waste from Wollongong City Council local government area. There is no known future use of the Site.
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. 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: ▪ 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;

CSM Element	Description
	▪ 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.

8.10.2 Data Gaps and Uncertainties

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

9 Conclusions and Recommendations

9.1 Conclusions

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

- Council implemented an environmental monitoring program during the 2017/2018 reporting period that satisfied the conditions and requirements of EPL 5861 and the *Consent to Discharge Industrial Trade Wastewater* (Sydney Water, 2017).
- 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 on Site within the pond and as such the concentrations are not considered a significant risk to human or environmental receptors.
- A surface water body located down gradient of the Site contained elevated faecal coliforms and an alkaline pH during a quarterly monitoring event. Faecal coliforms at monitoring Point 8 has fluctuated between 2 to 2,200 CFU/100mL between 2015 and 2018 and concentrations up to 8,600 CFU/100mL in 2013. As such the faecal coliform content is not considered an environmental concern but should be monitored closely during future monitoring events as discussed below in **Section 9.2**. The LEMP (GHD, 2008) indicates that the Site historically received “nightsoil and putrescible waste” between the 1960’s and 1991, which may be an attributing factor to the elevated faecal coliform concentration. Additionally the Helensburgh Pony Club is located immediately cross-gradient of Point 8 and horse manure may be contributing to faecal coliform concentrations.
- The surface water sample collected from Point 8 (pony club) recorded a pH of 9.4, which is outside of the acceptable range for stormwater in EPL 5861 and an elevated concentration of faecal coliforms. The results were unable to be verified due to dry weather conditions during subsequent sampling events. The pH at this location has fluctuated between 6.4 and 9.4 between 2015 and 2018 and is also not considered an environmental concern but should be monitored closely.
- 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.

9.2 Recommendations

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

- The pH and presence of faecal coliforms in surface water at Point 8 should be closely monitored during the 2018/2019 reporting period. If pH and coliforms are recorded continuously outside of the acceptable range further investigation may be required to identify the source, which may be from the Helensburgh Pony Club which is located up-gradient of Point 8.
- 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.

10 References

ANZECC (2000), Australian Water Quality Guidelines, 2000

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 (2017), Consent to Discharge Industrial Trade Wastewater, 2017

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

APPENDIX A

FIGURES

Location Plan

HELENSBURGH WASTE DISPOSAL DEPOT

Legend

- Perceived Site Boundary
- Distance Buffer
- Major Watercourse (LPI)

Land Use (ABS, 2016)

- Other
- Commercial
- Education
- Hospital/Medical
- Industrial
- Parkland
- Residential
- Water

FIGURE 1

1:60,000 Scale at A3

km
0 0.5 1 1.5 2

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2018-06-21 | Project: 8201819601
Coordinate System: GDA 1994 MGA Zone 56
Map: 82018196-GS-007-HelensburghLocationPlan.mxd 01

EPL ID	Latitude	Longitude
1	-34.178467	151.003066
2	-34.178245	151.003046
4 / 12	-34.178078	151.000061
5	-34.178374	151.000291
6	-34.178452	151.004315
7	-34.177271	151.003955
8	-34.178644	151.002954
13	-34.179134	151.000783
14	-34.179693	151.001092
15	-34.179854	151.002897
16	-34.177764	150.99943
17	-34.177508	150.999816
18	-34.17808	151.000176
19	-34.178829	151.000761
20	-34.179692	151.000985
21	-34.179771	151.002906
Trade Waste Monitoring Point	-34.181071	151.002919

Monitoring Site Locations

HELENSBURGH WASTE DISPOSAL DEPOT

Legend

- Perceived Site Boundary
- Dual (Landfill Gas and Ground Water Monitoring)
- Gas Monitoring Only
- Ground Water Monitoring Only
- Surface Water Monitoring Only
- Trade Waste Monitoring Point
- Inferred Groundwater Flow Direction
- 5m Contours (LPI LiDAR, 2013)
- Cadastre (DFSI-SS, 2017)

FIGURE 2

1:2,500 Scale at A3

m
0 20 40 60 80

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2018-07-23 | Project: 820189601
Coordinate System: GDA 1994 MGA Zone 56
Map: 82018196-GS-005-HelensburghMonitoringLocations 02.mxd 02
Aerial imagery supplied by nearmap (September, 2017)

ID	Latitude	Longitude
1	-34.179866	151.002766
2	-34.179707	151.001152
3	-34.179674	151.002673
4	-34.179567	151.001409
5	-34.179442	151.001352
6	-34.17868	151.001147
7	-34.179284	151.002171
8	-34.17936	151.001538
9	-34.178968	151.001547
10	-34.177784	151.001168
11	-34.177483	151.001163
12	-34.177251	150.999802
13	-34.179421	151.002691
14	-34.177884	151.002858
15	-34.179175	151.002237
16	-34.178082	151.002142
17	-34.179178	151.002134
18	-34.177988	151.002007
19	-34.179057	151.002016
20	-34.178078	151.001919
21	-34.177602	151.002004
22	-34.177012	150.999806
23	-34.176833	151.001684
24	-34.176849	150.99985
25	-34.176617	151.001603
26	-34.176685	151.000189
27	-34.178224	151.002449
28	-34.178246	151.002288
29	-34.178006	151.002517
30	-34.178026	151.002319
31	-34.177813	151.002683
32	-34.177825	151.002229
33	-34.178961	150.998465
34	-34.177738	150.998745

Surface Gas Monitoring Locations

HELENSBURGH WASTE DISPOSAL DEPOT

Legend

- Perceived Site Boundary
- Surface Gas Monitoring Transect
- Cadastre (DFSI-SS, 2017)

FIGURE 3

1:2,000 Scale at A3

m
0 20 40 60 80

N

Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2018-07-12 | Project: 820189601
Coordinate System: GDA 1994 MGA Zone 56
Map: 82018196-GS-008-HelensburghGasMonitoringLocations.mxd 01
Aerial imagery supplied by nearmap (September, 2017)

APPENDIX B

DATA SUMMARY TABLES

Helensburgh
Table 1A -
Surface Gas

Transect	Point	Unit	Level for Investigation and Corrective Action	Date
				9/08/2017
A	1	ppm	500	2.4
	2			2.3
	3			2.3
	4			2.5
	5			2.5
	6			2.2
B	1			2.2
	2			2
	3			2.1
	4			1.9
	5			2
	6			2.1
C	1			2.3
	2			1.9
	3			2.2
	4			2
D	1			-
	2			-
	3			-
	4			-
	5			-
	6			-
E	1			2
	2			2.3
	3			2.2
	4			2
	5			2.2
	6			2.1
	7			2.2
F	1			2
	2			1.6
	3			1.9
	4			1.9

The threshold levels for further investigation and corrective action were adopted from the *Environmental Guidelines: Solid Waste Landfills* (EPA 2016)

Notes:
ppm: parts per million
"-" denotes not accessible

Transect	Point	Unit	Level for Investigation and Corrective Action	Date
				9/08/2017
G	1	ppm	500	2.5
	2			2.4
	3			2.4
	4			2.2
	5			2.6
	6			2.5
	7			2.2
	8			2.2
H	1			2.9
	2			2.2
	3			2.4
	4			2.4
	5			3
	6			2.4
	7			2.4
I	1			2.1
	2			2.1
	3			1.7
	4			5.3
	5			2.9
	6			2.8
J	1			2.2
	2			2.3
	3			2.8
	4			3.3
	5			3.1
	6			2.8
K	1			22.2
	2			3.2
	3			2.3
	4			2.5
	5			2.2
	6			2.6
L	1			2.6
	2			2.3
	3			2.4
	4			2.4
	5			2.3
	6			2.5
	7			2.4

The threshold levels for further investigation and corrective action were adopted from the *Environmental Guidelines: Solid Waste Landfills* (EPA 2016)

Notes:
ppm: parts per million
"-" denotes not accessible

Helensburgh
Table 1C -
Surface Gas

Transect	Point	Unit	Level for Investigation and Corrective Action	Date
				9/08/2017
M	1	ppm	500	2.1
	2			2.5
	3			2.3
	4			2.3
	5			3
	6			2.2
N	1			1.8
	2			1.7
	3			2.2
	4			2.3
O	1			2
	2			2.5
	3			2.2
	4			2.1
	5			2.4
P	1			2.4
	2			2.2
	3			2.2
	4			2.2
	5			1.8
	6			1.9
Q	1			2.4
	2			2.2
	3			2.1
Halls Road and Nixon Place fenceline (adjoining landfill)	4			-
	5			1.9
	6			1.8
Weighbridge Office	1			2.4

The threshold levels for further investigation and corrective action were adopted from the *Environmental Guidelines: Solid Waste Landfills* (EPA 2016)

Notes:
ppm: parts per million
"-" denotes not accessible

Transact	Unit	Level for Investigation and Corrective Action	Date of Monitoring			
			19/07/2017	28/11/2017	21/02/18	29/05/2018
EPA point 4	% v/v	1	0	0	0	0
EPA point 17			0	0	0	0
EPA point 18			0.1	0.1	0.1	0
EPA point 19			0	0	0	0
EPA point 20			0	0	0	0
EPA point 21			0	0	0	0

The threshold levels for further investigation and corrective action were adopted from the *Environmental Guidelines: Solid Waste Landfills* (EPA 2016)

Notes:
% v/v: percentage as volume/volume

	BTEX							TRH					CRC Care TRH Fractions						
	Benzene	Toluene	Ethylbenzene	Xylene (m & p)	Xylene (o)	Xylene Total	Total BTEX	C6 - C9	C10 - C14	C15 - C28	C29-C36	+C10 - C36 (Sum of total)	C6-C10	C10-C16	C16-C34	C34-C40	C10 - C40 (Sum of total)	F1: C6-C10 less BTEX	F2: >C10-C16 less NAPHTHALENE
	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
LOR	1	2	2	2	2	2	1	20	50	100	50	50	20	100	100	100	100	20	100
ADWG 2015 Health	**1**	**800**	**300**			**600**													
ANZECC 2000 Freshwater (80%)	**2000**				**640**														
ANZECC 2000 Fresh Water (90%)	**1300**				**470**														
ANZECC 2000 Fresh Water (95%)	**950**				**350**														
Site ID	**Location Code**	**Sample Date**	**Field ID**																
Helensburgh	Point 2	9/08/2017	Point 2	<1	<2	<2	<2	<2	<2	<1	<20	<50	<100	<50	<50	<20	<100	<100	<100	<100	<20	<100
Statistical Summary																			
Maximum Concentration				<1	<2	<2	<2	<2	<2	<1	<20	<50	<100	<50	<50	<20	<100	<100	<100	<100	<20	<100

Created by SD (15/06/2018), Checked by MB (21/06/2018)

				PAH																			Metals															
				BaP TEQ (zero)	Benzo(b+j)fluoranthene	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a)pyrene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Naphthalene	PAHs (Sum of total)	Phenanthrene	Phenolics Total	Pyrene	Aluminium	Arsenic	Barium	Cadmium	Calcium	Chromium (hexavalent)	Chromium (III+VI)	Cobalt	Copper	Lead	Magnesium	Manganese	Mercury	Potassium	Zinc
				µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
LOR				0.5	1	1	1	1	1	0.5	1	1	1	1	1	1	1	1	0.5	1	50	1	0.01	0.001	0.001	0.0001	1	0.01	0.001	0.001	0.001	0.001	1	0.001	0.0001	1	0.005
ADWG 2015 Health										**0.01**														**0.01**	**2**	**0.002**		**0.05**			**2**	**0.01**		**0.5**	**0.001**		
ANZECC 2000 Freshwater (80%)																		**85**					**0.15**			**0.0008**		**0.04**			**0.0025**	**0.0094**		**3.6**	**0.0054**		**0.031**
ANZECC 2000 Fresh Water (90%)																		**37**					**0.08**			**0.0004**		**0.006**			**0.0018**	**0.0056**		**2.5**	**0.0019**		**0.015**
ANZECC 2000 Fresh Water (95%)								**0.4**										**16**					**0.055**			**0.0002**		**0.001**			**0.0014**	**0.0034**		**1.9**	**0.0006**		**0.008**
Site ID	**Location Code**	**Sample Date**	**Field ID**																																			
Helensburgh	Point 2	9/08/2017	Point 2	<0.5	<1	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<0.5	<1	<50	<1	<0.01	<0.001	0.273	<0.0001	133	<0.01	0.002	<0.001	0.012	<0.001	50	0.141	<0.0001	34	0.016
Statistical Summary																																						
Maximum Concentration				<0.5	<1	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<0.5	<1	<50	<1	<0.01	<0.001	0.273	<0.0001	133	<0.01	0.002	<0.001	0.012	<0.001	50	0.141	<0.0001	34	0.016

Created by SD (15/06/2018), Checked by MB (21/06/2018)

				Inorganics															PH	EC
				Alkalinity (Bicarbonate as CaCO3)	Alkalinity (Carbonate as CaCO3)	Alkalinity (Hydroxide) as CaCO3	Alkalinity (total) as CaCO3	Ammonia as N	Chloride	Fluoride	Nitrate (as N)	Nitrite (as N)	Nitrate & Nitrite (as N)	Phosphorus	Sodium	TDS	TOC	TSS	Sulfate as SO4 - Turbidimetric (Filtered)	pH (Field)	Electrical Conductivity 1:5 soil:water
				mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	pH Units	µS/cm
LOR				1	1	1	1	0.01	1	0.1	0.01	0.01	0.01	0.01	1	1	1	5	1	0.1	1
ADWG 2015 Health										**1.5**											
ANZECC 2000 Freshwater (80%)								**2.3**			**12**										
ANZECC 2000 Fresh Water (90%)								**1.43**			**8.7**										
ANZECC 2000 Fresh Water (95%)								**0.9**			**7.2**										
Site ID	**Location Code**	**Sample Date**	**Field ID**																		
Helensburgh	Point 2	9/08/2017	Point 2	670	<1	<1	670	**3.73**	49	0.3	4.65	0.27	4.92	0.02	93	851	18	<5	35	7.6	1440
Statistical Summary																					
Maximum Concentration				670	<1	<1	670	3.73	49	0.3	4.65	0.27	4.92	0.02	93	851	18	<5	35	7.6	1440

Created by SD (15/06/2018), Checked by MB (21/06/2018)

				Organochlorine Pesticides																							
				4,4-DDE	a-BHC	Aldrin	Aldrin + Dieldrin	b-BHC	Chlordane	Chlordane (cis)	Chlordane (trans)	d-BHC	DDD	DDT	DDT+DDE+DDD	Dieldrin	Endosulfan I	Endosulfan II	Endosulfan sulphate	Endrin	Endrin aldehyde	Endrin ketone	g-BHC (Lindane)	Heptachlor	Heptachlor epoxide	Hexachlorobenzene	Methoxychlor
				µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
LOR				0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	2	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	2
ADWG 2015 Health							**0.3**		**2**					**9**									**10**	**0.3**			
ANZECC 2000 Freshwater (80%)									**0.27**					**0.04**						**0.06**			**1**	**0.7**			
ANZECC 2000 Fresh Water (90%)									**0.14**					**0.02**						**0.04**			**0.4**	**0.25**			
ANZECC 2000 Fresh Water (95%)									**0.08**					**0.01**						**0.02**			**0.2**	**0.09**			
Site ID	**Location Code**	**Sample Date**	**Field ID**																								
Helensburgh	Point 2	9/08/2017	Point 2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2
Statistical Summary																											
Maximum Concentration				<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2

				Organophosphorous Pesticides															Pesticides			
				Azinophos methyl	Bromophos-ethyl	Carbophenothion	Chlorfenvinphos	Chlorpyrifos	Chlorpyrifos-methyl	Diazinon	Dichlorvos	Dimethoate	Ethion	Fenthion	Malathion	Methyl parathion	Monocrotophos	Prothiofos	Demeton-S-methyl	Fenamiphos	Parathion	Pirimphos-ethyl
				µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
LOR				0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	2	2	0.5	0.5	0.5	2	0.5
ADWG 2015 Health				**30**	**10**	**0.5**	**2**	**10**		**4**	**5**	**7**	**4**	**7**	**70**	**0.7**	**2**			**0.5**	**20**	**0.5**
ANZECC 2000 Freshwater (80%)				**0.11**				**1.2**		**2**		**0.3**			**1.1**						**0.04**	
ANZECC 2000 Fresh Water (90%)				**0.05**				**0.11**		**0.2**		**0.2**			**0.2**						**0.01**	
ANZECC 2000 Fresh Water (95%)				**0.02**				**0.01**		**0.01**		**0.15**			**0.05**						**0.004**	
Site ID	**Location Code**	**Sample Date**	**Field ID**																			
Helesburgh	Point 2	9/08/2017	Point 2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2	<2	<0.5	<0.5	<0.5	<2	<0.5
Statistical Summary																						
Maximum Concentration				<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2	<2	<0.5	<0.5	<0.5	<2	<0.5

		EC	Metals	Faecal	Inorganics			Field		
		Electrical Conductivity 1:5 soil:water	Potassium	Faecal Coliforms	Ammonia as N	TDS	TOC	Redox (In-situ)	Dissolved Oxygen	pH (Field)
		µS/cm	mg/L	CFU/100mL	mg/L	mg/L	mg/L	mV	mg/L	pH Units
LOR		1	1	1	0.01	10	1	0.1	0.01	0.1
ADWG 2015 Health										
ANZECC 2000 Freshwater (80%)					**2.3**					
ANZECC 2000 Fresh Water (90%)					**1.43**					
ANZECC 2000 Fresh Water (95%)					**0.9**					
ANZECC 2000 Trigger Values for Lowland Rivers				**1000**						
EPL 5861										**6.5 - 8.5**
Site	**Location Code**	**Sample Date**	**Field ID**							
Helensburgh	Point 8	9/08/2017	Point 8	1120	36	9	0.5	628	26	112	12.9	7.9
		15/11/2017		1180	71	2200	0.55	598	74	112	7.12	**9.4**
		21/02/2018		DRY								
		16/05/2018		DRY								
Statistical Summary										
Maximum Concentration				1180	71	2200	0.55	628	74	112	12.9	9.4

Created by SD (15/06/2018), Checked by MB (21/06/2018)

	Depth
	Depth
	m
LOR	0.01

Site	Location Code	Sampled Date	Field ID	
Helensburgh Groundwater	Point 5	16/05/2017	BH 1	3.1
		19/10/2017	BH1	4.49
		15/11/2017	BH 1	4.76
		21/02/2018	BH 1	5.08
	Point 7	16/05/2017	BH 4	2.78
		19/10/2017	BH4	6.1
		15/11/2017	BH 4	6.38
		21/02/2018	BH 4	7.3
	Point 16	19/10/2017	BH5	7.34
		16/05/2017	BH 5 GWMB5	3.09
		15/11/2017	BH 5 GWMB5	7.56
		21/02/2018	BH 5 GWMB5	7.9
	Point 6	19/10/2017	BH6	4.16
		16/05/2017	BH 6 GWMB6	1.73
		15/11/2017	BH 6 GWMB6	4.22
		21/02/2018	BH 6 GWMB6	4.72
	Point 12	16/05/2017	LGMB1	2.58
		19/10/2017	LGMB1	3.3
		15/11/2017	LGMB1	3.65
	Point 13	16/05/2017	LGMB2	2.66
		19/10/2017	LGMB2	4.7
		15/11/2017	LGMB2	4.6
	Point 14	16/05/2017	LGMB3	2.25
		19/10/2017	LGMB3	4.23
		15/11/2017	LGMB3	4.52
		21/02/2018	LGMB3	5.39
	Point 15	16/05/2017	LGMB4	2.78
		19/10/2017	LGMB4	4.14
		15/11/2017	LGMB4	4.52

Statistical Summary

Maximum Concentration	7.9
Average Concentration	4.5
Standard Deviation	1.7

Helensburgh
Groundwater
Table 5B - BTEX, TRH, CRC Care TRH Fractions, PAHs

				BTEX							TRH					CRC Care TRH Fractions							PAH																			
				Benzene	Toluene	Ethylbenzene	Xylene (m & p)	Xylene (o)	Xylene Total	Total BTEX	C6 - C9	C10 - C14	C15 - C28	C29-C36	+C10 - C36 (Sum of total)	C6-C10	C10-C16	C16-C34	C34-C40	C10 - C40 (Sum of total)	F1: C6-C10 less BTEX	F2: >C10-C16 less NAPHTHALENE	BaP TEQ (zero)	Benzo(b+j)fluoranthene	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a)pyrene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Naphthalene	PAHs (Sum of total)	Phenanthrene	Phenolics Total	Pyrene
				µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
LOR				1	2	2	2	2	2	1	20	50	100	50	50	20	100	100	100	100	20	100	0.5	1	1	1	1	1	0.5	1	1	1	1	1	1	1	0.5	1	50	1
ADWG 2015 Health				**1**	**800**	**300**			**600**																				**0.01**												
ANZECC 2000 Freshwater (80%)				**2000**				**640**																												**85**				
ANZECC 2000 Fresh Water (90%)				**1300**				**470**																												**37**				
ANZECC 2000 Fresh Water (95%)				**950**				**350**																			**0.4**									**16**				
Site	**Location Code**	**Sample Date**	**Field ID**																																							
Helensburgh Groundwater	Point 5	9/08/2017	BH1	<1	<2	<2	<2	<2	<2	<1	<20	<50	<100	<50	<50	<20	<100	<100	<100	<100	<20	<100	<0.5	<1	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<0.5	<1	<50	<1
		19/10/2017	BH1	<1	<2	<2	<2	<2	<2	<1	<20	<50	<100	<50	<50	<20	<100	<100	<100	<100	<20	<100	<0.5	<1	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<0.5	<1	<50	<1
	Point 7	9/08/2017	BH4	<1	<2	<2	<2	<2	<2	<1	<20	<50	<100	<50	<50	<20	<100	<100	<100	<100	<20	<100	<0.5	<1	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<0.5	<1	<50	<1
		19/10/2017	BH4	<1	<2	<2	<2	<2	<2	<1	<20	<50	<100	<50	<50	<20	<100	<100	<100	<100	<20	<100	<0.5	<1	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<0.5	<1	<50	<1
	Point 16	9/08/2017	BH5	<1	<2	<2	<2	<2	<2	<1	<20	<50	<100	<50	<50	<20	<100	<100	<100	<100	<20	<100	<0.5	<1	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<0.5	<1	<50	<1
		19/10/2017	BH5	<1	<2	<2	<2	<2	<2	<1	<20	<50	<100	<50	<50	<20	<100	<100	<100	<100	<20	<100	<0.5	<1	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<0.5	<1	<50	<1
	Point 6	9/08/2017	BH6	<1	<2	<2	<2	<2	<2	<1	<20	<50	<100	<50	<50	<20	<100	<100	<100	<100	<20	<100	<0.5	<1	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<0.5	<1	<50	<1
		19/10/2017	BH6	<1	<2	<2	<2	<2	<2	<1	<20	<50	<100	<50	<50	<20	<100	<100	<100	<100	<20	<100	<0.5	<1	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<0.5	<1	<50	<1
	Point 12	9/08/2017	LGMB1	<1	<2	<2	<2	<2	<2	<1	<20	<50	<100	<50	<50	<20	<100	<100	<100	<100	<20	<100	<0.5	<1	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<0.5	<1	<50	<1
		19/10/2017	LGMB1	<1	<2	<2	<2	<2	<2	<1	<20	<50	<100	<50	<50	<20	<100	<100	<100	<100	<20	<100	<0.5	<1	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<0.5	<1	<50	<1
	Point 13	9/08/2017	LGMB2	<1	<2	<2	<2	<2	<2	<1	<20	<50	<100	<50	<50	<20	<100	<100	<100	<100	<20	<100	<0.5	<1	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<0.5	<1	<50	<1
		19/10/2017	LGMB2	<1	<2	<2	<2	<2	<2	<1	<20	<50	<100	<50	<50	<20	<100	<100	<100	<100	<20	<100	<0.5	<1	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<0.5	<1	<50	<1
	Point 14	9/08/2017	LGMB3	<1	<2	<2	<2	<2	<2	<1	<20	<50	<100	<50	<50	<20	<100	<100	<100	<100	<20	<100	<0.5	<1	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<0.5	<1	<50	<1
		19/10/2017	LGMB3	<1	<2	<2	<2	<2	<2	<1	<20	<50	<100	<50	<50	<20	<100	<100	<100	<100	<20	<100	<0.5	<1	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<0.5	<1	<50	<1
	Point 15	9/08/2017	LGMB4	<1	<2	<2	<2	<2	<2	<1	<20	<50	<100	<50	<50	<20	<100	<100	<100	<100	<20	<100	<0.5	<1	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<0.5	<1	<50	<1
		19/10/2017	LGMB4	<1	<2	<2	<2	<2	<2	<1	<20	<50	<100	<50	<50	<20	<100	<100	<100	<100	<20	<100	<0.5	<1	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<0.5	<1	<50	<1
Statistical Summary																																										
Maximum Concentration				<1	<2	<2	<2	<2	<2	<1	<20	<50	<100	<50	<50	<20	<100	<100	<100	<100	<20	<100	<0.5	<1	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<0.5	<1	<50	<1
Average Concentration				1	2	2	2	2	2	1	20	50	100	50	50	20	100	100	100	100	20	100	0.5	1	1	1	1	1	0.5	1	1	1	1	1	1	1	0.5	1	50	1
Standard Deviation				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

				Metals																										
				Aluminium	Aluminium (Filtered)	Arsenic	Arsenic (Filtered)	Barium	Barium (Filtered)	Cadmium	Cadmium (Filtered)	Calcium	Chromium (hexavalent)	Chromium (III+VI)	Chromium (III+VI) (Filtered)	Cobalt	Cobalt (Filtered)	Copper	Copper (Filtered)	Lead	Lead (Filtered)	Magnesium	Manganese	Manganese (Filtered)	Mercury	Mercury (Filtered)	Potassium	Zinc	Zinc (Filtered)
				mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
LOR				0.01	0.01	0.001	0.001	0.001	0.001	0.0001	0.0001	1	0.01	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	1	0.001	0.001	0.0001	0.0001	1	0.005	0.005
ADWG 2015 Health						**0.01**	**0.01**	**2**	**2**	**0.002**	**0.002**		**0.05**					**2**	**2**	**0.01**	**0.01**		**0.5**	**0.5**	**0.001**	**0.001**			
ANZECC 2000 Freshwater (80%)				**0.15**	**0.15**					**0.0008**	**0.0008**		**0.04**					**0.0025**	**0.0025**	**0.0094**	**0.0094**		**3.6**	**3.6**	**0.0054**	**0.0054**		**0.031**	**0.031**
ANZECC 2000 Fresh Water (90%)				**0.08**	**0.08**					**0.0004**	**0.0004**		**0.006**					**0.0018**	**0.0018**	**0.0056**	**0.0056**		**2.5**	**2.5**	**0.0019**	**0.0019**		**0.015**	**0.015**
ANZECC 2000 Fresh Water (95%)				**0.055**	**0.055**					**0.0002**	**0.0002**		**0.001**					**0.0014**	**0.0014**	**0.0034**	**0.0034**		**1.9**	**1.9**	**0.0006**	**0.0006**		**0.008**	**0.008**
Site	**Location Code**	**Sample Date**	**Field ID**																											
Helensburgh Groundwater	Point 5	16/05/2017	BH 1	-	-	-	-	-	-	-	-	21	-	-	-	-	-	-	-	-	-	20	-	-	-	-	<1	-	-
		9/08/2017	BH1	**1.16**	-	0.002	-	0.031	-	**0.0003**	-	-	**<0.01**	0.001	-	0.005	-	**0.006**	-	**0.011**	-	-	0.249	-	<0.0001	-	-	**0.417**	-
		9/08/2017	BH 1	-	-	-	-	-	-	-	-	21	-	-	-	-	-	-	-	-	-	18	-	-	-	-	<1	-	-
		19/10/2017	BH1	**1.08**	-	0.002	-	0.035	-	**0.0003**	-	-	**<0.01**	0.001	-	0.005	-	**0.003**	-	**0.015**	-	-	**0.592**	-	<0.0001	-	-	**0.988**	-
		9/11/2017	BH1	**2.14**	0.01	0.004	<0.001	0.044	0.03	**0.0008**	<0.0001	-	-	0.002	<0.001	0.006	0.004	**0.019**	<0.001	**0.052**	<0.001	-	0.343	0.33	<0.0001	<0.0001	-	**2.4**	0.006
		15/11/2017	BH 1	-	-	-	-	-	-	-	-	14	-	-	-	-	-	-	-	-	-	12	-	-	-	-	<1	-	-
		21/02/2018	BH 1	-	-	-	-	-	-	-	-	18	-	-	-	-	-	-	-	-	-	14	-	-	-	-	1	-	-
		16/05/2018	BH 1	-	-	-	-	-	-	-	-	31	-	-	-	-	-	-	-	-	-	22	-	-	-	-	2	-	-
	Point 7	16/05/2017	BH 4	-	-	-	-	-	-	-	-	<1	-	-	-	-	-	-	-	-	-	4	-	-	-	-	<1	-	-
		9/08/2017	BH4	**2.15**	-	<0.001	-	0.017	-	<0.0001	-	-	**<0.01**	<0.001	-	0.001	-	0.001	-	**0.004**	-	-	0.046	-	<0.0001	-	-	**0.024**	-
		9/08/2017	BH 4	-	-	-	-	-	-	-	-	<1	-	-	-	-	-	-	-	-	-	5	-	-	-	-	<1	-	-
		19/10/2017	BH4	**2.02**	-	<0.001	-	0.02	-	0.0001	-	-	**<0.01**	<0.001	-	0.002	-	**0.003**	-	0.003	-	-	0.084	-	<0.0001	-	-	**0.044**	-
		15/11/2017	BH 4	-	-	-	-	-	-	-	-	<1	-	-	-	-	-	-	-	-	-	4	-	-	-	-	1	-	-
		21/02/2018	BH 4	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	5	-	-	-	-	2	-	-
		16/05/2018	BH 4	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	5	-	-	-	-	2	-	-
	Point 16	9/08/2017	BH5	**6.28**	-	0.001	-	0.044	-	**0.0004**	-	-	**<0.01**	0.027	-	0.03	-	**0.028**	-	**0.02**	-	-	0.216	-	<0.0001	-	-	**0.072**	-
		19/10/2017	BH5	**0.76**	-	<0.001	-	0.018	-	**0.0004**	-	-	**<0.01**	0.002	-	0.014	-	**0.004**	-	<0.001	-	-	0.348	-	<0.0001	-	-	**0.035**	-
		16/05/2017	BH 5 GWMB5	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	4	-	-	-	-	<1	-	-
		9/08/2017	BH 5 GWMB5	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	5	-	-	-	-	2	-	-
		15/11/2017	BH 5 GWMB5	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	6	-	-	-	-	3	-	-
		21/02/2018	BH 5 GWMB5	-	-	-	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-	7	-	-	-	-	2	-	-
		16/05/2018	BH 5 GWMB5	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	5	-	-	-	-	2	-	-
	Point 6	9/08/2017	BH6	**33.2**	-	**0.018**	-	0.407	-	**0.002**	-	-	**<0.01**	0.201	-	0.062	-	**0.138**	-	**0.066**	-	-	0.421	-	<0.0001	-	-	**0.085**	-
		19/10/2017	BH6	**7.9**	-	0.005	-	0.111	-	**0.0005**	-	-	**<0.01**	0.029	-	0.016	-	**0.024**	-	**0.014**	-	-	0.207	-	<0.0001	-	-	**0.028**	-
		16/05/2017	BH 6 GWMB6	-	-	-	-	-	-	-	-	41	-	-	-	-	-	-	-	-	-	27	-	-	-	-	5	-	-
		9/08/2017	BH 6 GWMB6	-	-	-	-	-	-	-	-	46	-	-	-	-	-	-	-	-	-	20	-	-	-	-	7	-	-
		15/11/2017	BH 6 GWMB6	-	-	-	-	-	-	-	-	19	-	-	-	-	-	-	-	-	-	9	-	-	-	-	4	-	-
		21/02/2018	BH 6 GWMB6	-	-	-	-	-	-	-	-	21	-	-	-	-	-	-	-	-	-	9	-	-	-	-	4	-	-
		16/05/2018	BH 6 GWMB6	-	-	-	-	-	-	-	-	22	-	-	-	-	-	-	-	-	-	12	-	-	-	-	4	-	-
	Point 12	16/05/2017	LGMB1	-	-	-	-	-	-	-	-	8	-	-	-	-	-	-	-	-	-	8	-	-	-	-	3	-	-
		9/08/2017	LGMB1	**39.8**	-	0.005	-	0.121	-	0.0001	-	-	**<0.01**	0.039	-	0.007	-	**0.063**	-	**0.054**	-	-	0.019	-	<0.0001	-	-	**0.036**	-
		9/08/2017	LGMB1	-	-	-	-	-	-	-	-	9	-	-	-	-	-	-	-	-	-	7	-	-	-	-	4	-	-
		19/10/2017	LGMB1	**3.71**	-	<0.001	-	0.022	-	<0.0001	-	-	**<0.01**	0.001	-	<0.001	-	**0.004**	-	0.001	-	-	0.008	-	<0.0001	-	-	**0.015**	-
		15/11/2017	LGMB1	-	-	-	-	-	-	-	-	15	-	-	-	-	-	-	-	-	-	7	-	-	-	-	1	-	-
		16/05/2018	LGMB1	-	-	-	-	-	-	-	-	15	-	-	-	-	-	-	-	-	-	7	-	-	-	-	2	-	-
	Point 13	16/05/2017	LGMB2	-	-	-	-	-	-	-	-	25	-	-	-	-	-	-	-	-	-	13	-	-	-	-	8	-	-
		9/08/2017	LGMB2	**272**	-	**0.018**	-	0.218	-	**0.0007**	-	-	**<0.01**	0.425	-	0.011	-	**0.105**	-	**0.15**	-	-	0.231	-	0.0002	-	-	**0.872**	-
		9/08/2017	LGMB2	-	-	-	-	-	-	-	-	23	-	-	-	-	-	-	-	-	-	11	-	-	-	-	6	-	-
		19/10/2017	LGMB2	**16.7**	-	0.003	-	0.035	-	<0.0001	-	-	**<0.01**	0.025	-	0.001	-	**0.008**	-	**0.01**	-	-	0.04	-	<0.0001	-	-	**0.082**	-
		15/11/2017	LGMB2	-	-	-	-	-	-	-	-	15	-	-	-	-	-	-	-	-	-	6	-	-	-	-	5	-	-
		16/05/2018	LGMB2	-	-	-	-	-	-	-	-	15	-	-	-	-	-	-	-	-	-	6	-	-	-	-	4	-	-
	Point 14	16/05/2017	LGMB3	-	-	-	-	-	-	-	-	8	-	-	-	-	-	-	-	-	-	5	-	-	-	-	5	-	-
		9/08/2017	LGMB3	**4.71**	-	<0.001	-	0.014	-	**0.0002**	-	-	**<0.01**	0.007	-	0.002	-	**0.004**	-	**0.005**	-	-	0.011	-	<0.0001	-	-	**0.022**	-
		9/08/2017	LGMB3	-	-	-	-	-	-	-	-	7	-	-	-	-	-	-	-	-	-	4	-	-	-	-	3	-	-
		19/10/2017	LGMB3	**5.18**	-	0.002	-	0.019	-	**0.0002**	-	-	**<0.01**	0.009	-	0.005	-	**0.012**	-	**0.01**	-	-	0.022	-	<0.0001	-	-	**0.057**	-
		9/11/2017	LGMB3	<0.01	<0.01	<0.001	<0.001	0.005	0.005	**0.0002**	<0.0001	-	-	<0.001	<0.001	0.002	<0.001	0.001	<0.001	<0.001	<0.001	-	0.016	0.018	<0.0001	<0.0001	-	**0.013**	**0.012**
		15/11/2017	LGMB3	-	-	-	-	-	-	-	-	19	-	-	-	-	-	-	-	-	-	10	-	-	-	-	8	-	-
		21/02/2018	LGMB3	-	-	-	-	-	-	-	-	16	-	-	-	-	-	-	-	-	-	8	-	-	-	-	4	-	-
		16/05/2018	LGMB3	-	-	-	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-	4	-	-	-	-	4	-	-
	Point 15	16/05/2017	LGMB4	-	-	-	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-	4	-	-	-	-	21	-	-
		9/08/2017	LGMB4	**23.1**	-	0.002	-	0.022	-	0.0001	-	-	**<0.01**	0.034	-	0.001	-	**0.009**	-	**0.014**	-	-	0.062	-	<0.0001	-	-	**0.061**	-
		9/08/2017	LGMB4	-	-	-	-	-	-	-	-	12	-	-	-	-	-	-	-	-	-	6	-	-	-	-	28	-	-
		19/10/2017	LGMB4	**2.01**	-	<0.001	-	0.008	-	<0.0001	-	-	**<0.01**	0.003	-	<0.001	-	**0.002**	-	0.003	-	-	0.042	-	<0.0001	-	-	**0.03**	-
		15/11/2017	LGMB4	-	-	-	-	-	-	-	-	16	-	-	-	-	-	-	-	-	-	7	-	-	-	-	35	-	-
Statistical Summary																														
Maximum Concentration				272	0.01	0.018	<0.001	0.407	0.03	0.002	<0.0001	46	<0.01	0.425	<0.001	0.062	0.004	0.138	<0.001	0.15	<0.001	27	0.592	0.33	0.0002	<0.0001	35	2.4	0.012
Average Concentration				24		0.0038		0.066		0.00037		14	0.01	0.045		0.0096		0.024		0.024		9.1	0.16		0.00011		5.2	0.29	
Standard Deviation				63		0.0053		0.1		0.00046		11	0	0.11		0.015		0.039		0.037		5.8	0.17		0.000024		7.4	0.6	

				Inorganics														
				Alkalinity (Bicarbonate as CaCO3)	Alkalinity (Carbonate as CaCO3)	Alkalinity (Hydroxide) as CaCO3	Alkalinity (total) as CaCO3	Ammonia as N	Chloride	Fluoride	Nitrate (as N)	Nitrite (as N)	Nitrate & Nitrite (as N)	Sodium	TDS	TOC	Sulfate as SO4 - Turbidimetric (Filtered)
				mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
LOR				1	1	1	1	0.01	1	0.1	0.01	0.01	0.01	1	1	1	1
ADWG 2015 Health										**1.5**							
ANZECC 2000 Freshwater (80%)								**2.3**			**12**						
ANZECC 2000 Fresh Water (90%)								**1.43**			**8.7**						
ANZECC 2000 Fresh Water (95%)								**0.9**			**7.2**						
Site	**Location Code**	**Sample Date**	**Field ID**														
Helensburgh	Point 5	16/05/2017	BH 1	10	<1	<1	10	0.16	73	-	-	-	-	43	326	5	96
		9/08/2017	BH1	-	-	-	-	-	-	<0.1	0.32	<0.01	0.32	-	-	-	-
		9/08/2017	BH 1	11	<1	<1	11	0.39	84	-	-	-	-	46	296	5	75
		19/10/2017	BH1	-	-	-	-	-	-	<0.1	0.08	<0.01	0.08	-	-	-	-
		15/11/2017	BH 1	9	<1	<1	9	0.84	107	-	-	-	-	48	245	4	45
		21/02/2018	BH 1	29	<1	<1	29	0.69	84	-	-	-	-	51	311	9	59
		16/05/2018	BH 1	48	<1	<1	48	**2.96**	152	-	-	-	-	63	462	5	73
	Point 7	16/05/2017	BH 4	<1	<1	<1	<1	0.04	103	-	-	-	-	100	304	3	96
		9/08/2017	BH4	-	-	-	-	-	-	<0.1	0.58	<0.01	0.58	-	-	-	-
		9/08/2017	BH 4	<1	<1	<1	<1	<0.01	84	-	-	-	-	94	309	3	86
		19/10/2017	BH4	-	-	-	-	-	-	<0.1	0.56	<0.01	0.56	-	-	-	-
		15/11/2017	BH 4	<1	<1	<1	<1	0.07	71	-	-	-	-	86	304	3	95
		21/02/2018	BH 4	<1	<1	<1	<1	0.22	72	-	-	-	-	88	324	6	108
		16/05/2018	BH 4	<1	<1	<1	<1	0.25	75	-	-	-	-	79	304	3	90
	Point 16	9/08/2017	BH5	-	-	-	-	-	-	<0.1	0.26	<0.01	0.26	-	-	-	-
		19/10/2017	BH5	-	-	-	-	-	-	<0.1	0.1	<0.01	0.1	-	-	-	-
		16/05/2017	BH 5 GWMB5	<1	<1	<1	<1	0.02	34	-	-	-	-	34	115	1	23
		9/08/2017	BH 5 GWMB5	282	<1	<1	282	<0.01	40	-	-	-	-	24	130	1	22
		20/09/2017	BH5 GWMB5	<1	<1	<1	<1	-	-	-	-	-	-	-	128 - 145	-	-
		15/11/2017	BH 5 GWMB5	<1	<1	<1	<1	0.01	41	-	-	-	-	24	153	2	22
		21/02/2018	BH 5 GWMB5	8	<1	<1	8	0.01	38	-	-	-	-	24	159	2	34
		16/05/2018	BH 5 GWMB5	<1	<1	<1	<1	0.02	40	-	-	-	-	23	98	2	19
	Point 6	9/08/2017	BH6	-	-	-	-	-	-	<0.1	<0.01	<0.01	<0.01	-	-	-	-
		19/10/2017	BH6	-	-	-	-	-	-	<0.1	<0.01	<0.01	<0.01	-	-	-	-
		16/05/2017	BH 6 GWMB6	190	<1	<1	190	<0.01	13	-	-	-	-	21	284	11	<1
		9/08/2017	BH 6 GWMB6	67	<1	<1	67	0.03	17	-	-	-	-	18	366	11	30
		20/09/2017	BH6 GWMB6	79 - 84	<1	<1	79 - 84	-	-	-	-	-	-	-	279 - 570	-	-
		15/11/2017	BH 6 GWMB6	59	<1	<1	59	0.05	28	-	-	-	-	25	230	8	32
		21/02/2018	BH 6 GWMB6	62	<1	<1	62	0.05	27	-	-	-	-	26	268	7	31
		16/05/2018	BH 6 GWMB6	64	<1	<1	64	0.03	41	-	-	-	-	27	222	8	40
	Point 12	16/05/2017	LGMB1	10	<1	<1	10	<0.01	14	-	-	-	-	37	160	9	68
		9/08/2017	LGMB1	-	-	-	-	-	-	<0.1	0.21	<0.01	0.21	-	-	-	-
		9/08/2017	LGMB1	20	<1	<1	20	0.02	19	-	-	-	-	26	223	15	56
		19/10/2017	LGMB1	-	-	-	-	-	-	<0.1	<0.01	<0.01	<0.01	-	-	-	-
		15/11/2017	LGMB1	45	<1	<1	45	0.03	17	-	-	-	-	30	191	27	62
		16/05/2018	LGMB1	44	<1	<1	44	0.02	24	-	-	-	-	31	152	6	62
	Point 13	16/05/2017	LGMB2	21	<1	<1	21	0.02	38	-	-	-	-	36	330	10	28
		9/08/2017	LGMB2	-	-	-	-	-	-	<0.1	0.04	<0.01	0.04	-	-	-	-
		9/08/2017	LGMB2	11	<1	<1	11	0.02	35	-	-	-	-	23	704	9	34
		20/09/2017	LGMB2	15 - 16	<1	<1	15 - 16	-	-	-	-	-	-	-	129 - 1510	-	-
		19/10/2017	LGMB2	-	-	-	-	-	-	0.1	0.06	<0.01	0.06	-	-	-	-
		15/11/2017	LGMB2	16	<1	<1	16	0.04	32	-	-	-	-	21	176	22	31
		16/05/2018	LGMB2	21	<1	<1	21	0.02	22	-	-	-	-	15	514	6	22
	Point 14	16/05/2017	LGMB3	18	<1	<1	18	0.06	12	-	-	-	-	10	110	2	14
		9/08/2017	LGMB3	-	-	-	-	-	-	<0.1	0.41	<0.01	0.41	-	-	-	-
		9/08/2017	LGMB3	14	<1	<1	14	0.03	16	-	-	-	-	8	90	2	13
		19/10/2017	LGMB3	-	-	-	-	-	-	<0.1	0.71	<0.01	0.71	-	-	-	-
		15/11/2017	LGMB3	20	<1	<1	20	0.32	57	-	-	-	-	32	235	5	11
		21/02/2018	LGMB3	30	<1	<1	30	0.04	65	-	-	-	-	36	254	4	11
		16/05/2018	LGMB3	13	<1	<1	13	**1.23**	47	-	-	-	-	26	128	2	12
	Point 15	16/05/2017	LGMB4	4	<1	<1	4	0.02	12	-	-	-	-	14	112	4	28
		9/08/2017	LGMB4	-	-	-	-	-	-	<0.1	5.57	<0.01	5.57	-	-	-	-
		9/08/2017	LGMB4	7	<1	<1	7	0.04	16	-	-	-	-	10	177	4	51
		19/10/2017	LGMB4	-	-	-	-	-	-	<0.1	5.16	<0.01	5.16	-	-	-	-
		15/11/2017	LGMB4	7	<1	<1	7	0.03	17	-	-	-	-	12	468	6	77

Statistical Summary

Maximum Concentration	282	<1	<1	282	2.96	152	0.1	5.57	<0.01	5.57	100	1510	27	108

				Organochlorine Pesticides																						
				4,4-DDE	a-BHC	Aldrin	Aldrin + Dieldrin	b-BHC	Chlordane	Chlordane (cis)	Chlordane (trans)	d-BHC	DDD	DDT	DDT+DDE+DDD	Dieldrin	Endosulfan I	Endosulfan II	Endosulfan sulphate	Endrin	Endrin aldehyde	Endrin ketone	g-BHC (Lindane)	Heptachlor	Heptachlor epoxide	Hexachlorobenzene	Methoxychlor
				µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
LOR				0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	2	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	2
ADWG 2015 Health							**0.3**		**2**					**9**									**10**	**0.3**			
ANZECC 2000 Freshwater (80%)									**0.27**					**0.04**						**0.06**			**1**	**0.7**			
ANZECC 2000 Fresh Water (90%)									**0.14**					**0.02**						**0.04**			**0.4**	**0.25**			
ANZECC 2000 Fresh Water (95%)									**0.08**					**0.01**						**0.02**			**0.2**	**0.09**			
Site	**Location Code**	**Sample Date**	**Field ID**																								
Helensburgh Groundwater	Point 5	9/08/2017	BH1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2
		19/10/2017	BH1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2
	Point 7	9/08/2017	BH4	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2
		19/10/2017	BH4	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2
	Point 16	9/08/2017	BH5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2
		19/10/2017	BH5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2
	Point 6	9/08/2017	BH6	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2
		19/10/2017	BH6	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2
	Point 12	9/08/2017	LGMB1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2
		19/10/2017	LGMB1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2
	Point 13	9/08/2017	LGMB2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2
		19/10/2017	LGMB2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2
	Point 14	9/08/2017	LGMB3	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2
		19/10/2017	LGMB3	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2
	Point 15	9/08/2017	LGMB4	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2
		19/10/2017	LGMB4	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2
Statistical Summary																											
Maximum Concentration				<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2
Average Concentration				<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2
Standard Deviation				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

				Organophosphorous Pesticides															Pesticides			
				Azinophos methyl	Bromophos-ethyl	Carbophenothion	Chlorfenvinphos	Chlorpyrifos	Chlorpyrifos-methyl	Diazinon	Dichlorvos	Dimethoate	Ethion	Fenthion	Malathion	Methyl parathion	Monocrotophos	Prothiofos	Demeton-S-methyl	Fenamiphos	Parathion	Pirimphos-ethyl
				µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
LOR				0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	2	2	0.5	0.5	0.5	2	0.5
ADWG 2015 Health				**30**	**10**	**0.5**	**2**	**10**		**4**	**5**	**7**	**4**	**7**	**70**	**0.7**	**2**			**0.5**	**20**	**0.5**
ANZECC 2000 Freshwater (80%)				**0.11**				**1.2**		**2**		**0.3**			**1.1**						**0.04**	
ANZECC 2000 Fresh Water (90%)				**0.05**				**0.11**		**0.2**		**0.2**			**0.2**						**0.01**	
ANZECC 2000 Fresh Water (95%)				**0.02**				**0.01**		**0.01**		**0.15**			**0.05**						**0.004**	
Site	**Location Code**	**Sample Date**	**Field ID**																			
Helensburgh Groundwater	Point 5	9/08/2017	BH1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2	<2	<0.5	<0.5	<0.5	<2	<0.5
		19/10/2017	BH1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2	<2	<0.5	<0.5	<0.5	<2	<0.5
	Point 7	9/08/2017	BH4	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2	<2	<0.5	<0.5	<0.5	<2	<0.5
		19/10/2017	BH4	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2	<2	<0.5	<0.5	<0.5	<2	<0.5
	Point 16	9/08/2017	BH5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2	<2	<0.5	<0.5	<0.5	<2	<0.5
		19/10/2017	BH5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2	<2	<0.5	<0.5	<0.5	<2	<0.5
	Point 6	9/08/2017	BH6	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2	<2	<0.5	<0.5	<0.5	<2	<0.5
		19/10/2017	BH6	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2	<2	<0.5	<0.5	<0.5	<2	<0.5
	Point 12	9/08/2017	LGMB1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2	<2	<0.5	<0.5	<0.5	<2	<0.5
		19/10/2017	LGMB1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2	<2	<0.5	<0.5	<0.5	<2	<0.5
	Point 13	9/08/2017	LGMB2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2	<2	<0.5	<0.5	<0.5	<2	<0.5
		19/10/2017	LGMB2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2	<2	<0.5	<0.5	<0.5	<2	<0.5
	Point 14	9/08/2017	LGMB3	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2	<2	<0.5	<0.5	<0.5	<2	<0.5
		19/10/2017	LGMB3	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2	<2	<0.5	<0.5	<0.5	<2	<0.5
	Point 15	9/08/2017	LGMB4	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2	<2	<0.5	<0.5	<0.5	<2	<0.5
		19/10/2017	LGMB4	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2	<2	<0.5	<0.5	<0.5	<2	<0.5
Statistical Summary																						
Maximum Concentration				<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2	<2	<0.5	<0.5	<0.5	<2	<0.5
Average Concentration				<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2	<2	<0.5	<0.5	<0.5	<2	<0.5
Standard Deviation				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

				Field
				pH (Field)
				pH Units
LOR				0.1

Site	Location Code	Sample Date	Field ID	
Helensburgh Groundwater	Point 5	16/05/2017	BH 1	5.1
		9/08/2017	BH 1	5.6
		19/10/2017	BH1	6.1
		15/11/2017	BH 1	5.7
		21/02/2018	BH 1	6.1
		16/05/2018	BH 1	5.7
	Point 7	16/05/2017	BH 4	4.4
		9/08/2017	BH 4	4.5
		19/10/2017	BH4	4.5
		15/11/2017	BH 4	4.4
		21/02/2018	BH 4	4.6
		16/05/2018	BH 4	4.4
	Point 16	19/10/2017	BH5	4.7
		16/05/2017	BH 5 GWMB5	4.7
		9/08/2017	BH 5 GWMB5	4.6
		15/11/2017	BH 5 GWMB5	4.6
		21/02/2018	BH 5 GWMB5	5.3
		16/05/2018	BH 5 GWMB5	4.6
	Point 6	19/10/2017	BH6	6
		16/05/2017	BH 6 GWMB6	6.9
		9/08/2017	BH 6 GWMB6	6.5
		15/11/2017	BH 6 GWMB6	6
		21/02/2018	BH 6 GWMB6	6
		16/05/2018	BH 6 GWMB6	6
	Point 12	16/05/2017	LGMB1	5
		9/08/2017	LGMB1	5.4
		19/10/2017	LGMB1	5.7
		15/11/2017	LGMB1	5.7
		16/05/2018	LGMB1	5.7
	Point 13	16/05/2017	LGMB2	5.6
		9/08/2017	LGMB2	5.5
		19/10/2017	LGMB2	5.7
		15/11/2017	LGMB2	5.7
		16/05/2018	LGMB2	5.4
	Point 14	16/05/2017	LGMB3	5.7
		9/08/2017	LGMB3	5.6
		19/10/2017	LGMB3	5.7
		15/11/2017	LGMB3	5.6
		21/02/2018	LGMB3	5.9
		16/05/2018	LGMB3	5.2
	Point 15	16/05/2017	LGMB4	5
		9/08/2017	LGMB4	5.2
		19/10/2017	LGMB4	5
		15/11/2017	LGMB4	5.1

Statistical Summary

Maximum Concentration	6.9
Average Concentration	5.4
Standard Deviation	0.61

Parameter	Unit	Trade Waste Agreement Criteria						
			17/05/2017	20/07/2017	14/09/2017	15/11/2017	17/01/2018	20/03/2018
Meter Reading (start)	Litres	-	34710	34898.69	34910.25	34924.42	34945.39	34956.25
Meter Reading (finish)	Litres	-	34747	34906.85	34910.54	34930.85	34946.34	34956.91
Volume Dishcharged	KL	120	37.3	8.16	0.29	6.43	0.95	0.66
Discrete Start pH (start) composite	pH Unit	7 to 10	7.5	7.1	NA	7.8	NA	NA
Total Dissolved Solids composite	mg/L	10000	923	1070	864	956	988	819
Total Dissolved Solids MDM	kg/day	104	-	-	-	-	-	-
Suspended Solids composite	mg/L	600	13	5	24	54	5	5
Suspended Solids MDM	kg/day	12	-	-	-	-	-	-
Ammonia as N composite	mg/L	100	7.1	18.9	0.5	23.6	18.5	2.1
Iron	mg/L	50	6.77	0.89	9.74	12.8	2.35	1.14
Ammonia as N MDM	kg/day	4	-	-	-	-	-	-
pH Finish composite	pH Unit	7 to 10	7.6	7.2	7.8	7.8	7.3	7.5
Temperature	°C	38	17	17	14	22	24	20

Notes:
KL: Kilolitres
mg/L: milograms per litre
kg/day: kilograms per day
µS/cm: microsiemens per centimeter
MDM: maximum daily mass

APPENDIX C

QUALITY ASSURANCE AND QUALITY CONTROL

Quality Assurance/Quality Control (QA/QC) procedures were implemented to ensure the precision accuracy, representativeness, completeness and comparability of all data gathered. The QA/QC procedures included:

- Equipment calibration to ensure field measurements obtained are accurate;
- Equipment decontamination to prevent cross contamination;
- The completion of a field form for each monitoring point;
- Use of appropriate measures (i.e. gloves) to prevent cross contamination;
- Appropriate sample identification;
- Correct sample preservation;
- Sample transport with Chain of Custody (CoC) documentation; and
- Laboratory analysis in accordance with NATA accredited methods.

Table C-1 details the QA/QC procedures and sample collection details undertaken during monitoring and sample collection. **Table C-2** summarises the number of QA/QC samples collected during this investigation. CoC, Sample Receipt Notifications (SRNs), laboratory certificates and Interpretive QA/QC Reports can be provided upon request. These documents are typically appended to the report but due to the quantity of documents they have been omitted.

Table C1: Field QAQC Method Validation

Requirement	Yes/No	Comments
Equipment calibration	Yes	Each field instrument was calibrated prior to use. Calibration certificates can be provided by ALS Environmental upon request.
Equipment decontamination	Yes	Decontamination of sampling equipment (interface probe) was undertaken by washing with phosphate free detergent (Decon 90) followed by a rinse with potable water.
Sampling and monitoring documentation	Yes	Water sampling and gas monitoring was documented by ALS Environmental during each sampling event. Copies of sampling and monitoring documentation can be provided upon request.
Sample collection	Yes	Samples were collected using laboratory provided sampling containers and a clean pair of gloves was used for each new sampling point to limit the potential for cross-contamination.
Sample identification	Yes	All samples were marked with a unique identifier including the sampling point and date.
Sample preservation	Yes	Following collection water samples were placed in an esky that contained bricks. Samples were kept chilled from sample collection until laboratory receipt.
COC documentation	Yes	A COC form was completed by ALS Environmental detailing the sample identification, collection date, sampler and laboratory analysis required. COC forms and SRN can be provided upon request. The SRN indicates that the samples were received at the laboratory intact and chilled and within the required holding times.
NATA accredited methods	Yes	ALS Environmental are a NATA accredited laboratory for the required analysis, which was completed in accordance with NATA accredited methods.

Laboratory QC and QCI Report Summary

The laboratory selected to undertake laboratory testing, ALS Environmental, is NATA accredited for the analysis required. ALS Environmental undertook internal QA/QC measures to demonstrate the suitability of the data. The laboratory is required to undertake and report internal laboratory Quality Control procedures for all chemical analysis undertaken, including:

- Laboratory duplicate sample analysis at the rate of one duplicate analysis per ten samples;
- Method blank at the rate of one method blank analysis per 20 samples;
- Laboratory control sample at the rate of one laboratory control sample analysis per 20 samples; and

> Spike recovery analysis at the rate of one spike recovery analysis per 20 samples.

Compliance with the internal laboratory QA/QC requirements is provided within the QC and QCI reports provided by ALS Environmental, which can be provided upon request and are discussed below.

The QC and QCI reports received from ALS Environmental highlight outliers of QA/QC standards including holding time breaches and internal QC results. Review of the QC and QCI documentation provided by ALS Environmental indicates that several outliers existed which are summarised below in **Table C-2**.

Table C-2: Laboratory QA/QC Outlier Summary

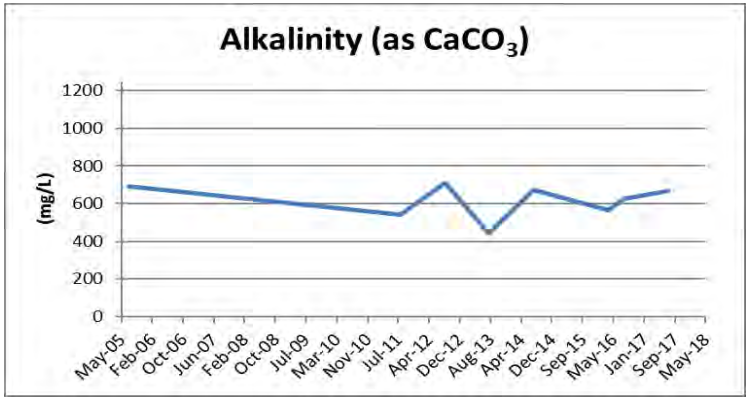
QA/QC Measure	QC Sample ID	Lab Report	Analyte
Duplicates	QC 0 Regular 10	EW1703407_1_QCI	PAH/Phenols Pesticides by GCMS
	QC 0 Regular 11		TRH – Semivolotile Fraction
	QC 0 Regular 8	EW1704319_1_QCI	PAH/Phenols Pesticides by GCMS
	QC 0 Regular 13		TRH – Semivolotile Fraction
Laboratory Control Spike (LCS) Recoveries	QC 2 Regular 25	EW1703403_2_QCI	Alkalinity by PC Titrator
	QC 1 Regular 17	EW1704719_1_QCI	Alkalinity by PC Titrator
	QC 1 Regular 15	EW1800698_1_QCI	Alkalinity by PC Titrator
	QC-1045309-002	EW1703407_1_QCI	C15 – C28 Fraction C29 – C36 Fraction >C10 – C16 Fraction >C16 – C34 Fraction
Matrix Spike (MS) Recoveries	QC 0 Regular 10	EW1703407_1_QCI	PAH/Phenols
	QC 0 Regular 11		Pesticides by GCMS TRH – Semivolotile Fraction
	QC 0 Regular 8	EW1704319_1_QCI	PAH/Phenols Pesticides by GCMS
	QC 0 Regular 13		TRH – Semivolotile Fraction
	ES1713097-001	EW1702162_2_QCI	Chloride
	EW1703403-005	EW1703403_2_QCI	Sulfate as SO4
	ES1719824-001		Sulfate as SO4
	ES1719289-001		Ammonia as N
	ES1814161-010	EW1802028_2_QCI	Sulfate as SO4 (Turbidmetric) Chloride
	ES1813834 -006		Ammonia as N
	ES1729011-009	EW1704719_1_QCI	Sulfate as SO4
	ES1726371-001	EW1704319_1_QCI	Barium
Holding time compliance	BH4	EW1702162_2_QCI	EA015: Total Dissolved Solids dried at 180 ED093T: Total Major Cations
	Clear Plastic Bottle – Natural Stormwater	EW1703487_1_QCI	Total Dissolved Solids Total Suspended Solids

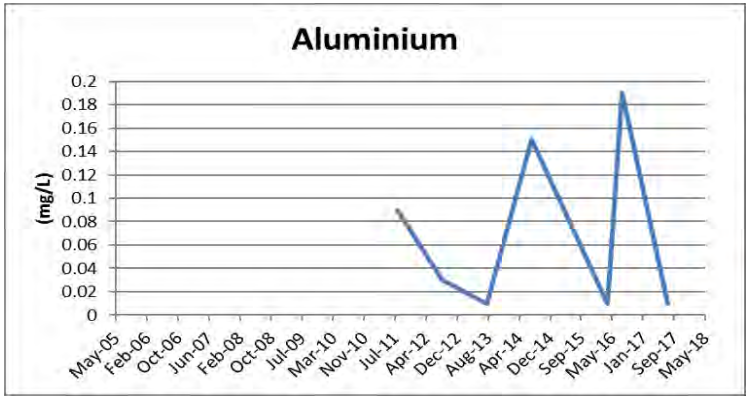
Cardno concludes that the data reported by ALS Environmental as presented in this Annual Report is suitable for interpretative to assess the environmental performance and compliance with EPL 5861.

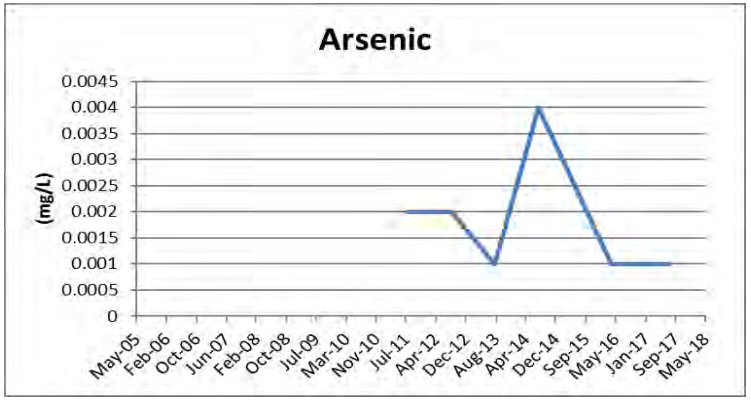
APPENDIX D

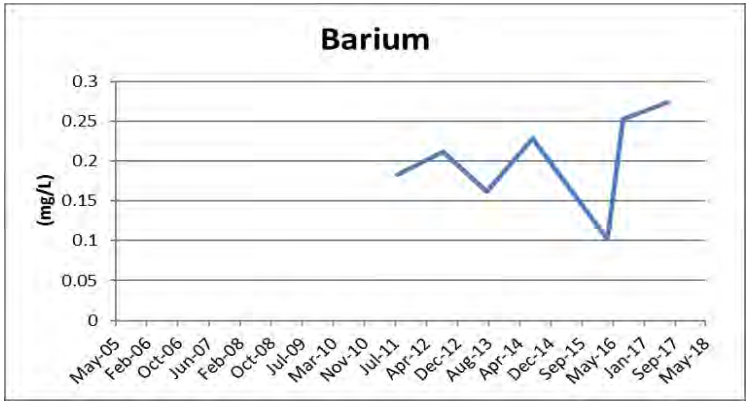
TREND GRAPHS

Sheet 1A - Leachate

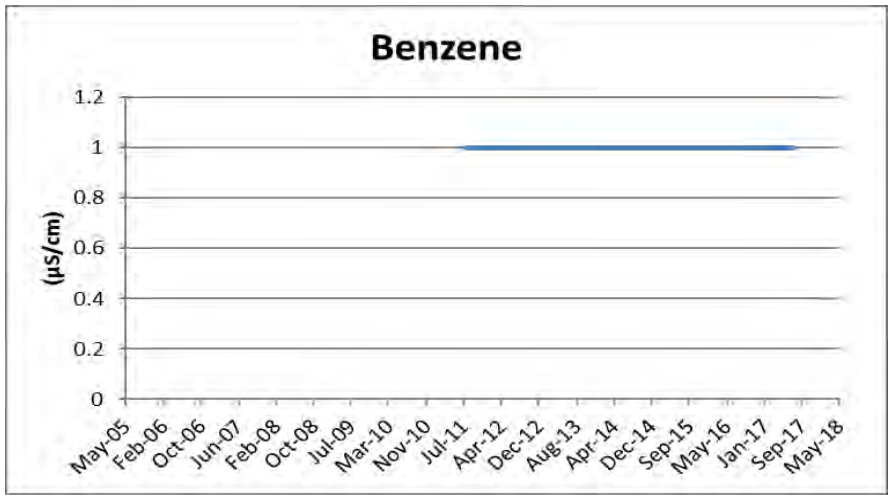


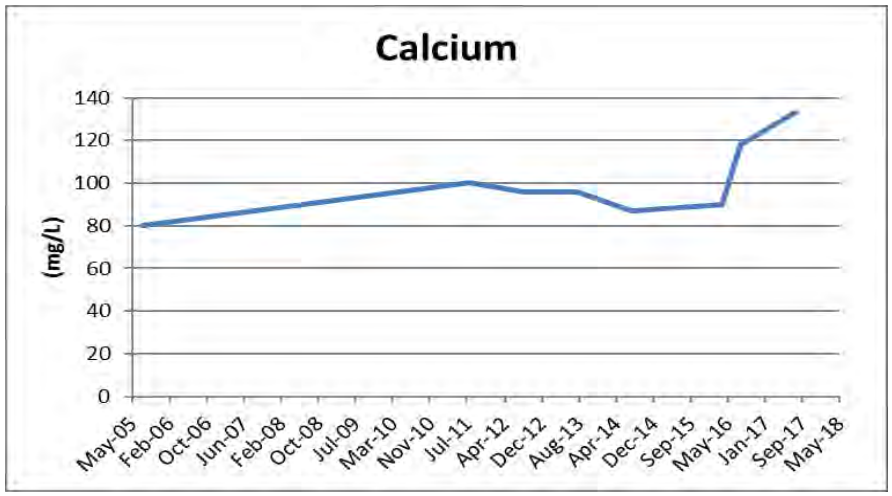


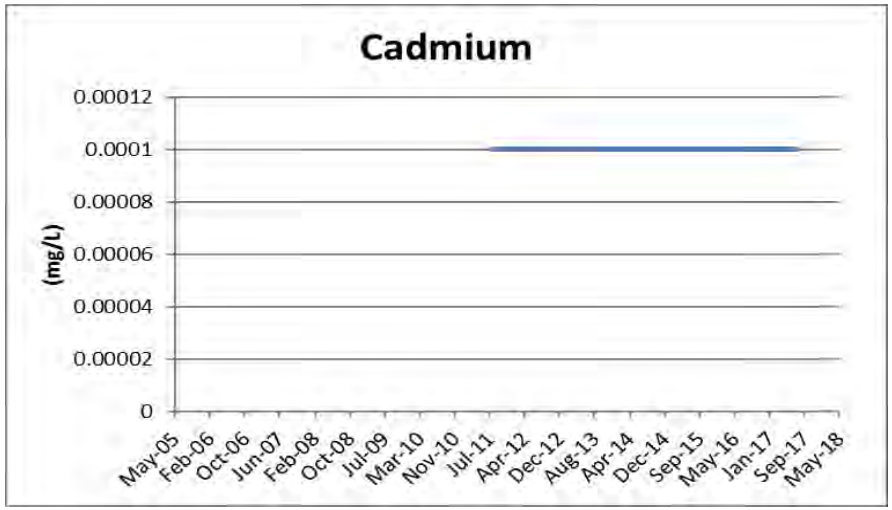


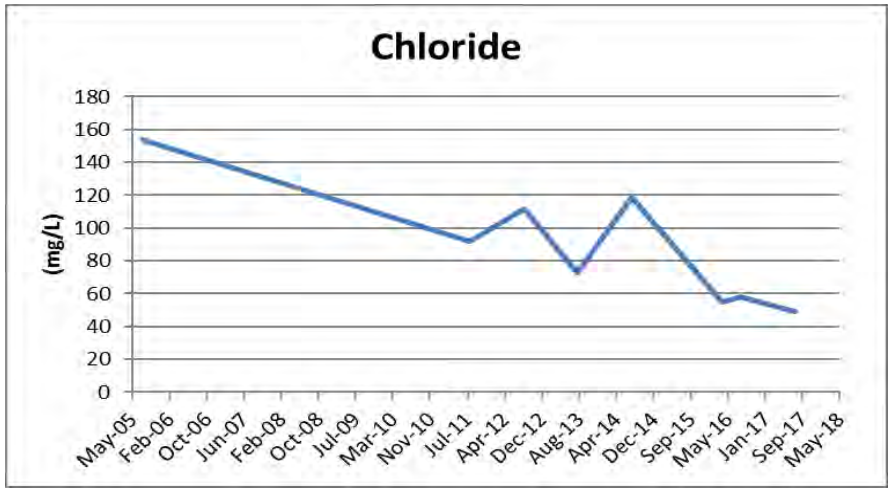


Sheet 1B - Leachate

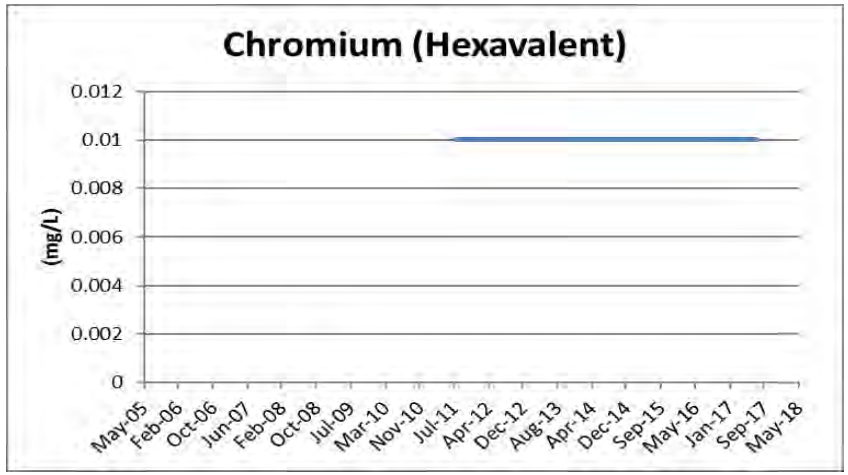


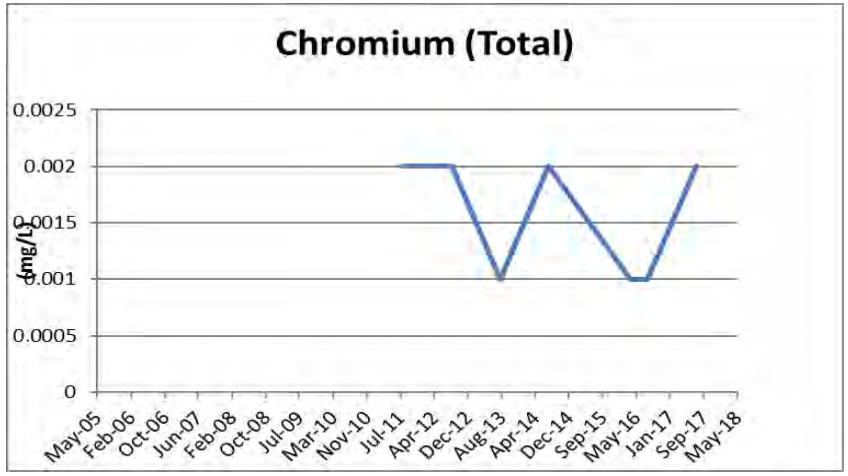


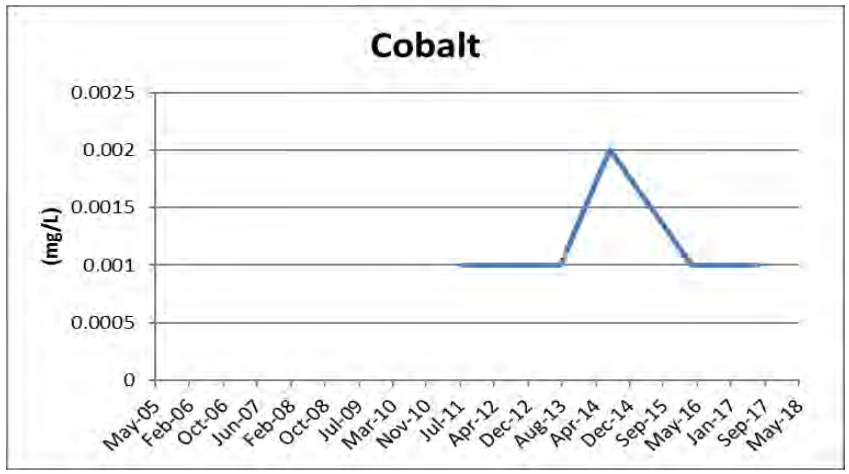


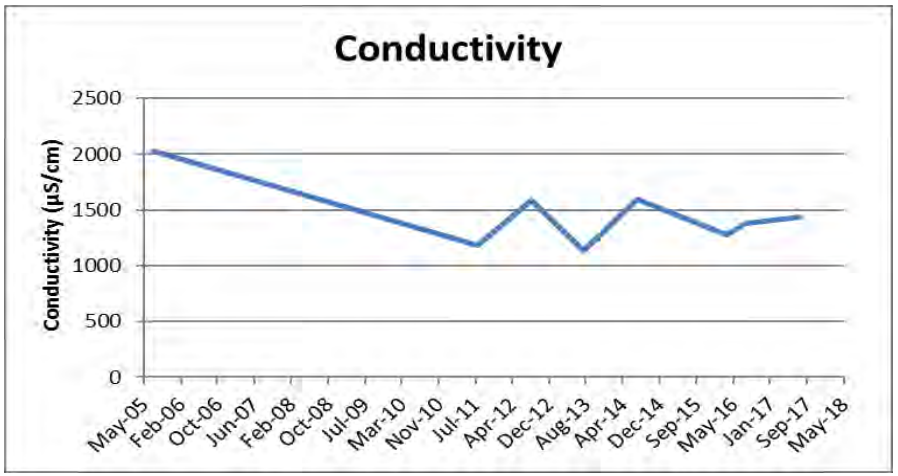


Sheet 1C - Leachate

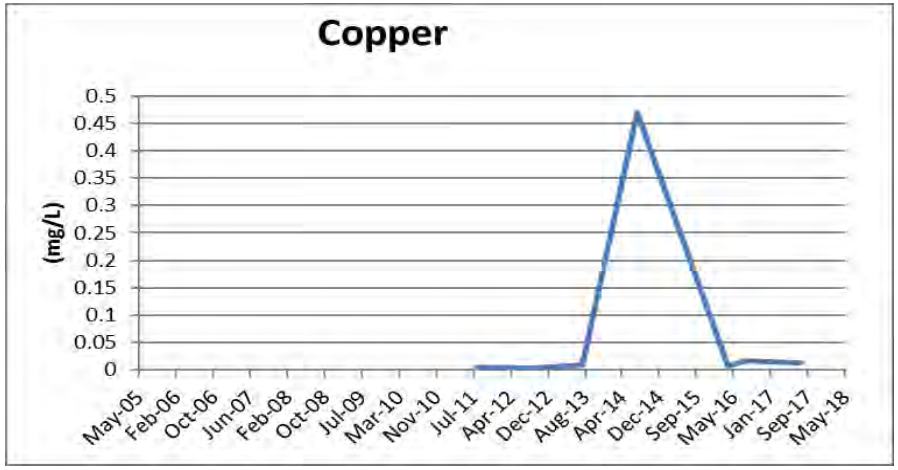


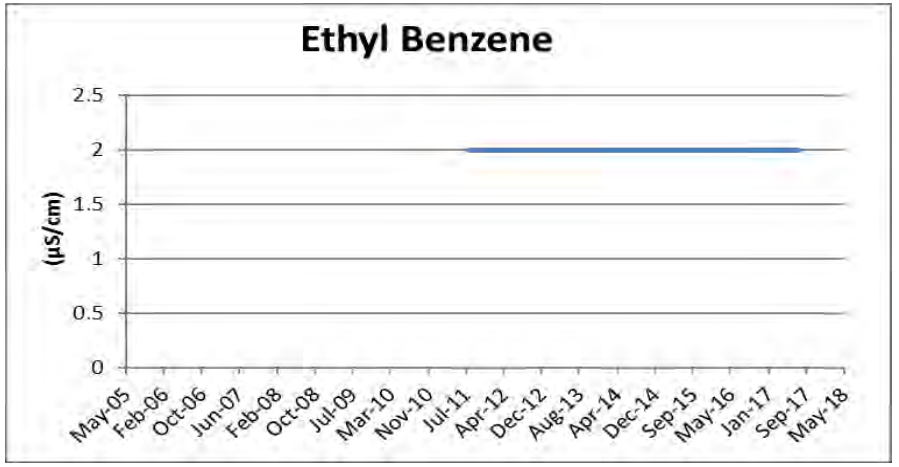


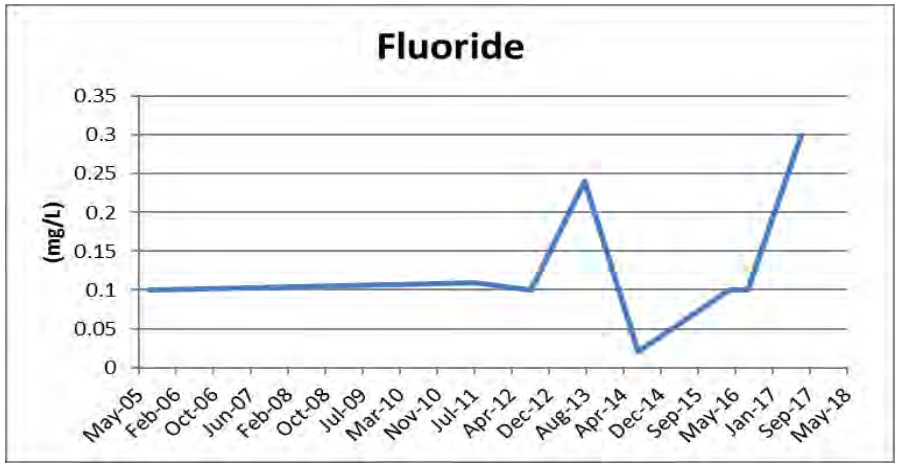


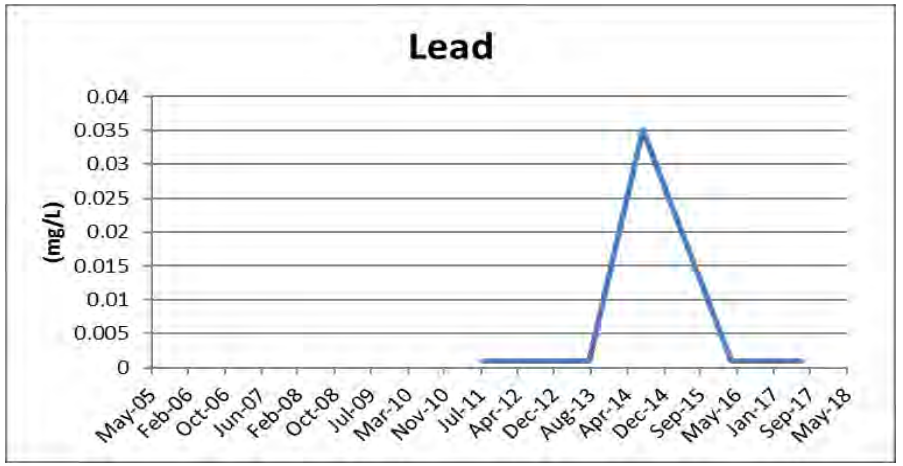


Sheet 1D - Leachate

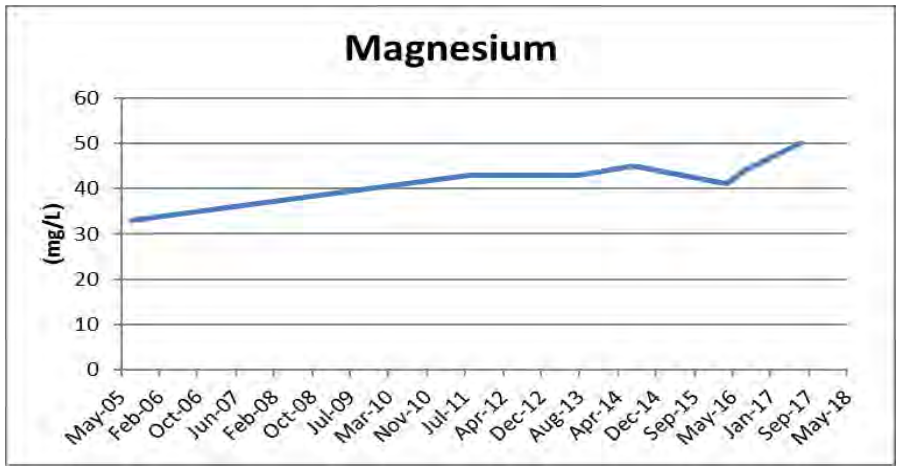


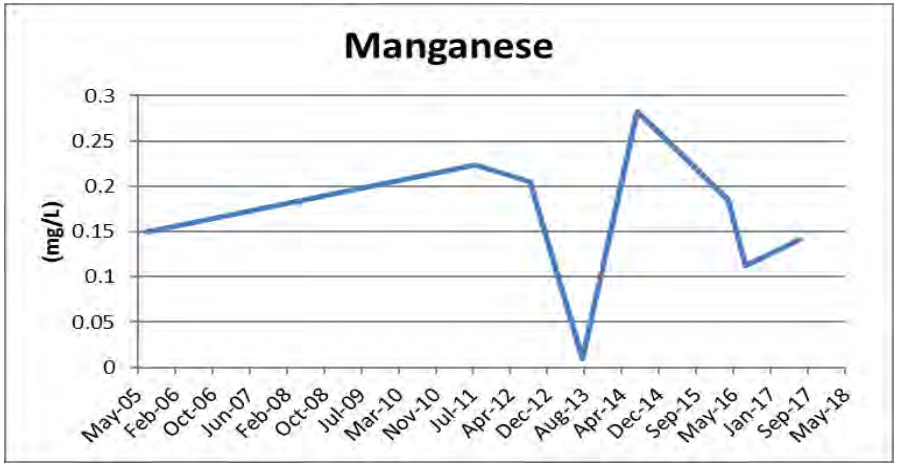


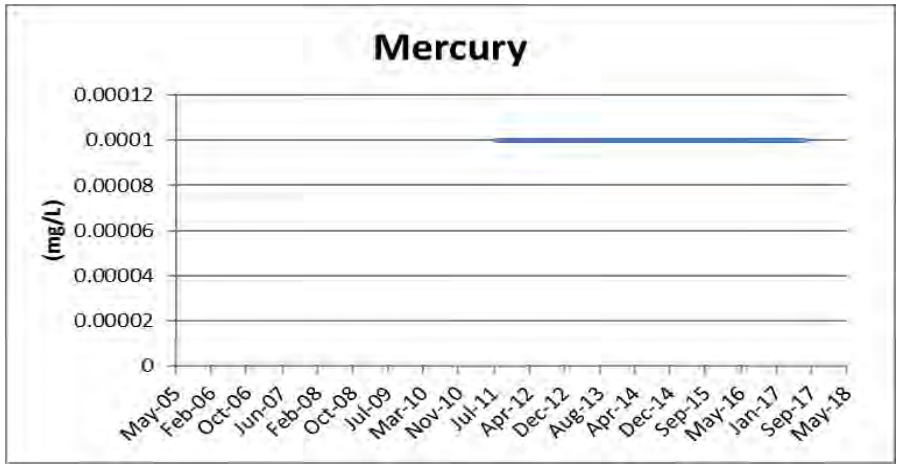


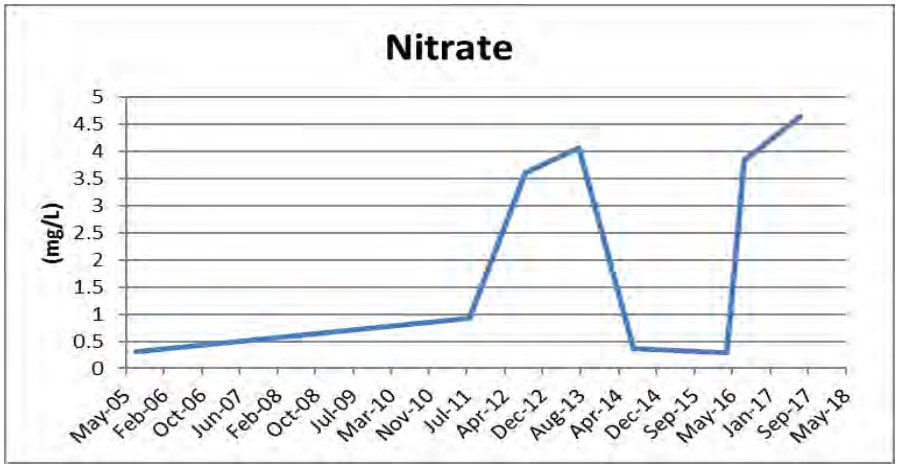


Sheet 1E - Leachate

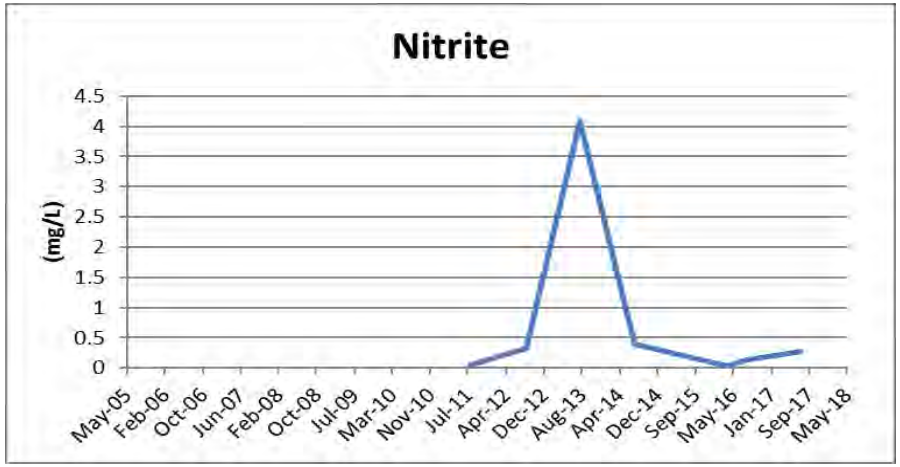


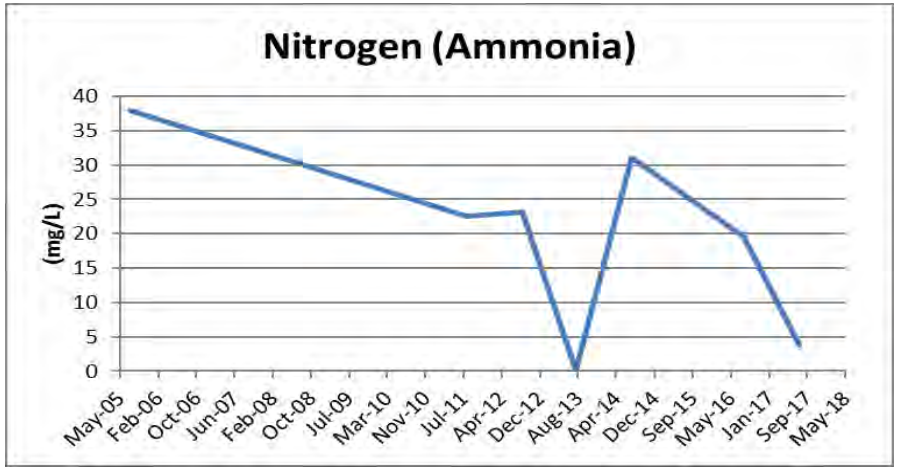


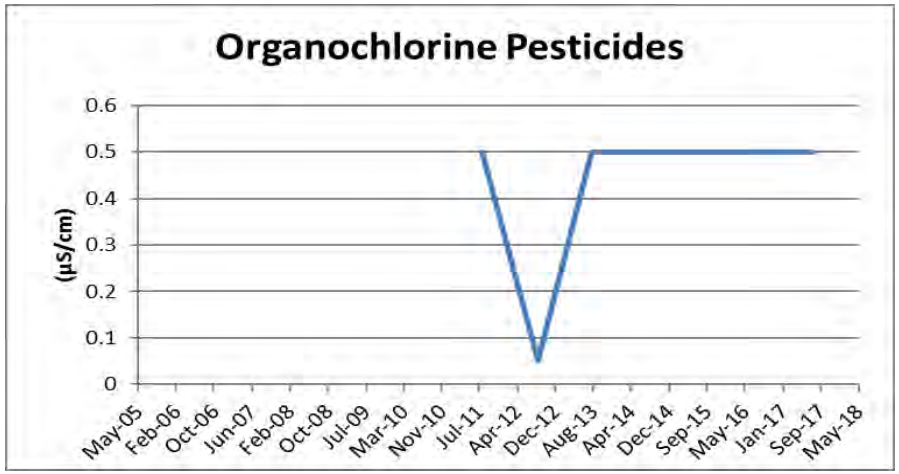


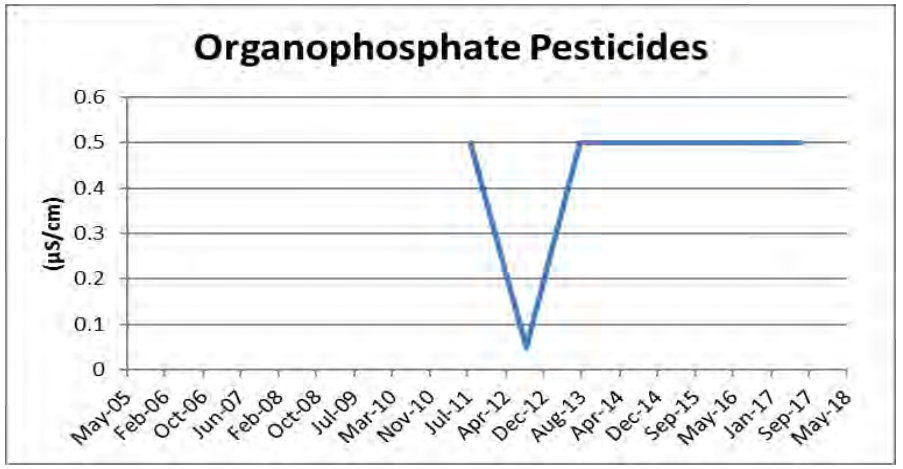


Sheet 1F - Leachate

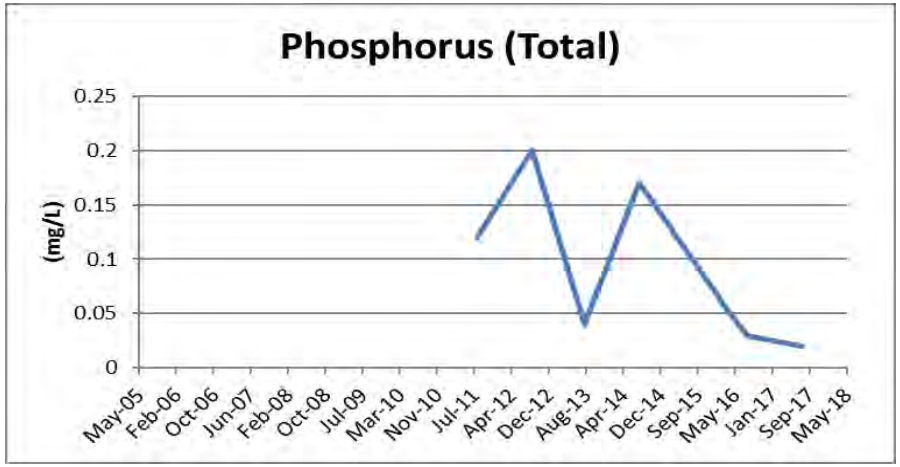


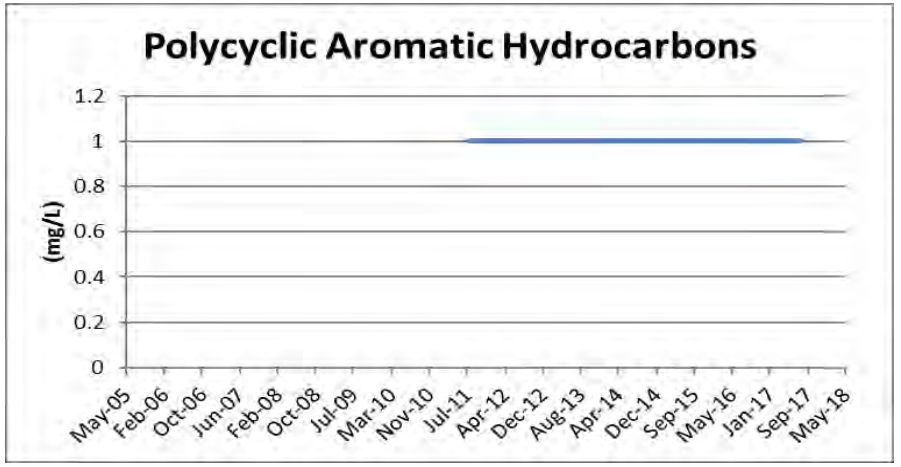


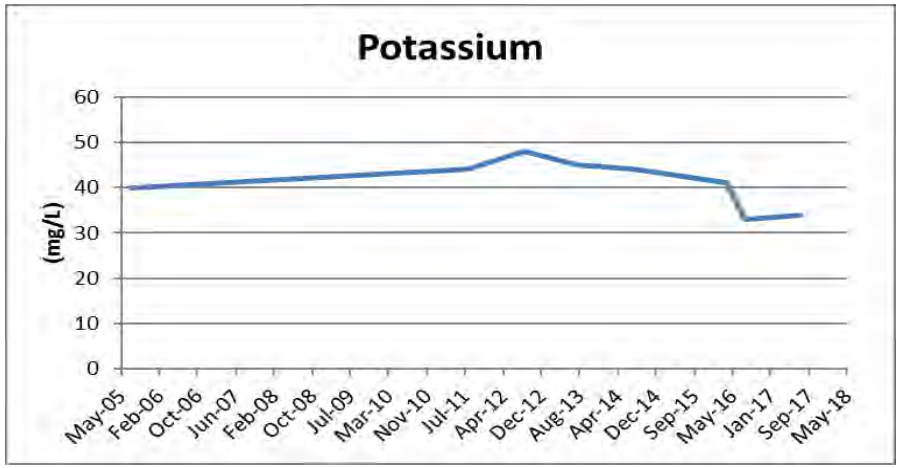


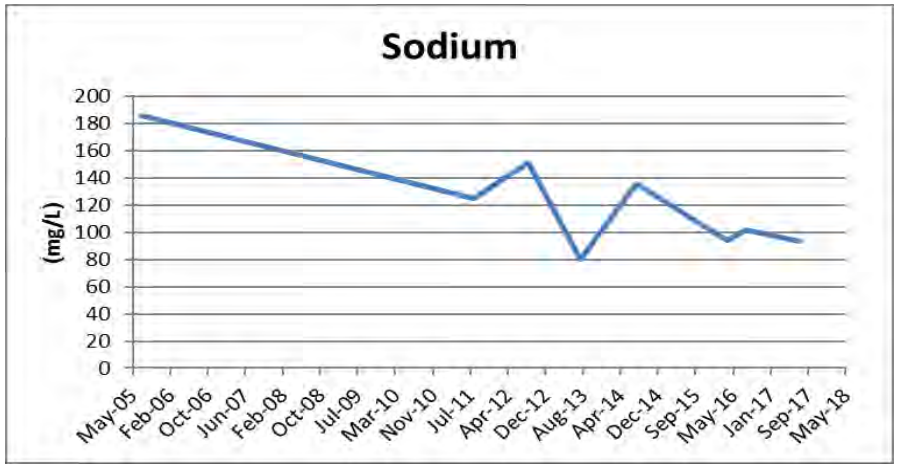


Sheet 1G - Leachate

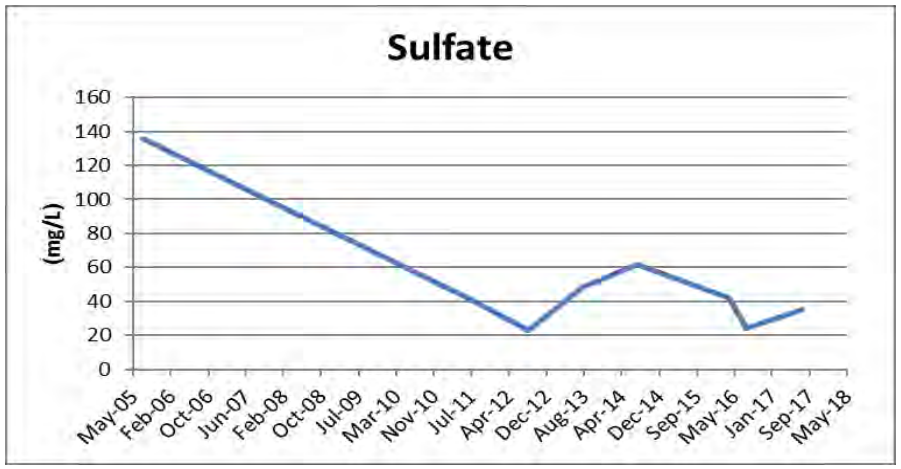


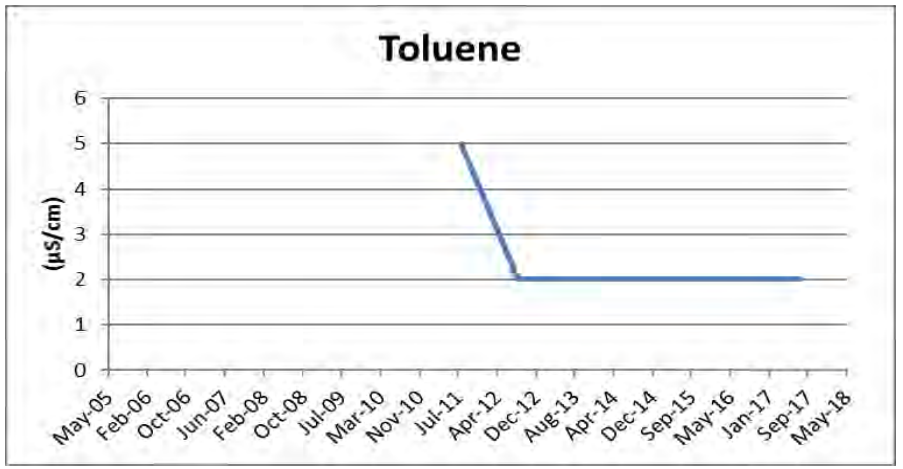


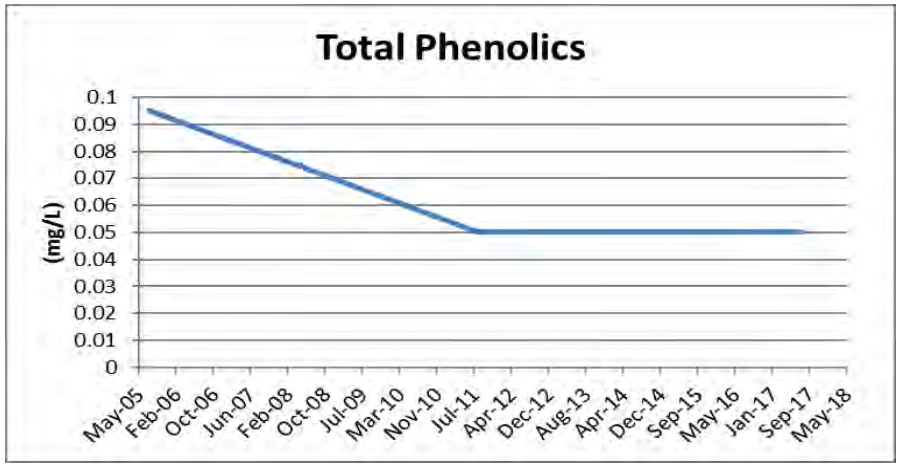


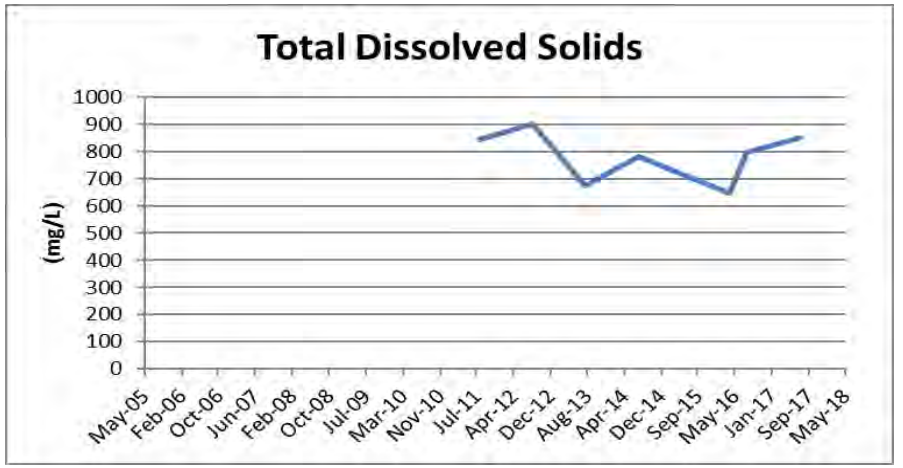


Sheet 1H - Leachate

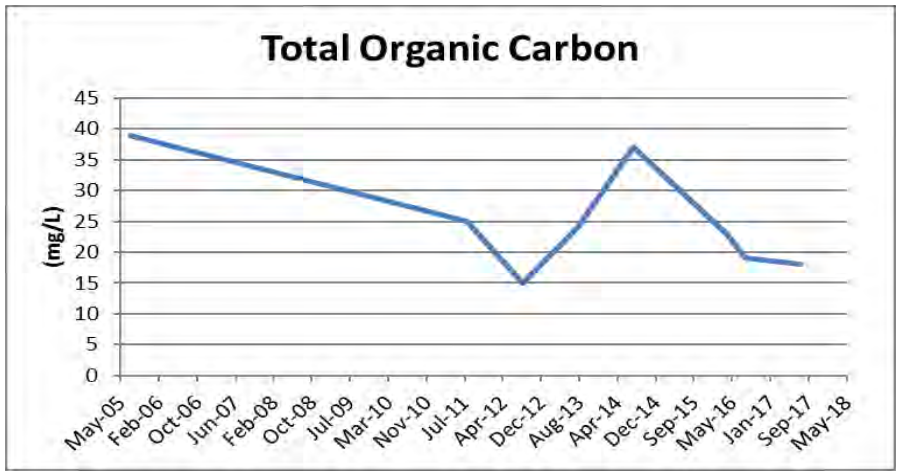


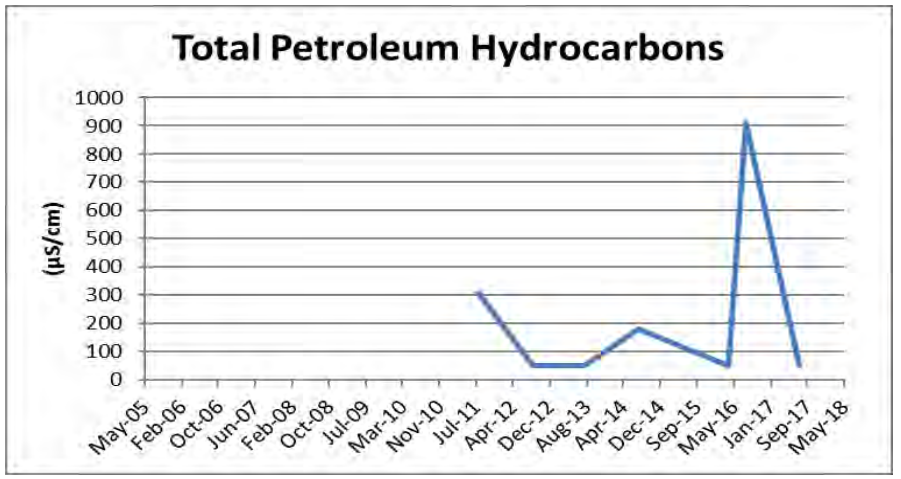


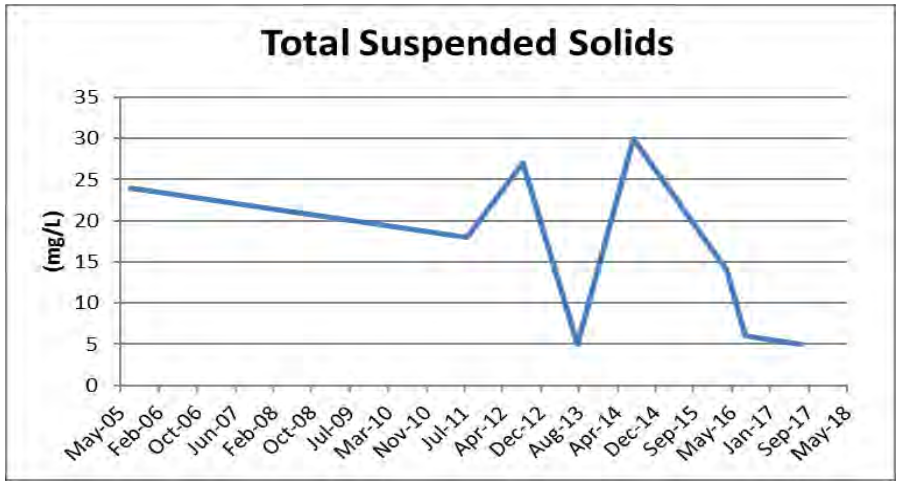


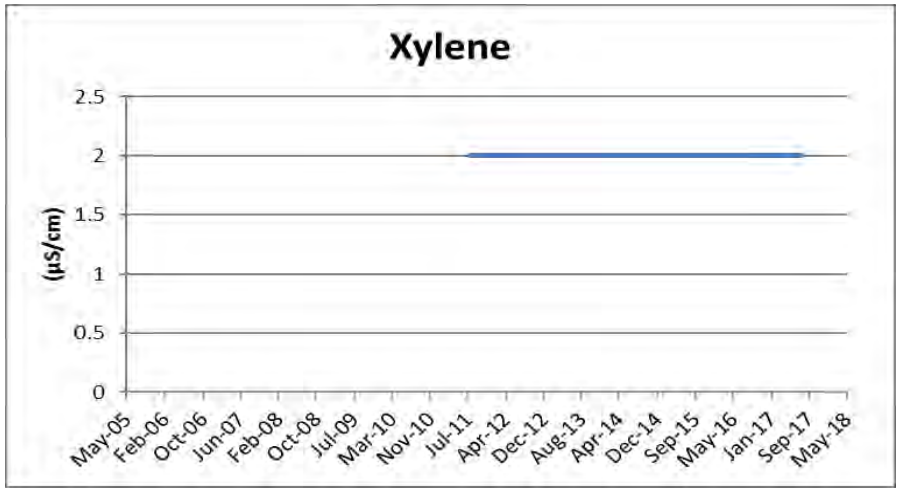


Sheet 1I - Leachate

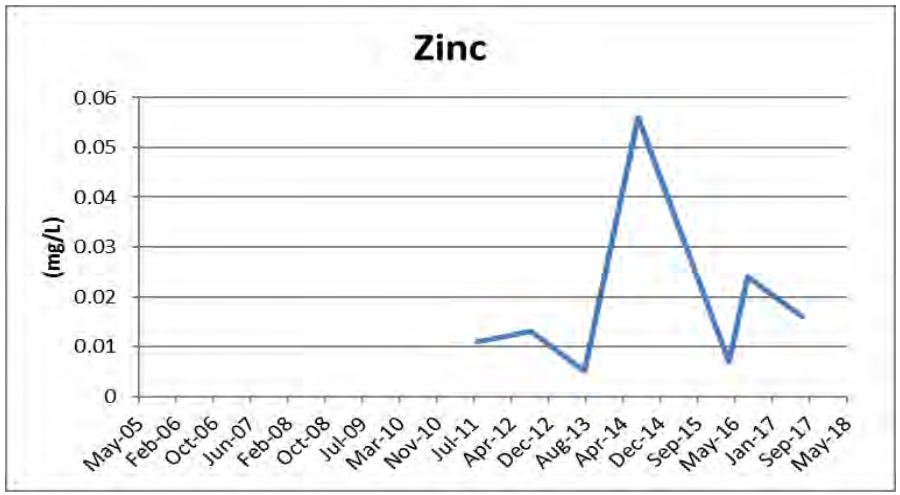


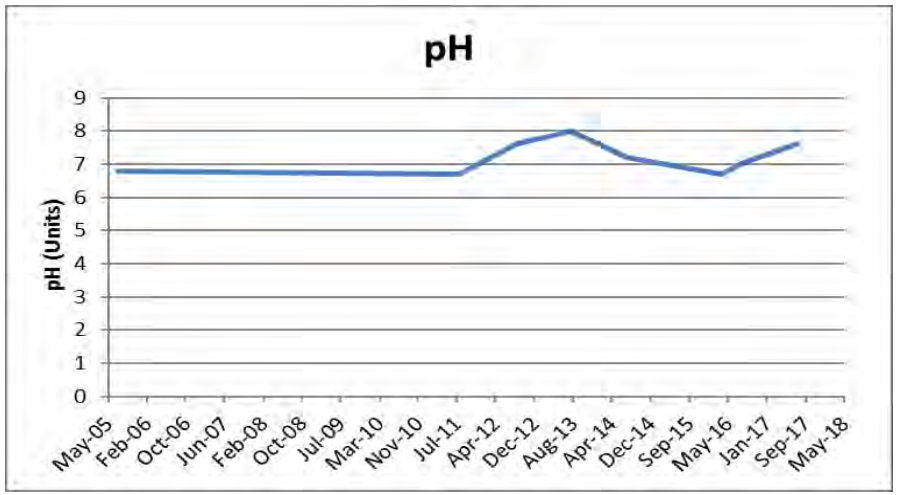


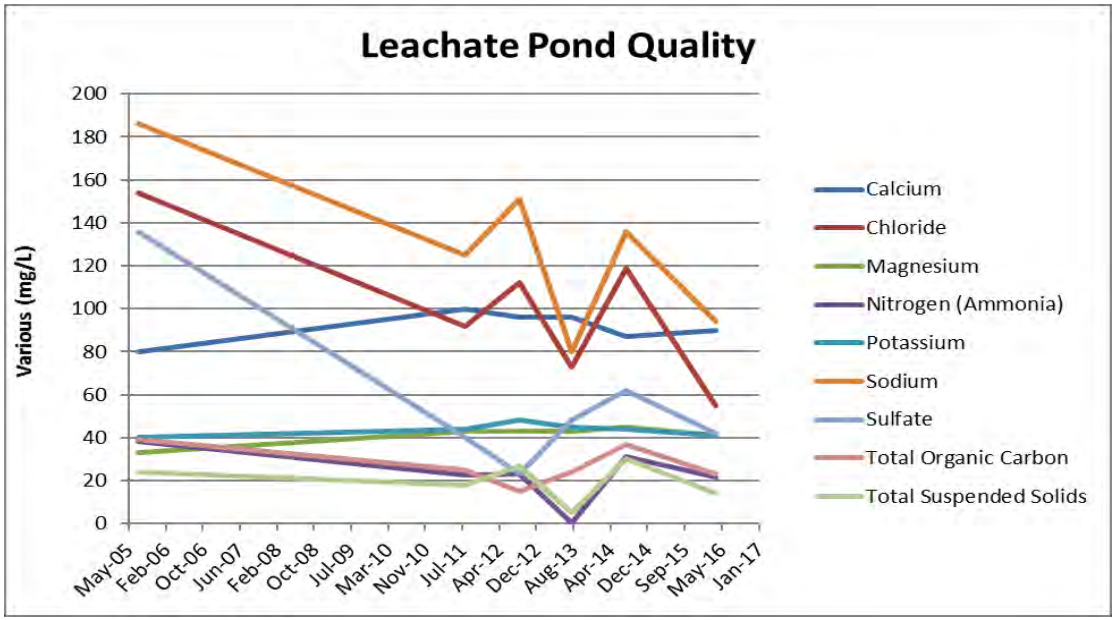




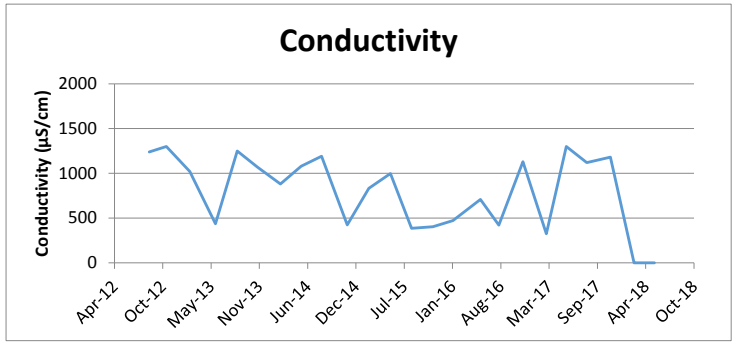
Sheet 1J - Leachate

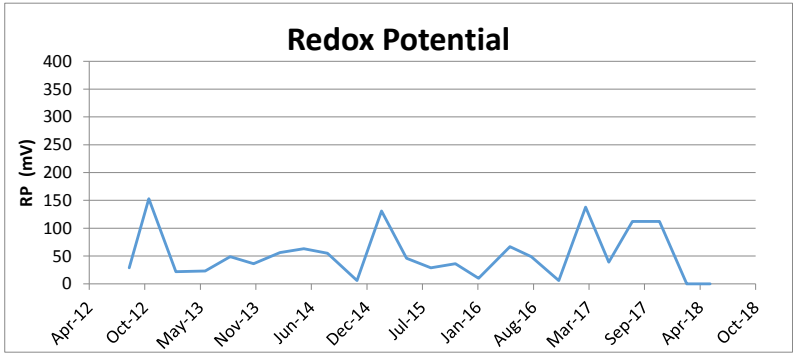


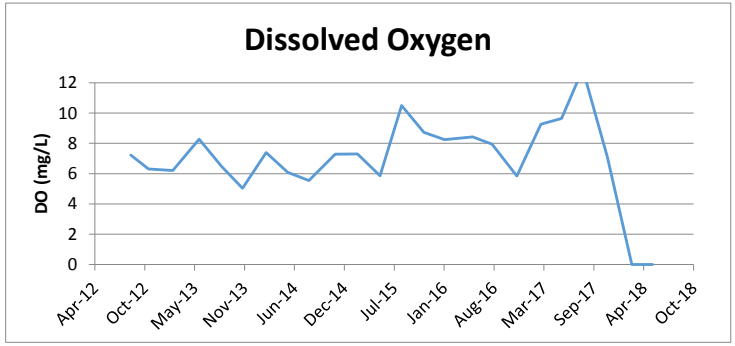


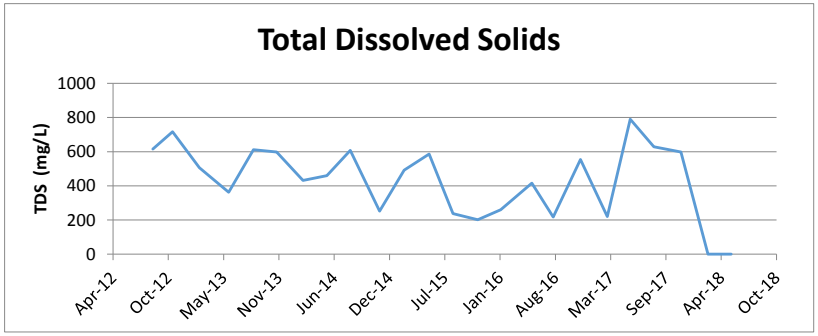


Sheet 2A - Surface Water

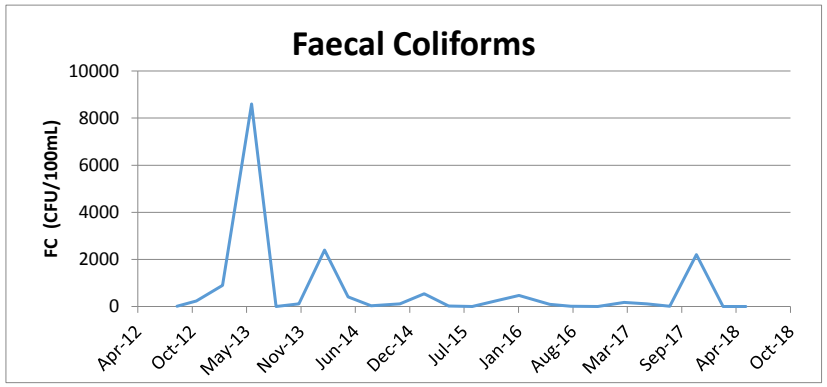


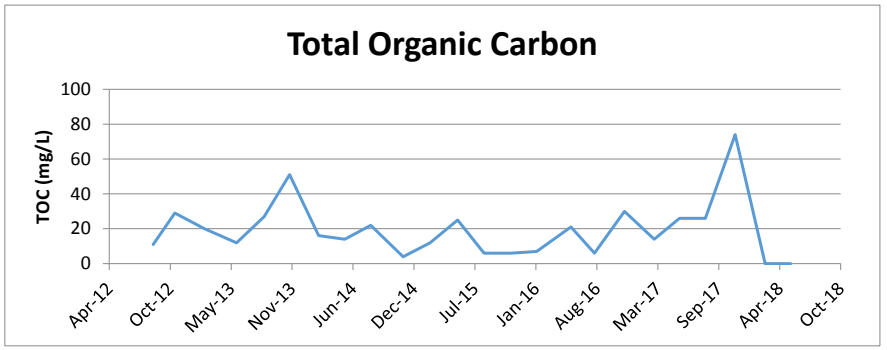


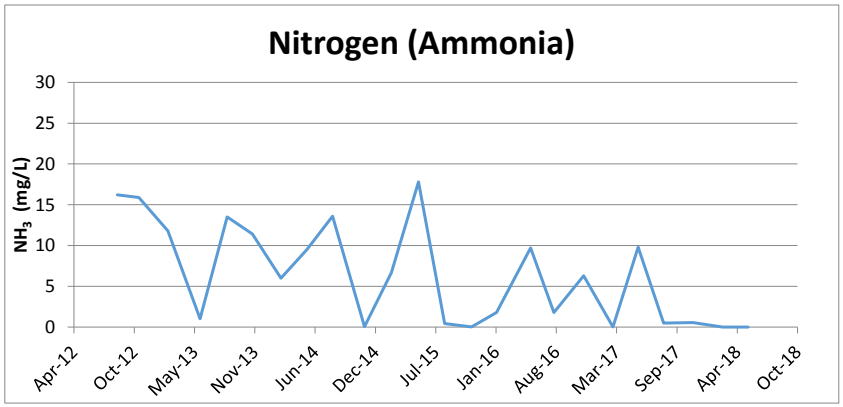


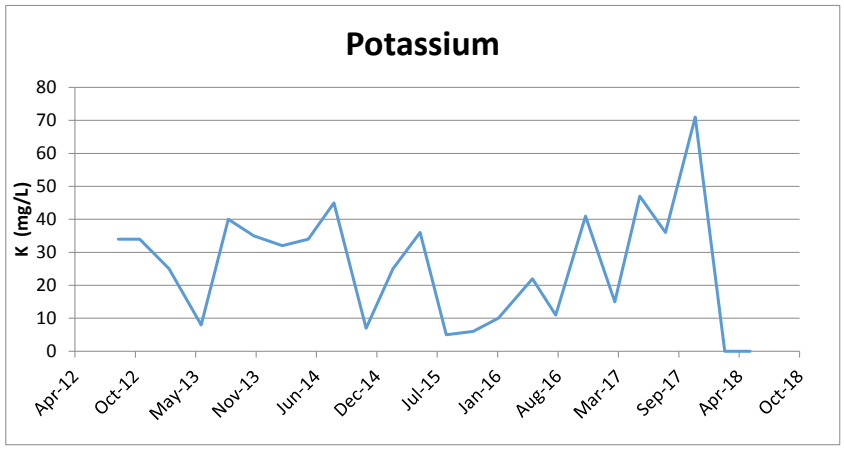


Sheet 2B - Surface Water

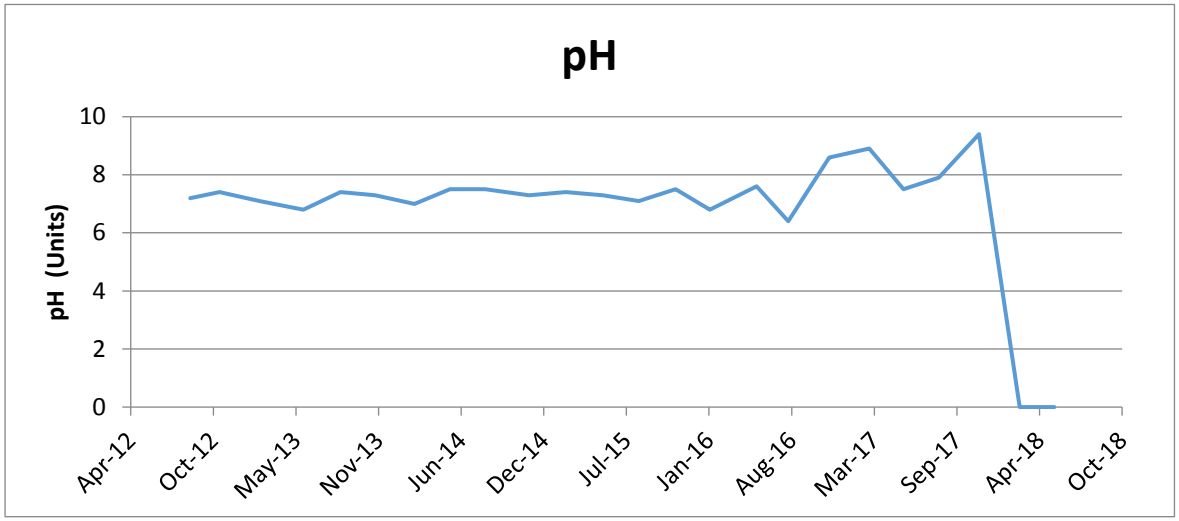




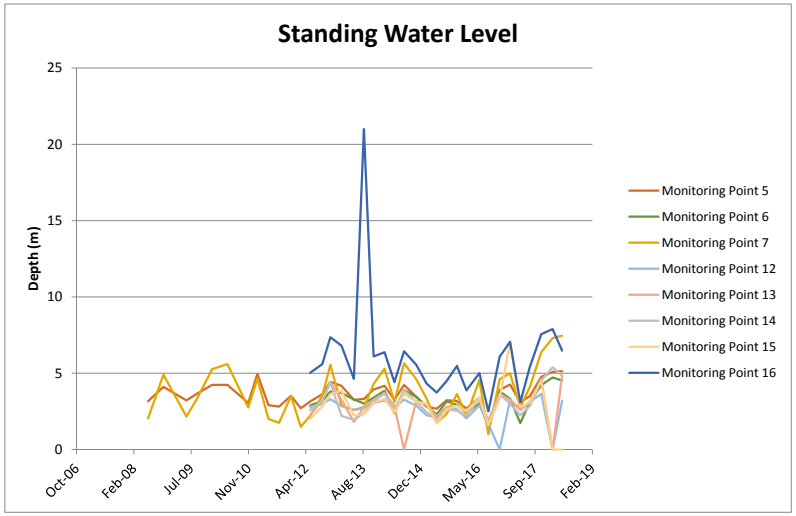




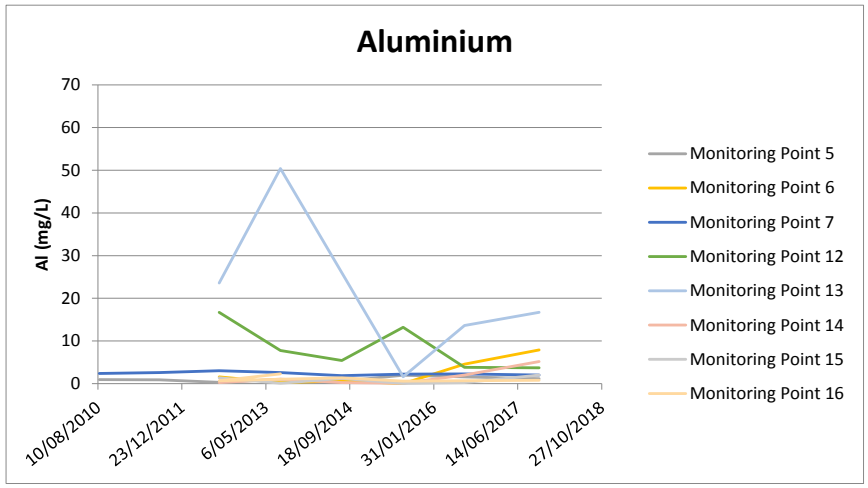
Sheet 2C - Surface Water

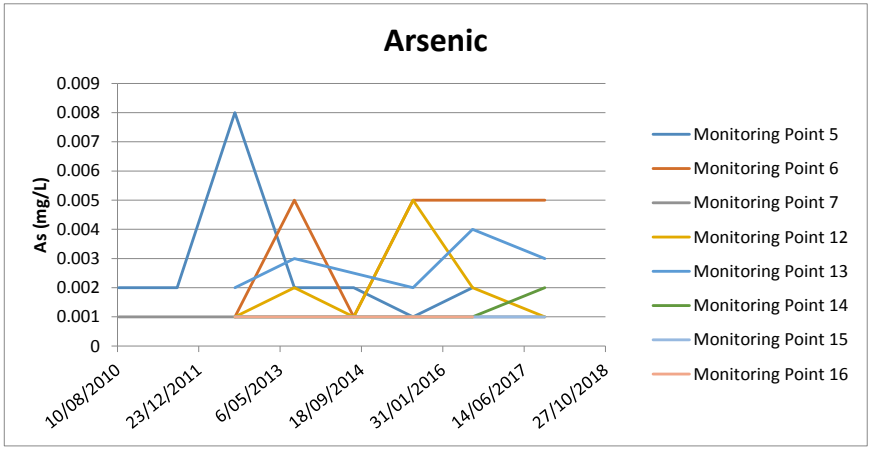


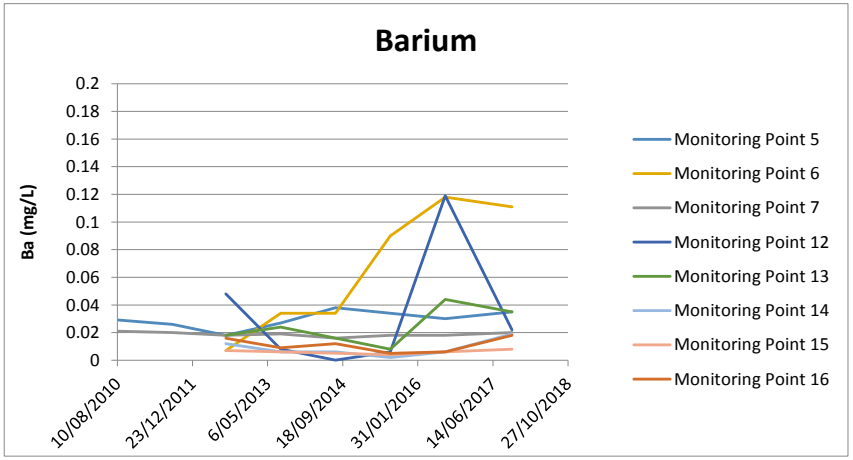
Sheet 3 - Groundwater

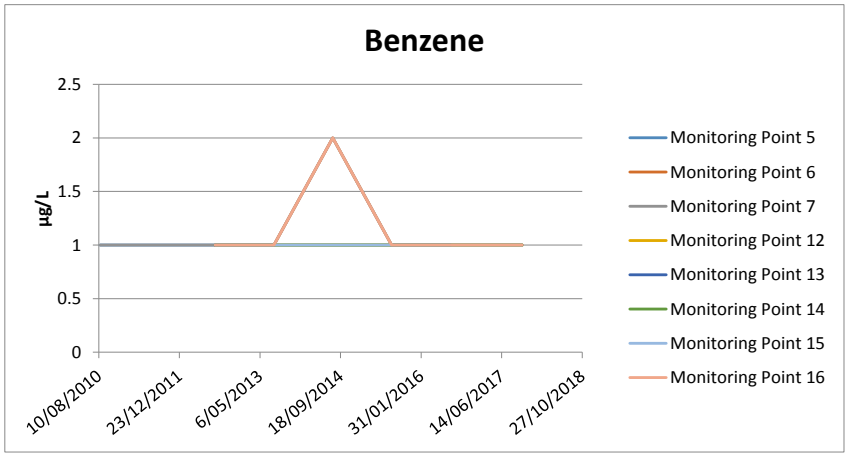


Sheet 4A - Groundwater

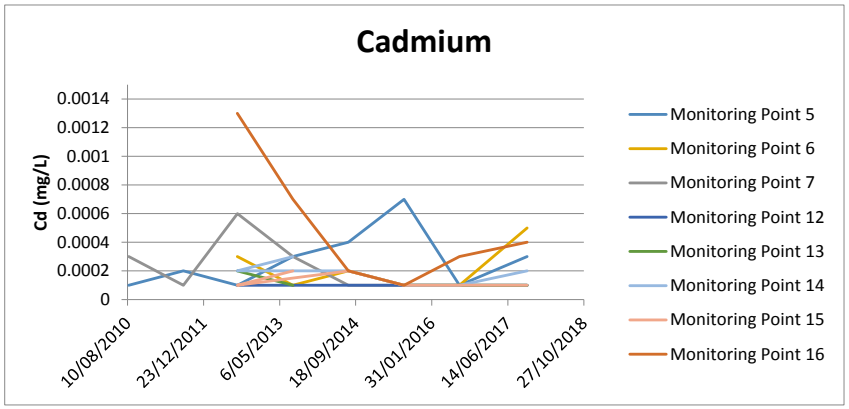


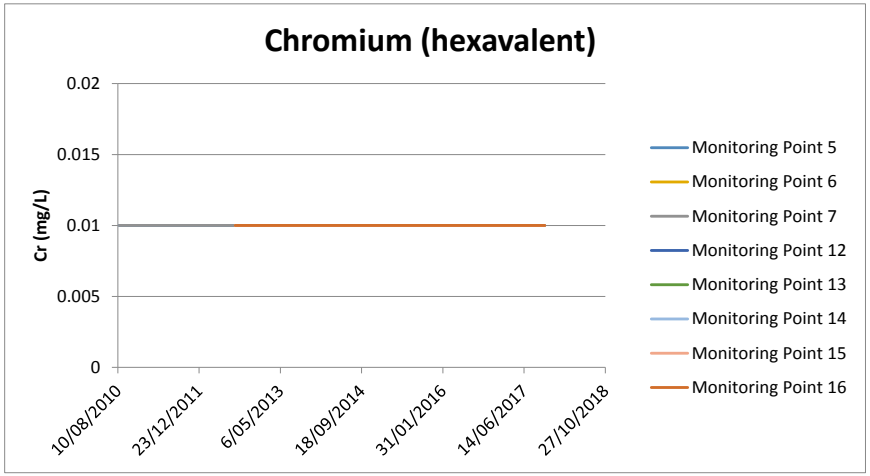


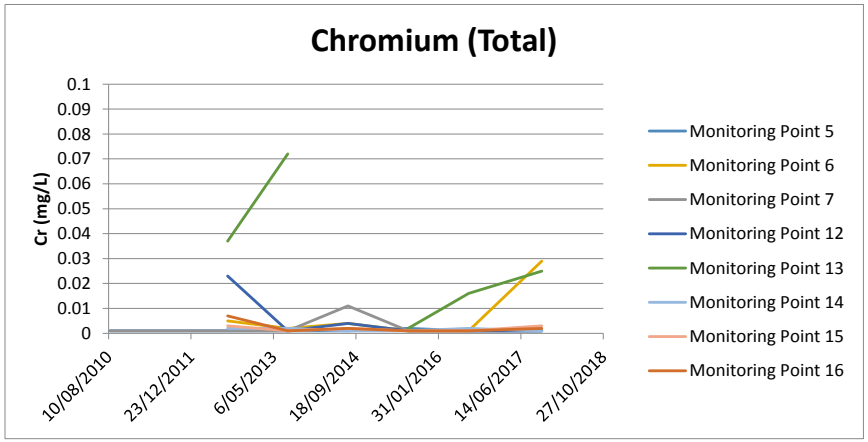


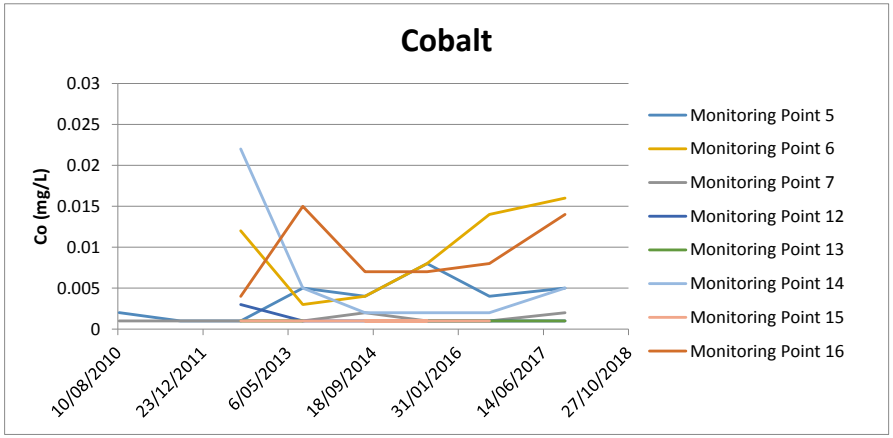


Sheet 4B - Groundwater

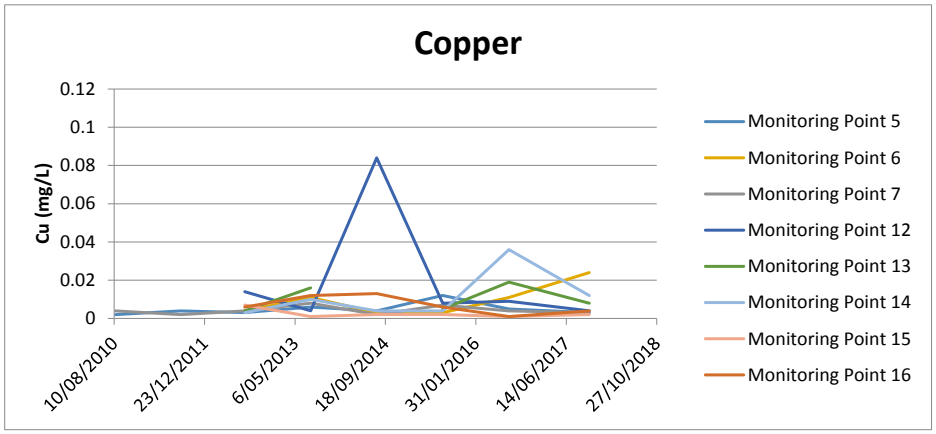


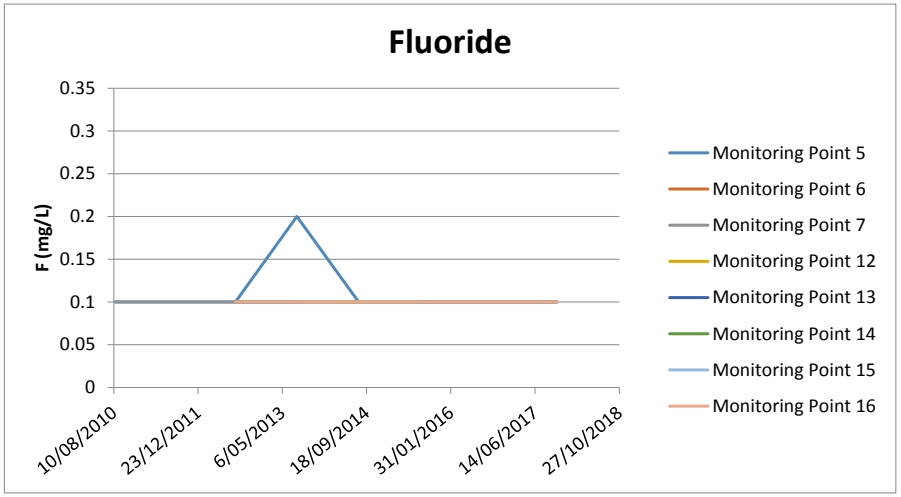


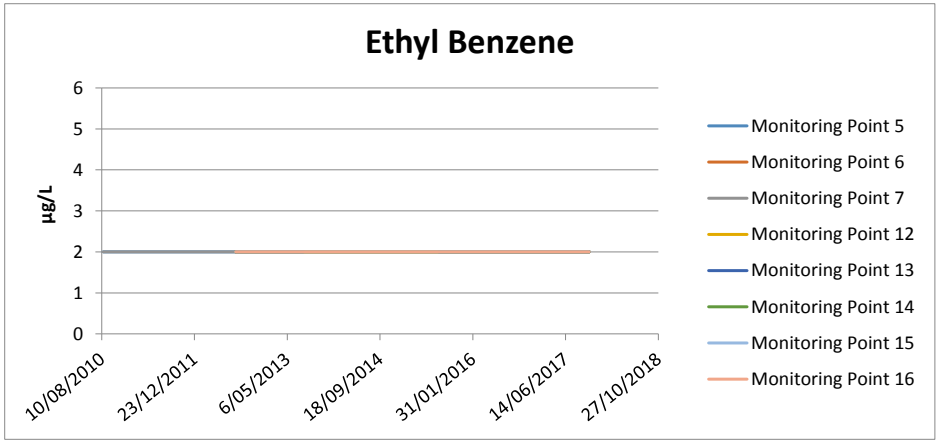


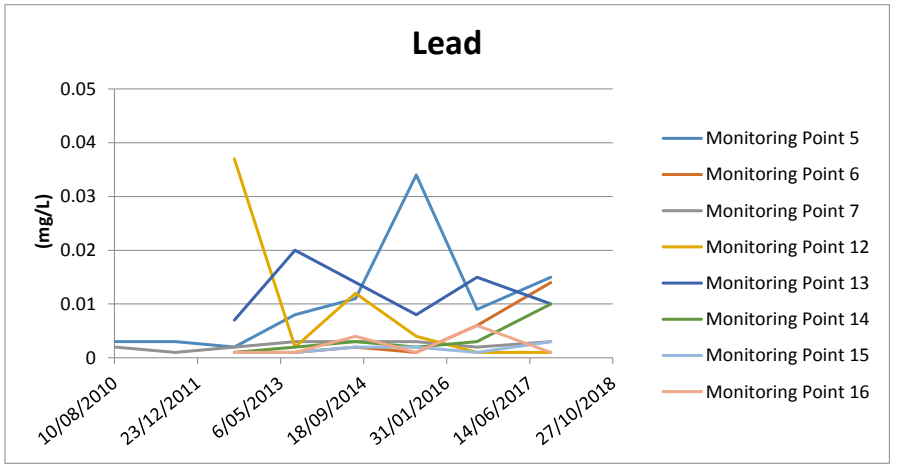


Sheet 4C - Groundwater

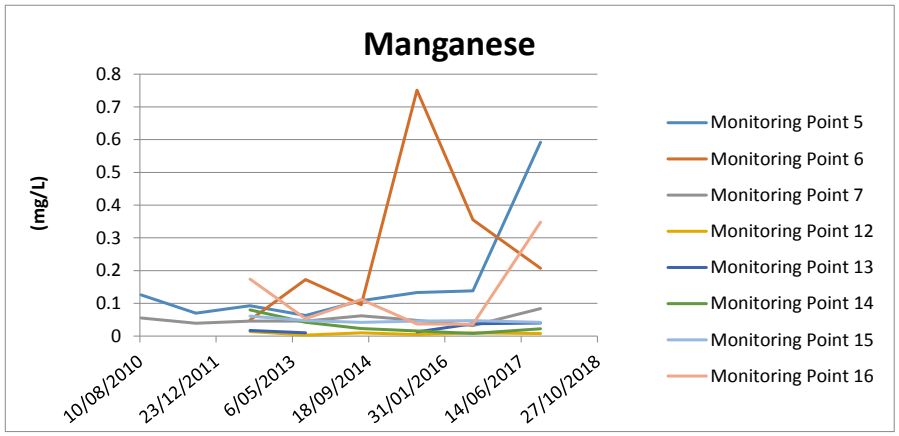


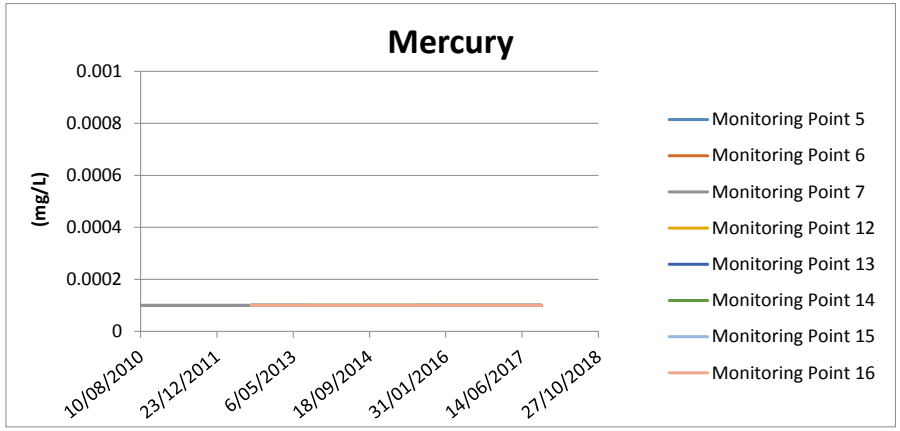


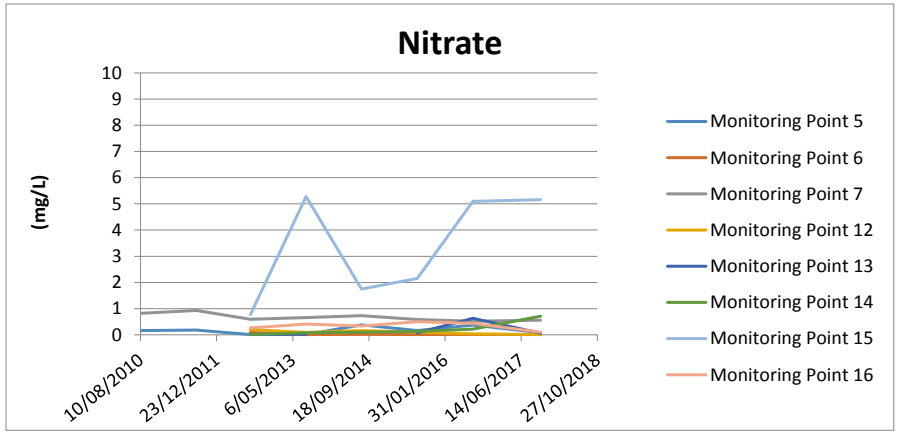


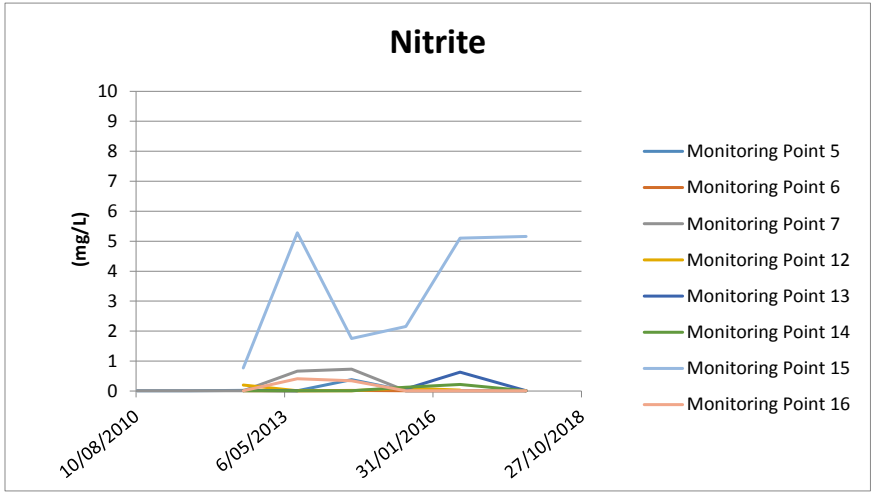


Sheet 4D - Groundwater

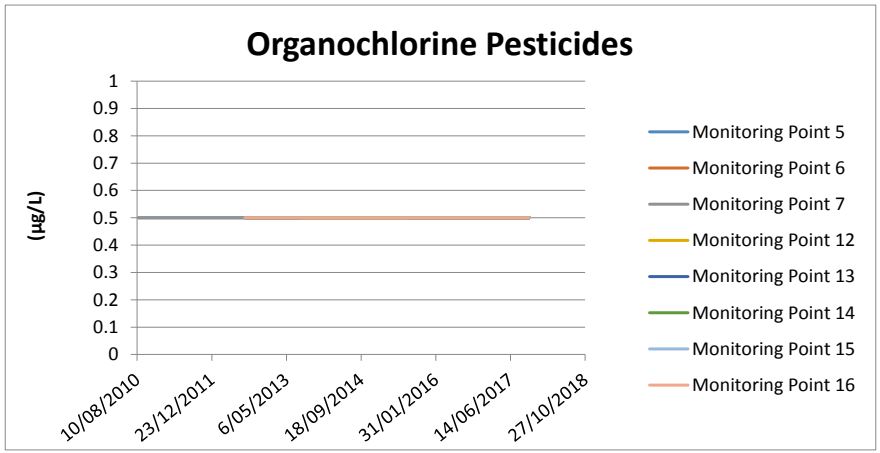


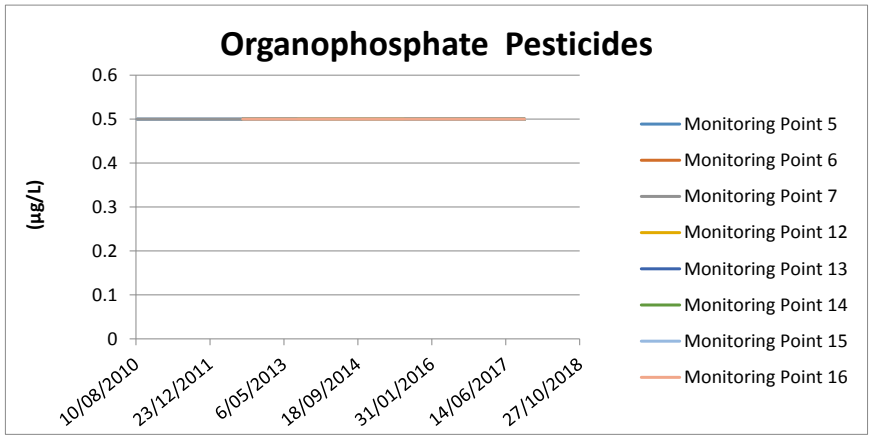


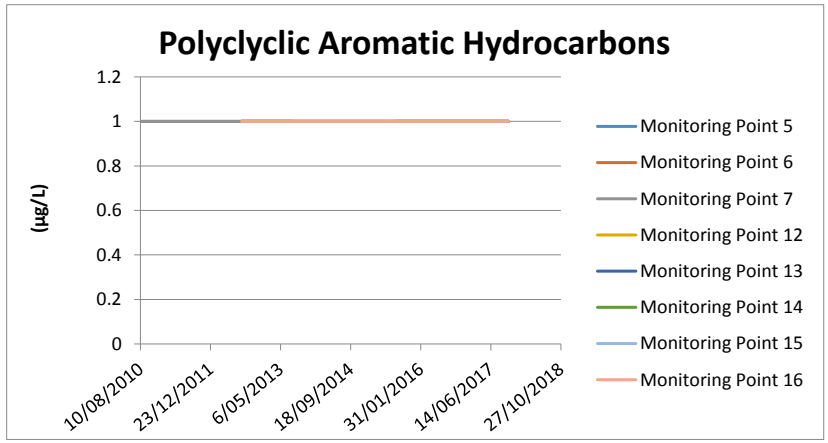


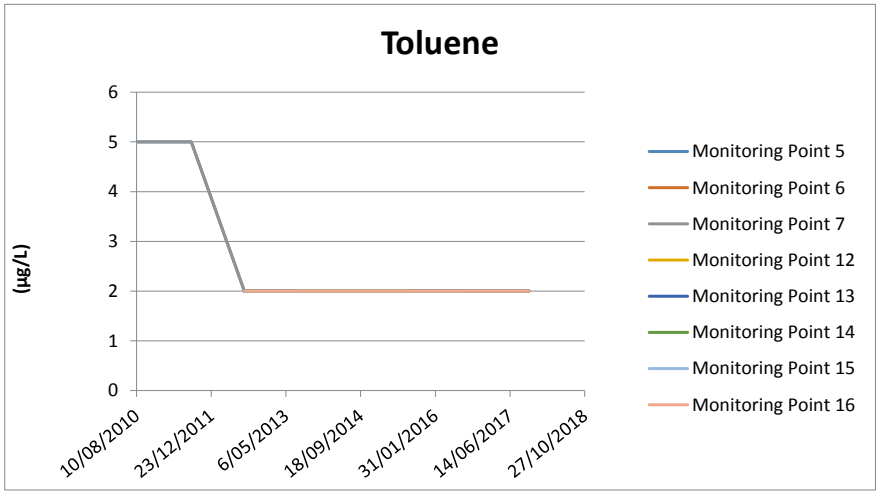


Sheet 4E - Groundwater

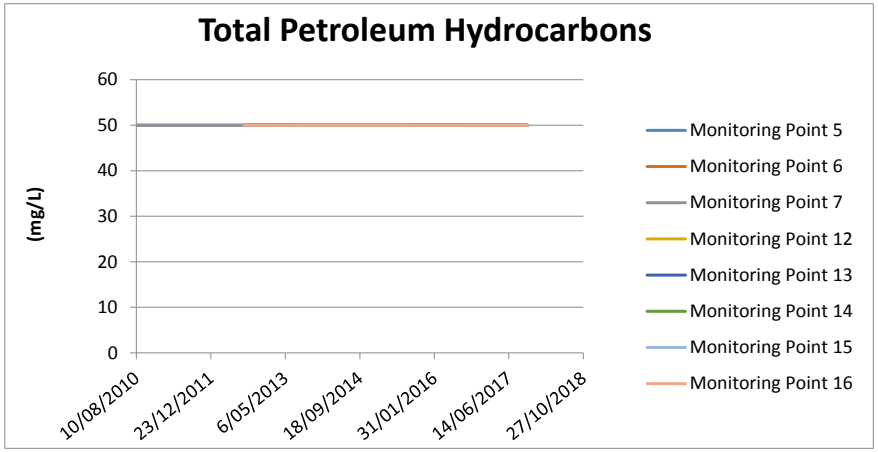


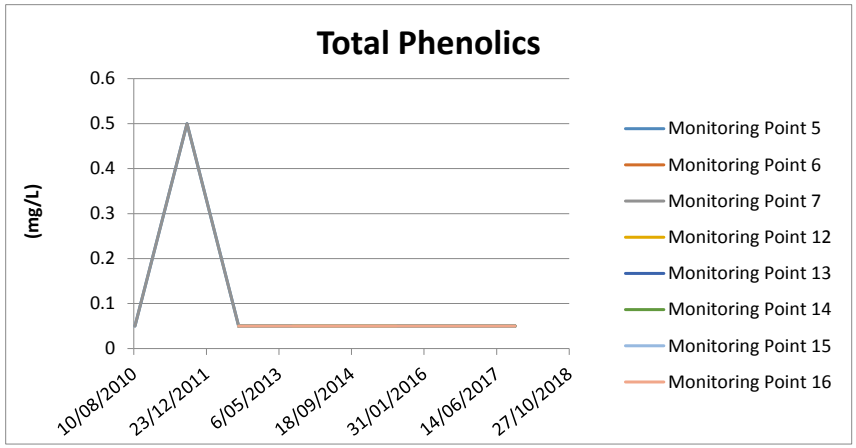


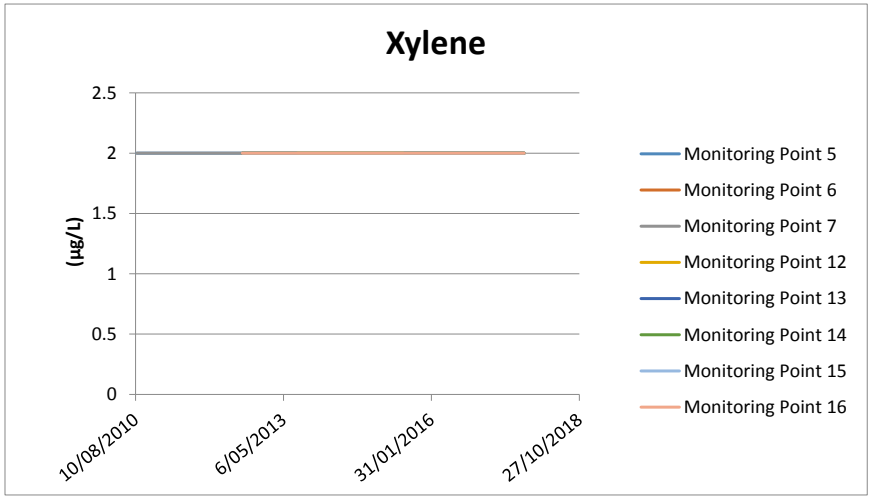


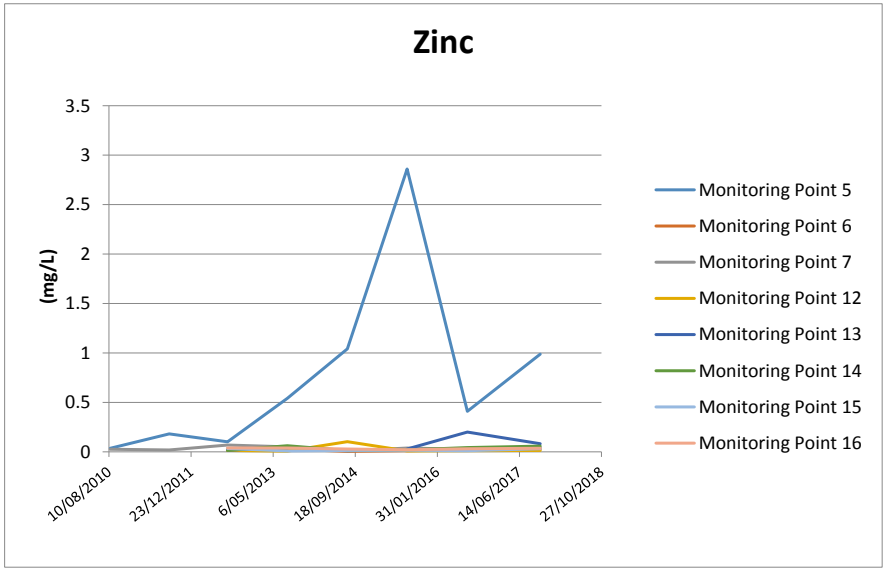


Sheet 4F - Groundwater

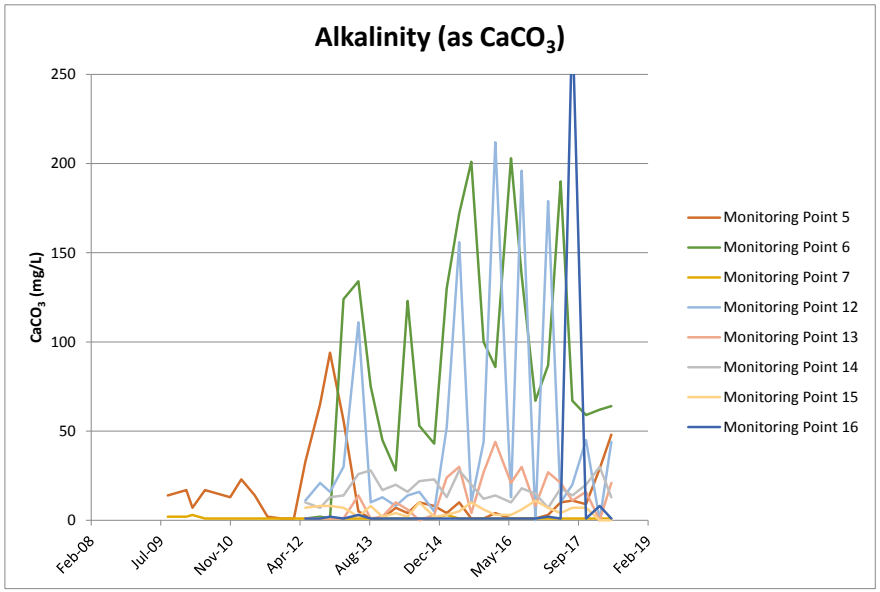


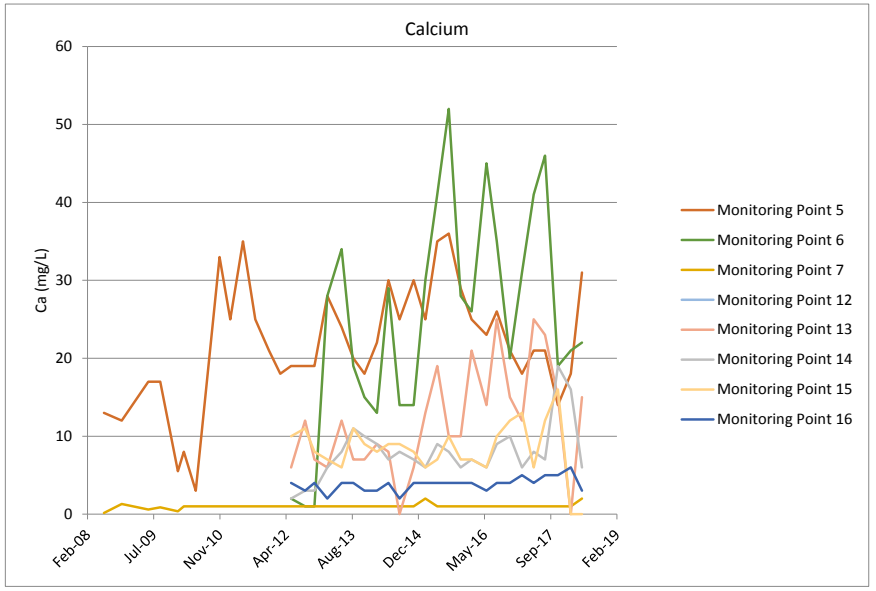


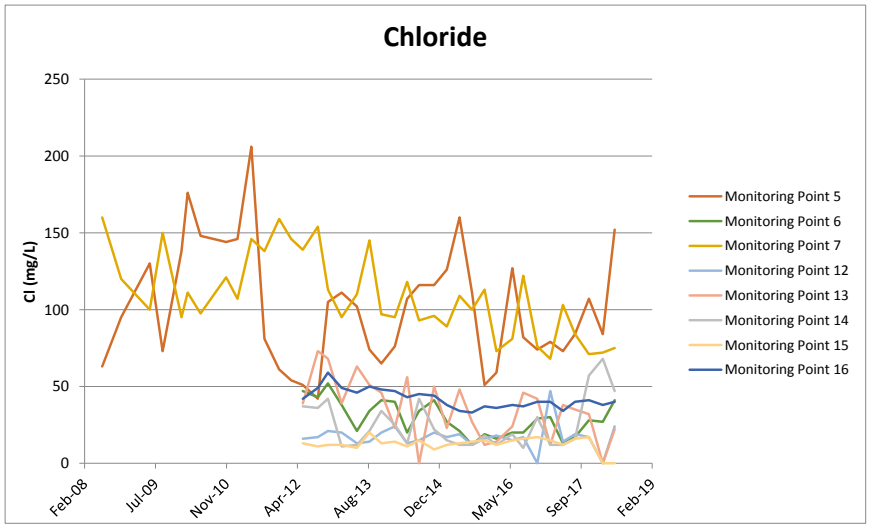


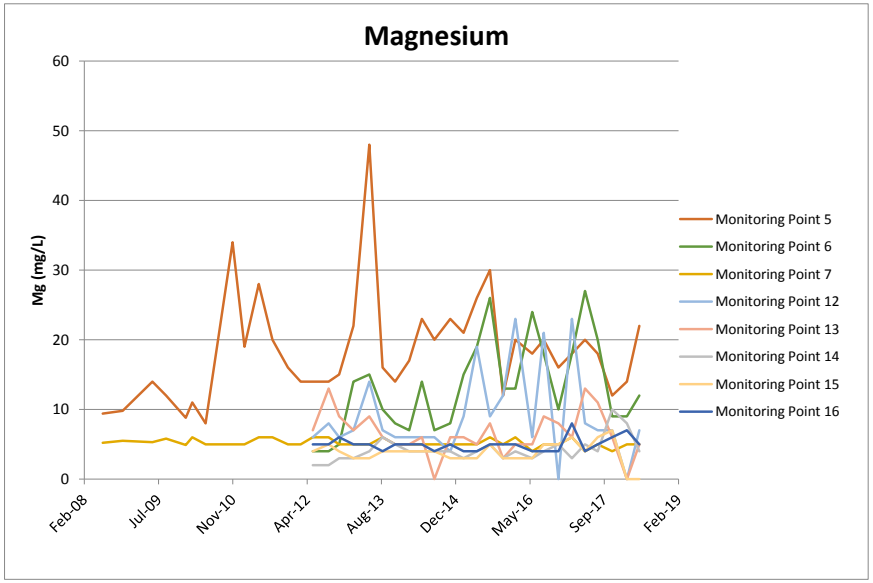


Sheet 4G - Groundwater

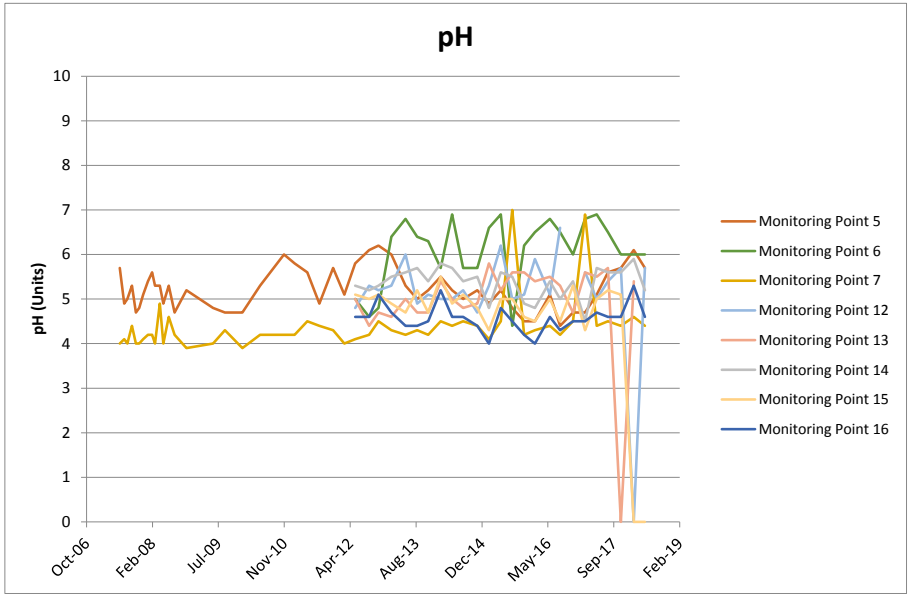


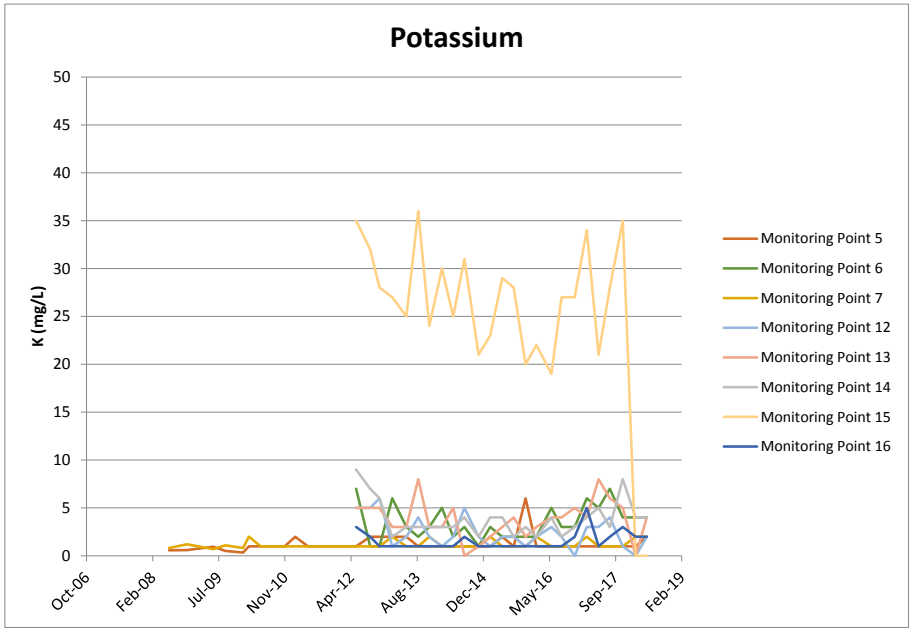


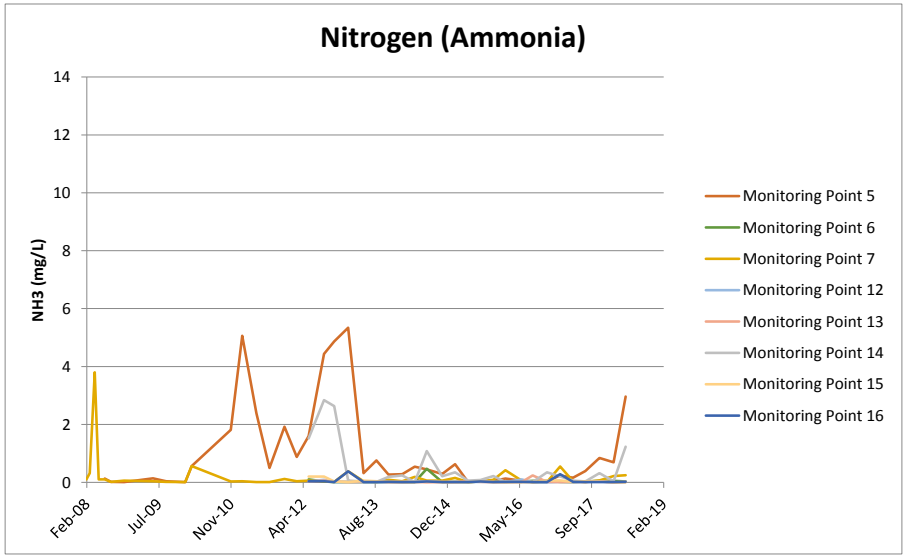


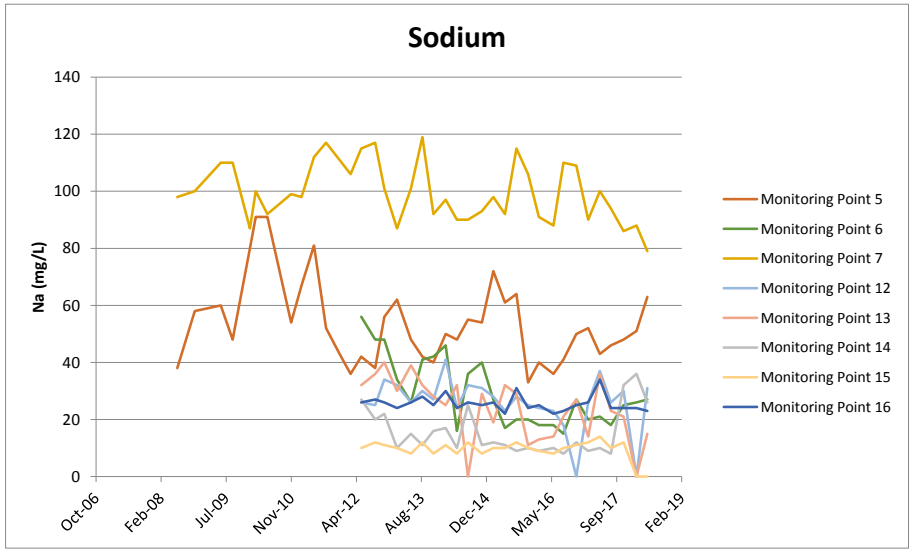


Sheet 4H - Groundwater









Sheet 4I - Groundwater